National Coastal Mapping Program

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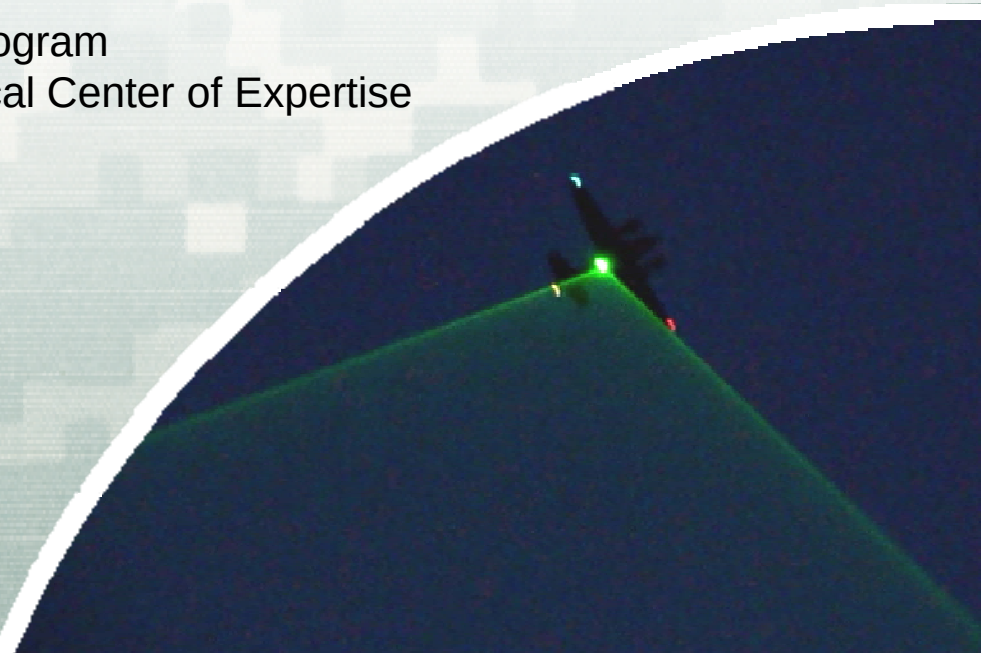
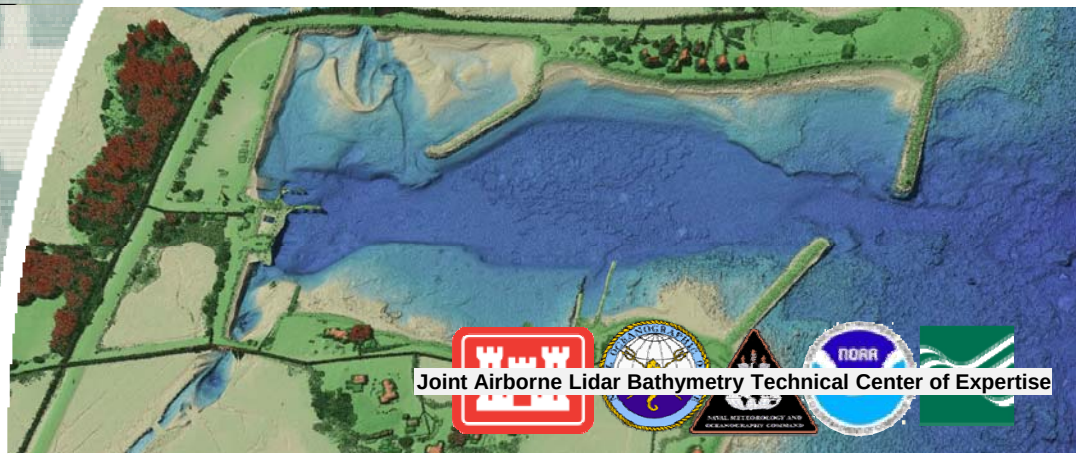
Director, Joint Airborne Lidar Bathymetry Technical Center of Expertise

08 April 2015

Outline

- Program goals
- JALBTCX and sensors
- Data acquisition
- Data products and applications
- Upcoming activities

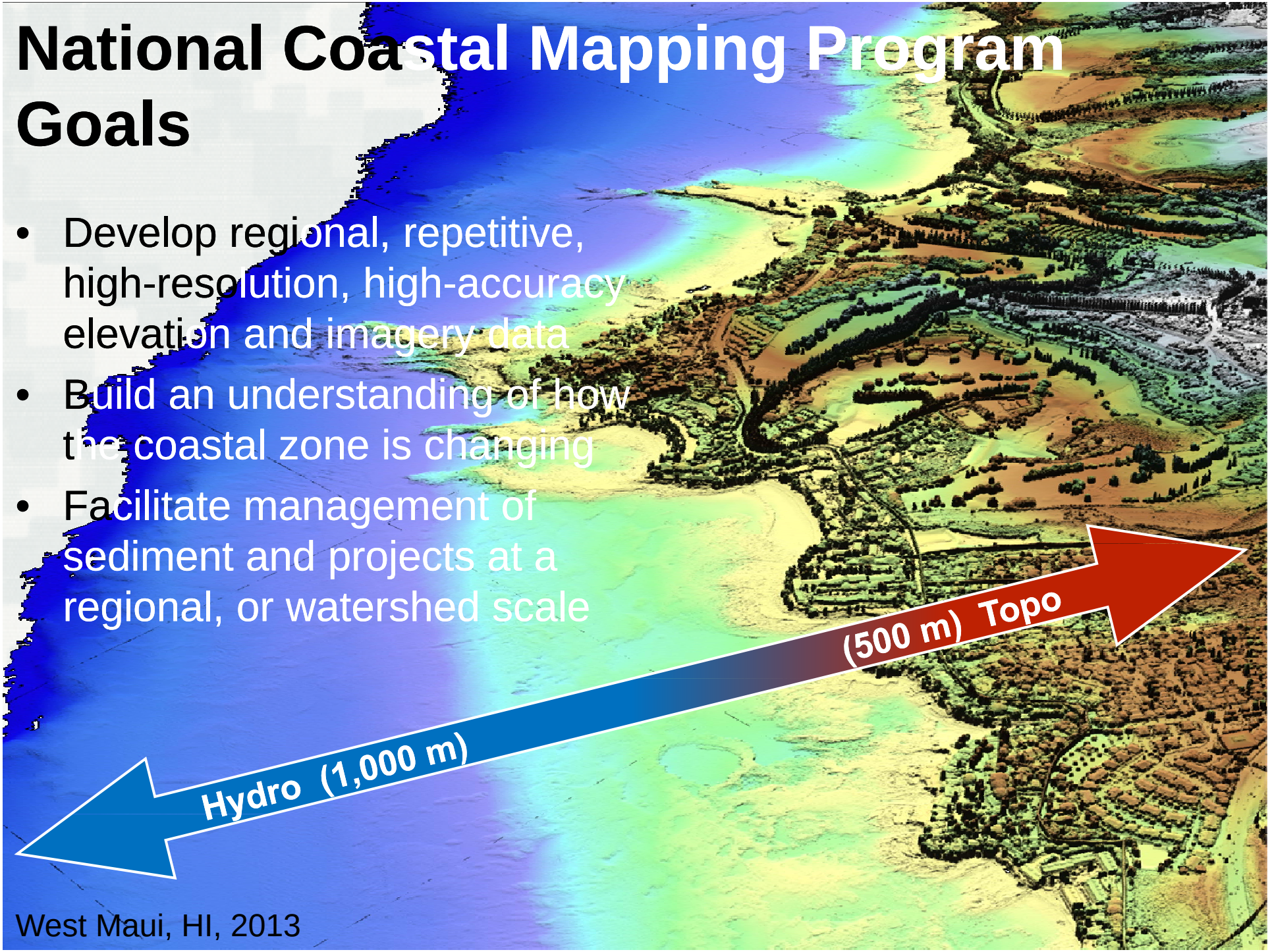




US Army Corps of Engineers
BUILDING STRONG®

National Coastal Mapping Program Goals

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



West Maui, HI, 2013

Joint Airborne Lidar Bathymetry Technical Center of Expertise

Annual Technical Workshop, 16-18 June 2015, Corvallis, OR

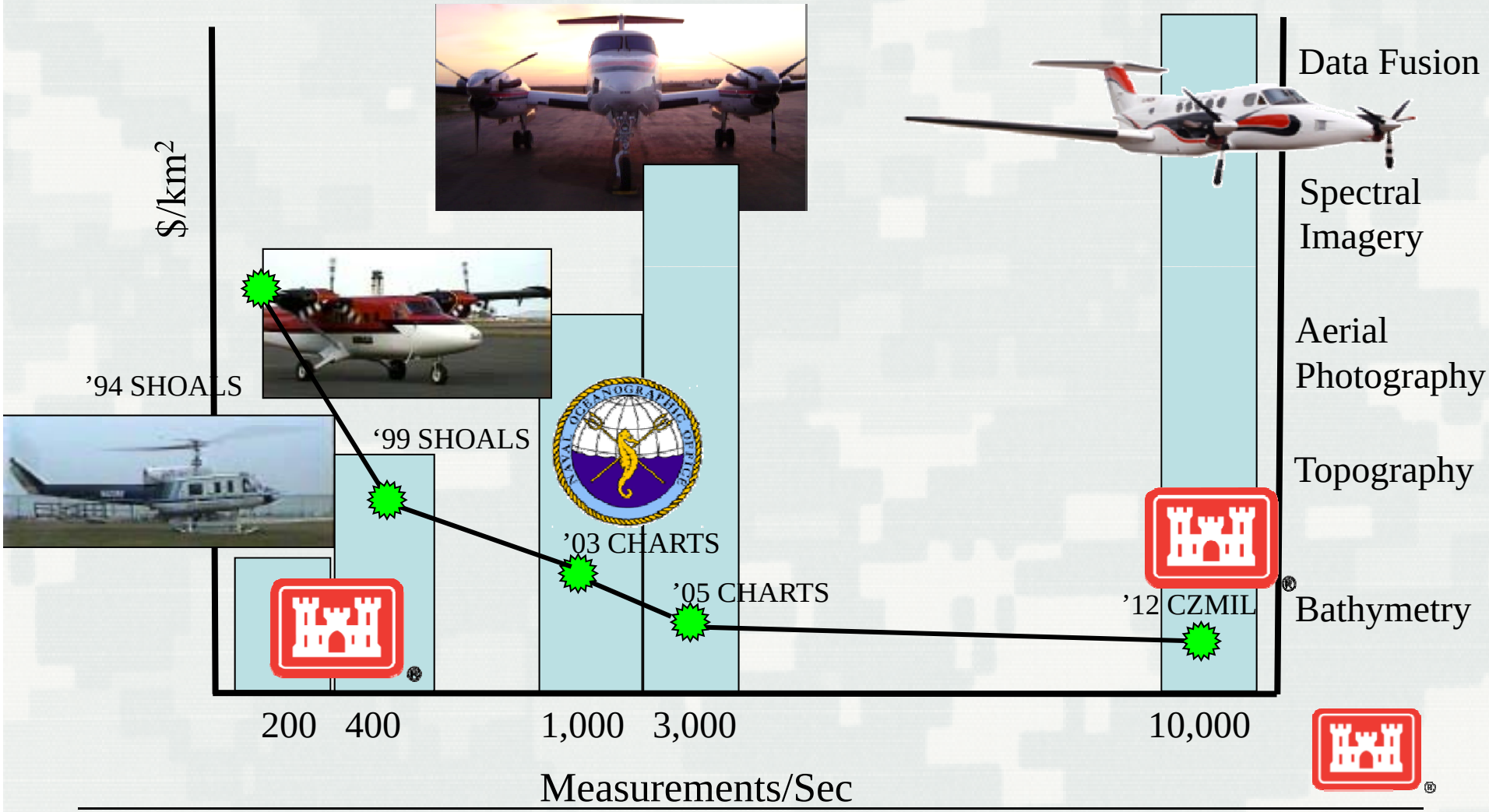
OPERATIONS

- Aircraft
- Surveys
- Procedures
- People

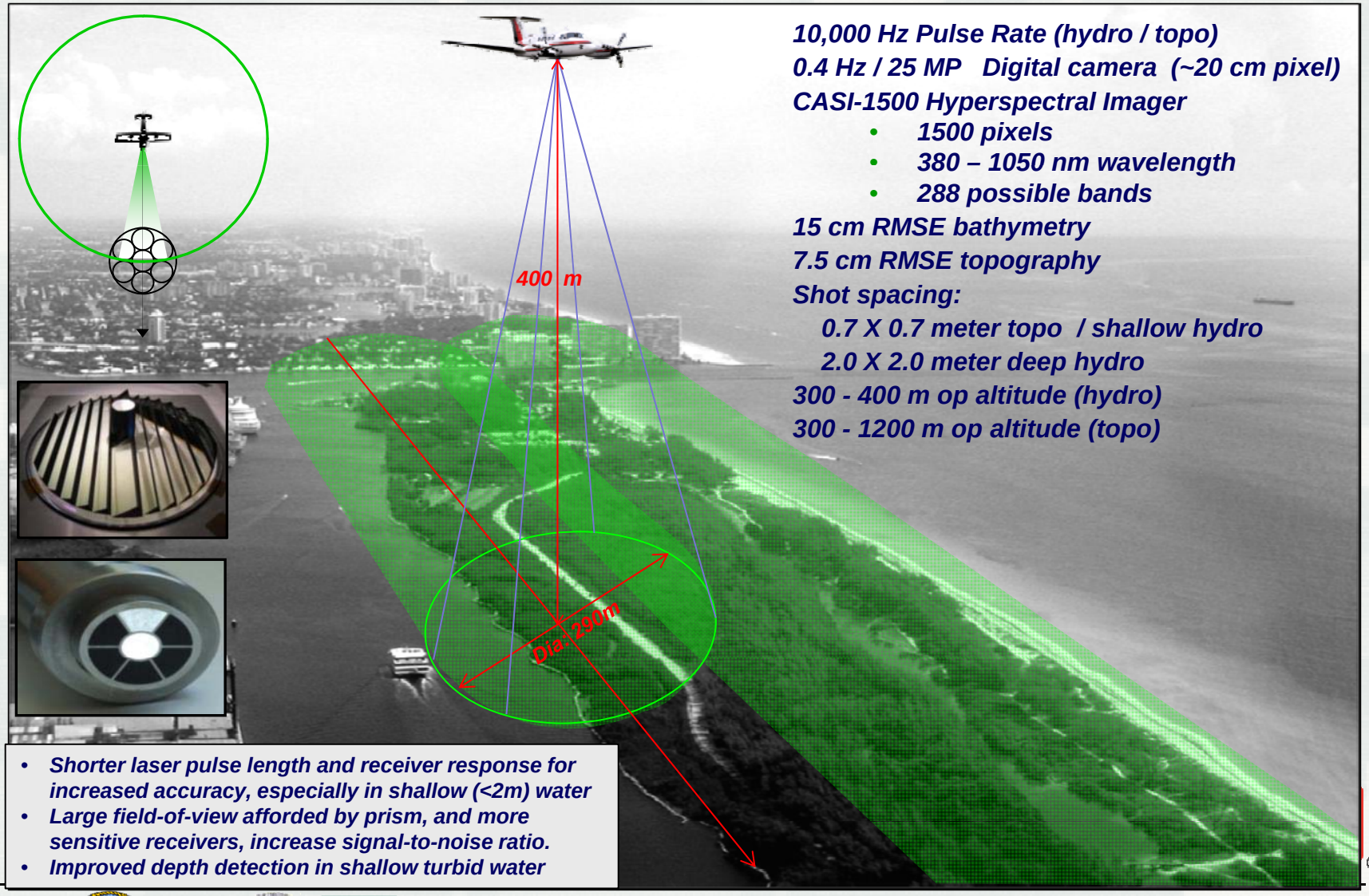
RESEARCH AND DEVELOPMENT

- Hardware
- Software
- Algorithms
- Data exploitation

JALBTCX sensor development history



CZMIL Coastal Zone Mapping and Imaging Lidar



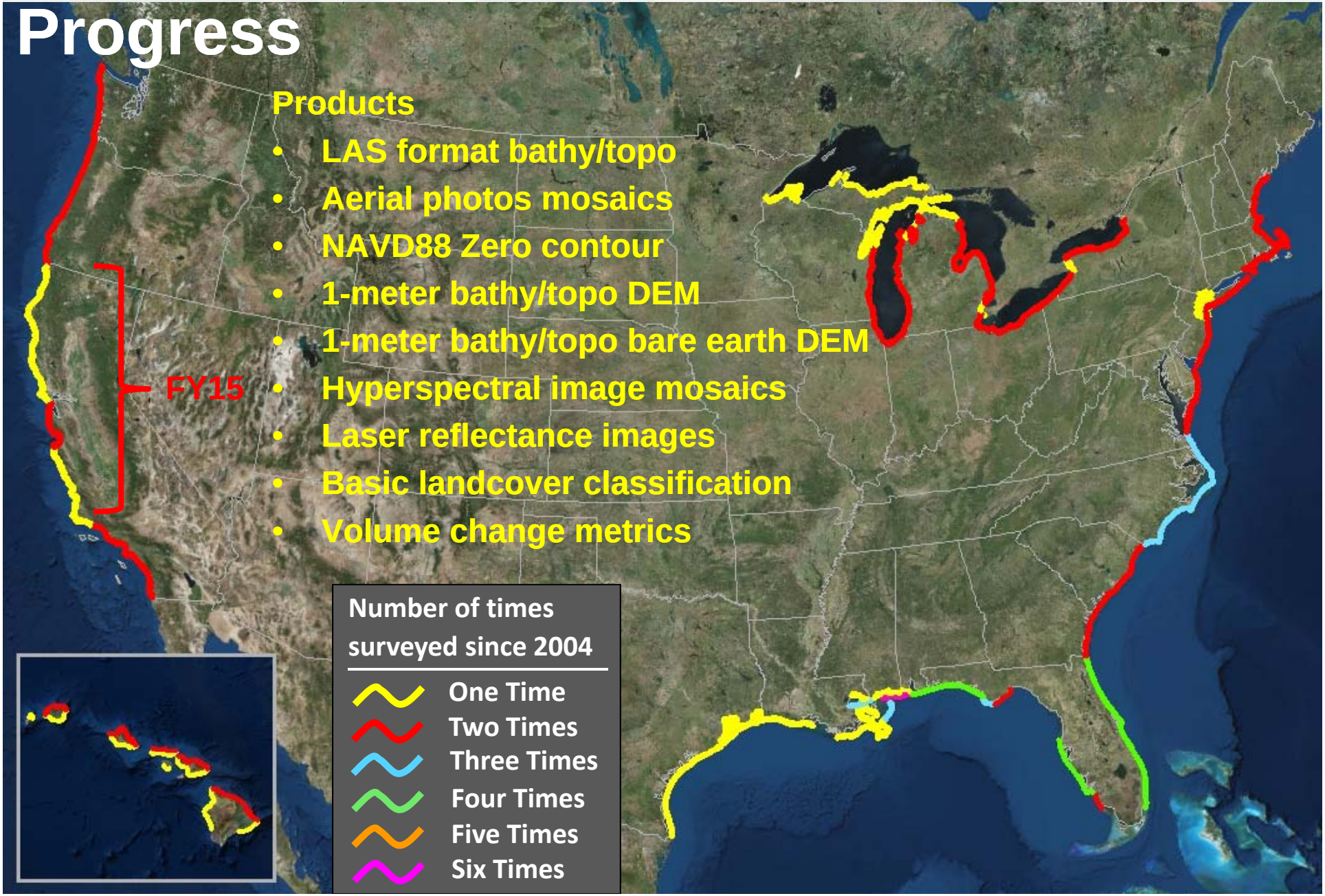
10,000 Hz Pulse Rate (hydro / topo)
0.4 Hz / 25 MP Digital camera (~20 cm pixel)
CASI-1500 Hyperspectral Imager
- *1500 pixels*
- *380 – 1050 nm wavelength*
- *288 possible bands*

15 cm RMSE bathymetry
7.5 cm RMSE topography
Shot spacing:
0.7 X 0.7 meter topo / shallow hydro
2.0 X 2.0 meter deep hydro
300 - 400 m op altitude (hydro)
300 - 1200 m op altitude (topo)

- *Shorter laser pulse length and receiver response for increased accuracy, especially in shallow (<2m) water*
- *Large field-of-view afforded by prism, and more sensitive receivers, increase signal-to-noise ratio.*
- *Improved depth detection in shallow turbid water*

National Coastal Mapping Program

Progress

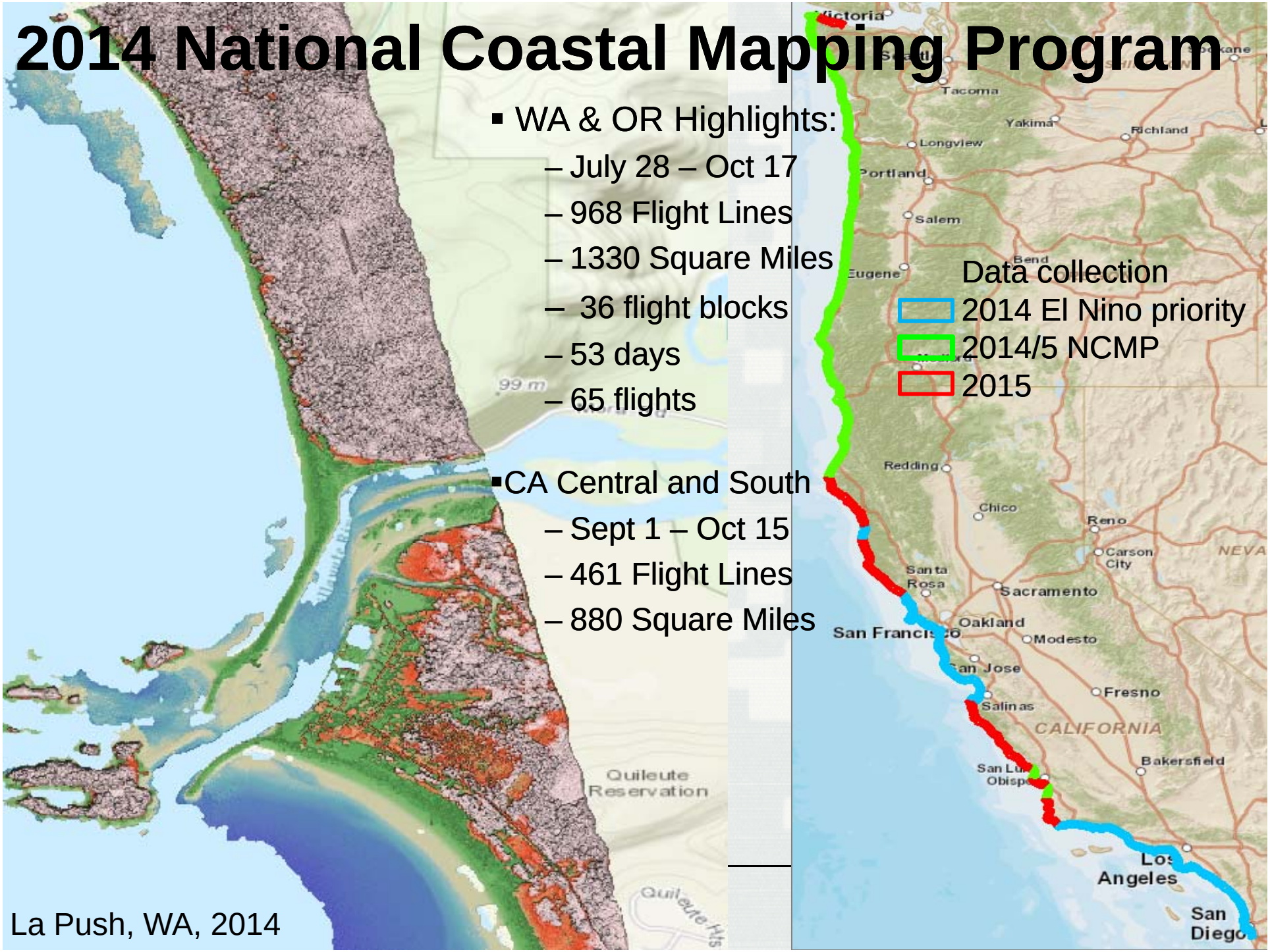


Products

- LAS format bathy/topo
- Aerial photos mosaics
- NAVD88 Zero contour
- 1-meter bathy/topo DEM
- 1-meter bathy/topo bare earth DEM
- Hyperspectral image mosaics
- Laser reflectance images
- Basic landcover classification
- Volume change metrics

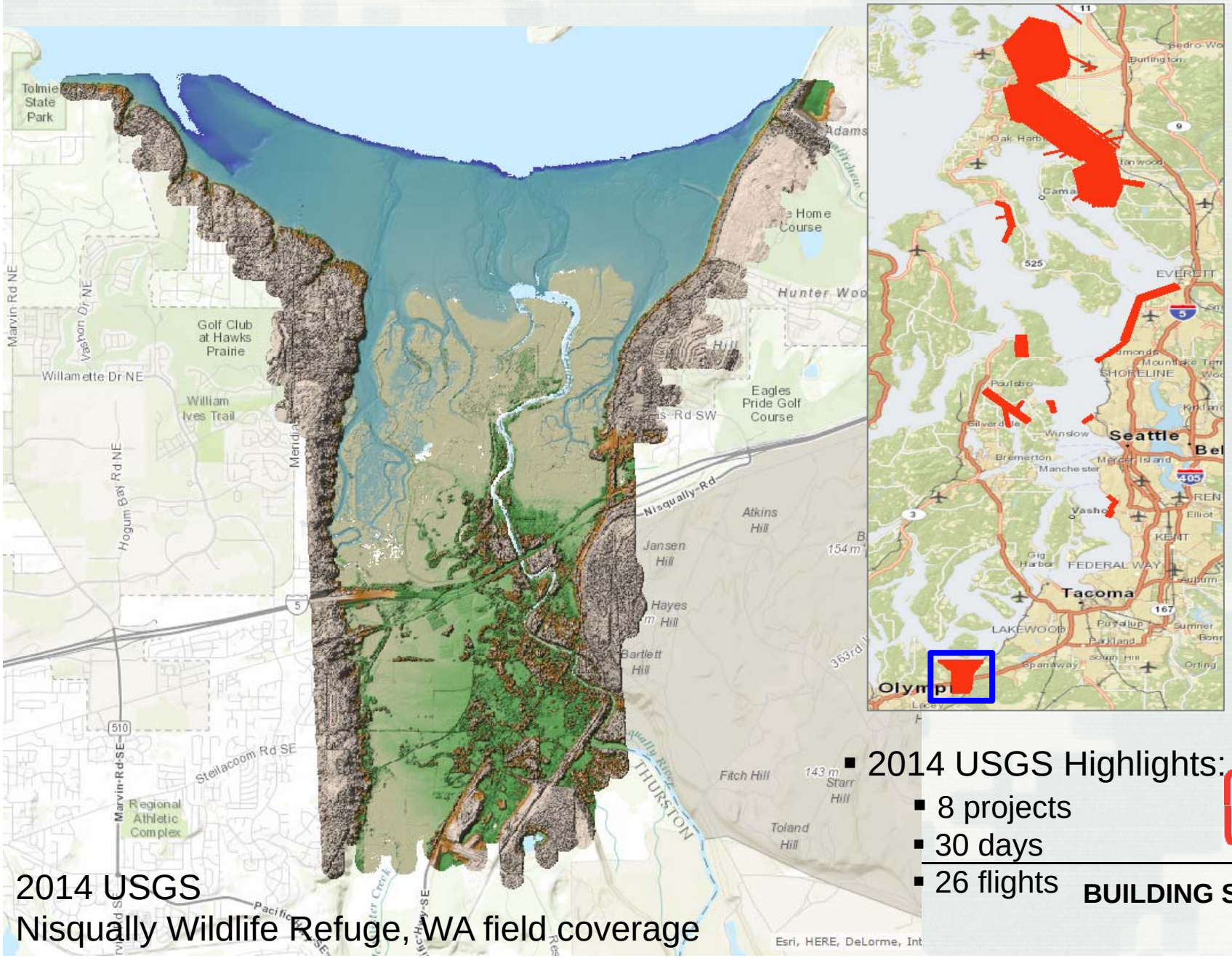
2014 National Coastal Mapping Program

- WA & OR Highlights:
  - July 28 – Oct 17
  - 968 Flight Lines
  - 1330 Square Miles
  - 36 flight blocks
  - 53 days
  - 65 flights
- CA Central and South
  - Sept 1 – Oct 15
  - 461 Flight Lines
  - 880 Square Miles



La Push, WA, 2014

2014 National Coastal Mapping Program



- 2014 USGS Highlights:
  - 8 projects
  - 30 days
  - 26 flights

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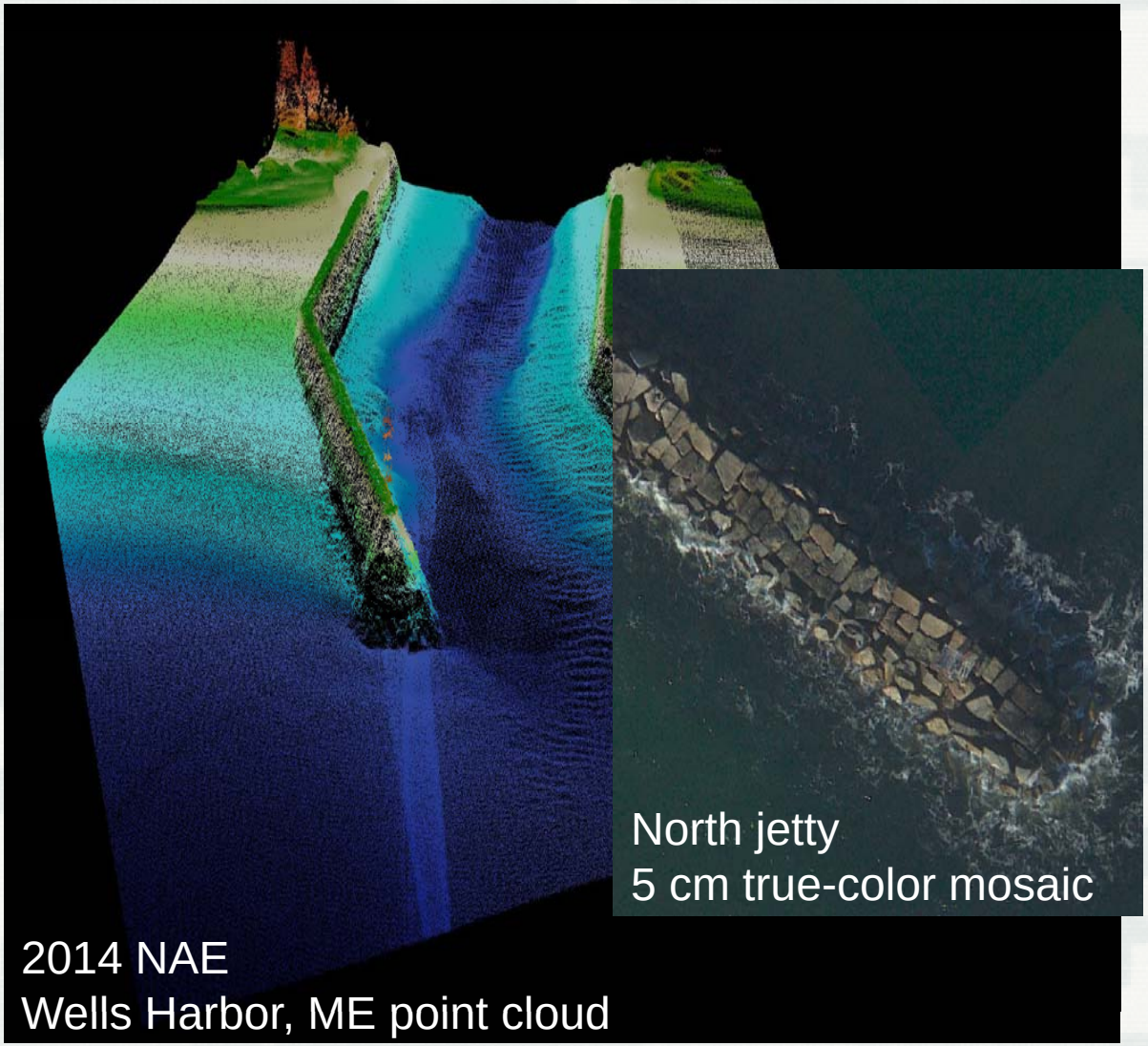
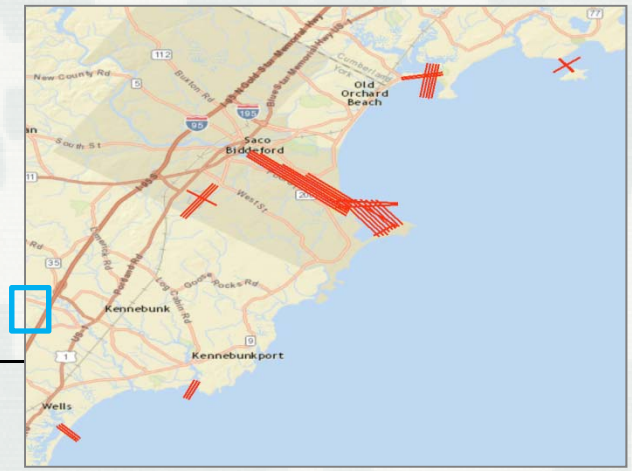
2014 USGS
Nisqually Wildlife Refuge, WA field coverage

2014 National Coastal Mapping Program



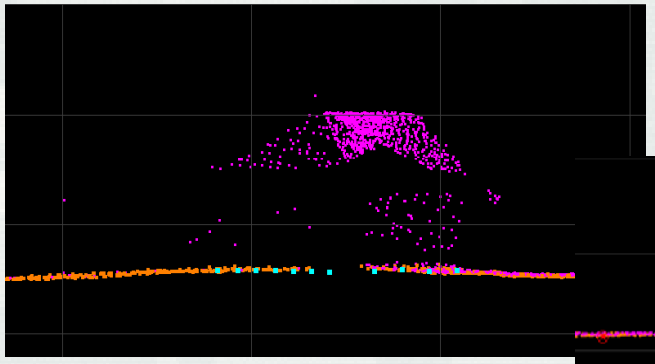
- Reimbursable work funded by New England District (NAE)
- Focus on navigation structures and channels
- 2014 NAE Highlights:
  - 47 structures
  - 24 projects
  - 13 days
  - 19 flights

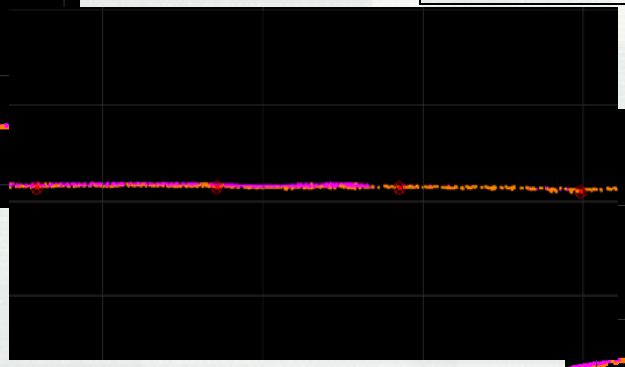


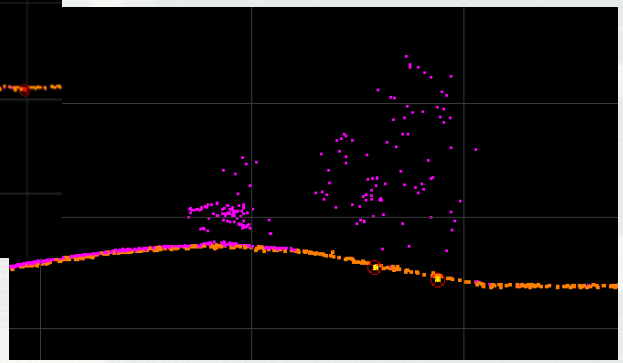
CZMIL Topographic Accuracy Assessment

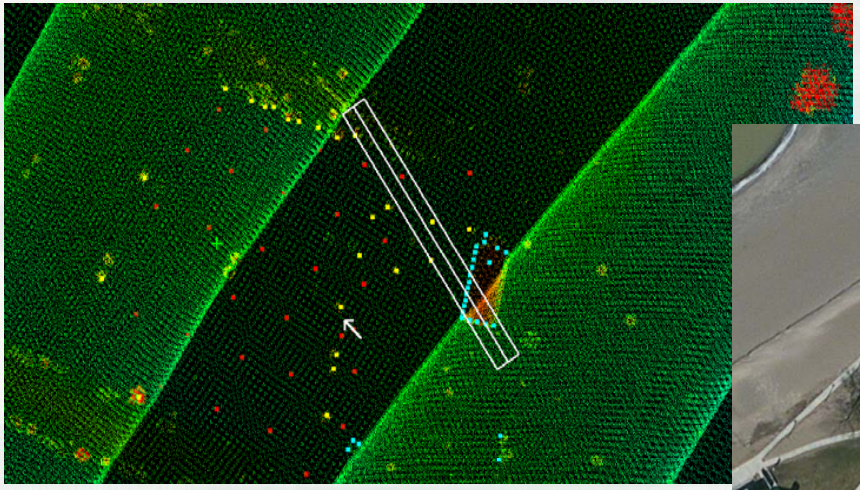
2012 NCMP Great Lakes

Category	n	Mean	RMSEz	σ
Bare earth	203	-0.008	0.033	0.025
Low grass	157	-0.034	0.050	0.033
Urban	122	-0.023	0.110	0.101
Trees	137	-0.105	0.150	0.087

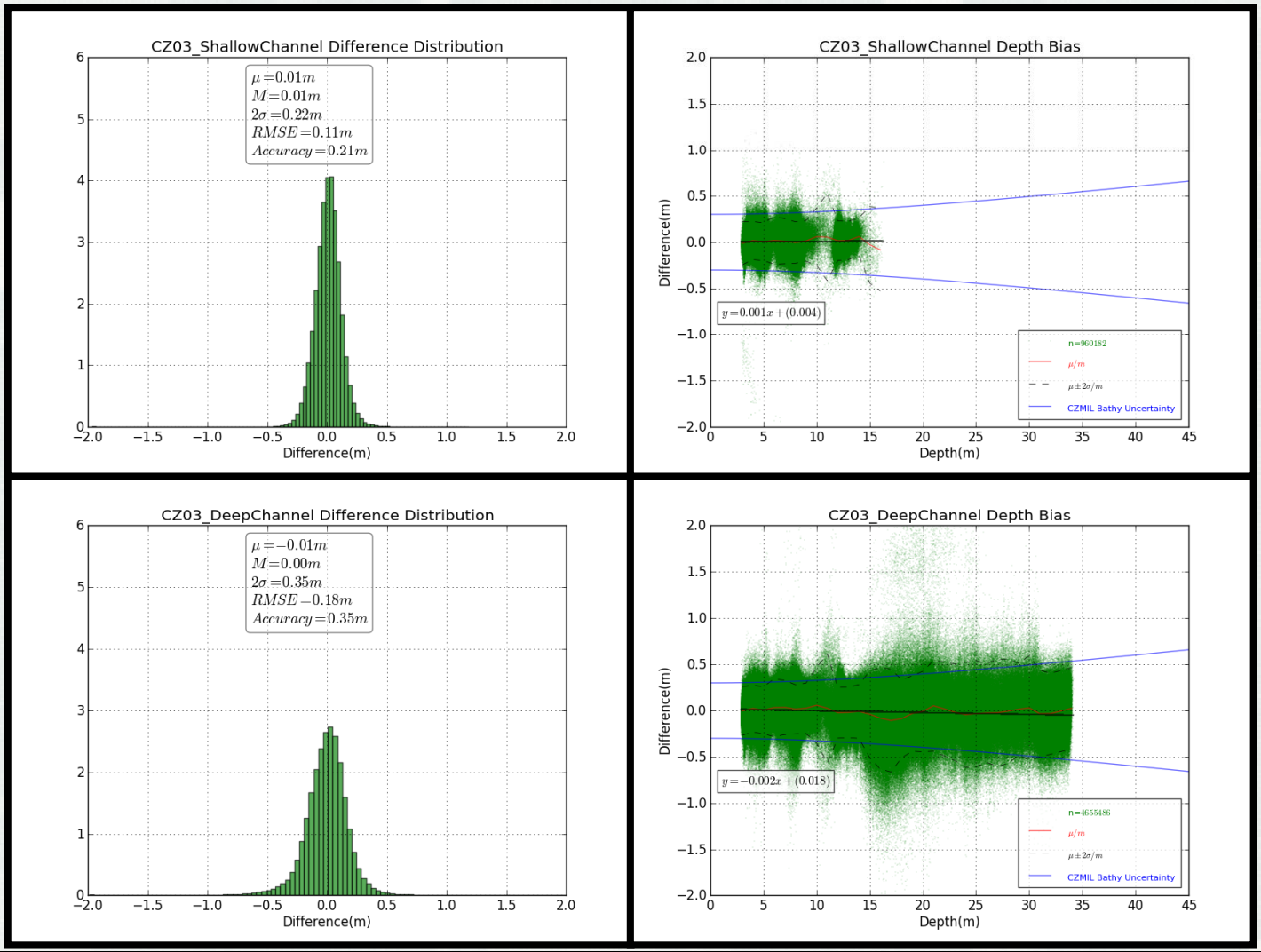




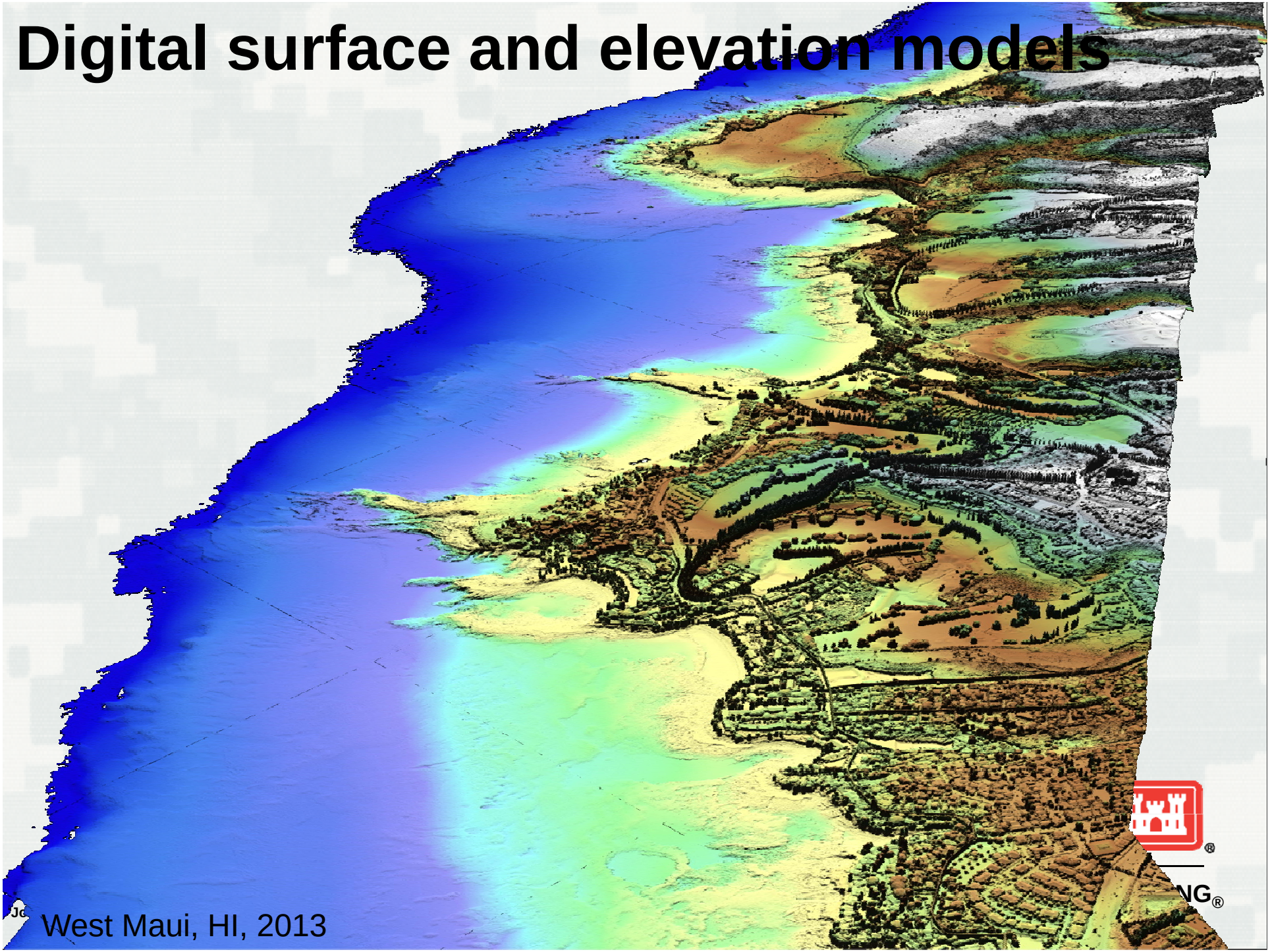




CZMIL Bathymetric Accuracy Assessment

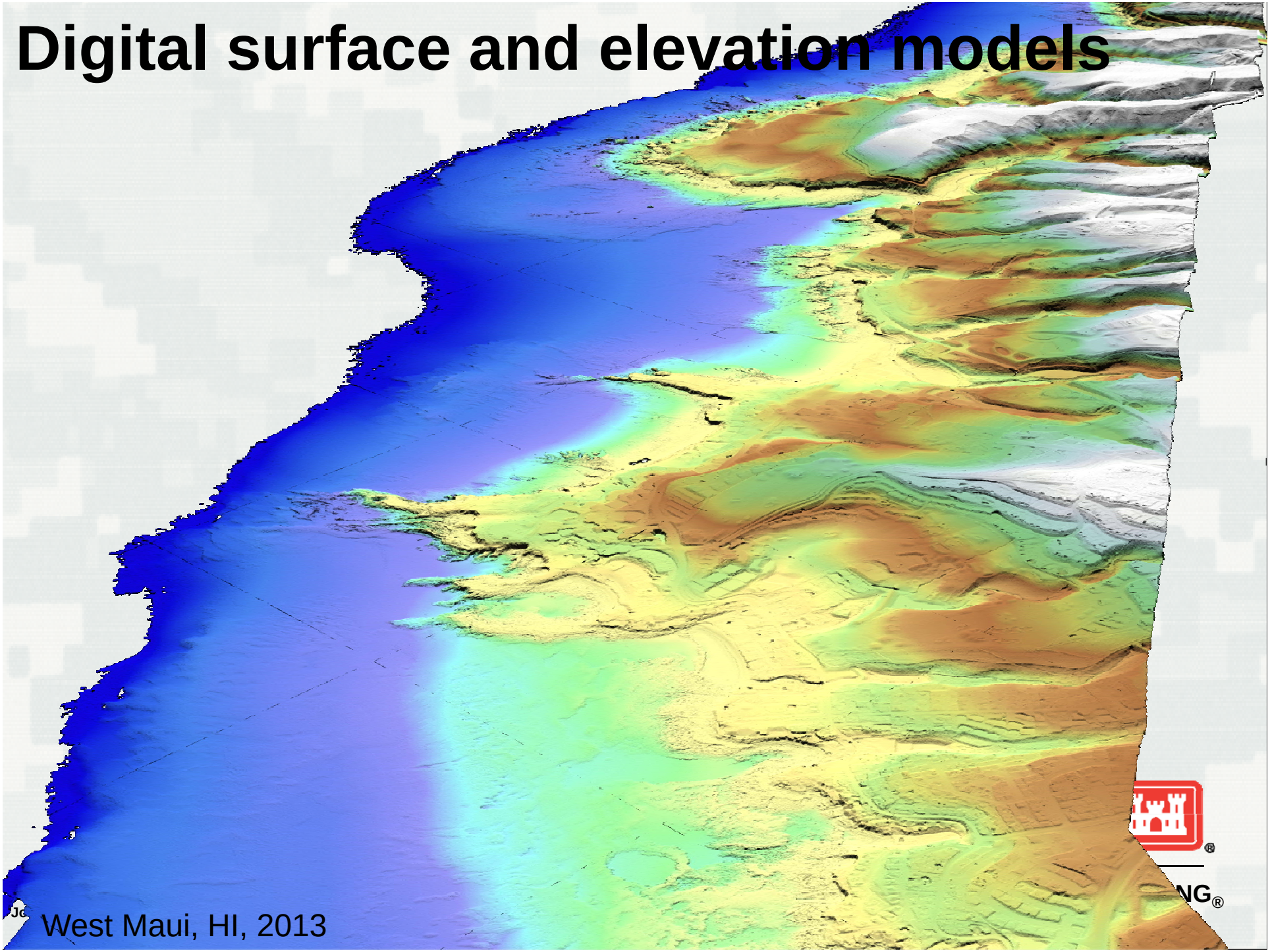


Digital surface and elevation models



West Maui, HI, 2013

Digital surface and elevation models



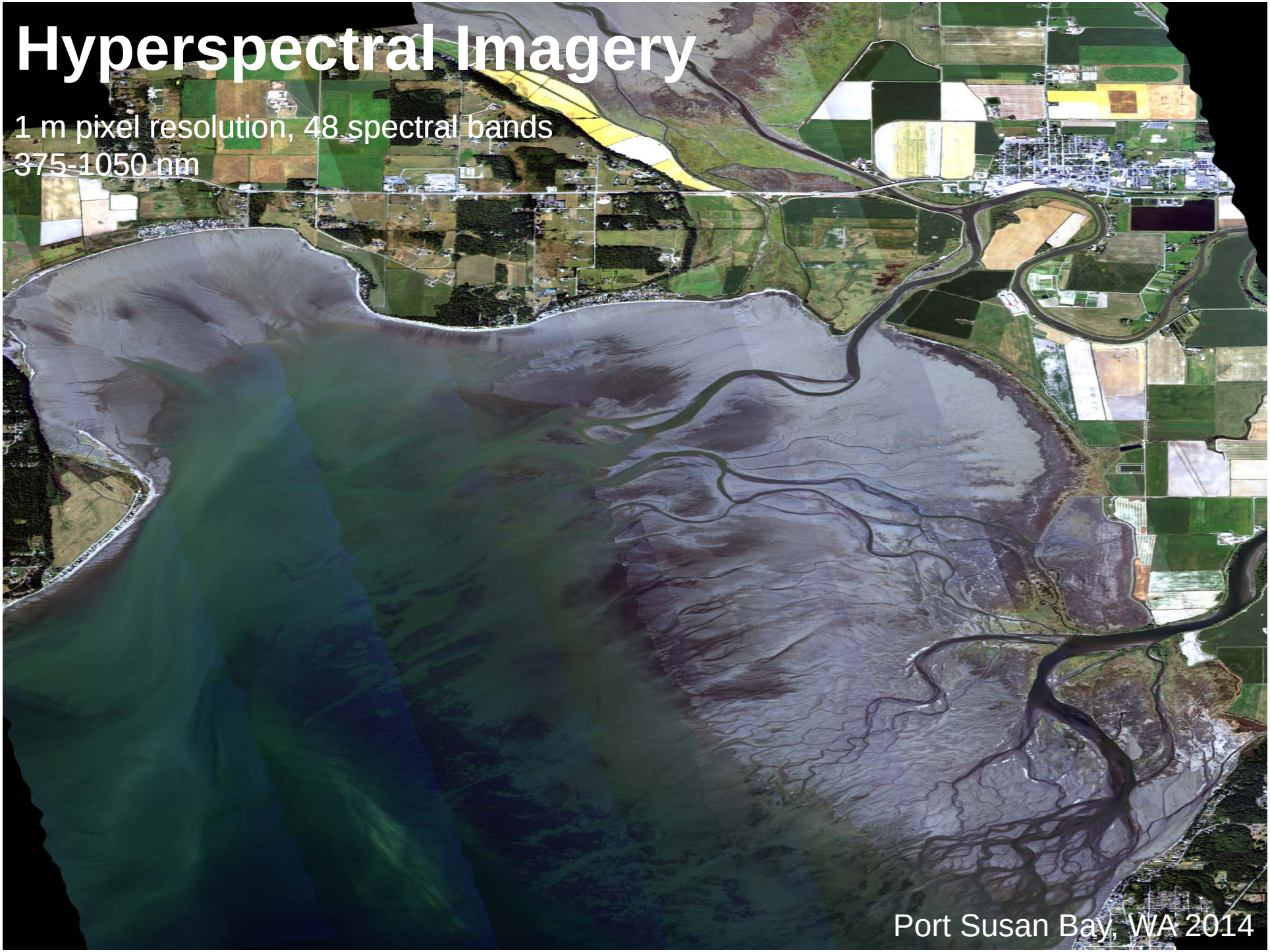
West Maui, HI, 2013

Aerial photography/lidar

Siuslaw River Entrance, OR 2014

Hyperspectral Imagery

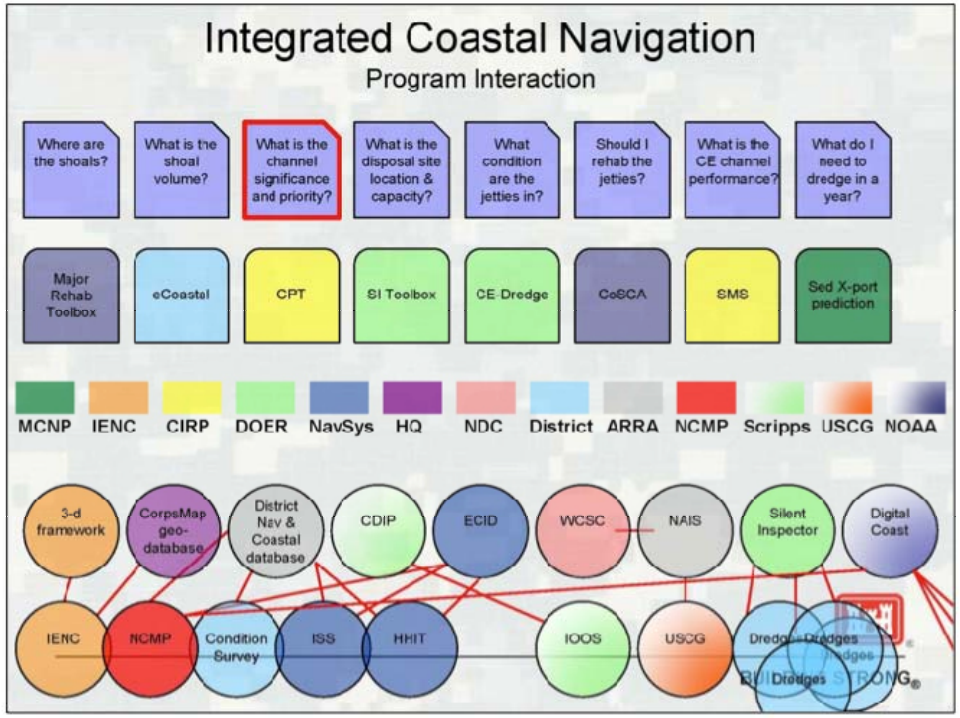
1 m pixel resolution, 48 spectral bands
375-1050 nm



NCMP Data Access

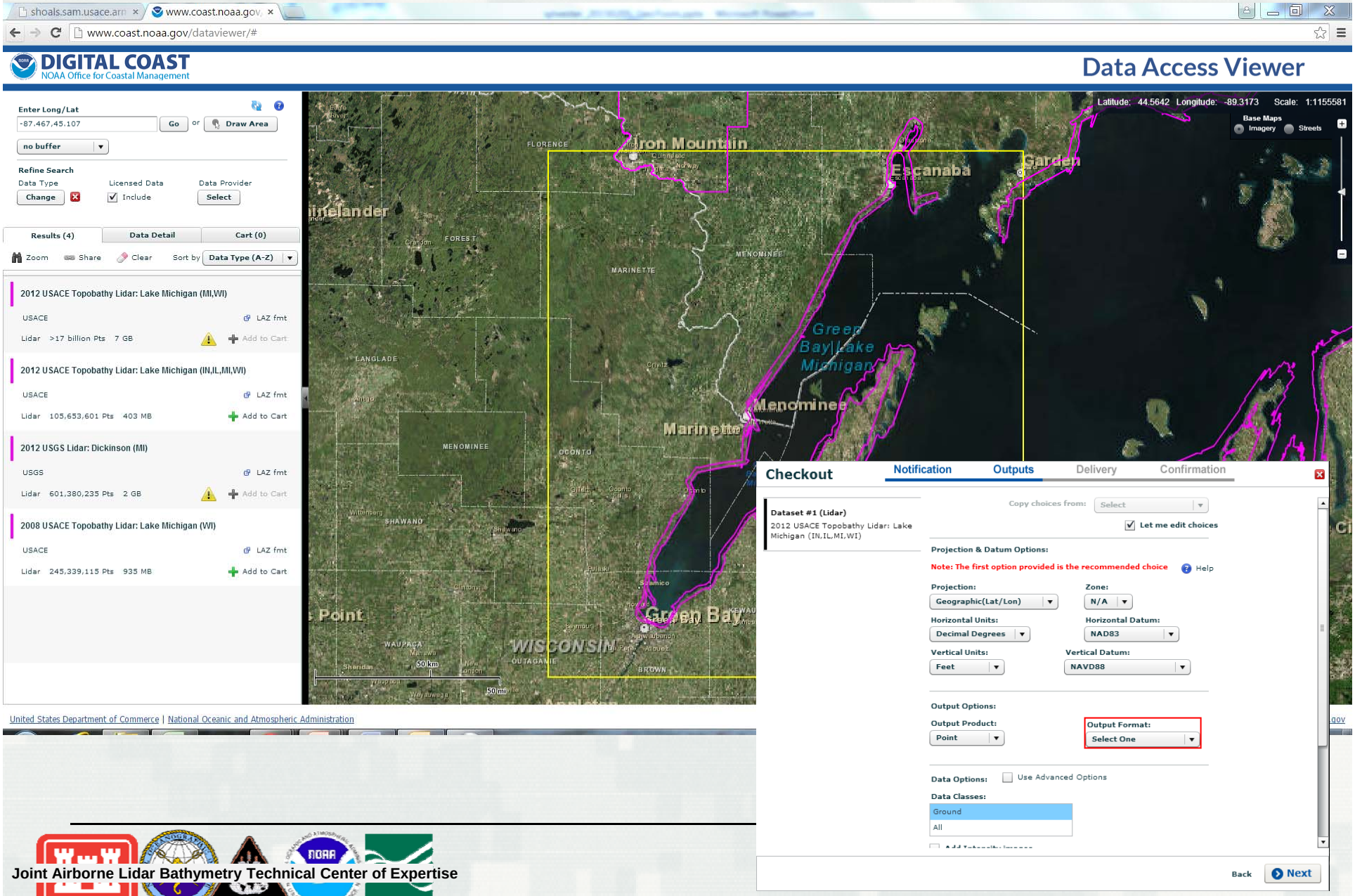
Navigation Data Integration Framework
Concept and Implementation Plan

US Army Corps of Engineers
Navigation Business Line



- USACE District Office
- NOAA Digital Coast
- USGS St. Petersburg
- USGS EROS
- USACE GRiD
- By request to jalbtcx@usace.army.mil

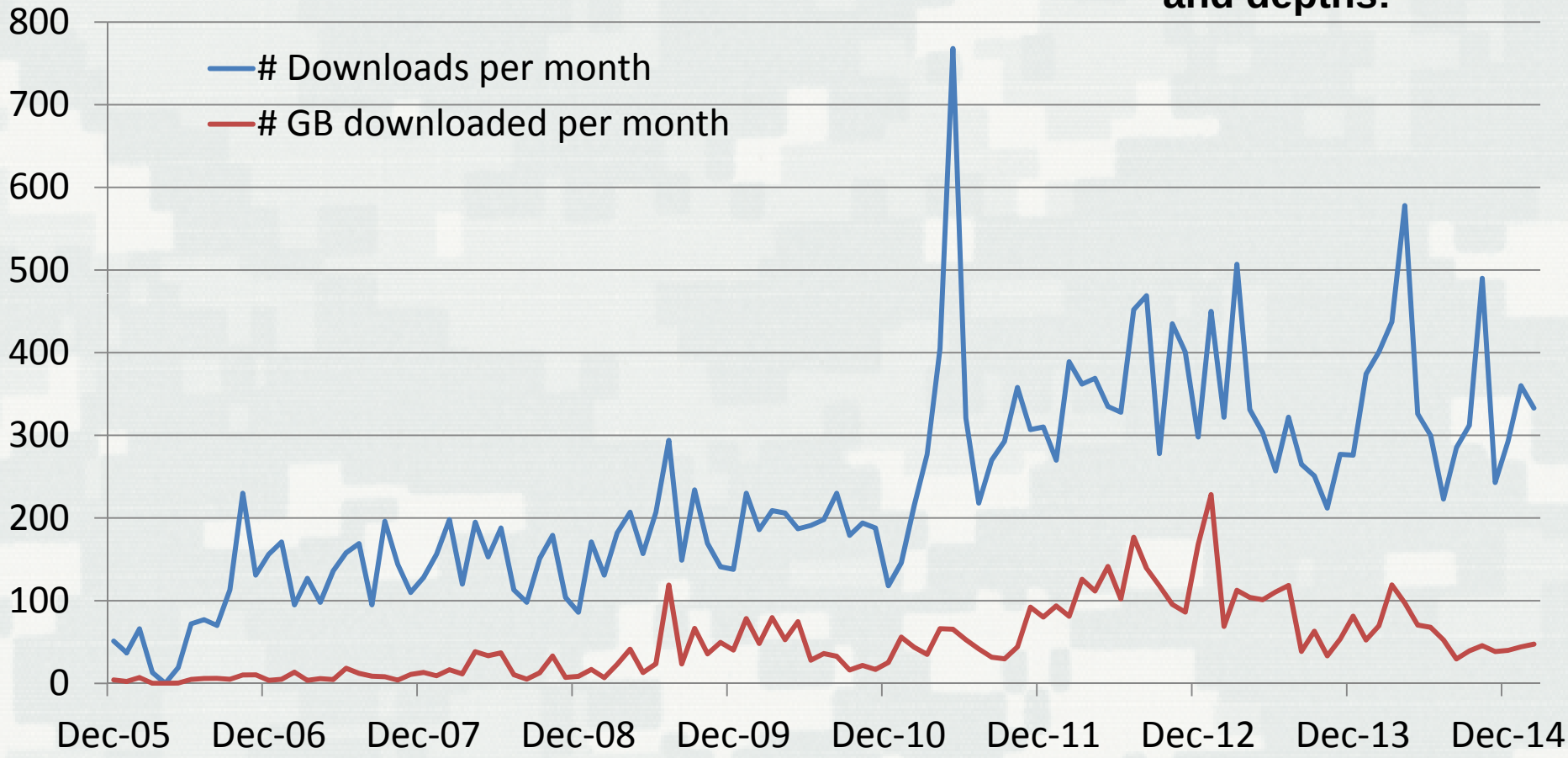
NCMP Data Access



JALBTCX at the DIGITAL COAST

Statistics

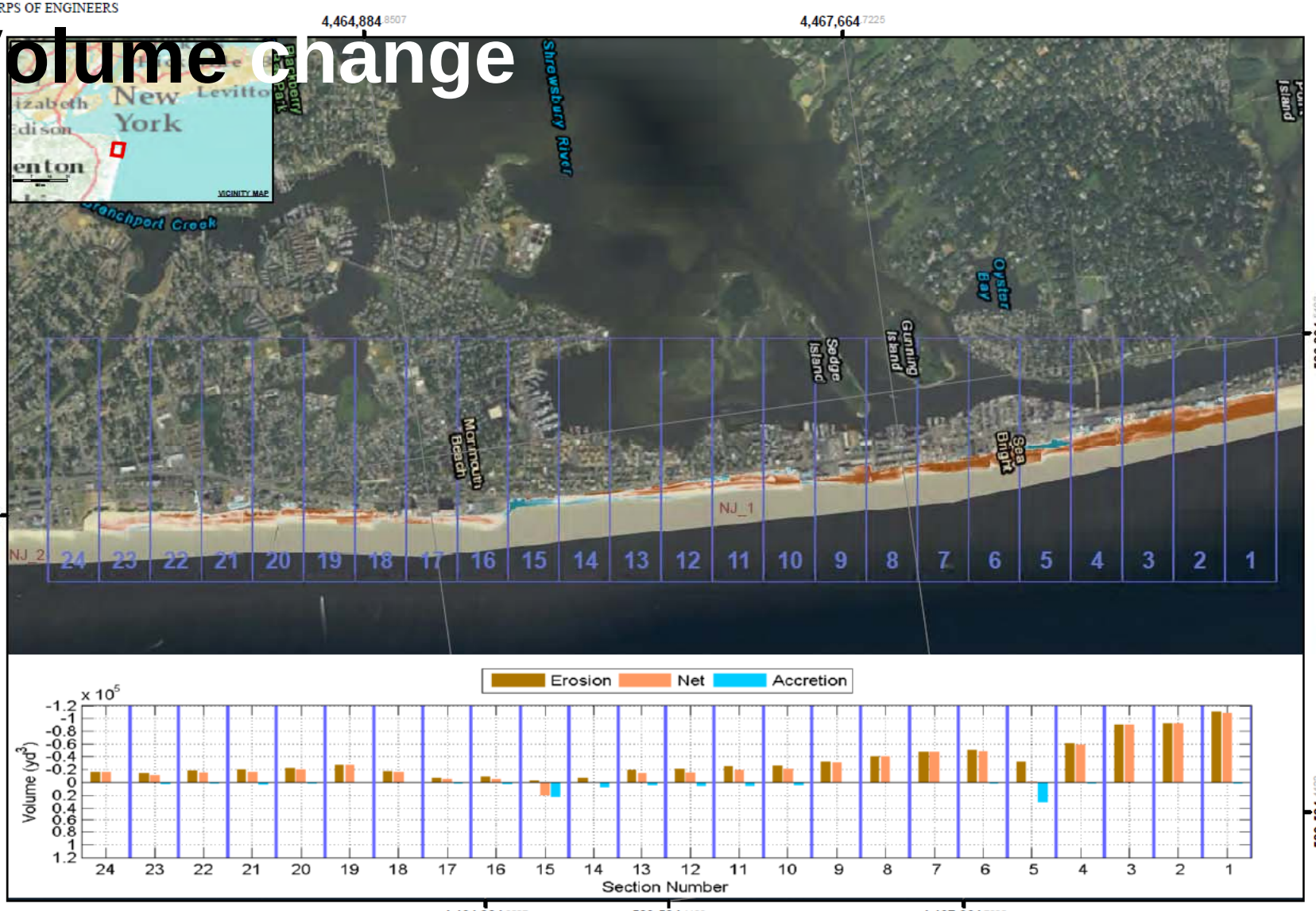
- **26,000 downloads**
- **5.4 TB**
- **1.2 trillion elevations and depths!**



CORPS OF ENGINEERS

U.S. ARMY

Volume change



Section	Net (yd³)	Erosion (yd³)	Accretion (yd³)	Section	Net (yd³)	Erosion (yd³)	Accretion (yd³)
1	-108000	-110000	2000	13	-14000	-19000	5000
2	-92000	-92000	1000	14	1000	-7000	8000
3	-90000	-90000	0	15	20000	-3000	23000
4	-59000	-61000	2000	16	-5000	-9000	3000
5	-1000	-32000	31000	17	-5000	-7000	2000
6	-49000	-51000	2000	18	-16000	-17000	1000
7	-48000	-48000	0	19	-27000	-27000	0
8	-41000	-41000	0	20	-20000	-22000	2000
9	-31000	-32000	1000	21	-16000	-20000	4000
10	-21000	-26000	5000	22	-15000	-18000	2000
11	-19000	-25000	6000	23	-11000	-14000	3000
12	-15000	-21000	6000	24	0	0	0

Elevation Difference (yd)

High : 2

Low : -2

Miles 0 0.5 1

Joint Airborne Lidar Bathymetry Technical Center of Expertise

Horizontal Coordinate System:
NAD 1983 UTM Zone 18N

Datum: North American 1983

Distance Units: Meter

Vertical Datum:
Elevation differences are shown in yards.

The information depicted on this map represents a comparison of survey data collected by JALBTCX after Superstorm Sandy in late October 2012. The data and comparison are preliminary.

Comparison data source: JALBTCX 2010 LIDAR

2012 Aerial Photography data source: NOAA Hurricane Sandy Response Imagery

US Army Corps of Engineers
District: CENAN

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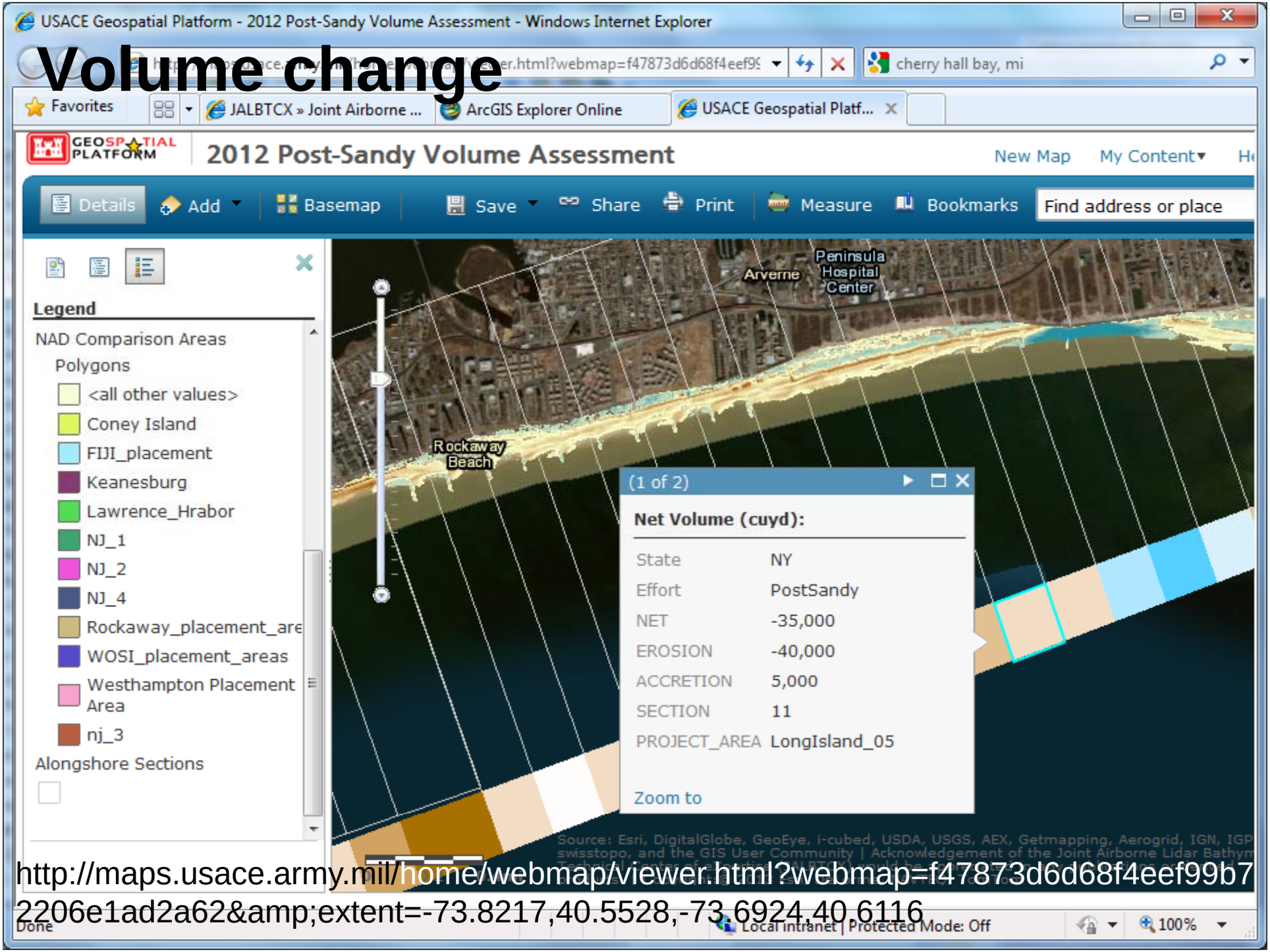
U.S. ARMY CORPS OF ENGINEERS
NEW YORK DISTRICT

National Coastal Mapping Program
Post-Superstorm Sandy
Elevation Differences and Volumes
New Jersey 03: 000258

Sheet Reference Number 1 of 1

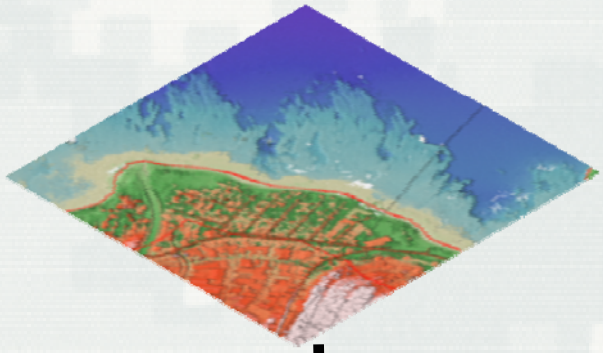
Volume change



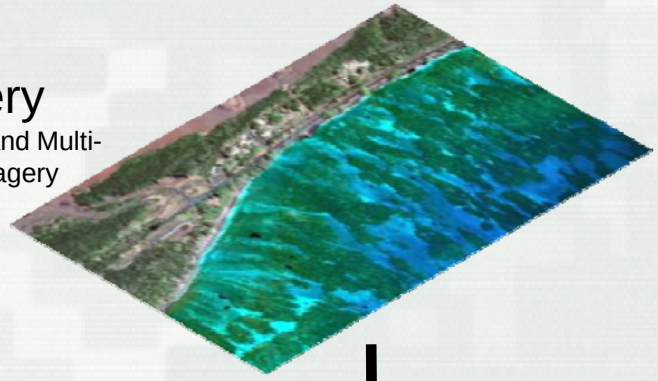
http://maps.usace.army.mil/home/webmap/viewer.html?webmap=f47873d6d68f4eef99b72206e1ad2a62&extent=-73.8217,40.5528,-73.6924,40.6116

Metrics/Parameters

Elevation
Change
(elevation/volume)
Contour (change)
Shoal

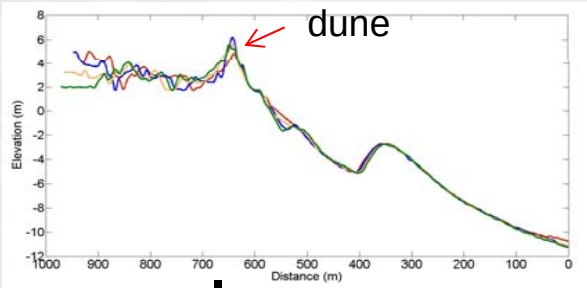


Imagery
Hyperspectral and Multi-Spectral Imagery

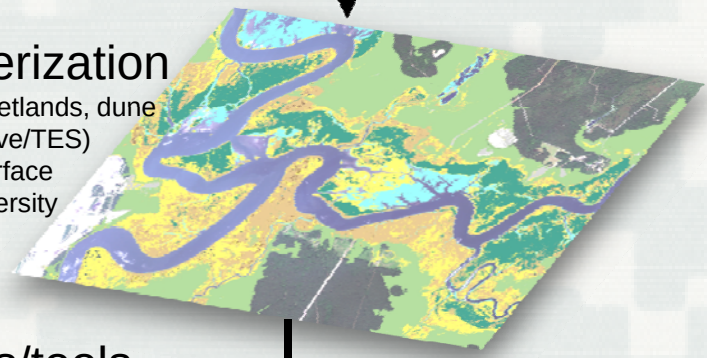


Dune
Elevation (crest/toe)
Continuity
Slope
Volume

Beach
Width
Slope



Land characterization
Critical habitat (SAV, wetlands, dune vegetation, invasive/TES)
Impervious surface
Landscape diversity



R&D/Value added products/tools

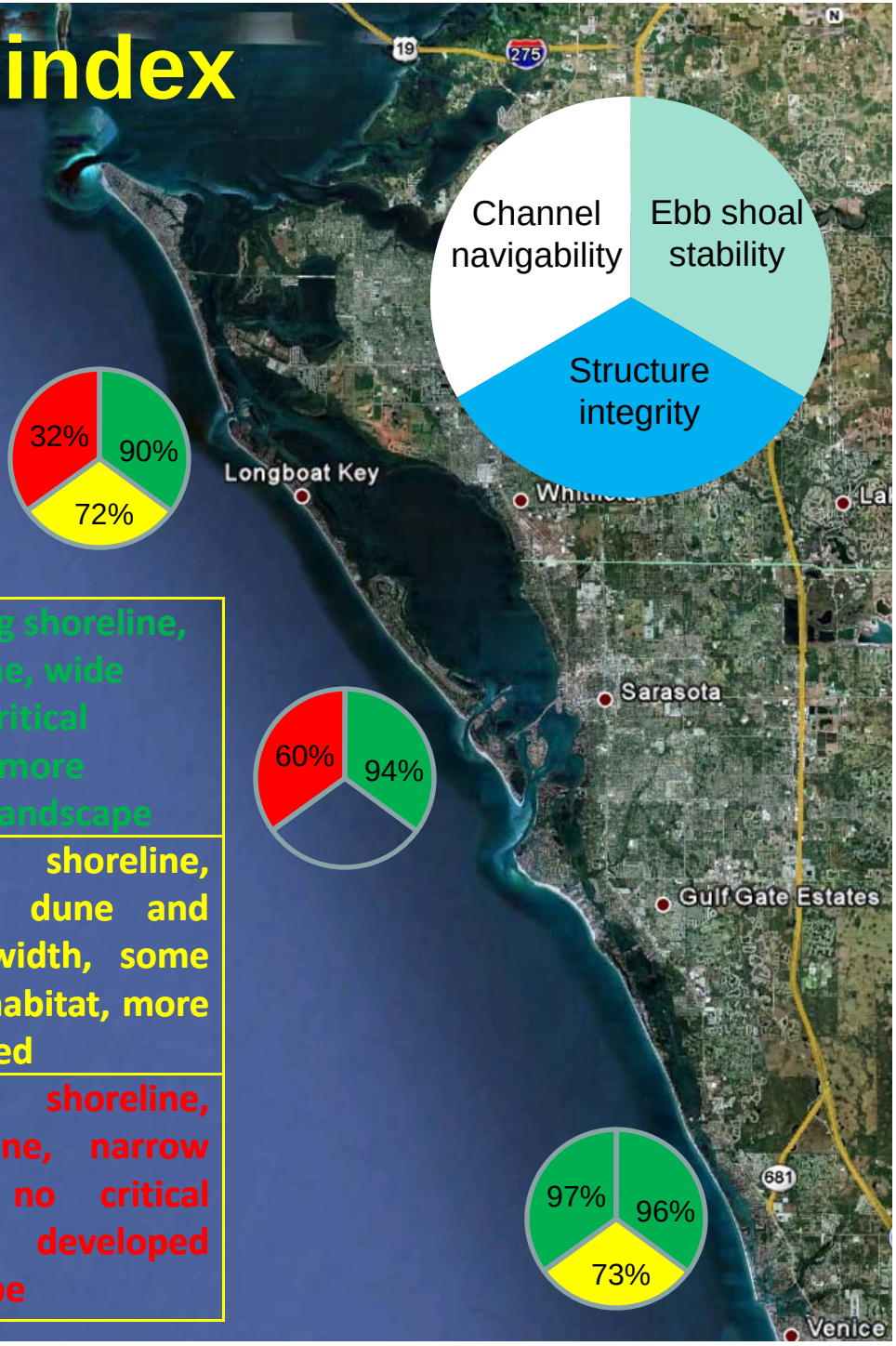
- Change Detection
  - Landscape change modeling
  - Volume/elevation/shoreline change
  - Structure assessment
- Sediment Budgets
- Monitoring Shore Protection
- Defining Coastal Regions

- Coastal Engineering Index
- Coastal Resilience
- Critical Species Detection and Modeling
  - Sea turtle nesting habitat
  - Oysters*
  - Salmonid

* ECO-PCX model certification

Coastal engineering index

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



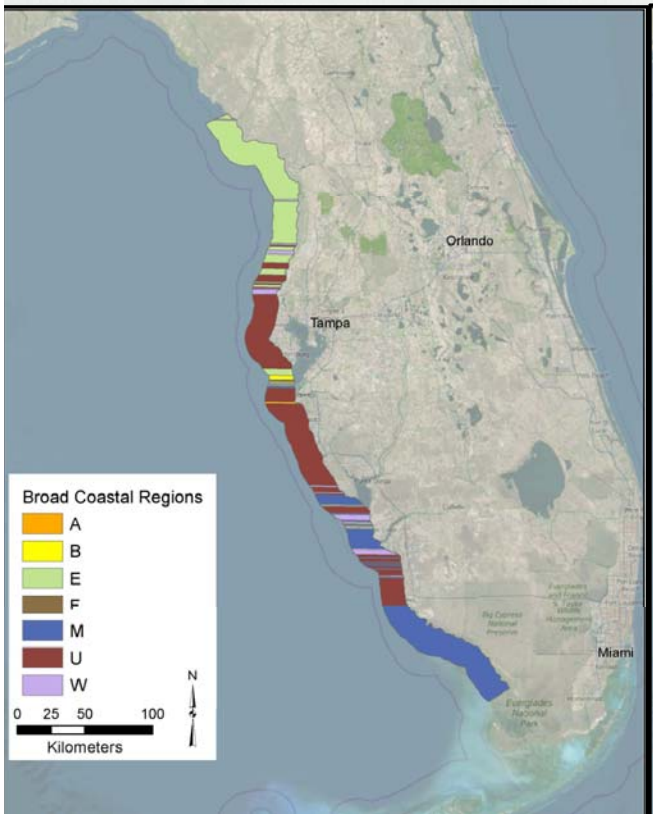
Defining coastal regions

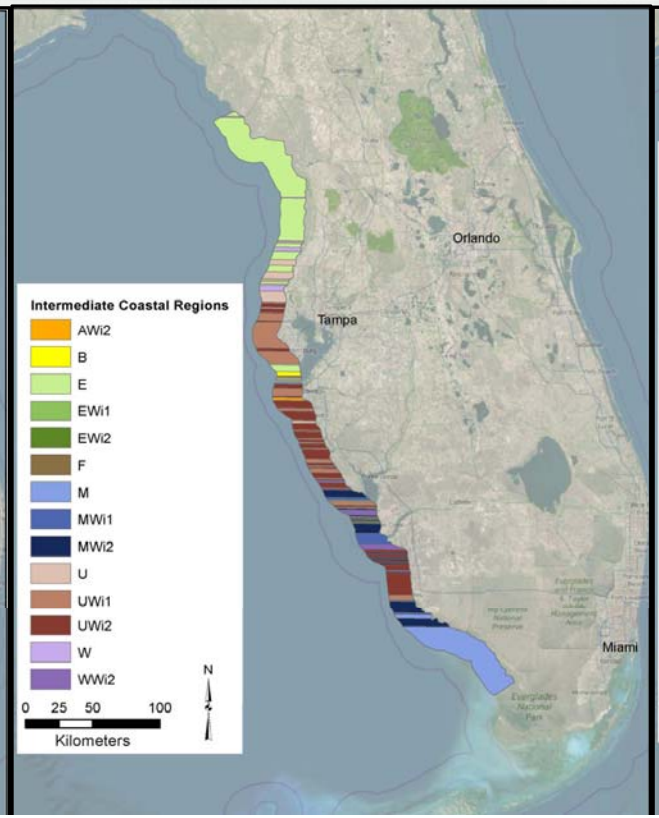
- The input data layers were combined to form a hierarchical gradient ranging from broad coastal regions to detailed coastal regions

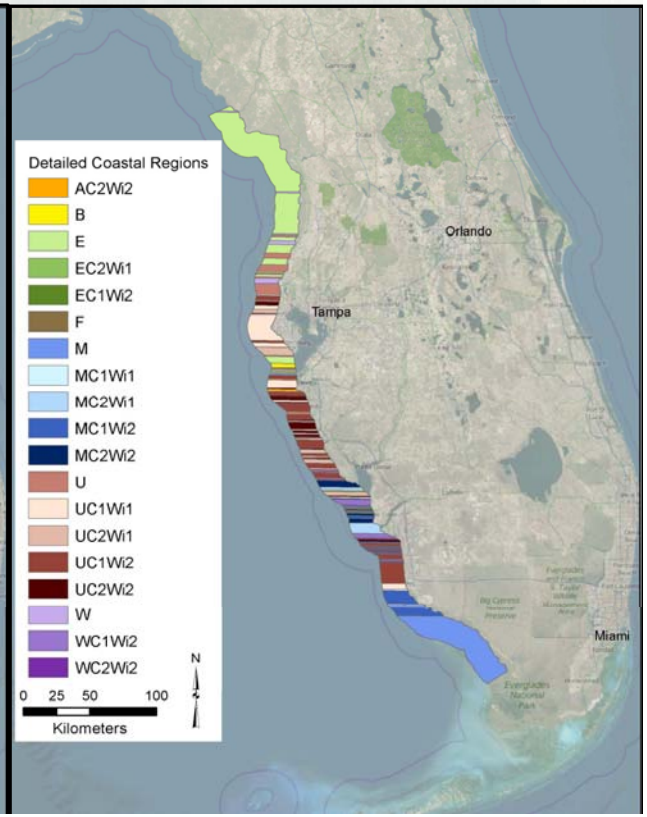
Broad coastal regions – 1km bins grouped based on majority land use/cover only, resulting in 7 divisions

Intermediate coastal regions – 1km bins grouped based on majority land use/cover and average beach width, resulting in 14 divisions

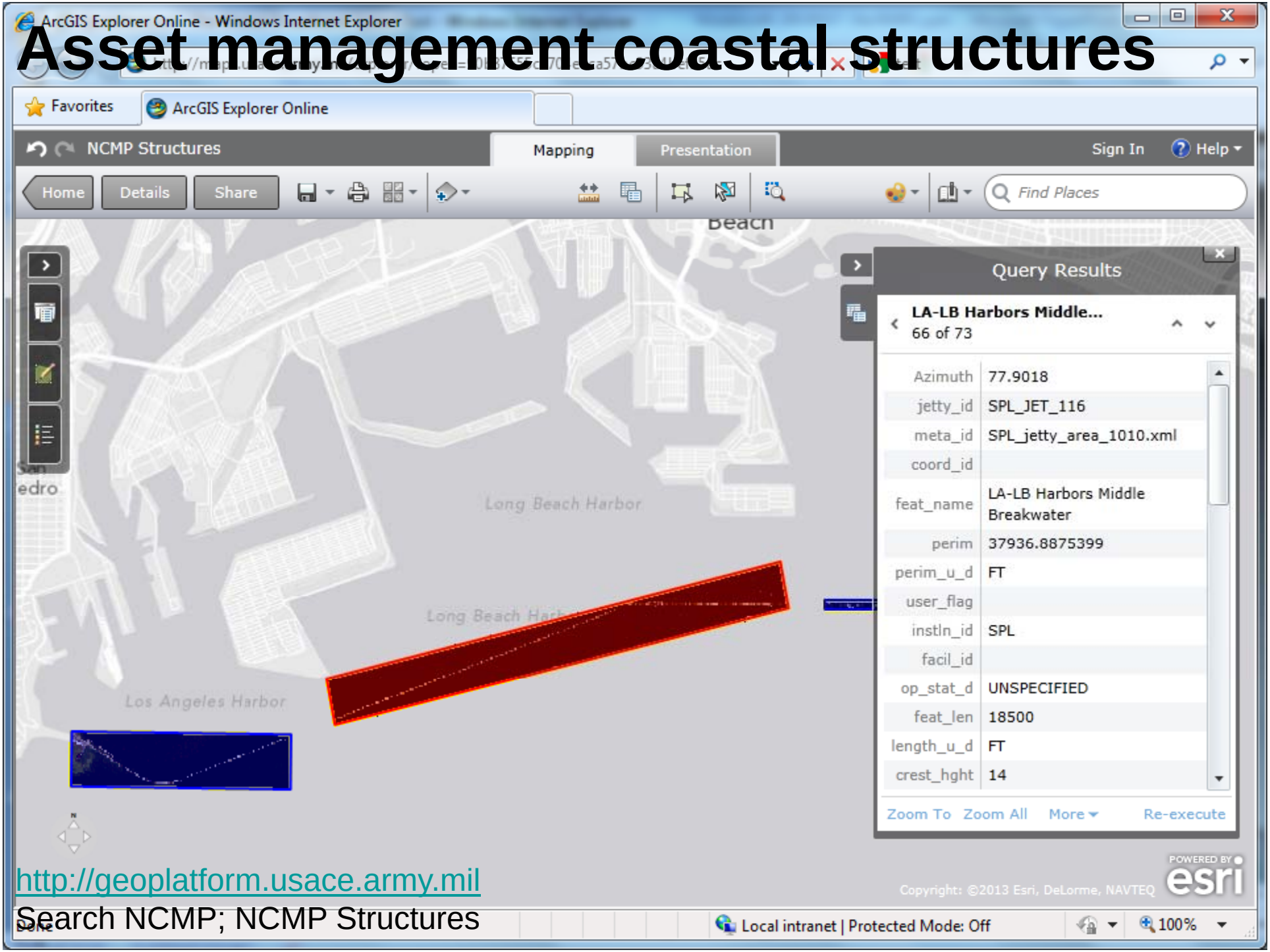
Detailed coastal regions - 1km bins grouped based on majority land use/cover, average beach width, and dune crest ranges, resulting in 19 divisions







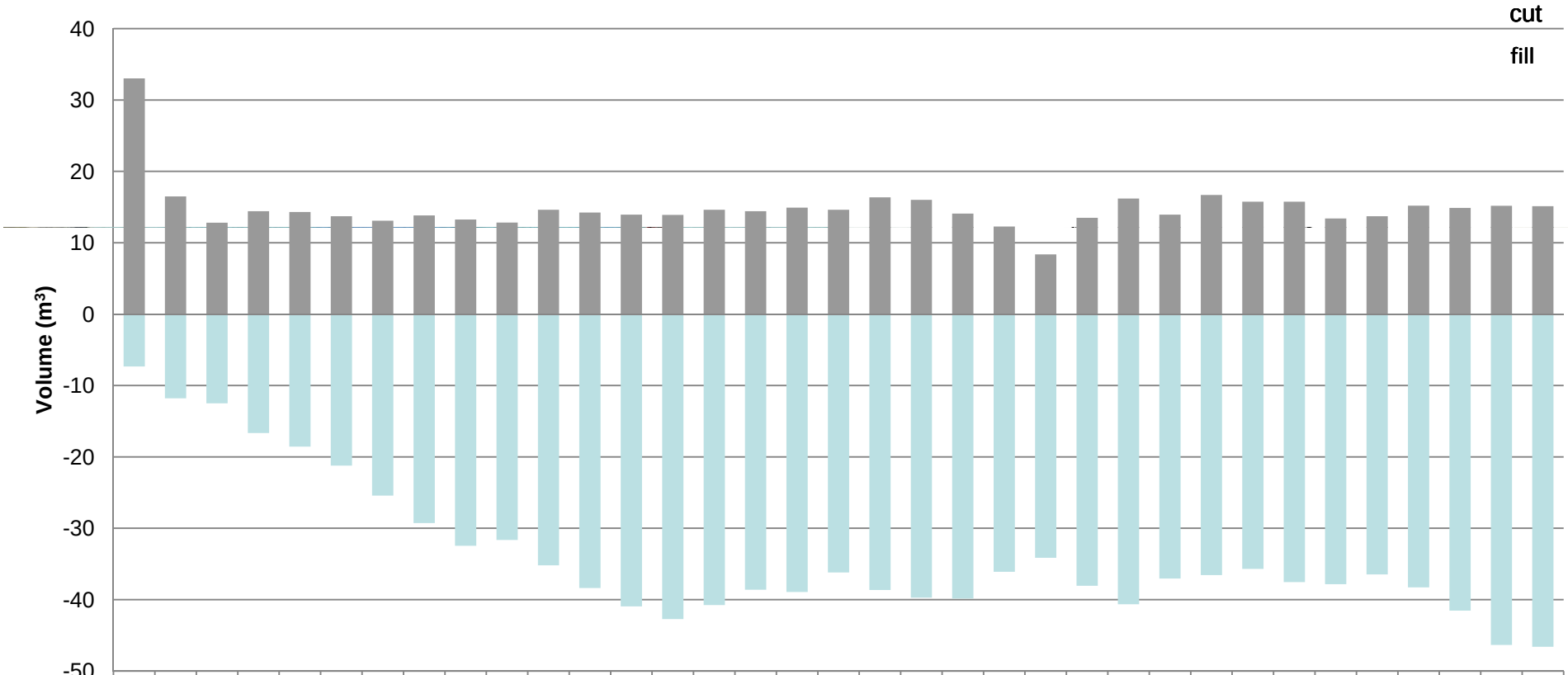
Asset management coastal structures



http://geoplatform.usace.army.mil

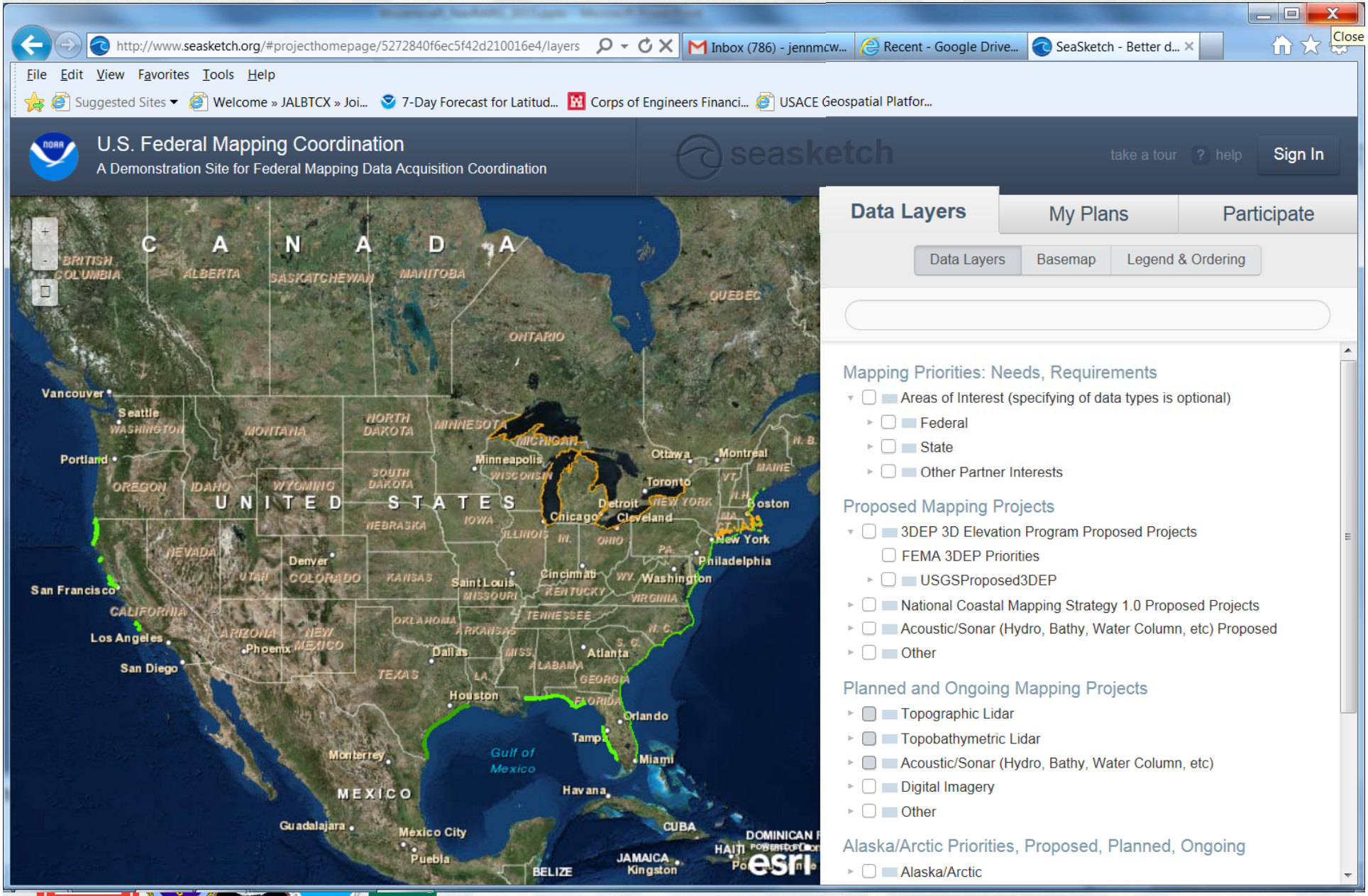
Search NCMP; NCMP Structures

Asset management coastal structures

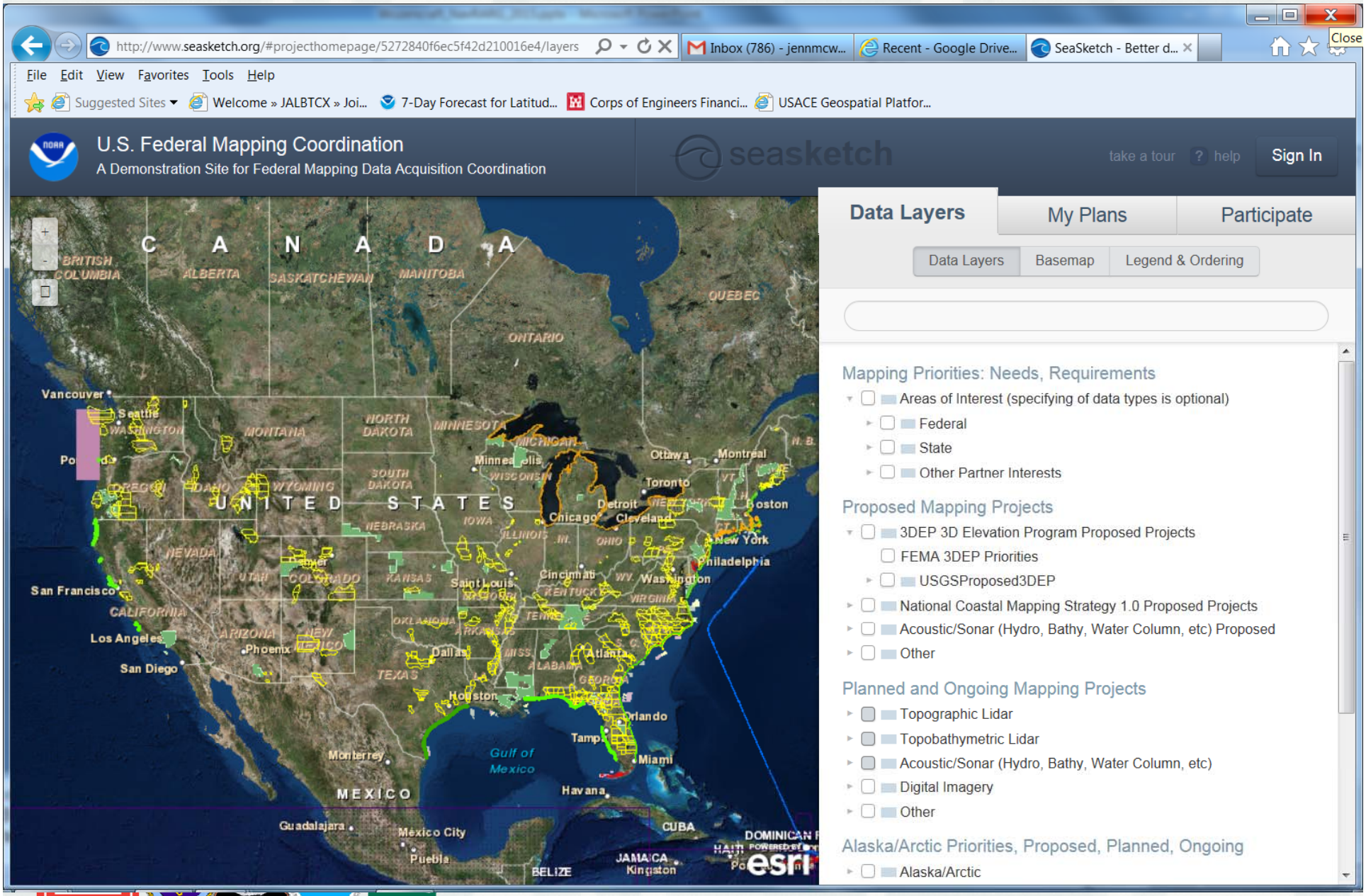


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Cut	33	16	13	14	14	14	13	14	13	13	15	14	14	14	15	14	15	15	16	16	14	12	8.4	13	16	14	17	16	16	13	14	15	15	15	15
Fill	-7	-12	-13	-17	-19	-21	-25	-29	-32	-32	-35	-38	-41	-43	-41	-39	-39	-36	-39	-40	-40	-36	-34	-38	-41	-37	-37	-36	-38	-38	-36	-38	-42	-46	-47

Future NCMP acquisitions

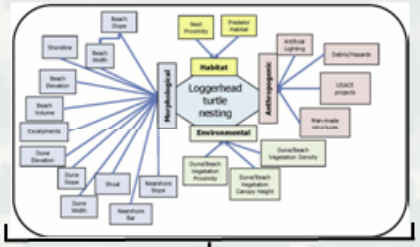


Federal mapping coordination



Future data development

Demonstration of a Sea Turtle Nesting Habitat Model Using Remotely Sensed Data

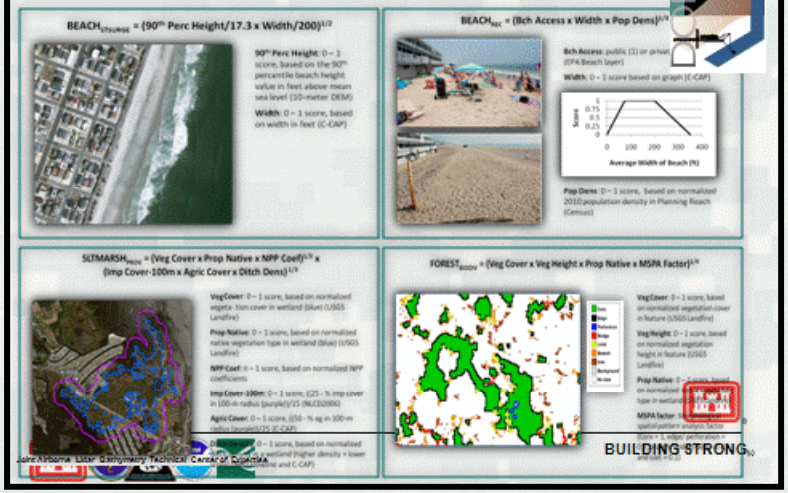


- Map of relative suitability based on spatially derived parameters
  - Regional value ranges (transferable to other sites)

- Mappable/spatial parameters identified through literature review
  - Morphological
  - Environmental
  - Anthropogenic
  - Habitat
- Parameter list refined based on feedback from subject matter experts
  - important for nesting habitat
  - correlates with the resolution of the spatial datasets

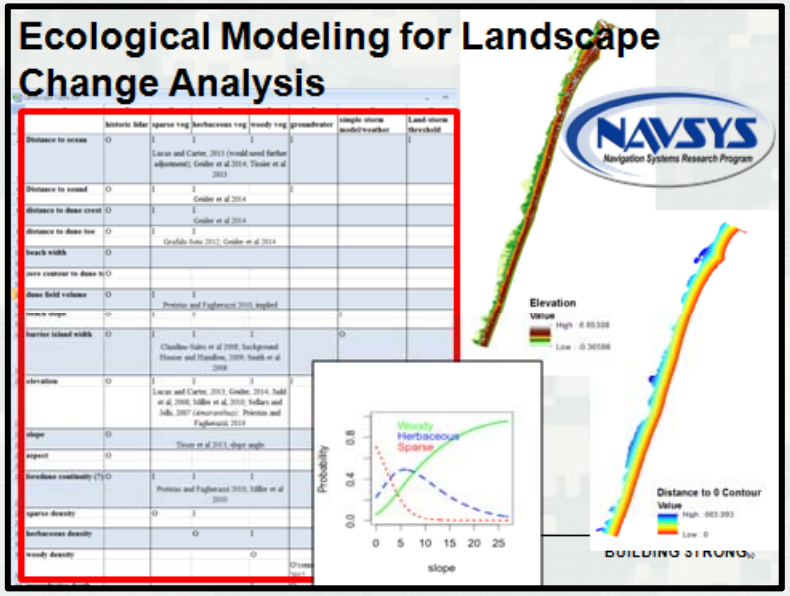
Joint Airborne Lidar Bathymetry Technical Center of Expertise 26 BUILDING STRONG®

Measuring and Analyzing Environmental Condition and Benefits



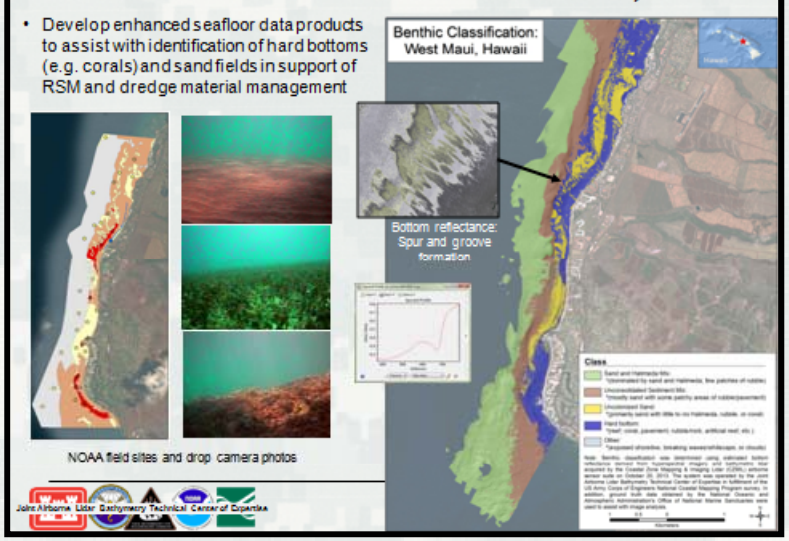
Joint Airborne Lidar Bathymetry Technical Center of Expertise BUILDING STRONG®

Ecological Modeling for Landscape Change Analysis



Benthic Classification: West Maui, HI

- Develop enhanced seafloor data products to assist with identification of hard bottoms (e.g. corals) and sand fields in support of RSM and dredge material management

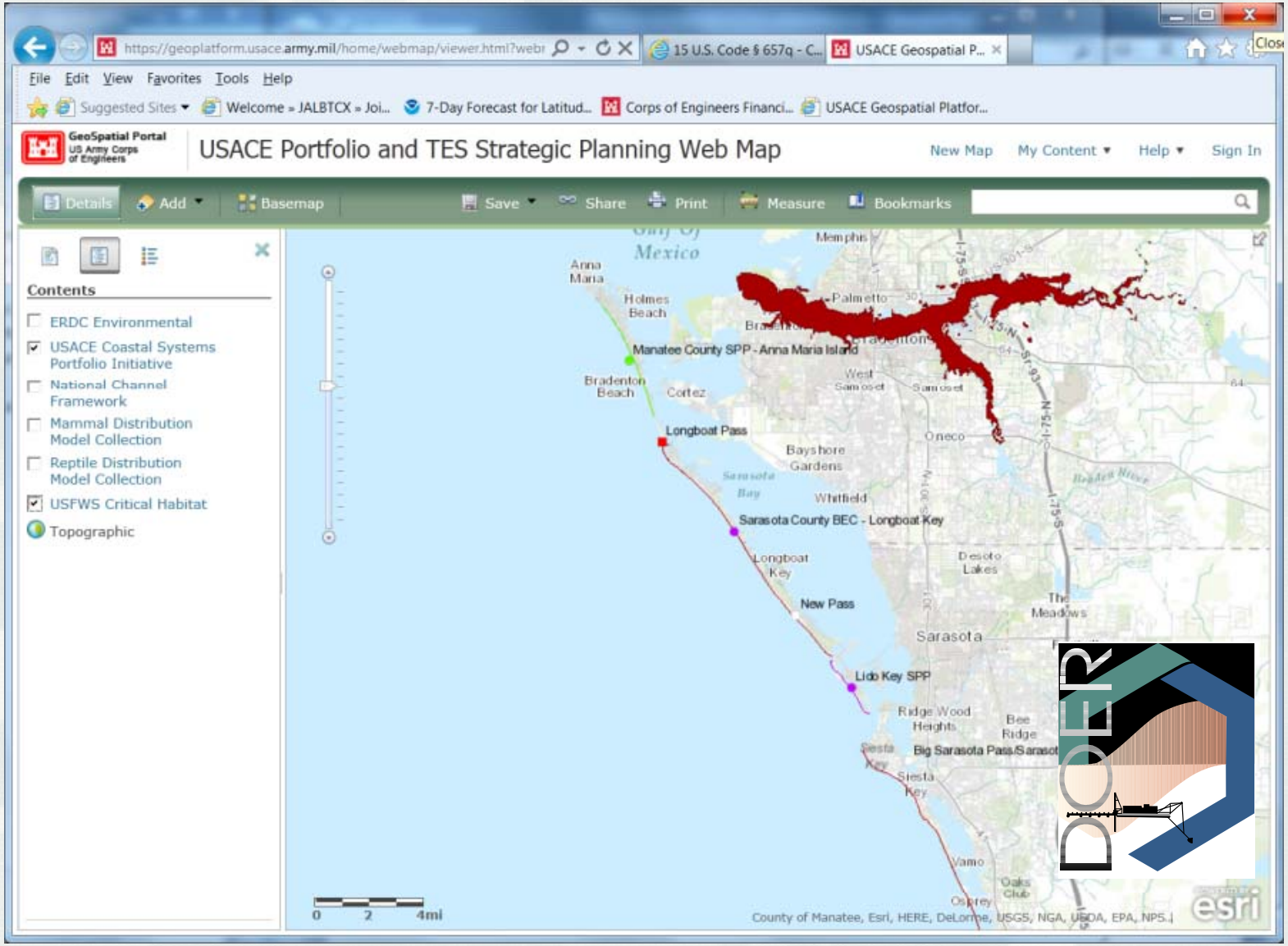


Joint Airborne Lidar Bathymetry Technical Center of Expertise

Joint Airborne Lidar Bathymetry Technical Center of Expertise

BUILDING STRONG®

Future data delivery and tools



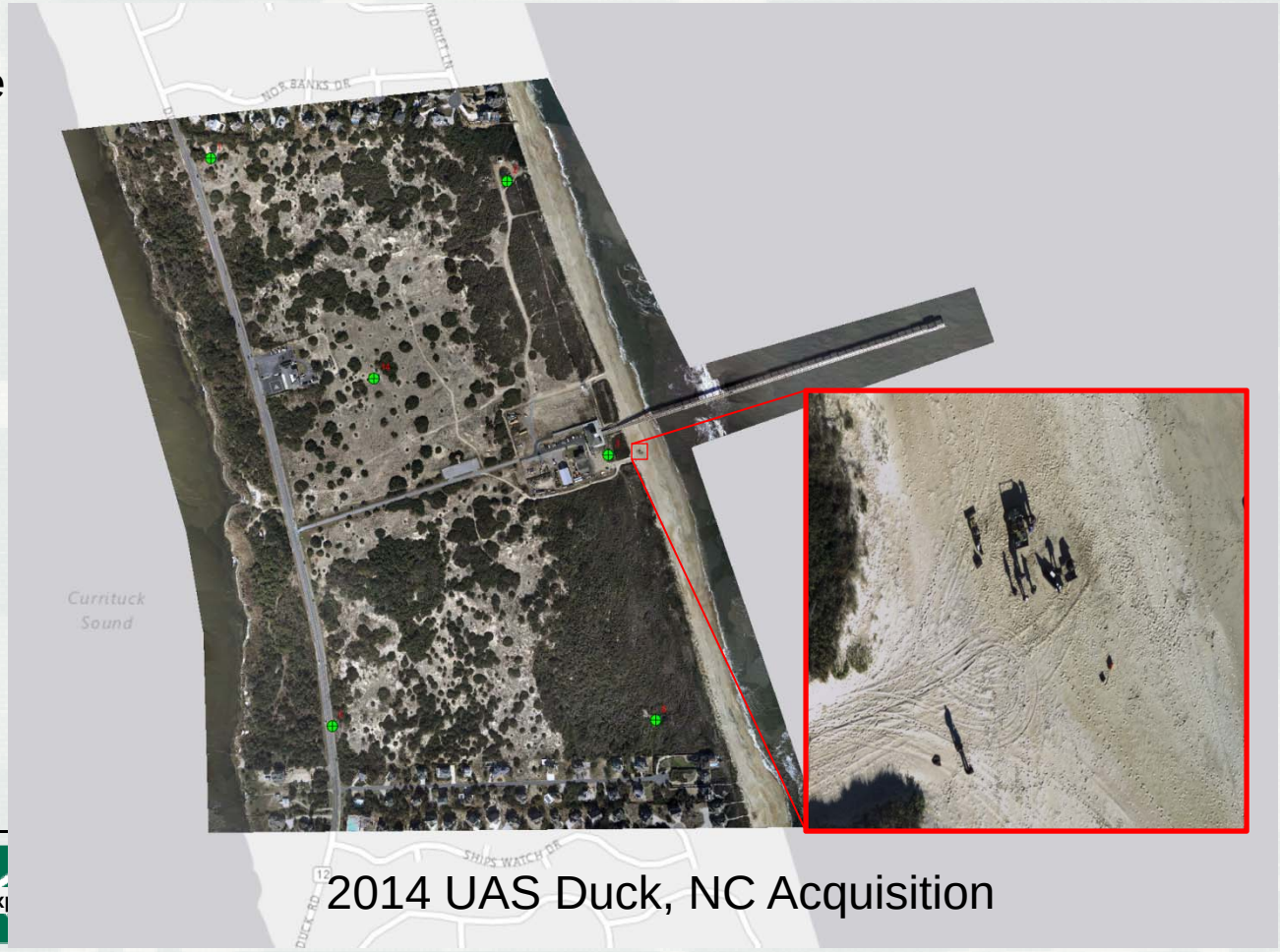
Future platforms

- 0.75 sq mile project area centered around the USACE Field Research Facility in Duck, NC
- Nova Block 3 Unmanned Aerial Vehicle (UAV)
- Imperix Bobcat 29mp True Color Camera 400ft @ 0.018 meter pixels (0.02m delivered products)
- 9 Missions
- 6 Ground control stations
- SimActive, Inc Correlator3D software for image processing and AeroTriangulation
- Final RMSE of > 1 pixel at 0.016m.

Control Point AT Residuals (pixels)			
Point ID	avg residual	std dev	image observations
1	0.68	0.34	23
2	0.54	0.28	26
3	0.74	0.38	31
5	0.81	0.39	19
6	0.98	0.43	52
14	0.94	0.26	16

Ground Control Used in Triangulation			
Point ID	X m	Y m	Z m
1	431852.55	4004842.02	7.298
2	432313.78	4004806.00	5.130
3	432471.92	4004377.71	5.988
5	432041.41	4003952.99	3.000
6	432545.78	4003962.19	3.138
14	432106.48	4004497.09	2.811

	pixels	meters
RMSE	0.796	0.016



2014 UAS Duck, NC Acquisition

Questions?

Siuslaw, OR, 2014 federal navigation project & adjacent beaches

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