



Mangrove Heart Attack: Mapping Mangrove Forests in Florida

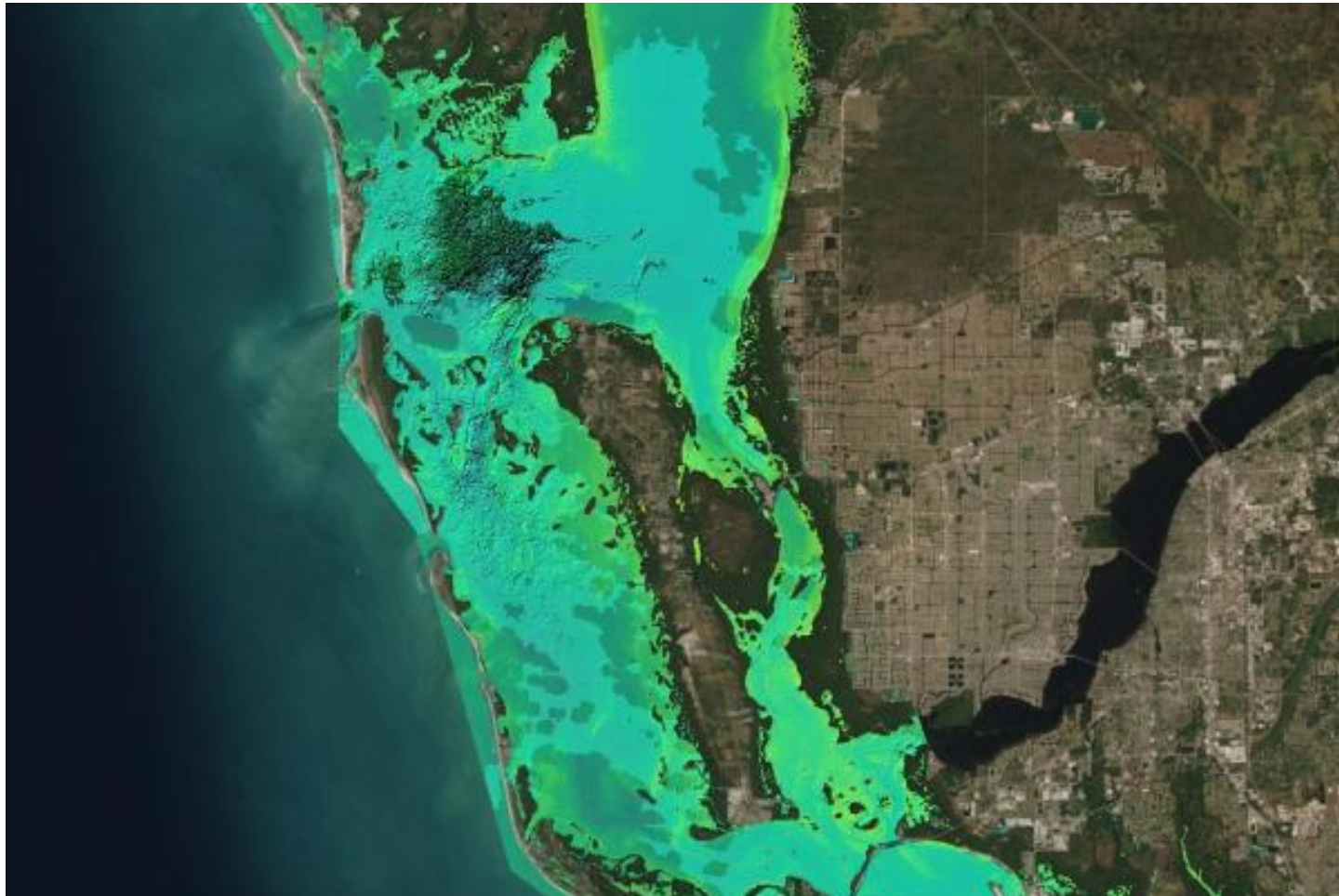
# Mangrove Heart Attack: Mapping Mangrove Forests in Florida

Sam Perrello (Team Lead), Kyle Stark, Emily Heltzel, and Koya Oki

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## Introduction



The NASA DEVELOP program conducts feasibility studies to bridge the gap between Earth science, information, and society. DEVELOP partners with organizations interested in integrating Earth observations to inform their environmental decision making. These DEVELOP projects center around a partner's decision-making needs.

The Summer 2022 DEVELOP Florida Water Resources project partnered with the **Florida Department of Environmental Protection** to aid in the management of aquatic preserves -

specifically investigating how mangrove forests are changing along Florida's Gulf Coast.



Mangrove forests are a crucial habitat that buffer the land from encroaching oceans, increase biodiversity, and protect urban areas along Florida's coast. They exist in tidal zones between fresh water rivers and saltier oceans.

The extent of mangrove forests is in constant flux but are now facing growing challenges. Sea level rise, more frequent and severe hurricanes, and constant human development along coastlines places these forests under unprecedented stress and restricts the area in which they can thrive.

## Community Concerns

**Extreme events, like Hurricane Irma, can cause significant damage to mangrove forests.**



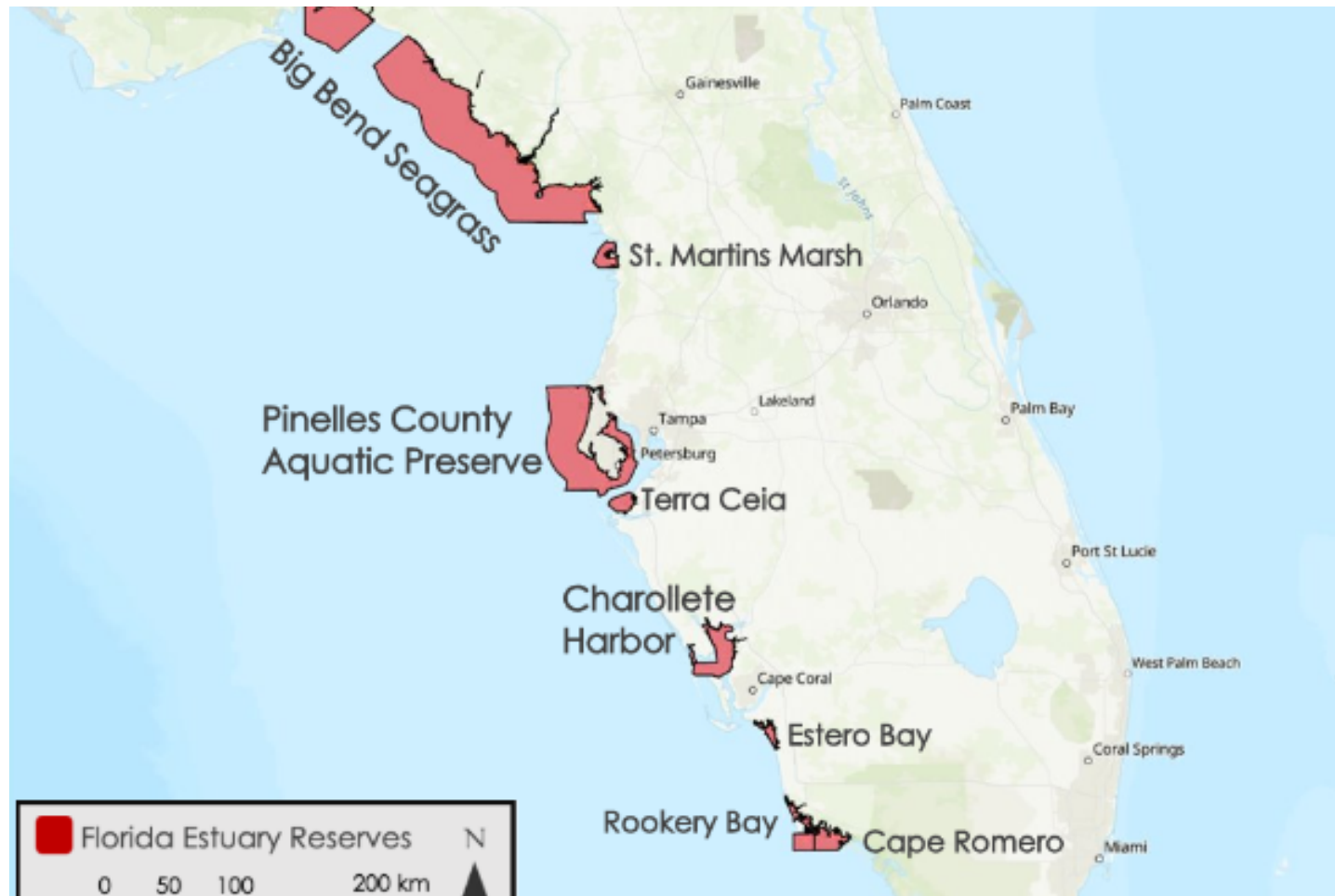
Aerial images showing the extent of mangrove forest damage from Hurricane Irma in 2017: before on March 28, 2017 (left) and after on December 1, 2017 (right); Image Credit: NASA | G-LiHT Science Team



The degradation of mangrove ecosystems can lead to the loss of biodiversity and ecologically significant species, in addition to the loss of coastal protection for surrounding communities which threatens the coastal Florida economy.

Water quality estimates are important for understanding the ecological health of a nature preserve. Collecting these data manually from a boat across the millions of acres of preserved land is difficult but necessary for a complete evaluation of these systems.

Shoreline changes are occurring along the entirety of Florida's gulf coast, including near urban centers. The aquatic preserves and mangrove forests near these areas are crucial for protecting life and property.



The Florida Department of Environmental Protection (FDEP) is charged with preserving much of the mangrove forest along the 2nd longest coastline in the U.S. To date, the Florida state representatives do not have the tools to investigate their 4.7 million acres of

preserved lands effectively. Understanding how these systems respond in the face of new and increasing challenges is vital in their management strategies and policy making.

The Florida Water Resources team worked with the FDEP to utilize NASA's extensive catalog of Earth observing datasets to map mangrove forests across their aquatic preserves.

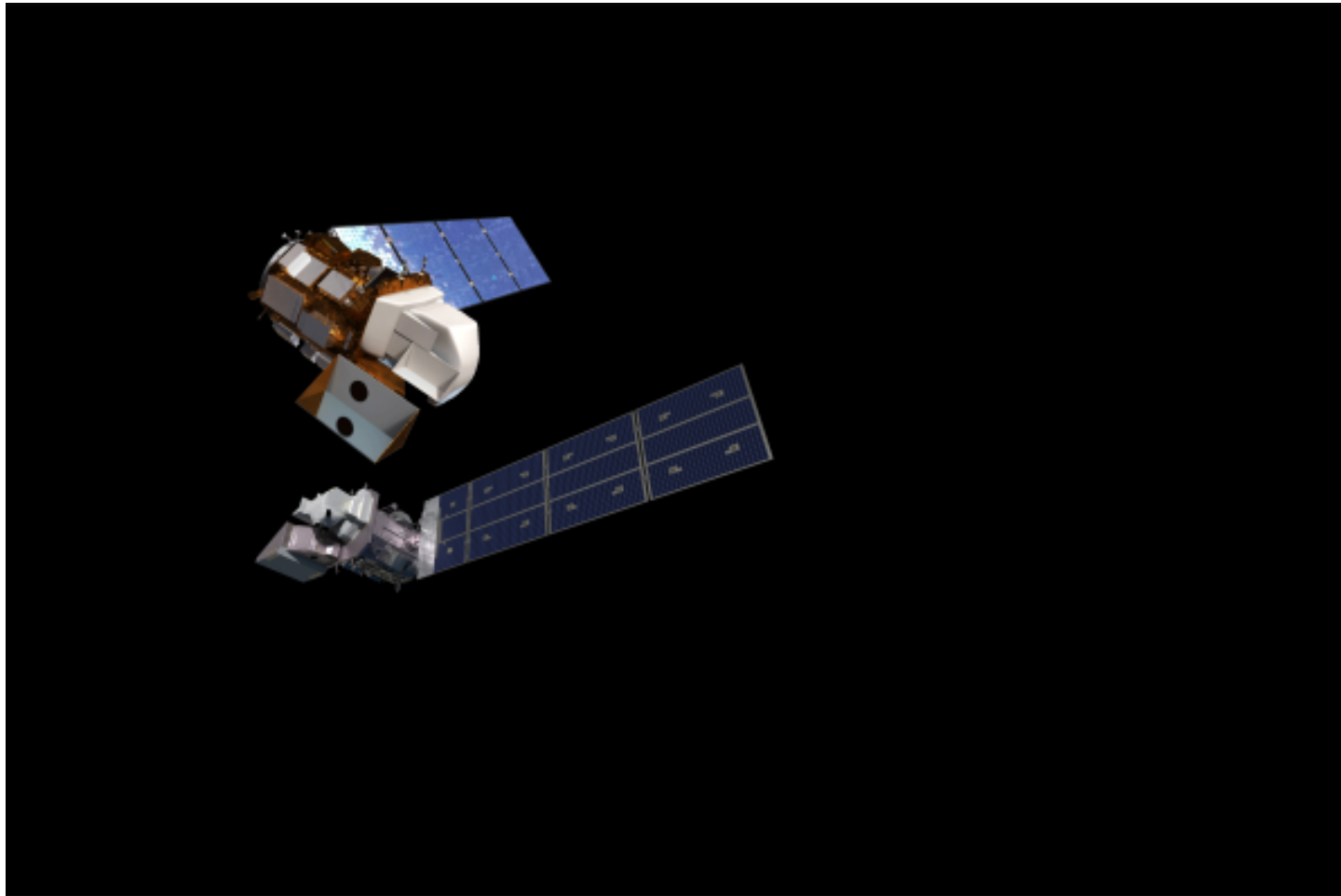
## **Methodology**

**By using NASA's Earth observations, we can examine large areas over many years.**



Landsat 7 ETM+ (2000 - 2021) provides a long history of earth observations at a 30-meter resolution.

This satellite can provide imagery from the past allowing partners to understand long term trends in forest extent. These data were used to generate the team's mangrove extent/health and water quality maps.



Landsat 8 was launched in 2013 while Landsat 9 was launched in 2021 and both are still in operation today. These satellites are used in a similar manner as Landsat 7 and were used to map water quality and mangrove extent and health.

These two satellites can provide near-real time estimates of mangrove forest health and water quality. Because they are still operational, they are able to provide ongoing imagery and maps in the future for our partners.

**The satellite imagery was compiled into a tool that our partners can use to analyze past trends and monitor future conditions.**



Our team utilized Google Earth Engine (GEE) to analyze thousands of Landsat images at once. We used in situ data from our partner organization along with their available mangrove extent data. These were used as training data for our machine learning algorithm.

We use the random forest classification function in GEE to determine mangrove extent. We then ran a model accuracy analysis with known mangrove sites and found our extent classification to be 90% accurate.

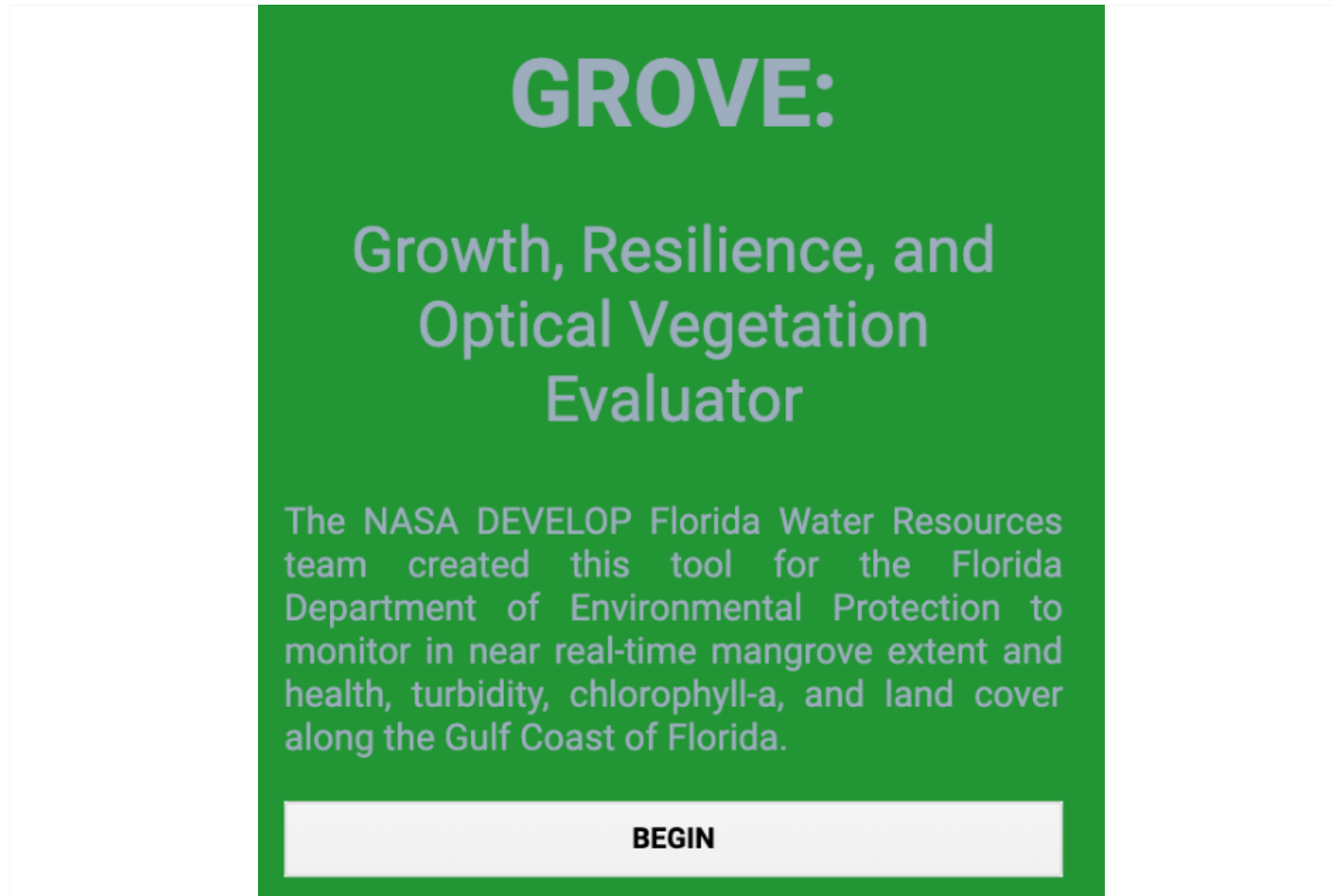


We then utilized the Normalized Difference Vegetation Index (NDVI) to measure the greenness/health of the vegetation. This allowed us to distinguish matured mangrove forests versus stressed mangrove forests. The FDEP provided us with known areas experiencing mangrove heart attack or mangrove die off to compare.



The water quality parameters of interest included chlorophyll-a, turbidity, and submerged aquatic vegetation.

Our team adapted code from a previous GEE tool called CREOL. We improved the tool by adapting it to Landsat 9 imagery and new locations. The parameters were averaged over each season to provide seasonal water quality trends.



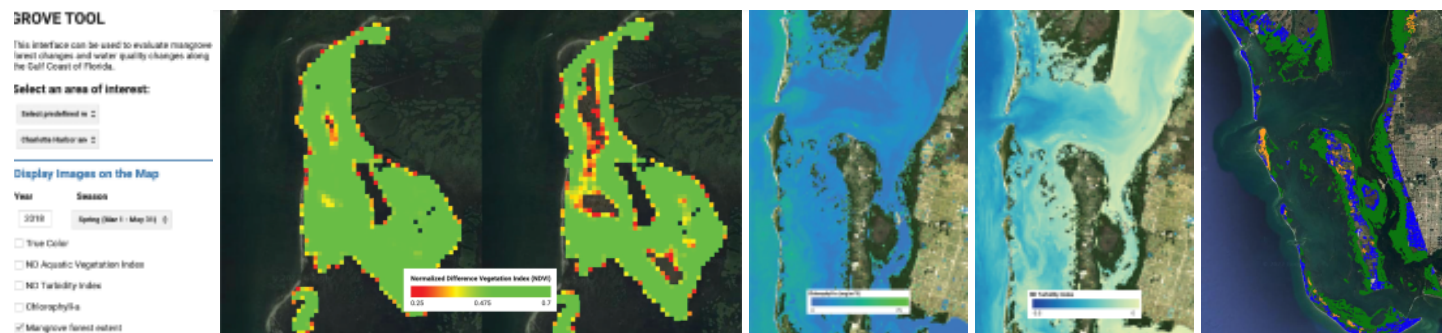
Each of these features were included in our tool called Growth, Resilience, and Optical Vegetation Evaluator or GROVE. With this tool, our partners at the FDEP will be able to access data and maps for specific areas, time periods, and parameters.

This tool was created to help inform management practices for these aquatic preserves, specifically pinpointing critical areas in need of conservation or restoration.

## GROVE

Our tool and user interface within Google Earth Engine creates maps that are available for download and use within ArcMap.

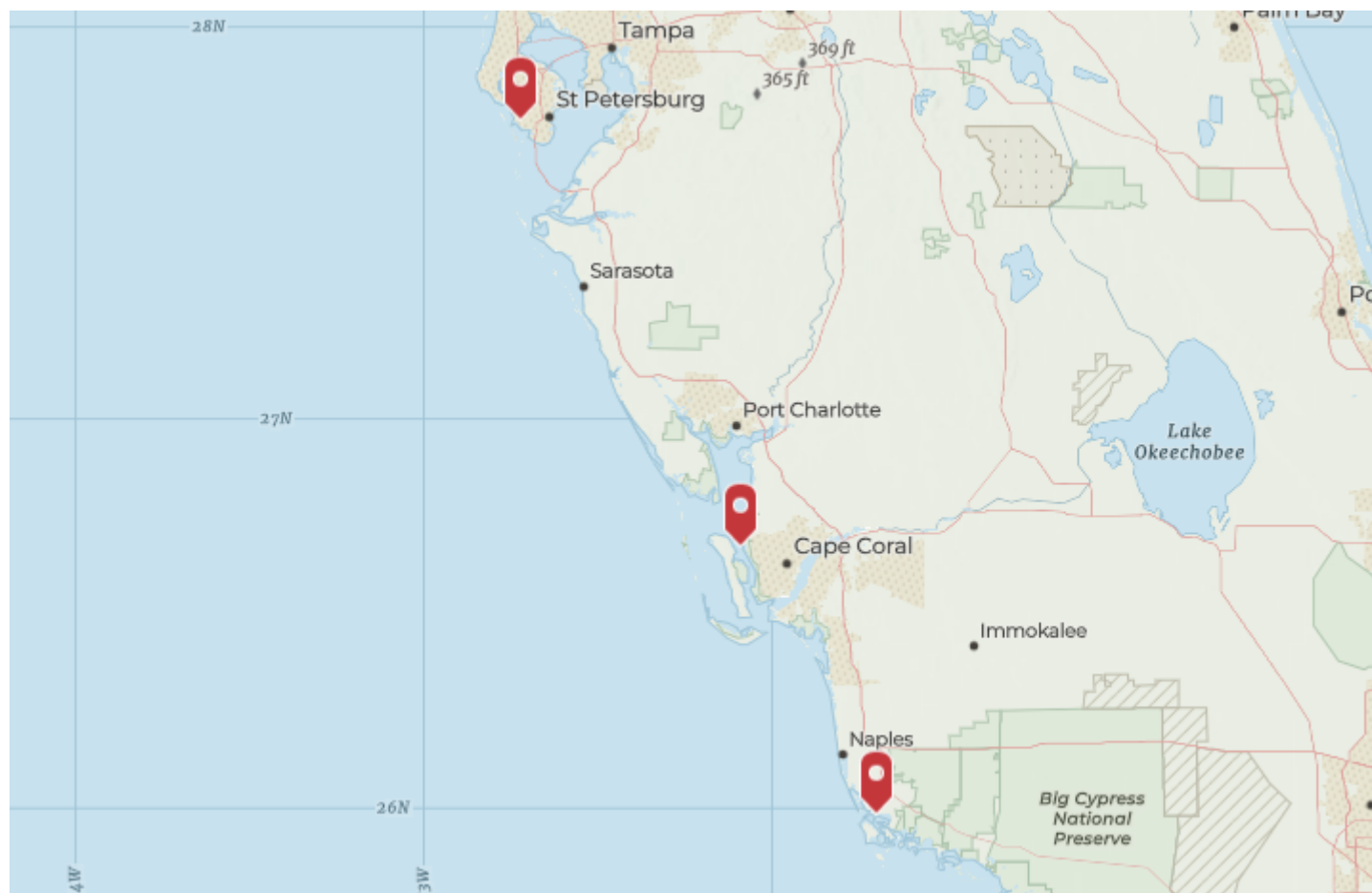
Data available for download includes: water quality parameters, mangrove extent, and mangrove health.



From left to right: User Interface of GROVE tool, NDVI map of island experiencing mangrove heart attack, Chlorophyll-a map of Charlotte Harbor Aquatic Preserve, Normalized Difference Turbidity map of Charlotte Harbor, Land cover classification map created by random forest model imbedded into the GROVE tool with mangrove (green), other vegetation (orange), and non-mangrove (blue). Image Credits: DEVELOP Florida Water Resources Team

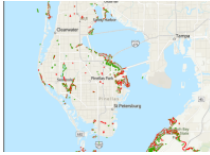
## Results

We see similar patterns of change in mangrove forest extent across all three Gulf Coast preserves.



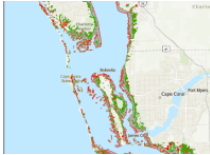
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### **Pinellas County and Terra Ceia**

In Pinellas County, the southern part of Tampa experienced the most change.



### **Charlotte Harbor / Estero Bay**

At Charlotte Harbor, significant mangrove stress was found in the outer islands. About 1,680 ha of mangrove were lost or are now considered highly stressed from 2000 - 2021.



### **Rookery Bay / Cape Romero**

Rookery Bay and Cape Romero experienced significant mangrove stress along the outer islands with an approximate loss of 1,400 ha from 2000-2021. Mangrove growth was observed further...

## **Conclusion**

The overall loss in mangrove extent from 2000-2021 was concentrated on the outer and coastal edges of these forests. This can largely be attributed to continual sea level rise forcing this habitat further inland. This pattern was reflected in the overall gain in mangrove extent as it was primarily located on the inland site of the forests. Mangrove forests have slowly been taking over inland salt



marshes over the past 20 years. Other gains can be attributed to the maturation of inland mangrove forests reaching full growth where it is identified and included in the classification.

**The GROVE tool will be used to help the Florida Department of Environmental Protection make informed decisions about where to target management resources.**

For more information about Florida's Aquatic Preserves, we invite you to visit the Florida Department of Environmental Protection's Office of Resilience and Coastal Protection.

FDEP - RCP

## Image Credits

In order of appearance

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### **Acknowledgments**

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**NASA Legal Statements**

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