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Human Dimensions of Climate Change in Coastal Oregon

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Executive Summary

This report provides the Bureau of Ocean Energy Management's (BOEM) National Environmental Policy Act (NEPA) practitioners with needed information on climate-relevant environmental and human dimensions issues and effects in coastal Oregon. The study area included two nested case studies situated in: 1) Coos County (Coos Bay area) and 2) Lincoln County (Newport). These areas of interest were selected due to their proximity to two offshore renewable energy lease requests that were being processed by BOEM in 2014. As of the publication of this report, the lease request offshore from Coos Bay—the WindFloat Pacific Lease Area—was no longer being processed.

The objectives of this study were to identify: 1) major issues and trends that characterize environmental change in the region; 2) current effects of climate change on Oregon's coastal population, specifying social, cultural, and economic impacts; 3) climate change's potential impacts on coastal populations in the future; 4) potential cumulative effects of climate change on social systems; and 5) information gaps and barriers to policy implementation related to the effects of climate change on human systems with particular relevance to Outer Continental Shelf (OCS) policy making.

Data were collected to address these objectives using literature review and primary data collection in coastal Oregon. A literature review was aimed at identifying past climate trends and climate projections for coastal Oregon, as well as a reviewing current weather events taking place in the study area during the period of data collection. Individuals were invited to participate in ethnographic discussions if they possessed expertise associated with key resource/livelihood categories selected to guide sampling: 1) fisheries, 2) forest resources, 3) tourism and recreation, and 4) coastal infrastructure. During ethnographic discussions, study participants were asked to share their perceptions of environmental issues and changes in the study area, as well as human dimensions effects (social, economic, and (or) cultural) that may be driven in part by these issues and changes. Differences in perceptions across these resource/livelihood categories are highlighted in this report.

Respondent perceptions of *current environmental issues* and changes largely reflected current weather events (i.e., record-breaking high temperatures, drought, unusual oceanographic conditions, and morbidity/mortality with typically harvested aquatic species), and in turn tended to align with projected climate impacts in the study area. *Longer-term manifestations of environmental change* (such as sea level rise, ocean acidification, and increased storm intensity and coastal erosion rates) were less likely to be perceived than current weather-related issues. Although these processes were each documented to be currently taking place in the study area, their incremental rates and largely imperceptible impacts likely contributed to their greater perceived prominence as expected future issues rather than current environmental changes.

The full list of perceived climate-related environmental issues and changes was grouped into nine thematic categories, including: 1) aquatic conditions and patterns (e.g., warmer ocean temperatures, sea level rise, ocean acidification; upwelling patterns); 2) ecological integrity and

ecosystem composition (e.g., changing abundance and (or) location of marine species), 3) fish and wildlife health and survival; 4) forest health and survival; 5) material processes (e.g., changes in sediment transport processes and risk of landslides); 6) moisture patterns (e.g., changes in volume and seasonality of rain, snow, and fog); 7) shifting seasonality (e.g., changing phenology of plants and animals); 8) storm activity (e.g., changes in the intensity and frequency of storms); and 9) temperature patterns (e.g., increasing air and water temperatures in the study area).

A number of *human dimensions of climate change (HDCC)* effects in the study area were discussed by respondents as both taking place *currently and also potentially leading to future impacts.* HDCC effects that received relatively equal emphasis as current and potential future issues included: increasing visitation and migration of people to the study area, negative and positive economic impacts on key livelihoods, changes in levels of risk to climate-related hazards and extreme weather events, human behavior changes and livelihood adaptations, changes in environmental regulations and policy, damage to infrastructure, concerns about water supply, diminished access to natural resources due to either decreased abundance or area closures, negative and positive impacts on recreational opportunities, and psychological stress associated with increased risks and economic impacts.

HDCC effects that were more likely to be perceived as current issues, and less likely to be discussed with regard to the future, tended to parallel specific current weather-related environmental events and impacts in the study area during the period of data collection. Perceived current HDCC effects included: health concerns arising from high domoic acid[1] levels in shellfish; economic impacts to fisheries due to the Dungeness crab fishery closure; crowding concerns in local communities as a result of increased tourism; and social costs linked to impacts on recreation (e.g., recreational salmon and shellfish closures). Conversely, overarching transformations in the social, economic, and cultural systems were more frequently perceived to be potential future HDCC effects. Specific issues included: concerns about economic transformation (e.g., declining abundance of resources that underlie traditional harvest industries; increasing tourism activity and coastal retirement); increased appeal of the coastal Oregon climate relative to other areas of the State and nation, furthering current trends of increased migration and visitation; and potential for increasing economic impacts arising from increasing sea level, increasing rates of coastal erosion, and higher volume rainfall events (e.g., increased maintenance and relocation costs for operating coastal infrastructure; increased risk of landslides affecting both industrial operations and residential areas; increased risk of flooding in low-lying commercial and residential areas).

An examination of *cumulative effects* associated with interactions between climate-related environmental stressors, HDCC effects, and other, non-climate-related stressors illuminates the causal complexity and interdependencies that exist between many of the individual variables identified in this study. By definition, HDCC effects arise from one or more

[1] Domoic acid is a neurotoxin produced by certain species of marine algae, including the diatom species, *Pseudo-nitzschia*. Domoic acid can build up in marine organisms, and consumption by humans can lead to Amnesic Shellfish Poisoning (Gilbert 2014).

climate-related environmental changes. Six key climate-related environmental changes were perceived to be root drivers of a majority of other environmental changes and HDCC effects discussed by respondents. These 'top environmental drivers' include: 1) a more attractive Oregon climate (e.g., warmer temperatures; less precipitation); 2) longer, drier summers; 3) increased frequency of high volume rain events in winter; 4) higher water temperatures; 5) increasing acidity (decreasing pH) of ocean waters; and 6) increasing sea level and storm intensities. In addition to environmental drivers, HDCC effects may also act as intermediary drivers of other HDCC effects. For example, changes in regulations were frequently noted to be an HDCC effect arising from management response to climate-related environmental change (e.g., increasing fire restrictions or fishery closures). These regulatory changes were in turn perceived by respondents to lead to additional economic, social, and cultural impacts. Climate-related environmental change and intermediary HDCC effects may further interact with non-climate-related issues and trends to produce cumulative HDCC effects. For example, rising coastal visitation numbers in the study area were perceived to be driven in part by warmer, sunnier weather associated with projected climate trends, but respondents also noted other, non-climate-related human dimensions issues and trends that may contribute (e.g., success of marketing and advertising campaigns; increases in disposable income; lower fuel prices).

Finally, several study respondents spoke about *social science information needs* that could assist managers and communities in coastal Oregon to more effectively consider human dimensions effects in decision-making, as well as *factors that present barriers to integration of social science information*. Respondents identified the following information needs: 1) more complete demographic information; 2) data regarding cultural and economic values; 3) assessment of public values, perceptions, and attitudes at the local scale; and 4) improved understanding of factors that influence risk, vulnerability, and adaptability.

Individual examples of barriers to integration in social science tended to fall within seven thematic categories (associated examples in parentheses): 1) data quality and availability (i.e., sampling limitations, validity, legitimacy, complexity/uncertainty); 2) established political and scientific frames (i.e., emphasis on natural science and economics, lack of adaptive management); 3) issues of political will and awareness (i.e., lack of urgency or issue salience, intangible nature of climate impacts, politicization of climate change); 4) procedural costs (i.e., financial costs and temporal requirements, such as respondent fatigue and other process burdens); 5) procedural inadequacies (i.e., legitimacy/validity, of data/information provider power dynamics, blanket prescriptions); and 6) social science expertise gaps (i.e., lack of training or social science expertise within agencies, lack of familiarity with non-economic methods, difficulty translating qualitative data to quantitative metrics).

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Abbreviations and Acronyms

ATV	All-terrain vehicle
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
CDP	Census Designated Place
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cm	centimeters
DLCD	Department of Land Conservation and Development
ENSO	El Niño Southern Oscillation
EPA	Environmental Protection Agency
HD	Human Dimensions (non-climate-related)
HDCC	Human Dimensions of Climate Change
km	kilometers
LNG	Liquefied natural gas
m	meters
NEPA	National Environmental Policy Act
NGO	Non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
OCCRI	Oregon Climate Change Research Institute
OCS	Outer Continental Shelf
ODFW	Oregon Department of Fish and Wildlife
PDO	Pacific Decadal Oscillation
PMEC-SETS	Pacific Marine Energy Center South Energy Test Site
RSL	Relative sea level
RSLR	Relative sea level rise
SD	Standard deviation
U.S.	United States
USGS	U.S. Geological Survey

1 Introduction

This report synthesizes primary and secondary data to describe the social and environmental characteristics of the central coast of Oregon and identify the associated social, cultural, and economic impacts of climate change in the region, heretofore known as the human dimensions of climate change (HDCC). The study was undertaken to support the Bureau of Ocean Energy Management's (BOEM) activities (under National Environmental Policy Act [NEPA]) to provide information on current, (potential) future, and cumulative impacts of climate change on human communities in central coastal Oregon. The need for this case study arose in response to Federal-level directives such as Executive Order 13653 to incorporate an improved understanding of the human dimensions of climate-related environmental change into Federal decision-making (Salazar 2009). BOEM and the U.S. Geological Survey (USGS) undertook this pilot case study to fulfill these management needs through the exploration of environmental change and associated human dimensions in coastal Oregon.

The study seeks to identify information regarding climate-related issues and changes arising in the study area that could be incorporated into cumulative impacts assessment and considered in conjunction with assessment of direct and indirect effects resulting from specific Federal actions. Regulations for implementing the procedural provisions of NEPA, including key definitions, are detailed in 40 CFR §§ 1500-1508. Under 40 CFR § 1508.8, the range of relevant human impacts are specified to include "aesthetic, historic, cultural, economic, social, or health" effects (CEQ 2005). Of these, this study aimed to explore cultural, social, and economic effects of climate change (HDCC effects) and "gain a broader understanding of the current and future impacts of climate change on the people of Oregon, with an emphasis on the State's coastal populations" (BOEM 2015). Following 40 CFR § 1508.8, the terms *impact* and *effect* are used synonymously (CEQ 2005). Specific study objectives related to this goal were to enhance understanding of:

1. Major issues and trends that characterize environmental change in the region
2. Current effects of climate change on Oregon's coastal population, specifying social, cultural, and economic impacts
3. Climate change's potential impacts on coastal population in the future
4. Potential cumulative effects of climate change on social systems

A separate but related goal of this research effort was to gather information about the availability and use of social science information in decision-making in the study area. To this end, a fifth study objective was to improve understanding of:

5. Information gaps and barriers to policy implementation related to the effects of climate change on human systems with particular relevance to OCS policy making

The report begins by providing background information regarding the study area climate, geography, ecology, and human history (Sections 2 and 3). These sections summarize literature and secondary data sources reviewed to inform study design. Study methods are presented (Section 4), followed by Results of Primary Data Collection (Section 5). Results are presented in an order that mirrors the five study objectives: Section 5.1 reviews perceptions of current and potential future environmental issues and changes (Objective 1); Section 5.2 reviews perceptions of current and potential future HDCC effects, highlighting examples of social, economic, and cultural impacts that may be linked to climate-related environmental changes (Objectives 2 and 3); Section 5.3 discusses the cumulative impacts that respondents noted currently exist or may arise as a result of environmental changes, HDCC effects, and other, non-climate drivers of human dimensions effects (Objective 4); Finally, Section 5.4 presents

respondents' thoughts regarding social science information gaps and barriers to integration of social science in decision-making (Objective 5).

The findings presented throughout Section 5 consist of participant perceptions of environmental changes and HDCC effects in the study area. In general, *perception* refer to "the way an individual observes, understands, interprets, and evaluates a referent object, action, experience, individual, policy, or outcome" (Bennett 2016). How an individual perceives their environment is influenced in part by the objective, physical qualities of their surroundings, as well as personal factors such as culture, training, experience, and perceptual ability (Gifford 2012). While not all of the environmental changes and human dimensions effects perceived by participants have been verified against secondary datasets, this information provides direct insights into participants' personal experiences, as well as their beliefs, attitudes, values, norms, preferences, and motivations. Respondents' experiences and psychological constructs in turn affect behaviors, responses, and levels of support for specific actions or policies (Bennett 2016, Gifford 2012), including the degree to which individuals or communities undertake climate change adaptation or mitigation efforts. Finally, Section 6 offers conclusions about key findings, and the relationship between respondent perceptions and biophysical data presented in Section 2.

1.1 Definition of Key Concepts

Prior to initiating this study, definitions of the following key terms were developed to ensure that individuals participating in the study would have a common understanding of topics of discussion: 1) environmental issues and changes, 2) cumulative effects; and 3) social, cultural and economic impacts. This section provides explanations of the definitions adopted for each of these terms.

Environmental Issues and Changes

For the purposes of this study, *environmental issues* are understood to be conditions, processes, events, and (or) changes that rise to prominence as concerns in arenas of public perception and (or) policy. *Environmental changes* are understood to encompass trends or cycles that produce shifting environmental conditions over time. Because at the time of observation it is difficult to know whether an event is part of a trend or cycle, discussion of environmental change was inclusive of potentially anomalous events producing current changes in the environment. Indicators of policy prominence include management actions and (or) attempts to influence management actions related to a given issue, while prominence in the arena of public perception can be inferred from the absolute number or percentage of respondents that mention an issue. The findings presented here are collectively identified as emergent environmental issues, inclusive of changes, as perceived by study respondents.

Cumulative Effects

Objective #4 of this study explores the cumulative effects of climate change on social systems in coastal Oregon. Impact assessment under NEPA concerns direct and indirect impacts arising from the Federal action under consideration, as well as cumulative effects of the Federal action's interaction with other change drivers. Cumulative impacts are defined in 40 CFR § 1508.7 as, "impact on the environment which results from the incremental impact of the [Federal] action when added to other past, present, and reasonably foreseeable future actions regardless of what agency—Federal or non-Federal—or person undertakes such other actions" (CEQ 2005). Cumulative impacts may accrue in a linear or exponential fashion, and they may lead to tipping points that trigger environmental, social, economic, and (or) cultural transformations (Vanclay and Esteves 2011).

Most examples of cumulative impacts assessment are focused only on environmental impacts (Vanclay and Esteves 2011). However, when social and natural or physical effects are recognized to be interrelated, NEPA environmental impact statements must also consider effects on the *human environment*, defined in 40 CFR § 1508.14 as, "the natural and physical environment and the relationship of people with that environment" (CEQ 2005). Specific guidance provided by CEQ for conducting NEPA cumulative impacts analysis is not legally binding (CEQ 1997, Smith 2005); however, CEQ recommends that four aspects of the affected human environment be considered: 1) status of natural, cultural, social, or economic resources or systems; 2) important environmental and social stress factors; 3) regulatory and administrative standards and plans; and 4) environmental and socioeconomic trends (CEQ 1997). This study's five objectives address many of these considerations.

Social, Cultural, and Economic Effects

The study objectives identified social, cultural, and economic effects of climate-related environmental change as the primary human impacts of interest for this study. Collectively, this suite of impacts is referred to as the human dimensions of climate change effects (HDCC effects). In contrast, human impacts not believed to be associated with climate-related environmental change are referenced as human dimensions effects (HD effects). The following definitions provided a common starting point for discussion of both HDCC effects and HD effects perceived to be occurring in the study area. They reflect categories commonly used in BOEM studies.

1) *Cultural Considerations*: This includes a people group's identity, beliefs, values, practices, activities, and traditions, as well as symbols and built structures.
2) *Social Considerations*: How groups of people interact with each other and function (e.g., work, recreate, get around, family life/household unit, etc.). This includes their social institutions (e.g. education, healthcare, governance, housing), community structure (e.g. family/household structure, religion, demographics, migration patterns), and is related to their well-being and quality of life.
3) *Economic Considerations*: How people make a living and exchange goods, including their industries and types of employment.

1.2 Selection and Definition of the Study Area

Coastal Oregon was selected as the setting for this case study given two proposed offshore renewable energy development projects in the region submitted to BOEM (Figure 1). The WindFloat Pacific Offshore Wind Pilot Project was proposed by Principle Power, Inc., in May 2013. The proposed lease request was approximately 15 nautical miles offshore of Coos Bay, OR. The WindFloat Pacific Project would consist of up to five wind turbines mounted on floating foundations. The Pacific Marine Energy Center South Energy Test Site (PMEC-SETS) Research Project was proposed by the Northwest National Marine Renewable Energy Center at Oregon State University in June 2013. The proposed research lease request is approximately five nautical miles offshore of Newport. The PMEC-SETS Research Project would consist of a wave energy device testing facility. At the time of this case study, BOEM was moving the project proposals through its renewable energy leasing process and associated NEPA analyses. As of the time of publication of this report, BOEM is no longer processing the WindFloat Pacific Project lease request and continues to process the PMEC-SETS lease request.

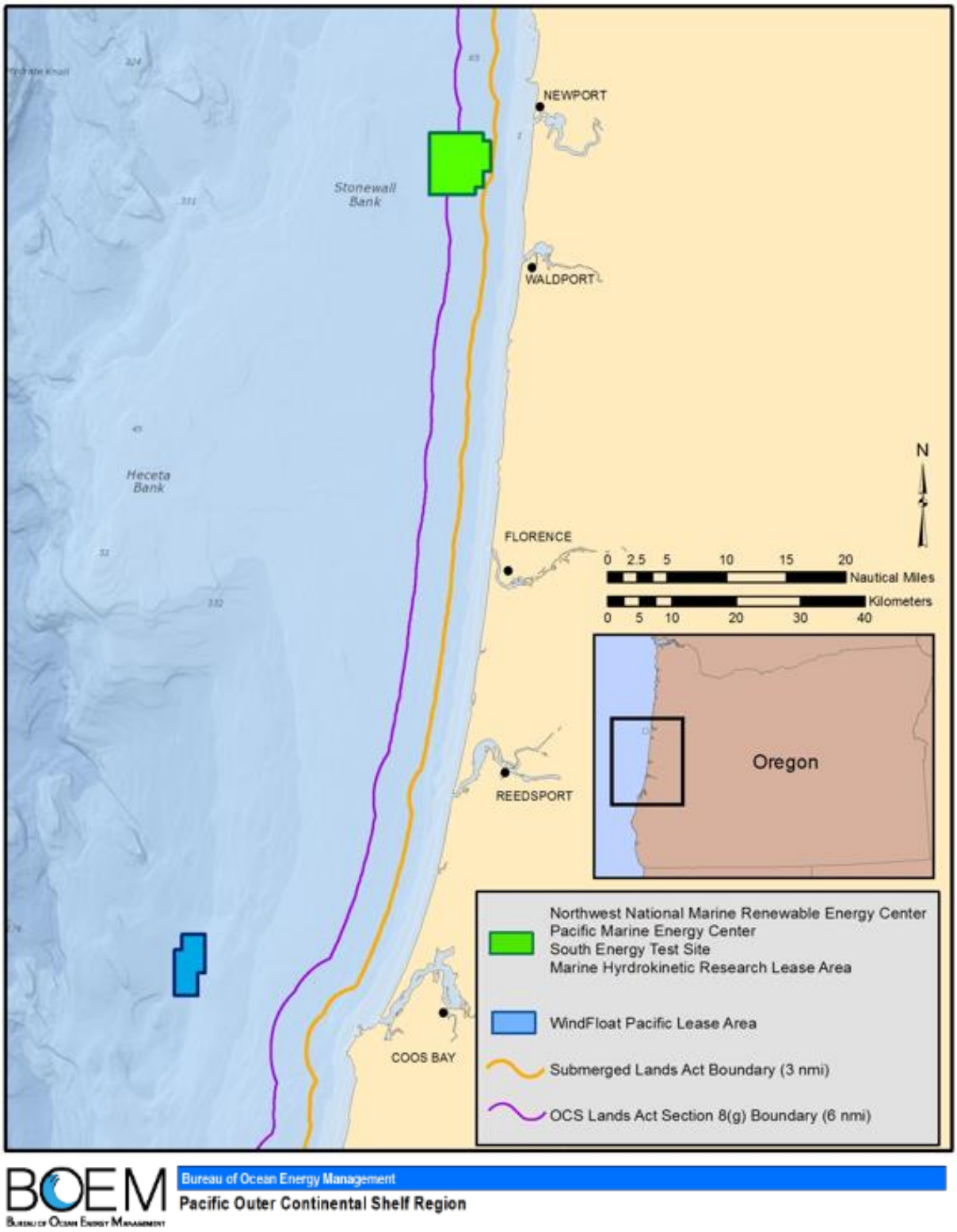

Figure 1. Map of proposed BOEM Outer Continental Shelf renewable energy projects (2014)

The area of interest specified for this study is associated with areas selected for the offshore renewable energy project proposals described above. As such, the area of interest for the study was defined as: 1) the Outer Continental Shelf (OCS) and State waters offshore of Oregon; 2) adjacent inland areas including the communities of Coos Bay and Newport; and 3) areas south and north of Coos Bay and Newport which are socially and economically tied to those communities. The BOEM HDCC Oregon Renewable Energy project is organized as a set of nested case studies detailing two localities as well as the areas south, north and inland from Coos Bay and Newport that are "socially and economically connected to those communities" (BOEM 2015).

The communities of Coos Bay and Newport each serve as the center of a mini-case study within the larger study area. Although the geographic areas of the two mini-case studies do not overlap, both are referenced together as the *study area* rather than two separate study areas. In addition to their role as hub communities, Coos Bay and Newport were chosen as primary localities due to the port infrastructure they provide proximal to proposed offshore renewable energy sites. It is important to note that the City of Coos Bay is one of several communities clustered closely together along the shores of Coos Bay, including Barview, North Bend, and Charleston at the mouth of the bay. Several key port facilities associated with the International Port of Coos Bay are located in Charleston, along with many seafood processing facilities. Throughout this report, the term "Coos Bay" will refer not only to the City of Coos Bay, but is inclusive of the other communities and neighborhoods located along the shores of Coos Bay.

For the purposes of this study, Coos and Lincoln Counties were determined to represent the area "socially and economically connected" to Coos Bay and Newport, respectively. According to the U.S. Census, the Coos Bay Micropolitan Statistical Area is equivalent to Coos County, and the Newport Micropolitan Statistical Area is equivalent to Lincoln County. A *micropolitan statistical area* is defined as an urban area of 10,000 or more (but less than 50,000 people) and the surrounding county or counties that "have a high degree of social and economic integration (as measured by commuting to work) with the urban core" (Census Bureau [date unknown]a). In other words, Coos Bay has been identified as a hub community for Coos County, while Newport has been identified as a hub community for Lincoln County; this means that both of these communities have been found to be primary localities where individuals residing throughout their respective counties come to access services and employment opportunities.

It is important to note that, while the area for this case study has been clearly delineated, in reality it is impossible to isolate the causes and effects of climate change to specific geographic areas. This case study is specifically designed to consider effects felt *within* the study area, and it is beyond the scope of this study to consider effects *outside* of the study area. However, environmental change and associated cultural, social, and economic effects and drivers that originate outside of the study area may have cultural, social, or economic effects inside the study area.

2 Study Area Climate

In order to understand the effects of environmental changes that are observed and discussed by study participants, it is important to understand historical climate conditions (Section 2.1) and the degree to which current weather events may be perceived as unusual (Section 2.3). In addition it is important to review the climate changes that are projected to occur in the study area in the future

(Section 2.2), including how these projections may interact with the distinct geographical and ecological characteristics of the study area (Sections 2.2.1 and 2.2.2, respectively).

2.1 Climate Baselines in the Study Area

Climate is defined as the prevailing weather patterns of an area over time, typically defined by scientists as a 30-year average (NASA 2005). Variation in climate patterns across Oregon State is largely attributable to the Cascade Mountain range of west-central Oregon. Areas west of the Cascades are more typical of a mild, wet maritime climate, while areas east of the Cascades are characterized by lower precipitation and higher temperature extremes (Jackson and Kimerling 1993). Smaller mountain ranges such as the Coast Range also contribute to spatial climate patterns at a smaller scale (OCCRI 2010).

Coastal Oregon, including Coos and Lincoln Counties, has been designated as Climate Division 1[2], characterized by high rainfall and moderate year-round temperatures. In general the region averaged 165–229 cm per year over the 1971–2000 period (Taylor [date unknown]a, Taylor [date unknown]b), with greater precipitation (≥254 cm) in some higher elevation areas (OCCRI 2010). Precipitation is concentrated in the fall, winter, and spring, with typically drier summers. Between 1971 and 2000, average monthly temperatures in Climate Division 1 ranged between 7.8 °C in December/January and 15.7 °C in August, with extreme temperatures varying from a low of -10 °C in February to a high of 35 °C in September/October (Taylor [date unknown]a, Taylor [date unknown]b).

2.2 Climate Trends in the Study Area

Several long-term climate trends are already apparent throughout the United States, including Oregon. The frequency of some extreme weather events has shifted over the past decades, including more frequent heat waves, less frequent cold waves, more frequent, high-intensity and longer-duration ocean storms, and changes in flood, drought, and wildfire patterns (EPA 2016). These patterns are also evident in Oregon, where there has been an observed temperature increase of ~0.83 ˚C between 1920 and 2003; winter wave heights have steadily increased from maximums of 9 m in the 1970s to 12 m in 2005 (OCCRI 2010); and local projections related to storm patterns suggest slightly fewer but more intense storms moving into the future as the North Pacific winter storm track shifts northward (OCCRI 2010). Changes in precipitation patterns have been more difficult to establish in the study area due to natural variability (OCCRI 2010).

Although shifts in precipitation patterns have not yet been confirmed, a key way that climate change is projected to impact the coastal Oregon climate in the future is through increased precipitation extremes. Specifically, summers are expected to be drier while fall/winter/spring seasons are projected to see increased precipitation volumes (OCCRI 2010). Another key projected climate trend in the study area is continued increases in annual temperatures, on the order of ~0.1–0.6 °C per decade, with emphasis on warmer summers (OCCRI 2010). Associated increases in water temperature will affect both freshwater and marine environments, with particular impacts in urban streams lacking shade from riparian vegetation. An increasing percentage of winter precipitation is projected to fall as rain. This,

[2] These climate divisions were developed by the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information for climate-division, statewide, regional, national, and population-weighted monitoring of drought, temperature, precipitation, and heating/cooling degree day values (NOAA, [date unknown]).

combined with warmer summer temperatures, is expected to lead to decreased snowpack, higher winter streamflows, and reduced summer streamflows (Dalton et al. 2013).

The Oregon coast is projected to experience further increases in storm frequency and ~0.6–1.2 m of sea level rise by the year 2100. In addition, ocean acidification is projected to alter the chemistry of coastal and estuarine waters (Dalton et al. 2013, OCCRI 2010). Changes in these variables interact with existing geological features and flora and fauna to lead to distinct forms of environmental change in each micro-climate and biome, as described below.

2.2.1 Geography and Climate-Related Environmental Change

The study area (Coos and Lincoln Counties) is located along the coastal strip of Oregon. This region is characterized by a mild, wet maritime climate. The topography includes a mix of sandy beaches, sand dunes, and rocky headlands, interspersed by bays, estuaries and spits at river mouths (Orr and Orr 2012). On land, a unifying geologic feature of the area is the Coast Range, a medium-elevation coastal mountain chain that extends from the Coquille River basin north to the Columbia River. In most areas, Oregon's Coast Range rises to between 426 and 762 m, with several peaks above 914 m (Orr and Orr 2012, ODFW 2006, Taylor [date unknown]a, Taylor [date unknown]b). Mary's Peak, located in Benton County immediately inland from Lincoln County, marks the Coast Range's maximum elevation of 1,249 m.

Among other impacts, the projected changes in precipitation and temperature patterns would have dramatic impacts on rivers in coastal Oregon. In particular, Coast Range rivers are predicted to be impacted by changing seasonal precipitation patterns through altered timing and intensity of water supply, sediment flows, and in-stream water temperatures (OCCRI 2010, ODFW 2006). All of the rivers entering the ocean within Coos and Lincoln Counties originate in the Coast Range which receives very little annual snowpack. Other Oregon rivers, such as the Rogue, Umpqua, and Columbia, originate further inland, bisecting the Coast Range on their way to the Pacific. For these rivers, projected reductions in snowpack in the higher peaks of the Cascades will be a major source of change (Loy et al. 2001, Orr and Orr 2012). Lincoln County rivers, from north to south, include the Salmon River entering the coast near the county's northern border with Polk County, the D River entering at Lincoln City, the Siletz River entering at Siletz Bay, the Yaquina River at Yaquina Bay, the Alsea River at Waldport, and the Yachats River entering at Yachats. Coos County rivers include Tenmile Creek, the outlet of Tenmile lakes in northern Coos County, the Coos River entering the ocean at Coos Bay, the Coquille River entering the ocean at Bandon, and the New River entering just north of Coos County's southern border with Curry County.

Both Oregon's coastal features and terrestrial landscapes have been dramatically shaped by plate tectonics. Oregon is located on the eastern edge of the Pacific ring of fire. Subduction of oceanic plates under the North American plate has historically produced significant volcanic activity, as well as periodic earthquake and tsunami events. In addition, the movement of the plates has affected the bedrock material of coastal Oregon, including both Coos and Lincoln Counties: approximately 38–67 million years ago a chain of volcanic seamounts was driven shoreward and was accreted to the margin of the North American continental plate (Orr and Orr 2012). Ensuing time periods saw deposition of marine and fluvial sediments and volcanic ash on top of the volcanic bedrock, creating the geologic layers present in coastal Oregon today (Orr and Orr 2012). The extensive, flat terraces of many coastal areas in Oregon, such as Cape Arago near Coos Bay, are also evidence of tectonic processes. They were created in part by the slow uplift of the land surface, in combination with sea level variability between

glacial and interglacial periods (Loy et al. 2001, Orr and Orr 2012). Today, plate tectonics continues to affect coastal Oregon through the presence of volcanoes in the Cascade Mountains, continued risk of earthquake and tsunami events, and the interactive dynamics between sea level rise and geologic uplift.

The influence of geologic uplift on relative sea level (RSL) plays an important role in determining the degree to which sea level rise may affect specific areas of the Oregon coast. RSL is a measure of the relative difference between changing regional sea level and land elevation. It is increasing in some areas of the Pacific coast and decreasing in others. Although there is high uncertainty given the relatively short time series of data available, recent analyses suggest that RSL has been increasing in both Coos and Lincoln Counties over the past 30–40 years, meaning that sea level is rising faster than land elevation in the study area (OCCRI 2010). Implications of increased RSL include increased erosion impacts along the coast, as well as the potential for interactions with climate variables such as storms, leading to increased wave heights (OCCRI 2010).

In addition to the ocean's role in shaping the coastline, the ocean environment plays major economic, social, and cultural roles in coastal Oregon. A key process is that of coastal upwelling, which brings cold nutrient-rich waters to the surface, enabling increased productivity of ocean organisms, from plankton at the base of the food chain to commercial species in the region such as salmon, Dungeness crab, hake, mackerel, rockfish, flatfish, sablefish, anchovy, sardine, squid, shrimp, scallops, and other shellfish (ODFW 2015a). "Upwelling events" happen when wind blows from the north along the coastline for an extended period. Wind from this direction pushes surface waters offshore, which are then replaced by upwelling of deeper, cold waters. On the continental shelf in Oregon and Washington, these conditions are typically present from April to September (NWFSC [date unknown]). Thus, local wind patterns play a significant role in the productivity of Oregon's fisheries. Wind patterns can be affected by large-scale, long-term oceanic cycles such as El Niño Southern Oscillation (ENSO), which typically varies over a 4-year cycle, and Pacific Decadal Oscillation (PDO), which is thought to be a slow Pacific Ocean response to the ENSO cycle (OCCRI 2010). In addition to affecting wind patterns, the ENSO and PDO cycles are associated with changes in temperature and precipitation patterns. During an El Niño year, Oregon will typically be warmer and drier than average (OCCRI 2010). In addition, PDO cycles are highly correlated with shifts in sea surface temperatures (Mantua et al. 1997).

2.2.2 Ecology and Projected Climate-Related Environmental Change

Oregon is a geographically and ecologically diverse State, made up of nine distinct Level III ecoregions (Thorson et al. 2003), from the moist, maritime-influenced Coast Range to the arid high desert of southeastern Oregon. Coos and Lincoln Counties both fall within the Coast Range ecoregion, and are bordered to the east and southeast by the Eastern Cascades Slopes and Foothills and Klamath Mountains ecoregions. Within the Coast Range Level III ecoregion, there are seven distinct Level IV ecoregions, including coastal lowlands, coastal uplands, volcanics, the Willapa Hills, mid-coastal sedimentary, Southern Oregon Coastal Mountains, and the Redwood Zone (Thorson et al. 2003). Terrestrial vegetation is primarily late successional conifer forest habitat, with scattered oak woodlands and savannahs and montane grasslands. Other key habitat types include coastal bluffs, coastal dunes, estuaries, freshwater wetlands, and riparian areas (ODFW 2006).

In Oregon, there are 642 distinct species of terrestrial vertebrates, including amphibians, reptiles, birds, and mammals. Of these, 474 native and introduced species spend their breeding season in Oregon (Csuti et al. 2001). This does not include the many fish species present in Oregon's fresh and marine waters, including 62 species of native freshwater and migratory fishes (salmon, trout, lamprey,

troutperch, sturgeon, minnows, burbot, suckers, stickleback, and sculpin) (ODFW 2015b) and numerous marine species, including many commercially valuable species (ODFW 2015c). In addition to native species, as of 2005 there were 32 documented invasive animals and 20 additional organisms that were potentially invasive, along with 39 documented invasive plants and 27 potentially invasive plants. These invasive species are a primary cause of native species being listed as threatened or endangered (ODFW 2006). As of January 2016, there were 27 Oregon fish, 16 mammal, eight bird, four reptile, and one amphibian species listed as threatened or endangered under the Federal and (or) Oregon State Endangered Species Acts. Two additional mammal species and one additional amphibian species were under consideration for listing (ODFW 2015d).

Projected climate changes in coastal Oregon have the potential to affect both native and invasive species in numerous, unpredictable ways. With predicted changes in precipitation and air and water temperatures, ranges would shift for many plant and animal species, affecting the suitability of habitats and the continued viability of many species in coastal Oregon. In addition, these trends may increase the prevalence of invasive species that are better adapted to the new climate. Loss or decline of native species, as well as potential shifts in the phenology of life cycles, could disrupt key ecosystem services such as pollination, which is critical for reproduction of native plants as well as agricultural production (OCCRI 2010). Many economic and cultural values associated with landscapes and species in Oregon may be at risk, such as recreational and commercial fisheries and forest health. For example, when trees become stressed the potential for disease and pest outbreaks increases, leading to associated increased risk of forest fires. However, along with the negative ecological implications of climate change it is important to consider that new climate conditions may pave the way for the emergence of new species and ecosystem configurations that may also offer ecosystem services. For example, declines in cold water marine fishes may be balanced by increasing abundance of warmer-water species (OCCRI 2010).

2.3 Notable Current Weather Events During the Study Period

Individual weather events cannot be directly linked to long-term climate trends. However, an individual's perceptions of long-term environmental change are impacted by their observation of weather events over time (Gifford 2012). During the qualitative data collection period for this study (fall–winter 2015), several temperature and precipitation-related events were taking place that were fresh in the minds of many study participants. These included record-breaking high temperatures, a multi-year drought, and a large, persistent warm water anomaly in the Pacific Ocean.

First, 2015 was the warmest year on record for the Oregon coast and State as a whole since temperature recording began in 1895 (Ryan 2016). The year 2015 also marked the fourth year of a West Coast drought driven by high temperatures and lower than average Cascade snowpack and snowmelt (Loew 2015). In July, 2015, Oregon Governor Kate Brown declared drought emergencies in two-thirds of Oregon's counties, including Coos, Douglas, and Lane counties, up to the southern border of Lincoln County (Navas 2015). Drought conditions worsened into late summer, moving further north along the coast. However, a drought emergency was not declared for Lincoln County (Loew 2015). These drought conditions were linked to increasing risk of forest fire throughout Oregon and the Pacific Northwest. The 2015 Oregon fire season was severe, although not record setting (Urness 2015). Warmer temperatures and low stream flow in rivers resulted in reduced survival of trout, salmon, and steelhead in Oregon rivers, and prompted the Oregon Department of Fish and Wildlife (ODFW) to place historic restrictions on recreational fishing throughout the State (Monroe 2015).

The ocean warm water anomaly, colloquially referred to as "the blob," was a ~500 km wide and ~100 m deep persistent mass of water in the northeast Pacific Ocean that originated in the fall of 2013 and persisted through 2015 (McCabe et al. 2016). It appeared to dissipate in late 2015, but strengthened again in 2016 (Rosen 2017). As of early 2017, it again appeared to be dissipating (Rosen 2017). During 2015, including the period of data collection for this study, sea surface temperatures within the water mass measured more than 2.5 °C above average (McCabe et al. 2016). Some scientists contend the multi-year warm water anomaly is the result of natural variability, although many also suggest similar conditions could become more common in the future with a warming climate (Kintisch 2015, McCabe et al. 2016, Rosen 2017).

In 2015, the warm water anomaly created enabling conditions for a toxic algae bloom of unprecedented expanse and record-breaking toxin levels (McCabe et al. 2016). The algae bloom led to numerous recreational and commercial fisheries closures in 2015 in Washington, Oregon, and California, including a delayed opening of the winter Dungeness crab fishery that resulted in economic hardship in the study area (Dillman 2016, McCabe et al. 2015, ODFW 2015a). The warmer water conditions were also linked to a series of illnesses and die offs in marine animals, including whales, seabirds, sea lions, and sea otters (Rosen 2017). The presence of exotic, primarily tropical aquatic species such as opah, marlin, and thresher shark in Oregon waters (Miller 2015), as well as a shift to more tropical species of plankton (NOAA 2015), was also explained by the warmer water temperatures.

3 History of Current Human Settlements

There has been tremendous change along the Oregon coast over the last several centuries, including the arrival of European explorers and later Euro-American settlement, the evolution of a series of resource-based industries, development of new transportation linkages, and demographic, economic, and environmental changes. The history presented in this report emphasizes the settlement of present-day communities located in Coos and Lincoln Counties. Secondary data sources, including the U.S. Decennial Census and the American Community Survey, provided a characterization of study area demographics and economic activity.

Information about the history of the Native populations of the study area was gathered during background research for this study, and some information is included in this history as it relates to American settlement. However, the authors of this report would like to direct those interested in the Native history of coastal Oregon to histories written by coastal Oregon Tribes or in close partnership with the Tribes. These resources include: Berg 2007, CTCLUSI 2013, CTSI [date unknown], Coquille Indian Tribe [date unknown], Wilkinson 2010.

3.1 Euro-American Settlement in Coastal Oregon

Prior to the arrival of European explorers and later Euro-American settlers, the rich natural environment of coastal Oregon supported thriving Native American societies. These included, from north to south, the Tillamook, Siletz, Yaquina, Alsea, Siuslaw, Kuitsh or Lower Umpqua, Hanis Coos, Coquille (including Miluk Coos), Tututni, and Chetco peoples (Ruby et al. 2010). The central coast from Yaquina Bay (Newport) to Coos Bay was populated by speakers of Yakona dialects: Yaquina, Alsea, Siuslaw, Kuitsh/Lower Umpqua, Hanis Coos, and Miluk Coos. Today, the descendants of these coastal Oregon peoples are represented by the Confederated Tribes of the Coos, Lower Umpqua and Siuslaw

Indians (office in Coos Bay, OR), the Confederated Tribes of Siletz Indians (main office in Siletz, OR), and the Coquille Indian Tribe (office in North Bend, OR).

European exploration of the Oregon coast began as early as the 1500s, beginning with Spanish explorers sailing north from Mexico. In 1579, Sir Francis Drake is thought to have taken shelter in the South Cove of Cape Arago, near Coos Bay. By the late 1700s, an increasing number of explorers and traders arrived in the Pacific Northwest, including Captain George Vancouver in 1792 (Douthit 1999). European diseases arrived with these explorers and traders. The early 1800s brought Euro-American exploration of coastal Oregon by land, including Lewis and Clark in 1806, a Hudson's Bay Company expedition in 1826, and the ill-fated explorer Jedediah Smith in 1828 whose party was killed at the Umpqua River near Reedsport, just north of Coos Bay, due to poor relations with the Native people (Berg 2007).

The northern Oregon coast saw the earliest Euro-American settlements, including Astoria and Seaside, which were easily accessed via the Columbia River. As early as the 1820s, the fur, timber, and salmon canning industries were booming along the northern coast (Explorer Media Group 2010). The central and south Oregon coasts were less accessible. Fur traders and missionaries pushed further south in the 1820s and 30s, leading the way for the first wave of settlers to central and southern coastal Oregon in the 1840s. Many of these early settlers were drawn by the California Gold Rush of 1849, and many settled in the Willamette Valley (Douthit 1999, Douthit 2001). Given their geographic isolation, early coastal settlements were linked to San Francisco as a shipping and transportation hub (Douthit 1999).

The pace of Euro-American settlement increased throughout Oregon in the 1850s following passage of the Donation Land Act of 1850. The Act entitled those settlers present prior to 1850 to claim 320 acres (130 hectares) of land, while those who arrived after 1850 could claim 160 acres (65 hectares) (Ruby et al. 2010). Treaty talks were held with Oregon Tribes in the context of this settlement pressure. Numerous treaties were signed between 1851 and 1855 in which Tribes ceded their lands to the U.S. Government in exchange for promises of a permanent home elsewhere and a number of Tribal rights. Although most treaties with interior Oregon Tribes were ratified, none of the coastal treaties were signed into law, leaving these Tribes particularly vulnerable (Ruby et al. 2010).

In 1855 President Franklin Pierce issued an Executive Order to create a permanent reservation for western Oregon Tribes. The original Coast Reservation (also known as the Siletz Reservation, based on the headquarters being located in the Siletz valley) occupied over a hundred miles of the north-central Oregon Coast (CTSI [date unknown], Wilkinson 2010). With the exception of those Tribes already living in the area of the Coast Reservation, most coastal Tribes were removed from their lands to occupy this area, along with many Tribes from the Willamette, Umpqua, and Rogue regions of Oregon (Kent 1973, Ruby et al. 2010).

Timber harvesting and coal mining increased in importance in the late 1800s and early 1900s. The coal industry collapsed in the 1920s and 1930s with the advent of fuel oil, but the forest products industry continued to grow to a peak of activity in the 1960s (Douthit 2001). Commercial fisheries entered a new era of expansion in the early 1900s, following the arrival of electricity which enabled refrigeration (Newport Chamber of Commerce c2016). The tourism industry blossomed along the coast following construction of Highway 101 in the 1930s (Pinyerd 2007). The industries that characterized the early pioneer days continue to play an important role in coastal Oregon, along with new and diversifying livelihoods.

3.2 History of Coos County and Coos Bay Settlements

Coos County is located on the southern coast of Oregon, encompassing 4,219 square km (Figure 2). Its coastline runs from just south of Winchester Bay and Reedsport at the north (~43° 35' Latitude) to just north of Langlois at the south (~42° 57') (State of Oregon 1973a). Permanent settlement of the southern Oregon coast began in the early 1850s following passage of the Donation Lands Act that enabled Americans to claim parcels of land as homesteads. The 1850s saw development of coal mines, sawmills and shipyards on the southern Oregon coast. Lumber and coal, along with salmon and agricultural products, were shipped to San Francisco and Portland to fuel growing urban populations (Douthit 2001).

Port Orford was the first Euro-American settlement in the region, founded in 1851 in what is now Curry County. The first official settlement in Coos County was Empire City, founded in 1853 along the western shore of the peninsula that is formed by Coos Bay (Douthit 1999, Ivy c2010). Various other settlements were established in the area the same year, including Marshfield (renamed Coos Bay in 1944) on the eastern shore of the peninsula, Charleston at the mouth of the bay, and Bandon to the south of Coos Bay (Douthit 1999, Oregon Secretary of State [date unknown]). Later settlements on the peninsula included Englewood, Eastside, Barview, and North Bend, and further inland, the communities of Coquille and Myrtle Point were soon to follow. The Coquille Valley was homesteaded in the late 1850s. The current site of the City of Coquille was homesteaded by E. Cunningham, and following its sale in 1864 was developed into a town site. Myrtle Point, which was originally the site of a Native village, was homesteaded by E. C. Catching in the 1850s, and became a town in 1861 following its sale (Dodge 1898). The City of Empire was named the county seat when Coos County was formed in 1854, although voters chose to relocate the seat to Coquille in 1896 (Oregon historical [date unknown]). To the north, the City of North Bend was an industry center, known for its sawmills and shipbuilders (Dodge 1898). The City of Marshfield, located on the eastern side of the peninsula, began to grow in the 1860s and emerged as a commercial and social hub by the mid-1870s.

Throughout most of its history, the economy of the Coos Bay area was based on natural resource extraction and export; harvest and processing of timber and fisheries resources were key contributors to local livelihoods, along with ship-building (Ivy c2010). Although these industries continue to play an important role in the economy and culture of Coos Bay today, the collapse of the timber economy in the 1980s and diminished opportunities in local fisheries have contributed to the growing importance of service industries (Ivy c2010, Robbins 1988).

After Marshfield was renamed Coos Bay in 1944, the city annexed the community of Englewood (1964) and the City of Empire (1965). Figure 3 reflects these changes, with the last population counts for Englewood and Empire showing up as of the 1960 U.S. Census, resulting in an associated dramatic increase in the Coos Bay population in 1970. In 1983, the City of Eastside was also annexed. The City of North Bend, located at the north tip of the peninsula, has voted against annexation by Coos Bay on numerous occasions (Jensen 2012).

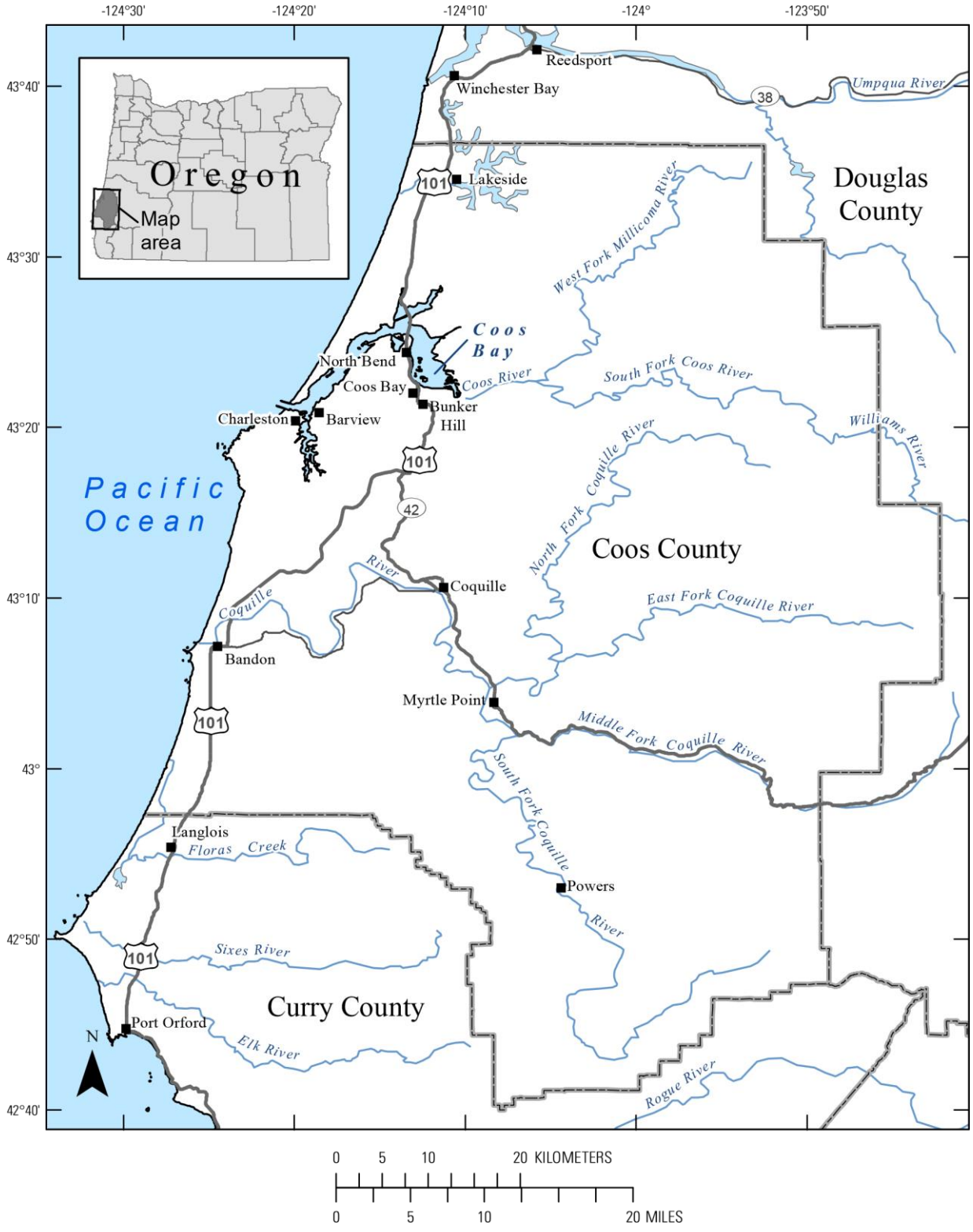

Figure 2. Map of Coos County
Source: USGS 2016a

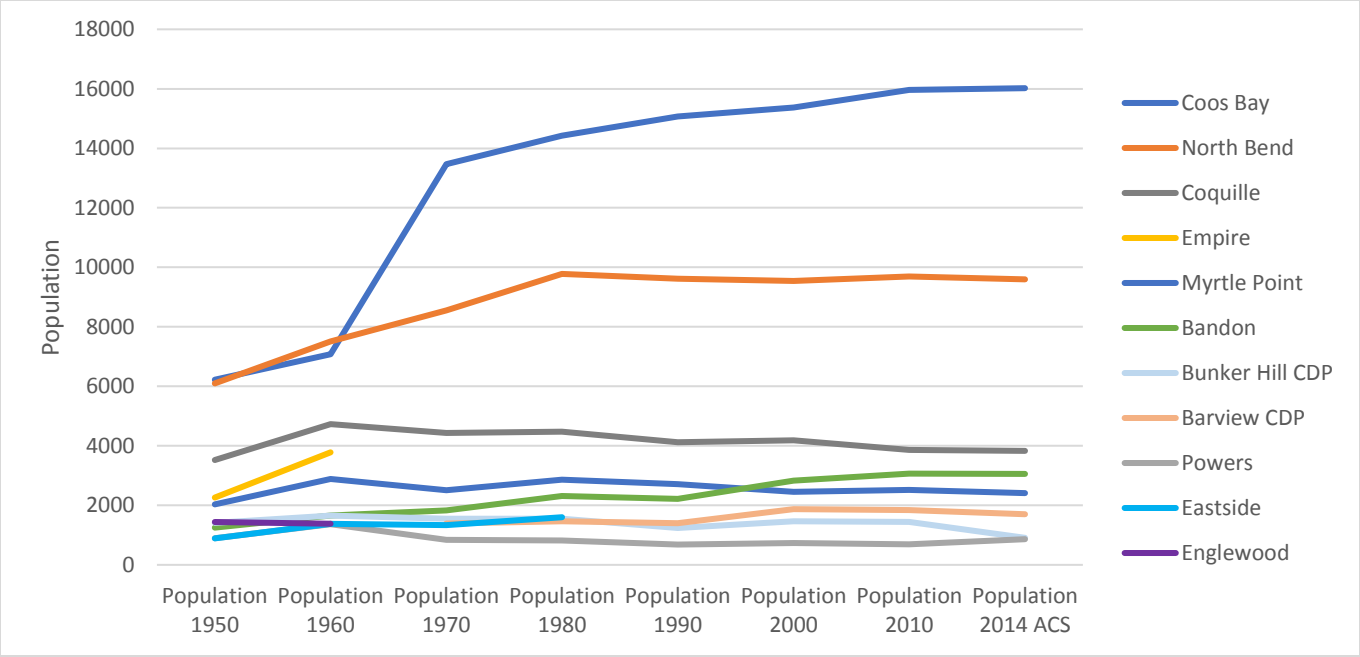

Figure 3. Historical population trends in Coos County communities (1950–2014)
Sources: Census Bureau 1952, 1981, 1990, 2000, 2010a

3.3 History of Lincoln County and the City of Newport

Lincoln County is located along the north-central Oregon coast (Figure 4). It encompasses 6693 square km, fronting 80 miles of coastline from Cascade Head and the mouth of the Salmon River at the north (~45° 2’ Latitude) to just south of the Yachats River near Cape Perpetua (~44° 17’) (State of Oregon 1973b). The two earliest settlements in the area were Newport at the mouth of Yaquina Bay, and Toledo on the Yaquina River, located 13 km inland from Newport.

Figure 4. Map of Lincoln County
Source: USGS 2016b

Most of the area that today makes up Lincoln County was originally included in the Coast Reservation, an area of well over a million acres (> 400,000 hectares) of the north-central Oregon coast. It was established as a reservation in 1855 to provide land for Native peoples relocated from other areas of the coast as well as the Willamette, Umpqua, and Rogue regions of the Oregon Territory (Ruby et al. 2010, Wilkinson 2010). As years went on, Euro-American speculators and developers became particularly interested in the Yaquina Bay area of the reservation, both for its natural harbor and plentiful resources (Wilkinson 2010). In 1861, Yaquina Bay oyster harvests by San Francisco speculators caused disputes with the Native population of the reservation over ownership of the intertidal resources (Youst 1997). As a result of growing tensions and political pressure, Congress re-opened the "Yaquina Strip" to American settlement in 1865 (Ruby et al. 2010, Wilkinson 2010), leaving portions of the original reservation to the north and south. The southern portion of the remaining Coast Reservation became known as the Alsea Sub-agency, and the northern portion was referred to as the Siletz Reservation.

The earliest Euro-American settlers to the Yaquina Bay area included fur traders and fishermen. Newport and Toledo were both founded in 1866 (Lincoln County Historical Society c2014–2017; City of Toledo c2016). In 1893, Lincoln County was formed from the western portions of Benton and Polk counties. Toledo was the seat of Lincoln County until 1952, when a vote was passed to relocate the seat to Newport (City of Toledo c2016). Newport has been the largest settlement throughout most of the history of American settlement in this region, and continues to serve as a hub for transportation and commerce for the surrounding communities. Throughout its history, fisheries and tourism have been two of its key industries. Salmon canneries and ocean resorts both sprang up soon after the town's establishment (Pinyerd 2007, Wells 2006). Today, Newport remains one of the top fishing ports in Oregon, overtaking Astoria as the top West Coast landings port in 2013 (Associated Press 2015), and tourism also remains a primary economic driver. Toledo was historically the hub for industrial logging activity in Coos County, with easy access to both railroad and river transport of logs (City of Toledo c2016). Toledo remains the hub for forest products in Lincoln County.

Following this initial development of the Yaquina Strip, continued settlement pressure led to the opening of most remaining Coast Reservation lands between 1875 and 1894 (Ruby et al. 2010, Wilkinson 2010). The Alsea Sub-agency lands to the south of Yaquina Bay were opened in 1875. George M. Starr homesteaded at Yachats in 1876, overtaking the Alsea Sub-agency buildings. Yachats would eventually be incorporated as a small municipality in 1966. Waldport was founded by David Ruble in 1879 and incorporated in 1910. It quickly became another center for sawmills, salmon canneries, and agriculture (Waldport Museum [date unknown], City of Waldport c2015). The Dawes Act of 1887 did away with communal ownership of reservation lands, and assigned individual allotments to each eligible Tribal member. After a 20-year period, these allotments could be sold to non-Tribal members. Additional Acts of Congress in 1892 and 1894 opened a majority of the remaining Siletz Reservation, to the north of Yaquina Bay. The Depoe Bay area was homesteaded in 1894, and the town was platted in 1927 and finally incorporated in 1973. The final 3,197 hectares of the Coast Reservation were released for non-Native settlement in 1954, under the Western Oregon Termination Act (Ruby et al. 2010). Lincoln City was incorporated in 1965, combining a series of small settlements along a 7-mile stretch of coastline in northern Lincoln County (Lincoln County Historical Society c2014–2017). At the time of its incorporation, Lincoln City eclipsed Toledo as the second largest city in Coos County, as illustrated in Figure 5.

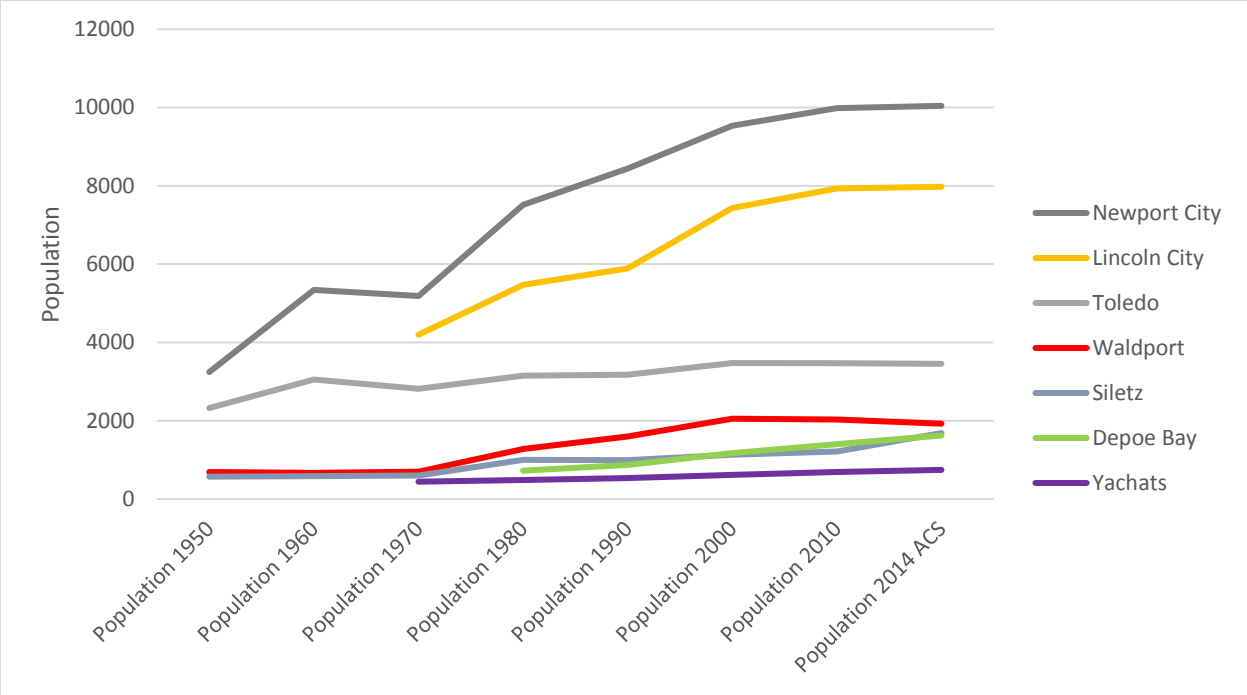

Figure 5. Historical population trends in Lincoln County communities (1950–2014)
Sources: Census Bureau 1950, 1981, 1990, 2000, 2010a

3.4 Present Day: A Characterization of Society, Culture, and Economy in the Study Area

In order to explore the implications of HD effects of climate-related environmental change in the study area, it is important to understand existing issues and trends that characterize the present-day cultural, economic, and social context. This section provides a summary of present socioeconomic and cultural characteristics available in the literature. Additional socioeconomic statistics of the study area are provided in Appendix 1.

The historical events and industries that characterized the origins of these communities remain key components of study area communities today, along with new and diversifying livelihoods. Over the past decades, both Coos and Lincoln Counties have seen substantial growth in service industries associated with tourism and recreation. Top employers in the Coos Bay area include tourism and hospitality services, medical and retirement facilities, outdoor recreation businesses, and Tribal casinos (Ivy c2010), while top employers in Lincoln County include the Confederated Tribe of Siletz Indians, health and educational services, county government, the nearby Georgia Pacific mill in Toledo, marine resource management agencies, seafood processing, and tourism and hospitality businesses (EDALC [date unknown]). Despite declines in overall output and relative importance, fisheries and forestry continue to be significant contributors to the economy and culture of coastal Oregon (CCD 2013, TRG 2014). As illustrated in Figure 6, in 2010 extractive industries (e.g., fisheries and forestry) and the service sector that supports tourism and recreation, represent a greater percentage of the economies of Coos and Lincoln Counties compared to the United States as a whole, and also compared to the State of Oregon.

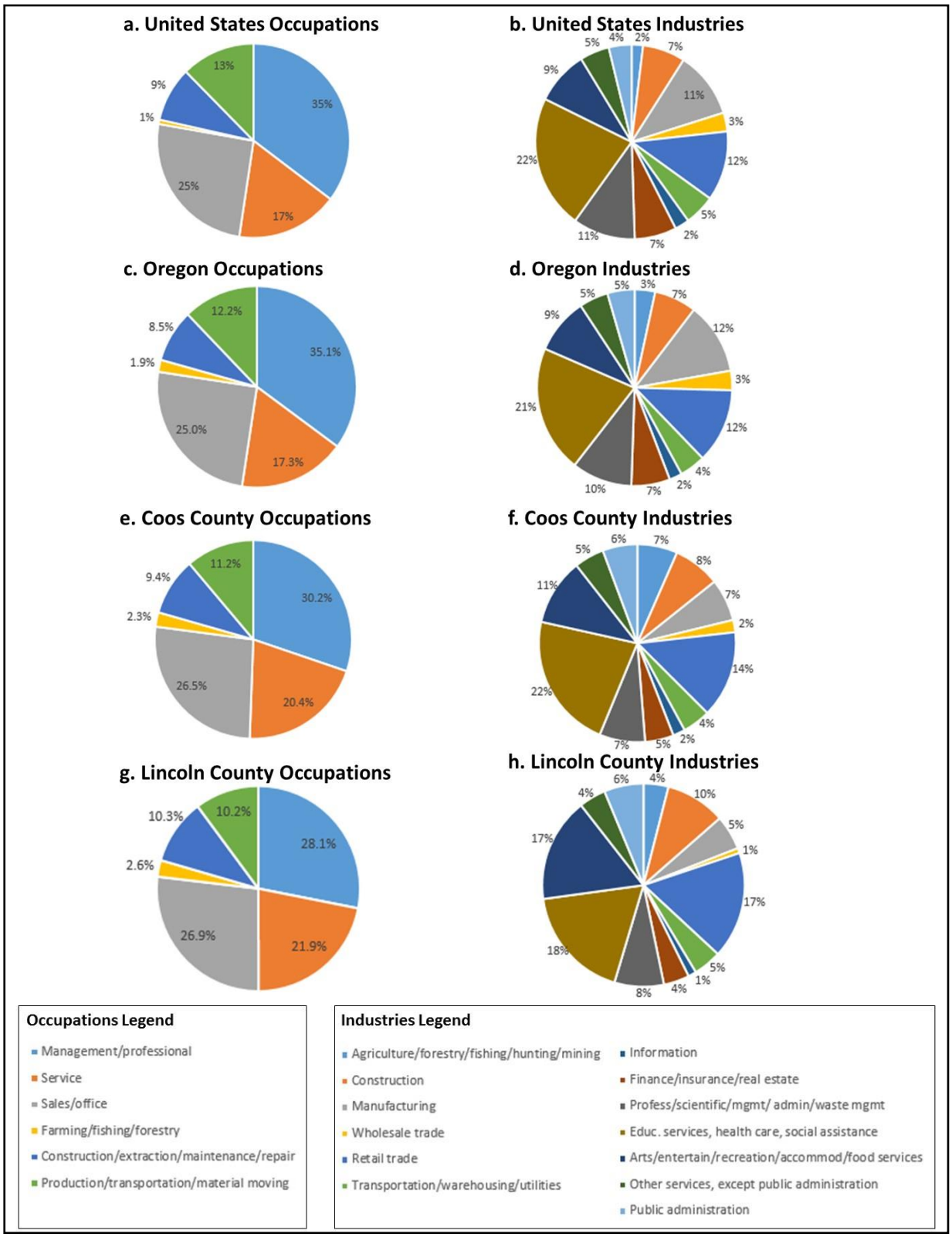

Figure 6. Profile of occupations and industries (2010)
Source: Census Bureau 2010b

In addition to the growth of the service sector, transfer payments associated with retirement are growing as a primary source of income in coastal Oregon. The large economic effect of retirement in the study area is evidenced by the higher percentage of the Coos and Lincoln County populations over the age of 65 (21.4% and 21.9%, respectively) compared to 13.9% of Oregon and 13.0% of the United States as a whole, and the fact that a greater percentage of transfer payments were associated with retirement funds (88%) compared to the State (84%) and nation (85%) (Census Bureau 2010, TRG 2014). Statewide, the median age of the population in Oregon in 2010 (38.4 years) was only slightly higher than the median age of the U.S. population as a whole (37.2 years). However, both Coos and Lincoln Counties exhibit substantially higher median ages (47.3 and 49.6 years, respectively) (Figure 7). This difference in age is in keeping with the experience of many rural areas that are relatively far removed from urban centers, and are experiencing an out-migration of youth. Relocation of retirees to the coast is also a driving factor influencing these statistics (TRG 2014, CCD 2013). The Resource Group (2014) reports that the demographics of coastal Oregon are "transforming from young families raising children to a population dominated by retirees drawn to the quality of life of the Oregon Coast" (p. 2). The changing demographics of coastal Oregon communities as a result of retirement patterns have been noted to contribute to shifting culture and economy, with a shift away from the dominant forest products industry of past decades to the service industry (Ivy c2010), and also have implications for school populations and ability of local governments to raise revenues to provide necessary community services (TRG 2014).

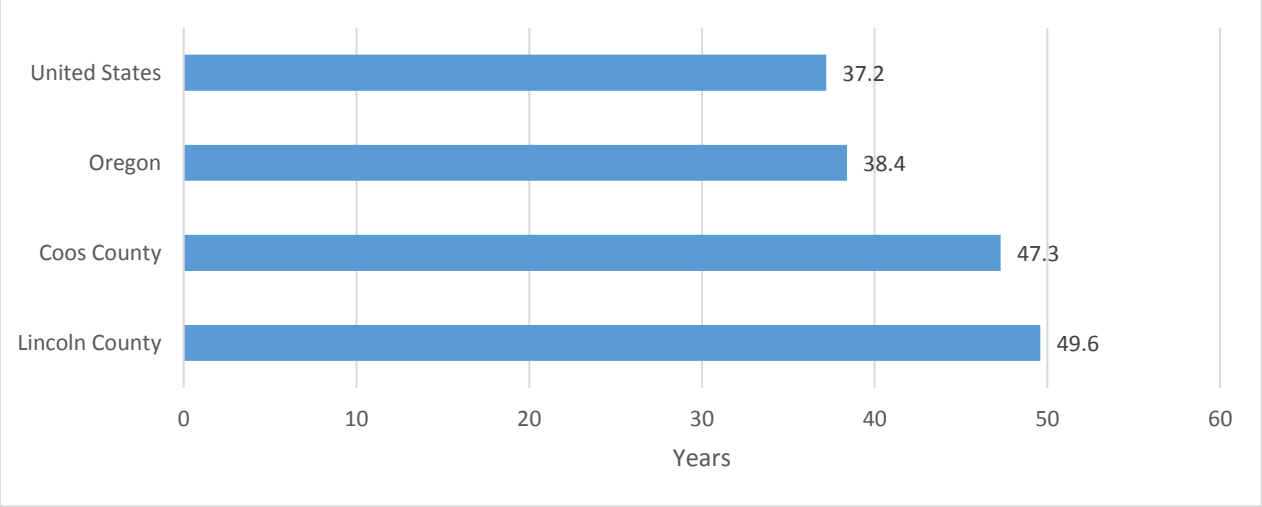

Figure 7. Median ages for the United States, Oregon State, and Coos and Lincoln Counties (2010)
Source: Census Bureau 2010a

Although the median age in rural coastal Oregon is clearly higher than other areas of the State and the nation, information about increasing trends over time should be considered in the context of an aging population both State- and nation-wide; between 2000 and 2010, the median age of the population increased in the United States, the State of Oregon, and in all communities in both Coos and Lincoln Counties (Figure 8). In Lincoln County in 2010, the Cities of Yachats, Depoe Bay, and Waldport had the highest median ages, whereas the Cities of Bandon and Powers topped the charts in Coos County. A slightly higher median age was reported overall in Lincoln County compared to Coos County in both 2000 and 2010.

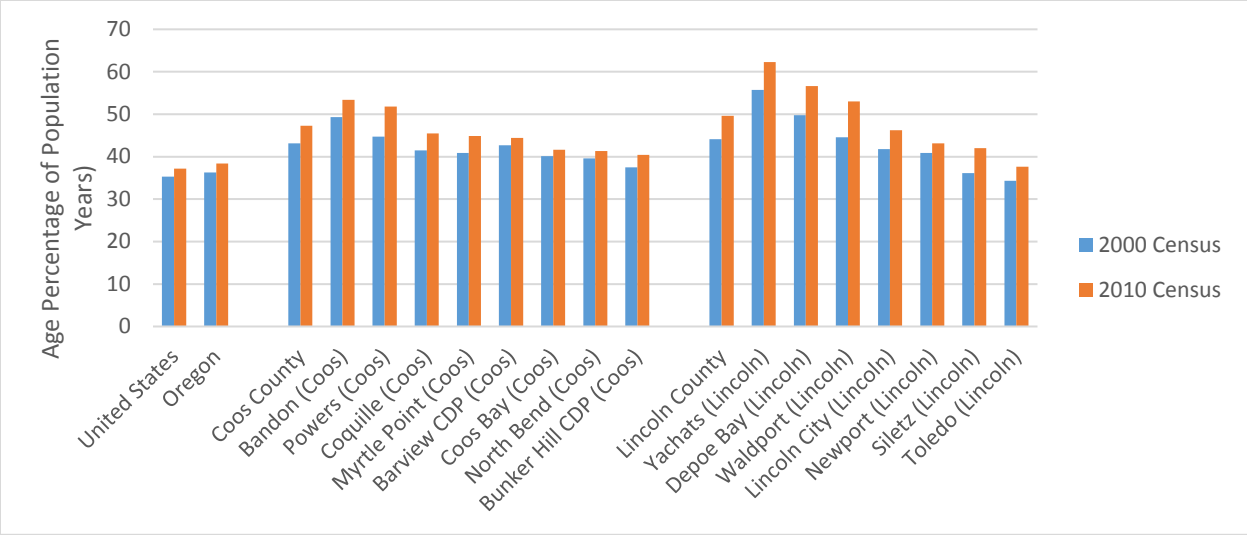

Figure 8. Median ages for the United States, Oregon State, and Coos and Lincoln Counties and Communities (2000 and 2010)
Source: Census Bureau 2000, 2010a

4 Methods

The study was carried out using two complementary data collection methods: 1) review and synthesis of literature and secondary datasets relevant to study area history, demographics, and economic activity, and 2) primary qualitative data collection using open-ended, ethnographic discussions with one or more respondents. The following section describes background research (Section 4.1), sampling design (Section 4.2), participant identification (Section 4.3) qualitative data collection (Section 4.4), pilot conversations (Section 4.5) and qualitative analysis (Section 4.6).

4.1 Selection of Key Resource/Livelihoods to Guide Sampling

Background research for the regional profile assisted in identification of a range of important natural resources and livelihoods in the study area, including agriculture, energy production, fisheries, forestry, research-related occupations, tourism, recreation and other service-related occupations, and health and education-related occupations (OCCRI 2010, Census Bureau 2010b). The literature review, in combination with review of secondary data sources including the U.S. Census and the American Community Survey, was used to generate a regional profile to describe the social, cultural, and economic characteristics of the study area where primary data collection would be carried out (Section 3). More detailed socioeconomic information is provided in Appendix 1. As a supplement to the literature review, scoping conversations regarding culturally and economically significant resources and livelihoods were carried out with social science researchers, State and local resource managers, and extension agents familiar with the study area. A total of 16 researchers and resource managers were contacted as part of this scoping exercise. These individuals were identified based on authorship of publications relevant to the study area and (or) their location in or near the study area.

Based on the literature review, secondary data sources, and scoping conversations, the following resources/livelihoods were selected to guide sampling: *Coos County*: 1) commercial fishing; 2)

forestry, and *Lincoln County*: 1) commercial fishing; 2) tourism and recreation. Criteria for selection of resource/livelihood categories for each of the nested cases included: 1) relevance to Federally managed lands, waters, or natural resources; 2) combined cultural and economic significance of the livelihoods in the study area; and 3) relevance to BOEM, and other resource management agencies. Available time and funding limited the overall number of resource/livelihood categories that could be selected to guide sampling within each of the nested case studies.

In addition to the resource/livelihood categories listed above that were identified through background research, BOEM was interested in emergent issues related to coastal infrastructure in the study area. As a result, individuals with expertise related to coastal infrastructure were also targeted to participate in the study. This included employees of ports and individuals involved in the management of other coastal utilities and infrastructure. Information about environmental changes and HDCC effects associated with coastal infrastructure is examined alongside the other three resource/livelihood categories. Like the other categories, coastal infrastructure is referred to throughout this report as a category of *resource/livelihood expertise*, for a total of four expertise categories.

4.2 Sampling Design

A purposive sampling approach was utilized to target individuals with expertise specifically related to the selected resource/livelihood categories. Purposive sampling is a non-probability sampling strategy that intentionally targets key informants that have the potential to provide in-depth information and unique perspectives (Tashakkori and Teddlie 2010). One common use of purposive sampling is pilot study research that is intended to identify emergent themes to inform the design of a larger study (Bernard et al. 2017).

In this study, the goal of sampling was not to generate a representative sample of the study area population. Instead, sampling logic was geared toward accessing a wide range of perspectives and experiences associated with the selected resource/livelihood categories. To this end, a stratified purposive sampling approach (Tashakkori and Teddlie 2010) was used to target respondents from nine different affiliations to ensure a diversity of viewpoints related to each resource/livelihood category. The following target quotas were set for the affiliation strata within each of the resource/livelihood expertise samples: Tribes (1–2 respondents), Federal agencies (1–2), State agencies (1–2), county agencies (1), local governing bodies (e.g., municipalities, chamber of commerce, other local service providers) (2–3), academic institutions (1), non-profit organizations (1), small businesses (e.g., family-run businesses with a small number of employees, or business associations) (2), and industry (i.e., corporations or industry associations) (1). Table 1 presents criteria for inclusion in the study sample based on expertise in one or more resource/livelihood categories, while Table 2 presents criteria for inclusion in each of the nine affiliation strata.

Table 1. Inclusion criteria for resource/livelihood expertise categories

Fisheries Expertise – Individual works in some aspect of the fishing industry or fisheries fishermen, seafood buyers, seafood processors, and State or Federal agency fisheries employees, Sea Grant Extension agents, and academics or representatives of non-profits engaged in fisheries research or policy work.
Forest Expertise – Individual works in some aspect of the forestry or non-timber forest resource management, including private, State, Federal, and Tribal forest land owners, timber mills, non-timber forest product harvests or buyers, county, state or federal agency forestry employees, Forest Extension agents, and academics or representatives of non-profits engaged in forest research or policy work.
Tourism & Recreation Expertise – Individuals works in some aspect of the tourism or management, including local tourism business owners, the Chamber of Commerce, tour companies, tourist educational programs, State or Federal agency tourism & recreation employees, and academics or representatives of non-profits engaged in tourism and recreation research or policy work.
Coastal Infrastructure Expertise – Individual works directly in the maintenance, operation, of coastal infrastructure, including port and navigational infrastructure and other shore-based utilities and transportation infrastructure.

Table 2. Criteria for characterization of affiliations

Tribal – Official representative of a Tribe, Tribal employee, or enrolled Tribal member
Federal – Employee of a Federal agency
State – Employee of a State agency
County – Employee of a county agency
City/Other Local Body – Employee of a municipality or other local governing body, including ports and utility districts
Academic – Individual employed by an academic institution to conduct research and/or engage in natural resource extension activities*
Non-Profit – Employee of a non-profit organization
Industry – Employee of a large corporation or industry association
Small Business – Employee of a family-owned or small company (e.g., family-run fishing boat; restaurants; tour companies; family-run forest product businesses)

* Individuals working for Cooperative Extension programs do not fit neatly in these affiliation categories, as their roles are designed to be boundary-spanning. Extension programs include agricultural and forest extension based out of Land Grant Universities, the NOAA Sea Grant program, and the NOAA Regional Integrated Sciences and Assessments (RISA) climate extension program (Stevenson et al. 2016). Given the need to maintain the anonymity of respondent quotations, the research team elected not to create a separate affiliation category for extension agents. Instead, the individuals with extension roles who participated in the study were included in the larger category "Academic" given that all held University appointments and were involved in academic research in combination with their extension activities.

4.3 Participant Identification

Distinct approaches were required to identify knowledgeable informants within the different affiliation strata. In the cases of seven out of nine of the affiliations—Tribes, Federal agencies, State agencies, county agencies, Cities or other local governing bodies, academic institutions, and non-profit organizations—individuals with expertise specific to the four different resource/livelihood categories were straightforward to identify. Specific names and contact information were often listed on websites, or could be obtained by calling an office and asking to speak with an individual with the appropriate job description. However, in the case of the other two affiliations – industry and small business – potential study participants were less readily identifiable from publicly available sources. For these affiliation strata, insider knowledge was required to assist in identification of potential study participants.

Snowball sampling was used to build a list of potential industry and small business participants with knowledge of the different resource/livelihood categories in the study area. In addition to the industry and business samples, recommendations of knowledgeable individuals within other affiliation strata were also pursued as time allowed. A snowball sampling approach begins with seed individuals with insider knowledge who can recommend knowledgeable individuals (Patton 2002). Data collection for this study took place in two phases, including two weeks in August, 2015 and two weeks in November, 2015. August fieldwork emphasized discussions with respondents in more easily accessible affiliation categories. During these initial conversations, respondents were asked for assistance in identifying knowledgeable individuals working in industry and (or) running small businesses in the study area.

4.4 Pilot Conversations

Prior to beginning field data collection, three pilot conversations were carried out to test whether the research goals would be understandable to study respondents. As part of the pilot conversations, the individuals were asked to engage in cognitive interviews to describe areas of confusion. During this process, they all requested definitions of several of the terms used in the study objectives. These concepts, which are defined in Section 1.1, were either not familiar to a wide audience or could be interpreted in multiple ways.

The pilot conversations thus highlighted the importance of providing basic descriptions of these terms at the beginning of ethnographic discussions to ensure that study respondents had a common starting point for consideration of these concepts. Providing definitions can influence the way respondents think about research topics. This was appropriate in the context of this study, because the purpose of primary data collection was to understand respondents' perceptions and observations of climate-related environmental issues and HDCC effects *as defined*, rather than to understand how respondents would independently conceive of the idea of environmental change or the idea of human dimensions effects.

4.5 Qualitative Data Collection

Ethnographic discussions were conducted for two weeks in August, 2015 and two weeks in November, 2015, and were carried out by the lead author. Discussions were scheduled at times and locations convenient for participants, and took place in groups of one or more participants. The largest group consisted of six participants. Eight conversations were conducted over the phone outside the field periods in an effort to fill in remaining gaps in the sampling targets. All discussions were completed by the end of January, 2016.

Prior to the conversations, participants were provided with information about the study by email and asked if they agreed to participate. At the beginning of each conversation, permission was requested to audio record. In all cases, permission was granted. All conversations were later fully transcribed to prepare for coding.

Discussions were open ended and were guided by three key topics of interest linked to the study objectives: 1) current or potential future environmental changes or issues that the participant had personally observed or heard about; 2) current or potential future social, cultural, and (or) economic effects of environmental issues or changes that the participant had personally observed or heard about, and 3) social science data gaps and barriers to use of social science information in climate-related decision-making or decision-making more broadly. At the beginning of each conversation, the researcher provided brief verbal definitions of key study concepts, as defined in Section 1.1. In addition, given the many confounding variables that contribute uncertainty around drivers of environmental change, participants were instructed that all environmental issues and changes were relevant to the discussion, whether or not they perceived a clear link to climate change as a driver.

4.5.1 Response Rate and Characteristics of the Respondent Sample

A total of 97 individuals were contacted and invited to participate in the study. Of these, 79 chose to participate. Of the 18 individuals who did not participate in the study, nine directly declined participation, while the other nine did not respond to emails or phone calls inviting their participation. Eight individuals communicated the reason for their decision not to participate. Of these, five were too busy to meet, two felt they did not possess the correct expertise to comment on issues of climate-related environmental issues or HDCC effects in coastal Oregon, and one was overwhelmed with requests to speak with climate researchers.

A total of 55 ethnographic discussions were carried out for this study. Of these, 41 were one-on-one conversations, and the remaining 14 included between 2 and 6 respondents. Of the total 79 individuals who were present during these discussions, 77 actively participated in the conversation and are considered in the following sample characteristics. Seven respondents were Federal employees; eight were representatives of Tribes located within the study area; nine were State employees; five were county employees; 11 were officials or employees of local governing bodies (e.g., municipalities, port authorities, public utility districts); nine were academics; 11 were employees of non-profit organizations; 18 were owners or employees of small businesses, including restaurants, fishing boats, tour companies, or other small businesses; and seven worked in industry (e.g., employees of large corporations or business or industry associations). Neither affiliation nor expertise categories were mutually exclusive; it was possible for individual respondents to be grouped into more than one expertise category and (or) more than one affiliation.

Table 3 presents the breakdown of respondent affiliations within each of the four resource/livelihood expertise categories compared to target quotas. Respondents were asked to confirm their assignments to both affiliation and resource/livelihood expertise categories prior to finalization of this breakdown.

Table 3. Respondent affiliation and gender, across resource/livelihood expertise categories

		Federal Agency	Tribe	State Agency	County Agency	Local Governing Body	Academic	Non-profit	Small Business	Industry	TOTAL
Fisheries	Female	1	0	0	0	0	3	1	3	1	**9**
	Male	1	3	1	2	2	0	0	5	3	**17**
	Total	**2**	**3**	**1**	**2**	**2**	**3**	**1**	**8**	**4**	**26**
Forest	Female	2	0	1	0	0	2	1	1	0	**7**
	Male	2	5	0	0	1	2	2	1	2	**15**
	Total	**4**	**5**	**1**	**0**	**1**	**4**	**3**	**2**	**2**	**22**
Tourism & Recreation	Female	1	0	1	0	0	0	3	6	0	**11**
	Male	0	0	2	0	0	1	3	2	0	**8**
	Total	**1**	**0**	**3**	**0**	**0**	**1**	**6**	**7**	**0**	**19**
Coastal Infrastructure	Female	0	0	0	0	1	0	0	0	0	**1**
	Male	1	0	0	0	7	0	0	1	1	**10**
	Total	**1**	**0**	**0**	**0**	**8**	**0**	**0**	**1**	**1**	**11**

Target quotas were achieved or exceeded for six out of the nine affiliation strata (Federal, State, academic, non-profit, small business, and industry). In the case of Tribes, county agencies, and local governing bodies, it was not always possible to identify individuals with specific resource/livelihood expertise, so these individuals were invited to discuss their general observations regarding environmental issues and changes and HDCC effects on the study area. One State-level and one small business respondent who did not possess specific resource/livelihood expertise were also included in the sample given their detailed knowledge of climate change policy and climate-related environmental effects in the study area.

The geography of respondent expertise was also an important sampling consideration. Where possible, it was preferred that respondents possess localized resource/livelihood expertise specific to Coos and (or) Lincoln Counties. However, in cases in which no respondents of a given affiliation strata could be identified with localized expertise, the sampling design allowed for respondents with more general knowledge of coastal Oregon to be included in the study. Respondents of certain affiliations were more likely to possess localized expertise (e.g., counties, local governing bodies, Tribes, and individuals working in industry or small businesses).

4.6 Qualitative Data Analysis

Qualitative analysis was carried out by the lead author, and involved three sequential coding methods: Provisional, Initial, and Axial Coding. Provisional Coding took place prior to narrative analysis. This coding method involves development of a 'start list' of anticipated code categories based on literature review, conceptual frameworks, and (or) established research questions (Saldaña 2009). For the purposes of this study, the development of provisional codes prior to initiating narrative analysis helped ensure that resulting code categories would contain information relevant to the study objectives.

Following data collection and transcription of the ethnographic discussions, narrative analysis built from the provisional code list through two full cycles of coding. The first cycle was carried out using Initial Coding, an approach originating from grounded theory that is used to split narrative data into numerous component parts (Saldaña 2009). The list of codes evolved substantially through the course of first cycle coding. In order to ensure that codes had been applied consistently across all 55 transcripts, the researcher kept a detailed record of the transcript number at which each new code was first applied, in addition to the point in the dataset at which other adjustments were made in the meaning of a specific code. This enabled the researcher to circle back to all earlier transcripts to ensure that codes were applied consistently throughout the dataset. For readers interested in exploring the codes that were used to facilitate qualitative analysis, the final list of codes and code descriptions produced during first cycle coding is included in Appendix 2.

Lastly, a second cycle of narrative analysis was carried out using Axial Coding, another method originating from grounded theory that is used to reassemble split data into meaningful categories and themes (Saldaña 2009). The process of Axial Coding was focused on generation of themes related specifically to the study objectives, including: 1) environmental issues and changes in the study area, 2) HDCC effects in the study area (human dimensions effects associated at least in part with climate-related environmental change), 3) social science information gaps; and 4) barriers to social science integration in decision-making. A list of the themes generated during second cycle coding, including individual codes that were theoretically linked to each theme, is presented in Appendix 3.

In response to study objectives #1 and #2, analysis of the salience of individual environmental issues and HDCC effects was aided by the calculation of simple frequency counts. A presence/absence calculation (i.e., participants who mentioned the code one or more times are counted toward the total) was preferred over raw frequency of codes (i.e., the total number of times a code is applied), because application frequency could more easily be influenced by an individual researcher's coding technique or the degree to which a respondent repeats him/herself. A simple presence/absence count is a more consistent and easily standardized method to determine the relative prevalence of a specific code or theme across respondents (Namey et al. 2008, Saldaña 2009). The presence/absence frequency count for each code is divided by the total number of respondents (77) to generate a percentage score. However, frequency calculations were merely an aid to qualitative analysis, and should not be interpreted as an absolute assessment of the relative importance of individual issues or effects. First, this is because many of the individual issues and effects mentioned by respondents are highly interrelated or interdependent. Second, it is important to acknowledge that frequency of mention may have more to do with what is tangible than what is most valued overall by participants. For example, cultural knowledge is often tacit and difficult for individuals to articulate (Polanyi 1958, Winthrop 2014), and as such cultural issues or effects arising from environmental change may be relatively difficult for individuals to formally communicate. Nevertheless, most economic and social impacts can be understood to have interdependent cultural ramifications.

Qualitative analyses responding to study objectives #3, #4, and #5 were supported by use of the co-occurrence tool in Atlas.Ti (2016). This tool allows for identification of the rate at which two particular codes were applied to the same portion of narrative data. For example, examination of co-occurrence between environmental issue/change and HDCC effect codes with the codes "Time – Current" and "Time – Future" helped rank those issues and effects that respondents most frequently perceived to be taking place currently vs. those they felt had the potential to impact the study area in the future (study objective #3). Co-occurrences between environmental issue/change and HDCC effect codes and two codes identifying discussion of causality – "Climate Effect Driver" and "Other Stressor" – were used to identify both climate- and non-climate-related issues and effects most frequently perceived by respondents to act as drivers of cumulative effects in the study area (study objective #4). Finally, co-occurrence of the codes "Social Science Data" and "Information Gap" was used to identify the most commonly perceived gaps in social science information (study objective #5).

In some cases, isolation of the units of information specified by the study objectives was a highly complex process. The following two sub-sections detail specific coding strategies that enabled identification of individual HDCC effects (study objective #2), as well as identification of cumulative effects of climate change on the social system (study objective #4).

4.6.1 Coding and Analysis of HDCC Effects

Two key challenges arose in isolating individual HDCC effects from the narrative data during the coding process. First, although study objective #2 specified that findings should isolate social, cultural, and economic effects, in practice these distinct human dimensions categories are highly interrelated; an individual human dimensions issue frequently has social, cultural, and economic elements. As a solution to this interrelatedness, individual HDCC effects identified during first cycle coding could later be grouped into more than one social, cultural, and (or) economic theme if relevant. For example, the issue of changing access to forest lands as a result of fire closures was relevant to both the social theme, *Recreation*, as well as the economic theme, *Economic Impacts on Forest Industries*.

A second challenge associated with isolating HDCC effects was the inherent difficulty in determining causality. There is a high level of uncertainty regarding climate trends, making it difficult for study respondents to conclusively point to climate-related effects. Further, climate change is only one driver among many that exert influence on human dimensions trends in the study area, calling into question the degree to which climate change is a primary factor influencing a given effect. Further, one HDCC effect may act as an intermediary driver of another HDCC effect, potentially obscuring the initial role of climate-related environmental change in triggering the chain of events. With these issues in mind, an analytical approach was devised to identify differences between human dimensions effects that respondents perceived to be climate-driven (HDCC effects) and those perceived to be non-climate-related (HD effects), as well as those for which respondents were uncertain regarding the role of climate as a causal factor.

Specifically, comments about human dimensions effects were coded as HDCC if either: 1) the respondent spoke with certainty that climate change *is a primary driver* of the effect; or 2) the respondent was uncertain what the cause of the effect was, but felt climate change was a *likely contributor*. Human dimensions effects were coded as HD if either: 1) the respondent spoke with certainty that climate *is not a primary driver* of the effect; or 2) the respondent was uncertain what the cause of the effect was, and identified *one or more possible non-climate drivers*. Thus, effects about which respondents expressed uncertainty regarding drivers were *double coded* as both HD and HDCC. For example, the HDCC effects discussed in Section 5 are derived from all quotations coded as HDCC, inclusive of the range of certainty levels. Therefore, HDCC effect findings represent the group of effects perceived by respondents to be driven – or potentially driven – in part or fully by climate-related environmental change. Respondent perceptions are compared against recorded scientific measurements and climate model projections throughout the report.

All HDCC effects were joined with the time codes described in Section 4.6 to produce two separate lists of HDCC effects – one that respondents spoke about in the present tense, and a second list of effects that respondents spoke about as possible future effects. Frequency counts were calculated for both the current and future lists, allowing for comparison of how frequently individual HDCC effects were perceived to be current and (or) potential future effects.

4.6.2 Coding and Analysis of Cumulative Effects

Cumulative effects are examined using a framework provided by Brereton et al. (2008). According to the typology, cumulative impacts can accrue through accumulation of impacts either temporally (i.e., multiple impacts within a certain amount of time), spatially (i.e., multiple impacts within a certain spatial area), they can be triggered in a series of indirect impacts (linked triggered effects), and (or) multiple distinct impacts can be triggered by a single action, event, or change (linked associative effects). A majority of the environmental issues/changes and HDCC effects discussed by respondents could be viewed as having some elements of these types of interactions, but some examples provided by respondents offered particularly useful illustrations. These more obvious examples of complex interactions between variables were coded as “Interaction Effect” during first cycle coding.

Generally, cumulative social effects can be understood to arise from interactions between social, cultural, economic, and environmental variables (Vanclay and Esteves 2011). This study is specifically interested in *climate-related* cumulative effects on the study area social system. As such, *climate-related cumulative social effects* were primarily considered to be those arising from interactions between climate-related environmental issues/changes and (or) HDCC effects. In addition, non-climate-

related stressors – including potential Federal agency actions – may interact with these climate-related drivers and contribute to climate-related cumulative effects.

5 Results of Qualitative Data Collection

The qualitative dataset provides perception data from the 77 study participants related to perceived current and potential future environmental issues and changes in the region (Section 5.1), perceived current and potential future HDCC effects in the study area (Section 5.2), and perceived interactions between these and non-climate-related variables to produce cumulative social impacts (Section 5.3). Finally, study respondents spoke about perceived social science information gaps in coastal Oregon (Section 5.4.1), as well as perceived barriers to integration of social science information in decision-making (Section 5.4.2).

The results of qualitative data analysis reflect the knowledge and experience of the individual respondents who participated in this study. Observations and perceptions provided by individuals with direct, lived experience in a location are well-suited to identification of environmental shifts and associated changes in way of life (Duerden 2004). The body of observations reported here serves to highlight issues that are currently salient in the minds of individuals living in the study area and (or) working on issues pertinent to the study area. Where possible, perception data are presented alongside discussion of existing scientific measurements and projected climate changes. Despite challenges inherent to isolating the role of climate change in environmental issues and HD effects perceived in the study area, information distilled from the narrative perception data can help identify emergent issues and changes that may warrant more in-depth investigation as part of a cumulative impacts assessment under NEPA.

5.1 Perceived Environmental Issues and Changes in the Study Area

Study objective #1 was to identify major environmental issues and changes taking place in the study area (Section 1). In addition to results of literature review that detail historical climate, and observed and projected climate trends, ethnographic discussions were carried out to explore perceptions of climate-related environmental issues and changes taking place in the study area. Study respondents were asked to comment on environmental issues and (or) changes in the study area that they had personally observed, read about, or heard others discussing. This section presents nine environmental themes that emerged from the narrative data during second cycle coding.

It is important to note that several current, weather-related events were taking place during the period of data collection, and these issues may have been particularly fresh in the minds of study participants. These included record-breaking heat and a long-term drought along the West Coast, increased wildfire risk, a persistent warm water mass in the Pacific Ocean known as the blob, the presence of unusual warm water species off the coast of Oregon, and an unusually expansive and potent toxic algae bloom that led to numerous recreational and commercial shellfish closures in 2015 (see Section 2.3).

5.1.1 Exploration of Environmental Themes

During second cycle coding, individual environmental issues and changes mentioned by respondents were grouped into one or more categories in an effort to identify overarching themes. Nine distinct but interrelated themes were identified. In alphabetical order, they include: 1) aquatic conditions and patterns; 2) ecological integrity and ecosystem composition; 3) fish and wildlife health and survival; 4) forest health and survival; 5) material processes; 6) moisture patterns; 7) shifting seasonality; 8) storm activity; and 9) temperature patterns.

Examples of specific environmental issues and trends described by respondents are provided in this section to illustrate environmental issues and changes associated with each of these themes. Results of basic frequency analyses were used to help build these themes. Lists of the most frequently mentioned environmental issues and changes, including differences in emphasis across resource/livelihood expertise categories and perceptions of current vs. future potential impacts, are included in Appendix 4.

A. Aquatic Conditions and Patterns

The theme, *Aquatic Conditions and Patterns*, captures respondents' discussion of changing dynamics in aquatic environments, including water temperatures, sea level, ocean acidification, and shifting patterns of coastal upwelling. Water temperature issues were noted by the widest variety of respondent expertise categories, while respondents with forest expertise were less likely than other respondent categories to discuss other environmental issues and changes associated with aquatic environments.

An observation widely shared among respondents was that water temperatures in the study area were warmer than usual in 2015, including in both fresh and salt water (current). It is important to note that water temperature was perceived to be a key driver of both current environmental changes and associated current HDCC effects in the study area, including changing distributions, health, and survival rates of aquatic organisms. For example, higher temperatures in rivers and streams were perceived to drive 2015 recreational fishing closures. Similarly, unusually warm ocean temperatures during the period of data collection for this study, colloquially known as the blob, created conditions for the occurrence of a widespread toxic algae bloom in 2015. Respondents perceived associated concerns regarding human health risks and the social, economic, and cultural effects of commercial and recreational Dungeness crab fishery closures.

In addition to temperature, aquatic issues discussed by respondents and potentially linked to climate change included sea level rise, ocean acidification, and changes in upwelling associated with shifting wind patterns. Six respondents, including four from Lincoln County and two from Coos County, specifically noted that they had not observed any direct change in sea level.

> "There's nothing that I can see here where the ocean levels or the Bay levels have changed. I'm not seeing anything like that." *(Local governing body employee with Lincoln County coastal infrastructure expertise)*

A lack of apparent sea level change is in keeping with scientific measurements of RSL rise in the study area, where tectonic uplift of the North American plate is generally keeping pace with incremental sea level rise. Sea level rise was most often discussed as a potential future environmental change that

could occur in the study area. However, some respondents did report examples of current, direct effects arising from current sea level changes.

> "A lot of people [have told me that they] used to come to surf that reef, and now [they say] it doesn't break anymore because of sea level rise." *(Non-profit employee with coastal Oregon tourism and recreation expertise)*

Many of those who did cite sea level rise as a current issue based this opinion on scientific documentation of a slow rate of sea level increase along the Oregon coast rather than personal observation of apparent change. Others reasoned that sea level rise, in combination with other stressors such as increased storm intensity, could be considered a driver of current examples of coastal erosion in the study.

> "All we need is a much smaller rise [in sea level] accompanied by the usual storms that we get. We're just going to see those storm surges coming increasingly inland. And I think that is what happened to that pump station, [which] was becoming flooded a lot more often than it used to be." *(Non-profit employee with general Coos County expertise)*

Comments related to ocean acidification followed similar patterns, with a majority of individuals discussing potential future impacts, but not reporting current noticeable impacts. An employee of a local governing body in Coos County with coastal infrastructure expertise cited data from the Oregon Department of Environmental Quality that indicated pH had not yet decreased in Coos Bay. Similarly, a State employee in Coos County referenced data provided by the Partnership for Coastal Watersheds that indicate pH levels have in fact increased in the South Slough of Coos Bay over the past eight years (i.e., they have become more basic rather than acidic), which is the opposite of what would be expected with ocean acidification (Partnership c2010).

However, as of the time of this study, one tangible, current impact of ocean acidification was cited by multiple respondents: the failure of larval oysters in forming shells. These effects had not been experienced in the immediate study area, but other high profile cases along the West Coast, including Netarts Bay and Puget Sound, were referenced.

> **"**There have been real documented effects [of ocean acidification]... The big story that's been out there is this oyster hatchery in Netarts Bay, which actually supplies most of the West Coast oyster spat – the young, tiny baby oysters that others plant in different bays up and down the coast to culture oysters. They saw the inability for these oysters to develop because of that acidification." *(State employee with general fisheries expertise)*

The same State employee went on to explain that the Netarts Bay hatchery had been able to identify the issue with their water chemistry and solve the problem within their controlled environment, but the case raised questions about what would happen in the wild.

Several other respondents with fisheries expertise reported awareness of the ocean acidification issue and concern about potential future impacts, particularly related to the Dungeness crab fishery.

> "[Other than shellfish aquaculture], I don't think anybody has seen impacts in other fisheries right now. Probably the most concerning one for our area is the Dungeness crab fishery,

because of the crustacean megalopae[3] stage of the crab – when they're young – being so highly susceptible to pH changes. I think that one thing that we're learning from the oyster industry is that the pH balance puts a stress on a very small organism. Once they get to a certain critical size, then they're going to cruise. It's not so much that the acidic water is corroding the shells constantly, as much as it's just stressing the growth of the animal at a really young age… There's a fear that things may happen that will negatively affect fisheries. But nobody knows that it's really, really happening yet. Except for the oyster growers, of course." *(Small business owner with Lincoln County fisheries expertise)*

The last aquatic issue included under this theme was respondent perceptions of changing patterns of coastal upwelling, a key process supporting the productivity of coastal fisheries by bringing nutrient-rich water to the surface. Several respondents had observed changes in wind patterns and changes in the intensity of upwelling events (current). One respondent with fisheries expertise explained that changes in wind pattern are linked to changing temperature differentials between the land and sea (current).

"What's been happening is two things. The intensity of upwelling has increased, and the intermittency has decreased. We're getting more intense, less intermittent upwelling… The people working on that are concluding this is a change due to warming. Part of the change is really simple to explain, in that our upwelling system is driven by a pretty steady, strong north wind – a flow of air from the north to the south. Basically, that occurs most of spring and summer. A lot of what drives that north wind is a big temperature differential between the land and the water." *(State employee with general fisheries expertise)*

B. Ecological Integrity and Ecosystem Composition

The theme, *Ecological Integrity and Ecosystem Composition*, incorporates respondents' discussion of changes in species distributions and ecological function of ecosystems in the study area. These secondary environmental issues and changes were perceived to result from climate-related changes in temperature, precipitation, and ocean chemistry. Individuals with experience in both aquatic and terrestrial environments provided examples of current impacts, and also voiced concerns about future potential impacts if current conditions continue as longer-term climate trends. Respondents with fisheries expertise were most likely to share examples of changes in ecosystem composition and ecological integrity in aquatic and riverine environments. Forest respondents were likely to share perceptions of potential future changes in ecosystem composition in forest habitats.

Many respondents felt that climate-related changes in temperature, precipitation, and ocean chemistry could impact the suitability of study area ecosystems for native animal and plant species. A key dynamic underlying this concern was how climate-related environmental changes may undermine ecological processes at a fundamental level, including ecosystem services (e.g., supporting and regulating services). For example, in the marine context ocean acidification may impact organisms at lower levels of the food web, leading to cascading effects on fish and shellfish, birds, and marine mammals that support both fisheries and tourism and recreation activities (future).

[3] The early development of Dungeness crab and other crustaceans begins with a larval period and is followed by the megalopae stage, in which young crustaceans begin to settle in nearshore areas (ODFW 2017).

> "[Climate change] will have a huge effect [on] tourism and fisheries, because if you have a collapse in the food chain in the ocean, it all happens so stinking fast. It's over. If we have a collapse in our food chain here, I say it'll be worse than any tsunami." *(Small business owner with Lincoln County tourism and recreation expertise)*

Several respondents stated that ecosystem composition is already changing in coastal Oregon waters. They linked these perceived changes to the presence of the persistent warm water mass in the Pacific Ocean, known as the blob. For example, respondents with fisheries expertise reported that unusual species of plankton were present in Oregon waters in 2015, and felt this presented a threat to organisms at higher trophic levels of the food web (current).

> "We're getting the type of plankton that they have down in tropical waters rather than in northern waters, and they don't have as much fat on them. And so, starting at that level, everything that eats isn't getting nourished as well." *(Small business owner with Lincoln County fisheries expertise)*

As another example, a fisheries respondent discussed the diminished fitness of hake caught off the Oregon coast in 2015, and shared evidence that this was likely caused by changes in prey availability (current).

> Respondent: "The production manager [at the processing facility] was dissecting fish, opening their bellies to see what they were eating… He did it every day for 15 days, trying to figure out, 'What's going wrong with this fish? Why aren't we building protein [in these hake]?' There's nothing in [the female's] bellies. The males don't have hardly any more food in their bellies either, but they have a little food in them. And a little food was krill. We didn't see anything else but krill in their bellies."
>
> Interviewer: "What do they normally eat, do you know?"
>
> Respondent: "It's krill. It's shrimp. It's baby octopus. It's squid. It's their own self when they don't have any other food… So we were looking at the fish and saying, 'Man, this is strange.'" *(Industry employee with Lincoln County fisheries expertise)*

One of the most commonly discussed examples of the consequences of warmer water on species composition was the expansive bloom of the toxigenic diatom, *Pseudo-nitzschia australis*, in summer 2015. This plankton species was responsible for the high levels of domoic acid that led to commercial and recreational fishery closures throughout Oregon in 2015 (current).

> "We're looking at a possible challenging year with the domoic [acid levels in shellfish], caused by the algae bloom. The toxic algae bloom is being fed by this warmer water [the blob] and the El Niño, all in one year." *(Industry employee with general fisheries expertise)*

As a counterpart to changing species composition, fisheries respondents spoke about shifting species ranges. One described unusual species caught by Oregon fishermen in 2015.

> "We saw a sea snake when we were out fishing – the northernmost sighting of the yellow-bellied sea snake ever. And then one of our fishermen fishing for hake caught an opah [which is] not [an Oregon] fish. And then one of our hake fishermen caught a swordfish, which is

unheard of. And the salmon fishermen are catching pompano, which is not what happens up here." *(Small business owner with Lincoln County fisheries expertise)*

Another respondent echoed the presence of unusual warm water species, and also observed that, in 2015, local fishermen had to travel further afield to catch commonly targeted commercial species, including tuna, shrimp, and hake (current).

> "It was as though the entire ecosystem – all of the fish – shifted to the north about 100 miles, maybe more. I work in a group that there are some guys that have been fishing for 40–50 years, and we were seeing and hearing reports of fish that no one in memory had ever seen, and experiencing temperatures that none of us had ever seen. I don't know if that's a result of 'the blob,' as they refer to it, or if it was a result of the El Niño. I'm still not convinced we have an El Niño. I'm more convinced that this is just the new norm, because things have been kind of haywire ever since the El Niño in [the late 1980s]." *(Small business owner with Coos County fisheries expertise)*

In addition to these examples of current impacts, several fisheries respondents were concerned that continued conditions of warm water and ocean acidification could result in the crossing of ecological thresholds (future).

> "What we know about the zooplankton is that the cascading impacts of [ocean acidification] are going to affect the entire food web at some level." (*Small business owner with Lincoln County fisheries expertise)*

Respondents with expertise in terrestrial and riverine ecosystems also raised concerns about the effects of temperature and precipitation changes on the suitability of Oregon habitats for native flora and fauna. They discussed the cumulative effect of decreased water supply and higher temperatures, leading increases forest stress. A respondent with forest expertise described concerns related to the long-term viability of Douglas fir in the study area under projected warmer winter temperatures (future).

> Respondent: "The scare is that Douglas fir is on the southern [edge of it's] range here [in Coos County]. It needs a certain number of chilling hours every winter to break dormancy. If it doesn't get cold, the trees don't think winter's ever come and they don't want to break bud until spring's come. Otherwise they freeze. So if you don't get that chilling requirement, they just never break bud and they just die."
>
> Interviewer: "Just one season will kill it?"
>
> Respondent: "One season wouldn't kill it… it would set bud elsewhere on the tree. You'd get some funky growth because of that." *(Academic with Coos County forest expertise)*

Another respondent with forest expertise did not perceive current shifts in the range of vegetative species, but had heard discussion of likely future expansion of southern tree species and habitats north into Oregon with a changing climate (future).

> "In the Coast Range I don't think we have [yet] seen much of that movement of vegetative species that you might expect with climate change. [But] there is talk of redwoods, sequoia, and

oaks changing their range, and more oak savanna [habitat] moving northward." *(Non-profit employee with general forest expertise)*

C. Fish and Wildlife Health and Survival

The theme, *Fish and Wildlife Health and Survival*, captures respondent discussion of changing condition and (or) mortality rates of organisms living in the study area. Although some respondents were uncertain how these changes were linked to long-term climate trends, they were quick to acknowledge the role of warmer water temperatures, in rivers and streams as well as in the ocean. Ocean acidification was also discussed as a current and potential future climate-related driver of health and survival impacts. Respondents with fisheries expertise were by far the most likely to share examples of changing health and survival of fish and wildlife in coastal environments, followed closely by respondents with tourism and recreation expertise.

One of the most tangible effects of warmer water temperatures discussed by respondents was the incidence of fish kills in multiple Oregon rivers during the summer of 2015. Respondents were particularly concerned about die offs of salmon. A State employee with general fisheries expertise noted, "One thing we're seeing with salmon across the State is fish die offs because of increased temperatures in streams and rivers."

Another respondent expressed concerns about long-term trends of reduced salmon viability in Oregon, and the Northwest more generally, which could be caused in part by climate-related environmental changes.

> "[Fisheries managers and fishermen] are seeing some fluctuations in salmon this year, and there's a real concern that heat waves could lead to a reduction in salmon. Our fisherman contacts in San Francisco are predicting another year of salmon disaster relief. Whether or not that's connected to climate change, that is something that they're worried about. We've had salmon disaster relief years in the not-too-far past." *(Non-profit employee with general fisheries expertise)*

In addition to concerns about increased mortality of salmon, multiple respondents discussed changes in the health and fitness of marine organisms in Oregon waters. For example, individuals involved with the Dungeness crab industry were concerned about behavioral changes of crab with the warmer ocean conditions in 2015.

> **"**I think we've shown that Dungeness crab don't like warmer water. When you're talking about environmental change, water temperature is a big one. They like colder water. They seem happier. The warmer water seems to make them aggressive. We'll find a lot of loose legs and that kind of thing when they're stressed. They appear to get stressed when they're in warmer water." *(Industry employee with general fisheries expertise)*

Respondents also linked current and potential future changes in health and survival to changes in feed availability resulting from warmer water temperatures. Multiple respondents discussed changing plankton species composition and abundance of food sources. One individual with Coos County fisheries expertise perceived potential effects due to shifting phenology of feeding cycles (future).

> "Because of the warm water conditions with El Niño, we potentially will lose a year class [of shrimp]… What happens is, when the water is warm like what we saw off the coast right here, when the shrimp hatch their eggs, say in February, March, or April… and then they come up towards the surface and they feed in that thermocline. If they don't survive that thermocline because there's nothing to feed on, then because the water's warm we will lose that year class." *(Small business owner with Coos County fisheries expertise)*

Respondents also discussed current and potential future impacts of ocean acidification on organisms that form calcium carbonate shells. Several shellfish aquaculture businesses were present in the study area. Although respondents did not discuss specific impacts on these local businesses, they commonly cited examples of oyster failures in Netarts Bay and Puget Sound. There was future concern about impacts on other organisms with calcium-based shells, including Dungeness crab and species of plankton that form the foundations of the ocean food web.

Study participants were primarily concerned with the health of commercially or recreationally harvested seafood species. In addition, several participants reported observing periodic sea bird starvation events and (or) marine mammal strandings. One State employee with tourism and recreation expertise commented on the health of marine mammals, noting that although no major die offs have yet been reported, projected ecosystem changes associated with climate change are likely to affect their populations in the future (future).

> "We haven't yet noticed a large die off [of marine mammals]. But I think the expectation is there… the prospect of more whales or pinnipeds [seals and sea lions] dying are pretty good. We haven't seen that yet, but I can expect that." *(State employee with Coos County tourism and recreation expertise)*

D. Forest Health & Survival

The theme, *Forest Health and Survival*, integrates concerns raised regarding stress on vegetative species in the study area resulting in changes in condition and (or) long-term viability. In addition, concerns related to changing forest fire dynamics were captured under this theme. Like issues related to fish and wildlife health and survival, the concerns discussed about forest health and survival are secondary environmental issues and changes that may arise as a result of primary climate-related environmental changes. Declining water availability and increasing temperature were the two most frequently discussed primary climate-related changes affecting terrestrial ecosystems in the study area. Respondents with forest expertise were most likely to share examples of changes in forest health and survival. Although they shared several examples of current issues and changes, they were much more likely to discuss potential future concerns related to this theme.

Respondents reported that drought stress was evident in 2015, affecting both trees and non-timber products used in commercial production, as well as other culturally important species. Key concerns raised by respondents included increased mortality of seedlings in tree plantations, and increased susceptibility of trees to diseases and pests (current).

> "The last three years have been the most extreme cycle of the dry that I've seen... We haven't seen, as of yet [in Coos County], a tremendous amount of disease. But particularly this past summer… [Douglas firs] on edges of pastures [are] starting to die. I think in this climate, where it can rain so much for such a large amount of the year, they don't need to establish [deep] root

systems, so they're not set up for long, dry periods. When they get in the long dry periods, they can't suddenly start developing that [root] system." *(State employee with Coos County forest expertise)*

Respondents with forest expertise also noted that it is particularly difficult to predict how changes in temperature and precipitation patterns will interact with forest disease dynamics. They stated that projected longer, drier summers could have a positive effect of reducing spread of some fungal diseases, even as drought stress increases. At the same time, projected higher volumes of precipitation and warmer temperatures during winter and early spring months may exacerbate fungal spore dispersal (future).

"There are questions that we don't know the answers to with these big, mega diseases we have. Swiss Needle Cast is a big one… It's a native pathogen that affects Douglas fir, and we have seen it intensify a lot in the last 20 years. It likes warm, wet springs. It's a foliar [fungal pathogen]… Since it affects Douglas fir, everyone's worried about what climate change is going to do – how it's going to affect annual temperatures. When we have warm, wet springs, we see a bigger Swiss Needle Cast year." *(Academic with Coos County forest expertise)*

Respondents involved in silviculture had mixed reports regarding current effects on productivity of tree growth. One respondent reported that there had been a notable spike in seedling mortality in 2015, primarily in less favorable planting sites, as a result of the extended drought period (current). Other respondents expressed less concern about seedling failure as a current issue. However, one timber industry employee perceived potential for greater impacts if the current temperature and weather patterns continue, including decreased productivity and reduced survival (future).

"How does that affect us if climate change indicates less moisture here? As far as growth on the tree farm, I don't [currently] see a significant indication that we're lacking growth. We're still getting phenomenal growth. We have adequate moisture for [the species] we're growing… But survival might be an issue on newly planted trees if you have these longer, extended dry periods in the summer." *(Industry employee with Coos County forest expertise)*

Several respondents raised the issue that the suitable ranges for tree species will be shifting as temperature and precipitation patterns move further away from the climate that allowed establishment of the forests originally (future).

"When we started going through the [forest-climate] modeling… the outcome was that within the next 30 or 40 years, productivity of timberland was going to be significantly affected – particularly in southern Oregon. [Projected climate changes are] going to have a whole host of impacts… A lot of these trees are already at the southern edge of their suitable range. If you push them a little bit too far, particularly in more droughty conditions, a lot of them won't be able to survive. Or at least they'll be less productive." *(Non-profit employee with general forest expertise)*

In addition to discussion of the suitability of current and future climate conditions for native species, several respondents discussed potential changes in the Coast Range fire regime that are expected to accompany projected climate changes. One respondent explained the historical fire regime, and then went on to discuss how climate change might alter fire patterns, possibly resulting in more frequent impacts on forests in the study area.

> "There have [historically] been huge conflagrations along the coast. They tend to be infrequent, on the order of 200 to 500 years... Climate change, at least what's projected, will affect the timing of rainfall. And maybe there will be a little more winter flooding, and a little longer dry season. Is that enough to really cause [more frequent] fires? It's hard to say, but maybe." *(Federal employee with general forest expertise)*

E. Material Processes

The theme, *Material Processes*, captures respondents' discussion of current and potential future changes in the movement of sediments as a result of climate changes, including coastal and riverine sediment transport, bluff erosion, and landslide dynamics. Primary climate-related environmental changes that respondents linked to changing material processes included changes in wind patterns as a result of changing temperature differentials, increased storm intensities and coastal erosion, and higher volume rain events moving greater volumes of sediment downstream to the coast. Respondents with coastal infrastructure and tourism and recreation expertise were most likely to share examples of changes in material processes.

Multiple respondents spoke about changing coastal wind patterns, with increased intensity and duration of north winds (current), and noted that if these patterns continue into the future it may alter the geography of the coastline (future).

> "Wave action accompanying storms [typically] pushes sand to the north. But for the last six months, all the sand is getting blown south. And that's because that [north] wind has been howling down the beach [for an extended period of time]… That sand is piled up against those houses and the dunes a little further south… It's very unusual – definitely a change in the weather pattern. If that continues from season to season it's going to change things. It's going to physically change beaches [with some] places being starved of sand, and other places getting buried." *(State employee with general expertise)*

One respondent with coastal infrastructure expertise discussed impacts of both storm and runoff events on sediment transport, with implications for the erosion of navigational infrastructure (current and future).

> "From an erosion standpoint… these [very intense] episodic [storm] events are the ones that typically move a lot of sediment around. This can cause erosion to the base that the jetties set on. So the very foundations of our jetties can be impacted by that, which can accelerate degradation of the jetties. That's one aspect. And then you [consider runoff events]. Does the riverine system have a high flushing power that pushes [sediments] out in such a way, where maybe it's not the ocean conditions that are dominating, but it's the broader climate? For example: an intense runoff situation [in which the] riverine strength is literally scouring between the jetties." *(Federal employee with Lincoln and Coos County coastal infrastructure expertise)*

In addition, respondents discussed links between climate change and changes in coastal upwelling patterns, which could affect sediment accretion patterns along the coast. The same coastal infrastructure respondent discussed the link between accretion driven by upwelling and possible impacts on navigational infrastructure (future).

> "Maybe we go through a cycle of a great deal of ongoing upwelling, and it's got enough strength that it's pulling a great deal of sediment on shore, [and] also filling in the navigation channel. That's something that can impact us." *(Federal employee with Lincoln and Coos County coastal infrastructure expertise)*

Several respondents with forest expertise also discussed impacts arising from high volume winter rainfall events. They noted potential for increased severity of landslides, leading to road damage and water quality concerns (current and future).

> "Where it's pouring down rain and the wind's blowing 40 miles per hour… you end up with a lot of landslide issues. The geology is very sandstone – we don't have any hard granite or basalt or anything like that here. So once it gets wet and then freezes and thaws, it tends to slide down the hill a lot. And a whole range of issues go along with that. Access. Water quality. All kinds of things." *(Local governing body official with Coos County forest expertise)*

F. Moisture Patterns

The theme, *Moisture Patterns*, includes respondents' discussion of current and potential future changes in moisture sources and availability in the study area. Moisture sources include rainfall, snowfall, and fog and mist. Moisture availability considers not only immediate precipitation or condensation events, but also year-round availability of stored moisture as groundwater or snowpack. Forest respondents were the most likely, and fisheries respondents the least likely, to discuss changes in moisture patterns in the study area.

The multi-year drought was in the front of the minds of most respondents. Many other environmental issues and HDCC effects mentioned by respondents were associated with the combination of reduced moisture and increased temperatures, including forest fire risk, salmon die offs in streams, stress on vegetation, and others (current).

> "When folks get together, what people talk about most is the fact that we're in a drought. The drought is almost tangible. I mean, you can go out in your yard and you can see your trees dying. You can relate to that. Whether that drought has anything to do with some sort of climate change per se is a big question on a lot of people's minds." *(Small business owner with Coos County fisheries expertise)*

However, in keeping with the findings of the Oregon Climate Assessment Report, which suggest that up to now trends in precipitation have been difficult to identify due to extreme variability, several respondents cautioned that the drought may be part of natural rainfall variability in the study area.

> "Our annual precipitation tends to the average of about 60 inches [152 cm] a year [in Coos Bay]. We may have a really, really dry year and then all of a sudden we'll get 10 inches [25.4 cm] of rain in one month, and it'll hit the average. But, what's interesting to me is that even when everybody has got dire predictions about it being the wettest year on record or the driest year on record, it sort of comes back around to the average most years." *(Local governing body official with Coos County coastal infrastructure expertise)*

In addition to moisture in the form of rainfall, a number of respondents referenced shifting fog patterns along the coast. Many described fog as a signature feature of the Oregon coast climate, especially in the summer time. Given the relative frequency with which fog patterns were mentioned

during discussions, this issue is important to note. However, there was disagreement between respondents regarding the way in which fog patterns were shifting. Most agreed that the number of foggy days had declined in 2015 compared to normal (current).

> "One thing that I noticed was, we used to have fog on the beach for days on end, especially in the summer. Because of the hot dry air in the valley and the cool wet air [on the coast], it would just form that fog bank at the beach. This year because of that north wind starting so early, it just blew it out, and we never had that long persistent fog on the beach phenomenon that we've had forever." *(State employee with general expertise)*

The resulting lack of moisture was noted to be stressful for the temperate rainforest ecosystem (current).

> "That fog and moisture in the air is a really big piece of maintaining the temperate rainforest environment. This summer we haven't been getting a lot of that. Occasionally, when it gets super hot in the valley we'll get fog, and then it will roll off in the early afternoon. There were several times this summer where we didn't have any dew in the morning, which is incredibly rare for living on the coast." *(Federal employee with Lincoln County forest expertise)*

However, other respondents observed an increase in fog in the study area. One employee of a local governing body in Lincoln County with coastal infrastructure expertise observed (current), "We seem to get a few more stormy, foggier days [this summer] with the heat coming on, like this year with the record heats that we've had in Oregon."

Finally, multiple fisheries and tourism and recreation respondents discussed changes in snowpack in the Cascade Mountains. Decreased snowpack leads to reductions in year-round water flow, and increased water temperatures, in Oregon rivers and streams. Several respondents clarified that, although a majority of coastal rivers are not fed by snowmelt since they originate closer to the ocean in the Coast Range, coastal residents are likely to experience indirect impacts. For example, several respondents pointed out that Cascade snowpack provides an important source of electricity for residents of coastal Oregon and the entire region via flow for hydro-electric dams along major rivers. In addition, fishermen living in the study area would be affected by region-wide impacts to salmon (future).

> **"**One of the big [climate] changes is that most [precipitation] will come in rain rather than snow, and so you'll get these rainfall events, but you won't get a snowpack. For the isolated region of the coast, we don't have a snowpack anyway. But it matters for the State because the snowpack and the Cascade Range is what feeds a lot of rivers and streams that are the primary spawning areas for salmon." *(State employee with general fisheries expertise)*

G. Shifting Seasonality

The theme, *Shifting Seasonality*, deals with a variety of current and potential future phenological shifts in both flora and fauna in the study area. Respondents perceived that these shifts were linked to primary climate-related environmental changes, including increased temperatures, decreased moisture, and changing seasonality of precipitation. Respondents with fisheries and forest expertise were most likely to comment on seasonal shifts, although respondents from all expertise categories provided examples.

Phenological shifts observed by respondents included changes in timing of emergence of plants in the spring, as well as timing of flowering and fruiting. Examples provided by respondents included earlier ripening of huckleberries (*Vaccinium* spp.) and flowering of camas root (a traditional food source for Native peoples, *Camassia* spp.), and altered timing for harvests of other culturally important plant resources.

> "Fruiting's coming earlier. I've now picked a little over a gallon of huckleberries out of my backyard [in August]. When I moved here 20 years ago, I couldn't have picked a gallon of huckleberries until at least the middle of September." *(Tribal representative with Coos County forest expertise)*

> "My camas came earlier… It was blooming at the end of March. It's typically at least the middle of April, end of April into Mother's Day is that normal cycle. There's something that's happening there that's triggering that, but I don't know what it is." *(Tribal representative with Coos County forest expertise)*

Several respondents with fisheries expertise provided examples of changing seasonality of aquatic organisms. The timing of the arrival of migratory fish species off the Oregon coast was a common issue. One respondent described a region-wide change in patterns of commercial and recreational fish species (current).

> "It started about four years ago up in Alaska. That was what I heard from fishermen, 'The cod are showing up late. The pollock are showing up late. Everything's showing up late.' And then… the salmon were running late the last few years. And stuff wasn't showing up that you'd normally go fishing for, like hake. Hake would show up late for our commercial guys… I started saying that about three years ago… The tuna would show early, and everything else showed late… and then they'd show up all at once, boom, and then it would be over with, and then disappear." *(Small business owner with Lincoln County fisheries expertise)*

Another common seasonality issue raised by fisheries respondents was a change in the timing of Dungeness crab molting (current).

> "The historic timing of molting of Dungeness crab is that they molt in the spring and then over the summer they harden up. And then by December 1st they're good and full. Since 1989, that molting line has gotten fuzzy. And now [my crabber friends are] telling me that they got crabs that still have barnacles on them, which means they haven't molted for a year. Then they've got other crabs that are new shell, full, obviously molted a long time ago and are already on their way to re-molting. So molting timing is all screwed up." *(Small business owner with Coos County fisheries expertise)*

When discussing these and other seasonality shifts, fisheries respondents often spoke about 'new levels of uncertainty' in fisheries.

> "A few years ago, we could've said, 'Yeah, it's going to do this, and it's going to do that.' All that's out even now… The new environmental regime that appears to be in front of us makes the uncertainty much greater than it is normally." *(Small business owner with Coos County fisheries expertise)*

Two respondents with many years of career experience in fisheries discussed their decreased ability to rely on their local ecological knowledge of typical patterns (current).

> Respondent 1: "Almost every year we can count on things in our fishery that we've seen over the years, you know? In my career here, this was the oddest year to see what's going on in the ocean."
>
> Respondent 2: "This time it's different. It's not the fish just being a different size, it's the fish being starved and having low protein in them and not being able to find them." *(Two industry employees with Lincoln County fisheries expertise)*

Seasonal shifts in temperature and precipitation also affected the timing of commercial, recreational, and subsistence-oriented land uses. Respondents noted that access to forest lands for both timber harvesting, recreation, and hunting and gathering was reduced for much of the summer as a result of fire risk. At the same time, they observed that the dry fall provided extended seasons for many of these activities.

H. Storm Activity

The theme, *Storm Activity*, captures respondents' observations of current storm activity, and how their observations match or diverge from scientific documentation and projections. Coastal infrastructure respondents more frequently discussed issues associated with storm patterns compared to other resource/livelihood expertise categories.

Individual observations of recent storm patterns were highly variable across respondents. One respondent with coastal infrastructure expertise noted that there had been fewer storms in recent years (current).

> **"**The last couple years we really didn't see any storms. What caused that, that's way beyond me. But this year is supposedly an El Niño year. And when that happens that generally means that we get more storms in the winter. And we're looking towards that right now." *(Employee of a local governing body with Lincoln County coastal infrastructure expertise)*

Another respondent reported that storminess had increased in recent years (current).

> "The increased erosion, I'd have to go back to some of the drivers around that with high frequency of storm activities that we have and the fact that those storms are way more intense. You know, the first nine years I lived in the Oregon Coast I never lost power more than 20 minutes or something like that. And in the past few years we've had storms that are bad enough to cause real, immediate impacts." *(Non-profit employee with coastal Oregon tourism and recreation expertise)*

This discrepancy possibly arises from the complexity of projected changes in storm patterns. Winter storms along the coast of Oregon are predicted to decrease in frequency but increase in overall intensity as the North Pacific winter storm track shifts northward (OCCRI 2010); Reduced *frequency* may be perceived as a lessening of storm activity while increased *intensity* may alternately be perceived as an increase in storminess.

Respondents had also observed changes in wind patterns in 2015. Several respondents noted reduced summer onshore winds, creating warmer, more pleasant conditions for beach-goers compared to previous summers.

> **"**Normally in the summer times, you've got these really strong offshore winds coming in in the afternoons that blow people off the beach. We've not had much of that at all [this year]. It's been an absolutely gorgeous summer." *(Federal employee with Lincoln County tourism and recreation expertise)*

Respondents also noted shifts in the intensity of north winds that influence upwelling patterns. There was some disagreement regarding changes in the north wind. One respondent noted a lessening of north winds in 2015 (current).

> "A lot of years, the wind will cause upwelling that is really consistent and really steady for a long period of time. And I don't think we saw that consistency [this year]." *(Non-profit employee with general tourism and recreation expertise)*

However, a greater number of respondents reported observing stronger, more sustained north winds than in previous years (current).

> "What I noticed this year – and this is climate−related – is an extreme change in the weather pattern. The north wind usually fires up around July, August. [This year it] started in May. And it didn't let up, and it was ferocious. And it's been blowing now for three, four months. And when it blows like that, it does two things. It really does cause a separation in the ocean temperature layers. Further offshore, we know we've got this huge blob of really warm water. But inshore, because of the way the wind blows and shears off, you still have that upwelling, so you have the cold water inshore. So that changes the fisheries. It changes everything." *(State employee with general expertise)*

In addition, several respondents noted reduced summer onshore winds, creating warmer, more pleasant conditions for beach-goers compared to previous summers.

I. Temperature Patterns

Along with changes in moisture patterns, changing air and water temperatures in the study area are key climate-related environmental issues that respondents perceived as drivers of a majority of other observed environmental issues and changes. The theme, *Temperature Patterns*, briefly summarizes respondents' discussion of this fundamental issue, which is also woven throughout other themes in this section as well as the HDCC themes presented in Section 5.2. Respondents of all expertise categories frequently commented on temperature issues, whether discussing temperature changes specifically, or the role of changing temperatures as a driver of other effects.

There was almost unanimous agreement among respondents that temperatures were higher than average in the study area during the period of data collection. This perception reflected clear scientific documentation of temperature increases in the study area. Average air temperatures in Oregon have increased measurably over the past century (OCCRI 2010). Further, 2015 saw record-breaking high temperatures throughout the State (Ryan 2016). Temperatures are projected to continue rising, with summer temperatures expected to rise at a faster rate than winter (OCCRI 2010). Although

many respondents were reluctant to equate individual temperature events to long-term climate change, other respondents perceived the high air temperatures and associated drought to be a clear reflection of these projected climate patterns.

> "This particularly bad, dry, warm, sunny year is getting people thinking, 'Yes, we know climate change is happening.' Now something is in front of their eyes that might get them thinking about what that means for the future. 'Maybe this is the new norm. Maybe it's an anomaly, but maybe it's not. And if this is the new norm, how are we going to deal with this?' So what I've seen is like a social shift. I used to hear all the time about people denying climate change. And at least locally here, I don't hear it as much." *(Small business owner with Coos County tourism and recreation expertise)*

Air temperature increases, in combination with low precipitation conditions, were implicated as drivers of numerous other secondary environmental impacts and changing risk levels in the study area. These are discussed in detail under other themes, but they including forest stress and changing phenology of native vegetation, higher risk of wildfire in the Coast Range, and higher water temperatures in streams and associated salmon die offs. In addition, air temperature patterns were noted as a key driver of changes in human behavior and other HDCC effects, including influencing patterns of tourism and recreation and population demographics in the study area, causing economic impacts on forest industries and tourism and recreation industries, and cultural impacts related to both changing demographics and impacts on culturally important resources.

Water temperature increases were also mentioned by respondents as one of the most influential drivers of secondary environmental changes and HDCC effects in the study area. Key impacts of warmer ocean temperatures that were described by respondents included changing ecosystem composition and seasonality of fish and shellfish species, and associated health risks arising from the toxic algae bloom. Several respondents linked an increased temperature differential between land and ocean as a key factor influencing wind patterns and upwelling. In addition, water temperature was perceived as a driver of other social, economic, and cultural impacts arising from changing access to marine resources.

5.2 Exploration of Perceived Human Dimensions of Climate Change (HDCC) Effects

Study objectives #2 and #3 sought to identify the range of current and potential future HDCC effects in the study area (Section 1). Environmental changes (cycles, trends, and anomalies) can result in a suite of human dimensions impacts, including disruptions to existing systems and processes and the behavioral responses (adaptations) that follow. This section specifically examines the HD effects arising from environmental changes perceived to arise fully or in part from climate changes.

Study objective #2 specified that social, economic, and cultural HDCC effects should be distinguished. During second cycle coding, individual HDCC effects mentioned by respondents were therefore grouped into one or more categories to explore distinct but interrelated social, cultural, and economic themes discussed by respondents. The greatest number of themes emerged in relation to social and economic impacts, with eight social themes and seven economic themes. In addition, cultural HDCC effects discussed by respondents coalesced into two distinct cultural themes.

Sections 5.2.1 – 5.2.3 draw out examples from the narrative data that illustrate themes associated with the specific human dimension domain of interest. However, it is important to note that

there are significant interrelationships between the social, economic, and cultural HDCC effects that arise from shifting environmental conditions. In particular, quotations that illustrate a key social and (or) cultural effect often also relate to an economic effect. For example, an academic with Coos County fisheries expertise discussed the linked cultural-economic impacts of reduced access to seafood: "[Shellfish closures lead to] cultural and (or) economic impact of changes based on not having access to that type of resource." Economic impacts are often more tangible and easier to describe so sometimes respondents blend discussion of economic and other, less tangible impacts.

5.2.1 Exploration of Social Themes

During second cycle coding, individual social HDCC effects mentioned by respondents were grouped into one or more categories in an effort to identify overarching themes. *Social considerations* were defined as: How groups of people interact with each other and function (e.g., work, recreate, get around, family life/household unit, etc.). This includes their social institutions (e.g. education, healthcare, governance, housing), community structure (e.g. family/household structure, religion, demographics, migration patterns), and is related to their well-being and quality of life (Section 1.1).

Seven key social themes emerged from qualitative analysis, and are presented in alphabetical order: 1) health and well-being concerns; 2) impacts on management; 3) impacts on recreation; 4) migration and visitation patterns; 5) quality of life impacts; 6) social vulnerability; and 7) strain on resources and infrastructure. Results of basic frequency analyses were used to help build these themes. Lists of the most frequently mentioned HDCC effects, including differences in emphasis across resource/livelihood expertise categories and perceptions of current vs. future potential impacts, are included in Appendix 4.

A. Health and Well-being Concerns

The theme, *Health and Well-being Concerns*, deals with respondents' discussion of air and water quality concerns, as well as other issues contributing to human physical and (or) mental illness. Respondents of all resource/livelihood expertise categories were similarly likely to mention some type of human health impact, with the exception of coastal infrastructure respondents who discussed these issues less frequently.

The climate-related health concern mentioned most frequently by study participants was high domoic acid levels in Dungeness crab and other shellfish during the 2015 season as a result of the widespread toxic algae bloom. Although the warm water conditions that precipitated the algae bloom were difficult to conclusively link to climate change, many respondents viewed the episode as a potential foreshadowing of the type of events that would occur with a warmer ocean in the future (current / future).

> "This is the worst toxic algae bloom we've seen, ever, [and] the domoic acid is in the meat in kind of startling numbers. That was surprising to me, because I don't remember it ever… causing a problem with the meat. It's always [only] been in the hepatopancreas.[4] I can only assume that

[4] The hepatopancreas is an organ in crabs and other crustaceans that combines the functions of a vertebrate's liver and pancreas (Merriam-Webster).

that [high level of toxin] is temperature related." *(Small business owner with Coos County fisheries expertise)*

In addition, multiple respondents noted air quality issues as a key health concern in Oregon due to widespread forest fires and associated smoke. Although there were no major fires in the Coast Range in 2015, respondents noted that smoke in inland areas of Oregon contributed to increasing numbers of people traveling to the coast to escape not only the smoke, but also the heat (current).

> "One thing that I heard over, and over, and over, from people coming to the coast this summer was they were escaping the heat and the fires. Whether or not those are climate change related, that's not for me to say, but it was the hottest year on record here. And I think that helped drive people en masse. If you ask them specifically, 'Oh, what brings you to Newport?' 'We're getting out of the heat. And the fires. Getting out of the smoke.'" *(Small business employee with Lincoln County tourism and recreation expertise)*

Further, study respondents perceived that, as issues like air and water quality worsen outside the study area, coastal Oregon will become an increasingly appealing location for people to visit, as well as relocate permanently (current / future).

> "I've already spoken to people that specifically chose to live here because it's supposed to be milder and more robust than places south. At least a few. Again, that's anecdotal. But I do know that a huge proportion of the in-migrants are Californians. I've been involved now in a couple of different climate change planning or adaptation processes. The concept of climate refugees, people moving from hot dry places to the Oregon Coast, comes up all the time. Even if it's only starting to happen, it's predicted to just increase in the future." *(State employee with general expertise)*

Finally, mental health issues associated with economic hardship were also mentioned by several respondents. They noted that, to the degree that climate-related environmental changes impact the viability of local livelihoods, they will also contribute to psychological stress in the study area.

> "Fisheries have gone down because of the change in climate. That adds to unemployment, which adds to the stress. Coos Bay has had its share of that kind of stress as well, and still does, but not as bad as sometimes. Timber is the same way here. Everybody is still talking about the boom time of timber in the '80s, and at certain time periods where everything was great and everybody was moving to town, and then it busts." *(State employee with Coos County tourism and recreation expertise)*

B. Impacts on Management

Respondents spoke frequently about the impact of climate-related environmental changes on natural resource management and policy. The theme, *Impacts on Management*, captures respondents' discussion of regulatory and policy shifts that are perceived to occur in response to climate-related environmental change, as well as impacts on management responsibilities and levels of uncertainty and risk faced by decision-makers. Respondents with forest and fisheries-related expertise were among those most likely to mention impacts on management, although several respondents mentioned regulations associated with recreational activity and coastal infrastructure as well.

One of the most common, direct examples of regulation in response to climate-related environmental change was fire closures. Extreme fire restrictions became necessary in 2015 as a result of the extended drought in the study area. One respondent working in the non-timber forest product industry described reduced access to harvest areas as a result of fire closures (current): "We got shut out [of the areas where we harvest our products] quite a bit. I lost a lot of production of cascara [a medicinal plant] because of the fire closures." *(Small business owner with general forest expertise)*

Numerous respondents also discussed the impacts of fire closures on recreation. Respondents primarily spoke about decreased access to hunting and foraging on private forest lands in the study area (current). In addition, fire bans impacted recreational opportunities on public beaches and in State campgrounds (current).

> **"**State Parks just issued that there are no bonfires allowed on the beach and no fires in the campgrounds. There have been times when fire danger is extremely high and they've restricted activities, but I can't recall a time when I've ever heard of no bonfires on the beach. But your wind patterns can carry sparks to the shore and to the grasslands and fire can spread very quickly. And fire crews are really stretched thin." *(Industry employee with Lincoln County tourism and recreation expertise)*

Another example of the effects of climate change on regulations was the declaration of a drought emergency in some areas of Oregon in 2015. A respondent pointed out that the drought emergency precipitated the removal of other environmental regulations intended to protect fish in streams. They perceived that this situation could happen more frequently if drought conditions become more common as projected (current / future).

> "[Declaring a drought emergency] basically removes some of the environmental protections on these streams, and allows increased withdraw. So, there are environmental impacts that are secondarily associated with that. You don't have to leave enough water in for fish anymore." *(State employee with general tourism and recreation expertise)*

Several respondents also pointed out connection between climate change and shifts in Federal policies. For example, one respondent discussed links between climate change and proposed offshore renewable energy development in the study area (current / future).

> "I think most of us will understand that we're [exploring offshore renewable energy] because of a changing climate and the need to lower our emissions. And whether or not [people] do connect that, you can't doubt that renewable energy is a climate change strategy." *(Non-profit employee with coastal Oregon tourism and recreation expertise)*

In addition to regulatory and policy changes, the *Impacts on Management* theme incorporated respondents' discussion of increased management responsibilities and risks. With regard to community infrastructure, several respondents discussed implications of increasing rates of coastal erosion on the viability of transportation corridors and other coastal infrastructure, such as wastewater treatment facilities (current / future).

> "That's one of the things that [the Oregon Department of Transportation] is working on, is do we move [that 16 km of Highway 20 that is eroding] inland, as was evaluated in the past? Or do we try to find a way to work through the stage where we'll still armor it so that it can stay in its

present location for some additional period of time?" *(Employee of a local governing body with Lincoln County expertise)*

Another common management stress that respondents associated with climate change was public demand for increased management flexibility in response to shifting seasonality of resource availability. For example, one respondent discussed conflicts arising from changing demand for winter access to Federal recreational lands during a warmer than average winter season (current).

> "This year, 2015, we had our all-time record high temperatures and droughts in the Northwest, at a level that was suggested to be around what we expect in 2060 or 2070. So what happened in some places was people wanted to be out there hiking and mountain biking in February, but there [was] no access. None of the campgrounds or roads [were] open. Forest Service hadn't brought on their seasonal workforce yet. So people were very upset that they couldn't have access to their usual recreation sites [during the unseasonably warm winter]. They were even breaking down gates and stuff." *(Federal employee with general forest expertise)*

Respondents also shared examples in which established fisheries seasons were no longer functioning as the seasonality of fish species shifted. In one instance, Dungeness crab were not ready for harvest in the summer as they have been historically, resulting in the harvest of crab that had only 17–18% meat fill and low survival rates, leading to significant waste. Dungeness crab managers were challenged to gather data and revise the management plan to both protect the resource and minimize economic impacts (current).

> "A lot of people think that we're really harming our industry [when we harvest low meat fill crab]. What we're looking at doing is to [research] the economic impacts if we shut the season off sooner and not fish during the soft shell so all those crabs will live and we can actually harvest more of those crabs in December." *(Small business owner with Coos County and general fisheries expertise)*

Respondents also discussed the ways that climate change exacerbates the uncertainty and risk inherent in natural resource management decisions. For example, one respondent noted that increased climate uncertainty raised new questions about the effectiveness of restoration and conservation investments made in the study area (future).

> "They've documented the economic impacts of the restoration economy in the Coast Range. [But how climate change] might undo some of that work, or make it more necessary, or change the lessons that we learn from that restoration, remains to be seen." *(Non-profit employee with general forest expertise)*

Finally, a fisheries respondent linked increasing uncertainty of the location of commercial fish stocks to climate change, and pointed out that this uncertainty can affect the success of international fish negotiations (current).

> "A couple of years ago [during bilateral talks with Canada regarding the treaty that allows us to fish in reciprocal waters], the U.S. gave them three years notice that Canada was going to no longer be able to fish [off the west coast]. Then the tuna moved north. Now they're kind of in the driver's seat… We can't fish up there either… So, that's really a potential long-range, far-reaching, international morass." *(Small business owner with Coos County fisheries expertise)*

C. Impacts on Recreation

The theme*, Impacts on Recreation*, focuses on respondents' discussion of changing recreational opportunities in the study area. A variety of secondary climate-related environmental changes were perceived to affect either the seasonality of recreational opportunity, and (or) the ability to engage in some activities at all. Respondents with tourism and recreation expertise were most likely to comment on issues that fit under this theme, although recreation was personally relevant to a majority of respondents, and individuals from all expertise categories observed recreation impacts.

Changes in the seasonality of recreational opportunities were the most frequently mentioned HDCC effect in this category. Respondents had observed longer, drier summers in recent years, resulting in increased opportunities for summer-oriented activities into the shoulder seasons (spring and fall). These activities included camping, hiking, mountain biking, and beach-related activities generally. One Coos County respondent had observed an extended camping opportunities and increased visitation to local recreation sites (current).

> "We've probably had more recreational opportunities… such as camping. Normally, locally, we don't really start planning camping until after July, because the rain usually doesn't stop until about July. And lately, May is there, June is there, so you have an extra couple of months that you can start planning without being rained out… I think the Sand Dunes have increased [visitation], and we have seen our county parks increase revenue-wise, so I know that there are a lot more people recreating." *(Two county employees with Coos County expertise)*

A State-level respondent similarly noted that this increased activity was of benefit to the State Parks budget. However, alongside the increased revenues from coastal recreation facilities as well as for many local businesses, the increased volume of visitors also created new recreation management challenges. These including increasing strain on public infrastructure and facilities as the volume of visitors exceeded capacities.

In addition to the positive HDCC effect of extended recreational opportunities, respondents also cited multiple negative impacts to recreation as a result of changing temperature and precipitation patterns. For example, multiple respondents noted that winter recreation had become more limited, and people often had to drive farther to access snow. But perhaps the most frequently mentioned negative recreation impacts were had to do with reduced access to recreational lands. For example, fire closures due to the extended drought led to closures of private forest lands where people are accustomed to engaging in a wide range of recreational activities (current).

> **"**[The way fire risk mitigation] affects the general public and the local people is that we restrict access to our properties. We normally allow people to recreate, hike, ride horses, bicycle, whatever they want to do – because they're not hurting anything – but when it gets that dry we try to restrict all public access to prevent fires that are just accidental in nature. And so what that does is it cuts down on local folks' ability to access the property for recreation. The County Forest and BLM [Bureau of Land Management] and Forest Service lands here very seldom ever get closed down for public access, [but] if people can't recreate on lands close to home, they might go farther, it costs them more to travel, those kinds of things.**"** *(Industry employee with Coos County forest expertise)*

A Tribal representative discussed specific impacts of forest closures on access to recreational and subsistence hunting opportunities (current).

"One of the other things that comes to mind, as Tribal members, and all the population around here, too [is] hunting seasons. The seasons haven't changed, but with the drier summer [and fall], higher fire danger results in the landowners closing their lands so there's no access to hunt. The season may be open, but there's no place to go and hunt because you can't get out in the woods. That's been occurring more frequently… And it's kind of a combination of longer periods with less precipitation and warmer temperatures." *(Tribal representative with Lincoln County forest expertise)*

Respondents also mentioned restrictions on activities on State Lands, such as a ban on beach fires during part of the summer of 2015 (current). In addition to fire closures, respondents perceived that beach recreation could be threatened by increasing sea level rise and coastal erosion (future).

"We've talked about changing beaches and the potential for increased erosion. One of the ways climate change may impact people's way of life in the recreation and tourism arena… is if sea level rise and all those other things associated with climate change, like increasing wave heights, lead to a narrower beach or a beach that's not accessible except at low tide. In some [climate change model scenarios], I've heard that more of the access on the Oregon coast could be limited. Depending on hardening and how much it proliferates, this may also reduce recreational access to the beach." *(State employee with general tourism expertise)*

With regard to recreational fisheries, respondents noted a variety of impacts arising from warmer water temperatures. They experienced salmon fishing closures as a result of warmer stream temperatures (current).

"The drought was such that there were extreme low flows and high stream temperatures in the summer, so fishing was banned for the good portion of the summer. Not in the big rivers, but almost all of the other streams were closed. So that's a hit on recreation, that's a hit on local economies, those sorts of things." *(Federal employee with general forest expertise)*

Respondents also noted that the location of warm water currents had a direct effect on tuna fishing opportunities, although they were less certain of the links between climate trends and the location of currents (current).

"You get a lot of people that will come from a long ways away [to fish recreationally] if the [tuna] gets close enough to shore or gets close enough to the Port. I don't think there's a trend necessarily. But it has to do with the ocean currents and [the location of the warmer water]." *(Local governing body official with Coos County coastal infrastructure expertise)*

Respondents also linked shellfish closures to warmer ocean conditions, which they noted had contributed to the toxic algae bloom (current). Several respondents also expressed concerns about future impacts on shellfish-related recreation resulting from ocean acidification impacts to shell formation (future).

"There's just a ton of recreational clam digging and crabbing in this area. If the acidity gets high enough or the pH gets low enough, those animals just can't create their shells anymore. And that'll be a shift and that'll be a decrease in access to resources." *(Small business owner with Coos County tourism and recreation expertise)*

D. Migration and Visitation Patterns

The theme, *Migration and Visitation Patterns*, captures respondents' discussion of changes in patterns of both temporary visitation and permanent settlement in the study area. Respondents placed particular emphasis on the higher than average volume of tourism and recreation taking place in the study area in recent years, as well as discussion of increasing retirement and changing study area demographics. They perceived both of these trends to be driven, at least in part, by changing weather patterns. Many respondents discussed the potential long-term effects of climate projections on retirement and relocation to costal Oregon. Respondents with tourism and recreation expertise were most likely to discuss increases in visitation to the coast, while discussion of demographic shifts was a more equally distributed topic of discussion across respondent categories.

Although respondents pointed out that numerous factors may influence visitation patterns, they perceived temperature and weather patterns during the summer of 2015 to be one key factor influencing rates of visitation. The State of Oregon was in the 4th year of an extended drought, and temperatures were higher than average throughout the State. In addition, some respondents noted that weather on the coast had been sunnier than normal, with fewer cold, foggy days. Respondents perceived that these weather 'improvements', in addition to poor air quality and extreme temperatures outside the study area, increased the appeal of coastal Oregon as a travel destination (current).

> "If you have the Willamette Valley in the 90s and the 100s for very long periods of time, the place to go cool off is the coast. I left Corvallis one day and it was 98 degrees, and I got home an hour and a half later and it was 68. That's significant… We have had record visitation this year. Our campgrounds are absolutely busting at the seams. Our day-use areas, including the Cape Perpetua Visitor Center, have broken all previous visitation records, and by a lot. The record for walk-in visitors at the Cape Perpetua Visitor Center was 500 people for a day. There was one day this summer that they documented 800 people. So, they didn't just break the record, it was completely shattered." *(Federal agency employee with Lincoln County tourism & recreation and forest expertise)*

This increase in visitation was perceived as both a benefit and a potential warning sign of the type of social effects that may accompany longer-term trends in climate conditions (current and future).

> "It was so unbearably hot in Portland this summer, that people... escape the heat, and they come to the coast. And that was a benefit to us, but it's also a little bit of a warning sign, because we're thinking, 'Is this the new normal?' It's been an extremely dry year." *(Non-profit employee with Lincoln County tourism and recreation expertise)*

Respondents also perceived that the increasing appeal of the coastal Oregon climate, particularly in relation to declining comfort in other areas of the world, might add to the existing trend of coastal retirement (future).

> "In terms of long-term, it's just not increased visitations. I have conversations with people all the time that are scouting for places to retire, places to move. As it gets hotter and drier in some places, people are going to be looking for places that are buffered from climate change. Coastal areas have been projected to be buffered areas, both for biodiversity, but also just for temperature and comfort. So in some ways they're the most valuable places. And at the same time they're going to be the most desirable places for people to move to." *(Small business owner with Coos County tourism and recreation expertise)*

Respondents questioned how these societal trends might impact local communities, including water supplies and other local infrastructure (future).

> "I think that people are going to move here because we still have water – we have just a beautiful climate. And I could see it shifting – the population's growing, putting more pressure on our water supplies in these local communities. I think it could be real interesting how the local infrastructure survives, how much building starts to go on. Do our schools have enough room to absorb these types of things? Where are the people going to work that want to live here? [I'm curious] what it's going to look like in 10 years, because I don't know why people wouldn't want to live here with that kind of weather, particularly during the summertime." *(Federal employee with Lincoln County tourism and recreation expertise)*

E. Quality of Life Impacts

The theme, *Quality of Life Impacts*, highlights respondents' perceptions of lifestyle impacts linked to climate-related environmental changes and associated intermediary HDCC effects. Respondents with tourism and recreation expertise were much more likely to discuss issues associated with this theme, with much greater emphasis on current effects compared to future potential concerns.

Respondents discussed both positive and negative impacts to quality of life in the study area. They frequently mentioned that they were personally enjoying the sunny, warm days, and appreciated increased productivity of local gardens and fruit trees (current). However, most respondents also mentioned concerns about potential longer-term negative consequences of these patterns, such as water scarcity or impacts on native flora and fauna (future).

> "I think people really like [it] that you can be outside more. We see people outside on days that you wouldn't normally see people outside. We could be in Tuscany or something. We're not hot like the Willamette Valley. They've been having 109 degrees, but we've been having 70. It's like, 'Well, this is nice.' So if you can sustain what you need from the water itself for drinking and use and everything, and you could have the summers like this and the winters rainy again, well that would be fabulous." *(Official of a local governing body with Coos County expertise)*

Respondents were particularly concerned about potential future impacts to local resources and traditions that they associate with their quality of life on the Oregon coast, such as access to recreational opportunities and culturally important seafood species. One respondent discussed impacts of ocean acidification on oyster viability, and shared concerns that decreased availability of oysters would constitute a negative quality of life impact in, particularly for those who could not afford higher prices (future).

> "Our way of life includes being able to go and buy oysters whenever we want. There's never any shortage. So I can imagine there would be a pretty fundamental shift in people's quality of life if oysters were significantly more expensive, and therefore not as easily accessible for everyone. Oysters would become a luxury item which changes the way of life especially for blue-collar folks around here" *(State employee with Coos County expertise)*

In addition, the more pleasant weather was perceived to lead to increased tourism, which in turn created crowding issues in coastal communities. This was a particular concern in Newport, where the tourism industry is a strong focus of the local economy (current).

"You have great weather and you have people coming to the coast, and your infrastructure is taxed. Your roads, your sewer, your water, your local resources that are usually readily available to residents are now in higher demand by the influx of people… When you have more people here, you have more trash. You have more demand at the grocery story. You have more demand on the streets. And so the locals kind of grimace about, 'Oh, it's really hard to make a left-hand turn onto 101.' Or you find them sometimes just avoiding certain areas. 'Let's avoid going on the Bayfront for lunch, because we can't find a parking place. Let's avoid going to Nye Beach, because we can't find a parking place.' I think people change their habits when we have so many visitors." *(Industry employee with Lincoln County tourism and recreation expertise)*

F. Social Vulnerability

The theme, *Social Vulnerability*, captures respondents' discussion of populations that were particularly vulnerable to HDCC effects in the study area. A relatively smaller number of respondents mentioned issues relevant to social vulnerability compared to other themes. However, they highlighted many different dimensions of vulnerability, including those who are dependent on natural resources for their livelihoods, those who are less able to adapt due to disability or lack of resources, and those living in areas increasingly exposed to potential coastal erosion and flooding impacts. Respondents of all expertise categories were equally likely to discuss effects linked to this theme.

Individuals working in natural resource-based industries were perceived by respondents to be more vulnerable to climate-related environmental change, as well as other stressors that may contribute to loss of access to resources on which their businesses and industries are based (future).

"I look at our business and know that we're very vulnerable to having access to [local seafood] resources. [We could] lose access to that… if biological constraints occur, like [changes in] ocean chemistry, etc." *(Small business owner with Lincoln County tourism and recreation expertise)*

Respondents discussed economic, cultural, and social impacts resulting from reduced access to resources. The most tangible social effects described by respondents included rising stress and the suite of social ills that accompany unemployment and economic depression. For example, fisheries respondents frequently discussed the negative consequences of the Dungeness crab fishery closure that began in the fall of 2015 (current).

"[The crab closure] is going to be tough on the families. The only ones who win in this scenario are the bars. In these situations, all the alcohol- and drug-related problems, like domestic violence, etc., go up." *(Small business owner with Coos County fisheries expertise)*

Respondents also perceived that residents living adjacent to the coastline and (or) in low-lying areas were increasingly vulnerable to flooding and coastal erosion increases under projected future conditions of rising sea level and increasing storm intensities (future).

"One thing that we're anticipating related to the Ocean Shore Protection Permit Program… when sea level rises and erosion occurs, a lot of houses will be more at risk of falling into the ocean, whether we give them permits to protect their property or not." *(State employee with tourism and recreation expertise)*

Specific low-lying neighborhoods within study area communities were noted to be particularly vulnerable to coastal erosion and flooding impacts, including downtown Coos Bay and the South Beach neighborhood in Newport (future).

> "In Newport we have pockets of low-lying areas that… might be inundated as ocean rises… Areas [like] South Beach are of a concern both for sea level rise and for a tsunami. [And] there are other towns, like Seaside, where the entire town is built like South Beach is. It's all right there [at the level of the ocean]." *(Academic with Lincoln County fisheries expertise)*

Populations with less ability to adapt to changing conditions, including those with minimal financial resources as well as individuals with physical disabilities, were also mentioned as particularly vulnerable to climate-related changes. For example, one respondent with forest expertise discussed the disproportionate impacts of recreational fire restrictions on individuals with limited mobility (current).

> "The strategy of [timber] companies is to protect their lands. They close them to public entry during the fire season… More locked gates and more travel management areas that ODFW establishes with the consent of the landowner – walk-in only kinds of places [to limit fire risk from vehicles]. For people that are struggling health-wise anyway, it's limiting their ability to actually get out and effectively hunt." *(Tribal member with Lincoln County forest expertise)*

In addition to discussion of existing populations in the study area who may be impacted by climate changes, several respondents noted an increase in a new, vulnerable population: they reported an increasing number of homeless individuals moving to the coast, driven in part by the increasingly moderate climate of the Oregon coast.

> "One of the issues that I hear from folks in the community is that they believe they've seen an increase in our homeless population, in part because of the milder and drier winters that we've had the last couple of years." *(Official of a local governing body with Lincoln County expertise)*

G. Strain on Resources and Infrastructure

The theme, *Strain on Resources and Infrastructure*, highlights respondents' discussion of HDCC impacts that place high demand on public facilities, infrastructure, and services. These issues were perceived to result from both public facilities being at or beyond capacity, as well as high demands placed on limited staff of community and emergency services. Tourism and recreation respondents, as well as individuals affiliated with local- or county-level government agencies, were particularly likely to express concerns associated with this theme.

The higher than normal volume of tourists and recreationists traveling to the Oregon coast was among the most common drivers of strain noted by respondents. Two Coos Bay residents with tourism and recreation expertise described the massive demand being placed on Oregon State Park beaches and campgrounds during the summer of 2015 (current).

> Respondent 1: "The beach is seeing so much extra traffic. And talking to the State Parks, they're seeing increased traffic as well, with so many more visitors to the campgrounds that they're having a hard time dealing with the numbers."

> Respondent 2: "About three weeks ago, they had said there was increased usage of campgrounds by over 200,000 campers than any other year they've seen, and that was only partway through the summer… I can only imagine those numbers have gone way up since then." *(Small business owners with Coos County tourism and recreation expertise)*

Federal campgrounds were also feeling the impacts of higher than normal demand. A Federal employee discussed measures taken in Forest Service campgrounds to limit the use of facilities as demand met or exceeded capacity (current).

> "[Increased campground usage] puts a tremendous amount of pressure on our facilities. One of the things we've done is we've limited the number of showers and shower times in some of our facilities, because we only have a certain amount of effluent that we can push through some of our systems under our permits." *(Federal employee with Lincoln County tourism and recreation expertise)*

Respondents in Lincoln County also noted impacts on emergency response as a result of the high number of forest fires happening throughout Oregon in 2015. Local fire crews were called away from the coast to fight fires elsewhere, leaving a shortage of emergency service providers to respond to local emergencies (current).

> "Fire crews are really stretched thin. Yesterday for instance, one of our staff lives in Toledo, and their neighbors' house burned down. She called 911 nine times before she finally got an answer. It just kept ringing. When she finally got through, hers was the first call about the fire. And of course all the neighbors were trying to call in. They were only able to dispatch two fire trucks. The house burned to the ground because local fire crews are fighting fires elsewhere in Oregon." *(Industry employee with Lincoln County tourism and recreation expertise)*

5.2.2 Exploration of Economic Themes

During second cycle coding, individual economic HDCC effects mentioned by respondents were grouped into one or more categories in an effort to identify overarching themes. *Economic considerations* were defined as: How people make a living and exchange goods, including their industries and types of employment (Section 1.1).

Seven key economic HDCC effect themes emerged during qualitative analysis. In alphabetical order, they include: 1) business adaptations; 2) economic impacts on coastal infrastructure; 3) economic impacts on commercial fisheries; 4) economic impacts on forest industries; 5) economic impacts on tourism and recreation industries; 6) economic reorganization; and 7) personal costs. The themes are described below, and are illustrated using examples from the narrative data. Results of basic frequency analyses were used to help build these themes. Lists of the most frequently mentioned HDCC effects, including differences in emphasis across resource/livelihood expertise categories and perceptions of current vs. future potential impacts, are included in Appendix 4.

A. Business Adaptations

The theme, *Business Adaptations*, captures respondents' discussion of livelihood shifts and business management adaptations driven by climate-related environmental changes. Environmental

changes that were most frequently perceived to be drivers of these adaptations included shifting abundances and locations of target commercial fish species as a result of warmer ocean conditions, and effects of the extended drought on timber and non-timber forest products. Forest and coastal infrastructure respondents were particularly likely to discuss adaptations in business strategies. Fisheries respondents were somewhat less likely to discuss current livelihood adaptations, but more frequently emphasized this issue during conversation of future potential HDCC effects.

Some fisheries respondents noted that involvement in fisheries inherently requires flexibility and adaptation. As a small business owner with Coos County fisheries expertise explained, "It's always uncertain. Fishing is a series of uncertainties tied together with disasters in between." However, other fisheries respondents perceived that the changes they were currently observing in the ocean were beyond the range of normal variability, adding 'new uncertainty' and requiring new forms of adaptation. In this context, some fishermen were considering getting out of the business, while others were considering their options for diversification, as illustrated by the following quotation (current / future).

> "It's got me thinking, 'OK, do I go over and get in the Big Eye fishery? Lease some permits and go over to Hawaii and fish big eyed tuna?' Or do I go up to Alaska and pack salmon? What are my options, you know? Do I go tuna fishing?" *(Small business owner with Coos County fisheries expertise)*

A Federal employee who works with coastal Oregon fishermen pointed out that fishermen were currently exhibiting the ability to adapt and capitalize on the variability of fish stocks (current).

> "Fishermen… are very familiar with changing ocean cycles. For example, [the groundfish fishermen] have taken great advantage over the last few years of massive pink shrimp and crab fisheries, because the ocean cycles have been very productive for those. They have the ability to adjust their schedules to take advantage of pink shrimp off Oregon. And economically they've benefited from that, because the effort is more bang for your buck in a sense. And they're able to adjust their gear to capitalize on that." *(Federal employee with general fisheries expertise)*

Forest respondents involved in timber production mentioned several examples of shifting management strategies as a result of changing temperature and precipitation regimes. One respondent described that, due to increasing competition for water from weeds, some forest management companies have increased the number of herbicide applications (current). Another respondent stated that the warmer, drier winter had complicated annual controlled burn activity on the tree plantation (current). The respondent went on to acknowledge that, if this weather pattern becomes a long-term trend, it will result in the company having to more permanently alter its management strategy (future).

> "We [historically] get periods in the winter when it's dry and warm. But it's usually been wetter so that we do a considerable amount of slash burning in the winter on south slopes and that's all that would burn. Well, [around the New Year] it was dry and we actually had a stronger offshore [wind] flow and lower humidities. We ended up with about a 220‑acre fire that burned through our ground and the neighbor's ground. Not a huge amount of damage, but it was a pretty extensive fire for that time of year. There was considerably more that would burn just because we hadn't had the rain. Now, if that's a long-term effect of climate change, that will affect how we manage." *(Industry employee with Coos County forest expertise)*

A respondent with expertise related to non-timber forest products also provided an example of a livelihood adaptation. Because of the extended drought, commercial mushroom hunting was not yielding sufficient revenues, and they shifted their company's focus more toward farming (current).

> "We put more emphasis on farming just because it's getting harder to find mushroom hunting grounds. And the grounds that we have this year just didn't really yield well because we had such a dry summer and such a dry fall. So we've focusing on growing more at the farm, something that's just sustainable for us." *(Small business owner with general non-timber forest expertise)*

B. Economic Impacts on Coastal Infrastructure

The theme, *Economic Impacts on Coastal Infrastructure*, highlights the costs of maintenance, repairs, and (or) relocation of coastal infrastructure that arise as a result of climate-related environmental issues or changes. Respondents perceived climate-related drivers of these effects to include storm intensity, sea level rise, and associated coastal erosion, as well as changing precipitation patterns. Respondents with coastal infrastructure expertise were the most likely to provide examples under this theme, although several examples were also provided by respondents from other expertise categories who were affiliated with local and county agencies involved in maintenance of coastal facilities and roadways.

Respondents found it particularly difficult to distinguish the climate-related drivers contributing to impacts on coastal infrastructure from more general depreciation of infrastructure in the dynamic coastal environment; coastal erosion is a natural process that is projected to be exacerbated by incremental increases in storm intensity and sea level rise. However, respondents were able to identify several current and future potential structural issues for which they perceived potential links to climate-related changes in the ocean environment. For example, multiple respondents referenced the example of the relocation of a Charleston Sanitation District pump station due to coastal erosion (current).

> "The Charleston Sanitation District, just at fairly considerable expense, relocated one of their lift stations because it was right on the Bay, and it was eroding. The shoreline was eroding right by it and they were potentially going to lose it, and so they moved it uphill from the highway, recognizing that they were going to receive some protection because the highway was there." *(Non-profit employee with Coos County expertise)*

Another example was the local debate over a section of coastal highway near Newport, which was increasingly threatened by coastal erosion (current).

> "Does it make more sense to try to continue to armor [this section of highway], and try to protect and make your investment in the existing alignment of the road? Or does it make more sense to shift it further inland? They both have costs." *(Employee of a local governing body with Lincoln County expertise)*

Respondents were careful to note that decisions to invest in relocating or upgrading coastal infrastructure have not primarily been motivated by climate change as a driving factor. For example, respondents reported that upgrades to port facilities in Lincoln County were initiated as a result of increased regulatory standards at the State and Federal levels, and the choice to relocate the City of

Coos Bay wastewater treatment facilities was more directly driven by a land use disagreement than coastal erosion impacts.

> "The City of Coos Bay [is] relocating one of their two sewage treatment plants, again, moving it inland. And while they would have desired to rebuild it at its current location right on the shoreline, they couldn't because there were limitations for the ability to fill, and there was also actually a threatened marsh plant species around them, too. But there was a real concern also about potential climate effects." *(Non-profit employee with Coos County expertise)*

However, several respondents felt that climate resilience was one of several key issues in the minds of coastal community planners as they considered options for siting facilities. Climate change preparedness was noted to coincide with the need to prepare for coastal erosion issues more broadly, as well as earthquake/tsunami preparedness (future).

> Respondent 1: "We've talked about moving some of the development to higher lands, especially any type of healthcare facilities."
>
> Respondent 2: "[And] emergency response facilities. That would be [in preparation] both for climate change impacts like sea level rise, and for seismic impacts like tsunami and earthquake." *(Two Coos County employees with general expertise)*

In addition to commonly recognized forces of coastal erosion, one respondent with coastal infrastructure expertise brought up two additional climate-related natural forces that can add to maintenance requirements for coastal infrastructure: sediment accretion events due to coastal upwelling, and heavy scouring events resulting from more intense, high volume rainfall events that deposit additional sediments in estuarine and coastal zones. Both of these issues may be influenced by projected climate changes, with respect to the projected northward shift in the North Pacific winter storm track and likely increased concentration of high volume precipitation events during winter months (OCCRI 2010). The respondent discussed the damages that both of these forces could inflict on navigational infrastructure.

C. Economic Impacts on Commercial Fisheries

The theme, *Economic Impacts on Commercial Fisheries*, reviews respondents' discussion of a variety of economic impacts on fisheries at multiple scales, including individual fishermen, fish buyers, and seafood processors. Climate-related environmental changes that were most frequently implicated as causes of these economic effects included changing species abundance and distribution, the toxic algae bloom, and changing health/fitness of aquatic organisms due to warmer water conditions. A majority of the discussion on commercial fisheries impacts came from respondents with fisheries expertise, as well as tourism and recreation respondents.

One respondent explained that fishing businesses were losing revenue and experiencing increased costs as a result of diminished abundance and changing location of target commercial species. Fishermen are accustomed to following fish as they move throughout the season and shift locations from year to year. However, a majority of fisheries respondents consulted for this study stated that the changes they were currently observing in the ocean were beyond their understanding of normal variability. The odd locations of commercial species in 2015 were noted to result in increased travel

costs and lost revenues. One respondent described some odd patterns in the hake, shrimp, and tuna fisheries (current).

> "In my whole career here, this was our oddest year of how the [hake] act, and where they were, and what else was out there around this fish... [In the shrimp fishery, normally they catch most down] by Coos Bay and Bandon. This year, 80 to 90 percent of that shrimp was above the Columbia River. Way north, almost to the Canadian border. And these guys from Newport were going all the way up north to shrimp, between Westport and the Canadian border. I've never seen that in my career here… Tuna started in July, and then kind of disappeared and went north. There were guys catching tuna in Alaska and in Canada. The tuna kind of migrated north. The shrimp migrated north. What's causing that to happen? The only thing I see different in the ocean is the blob, or a real heavy El Niño year. I don't know of any other things." *(Industry employee with Lincoln County fisheries expertise)*

Fish buyers noted economic impacts arising from declining health/quality of the products. For example, one respondent linked warmer water conditions to declining survival of Dungeness crab and associated market limitations (current and future).

> **"**We're really concerned about [the weaker crab with the warm water]… If that continued then the price you could pay for crab in the live market is less, because you don't know if it's going to live. [There is] more risk [that the crab will not survive], which would make for reduced price… When you have live crab, that's export. So [with less survival of live crab] then we're talking about less export, more domestic, because more would have to be sold to the cook market which is not shipped to China." *(Small business owner with Lincoln County fisheries expertise)*

Respondents also described economic impacts at the scale of seafood processors. Several employees of processing facilities described the economic costs of shortened processing seasons, including unemployment concerns (current).

> "[Ocean conditions] affected us greatly. Our shrimp season was cut off very short this year due to lack of product. It's very hard to tell 180 employees and their families that they will not work from September until crab starts in December, just to find out that because of the warm water there's this algae bloom that caused domoic in the crab that they're not even going to fish until January." *(Industry employee with Coos County fisheries expertise)*

Respondents discussed potential future economic impacts as a result of projected ocean acidification trends. A majority of concerns were voiced related to economically and culturally significant species such as Dungeness crab (future).

> "A lot of people are concerned, because the commercial crab industry is the bread and butter of the commercial fishing industry in Oregon. Not just for Newport but in Oregon [overall], it is the number one dollar earner for commercial fisheries… That's a big concern. We talk about softening of shells [due to] ocean acidification. It's not so much [that we talk] about ocean acidification as it is how will that impact this particular species that is so important to us economically." *(State employee with Lincoln County fisheries expertise)*

Some respondents also expressed more systemic concerns about the possibility that ocean acidification could undermine the food chain, collapsing ocean ecosystems and the industries that depend on them (future).

"With regard to acidification, not only the shellfish industry is in trouble but also the food chain. If the zooplankton at the base of the chain can't form their shells, the whole system is in jeopardy." *(Non-profit employee with general fisheries expertise)*

D. Economic Impacts on Forest Industries

The theme, *Economic Impacts on Forest Industries*, summarizes respondents' discussion of climate-related economic effects on timber and non-timber forest product businesses in the study area. Key environmental changes that were linked to economic impacts on forest industries included forest stress associated with the long-term drought, limited access to harvest activities as a result of fire closures, and some shifts in timber management strategies as a result of water stress and higher fire risk. Discussion relevant to this theme was primarily contributed by respondents with forest expertise, although a number of tourism and recreation respondents also discussed the effects of fire closures on both forest industries as well as recreational opportunities.

The drought was perceived to be perhaps the most critical driver of impacts for both timber and non-timber forest product companies. In the case of timber cultivation, respondents noted increased forest stress, susceptibility of trees and other vegetation to increased mortality, disease and pest issues, and resulting declines in timber productivity and increasing management costs. For example,

"[Drought-related] mortality is more in young plantations where trees are the most vulnerable… You have lots of other vegetation growing in – grass and shrubs and forbs that are sucking up water – and the trees don't have a well‑developed root system so they're most susceptible to drought then. We're not seeing wide‑spread plantation failures, but on tougher sites we're seeing probably more mortality than normal. It's not a game changer, but it's definitely noticeable… I've seen plantations where you would expect… maybe 10, 20 percent mortality [because they are tougher sites]… but we've seen 50 percent mortality across the unit. [Normally] you put the trees in the ground, you might do some weeding [using herbicide treatments]… [Plantation managers] are planning on having to do more [herbicide treatments]." *(State employee with Coos County forest expertise)*

Respondents with non-timber forest expertise also described economic impacts resulting from the drought. One company elected to shift from mushroom hunting to farming due to limited mushrooms under drought conditions (current). Another reported inability to fill pine cone orders because trees did not set enough cones due to the drought (current).

"I had some orders for Jeffrey pine cones [a craft product], which grow in Northern California. And the drought down there was so bad that the trees didn't set cones and I couldn't fulfill the order." *(Small business owner with general forest expertise)*

In addition, respondents discussed potential economic impacts to forest-based industries resulting from changes in forest regulations. This included possible changes in requirements for stream buffers to protect stream habitat in the face of warmer temperatures, as well as regulations responding to increasing risk of wildfire. Although wildfires have historically burned infrequently in coastal forests due to higher moisture levels, drought and high temperatures contributed to increased risk in the Coast Range in 2015 and precipitated extended fire closures. Forest respondents described several clear

economic impacts resulting from these closures. For example, timber companies were unable to operate during much of the harvest season (current).

> "I think this really is the first year, this summer, where we have realized that, 'This is what climate change may look like for us,' and so we've been dealing with some interesting issues from that. The first one is the fire danger. It obviously impacts our timber sales, and the limitations that our purchasers have in actually operating during certain times of the day, and their responsibilities related to fire suppression if it should happen… Because we're a temperate rainforest, we would typically waive all their fire restrictions, just because we have so much wet weather, our thousand-hour fuels are normally pretty saturated. This year that hasn't been the case, so the operations of timber sales have been limited by fire risk restrictions. That's really affecting their ability to work and move the wood off of our timber sales like they have planned. So that's a pretty direct effect that I see… And I don't see that changing if our weather patterns continue. That's a pretty current, obvious impact from climate change from a timber standpoint." *(Federal employee with Lincoln County forest and tourism and recreation expertise)*

Another timber manager explained that the warmer, drier winter conditions demanded a shift in approach to burning slash piles and landings, costing additional time and money. The lack of moisture enabled one of their burn piles to spread into a 220-acre fire, and for the remainder of the winter, work crews spent extra time in the field monitoring burn piles (current). He noted that, if the warmer, drier conditions were to continue, management of winter burn piles would need to shift indefinitely, adding long-term costs to the timber company's operations (future).

Reduced access to forest lands due to fire closures was a concern for non-timber forest companies. For example, one respondent reported negative economic impacts resulting from inability to access cascara [a medicinal plant] harvest sites as a result of fire restrictions (current).

Finally, the issue of changing climate suitability for native tree species was raised by several respondents as a possible future economic concern for the timber industry. Respondents discussed possible adaptation strategies, such as assisted migration of species or phenotypes likely to survive better under projected climate conditions, and increasing the diversity of timber plantations (future).

> "The big scary issue is [that] we're on the southern [edge of the] range of Douglas fir. Doug fir goes a lot further south when you go inland, but as far as on the coast here, where it's considered really productive, this is really the lower range. Even once you get into California, it becomes much less important. So the fear there is that if there is enough of a climate shift to bring Douglas fir out of the equation, it is going to be a pretty big hit economically, as far as our competitive advantage to grow fiber… There are scientists working on assisted migration and those concepts." *(Federal employee with Lincoln County forest expertise)*

However, several respondents noted that the timber industry may be less receptive to climate change adaptation strategies than other industries due to the longer timescales on which they operate.

> "With forestry, the timescales – the long term nature of the forestry enterprise – make it such that you expect for there to be cycles and droughts and this and that, so people have trouble when they're thinking about climate change. The timescales are different than maybe in agriculture or other things on more of an annual cycle." *(Academic with Coos County forest expertise)*

E. Economic Impacts on Tourism & Recreation

The theme, *Economic Impacts on Tourism & Recreation*, captures respondents' discussion of economic effects on tourism and recreation businesses that arise as a result of climate-related environmental changes. The primary climate-related drivers of impacts on tourism and recreation were perceived by respondents to include year-round temperature increases, diminished summer fog, and the extended drought and related fire closures. Discussion relevant to this theme was primarily contributed by respondents with tourism and recreation expertise, although coastal infrastructure respondents also frequently discussed impacts on recreational fisheries that utilize port facilities.

Changes in the seasonality and location of recreation opportunities were often perceived to have positive impacts for coastal Oregon; with drier, warmer conditions into the fall, coastal tourism increased during shoulder seasons [spring and fall]. In addition, while respondents perceived that losses of snow-based recreation in the Cascades created economic hardship for winter recreation businesses in other communities, they felt that "location switching" benefitted coastal Oregon communities. Respondents observed that visitors continued to arrive and pursue summer-based activities more consistently throughout the winter. This resulted in financial benefits, both for individual tourism and recreation companies, as well as for revenues from recreation on public lands (current).

> "It used to be very, very seasonal, and now you're seeing tourism expand more throughout the year, where it used to be just summertime. Where shops, even when I moved [to Newport] 11 years ago, shops would shut down in the wintertime or restaurant would be closed for a few months. Now more and more it's open year‑round [because there are] more tourists." *(State employee with general expertise)*

However, the effects of warmer temperatures were not unanimously perceived to result in positive impacts in the study area. The increased daily volume of visitors in the summer and shoulder seasons also led to some negative impacts on local businesses. For example, one respondent reported that local residents were feeling burdened by the crowds, and hotels were having difficulty finding enough employees to manage the high demand (current).

> "There's a lot to be said for when you put more bodies in a room than you can, something happens. Something trickles out, and the locals oftentimes suffer the impacts of that… We're just all doing the best we can. Even some of the local hotels are saying that they can't find the help that they need for housekeeping teams and maintenance teams because the demand [for hotel rooms] is just so great. They've got [employee] turnover every day, and there are not enough people for the jobs." *(Industry employee with Lincoln County tourism and recreation expertise)*

Two Coos County business owners perceived that climate-related changes would result in positive economic impacts for local tourism and recreation businesses over time. However, they questioned the long-term negative ramifications for quality of life and their desire to stay in Coos Bay in the future (future).

> "As business owners, we are anticipating tourism getting bigger and bigger here in Coos Bay. It is a good investment, but part of that, I believe… is because the coastal areas will be a refuge [from the impacts of climate change elsewhere]. For those of us who have businesses that are reliant on tourism, I think it's going to be good… It's horrible to benefit from something that's so

destructive, but I think our business will. And I don't know that I like it. We're here because of low population density. We're here because you can go to the beach and relax. That's the reason that I want to live here. That's the reason that I wanted to live here indefinitely. But if it becomes very very crowded, I don't know. We might have to move." *(Small service business owner with Coos County tourism and recreation expertise)*

In addition, respondents brought up multiple current and possible future impacts on recreational fisheries that could create negative economic impacts in coastal communities. Many noted that low survival of salmon in many area rivers due to warmer water had triggered recent salmon fishing closures (current). Similarly, the toxic algae bloom resulted in multiple shellfish recreation closures during the summer of 2015 (current). One respondent with coastal infrastructure expertise noted that changes in the location of warm water currents in the ocean can affect whether or not people come to the coast to recreational fish for tuna; if tuna follow the warmer water too far offshore, recreational fishermen will not be able to safely target them. In addition, one respondent expressed concern that declining fitness and survival of Dungeness crab due to warmer ocean temperatures could eliminate a key recreational fishing activity that draws tourists to the coast (future).

"If [the water is] warmer and there's less crab in the bay, then we're talking, 'Does that change tourism?'… Because a lot of people come here to go bay crabbing and ocean crabbing. Maybe there's other reasons people are coming here for tourism, but changes in the fisheries resources… might affect the activities people might come here to do." *(Small business owner with Lincoln County tourism and recreation expertise)*

F. Economic Reorganization

The theme, *Economic Reorganization*, captures respondents' discussion of fundamental changes in the fabric of the study area economy. Although many non-climate-related drivers have contributed to economic shifts in coastal Oregon over time, respondents perceived that several climate-related drivers could be contributing to these processes. Respondents with fisheries and forest expertise more commonly discussed current or potential future economic shifts. In addition to climate-related economic impacts on key natural resource-based industries, respondents also pointed to the increasing role of retirement, and the increasing prominence of transfer payments, as a force for economic change.

The topic of economic upheaval is a long-standing issue in coastal Oregon, where natural resource-based industries have risen and fallen over the years. Particularly in Coos County, multiple respondents noted that communities are still adjusting – economically, socially, and culturally – from the timber crash of the 1980s. They also discussed the impacts of changes in the management of timber and fisheries. Climate change was discussed as one more shock on top of many other drivers of change already present in coastal Oregon communities.

"There are all of these external shocks to their communities, whether it's the Northwest Forest Plan, whether it's fisheries collapses, whatever it is. Wave energy is the latest thing. Climate change is another. They're asked to cope with all of this, and it's just a lot to deal with. [Climate change is] one more change that they're trying to cope with." *(Academic with climate expertise)*

Multiple respondents spoke about current and potential future impacts of resource decline and (or) ecosystem collapse on the local economy. For example, one respondent discussed what would happen if ocean acidification led to a collapse of the Dungeness crab stock (future).

> "[A collapse of Dungeness crab would affect fishermen] pretty much the same way [collapse] affected the timber people. Basically, what you would expect [with ocean acidification] is a kill‑off of species… If acidification interfered with shell development in any way, created soft shells or didn't allow shells to harden that would leave those critters more subject to predation, it would eventually interfere with their breeding capabilities… On the Oregon coast, Dungeness is [big] business. [If] you take a [that money] out of the Oregon economy, that's significant." *(Small business owner with Coos County fisheries expertise)*

Respondents also frequently spoke about economic shifts driven by large-scale demographic change. Many pointed to climate change as both a current and potential future driver of demographic changes including increasing retirement. Respondents observed links between coastal retirement and the increasing importance of transfer payments relative to other economic sectors in coastal Oregon (current).

> "A lot of retirees [are] coming from south, north, and inland, and they bring with them transfer payments – basically retirement money. It's a whole different kind of economy. If you look at the coastal economy, it is dominated by transfer payments, not by forest, or agriculture, or fishing, which are actually very small parts of the coastal economy. The coastal economy is dominated by transfer payments, money coming in from the outside. That's money that these people bring with them or is sent to them. And many of these people are new. They're immigrating into the State from other areas. And that overwhelms all the natural resource economy and recreational tourism figures, it really does. In some communities, [transfer payments] make up almost the entire economy, along with recreation and tourism. [Retirement, tourism, and recreation] improve when the weather is better, and the climate seems to be more favorable. So that's definitely a whole [transformation]." *(State employee with general expertise)*

G. Personal Costs

The theme, *Personal Costs*, highlights examples provided by respondents of climate-related costs they incur on a personal level, rather than at the scale of business and industry. Respondents perceived personal economic costs arising from a variety of climate-related issues, including increasing risk of extreme weather events such and increasing storm intensity and flooding, and increased temperatures and decreased precipitation. Issues relevant to this theme were less commonly discussed compared to other themes described in this section. Respondents from all resource/livelihood expertise categories, except coastal infrastructure, shared examples of increasing personal costs.

Several respondents provided examples of personal costs associated with increased risk of climate-related hazards and weather events. For example, one respondent discussed increasing demand for private power generation and (or) backup systems as local residents prepare for more severe weather patterns (current).

> "On the residential level, we have more of a call for battery backup systems and for passive solar integration. Let's work on the daylighting in our house and insulation… I think the knowledge and increased information about climate change and the dubious forecasting of what it's going to mean for anyone has resulted in a little bit of a consumer shift into more of a prepper mentality." *(Small business owner with general Coos County expertise)*

Other respondents spoke about the impact of climate-related hazards and weather events on property values and insurance rates. They perceived that property values and insurance rates on homes in vulnerable areas have been impacted by policy responses to issues such as increased incidence and risk of coastal erosion and flooding. One respondent pointed out that, in addition to the effects of local policy reactions, extreme weather events that take place in other areas of the country can also impact insurance costs (current and future).

> "Another big issue… is the impact on property values of… either bluff erosion or flooding along the coast… There can be an overreaction at the policy level to potential risk, to the point where it can have very meaningful and painful impacts to people on the ground… If [local risk assessments are] then taken, and the insurance companies go, 'OK, that means we're not going to insure property that might be subjected to something like that,' that's when things could become problematic… We even had it on the flood insurance side of things, with the issues Congress has had back east with hurricanes… Congress goes and passes a law that would have jacked up rates considerably for people in flood‑prone areas in Oregon, even though our properties weren't the ones driving the need. They later backtracked because it was too draconian. But it gives you a sense of that ebb and flow." *(Official of a local governing body with general Lincoln County expertise)*

In addition, respondents often discussed the personal costs associated with higher temperatures and reduced precipitation. In the following quotation, one respondent discusses increasing costs associated with water bills and air conditioning (current).

> "What we're seeing in our homes, certainly in businesses, is the need to water our lawns more frequently, which increases water usage, water bills. That can have a huge burden on people trying to just afford to get by when their water bills soar, because they're trying to keep a lawn or growing gardens and things like that. The other thing, of course, it increases the demand for energy. Air conditioning or fans, or just keeping things cool in the home can also be a drain on resources, because you're utilizing more power, more energy, just to keep things cool." *(Industry employee with Lincoln County tourism and recreation expertise)*

5.2.3 Exploration of Cultural Themes

During second cycle coding, individual cultural HDCC effects mentioned by respondents were grouped into one or more categories in an effort to identify overarching themes. *Cultural considerations* were defined as: A peoples' identity, beliefs, values, practices, activities, and traditions, as well as symbols and built structures (Section 1.1).

Two distinct cultural HDCC effect themes emerged, and are discussed here in alphabetical order: 1) cultural reorganization; and 2) effects on culturally important resources. The themes are described below, and illustrated using examples from the narrative data. Results of basic frequency analyses were used to help build these themes. Lists of the most frequently mentioned HDCC effects, including differences in emphasis across resource/livelihood expertise categories and perceptions of current vs. future potential impacts, are included in Appendix 4.

A. Cultural Reorganization

The theme, *Cultural Reorganization*, captures respondents' discussion of cultural shifts occurring within the study area. As in the case of social and economic shifts, respondents perceived climate-related changes to be one set of drivers among many factors affecting cultural change. Respondents from all resource/livelihood expertise categories, except coastal infrastructure, mentioned issues and examples related to this theme.

Respondents cited demographic change as one of the greatest drivers of cultural change in the study area. Although respondents noted that these changes were caused by other large-scale economic and cultural drivers, they perceived that climate changes were enhancing these trends. For example, one respondent discussed trends toward retirement and second homes in the study area, and felt that climate played some role (current).

> "When you define the economic base of the given communities in the different sectors… retirement is non-trivial. In every place around here, the magnitude of second homes in this region would blow you away. We're talking 40 percent of the housing stock in some places. It's way off the scale... And it does have relationships to climate… How much is climate related is a different question. [But] if you've got 40 percent of your housing vacant, whether for rentals or retirement, that means potentially a sea change of cultural identity." *(State employee with general expertise)*

Many respondents felt that these demographic changes were accompanied by shifting priorities and values among study area residents (current).

> "I meet so many people who most often have lived in the valley and just dreamed of retiring at the coast. And they bring different priorities, different values. I've seen clashes maybe a little more intense in recent years." *(County employee with Lincoln County expertise)*

Changes in values and priorities were perceived to result in some culture clashes in the study area. A common example was conflict over differing visions for appropriate use of natural resources. The following quotations provides an example of how new residents were perceived to hold different values and to attempt to alter natural resource management policies to fit those values (current).

> "I think there's a lot of people who move to some of these communities in the Coast Range… that don't fully understand a lot of the management implications that they're moving into, or the culture that's there around resource extraction. And then [they] are either disappointed, or then seek change in their communities. I'm thinking of some people I know that moved to the coast, and then get really outraged by logging practices that they see, because they thought they were moving to a place for its natural beauty. And maybe they thought that people valued things the same way they did, but they come and they find things are a little bit different, because there's this historical culture of more extraction. And so then they might seek change through community activism, or electing different people to office, that sort of thing." *(Non-profit employee with general forest expertise)*

B. Effects on Culturally Important Resources

The theme, *Effects on Culturally Important Resources*, captures respondents' discussion of climate-related effects on native plants and animals that have a direct connection to cultural identity and way of life in the study area. Respondents from all expertise categories spoke about impacts to culturally significant resources that underpin way of life in the study area.

Examples of cultural impacts pertained to both Tribal and non-Tribal cultural resources. Across the board, individuals noted the cultural importance of emblematic seafood species such as salmon, Dungeness crab, and other shellfish such as oysters and clams, and the cultural impact of changing in access to these resources. One respondent pointed to the cultural impact of Dungeness crab closures due to toxic algae blooms, which was perceived to be driven by warmer water temperatures (current).

> "Then you have the [commercial and recreational] Dungeness crab closure… because of red tide [toxic algae bloom]. How does that affect not only the culture of traditional practitioners, but the culture of local communities who depend on fisheries for their economy and their sustainability?" *(Tribal representative with Coos County expertise)*

Multiple respondents also perceived links between warmer water temperatures and the viability of Oregon salmon runs. The possibility that local residents could lose access to salmon was a key cultural concern. One respondent described the threat to salmon arising from a combination of warmer temperatures and logging practices, and the associated implications for local way of life (future).

> "Higher air temperatures is not going to help [salmon] spawning creeks, especially in those places where timber's still being harvested. Industrial timber operators are required to leave buffers, but [the buffers are] sometimes pretty minimal. So, people are a little worried about that. If salmon get more expensive or less common, then that's going to change people's way of life around here. And particularly for Tribal folks." *(State employee with Coos County expertise)*

Respondents also noted the potential impact of climate changes on many plant species that provide important cultural value in the study area. This include agricultural crops associated with regional cultural identity. One respondent expressed pride around regional apple production and the tradition of apple cider in the fall and concern about the impacts on this tradition as a result of unseasonable temperatures (current).

> "[There are impacts on] little things that are really significant in your day-to-day life and in what you consider normal… You're supposed to have hard-pressed apple cider [in the fall]. How come we're not? I mean, it was [unseasonably warm] here up [this fall]" *(Non-profit employee with Lincoln County tourism and recreation expertise)*

In addition, multiple respondents noted changes in the phenology of native plants that are important for subsistence, ceremonial, and (or) artistic purposes, such as huckleberry (*Vaccinium* spp.) and Camas root (*Camassia* spp.) which are important food sources, the gray pine (*Pinus sabiniana*) which provides a seed important for Tribal regalia, and plants used in basketry such as bear grass (*Xerophyllum tenax*), hazel sticks (*Corylus* spp.) and red cedar root (*Thuja plicata*). One Tribal representative described increasing challenges in harvesting basketry materials as a result of changing seasonality (current).

> "For basket materials gathering, usually it would be kind of mid-May through first week at least of June. Three good weeks at least of hazel stick-picking for basket material. And now it comes on early. It's done by Memorial Day, and usually only lasts about a week/week and a half before it gets so warm so quick that that new growth shoots out, and it makes the sticks unusable." *(Tribal representative with Lincoln County forest expertise)*

Another Tribal representative described possible positive cultural impacts associated with the gray pine, noting that the suitable climate range is expected to extend further northward into Oregon. The respondent noted that this could improve Tribal access to the gray pine seeds, which have cultural significance (future).

> "There have been little populations of *Pinus sabiniana* [in Oregon]. 'Gray pine' is the usual common term now. [It produces] great, big, football-sized cones – not the long, skinny cone like a sugar pine. Those hard-coated pine seeds [from the gray pine] are really culturally important for us, for food and for bead making for regalia... Most people, especially in the last few generations, have treated them as introduced or just brought up and planted as specimen trees. But there's really good evidence that there are still little pockets of native populations in the Rogue Valley. Even though it's a low timber value species, it holds on, especially in really harsh dry spots. And so, part of that discussion about loss of oak habitat in the Rogue Valley is, 'Maybe some good can come out of this.'" *(Tribal representative with Lincoln County forest expertise)*

5.3 Current and Potential Future Cumulative Impacts in the Study Area

Study objective #4 was to improve understanding of potential cumulative social effects arising from climate change (Section 1). Cumulative impacts are defined in 40 CFR § 1508.7 as impacts which result from, "the incremental impact of the [Federal action under consideration] when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (CEQ 2005). Human-induced climate change can be considered the result of the collective actions of humanity over an extended period of time, and thus fits the definition above of "other past, present, and reasonably foreseeable… collectively significant actions" that may create cumulative impacts in concert with a given Federal action proposed in the study area.

A typology of cumulative impacts developed by Bererton et al. (2008) guides identification of examples of cumulative impacts. According to the typology, cumulative impacts can accrue as a result of a combination of spatial, temporal, and (or) linked impacts. *Spatial* impacts can accumulate by *extent* (i.e., increased area of effect) or *intensity* (i.e., increased concentration of impact within a given space); *temporal* impacts refer to one or more impacts with measurable duration(s) occurring over a specific time span; *linked* impacts include *linked triggered* interactions (i.e., when one impact occurs or reaches a threshold it triggers another impact) and *linked associative* interactions (i.e., multiple impacts result from the same event or change) (Brereton et al. 2008, Vanclay and Esteves 2011). Many of the examples of climate-related environmental issues/changes and HDCC effects referenced in Sections 5.1 and 5.2 involve some form of interaction effects. This section builds on previous examples by drawing out particularly clear illustrations of cumulative impacts that respondents perceived to contribute to HDCC effects in the study area. The type(s) of cumulative interaction(s) represented by each illustration are noted in parentheses (e.g., spatial; temporal; linked triggered; linked associative).

Effective identification of cumulative HDCC effects requires knowledge of perceived drivers of social, cultural, and (or) economic effects in the study area. Thus, as a starting point for identification of key examples of cumulative effects, this section includes results of co-occurrence analyses that identified top climate- and non-climate-related drivers of change discussed by respondents. Section 5.3.1 presents a list of the environmental issues/changes most frequently discussed as drivers of HDCC effects in the study area and provides examples from the narrative data. Section 5.3.2 presents the HDCC effects that respondents most frequently perceived to act as intermediary drivers of additional HDCC effects, along with examples of cumulative effects that that involve these intermediary HDCC drivers. Section 5.3.3 discusses other, non-climate-related stressors perceived to be acting on the study area, and includes examples of climate-related cumulative effects involving interactions with these other stressors. Finally, Section 5.3.4 provides a more complete summary of the causal linkages most commonly described by respondents, including current and potential future cumulative interactions.

5.3.1 Environmental Issues and Changes as Drivers of Cumulative Effects

Table 4 summarizes environmental issues/changes that were frequently mentioned as drivers of HDCC effects in the study area. Although respondents mentioned all of these issues when discussing both current and future potential HDCC effects, some were more frequently mentioned as current drivers, while others were more commonly perceived to be drivers of future potential effects. Specifically, air and water temperature increases, shifting precipitation patterns, forest fires, and changing abundance and seasonality of organisms in the study area were more frequently discussed as drivers of *current* HDCC effects. When discussing *potential future* HDCC effects, respondents were more likely to mention long-term processes of ocean acidification and sea level rise, as well as changes in overall survival rates of organisms (e.g., species decline or wider ecosystem collapse).

Table 4. Climate-related environmental changes perceived to drive HDCC effects

◊ Key climate projections for coastal Oregon, including increasing temperatures, changing seasonality and intensity of precipitation, and changing storm frequency/intensity.
◊ Numerous environmental changes resulting from these key shifts in climate patterns, such as: ● Forest fires ● Drought ● Changes in species location, abundance, and survival ● Outbreaks of pests, diseases ● Toxic algae blooms
◊ Long-term, incremental processes of sea level rise and ocean acidification and increasing rates of coastal erosion.

Respondents observed both direct and indirect HDCC effects arising from cumulative environmental issues and changes in the study area. In some instances, spatial or temporal accumulation of a particular environmental event or condition was perceived to lead directly to HDCC effects. For example, respondents with tourism and recreation expertise frequently observed that the extended duration of warmer, drier conditions on the Oregon coast (current temporal accumulation) was a direct driver of increased visitation to the study area during summer and fall months. This was perceived to have resulted in both social and economic effects (current).

> Respondent 1: “The more nice beach days [you have], the more people you're going to have at the beach… It's definitely a change. If [the nicer weather is] the new norm, then all those hotel people and restaurants… are going to benefit.”
>
> Respondent 2: “We have absolutely benefitted this year because of this increase in [fall] shoulder season [visitation]. We've had more camping and we've had bigger income, and that's really been a boon for our budget.” *(Two State employees with Coos County tourism and recreation expertise)*

More commonly, however, basic climatic trends (e.g., changing temperature, precipitation, and storm patterns) were perceived to lead to intermediary environmental changes in a chain reaction that ultimately produced one or more HDCC effects (linked triggered and linked associative effects). For example, respondents with forest expertise noted that extended conditions of low moisture and high temperatures (current temporal accumulation) resulted in both observed and projected future increases in the incidence of forest fire over a greater area (current and future spatial accumulation). Increased fire risk in turn was observed to result in fire closures and restrictions (current linked triggered effects), which were then perceived to result in a suite of other social and economic effects (current linked associative effects), including reduced timber revenues, stress on emergency response resources, and reduced access to recreational on public and private land, among others. A good example of an HDCC effect arising from these cumulative effects was decreased local fire response capacity, as described in the following quotation (current).

> “This summer was pretty difficult financially on our company, because we actually got into periods where we couldn't log at all. It was too dry, and the fire agency shut off all the logging. Total closure. In some places, it was an extended four‑week period when we couldn't even operate… The main reason is that if you got a fire, you couldn't control it. And the other thing that happens is you have big fires other places, so all the resources are tied up fighting those fires… so if you got one [here], you wouldn't have access to the resources to fight it.” *(Industry employee with Coos County forest expertise)*

Similarly, some forest respondents noted current increases in forest stress due to longer durations of low moisture conditions (current temporal accumulation), leading to increased susceptibility to pests and foliar pathogens (current linked triggered effects) and associated economic impacts (current). The following quotation illustrates this chain of events (current).

> “When [Douglas fir] becomes stressed by drought it drops its defenses a little. So then bugs [like the] Douglas fir bark beetles come in. Different insects can infect the tree where they wouldn't be able to infect a healthy tree. [We’re also] seeing different foliar pathogens…on the leaves, that are taking advantage of these stressed trees. The organisms that are causing the disease are native pests that are always around, but we're seeing them a lot worse because of the drought stress. And it's not just one year of drought stress, it's been several, so it's been pretty hard on them.” *(State employee with Coos County forest expertise)*

Several respondents with coastal infrastructure expertise noted increasing frequency and intensity of winter precipitation events (current and future temporal and spatial accumulation), and suggested that these events could lead to increased movement of material downstream with effects on coastal sediment transport patterns (future spatial accumulation). The following quotation provides an

example of potential future impacts on jetties that could result from the cumulative effects of increased winter precipitation events and associated changes in coastal sediment dynamics (future).

> "[Maybe] we get more intense rain and runoff events in the wintertime scouring the jetties, affecting them at the entrance – and then we turn around and have a dry, warm summer that maybe causes more material to push then back in. The damage is done for the winter, and now you get more material that moves in [close to shore] that might cause waves to break closer to the nearshore environment, as opposed to breaking further offshore. Now you've got an even worse situation, because you're being affected by more intense waves more frequently." *(Federal employee with Coos and Lincoln County coastal infrastructure expertise)*

Finally, respondents with fisheries expertise noted the unusual size and duration of the warm water patch in the Pacific Ocean known as the blob (current spatial and temporal accumulation), and the resulting extensive and persistent toxic algae bloom (current linked triggered effect). Respondents observed that the toxic algae bloom led to a suite of social, economic, and cultural effects (current linked associative effects), including human health concerns, recreational and commercial fishery closures, and loss of access to culturally important seafood species such as Dungeness crab. The following quotation illustrates this series of impacts (current).

> "The reports that I've read said that [the blob] is having a detrimental effect to the entire food chain. [Domoic acid] is showing up in shellfish and in forage fish and all the way up the food chain. So, because of [the toxic algae bloom's] persistence and its extremely large area, no one can avoid it. And it's just starting to set in to the populations. And there's some fear that it may cause some of them to really either move out or start to die." *(State employee with general fisheries expertise)*

5.3.2 HDCC Effects as Intermediary Drivers of Cumulative Effects

When describing the causes of HDCC effects, respondents often referenced series of events in which initial HDCC effects acted as intermediary drivers of additional HDCC effects in the study area. Table 5 summarizes the HDCC effects that were most often identified as intermediary drivers of additional HDCC effects. This list reflects perceptions of both current and potential future intermediary drivers of HDCC effects. However, changing appeal of coastal Oregon and quality of life issues were more frequently perceived to be *potential future* intermediary drivers rather than drivers of current HDCC effects.

Table 5. HDCC effects perceived to act as intermediary drivers for additional HDCC effects

◊ Shifting patterns in the movement and volume of people in the study area.
◊ Changes in risk associated with extreme weather events and resource stress, such as risk of forest fires, exposure to domoic acid resulting from toxic algae blooms, and vulnerability to water scarcity resulting from periods of drought.
◊ Economic impacts on fisheries, forest livelihoods, tourism and recreation, and maintenance of coastal infrastructure.
◊ Economic impacts on recreational activities.
◊ Diminished availability of, and access to, natural resources, affecting both commercial and recreational activities.
◊ Changes in environmental policy and regulation in response to climate-related environmental changes.
◊ Increasing resource management challenges and responsibilities.
◊ Adaptations, including shifting livelihood strategies and business management decisions.
◊ Changes in the appeal of coastal Oregon, including increased quality of life relative to other areas of the State and nation.

Cumulative effects involving intermediary HDCC effects most commonly took the form of linked triggered effects: respondents described chains of events originating with climate-related environmental issues/changes; these environmental issues/changes led to initial HDCC effects; which in turn were perceived to trigger other social, cultural, or economic effects in the study area. For example, issues of coastal erosion were noted to lead to human adaptation consisting of modifying the shoreline with permanent protective structures. This shoreline armoring activity, in turn, was perceived to have negative effects on recreation due to disappearance of beaches (current). The following quotation illustrates this linked triggered set of impacts.

> "The acceleration of erosion through high-intensity storm events, increased wave heights... the impacts are quite noticeable… The impact of that is real, and the response to that is challenging for us – how people are responding. Number one, when we armor our coastline and move forward with this hold-the-line type scenario for climate change impacts like shoreline erosion, we undermine the beach. We undermine the recreational opportunities that are vastly important... There was a time when you could walk down Gleneden Beach at high tide. You can't do that anymore. And you can't do that because of the way we have responded to shoreline erosion and armored that beach. It has undermined the beach." *(Non-profit employee with coastal Oregon tourism and recreation expertise)*

An example of cumulative effects on fishing livelihoods arose from the long-term decline of salmon resources (current temporal accumulation). One respondent described a fisherman who, after years of working to save salmon stocks, had crossed a threshold of stress and exhaustion as a result of the current salmon disaster. The fisherman was now looking to sell his salmon boat (current linked triggered effect). This is an example of a livelihood adaptation resulting from the cumulative interactions between climate-related environmental changes (reduced salmon survival during the 2015 drought) and the intermediary HDCC effect of chronic stress.

> "I know of a fisherman who is trying to sell his boat right now, because he is looking at what's going on in California with the drought. The fish they catch up here [in Oregon come] from Sacramento runs and Klamath runs. In four or five years those fish would be returning… I think people do change their behavior when they see what's coming. But there's also cumulative

impacts of years of trying to get by and fight for salmon… In that scenario, I think he's tired." *(State employee with Coos County fisheries expertise)*

Respondents frequently provided examples of the intermediary role of climate-related policy changes in driving HDCC effects. A respondent with forest expertise provided an example, in which concerns about climate change prompted regulations limiting the use of controlled burns in Oregon forests. In the absence of their traditional management strategy, Tribal forest managers were forced to move toward chemical management strategies. This is an example of one HDCC effect (a regulatory change) driving a management adaptation (current linked triggered effect). The respondent also noted an additional linked environmental effect of increased chemical applications: changes in the forest ecosystem.

> "The frustrating piece with [smoke regulations] is, for a Tribe that maybe would harvest timber off of 100 acres every year, and if they were to go in and burn like they used to, how measurable [is that smoke] in terms of the broader scale of climate change?... Now with the restrictions in burning after harvest operations, folks have turned a lot more to chemical application. I think that has a real effect, short term and long term, on what kinds of communities you have coming back out in the forest. Where before you had really a fire managed forest, and now you have more of a chemical managed forest." *(Tribal representative with Coos County forest expertise)*

Similarly, climate-driven increases in management challenges were a commonly perceived intermediary driver of HDCC effects. A respondent with coastal infrastructure expertise discussed an example of potential future cumulative effects arising from increasing storm energy and coastal erosion, which in turn would lead to increased costs of maintaining coastal structures. The respondent suggested that increased maintenance challenges would eventually contribute to shifts in willingness of the government to invest in building and maintaining coastal structures. This is an example of one potential future HDCC effect (increasing maintenance challenges) leading to a potential future adaptation in management strategy (future linked triggered effect).

> "As you can imagine, if the current trends of climatology pieces continue to rise, then you can see how [the storm energy and heavier river scouring events] would coincide with major erosional effects… If [climate trends] continue to climb as they are projected, then we do have our work cut out for us. And at some point we will pass the threshold of saying, 'Guess what? The degradation [of coastal structures] is accelerating much faster than we as a nation are, have previously invested. We can no longer maintain the kind of investments that we've historically used. We're going to have to use a new process.' And [the possibility of this situation] is very much on the radar." *(Federal employee with Coos and Lincoln County coastal infrastructure expertise)*

5.3.3 Other Stressors Interacting to Produce Cumulative Effects

Some of the HDCC effects discussed by respondents were perceived to arise primarily from climate-related environmental changes. More commonly, however, respondents perceived greater causal complexity, and pointed to multiple other, non-climate-related drivers that acted as concurrent drivers of human dimensions issues and changes. These other contributing factors should be considered alongside climate-related drivers to gain a complete understanding of the cumulative effects of climate change on social systems.

Table 6 presents the non-climate-related stressors that respondents most frequently perceived to provide additional causal mechanisms for HDCC effects. The list summarizes stressors perceived to drive both current and potential future HD effects. In addition to economic, social, and cultural shifts, respondents frequently referenced the importance of regulatory and policy changes, changes in access to and the health of natural resources. Historical land use was a particularly important non-climate-related variable that lent richness to respondents' understanding of the drivers of current ecosystem conditions. Of the non-climate-related drivers noted in Table 6, cultural shifts were more frequently noted to be *potential future* drivers of HDCC effects in the study area. For example, respondents perceived that coastal Oregonians' sense of place and connection to the current way of life may change over time. They suggested this could result from numerous factors, including shifts away from resource-based livelihoods and larger societal shifts associated with technology use and declining awareness of the natural environment (e.g., a perceived decline in environmental awareness due to reduced time outdoors).

Table 6. Other stressors perceived to interact as drivers of HDCC effects

◊ Non-climate related economic reorganization.
◊ Non-climate related changes in movements of people.
◊ Non-climate related cultural shifts.
◊ Non-climate related changes in the regulatory environment.
◊ Non-climate related changes in availability of and access to natural resources.
◊ Non-climate factors influencing the condition of natural resources and ecosystems (e.g., past land use and resource management; natural variability).
◊ Non-climate related human health issues.

One group of HDCC effects that was commonly perceived to arise from interactions between climate and other, non-climate drivers was changes in human migration and visitation patterns. This theme encompasses increases in the volume of tourism and recreation in coastal Oregon, as well as changes in the demographics of permanent residents. Respondents saw clear links between these patterns and climate-related drivers (e.g., increased year-round temperatures and decreased fog), but many also cited the role of larger market and sociocultural trends. For example, respondents noted that increased visitation to coastal Oregon could also be explained by factors such as an improving economy and reduced fuel costs, and the impact of marketing and advertising on the part of coastal businesses. This is an example of temporal accumulation of climate- and non-climate-related effects, as illustrated by the following quotation (current).

> "[In the last two years] we have seen a tremendous spike in visitors' spending. And it's not just due to the weather, but [that] certainly is one of the major contributing factors. The ski resorts haven't seen much snow in the last two winters, and so people are taking vacations at the beach when we've had nicer weather… even in the winter time. Our winter time numbers were up for both this last year and the year before... Year-round we're staying busy and it's unusual for us. Again, there are a lot of factors that we think contribute to that. Marketing and advertising certainly are some of the factors. But when you see an increase in visitor spending like we've seen in the last two years... you have to ask yourself, why?" *(Industry employee with Lincoln County tourism and recreation expertise)*

Similarly, respondents noted that demographic change in the study area was driven by large-scale economic and cultural trends, independent of climate-related environmental change. However, many perceived that climate change will play a tangible role in this process. One respondent explained this conjunction between multiple drivers, and also noted that the cumulative effects may lead to cultural transformation. This is an example of weather patterns interacting with other concurrent drivers (temporal accumulation) to produce changes in study area demographics (linked triggered effect), which in turn could lead to cultural effects (linked triggered effect).

> "I think a lot about western Oregon being one of the fastest growing parts of a country right now. In-migration of people from other places is being economically and socially driven. You have to consider that it will likely become climatically‑driven eventually, and that those combinations may radically transform the Northwest." *(Academic with general forest expertise)*

Similarly, respondents with natural resource expertise frequently mentioned multiple drivers of impacts on resource condition and the economic health of their industries. For example, a fisheries respondent described economic challenges arising from the natural variability of ocean cycles. The respondent also perceived additional uncertainty, stress, and economic impacts arising from warm water conditions in 2015 (current linked associative effects).

> "There are always cycles in the seafood industry, and you watch them over the years. You can't pinpoint them and say, 'The fifth year it's going to be great,' or anything like that. But you can see that between four and seven years you're kind of on an upward hill, and then a downward slide. And we expect that cycle to run through. We're going to have some great boomer years, and we're going to have some kind of crappy years in between. However, the last few years, with the warming of the water, has been a huge change for us. The tuna has moved further offshore. The shrimp are doing the same thing, I believe, [though] it's too new to tell with that. So, not only [are the fisheries] on a downward trend anyway, but now we've got this warmer water working against us." *(Industry employee with Coos County fisheries expertise)*

Forest condition was also perceived to be influenced by both climate- and non-climate-related drivers. One respondent discussed the increasing prevalence of a new disease affecting Douglas fir. The respondent perceived that historical land use and forest management practices were a critical variable influencing current forest health, but also recognized the role of the extended drought in driving forest stress. In combination, these drivers of change contributed to increased forest disease, with associated negative impacts for the timber industry. Thus, the temporal accumulation of climate- and non-climate forest stressors led to increased incidence of forest disease (current linked triggered effect), which can in turn lead to declining health and productivity of timber resources (current linked triggered effect).

> "There's a new disease they're trying to figure out that's seriously browning some Douglas firs just starting this summer. Some of that might have to do with changes in the climate and continued drought, but a lot of it has to do with past management of clearcut harvest and replanting too densely and monoculture. It's hard to tease those out… Climate change is a new stress on top of all these existing stresses." *(Non-profit employee with general forest expertise)*

Non-timber forest products companies experienced similar effects arising from cumulative impacts. As one respondent noted, reduced availability of wild mushrooms was driven by both climate changes and loss of habitat due to other industrial uses of forest lands (current temporal accumulation).

"[Drier summers and falls are] the main change [affecting mushroom hunting]. I mean, the biggest problem really is the logging going on, as far as loss of habitat and loss of species that way. But as far as climate change [the drier conditions are the primary change]." *(Small business owner with general forest expertise)*

Historical land use management was also a factor noted to impact coastal erosion processes. Several respondents discussed the impact of shoreline armoring on coastal erosion along adjacent shoreline areas. For example, one respondent expressed concern that the cumulative effects of existing coastal protection structures and future climate-related increases in storm intensity will result in more extreme shoreline damage (future temporal accumulation).

"I am no fan of rip-rap, because I have already seen and learned enough about the damage it does – the way it just shifts erosion. I'm fearing that... with the more intense winter storms... there just seems to be more volatility than we've ever experienced before. And I'm afraid if we don't try to tighten [regulations] on rip-rap at least a little bit, we're going to see more negative effects to the shoreline." *(County employee with Lincoln County expertise)*

Finally, one of the most frequently perceived non-climate drivers of cumulative impacts was the regulatory environment. In many cases, respondents noted that regulations prevented them from responding to climate-related environmental change. For example, one respondent described a lack of flexibility in fisheries management which they perceived to prevent adaptation to climate-related shifts in the seasonality of Dungeness crab. This is an example of a climate-related environmental effect (shifting seasonality) interacting with a non-climate stressor (the regulatory environment) to prevent adaptation, thus leading to economic losses in the fishery (current linked triggered effects).

"Our managers can't change the calendar in our fishery. If we do our pre-season testing on crab and we determine that their [meat] fill rate meets the criteria to open the season, they have to open the season. Our [fishermen] might say, 'No, it's a real mixed bag. Some are really nice and heavy and then there's a lot of light ones and they're not filled in yet. We need another couple of weeks for them to fill in.' [But] fisheries managers can't change anything. They have to open by the calendar if it meets the criteria they have set up to open." *(Industry employee with Coos County fisheries expertise)*

5.3.4 Summary of Commonly Described Cumulative Interactions

The examples provided above explore the details of cumulative interactions between climate-related environmental issues/changes and human dimensions trends in the study area. This section provides a more comprehensive summary of the variety of causal linkages that were commonly perceived by respondents. Based on qualitative analysis of the perception data, six key climate-related environmental changes appeared to be at the root of a majority of other environmental changes and HDCC effects discussed by respondents. These included: 1) an increasingly attractive Oregon climate; 2) longer, drier summers; 3) increased frequency of high volume rain events in winter; 4) high water temperatures; 5) increasing acidity (decreasing pH) of ocean waters; and 6) increasing sea level and storm intensities.

1) <u>An increasingly attractive Oregon climate (current and future)</u>, particularly relative to climate stresses elsewhere in the State and nation, contributing to: 1) increased movement of people to the Oregon coast (in combination with other economic and social variables such as the current

trend of increasing coastal retirement); 2) increases in tourist traffic in the summer of 2015, contributing financial benefits (positive) and stresses to management, facilities, and infrastructure (negative) to the tourism and recreation industries and community resources, and impacted quality of life for some coastal residents as a result of crowding issues (negative) and comfort levels (positive); and 3) shifting demographics as a result of new populations moving to the area, and associated implications for cultural shifts including new cultural values regarding natural resource use.

2) Longer, drier summers (current and future), leading to: 1) longer recreation seasons contributing financial benefits (positive) and stresses to management, facilities, and infrastructure (negative) to the tourism and recreation industries and community resources; and 2) increased risk of forest fire associated with: 1) economic and managerial impacts on the timber industry arising from shifting operational seasons (e.g., later start due to wet spring and potentially later fall operations with extended dry summers), 2) stress on emergency services with ripple effects throughout the community (e.g., potentially slower response to community fires), and 3) loss of recreational access to forest lands due to fire risk mitigation; 3) decreased freshwater supply associated with increased stress on vegetation, including decreased productivity of timber and non-timber forest products and greater susceptibility of stressed tree species to disease and pests; and 4) concerns regarding suitability of existing community water infrastructure, as well as the continued reliability of wells used by the high percentage of coastal residents living outside city boundaries.

3) Increased frequency of high volume rain events in winter (primarily future), leading to: 1) increased scouring of river systems and associated increases in sediment flows into estuarine and coastal sediment supplies; 2) increased potential for soil erosion and land instability, with implications for: 1) impacts on infrastructure, including threats to residences and road closures; 2) associated impacts on property values and permitting decisions in coastal areas; 3) increased challenges and costs associated with winter timber harvests; 4) water quality concerns; and 5) exposure of new cultural and historic archaeological sites.

4) Higher water temperatures (current and future), contributing to: 1) shifting ranges of aquatic organisms and associated changes in ecosystem composition and species abundance off of coastal Oregon; 2) increased risk of toxic algae blooms and associated economic and recreational consequences of fisheries and shellfish closures; 3) salmon die offs resulting from high stream temperatures in combination with low water levels and associated impacts to salmon fisheries; 4) declining health and survival of Dungeness crab in warmer water, and associated economic impacts on fisheries businesses; and 5) Potential concerns regarding the impact of shifts in temperature differentials on wind patterns and coastal upwelling, and associated primary productivity of coastal waters.

5) Increasing acidity (decreasing pH) of ocean waters (primarily future), leading to: 1) current physiological impacts to oysters, and associated increased costs and management challenges for shellfish growers; 2) potential direct impacts on other species with calcium carbonate shells, including many zooplankton species that are foundational to the ocean food web and commercially and recreationally important species such as Dungeness crab, shrimp, and clams, with associated economic and cultural impacts; and 3) potential links between acidification and increased incidence of hypoxia.

6) Increasing sea levels and storm intensities (primarily future), resulting in: Increased rates of coastal erosion, with associated potential for: 1) increased threats to both public and private coastlands and infrastructure (e.g., residences, coastal utilities, and roads), 2) increased concerns regarding threats to private property, and 3) potential for exacerbated public policy conflicts regarding the costs and benefits of shoreline armoring; and loss of recreation opportunities along the coast, including erosion of beaches and submersion of well-known surfing reefs.

5.4 Social Science Information Gaps, and Barriers to Integration in Decision-Making

In response to research objective #5 for this study (Section 1), narrative data were also coded for information pertinent to social science needs in the study area, as well as local barriers to integration of social science information in policy- and decision-making. Emphasis was placed on climate-relevant social science. However, it became clear through the course of fieldwork that questions of social science gaps and integration were challenging for many respondents to answer, and the phrasing of the question was broadened to social science more generally to encourage responses. Therefore, some of the barriers discussed in this section are directly related to climate change social science, and others are more general. Respondents spoke not only about formal quantitative and qualitative social science data, but also science communication, community outreach, and informal information gathering related to public opinions and values at the local level. The term *social science* was thus understood to be inclusive of these arenas.

5.4.1 Social Science Information Gaps

Table 7 presents the data content areas that respondents most frequently identified as social science information gaps. Types of social science data that respondents most frequently noted to be information gaps included demographic information, cultural and economic value, public values, perceptions, and attitudes, factors influencing risk, vulnerability, and adaptability, and the study of how decision-making functions and results in impacts to communities. Several respondents spoke generally about sociocultural data gaps without specifying which aspect.

The numbers were calculated by identifying the number of individual respondents that mentioned each social science data type as an information gap, identified by the co-occurrence between individual data codes and the code, “Social Science Information Gap.” Responses to queries in this domain were minimal, given that a large number of respondents did not have specific thoughts or feedback related to this topic. Despite a low response rate on this issue, the data may be useful in the formulation of future research.

Table 7. Data types co-occurring with the code "Social Science Information Gap"

Data Types	# of Respondents who Mentioned this Information Need
Demographics	3
Cultural Value	2
Economics	2
Sociocultural (General)	2
Values	2
Attitudes	1
Concerns/Risks/Vulnerabilities	1
Adaptability	1
Impacts of Decision-Making	1
Decision-Making Process	1
Perceptions	1
Social capital	1

The following quotations illustrate respondents' opinions regarding the availability or access to information, and their thoughts about how improved access to these data could improve decision-making processes. For example, one respondent noted that although demographic census data are readily available for the study area, these data often remain insufficient to substantiate localized issues and trends.

> "A lot of what we've been talking about in terms of coastal demographics is just census data. [There are some demographic patterns that] we accept as truisms but we haven't quantified… And that migration pattern is one of them." *(State employee with general expertise)*

Respondents noted that there were gaps in availability of economic data in the study area. At the same time, respondents also noted that economic analyses were the most frequently utilized form of social science data in local decision-making processes. Several respondents specifically commented that economics often overshadowed other important values, such as cultural value which they perceived to play less of a role in decision-making.

> "Many of my fishing colleagues focus on identifying our activities in terms of economics [which is] very understandable. However, I feel that a core value of commercial fishing is in its cultural contribution. Here we have a very old, even primitive, activity that was long viewed as extractive. In the short course of my career – at least on this coast – fishing has matured into a proven biological renewable. We have figured out how to harvest appropriate volume and not destroy habitat while doing it. We sustainably produce top quality animal protein while leaving a much lighter carbon footprint than that of land-based agriculture. This responsible progress reflects key societal growth." *(Small business owner with Lincoln County fisheries expertise)*

Public values, attitudes, and perceptions were mentioned as a data gap by four different respondents. One respondent spoke specifically about the lack of public values data to inform climate impacts assessment, stating that there are a wide variety of impacts that are not currently reflected in available data.

"I think that what would be good to get from people… is what are the attitudes and perceptions around values that people have that could be impacted by climate change? And I pretty much could say that any value you have in your life [is] going to have a climate change impact on it." *(Non-profit employee with general tourism and recreation expertise)*

One respondent spoke about policymakers' lack of emphasis on understanding the adaptive capacity of communities in the face of climate change.

"I think a piece that policymakers do need to be informed about is… what's the potential for adaptability [in these communities]? You could have some type of [social or economic] change. It is going to create an impact. That doesn't mean that it's not OK.... That doesn't mean that the community can't adapt to that, or doesn't want to adapt to that… But what I'm trying to say is we [fail to assess], 'Here's what we're doing. Here's how it might affect these things – social-cultural, economic, environmental, etc.' We leave [assessment of impacts and adaptability] out sometimes… What's the scale of adaptability? Is it like a zero or is it like a five?... I think that [kind of information] would help make decisions more informed." *(State employee with Lincoln County fisheries expertise)*

Similarly, one respondent discussed the utility of information related to perceptions of vulnerability and risk, which they argued could assist managers in developing more relevant tools to assist stakeholders in mitigating or adapting to climate change impacts.

"The [information gaps] that come to my mind are questions to people about what they're concerned about… What they see as the things that, if climate change were to bring in, that would most… [cause them to] lay awake worrying about it at night..." *(Federal employee with general forest expertise)*

5.4.2 Barriers to Social Science Integration in Decision-Making

In addition to discussing social science data gaps, respondents spoke about factors that present barriers to integration of social science information in decision-making. Six key themes emerged from qualitative analysis, and are presented in alphabetical order: 1) data quality and availability; 2) established political and scientific frames; 3) issues of political will and awareness; 4) procedural costs; 5) procedural inadequacies; and 6) social science expertise gaps. The themes are described below, and illustrated using examples from the narrative data.

A. Data Quality and Availability

The theme, *Data Quality and Availability*, highlights respondents' discussion of accessibility of data, both with regard to its existence, as well as issues of complexity and uncertainty that may inhibit its utility. Issues associated with data validity were also relevant to this theme.

Data availability and data quality and completeness were the two most frequently cited barriers related to this theme. For example, one Federal respondent noted that some data do not exist, and even when datasets exist, the investment of time required to locate them may prevent access to information.

"I don't know if it's the kinds of data as much as having access to the data that we need. Every time we do one of these [climate] assessments we have to kind of grub around, see what the

Forest Service has, see what the States have, and see what some other NGO [non-governmental organization] has. And it's very difficult to access consistent high quality data – demographic data, economic data – in a form that we can use it for this type of assessment. Of course we don't have any proprietary [economic data from] private lands, and that's huge. For the Coast Range it's probably half of the landscape that you're missing if you don't [access data from private lands]." *(Federal employee with general forest expertise)*

The validity of sampling procedures was another major issue raised in relation to this theme. One respondent perceived that study design, including how information is weighted according to population size, can easily sway the results of regional values assessments.

"How do you break it up [value assessment across communities]? If you go to a [region-wide] issue the big cities will dominate because we have a higher population, whereas Depoe Bay is a small population. It has different values and a different societal standard than Newport does. [Newport's value system] is centered more around commercial fisheries. [Depoe Bay's values] are based around taking people [out on] the ocean and either seeing a whale, which is a big thing up there, or catching their limit of fish... [It will really impact them] if you change the [recreational catch] limit... And then, Lincoln City doesn't have a port at all, so they don't even hardly pay attention [to these kinds of issues]… It's a different societal standard. That's what the problem is [for values assessment and decision-making, is] you've got such a variety here." *(County employee with Lincoln County fisheries expertise)*

Differences in perspective were evident in the narrative data regarding the most appropriate sampling methods to achieve high quality, valid data. Multiple respondents noted that social information is informally integrated into local-level decision-making processes through consistent personal interactions with community members, or in the context of State and Federal projects in which agency officials have consistent contact with local communities. For example, a State employee noted that officials often glean value information through informal public engagement processes.

"My thought is that the Oregon Way, [our tradition of public engagement], not accidentally brings a lot of human dimensions and social observation to the table. It's not in a formal way necessarily, but because it's constituent [feedback]… we end up relying on that a lot when we don't have [other data sources]… And you can glean [people's value systems] from that... whether you're consciously or unconsciously doing it." *(State employee with general expertise)*

However, other respondents were uncomfortable with basing decisions on information gained from informal public engagement by officials of assessments of public opinion. One respondent recognized that the public process operates a certain way, but argued that effective integration of social science would be better facilitated by more representative sampling, and by examining societal levels beyond the local community scale.

"I don't think they're using as much data that's representative as they should. Most of the [research] I've seen on the coast is not representative. It's [based on] targeted small groups of vested stakeholders… As a scientist, I'm far more interested in what the population feels like. What I see happening, which I think is a fundamental attribution error, is that they're taking these results from focus groups, interviews with a small number of people, and saying the community feels this way. What is needed are more rigorous surveys of large representative samples of the target populations of interest so the level of confidence in the data and results is

at least 95% with a margin of error of plus or minus 5% or less. This will ensure we have the most scientifically rigorous and representative data on which to base management and policy decisions. We have people in the State who specialize in this kind of work." *(Academic with general coastal expertise)*

B. Established Political and Scientific Frames

The theme, *Established Political and Scientific Frames,* arose from respondents' perceptions of the inherent difficulties in prioritizing social science data collection, as well as creating space for social science to be formally considered in decision-making processes.

Multiple respondents mentioned a perceived tendency of management agencies to prioritize collection and analysis of natural science to inform decision-making. For example, one respondent noted that fisheries management agencies invest a disproportionate amount of resources in the collection of natural science information compared to social science data collection.

> "They have these regular trawl surveys where they collect samples from the ocean, and they could tell you a lot about what the trends are. We just don't have the equivalent of that [for social science data collection]. I mean, you can take survey data, and do a social network analysis on some of the survey respondents and players. And you can do it a couple of years later when [they re-run] the survey. But, that kind of consistent, regularly updated monitoring flow data – there's just no parallel with social science. I used to think, 'Oh, that's just the way it is, because [social scientists] have challenges [natural scientists] don't have.' But I also realized that a big chunk of it is priorities. There's really expensive research vessels out there doing stuff, and you could redirect some of those expenditures within the agency. But I think in order to make that happen, [social scientists] have to do a better job of demonstrating what can be done, or what our work is." *(Federal employee with general fisheries expertise)*

Further, when social science was considered by managers, respondents perceived that focus was placed solely on economic data. One respondent provided an example of this from a Federal agency perspective, noting that the agency does not take a holistic approach to understanding human dimensions impacts affecting or arising from coastal infrastructure.

> "When these [coastal facilities] were originally constructed, the full socioeconomic impact discussion was had through the NEPA process. Beyond that though, culture begins to take a back seat. From then on, the [agency's] view of things is National Economic Development… And I think you and I both know that [culture, society, and economy] are highly tied together. It's so difficult to untangle that. But the [agency] looks only at monetized assets." *(Federal employee with Coos and Lincoln County coastal infrastructure expertise)*

C. Issues of Political Will

The theme, *Issues of Political Will,* captures respondents' discussion of the lack of receptivity to climate-related social science on the part of policymakers as well as local stakeholders. Specific barriers related to this theme included low levels of perceived salience of climate social science, as well as low levels of urgency or low priority placed on climate change in general. One respondent noted that climate

change suffers from low salience in some coastal communities due to its lack of tangible, current impacts.

> "If an effect [on a community] is obvious, there's a lot of effort that goes into how to manage it. And if the effect is likely, or possible, or in the future, it's a totally different scenario on whether there's going to be resources or effort to go into it. Sometimes there may be some forward thinking people that see the writing on the wall on certain things, but it's always sort of reactionary when they start seeing something come down the pike." *(Academic with Coos County fisheries expertise)*

Community members' buy-in to Federal social science research efforts was also perceived to be a key factor linked to this theme, as valid climate-related social science research was perceived to be only possible with the participation of relevant stakeholders. Levels of support for social science research were noted to be influenced by political leanings in local communities, and community members' levels of awareness and interest in the issue of climate change. Respondents also discussed the role of the media in influencing local interest and awareness regarding this issue.

In addition, mistrust of how government agencies will utilize social science information was perceived to be a key barrier to local stakeholders' support of and willingness to engage in Federal social science research efforts. For example, one respondent discussed the potential negative consequences arising from the results of the recent Marine Spatial Planning Process along the Oregon coast.

> "I think there's a fear, like during the Marine Spatial Planning Process with informing BOEM or DLCD [Department of Land Conservation and Development] on the value of certain areas… There's the secrecy of, 'I don't want people to know where I fish.' But I think there's a bigger fear beyond that which is, 'If they see how much this patch of ground is worth, that's chump change to an energy developer.' [Commercial fishing is] not important enough, there's not enough dollars. They'd buy us out of that in a heartbeat, and then we'd lose it forever." *(Small business owner with Lincoln County fisheries expertise)*

D. Procedural Costs

The theme, *Procedural Costs,* captures respondents' discussion of limited financial capital, time, or other resources required to enable effective social science data collection and (or) effective consideration of social science information in decision-making.

At the local community level, respondents mentioned barriers associated with respondent fatigue and lack of resources to participate in decision-making processes. Respondent fatigue was a particular problem in Newport, where respondents perceived a recent flood of social science research particularly focused on the fishing industry. According to one participant, fisherman and fishing organizations were feeling a heavy research burden, and had become much more selective about participating in research projects as a result.

> "They're… just constantly contacted [to participate in studies]... They decided that they needed a better way of filtering that out. They have a specific mission… so they decided that as an organization, they really needed to just participate in research that met the goals of the organization." *(State employee with Lincoln County fisheries expertise)*

Other respondents noted that natural resource managers face significant procedural costs associated with social science research as well. Social science research techniques are often utilized in the context of collaborative natural resource management, and one Federal respondent discussed the challenges inherent in this approach.

> "It's hard for people in natural resource management to really listen, and some of the more productive approaches that people are taking now involve developing collaboratives and listening to what their concerns are, and trying to come to solutions that will work for everybody. And sometimes that's really hard to do. It takes an awful lot of time and effort." *(Federal employee with general forest expertise)*

Respondents working at a more local level also noted high costs associated with gathering sufficient social science information to inform decision-making. One county employee described the investment of resources required to monitor public values.

> "To me, you've got to understand what people feel is important. Then you've got to figure out how to monitor it. That kind of research is very expensive to do." *(County employee with Lincoln County fisheries expertise)*

E. Procedural Inadequacies

The theme, *Procedural Inadequacies,* highlighted barriers to social science integration that respondents perceived to be related to the structure of decision-making processes themselves. Respondents raised issues associated with process legitimacy and perceived overreliance on blanket prescriptions that do not take local sociocultural context into account.

A number of respondents mentioned issues related to the politicization of science, including both social and natural science information. One respondent suggested that data can only truly inform a decision if a legitimate process has been used to bring the information to the decision-making table.

> "I feel like you need [public process] in order to even bring any other sort of data or information to the table that people would even be willing to listen to. And I wouldn't say just on the social science data, I'd say when we bring in biological or ecological data, if the public process isn't working, there's no way people are going to want to listen to that… It's thrown out like, 'That can't be right...' You know? I think it's more true in the social sciences because everybody is an expert on social science." *(State employee with general expertise)*

Another respondent provided an example of how social science fails to effectively inform forest policy due to issues of politicization of data.

> **"**There's a lot of room for improvement in integrating all forms of science into management. Tons of agencies come to NEPA projects with a predetermined outcome in mind, and they just line the evidence up to support the predetermined outcome… It's not just the agencies who are guilty. [The environmental community] has an agenda. Industry has an agenda… The social science doesn't make it into the realm of public debate. It doesn't make it onto the [agenda]." *(Non-profit employee with general forest expertise)*

Related to the same issue, another respondent shared a perception that the Federal government often makes decisions without fully considering locally-produced and validated social science.

> "It seems somewhat futile in terms of dealing with the Federal government, because in my mind we do a very good job here in Oregon of getting the stakeholders together, doing the socioeconomics. We [commissioned] a non-consumptive use report, for example, or the fishers… mapping [space use]. And, you know, doing all the hard work, you do this great job just to find out that, forget it, the Federal government is going to do what they are going to do." *(Small business owner with Lincoln County fisheries expertise)*

F. Social Science Expertise Gaps

The theme, *Social Science Expertise Gap,* focuses on respondents' discussion of perceived challenges in the translation of qualitative information into the quantitative metrics that are often required to inform decision-making processes. One respondent noted particular challenges in the integration of sociocultural information compared to more easily quantified economic information.

> "We always struggle with that socio-cultural piece, trying to quantify that. It is so much harder to deal with and integrate in possible management and decision-making scenarios than economics. I mean, [with] economics, typically you do have a number – like the [monetary] value of the commercial fishing. Yeah, there's a number I can give you. [But] what's the value of a culture?" *(State employee with Lincoln County fisheries expertise)*

Respondents also felt that a lack of sociocultural social scientists (e.g., anthropologists, social psychology, sociology) working in management position exacerbated the reliance on quantitative, economic metrics in decision-making. One respondent noted difficulty finding social scientists to participate on interdisciplinary research teams. The respondent also perceived that economics was the most commonly accessible social science discipline to engage in the agency's climate assessment efforts.

> "We try to build [social science] into all of our [climate] assessments as best we can. Since social scientists aren't quite as numerous as other disciplines, sometimes it's hard to find folks who are available to do that. We've [integrated social science] in a couple ways. One is through the economic channel, and the other is through recreation. More recently we're doing a lot more work with ecosystem services. It seems like folks with social science backgrounds tend to be more active in that than other biological or physical disciplines." *(Federal employee with general forest expertise)*

In addition to a lack of trained social scientists, respondents perceived that management agencies were not doing enough to train managers how to utilize the social science information that is provided to them by social scientists.

> "We need workshops to help managers figure out how to use social science. We need to [provide managers with] social science, because often they don't know what to do with it. They might ask for it, but not be familiar with it, and not know what to do with it." *(Federal employee with general fisheries expertise)*

6 Conclusions

The aim of this study was to assist BOEM in carrying out cumulative impacts assessment related to proposed activities in coastal Oregon. The first four study objectives were geared toward achieving this goal, through understanding: 1) major issues and trends that characterize environmental change in the region; 2) current effects of climate change on Oregon's coastal peoples, specifying social, cultural, and economic impacts; 3) climate change's potential impacts on coastal peoples in the future; and 4) potential cumulative effects of climate change on social systems. The study was also designed to enhance our understanding of: 5) information gaps and barriers to policy implementation related to the effects of climate change on human systems with particular relevance to OCS policy making (BOEM 2015).

This report presents the results of literature review and primary data collection responding to the five study objectives. Historical and projected climate trends in the study area were presented in Section 2, while a brief history of study area communities was reviewed in Section 3. Section 4 outlined the methods utilized to carry out primary data collection. The results presented in Section 5 detailed respondents' perceptions of climate-related environmental issues and changes, HDCC effects, cumulative interactions between multiple drivers that contribute to HDCC effects in the study area, and perceived social science gaps and barriers to integration of social science information in decision-making. This closing section provides discussion of key findings, and reviews research challenges and limitations and intended uses of this report.

6.1 Key Findings

6.1.1 Climate-Related Environmental Change in the Study Area

Information about climate-related environmental change was collected from secondary data sources, as well as from the personal experiences and observations that were shared by respondents during ethnographic discussions. In most cases, respondents' perceptions were aligned with historical and projected climate trends. Some of the most frequently mentioned environmental issues noted by respondents to be currently occurring in the study area, included: changes in seasonality (of plants, animal migrations, and temperature and precipitation patterns); increased water temperature in both the ocean and fresh water; changes in the abundance and distribution of aquatic species; increasing incidence of forest fire in the Pacific Northwest broadly, and increased forest fire risk in the study area specifically; increased air temperatures; changing health and survival of flora and fauna; and long-term drought.

These most frequently discussed current environmental issues largely reflect the current weather events that were taking place in the study area. During the period of data collection, temperature and moisture patterns typified projected climate conditions for the Oregon coast. For example, the extended drought and record-breaking warm temperatures in Oregon were in line with projected long-term temperature and moisture trends; the warm water anomaly in the Pacific Ocean, along with the associated toxic algae bloom and shifting distribution of aquatic species, are conditions reflective of a projected future, warmer ocean; similarly, reduced Cascade snowpack, warmer stream temperatures, and increased forest stress and fire risk were all current environmental issues in the study area that echoed projected climate change scenarios. There was strong agreement among respondents

that these issues were currently taking place. However, respondents were not always comfortable drawing associations between these current events and long-term climate trends.

In contrast, long-term, incremental processes of sea level rise, ocean acidification, and increasing storm intensity were less commonly perceived by respondents to be current environmental issues, and were more likely to be perceived as future potential changes. There have been documented changes in all three of these variables along the Oregon coast. The discrepancy between respondents' perceptions and the documented changes can be explained in several ways. First, acidification is invisible and sea level rise is imperceptible to the naked eye. Similarly, given the highly dynamic ocean environment, it is notoriously difficult to isolate the role that climate change plays in influencing storm intensity and resulting coastal erosion rates. Second, current pH measurements in the study area are not necessarily declining in concert with global acidification trends (Partnership c2010), and relatively little *apparent* sea level rise has yet occurred in the study area, where tectonic uplift has so far kept pace with *relative* sea level rise (OCCRI 2010). Thus, although respondents' perceptions of sea level and acidification trends did not align with climate projections for these issues, perceptions were largely reflective of current conditions in the study area.

In addition to these long-term, incremental processes, other environmental issues and changes that were most likely to be characterized as future potential impacts included increasing risk of forest fires, changes in the health and survival of flora and fauna, and changes in species ranges. While these issues also appeared in the list of top current issues, their presence as top future codes reflects an added concern: the potential that primary environmental changes such as ocean acidification might eventually undermine food webs or the suitability of habitat for native species, leading to more widespread ecological transformations.

6.1.2 HDCC Effects in the Study Area

Findings about HDCC effects in the study area are based on perception data collected during ethnographic discussions. Considering the study sample as a whole, the HDCC effects most frequently mentioned by respondents had to do with: increases in coastal visitation and retirement; economic impacts on key livelihoods; livelihood adaptations in response to declining resource availability; changes in levels of vulnerability/exposure to environmental risks such as flooding and landslides; changes in regulations/policy in response to environmental change; impacts on infrastructure (e.g., navigation, roadways, community services); concerns about the adequacy of local water supply; loss of availability of and (or) access to natural resources (e.g., commercial fish species; native plants); and psychological stress associated with increasing risks and economic impacts.

A majority of HDCC effects discussed by respondents were equally likely to be perceived as current and as future potential impacts. However, in some cases there was a more clear differentiation between current and potential future effects. For example, HDCC effects with clear links to current weather events were more likely to be discussed as current issues. These included: health concerns arising from high domoic acid levels in shellfish; negative impacts on commercial fisheries (e.g., Dungeness crab closure; target commercial species moving further from the study area); crowding issues associated with increased coastal tourism; and both positive and negative impacts on coastal recreation (e.g., longer seasons for coastal recreation activities such as camping and mountain biking; decreased forest recreation due to fire closures). In contrast, issues more likely to be perceived as future HDCC effects included the potential for: long-term demographic changes as coastal Oregon weather becomes increasingly appealing (i.e., sunnier and warmer); increased flooding and coastal erosion

impacts due to increases in sea level and (or) future high volume winter rain events, and overarching economic and cultural transformations (e.g., loss of viability of natural-resource based livelihoods; cultural shifts associated with changing livelihoods and demographic transformation).

Several examples of current or potential future *positive* HDCC effects were discussed by respondents. Current positive effects included general quality of life increases associated with sunnier, warmer weather patterns on the Oregon coast (e.g., comfort; successful gardens), as well as benefits to coastal businesses resulting from the increased visitation perceived to be driven in part by this weather shift. However, respondents often added that they were uncertain whether these positive impacts would last, and also questioned whether the benefits would outweigh costs. For example, heavier tourist traffic in the study area resulted in increased strain on community resources and infrastructure, and many local residents expressed that increasing crowds detracted from their quality of life.

In addition, respondents discussed possible adaptations that could enable them to avoid negative consequences and take advantage of possible benefits of climate-related environmental change. For example, warm water was perceived to cause many target commercial fish species to move further northward. This was generally perceived to result in negative HDCC effects, such as increased travel investments. However, some respondents pointed to the possibility that new species might become more abundant in Oregon waters, potentially offering opportunities to engage in new fisheries. However, several barriers to this type of adaptation were noted by respondents. Several felt that lack of flexibility in fisheries management may prevent fishermen from capitalizing on availability of new fisheries resources. Another respondent pointed out that a new species would need to be available in very consistent quantities before investment in new processing equipment could be financially justified.

6.1.3 Comparing Perceptions Across Resource/Livelihood Expertise Categories

Perceptions of current and potential future environmental conditions and HDCC effects collected through ethnographic discussions varied across resource/livelihood expertise categories. Although participants often commented on issues relevant to several resource/livelihood categories, they were most likely to discuss the resource categor(ies) for which they had specific expertise. There were pronounced differences in overall thematic emphasis across these respondent categories, including shifts in perceived prominence of specific themes as current vs. potential future issues or effects.

Respondents with fisheries expertise more frequently perceived current increases in water temperature, along with associated current impacts on aquatic species composition, fitness, and survival. The current HDCC effects that fisheries respondents most frequently linked to these environmental changes included economic impacts on fisheries revenues due to declining abundance and (or) accessibility of fisheries resources, health concerns arising from the toxic algae bloom, and livelihood adaptations (e.g., moves to diversify and (or) exit the fishing industry). Environmental issues more likely to be perceived by fisheries respondents as future potential changes included impacts of ocean acidification on commercial fish species, as well the integrity of the food web and ocean ecosystems broadly. Building from this concern, the most frequently mentioned potential future HDCC effects included overarching cultural impacts to fishing community identify and way of life.

Respondents with forest expertise more frequently spoke about current changes in temperature and moisture patterns, along with associated changes in the health and survival of forest species, changing seasonality and abundance of forest products, and changes in forest disease dynamics. All of

these issues were also high on the list of concerns related to future potential change. One issue that forest respondents were more likely to perceive as a future change was shifting species ranges and forest composition, as this process was perceived to occur over a longer time horizon. These environmental changes were perceived to lead to numerous current HDCC effects, including economic impacts on timber and non-timber forest product industries, and the social impact of increasing management challenges associated with fire risk mitigation. Forest respondents also spoke about social and cultural impacts arising from changing access to recreational areas and cultural resources due to fire risk and phenological changes. Finally, forest respondents also discussed broader current social impacts arising from increased fire risk, such as strain on emergency services, and increased employment of fire fighters.

Respondents with coastal infrastructure expertise were less likely than other respondent categories to perceive current environmental changes. Some respondents did perceive that current examples of erosion affecting coastal facilities were driven by cumulative effects of sea level rise and increased storm intensities. However, others specifically stated that they saw no current environmental changes, and perceived that issues of sea level rise and increasing storm intensity were limited to potential future environmental changes. The HDCC effects most discussed by coastal infrastructure respondents included potential future increases in erosion of navigational structures and coastal facilities. Several current relocations of facilities were perceived to be linked to these changing forces, but for the most part coastal infrastructure respondents focused on the potential for future changes in maintenance requirements and facility relocations.

Tourism and recreation respondents echoed concerns raised by all of the other respondent categories. The overlap is likely related to the fact that tourism and recreation activities take place both on the ocean, on forest lands, and also along the coastline, contributing to some shared experiences and awareness. Current and potential future impacts on the health of both forests and fish and wildlife populations have clear ramifications for tourism and recreation industries. In addition, issues of coastal erosion and impacts on coastal infrastructure (e.g., beach erosion and impacts to port facilities) were highly relevant to tourism and recreation respondents, though these issues were more frequently perceived to be future potential environmental changes. HDCC effects perceived by tourism and recreation respondents also overlapped with the concerns of other resource/livelihood categories. For example, they mentioned current effects such as the recreational shellfish and salmon closures associated with warmer water conditions, reduced access to forest recreation sites as a result of fire closures, and reduced access to beaches as a result of coastal erosion processes. However, tourism and recreation respondents were more likely, compared to other resource/livelihood categories, to discuss current increases in air temperatures, declining precipitation, and changes in wind patterns. They noted a strong connection between these issues and HDCC effects associated with changing patterns in the movement of people, including positive economic impacts for coastal businesses and negative impacts of crowding and strain on infrastructure.

6.1.4 Cumulative HDCC Effects

Perception data collected during ethnographic discussions also provided insight into the dynamics of cumulative HDCC impacts in the study area. Cumulative impacts arise from complex interactions between multiple stressors at different scales and over time. Multiple HDCC effects are often interrelated. Further, climate-related drivers often act concurrently with non-climate-related drivers in the context of complex system dynamics. For example, fisheries respondents perceived climate-related links between warmer water temperatures and the toxic algae bloom as well as changes

in the migration patterns of aquatic organisms, both leading to the HDCC effect of economic impacts on fisheries livelihoods. However, some respondents also pointed to interaction effects between long-term warming trends and climate cycles (e.g., ENSO and PDO) that may have compounded this impact. In the case of forest resources, respondents perceived past land use to be a key confounding variable making it more difficult to tease out the climate-related element of current forest health dynamics, with associated economic impacts on timber and non-timber forest product companies. In the context of tourism and recreation, respondents spoke about non-climate-related economic trends that they believed were partly responsible for increases in coastal visitation rates, such as changes in the price of gasoline or levels of disposable income. As another example, coastal infrastructure respondents commonly noted that the ocean is a particularly dynamic environment, and the specific impact of climate-related changes (e.g., incremental changes in wave heights or storm intensities) on infrastructure maintenance costs is difficult to isolate.

In an effort to assist BOEM cumulative impact assessment practitioners in designing cumulative impacts assessment for coastal Oregon, data from ethnographic discussions were analyzed to identify a range of climate- and non-climate-related drivers perceived to be associated with HDCC effects. As discussed in the Section 5.3.4, six key climate-related environmental changes were most frequently perceived to drive HDCC effects: 1) an increasingly attractive Oregon climate (driver of current and potential future effects); 2) longer, drier summers (current and future); 3) increased frequency of high volume rain events in winter (primarily perceived as a future potential issue); 4) higher water temperatures (current and future); 5) increasing acidity (decreasing pH) of ocean waters (primarily future); and 6) increasing sea levels and storm intensity (primarily future). As noted above, these findings generally coincide with observed biophysical trends in the study area at the time of data collection.

HDCC effects arising from these environmental changes were also frequently discussed as intermediary drivers of additional HDCC effects. Those HDCC effects most frequently perceived as intermediary drivers of effects included: 1) shifting patterns in the movement and volume of people in the study area; 2) changes in risk associated with extreme weather events and resource stress (e.g., risk of forest fire, flooding, spread of pathogens); 3) economic impacts on key livelihoods and recreational activities; 4) changing availability of or access to natural resources; 5) changing environmental policy; 6) increasing management challenges and responsibilities; 7) increased pressure to adapt (e.g., shift livelihood strategy or management practices); and 8) increased quality of life in coastal Oregon due to changing climate patterns (e.g., sunnier, warmer weather).

Finally, non-climate-related environmental and HD issues were commonly perceived to act alongside climate-related variables to produce cumulative HDCC effects. Those HD issues most frequently perceived to interact to HDCC effects included: 1) economic and cultural transformation/reorganization (e.g., broad shifts away from natural resource-based livelihoods and identities); 2) changes in movement of people (e.g., increased coastal visitation or retirement due to non-climate-related dynamics); 3) changes in the regulatory environment due to non-climate-related dynamics; 4) changes in availability of or access to resources due to non-climate-related forces; 5) other factors influencing the health of resources and ecosystems (e.g., past land use, natural variability); and 6) human health issues (e.g., non-climate-related water supply limitations or pathogen issues).

6.1.5 Social Science Information Gaps and Barriers to Social Science Integration

During ethnographic discussions, respondents were invited to share thoughts related to social science information gaps in the study area, as well as barriers to the use of social science information in policy making. Based on these perception data, the following information needs were identified: 1) more complete demographic information; 2) data regarding cultural and economic values; 3) assessment of public values, perceptions, and attitudes at the local scale; and 4) improved understanding of factors that influence risk, vulnerability, and adaptability. Building from discussion of social science information gaps, respondents perceived that one key barrier to the use of social science in policy making is insufficient data quality and availability. More specifically, respondents spoke about both lack of data (i.e., it does not exist or is not accessible) as well as poor data quality. Data quality issues were perceived to arise from sampling limitations and issues of validity, legitimacy, and uncertainty that undermine the dependability and comprehensiveness of datasets.

In addition to barriers associated with data quality and availability, respondents identified five additional barriers they perceived to limit integration of social science information. These included: 1) established political and scientific frames (i.e., privileging of natural science and economics over other social sciences, lack of adaptive management); 2) issues of political will and awareness (i.e., lack of urgency or issue salience, intangible nature of climate impacts, politicization of climate change); 3) procedural costs (i.e., financial costs and temporal requirements, such as respondent fatigue and other process burdens); 4) procedural inadequacies (i.e., legitimacy/validity, of data/information provider power dynamics, blanket prescriptions); and 5) social science expertise gaps (i.e., lack of training or social science expertise within agencies, lack of familiarity with non-economic methods, difficulty translating qualitative data to quantitative metrics).

Many of the barriers discussed by respondents are systemic, ingrained in the structure and culture of federal institutions or society at large. For example, established scientific and political frames (e.g., set decision protocols or legal requirements that privilege some types of data over others) and the inherent procedural costs that accompany decision-making processes (e.g., time and resource inputs, respondent fatigue) may be difficult to mitigate. However, the barriers discussed by respondents also highlight potential opportunities for improving use of social science information in policy. For example, increased attention could be placed on ensuring that adequate social science expertise is available within agencies, both to improve social science data collection efforts as well as capacity for translation of social research products for use in policy. This could be accomplished through new hiring and (or) providing social science training to existing agency staff. In addition, multiple respondents voiced the belief that engaging with a more comprehensive range of stakeholders and (or) incorporating locally-produced and trusted data sources as inputs for decision-making could increase the efficacy of federal social science research and decision-making processes overall. This points to a need to evaluate the scoping methods utilized during BOEM permit review processes.

6.2 Research Challenges and Limitations

A central challenge for data collection had to do with levels of respondent understanding of and (or) experience with concepts highlighted in the study objectives. Despite providing definitions of key terms at the beginning of each ethnographic discussion, respondents often asked for further clarification or stated that they did not have sufficient knowledge to comment. This was particularly true around

concepts of climate social science gaps and integration of climate social science in decision-making. In many cases, respondents simply declined to provide information regarding this study objective. In other cases, the notion of climate-related social science was too specific, and the conversation necessarily broadened to discussion of social science in general. Discussion of potential future environmental changes and HDCC effects also presented challenges during data collection. Whereas respondents generally appeared comfortable commenting on environmental issues/changes and HDCC effects they currently observed, they were often reluctant to speculate regarding the future. They cited high levels of uncertainty regarding the links between current weather events and long-term climate changes. In addition, they discussed a variety of confounding variables, such as natural climate cycles, that limited their ability to forecast future trends. Respondents generally mentioned a greater number of current issues and effects compared to discussion of future possibilities.

Key challenges for data analysis included: 1) differentiation between perceptions of current vs. potential future issues and effects, and 2) isolating individual environmental issues/changes and HDCC effects, including distinguishing between the social, economic, and cultural dimensions of a single event or experience. First, in the case of current vs. future, it was not possible to determine when a respondent's discussion of a current issue or effect also implied that the issue would continue into the future; issues and effects were only counted toward lists of potential future effects when they were specifically discussed in those terms, likely contributing to the lesser emphasis on discussion of future potential effects overall. Second, while the exercise of isolating individual environmental issues and social, economic, and cultural HDCC effects can assist impact assessment practitioners in identifying important variables, this activity can obscure interrelationships, interdependences, and intermediary effects. For this reason, the basic frequency counts that were generated to assist in qualitative analysis (Tables A-4a through A4-j) should not be interpreted as a complete assessment of the relative importance of individual variables. Further, interdependencies between social, economic, and cultural HDCC effects suggest that cumulative impact assessment is a more appropriate analytical framework than viewing these dimensions in isolation.

Finally, a key limitation of this research is the lack of time-series information. The perception data gathered for this study reflect a single period in time, and as such they are highly influenced by the weather events that were taking place during the period of data collection. As this is a pilot study for a rapid assessment method to support NEPA cumulative impacts assessment, this limitation is likely not resolvable; the timeline over which climate changes unfold is mismatched against the limited timelines of most Federal decision processes. Therefore, it is important that the findings presented in this study are utilized with the important caveat that perceptions are likely to change over time depending on both long-term climate trends and current weather events.

6.3 Uses of This Report

A primary goal of this research was to support BOEM in the design of cumulative impacts assessment research focused on coastal Oregon. Information about the variety of climate-related environmental issues/changes and HDCC effects can be used in this way, along with the examples of cumulative interactions between climate-related issues and effects and other agents of change acting on the study area. Information regarding local perceptions of social science information gaps and barriers to integration of social science information in policy making can further assist BOEM in assessing the availability of human dimensions data for use in their cumulative impact assessment activities.

The perception data presented in this report were collected using a purposeful sampling strategy in which knowledgeable individuals were invited to participate due to their expertise in one or more of the resource/livelihood categories of interest (I.e., fisheries, forest resources, tourism and recreation, and coastal infrastructure). This approach was used to garner an initial understanding of HDCC effects relevant to the four specific areas of expertise, as opposed to surveying large samples of the general public, many of whom may be unaware or ill-informed on these specific domains of interest. Further, the sample was stratified to include a diverse set of stakeholder perspectives (affiliation strata) within each resource/livelihood category (i.e., Tribal, Federal, State, county, City/local government, academic, non-profit, small business, and industry), with the goal of identifying a broad array of emergent themes within each expertise category. The information presented in this report should not be generalized beyond the four expertise categories identified, and is not representative of the study area population as a whole.

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Appendix 1 – Additional Description of Study Area Demographics

1. Purpose

This section presents study area demographic information based on the 2000 and 2010 U.S. Censuses and the American Community Survey, along with some historical census data related to population and poverty. The variables included are intended to paint a picture of the study area population, including: 1) population size and density; 2) population age structure; 3) gender; 4) race and ethnicity; 5) education; and 6) income, unemployment, and poverty. In addition, the final sub-section reviews these descriptive statistics to identify and discuss 7) populations of concern, including individuals living in poverty, minorities, undereducated populations, children, and the elderly. These populations are of interest with respect to Federal mandates regarding environmental justice (e.g., Clinton, 1994), as well as questions of community vulnerability and resilience (Cutter et al. 2003, Jepson and Colburn 2013, Morrow 1999).

In keeping with the nested case study format of this study, these data are presented at the county level for both Coos and Lincoln Counties, as well as their respective hub communities. For both the Coos Bay and Yaquina Bay areas, some information is also presented using more inclusive census tracts. This is done for two reasons. First, some complications arise when using Census Places to represent the population present in the Coos Bay area. A primary concern is that a major section of the community, Charleston, is not distinguished as a Census Designated Place (CDP) in the U.S. Census. Second, census tracts can complement place data because they do not align with the boundaries of municipalities, and therefore can be used to identify neighborhoods or regions within the larger area that display higher or lower rates or values for specific variables.

For the Coos Bay area, the selected census tracts cover the core population areas, including the City of Coos Bay, the City of North Bend, Barview CDP, Bunker Hill CDP, and Charleston, as well as adjacent rural areas included in the outer-most census tracts. The Coos Bay area census tracts include 3, 4, 5.02, 5.03, 5.04, 6, 7, and 8 (Figure A-1a).

In the case of the Yaquina Bay area, the heavily populated areas are located in close proximity to the coast, generally mirroring the boundaries of the City of Newport. Coastal census tracts have been chosen that include all portions of the City of Newport as well as some adjacent rural areas. These census tracts include 9508, 9509, 9510, 9511, and 9512 (Figure A-1b). Census tract 9513 is not included because it extends far enough inland to capture part of City of Toledo.

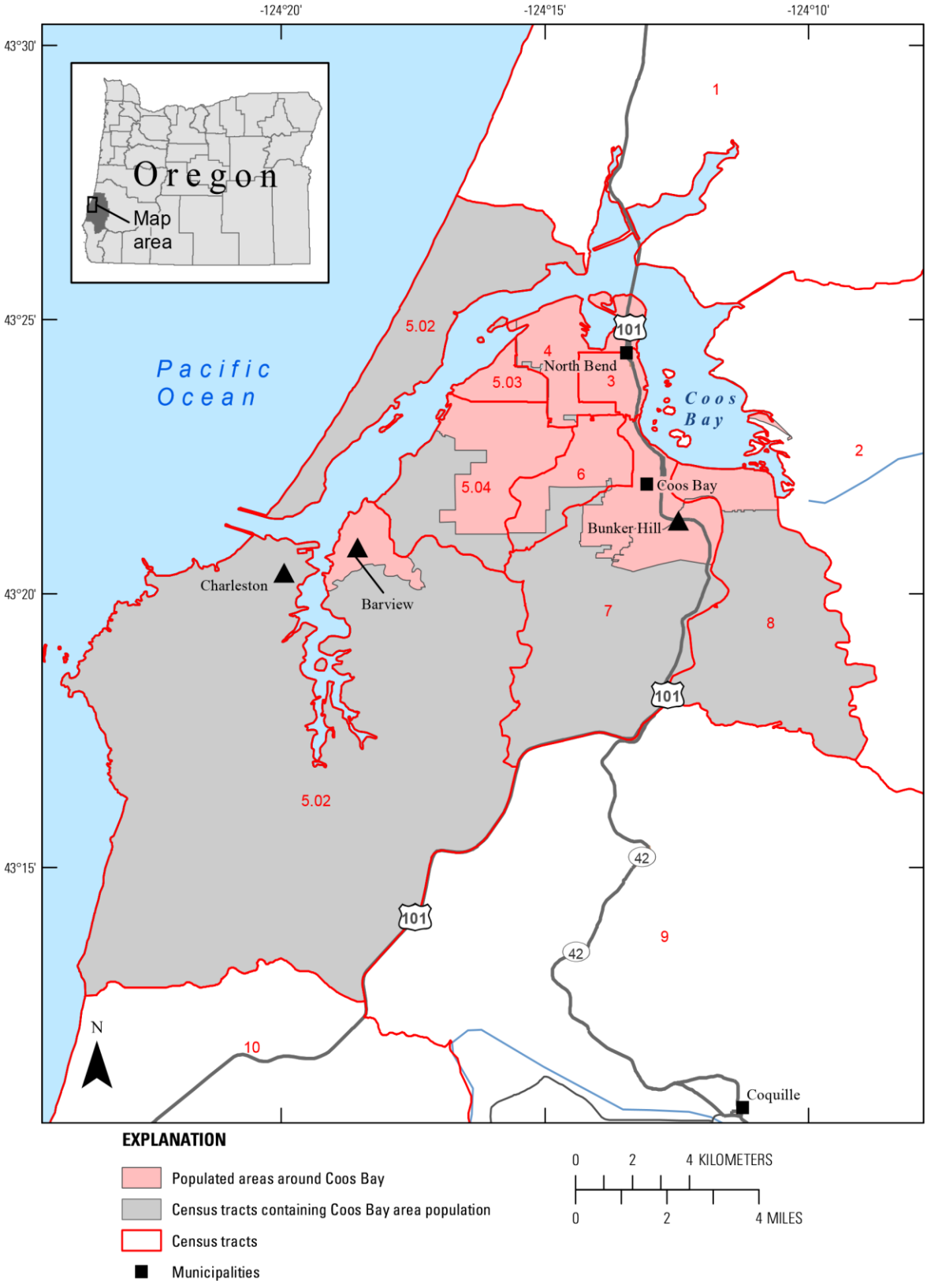

Figure A-1a. Map of Coos Bay area census tracts
Source: USGS 2016c

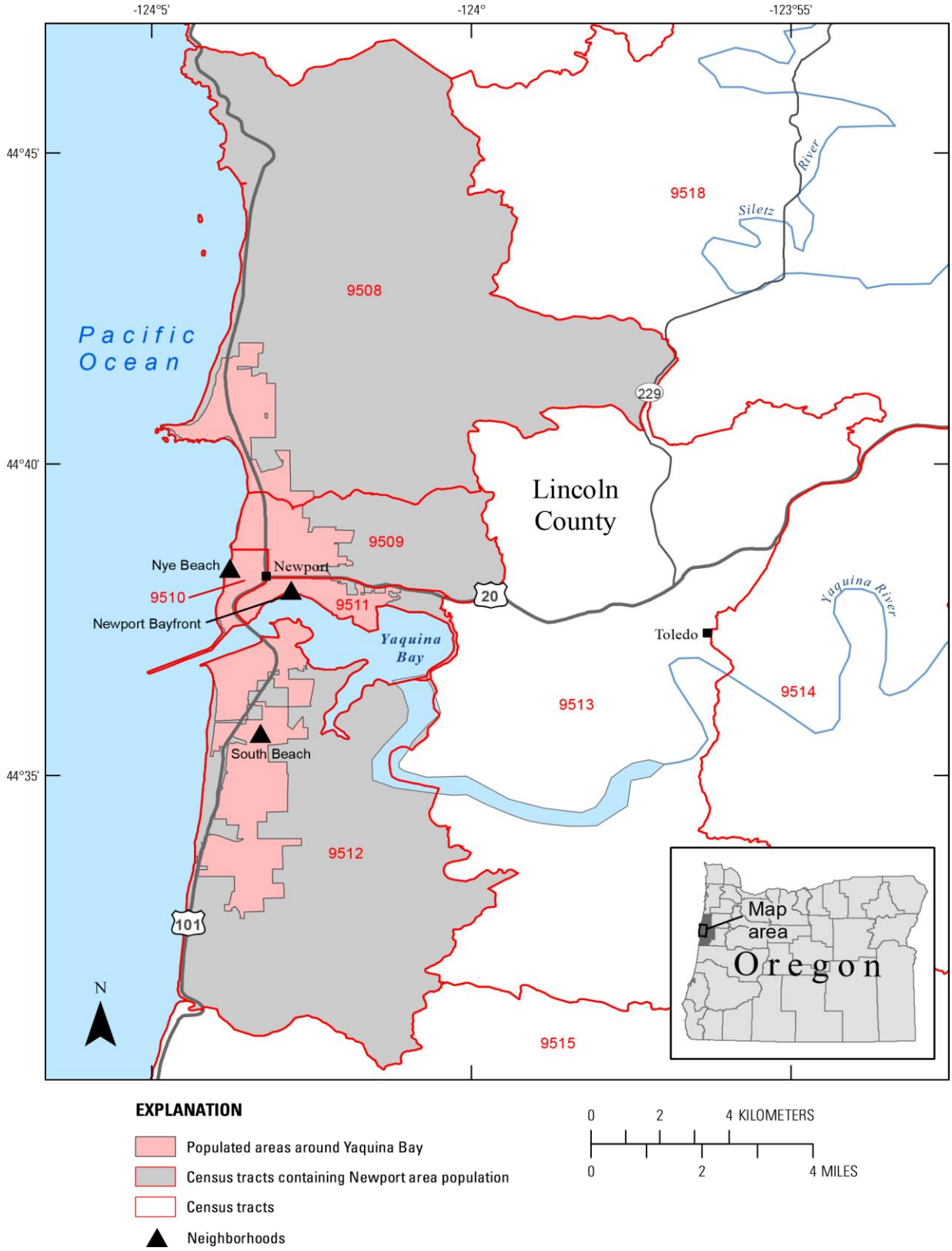

Figure A-1b. Map of Yaquina Bay area census tracts
Source: USGS 2016d

2. Population Size and Density

The populations of Coos and Lincoln Counties have both grown steadily since 1900, although growth in Coos County was more rapid during the timber boom years between 1910 and 1980, followed by a slight decline in residents between 1980 and 1990 (Figure A-1c). During this period, the Yaquina Bay area (City of Newport and adjacent residential areas) and the Coos Bay area (Cities of Coos Bay and North Bend, Bunker Hill CDP, Barview CDP, and Charleston and adjacent residential areas) have been the primary population centers.

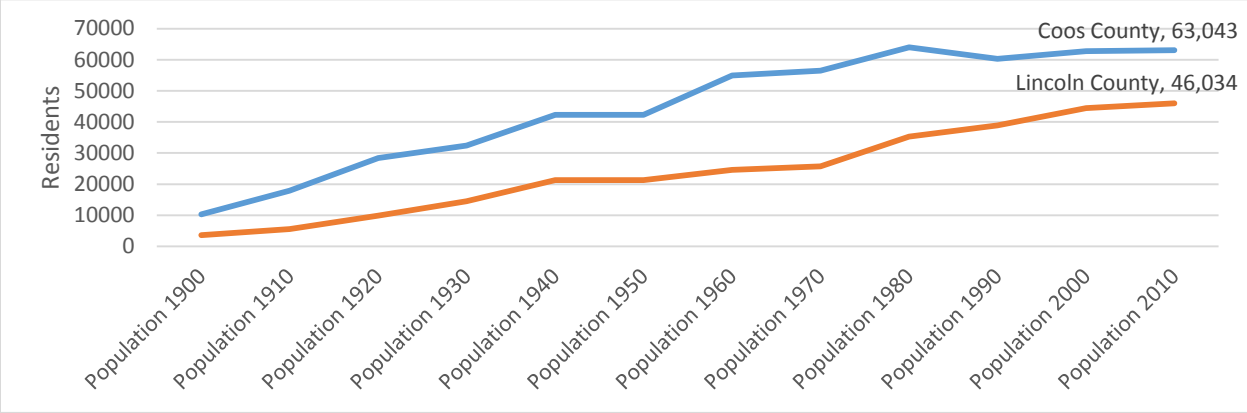

Figure A-1c. Population of Coos and Lincoln counties (1900–2010)
Source: Census Bureau 1995

In 2010, the City of Newport had an overall population density of 1107.5 individuals per square mile, compared to 47.1 individual per square mile in Lincoln County overall. When looking at density across census tract in the Yaquina Bay area, the greatest population densities were found in tracts 9510 and 9511, at 3756.3 and 1210.8 individuals per square mile, respectively. These census tracts loosely correspond with the Nye Beach area (tract 9510) and the Newport Bayfront (tract 9511). The Yaquina Bay area census tracts with the lowest population densities included tracts 9508 and 9512, at 103.2 and 94.8 individuals per square mile, respectively. These census tracts correspond to the rural outskirts to the north of Newport (tract 9508) and to the south of Newport, including South Beach (tract 9512) (Figure A-1b).

Coos County to the south had an average density of 39.6 individual per square mile in 2010. Of the Census Places in the Coos Bay area, the City of North Bend was the most densely populated at 2481.8 individuals per square mile. The City of Coos Bay was the next densest CDP in the Coos Bay area, with 1512.1 individuals per square mile, followed by Barview CDP at 1338.5 individuals per square mile and Bunker Hill CDP with 992.0 individuals per square mile. It is important to note that a segment of the Coos Bay area population resides in the Charleston area, which is not represented as a CDP. Thus, it is important to examine these density statistics across census tracts as well as Census Places. Looking at the scale of census tract also allows for identification of variation within the City of Coos Bay, which is overlapped by six distinct census tracts (5.03, 5.04, 6, 7, 8 and a small part of tract 2). The census tract in the Coos Bay area with by far the highest population density is tract 5.03, which corresponds with the northwestern portion of the City of Coos Bay, adjacent to North Bend (Figure A-1a).

3. Population Age Structure

Statewide, the median age of the population in Oregon in 2010 (38.4 years) was only slightly higher than the median age of the U.S. population as a whole (37.2 years). However, both Coos and Lincoln Counties exhibit substantially higher median ages (47.3 and 49.6 years, respectively) (Figure A-1d). This difference in age is in keeping with the experience of many rural areas that are relatively far removed from urban centers, and are experiencing an out-migration of youth. Relocation of retirees to the coast is also a driving factor influencing these statistics (The Research Group, 2014; CCD Business Development Corporation, 2013).

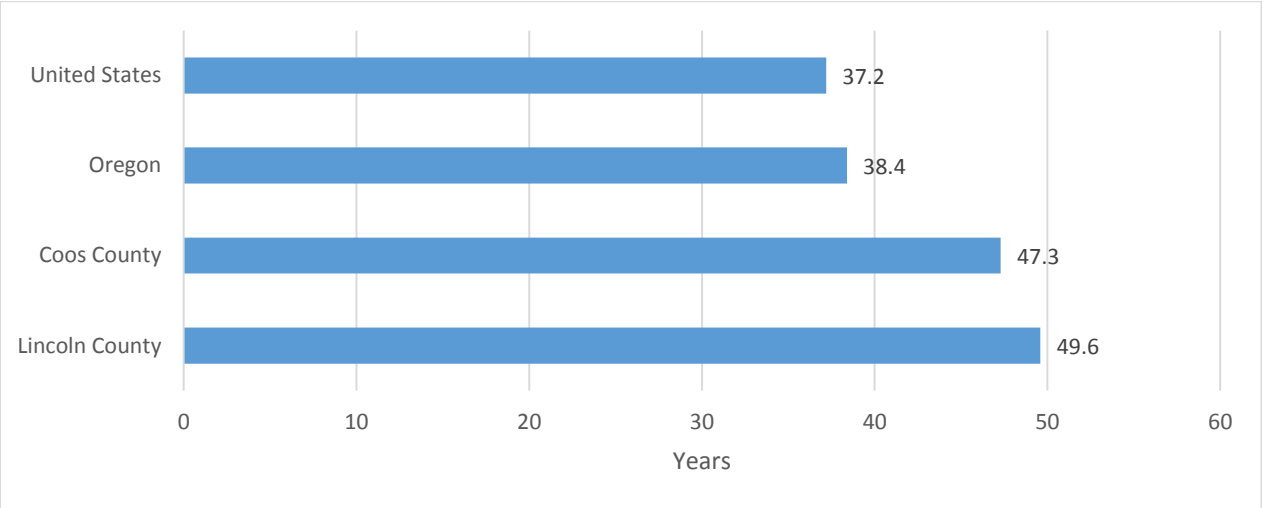

Figure A-1d. Median ages for the United States, Oregon, and Coos and Lincoln counties (2010)
Source: Census Bureau 2010a

It is also interesting to note that, between 2000 and 2010, the median age of the population increased in the United States, the State of Oregon, and in all communities in both Coos and Lincoln Counties (Figure A-1e). Thus, although the median age in rural coastal Oregon is clearly higher than other areas of the State and the nation, information about increasing trends over time should be considered in the context of an aging population both State- and nation-wide. Figure A-1e also shows the communities with the highest median ages. In Lincoln County in 2010, the Cities of Yachats, Depoe Bay and Waldport had the highest median ages, whereas the Cities of Bandon and Powers topped the charts in Coos County. A slightly higher median age was reported overall in Lincoln County compared to Coos County in both 2000 and 2010.

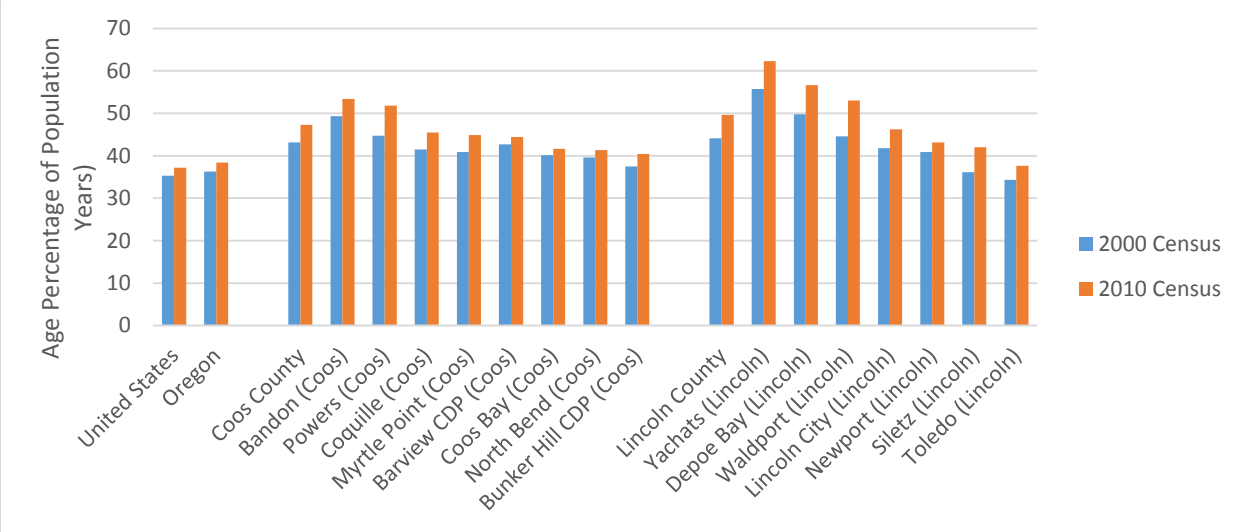

Figure A-1e. Median ages for the United States, Oregon, and Coos and Lincoln counties and communities (2000 and 2010)
Source: Census Bureau 2000, 2010a

In addition to median age, other potentially useful age distribution statistics include the percent of the population over age 65, the percentage of households in a community with individuals under 18, and the overall percentage of the population under the age of 18. Figure A-1f displays these statistics for the United States, Oregon, and Coos and Lincoln Counties based on the 2010 census. These numbers reveal that a smaller percentage of the population of Coos and Lincoln Counties is under the age of 18 compared to both the State and the nation, although Coos County appears has a slightly higher percentage of individuals under 18 and households with children compared to Lincoln County. Interestingly, there are opposite findings in Coos and Lincoln Counties related to the elderly: in Coos County, a smaller percentage of the population is above age 65 compared to the State and the nation, while in Lincoln County a higher percentage of the population is over age 65. This is in keeping with the higher median ages in Lincoln County communities illustrated in Figure A-1e.

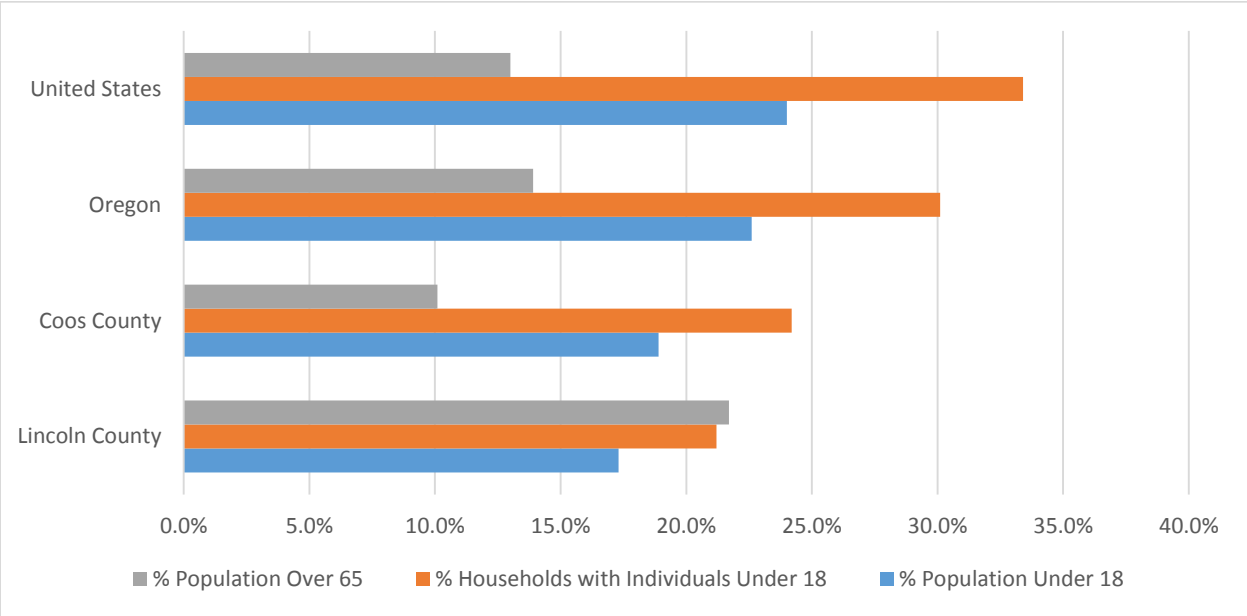

Figure A-1f. Other age distribution statistics (2010)
Source: Census Bureau 2010a

Median age across census tracts making up each county's hub community (the Coos Bay and Yaquina Bay areas, respectively), are provided in Figure A-1g. In 2010 census tracts with the lowest median age in the Coos Bay area were tracts 5.03 and 4, which correspond with the northwest portion of the City of Coos Bay (tract 5.03) and the City of North Bend (tract 4). The lowest median ages in the Yaquina Bay area were found in census tracts 9509 and 9510, loosely corresponding with the Nye Beach area (tract 9510) and the area to the north of east-west Highway 20 and the Nye Beach area (tract 9509). The highest median ages in the Coos Bay area were reported in census tracts 5.02 and 8, corresponding with rural areas on the outskirts of the population center, including the area around South Slough (tract 5.02) and the area west of Bunker Hill CDP and Isthmus Slough (tract 8).

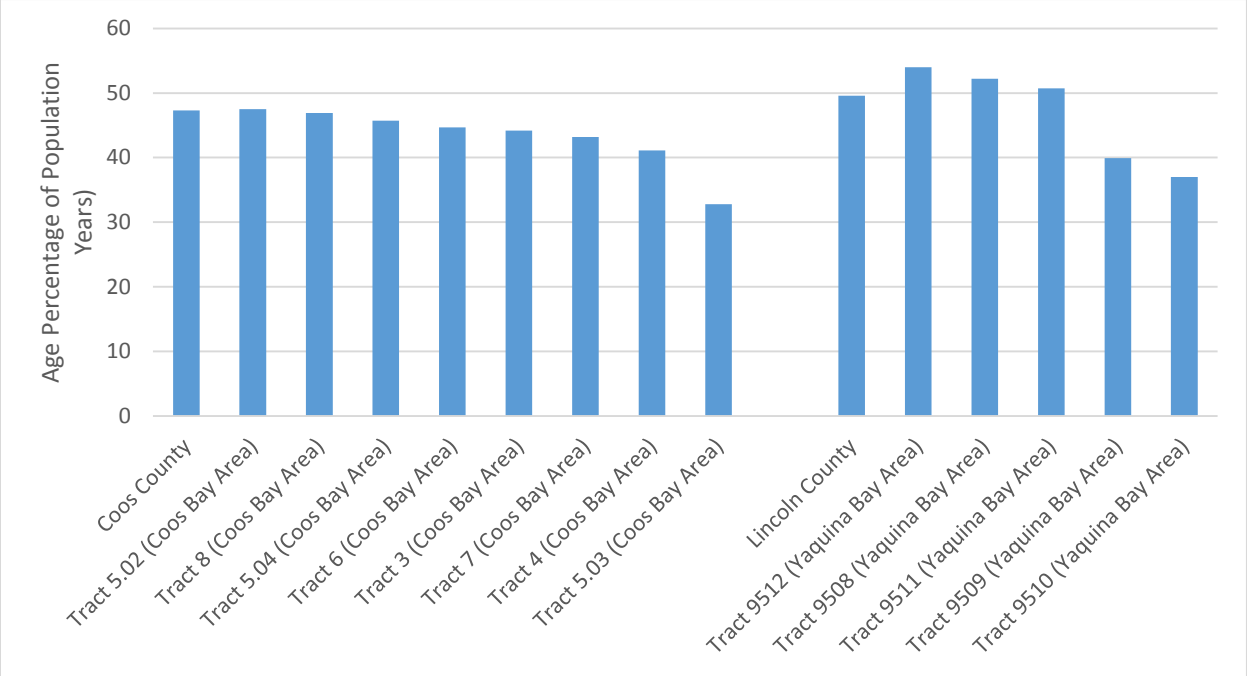

Figure A-1g. Median age 2010 across census tracts in hub communities around Coos Bay and Yaquina Bay (2010)
Source: Census Bureau 2010a

Figure A-1h presents additional age distribution statistics across these census tracts, including the percentage of the population over age 65, the percentage of the population under age 18, and the percentage of all households with related children (under age 18). It is not surprising that the areas with the greatest percentages of the population over age 65 frequently coincide with lower percentages of the population under the age of 18. However, the percentage of households with related children does not follow as clear of an opposite trend.

The census tracts in the Coos Bay area with the greatest population percentage over the age of 65 include tracts 5.04 and 6, corresponding with the older neighborhoods at the heart of the City of Coos Bay, including the Coos Bay downtown and waterfront (tract 6) and areas immediately west of downtown (tract 5.04). In the Yaquina Bay area, the census tract with the greatest percentages of the population above the age of 65 include tracts 9508 and 9511, corresponding with the northern portion of the City of Newport and rural outskirts northward along the coast (tract 9508) and the residential area adjacent to the Newport Bayfront (tract 9511).

In both the Coos Bay and Yaquina Bay areas, the census tracts with the lowest median age, as illustrated in Figure A-1g, were the same as the census tracts with the highest percentage of individuals under the age of 18, and also the same as the census tracts with the highest percentage of households with related children. In Coos Bay, these were the northwest portion of the City of Coos Bay (tract 5.03) and the northern portion of the City of North Bend (tract 4). In the Yaquina Bay area, these are the Nye Beach area (loosely corresponding with tract 9510) and the area to the north of east-west Highway 20 and Nye Beach (tract 9509).

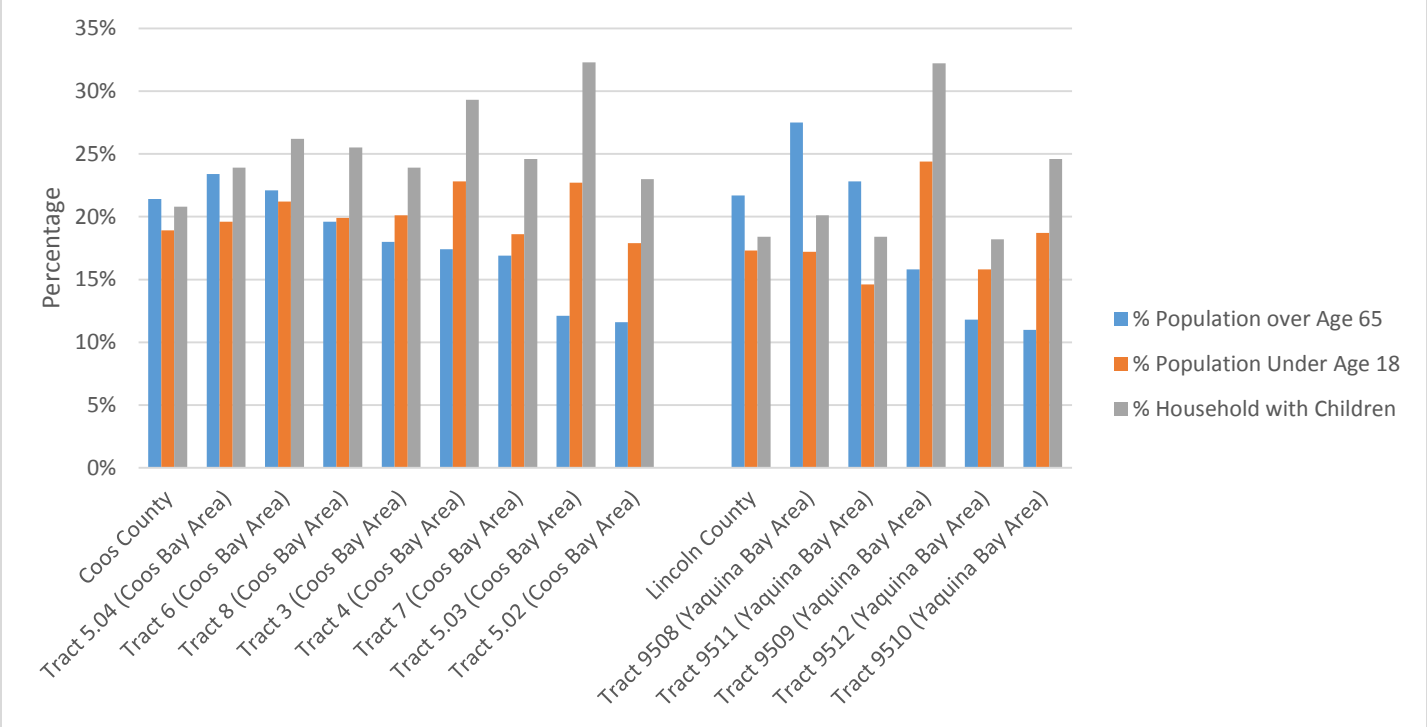

Figure A-1h. Other population age distribution statistics across census tracts in Coos Bay and Yaquina Bay areas (2010)
Source: Census Bureau 2010a

4. Gender

There are more women than men in the United States overall, a statistic that holds true in the State of Oregon as well. This is also true in both Coos and Lincoln Counties and a majority of the individual communities within them with several exceptions (Figure A-1i). The gender balance in Coos County is closer to the national and State averages than Lincoln County, which appears to be even more skewed toward females. This difference appears to be due to a greater number of Lincoln County communities highly skewed toward females, and a greater number of Coos County communities with higher percentages of males, such as the City of Powers and Bunker Hill CDP. In 2010, the widest gender gaps (female > male) were reported for the Lincoln County communities of Lincoln City, Waldport and Yachats, as well as the Coos County community of Bandon.

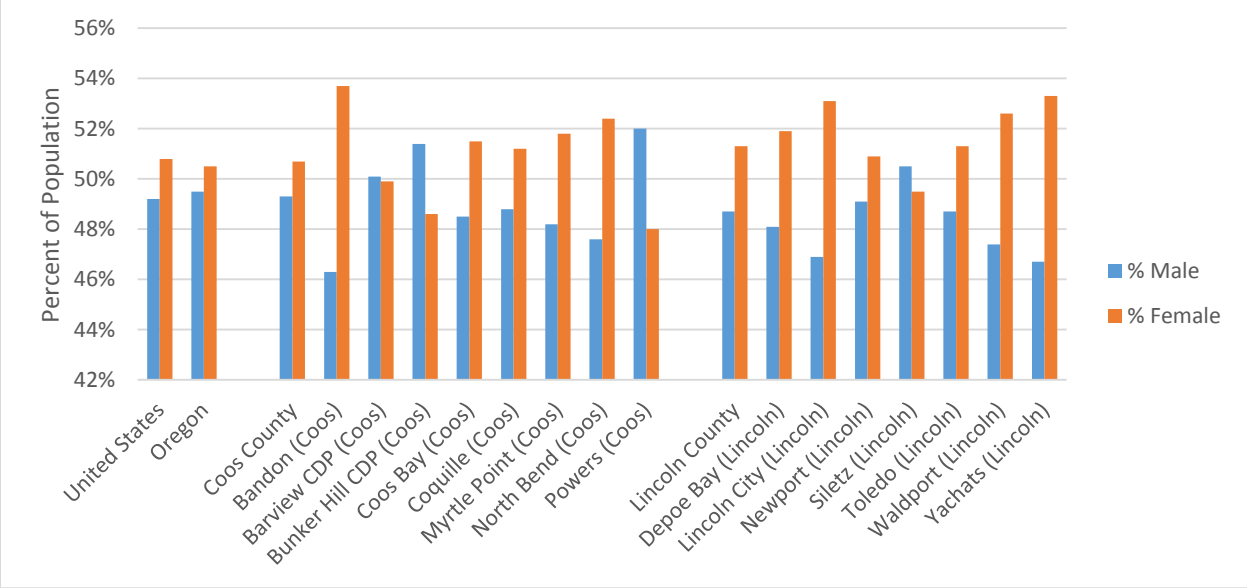

Figure A-1i. Gender balance for the United States, Oregon, Coos and Lincoln counties and communities (2010)
Source: Census Bureau 2010a

Census tract data provide an opportunity to examine how gender balance might vary within an individual community. Figure A-1j presents information about gender balance across the individual census tracts that make up the hub communities in both Coos and Lincoln Counties (the Coos Bay and Yaquina Bay areas).

In the Coos Bay area in 2010, census tracts 3, 4, 5.04 and 6 were the most highly skewed toward females compared to Coos County overall. These tracts correspond with the City of North Bend (tracts 3 and 4), the portions of the City of Coos Bay that lie west of downtown (tracts 5.04 and 6). The regions of the Coos Bay area with greater proportions of males compared to females included census tracts 5.02, 7 and 8. These tracts correspond with the more rural areas on the outskirts of the population center to the south, including Charleston and South Slough (tract 5.02), and the Bunker Hill and Isthmus Slough areas (tracts 7 and 8).

In the Yaquina Bay area in 2010, census tracts 9509 and 9512 were the most highly skewed toward females compared to Lincoln County overall. These tracts correspond to the portion of the City of Newport and adjacent county lands that are immediately north of east-west Highway 20 and the Nye Beach district (tract 9509), and the portion of the City of Newport and adjacent county stretching south

along the coast, including South Beach (tract 9512). The sections of the Yaquina Bay area that had the highest proportion of men were tracts 9510 and 9511, which loosely correspond with some of the most densely populated areas: Nye Beach district (tract 9510) and the Newport Bayfront and adjacent county lands to the east (tract 9511).

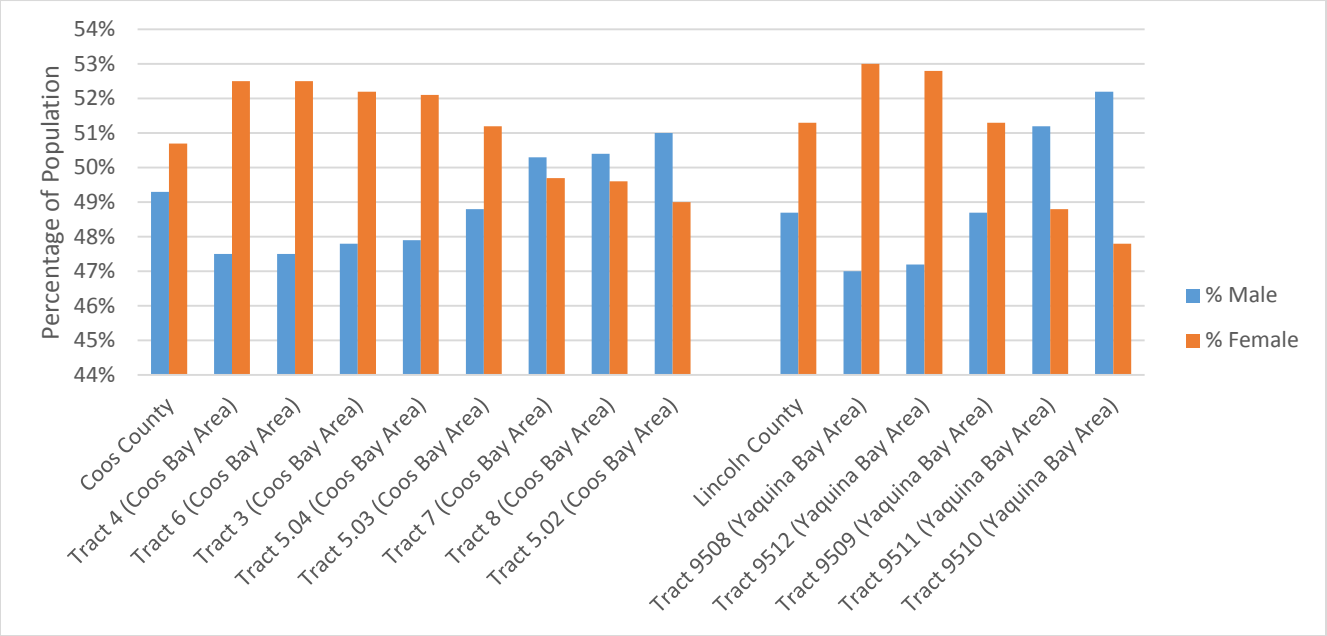

Figure A-1j. Gender balance across census tracts in hub communities around Coos Bay and Yaquina Bay (2010)
Source: Census Bureau 2010a

5. Race and Ethnicity

In 2010, there was less racial and ethnic diversity in Coos and Lincoln Counties compared to the State and the nation, with higher percentages of the population that identify as White. However, it is important to note that a greater percentage of both the Coos and Lincoln County populations identified as American Indian or Alaska Native compared to the larger populations of both the United States and the State of Oregon (Figure A-1k).

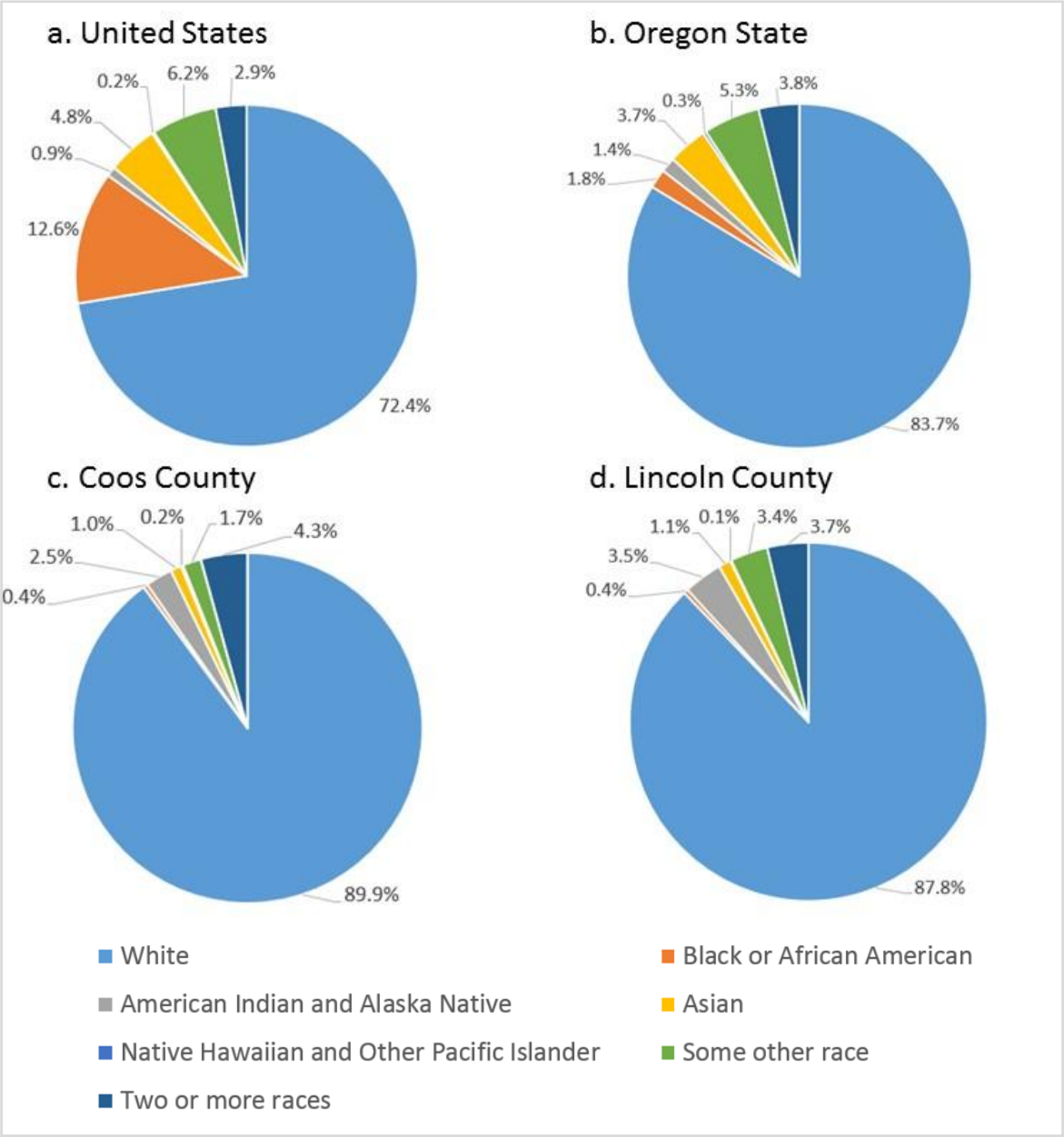

Figure A-1k: Racial breakdowns for the United States, Oregon, and Coos and Lincoln counties (2010)
Source: Census Bureau 2010a

Figure A-1l presents information about the distribution of minority racial and ethnic groups throughout Coos and Lincoln County communities. Within Coos and Lincoln Counties, in 2010 the two most highly represented racial and ethnic minorities were Hispanics and American Indian and Alaska Native peoples. Much of the racial and ethnic diversity in both Coos and Lincoln Counties is centered in their respective hub communities, referred to here as the Coos Bay area (including the Cities of Coos Bay and North Bend, as well as Barview and Bunker Hill CDPs) and the Yaquina Bay area (City of Newport and immediate adjacent lands).

In Coos County, the highest percentages of Hispanics were found in Bunker Hill CDP (9.8% of the population) and the City of Coos Bay (7.6%). The highest percentage of individuals identifying as American Indian and Alaska Native resided in the City of Powers (4.1% of the population) and Barview CDP (3.4%). In Coos County, the communities with the greatest percentage of Asian Americans were the Cities of North Bend (1.7%) and Coos Bay (1.4%), the community with the highest percentage of individuals identifying as Black or African American was Bunker Hill CDP (1.5%), and the communities with the greatest percentage of Native Hawaiians or Other Pacific Islanders were the Cities of North Bend (0.3%) and Coos Bay (0.2%).

In Lincoln County, the highest percentage of Hispanics was found in the Cities of Newport (15.3%) and Lincoln City (13.2%). By far the largest percentage of individuals identifying as American Indian or Alaska Native were reported to be living in Siletz (18.4%). This makes sense given the proximity of the City of Siletz to Siletz Reservation lands. Other communities with relatively high percentages of American Indians or Alaska Natives included Toledo (3.8%) and Lincoln City (3.5%). In Lincoln County, the communities with the greatest percentage of Asian Americans were the Cities of Newport (1.6%) and Lincoln City (1.5%), the community with the highest percentage of individuals identifying as Black or African American was the City of Waldport (0.8%), and the community with the greatest percentage of Native Hawaiians or Other Pacific Islanders was also the City of Waldport (0.3%).

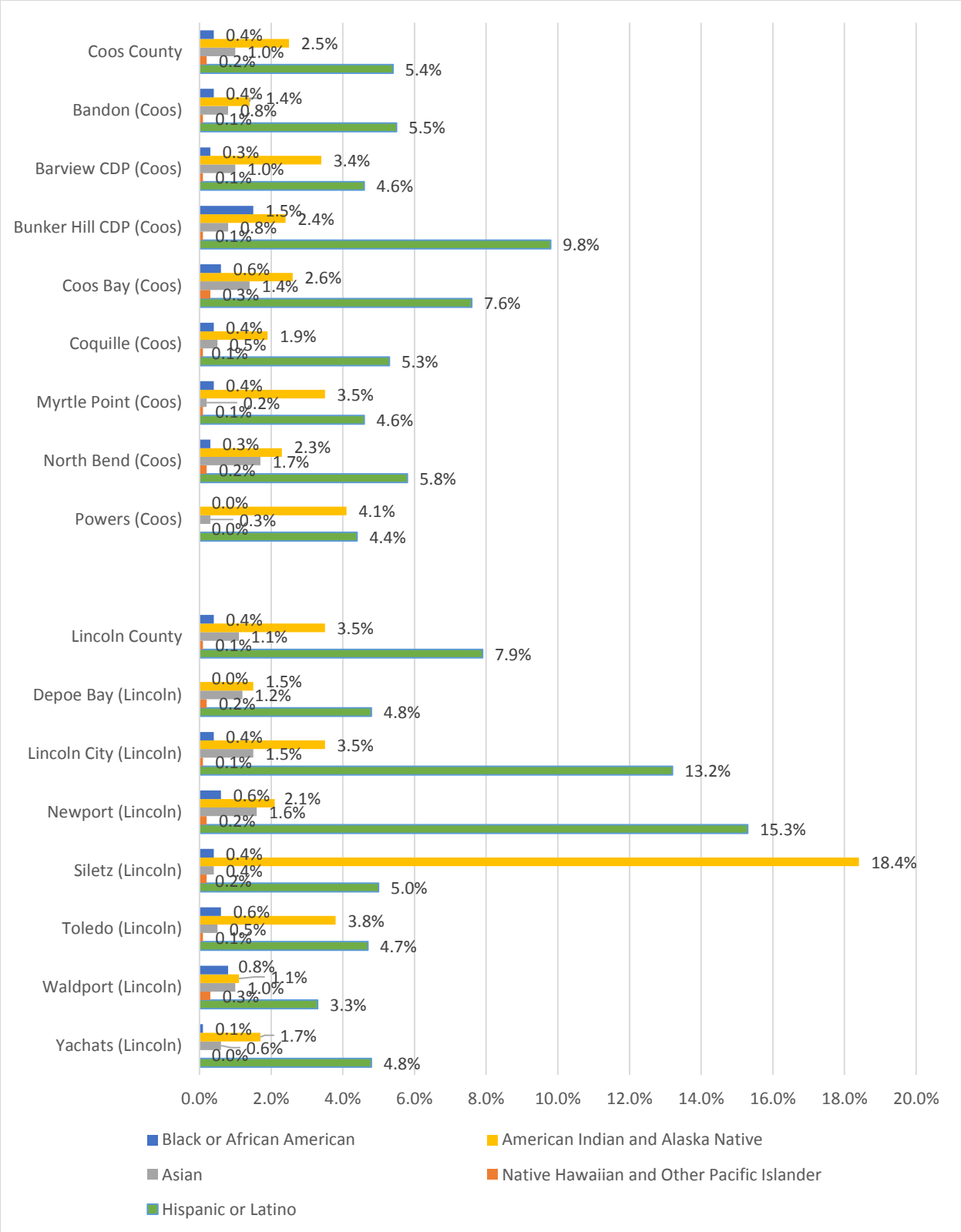

Figure A-1l. Distribution of non-white races and ethnicities in Coos and Lincoln counties and communities (2010)

Source: Census Bureau 2010a

It is also useful to look at the distribution of racial and ethnic distributions within Coos and Lincoln Counties' respective hub communities, the Coos Bay area and the Yaquina Bay area. Figure A-1m provides a breakdown of the percentage of census tract populations that fell into distinct racial and ethnic categories.

Among Coos Bay area census tracts, the populations of tracts 5.03 and 5.04 had the highest percentages of Hispanics (11.1% and 8.2%, respectively) in 2010. These same census tracts also exhibited the highest population percentages of individuals identifying as American Indian and Alaska Native, at 3.6% and 4.9%, respectively. The Coos Bay area census tracts that appeared to have the least racial and ethnic diversity were tracts 5.02, 6, and 8. Tract 6 corresponds to the area just inland from the Coos Bay waterfront (tract 6), and several rural areas south of Coos Bay, including the South Slough / Charleston / Barview CDP area (tract 5.02) and the area east of Isthmus Slough (tract 8). In 2010, the population of census tract 5.02 was 4.3% Hispanic, 3.3% American Indian or Alaska Native, 1.4% Asian, 0.4% Black or African American, and 0.1% Native Hawaiian or Other Pacific Islander. The population of census tract 6 was 4.8% Hispanic, 2.2% American Indian or Alaska Native, 2.1% Asian, 0.1% Black or African American, and 0.1% Native Hawaiian or Other Pacific Islander. The population of census tract 8 was 3.6% Hispanic, 2.3% American Indian or Alaska Native, 1.3% Asian, 0.2% Black or African American, and 0.0% Native Hawaiian or Other Pacific Islander.

In the Yaquina Bay area, the census tracts with the highest population percentage of Hispanics in 2010 included tracts 9509, 9510, and 9511, with percentages of 17.9%, 20.1% and 13.2%, respectively. These tracts correspond with the most highly populous areas in the City of Newport, including the Newport Bayfront (tract 9511), the Nye Beach district (loosely corresponding with tract 9510), and the area immediately north of the east-west Highway 20 and Nye Beach (tract 9509). Tracts 9509 and 9510 were also the areas with the greatest population percentage of American Indian and Alaska Native in 2010, at 2.9% and 2.1% of their populations, respectively. The Yaquina Bay area census tract that appeared to have the lowest level of racial and ethnic diversity in 2010 was tract 9512, which corresponds with the southern portion of the City of Newport and adjacent rural outskirts, including the South Beach district. This population of this census tract was 3% Hispanic, 1.6% American Indian and Alaska Native, 0.8% Asian, 0.1% Black or African American, and 0.1% Native Hawaiian or Other Pacific Islander.

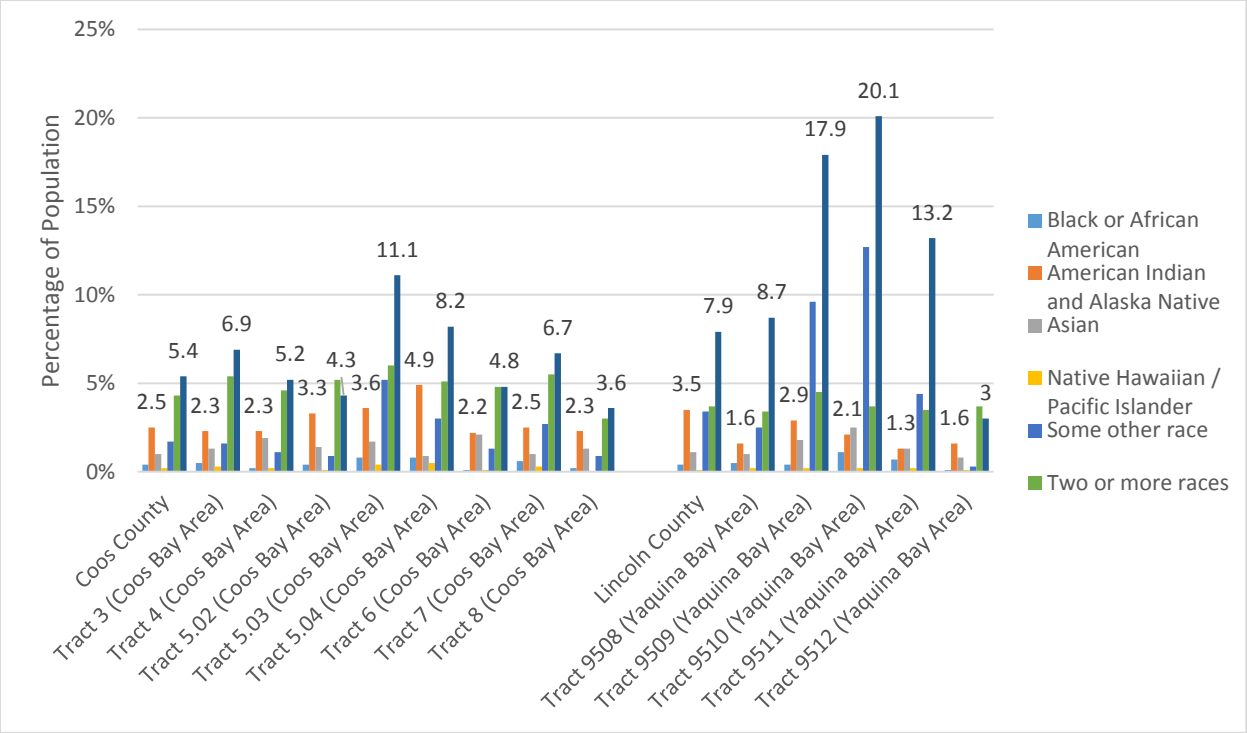

Figure A-1m. Races and Ethnicities across census tracts in hub communities around Coos Bay and Yaquina Bay, 2010
Source: Census Bureau 2010a

6. Education

Figure A-1n shows educational attainment of the populations of Coos and Lincoln County in 2010, with individual communities compared to the overall educational attainment of the larger United States and Oregon populations. In both counties there was some variation in the percentage of individual communities' populations that had received high school diplomas. In Coos County, the population of Bunker Hill CDP reported the lowest rate of high school completion at 77.4%, while the population of the City of North Bend had the highest rate at 91.3%. In Lincoln County, the lowest percentage of a community population was reported in the City of Siletz at 83%, while the highest rate was reported in the City of Depoe Bay (94.4%).

The communities with the highest rates of Bachelor's degrees were not necessarily the same as those with the highest rates of high school completion, although there were some parallels. In Coos County, the population with the greatest percentage of Bachelor's degrees was the City of Bandon at 28.5%, while the lowest population percentages were reported in the City of Powers (7.5%) and Bunker Hill CDP (7.6%). In Lincoln County, rates of receipt of Bachelor's degrees ranged from 5.7% in the City of Siletz to 21.5% in the City of Depoe Bay.

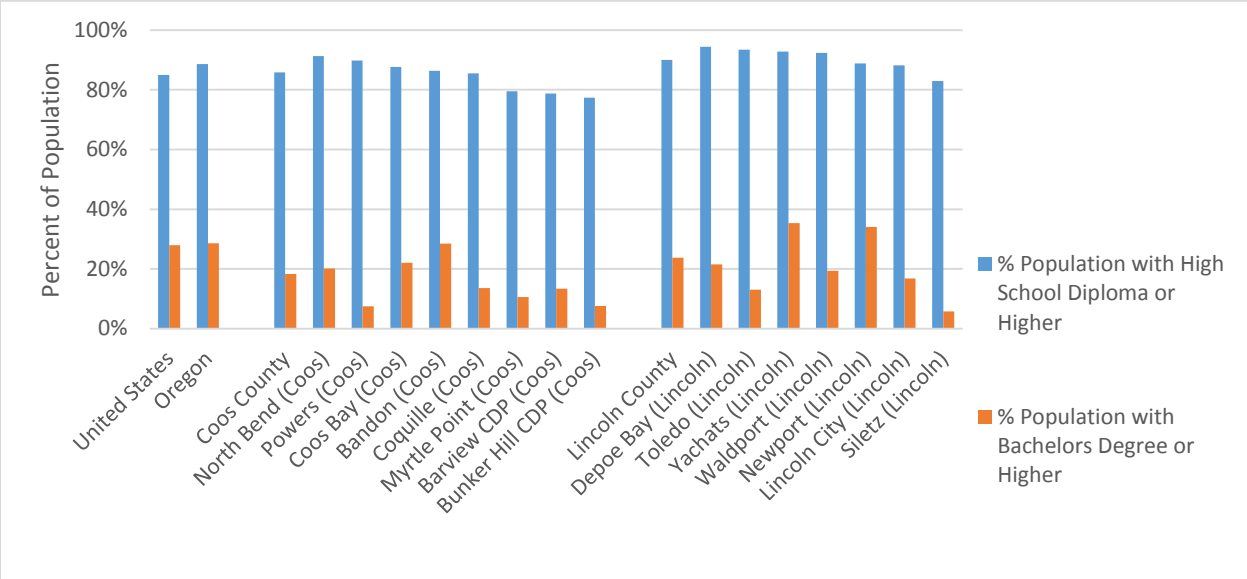

Figure A-1n. Educational attainment in the United States, Oregon, Coos and Lincoln counties and communities (2010)
Source: Census Bureau 2010a

A look at the distribution of educational attainment within the hub communities (Figure A-1o) exposes slightly greater variation compared to an inter-community view presented in Figure A-1n, with higher maximum rates in both the Coos and Yaquina Bay areas, and lower minimum rates in the Coos Bay area. Looking across Coos Bay area census tracts, the spread of high school completion rates in 2010 ranged from 76.8% in census tract 5.04 (corresponding with the western portion of the City of Coos Bay and adjacent county and Tribal lands) to 95.7% in census tract 6 (corresponding with the portion of the City of Coos Bay just inland from the Coos Bay waterfront and downtown sector). Census tract 5.04 was also the segment of the community that reported the lowest university graduation rate (10.4%), and census tract 6 was also the segment that reported the highest percentage of Bachelor's degrees (32.7%). In Lincoln County, census tract 9512 reported the highest rates of both high school completion (96.4%) and college graduation (40.7%). This census tract corresponds with the southern portion of the City of Newport and adjacent rural outskirts, including the South Beach neighborhood. Overall, the Yaquina Bay area had higher educational attainment than the Coos Bay area, based on high school diplomas and Bachelor's degrees. The lowest rate of high school completion in the Yaquina Bay area was reported in census tracts 9509 and 9510 (85.5%), but this rate is relatively high compared to the lowest rates reported in for the Coos Bay area. Similarly, the lowest college graduation rates reported in the Yaquina Bay area were much higher than those reported in the Coos Bay area, with the lowest rate of 27.8% reported for census tract 9509. Census tract 9510 loosely corresponds with the Nye Beach district, while census tract 9509 corresponds to the area north of the east-west Highway 20 and Nye Beach.

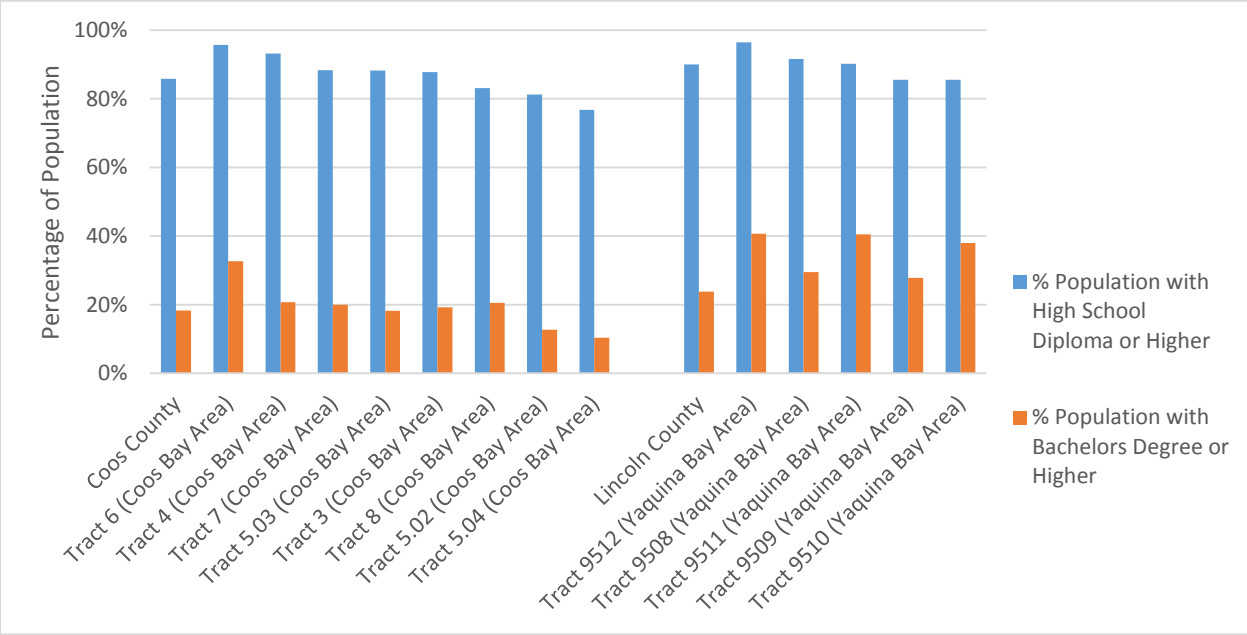

Figure A-1o. Educational attainment across census tracts in hub communities around Coos Bay and Yaquina Bay (2010)
Source: Census Bureau 2010a

7. Income, Unemployment, and Poverty

7a. Income

Figure A-1p presents median household income and per capita income figures for 2010 for Coos and Lincoln County communities. In 2010, the highest median household incomes in Coos County were reported in the Cities of North Bend and Coos Bay. These Cities also reported high per capita income levels, although similar per capita incomes were reported in the Cities of Coquille and Bandon as well. The lowest median household income in Coos County was reported in Bunker Hill CDP. However, Bunker Hill CDP did not have the lowest per capita income, with the City of Powers coming in just under the former's figure. In Lincoln County, the highest median household incomes were reported in the Cities of Newport and Toledo, while the Cities of Depoe Bay and Newport reported the highest per capita incomes. The lowest median household income figures were reported for the Cities of Waldport and Lincoln City, while the lowest per capita incomes were reported for the Cities of Siletz and Toledo.

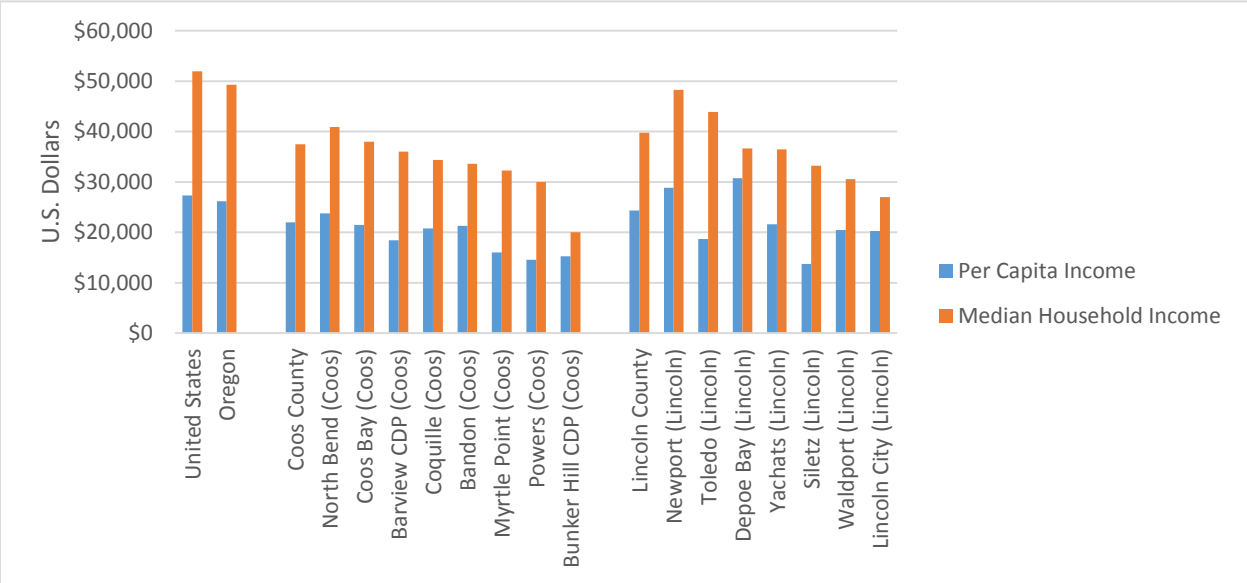

Figure A-1p. Per capita and median household income levels in the United States, Oregon, Coos and Lincoln counties and communities (2010)
Source: Census Bureau 2010b

Within the hub communities, the census tracts with by far the highest income levels (median household and per capita income) in the Coos Bay area was tract 6, which corresponds to the portion of Coos Bay city just inland (west) of downtown and the Coos Bay waterfront. The lowest income levels in the Coos Bay area were reported for tracts 5.04 and 7, which correspond with the southwestern portion of the City of Coos Bay that sits along the western edge of the peninsula (tract 5.04) and the Coos Bayfront and southern rural outskirts, including Bunker Hill CDP (tract 7). In the Yaquina Bay area, the highest income levels were reported for census tracts 9511 and 9512, which correspond with the residential zone adjacent to the Newport Bayfront (tract 9511) and the southern portion of the City of Newport and adjacent rural county lands, including the South Beach area (tract 9512). There was less variation in income level in the Yaquina Bay area compared to the Coos Bay area in 2010, and the lowest income levels were not dramatically below the tracts 9511 and 9512. However, the lowest median household income level was reported in census tract 9508, which corresponds to the northernmost coastal area of the City of Newport and the adjacent rural county outskirts to the north, while the lowest per capita income was reported for tract 9509, which loosely corresponds with the Nye Beach district (Figure A-1q).

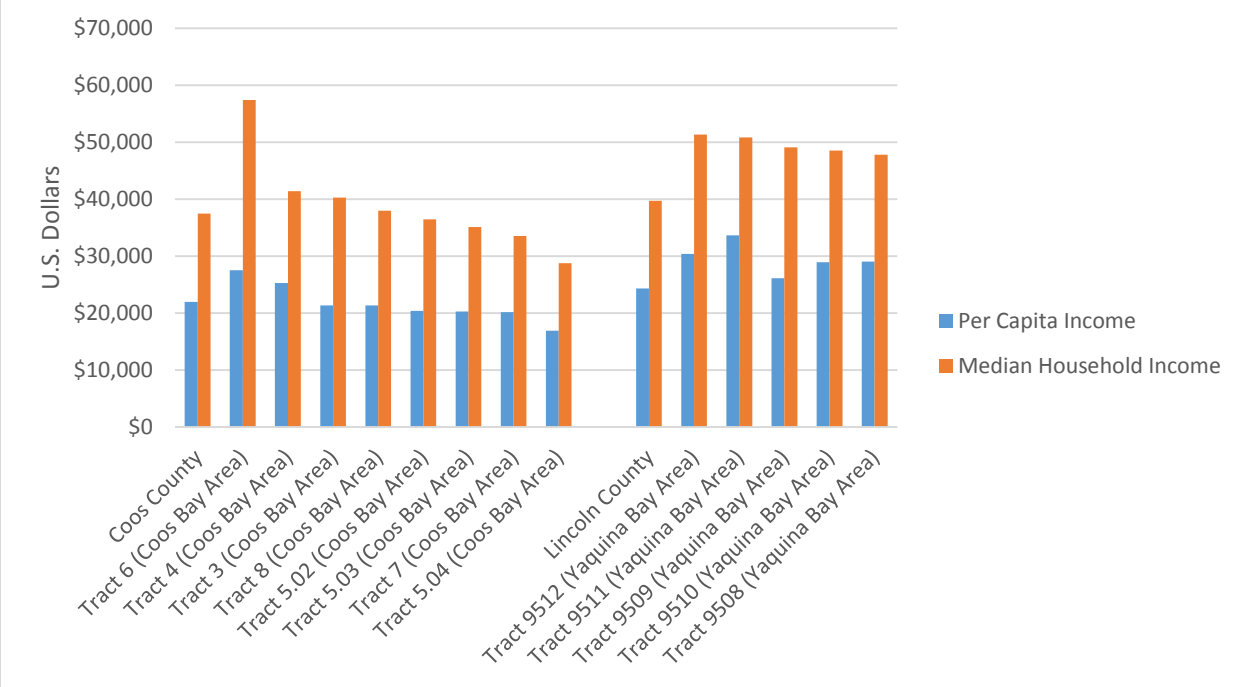

Figure A-1q. Per capita and median household income levels across census tracts in hub communities around Coos Bay and Yaquina Bay (2010)
Source: Census Bureau 2010b

7b. Unemployment

Overall, unemployment rates in Coos and Lincoln Counties in 2000 and 2010 appear to have been very similar on average to the State of Oregon as a whole. However, Figure A-1r illustrates the dramatic differences in unemployment rates across individual communities within these counties. In Lincoln County in 2010, unemployment rates were highest in Toledo and Siletz and lowest in Depoe Bay, Yachats, and Waldport. It is important to note that the Cities of Depoe Bay, Yachats, and Waldport are the same Lincoln County communities for which the greatest percentage of the populations were over the age of 65 (Figure A-1e), indicating that a smaller percentage of the population is likely in the labor force overall. In Coos County, the communities with the highest unemployment rates in 2010 were Bunker Hill CDP and the City of Powers, while the lowest rates of unemployment were reported for the Cities of Bandon and Coquille. Like the three communities in Lincoln County with the lowest unemployment rates, Bandon is the Coos County community with the highest percentage of the population over the age of 65 (Figure A-1e). In the case of Coquille, this low unemployment rate may be related to the fact that Coquille is the seat of Coos County, providing a number of local employment opportunities that may not be available elsewhere in the County.

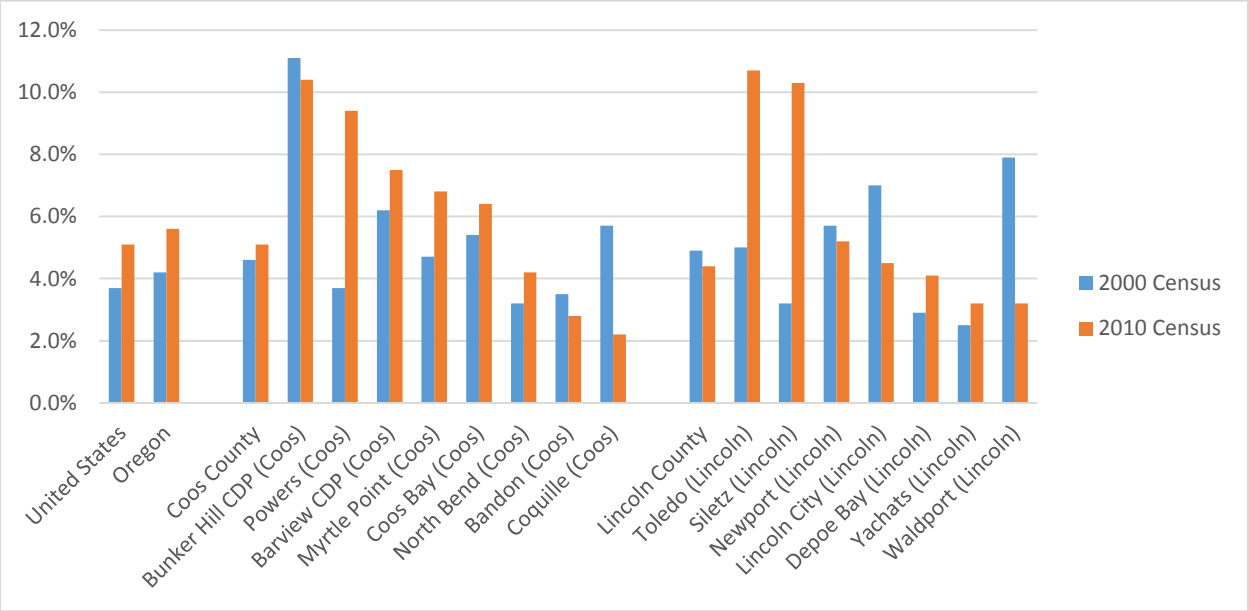

Figure A-1r. Unemployment rates for the United States, Oregon, Coos and Lincoln counties and communities (2000 and 2010)

Sources: Census Bureau 2000, 2010b

Unemployment rates varied several percentage points across census tracts in both the Coos Bay area and the Yaquina Bay area, also the variation appeared slightly greater in the Coos Bay area (Figure A-1s). In the Coos Bay area, the census tracts with the highest unemployment rates were tracts 4, 5.04, and 5.03. These correspond to the northern portion of the City of North Bend (tract 4), and the western portion of the City of Coos Bay running along the western edge of the peninsula (tracts 5.03 and 5.04). In the Yaquina Bay area, the highest unemployment rates were found in tracts 9509 and 9511, while the lowest unemployment rate was in tract 9512. These correspond to the portion of the city and adjacent county lands lying north of east-west Highway 20 and the Nye Beach district (tract 9509), the residential zone adjacent to the Newport Bayfront (tract 9511), and the southern portion of the City of Newport, including adjacent county lands to the south and east (tract 9512).

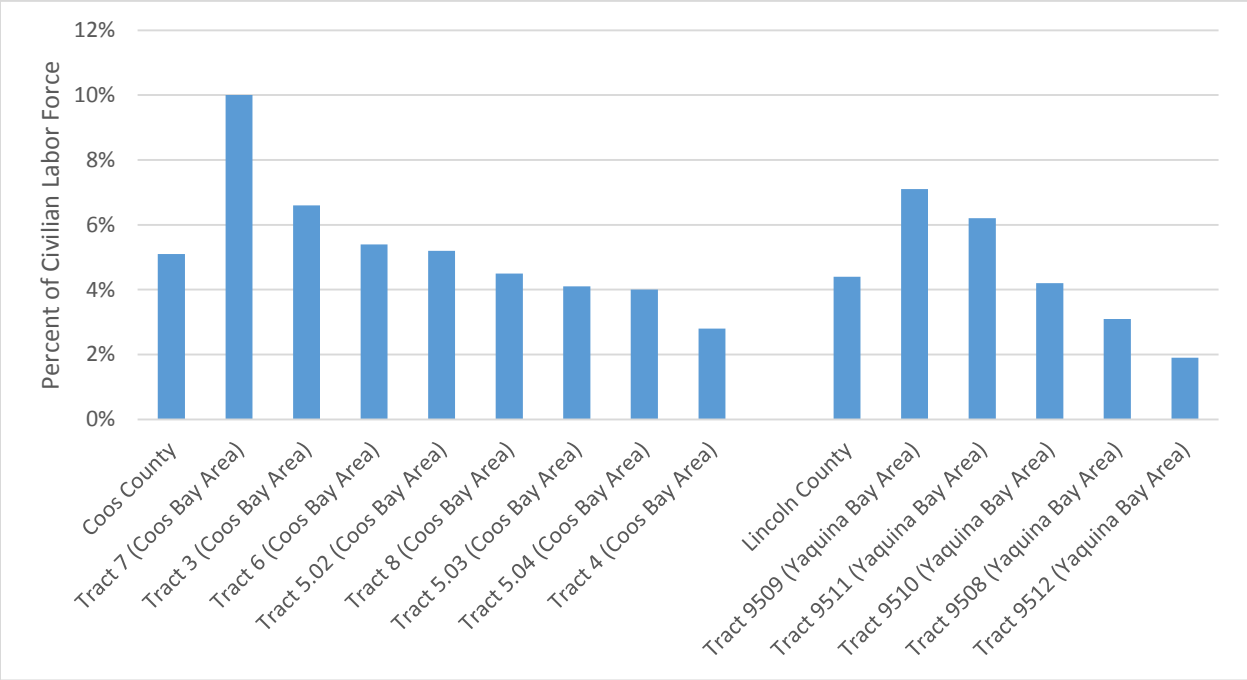

Figure A-1s. Unemployment rates across census tracts in hub communities around Coos Bay and Yaquina Bay (2010)
Source: Census Bureau 2010b

7c. Poverty

Historical poverty rates (for all people) are available from the U.S. Census Bureau for Coos and Lincoln Counties beginning in 1960 (U.S. Census Bureau 1960, 1970, 1980b, 1990). Figure A-1t in the technical report demonstrates that, although Coos and Lincoln County historically had poverty rates below the rate in the United States, today both counties have rates higher than the national average. Also of note in Figure A-1t is the sharp increase in poverty in Coos County between 1980 and 1990, reflecting the closure of numerous sawmills and timber harvesting operations over that decade (Loy et al. 2001, Robbins, 1988).

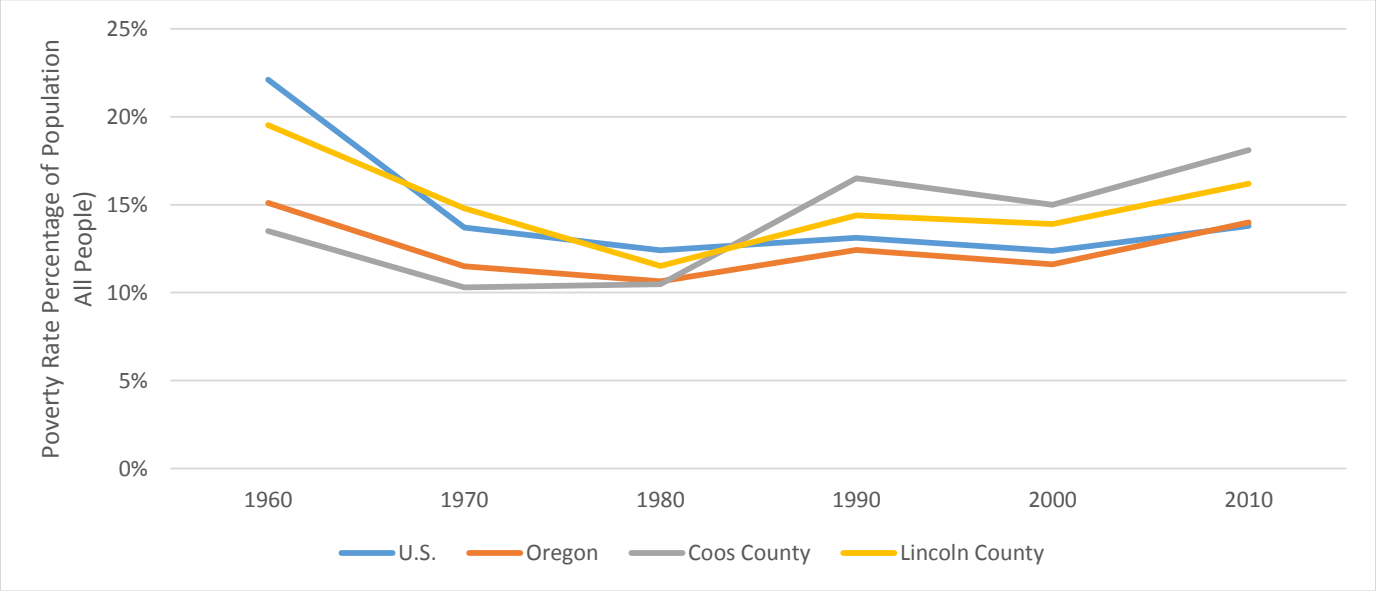

Figure A-1t. Historical poverty rates for the United States, Oregon, and Coos and Lincoln counties (1960–2010)

Sources: Census Bureau [date unknown]b; Census Bureau 2010b

In 2010, poverty rates in Coos and Lincoln County were slightly higher than State- and nation-wide rates. Three distinct poverty statistics are reported in Figure A-1u, including the poverty rates for: 1) all people, 2) for related children in households (a census designation to distinguish between related children and those under the age of 18 living away from their families of origin), and 3) for all individuals over the age of 65. For all geographies, the highest poverty rates were those reported for related children, while the poverty rate for individuals over age 65 were the lowest. Although the poverty rate for all people was similar between Coos and Lincoln Counties, overall, Lincoln County appeared to have the highest poverty rates relative to the other geographies.

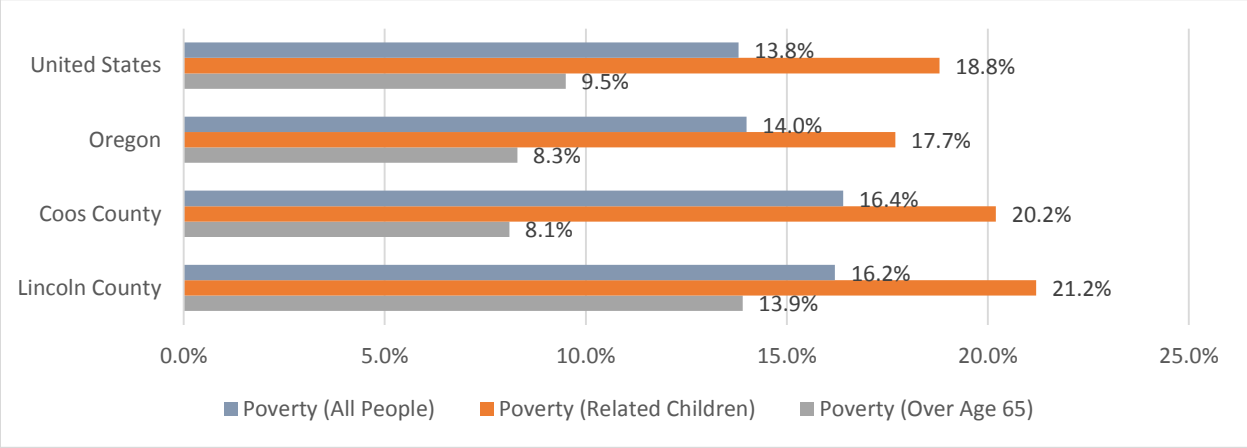

Figure A-1u. Poverty rates for the United States, Oregon, and Coos and Lincoln counties (2010)
Source: Census Bureau 2010b

Poverty rates were not evenly distributed among Coos and Lincoln County communities in 2010. In Coos County, Bunker Hill CDP reported the highest poverty rates for all three statistics. The lowest overall Coos County poverty rates were reported for Powers and Coquille, although these communities had variable rates of poverty among the children and elderly. In Lincoln County, Lincoln City and Siletz had the highest poverty rates for all three statistics, while Yachats and Depoe Bay reported the lowest rates overall (Figure A-1v).

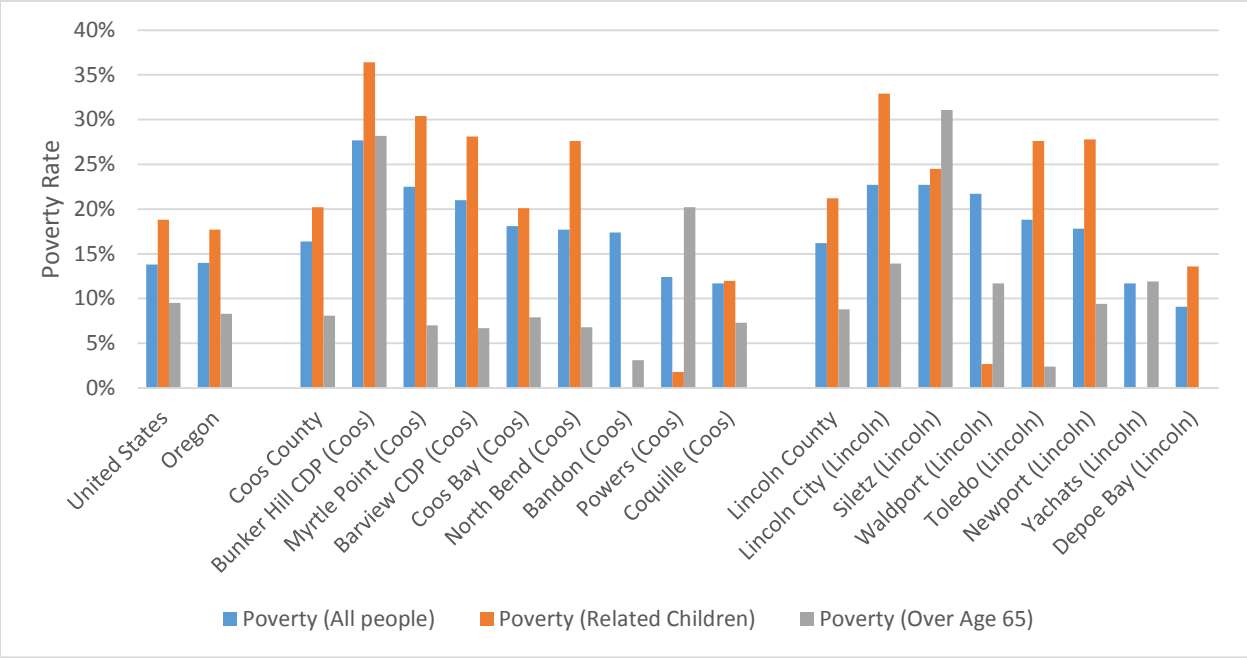

Figure A-1v. Poverty rates for the United States, Oregon, Coos and Lincoln counties and communities (2010)
Source: Census Bureau 2010b

Poverty rates were not evenly distributed within the hub communities in 2010 (Figure A-1w). In the Coos Bay area, the greatest rates of poverty were reported for census tracts 5.03, 7 and 3, corresponding with the northwestern corner of the City of Coos Bay (tract 5.03), the region to the south of the City of Coos Bay, including Bunker Hill CDP (tract 7), and the southeastern portion of the City of North Bend (tract 3). The lowest rate in the Coos Bay area were reported for tract 6, corresponding with the area just inland from downtown and the Coos Bay waterfront. In the Yaquina Bay area, there was substantially less poverty in census tracts 9509 and 9512, corresponding with the area north of east-west Highway 20 (tract 9509) and the southern portion of the City of Coos Bay, including South Beach and adjacent county lands (tract 9512). Overall poverty rates (among all people) were quite similar in the remaining census tracts, with the highest rates of overall poverty and child poverty in tract 9511, corresponding with the residential area adjacent to the Newport Bayfront. The highest level of poverty in individuals over the age of 65 was reported in census tract 9510, which loosely corresponds with the Nye Beach district.

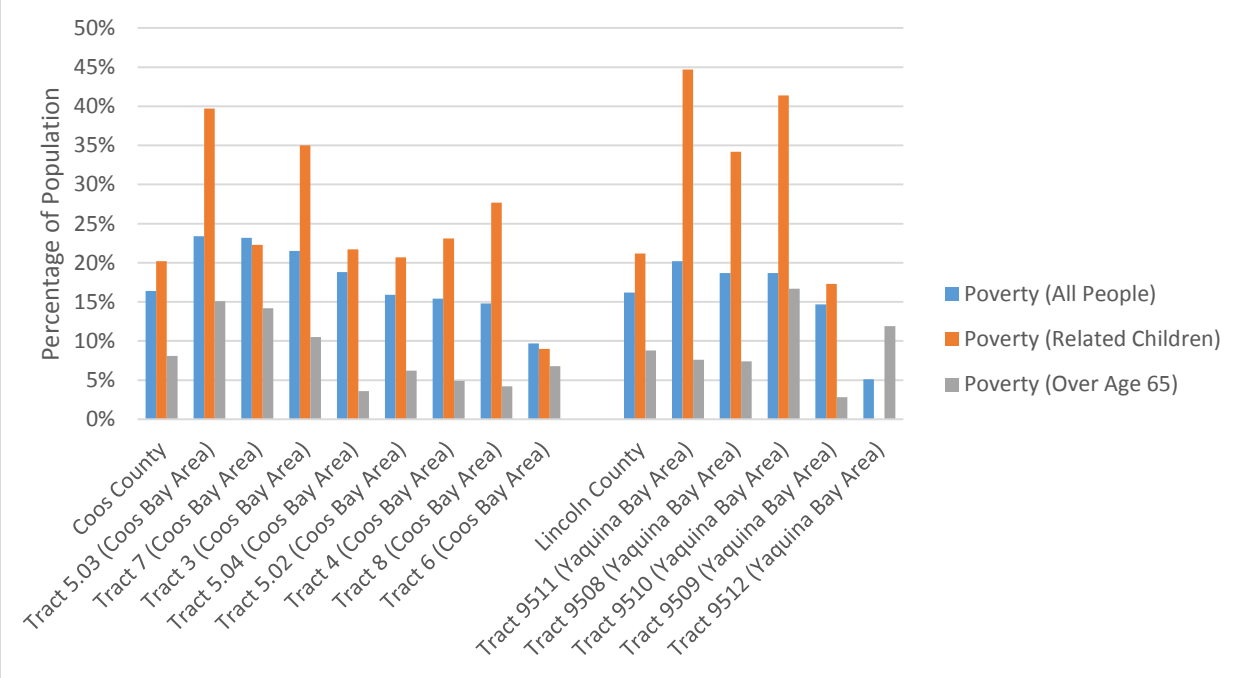

Figure A-1w. Poverty rates across census tracts in hub communities around Coos Bay and Yaquina Bay (2010)
Source: Census Bureau 2010b

8. Identification of Populations of Concern (Vulnerable Populations)

For the purposes of this study, populations of concern will also include several additional populations that have been defined as "vulnerable" in the hazards literature (e.g., Cutter et al. 2003, Jepson and Colburn 2013, Morrow 1999). According to a literature review conducted by Cutter et al. (2003), individual-level factors influencing vulnerability to natural hazards include: 1) socioeconomic status (income, political power, prestige); 2) gender (women have been found to be more vulnerable); 3) race and ethnicity (minorities have been found to be more vulnerable); 4) age (extremes of the age spectrum, including youth and the elderly, have been found to be more vulnerable); 5) rural vs. urban (rural residents have been found to be more vulnerable to natural disasters); 6) housing status (renters have been found to be more vulnerable); 7) occupation (resource extraction industries have been found to be more vulnerable), 8) family structure (families with a large number of dependents have been found to be more vulnerable); 9) level of education (lower educational attainment has been linked to higher vulnerability); 10) social dependence (individuals that rely on social services for survival have been characterized as more vulnerable); and 11) special needs populations (e.g., infirm, institutionalized, transient, homeless). Of these populations, this socioeconomic profile includes information about racial and ethnic minorities, children and the elderly, individuals with low educational attainment, and individuals with low income levels.

This section seeks to identify individual communities within Coos and Lincoln County, as well as sections of the hub communities in each county, where these populations of concern appear to be concentrated. Tables A-1a through A-1h highlight individual communities and census tracts for which individual variables of interest are found to be greater than one standard deviation above the average for that statistic.[5] These communities and census tracts are described as having "relatively high" measures of these statistics.

Both the average and standard deviation calculations were internally referenced against the other communities in the county or census tracts in the same hub community, and thus do not provide information about how these statistics compare to each other, to the rest of Oregon, or the United States as a whole; for example, a Coos Bay area census tract that is found to have a relatively higher poverty rate than other Coos Bay area census tracts may or may not be relatively higher or lower than poverty rates in other geographies. Totals at the far right of each Table reveal the number of indicators for the particular community or census tracts that were above one standard deviation. Although these numbers do not provide a complete picture of the constructs of interest and may include redundancies, they provide an initial exploration of the dataset and can be used to identify apparent trends for further investigation.

Tables A-1a through A-1d contain information about racial and ethnic minorities. Tables A-1a and A-1c highlight those communities in Coos and Lincoln Counties for which racial or ethnic population percentages are greater than one standard deviation above the average for that statistic for all communities in the respective county. Likewise, Tables A-1b and A-1d highlight those census tracts within the Coos Bay and Yaquina Bay areas for which racial or ethnic population percentages are greater than one standard deviation above the average for that statistic across census tracts in the respective

[5] This is true for all cases except determination of communities in Lincoln County for which a relatively high percentage of the population was made up of American Indians or Alaska Natives (Table A-1c). In this case, the percentage of population of the City of Siletz that was Native was high enough to constitute an outlier. The standard deviation calculation was run a second time without including Siletz, resulting in identification of both Toledo and Lincoln City as communities with relatively high percentages of American Indians or Alaska Natives.

hub community area. Based on these tables, the greatest racial and ethnic diversity in Coos County appears to exist in Bunker Hill CDP and the Cities of Coos Bay and Powers, while the greatest racial and ethnic diversity within the Coos Bay area census tracts appears to be concentrated in tracts 5.03 and 5.04, corresponding with the western portions of the City of Coos Bay, along the western edge of the peninsula (Figure A-1a). In Lincoln County, the greatest racial and ethnic diversity appears to be concentrated in the City of Lincoln City, with substantial diversity also found in the Cities of Newport, Siletz, Toledo, and Waldport. Among Yaquina Bay area census tracts, the greatest racial and ethnic diversity appears to be concentrated in 9509 and 9510, loosely corresponding with the Nye Beach district and adjacent coastline (tract 9510) and the area north of east-west Highway 20 and Nye Beach (tract 9509).

Tables A-1e through A-1h contain information about the distribution of elderly and youth populations, educational attainment, and poverty. Tables A-1e and A-1g highlight those communities in Coos and Lincoln Counties for which identified age, education, and poverty indicators are greater than one standard deviation above the average for that statistic for all communities in the respective county. Likewise, Tables A-1f and A-1h highlight those census tracts within the Coos Bay and Yaquina Bay areas for which identified age, education, and poverty indicators are greater than one standard deviation above the average for that statistic across census tracts in the respective hub community area.

Based on these tables, the highest population percentage of elderly individuals in Coos County appears to be located in the City of Bandon (Table A-1e), while the greatest population percentage of elderly individuals within Coos Bay area census tracts seems to be located in tracts 5.04 and 6 (Table A-1f), which correspond with the areas of the City of Coos Bay that lie west of downtown and the Coos Bay waterfront and stretch all the way to the western edge of the peninsula. In Lincoln County, the City of Yachats appears to be the community with the greatest population percentage made up of elderly individuals (Table A-1g), while the greatest percentages of elderly individuals in Yaquina Bay area census tracts is found in tract 9508 (Table A-1h), which corresponds to the northern portion of the City of Coos Bay and adjacent rural outskirts the run north along the coast and east toward Siletz (Figure A-1b).

In Coos County, the community with the greatest percentage of individuals under the age of 18 is Myrtle Point (Table A-1e), while the Coos Bay area census tracts with the greatest youth percentages are tracts 4 and 5.03 (Table A-1f), which correspond with the northern portion of the City of North Bend (tract 4), and the adjacent northern portion of the City of Coos Bay (tract 5.03). In Lincoln County, the Cities of Siletz and Toledo had the highest percentages of youth in their populations (Table A-1g), while the Yaquina Bay area census tract with the greatest percentage of individuals under the age of 18 was tract 9509 (Table A-1h), which corresponds to the northern portion of the City of Coos Bay and adjacent rural outskirts the run north along the coast and east toward Siletz.

The education statistic included in Tables A-1e through A-1h is the percentage of the population that had achieved less than a high school education. In Coos County, the communities with the highest rates of individuals with less than a high school education in 2010 were Barview and Bunker Hill CDPs (Table A-1e), while the Coos Bay area census tract with the highest rate was tract 5.04 (Table A-1f). Tract 5.04 is the southwestern portion of the City of Coos Bay that lies along the western edge of the peninsula, and while it is adjacent to Barview CDP, it does not appear to overlap. In Lincoln County, the City of Siletz appeared to have a relatively higher rate of individuals who had not completed high school compared to other areas of the county (Table A-1g). No Yaquina Bay area census tracts were singled out as having a particularly higher rate of less than high school education (Table A-1h).

Three poverty statistics are included in Tables A-1e through A-1g: Poverty rates of 1) all ages, 2) individuals under the age of 18 (related children in family households), and 3) individuals over the age of 65. In Coos County, Bunker Hill CDP had relatively higher rates of poverty for all three categories relative to other communities in the county, while the City of Powers was only identified as having a high rate of poverty among individuals over the age of 65 (Table A-1e). Among Coos Bay area census tracts, tract 5.03 was found to have relatively higher rates of poverty in all three categories, while tract 7 had higher rates for all people and for individuals over the age of 65, but not for related children. Finally, tract 3 was found to have a relatively higher rate of poverty for related children, but not for the other two categories (Table A-1f). These census tracts correspond to the northern portion of the City of Coos Bay, west of the City of North Bend (tract 5.03), the Coos Bay waterfront and southern rural outskirts, including Bunker Hill CDP (tract 7), and the southeastern portion of the City of North Bend (tract 3). Lincoln County had far fewer communities or census tracts that were noteworthy for relatively high poverty rates. Lincoln City was shown to have a relatively higher rate of poverty only among related children, while the City of Siletz had a relatively higher rate of poverty among individuals over the age of 65 (Table A-1f). Among Yaquina Bay area census tracts, census tract 9510 was found to have a relatively higher rate of poverty among individuals over age 65, but not for the other two poverty statistics (Table 8). Census tract 9510 loosely corresponds with the Nye Beach distinct and adjacent coastline to the north.

Table A-1a: Communities in Coos County with higher percentage of minority populations in 2010 (> 1 standard deviation [SD]) Source: Census Bureau 2010a

	% Black or African American	% American Indian or Alaska Native	% Asian	% Native Hawaiian or Other Pacific Islander	% Some Other Race	% Hispanic or Latino	**TOTAL**
Bandon	-	-	-	-	-	-	**0**
Barview	-	-	-	-	-	-	**0**
Bunker Hill	X	-	-	-	X	X	**3**
Coos Bay	-	-	-	X	-	-	**1**
Coquille	-	-	-	-	-	-	**0**
Myrtle Point	-	-	-	-	-	-	**0**
North Bend	-	-	-	-	-	-	**0**
Powers	-	X	X	-	-	-	**2**

Table A-1b: Census tracts in the Coos Bay Area with higher percentage of minority populations in 2010 (> 1 SD) Source: Census Bureau 2010a

	% Black or African American	% American Indian or Alaska Native	% Asian	% Native Hawaiian or Other Pacific Islander	% Some Other Race	% Hispanic or Latino	**TOTAL**
Census Tract 3	-	-	-	-	-	-	**0**
Census Tract 4	-	-	-	-	-	-	**0**
Census Tract 5.02	-	-	-	-	-	-	**0**
Census Tract 5.03	X	-	-	-	X	X	**3**
Census Tract 5.04	X	X	X	X	-	-	**4**
Census Tract 6	-	-	-	-	-	-	**0**
Census Tract 7	-	-	-	-	-	-	**0**
Census Tract 8	-	-	-	-	-	-	**0**

Table A-1c: Communities in Lincoln County with higher percentage of minority populations in 2010 (> 1 SD) Source: Census Bureau 2010a

	% Black or African American	% American Indian or Alaska Native	% Asian	% Native Hawaiian or Other Pacific Islander	% Some Other Race	% Hispanic or Latino	**TOTAL**
Depoe Bay	-	-	-	-	-	-	**0**
Lincoln City	-	X	X	-	X	X	**4**
Newport	-	-	-	-	X	X	**2**
Siletz	-	X	X	-	-	-	**2**
Toledo	-	X	X	-	-	-	**2**
Waldport	X	-	-	X	-	-	**2**
Yachats	-	-	-	-	-	-	**0**

Table A-1d: Census tracts in the Yaquina Bay Area with higher percentage of minority populations in 2010 (> 1 SD) Source: Census Bureau 2010a

	% Black or African American	% American Indian or Alaska Native	% Asian	% Native Hawaiian or Other Pacific Islander	% Some Other Race	% Hispanic or Latino	**TOTAL**
Census Tract 9508	-	-	-	-	-	-	**0**
Census Tract 9509	-	X	X	-	-	-	**2**
Census Tract 9510	X	-	-	-	X	X	**3**
Census Tract 9511	-	-	-	-	-	-	**0**
Census Tract 9512	-	-	-	-	-	-	**0**

Table A-1e: Communities in Coos County with higher age, education or poverty statistics in 2010 (> 1 SD) Source: Census Bureau 2010a, 2010b

	% Over Age 65	% Under Age 18	% Less than High School Education	% Poverty (All People)	% Poverty (Related Children)	% Poverty (Over Age 65)	**TOTAL**
Bandon	X	-	-	-	-	-	**1**
Barview	-	-	X	-	-	-	**1**
Bunker Hill	-	-	X	X	X	X	**4**
Coos Bay	-	-	-	-	-	-	**0**
Coquille	-	-	-	-	-	-	**0**
Myrtle Point	-	X	-	-	-	-	**1**
North Bend	-	-	-	-	-	-	**0**
Powers	-	-	-	-	-	X	**1**

Table A-1f: Census tracts in the Coos Bay Area with higher age, education or poverty statistics in 2010 (> 1 SD) Source: Census Bureau 2010a, 2010b

	% Over Age 65	% Under Age 18	% Less than High School Education	% Poverty (All People)	% Poverty (Related Children)	% Poverty (Over Age 65)	**TOTAL**
Census Tract 3	-	-	-	-	X	-	**1**
Census Tract 4	-	X	-	-	-	-	**1**
Census Tract 5.02	-	-	-	-	-	-	**0**
Census Tract 5.03	-	X	-	X	X	X	**4**
Census Tract 5.04	X	-	X	-	-	-	**2**
Census Tract 6	X	-	-	-	-	-	**1**
Census Tract 7	-	-	-	X	-	X	**2**
Census Tract 8	-	-	-	-	-	-	**0**

Table A-1g: Communities in Lincoln County with higher age, education or poverty statistics in 2010 (> 1 SD) Source: Census Bureau 2010a, 2010b

	% Over Age 65	% Under Age 18	% Less than High School Education	% Poverty (All People)	% Poverty (Related Children)	% Poverty (Over Age 65)	TOTAL
Depoe Bay	-	-	-	-	-	-	**0**
Lincoln City	-	-	-	-	X	-	**1**
Newport	-	-	-	-	-	-	**0**
Siletz	-	X	X	-	-	X	**3**
Toledo	-	X	-	-	-	-	**1**
Waldport	-	-	-	-	-	-	**0**
Yachats	X	-	-	-	-	-	**1**

Table A-1h: Census tracts in the Yaquina Bay area with higher age, education or poverty statistics in 2010 (> 1 SD) Source: Census Bureau 2010a, 2010b

	% Over Age 65	% Under Age 18	% Less than High School Education	% Poverty (All People)	% Poverty (Related Children)	% Poverty (Over Age 65)	TOTAL
Census Tract 9508	X	-	-	-	-	-	**1**
Census Tract 9509	-	X	-	-	-	-	**1**
Census Tract 9510	-	-	-	-	-	X	**1**
Census Tract 9511	-	-	-	-	-	-	**0**
Census Tract 9512	-	-	-	-	-	-	**0**

Appendix 2 – Final Code List from First Cycle Coding, with Code Descriptions

1. Purpose

This Appendix presents the final code list that was generated through the process of first cycle coding. The codes in this list were used to guide second cycle coding. The codes are grouped into major categories. The code list contains descriptions of both the code categories and individual codes.

2. Code List

BOEM-USGS HDCC Oregon Renewable Energy
IA M15PG00008
Final Codebook - 9/30/2016

There are two sections of codes
1) Attribute Codes
2) Codes used to respond to study objectives / answering research questions

1) Attribute Codes:	
AFFILIATION	*This group of codes is applied to transcripts to identify entit(ies)/scale(s) represented by respondent. A respondent qualifies for a specific "Affiliation" code if they are an official representative or employee of a type of entity.*
>> Tribal	>> Criteria for application of this code: Tribal staff and leadership, and (or) enrolled Tribal member
>> Federal	>> Criteria for application of this code: Employee of a Federal agency
>> State	>> Criteria for application of this code: Employee of a State agency
>> County	>> Criteria for application of this code: Employee of a county agency

>> Local Governing Body	>> Criteria for application of this code: Employee of the city or other local body, including utility districts and port authorities	
>> Academic	>> Criteria for application of this code: Individual employed at least in part by an academic entity and engaged in research as a primary work duty	**NOTE:** Extension agents are included in this category.
>> Non-profit	>> Criteria for application of this code: Employee of a Non-Profit entity	
>> Industry	>> Criteria for application of this code: Employee of a large company (e.g., seafood processors, large-scale timber)	
>> Small Business	>> Criteria for application of this code: Employee of a small company (e.g., family-owned, small number of employees)	
EXPERTISE - RESOURCE	*This group of codes is applied to identify the expertise possessed by a given respondent related to the three keystone livelihoods – fisheries resources, forest resources, and tourism and recreation.*	
>> Expertise - Fisheries Resources	>> Criteria for application of this code: Respondent makes livelihood directly or indirectly from fisheries resources in Oregon, whether through harvest, management, or natural or social science research	
>> Expertise - Forest Resources	>> Criteria for application of this code: Respondent makes livelihood directly or indirectly from forest resources in Oregon, whether through harvest, management, or natural or social science research	
>> Expertise - Tourism & Recreation	>> Criteria for application of this code: Respondent makes livelihood directly or indirectly from tourism and (or) recreation-related businesses, or natural or social science research about tourism and recreation	
>> Expertise - Coastal Infrastructure	>> Criteria for application of this code: Respondent is involved in the maintenance or design of coastal infrastructure, including port facilities and other structures located in or near the ocean surf zone, including utilities and roadways	
EXPERTISE - GEOGRAPHIC	*This group of codes is applied to identify the expertise possessed by a given respondent related to the two counties under investigation within the study area – Coos and Lincoln Counties, as well as general, regional expertise related to one of the keystone livelihoods.*	

>> Expertise - Coos	>> Code applied to all text spoken by a respondent with direct experience living or working in, or studying, Coos County (can overlap with General and (or) Lincoln County-specific knowledge)	
>> Expertise - General	>> Code applied to all text spoken by a respondent general, statewide knowledge in Oregon related to one of the specific resource/livelihoods or another area of expertise not included in the sampling categories (e.g., climate, social science, community planning) (can overlap with Coos and (or) Lincoln County-specific knowledge)	
>> Expertise - Lincoln	>> Code applied to all text spoken by a respondent with direct experience living or working in, or studying, Lincoln County (can overlap with General and (or) Coos County-specific knowledge)	
GENDER	*This code group is applied to all text, based on the gender of the respondent.*	
>> Male	>> Code applied to all text spoken by a man	
>> Female	>> Code applied to all text spoken by a woman	

2) Codes used to answer study objectives / research questions:

CHANGE QUALITY	*This set of codes is used to label specific qualities of environmental change that may be associated with spatial or temporal cumulative impacts.*	**NOTE**: The name of this code category was previously "Env Change."
>> Duration	>> Code applied to all text in which a respondent discusses changes in the duration of an event (e.g., drought, algae bloom, warm water phase, length of cycles)	**NOTE:** This code can assist in the identification of temporal cumulative impacts.
>> Frequency / Probability / Intermittency	>> Code applied to all text in which a respondent discusses changes in the frequency of an event, including changes in the probability of occurrence (e.g., forest fire risk), and changes in the intermittency (e.g., occurrence of winds sufficient to trigger upwelling)	**NOTE:** This code can assist in the identification of temporal cumulative impacts.

>> Intensity / Extremes	>> Code applied to all text in which a respondent discusses changes in intensity of events or the extremes (variability) on either end of a range of conditions (e.g., changes in temperature or precipitation extremes; increasing intensity of events such as heat waves, drought, or flooding events; increasing wave heights; increasing cyclical extremes)	**NOTE:** This code can assist in the identification of spatial and temporal cumulative impacts.
>> Rate / Pace	>> Code applied to all text in which a respondent discusses changes in the rate at which processes occur (e.g., sea level rise; marsh landward migration; spread of fire; ocean acidification; erosion of coastal infrastructure)	**NOTE:** This code can assist in the identification of temporal cumulative impacts.
>> Scale	>> Code applied to all text in which a respondent discusses changes in the extent or expanse of a specific issue or event (e.g., warm water and algae blooms; larger areas affected by fire; size of hypoxic events; larger-scale disease outbreaks)	**NOTE:** This code can assist in the identification of spatial cumulative impacts.
>> Volume	>> Code applied to all text in which a respondent discusses changes in the volume of material (e.g., volume of precipitation and flood events; volume of material inputs to beaches)	**NOTE:** This code can assist in the identification of spatial and temporal cumulative impacts.
DESCRIPTION	*The "Description" code group is used to code portions of text that describe larger interest areas, including 1) society, 2) economy, 3) culture, 4) institutions, along with several other smaller emergent categories. These codes can be used both to generate more robust descriptions of the study area communities, and can also be used to generate lists of Env, HD, and HDCC codes that relate to the different human dimensions (economy, society, and culture).*	
>> Climate	>> Sub-code applied to all text in which a respondent describes local or regional climate	
>> Cultural	>> Sub-code applied to all text in which a respondent describes local or regional culture	**NOTE**: "Culture" was defined as: "A peoples' identity, beliefs, values, practices, activities, and traditions, as well as symbols and built structures."
>> Ecological / Geography	>> Sub-code is applied to all text in which a respondent describes local or regional ecology and (or) geography (including geology)	

>> Economy	>> Sub-code applied to all text in which a respondent describes local or regional economy	**NOTE**: "Economy" was defined in the study research instrument as: "How people make a living and exchange goods, including their industries and types of employment."
>> Financial	>> Sub-code applied to all text in which a respondent describes finances or funding dynamics that support or limit specific community planning or management actions	
>> Infrastructure	>> Sub-code applied to all text in which a respondent describes local or regional infrastructure	
>> Institutional / Procedural / Regulatory / Legal	>> Sub-code applied to all text in which a respondent discusses rules, regulations, governance processes, and (or) regulatory bodies	
>> Land Ownership	>> Sub-code applied to all text in which a respondent discusses who owns specific properties	
>> Land Use and Management	>> Sub-code applied to text describing past or present management or uses of the terrestrial portion of the study area	
>> Ocean Space Use	>> Sub-code applied to text describing management of ocean space, including historical and present-day management patterns and the rights of distinct user groups. Key issues highlighted with this code include marine reserves and renewable energy leasing	**NOTE:** While fisheries management could be considered a sub-code under Ocean Space Use, it was much more frequently discussed and therefore was given its own code. However, it is important to note the link of fisheries in general to ocean space use.
>> Protest / Advocacy	>> Sub-code applied to all text in which a respondent describes attempts to influence the outcomes of decisions through protest or advocacy	
>> Real Estate	>> Sub-code applied to all text in which a respondent describes local or regional real estate dynamics. This sub-code is highly linked to the codes "Description - Economy" and "Description - Social," but emerged as a salient theme of its own that warranted its own sub-code to track the conversation	

>> Resource Management	>> Sub-code applied to all text that describes the management of a specific resource, livelihood, or the land or seascape. Livelihoods are the same as those referenced in the definition of the "Livelihood" code group. The "Description - Management" code sub-group also tags examples of ecological restoration, conservation, and management of habitat.	
>>>> Fisheries	>>>> Sub-code applied to text describing management of fisheries resources and livelihoods	
>>>> Forest	>>>> Sub-code applied to text describing management of forest resources and livelihoods	
>>>> Habitat	>>>> Sub-code applied to text describing management of habitat	
>>>> Recreation	>>>> Sub-code applied to text describing management of lands and waters used for recreation, as well as management of recreation volume, use types, and interactions between use types, etc	
>>>> Restoration / Rebuilding	>>>> Sub-code applied to text describing ecological restoration, including ecosystem restoration and species rebuilding efforts	
>>>> Rivers	>>>> Sub-code applied to text describing management of rivers, and specifically stream buffers	**NOTE:** Related issues of water supply and stream temperatures are coded separately with "Env - Moisture - Water Supply," HD Issue - Water Supply," "HDCC - Water Supply," and "Env - Temperature - Water - Increase"
>>>> Wildlife	>>>> Sub-code applied to all text describing management of individual wildlife species (non-fisheries)	
>> Social	>> Sub-code applied to all text in which a respondent describes local or regional societal structures, demographics, or other social dynamics	**NOTE**: "Society" was defined as: "How groups of people interact with each other and function (e.g., work, recreate, get around, family life/household unit, etc.). This includes their social institutions (e.g. education, healthcare, governance, housing),

		community structure (e.g. family/household structure, religion, demographics, migration patterns), and is related to their well-being and quality of life."
DRIVER	This small code group was used to identify text in which respondents spoke about causation. When a respondent was certain that the causal chain began with climate-related environmental change, or that the issue may be caused in part by climate-related environmental change, the driver was coded as "Driver - Climate Related." For all other drivers of change, the code "Driver - Other Stressor" was applied.	**NOTE:** These codes were used in a co-occurrence analysis to identify the most frequently mentioned environmental issues and changes (Env) and HDCC effects that were noted to drive HDCC effects, and the most frequently mentioned other, non-climate-related drivers.
>> Climate Related	>> Sub-code applied to text in which a respondent spoke about climate-related drivers of change, including environmental change and intermediate HDCC effects that precipitated additional HDCC effects	
>> Other Stressor	>> Sub-code applied to text in which a respondent spoke about non-climate-related drivers of change, including HD issues and larger description codes such as "Description - Institutional / Procedural / Regulatory / Legal" or "Description - Land Use / Management"	
ENV	*This code group is used to label any environmental issue mentioned by a respondent, regardless of whether it is changing.*	
>> Env - Accretion	>> Sub-code applied to text in which a respondent discusses the addition of sediments (as opposed to erosion)	
>> Env - Acidification	>> Sub-code applied to text in which a respondent discusses the increasing acidity in ocean and coastal waters	
>> Env - Air Quality	>> Sub-code applied to text in which a respondent discusses issues of air quality	
>> Env - Algae Bloom	>> Sub-code applied to text in which a respondent discusses the phenomenon of algae blooms in the ocean	**NOTE:** In a majority of cases, the algae blooms being discussed were "harmful algae blooms" that produce a toxin

		known as domoic acid. Domoic acid was primarily coded as "HDCC - Health - Domoic Acid" and occasionally also coded as "HD Issue - Health - Domoic Acid" when a respondent was clear that algae blooms were not climate-related.
>> Env - Beach / Coastal Erosion	>> Sub-code applied to text in which a respondent discusses the erosion of beaches, bluffs, coastal headlands, and other coastal areas	
>> Env - Change - Abundance	>> Sub-code applied to text in which a respondent discusses changes in abundance of individual species.	**NOTE:** This code is by and large applied to discussion of fish and wildlife species. However, it is also occasionally applied to discussion of shorter-lived plant species (e.g., invasive weeds; berry species; and seaweed).
>> Env - Change - Ecosystem Composition	>> Sub-code applied to text in which a respondent discusses changes in relative abundance and overall species composition within an ecosystem.	
>> Env - Change - Ecosystem Configuration / Geography	>> Sub-code applied to text in which a respondent discusses changes to the substrates and layout of an ecosystem through natural or human processes of alteration (e.g., coastal orientation affected by beach erosion and sea level rise; diking of estuaries to create farmland)	
>> Env - Change - Health / Survival	>> Sub-code applied to text in which a respondent discusses changes in relative health and survival of species within an ecosystem.	
>> Env - Change - Location	>> Sub-code applied to text in which a respondent discusses changes in the location of species or materials (e.g., shifting river mouths; changing location of fish species such as tuna, hake, and shrimp).	
>> Env - Change - Material Inputs	>> Sub-code applied to text in which a respondent discusses changes in the flow of materials into or out of a system (e.g., sediment flows from rivers to coastal systems).	

>> Env - Change - Moisture	>> Sub-code applied to text in which a respondent discusses changes in moisture levels, including precipitation, glacial snowmelt patterns, fog patterns, etc.
>> Env - Change - Seasonality	>> Sub-code applied to text in which a respondent discusses changes in seasons, including phenology of flowering plants, the emergence of pollinators, or migration patterns of species.
>> Env - Change - Temperature	>> Sub-code applied to text in which a respondent discusses changes in temperature patterns, including changes in seasonal temperature patterns and extreme temperatures for air and water.
>> Env - Die Off	>> Sub-code applied to text in which a respondent discusses a die off event for a species. This code is primarily applied to examples of fish kills, but is also applied for other species, including birds, marine mammals, and marine invertebrates.
>> Env - Drought	>> Sub-code applied to text in which a respondent discusses a drought event. It co-occurs with moisture codes, but is distinct in that it identifies a specific extreme weather event.
>> Env - Earthquake	>> Sub-code applied to text in which a respondent discusses the risk of an earthquake along the Pacific coast.
>> Env - El Niño	>> Sub-code applied to text in which a respondent discusses the ENSO cycle in the Pacific Ocean.
>> Env - Flooding	>> Sub-code applied to text in which a respondent discusses a flooding event. It co-occurs with moisture codes around increasing precipitation and changing seasonality of precipitation, but is distinct in that it identifies a specific extreme weather event.
>> Env - Forest Fire	>> Sub-code applied to text in which a respondent discusses changing occurrence and (or) risk of forest fire in coastal Oregon, and Oregon more generally.
>> Env - Habitat Loss	>> Sub-code applied to text in which a respondent discusses loss of habitat in the study area.

>> Env - Heat Wave	>> Sub-code applied to text in which a respondent discusses a heat wave event. It co-occurs with temperature codes related to increases in air temperature, but is distinct in that it identifies a specific extreme weather event.
>> Env - Hypoxia	>> Sub-code applied to text in which a respondent discusses a hypoxic event in the ocean.
>> Env - Impact on Food Web	>> Sub-code applied to text in which a respondent discusses changes to the food web, including impacts to plankton and forage fish that form the foundation of the ocean and coastal food web.
>> Env - Inversion (temp)	>> Sub-code applied to text in which a respondent discusses temperature inversions that sometimes occur in the Willamette Valley.
>> Env - King Tides	>> Sub-code applied to text in which a respondent discusses the phenomenon of "King Tides," in which the highest tides are perceived to be higher than historical highs.
>> Env - Landslide / Land Instability	>> Sub-code applied to text in which a respondent discusses instability of land, including landslide events.
>> Env - Marsh Landward Migration	>> Sub-code applied to text in which a respondent discusses the phenomenon of landward migration of marshes in concert with sea level rise.
>> Env - Moisture - Fog Patterns	>> Sub-code applied to text in which a respondent discusses changes in fog patterns in coastal Oregon.
>> Env - Moisture - General	>> Sub-code applied to text in which a respondent discusses moisture levels generally, without specifying what form of moisture.
>> Env - Moisture - Glaciers	>> Sub-code applied to text in which a respondent discusses changes in the extent of glaciers in the Cascade Mountain range, and associated issues of changing glacial snowmelt.
>> Env - Moisture - More rain less snow	>> Sub-code applied to text in which a respondent discusses changes in precipitation that result from warmer temperatures, in which a greater proportion of the precipitation falls as rain and less as snow.

>> Env - Moisture - Precipitation - General	>> Sub-code applied to text in which a respondent discusses precipitation generally, without specifying a change in patterns or levels.
>> Env - Moisture - Precipitation decrease	>> Sub-code applied to text in which a respondent discusses decreases in precipitation levels. Most often they mention that precipitation decreases during summer months.
>> Env - Moisture - Precipitation increase	>> Sub-code applied to text in which a respondent discusses increases in precipitation levels. Most often they mention that precipitation increases during winter months.
>> Env - Moisture - Precipitation Seasonality	>> Sub-code applied to text in which a respondent explains that precipitation levels are changing throughout the year, including increases in intensity and volume of winter precipitation events, and decreases in volume of summer rainfall.
>> Env - Moisture - Seasonality - Decrease in Cascades Snowpack	>> Sub-code applied to text in which a respondent explains discusses decreased snowpack in the Cascade Mountains. This code is linked to the code, "Env - Moisture - More rain less snow," but is more specific in that respondents directly mention snowpack.
>> Env - Moisture - Water Supply	>> Sub-code applied to text in which a respondent discusses lack of sufficient water for ecological processes such as fish health in streams or increased stress on trees or other vegetation.
>> Env - Ocean Currents / Circulation	>> Sub-code applied to text in which a respondent discusses patterns of ocean currents, including general descriptions and discussion of changing patterns.
>> Env - Pathogens (Disease/Pests)	>> Sub-code applied to text in which a respondent discusses issues and changes associated with diseases or pests affecting plants and animals in Oregon.
>> Env - PDO	>> Sub-code applied to text in which a respondent discusses the PDO cycle in the Pacific Ocean.
>> Env - Physical Effects - General	>> Sub-code applied to text in which a respondent discusses physical effects on plants and animals generally, without specifying an effect.

>> Env - Physical Effects - Physiological Change	>> Sub-code applied to text in which a respondent discusses a specific physiological effect in a plant or animal species (e.g., noticeable changes in the size of a fish; impacts of acidification on organisms with calcium shells).
>> Env - Physical Effects - Productivity	>> Sub-code applied to text in which a respondent discusses changes in growth rates. It is most often applied to discussion of trees harvested for timber, but is also occasionally applied to discussion of changes in the productivity of fisheries.
>> Env - Physical Effects - Stress	>> Sub-code applied to text in which a respondent discusses stress to animal or plant species (e.g., drought stress on tree species; water temperature increasing levels of stress for Dungeness crab).
>> Env - Pollination	>> Sub-code applied to text in which a respondent discusses impacts to pollination, including whether changes in plant phenology may impact success of pollination.
>> Env - Pollution	>> Sub-code applied to text in which a respondent discusses pollution issues, including air quality issues associated with smoke and water quality issues associated with dumping of wastes or chemicals.
>> Env - Sea Level Rise	>> Sub-code applied to text in which a respondent discusses the process of relative sea level rise (RSLR).
>> Env - Species Shifts (Range/Composition)	>> Sub-code applied to text in which a respondent discusses changes in the range or distribution of individual species, which affects the species composition of coastal Oregon.
>> Env - Sea Star Wasting Disease	>> Sub-code applied to text in which a respondent discusses the phenomenon of sea star wasting disease, a viral malady that resulted in the collapse of sea stars all along the West Coast in recent years. This code is related to "Env - Pathogens (Disease/Pests) but is distinctive in that it identifies a specific event.
>> Env - Storms	>> Sub-code applied to text in which a respondent discusses storm activity. It may simply refer to the occurrence of an individual storm, and also is applied to text that discusses changes in frequency or intensity of storms.

>> Env - Tectonic Uplift / Subsidence	>> Sub-code applied to text in which a respondent discusses geological processes associated with the subduction of the Pacific plate under the North American plate. One respondent also discussed subsidence in areas of Coos County.
>> Env - Temperature - Air - General	>> Sub-code applied to text in which a respondent discusses air temperature generally, without specifying a change.
>> Env - Temperature - Air - Decrease	>> Sub-code applied to text in which a respondent discusses decreases in air temperature (e.g., colder temperatures along the coast compared to inland as a result of upwelling; colder winter temps in inland areas of Oregon)
>> Env - Temperature - Air - Increase	>> Sub-code applied to text in which a respondent discusses increases in air temperatures.
>> Env - Temperature - Air - Shift/Differential	>> Sub-code applied to text in which a respondent discusses the temperature differential between coastal Oregon and inland areas of Oregon.
>> Env - Temperature - Seasonal Shifts	>> Sub-code applied to text in which a respondent explains that temperature patterns are changing throughout the year.
>> Env - Temperature - Water - General	>> Sub-code applied to text in which a respondent discusses air temperature generally, without specifying a change.
>> Env - Temperature - Water - Decrease	>> Sub-code applied to text in which a respondent discusses decreases in water temperatures as part of cyclical processes.
>> Env - Temperature - Water - Increase	>> Sub-code applied to text in which a respondent discusses increases in water temperatures as part of both cyclical processes and climate-related long-term trends (oceans and rivers).

>> Env - Temperature - Water - Shift / Differential	>> Sub-code applied to text in which a respondent specifically discusses separation of warmer water offshore (the blob) from colder coastal waters associated with upwelling.	
>> Env - The Blob	>> Sub-code applied to text in which a respondent discusses the persistent warm water area in the Pacific Ocean that persisted through March, 2016. It is associated with other Env - Temperature - Water codes, but is distinct in that it refers to a specific event.	
>> Env - Tsunami	>> Sub-code applied to text in which a respondent discusses the risk of a tsunami along the Pacific coast in association with a large earthquake.	
>> Env - Upwelling	>> Sub-code applied to text in which a respondent discusses upwelling patterns along the coast of Oregon, including general descriptions and discussion of changes in this pattern. Changes in upwelling are often discussed in association with changing wind patterns (Env - Wind Patterns).	
>> Env - Water Quality	>> Sub-code applied to text in which a respondent discusses issues of water quality.	
>> Env - Wave Run-up / Storm Surge / Wave Heights	>> Sub-code applied to text in which a respondent discusses issues associated with increasing wave heights and storm surges in association with storm events (Env - Storms).	
>> Env - Wind Patterns	>> Sub-code applied to text in which a respondent discusses wind patterns in coastal Oregon, including general descriptions and discussion of changing patterns.	
HD Effect	This set of codes is applied when a respondent discusses an "impact/effect" to one or more HD domains that is not known or believed to be connected to climate change. HD domains include society, culture,	***NOTE:*** *As noted in the methods section, decisions about whether to apply the "HD Issue" version of these codes, the "HDCC" version, or both versions to the same quotation depended on the level of certainty the respondent displayed in their discussion of drivers. If they were confident that a particular issue or change was NOT driven by climate change, the quotation was coded as "HD Issue" only. If they were confident that the issue or change WAS driven by climate change, at least in part, the quotations was coded as "HDCC." If they were uncertain about the driver(s), the quotation was coded as both "HD Issue" and "HDCC."*

	economy, and institutional/regulatory. Because these codes identify human dimensions impacts, but are not associated with climate change as a driver, these codes can help build a list of "other stressors" acting on the communities in the study area.	
>> HD Effect - Access to Resources	>> Sub-code applied to all text discussing changes in access to resources that the respondent links to non-climate-related drivers (e.g., changes in access to timber and non-timber forest products, fisheries resources, and recreational access; fishing regulation changes; changes in ocean space use, etc.).	
>> HD Effect - Adaptation/Transformation	>> This HD sub-code group is applied to all text in which a respondent discusses examples of adaptations (or transformations) in response to stressors or drivers not associated with climate changes. When responding to Env Change and other stressors (e.g., social, cultural, economic, and (or) institutional change), actors in a social-ecological system may alter their approaches, strategies, infrastructure, behaviors, and even cultural models, beliefs, and values in order to enhance their own resilience through adaptation or transformation. "Adaptation" can be defined as learning, combining experience and knowledge, and adjusting responses to changing external drivers and internal processes in order to continue developing within the current stability domain or basin of attraction (Folke et al. 2006). "Transformation" has been defined as "the capacity to create untried beginnings from which to evolve a new way of living when existing ecological, economic, or social structures become untenable" (Walker et al., 2004, p. 5).	**NOTES:** (**Note 1**: The line between adaptation (retaining system structure) and transformation (fundamental alteration of a system) is fuzzy (Walker et al., 2004, pg. 2), and it is beyond the scope of the present study to conclusively determine which examples of alterations in response to stressors constitute adaptation vs. transformation.) This code is applied to all text in which a respondent discusses such shifts in response to stressors not known or believed to be associated with climate changes.) (**Note 2**: Whether or not the stressor is coded as HD (non-climate-related) or HDCC (climate-related) depends on the

		opinion, knowledge, and perspective of the respondent.)
>>>> Adaptation / Transformation - General	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. The "general" sub-code is applied to examples that are unspecified, or do not fit in one of the other specific Adaptation/Transformation categories.	
>>>> Adaptation / Transformation – Government /Management - Diversification	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. "Government/Management" codes are applied to discussion of changes in a policy or corporate business strategy, as opposed to individual livelihood choices. This specific code is applied to discussion of policies or corporate business strategies that pursue diversification (e.g., economic diversification within a community; species diversity within a tree plantation).	
>>>> Adaptation / Transformation - Livelihood - Diversification	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. "Livelihood" codes are applied to discussion of changes in an individual's business strategy, as opposed to corporate management changes. This specific code is applied to discussion of livelihood diversification.	
>>>> Adaptation / Transformation - Livelihood - Location Switching	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. "Livelihood" codes are applied to discussion of changes in an individual's business strategy, as opposed to corporate management changes. This specific code is applied to discussion of switching the location of livelihood activities.	
>>>> Adaptation / Transformation - Livelihood - Species Switching	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. "Livelihood" codes are applied to discussion of changes in an individual's business strategy, as opposed to corporate management changes. This specific code is	

	applied to discussion of switching the species targeted by a livelihood activity.
>>>> Adaptation / Transformation - Livelihood - Leaving Industry	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. "Livelihood" codes are applied to discussion of changes in an individual's business strategy, as opposed to corporate management changes. This specific code is applied to discussion of ceasing a specific livelihood activity.
>>>> Adaptation / Transformation - Personal Behavior/Habits	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. "Personal Behavior/Habits" codes are applied to discussion of changes in an individual's personal behaviors, other than their livelihood decisions. This code is applied to discussion of personal shifts, with the exception of changing the location of activities, which is captured by an additional specific code.
>>>> Adaptation / Transformation - Personal Behavior/Habits - Location Switching	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. "Personal Behavior/Habits" codes are applied to discussion of changes in an individual's personal behaviors, other than their livelihood decisions. This code is applied to discussion shifts in the location of non-livelihood activities -- primarily recreational activities.
>>>> Adaptation / Transformation - Personal Behavior/Habits - Seasonal Shifts	>>>> The HD Issue - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior resulting from drivers OTHER THAN climate change. "Personal Behavior/Habits" codes are applied to discussion of changes in an individual's personal behaviors, other than their livelihood decisions. This code is applied to discussion shifts in the timing and seasonality of non-livelihood activities -- primarily recreational activities.
>> HD Effect - Affect Price of Product	>> Sub-code applied to text discussing price effects that the respondent links to non-climate-related drivers.

>> HD Effect - Beach Loss / Coastal Erosion Threatens Homes	>> Sub-code applied to text discussing coastal erosion impacts on residential structures that the respondent links to non-climate-related processes (i.e., natural erosion processes rather than climate change influenced erosion).
>> HD Effect - Commercial Closure (or Delay)	>> Sub-code applied to text discussing commercial fisheries closures or delays that the respondent links to non-climate-related drivers.
>> HD Effect - Crowding	>> Sub-code applied to text discussing crowding issues (e.g., higher volumes of people traveling to study area communities; higher numbers of fishing boats in certain area) that the respondent links to non-climate-related drivers.
>> HD Effect - Cultural Impact - General	>> Sub-code applied to text discussing unspecified cultural impacts in the study area that the respondent links to non-climate-related drivers.
>> HD Effect - Cultural Resource Impacts	>> Sub-code applied to text discussing impacts to cultural resources (e.g., Dungeness crab, salmon, non-timber forest products utilized by Tribes) that the respondent links to non-climate-related drivers.
>> HD Effect - Cultural Shift	>> Sub-code applied to text discussing cultural shifts (e.g., changes in values, loss or erosion of cultural traditions or ways of life, etc.) that the respondent links to non-climate-related drivers.
>> HD Effect - Demographic Shift	>> Sub-code applied to text discussing changing demographics within the study area population that the respondent links to non-climate-related drivers.
>>>> Demographics - Graying Population	>>>> Sub-code applied to text discussing demographic shifts toward an older population that the respondent links to non-climate-related drivers.
>>>> Demographics - Increasing Population	>>>> Sub-code applied to text discussing increasing population in the study area that respondents link to non-climate-related drivers.

>>>> Demographics - Shifting (General)	>>>> This demographic shift code refers to all other non-climate-related changes in demographics, other than "HD Effect - Demographics - Graying Population"."
>> HD Effect - Directing Research Dollars	>> Sub-code applied to text discussing (non-climate-related) factors that influence decisions regarding what topics should receive research funding.
>> HD Effect - Econ - Corporate consolidation	>> Sub-code applied to text discussing corporate consolidation processes (e.g., vertical integration of timber and fishing operations) that the respondent links to non-climate-related drivers.
>> HD Effect - Econ - Disposable Income	>> Sub-code applied to text discussing changes in the level of disposable income available in study communities, an issue that was only linked to non-climate-related drivers.
>> HD Effect - Econ - Transfer Payments	>> Sub-code applied to text discussing the (non-climate-related) increasing prevalence of transfer payments as a primary income source in study communities.
>> HD Effect - Econ - Upswing	>> Sub-code applied to text discussing (non-climate-related) increases in economic prosperity in the study area.
>> HD Effect - Economic Decline	>> Sub-code applied to text discussing (non-climate-related) decreases in economic prosperity in the study area.
>> HD Effect - Economic Impact - General	>> Sub-code applied to text discussing unspecified, or rarely mentioned, economic impacts in the study area that the respondent links to non-climate-related drivers.
>> HD Effect - Economic Reorganization	>> Sub-code applied to text discussing (non-climate-related) economic reorganization processes in the study area (i.e., shifting prominence/importance of industries in the study area).
>> HD Effect - Educational Changes	>> Sub-code applied to text discussing (non-climate-related) educational changes in the study area (e.g., changing levels of education, educational requirements, educational opportunity).

>> HD Effect - Emergency Services Stressed	>> Sub-code applied to text discussing stresses on emergency services (e.g., fire response) that the respondent links to non-climate-related drivers.	
>> HD Effect - Employment Concerns (Unemployment / Layoffs / Low Wages / Lack of Workers)	>> Sub-code applied to text discussing employment concerns that the respondent links to non-climate-related drivers. "Concerns" is interpreted broadly, including concern about the availability of employment with adequate wages (low wages), the availability of employment generally (unemployment, layoffs), and concern on the part of employers regarding the availability of skilled and hard-working employees (lack of workers).	
>> HD Effect - Energy Provision / Energy Demand	>> Sub-code applied to text discussing impacts, or changes in energy demand or provision that the respondent links to non-climate-related drivers.	
>> HD Effect - Erosion / Depreciation of Infrastructure	>> Sub-code applied to text discussing erosion and depreciation of infrastructure that the respondent links to non-climate-related processes (i.e., natural rates of erosion and depreciation of port facilities or other coastal infrastructure exposed to the surf zone, rather than climate influenced erosion/depreciation).	
>> HD Effect - Facility / Infrastructure Relocation	>> Sub-code applied to text discussing instances of the relocation of facilities or infrastructure that the respondent links to non-climate-related drivers (i.e., moving roadways or facilities inland away from naturally eroding shorelines, as opposed to shorelines eroding as a result of climate changes).	
>> HD Effect - Facility Upgrade / Renovation	>> Sub-code applied to text discussing instances of the facility upgrades and renovations that the respondent links to non-climate-related drivers.	
>> HD Effect - Fisheries Economic Impact	>> Sub-code applied to text discussing economic impacts to individual fishermen or the fishing industry broadly that respondents link to non-climate-related drivers (e.g., loss of revenue due to commercial closures or decreases in abundance).	**Note:** Respondents often speak about "impacts to fisheries" generally, including changing fishing opportunity and species abundance. The researcher was not always able to directly ask for clarification regarding the type of

		impact (economic, social, or cultural) a respondent was speaking about. However, when asked respondents were typically thinking of economic impacts arising from the changes in fisheries. Thus, this code is applied when respondents discuss general impact to commercially harvested species in Oregon, including salmon, Dungeness crab, shrimp, hake, and groundfish. In contrast, social or cultural impacts associated with declining fisheries were identified when respondents spoke about effects on intra-community relationships and norms, or on traditions and customs impacted by changes in fisheries.
>> HD Effect - Garbage / Litter	>> Sub-code applied to text discussing changes in quantities of garbage or litter in the study are that the respondent links to non-climate-related drivers.	
>> HD Effect - Health	>> This set of sub-codes is applied to text discussing health-related impacts that respondents link to non-climate-drivers.	
>>>> Health - Air Quality	>> Sub-code applied to text discussing changes in air quality, and associated health concerns, that the respondent links to non-climate-related drivers (i.e., the air quality concern is not perceived to be driven by climate change).	
>>>> Health - Domoic Acid	>>>> Sub-code applied to text discussing increased levels of domoic acid in shellfish, and associated health concerns, that the respondent links to non-climate-related drivers (i.e., the cause of increased levels is not perceived to be driven by climate change).	
>>>> Health - Pollution	>>>> Sub-code applied to text discussing pollution in the environment, and associated health concerns, that the respondent links to non-	

	climate-related drivers (e.g., mercury in fish, radiation from Japan, herbicide levels on subsistence foods).
>>>> Health - Water Quality	>>>> Sub-code applied to text discussing changes in water quality, and associated health concerns, that the respondent links to non-climate-related drivers (i.e., the water quality concern is not perceived to be driven by climate change).
>> HD Effect - Human-Wildlife Conflict	>> Sub-code applied to text discussing human-wildlife conflicts that respondents link to non-climate-related drivers (e.g., interactions between all-terrain vehicle (ATV) drivers and marine mammals in the Coastal Dunes).
>> HD Effect - Impact on Effectiveness of Restoration / Remediation / Preservation	>> Sub-code applied to text discussing factors that get in the way of effective restoration, remediation, or preservation efforts that the respondent links to non-climate-related drivers (e.g., natural cycles or ecological processes that counteract management efforts).
>> HD Effect - Impact on Environmental Regulation / Policy	>> Sub-code applied to text discussing (non-climate-related) factors that lead to changes in environmental regulations or policies (e.g., problems arising from non-climate change sources require regulation, such as overfishing, need to protect spawning habitat with riparian buffers, non-climate-related justifications for marine reserves).
>> HD Effect - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	>> Sub-code applied to text discussing impacts on existing infrastructure, and impacts to the possibility of new infrastructure development, that the respondent links to non-climate-related processes (i.e., natural erosion processes rather than climate change influenced erosion).
>> HD Effect - Impact on Research Topics	>> Sub-code applied to text discussing research needs that arise from issues or changes that respondents link to non-climate-related drivers (e.g., allocation disputes that require economic analysis to achieve resolution).

>> HD Effect - Impacts Appeal of Oregon	>> Sub-code applied to text discussing shifts in the attractiveness of the study area as a destination for tourism or permanent retirement that respondents link to non-climate-related drivers (e.g., Oregon has a mild climate relative to other parts of the world, independent of whether climate change is occurring).
>> HD Effect - Impacts Aquaculture Industry (Economic)	>> Sub-code applied to text discussing economic impacts to the aquaculture industry that respondents link to non-climate-related drivers (e.g., respondents who are uncertain whether ocean acidification is to blame for the failures of oyster spat).
>> HD Effect - Increasing SS Research Pressure	>> Sub-code applied to text discussing (non-climate-related) drivers of increasing social science research pressure in the study area (e.g., increasing interest in social science research in general; proximity to Oregon State University).
>> HD Effect - Insurance Costs	>> Sub-code applied to text discussing changes in insurance costs that respondents link to non-climate-related drivers.
>> HD Effect - Intra-Community Conflict	>> Sub-code applied to text discussing examples of conflict within study area communities that respondents associate with non-climate-related drivers.
>> HD Effect - Investment / Divestment	>> Sub-code applied to text discussing patterns in investment and divestment in study area industries and infrastructure that respondents link to non-climate-related drivers.
>> HD Effect - Maintenance Requirements	>> Sub-code applied to text discussing changes in maintenance requirements in study area industries and infrastructure that respondents link to non-climate-related drivers.
>> HD Effect - Modernization	>> Sub-code applied to text discussing societal changes that respondents characterize as "modernization" that are not linked to climate-related drivers (e.g., changes in technology, mobility, moves away from traditional diets).
>> HD Effect – Migration and Visitation	>> Sub-code applied to text discussing changes in patterns of movement of people to and from the study area that respondents link to non-climate-related drivers (e.g., patterns influenced by changes in

	disposable income; increased retirement on the coast that would be happening regardless of changing climate, etc.)
>> HD Effect - Need for Adaptation / Policy Reform	>> Sub-code applied to text discussing (non-climate-related) human dimensions issues that respondents feel deserve a policy response but have not yet been addressed.
>> HD Effect - New Industry	>> Sub-code applied to text discussing the emergence of new industries that respondents link to non-climate-related drivers (e.g., relocation of NOAA facilities to Newport bringing research and resource management employment; discussions of new industries being located in Coos Bay such as the liquefied natural gas [LNG] plant or renewable energy).
>> HD Effect - Personal Costs/Benefits	>> Sub-code applied to text discussing (non-climate-related) personal costs that respondents discuss (e.g., fishermen increasingly having to give up fishing time to become engaged in policy processes).
>> HD Effect - Political Engagement	>> Sub-code applied to text discussing instances when individuals or groups become engaged in the political process through protest or lobbying as a result of non-climate-related concerns (e.g., disagreement with forest-related rules and regulations).
>> HD Effect - Population Increase	>> Sub-code applied to text discussing increasing population in the study area that respondents link to non-climate-related drivers.
>> HD Effect - Port - Management Responsibilities	>> Sub-code applied to text discussing increased challenges for port management that respondent links to non-climate-related drivers.
>> HD Effect - Port Consolidation / Aggregation	>> Sub-code applied to text discussing the (perceived non-climate-related) loss of ports along the Pacific coast and the resulting consolidation of port infrastructure in fewer locations.
>> HD Effect - Poverty	>> Sub-code applied to text discussing changes in poverty rates in the study area that respondents link to non-climate-related drivers.
>> HD Effect - Property Rights	>> Sub-code applied to text discussing threats/impacts to property rights that respondents link to non-climate-related drivers.

>> HD Effect - Property Value	>> Sub-code applied to text discussing changes in property values that respondents link to non-climate-related drivers.
>> HD Effect - Psychological Stress	>> Sub-code applied to text discussing psychological stress experienced by individuals in the study area as a result of non-climate-related risks (e.g., threat of earthquake / tsunami).
>> HD Effect - Public Safety	>> Sub-code applied to text discussing changes in public safety in the study area that respondents link to non-climate-related drivers.
>> HD Effect - Quality of Life	>> Sub-code applied to text discussing changes in quality of life in the study area that respondents link to non-climate-related drivers.
>> HD Effect - Recreation	>> This set of sub-codes is applied to text discussing impacts on recreation that respondents link to non-climate-related drivers.
>>>> Recreation - Beach Access	>>>> Sub-code applied to text discussing changes in access to the beach that the respondent links to non-climate-related drivers (e.g., natural beach erosion processes rather than climate change influenced erosion patterns).
>>>> Recreation - General Impacts	>>>> "General" sub-code applied to unspecified impacts on recreation perceived to be linked to non-climate-related drivers
>>>> Recreation - Fish / Shellfish Closure	>>>> Sub-code applied to closure of fish or shellfish fisheries, in association with red tide / domoic acid issues that are not perceived to be linked to climate change.
>>>> Recreation - Hunting	>>>> Sub-code applied to impacts on hunting activity resulting from issues not perceived to be linked to climate change.
>>>> Recreation - Impacts on Winter Recreation	>>>> Sub-code applied to discussion of non-climate-related impacts on winter recreation (e.g., changes in snowpack or winter temperatures that are perceived to be part of natural cycles rather than driven by long-term climate change).
>>>> Recreation - Sport Fishing	>>>> Sub-code applied to discussion of impacts to sport fishing linked to non-climate-related drivers (e.g., changes in regulations, changes in abundance related to natural cycles).

>>>> Recreation - Sunbathing / Warm Beach Activities	>>>> Sub-code applied to discussion of impacts on access to sunbathing / warm beach activities perceived to originate from non-climate-related drivers (e.g., longer, warmer summers resulting from natural cycles rather than long-term climate change).
>> HD Effect - Regulatory Conflict	>> Sub-code applied to text discussing examples of conflict between communities and regulators that respondents associate with non-climate-related drivers.
>> HD Effect - Risk	>> Sub-code applied to text discussing changing risk that respondents associate with non-climate drivers (e.g., changing risk of large-scale forest fire in the Coast Range due to drought, when respondents are uncertain whether the drought is associated with long-term climate change).
>> HD Effect - Second Homes	>> Sub-code applied to text discussing the increasing prevalence of second homes in the study area, and particularly in Lincoln County, that respondents link to non-climate-related drivers.
>> HD Effect - Sense of Place / Special Connection	>> Sub-code applied to text discussing the changes in sense of place and connection to the natural environment of the study area that respondents link to non-climate-related drivers (e.g., changes in livelihoods that remove people from direct interaction with the land).
>> HD Effect - Shifting Attitudes	>> Sub-code applied to text discussing changes in attitudes within the study area population that the respondent links to non-climate-related drivers.
>> HD Effect - Shifting Perceptions	>> Sub-code applied to text discussing changes in perceptions within the study area population that the respondent links to non-climate-related drivers.
>> HD Effect - Shifting Values	>> Sub-code applied to text discussing changes in values within the study area population that the respondent links to non-climate-related drivers.
>> HD Effect - Social Ills	>> Sub-code applied to text discussing presence of social ills in the study area that respondents link to non-climate-related drivers (e.g., drug abuse, domestic violence).

>> HD Effect - Social impact - General	>> Sub-code applied to text discussing unspecified, or single occurrences of specific social impacts in the study area that the respondent links to non-climate-related drivers.
>> HD Effect - Strain on Infrastructure & Services	>> Sub-code applied to text discussing stresses on infrastructure and community services that respondents link to non-climate-related drivers (e.g., increasing population not related to climate change stresses roadways and water supply).
>> HD Effect - Subsistence / Local Foods Impacts	>> Sub-code applied to text discussing (non-climate-related) impacts on subsistence food resources (e.g., loss of access to areas where subsistence foods are harvested; changes in health/survival of species due to non-climate-related processes).
>> HD Effect - Timber	>> This set of sub-codes is applied to text discussing impacts on the timber industry that respondents link to non-climate-related drivers.
>>>> Timber - Impact on Revenues / Productivity	>>>> Sub-code applied to text discussing economic impacts to timber businesses due to decreasing productivity of timber stands or other factors that respondents link to non-climate-related drivers.
>>>> Timber - Management Responsibilities	>>>> Sub-code applied to text discussing increased challenges for timber managers (public and private) that respondent links to non-climate-related drivers.
>> HD Effect - Tourism & Rec Businesses impacted	>> Set of sub-codes applied to text discussing impacts on tourism and recreation businesses that respondents link to non-climate-related drivers.
>>>> Tourism & Rec Businesses impacted - General	>>>> "General" sub-code is applied when a respondent discusses unspecified impacts to the tourism and recreation industry that he/she links to non-climate-related drivers.
>>>> Tourism & Rec Businesses impacted - Decrease	>>>> Sub-code applied when a respondent discusses decreases in revenues or activity in tourism and recreation that he/she links to non-climate-related drivers.
>>>> Tourism & Rec Businesses impacted - Increase	>>>> Sub-code applied when a respondent discusses increases in revenues or activity in tourism and recreation that he/she links to non-climate-related drivers.

>> HD Effect - Traffic	>> Sub-code applied to text discussing changes in volume of vehicle traffic (e.g., higher volumes of cars on roadways) that the respondent links to non-climate-related drivers.	
>> HD Effect - Water Supply	>> Sub-code applied to text discussing changes in the availability of water in the study area that the respondent links to non-climate-related drivers (e.g., natural drought cycles rather than drought influenced by climate change trends).	
>> HD Effect - Water Usage	>> Sub-code applied to text discussing changes in the level of demand for water that the respondent links to non-climate-related drivers (e.g., population growth that is not driven by climate change).	
HDCC EFFECT	*This set of codes is applied when a respondent discusses a climate-related change or "impact/effect" to one or more HDCC domains, including society, culture, economy, and institutional/regulatory. These codes can help build a list of climate-related stressors acting on the communities in the study area.*	***NOTE:** As noted in the methods section, decisions about whether to apply the "HD Issue" version of these codes, the "HDCC" version, or both versions to the same quotation depended on the level of certainty the respondent displayed in their discussion of drivers. If they were confident that a particular issue or change was NOT driven by climate change, the quotation was coded as "HD Issue" only. If they were confident that the issue or change WAS driven by climate change, at least in part, the quotations was coded as "HDCC." If they were uncertain about the driver(s), the quotation was coded as both "HD Issue" and "HDCC."*
>> HDCC Effect - Access to Resources	>> Sub-code applied to all text discussing changes in access to resources that the respondent links to climate-related drivers (e.g., changes in access to timber and non-timber forest products, fisheries resources, and recreational access; regulatory changes prompted by policy response to climate change; changes in ocean space use prompted by policy response to climate change, etc.).	

>> HDCC Effect - Adaptation/Transformation	>> This group of HDCC Effect sub-codes is applied to all text in which a respondent discusses shifts that arise at least in part as a result of climate-related stressors or drivers. In response to Env Change and other stressors (e.g., social, cultural, economic, and (or) institutional change), actors in a social-ecological system may alter their approaches, strategies, infrastructure, behaviors, and even cultural models, beliefs, and values in order to enhance their own resilience through adaptation or transformation. "Adaptation" can be defined as learning, combining experience and knowledge, and adjusting responses to changing external drivers and internal processes in order to continue developing within the current stability domain or basin of attraction (Folke et al. 2006). "Transformation" has been defined as "the capacity to create untried beginnings from which to evolve a new way of living when existing ecological, economic, or social structures become untenable" (Walker et al., 2004, p. 5).	**NOTES:** (**Note 1**: The line between adaptation (retaining system structure) and transformation (fundamental alteration of a system) is fuzzy (Walker et al., 2004, pg. 2), and it is beyond the scope of the present study to conclusively determine which examples of alterations in response to stressors constitute adaptation vs. transformation.) (**Note 2**: Whether or not the adaptation is coded as HD (non-climate-related) or HDCC (climate-related) depends on the opinion, knowledge, and perspective of the respondent.)
>>>> Adaptation / Transformation - General	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-related drivers. The "general" sub-code is applied to examples that are unspecified, or do not fit in one of the other specific Adaptation/Transformation categories.	
>>>> Adaptation / Transformation - Management - Diversification	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-related drivers. "Government/Management" codes are applied to discussion of changes in a policy or corporate business strategy, as opposed to individual livelihood choices. This specific code is applied to discussion of policies or corporate business strategies that pursue diversification (e.g., economic diversification within a community; species diversity within a tree plantation).	
>>>> Adaptation / Transformation -	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-	

Management - Location Switching	related drivers. "Government/Management" codes are applied to discussion of changes in a policy or corporate business strategy, as opposed to individual livelihood choices. This specific code is applied to discussion of policies or corporate business strategies that involve shifting activities to another location (e.g., a processor sending its fishing fleet further away to find fish).
>>>> Adaptation / Transformation - Livelihood - Diversification	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-related drivers. "Livelihood" codes are applied to discussion of changes in an individual's business strategy, as opposed to corporate management changes. This specific code is applied to discussion of livelihood diversification.
>>>> Adaptation / Transformation - Livelihood - Location Switching	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-related drivers. "Livelihood" codes are applied to discussion of changes in an individual's business strategy, as opposed to corporate management changes. This specific code is applied to discussion of switching the location of livelihood activities.
>>>> Adaptation / Transformation - Livelihood - Species Switching	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-related drivers. "Livelihood" codes are applied to discussion of changes in an individual's business strategy, as opposed to corporate management changes. This specific code is applied to discussion of switching the species targeted by a livelihood activity.
>>>> Adaptation / Transformation - Livelihood - Leaving Industry	>>>> Sub-code applied to discussion of changes in approach, strategy, or behavior resulting from climate-related drivers. "Livelihood" codes are applied to discussion of changes in an individual's business strategy, as opposed to corporate management changes. This specific code is applied to discussion of ceasing a specific livelihood activity.

>>>> Adaptation / Transformation - Personal Behavior/Habits	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-related drivers. "Personal Behavior/Habits" codes are applied to discussion of changes in an individual's personal behaviors, other than their livelihood decisions. This code is applied to discussion of personal shifts, with the exception of changing the location of activities, which is captured by an additional specific code.
>>>> Adaptation / Transformation - Personal Behavior/Habits - Location Switching	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-related drivers. "Personal Behavior/Habits" codes are applied to discussion of changes in an individual's personal behaviors, other than their livelihood decisions. This code is applied to discussion of shifts in the location of non-livelihood activities -- primarily recreational activities.
>>>> Adaptation / Transformation - Personal Behavior/Habits - Seasonal Shifts	>>>> The HDCC Effect - Adaptation/Transformation sub-codes are applied to discussion of changes in approach, strategy, or behavior changes in approach, strategy, or behavior resulting from climate-related drivers. "Personal Behavior/Habits" codes are applied to discussion of changes in an individual's personal behaviors, other than their livelihood decisions. This code is applied to discussion of shifts in the timing and seasonality of non-livelihood activities -- primarily recreational activities.
>> HDCC Effect - Affect Price of Product	>> Sub-code applied to text discussing price effects that the respondent link to climate-related drivers
>> HDCC Effect - Beach Loss / Coastal Erosion Threatens Homes	>> Sub-code applied to text discussing coastal erosion impacts on residential structures that the respondent links to climate-related processes (i.e., climate change-exacerbated erosion patterns).

>> HDCC Effect - Commercial Closure (or Delay)	>> Sub-code applied to text discussing commercial fisheries closures or delays that the respondent links to climate-related drivers.	
>> HDCC Effect - Crowding	>> Sub-code applied to text discussing crowding issues (e.g., higher volumes of people traveling to study area communities; higher numbers of fishing boats in certain area) that the respondent links to climate-related drivers.	
>> HDCC Effect - Cultural Impact - General	>> Sub-code applied to text discussing unspecified cultural impacts in the study area that the respondent links to climate-related drivers. More specific cultural HDCC effects are captured by many other codes, as detailed in Appendix 4 - Code Groupings Underlying Themes.	
>> HDCC Effect - Cultural Resource Impacts	>> Sub-code applied to text discussing impacts to cultural resources (e.g., Dungeness crab, salmon, non-timber forest products utilized by Tribes) that the respondent links to climate-related drivers.	**NOTE:** "Cultural resources" are identified when respondents speak about the role of a species in community identity or traditional practices and customs, including subsistence harvest and crafts.
>> HDCC Effect - Cultural Shift	>> Sub-code applied to text discussing cultural shifts (e.g., changes in values, loss or erosion of cultural traditions or ways of life, etc.) that the respondent links to climate-related drivers.	
>> HDCC Effect - Demographic Shift	>> Sub-code applied to text discussing changing demographics within the study area population that the respondent links to climate-related drivers.	
>>>> Demographics - Graying Population	>>>> Sub-code applied to text discussing demographic shifts toward an older population that the respondent links to climate-related drivers.	
>>>> Demographics - Increasing Population	>>>> Sub-code applied to text discussing increasing population in the study area that respondents link to climate-related drivers.	
>>>> Demographics - Shifting (General)	>>>> This demographic shift code refers to all other perceived climate-driven changes in demographics, other than "HD Effect - Demographics - Graying Population."	

>> HDCC Effect - Directing Research Dollars	>> Sub-code applied to text discussing how climate change influences decisions regarding what topics should receive research funding.
>> HDCC Effect - Econ - Transfer Payments	>> Sub-code applied to text discussing the (climate-related) increasing prevalence of transfer payments as a primary income source in study communities.
>> HDCC Effect - Economic Impact - General	>> Sub-code applied to text discussing unspecified economic impacts in the study area that the respondent links to climate-related drivers. Specific economic HDCC effects are captured by many other individual codes, as detailed in Appendix 4 - Code Groupings Underlying Themes.
>> HDCC Effect - Economic Reorganization	>> Sub-code applied to text discussing perceived climate change-driven economic reorganization processes in the study area (i.e., shifting prominence/importance of industries in the study area).
>> HDCC Effect - Emergency Services Stressed	>> Sub-code applied to text discussing stresses on emergency services (e.g., fire response) that the respondent links to climate-related drivers.
>> HDCC Effect - Employment Concerns (Unemployment / Layoffs / Lack of Workers)	>> Sub-code applied to text discussing employment concerns that the respondent links to climate-related drivers. "Concerns" is interpreted broadly, including concern about the availability of employment with adequate wages (low wages), the availability of employment generally (unemployment, layoffs), and concern on the part of employers regarding the availability of skilled and hard-working employees (lack of workers).
>> HDCC Effect - Energy Provision / Energy Demand	>> Sub-code applied to text discussing impacts, or changes in energy demand or provision that the respondent links to climate-related drivers.
>> HDCC Effect - Erosion / Depreciation of Infrastructure	>> Sub-code applied to text discussing erosion and depreciation of infrastructure that the respondent links to climate-related processes (i.e., erosion rates influenced by climate change).

>> HDCC Effect - Facility / Infrastructure Relocation	>> Sub-code applied to text discussing instances of the relocation of facilities or infrastructure that the respondent links to climate-related drivers (i.e., climate influenced erosion rates requiring roadways or facilities be moved inland).	
>> HDCC Effect - Facility Upgrade / Renovation	>> Sub-code applied to text discussing instances of the facility upgrades and renovations that the respondent links to climate-related drivers.	
>> HDCC Effect - Fisheries Economic Impact	>> Sub-code applied to text discussing economic impacts to individual fishermen or the fishing industry broadly that respondents link to climate-related drivers (e.g., loss of revenue due to commercial closures or decreases in abundance).	**Note:** Respondents often speak about "impacts to fisheries" generally, including changing fishing opportunity and species abundance. The researcher was not always able to directly ask for clarification regarding the type of impact (economic, social, or cultural) a respondent was speaking about. However, when asked, respondents were typically thinking of economic impacts arising from the changes in fisheries. Thus, this code is applied when respondents discuss general impact to commercially harvested species in Oregon, including salmon, Dungeness crab, shrimp, hake, and groundfish. In contrast, social or cultural impacts associated with declining fisheries were identified when respondents spoke about effects on intra-community relationships and norms, or on traditions and customs impacted by changes in fisheries.
>> HDCC Effect - Garbage / Litter	>> Sub-code applied to text discussing changes in quantities of garbage or litter in the study are that the respondent links to climate-related drivers.	

>> HDCC Effect - Have to travel farther	>> Sub-code related to all "location switching" codes, but specifies the costs associated with having to travel further as a result of changes in access or abundance of resources resulting from climate-related drivers (e.g., warmer temperatures leading to species range shifts; beach erosion leading to closure of nearby beaches; lack of snow leading to winter recreation shifts, etc.).
>> HDCC Effect - Health	>> Set of sub-codes applied to text discussing health-related impacts that respondents link to climate drivers.
>>>> HDCC Effect - Health - Air Quality	>>>> Sub-code applied to text discussing changes in air quality, and associated health concerns, that the respondent links to climate-related drivers (i.e., the air quality concern is perceived to be driven by climate change).
>>>> HDCC Effect - Health - Domoic Acid	>>>> Sub-code applied to text discussing increased levels of domoic acid in shellfish, and associated health concerns, that the respondent links to climate-related drivers (i.e., the cause of increased levels is perceived to be driven by climate change).
>>>> HDCC Effect - Health - Smoke	>>>> Sub-code applied to text discussing smoke in the air resulting from forest fires, perceived as being linked to climate drivers of increased temperatures and decreased precipitation.
>>>> HDCC Effect - Health - Water Quality	>>>> Sub-code applied to text discussing changes in water quality, and associated health concerns, that the respondent links to climate-related drivers (i.e., the water quality concern is perceived to be driven by climate change).
>> HDCC Effect - Human-Wildlife Conflict	>> Sub-code applied to text discussing human-wildlife conflicts that respondents link to climate-related drivers (e.g., interactions between ATV drivers and marine mammals in the Coastal Dunes that are exacerbated by shifting species ranges).
>> HDCC Effect - Impact on Effectiveness of Restoration /	>> Sub-code applied to text discussing factors that get in the way of effective restoration, remediation, or preservation efforts that the respondent links to climate-related drivers (e.g., climate change undermines other management efforts).

Remediation / Preservation	
>> HDCC Effect - Impact on Environmental Regulation / Policy	>> Sub-code applied to text discussing (non-climate-related) factors that lead to changes in environmental regulations or policies (e.g., problems arising from non-climate change sources require regulation, such as overfishing, need to protect spawning habitat with riparian buffers, non-climate-related justifications for marine reserves; zoning decisions influenced by increasing coastal erosion due to climate change; fisheries species range shifts add risk and complexity to international diplomatic relations).
>> HDCC Effect - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	>> Sub-code applied to text discussing impacts on existing infrastructure, and impacts to the possibility of new infrastructure development, that the respondent links to climate-related processes (i.e., rates of erosion increased or patterns altered by climate change).
>> HDCC Effect - Impact on Research Topics	>> Sub-code applied to text discussing research needs that arise from issues or changes that respondents link to climate-related drivers.
>> HDCC Effect - Impacts Appeal of Coastal Oregon	>> Sub-code applied to text discussing shifts in the attractiveness of the study area as a destination for tourism or permanent retirement that respondents link to climate-related drivers (e.g., Oregon's climate is becoming increasingly attractive as other areas experience increasing extreme weather events).
>> HDCC Effect - Impacts to Aquaculture (Economic)	>> Sub-code applied to text discussing economic impacts to the aquaculture industry that respondents link to climate drivers (e.g., respondents who link ocean acidification and climate change to failures of oyster spat).
>> HDCC Effect - Increased uncertainty in	>> Sub-code applied to text discussing increasing, and new forms of, uncertainty associated with climate change, and how this impacts the ability of government agencies or businesses to plan for the future.

planning (gov't or business)	
>> HDCC Effect - Increasing SS Research Pressure	>> Sub-code applied to text discussing climate-related drivers of increasing social science research pressure in the study area (e.g., increasing interest in climate resilience).
>> HDCC Effect - Insurance Costs	>> Sub-code applied to text discussing changes in insurance costs that respondents link to climate-related drivers.
>> HDCC Effect - Intra-Community Conflict	>> Sub-code applied to text discussing examples of conflict within study area communities that respondents associate with climate drivers.
>> HDCC Effect - Investment / Divestment	>> Sub-code applied to text discussing patterns in investment and divestment in study area industries and infrastructure that respondents link to climate drivers.
>> HDCC Effect - Maintenance Requirements	>> Sub-code applied to text discussing changes in maintenance requirements in study area industries and infrastructure that respondents link to climate drivers (e.g., increasing erosion rates associated with increasing frequency and intensity of ocean storms).
>> HDCC Effect - Movement of people	>> Sub-code applied to text discussing changes in patterns of movement of people to and from the study area that respondents link to climate-related drivers (e.g., increasing visitation to the coast to escape heat waves in inland areas of Oregon; longer seasons for coastal recreation activities).
>> HDCC Effect - Need for Adaptation / Policy Reform	>> Sub-code applied to text discussing climate-related human dimensions issues that respondents feel deserve a policy response but have not yet been addressed.
>> HDCC Effect - Need for education / behavior change	>> Sub-code applied to text discussing changes in educational requirements and other personal adaptations in the face of climate change impacts.
>> HDCC Effect - New Industry	>> Sub-code applied to text discussing the emergence of new industries that respondents link to climate-related drivers (e.g., movement of new

	harvestable species into the study area; adaptations and innovations that enable different uses of traditional materials).
>> HDCC Effect - Personal Costs/Benefits	>> Sub-code applied to text discussing climate-related personal costs and benefits discussed by respondents.
>>>> Personal Costs/Benefits - General	>>>> This sub-code captures climate-related increases in personal costs (e.g., purchasing supplies to prepare for increasing storm events; having to pay for higher water and energy usage).
>>>> Personal Costs/Benefits - Gardening	>>>> This sub-code captures personal benefits associated with more productive gardens resulting from warmer, longer summers.
>> HDCC Effect - Political Engagement	>> Sub-code applied to text discussing instances when individuals or groups become engaged in the political process through protest or lobbying as a result of climate-related concerns (e.g., disagreement with forest-related rules and regulations that have been put in place in part in response to climate change).
>> HDCC Effect - Port - Management Responsibilities	>> Sub-code applied to text discussing increased challenges for port management that respondent links to climate-related drivers.
>> HDCC Effect - Property Rights	>> Sub-code applied to text discussing threats/impacts to property rights that respondents link to climate drivers.
>> HDCC Effect - Property Value	>> Sub-code applied to text discussing changes in property values that respondents link to climate drivers.
>> HDCC Effect - Psychological Stress	>> Sub-code applied to text discussing psychological stress experienced by individuals in the study area as a result of climate-related risks (e.g., increased fire risk).
>> HDCC Effect - Public Safety	>> Sub-code applied to text discussing changes in public safety in the study area that respondents link to climate drivers.
>> HDCC Effect - Quality of Life	>> Sub-code applied to text discussing changes in quality of life in the study area that respondents link to climate drivers.

>> HDCC Effect - Recreation	>> Set of sub-codes applied to text discussing impacts on recreation that respondents link to climate drivers.
>>>> Recreation - Beach Access	>>>> Sub-code applied to text discussing changes in access to the beach that the respondent links to climate-related drivers (e.g., exacerbated beach erosion processes and rates).
>>>> Recreation - Budget	>>>> Sub-code applied to text discussing changes in revenues from recreation as a result of increases in visitation perceived to be driven by climate changes.
>>>> Recreation - General	>>>> "General" sub-code applied to unspecified impacts on recreation perceived to be driven by climate changes.
>>>> Recreation - Fish / Shellfish Closure	>>>> Sub-code applied to closure of fish or shellfish fisheries, in association with red tide / domoic acid issues perceived to be driven by climate changes.
>>>> Recreation - Hunting	>>>> Sub-code applied to impacts on hunting activity perceived to be driven by climate changes.
>>>> Recreation - Impacts on Winter Recreation	>>>> Sub-code applied to discussion of climate-related impacts on winter recreation (e.g., decreased skiing, increased access to summer or shoulder season activities during the winter as a result of long-term climate change).
>>>> Recreation - Management Responsibilities	>>>> Sub-code applied to text discussing increased challenges for recreation managers that respondent link to climate-related drivers (e.g., rapid changes in the seasonality of demand for specific recreational uses and resources).
>>>> Recreation - Sport Fishing	>>>> Sub-code applied to discussion of impacts to sport fishing arising from changes in climate (e.g., warmer water temperatures lead to decreases in abundance or location of sport fishing species).
>>>> Recreation - Sunbathing / Warm Beach Activities	>>>> Sub-code applied to discussion of impacts on access to sunbathing / warm beach activities perceived to originate from climate-related drivers (e.g., longer, warmer summers increase opportunities for these activities resulting from climate change).

>>>> Recreation - Water-Based Recreation	>>>> Sub-code applied to discussion of impacts on access to water-based activities perceived to originate from climate-related drivers (e.g., longer, warmer summers increase opportunities for these activities resulting from climate change).
>> HDCC Effect - Regulatory Conflict	>> Sub-code applied to text discussing examples of conflict between communities and regulators that respondents associate with climate drivers.
>> HDCC Effect - Risk	>> Sub-code applied to text discussing changing risk that respondents associate with climate drivers (e.g., changing risk of large-scale forest fire in the Coast Range due to drought that respondents associate with long-term climate change).
>> HDCC Effect - Second Homes	>> Sub-code applied to text discussing the increasing prevalence of second homes in the study area, and particularly in Lincoln County, that respondents link to climate drivers (e.g., climate-driven population increases).
>> HDCC Effect - Sense of Place / Special Connection	>> Sub-code applied to text discussing the changes in sense of place and connection to the natural environment of the study area that respondents link to non-climate drivers (e.g., changing demographics driven by climate change lead to changing values related to the landscape and resource use; sense of place is activated/stressed when residents face relocation questions).
>> HDCC Effect - Shifting Attitudes	>> Sub-code applied to text discussing changes in attitudes within the study area population that the respondent links to climate-related drivers.
>> HDCC Effect - Shifting Perceptions	>> Sub-code applied to text discussing changes in perceptions within the study area population that the respondent links to climate-related drivers.
>> HDCC Effect - Shifting Values	>> Sub-code applied to text discussing changes in values within the study area population that the respondent links to climate-related drivers.

>> HDCC Effect - Social Ills	>> Sub-code applied to text discussing changing prevalence of social ills in the study area that respondents associate with climate-driven economic impacts (e.g., Dungeness crab closure due to domoic acid resulting from warmer water temperatures leads to increased alcohol abuse).
>> HDCC Effect - Social impact - General	>> Sub-code applied to text discussing unspecified, or single occurrences of specific social impacts in the study area that the respondent links to climate-related drivers. In addition to this general code, specific social HDCC effects are captured by numerous other codes, as detailed in Appendix 4 - Code Groupings Underlying Themes.
>> HDCC Effect - Strain on Infrastructure & Services	>> Sub-code applied to text discussing stresses on infrastructure and community services that respondents link to climate drivers (e.g., increasing population due to climate change trends stresses roadways and water supply).
>> HDCC Effect - Subsistence / Local Food Impacts	>> Sub-code applied to text discussing climate-related impacts to subsistence food resources (e.g., loss of access to areas where subsistence foods are harvested due to increasing fire risk; changes in health/survival of species due to increasing water temperatures).
>> HDCC Effect - Timber	>> This set of sub-codes is applied to text discussing impacts on the timber industry that respondents link to climate-related drivers.
>>>> Timber - Impact on Revenues / Productivity	>>>> Sub-code applied to text discussing economic impacts to timber businesses due to decreasing productivity of timber stands or other factors that respondents link to climate-related drivers.
>>>> Timber - Longer Season	>>>> Sub-code applied to text discussing climate-related changes that result in extended timber harvesting seasons.
>>>> Timber - Management Responsibilities	>>>> Sub-code applied to text discussing increased challenges for timber managers (public and private) that respondent link to climate-related drivers.
>>>> Timber - Shorter Season	>>>> Sub-code applied to text discussing climate-related changes that result in shortened timber harvesting seasons.

>> HDCC Effect - Tourism & Rec Businesses impacted	>> Set of sub-codes is applied to text discussing impacts on tourism and recreation businesses that respondents link to non-climate-related drivers.	
>>>> Tourism & Rec businesses Impacted - General	>>>> "General" sub-code is applied when a respondent discusses unspecified impacts to the tourism and recreation industry that he/she links to climate drivers.	
>>>> Tourism & Rec businesses Impacted - Decrease	>>>> Sub-code applied when a respondent discusses decreases in revenues or activity in tourism and recreation that he/she links to climate drivers.	
>>>> Tourism & Rec businesses Impacted - Increase	>>>> Sub-code applied when a respondent discusses increases in revenues or activity in tourism and recreation that he/she links to climate drivers.	
>> HDCC Effect - Traffic	>> Sub-code applied to text discussing changes in volume of vehicle traffic (e.g., higher volumes of cars on roadways) that the respondent links to climate-related drivers.	
>> HDCC Effect - Water Supply	>> Sub-code applied to text discussing changes in the availability of water in the study area that the respondent links to climate-related drivers (e.g., drought severity influenced by climate change trends).	
>> HDCC Effect - Water Usage	>> Sub-code applied to text discussing changes in the level of demand for water that the respondent links to climate-related drivers (e.g., population growth that is driven by climate change).	
SOCIAL SCIENCE	*This code group is applied to text discussing social science, and specifically 1) types of social science data; 2) instances of social science data gaps, 3) factors that present barriers to integration of social science in decision-making, and 4) factors that enable integration of social science.*	***NOTE:** "Social Science" is defined as "the study of society and of the relationship of individual members within society, including economics, history, political science, psychology, anthropology, and sociology" (Collinsdictionary.com/dictionary/english). Issues relating to these distinct social science disciplines can also be referred to as "human dimensions."*

>> Barrier	>> This group of sub-codes is applied to specific instances of barriers to integration of social science information in decision-making.
>>>> Blanket Prescriptions / Language	>>>> This sub-code highlights discussion of government use of standardized, blanket prescriptions or language as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Climate Change Denial	>>>> This sub-code highlights discussion of "climate change denial" as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Complexity	>>>> This sub-code highlights discussion of social-ecological complexity as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Conflict	>>>> This sub-code highlights discussion of conflict (between stakeholders or between agencies and communities) as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Cost	>>>> This sub-code highlights discussion of cost (e.g., time and financial resources) as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Data Availability	>>>> This sub-code highlights discussion of data availability as one barrier to integrating social science in decision-making.
>>>> Data Legitimacy/Validity	>>>> This sub-code highlights discussion of perceived lack of validity or legitimacy of data utilized in a decision-making process as one barrier to effective integration of social science in decision-making.
>>>> Data Quality / Completeness	>>>> This sub-code highlights discussion of data quality and completeness as one barrier to integrating social science in decision-making.
>>>> Defining Community Boundaries	>>>> This sub-code highlights discussion of challenges in defining community boundaries as one barrier to producing social science for decision-making.

>>>> Focus on Community or Individual Scale	>>>> This sub-code highlights discussion of the scale of social science research emphasis - typically at the individual or community scale rather than a larger systems view - as one barrier to producing complete/accurate social science for decision-making.
>>>> Focus on Economics	>>>> This sub-code highlights discussion of emphasis on economic data as one barrier to producing complete/accurate social science for decision-making.
>>>> Focus on Natural Science	>>>> This sub-code highlights discussion of emphasis on natural science information as one barrier to producing social science for decision-making.
>>>> Inadequate Process / Need for procedural reform	>>>> This sub-code highlights discussion of perceived procedural inadequacies as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Intangible Value	>>>> This sub-code highlights discussion of difficulty measuring intangible value as one barrier to producing complete/accurate social science for decision-making.
>>>> Issue Salience / Interest Level / Priority	>>>> This sub-code highlights discussion of issue salience in the minds of the public and decision-makers as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Lack of Expertise / Lack of Available SS's	>>>> This sub-code highlights discussion of lack of social science expertise at government agencies as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Lack of Personal Relationships	>>>> This sub-code highlights discussion of the lack of personal relationships between researchers or policymakers and the public as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Lack of Training / Managers need to learn how to use SS	>>>> This sub-code highlights discussion of lack of social science training at government agencies as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.

>>>> Lack of Voice / Access to Process	>>>> This sub-code highlights discussion of perceived lack of voice / access to decision-making processes on the part of stakeholders as one barrier to producing high quality social science for decision-making and (or) integrating social science in decision-making.
>>>> Marketing / Media	>>>> This sub-code highlights discussion of the role of the media in preventing the production of social science for decision-making (e.g., because potential respondents are afraid of how the media will sensationalize information; or because the media has not effectively raised salient issues in the minds of potential respondents).
>>>> NEPA already completed	>>>> This sub-code highlights discussion of the scale mismatch of availability of data vs. timeline of decision-making processes as one barrier to integrating social science in decision-making.
>>>> Not Tangible or Specific	>>>> This sub-code highlights discussion lack of specificity or tangibility as a barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Paradigm / Frame	>>>> This sub-code highlights discussion of existing paradigms or frames (e.g., emphasis on quantitative data and monetary valuation) as a barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Past trends don't relate to future	>>>> This sub-code highlights discussion of difficulty predicting future trends based on past information as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Political Leanings	>>>> This sub-code highlights discussion of political leanings of potential respondents and decision-makers as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Power	>>>> This sub-code highlights discussion of perceived power imbalances as one barrier to producing legitimate / accurate social science for decision-making and (or) integrating social science in decision-making.

>>>> Process Burden	>>>> This sub-code highlights discussion of one specific type of cost that presents a barrier to production of social science for decision-making and (or) integration of social science in decision-making: the time and financial investments required by managers and stakeholders to carry out social science research and (or) collaborative decision-making processes.
>>>> Psychology	>>>> This sub-code highlights discussion of aspects of human nature that may present barriers to producing social science for decision-making and (or) integrating social science in decision-making (e.g., lack of openness to change).
>>>> Receptivity	>>>> This sub-code highlights discussion of personal openness to discussing these issues as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Respondent Fatigue	>>>> This sub-code highlights discussion of the overwhelm of potential study respondents who are asked to participate in too many social science studies as one barrier to production of social science for decision-making.
>>>> Sampling Limitations	>>>> This sub-code highlights discussion of sampling limitations and challenges as one barrier to producing accurate / high quality social science for decision-making.
>>>> Social Norms	>>>> This sub-code highlights discussion of aspects of social interactions and social norms that may present barriers to producing social science for decision-making and (or) integrating social science in decision-making (e.g., not wanting to engage in offensive or polarizing conversations at the community level).
>>>> Technique	>>>> This sub-code highlights discussion of general technique limitations that present barriers to producing accurate / high quality social science for decision-making.
>>>> Timescale	>>>> This sub-code highlights other discussion of timescale issues that create barriers to producing and integrating social science in decision-making and (or) integrating social science in decision-making (e.g., data

	is a snapshot in time and stops being relevant/accurate after it is collected).
>>>> Too Big / Not at scale of people's lives	>>>> This sub-code highlights discussion of difficulty thinking at large enough spatial or temporal scales to conceive of or address climate change as a barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Top-down Process / Focused on Checking Boxes	>>>> This sub-code highlights discussion of a specific form of perceived procedural inadequacy - the tendency of decision-making processes to involve checking boxes or predetermined outcomes - as one barrier to integrating social science in decision-making.
>>>> Translating Qualitative to Quantitative	>>>> This sub-code highlights discussion of a specific form of technique limitation - difficulty translating qualitative information to quantitative metrics - that presents a barrier to producing social science for decision-making.
>>>> Trust	>>>> This sub-code highlights discussion of trust issues (between stakeholders or between agencies and communities) as one barrier to producing social science for decision-making and (or) integrating social science in decision-making.
>>>> Uncertainty	>>>> This sub-code highlights discussion of scientific uncertainty as one barrier to engaging with complex social-ecological issues to produce social science for decision-making and (or) integrate that social science in decision-making.
>>>> Values vary across context	>>>> This sub-code highlights discussion of a specific type of sampling limitations - the fact that values vary widely across different contexts - that presents one barrier to producing accurate / high quality values data for decision-making.
>> Data	>> Sub-code applied whenever a respondent discusses specific content that is missing from extant social science informing decision-making.
>>>> Adaptive Capacity	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize adaptive capacity within a community or group.

>>>> Attitudes	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize attitudes of individuals or groups.
>>>> Behaviors / Uses	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize behavior or use patterns of individuals or groups.
>>>> Beliefs	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize the beliefs of individuals or groups.
>>>> Community Impacts	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize community impacts arising from a specific stressor (e.g., climate change; regulatory change).
>>>> Compliance	>>>> Sub-code applied to text discussing a specific type of behavior/use data related to compliance with rules and regulations.
>>>> Concerns /Risks/Vulnerabilities	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize community concerns, risk levels, and vulnerabilities arising from distinct stressors (e.g., climate change; earthquake/tsunami).
>>>> Decision-making	>>>> Sub-code applied to text discussing information that can be used to understand and evaluate decision-making processes.
>>>> Demographics	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize the demographics of communities.
>>>> Economics	>>>> Sub-code applied to text discussing economic information for use in decision-making.
>>>> Incentives / Motivations	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize incentives or motivations of individuals or groups.
>>>> Local or Traditional Ecological Knowledge	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize local or traditional ecological knowledge.

>>>> Perceptions	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize the perceptions of individuals.
>>>> Power Dynamics (Political Ecology)	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize power dynamics within a group, community, or society.
>>>> Social capital / Network analysis	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize the relationships between individuals in a community or group, and how information or influence is passed throughout a network based on these relationships.
>>>> Sociocultural (General)	>>>> Sub-code applied to text discussing unspecified, general information that can be used to understand, measure, or characterize culture or society.
>>>> Values	>>>> Sub-code applied to text discussing information that can be used to understand, measure, or characterize the values of individuals or groups.
>> Enabling	>> Group of sub-codes applied to specific factors that enable or facilitate the integration of social science information in decision-making.
>>>> Financial Capital	>>>> Sub-code applied to text discussing the role of financial resources in enabling the integration of social information in decision-making.
>>>> Economic Salience	>>>> Sub-code applied to text discussing the role of economic salience of the social science information (e.g., ability to communicate monetary value) in enabling the integration of specific types of social information in decision-making.
>>>> Focus on Common Threats	>>>> Sub-code applied to text discussing the role of common threats in bypassing conflict that often prevents effective discussion of and integration of social information in decision-making.
>>>> Government Mandate	>>>> Sub-code applied to text discussing the role of government regulation in enabling the integration of social science information in decision-making.

>>>> Leadership	>>>> Sub-code applied to text discussing the role of leadership in effectively dealing with common barriers and thereby enabling the integration of social science information in decision-making.	
>>>> Personal Investment/Relationship	>>>> Sub-code applied to text discussing the role of developing personal relationships between decision-makers and stakeholders to deal with common barriers (e.g., lack of trust; process legitimacy concerns), thereby enabling the integration of social science information in decision-making.	
>>>> Population Size (Small)	>>>> Sub-code applied to text discussing the fact that smaller population sizes are often more able to come to consensus around community visioning, often enabling improved articulation of collective values and priorities to inform decision-making.	
>>>> Process	>>>> Sub-code applied to text discussing the importance of legitimate process in diminishing conflict and thereby enabling integration of social science information in decision-making.	
>>>> Protest / Lawsuit / Stakeholders Demand	>>>> Sub-code applied to text discussing alternative tactics employed by stakeholders to bring values into decision-making when they don't feel the established agency process is effective (e.g., through lawsuits or protest).	
>>>> Receptivity / Paradigm Shift	>>>> Sub-code applied to text discussing shifting attitudes and perceptions among stakeholders and (or) decision-makers that improve receptivity to production of and (or) integration of social science information in decision-making.	
>>>> Representative Sample	>>>> Sub-code applied to text discussing the role of representative samples in increasing the validity of information to improve its chances of correctly informing decision-making.	
>> SS - Information Gap	>> Sub-code applied whenever a respondent discusses a social science data gap.	**NOTE**: This code is used in analysis to identify co-occurrence of specific SS - Data codes with SS - Information Gap to specify types of social science data

		that are identified by respondents as unavailable or inadequate.
TIME	This code group is used to distinguish discussion of current events, issues, and changes versus potential future events, issues, and changes.	
>> Current	>> This code is applied when a respondent is referring to current issues or events. (The line between recent past and current events is not always clear, so the researcher makes her best judgement about whether the respondent is describing current or recent and still relevant events.)	
>> Future	>> This code is applied when a respondent is referring to potential or predicted issues or events. (E.g., projections, "if/then" statements.)	

Appendix 3 – Issues and Effects Grouped Under Each Theme

1. Purpose

This Appendix presents themes that were developed through the course of second cycle coding with respect to: 1) Environmental Issues and Changes; 2) HDCC Effects; and 3) Barriers to Social Science Integration. Individual codes relevant to each theme are included, and can be cross-referenced against the full code list in Appendix 2.

2. Environmental Issue Themes – Code Groupings

Aquatic Conditions and Patterns

Env - Aquatic - King Tides
Env - Aquatic - Ocean Currents / Circulation
Env - Aquatic - Water Quality
Env - Aquatic - Wave Run-up / Storm Surge / Wave Heights
Env - Process - Aquatic - Acidification
Env - Process - Aquatic - Sea Level Rise
Env - Process - Aquatic - Upwelling
Env - Temperature - Aquatic - Water
Env - Temperature - Aquatic - Water - Increase
Env - Temperature - Aquatic - Water - Shift / Differential
Env - Event - Aquatic - Algae Bloom
Env - Event - Aquatic - Hypoxia
Env - Event - Aquatic - Temperature - The Blob

Ecological Integrity and Ecosystem Composition

Env - Other - Impact on Food Web
Env - Change - Ecosystem Composition
Env - Moisture - Water Supply

Fish and Wildlife Health and Survival

Env - Change - Abundance
Env - Change - Health / Survival
Env - Event - Die Off
Env - Physical Effects
Env - Physical Effects - Physiological Change
Env - Physical Effects - Productivity
Env - Physical Effects - Stress
Env - Physical Effects - Survival

Forest Health and Survival

Env - Change - Health / Survival

Env - Event - Seedling Failure
Env - Physical Effects - Physiological Change
Env - Physical Effects - Productivity
Env - Physical Effects - Stress
Env - Physical Effects - Survival

Material Processes
Env - Change - Ecosystem Configuration / Geography
Env - Change - Location
Env - Process - Geography - Marsh Landward Migration
Env - Process - Geography - River Migration
Env - Process - Geography - Subsidence
Env - Process - Geography - Tectonic Uplift
Env - Change - Material Inputs
Env - Process - Materials - Geography - Accretion
Env - Process - Materials - Geography - Beach / Coastal Erosion

Moisture Patterns
Env - Change - Moisture
Env - Event - Moisture - Flooding
Env - Event - Moisture - Drought
Env - Moisture
Env - Moisture - Fog Patterns
Env - Moisture - Glaciers
Env - Moisture - More rain less snow
Env - Moisture - Precipitation
Env - Moisture - Precipitation decrease
Env - Moisture - Precipitation increase
Env - Moisture - Precipitation Seasonality
Env - Moisture - Seasonality - Decrease in Cascades Snowpack
Env - Moisture - Water Supply

Shifting Seasonality
Env - Temperature - Seasonal Shift - Phenology
Env - Temperature - Seasonal Shifts
Env - Moisture - Precipitation Seasonality
Env - Moisture - Seasonality - Decrease in Cascades Snowpack
Env - Change - Seasonality

Storm Activity
Env - Event - Atmosphere - Storms
Env - Aquatic - Wave Run-up / Storm Surge / Wave Heights
Env - Atmosphere - Wind Patterns

Temperature Patterns
Env - Change - Temperature
Env - Event - Temperature - Heat Wave
Env - Temperature - Aquatic - Water
Env - Temperature - Aquatic - Water - Increase
Env - Temperature - Aquatic - Water - Shift / Differential
Env - Temperature - Atmosphere - Air
Env - Temperature - Atmosphere - Air - Decrease
Env - Temperature - Atmosphere - Air - Increase
Env - Temperature - Atmosphere - Air - Shift/Differential

3. HDCC Effect Grouped Under Social, Economic, and Cultural Themes

Social Themes

Health & Well-being Concerns
HDCC - Food Security
HDCC - Health - Air Quality
HDCC - Health - Domoic Acid
HDCC - Health - Smoke
HDCC - Psychological Stress

Impacts on Management
HDCC - Behavior / Habits - Management Decisions
HDCC - Commercial Closure (or Delay)
HDCC - Community Planning
HDCC - Community Services - Management Responsibilities
HDCC - Data Requirements
HDCC - Diplomatic Relations
HDCC - Impact on Effectiveness of Restoration / Remediation / Preservation
HDCC - Impact on Environmental Regulation / Policy
HDCC - Increased uncertainty in planning (government or business)
HDCC - Land Use - Management Responsibilities
HDCC - Need for Policy Reform
HDCC - Recreation - Budget
HDCC - Recreation - Fish / Shellfish Closure
HDCC - Recreation - Management Responsibilities
HDCC - Regulatory Conflict
HDCC - Zoning

Impacts on Recreation
HDCC - Have to go farther

HDCC - Human-Wildlife Conflict
HDCC - Recreation
HDCC - Recreation - Beach Access
HDCC - Recreation - Fish / Shellfish Closure
HDCC - Recreation - Hunting
HDCC - Recreation - Impacts on Winter Recreation
HDCC - Recreation - Longer Summer Seasons
HDCC - Recreation - Sport Fishing
HDCC - Recreation - Sunbathing / Warm Beach Activities
HDCC - Recreation - Water Activities

Migration and Visitation Patterns
HDCC - Graying Population
HDCC - Have to go farther
HDCC - Increasing population (permanent or tourist)
HDCC - Movement of people
HDCC - Shifting Demographics
HDCC - Recreation - Longer Seasons

Quality of Life
HDCC - Crowding
HDCC - Garbage / Litter
HDCC - Gardening
HDCC - Impacts Appeal of Coastal Oregon
HDCC - Public Safety
HDCC - Quality of Life - General
HDCC - Quality of Life - Comfort
HDCC - Traffic

Social Vulnerability
HDCC - Beach Loss / Coastal Erosion Threatens Homes
HDCC - Employment Concerns (Unemployment / Layoffs / Lack of Workers)
HDCC - Flood / Tide level Impacts
HDCC - Psychological Stress
HDCC - Risk
HDCC - Social Ills

Strain on Resources and Infrastructure
HDCC - Beach Loss / Coastal Erosion Threatens Homes
HDCC - Community Services - Management Responsibilities
HDCC - Crowding
HDCC - Emergency Services Stressed
HDCC - Energy Provision / Energy Demand

HDCC - Facility / Infrastructure Relocation
HDCC - Facility Upgrade / Renovation
HDCC - Flood / Tide level Impacts
HDCC - Impact on Existing Infrastructure / New Infrastructure Development
HDCC - Land Use Pressure
HDCC - Saltwater Intrusion
HDCC - Strain on Infrastructure & Services
HDCC - Traffic
HDCC - Waste Disposal
HDCC - Water Usage

Business Adaptations
HDCC - Adaptation/Transformation - Example
HDCC - Adaptation/Transformation - Example - Strategy
HDCC - Behavior / Habits - Livelihood Decisions
HDCC - Behavior / Habits - Management Decisions
HDCC - Employment Concerns (Unemployment / Layoffs / Lack of Workers)
HDCC - Facility Upgrade / Renovation
HDCC - Increased uncertainty in planning (government or business)
HDCC - Investment / Divestment
HDCC - Port - Management Responsibilities
HDCC - Timber - Management Responsibilities

Economic Impacts on Coastal Infrastructure
HDCC - Facility Upgrade / Renovation
HDCC - Flood / Tide level Impacts
HDCC - Impact on Existing Infrastructure / New Infrastructure Development
HDCC - Maintenance Requirements
HDCC - Strain on Infrastructure & Services

Economic Impacts on Commercial Fisheries
HDCC - Access to Resources
HDCC - Affect Price of Product
HDCC - Employment Concerns (Unemployment / Layoffs / Lack of Workers)
HDCC - Facility Upgrade / Renovation
HDCC - Have to go farther
HDCC - Impact on Fisheries - Economic
HDCC - Impacts to Aquaculture - Economic
HDCC - Processing - Shorter Season

Economic Impacts on Timber Industry
HDCC - Forest Industry - Increased Difficulty cutting trees
HDCC - Timber - Impact on Revenues / Productivity

HDCC - Timber - Longer Season
HDCC - Timber - Shorter Season

Economic Impacts on Tourism & Recreation
HDCC - Recreation - Budget
HDCC - Recreation - Longer Seasons
HDCC - Recreation - Management Responsibilities
HDCC - Tourism impacted
HDCC - Tourism impacted - Decrease
HDCC - Tourism impacted - Increase

Economic Reorganization
HDCC - Econ - Transfer Payments
HDCC - Economic Reorganization
HDCC - Investment / Divestment
HDCC - New Industry

Personal Costs
HDCC - Insurance Costs
HDCC - Energy Provision / Energy Demand
HDCC - Cost of Electricity
HDCC - Disaster Supplies
HDCC - Have to go farther

Cultural Themes

Cultural Reorganization
HDCC - Adaptation/Transformation - Example
HDCC - Adaptation/Transformation - Example - Strategy
HDCC - Behavior / Habits - Livelihood Decisions
HDCC - Cultural Loss
HDCC - Cultural Shift
HDCC - Sense of Place / Special Connection
HDCC - Shifting Attitudes
HDCC - Shifting Perceptions
HDCC - Shifting Values

Effect on Culturally Important Resources
HDCC - Cultural Resource Impacts
HDCC - Subsistence / Local Food Impacts

4. Barriers to Social Science Integration Themes – Code Groupings

Community Barriers
SS - Barrier - Social Norms
SS - Barrier - Respondent Fatigue
SS - Barrier - Process Burden
SS - Barrier - Conflict
SS - Barrier - Lack of Direct Relationships
SS - Barrier - Trust

Costs
SS - Barrier - Cost
SS - Barrier - Respondent Fatigue
SS - Barrier - Process Burden
SS - Barrier - Conflict

Data Quality and Availability
SS - Barrier - Data Availability
SS - Barrier - Complexity
SS - Barrier - Sampling Limitations
SS - Barrier - Focus on Community or Individual Scale
SS - Barrier - Data Quality / Completeness
SS - Barrier - Legitimacy / Validity
SS - Barrier - Relevance (Past trends don't relate to future)
SS - Barrier - Uncertainty
SS - Barrier - Defining Community Boundaries

Established Political and Scientific Frames
SS - Barrier - Focus on Natural Science
SS - Barrier - Focus on Economics
SS - Barrier - Paradigm / Frame
SS - Barrier - Focus on Community or Individual Scale
SS - Barrier - Blanket Prescriptions / Language

Issues of Political Will
SS - Barrier - Issue Salience / Interest Level / Priority
SS - Barrier - Political Leanings
SS - Barrier - Lack of Urgency
SS - Barrier - Marketing / Media
SS - Barrier - Psychology
SS - Barrier - Receptivity
SS - Barrier - Not Tangible or Specific

Procedural Inadequacies

SS - Barrier - Blanket Prescriptions / Language
SS - Barrier - Legitimacy / Validity
SS - Barrier - Power
SS - Barrier - Lack of Voice / Access to Process

Scale Mismatches

SS - Barrier - Timescale
SS - Barrier - NEPA already completed
SS - Barrier - Too Big / Not at scale of people's lives

Social Science Expertise Gaps

SS - Barrier - Lack of Expertise / Lack of Available SS's
SS - Barrier - Lack of Training / Managers need to learn how to use SS
SS - Barrier - Technique
SS - Barrier - Translating Qualitative to Quantitative
SS - Barrier - Intangible Value

Appendix 4 – Top Frequency Environmental Issues/Changes & HDCC Effects

1. Purpose

This Appendix presents 10 tables that detail the most frequently mentioned environmental issues and changes (Part 2) and the most frequently mentioned HDCC effects (Part 3). The tables contain code names that were used to calculate basic frequency counts, and these codes can be cross-referenced against the final code list in Appendix 2 if the reader desires to learn more about how a given code was defined. As noted in Section 4 (Methods), the frequency counts used a presence/absence calculation (i.e., participants who mentioned the code one or more times are counted toward the total). The number of participants who mentioned each code was then divided by 77 (the total number of respondents who participated in the study), resulting in a percentage of all participants who brought up each item at least once during discussion.

Each table contains two lists: one that presents the codes most frequently spoken about as *current* issues or effects, and one that presents the codes most frequently spoken about as *potential future* issue or effects. It is of note that many of the same codes were present in both current and future lists. This is because different respondents perceived the issues in different ways. Also, there were generally fewer items spoken about as potential future effects. This is likely because respondents were less likely to speculate about the future compared to share observations about the present. It is also likely affected by the fact that current effects generally are expected to continue into the future, but they are not reflected as such in the future potential lists.

These frequency calculations were generated as an aid to qualitative analysis, and should not be interpreted as an absolute assessment of the relative importance of individual issues or effects. This is because many of the individual issues and effects mentioned by respondents are highly interrelated or interdependent. Also, it is important to acknowledge that frequency of mention may have more to do with what is easily articulated than what is most valued overall by participants.

2. Most Frequently Discussed Current and Potential Future Environmental Issues and Changes

Table A-4a. Top frequency environmental codes with (a) current issues and (b) future potential issues

(a) Current Environmental Issues	% who mentioned this Current Issue (of 77 Respondents)
Env - Change - Seasonality	49.4%
Env - Temperature - Aquatic - Water - Increase	46.8%
Env - Change - Abundance	45.6%
Env - Event - Forest Fire	43.0%
Env - Temperature - Atmosphere - Air - Increase	43.0%
Env - Other - Species Shifts (Range/Composition)	40.5%
Env - Change - Health / Survival	40.5%
Env - Event - Moisture - Drought	39.2%
Env - Change - Temperature	39.2%
Env - Moisture - Precipitation decrease	38.0%
Env - Change - Location	35.4%
Env - Process - Aquatic - Sea Level Rise	32.9%
Env - Change - Moisture	32.9%
Env - Cycle - Atmosphere - Aquatic - El Niño	30.4%
Env - Atmosphere - Wind Patterns	29.1%
Env - Event - Atmosphere - Storms	27.8%
Env - Other - Disease/Pests	27.8%
Env - Physical Effects - Stress	27.8%
Env - Physical Effects - Survival	27.8%
Env - Process - Aquatic - Acidification	27.8%
Env - Event - Aquatic - Temperature - The Blob	24.1%
Env - Process - Materials - Beach / Coastal Erosion	22.8%
Env Change - Ecosystem Composition	22.8%
Env - Event - Aquatic - Algae Bloom	20.3%
Env - Other - Impact on Food Web	20.3%
Env - Temperature - Air - Shift/Differential	20.3%
Env - Event - Aquatic - Hypoxia	19.0%
Env - Physical Effects - Productivity	19.0%

(b) Future Environmental Issues	% who mentioned this Future Issue (of 77 Respondents)
Env - Change - Health / Survival	29.1%
Env - Other - Species Shifts (Range/Composition)	25.3%
Env - Process - Aquatic - Sea Level Rise	24.1%
Env - Change - Abundance	24.1%
Env - Process - Aquatic - Acidification	21.5%
Env - Event - Forest Fire	19.0%
Env - Temperature - Aquatic - Water - Increase	19.0%
Env - Temperature - Atmosphere - Air - Increase	19.0%
Env - Event - Atmosphere - Storms	17.7%
Env - Process - Materials - Beach / Coastal Erosion	16.5%
Env - Event - Moisture - Flooding	15.2%
Env - Physical Effects - Survival	15.2%
Env - Change - Ecosystem Composition	15.2%
Env - Change - Temperature	15.2%
Env - Cycle - Atmosphere - Aquatic - El Niño	13.9%
Env - Moisture - Precipitation decrease	13.9%
Env - Change - Moisture	13.9%
Env - Change - Seasonality	13.9%
Env - Event - Moisture - Drought	11.4%
Env - Other - Impact on Food Web	11.4%
Env - Physical Effects - Productivity	11.4%
Env - Physical Effects - Stress	11.4%
Env - Other - Disease/Pests	10.1%
Env - Moisture - Precipitation Seasonality	8.9%
Env - Change - Material Inputs	8.9%
Env - Moisture - Water Supply	7.6%
Env - Change - Location	7.6%

Table A-4b. Top frequency individual environmental codes based on fisheries respondents on (a) current issues and (b) future potential issues

(a) Fisheries Respondents - Current Environmental Issues	% of Fisheries Respondents who mentioned this Current Issue (of 22)	% of Total Current Issues mentioned by Fisheries Respondents (of 273)
Env - Temperature - Aquatic - Water - Increase	68.2%	5.5%
Env Change - Abundance	68.2%	5.5%
Env - Other - Species Shifts (Range/Composition)	59.1%	4.8%
Env Change - Seasonality	59.1%	4.8%
Env Change - Ecosystem Composition	50.0%	4.0%
Env Change - Location	50.0%	4.0%
Env Change - Temperature	50.0%	4.0%
Env - Cycle - Atmosphere - Aquatic - El Niño	45.5%	3.7%
Env - Event - Aquatic - Temperature - The Blob	45.5%	3.7%
Env - Process - Aquatic - Acidification	45.5%	3.7%
Env Change - Health / Survival	45.5%	3.7%
Env - Event - Aquatic - Hypoxia	40.9%	3.3%
Env - Event - Moisture - Drought	40.9%	3.3%
Env - Other - Impact on Food Web	40.9%	3.3%
Env - Physical Effects - Survival	36.4%	2.9%
Env - Event - Aquatic - Algae Bloom	31.8%	2.6%
Env - Physical Effects - Stress	31.8%	2.6%
Env - Temperature - Seasonal Shifts	31.8%	2.6%
Env - Event - Extreme Weather Events	27.3%	2.2%
Env - Process - Aquatic - Upwelling	27.3%	2.2%
Env - Temperature - Atmosphere - Air - Increase	27.3%	2.2%
Env - Temperature - Atmosphere - Air - Shift/Differential	22.7%	1.8%
Env - Event - Atmosphere - Storms	18.2%	1.5%
Env - Event - Earthquake	18.2%	1.5%
Env - Event - Forest Fire	18.2%	1.5%
Env - Moisture - Precipitation decrease	18.2%	1.5%
Env - Physical Effects - Physiological Change	18.2%	1.5%
Env - Process - Aquatic - Sea Level Rise	18.2%	1.5%
Env - Temperature - Aquatic - Water	18.2%	1.5%

(b) Fisheries Respondents - Future Environmental Issues	% of Fisheries Respondents who mentioned this Future Issue (of 22)	% of Total Future Issues mentioned by Fisheries Respondents (of 123)
Env Change - Abundance	36.4%	6.5%
Env - Other - Species Shifts (Range/Composition)	31.8%	5.7%
Env - Physical Effects - Survival	31.8%	5.7%
Env - Process - Aquatic - Acidification	31.8%	5.7%
Env - Temperature - Aquatic - Water - Increase	31.8%	5.7%
Env Change - Health / Survival	31.8%	5.7%
Env Change - Temperature	27.3%	4.9%
Env - Physical Effects - Stress	22.7%	4.1%
Env Change - Ecosystem Composition	22.7%	4.1%
Env - Cycle - Atmosphere - Aquatic - El Niño	18.2%	3.3%
Env - Event - Aquatic - Temperature - The Blob	13.6%	2.4%
Env - Event - Moisture - Drought	13.6%	2.4%
Env - Event - Moisture - Flooding	13.6%	2.4%
Env - Moisture - Precipitation decrease	13.6%	2.4%
Env - Other - Impact on Food Web	13.6%	2.4%
Env - Temperature - Aquatic - Water	13.6%	2.4%
Env - Temperature - Atmosphere - Air - Increase	13.6%	2.4%
Env Change - Seasonality	13.6%	2.4%
Env - Event - Aquatic - Algae Bloom	9.1%	1.6%
Env - Event - Aquatic - Hypoxia	9.1%	1.6%
Env - Event - Tsunami	9.1%	1.6%
Env - Physical Effects - Productivity	9.1%	1.6%
Env - Process - Aquatic - Upwelling	9.1%	1.6%
Env - Temperature - Atmosphere - Air	9.1%	1.6%
Env - Temperature - Atmosphere - Air - Shift/Differential	9.1%	1.6%
Env Change - Location	9.1%	1.6%
Env Change - Moisture	9.1%	1.6%

Table A-4c. Top frequency individual environmental codes based on forestry respondents on (a) current issues and (b) future potential issues

(a) Forest Respondents - Current Environmental Issues	% of Forest Respondents who mentioned this Current Issue (of 16)	% of Total Current Issues mentioned by Forest Respondents (of 180)
Env - Event - Forest Fire	81.3%	7.2%
Env - Event - Moisture - Drought	75.0%	6.7%
Env - Other - Pathogens (Disease/Pests)	56.3%	5.0%
Env - Temperature - Aquatic - Water - Increase	56.3%	5.0%
Env Change - Health / Survival	56.3%	5.0%
Env Change - Seasonality	56.3%	5.0%
Env - Moisture - Precipitation decrease	50.0%	4.4%
Env Change - Moisture	50.0%	4.4%
Env - Physical Effects - Stress	43.8%	3.9%
Env - Temperature - Atmosphere - Air - Increase	43.8%	3.9%
Env - Physical Effects - Productivity	37.5%	3.3%
Env - Atmosphere - Wind Patterns	31.3%	2.8%
Env - Moisture - Seasonality - Decreased Snowpack	31.3%	2.8%
Env - Moisture - Water Supply	31.3%	2.8%
Env - Other - Species Shifts (Range/Composition)	31.3%	2.8%
Env Change - Temperature	31.3%	2.8%
Env - Moisture - Fog Patterns	25.0%	2.2%
Env - Moisture - Precipitation Seasonality	25.0%	2.2%
Env - Other - Smoke	25.0%	2.2%
Env - Physical Effects - Survival	25.0%	2.2%

(b) Forest Respondents - Future Environmental Issues	% of Forest Respondents who mentioned this Future Issue (of 16)	% of Total Future Issues mentioned by Forest Respondents (of 79)
Env - Event - Forest Fire	37.5%	7.6%
Env Change - Health / Survival	37.5%	7.6%
Env - Other - Pathogens (Disease/Pests)	31.3%	6.3%
Env - Other - Species Shifts (Range/Composition)	31.3%	6.3%
Env - Physical Effects - Productivity	25.0%	5.1%
Env Change - Moisture	25.0%	5.1%
Env - Event - Moisture - Drought	18.8%	3.8%
Env - Moisture - Water Supply	18.8%	3.8%
Env - Physical Effects - Stress	18.8%	3.8%
Env - Physical Effects - Survival	18.8%	3.8%
Env - Process - Aquatic - Sea Level Rise	18.8%	3.8%
Env - Temperature - Aquatic - Water - Increase	18.8%	3.8%
Env - Temperature - Atmosphere - Air - Increase	18.8%	3.8%
Env - Event - Materials - Landslide / Land Instability	12.5%	2.5%
Env - Moisture - Precipitation	12.5%	2.5%
Env - Moisture - Precipitation decrease	12.5%	2.5%
Env - Moisture - Precipitation Seasonality	12.5%	2.5%
Env Change - Ecosystem Composition	12.5%	2.5%

Table A-4d. Top frequency individual environmental codes based on tourism and recreation respondents on (a) current issues and (b) future potential issues

(a) Tourism & Recreation Respondents - Current Environmental Issues	% of Tourism & Recreation Respondents who mentioned this Current Issue (of 16)	% of Total Current Issues mentioned by Tourism & Recreation Respondents (of 180)
Env - Other - Species Shifts (Range/Composition)	61.1%	4.2%
Env Change - Abundance	61.1%	4.2%
Env Change - Location	55.6%	3.8%
Env - Event - Forest Fire	50.0%	3.4%
Env - Temperature - Aquatic - Water - Increase	50.0%	3.4%
Env - Temperature - Atmosphere - Air - Increase	50.0%	3.4%
Env Change - Health / Survival	50.0%	3.4%
Env Change - Seasonality	50.0%	3.4%
Env - Moisture - Precipitation decrease	44.4%	3.1%
Env - Physical Effects - Stress	44.4%	3.1%
Env Change - Moisture	44.4%	3.1%
Env Change - Temperature	44.4%	3.1%
Env - Event - Atmosphere - Storms	38.9%	2.7%
Env - Other - Pathogens (Disease/Pests)	38.9%	2.7%
Env - Physical Effects - Survival	38.9%	2.7%
Env - Process - Aquatic - Acidification	38.9%	2.7%
Env - Temperature - Atmosphere - Air - Shift/Differential	38.9%	2.7%
Env - Atmosphere - Wind Patterns	33.3%	2.3%
Env - Cycle - Atmosphere - Aquatic - El Niño	33.3%	2.3%
Env - Event - Moisture - Drought	33.3%	2.3%
Env - Event - Tsunami	27.8%	1.9%
Env - Other - Impact on Food Web	27.8%	1.9%
Env - Physical Effects - Productivity	27.8%	1.9%
Env - Process - Aquatic - Sea Level Rise	27.8%	1.9%
Env - Process - Materials - Geography - Beach / Coastal Erosion	27.8%	1.9%
Env - Temperature - Aquatic - Water	27.8%	1.9%

(b) Tourism & Recreation Respondents - Future Environmental Issues	% of Tourism & Recreation Respondents who mentioned this Future Issue (of 16)	% of Total Future Issues mentioned by Tourism & Recreation Respondents (of 79)
Env Change - Health / Survival	38.9%	6.9%
Env - Process - Aquatic - Acidification	33.3%	5.9%
Env - Process - Aquatic - Sea Level Rise	33.3%	5.9%
Env Change - Abundance	33.3%	5.9%
Env - Event - Atmosphere - Storms	22.2%	3.9%
Env - Moisture - Precipitation decrease	22.2%	3.9%
Env - Other - Impact on Food Web	22.2%	3.9%
Env - Other - Species Shifts (Range/Composition)	22.2%	3.9%
Env - Temperature - Atmosphere - Air - Increase	22.2%	3.9%
Env - Physical Effects - Stress	16.7%	2.9%
Env - Physical Effects - Survival	16.7%	2.9%
Env - Process - Materials - Geography - Beach / Coastal Erosion	16.7%	2.9%
Env - Temperature - Aquatic - Water - Increase	16.7%	2.9%
Env Change - Seasonality	16.7%	2.9%
Env - Cycle - Atmosphere - Aquatic - El Niño	11.1%	2.0%
Env - Event - Aquatic - Algae Bloom	11.1%	2.0%
Env - Event - Extreme Weather Events	11.1%	2.0%
Env - Event - Forest Fire	11.1%	2.0%
Env - Event - Moisture - Flooding	11.1%	2.0%
Env - Event - Tsunami	11.1%	2.0%
Env - Other - Pathogens (Disease/Pests)	11.1%	2.0%
Env - Physical Effects - Productivity	11.1%	2.0%
Env Change - Ecosystem Composition	11.1%	2.0%
Env Change - Location	11.1%	2.0%
Env Change - Moisture	11.1%	2.0%

Table A-4e. Top frequency individual environmental codes based on coastal infrastructure respondents on (a) current issues and (b) future potential issues

(a) Tourism & Recreation Respondents - Current Environmental Issues	% of Coastal Infrastructure Respondents who mentioned this Current Issue (of 16)	% of Total Current Issues mentioned by Coastal Infrastructure Respondents (of 180)
Env - Atmosphere - Wind Patterns	62.5%	6.7%
Env Change - Location	62.5%	6.7%
Env - Aquatic - Ocean Currents / Circulation	50.0%	5.3%
Env - Cycle - Atmosphere - Aquatic - El Niño	50.0%	5.3%
Env - Event - Atmosphere - Storms	50.0%	5.3%
Env - Process - Aquatic - Sea Level Rise	50.0%	5.3%
Env - Moisture - Precipitation decrease	37.5%	4.0%
Env - Temperature - Atmosphere - Air - Increase	37.5%	4.0%
Env Change - Abundance	37.5%	4.0%
Env Change - Material Inputs	37.5%	4.0%
Env Change - Moisture	37.5%	4.0%
Env Change - Seasonality	37.5%	4.0%
Env - Aquatic - Wave Run-up / Storm Surge / Wave Heights	25.0%	2.7%
Env - Event - Materials - Landslide / Land Instability	25.0%	2.7%
Env - Moisture - Precipitation increase	25.0%	2.7%
Env - Other - Species Shifts (Range/Composition)	25.0%	2.7%
Env - Process - Materials - Geography - Beach / Coastal Erosion	25.0%	2.7%
Env - Temperature - Aquatic - Water	25.0%	2.7%
Env - Temperature - Aquatic - Water - Increase	25.0%	2.7%

(b) Tourism & Recreation Respondents - Future Environmental Issues	% of Coastal Infrastructure Respondents who mentioned this Future Issue (of 16)	% of Total Future Issues mentioned by Coastal Infrastructure Respondents (of 79)
Env - Process - Materials - Geography - Beach / Coastal Erosion	37.5%	10.0%
Env - Aquatic - Wave Run-up / Storm Surge / Wave Heights	25.0%	6.7%
Env - Cycle - Atmosphere - Aquatic - El Niño	25.0%	6.7%
Env - Event - Atmosphere - Storms	25.0%	6.7%
Env - Moisture - Precipitation Seasonality	25.0%	6.7%
Env - Temperature - Atmosphere - Air - Increase	25.0%	6.7%
Env Change - Abundance	25.0%	6.7%
Env Change - Moisture	25.0%	6.7%
Env - Event - Aquatic - Algae Bloom	12.5%	3.3%
Env - Moisture - Precipitation decrease	12.5%	3.3%
Env - Moisture - Precipitation increase	12.5%	3.3%
Env - Other - Pollution	12.5%	3.3%
Env - Other - Species Shifts (Range/Composition)	12.5%	3.3%
Env - Physical Effects	12.5%	3.3%
Env - Physical Effects - Productivity	12.5%	3.3%
Env - Process - Aquatic - Sea Level Rise	12.5%	3.3%
Env - Temperature - Aquatic - Water - Increase	12.5%	3.3%
Env Change - Ecosystem Configuration / Geography	12.5%	3.3%
Env Change - Health / Survival	12.5%	3.3%
Env Change - Location	12.5%	3.3%
Env Change - Material Inputs	12.5%	3.3%

3. Most Frequently Discussed Current and Potential Future HDCC Effects

Table A-4f. Top frequency individual HDCC effect codes based on all respondents on (a) current issues and (b) future potential issues

(a) All Respondents - Current HDCC Effect Codes	% of All Respondents who mentioned this Current Effect (of 77)	% of Total Current Effects mentioned by Respondents (of 675)
HDCC - Movement of people	48.1%	5.6%
HDCC - Impact on Fisheries	39.2%	4.6%
HDCC - Adaptation/Transformation - Example	32.9%	3.9%
HDCC - Risk	30.4%	3.6%
HDCC - Access to Resources	26.6%	3.1%
HDCC - Impact on Environmental Regulation / Policy	26.6%	3.1%
HDCC - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	25.3%	3.0%
HDCC - Water Supply	25.3%	3.0%
HDCC - Tourism impacted - Increase	24.1%	2.8%
HDCC - Health - Domoic Acid	21.5%	2.5%
HDCC - Recreation - Fish / Shellfish Closure	19.0%	2.2%
HDCC - Recreation - Longer Seasons	19.0%	2.2%
HDCC - Cultural Keystone Species impacted	15.2%	1.8%
HDCC - Behavior / Habits - Management Decisions	13.9%	1.6%
HDCC - Fishing Opportunity	13.9%	1.6%
HDCC - Increasing population (permanent or tourist)	13.9%	1.6%
HDCC - New Industry	13.9%	1.6%
HDCC - Commercial Closure (or Delay)	12.7%	1.5%
HDCC - Timber - Management Responsibilities	12.7%	1.5%
HDCC - Traffic	12.7%	1.5%
HDCC - Behavior / Habits	11.4%	1.3%
HDCC - Gardening	10.1%	1.2%
HDCC - Health - Smoke	10.1%	1.2%
HDCC - Psychological Stress	10.1%	1.2%
HDCC - Recreation - Impacts on Winter Recreation	10.1%	1.2%
HDCC - Timber - Impact on Revenues / Productivity	10.1%	1.2%

(b) All Respondents - Future HDCC Effect Codes	% of All Respondents who mentioned this Future Effect (of 77)	% of Total Future Effects mentioned by Respondents (of 390)
HDCC - Movement of people	34.2%	6.9%
HDCC - Economic Reorganization	29.1%	5.9%
HDCC - Impact on Fisheries	25.3%	5.1%
HDCC - Adaptation/Transformation - Example	21.5%	4.4%
HDCC - Water Supply	19.0%	3.8%
HDCC - Impact on Environmental Regulation / Policy	16.5%	3.3%
HDCC - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	12.7%	2.6%
HDCC - Impacts Appeal of Coastal Oregon	12.7%	2.6%
HDCC - Increasing population (permanent or tourist)	12.7%	2.6%
HDCC - Risk	12.7%	2.6%
HDCC - Access to Resources	11.4%	2.3%
HDCC - Tourism impacted - Increase	11.4%	2.3%
HDCC - Timber - Management Responsibilities	10.1%	2.1%
HDCC - Tourism impacted	10.1%	2.1%
HDCC - Behavior / Habits - Management Decisions	8.9%	1.8%
HDCC - Investment / Divestment	8.9%	1.8%
HDCC - Recreation	8.9%	1.8%
HDCC - Flood / Tide level Impacts	7.6%	1.5%
HDCC - Adaptation/Transformation - Strategy	6.3%	1.3%
HDCC - Behavior / Habits	6.3%	1.3%
HDCC - Cultural Keystone Species impacted	6.3%	1.3%
HDCC - New Industry	6.3%	1.3%
HDCC - Psychological Stress	6.3%	1.3%
HDCC - Strain on Infrastructure & Services	6.3%	1.3%
HDCC - Timber - Impact on Revenues / Productivity	6.3%	1.3%

Table A-4g. Top frequency individual HDCC effect codes based on fisheries respondents on (a) current issues and (b) future potential issues

(a) Fisheries Respondents - Current HDCC Effect Codes	% of Fisheries Respondents who mentioned this Current Effect (of 22)	% of Total Current Effects mentioned by Fisheries Respondents (of 194)
HDCC - Impact on Fisheries	54.5%	6.2%
HDCC - Movement of people	50.0%	5.7%
HDCC - Adaptation/Transformation - Example	45.5%	5.2%
HDCC - Health - Domoic Acid	40.9%	4.6%
HDCC - Recreation - Fish / Shellfish Closure	36.4%	4.1%
HDCC - Commercial Closure (or Delay)	31.8%	3.6%
HDCC - Fishing Opportunity	31.8%	3.6%
HDCC - Access to Resources	27.3%	3.1%
HDCC - Behavior / Habits - Livelihood Decisions	27.3%	3.1%
HDCC - Impact on Environmental Regulation / Policy	22.7%	2.6%
HDCC - Investment / Divestment	22.7%	2.6%
HDCC - Crowding	18.2%	2.1%
HDCC - Cultural Keystone Species impacted	18.2%	2.1%
HDCC - Increasing population (permanent or tourist)	18.2%	2.1%
HDCC - New Industry	18.2%	2.1%
HDCC - Regulatory Conflict	18.2%	2.1%
HDCC - Affect Price of Product	13.6%	1.5%
HDCC - Behavior / Habits - Management Decisions	13.6%	1.5%
HDCC - Employment Concerns (Unemployment / Layoffs / Lack of Workers)	13.6%	1.5%
HDCC - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	13.6%	1.5%
HDCC - Impacts Appeal of Coastal Oregon	13.6%	1.5%
HDCC - Impacts to Aquaculture	13.6%	1.5%
HDCC - Recreation - Longer Seasons	13.6%	1.5%
HDCC - Traffic	13.6%	1.5%

(b) Fisheries Respondents - Future HDCC Effect Codes	% of Fisheries Respondents who mentioned this Future Effect (of 22)	% of Total Future Effects mentioned by Fisheries Respondents (of 105)
HDCC - Impact on Fisheries	36.4%	7.6%
HDCC - Movement of people	31.8%	6.7%
HDCC - Adaptation/Transformation - Example	27.3%	5.7%
HDCC - Impact on Environmental Regulation / Policy	22.7%	4.8%
HDCC - Fishing Opportunity	18.2%	3.8%
HDCC - Behavior / Habits - Livelihood Decisions	13.6%	2.9%
HDCC - Commercial Closure (or Delay)	13.6%	2.9%
HDCC - Cultural Keystone Species impacted	13.6%	2.9%
HDCC - Increasing population (permanent or tourist)	13.6%	2.9%
HDCC - Investment / Divestment	13.6%	2.9%
HDCC - Psychological Stress	13.6%	2.9%
HDCC - Tourism impacted	13.6%	2.9%
HDCC - Access to Resources	9.1%	1.9%
HDCC - Adaptation/Transformation - Example - Diversification	9.1%	1.9%
HDCC - Adaptation/Transformation - Example - Location Switching	9.1%	1.9%
HDCC - Adaptation/Transformation - Example - Species Switching	9.1%	1.9%
HDCC - Affect Price of Product	9.1%	1.9%
HDCC - Behavior / Habits - Management Decisions	9.1%	1.9%
HDCC - Health - Domoic Acid	9.1%	1.9%
HDCC - Impact on Research Topics	9.1%	1.9%
HDCC - Impacts to Aquaculture	9.1%	1.9%
HDCC - Regulatory Conflict	9.1%	1.9%
HDCC - Risk	9.1%	1.9%
HDCC - Traffic	9.1%	1.9%
HDCC - Water Supply	9.1%	1.9%

Table A-4h. Top frequency individual HDCC effect codes based on forest respondents on (a) current issues and (b) future potential issues

(a) Forest Respondents - Current HDCC Effect Codes	% of Forest Respondents who mentioned this Current Effect (of 17)	% of Total Current Effects mentioned by Forest Respondents (of 136)
HDCC - Risk	56.3%	6.6%
HDCC - Adaptation/Transformation - Example	50.0%	5.9%
HDCC - Impact on Env. Regulation / Policy	50.0%	5.9%
HDCC - Water Supply	43.8%	5.1%
HDCC - Behavior / Habits - Management Decisions	37.5%	4.4%
HDCC - Timber - Management Responsibilities	37.5%	4.4%
HDCC - Access to Resources	31.3%	3.7%
HDCC - Adaptation/Transformation - Strategy	25.0%	2.9%
HDCC - Health - Smoke	25.0%	2.9%
HDCC - Impact on Fisheries	25.0%	2.9%
HDCC - Movement of people	25.0%	2.9%
HDCC - New Industry	25.0%	2.9%
HDCC - Timber - Impact on Revenues / Productivity	25.0%	2.9%
HDCC - Adaptation/Transformation - Example - Diversification	18.8%	2.2%
HDCC - Emergency Services Stressed	18.8%	2.2%
HDCC - Recreation - Hunting	18.8%	2.2%
HDCC - Recreation - Impacts on Winter Recreation	18.8%	2.2%
HDCC - Behavior / Habits	12.5%	1.5%
HDCC - Economic Reorganization	12.5%	1.5%
HDCC - Health - Domoic Acid	12.5%	1.5%
HDCC - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	12.5%	1.5%
HDCC - Impacts Appeal of Coastal Oregon	12.5%	1.5%
HDCC - Psychological Stress	12.5%	1.5%
HDCC - Recreation	12.5%	1.5%
HDCC - Recreation - Management Responsibilities	12.5%	1.5%
HDCC - Sense of Place / Special Connection	12.5%	1.5%
HDCC - Subsistence / Local Food Impacts	12.5%	1.5%
HDCC - Water Usage	12.5%	1.5%

(b) Fisheries Respondents - Future Environmental Issues	% of Forest Respondents who mentioned this Future Effect (of 17)	% of Total Future Effects mentioned by Forest Respondents (of 84)
HDCC - Movement of people	37.5%	7.1%
HDCC - Adaptation/Transformation - Example	25.0%	4.8%
HDCC - Timber - Impact on Revenues / Productivity	25.0%	4.8%
HDCC - Timber - Management Responsibilities	25.0%	4.8%
HDCC - Water Supply	25.0%	4.8%
HDCC - Adaptation/Transformation - Strategy	18.8%	3.6%
HDCC - Behavior / Habits - Management Decisions	18.8%	3.6%
HDCC - Cultural Values	18.8%	3.6%
HDCC - Impact on Effectiveness of Restoration / Remediation / Preservation	18.8%	3.6%
HDCC - Impacts Appeal of Coastal Oregon	18.8%	3.6%
HDCC - Increasing population (permanent or tourist)	18.8%	3.6%
HDCC - New Industry	18.8%	3.6%
HDCC - Risk	18.8%	3.6%
HDCC - Sense of Place / Special Connection	18.8%	3.6%
HDCC - Health - Smoke	12.5%	2.4%
HDCC - Impact on Env. Regulation / Policy	12.5%	2.4%
HDCC - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	12.5%	2.4%
HDCC - Impact on Fisheries	12.5%	2.4%
HDCC - Increased uncertainty in planning (gov't or business)	12.5%	2.4%
HDCC - Investment / Divestment	12.5%	2.4%
HDCC - Psychological Stress	12.5%	2.4%
HDCC - Recreation	12.5%	2.4%
HDCC - Tourism impacted - Increase	12.5%	2.4%
HDCC - Water Usage	12.5%	2.4%

Table A-4i. Top frequency individual HDCC effect codes based on tourism and recreation respondents on (a) current issues and (b) future potential issues

(a) Tourism & Recreation Respondents - Current Environmental Issues	% of Tourism & Recreation Respondents who mentioned this Current Effect (of 18)	% of Total Current Effects mentioned by Tourism & Recreation Respondents (of 172)
HDCC - Movement of people	77.8%	8.1%
HDCC - Tourism impacted - Increase	50.0%	5.2%
HDCC - Impact on Fisheries	44.4%	4.7%
HDCC - Increasing pop. (permanent or tourist)	33.3%	3.5%
HDCC - Health - Smoke	27.8%	2.9%
HDCC - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	27.8%	2.9%
HDCC - Recreation - Longer Seasons	27.8%	2.9%
HDCC - Traffic	27.8%	2.9%
HDCC - Water Supply	27.8%	2.9%
HDCC - Access to Resources	22.2%	2.3%
HDCC - Crowding	22.2%	2.3%
HDCC - Gardening	22.2%	2.3%
HDCC - Impact on Env. Regulation / Policy	22.2%	2.3%
HDCC - Recreation - Water Activities	22.2%	2.3%
HDCC - Risk	22.2%	2.3%
HDCC - Adaptation/Transformation - Example	16.7%	1.7%
HDCC - Behavior / Habits	16.7%	1.7%
HDCC - Garbage / Litter	16.7%	1.7%
HDCC - Impacts Appeal of Coastal Oregon	16.7%	1.7%
HDCC - Impacts to Aquaculture	16.7%	1.7%
HDCC - Psychological Stress	16.7%	1.7%
HDCC - Recreation	16.7%	1.7%
HDCC - Recreation - Beach Access	16.7%	1.7%
HDCC - Recreation - Impacts on Winter Recreation	16.7%	1.7%
HDCC - Recreation - Management Responsibilities	16.7%	1.7%
HDCC - Shift in Mindset	16.7%	1.7%
HDCC - Shifting Attitudes	16.7%	1.7%
HDCC - Strain on Infrastructure & Services	16.7%	1.7%
HDCC - Water Usage	16.7%	1.7%

(b) Tourism & Recreation Respondents - Future Environmental Issues	% of Tourism & Recreation Respondents who mentioned this Future Effect (of 18)	% of Total Future Effects mentioned by Tourism & Recreation Respondents (of 98)
HDCC - Impact on Fisheries	38.9%	7.1%
HDCC - Movement of people	38.9%	7.1%
HDCC - Tourism impacted	33.3%	6.1%
HDCC - Access to Resources	22.2%	4.1%
HDCC - Risk	22.2%	4.1%
HDCC - Tourism impacted - Increase	22.2%	4.1%
HDCC - Impact on Coastal Infrastructure / New Infrastructure Development (incl. Real Estate)	16.7%	3.1%
HDCC - Impacts Appeal of Coastal Oregon	16.7%	3.1%
HDCC - Increasing pop. (permanent or tourist)	16.7%	3.1%
HDCC - Recreation - Beach Access	16.7%	3.1%
HDCC - Recreation - Management Responsibilities	16.7%	3.1%
HDCC - Water Supply	16.7%	3.1%
HDCC - Adaptation/Transformation - Example	11.1%	2.0%
HDCC - Coastal Erosion Threatens Homes	11.1%	2.0%
HDCC - Behavior / Habits	11.1%	2.0%
HDCC - Cultural Resource Impacts	11.1%	2.0%
HDCC - Cultural Values	11.1%	2.0%
HDCC - Impact on Env. Regulation / Policy	11.1%	2.0%
HDCC - Increased planning uncertainty	11.1%	2.0%
HDCC - Recreation	11.1%	2.0%
HDCC - Timber - Impact on Revenues / Productivity	11.1%	2.0%

Table A-4j. Top frequency individual HDCC effect codes based on coastal infrastructure respondents on (a) current issues and (b) future potential issues

(a) Coastal Infrastructure Respondents - Current HDCC Effect Issues	% of Coastal Infrastructure Respondents who mentioned this Current Effect (of 8)	% of Total Current Effects mentioned by Coastal Infrastructure Respondents (of 58)
HDCC - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	62.5%	8.6%
HDCC - Fishing Opportunity	50.0%	6.9%
HDCC - Access to Resources	37.5%	5.2%
HDCC - Adaptation/Transformation - Example	37.5%	5.2%
HDCC - Impact on Fisheries	37.5%	5.2%
HDCC - Movement of people	37.5%	5.2%
HDCC - Maintenance Requirements	25.0%	3.4%
HDCC - Recreation - Sport Fishing	25.0%	3.4%
HDCC - Regulatory Conflict	25.0%	3.4%
HDCC - Timber - Management Responsibilities	25.0%	3.4%
HDCC - Tourism impacted - Decrease	25.0%	3.4%
HDCC - Tourism impacted - Increase	25.0%	3.4%

(b) Coastal Infrastructure Respondents - Future Environmental Issues	% of Coastal Infrastructure Respondents who mentioned this Future Effect (of 8)	% of Total Future Effects mentioned by Coastal Infrastructure Respondents (of 26)
HDCC - Impact on Existing Infrastructure / New Infrastructure Development (incl. Real Estate)	37.5%	11.5%
HDCC - Impact on Env. Regulation / Policy	25.0%	7.7%