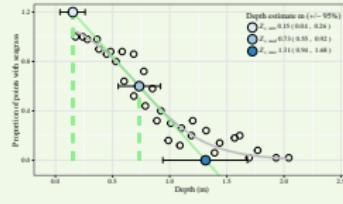


Quantifying seagrass light requirements using an algorithm to spatially resolve depth of colonization

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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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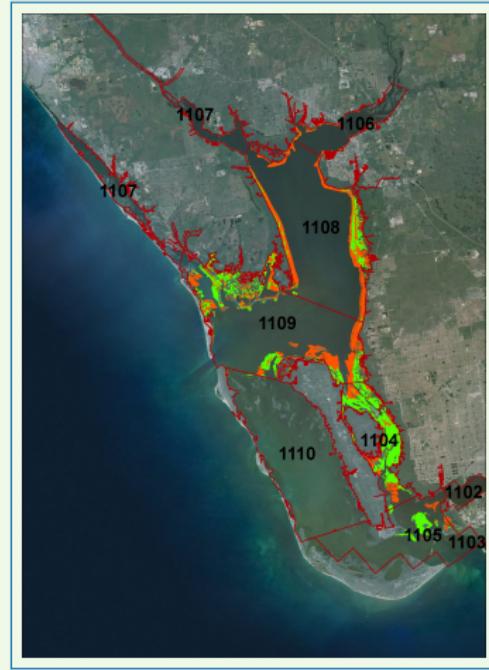
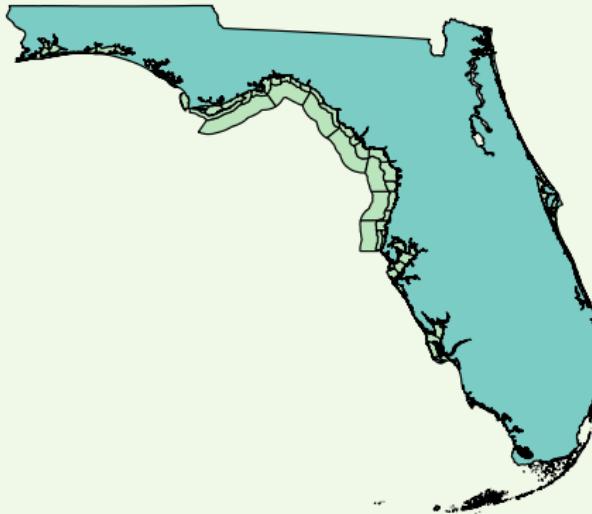
Develop and apply an algorithm that uses geospatial data to describe relationships between seagrass depth limits, water clarity, and light requirements [Beck, Hagy, Le, in review]



Estimating seagrass depth of colonization

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

Segment-based approach





Estimating seagrass depth of colonization

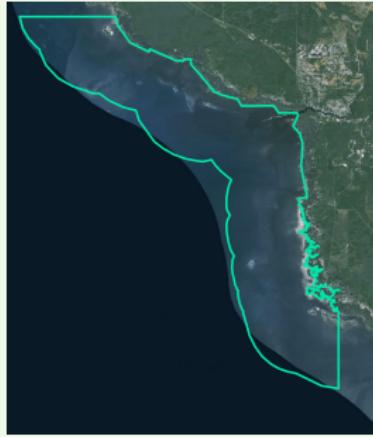
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Estimating seagrass depth of colonization

How can we estimate depth of colonization?

1. Pick a segment

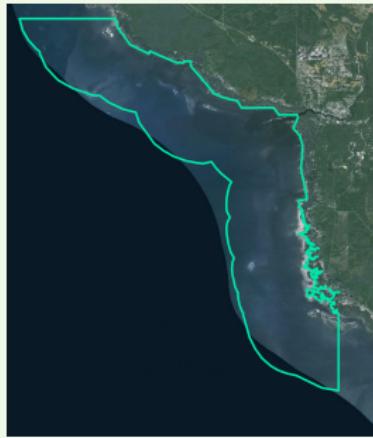




Estimating seagrass depth of colonization

How can we estimate depth of colonization?

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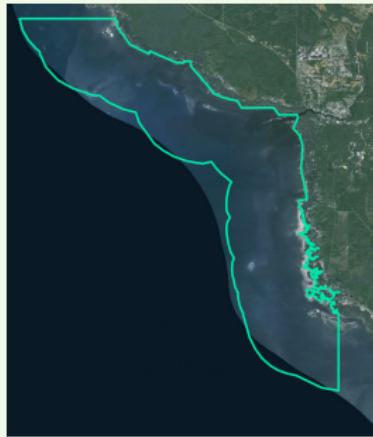




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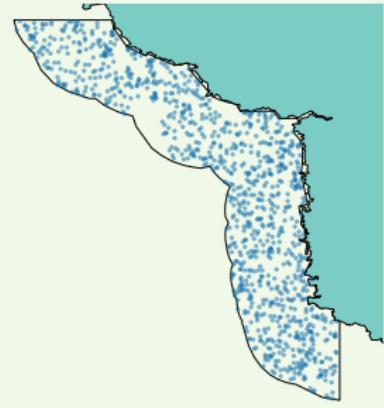
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3. Get depth points

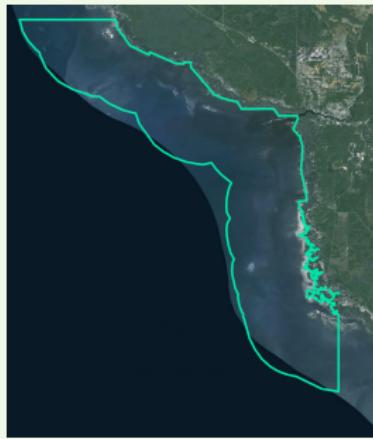




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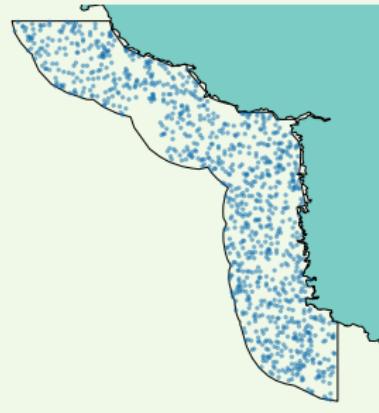
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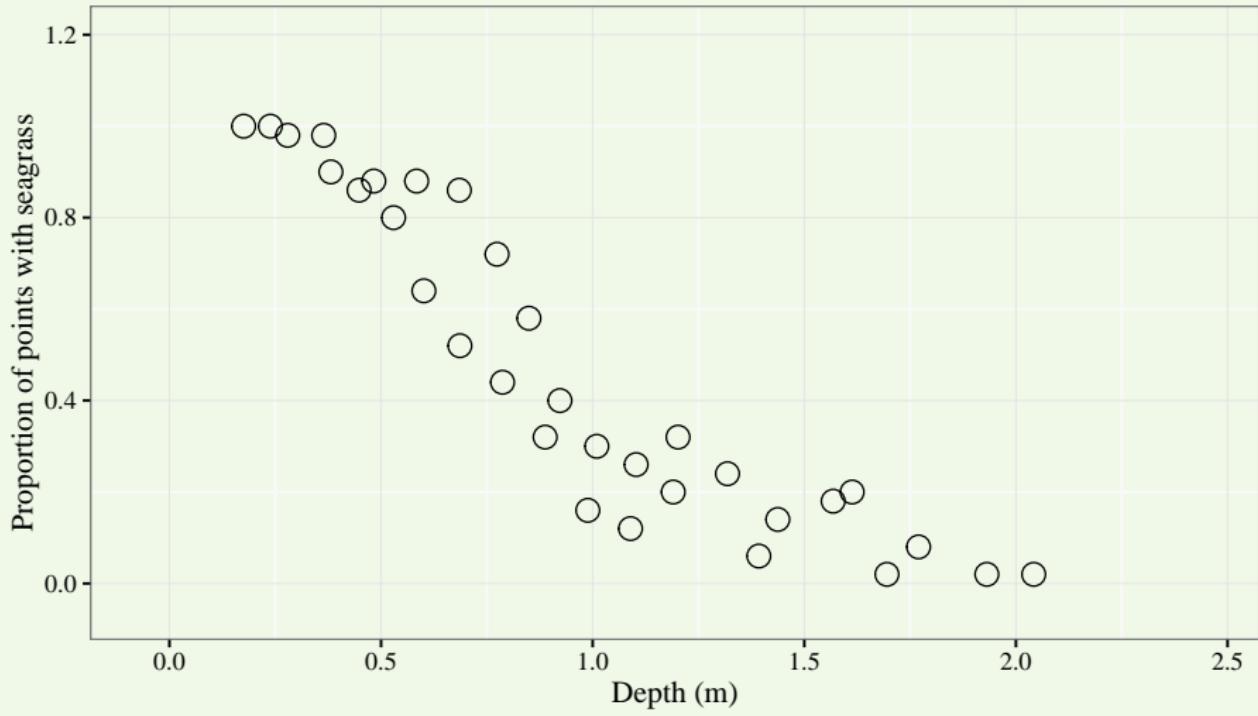
3. Get depth points



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

Estimating seagrass depth of colonization

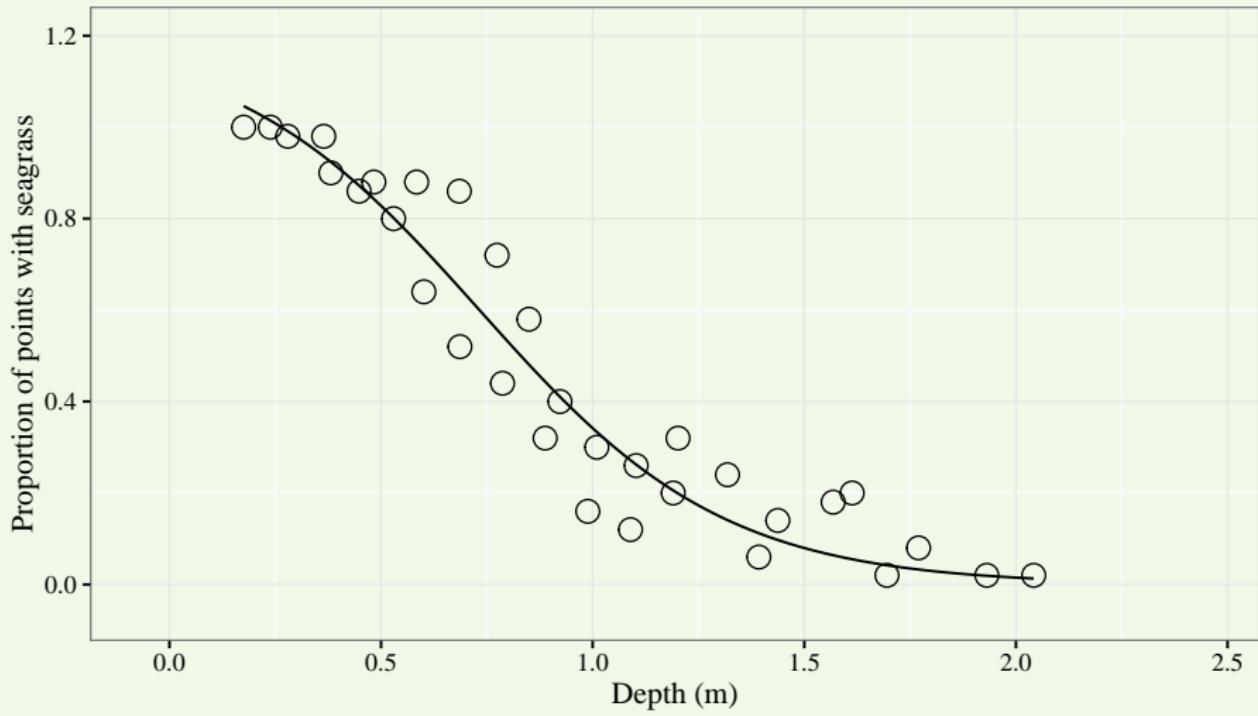
5. Plot the distribution of seagrass by increasing depth





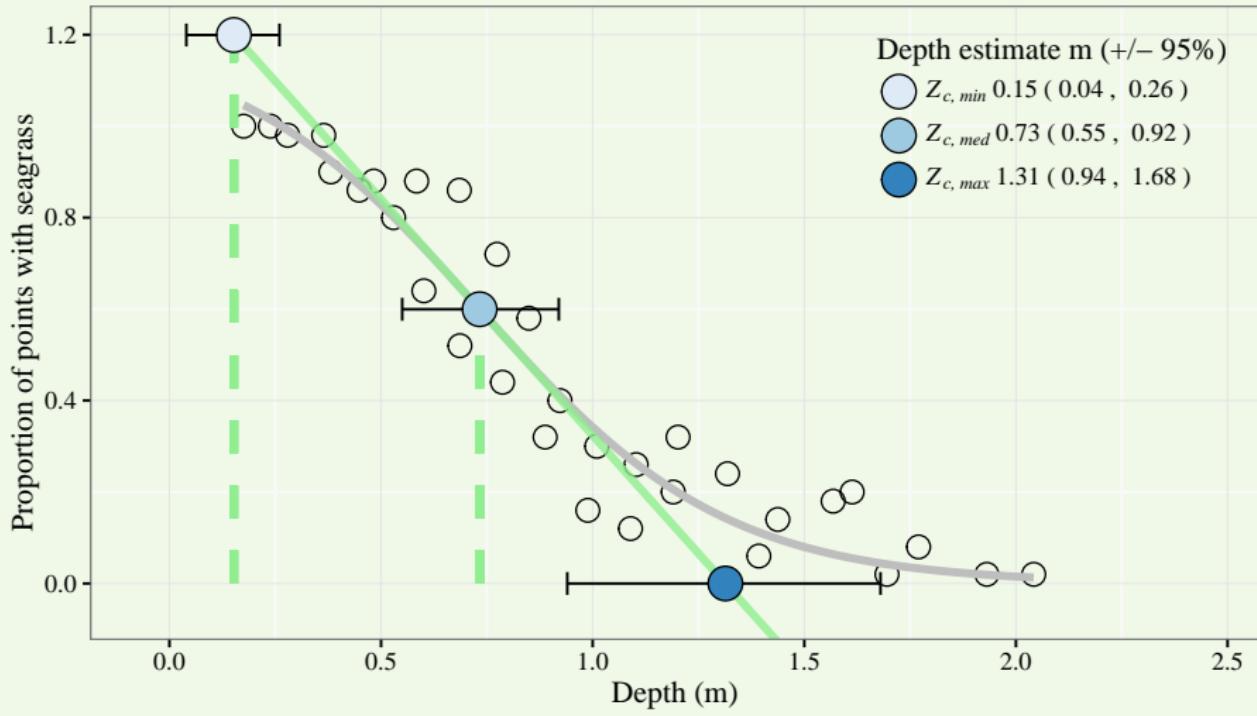
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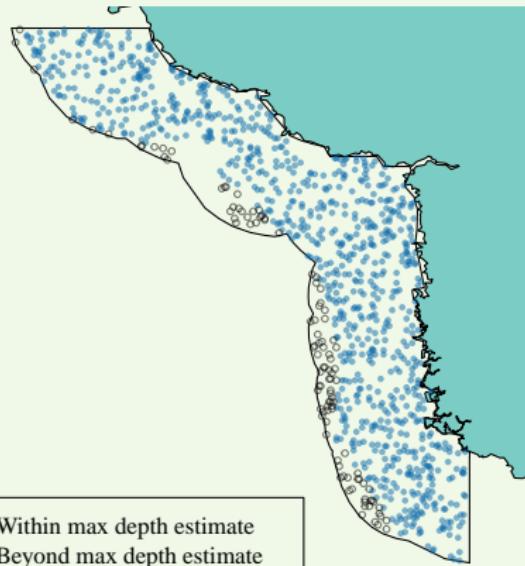
SEstimating seagrass depth of colonization

The estimate depends on the spatial context...



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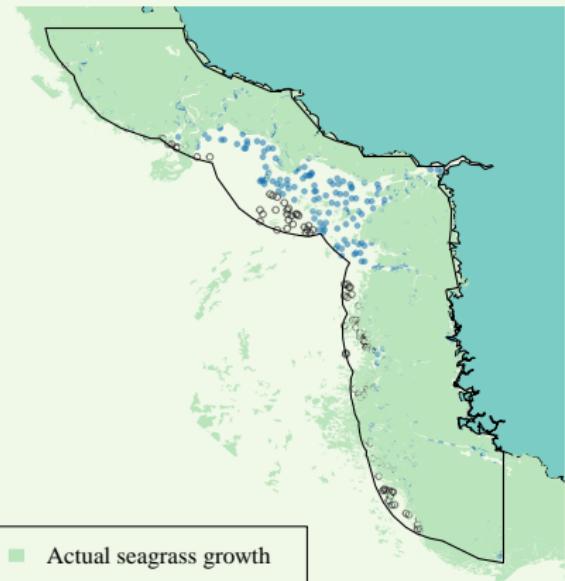
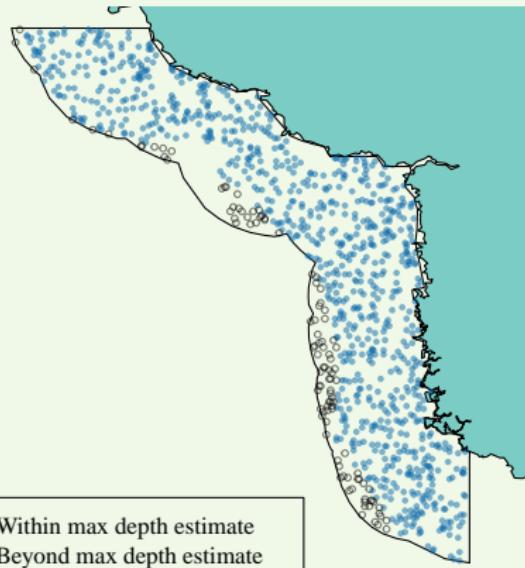
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Estimating seagrass depth of colonization

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Estimating seagrass depth of colonization

The algorithm was applied to entire estuaries with appropriate data

Boundaries



Depth



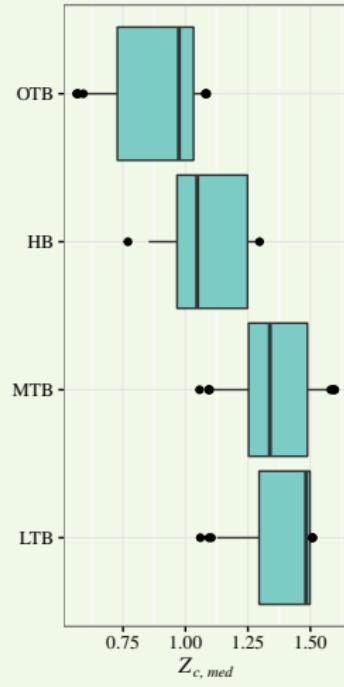
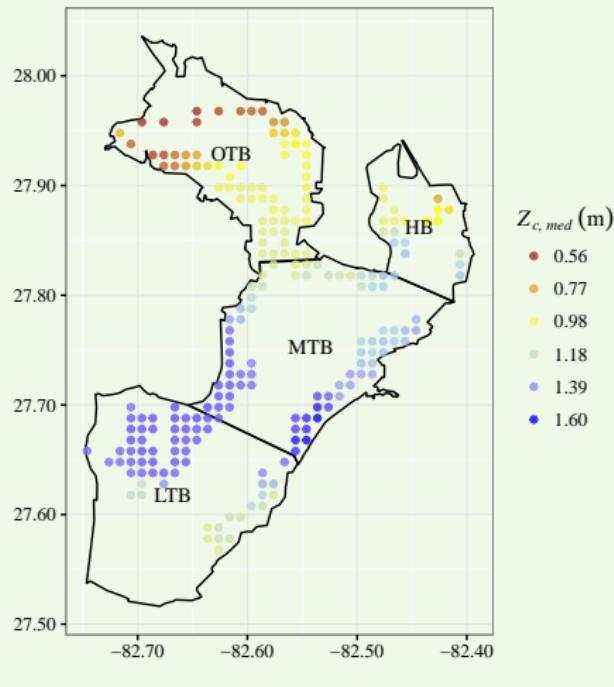
Seagrass





Linking estimates to light requirements

Tampa Bay summary:



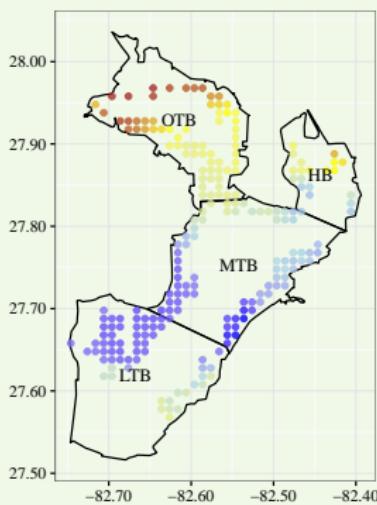
Linking estimates to light requirements

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

Depth of colonization

$Z_{c, med}$ (m)

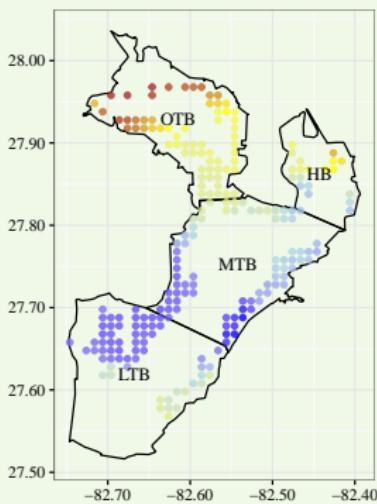
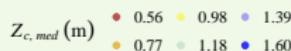
- 0.56
- 0.77
- 0.98
- 1.18
- 1.39
- 1.60



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

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

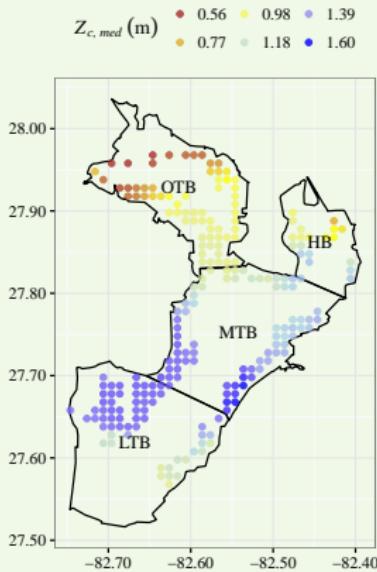
K_d : light extinction coefficient

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

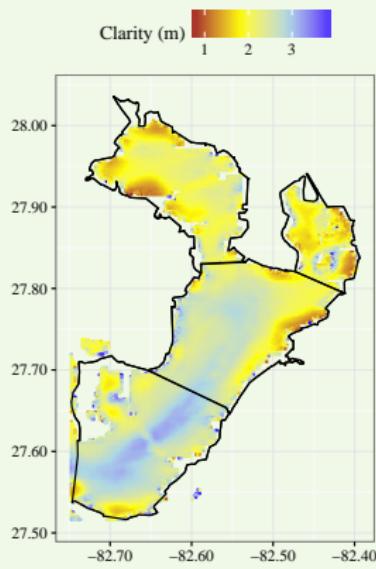
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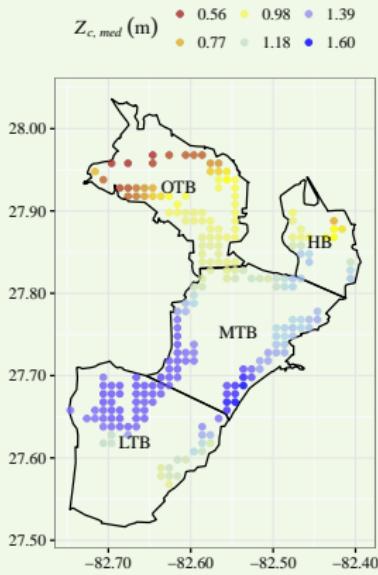
Water clarity



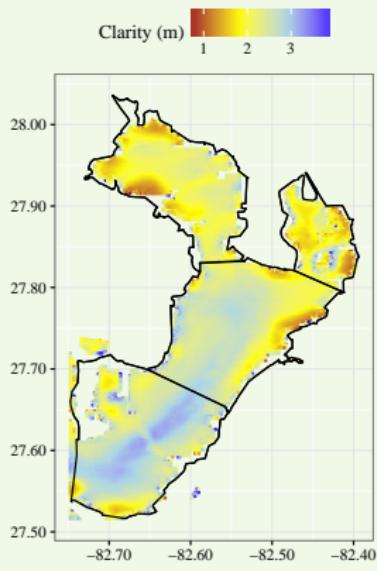
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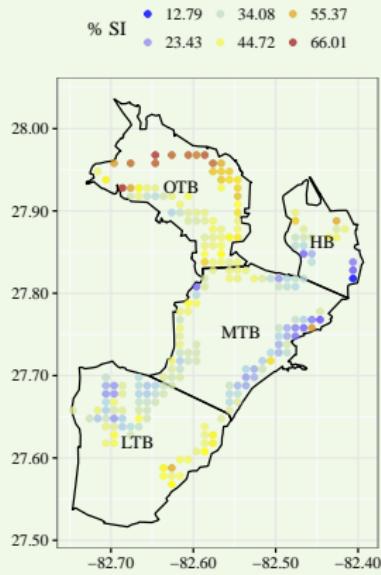
Depth of colonization



Water clarity

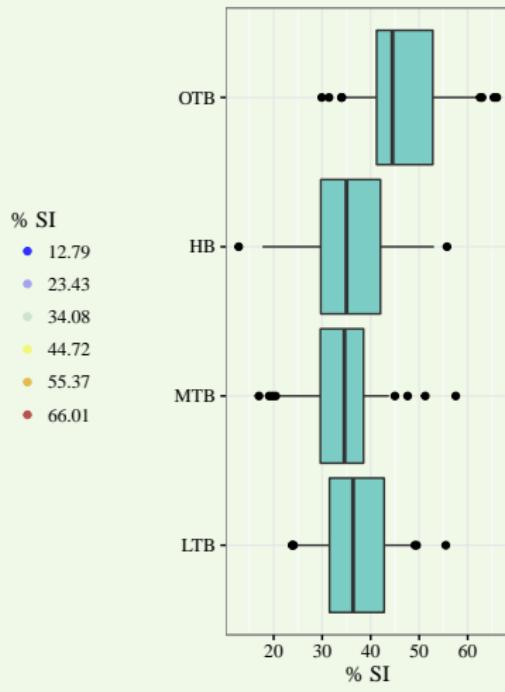
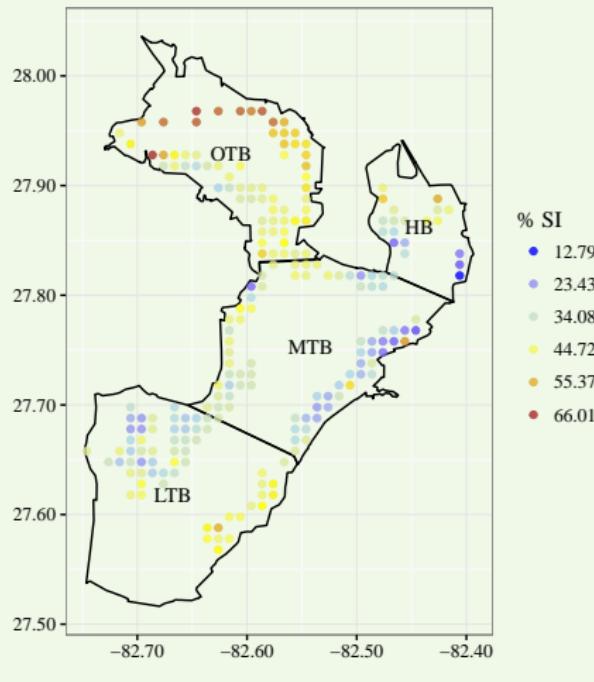


Light requirements



Linking estimates to light requirements

Tampa Bay summary:





Linking estimates to light requirements

Table : Summary of median depth of colonization ($Z_{c, med}$, m) for Tampa Bay and bay segments.

Segment	n	$Z_{c, med}$			
		Mean	St. Err.	Min	Max
Tampa Bay	218	1.2	0.1	0.6	1.6
HB	20	1.1 ^{ab}	0.2	0.8	1.3
LTB	60	1.3 ^b	0.1	1.1	1.5
MTB	74	1.4 ^b	0.1	1.1	1.6
OTB	64	0.8 ^a	0.2	0.6	1.1

Table : Summary of light requirements (%) for Tampa Bay and bay segments.

Segment	n	% light			
		Mean	St. Err.	Min	Max
Tampa Bay	218	41	2.5	13	66
HB	20	34.1	11.2	12.8	55.7
LTB	60	40.0	7.5	23.8	55.5
MTB	74	36.1	7.6	17.0	57.5
OTB	64	48.9	8.7	29.9	66.0



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*



Acknowledgments:

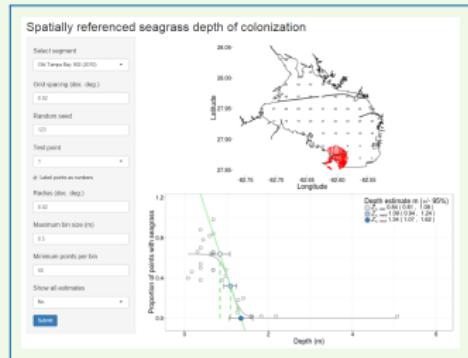
Research staff and employees at USEPA Gulf Ecology Division

Field staff and data managers at Hillsborough County Environmental Protection Commission, Tampa Bay Estuary Program

Peter Tango for reviewing a manuscript draft

Online app

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



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Github: github.com/fawda123/

Blog: beckmw.wordpress.com/

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