Coquille Estuary Climate Change Vulnerability Assessment

January 2014

Appendices

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Jeff Weber, Oregon Coastal Management Program

Chris Swenson, U.S. Fish and Wildlife Service

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Steve Denney, The Nature Conservancy

January 2014

This project is dedicated to Kristle Volin, who worked tirelessly to help the Coquille River estuary remain beautiful for all to enjoy

Special thanks to Nicholas Jones, Rich Young and Dan Uthman for their expertise in SLAMM, GIS, and cartography

This project was generously funded by the U.S. Fish and Wildlife Service through the North Pacific Landscape Conservation Cooperative. It could not have been completed without significant contributions from project partners including TNC, the Coquille Watershed Association, the Oregon Department of Fish and Wildlife, and the South Slough National Estuarine Research Reserve.

Appendices

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Appendix A

Project Expert Panel Participants

Project Expert Panel Participants

The authors are grateful to those listed below who kindly provided valuable project input. Other local and regional experts were invited but were not able to participate.

(*Denotes project steering committee member)

Larry Basch, South Slough NERR

Bill Bridgeland, U.S. Fish and Wildlife Service, Bandon Refuge

Kevin Buffington, Oregon State University

Chris Claire, Oregon Department of Fish and Wildlife

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Debbie Reusser, U.S. Geological Survey

Steve Rumrill, Oregon Department of Fish and Wildlife

Chris Swenson*, U.S. Fish and Wildlife Service Coastal Program

Dick Vander Schaaf, The Nature Conservancy

Jeff Weber*, Oregon Coastal Management Program

Appendix B

Information Sent to Participants Prior to the Expert Panel Meeting

Please note that the material in this appendix is intended to demonstrate the breadth and depth of data and other information that was provided to the expert panel to support its activities. Some of these data were preliminary at the time of the expert panel's workshop. As such, note that differences may exist between this preliminary data and the final data presented in the report.

Coquille Estuary Climate Change Vulnerability Project

Expert Panel Meeting 2 Information Package

The information contained here is in draft form. Please do not distribute.

Contact Eric Mielbrecht with any questions
Eric@EcoAdapt.org / 206 201 3244

The project is co-led by EcoAdapt, The Nature Conservancy, the Oregon Coastal Management Program of the Oregon Dept. of Land Conservation and Development, and the Coastal Program of the U.S. Fish and Wildlife Service. Many other organizations and entities have participated through workshops and other means.

Eric Mielbrecht | Directing Scientist & Director of Operations, EcoAdapt
Steve Denney |South Coast Conservation Director, The Nature Conservancy
Jeffrey A. Weber | Coastal Conservation Coordinator, Oregon Coastal Management Program Oregon Dept. of Land Conservation and Development
Chris Swenson |Coastal Program Regional Coordinator, Pacific Region, U.S. Fish and Wildlife Service
David Patte |Climate Change Coordinator, Pacific Region, U.S. Fish and Wildlife Service

Contents

Available on the Project Webpage

1. *Climate Change and the Lower Coquille Watershed*
2. *Coquille River Basin Stream Temperature Assessment*
3. *USGS Open-File Report 2012-1274: Potential Climate-Induced Runoff Changes and Associated Uncertainty in Four Pacific Northwest Estuaries*
4. *Preliminary Assessment of Channel Stability and Bed-Material Transport in the Coquille River Basin, Southwestern Oregon*
5. *Scanning the Conservation Horizon: A guide to Climate Change Vulnerability Assessment.*

Available on Dedicated Computers During Meeting 2

1. *Coquille Estuary Climate Change Vulnerability Assessment,* project rough draft report
2. Coquille River Basin Mapping Resources
3. SLAMM results pdf Atlas. Full pdf Atlas of SLAMM results is also available for download at: http://www.fws.gov/pacific/ecoservices/CoquilleCCVA/Coquille_PDF_Atlas.zip

Assessing Climate Change Vulnerability

Vulnerability = Exposure + Sensitivity ± Adaptive Capacity

Vulnerability:
Climate change vulnerability refers to the extent to which a species, habitat, or ecosystem process is susceptible to harm from climate change impacts

Exposure:
Measure of how much of a change in climate or other environmental factor a species or system is likely to experience

Sensitivity:
Measure of whether and how a species or system is likely to be affected by a given change in climate or factors driven by climate

Adaptive Capacity:
Ability to accommodate or cope with climate change impacts with minimal disruption

Habitat - Exposure

<table>
<tr><th>Habitat</th><th>Coquille Mid SLR (SLAMM) 2030 Dikes Intact</th><th>Coquille Mid SLR (SLAMM) 2050 Dikes Intact</th><th>Air Temperature</th><th>Water Temperature</th><th>Precipitation</th><th>Hydrology / Flow</th><th>Ocean Acidification</th><th>Upwelling</th><th>Waves/Wind</th></tr>
<tr><td></td><td colspan="9">Exposure</td></tr>
<tr><td>1. Estuarine Open Water</td><td rowspan="10">8cm / 3in SLR (eustatic)</td><td rowspan="10">21cm / 8in SLR (eustatic)</td><td rowspan="10">+1.8°C annual mean air temp
+2.3°C in summer (2060)</td><td rowspan="2">+0.9°C at top of estuary (2060)
+1°C at ocean (2050 A1B)</td><td rowspan="10">Overall Annual precipitation unchanged
Drier summers
Increased winter extreme events</td><td rowspan="10">Somewhat lower flows in summer
Higher flow in fall
Increased winter flood/high flow events possible
Salinity changes possible</td><td rowspan="4">Nearshore pH may be as low as 7.82 (2050)</td><td rowspan="5">Inconclusive</td><td rowspan="10">Potential increase in wave height and wind speed in the NE Pacific Ocean
Increase in SLR+wind+wave driven flooding (100yr floods every 5 years)</td></tr>
<tr><td>2. Eelgrass (map data gap)</td></tr>
<tr><td>3. Tidal Flat</td><td rowspan="5">+0.9°C at mouths of three tributaries (2060)</td></tr>
<tr><td>4. Tidal Saltmarsh</td></tr>
<tr><td>5. Tidal Transitional Marsh</td><td></td></tr>
<tr><td>6. Tidal Freshwater Marsh</td><td></td><td></td></tr>
<tr><td>7. Tidal Freshwater Swamp</td><td></td><td></td></tr>
<tr><td>8. Nontidal Freshwater Marsh</td><td></td><td></td><td></td></tr>
<tr><td>9. Nontidal Freshwater Swamp</td><td></td><td></td><td></td></tr>
<tr><td>10. Upland Riparian (map data gap)</td><td></td><td></td><td></td></tr>
</table>

~ = no significant change
<10% = less than 10% change

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Habitat - Sensitivity

Habitat (2011 SLAMM Habitat Area)	Coquille Mid SLR (SLAMM) 2030 Dikes Intact (% change in habitat area)	Coquille Mid SLR (SLAMM) 2050 Dikes Intact (% change in habitat area)	Air Temperature	Water Temperature	Precipitation	Hydrology / Flow	Ocean Acidification	Upwelling	Waves/Wind
	EXPOSURE Summary								
	8cm / 3in SLR (eustatic)	21cm / 8in SLR (eustatic)	+1.8°C annual mean air temp +2.3°C in summer (2060)	+0.9°C at mouths of three tributaries (2060) +1°C at ocean (2050 A1B)	Overall Annual precipitation unchanged Drier summers Increased winter extreme events	Lower flows in summer Increased winter flood/high flow events possible Salinity changes possible	Nearshore pH may be as low as 7.82 (2050)	**Inconclusive**	Potential increase in wave height and wind speed in the NE Pacific Ocean Increase in SLR+wind+wave driven flooding (100yr floods every 5 years)
	SENSITIVITY								
1. Estuarine Open Water (1150 acres)	<10%	<10%	Eelgrass wasting disease affected by temp	Water temp is a major factor driving physiology and respiration, transpiration (WQ, DO)	(see hydrology/flow)→	Increasing salinity in summer possible Increasing winter freshwater flood events possible- delivering sediment, nutrients, woody debris	Early life stages and shell building organisms sensitive to decreasing pH		Increased shore erosion, changes in channels Flood driven changes, sediment & debris movement
2. Eelgrass (map data gap)	Light limited, less light in deeper water	Light limited, less light in deeper water	Increases in air temperature may cause more drying, especially in low tide systems Eelgrass wasting disease affected by temp			Increasing salinity in summer possible Increasing winter freshwater flood events possible- delivering sediment, nutrients, woody debris Eelgrass wasting disease affected by salinity			
3. Tidal Flat (926 acres)	+25% Tidal Flat <10% Ocean Beach <10% Estuarine Beach	+123% Tidal Flat -38% Ocean Beach <10% Estuarine Beach	Increases in air temperature may cause more drying, especially in low tide systems			Increasing salinity in summer possible Increasing winter freshwater flood events possible- delivering sediment, nutrients, woody debris			
4. Tidal Saltmarsh (255 acres Feg Flooded Marsh, 407 acres Irreg Flooded Marsh)	+68% Reg Flooded Marsh (<10% Irreg Flooded Marsh)	+66% Reg Flooded Mash (<10% Irreg Flooded Marsh)							
5. Tidal Transitional Marsh (46 acres Trans Salt Marsh, 407 acres Irreg Flooded Marsh)	+271% Trans Salt Marsh (<10% Irreg Flooded Marsh)	+279% Trans Salt Marsh (<10% Irreg Flooded Marsh)							
6. Tidal Freshwater Marsh (9 acres)	-14% Tidal Fresh Marsh	-14% Tidal Fresh Marsh							
7. Tidal Freshwater Swamp (4 acres Tidal Swamp, 1,258 acres Swamp)	<10% Tidal Swamp <10% Swamp	<10% Tidal Swamp <10% Swamp	Shrub scrub and forested wetlands are relatively resilient						
8. Nontidal Freshwater Marsh (12,476 acres Inland Fresh Marsh)	<10% Inland Fresh Marsh	<10% Inland Fresh Marsh	Increases in air temperature may cause more drying, especially in low tide systems		Increasing winter freshwater flood events possible				
9. Nontidal Freshwater Swamp (1,258 acres Swamp, 12,476 acres Inland Fresh Marsh)	<10% Swamp <10% Inland Fresh Marsh	<10% Swamp <10% Inland Fresh Marsh	Shrub scrub and forested wetlands are relatively resilient						
10. Upland Riparian (map data gap)	NA								

<10% = less than 10% change

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Habitat - Vulnerability

Habitat	Coquille Mid SLR (SLAMM) 2050 Dikes Intact (% change in habitat area)	Air Temperature	Water Temperature	Precipitation	Hydrology / Flow	Ocean Acidification	Upwelling	Waves/Wind
	Vulnerability							
1. Estuarine Open Water	Low- Minimal increase in habitat area	Low- Influenced primarily by ocean temp	Medium- +1C, estuary species adapted to temp fluxes		Medium- higher salinity in summer, very low salinity during floods	High- The lower estuary is most influenced by ocean water Early life stages and shell builders are likely to be at risk		Medium- storm waves and flooding may alter lower estuary structure
2. Eelgrass Meadow (map data gap)	Medium- light limited by depth (no habitat area data)	Medium- more low-tide drying possible	Medium- Reduced productivity & loss beyond upper thermal limits (species dependent, +5C *Z.m.*) Thermal stress increases susceptibility to wasting disease		Medium- Affected by increased turbidity and sedimentation. Higher salinity increases susceptibility to wasting disease.	Low- Productivity may increase with increased water CO2		Medium- Affected by increased turbidity and sedimentation. Flooding depth may limit light.
3. Tidal Flat	Low- Large increase in tidal flat habitat (Ocean beach not considered)	Medium- more low-tide drying possible, especially during warm summers	Low- Water temp effects physiology, but tidal flat species used to broad temp ranges		Medium- High erosion and sedimentation during flood events. Higher salinity in summer and greater fluctuations	Medium- Early life stages and shell builders at risk		Medium- Erosion and sedimentation from storm waves and flooding
4. Tidal Salt Marsh	Low- Large increase in tidal salt marsh	Medium- more low-tide drying possible, especially during warm summers. Increased transpiration.	Low- Water temp effects physiology, but marsh species used to broad temp ranges	(see hydrology/flow)→	Medium- High erosion and sedimentation during flood events. Flooding caused inundation. Higher salinity in summer and greater fluctuations	Medium- Early life stages and shell builders at risk		Medium- Erosion and sedimentation from storm waves and flooding
5. Tidal Transitional Marsh	Low- Very large increase in Trans Salt Marsh	Medium- more low-tide drying possible, especially during warm summers. Increased transpiration.	Low- Water temp effects physiology, but marsh species used to broad temp ranges		Medium- High erosion and sedimentation during flood events. Flooding caused inundation. Higher salinity in summer and greater fluctuations.	Low- Lower influence from ocean acidification		Medium- Erosion and sedimentation from storm waves and flooding
6. Tidal Freshwater Marsh	Medium- Decrease in tidal freshwater marsh area	Medium- more low-tide drying possible, especially during warm summers. Increased transpiration.	Low- Water temp effects physiology, but marsh species used to broad temp ranges		Medium- High erosion and sedimentation during flood events. Flooding caused inundation. Possible salinity increases in summer.	Low- Little to no connection to ocean water		Low- Erosion and sedimentation from storm waves and flooding, but minimal in smaller channels
7. Tidal Freshwater Swamp	Low- Minimal change in tidal freshwater swamp area	Low- More low-tide drying possible, especially during warm summers. Increased transpiration. Shrub scrub and forested wetlands more resilient.	Low- Water temp effects physiology, but swamp species used to broad temp ranges		Medium- High erosion and sedimentation during flood events. Flooding caused inundation. Possible salinity increases in summer.	Low- Little to no connection to ocean water		Low- Erosion and sedimentation from storm waves and flooding, but minimal in smaller channels
8. Nontidal Freshwater Marsh	Low- Little change in nontidal freshwater marsh area	Medium- More drying possible, especially during warm summers. Increased transpiration.	Low- Water temp effects physiology, but marsh species used to broad temp ranges	Medium- Drier summers, winter precip coming in extreme events.	Medium- High erosion and sedimentation during flood events. Flooding caused inundation.	Low- No connection to ocean water		Low- Erosion and sedimentation from storm waves and flooding, but minimal in smaller channels
9. Nontidal Freshwater Swamp	Low- Little change in nontidal freshwater swamp area	Low- More drying possible, especially during warm summers. Increased transpiration. Shrub scrub and forested wetlands more resilient.	Low- Water temp effects physiology, but swamp species used to broad temp ranges	Medium- Drier summers, winter precip coming in extreme events.	Medium- High erosion and sedimentation during flood events. Flooding caused inundation.	Low- No connection to ocean water		Low- Erosion and sedimentation from storm waves and flooding, but minimal in smaller channels
10. Upland Riparian (map data gap)	NA	Low- More drying possible, especially during warm summers. Increased transpiration. Shrub scrub and forested areas more resilient.		Medium- Drier summers, winter precip coming in extreme events.	Medium- Erosion and sedimentation during flood events. Flooding caused inundation.			Low- Erosion and sedimentation from storm waves and flooding, but minimal in smaller channels

<10% = less than 10% change

Species & Habitats

<table>
<tr><th>Species</th><th>Species Relevance (to include more details)</th><th>1. Estuarine Open Water</th><th>2. Eelgrass</th><th>3. Tidal Flat</th><th>4. Tidal Saltmarsh</th><th>5. Tidal Transitional Marsh</th><th>6. Tidal Freshwater Marsh</th><th>7. Tidal Freshwater Swamp</th><th>8. Nontidal Freshwater Marsh</th><th>9. Nontidal Freshwater Swamp</th><th>10. Upland Riparian</th></tr>
<tr><td>Invertebrates</td><td></td><td colspan="10"></td></tr>
<tr><td>Dungeness crab
(Metacarcinus magister)</td><td>Important to mangers
Important sport & commercial species.
Secure species.</td><td colspan="5">Juveniles (2yr): Shallow estuarine areas with protective structures, woody debris, eelgrass; 2 years
Adults (3+yr): sandy and muddy areas in shallowest parts of lower estuaries and to 200ft. depth</td><td colspan="5"></td></tr>
<tr><td>Fish</td><td></td><td colspan="10"></td></tr>
<tr><td>Coho salmon
(Ncorhynchus kisutch)</td><td>Important to managers and tribes
Important sport fish
Vulnerable & threatened species in OR
Long Distance Migrant</td><td colspan="4">Habitat: Bay/Sound, river mouth/ Tidal River
Juveniles: overwinter in lower watershed, off-channel habitats.
Summer Parr (may-June): utilize tidal reach/ estuary, slow cold water, off-channel habitats
Overwinter rearing: salt marshes and off-channel habitats (less common)
Smolt migration: remain in estuary 2-3 wks for acclimation, cold water, off-channel habitats
Food: Insects, aquatic inverts, fish</td><td colspan="6">Above the Estuary: Streams most important: spawning, early life stages
Habitat: Big, Medium River, Pools, Riffle
Stream spawning/rearing/overwintering: woody debris, structural cover, shade, pools, complex channels
Food: Insects, aquatic inverts, fish</td></tr>
<tr><td>Pacific lamprey
(Entosphenus tridentatus, Lapmetra tridentata)</td><td>Important to managers and tribes
Vulnerable species in OR
Long Distance Migrant</td><td colspan="5">Habitat: Bay/Sound, River mouth/Tidal river; Predatory phase ocean, stream mouths in estuaries
Migrate up estuary to freshwater streams for spawning.
Juveniles migrate down estuary to ocean for adult lifestage
Food: Herbivore, Invertivore, Piscivore</td><td colspan="4">Spawning in freshwater streams.
Ammocoete life stage in freshwater streams. Prefer habitat similar to salmon
Food: Larval stage filter feeders</td><td></td></tr>
<tr><td>Birds</td><td></td><td colspan="10"></td></tr>
<tr><td>Northern pintail
(Anas acuta)</td><td>Important to Refuge
Secure species in OR
Winter resident, non-breeding resident, long distance migrant</td><td colspan="3">Habitat: River mouth/tidal river, tidal flats/shore
Feeding: aquatic plant seeds, aquatic inverts, insects, fish</td><td colspan="2">Habitat: Herbaceous wetland. Winters brackish waters
Feeding: aquatic plant seeds, aquatic inverts, insects, fish</td><td colspan="5">Habitat: Herbaceous wetland, riparian; Winters freshwater lagoons
Breeding: Marshes, ponds in grasslands, associated with seasonal & semi permanent wetlands
Feeding: aquatic plant seeds, aquatic inverts, insects, fish</td></tr>
<tr><td>Western sandpiper
(Calidris mauri)</td><td>Important to Refuge
Non-breeding resident, long distance migrant</td><td colspan="2"></td><td colspan="5">Habitat: tidal flats/shore- muddy, sandy, or gravelly shores
Feeding: aquatic insects, mollusks, worms, crustaceans</td><td colspan="3">Habitat: Riparian, Temporary Pools
Feeding: aquatic insects, mollusks, worms, crustaceans</td></tr>
<tr><td>Mammals</td><td></td><td colspan="10"></td></tr>
<tr><td>Beaver
(Castor canadensis)</td><td>Keystone species
Secure population in OR
Permanent resident</td><td colspan="4"></td><td colspan="6">Habitat: Riparian, deciduous tree and shrub communities
Beaver lodges/dam in tidal scrub/shrub in Puget Sound
Food: Herbivore</td></tr>
</table>

Species & Exposure

Species	Sea Level Rise	Air Temperature	Water Temperature	Precipitation	Hydrology / Flow	Ocean Acidification	Upwelling	Waves/Wind
Invertebrates	**Exposure**							
Dungeness crab (*Metacarcinus magister*)	Little change in deep estuary habitats. Eelgrass beds may decrease or shift due to lower light penetrance. Tidal Flats, Tidal Saltmarsh & Tidal Transitional Saltmarsh predicted to expand	NA	+0.9°C at top of estuary (2060) +1°C at ocean (2050 A1B)	See Hydrology / Flow	Somewhat lower flows in summer Higher flow in fall Increased winter flood/high flow events possible Salinity changes possible	Nearshore pH decreasing & may be as low as 7.82 (2050)	Inconclusive	Potential increase in wave height and wind speed in the NE Pacific Ocean Increase in SLR+wind+wave driven flooding (100yr floods every 5 years)
Fish								
Coho salmon (N*corhynchus kisutch*) Pacific lamprey (*Entosphenus tridentatus, Lapmetra tridentata*)	Little change in deep estuary habitats. Eelgrass beds may decrease or shift due to lower light penetrance. Tidal Flats, Tidal Saltmarsh & Tidal Transitional Saltmarsh predicted to expand	NA	+0.9°C at top of estuary (2060) +1°C at ocean (2050 A1B) '+0.9°C at mouths of three tributaries (2060)	See Hydrology / Flow	Somewhat lower flows in summer Higher flow in fall Increased winter flood/high flow events possible Salinity changes possible	Nearshore pH decreasing & may be as low as 7.82 (2050)	Inconclusive	Potential increase in wave height and wind speed in the NE Pacific Ocean Increase in SLR+wind+wave driven flooding (100yr floods every 5 years)
Birds								
Northern pintail (*Anas acuta*) Western sandpiper (*Calidris mauri*)	Little change in estuary open water areas. Tidal Flats, Tidal Saltmarsh & Tidal Transitional Saltmarsh predicted to expand. Tidal Fresh Marsh predictected to decrease.	+1.8°C annual mean air temp +2.3°C in summer (2060)	+0.9°C at top of estuary (2060) +1°C at ocean (2050 A1B) '+0.9°C at mouths of three tributaries (2060)	Overall Annual precipitation unchanged Drier summers Increased winter extreme events	Somewhat lower flows in summer Higher flow in fall Increased winter flood/high flow events possible Salinity changes possible	Nearshore pH decreasing & may be as low as 7.82 (2050)	Inconclusive	Potential increase in wave height and wind speed in the NE Pacific Ocean Increase in SLR+wind+wave driven flooding (100yr floods every 5 years)
Mammals								
Beaver (*Castor canadensis*)	Tidal Flats, Tidal Saltmarsh & Tidal Transitional Saltmarsh predicted to expand. Tidal Fresh Marsh predictected to decrease.	+1.8°C annual mean air temp +2.3°C in summer (2060)	+0.9°C at top of estuary (2060) +1°C at ocean (2050 A1B) '+0.9°C at mouths of three tributaries (2060)	Overall Annual precipitation unchanged Drier summers Increased winter extreme events	Somewhat lower flows in summer Higher flow in fall Increased winter flood/high flow events possible Salinity changes possible	NA	NA	Potential increase in wave height and wind speed in the NE Pacific Ocean Increase in SLR+wind+wave driven flooding (100yr floods every 5 years)

Species & Sensitivity

Species	Overall Sensitivity[1]	Sea Level Rise (Sensitivity of Habitat)	Air Temperature	Water Temperature	Precipitation	Hydrology / Flow	Ocean Acidification	Upwelling	Waves/Wind
Invertebrates					**Sensitivity**				
Dungeness crab (*Metacarcinus magister*)	Not Reported	Sensitive to changes in shallow estuarine habitats, eelgrass, sandy and muddy areas of lower estuary.	NA	Directly sensitive to salinity changes at certain life stages, and water quailty in general. Indirectly sensitive to changes in food availabilty.	See Hydrology	Directly sensitive to salinity changes at certain life stages, and water quailty in general.	Sensitive to decreasing pH	Sensitive to hypoxia events. Indirectly sensitive to changes in food availabilty.	Sensitive to flooding events
Fish									
Coho salmon (*Ncorhynchus kisutch*)	Not Reported	Sensitive to changes in estuaries, rivers, salt marshes, off-channel habitats. Sensitive to change in habitat based food sources.	NA	Directly sensitive to temperature (streams, spawning, larvae)	See Hydrology	Directly sensitive to flow timing and volume (streams, spawning, larvae, eggs)	Directly and indirectly sensitive to lower pH.	Directy sensitive to hypoxia events. Indirectly sensitive to changes in food availabilty (adult).	Sensitive to flooding and scouring events (eggs, larvae)
Pacific lamprey (*Entosphenus tridentatus, Lapmetra tridentata*)	High (Record not yet completed)	Sensitive to chages in coastal lowlands, marshes, estuaries, beaches. Sensitive to channelization, side channel loss, scouring. Spawning in seasonal streams Sensitive to barriers	NA	Directly sensitive to elevated water temerature (ammocetes), though not as much as salmonids.	See Hydrology	Directly sensitive to salinity changes at certain life stages, and water quailty in general (streams).	Potentially directly sensitive to lower pH.	Directly sensitive to hypoxia events. Indirectly sensitive to changes in food availabilty (adult, juvenile).	Sensitive to flooding and scouring events (ammocetes)
Birds									
Northern pintail (*Anas acuta*)	High (Confidence Poor)	Sensitive to changes in nesting habitat: marshes, grassland ponds, seasonal & semi permanent wetlands (migratory stopover sites). Indirectly sensitive to habitat based food availability. Medium philopatry.	Nesting initation & success related to temperature, precipitation & storms	NA	Nesting initation & success related to temperature, precipitation & storms. Habitat & food sources sensitive to precipitation & storms	Nesting and feeding habitat sensitive to hydrologic change & flooding	Indirectly sensitive to changes in food sources	Indirectly sensitive to changes in food sources	Nesting initation & success related to temperature, precipitation & storms. Habitat & food sources sensitive to storms & flooding.
Western sandpiper (*Calidris mauri*)	Medium (Confidence Poor)	Sensitive to changes in coastal lowlands, marshes, estuaries & beaches (migratory stopover sites). Indirectly sensitive to habitat based food availability. High philopatry.	Habitat sensitive to temperature	NA	Habitat & food sources sensitive to precipitation & storms	Habitat & food sources sensitive to hydrologic change & storms	Indirectly sensitive to changes in food sources	Indirectly sensitive to changes in food sources	Habitat & food sources sensitive to storms & flooding.
Mammals									
Beaver (*Castor canadensis*)	Medium (Confidence Fair)	Sensitive to changes in wetlands, vernal pools, seasonal streams, marshes, estuaries, beaches. Indirectly sensitive to habitat based food availability	Habitat sensitive to temperature	NA	Habitat & food sources sensitive to precipitation & storms	Habitat & food sources sensitive to hydrologic change & storms	NA	NA	Habitat sensitive to storms & flooding.

1 Climate Change Sensitivity Database (http://climatechangesensitivity.org)

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Species & Vulnerability

Species	Sea Level Rise (Effect on Habitat)	Air Temperature	Water Temperature	Precipitation	Hydrology / Flow	Ocean Acidification	Upwelling	Waves/Wind
Invertebrates	**Vulnerability**							
Dungeness crab (*Metacarcinus magister*)	Low- Most habitat predicted to expand with SLR (Eelgrass beds vulnerable to SLR)	NA	Low- ?	See Hydrology	Medium- Erosion & sedimentation during flood events. Higher salinity in summer & higher fluctuation during floods.	High- Shell-building sensitive. Early life stages sensitive. Food sources sensitive.	Medium- Upwelling can bring hypoxic water.	Medium- Storms & flooding may alter estuary structure, increase turbidity & sedimentation, & limit light.
Fish								
Coho salmon (*Neorhynchus kisutch*)	Low- Tidal Flat, Tidal Salt Marsh habitats expand. Tidal Freshwater Marsh, Tidal Freshwater Swamp habitats decrease. Others little change.	NA	Medium (lower estuary)- Juveniles less sensitive to temperature. High (above estuary)- Eggs, larvae very sensitive. Portions of watershed already above temp criteria.	See Hydrology	Medium (estuary)- Erosion & sedimentation during flood events. Higher salinity in summer. High (above estuary)- Lower summer flow and freshet timing.	Medium (lower estuary)- Physiology and food sources sensitive to pH.	Low- Little trend in upwelling.	Medium (estuary)- Erosion & sedimentation during flood events. High (above estuary)- Sensitive to flooding and scouring events (eggs, larvae)
Pacific lamprey (*Entosphenus tridentatus, Lapmetra tridentata*)	Low- Tidal Flat, Tidal Salt Marsh habitats expand. Tidal Freshwater Marsh, Tidal Freshwater Swamp habitats decrease. Others little change.	NA	Low (lower estuary)- non-resident Medium (above estuary)- Ammocete stage sensitive to temperature, though not as sensitive as salmonids.	See Hydrology	Medium (estuary)- Turbidity during flood events. Water quality during low summer flow. Medium (above estuary)- Low summer flow, water quality, winter flood events.	Medium (lower estuary)- Physiology and food sources sensitive to pH.	Low- Little trend in upwelling.	Medium (estuary)- Erosion & sedimentation during flood events. High (above estuary)- Sensitive to flooding and scouring events (ammocetes)
Birds								
Northern pintail (*Anas acuta*)	Medium- breeding habitat potentially decreasing. Estuarine foraging habitat expanding.	Medium- Temp changes may effect phenology. Overall warming & summer highs may alter important habitat.	NA	High- Habitat & food sources sensitive to precipitation timing & amount.	High- Habitats sensitive to summer low flow and winter flood events.	Low- Food availability may change in lower estuary.	Low- Little trend in upwelling.	High- Storms affect phenology. Habitat & food sources sensitive to storms & flooding.
Western sandpiper (*Calidris mauri*)	Low- Tidal Flat, Tidal Salt March, Tidal Transitional Marsh habitat expanding. Tidal Freshwater Marsh, Tidal Freshwater Swamp contracting.	Medium- Temp changes may effect phenology. Overall warming & summer highs may alter important habitat.	NA	Medium- Habitat & food sources sensitive to precipitation timing & amount.	Low- Some habitats sensitive to summer low flow and winter flood events.	Low- Food availability may change in lower estuary.	Low- Little trend in upwelling.	Medium- Storms affect phenology. Food sources and some habitat sensitive to storms & flooding.
Mammals								
Beaver (*Castor canadensis*)	Medium- Tidal Transitional Marsh expanding. Tidal Freshwater Marsh, Tidal Freshwater Swamp contracting. Little change in Nontidal Freshwater Marsh and Nontidal Swamp habitat.	Medium- Overall warming & summer highs may alter important habitat.	NA	Medium- Habitat & food sources sensitive to precipitation timing & amount.	Medium- Habitats sensitive to summer low flow and winter flood events.	NA	NA	Medium- Habitat sensitive to storms & flooding.

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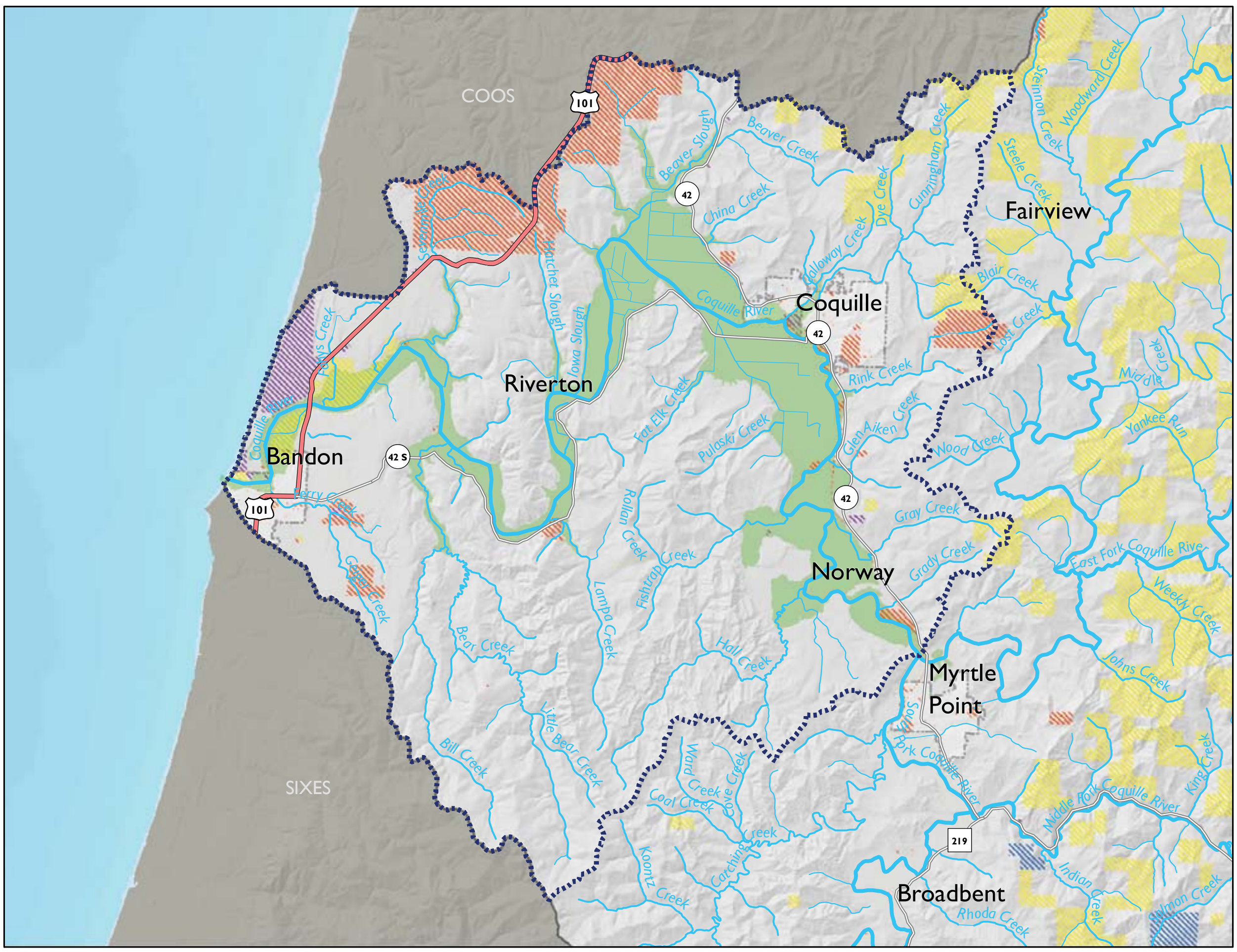
Climate-Related Parameter	Historical Change & Projection(s)
Temperature	Historical: There has been a warming trend of 0.1°C (0.2°F) per decade (1903-2010 period at the nearest North Bend station). While this trend has varied by season, all seasons show a warming trend. Projections: 2040s: Increase in the annual mean temperature of 1.3°C (2.3°F), range 0.7-1.9°C (1.3-3.4°F). 2060s: Increase in the annual mean temperature of 1.8°C (3.2°F), range 1.2-2.6°C (2.1-4.7°F). For both decades, the summer months have the largest projected temperature increase, as well as the largest projection range.
Precipitation	Historical: There is no statistically significant trend in precipitation (1903-2010 at North Bend weather station). Projections: 2040s and 2060s: The data suggest drier summers. Inconclusive as to whether total annual precipitation will increase or decrease. Data suggests an increase in winter extreme precipitation events.
Ocean Acidification	Historical: Over the past 250 years, there has been about a 16% decrease in aragonite and calcite saturation state in the Pacific Ocean due to ocean acidification processes (calcifiers, such as shellfish and some plankton, depend on calcite and aragonite for shell building). Recently published results of repeat oceanographic surveys in the Pacific Ocean show accelerating ocean acidification trends over the past 14-year period (average 0.34% per year decrease in aragonite and calcite saturation state of surface seawater). Projections: pH will continue to drop (i.e. increased acidification). Annual mean pH by 2050 projected to drop to 7.82 +/-0.04 (10 km nearshore, A2 emissions), compared to a pre-industrial value of 8.03 +/-0.03.
Local Relative Sea Level Rise	Historical: Globally, sea level has risen approx. 22 cm (8.7 inches) since 1870. In the Coquille Estuary, the land is rising due to local geologic forces, and thus the area has not yet experienced significant sea level rise. Projections: For Coos Bay, OR average sea level rise is forecast to increase +9 cm (+3.5 inches) by 2030; and +24 cm (+9.4 inches) by 2050 relative to 2008. Projections for the Coquille Estuary would be lower due to the area's current upward vertical land movement. The range of sea level rise in the region from northern California to the Puget Sound (due to many localized factors) is -3.5 inches to +22.7 inches by 2030; and -2.1 inches to +48.1 inches by 2050 compared to 2008.

Hydrology/ Stream Flow (Steele et al. 2012)	Historical: No historic trend. Projections: Higher mean flow in the fall likely, with the possibility of lower mean flow in the late summer. Probable increase in high flow events (top 5%). (All are 2041-2065 compared to 1971-1995). (Steele et al. 2012)
Stream Temperature (Mayer 2012)	Historical: Stream temperature data are mostly available for sites at and upstream of the mouths of the three major tributaries (North Folk, Middle Fork and South Fork). The 7-day average summer maxima range from 22 ˚C to 24.6˚C (the temperature criterion is 16˚C). Daily average temperature for the lower mainstem Coquille (only four days of data from Sept 11-14, 2007) was 19.9˚C at RM 30 and 20.2˚C at RM 23 (the temperature criterion is 20˚C). Projections: Stream temperatures at the mouths of all three tributaries are estimated to increase about 0.7°C by the 2040s and 0.9°C by the 2060s given the projections in air temperature increases for the area.
Upwelling (Sharp 2012)	Historical and Projections: Inconclusive. Some data suggests increased upwelling.
Waves/ Storms (Sharp 2012)	Historical and Projections: Suggestion of increased waves/storms. Data suggest more frequent flood events, with some west coast locations experiencing 100 year events every 5 years.
Sea Surface Temperatures	Historical: The global mean sea surface temperature has increased by approximately +0. 6°C (+1.1°F) since 1950 Projections: Increase on the order of 1.0°C (1.8°F) by mid-century (A1B emissions scenario).



Lower Coquille Watershed

Key

- Lower Watershed Boundary
- Extent of Tidal Wetlands
- Urban Growth Boundary
- Tribal Land

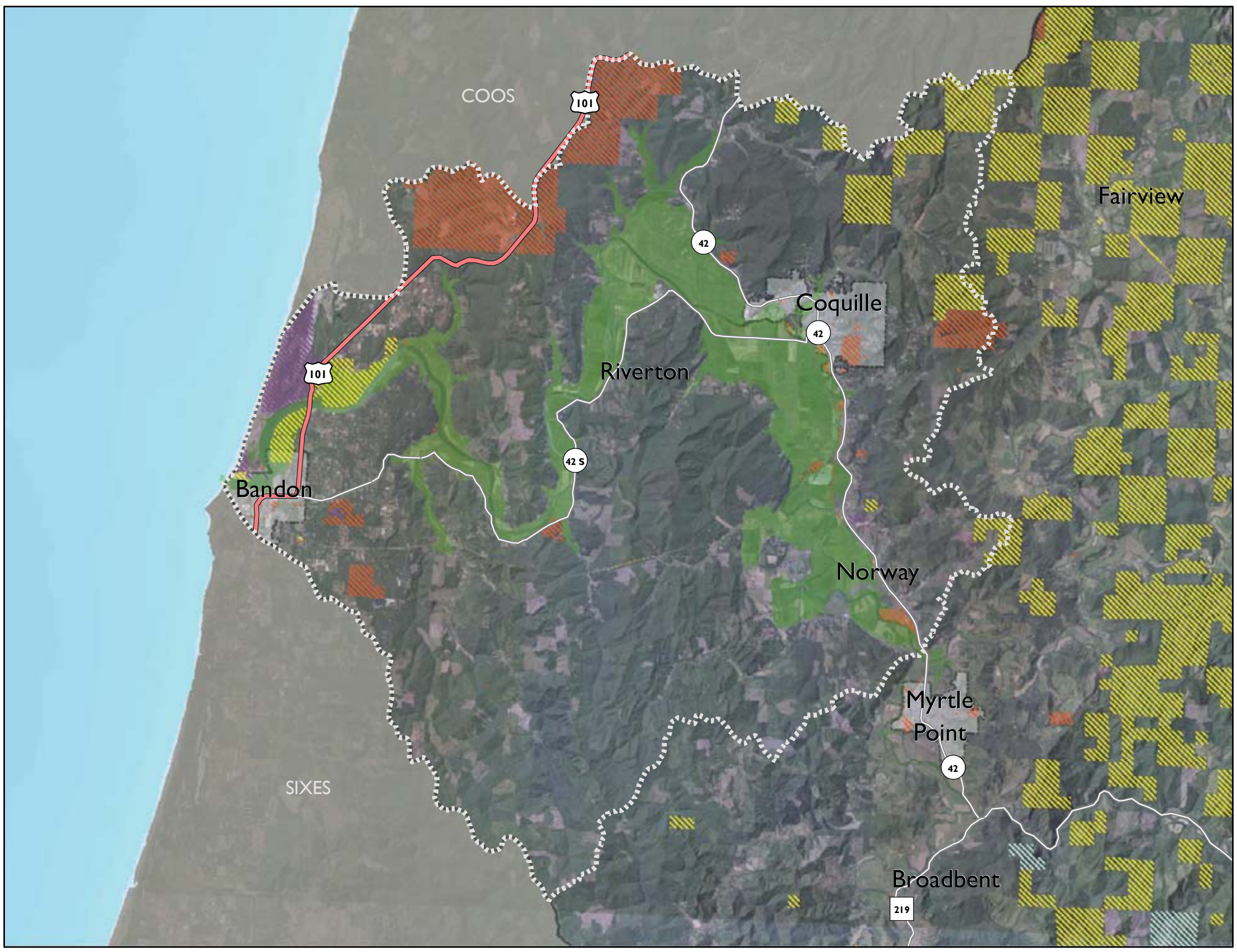
Public land ownership

- City or County
- State
- Federal

Ownership source: Coos County taxlot data.

N 0 2 4 Miles

Lower Coquille Watershed



Key

- Lower Watershed Boundary
- Extent of Tidal Wetlands
- Urban Growth Boundary
- Tribal Land

Public land ownership

- City or County
- State
- Federal

Ownership source: Coos County taxlot data.

N 0 2 4 Miles

Lower Coquille Watershed

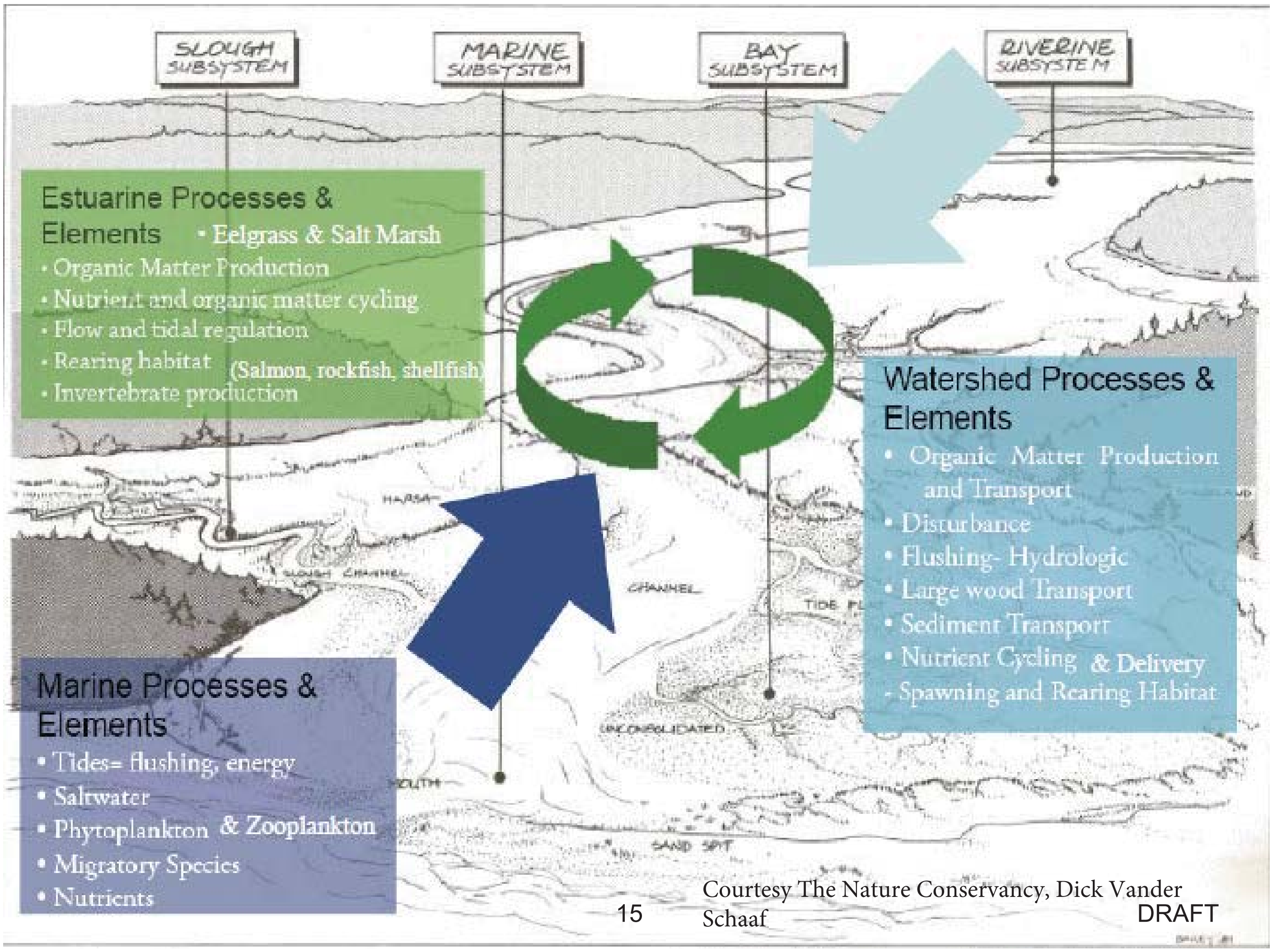
Estuarine Processes

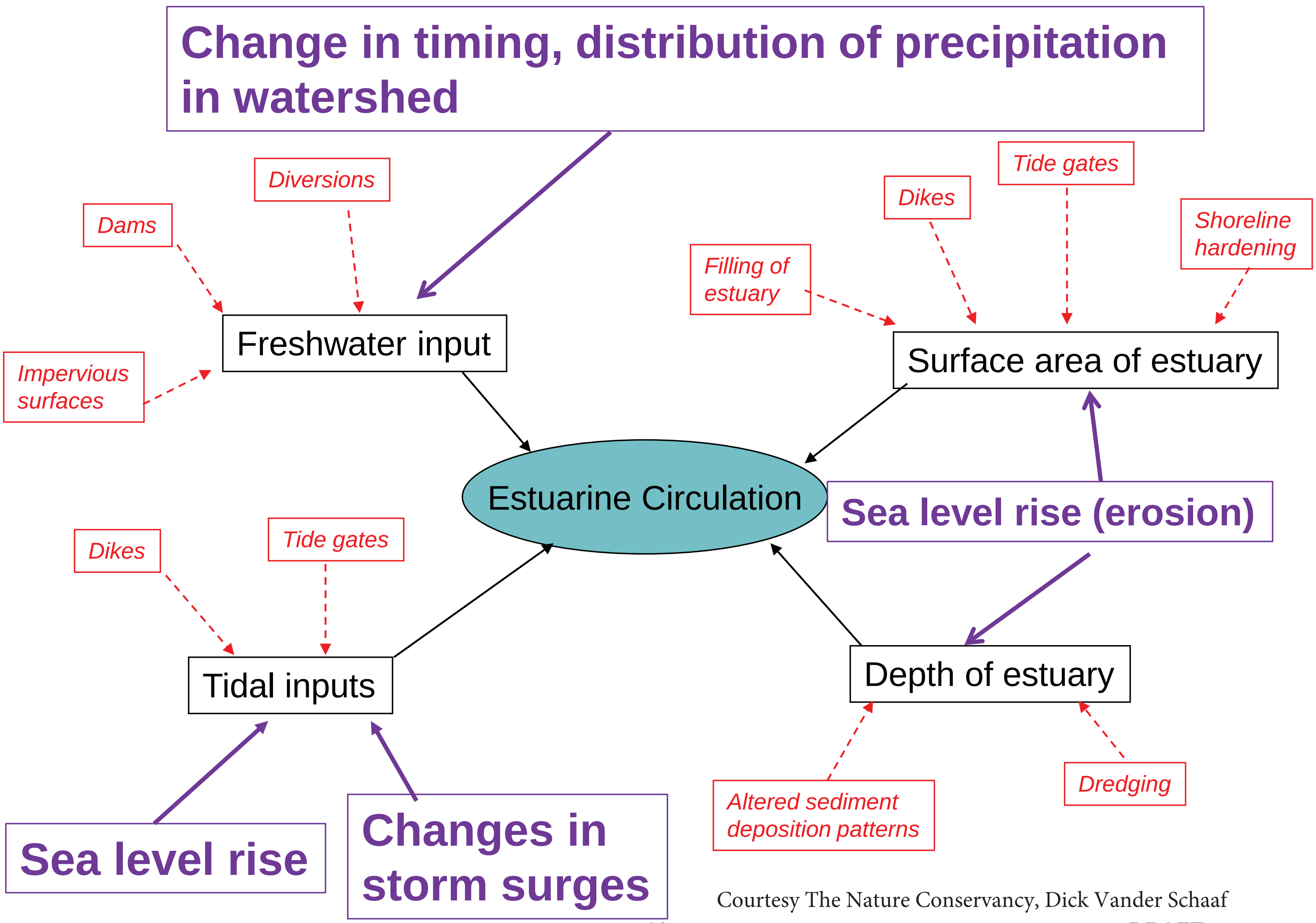
Determine the distribution, abundance, and viability of species and ecosystems.

1. Circulation (freshwater + marine)
2. Sediment transport and deposition
3. Nutrient cycling

Courtesy The Nature Conservancy, Dick Vander Schaaf

Estuary Ecological Model





Courtesy The Nature Conservancy, Dick Vander Schaaf

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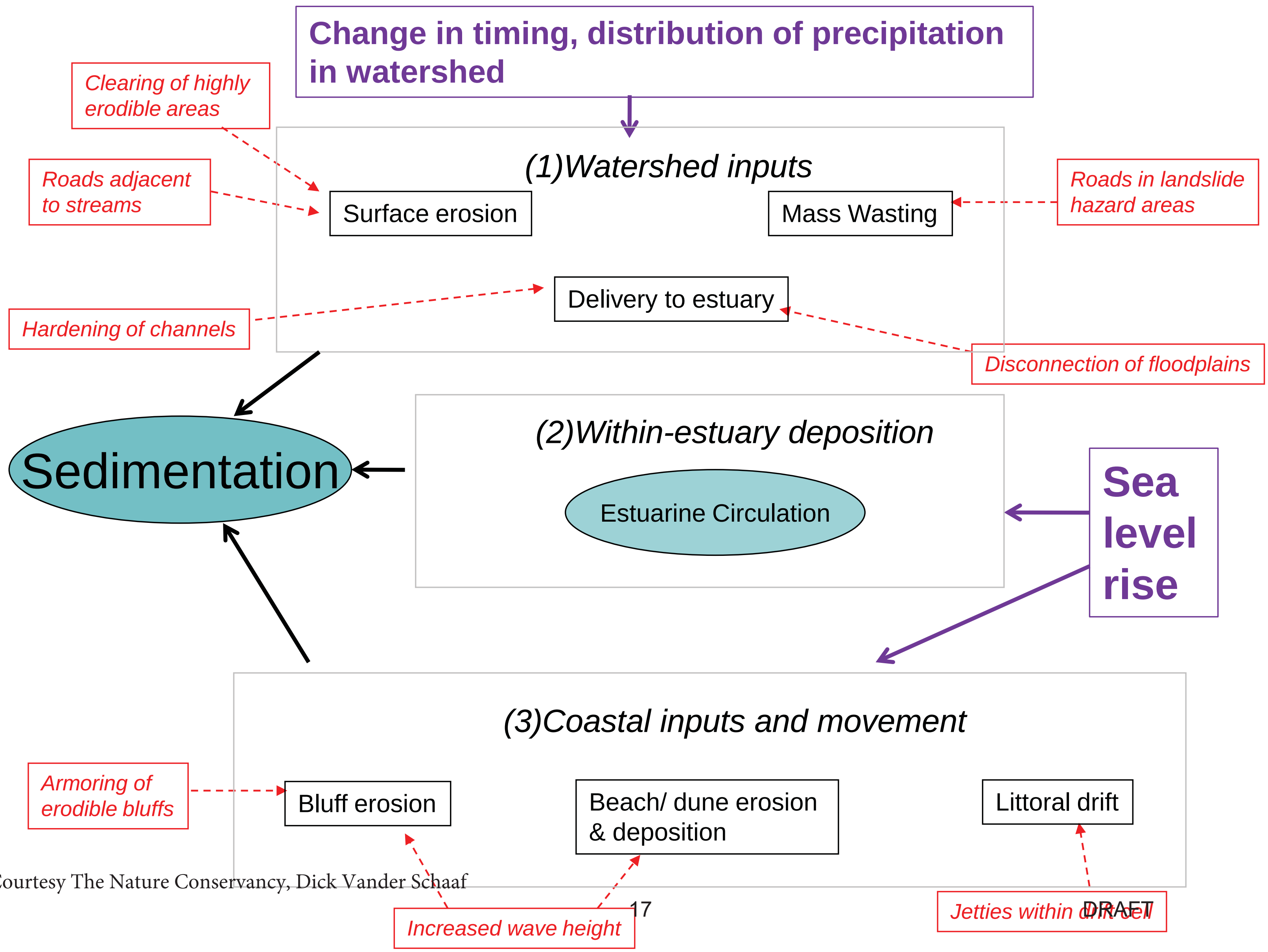
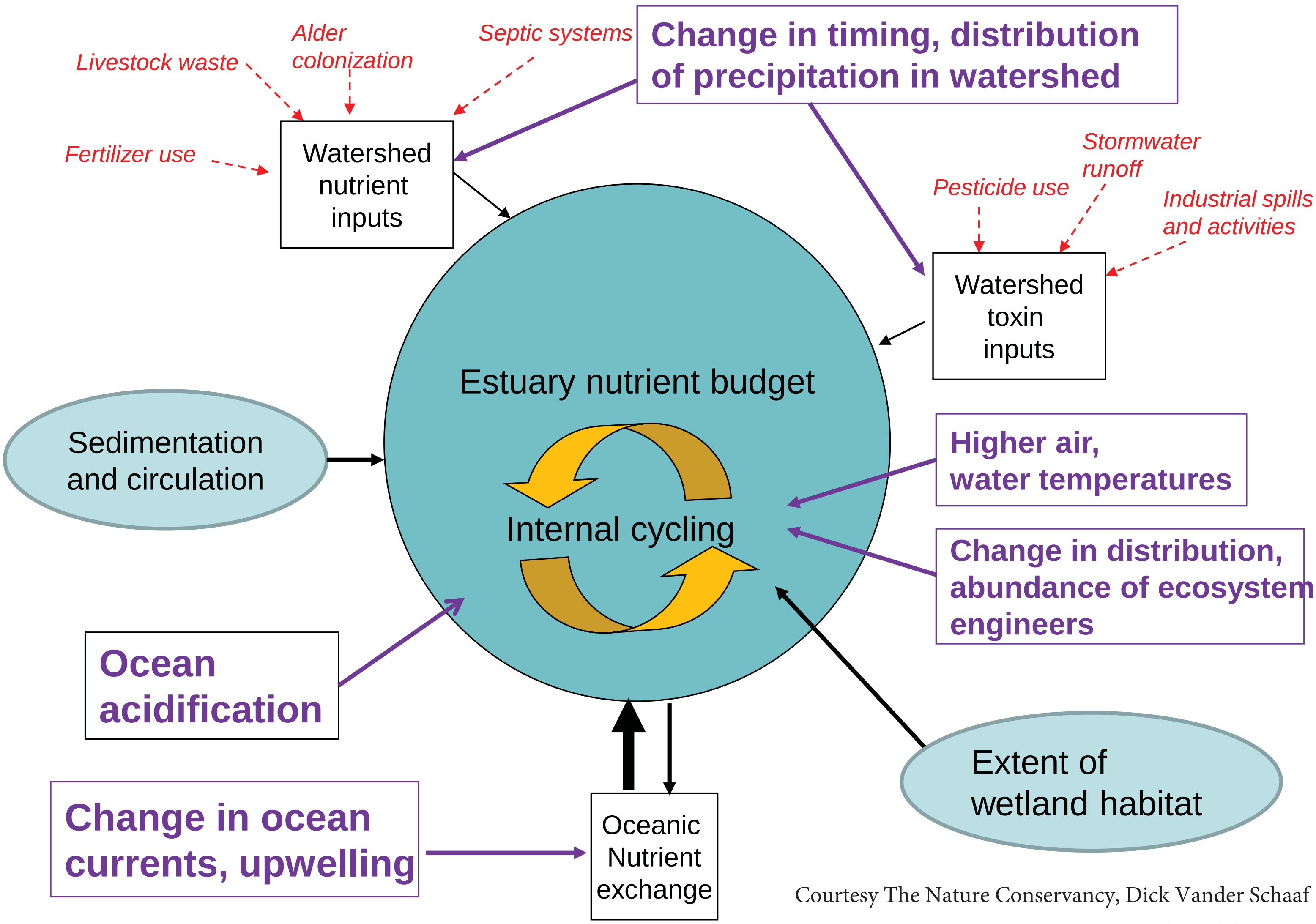


Courtesy The Nature Conservancy, Dick Vander Schaaf



Courtesy The Nature Conservancy, Dick Vander Schaaf

SLAMM Sea Level Rise Modeling for Coquille Estuary – 'Medium' Scenario

SLAMM Metadata Report: Coquille River

SLAMM version: SLAMM 6.1 beta

Project Area Description:

Lower Coquille River valley, including all areas below 20 meters elevation and from the mouth of the river to head of tide

Methodology:

National Wetlands Inventory data was cross-walked and generalized into SLAMM land categories using the matrix provided by Warren Pinnacle Consulting and developed by Bill Wilen. ArcGIS was used to rasterize vector data into ASCII raster data suitable for use in the SLAMM software.

Data Sources:

Wetlands Data: NWI, heads up digitized using 2011 1m resolution NAIP 4 band imagery
Elevation and Slope: USGS 3m LiDAR derived Digital Elevation Model
Dikes/Levees: Laura Mattison. "Estuarine Levee Protected Lands" data layer: Oregon Spatial data library
Percent Impervious: National Land Cover Database (NLCD), Digital Coast: NOAA Coastal Services Ctr.
NOAA vDatum Corrections file?: Yes. Derived using NOAA's vDatum correction software
Uplift Data: Verdonck, David. **"**Derivation of contemporary vertical deformation associated with the Cascadia Subduction Zone from historical leveling surveys." p. 6, figure 2. Eastern Geodynamics Laboratory Incorporated, 2005.
Accretion Data: Thom, Ronald. "Accretion Rates of Low Intertidal Salt Marshes in the Pacific Northwest." *Wetlands*, Vol. 12, No. 3, Dec. 1992, pp. 147-156 1992, The Society of Wetlands Scientists.
Head of Salt Water: Averaged from dissolved solids data - DEQ LASAR tabular data from 08/29/1960 to 11/09/2011 (multiple sampling points from the mouth of the river to river mile 55.5)
Head of Tide: River mile 41. Weeks, Hal, Riggers, Brian and White, Jody. "Fall Chinook Salmon in the Coquille River: Spawner Escapement, Run Reconstruction and Survey Calibration 2001 – 2002." p. 5, NOAA cumulative progress report.

Parameters:

Parameter	Global	SubSite 1	SubSite 2	SubSite 3	SubSite 4	SubSite 5	SubSite 6
Description	Global	Ni-Les'tun	Low-mid river	Winter Lake	Coquille	Myrtle Point	mid river
NWI Photo Date (YYYY)	2011	2011	2011	2011	2011	2011	2011
DEM Date (YYYY)	2009	2009	2009	2009	2009	2009	2009
Direction Offshore [n,s,e,w]	West	West	West	West	West	West	West

Predominant direction of salt water influence							
Historic Trend (mm/yr) *Historic rate of local SLR*	1.29	1.29	1.29	1.29	1.29	1.29	1.29
MTL-NAVD88 (m) *Vertical datum correction for elevation data*	1.12	1.12	1.12	1.12	1.12	1.12	1.12
GT Great Diurnal Tide Range (m)	2.162	2.162	2	1.5	1.25	1	1.75
Salt Elev. (m above MTL) *Height above mean sea level where freshwater plant communities begin*	1.513	1.513	1.38	1.035	0.8625	0.69	1.2075
Marsh Erosion (horz. m /yr)	0	0	0	0	0	0	0
Swamp Erosion (horz. m /yr)	0	0	0	0	0	0	0
T.Flat Erosion (horz. m /yr)	0	0	0	0	0	0	0
Reg. Flood Marsh Accr (mm/yr)	3	3	3	3	3	3	3
Irreg. Flood Marsh Accr (mm/yr)	3	3	3	3	3	3	3
Tidal Fresh Marsh Accr (mm/yr)	3	3	3	3	3	3	3
Beach Sed. Rate (mm/yr)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Freq. Overwash (years)	0	0	0	0	0	0	0
Use Elev Pre-processor [True,False]	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE	FALSE

Global Sea Level Rise models:

3 scenarios were run to encompass the range of “best case” to median to “worst case” predictions of global sea level rise between now and 2100 that best fit the National Research Council’s (NRC) 2012 report: “Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future.”

The A1B minimum (12.9 cm by 2100) and A1B maximum (69.4 cm by 2100) scenarios – extrapolated from the global patterns of population growth and energy consumption, proposed by the Intergovernmental Panel on Climate Change (IPCC) in 2001 – roughly approximate the low and median predictions established by the NRC report and a 1.65 meters rate of global sea level rise (scaled from the A1B scenario) approximates the NRC's high end estimate.

Literature and References:

Thom, Ronald. "Accretion Rates of Low Intertidal Salt Marshes in the Pacific Northwest." *Wetlands*, Vol. 12, No. 3, Dec. 1992, pp. 147-156 1992, The Society of Wetlands Scientists.

Verdonck, David. **"**Derivation of contemporary vertical deformation associated with the Cascadia Subduction Zone from historical leveling surveys." Eastern Geodynamics Laboratory Incorporated, 2005.

Clough, Jonathan S. & Larson, Evan C. "Application of the Sea-Level Affecting Marshes Model (SLAMM 6) to Bandon Marsh NWR." Warren Pinnacle Consulting, Inc., February 15, 2010.

Clough, Jonathan S., "SLAMM 6 beta Technical Documentation." Warren Pinnale Consulting, Inc., May 2010. http://warrenpinnacle.com/prof/SLAMM6/SLAMM6_Technical_Documentation.pdf

Weeks, Hal, Riggers, Brian and White, Jody. "Fall Chinook Salmon in the Coquille River: Spawner Escapement, Run Reconstruction and Survey Calibration 2001 – 2002." p. 5, NOAA cumulative progress report.

Table 1. Modeled Sea Level Rise Compared to 2011 and Locally Corrected for Coquille Estuary (eustatic)

Scenario	2011-2030	2011-2050	2011-2100
Coquille Low SLR Scenario	2cm / 1in	5cm / 2in	11cm / 4in
Coquille Mid SLR Scenario	8cm / 3in	21cm / 8in	62cm / 24in
Coquille High SLR Scenario	20cm / 8in	49cm / 19in	147cm / 58in

Table 2. Expected Sea Level Rise at Various Regional Locations. Please Note Reference Year.

Location	2000-2030	2000-2050	2000-2100
Newport, OR[1]	6.8cm / 2.7in	17.2cm / 6.8in	63.3cm / 24.9in
	2008-2030	**2008-2050**	
Charleston, Coos Bay, OR[2]	9cm / 3.5in	24cm / 9.4in	
South Beach, Yaquina R., OR[3]	12cm / 4.7in	30com / 11.8in	

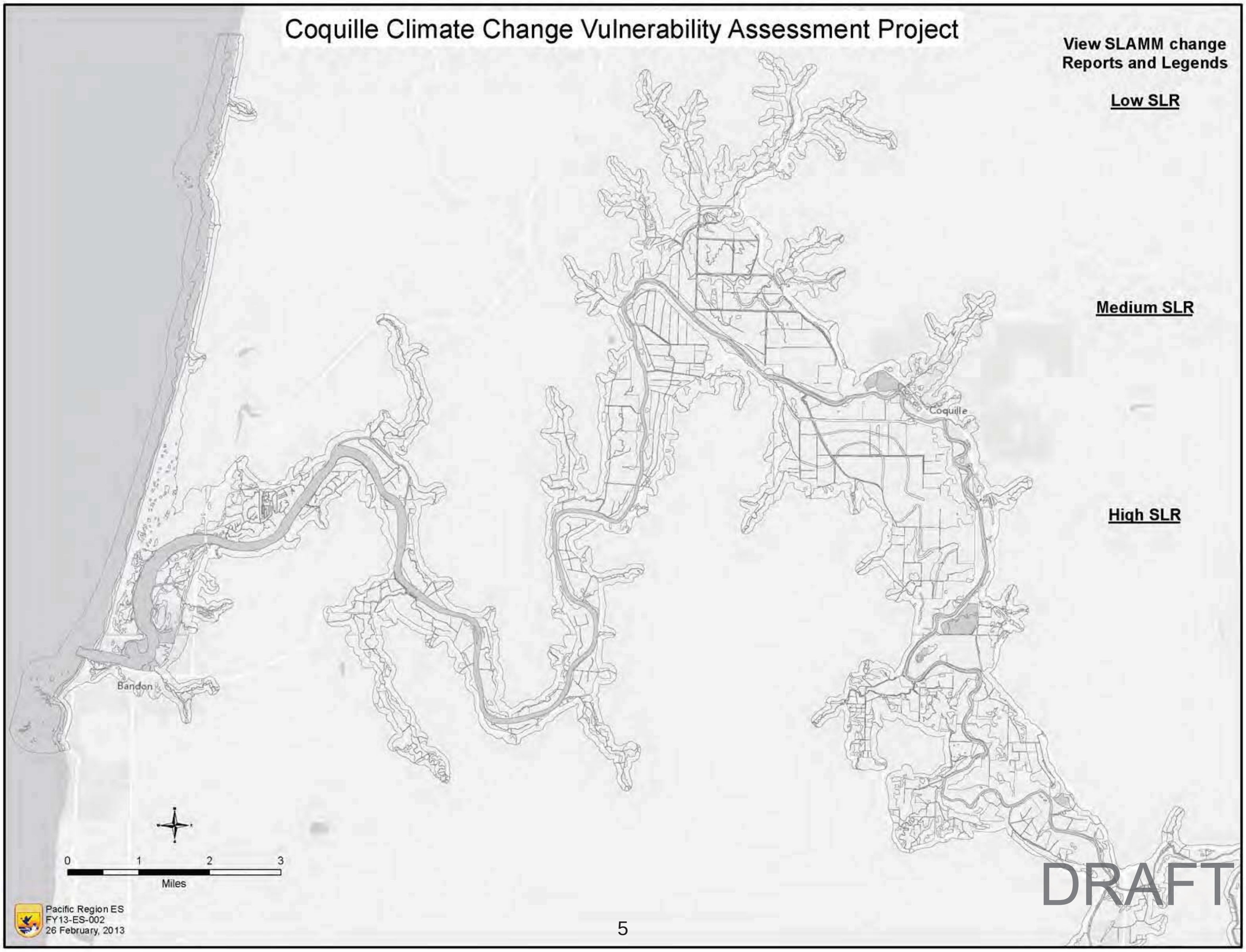
Table 3. SLAMM Estuary Habitat Change, Coquille Mid SLR Scenario and Developed Dry Land is Diked (Does not Change)

SLAMM Habitat	Current 2011 (ac)	2030--> (ac)	Gain/ Loss (ac)	% Change	2050--> (ac)	Gain/ Loss (ac)	% Change
Developed Dry Land	774	774	0	0%	774	0	0%
Undeveloped Dry Land	13297	13151	-146	-1%	13143	-154	-1%
Swamp	1258	1159	-99	-8%	1149	-108	-9%
Inland-Fresh Marsh	12476	12408	-68	-1%	12405	-71	-1%
Tidal-Fresh Marsh	9	8	-1	-14%	8	-1	-14%
Trans. Salt Marsh	46	172	125	271%	176	129	279%
Regularly-Flooded Marsh	255	427	173	68%	423	168	66%
Estuarine Beach	231	232	1	0%	232	1	1%
Tidal Flat	17	22	4	25%	39	21	123%
Ocean Beach	678	686	8	1%	419	-260	-38%
Ocean Flat	0	0	0		0	0	
Rocky Intertidal	12	12	-1	-6%	12	-1	-6%
Inland Open Water	700	691	-9	-1%	691	-9	-1%
Riverine Tidal	570	530	-40	-7%	528	-42	-7%
Estuarine Open Water	1150	1207	57	5%	1210	60	5%
Tidal Creek	18	18	0	0%	18	0	0%
Open Ocean	1142	1146	4	0%	1417	275	24%
Irreg.-Flooded Marsh	407	399	-8	-2%	399	-8	-2%
Inland Shore	77	77	0	0%	77	0	0%
Tidal Swamp	4	4	0	-2%	4	0	-2%

[1] National Resource Council 2012. Mean for A1B emission scenario
[2] Tebaldi et al. 2012
[3] Tebaldi et al. 2012

Table 4. SLAMM Estuary Habitat Change, Coquille Mid SLR Scenario and Developed Dry Land is NOT Diked (Changes)

Habitat	A1B Max No Protection						
	Current (Ha)	2030-->	Gain/ Loss	% Change	2050-->	Gain/ Loss	% Change
Developed Dry Land	773.8	772.5	-1.3	0%	772.1	-1.7	0%
Undeveloped Dry Land	13297.0	13109.9	-187.1	-1%	13012.1	-284.9	-2%
Swamp	1257.6	1115.1	-142.5	-11%	1099.8	-157.9	-13%
Inland-Fresh Marsh	12476.1	9120.8	-3355.3	-27%	8575.4	-3900.7	-31%
Tidal-Fresh Marsh	8.9	7.7	-1.2	-14%	7.7	-1.2	-14%
Trans. Salt Marsh	46.3	3715.1	3668.8	7924%	1544.0	1497.7	3235%
Regularly-Flooded Marsh	254.6	265.0	10.4	4%	3087.5	2832.9	1113%
Estuarine Beach	230.8	232.2	1.5	1%	232.5	1.7	1%
Tidal Flat	17.5	19.2	1.7	10%	22.0	4.6	26%
Ocean Beach	678.4	687.9	9.5	1%	418.3	-260.1	-38%
Ocean Flat	0.0	0.0	0.0		0.0	0.0	
Rocky Intertidal	12.2	11.5	-0.7	-6%	11.5	-0.7	-6%
Inland Open Water	699.5	695.6	-4.0	-1%	599.6	-100.0	-14%
Riverine Tidal	570.4	570.4	0.0	0%	451.0	-119.4	-21%
Estuarine Open Water	1149.7	1154.3	4.6	0%	1371.8	222.1	19%
Tidal Creek	18.0	18.0	0.0	0%	18.0	0.0	0%
Open Ocean	1142.3	1145.5	3.2	0%	1418.4	276.1	24%
Irreg.-Flooded Marsh	406.8	399.5	-7.3	-2%	398.7	-8.2	-2%
Inland Shore	77.2	77.1	-0.1	0%	77.0	-0.2	0%
Tidal Swamp	4.0	3.9	-0.1	-2%	3.9	-0.1	-2%
Vegetated Tidal Flat	0.0	0.0	0.0		0.0	0.0	
Backshore	0.0	0.0	0.0		0.0	0.0	
		Gain	3699.7		Gain	4835.1	
		Loss	-3699.7		Loss	-4835.1	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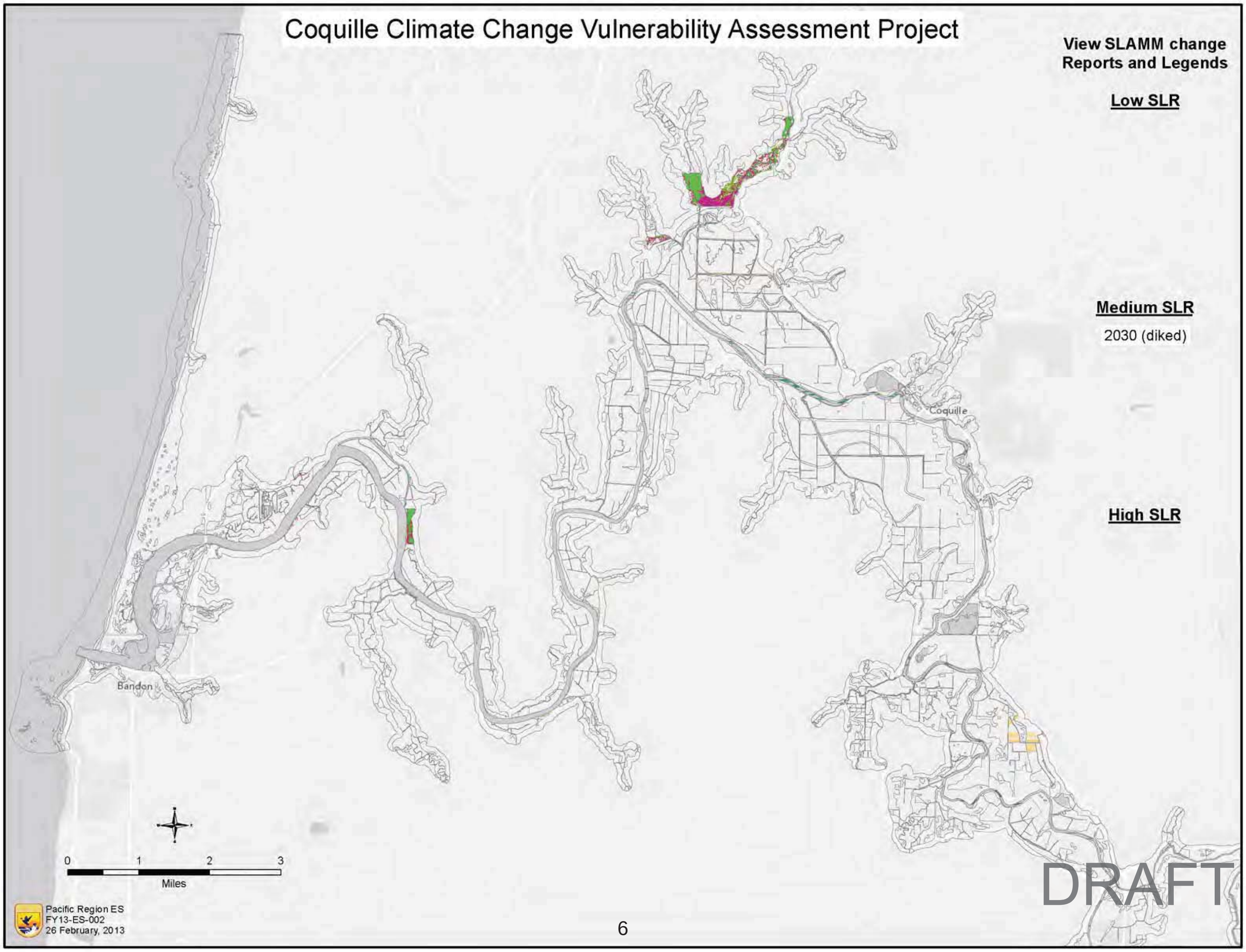
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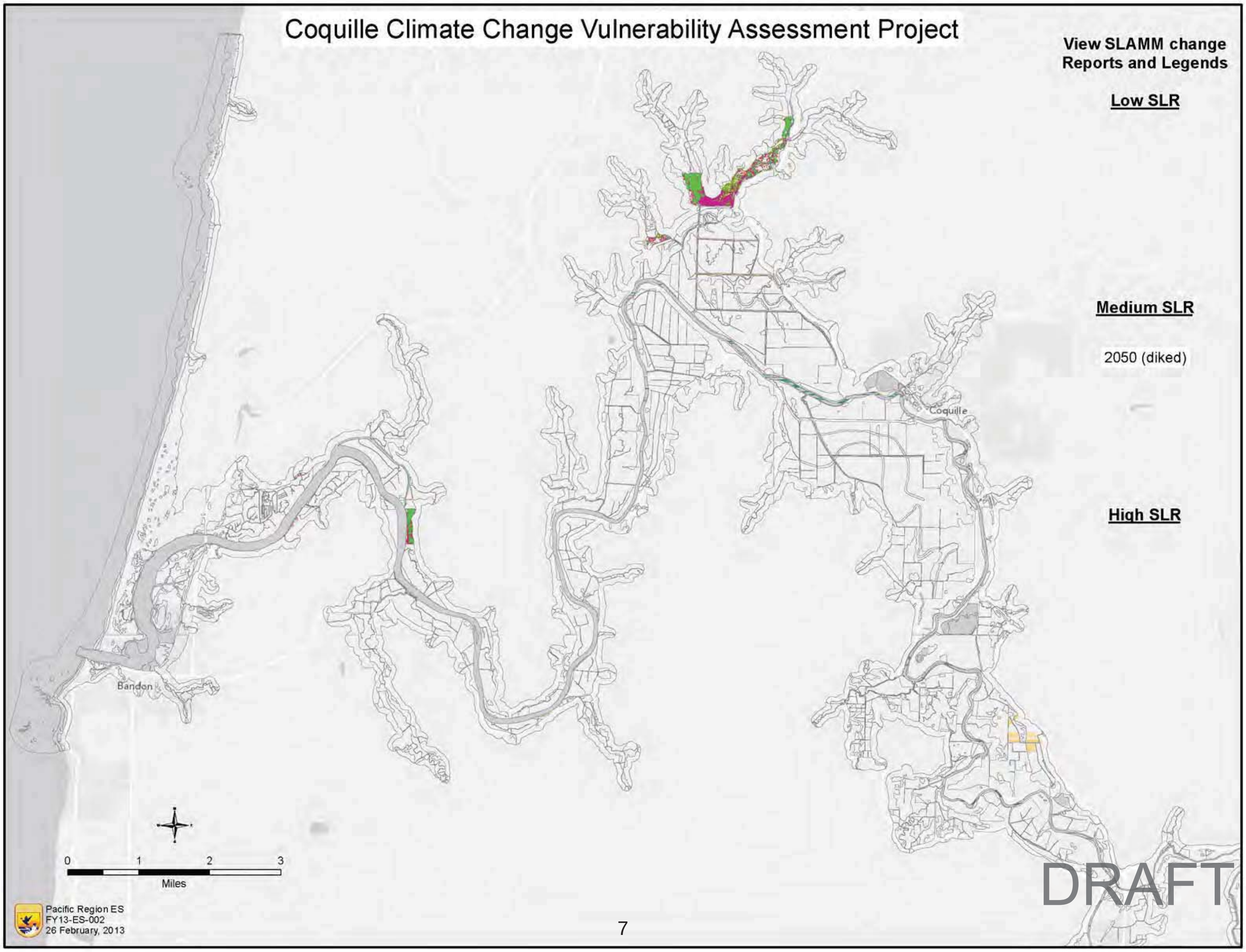

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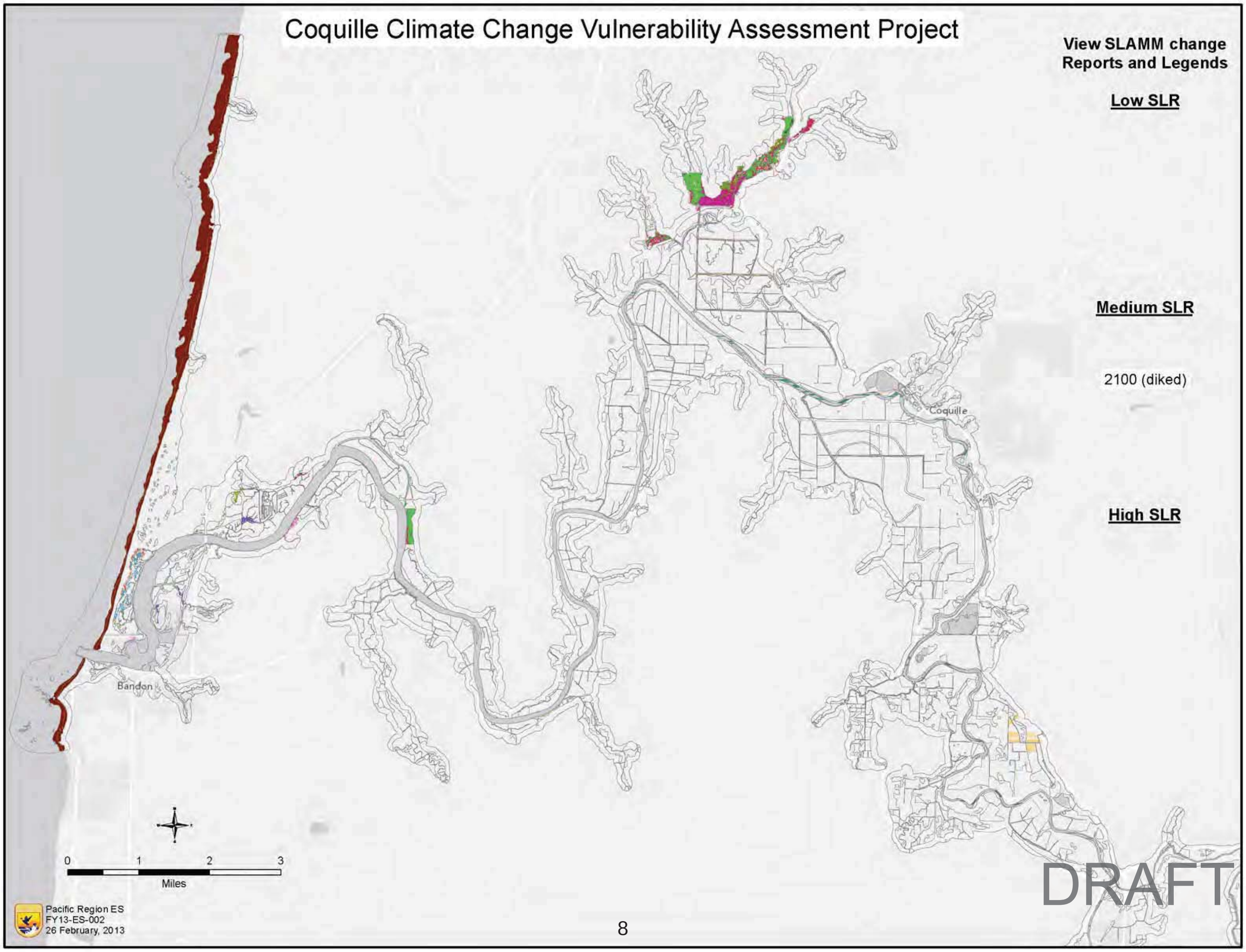
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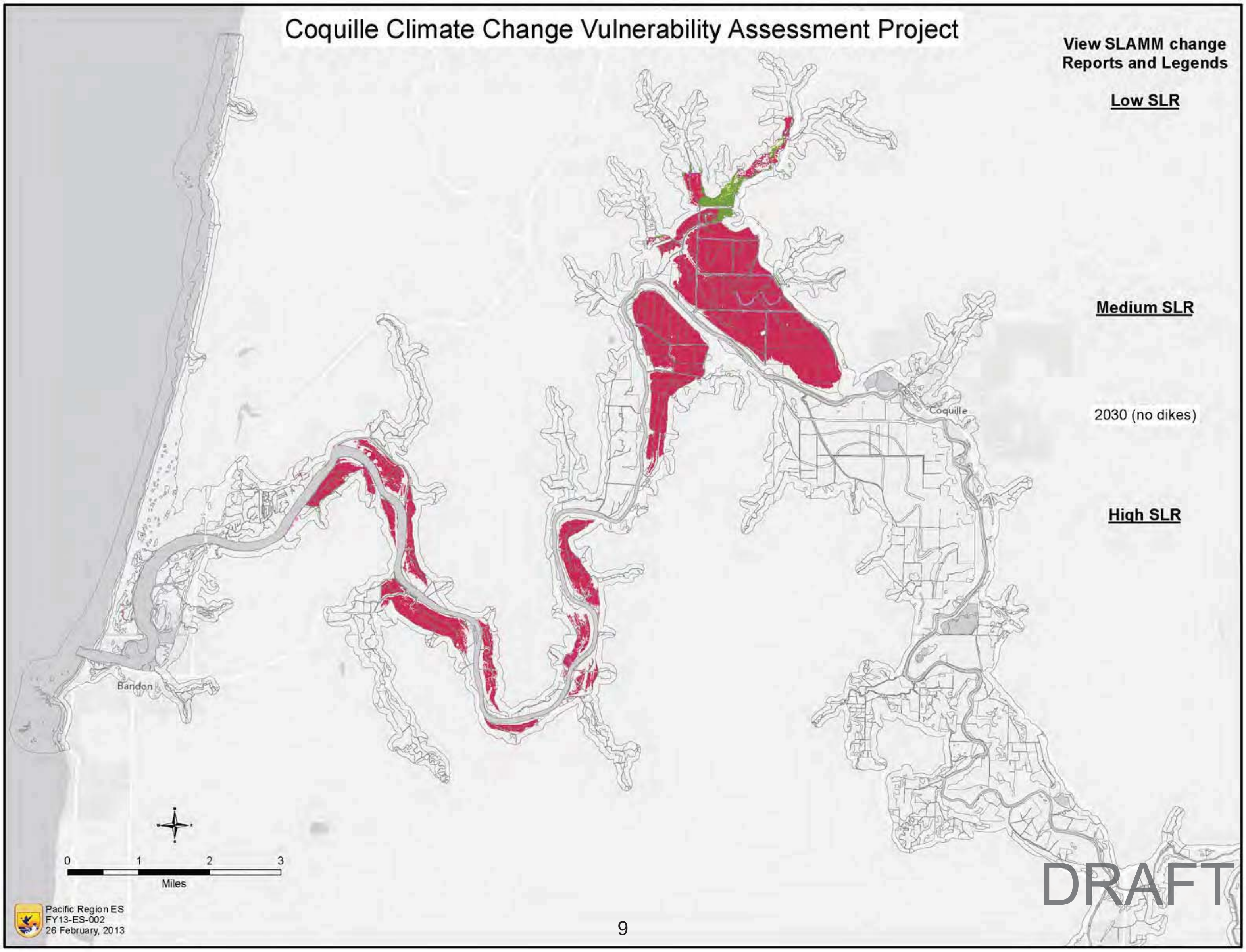
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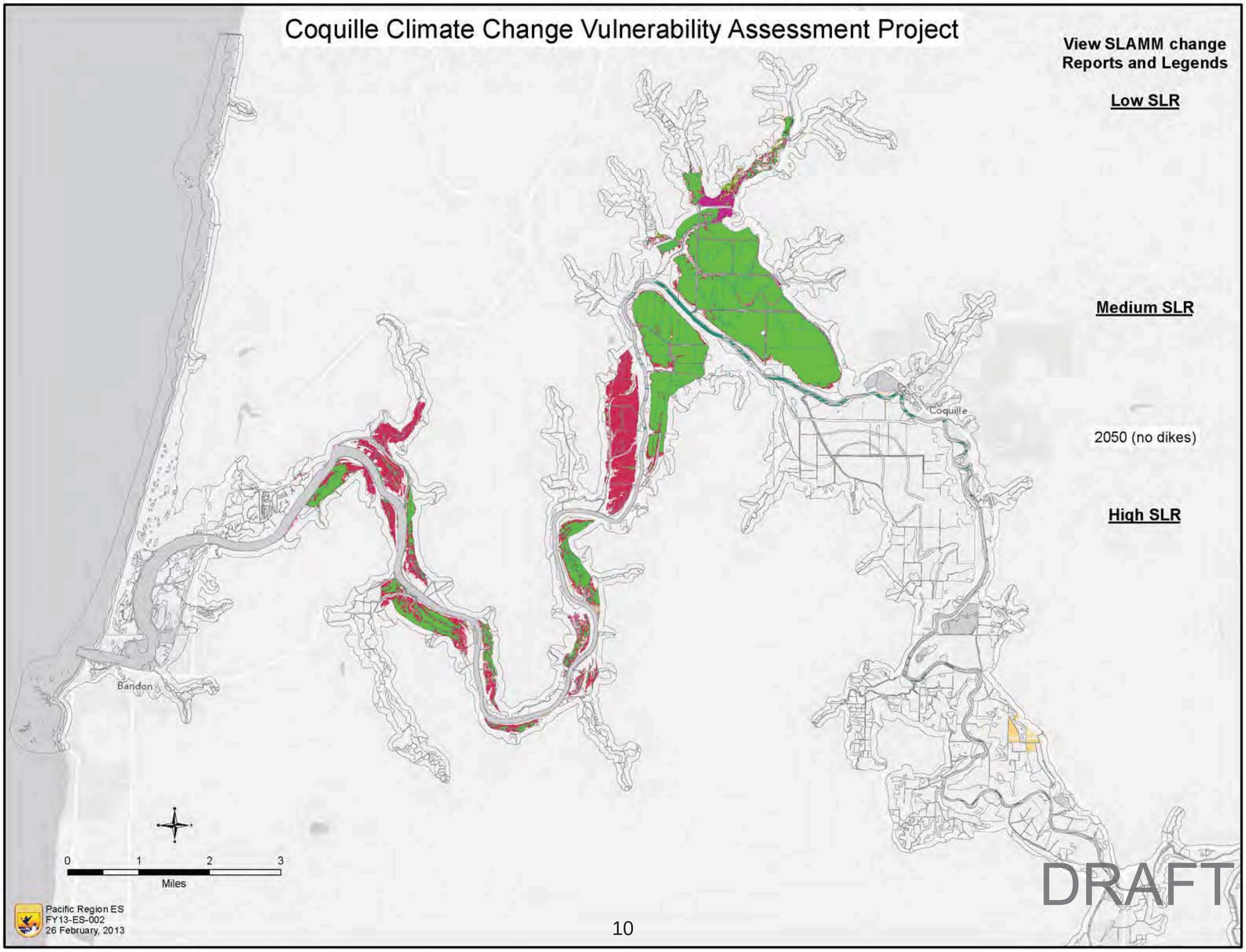
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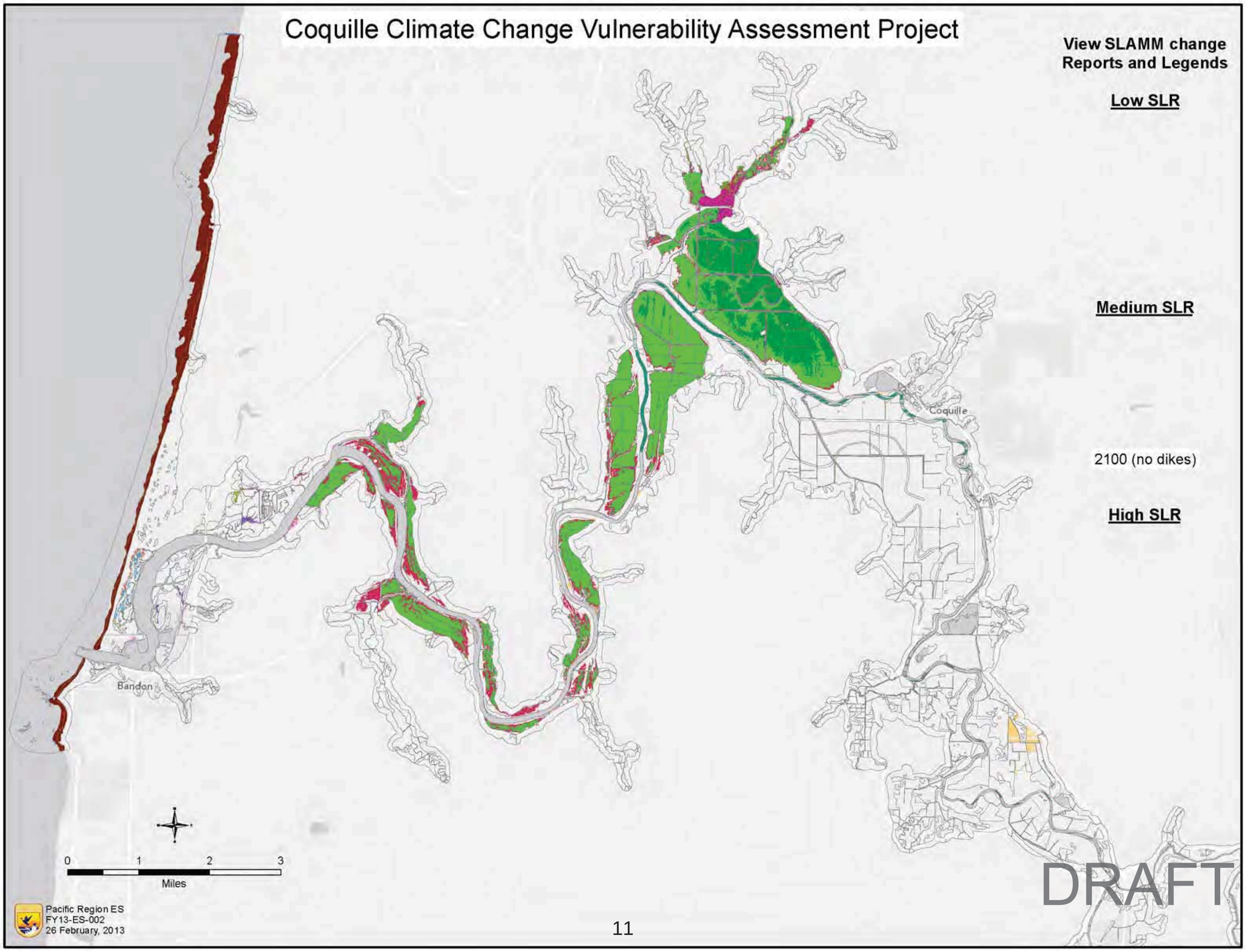
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Coquille Climate Change Vulnerability Assessment

Sea Level Rise Scenario:	Low	**Medium**	High
Level of Protection:	**Diked**		No Dikes
Projected Year:	**2030**	2050	2100
Local Projected SLR (Low):	**0.08m**	0.21m	0.62m

Change Categories	**Acres**
Inland Fresh Marsh to Regularly Flooded Marsh	85
Inland Fresh Marsh to Transitional Salt Marsh	76
Riverine Tidal to Estuarine Water	40
Swamp to Regularly Flooded Marsh	58
Swamp to Transitional Salt Marsh	38
Undeveloped Dryland to Inland Fresh Marsh	94
Undeveloped Dryland to Regularly Flooded Marsh	22
Undeveloped Dryland to Transitional Salt Marsh	11

Note: Does not include change categories totaling less than 10 acres for this layer
OR
categories totaling less than 50 acres across all 18 change layers combined.

Creation date: February 26, 2013

Coquille Climate Change Vulnerability Assessment

Sea Level Rise Scenario:	Low	**Medium**	High
Level of Protection:	**Diked**		No Dikes
Projected Year:	2030	**2050**	2100
Local Projected SLR (Low):	0.08m	**0.21m**	0.62m

Change Categories	**Acres**
Inland Fresh Marsh to Regularly Flooded Marsh	91
Inland Fresh Marsh to Transitional Salt Marsh	73
Riverine Tidal to Estuarine Water	42
Swamp to Regularly Flooded Marsh	53
Swamp to Transitional Salt Marsh	44
Undeveloped Dryland to Inland Fresh Marsh	96
Undeveloped Dryland to Regularly Flooded Marsh	17
Undeveloped Dryland to Transitional Salt Marsh	12

Note: Does not include change categories totaling less than 10 acres for this layer
OR
categories totaling less than 50 acres across all 18 change layers combined.

Creation date: February 26, 2013

Coquille Climate Change Vulnerability Assessment

Sea Level Rise Scenario:	Low	**Medium**	High
Level of Protection:	**Diked**		No Dikes
Projected Year:	2030	2050	**2100**
Local Projected SLR (Low):	0.08m	0.21m	**0.62m**

Change Categories	**Acres**
Inland Fresh Marsh to Regularly Flooded Marsh	120
Inland Fresh Marsh to Transitional Salt Marsh	79
Inland Open Water to Estuarine Water	11
Irregularly Flooded Marsh to Regularly Flooded Marsh	18
Ocean Beach to Open Ocean	678
Riverine Tidal to Estuarine Water	46
Swamp to Regularly Flooded Marsh	70
Swamp to Transitional Salt Marsh	50
Undeveloped Dryland to Inland Fresh Marsh	101
Undeveloped Dryland to Ocean Beach	12
Undeveloped Dryland to Open Ocean	25
Undeveloped Dryland to Regularly Flooded Marsh	16
Undeveloped Dryland to Transitional Salt Marsh	25

Note: Does not include change categories totaling less than 10 acres for this layer

OR

categories totaling less than 50 acres across all 18 change layers combined.

Creation date: February 26, 2013

Coquille Climate Change Vulnerability Assessment

Sea Level Rise Scenario:	Low	**Medium**	High
Level of Protection:	Diked		**No Dikes**
Projected Year:	**2030**	2050	2100
Local Projected SLR (Low):	**0.08m**	0.21m	0.62m

Change Categories	Acres
Inland Fresh Marsh to Transitional Salt Marsh	3,362
Swamp to Transitional Salt Marsh	142
Undeveloped Dryland to Transitional Salt Marsh	166

Note: Does not include change categories totaling less than 10 acres for this layer
OR
categories totaling less than 50 acres across all 18 change layers combined.

Creation date: February 26, 2013

Coquille Climate Change Vulnerability Assessment

Sea Level Rise Scenario:	Low	**Medium**	High
Level of Protection:	Diked		**No Dikes**
Projected Year:	2030	**2050**	2100
Local Projected SLR (Low):	0.08m	**0.21m**	0.62m

Change Categories	**Acres**
Inland Fresh Marsh to Regularly Flooded Marsh	2,589
Inland Fresh Marsh to Transitional Salt Marsh	1,389
Inland Open Water to Estuarine Water	102
Riverine Tidal to Estuarine Water	119
Swamp to Regularly Flooded Marsh	105
Swamp to Transitional Salt Marsh	51
Undeveloped Dryland to Inland Fresh Marsh	79
Undeveloped Dryland to Regularly Flooded Marsh	133
Undeveloped Dryland to Transitional Salt Marsh	48

Note: Does not include change categories totaling less than 10 acres for this layer

OR

categories totaling less than 50 acres across all 18 change layers combined.

Creation date: February 26, 2013

Coquille Climate Change Vulnerability Assessment

Sea Level Rise Scenario:	Low	**Medium**	High
Level of Protection:	Diked		**No Dikes**
Projected Year:	2030	2050	**2100**
Local Projected SLR (High):	0.08m	0.21m	**0.62m**

Change Categories	Acres
Inland Fresh Marsh to Regularly Flooded Marsh	2,448
Inland Fresh Marsh to Tidal Flat	1,012
Inland Fresh Marsh to Transitional Salt Marsh	869
Inland Open Water to Estuarine Water	119
Irregularly Flooded Marsh to Regularly Flooded Marsh	18
Ocean Beach to Open Ocean	678
Riverine Tidal to Estuarine Water	164
Swamp to Regularly Flooded Marsh	107
Swamp to Tidal Flat	24
Swamp to Transitional Salt Marsh	61
Undeveloped Dryland to Inland Fresh Marsh	94
Undeveloped Dryland to Ocean Beach	12
Undeveloped Dryland to Open Ocean	26
Undeveloped Dryland to Regularly Flooded Marsh	89
Undeveloped Dryland to Tidal Flat	67
Undeveloped Dryland to Transitional Salt Marsh	75

Note: Does not include change categories totaling less than 10 acres for this layer
OR
categories totaling less than 50 acres across all 18 change layers combined.

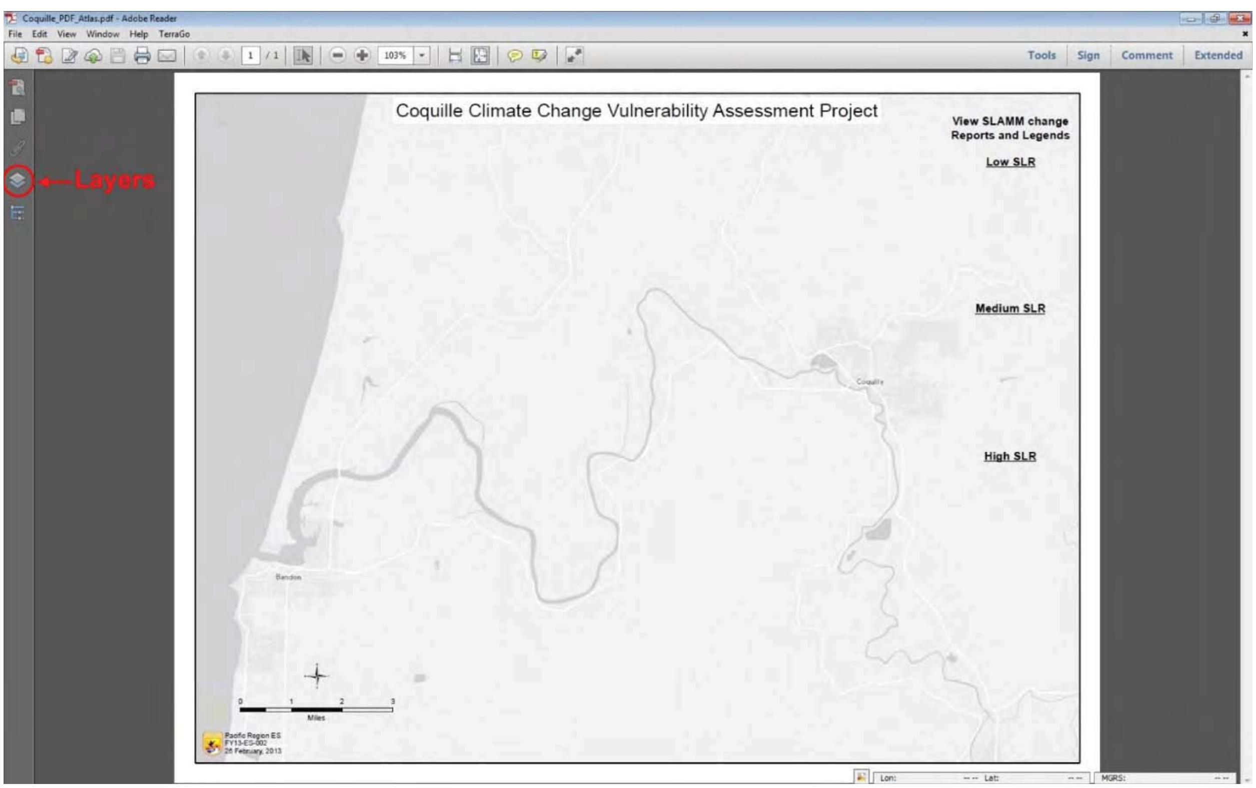
Creation date: February 26, 2013

Coquille Climate Change Vulnerability Assessment – PDF Atlas of Sea Level Rise Models
User Instructions

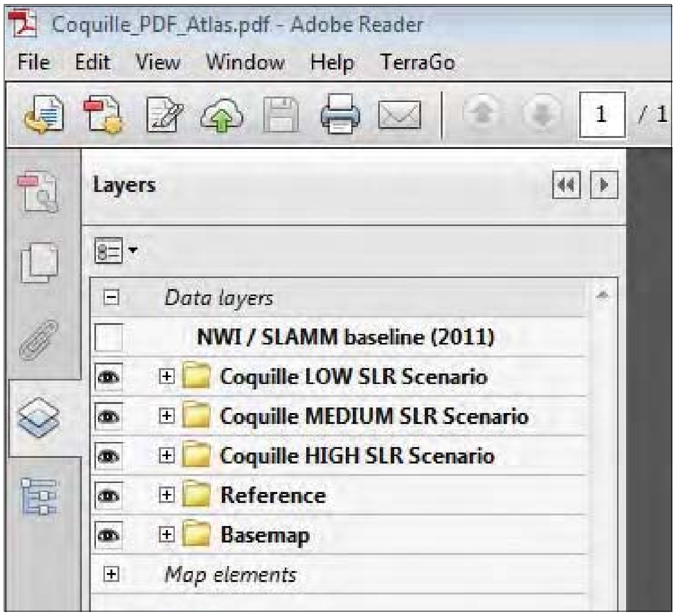
This CD contains all of the files necessary for viewing the Coquille Climate Change Vulnerability Assessment (CCCVA) PDF Atlas. The purpose of the atlas is to provide users with an interactive method for examining multiple data layers that model potential habitat changes due to sea level rise (SLR) within the CCCVA study area under various SLR scenarios. The atlas itself ("Coquille_PDF_Atlas.pdf") is actually a GeoPDF, which is a proprietary file format of the TerraGo company (http://www.terragotech.com/). In order to view the GeoPDF, you will need to have either Adobe Reader or Adobe Acrobat (version 7 or later) loaded on your system. Reader is available for free download at http://get.adobe.com/reader/. Acrobat is licensed software available for purchase from Adobe (http://www.adobe.com/products/acrobat.html?promoid=JOLIR) or other software retailers.

The change layers displayed in the atlas are products of the Sea Level Affecting Marsh Model (SLAMM) work conducted by Nick Jones, a contractor with the US Fish & Wildlife Service's National Wetlands Inventory (NWI) Program in Portland, Oregon. The layers represent three different SLR scenarios (low, medium and high), each with two levels of protection (diked vs. no dikes) and for three time periods (2030, 2050 and 2100) for a total of eighteen raster change layers. In addition, there is one vector (polygon) layer representing the baseline (2011) classification of habitats using both the NWI and SLAMM categories.

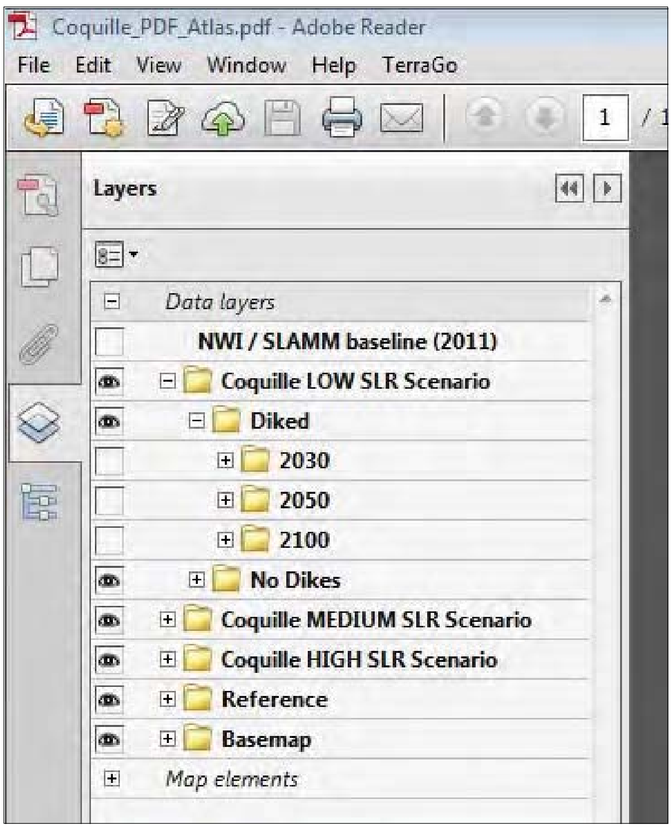
When you first open the Atlas in Adobe Reader (or Acrobat), you will see a rather sparse canvas with a minimal, light gray basemap with a few reference points and some basic map elements (title, north arrow, scale bar, etc.), as shown below:



To view the layers that are available for display, click on the "Layers" icon (indicated in the figure above). A Layers pane will open up to the left of the map and you will see two expandable headings: "Data layers" and "Map elements". The latter controls the visibility of the basic map elements (title, north arrow, scale bar, etc.), and you will probably not use this much, if at all. Expand the "Data layers" category by clicking on the plus sign next to the heading. A tree structure, similar to the directory tree in Windows Explorer for example, will open up, as in the upper figure below:



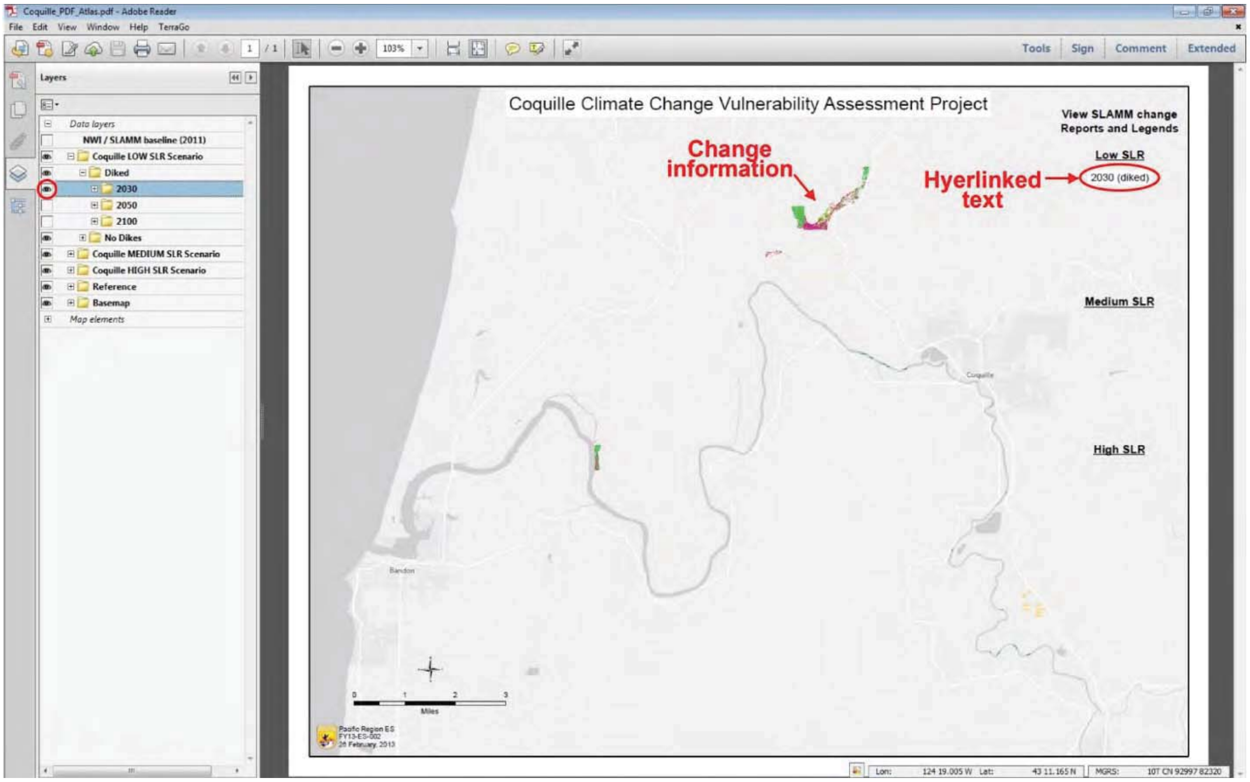
As you can see, there are a number of elements that exist in the tree under the “Data layers” heading. The first layer, “NWI / SLAMM baseline (2011)”, does not have any sub-elements associated with it. If it did, you would see a folder icon and a plus sign to the left of it, as is seen with the other five elements in the tree. The box to the far left of the tree elements controls which layers are visible at any one time. The NWI/SLAMM layer does not have an “eye” icon in the box, meaning that this layer is currently not visible. To make it visible, click inside the box. The “eye” will appear and the layer will draw in the map. To turn visibility off, simply click in the box again and the “eye” will disappear.



You will notice that, although visibility appears to be turned on for all three SLR scenario layers, there is nothing displaying in the map. That is because there are sub-elements associated with each scenario (again, indicated by the folder icon and the plus sign) that are currently turned “off”. If you click on the “+” next to the first SLR scenario element (“Coquille LOW SLR Scenario”), you will see two sub-elements named “Diked” and “No Dikes”, each with sub-elements of their own and each with visibility currently turned “on”. Expand the “Diked” element by clicking on the “+” and you’ll see three sub-elements named “2030”, “2050” and “2100”, for the three projected time periods, as in the lower figure to the left.

Visibility on these sub-elements is turned “off”. As you click in the visibility box for any of the projected time periods, you will see the raster change layer appear in the map. You can turn on multiple change layers at once, however, they will display is the same order that they appear in the tree, with the lowest layer in the tree displaying first (on bottom) and the highest layer in the tree displaying last (on top). The layers are opaque, so you may only see the information for the topmost layer. The exception to this is in areas where two or more layers to not overlap, you may see the change information from the lower layer. For example, if a particular area exhibits no change in the topmost layer, but does in a lower layer, you will see the lower layer’s information for that area when both are visible. To minimize confusion, it may be best to display only one layer at a time. One notable exception to this is the NWI/SLAMM (vector) layer, which displays as hollow polygons and therefore does not obscure layers that are displaying below it.

When you turn on visibility for a particular change layer, there are actually two things that display on the map. One is the raster change information itself and the other is a hyperlinked text string that allows you to open and view a separate PDF file containing a report and a color-coded legend for that layer. These are the two sub-elements “change layer” and “report” that you will see if you click on the “+” next to “2030”, for example (although it’s not necessary to do this since these sub-elements are turned “on” by default). The figure below illustrates this:



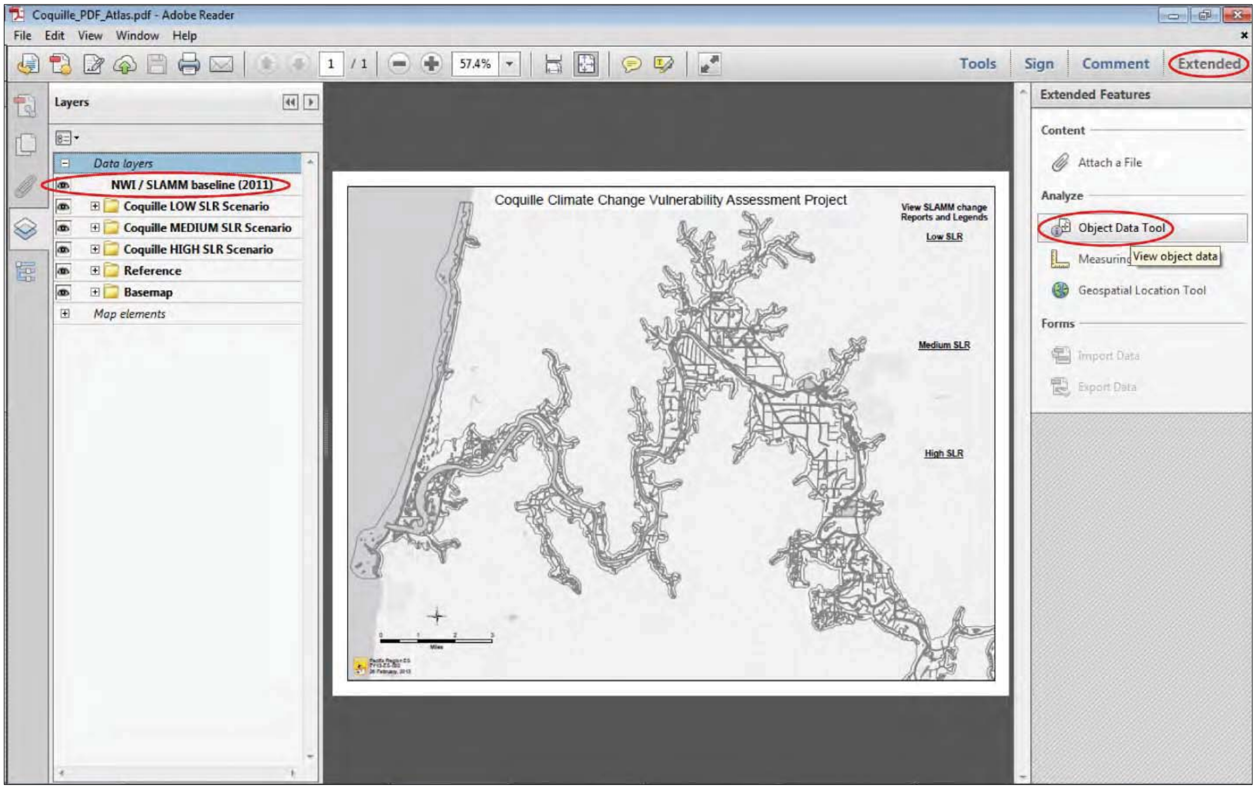
When you click on the hyperlinked text (eg. "2030 (diked)"), a new window will open up displaying the report and legend for that map. This document provides the following:

- Acreage totals by type (SLAMM type at baseline to SLAMM type at the predicted year) for the area of predicted change. Note: in order to keep the number of unique change types to a manageable number, no changes that were predicted to total less than 10 acres will be displayed for any one layer. In addition, no change types that total less than 50 acres for all eighteen change layers combined will be displayed. Given these parameters, the total number of unique change types identified is twenty.

- A color key to the change categories for the layer. Note: if possible, it will work best if you have a dual-screen setup on your computer so that you can view the map on one screen and the report on the other. If you were to print a hardcopy of the report and then attempt to compare it to the map on your computer monitor, you may have difficulty distinguishing the colors as different devices can render colors quite differently. This effect is particularly noticeable when comparing digital images with hardcopy printouts.

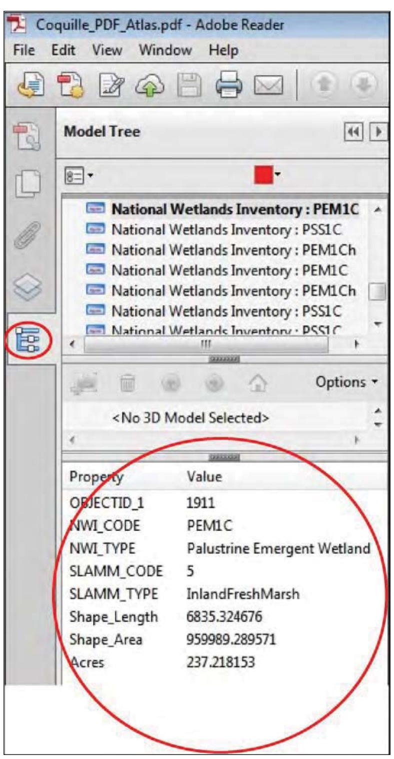
The GeoPDF format also has the ability to carry with it GIS attribute information, but only for vector layers, not rasters. Currently, the only vector layer included in the CCCVA PDF Atlas is the NWI / SLAMM baseline polygon layer. The ability to identify the attributes of a baseline polygon should help in determining the change type of an underlying raster layer. Once you know the baseline type, you will be able to rule out any change that does not begin with that type, thereby narrowing the field of possibilities.

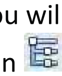
To be able to identify vector polygon attributes, you will have to do two things. First, be sure the vector layer ("NWI / SLAMM baseline (2011)") is visible, and second, activate the "Object Data Tool" . The location and method of activation for this tool differs depending on whether you're using Reader or Acrobat, and on the version you're using. In the most current version of Reader (XI), you will see a dropdown menu called "Extended" above and to the right of the map area. If you click on that, a pane will open up to the right of the map and you will see the "Object Data Tool" in the Analyze section, as below:



If you're using the most current version of Acrobat (also XI), you will need to click on "Tools", then "Analyze" then "Object Data Tool". For earlier versions of Reader and Acrobat, please consult your online help pages.

Once you have the Object Data Tool activated, you can use it to identify polygon attributes in the NWI/SLAMM baseline layer by clicking on them. The selected polygon will highlight with a red border and the attribute information will appear



in the left-hand pane, as shown in the figure to the left. Notice that in this pane, the "Layers" information is no longer displaying, but rather the "Model Tree" information. This change occurs automatically whenever you identify a polygon using the Object Data Tool. If you want to view the Layers information again, you will need to click on the Layers icon , located directly above the "Model Tree" icon  on the far left menu bar.

Please note that the Object Data Tool is only used when identifying vector polygons in order to view their attribute information; in this case, the NWI/SLAMM baseline data attributes. If, after using the Object Data Tool, you wish to continue viewing Change reports and legends using the hyperlinked text in the map, you will first need to switch your tool back to the "Select Tool" , located on the top menu bar. If you do not do this, the hyperlinks in the map will not be accessible. If you don't see the Select Tool, you will have to add it by right-clicking anywhere on the top menu bar, then choosing "Select & Zoom", then "Select Tool". The tool will then appear on the menu bar.

DRAFT

Appendix C

Habitat and Species Vulnerability Assessment Worksheets Used by the Expert Panel

Habitat Sensitivity Assessment

Coquille Estuary Climate Change Vulnerability Assessment

Habitat: ____

1. Direct sensitivities to changes in sea level rise and hydrology

Two ways to consider habitat sensitivity to changes in sea level rise and hydrology:

(1) Does the habitat inhabit a relatively narrow or limited vertical profile (= more sensitive); and

(2) Does the habitat experience large changes (composition or structure) to small climatic changes (sea level rise or hydrology) (= more sensitive), or does the habitat experience small changes even with larger climatic changes (= less sensitive)?

How sensitive is the habitat to sea level rise? *Please circle.* **Low** **Moderate** **High**	**Confidence in the direct sensitivity to changes in sea level rise:** *Please circle.* **Low** **Moderate** **High**
How sensitive is the habitat to changes in hydrology (flow, timing, means and extremes)? *Please circle.* **Low** **Moderate** **High**	**Confidence in the direct sensitivity to changes in hydrology:** *Please circle.* **Low** **Moderate** **High**

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*

2. Sensitivity of component species

The sensitivity of dominant species, ecosystem engineers, flagship species, keystone species, and “strong interactors” are likely to have large influences on the sensitivity of a habitat.

Habitat with sensitive component species = higher sensitivity.

How sensitive are the component species of the habitat to climate change? *Please circle.* **Low** **Moderate** **High**	**Confidence in the sensitivity of component species to climate change:** *Please circle.* **Low** **Moderate** **High**

Comments and Citations: *Please briefly describe the sensitivities of component species that make up the habitat.*

Habitat Sensitivity Assessment

3. Sensitivity to changes in disturbance regimes

Larger changes in composition or structure due to smaller changes in disturbance regime (= more sensitive).

Please circle all disturbance regimes to which the habitat is sensitive:
If none apply, do not circle any.

Flooding	Storms	Wildfire
Disease	Drought	Invasive/opportunistic species
Other (please specify)		

How sensitive is the habitat to one or more of these disturbance regimes? *Please circle.*

Low **Moderate** **High**

Confidence in sensitivity to disturbance regimes: *Please circle.*

Low **Moderate** **High**

Comments and Citations: *Please briefly describe your selection of disturbance regimes above, detailing how changes in the specified disturbance regime might affect the habitat.*

4. Sensitivity to other types of climate and climate-driven changes

Please circle all of the other types of climate and climate-driven changes to which this habitat is sensitive:

Air Temperature (average or extremes)	Precipitation (amount, timing)
Water temperature (average or extremes)	Storms / Flooding
Evapotranspiration and soil moisture	Ocean acidification
Altered fire regimes	Upwelling
Wind/Waves	Other (please describe)

How sensitive is the habitat to one or more of these changes? *Please circle.*

Low **Moderate** **High**

Confidence in sensitivity to other types of climate and climate-driven changes: *Please circle.*

Low **Moderate** **High**

Comments and Citations: *Please describe your selection of the change(s) above and why/how the habitat is sensitive to each factor.*

Habitat Sensitivity Assessment

5. Sensitivity to impacts of other non-climate stressors	
List the <u>top three other non-climate stressors</u> that make the habitat more sensitive to climate change: *If none apply, please indicate. Examples might include (circle if apply):* Development & construction activities Habitat loss due to other activities Others (list below) Industrial, municipal & agriculture activities Invasives and other problematic species	
To what degree do these other stressors <u>currently</u> affect the habitat? *Please circle. If regional differences exist, please document those differences in the Comments box below.* **Low Moderate High**	**Confidence in the degree to which these other stressors <u>currently</u> affect the habitat:** *Please circle.* **Low Moderate High**
To what degree do these non-climate stressors make the habitat more sensitive to climate change? *Please circle.* **Low Moderate High**	**Confidence in the degree to which non-climate stressors affect the habitat's sensitivity to climate change:** *Please circle.* **Low Moderate High**
Comments and Citations: *Please briefly describe your selection of stressors above, detailing how they are likely to make the habitat more or less sensitive to climate change. Please document any location specific information that is relevant to the impact(s).*	

Habitat Sensitivity Assessment

6. Other Sensitivities

Are there other critical factors that have not been addressed that will likely make the habitat more sensitive to climate change?	Confidence in the degree to which these factors make the habitat more sensitive to climate change: *Please circle.*
Please list below any other factor that you may consider critical to understanding the potential response of this habitat to climate change that was not represented with the previous questions. If no other factors apply, please leave it blank but specify your confidence associated with this answer.	**Low** **Moderate** **High**

Collectively, to what degree do these factors make the habitat sensitive to climate change?
Please indicate the overall relative importance of the factor(s) that you listed above. Please circle.

Low **Moderate** **High**

Comments and Citations: *Please describe any "other sensitivities" and how they make the habitat sensitive to climate change.*

7. Overall User Ranking

THIS QUESTION IS NOT INCLUDED IN THE SENSIVITY SCORE

In your opinion, how would you rank the overall sensitivity of this habitat to climate change? *Given your experience and knowledge, what would be your gut assessment for this habitat? Just express your opinion. Please circle.*	Confidence in your overall assessment of the sensitivity of the habitat to climate change: *Please circle.*
Low **Moderate** **High**	**Low** **Moderate** **High**

Comments:

Habitat Adaptive Capacity Assessment

Coquille Estuary Climate Change Vulnerability Assessment

Habitat: ____

1. Extent and Integrity

Ecosystems and habitats that are currently widespread in their extent may be more likely to withstand and persist into the future despite climate and non-climate stressors (= more adaptive capacity). Similarly, systems and habitats that have low current rates of loss or fragmentation may be less vulnerable to both climate and non-climate stressors in the future.

Ecosystems and habitats that are rarer, more fragmented, or narrow in extent, or are currently undergoing major losses due to climate and non-climate stressors = less adaptive capacity

How widespread is the habitat across the Coquille Estuary? *Please circle.* **Low** **Moderate** **High**	**Confidence in extent:** *Please circle.* **Low** **Moderate** **High**
How fragmented is the habitat across the Coquille Estuary? *If there are specific regional differences, please describe them in the comments. Please circle.* **Low** **Moderate** **High**	**Confidence in fragmentation:** *Please circle.* **Low** **Moderate** **High**

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*

Habitat Adaptive Capacity Assessment

2. Resistance, Recovery, and Refugia

Some ecosystems and habitats may be more resistant to changes or stressors, or able to recover more quickly from stressors = more adaptive capacity

To what degree has the habitat been able to resist or recover from the impacts of stressors? *For example, some systems may be intrinsically more resistant to stressors because they have more rapid regeneration times and/or are dominated by r-strategist species. Systems and habitats that recover quickly from the impacts of stressors (e.g., <20 years) may have greater intrinsic adaptive capacities than slower developing habitats. Please circle.* **Low** **Moderate** **High**	**Confidence in degree to which the habitat is able to resist or recover from impacts:** *Please circle.* **Low** **Moderate** **High**

Are there microclimates or are areas of appropriate vertical profile within the ecosystem range that could support refugial communities? *Please describe any regional differences.*

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*

Habitat Adaptive Capacity Assessment

3. Landscape Permeability

More permeable landscapes with fewer barriers to dispersal or migration will likely result in greater adaptive capacity for species, habitats, and ecosystems.

To what degree is the landscape around this habitat permeable?	Confidence in the degree of landscape permeability:
Is the geography, land use, etc. such that it would be possible for the habitat to shift location over time? If regional differences exist, please document them below in the Comments box. Please circle. **Low** **Moderate** **High**	*Please circle.* **Low** **Moderate** **High**

Please select all general types of barriers to dispersal that apply:
Please circle all that apply. If none apply, do not circle any.

Road (Highway)
Road (Arterial)
Road (Low Volume)
Agriculture
Industrial or Urban Development
Other (please specify)
Suburban or Residential Development
Clear cut
Geologic features
Arid lands
Wind
Culverts
Dikes/levees
Dams
Rivers
Waterfalls

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above, particularly as they relate to geographic location and/or regional differences.*

4. Habitat Diversity

Ecosystems and habitats with diverse physical and topographical characteristics (variety in aspects, slopes, geologies and soil types, elevations) = higher adaptive capacity
Level of diversity of component species and functional groups in a habitat may affect the adaptive capacity (or sensitivity) to climate change impacts. More diversity in component species and functional groups = higher adaptive capacity

How diverse are the physical and topographical characteristics of the habitat? *Please circle.* **Low** **Moderate** **High**	**Confidence in the degree of physical diversity of the habitat:** *Please circle.* **Low** **Moderate** **High**
What is the level of diversity of component species and functional groups in the habitat? *Please circle.* **Low** **Moderate** **High**	**Confidence in the degree of diversity of the component species and functional groups:** *Please circle.* **Low** **Moderate** **High**

Describe the level of diversity of component species and functional groups, and/or the diversity of physical and topographical characteristics. *For example, is there a diversity of component species in the habitat? Is there diversity of functional groups within the habitat and a diversity of species within each functional group? What is the nature of the physical and topographical characteristics?*

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*

5. Management Potential

Habitats and ecosystems that occur in areas where management opportunities are limited or where current value limits management flexibility = less adaptive capacity

How much do people value this habitat (e.g., because of services it provides such as water, recreation opportunities, aesthetic value, etc.)? *Please circle.* **Low** **Moderate** **High**	**Confidence in habitat value:** *Please circle.* **Low** **Moderate** **High**
How rigid or specific are the rules governing management of the habitat? *For example, does the habitat typically occur in areas that fall under specific management guidelines? If the habitat occurs in multiple management areas, please document below under the Comments box. Please circle.* **Low** **Moderate** **High**	**Confidence in how specific the rules are for management of the habitat:** *Please circle.* **Low** **Moderate** **High**

Are there any use conflicts for this ecosystem in specific areas? *For example, does the habitat occur in areas where there is strong development pressure? Use conflicts may reduce the adaptive capacity of systems that have more flexible management. Please describe.*

What is the potential for managing or alleviating climate impacts? Please describe. *Are climate impacts on the habitat easier to manage than for other systems (e.g., those systems that are more intrinsically vulnerable to climate change or have numerous other stressors affecting them)? For example, early seral or riverine habitats may be easier to manage through restoration techniques.*

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*

6. Other Adaptive Capacity Factors	
Are there other critical factors that have not been addressed, which may affect the habitat's adaptive capacity? *Please list below any other factor that you may consider critical to understand the potential adaptive response of the habitat to climate change that has not been addressed yet. If no other factors apply, please leave it blank but specify your confidence associated with this answer.*	**Confidence in the degree to which these factors affect the habitat's adaptive capacity:** *Please circle.* **Low** **Moderate** **High**
Collectively, to what degree do these factors affect the adaptive capacity of the habitat? *Please indicate the overall relative importance of the factor(s) that you listed above. Please circle.* **Low** **Moderate** **High**	
Comments and Citations: *Please describe any other adaptive capacity factors for the habitat.*	

7. Overall User Ranking THIS QUESTION IS NOT INCLUDED IN THE ADAPTIVE CAPACITY SCORE	
In your opinion, how would you rank the overall adaptive capacity of the habitat to climate change? *Given your experience and knowledge, what would be your gut assessment for this habitat? Just express your opinion. Please circle.* **Low** **Moderate** **High**	**Confidence in your overall assessment of the adaptive capacity of the habitat to climate change:** *Please circle.* **Low** **Moderate** **High**
Comments:	

Habitat Exposure Assessment

Coquille Estuary Climate Change Vulnerability Assessment

Habitat: ____

1. Elements of Exposure

What elements of climate exposure are likely to be most relevant or important to consider for the habitat?

	Please indicate potential level of exposure to each element for this habitat (Low, Mod, High, N/A)	Is the exposure element important to consider for the resource across all of the Coquille Estuary or in specific regions? Please specify which region(s) or write "All".	What is the relevant annual time frame upon which to consider this exposure element? (e.g., Monthly? Seasonal? Yearly?)	What is the relevant time frame upon which to consider this exposure element? (e.g. 0-20, 20-50, 50-100 years)	Please document your confidence associated with your assessment of each element of exposure (Low, Mod, High)
Sea Level Rise					
Water Temperature					
Air Temperature					
Precipitation (average)					
Precipitation (timing/extremes)					

Habitat Exposure Assessment

Elements of Exposure continued

	Please indicate potential level of exposure to each element for this habitat (Low, Mod, High, N/A)	Is the exposure element important to consider for the resource across all of the Coquille Estuary or in specific regions? Please specify which region(s) or write "All".	What is the relevant annual time frame upon which to consider this exposure element? (e.g., Monthly? Seasonal? Yearly?)	What is the relevant longer term time frame upon which to consider this exposure element? (e.g. 0-20, 20-50, 50-100 years)	Please document your confidence associated with your assessment of each element of exposure (Low, Mod, High)
Hydrology (timing of flows)					
Hydrology (low flow)					
Hydrology (high flow)					
Water pH					
Upwelling					
Wind/Waves					
Storms/Flooding					

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions from the table above.*

4. Overall User Ranking THIS QUESTION IS NOT INCLUDED IN THE EXPOSURE SCORE	
In your opinion, how would you rank the overall exposure of this resource to climate change? *Given your experience and knowledge, what would be your gut assessment for this resource? Just express your opinion. Please circle.* **Low** **Moderate** **High**	**Confidence in your overall assessment of the exposure of this resource to climate change:** *Please circle.* **Low** **Moderate** **High**
Comments:	

Species Sensitivity Assessment

Coquille Estuary Climate Change Vulnerability Assessment

1. Taxonomy

Scientific Name / Common Name *Genus and species / all that apply*	
Management Status *Listed / Cultural importance / Recreational significance*	
Approx. Population Size *Within estuary*	
Habitat(s) *Indicate general habitat(s) utilized within the estuary, most common first.*	
Region & Migratory Behavior *For what area(s) of the estuary is this sensitivity information relevant?* *Is this a long distance migrant? What proportion of a year is spent in the region?*	

2. Generalist/Specialist

Generalist: species that use multiple habitats, have multiple prey or forage species, or have multiple host plants (= less sensitive to climate change)

Specialist: species with very narrow habitat needs, single forage or prey species, or single host-plant species (= more sensitive)

Broadly, where does this species fall on the spectrum of generalist to specialist? *Please circle.* **Generalist** **Neither/In-between** **Specialist**	**Confidence in your assessment of the degree to which the species is a generalist or specialist?** *Please circle.* **Low** **Moderate** **High**

Please specify which factors make the species more of a specialist:

Please circle the relevant relationship(s) that apply. If none apply, do not circle any.

- Predator/prey relationship
- Foraging dependency
- Seed dispersal dependency
- Host plant dependency
- Other dependencies (please describe)
- Phenology dependency
- Pollinator dependency
- Symbiont/Mutualist/Parasite
- Habitat dependency

Comments and Citations: *Please further describe the relationships that make the species more of a specialist. List all relevant relationships and component species. For example, if the species being assessed is dependent on one host plant, please describe that relationship (e.g., food resource) and list the host plant.*

3. Physiology

Physiological sensitivity is directly related to a species' physiological ability to tolerate changes in temperature, precipitation, salinity, pH, and CO_2 that are higher or lower than the range that they currently experience.

Species tolerates wide range of variables = less sensitive

Indicate whether this species is physiologically sensitive to one or more of the following:
Please circle all that apply. If none apply, do not circle any.

Temperature (air/water)	CO_2
Precipitation	Dissolved O_2
Salinity	Air/water pollution
pH	Other (please specify)

How sensitive is the species' physiology to one or more of the factors above: *Please circle.*

Low **Moderate** **High**

Confidence in physiological sensitivity of the species: *Please circle.*

Low **Moderate** **High**

Comments and Citations: *Please describe any specific physiological sensitivities; list all physiological mechanisms and limits to the species in question.*

4. Habitats

Species that depend on habitats that are sensitive to climate change = higher sensitivity

Indicate whether the species depends on the following sensitive types:
Please circle all that apply. If none apply, do not circle any.

Estuarine open water	Eelgrass	Tidal flats
Tidal saltmarsh	Tidal transitional marsh	Tidal freshwater marsh
Tidal freshwater swamp	Nontidal freshwater marsh	Nontidal freshwater swamp
Upland riparian	Other (please specify)	

How dependent is the species on one or more of the sensitive habitat types: *Please circle.*

Low **Moderate** **High**

Confidence in species dependence on sensitive habitat types: *Please circle.*

Low **Moderate** **High**

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*

5. Life History

Species with longer generation times (e.g., k-selection) = more sensitive
Species with short generation times and many offspring (e.g., r-selected) = less sensitive

Species reproductive strategy	Confidence in your assessment of the species' reproductive strategy: *Please circle.*
→ *R-selection = a species that produces many offspring and has a short generation time (e.g., fruit fly).* → *K-selection is a species that produces few offspring and has high parental investment (e.g., elephant).* → *A mid-range example would be a species that produces 3-5 young/year.* *Please circle a value that corresponds to the reproductive strategy above.* **One being r-selection, two being mid-range, three being k-selection.** **One** **Two** **Three**	**Low** **Moderate** **High**

Is the species polycyclic, iteroparous, or semelparous? *Please circle the one that applies.*

Polycyclic (reproduces intermittently throughout a lifespan)

Semelparous (reproduces only once; characteristic of r-strategists; e.g., salmon, insects, annual plants, bamboo)

Iteroparous (reproduces in successive cycles; characteristic of k-strategists; e.g., perennial plants, most animals)

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above. Also, please provide any additional information about the species' life history that you think is important to know when evaluating sensitivity.*

Species Sensitivity Assessment

6. Ecological Relationships

Indicate which of the below (if any) ecological relationships of this species are sensitive to climate change:
Please circle the relevant ecological climate effects that apply. If none apply, do not circle any.

Predator/prey relationship	Competition
Forage	Hydrology/flow
Habitat	Other (please describe)

Which types of climate and climate-driven changes in the environment affect these aspects of the species' ecology?
Please circle the relevant climate effects that apply. If none apply, do not circle any.

Temperature (air/water)	pH	Sea level rise
Precipitation	CO_2	Hydrology/flow
Upwelling	Wind/Waves	Other (please describe)

How sensitive is the species to other effects of climate change on its ecology: *Please circle.*

Low **Moderate** **High**

Confidence in how sensitive the species is to other effects of climate change on its ecology: *Please circle.*

Low **Moderate** **High**

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*

7. Disturbance Regimes

This section collects information about the relationship with different types of disturbance that may be affected by climate change. This relationship may be either positive or negative (please specify in the "Comments" section).

Please circle all disturbance regimes to which the species is sensitive:
If none apply, do not circle any.

Wildfire	Drought	Wind/waves	Other (please specify)
Flooding	Insects	Disease	Invasives

How sensitive is this species to one or more of these disturbance regimes: *Please circle.*

Low **Moderate** **High**

Confidence in sensitivity to disturbance regimes: *Please circle.*

Low **Moderate** **High**

Comments and Citations: *Please describe the disturbance regime(s) upon which the species is sensitive – frequency, severity, timing, duration. If more than one disturbance regime was selected, please provide information, as available, on each of them.*

<table>
<tr><td colspan="2">8. Interacting Non-Climatic Stressors
Please indicate whether this species is affected by other threats, predisposing it to be more sensitive to climate change.</td></tr>
<tr><td colspan="2">List the <u>top three other non-climate stressors</u> that may make this species more sensitive to climate change: If none apply, please indicate. Examples might include (circle if apply):
Development & construction activities
Habitat loss due to other activities
Others (list below)
Industrial, municipal & agriculture activities
Invasives and other problematic species</td></tr>
<tr><td>To what degree do these other stressors <u>currently</u> affect the species: Please circle.
Low Moderate High</td><td>Confidence in the degree to which these other stressors <u>currently</u> affect the species: Please circle.
Low Moderate High</td></tr>
<tr><td>To what degree do these non-climate stressors make the species more sensitive to climate change: Please circle.
Low Moderate High</td><td>Confidence in the degree to which non-climate stressors affect the species' sensitivity to climate change: Please circle.
Low Moderate High</td></tr>
<tr><td colspan="2">Comments and Citations: Please briefly describe your selection of stressors above, detailing how the stressor(s) are likely to make the species more or less sensitive to climate change.</td></tr>
</table>

Species Sensitivity Assessment

9. Other Sensitivities	
Are there other critical factors that have not been addressed, which may make this species more sensitive to climate change? *Please list below any other factor that you may consider critical to understanding this species' potential response to climate change that has not been addressed yet. If no other factors apply, please leave it blank but specify your confidence associated with this question.*	**Confidence in the degree to which these factors make this species more sensitive to climate change:** *Please circle.* **Low** **Moderate** **High**
Collectively, to what degree do these factors make the species sensitive to climate change? *Please indicate the overall relative importance of the factor(s) that you listed above. Please circle.* **Low** **Moderate** **High**	
Comments and Citations: *Please describe any "other sensitivities" and how they make the species sensitive to climate change.*	

10. Overall User Ranking THIS QUESTION IS NOT INCLUDED IN THE SENSIVITY SCORE	
In your opinion, how would you rank the overall sensitivity of this species to climate change? *Given your experience and knowledge, what would be your gut assessment for this species? Just express your opinion. Please circle.* **Low** **Moderate** **High**	**Confidence in your overall assessment of the sensitivity of this species to climate change:** *Please circle.* **Low** **Moderate** **High**
Comments:	

Species Adaptive Capacity Assessment

Coquille Estuary Climate Change Vulnerability Assessment

Species: ____

1. Dispersal / Movement Ability

Species that are poorer dispersers, in general, are more susceptible to climate change = less adaptive capacity
Barriers to dispersal can increase the vulnerability of some species with high innate dispersal ability.

Maximum annual dispersal distance: *The maximum average distance a species will likely move to establish a new population in a more suitable habitat. We are interested in how quickly a species could spread across the landscape in response to climate change. This should reflect a distance that is feasible (not just possible).*

Please circle one.

>100 km
10-100km   1-10km   100m-500m
<100 m

Confidence in maximum annual dispersal distance: *Please circle.*

Low   Moderate   High

What is the ability of the species to disperse? *Please circle.*

Low   Moderate   High

Confidence in species ability to disperse: *Please circle.*

Low   Moderate   High

Indicate all general types of barriers to dispersal:
Please circle all that apply. If none apply, do not circle any.

Road (Highway)	Residential, suburban development	Culverts
Road (Arterial)	Clear cut	Dikes/levees
Road (Low Volume)	Geologic features	Dams
Agriculture	Arid lands	Rivers
Industrial or Urban Development	Wind	Waterfalls
Other (please specify)		

To what degree do these barriers affect dispersal for the species? *Please circle.*

Low   Moderate   High

Confidence in degree to which barriers affect dispersal: *Please circle.*

Low   Moderate   High

Is the geography, land use, etc. such that it would be possible for individuals to seek out refugia during times of particular climate stress? *Please describe any regional differences.*

Comments and Citations: *Please list any relevant information that was missed above or clarify any regional differences.*

Species Adaptive Capacity Assessment

2. Plasticity	
A species' capacity to express different traits (e.g., phenology, behavior, physiology) in response to environmental variation. Many species exhibit phenotype plasticity in response to inter-annual variation in water temperature and precipitation. Ability to express different traits (e.g., phenology, behavior, physiology) = high adaptive capacity	
To what degree is the species able to modify its physiology or behavior to increase the likelihood that it will be better able to respond to both climate change and to the effects of climate change? *Please circle.* **Low Moderate High**	**Confidence in degree to which species is able to modify its behavior or physiology to respond to climate change:** *Please circle.* **Low Moderate High**
Please describe how the species is able to modify its physiology or behavior to better cope with climate changes and its associated effects:	
Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions above.*	

Species Adaptive Capacity Assessment

<table>
<tr><td colspan="2">3. Evolutionary Potential
Some species and some populations will be better able to adapt (evolutionarily) to climate change.
For example, species with characteristics such as faster generation times, genetic diversity, heritability of traits, larger population size, or multiple populations with connectivity among them to allow for gene flow = more adaptive capacity</td></tr>
<tr><td>To what degree might the species be able to adapt evolutionarily to climate change? Please circle.

Low Moderate High</td><td>Confidence in degree to which the species may be able to adapt evolutionarily to climate change: Please circle.

Low Moderate High</td></tr>
<tr><td colspan="2">Please describe the characteristics that may allow the species to adapt evolutionarily to climate change.
For example, generation time, genetic diversity, heritability of traits, population size or multiple populations with connectivity among them to allow for gene flow, etc.</td></tr>
<tr><td colspan="2">Comments and Citations: Please provide any comments or citations to support or clarify your conclusions above.</td></tr>
</table>

<table>
<tr><td colspan="2">4. Intraspecific Diversity/Life History
Species with a diversity of life history strategies (e.g., variations in age at maturity, reproductive or nursery habitat use, or resource use) may be more resilient to climate change.</td></tr>
<tr><td>To what degree might the diversity of the specie’s life history strategies confer adaptive capacity? Please circle.

Low Moderate High</td><td>Confidence in the adaptive capacity conferred within the diversity of the species’ life history strategies: Please circle.

Low Moderate High</td></tr>
<tr><td colspan="2">Please describe the diversity (if any) of life history strategies for the species:</td></tr>
<tr><td colspan="2">Comments and Citations: Please provide any comments or citations to support or clarify your conclusions above.</td></tr>
</table>

Species Adaptive Capacity Assessment

<table>
<tr><td colspan="2">5. Management Potential
Species that occur in areas where management opportunities are limited or where current value limits management flexibility = less adaptive capacity</td></tr>
<tr><td>How much do people value this species? Please circle.

Low Moderate High</td><td>Confidence in system value: Please circle.

Low Moderate High</td></tr>
<tr><td>How specific are the rules governing management of the species? For example, is the species listed as threatened or endangered, thus providing an opportunity for implementing more management measures to help the species recover? Please circle.

Low Moderate High</td><td>Confidence in how specific the rules are for management of the system: Please circle.

Low Moderate High</td></tr>
<tr><td colspan="2">Are there any use conflicts for this species in specific regions? For example, does the species occur in areas where there is strong development pressure? Use conflicts may reduce the adaptive capacity of species that have more flexible management. Please describe.</td></tr>
<tr><td colspan="2">What is the potential for managing or alleviating climate impacts? Please describe. For example, are climate impacts on this species easier to manage than for other species (e.g., those species that are more intrinsically vulnerable to climate change because of physiological thresholds or that have numerous other stressors affecting them)?</td></tr>
<tr><td colspan="2">Comments and Citations: Please describe any other adaptive capacity factors for this species.</td></tr>
</table>

<table>
<tr><td colspan="2">6. Other Adaptive Capacity Factors</td></tr>
<tr><td>Are there other critical factors that have not been addressed, which may affect this species ability to adapt climate change?
Please list below any other factor that you may consider critical to understanding this species' potential response to climate change that has not been addressed yet. If no other factors apply, please leave it blank but specify your confidence associated with this question.</td><td>Confidence in the degree to which these factors affect this species' ability to adapt to climate change: Please circle.
Low Moderate High</td></tr>
<tr><td colspan="2">Collectively, to what degree do these factors affect the species' ability to adapt to climate change?
Please indicate the overall relative importance of the factor(s) that you listed above. Please circle.
Low Moderate High</td></tr>
<tr><td colspan="2">Comments and Citations: Please describe any other adaptive capacity factors for this species.</td></tr>
</table>

<table>
<tr><td colspan="2">7. Overall User Ranking
THIS QUESTION IS NOT INCLUDED IN THE ADAPTIVE CAPACITY SCORE</td></tr>
<tr><td>In your opinion, how would you rank the overall adaptive capacity of this species to climate change? Given your experience and knowledge, what would be your gut assessment for this species? Just express your opinion. Please circle.
Low Moderate High</td><td>Confidence in your overall assessment of the adaptive capacity of this species to climate change: Please circle.
Low Moderate High</td></tr>
<tr><td colspan="2">Comments:</td></tr>
</table>

Species Exposure Assessment

Coquille Estuary Climate Change Vulnerability Assessment

Species: ____

1. Elements of Exposure

What elements of climate exposure are likely to be most relevant or important to consider for the species?

	Please indicate potential level of exposure to each element for this species (Low, Mod, High, N/A)	Is the exposure element important to consider for the species across all of the Coquille Estuary or in specific regions? Please specify which region(s) or write "All".	What is the relevant annual time frame upon which to consider this exposure element? (e.g., Monthly? Seasonal? Yearly?)	What is the relevant time-frame which to consider this exposure element? (e.g. 0-20, 20-50, 50-100 years)	Please document your confidence associated with your assessment of each element of exposure (Low, Mod, High)
Sea Level Rise					
Water Temperature					
Air Temperature					
Precipitation (average)					
Precipitation (timing/extremes)					

Species Exposure Assessment

Elements of Exposure continued

	Please check which element(s) of exposure are likely to be most relevant or important to consider for this species.		Is the exposure element important to consider for the species across all of the Coquille Estuary or in specific regions? Please specify which region(s) or write "All".		What is the relevant annual time frame upon which to consider this exposure element? (e.g., Monthly? Seasonal? Yearly?)		What is the relevant longer term time frame upon which to consider this exposure element? (e.g. 0-20, 20-50, 50-100 years)		Please document your confidence associated with your assessment of each element of exposure (Low, Mod, High)
Hydrology (timing of flows)									
Hydrology (low flow)									
Hydrology (high flow)									
Water pH									
Upwelling									
Wind/Waves									
Storms/Flooding									

Comments and Citations: *Please provide any comments or citations to support or clarify your conclusions from the table above.*

Species Exposure Assessment

<table>
<tr><td colspan="2">4. Overall User Ranking
THIS QUESTION IS NOT INCLUDED IN THE EXPOSURE SCORE</td></tr>
<tr><td>In your opinion, how would you rank the overall exposure of this species to climate change? Given your experience and knowledge, what would be your gut assessment for this resource? Just express your opinion. Please circle.

Low Moderate High</td><td>Confidence in your overall assessment of the exposure of this species to climate change: Please circle.

Low Moderate High</td></tr>
<tr><td colspan="2">Comments:</td></tr>
</table>

Appendix D

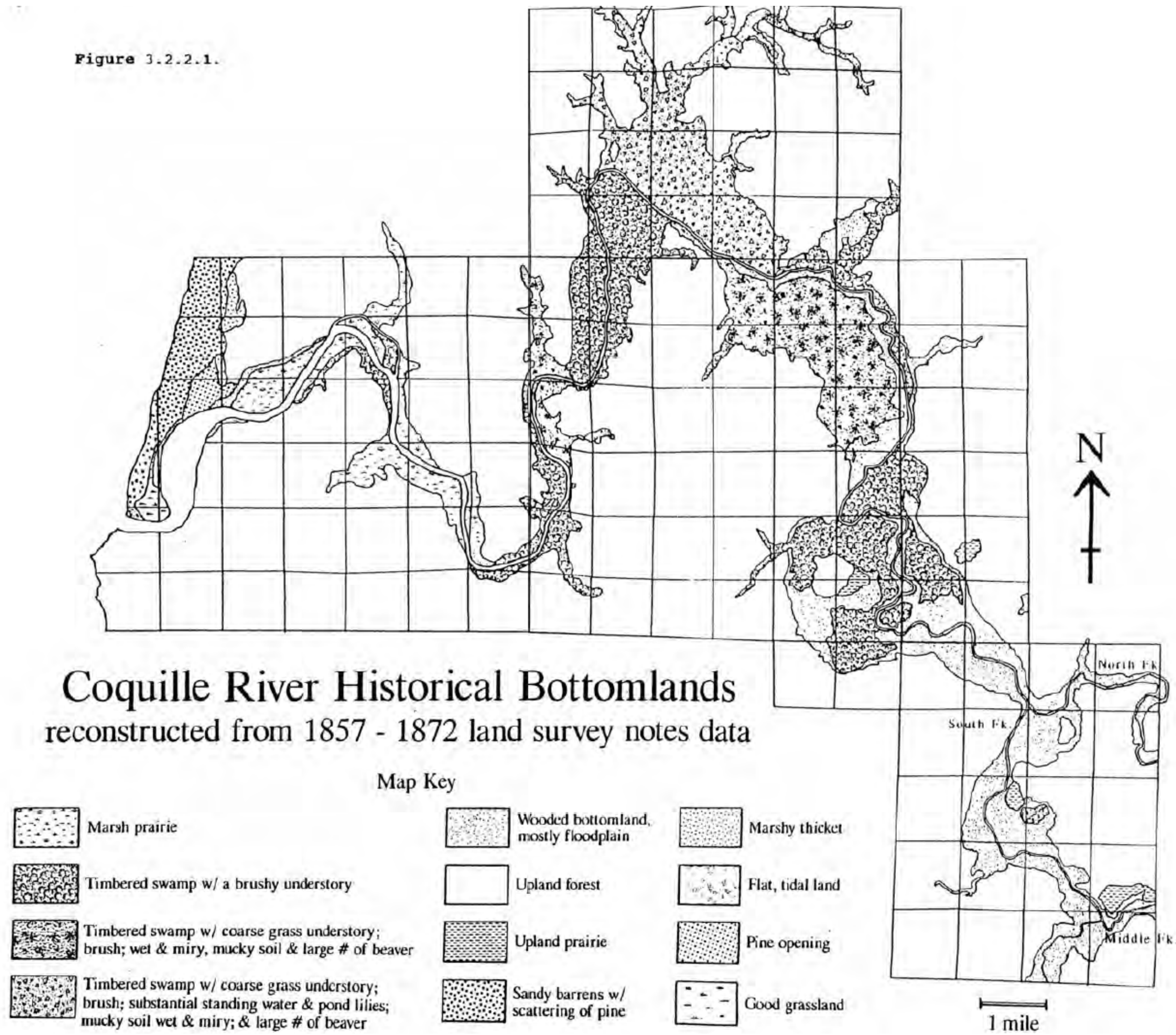
Crosswalk Table: Relationships of Habitat Classifications

National Wetlands Inventory	SLAMM Habitat	Project Habitat
E1UBL	EstuarineWater	Estuary Open Water
E2EM1N	RegFloodMarsh	Tidal Saltmarsh (low)
E2EM1P	IrregFloodMarsh	Tidal Saltmarsh (high)
E2SBN	TidalCreek	Estuary Open Water
E2SS1P	TransSaltMarsh	Tidal Freshwater Wetlands
E2USM	EstuarineWater	Estuary Open Water
E2USN	EstuarineBeach	Tidal Flat
E2USP	EstuarineBeach	Tidal Flat
L1UBH	InlandOpenWater	Non-tidal Freshwater Wetlands
L1UBHh	InlandOpenWater	Non-tidal Freshwater Wetlands
L1UBKx	InlandOpenWater	Non-tidal Freshwater Wetlands
M1UBL	OpenOcean	
M2USN	OceanBeach	
M2USP	OceanBeach	
PABH	InlandOpenWater	Non-tidal Freshwater Wetlands
PEM1/SS1A	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1/SS1C	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1A	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Ad	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Ah	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1B	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1C	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Cd	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Ch	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Cx	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1F	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Fd	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Fh	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Hh	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Hx	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1R	TidalFreshMarsh	Tidal Freshwater Wetlands
PEM1S	TidalFreshMarsh	Tidal Freshwater Wetlands
PFO1A	Swamp	Non-tidal Freshwater Wetlands
PFO1Ah	Swamp	Non-tidal Freshwater Wetlands
PFO1C	Swamp	Non-tidal Freshwater Wetlands
PFO1Ch	Swamp	Non-tidal Freshwater Wetlands
PSS1/EM1A	Swamp	Non-tidal Freshwater Wetlands
PSS1/EM1C	Swamp	Non-tidal Freshwater Wetlands
PSS1A	Swamp	Non-tidal Freshwater Wetlands
PSS1Ah	Swamp	Non-tidal Freshwater Wetlands
PSS1B	Swamp	Non-tidal Freshwater Wetlands
PSS1C	Swamp	Non-tidal Freshwater Wetlands
PSS1Ch	Swamp	Non-tidal Freshwater Wetlands
PSS1F	Swamp	Non-tidal Freshwater Wetlands
PSS1Fh	Swamp	Non-tidal Freshwater Wetlands
PSS1R	TidalSwamp	Tidal Freshwater Wetlands
PUBF	InlandOpenWater	Non-tidal Freshwater Wetlands
PUBFh	InlandOpenWater	Non-tidal Freshwater Wetlands
PUBFx	InlandOpenWater	Non-tidal Freshwater Wetlands
PUBH	InlandOpenWater	Non-tidal Freshwater Wetlands
PUBHh	InlandOpenWater	Non-tidal Freshwater Wetlands
PUBHx	InlandOpenWater	Non-tidal Freshwater Wetlands
PUBK	InlandOpenWater	Non-tidal Freshwater Wetlands
PUBT	InlandOpenWater	Tidal Freshwater Wetlands
PUBV	InlandOpenWater	Tidal Freshwater Wetlands
PUSC	InlandShore	Non-tidal Freshwater Wetlands
PUSCh	InlandShore	Non-tidal Freshwater Wetlands
PUSCx	InlandShore	Non-tidal Freshwater Wetlands
R1UBV	RiverineTidal	Tidal Freshwater Wetlands
R1UBVx	RiverineTidal	Tidal Freshwater Wetlands
R1USR	InlandShore	Tidal Freshwater Wetlands
R2UBH	InlandOpenWater	Non-tidal Freshwater Wetlands
R2UBHx	InlandOpenWater	Non-tidal Freshwater Wetlands
R2USC	InlandShore	Non-tidal Freshwater Wetlands
E2ABM	EstuarineWater	Estuary Open Water
E2ABN	RegFloodMarsh	Tidal Saltmarsh (low)
E2SBNx	TidalCreek	Estuary Open Water
L1ABKx	InlandOpenWater	Non-tidal Freshwater Wetlands
L1UBK	InlandOpenWater	Non-tidal Freshwater Wetlands
PABF	InlandOpenWater	Non-tidal Freshwater Wetlands
PABK	InlandOpenWater	Non-tidal Freshwater Wetlands
PEM1/SS1Ch	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Af	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1Cf	InlandFreshMarsh	Tidal Freshwater Wetlands
PEM1H	InlandFreshMarsh	Tidal Freshwater Wetlands
PSS1H	Swamp	Non-tidal Freshwater Wetlands
PSSKf	Swamp	Non-tidal Freshwater Wetlands
PUSS	InlandShore	Non-tidal Freshwater Wetlands
R2UBF	InlandOpenWater	Non-tidal Freshwater Wetlands
R2UBFx	InlandOpenWater	Non-tidal Freshwater Wetlands
R3UBF	InlandOpenWater	Non-tidal Freshwater Wetlands
R3UBFx	InlandOpenWater	Non-tidal Freshwater Wetlands
R3UBH	InlandOpenWater	Non-tidal Freshwater Wetlands
R3UBHx	InlandOpenWater	Non-tidal Freshwater Wetlands
R4SBC	InlandOpenWater	Non-tidal Freshwater Wetlands
R4SBCx	InlandOpenWater	Non-tidal Freshwater Wetlands

Appendix E

Historical Wetland Map of the Coquille Estuary
(from Benner 1991)

Figure 3.2.2.1.


Coquille River Historical Bottomlands
reconstructed from 1857 - 1872 land survey notes data
N
North Fk.
South Fk.
Middle Fk.
1 mile
Map Key
Marsh prairie
Timbered swamp w/ a brushy understory
Timbered swamp w/ coarse grass understory; brush; wet & miry, mucky soil & large # of beaver
Timbered swamp w/ coarse grass understory; brush; substantial standing water & pond lilies; mucky soil wet & miry; & large # of beaver
Wooded bottomland, mostly floodplain
Upland forest
Upland prairie
Sandy barrens w/ scattering of pine
Marshy thicket
Flat, tidal land
Pine opening
Good grassland

EcoAdapt, founded by a team of some of the earliest adaptation thinkers and practitioners in the field, has one goal - creating a robust future in the face of climate change. We bring together diverse players in the conservation, policy, science, and development communities to reshape planning and management in response to rapid climate change.

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