Who we are

Principal/Associate Investigators

Marine Science Institute
Robert Miller, Andrew Rassweiler, Daniel Reed, Milton Love

Ecology Evolution and Marine Biology
Craig Carlson, Deborah Iglesias-Rodriguez, Doug McCauley

Geography
David Siegel, Phaedon Kyriakidis

Electrical and Computer Engineering
BS Manjunath

USGS
Kevin Lafferty

UCSD - SIO
John Hildebrand

NOAA – NMFS SWFSC
Andrew Thompson
Who we are

Partners

Plumes and Blooms
Channel Islands National Marine Sanctuary
Southern California Coastal Water Research Project
Santa Barbara Coastal Long Term Ecological Research Program
Southern California Coastal Ocean Observing System (SCCOOS)
Channel Islands National Park
Gray Whales Count
CalCOFI
Goals:

1. Integrate biodiversity data to enable inferences about regional biodiversity

2. Develop advanced methods using imagery and genomics for monitoring biodiversity

3. Implement a tradeoff framework that optimizes allocation of sampling effort
Uncovering the complex and multiscale drivers of kelp forest communities

What environmental factor(s) underlie each spatial scale?

Thomas Lamy

What are the most important scales of variation?

Lamy et al., in review, *Oecologia*
Species Archetype Modelling (SAM) for ecological forecasting

Modelling species response to environmental gradients and reducing dimensionality

**DATA MATRICES**

**GLMs**

\[ E(Y_{i1}) = g^{-1}(\beta_{i0} + X_{i1} \beta_{i1} + ... + X_{ip} \beta_{ip}) \]

\[ E(Y_{i2}) = g^{-1}(\beta_{i0} + X_{i1} \beta_{i1} + ... + X_{ip} \beta_{ip}) \]

\[ E(Y_{i3}) = g^{-1}(\beta_{i0} + X_{i1} \beta_{i1} + ... + X_{ip} \beta_{ip}) \]

\[ E(Y_{iN}) = g^{-1}(\beta_{i0} + X_{i1} \beta_{i1} + ... + X_{ip} \beta_{ip}) \]

**CLUSTERING/FITTING**

**OUTPUT**

<table>
<thead>
<tr>
<th>Species</th>
<th>Arch</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>0.02</td>
</tr>
<tr>
<td>A</td>
<td>2</td>
<td>0.97</td>
</tr>
<tr>
<td>A</td>
<td>3</td>
<td>0.01</td>
</tr>
<tr>
<td>...</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>3</td>
<td>0.95</td>
</tr>
</tbody>
</table>

**Envt1** | **Envt2** | **Envt3**
---|---|---
Arch1 | -0.9 | 0.5 | -0.3
Arch2 | 0.5  | 0.9 | 0.2
Arch3 | 0.5  | -0.2| 0

SAM method: Dunstan et al. 2011, 2013
Landsat Kelp Forest Canopy Biomass & NPP

\[ y = 0.9722x - 0.0012 \]
\[ r^2 = 0.66 \]

Cavanaugh et al 2010, 2011, 2013, Bell et al. 2015 J Biogeography, Bell et al. L&O in review
Hyperspectral aerial flights conducted 3x year\(^{-1}\) in 2013 – 2015 using the AVIRIS sensor as part of the HyspIRI preparatory campaign.

Chl:C estimated from hyperspectral images closely resembles Chl:C measured in the laboratory.

Bell et al. 2015 Remote Sensing Env. and Bell et al. *in prep*
Giant kelp is a foundation species that positively affects reef biodiversity directly and indirectly.
Deep learning for image analysis

- Scalable deployment of CNN models
- Hierarchical models
  - Taxonomic: Genus -> Species
  - Ontological: Substrate -> Exact object
Acoustic Detection of Marine Mammals

Warm anomaly in 2013-2015 caused baleen whales to move into SBC

Hildebrand et al. *in prep*

Blue Whale

Fin Whale
Prokaryote diversity and richness show distinct temporal patterns in the surface SBC

- Time-series from 2010 –2014
- Bacteria and archaea from 16S rRNA gene (V4 region)
- 578 samples from 43 cruises sequenced

Wear et al. *in prep*
Modeling Phytoplankton Pigment “Communities”

- Derivative analysis of phytoplankton absorption spectra isolates absorption features with robust relationships to phytoplankton pigments and communities
- Pigment communities (defined with cluster, EOF analyses) can be modeled using relationships with spectral absorption signatures

<table>
<thead>
<tr>
<th>Model Retrievals</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>TChlb (green algae)</td>
<td>0.815</td>
</tr>
<tr>
<td>HexFuco (haptophytes)</td>
<td>0.733</td>
</tr>
<tr>
<td>Fuco (diatoms)</td>
<td>0.856</td>
</tr>
<tr>
<td>Perid (dinoflagellates)</td>
<td>0.887</td>
</tr>
<tr>
<td>Pigment EOF Mode 1 (Early upwelling mixed bloom)</td>
<td>0.884</td>
</tr>
<tr>
<td>Pigment EOF Mode 2 (Diatoms vs. mixed nano-/pico-)</td>
<td>0.852</td>
</tr>
<tr>
<td>Pigment EOF Mode 3 (Pico-plankton vs. haptophytes)</td>
<td>0.454</td>
</tr>
<tr>
<td>Pigment EOF Mode 4 (Dinoflagellates vs. mixed diatoms/haptophytes)</td>
<td>0.809</td>
</tr>
</tbody>
</table>

*Catlett and Siegel, in prep.*
Next Steps

- Apply model to hyperspectral remote sensing reflectance observations from AVIRIS and Plumes and Blooms archive
- Incorporate Next-Gen Sequencing observations for validation of phytoplankton community composition retrievals from remote sensing algorithms

*Figure adapted from Dierssen et al. 2006 (left), Catlett and Siegel in prep. (center), and Ciccarelli et al. 2006 (right)*
Metabarcoding to identify pelagic ichthyoplankton

- Collected 74 samples from three coastal cruises
- Morphologically ID all fish
- Confirmed ID with Sanger sequencing
- In process of bulk tissue sequencing
- Working with Sanctuaries MBON team

Dovi Kacev