Using hyperspectral airborne PRISM imagery to map vulnerable coastal salt marsh and seagrass habitats

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Marine Sciences/Geography

Acknowledgements

- UCONN COLORS Lab- Eric Heupel (photographs), Kelley Bostrom, Brandon Russell
- NASA JPL
- Naval Research Lab
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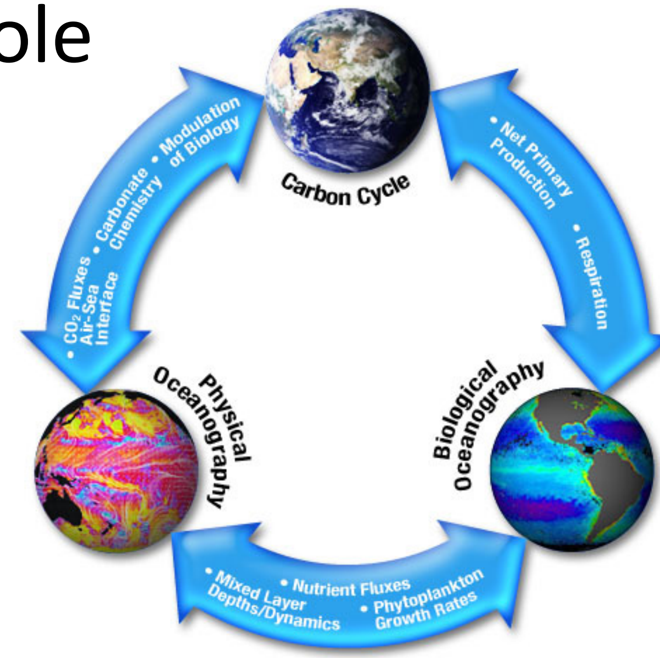
- Field Validation team for PRISM
  - NASA Ames
  - University of Santa Cruz
  - Moss Landing Marine Labs
  - Monterey Bay Aquarium Research Institute
- Richard Zimmerman, Old Dominion University

Why seagrasses and salt marshes?

- Improved understanding of role of shallow banks and bays on carbon cycle and climate



- ***BLUE*** Carbon
  - Coastal vegetation sequesters carbon more effectively than terrestrial ecosystems

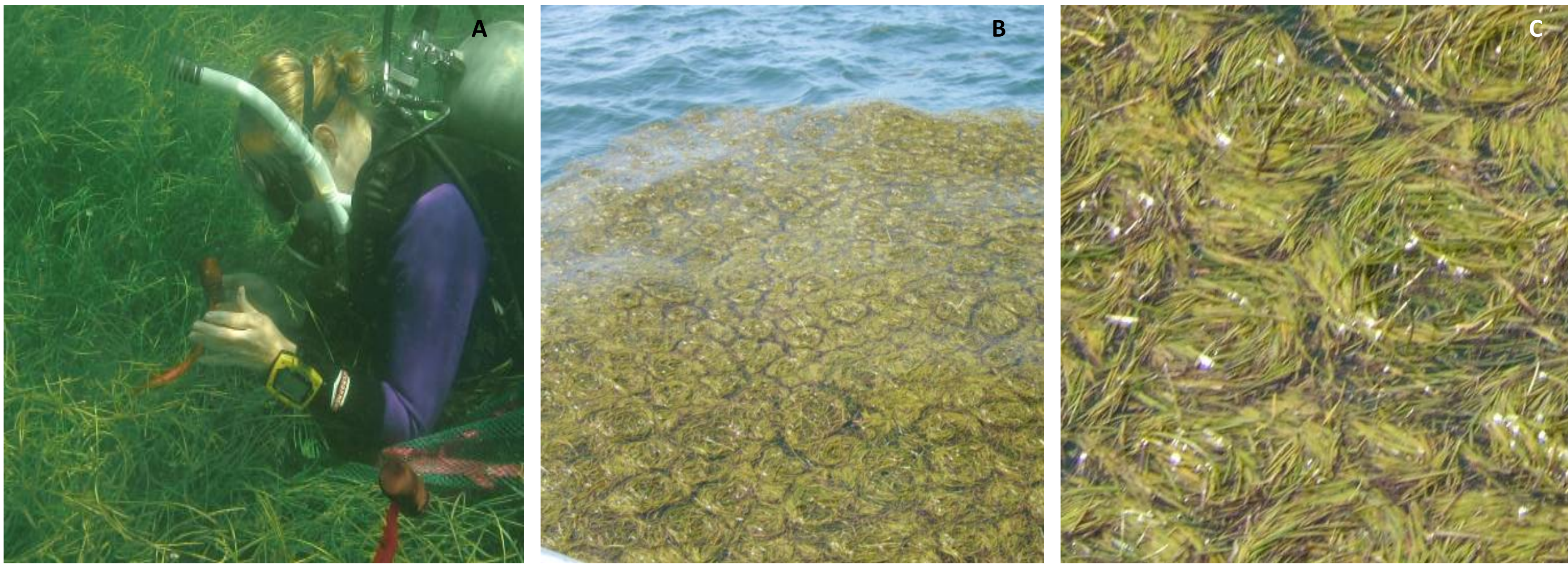
Questions regarding fate of carbon

- Different seagrass species play different ecological roles

- Turtlegrass leaves decompose in the beds

Manateegrass

- Buoyant leaves, exported carbon



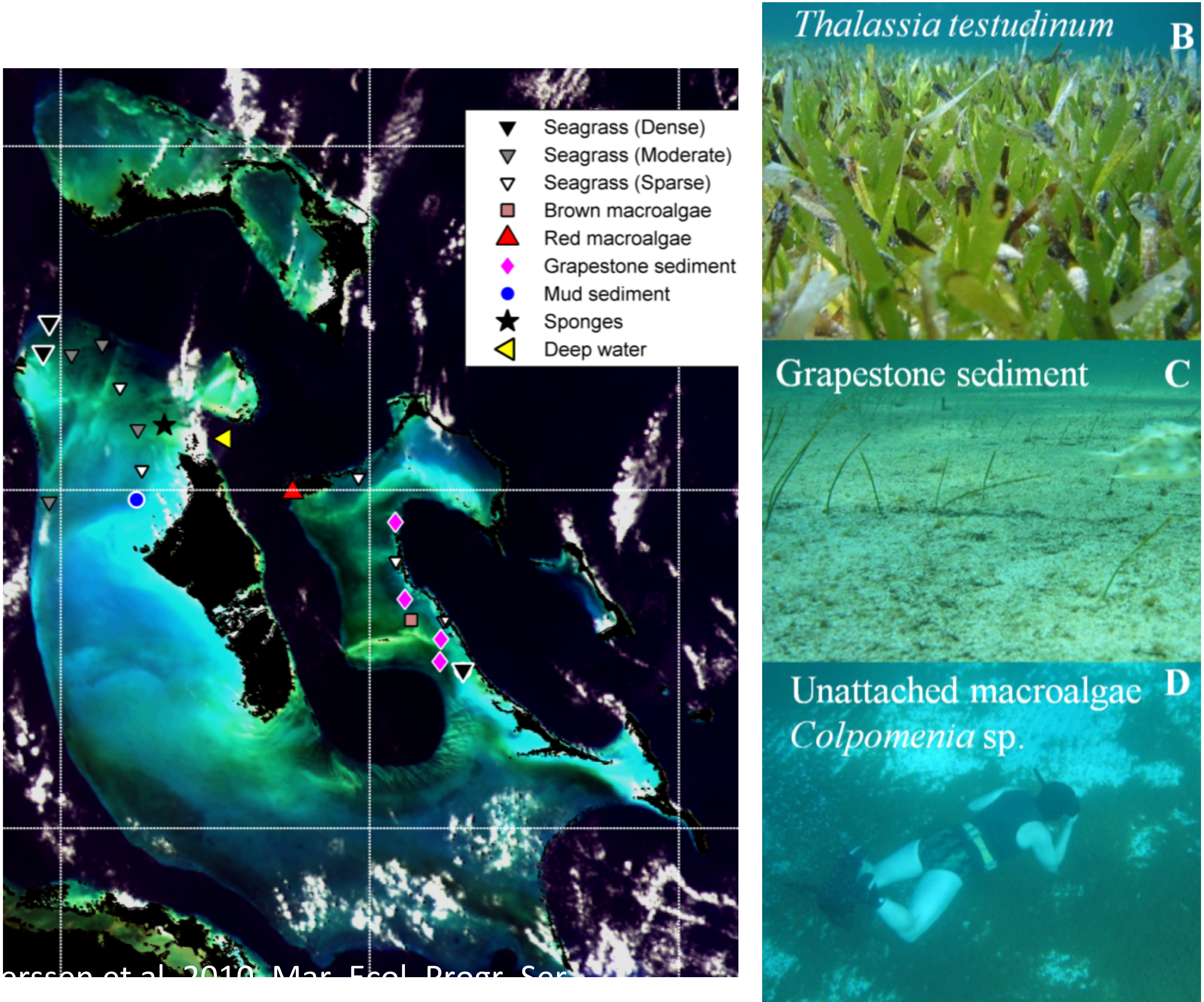

FL Bay seagrass beds have little debris
Export Carbon out of system

Seagrass serves as critical habitat

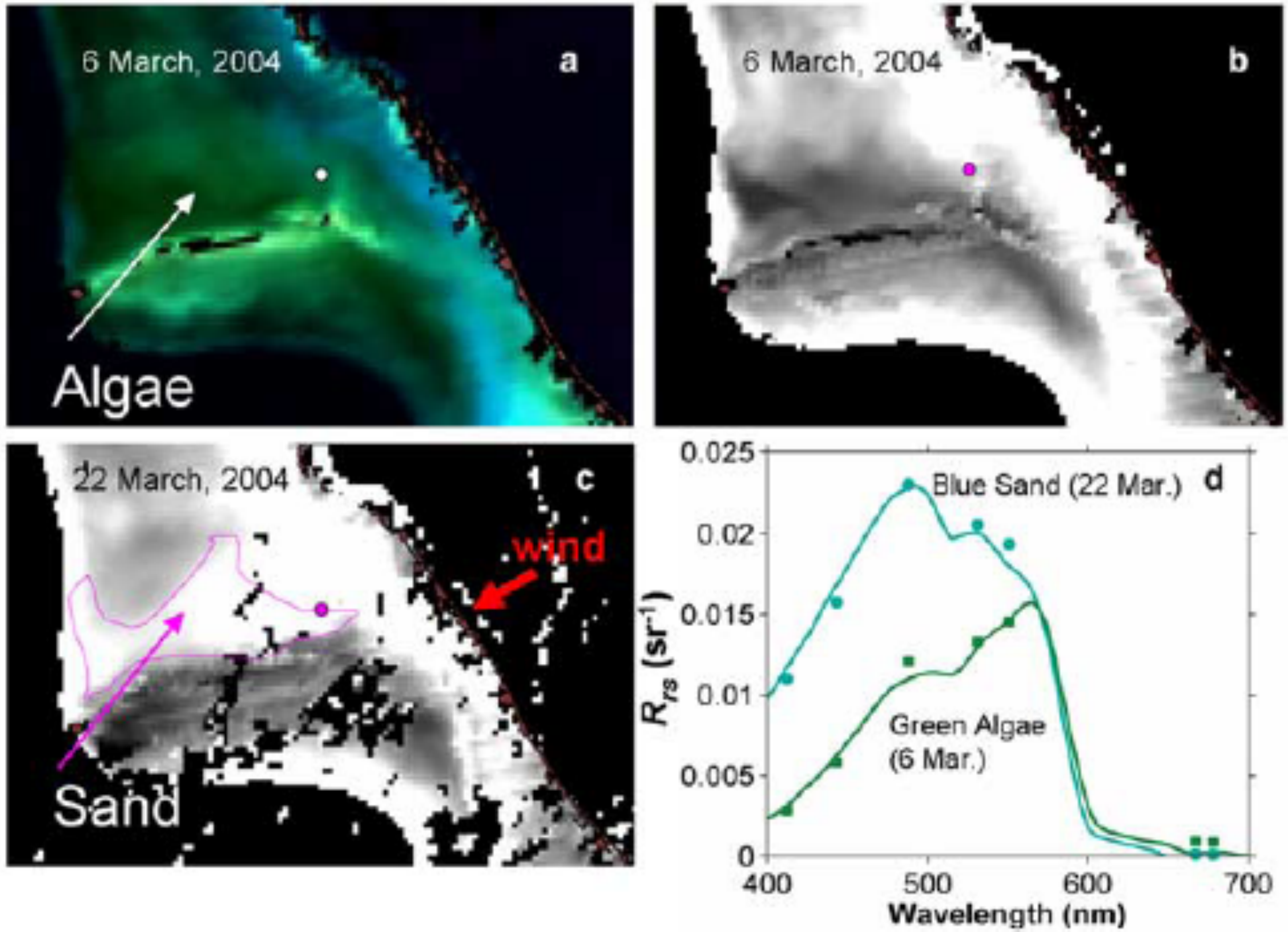
>150 species small invertebrates
100 species algae
Fish

Seagrass as Habitat for Other Organisms


5
3
4
2
1



rsson et al. 2010, Mar. Ecol. Progr. Ser.



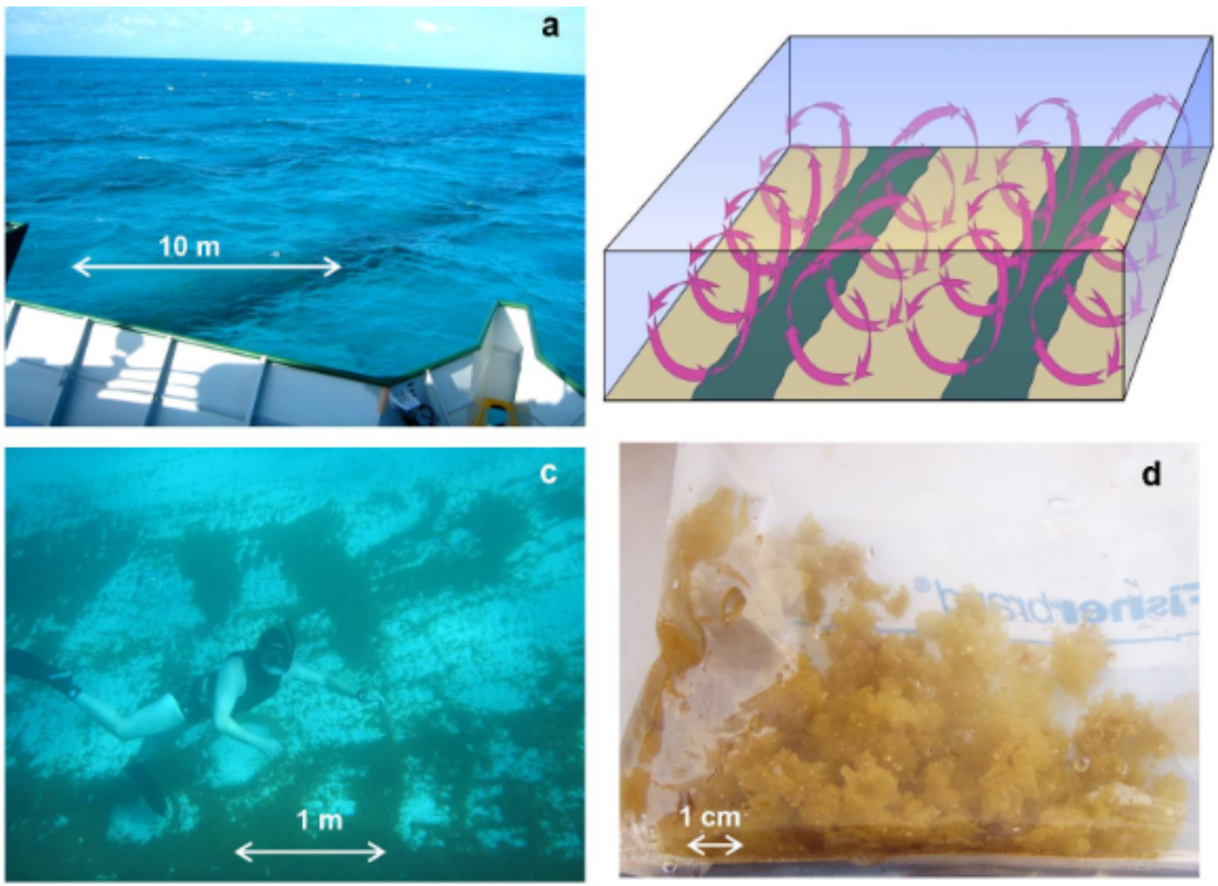
Pulsed export of >7 x10^{10} g of carbon directly to seafloor (negatively buoyant). This is equivalent to the daily carbon flux of phytoplankton biomass in the pelagic tropical North Atlantic and 0.2–0.8% of daily carbon flux from the global ocean.

Dierssen et al. 2009. Geophys. Res. Lett.

GEOPHYSICAL RESEARCH LETTERS, VOL. 36, L04602, doi:10.1029/2008GL036188, 2009

Potential export of unattached benthic macroalgae to the deep sea through wind-driven Langmuir circulation

H. M. Dierssen,[1] R. C. Zimmerman,[2] L. A. Drake,[2,3] and D. J. Burdige[2]



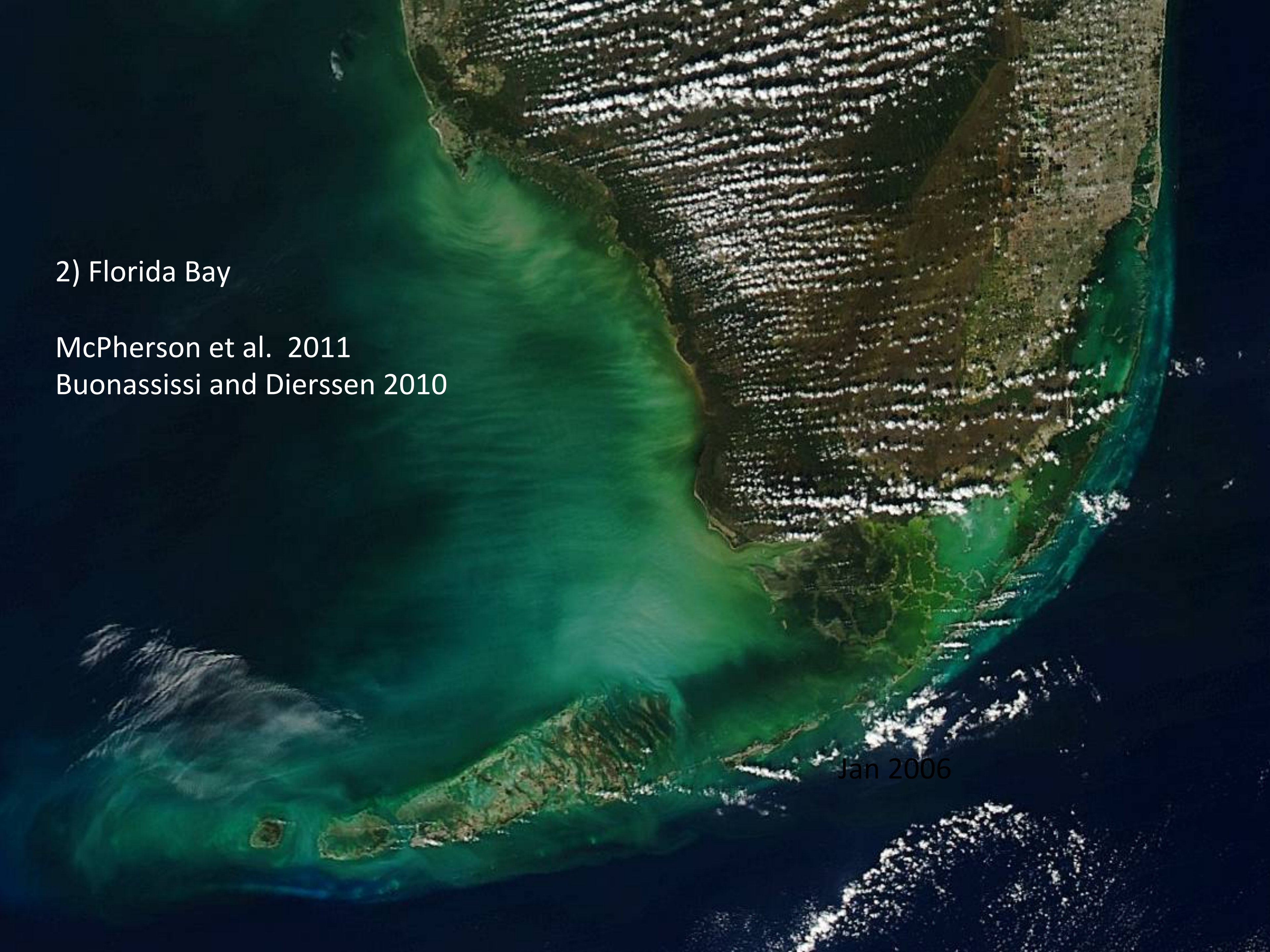
Optics and remote sensing of Bahamian carbonate sediment whitings and potential relationship to wind-driven Langmuir circulation

Biogeosciences, 6, 1–14, 2009
www.biogeosciences.net/6/1/2009/

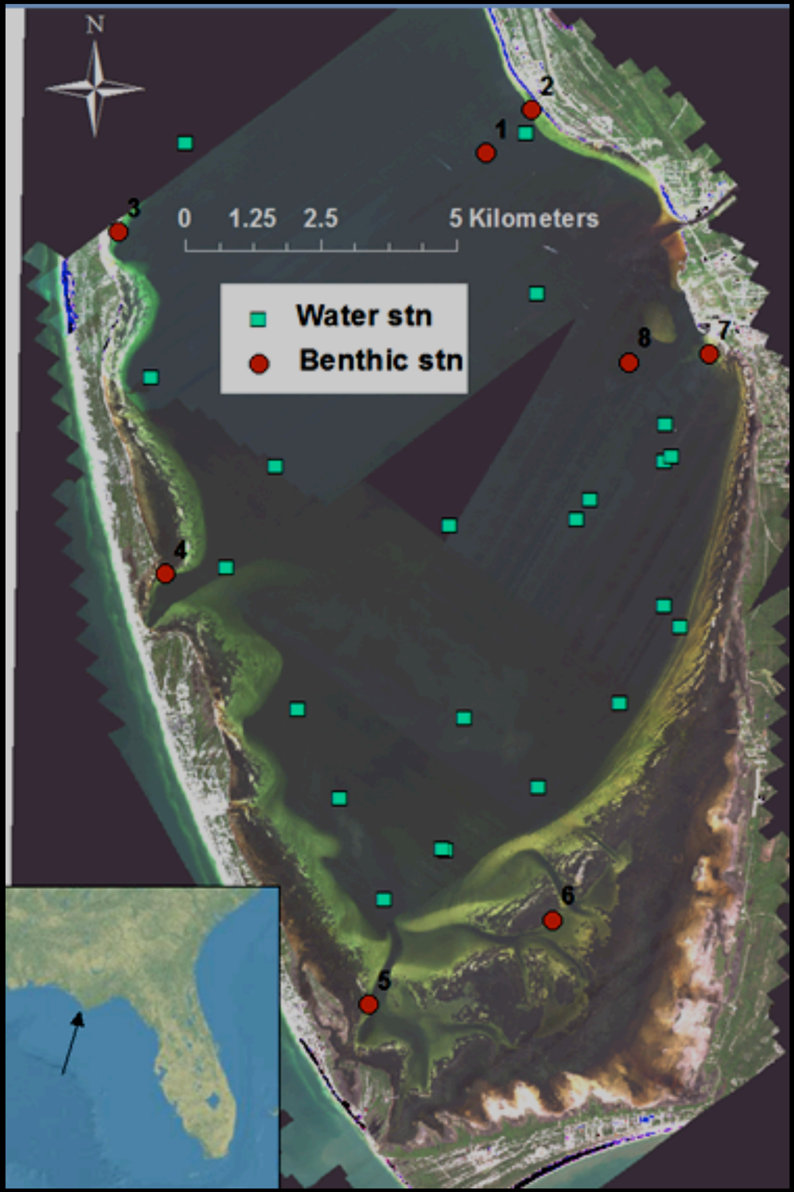
H. M. Dierssen[1], R. C. Zimmerman[2], and D. J. Burdige[2]

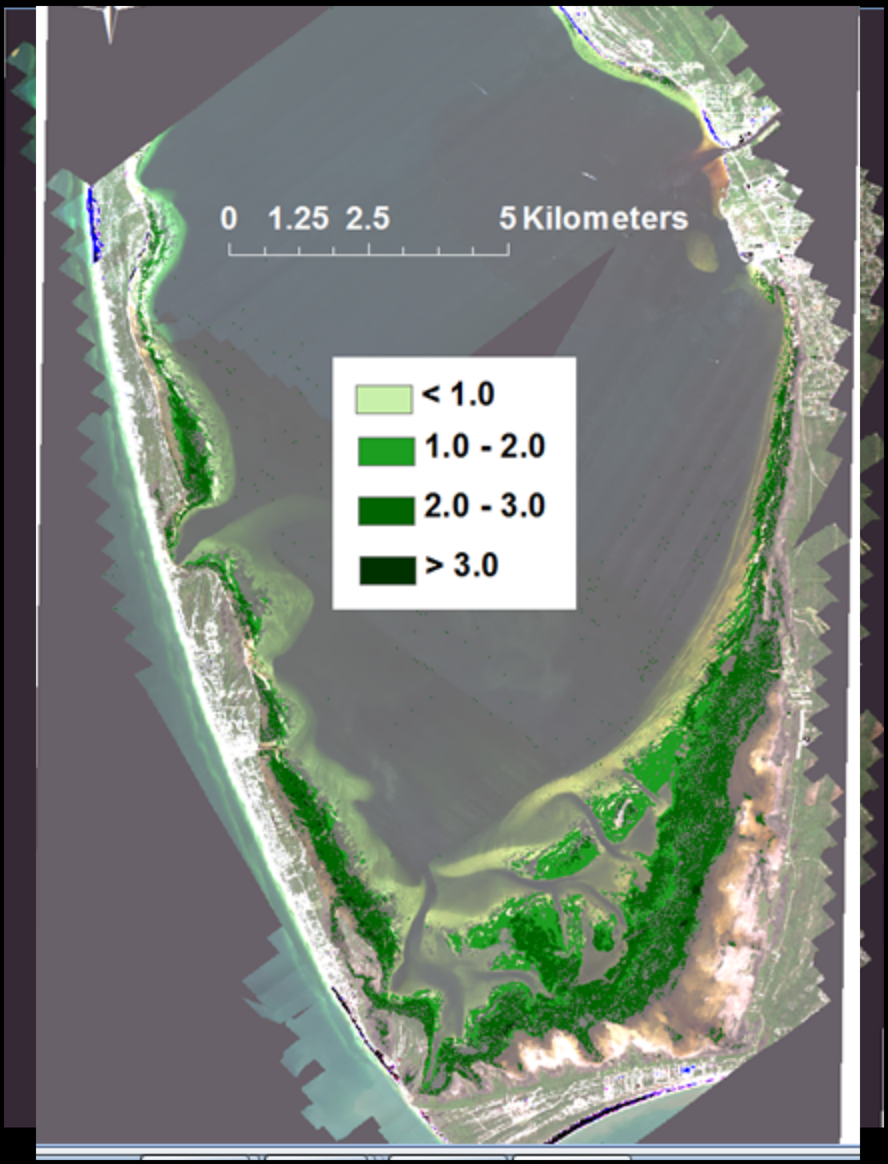
2) Florida Bay

McPherson et al. 2011
Buonassissi and Dierssen 2010



St. Joseph Bay, Florida

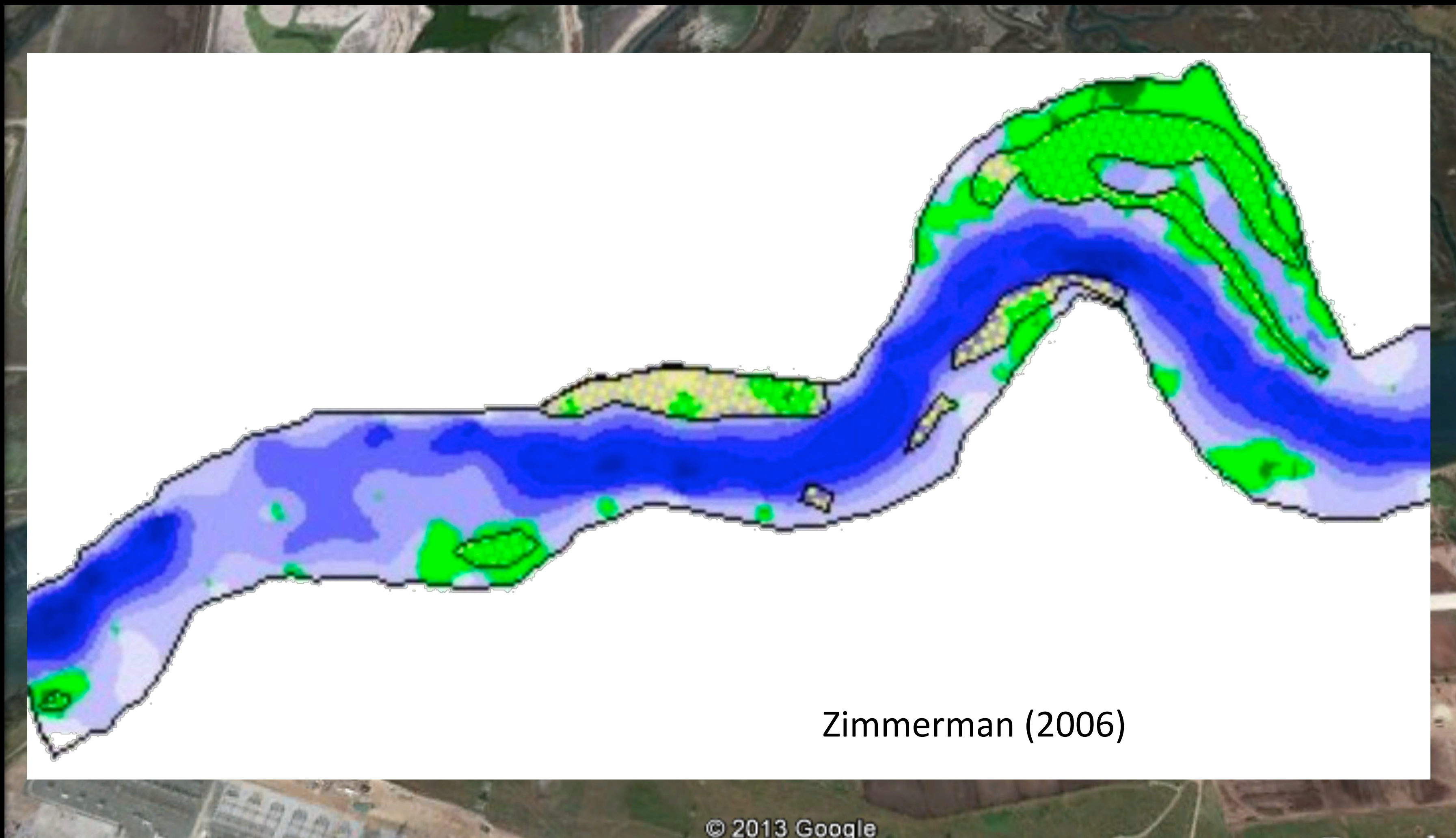


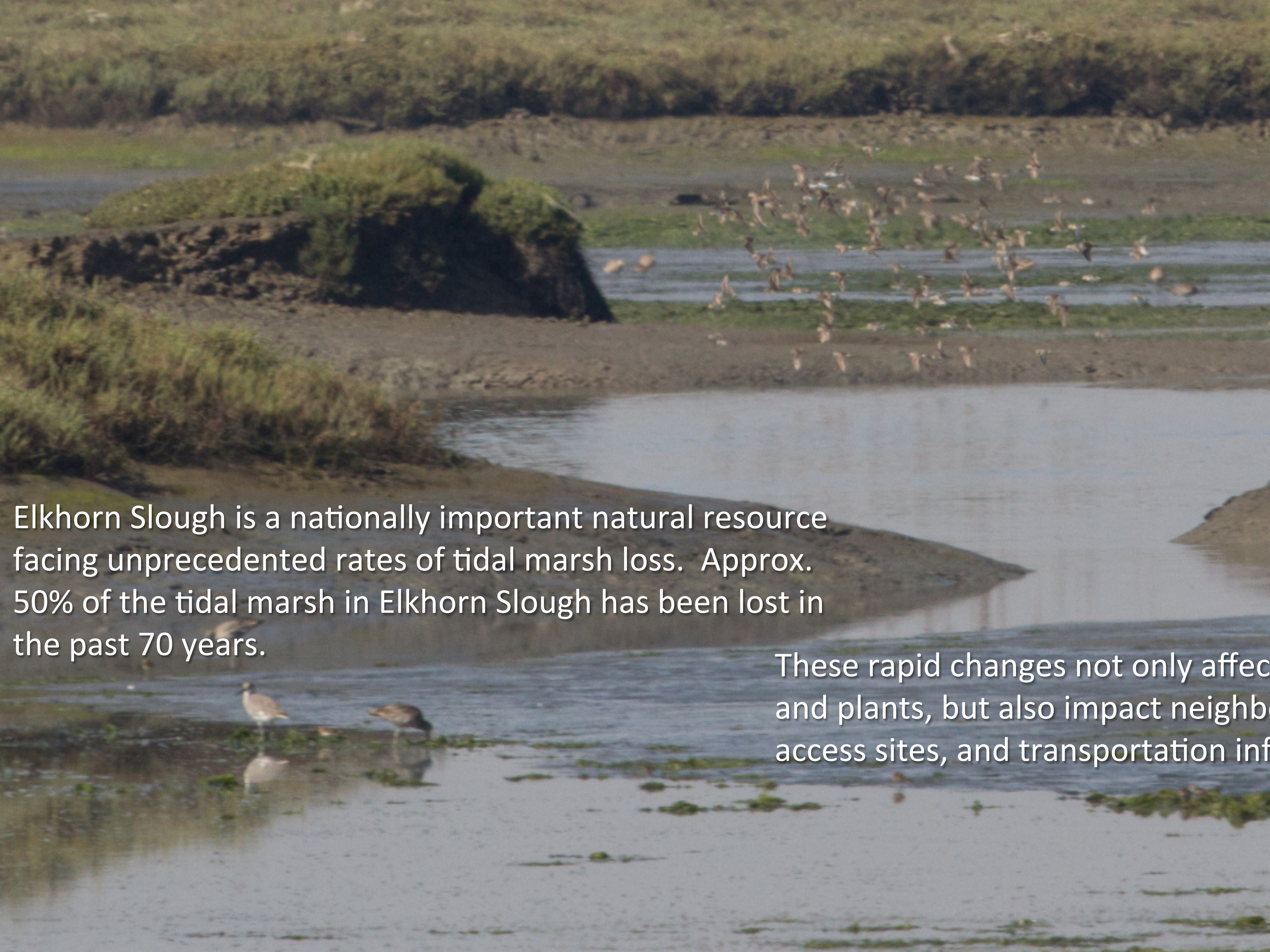


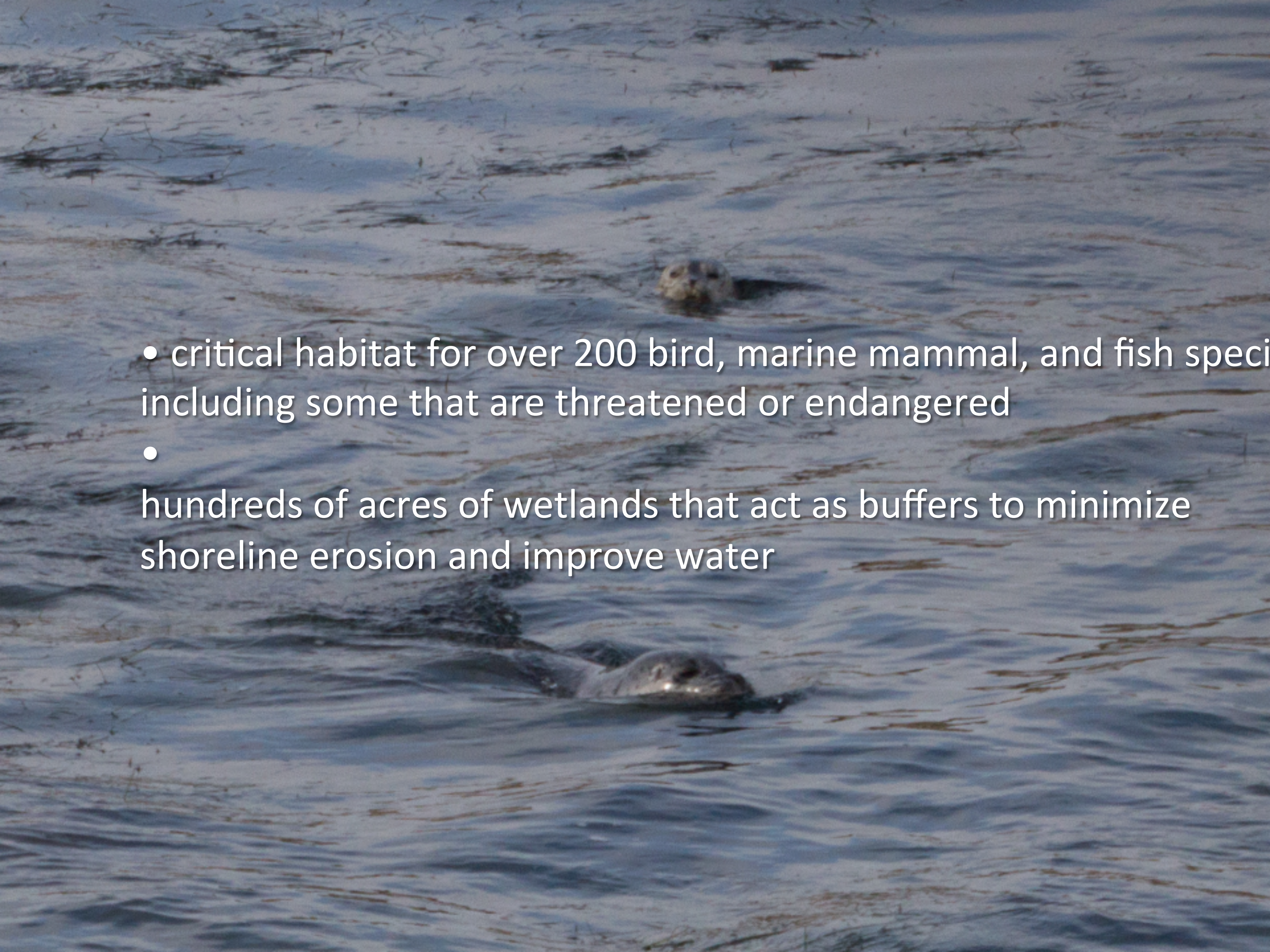
Hill et al. submitted, Est. and Coasts

4) Port Aransas, TX

5) Elkhorn Slough, California




Elkhorn Slough is a nationally important natural resource facing unprecedented rates of tidal marsh loss. Approx. 50% of the tidal marsh in Elkhorn Slough has been lost in the past 70 years.
These rapid changes not only affec
and plants, but also impact neighb
access sites, and transportation inf



- critical habitat for over 200 bird, marine mammal, and fish speci
including some that are threatened or endangered
-

hundreds of acres of wetlands that act as buffers to minimize
shoreline erosion and improve water

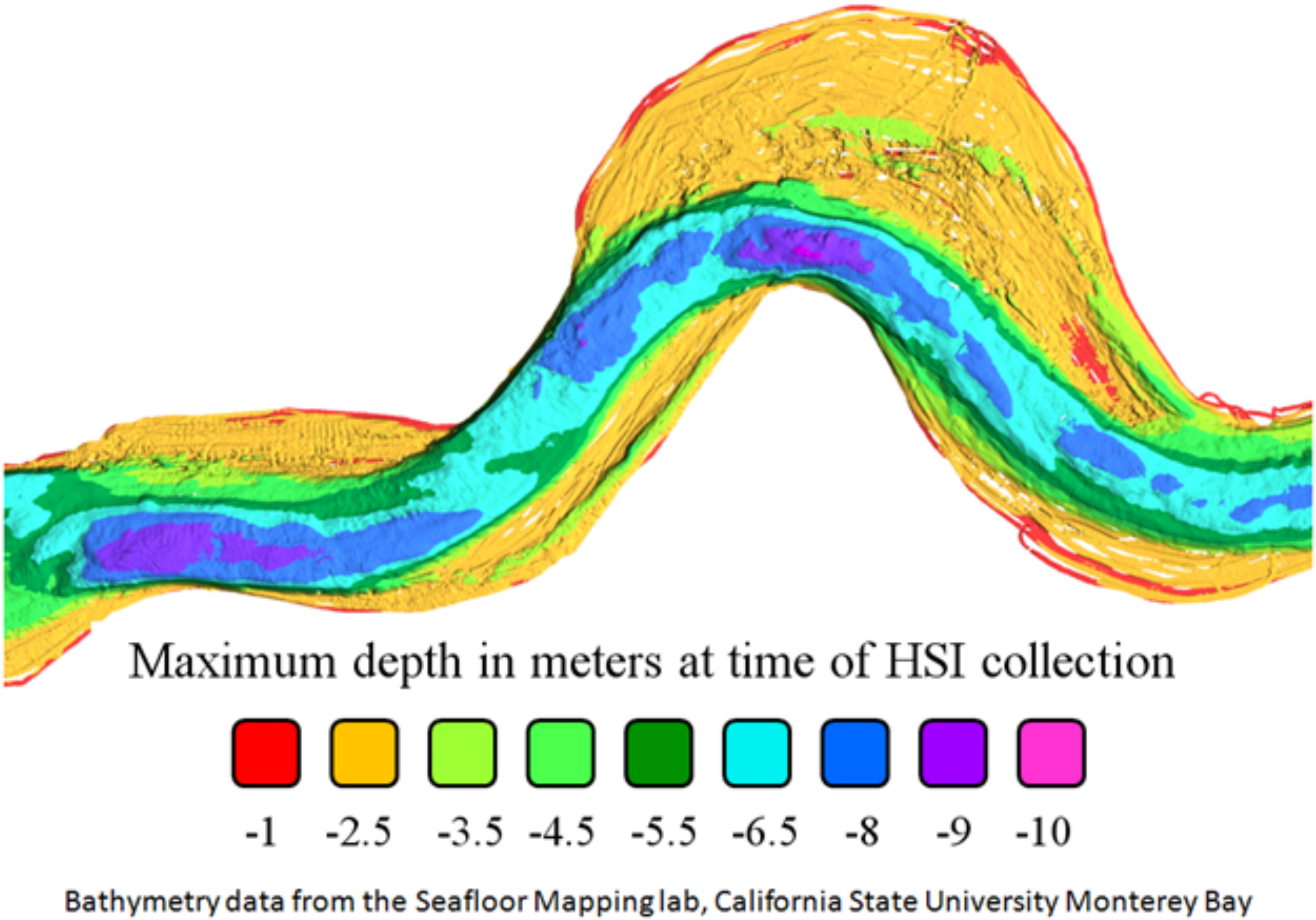


Figure 24 Bathymetry of Elkhorn Slough

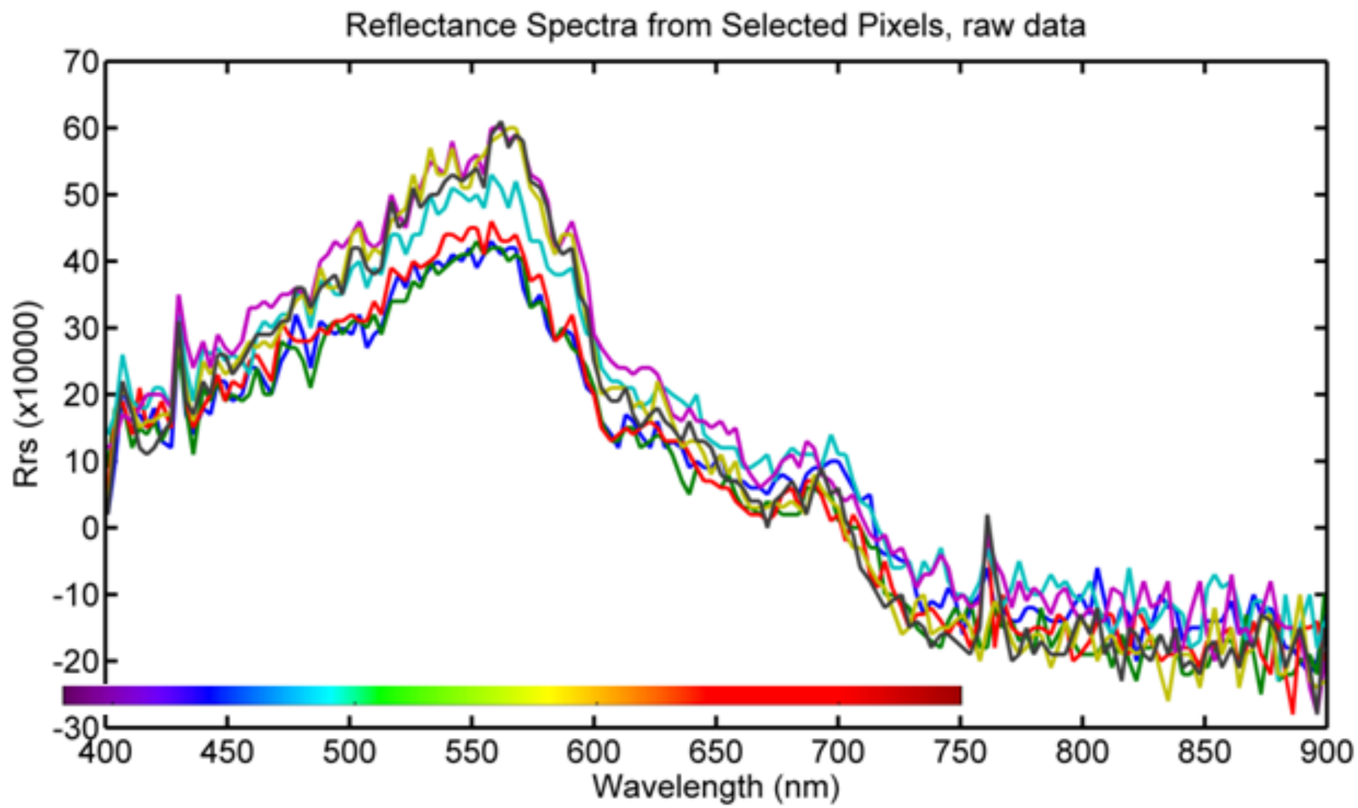
Bostrom, 2012, M.S. thesis

Figure 36 Glint visible in the hyperspectral imagery

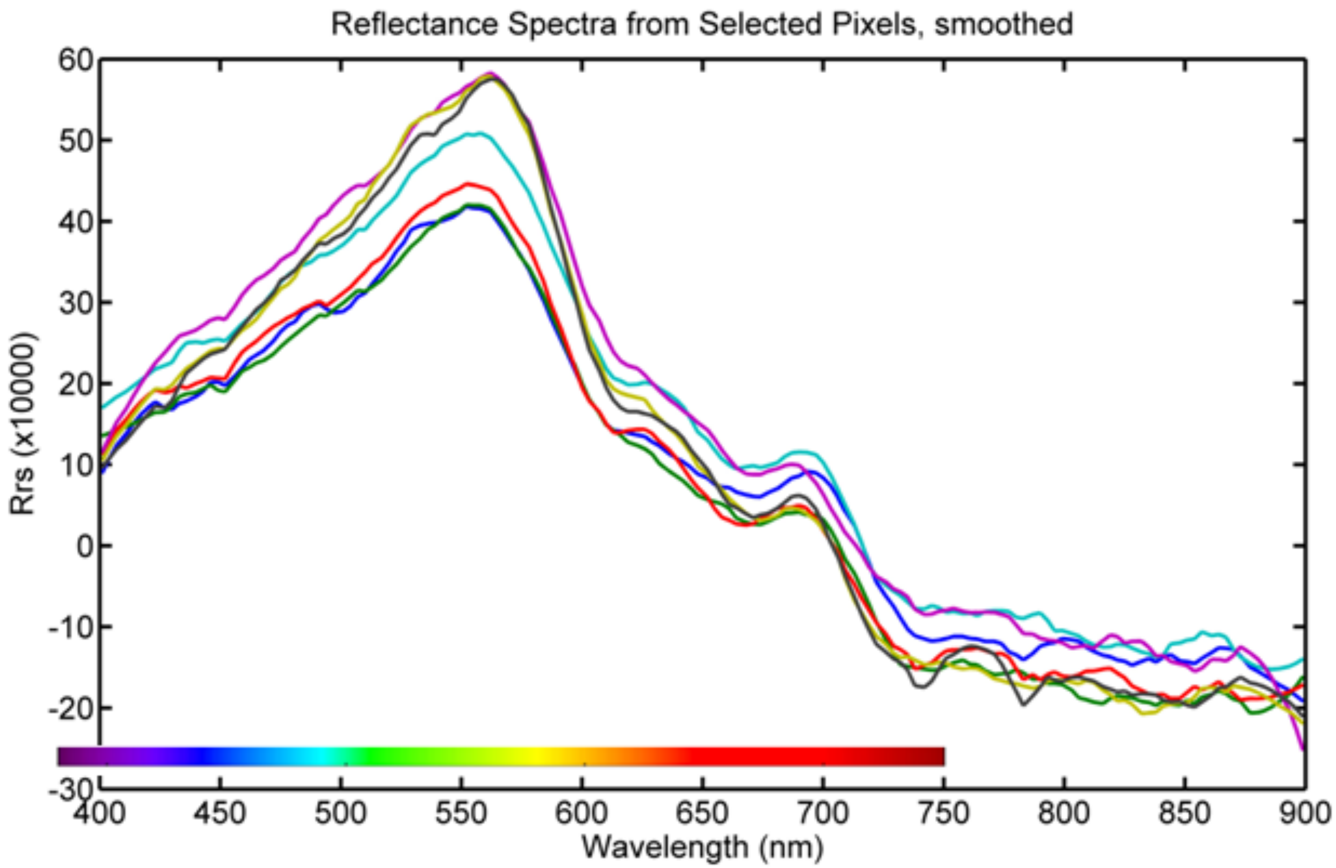
A pseudo true color image of the study location from the SAMSON imagery shows differences in the magnitude of reflected light due to sun glint between the NE/SW flight track lines (arrows).

Heritage sensor: SAMSON

R_{rs} Spectra from Image



R_{rs} Spectra from Image, filtered



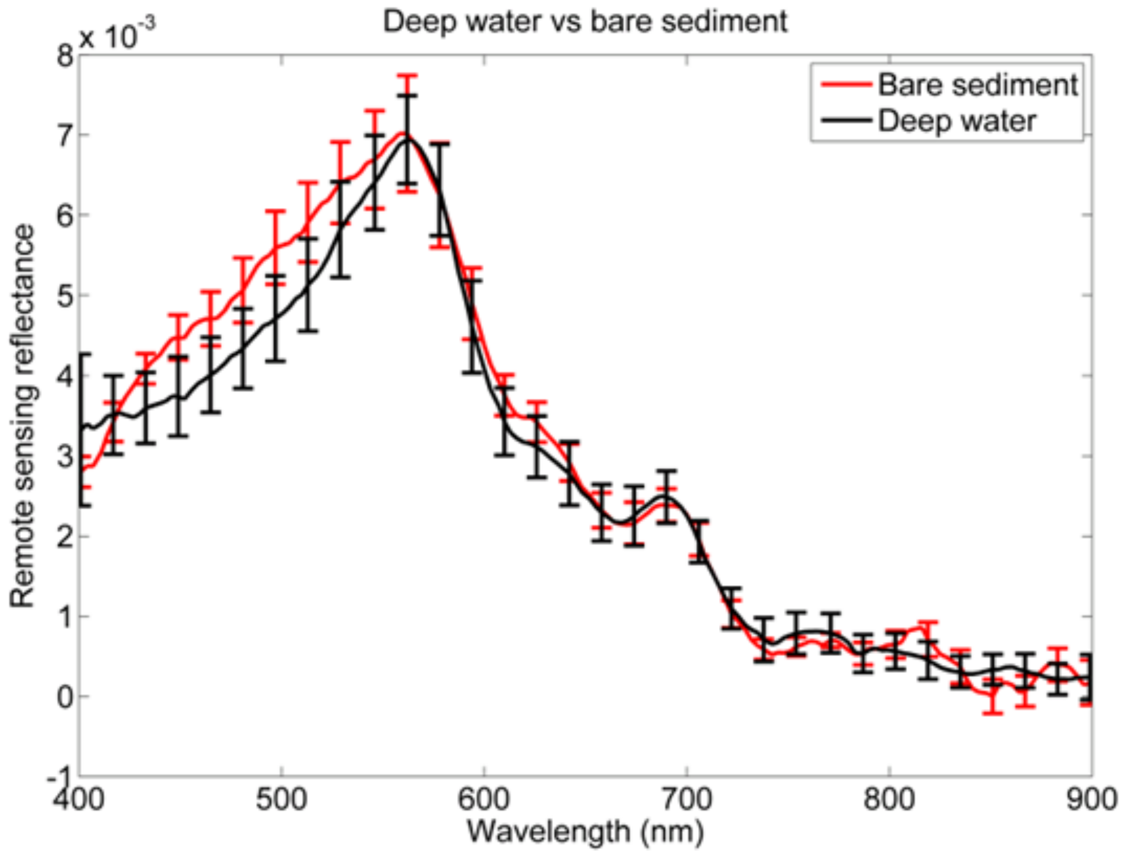
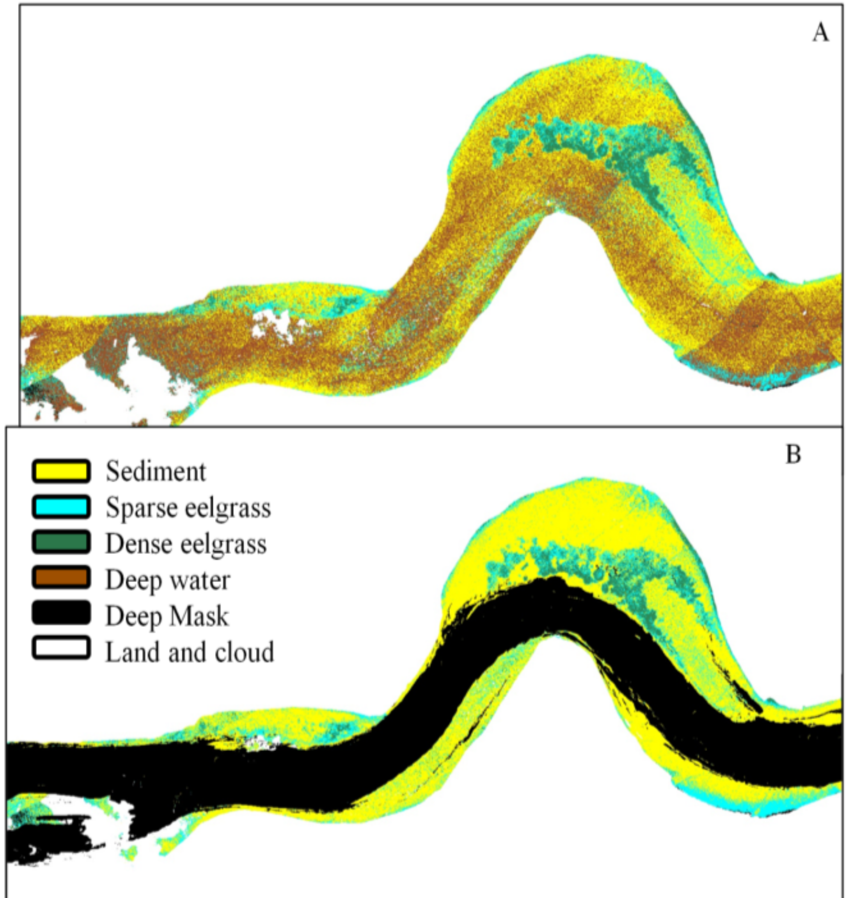


Figure 32 Standard errors in sediment and deep water spectra

The average Remote Sensing Reflectance (sr^{-1}) spectrum with one standard error for all field stations containing bare sediment on the seafloor (<3 m water depth) compared to a similar number of deep water (>5.5 m water depth) pixels. The overlap of error bars across the visible spectrum indicate no significant difference between the two spectra and show that deep water and sediment cannot be spectrally distinguished.

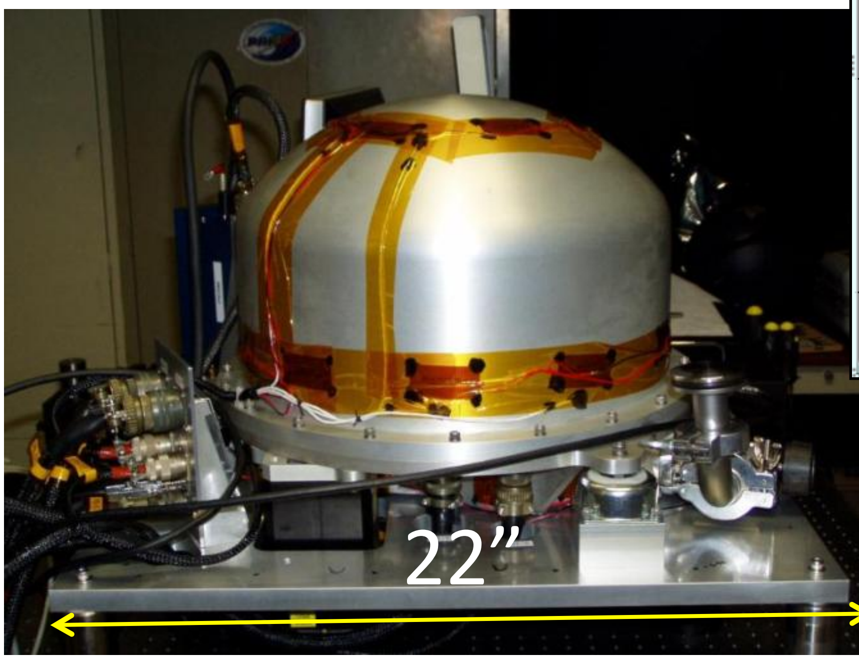


C

Remotely Sensed Product (columns) / **Field Measurement** (rows)

	Dense eelgrass	Sparse Eelgrass	Bare Sediment	Total
Dense eelgrass	**5**	0	0	5
Sparse Eelgrass	3	**2**	2	7
Bare Sediment	2	0	**4**	6
Total	10	2	6	**18**

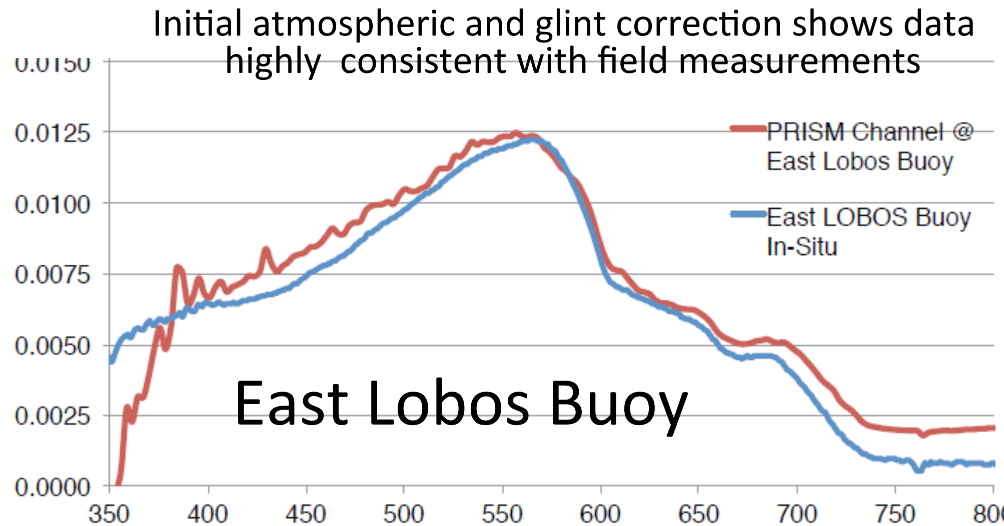
Portable Remote Imaging SpectroMeter (PRISM): NASA Coastal Applications

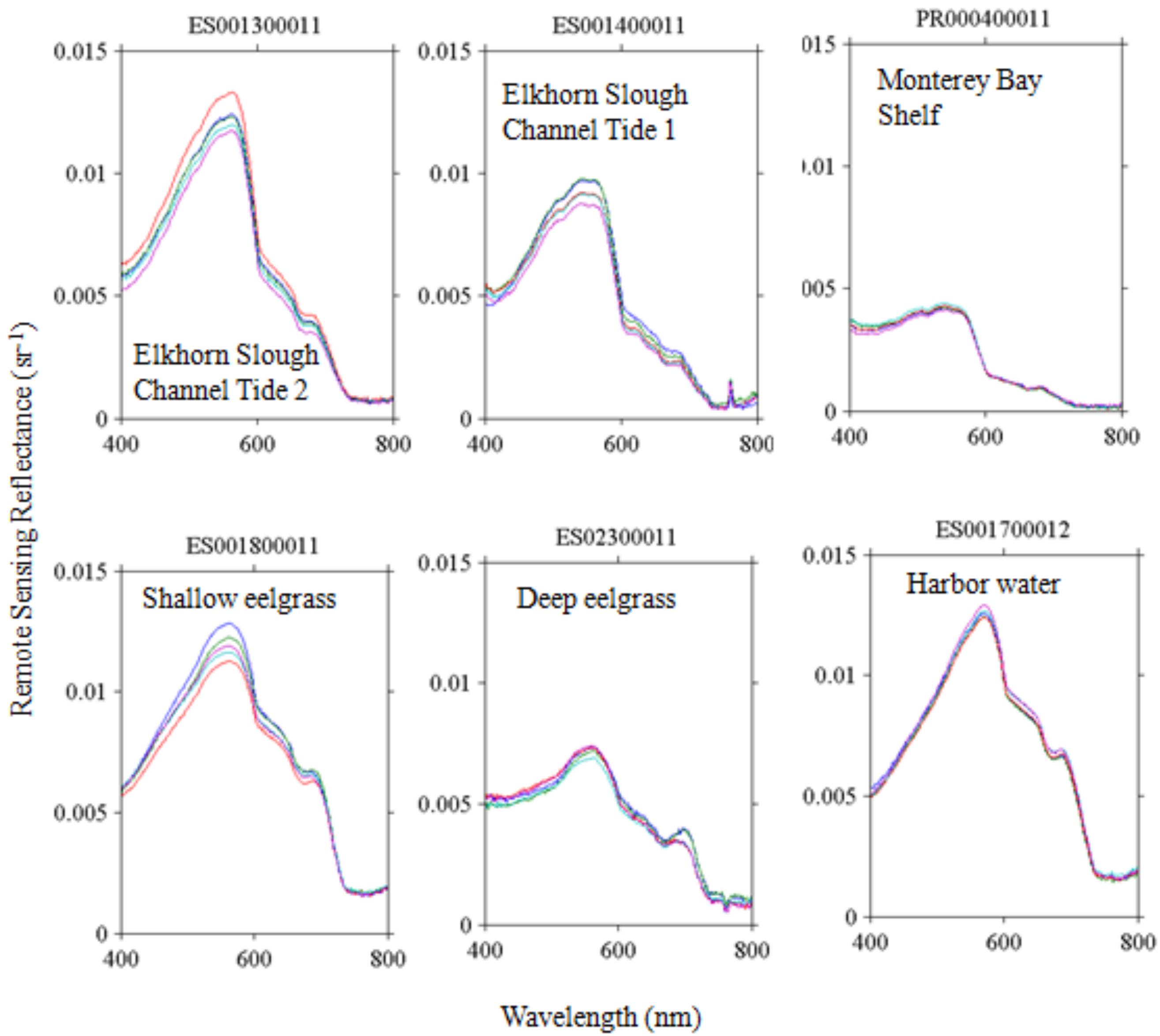


Spectral	Range	**350-1050 nm**
	Sampling	**2.85 nm**
	Resolution (FWHM)	3.5 nm
	Calibration uncertainty	< 0.1nm
Spatial	Field of view	30.7º
	Instantaneous FOV sampling	0.882 mrad
	IFOV resolution (FWHM)	0.97 mrad
	Cross-track spatial pixels	608
	Ground resolution	**0.35 – 20 m**
Radiometric	Range	0 to max. beach R
	Sampling	**14 bit**
	Stability	>99%
	Calibration uncertainty	<2%
	SNR	**2000 @450 nm***
	Polarization variation:	**< 1%**
Uniformity	Spectral cross-track uniformity	**>95%**
	Spectral IFOV mixing uniformity	**>95%**

Built in 2012 by NASA JPL funded by NASA Ocean Biology and Biogeochemistry to address challenges of coastal remote sensing. Integrated on Twin Otter Platform.

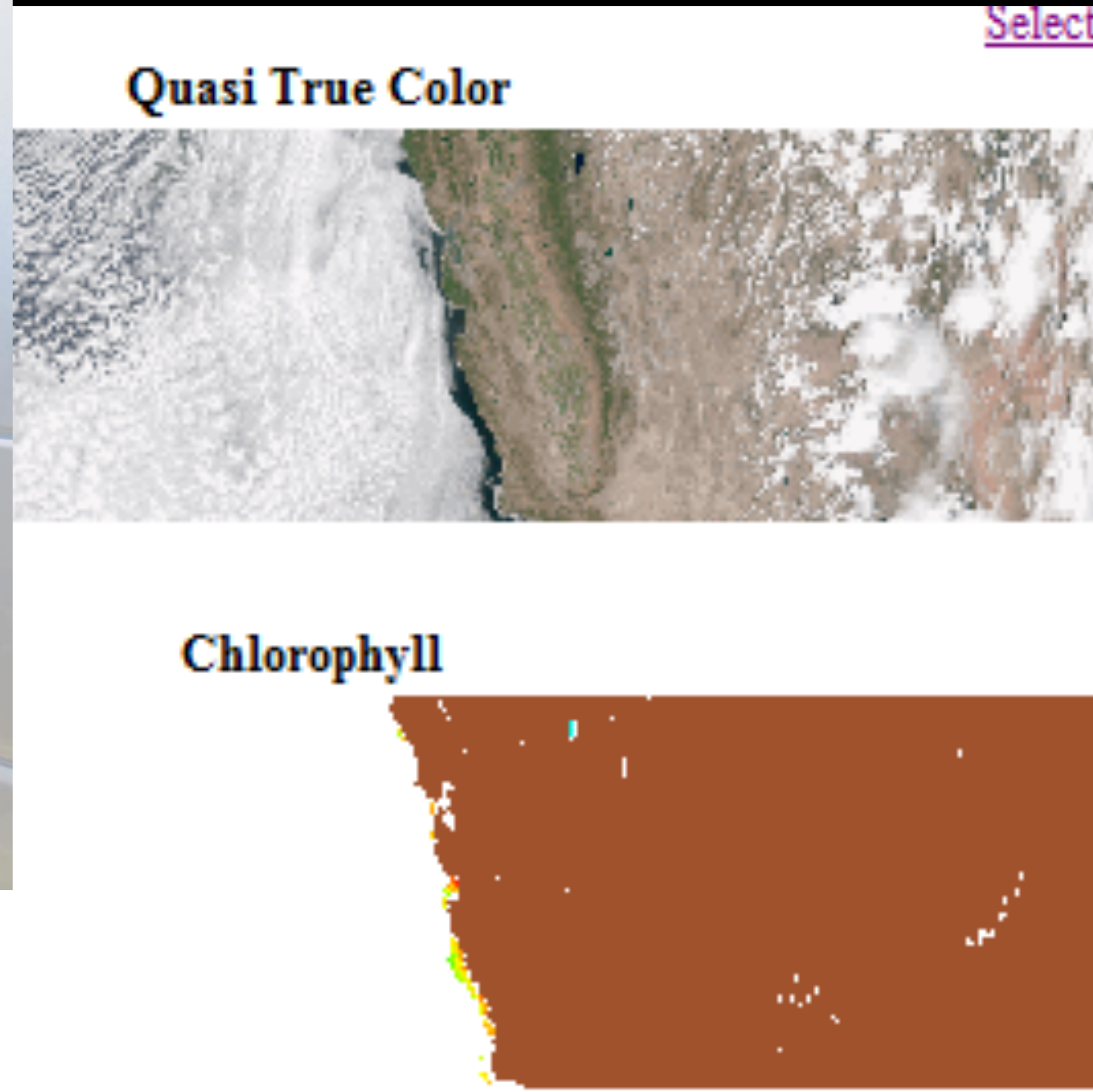
PRISM Field Validation

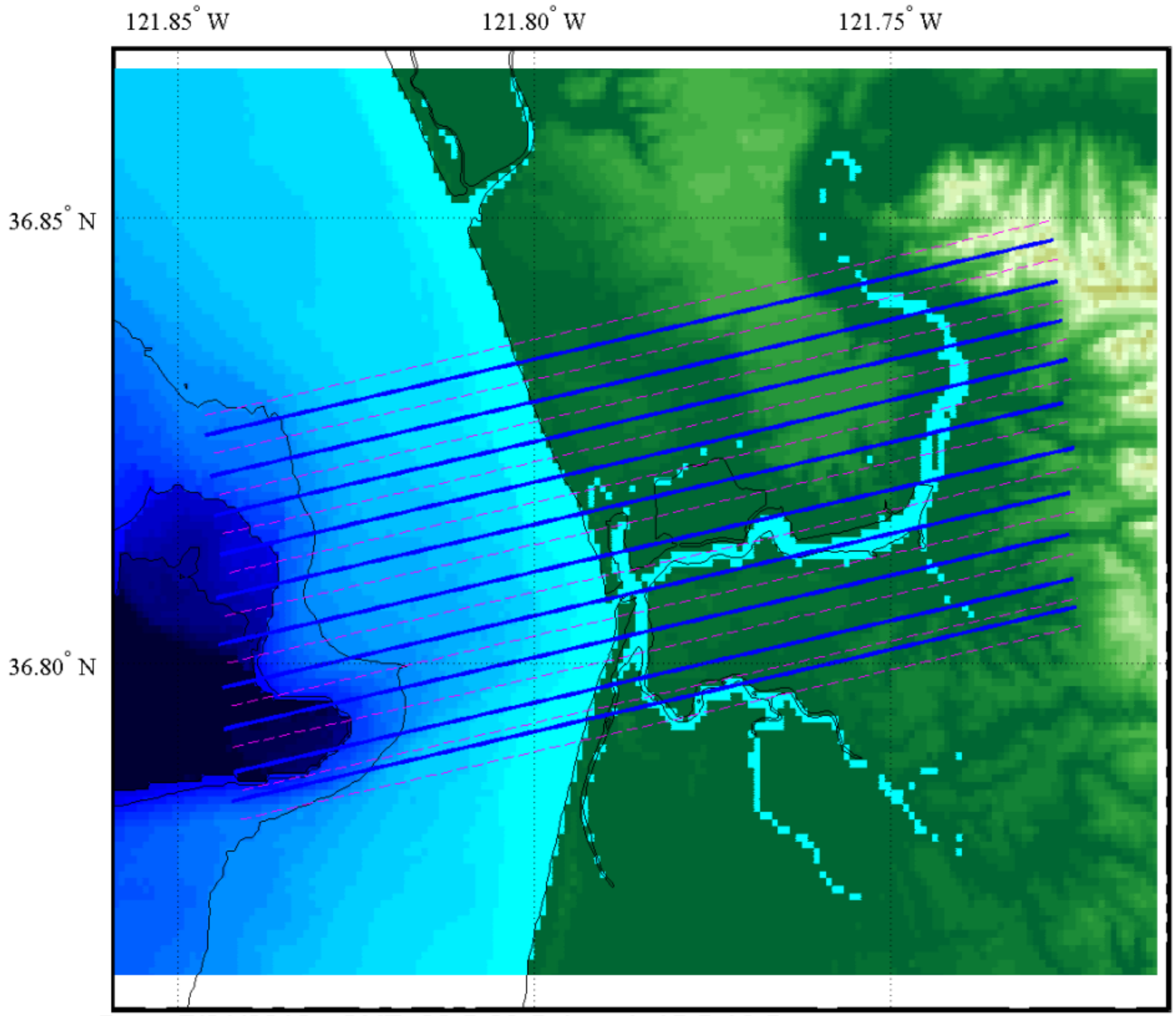



ES001300011
Elkhorn Slough
Channel Tide 2
ES001400011
Elkhorn Slough
Channel Tide 1
PR000400011
Monterey Bay
Shelf
ES001800011
Shallow eelgrass
ES02300011
Deep eelgrass
ES001700012
Harbor water
Remote Sensing Reflectance (sr^{-1})
Wavelength (nm)
0.015
0.01
0.005
0
400
600
800



07/24/2012 15:47


Select
Quasi True Color
Chlorophyll



Date: 7/21/2012; GMT: 22.5-23.5; Local: 15.5-16.5

Line 1: [36.8475N, -121.7272W] to [36.8256N, -121.8461W]; 10.86 km; Time 0.098 hr

Line 2: [36.8428N, -121.7266W] to [36.821N, -121.8453W]; 10.84 km; Time 0.098 hr

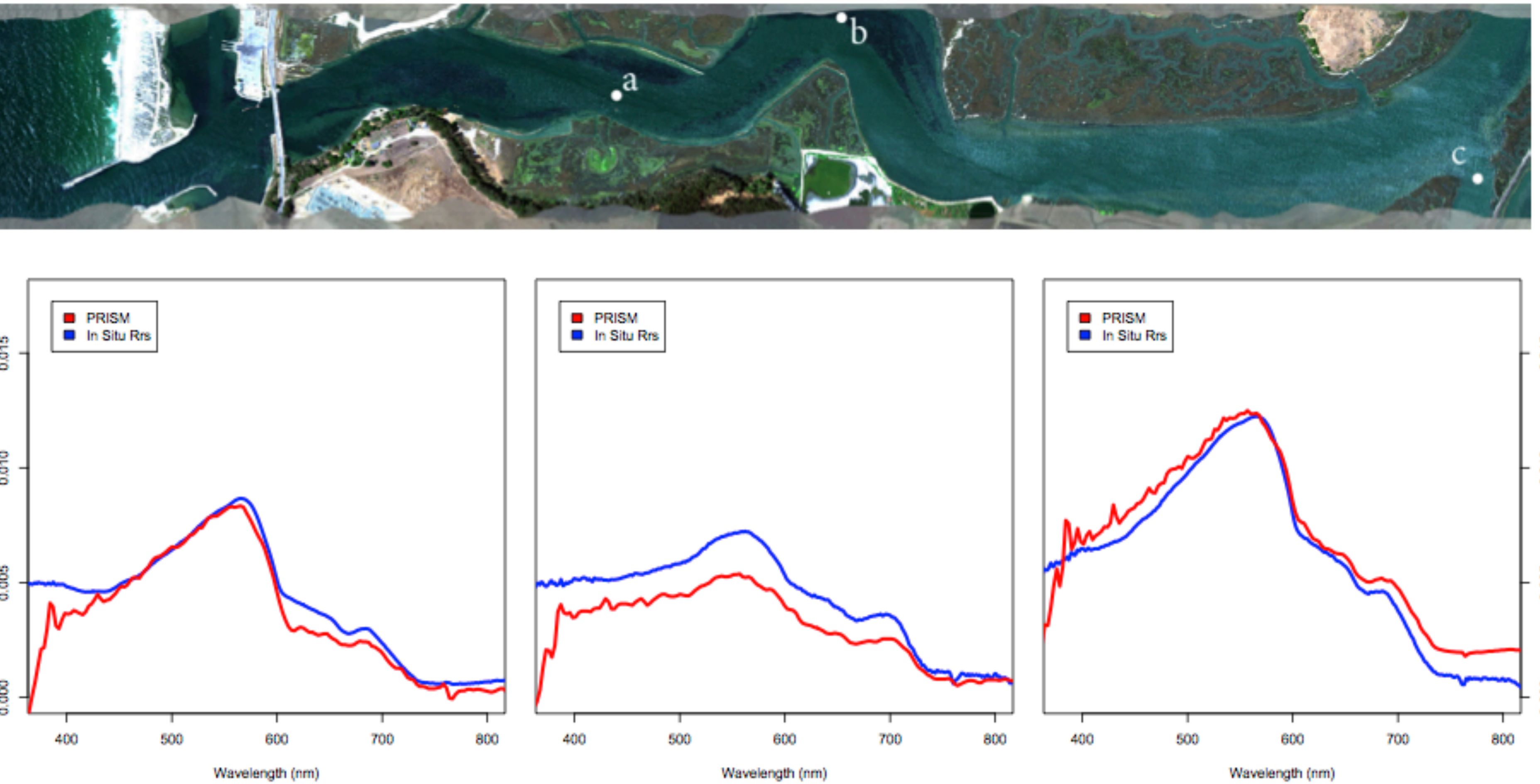
Line 3: [36.8385N, -121.726W] to [36.8166N, -121.8448W]; 10.85 km; Time 0.098 hr

Line 4: [36.834N, -121.7252W] to [36.8122N, -121.8439W]; 10.84 km; Time 0.098 hr

Line 5: [36.8292N, -121.7258W] to [36.8073N, -121.8445W]; 10.84 km; Time 0.098 hr

Line 6: [36.8242N, -121.7242W] to [36.802N, -121.8442W]; 10.96 km; Time 0.099 hr

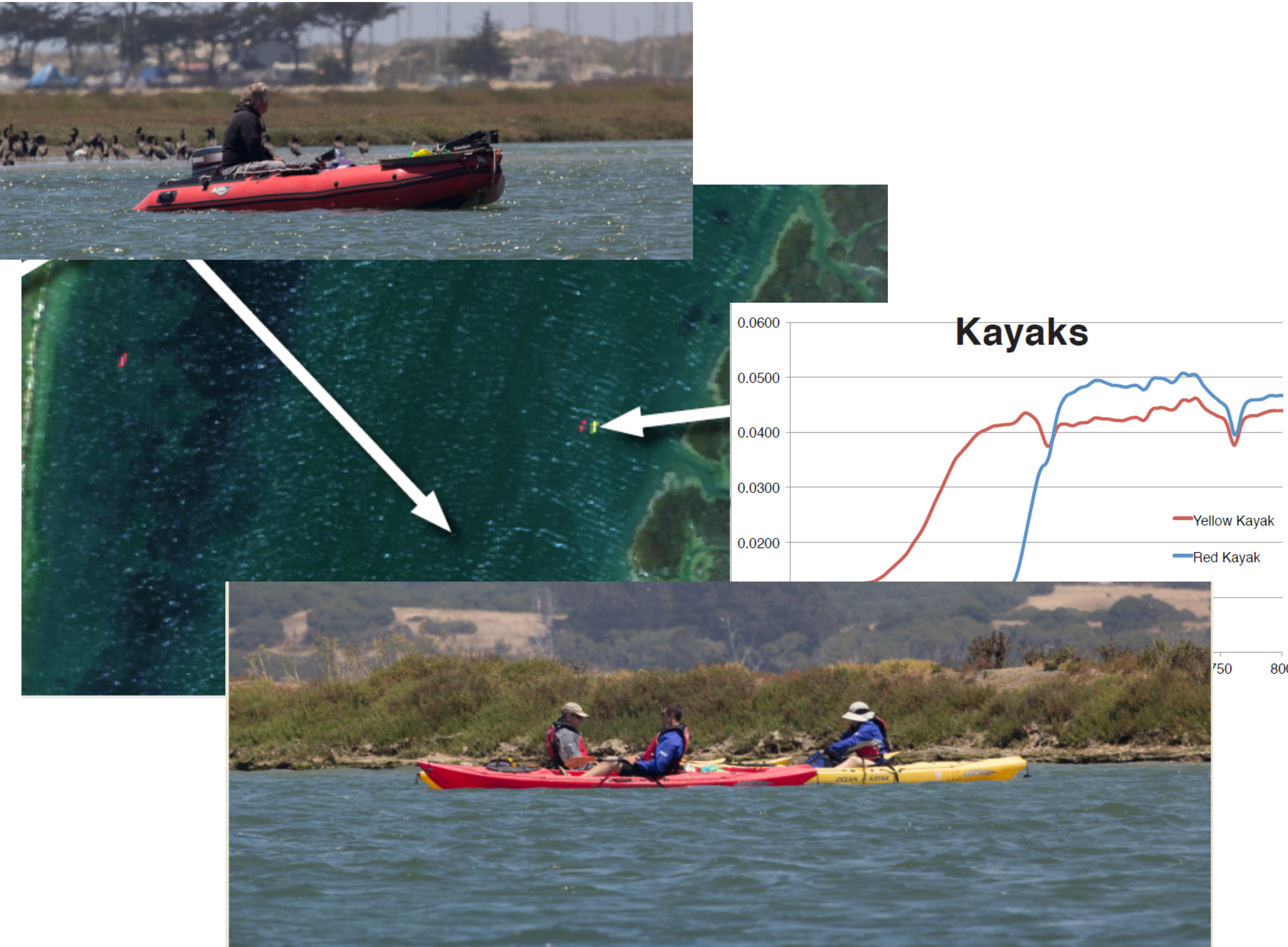
Line 7: [36.8191N, -121.7249W] to [36.7972N, -121.8437W]; 10.85 km; Time 0.098 hr



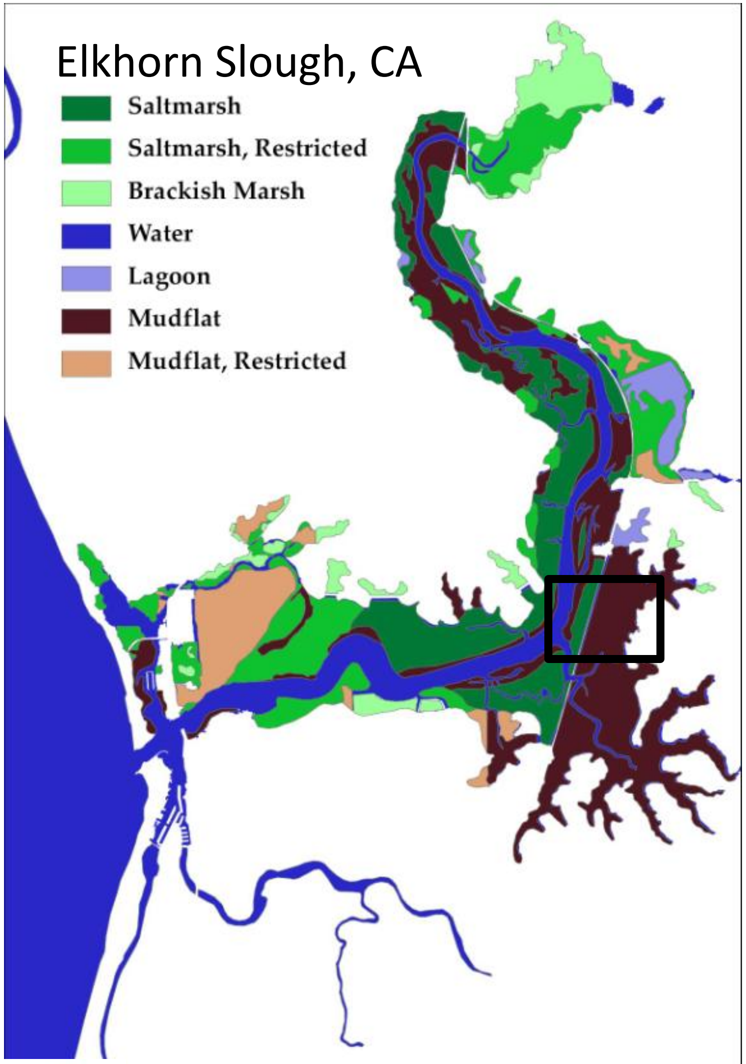
(a) West LOBO Buoy

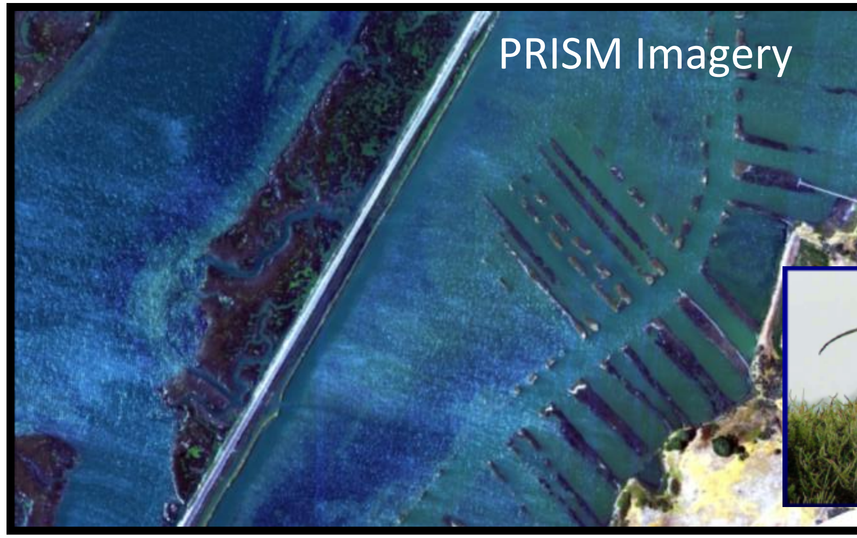
(b) Seal Bend Dense Eelgrass

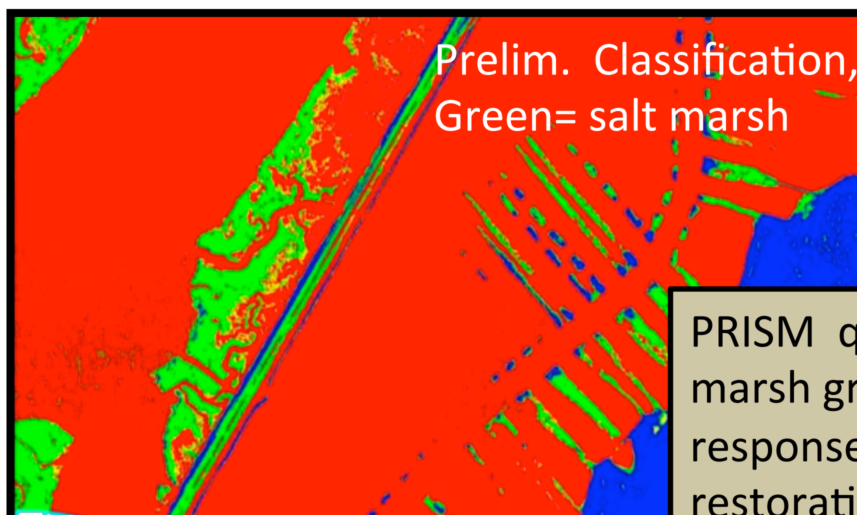
(c) East LOBO Buoy


Kayaks
0.0600
0.0500
0.0400
0.0300
0.0200
Yellow Kayak
Red Kayak

PRISM Science: Mapping Coastal Habitats **Salt Marsh Restoration**

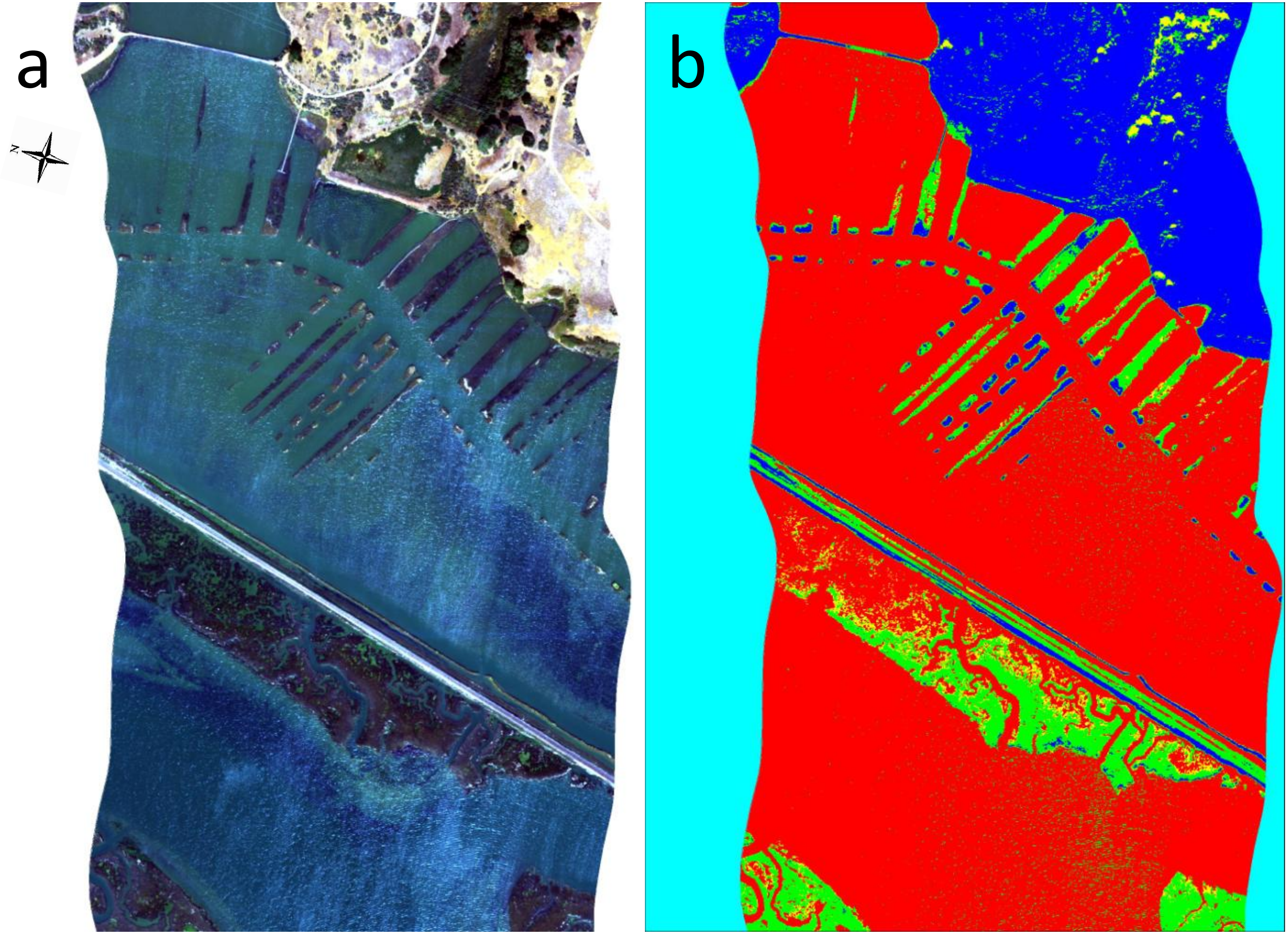






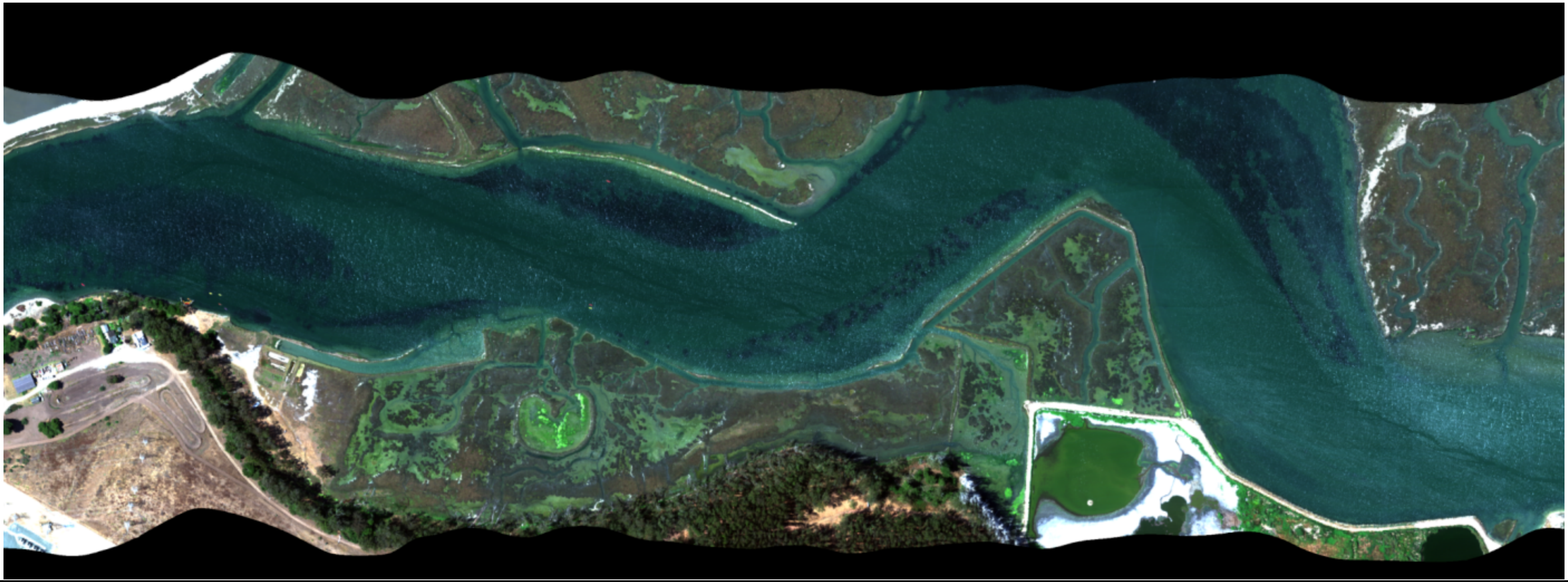
PRISM quantifies marsh growth in response to restoration efforts

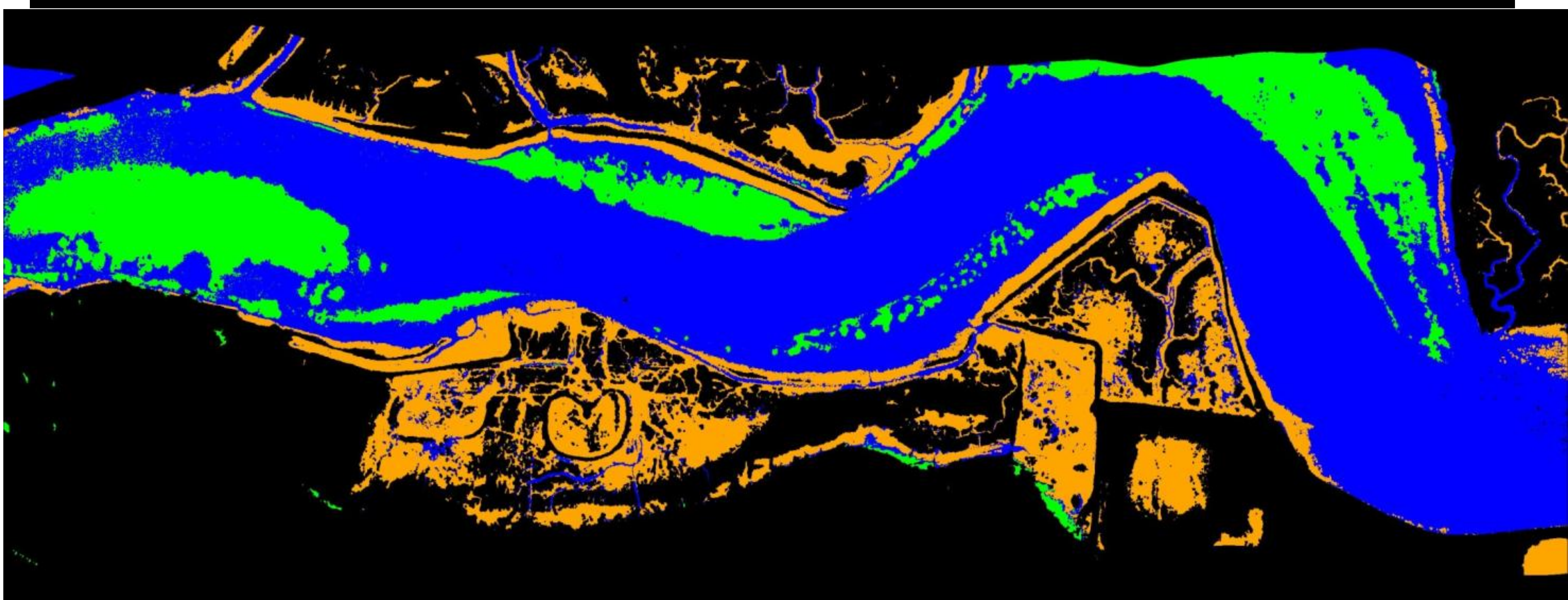
UConn


a
N
b


PINNACLE

Eelgrass Beds in Turbid Water





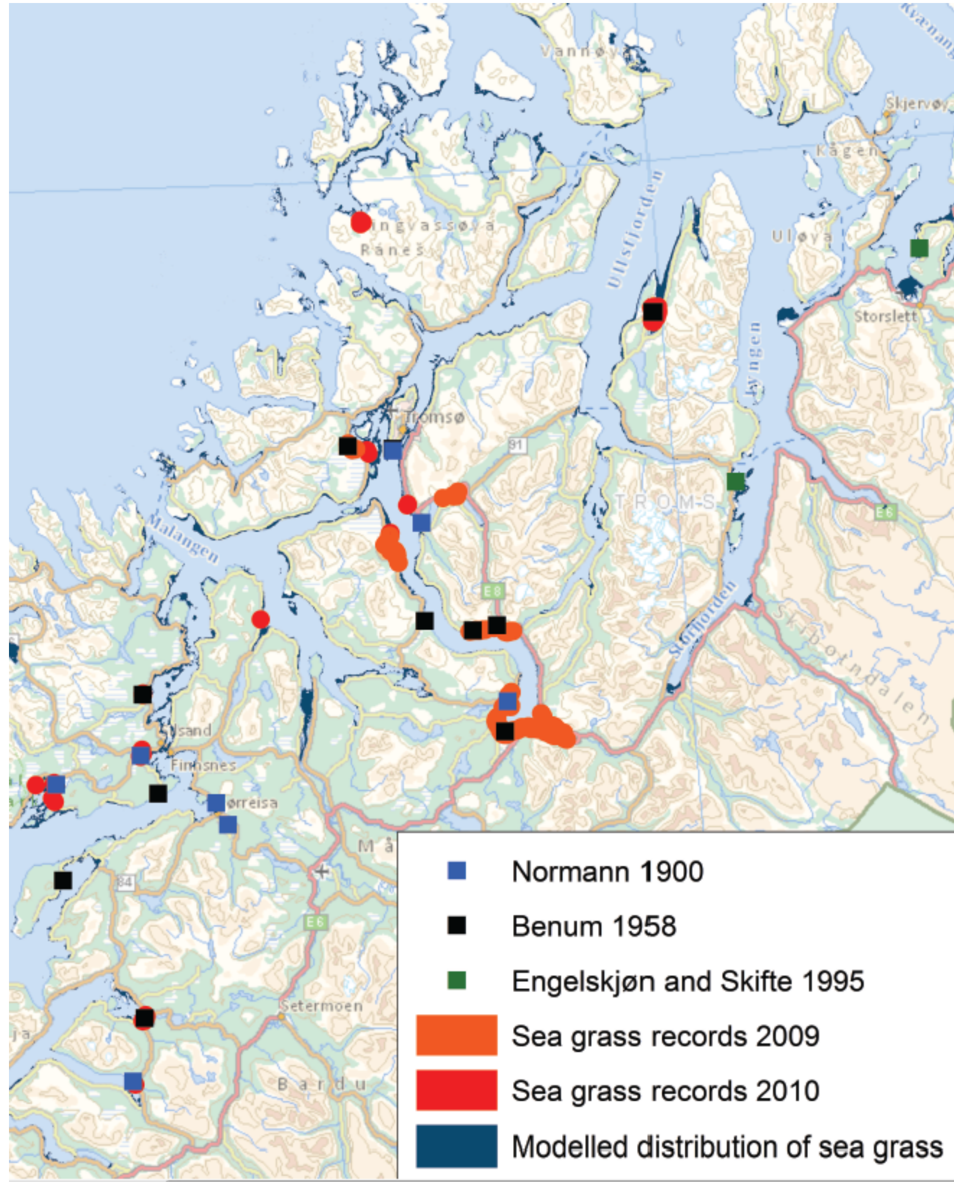

Pauls Island
© 2013 Google

Validation Points

Next HyspIRI Study Site: Eelgrass in Clear Waters

Nina Mari Jørgensen, Akvaplan-niva, FRAM – High North Research Centre on Climate and the Environment, 9296 Tromsø.

Seagrass at 70ºN



The largest eelgrass meadow in Troms was 324,000 m^2 found in Balsfjorden, first discovered in 1884 (Normann 1900).

Troms
Tromso
Balsfjord, Troms, Norway
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Image IBCAO