From Arboreal to Benthic Communities:

The ABCs of land-to-ocean biodiversity observations

Land to Ocean Biodiversity Observations
From Arboreal to Benthic Communities: The ABCs of land-to-ocean biodiversity observations

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Erik Bolch, Justin Saarinen, Matt McCarthy
Over 75% of aquatic ecosystems are endangered.

Coastal and freshwater ecosystems support some of the highest biodiversity in the world.
Remote sensing enables us to consider land and adjacent marine ecosystems as part of a continuum.
The ABCs of land-to-ocean biodiversity observations

Scoping study for land-to-ocean airborne campaign with ER-2

- AVIRIS-NG
- PRISM
- HyTES
- LVIS

Airborne missions designed to explicitly address the needs of linked terrestrial, aquatic, and benthic ecological research

- Observations strategies
- Calibration correction & algorithm requirements
- Complementary field & satellite data, numerical models & simulations
Overarching science questions

• What is the distribution and spatial configuration of coastal biodiversity at the scales of ecosystem, species, functional & phenological diversity?

• How does coastal biodiversity change due to tidal and event-driven flooding, with the seasons, and inter-annually?

• What specific remote sensing strategies are required to clearly identify these changes and processes?
  – From tree-top to sea-floor
South Florida: A major sub-tropical Land-Ocean domain

- Substantial ecological, community, taxonomic and genetic diversity
  - 68 federally listed species
  - 422 state listed species
- Everglades National Park
  - 3rd largest wilderness area in US
- Florida Keys National Marine Sanctuary
  - Over 6,000 species
  - Only living barrier reef in N. America
- Complex social-ecological system
Key partners and existing efforts

- FL Coastal Everglades LTER
  - Watershed focus
  - Social-ecological systems
- NOAA Atlantic Oceanographic & Met Lab
- FL Keys National Marine Sanctuary (FKNMS)
  - GCOOS & MBON
High spatial resolution wetland mapping
G-LiHT as a proof of concept

Mixing of Shark River and Gulf waters

Mouth of Shark River

VNIR At-Sensor Reflectance Spectra

[From David Lagomasino]
DMAC: Development of MBON Visualization

Select biodiversity indices

Select individual species, plot over time

Satellite overlay layers (SST, VIS bands, FLH)

Select biodiversity indices plot over time

[From Frank Muller-Karger]
Current capabilities and future opportunities

<table>
<thead>
<tr>
<th>EBV class</th>
<th>EBV</th>
<th>Habitat Type</th>
<th>Wetland Vegetation</th>
<th>Benthic Communities</th>
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Legend:
- Unproven
- Demonstrated limited cases
- In use
- Habitat model required

[Muller-Karger et al 2017]
Observation strategies:

H4 sensing

1. High spatial resolution
2. High spectral resolution
3. High radiometric quality
4. High temporal resolution
Spatial resolution

FRACTION OF PIXEL CONTAINING MARINE WETLAND CLASS

30 m

60 m

100 m

240 m

600 m

1200 m [Turpie et al. 2015]
High spectral resolution for species discrimination

Species detectable at leaf scale

Native vs Non-native detectable at canopy (pixel) scale

[Santos et al. 2012 New Phytologist]
Wetlands and aquatic targets at different view angles

Higher reflectance when looking straight down because you see water in addition to vegetation.
Med-high view angles are optimal for above-ground biomass estimation from spectroscopy.
Radiometric and spatial resolution

Giardino et al. 2007: Hyperion SNR 30 m → 150 m
Vanhellemont & Ruddick 2014: Landsat 7 to 8 SNR 30 m → 270 m
Vanhellemont & Ruddick 2014: Landsat 7 to 8 bits 30 m → 330 m
Phenology may vary spatially

[From Christiana Ade]
Temporal resolution

[Image of a graph showing changes in phycoerythrin index over the year with labeled data points and a reference to Muller-Karger et al. 2017]
Stakeholder engagement for STM, implementation, sampling strategy and data users

- FL FCE LTER
- NOAA AOML
- FKNMS
- USDA Forest Service
- Everglades NPS
- South FL Water Management District
- Research Organizations
  - Smithsonian TRI
  - Universities
Let’s fly Florida!

ER-2 campaigns across the land-ocean continuum will enable innovation in biodiversity observations and applications.

The ABC LOBOs campaign will enable valuation of coastal ecosystem services, and help conservation and restoration planning and implementation.