Joint Airborne Lidar Bathymetry Technical Center of Expertise

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Program Manager, National Coastal Mapping Program

JALBTCX 15th Annual Airborne Coastal Mapping and Charting Workshop
10 June 2014

Joint Airborne Lidar Bathymetry Technical Center of Expertise

Annual Technical Workshop, 9-12 June 2015

OPERATIONS

- Aircraft
- Surveys
- Procedures
- People
- Hardware
- Software

RESEARCH AND DEVELOPMENT

- Data exploitation
- Algorithms

Optech

US Army Corps of Engineers MOBILE DISTRICT

CCOM JHC

NORTHROP GRUMMAN

US Army Corps of Engineers® Engineer Research and Development Center

NAVAL METEOROLOGY AND OCEANOGRAPHY COMMAND

COASTAL PLANNING & ENGINEERING CPE

Kenn Borek Air Ltd. Anytime, Anywhere ... Worldwide

ONR Office of Naval Research

AIRBORNE IMAGING

itres

NOAA

USGS science for a changing world

Dynamic Aviation

NAVAL RESEARCH LABORATORY WASHINGTON, D.C.

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

MAGNOLIA river

UNIVERSITY OF NOTRE DAME

Bowhead

AHAB Airborne Hydrography AB

UGRO

WOOLPERT DESIGN | GEOSPATIAL | INFRASTRUCTURE

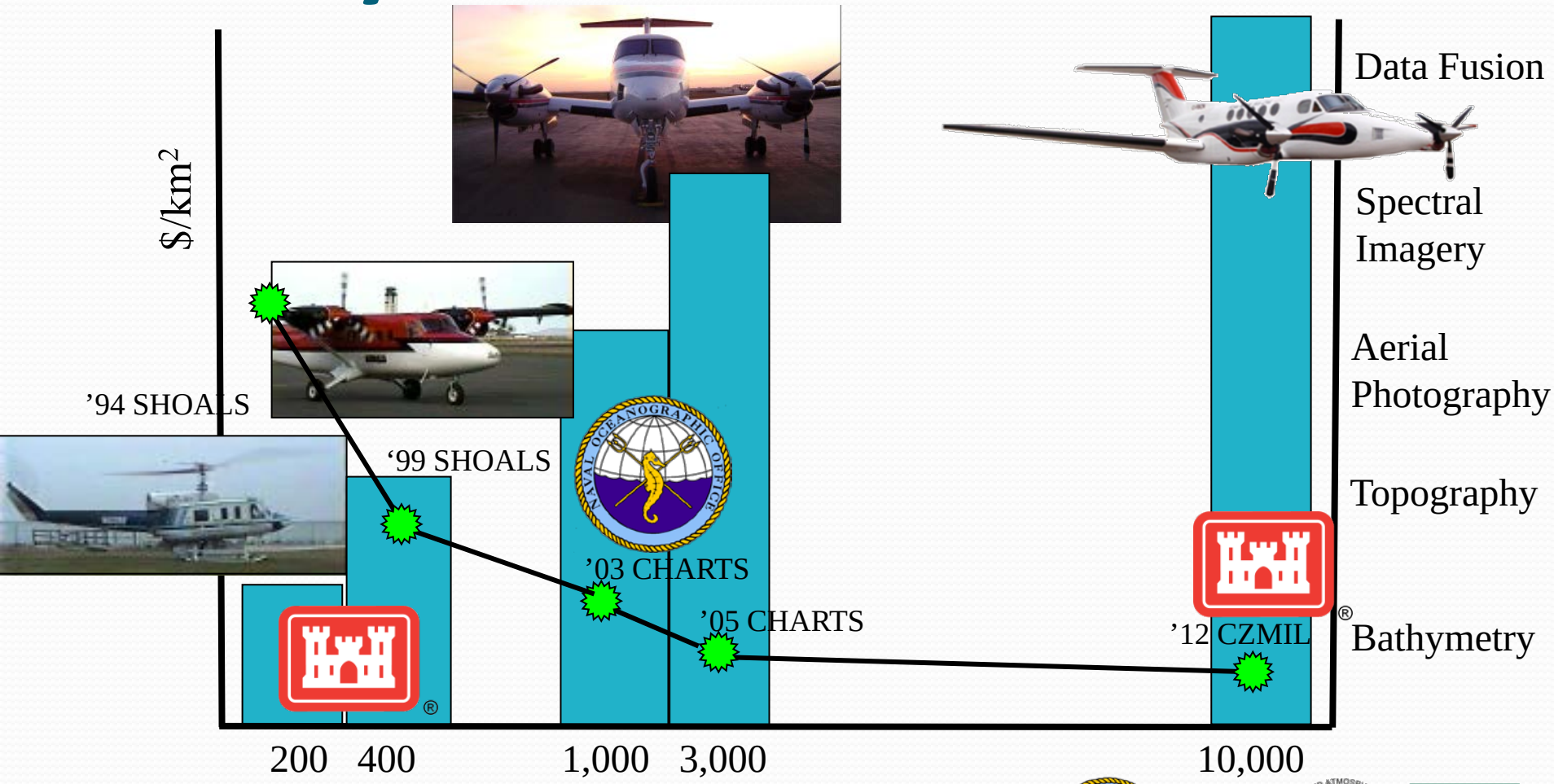
U. S. Naval Research Laboratory Stennis Space Center, MS

Pelydryn

TEXAS A&M UNIVERSITY

UNIVERSITY of NEW HAMPSHIRE

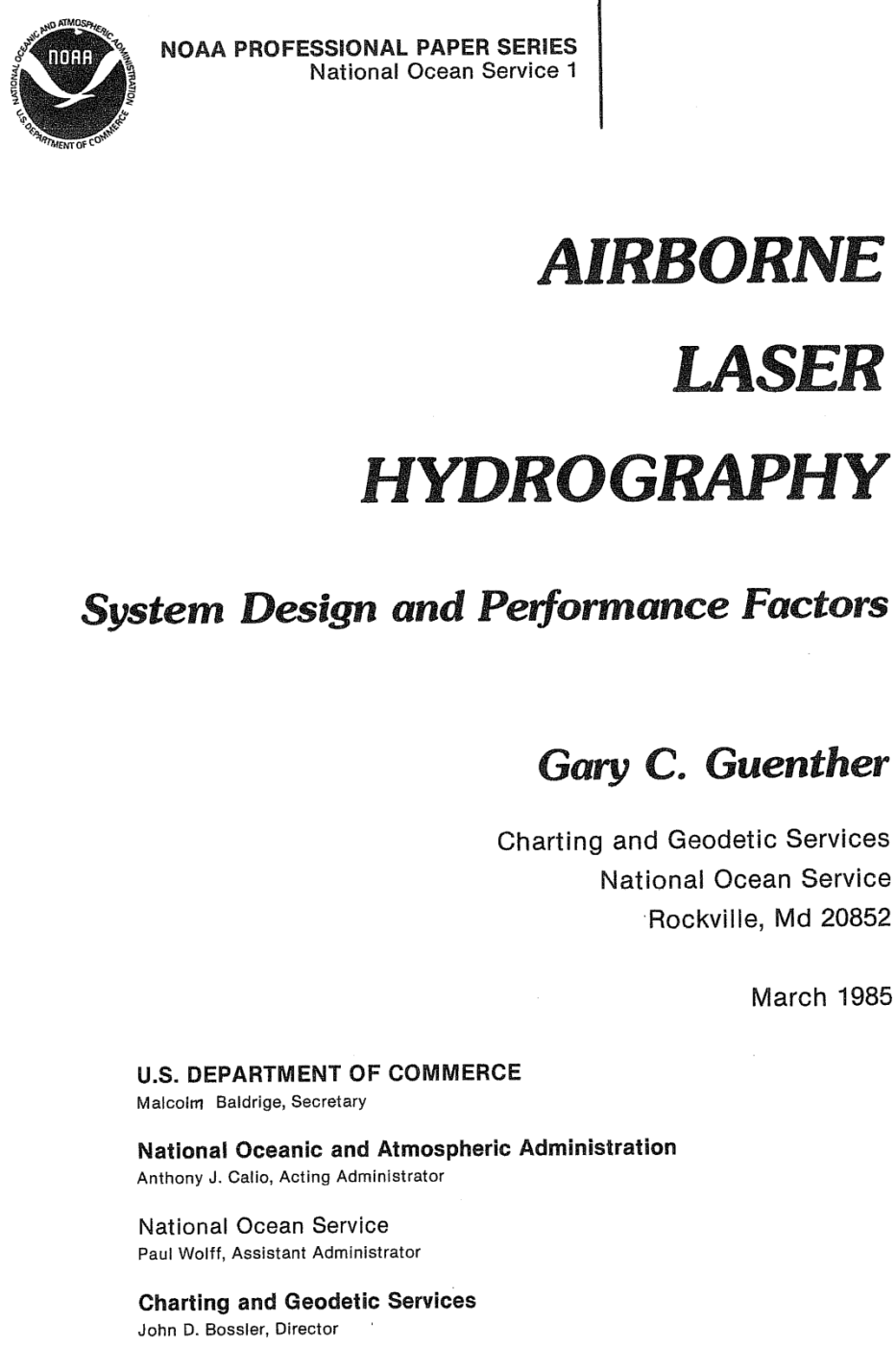
History



Joint Airborne Lidar Bathymetry Technical Center of Expertise

Blue Book II

- Update of the original
- Fall 2013 products
  - Searchable BB I
  - ALB bibliography
  - Table of systems
- Publishing expected September 2014
- Looking for reviewers



NOAA PROFESSIONAL PAPER SERIES
National Ocean Service 1

AIRBORNE
LASER
HYDROGRAPHY

System Design and Performance Factors

Gary C. Guenther

Charting and Geodetic Services
National Ocean Service
Rockville, Md 20852

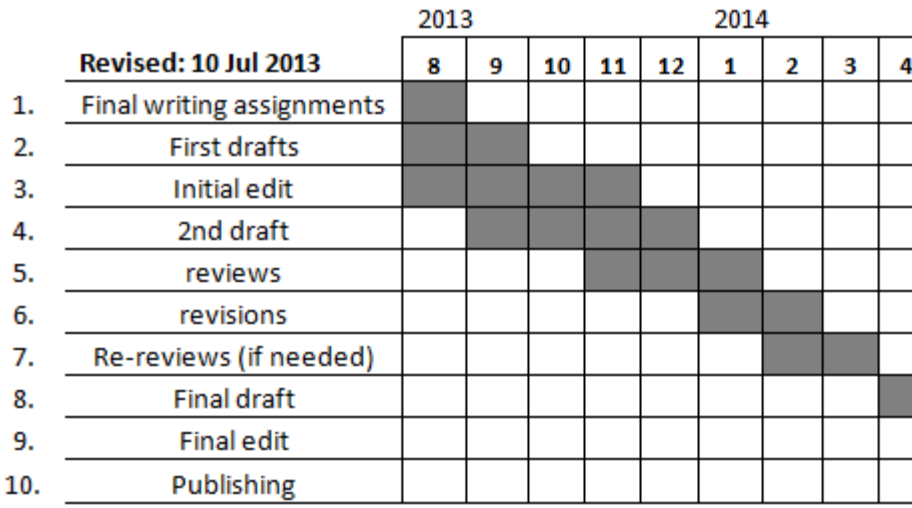
March 1985

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and Atmospheric Administration
Anthony J. Calio, Acting Administrator

National Ocean Service
Paul Wolff, Assistant Administrator

Charting and Geodetic Services
John D. Bossler, Director



		2013					2014			
	Revised: 10 Jul 2013	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1.	Final writing assignments									
2.	First drafts									
3.	Initial edit									
4.	2nd draft									
5.	reviews									
6.	revisions									
7.	Re-reviews (if needed)									
8.	Final draft									
9.	Final edit									
10.	Publishing									

National Coastal Mapping Strategy

1) Establish an Annual Coastal Mapping Coordination Summit and web-based reporting of mapping plans

2) Build on the JALBTCX topographic-bathymetric specifications matrix and 3DEP specifications to consolidate and align to a set of recommended specifications with cost increments

- Part 1: Define multiple-quality-levels for topo-bathy lidar
- Part 2: Recommend hydrographic lidar specification
- Part 3: Identify additional mapping techniques require a specification (e.g., multi- and hyperspectral imagery)

3) Coordinate data validation, stewardship, dissemination and archive for efficiency gains

4) Coordinate research and development on new tools and technologies that facilitate interagency coordination on and use of coastal mapping data

- R&D themes (examples)
  - New sensor technology
  - Algorithms
  - Applications

Gulf of Mexico Master Mapping Plan

The Gulf of Mexico Master Mapping Plan (GMMMP) is a comprehensive plan to collaboratively acquire data on the physical characteristics of the Gulf region, particularly elevation, shoreline, and surface data. The Gulf is too large for any one agency to map, thus a collaborative approach is required; one that identifies and fulfills all mapping requirements with ongoing mapping programs. Therefore, by aligning data collection methods and sharing resources, critical mapping information can be collected at a lower cost to the program partners.

Action Steps:

1. Identify mapping needs and requirements to allow for informed coastal management decisions and data gap analysis.
2. Conduct an inventory of the capabilities and data assets of existing mapping programs and leverage ongoing efforts of the Interagency Working Group on Ocean and Coastal Mapping.
3. Develop a collaborative strategy to acquire the necessary region-wide physical characteristics data.

Expected Results:

- *A GMMMP is developed using shared resources.*
- *Coastal management decisions across the Gulf are made more effectively by updated elevation, shoreline, and sea floor characterization data.*

DO YOU KNOW OF A MAPPING REQUIREMENT? Click here to submit a program, project or other information for inclusion in the GMMMP or email us at gomamapping@usace.army.mil.

Links:

Gulf of Mexico Alliance Website: http://gulfofmexicoalliance.org/
Ecosystem Integration and Assessment Priority Issue Team Website: http://gulfofmexicoalliance.org/issues/ecosystems.html

Highlight Gulf of Mexico Alliance Web Viewer! Emphasize!!
Gulf of Mexico Alliance Web Viewer: TBD

Requirements and Activities
Elevation and Derived Products
- Topography
- Bathymetry
- Elevation Transects
- Ground Control

Imagery
- Down-looking RGB
- Oblique RGB
- Multispectral and hyperspectral
- Underwater Still Photography and Videography

Administrative, Political
Environment and Conservation
- Land Cover
- Habitat Delineation
- Ecology, Restoration and Ecosystem Services

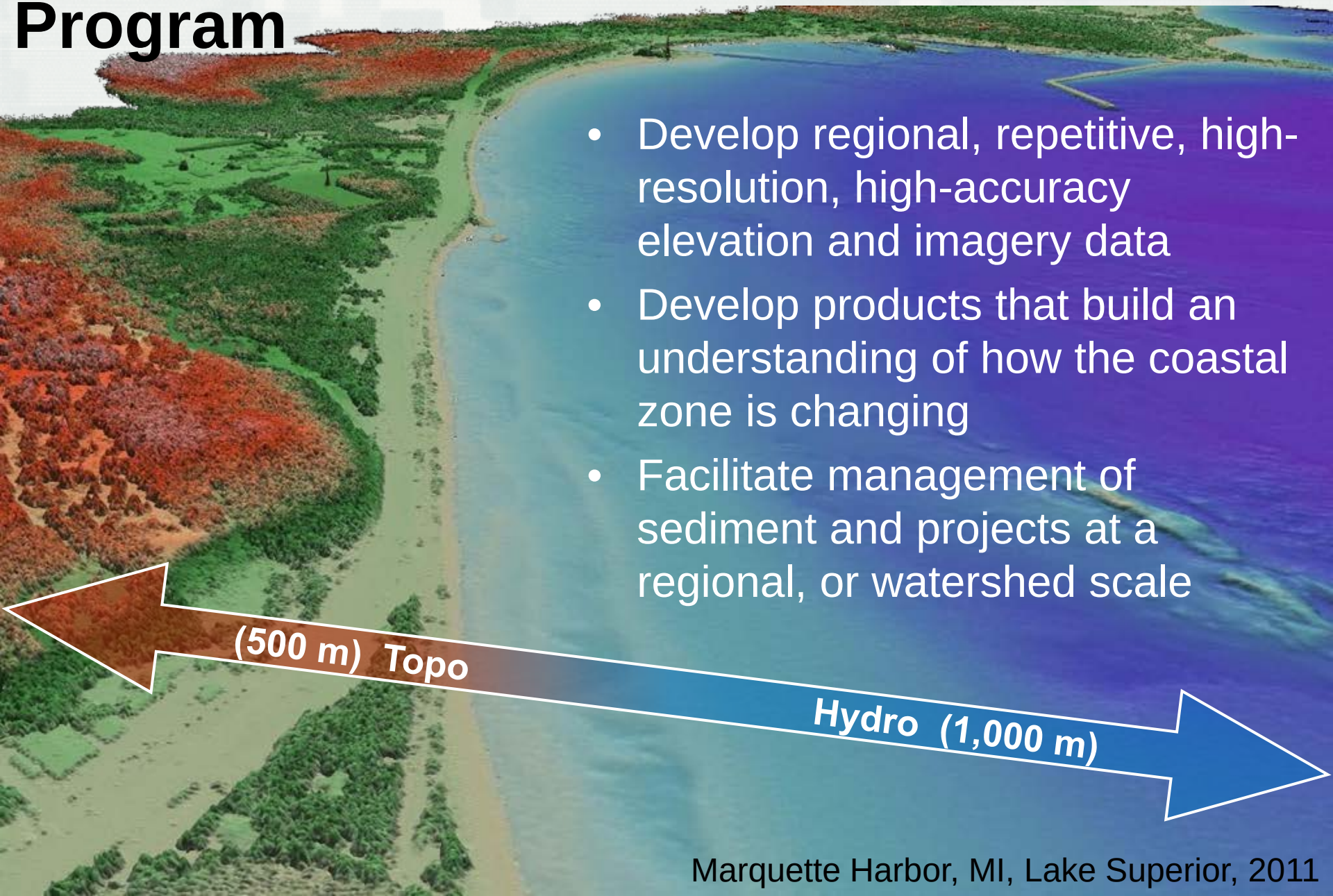
Geological and Geophysical
- Geology
- Oil, Gas and Mineral Resources
- Oil Spill Hazard Response

Oceans and Coasts
- Shoreline
- Marine Boundaries

Climate Change
- Sea Level Rise
- Storm Protection/Resiliency

Click here for a printable report!

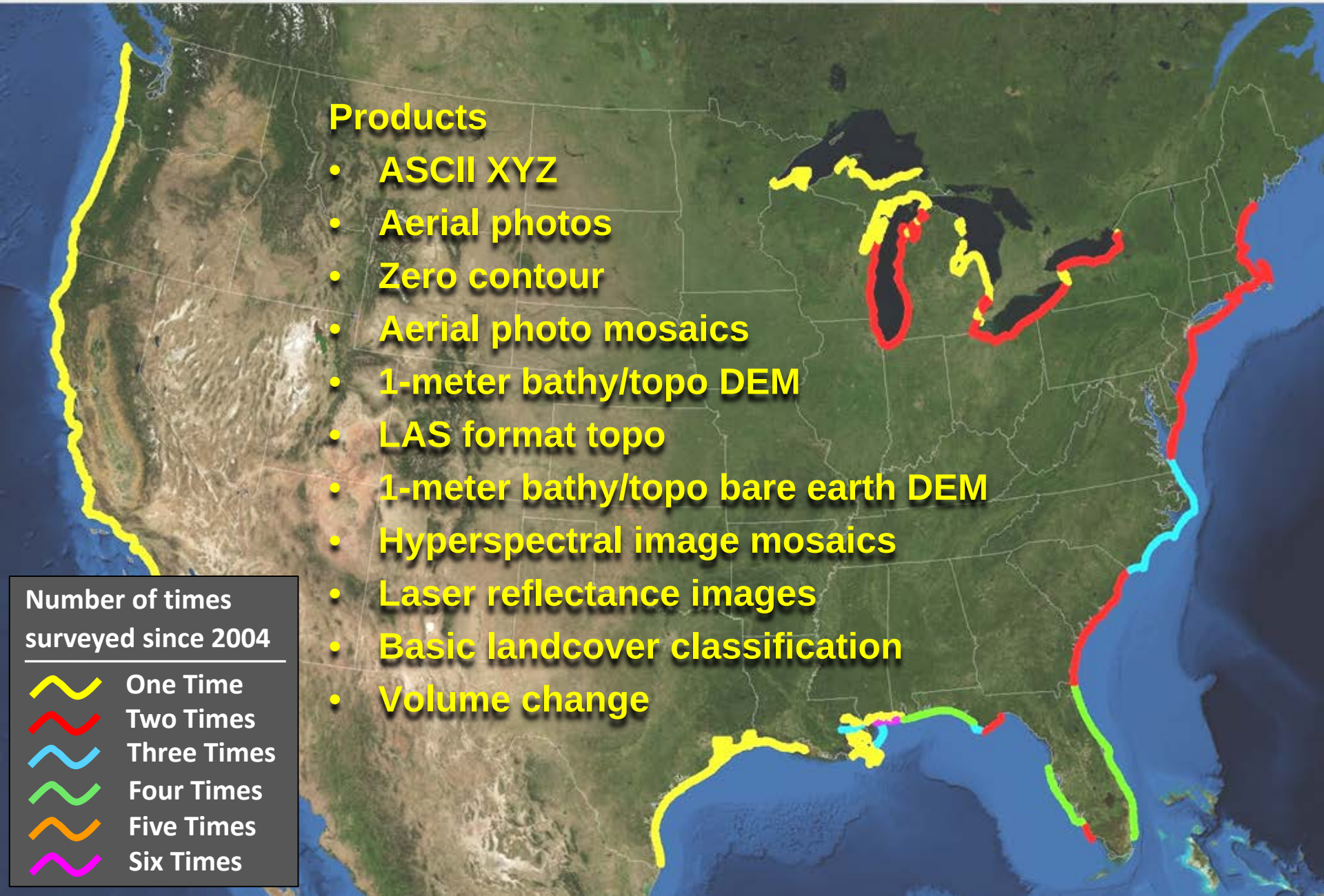
USACE National Coastal Mapping Program



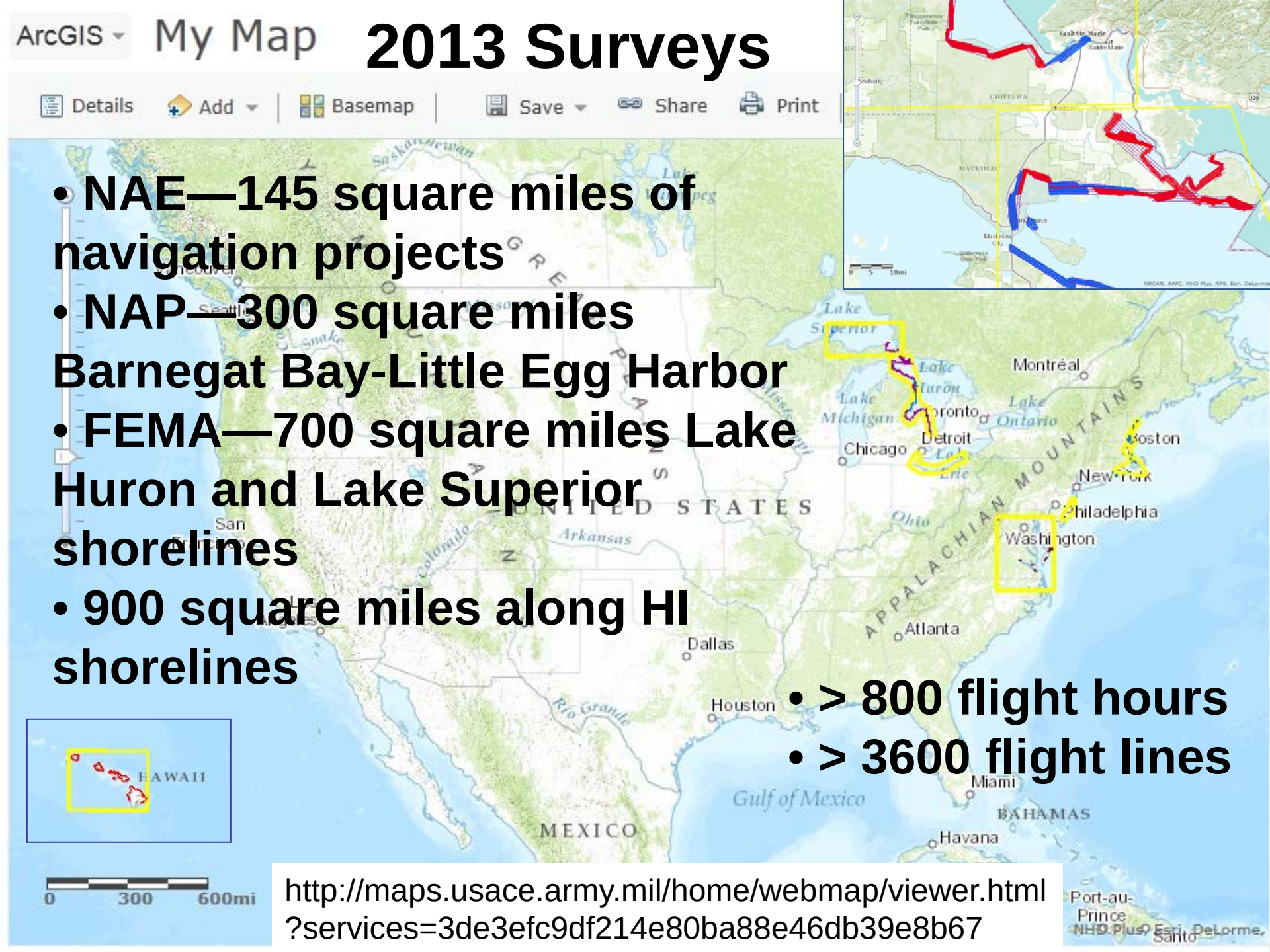
- Develop regional, repetitive, high-resolution, high-accuracy elevation and imagery data
- Develop products that build an understanding of how the coastal zone is changing
- Facilitate management of sediment and projects at a regional, or watershed scale

Marquette Harbor, MI, Lake Superior, 2011

National Coastal Mapping Progress



2013 Surveys

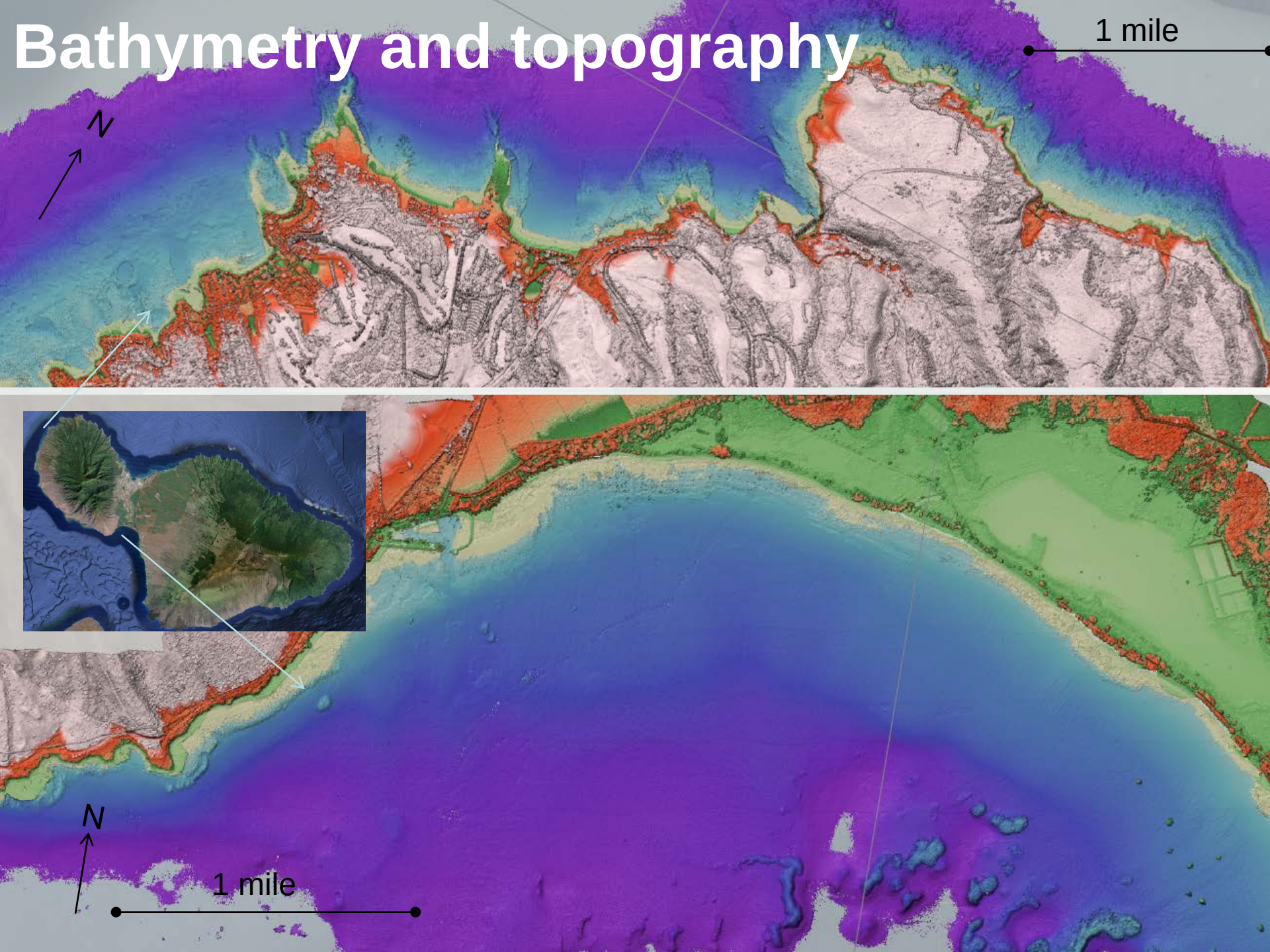


- NAE—145 square miles of navigation projects
- NAP—300 square miles Barnegat Bay-Little Egg Harbor
- FEMA—700 square miles Lake Huron and Lake Superior shorelines
- 900 square miles along HI shorelines

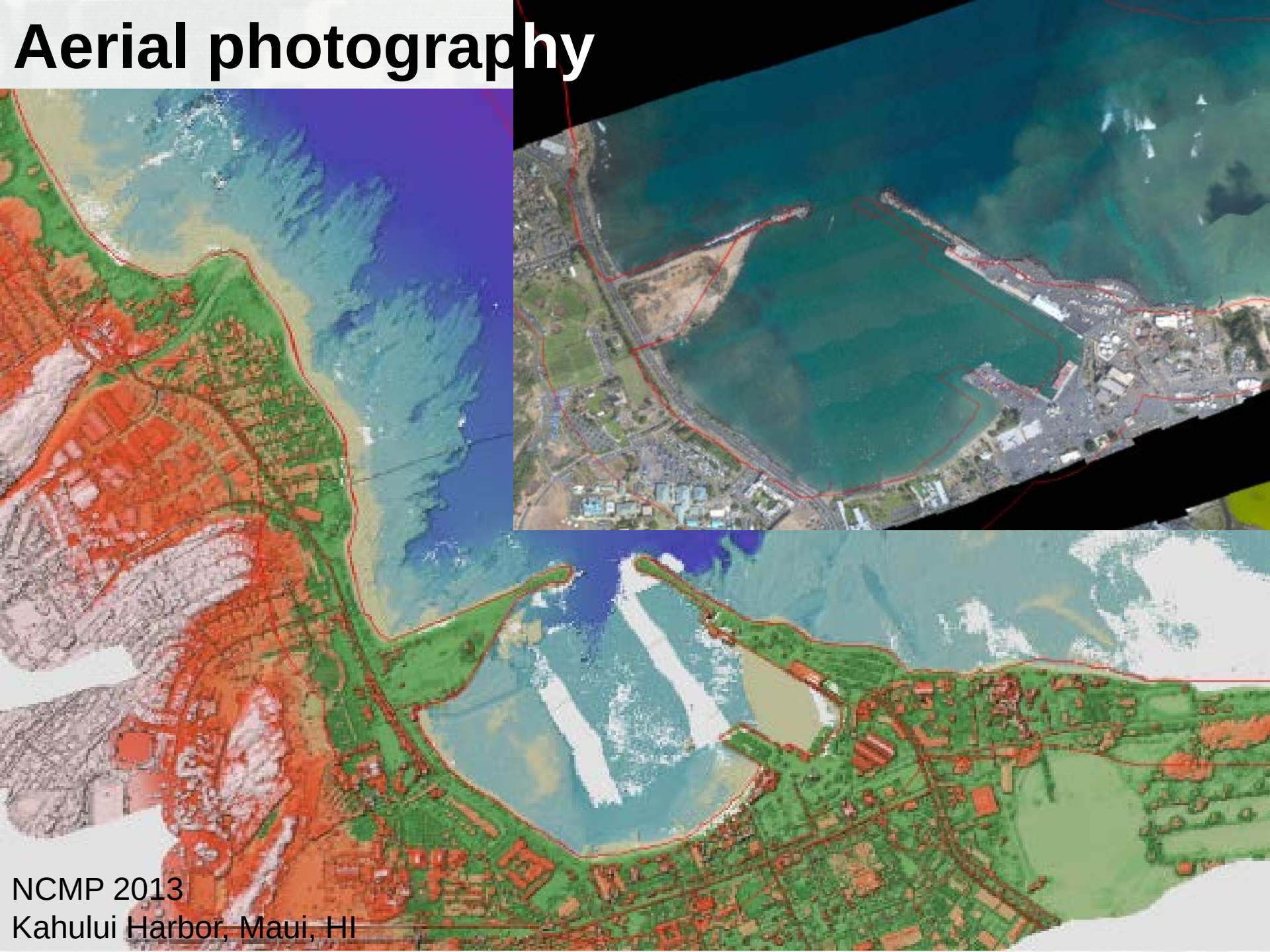
- > 800 flight hours
- > 3600 flight lines

http://maps.usace.army.mil/home/webmap/viewer.html?services=3de3efc9df214e80ba88e46db39e8b67

Bathymetry and topography



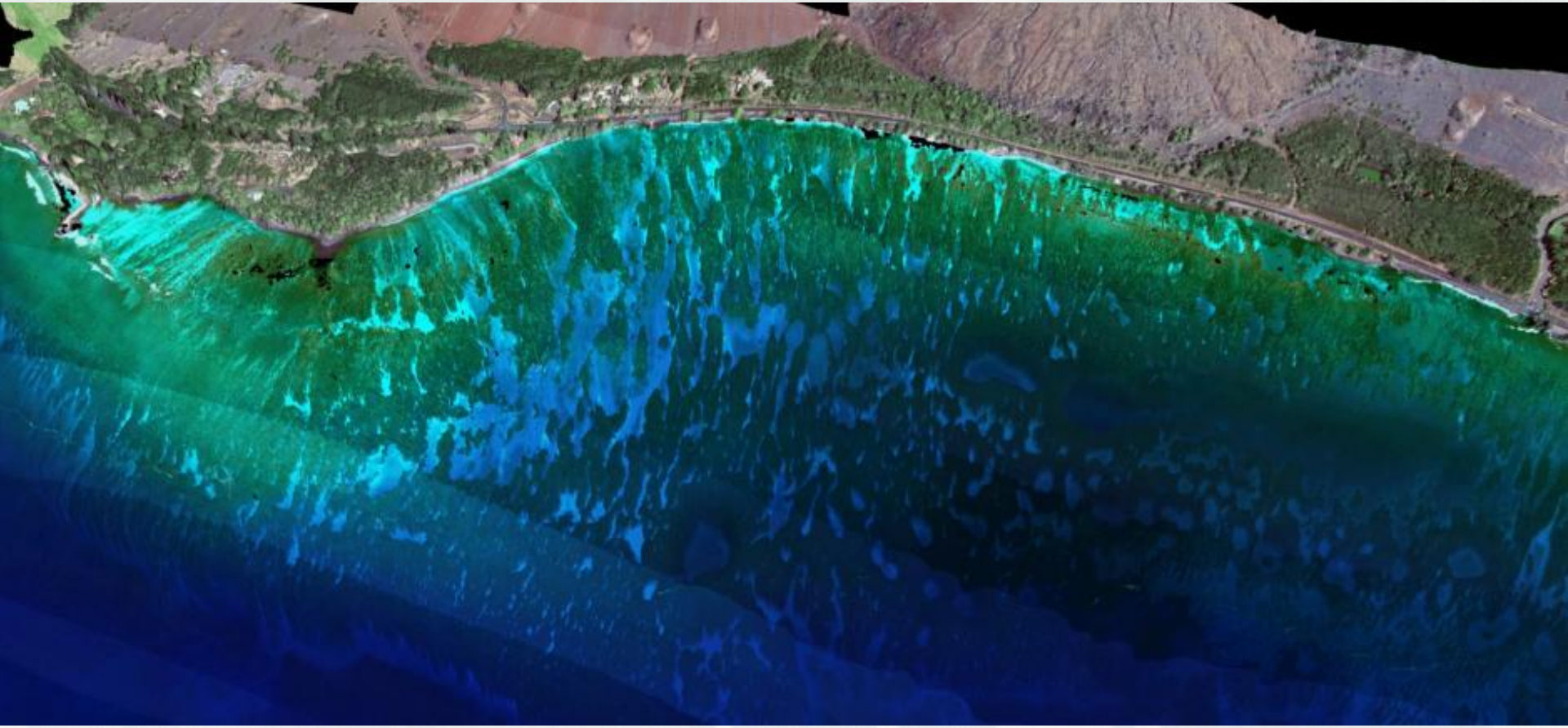
Aerial photography



NCMP 2013
Kahului Harbor, Maui, HI

Hyperspectral imagery

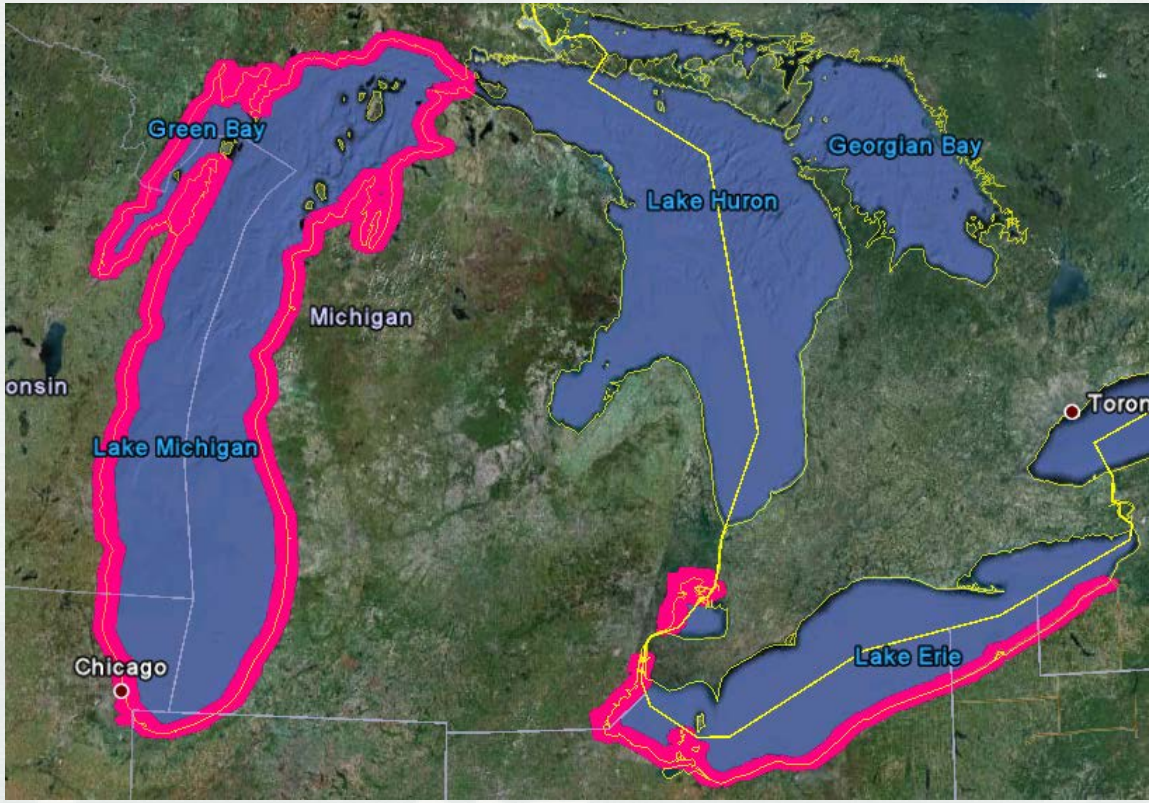
1 m pixel resolution, 36 spectral bands
375-1050 nm



Olowalu, Maui, HI
2013

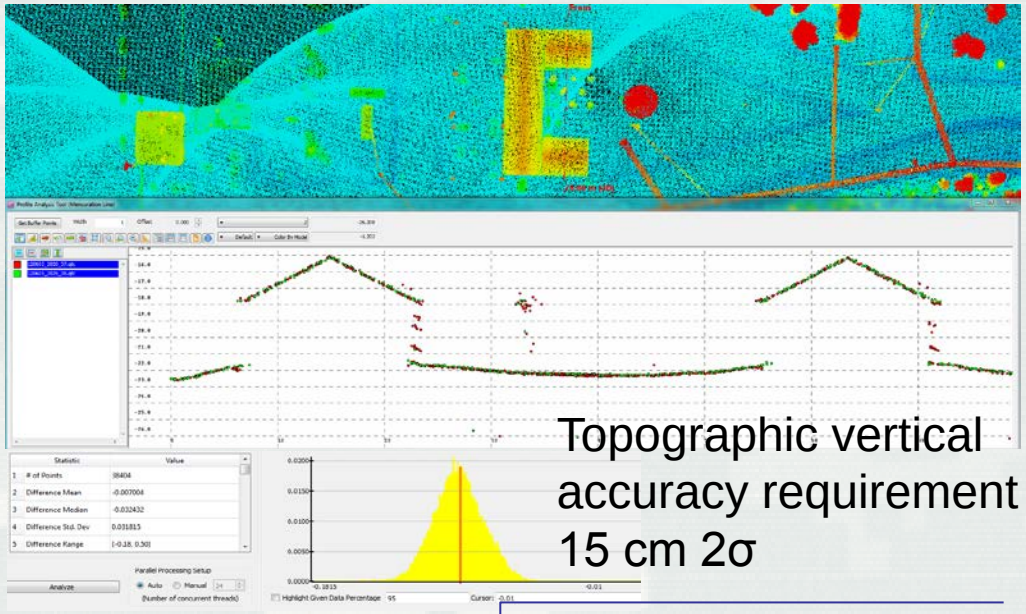
2012 NCMP operations

- Mission Stats
  - Survey Season from 6/12-10/20/2011
  - CZMIL Green Bay and Lake Erie
  - SHOALS Lake Michigan
- Coverage Stats
  - >1400 Miles of Shoreline
  - >600 flight hours
  - >3000 flight lines
  - >65 Billion lidar shots
  - >500,000 aerial photos
  - >5000 hyperspectral images
  - 56 Federal navigation projects

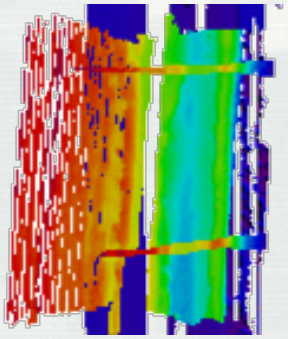


Accuracy assessment

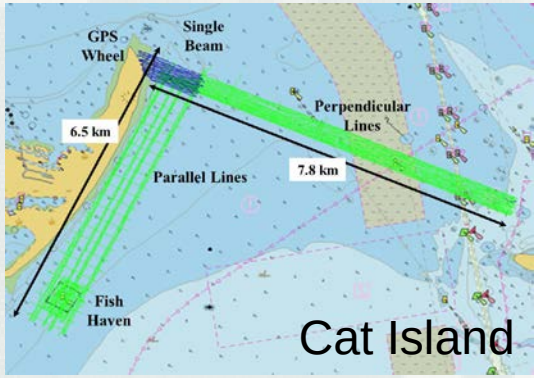
Bathymetric vertical accuracy requirement
$[0.3^2 + (0.013d)^2]^{1/2}$m, 2σ, 0-30m



Topographic vertical accuracy requirement
15 cm 2σ

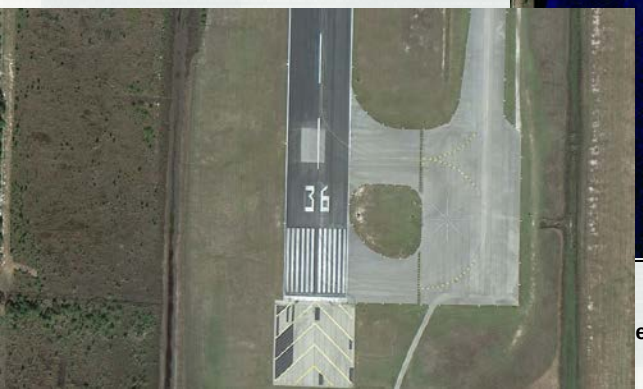


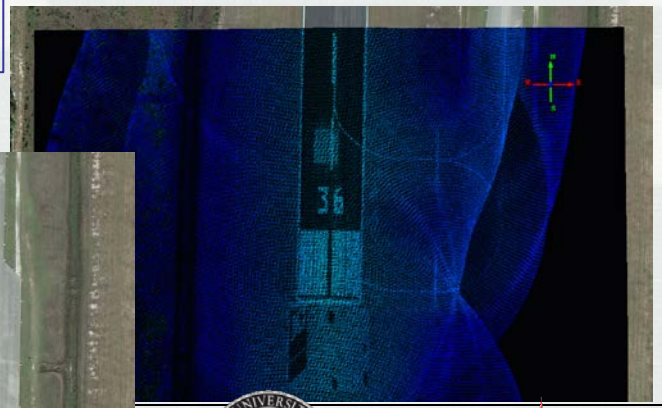
Fort Lauderdale



Cat Island

Horizontal accuracy





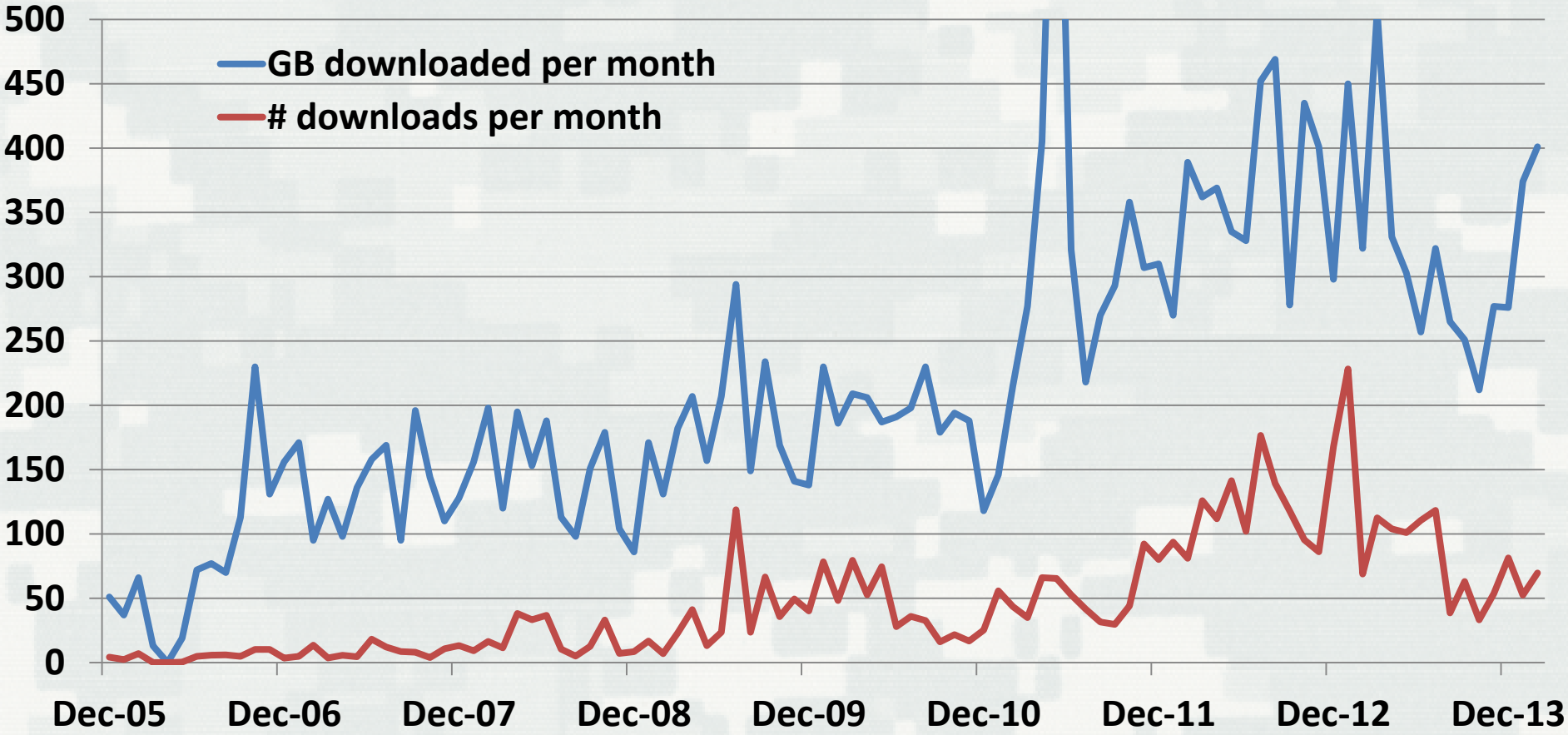
Area	Mean Difference (cm)	1σ St dev (cm)	2σ RMS (cm)	Requirement (cm)
North Area	5.3	15.3	32.6	40
North XChk	5.2	15.0	31.6	40
North-Central XChck	5.9	17.6	37.2	40
Central XChk	4.2	15.4	31.8	40
South-Central XChk	4.4	15.5	31.1	40
South XChk	1.6	14.8	29.8	40
Borrow Pit	-2.8	20.0	40.3	45
Area 02	-2.9	9.7	20.2	30
Area 03	3.2	14.3	29.3	40
Area 5/10	6.3	13.8	30.4	45
Area 7/8	2.8	20.8	42.0	41
Area 11	7.1	14.9	33.0	34
Area 12	-14.7	8.9	34.4	34
Area 14	12.6	12.7	35.8	45

Area	Mean difference	St dev (1σ)	RMS (2σ)
Wheel Topo	1.3	11.0	22.2
Wheel Bathy	6.0	4.5	15.0
SB	2.2	8.2	16.0
Parallel MB	4.1	13.7	28.6
Perpendicular MB	1.1	9.6	19.3
Fish Haven	6.7	9.1	22.6

Optech INTERNATIONAL

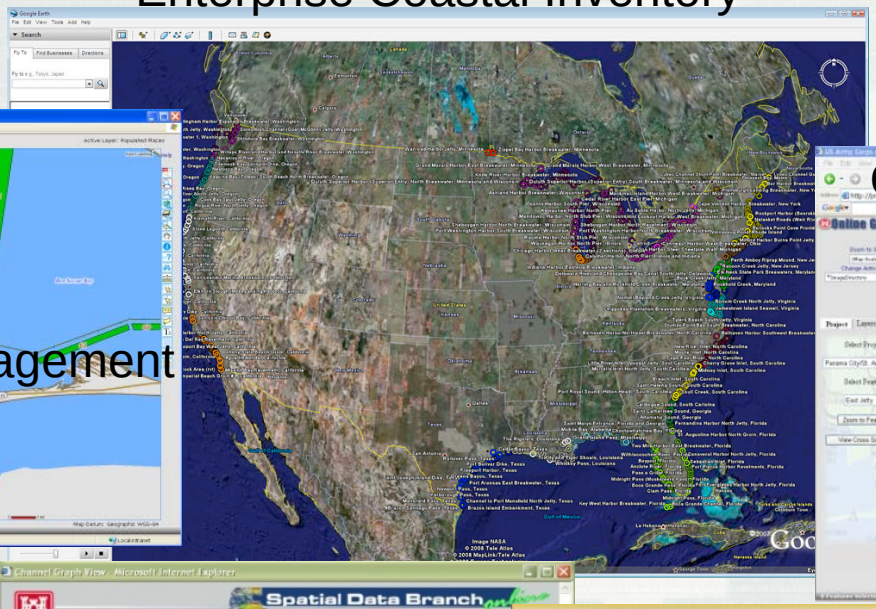
JALBTCX at the DIGITAL COAST

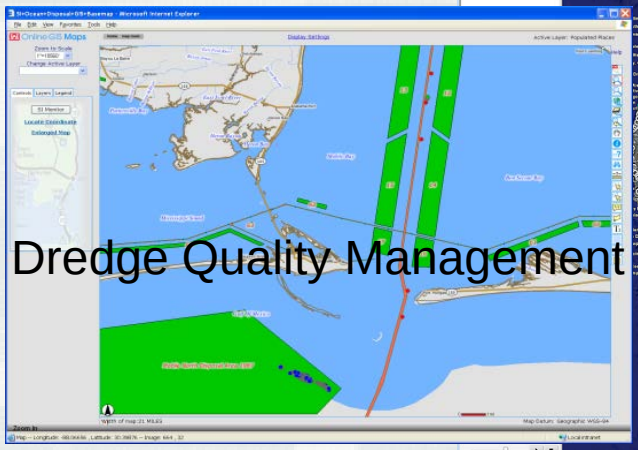
Statistics
- 4.7 TB
- 20,000 downloads
- 1.1 trillion elevations and depths!



Navigation Data Integration Framework: Navigation and Coastal Data Bank

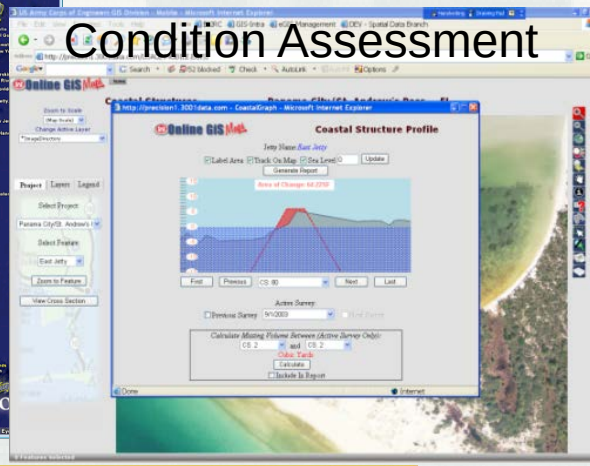
Enterprise Coastal Inventory

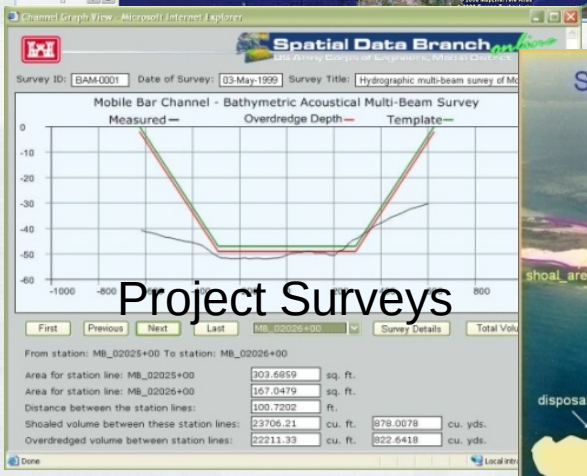




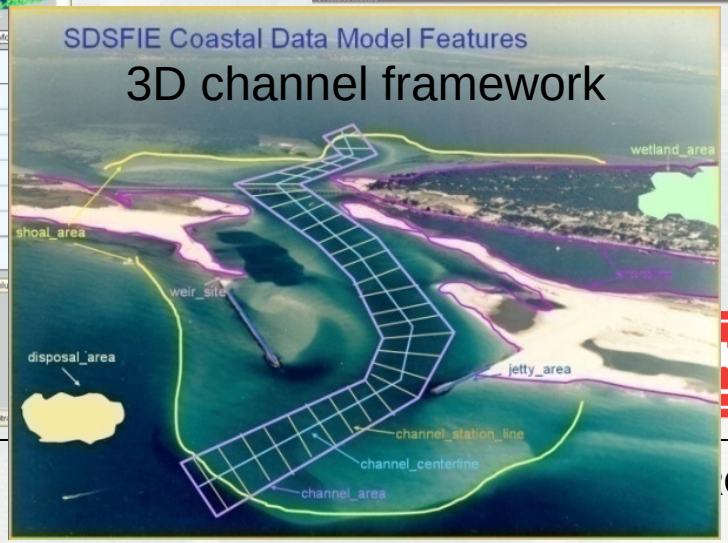
Dredge Quality Management

Coastal Structure Condition Assessment





Project Surveys



3D channel framework

- USGS St. Petersburg
- USGS EROS Data Center
- NOAA CSC
- NOAA NGDC
- By Request

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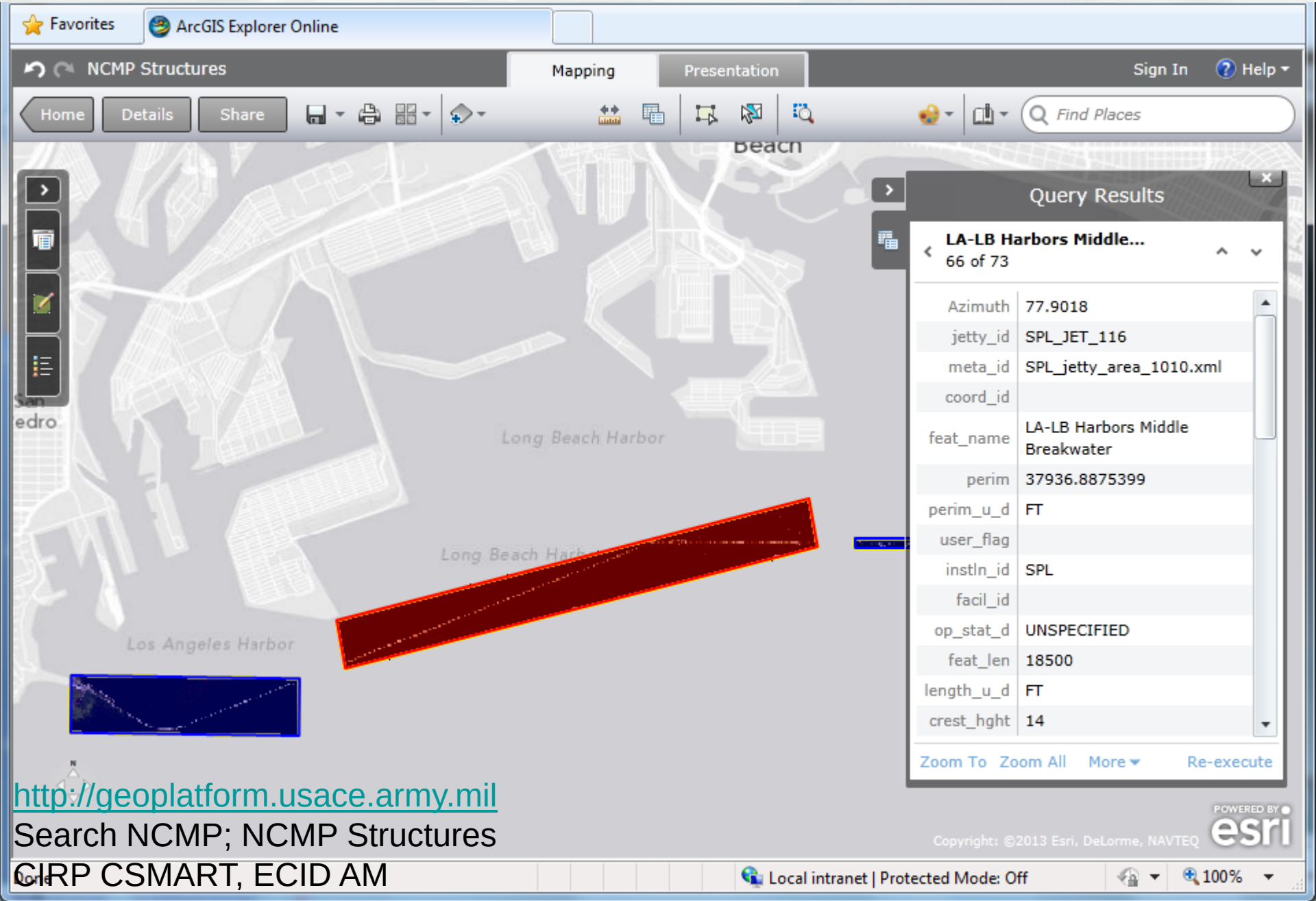
Asset management coastal structures

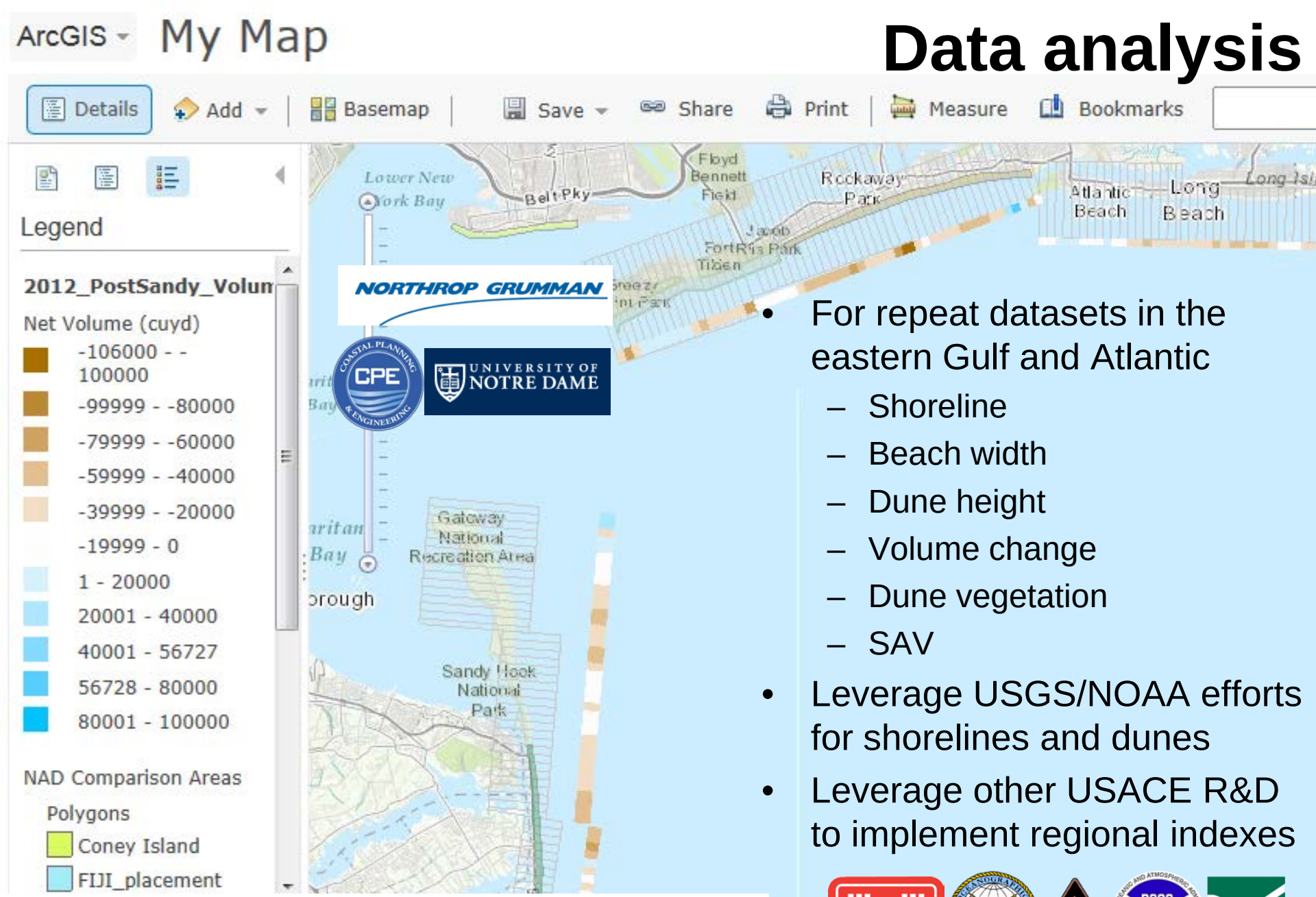


http://geoplatform.usace.army.mil

Search NCMP; NCMP Structures

CIRP CSMART, ECID AM

Data analysis



- For repeat datasets in the eastern Gulf and Atlantic
  - Shoreline
  - Beach width
  - Dune height
  - Volume change
  - Dune vegetation
  - SAV
- Leverage USGS/NOAA efforts for shorelines and dunes
- Leverage other USACE R&D to implement regional indexes

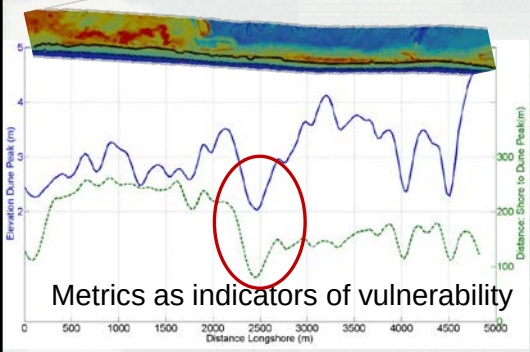
Joint Airborne Lidar Bathymetry Technical Center of Expertise

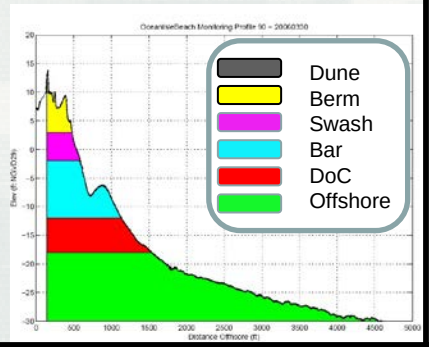
http://155.82.160.6/arcgis/rest/services/JALBTCX/2012_PostSandy_Volumes/MapServer

Coastal Engineering Applications

Coastal Vulnerability/Resiliency – identify areas of vulnerability and resiliency

- Metrics (narrow beach width, low dune line)
- Sea level change analysis
- Modeling for risk assessment

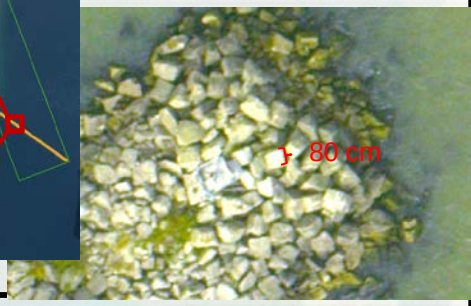




Asset Management – structure condition and functional performance

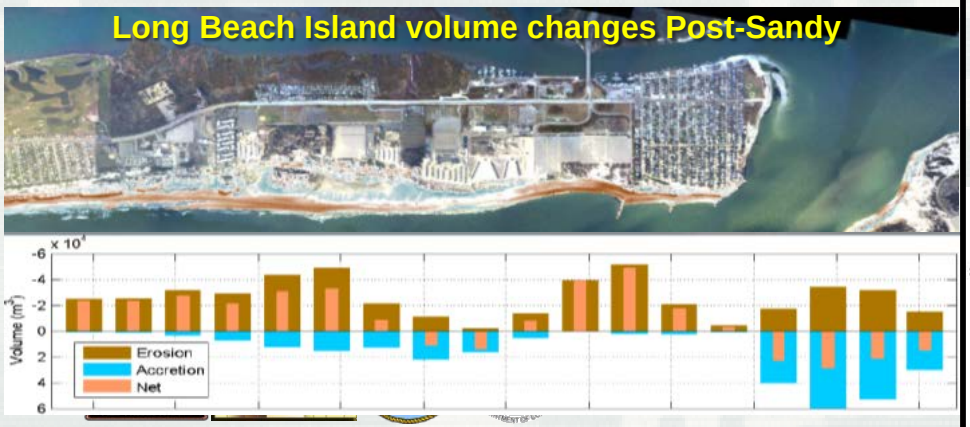
- Initial screening to support condition assessment (length of structure, elevation)
- Elevation and imagery data used for assessment

5cm Pixel size



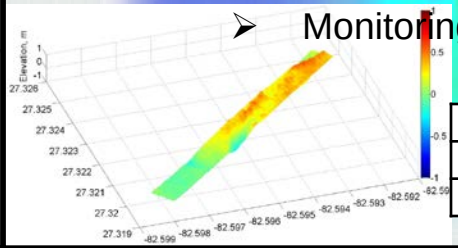
Coastal storm damage assessment – identify areas resilient to storm impacts and quantify pre- and post- storm changes

- Change detection (elevation, volume, shoreline)



Project condition and monitoring

- Navigation project – identification of inlet bathymetric features for navigable conditions
- Coastal storm damage reduction project – quantification of volumetric change for efficient monitoring of project performance
  - Regional Sediment Management
  - Sediment budgets and pathways
  - Monitoring beach fill placement

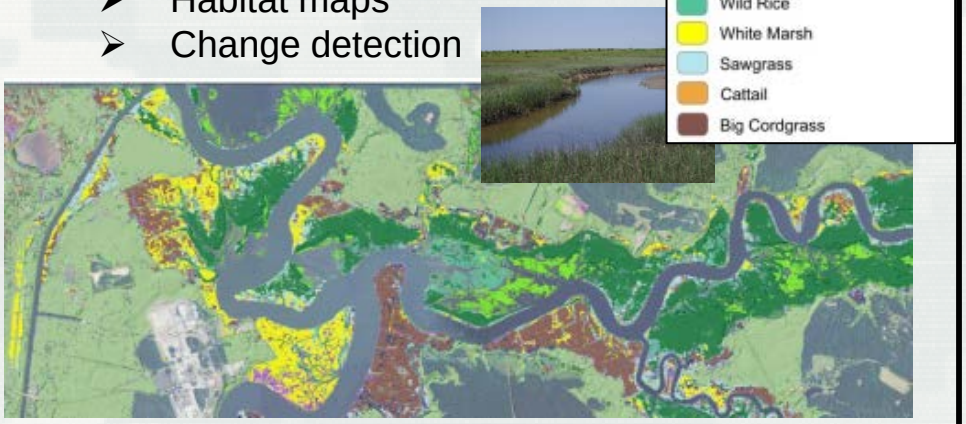


Channel Volume CY/yr		
Average	Maximum	Minimum
13,307	25,568	2,543

Environmental Applications

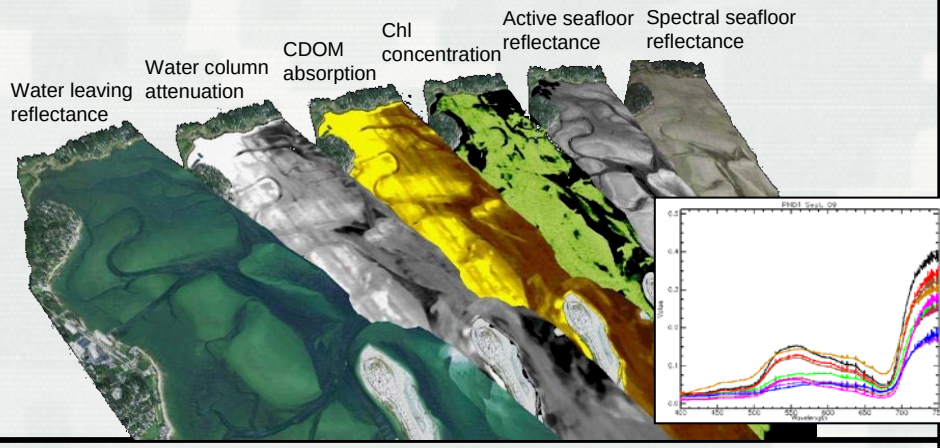
Land Cover and Habitat Characterization – identify critical physical and natural features for resource management and planning

- Wetlands identification
- Habitat maps
- Change detection



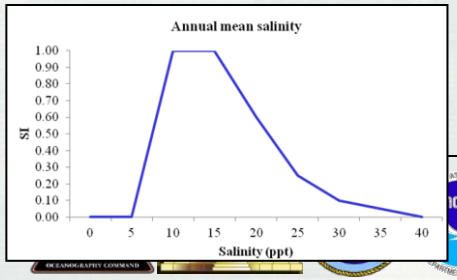
Benthic Habitat Mapping – identify habitats such as submerged aquatic vegetation

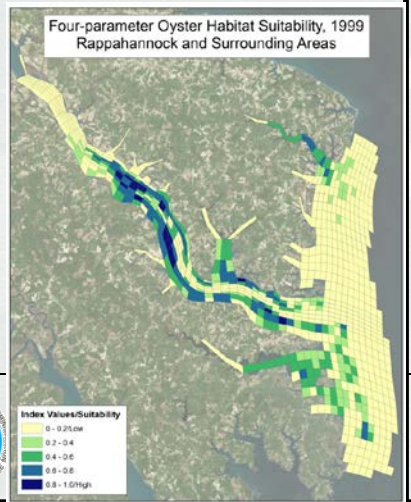
- Operations support
- Restoration/mitigation planning



Critical Species Detection & Modeling – discriminate particular species and habitat suitability for ecosystem restoration and monitoring

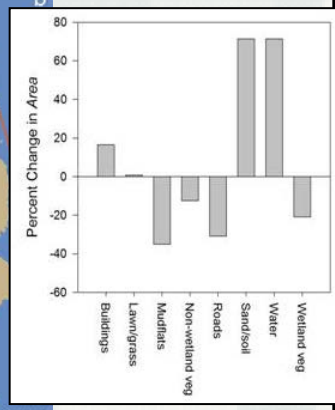
- Invasive/threatened/ endangered species identification
- Habitat suitability index analysis





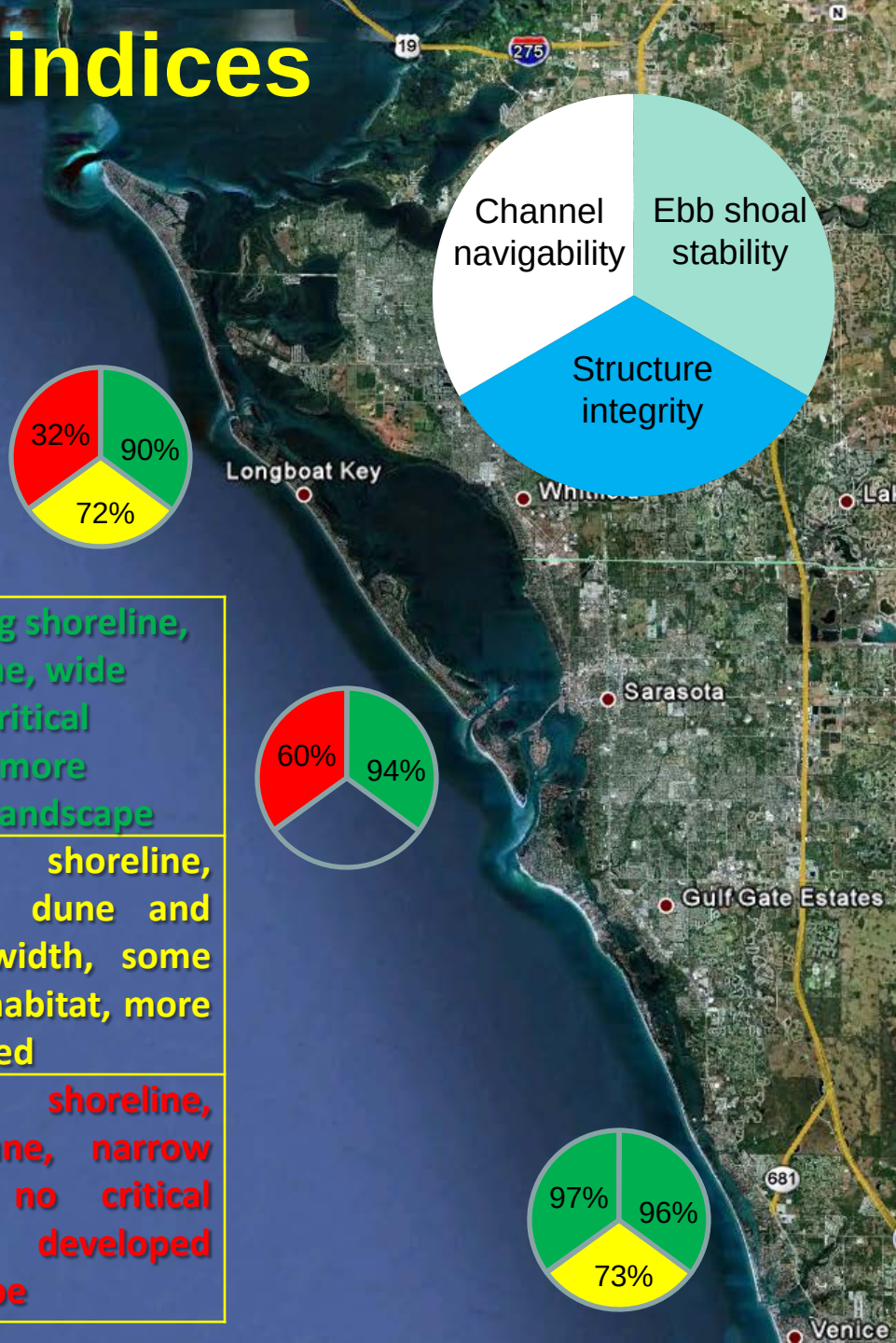
Landscape Modeling – link landscapes to ecological processes to better predict ecosystem changes

- Landscape structure analysis
- Ecosystem restoration planning



Coastal engineering indices

Green	Accreting shoreline, high dune, wide beach, critical habitat, more natural landscape
Yellow	Stable shoreline, medium dune and beach width, some critical habitat, more developed
Red	Eroding shoreline, low dune, narrow beach, no critical habitat, developed landscape



Measurements for Environmental Condition and Benefits

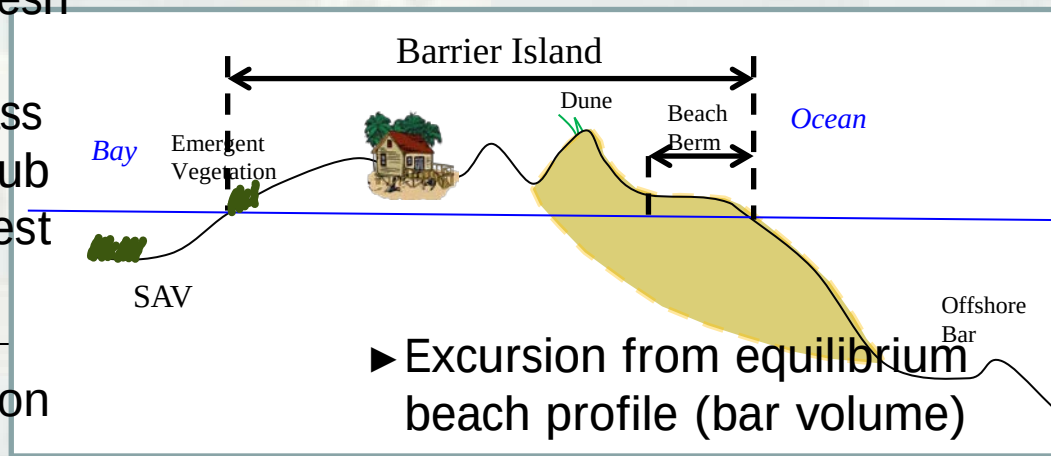
Demographics/ Cadastre
- Population
- Schools
- Public accessibility

Soils
- Hydric
- Infiltration rate

Habitat
- T&E species
- Biodiversity
- Native/non-native
- Fisheries
- Connectivity
- Transition zones
- Spatial pattern factor

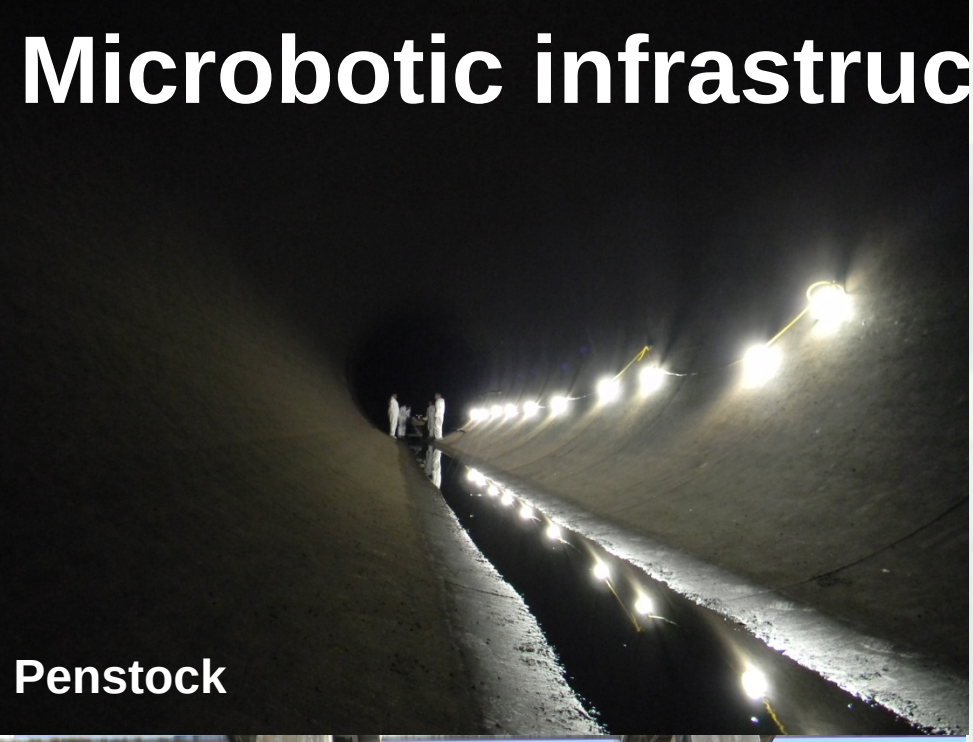
Geographic extent (landcover)
- Beach
- Vegetation cover
- Mudflat/sandflat
- Impervious cover
- Bluff
- Dune
- Salt marsh
- Scrub-wetland brackish/fresh
- Forest swamp brackish/fresh
- Maritime shrubland
- Maritime forest
- SAV
- Riparian
- Herb marsh fresh
- Pond
- Terrestrial grass
- Terrestrial shrub
- Terrestrial forest
- Tree cover
- Water cover
- Dune vegetation

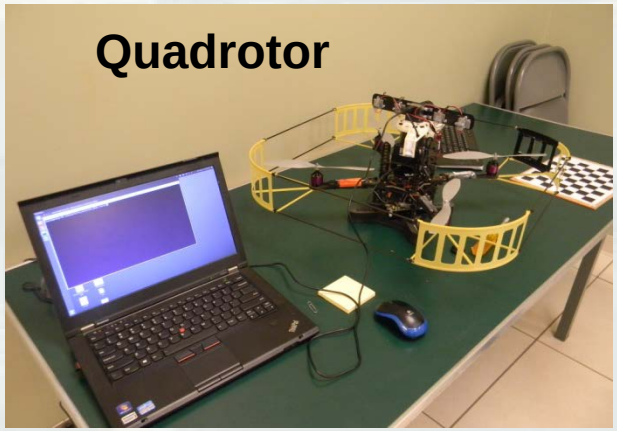
Morphology
- Beach height/volume/slope
- Dune height/volume/slope
- Watershed size
- Floodplain size
- Distance to shore (of offshore features)
- Length shoreline shadowed (")
- Height (")
- Barrier island height/width
- Distance to inlet
- Alongshore gradient discontinuities



- Excursion from equilibrium beach profile (bar volume)

Microbotic infrastructure assessment





- Constrained, featureless environments
- 3-D (not just 2.5-D)
- Poor illumination

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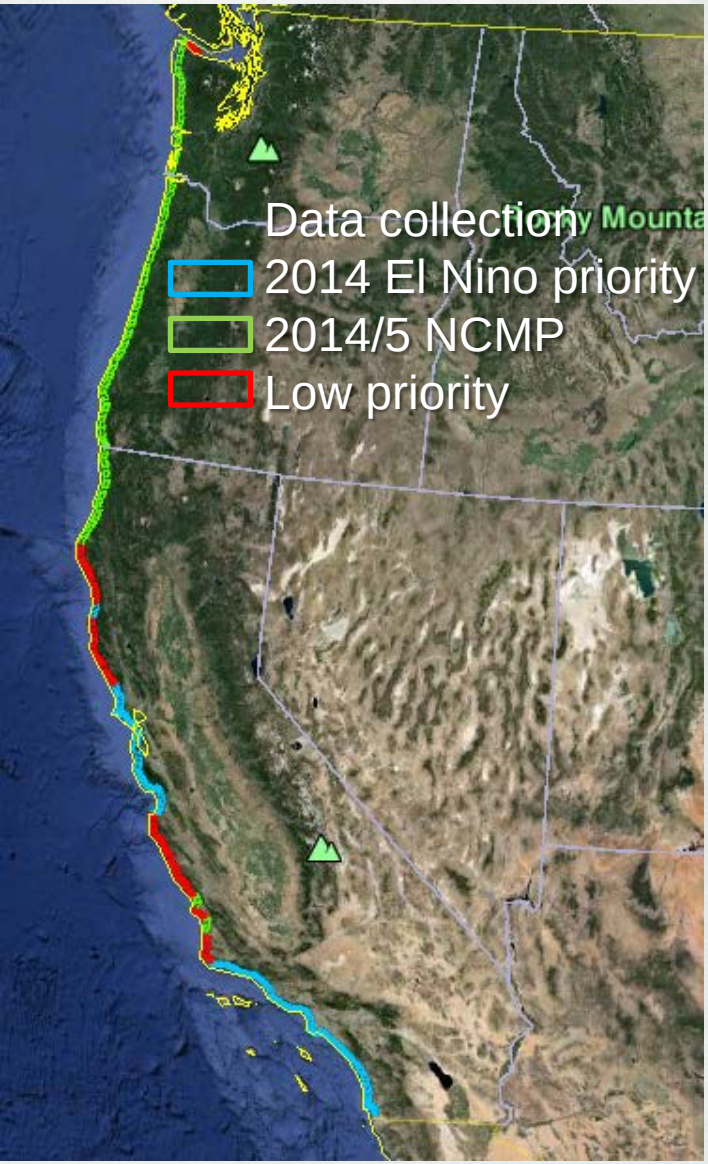
s for a safer, better world

FY14/FY15



CZMIL Coastal Zone Mapping and Imaging Lidar

- Quantify performance in varying water/bottom types
- Further improve and automate calibration and depth extraction algorithms
- Redesign thermal management system
- Laser redesign to improve thermal performance and decrease size/weight

UAS technology demonstration
Fall 2014

Questions?

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