

Mapping coastal protection services provided by habitats in a National Estuarine Research Reserve

G. Verutes^a, N. Dix^b, C. Doughty^c, P. Yang^d, S. Eastman^b, A. North^b, T. Adgie^d & S. Chapman^d

^a Department of Applied Economy, University of Santiago de Compostela, Santiago de Compostela, Spain

^b Guana Tolomato Matanzas National Estuarine Research Reserve, St Augustine FL, USA

^c Department of Geography, UCLA, Los Angeles CA, USA

^d Center for Biodiversity and Ecosystem Stewardship, Department of Biology, Villanova University, Villanova PA, USA



<http://wetfeetproject.com>

BACKGROUND

- The existence of coastal ecosystems depends on their ability to gain soil to keep pace with rising sea levels. A federally-funded National Science Foundation project is examining the influences of climate change and plant invasion on surface elevation.
- The goal of this study is to assess the role of natural habitats in protecting people and property in the **Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR; Fig. 1; Table 1)**



Figure 1. Location of GTMNERR study area in northeast Florida, USA.

Table 1. Summary of existing habitats known to attenuate (buffer) wave energy, their potential in terms of coastal protection and co-benefits, and major threats.

Habitat name	Wave attenuation	Potential co-benefits	Threats in GTMNERR
Mangrove forests	Highest	Fisheries, blue carbon, water purification, habitat for flora & fauna	Hardening of shoreline, dredging of channels, sea level rise (SLR), freeze events, boat wakes
Salt marshes	Medium	Blue carbon, recreation, habitat for flora & fauna, fisheries, aesthetics	Coastal development, mangrove encroachment, SLR, marsh die backs, boat wakes, dredging
Oyster reefs	Medium	Water purification, fisheries, habitat for flora & fauna, commercial and recreational harvest, blue carbon	Boat wakes, dredging of Intracoastal Waterway, unsustainable harvest, degradation of food quality via water pollution, increasing water levels due to SLR and storm events

METHODS

- We used the **InVEST coastal vulnerability assessment tool** to produce spatially-explicit estimates of coastal areas most exposed to storm-induced erosion and flooding.
- A **coastal exposure index** was calculated based on the distribution of natural habitats, elevation, wind and wave characteristics, shoreline type, surge potential and other factors. We ranked these variables for each 250 meter coastline segment from lowest to highest exposure (1 to 5; Table 2).

Table 2. Biophysical variables and ranks for the coastal vulnerability tool. Ranks for relief, wave exposure, and surge potential are based on the distribution of values for these variables across all coastal segments in the GTMNERR study area.

Variable Rank	Contribution to Coastal Exposure				
	Very Low Exposure Rank (1)	Low Exposure Rank (2)	Moderate Exposure Rank (3)	High Exposure Rank (4)	Very High Exposure Rank (5)
Geomorphology	Rocky; high cliffs; seawalls	Medium cliff; bulkheads and small seawalls	Low cliff; alluvial plain; revetments, rip-rap walls	Cobble beach; estuary; lagoon; bluff	Barrier beach; sand beach; mud flat; delta
Relief	> 80th percentile	60th to 80th percentile	40th to 60th percentile	20th to 40th percentile	< 20th percentile
Natural habitats	Mangroves	Marshes; oyster reefs	-	-	No habitat
Wave exposure	< 20th percentile	20th to 40th percentile	40th to 60th percentile	60th to 80th percentile	> 80th percentile
Surge potential	< 20th percentile	20th to 40th percentile	40th to 60th percentile	60th to 80th percentile	> 80th percentile

PRELIMINARY FINDINGS

- Coastal exposure is highest in the northern and southernmost extents of the Reserve**, driven by low elevation and less stable shoreline geomorphology (mud/sand) (Fig. 2A). Fewer habitats protect the north and storm surge potential is greater in south.
- The proposed extension of GTMNERR would add coastline more protected by habitats but subject to higher wind/waves (Fig. 2B).

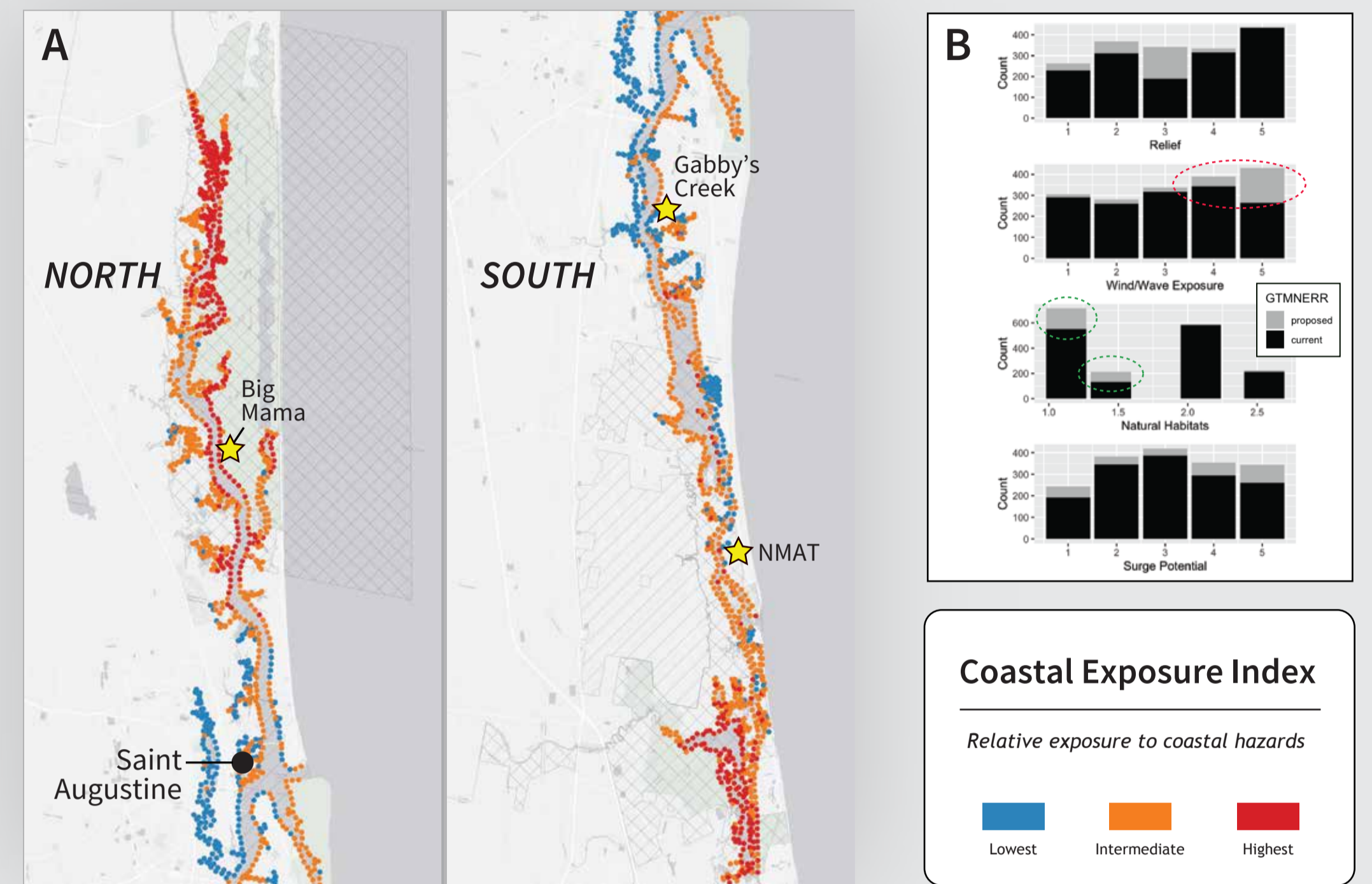


Figure 2. Map of coastal exposure index scores for GTMNERR.

- The habitat role metric highlights the relative importance of coastal protection services provided by natural habitats. Early findings suggest this is highest in the southern and central sections of the Reserve (Fig. 3).

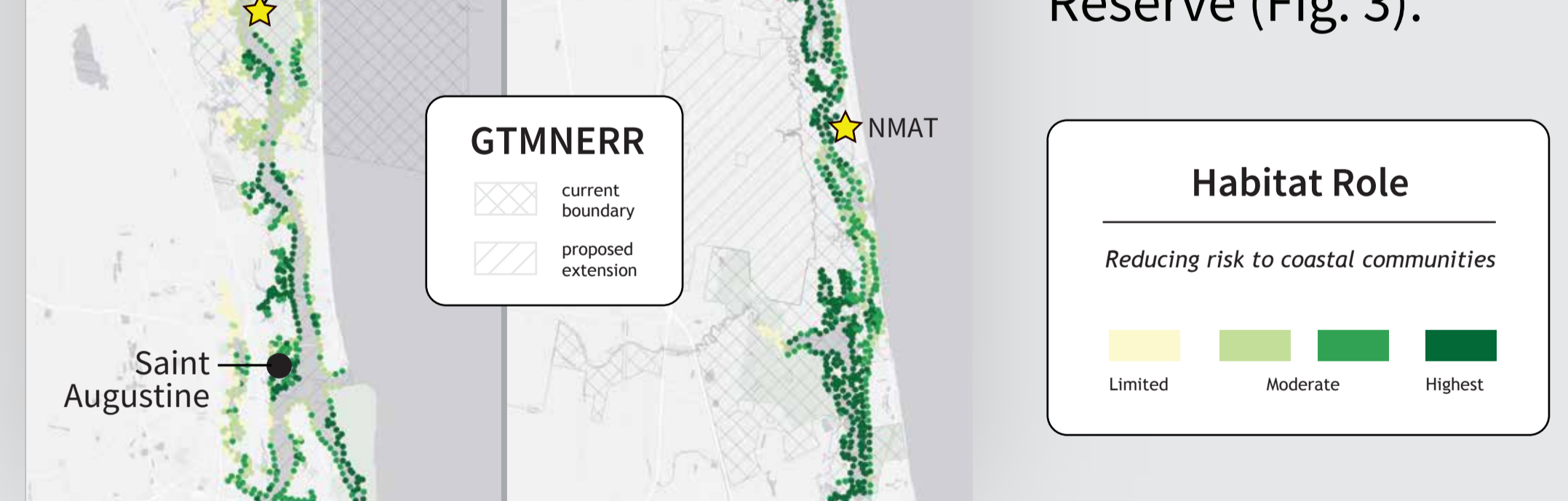


Figure 3. Map of habitat role scores throughout GTMNERR. The darkest green areas highlight the greatest combined role of habitats in natural protection based on their distribution relative to other factors that contribute to exposure.

KEY CONTRIBUTIONS

- Mapped new mangrove colonies in the south Reserve using a Random Forest classifier (remote sensing technique) to fill gaps in the Florida state vegetation inventory.
- Added new variable ranks to the assessment, specifically the effects of boat wakes, shoreline armoring, and climatic forcing conditions inside the estuary.
- Explored wetland surface elevation maintenance strategies (e.g., land form modification, living shorelines, mangrove establishment) in vulnerable areas identified by this study.
- Developed an interactive results viewer to confirm with GTMNERR stakeholders how these public lands are changing.