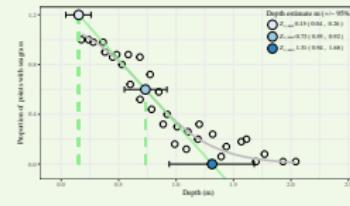


Quantifying seagrass light requirements using an algorithm to spatially resolve depth of colonization

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Seagrasses and water quality

Seagrasses are beneficial - healthy seagrass, healthy estuary

[Williams and Heck, 2001, Hughes et al., 2009]



Seagrasses are sentinels of water quality

[Duarte, 1995, Short and Wyllie-Echeverria, 1996]

flickr.com/photos/swimvixen2



Research challenges and study objective

The maximum depth of colonization is a useful proxy of eutrophication

[Kenworthy and Fonseca, 1996, Choice et al., 2014]

Often used as a basis for establishing nutrient criteria

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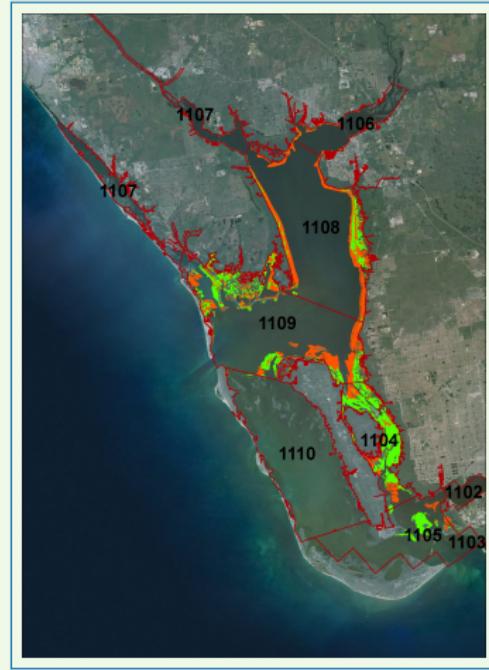
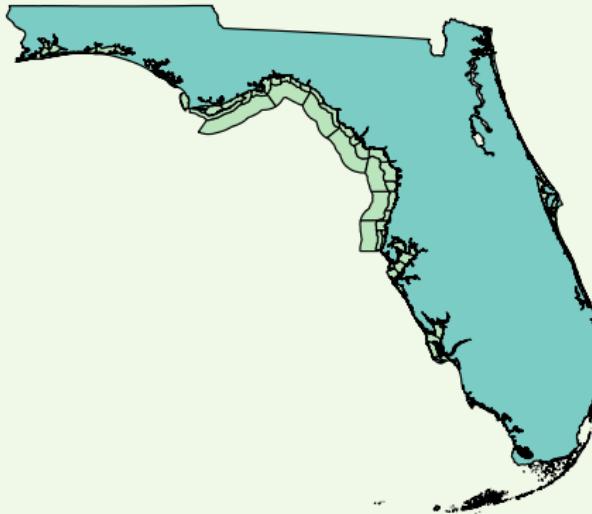
Develop and apply an algorithm that uses geospatial data to describe relationships between seagrass depth limits, water clarity, and light requirements [Beck et al., 2017]



Estimating seagrass depth of colonization

Existing geospatial datasets - coastal segments, seagrass areal coverage, bathymetry

Segment-based approach





Estimating seagrass depth of colonization

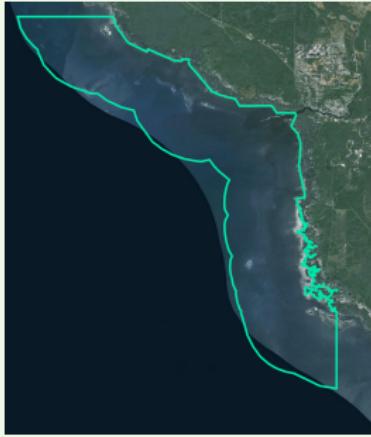
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Estimating seagrass depth of colonization

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1. Pick a segment

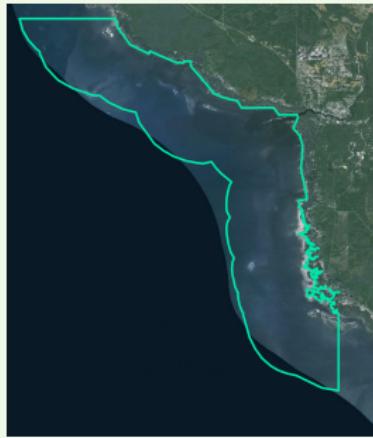




Estimating seagrass depth of colonization

How can we estimate depth of colonization?

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2. Get seagrass area

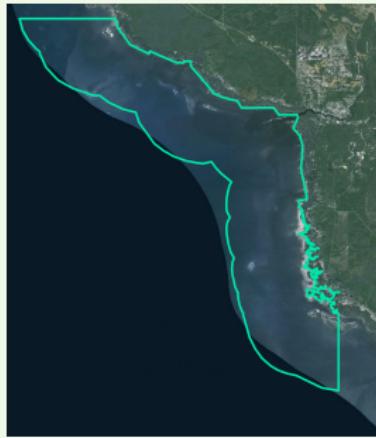




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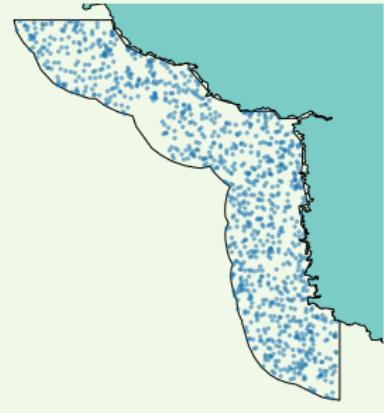
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2. Get seagrass area



3. Get depth points

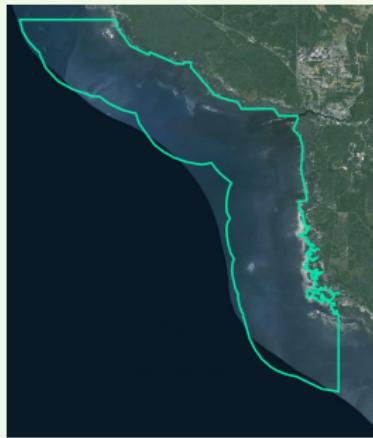




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How can we estimate depth of colonization?

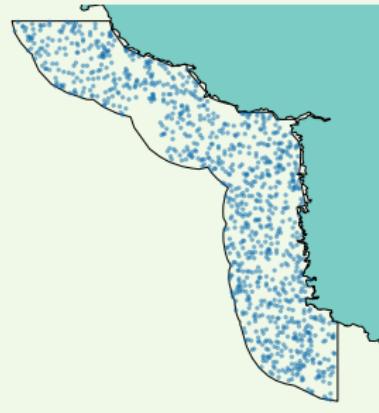
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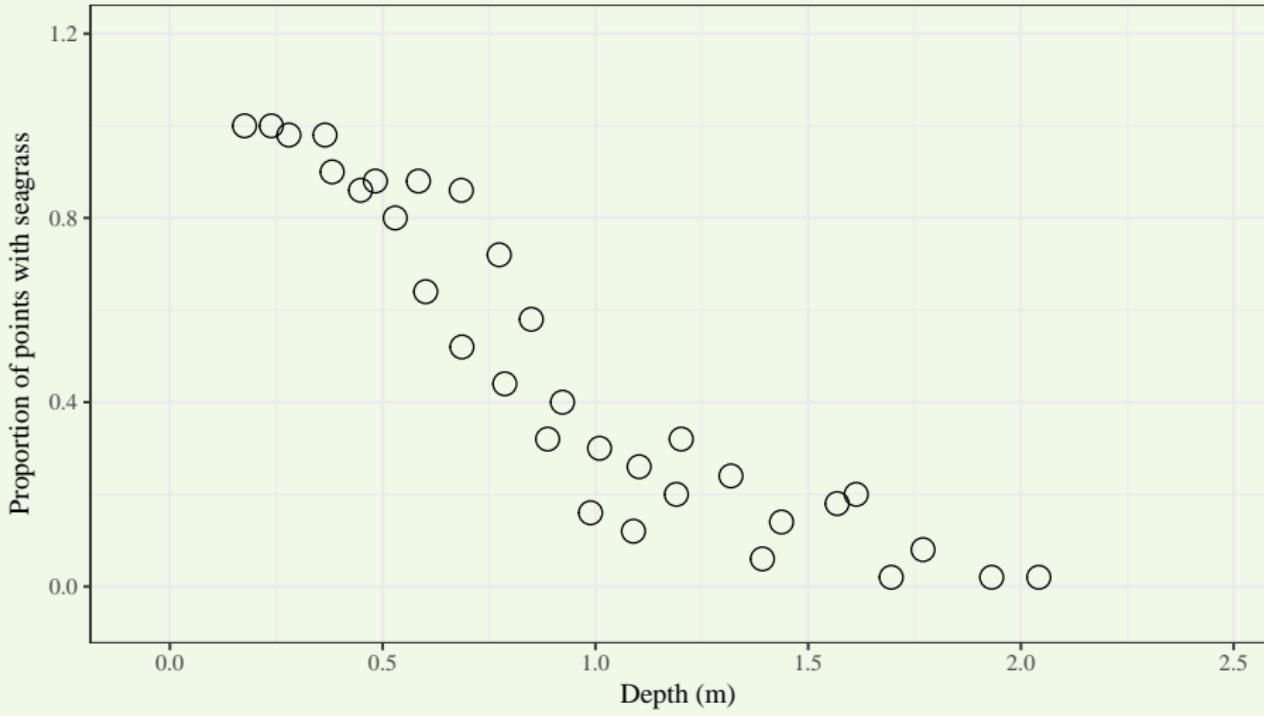


4. Match depth points with seagrass presence/absence...



Estimating seagrass depth of colonization

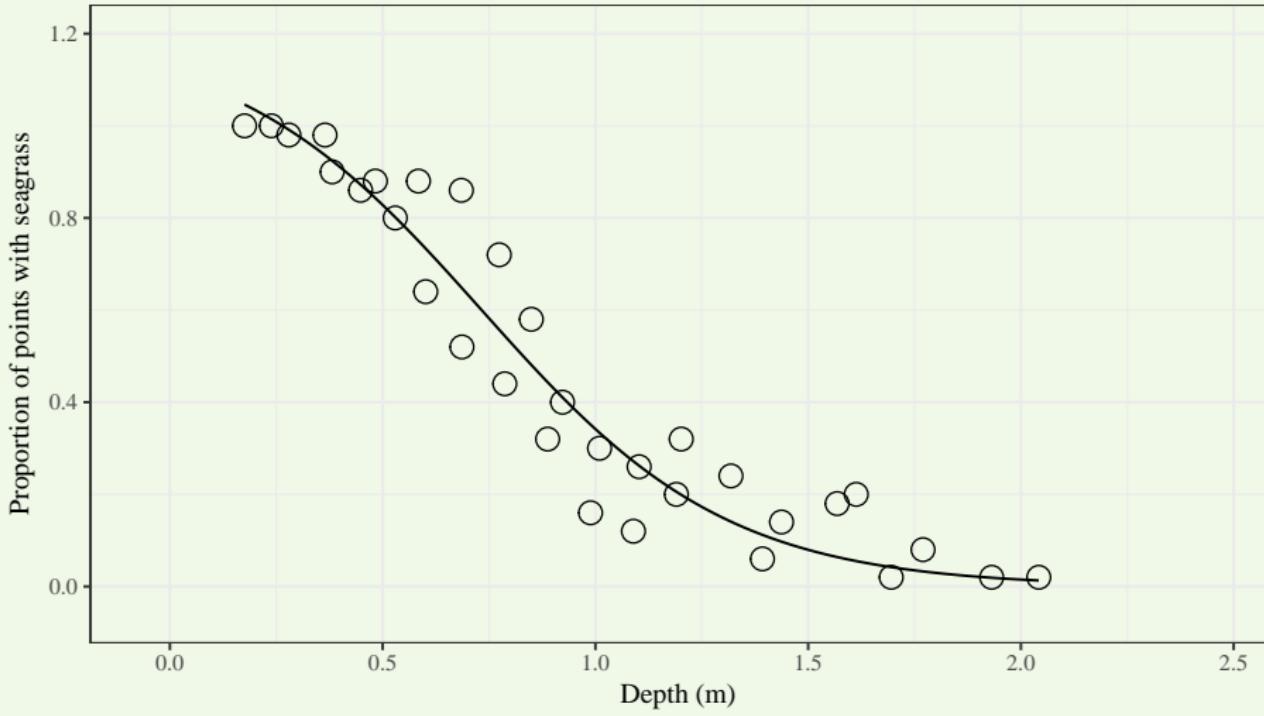
5. Plot the distribution of seagrass by increasing depth





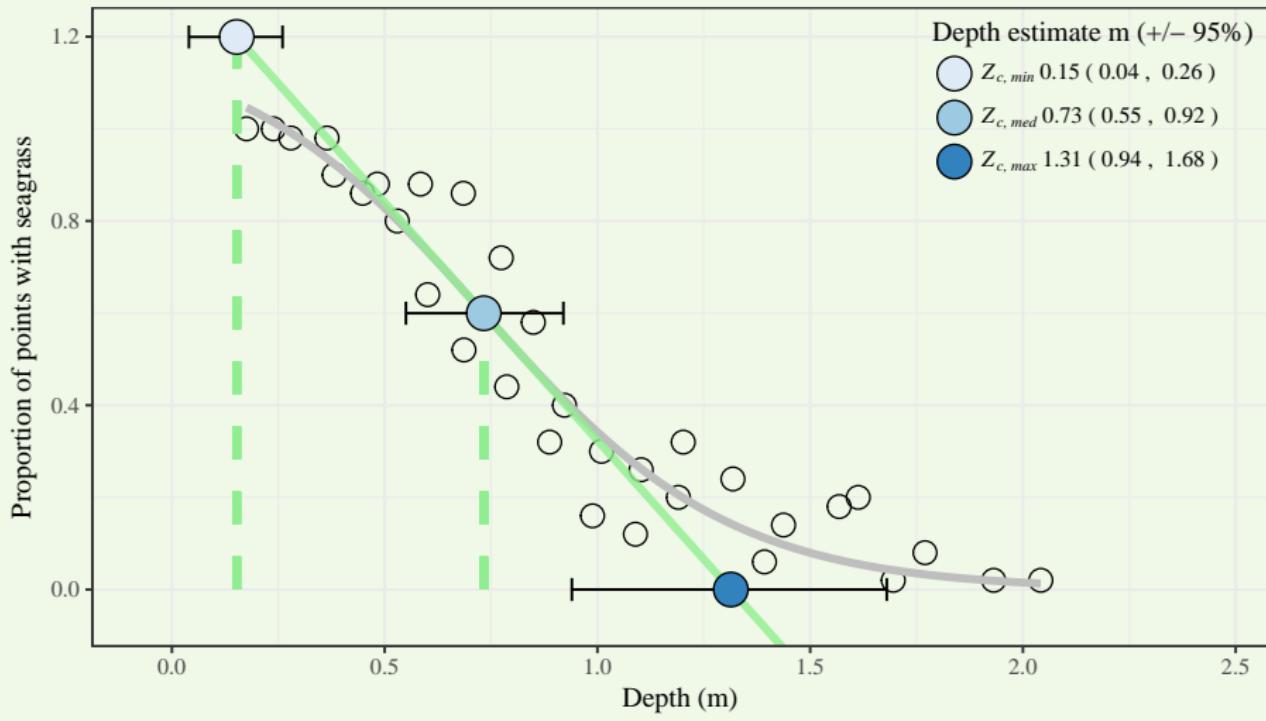
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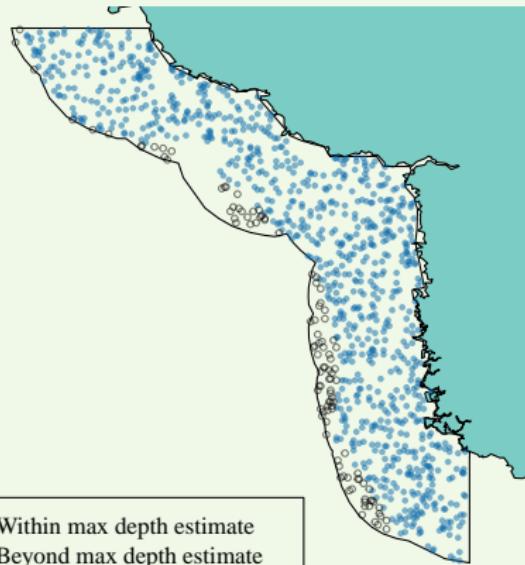
SEstimating seagrass depth of colonization

The estimate depends on the spatial context...



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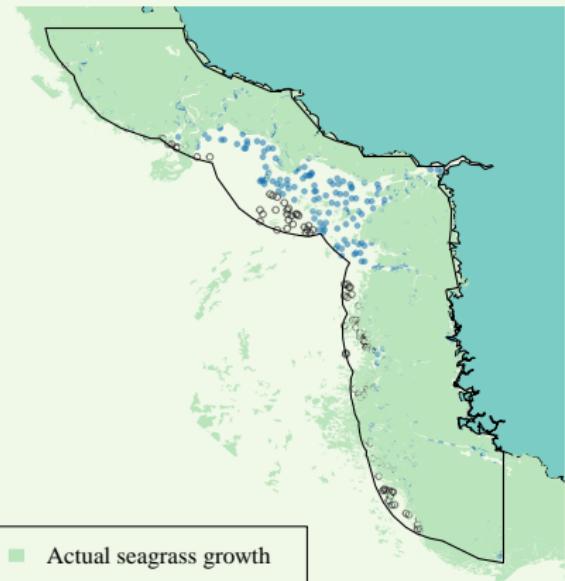
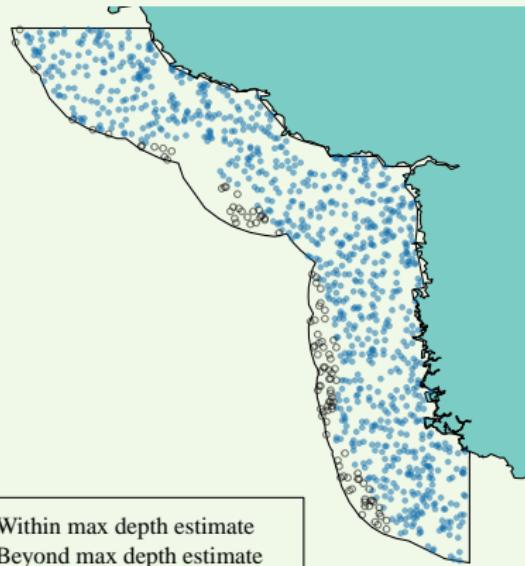
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Estimating seagrass depth of colonization

The algorithm was applied to entire estuaries with appropriate data

Boundaries



Depth



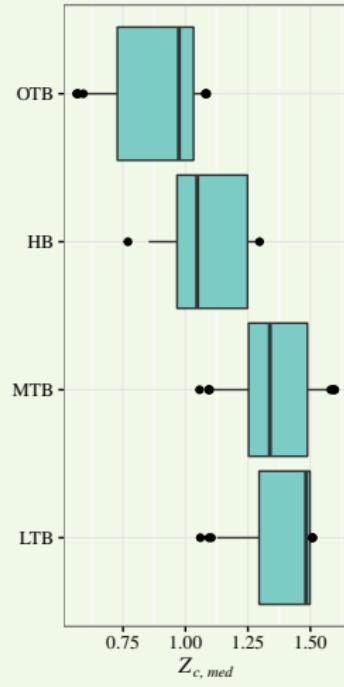
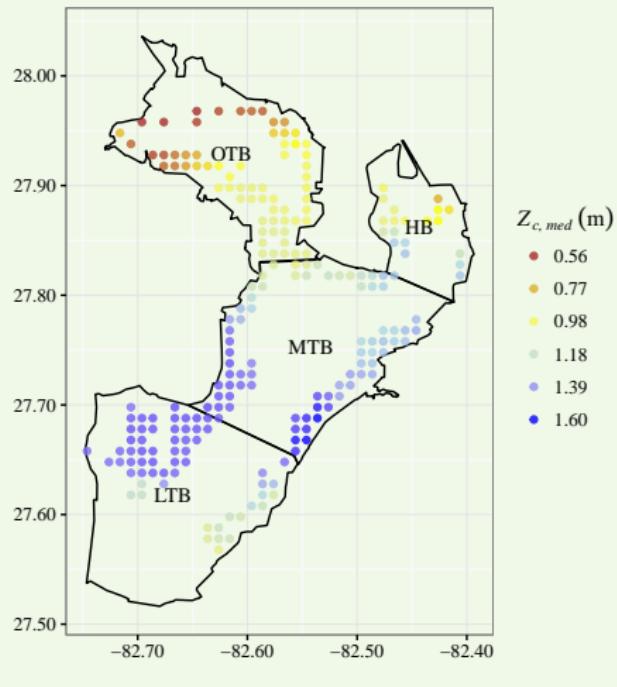
Seagrass





Linking estimates to light requirements

Tampa Bay summary:



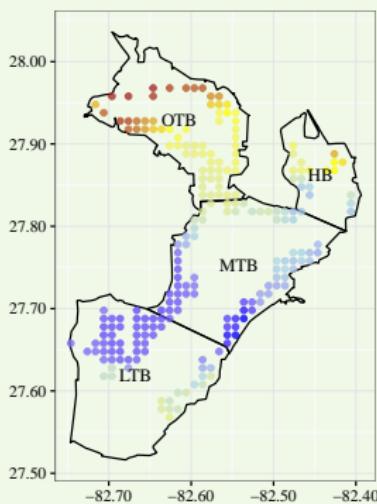
Linking estimates to light requirements

Can we link depth estimates with water clarity to understand light requirements?

Depth of colonization

$Z_{c, med}$ (m)

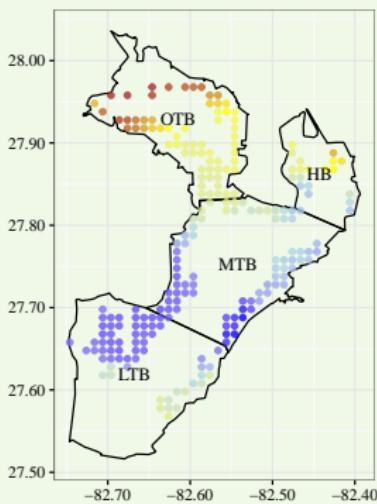
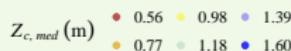
- 0.56
- 0.77
- 0.98
- 1.18
- 1.39
- 1.60



Linking estimates to light requirements

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Depth of colonization



$$\%SI = 100 \cdot \frac{I_z}{I_o} = \exp(-K_d \cdot Z_{c,med})$$

I_z : irradiance at depth

I_o : irradiance at surface

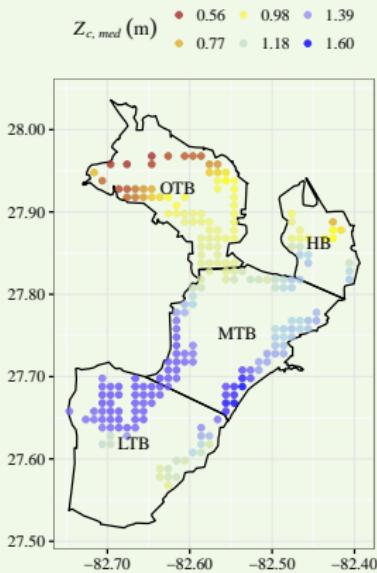
K_d : light extinction coefficient

- Percent surface irradiance at depth as a measure of seagrass light requirements
- Can be used to characterize light regimes that maintain seagrass habitat

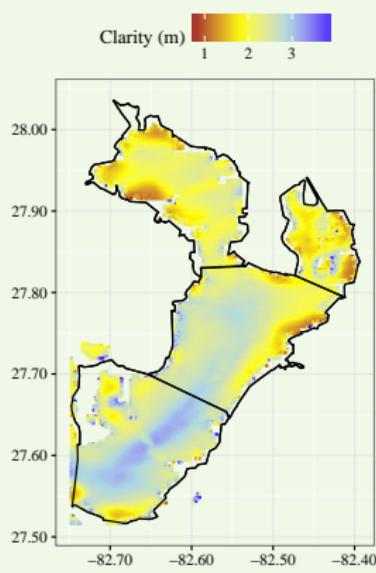
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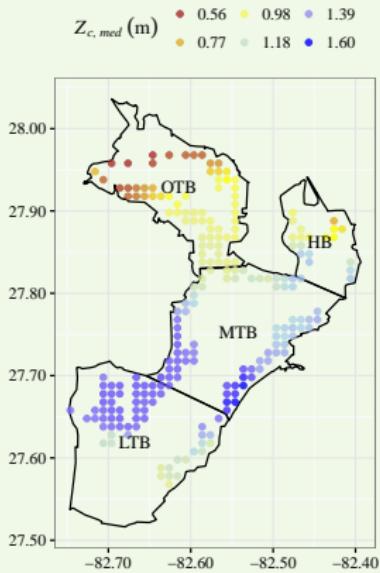
Water clarity



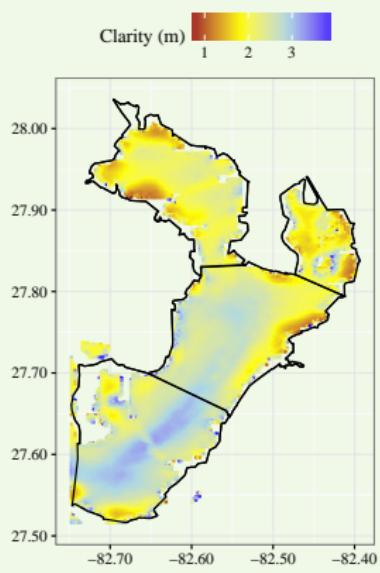
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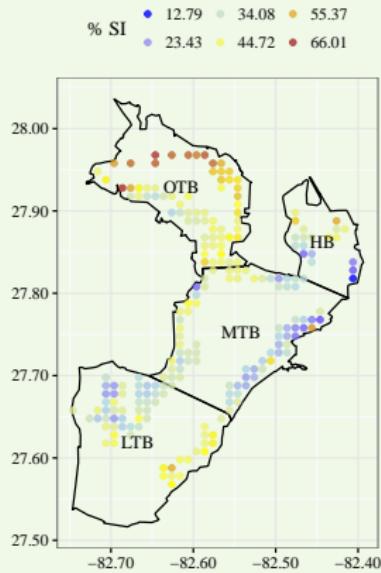
Depth of colonization



Water clarity

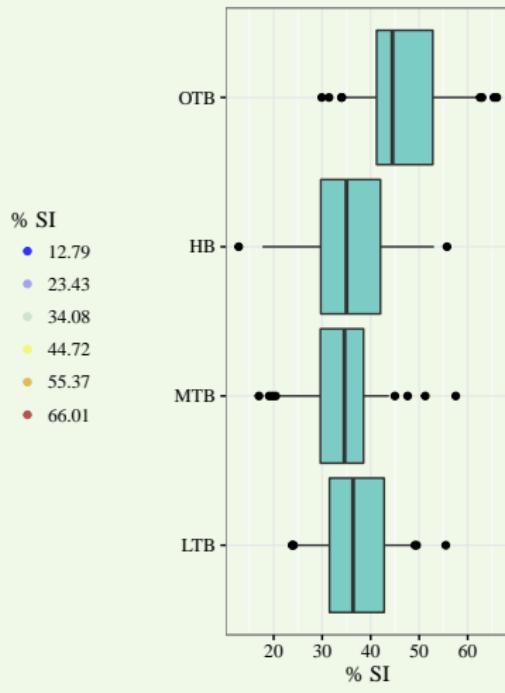
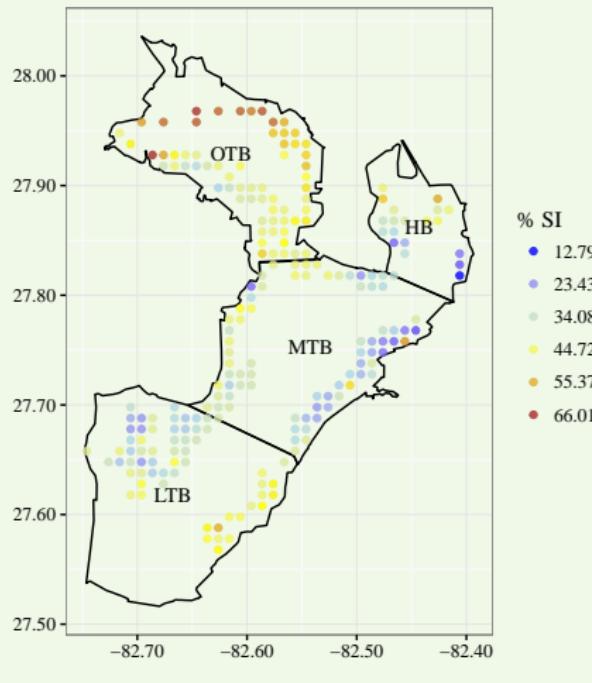


Light requirements



Linking estimates to light requirements

Tampa Bay summary (one year):



Linking estimates to light requirements

Tampa Bay summary (many years):

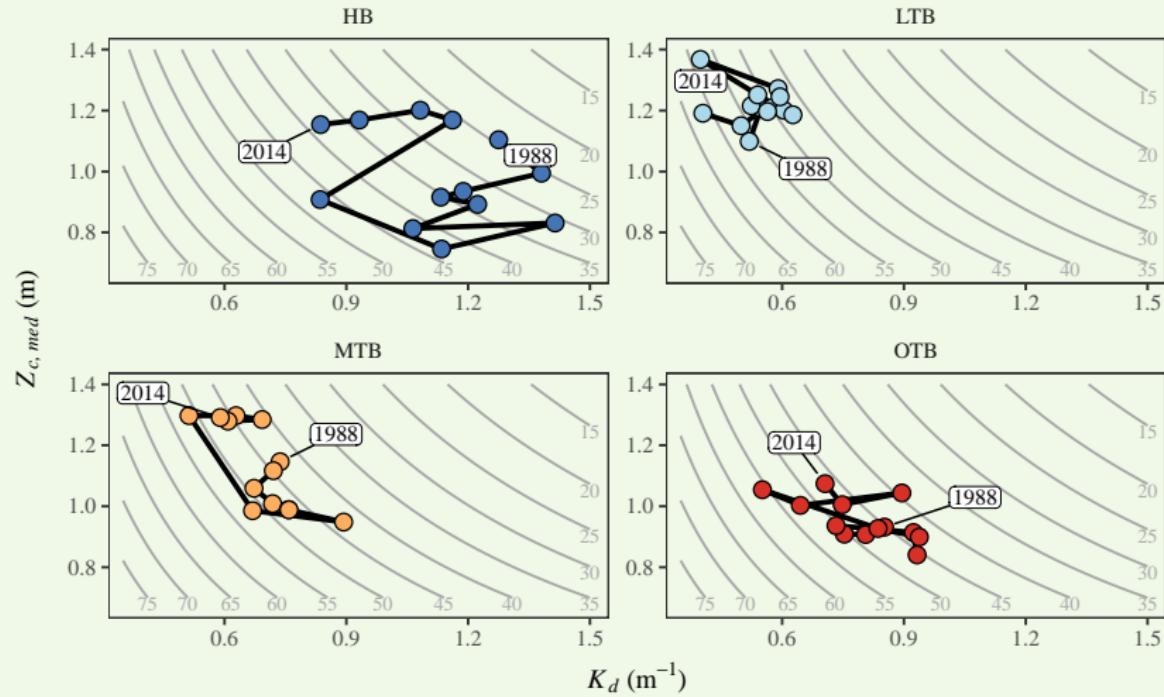


Figure: Depth of colonization and light attenuation from 1988 - 2014 by Bay segment

Linking estimates to light requirements

Tampa Bay summary (many years):

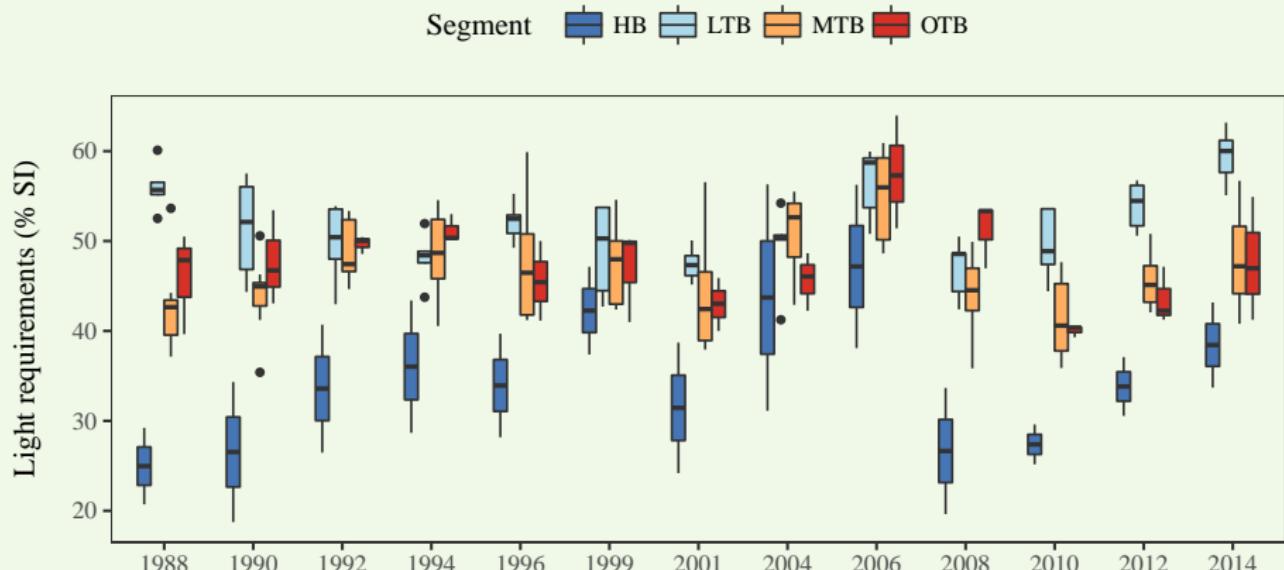


Figure: Seagrass light requirements from 1988 - 2014 by Bay segment



Conclusions

Benefits of the approach:

- Better characterization of *spatial patterns* - 20% light requirements may not be sufficient for all



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Benefits of the approach:

- Better characterization of *spatial patterns* - 20% light requirements may not be sufficient for all
- The spatial unit for any estimate of seagrass growth limit is *problem-specific* - a ‘compliance-point’ approach
- Increased understanding of seagrass growth patterns can lead to *testable hypotheses*



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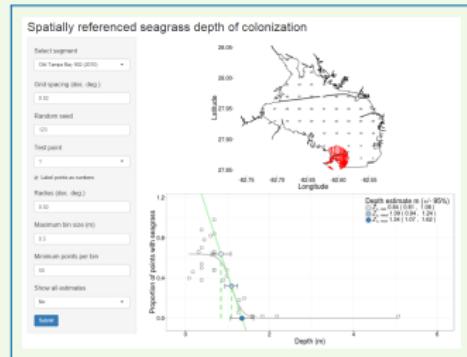
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Phone: 714-755-3217

Github: github.com/fawda123/

Blog: beckmw.wordpress.com/

Online app
https://beckmw.shinyapps.io/sg_depth/



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