



## A MULTIDISCIPLINARY, INTEGRATIVE APPROACH TO VALUING COASTAL ECOSYSTEM SERVICES FROM NATURAL INFRASTRUCTURE

2018 ADVISORY BOARD MEETING

Hatfield Marine Science Center – Newport, Oregon  
Guin Library Seminar Room  
April 12<sup>th</sup> and 13<sup>th</sup>, 2018

This research is supported by funding from the NOAA National Centers for Coastal Ocean Science Competitive Research Program through NOAA Cooperative Institutes Program award numbers NAI10AR4320091A and NAI16OAR4320152 to the Cooperative Institute for Marine Resources Studies at Oregon State University.



**Oregon State**  
University

**CIMRS**



**NCCOS** NATIONAL CENTERS FOR  
COASTAL OCEAN SCIENCE

## WELCOME

- Welcome and thank you for your participation on our Advisory Board!
- 7 OSU faculty from 4 colleges working on an interdisciplinary research agenda
- Work is made possible by NOAA's National Centers for Coastal Ocean Science and their Competitive Research Program, and OSU's Cooperative Institute for Marine Resources Studies (CIMRS).
- **Funding Title:** Assessing the Benefits of Natural (Green) Infrastructure for Shoreline Stabilization: Ecosystem Service Valuation for Decision-making in Coastal Communities

## MEETING OBJECTIVES

- Bring together stakeholders, decision makers, and experts on coastal issues in the Pacific Northwest.
- Provide context to these issues with site visits
- Provide updates on project objectives and research progress.
- Provide a structured setting for comments and input from the board.
- Plan future outreach and engagement with board members and the general public.

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## TODAY'S AGENDA

### 9:15 am **Welcome, Introductions, and Project Update/Overview**

*Steven Dundas – OSU Applied Economics, COMES*

### 10:00 am **Depart HMSC for Pacific City**

### 11:15 am **Dune Management on the Oregon Coast**

*Bob Straub State Park, Pacific City*

*Peter Ruggiero – CEOAS*

### 12:15 pm **Lunch in Pacific City**



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## TODAY'S AGENDA

### 1:45 pm **Coastline Stabilization Issues**

*Pacific Sands Resort, Neskowin*

*Dundas & Ruggiero*

*Guy Sievert – Tillamook County Planning Commission*

*Bill Busch – Neskowin Coastal Hazards Committee*

### 3:15 pm **Salt Marsh Restoration and Salmon**

*Salmon River Estuary, Knight Park, Otis*

*Sally Hacker – Integrative Biology*

*Caitlin Magel – Applied Economics*

*Cassie Finer – Applied Economics*

### 5:00 pm **Arrive back at HMSC**

### 6:00 pm **Dinner at Local Ocean Seafoods in Newport**

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## TOMORROW'S AGENDA

9:00 Welcome and Introductions

9:15 Estuary Pathway

10:45 Coffee break

11:00 Coastal Protection Pathway

12:30 Working Lunch



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# TOMORROW'S AGENDA

- 1:30 Dune Landscapes Survey
- 2:00 Dune Landscapes Projects
- 2:30 Outreach and Engagement
- 3 pm Adjourn



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# Project Overview



## PROJECT OVERVIEW

- Advances the transdisciplinary science of ecosystem services
- Focus is on coastal natural infrastructure in Pacific Northwest: beaches, dunes, and estuaries.
- Aim to understand the nature and determinants of socially-optimal investment in natural infrastructure in coasts and estuaries from an economic perspective.



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## PROJECT OVERVIEW

- Optimizing provision of ecosystem services with natural infrastructure investments is a complex, transdisciplinary challenge with substantive implications for human well-being
- A cost-effective approach to natural infrastructure investment seeks out high-expected return projects over broad ecological and economic scales.

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## PROJECT OVERVIEW

- Little is known about the total economic value of natural infrastructure investments
- Two major methodological challenges:
  - Quantifying the benefit of an ecosystem service that lacks a market price
  - Understanding the “production function” relationship between an investment and expected service provision (plus expected ancillary effects on other service flows).

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## PROJECT OVERVIEW

- Our research addresses these two challenges by joining state-of-the-art non-market valuation methods with empirical ecological-economic and engineering-economic models of natural infrastructure investment.



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## PRIMARY RESEARCH QUESTION

- How do we allocate coastal natural infrastructure investments that provide ecosystem services efficiently?
  
- In other words, how to we prudently budget for nature-based investments in coastal ecosystems?

## RECENT RESEARCH OUTPUT

- Dundas, S.J. 2017. Benefits and Ancillary Costs of Natural Infrastructure: Evidence from the New Jersey Coast. *Journal of Environmental Economics and Management*. 85: 62-80
- Biel R.G., S.D. Hacker, P. Ruggiero, N. Cohn, and E.W. Seabloom. 2017. Coastal protection and conservation along sandy beaches and dunes: context-dependent tradeoffs in ecosystem services. *Ecosphere* 8: e01791.
- Ruggiero P., S.D. Hacker, E. Seabloom, and P. Zarnetske. In Press. The role of vegetation in determining dune morphology, exposure to sea level rise, and storm-induced coastal hazards: A U.S. Pacific Northwest perspective. Chapter 11 in Moore, L., B. Murray. *Barrier Dynamics and Response to Climate Change*, Springer.

## RECENT ACADEMIC PRESENTATIONS

- 2018 (scheduled)
  - Western Economic Association International annual conference (Vancouver BC)
  - Agricultural and Applied Economics Association annual meeting (Washington, DC)
  - International Institute of Fisheries Economics & Trade biennial conference (Seattle)
  - Numerous regional, state, and OSU presentations
- 2016 - 2017
  - American Geophysical Union fall meeting (San Francisco)
  - Ecological Society of America annual meeting (Portland, OR & Fort Lauderdale, FL)
  - Association of Environmental and Resource Economists summer conference (Pittsburgh, PA)
  - Numerous regional, state, and OSU presentations

## RESEARCH STRUCTURE

### Three Applied Pathways

- Coastal Protection Pathway
- Estuary Restoration Pathway
- Dune Landscapes Pathway





## COASTAL PROTECTION PATHWAY



### Research Questions

- How do coastal housing markets respond to the ability to invest in coastal protection?
- Do parcel-level options for protective structures generate spillover effects?
- What socioeconomic and geomorphological factors impact coastal landowner's land use decisions?

## COASTAL PROTECTION PATHWAY



### Research Questions

- Does the general public value investments in coastline stabilization?
- If so, does that value differ based on type and location of investment?

## COASTAL PROTECTION PATHWAY



### Research Questions

- How can natural infrastructure be optimally allocated within coastal communities, accounting for the value of life safety (via tsunami evacuation facilitation)?
- Given the current suite of risks, what land use policy decisions in the area of natural infrastructure can make coastal communities more resilient against those risks?

## COASTAL PROTECTION PATHWAY



### *Estimating Option Values and Spillover Damages for Coastal Protection*

- Our results suggest the value of option to invest in armoring is substantial (13 – 24 %), but only for homes vulnerable to erosion risk
- Goal 18 eligibility likely generate benefits for individual landowners, but may impose costs on neighboring parcels unable to armor themselves



## COASTAL PROTECTION PATHWAY



### *Identifying Determinants of the Decision to Install Beachfront Protective Structures*

- Both economic and geomorphological factors significantly impact landowner decisions to armor
- Planned integration of economic-morphodynamic models to simulate evolution of future coastlines under different policy & climate scenarios.

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## COASTAL PROTECTION PATHWAY



### *Public Preferences for Coastal Protection Options*

- What are the attributes of coastal natural infrastructure that matter to the general public?
- Data collected will inform public policy and provide empirical inputs to integrated models of optimizing investments in natural infrastructure

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## COASTAL PROTECTION PATHWAY



### *Life Safety and Natural Infrastructure: An Economic Perspective*

- We plan to conduct a benefit-cost analysis demonstrating the potential upsides to using green infrastructure as justification for an investment in vertical tsunami evacuation (i.e., life-safety) locations.
- Multi-agent simulations will help us estimate mortality risk to different segments of the at-risk population (tourists, the elderly, etc.)



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## COASTAL PROTECTION PATHWAY



### **Today's Field Trip: Neskowin**

Neskowin Coastal Hazards Committee formed in 2009 to deal with erosion and was intended to serve as a model for Tillamook County.

Guy Sievert (Tillamook County Planning Commission) and Bill Busch (NCHC) will meet us to discuss stabilization issues in Neskowin.



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## ESTUARY RESTORATION PATHWAY



### Research Questions

- How will coastal ecosystem services respond to estuarine restoration activities, and what are the values associated with restoration?
- Where should estuarine restoration activities be targeted to maximize benefits of such investments?



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## ESTUARY RESTORATION PATHWAY



### *A Choice experiment for Coho salmon*

- What are the non-market benefits from restoration activities that increase the population of Oregon Coast Coho salmon?
- We use a choice experiment and find evidence that the general public has significant economic demand for improvements in Oregon Coast Coho salmon.
- The general public is willing-to-pay for i) more returning salmon, ii) quick restoration, and iii) recovery off the Endangered Species Act.



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## ESTUARY RESTORATION PATHWAY



### *Bayesian Coho Population Model*

- How many salmon will be "produced" by marsh restoration is not known
- Integrated Pop. Model will determine the variance explained by various habitat and ocean factors on Coho salmon production
- We can use this production function to estimate the number of Coho produced under future restoration scenarios

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## ESTUARY RESTORATION PATHWAY



### *The Economic Value of a Salt Marsh*

- Estuarine restoration can convert diked land to salt marsh. How does the economic value of a salt marsh compare to the market value of that land in alternative uses?
- We integrate the Choice experiment for Coho salmon with the Coho Population model to quantify the economic value of an acre of Oregon salt mash as a natural capital stock.



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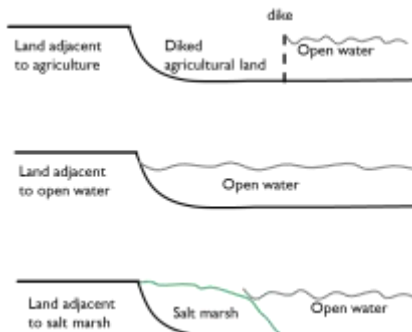
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## ESTUARY RESTORATION PATHWAY



### *Valuing shoreline changes in estuarine land markets*

- Coho habitat restoration costs go beyond the “backhoe” costs
- Restoring habitat significantly alters shoreline geography and thus land values
- Modelling these changes allows for large scale natural infrastructure investment simulation



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## ESTUARY RESTORATION PATHWAY



### **Today's Field Trip: Salmon River**

- Most tidal wetlands in the Salmon River estuary were previously diked for agricultural use. Restoration projects have removed dikes and tide gates and restored salmon access to about 75 percent of the historical wetland habitat.
- Sally Hacker, Caitlin Magel, and Cassie Finer will discuss our ongoing research related to estuary restoration in Oregon



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## DUNE LANDSCAPES PATHWAY



### Research Questions

- What are the values associated with ecosystem services provided by sandy beach and dune systems?
- Where and how should optimal management of natural infrastructure occur in Pacific Northwest sandy beach and dune systems?



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## DUNE LANDSCAPES PATHWAY



### *Valuing Coastal Dune Landscape Restoration*

- There is ongoing work to restore invaded PNW sandy beach and coastal dune landscapes.
- General population survey will measure willingness-to-pay for potential additional coastal dune landscape restoration projects in terms of their extent, “naturalness,” and accessibility to the public.



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## DUNE LANDSCAPES PATHWAY



### *Conceptual model of beach and dune ecosystem services*

- Ecosystem services of beaches and dunes include coastal protection, recreation, view shed, water catchment, etc.
- On undeveloped shorelines, these services vary with geomorphology and ecology (wide beaches and tall vegetated dunes)
- On developed shorelines, services and management actions must include aspects of geomorphology and ecology



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## DUNE LANDSCAPE PATHWAY



### *Design of a Spatially Explicit Beach and Dune Landscape Model*

- Maximize economic returns from a suite of ecosystem services along coastline for a given investment
- Case Study: Tillamook County, Oregon
- Identified a set ecosystem services and amenable management options
- Compiling required field measurements and economic datasets



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## DUNE LANDSCAPES PATHWAY



### *Modelling Cost-Effective Coastal Dune Management*

- Cost-effective management of coastal dunes depends on economic factors as well as local dune morphodynamics.
- A stylized economic-morphodynamic optimization model underdevelopment will generate cost-effective multi-year (dynamic) dune management plans for a variety of scenarios.

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## DUNE LANDSCAPES PATHWAY



### **Today's Field Trip: Bob Straub State Park**

- Pacific City has a different problem than many of the places on the coast with eroding beaches – they have excess sand
- Peter Ruggiero will discuss our ongoing research related to dune and beach management options



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# Discussion



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