



Planning for Resilience to
Sea Level Rise in the
Matanzas Basin

Heritage at Risk, Flagler College
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University of Florida

Thank you to Flagler College for inviting me to speak as part of the series Heritage at Risk. I will present the results of a three-year planning project to begin the conversation about the potential impacts of sea level rise in the Matanzas Basin, including St. Augustine. The interdisciplinary project used the best available science and public engagement. Several public workshops were held in St. Augustine in December 2012.

The photo shows the Matanzas River and Marineland, courtesy of the GTM Research Reserve.

Planning for this place

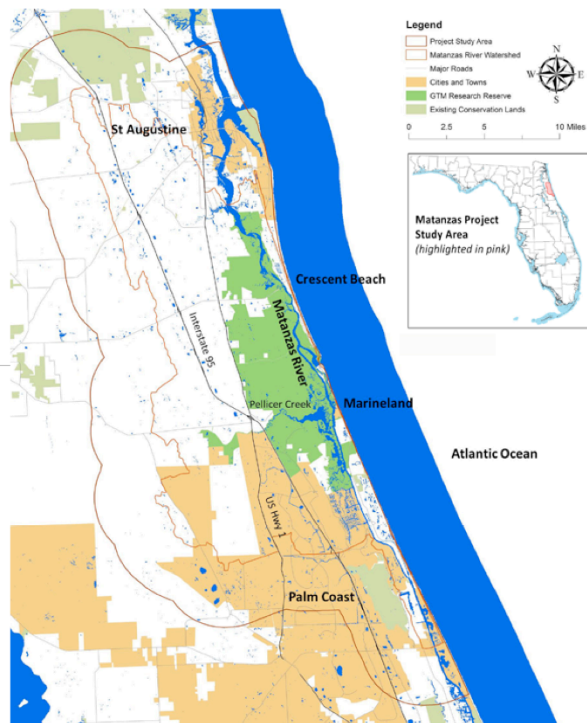


This presentation offers something unique compared the previous speakers, a local study with findings specific to this area.

The photo is of Princess Place Preserve, courtesy of Ed Siarkowicz.

Matanzas Basin study area

264,000 acres
150,000 residents
9 conservation areas

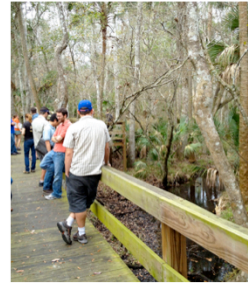


Population in two counties in 2010:

St. Johns 190,000

Flagler 96,000

Total 286,000



Study at different levels

GTM Research Reserve

Watershed (basin), including Pellicer Creek

Cities, including St Augustine, Palm Coast, and coastal communities

Northeast Florida region

Photos of Matanzas River, Pellicer Creek, and Palm Coast canal, courtesy of the project.



For different issues

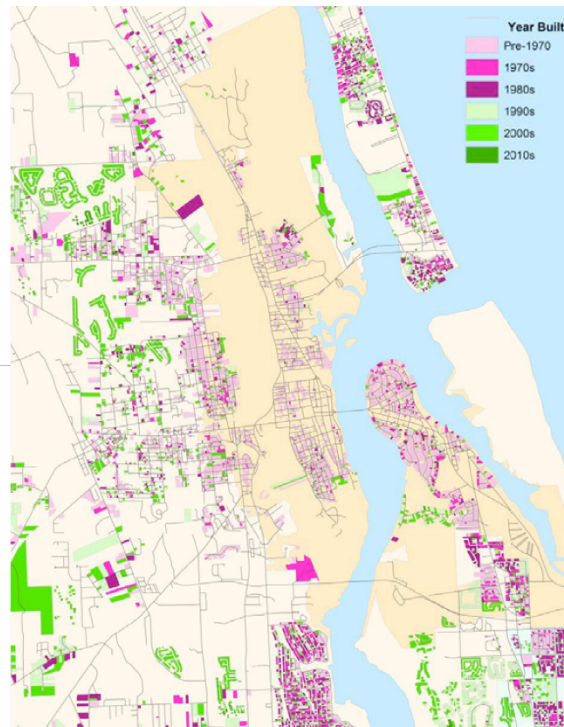
Sea level rise

Development

Conservation and agriculture/timber

Aerial photo of Pellicer Creek, courtesy of GTM Research Reserve. Photo of coastal development near St. Augustine Beach, taken by the project team.

Past, present, and
future



This map shows the timing of past residential development in St. Augustine area. The parcels are color coded by decade. We created this map in response to citizen questions about where future development, based on population projects, may locate.



Vulnerability and adaptive capacity

We examined regional vulnerability as well as adaptive capacity. Vulnerability is defined as potential impacts to people, property, infrastructure, and conservation areas. Adaptive capacity is a measure of the ability of people, organizations, and the environment to adapt to the changes while maintaining current core values.

To study both vulnerability and adaptive capacity, we gathered and analyzed the following information:

- Coastal hazards

- Long-term changes

- Policy analysis

- Social science, public input

Photo is of the Matanzas Inlet, courtesy of Ed Siarkowicz

Partnership with
Guana Tolomato
Matanzas (GTM)
Research Reserve

National Estuarine Research
Reserve
Science Collaborative



The GTM Research Reserve was the key partner, led by Dr. Michael Shirley with assistance from the Reserve's Coastal Training Program staff. The study area centered on the Reserve's southern component, i.e., the Matanzas River and surrounding lands and watershed.

The project was funded by the NERRS Science Collaborative, which focuses on combining the best available science and policy analysis with involvement of "users" of the science - the local and regional stakeholders and citizens.

Photo shows GTM Research Reserve's Education Center in Ponte Vedra Beach.

Planning objectives

- Environment
- Economy
- Quality of life
- Regional resilience



The large study area allowed the project to coordinate planning for multiple objectives involving the environment, economy, and society to achieve a region that has adaptive capacity, also known as long-term “resilience.”

Photo is of Pellicer Creek, courtesy of Ed Siarkowicz

Potential Sea Level Rise Impacts	Elevation Model	Storm Surge Model: Hazus	Habitat Changes Model: SLAMM	Local Knowledge
Inundation and increased flooding	✓	✓	✓	✓
Greater coastal erosion				✓
Saltwater intrusion into aquifers				✓
Higher storm surges		✓		✓
Habitat and species changes			✓	✓

Science

Physical

The project extensively used geographic information systems (GIS) models to identify potential sea level rise impacts at regional scales. The project also applied a GIS model, LUCIS (land use conflict identification strategy), to project future development patterns.

Science

Social and policy analysis



Social science was as important as the physical science. Social science was gathered through public workshops, policy analysis, and qualitative research of secondary sources, such as websites.

Photo of St. Augustine historic building.



Collaboration

The project held public workshops over three years (2012-15) in three phases: (1) residents and stakeholder groups, (2) multi-group meeting, and (3) final public presentation. Workshop locations included St. Augustine and Marineland. Youth also participated in workshops during school classes and camp.

Workshop photos courtesy of the project team.



Project Steering
Committee

The project steering committee had 14 members representing a wide range of groups and interests in the Matanzas study area. The committee met quarterly to guide the project, informal outreach, and the public workshops.

Steering Committee photo taken by the project team.

Produced

- Spatial data
- Posters and briefs
- Report
- Website
 - PlanningMatanzas.org



The poster shown is one of many presented at the final public presentation.



Findings

Photo of Summer Haven, courtesy of Ed Siarkowicz



Special places: cities, historic

Photo of St. Augustine and Flagler College.



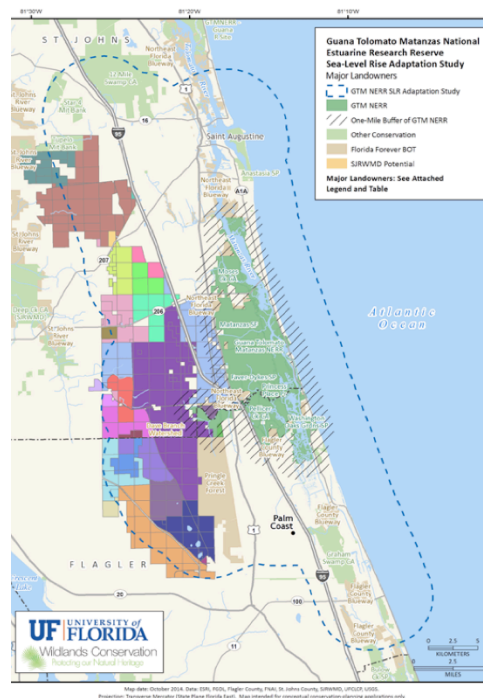
Special places: natural, unincorporated. The lack of development in the Pellicer Creek watershed has led to a rare intact, high quality coastal watershed. This watershed is important not only for wildlife but also people's quality of life and the economy.

Photo of Pellicer Creek, courtesy of GTM Research Reserve



Special people: Strong local and regional leadership, led to
designation of the GTM Research Reserve
Regional visioning

Conservation areas



This map shows the GTM Research Reserve in dark green, other conservation areas in light green, and large privately owned tracts of land that could support future conservation areas.



Development patterns

Population growth in St. Johns and Flagler counties has been high. In 1950, the populations were 25,000 and 3,000 people respectively (total 28,000). Currently, the combined population of the two counties is 286,000. If similar growth continues, an additional 511,000 people will move to the two counties by 2060.

Photo of a beachside lot for sale in the Matanzas study area, courtesy of the project.



Vulnerabilities

The Matanzas study area, including St. Augustine, is vulnerable to flooding, erosion, and saltwater intrusion.

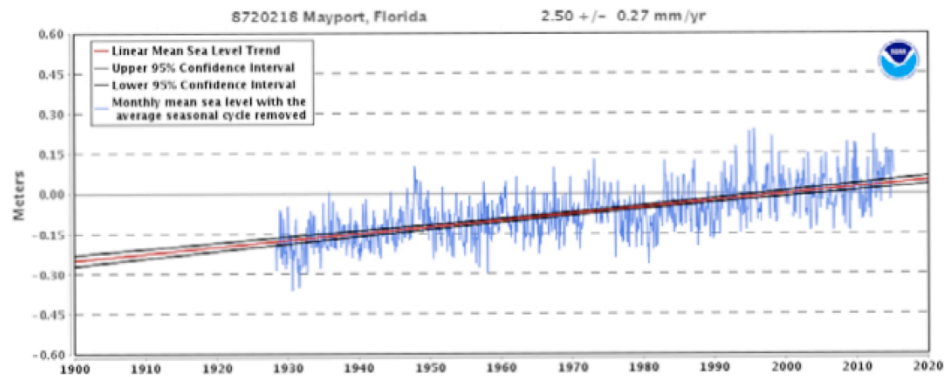
The photos are downtown flooding in St. Augustine, a house suffering erosion in Vilano Beach, and a water supply well for the City of Palm Coast.



Sea level has been rising

Notice the migration of saltmarsh to the left of the historic sea wall. As sea level rises, existing marshes become open water, and upland forest become marshes.

Photo is Princess Place Preserve, courtesy of Ed Siarkowicz

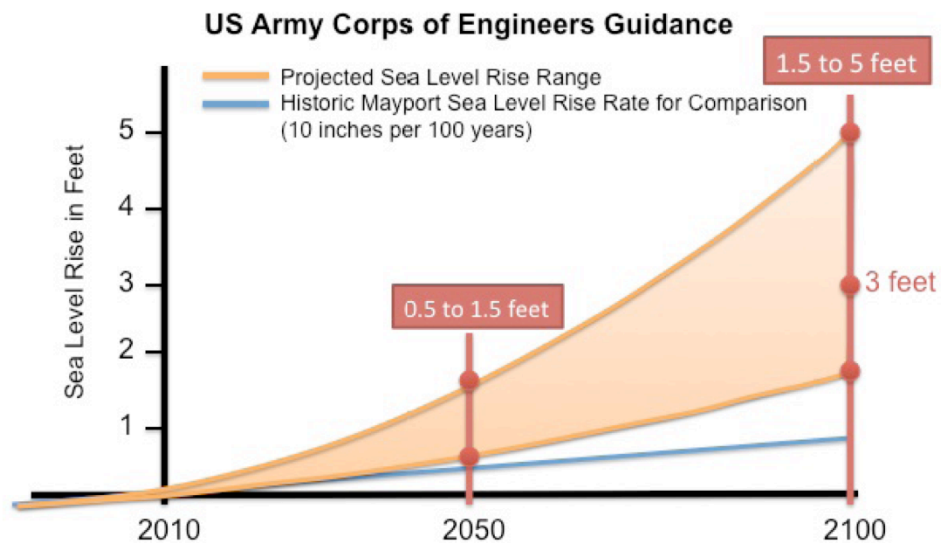


Northeast Florida sea level
increased 10 inches
over past century

Mayport
tide station



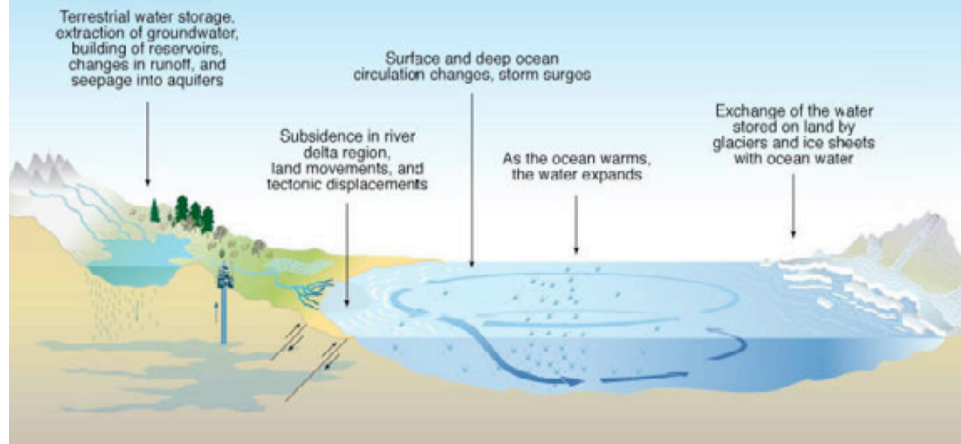
Mayport tide station is near Jacksonville, at the mouth of the
St. Johns River.



Going to rise faster: Sea level rise curve.

The range of uncertainty is caused by the potential for different ways in which the earth systems may behave and interact. This uncertainty also appears as a variety of projections in the scientific literature. USACE curves are representative of the middle range projections.

What causes the sea level to change?



Linked to increasing
global temperature

Plus local phenomena

Not question of
whether it will rise, but
when



Scientists believe that the recent warming of the earth's atmosphere has "locked in" substantial sea level rise well past 2100.

Photo is remnants of eroded house near Summer Haven, courtesy of Florida Sea Grant.

What if disagree about future sea level?

- High stakes and high uncertainty/disagreement
- Reduce uncertainty/disagreement
 - Better science
 - Local monitoring
- Manage uncertainty/disagreement
 - Possible scenarios
 - Worst case strategies
 - No regrets strategies
 - Good no matter what the future

What if disagree about future population?

- Same approaches to uncertainty/disagreement
 - Reduce
 - Manage
- Direct the future
 - Set policies and enforcement

What if disagree about future goals?

- Democracy
 - Deliberative
 - Representative
 - Direct



Photo is erosion along road near Summer Haven, courtesy of Ed Siarkowicz

Consensus building

- What agree that leads to action
- What disagree but not necessary for action
- What disagree and necessary for action
- Continue to work through

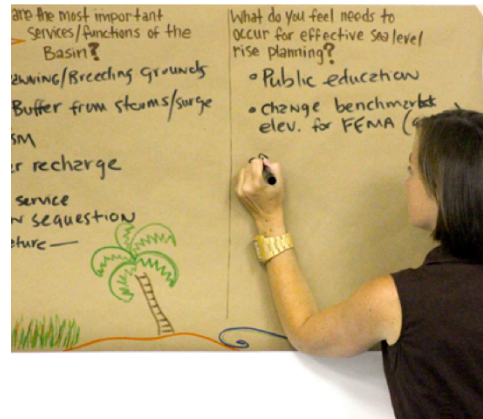
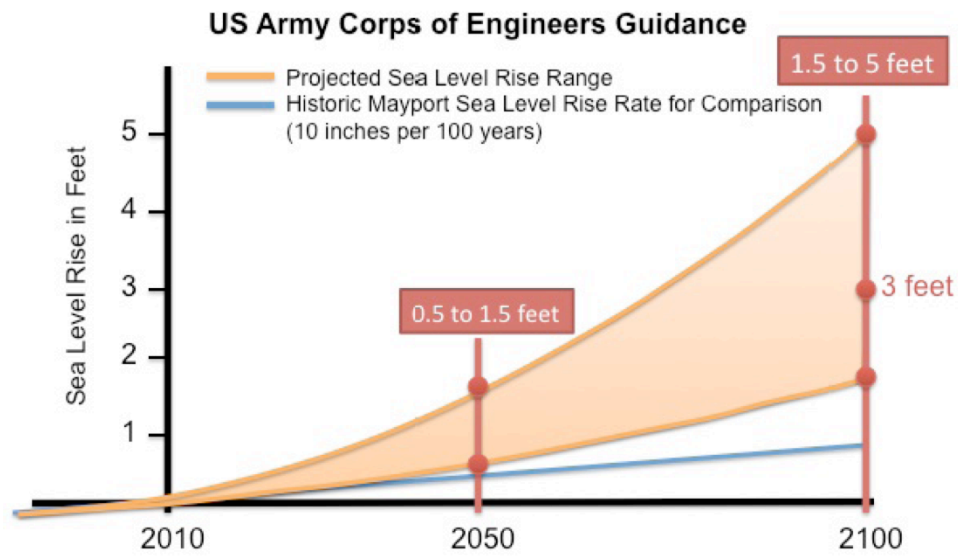


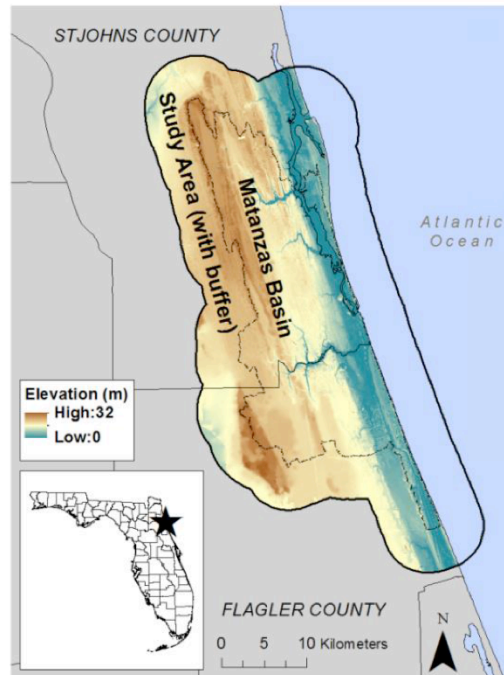
Photo is from one of the first public workshops held by the Matanzas planning project.



Matanzas planning
scenarios

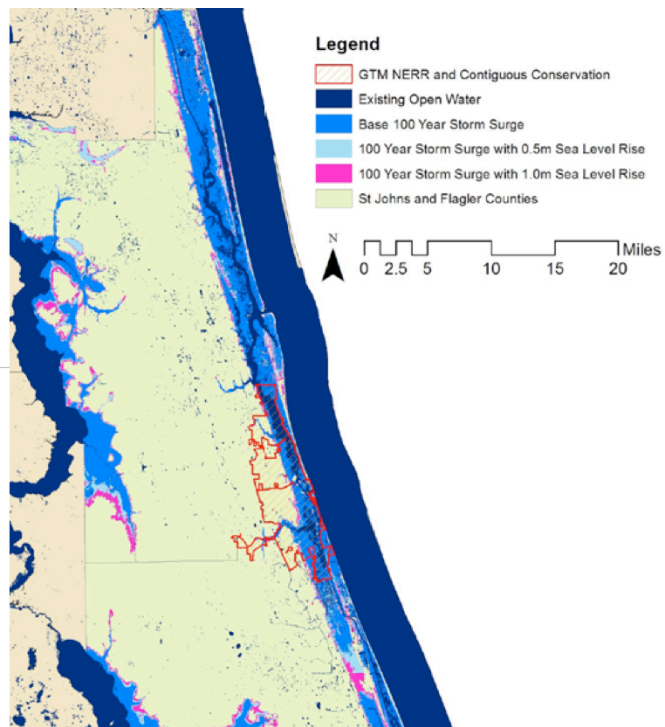
Due to the uncertainty about future sea level rise, the project analyzed a variety of scenarios, from sea level rise of 10 inches to 8 feet by 2100. At the public workshops the team presented the results for the 3 ft by 2100 scenario, since that is the most likely scenario, it is mid-range between extreme scenarios, and it begins to show significant impacts to natural and built areas.

Elevation

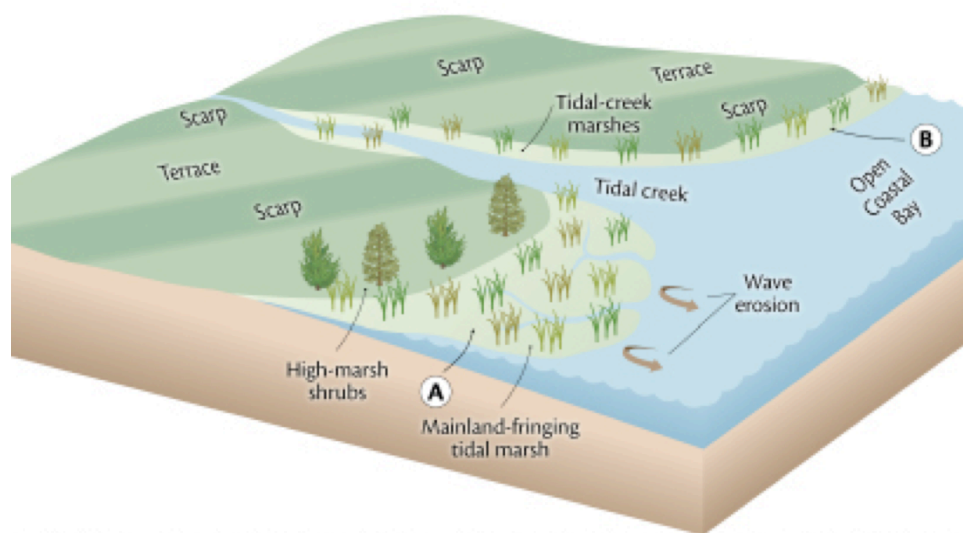


The approximately 2 mile wide low-lying area in blue is the Silver Bluff, with elevation from 0 to 10 feet above sea level. The blue area is the most vulnerable for all the sea level rise scenarios analyzed. St. Augustine is located in the blue area. The highest areas in dark brown are the Atlantic Coastal Ridge, which is about 100 feet above sea level.

Storm surge



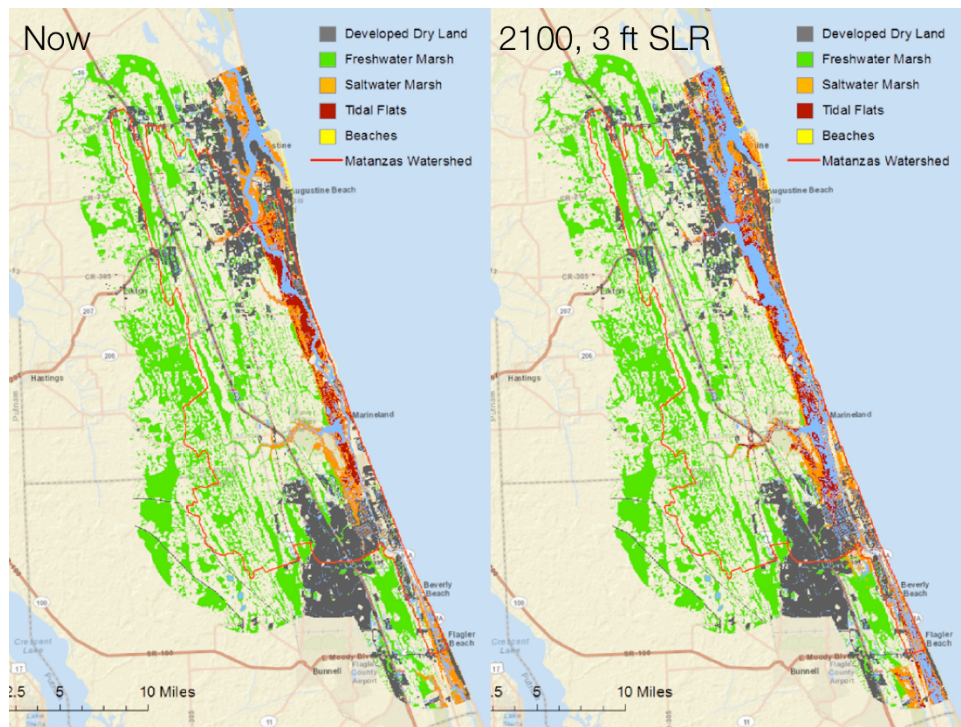
In addition to long-term changes due to sea level rise, the project modeled current and future storm surge areas and depths of flooding. Sea level rise mainly affects depths of flooding for up to 3 feet rise.



Natural landscape changes

Sea Level Affecting Marshes Model

SLAMM predicts the changes in natural landscape habitats due to sea level rise. These changes are important considerations for the GTM Research Reserve and regional conservation planning.



These maps show the results of the SLAMM model for the most likely scenario of 3 feet rise by 2100.

In the GTM Research Reserve the tidal flats (red) change to open water (blue), and saltwater marshes (orange) are reduced. At the most extreme scenario of 8 feet rise by 2100 (not shown), the Reserve loses 95% of estuarine habitats.

In St. Augustine saltwater marshes convert to open water, and developed dry land becomes saltwater marsh.

Impacts of sea level rise on wildlife

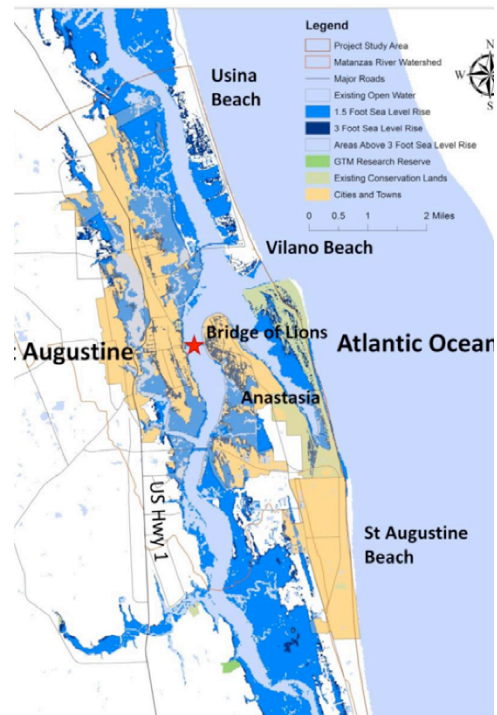


Within the Matanzas study area, sea level rise causes gains in wetland and open water habitats, which benefit some species. Most species in the area lose habitat with sea level rise. Sea level rise also affects several biodiversity hot spots.

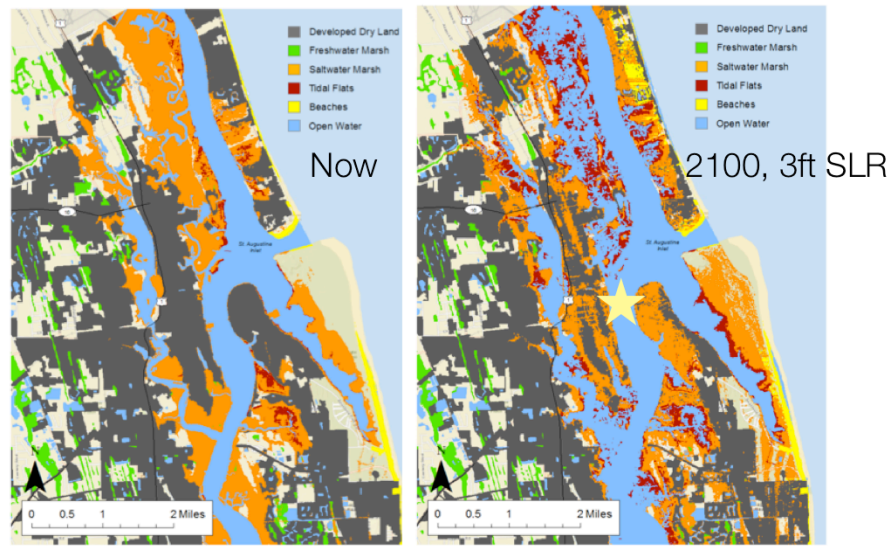
Photo is osprey along Matanzas River, courtesy of Ed Siarkowicz

Impacts on existing development

- Elevation



This map shows impacts to St. Augustine due to sea level rise based on a digital elevation model, which is a simple way of examining vulnerability.



Impacts on existing
development

Sea Level Affecting Marshes Model
Assuming no protection

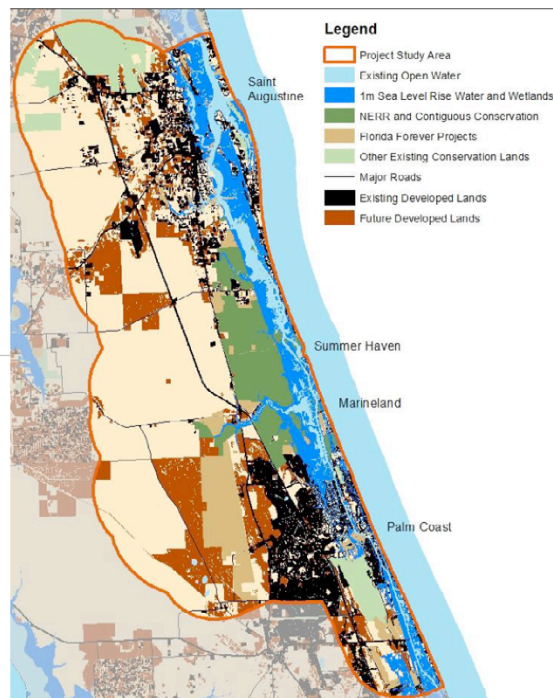
These maps show the impacts to St. Augustine based on the SLAMM, which is a sophisticated ecological model. This model result assumes that developed areas are not protected from flooding by infrastructure such as sea walls and pumping.

Across the Matanzas study area, 3 feet sea level rise by 2100 will impact 2,500 acres of developed residential parcels, which would affect 30,000 residents. Across both counties, the 3 feet sea level rise scenario was found to displace 50,000 residents.

Impacts to undeveloped parcels

Future development trend

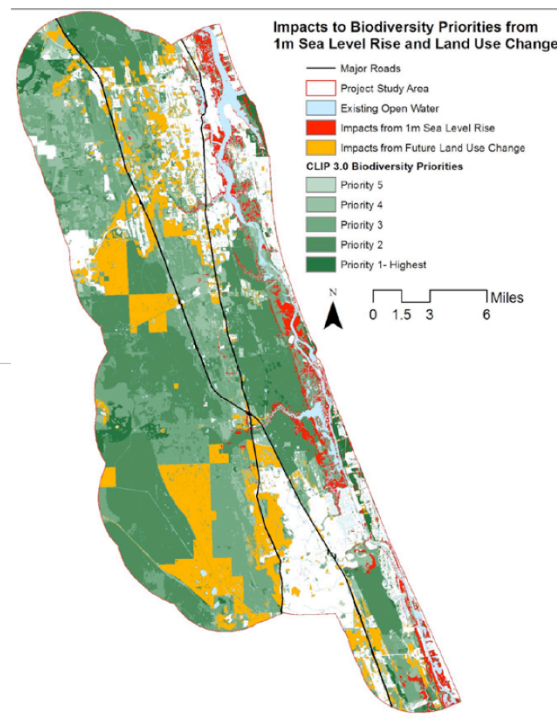
Population growth
Displacement from sea level rise
Current land use policies and development permits



By overlaying the SLAMM results for 3 feet sea level rise with current land use in the study area, the project team found that about 1,600 acres of undeveloped residential lands in the Matanzas study area would be affected.

The LUCIS model was used to identify likely inland areas to develop in the future. Inputs to the model included population projections for the two counties in 2060, the number of coastal lands and residents displaced by 3 feet sea level rise, land suitability for development, and current development policies. The new development was predicted to occupy 134,000 acres across both counties. The new population density in the developed areas was 4.3 people per acre on average. This is higher than the current population densities in developed areas, which are 3.7 and 2.3 people per acre in St. Johns and Flagler counties, respectively. The higher development densities in the future reflect current land use policies and available platted lands.

Impacts of sea level rise and future development on natural environment



This map was created by first identifying current statewide conservation priorities shown in green. The areas where 3 feet sea level rise impacts these conservation priorities are red. Where this future development impacts the conservation priorities is shown in orange.

The team modeled habitats for 37 species important for conservation management. For sea level rise of 3 feet, the black rail bird habitat was most affected, at a loss of 58%. With the exception of the oystercatcher bird, which significantly gained habitat, the average loss of habitat for the species was 6%. Sea level rise also moderately to severely impacted biodiversity hot spots, depending on the sea level rise scenario.

Future development was found to cause a loss of 10-30% of habitats for upland species in the Matanzas study area, such as gopher tortoise.



Adaptation

Recommendations and current actions

Photo is sea gulls along a beach in the study area, courtesy of Ed Siarkowicz

Strategies chosen will depend on

Priorities
Where and what
Goals
How long last
Feasibility
Cost
Effectiveness
Uncertainty

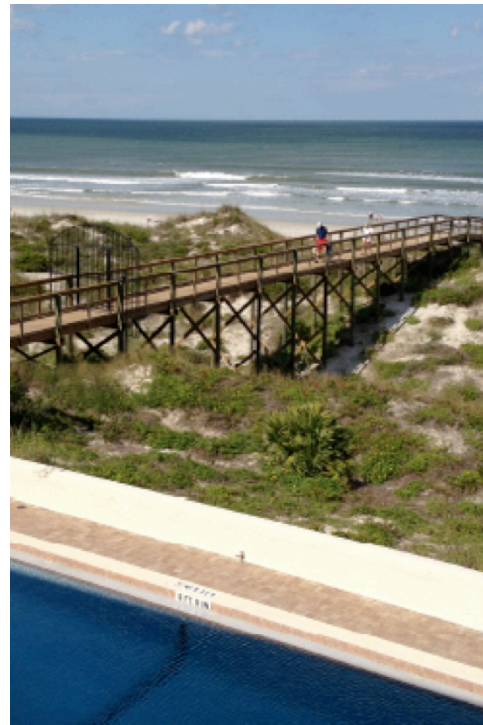
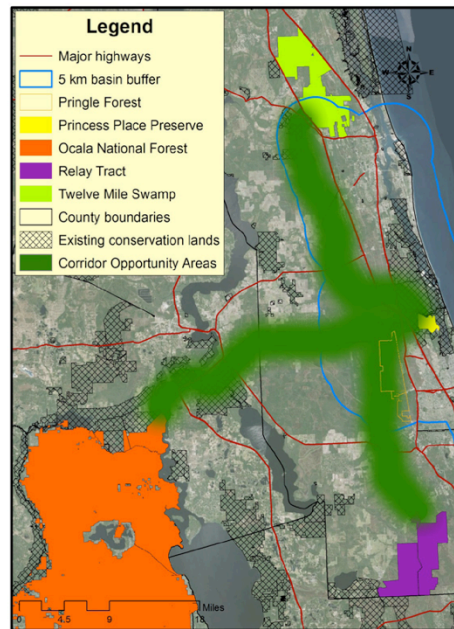


Photo of Crescent Beach, taken by project team.

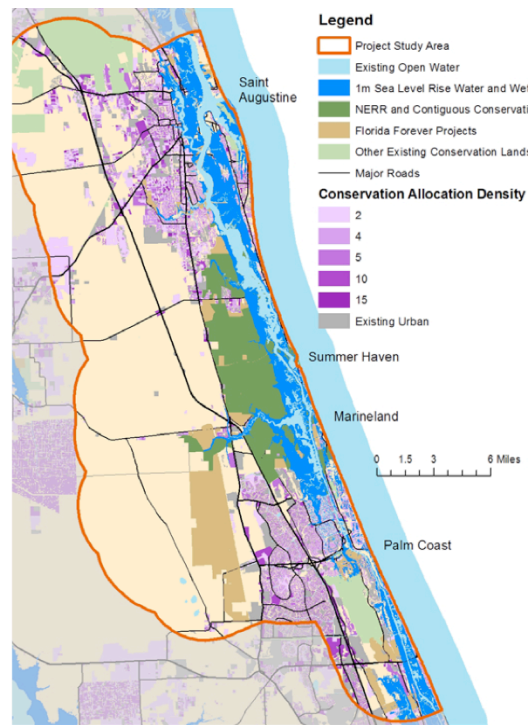
Future conservation priorities



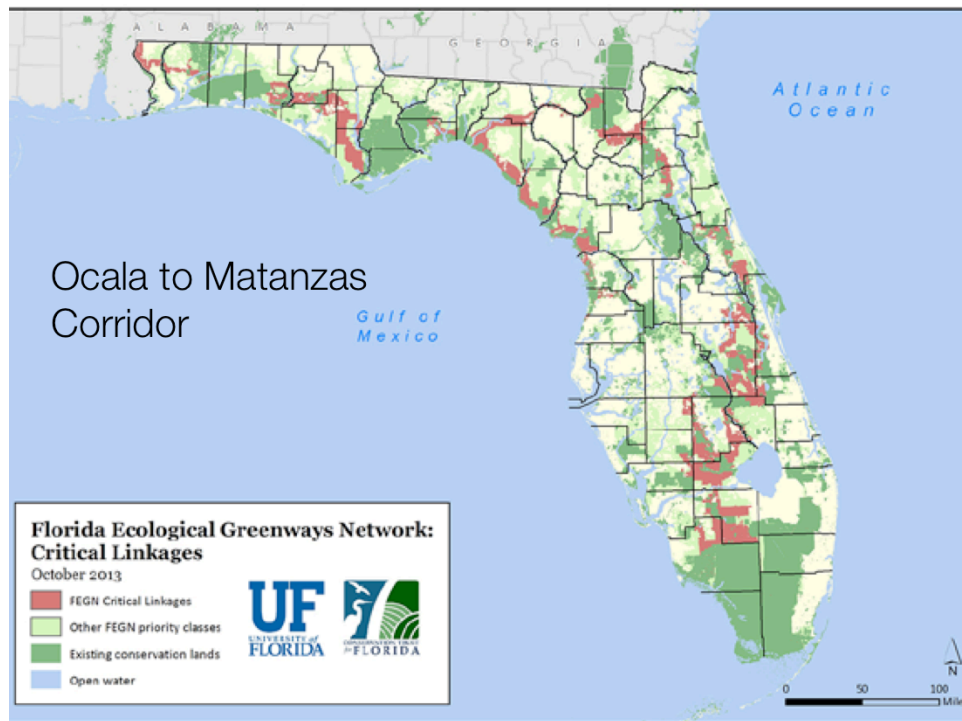
The project team identified future conservation priorities at several scales, the GTM Research Reserve, the Matanzas study area, the two counties, and the larger region. At the Reserve scale, the team recommended that the Reserve consider expanding its boundaries to undeveloped adjacent land to the north and south, in order to mitigate the loss of estuarine habitats within the reserve. At the regional scale, as shown in the map, the team identified several large wildlife corridors to connect the major conservation areas, including along Pellicer Creek, thus providing vital coastal to inland habitat linkages.

Future development to avoid conservation priorities

- Land use planning and policies



The project team combined the results of the many conservation analyses to create an overlay of future conservation priorities that take into account changes due to sea level rise. The team then ran the LUCIS model again for the year 2060, with the additional specification that development would avoid the future conservation priority areas to the extent practicable. This development scenario occupied 14,000 less acres and avoided impacting 64,000 acres of future conservation priorities. The number of people per acre in developed areas was 4.7, which was only slightly higher than occurred with the "trend" scenario that did not avoid the future conservation priorities.



The coastal to inland wildlife linkage along Pellicer Creek is now called the Ocala to Matanzas Corridor. Local and statewide conservation leaders were recently successful in petitioning the state to add the corridor to the Florida Forever list for prioritized funding for conservation easements and land acquisition.

GTM Research Reserve strategies



This poster summarizes the various ways in which the GTM Research Reserve is using the data and information generated by the project.

Development strategies

Options, not specific recommendations
Selection and design requires focused planning

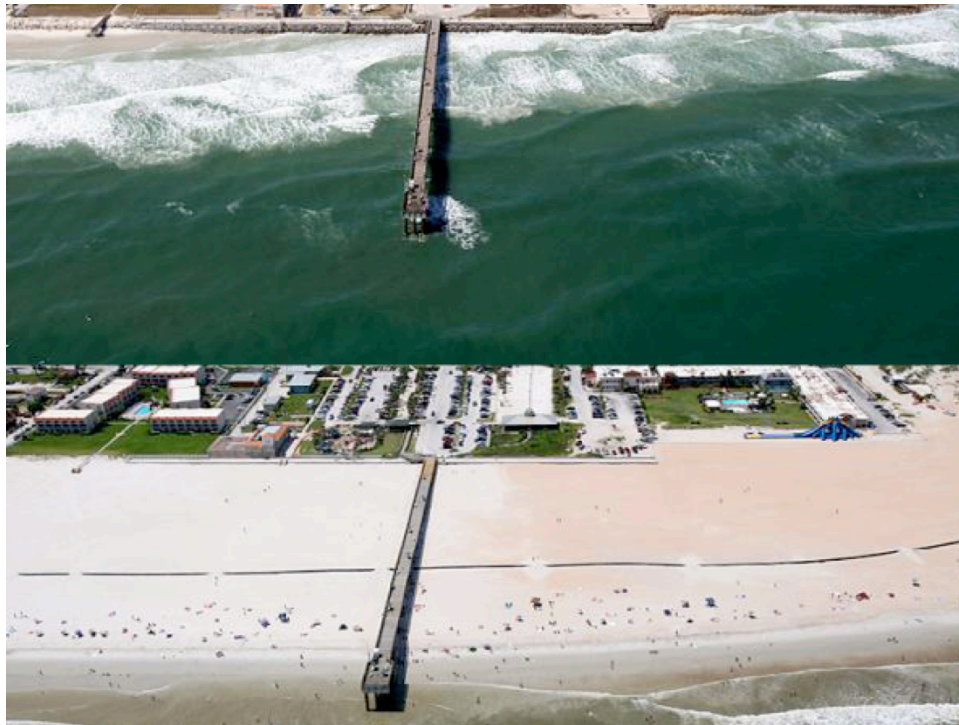


The most promising strategies for the Matanzas study area combine designs for the built and natural environments, and that respect historic and cultural resources, the local economy, and community values. For example, the new St. Augustine sea wall provides greater flood control, preserved the historic sea wall, and created a promenade.



More development strategies

The photos show strategies in use in the Matanzas study area, including rip-rap and a living shoreline/reef to protect against erosion, and a large building set-back to avoid building exposure to waves.



These photos show sand renourishment at St. Augustine Beach.



Vulnerable development may be relocated or abandoned. Vulnerable areas can be avoided as sites for future development, and they can function as conservation areas.

Photo is remnant of historic Flagler sightseeing trolley, courtesy of Ed Siarkowicz

St. Augustine activities

- Hazard mitigation
 - Sea wall
 - Storm drainage
- UF white paper
- Support from Florida Department of Economic Opportunity

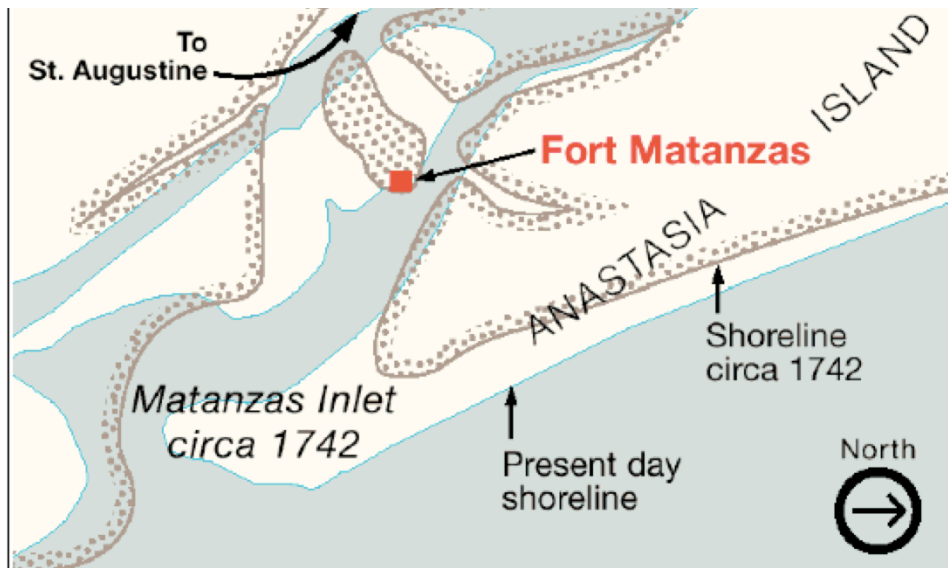


Adaptation principles

Photo of Crescent Beach, courtesy the project.

The future will be very different

- More development
- Increasing hazards
- Changing landscape
 - Permanent loss of land



The coast is always
changing

Sea level rise means
permanent loss of land

Forces with limited local control

- Sea level rise
- Population growth
- Economy
- Insurance

Clarify goals

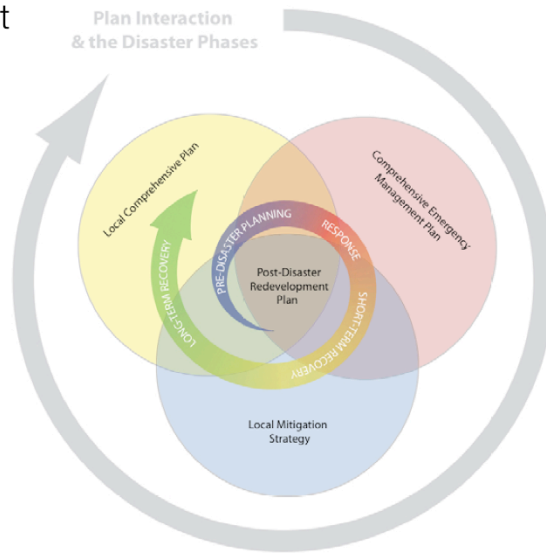
- Community values
- What want to save, for how long
- What let go



Old A1A road near Summer Haven, photo from project.

Basic planning and emergency management

- Foundation
- Take advantage of current policies directing development
 - Existing platted lands
 - Comprehensive plan
- Benefits to quality of life



Local plans provide the foundation for hazard mitigation and future changes, and their coordination improves the overall effect. The plans address land use (comprehensive), emergency management, local mitigation (reduce vulnerability), and post-disaster redevelopment.

Plan now

- Choices made now have major impacts
- Get ahead of rapid changes while have options
- Planning and implementation take time
- Demonstrate responsibility and leadership
- Competition for limited funds



- County leadership
- Ecosystem services
- Development choices



This poster shows “low impact” design and land use strategies that improve the quality of communities and regions, reduce environmental impacts, and lower vulnerability to short and long-term hazards.

Science collaborative approach

- Studies are important
 - Partner with researchers
- So is collaboration
 - Local leadership
 - Capacity building
 - Resource networks



Chart a path that is right
for your community

Photo of neighborhood near the Matanzas River, taken by
project team.

Thank you

Questions and comments?

PlanningMatanzas.org



The project website has the final report, a blog, key contacts, and other information: www.PlanningMatanzas.org

Photo of beach in Matanzas area, courtesy of Ed Siarkowicz