
inter·fluve

Incorporating future climate predictions into today's ecosystem restoration design

Caitlin Alcott, CE
Matt Cox, PE

April 8, 2019

inter·fluve

Overview

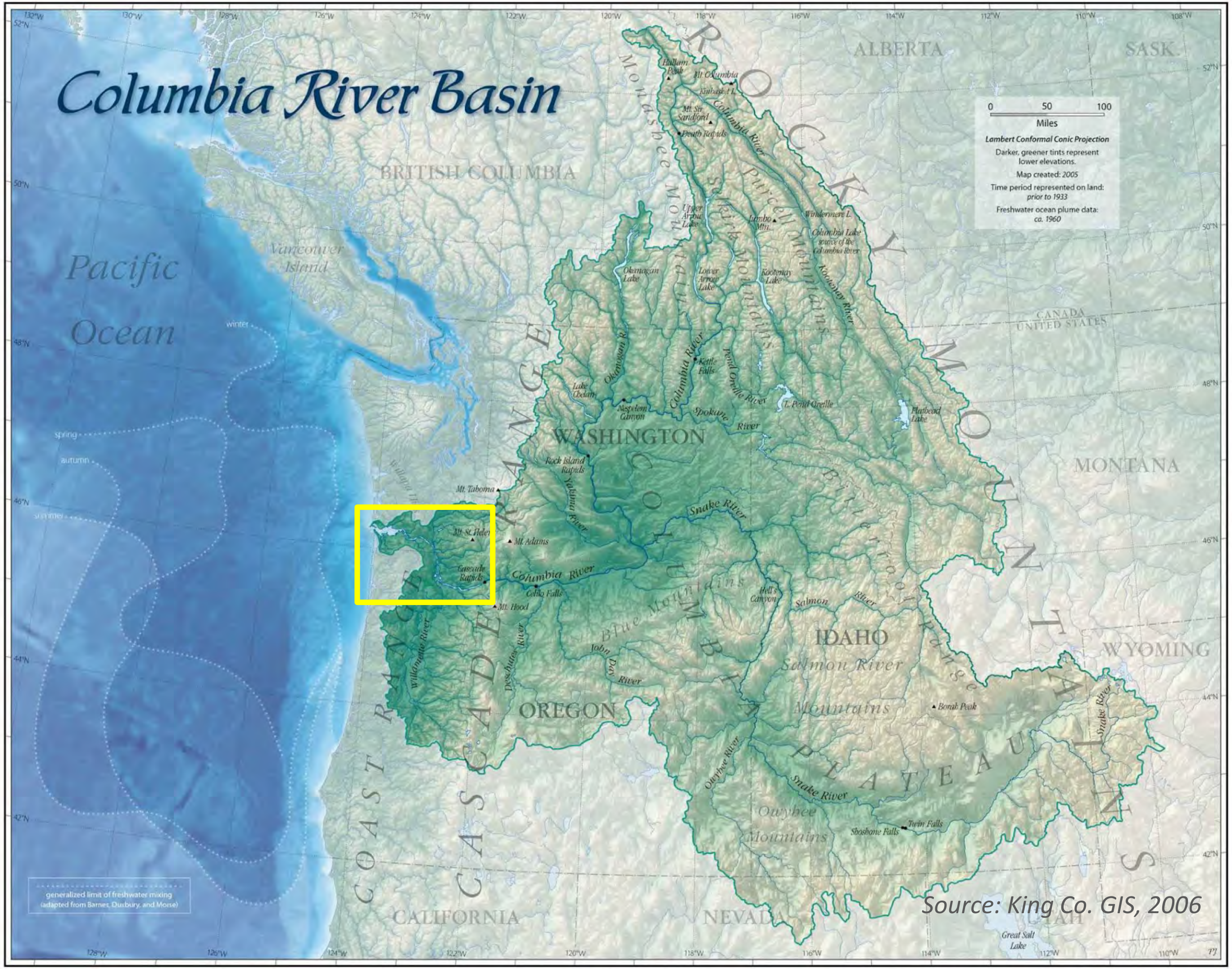
1. Region:
   Columbia River Estuary

2. Guidance:
   Consider climate change

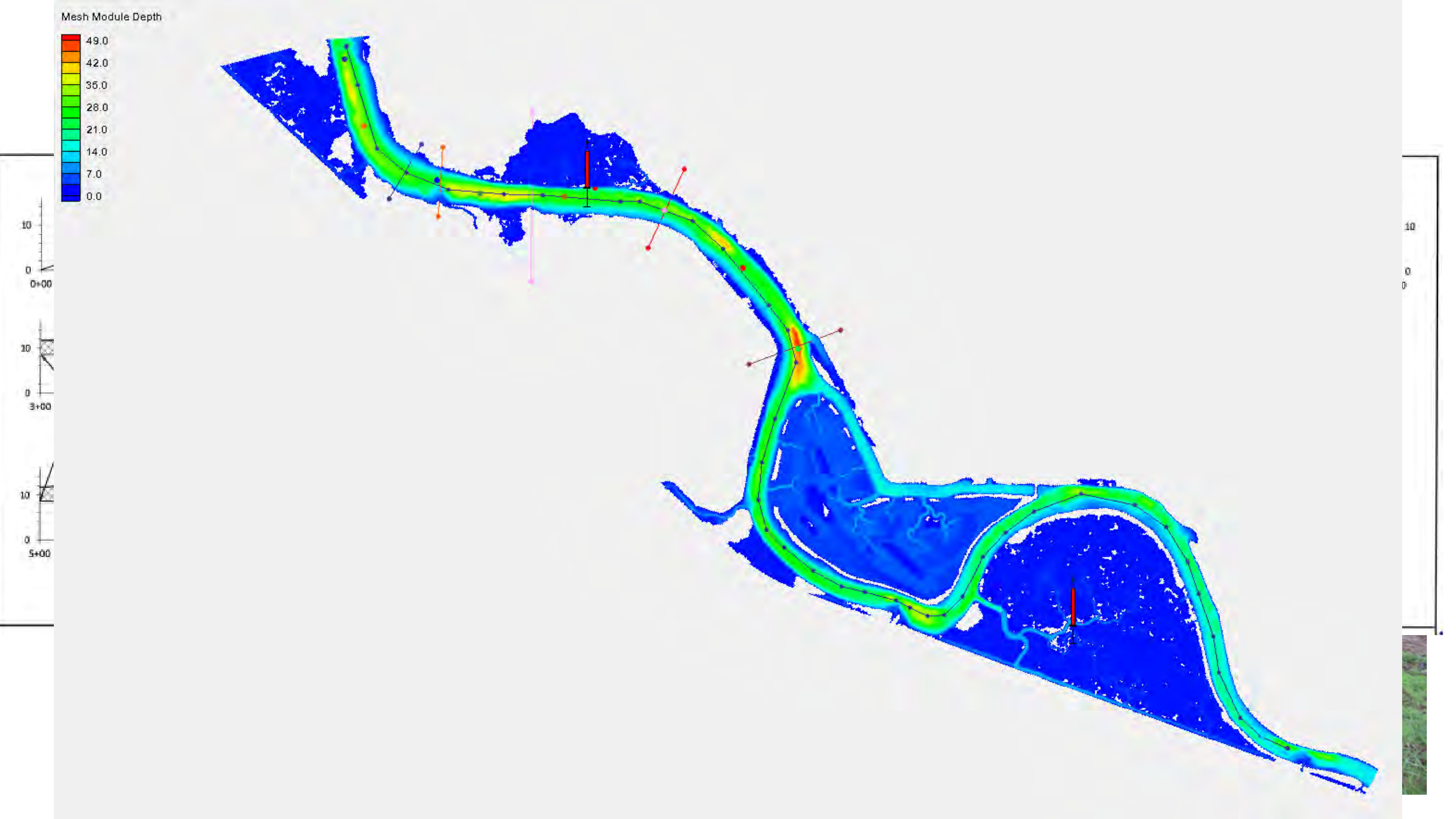
3. Existing tools to incorporate climate change into design

4. Next steps:
   Design standards
   Practitioner buy-in

1. Columbia River Estuary Restoration



Source: King Co. GIS, 2006



Mesh Module Depth
49.0
42.0
35.0
28.0
21.0
14.0
7.0
0.0
10
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0+00
10
0
3+00
10
0
5+00

2. Consider climate change

FEMA ADMINISTRATOR POLICY

2011-OPPA-01

FEMA CLIMATE CHANGE ADAPTATION POLICY STATEMENT

I. Purpose

The purpose of this policy statement is to establish an Agency-wide directive to integrate climate change adaptation planning and actions into Agency programs, policies, and operations.

Home >> Climate Preparedness and Resilience >> Comprehensive Evaluation of Projects with Respect to Sea-Level Change >> Sea Level Change Curves

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Adaptation Policy/Plan
Responses to Climate Change Program
Climate Preparedness and Resilience
Public Tools Developed by USACE
What is Climate Preparedness and Resilience?
Info on Climate Change Impacts
Interagency Activities
International Activities
District Activities
About the Program
Contacts
History of Climate Change at USACE

Climate Change Adaptation

Comprehensive Evaluation of Projects with Respect to Sea-Level Change

Climate Preparedness and Resilience Home | Coastal Risk Reduction and Resilience | Application of Flood Risk Reduction Standard for Sandy Rebuilding Projects | Comprehensive Evaluation of Projects with Respect to Sea-Level Change | Update Drought Contingency Plans | Update Reservoir Sediment Information

Sea-Level Change Curve Calculator (2017.55)

Version 2017.55 employs the same computations as previous versions, yielding the same projections along with some additional functionality, the 2014 NOAA rates, and several additional gauges. Previous versions include Version 2015.46 and its manual (*pdf, 1.4MB*); 2014.88 and its manual (*pdf, 4.5 MB*); and the original superseded calculator.

EC 1165-2-212 (*pdf, 845 KB*) and its successor ER 1100-2-8162 *(pdf, 317 KB)* were developed with the assistance of coastal scientists from the NOAA National Ocean Service and the US Geological Survey. Their participation on the USACE team allows rapid infusion of science into engineering guidance. ETL 1100-2-1 (*pdf, 9.87 MB*) , Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation.

EC 1165-2-212 (*pdf, 845 KB*) and its successor ER 1100-2-8162 *(pdf, 317 KB)* use the historic rate of sea-level change as the rate for the "USACE Low Curve". ETL 1100-2-1 (*pdf, 9.87 MB*) , Procedures to Evaluate Sea Level Change: Impacts, Responses, and Adaptation.

The rate for the "USACE Intermediate Curve" is computed from the modified NRC Curve I considering both the most recent IPCC projections and modified NRC projections with the local rate of vertical land movement added.

The rate for the "USACE High Curve" is computed from the modified NRC Curve III considering both the most recent IPCC projections and modified NRC projections with the local rate of vertical land movement added.

The three scenarios proposed by the NRC result in global eustatic sea-level rise values, by the year 2100, of 0.5 meters, 1.0 meters, and 1.5 meters. Adjusting the equation to include the historic GMSL change rate of 1.7 mm/year and the start date of 1992 (which corresponds to the midpoint of the current National Tidal Datum Epoch of 1983-2001), instead of 1986 (the start date used by the NRC), results in updated values for the coefficients (b) being equal to 2.71E-5 for modified NRC Curve I, 7.00E-5 for modified NRC Curve II, and 1.13E-4 for modified NRC Curve III.

The three local relative sea level change scenarios updated from EC 1165-2-212 (*pdf, 845 KB*) (and and its successor ER 1100-2-8162*)*, Equation 2 are depicted in the Figure to the right of

Chapter 4: HIP III Conservation Measures.

General Aquatic Conservation Measures Applicable to all Actions.

The activities covered under the HIP III are intended to protect and restore fish and wildlife habitat with long-term benefits to ESA-listed species; however, construction activities may have short-term adverse effects on ESA-listed species and associated critical habitat. To avoid and minimize these short-term adverse effects, BPA has developed the following general Conservation Measures in coordination with USFWS and NMFS. These measures will be implemented on all projects covered under the HIP III.

Project Design and Site Preparation.

1) **Climate change.** Best available science regarding the future effects within the project area of climate change, such as changes instream flows and water temperatures, will be considered during project design.

Manual 18

Salmon Recovery Grants

March 2018

- Project proposal sufficiently identified and considered how climate change will affect the project.

Washington State Recreation and Conservation Office
Salmon Recovery Funding Board

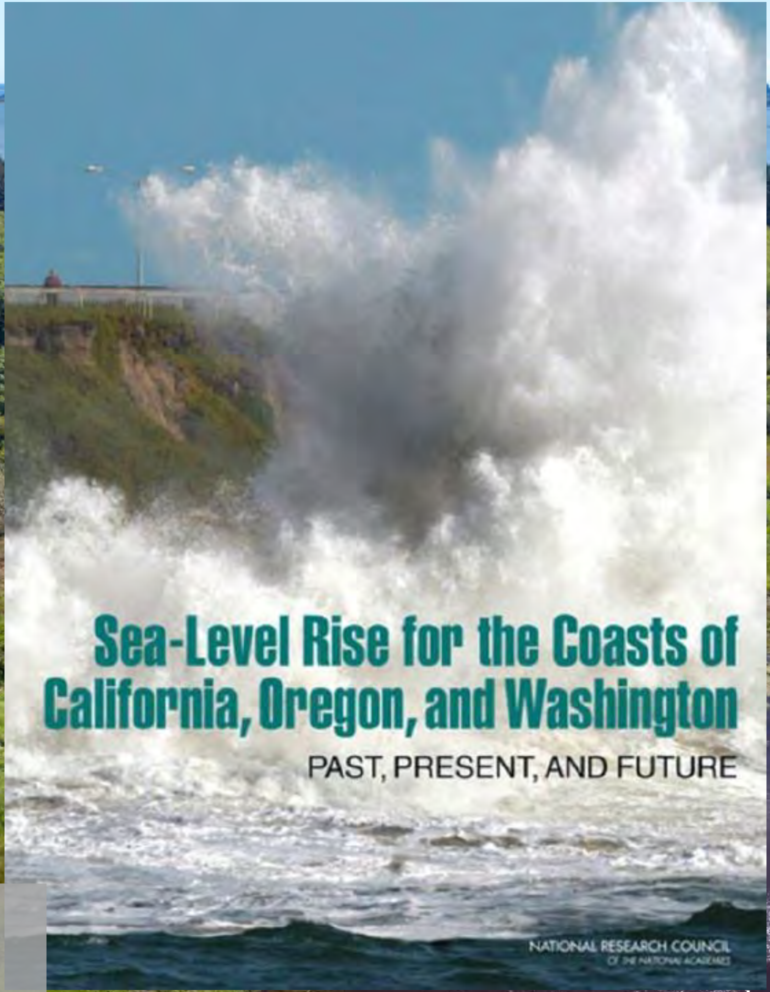
What do we mean when we say “consider climate change”?

- Sea level rise
- River flow amount/timing
- Storms
- Salinity
- Water temperatures
- Sediment dynamics
- Aquatic species responses
- Wetland/marsh migration
- Human infrastructure risks

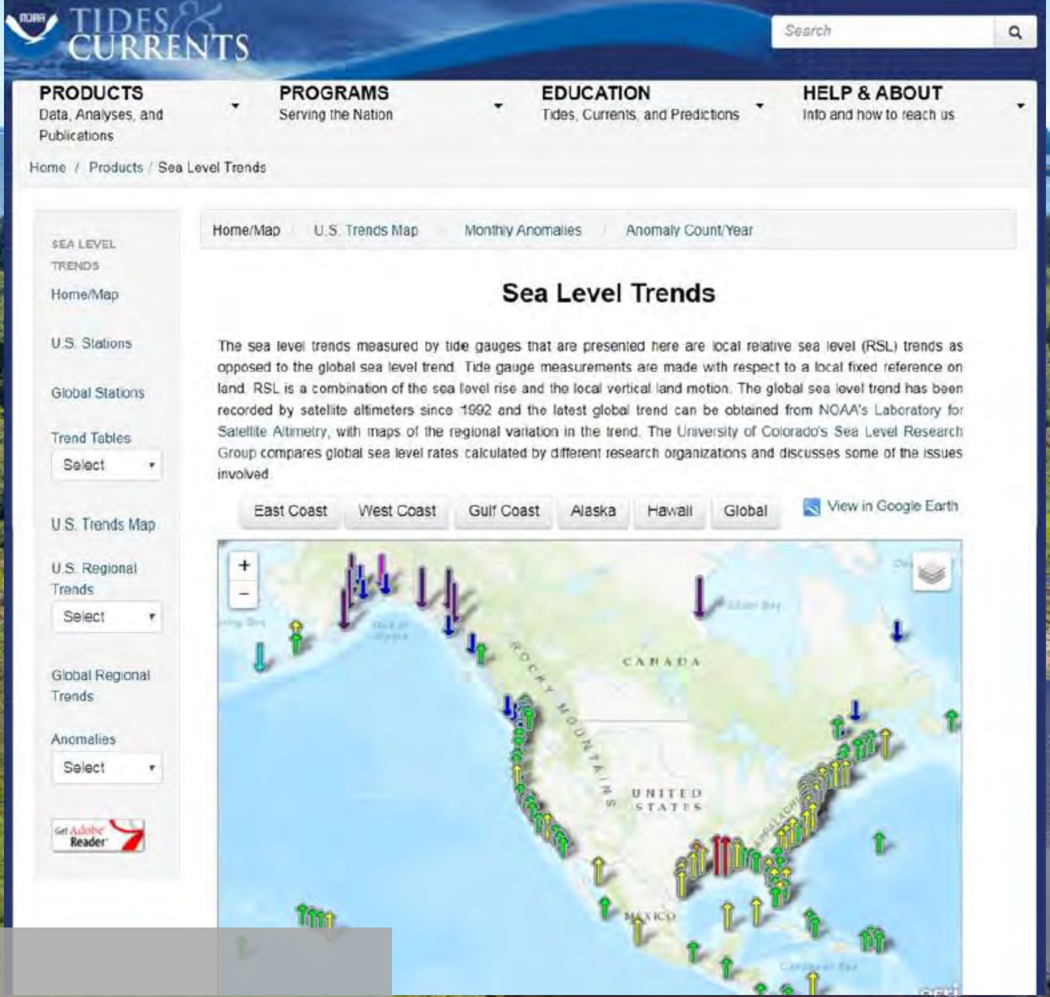
and more…

3. Existing tools to incorporate climate change into design

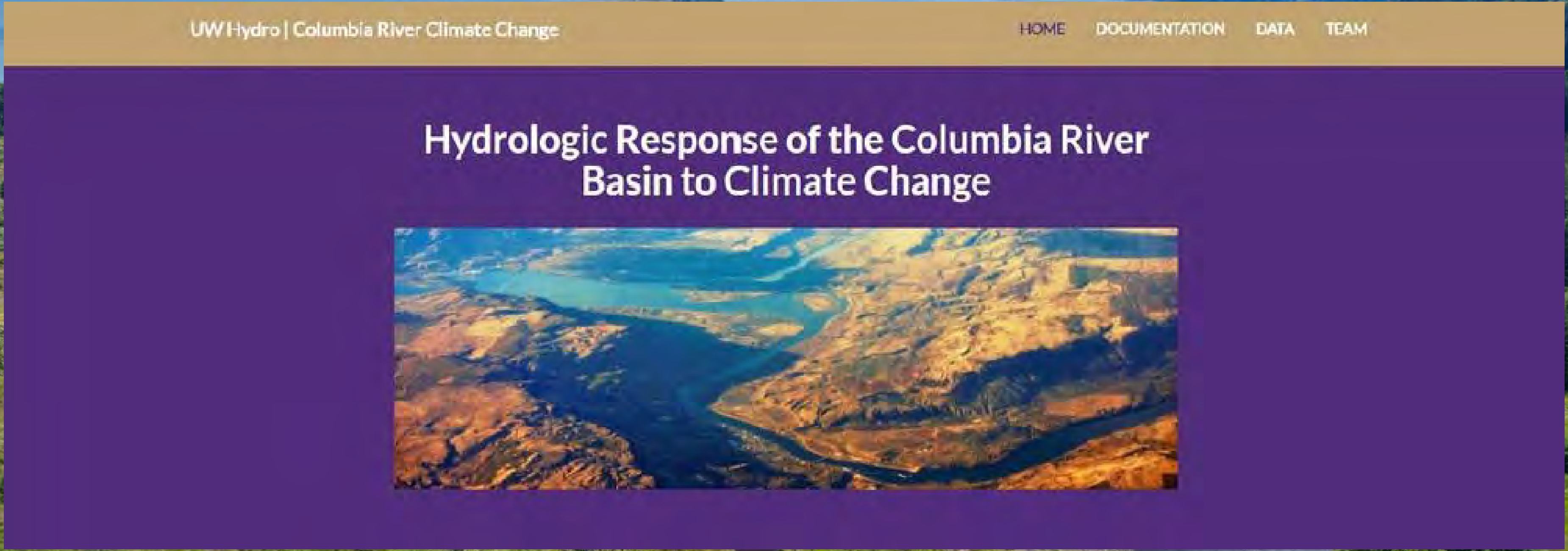
Guiding Documents



National Research Council

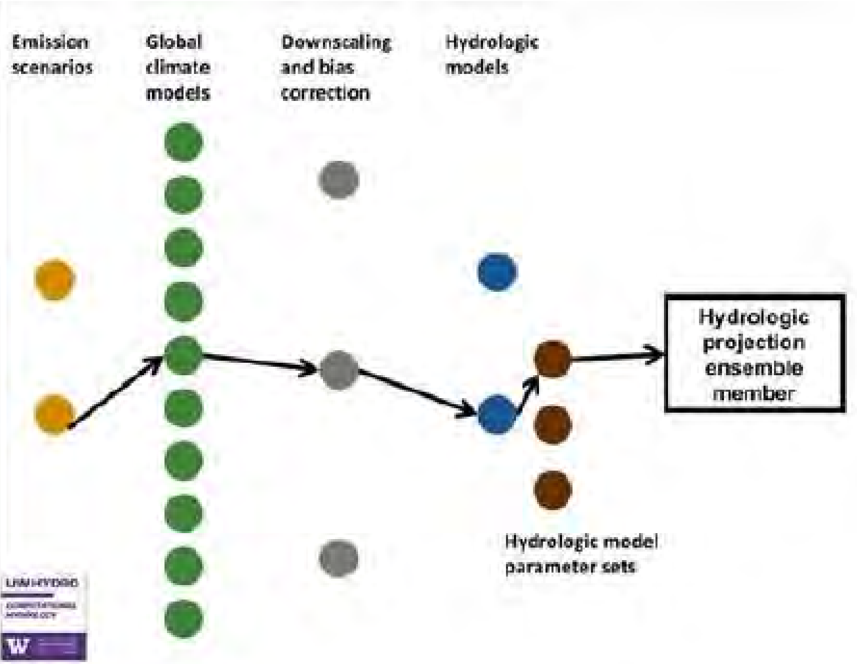


Large Data Sets

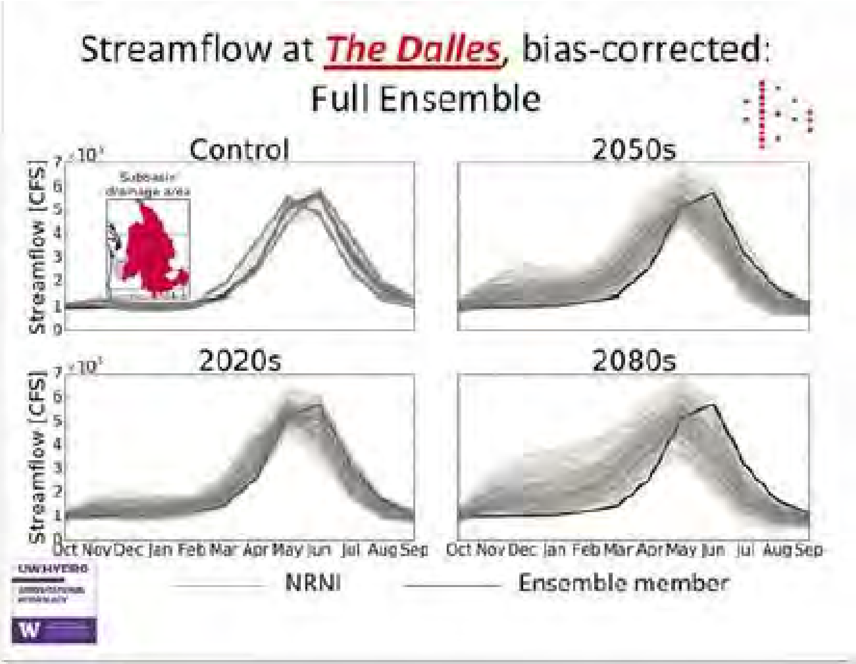


UW CRCC

Downscaled Models



Emission scenarios
Global climate models
Downscaling and bias correction
Hydrologic models
Hydrologic projection ensemble member
Hydrologic model parameter sets



Streamflow at The Dalles, bias-corrected:
Full Ensemble
Control
2050s
2020s
2080s
Streamflow [CFS]
Subbasin drainage area
Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep
NRNI
Ensemble member

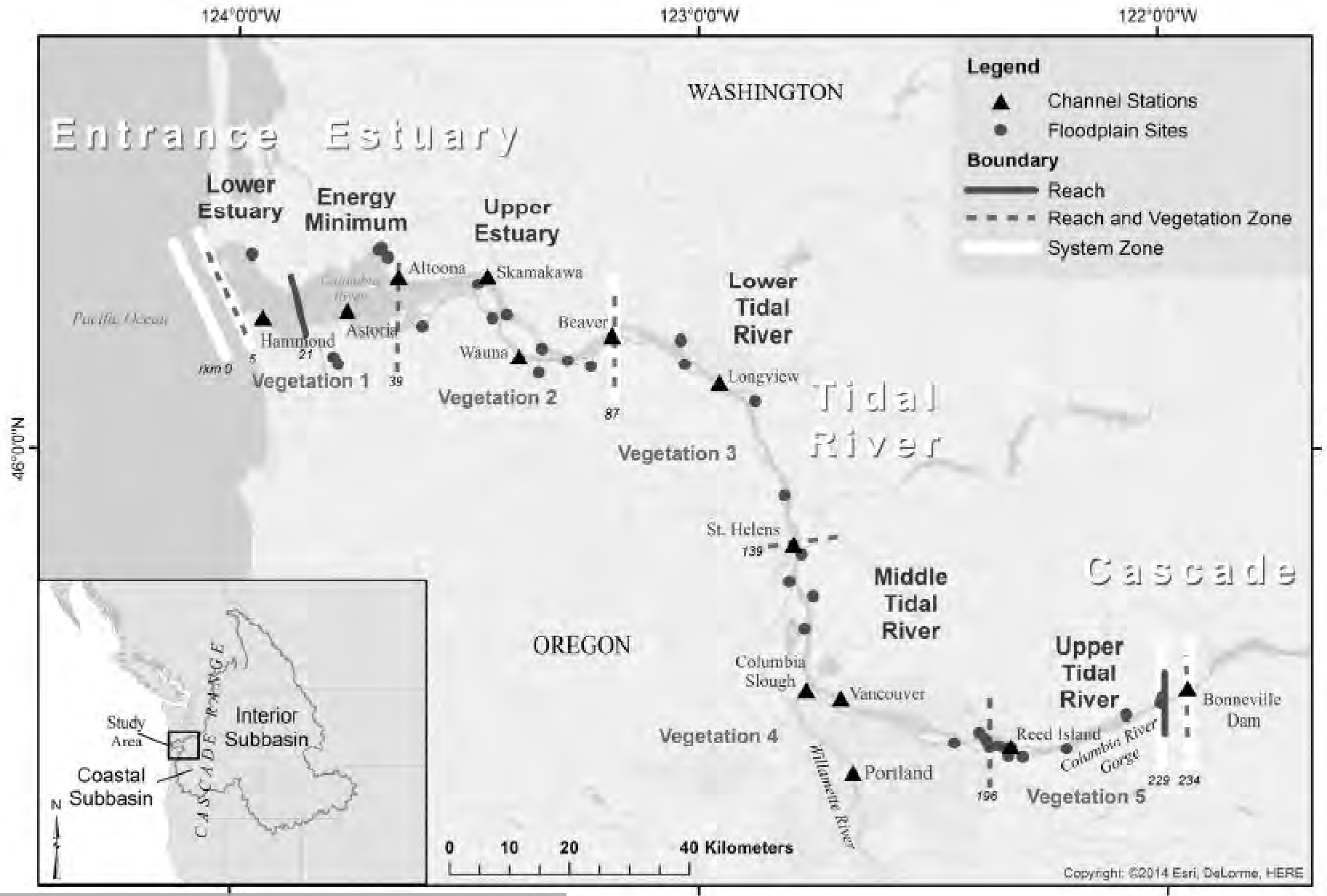
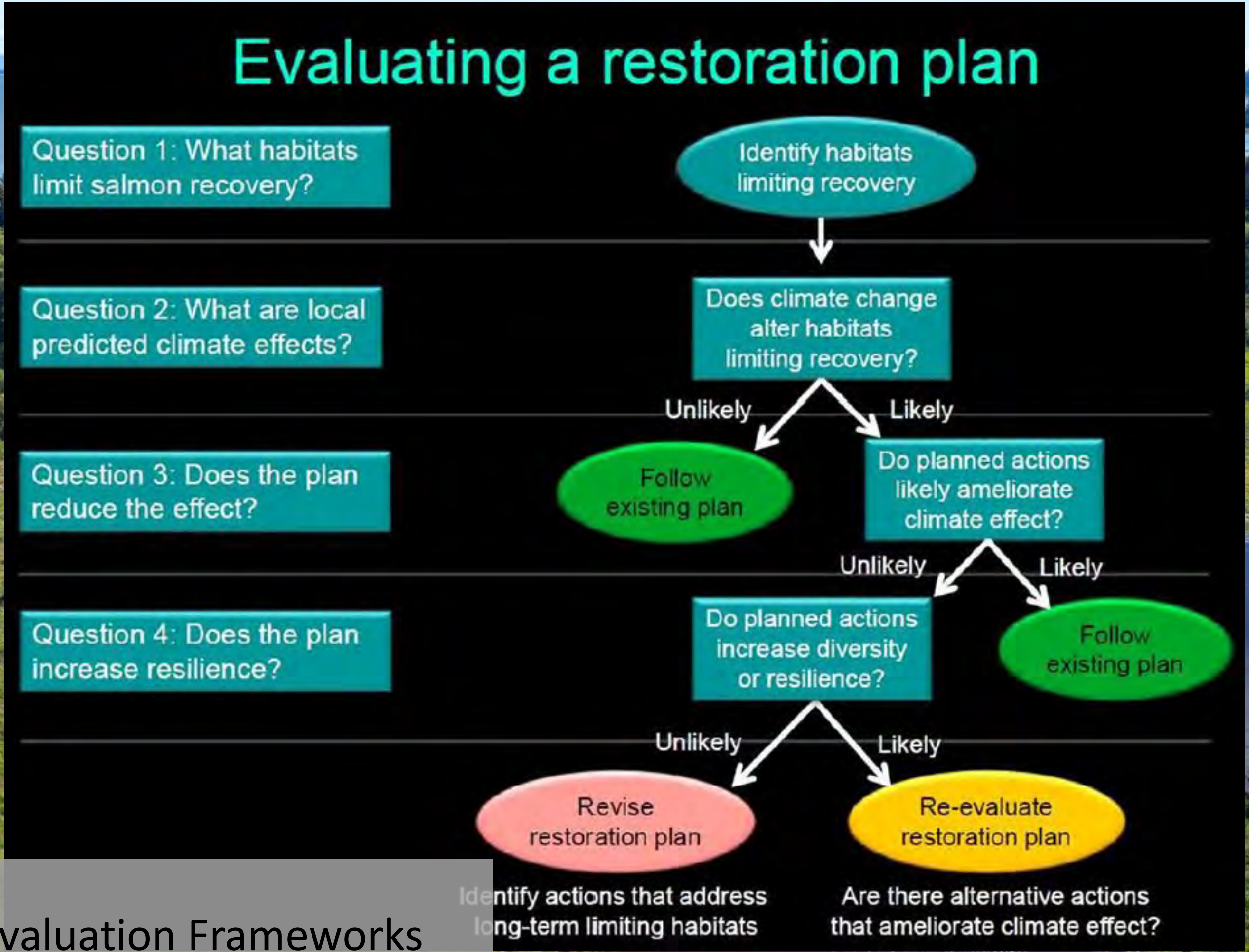


Fig. 1 Lower Columbia River and estuary (LCRE) place names and system zonation

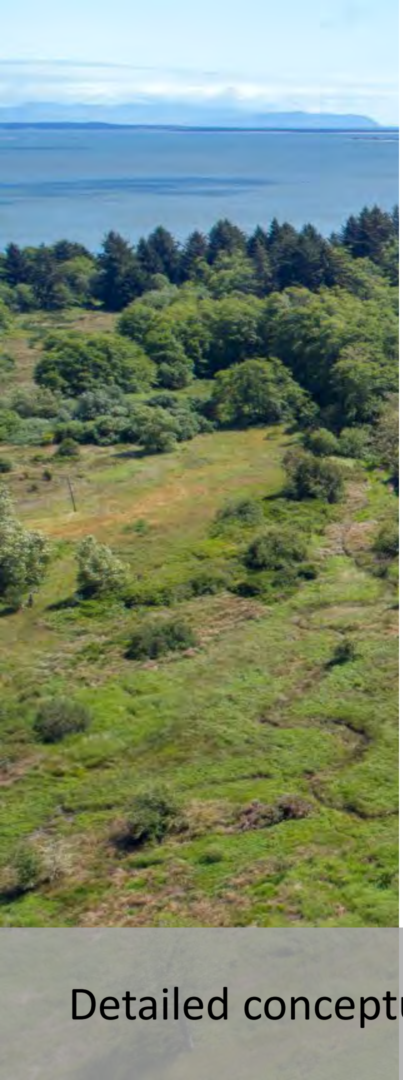
Jay et al. 2016

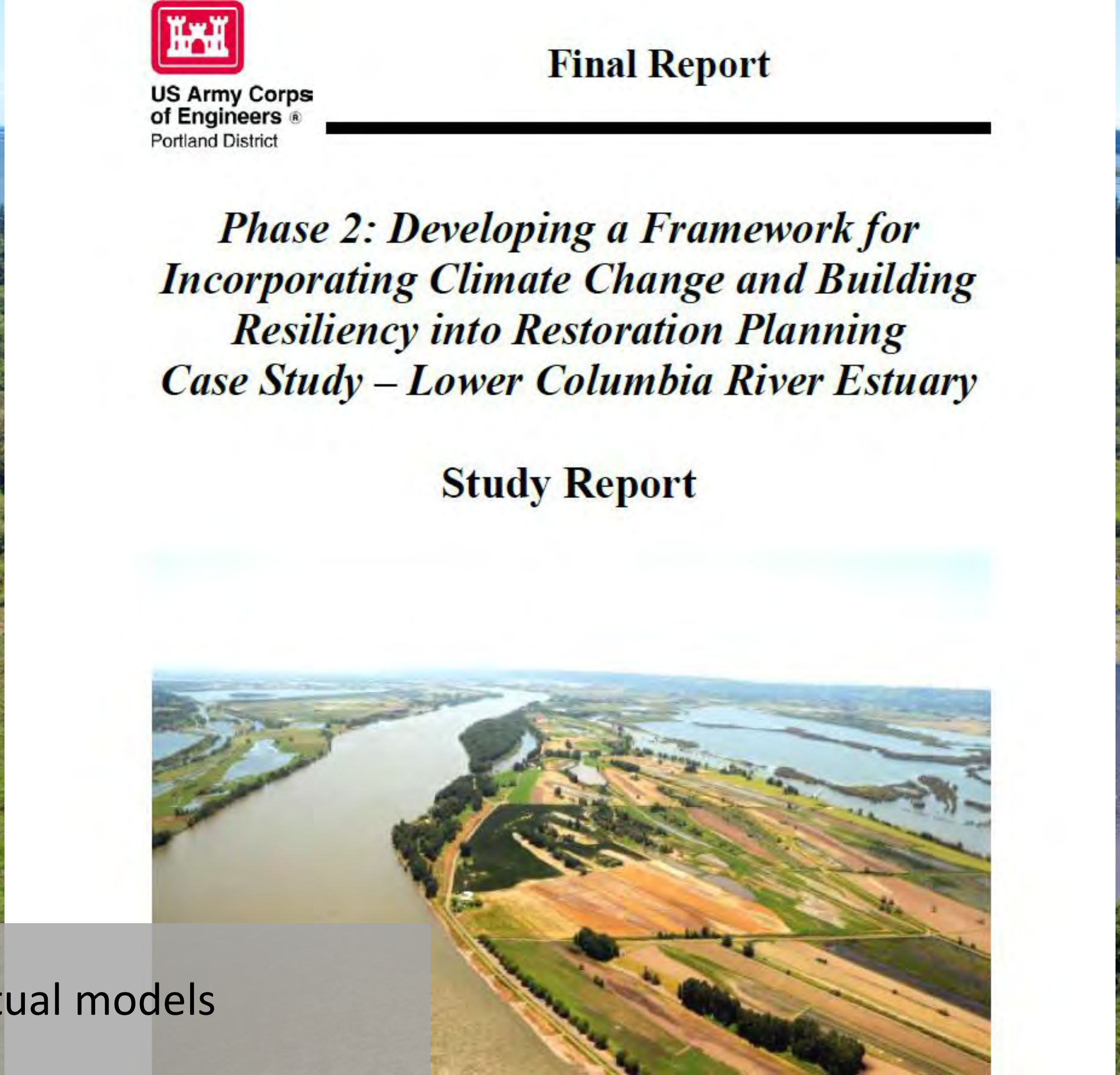
Long term trends



Restoration Evaluation Frameworks

Beechie, 2014




US Army Corps of Engineers ®
Portland District

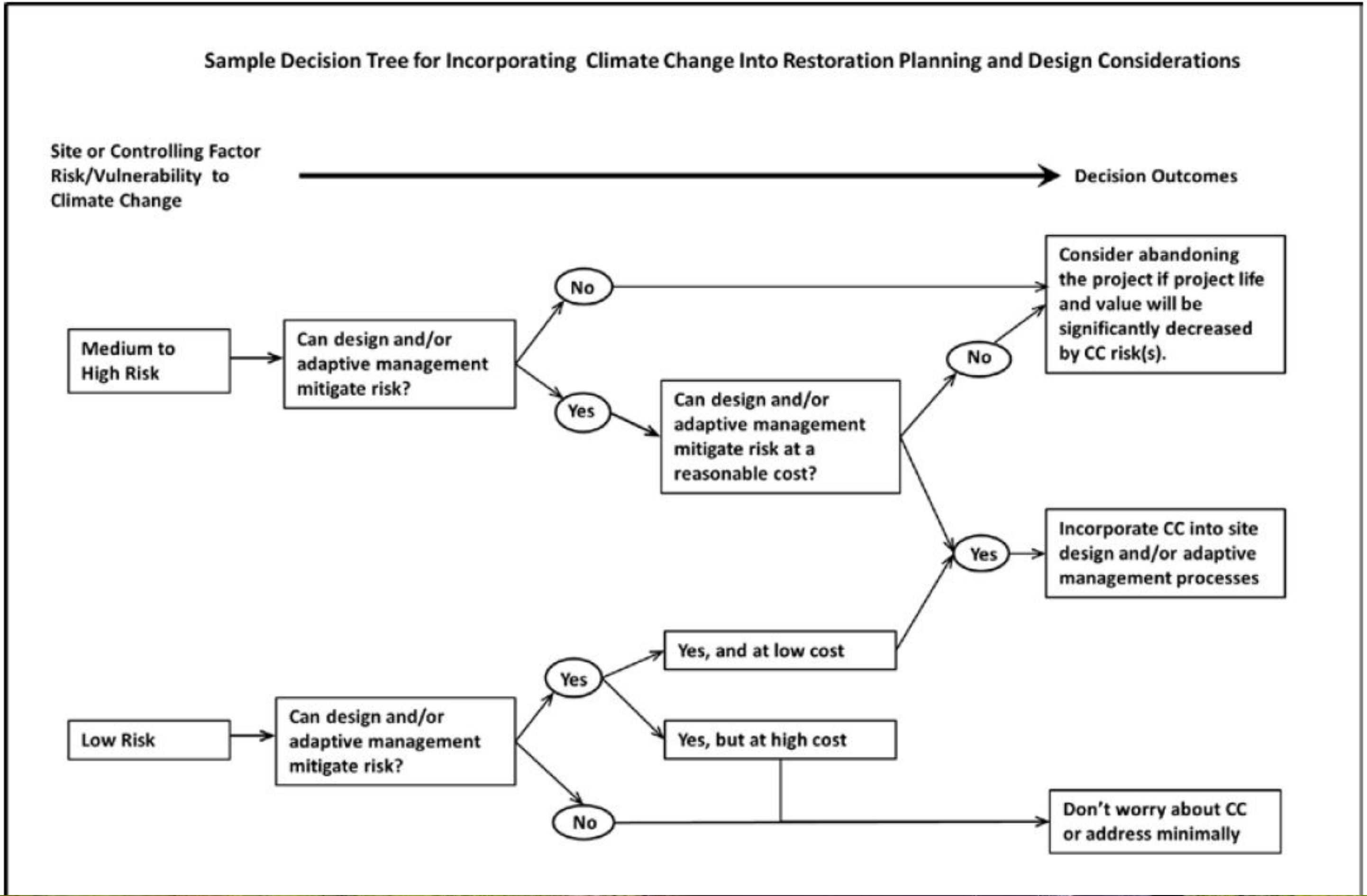
Final Report

Phase 2: Developing a Framework for Incorporating Climate Change and Building Resiliency into Restoration Planning Case Study – Lower Columbia River Estuary

Study Report

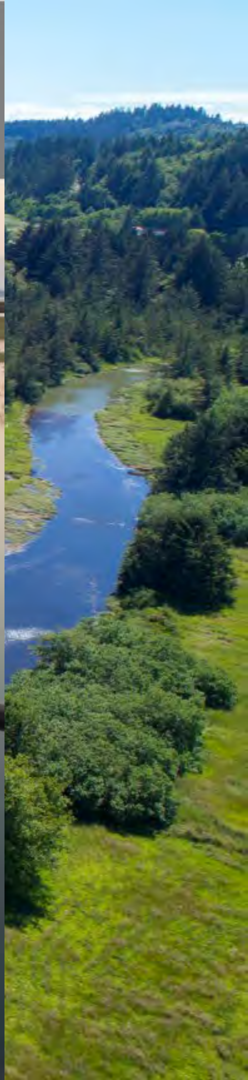
Detailed conceptual models

ACOE 2015


Sample Decision Tree for Incorporating Climate Change Into Restoration Planning and Design Considerations
Site or Controlling Factor Risk/Vulnerability to Climate Change
Decision Outcomes
Medium to High Risk
Can design and/or adaptive management mitigate risk?
No
Yes
Can design and/or adaptive management mitigate risk at a reasonable cost?
No
Yes
Consider abandoning the project if project life and value will be significantly decreased by CC risk(s).
Incorporate CC into site design and/or adaptive management processes
Low Risk
Can design and/or adaptive management mitigate risk?
Yes
Yes, and at low cost
Yes, but at high cost
No
Don't worry about CC or address minimally

ACOE 2015

Fir Island Farm Estuary Restoration Project
Lessons Learned
Washington State Department of Fish and Wildlife



Case study examples

Jenna Friebel

Image: Julie Morse, The Nature Conservancy

Lessons Learned: Dike Design, Construction, and Settlement

- Level of Protection/Storm surge/climate change
- Constructability
- Settlement

Battelle
The Business of Innovation

PNWD-4398

Hydrodynamic Modeling Analysis for the Fir Island Farm Restoration Project in Skagit Bay, Washington

4.1.4 Long-Term Sea Level Rise (η_{slr})

In this study, the effect of relative sea-level rise (SLR) was superimposed on top of the water level at the project site based on values reported from literature review. Various factors, including changes in

Battelle 2013

Battelle
Pacific Northwest Division
Richland, Washington 99352

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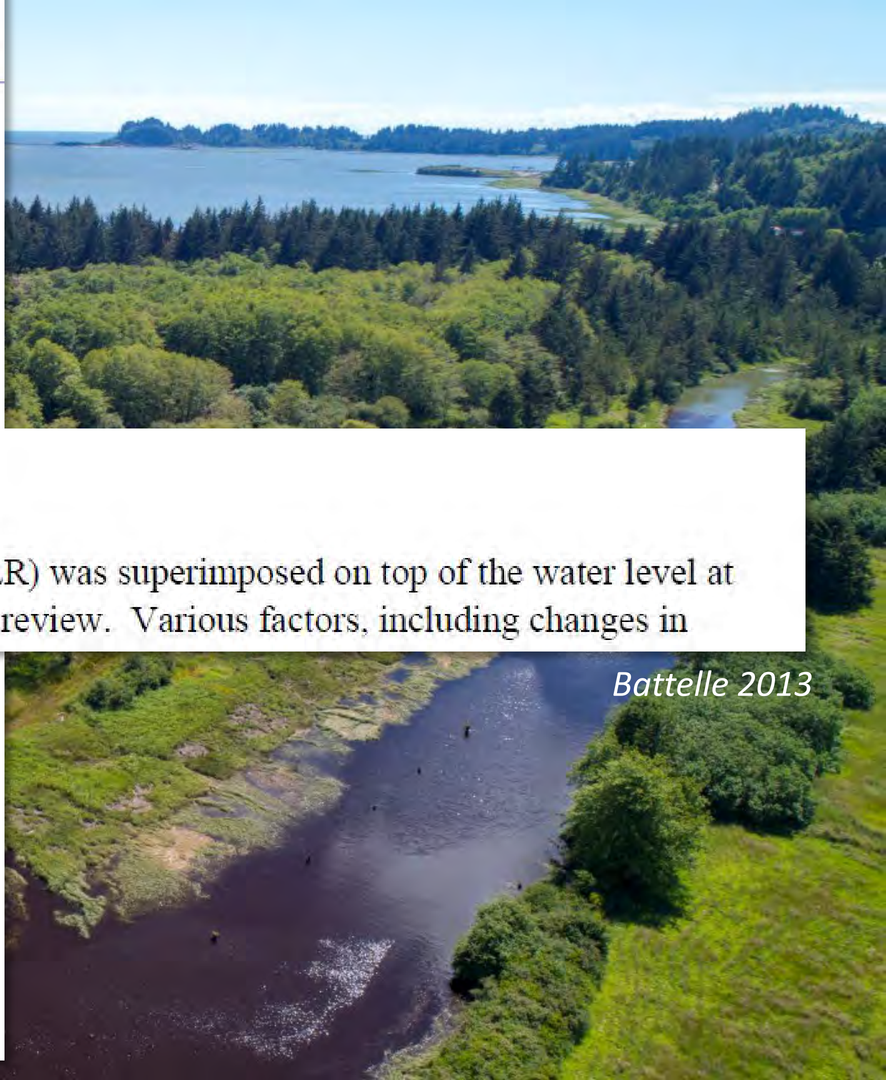
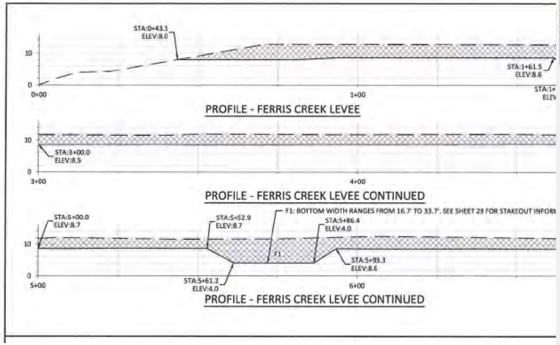
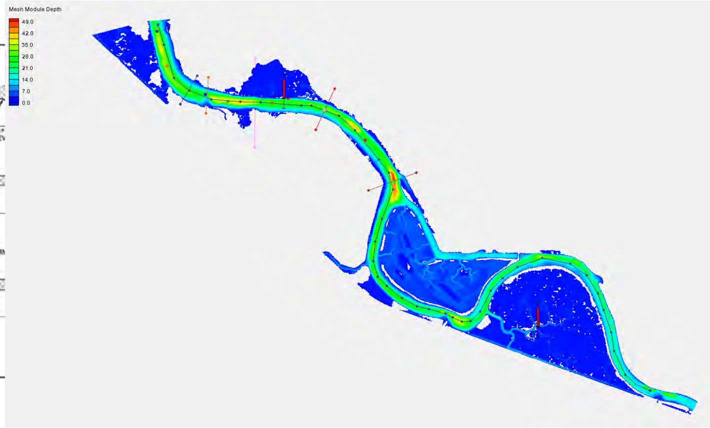
Seattle, Washington 98103
under Contract No. 63526




STA:0+43.5
ELEV:8.0
STA:1+61.5
ELEV:8.6
10
0
0+00
1+00
PROFILE - FERRIS CREEK LEVEE
STA:3+00.0
ELEV:8.5
3+00
4+00
PROFILE - FERRIS CREEK LEVEE CONTINUED
F1: BOTTOM WIDTH RANGES FROM 16.7' TO 33.7'. SEE SHEET 29 FOR STAKEOUT INFORM
STA:5+00.0
ELEV:8.7
STA:5+52.9
ELEV:8.7
STA:5+86.4
ELEV:4.0
F1
STA:5+93.3
ELEV:8.6
STA:5+61.2
ELEV:4.0
5+00
6+00
PROFILE - FERRIS CREEK LEVEE CONTINUED


Mesh Module Depth
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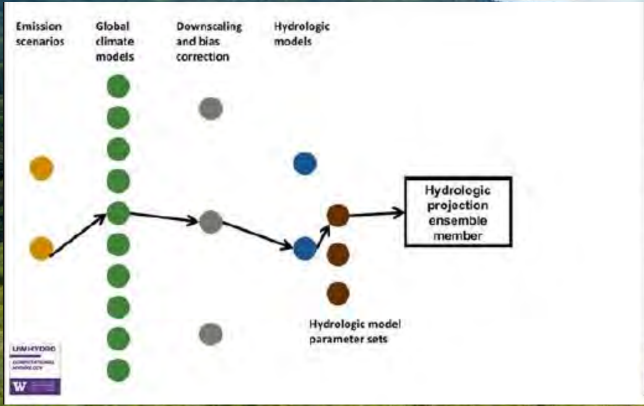
14.0
7.0
0.0

4a. Next steps: Specific design guidance



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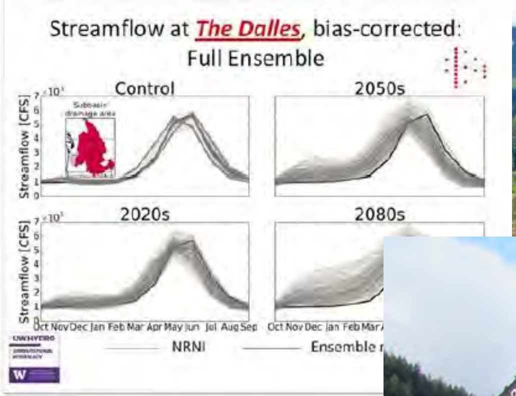
UWHYDRO



Streamflow at The Dalles, bias-corrected:
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Subbasin drainage area
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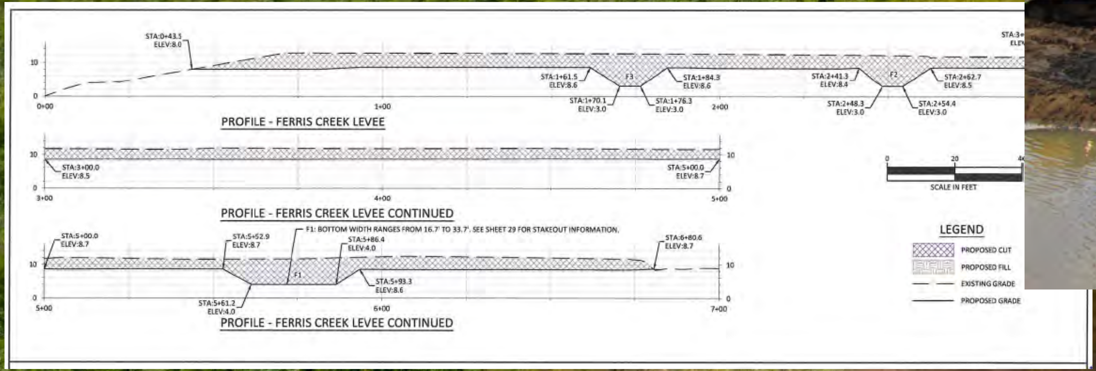
+



STA:0+43.5
ELEV:8.0
STA:1+61.5
ELEV:8.6
STA:1+70.1
ELEV:3.0
STA:1+76.3
ELEV:3.0
STA:1+84.3
ELEV:8.6
STA:2+41.3
ELEV:8.4
STA:2+48.3
ELEV:3.0
STA:2+54.4
ELEV:3.0
STA:2+62.7
ELEV:8.5
PROFILE - FERRIS CREEK LEVEE
STA:3+00.0
ELEV:8.5
STA:5+00.0
ELEV:8.7
SCALE IN FEET
PROFILE - FERRIS CREEK LEVEE CONTINUED
STA:5+00.0
ELEV:8.7
STA:5+52.9
ELEV:8.7
F1: BOTTOM WIDTH RANGES FROM 16.7' TO 33.7'. SEE SHEET 29 FOR STAKEOUT INFORMATION.
STA:5+86.4
ELEV:4.0
STA:5+93.3
ELEV:8.6
STA:5+61.2
ELEV:4.0
STA:6+80.6
ELEV:8.7
PROFILE - FERRIS CREEK LEVEE CONTINUED
LEGEND
PROPOSED CUT
PROPOSED FILL
EXISTING GRADE
PROPOSED GRADE

DEERE
DEERE

- Levee breaching/removal
- Reconstructing tidal channels
- Thin layer placement
- Vegetation planting/management
- Culvert/bridge replacement
- …

4b. Next steps: Building buy-in

- Academic researchers
- Restoration practitioners
- Local managers (eg, floodplain development)
- State/federal agencies (eg, wetland, ESA fish)
- Funders & lawmakers
- Hydro-regulators

Thank you.

Caitlin Alcott
calcott@interfluve.com