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

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Xiuning Du, Samantha Zeman

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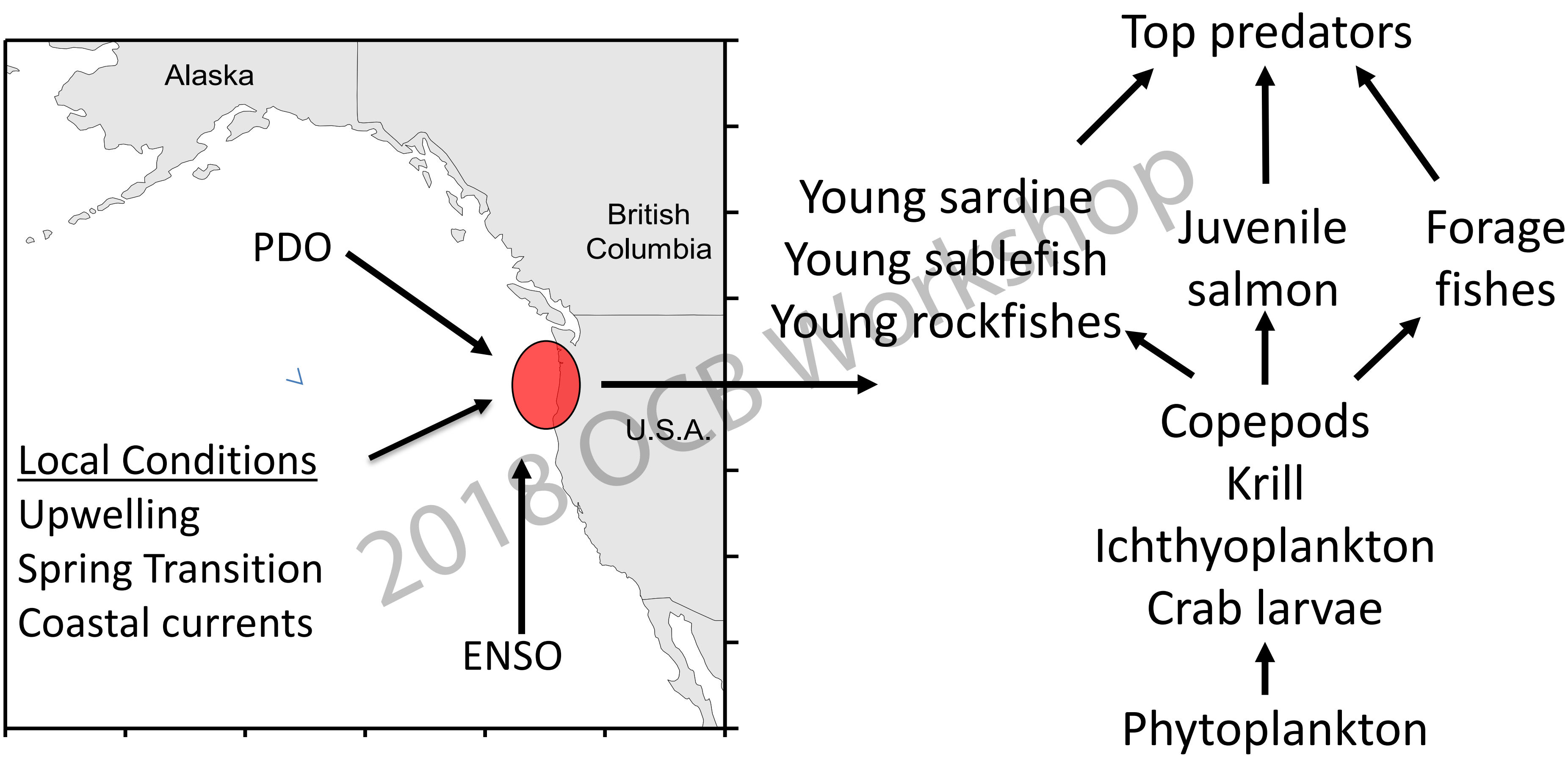
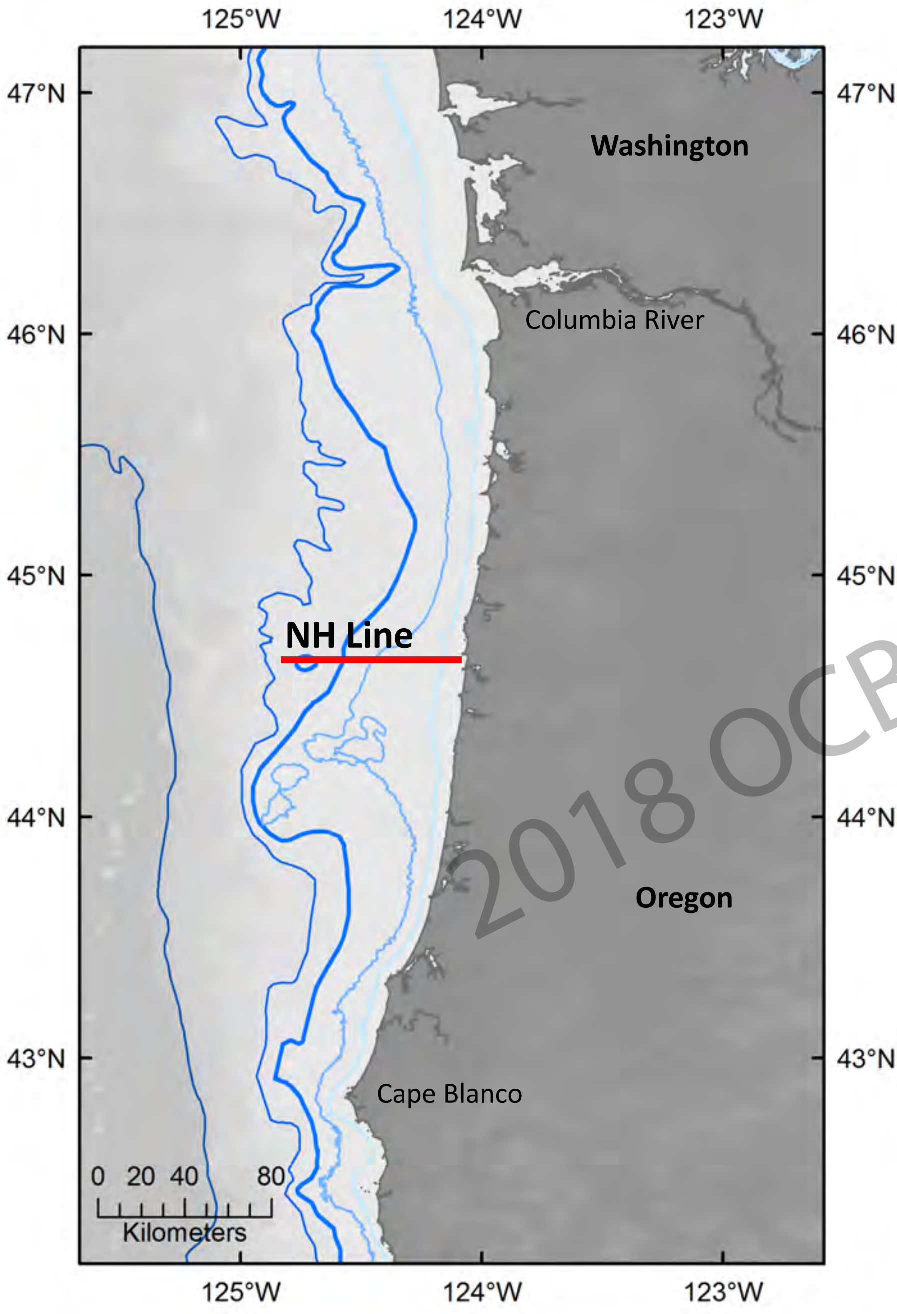
Jesse F. Lamb, Toby Auth, Julie Keister, Hongsheng Bi, Aaron Chappell,
Bobby Ireland, Thomas Murphy, Ryan Rykaczewski, Rian Hooff
Ramiro Riquelmo, Jaime Gomez, Mitch Vance, Hui Lui

Local and large scale physical forces influence ocean productivity and food web structure

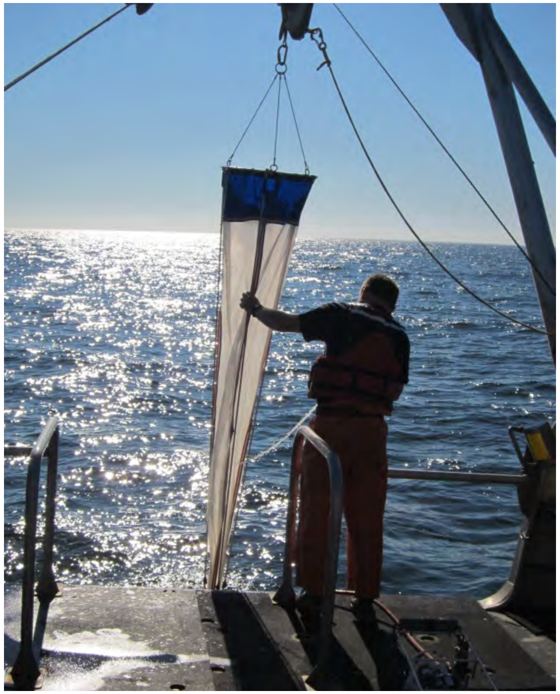


We use a suite of physical *and* biological indicators to index ocean conditions that relate to different fisheries



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
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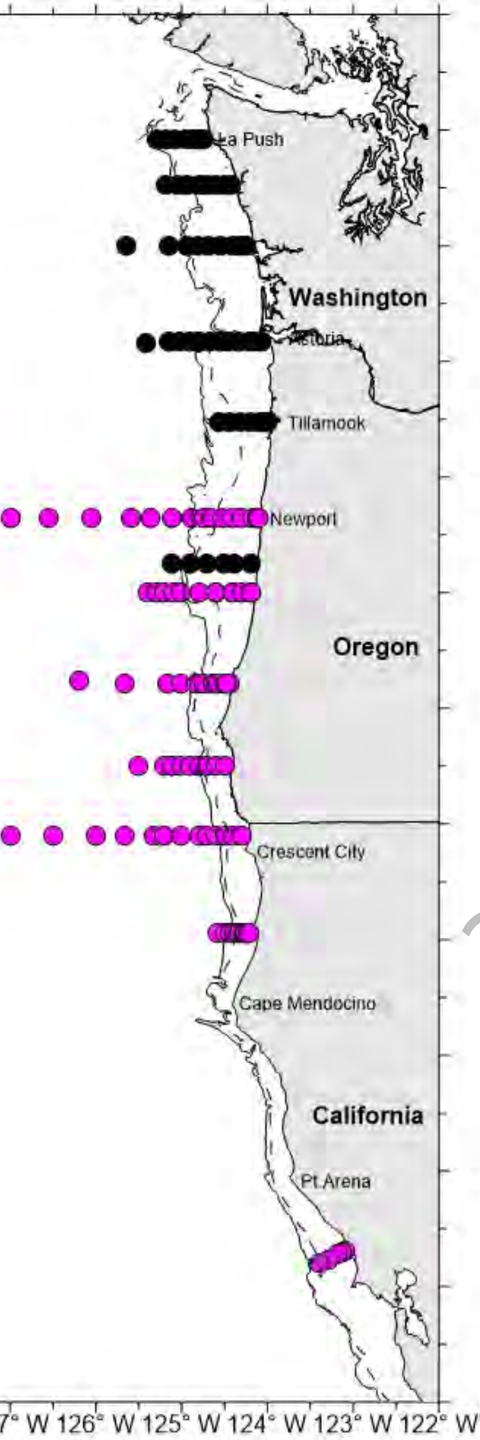
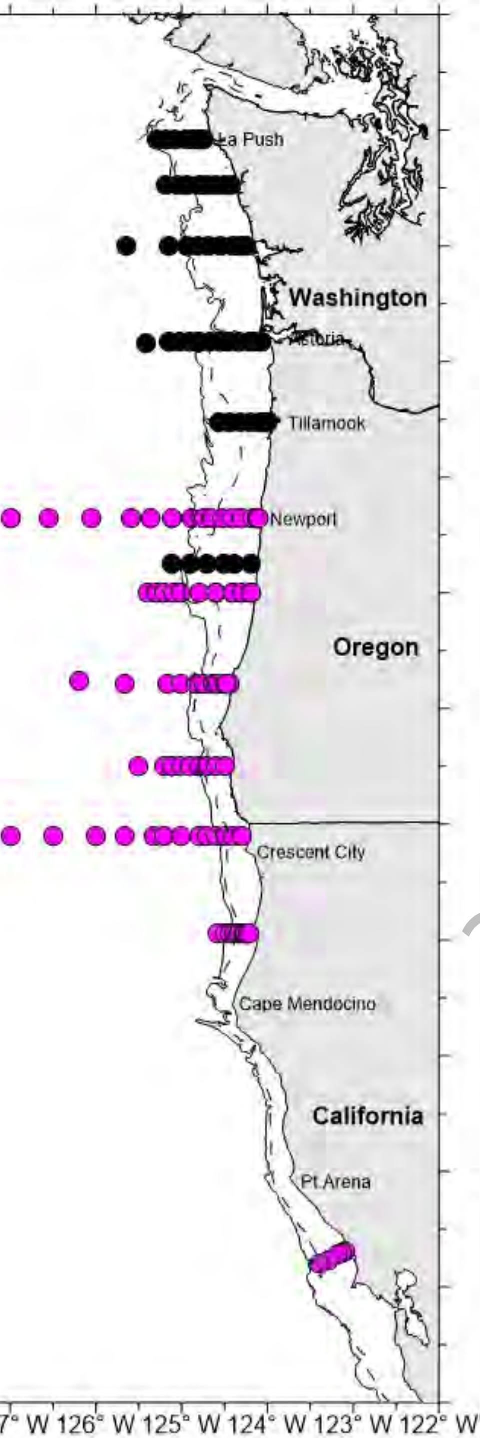
- CTD, chlorophyll, nutrients
- Phytoplankton, copepods, krill, ichthyoplankton, pteropods, invertebrate larvae (e.g., Dungeness crab)

Broadscale Surveys

- 1997-2003

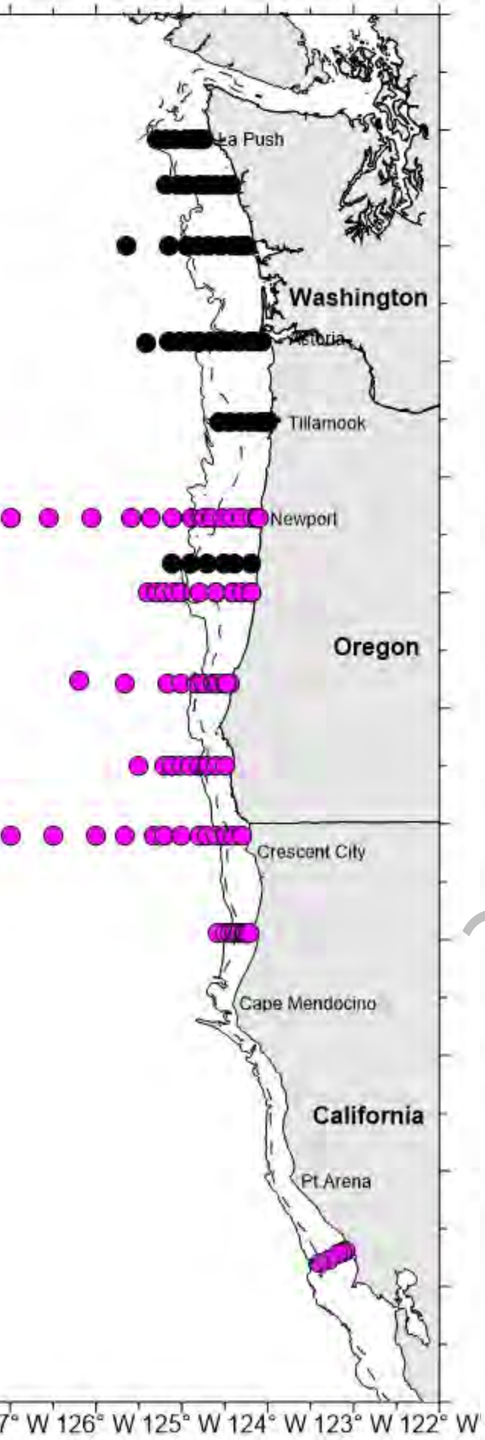




Broadscale Surveys

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

Broadscale Surveys



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

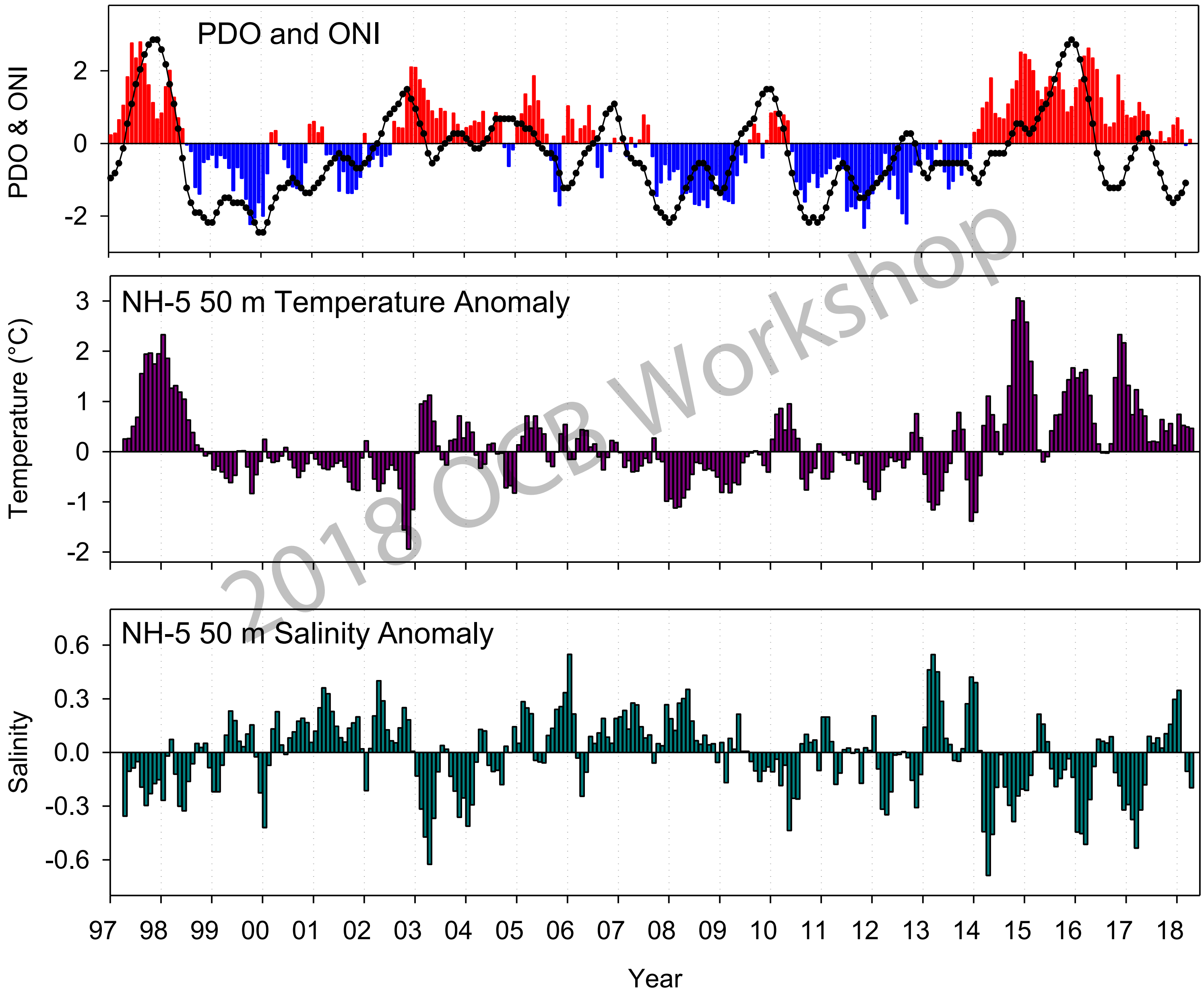
- 1997-2018
  Spring (12)
  Summer (8)
  Fall (10)
  Winter (4)

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



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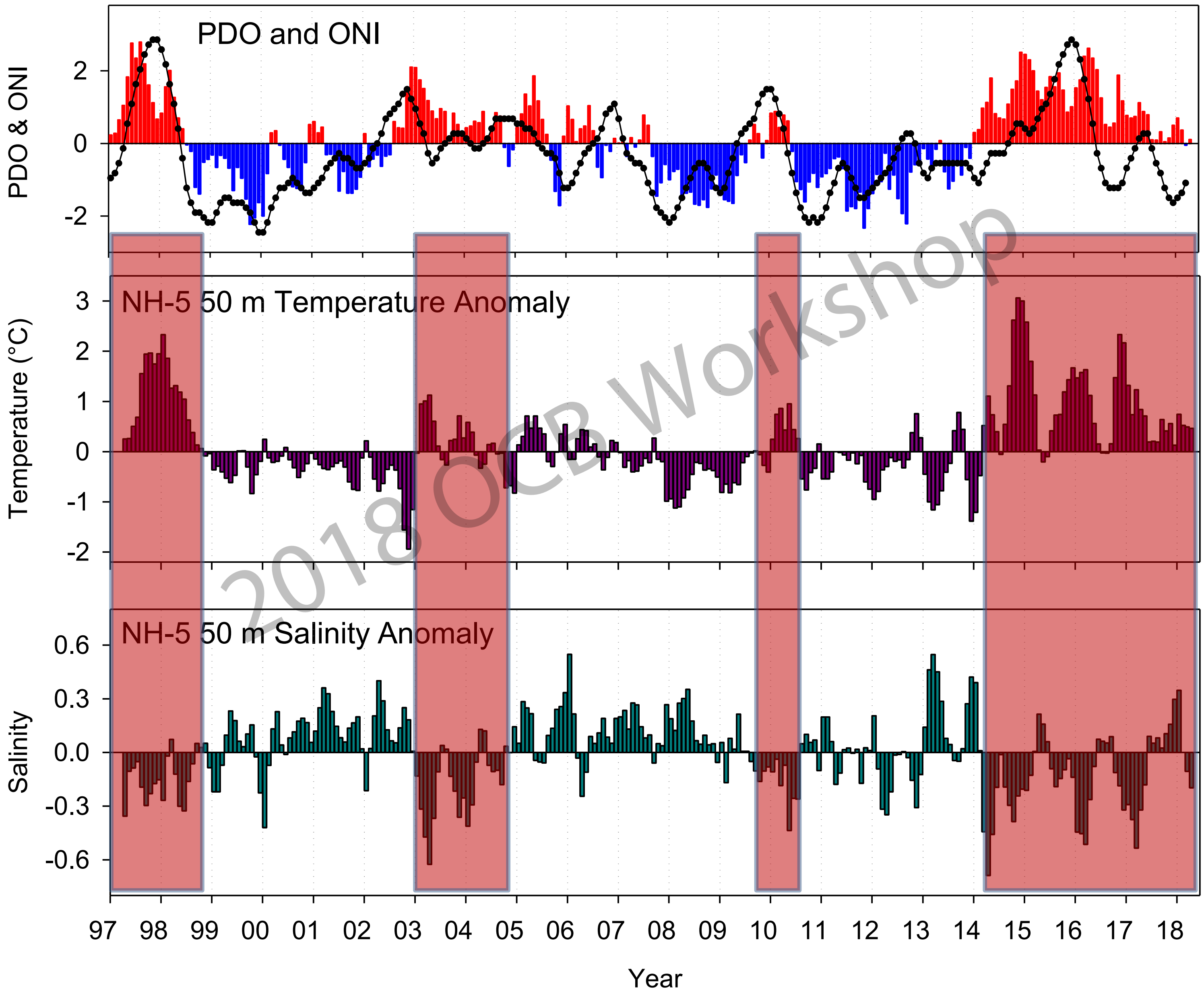

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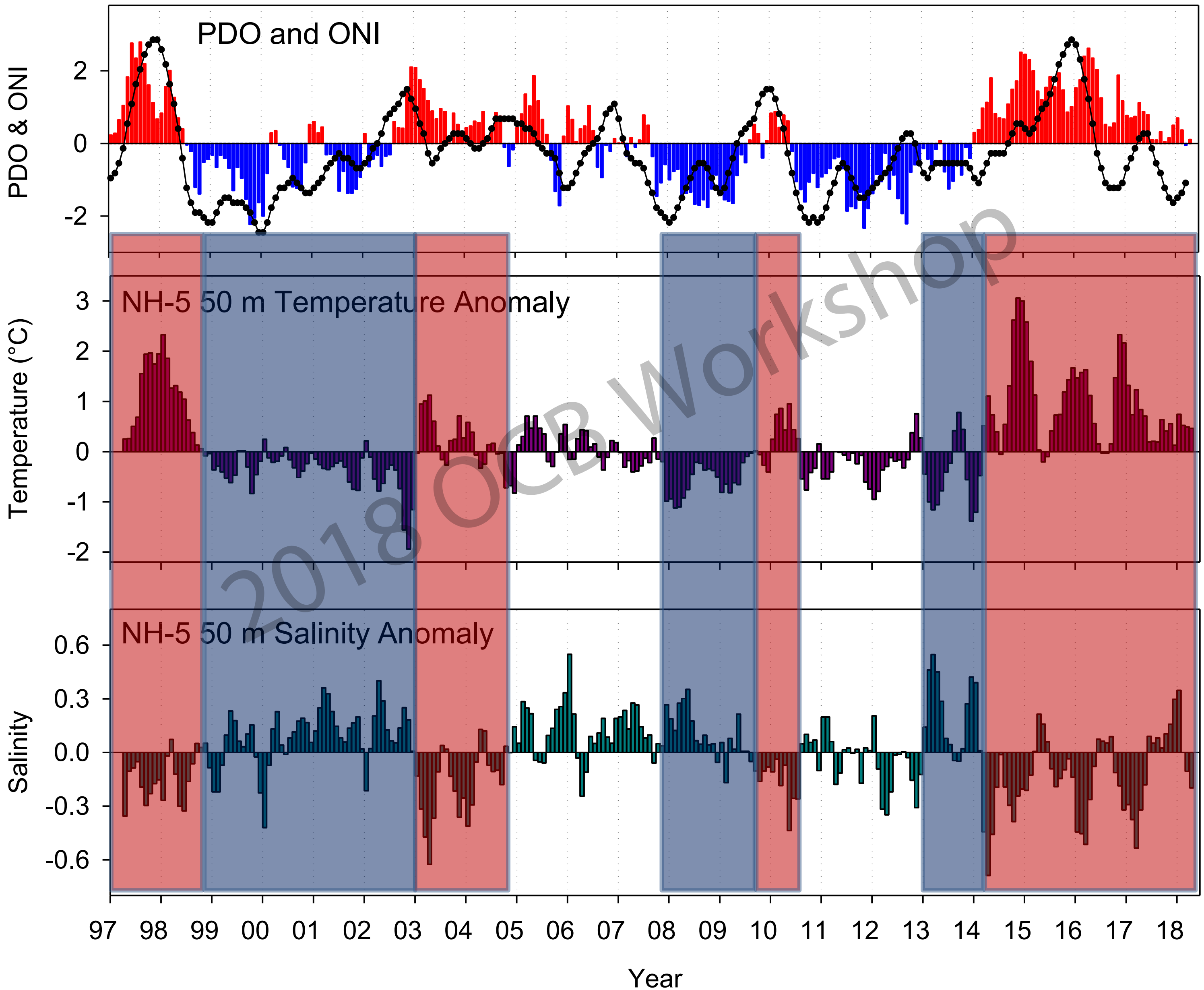

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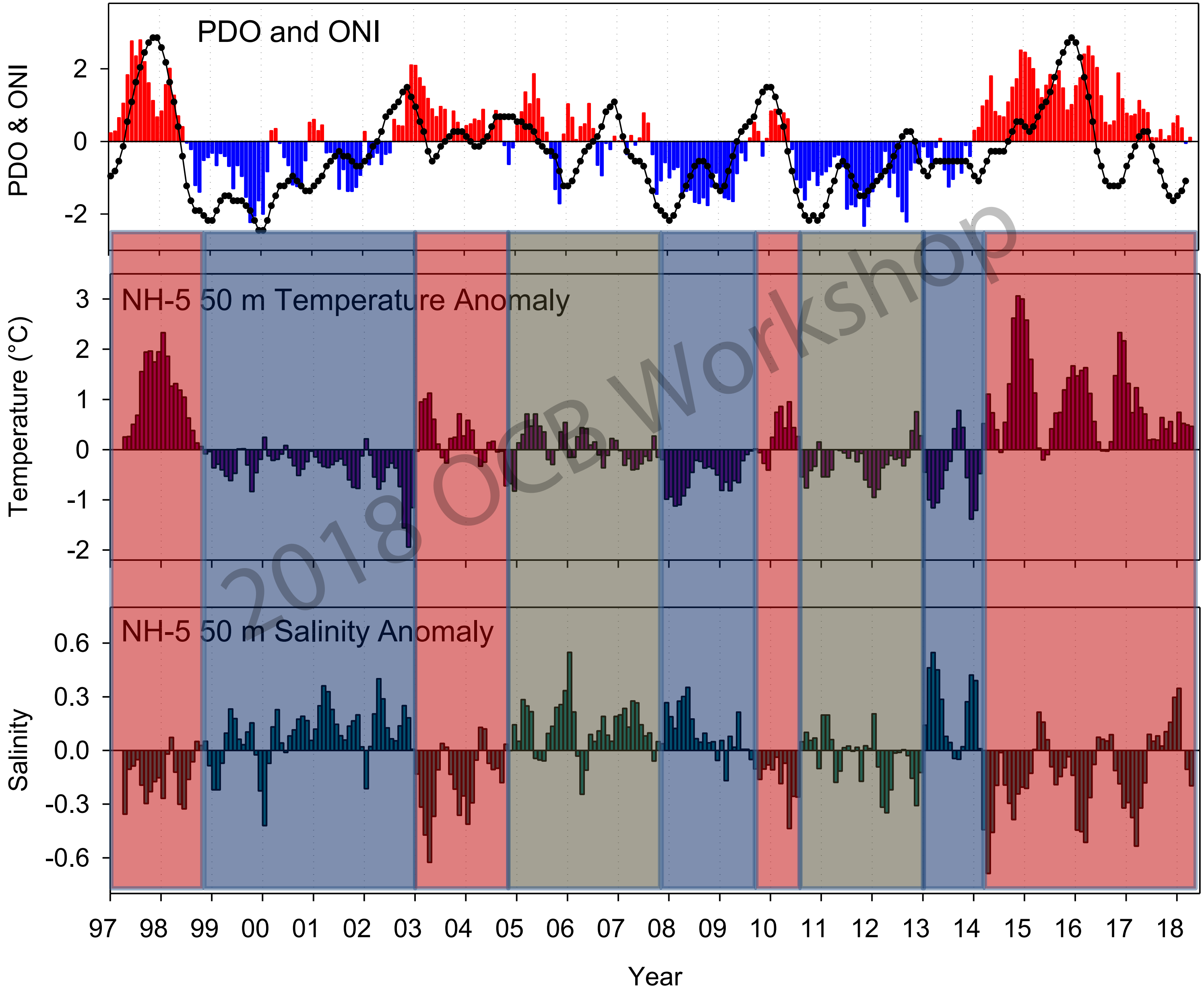
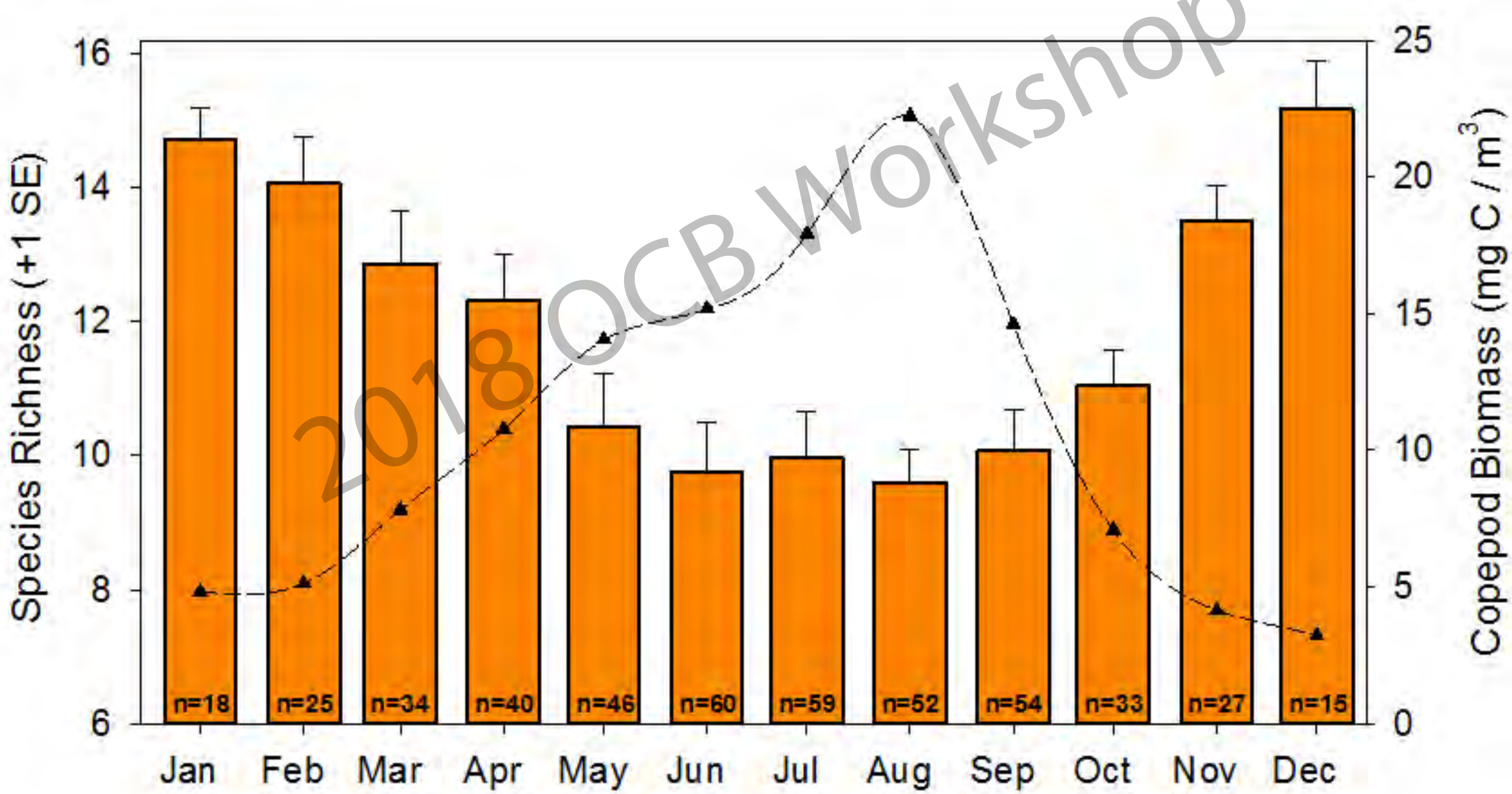


Ecosystem-Based Management Research Themes/Questions

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



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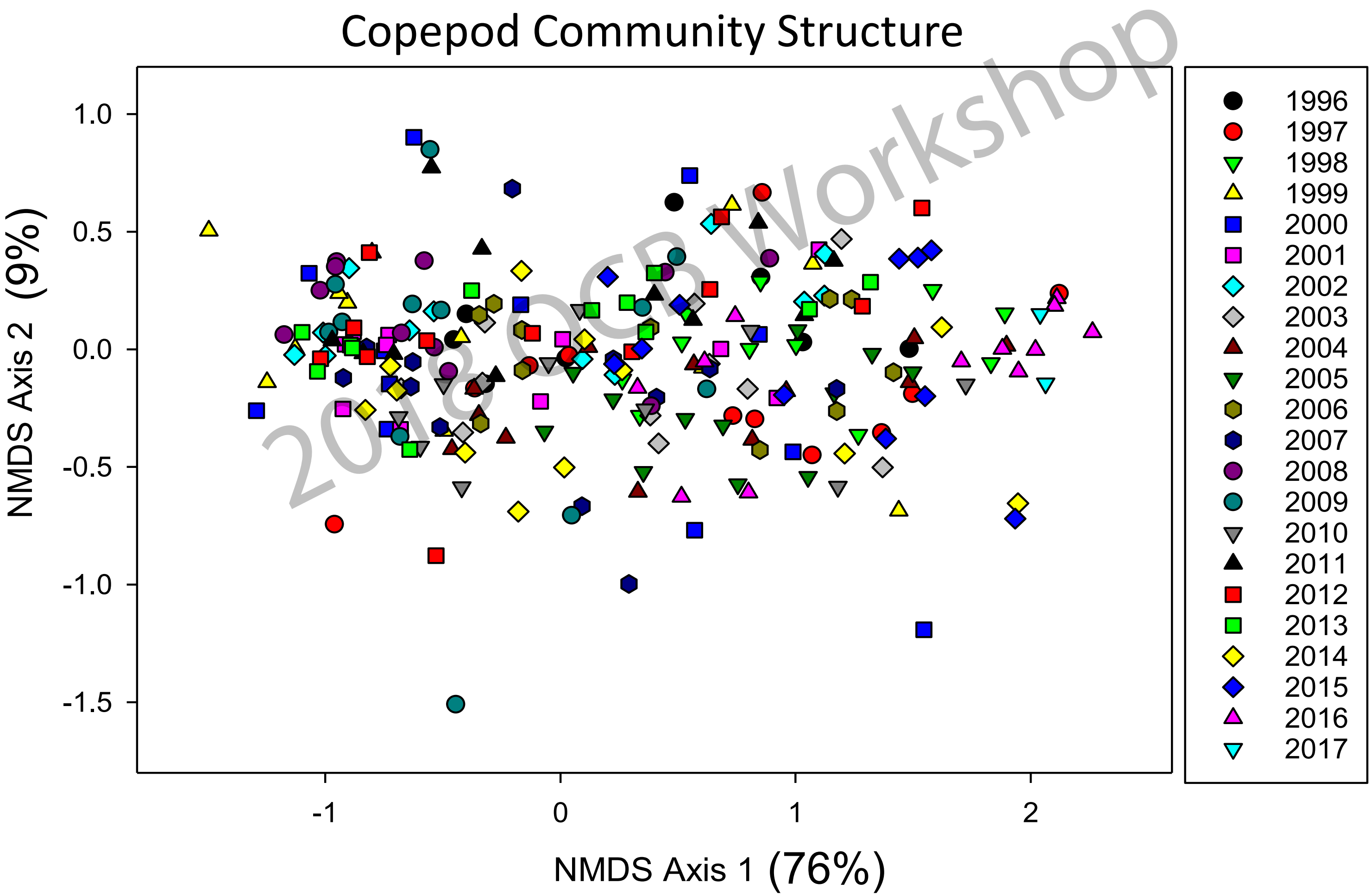
Copepod Community Structure



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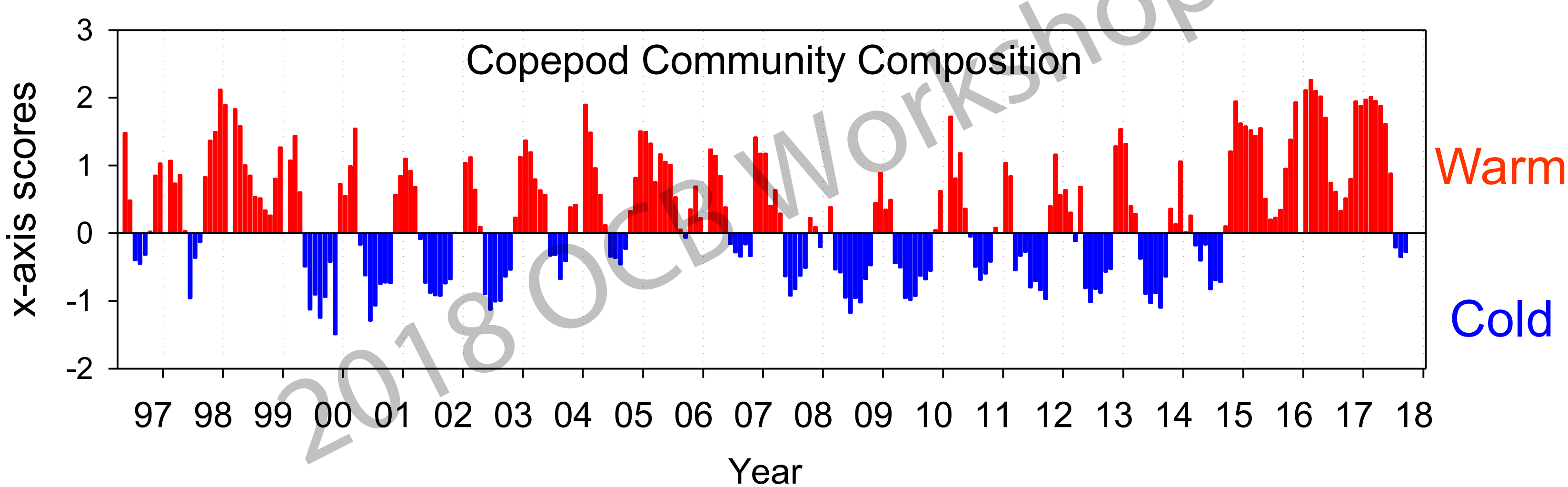

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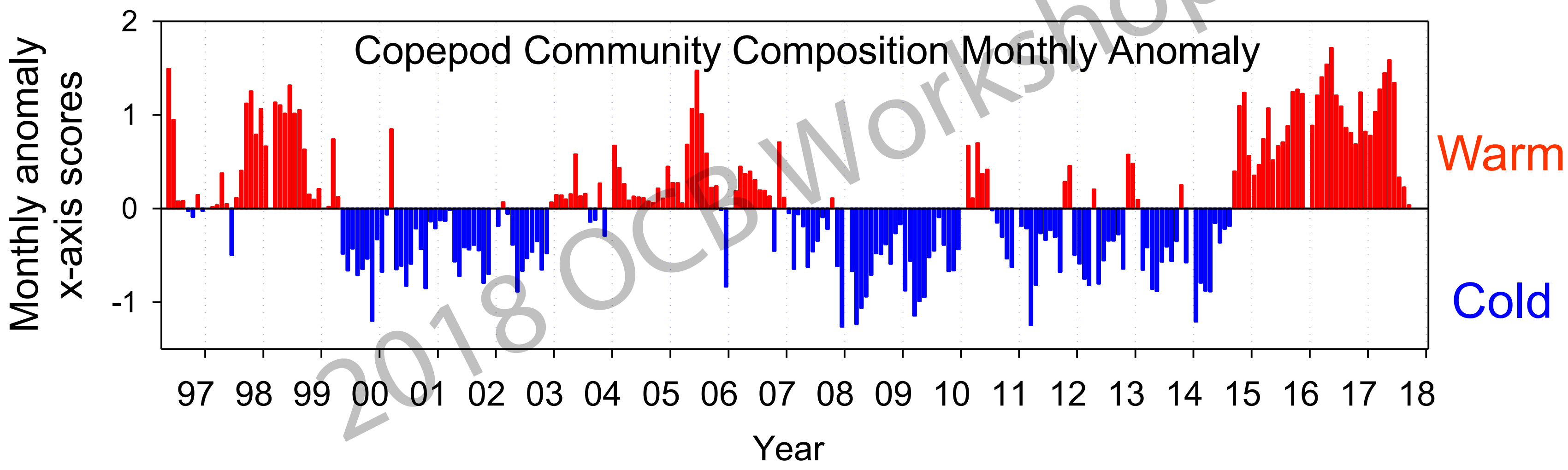

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- How do basin scale, regional, and local physical drivers affect primary and secondary production?
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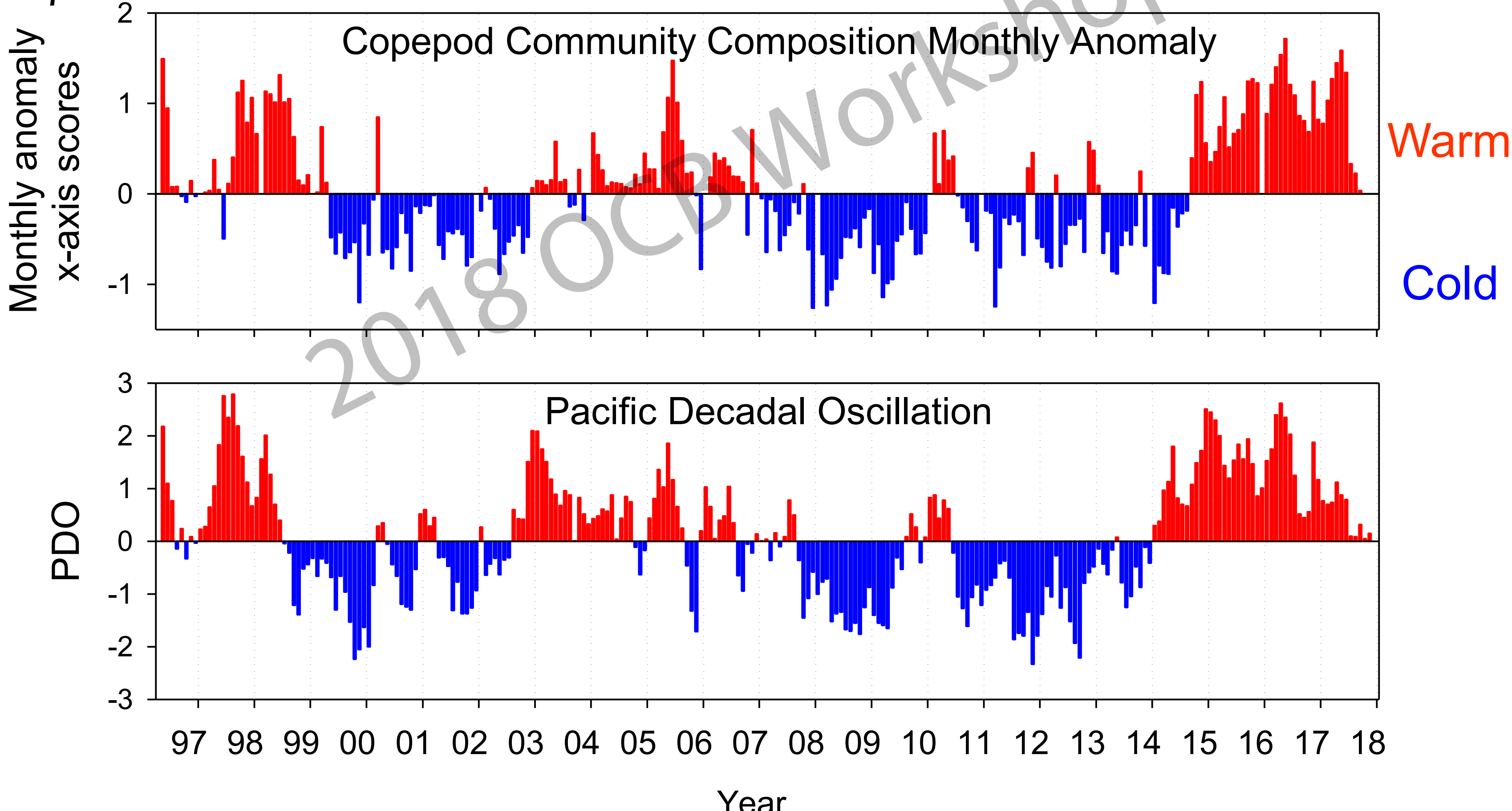

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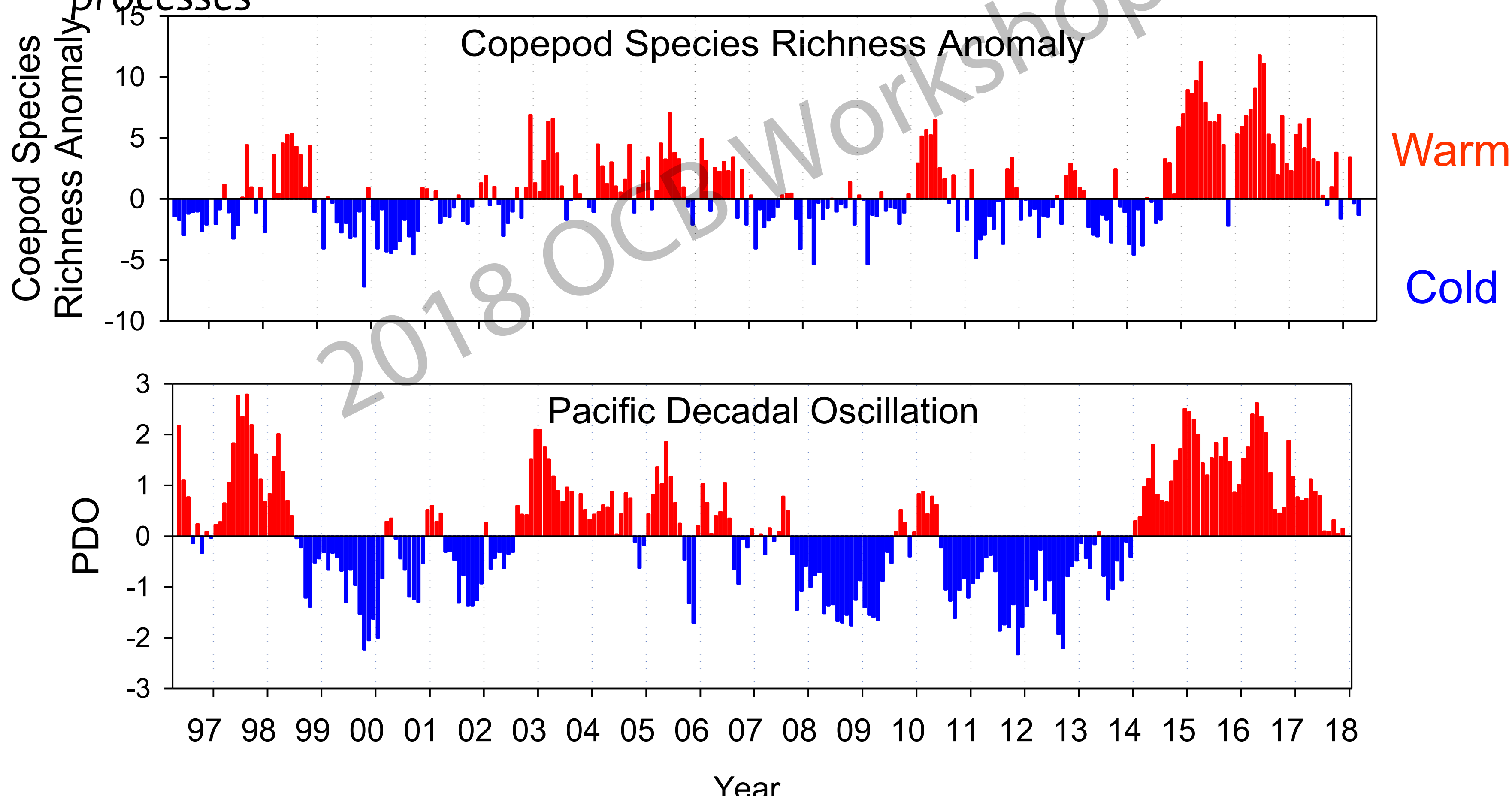

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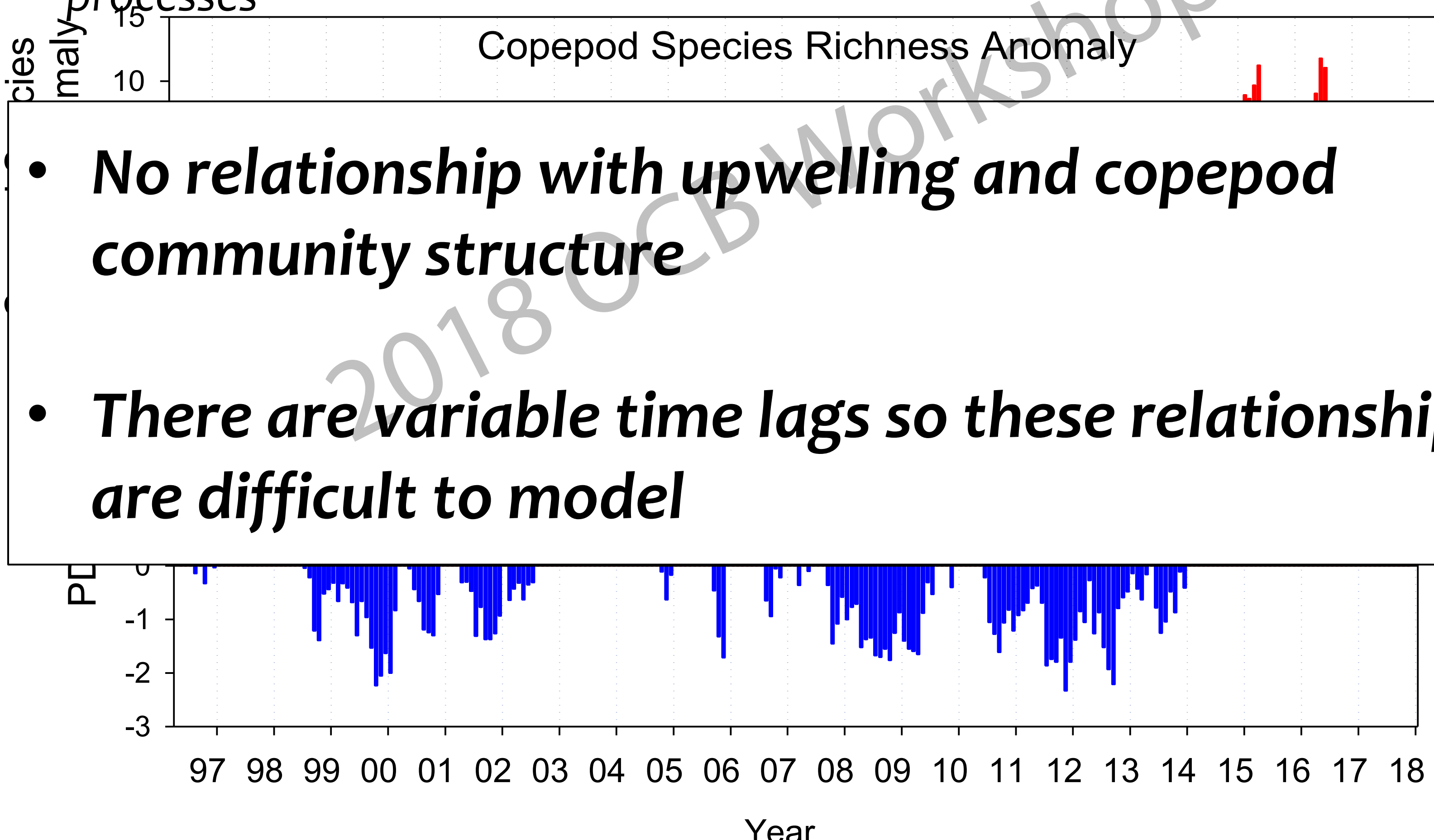


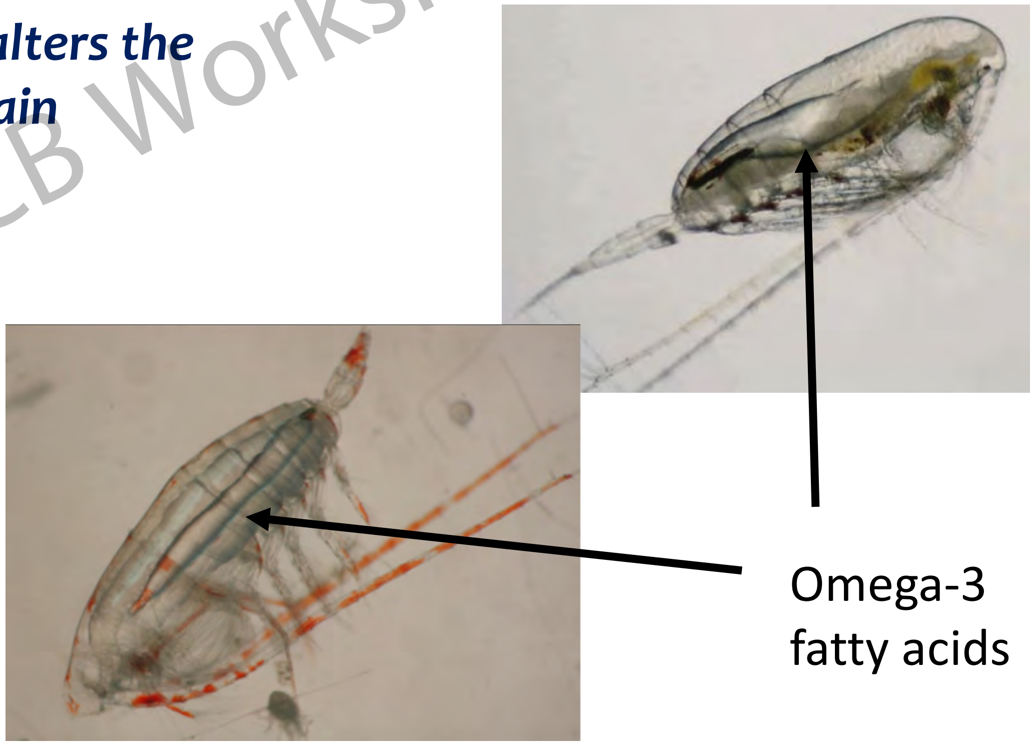
- ***No relationship with upwelling and copepod community structure***
- ***There are variable time lags so these relationships are difficult to model***

Ecosystem-Based Management Research Themes/Questions

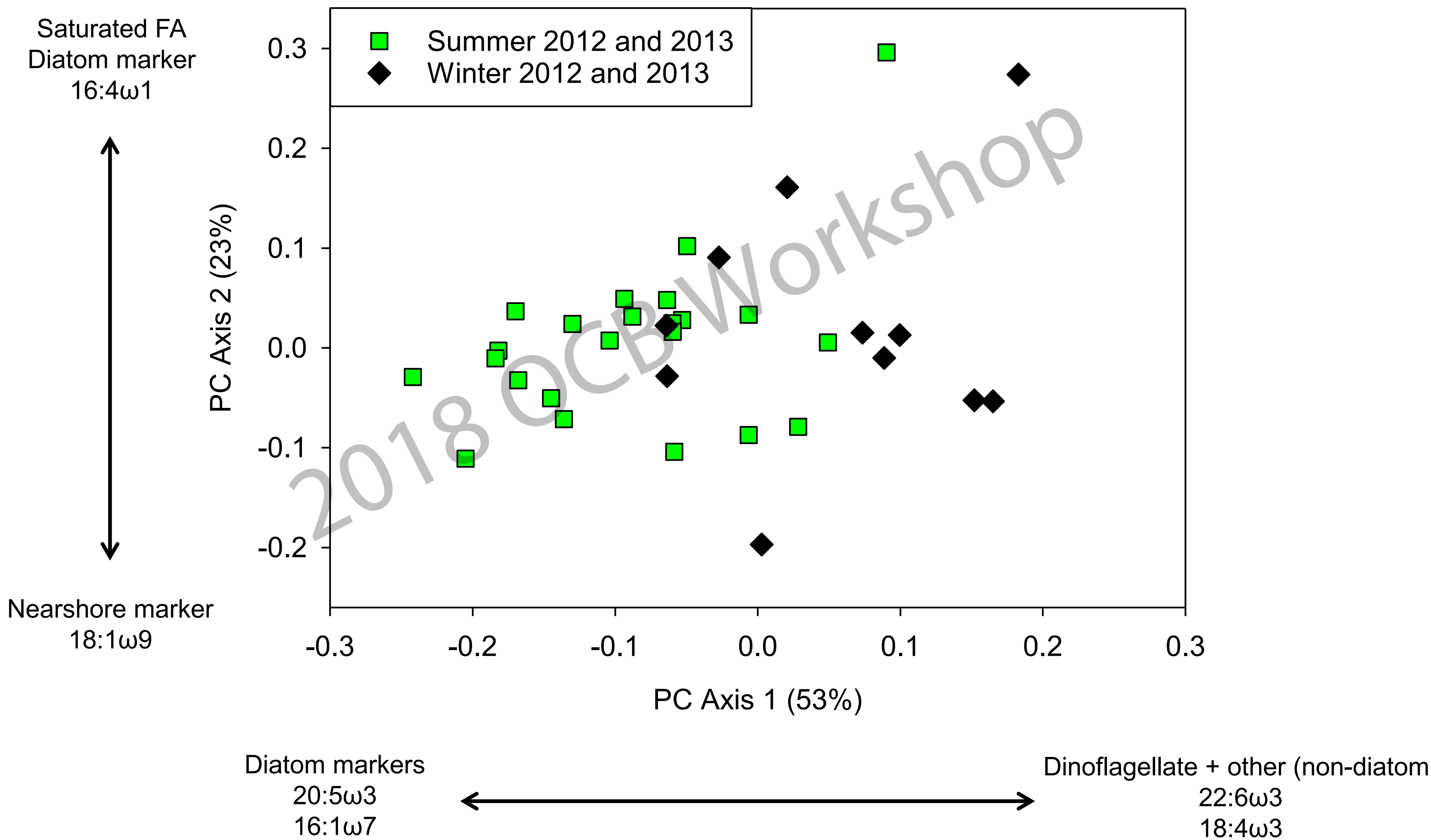
- How do fluctuations in primary and secondary production affect higher trophic levels?
  - *Interannual differences in copepod species composition are correlated to fisheries (e.g., salmon returns)*

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



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



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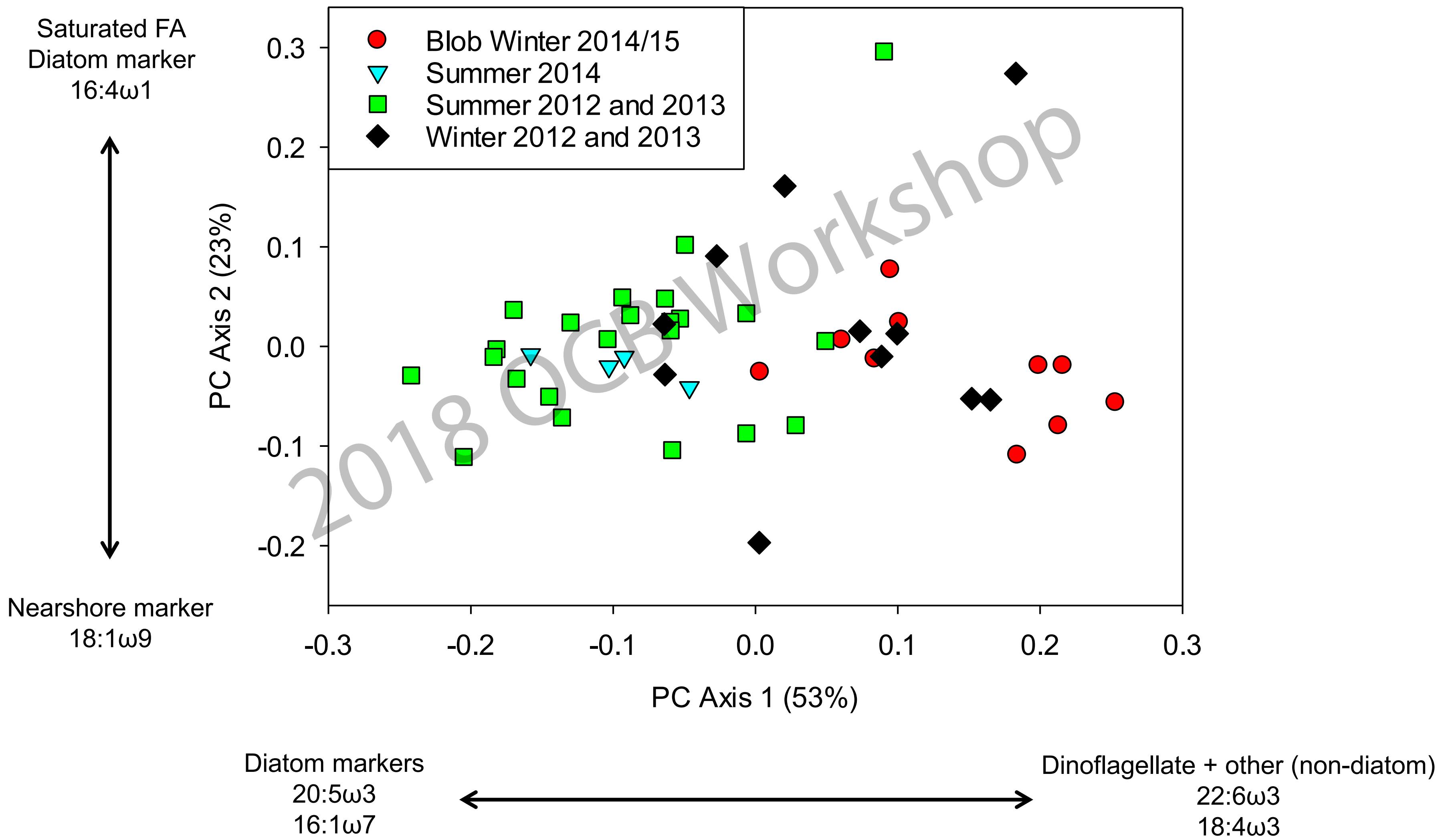
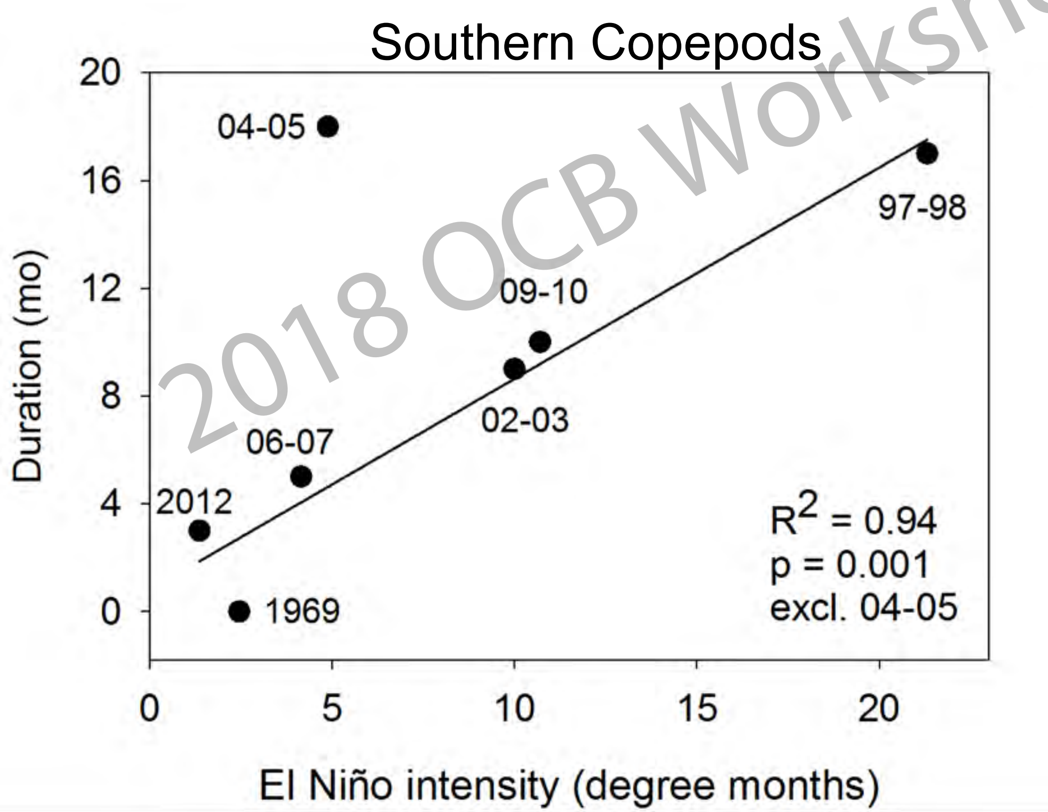


Ecosystem-Based Management Research Themes/Questions

- 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'*



From 7 El Niño events

Fisher et al. 2015 Global Change Biology

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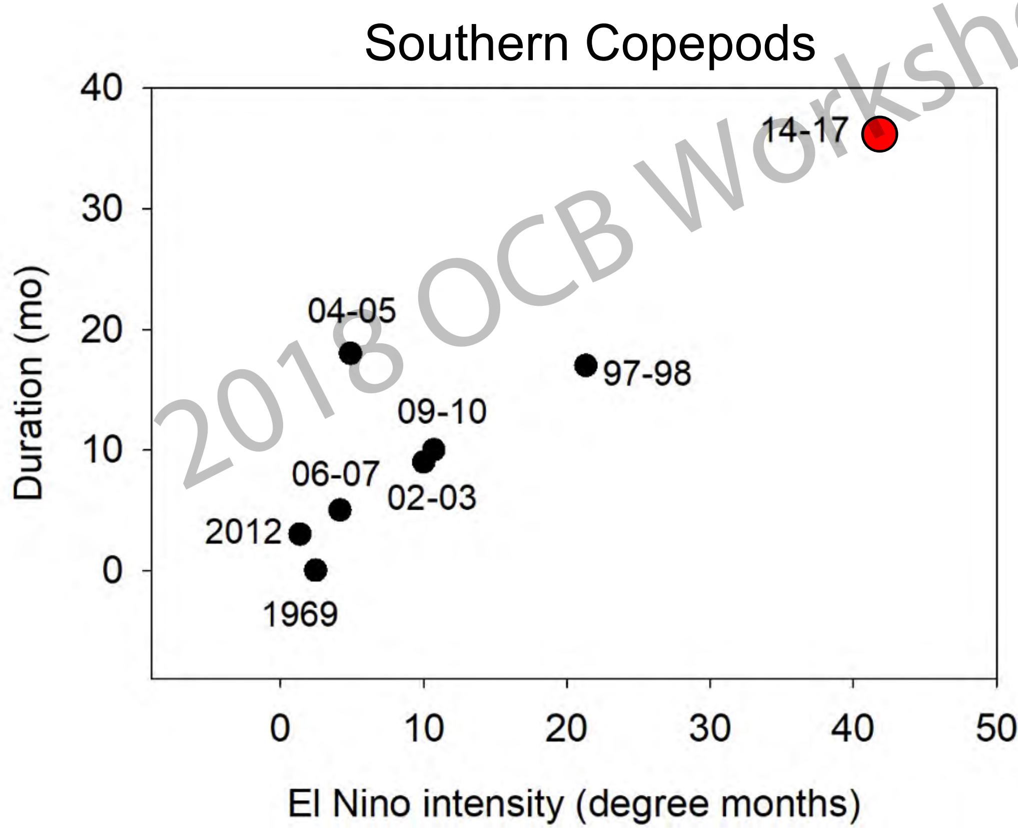

Fisher et al. 2015
Global Change Biology

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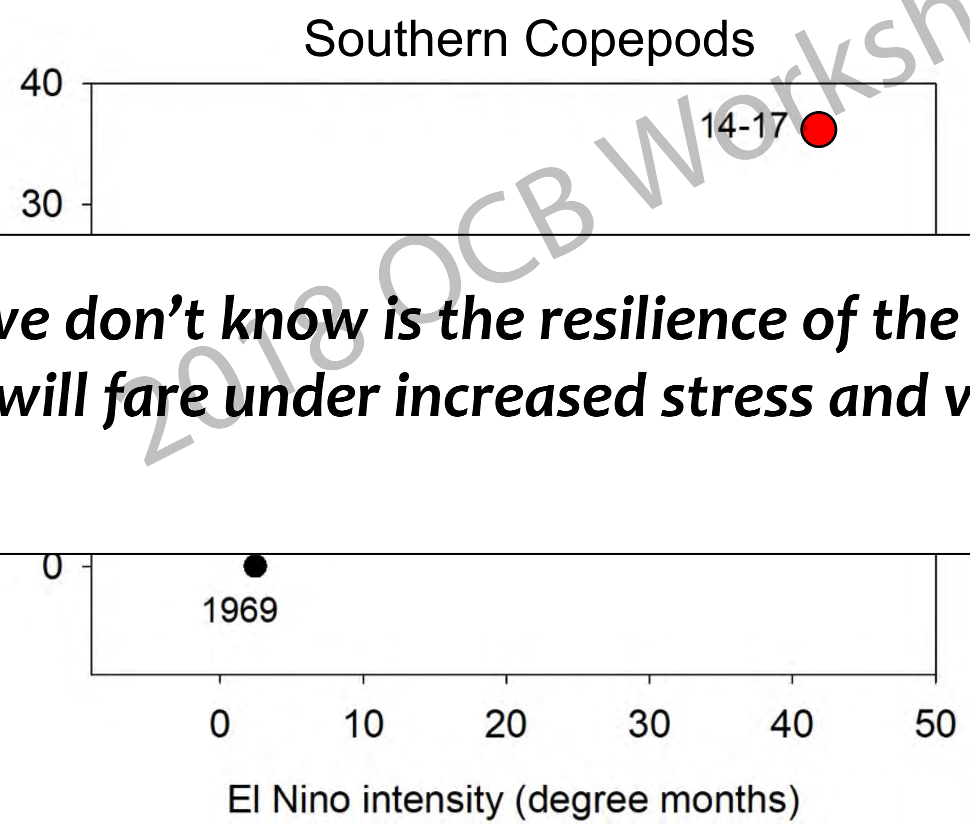
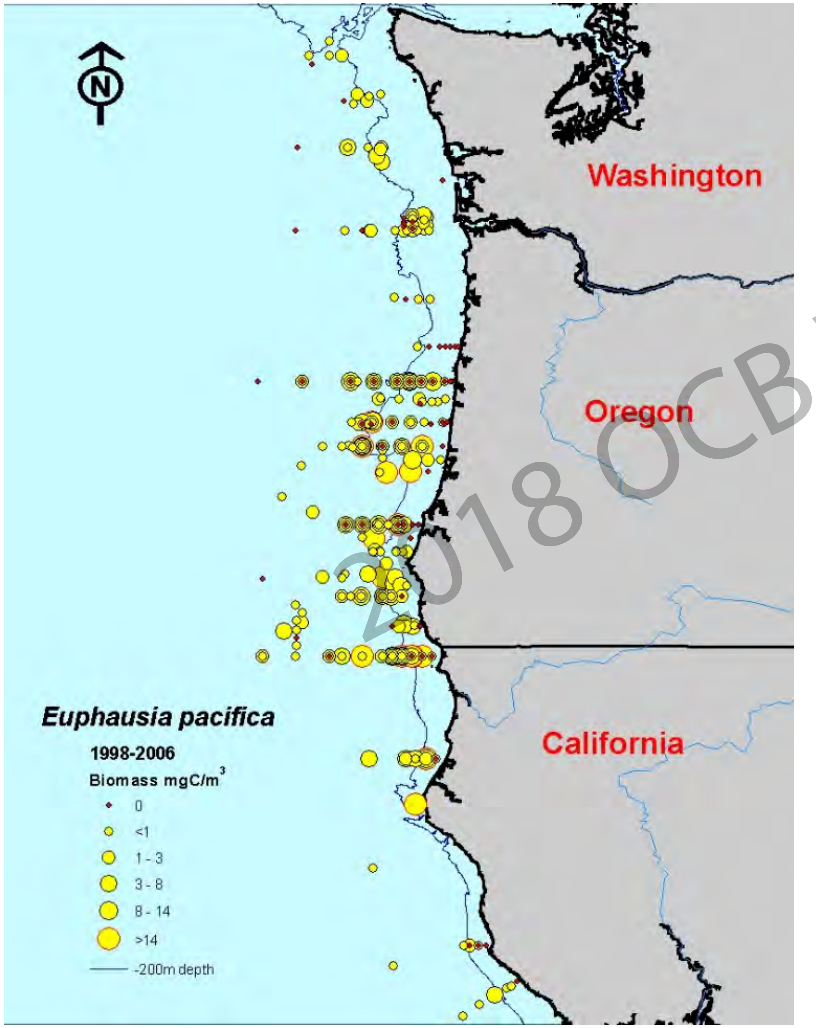


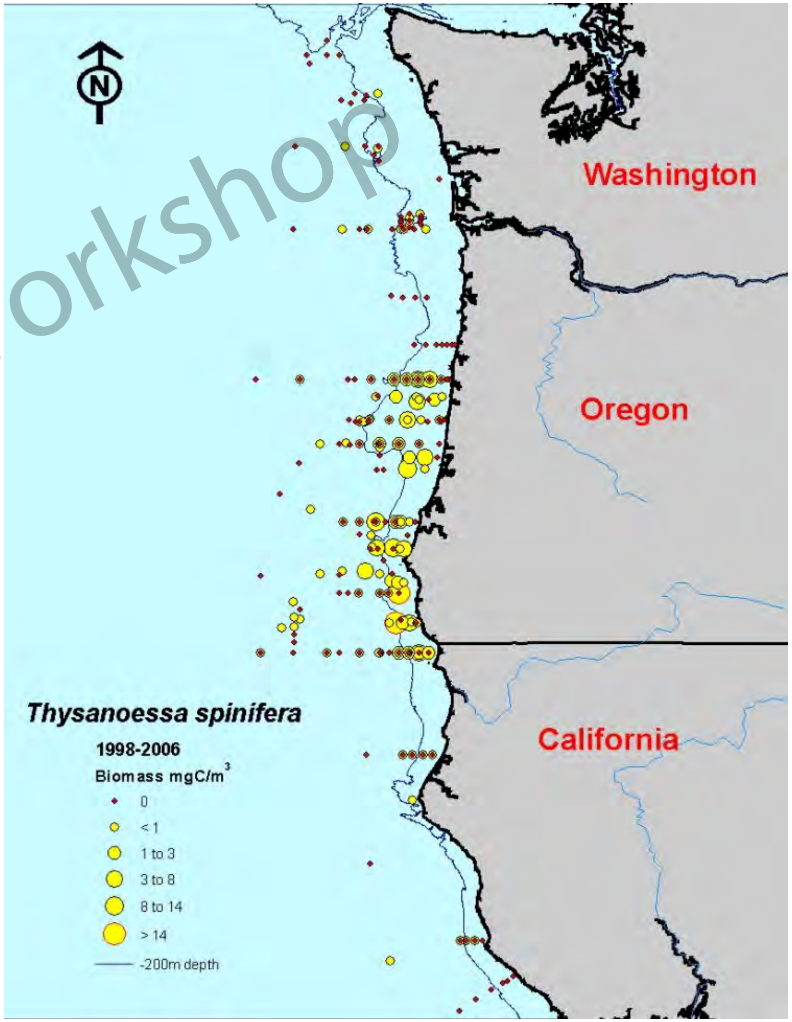
- ***What we don't know is the resilience of the ecosystem and how it will fare under increased stress and variability***

Fisher et al. 2015
Global Change Biology

Ecosystem-Based Management Research Themes/Questions

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





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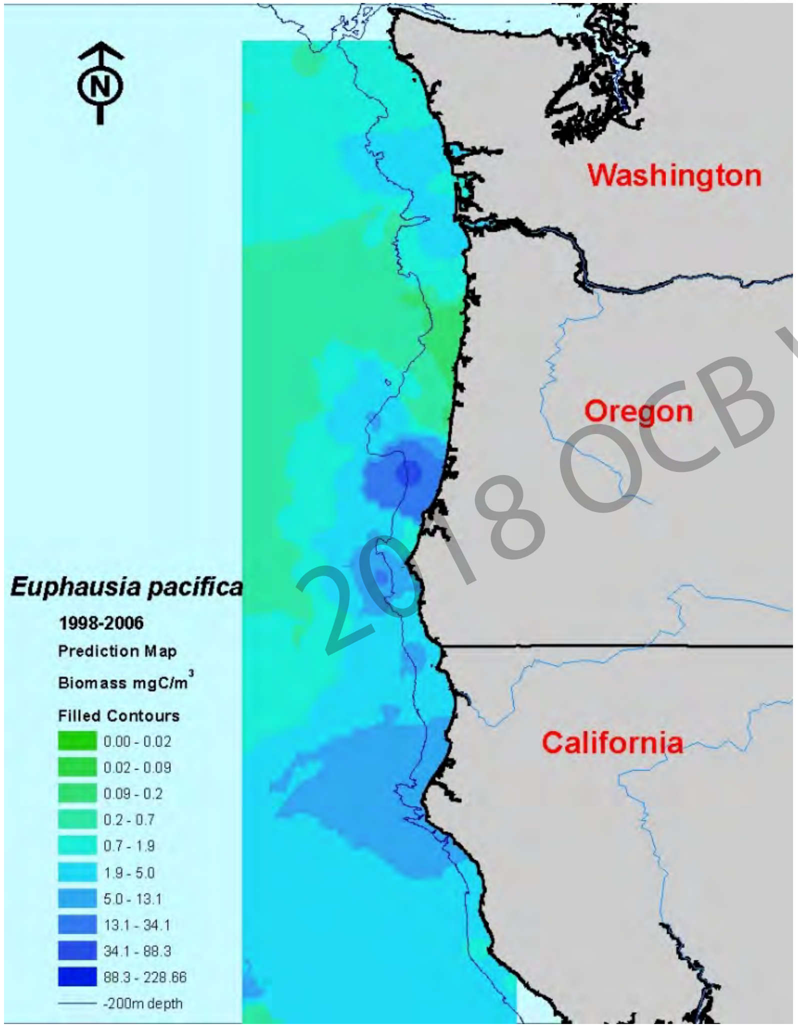
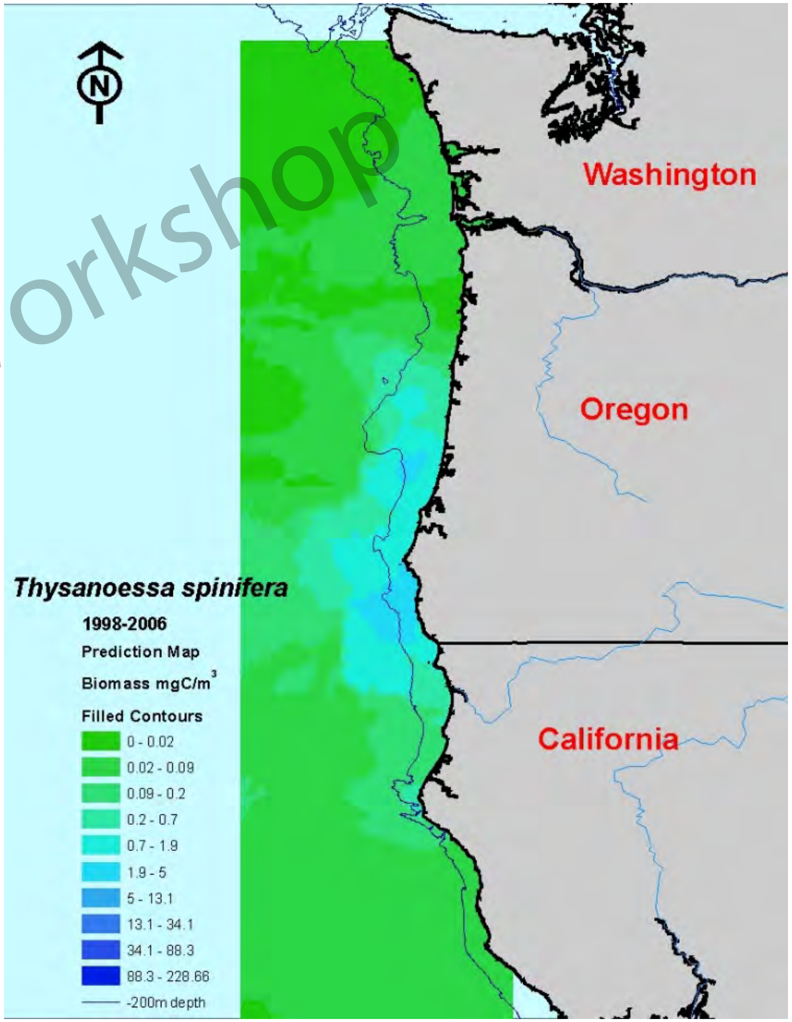
- What are the environmental drivers of krill abundance and distribution?





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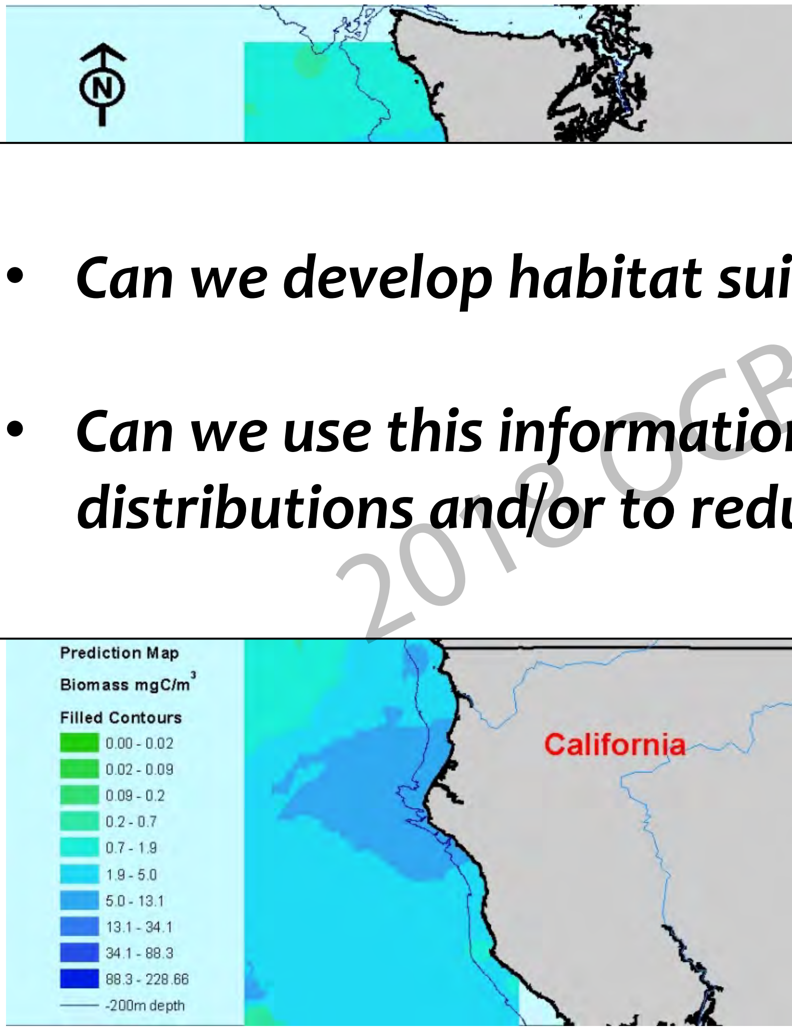
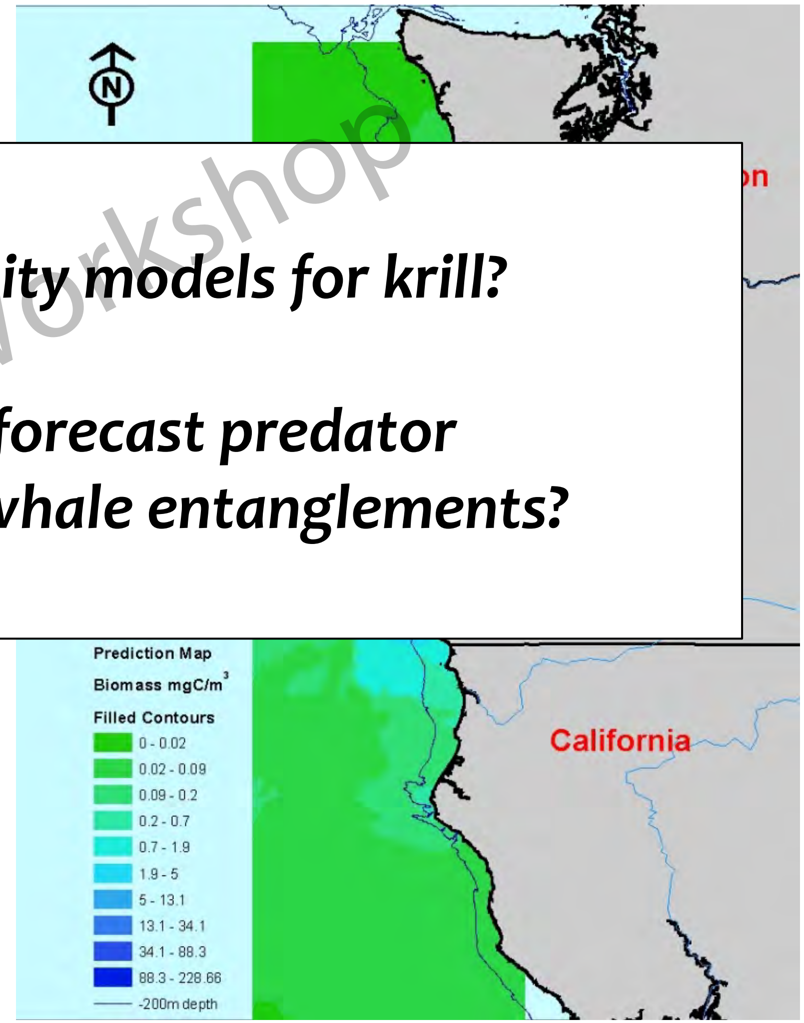
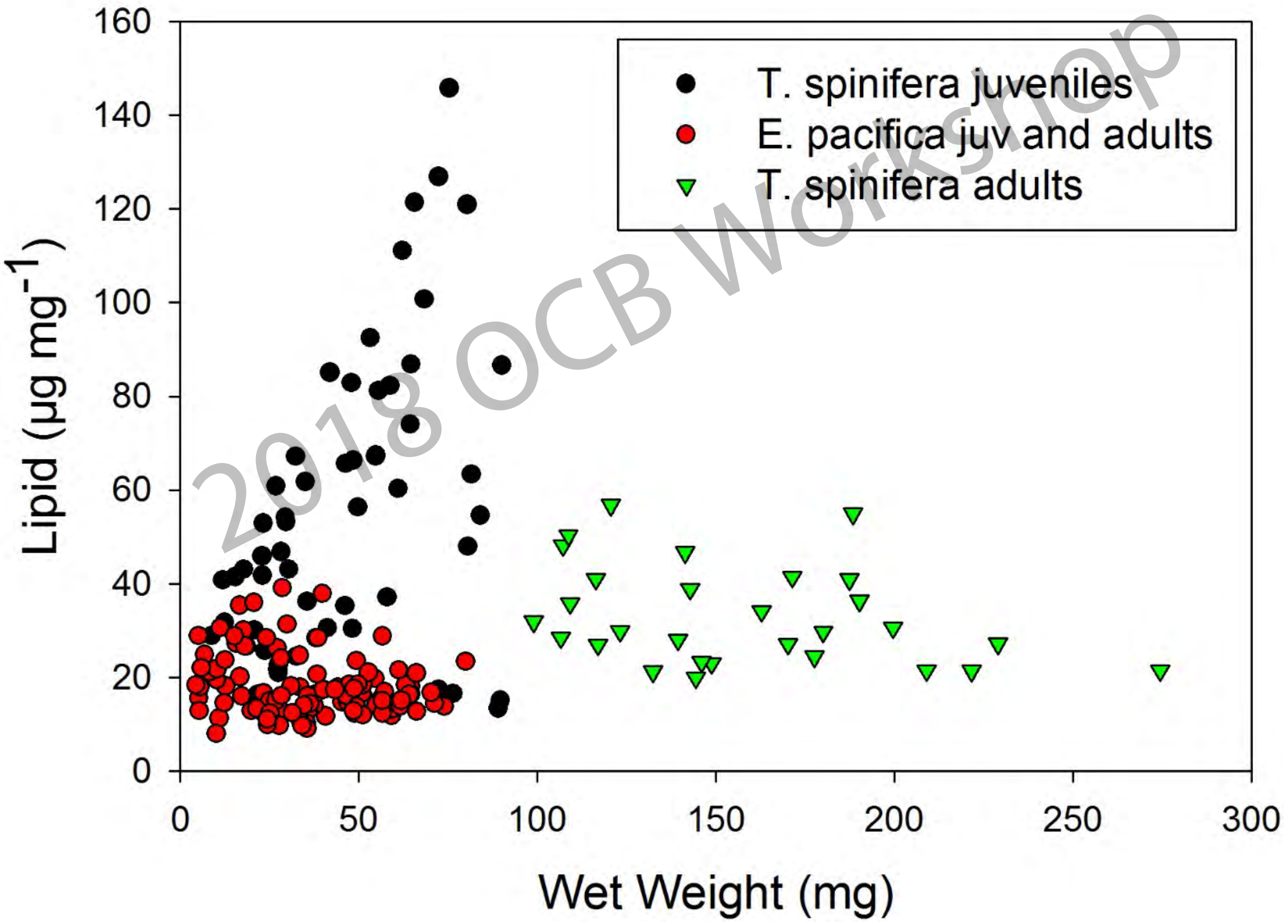




- ***Can we develop habitat suitability models for krill?***
- ***Can we use this information to forecast predator distributions and/or to reduce whale entanglements?***

Ecosystem-Based Management Research Themes/Questions

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



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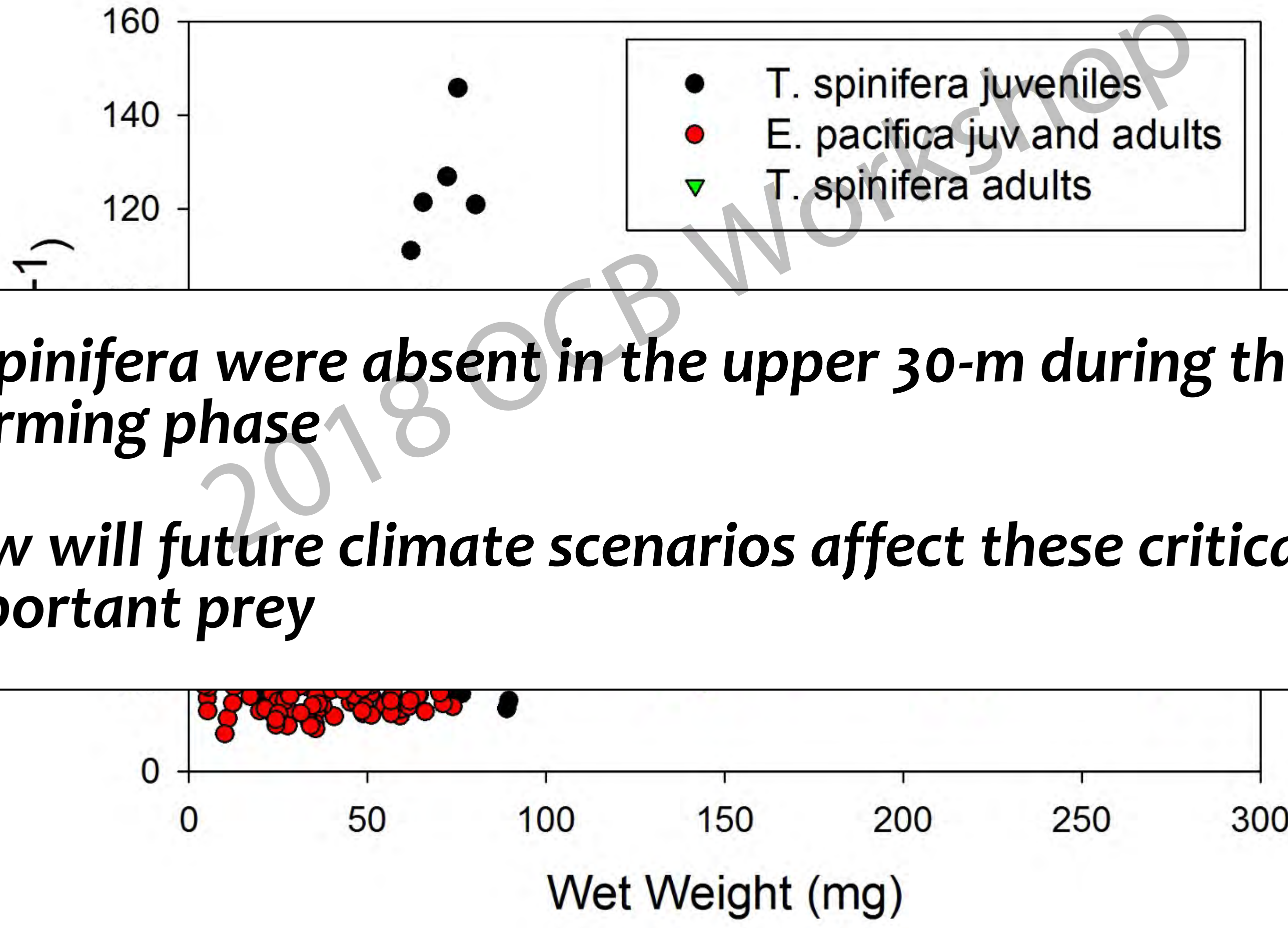


- ***T. spinifera were absent in the upper 30-m during the last warming phase***
- ***How will future climate scenarios affect these critically important prey***

Ecosystem-Based Fisheries Management Research Themes/Questions

- Can ocean ecosystem indicators forecast fisheries?

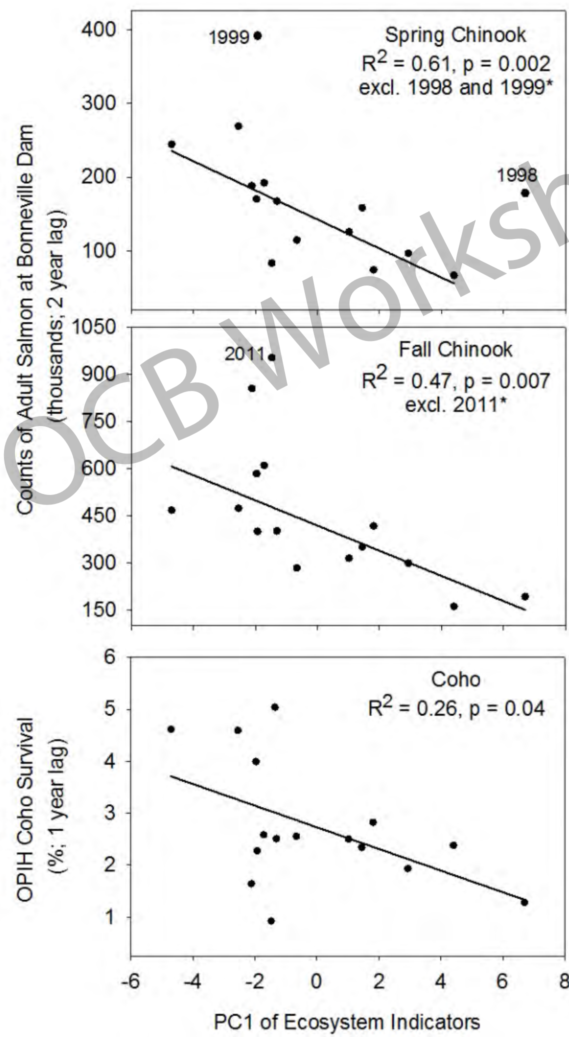
		Year																			
	Ecosystem Indicators	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*
Basin-scale physical indices	PDO (Sum Dec-March)	17	6	3	12	7	19	11	15	13	9	5	1	14	4	2	8	10	20	18	16
	PDO (Sum May-Sept)	10	4	6	5	11	16	15	17	12	13	2	9	7	3	1	8	18	20	19	14
	ONI (Average Jan-June)	19	1	1	6	13	15	14	16	8	11	3	10	17	4	5	7	9	18	20	12
Regional physical indices	46050 SST (°C; May-Sept)	16	9	3	4	1	8	20	15	5	17	2	10	7	11	12	13	14	19	18	6
	Upper 20 m T (°C; Nov-Mar)	19	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2	20	18	17
	Upper 20 m T (°C; May-Sept)	16	12	14	4	1	3	20	18	7	8	2	5	13	10	6	17	19	9	15	11
	Deep temperature (°C; May-Sept)	20	6	8	4	1	10	12	16	11	5	2	7	14	9	3	15	19	18	13	17
	Deep salinity (May-Sept)	19	3	9	4	5	16	17	10	7	1	2	14	18	13	12	11	20	15	8	6
Regional biological indices	Copepod richness anom. (no. species; May-Sept)	18	2	1	7	6	13	12	17	15	10	8	9	16	4	5	3	11	19	20	14
	N. copepod biomass anom. (mg C m^{-3}; May-Sept)	18	13	9	10	3	15	12	19	14	11	6	8	7	1	2	4	5	16	20	17
	S. copepod biomass anom. (mg C m^{-3}; May-Sept)	20	2	5	4	3	13	14	19	12	10	1	7	15	9	8	6	11	17	18	16
	Biological transition (day of year)	17	8	5	7	9	14	13	18	12	2	1	3	15	6	10	4	11	20	20	16
	Ichthyoplankton biomass (log (mg C 1000 m^{-3}); Jan-Mar)	20	11	3	7	9	18	17	13	16	15	2	12	4	14	10	8	19	5	6	1
	Ichthyoplankton community index (PCO axis 1 scores; Jan-Mar)	9	13	1	6	4	10	18	16	3	12	2	14	15	11	5	7	8	17	20	19
	Chinook salmon juvenile catches (no. km^{-1}; June)	18	4	5	15	8	12	16	19	11	9	1	6	7	14	3	2	10	13	17	20
	Coho salmon juvenile catches (no. km^{-1}; June)	18	7	12	5	6	2	15	19	16	4	3	9	10	14	17	1	11	8	13	20

Ecosystem-Based Fisheries Management Research Themes/Questions

- Can ocean ecosystem indicators forecast fisheries?

Multiple indicators are better than single predictors for:

- *Salmon returns to Bonneville Dam*
- *Coho survival*



Peterson et al. 2014, Oceanography

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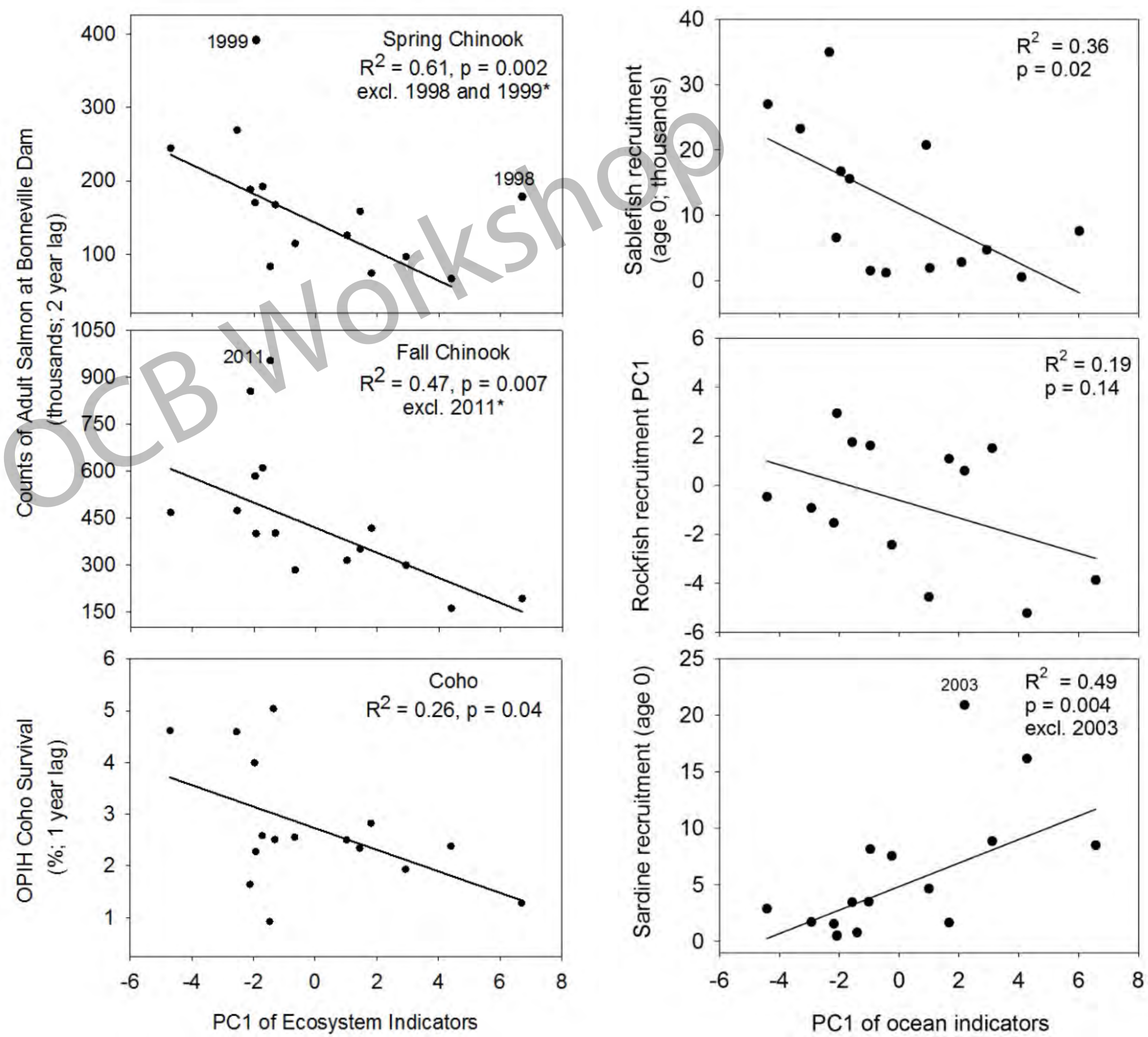
- Sablefish in the NCC
- Rockfish in the CCC
- Sardine in the SCC



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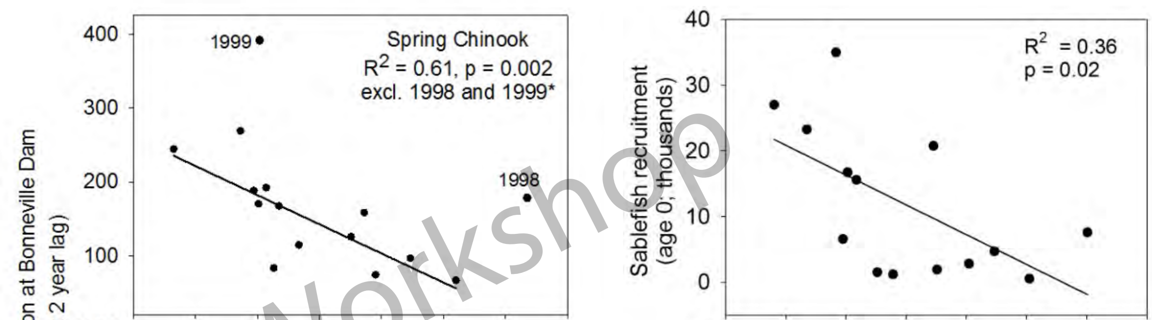
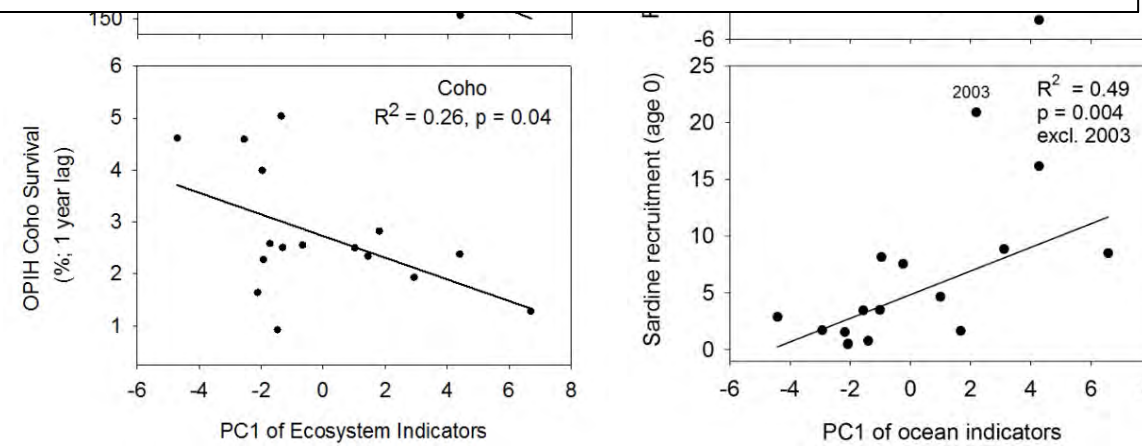


- ***How can we incorporate ocean ecosystem indicators into stock assessment?***



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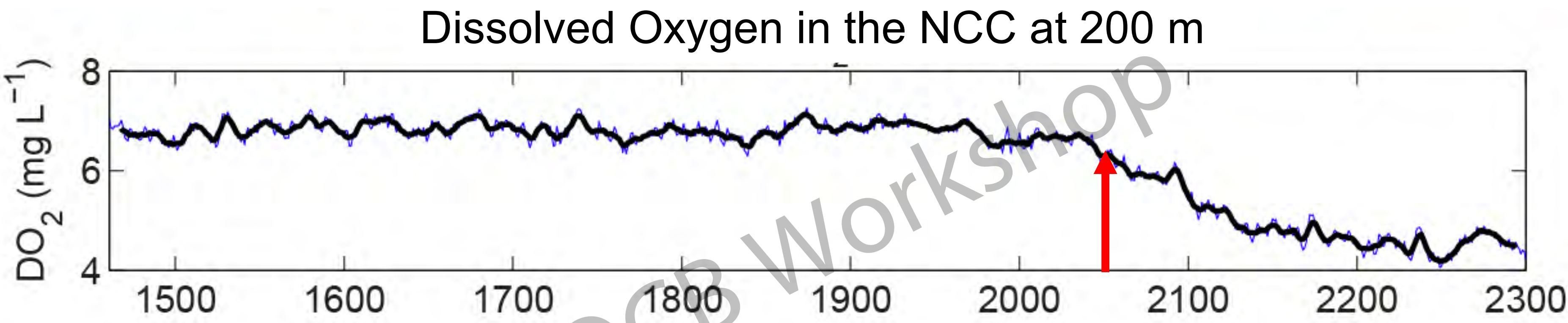
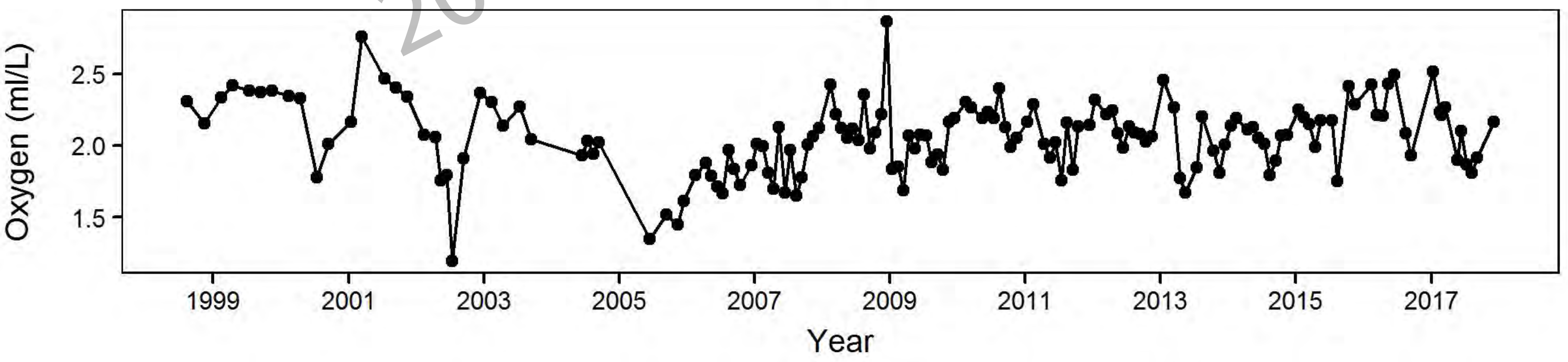
Peterson et al. 2014, Oceanography

Climate Science
Research Themes/Questions

- Are NCC waters decreasing in dissolved oxygen- hypoxia?

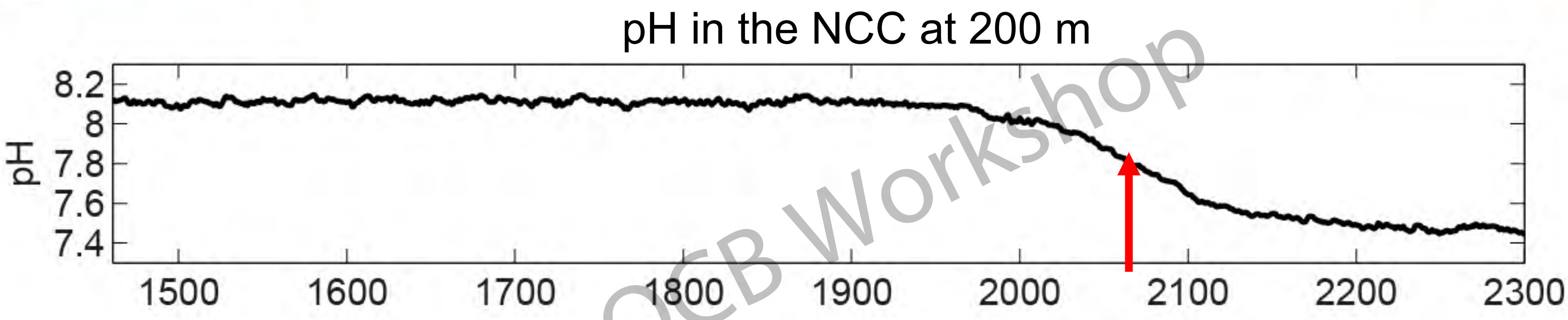


Courtesy of Ryan Rykaczewski (USC)



Climate Science
Research Themes/Questions

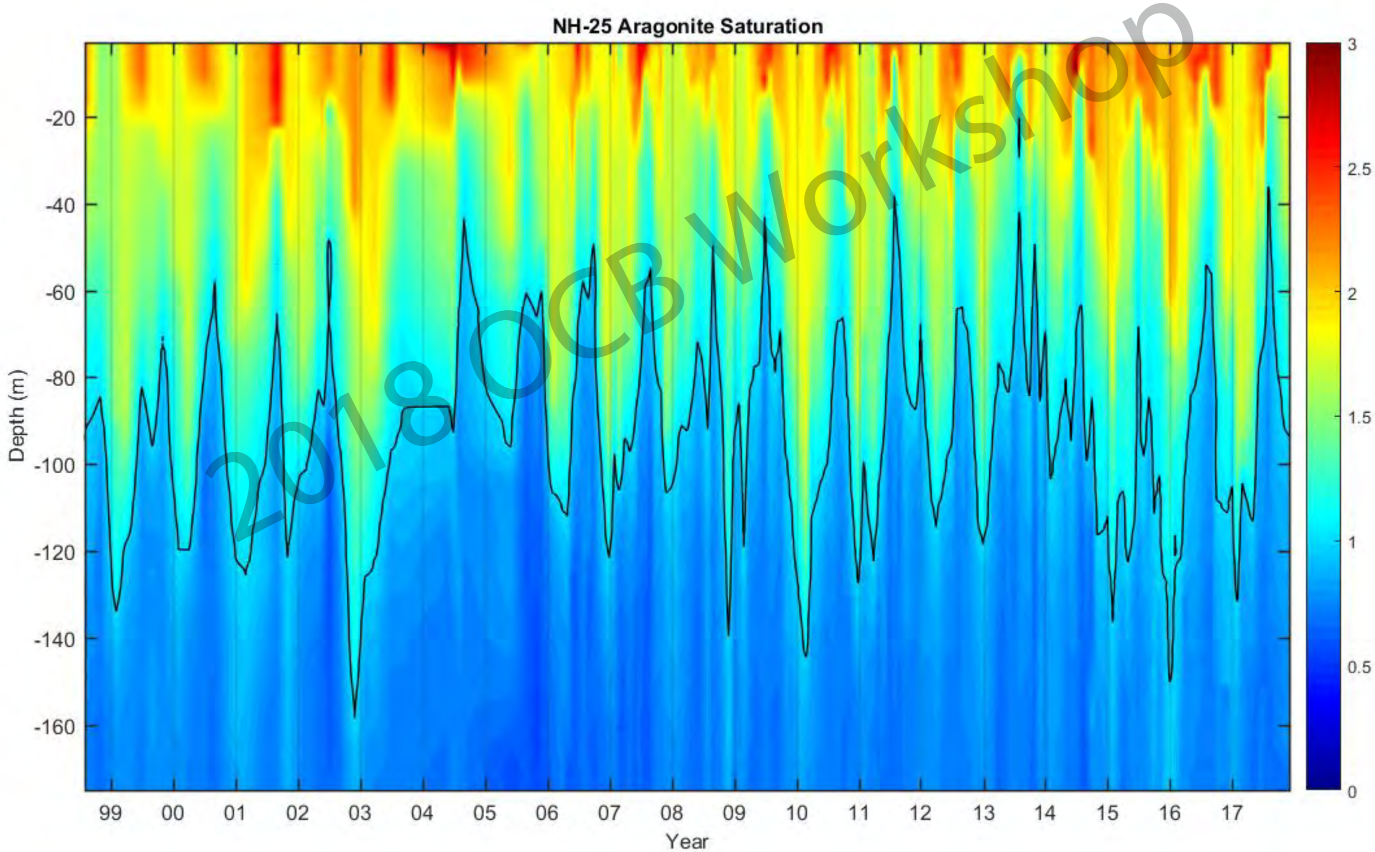
- Is ocean acidification impacting the NCC?



Courtesy of Ryan Rykaczewski (USC)

Climate Science
Research Themes/Questions

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



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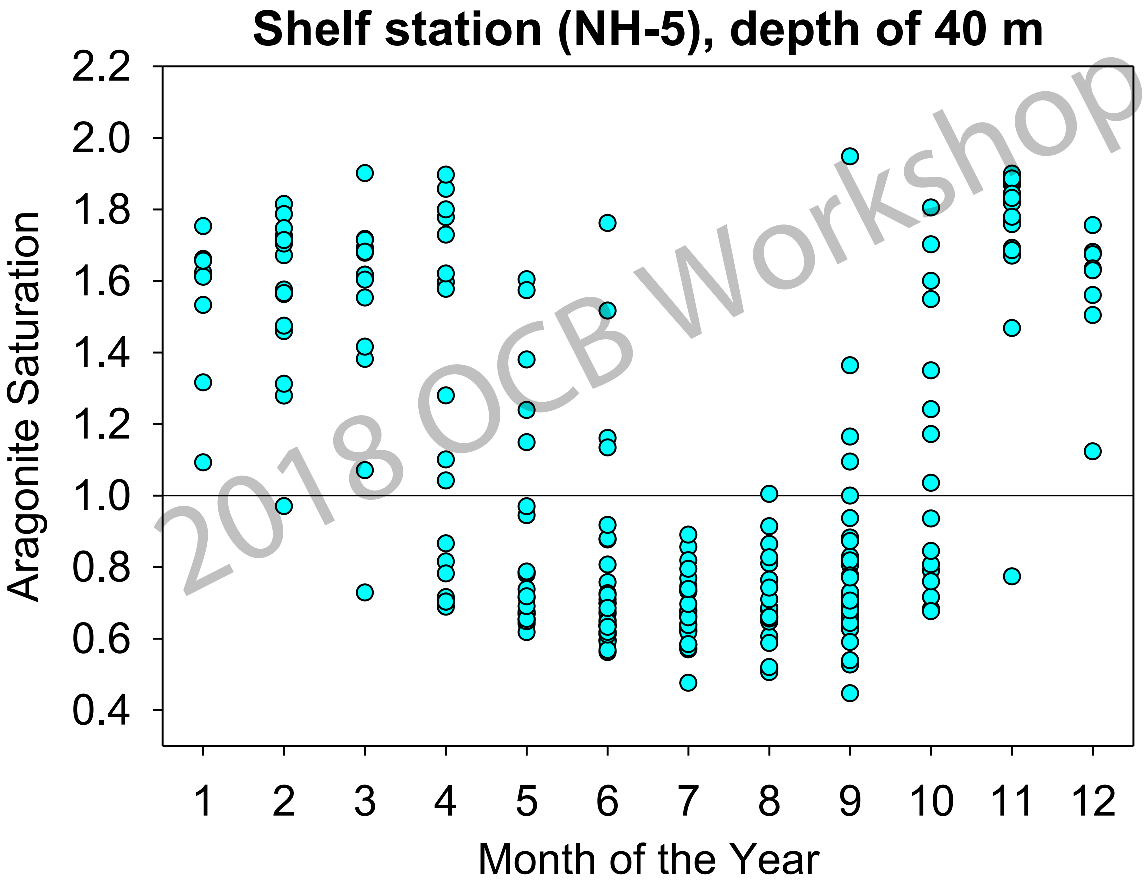

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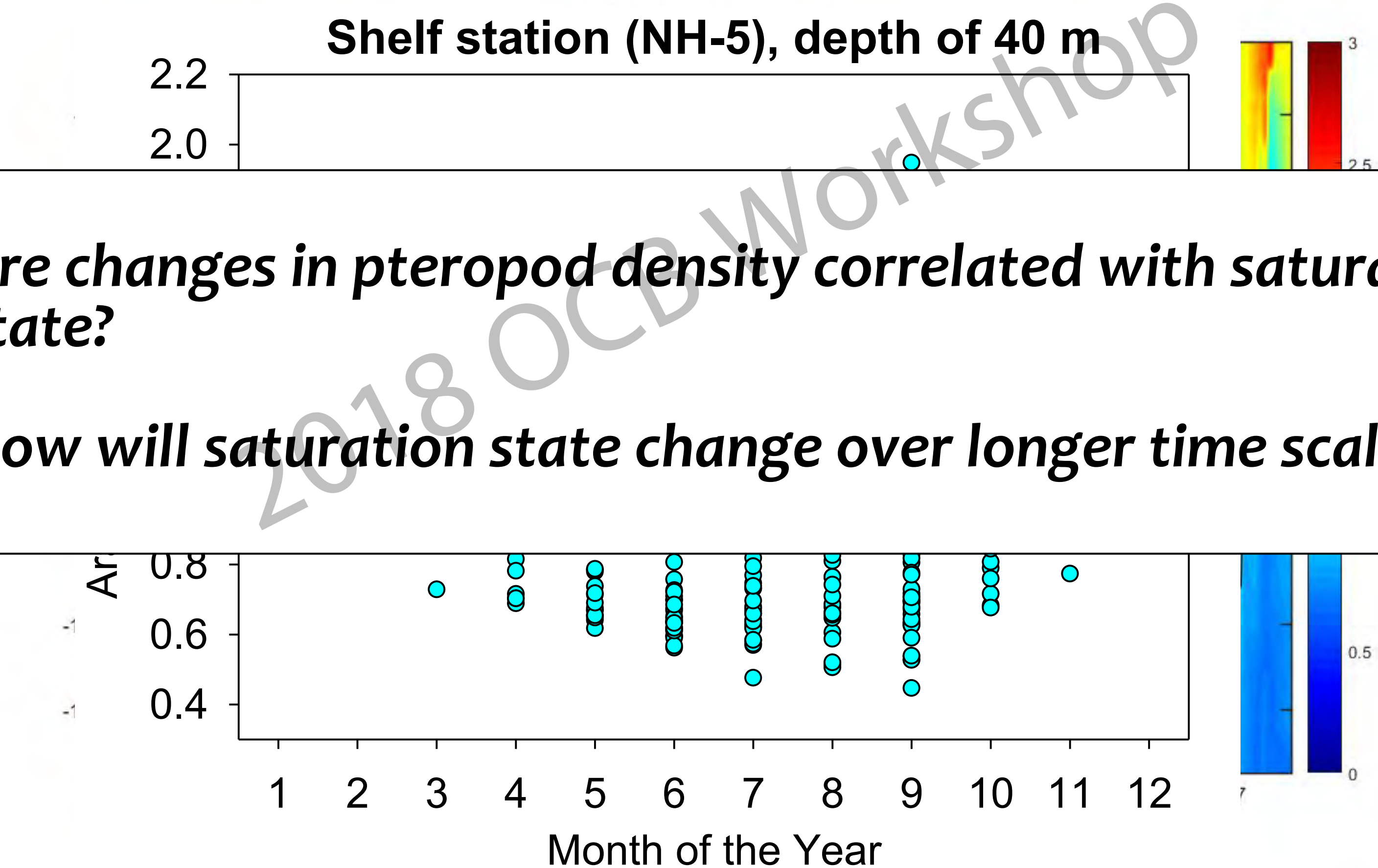

- ***Are changes in pteropod density correlated with saturation state?***
- ***How will saturation state change over longer time scales?***

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