Regional Framework for Climate Adaptation

Clatsop and Tillamook Counties

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Acknowledgments

This regional framework could not have materialized without the assistance, support, and expertise of the project assistants and facilitators at Oregon Sea Grant and the Climate Impacts Research Consortium.

Several people reviewed preliminary versions of material originally developed in the work groups and provided detailed suggestions for important revisions. The framework has been improved considerably by assistance from Alyssa Mucken, Rachel Lovellford, Dave Jepsen, Dave Fox, Geoff Crook, Kevin Cupples, Rosemary Johnson, Brendon Haggerty, Emily York, Margaret Matter, Judith Callens, Steve Lucker, and Laren Woolley.

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Contributing editor: Joe Cone, Oregon Sea Grant.

Copyediting, design, and layout: Rick Cooper, Oregon Sea Grant.

Development of *Regional Framework for Climate Adaptation for Clatsop and Tillamook Counties* was supported in part with funding to the Oregon Coastal Management Program from the National Oceanic and Atmospheric Administration, Office for Coastal Management, under the Coastal Zone Management Act of 1972, as amended, administered by NOAA's Office for Coastal Management.

The participation of Oregon Sea Grant was enabled under award number NA10OAR4170059 (project number A/CC-18) from the National Oceanic and Atmospheric Administration's National Sea Grant College Program, U.S. Department of Commerce, and by appropriations made by the Oregon State Legislature.

The participation of the Climate Impacts Research Consortium was enabled under award number NA10OAR4310218 from the National Oceanic and Atmospheric Administration's Climate Program Office, Regional Integrated Sciences and Assessments program, U.S. Department of Commerce, and Oregon State University Extension Service. The statements, findings, conclusions, and recommendations herein do not necessarily reflect the views of these funders.

Cover photograph of the Necanicum Estuary by J. Weber.

A digital version of this publication is available at
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Participating organizations

This Regional Framework was developed with the expertise, support, and assistance of participants from numerous federal and state agencies, local governments, and non-governmental organizations:

Local governments		
Astoria	Nehalem	Tillamook County
Cannon Beach	Tillamook	Clatsop County
Seaside		CREST
Non-governmental organizations		
The Nature Conservancy	Columbia Land Trust	Wild Salmon Center
Tillamook Estuaries Partnership	Tillamook Bay Community College	Lower Nehalem Trust
Oregon state agencies		
Land Conservation and Development	Geology and Mineral Industries	Governor's Natural Resources Office
Oregon Health Authority	Agriculture	Parks and Recreation
Fish and Wildlife	Transportation	Forestry
Water Resources	State Lands	Environmental Quality
Federal agencies		
NOAA Fisheries	U.S. Geological Survey	National Weather Service
National Park Service	U.S. Fish and Wildlife Service	Bureau of Land Management
Natural Resources Conservation Service		
U.S. Army Corps of Engineers	Environmental Protection Agency	
Federal Emergency Management Agency		
Universities and institutes		
Oregon Sea Grant	Conservation Biology Institute	
Oregon Climate Change Research Institute	Institute for Natural Resources	
Climate Impacts Research Consortium	Oregon State University	

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Executive Summary

Climate change is a landscape-scale problem that calls for landscape-scale solutions. This regional framework is a proof-of-concept to implement a risk-based and landscape-scale approach to planning for changes in Oregon's climate and the effects of those changes on resources, assets, and communities in Clatsop and Tillamook Counties on the north coast of Oregon.

This regional framework is designed to help communities, land managers, and people in Clatsop and Tillamook Counties identify and revise policies, standards, criteria, and management practices that may underestimate risks to people, property, resources, and infrastructure from future climate conditions. Underestimating risk can result in unanticipated costs to individuals and communities.

This framework builds on Oregon's state-level Climate Change Adaptation Framework. It is based on an overview of downscaled climate projections *specific to the region* and expert presentations about the effects of projected changes on natural systems in Clatsop and Tillamook Counties. By emphasizing the climate science that applies to the region, the framework will help communities focus on real risks.

To develop the regional framework, the Oregon Coastal Management Program (OCMP) and Oregon Sea Grant (OSG) invited federal and state agencies, local governments, and non-governmental organizations to a series of three meetings to identify priority climate risks for the region, management objectives to address those risks, and mechanisms and actions to implement the management objectives. Most of the framework was developed by four work groups, which were organized around *management regimes* for infrastructure, public health and safety, natural systems, and working lands.

Climate change is a landscape-scale problem that calls for landscape-scale solutions.

Priority climate risks and management objectives to address those risks are at the center of the framework. Priority climate risks identified for Clatsop and Tillamook Counties are:

- Sea-level rise and coastal erosion
- Increased flooding
- Changes in hydrology
- Increased forest fires
- Increased average temperatures

After identifying the priority risks for the region, the work groups developed a set of management objectives for adaptation to address the anticipated effects of the priority risks within each management regime. The overarching management objective for each management regime is

Infrastructure: Manage risks to infrastructure from flooding, wildfire, and changes in stream hydrology and ocean water levels to ensure safe, reliable services

Public health and safety: Reduce risks of illness, injury, death, and property damage from flooding, wildfire, and heat events.

Natural systems: Develop and implement coordinated management strategies that enhance, protect, and restore high-quality and important habitats to mitigate the effects of higher temperatures, changes in hydrology, and changes in ocean chemistry and water levels.

Working lands: Manage the use of working lands to sustain production of food and fiber (forest, farm, and fishing activities) with projected changes in average temperatures, precipitation, and stream hydrology.

Each of these overarching objectives is expanded upon with a set of more-detailed objectives. In all, the framework contains almost fifty management objectives for adaptation, and implementation mechanisms and suggested actions to achieve each objective.

The next phase in developing and implementing the framework will

rely on endorsement and support by the agencies and communities that have management responsibilities in northwest Oregon. These are the same entities that developed the framework. At the practical level, the next step is to continue regional-level collaboration to resolve conflicts, if possible, between some of the adaptation objectives. Development of this framework highlights a gap in our current structures for governance for addressing important—some would say critically important—landscape-scale issues such as climate change. Finally, to continue the momentum behind this framework, an important task will be to identify *key actions* and *lead actors* for each of the adaptation objectives.

The management objectives state what needs to be done, and the implementation mechanisms suggest how the objectives can be achieved; but no entity has continuing oversight or dedicated resources to ensure the objectives actually get implemented. A mechanism is needed at the regional level to foster overall implementation of the framework. An important action in implementing the framework will be to consider establishing a regional ad-hoc body or intergovernmental mechanism to oversee its implementation. The first task that the team should take on would be to identify priority actions, or "low-hanging fruit," among the suggested actions, and to identify champions or lead entities for priority management objectives.

This regional framework *is not a plan*. A plan would contain detailed commitments and clear mechanisms for their implementation. The regional framework is a starting point. In time, the experience of implementing the framework, and refining, updating, and adapting it as warranted, would lead to distinct public benefits in collectively preparing for and responding to the effects of a changing climate on the north Oregon coast. That would be a success worth striving for.

Synopsis: How to Use this Framework

This regional framework represents an ambitious proof-of-concept designed to provide an efficient, practical, landscape- and risk-based approach to local climate change adaptation planning. It is the outcome of an approach to adaptation planning that is distinctly different from an approach based on climate change "vulnerability assessments." It represents a bottom-up, collaborative, objective-driven approach to adaptation planning that ultimately focuses on *decisions* that affect communities and natural systems. This project arose in discussions with Oregon Sea Grant, whose survey research in 2008 and 2012 (*An Analysis of a Survey of Oregon Coast Decision Makers Regarding Climate Change* and *Working Group Considers Effects of a Changing Climate: A Report to the Port Orford Community*, respectively) revealed that for a range of reasons, adaptation planning has been slow to gain momentum in Oregon's coastal communities.[1] It was designed in part to address some of the factors that contribute to putting off local action to address climate change. And development of the proof-of-concept has been tracked in research undertaken by Sea Grant, described in a companion report.

The overarching purpose of this framework is to improve the ability of communities, land managers, and people in Clatsop and Tillamook Counties to take actions and make decisions that will reduce the risks and consequences of future climate conditions.

This framework was developed to inform decisions. It is intended to provide a new and useful context for decisions that will affect how people, communities, and organizations respond to future climate conditions. More specifically, it is intended to help reorient policies, standards, criteria, and management practices—referred to collectively in this framework as decisions—that reflect assumptions about future climate conditions. In this framework, such decisions are called *climate-sensitive decisions*. Climate-sensitive decisions are decisions about the management and use of land and other resources that incorporate information or reflect assumptions about future climate conditions. Climate sensitivity occurs within a broad range of decisions that affect communities and the use of land and resources, from the development of policies and regulations to conducting activities on the land. Assumptions about climate are incorporated throughout the laws, policies, plans, customs, practices, standards, and criteria that influence how land and natural resources are used. Implicitly or explicitly, climate is a basic factor in countless decisions.

"Climate-sensitive" decisions are decisions that reflect assumptions about future climate conditions.

Climate change associated with increases in global surface temperatures is forcing communities and managers to review assumptions that underlie a broad suite of climate-sensitive decisions. The purpose of this framework is to help identify climate-sensitive decisions so they can be revised as necessary to reduce the consequences and costs of future climate risks.

The basic challenge of adapting to climate change is that climate-sensitive decisions *may not accurately reflect likely future conditions*. They may underestimate the risks to people, property, resources, and infrastructure from climate-related conditions and events such as floods, drought, wildfire, and ocean water levels. Underestimating risk can result in unanticipated costs to individuals and communities. Ultimately, well-considered adaptation will save communities money.

The framework consists of three elements:

- Priority climate risks for Clatsop and Tillamook Counties
- Management objectives for climate adaptation
- Actions to achieve the adaptation objectives

The most important element in the framework consists of a set of management objectives for climate adaptation. These management objectives indicate what should or can be done to reduce the costs and consequences of priority climate risks in Clatsop and Tillamook Counties. Objectives

1 See Appendix A, "Why Develop a Regional Framework for Adaptation?"

are laid out for infrastructure, public health and safety, natural systems, and working lands. They are designed to inform the review of various management plans and other mechanisms and criteria for decisions. Such mechanisms include land use plans, transportation plans, watershed restoration plans, natural hazard management plans, and so on.

This framework provides only a starting point. It will be important to maintain momentum and continue collaboration as discussed below. There may be a unique opportunity to use Oregon's Regional Solutions framework for community problem-solving to implement some of the objectives in this framework. The North Coast Regional Solutions Team involves several state agencies that have a stake in the management objectives for adaptation.

Finally, the framework should be continually revised as climate projections and information about landscape responses to future climate conditions become available.

Starting Point: Oregon Climate Change Adaptation Framework

The first task in adaptation planning is to get a clear idea of what scientific information is relevant to the area under consideration, since information about climate change that is readily available may not accurately reflect conditions in a particular place. Much of the climate information available online, for instance, describes change and consequences at a very broad scale; some of it may not be detailed enough to use for planning in a specific place.

Four of the most valuable sources of information on climate change:

- The Intergovernmental Panel on Climate Change (IPCC) publishes climate assessment reports that are the best information available about change *at the global scale*. The most recent assessment, the *Fifth Assessment Report*, was published in 2013 and 2014.[2]
- The United States' *National Climate Assessment* provides information about change at the national and regional scales, and for various sectors in the United States. The Assessment released in 2014 contains a chapter on climate change in the Northwest.
- The material compiled for the Northwest chapter for the National Climate Assessment provided the basis for a more in-depth assessment published in 2013, *Climate Change in the Northwest, Implications for Our Landscapes, Waters, and Communities*[3]
- In 2010, the Oregon Climate Change Research Institute published the *Oregon Climate Assessment Report* (OCAR),[4] which summarized (1) the scientific knowledge available at the time about changes in climate that are likely to affect Oregon, and (2) the effects of those changes on different resources and systems in the coming decades.

The first task in adaptation planning is to get a clear idea of what scientific information is relevant to the area under consideration.

As powerful and informative as these resources are, they provide only a broad context for local planning for climate change. Planning at the scale of a hydrologic unit, watershed, region, county, or community requires more-detailed information. The next section contains a summary of information about climate change and the effects of climate change in Clatsop and Tillamook Counties that was used as the foundation for this Regional Framework. Appendix I contains more detail about the effects of climate change on natural systems in northwest Oregon.

In conjunction with the release of the *Oregon Climate Assessment Report*, Oregon released the *Oregon Climate Change Adaptation Framework*,[5] which provides a foundation for adaptation at the regional and local levels in Oregon. Among other things, the framework lays out a series of eleven "climate risks" that are expected to affect the state in the next few decades. These risks, listed in Table 1 below, represent changes in climate and natural system conditions that Oregon agencies, communities, organizations, businesses, and citizens likely will have to address in the coming decades.

The eleven climate risks outlined in Oregon's *Adaptation Framework* provide a starting point for regional and local climate adaptation planning. Since Oregon is such a large and geologically, climatologically, and ecologically diverse state, different regions will experience these risks—or not—in varying degrees. That is, northwest Oregon will experience the eleven risks in a somewhat different mix and degree from other areas of the state. For some of the risks, the differences may be dramatic. For example, changes in stream hydrology will be more pronounced in watersheds where the hydrology

2 See http://www.ipcc.ch/report/ar5/

3 Dalton, M., P. Mote, and A. Snover (eds). 2013. Climate Change in the Northwest, Implications for Our Landscapes, Waters, and Communities. Washington D.C.: Island Press. http://occri.net/wp-content/uploads/2013/11/ClimateChangeInTheNorthwest.pdf

4 Oregon Climate Change Research Institute (2010). Oregon Climate Assessment Report. K. D. Dello and P. W. Mote (eds). College of Oceanic and Atmospheric Sciences, Oregon State University, Corvallis, OR. Available at http://www.occri.net/reports

5 Oregon Department of Land Conservation and Development (2010), Oregon Climate Change Adaptation Framework. Department of Land Conservation and Development, Salem, OR. Available at http://www.oregon.gov/energy/GBLWRM/docs/Framework_Final_DLCD.pdf

is dominated by spring snowmelt than in coastal watersheds, where snowfall is not normally a significant hydrologic factor. Ultimately, the state-level *Framework* is not sufficiently detailed for local adaptation planning. It provides context, but in order to make progress in adaptation planning, the state framework needs to be scaled down to the regional, watershed, or local level.

One of the basic ideas behind this proof-of-concept is to focus local adaptation planning on the reliable science that applies specifically to the planning area. The intention is to rely on the applicable science to identify which of the eleven risks in the state framework are priority risks for Clatsop and Tillamook Counties. The next section provides a summary of the available scientific knowledge about future climate conditions and their effects on natural systems in northwest Oregon.

Table 1. Climate risks in the Oregon Climate Adaptation Framework

1.	Increase in average annual air temperatures, and likelihood of extreme heat events (HEAT)
2.	Changes in hydrology and water supply; reduced snowpack and water availability in some basins; changes in water quality and timing of water availability (HYDRO)
3.	Increase in wildfire frequency and intensity (FIRE)
4.	Increase in ocean temperatures, with potential for changes in ocean chemistry and increased ocean acidification (OCEAN)
5.	Increased incidence of drought (DROUGHT)
6.	Increased coastal erosion and risk of inundation from increasing sea levels and increasing wave heights and storm surges (SLR)
7.	Changes in the abundance and geographical distributions of plant species and habitats for aquatic and terrestrial wildlife (HAB)
8.	Increase in diseases, invasive species, and insect, animal, and plant pests (ILL)
9.	Loss of wetland ecosystems and services (WET)
10.	Increased frequency of extreme precipitation events and incidence and magnitude of damaging floods (FLOOD)
11.	Increased incidence of landslides (SLIDE)

Effects of Climate Change in Clatsop and Tillamook Counties

Most of the risks outlined in the state framework might at some point affect Clatsop and Tillamook Counties, but it is very likely that only a few of them represent the greatest threat of damage or loss to the region. This regional framework is based as much as possible on downscaled climate projections *specific to the region* and expert presentations about the effects of projected changes on natural systems in Clatsop and Tillamook Counties. Outlines of the presentations are included in Appendix I, and the complete presentations are available online.[6]

Climate projections and assessments are readily available at the global, continental, and regional scales, but they generally are not detailed enough to provide a reliable foundation for planning at the local level. To provide the foundation for this regional framework, the Oregon Climate Change Research Institute (OCCRI) provided an overview of projected changes in climate in Clatsop and Tillamook Counties, based in part on projections developed roughly for the Tillamook Bay watersheds (Sharp et al. 2013). The Climate Impacts Research Consortium (CIRC) provided a summary of climate changes and landscape responses, drawing on several other research reports, listed below.

6 http://www.climateadaptationplanning.net/alignment/

Projections of likely climate and climate-related landscape changes include:

- Yearly average temperature is expected to increase between 3 and 4.5°F by mid-century and between 4 and 7.5°F by late-century in Tillamook County (see Figure 1). (Sharp et al. 2013).
- Yearly average precipitation may increase between 1 and 5 percent above historical average (ibid.) and this increase is likely to occur predominantly during winter months, while summer months will be drier than average (Sharp et al. 2013).
- Stream flows may increase during winter with more-frequent extreme precipitation events (more than 2 inches per day), but decrease in summer (Sharp et al. 2013, Mantua et al. 2010).
- Fire disturbance is expected to increase regionally, but it is less understood how this may change in Oregon's more-temperate coastal forests, where fire has been rare (Dalton et al. 2013).
- Sea surface temperatures are expected to increase between 2 and 3°F by mid-century (Mote and Salathe 2010).
- Ocean pH is expected to decline to approximately 7.8, a 150 percent change from pre-industrial levels (Tillman and Siemann 2011; Feely et al. 2009).

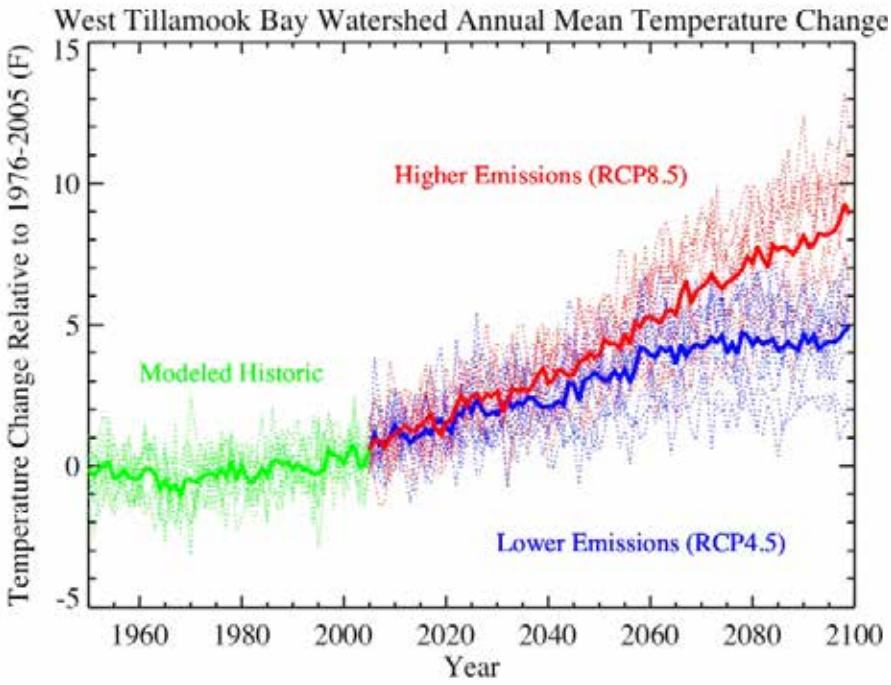

Figure 1. Projected change in mean temperature in west Tillamook County (from OCCRI presentation).

- Sea levels on the central Oregon coast may increase by up to 19 inches by mid-century (Reeder et al. 2013). Increasing wave heights and local tectonics will also influence local water levels on the north coast (Méndez et al. 2010).
- Coastal wetlands will experience increasing salinity in estuarine systems and push existing coastal plant and animal communities inland (Tillman and Sieman 2011).[7]
- Human health risk will increase from extreme climate-related hazards such as winter flooding, and erosion events (Dalton et al. 2013). Higher ocean and estuarine temperatures may also increase the number of *Vibrio parahaemolyticus* infections from eating raw oysters or other shellfish (Bethal et al. 2013).
- The coastal economy will be affected as climate impacts ecosystem services that support industries such as fisheries and tourism. Sea levels will also impact seaport, municipal and private coastal infrastructure, with limited options for alternative transportation (Dalton et al. 2013).

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Tillman, P., and D. Siemann. 2011. Climate change effects and adaptation approaches in freshwater aquatic and riparian ecosystems of the North Pacific Landscape Conservation Cooperative region: A compilation of scientific literature. Final Report. National Wildlife Federation, Pacific Region. Seattle, WA. Available at: http://www.nwf.org/~/media/PDFs/Global-Warming/2014/Freshwater-Report/NPLCC_Freshwater_Climate-Effects_Final.pdf [last accessed 26 March 2015].

7 Verbatim, or nearly so.

Priority Climate Risks in Clatsop and Tillamook Counties

After reviewing the available science about climate change and the effects of projected changes on the region, the next step in developing the regional framework was to identify the *priority* risks—the climate risks that are likely to account for the majority of potential damage and risk to people, property, infrastructure, and resources in Clatsop and Tillamook Counties.

Most of the collaborative effort to develop this framework was done by four work groups, organized according to different *management regimes*. Management regimes represent broad categories of public policy concern, and thus encompass numerous laws, priorities, and programs. The management regimes were for infrastructure, public health and safety, natural systems, and working lands. Each work group was comprised of experts, professional staff, and agency officials who work in that particular management regime.

The work groups identified which of the eleven risks in the state framework are the highest priority for their management regime in Clatsop and Tillamook Counties. The results of the work groups' collaboration to identify priority risks are shown in Table 2.

Table 2. Priority climate risks for Clatsop and Tillamook Counties

Climate risks	Infra-structure	Health and safety	Natural systems	Working lands
Sea-level rise and increased coastal erosion **(SLR)**	X		X	
Increased storm water; increased flooding; changes in flood intensity and frequency; increased erosion and sedimentation (**FLOOD**)	X	X		X
Decline in late-season streamflow; drier conditions; reduced rainfall; changes in hydrology, including decreased summer precipitation, reduced base flows, increased seasonal extremes of rivers (**HYDRO**)	X		X	X
Increased forest fires, including an increase in air-quality and associated health problems; safety (**FIRE**)	X	X		X

The selection of priority risks does not mean that other risks in the state framework will not affect northwest Oregon. The priority risks are primarily intended to clarify *where agencies, communities, and people should focus their initial efforts to prepare for future climate conditions.* Most of the risks laid out in the state framework that weren't identified as priorities in northwest Oregon—habitat changes, wetland losses, landslides, and so on—*will* affect the region. Those risks still need to be addressed by agencies and communities.

The list of priority risks does not represent any kind of ranking. They are all important. And clearly, priority risks will change over time and from place to place. Sea-level rise, for example, will be a priority risk for an oceanfront city, whereas habitat change or wildfire might be a priority for a watershed council or state agency working in the same area.

Ultimately, the priority risks provided the foundation for developing management objectives for adaptation and preparation.

Management Objectives for Adaptation

Once the work groups identified priority climate risks, the next task was to develop *management objectives for adaptation*, which are also referred to as *adaptation objectives*. These adaptation objectives are intended to be landscape-scale objectives that can be implemented largely through mechanisms that are already in place, like land use planning, forest management plans, habitat restoration plans, capital improvement plans, and the like. These management objectives for adaptation are intended to apply to all entities of a similar kind—that is, to *all* water supply districts, not just water district *x*; to *all* local land use plans, not just city *y*'s land use plan. In other words, the adaptation objectives are intended to apply at a broader *landscape* scale than to any single specific location or entity.

The adaptation objectives for each management regime are listed below. These objectives are the central element of the framework. They are intended to inform the review of priorities, criteria, standards, and outcomes of a broad range of climate-sensitive decisions. Implementation mechanisms and actions for these objectives are listed in the following section.

Note that because of time and resource limitations, these objectives have not been reviewed as a whole; at this point, they remain distinct sets. In a subsequent phase of developing the regional framework, all the objectives should be reviewed together to identify conflicting and complementary objectives, and then adjusted where possible to produce a comprehensive, integrated set of climate change adaptation objectives for the region.

Infrastructure management objectives for adaptation
IN-1. Manage risks to infrastructure from flooding, wildfire, and changes in stream hydrology and ocean water levels to ensure safe, reliable services
IN-2. Identify areas subject to flooding, sea-level rise, and wildfire
IN-3. Assess risks to infrastructure assets in areas subject to flooding, sea-level rise, and wildfire under likely future climate conditions or scenarios
IN-4. Protect, modify, replace, move, or abandon existing infrastructure at risk of damage from climate-related hazard events
IN-5. Guide future infrastructure development away from areas of risk
IN-6. Revise standards and practices for infrastructure planning, design, construction, and maintenance to reflect likely future climate conditions
IN-7. Develop and implement watershed and water system management strategies and practices that can ensure sufficient year-round water supply
IN-8. Ensure that water system management practices designed to mitigate the effects of changes in temperature and hydrology do not adversely impact natural systems
IN-9. Collaborate across management regimes to identify and implement management objectives, practices, and projects for infrastructure that also support management objectives for health and safety, natural systems, and working lands

Public health and safety management objectives for adaptation
HS-1. Reduce risks of illness, injury, death, and property damage from flooding, wildfire, and heat events
HS-2. Identify infrastructure needed for access to food, water, and health care, and protect against climate-related conditions
HS-3. Reduce risk of illness, injury, death, and property damage from floods, wildfire, coastal erosion, and climate-related ocean inundation
HS-4. Identify, support, and coordinate public health and emergency services necessary to respond to climate-related hazard events
HS-5. Improve the efficiency and management of water supply systems to reduce demand and increase supplies in periods of low streamflows
HS-6. Revise standards for stormwater infrastructure to reflect projected precipitation extremes through the end of the expected service life of facilities
HS-7. Foster improved public understanding of climate-related health and safety risks
HS-8. Ensure that natural hazards mitigation plans and public health and emergency services plans address the needs of underserved and disadvantaged community members
HS-9. Identify adaptation objectives, practices, and projects for health and safety that also support objectives for infrastructure, natural systems, and working lands
HS-10. Improve the capacity of local health offices to respond to climate-related health risks

Natural systems management objectives for adaptation
NS-1. Develop and implement coordinated management strategies that enhance, protect, and restore high-quality and important habitats, to mitigate the effects of higher temperatures, changes in hydrology, and changes in ocean chemistry and water levels
Aquatic habitats
NS-2. Implement watershed management projects and practices to improve streamflows in periods of low rainfall
NS-3. Identify, prioritize, and protect instream flows in key watersheds and cold water streams to sustain viable native fish populations.
NS-4. Manage watershed resources, features, and uses to reduce surface water temperatures, especially in periods of low flow
NS-5. Ensure that water system management practices designed to mitigate the effects of low streamflows and changes in hydrology do not adversely impact natural systems
NS-6. Implement sediment management measures where needed to mitigate the effects of forest fires and forest management practices
Habitat fragmentation and loss
NS-7. Protect and restore large areas of high-quality, less-fragmented habitats for fish and wildlife, to mitigate the effects of changes in hydrology, temperature, and ocean water levels on habitats
NS-8. Restore natural sediment regimes and other stream temperature controls in Coast Range watersheds
NS-9. Restore the functional connectivity between aquatic systems and floodplains and riparian areas
Estuarine and marine resources
NS-10. Restore carefully selected former tidelands to estuarine influence by active removal of dikes, levees, and tidegates (or create setback levees) to provide greater flood storage capacity and other ecosystem services
NS-11. Manage shorelands to provide for changes in the location of coastal shorelines and shorelands in response to rising ocean water levels
NS-12. Manage estuarine and coastal shoreland habitats and natural systems to mitigate the effects of higher temperatures, changes in hydrology, and changing ocean water levels
NS-13. Decrease stressors on fish stocks by improving water quality and adjusting harvests
NS-14. Protect marine and estuarine functions and features (such as eelgrass beds) that mitigate changes in ocean pH
NS-15. Collaborate across management regimes to identify natural system functions and services that support management objectives for infrastructure, health and safety, and working lands

Working lands management objectives for adaptation
WL-1. Manage the use of working lands to sustain production of food and fiber (forest, farm, and fishing activities) with projected changes in average temperatures, precipitation, and stream hydrology
Erosion, sedimentation, and water temperatures
WL-2. Protect and restore watershed resources and functions that regulate sedimentation and stream temperatures
WL-3. Implement management practices for working lands that sustain ecosystem services and watershed functions necessary to recover from disturbances
WL-4. Revise logging practices on steep slopes to reduce the effects of logging on landslides
WL-5. Minimize erosion and sedimentation from construction sites
WL-6. Minimize soil loss through erosion from agricultural lands
Increased risk of wildfires
WL-7. Assess the effects of Coast Range forest and land management practices on future fire risk, and evaluate whether changes are needed to reduce future fire risk
WL-8. Improve the resilience of forested watershed communities to fire by increasing the diversity of forest species used in reforestation
WL-9. Implement practices to reduce wildfire risk from development adjacent to forested working lands
Changes in hydrology: Reduced base flows, increased seasonal extremes of rivers
WL-10. Develop and implement watershed and water system management strategies and practices to mitigate the effects of higher temperatures and lower summer flows on water supplies and aquatic habitats
WL-11. Maintain anadromous fish migration and spawning habitats under likely future hydrologic regimes
WL-12. Minimize the effects of urbanization on water quality and hydrologic patterns
WL-13. Engage and provide information to working land managers about climate variability to improve their understanding of and ability to implement adaptation actions
WL-14. Identify adaptation objectives, practices, and projects for working lands that also support objectives for infrastructure, public health and safety, and natural systems

Implementing the Management Objectives

Four tables on the following pages present a compilation of ideas on how to achieve the management objectives for adaptation in Clatsop and Tillamook Counties. They reflect the collaboration of the four work groups representing different *management regimes*. Each management regime represents an area of expertise and responsibility within which the effects of climate change will need to be addressed and managed: infrastructure, public health and safety, natural systems, and working lands. The tables contain the following elements:

Management Objectives for Adaptation. Each table contains a set of objectives for adapting to climate variability and change for a particular management regime. The work groups were encouraged to focus on climate-related issues *at the landscape scale*—that is, to identify desired conditions to be achieved across the region, rather than in a specific location.

While the objectives are referred to as "management objectives for adaptation" and "adaptation objectives," they are properly understood as objectives for the management regime in addressing the effects of climate variability and change in Clatsop and Tillamook Counties.

Note that the boundaries between management regimes are not hard and fast. This is reflected by a handful of similar objectives across the tables.

Implementation Mechanisms and **Implementation Actions**. For each management objective, several implementation *mechanisms* and implementation *actions* are listed. Implementation mechanisms are a critical element of this framework. They are any planning, management, or decision framework at the local, state, or federal level that can be used to implement or achieve an objective. Examples of implementation mechanisms include:

- Federal and state natural resource management plans and programs
- Infrastructure system master plans, operations, and maintenance practices
- Special district management plans and operations
- Comprehensive land use plans
- Zoning ordinances
- Forest management plans
- Stormwater management programs
- Estuary and wetland restoration plans
- Land division ordinances
- Building codes
- Transportation plans
- Natural hazard mitigation plans
- Watershed restoration and management plans

The most important next step for implementing the framework will be to undertake a review of the objectives.

The lists of Implementation Mechanisms in these tables are not exhaustive. Implementation mechanisms are *any* processes that involve climate-sensitive policies, standards, criteria, and practices. Implementation mechanisms are the way by which the adaptation objectives can be translated into conditions on the ground.

The *possible implementation actions* are a preliminary set of possible tasks, projects, initiatives, or steps that can be taken to achieve the objectives. The actions listed for each objective vary in scope and detail, and, like the implementation mechanisms, the listed actions in these tables is not meant to be exhaustive.

The contents of these tables will evolve over time, *especially* if the professional community that developed the framework continues to collaborate *across* management regimes. As noted earlier, the most important next step for implementing the framework will be to undertake a review of the objectives for all four management regimes, to identify similarities—so-called co-benefits—and objectives that may represent challenges to the mission or objectives for another management regime.

The first objective in each table is an overarching management objective for that management regime. These overarching objectives establish the overall context for, and would be achieved through, the rest of the objectives in each table, so they do not have implementation mechanisms and actions.

Implementing the Infrastructure Management Objectives

Infrastructure management objectives	Implementation mechanisms	Possible implementation actions
IN-1. Manage risks to infrastructure from flooding, wildfire, and changes in stream hydrology and ocean water levels to ensure safe, reliable services		
IN-2. Identify areas subject to flooding, sea-level rise, and wildfire	▪ Natural Hazard Mitigation Plans (to help identify location and magnitude of future climate-related risks) ▪ Natural hazard elements in local comprehensive land use plans ▪ Statewide Planning Goal 7 for Natural Hazards, Goal 17 for Coastal Shorelands, and Goal 18 for Beaches and Dunes	▪ Collaborate with climate and other specialists to generate scenarios of likely future conditions related to flood, sea levels, and wildfire ▪ Use GIS to display and distribute data and information on the location and extent of areas subject to climate-related risks
IN-3. Assess risks to infrastructure assets in areas subject to flooding, sea-level rise, and wildfire under likely future climate conditions or scenarios	▪ Capital improvement plans and system master plans for managing infrastructure ▪ Infrastructure vulnerability assessments ▪ Local natural hazard mitigation plans ▪ Transportation improvement plans	▪ Develop data, information, and other technical assistance to support risk assessments for transportation and other infrastructure systems ▪ Develop methodologies to evaluate climate risks to infrastructure assets ▪ Inventory infrastructure exposure to flooding, wildfire, and ocean water levels ▪ Review existing capital-improvement plans, master plans for infrastructure systems, and information on infrastructure vulnerability, and revise plans to factor in climate change where appropriate ▪ Assess the risks from flooding, wildfire, and ocean water levels on current and planned infrastructure investments ▪ Identify infrastructure assets subject to damage from flooding, sea-level rise, and wildfire ▪ Establish best practices for monitoring risks based on asset types
IN-4. Protect, modify, replace, move, or abandon existing infrastructure at risk of damage from climate-related hazard events	▪ Capital improvement plans and system master plans for managing infrastructure ▪ Local natural hazard mitigation plans ▪ Detour planning ▪ Adopt interagency agreements to formalize detour route status, function, and agency roles during hazard events ▪ IWRS water planning, feasibility, and	▪ Develop a decision matrix to lay out management options under specific scenarios or thresholds (e.g., protect and maintain asset, increase redundancy, relocate asset, etc.) ▪ Prioritize infrastructure assets at risk from climate-related conditions to protect, modify, move, or abandon ▪ Identify where system redundancies and risk transfer (i.e., insurance) may be economical and prudent strategies to

Implementing the Infrastructure Management Objectives *continued*

Infrastructure management objectives	Implementation mechanisms	Possible implementation actions
	implementation funds	maintain system functions ▪ Identify funding for local infrastructure improvements to reduce risk of damage or loss ▪ Convene a regional task force to identify funding options for regionally important infrastructure improvements to address climate risks ▪ Identify beneficial infrastructure redundancies ▪ Assess vulnerability of infrastructure assets ▪ Designate detour routes in vulnerable corridors where needed
IN-5. Guide future infrastructure development away from areas of risk	▪ Land use planning and zoning ▪ Buildable lands inventories ▪ Urban Growth Management plans ▪ Local natural hazard mitigation plans ▪ Conservation easements ▪ Property acquisition and relocation	▪ Clearly identify areas at risk from climate-related hazards in inventories and maps used for land use planning and managing infrastructure systems ▪ Consider restricting development in areas of known climate risk ▪ Incorporate information about future climate risks into infrastructure master plans ▪ Prohibit redevelopment of areas at risk from climate-related hazards as infrastructure relocation occurs ▪ Provide the best available scientific information on climate-related impacts to the public, businesses, local governments, and others to support informed decisions about development in identified areas of climate risk
IN-6. Revise standards and practices for infrastructure planning, design, construction, and maintenance to reflect likely future climate conditions	▪ State and local natural hazards management plans ▪ Local land use plans, zoning ordinances and land division ordinances ▪ Infrastructure design standards ▪ Best practices manuals and planning guidelines ▪ Integrated asset-management tools (data and mapping systems)	▪ Identify climate-related factors, standards, and criteria in asset planning, design, construction, and maintenance decisions, and revise as necessary ▪ Support continued improvement in the accuracy of "downscaled" climate projections, which are more appropriate for local adaptation planning than projections from Global Circulation Models ▪ Compile and utilize credible information about future climate-related conditions at the appropriate (regional) scale

Implementing the Infrastructure Management Objectives *continued*

Infrastructure management objectives	Implementation mechanisms	Possible implementation actions
		▪ Acquire data on design events based on regional-scale climate projections ▪ Support continued improvement in the ability to translate climate projections into descriptions of likely watershed and landscape conditions (floods, sea-level rise, fire, hydrologic changes)
IN-7. Develop and implement watershed and water-system management strategies and practices that can ensure sufficient year-round water supply	▪ IWRS water planning, feasibility, and implementation funds ▪ Domestic water-supply-system master plans ▪ Water-supply-system maintenance ▪ Watershed restoration plans ▪ Water conservation plans	▪ Compile and utilize credible information about future climate-related conditions at the appropriate (regional) scale ▪ Promote management practices that enhance water retention in watersheds ▪ Promote water conservation and reduced use to avoid unnecessary waste and consumption
IN-8. Ensure that water-system management practices designed to mitigate the effects of changes in temperature and hydrology do not adversely impact natural systems	▪ A Regional Adaptation Agreement, Charter, or other mechanism to implement this framework (see IN-9) ▪ IWRS water planning, feasibility, and implementation funds ▪ Stewardship plans, forest management plans, forest land-management certifications ▪ Habitat restoration projects	▪ Establish a regional mechanism to consult across management regimes on major infrastructure projects
IN-9. Collaborate across management regimes to identify and implement management objectives, practices, and projects for infrastructure that also support management objectives for health and safety, natural systems, and working lands	▪ A Regional Adaptation Agreement, Charter, or other mechanism to implement this framework	▪ Solicit support from regional leaders and convene a regional leadership team to oversee implementation of the regional framework ▪ Develop a mechanism for continued expert consultation across management regimes on priority climate risks

Implementing the Public Health and Safety Management Objectives

Health and safety management objectives	Implementation mechanisms	Possible implementation actions
HS-1. Reduce risks of illness, injury, death, and property damage from flooding, wildfire, and heat events		
HS-2. Identify infrastructure needed for access to food, water, and health care, and protect against climate-related conditions	▪ Local natural hazard management plans ▪ Local emergency management plans ▪ Transportation system master plans	▪ Ensure that infrastructure needed to protect public health and safety is addressed in the adaptation objectives for infrastructure ▪ Incorporate information about change in climate-related events into emergency management plans ▪ Establish regional emergency management framework and oversight group
HS-3. Reduce risk of illness, injury, death, and property damage from floods, wildfire, coastal erosion, and climate-related ocean inundation	▪ Local comprehensive land use plans and implementing ordinances ▪ Local flood hazard zone and development standards for flood hazard areas ▪ Local coastal erosion overlay zone and development standards for erosion areas ▪ Local emergency evacuation plans ▪ Emergency management plans ▪ Community Emergency Response Teams (CERTs) ▪ State and local natural hazard mitigation plans ▪ Statewide Planning Goals 7 for Areas Subject to Natural Hazards and 18 for Beaches and Dunes ▪ FEMA's RiskMAP, Community Rating System, and National Flood Insurance Programs ▪ State building codes ▪ Model ordinances for natural hazards ▪ Conservation easements ▪ Property acquisition and relocation	▪ Inventory and map developed and developable areas that are subject to floods, wildfire, coastal erosion, and climate-related ocean inundation ▪ Integrate information about future climate conditions into local natural hazard mitigation plans ▪ Align flood hazard mitigation planning activities with emerging FEMA guidance to require consideration of climate impacts in mitigation planning ▪ Implement Statewide Planning Goal 7 for all climate-related natural hazards ▪ Integrate DOGAMI coastal erosion risk zone maps into local comprehensive plans and implementing measures for coastal erosion ▪ Update local natural hazard mitigation plans to address future climate-related risks ▪ Integrate updated natural hazard mitigation strategies into local land use plans and regulations ▪ Prohibit or restrict development in areas subject to future climate risks ▪ Review building and zoning codes to determine whether they should be revised to reflect risks from climate-related hazards ▪ Encourage local adoption of building code requirements that exceed the National Flood Insurance Program standards

Implementing the Public Health and Safety Management Objectives *continued*

Health and safety management objectives	Implementation mechanisms	Possible implementation actions
		▪ Retrofit existing buildings to reduce exposure to floods
HS-4. Identify, support, and coordinate public health and emergency services necessary to respond to climate-related hazard events	▪ Local emergency management plans ▪ Regional emergency services plan ▪ Mutual support agreements	▪ Review emergency management plans to identify gaps and overlaps in services needed to respond to climate-related hazards ▪ Develop a regional plan for coordinating emergency services ▪ Ensure continuity of care following hazard events ▪ Ensure stable funding for local emergency management services and public health departments to address climate risks ▪ Identify potential funding sources for emergency management services such as tax, percentage of court fines, grants, etc.
HS-5. Improve the efficiency and management of water-supply systems to reduce demand and increase supplies in periods of low streamflows	▪ Water Management and Conservation Plans (WMCPs) ▪ Water-supply-system maintenance practices ▪ Watershed restoration plans ▪ Forest management plans ▪ IWRS water planning, feasibility, and implementation funds	▪ Adopt water conservation measures to address constrained summer stream flows ▪ Promote water conservation ▪ Reduce water losses through system leakage ▪ Factor projected changes in temperature and precipitation into water-supply plans ▪ Encourage landscaping with drought-tolerant plants
HS-6. Revise standards for stormwater infrastructure to reflect projected precipitation extremes through the end of the expected service life of facilities	▪ Local land use and land division regulations ▪ Stormwater management plans and design standards ▪ IWRS water planning, feasibility, and implementation funds	▪ Develop reliable, regional-scale projections of precipitation extremes ▪ Incorporate projections for extreme events into local stormwater system design standards and erosion control measures ▪ Encourage the integration of ecosystem services and "green infrastructure" into infrastructure management plans
HS-7. Foster improved public understanding of climate-related health and safety risks	▪ Public health outreach and education programs ▪ Public Service Announcements ▪ CDC and Oregon Health Authority communication toolkits ▪ Curriculum development ▪ Triennial reviews of Environmental	▪ Develop guidance for health care providers regarding climate-related health concerns ▪ Develop and distribute information and educational materials about climate risks and how individuals can be better prepared for climate-related events and conditions

Implementing the Public Health and Safety Management Objectives *continued*

Health and safety management objectives	Implementation mechanisms	Possible implementation actions
	Health and Communicable Diseases programs ▪ State Public Health Communications Unit operations	▪ Find funding to communicate about risks associated with climate change
HS-8. Ensure that natural hazards mitigation plans and public health and emergency services plans address the needs of underserved and disadvantaged community members	▪ Local natural hazard mitigation plans ▪ Community social vulnerability assessments	▪ Collaborate with vulnerable populations to understand their needs ▪ Partner with disadvantaged populations and include them in decision-making
HS-9. Identify adaptation objectives, practices, and projects for health and safety that also support objectives for infrastructure, natural systems, and working lands	▪ A Regional Adaptation Agreement, Charter, or other mechanism to implement this framework ▪ Regional Solutions Plan and project review	▪ Establish a regional network to share adaptation-related ideas, information, and resources, promote policies, and initiate pilot projects ▪ Establish a mechanism for continued expert consultation on priority climate risks across management regimes
HS-10. Improve the capacity of local health offices to respond to climate-related health risks	▪ Participate in Oregon's syndromic surveillance system (ESSENCE) to capture data on emerging health concerns in real time ▪ CDC's Building Resilience Against Climate Effects (BRACE) program	▪ Assess local health department capacity to detect, report, and assess vector-borne diseases ▪ Identify local susceptibility to likely vector-borne diseases and other public health impacts of changing climate conditions ▪ Access and use tools from the state Climate and Health Program ▪ Identify potential vector-borne diseases and carriers; assess change in risk related to climate change ▪ Research ways to reduce carriers and/or counteract potential diseases ▪ Implement existing disease outbreak response protocols at state and local health departments ▪ Monitor incidence of heat-related illness ▪ Monitor mental health impacts

Implementing the Natural Systems Management Objectives

Natural systems management objectives	Implementation mechanisms	Possible implementation actions
NS-1. Develop coordinated management strategies that enhance, protect, and restore high-quality and important habitats to mitigate the effects of higher temperatures, changes in hydrology, and changes in ocean chemistry and water levels		
Aquatic Habitats		
NS-2. Implement watershed management projects and practices to improve streamflows in periods of low rainfall	**Protection mechanisms** ▪ DSL Removal/Fill review process ▪ Forest management plans ▪ TMDL development and implementation under the Clean Water Act §303(d) ▪ OWRD Instream Transfers and Lease Program **Enhancement and incentive mechanisms** ▪ Watershed, wetland, riparian, and floodplain restoration plans ▪ IWRS water planning, feasibility, and implementation funds ▪ Water transactions/banking program ▪ Oregon Conservation Strategy ▪ Water quality management plans and programs ▪ Species recovery plans ▪ Wetland mitigation banking	▪ Develop an appropriately scaled policy and funding framework for watershed-scale planning to use natural processes and functions to mitigate projected changes in climate ▪ Reestablish large wood production and recruitment to restore watershed functions such as floodplain connectivity, sediment regulation, groundwater recharge, and hyporheic flow ▪ Review the need for increased riparian areas on public lands ▪ Institute water conservation measures and practices ▪ Identify, implement, and incentivize instream voluntary water-rights transfers and leases ▪ Develop credits for larger, more-effective wetland mitigation projects ▪ Prioritize and protect instream flows for fish in key watersheds (see NS-3)
NS-3. Identify, prioritize, and protect instream flows in key watersheds and cold-water streams to sustain viable native fish populations	▪ DEQ water quality management programs ▪ Oregon's Integrated Water Resource Strategy ▪ OWRD Water Rights instream transfer ▪ Watershed assessments and restoration plans ▪ USGS basin studies ▪ Forest management plans ▪ Oregon Plan for Salmon and Watersheds; Streamflow Restoration Priority Areas (ODFW/OWRD)	▪ Develop a coordinated regulatory framework to protect cold water streams that will serve as thermal refugia ▪ Develop incentives and funding for projects that explicitly increase riparian and floodplain connectivity ▪ Inventory and map cold water refugia ▪ Identify key cold water input streams in major coho population basins ▪ Determine instream flows required to sustain viable native fish ▪ Install stream gauges and monitor stream flows, temperatures, and fish ▪ Protect riparian areas ▪ Identify problem areas and restore riparian buffers ▪ Replace culverts that are inadequate to

Implementing the Natural Systems Management Objectives *continued*

Natural systems management objectives	Implementation mechanisms	Possible implementation actions
		pass anticipated peak streamflows ▪ Re-meander and reconnect streams ▪ Identify streams and reaches that are either major nurseries or food sources for mainstem rivers and streams, and assess the need for protection under the Clean Water Act (303(d))
NS-4. Manage watershed resources, features, and uses to reduce surface water temperatures, especially in periods of low flow	▪ Watershed assessments and restoration plans ▪ DEQ water quality management programs ▪ Water transactions/banking program ▪ Forest management plans ▪ Oregon Plan for Salmon and Watersheds ▪ IWRS water planning, feasibility, and implementation funds	▪ Establish comprehensive and continuous riparian area protections across all land uses ▪ Restore riparian structure and function to degraded streamside areas
NS-5. Ensure that water system management practices designed to mitigate the effects of low streamflows and changes in hydrology do not adversely impact natural systems	▪ Oregon's Integrated Water Resources Strategy ▪ Oregon Scenic Waterway Program	▪ Develop technical information for water system managers that describes the intrinsically dynamic role of hydrology on habitat formation, flood buffering, and species diversity ▪ Designate instream water rights where not already established ▪ Consider the effects of new water appropriations on freshwater ecosystems ▪ Propose new scenic waterways where needed to protect recreation, fish, and wildlife uses ▪ Assess the effects of saltwater intrusion on habitats and other ecosystem services and develop mitigation plans as necessary
NS-6. Implement sediment management measures where needed to mitigate the effects of forest fires and forest management practices	▪ Watershed action plans ▪ Forest Practices Act ▪ Riparian management rules	▪ Research sediment budgets of basins susceptible to forest fire, estimate likely geomorphic impact, and estimate likely impacts on habitat ▪ Construct and test sediment dams in rivers with lost nick points, to retain sediment important to habitat formation within the river system
Habitat fragmentation and loss		
NS-7. Protect and restore large areas of	▪ ODFW Conservation Strategy ▪ Forest management plans	▪ Develop a mechanism to protect large, contiguous areas that currently have

Implementing the Natural Systems Management Objectives *continued*

Natural systems management objectives	Implementation mechanisms	Possible implementation actions
high-quality, less-fragmented habitats for fish and wildlife, to mitigate the effects of changes in hydrology, temperature, and ocean water levels on habitats	▪ Watershed restoration plans ▪ Conservation land acquisitions and easements ▪ County land use plans ▪ Estuary and coastal shoreland management plans (Statewide Planning Goals 16 and 17)	high-quality habitats for fish and wildlife ▪ Develop incentives and funding for projects that enhance connectivity between existing high-quality habitats, or habitats that could be feasibly enhanced and connected ▪ Identify areas of connected, less-fragmented habitats suitable for long-term protection ▪ Map isolated habitat units and increase spatial density of good-quality habitat ▪ Identify and map large and ecologically significant areas ▪ Assess the need to revise common watershed management practices to mitigate the effects of temperature and precipitation changes on fish and wildlife habitats ▪ Assess the need for buffer areas around ecologically significant areas ▪ Protect sensitive estuarine habitats (eelgrass beds and tidal wetlands) from adverse impacts ▪ Manage estuarine shorelands to allow for the migration of shorelines and habitats in response to sea-level rise ▪ Modify forest harvest methods to increase the use of selective cutting ▪ Restore former tidelands to estuarine influence and function ▪ Identify and protect connectivity between significant habitat types and areas ▪ Monitor habitat utilization in protected areas to ensure the "right" places are protected
NS-8. Restore natural sediment regimes and other stream temperature controls in Coast Range watersheds	▪ Forest management plans ▪ Forest Practices Act ▪ Watershed Action Plans ▪ Riparian and wetland conservation easements	▪ Adopt management practices to restore natural sediment regimes (e.g., woody debris) and stream temperature controls ▪ Enhance forested buffers along streams and drainages ▪ Identify areas likely to become prone to erosion or landslides under future extreme precipitation events ▪ Decrease logging in slide-prone areas

Implementing the Natural Systems Management Objectives *continued*

Natural systems management objectives	Implementation mechanisms	Possible implementation actions
		▪ Disconnect roads from stream channels (e.g., cross drains) ▪ Investigate the use of alternative forest-harvesting techniques (e.g., thinning; reintroduction of fire for fuel reduction) to restore natural sediment regimes ▪ Provide financial incentives (credits) to forest managers to restore sediment regimes, and assess effects ▪ Consider wider range of genotypes in reforestation ▪ Conduct research to determine empirical relationships between forest practices (reforestation, road building, maintenance, timber harvest, fire suppression, etc.) and sediment delivery dynamics in north coast basins
NS-9. Restore the functional connectivity between aquatic systems and floodplains and riparian areas	▪ Oregon Conservation Strategy ▪ Watershed assessments, including culvert inventories and riparian assessments ▪ Forest management plans ▪ Transportation improvement plans ▪ Natural hazard mitigation plans ▪ Land use plans	▪ Map changes in flooding from projected future precipitation extremes ▪ Consider measures to protect areas subject to future flooding ▪ Reconnect streams to their floodplains ▪ Identify and remove unnecessary roads ▪ Replace culverts and resize for projected future extreme flows ▪ Restore riparian structure and function
Estuarine and Marine Resources		
NS-10. Restore carefully selected former tidelands to estuarine influence through active removal of dikes, levees, and tidegates (or create setback levees), to provide greater flood-storage capacity and other ecosystem services	▪ Comprehensive land use plans, especially under Goals 16 and 17 for Estuarine Resources and Coastal Shorelands ▪ Natural Hazard Mitigation Plans ▪ Watershed assessments and action plans ▪ Estuary and wetland restoration plans ▪ Conservation land acquisitions	▪ Complete the inventory of tidegates, dikes, and levees, including elevations and associated former tidelands ▪ Identify dikes and levees that are obsolete, unnecessary, or otherwise not necessary to protect life and property ▪ Identify estuary and floodplain restoration opportunities ▪ Develop funding mechanism for restoration projects
NS-11. Manage shorelands to provide for changes in the location of coastal shorelines and shorelands in response to rising ocean water levels	▪ Land use plans ▪ Estuary and shoreland management plans	▪ Identify areas likely to be inundated due to sea-level rise and total water levels ▪ Protect coastal shoreland areas to allow for estuarine shoreline migration in response to increased frequency of ocean inundation and changing sea

Implementing the Natural Systems Management Objectives *continued*

Natural systems management objectives	Implementation mechanisms	Possible implementation actions
		levels ▪ Identify and remove barriers (e.g., roads, dikes) to migration of estuarine shorelands and tidal wetlands
NS-12. Manage estuarine and coastal shoreland habitats and natural systems, to mitigate the effects of higher temperatures, changes in hydrology, and changing ocean water levels	▪ Estuary and Coastal Shoreland management planning under Statewide Planning Goals 16 and 17 ▪ DSL rules for Removal/Fill and waterway leasing	▪ Update estuary inventories and habitat assessments ▪ Identify and protect future subtidal and intertidal habitat (eelgrass, tidal marshes) ▪ Protect eelgrass beds and tidal wetlands from adverse impacts ▪ Identify and conserve existing high-quality intertidal habitat, eelgrass beds, and tidal marshes ▪ Implement practices to improve carbon sequestration by estuarine wetlands ("Blue Carbon") ▪ Restore former tidelands to estuarine influence by removing dikes, levees, and tidegates or creating setback levees ▪ Develop protective measures at state level to protect current and future tidally influenced areas
NS-13. Decrease stressors on fish stocks by improving water quality and adjusting harvests	▪ Fishery catch monitoring and fishery-independent monitoring programs (note: these are most useful when done on a statewide or West Coast-wide scale)	▪ Monitor harvested fish and shellfish stocks to detect changes in populations that might signal climate-related impacts. Use the currently established fishery-management processes to determine if/when harvest adjustments are needed to address changes in populations ▪ Implement watershed and estuary protection and restoration measures identified in management objectives for Natural Systems enumerated above
NS-14. Protect marine and estuarine functions and features (such as eelgrass beds) that mitigate changes in ocean pH	▪ Estuary management plans ▪ Removal-Fill rules ▪ Waterway leasing	▪ Protect eelgrass beds and tidal wetlands from adverse impacts ▪ Restore eelgrass beds ▪ Restore tidal wetlands ▪ Establish buffers around important estuarine resources, features, and habitats

Implementing the Natural Systems Management Objectives *continued*

Natural systems management objectives	Implementation mechanisms	Possible implementation actions
NS-15. Collaborate across management regimes to identify natural system functions and services that support management objectives for infrastructure, health and safety, and working lands	▪ A Regional Adaptation Agreement, Charter, or other mechanism to implement this framework	▪ Establish a regional network to share ideas, information, and resources, promote policies, and initiate pilot projects ▪ Establish a mechanism for continued expert consultation across management regimes on priority climate risks

Implementing the Working Lands Management Objectives

Working Lands Management Objectives	Implementation mechanisms	Possible implementation actions
WL-1. Manage the use of working lands to sustain production of food and fiber (forest, farm, and fishing activities) with projected changes in average temperatures, precipitation, and stream hydrology		
Erosion, sedimentation, and water temperatures		
WL-2. Protect and restore watershed resources and functions that regulate sedimentation and stream temperatures	▪ Agricultural Water Quality Management Act (AWQMA), basin plans and area rules ▪ ODA strategic implementation areas that work toward compliance with AWQM plans and area rules ▪ Watershed action plans ▪ Forest management plans ▪ Forest Practices Act ▪ Oregon Plan for Salmon and Watersheds ▪ ODFW riparian lands tax incentive program ▪ Comprehensive Conservation and Management Plans (CCMPs) for Lower Columbia and Tillamook Estuaries ▪ Conservation Reserve Enhancement Program (CREP) ▪ Environmental Quality Incentives Program (EQIP) for agricultural activities ▪ TMDLs under the Clean Water Act ▪ ODFW western Oregon stream restoration program ▪ Local land use plans and zoning codes ▪ Implement Statewide Planning Goal 5 requirements for riparian areas and wetlands	▪ Adopt watershed and land management practices to reduce sediment delivery to streams and lower surface water temperatures ▪ Protect, enhance, and restore riparian areas to reduce sediment delivery to streams and lower surface water temperatures ▪ Identify other measures needed to minimize sediment delivery to streams and to lower surface water temperatures ▪ Adopt a comprehensive state riparian management policy to apply across all land uses ▪ Improve riparian area protections across all land uses and management regimes ▪ Restore and enhance riparian areas across all land use types and management regimes ▪ Provide technical assistance to landowners ▪ Implement and enforce existing riparian protection rules across all enforcement authorities ▪ Move from complaint-driven enforcement to systemic monitoring and enforcement using distributed sampling protocols ▪ Provide adequate funding capacity for monitoring and enforcement
WL-3. Implement management practices for working lands that sustain ecosystem services and watershed functions necessary to recover from	▪ Oregon Forest Practices Act ▪ Agricultural Water Quality Management Act basin plans and area rules ▪ ODA Strategic Implementation Areas ▪ Environmental Quality Incentives Program (EQIP) ▪ Regional Conservation Partnership	▪ Implement agricultural land- and water-management practices to adapt to increased temperatures and altered stream flows ▪ Implement land management practices to reduce water demand in periods of low streamflow ▪ Provide technical assistance to

Implementing the Working Lands Management Objectives *continued*

Working Lands Management Objectives	Implementation mechanisms	Possible implementation actions
disturbances	Program RCPP ▪ TMDLs under the Clean Water Act	landowners about BMPs to achieve Working Land objectives
WL-4. Revise logging practices on steep slopes to reduce the effects of logging on landslides	▪ Oregon Forest Practices Act ▪ Forest management plans ▪ Environmental Quality Incentives Program (EQIP) for forest management activities ▪ Interagency research collaborations	▪ Maintain full funding of ODF programs for implementing and monitoring OAR Divisions 623, 625, 630, 640; 527.676, and 527.710 of the FPA. ▪ Ensure full implementation of OAR Divisions 623, 625, 630, 640, 527.676, and 527.710 of the Forest Practices Act ▪ Collaborate to develop a plan that involves education and incentives to adopt new practices for forest owners, managers, loggers, and consultants ▪ Include new logging practices in EQIP-funded forest management plans ▪ Support research that evaluates the sustainability of Coast Range forests in a changing climate ▪ Support research to simulate landscape responses to future precipitation levels that reflect the IPCC's full range of Representative Concentration Pathways
WL-5. Minimize erosion and sedimentation from construction sites	▪ Local land use plans, zoning codes, and development regulations ▪ Coastal Nonpoint Pollution Control Program (CNPCP) ▪ TMDLs	▪ Implement nonpoint pollution control measures and practices to reduce erosion and sedimentation associated with construction sites ▪ Provide education and technical assistance on construction-site erosion control ▪ Adopt measures to protect water quality from development on rural and urban lands ▪ Develop or revise local erosion-control and stormwater-management measures that integrate regional-scale climate change impacts
WL-6. Minimize soil loss through erosion from agricultural lands	▪ Agricultural Water Quality Management Act, basin plans, and area rules ▪ Coastal Nonpoint Pollution Control Program (CNPCP)	▪ Implement agricultural land management practices that minimize soil loss through erosion ▪ Provide education and technical assistance on minimizing soil loss from

Implementing the Working Lands Management Objectives *continued*

Working Lands Management Objectives	Implementation mechanisms	Possible implementation actions
	▪ TMDLs under the Clean Water Act ▪ Environmental Quality Incentives Program (EQIP) for forest management activities	agricultural lands ▪ Develop EQIP Conservation Implementation Strategy (CIS) that focuses on annual crops grown on highly erodible soils
Increased risk of wildfires		
WL-7. Assess the effects of Coast Range forest and land management practices on future fire risk, and evaluate whether changes are needed to reduce future fire risk	▪ State and federal forest management planning processes ▪ Updates to the Westwide Wildfire Risk Assessment	▪ Integrate results of large wildfire modeling and future climate normals (Yang et al. *in prep*) ▪ Continue to validate and update large wildfire and future ignition models with new fire-occurrence data ▪ Determine how fuel characteristics under Coast Range and alternative forest management regimes influence probability models of future large wildfires ▪ Support research on forest management regimes that maximize carbon sequestration ▪ Utilize future fire probability predictions based on RCP emissions scenarios in Fire Risk Assessments
WL-8. Improve the resilience of forested watershed communities to fire by increasing the diversity of forest species used in reforestation	▪ Environmental Quality Incentives Program (EQIP) for forest management activities ▪ State and federal forest management planning processes ▪ Forest Practices Act	▪ Implement the existing EQIP Conservation Implementation Strategy (CIS) in selected parts of Clatsop County; assess this CIS and adapt it as needed, and extend it to priority watersheds ▪ Define resilience and identify the range of desired future conditions among Coast Range forest landowners in light of future fire modeling research ▪ Support systematic review of scientific literature related to the relationship between species composition, forest structure, and risk of wildfire in the Coast Range ▪ Model future probability of wildfire and evaluate predictive contribution of species composition; utilize results in modeling changes in geographical distributions of forest species and habitats
WL-9. Implement practices to reduce wildfire risk from	▪ Local natural hazard mitigation plans ▪ Local comprehensive land use plans and implementing ordinances	▪ Provide information to rural landowners and residents on site management practices to reduce

Implementing the Working Lands Management Objectives *continued*

Working Lands Management Objectives	Implementation mechanisms	Possible implementation actions
development adjacent to forested working lands	▪ Community Wildfire Protection Plans ▪ Site-development guidelines for residential development in the Wildland-Urban Interface (WUI)	wildfire risk ▪ Conduct research that includes input and guidance from forest land managers on simulating realistic/viable forest management strategies, in light of predicted changes in fire regimes
Changes in hydrology: Reduced base flows, increased seasonal extremes of rivers		
WL-10. Develop and implement watershed and water-system management strategies and practices to mitigate the effects of higher temperatures and lower summer flows on water supplies and aquatic habitats	▪ Integrated Water Resources Strategy ▪ Forest management plans ▪ Watershed Action Plans ▪ OWRD Water Rights instream transfer ▪ Wetland reserve easements ▪ EQIP for irrigation water efficiency ▪ TMDLs under the Clean Water Act	▪ Protect and restore wetlands and floodplains to improve watershed functions and soil water retention ▪ Restore floodplains and upper watershed functions to maximize natural soil water retention ▪ Identify opportunities and practices for water storage that can support habitat management objectives ▪ Increase irrigation water efficiency and allocate conserved water to instream flows ▪ Identify practices that simultaneously increase base flows and water supplies in periods of low flow ▪ Use water pricing and other economic incentives to reduce water use in periods of low flow ▪ Investigate the potential effects of regionalizing water supply systems to increase water supplies during periods of low flow ▪ Increase water storage where technically, environmentally, and financially feasible
WL-11. Maintain anadromous fish migration and spawning habitats under likely future hydrologic regimes	▪ Watershed restoration plans ▪ Oregon Plan for Salmon and Watersheds	▪ Revise standards for fish passage to maintain salmon migration under likely future hydrologic regimes ▪ Identify changes in anadromous fish migration patterns and spawning habitats as they respond to changes in temperature and stream hydrology
WL-12. Minimize the effects of urbanization on water quality and hydrologic patterns	▪ Coastal Nonpoint Pollution Control Program ▪ Stormwater design standards ▪ City and county land division codes	▪ Implement urban stormwater management standards and practices that reflect future precipitation regimes ▪ Incorporate green infrastructure values and features into stormwater design standards ▪ Reduce impervious surface areas ▪ Utilize stormwater system designs and

Implementing the Working Lands Management Objectives *continued*

Working Lands Management Objectives	Implementation mechanisms	Possible implementation actions
		materials that increase stormwater infiltration
WL-13. Engage and provide information to working land managers about climate variability, to improve their understanding of and ability to implement adaptation actions	▪ Agricultural Water Quality Management Act, basin plans, and area rules ▪ Soil and Water Conservation District Program for technical assistance to landowners ▪ ODA Water Quality website ▪ Agricultural organizations educational outreach programs ▪ Forest Practices Act ▪ Interagency research collaborations	▪ Conduct outreach and provide technical assistance to working land managers about the effects of climate variability and change on working lands and natural systems ▪ Utilize existing information resources about climate variability and change ▪ Work with forest land managers to integrate contemporary fire modeling research and analyses and to identify alternative or improved forest management strategies
WL-14. Identify adaptation objectives, practices, and projects for working lands that also support objectives for infrastructure, public health and safety, and natural systems	▪ A Regional Adaptation Agreement, Charter, or other mechanism to implement this framework ▪ Regional Solutions Plan and project review	▪ Establish a regional network to share adaptation-related ideas, information, and resources, promote policies, and initiate pilot projects ▪ Establish a mechanism for continued expert consultation on priority climate risks across management regimes

Follow-Through: Endorsement and Implementation

Two important initial purposes of this proof-of-concept were for the participants—who were from local, state, federal, and nongovernmental organizations—to learn and work together and to co-develop a framework to align their adaptation efforts. With completion of the regional framework, continuing goals of this effort are (1) to have actions taken by appropriate parties put the framework into practice; and (2) ultimately, to have such actions yield beneficial results *on the ground* for the people of Oregon.

In looking forward to implementation, it is important to stress that this regional framework *is not a plan*. A plan would contain clear commitments and mechanisms for their implementation. Rather, the framework is a springboard for revising current plans to achieve the adaptation objectives. The objectives need to be integrated into a wide range of climate-sensitive decisions that stem from plans and mechanisms that are already in place for managing resources and assets in Clatsop and Tillamook Counties. Most of those mechanisms are called out in the previous section. This emphasis on climate-sensitive decisions and existing mechanisms deeply reflects the idea that adapting to climate change doesn't automatically mean doing new things. Rather, much adaptation will mean generally doing what we're already doing, only doing those things *differently*. It means, basically, using different criteria and assumptions for decisions.

For the framework to succeed in changing conditions on the ground, it needs to be actively endorsed, implemented, and updated as new information becomes available. These overarching considerations surfaced at several points in the three meetings, especially as the process was wrapping up.

Strategy for Implementation

To accomplish all the goals of this effort requires what can be thought of as a multi-level and multi-phase implementation and communication strategy. It is not the intent here to present all the elements or all the detailed tactics of such a strategy, but rather to present an overall outline.

It's important to stress that this regional framework is not a plan.

The first level and phase come to fruition with this report. Knowledgeable professionals in various roles and with various responsibilities for governance in Clatsop and Tillamook Counties have been brought together, have participated in, and have indicated their acceptance of the Regional Framework for Adaptation.

Endorsement. At the strategic level, the next step in moving the framework forward is to engage decision-makers to actively endorse the framework. Implementing the framework requires the approval of those in positions of authority and responsibility within the relevant agencies, organizations, and communities. To obtain that approval, the participants in developing the framework have been asked to communicate their support of the framework to their executives. The idea is for agency executives to actively endorse the framework in such a way that their commitment to it is communicated and the framework objectives and actions are implemented in concert with other agencies and interested parties. Agency endorsement will establish a mutual support network for adaptation in Clatsop and Tillamook Counties.

At the same time, endorsement of this approach to align adaptation efforts at the regional level, based on and deriving from the risk-based adaptation approach laid out in the state-level Climate Change Adaptation Framework, will prepare agencies to replicate the approach elsewhere. This would manifest the needed leadership and progress in addressing future climate conditions in Oregon. In the absence of any other model or initiative at the federal, state, or local level, the project team anticipates that this approach, either in whole or in what others consider its most valuable parts, will be used in other parts of Oregon.

Implementation. At the practical level, the next step is to continue collaboration across the two-county region to resolve conflicts, if possible, between some of the adaptation

Key themes in the World Café

The last meeting for developing the framework involved an activity over a working lunch loosely based on a "World Café" process.[8] Participants were given about an hour to write down and discuss with one another needs, challenges, and opportunities they saw for implementing the adaptation objectives in each of the management regimes. To foster cross-discipline interaction, participants were encouraged to circulate through all four management regimes. A synthesis of the information collected in the World Café highlights key themes.

Funding. The challenge noted most often was lack of identified funding sources to implement adaptation measures. Some participants noted that there are existing conditions in the region that are already being affected by climate drivers, and thus already in need of funding to address. For example, some participants talked about the need to protect existing infrastructure assets even *before* addressing future climate-related risks to infrastructure.

Resolve. In some cases, participants felt that the political will to take on climate change preparation and adaptation at the local level is lacking. Climate change remains a sensitive topic in many communities, and that sensitivity can be the pretext for taking little or no action. This lack of resolve affects funding for adaptation. Many participants felt that when political will is lacking, there is little they can do on their own. A lack of resolve at the state and federal levels was also noted. The willingness or capacity to participate in this project varied across state and federal agencies that have responsibilities in Clatsop and Tillamook Counties.

Engagement. Stakeholders for the regional framework should be engaged in continued collaborative discussion that allows for meaningful dialogue about their differences and fosters the development of mutually beneficial outcomes. Many participants felt that by working together, they could get people more interested in climate adaptation, which could lead to heightened awareness among decision makers, who in turn will eventually support funding for necessary adaptation measures.

Many participants brought up the need for public engagement in ways that suggest that engaging members of the public in two-way information and education processes about the effects of climate change on their communities and interests would be an important element in any successful approach to adaptation. Public engagement often requires reliable information about physical sciences, which in some areas is lacking and must be obtained. The likelihood of success can also be improved by using sound social science to understand the perceptions, needs, and resistance to action that individuals and communities have in approaching climate issues that are relevant to them.

Follow-Through. Several participants noted the need for and a desire to maintain momentum on adaptation in the region. Looking ahead, they stressed the need to align disparate objectives and interests represented in the four management regimes. While acknowledging that the regional framework is an important first step, they said that more work needs to be done to resolve conflicting objectives between different management regimes. Not surprisingly, there are different opinions about what needs to be done to adapt to climate risks. Several people expressed concerns about potential conflicts between infrastructure and natural system adaptation objectives. For example, there are potential conflicts between developing water storage to support current human needs and maintaining aquatic species and habitats and functioning hydrologic systems.

8 "A 'World Café' is a structured conversational process intended to facilitate open and intimate discussion and link ideas within a larger group to access the 'collective intelligence' or collective wisdom in the room. Participants move between a series of tables where they continue the discussion in response to a set of questions, which are predetermined and focused on…specific goals. …" —Wikipedia, accessed 1/12/15

objectives, and to identify *key* actions and *lead actors* for each adaptation objective. It has been suggested that the North Coast Regional Solutions Team could host this regional-level collaboration.

The tables in the previous section represent the collaboration of work groups for four different management regimes. The contents of these tables will evolve over time, *especially* if the professional community that developed the framework continues to collaborate, in particular *across* management regimes. While the management objectives and implementation mechanisms reflect collaboration across jurisdictions, agencies, nongovernmental organizations, and levels of government, there is need for further collaboration *across management regimes*. Such cross-regime collaboration should review the objectives for all four management regimes *together* to identify those that support, or that work at cross-purposes to, the objectives of a different management regime.

Finally, this Regional Framework for Adaptation implicitly raises an issue that is likely to grow in importance: Currently, there is no governance mechanism, framework, or forum that can sustain a comprehensive landscape-scale, multi-party effort to address the effects of climate change. While a proof-of-concept involving coordination and collaboration produced this framework, a mechanism is needed at the regional level to continue to foster its overall implementation. Implementation requires more than just coordination. The management objectives state what needs to be done, and the implementation mechanisms suggest how they can be achieved. But no entity has responsibility for continuing oversight or dedicated resources to ensure the objectives actually get implemented. This is a distinctly different task from other tasks oriented to changing conditions on the ground. An important action in implementing the framework will be to consider establishing some regional ad-hoc body or intergovernmental mechanism to oversee its implementation. As noted above, Oregon's Regional Solutions process and the North Coast Regional Solutions Team might provide an opportunity to host or undertake some of the cross-regime collaboration that will be important for implementing the Regional Framework.

Outreach. This framework has the potential to affect people, communities, and quality of life in Clatsop and Tillamook Counties in the coming decades. The intent, of course, is for those effects to be beneficial. If the

framework does result in different decisions, then it has the potential to generate resistance to needed change. At the same time, interested and affected stakeholders certainly have ideas, interests, and values that may not be fully reflected in the adaptation objectives. The need to engage stakeholders was a common and persistent theme that surfaced in the four management-regime work groups. Some of the adaptation objectives and actions directly reflect those discussions. Ultimately, the outreach and two-way learning need to be reflected in strategies, actions, plans, and budgets to implement the framework.

The regional framework is a starting point. In time, the experience of implementing the framework, and refining, updating, and adapting it as warranted, would lead to distinct public benefits in collectively preparing for and responding to the effects of a changing climate on the north Oregon coast. That would be a success worth striving for.

Funding. As noted above, the lack of funding for climate adaptation is a dominant issue. Even though many of the implementation mechanisms involve making changes to current practices and decision criteria, as opposed to taking on entirely new responsibilities, revising plans and criteria for decisions still requires work effort and, therefore, funding. Resources are available from various sources; for example, many of the implementation mechanisms may have funding available for local adaptation actions. An appendix compiled early in the project identifies agency programs and activities related to climate change, many of which may represent opportunities for funding local implementation of the framework. A preliminary list of potential funding sources includes the following sources:

Oregon's Infrastructure Finance Authority (IFA) Funding Programs

- Clean Water Revolving Loan Fund
- Seismic Rehabilitation Grants
- Drinking Water Source Protection Fund
- Community Development Block Grants
- Special Public Works Fund

Oregon Water Resources Department Funds

- Place-based planning grants (possibly in 2015–17)
- Feasibility Study Grants
- Implementation Grants/Loans for Instream or Out-of-Stream Water Projects

Oregon Office of Emergency Management (FEMA funds)

- Natural hazard mitigation plan development
- Pre-disaster mitigation grants

DEQ Nonpoint source pollution control program

Oregon Watershed Enhancement Board Grants

- Technical assistance
- Monitoring
- Restoration (on-the-ground projects)
- Focused Investment Priorities (upcoming in 2015)

Department of Land Conservation and Development

- Oregon Coastal Management Program Grants
- Planning Assistance grants

Federal Programs

- USDA-NRCS (2014 Farm Bill Conservation Programs)
- EPA
- U.S. Army Corps of Engineers' Planning Assistance Grants

In the end, the current opportunistic and ad-hoc approach to funding adaptation will probably never be adequate. This framework can't solve that problem, but a commitment to the framework may help agencies and communities get access to whatever funding becomes available.

Next Steps

On February 10, 2015, the OCMP conducted a conference call primarily to determine whether there were issues in the draft Regional Framework that needed to be resolved or changes that needed to be made before the framework is finalized and distributed. No substantive issues were brought up in the call. Much of the discussion centered on possible next steps. It was concluded in the conference call that it would be useful to summarize suggested next steps to include in this section of the framework. The material below provides that summary. Several suggestions highlight implementation mechanisms and actions under some of the adaptation objectives. Repetition in the summary reflects repetition in the discussion.

It should be emphasized that there is a difference between a framework and other planning efforts; implementing a *framework* is different from implementing a *plan*. A framework functions at a different level from most plans; it is an umbrella. Implementing elements of the framework will occur in many

different ways, according to management regime, adaptation objective, and agency or actor. As noted at the outset, this framework is intended and designed to *inform* a broad suite of other, more sector-specific planning efforts. Implementation on the ground will occur by incorporating the adaptation objectives into existing planning and management activities.

Overall, suggested next steps fell into a few categories.

Governance

- Convene a regional team to foster implementation of the regional framework and to maintain a capacity for landscape-scale and region-wide consultation and collaboration on climate change adaptation
- Convene a regional ad-hoc Adaptation Work Group; solicit representation and champions; and initiate a process to review objectives across all four management regimes
- Convene a work group to continue the cross-agency, cross-regime, cross-jurisdiction collaboration, and
    - identify priority management objectives for adaptation
    - identify priorities from each agency
    - identify quick-win projects

      identify where mainstreaming adaptation objectives can occur with minimal financial cost to existing programs
    - identify cross-sector opportunities that maximize co-benefits
- Foster endorsement of the Framework by executives in the participating communities and agencies; outline expectations that are associated with endorsement
- Identify lead actors or teams for each adaptation objective
- Consider turning over responsibility for governance—for maintaining and continuing the regional collaboration—to the Northwest Regional Solutions Team
- Identify a regional body such as the Regional Solutions Team to provide oversight (expand its scope) and to help coordinate efforts, since much of the work needs to be done regionally and not just on an individual community basis.

Outreach

- Develop a short presentation about climate adaptation, and provide the presentation and the Regional Framework document to local planning commissions, city councils and boards of

county commissioners, and state-agency governing boards and commissions

- Prepare a presentation to give an overview of climate change issues relevant for Tillamook and Clatsop Counties; explain what the Regional Framework is and how to use it
- Engage with communities in Clatsop and Tillamook Counties to use the Regional Framework to develop a "Climate Change Action Agenda" to reduce the risks and potential impacts of climate change

Implementation on the ground

- Identify priority near-term tasks or key actions, lead actors for those tasks, and a timeframe for completing priority tasks to achieve management objectives in the Framework.
- Use Oregon's Statewide Planning Program—both the Statewide Planning Goals and local comprehensive plans—to implement the Regional Framework. For example:
  - Consider rule-making to incorporate climate change adaptation into OAR Chapter 660
  - Begin the process of incorporating climate change adaptation language into comprehensive plans and zoning ordinances
- Identify objectives that can be incorporated into local natural hazards mitigation plans
- Begin the process of incorporating adaptation to climate change into state forest management plans, state highway improvement plans, and other relevant state agency planning/policy documents
- Make existing maps and data available to communities
- Develop technical assistance material for use by communities in amending their comprehensive plans and development codes to address climate change
- Provide links in the website on climate change adaptation to various state and federal websites and other adaptation resources
- Review and coordinate actions between management objectives to address overlap and/or conflicts
- Consider prioritizing action items based on immediate likely results, cost effectiveness of implementing the action, and feasibility of completing actions

Other issues

- Consult with the Oregon Climate Change Research Institute to better understand the way ecosystems may change over the medium- and long-term, and how such projected changes should be integrated into conservation, protection, and restoration initiatives

Appendix I

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Appendix I

A. Why Develop a Regional Framework for Adaptation?

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D. Presentations and Materials Used in Developing the Regional Framework

References

Appendix II

(Under separate cover and available online at http://www.oregon.gov/LCD/OCMP/pages/publications.aspx)

Summary of Climate Adaptation Work
Agencies and Organizations Working in Clatsop and Tillamook Counties

Appendix A. Why Develop a Regional Framework for Adaptation?

Research Background

In coastal Oregon, climate adaptation planning by local governments has been slow to take hold, as confirmed by a 2012 survey of 140 coastal management professionals. Competing community priorities, unclear direction, limited access to information, and lack of urgency are among the causes of delay. The majority of respondents, including both elected and other officials, believe that a combination of government and other organizations is the preferred way to initiate a community's response to planning for climate change. However, such planning is not happening that way. Adaptation planning is occurring opportunistically and in piecemeal fashion, and has generally been fostered by availability of outside funding. Managers who seek to be adaptive are working more or less independently, rendering adaptive decisions piecemeal. They are generally working without reference to landscape-scale adaptation priorities or objectives, since such priorities and objectives had yet to be developed. While such actions are no doubt helpful, their opportunistic, isolated, or independent nature belies the need: Climate change is fundamentally a landscape-scale problem that warrants a landscape-scale response.

Climate adaptation tends to occur along institutional or sectoral lines—by jurisdiction, agency, NGO, profession, and so on. Under the prevailing model for adaptation, every actor, agency, or governmental unit is an independent agent. Again, while most actions are likely to be beneficial, climate change is a landscape-scale challenge. This project establishes a landscape-scale foundation for adaptation planning in Clatsop and Tillamook Counties.

Every state and federal agency, county, Native American tribal community, and city in Oregon currently has the option to develop an independent climate adaptation plan. Despite the staggering increase in both climate science and adaptation "tools" and guidance designed to be used by communities to adapt to the effects of climate change, only a couple of these entities have a comprehensive climate adaptation plan that includes policies, objectives, and implementation resources. In other words, the flood of scientific information and planning guidance hasn't resulted in broad-scale resolve to address climate change. Indeed, the two major "hurdles" to adaptation planning that the professionals surveyed in 2012 described were "lack of agreement over the importance of climate change effects" and "lack of urgency regarding climate effects." At the same time, most respondents believe their "professional actions to plan for the effects of climate change could benefit [their] community."

The fragmentary approach to climate adaptation by different governments, agencies, communities, individuals, and organizations contradicts the integrated nature of the climate system and the effects—negative and otherwise—that changing climate will have on human and natural systems.

Project Purpose

The overarching purpose in developing a regional adaptation framework is to *build capacity* to address climate change at the community and regional levels. The mechanism for building capacity is to compile and organize information to relate to the landscapes in Clatsop and Tillamook Counties. There is an overwhelming amount of information available about climate change and climate adaptation. Unfortunately, what is readily available has varying degrees of applicability or relevance to any particular place. The best first step in building capacity is to select and organize reliable information that pertains to the place under consideration—in this case, the north coast counties in Oregon.

The intent of this framework is to clarify how climate change is likely to affect landscapes and communities in northwest Oregon, and to align the resources and expertise in cities, counties, agencies, and organizations to address priority climate risks.

This effort began as a proof-of-concept, whose purposes as stated at the outset were to

- build partnerships to support adaptation to climate change in Clatsop and Tillamook Counties
- align federal, state, and local efforts, where possible, to address climate change
- build support for developing state- and local-level adaptation measures
- get Oregon's risk-based *Climate Change Adaptation Framework* on the ground
- develop a landscape- and risk-based approach to climate change adaptation

This proof-of-concept grew from an observation that **the current laissez-faire approach to climate change adaptation is insufficient** to address the breadth and scope of the challenge. An implicit but telling assumption in the prevailing approach is that each community is an independent agent that will take on adaptation on its own. However, no community should be expected to address climate adaptation on its own.

Climate change is a landscape-scale problem that calls for a landscape-scale response.

But what does it mean to have a landscape-scale response to climate change?

- It means getting all the various parties affecting activities in a manageable-sized landscape to more or less agree on the **problems likely to result *in this place*** due to changing climate conditions.
- It means providing the opportunity for those parties to lay out ways to address those problems.
- It means *aligning* programs and measures to more effectively and efficiently address climate risks ***in this place***.
- Finally, it means fostering partnerships—across organizations, across sectors, and across management regimes—to implement adaptation actions.

Adaptation will remain an abstraction until we define what it means ***in this place***.

Appendix B. Framework Process: From Climate Risks to Adaptation Actions

At the beginning of the effort to develop this regional framework, the Oregon Coastal Management Program and Oregon Sea Grant committed to a "low overhead" process. The intent was to maximize participation by agencies, communities, and organizations that have responsibilities that affect the use and management of lands, infrastructure, communities, or natural resources in Clatsop and Tillamook Counties, and to maintain their involvement through the end of the effort.

Most of the framework was developed in work groups organized by "management regimes" for Infrastructure; Public Health and Safety; Natural Systems; and Working Lands.

The information flow used to develop the framework is shown in Figure 1 below.

The first step was to lay out the known science on climate change and its effects *on the north coast landscape*. Based on this summary of the current scientific understanding of changes in climate that are likely to affect the area, the work groups identified priority climate risks for each management regime. Then the work groups developed *management objectives for adaptation* (also called *adaptation objectives*) to address the likely effects of those risks. Finally, the work groups identified mechanisms and actions to achieve the objectives.

Figure 2 on the next page shows a different conceptual overview used to develop the regional framework. The process started with an overview of likely changes in climate that drive landscape processes and functions. It then focused on the *landscape* or *natural system responses* to those projected changes. The causal pathway laid out in Figure 2—from climate drivers to natural system responses to management regime responses—is situated right in the center of the four arrows in Figure 1. In practice, the step from priority risks to objectives necessitated some understanding of the landscape responses to changes in the priority climate drivers.

This focus on the landscape responses to priority risks emphasizes the idea that most planning for climate change does not rely directly on climate information *per se*. Rather, planning needs to deal with the effects of climate drivers on landscape resources, functions, and conditions. The idea is to shift the focus away from climate change *per se*, to focus on how climate drives changes in the landscape. In other words, for the most part, resource managers and community planners don't need direct access to climate projections. Rather, they have a greater need for information on how the projected future climate conditions will affect the landscape—the *natural system responses* in Figure 2.

In order to develop appropriate adaptation responses, infrastructure, land use, and natural resource managers need information about how climate will affect the systems they manage.

The process of developing the regional framework began with a review of current available downscaled climate projections and a general survey of likely effects of those climate changes on the landscape. In the second meeting, a panel of scientists provided a more detailed look at the effects of the projected conditions on the landscapes and resources in the north

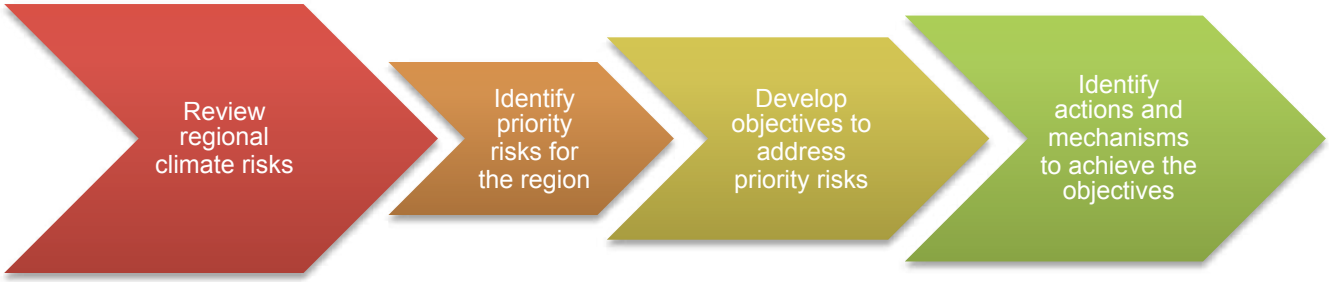

Figure 1. Information flow used to develop the regional climate-adaptation framework.

Coast Range mountains.

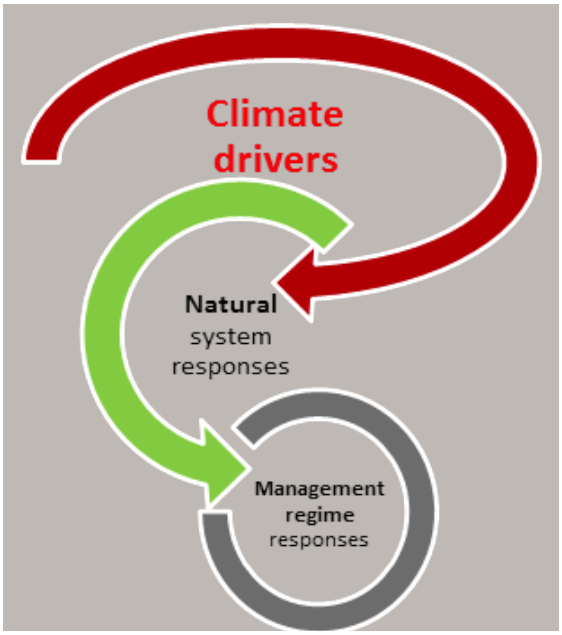

Figure 2. Regional framework development process.

These presentations provided the scientific basis for work groups to identify priority climate risks, adaptation objectives, and actions to achieve those objectives in the second and third meeting. The next section contains outlines of these presentations, and links to the presentations are provided in the "Presentations and Materials Used in the Meetings" section later in this appendix.

Appendix C. Possible Consequences of Future Climate

1. In the Watersheds: Coupling stress and fire to project forest change

Dominique Bachelet, Ph.D., senior climate change scientist at the Conservation Biology Institute and associate professor at Oregon State University

1. Climate projections from the latest IPCC (5th Assessment Report, 2013) show consistent trend upward for all seasonal *temperatures*

   Reality check: Since the 1930s, when summer temperatures were the lowest of the 20th century in Astoria, the trend has been upward.

   Social/Economic Response to Observed Change: Seed zone in western Oregon has changed.

2. Projected forest response:
   a. Large scale model (based on process) shows decrease in the dominance of evergreens, switch to a mixed type forest, expansion of subtropical types (common in coastal California) northward.
   b. Species distribution models (based on correlations) show increased habitat restrictions, possibility of maladaptation of existing species.

3. Despite the fact existing trees are expected to have a long term legacy, *disturbance* can make the changes occur sooner rather than later.
   a. Fire is such disturbance: large scale model simulating potential vegetation response to changes in climate project more frequent fire occurrence mostly in the second half of the 21st century (not if, but when).

      BUT it could happen earlier because of forest condition. The coast range includes private lands with even age monospecific forests prone to allow fire spread (remember the Tillamook). Old growth enclaves on federal land will be at risk due to their proximity.

      Note: *Old growth* provides many ecosystem services - cultural (tribal and local history), esthetic and touristic, but also ensuring long term carbon sequestration (climate regulation), decoupling from regional heat in the understory (wildlife habitat). Its diversity of species and age gives it some insurance against destruction by disturbance.
   b. Insect outbreaks are likely: Endemic insects and/or pathogens could profit from changes in climate and cause havoc just like they did in British Columbia. Some scientists have been looking at the pathogen for Swiss needle cast as a potential problem in the making.

      The perfect storm - forest condition due to land use and changes in climate (direct and indirect effects i.e., drought stress on trees as well as drying of fuels or enhancement of reproductive cycle of insects for ex - can create changes that are extensive and abrupt. Do not expect chronic linear predictable changes. Prepare now and monitor closely.

4. Projections of precipitation are uncertain because 1) it is difficult to measure (sometimes it is snow, sometimes it is drizzle or fog that does not accumulate and thus cannot be measured yet has large effect on plants, sometimes the wind makes it hard to measure also) so there are few reliable datasets available to calibrate the models (also not all met stations have instruments yet all measure temperature; technology has also evolved so long term records need reconciling are prone to error); 2) natural climate variability (El Nino, Pacific decadal oscillation) affect the amount of precipitation over (multi)decadal periods yet the cause in shifts for ex. between La Nina and El Nino years is not known - sea surface temperature changes can be measured and projected for the short term but what causes the shift in sea surface temperatures is the object of research.

   Reality check: Less precipitation observed in the last decade.

   Projections of extremes: while uncertainty is large, more intense fall and winter events have always been projected by several climate models.

   Reality check: We have seen such extremes occurring in the last decade.

These are important for the hydrological cycle of forested areas. Soil erosion, landslides (another disturbance allowing for shifts during recovery period), affect stream network and water quality for communities downstream.

5. Riparian areas are important components of PNW forests.

   They provide fish/wildlife habitat, recreation venues, water quality and provision.

   Municipal watersheds provide water to coastal cities through stream network.

   Projections: most common species (alder) may become less adapted to warmer drier conditions if (natural or human) disturbance causes loss of watershed integrity. Look for southern riparian species to start moving in.

6. Remember that human activities may mask but also exacerbate climate change effects: pollution, introduction of invasive exotics, fragmentation affecting naturally moist cool microclimate, more sources of fire ignition due to more recreation as population centers along the coast (and in the whole state) expand, increasing demand from coastal populations for resources -including water.

7. In summary:

   - While timber production in the southeast part of the United States will be at risk from sea level rise and drought, the demand on forest land in the Pacific Northwest will likely increase. However, climate may affect productivity directly through species sensitivity to increased temperatures and evaporative demand causing some maladaptation problems, as well as indirectly through the increased likelihood of large scale disturbance (fires, pest outbreaks). Solutions are being discussed by foresters, including the use of adapted genotypes (new seed sources), introduction of new species, longer rotations, increased species diversity, thinning/less dense plantations.
   - Large disturbances will affect carbon sequestration potential (climate regulation), water capture and retention (more runoff and less ground water recharge). They will also affect recreation and cultural values especially from the few remnant old growth patches in a patchwork of tree farms. Coordination between landowners (private, federal, state) to optimize land use is important. Scenario planning for large scale disturbance (ex. large fire followed by extreme rainfall) in the region would help coordinate efforts and raise the level of preparedness.
   - Riparian habitats are at risk from a variety of disturbance and this will affect fish habitat, water quality and provision to municipalities. Protecting critical areas of watersheds should allow for resilience to change.
   - Current wildlife will be affected by changes but new or less common species may form new assemblages taking advantage of dead snags, abundance of beetles, etc.

2. Rivers and Streams: Effects of climate change on aquatic systems in Clatsop and Tillamook Counties

Jennifer McAdoo, hydrographer, Oregon Water Resources Department

David Jepsen, research project leader, Oregon Department of Fish and Wildlife

This talk will outline the ways in which climate change could affect water resources in Tillamook and Clatsop Counties. Specific water resource characteristics discussed in the talk include: minimum summer flows, groundwater, peak flows, storage, sedimentation, and water quality.

Emphasis will be placed on understanding the natural water system, how climate variables interact with it, and how other components of the water system could mediate or exacerbate climate-driven change to water resources. Projected changes to the climate will be taken from the OCCRI report for Tillamook and Clatsop Counties.

Published findings, which include Tillamook and Clatsop counties, project:

- **Decreased spring and summer stream flow** due to projected decreases in spring and summer precipitation and possible decreases to snow in the upper elevations
- **Slightly increased and earlier winter stream flow** due to projected increase in fall and winter precipitation and possible decrease to snow pack in the upper elevations

Preliminary local findings suggest *possible*:

- **Slight increase or increased variability in peak flows**, due to increased winter precipitation, possible decrease in snow pack, and possible, periodic vegetation loss due to increased chance of forest fire

The following changes are *possible*, but they are not included in peer-reviewed, local analyses:

- **Saltwater intrusion into groundwater** resource in low elevation areas, due to possible increased groundwater pumping and sea level rise
- **Periodic increase in erosion** in steeper areas, corresponding to possible increased sediment deposition in flatter areas due to possible increases in forest fire and peak flows
- **Increased inundation** in highly localized areas, due to possible peak flow increases, possible sediment deposition in flatter areas, and sea-level rise in estuaries
- **Increase or increased variability in water temperature** due to increases in forest fire, decreases in snow pack in high elevations, and possible changes in groundwater level in the low areas

Projected watershed conditions (scenarios) given current understanding of change in climate drivers (air temperature, precipitation), and the probable watershed responses that we need to plan for include:

- Changes in precipitation patterns will lead to changes in stream hydrology and sediment regimes
  - **More frequent and protracted low flow conditions** in summer might affect municipal and rural water availability
  - More intense storm events (peak flows) might lead to **greater frequency and magnitude of flooding**
  - More intense storm events (peak flows) might lead to **greater stream scour and more frequent debris flows**
- Increases in air temperature will lead to several watershed-level responses, including:
  - Drier soils, greater evapotranspiration, and more frequent and intense fire regimes, leading to **changes in forests composition** (see Dominique Bachelet's presentation)
  - The combination of higher air temps, lower summer precipitation, and vegetative response will **lead to higher water temperatures**, potentially impacting cold-water adapted animals

Given the above set of watershed-level responses, the presentation will use coastal salmon species to outline some scenarios of aquatic habitat and biotic responses that we may need to plan for:

- Reduced stream flows and water depth in spring/summer/fall increases water temperatures, which changes habitat availability/distribution, and **leads to greater habitat fragmentation**, and potentially to greater continuous exposure to conditions affecting adult salmon mortality
- Increased storm intensity leads to greater channel scour, more stochastic spring flows, and warmer spring water temperatures, which in turn **subjects juvenile life stages to greater occurrence of discreet mortality events**
- Increase in summer air temperatures leads to late summer/early fall flow declines, and more severe and frequent drought events. This leads to **greater probability of juvenile salmonid mortality**.
- Flow declines in combination with other factors lead to increase water temperatures, decrease dissolved oxygen, and **less habitat and altered timing for juveniles transitioning to salt water**

3. Ocean and coastal systems: Erosion and flood hazards on the north coast due to changing climate

Jonathan Allan, coastal geomorphologist, Oregon Department of Geology and Mineral Industries

The Oregon coast is 366 miles long from the Columbia River to the California border. The coastal geomorphology of this landscape reflects a myriad of geomorphic features (Figure 1) that range from plunging cliffs (in regions 1, 4, & 5), rocky shorelines and shore platforms (regions 1, 3, 5, & 6), wide and narrow sandy beaches backed by both dunes (regions 2, 5 & 6) and cliffs (regions 3 & 4), gravel and cobble beaches backed by cliffs (regions 1, 5 & 6), barrier spits (regions 2, 4 & 5), and estuaries (regions 1-6). Cliffed or bluff-backed shorelines make up the bulk of the coast accounting for 58 percent of the coastline, the remainder being dune-backed. Geomorphically, the coast can be broken

Figure 1. The coastal geomorphology of the Oregon coast, including a breakdown of Oregon littoral cells. Bold black lines denote the locations of cliffs and rocky shores. Numbers indicate regional coastal geomorphic features: plunging cliffs (1, 4 & 5), rocky shorelines and shore platforms (1, 3, 5 & 6), wide and narrow sandy beaches backed by both dunes (2, 5 & 6) and cliffs (3 & 4), gravel and cobble beaches backed by cliffs (1, 5 & 6), barrier spits (2 & 5), and estuaries (1-6).

up into a series of "pocket beach" littoral cells (Figure 1) that reflect resistant headlands (chiefly basalt) interspersed with short to long stretches of beaches backed by both less resistant cliffs and dunes (e.g. Lincoln and Tillamook Counties (regions 3 & 5 in Figure 1). The headlands effectively prevent the exchange of sand between adjacent littoral cells. Sediment inputs are considered to be negligible such that the littoral cells have a finite volume of sand. Some beaches form barrier spits, creating estuaries or bays behind them (e.g. Nestucca and Netarts Spits). About 75.6 percent of the coastline consists of beaches comprised of sand or gravel backed by either dunes or bluffs, while the remaining 24.4 percent of the coast is comprised of a mixture of rocky cliffs (including headlands) and shores. Of the 18 littoral cells on the Oregon coast, the largest is the Coos cell, which extends from Cape Arago in the south to Heceta Head in the north, some 62.6 miles in length.

Along the Oregon coast, coastal communities are increasingly under threat from a variety of natural hazards, including coastal (wave-induced) erosion (both short and long-term) and flooding, sand inundation, and potentially catastrophic tsunamis generated by the Cascadia subduction zone. 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 (Allan and others, 2009). 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.

Beaches and dunes are particularly susceptible to the occurrence of large storms coupled with high ocean water levels. Along the Tillamook County coast, coastal erosion hazards have been especially acute over the past 15 years due to the occurrence of several major storms, coupled with the occurrence of the 1997-98 El Niño. Collectively such events have resulted in extensive erosion in several communities (e.g. Neskowin, Tierra Del Mar, and Rockaway), leading to the proliferation of coastal engineering structures in order to protect backshore properties from the erosion hazard. Although scientists are now beginning to gain an understanding of the short to long-term patterns of Oregon coastal change (e.g. Allan and Hart, 2008; Ruggiero et al. 2013), the most significant erosion and flood events are forced by major storms (e.g. January 1939) or storms-in-series (e.g. 1998-99 winter). In all cases, it is the combination of large waves, low atmospheric pressure, strong onshore directed winds, coupled with high tides, which produces high total water levels along the coast and causes the most significant erosion and flood hazards. A case in point is the extreme 1998-99 winter, which was characterized by the equivalent of five 100-year (1%) events over a two

month period and led to the removal of ~1.4 million m^3 of sand in the Rockaway sub-cell. At the time, the calculated extreme storm wave was 10 m. Following those major events, the 1% event was revised upward to ~14-15 m. Following periods of storminess it can take beaches years to decades to fully recover and in some cases recovery may not be possible due to the removal of sand into deeper water. Along much of the Tillamook County coast this is essentially the situation with many beaches remaining in a degraded state. As a result, coastal communities are vulnerable today to major storms let alone from the effects of future climate change.

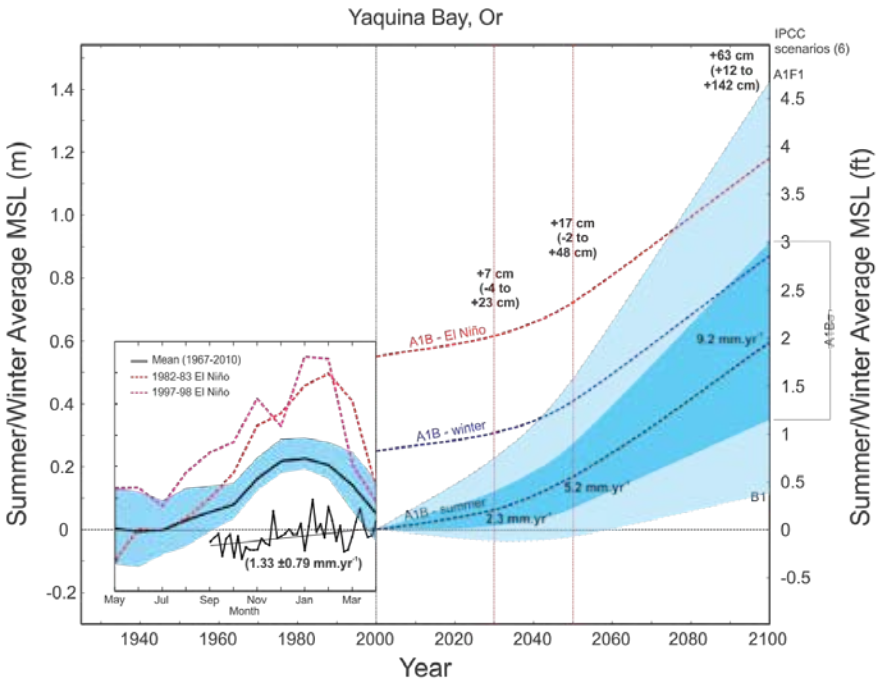

Figure 2. Projections of future sea level rise for the central Oregon coast. Dashed lines reflect the mid-range (A1B) estimate. Darker shading depicts the uncertainty for the A1B scenarios, while the lighter shading reflects the uncertainty for all global climate models. Insert figure depicts the seasonal and El Niño cycle in monthly mean sea levels along with the historical rate of sea level rise determined for the Newport tide gauge.

Although the same sets of processes are important for driving coastal erosion and flood hazards in Clatsop County, the impacts have not been as severe. This is in large part due to the local geomorphology (mostly homes built on marine terraces that are somewhat resistant to erosion) and anthropogenic effects such as the construction of the Columbia River jetties, which have strongly influenced the development of the Clatsop Plains. The latter has seen significant accretion and shoreline progradation since the early 1900s. However, there is some suggestion that this process may be reversing along the northern end of the Clatsop Plains (north of the Peter Iredale), where erosion processes are now beginning to drive the overall coastal response.

Due to the prevalence of sandy beaches and dunes along the Tillamook and Clatsop County coast, coastal erosion and flood hazards will almost certainly increase in the future due to projected regional increases in sea level. Global sea level has risen approximately 20 cm during the 20th century at an average rate of ~1.75 mm/yr (Holgate, 2007). The rate of sea level rise (SLR) has accelerated over the last few decades, reaching rates of 2.8-3.4 mm/yr, determined from satellite altimetry (Cazenave and Llovel, 2010), although some of this probably reflects steric (temperature and salinity) variations due to interdecadal ocean cycles.

On the Oregon coast, historic rates of relative sea level change vary from a decrease of -0.62 ±0.35 mm/yr at Astoria on the northern Oregon coast, to an increase of +1.33 mm/y (±0.79 mm/y) on the central coast, and a decrease of -1.10 mm/y (±0.5 mm/y) on the northern California coast at Crescent City (Komar et al., 2011). Differences in the response between these sites (and others) reflect the effects of regional tectonics, such that the southern Oregon coast (south of about Coos Bay) is presently an emergent coast as tectonic uplift outpaces sea level rise, while the central to northern Oregon coast (including Tillamook County) is gradually being submerged (i.e. sea level rise exceeds tectonic uplift).

In December 2010, state and federal agencies on the U.S. West Coast commissioned a sea level change study by the National Academies of Sciences with the expressed purpose of deriving future projections of SLR in 2030, 2050, and 2100. Importantly, a major component of the study was to incorporate such factors as regional tectonics, glacial isostatic adjustments, and tide gauge information in order to constrain the estimates to the regional level (NRC, 2012). Results from the NRC study were published late in 2012 and

for the central Oregon coast they indicate that mean sea level is projected to increase by +7 cm (-4 to +23 cm range) by 2030, +17 cm (-2 to +48 cm range) by 2050, and +63 cm (+12 to +142 cm range) by 2100 (NRC, 2012). These projections are presented conceptually in Figure 2, which demonstrates the effect of these increases under a range of mean sea level conditions (summer, winter and El Niño effects) typical of the Oregon coast, forecast for the next 85 years.

To improve our understanding of the effects of climate change on the northern Oregon coast, researchers are now focusing their attention on a variety of climate change issues. This includes (but not limited to) the effects of coastal erosion and flood hazards due to storms and SLR (Ruggiero et al., 2011; Stimely and Allan, 2014), analyses of extreme wave overtopping and flood effects (Allan et al., 2012), SLR on tidal hydrodynamics, ecology and flooding in estuaries (Cheng et al., 2014), and ocean acidification (Barton et al., 2012).

Ocean acidification, which reflects a change in the chemistry of the ocean due to the ocean's absorption of carbon dioxide from the atmosphere, is of particular concern in the Pacific Northwest due to its potential effect on the shellfish industry. In 2012, scientists in Oregon found evidence that higher levels of carbon dioxide in the Pacific Ocean were responsible for the failure of oyster larvae to survive in 2005 at Whiskey Creek Shellfish Hatchery on Netarts Bay.

Appendix D. Presentations and Materials Used in Developing the Regional Framework

Meeting 1, July 2014. Tillamook Bay Community College, Tillamook

Meeting 1 agenda and overview (OCMP)

Material presented in the first meeting began with a summary overview of Oregon Sea Grant research based on interviews of coastal officials about climate change adaptation. The project provided an opportunity for Sea Grant to determine if the process and material used to develop the Regional Framework resulted in any change in perception about climate adaptation, particularly on the part of local government officials.

Summary of interviews on adaptation (Oregon Sea Grant)

Also in the first meeting, representatives of the Oregon Climate Change Research Institute (OCCRI) and the Climate Impacts Research Consortium (CIRC) presented an overview of the available scientific information about climate change and a summary of the likely impacts of such changes on Tillamook and Clatsop Counties.

Climate change in Clatsop and Tillamook Counties (OCCRI)

Impacts of climate changes (Climate Impacts Research Consortium)

In preparing for the first meeting, participating agencies and entities were asked to provide a brief summary of their activities related to climate adaptation. These summaries have been compiled into a *Summary of Climate Adaptation Work*, which is Appendix II.

Summary of Climate Adaptation Work

Meeting 2, September 2014. Clatsop Community College, Astoria

The second meeting provided more detailed information about system responses to changes in climate conditions. These presentations were designed to provide information about changes in forest ecosystems; changes in hydrology; watershed and aquatic habitat changes; and changes in coastal and ocean conditions.

In the second half of the meeting, participants broke into four work groups representing four 'management regimes': infrastructure, health and safety, natural systems, and working lands. The work groups identified priority risks for that management regime and developed preliminary management objectives for climate adaptation to address those priority risks.

Materials used in the second meeting include a draft outline for a regional climate adaptation framework and guidelines for the work groups on drafting management objectives for adaptation.

Meeting 2 agenda and overview (OCMP)

Presentations on landscape responses to climate changes in Clatsop and Tillamook Counties

Changes in forest systems (Conservation Biology Institute)

Changes in hydrology and aquatic systems (OWRD and ODFW)

Changes in coastal and ocean conditions (DOGAMI and ODFW)

The second half of the meeting was organized into work groups to identify priority risks and develop management objectives for adaptation. The workgroups, which were provided with guidance for developing adaptation objectives, were organized according to four different *management regimes*:

WG1: Infrastructure: Address climate-related risks to public infrastructure investments for systems that support communities, including water supply, waste treatment, stormwater management, energy, and transportation

WG2: Public Health & Safety: Address climate-related risks to the health and safety of coastal residents, visitors, and communities; and private property improvements

WG3: Natural Systems: Address climate-related risks to ecosystem functions and services, including fish and wildlife and their habitats and the capacity of natural systems to mitigate the effects of natural hazards

WG4: Working Lands & Economy: Address climate-related risks to the natural resource base for local and state economies, including commercial farm and forest lands, fisheries, recreation and tourism

The guidance provided to the work groups elaborated on the idea of management objectives for adaptation:

> The principal elements of a regional adaptation framework are *management objectives for adaptation* or simply *adaptation objectives*. Some may call these goals, principles, strategies, or guidelines. The important point is that they indicate an *approach or action aimed at a desired future condition*.
>
> The work groups' task is to develop management objectives for adaptation.
>
> Management objectives for adaptation are broad-scale statements that lay out what should be done within various management regimes—or 'decision environments'—to adapt to variable and changing climate conditions. Management objectives for adaptation are specifically designed to address one or more climate risks. The workgroups are organized to represent different management regimes. Preliminary management objectives from each work group will be revised as necessary when they are brought together with the objectives from other work groups/management regimes.
>
> Management objectives for adaptation are not intended to be directed at any one specific entity or location. Rather, they are intended to work at the broad scale of the entire region. In a regional framework they are designed to address a condition and apply to a broad range of decisions and organizations. They are designed to *inform* the review and revision of various plans and decision processes and criteria that affect public health and safety and the management and use of land, natural resources, community assets and infrastructure. They may state desired future landscape conditions and incorporate adaptive measures.

Meeting 3, November 2014. Seaside Civic and Convention Center, Seaside

The third meeting was organized into two work sessions. In the first work session, the 'management regime' work groups reviewed the preliminary adaptation objectives and selected priority objectives. In the second work session, the work groups then identified implementation mechanisms and actions to achieve the priority objectives. Worksheets were provided for both work sessions.

Meeting 3 agenda and overview (OCMP)

Worksheets for work session 1

The worksheets used in the third meeting and linked to below contained the management objectives for adaptation that had been developed in Meeting 2. Note that some of the objectives were revised in meeting 3, and further revised in the process of compiling the framework after the third meeting.

Infrastructure

Health and Safety

Natural systems

Working lands

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Organizations Involved in Developing the Framework

The project management team made a concerted effort to involve in this effort all levels of government, all agencies, all local governments, and all non-governmental organizations with some management responsibility in Clatsop and Tillamook Counties and an interest in adaptation. It was particularly important to involve federal and state agencies, which appear to be involved in adaptation to a greater degree than are local governments. The team that produced this regional framework included representatives, at one time or another, of the agencies listed below. The project managers are particularly grateful for and indebted to the entities that provided enthusiasm and support throughout the effort.

Local governments		
Astoria	Nehalem	Tillamook County
Cannon Beach	Tillamook	Clatsop County
Seaside		CREST
Non-governmental organizations		
The Nature Conservancy	Columbia Land Trust	Wild Salmon Center
Tillamook Estuaries Partnership	Tillamook Bay Community College	Lower Nehalem Trust
Oregon state agencies		
Land Conservation and Development	Geology and Mineral Industries	Governor's Natural Resources Office
Oregon Health Authority	Agriculture	Parks and Recreation
Fish and Wildlife	Transportation	Forestry
Water Resources	State Lands	Environmental Quality
Federal agencies		
NOAA Fisheries	U.S. Geological Survey	National Weather Service
National Park Service	U.S. Fish and Wildlife Service	Bureau of Land Management
Natural Resources Conservation Service		
U.S. Army Corps of Engineers	Environmental Protection Agency	
Federal Emergency Management Agency		
Universities and institutes		
Oregon Sea Grant	Conservation Biology Institute	
Oregon Climate Change Research Institute	Institute for Natural Resources	
Climate Impacts Research Consortium	Oregon State University	

Oregon Sea Grant
Corvallis, Oregon

ORESU-H-15-003

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