# JALBTCX Activities and USACE National Coastal Mapping Program Update

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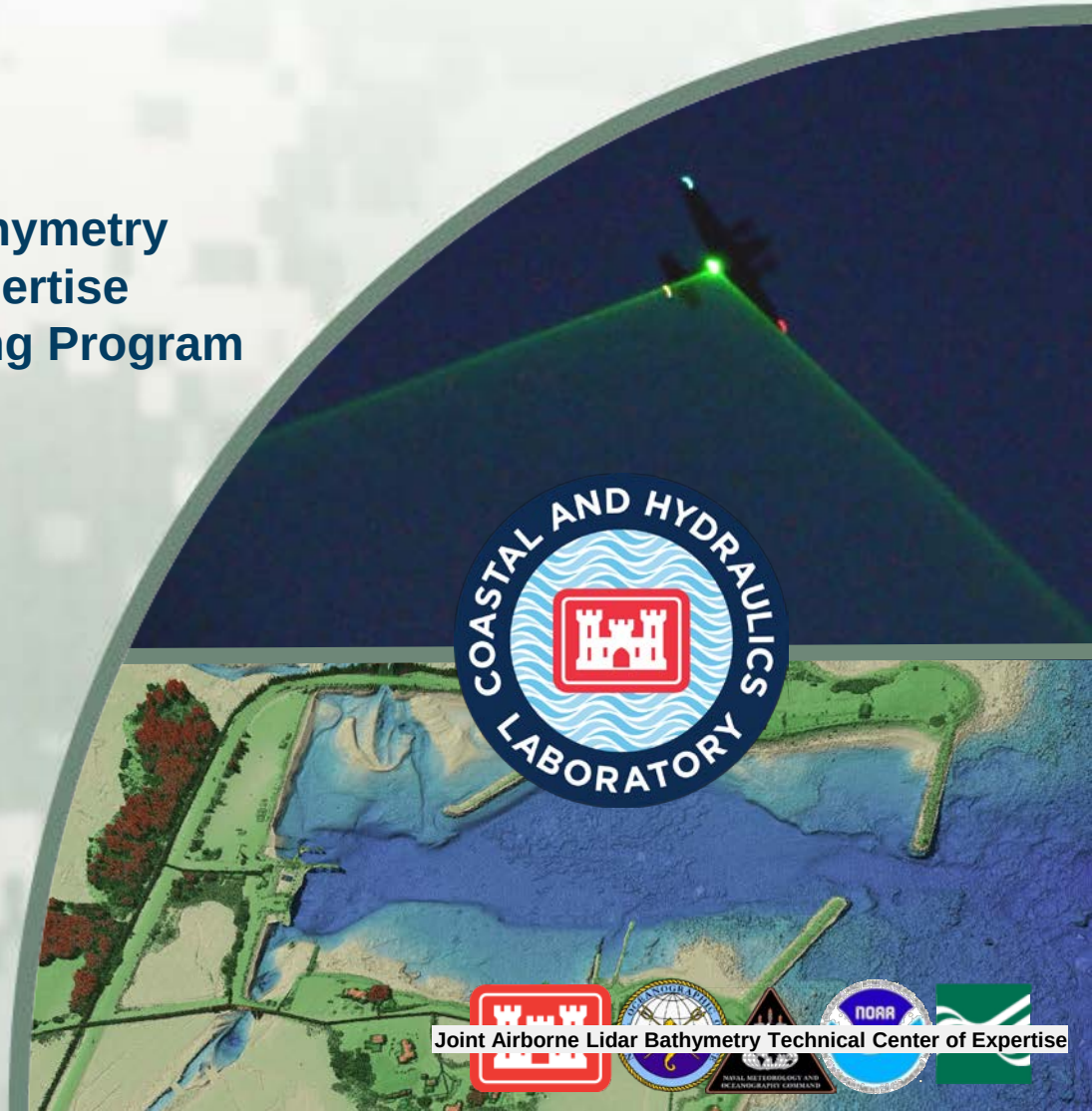
Engineer Research and Development Center


**Jennifer M. Wozencraft**
**Director, Joint Airborne Lidar Bathymetry Technical Center of Expertise**
**Manager, National Coastal Mapping Program**

**Research Physical Scientist**
**Coastal and Hydraulics Laboratory**
**US Army Engineer R&D Center**


**19 July 2016**
**JALBTCX Airborne Coastal Mapping and Charting Workshop**
**Silver Spring, MD**



# Joint Airborne Lidar Bathymetry Technical Center of Expertise

Annual Technical Workshop 2017 TBD

## OPERATIONS

Aircraft
Surveys
Procedures
People

## RESEARCH AND DEVELOPMENT

Hardware
Software
Data exploitation
Algorithms

Spatial Data MOBILE DISTRICT
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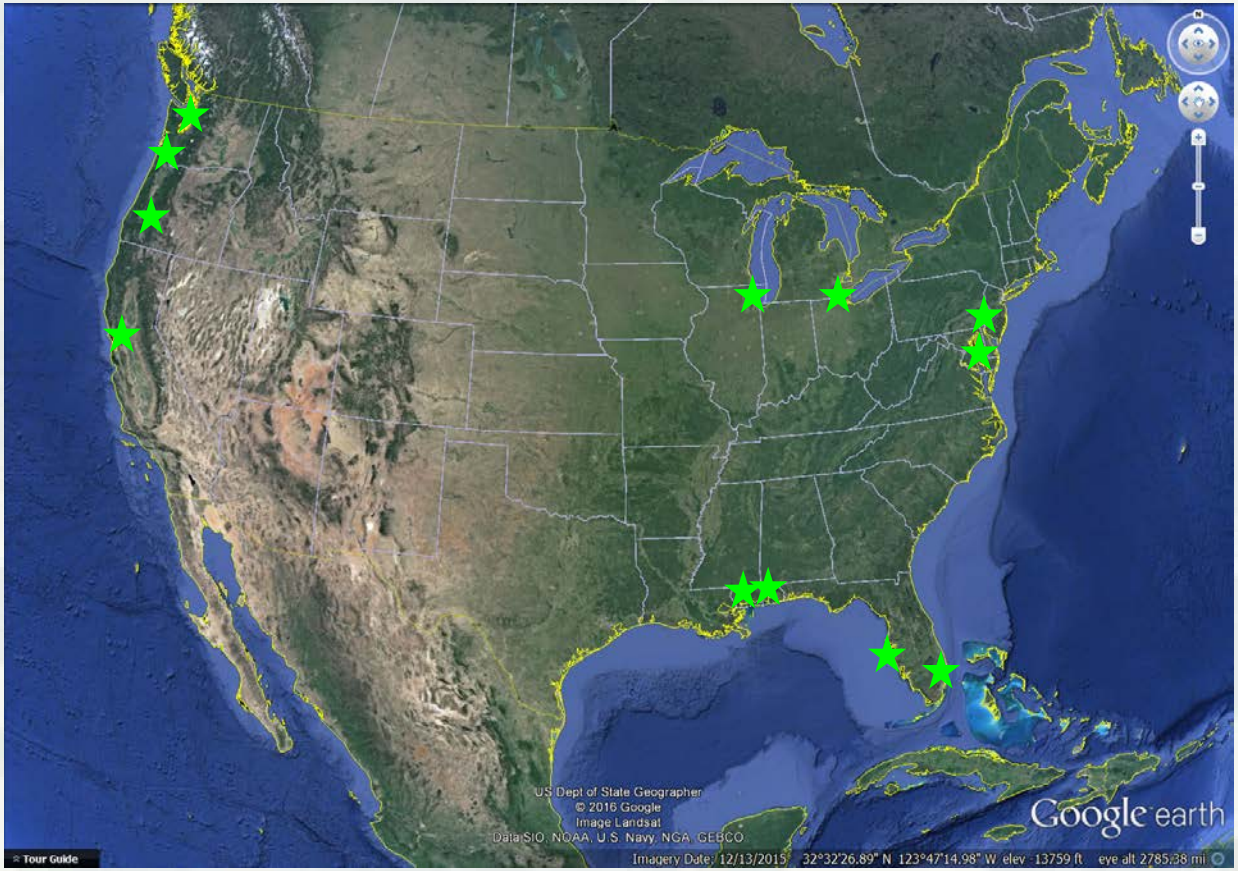
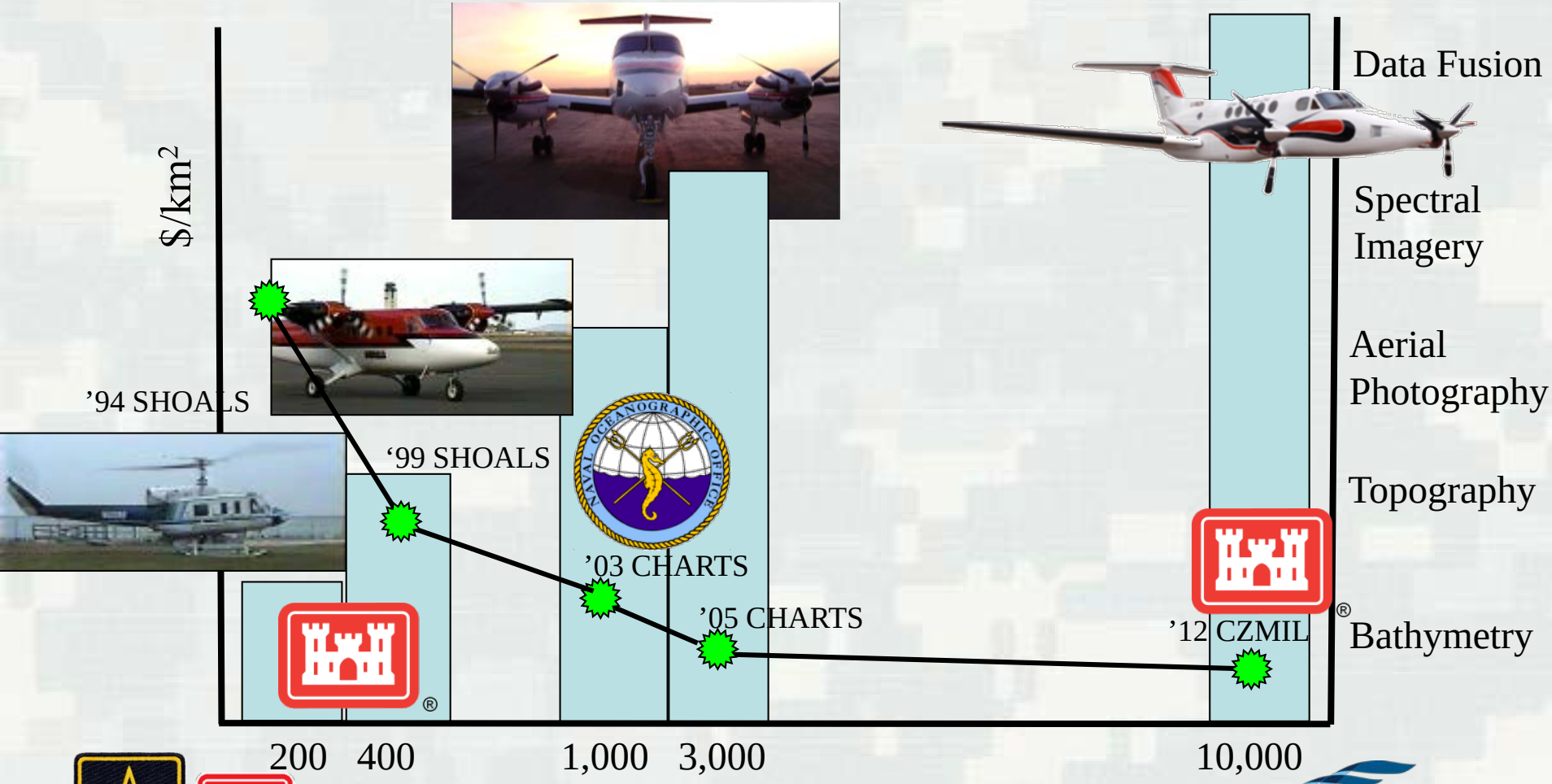
TELEDYNE OPTECH Everywhereyoulook™
US Army Corps of Engineers® Engineer Research and Development Center
NAVAL METEOROLOGY AND OCEANOGRAPHY COMMAND
NORTHROP GRUMMAN
ONR Office of Naval Research
AIRBORNE IMAGING
CBI
Kenn Borek Air Ltd. Anytime, Anywhere ... Worldwide
itres
Bowhead
Dynamic Aviation
WMR
USGS science for a changing world
NOAA
NAVAL RESEARCH LABORATORY WASHINGTON, D.C.
THE UNIVERSITY OF SOUTHERN MISSISSIPPI
MAGNOLIA river
UNIVERSITY OF NOTRE DAME
AHAB Airborne Hydrography AB
FUGRO
Virginia Tech
WOOLPERT DESIGN | GEOSPATIAL | INFRASTRUCTURE
U. S. Naval Research Laboratory Stennis Space Center, MS
Pelydryn
Dewberry
UNIVERSITY of NEW HAMPSHIRE
TEXAS A&M UNIVERSITY
GEOMATICS DATA SOLUTIONS

# JALBTCX workshops




2015 Corvallis, OR
2014 Mobile, AL
2013 Mobile, AL
2012 Chicago, IL
2011 Baltimore, MD
2010 Mobile, AL
2009 Portland, OR
2008 San Francisco, CA
2007 Seattle, WA
2006 Detroit, MI
2005 Philadelphia, PA
2004 St. Petersburg, FL
2003 SFTF, FL
2002 San Francisco, CA
2001 Stennis Space Center, MS
2000 Daphne, AL

# JALBTCX sensor development history

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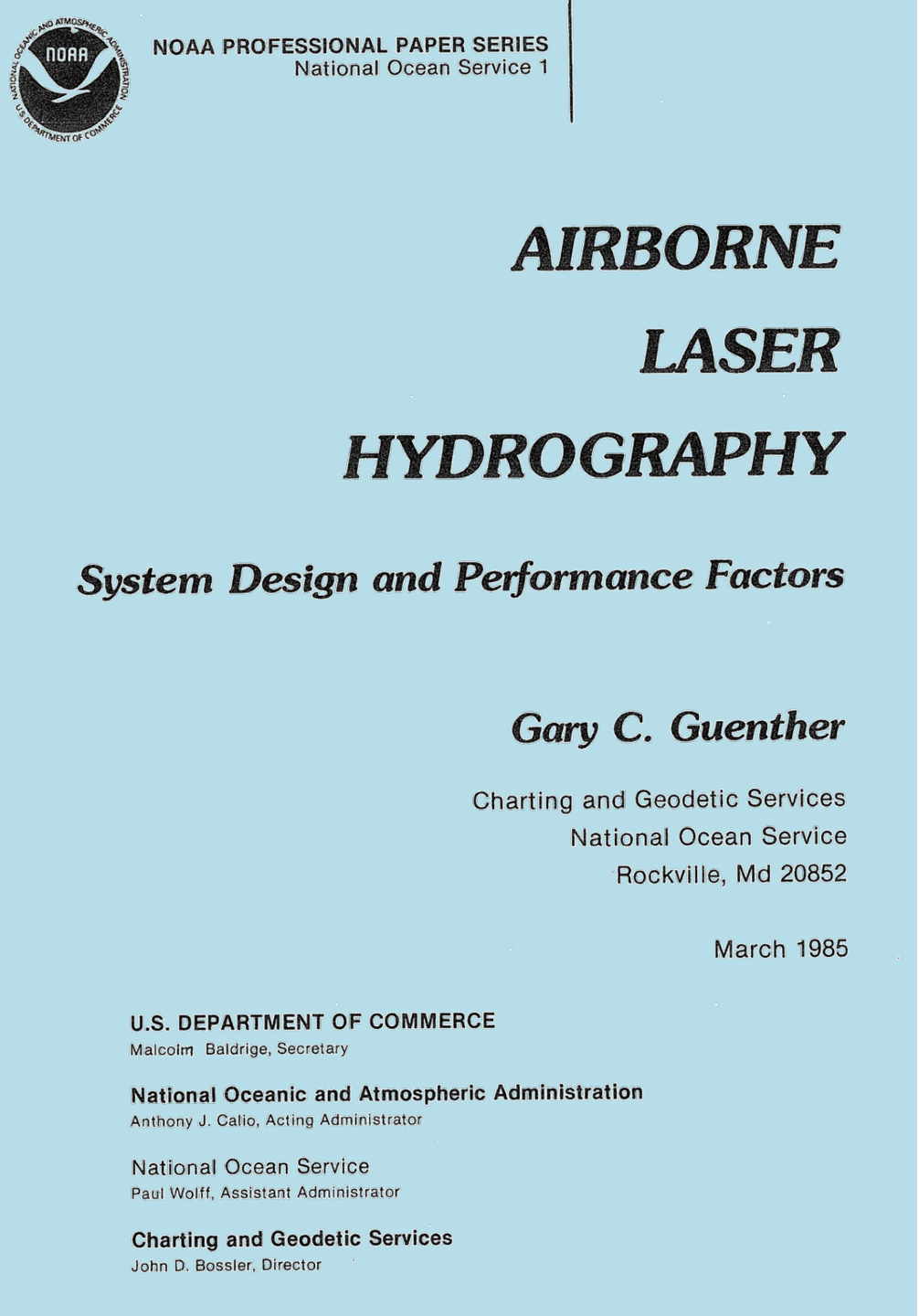


NOAA PROFESSIONAL PAPER SERIES
National Ocean Service 1

# 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

# Blue Book II

| Introduction |
| --- |
| History and Reference Guide |
| Environmental Optical Properties |
| Basic Concepts and System Design |
| Basic Concepts in Data Processing |
| Performance Evaluation |
| Applications, Ancillary Sensor and Fusion |
| Epilogue: Emerging Systems, Future Directions |

- Products
  - Searchable BB I
  - ALB bibliography
  - Table of systems

# National Coastal Mapping Strategy 1.0

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

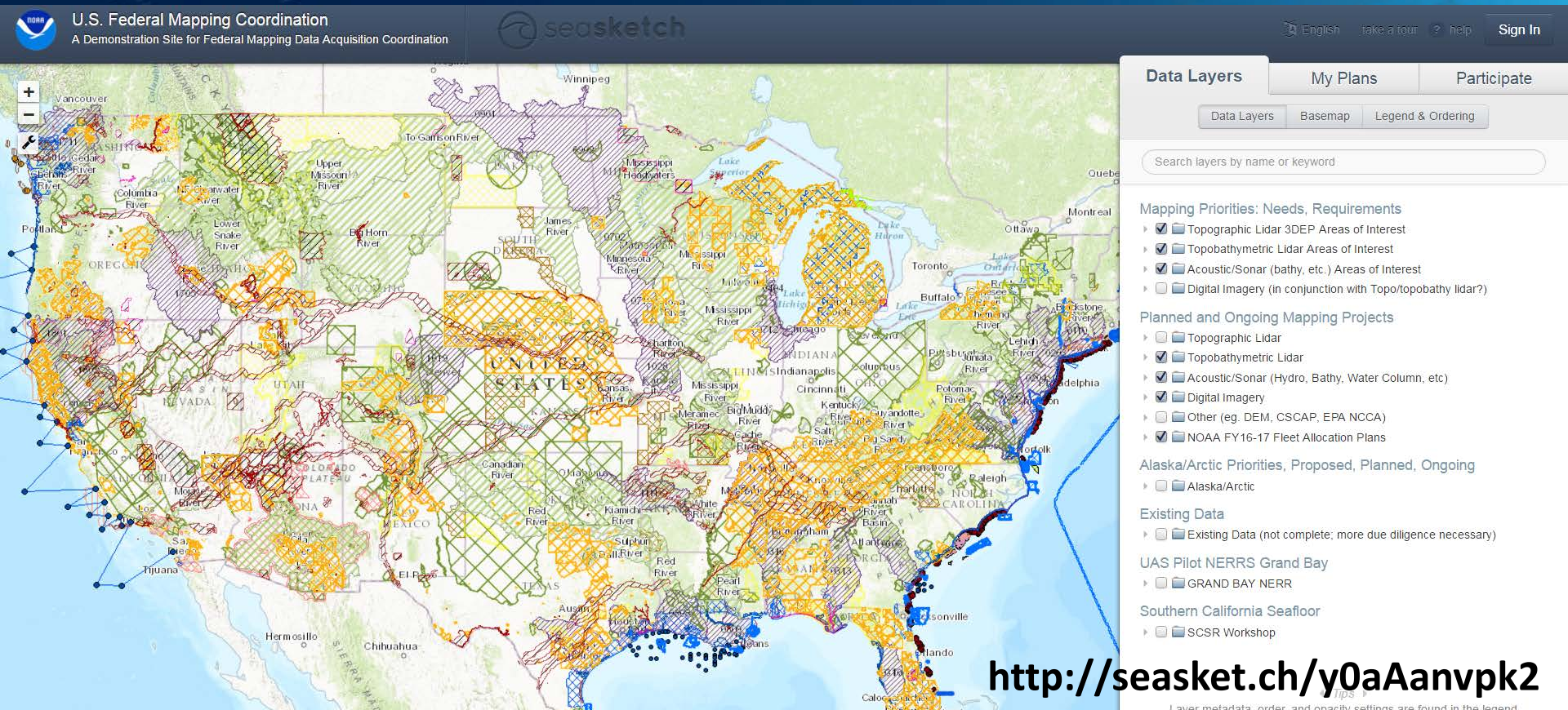
4) Coordinate research and development on new tools and technologies that facilitate interagency coordination on and use of coastal mapping data

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

**https://federalregister.gov/a/2016-13568**

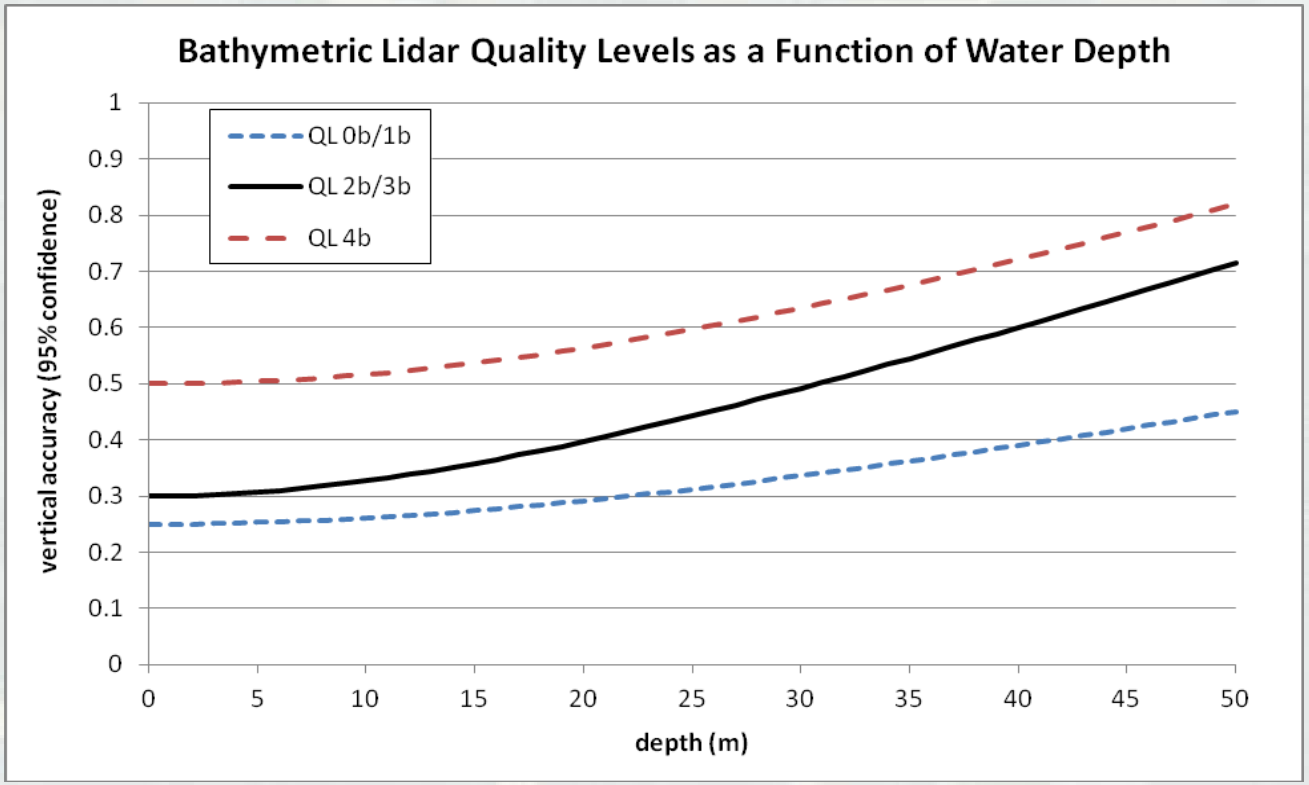
# National Mapping Coordination

- Great visualization tool for understanding requirements, plans
- NOAA/USGS/USACE and partners worked to maximize Sandy topobathy lidar data collects
- Eg. USACE worked with USGS and WA stakeholders to discuss overlap requirements, modify plans for best outcome




http://seasket.ch/y0aAanvpk2

# 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 |

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From National Coastal Mapping Strategy,
Interagency Working Group on Ocean and Coastal Mapping

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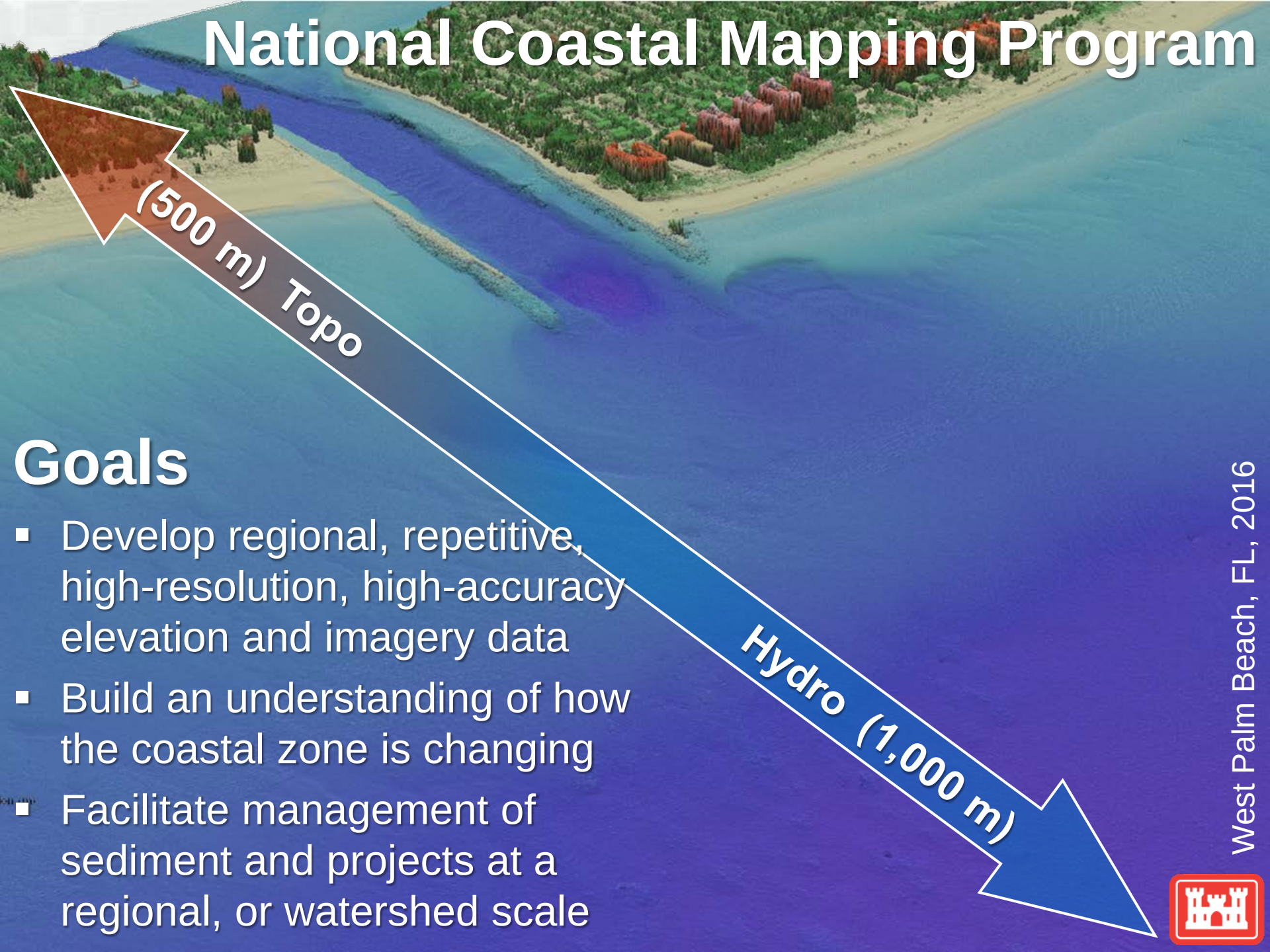
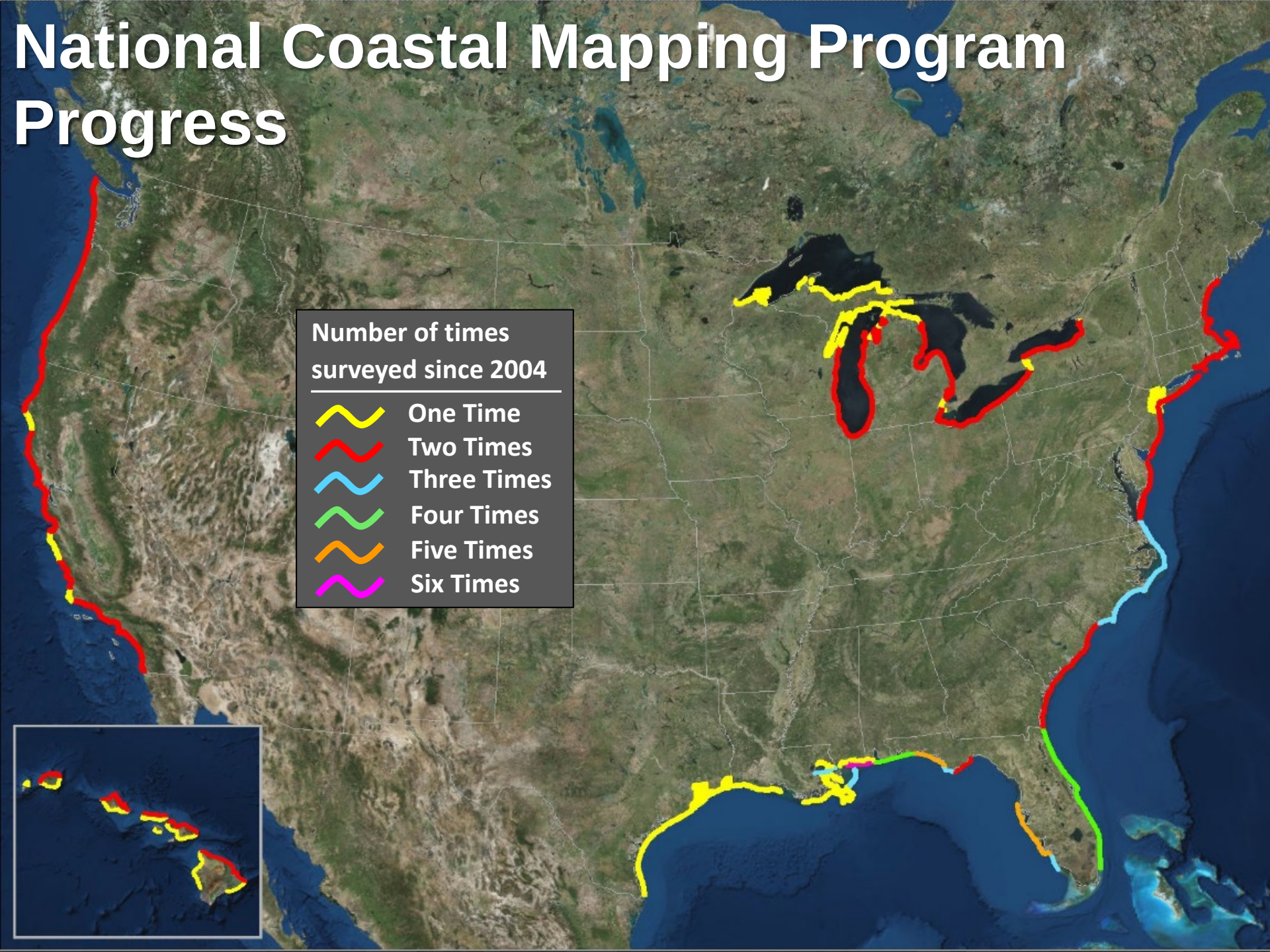
# National Coastal Mapping Program



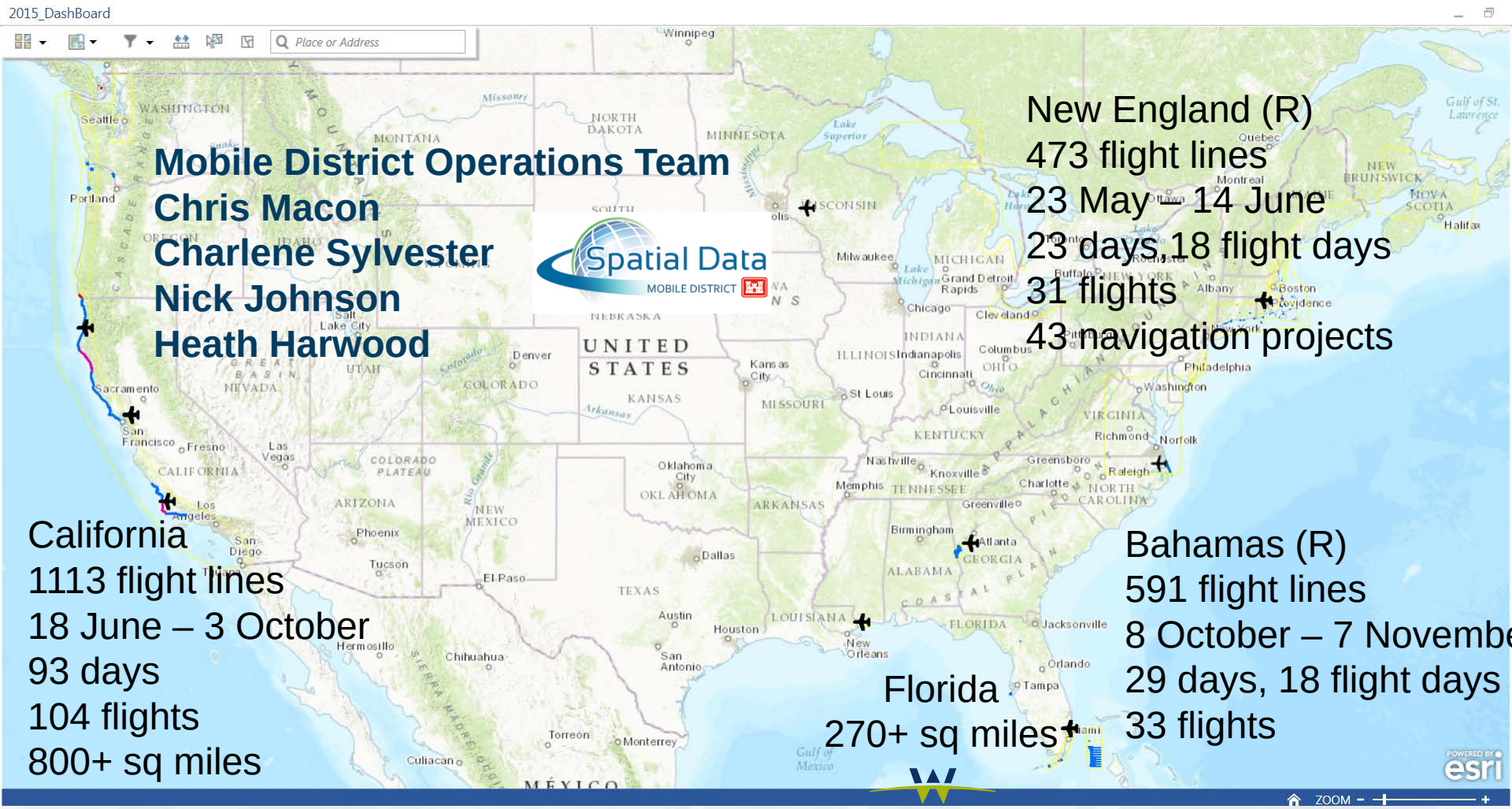

## Goals

- 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

# National Coastal Mapping Program Progress



# 2015 JALBTCX Survey Season

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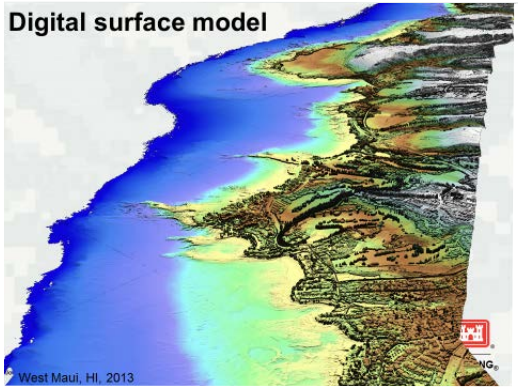
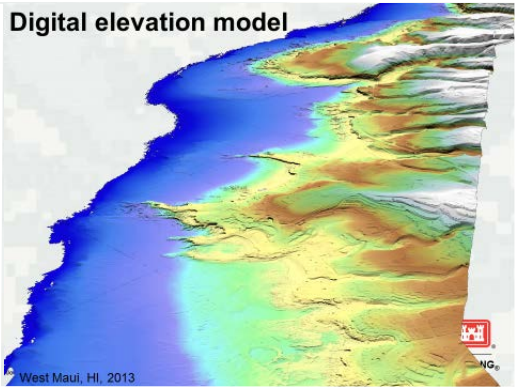
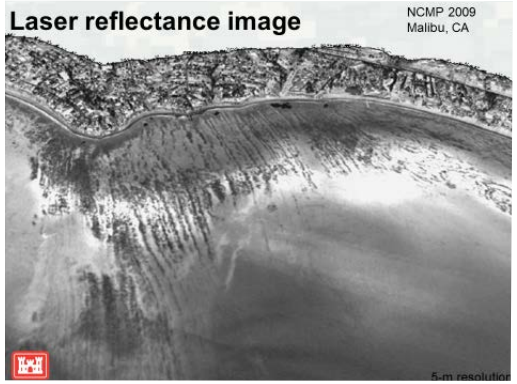
# JALBTCX Products for Coastal Engineers

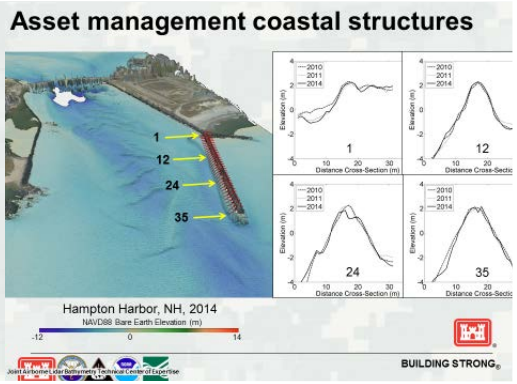
Basic lidar and imagery products

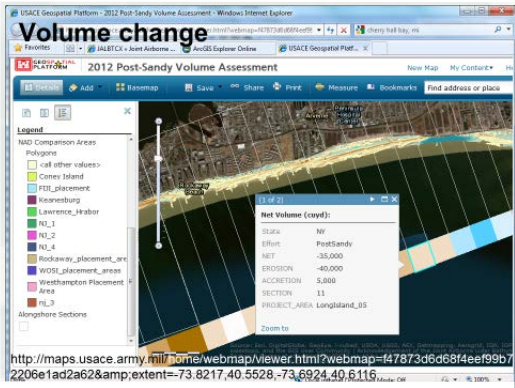


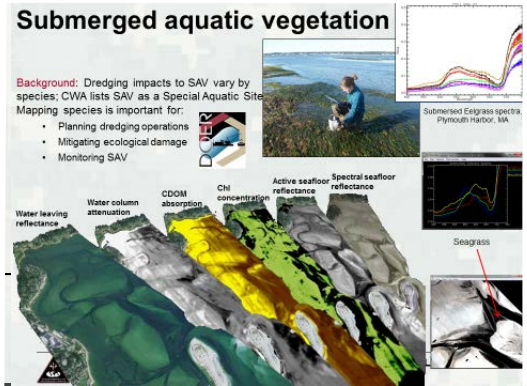
Advanced lidar products

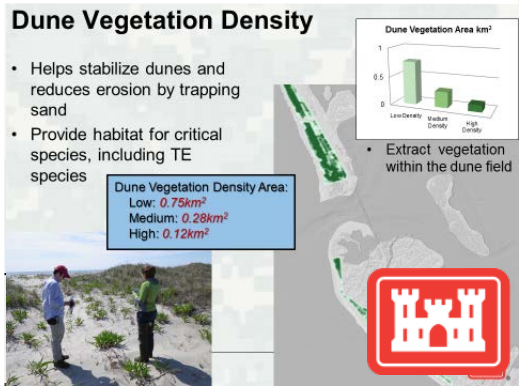



Fusion products



# Volumes

**Table 6. Condensed Results by State**

| State | Start Date | End Date | Baseline Length | Number of Transects | Average Shoreline Change Rate | Volume Density Rate | MHW Volume Density Rate | Above MHW Volume Density Rate |
|---|---|---|---|---|---|---|---|---|
| | | | km | n | ft/yr | cy/ft/yr | cy/ft/yr | cy/ft/yr |
| ME | 10/19/2005 | 6/19/2010 | 62 | 633 | (0.4) | 13.5 | 0.7 | 0.6 |
| NH | 11/01/2005 | 6/20/2010 | 15 | 152 | (1.0) | 2.6 | (0.5) | (0.5) |
| MA | 11/11/2005 | 5/26/2010 | 381 | 3,834 | (2.8) | (2.8) | (0.9) | (0.8) |
| NY | 10/26/2005 | 8/13/2010 | 192 | 1,921 | 6.9 | 4.5 | 4.1 | 4.2 |
| NJ | 9/2/2005 | 8/28/2010 | 203 | 2,034 | 0.6 | 2.1 | 2.2 | 2.2 |
| DE | 9/3/2005 | 9/11/2010 | 44 | 440 | 5.1 | 3.9 | 4.1 | 4.2 |
| MD | 9/3/2005 | 8/2/2010 | 50 | 505 | (4.3) | 2.8 | 2.7 | 2.7 |
| VA | 9/8/2005 | 7/28/2010 | 183 | 1,835 | 7.2 | 3.1 | 3.4 | 2.9 |
| NC_2009 | 9/28/2005 | 8/16/2009 | 272 | 2,725 | 3.9 | 0.6 | (1.3) | 0.2 |
| NC_2010 | 9/28/2005 | 5/4/2010 | 236 | 2,369 | 0.2 | 2.7 | 2.5 | 2.5 |
| SC | 1/13/2006 | 5/4/2010 | 277 | 2,778 | 2.1 | 2.3 | 1.3 | 0.9 |
| GA | 1/13/2006 | 5/4/2010 | 145 | 1,452 | (0.2) | 4.2 | 3.0 | 2.8 |
| FL-E | 7/1/2004 | 5/4/2010 | 587 | 5,875 | (2.7) | 6.2 | 1.0 | 0.8 |
| FL-W | 6/1/2004 | 6/20/2010 | 298 | 2,998 | 7.7 | 19.3 | 2.3 | 2.4 |
| FL-NW | 6/1/2004 | 6/20/2010 | 346 | 3,461 | (9.5) | 4.6 | (0.2) | (0.2) |
| Total/ Average | | | 3,289 | 33,012 | 0.9 | 4.6 | 1.6 | 1.7 |

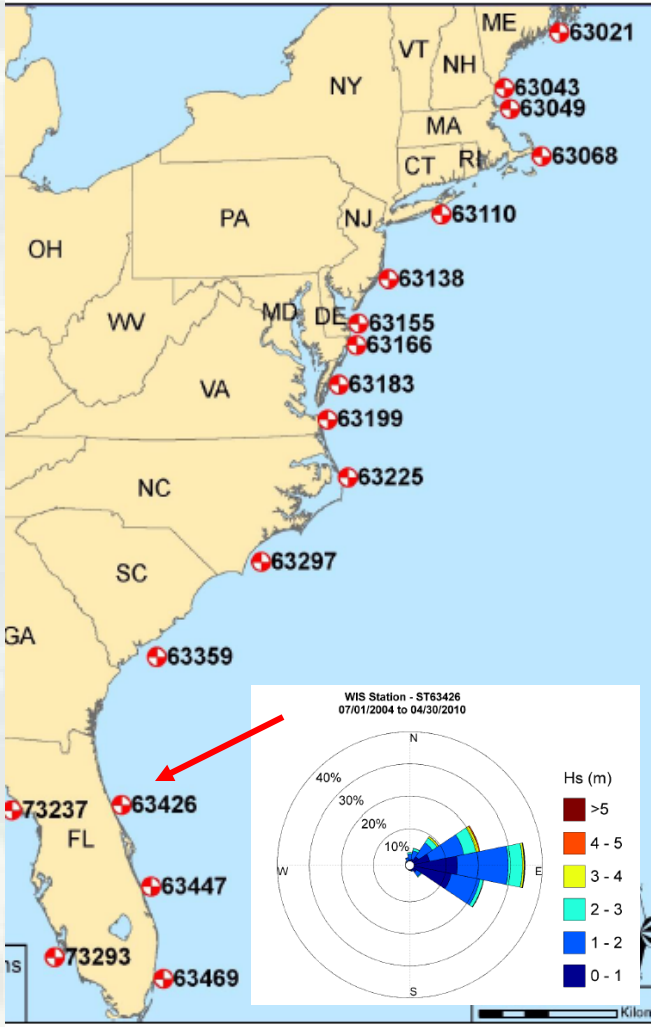



Figure 5. Locations of selected WIS stations.

# Volumes

**Table 6. Condensed Results by State**

| State | Start Date | End Date | Baseline Length | Number of Transects | Average Shoreline Change Rate | Volume Density Rate | MHW Volume Density Rate | Above MHW Volume Density Rate |
|---|---|---|---|---|---|---|---|---|
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| NH | 11/01/2005 | 6/20/2010 | 15 | 152 | (1.0) | 2.6 | (0.5) | (0.5) |
| MA | 11/11/2005 | 5/26/2010 | 381 | 3,834 | (2.8) | (2.8) | (0.9) | (0.8) |
| NY | 10/26/2005 | 8/13/2010 | 192 | 1,921 | 6.9 | 4.5 | 4.1 | 4.2 |
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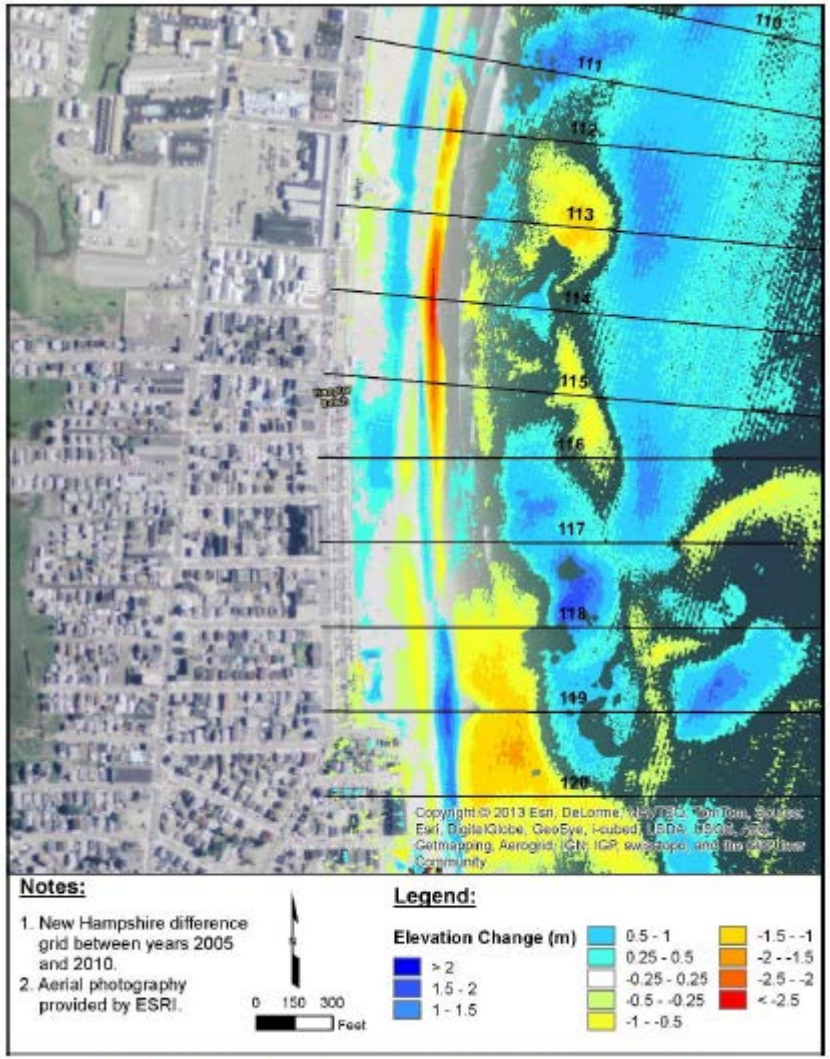


**Figure 8. Elevation change near Hampton Beach, NH.**

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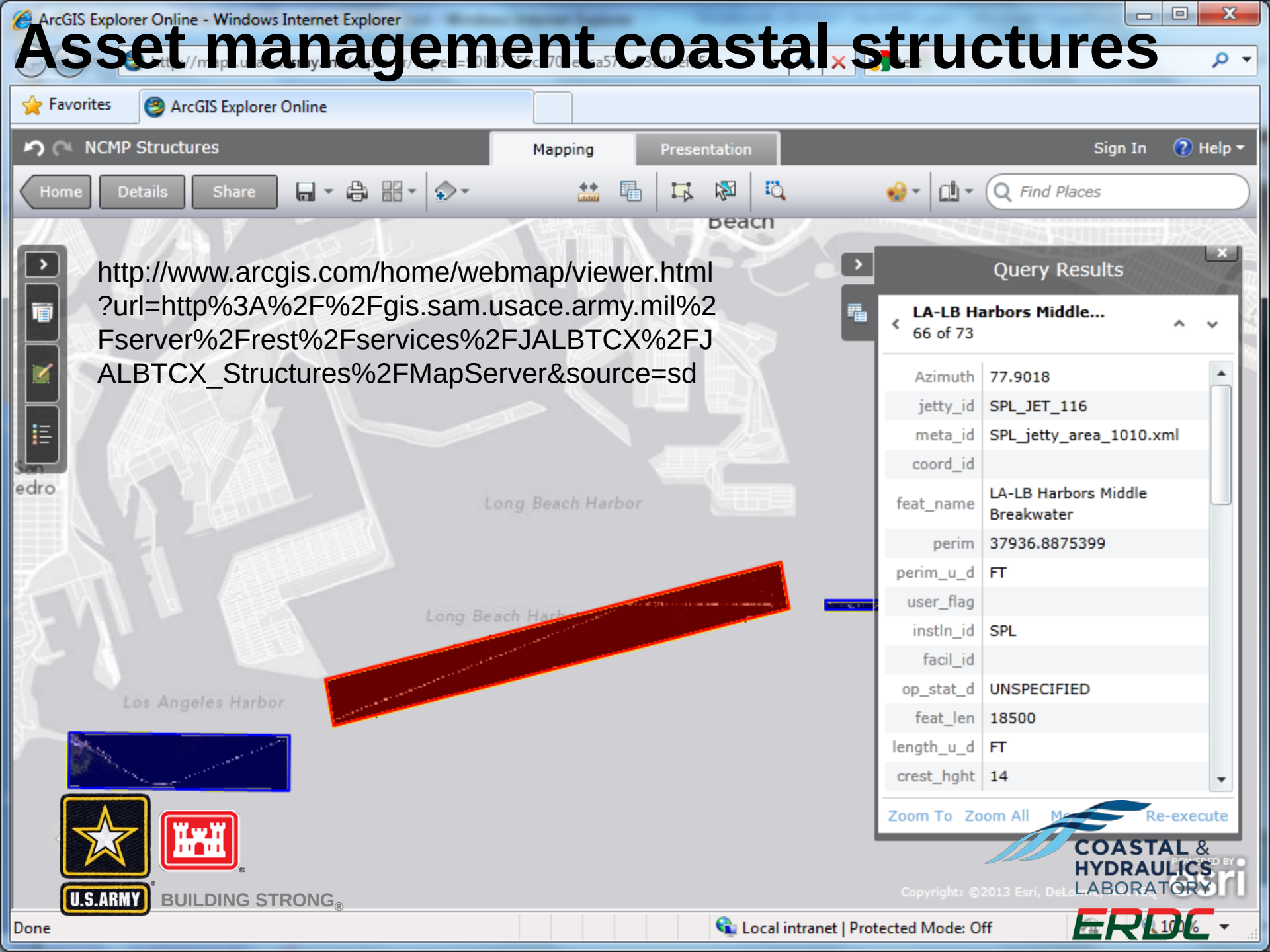
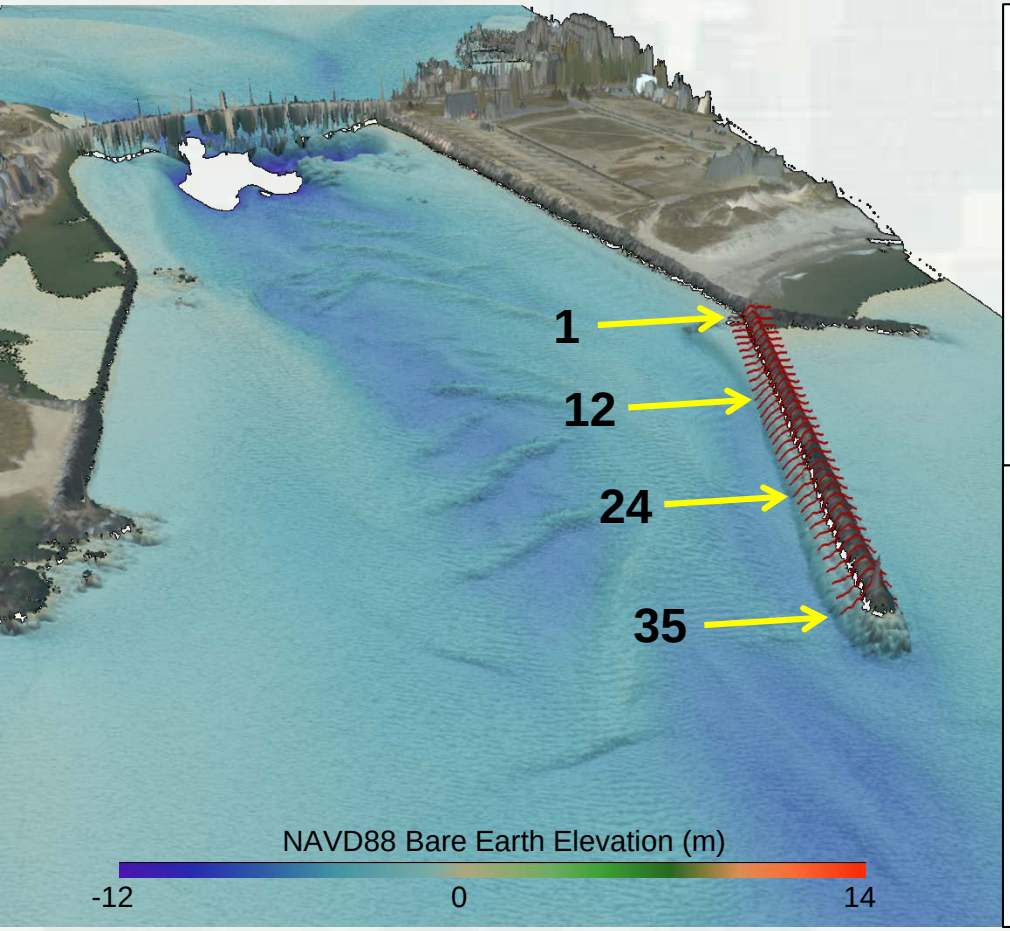
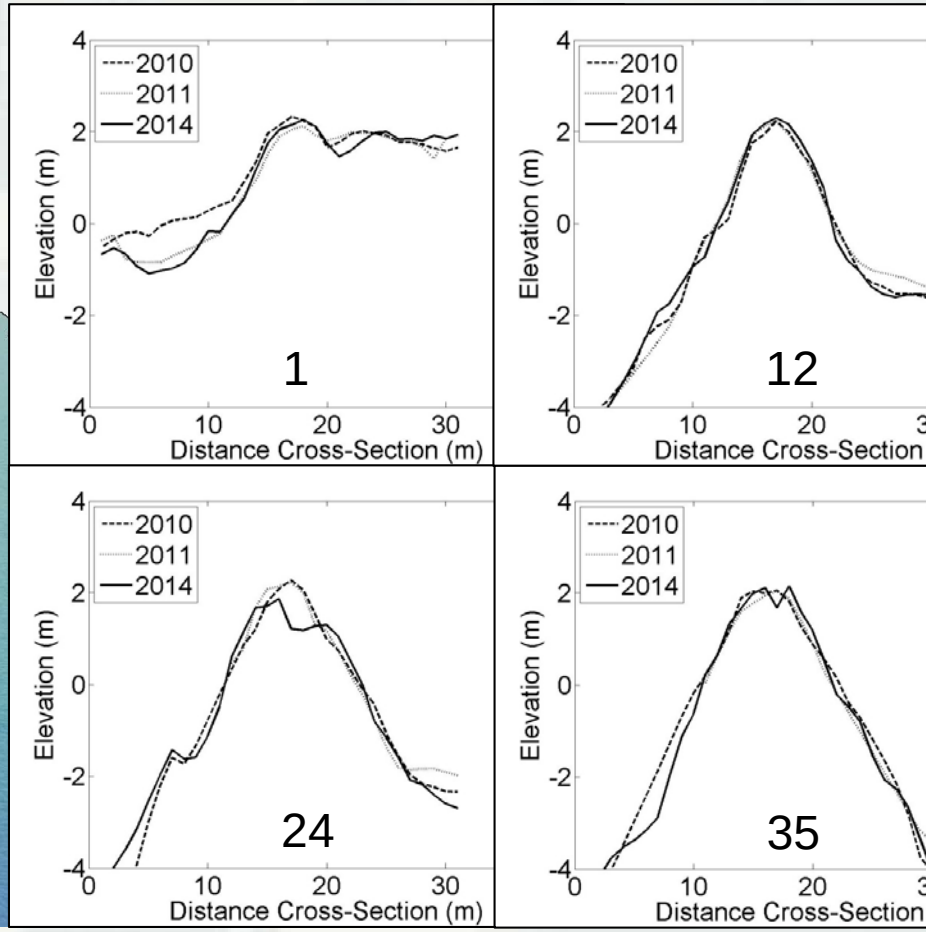
# Asset management coastal structures




http://www.arcgis.com/home/webmap/viewer.html?url=http%3A%2F%2Fgis.sam.usace.army.mil%2Fserver%2Frest%2Fservices%2FJALBTCX%2FJALBTCX_Structures%2FMapServer&source=sd

# Asset management coastal structures




Hampton Harbor, NH, 2014

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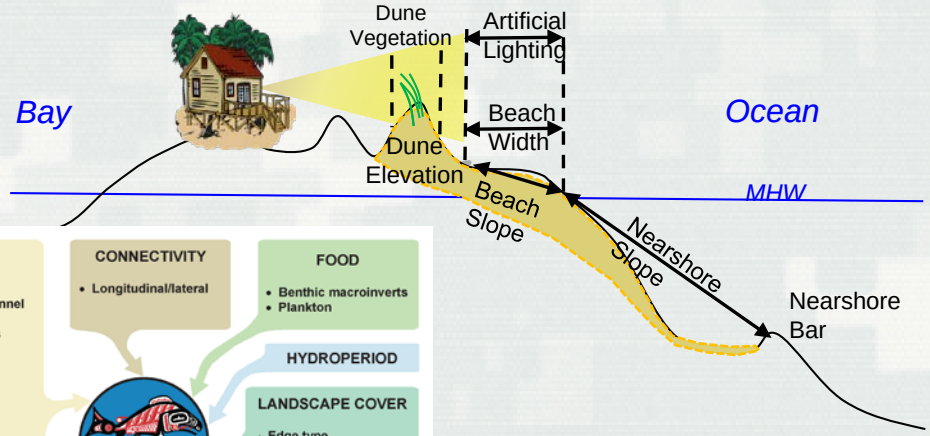
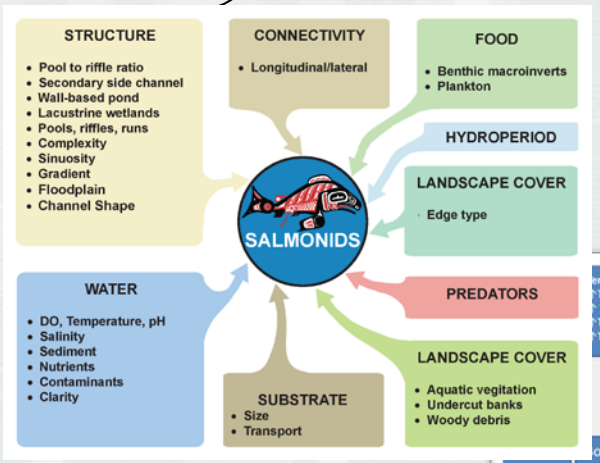
# Metrics for engineering, planning, restoration, and resilience

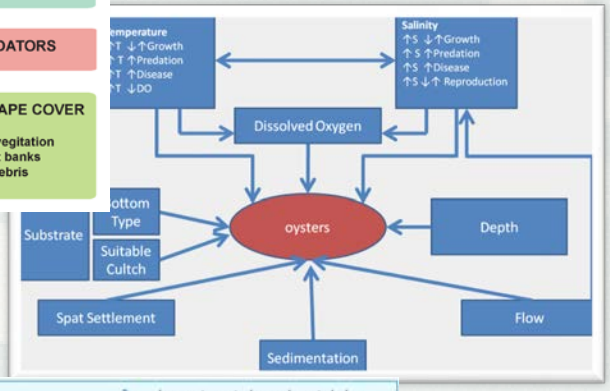
**Geomorphic:** elevation/depth, slope, dune characteristics, beach width, substrate size, volume/elevation change, distance to shoreline or dune peak, foredune continuity, channel shape/gradient and other structural characteristics

**Environmental:** terrestrial and aquatic habitat/vegetation type (e.g., SAV, wetlands), TES, invasives, cover density/diversity, fragmentation/connectivity, substrate type, impervious surface, height of vegetation above ground

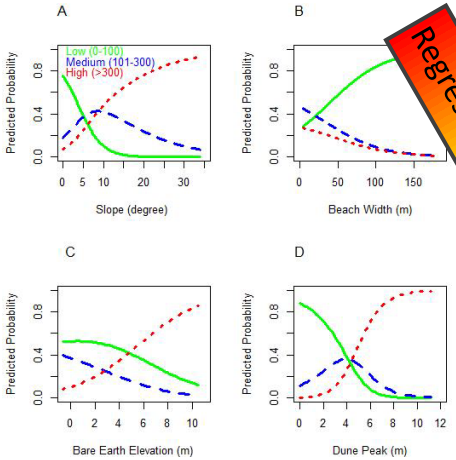
**Water:** stream length, watershed size, salinity, turbidity, chlorophyll, toxicity exposure



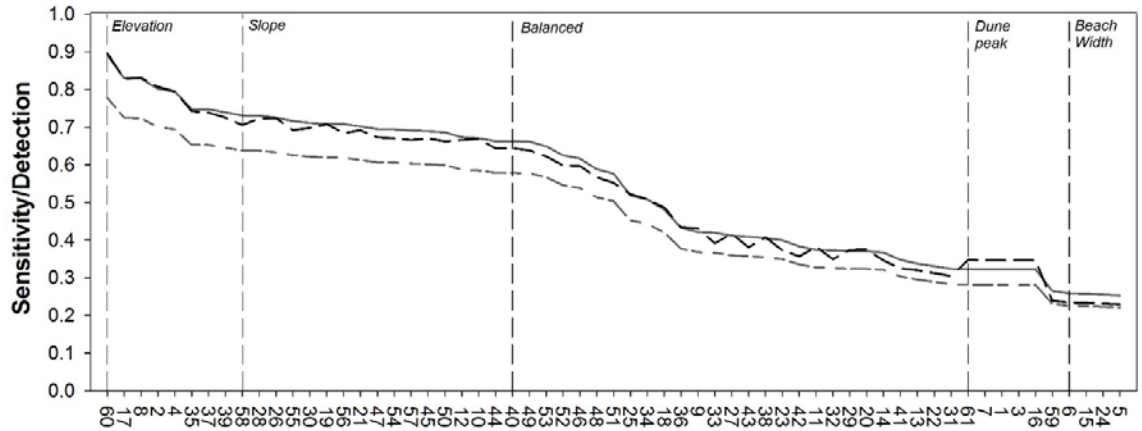



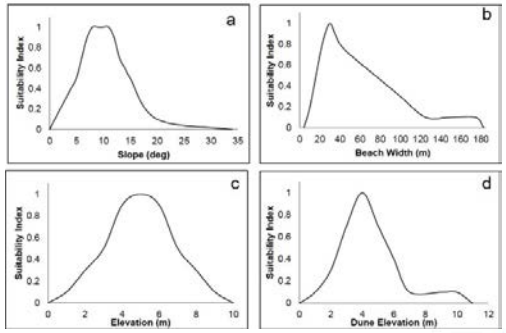



# Spatially Explicit Model for Sea Turtle Nesting Habitat Suitability

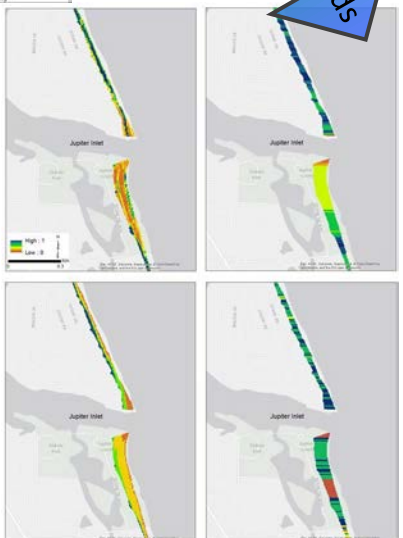


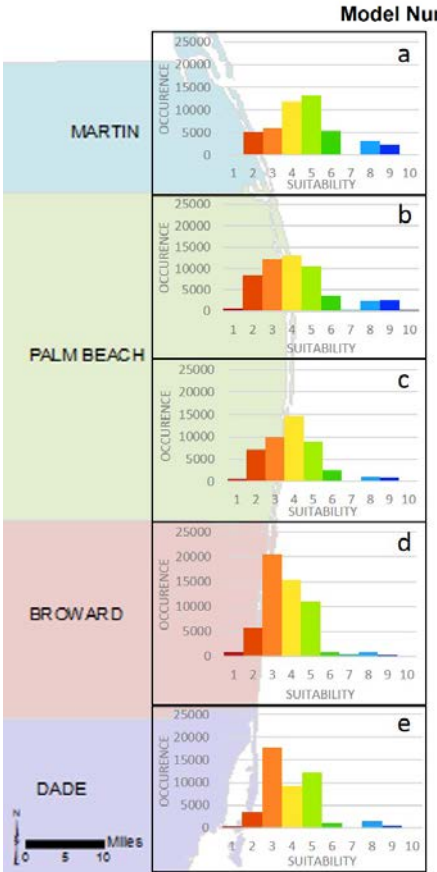

Regression Analysis – Suitability Curves – Rasterized model grids




- Multinomial logistic regression run on individual parameters
- Suitability index curves for (a) beach slope; (b) beach width; (c) elevation; and (d) dune
- Rasterized model grids

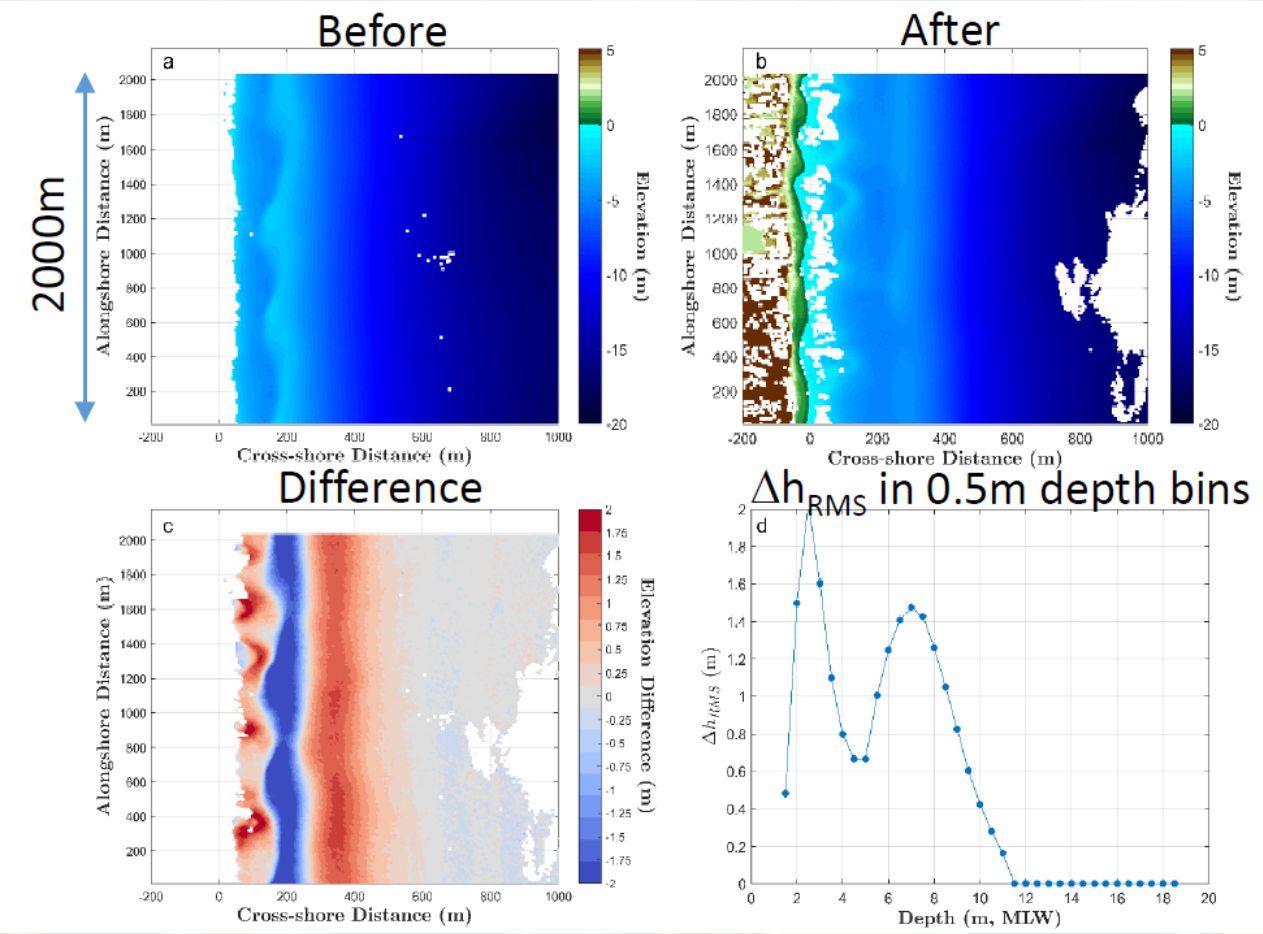


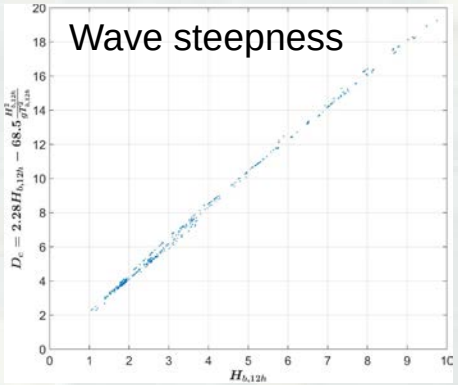


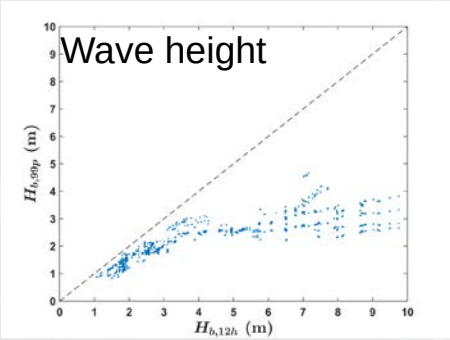

**Project Value**:

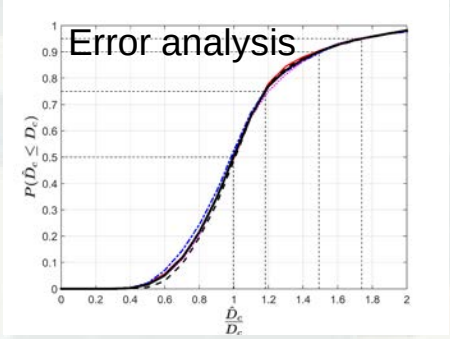
- Evaluate potential impacts of operational activities to nesting habitat and track changes through time
- Understanding of physical parameters needed to support nesting habitat
- Regional approach using remote sensing data

# Depth of closure

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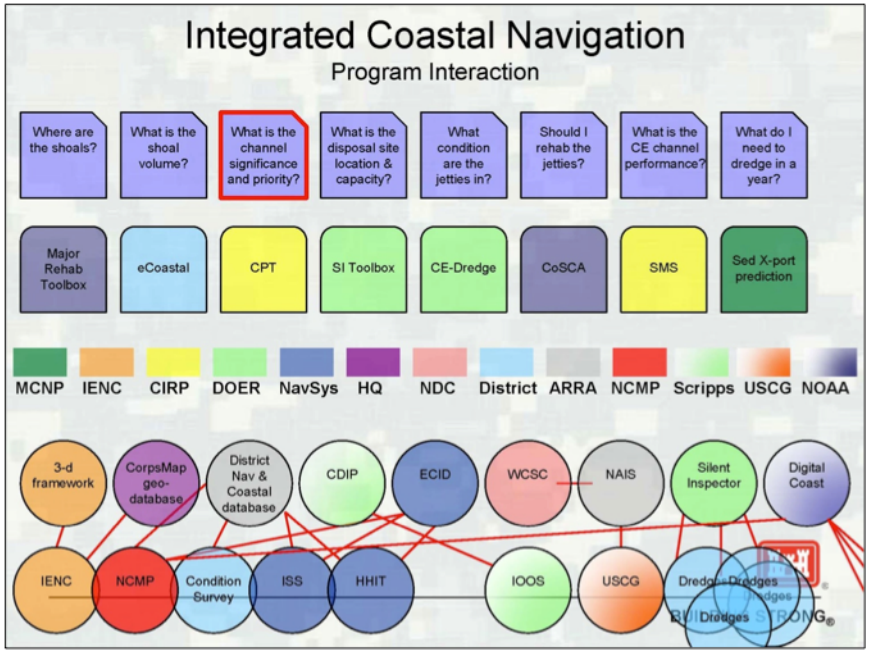
# National Coastal Mapping Program Data Access

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

**Navigation Data Integration Framework Concept and Implementation Plan**

**US Army Corps of Engineers Navigation Business Line**

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ERDC

# NCMP Data Access

shoals.sam.usace.arm | www.coast.noaa.gov

www.coast.noaa.gov/dataviewer/#

DIGITAL COAST
NOAA Office for Coastal Management

Data Access Viewer

Enter Long/Lat
-87.467,45.107 Go or Draw Area
no buffer

Refine Search
Data Type: Change
Licensed Data: Include
Data Provider: Select

Results (4) | Data Detail | Cart (0)

Zoom Share Clear Sort by Data Type (A-Z)

2012 USACE Topobathy Lidar: Lake Michigan (MI,WI)
USACE LAZ fmt
Lidar >17 billion Pts 7 GB Add to Cart

2012 USACE Topobathy Lidar: Lake Michigan (IN,IL,MI,WI)
USACE LAZ fmt
Lidar 105,653,601 Pts 403 MB Add to Cart

2012 USGS Lidar: Dickinson (MI)
USGS LAZ fmt
Lidar 601,380,235 Pts 2 GB Add to Cart

2008 USACE Topobathy Lidar: Lake Michigan (WI)
USACE LAZ fmt
Lidar 245,339,115 Pts 935 MB Add to Cart

Latitude: 44.5642 Longitude: -89.3173 Scale: 1:1155581
Base Maps: Imagery Streets

Iron Mountain, Escanaba, Garden, Green Bay/Lake Michigan, Menominee, Marinette, Green Bay, WISCONSIN, FLORENCE, FOREST, MARINETTE, MENOMINEE, LANGLADE, OCONTO, SHAWANO, WAUPACA, OUTAGAMIE, BROWN

Checkout: Notification | Outputs | Delivery | Confirmation

Dataset #1 (Lidar)
2012 USACE Topobathy Lidar: Lake Michigan (IN,IL,MI,WI)

Copy choices from: Select
Let me edit choices

Projection & Datum Options:
Note: The first option provided is the recommended choice Help

Projection: Geographic(Lat/Lon)
Zone: N/A
Horizontal Units: Decimal Degrees
Horizontal Datum: NAD83
Vertical Units: Feet
Vertical Datum: NAVD88

Output Options:
Output Product: Point
Output Format: Select One

Data Options: Use Advanced Options
Data Classes:
Ground
All

Back Next

United States Department of Commerce | National Oceanic and Atmospheric Administration

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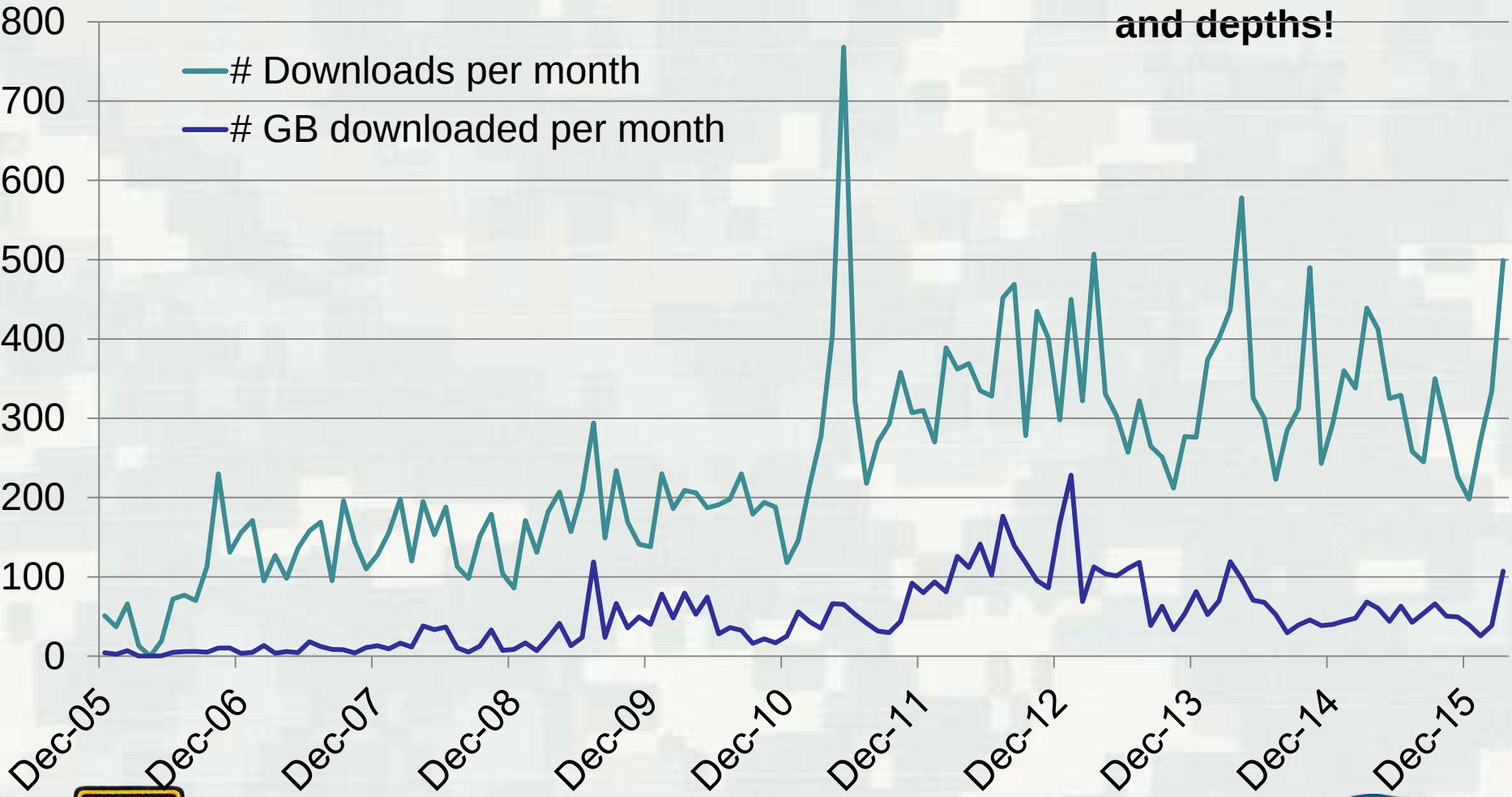
# JALBTCX at the DIGITAL COAST

**Statistics**

- **29,000 + downloads**
- **5.6 TB**
- **1.4 trillion elevations and depths!**

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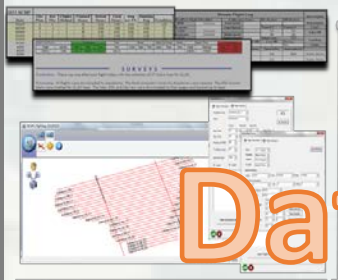
# NCMP Field Geodatabase Evolution



**Python/Web**

- Automated input
- Database synchronization
- Web-based reporting and log generation

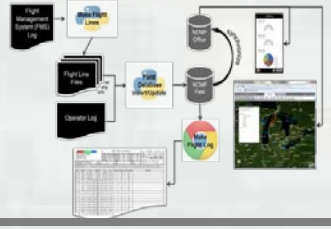
**Databases**

**2012**

- Form-based user input
- Check in/out data
- Manual flight log

**ArcPad**

**2013 - 2016**

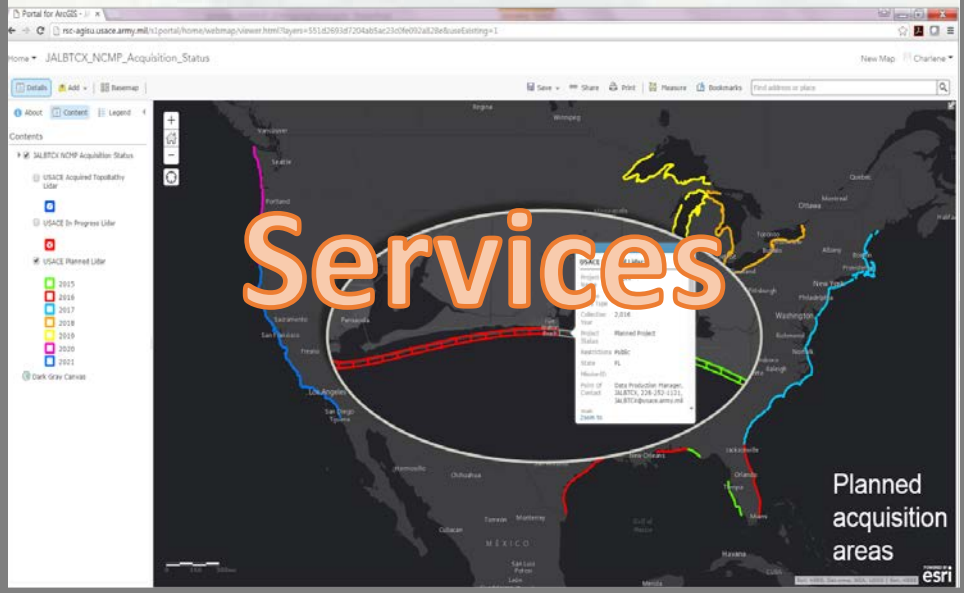


**2017+**

- Microsoft Azure (*likely*)
- Web-based reporting and log generation
- Multi-user access

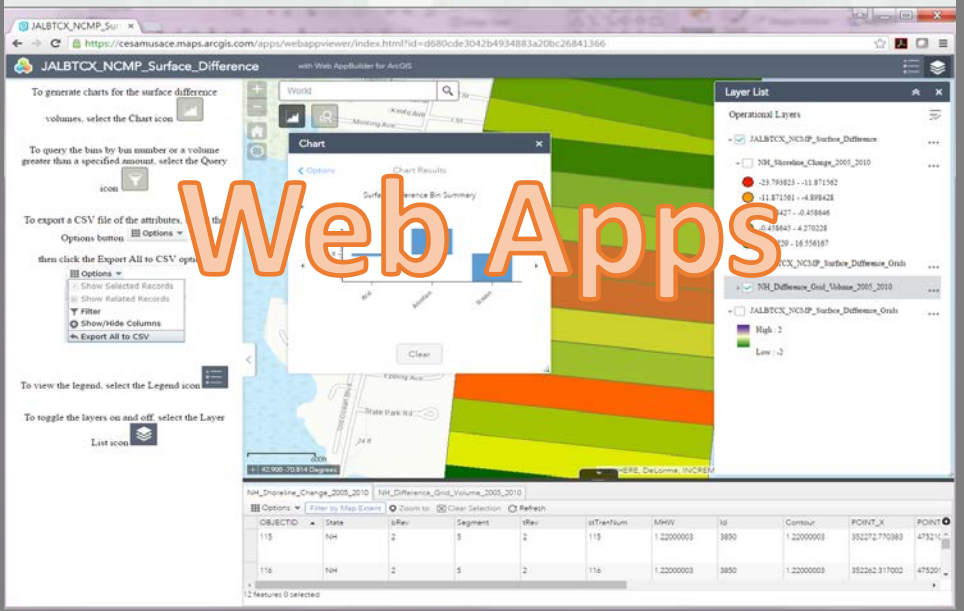
**Cloud**

# NCMP Acquisition Status Web Service: Planned




**Services**

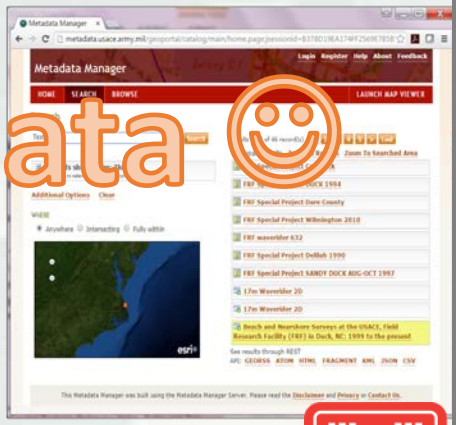
# NCMP Surface Difference, Shoreline Change and Volume Web App




**Web Apps**

# Towards Implementing SDSFIE-M

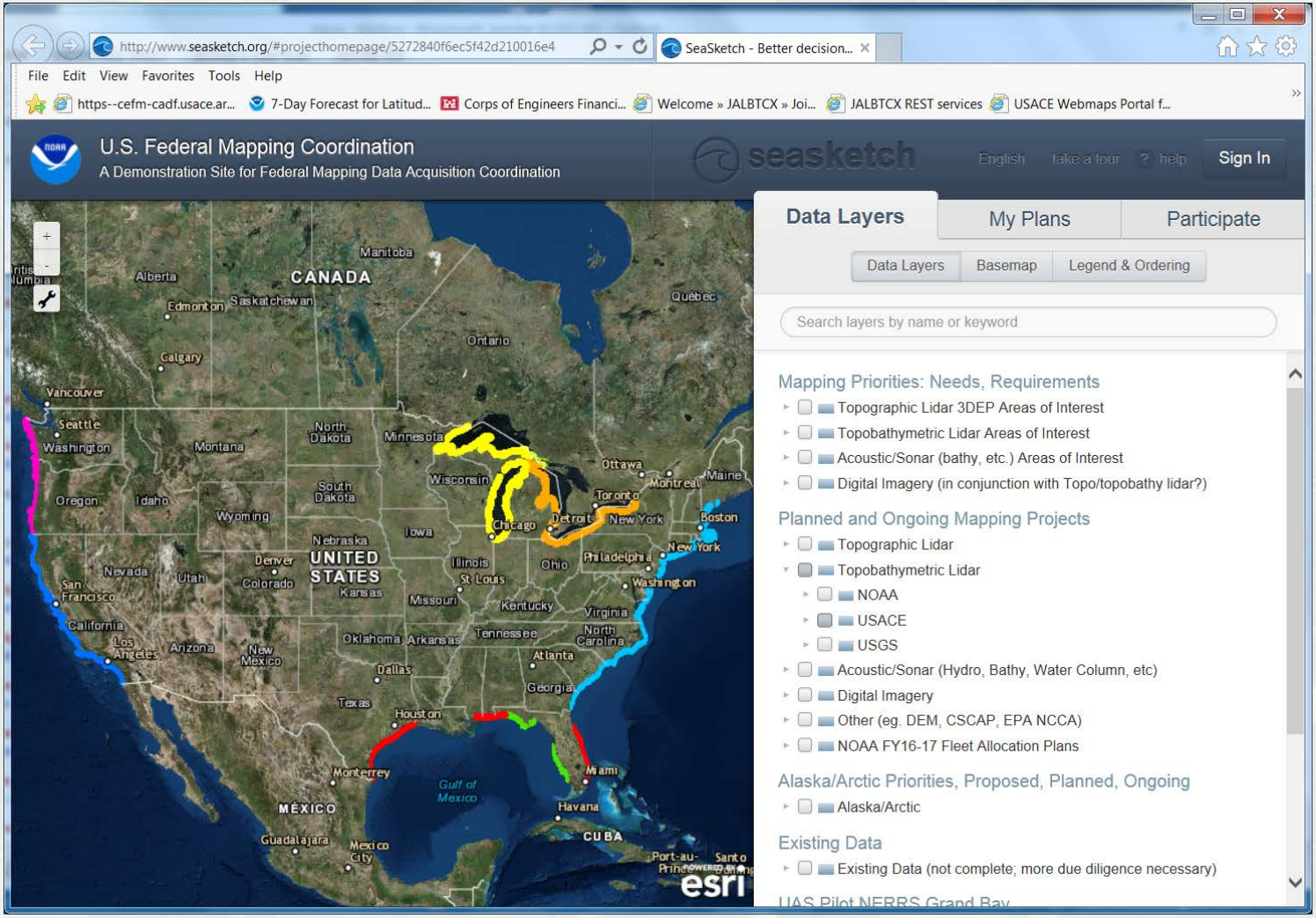
- Metadata Manager configuration for SDSFIE-M – in progress
  - Enables editing and validation of SDSFIE-M Style Metadata
  - Ava[illegible] co[illegible]
- Data.gov linkage – in progress
  - Housekeeping of existing records
  - Harvesting of geospatial metadata records
  - Provisioning of data.json file
    - Potential roadblock: only a single data.json for DoD will be accepted




**Metadata ☺**

* Once complete

# Future NCMP collections

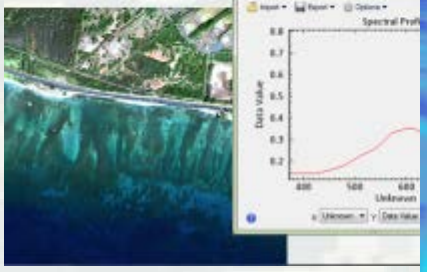


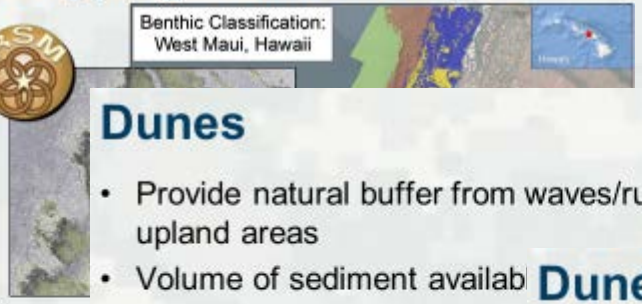

http://www.seasketch.org/#projecthomepage/5272840f6ec5f42d210016e4

# Future data development

## Benthic Habitat Mapping – West Maui, HI

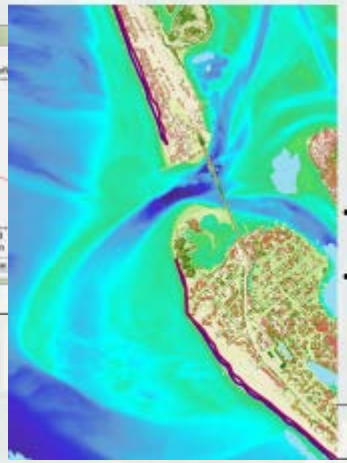
- Estimate bottom reflectance from hyperspectral imagery and depth
- Apply NOAA's ground truth data to create regions of interest in a supervised classification approach to identify major bottom types

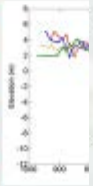





## Dunes

- Provide natural buffer from waves/runup to upland areas
- Volume of sediment availab
- Included as part of beach n





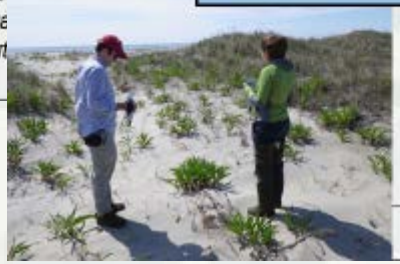
- Dune dune
- Dune

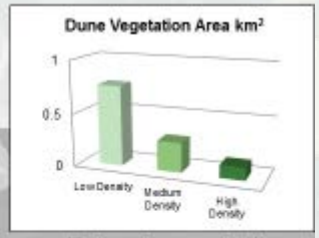
*1) Dune*
*2) Dune*
*3) Eleva distribut*

## Dune Vegetation Density

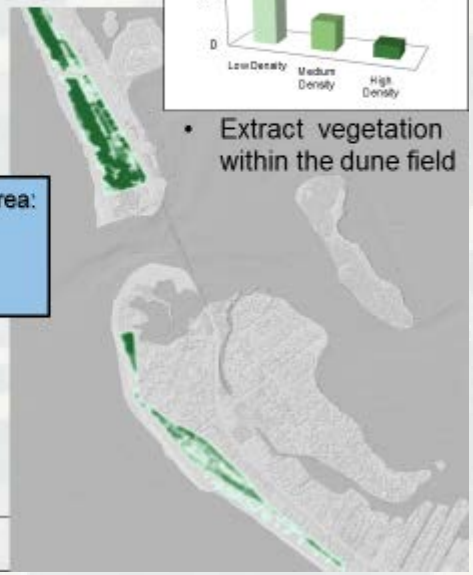
- Helps stabilize dunes and reduces erosion by trapping sand
- Provide habitat for critical species, including TE species

Dune Vegetation Density Area:
Low: *0.75km²*
Medium: *0.28km²*
High: *0.12km²*






- Extract vegetation within the dune field



# More upcoming USACE NCMP Activities

- Develop TPU for CZMIL
- Deliver West coast data and products from 2014 and 2015
- Update structures service
- Continue volume and shoreline change work in the Great Lakes
- Rolling delivery 2016 data
- Metadata activities
  - Implement SDSFIE-M for NCMP data products and publication of metadata to USACE Geoportal and national catalogs
  - Implement ISO 19157 (Data Quality) metadata in support of NCMP products
- Implement workflow developed in support of USIEI into production and back-populate acquisition status web service
- Migrate field database to the cloud environment

# JALBTCX 2016 Challenges

- Data processing
  - Point cloud editing – ~ ½ of total time and ¼ cost. Need for automation of this effort. Problem areas are low signal to noise (extinction, turbid water) and along the shoreline.
- Data management
  - Data volumes, backups, and associated processing unmanageable. 0.5-1 TB per 4 hour flight

# JALBTCX 2016 Challenges

- Data delivery
  - Future LAS format needs capability to store point-by-point datum shifts (ex. WGS84 separation models to tidal surface; AK and Pacific Islands where Geoid needs improvement)
  - Implement LAS 1.4
  - Non-proprietary compression algorithms
  - Move to image services
  - Tracking usage of data and outcomes

# JALBTCX 2016 Challenges

- Products
  - Transition selected prototype derived products (benthic classification, dune  vegetation density, etc.) into standard production through standardization and automation, overcome inconsistent image quality
  - Identify products to better support the coastal modeling community - land cover datasets, structures extracted for breaklines, etc.
- Need a permanent calibration range for continued sensor development and evaluation.

# JALBTCX 2016 Opportunities

- Depth inversion solution for turbid water areas that takes advantage of our imagery and lidar water surface measurements
- Leveraging cloud capabilities for point clouds and rasters, and delivery of data products
- Identifying requirements for next generation systems – open source cloud to real time processing, UAS/OPA capable, better performance in turbid and nearshore environments, etc.
- Better engagement by government, industry, and manufacturers with academia to develop the next generations of coastal mapping experts.

# Questions?

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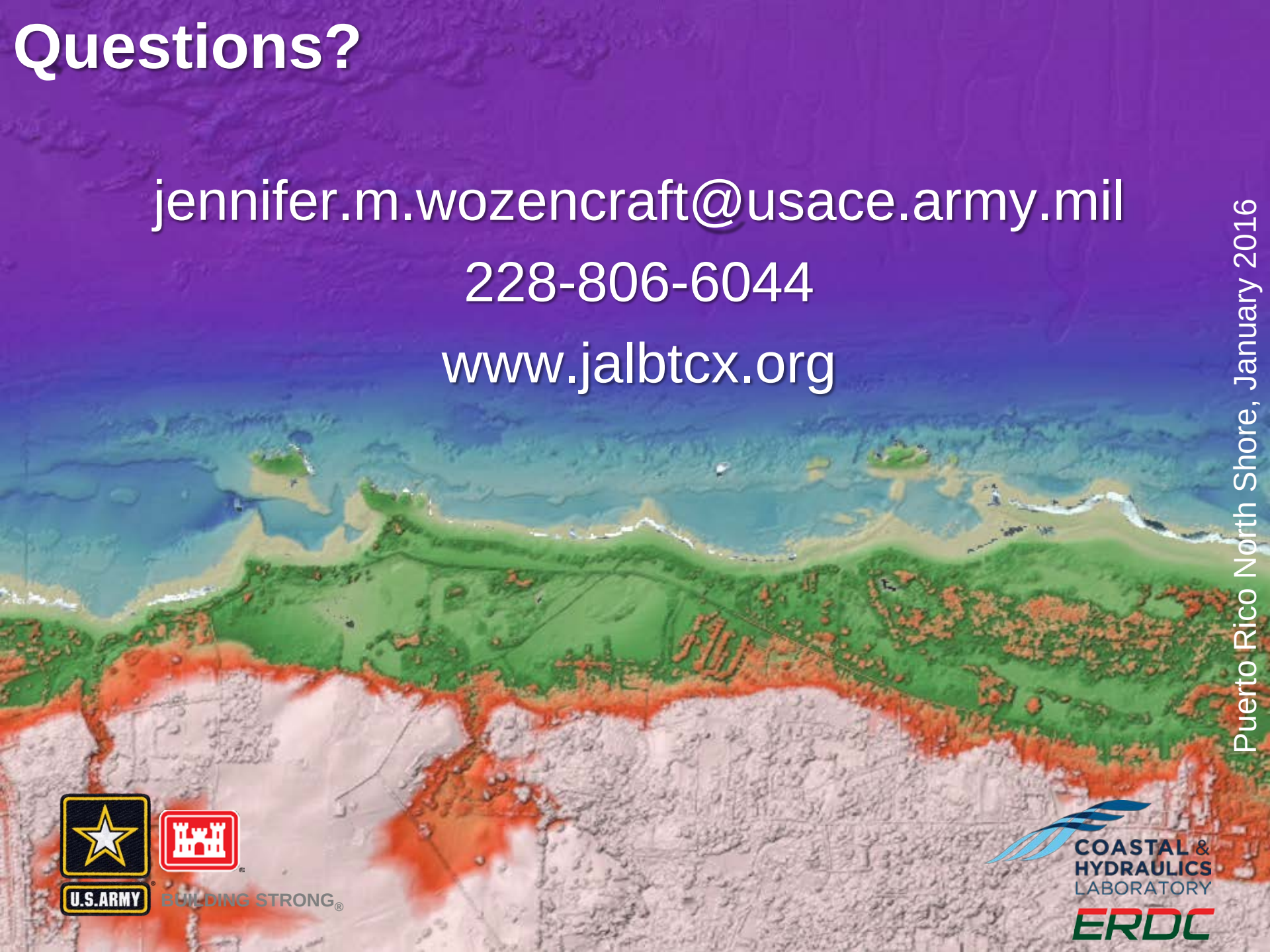
228-806-6044

www.jalbtcx.org



Puerto Rico North Shore, January 2016

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