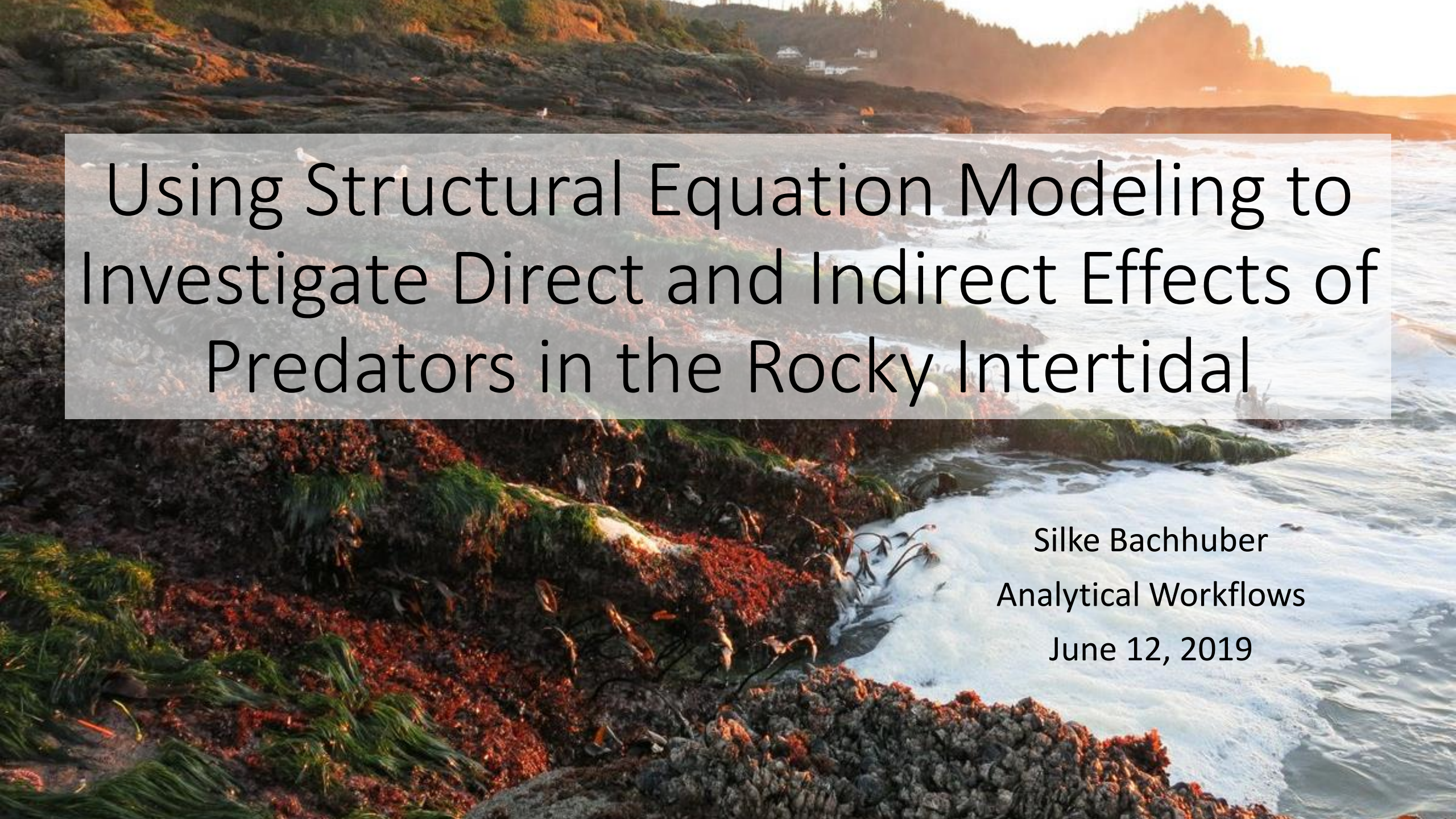


# Using Structural Equation Modeling to Investigate Direct and Indirect Effects of Predators in the Rocky Intertidal

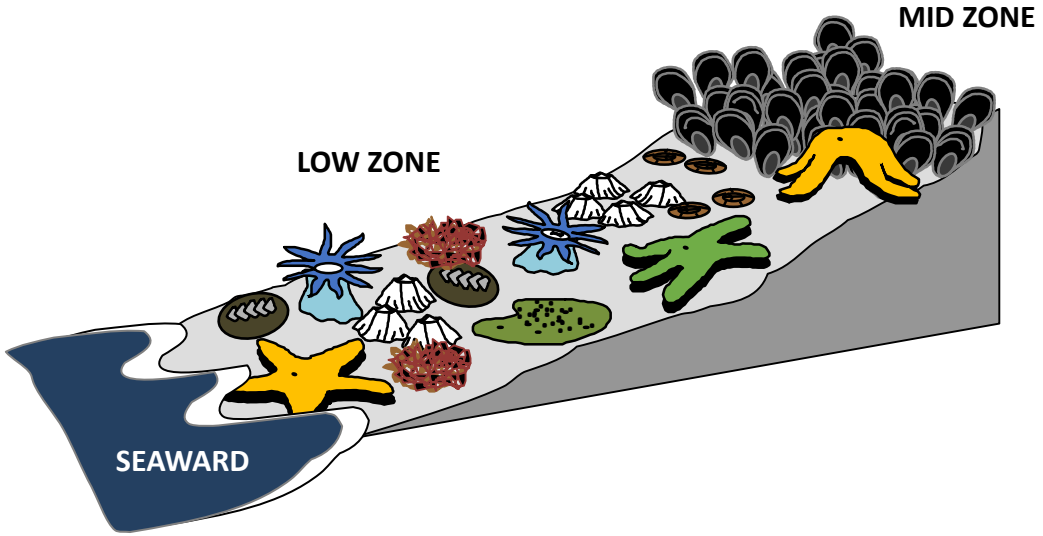
Silke Bachhuber

Analytical Workflows

June 12, 2019

# Mechanisms of resistance, resilience to SSWS

*Pisaster* present




*Pisaster* removed

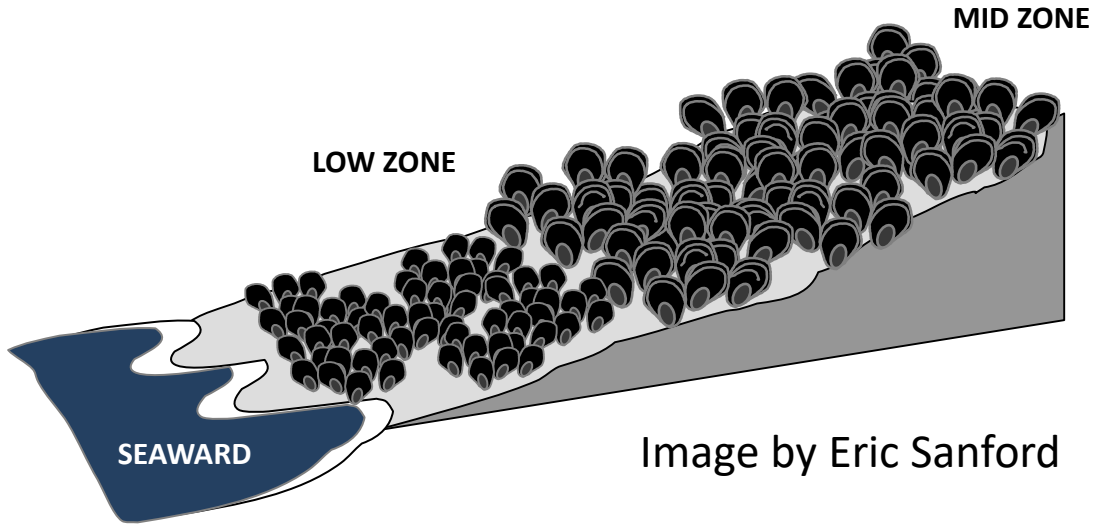



Image by Eric Sanford

- Recruitment of mussels and barnacles
- Large predators (stars and birds)

- Facilitation by algae, barnacles
- **Small predators**

# Can compensatory predation by *Nucella ostrina* and *Leptasterias spp.* prevent downward spread of mussels into the low zone?

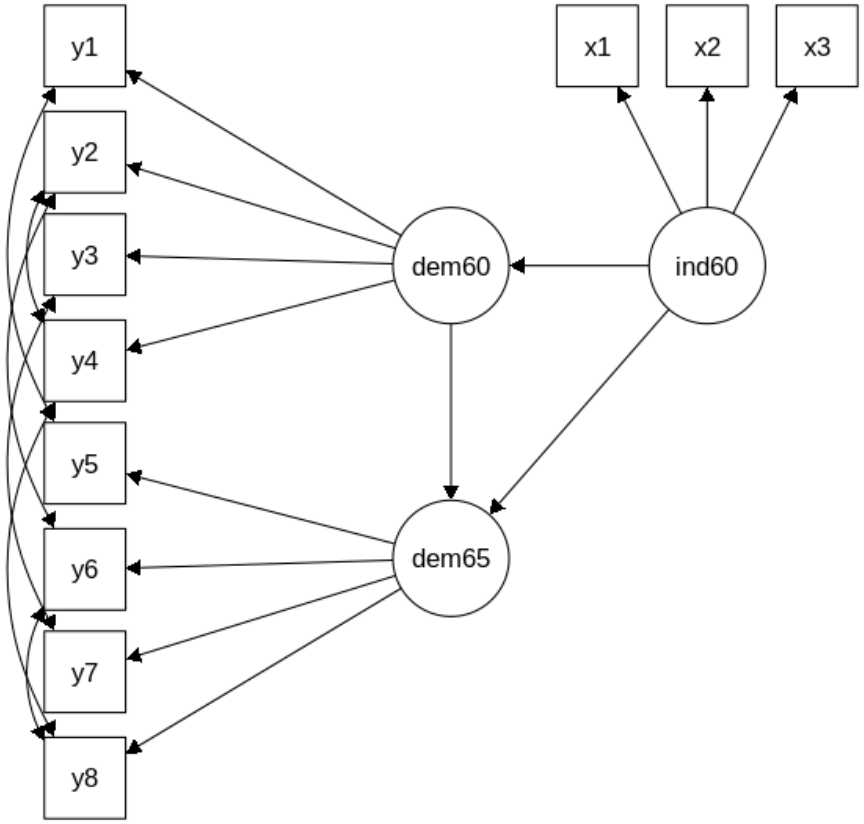
- How does the strength of compensatory predation vary from SoCal to Oregon?

- Hypothesis: higher densities of predator species in OR=increased compensatory predation

- How do recruitment and colonization dynamics vary from SoCal to Oregon over the course of ~16 months?

# Products of this class

- Work through vignettes in R package lavaan *(and visualize with semPlot)*
- Build an SEM for SPITFIRE- conceptual framework
- Stretch goal: use SP SEM to generate a dataset that, when model is fitted, returns the same parameter estimates used to generate the dataset

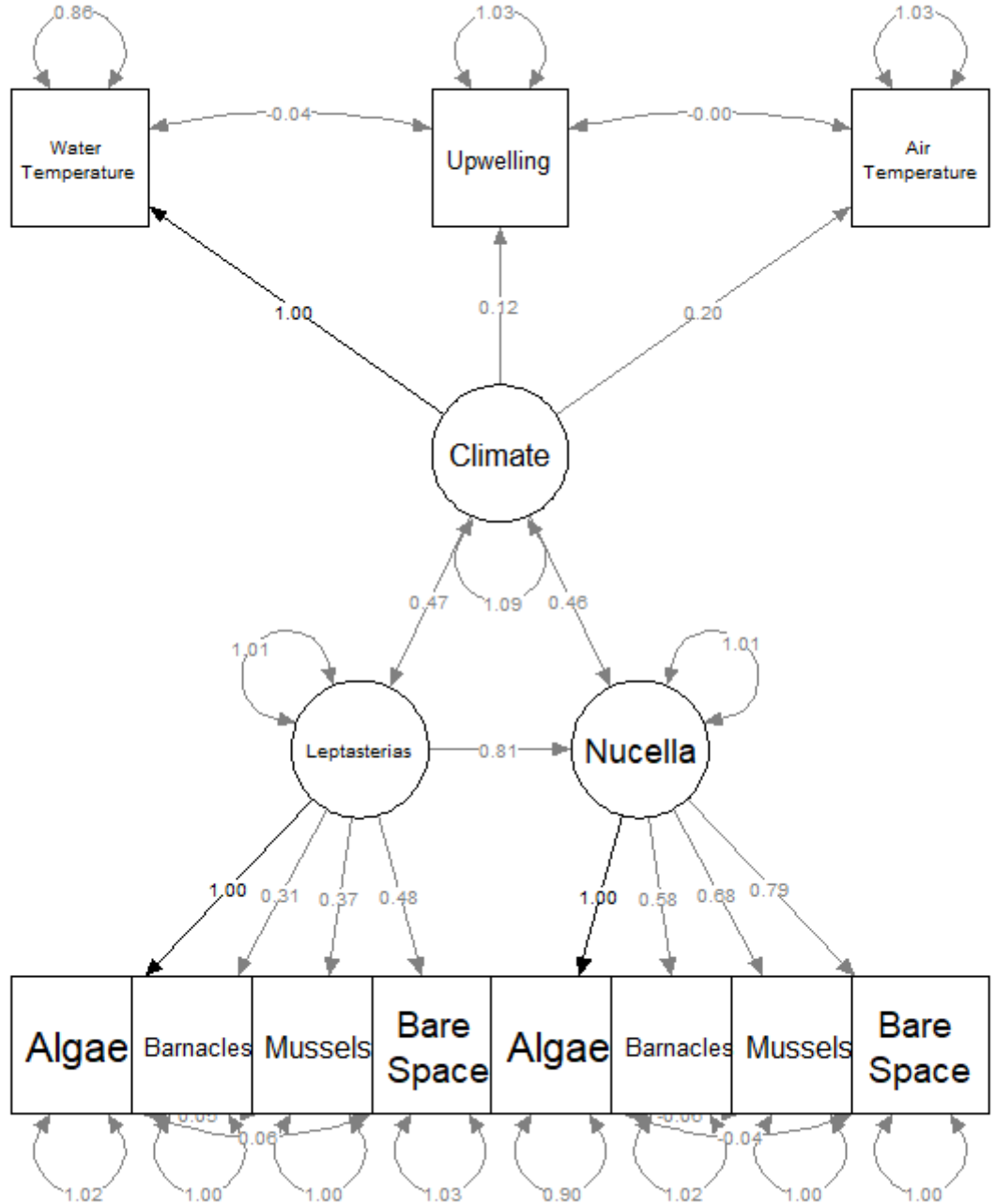


# Can compensatory predation by *Nucella ostrina* and *Leptasterias spp.* prevent downward spread of mussels into the low zone?

- What is the relative strength of predation for each predator species on four functional groups of prey?

- Effects of environment (water temperature, air temperature, upwelling index) on predators

# SPITFIRE structural equation model



# What was involved in getting to the model

- Working through Lavaan vignettes
- Reading/research- application of SEM in biological systems, how SEM works
- Troubleshooting model parameterization + fitting; drawing tons of conceptual models

# Workflow

- Part of workflow is currently missing: don’t have dataset in hand
- Data simulation + model parameterization is one script; easily reproducible
- “troubleshooting” branch for testing data simulation functions; main branch has vignettes + models

# Ongoing work

1. Finish data processing
2. Assess model fit to my dataset
3. Make changes as needed- “model generating”
4. Profit

# Questions?

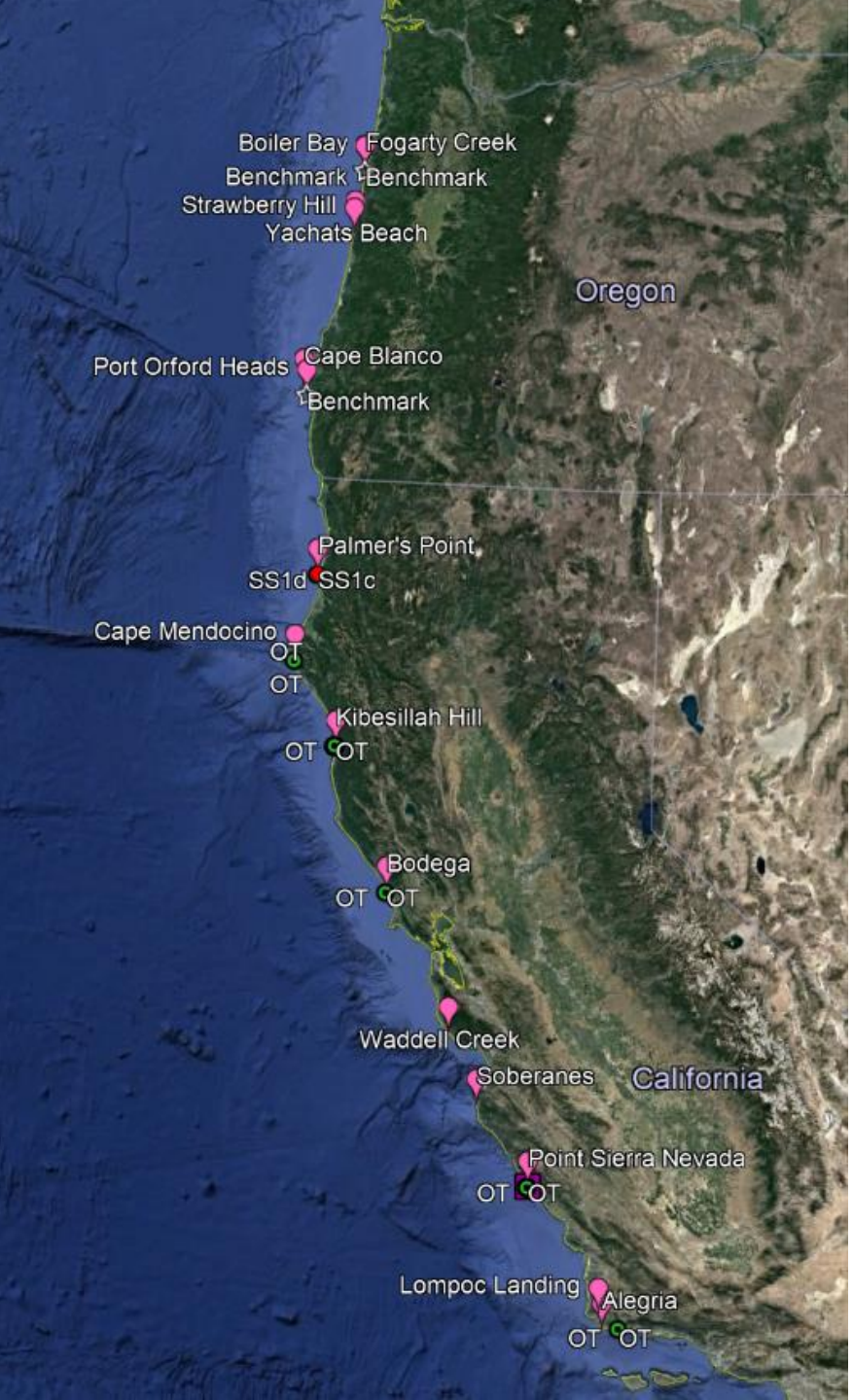
# Stretch goal

- Developing a theoretical SEM that's good enough to simulate data

- Can use to assess predictive capacity of the model once I have fit it to my actual data + ground truth mechanisms

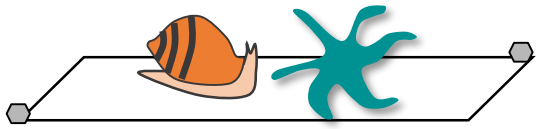
# Desired end result

- Workflow for example previously described
- Drawn version of my actual model
- Goal is to have a flexible workflow that I can modify to run my data once I have it



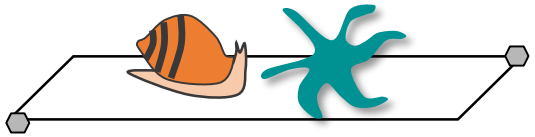

# Methods

- 2 plots, 1 fence, 4 cages per site
  - OR: Nucella only, Nucella and Leptasterias, Leptasterias only, no preds (control)
  - CA: Nucella only, no preds (control)
- 15x15 cm cages deployed ~1m under lower limit of mussel bed
- Cleared at experiment start (May 2018)
- Stocked w/preds (site specific density) once prey had recruited
  - OR/NorCal: July 2018
  - CenCal: September 2018 (low recruitment)



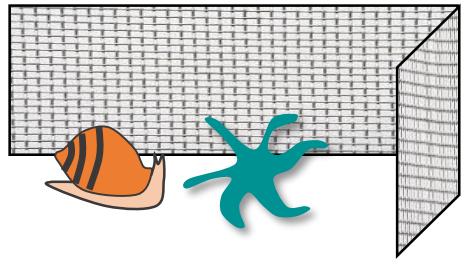
Recruitment plot (cleared ~monthly)

+ Nucella ostrina + Leptasterias



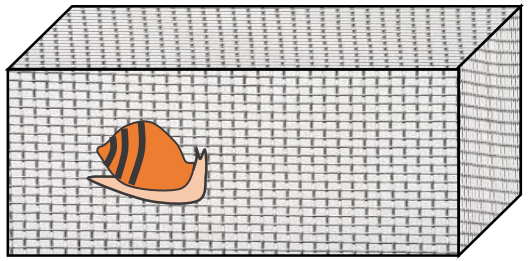
Colonization plot (cleared once)

+ Nucella + Leptasterias



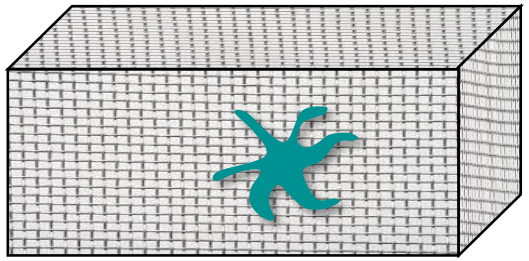
Colonization fence (Cage Control)

+ Nucella + Leptasterias



Nucella only

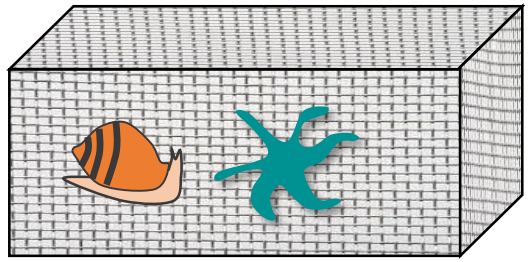
+ Nucella - Leptasterias



Leptasterias only

- Nucella + Leptasterias

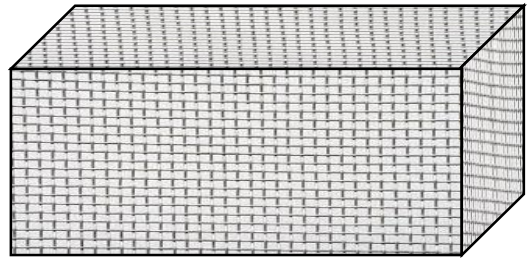
OR only



Both predators

+ Nucella + Leptasterias

OR only



Predator exclusion

- Nucella - Leptasterias

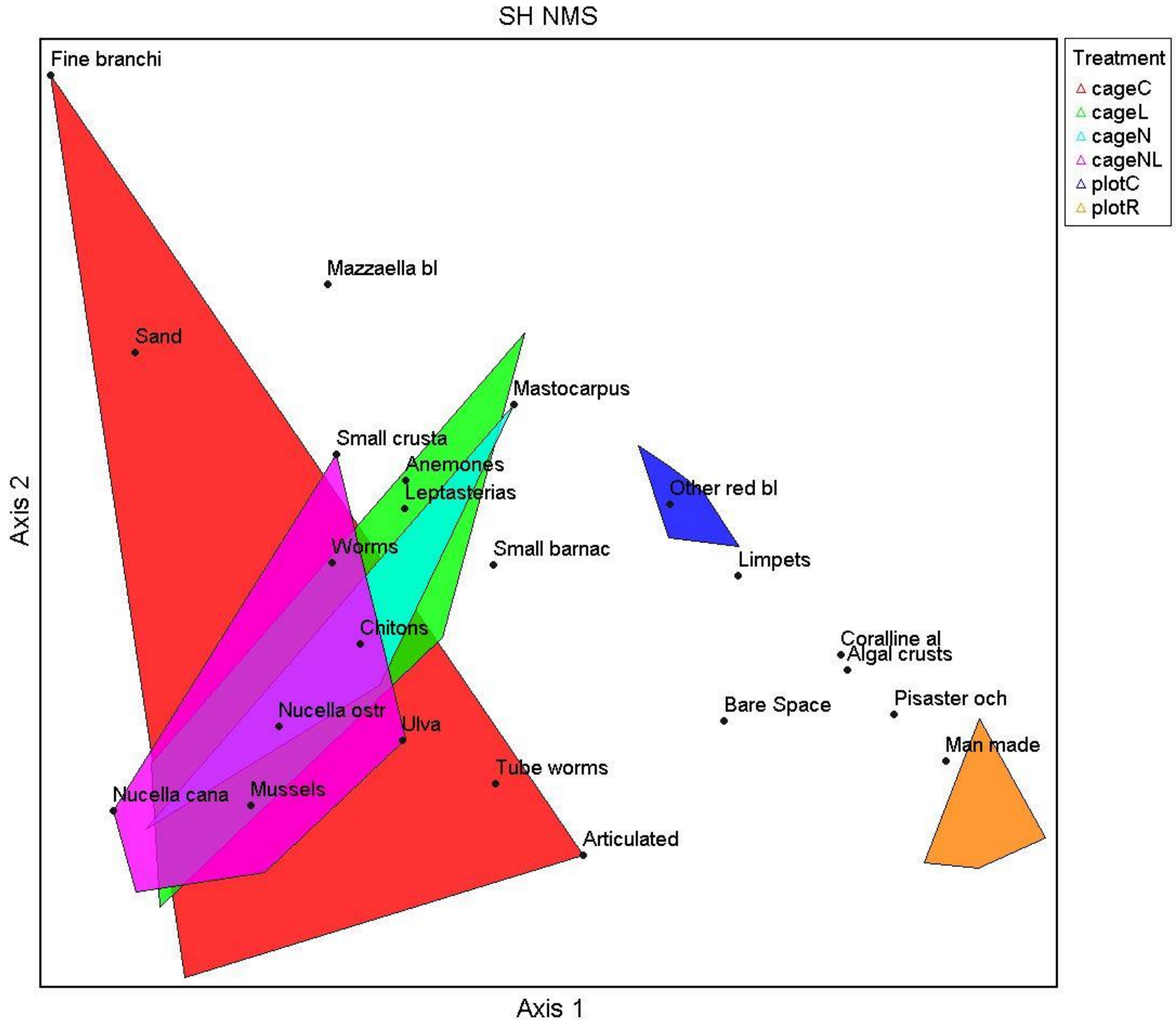
# Overarching goals- did I achieve them?

- Build a Structural Equation Model (SEM) – multivariate method that facilitates investigation of direct and indirect interactions

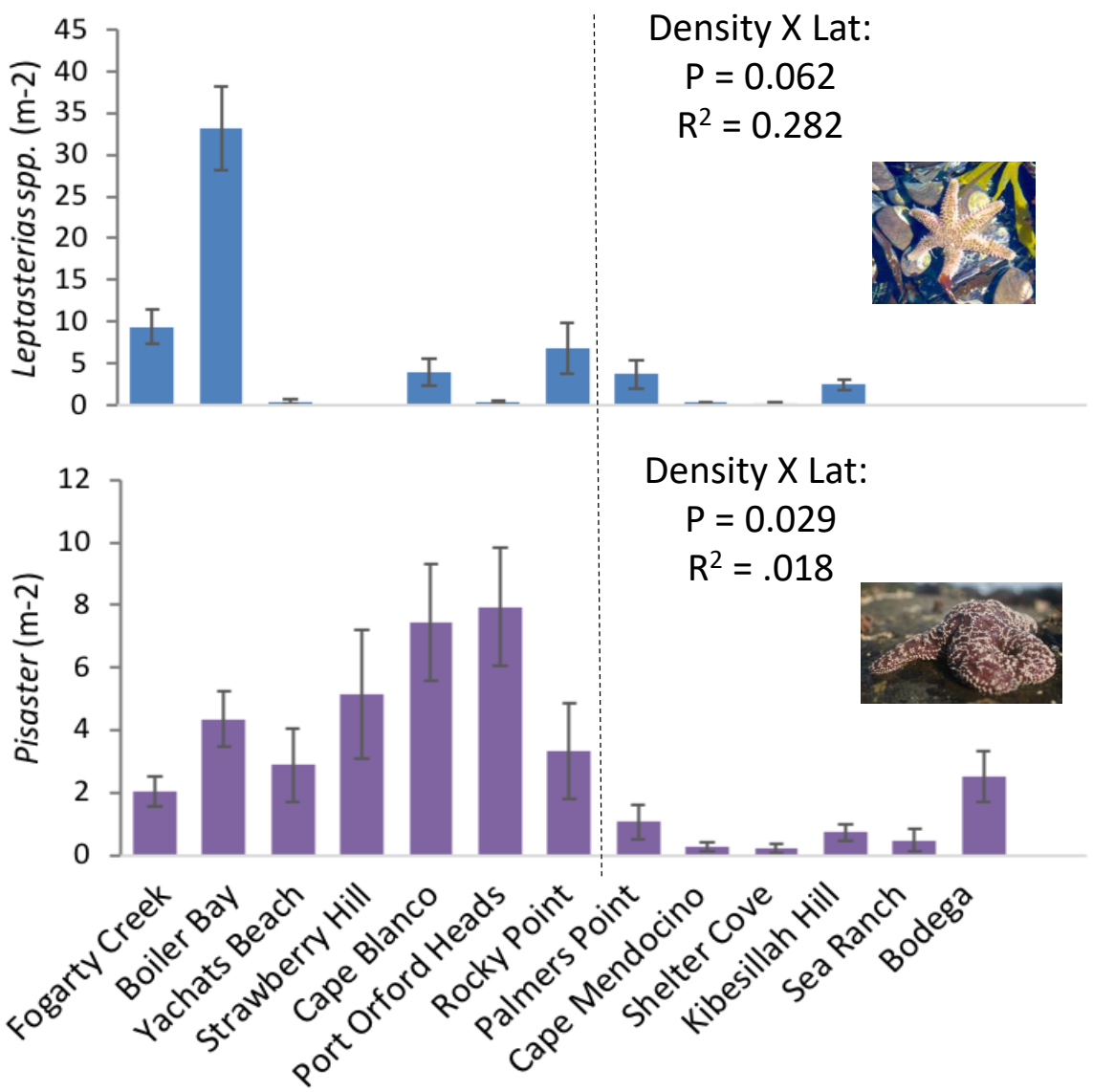
- Investigate mechanisms behind variation in interaction strengths across a wide biogeographic gradient

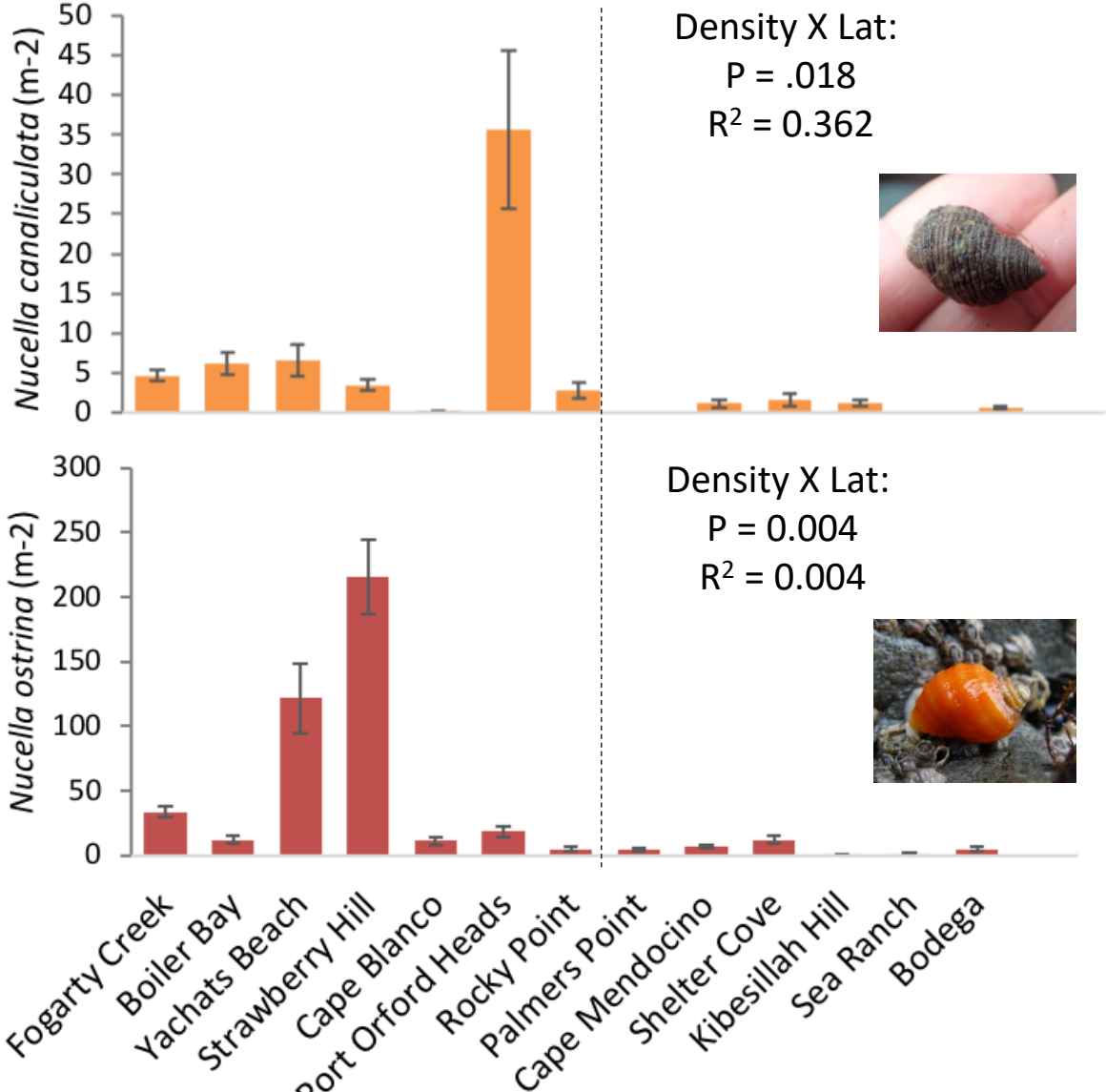
- Increasing understanding of mechanisms shaping community structure -> increased predictive capacity re: community-level response to climate change


Fisher Scientific
Cat. No. 09-016
CENTIMETERS
INCHES
PRINTED IN U.S.A.


SH NMS
Fine branchi
Mazzaella bl
Sand
Mastocarpus
Small crusta
Anemones
Leptasterias
Other red bl
Worms
Small barnac
Limpets
Chitons
Coralline al
Algal crusts
Nucella ostr
Ulva
Bare Space
Pisaster och
Man made
Tube worms
Nucella cana
Mussels
Articulated
Axis 2
Axis 1
Treatment
cageC
cageL
cageN
cageNL
plotC
plotR

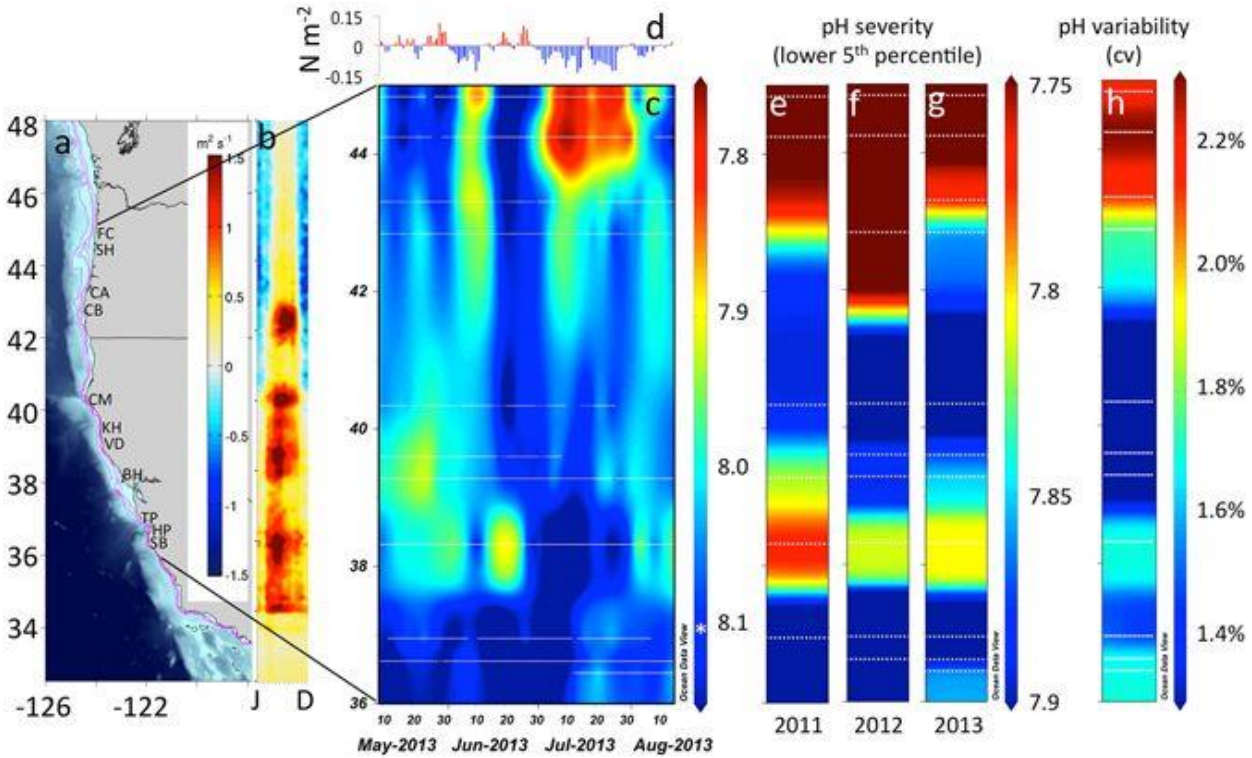
# Predator Densities

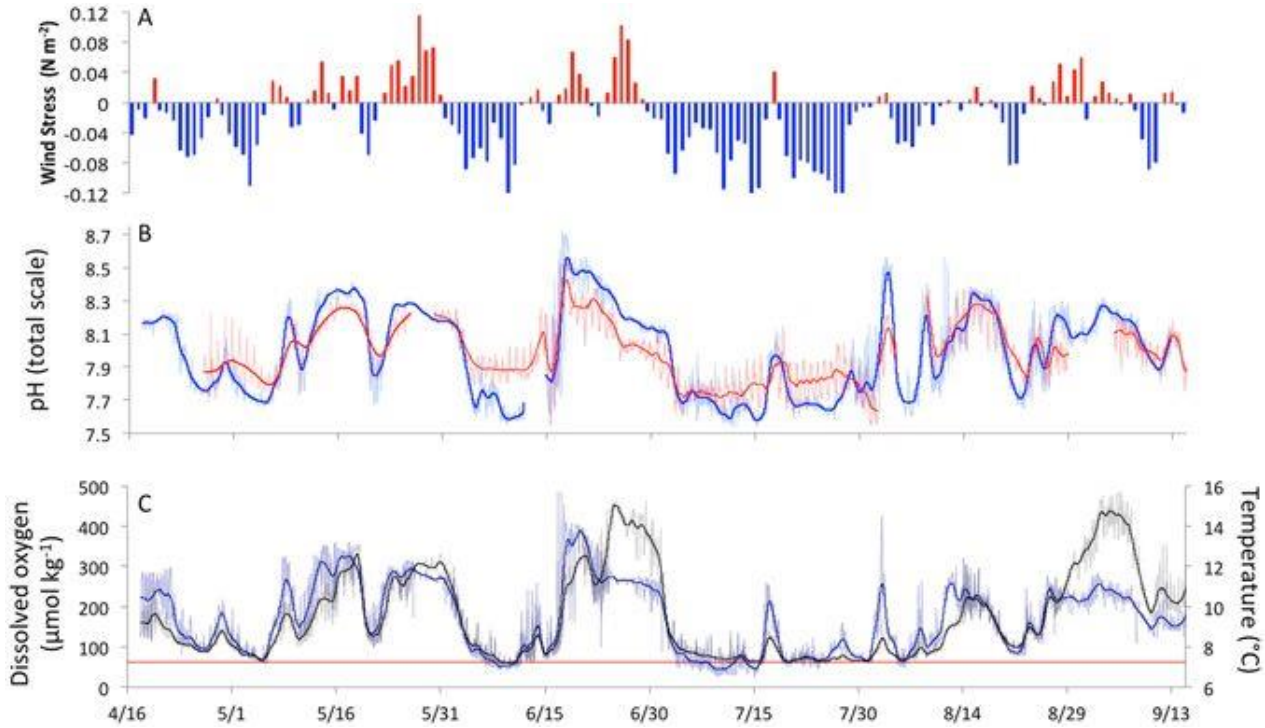


# The system is both spatially variable

# …and temporally variable




Chan et. al. 2017 *Sci Reports*