Two decades of monthly biophysical sampling of the coastal ocean off Newport, Oregon and how this informs fisheries

Jennifer Fisher, Bill Peterson, Kym Jacobson, Xiuning Du, Samantha Zeman

Cheryl Morgan, Leah Feinberg, Tracy Shaw, Jay Peterson, Jennifer Menkel, Jesse F. Lamb, Toby Auth, Julie Keister, Hongsheng Bi, Aaron Chappell, Bobby Ireland, Thomas Murphy, Ryan Rykaczewski, Rian Hooff Ramiro Riquelmo, Jaime Gomez, Mitch Vance, Hui Lui
Local and large scale physical forces influence ocean productivity and food web structure.

We use a suite of physical and biological indicators to index ocean conditions that relate to different fisheries.
Newport Hydrographic Line

- Sampled biweekly for 22 years
  - 1996 - present
  - 7 stations (1 – 25 nm)
  - Single transect but high frequency (only 10 missing months)
Newport Hydrographic Line

- Sampled biweekly for 22 years
  - 1996 - present
  - 7 stations (1 – 25 nm)
  - Single transect but high frequency (only 10 missing months)

- CTD, chlorophyll, nutrients

- Phytoplankton, copepods, krill, ichthyoplankton, pteropods, invertebrate larvae (e.g., Dungeness crab)
Broadscale Surveys

• 1997-2003
Broadscale Surveys

- 1997-2003
- 2003-2011
- 2011-2018
Broadscale Surveys

- 1997-2003
- 2003-2011
- 2011-2018

- 1997-2018
  - Spring (12)
  - Summer (8)
  - Fall (10)
  - Winter (4)
Management Drivers- NOAA-NWFSC

- **Ecosystem-Based Management**
  - Physical environment, species abundance, anomalies
  - Habitat suitability models
  - Thresholds and tipping points
  - Vulnerability/risk/resilience

- **Ecosystem-Based Fisheries Management**
  - Indicators for forecasting fisheries
  - Ocean salmon survival modeling

- **Sustainable, Safe, Secure Seafood for Healthy Populations**
  - Incorporating ocean conditions into stock assessments
  - Understanding and forecasting Harmful Algal Blooms

- **Climate Science**
  - Climate variability and climate change
  - Ocean Acidification and Hypoxia
  - Multiple stressors
Ecosystem-Based Management

Local temperature and salinity signal (50 m NH-5) in response to basin scale forcing

- **PDO and ONI**
- **NH-5 50 m Temperature Anomaly**
- **NH-5 50 m Salinity Anomaly**

Year: 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18
Ecosystem-Based Management

Local temperature and salinity signal (50 m NH-5) in response to basin scale forcing
Ecosystem-Based Management

Local temperature and salinity signal (50 m NH-5) in response to basin scale forcing

PDO and ONI

NH-5 50 m Temperature Anomaly

NH-5 50 m Salinity Anomaly
Ecosystem-Based Management
Local temperature and salinity signal (50 m NH-5) in response to basin scale forcing
How do basin scale, regional, and local physical drivers affect primary and secondary production?

- Strongest cycle in production is seasonal
Ecosystem-Based Management
Research Themes/Questions

- How do basin scale, regional, and local physical drivers affect primary and secondary production?
  - *Strongest cycle in production is seasonal*
Ecosystem-Based Management

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  - *Interannual variability in the copepod community is driven by basin scale processes*

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Copepod Community Composition Monthly Anomaly

- Monthly anomaly

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Pacific Decadal Oscillation

- PDO

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2018 OCP Workshop
Ecosystem-Based Management
Research Themes/Questions

- How do basin scale, regional, and local physical drivers affect primary and secondary production?
  - *Strongest cycle in production is seasonal*
  - *Interannual variability in the copepod community is driven by basin scale processes*

![Graph of Copepod Species Richness Anomaly](image1)

![Graph of Pacific Decadal Oscillation (PDO)](image2)
Ecosystem-Based Management
Research Themes/Questions

• How do basin scale, regional, and local physical drivers affect primary and secondary production?
  • Strongest cycle in production is seasonal
  • Interannual variability in the copepod community is driven by basin scale processes

• No relationship with upwelling and copepod community structure

• There are variable time lags so these relationships are difficult to model
How do fluctuations in primary and secondary production affect higher trophic levels?

- *Interannual differences in copepod species composition are correlated to fisheries (e.g., salmon returns)*

Large scale climatic forcing alters the bioenergetics of the food chain

- **Warm-water taxa** - (southern species) are **small** in size and have minimal lipid depots

- **Cold-water taxa** – (northern species) are **large** and store high-energy **wax esters** as an over-wintering strategy

Omega-3 fatty acids
Fatty acid composition of the plankton NH-5 (11 FA >1.5% of the total)

- **PC Axis 1 (53%)**
  - Diatom markers: 20:5ω3, 16:1ω7
  - Saturated FA Diatom marker: 16:4ω1
- **PC Axis 2 (23%)**
  - Nearshore marker: 18:1ω9
  - Dinoflagellate + other (non-diatom): 22:6ω3, 18:4ω3

**Graph notes**:
- Green squares: Summer 2012 and 2013
- Black diamonds: Winter 2012 and 2013

**Fatty acid composition**
- 20:5ω3
- 16:1ω7
- 16:4ω1
- 18:1ω9
- 22:6ω3
- 18:4ω3
Fatty acid composition of the plankton NH-5 (11 FA >1.5% of the total)

- PC Axis 1 (70%)
  - -0.3 -0.2 -0.1 0.0 0.1 0.2 0.3
- PC Axis 2 (15%)
  - -0.2 -0.1 0.0 0.1 0.2 0.3

Blob Winter 2014/15
Summer 2014
Summer 2012 and 2013
Winter 2012 and 2013

Fatty acid composition of the plankton NH-5 (11 FA >1.5% of the total)

- Saturated FA
  - Diatom marker 16:4ω1

- Nearshore marker
  - 18:1ω9

- Diatom markers
  - 20:5ω3
  - 16:1ω7

- Dinoflagellate + other (non-diatom)
  - 22:6ω3
  - 18:4ω3

2018 OCB Workshop
Ecosystem-Based Management
Research Themes/Questions

• How will lower trophic levels be affected in the future?
  • Large scale climate forcing becoming more variable
  • We know that the intensity of the perturbation is related to the time it takes for the ecosystem to ‘recover’

Fisher et al. 2015
Global Change Biology
Ecosystem-Based Management Research Themes/Questions

- How will lower trophic levels be affected in the future?
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Fisher et al. 2015
Global Change Biology
Ecosystem-Based Management
Research Themes/Questions

- How will lower trophic levels be affected in the future?
  - Large scale climate forcing becoming more variable
  - We know that the intensity of the perturbation is related to the time it takes for the ecosystem to ‘recover’

- What we don’t know is the resilience of the ecosystem and how it will fare under increased stress and variability

Fisher et al. 2015
Global Change Biology
Ecosystem-Based Management
Research Themes/Questions

- What are the environmental drivers of krill abundance and distribution?
Ecosystem-Based Management
Research Themes/Questions

- What are the environmental drivers of krill abundance and distribution?
Ecosystem-Based Management
Research Themes/Questions

• What are the environmental drivers of krill abundance and distribution?

• **Can we develop habitat suitability models for krill?**

• **Can we use this information to forecast predator distributions and/or to reduce whale entanglements?**
How does krill distribution affect higher trophic levels?

- 2 krill species vary in their lipid content

![Graph showing lipid content vs. wet weight for different krill species](image-url)
Ecosystem-Based Management
Research Themes/Questions

- How does krill distribution affect higher trophic levels?
  - 2 krill species vary in their lipid content

- *T. spinifera* were absent in the upper 30-m during the last warming phase

- How will future climate scenarios affect these critically important prey
Ecosystem-Based Fisheries Management
Research Themes/Questions

- Can ocean ecosystem indicators forecast fisheries?

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Multiple indicators are better than single predictors for:

- Salmon returns to Bonneville Dam
- Coho survival

Peterson et al. 2014, Oceanography
Multiple indicators are better than single predictors for:

- Salmon returns to Bonneville Dam
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- Sablefish in the NCC
- Rockfish in the CCC
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*Peterson et al. 2014, Oceanography*

Research Themes/Questions

• How can we incorporate ocean ecosystem indicators into stock assessment?

• Sablefish in the NCC
• Rockfish in the CCC
• Sardine in the SCC

*Peterson et al. 2014, Oceanography*
Climate Science
Research Themes/Questions

• Are NCC waters decreasing in dissolved oxygen- hypoxia?

Dissolved Oxygen in the NCC at 200 m

Courtesy of Ryan Rykaczewski (USC)
Is ocean acidification impacting the NCC?

pH in the NCC at 200 m

Courtesy of Ryan Rykaczewski (USC)
Is ocean acidification impacting the NCC?

- *Shelf water is seasonally corrosive*
Climate Science

Research Themes/Questions

- Is ocean acidification impacting the NCC?
  - *Shelf water is seasonally corrosive*

![Shelf station (NH-5), depth of 40 m](image-url)

- Aragonite Saturation
- Month of the Year

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*OCB Workshop 2018*
Climate Science
Research Themes/Questions

• Is ocean acidification impacting the NCC?
  • *Shelf water is seasonally corrosive*

• Are changes in pteropod density correlated with saturation state?

• How will saturation state change over longer time scales?
Challenges of maintaining a time series

• Generating monitoring datasets used by managers
  – Move from correlation to mechanism
  – Incorporate ocean monitoring data into stock assessments

• Funding $$
  – More with less
  – Not fully funded- not line item funding
  – Presently NOAA-NWFSC supports 1.5 OSU FTEs and ship time
  – Leverage partnerships

• Personnel changes
  – We are not machines- with a long time series you need continuity and overlap to train new people so that data are comparable
Thanks for your attention

http://www.nwfsc.noaa.gov/oceanconditions

Newportal Blog