# An investigation into the potential anthropogenic impact on growth rate and biomass of Turtle Grass, *Thalassia testudinum,* in South Eleuthera.

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## Introduction to Coastal Ecosystems

Coastal environments are some of the most biologically diverse and unique ecosystems around the world. Almost 40% of the human population live on the coast and thousands of species rely on the shallow waters and sunlit conditions to flourish. The Bahamas acquires 50% of their annual GDP from tourism and a major attraction of The Bahamas is the clear blue water and vibrant reefs.

**What is seagrass?** The foundations of coastal ecosystems are primary producers such as seagrass. With the ocean comprising 71% of the earth's surface, seagrass is one of the major contributors to ocean health as the world's second largest carbon sink. Seagrasses like *Thalassia testudinum*, or turtle grass, utilise photosynthesis to produce their own food, and nutrients for other organisms. There are a multitude of ecosystem services performed by seagrass, including the cycling of nutrients, stabilizing sediments (giving The Bahamas water its clear, blue colour), absorbing $CO_2$, and providing a nursery for fisheries (Amos et al., 2017; Lamb et al., 2017). In the California and Washington states' coastal ecosystems, seagrass is a source used to moderate temperatures and community composition (Honig, et al., 2017). Studies on seagrass include some that investigate various animals that forage on seagrass, such as Bjorndal (1980). Sea turtles, manatees, and juvenile fish are some of the most dependent organisms, but there is also evidence that coral reefs benefit from the presence of seagrass (Bjorndal, 1980; Lamb et al., 2017); even zoophytes and epiphytes are dependent upon seagrass.

Figure1: A bed of healthy seagrass.

## Methods:

### Percentage Cover of Seagrass in Quadrat:

- A quadrat was laid down at each sub-site, determined by a GPS waypoint.
- Water depth, time, sediment type, GPS waypoint were recorded, as well as percentage cover of macroalgae and the three seagrass species.
- Picture of quadrat was taken (Figure 4.)

Figure 4: A quadrat use to estimate percentage cover.

### Temperature:

- A temperature logger was tied onto a cinderblock.
- The logger was placed at a similar depth in the water at a central location in each of the 10 study sites.

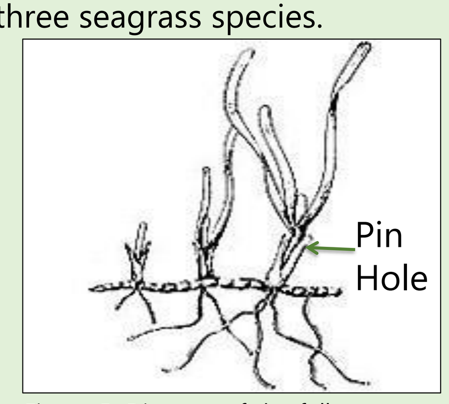


Figure 5: Diagram of the full seagrass composition.

### Growth Rate:

- A permanent piece of re-bar was placed at 3 of the sub-sites at each study site.
- A quadrat was laid down adjacent to the re-bar and a pin used to make a hole in the sheath of the seagrass.
- Two weeks later, half the seagrass in the quadrat was collected and a scar on the blade was identified and used to measure the growth of youngest mature leaf (Figure 6.)


Figure 6: A full piece of seagrass including the blade, sheath, rhizome and roots.

## Importance of Research

Seagrass shoots create a net to catch and filter the water of nutrients, pathogens and other debris. Phosphates, nitrates, ammonia and potassium are all key nutrients in the success and usual growth patterns of *T. testudinum*, but with the direct access to nutrient rich man-made inputs, seagrass may be nutrient overloaded, growing too quickly and potentially even dying. For *T. testudinum*, too much of a good thing is bad which is why this research focused on the growth rate and biomass of the seagrass, as they are all important factors in the success of the future health of pastures and the growth of seagrass.

## Objectives

- Test seagrass around South Eleuthera to determine the anthropogenic impacts affecting seagrass populations in close proximity to humans and isolated from human activity.
- Observe and compare any differences in percentage coverage of seagrass at the different sites.
- Determine whether there was any change in growth rate when compared to the proximity to human habitation.
- Determine any relationships between growth rate, percentage cover, temperature and distance to humans.

Figure 2: A student swims down to use a pin and poke holes through the sheaths.

Figure 3: A student and research advisor remove seagrass from the quadrat to look at growth rate.

## Study Sites

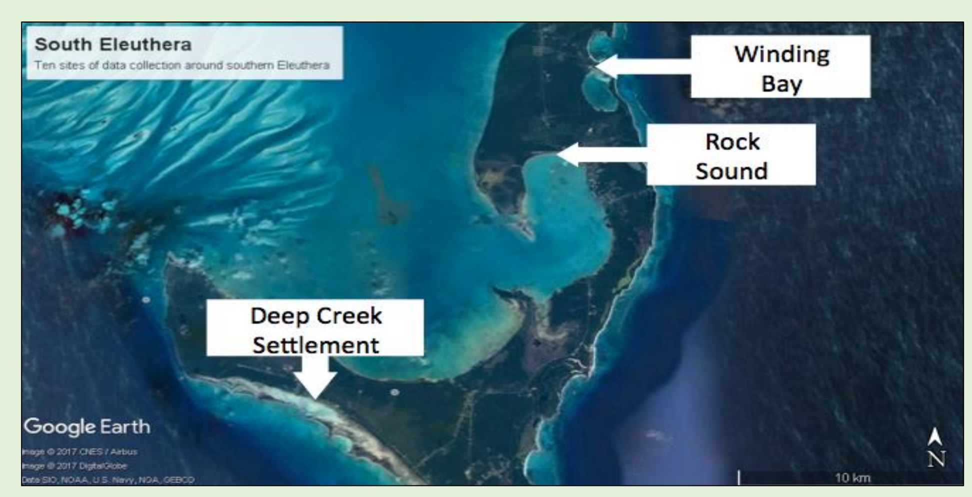


Figure 7: Three main settlements that provide anthropogenic effects to the sites where we conduct our research.

### 3 Locations Linked to Humans

- Winding Bay Holiday Homes, Rock Sound Town and Deep Creek settlement.

### These were then split:

- Rock Sound, Deep Creek, Winding Bay = High Human Population Density
- Poison Creek and Starved Creek = Low Population Density
- Plum Creek and Half Sound = Adjacent to High Human Population Density

## Results

### Hot Spot Analysis:

- The hot spot analysis showed the seagrass is far up the creek, and at the mouth (figures 8 and 9). This was likely due to temperature and water fluctuation with the tides.

Figure 8: hotspot analysis of turtle grass in Poison and Starved Creek

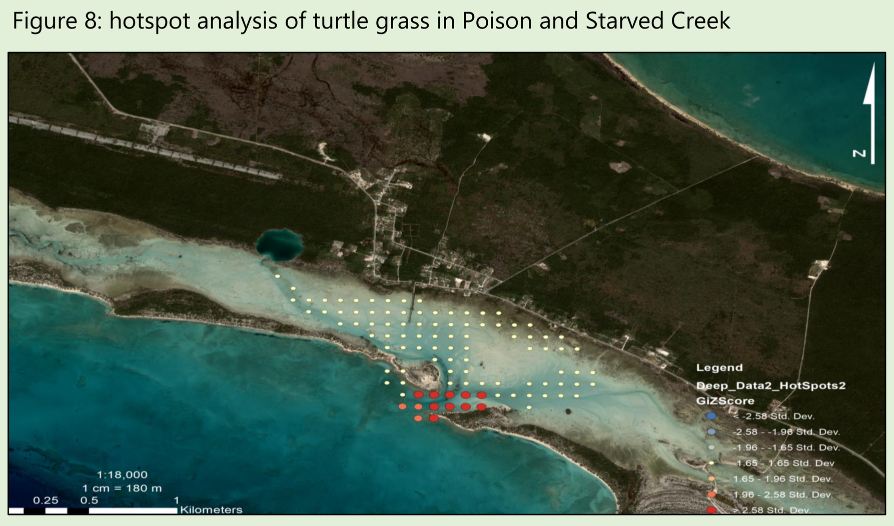

Figure 9: Hotspot analysis of turtle grass in Deep Creek

### Growth Rate of Turtle Grass:

- The growth rate data showed that the settlements closest to human settlements had the highest growth rate, which confirmed our hypothesis that seagrass closer to human settlements would have a higher growth rate compared to isolated seagrass (figure 11).

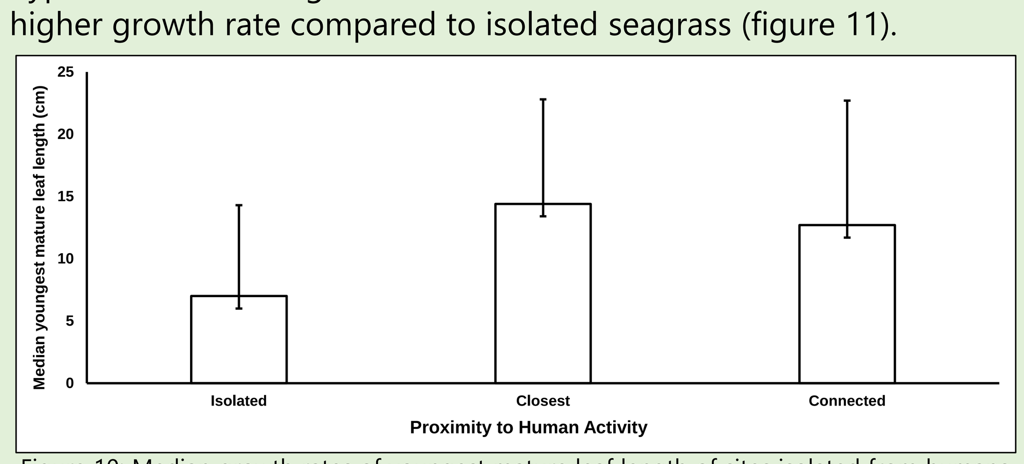


Figure 10: Median growth rates of youngest mature leaf length of sites isolated from humans settlements (n= 0), closest to settlements (n= 11 - 453), and connected to sites closest to settlements (n= 0). n = number of buildings.

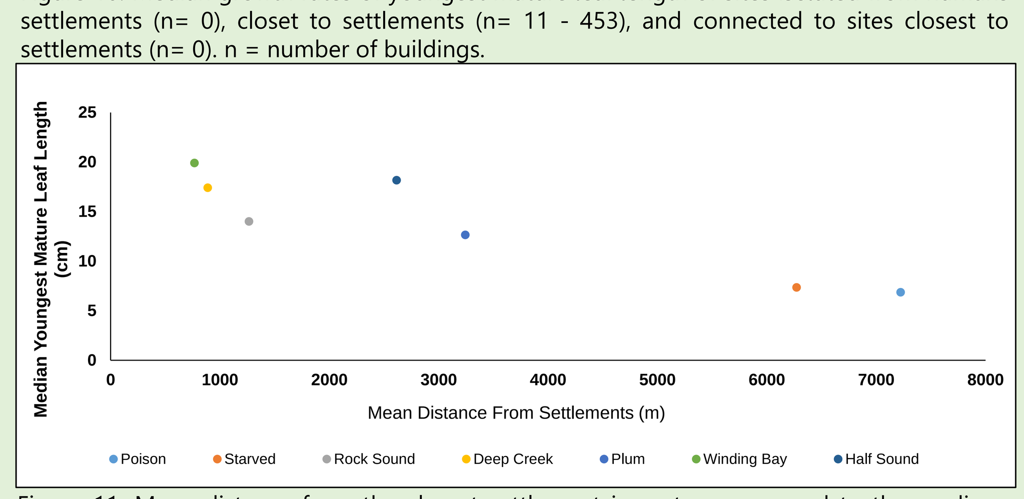


Figure 11: Mean distance from the closest settlement in meters compared to the median youngest mature leaf length in centimeters

### Temperature of Study Sites:

- The temperature data showed the creeks have a large fluctuation ranging from 23ºC to 30ºC in one day (figure 13).
- Half Sound, a location connected to the Atlantic Ocean and south of Winding Bay, had the most fluctuation due to the changing tides and ocean currents.

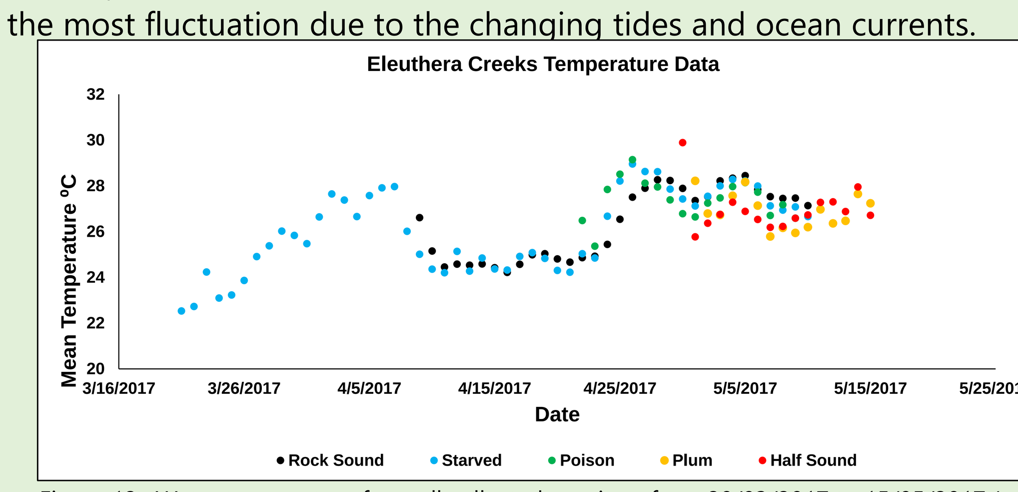


Figure 12: Water temperature from all collected monitors from 20/03/2017 to 15/05/2017 (n = 5).

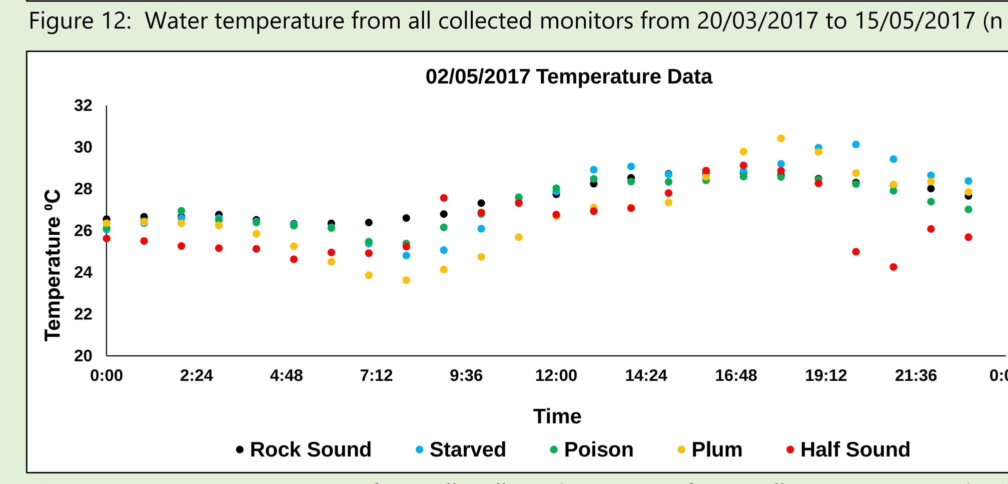


Figure 13: Water temperature from all collected monitors from all sites on a randomly generated day to show fluctuation. Day = 02/05/2017.

## Discussion

### Percentage Cover:

- Seagrass was found much further into a creek system when compared to macroalgae. This trend was consistent throughout Starved creek, Poison creek, Deep creek.
- This May be a result of the consistent water and temperature fluctuation in the creeks due to constant replenishment of salt water and nutrients flushing through the creeks.
- This is beneficial for the seagrass because they thrive in conditions with constant new nutrients and water fluctuation.
- While this may seem beneficial for the seagrass, the constant influx of salt water and nutrients could turn out to be detrimental to the seagrass and the ecosystem.

### Growth Rate:

- Turtle grass had differing growth rates at the different study sites. This could be due to various different anthropogenic inputs into each site.
- Sites such as Deep creeks, Winding Bay, and Rock Sound are adjacent to human settlements, which could increase the likelihood of nutrients entering the areas.
- Poison, Plum, and Starved creeks are further from humans and have a lower growth rate, likely because there was a lower nutrient input into the seagrass beds.
- Some creeks are connected through channels, such as Plum to Deep creek, and Winding Bay to Half Sound. This could allow nutrients from the settlement to impact seagrass beds that may seem to have some distance from a settlement.
- Other creeks, such as Poison Creek or Starved creek (Figure 8) are not connected to other creeks and have some distance to the nearest settlement, which may mean they do not get the anthropogenic inputs that the connected creeks do (Figure 15).

### Impacts:

- Anthropogenic nutrient input may allow the seagrass to continue to grow at its current rate or may increase the growth to where it becomes unable to be controlled by green sea turtle grazing.
- This could result in the seagrass becoming more fibrous or "woody," through an increase in lignin, resulting in an unpalatable seagrass. In turn, green sea turtles may potentially relocate and thus disturb the balance of the natural food web.

Figure 14: Research Advisor collects seagrass from a quadrat in Poison Creek that had been scarred two weeks prior to measure growth rate.

## Conclusion & Future Directions

Turtle grass has some impact on marine ecosystems in Southern Eleuthera through sequestering carbon, providing habitat for many organisms both in their adult and juvenile stages, and also as a food source for some species, forming the base of the food chain. This study was able to conclude that humans have a some impact on turtle grass in Southern Eleuthera (similar to figure 15. below). As seen in figures 10 and 11,, turtle grass growth rate was correlated with human population and as such, if anthropogenic disturbances like sewage and fertilizers continue to impact *Thalassia testudinum*, this could result in unbalanced, overgrown ecosystems filled with "woody," unpalatable turtle grass.

### Further research:

- Repeat the research on different seagrass species around the world.
- Studies of kelp and macroalgae, as they perform similar ecosystem roles and are indicator species
- A comprehensive study of nutritional content, to further assess the effects anthropogenic disturbances on *Thalassia testudinum*.

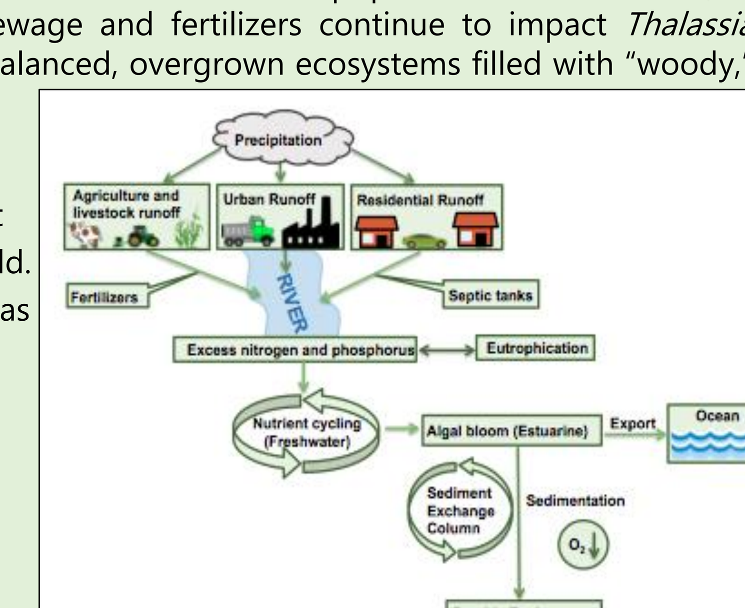


Figure 15: Cycle of anthropogenic impacts on coastal ecosystems

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Literature Cited: Bjorndal, K., (1980). Nutrition and Grazing Behavior of the Green Turtle *Chelonia mydas*, Marine Biology 56, 147-154.; Humann, P., (1992). *Reef Coral Identification*, New World Publications. 191.; Short, F., Duarte, C., (2001) Methods for the measurement of seagrass growth and production. DOI: 10.1016/B978-044450891-1/50009-8.; Stoner, E., Layman, C., Yeager L., Hassett, H., (2011). *Effects of anthropogenic disturbance on the abundance and size of epibenthic jellyfish Cassiopea spp.*, Marine Pollution Bulletin, 1109-1114.; Honig, S., Mahoney B., Hughes B. and Glanz, J., (2016). *Are seagrass beds indicators of anthropogenic nutrient stress in the rocky intertidal?*, Marine Pollution Bulletin, 539-546.