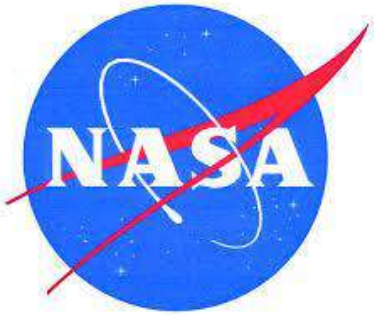


BOEM
Bureau of Ocean Energy Management

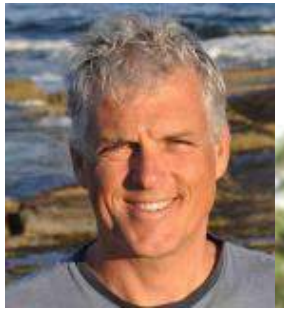
MARINE BIODIVERSITY OBSERVATION NETWORK

SANTA BARBARA CHANNEL

Marine Science Institute
University of California Santa Barbara

Who we are

Principal/Associate Investigators



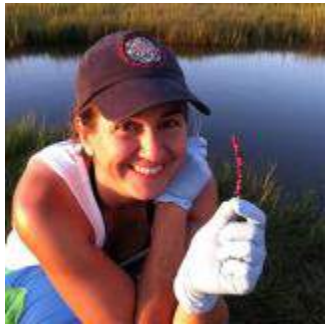

UCSB

Robert Miller, David Siegel, Craig Carlson, Daniel Reed, BS Manjunath, Deborah Iglesias-Rodriguez, Doug McCauley, Milton Love



Florida State University

Andrew Rassweiler



USGS

Kevin Lafferty

UCSD - SIO

John Hildebrand

NOAA – NMFS SWFSC

Andrew Thompson

Partners

Plumes and Blooms (NASA)

BOEM Pacific Region

Santa Barbara Coastal LTER (NSF)

Channel Islands National Marine Sanctuary

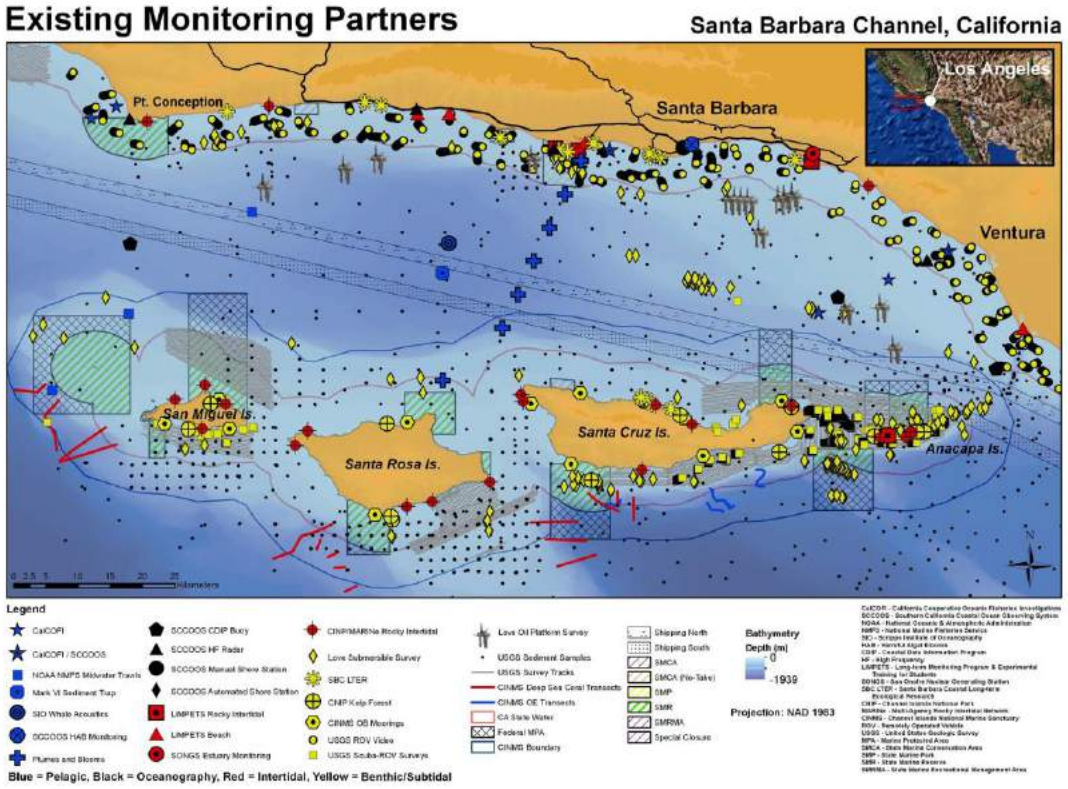
Southern California Coastal Water Research Project

Southern California Coastal Ocean Observing System (SCCOOS)

Channel Islands National Park

Gray Whales Count

CalCOFI



MARINE BIODIVERSITY OBSERVATION NETWORK
SANTA BARBARA CHANNEL

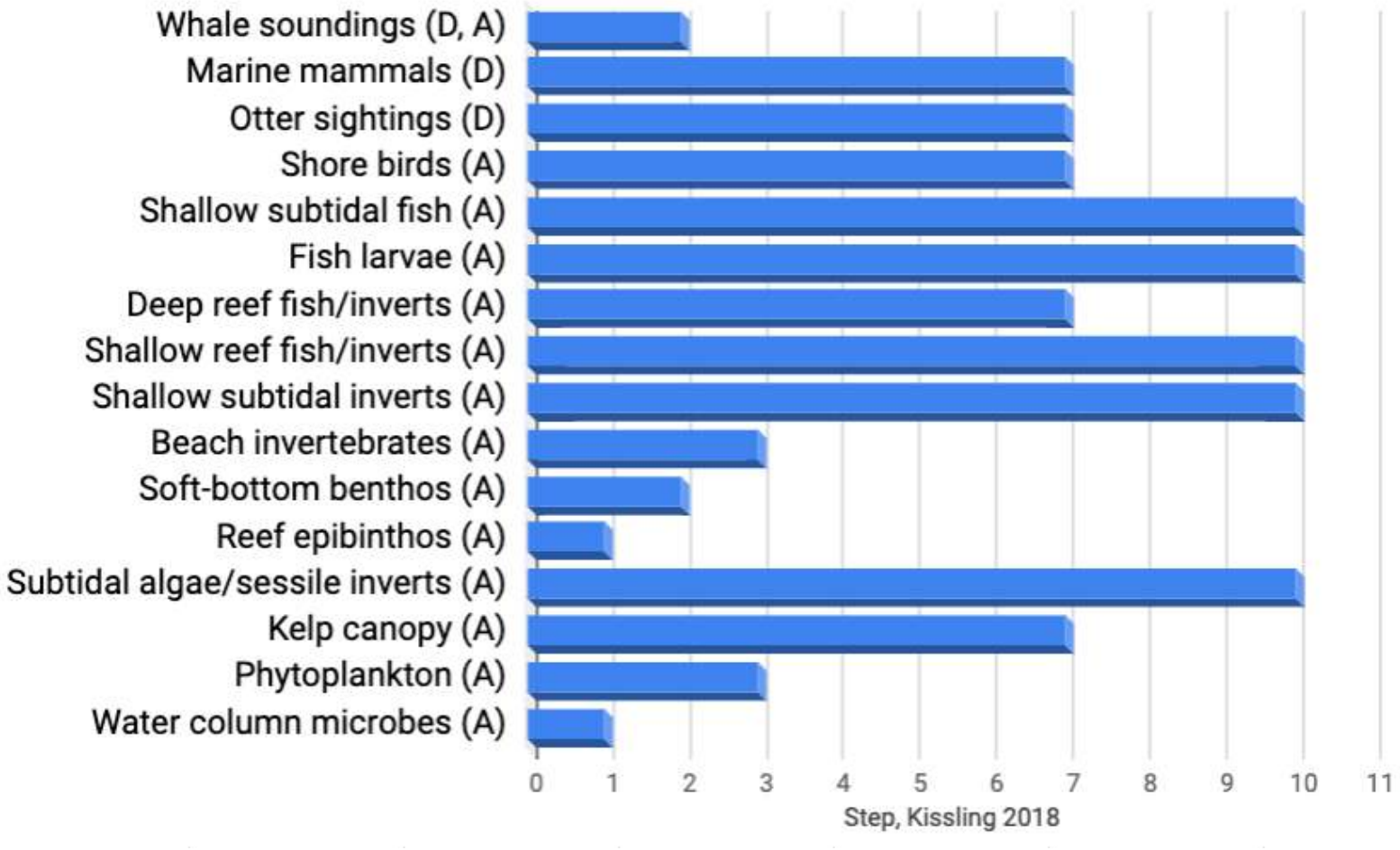
MBON Prototype:

1. Provide data to inform managers and society about patterns of biodiversity across taxa, space, and time
    - *Integrate existing data*
    - *Develop new methods & products*

2. Build a framework to facilitate MBON development under diverse circumstances

GEO BON

Progress, by Taxonomic Group



Measurement Class:

D: Occurrence (EBV “distribution”)

A: abundance or density (EBV “abundance”)

Focus on time series

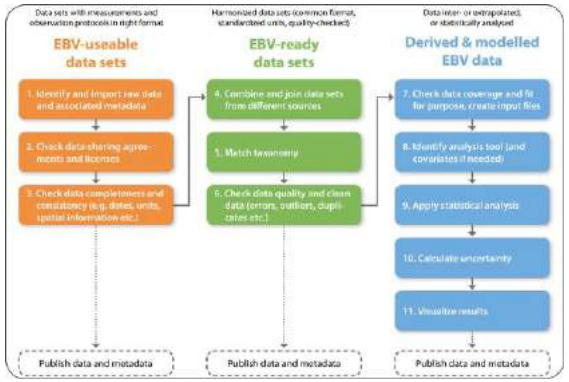
oldest: 35 yrs

youngest: 18 yrs

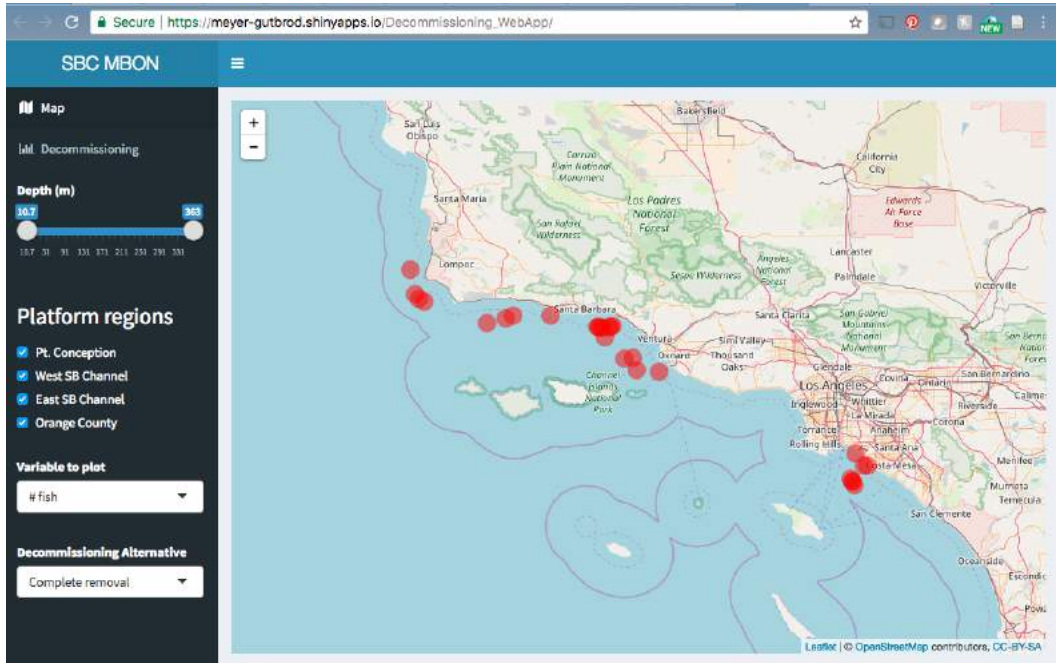
14 Data packages published

stable, immutable with DOI

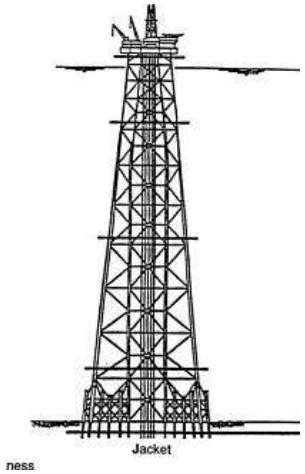
Spanning taxa from microbes to whales



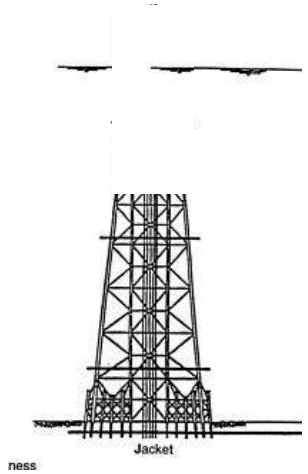
Net Environmental Benefit Analysis of offshore platform decommissioning alternatives



Leave in place



Partial Removal



Total Removal

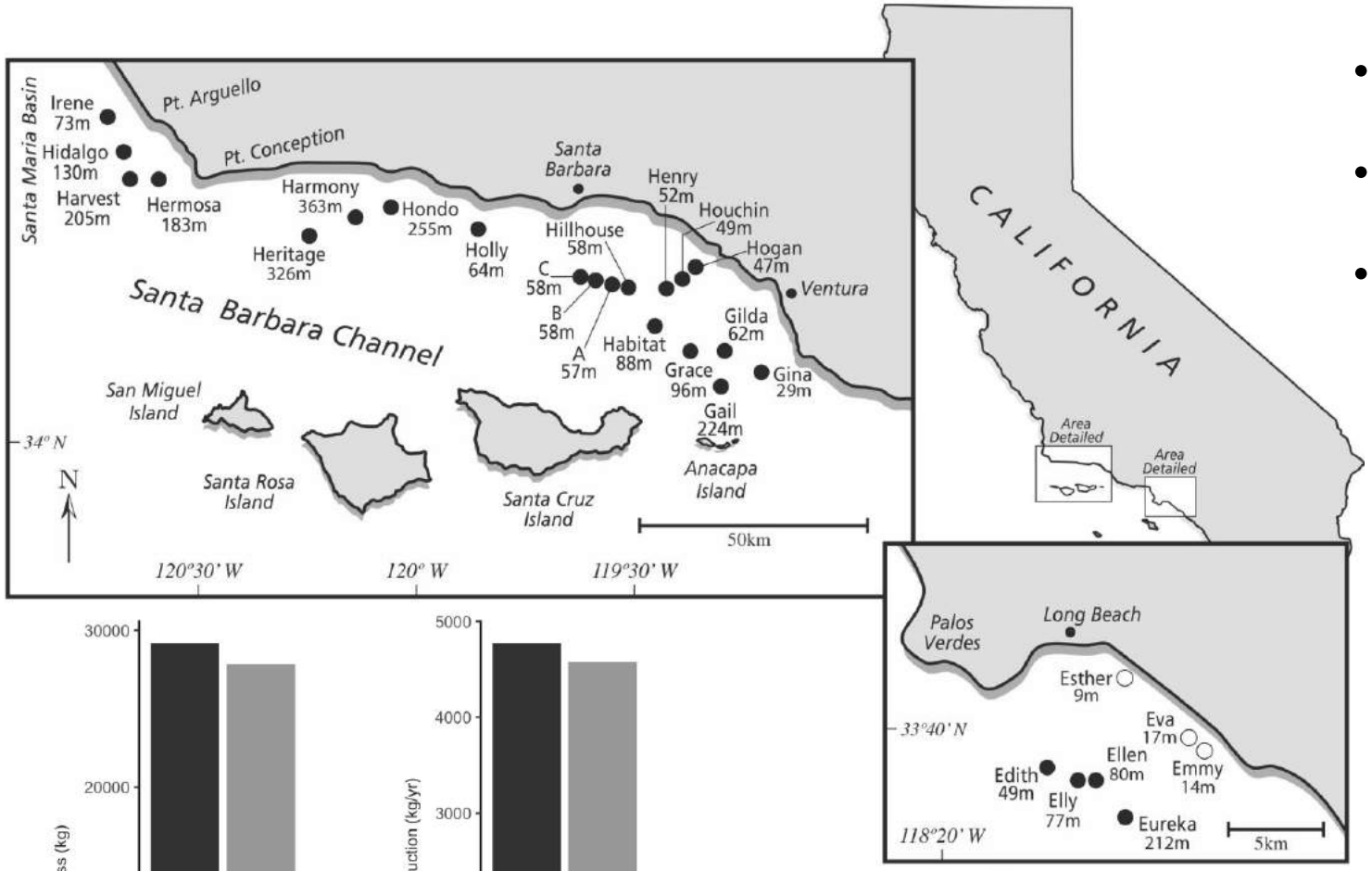
Users:

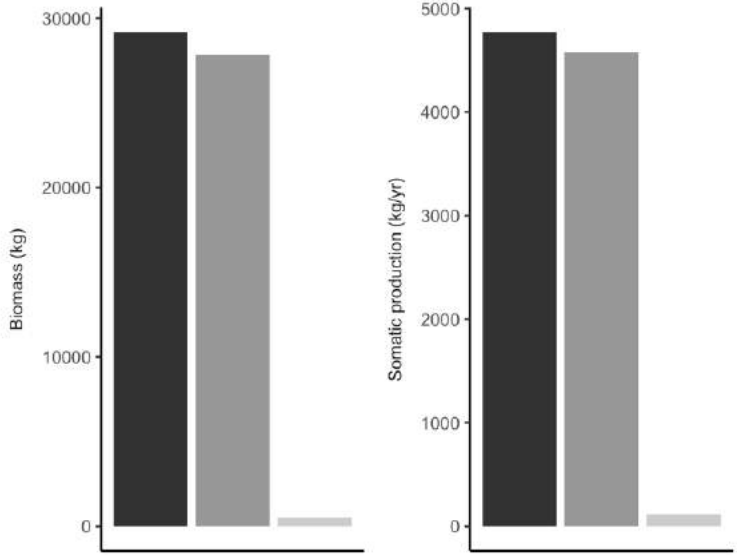
- US Bureau of Ocean Energy Management
- CA State Lands Commission
- Petroleum industry (e.g. Exxon, Chevron, Venoco)

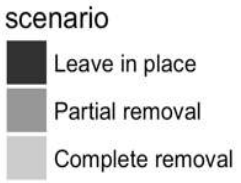
https://meyer-gutbrod.shinyapps.io/Decommissioning_WebApp/

Meyer-Gutbrod et al., *in prep*

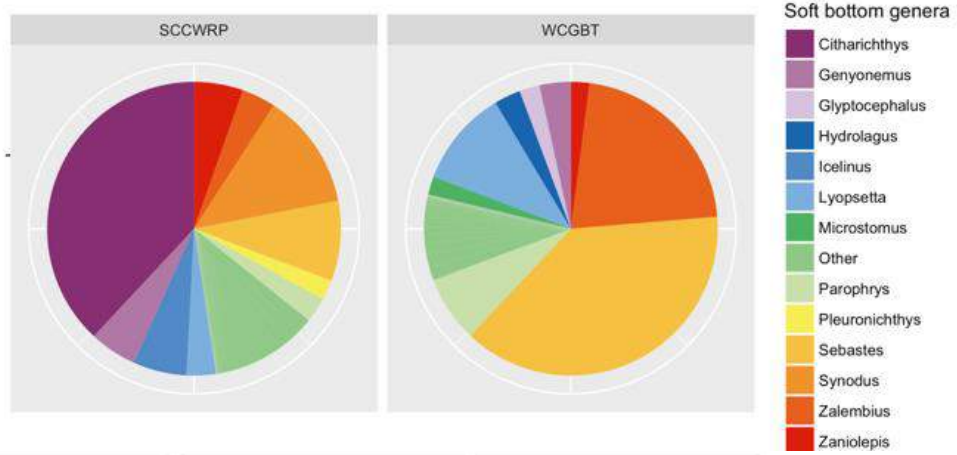
Comparing platform decommissioning scenarios

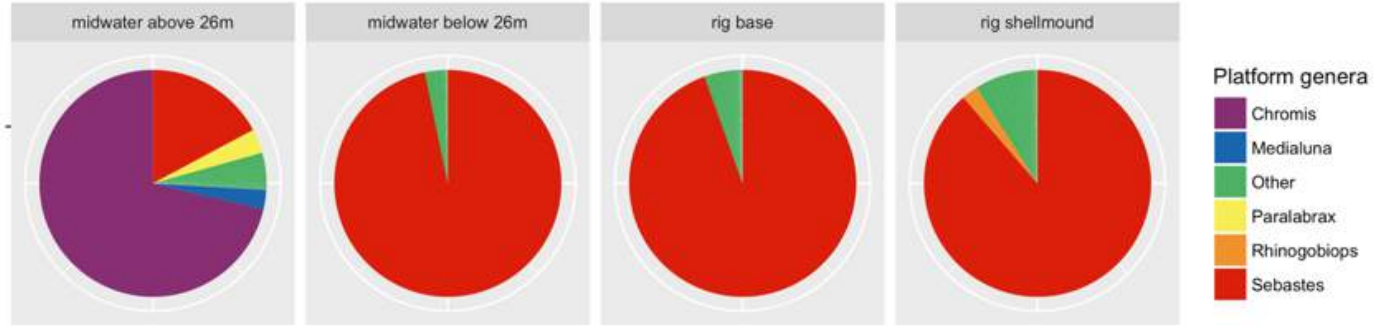






- Platform structures are dominated by rockfish
- If removed, sites will return to mud inhabited by soft bottom species such as flatfish
- Removal of 24 platforms will result in the loss of 28,700 kg of fish biomass, and an additional loss of 4,700 kg of annual fish production





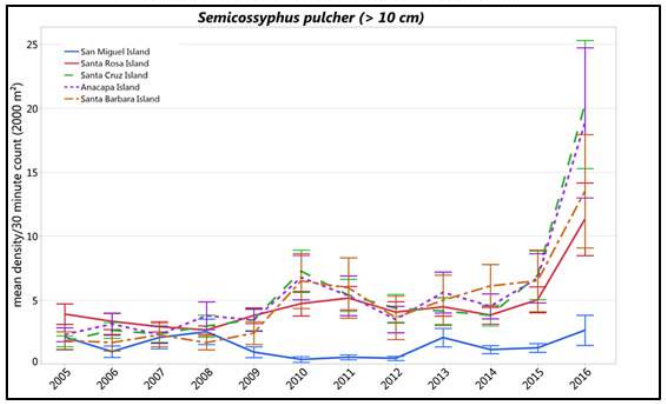
Meyer-Gutbrod et al. *In prep*.

n of Condition Reports

California Sheephead Abundance in CINMS

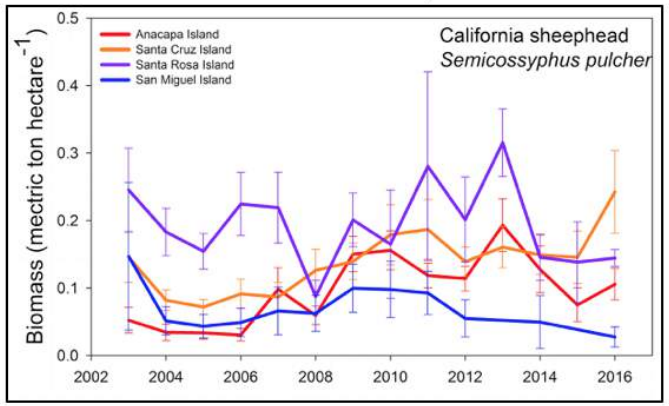
The California sheephead (*Semicossyphus pulcher*) is a large and beautiful fish that plays an important role in the food web of kelp forests and rocky reefs in southern California. Sheephead are also a popular sport fish for recreational and commercial fishing and a draw for SCUBA divers.

Abundance of California Sheephead

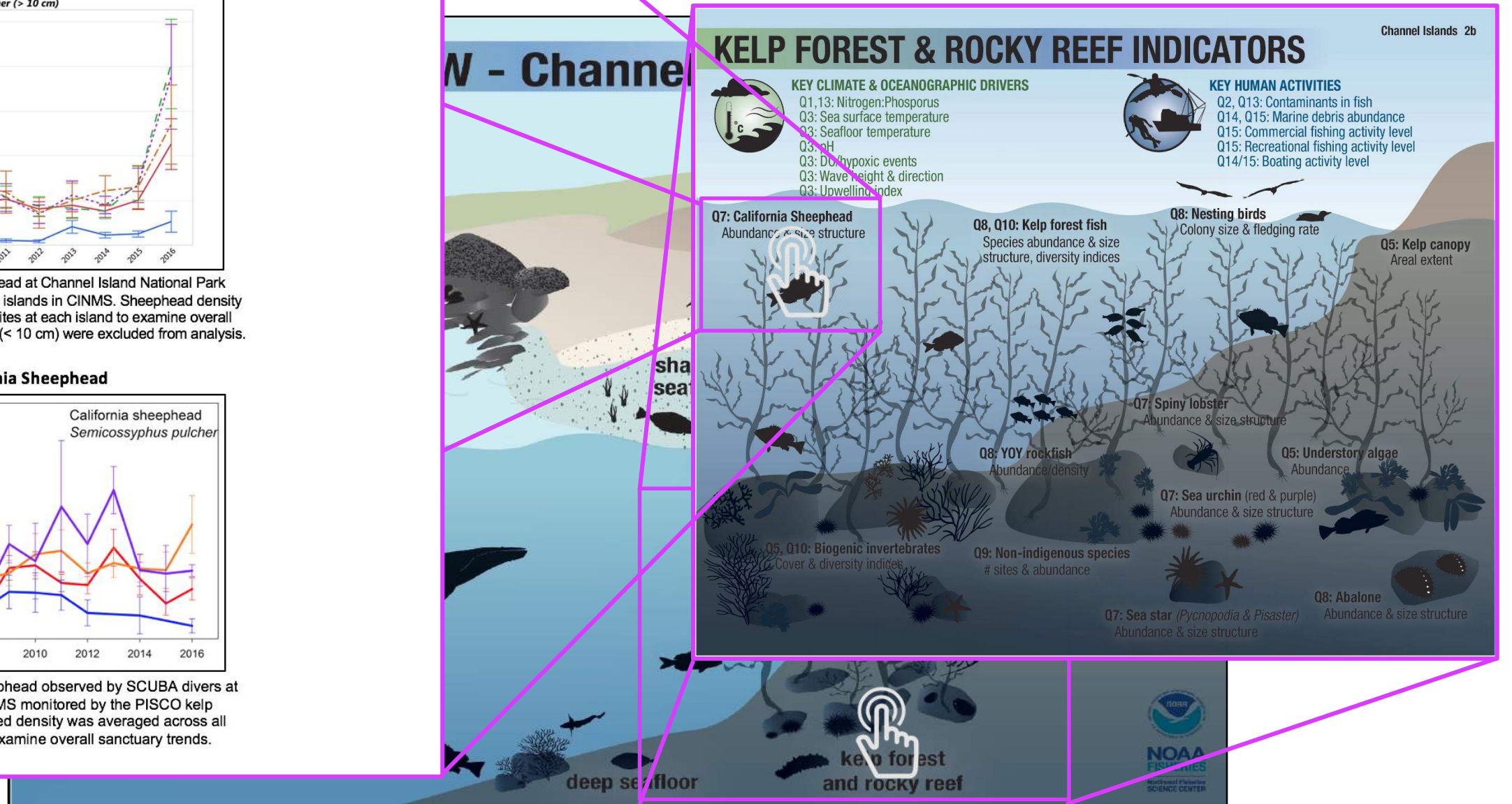


Average density of California sheephead at Channel Island National Park kelp forest monitoring sites at the five islands in CINMS. Sheephead density was averaged across all monitoring sites at each island to examine overall sanctuary trends. Note that juveniles (< 10 cm) were excluded from analysis.

Abundance of California Sheephead

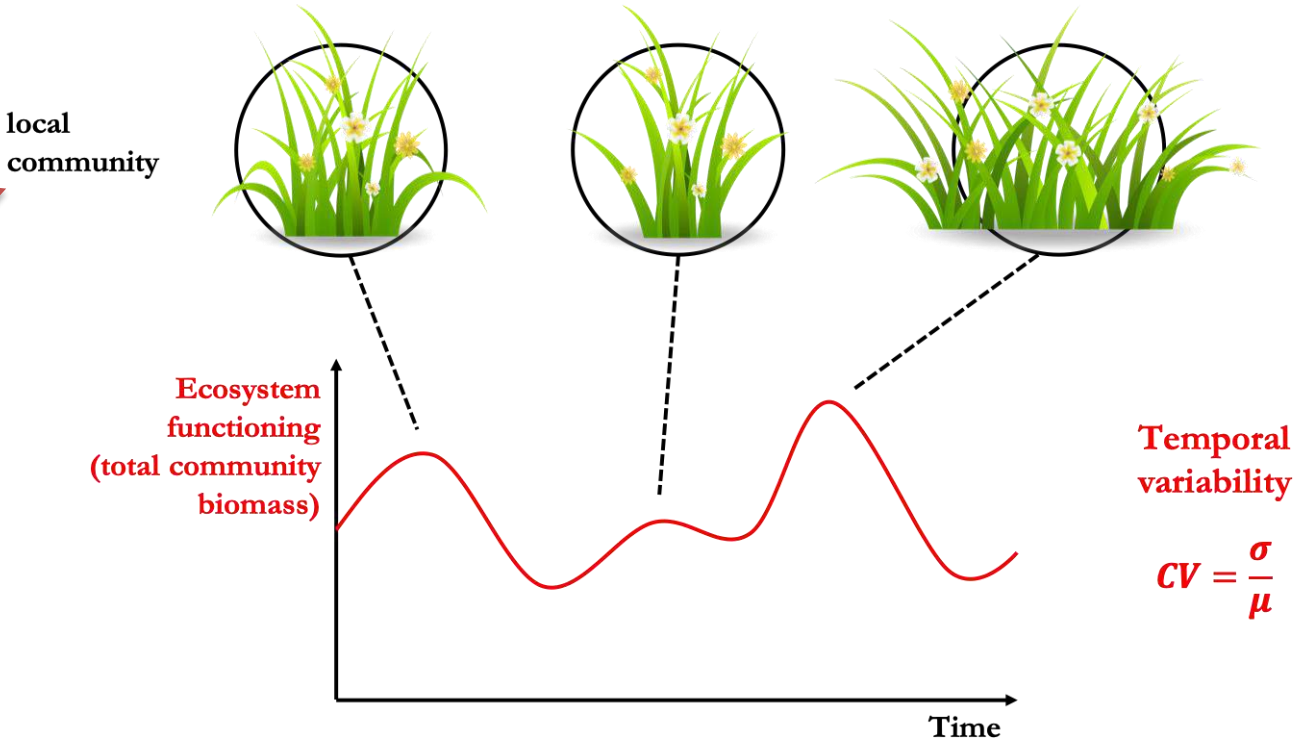


Average density of California sheephead observed by SCUBA divers at 14 sites across four islands in CINMS monitored by the PISCO kelp forest monitoring program. Observed density was averaged across all monitoring sites at each island to examine overall sanctuary trends.



How does biodiversity affect ecosystem function and stability?

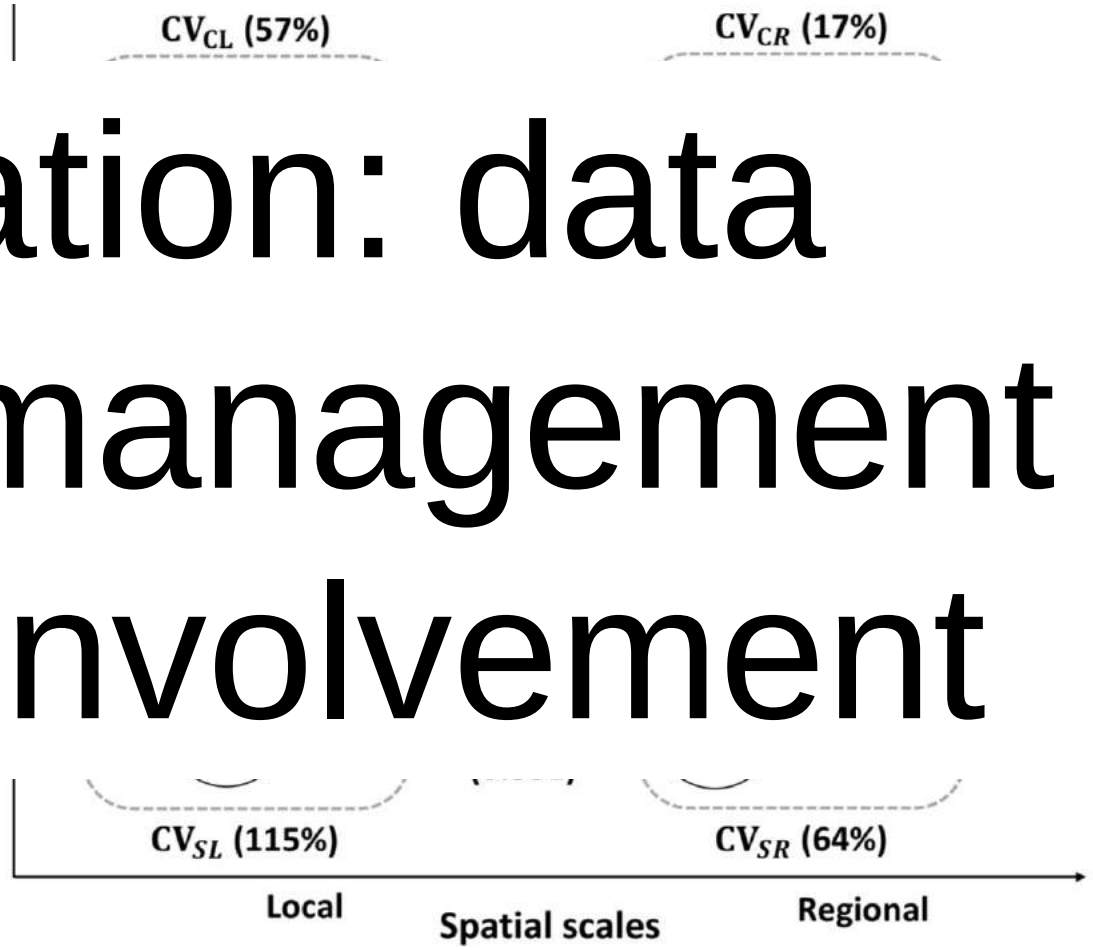
Understanding the factors that dampen variability of biomass production is a core concept of Ecology



However, most empirical and theoretical studies which have investigated ecological variability and its relation with biodiversity have focused on local scales

Species diversity begets stability

Real-world ecosystems are complex: from populations of single species to multi-species communities to

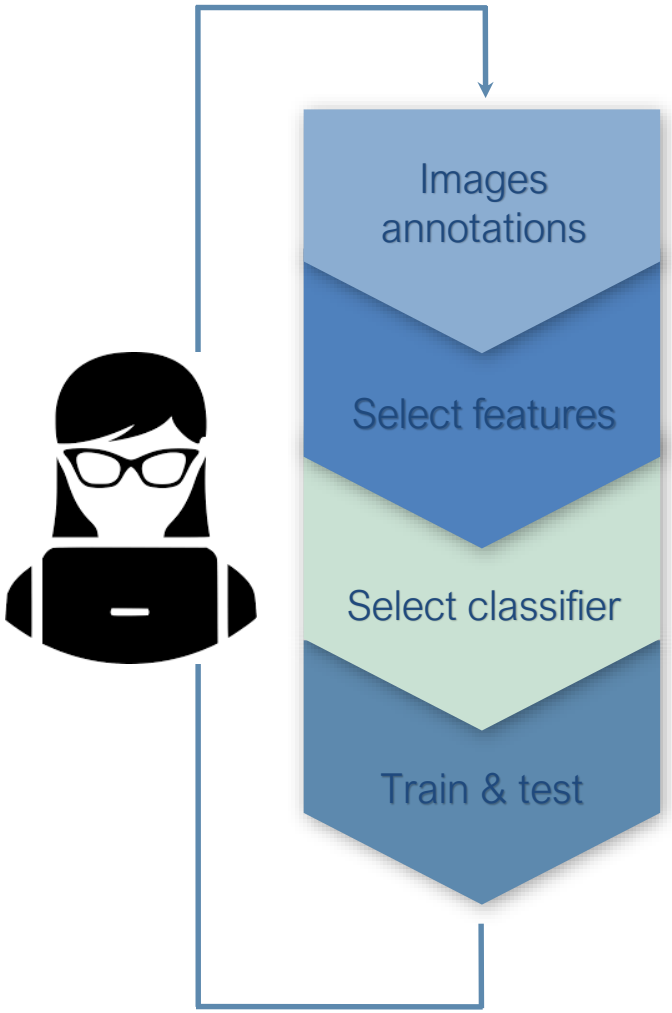


Recommendation: data integration and management needs science involvement

Lamy et al. 2019, *Ecology,* Wang et al. 2019*, Ecography*

New Products: Deep learning for image analysis

Typical machine learning



Engineer required throughout

Time consuming (months)

Only works on specific type of data

Deep learning

Benefits

- Generalizes to your data
- Fully automated - no feature selection
- High accuracy

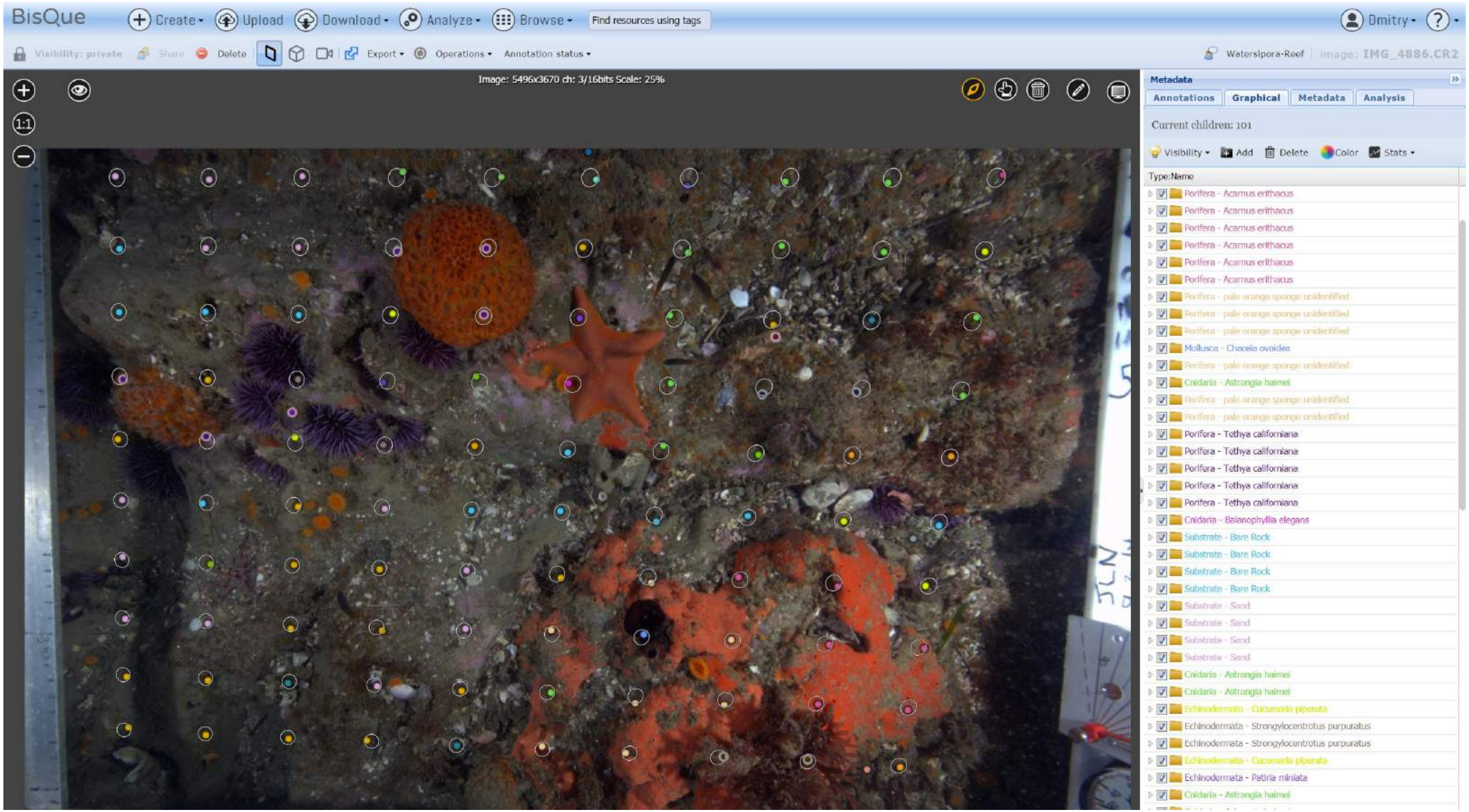
Leverages

- Scalable services
- Annotation system
- Cluster processing
- Fast classification on GPUs

BisQue | ViQi

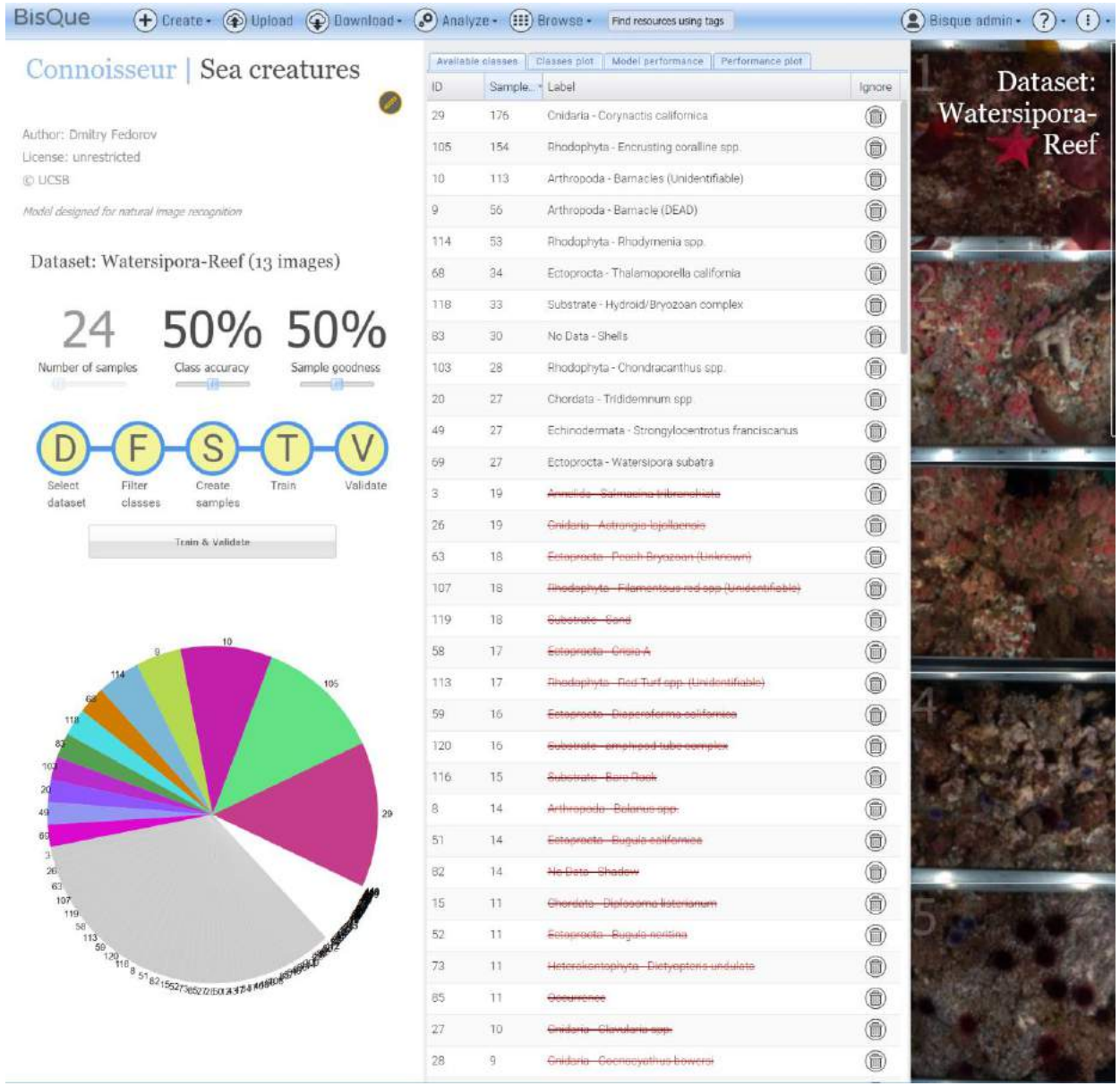
mage management & annotation

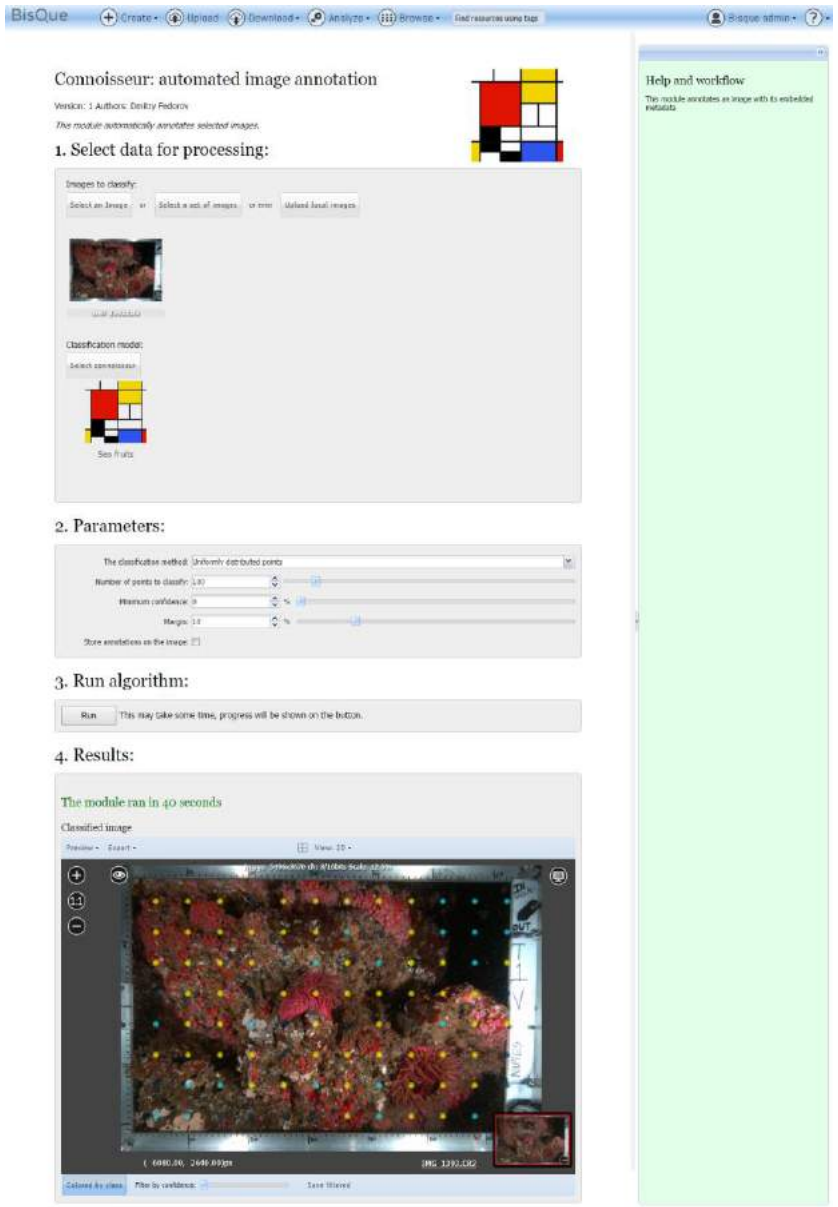
BisQue | ViQI



Model building & usage

BisQue | ViQI

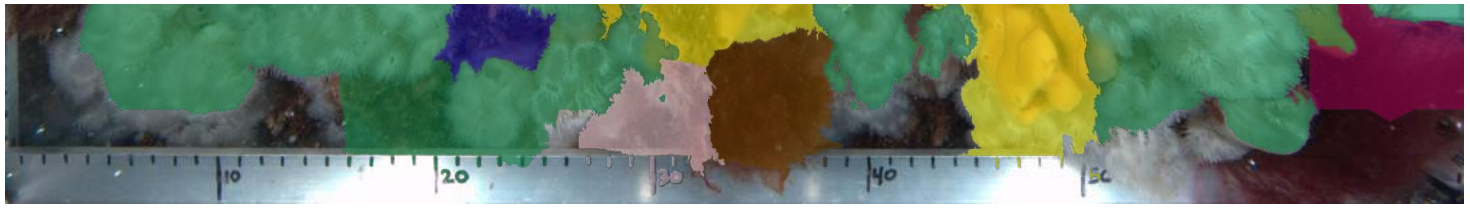


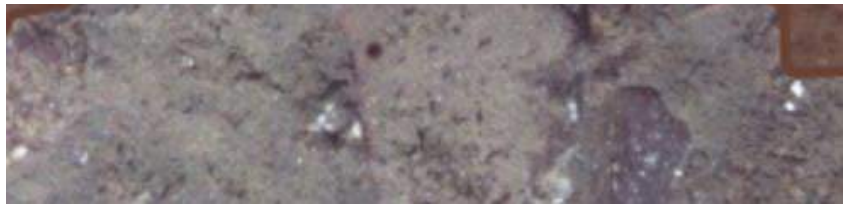


BisQue | ViQi

Identification & segmentation

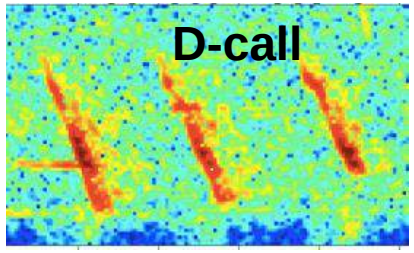
Recommendation: machine learning requires time but saves work in the long run



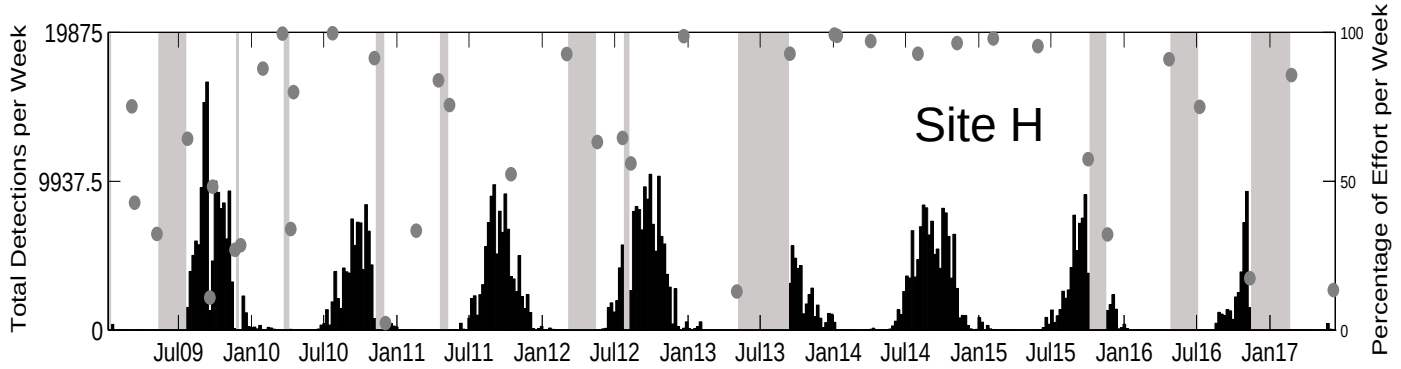


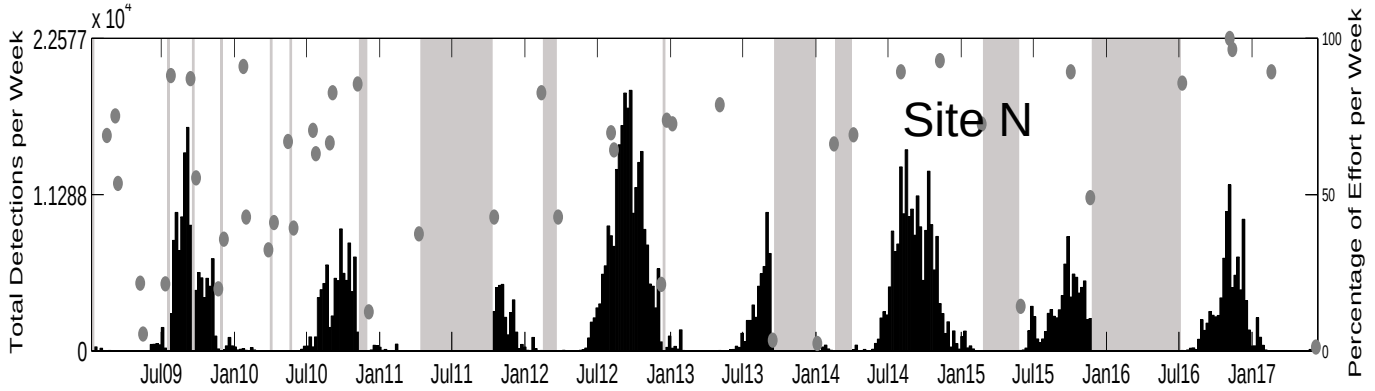
New Products: Acoustics

Acoustic Detection of Marine Mammals



Seasonal patterns of blue whale song

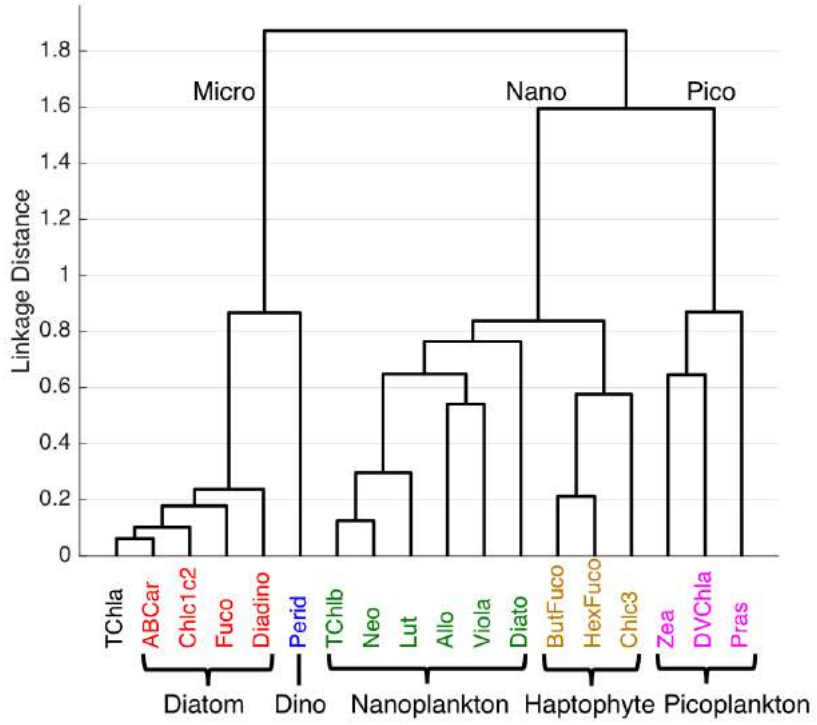




New Products: Remote Sensing

Phytoplankton functional diversity

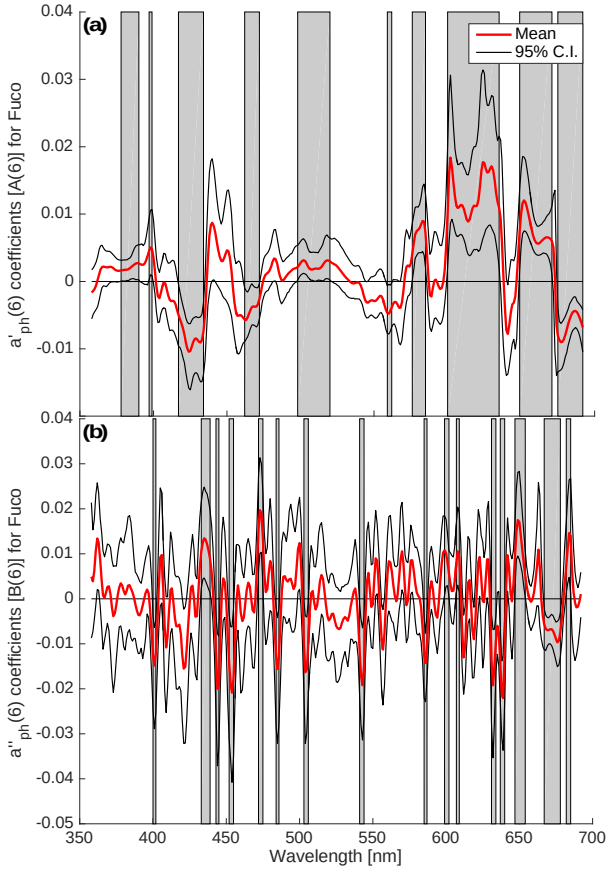
Phytoplankton pigment community clusters define five clusters



JOURNAL OF GEOPHYSICAL RESEARCH
Oceans
AN AGU JOURNAL

Catlett and Siegel, 2018.

Bio-optically modeled PFTs give us the links to PACE/ESBG



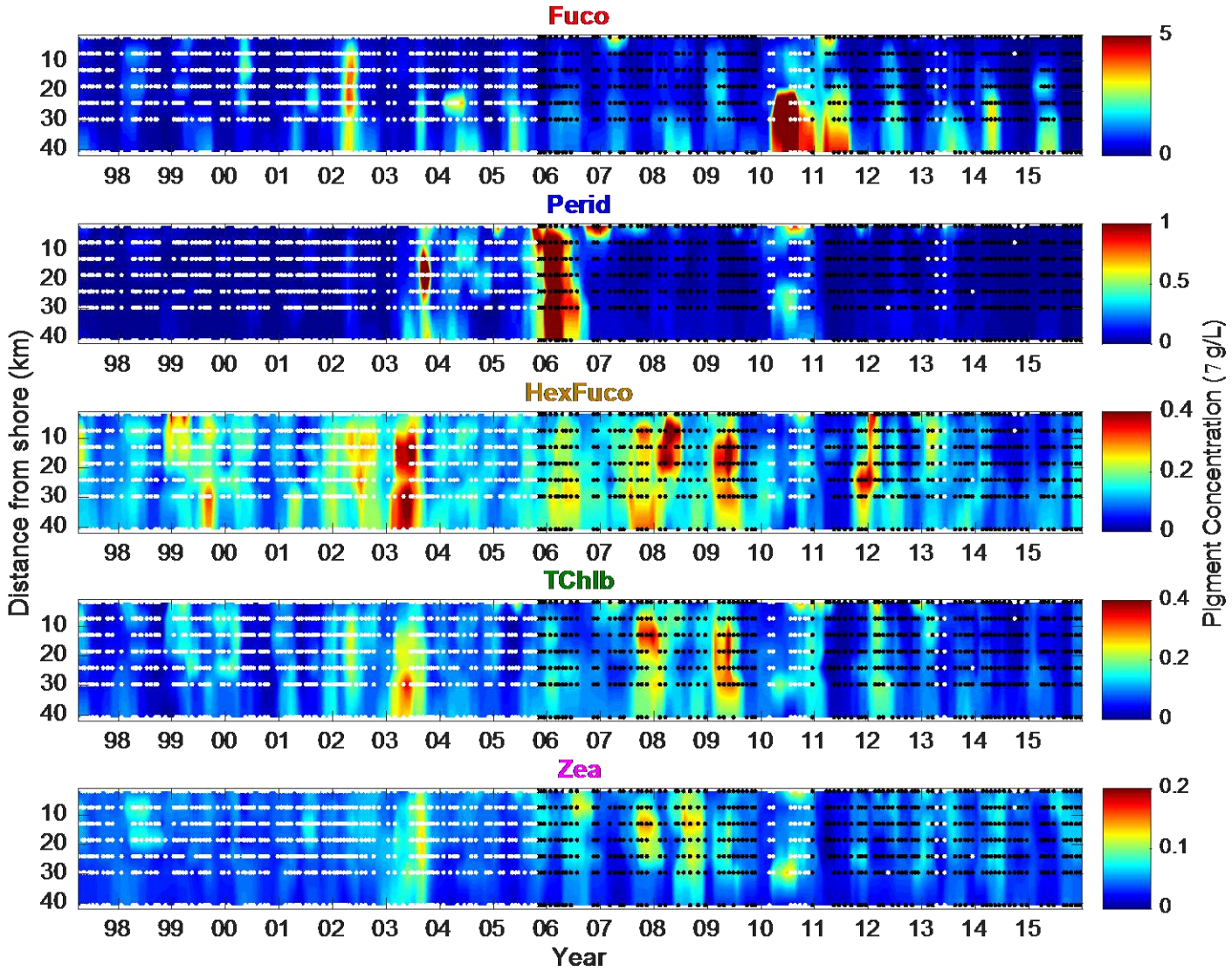
Prediction of fucoxanthin (diatom marker) from optical derivative spectra

Works well - $r^2 = 0.86$

Similar performance for other marker pigments'

Requires info from the entire spectrum

Bio-Optical Model Extends Biomarker Pigment Time Series

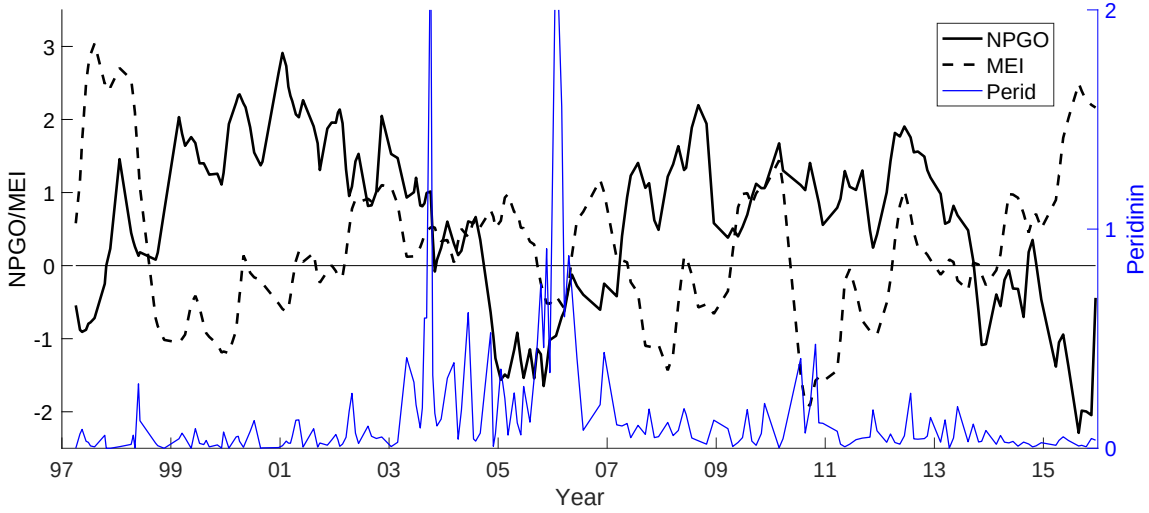


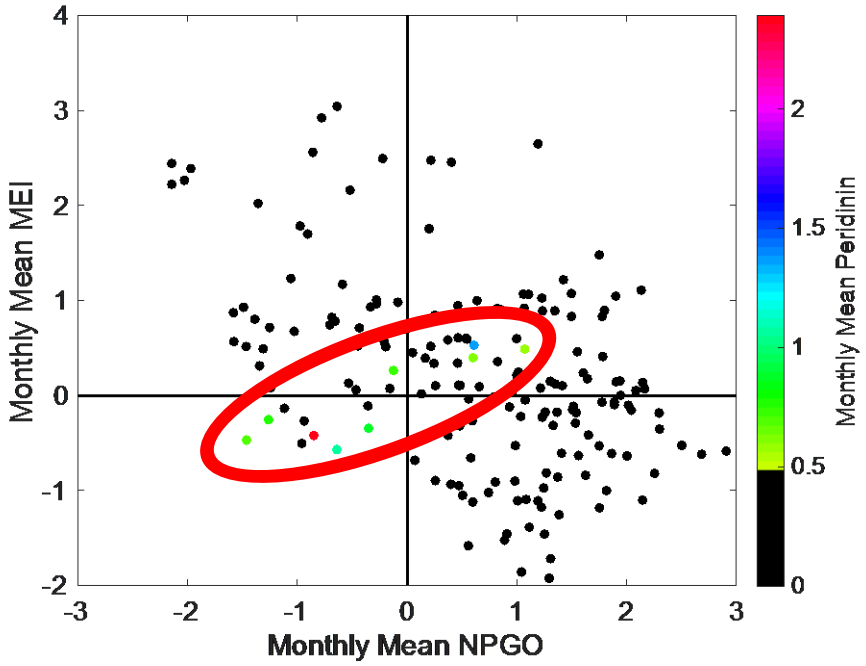
Model Retrievals	R^2
TChlb (green algae)	0.815
HexFuco (haptophytes)	0.733
Fuco (diatoms)	0.856
Perid (dinoflagellates)	0.887
Zea (picoplankton)	0.541
Pigment EOF Mode 1 (Early upwelling mixed bloom)	0.884
Pigment EOF Mode 2 (Diatoms vs. mixed nano-/pico-plankton)	0.852
Pigment EOF Mode 3 (Pico-plankton vs. haptophytes)	0.454
Pigment EOF Mode 4 (Dinoflagellates vs. mixed diatoms/haptophytes)	0.809

*Catlett et al., in prep.

PFTs and Climate

- Investigating PFT associations with climate 1997-2015
- SBC dinoflagellate blooms associated with low or negative NPGO + MEI
- Hypothesis: climate-driven variations in surface-ocean circulation drive variations in PFTs
  - Low/negative NPGO = weaker equatorward flows in Cal Current, dino-rich SoCal Bight waters can be transported North into SBC to seed blooms
  - Low/negative MEI = weak El Nino/La Nina provides favorable conditions for dino blooms

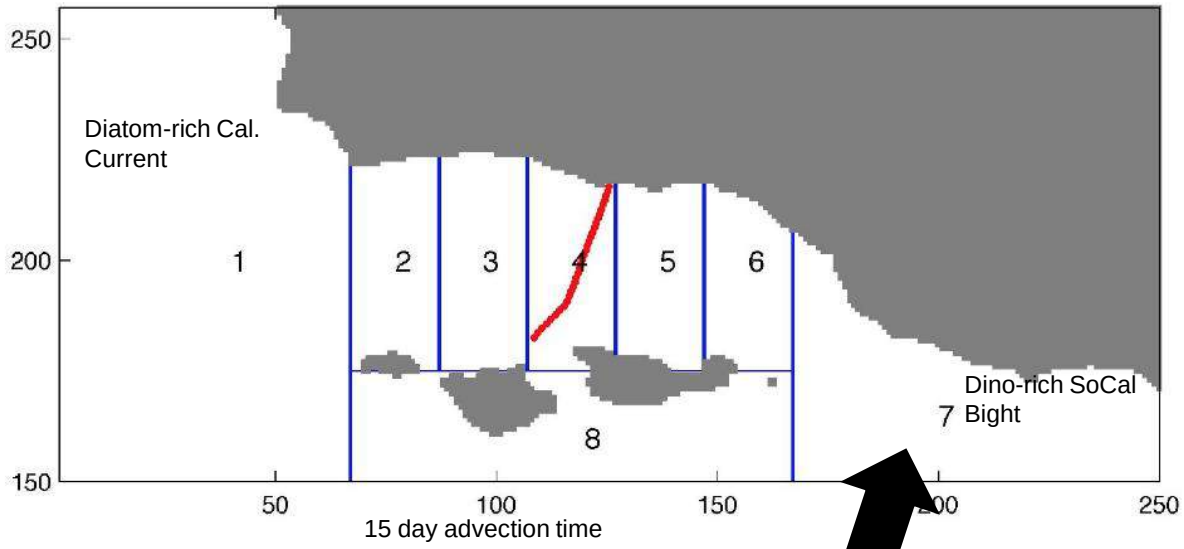


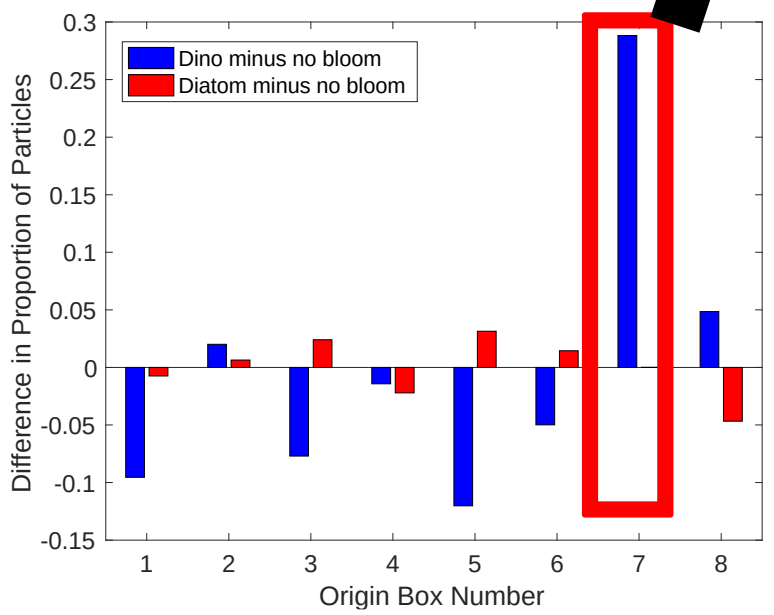


*Catlett et al. preliminary

PFTs and Surface Ocean Circulation

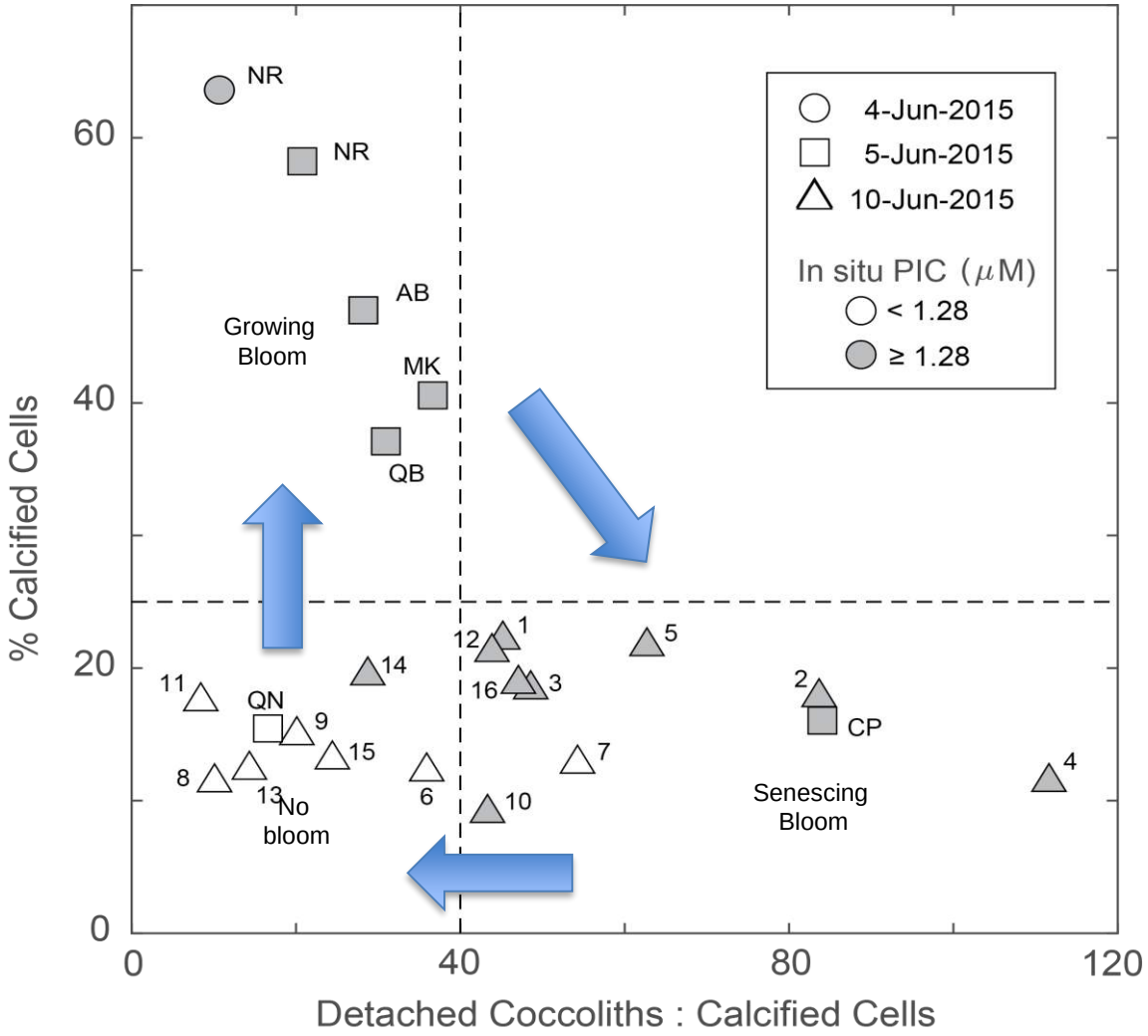
- ROMS particle trajectory modeling used to quantify water mass origins for each PnB cruise
- Particles released back in time from the PnB transect (red), count how many originated in each box (blue)
- ~30% increase in proportion of particles from Box 7 for dino blooms relative to diatom or no bloom
- (Climate-driven) surface ocean circulation may be important in biodiversity monitoring

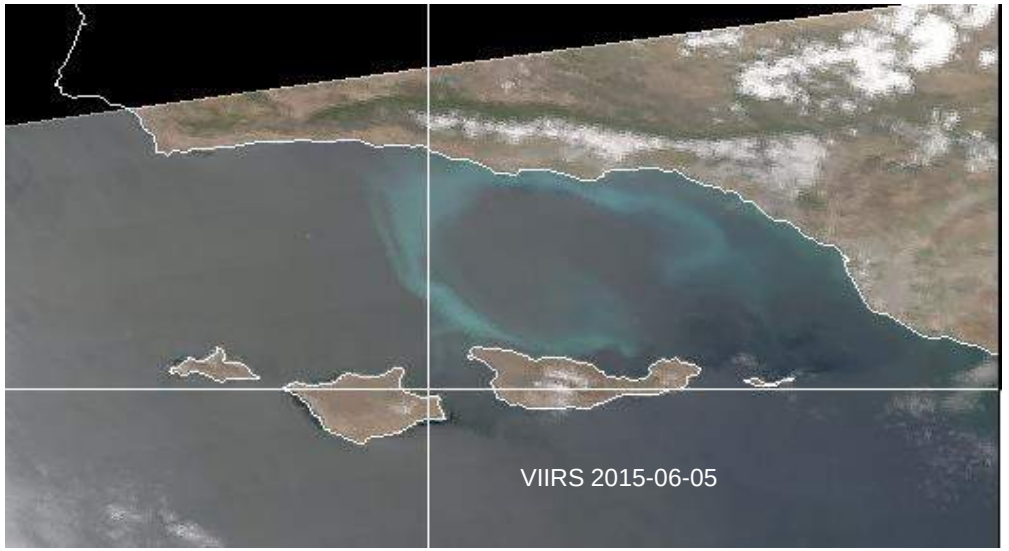


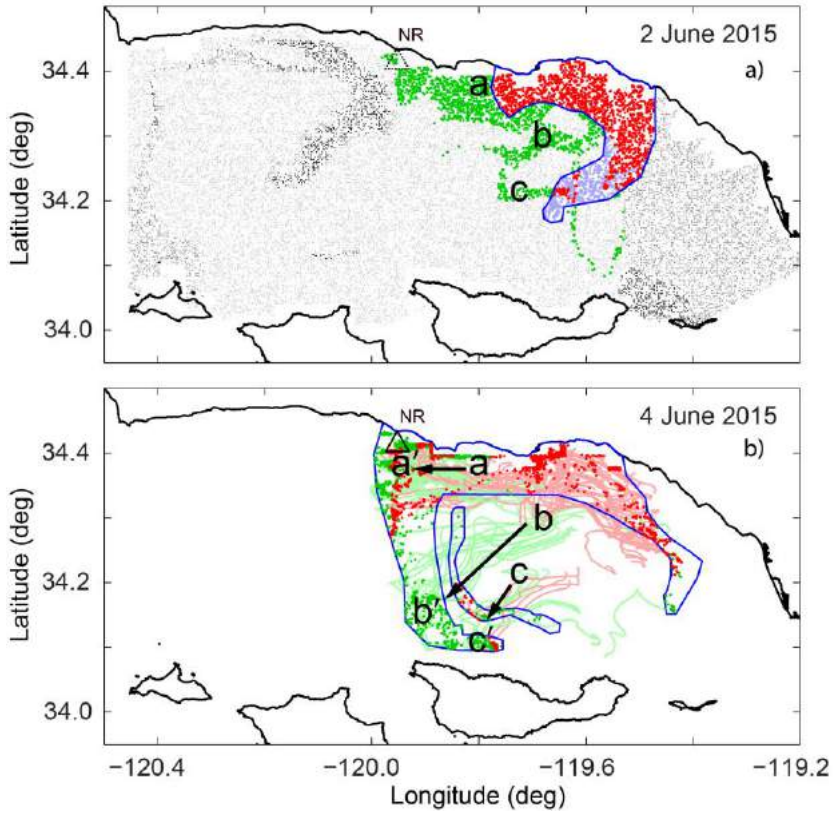


*Catlett, Siegel, Simons, et al, preliminary

Formation, Development, and Propagation of a Coastal Coccolithophore Bloom

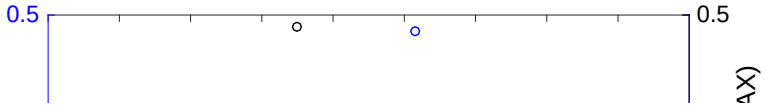


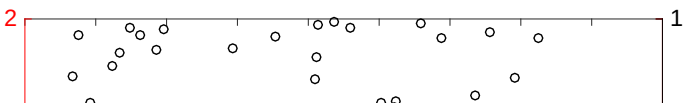




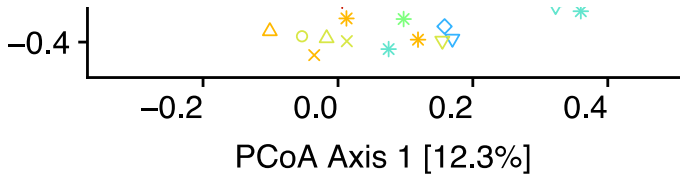
Matson *et al.* (*in press*) *JGR Oceans*

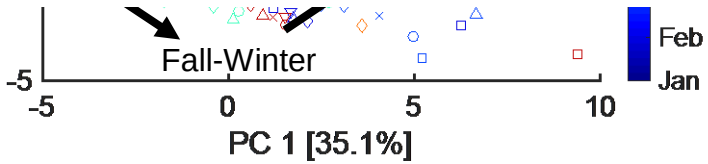
Genomic Links with Pigment PFTs + Bio-optics





Recommendation: Determine remotely sensible and validated PFTs





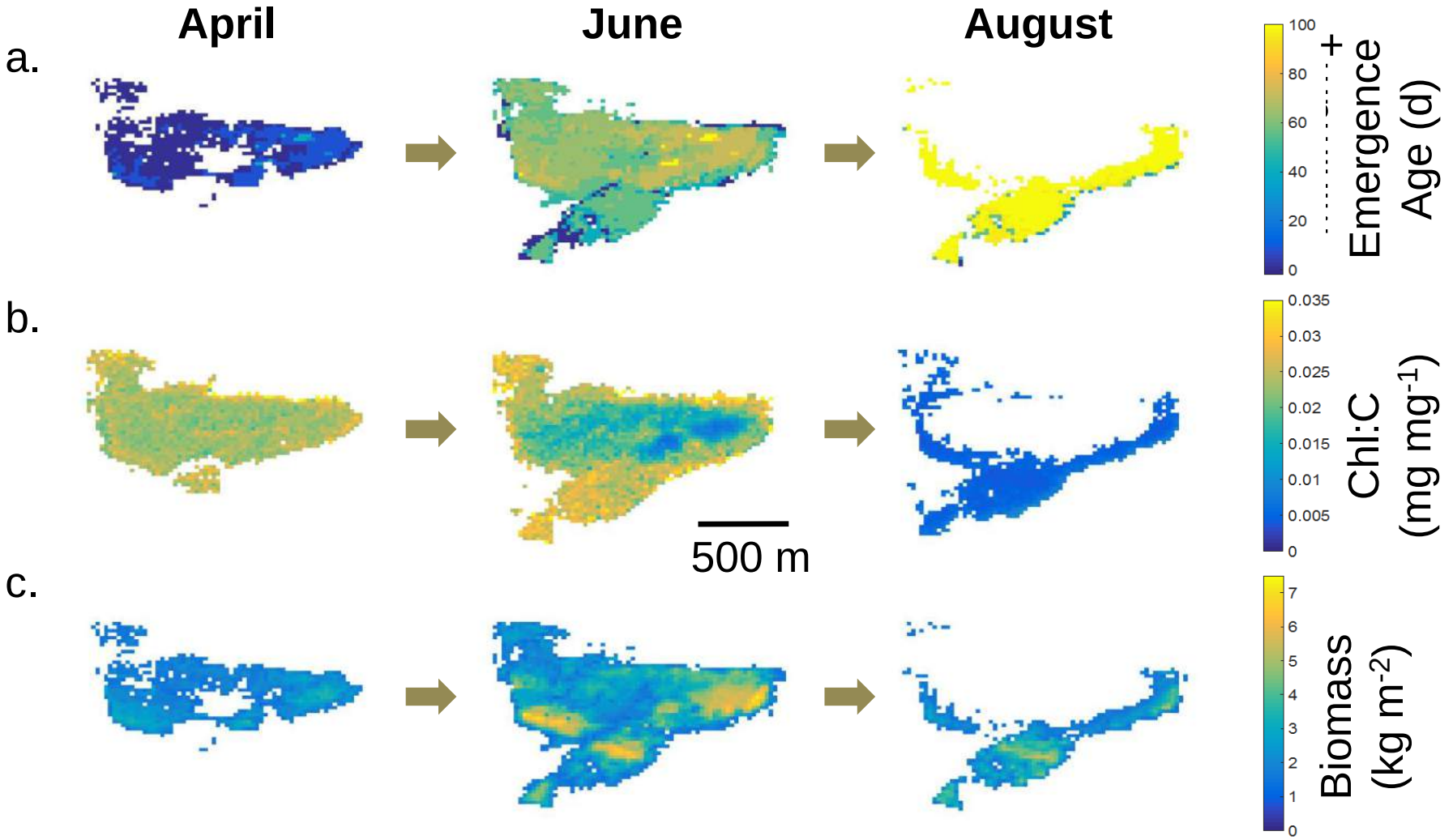
*Catlett et al., preliminary

New Products: Remote Sensing

Kelp condition, age, and forest extent

AVIRIS
Airborne Visible / Infrared Imaging Spectrometer

Bell & Siegel in prep
Bell et al. L&O 2018



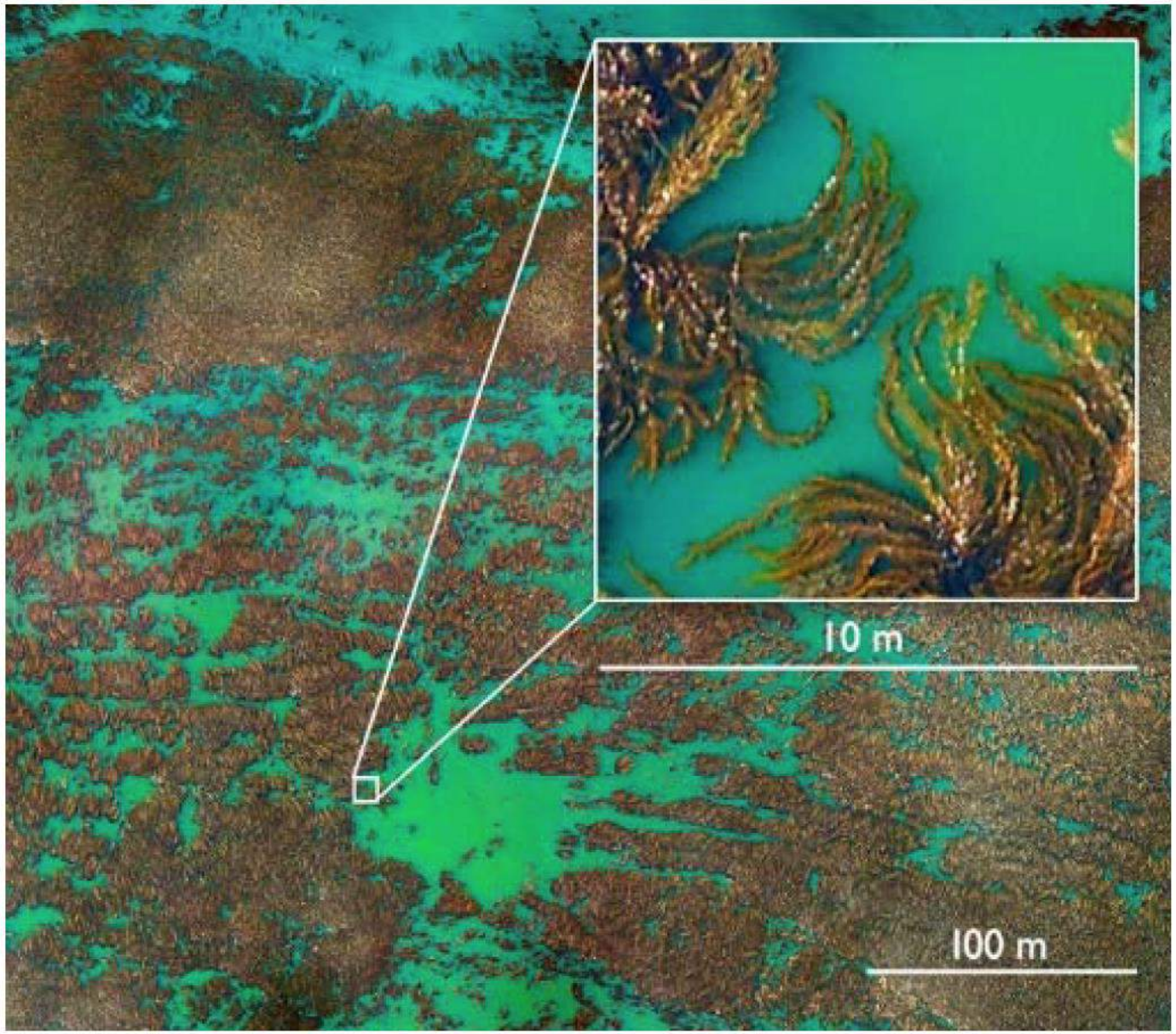
arpa·e

U.S. DEPARTMENT OF ENERGY

SAMS

Scalable **A**quaculture **M**onitoring **S**ystem

PIs: Siegel, Bell, Cavanaugh, Miller, Nidzieko, Nelson, Reed

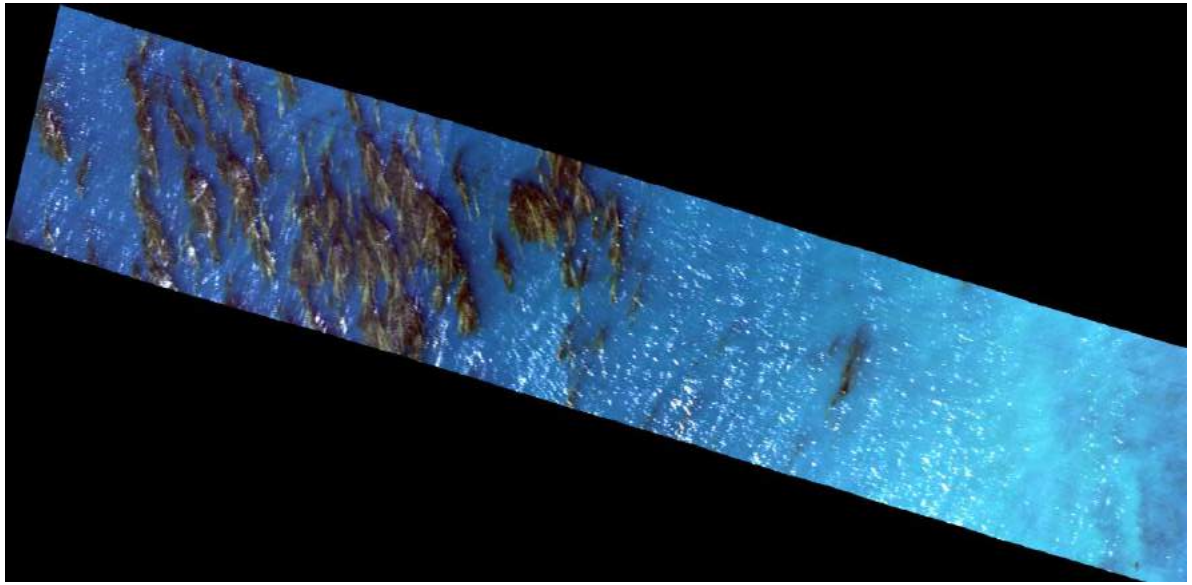


SAMS

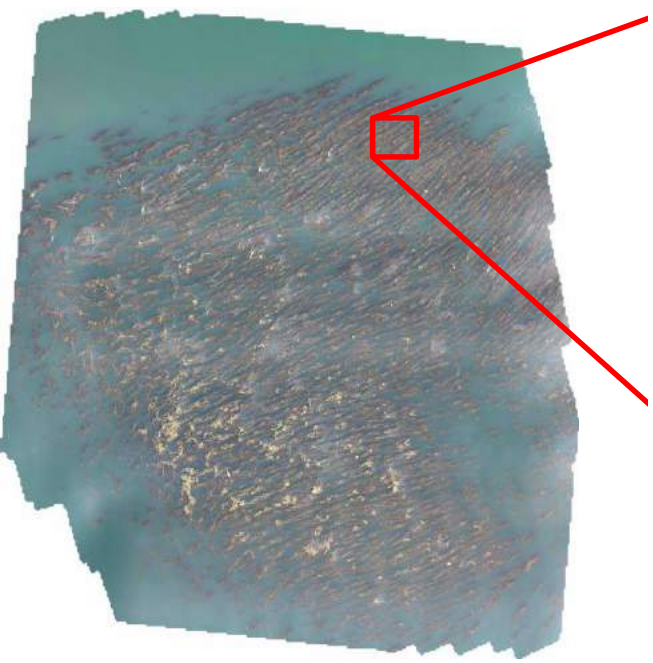
Scalable Aquaculture Monitoring System

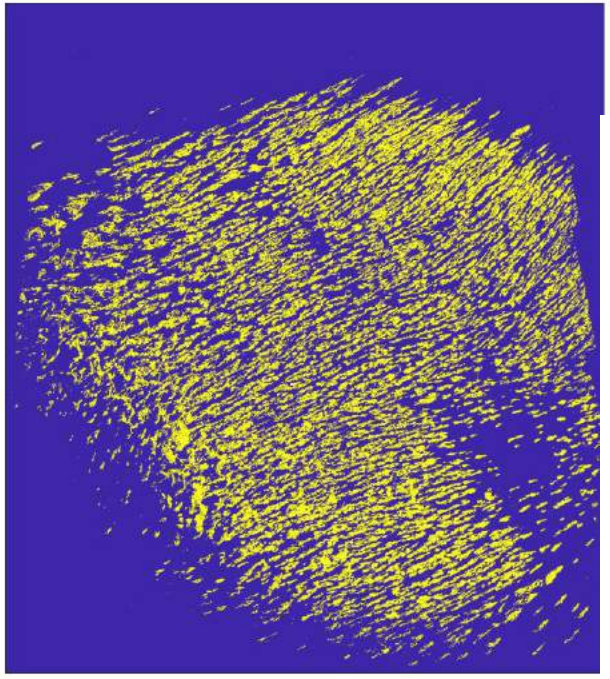
Santa Barbara Coastal Long-Term Ecological Research

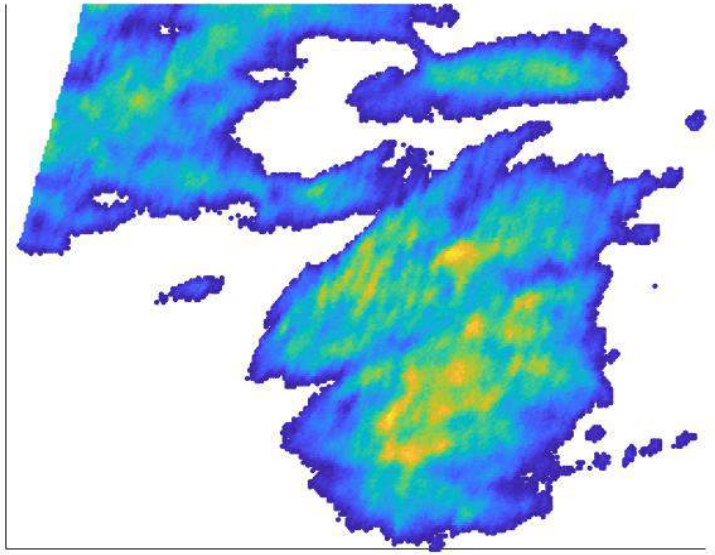
Biomass and condition: multispectral

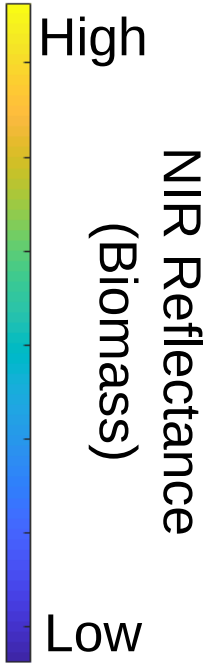


Aerial extent: color imagery









Bell et al. in prep

Giant kelp creates a diverse ecosystem

Giant kelp increases biodiversity through physical engineering

Giant kelp stability indirectly stabilizes the community via its effect on biodiversity

Recommendation: focus on dynamics of foundation species (best with RS!)

Miller et al. 2018, *Proc. Royal Soc. B.,*Castorani et al. 2018 Ecology

Lamy et al. Ecology *in review*

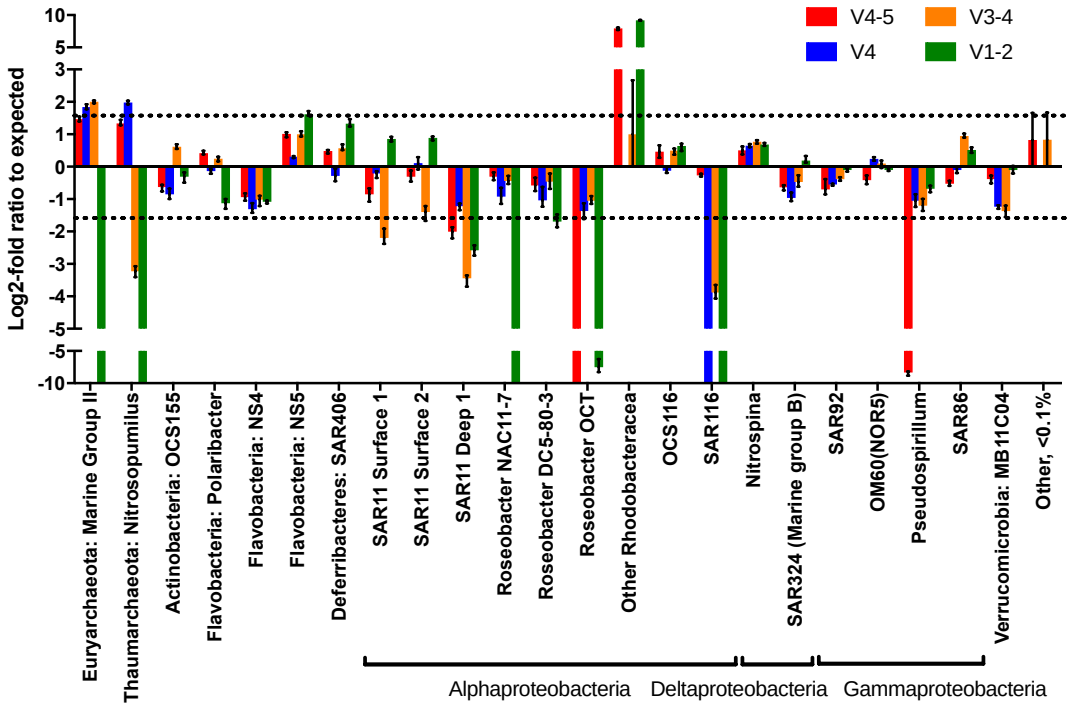
New Products: Genomics

Microbial diversity & community structure

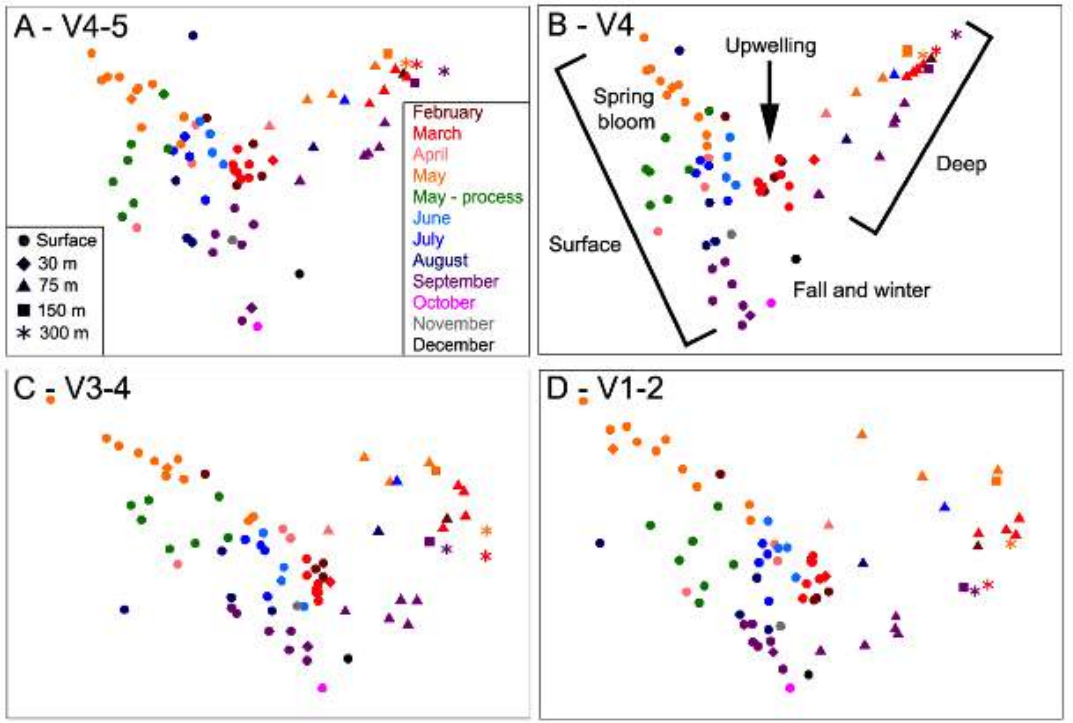
environmental microbiology

Environmental Microbiology (2018) **00**(00), 00–00 doi:10.1111/1462-2920.14091

Mock community deviation from expected abundance with four different primer sets:



Ordination plots of the same marine time-series samples sequenced with four primer sets



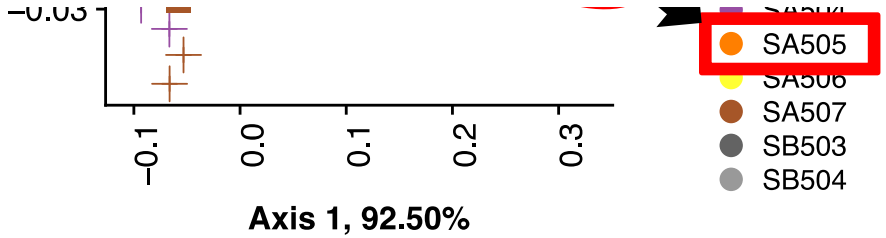
Wear et al. 2018

Phytoplankton Genomics Method Validation

- Mock communities

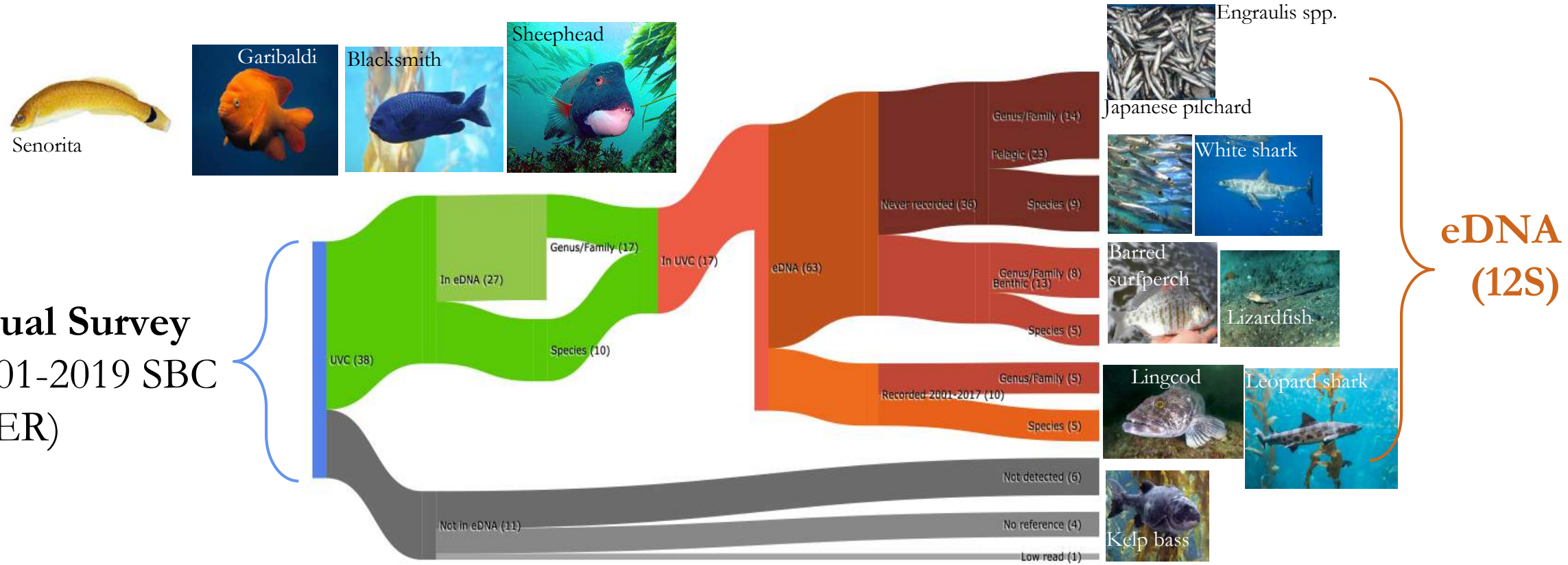
Recommendation: method validation is critical for genomic surveys

dramatically reduce
accuracy + precision



*Catlett et al., 2019, submitted, *Environmental Microbiology*

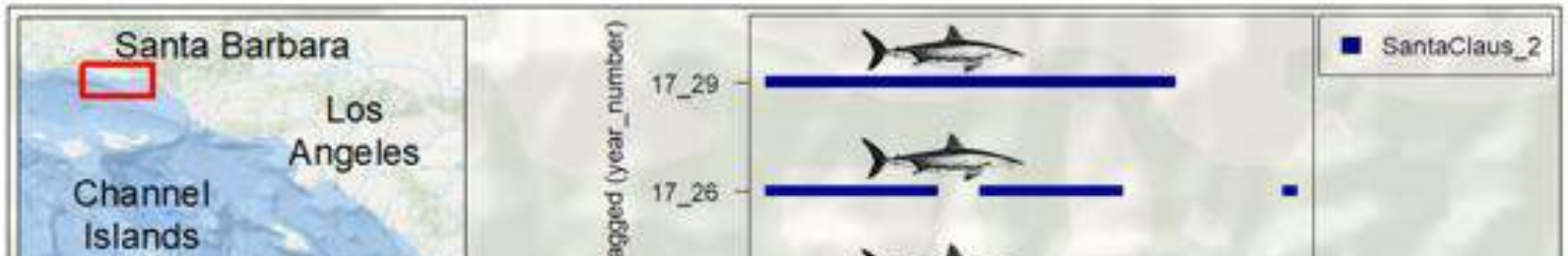
Environmental DNA captures the fine scale and hierarchical spatial structure of kelp forest fish communities



Spatially stratified sampling of 49 water samples on 27 transects across 11 rocky reefs

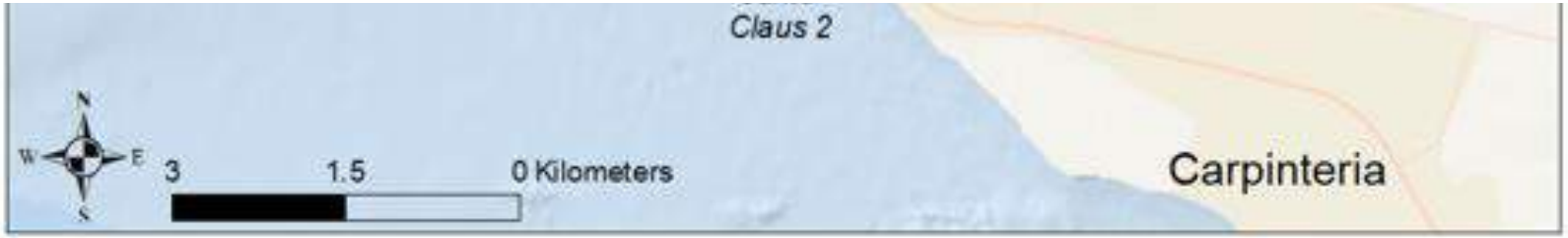
Lamy et al., in prep.

eDNA and Acoustic Telemetry Detection of Great White Sharks

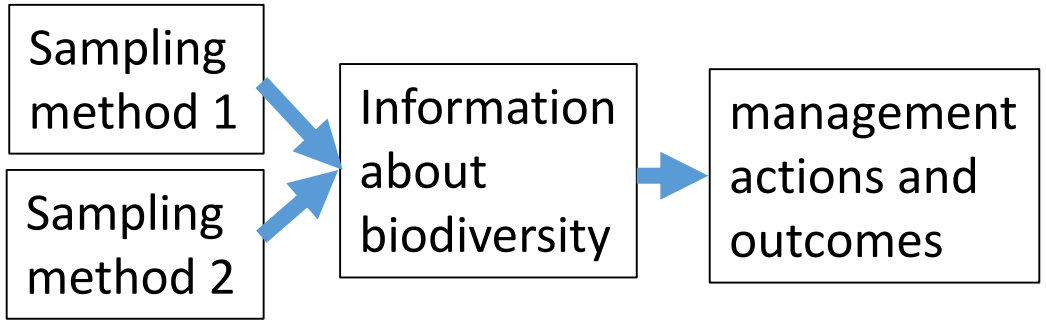


Recommendation: eDNA useful especially for known targets

Lafferty et. al 2018, Frontiers Mar. Sci.



Comparing the efficiency of alternative methods of monitoring biodiversity



Biodiversity information:

status of rare species

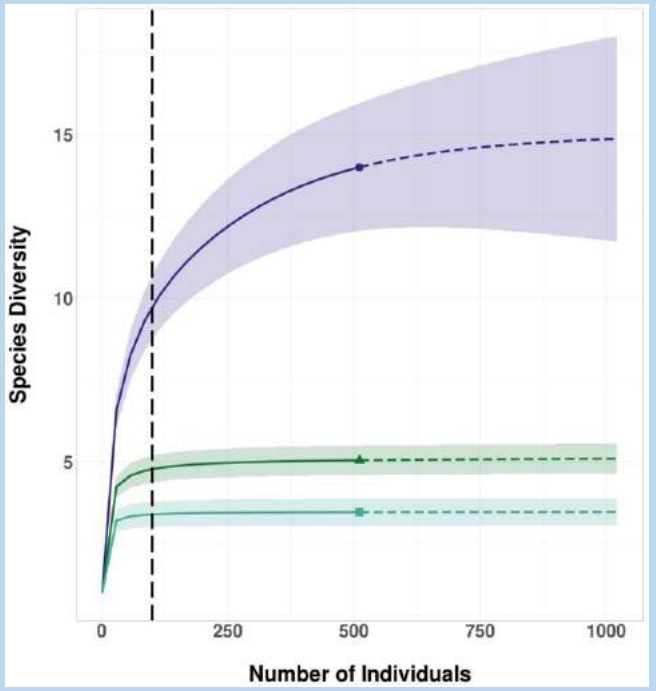
richness and evenness

Trends in abundance

Spatial patterns of diversity

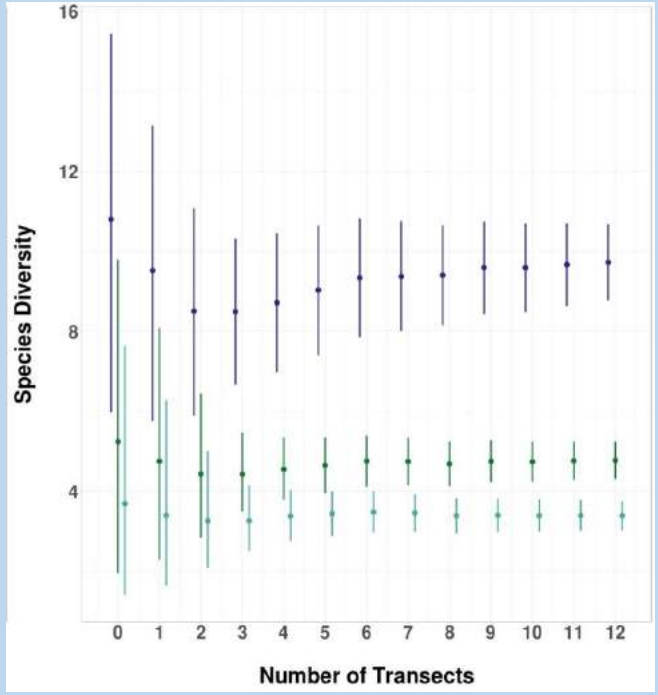
For each method:

- Rarify biodiversity to 100 individuals observed
- Calculate associated confidence intervals (CI)
- Uncertainty is CI/mean



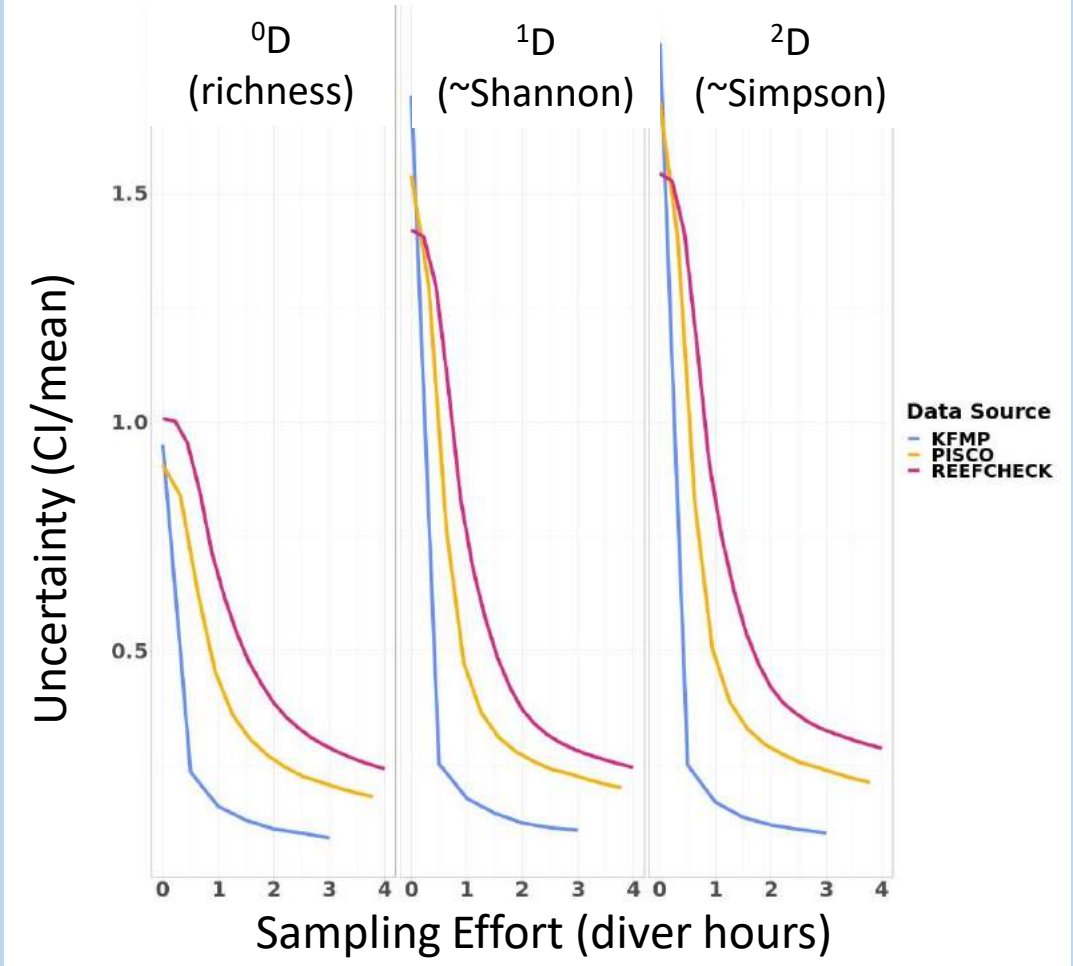
Uncertainty-effort curves:

- Randomly subsample replicates
- Calculate expected CI and uncertainty

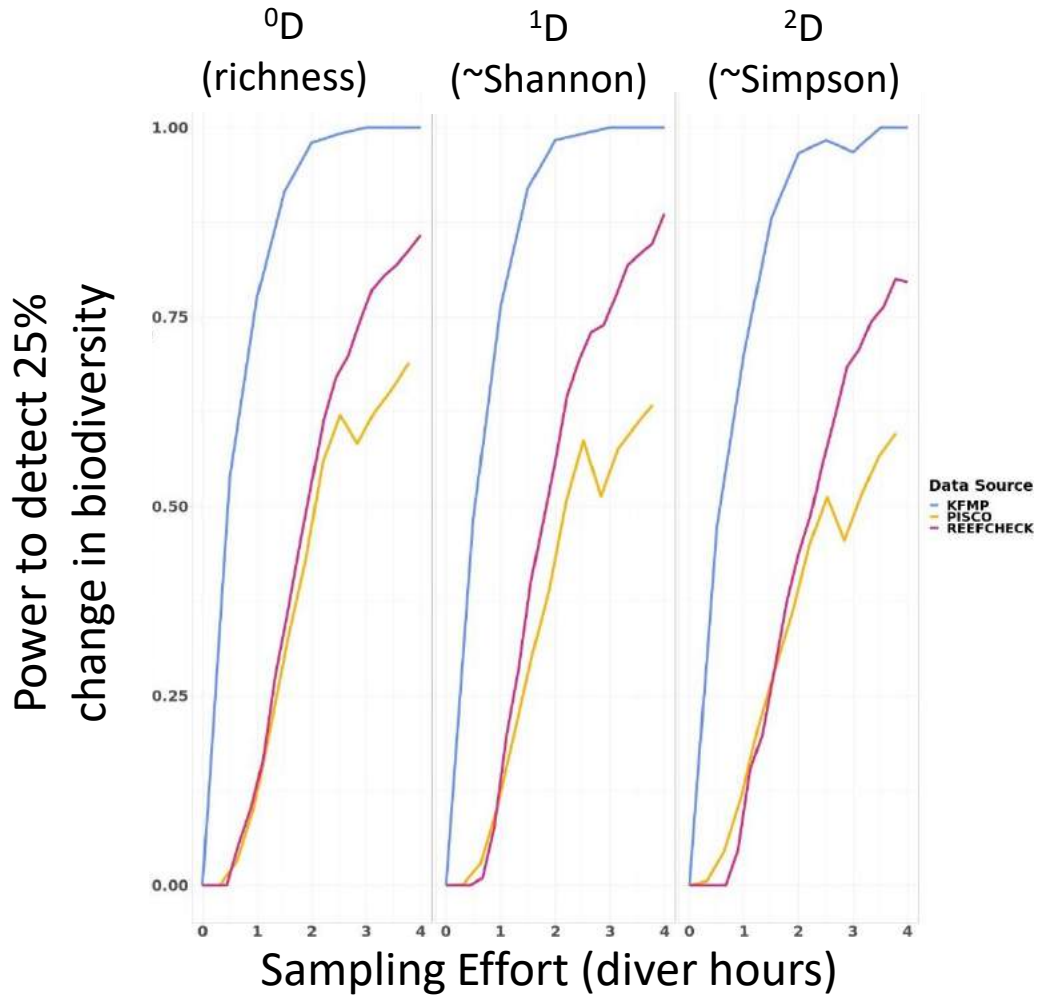


^{0}D = Richness, $^{1}D \approx$ Shannon Diversity, $^{1}D \approx$ Simpson Diversity

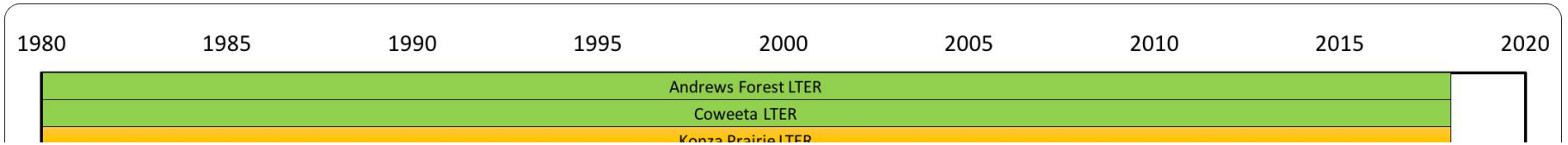
Compare sampling efficiency across methods:



Compare power to detect change:

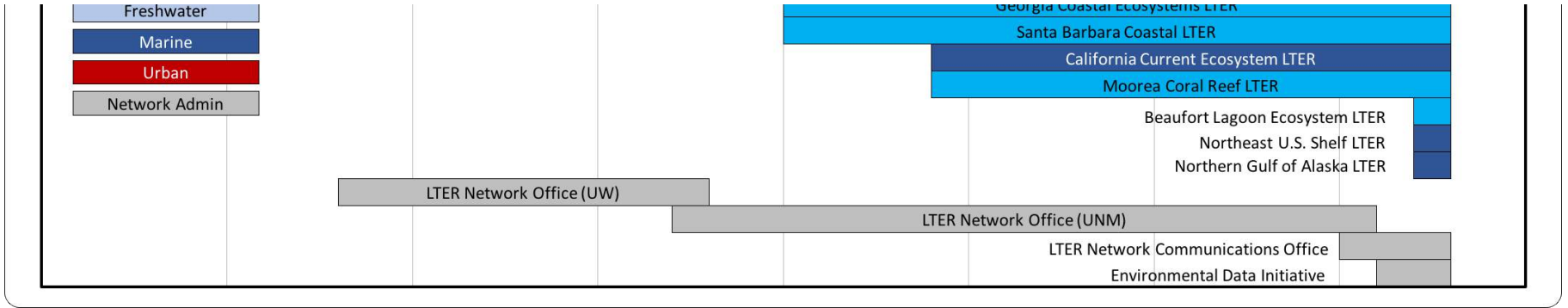


Program Development



NATIONAL SCIENCE FOUNDATION

Recommendation: MBON support should be competitive but predictable



SBC MBON: by the numbers

- Publications: **47**
- Undergraduate Students: **67**
- Graduate students: **17**
- Postdocs: **7**