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)

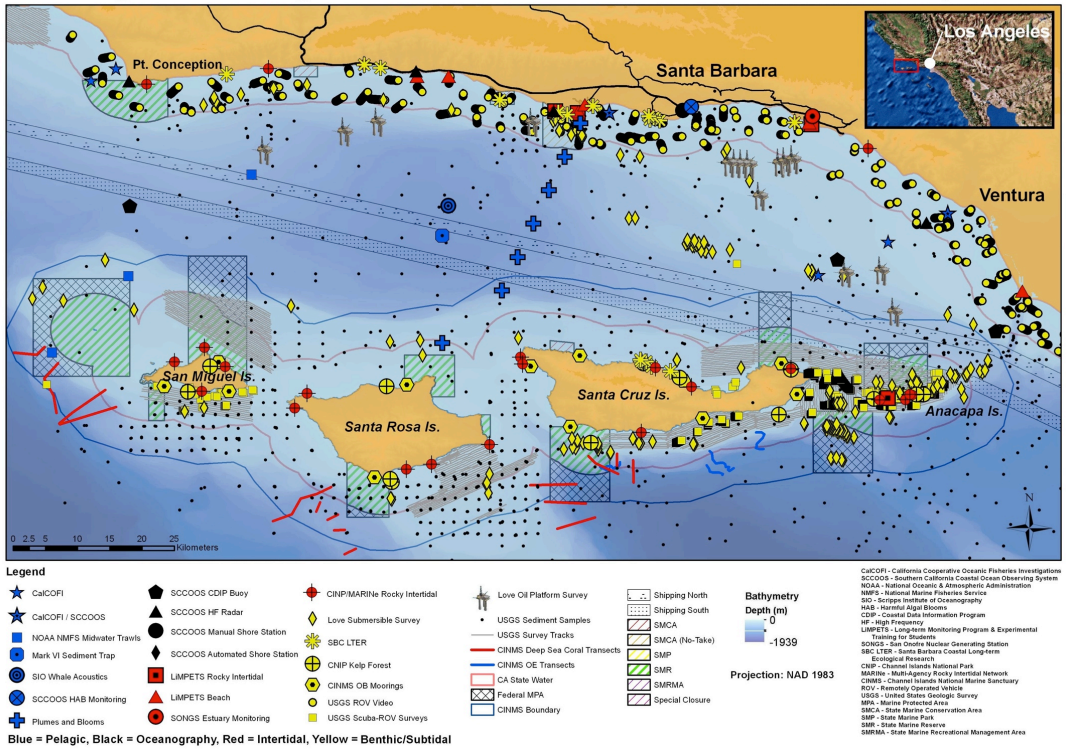
Channel Islands National Park

Gray Whales Count

CalCOFI

Existing Monitoring Partners

Santa Barbara Channel, California



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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 replicable framework to allow MBON production under diverse circumstances

GEO BON

Data Integration and Delivery

Focus on time series

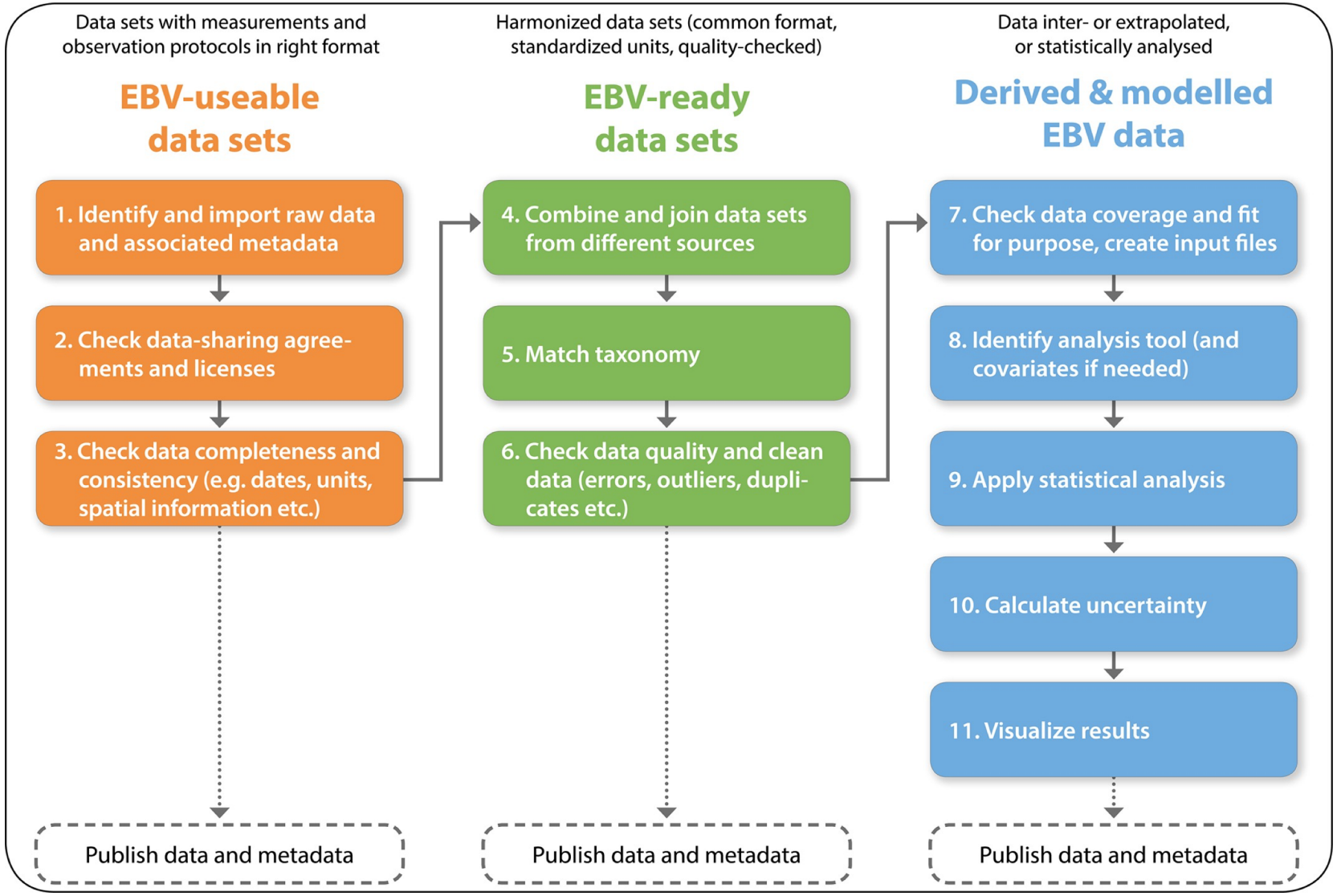
oldest: 34 yrs

youngest: 17 yrs

13 Data packages published

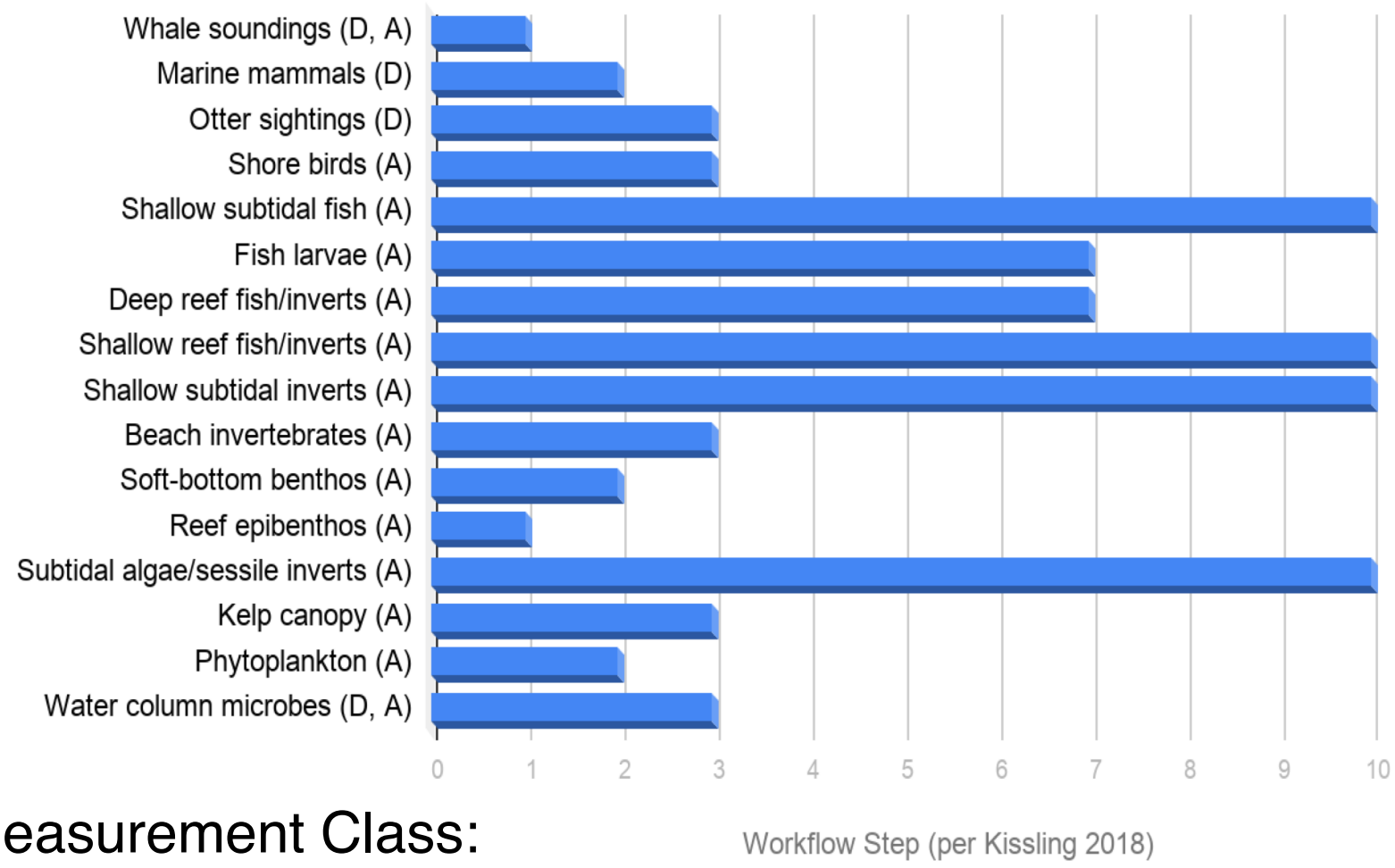
stable, immutable with DOI

Spanning taxa from microbes to whales



Reproduced from Kissling et al 2018, Figure 1.

Progress, by Taxonomic Group



Measurement Class:

D: Occurence (EBV “distribution”)

A: abundance or density (EBV “abundance”)

Delivery Mechanisms:

<u>Tested mechanisms for:</u>

DwC-A in repository

EDI/DataONE

EML-to-ERDDAP

SCCOOS

Manual contributions

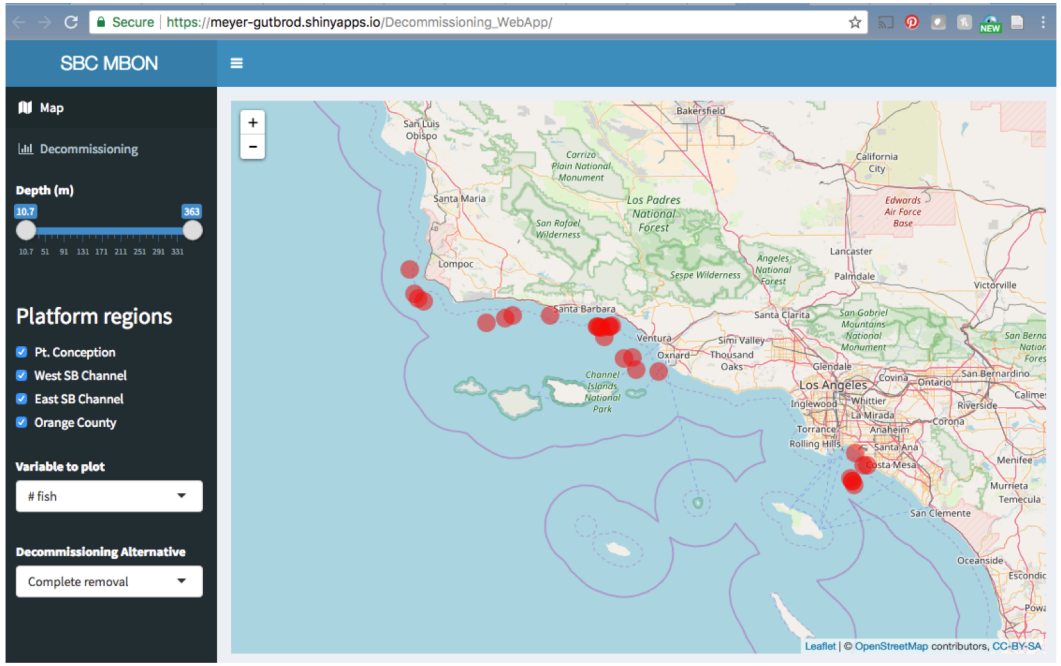
OBIS

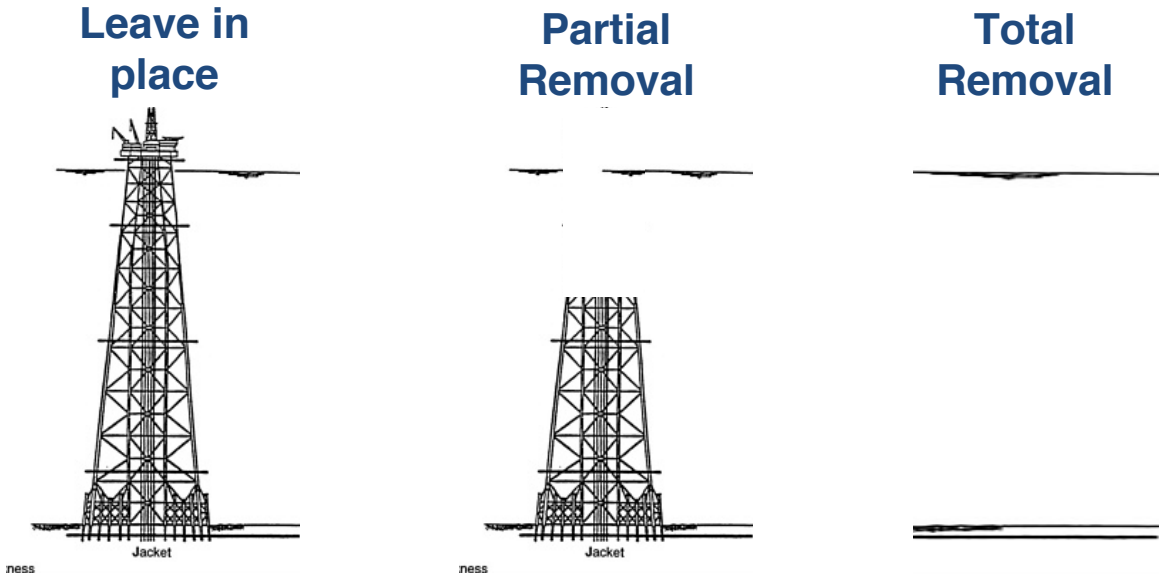
Workflow input to research community formats

EDI

Pros & cons outlined

Net Environmental Benefit Analysis of offshore platform decommissioning alternatives





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/

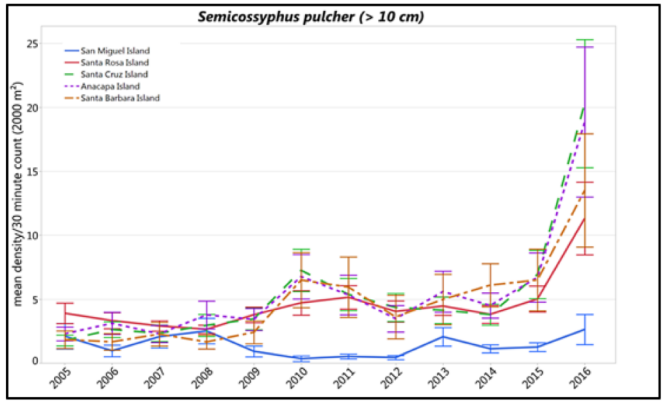
Meyer-Gutbrod et al., *in prep*

n of Condition Reports

California Sheephead Abundance in CINMS

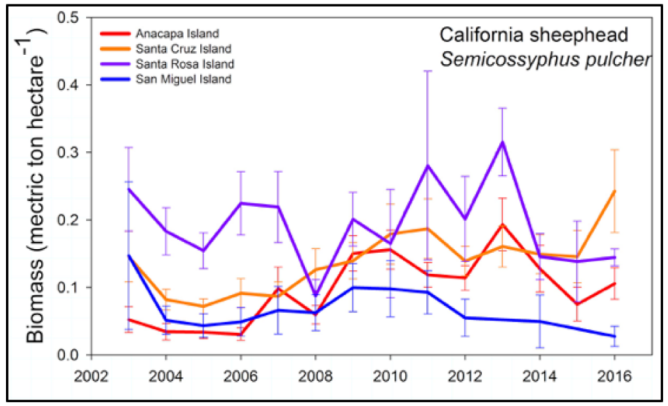
The California sheephead (*Semicossyphus pulcher*) is a large and beautiful fish that plays an important role in the food web of kelp forests and rocky reefs in southern California. Sheephead are also a popular sport fish for recreational and commercial fishing and a draw for SCUBA divers.

Abundance of California Sheephead

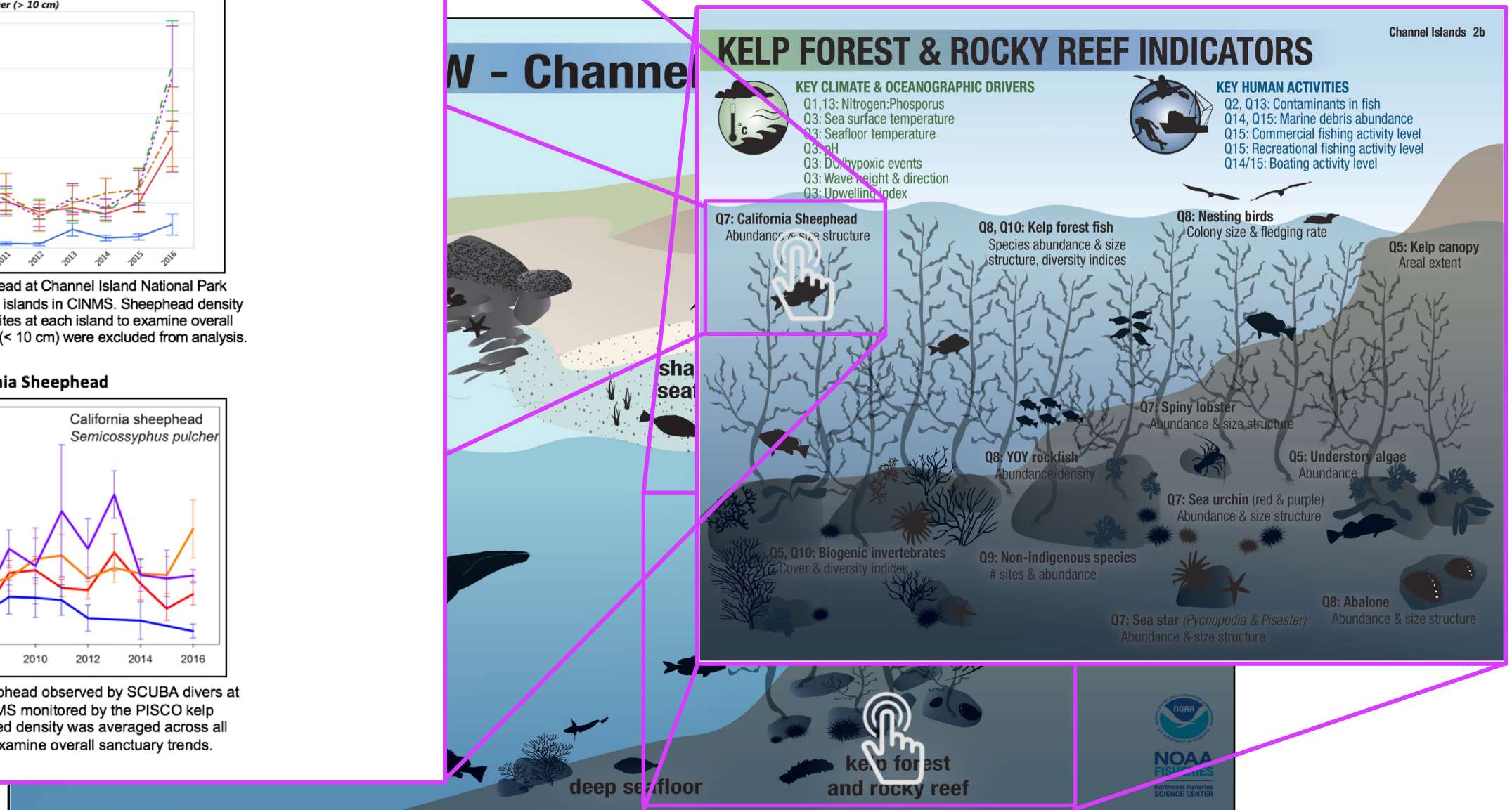


Average density of California sheephead at Channel Island National Park kelp forest monitoring sites at the five islands in CINMS. Sheephead density was averaged across all monitoring sites at each island to examine overall sanctuary trends. Note that juveniles (< 10 cm) were excluded from analysis.

Abundance of California Sheephead

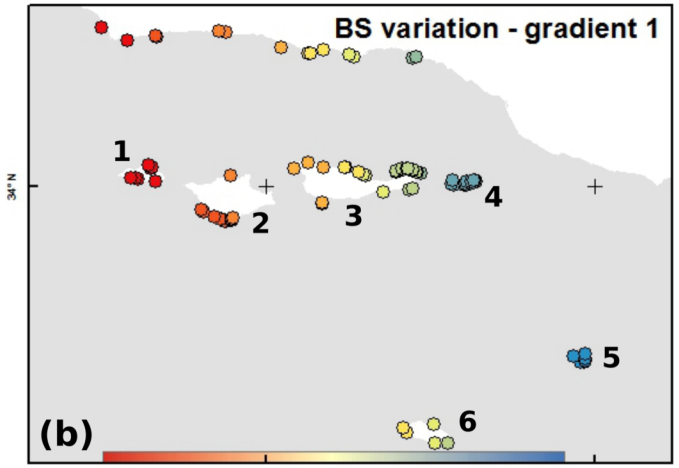


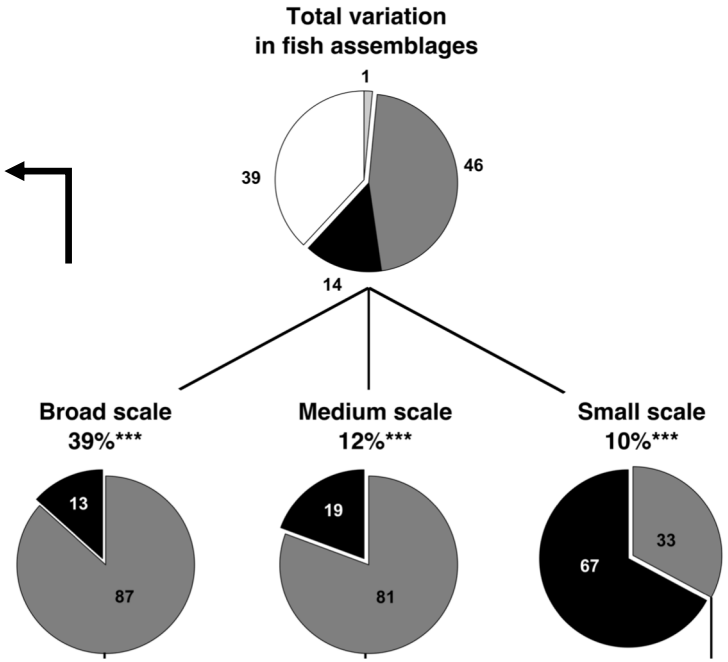
Average density of California sheephead observed by SCUBA divers at 14 sites across four islands in CINMS monitored by the PISCO kelp forest monitoring program. Observed density was averaged across all monitoring sites at each island to examine overall sanctuary trends.



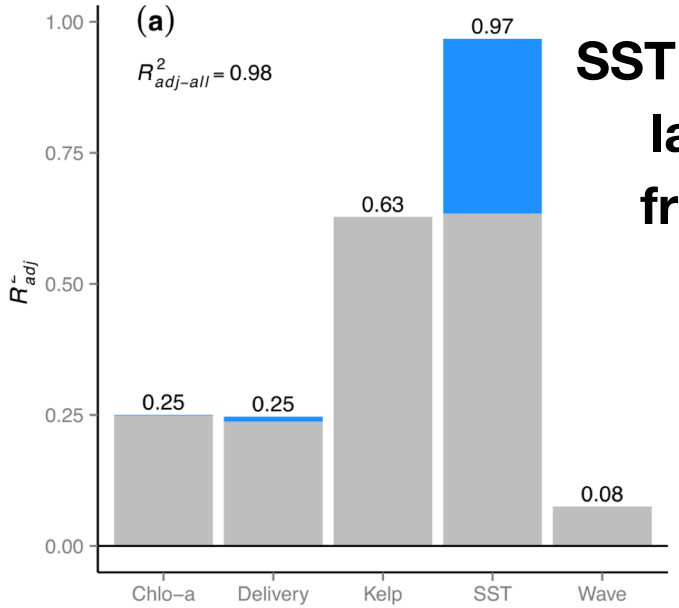
Uncovering the complex and multiscale drivers of kelp forest communities

What are the most important scales of variation?





What environmental factor(s) underlie each spatial scale?

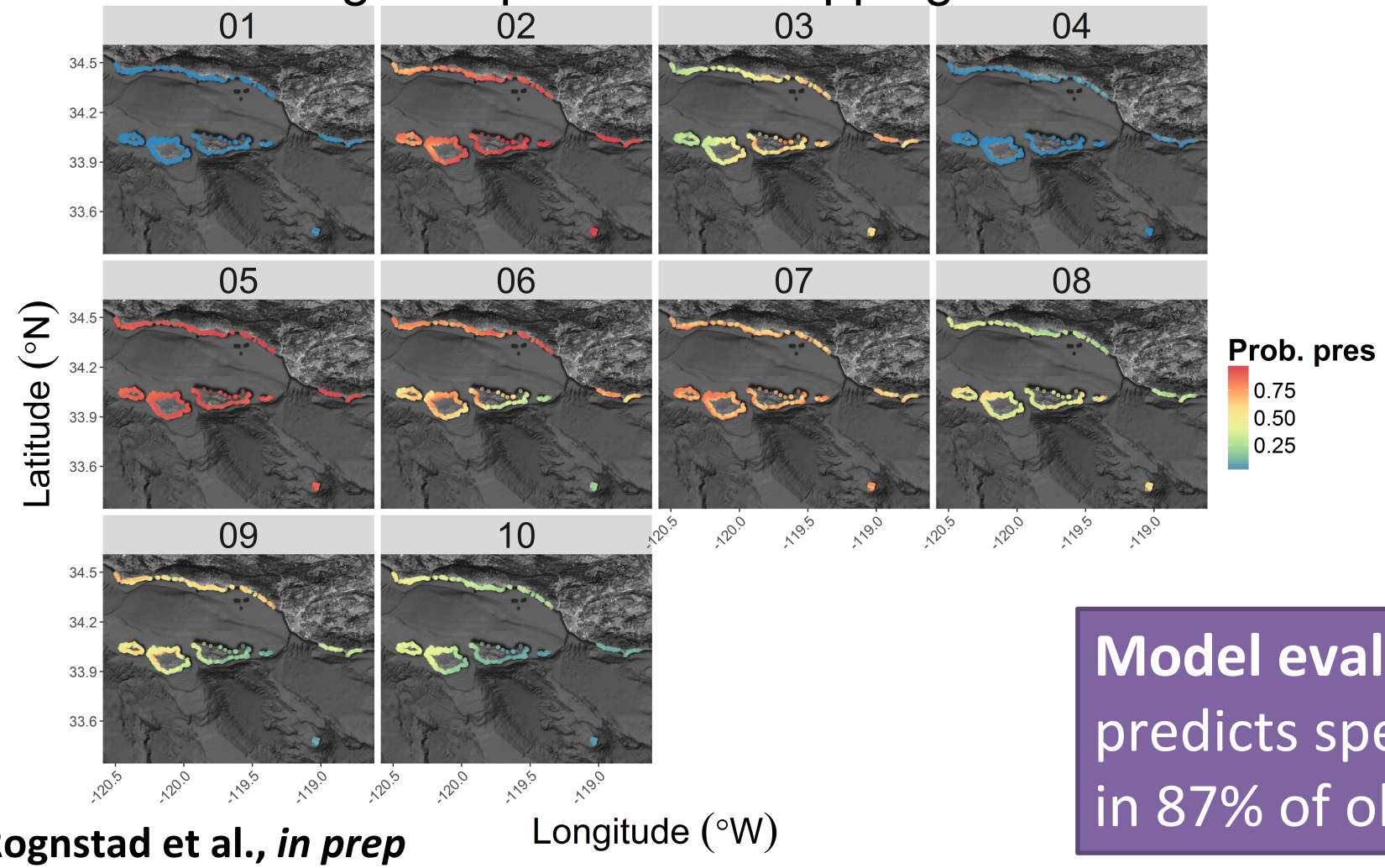


SST explains largest fraction

Lamy et al. 2018, *Oecologia*

Species Archetype Modelling (SAM) identifies nine archetypes, **SST** and **wave height** important predictors

Regional prediction mapping



Rognstad et al., *in prep*

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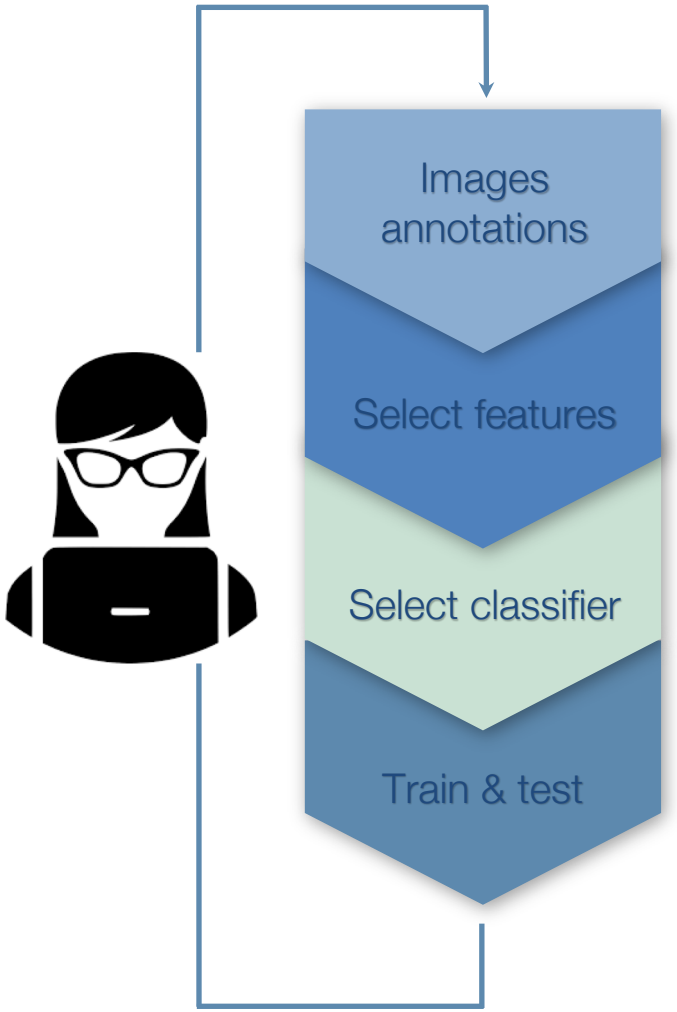
NCCOS NOAA

NATIONAL MARINE SANCTUARIES

Model evaluation: Correctly predicts species presence/absence in 87% of observations

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

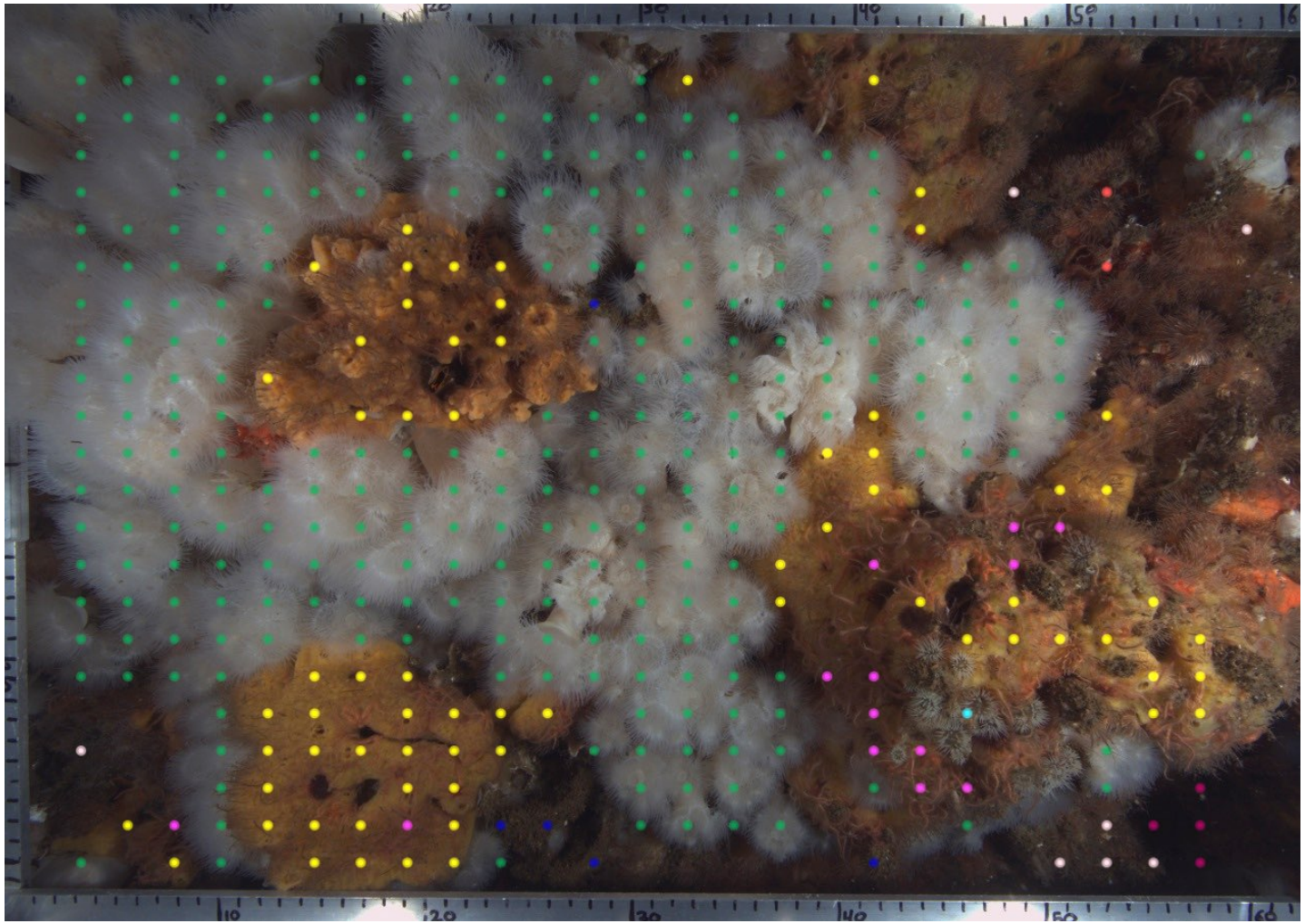
- Scalable services
- Annotation system
- Cluster processing
- Fast classification on GPUs

BisQue

NSF

Diver images: reef communities

Percent cover at 95% confidence



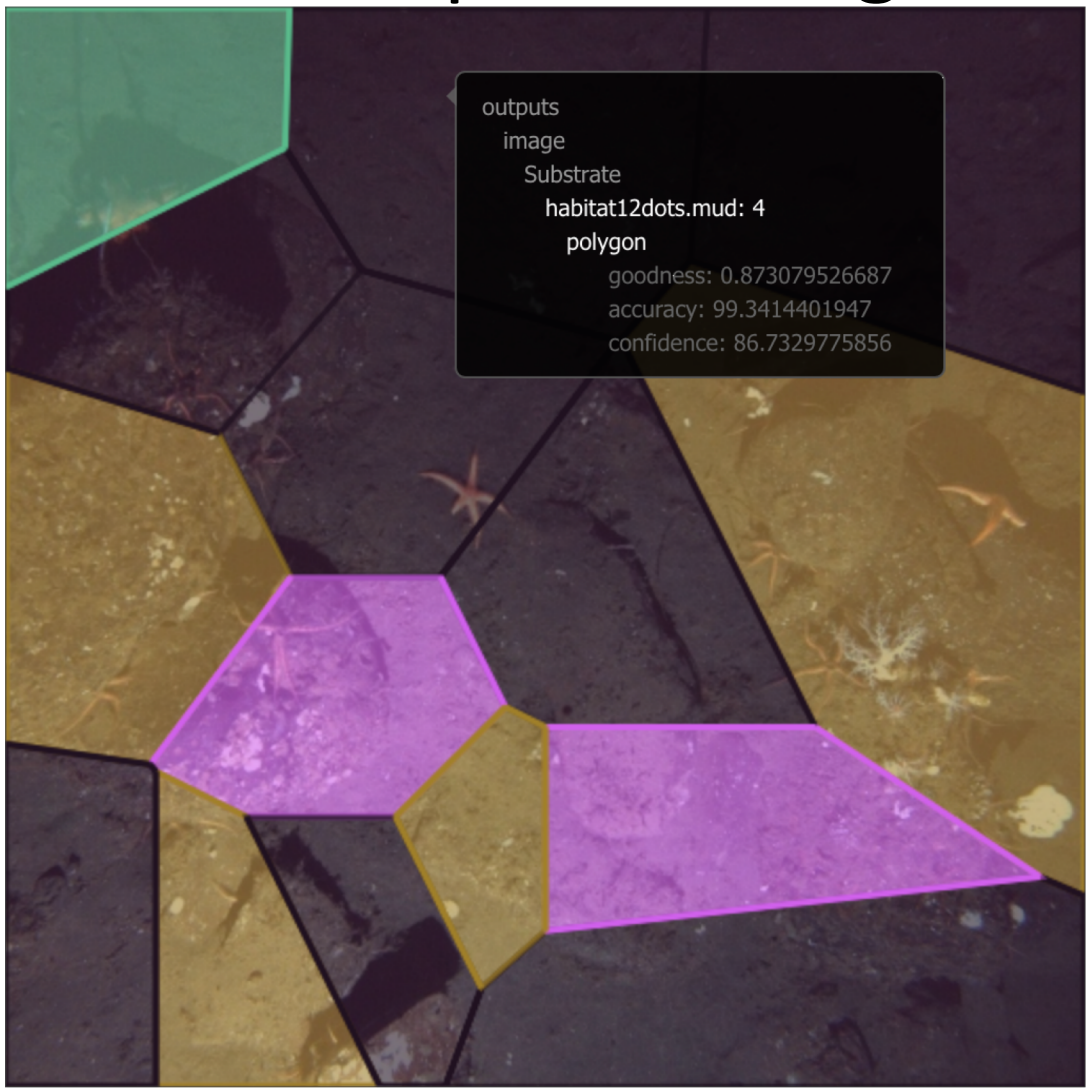
Top performers

Samples	Accur...	Error...	F1 %	Label
2140	100.0	0.0	100.0	Rhodophyta - Ahnfeltiopsis linearis
1830	100.0	0.0	100.0	Rhodophyta - Calliarthron tuberculosum
1180	100.0	0.0	100.0	Ectoprocta - Crisia sp B unidentified
1106	100.0	0.0	100.0	Ectoprocta - Cellaria spp
507	100.0	0.0	100.0	Annelida - Pista elongata
2741	100.0	0.2	99.6	Echinodermata - Ophiothrix spiculata
4590	99.6	0.0	99.6	Cnidaria - Paracyathus stearnsii
2920	99.3	0.0	99.3	Ectoprocta - Phidolopora labiata
3630	99.8	0.4	99.2	Cnidaria - Muricea californica
1660	99.0	0.1	98.8	Cnidaria - Anthopleura elegantissima
803	100.0	0.1	98.8	Ectoprocta - sunflower encrusting bryozoan uni...
4760	99.2	0.1	98.7	Cnidaria - zoanthid unidentified
1290	100.0	0.7	98.6	Echinodermata - Apostichopus parvimensis
1570	98.1	0.0	98.1	Chordata - Trididemnum opacum
1350	100.0	0.3	97.7	Rhodophyta - Laurencia pacifica
4200	97.6	0.0	97.6	Echinodermata - Patiria miniata
2340	97.6	0.0	97.6	Rhodophyta - Plocamium cartilagineum subsp ...

BisQue

AUV images: deep benthic communities

Habitat partitioning



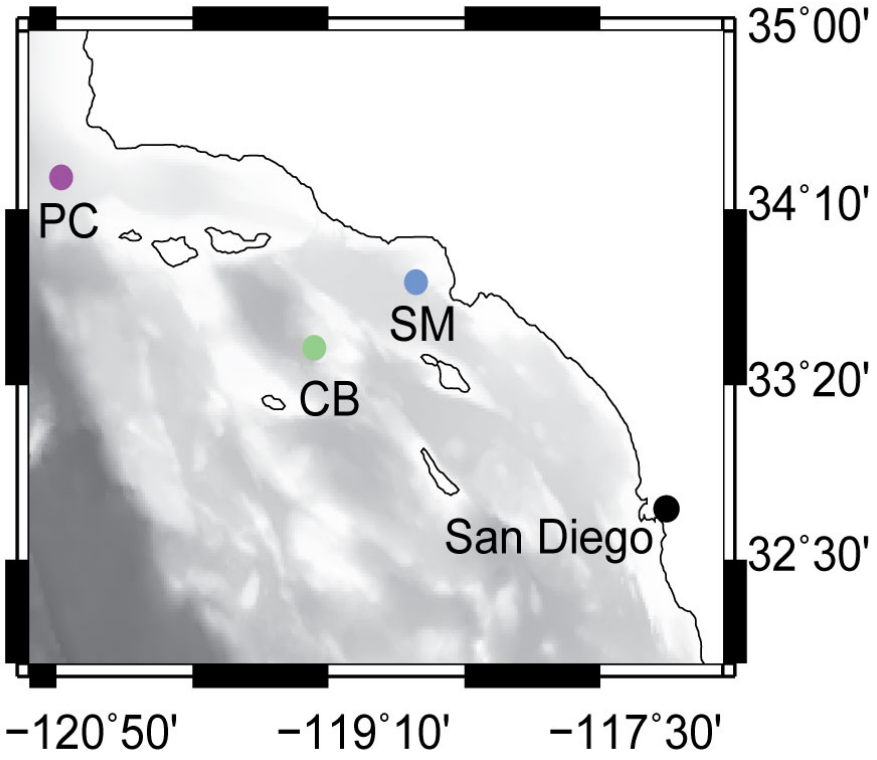
Top performers

Samples	Accura...	Error %	F1 %	Label
1060	94.5	0.3	94.0	invert.asteroidea.luidia_foliolata
1410	96.5	1.4	93.1	invert.porifera.cluster.hexactinellid
631	93.3	0.7	88.1	fish.agonidae
503	75.0	0.0	75.0	invert.alcyonacea.acanthogorgia
792	77.8	3.3	73.4	invert.asteroidea.rathbunaster_californicus
2490	80.7	3.8	72.6	invert.asteroidea.benthopecten
11968	99.6	18.8	70.9	invert.echinoidea.strongylocentrotus_fragilis
1330	65.8	0.0	65.8	invert.gastropoda
3710	75.0	2.6	58.8	invert.echinoidea.brisaster
1780	81.0	13.2	53.3	invert.porifera.clump.mycale
1100	58.5	2.4	53.1	fish.sebastolobus
2567	82.8	17.1	50.9	invert.anomura.galatheoidea
3920	94.1	41.7	40.3	invert.holothuroidea.parastichopus_leukothele
1294	38.9	0.1	38.5	invert.asteroidea
2140	36.6	0.7	35.2	invert.actinaria
3710	34.3	0.0	34.3	invert.holothuroidea.pannychia_moseleyi

Miller et al. in prep

New Products: Acoustics

Acoustic Detection of Marine Mammals



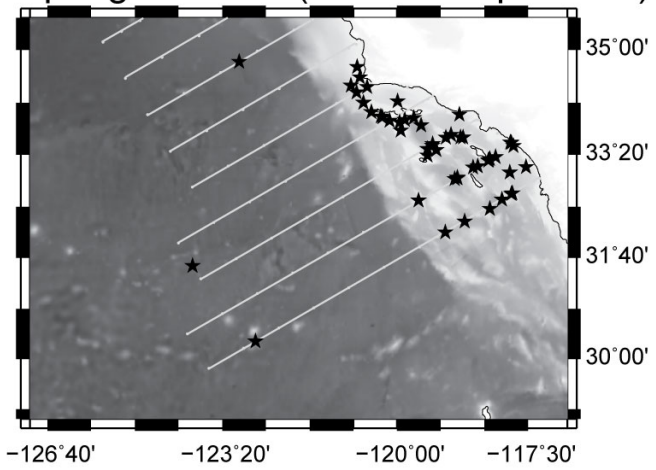
Hildebrand et. al submitted

<u>Seasonal shift</u>
daytime foraging
In the fall / winter on squid

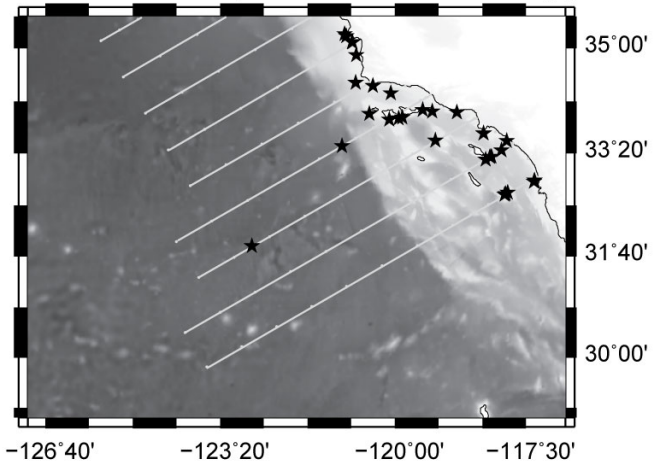
Nightime foraging
in the spring/summer on fish

Grampus (Risso's dolphin)

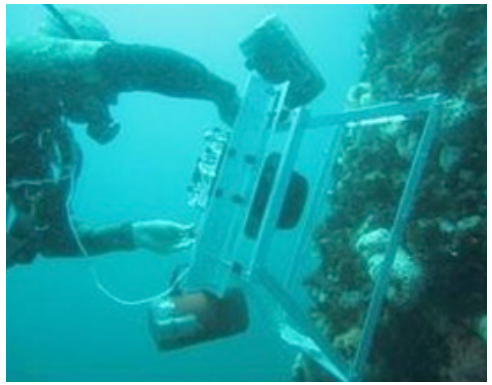
Spring/Summer (March - September)

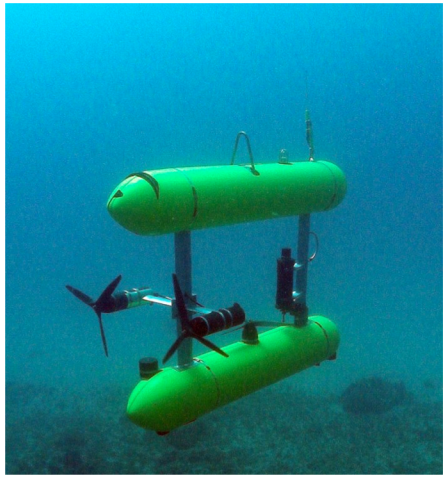


Fall/Winter (October - February)



Optical imagery and acoustics: users





BOEM
Bureau of Ocean Energy Management

- Oil platforms and natural reefs
- Rocky intertidal
- Deep benthos
- Marine mammals

MARINe

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

- Marine mammals
- Noisy fish
- Deep benthos
- Deep sea corals

National Marine Sanctuaries
Channel Islands

BisQue

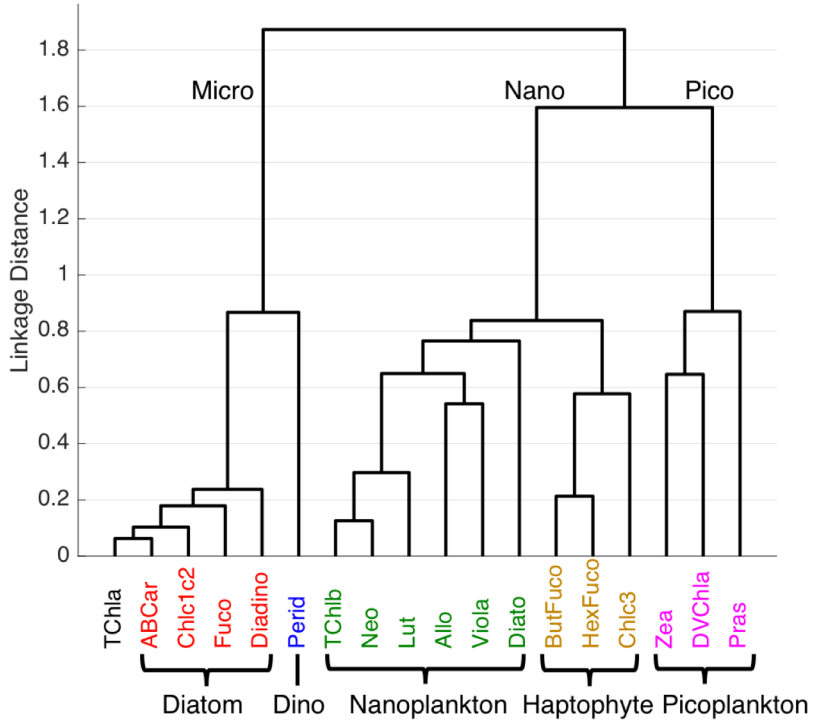
Santa Barbara Coastal
Long-Term Ecological Research

DEEP Coral Communities
Sentinels of a Changing Ocean

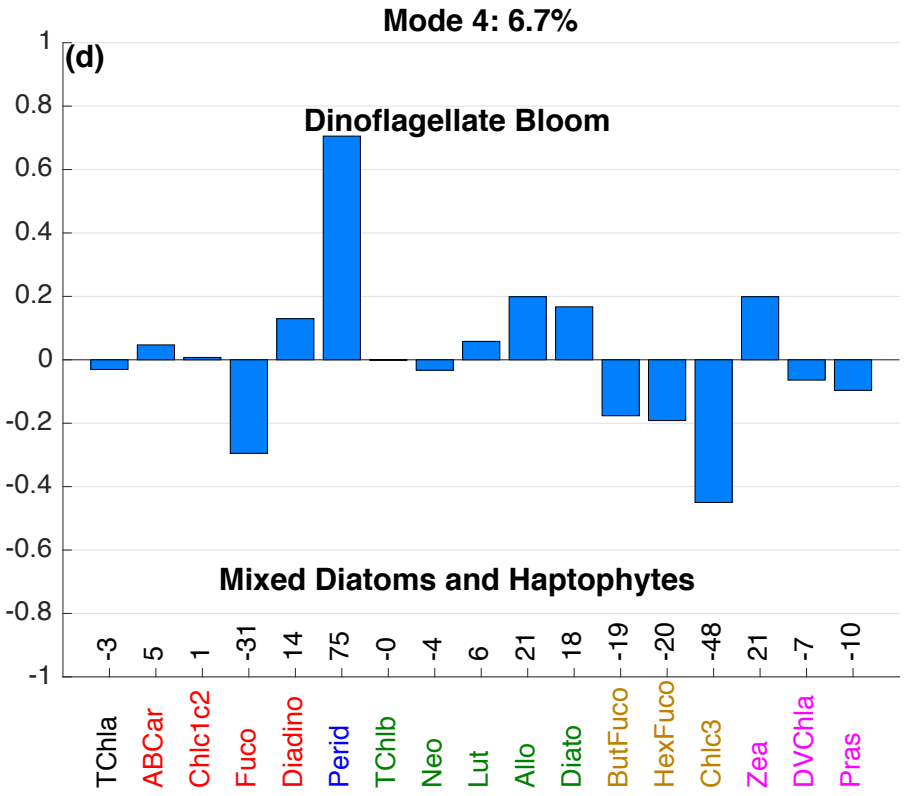
New Products: Remote Sensing

Phytoplankton functional diversity

Phytoplankton Pigment "Communities"



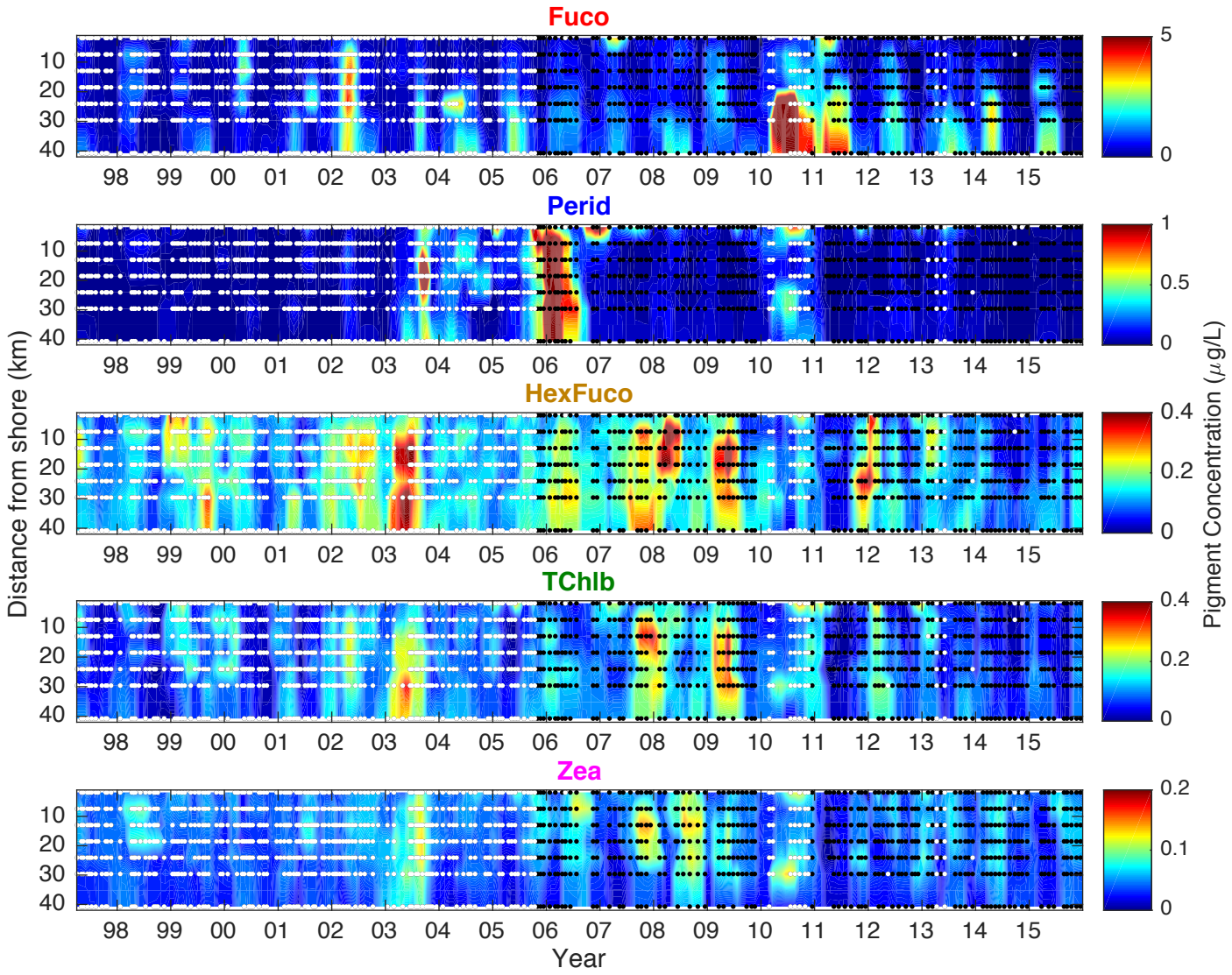
Pigment communities defined with cluster, EOF analyses as proxy for PFTs



JOURNAL OF GEOPHYSICAL RESEARCH
Oceans
AN AGU JOURNAL

Catlett and Siegel, 2018.

Bio-Optical Models Extend 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.

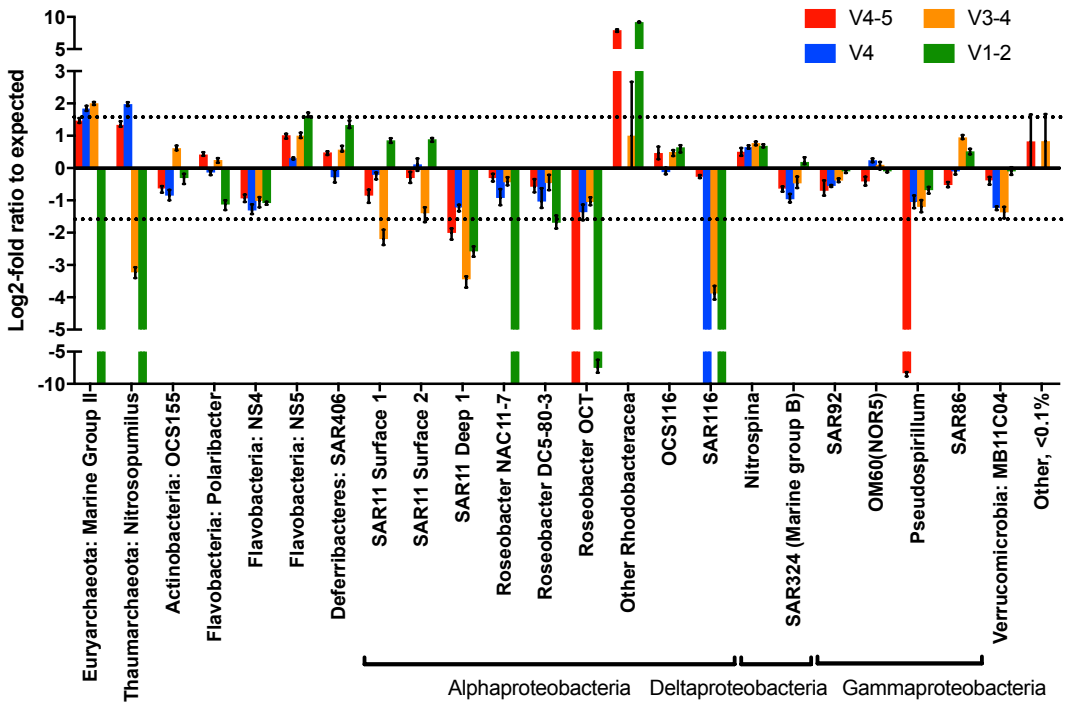
New Products: Genomics

Microbial diversity & community structure

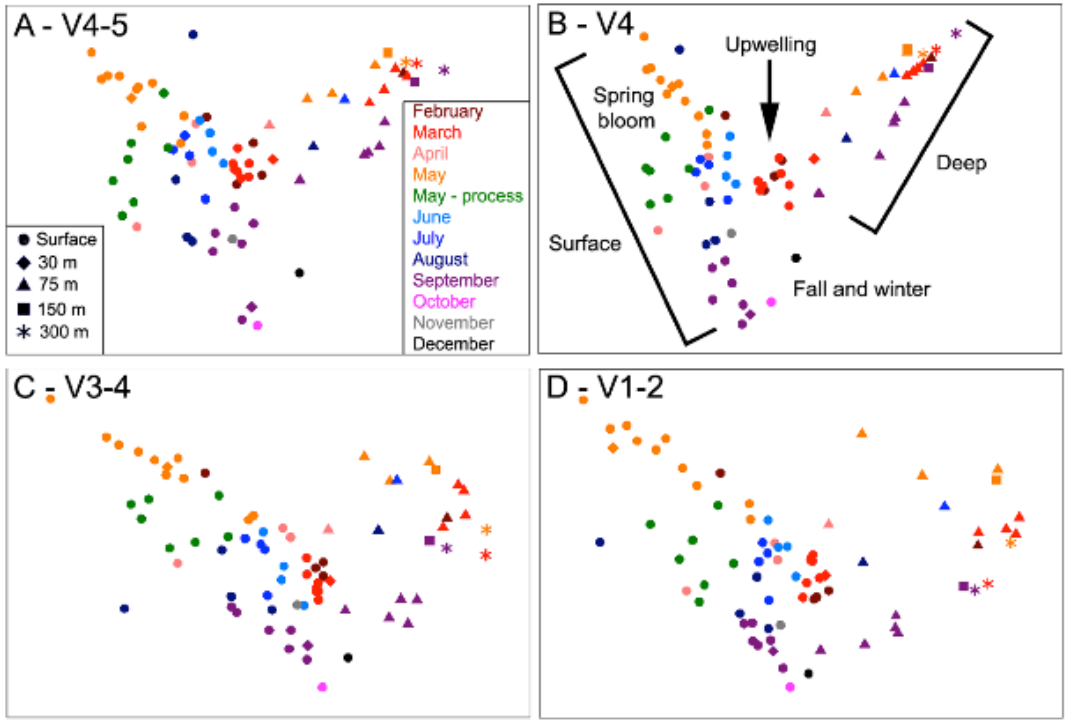
environmental microbiology

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

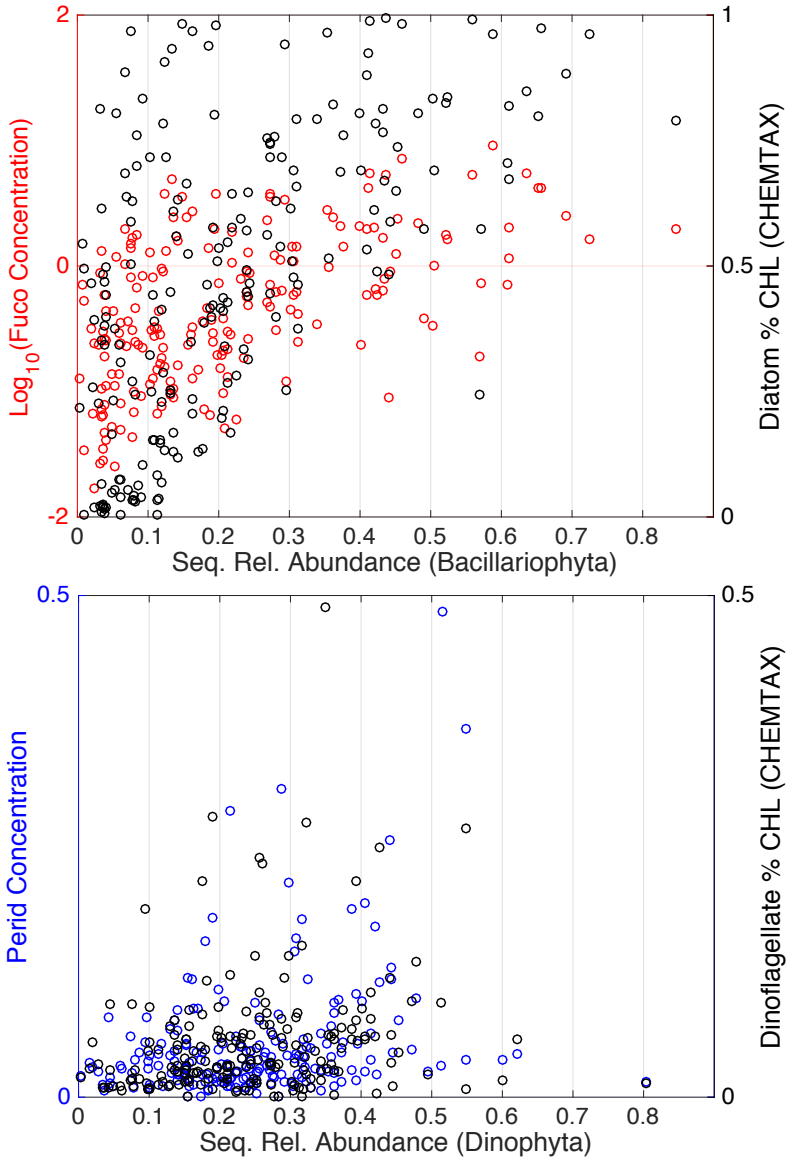


Wear et al. 2018

Linking Genomics and Bio-optics

- Mock communities developed for testing methods
- Lots of work left to answer these questions:

1. Can we derive PFT indices from sequences?
2. Do they align with pigment PFTs?
3. Can we use PFTs to predict microbes?

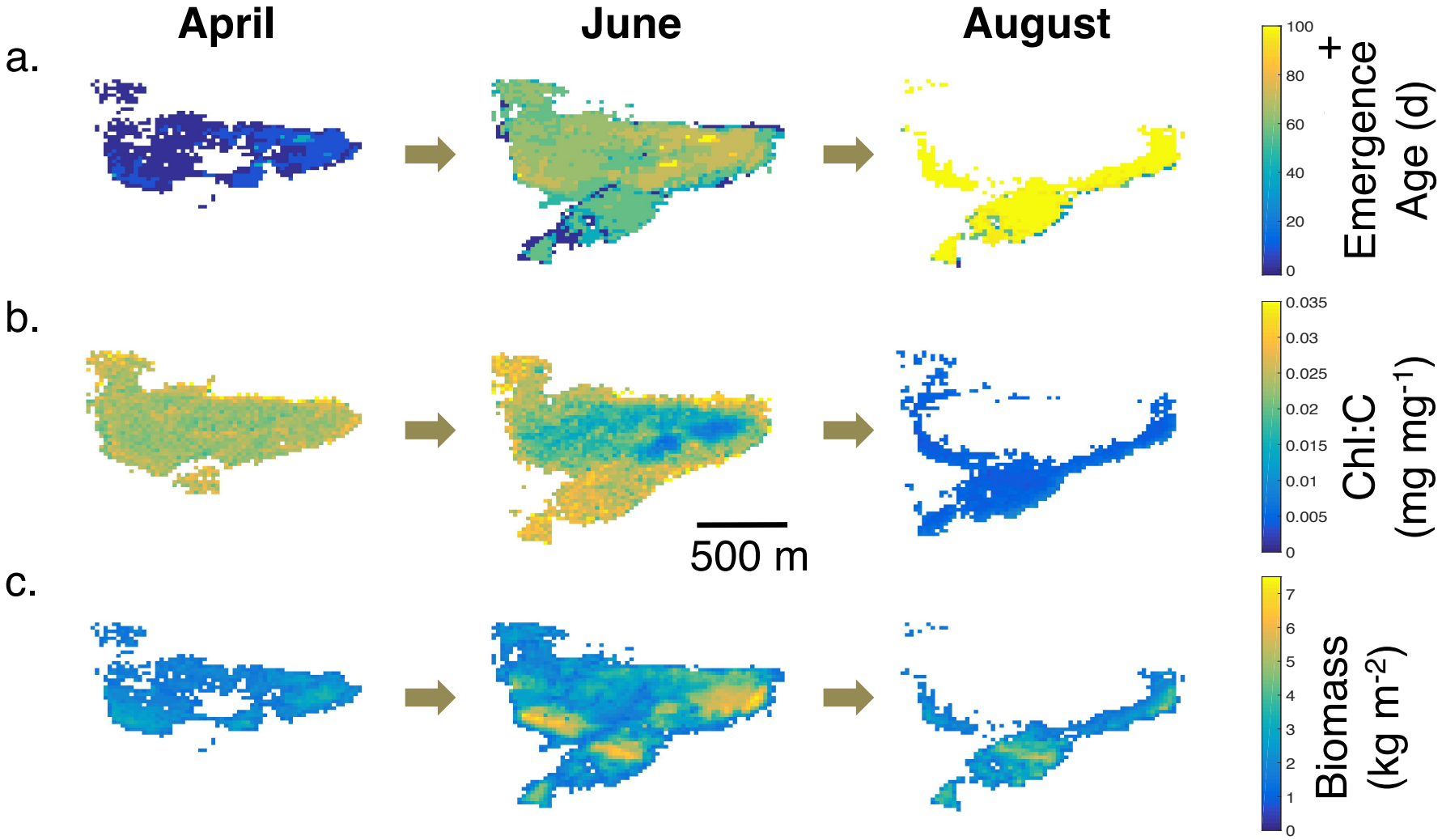


Catlett et al., in prep

New Products: Remote Sensing

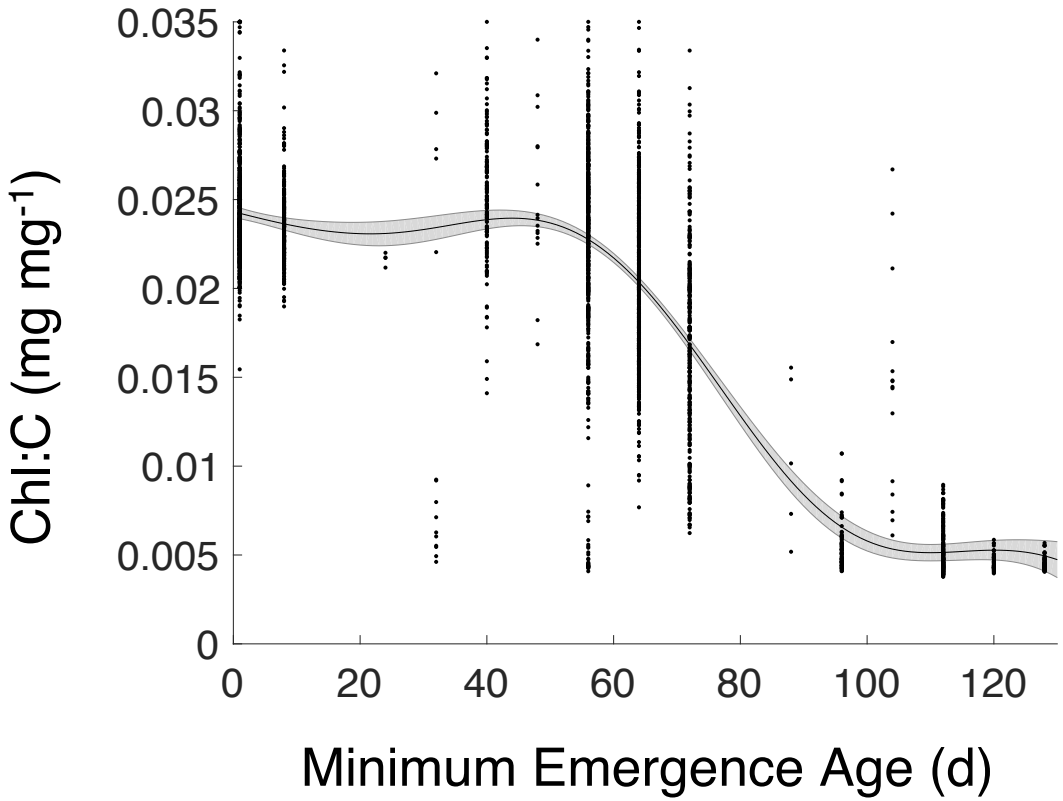
Kelp condition, age, and forest extent

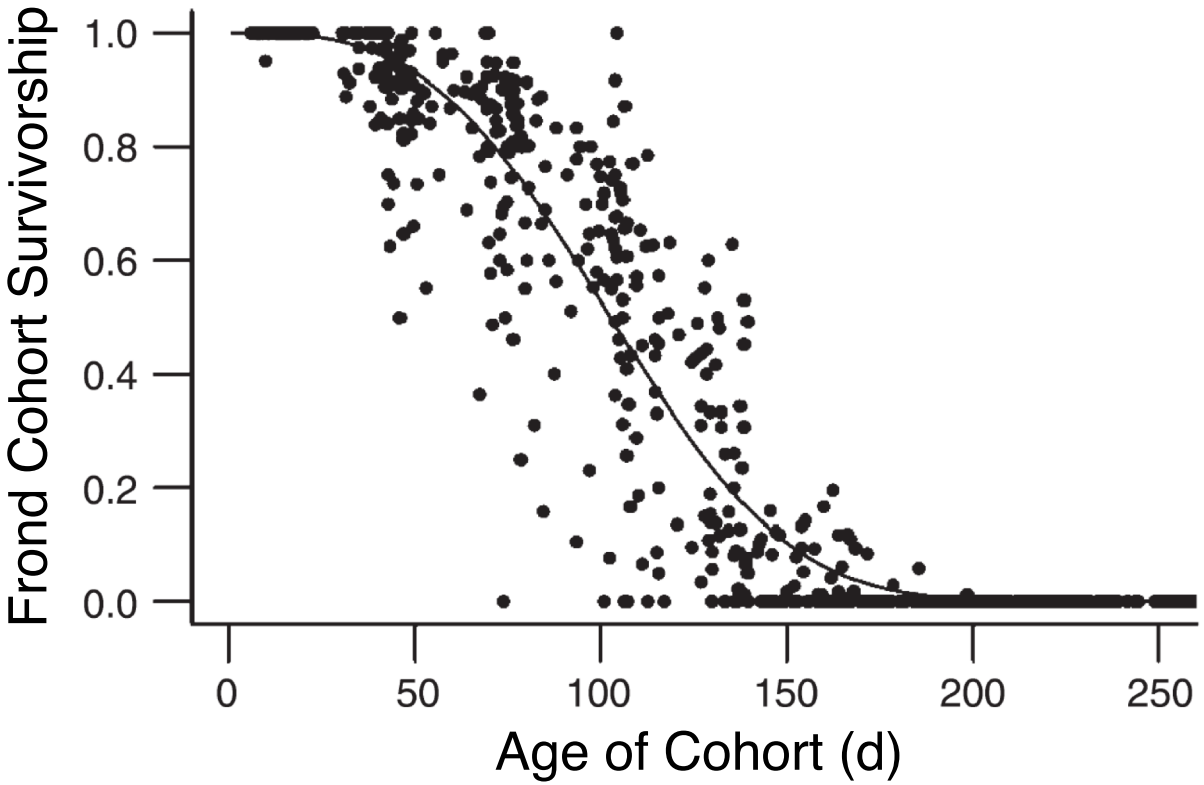
AVIRIS
Airborne Visible / Infrared Imaging Spectrometer



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

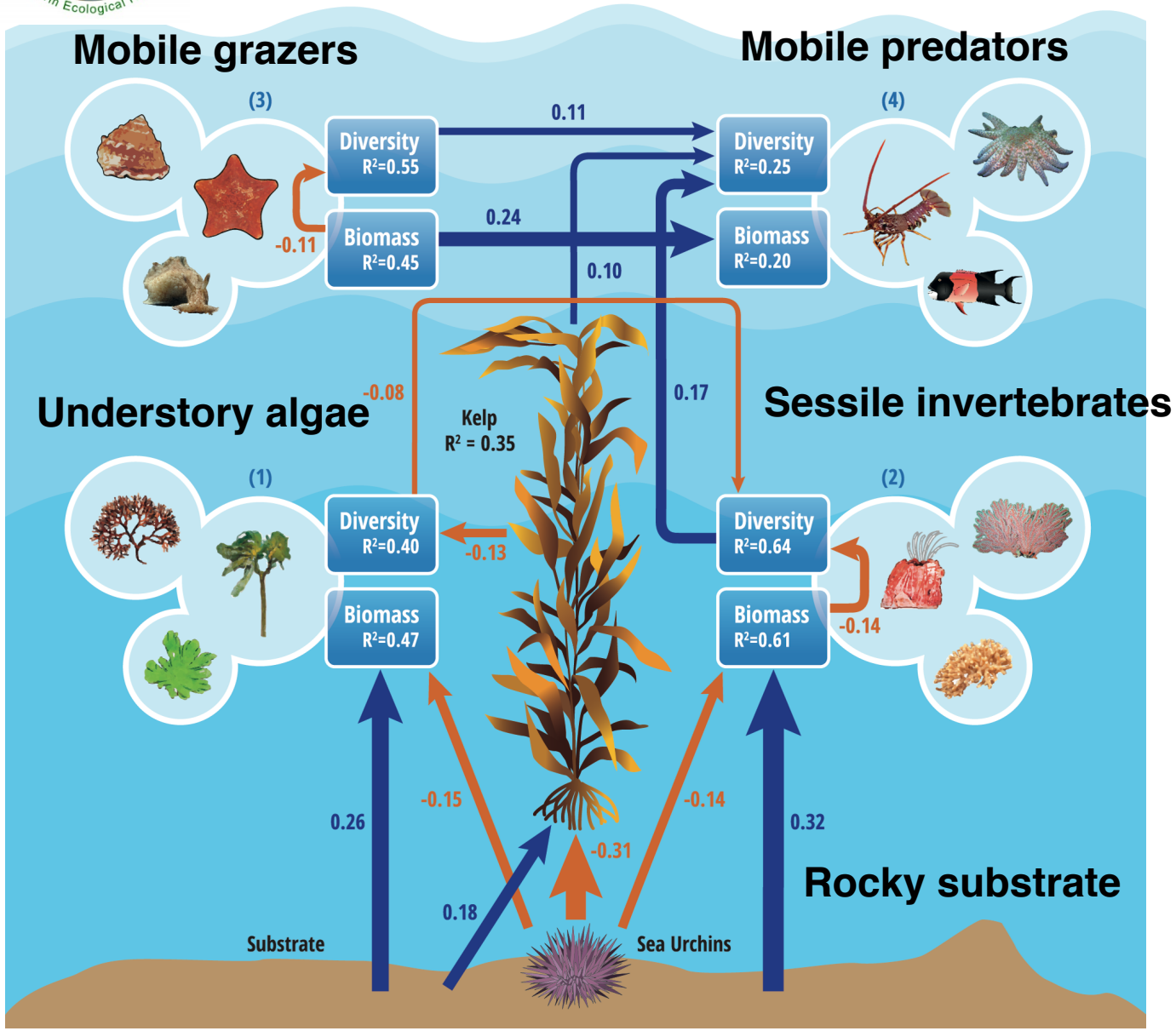
Kelp age and demographics can be modeled from RS data





Bell & Siegel in prep

What does kelp data tell us about broader biodiversity?



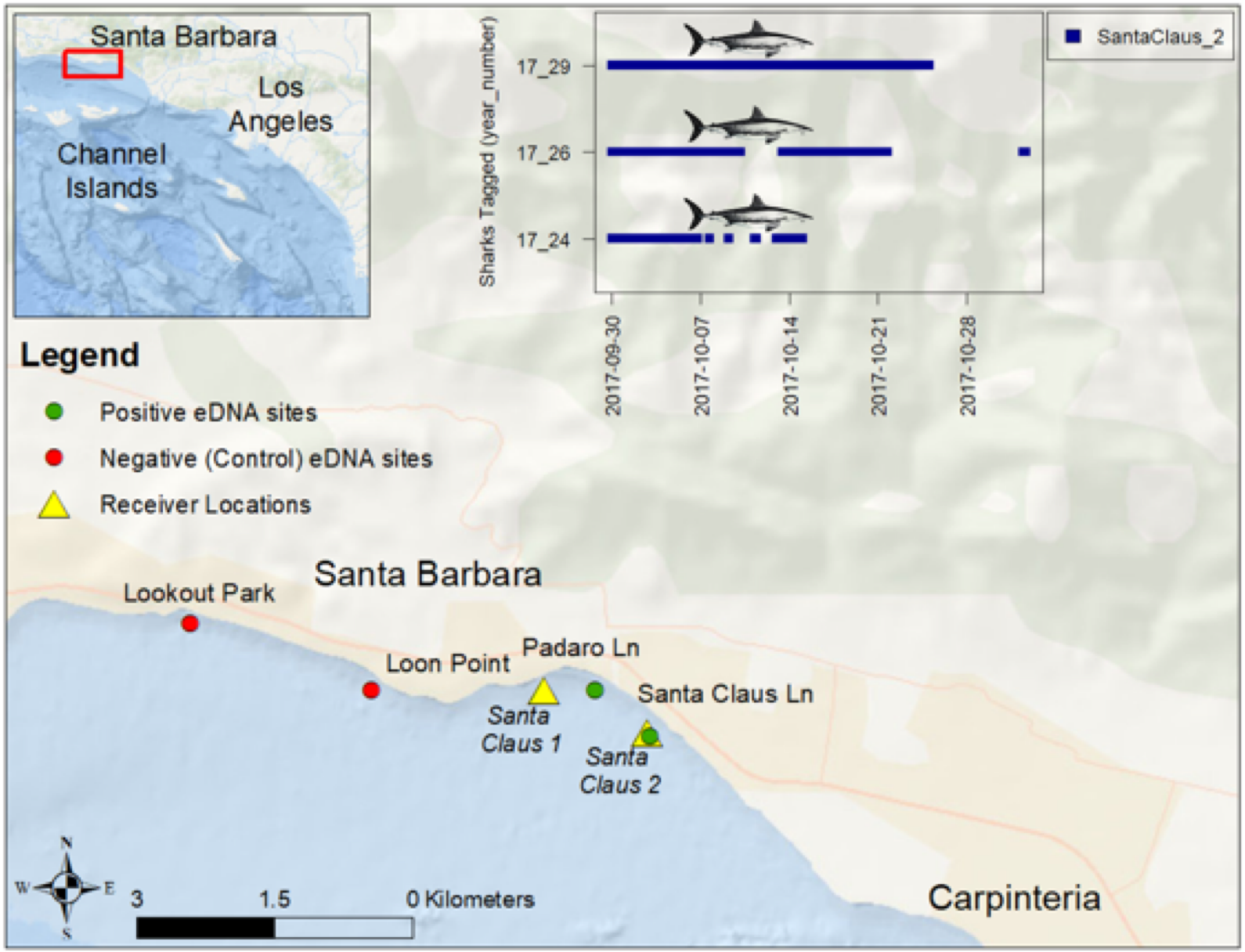
Giant kelp increases biodiversity through physical engineering

Kelp positively affects kelp forest species richness, especially sessile invertebrates and mobile predators

PROCEEDINGS OF THE ROYAL SOCIETY B
BIOLOGICAL SCIENCES

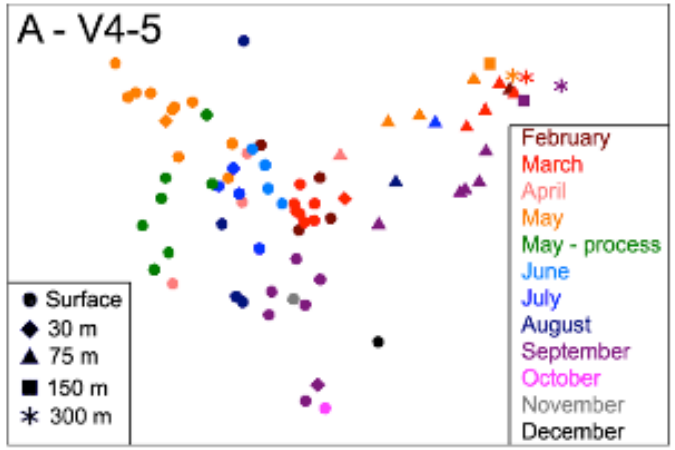
Miller et al 2018

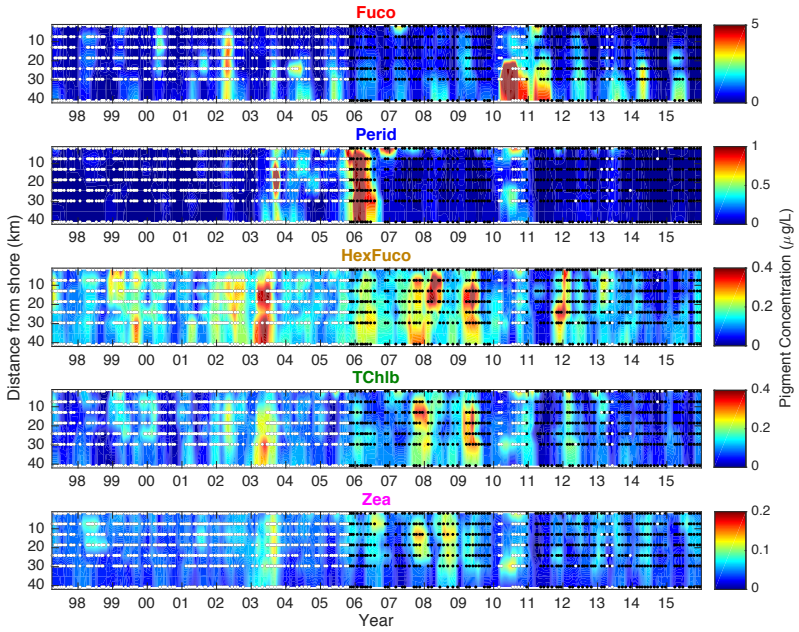
eDNA and Acoustic Telemetry Detection of Great White Sharks



Lafferty et. al in review, Biology Letters

Remote Sensing & Genomics: users





BOEM
Bureau of Ocean Energy Management

- Spatial maps of biodiversity
- Oil-degrading microbes
- Natural seeps as source
- DOI Remote Sensing Working Group (DOIRSWG)

SCCWRP
Established 1969

- Coliform bacteria
- Pathogens

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

- HABS
- *Pseudo-Nitschia*

NASA

- PACE, HyspIRI/ESBG
- Phyto Functional Types

MARINE BIODIVERSITY OBSERVATION NETWORK

SANTA BARBARA CHANNEL

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Marine Science Institute
University of California Santa Barbara