JALBTCX Activities and USACE National Coastal Mapping Program

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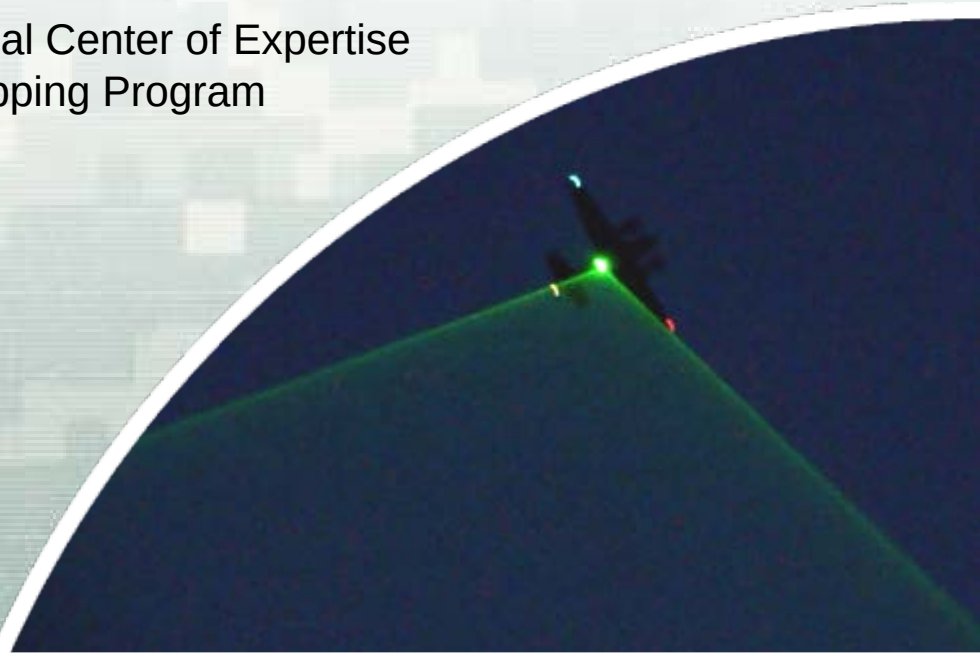
Program Manager, USACE National Coastal Mapping Program

16 June 2015

Outline

- JALBTCX background and activities
- NCMP data acquisition
- NCMP data products and applications
- Upcoming activities



US Army Corps of Engineers
BUILDING STRONG®

Joint Airborne Lidar Bathymetry Technical Center of Expertise

Joint Airborne Lidar Bathymetry Technical Center of Expertise

Annual Technical Workshop, 14-16 June 2016

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

CBI

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

FUGRO

Virginia Tech

WOOLPERT DESIGN | GEOSPATIAL | INFRASTRUCTURE

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

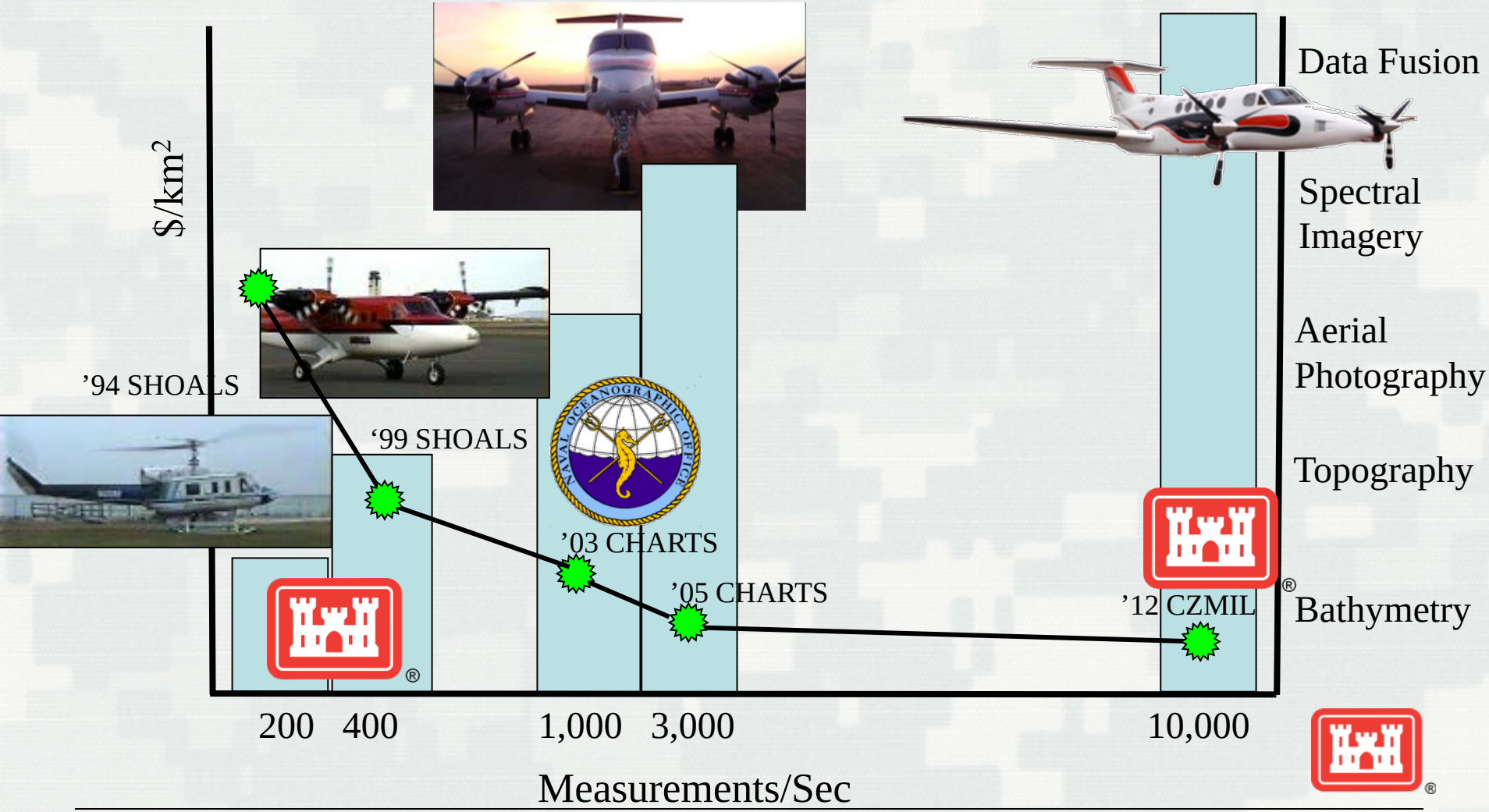
Pelydryn

TEXAS A&M UNIVERSITY

UNIVERSITY of NEW HAMPSHIRE

GEOMATICS DATA SOLUTIONS

JALBTCX sensor development history



Blue Book II

- Update of the original
- Fall 2013 products
  - Searchable BB I
  - ALB bibliography
  - Table of systems
- 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

	Revised: 10 Jul 2013	2014 8	9	10	11	12	1	2
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

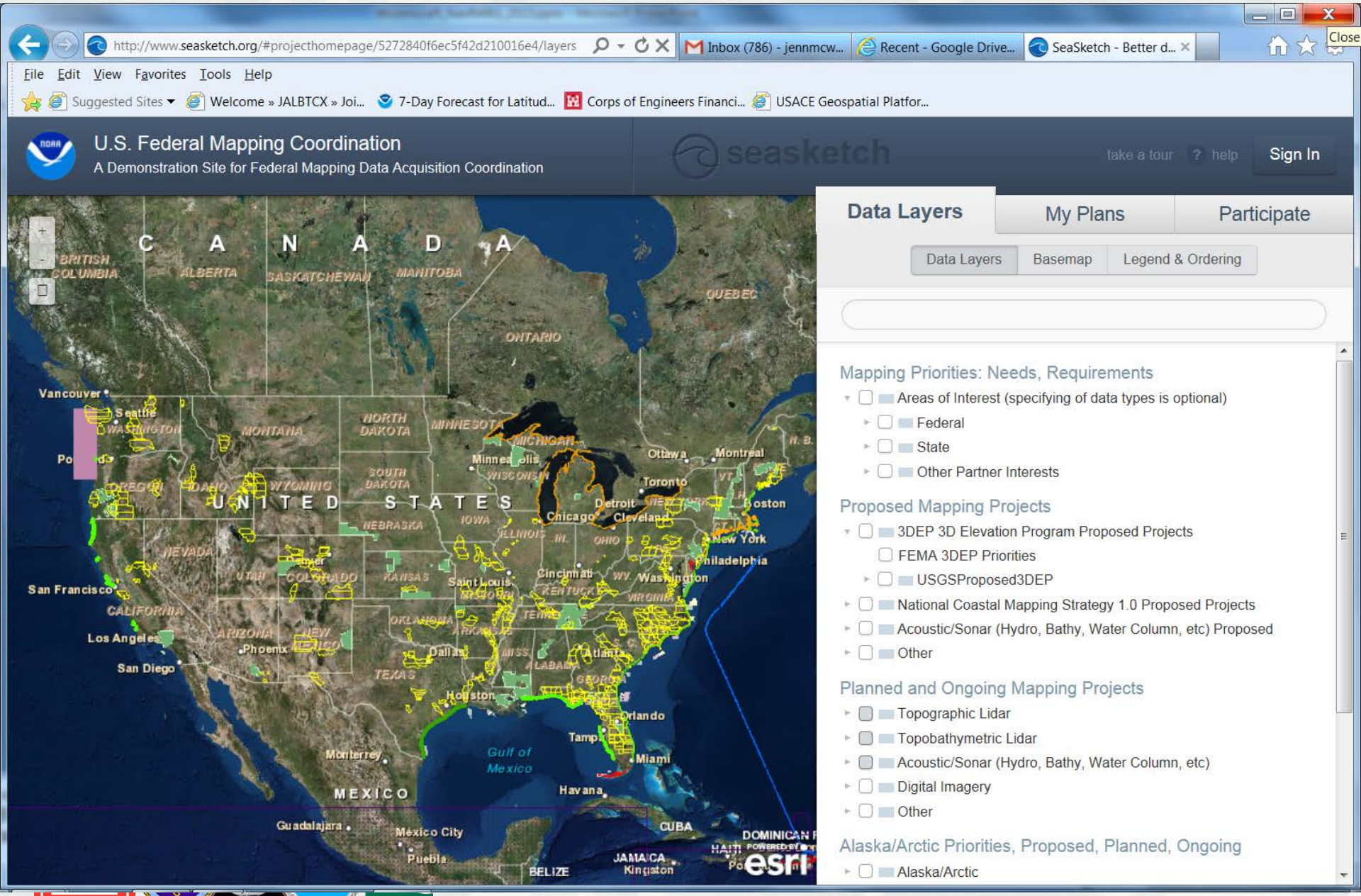
- Part 1: Define multiple-quality-levels for topo-bathy lidar
- Part 2: Recommend hydrographic lidar specification
- Part 3: Identify additional mapping techniques require a specification (e.g., multi- and hyperspectral imagery)

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

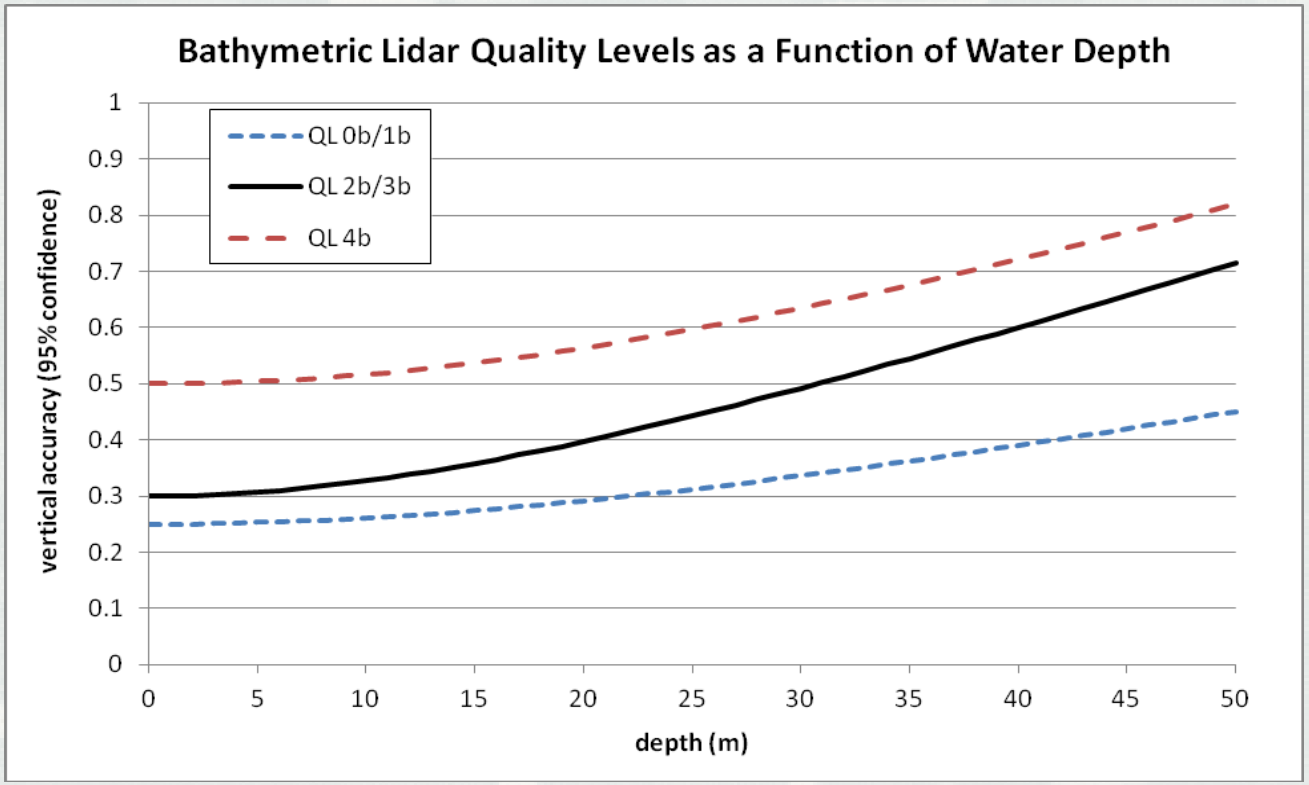
4) Coordinate research and development on new tools and technologies that facilitate interagency coordination on and use of coastal mapping data

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

Federal mapping coordination



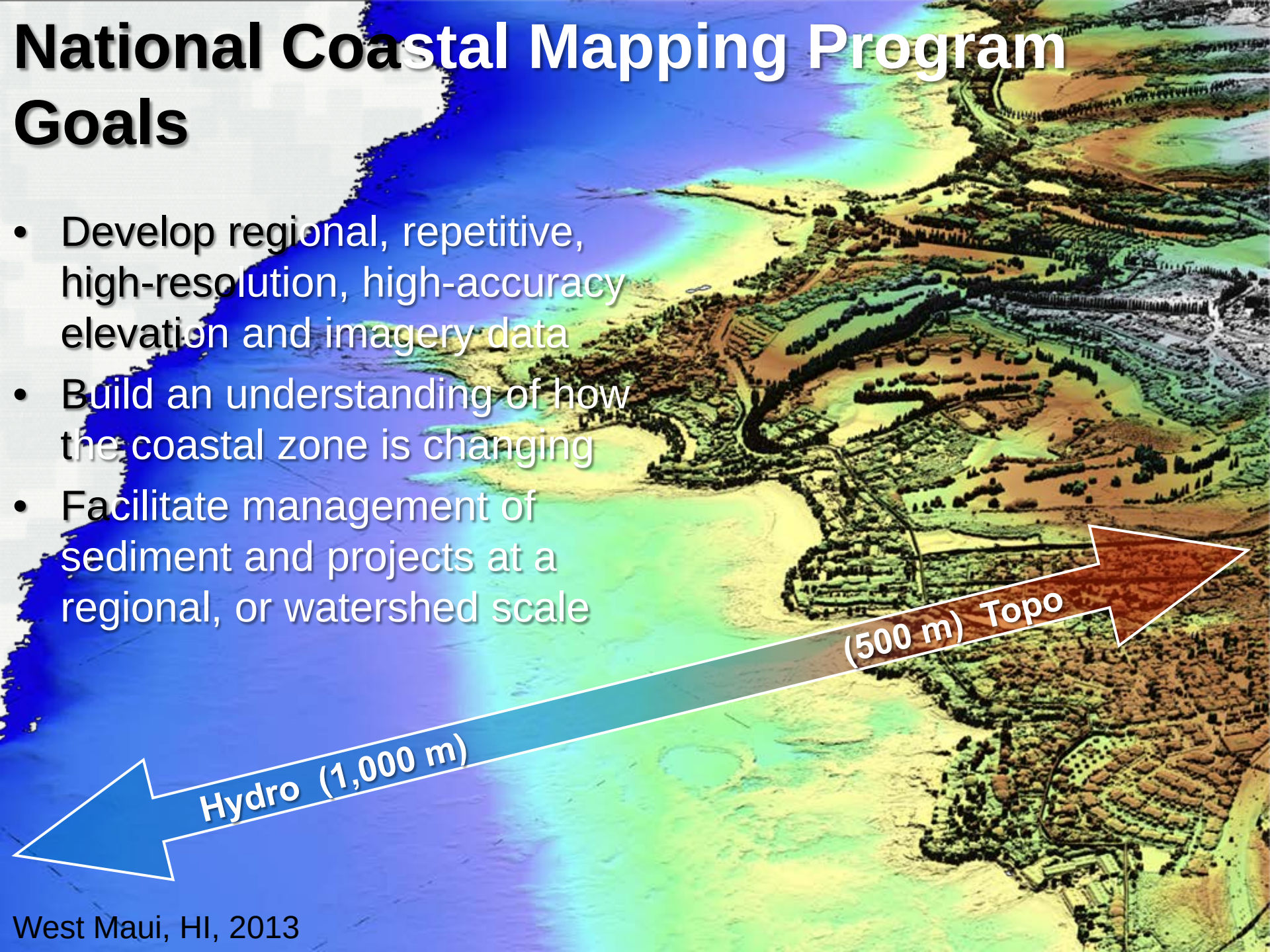
Bathymetric lidar quality levels



Bathy Lidar Quality Level	Source	Vertical accuracy coefficients a,b as in sqrt(a^2+(b*d)^2))	Nominal Pulse Spacing (m)	Point Density (pt/m²)
$QL0_B$	Bathymetric Lidar	0.25, 0.0075	≤0.7	≥2.0
$QL1_B$	Bathymetric Lidar	0.25, 0.0075	≤2.0	≥0.25
$QL2_B$	Bathymetric Lidar	0.30, 0.0130	≤0.7	≥2.0
$QL3_B$	Bathymetric Lidar	0.30, 0.0130	≤2.05.0	≥0.25
$QL4_B$	Bathymetric Lidar	0.50, 0.0130	≤5.0	≥0.04

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

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

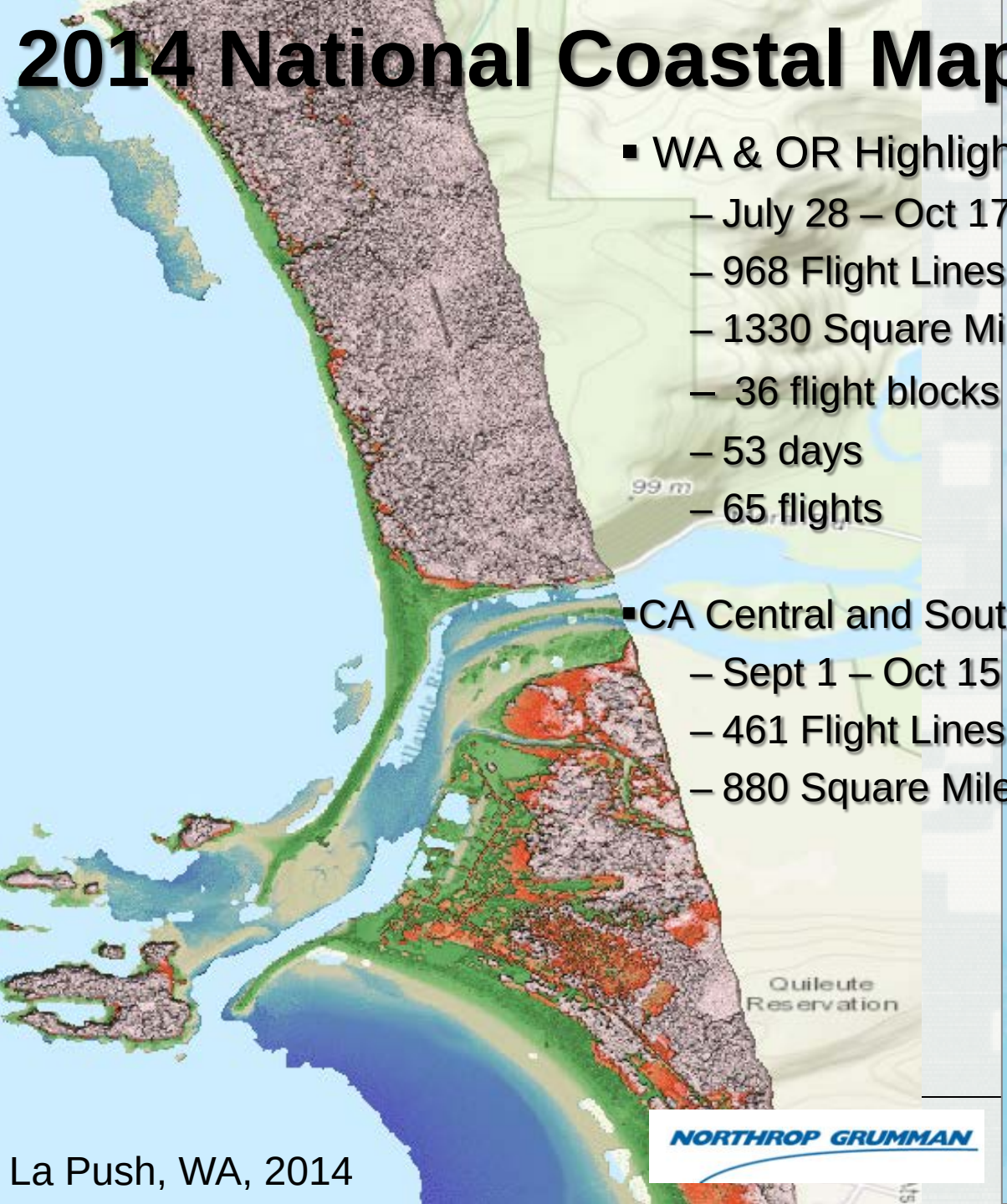
FY15

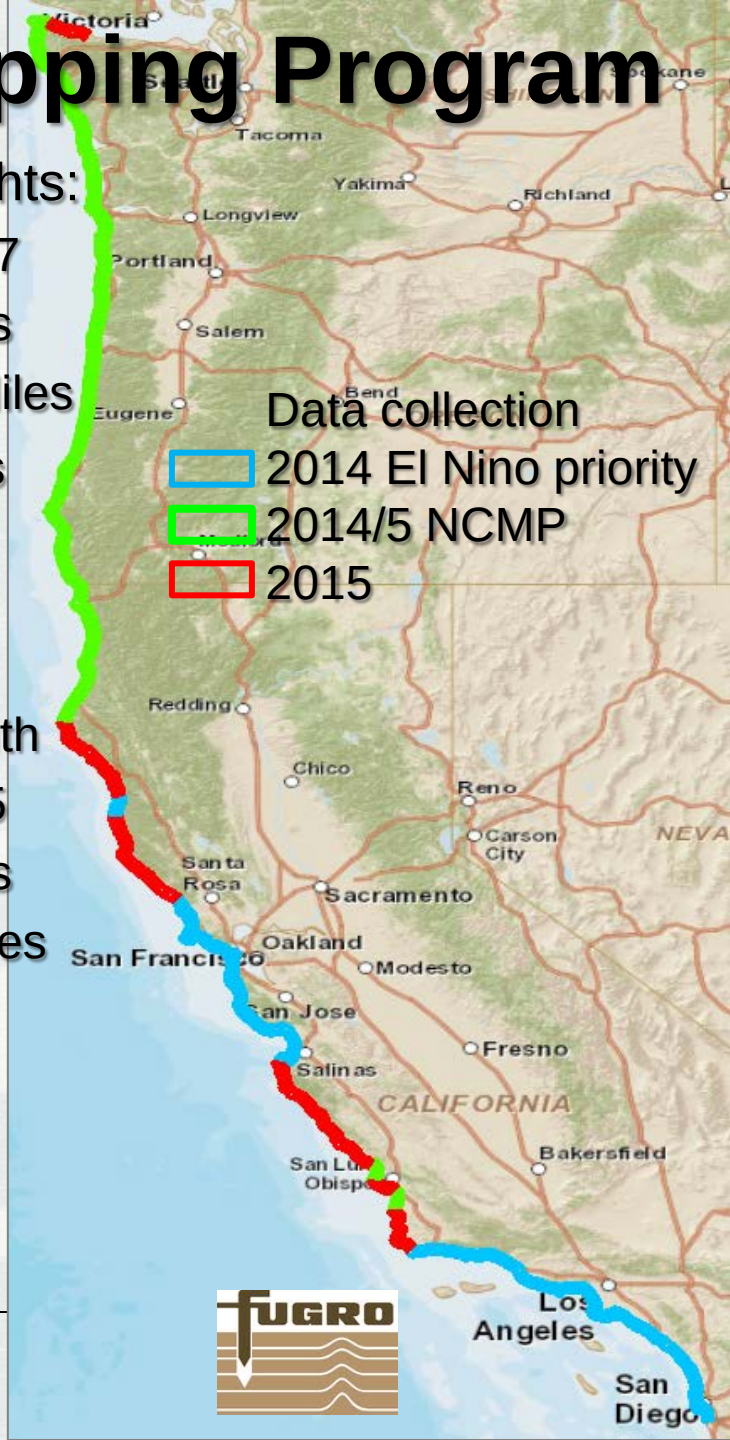
Number of times surveyed since 2004

- One Time
- Two Times
- Three Times
- Four Times
- Five Times
- Six Times

2014 National Coastal Mapping Program

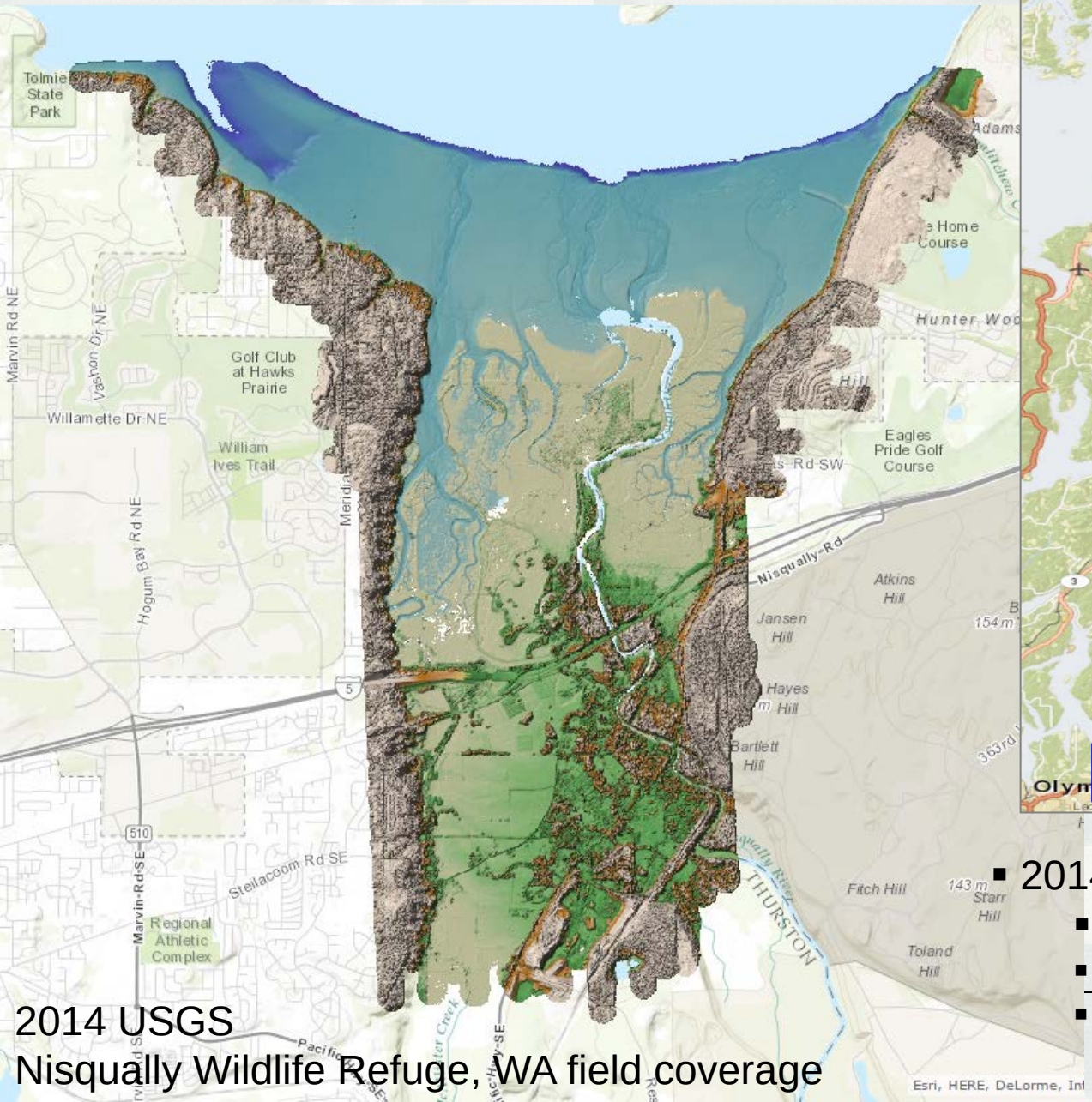
- WA & OR Highlights:
  - July 28 – Oct 17
  - 968 Flight Lines
  - 1330 Square Miles
  - 36 flight blocks
  - 53 days
  - 65 flights
- CA Central and South
  - Sept 1 – Oct 15
  - 461 Flight Lines
  - 880 Square Miles

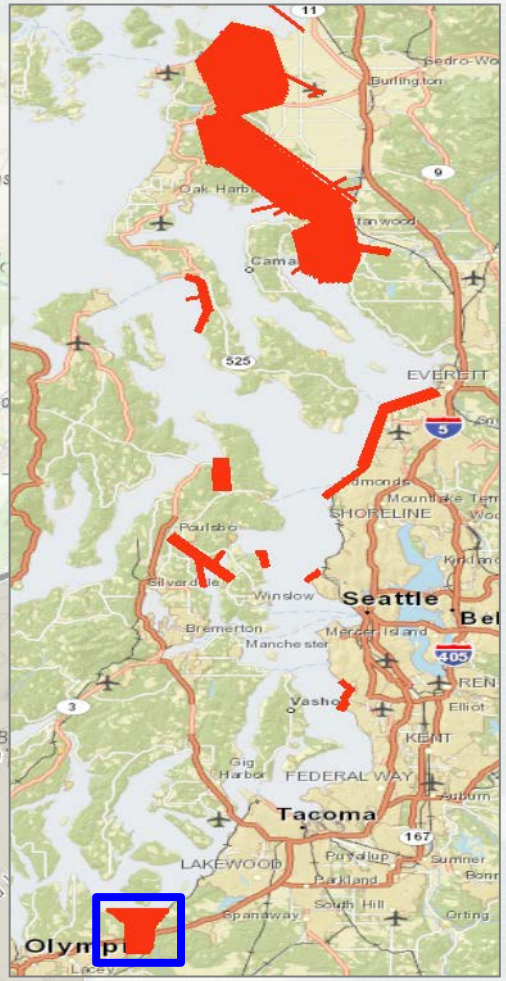




La Push, WA, 2014

2014 National Coastal Mapping Program





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

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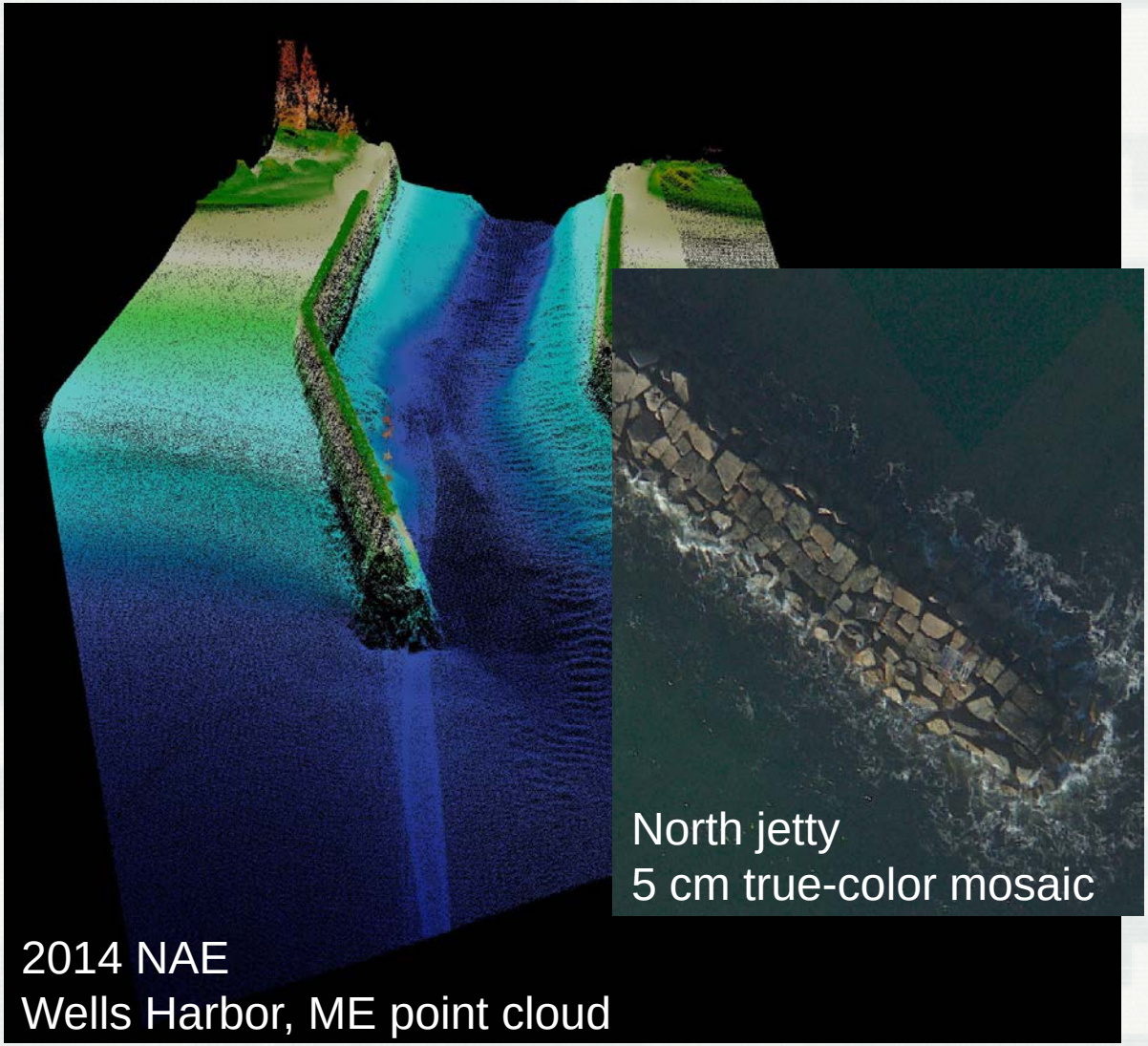
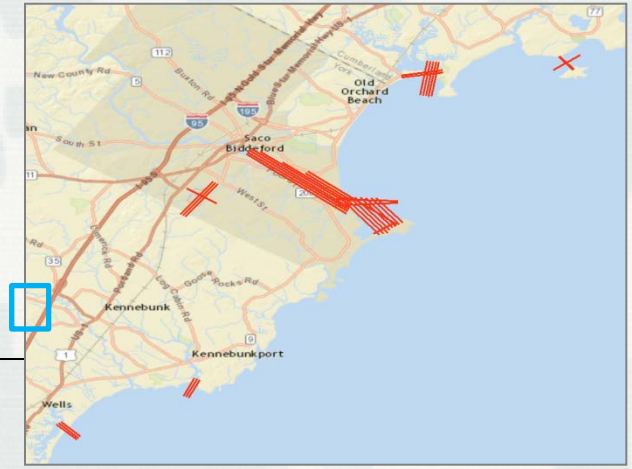
2014 USGS
Nisqually Wildlife Refuge, WA field coverage

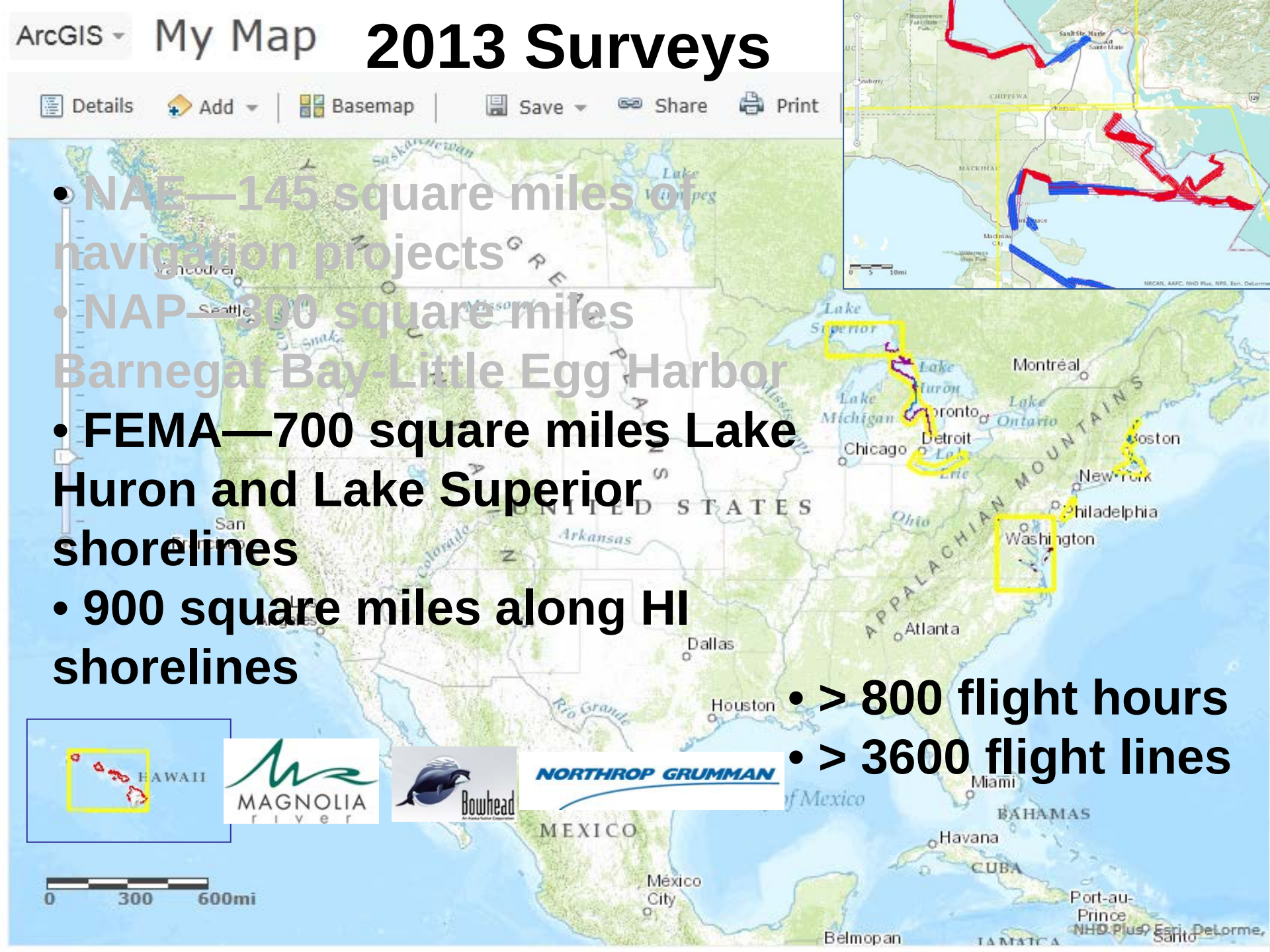
2014 National Coastal Mapping Program



- 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



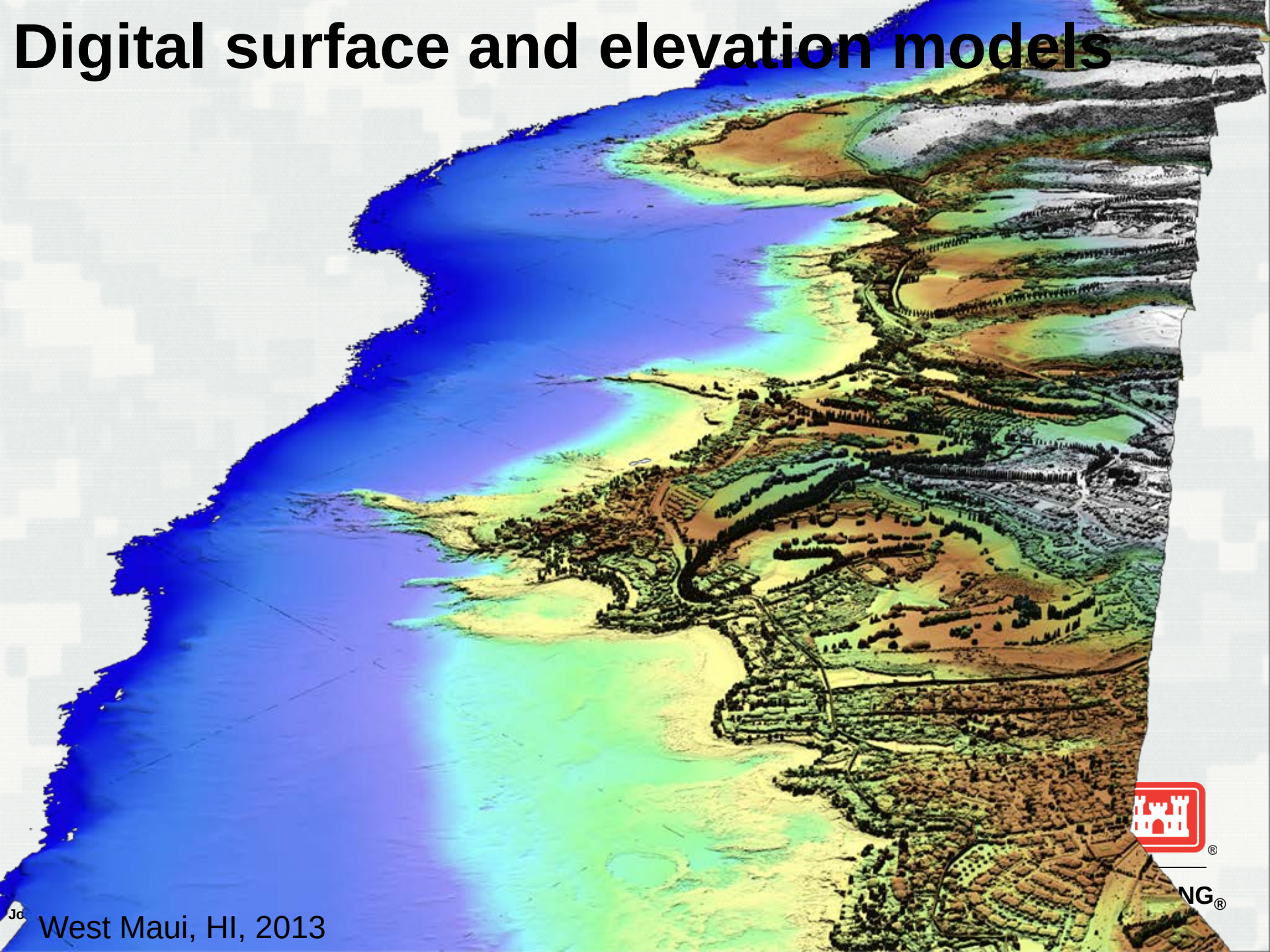
2013 Surveys



- 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**

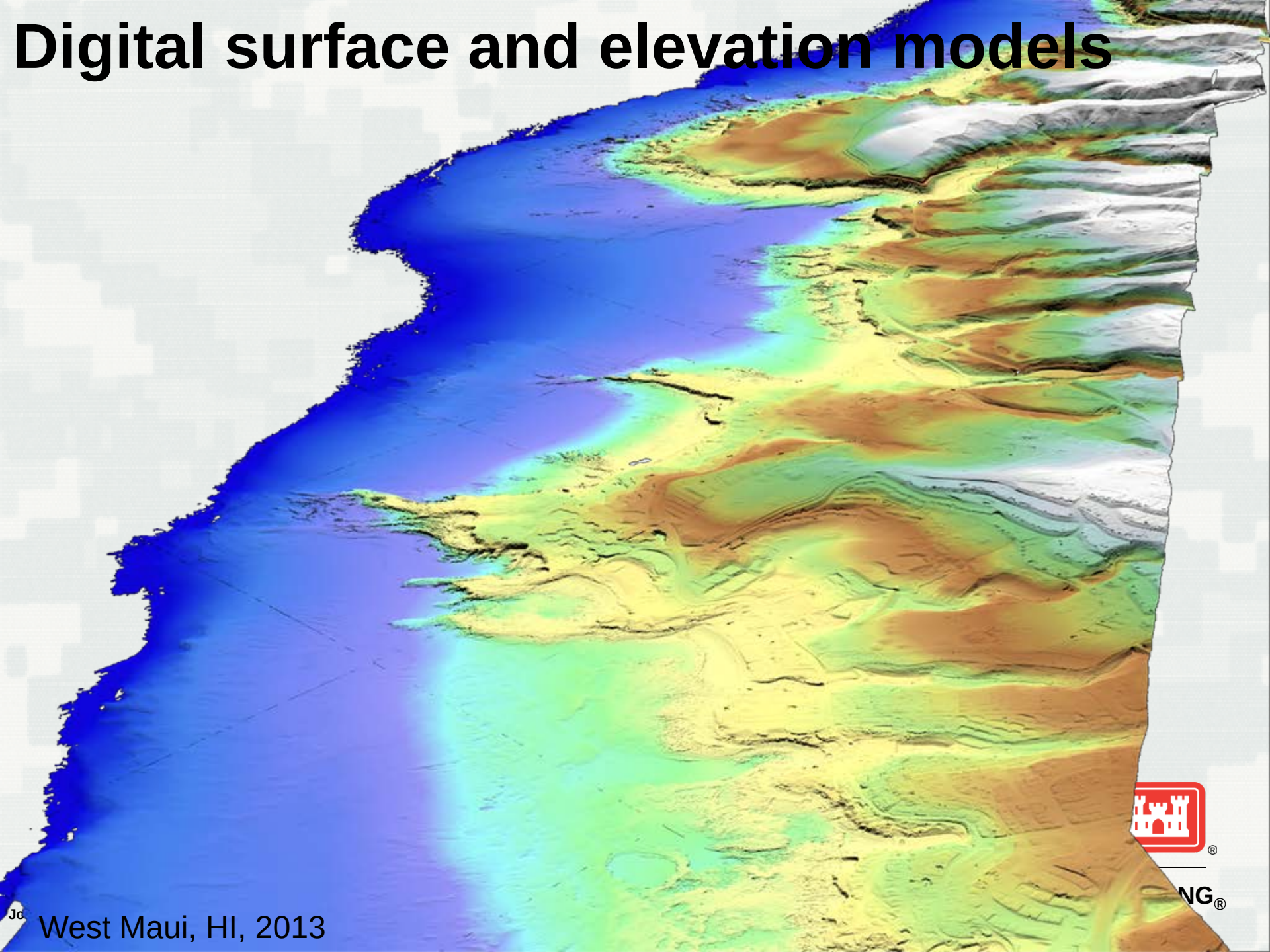
- **> 800 flight hours**
- **> 3600 flight lines**

Digital surface and elevation models



West Maui, HI, 2013

Digital surface and elevation models



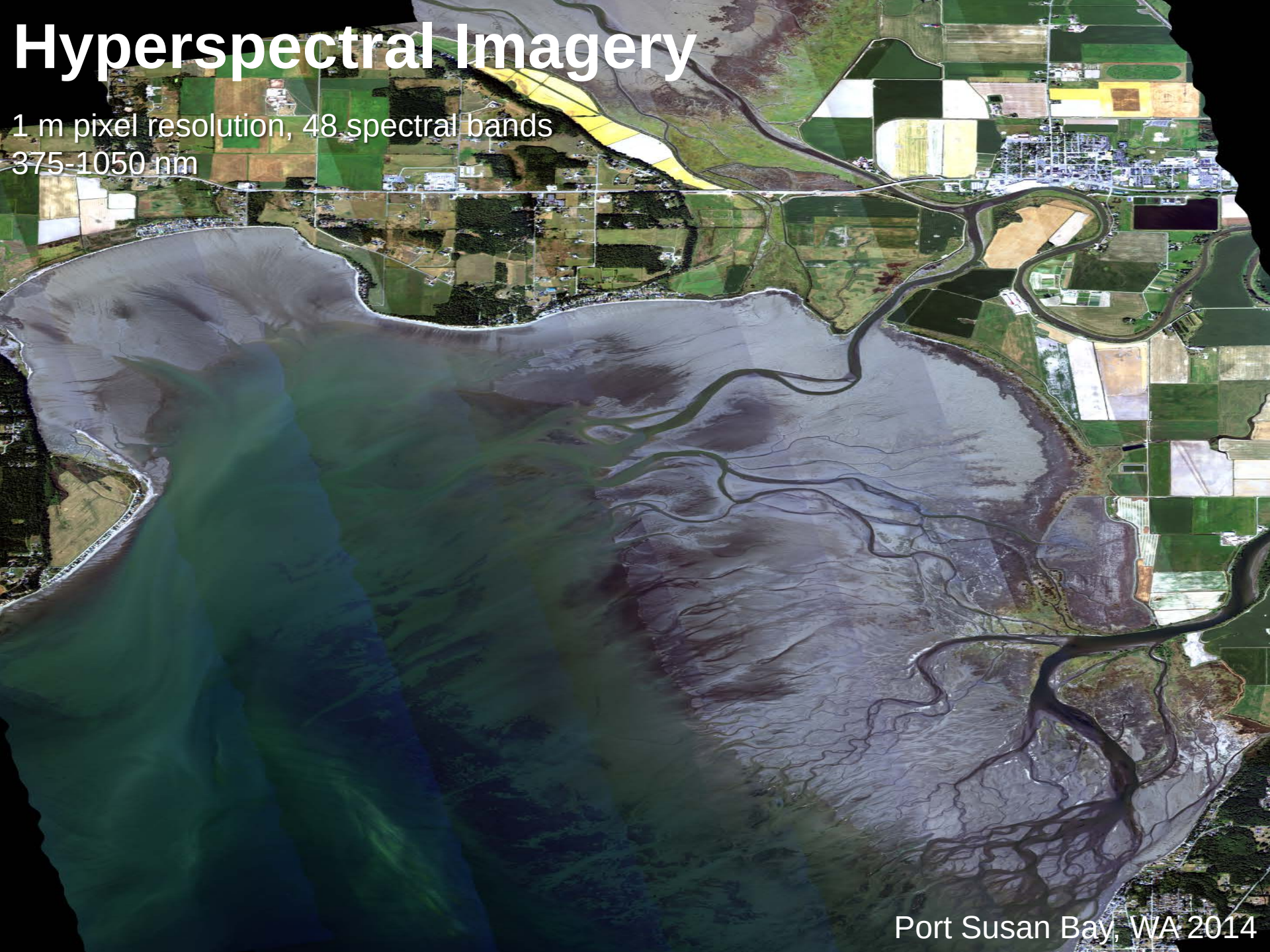
West Maui, HI, 2013

Aerial photography/lidar

Siuslaw River Entrance, OR 2014

Hyperspectral Imagery

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

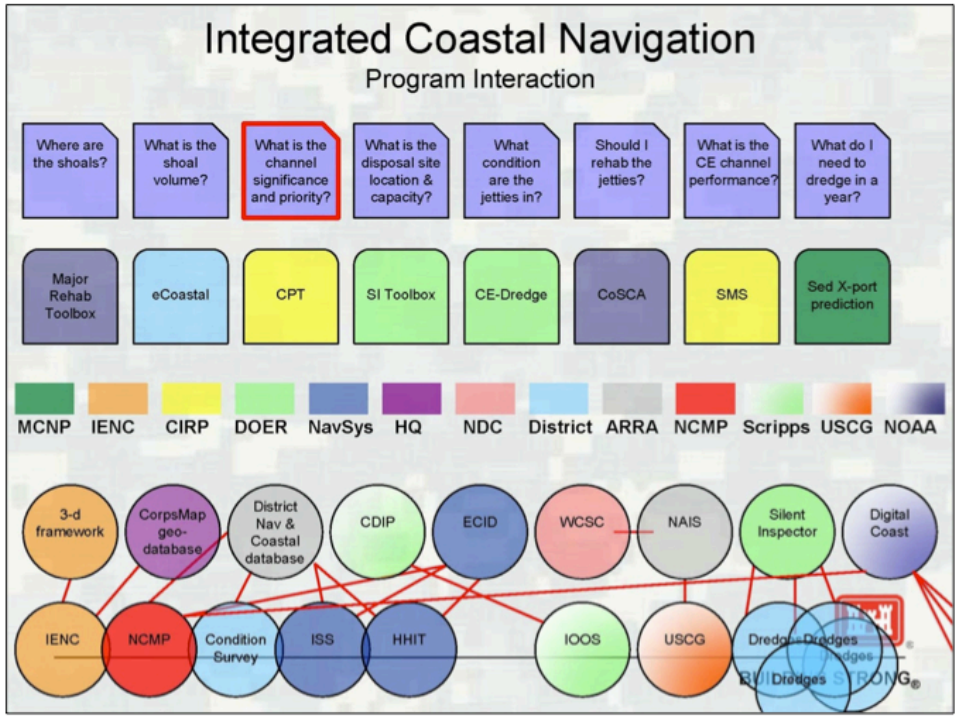


Port Susan Bay, WA 2014

NCMP Data Access

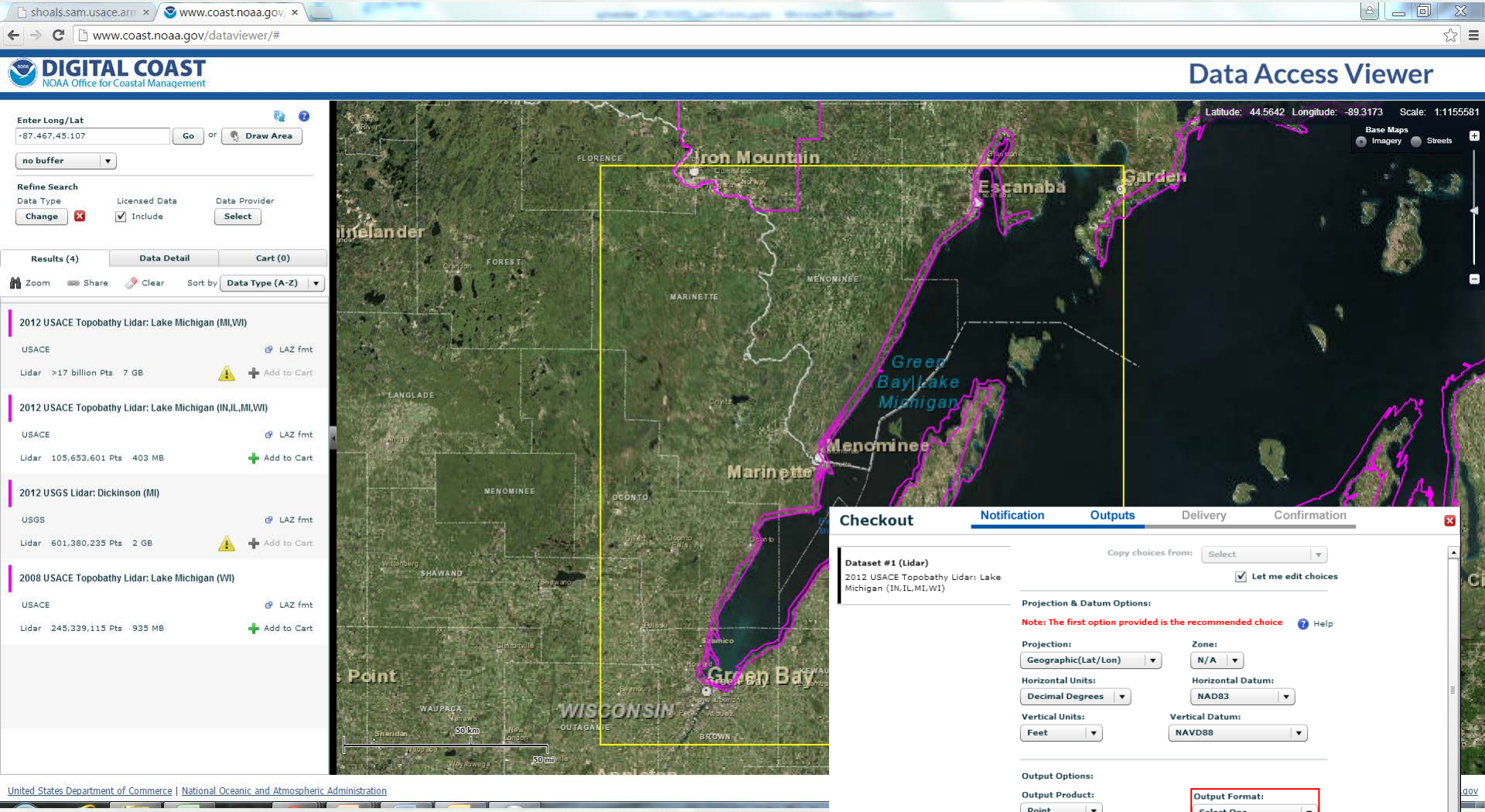
Navigation Data Integration Framework Concept and Implementation Plan

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

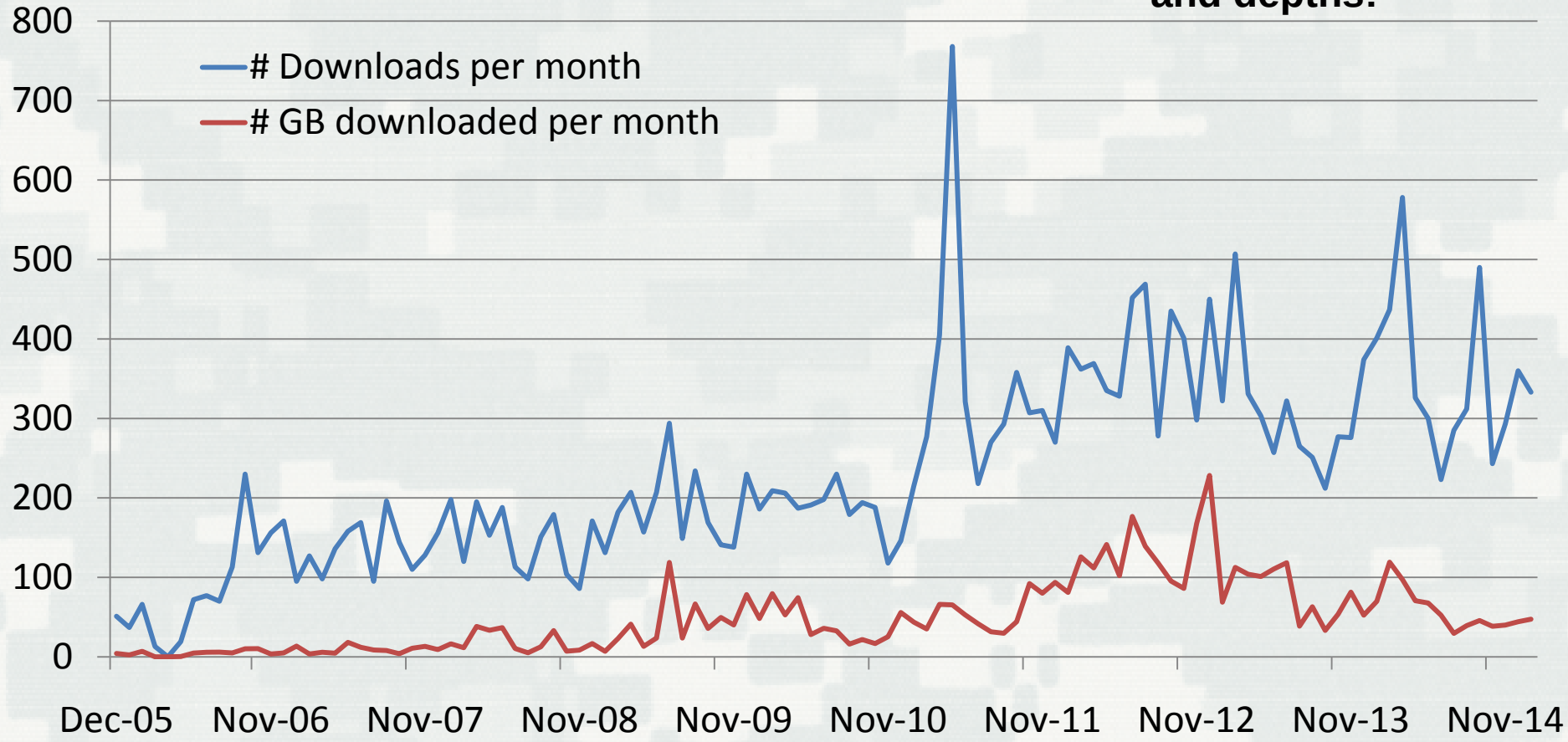
NCMP Data Access



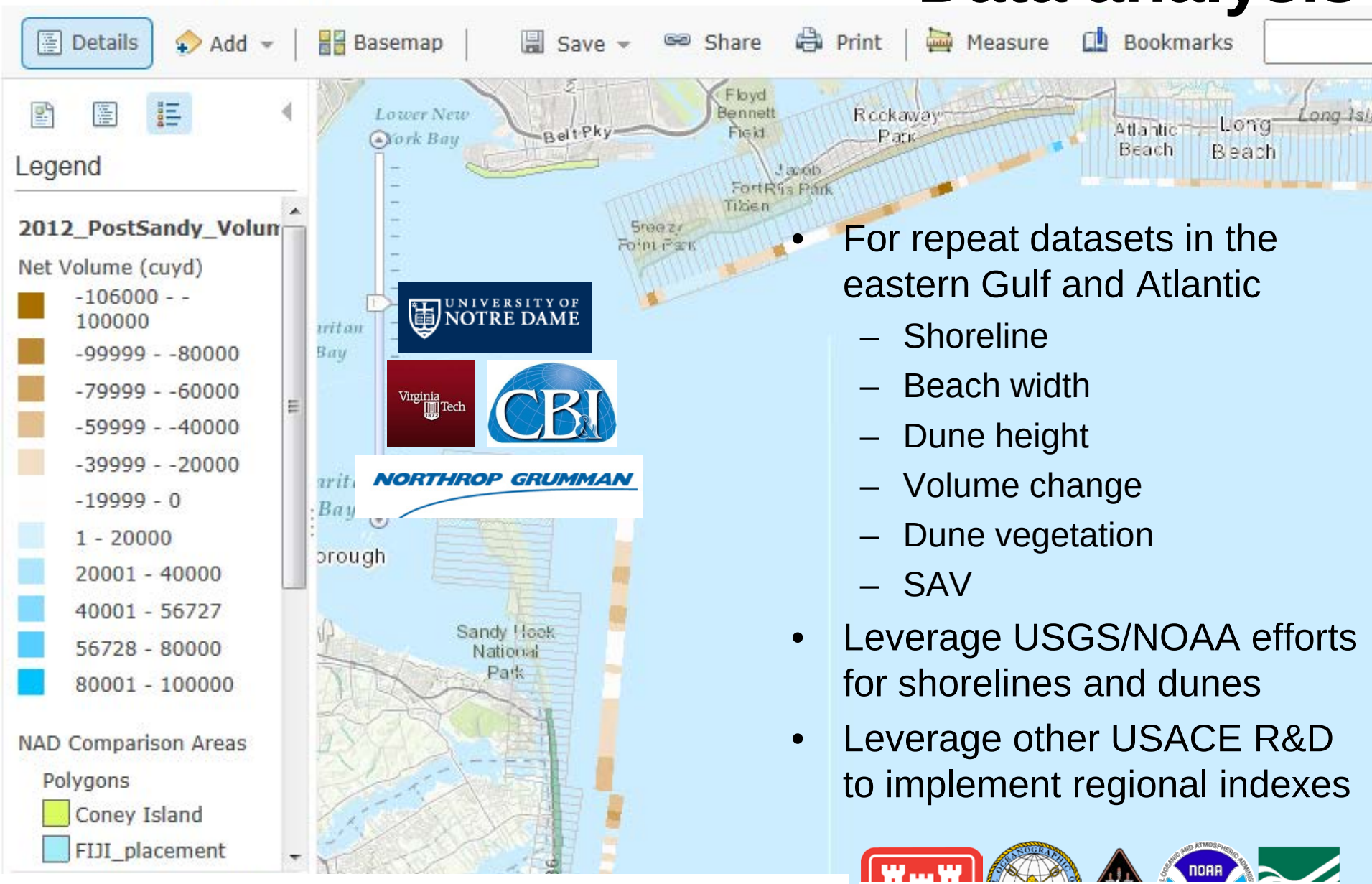
JALBTCX at the DIGITAL COAST

Statistics

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



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

https://gis.sam.usace.army.mil/server/rest/services/JALBTCX/2012_PostSandy_volumes_mdo/MapServer

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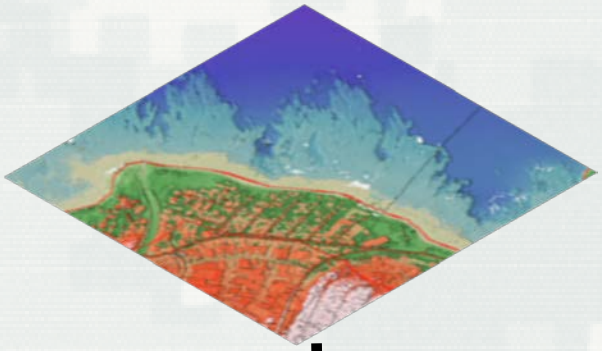
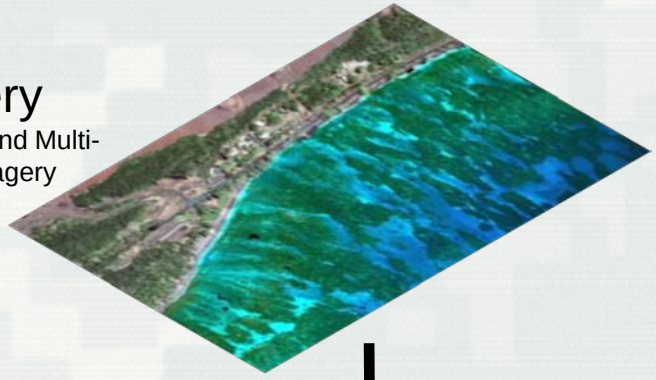
Metrics/Parameters

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

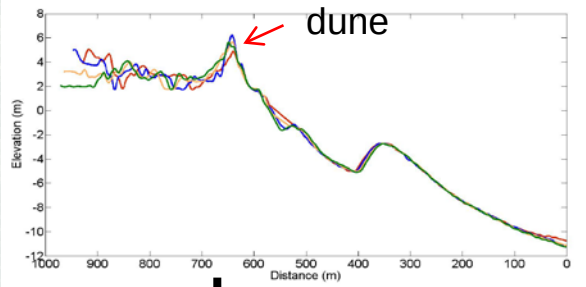


Imagery
Hyperspectral and Multi-Spectral Imagery

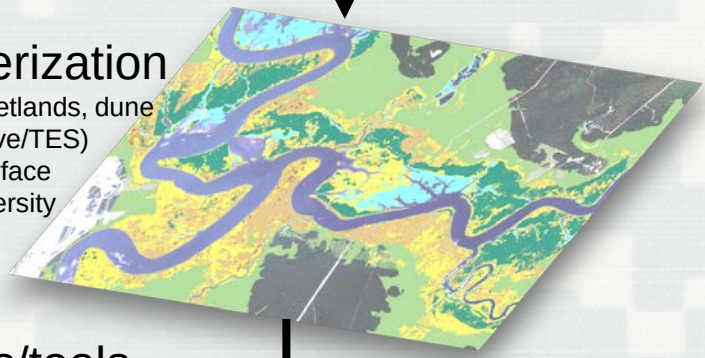


Dune
Elevation (crest/toe)
Continuity
Slope
Volume

Beach
Width
Slope



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



R&D/Value added products/tools

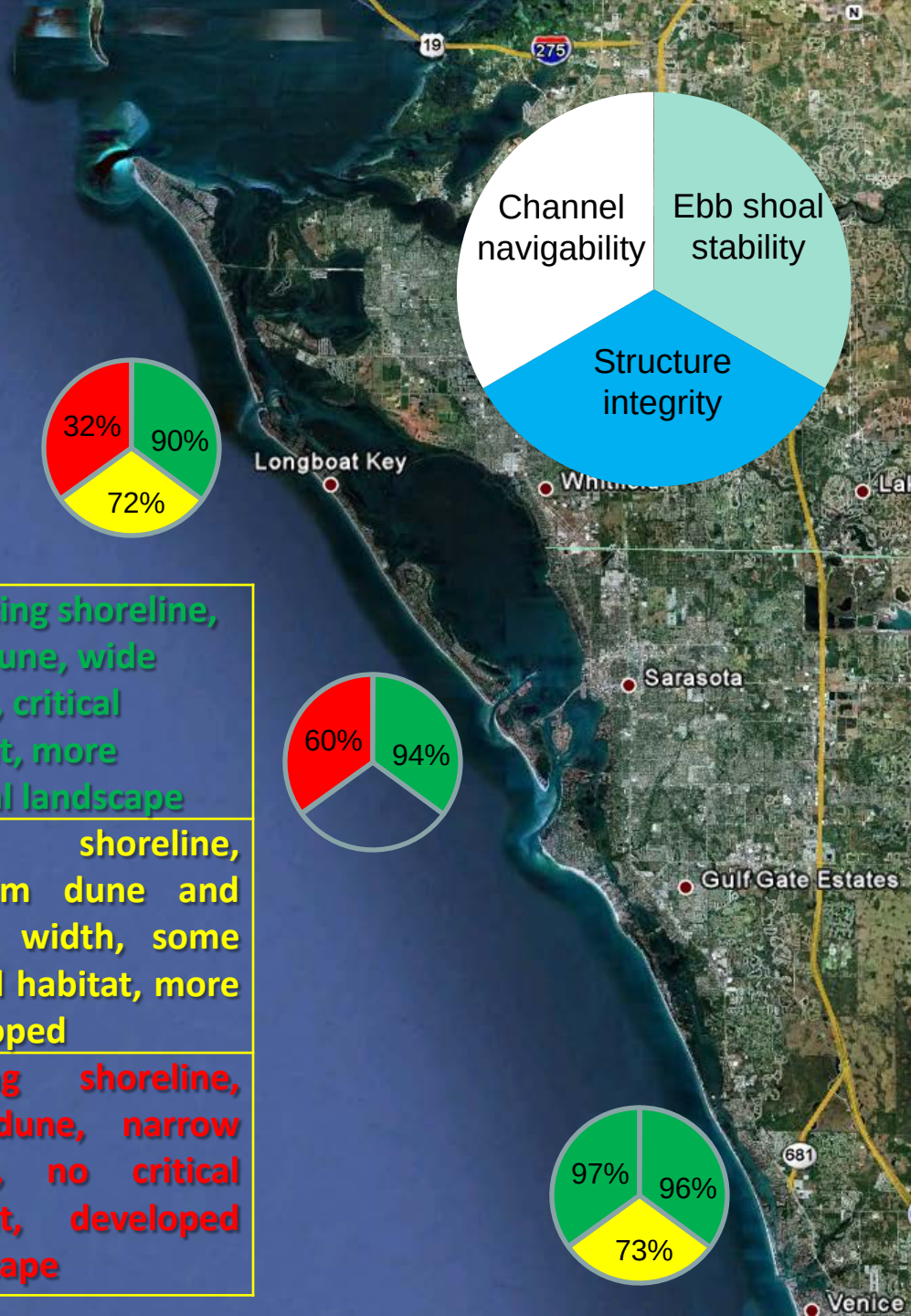
- Change Detection
  - Landscape change modeling
  - Volume/elevation/shoreline change
  - Structure assessment
- Sediment Budgets
- Monitoring Shore Protection
- Defining Coastal Regions

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

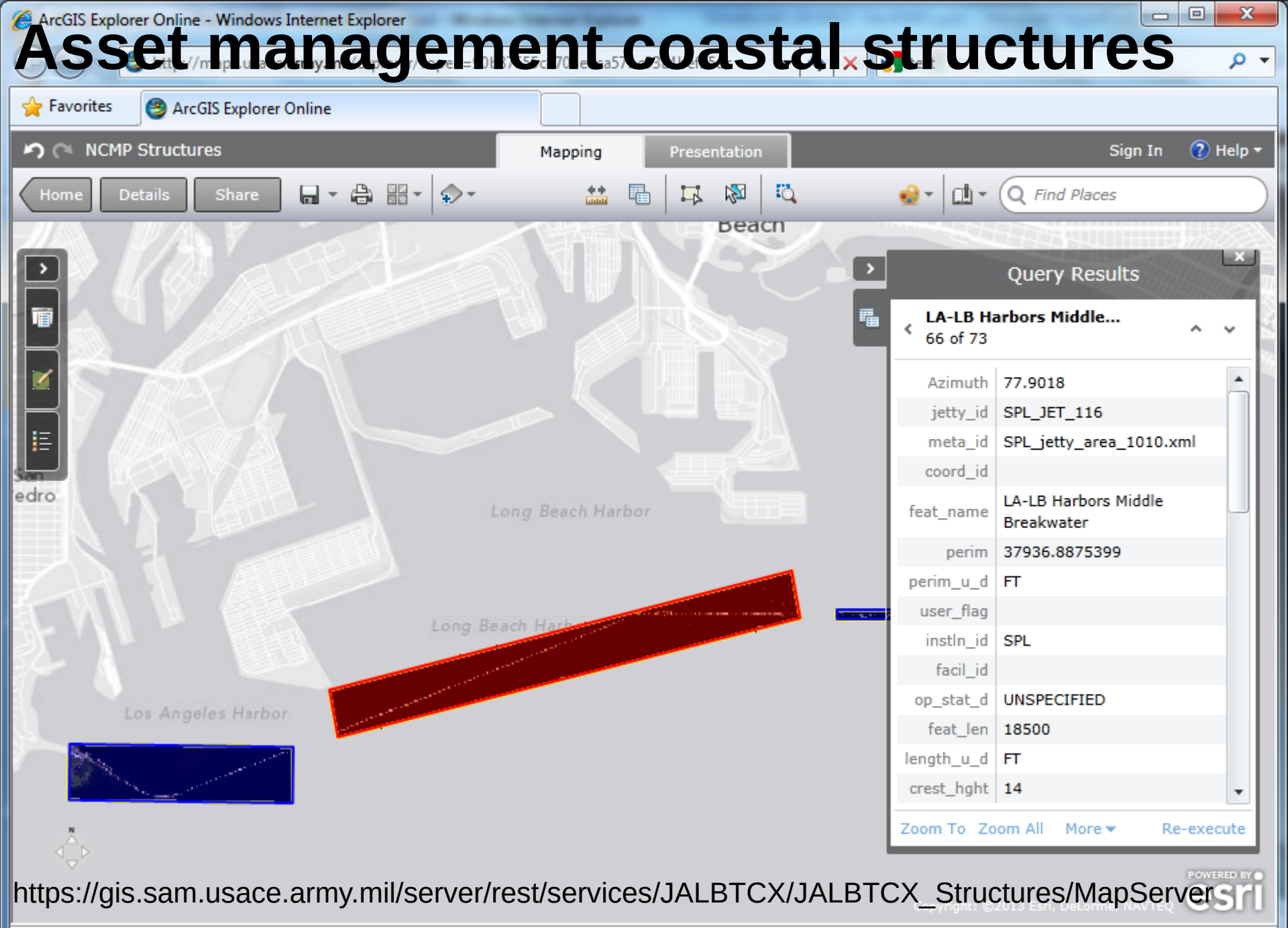
    * ECO-PCX model certification

Coastal dashboard

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

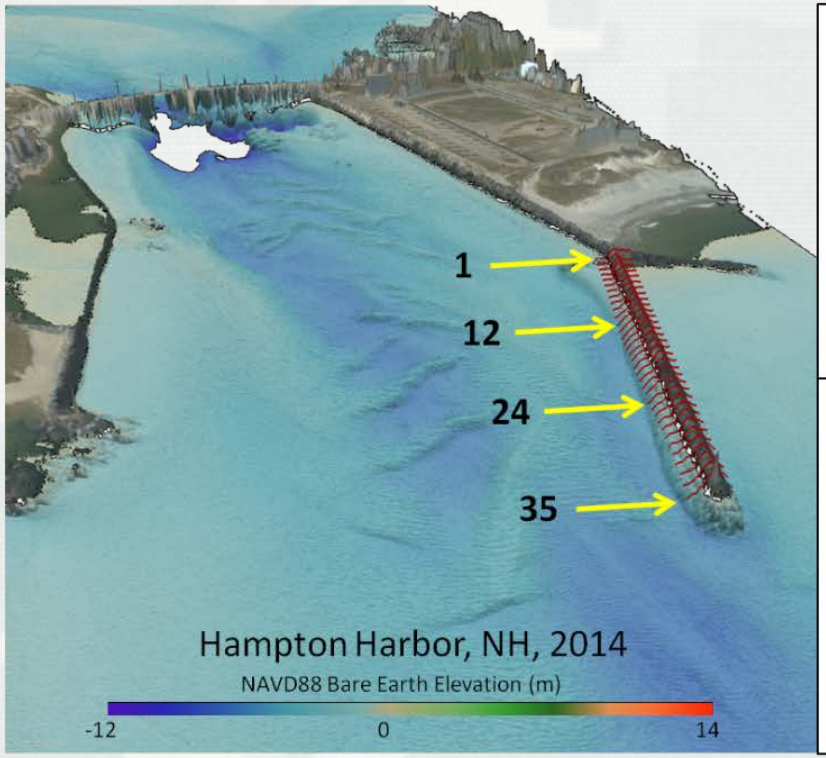


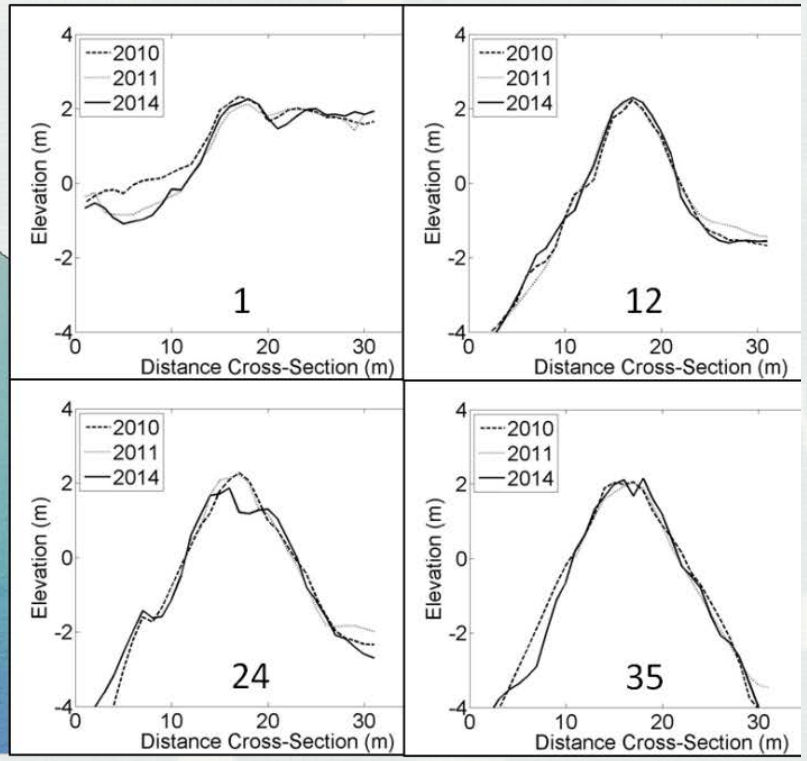
Asset management coastal structures

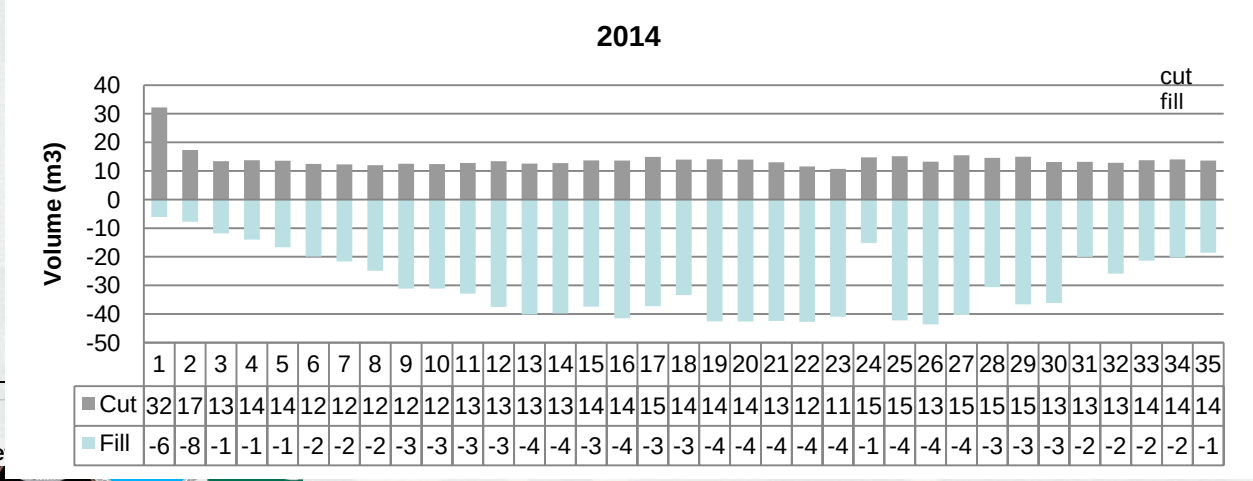


https://gis.sam.usace.army.mil/server/rest/services/JALBTCX/JALBTCX_Structures/MapServer

Asset management coastal structures



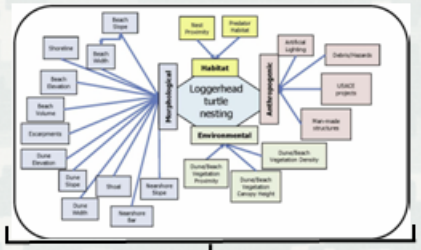




	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Cut	32	17	13	14	14	12	12	12	12	12	13	13	13	13	14	14	15	14	14	14	13	12	11	15	15	13	15	15	15	13	13	13	14	14	14
Fill	-6	-8	-1	-1	-1	-2	-2	-2	-3	-3	-3	-3	-4	-4	-3	-4	-3	-3	-4	-4	-4	-4	-4	-1	-4	-4	-4	-3	-3	-3	-2	-2	-2	-2	-1

Future data development

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

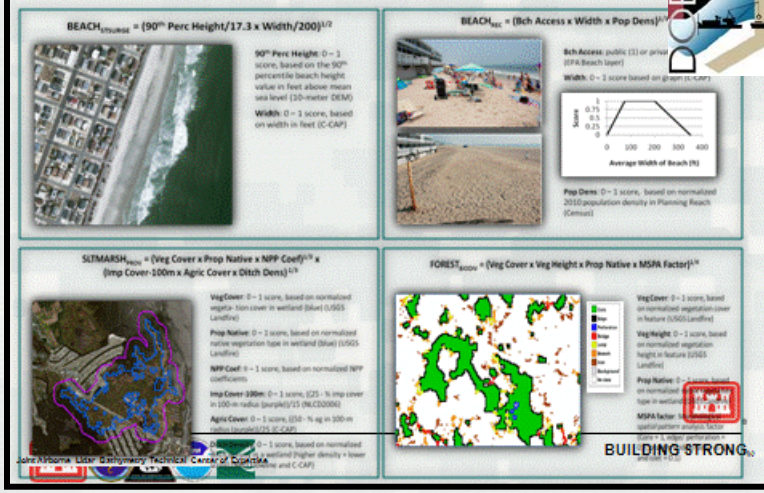


- Map of relative suitability based on spatially derived parameters
  - Regional value ranges (transferable to other sites)

- 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



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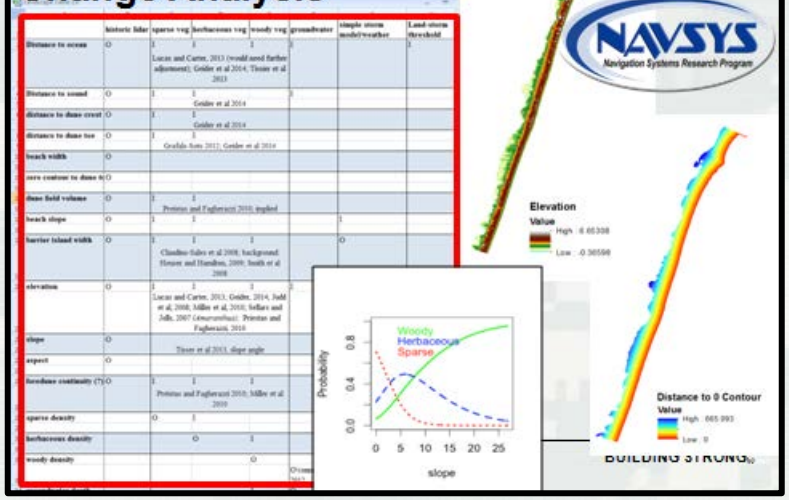
Ecological Modeling for Landscape Change Analysis



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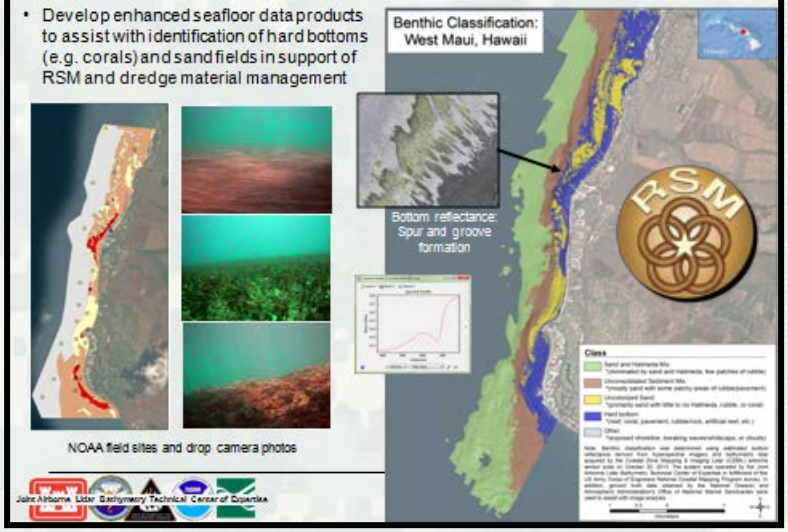
Benthic Classification: West Maui, HI

- 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



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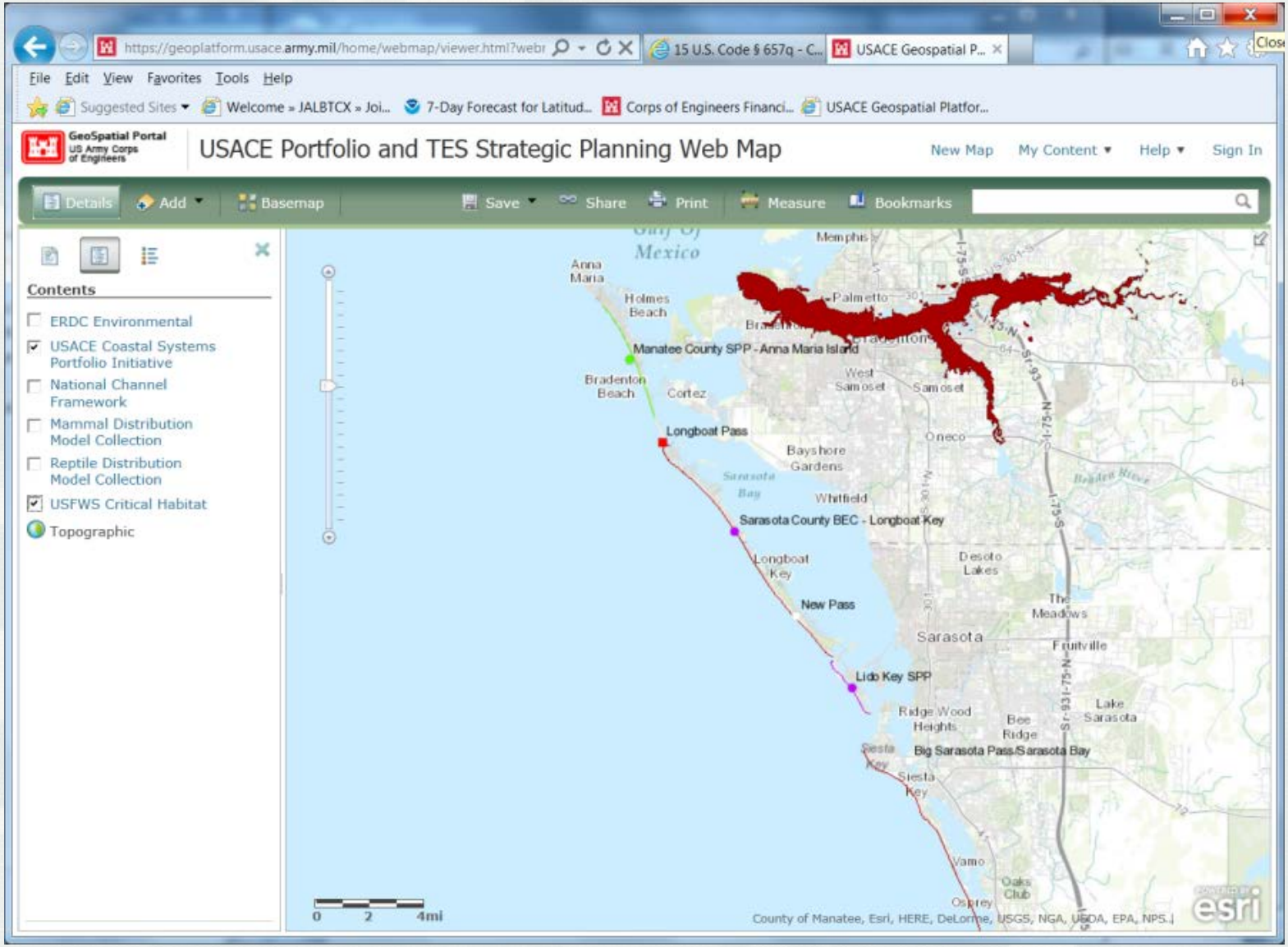
Future data delivery and tools



Future platforms

US Army Corps of Engineers®
Mobile District
spatial data branch

- 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

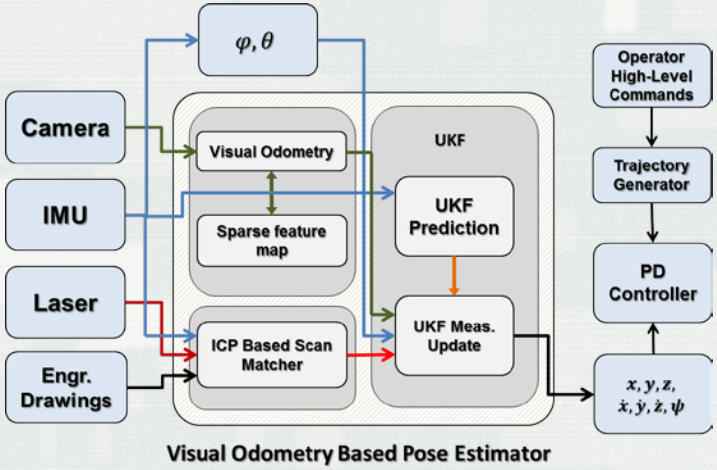
Ground Control Used in Triangulation			
Point ID	X m	Y m	Z m
1	431852.55	4004842.02	7.298
2	432313.78	4004806.00	5.130
3	432471.92	4004377.71	5.988
5	432041.41	4003952.99	3.000
6	432545.78	4003962.19	3.138
14	432106.48	4004497.09	2.811

	pixels	meters
RMSE	0.796	0.016

2014 UAS Duck, NC Acquisition

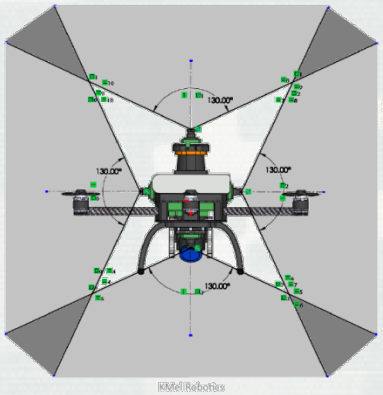
Microbotic infrastructure assessment

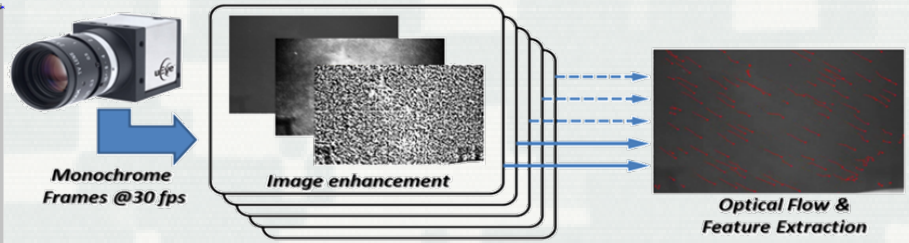
Inspection of Penstocks and Featureless Tunnel-like Environments using Micro UAVs



Visual Odometry Based Pose Estimator

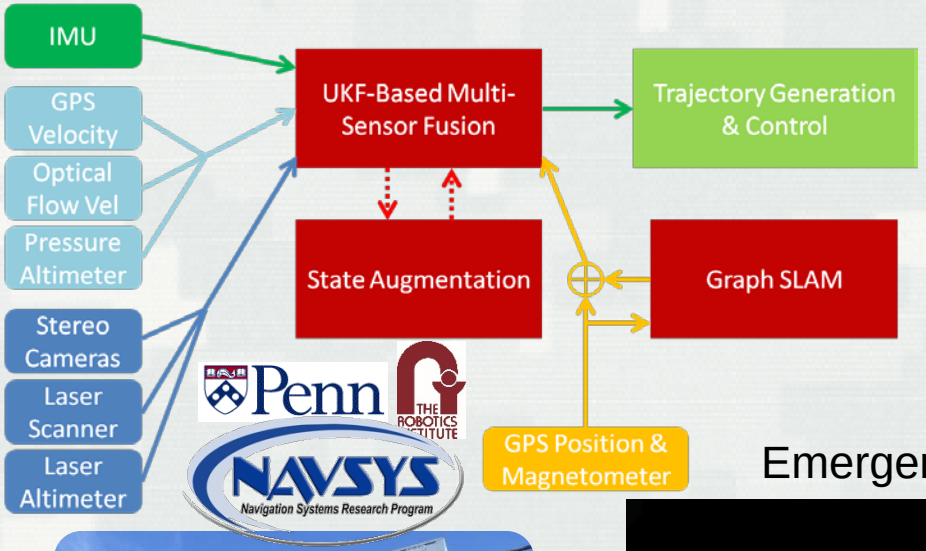
Camera Overlap

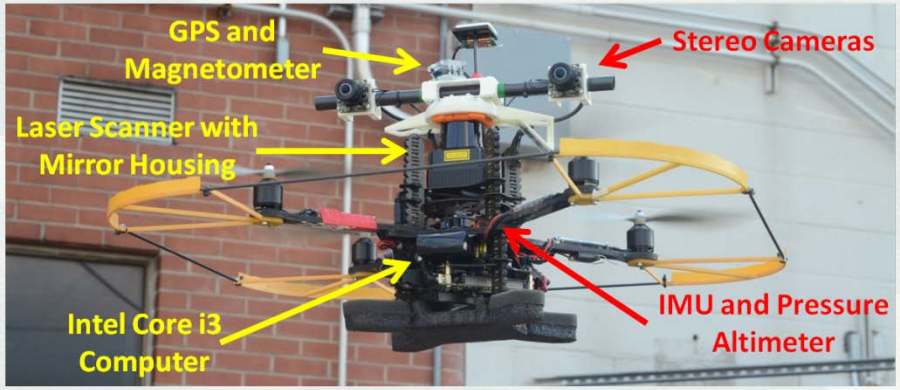




Microbotic infrastructure assessment

Multi-Sensor Fusion for Robust Autonomous Flight in Indoor and Outdoor Environments

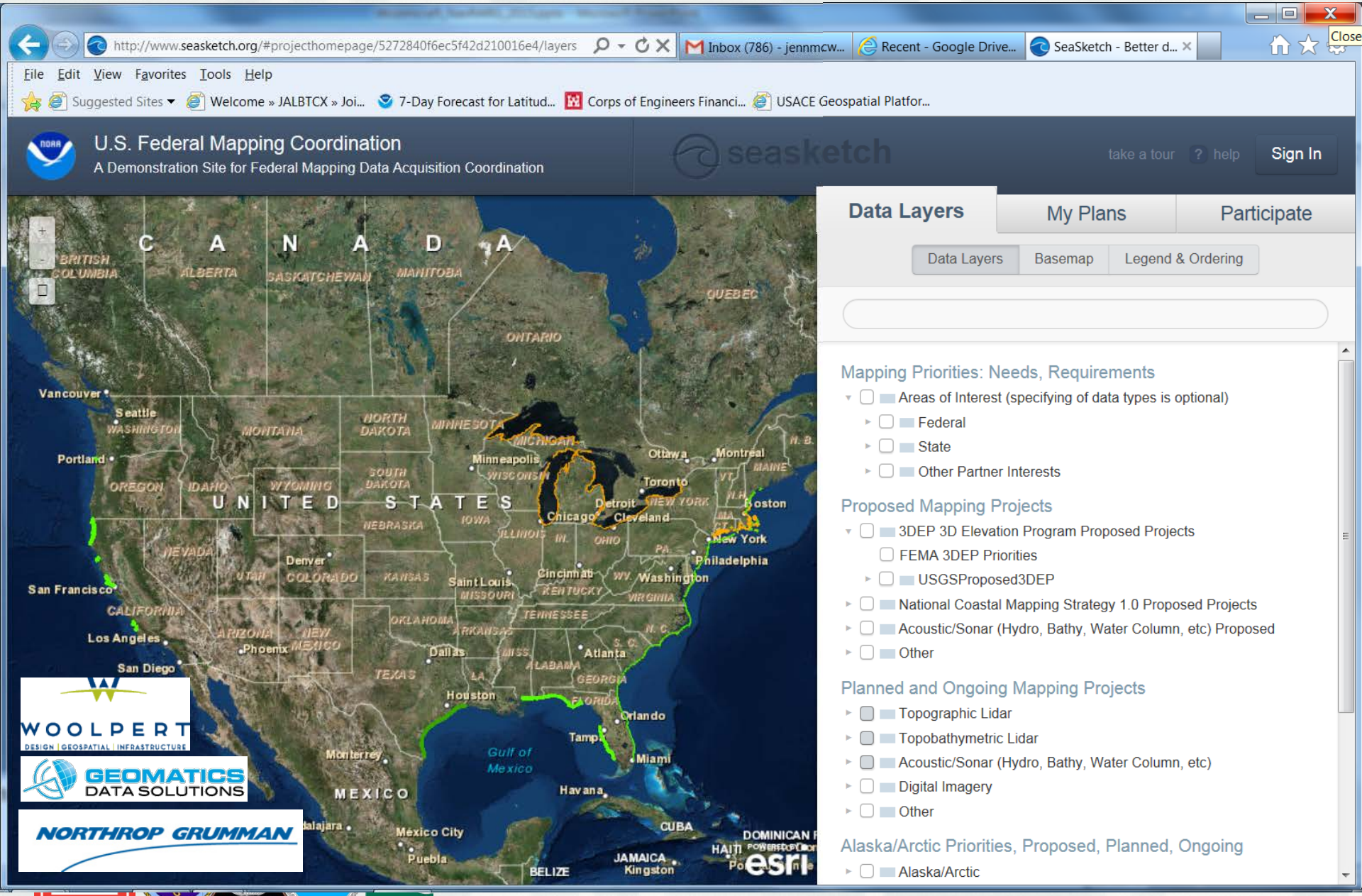




Emergency spillway tainter gates, Carter's Dam, GA

[redacted]

Upcoming NCMP acquisitions



Questions?

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www.jalbtcx.org

Siuslaw, OR, 2014 federal navigation project & adjacent beaches