Nearshore Hardbottom Monitoring:
Alternative Methods to Effectively Assess Potential Impacts & Reduce Monitoring Costs Associated with Beach Restoration Projects in Florida

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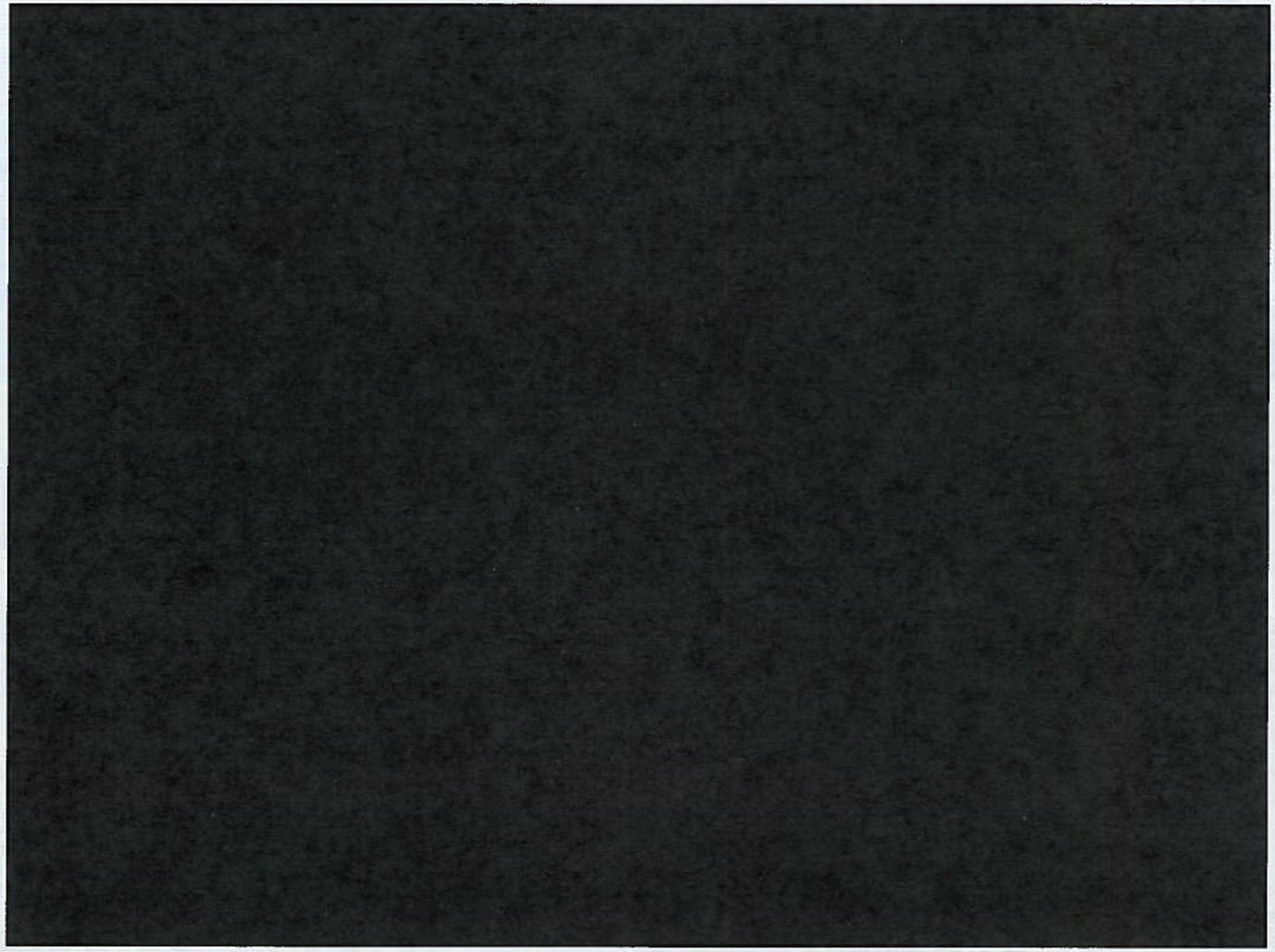
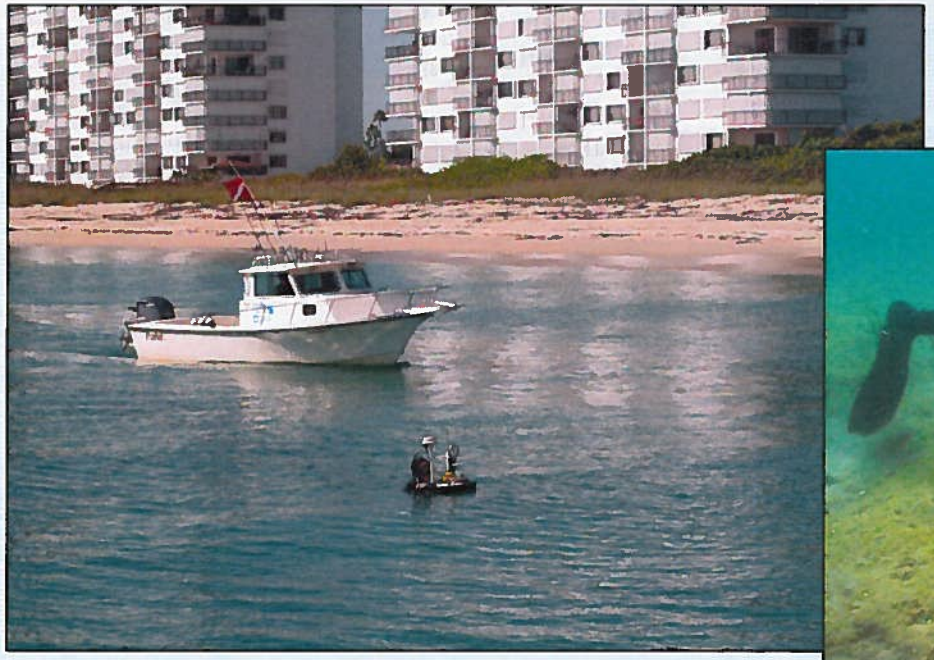
From Quadrats to Quickbird...

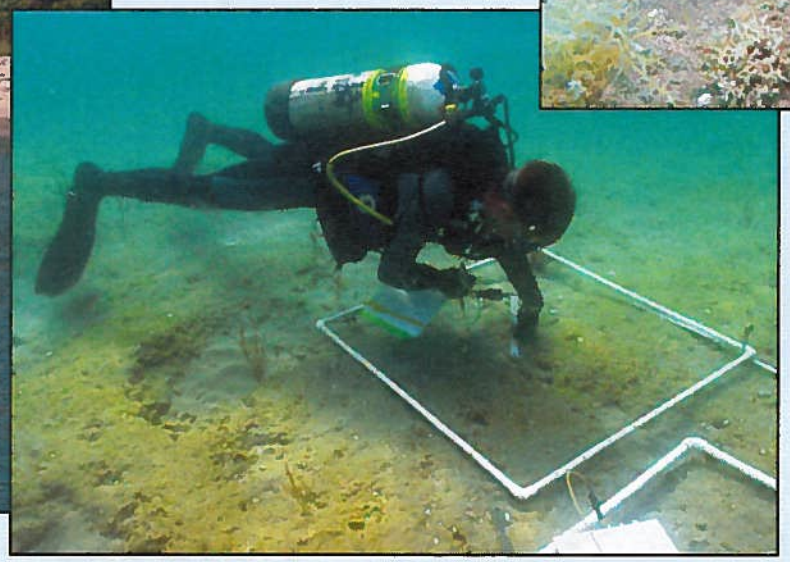


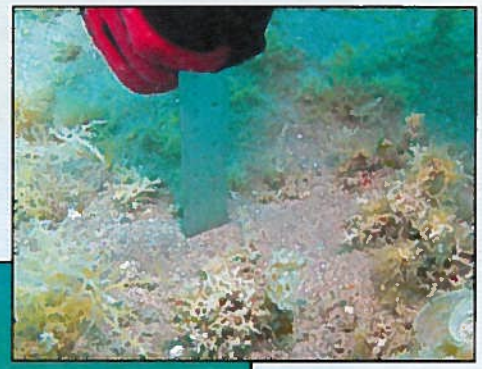
Florida's Nearshore Hardbottom

Biological Monitoring of Hardbottom for Beach Restoration Projects

1. Nearshore hardbottom edge mapping.
2. Assessment of marine plants and animals via quadrats and/or video.
3. Sediment depth.







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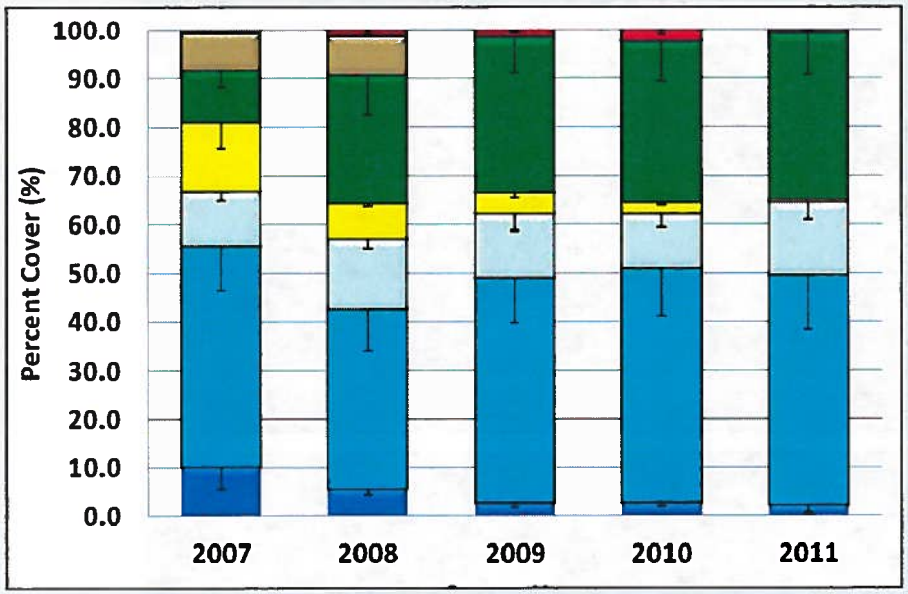
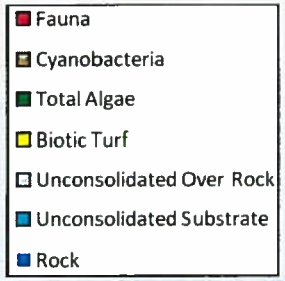
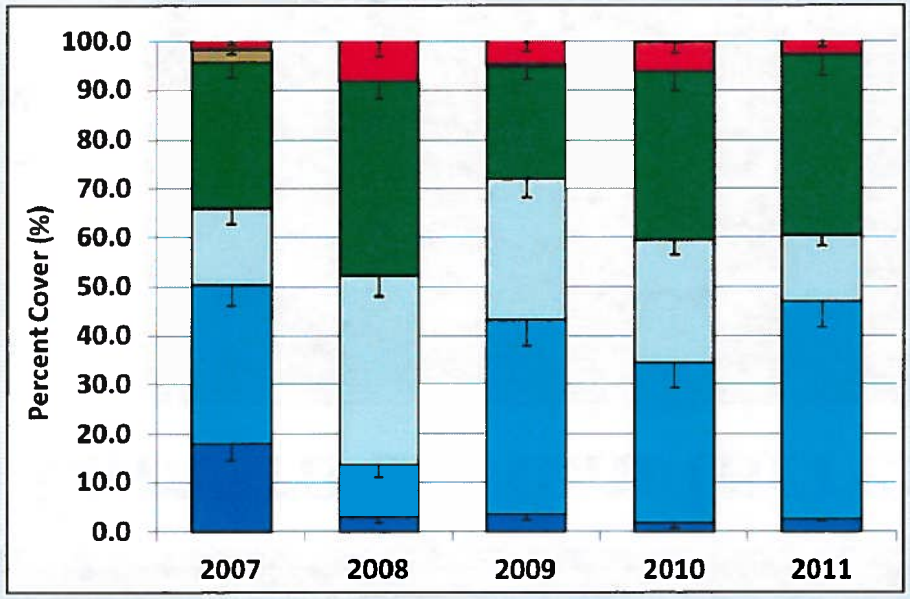
Video AND Quadrats?

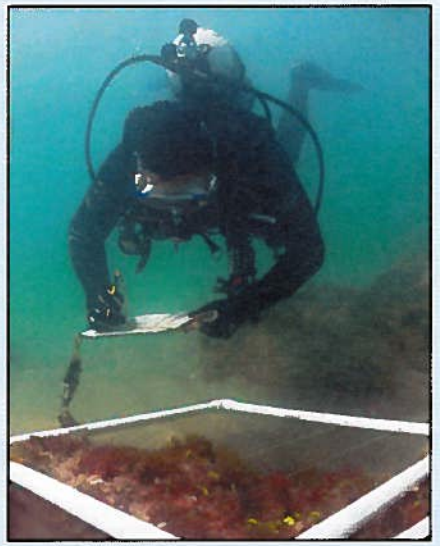
Video





Quads





Dual Camera System Increases Efficiency

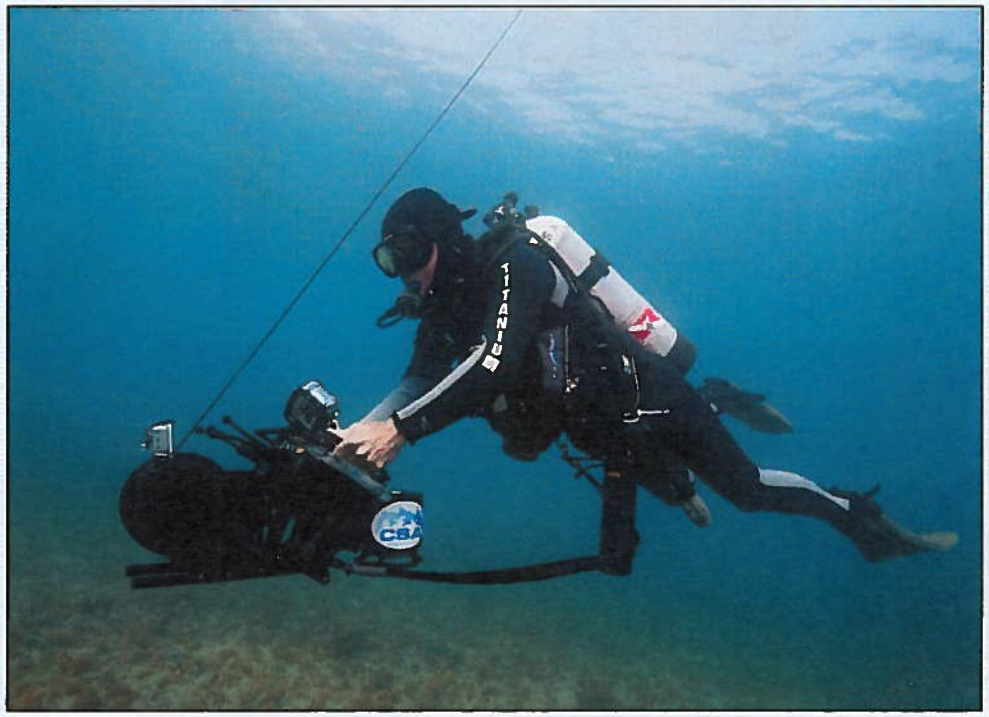
Qualitative = Oblique View

Quantitative = Planar View

Cost Saving Tools/New Technology

1. Shark Marine ™ Navigator

- Autonomous underwater mapping system.
- Simultaneous collection of multiple data.
- High resolution.
- Small survey area.
- **Cost savings up to 20%.**



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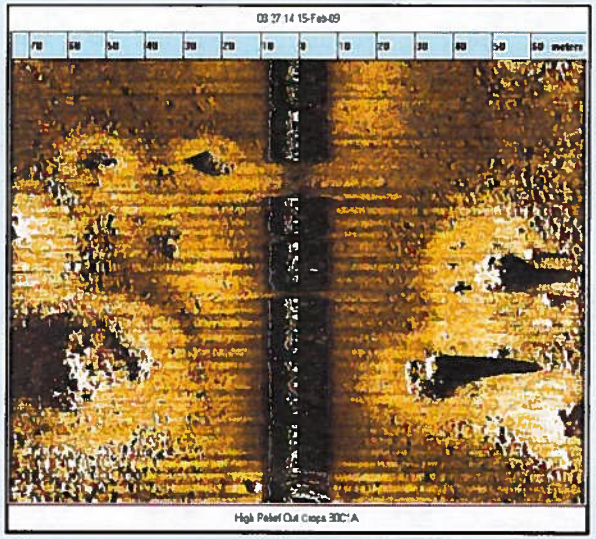
Cost Saving Tools/New Technology

2. Unmanned Surface Vessel (USV)

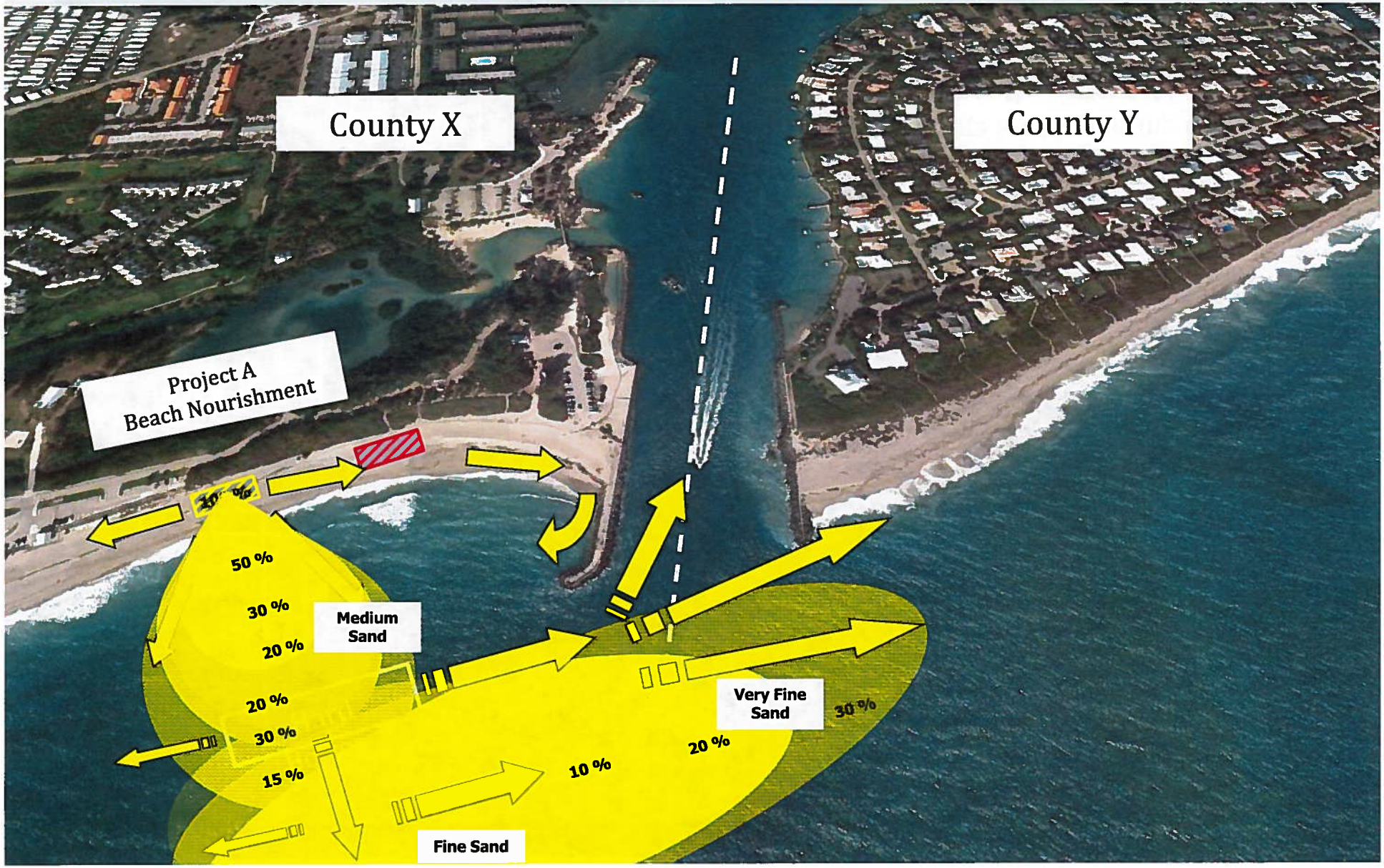
- Very shallow or hazardous conditions.
- Interactive or autonomous operation.
- Survey equipment:
  - DGPS/RTK
  - Side Scan
  - Sub-bottom
  - Bathymetry
- Large survey area.
- **Cost savings ~50%.**

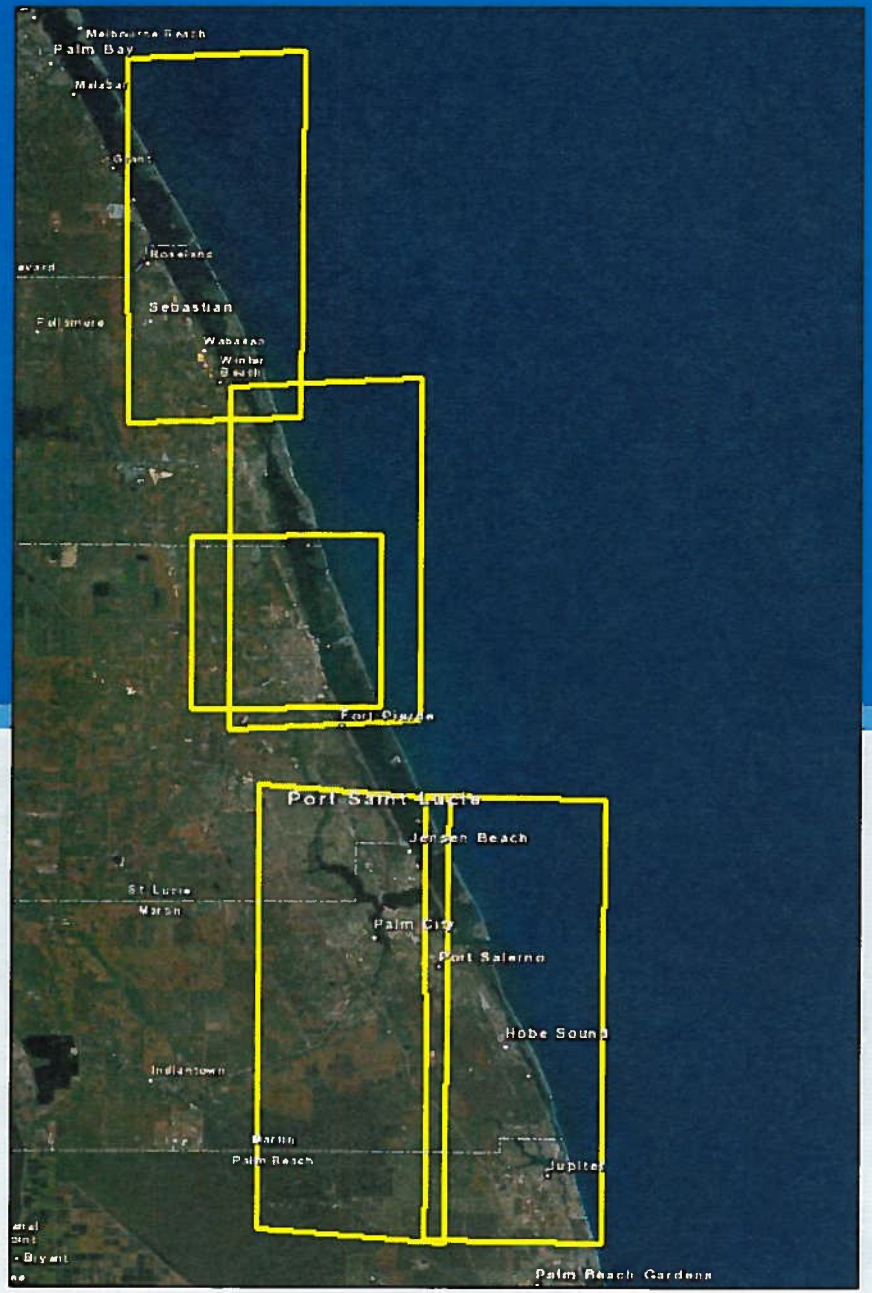


Cost Saving Tools/New Technology

3. Sediment Tracers

ETS Worldwide Ltd





2011-2012 representative WV-2 satellite imagery coverage areas meeting criteria acceptable for benthic interpretation

Indian River County to Martin County

Satellite Imagery Platforms

(Suitable for Benthic Habitat Classification)

- WordView-1
- WorldView-2
- QuickBird
- Pleiades
- IKONOS

- Typical Resolution
  - 2-m multispectral
  - 50-cm panchromatic

- 3- to 8-band Imagery Availability
  - Color (RGB)
  - Near-infrared
  - Coastal band

	Select	Select Plus	Assured	Single Shot*
Priority	Normal	High	Guaranteed—dedicated capacity	Guaranteed—specified orbit
Collection Window	Flexible: Customer selected (up to 365 days) or DigitalGlobe suggested	Flexible: Customer selected (up to 365 days) or DigitalGlobe suggested	DigitalGlobe suggested only (must have high feasibility)	Customer selected from 1 – 14 days
Available Satellites	QuickBird WorldView-1 WorldView-2	QuickBird WorldView-1 WorldView-2	QuickBird WorldView-2	QuickBird
Product Exclusions	None	None	Basic Stereo Pair	Basic Stereo Pair, Ortho Imagery
Feasibility Information Provided	• Low/high probability • Suggested high probability window	• Low/high probability • Suggested high probability window	High probability collection window	Order accepted if specific time is available
Maximum Cloud Cover	15%	15%	15%	100% (see cancellation policy)
Options if AOI is not collected in full within Collection Window	• Purchase/take delivery of partial collect • Cancel entire order with no cancellation fee (regardless of amount collected) • Extend order	• Purchase/take delivery of partial collect • Cancel entire order with no cancellation fee (regardless of amount collected) • Extend order	• Receive free ImageLibrary data for equivalent area (will be billed only for area collected) • Extend order	• No charge if AOI is not collected
Cancellation	May cancel any time prior to collect; must pay for any successful collections	May cancel any time prior to collect; must pay for any successful collections	May not cancel after order confirmation; must pay for any successful attempts	May cancel up to 24 hours before access time, 100% cancellation penalty within 24 hours
Cost	$	$$	$$$	$$$$

Information courtesy of Digital Globe

Satellite Imagery Specifications

(Suitable for Benthic Habitat Classification)

- Imagery delivered within 48 to 72 hr
- Collected regularly based on satellite orbit pattern
- Can be tasked in advanced and in an emergency scenario
- Typically covers entire project area within a single image capture
- Opportunity to look at regional factors
  - Turbidity plumes
  - Inlets
  - Jetties/Structures
- Limited to clear-water applications where aerial imagery is already accepted
- ~~Good way to perform a historical hardbottom analyses for~~ potential data gap areas
- Show conditions pre- and post-event (bracketing)
- There is a minimum ordering size
  - Usually 100 sq. km for tasking
  - Usually 25 sq. km for archive
- Does not meet tide and sun angle specifications for aerial collection
- Some satellite platforms offer bathymetry derived from imagery
- 20 to 30 m visibility/water surface penetration

Product Options

	Pixel Resolution	Image Bands
Panchromatic	50 cm, 60 cm	Panchromatic
Multispectral (4-band)[A]	2.0 m, 2.4 m	Blue, Green, Red, NIR1
Multispectral (8-band)	2.0 m	Coastal, Blue, Green, Yellow, Red, Red Edge, NIR1, NIR2
Bundle (pan + 4-band)	50 cm, 65 cm	Panchromatic
	2.0 m, 2.62 m	Blue, Green, Red, NIR1
Bundle (pan + 8-band)	50 cm	Panchromatic
	2.0 m	Coastal, Blue, Green, Yellow, Red, Red Edge, NIR1, NIR2
Natural Color	50 cm, 60 cm	Blue, Green, Red
Color Infrared	50 cm, 60 cm	Green, Red, NIR1
4-band Pan Sharpened	50 cm, 60 cm	Blue, Green, Red, NIR1

Spectral Characteristics

	QuickBird	WorldView-1	WorldView-2
Panchromatic (B&W)	405 - 1053 nm	397 - 905 nm	447 - 808 nm
Multispectral:			
Coastal Blue			396 - 458 nm
Blue	430 - 545 nm		442 - 515 nm
Green	466 - 620 nm		506 - 586 nm
Yellow			584 - 632 nm
Red	590 - 710 nm		624 - 694 nm
Red Edge			699 - 749 nm
Near-IR 1	715 - 918 nm		765 - 901 nm
Near-IR 2			856 - 1043 nm

Image Accuracy Specification[B]

	QuickBird	WorldView-1	WorldView-2
CE90	23 m	5.0 m	5.0 m

[A] - All four bands delivered in a single file
[B] - At nadir, exclusive of terrain distortions

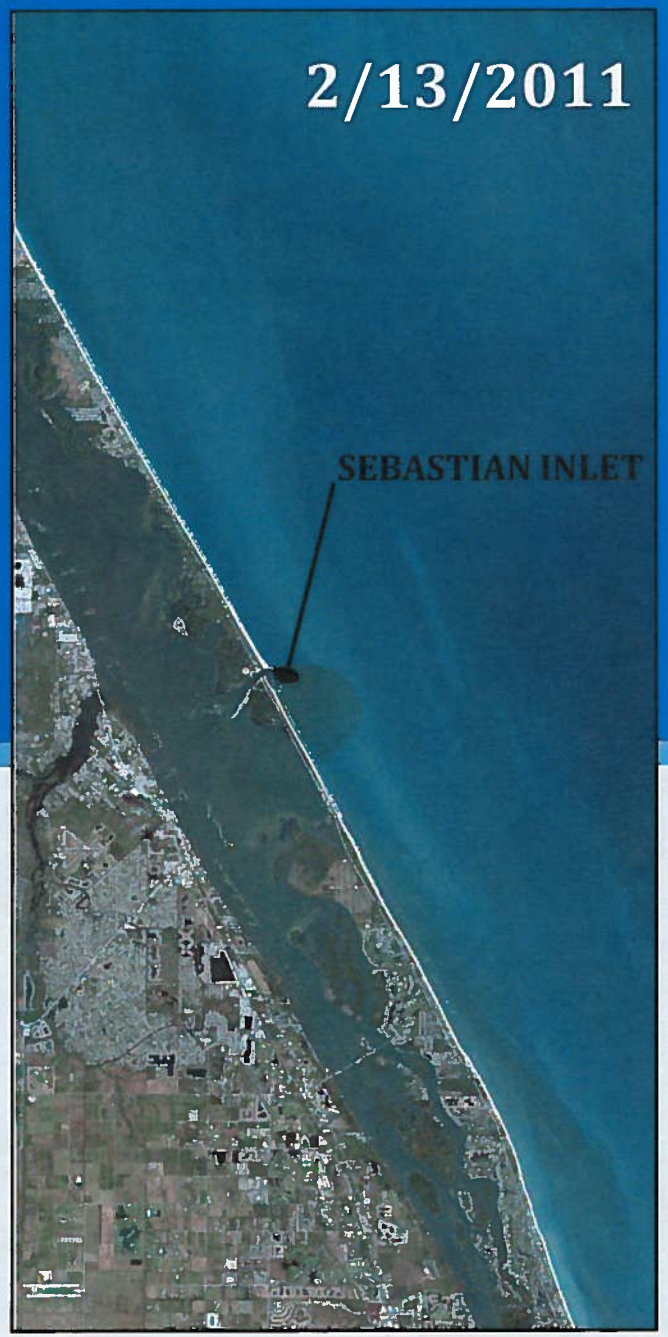
Processing

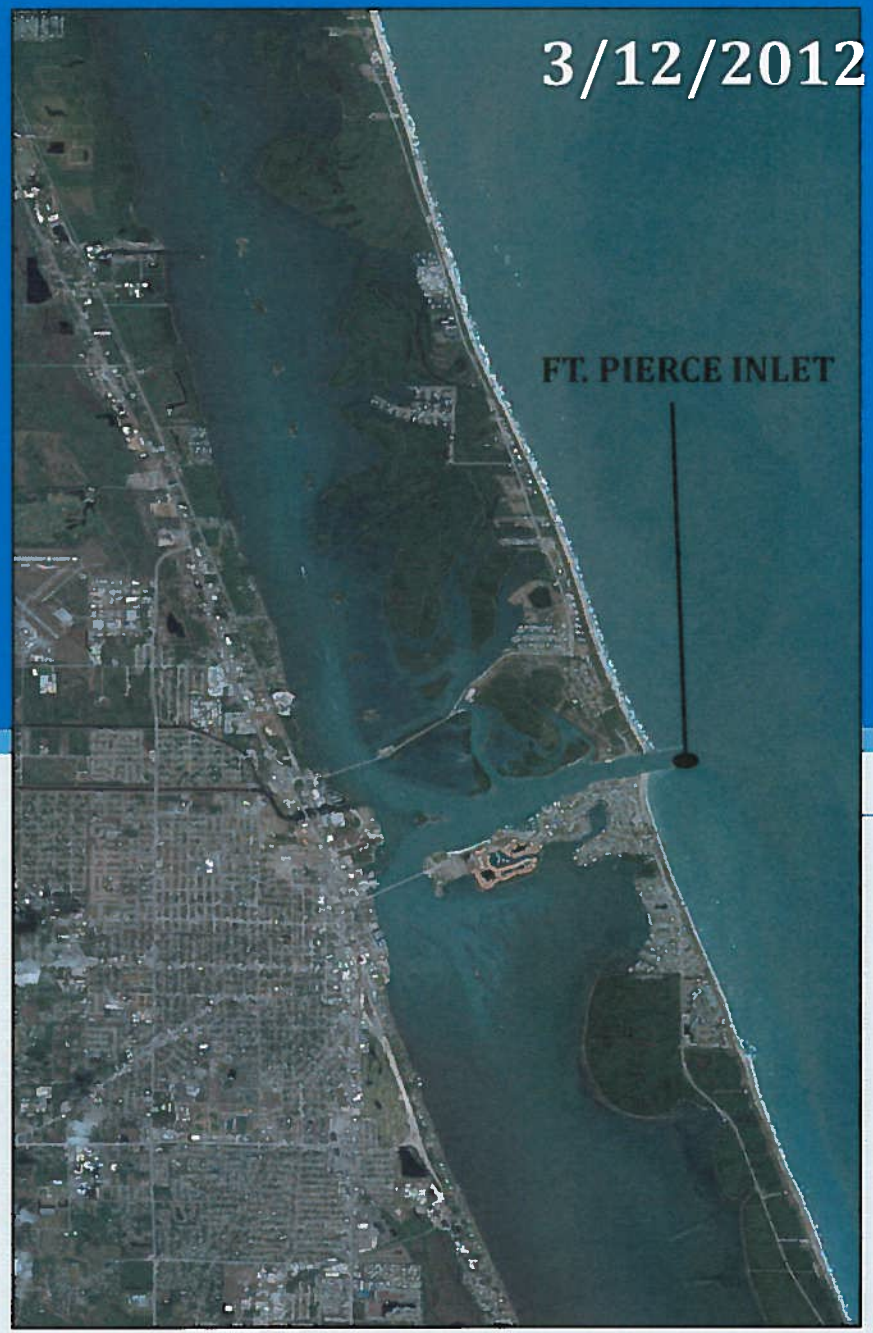
Applied Corrections	• Radiometric, sensor, and geometric corrections • Mapped to a cartographic projection

Order Parameters

Product Type	Panchromatic, Multispectral, or Bundle; Natural Color; Color Infrared; 4-band Pan Sharpened
Image Bits/Pixel	8 or 16-bits
File Formats	GeoTIFF 1.0, NITF 2.1 or NITF 2.0

Information courtesy of Digital Globe


2/13/2011
SEBASTIAN INLET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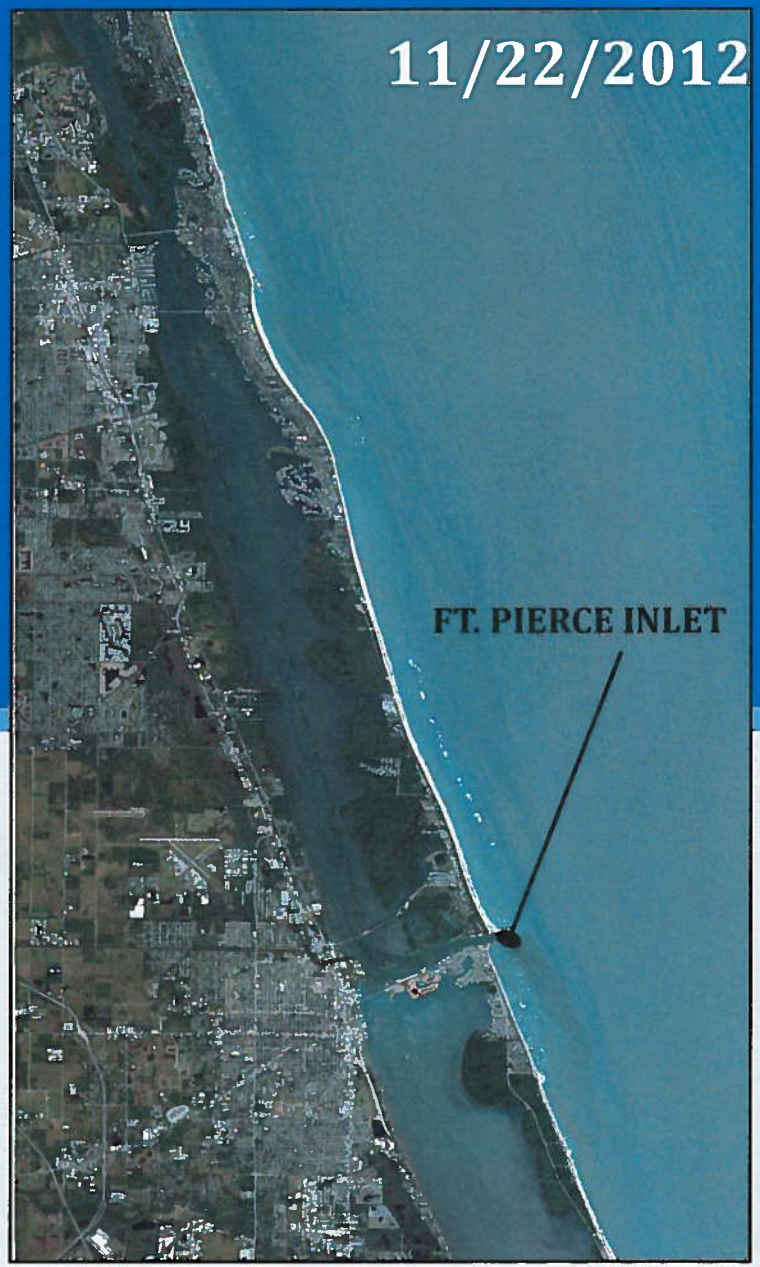
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11/22/2012
ST. LUCIE INLET

Acknowledgements