Oregon’s Changing Ocean
Scientists’ presentations to the Oregon Ocean Science Trust
January 22, 2016
The Oregon Coast

AVHRR Composite
12-16 August 2000

Columbia River

Cape Blanco

Cape Mendocino

San Francisco

Point Conception

San Diego
Dr. Jack Barth
OSU College of Earth, Ocean, and Atmospheric Sciences

Dr. Selina Heppell
OSU Department of Fisheries and Wildlife

Dr. Caren Braby
Oregon Department of Fish and Wildlife
Oregon’s ocean is dynamic and ever changing

Ocean conditions influence weather and climate ... and vice versa

Climate change will impact Oregon’s ocean and all that it touches

Dr. Jack Barth
Increasing sea level and wave heights

Sea Level Rise
past and future

One of the most intense wave climates in the world

Extreme Wave Heights > 14 m!

IPCC 5th Assessment, 2013

Ruggiero et al., 2010
Waters off Oregon are connected to the larger North Pacific circulation
Upwelling supports a productive marine ecosystem off Oregon
Shifts in the Jet Stream and atmospheric forcing strongly influences Oregon’s weather and ocean conditions
“2015 was Oregon's warmest year on record, data shows”

Warming a result of Jet Stream pattern
The “Warm Blob”
What did we see right off of Yachats?

2015 Sea Surface Temperature

![Graph showing temperature changes from May to September 2015. The x-axis represents dates from 1 May to 1 Sep 2015, and the y-axis represents temperature in °C. The graph shows fluctuations in temperature throughout the months.]

What did we see right off of Yachats?
Hypoxia & Ocean Acidification

**Hypoxia**: Oxygen at levels too low for healthy marine life.

**Ocean acidification (OA)**: Decrease in ocean pH, from invasion of anthropogenic CO$_2$ from the atmosphere.
Low $O_2$ & High $CO_2$ zone

Modified from Gewin (2011)
CO₂ uptake has measurably changed ocean chemistry and made it harder for organisms to grow shells

More changes are coming our way, yet full impacts are not known

Feely et al. 2010

http://hahana.soest.hawaii.edu/hot/
Welcome to the future

Ocean Acidification (OA) – can’t grow a shell

Hypoxia (not enough oxygen) – can’t breathe

Welcome to the future

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Welcome to the future

Ocean Acidification (OA) – can’t grow a shell

Hypoxia (not enough oxygen) – can’t breathe
Key Unknowns

- How will winds change and how will that affect ocean cycles?
- What effects do “warm blobs” and El Niño/La Niña cycles have on Oregon’s ocean?
- What are the spatial patterns of ocean warming, hypoxia and ocean acidification? Are there refuges?
- How can we best keep our fingers on the pulse of Oregon’s coastal ocean?
Take-Homes

• Oregon’s ocean is dynamic and ever changing

• Ocean Acidification is underway, and the fundamentals of the process are CERTAIN

• Upwelling coastal waters are particularly sensitive to ocean acidification because of natural processes, in addition to rising atmospheric CO$_2$

• There are real existing and potential impacts to important fisheries
Diversity of Oregon’s Ocean

500+ species of fishes
Over 50 species of genus *Sebastes*
3000 species of invertebrates
155 species of shore and seabirds
26 species of mammals
Ocean conditions have a big impact on biology; our system is adapted to variability

Kelp forest renewal

Spawning and productivity

Algae and krill blooms
Impacts of low pH

Coccolithophores

Copepods

Pteropods

V. Fabry

Oysters and other shellfish

Pacific Salmon
Our coastal food web is complex!
People are part of complex community webs, too.

Collapse of Pacific sardine population

Tracking the downturn:

2007: 1,037,000 metric tons

2015 (projected): 96,688 metric tons

Source: NOAA Fisheries Service

Todd Trumbull / The Chronicle
Ocean Acidification and Hypoxia effects some key unknowns

Oysters = pretty clear-cut effects, but where and how bad?

Are crab getting moved around by low oxygen conditions?

What are long-term impacts of acidification for many species (diatoms, food webs)?

Barton et al. 2015

Rorre 2012

NOAA
NOAA’s Integrated Ecosystem Assessment

- Currently developing physical and biological indicators
- Advisory documents for managers
- Broad scale (Washington, Oregon and California)
Oregon’s Territorial Sea

U.S. Exclusive Economic Zone

Oregon Territorial Sea
Regional Territorial Sea

(connected to a much larger area by political neighbors, California current, and existing collaboration)
## Commercial fisheries

Economic powerhouse

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$150 Million/Yr
Fishery monitoring

~50% of our effort goes to counting fish on the docks

One fish, two fish, red fish, blue fish
Addressing change

- Nearshore ecosystem is at **greatest risk**
- Offshore ecosystem receives **greatest investment**
What do we need to build resilience?

• Understand nearshore function
  – Measure *ecosystem*, and ecosystem change
  – Physical, chemical, biological *monitoring*
    • Long-term data
    • Fishery-independent data

• Adapt our approach
  – **Research**: Grow survey methodologies & partnership
    • *In progress*: Marine reserves, nearshore reefs, estuaries, OR-COOS, PISCO
  – **Management**: Build “changing ocean” into framework
    • *In progress*: Integrated Ecosystem Assessment, Climate Strategy, etc.
The New Normal? Jellyfish distribution

“Normal” year

Summer 2015

Sea nettle

Water jelly
• Harmful Algal Blooms (HABs)

• 2015:
  – Razor clams closed
  – Dungeness crab closed, opener delayed
  – Food web/marine mammal impacts?
The New Normal? OAH extremes

- Ocean Acidification and Hypoxia (OAH) – shorthand for “changing ocean”
- Beyond oysters:
  - Salmon
  - Dungeness crab
  - Pink shrimp
  - Groundfish
  - Food web
Conclusions
New Tools
Richer Data

NVS
NANODES VISUALIZATION SYSTEM

NRT OSU Slocum Gliders

Glider "Jane"
Chlorophyll, Fluorometer, Backscatter
Temperature, Salinity, Density
Temperature, Salinity, Dissolved Oxygen
Glider Positions

Glider "Boo"
Chlorophyll, Fluorometer, Backscatter
Temperature, Salinity, Density
Temperature, Salinity, Dissolved Oxygen
Glider Positions

Jane - Chlorophyll, Fluorometer, Backscatter

Glider Research Group: https://gliders.coas.oregonstate.edu/gliderweb

125 km
500 km

Coastal Mooring
Glider Mooring
Deep Water Column Mooring
High Voltage Primary Node
Medium Voltage Node
PSU cable
Glider line - Slocum Glider

Central Oregon Line
Central Washington Line
Grays Harbor

OCEAN OBSERVATOIRES INITIATIVE

NSF
Collaboration