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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- 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







How to Improve Classifications?

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





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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



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



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

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







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



- 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

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- NASA Marine Biodiversity Observation Network
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- Microsoft Artificial Intelligence for Earth







