Effects of Sea Level Rise on Fishable Area and Mangrove Habitat in Kemps Creek

Philip Beardsley, Anne Graziano, Lucy Hartwell, Sam Mackenzie, and Ross Sherman

Advisors: Kit Hayward, Annabelle Oronti, and Jeffrey A. Stein

Introduction

Over the past century the global sea level has risen 0.1-0.3 meters due to climate change (Roessig et al., 2004) . Roessig et al conducted a study that suggested that this rise is occurring at a faster rate than coastal mangrove ecosystems can adapt.

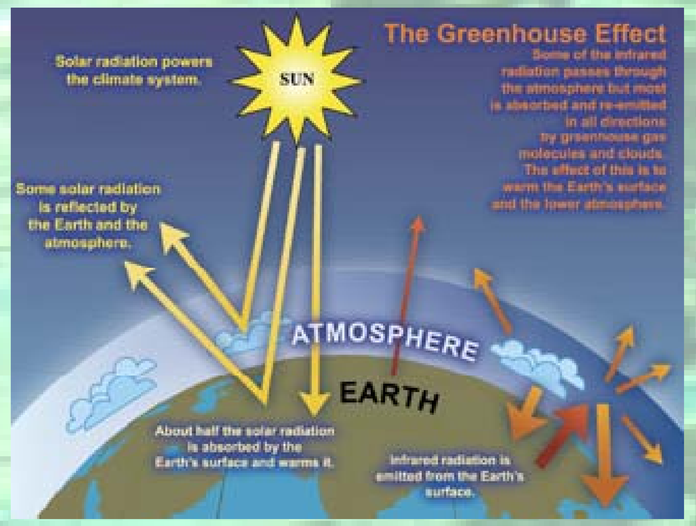


Figure 1. Climate change: the greenhouse effect

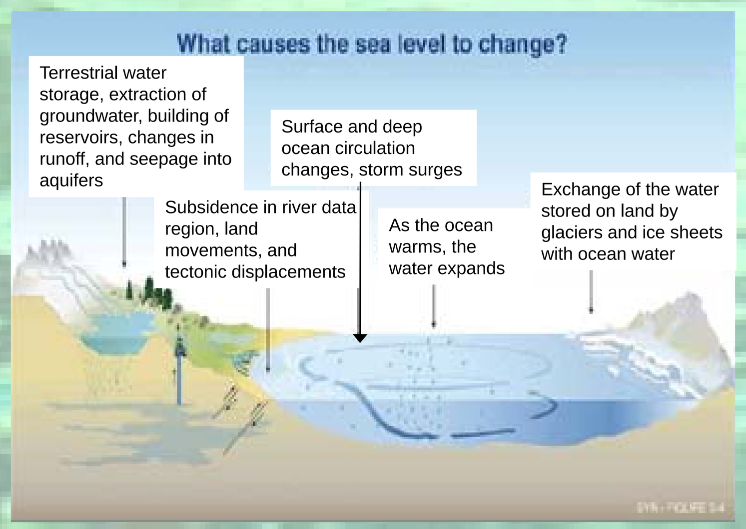


Figure 2. Causes of sea level rise.

Mangroves are a sensitive species that can only handle a small range of salinity, and tend to be located in the upper-half of the inter-tidal zone (Gilman et al., 2006). If the rise in predicted IPCC sea level negatively impacts and stresses mangrove ecosystems, local fish species may also be negatively impacted.

One example of a species that thrive in mangroves is bonefish (Kaufmann, 2000)**,** which live and breed in mangroves. Mangroves provide protection from predators for bonefish because they can hide in the mangrove roots and shallow waters (MacDonald, 2009). Bonefish also have a large impact on local Bahamian economies, which may be entirely dependent on the revenues from recreational bonefishing when other sources of income are absent (Ault, 2008**)**. Every year approximately 5,000 tourists visit the Bahamas for the sole purpose of fishing this species.

The purpose of this study was to construct a topographical map of the tropical flats environment of Kemps Creek. The hypothesis was that rising sea level would cause a decrease in fishable area and suitable mangrove habitat.

Methods

In order to get a detailed map of Kemps Creek, elevation, substrate, and vegetation data was collected. The elevation data was taken relative to cinderblocks along transects, signifying the high tide line and providing a benchmark for all elevation measures. Elevation measurements were taken at each individual waypoint along a transect chosen by an observer (See Figure 3). Substrate and vegetation type were also recorded (See Table 1)

Vegetation	Substrate
Low Density Mangrove (LDM)	Sand Plain (SP)
Medium Density Mangrove (MDM)	Mud Plain (MP)
High Density Mangrove (HDM)	Rock (R)
Sea Grass (SG)	Hardpan (H)
Algae (A)	
Coppice (C)	

Table 1. Defined vegetation and substrate types

All data collected was inserted into a Geographical Information System (GIS) to create a detailed topographical map, which three-dimensionally portrayed the elevation and habitat types of the creek. From this map, a maximum, median, and low estimation of sea level rise from the IPCC was applied to test the effects of sea level rise on fishable area and mangrove habitat in Kemps Creek. When an increase in sea level was inputted into the software, the GIS map displayed what areas would be covered in water or made deeper, showing us how fishable area and mangrove habitat would be affected.

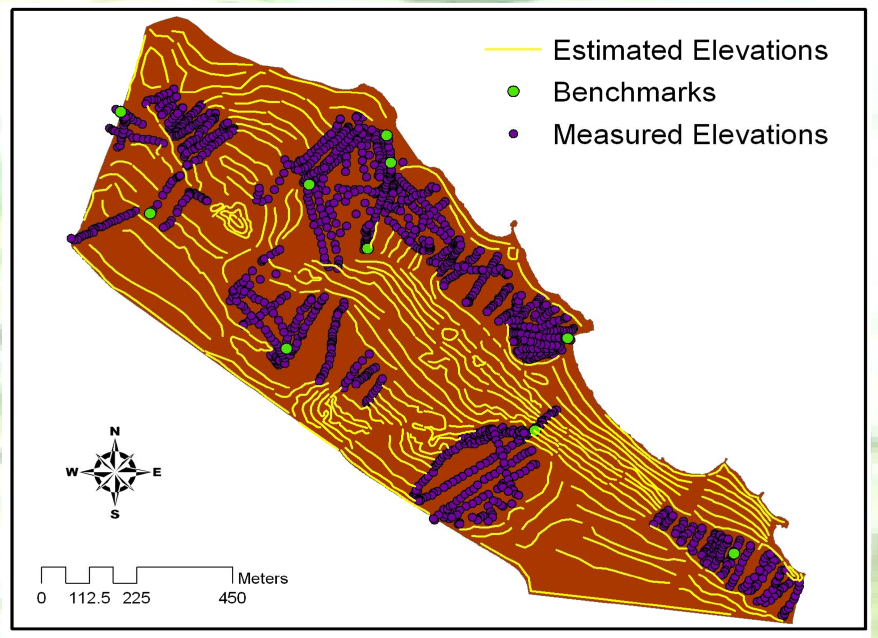


Figure 3. Map of Kemps Creek portraying location of elevation measurements

Results

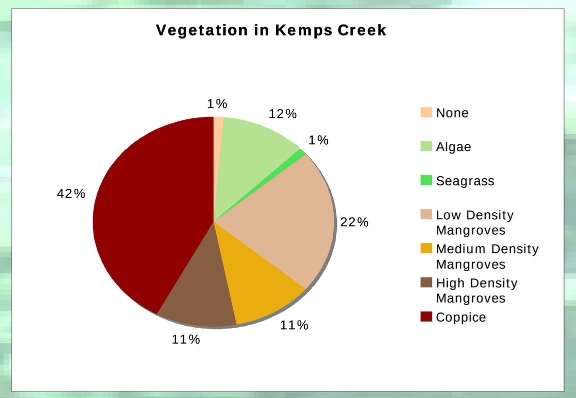


Figure 4. Percent coverage of substrate.

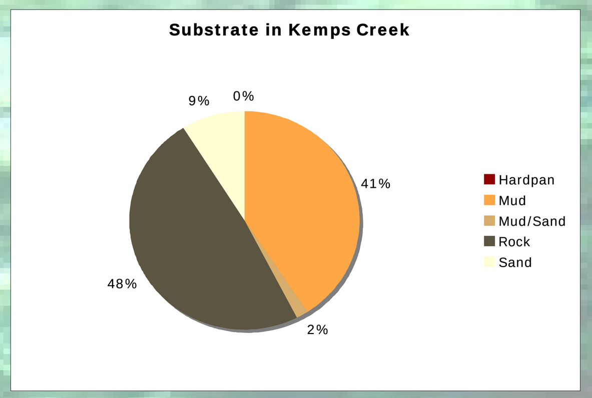


Figure 5. Percent coverage of substrate.

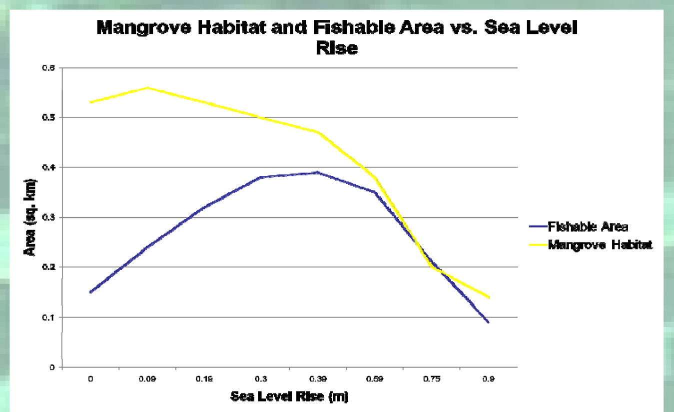
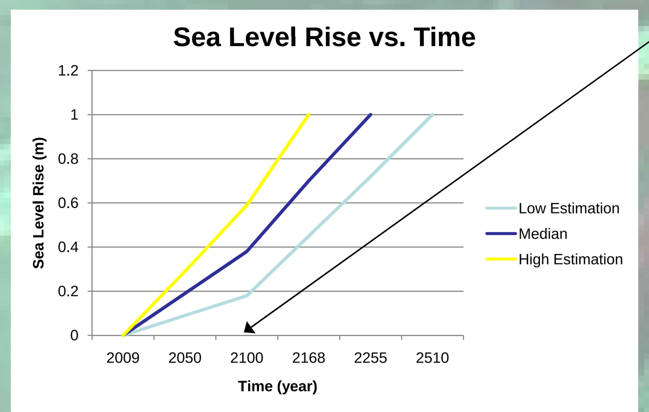


Figure 6. Change in fishable areas and suitable mangrove habitats as sea level rises.



All points beyond 2100 are projected using IPCC data. Sea level is most likely not going to stay constant and probably increase with melting ice caps, so this estimate is conservative.

Figure 7. Projected time of when sea level rise will reach 1 meter.

Fishable Area (See Figure 8)

Low sea level rise projection:
- 0.9 square km increase by 2050
- 0.17 square km increase by 2100

Median sea level rise projection:
- 0.17 square km increase by 2050
- 0.24 square km increase by 2100

High sea level rise projection:
- 0.23 square km increase by 2050
- 0.03 square km decrease by 2100

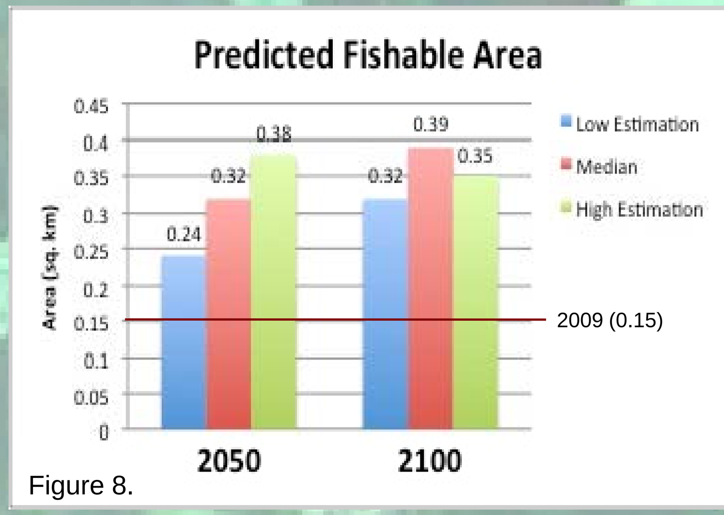


Figure 8.

Suitable Mangrove Habitat (See Figure 9)

Low sea level rise projection:
- 0.00 square km change by 2050
- 0.00 square km change by 2100

Median sea level rise projection:
- 0.00 square km change by 2050
- 0.06 square km decrease by 2100

High sea level rise projection:
- 0.03 square km decrease by 2050
- 0.06 square km by 2100

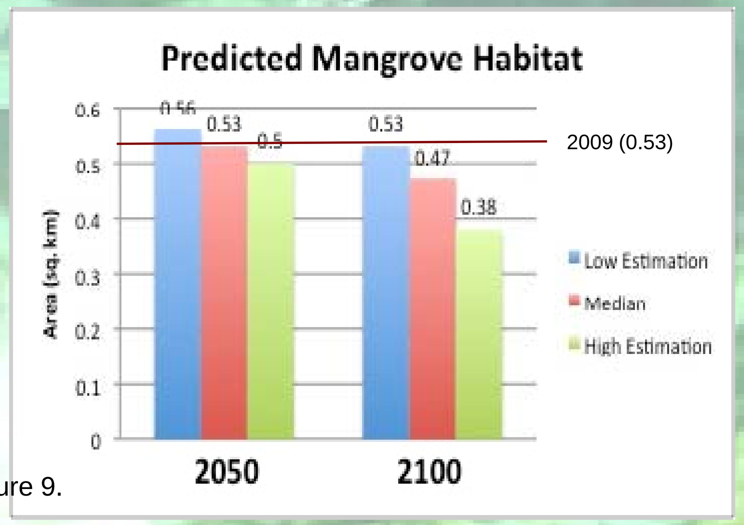


Figure 9.

Discussion

The increase in fishable area at low sea levels did not support our initial predictions, however at higher levels of sea level, observed fishable area decreased. As predicted sea level rose it created more available fishing area, while other existing areas remained wadeable. Over time, and with increased sea level, existing fishable area got too deep, therefore making a large amount of area no longer fishable, and creating an overall net loss of fishable area.

The data predicts that mangroves will shift their habitat landward as sea level rises, because mangroves tend to live in the upper half of the intertidal zone, which would cause them to shift with the rising sea level (Gilman, 2006) These shifts may be obstructed by landmarks, such as Queens Highway on the south side of Kemps Creek, which would prevent mangroves from shifting landward and therefore causing the decease in suitable mangrove habitat found in our data.

In our results, we did not take into consideration sedimentation. It is possible that an area that is currently rock substrate could fill in with sand in the future and become either a suitable mangrove habitat or a fishable area, possibly causing the trend in Figure 6 to level off or continue to increase.

Results (cont.)

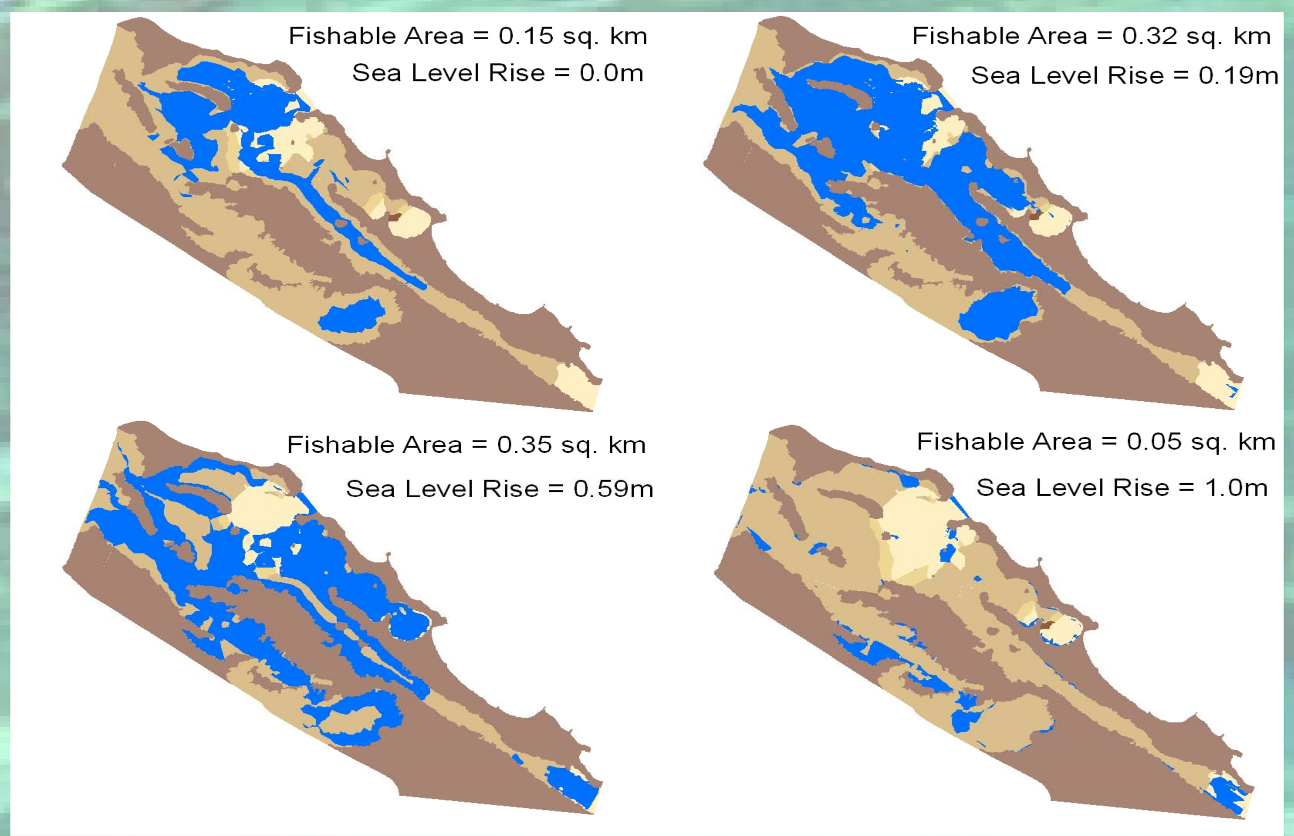


Figure 10. Map of change in fishable area over substrate as sea level rises.

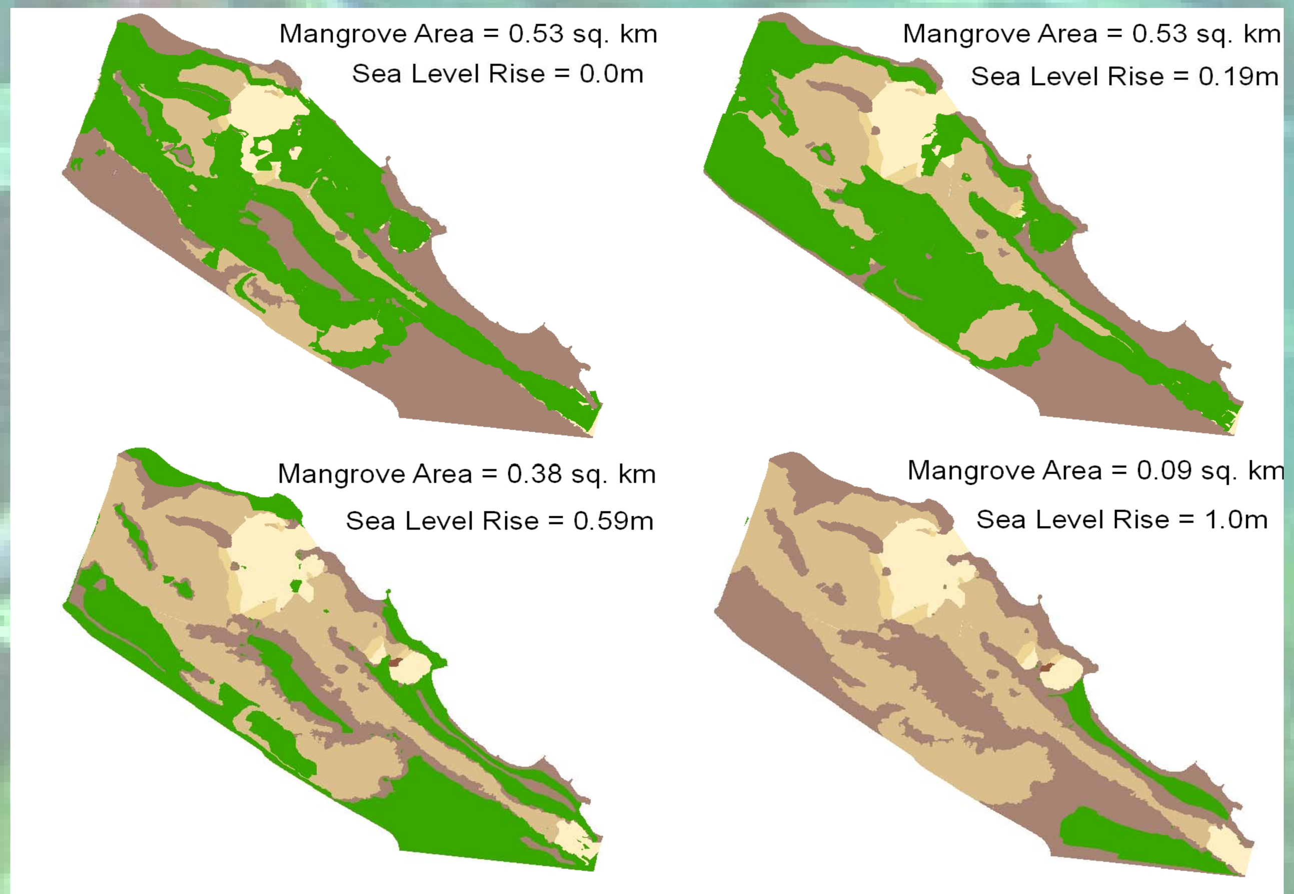


Figure 8. Map of change in suitable mangrove habitats over substrate as sea level rises.

This sea level rise of 1 meter is projected to occur:
- By 2510 with low estimation of sea level rise
- By 2255 with median estimation of sea level rise
- By 2168 with high estimation of sea level rise
- (See Figure 7)

Literature Cited

Bernstein, Lenny *et al.* 2007. An Assessment of the Intergovernmental Panel on Climate Change. Valencia, Spain: IPCC Plenary XXVII.

Blaber, Stephen J.M. 2007. Mangroves and fishes: issues of diversity and dogma. Miami, FL: Bulletin of Marine Science.

Blasco, F. (1996). Mangroves as indicators of coastal change. *Catena,* 27, 167-178.

Danylchuk, A.J., Danylchuk, S.E. Cooke, S.J., Goldberg, T.L., Koppelman, J., Philipp, D.P. 2007. Ecology and Management of Bonefish (*Albula spp*) in the Bahamian Archipelago. Pages 79-92 in Ault, editor. Ecology and Management of the World Tarpon and Bonefish Fisheries.

Gilman, E., Ellison, J. and Coleman, R.. 2006. Assessment of mangrove response to projected relative sea-level rise and recent historical reconstruction of shoreline position. Honolulu, Hawaii: School of Geography and Environmental Studies.

MacDonald, J.A., *et al.* 2009. Behavior and space utilization of two common fishes within Caribbean mangroves; implications for the protective function of mangrove habitats. Newark, New Jersey: Department of Biological Science.
Roessig, J.M., Woodley, C.M., Cech J.J. Jr., and Hansen, L.J. 2004. Effects of Global Climate Change on Marine and Estuarine Fishes and Fisheries. Washington, DC: World Wildlife Fund.

Kaufmann, R., Bonefishing, Western Fisherman's Press, moose, WY, 2000

Acknowledgements

A special thanks to Kit Hayward and Jeff Stein for their unwavering support. Another thanks goes out to Annabelle Oronti for leading a great research program. We would also like to thank the University of Illinois for making all this research possible. Finally, a thanks to Sophie Atwood and all the CEI interns for their help throughout the semester.

THE ISLAND SCHOOL cape eleuthera bahamas

www.islandschool.org

CAPE ELEUTHERA INSTITUTE RESEARCH

UMASS AMHERST

Carleton UNIVERSITY Canada's Capital University

ILLINOIS UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN