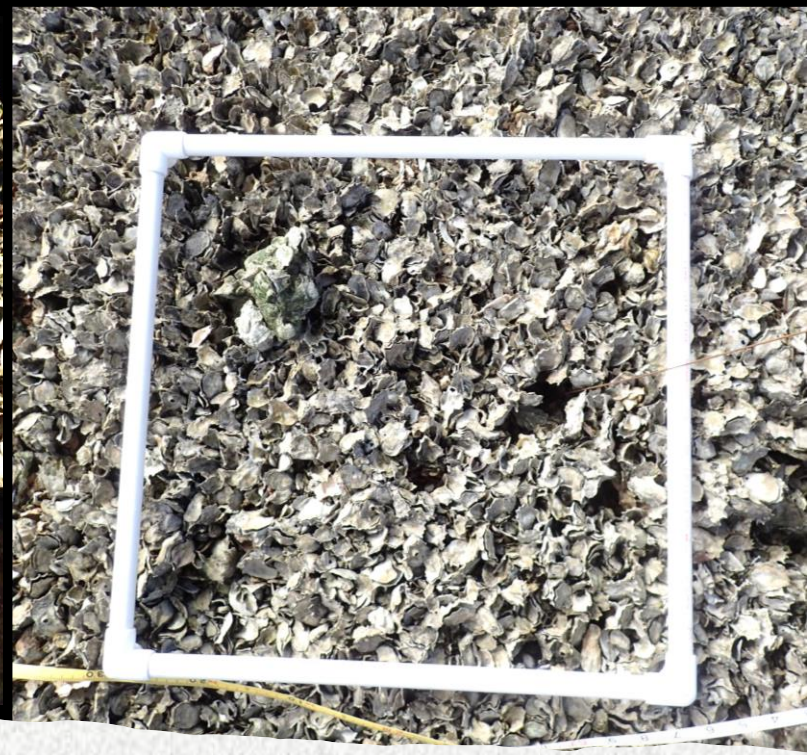
Oyster Density on Varying Artificial Reef Substrates and Elevations in Tampa Bay, Florida

Savanna Hearne, C. Scott Adams, Kara R. Radabaugh, Emily Ritz, Christine Russo, Eric Plage, Serra Herndon, Gary E. Raulerson, and Ryan P. Moyer

Oyster Integrated Mapping and Monitoring Program 2022

History of Eastern Oysters in Tampa Bay

- Early 1800s- abundant oyster reefs provide economic/ecological services
- Late 1800s- decline in oyster reefs noticed (Smeltz 1897)
- 1970s- reef area has declined over 85% due to harvesting, shell mining, and habitat loss (Whitfield 1975; Beck 2011)
- 2000s- restoration efforts focus on providing hard substrate to compensate for natural reef loss (Hernandez 2018)

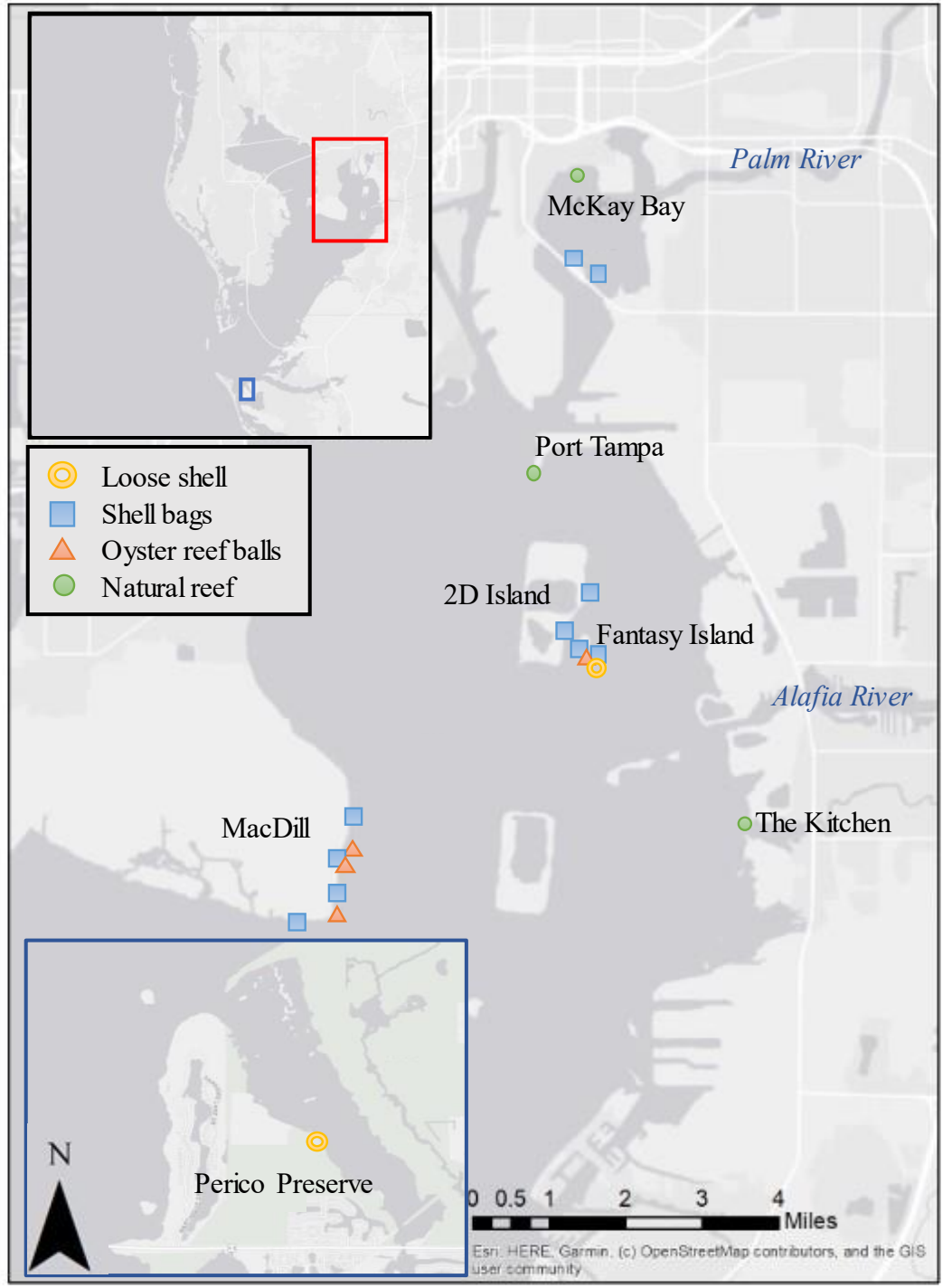


Goal of this study:

Determine which artificial substrates and reef elevations support optimal development of oyster populations

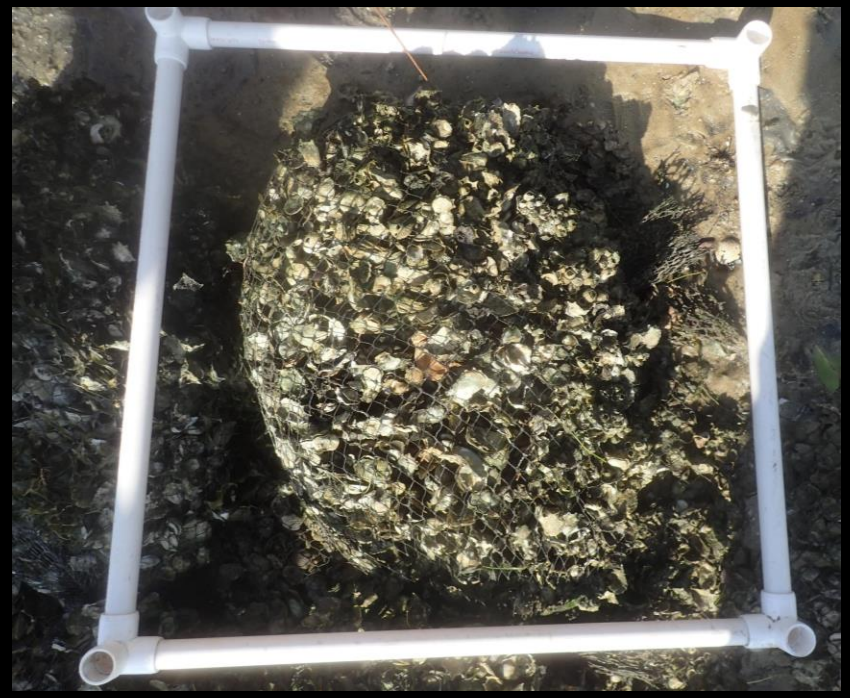
Study sites

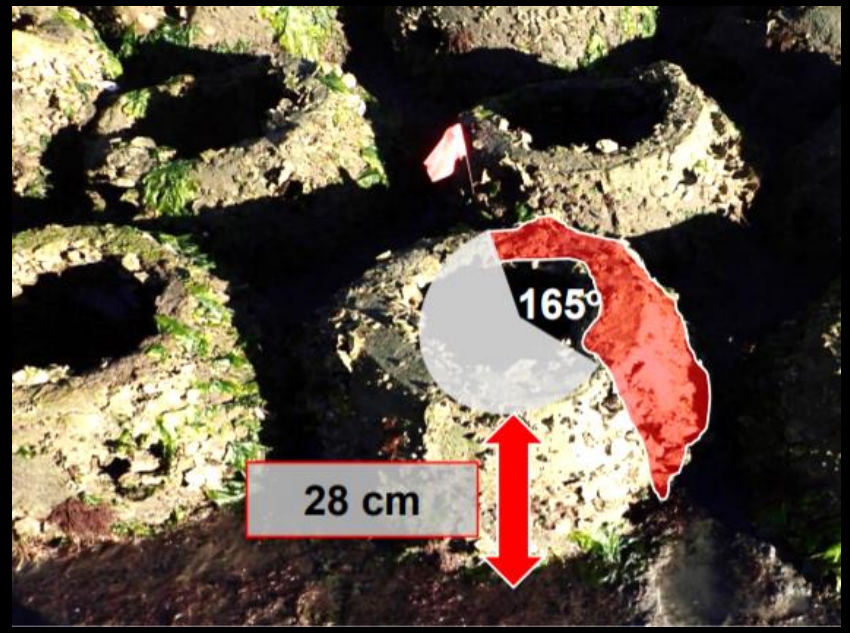
- 19 total oyster reefs across 8 locations
  - -2 loose shell
  - -10 shell bag
  - -4 oyster reef ball (ORB)
  - -3 natural
- Reefs constructed between 2006-2008, 2015-2016, or 2018-2019



Monitoring Methods

- 10 permanent plots at each reef were monitored annually/semi-annually
- An RTK-GPS was used to locate plots (ORB or 0.5 x 0.5 m quadrat)
- For ORBs, a 0.25 m^2 surface area was calculated as a wedge
- Live oysters and boxes (recently dead oysters) were counted and measured *in situ*
- Density of gastropod predators (i.e., oyster drills, crown conch) was recorded for each plot
- Additional parameters include burial by sediment and water quality



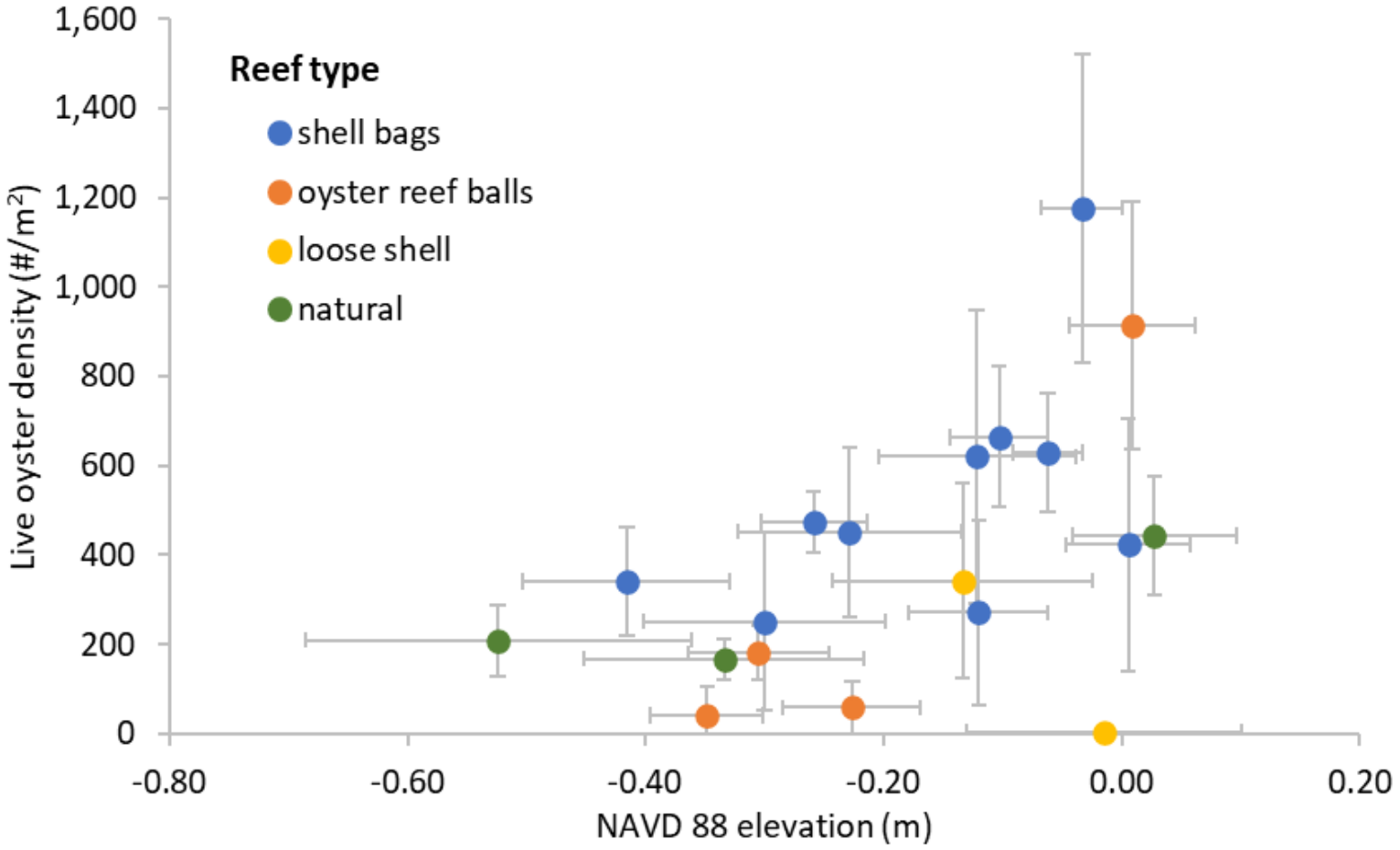


Elevation Methods

- Elevation relative to NAVD88 was recorded with an RTK-GPS receiver and coupled HC1 data collector
- Elevation recorded in every quadrat at 1-Hz occupation

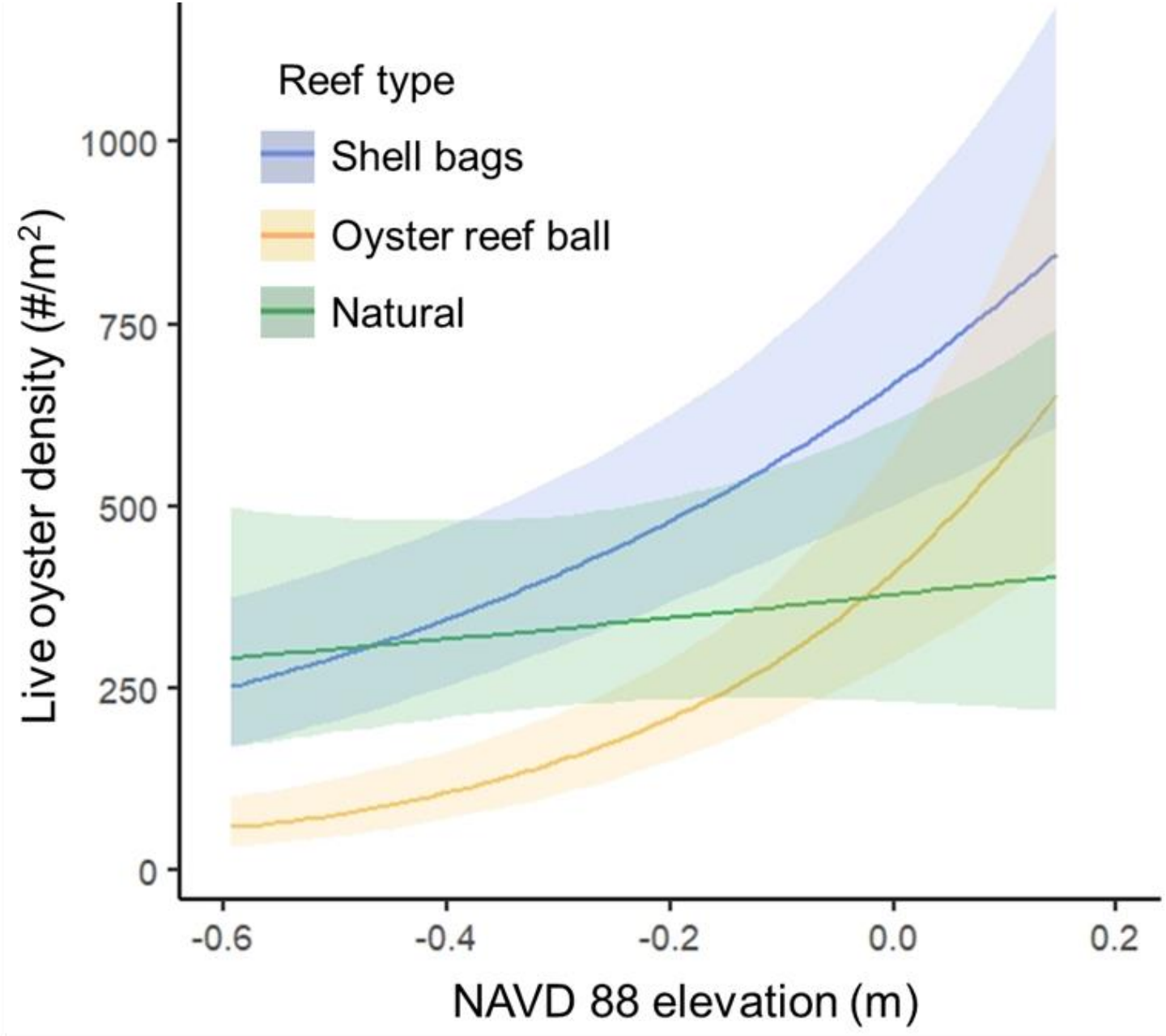
Results: Oyster Density

- Shell bags generally had higher oyster density than other substrates
- ORBs have lower densities than natural reefs and shell bags, especially at lower elevations
- Highest densities occur between -0.2 m and 0.2 m NAVD88 for all substrates



Results: Oyster Density

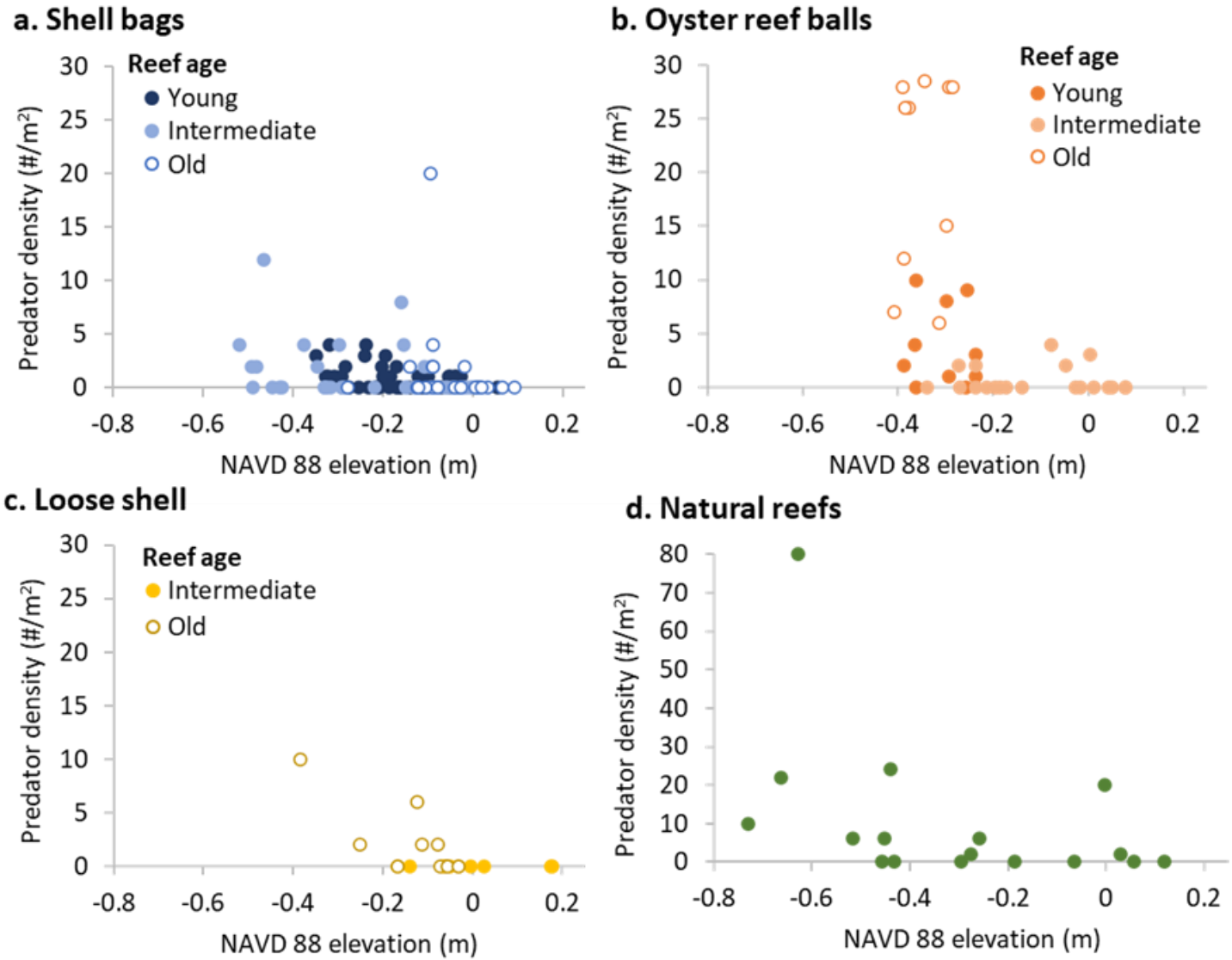
- Mixed-effects generalized linear model built in R
- Model shows interacting influence of elevation and substrate type on oyster density
- Loose shell excluded from models due to poor recruitment and small sample size



Results: Predator Density

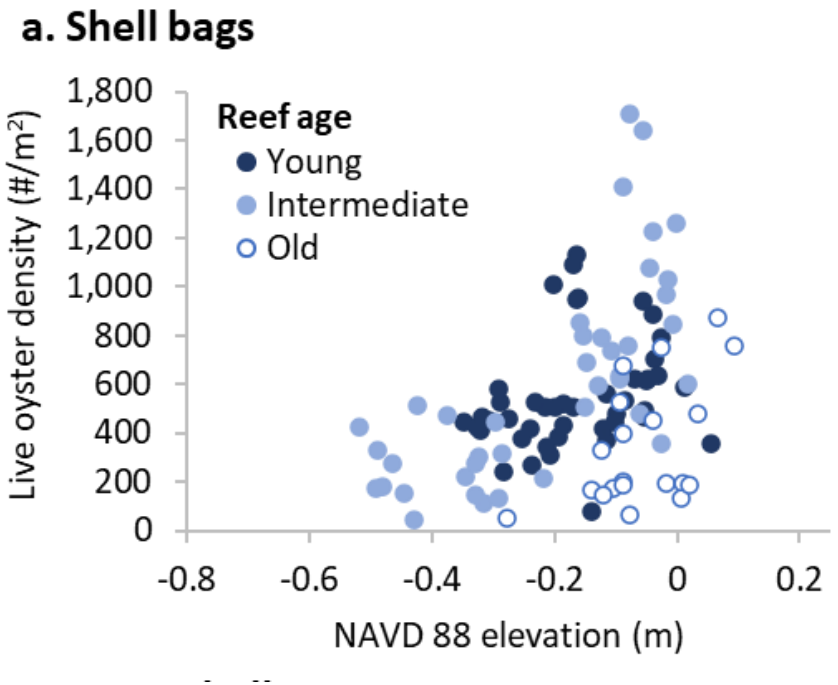
- Highest gastropod predator density observed at low elevations, particularly on ORBs.

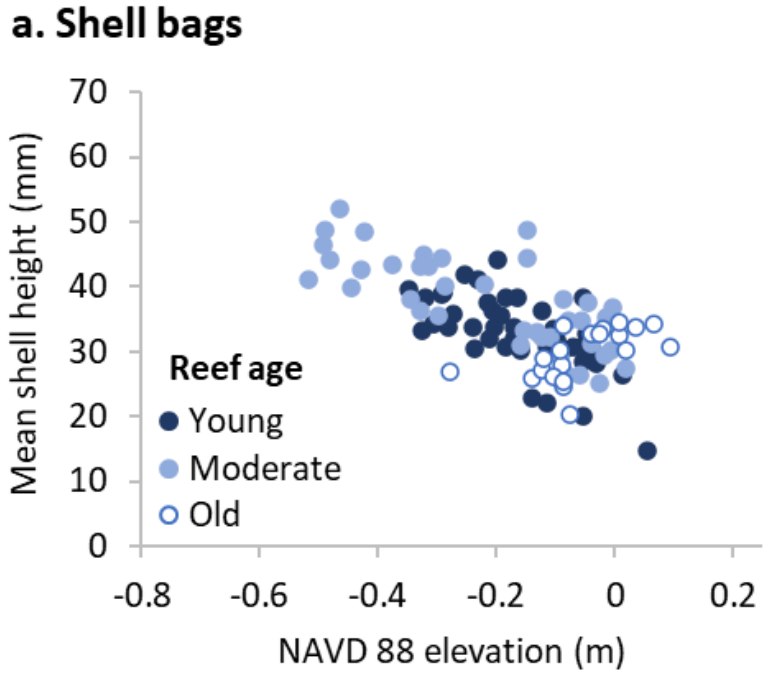
Photo by M. Ligthart

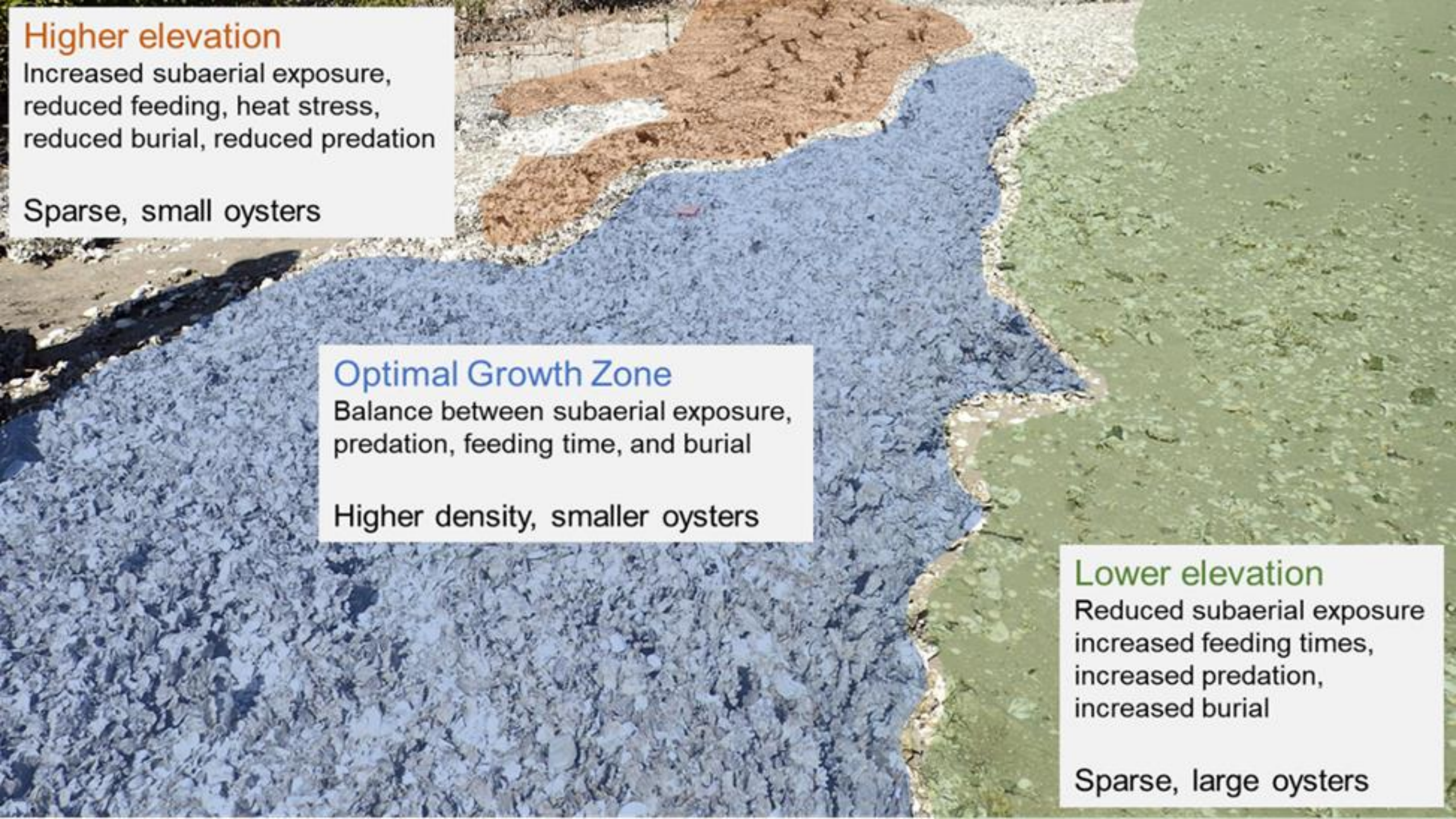


Results: Shell bags

- Higher densities of small oysters on shell bags at high elevations
- Lower densities of larger oysters on shell bags at lower elevations






Higher elevation
Increased subaerial exposure, reduced feeding, heat stress, reduced burial, reduced predation
Sparse, small oysters
Optimal Growth Zone
Balance between subaerial exposure, predation, feeding time, and burial
Higher density, smaller oysters
Lower elevation
Reduced subaerial exposure increased feeding times, increased predation, increased burial
Sparse, large oysters

Discussion

- Reefs at lower elevations experience longer submergence, allowing for increased filter feeding time and reduced stress from exposure to air.
- Longer inundation time may allow for higher rates of sedimentation and predation by gastropods
- Significantly more sediment burial found on lower elevation reefs

Conclusions

- Higher elevation reefs have smaller, but more abundant oysters
- Density and size are influenced by elevation and associated factors (predation, burial, exposure to air, feeding duration, thermal stress)
- Information from this study should be used for planning future oyster restoration with anticipated sea-level rise

Acknowledgements

Sam Roussopoulos
Mike Wheeler
Colin Shea
Katie Toth
Melanie Grillone
Samantha Iliff
Paige Lansky
Richard Radigan
Andy Lykens
Jason Kirkpatrick

References

- Beck, M.W, Raulerson, G.E., Burke M.C., Whalen, J., Scolaro, S., Sherwood, E.T. (2021) Tampa Bay Estuary Program: Data Management Standard Operating Procedures, Technical report #12-21, Tampa Bay Estuary Program, St. Petersburg, Florida. https://drive.google.com/file/d/1vO4B8DJATgCSV1qOxZz-kN6Uj1BrgNsg/view?usp=sharing
- Burke, M.C., Carnahan, L., Hammer-Levy, K., and Mitchum, G., 2019. Recommended Proje[illegible]Level Rise for the Tampa Bay Region (Update). Technical report #05-19, Tampa Bay Estuary Program, St. Petersbu[illegible] https://drive.google.com/file/d/1c_KTSJ4TgVX9IugnyDadr2Hc0gjAuQg2/view?usp=drives[illegible]
- Camp, E., Pine, W. III, Havens, K., Kane, A., et al., 2015. Collapse of a historic oyster fishery: di[illegible]ing causes and identifying paths toward increased resilience. Ecology and Society, v. 20(3).
- Hernandez, A.B., Brumbaugh, R.D., Frederick, P., Grizzle, R., Luckenbach, M.W., Peterson, C.H., and Angelini, C., 2018. Restoring the eastern oyster: how much progress has been made in 53 years? Frontiers in Ecology and the Environment, v. 16 p. 1–9
- Kaufman, K., 2017. Tampa Bay Environmental Restoration Fund Final Feport: Hard bottom mapping and characterization for restoration planning in Tampa Bay. St. Petersburg, FL: Tampa Bay Estuary Program. TBEP Technical Report #03-17. Available from https://www.tbeptech.org/TBEP_TECH_PUBS/2017/TBEP_03_17_Hard_Bottom.pdf.
- Rodriguez, A.B., Fodrie, F.J., Ridge, J.T., Lindquist, N.L., Theuerkauf, E.J., Coleman, S.E., Grabowski, J.H., Brodeur, M.C., Gittman, R.K., Keller, D.A., and Kenworthy, M.D., 2014. Oyster reefs can outpace sea-level rise. Nature climate change, v. 4(6), p. 493–497.
- Smeltz, A. 1897. The oyster-bars of the West Coast of Florida: their depletion and restoration. Bulletin of the United States Fish Commission 17:305-308. Washington, D.
- Whitfield, W.K. Jr, 1975. Mining of submerged shell deposits: history and status of regulation and production of the Florida industry. St. Petersburg, FL: Florida Department of Natural Resources Marine Research Laboratory. Florida Marine Research Publication Number 11

Questions?