Mapping terrestrial and benthic habitat change to address mangrove and seagrass migration and die-off in response to recent and long-term environmental drivers

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Collaborative Lead: Brita Jessen
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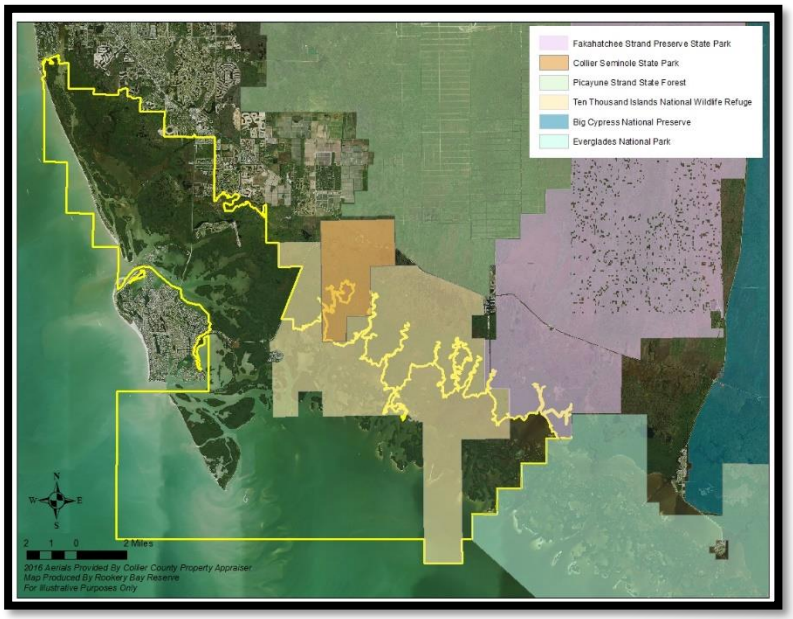
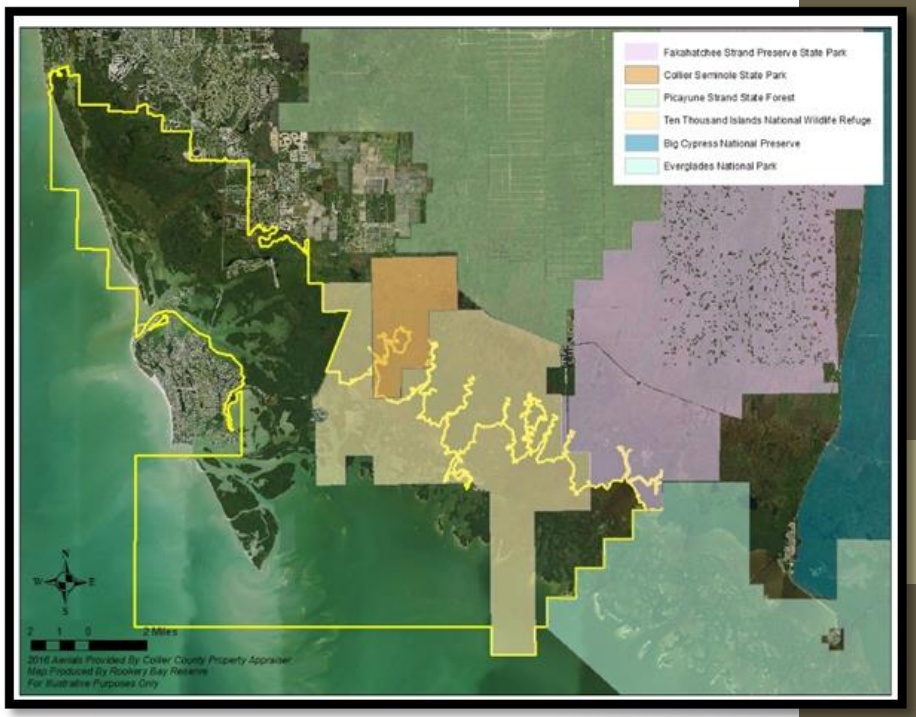
Consultants: Mike Barry, Axiom Data Science



Rookery Bay Mapping

- Project Goals:
  - Map land and aquatic habitats throughout the reserve for years:
    - 2010, 2013, 2016, 2017, 2018
  - Data:
    - High-resolution and medium-resolution satellite imagery
    - Field surveys (M. Barry)

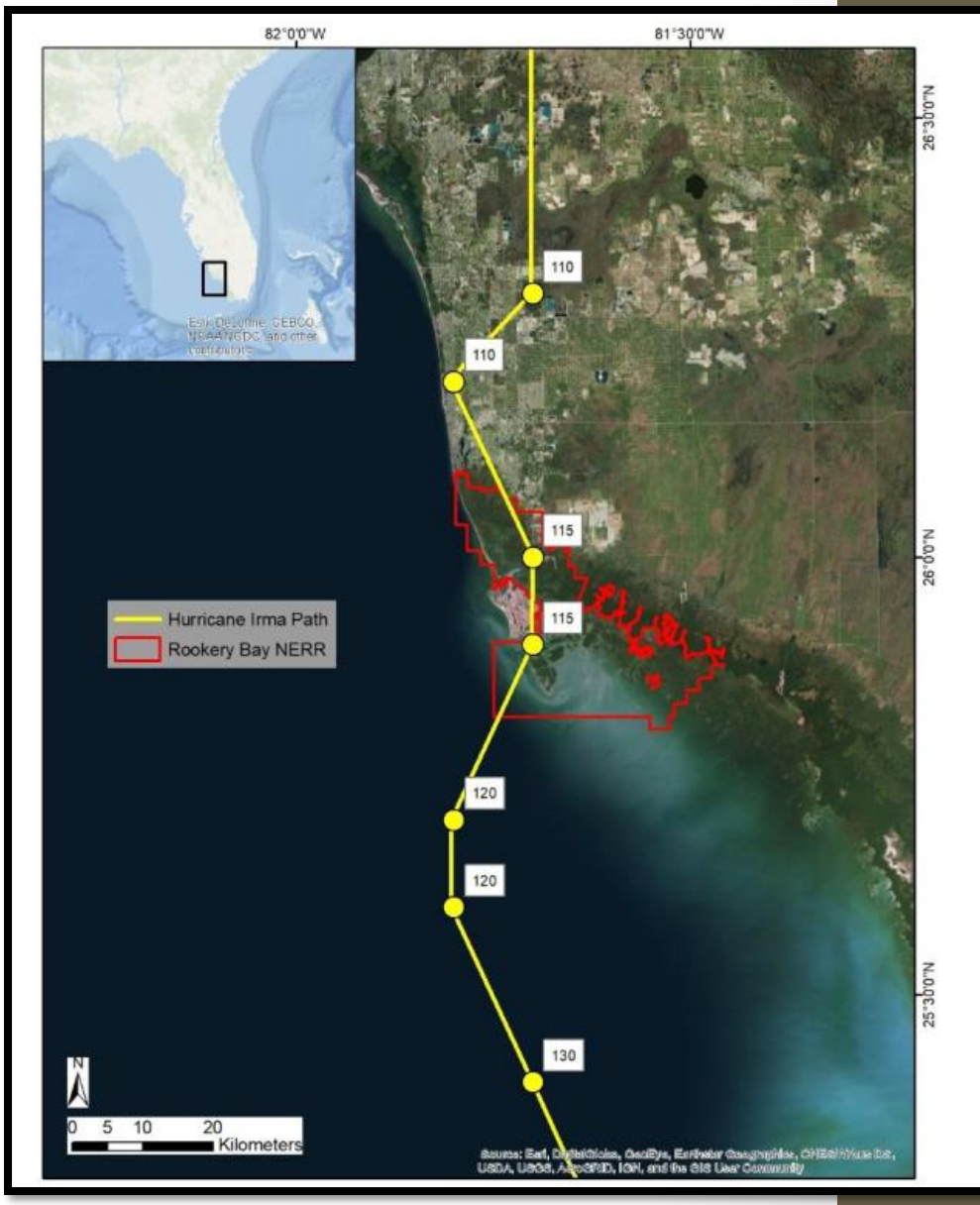


Purpose

- Management Need:
  - Identify location, extent, and severity of mangrove and seagrass degradation
  - Inform management how to mitigate loss and improve resiliency

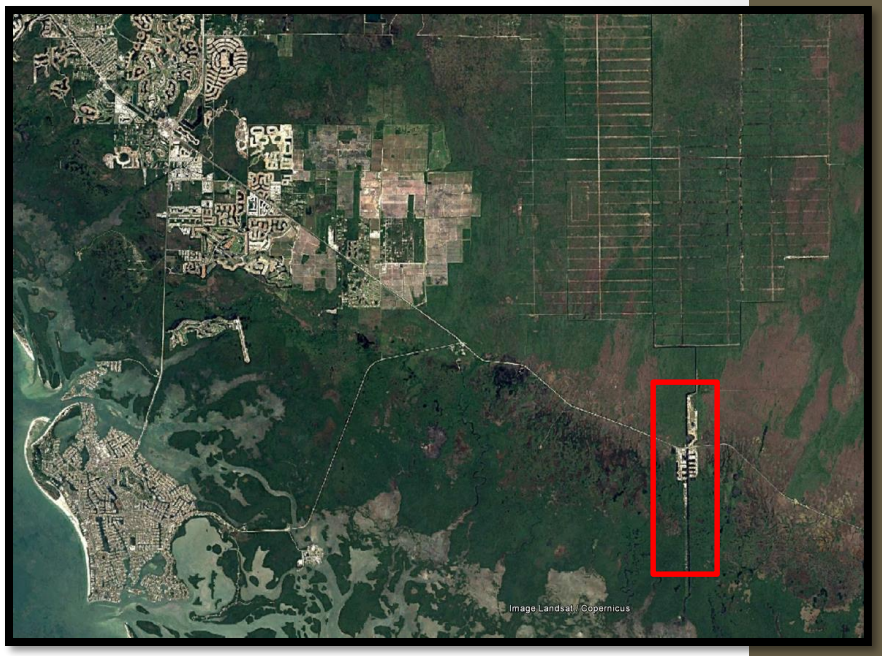
Purpose

- Habitat degradation causes:
  - Mangroves
    - Chronic hydrologic stress – road/highway construction, water diversion, sea level rise
    - Short-term events – Hurricane Irma
  - Seagrass
    - Boat scarring
    - Fragmentation



Background

- Ken Krauss et al. 2011
  - Ten Thousand Islands NWR
  - Sea-level rise and freshwater flow alteration drive mangrove migration inland
    - Mangrove coverage increased 35% 1927-2005
    - Marsh lost
    - Caused by development: canals, roads, houses
    - Recommend return to natural, overland freshwater flow

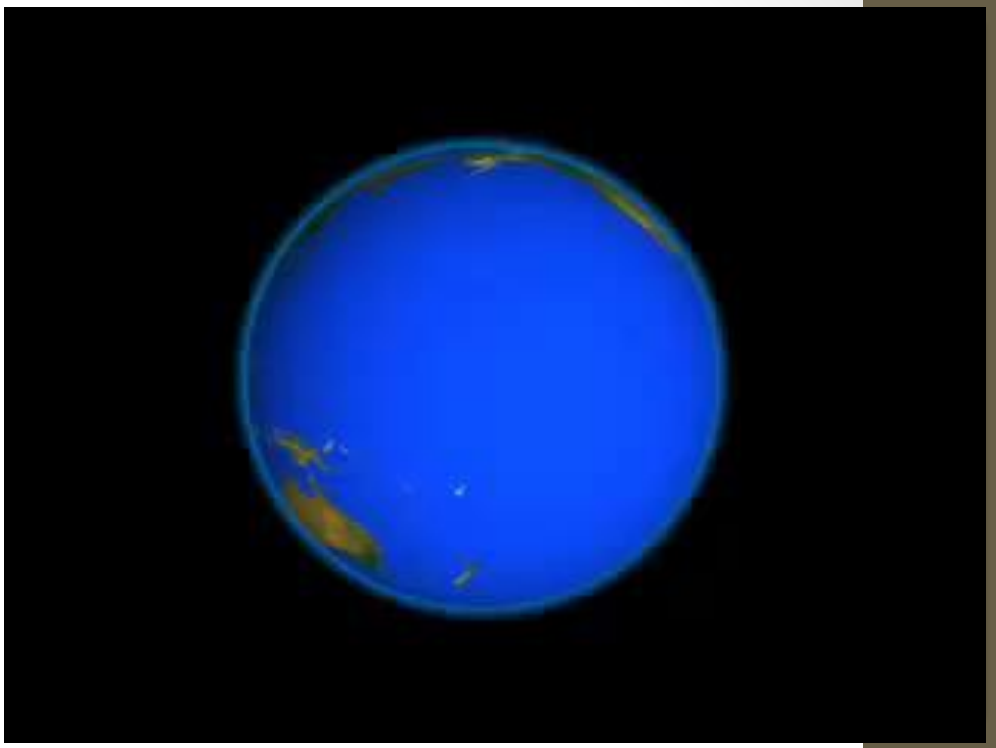


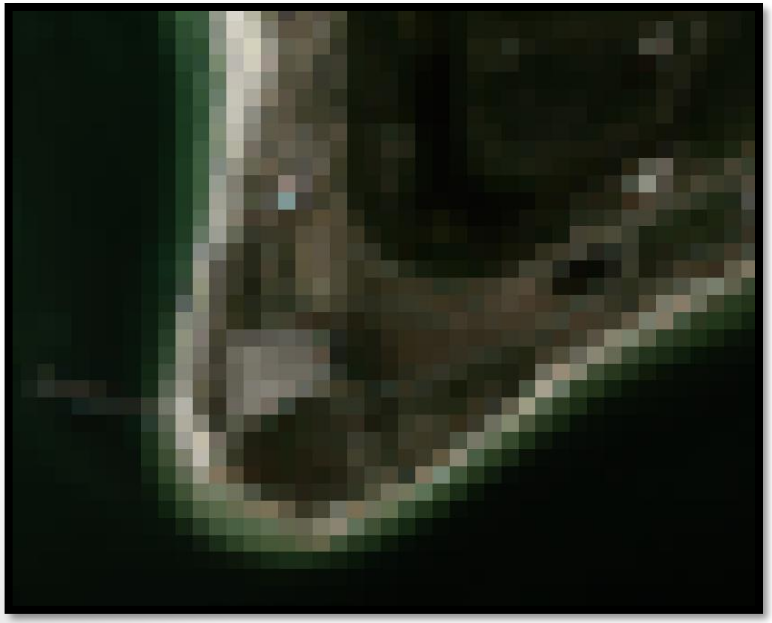
Background

- Lewis et al. 2016
  - Long-term stress + acute events = rapid die-off
  - Loss can occur in just a few years
  - Mangrove heart attack prevention
    - Stress must be detected early
    - Cause: impaired water flow
  - Requires large-scale monitoring
    - Satellite or aerial mapping
    - Ground-truthing

Methods

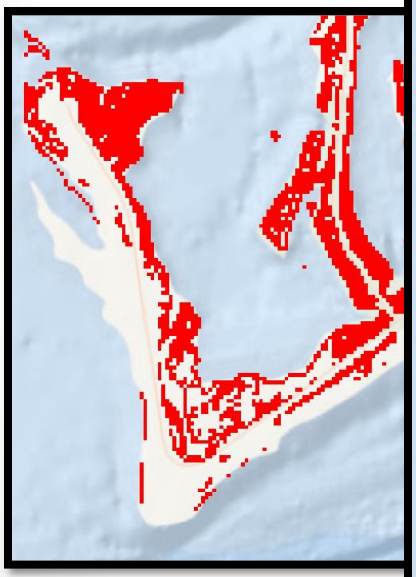
- Wetland classification challenges:
  - Misclassification with adjacent vegetation
  - Sparse Aerial Imagery
  - Spatial Resolution

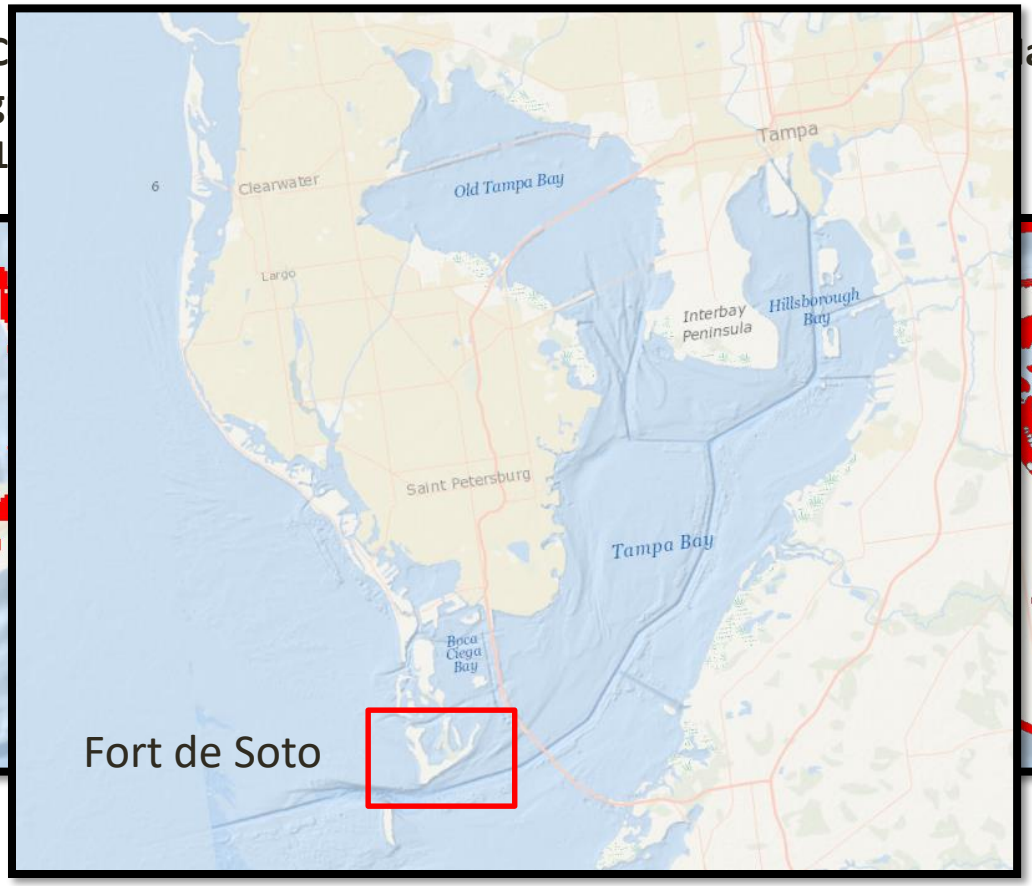




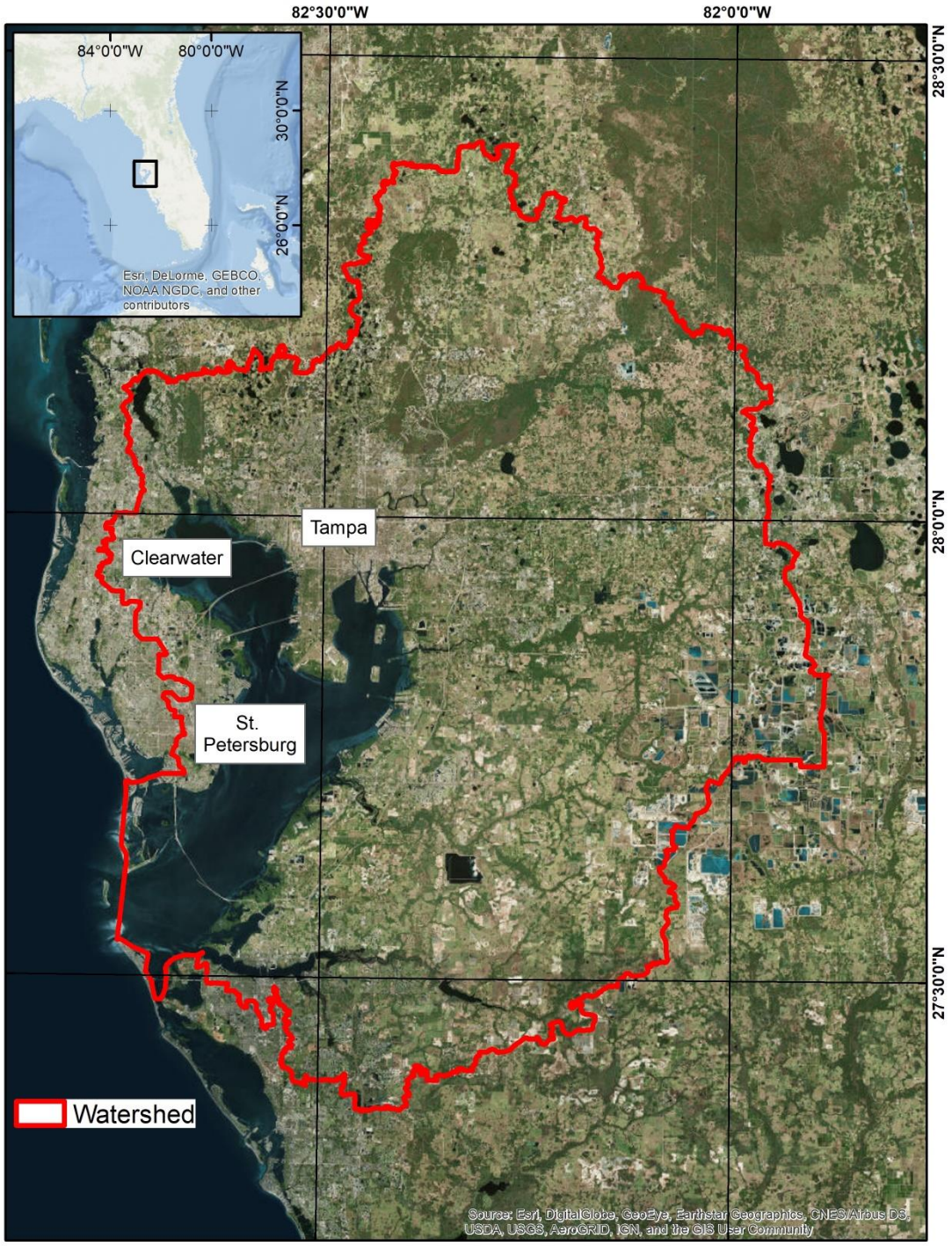
Wetland Map Inconsistencies

NOAA Coastal C
Analysis Prog
(CCAP) 201

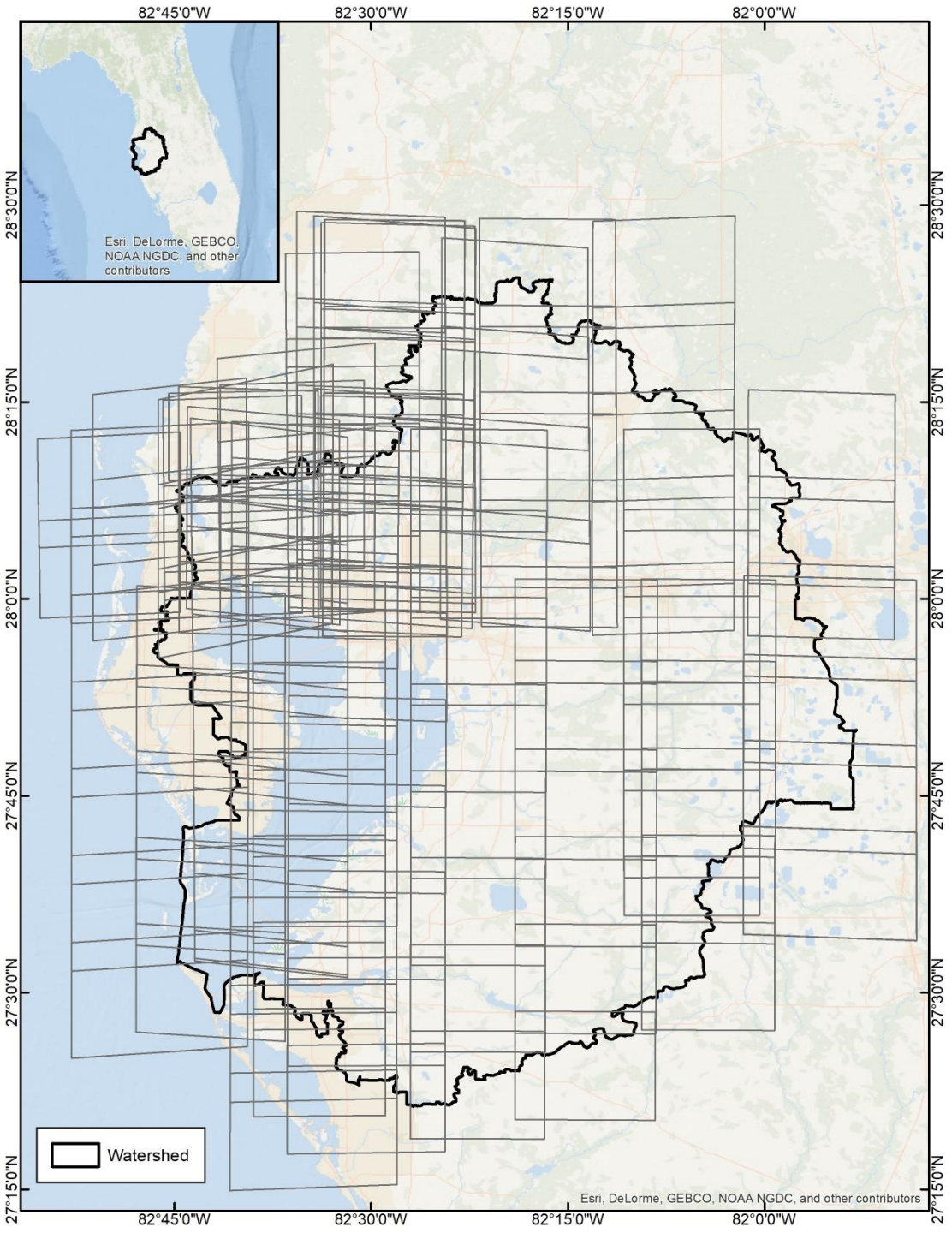




ational Wetland
Inventory
(NWI) 2009

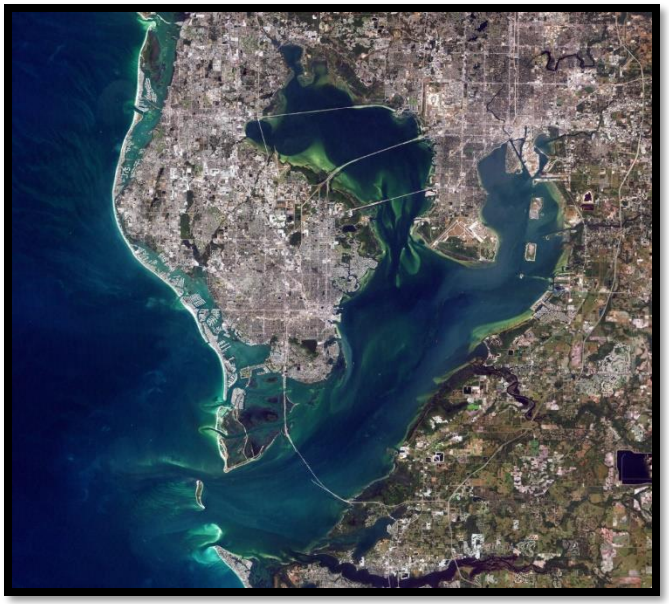

82°30'0"W
82°0'0"W
28°30'0"N
28°0'0"N
27°30'0"N
84°0'0"W
80°0'0"W
30°0'0"N
26°0'0"N
Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors
Tampa
Clearwater
St. Petersburg
Watershed
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

130 WorldView-2 Images



How to Improve Classifications?

- Use satellite-images:
  - Continual monitoring
  - Objective and ***Efficient***
  - Digital data = automated classification methods
- Use high-resolution imagery:
  - More detail = higher precision & greater accuracy



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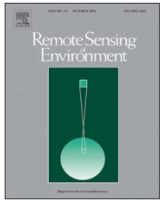


Enabling efficient, large-scale high-spatial resolution wetland mapping using satellites

Matthew J. McCarthy[a,b,*], Kara R. Radabaugh[b], Ryan P. Moyer[b], Frank E. Muller-Karger[a]

Automated Mapping

- Step 1:
  - Python: pgc_ortho code
    - Developed by the Polar Geospatial Center
    - Loads NITF WorldView-2 images
    - Projects image to user-defined projection
    - Outputs a GeoTIFF
  - Time: 17 seconds/image

- Step 2:
  - Matlab: new code
    - Loads GeoTIFFs and metadata
    - Radiometrically calibrates image
    - Corrects for atmosphere
    - Converts to remote-sensing reflectance
    - Classifies image using Decision Tree
    - Smooths image through moving window filter
    - Outputs a classified GeoTIFF
  - Time: ~10 mins/image w/ filter

    ~1 min/image w/o filter

Methodology

130 WorldView-2 Images

Python code

Matlab code

USF CIRCE Compute Cluster
4,000 processors
2.5 TB Memory

ArcGIS Mosaic (121 Images)

FWRI Field Survey

Classified Map

Validation dataset

Map Accuracy

Field Survey

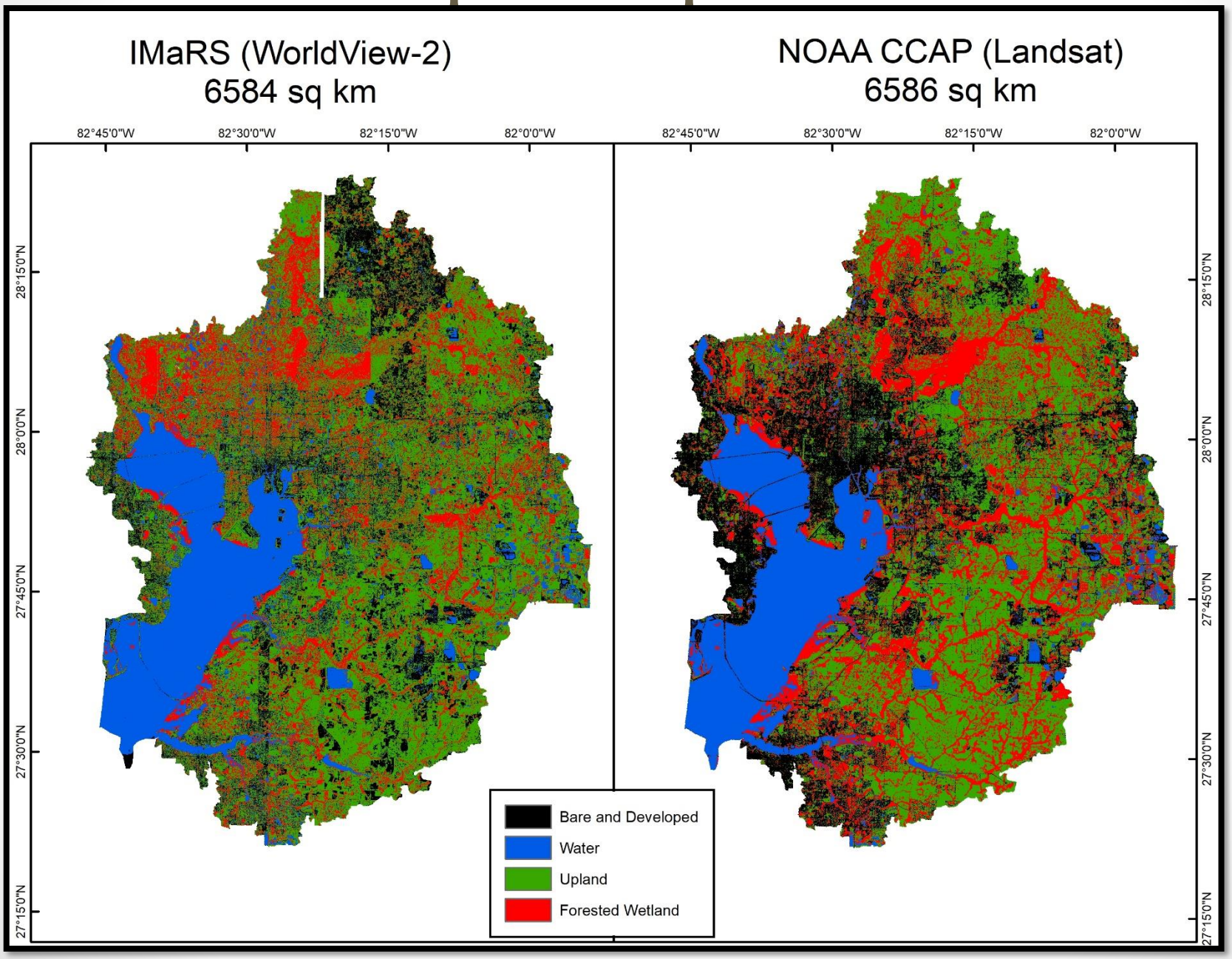
Wetlands

Upland Forest

Results: Map Accuracy

	Upland Accuracy	Wetland Accuracy
CCAP 2010	19%	62%
IMaRS	63%	81%

Results: Map Comparison

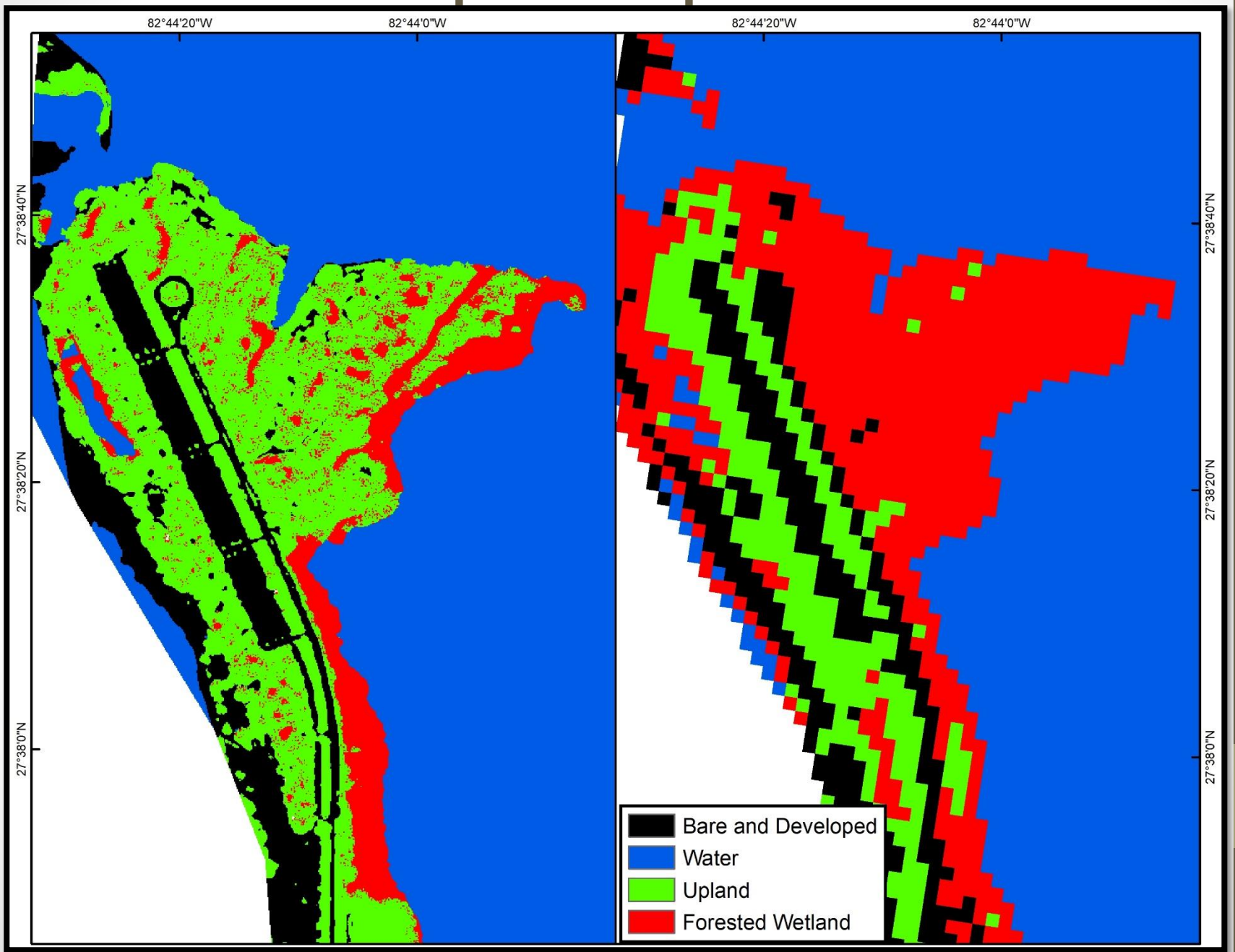


Results: Vegetation Area

	Upland Area (km^2)		Wetland Area (km^2)	
	IMaRS	NOAA	IMaRS	NOAA
Watershed	3134.9	2069.3	1455.7	1679.3

	IMaRS (km^2)	NOAA (km^2)	Difference (km^2)
Total vegetation:	4590.6	3748.6	841.9

Results: Map Comparison



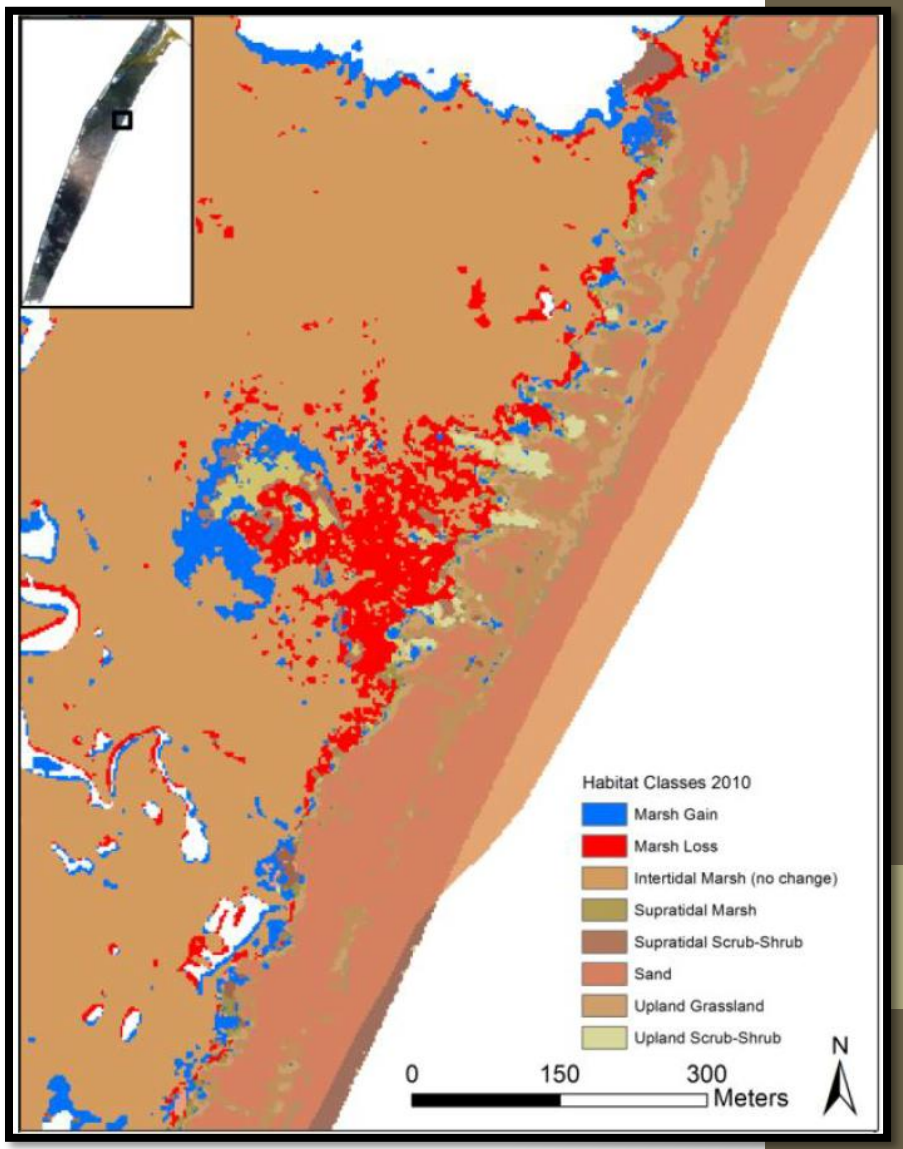
Rookery Bay Mapping

- Project Goals:
  1. Map land and aquatic habitats throughout the reserve for years:
     - 2-meter: 2010, 2016, 2017, 2018
     - 30-meter: 2013, 2016, 2017, 2018
     - Target Habitats
       - Seagrass
       - Sand/Mud bottom
       - Hard bottom
       - Forested Mangrove
       - Marsh Grass
       - Beach
       - Salt Flat
       - Upland Vegetation
       - Developed
  2. **Assess Change**

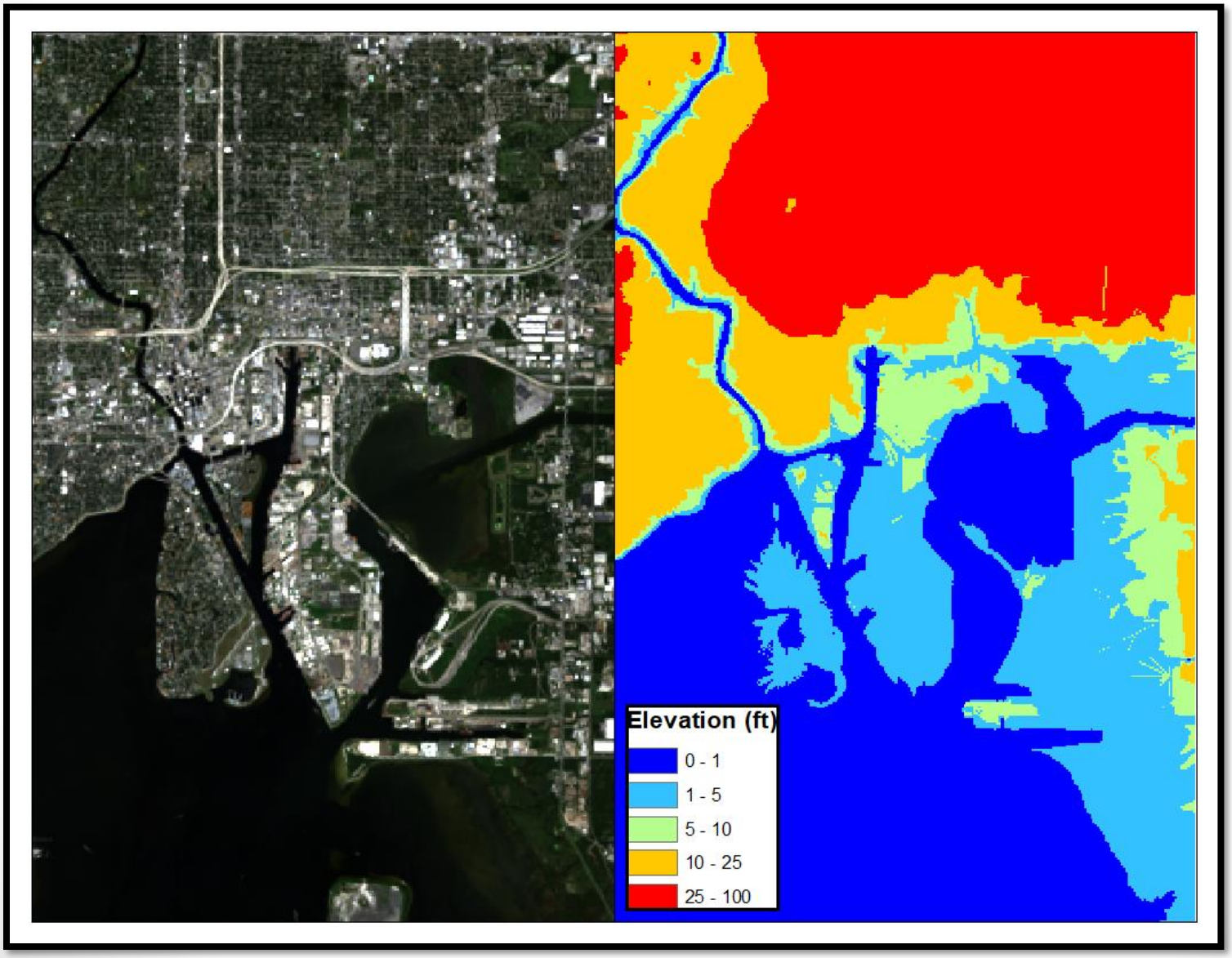
Rookery Bay Mapping

- Change Detection
  - 2010-2016 (2013-2016)
  - 2016-2017
  - 2017-2018
  - Early 2018 – Late 2018(?)

- Hydrology Mapping



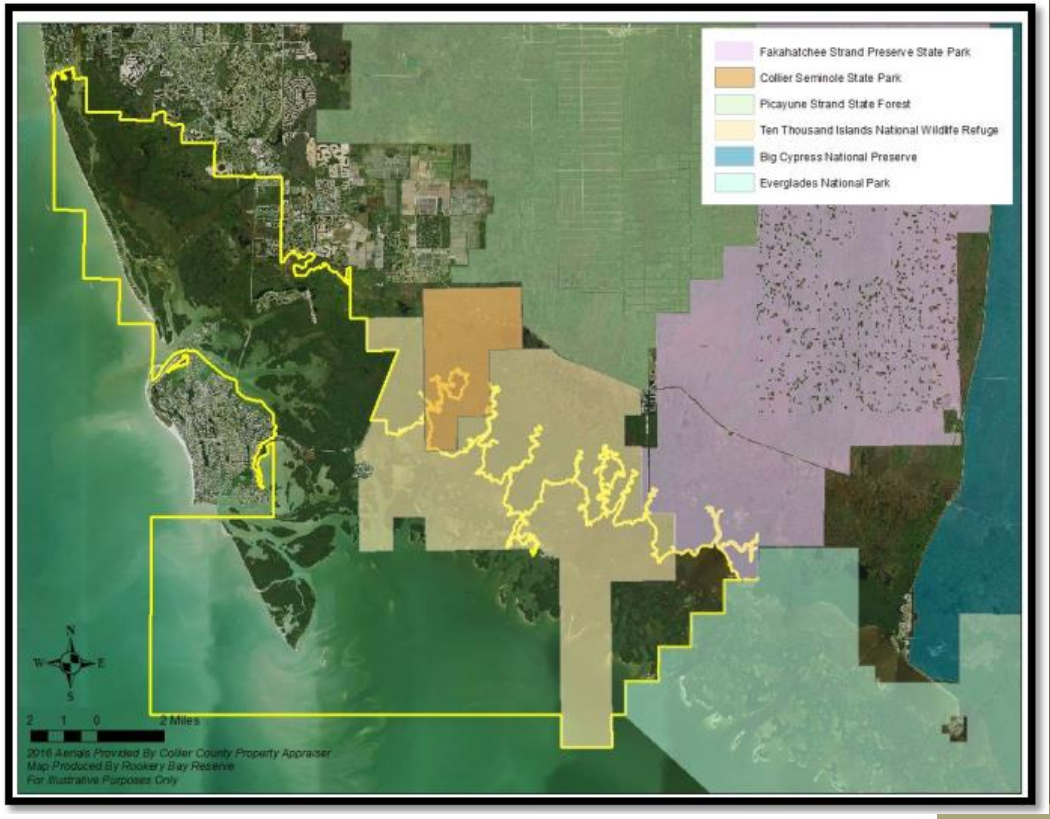
Rookery Bay Mapping



Rookery Bay Mapping

Rookery Bay Mapping

- End-Users
  - RBNERR
  - Ten Thousand Islands National Wildlife Refuge
  - USGS
  - US Marine Biodiversity Observation Network

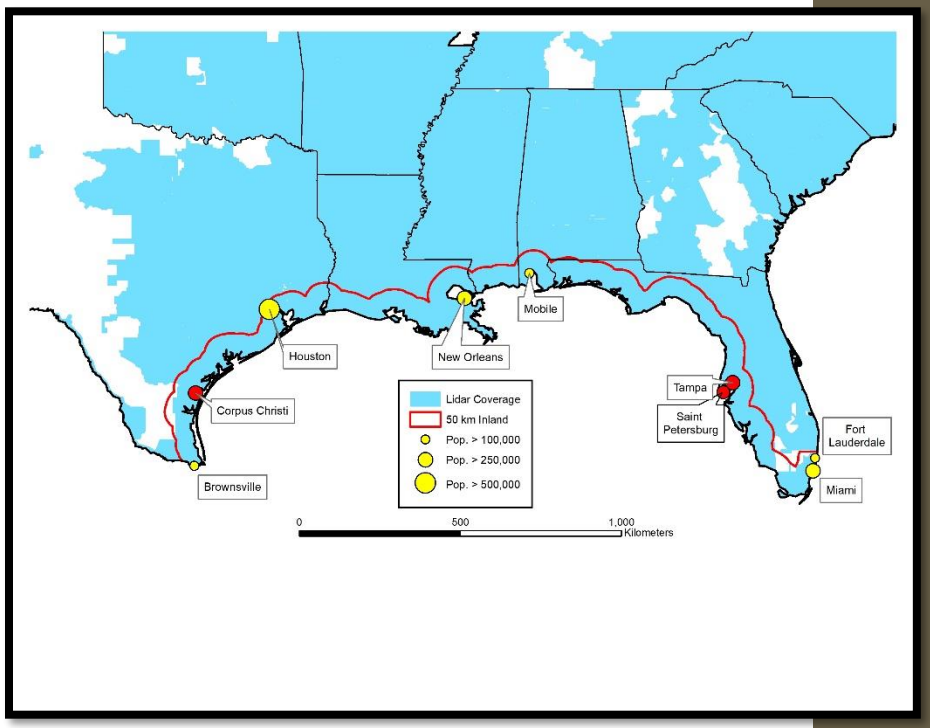


Rookery Bay Mapping

- Benefits & Outputs
  - More efficient mapping protocol
  - Annual habitat maps
    - 2-meter
    - 30-meter
  - Interannual change detection
    - Location and extent of degradation or recovery
  - Hydrologic model of RBNERR
  - New collaborative relationships
  - Open Access to all products
    - Axiom Data Science web portal

Acknowledgements

- NASA Marine Biodiversity Observation Network
- NSF 3D Wetland Spoke
- Microsoft Artificial Intelligence for Earth



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NOAA National Estuarine Research Reserves Science Collaborative

Rookery Bay National Estuarine Research Reserve