Application of Unmanned Aerial Systems (UAS) to evaluate high-frequency changes in intertidal wormreef and nearshore reef at Bathtub Beach Park, Martin County Florida

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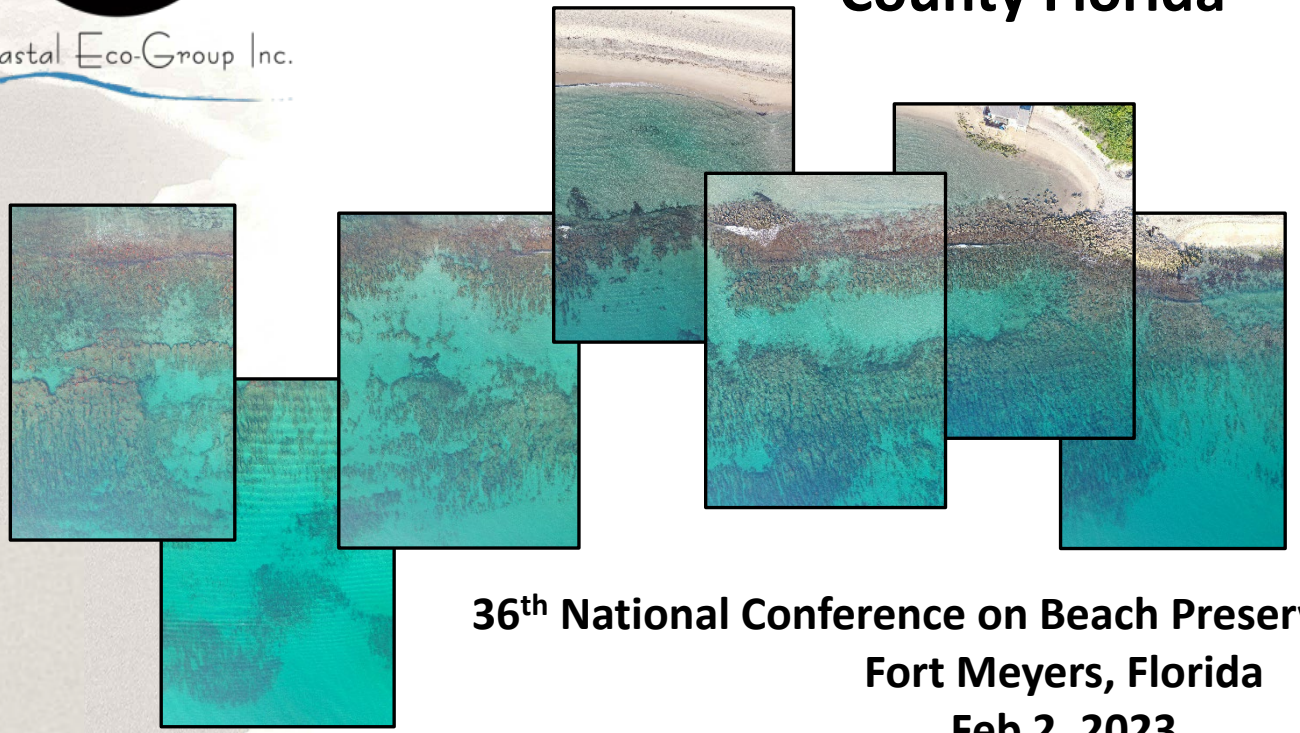


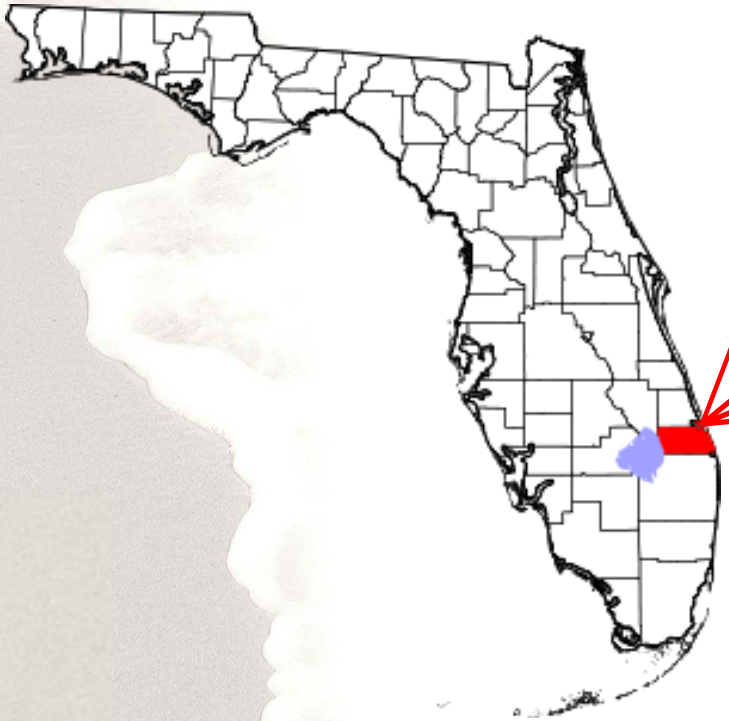
Greg Ward &
Cheryl Miller
Coastal Eco-Group Inc.

Kathy Fitzpatrick, PE &
Jessica Garland
Martin County, Florida.

36th National Conference on Beach Preservation Technology
Fort Meyers, Florida
Feb 2, 2023

Coastal Eco-Group Inc.

Martin County



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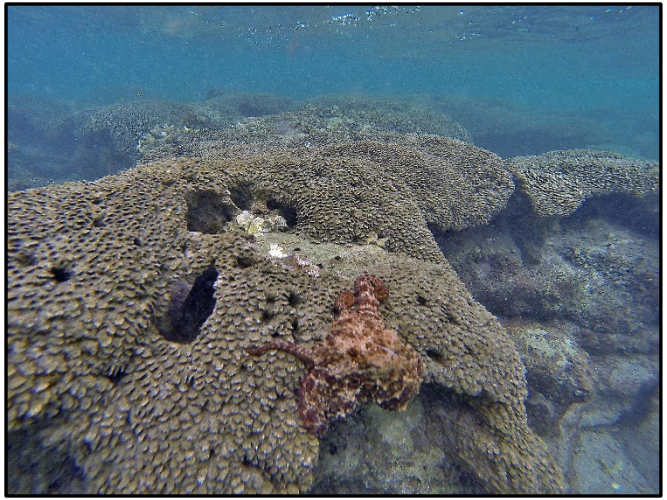
Bathtub Reef Beach Park



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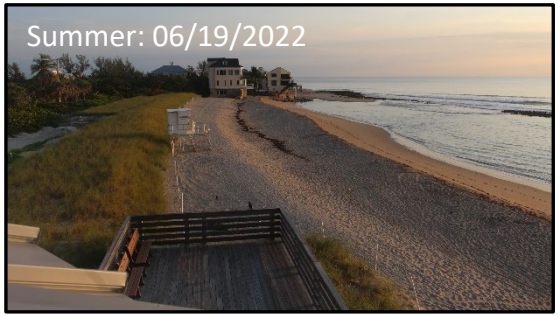
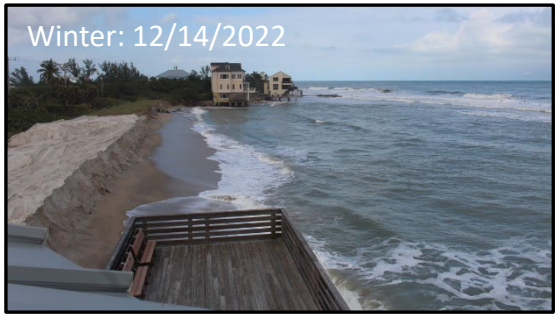
Bathtub Reef Beach Park

Year Completed	Volume (cy)	Sand Source	R-monument Location
2008	2,855	Upland	R34 – R36
2010	6,544	Upland	R34 – R36
2010	35,012	Inlet	R34 – R36
2011	6,664	Upland	R34 – R36
2012	22,617	Upland	R34 – R36
2013	2,554	Upland	R34 – R36
2014	1,295	Upland	R34 – R36
2016	325,400	Inlet	R34.4 – R40
2017	27,477	Upland	R34 – R36
2017	72,106	Inlet	R34.5 – R38
2018	142,843	Inlet	R34.5 – R37.4
2021	181,852	Inlet	R34.3 – R40





Bathtub Reef Beach Park

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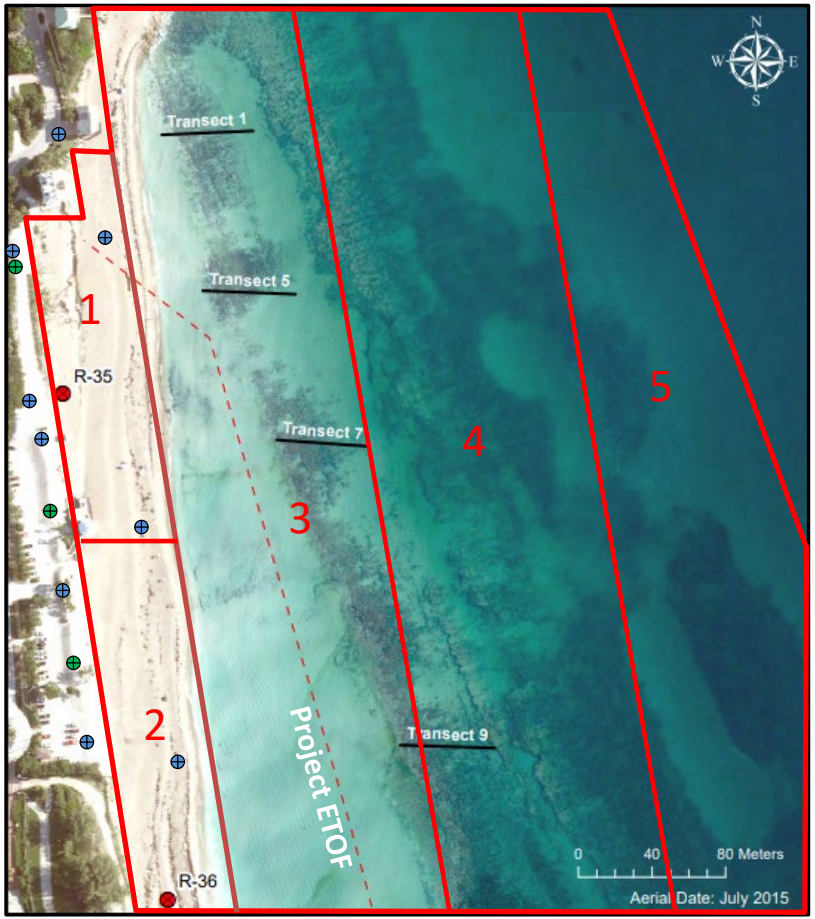
Survey Flight Specifications:

Bi-monthly goal, with five flight missions per survey:

- Targeting morning (few people), low-tide, and clear
- Sample beach and nearshore resources at different heights to accommodate different purposes (GSD)
- Sections 1 & 2 for dry beach profile change estimates, high overlap imagery flown at 150 feet
- Sections 3,4 & 5 for nearshore hardbottom resource estimates, high overlap imagery flown at 350 feet
- Ground control points surveyed into hard infrastructure surfaces and to sand beach profile when survey mobilization logistics allowed

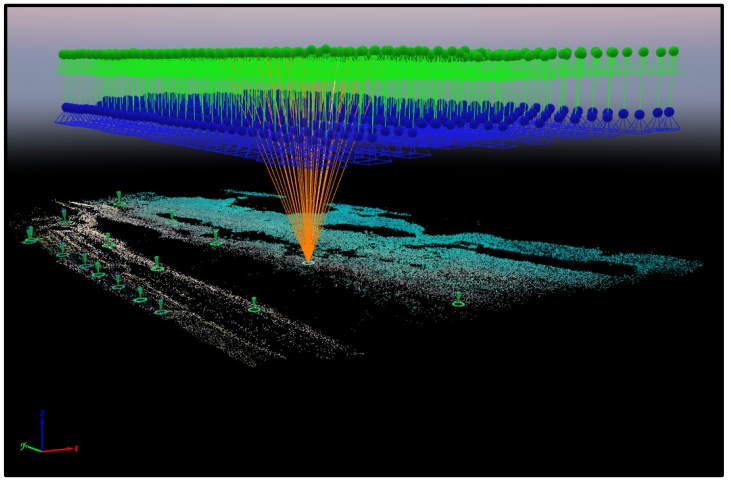


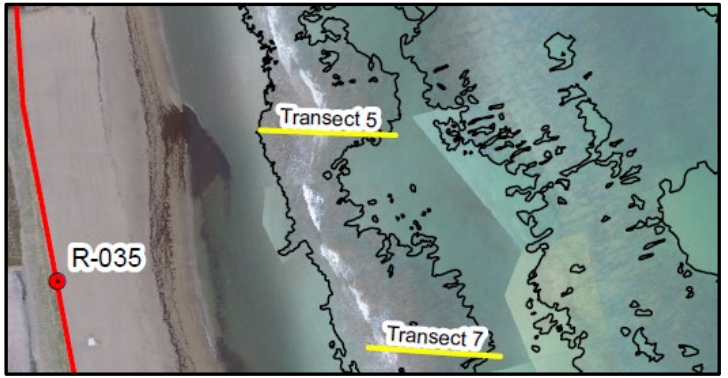
Bathtub Reef Beach Park

Image Post-processing:

Orthomosaic, Digital Surface Model (DSM), and Hardbottom Delineations:

- Pix4D mapper used for all photogrammetry product development
- Flight images grouped by purpose, beach or nearshore, for final product development
- Typically, at least five land-based GCPs applied in any processing run. Manual tie-points distributed throughout beach and nearshore hardbottom based on opportunistically available features in images – *e.g.* objects on beach sand or nearshore hardbottom features





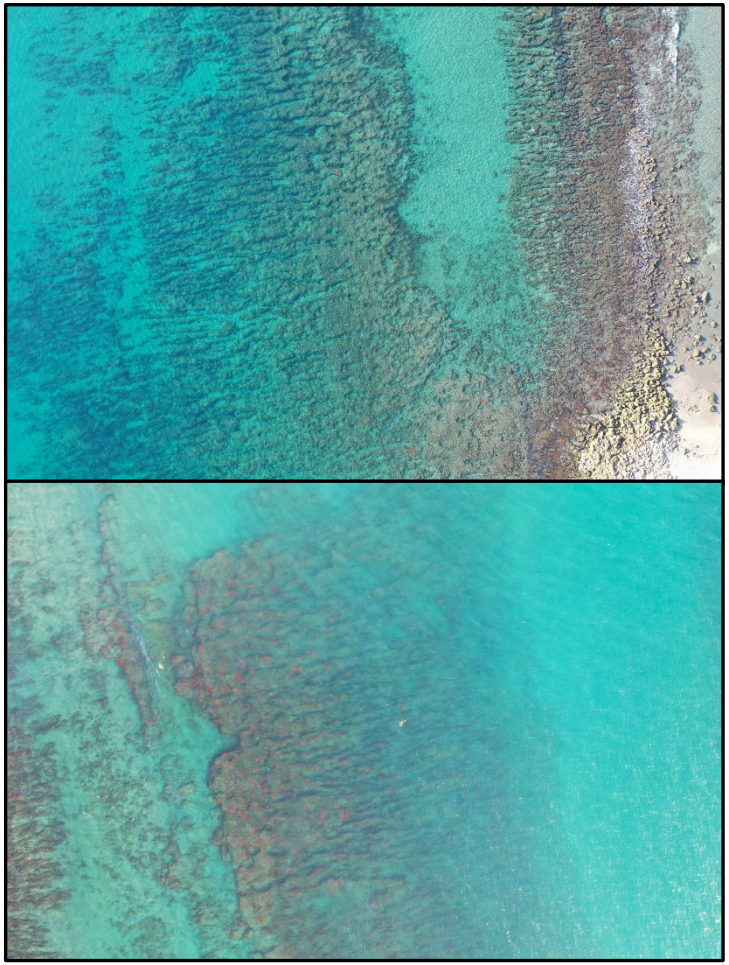
Bathtub Reef Beach Park

Hardbottom Delineations:

Nearshore orthomosaic imported to ArcGIS:

- Hardbottom delineations in ArcGIS based on visual color variations and textural disparities at a 1:50 scale. Polygons drawn at a minimum mapping unit of 4 ft^2.
- Total area of hardbottom delineation for any survey defined by ability to calibrate images in post-processing.

  - Problematic to calibration were waves, wave-swash, light refraction, surface chop, water clarity, etc.



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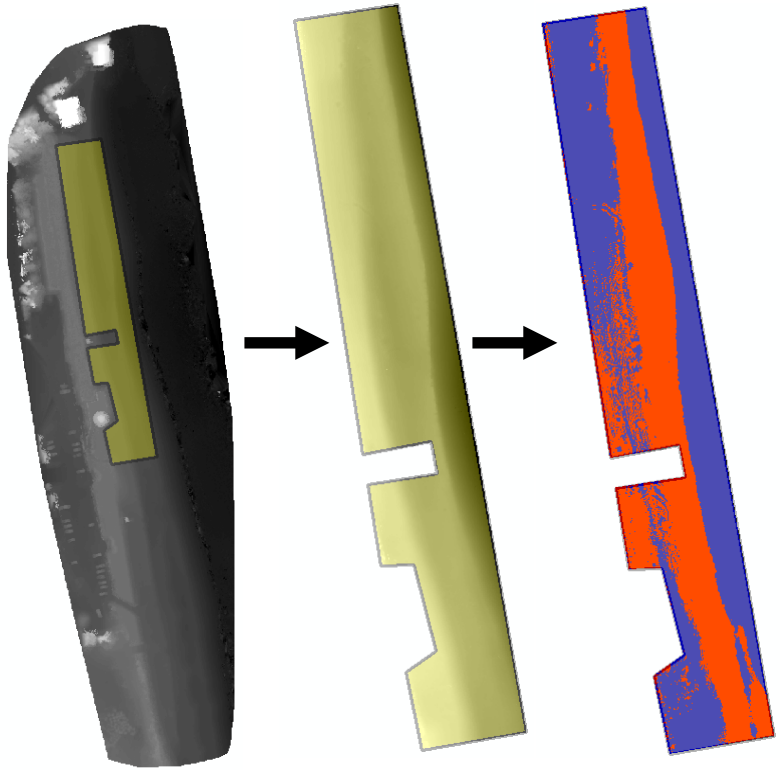
Beach DSM processing:



Crop survey digital surface models (DSM) of beach area to a common dry beach area polygon size:

- All beach survey DSM products cropped to a ~ 1.3-acre north beach-berm polygon. From base of dune to about 90 ft of beach width
- Areas with dune or manmade features (*e.g.* lifeguard towers) excluded so that changes apply only to dry beach
- ArcGIS cut and fill tool used to find volumetric (sq ft) gain (red) and loss (blue) between consecutive surveys

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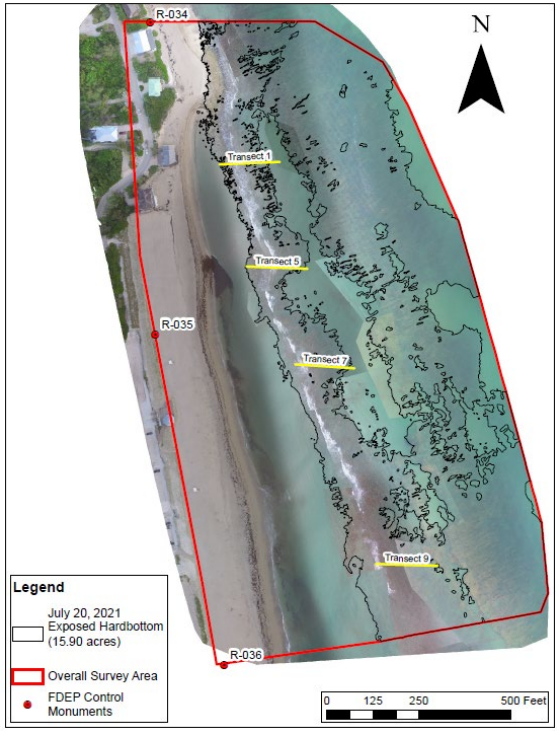
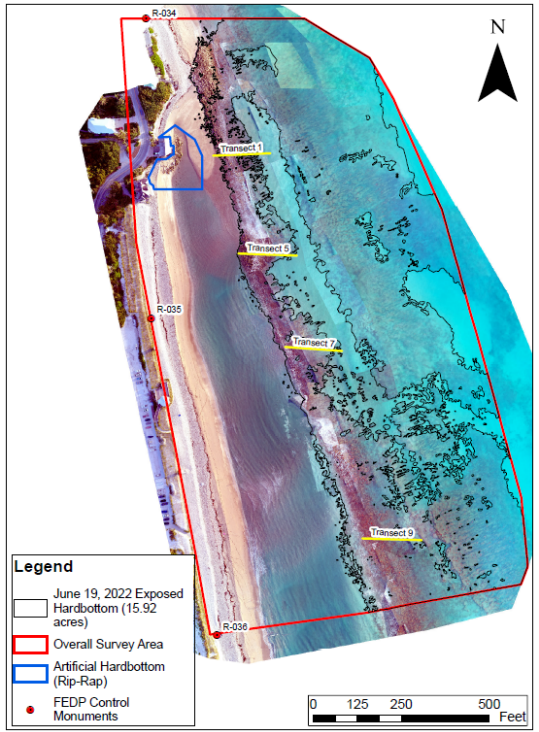
Results: Hardbottom Delineation





Largest common survey area:

- Defined by ability to calibrate images in post-processing.
  - Waves, wave swash, light refraction, water clarity, etc.
- Images in the red outline were well calibrated in:
  - July 2021 (Survey 1)
  - September 2021 (Survey 2)
  - June 2022 (Survey 6)
- Exposed Natural Hardbottom:
  - July 2021 (15.9 acres)
  - September 2021 (15.4 acres)
  - June 2022 (15.9 acres)

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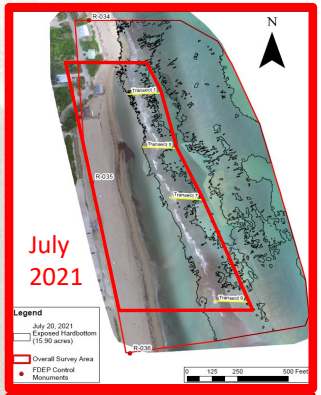
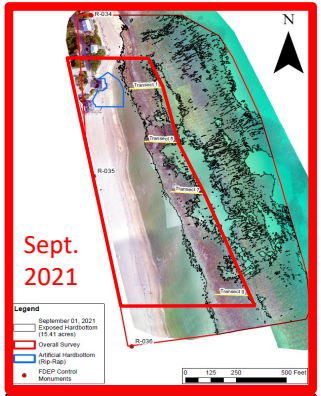
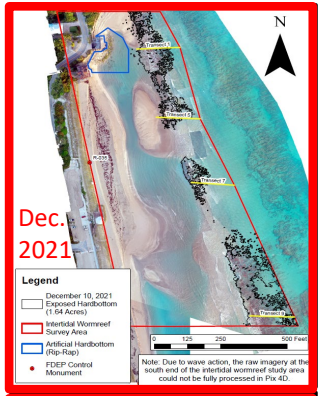
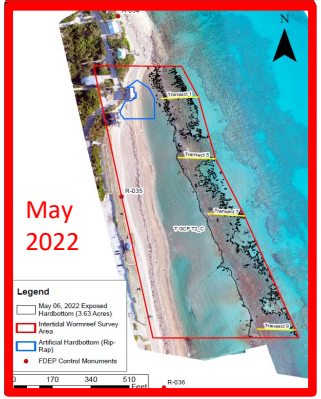
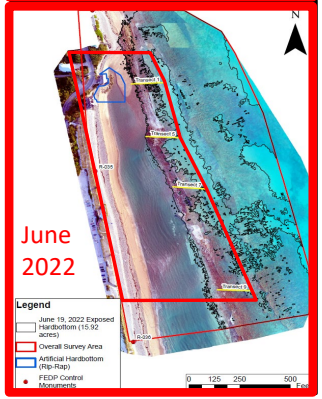
Results: Hardbottom Delineation











Smallest common survey area:

- Concerned with nearshore wormrock habitat, exposed hardbottom extending to transect offshore ends
- Relatively large area of wormreef habitat buried in December 2021 survey.

Orthomosiac Aerial Date	Overall Survey Area Acreages	Intertidal Wormreef Survey Area Acreages
July 20, 2021	15.90	4.14
September 01, 2021	15.41	4.13
December 10, 2021	-	1.64
March 11 & 17, 2022	-	3.67
May 06, 2022	-	3.63
June 19, 2022	15.92	3.79

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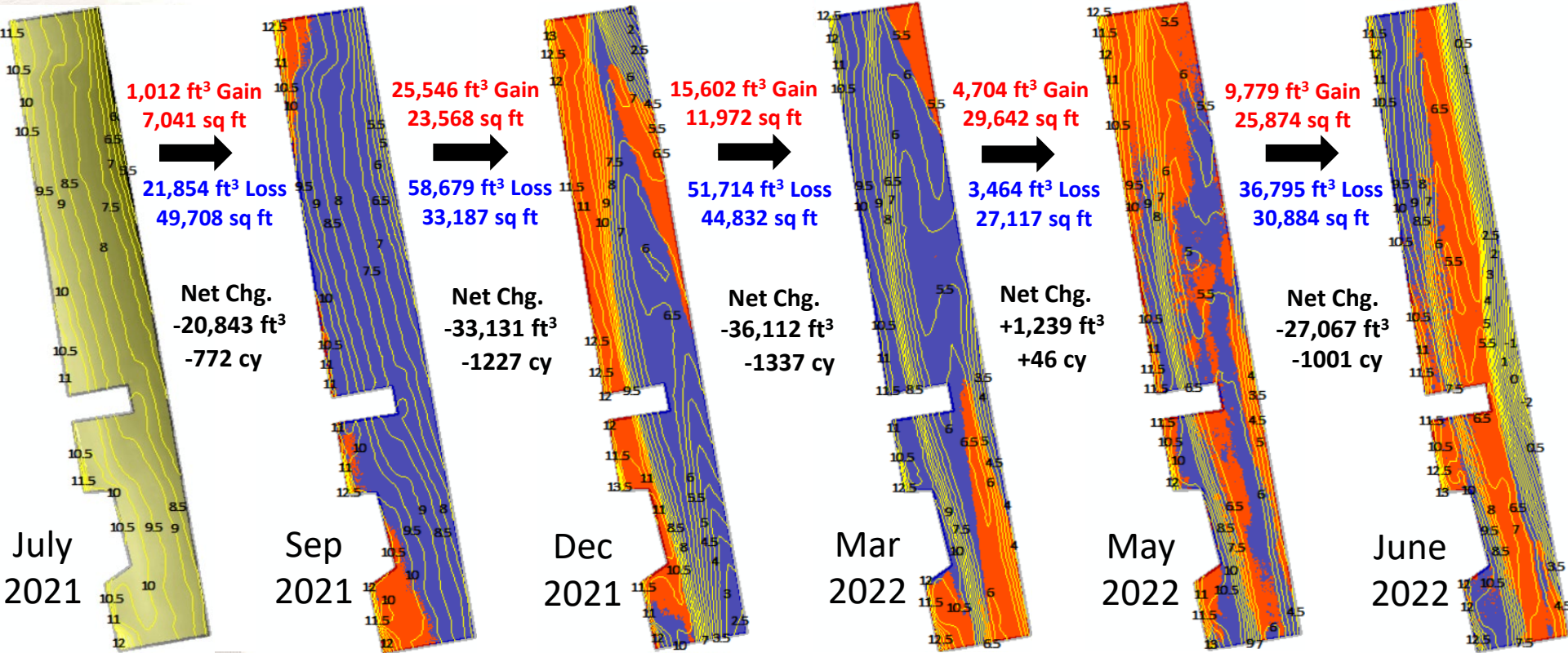
Results: DSM Survey Volume Change Estimates



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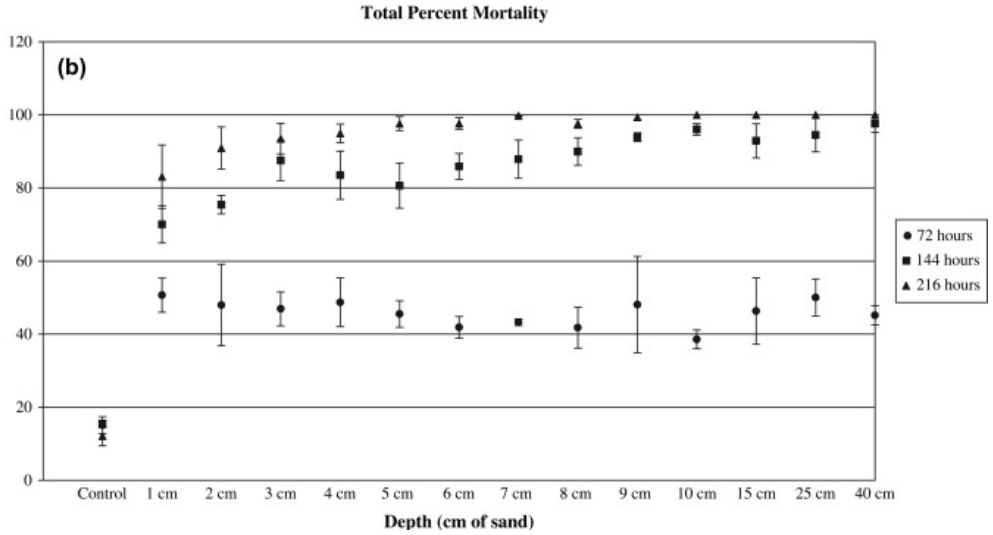
- *P. lapidosa* direct burial tolerances trend towards full mortality sometime between 144 and 216 hours under 10 cm of sediment (Sloan & Irlandi, 2008).

  - varies, with mortality increasing with greater depths and longer durations, and decreasing conversely, as you might expect.



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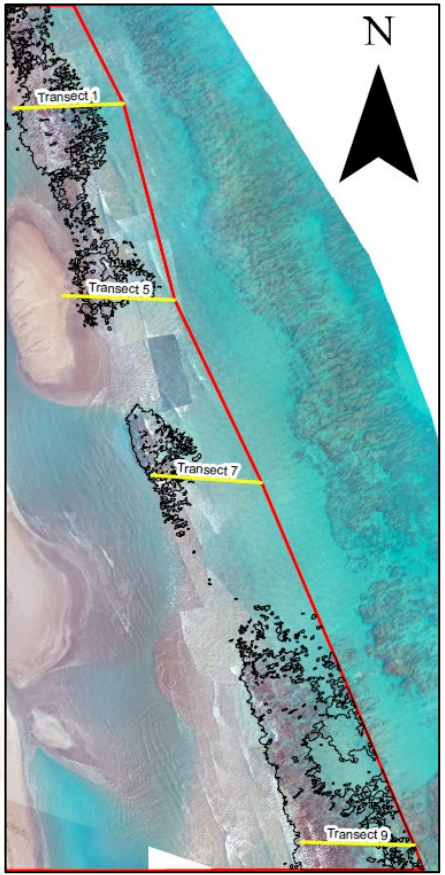

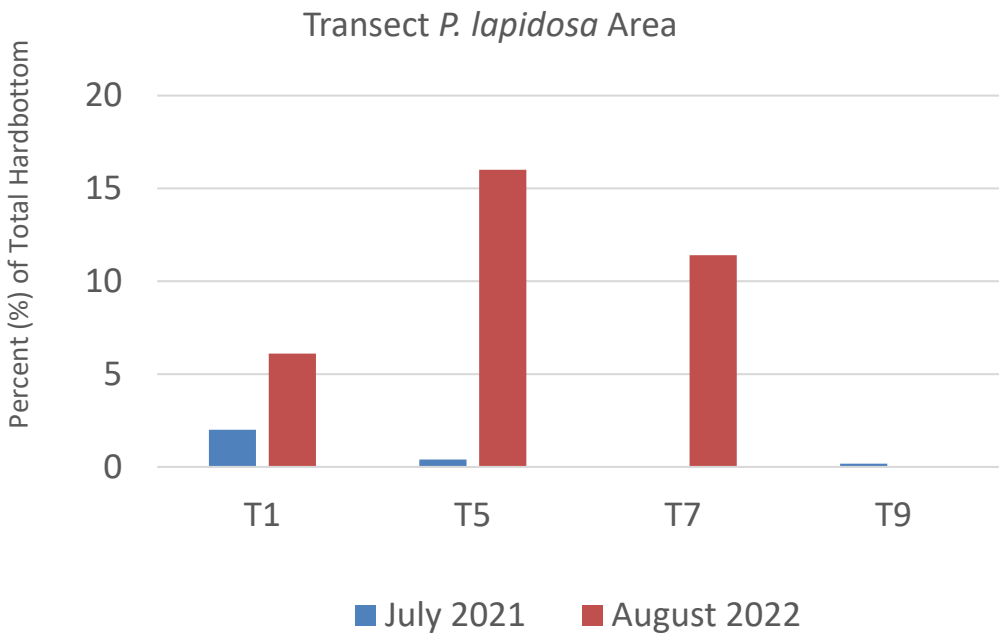

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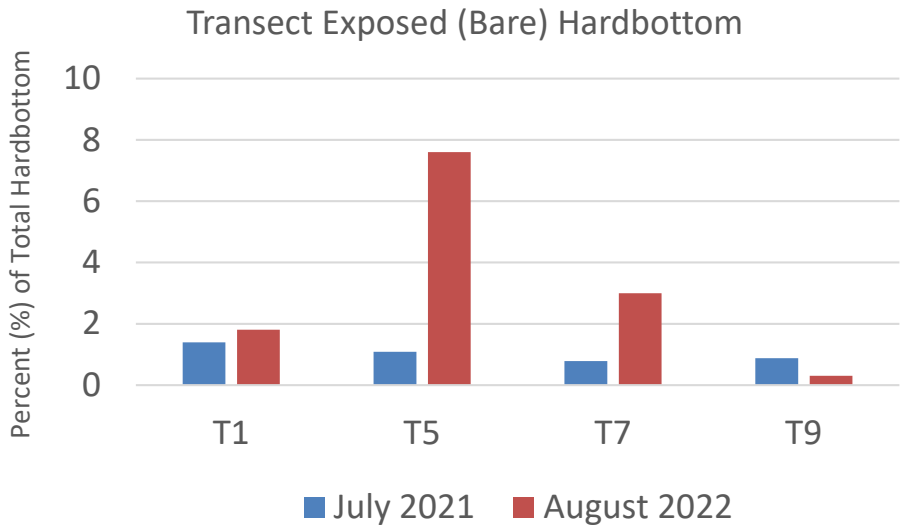
1) Recruitment occurs throughout most of the year but peaks during fall and winter (McCarthy 2001).

2) *P. lapidosa* require hard substrate for recruitment and settlement, often repeatedly settling to test substrate for suitability (Eckelbarger 1976; Pawlik 1988; McCarthy, 2020).



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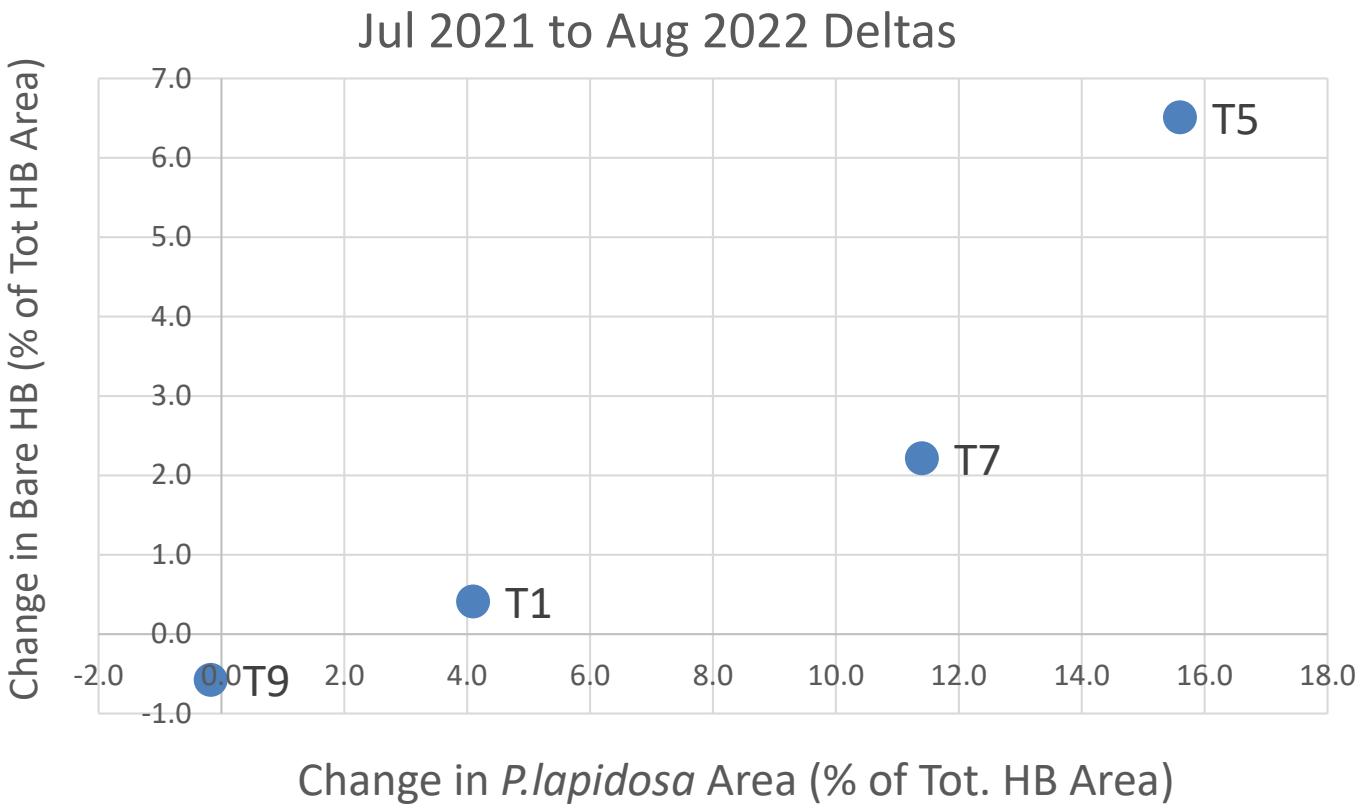

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Special thanks to those that contributed to the development of this data and presentation: Martin County Katelyn Klug, Nicole Dancho, Jenna Soulliere

Thoughts:

- Correlation does not equal causation.
- This preliminary attempt to find links between sediment environment and biotic change through more frequent observation of physical processes may have exposed other, less obvious, mechanisms of effect.
- *P. lapidosa* colonies may succumb to reef overtopping and burial in winter months, but associated scouring may facilitate recruitment, and rapid growth (approximately 0.5 cm/day) fast recolonization of area.

Thank you!

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