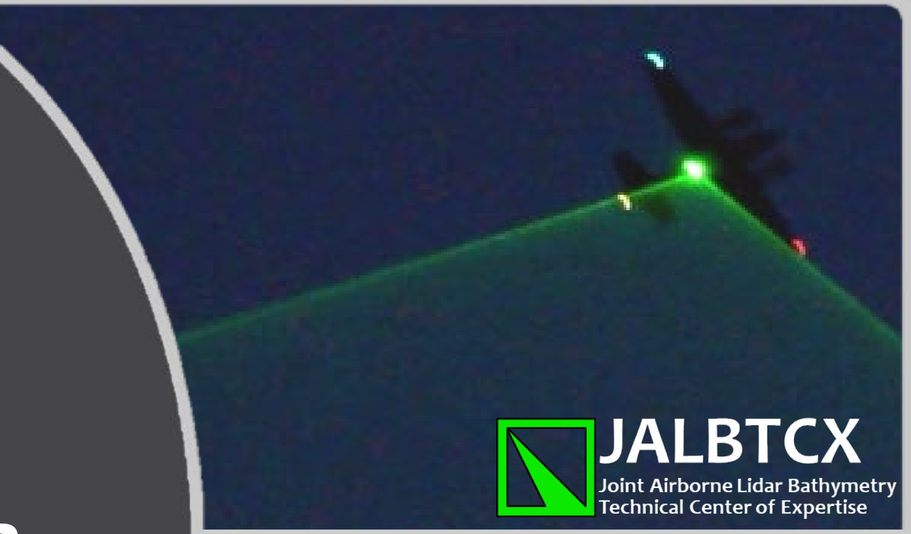
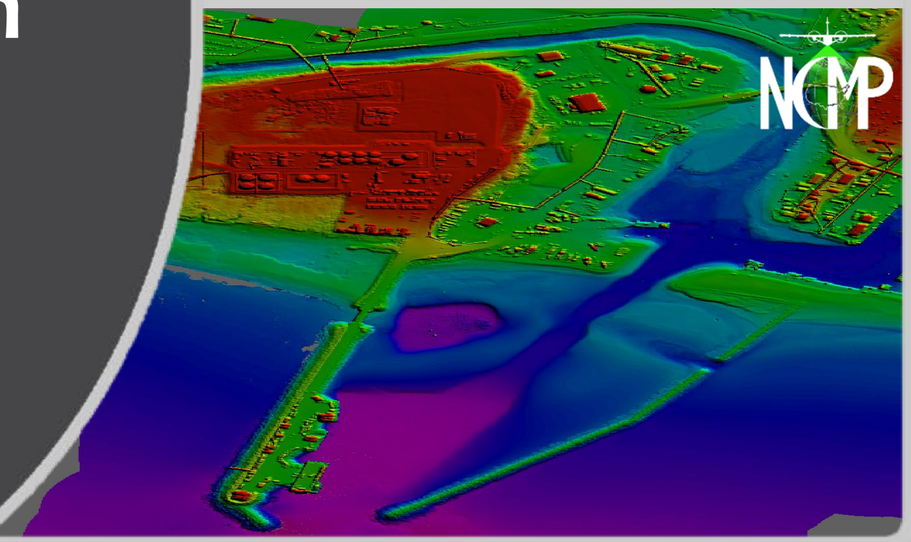
US Army Corps of Engineers National Coastal Mapping Program





Jennifer M. Wozencraft

- US Army Corps of Engineers National Coastal Mapping Program Manager
- Joint Airborne Lidar Bathymetry Technical Center of Expertise Director
- Coastal and Hydraulics Laboratory, US Army Engineer Research and Development Center

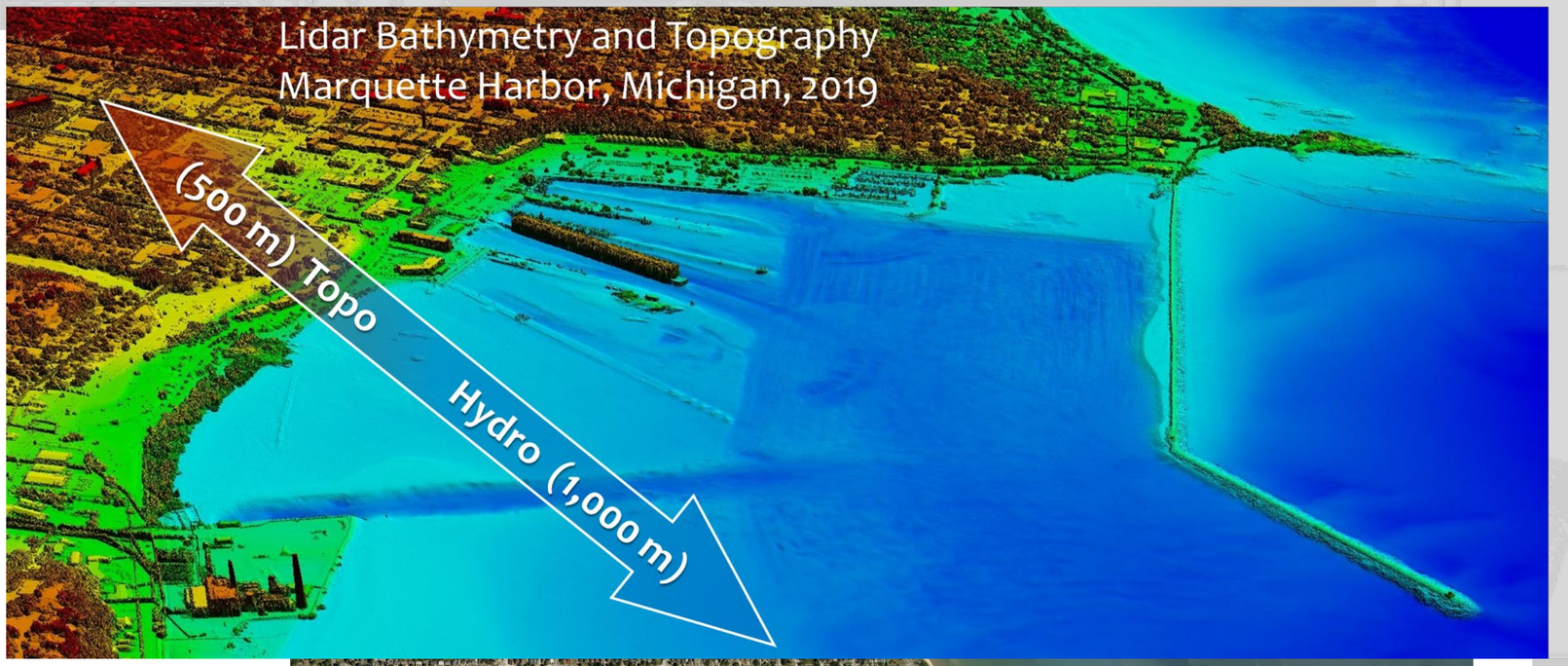
22 September 2021

US Army Corps of Engineers

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

National Coastal Mapping Program

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



The Team

Mobile District

Chris Macon
Nick Johnson
Heath Harwood

WMR 532
Woolpert | Magnolia River
Joint Venture

Bowhead

Coastal and Hydraulics Laboratory

Lauren Dunkin
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Eve Eisemann*
Michael Hartman
Sean McGill
Scott Spurgeon
Ashley Elkins
Cassandra Hankins

Environmental Laboratory

Molly Reif
Sam Jackson
Glenn Suir
Christina Saltus
Scott Bourne
Richard Johansen

US Army Corps of Engineers

Time-lapse of a night flight, Long Island, NY, September 2017

NOAA NCMP

JALBTCX
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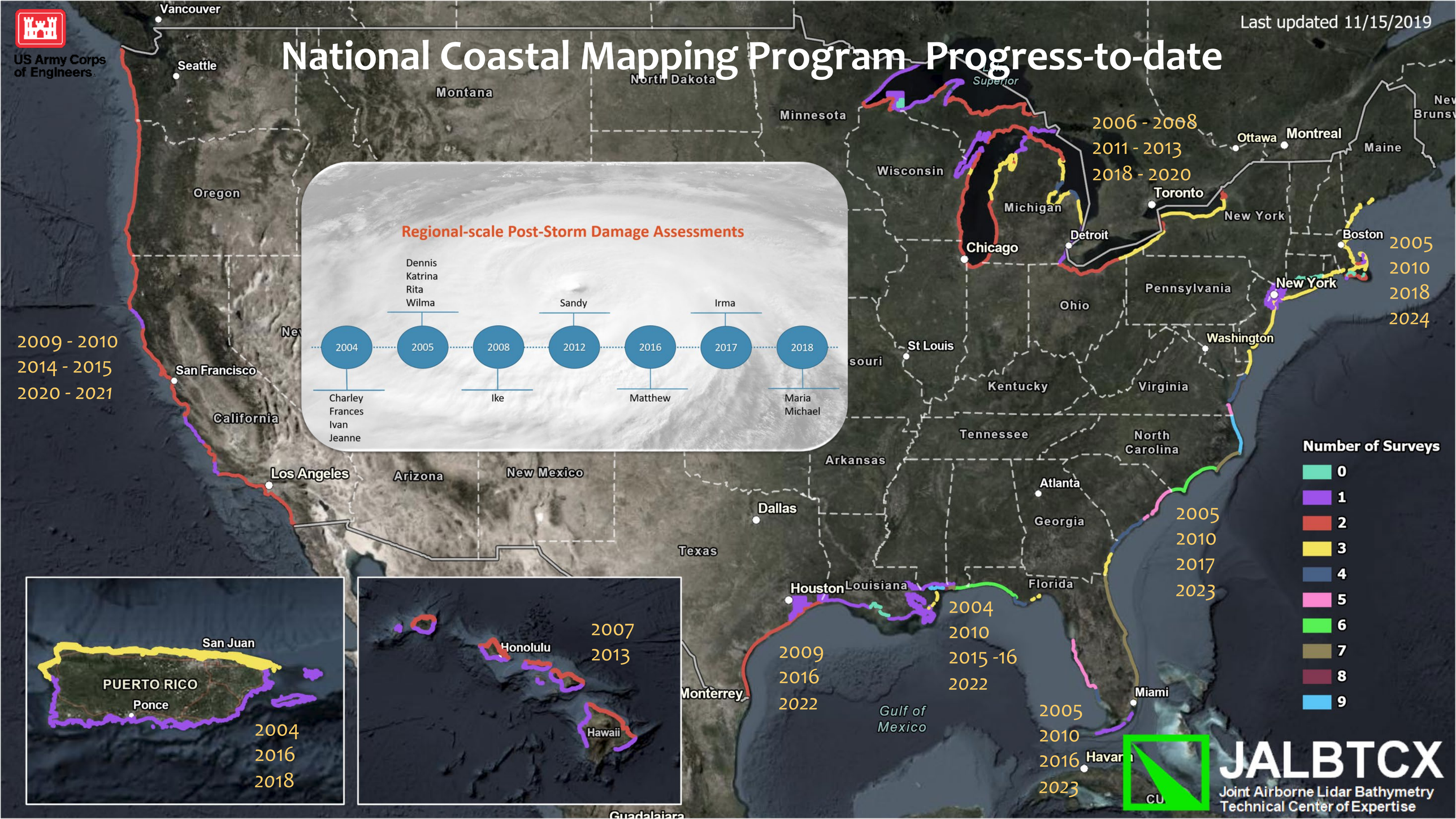
US Army Corps of Engineers
Last updated 11/15/2019
National Coastal Mapping Program Progress-to-date
Regional-scale Post-Storm Damage Assessments
2004
Charley
Frances
Ivan
Jeanne
2005
Dennis
Katrina
Rita
Wilma
2008
Ike
2012
Sandy
2016
Matthew
2017
Irma
2018
Maria
Michael
2009 - 2010
2014 - 2015
2020 - 2021
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2005
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2016
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2004
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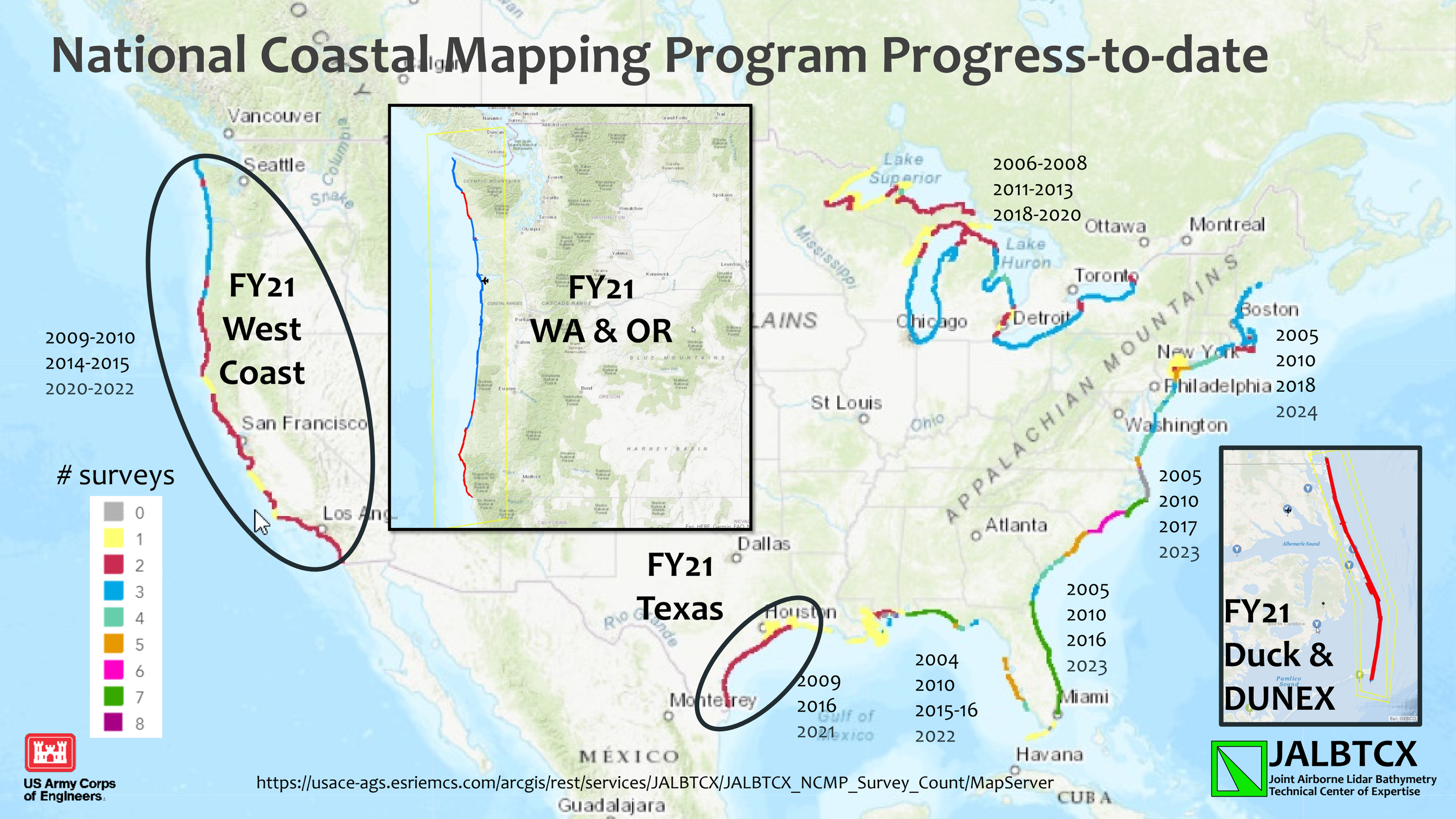
2018
2007
2013
Number of Surveys
0
1
2
3
4
5
6
7
8
9
JALBTCX
Joint Airborne Lidar Bathymetry Technical Center of Expertise
Vancouver
Seattle
Montana
North Dakota
Minnesota
Superior
Wisconsin
Michigan
Oregon
Chicago
Detroit
Toronto
Ottawa
Montreal
Maine
New York
Boston
Pennsylvania
Ohio
St Louis
Washington
San Francisco
California
Kentucky
Virginia
Tennessee
North Carolina
Arkansas
Los Angeles
Arizona
New Mexico
Atlanta
Georgia
Dallas
Texas
Houston
Louisiana
Florida
Miami
Monterrey
Gulf of Mexico
San Juan
PUERTO RICO
Ponce
Honolulu
Hawaii
Guadalajara

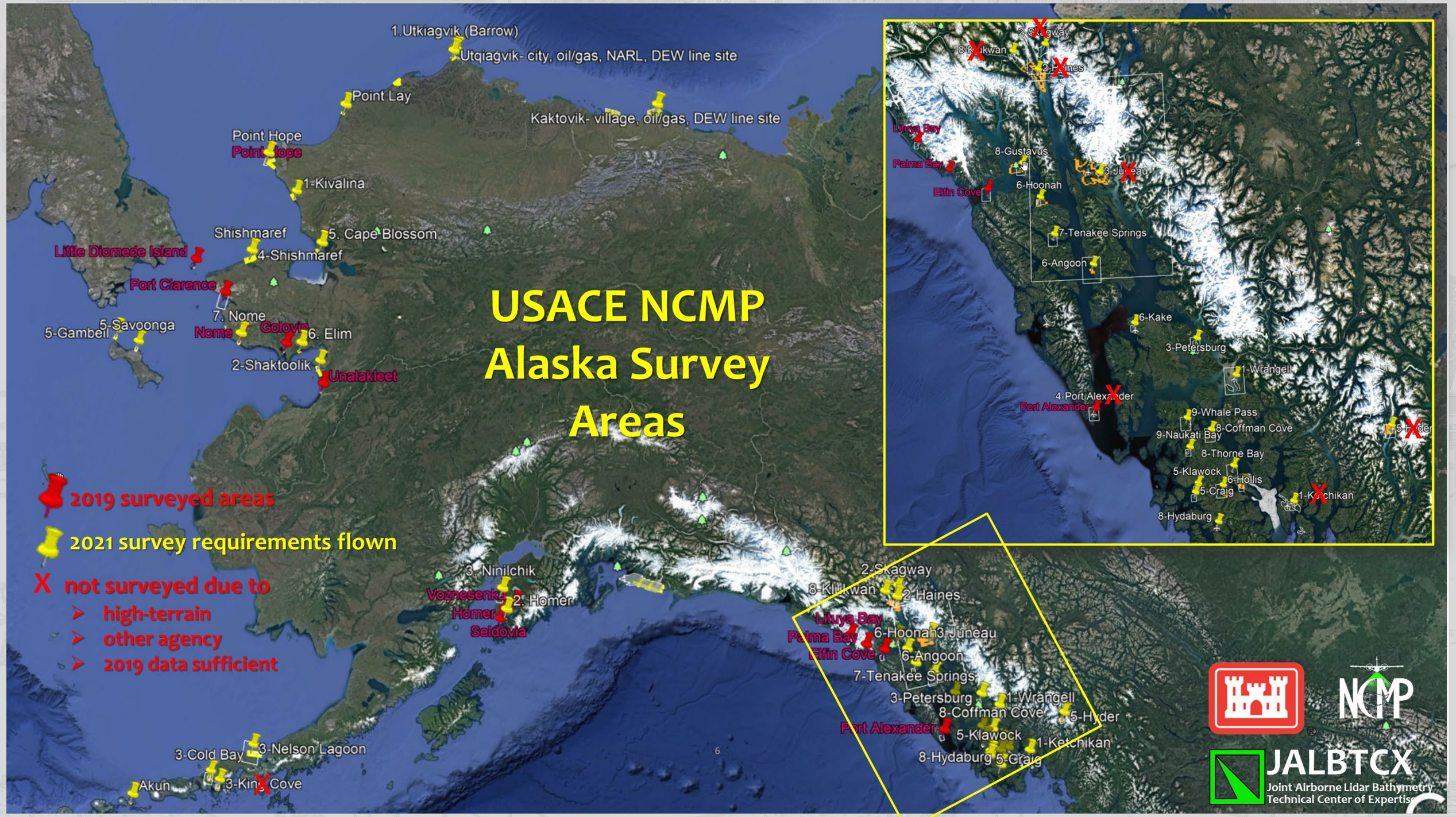
National Coastal Mapping Program Progress-to-date



US Army Corps of Engineers

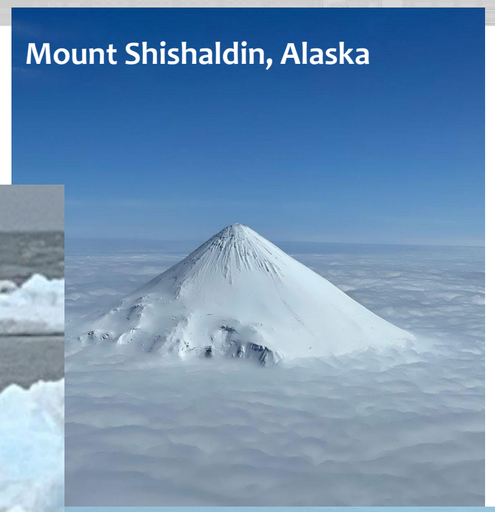
https://usace-ags.esriemcs.com/arcgis/rest/services/JALBTCX/JALBTCX_NCMP_Survey_Count/MapServer

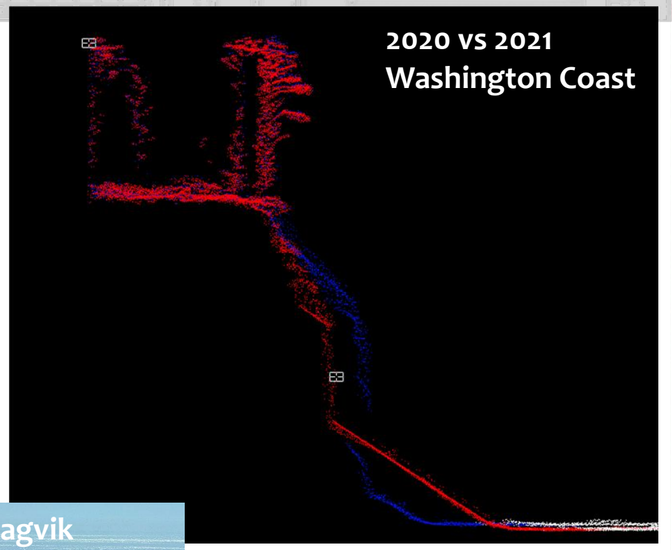
JALBTCX
Joint Airborne Lidar Bathymetry Technical Center of Expertise


1.Utkiagvik (Barrow)
Utqiaġvik- city, oil/gas, NARL, DEW line site
Point Lay
Kaktovik- village, oil/gas, DEW line site
Point Hope
Point Hope
1-Kivalina
Shishmaref
5. Cape Blossom
Little Diomede Island
4-Shishmaref
Port Clarence
7. Nome
5-Savoonga
5-Gambell
Nome
Golovin
6. Elim
2-Shaktoolik
Unalakleet
USACE NCMP
Alaska Survey
Areas
2019 surveyed areas
2021 survey requirements flown
X not surveyed due to
high-terrain
other agency
2019 data sufficient
3. Ninilchik
Voznesenka
2. Homer
Homer
Seldovia
3-Cold Bay
3-Nelson Lagoon
Akun
3-King Cove
2-Skagway
8-Klukwan
2-Haines
Lituya Bay
Palma Bay
Elfin Cove
6-Hoonah
3-Juneau
6-Angoon
7-Tenakee Springs
3-Petersburg
1-Wrangell
8-Coffman Cove
5-Hyder
Port Alexander
5-Klawock
1-Ketchikan
8-Hydaburg
5-Craig
8-Gustavus
6-Kake
4-Port Alexander
9-Whale Pass
9-Naukati Bay
8-Thorne Bay
6-Hollis
NCMP
JALBTCX
Joint Airborne Lidar Bathymetry
Technical Center of Expertise

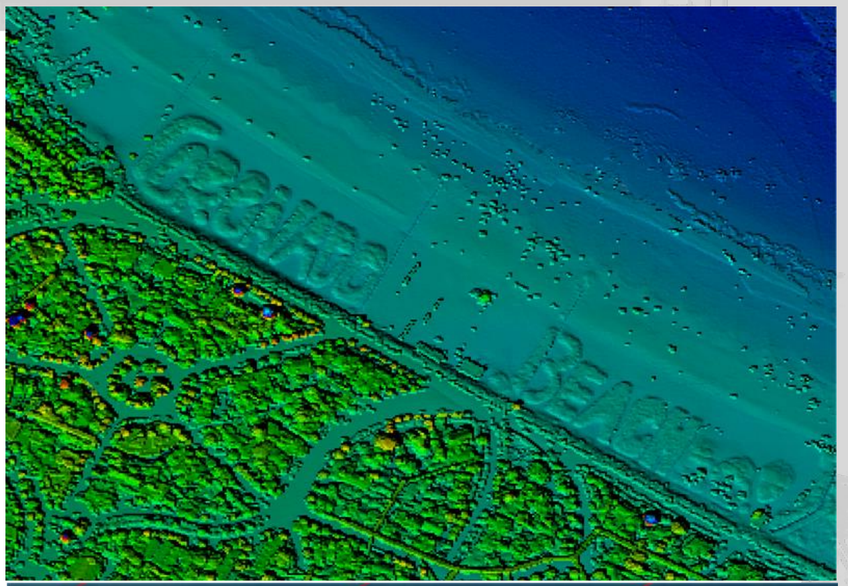
Fun stuff

Mount Shishaldin, Alaska





2020 vs 2021
Washington Coast



Photograph of Utqiagvik
(Barrow) during collection flight

Rockaway Beach, Oregon
July 2020
Not survey weather

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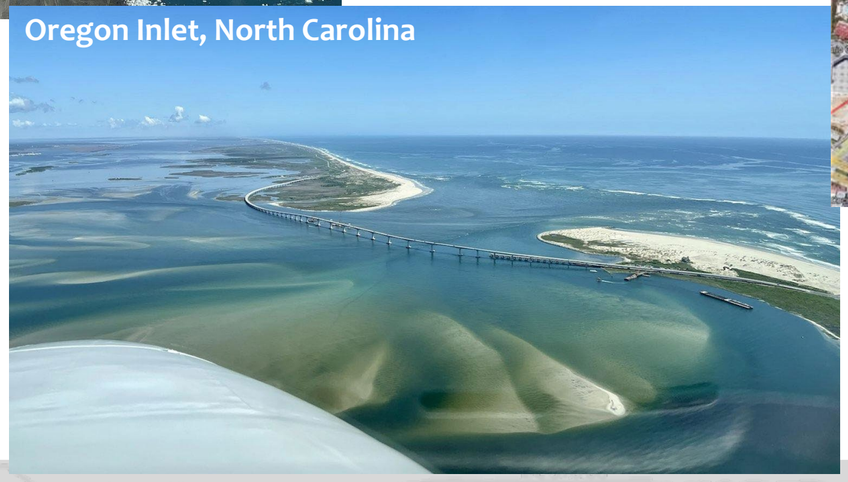
Technical Center of Expertise

Oregon Inlet, North Carolina



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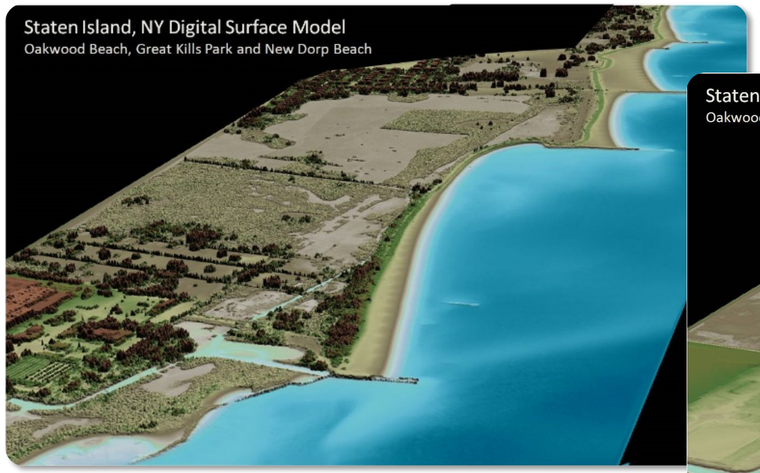
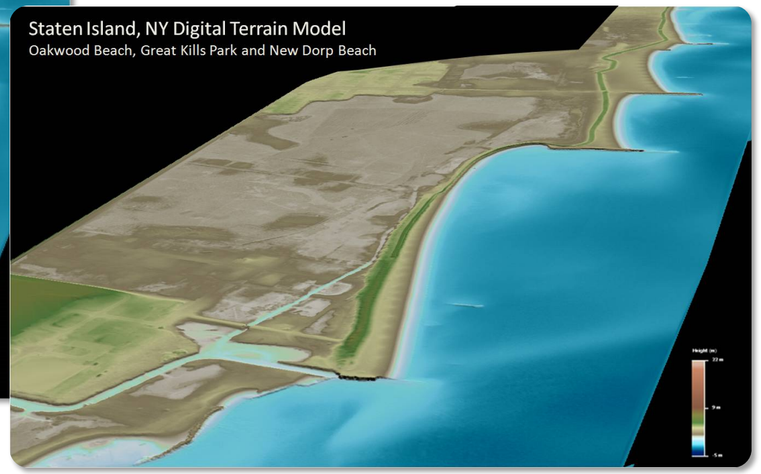
jennifer.m.wozencraft@usace.army.mil

National Coastal Mapping Program Products and Applications

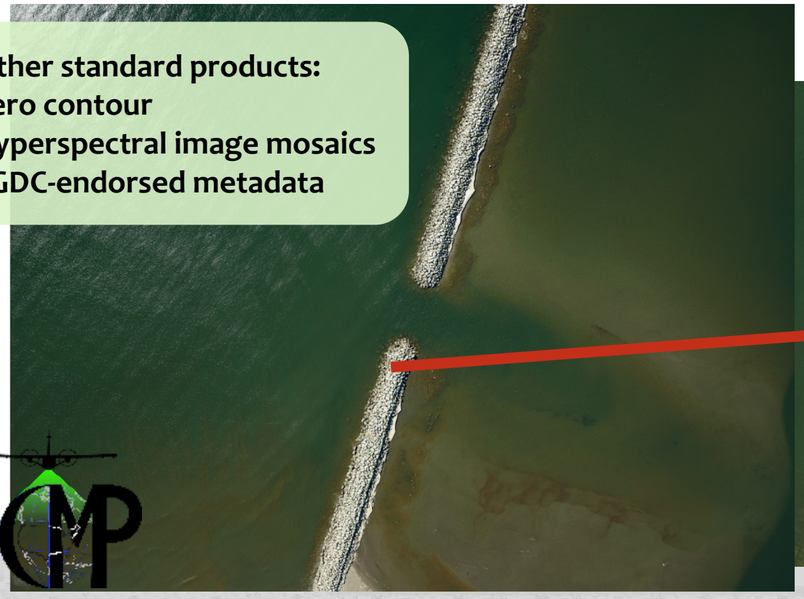




bathymetry and topography
JALBTCX Image Service: 1-meter topographic/bathymetric lidar surface models
https://www.arcgis.com/home/item.html?id=474ff2c6fc1d406e8e9dd635ff571ea3

“bare earth” for coastal flood models
JALBTCX Image Service: 1-meter topographic/bathymetric lidar elevation models
https://www.arcgis.com/home/item.html?id=4c32933fd57e4a53b830a56017c6670a

Other standard products:
Zero contour
Hyperspectral image mosaics
FGDC-endorsed metadata



How USACE uses NCMP data:

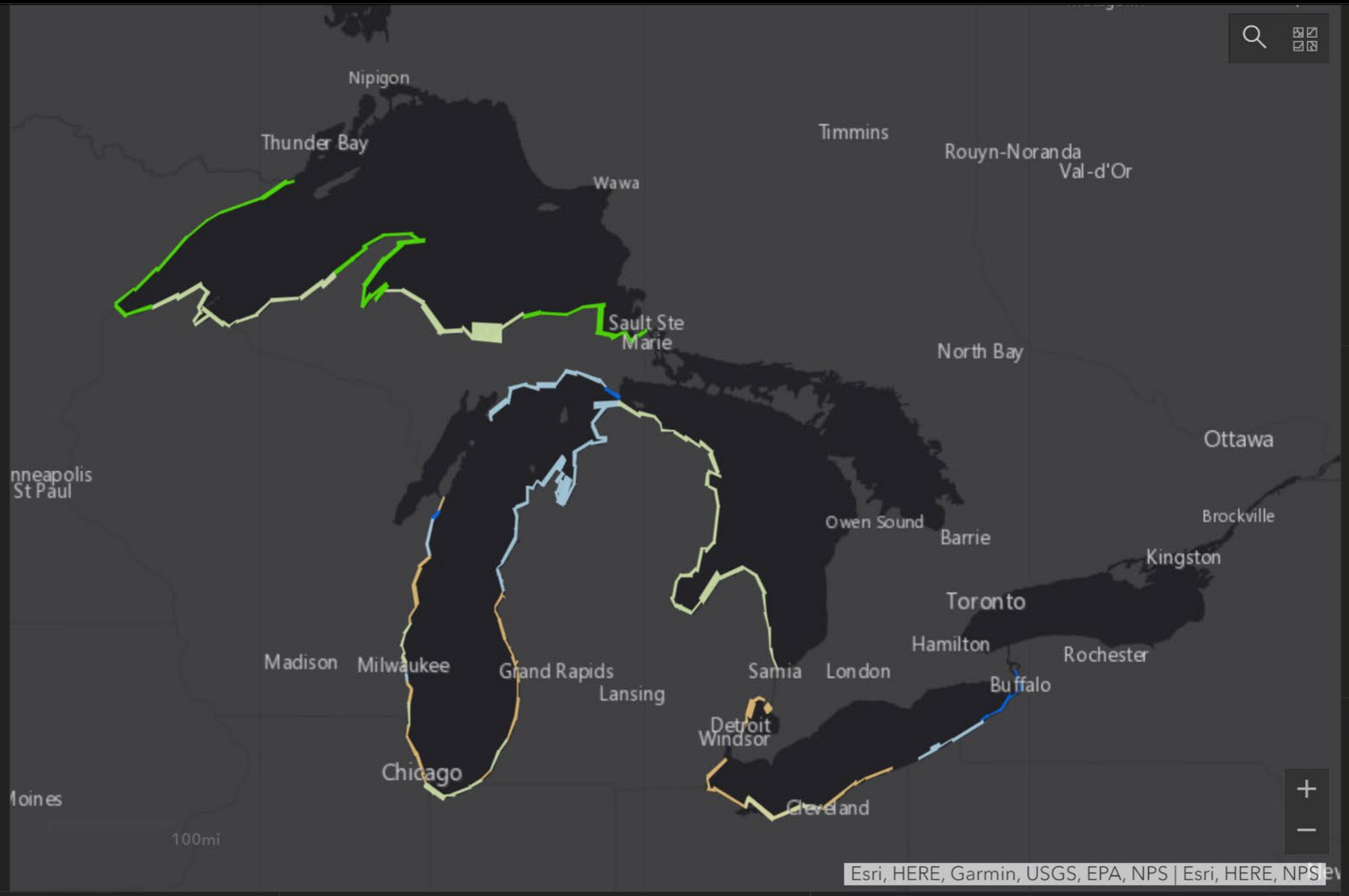
- Regional context for regional sediment management
- Regional sediment budgets
  - Integration with RSM-SBAS (Sediment Budget Analysis System)
- Coastal structure asset management
  - Measure and monitor coastal infrastructure
  - Coastal structure physical condition assessment
  - Data for modeling functional performance
  - Ongoing Remote Inspection of Coastal Structures Project
- Quantify capacity of upland dredge placement sites
- Navigation channel impacts to adjacent shorelines
- Physical/environmental baseline for operational changes such as channel deepening
- Channel condition assessment in clear water
- Design and monitoring of beneficial use sites and natural and nature-based features
- Habitat data for sensitive species like eelgrass, sea turtles, & wetlands
- Base data/layer for Navigation Portal
- On-the-shelf data and analysis products for Smart Planning and Coastal Comprehensive Studies
- Emergency response storm impacts
  - Quantify storm impacts to channels and jetties
  - Quantify storm impacts to beaches projects
- Updated bathymetry and topography to drive coastal models

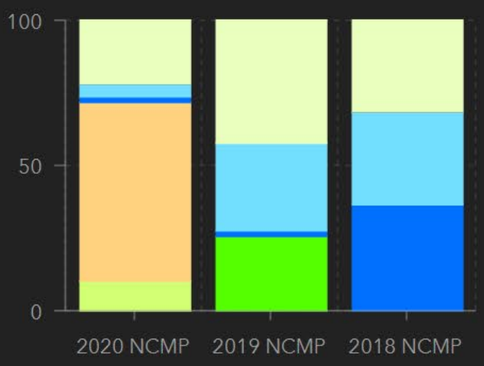
JALBTCX Production Dashboard

Lidar: All | RGB: 2020_NCMP_PostSally | HSI: 2020_NCMP_PostSally | Date Range: All

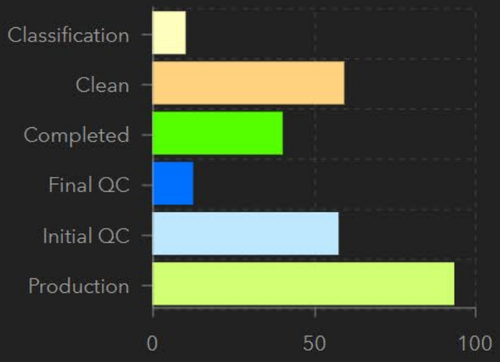
Flight Blocks - Lidar

- Not Flown
- Flown
- Process
- Clean
- Classification
- Initial QC
- Final QC
- Production
- Completed
- Available in Digital Coast



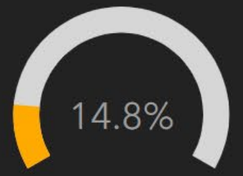


Last update: a few seconds ago



Last update: a few seconds ago

Percent Delivered:



OG: 126
BH: 93

Last update: a few seconds ago

In Field: 0
Editing: 69

Last update: a few seconds ago

Initial QC: 57
Final QC: 12

Last update: a few seconds ago

Production: 93
Delivered: 40

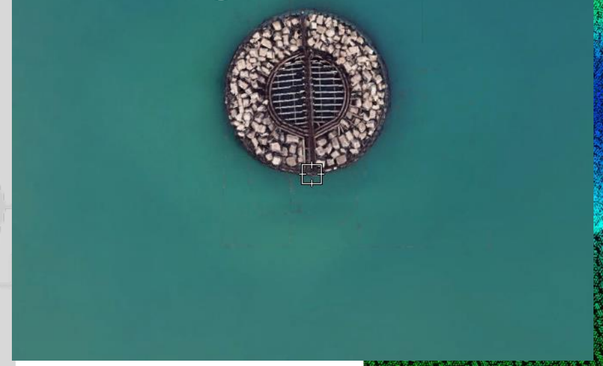
Last update: a few seconds ago

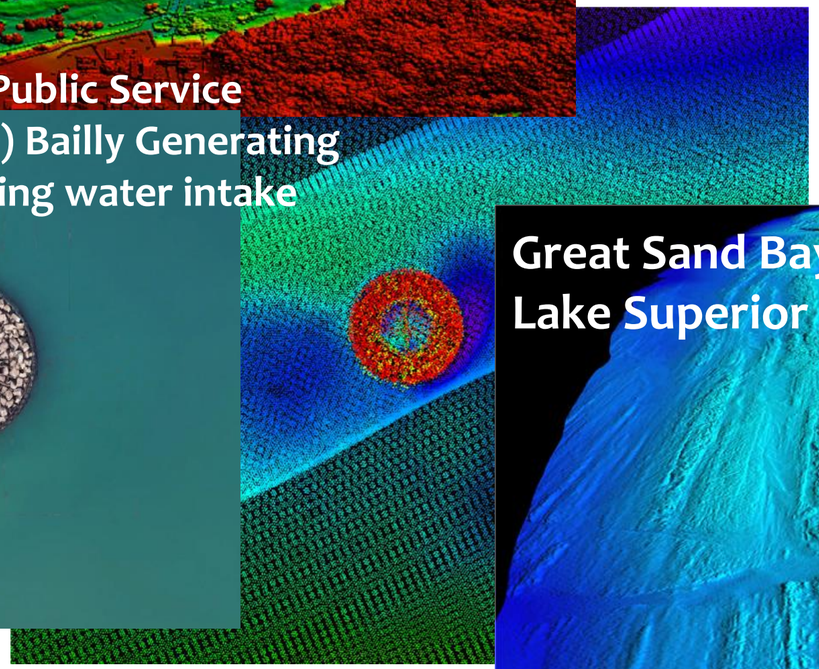
Lidar | RGB | HSI

https://arcgis.usacegis.com/arcgis/rest/services/JALBTCX/JALBTCX_Flight_Blocks_Viewer/MapServer

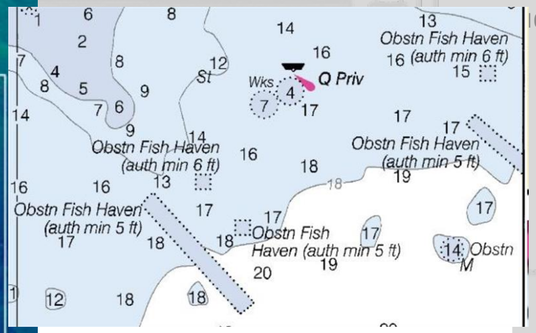
Fun stuff

Northern Indiana Public Service Company (NIPSCO) Bailly Generating Station (BGS) cooling water intake
Lake Michigan

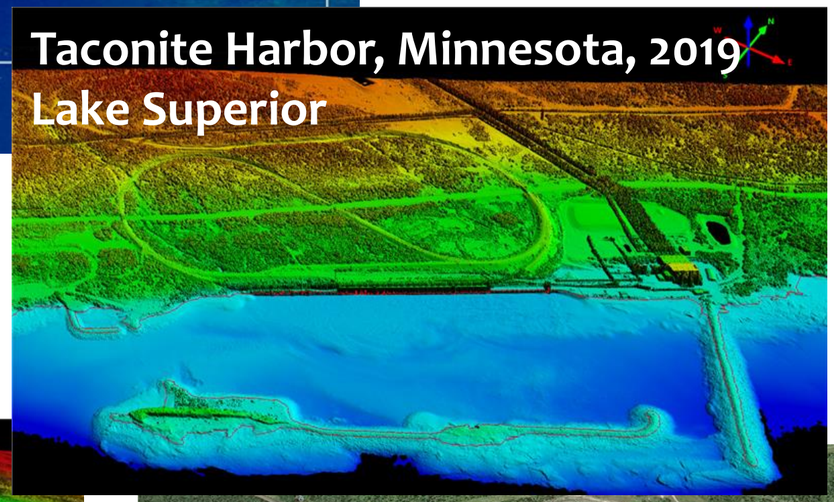




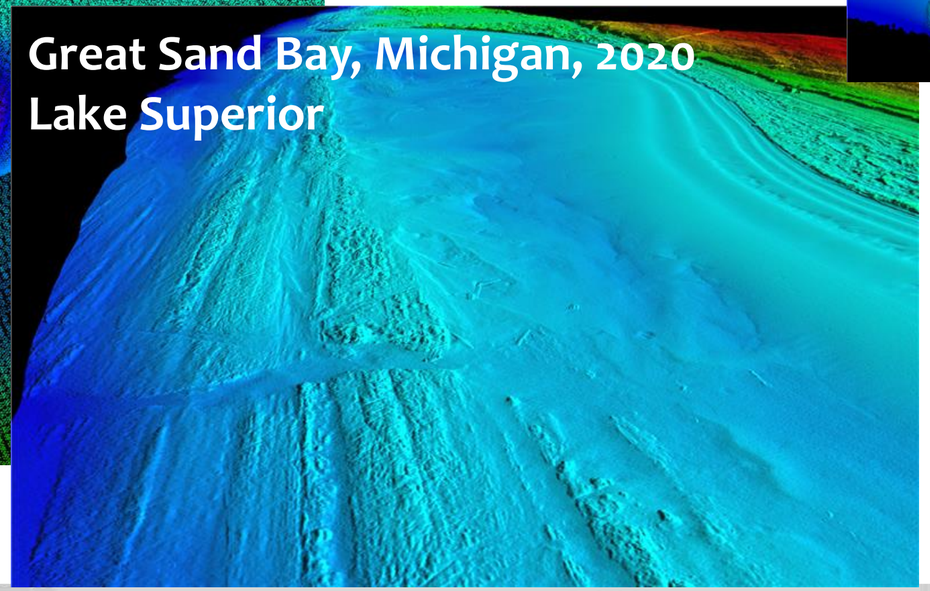
Alpena, Michigan, 2020
Lake Huron



Taconite Harbor, Minnesota, 2019
Lake Superior



Great Sand Bay, Michigan, 2020
Lake Superior



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US Army Corps of Engineers ®

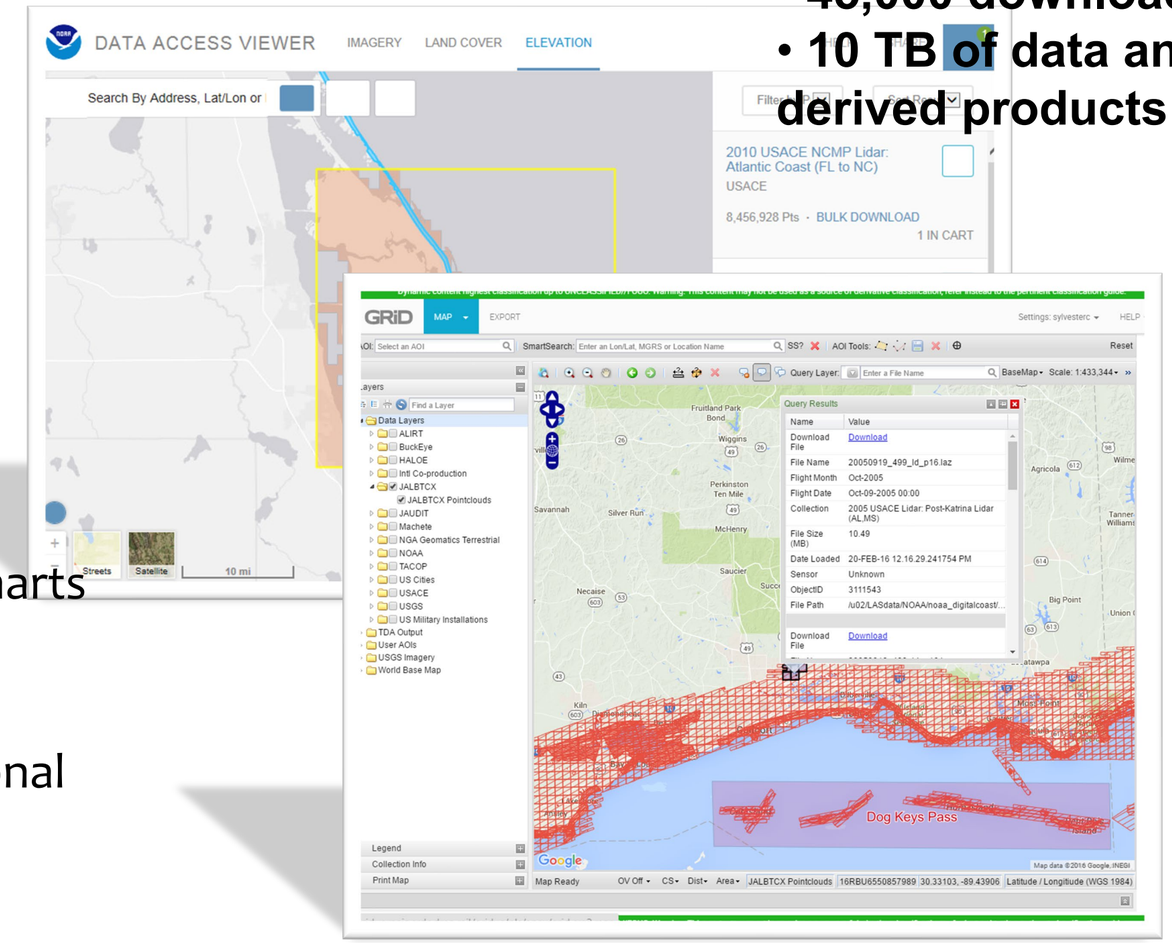
U.S.ARMY

jennifer.m.wozencraft@usace.army.mil

DATA DISTRIBUTION

- USACE
  - District Office
  - Geospatial Repository and Data Management System (GRiD)
- NOAA
  - Office of Coastal Management (Digital Coast)
  - National Centers of Environmental Information (Boulder)—tsunami DEMs
  - Marine Chart Division for inclusion on nautical charts
- USGS
  - Coastal and Marine Geology Program (St. Petersburg, FL)--coastal hazard studies, operational storm forecasts, coastal studies
  - Earth Resources Observation and Science Data Center (Sioux Falls, SD)
- By request to jalbtcx@usace.army.mil
- JALBTCX web services
  - https://usace-ags.esriemcs.com/arcgis/rest/services/JALBTCX

https://coast.noaa.gov/dataviewer/



https://griduc.rsgis.erdc.dren.mil/griduc/corpsmap/

Statistics
- **45,000 downloads**
- **10 TB of data and derived products**

How other agencies use NCMP Data
- **FEMA—flood hazard mapping, eligibility for public assistance**
- **NPS—monitor National Parks**

US Army Corps of Engineers

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USACE Volume Change Toolbox

A standard procedure to compute elevation, volume, and shoreline change consistently on a regional scale

Development history and usage

- 2012 pilot project
- 2012 post-Sandy
- 2013 webservices
- 2015 East coast volumes
- 2016 Post-Matthew
- 2017 Post-Irma
- 2018 Post-Maria
- 2018 Post-Michael
- 2019 Post-Sally/Zeta

JALBTCX_quick_response_v2.tbx
- QR 01. Label Baseline and Generate Transects (optional)
- QR 01b. Update Transect Coordinates (optional)
- QR 02. Generate Transect Mask and Clip Mask (optional)
- QR 03. Generate Difference Grid by Clip Mask (optional)
- QR 03b. Clip Difference Grid to Segment (optional)
- QR 04. Calculate Difference Grid Volume by Zonal Statistics
- QR 05. Generate Shoreline (optional)
- QR 06. Label Transect and Mask with MHW Value (optional)
- QR 06b. Generate Mask Between Transect above MHW (optional)
- QR 07. Calculate MHW Volume and Volume above MHW
- QR 08. Calculate MHW Volume Difference and Volume above MH
- QR 09. Calculate Shoreline Change
- QR 10. Generate Final Table
- QR 11. Summarize Table

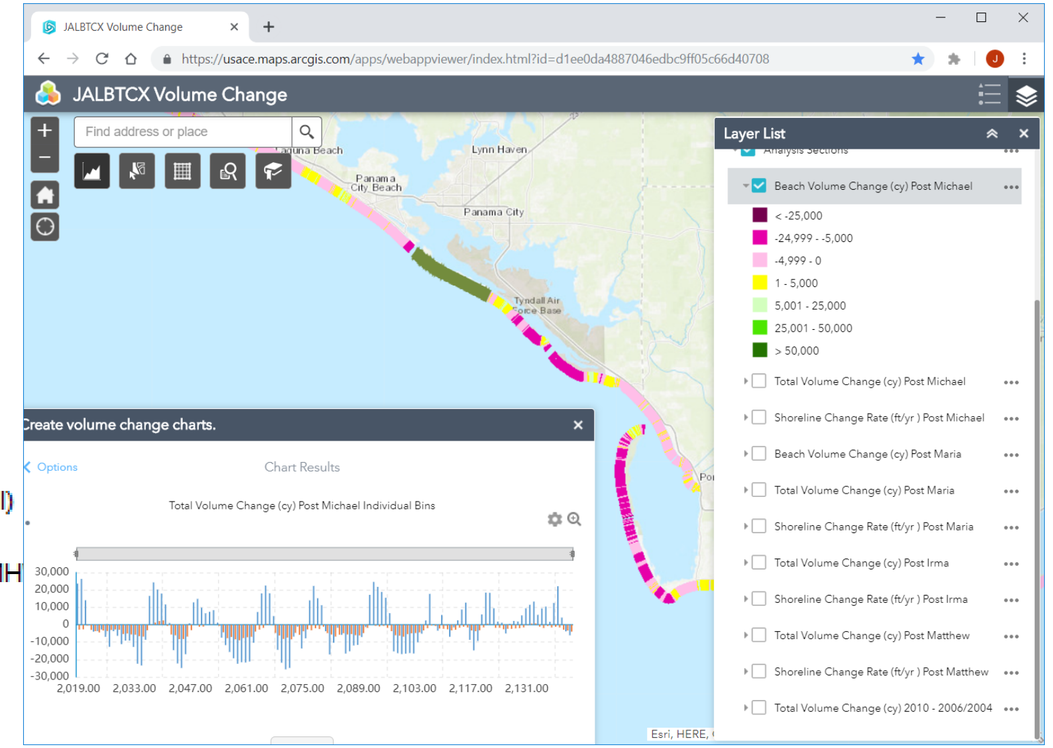
FY21

- Convert to python 3 for ArcPro
- Improve transect generation
- Automate pdf map making
- Multiple dataset toolbox

FY22

- Create DEMs from beach profile data for use in Toolbox

Access change products through web app.



Legacy
https://usace.maps.arcgis.com/apps/webappviewer/index.html?id=d1ee0da4887046edbc9ff05c66d40708

New
https://www.arcgis.com/apps/webappviewer/index.html?id=1c27ace28b7845deb7f126935f490878

US Army Corps of Engineers

Coastal and Hydraulics Laboratory · RSM · Coastal Protection Engineering

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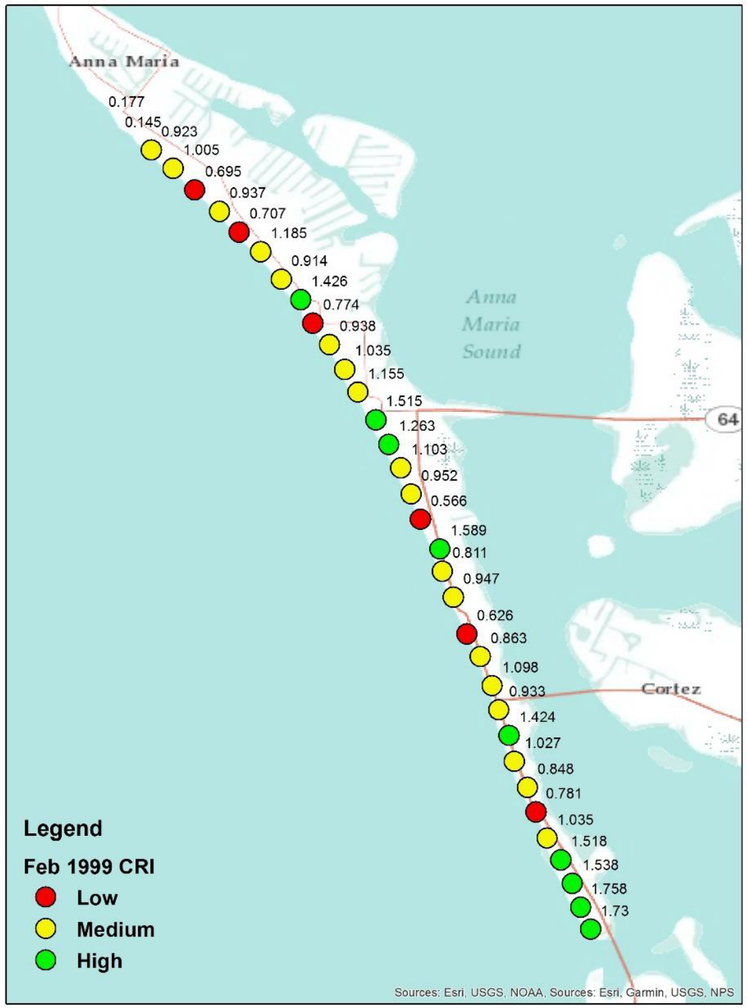
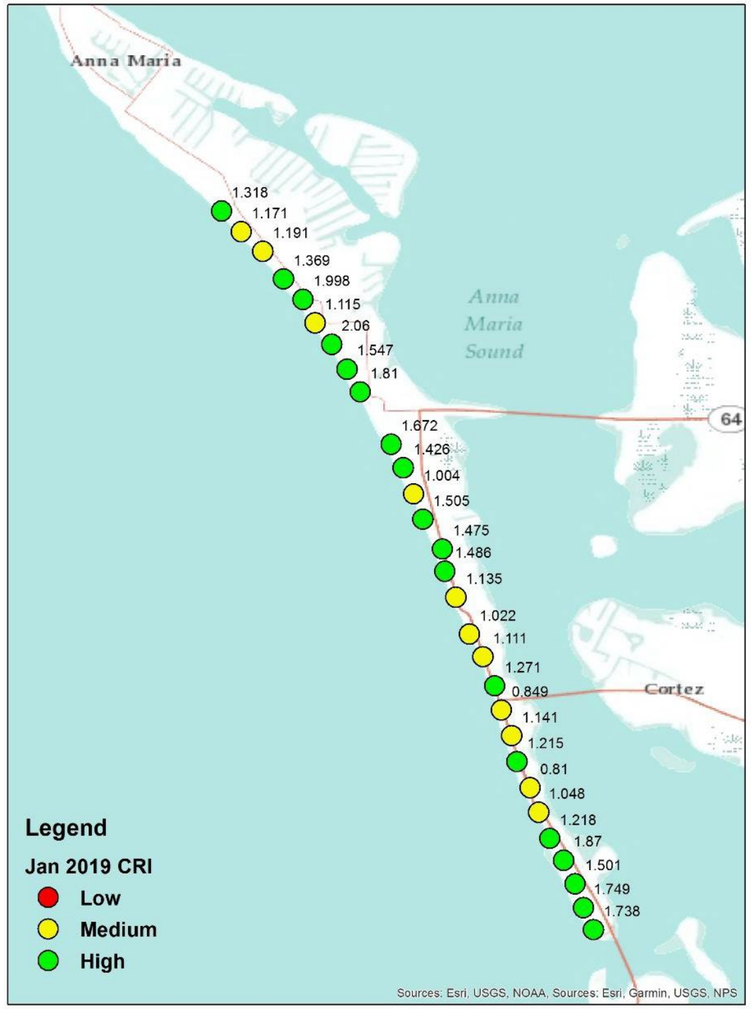
USACE Coastal Resilience Index

Anna Maria Island, Florida, February 1999



Anna Maria Island, Florida, January 2019



Five non-dimensional factors based on beach, storm and wave parameters:

$$a = \frac{PE}{PE_0}; b = \frac{PE * PW * (1 - s)}{PE_0 * PW_0}; c = \frac{PW - MR}{PW_0};$$
$$d = \frac{DE - (MS + MHW)}{CF_0}; e = \frac{WR_0}{WR}$$
$$CRI = a + b + c + d + e$$

where :

PE_0: Protective Elevation; 15 ft

PW_0: Protective Width; 500 ft

CF_0: Crest Freeboard; 20 ft

WR_0: Wave Runup; 2 ft

WR: Wave Run-up

MHW: Mean High Water

PE: Protective Elevation

PW: Protective Width

s: percentage of fine sediment

DE: Dune Crest Elevation

MR: Maximum Shoreline Recession

MS: Maximum Storm Surge

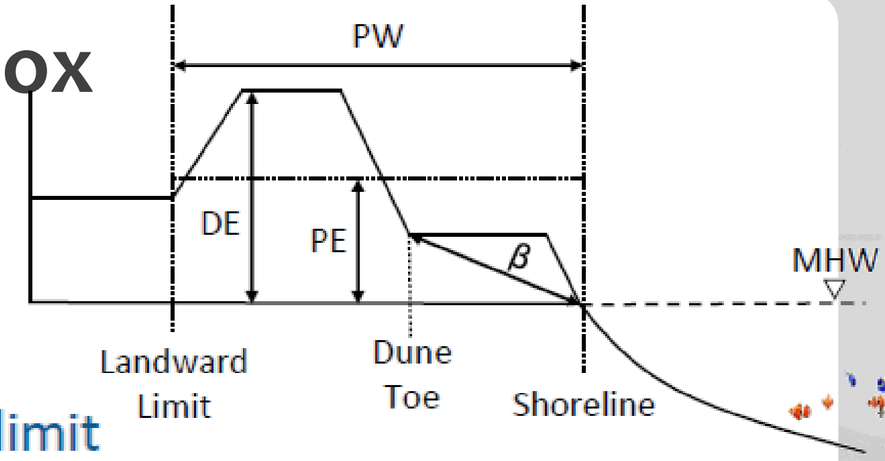
US Army Corps of Engineers

Coastal and Hydraulics Laboratory — Coastal Protection Engineering

Dong, Z., Elko, N., Robertson, Q., & Rosati, J. (2018). QUANTIFYING BEACH AND DUNE RESILIENCE USING THE COASTAL RESILIENCE INDEX. *Coastal Engineering Proceedings*, *1*(36), papers.30. https://doi.org/10.9753/icce.v36.papers.30

JALBTCX
Joint Airborne Lidar Bathymetry Technical Center of Expertise

USACE Coastal *Engineering* Resilience Toolbox



- Automated – Python in ESRI Arc
- Use existing data – beach profile and LiDAR
- Consistent metrics – shoreline, dune toe, dune crest, landward limit

Inputs
- Beach Profile
- LiDAR
- Wave
- Surge
- MHW
- % Fines

Metrics
- Shoreline
- Dune Toe
- Dune Crest
- Landward limit

Outputs
- Protective Elevation
- Protective Width
- Volume Density
- Wave runup
- Crest Freeboard

FY21 CERI for three large areas
- Northern Gulf of Mexico
- Northern Outer Banks
- Long Island, NY

FY22 CERI areas
- Cape Cod to Portsmouth, ME
- Lake Ontario
- 200 miles in NWD
- Southern CA

FY22 CERI advancements
- Add dune vegetation metric
- Add capability to weight metrics

US Army Corps of Engineers

Coastal and Hydraulics Laboratory | Coastal Protection Engineering

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During Nearshore Event Vegetation Gradation (DUNEVEG): Geospatial Tools for Automating Remote Vegetation Extraction

PROBLEM

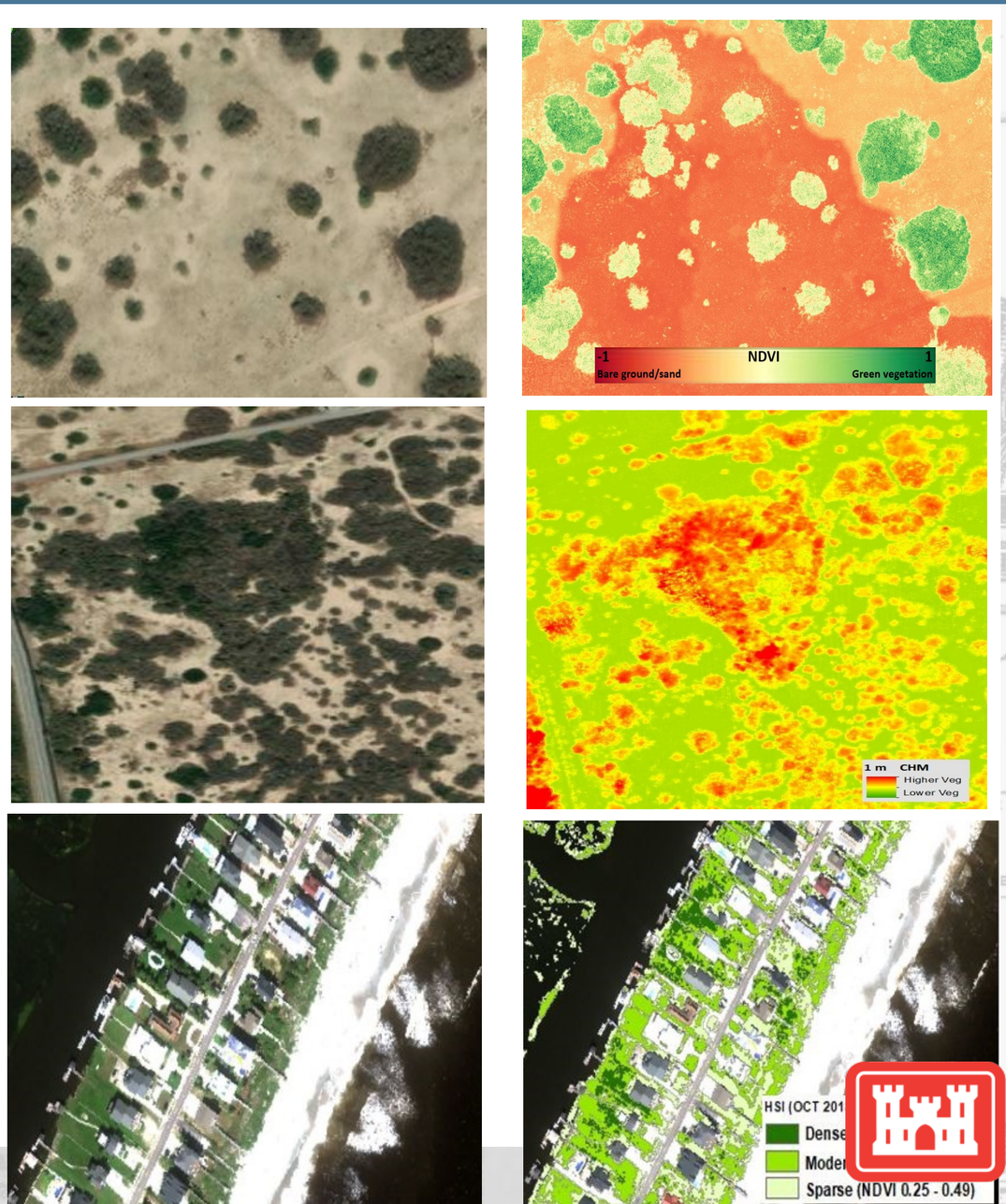
- Coastal systems are increasingly susceptible to climate change and erosion
- Coastal vegetation is critical to ecosystem stability and resilience
- Few studies have correlated vegetation properties with natural and built coastal infrastructure stability

SOLUTION

- Utilize high-resolution imagery and lidar to extract coastal dune vegetation characteristics
- Develop an ArcGIS Pro geoprocessing toolbox to streamline future data analysis

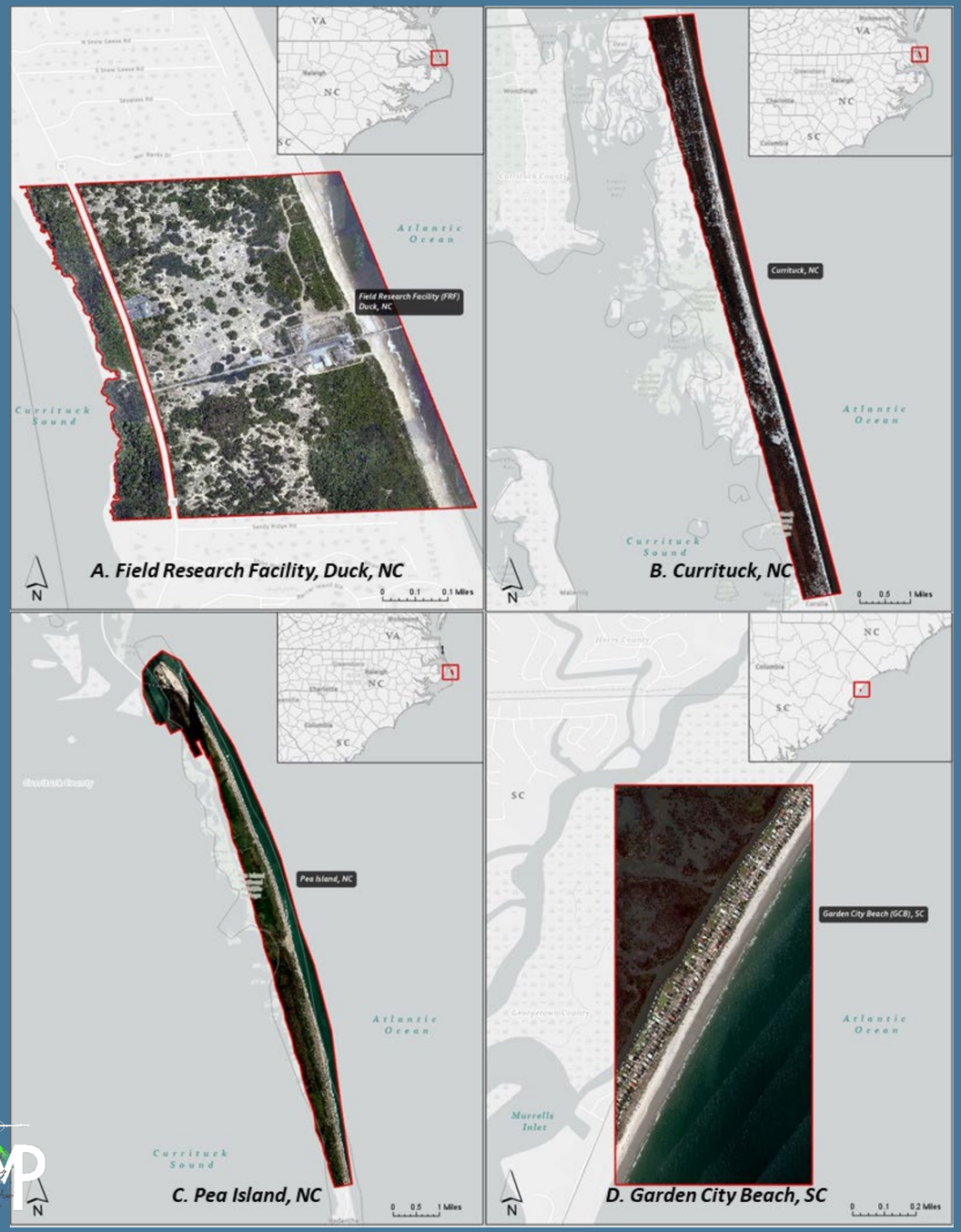
IMPACT

- Remote sensing can reduce time and cost associated with monitoring coastal ecosystems
- New and improved sensors can rapidly quantify coastal vegetation properties
- Toolbox provides a streamlined method to classify, quantify, and estimate critical dune vegetation metrics



DRAFT Mar 2021

STUDY SITES



APPLICATIONS

- Four sites were used to develop and test the ArcGIS Pro geoprocessing toolbox*: Duck, NC; Currituck, NC; Pea Island, NC; and Garden City Beach, SC

STATUS

- Technical note documenting Geoprocessing Toolbox in review
- Next steps include:
  1. Evaluate toolbox for different site locations including the Mississippi Barrier Islands to Cape San Blas, FL; Virginia/NC border to Cape Hatteras, NC; Northern NJ to Montauk, NY; and Lake Ontario (NY shoreline)
  2. Perform multi-temporal (2018-2020) trend analysis of landscape level vegetation change using established metrics

BENEFITS

- Method provides streamlined workflow and high priority metrics for assessing coastal vegetation characteristics
- Expands library of vegetation metrics for numerical modeling of coastal storm response to build regional coastal resilience
- Semi-automated tool provided a transparent, uniform approach to quantify vegetation characteristics to save time and cost for coastal studies

*ArcGIS Pro (version 2.6) geospatial analysis software in a Windows 10 desktop environment

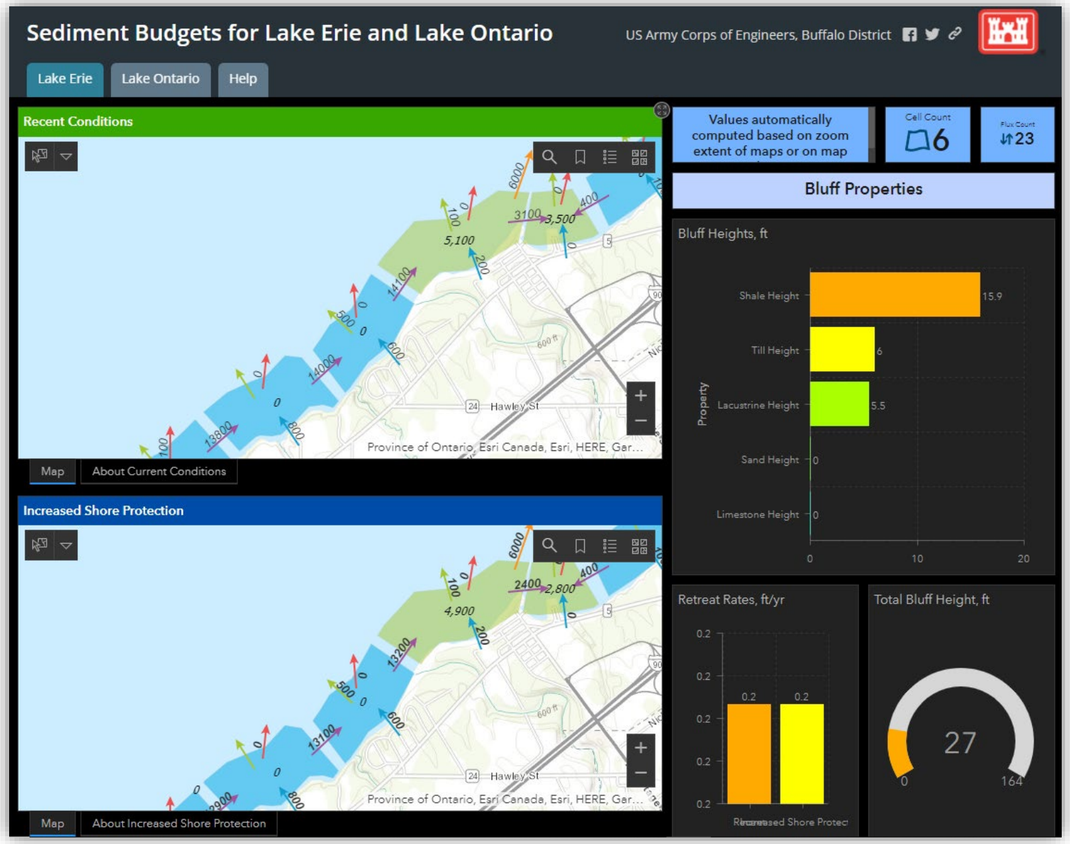
Great Lakes Sediment Budgets

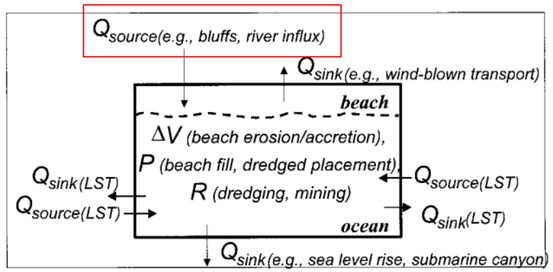
- **Purpose**
  - Develop a seamless sediment budget framework for the entire Great Lakes coastline within the US
  - Sediment budgets exist for Lake Ontario, Lake Erie, and a number of smaller areas
  - Create a central repository for Great Lake sediment budget information.
  - *Current focus: Lake Michigan*

Great Lakes RESTORATION

- **Sediment Budget background**
  - Accounting of sediment sources and sinks
  - Great Lakes budgets: importance of bluffs, lake level changes, relatively small contribution from river inflow

- **Datasets needed to develop a Great Lakes budget**
  - Existing budgets
  - Dredging data
  - *Bluff retreat volume (historic bluff and modern bluff)*
  - Bluff stratigraphy (relative sand content)

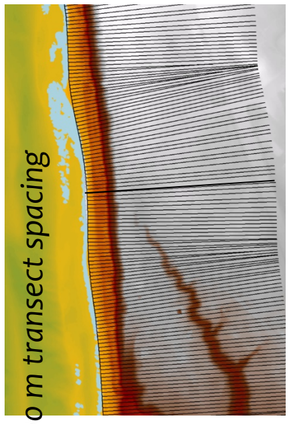


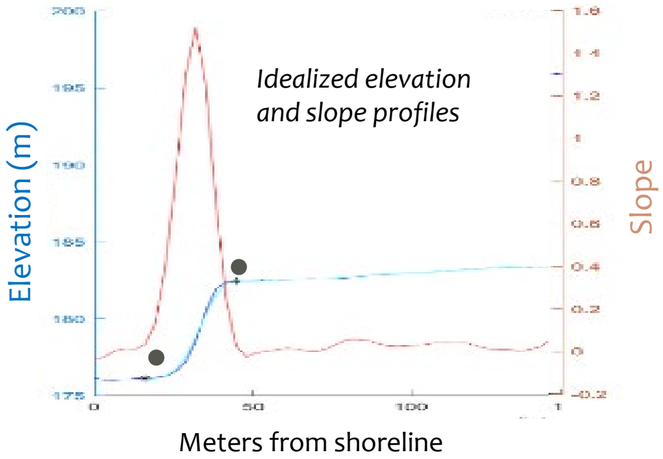


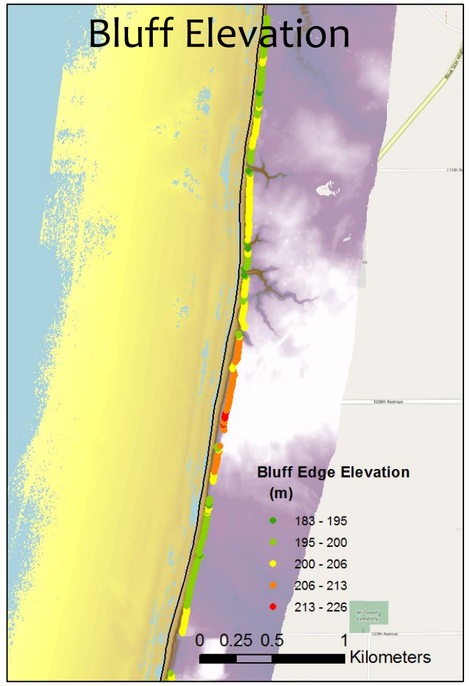
$$\sum Q_{source} - \sum Q_{sink} - \Delta V + P - R = Residual$$

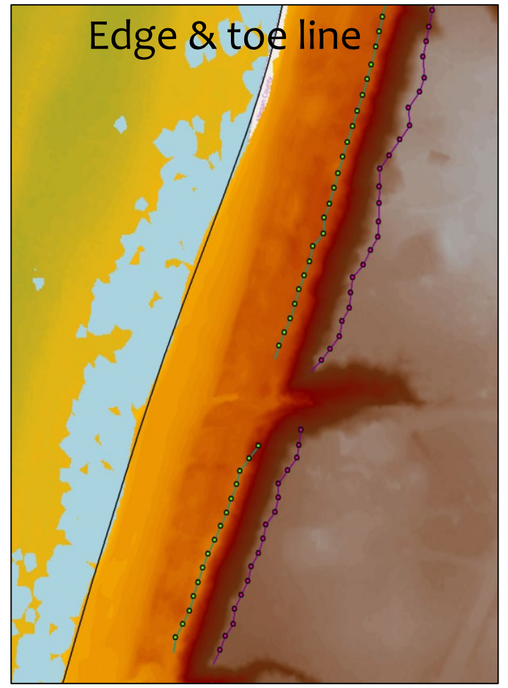
(Rosati, 2005)

Great Lakes Sediment Budgets: Bluff Mapping









- Transect-based feature detection in Matlab
- Candidate bluffs chosen based on slope and distance parameters
- Regional functionality – can handle thousands of transects and numerous lidar files
- Flexible – detects various bluff morphologies

Great Lakes Nearshore Geomorphic Vulnerability Index (GVI)

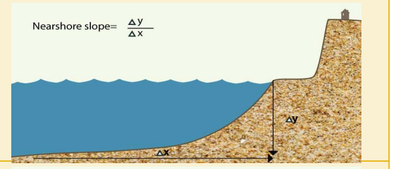
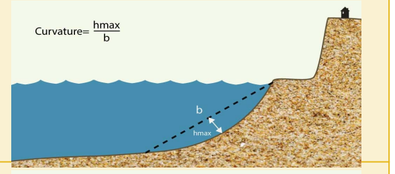
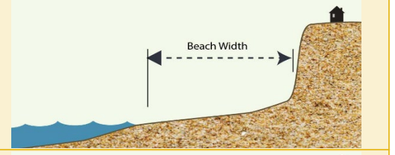
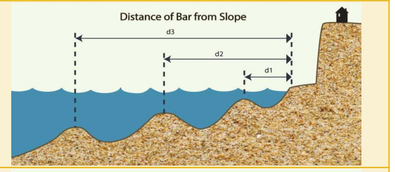
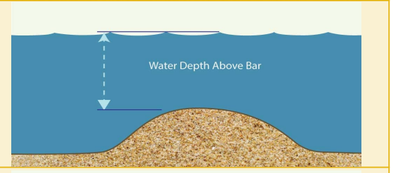
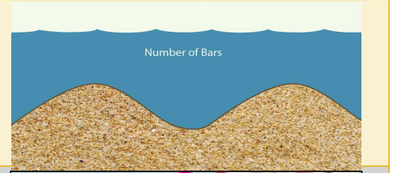
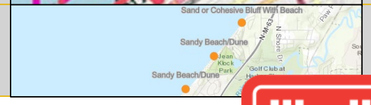
Purpose

- Build a database of indicative nearshore features
- Develop a methodology for understanding how natural nearshore features relate to coastal change/erosion
- Determine which features are most likely to minimize coastal erosion & use this information for decision making

Interagency Team

- USACE Buffalo, Chicago, and Detroit Districts
- USACE ERDC-Coastal and Hydraulics Lab (ERDC-CHL)*
- NOAA Office for Coastal Management
- USGS Upper Midwest Water Science Center
- USGS Woods Hole Coastal and Marine Science Center

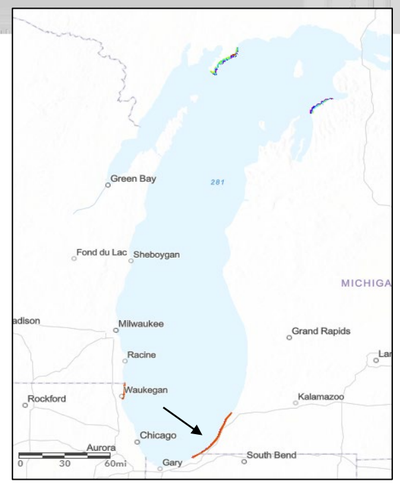
ERDC Team: Lauren Dunkin, Eve Eisemann, Charlene Sylvester, Sean McGill, Tony Friona

Measurement	Explanation/Definition	Figure
Nearshore Slope	Average slope from shoreline to 30 feet of water depth or depth of closure.	
Nearshore Curvature	Shape of the nearshore slope. Concavity given as up/down, and values calculated as shown.	
Beach Width	Width of active beach between the bluff or dune toe and the shoreline.	
Bar distance from shoreline	Distance from the shoreline to the crest of the bar.	
Bar water depth	Water depth above bar crest	
Number of bars	Number of bars in the cross shore	
NOAA Hardened Shoreline Classification	Shoreline classification dataset derived from imagery collected 2014 – 2017. https://coast.noaa.gov/digitalcoast/data/hardened-shorelines.html	
Nearshore Type	Classifies the nearshore into bedrock, sandy, cohesive, etc. Detroit District's Lk. Michigan Potential Damages Study Progress Report on activities 1996-1998.	

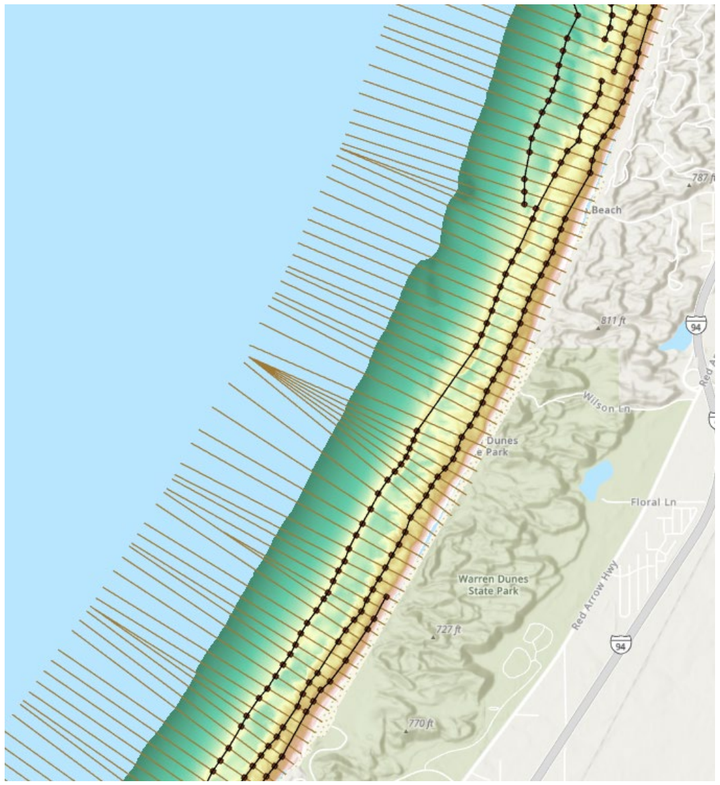
Nearshore Index: Nearshore Bar Mapping

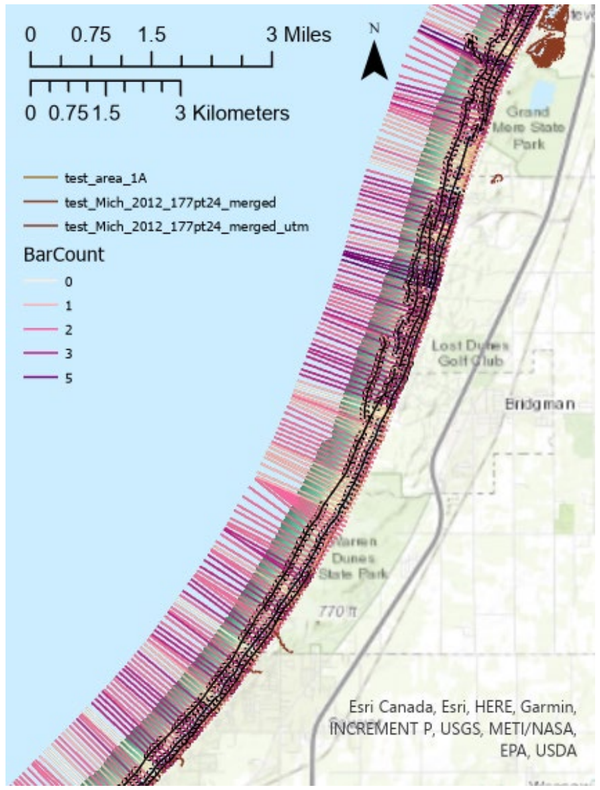
"Geomorphic Feature Extraction for the Development of Sediment Budgets and a Resiliency Index for the Great Lakes – An ERDC Collaboration with LRD, NOAA and USGS to Support the Great Lakes Restoration Initiative (GLRI)", CHL Forum Talk 3 Feb 2021

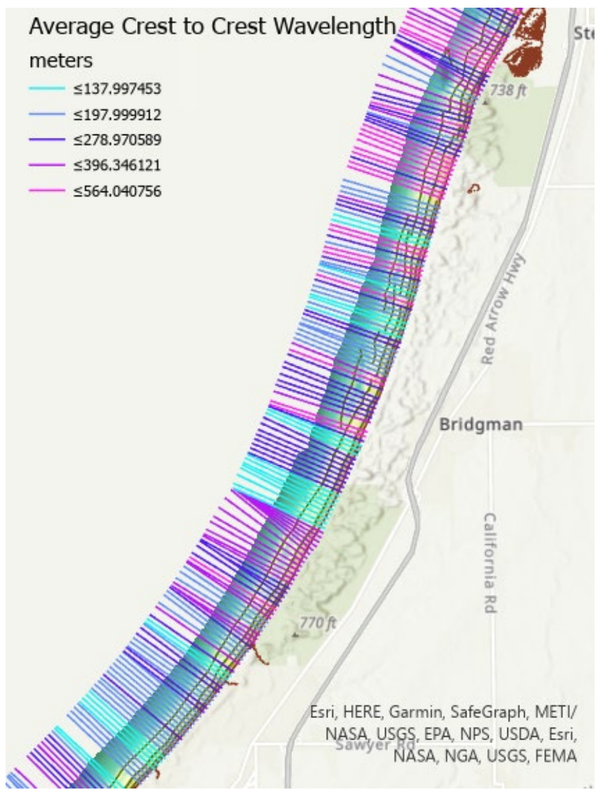
by Eve Eisemann and Charlene Sylvester

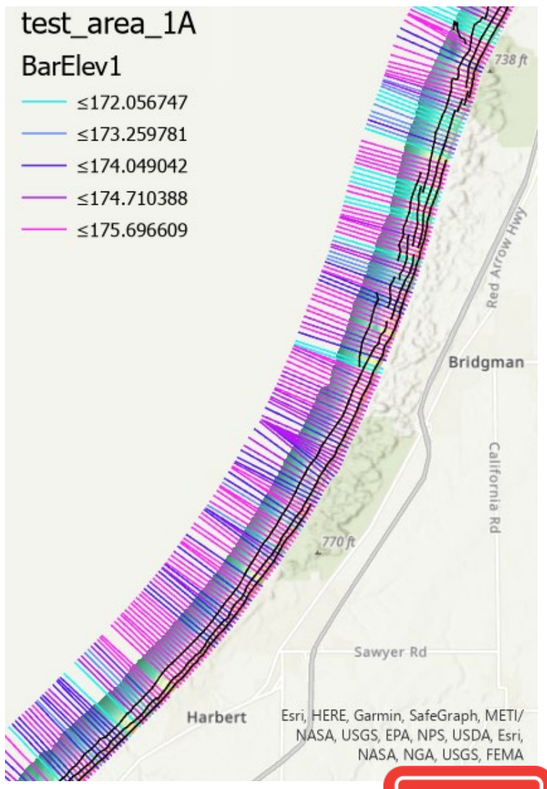


BarCount	AveWavelength	BarID1	BarDist1	BarElev1	BarID2	BarDist2	BarElev2	BarID3	BarDist3	BarElev3	BarID4	BarDist4
3	122.006437	10	77.272852	174.430038	33	207.269874	173.204025	11	321.285727	171.388931	<Null>	<Null>
3	128.508457	10	79.495488	174.914795	33	206.495513	173.388123	11	336.512402	171.602875	<Null>	<Null>
3	137.021241	10	79.529478	174.658081	33	206.560427	173.372665	11	353.57196	171.085953	<Null>	<Null>
3	157.988306	10	47.2353	174.765244	33	205.225832	173.222	11	363.211912	171.320023	<Null>	<Null>



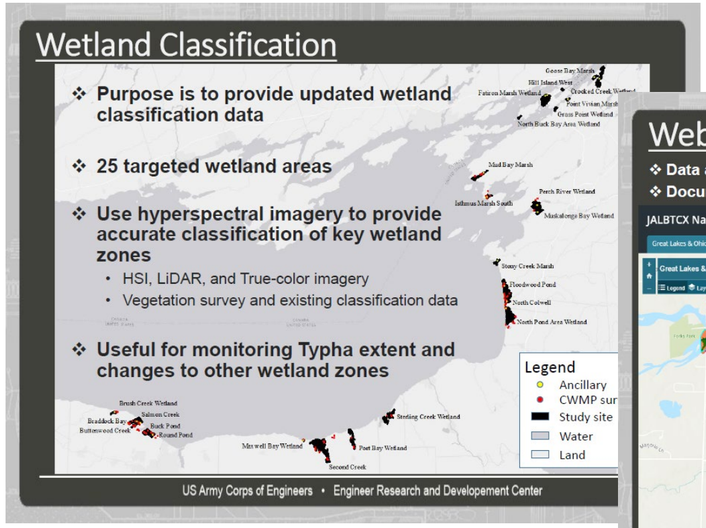


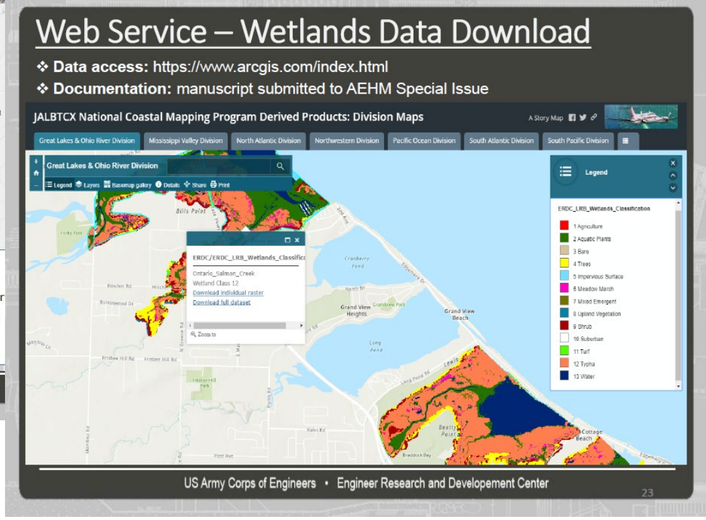




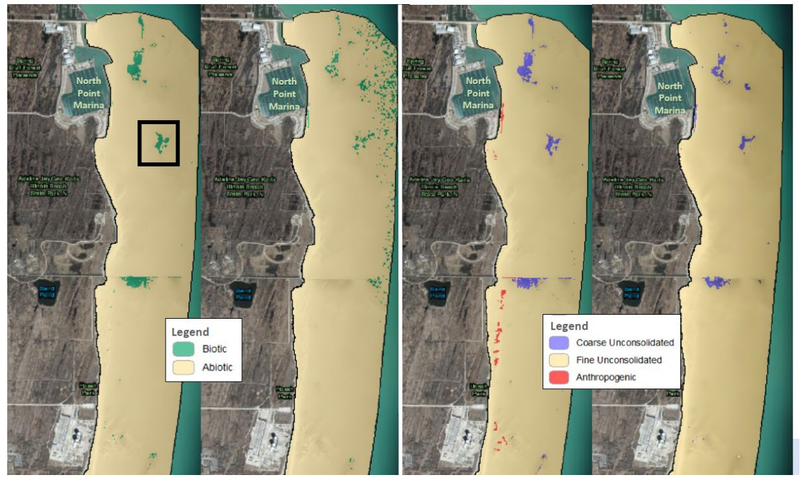
Coastal Wetland and Benthic Mapping in the Great Lakes

- **What:** National Coastal Mapping Program (NCMP) hyperspectral imagery and topobathymetric lidar data used to identify unique wetland habitats (Lake Ontario) and nearshore benthic features (Lake Michigan)
- **Why:** Agency partnership and innovative approach to integrate freely available high spectral and spatial resolution imagery and lidar with routinely collected ground truth data in support of ecosystem restoration, operations, and other management initiatives
- **How:** High fidelity data come together in which traditional and new remote sensing classification techniques are used to: 1) classify wetland habitat types prioritized by local stakeholders, including wetland structure and function, and 2) discriminate nearshore benthic features using the Coastal & Marine Ecological Classification Standard
- **Benefits:** Roadmap to develop much needed data for coastal wetland and nearshore monitoring and management, utilizing existing/free resources and partnerships
- **Who:** Benthic mapping funded by the USACE Ecosystem Management and Restoration Research Program; coastal wetlands mapping funded by the Buffalo District and NCMP





Sample Tier 1 Results



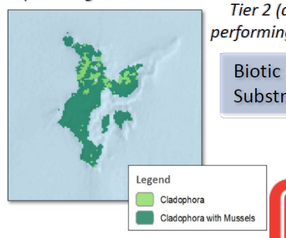
Overall Accuracy

Tier 1

Biotic component:
Airborne: 92 – 95%
Satellite: 92 – 94%
Substrate component:
Airborne: 90 – 91%
Satellite: 88 – 92%

Sample Tier 2 Results

Aquatic Vegetation Bed 3m

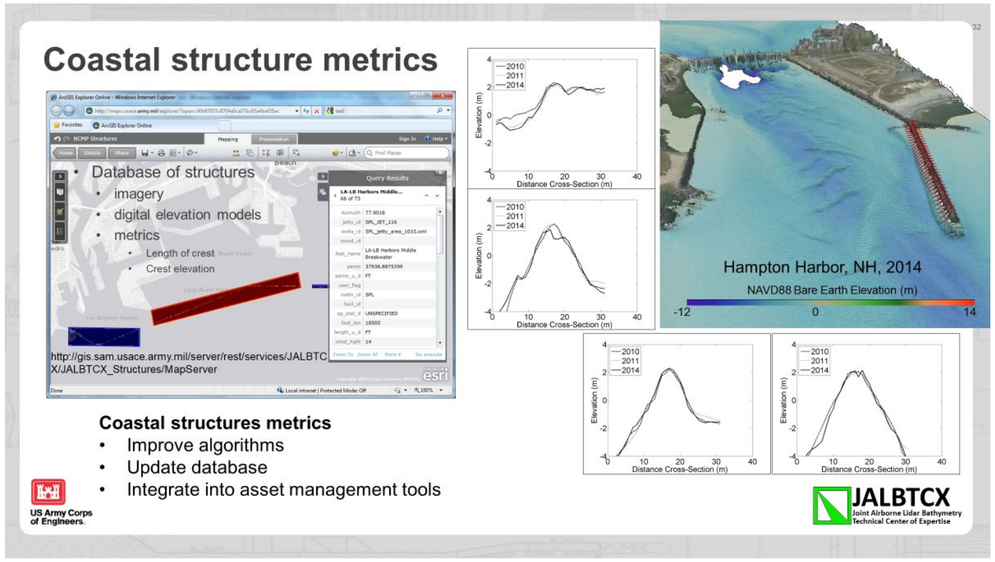


Tier 2 (airborne only using best performing data combo from Tier 1)

Biotic component: 95%
Substrate component: 93%

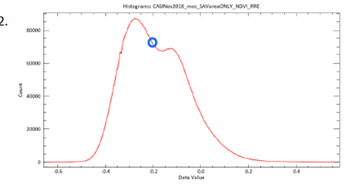
What's next

- FY22 survey operations in Gulf of Mexico
- Processing and delivery of Great Lakes, West Coast, Texas, and Alaska data
- New metric development for USACE navigation structures and beach projects
- Investigate CERI from 1999 to present at Panama City, develop workflow to extract representative BeachFx profile from JALBTCX data
- Develop standard process for creation of high-resolution landcover classification in NLCD schema and extraction of submerged aquatic vegetation metrics from combined lidar and hyperspectral imagery
- Support the IWG-OCM in updating the National Coastal Mapping Strategy



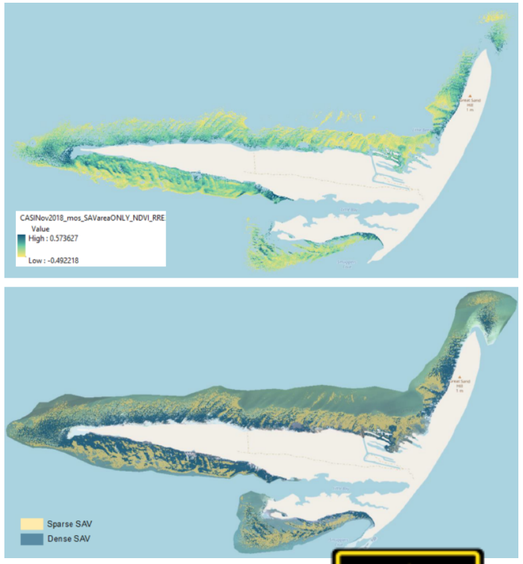
1. $NDVI_{RER} = \frac{Rededge - Red}{Rededge + Red}$

Modified Normalized Difference Vegetation Index (RER = Rededge & Red bands); Rededge = (band 25) 714nm and Red = (band 21) 657nm applied only to SAV pixels (CASI image masked using the SAV classification result)

2. 

Distribution of $NDVI_{RER}$ values applied to SAV classified pixels only (values range from – 0.5 to 0.6)

3. Threshold applied to $NDVI_{RER}$ to separate sparse vs dense SAV based on approximate visual estimation (blue circle in graph above: sparse = -0.5 to -0.2; dense = -0.2 to 0.6)



NCMP

JALBTCX
Joint Airborne Lidar Bathymetry Technical Center of Expertise

US Army Corps of Engineers ®

U.S.ARMY

Questions?

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https://jalbtcx-live.azurewebsites.net

US Army Corps of Engineers

Ship and Cat Islands, MS, 2020

NOAA NCMP

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