USACE NAVIGATION R&D UPDATE

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For Harbors & Navigation Committee and QPI Meeting

15 November 2017

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OVERVIEW

- Channel and Dredging Decision Support Tools
- Marine Transportation System Analysis Tools
- Condition Assessment Tools
- Planning Tools
- Engineering With Nature

USACE NAVIGATION PORTAL

Dredging

Maintenance of inland, intracoastal, and coastal waterways, channels, ports, and harbors

Survey & Mapping

Hydrographic Surveying, National Channel Framework (NCF), and Inland Electronic Navigational Charts (IENC)

Marine Transportation System

Performance measures, including economic benefits, safety & security, environmental stewardship, and resilience.

eNavigation

Harmonized navigation information resources for US inland, intracoastal, and coastal waterways and channels

Sediment & Ecosystem Restoration

Regional Sediment Management & Engineering with Nature

Infrastructure & Asset Management

Engineering, design, operation, monitoring, maintenance, and repair of coastal and inland structures

USACE Navigation Portal

Provides other agencies & public access to approved data and tools

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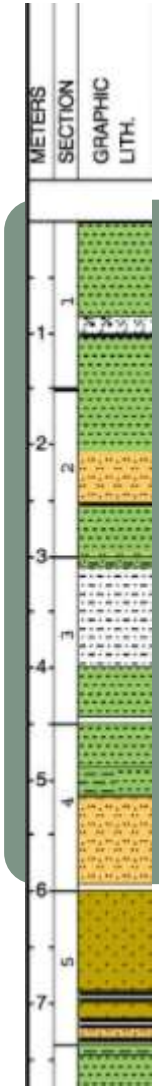
SEDIMENT ANALYSIS WITH THE SAGA DATABASE



Sediment Analysis GeoApp (SAGA)

The SAGA database schema supports the storage and retrieval of all data related to sediment analysis.

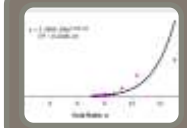
Each characteristic tied back to an XY location and noted depth.

Visualize distribution of detected chemicals.

Symbolize sites based on average grain size.

Isolate sites based on a physical characteristic.

Determine volume of material at specified depths.



Run computations to generate input values for models.

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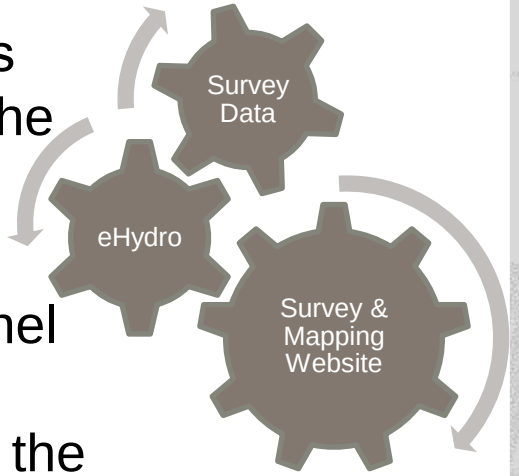
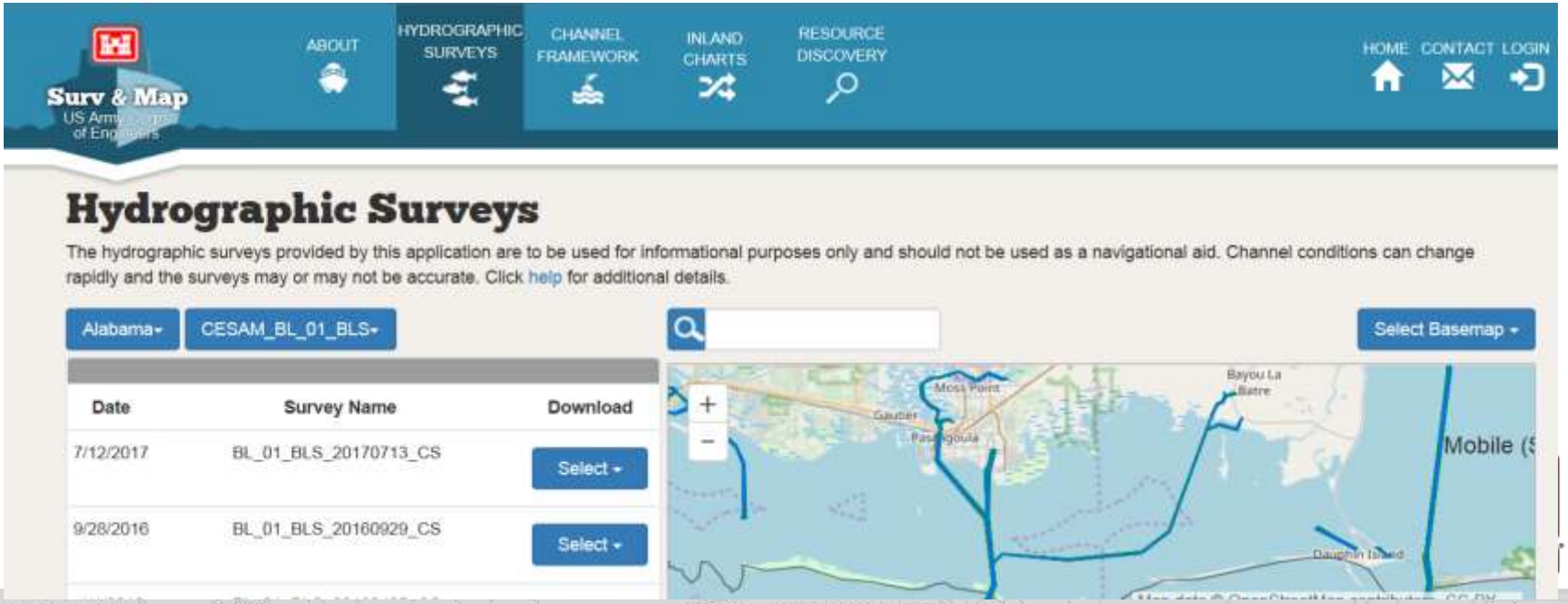
EHYDRO

eHydro is designed to easily integrate into the District's normal survey data processing workflow and reduces the time and costs required to produce similar reports.



Maritime pilots and shippers can now access the channel depth data for several deep-draft channels along the nation's coast online and view hydrographic surveys at the click of a mouse.



TOOLS FOR MONITORING AND ANALYZING THE MARINE TRANSPORTATION SYSTEM

Complimentary Analysis Tools

- Channel Portfolio Tool (CPT) – https://cpt.usace.army.mil
  - Uses “reported data” that is compiled by the USACE Waterborne Commerce Statistics Center (WCSC)
  - Population data set (not a sample); annualized origin-destination tonnage flows by commodity, vessel types and drafts, direction
- Automatic Identification System Analysis Portal (AISAP) – http://ais-portal.usace.army.mil
  - Web-based tool for acquiring, analyzing, and visualizing real-time and archival data from the U.S. Coast Guard’s National Automatic Identification System (NAIS).

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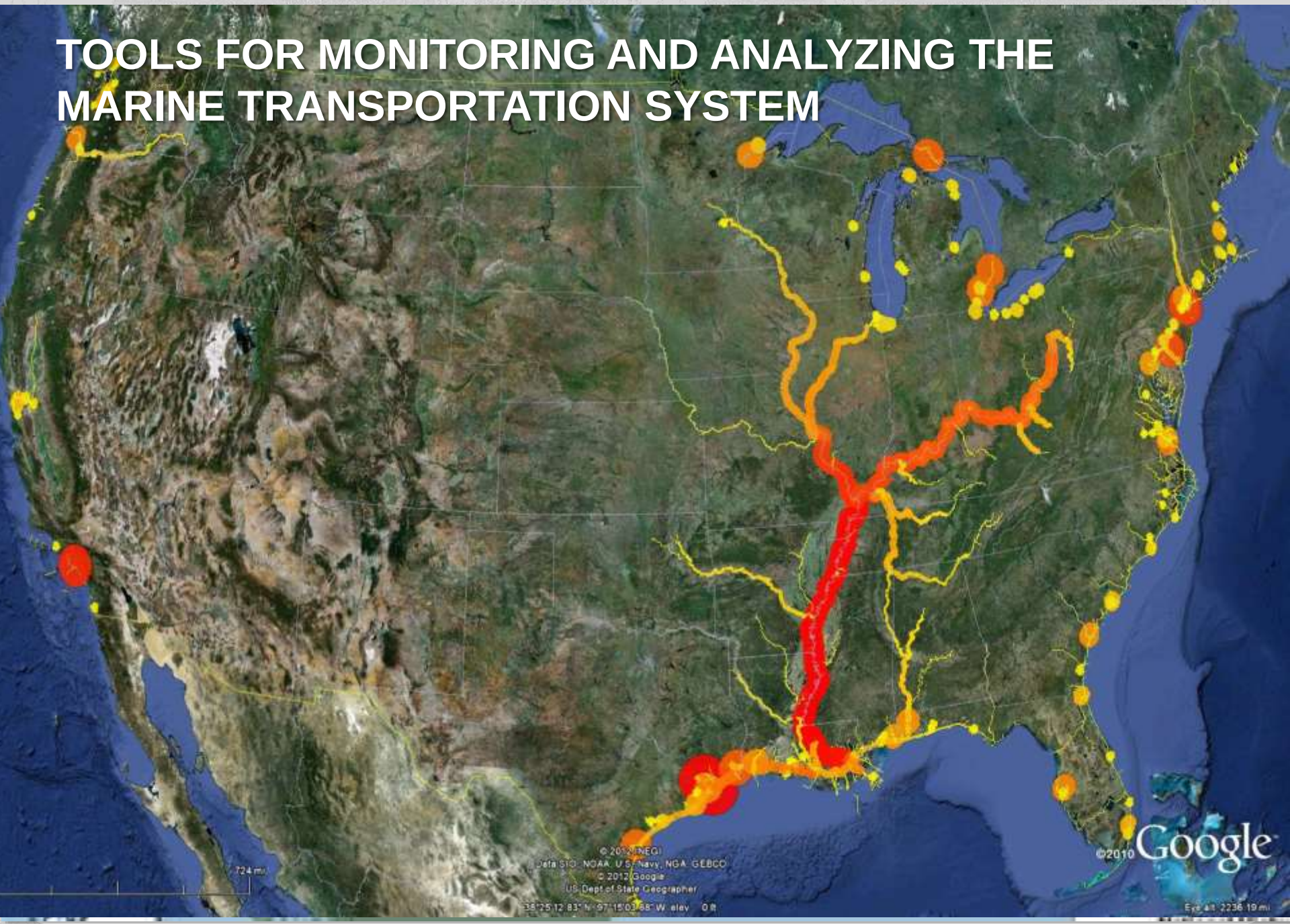
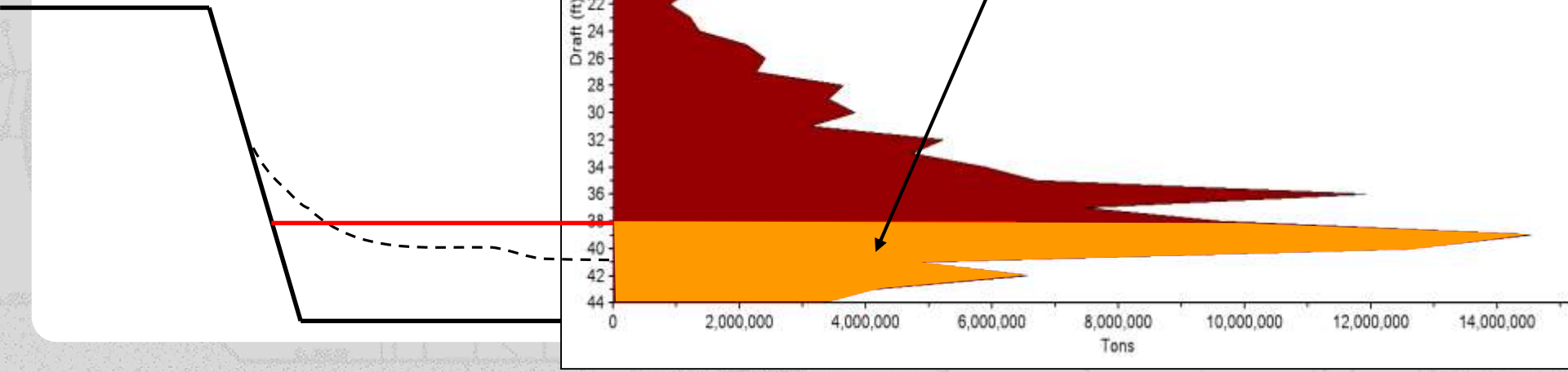


TOOLS FOR MONITORING AND ANALYZING THE MARINE TRANSPORTATION SYSTEM

Depth Utilization Analysis

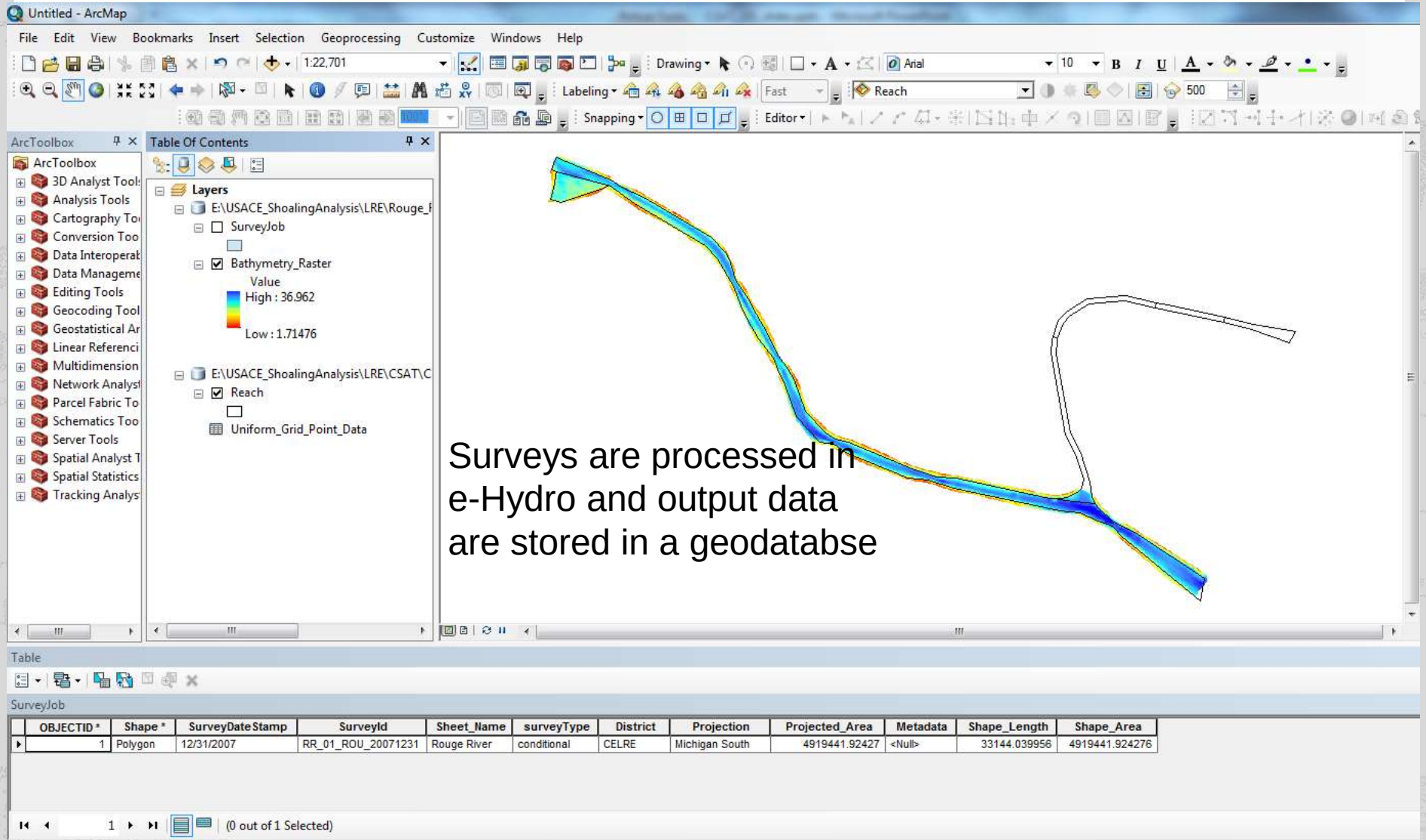
CPT can generate depth-utilization profiles showing the distribution of cargo across the range of maintained depths for any system of navigation channels.

CPT then compares these tonnage-draft profiles to the segment controlling depths resulting from present shoaling conditions.



TOOLS FOR MONITORING AND ANALYZING THE MARINE TRANSPORTATION SYSTEM

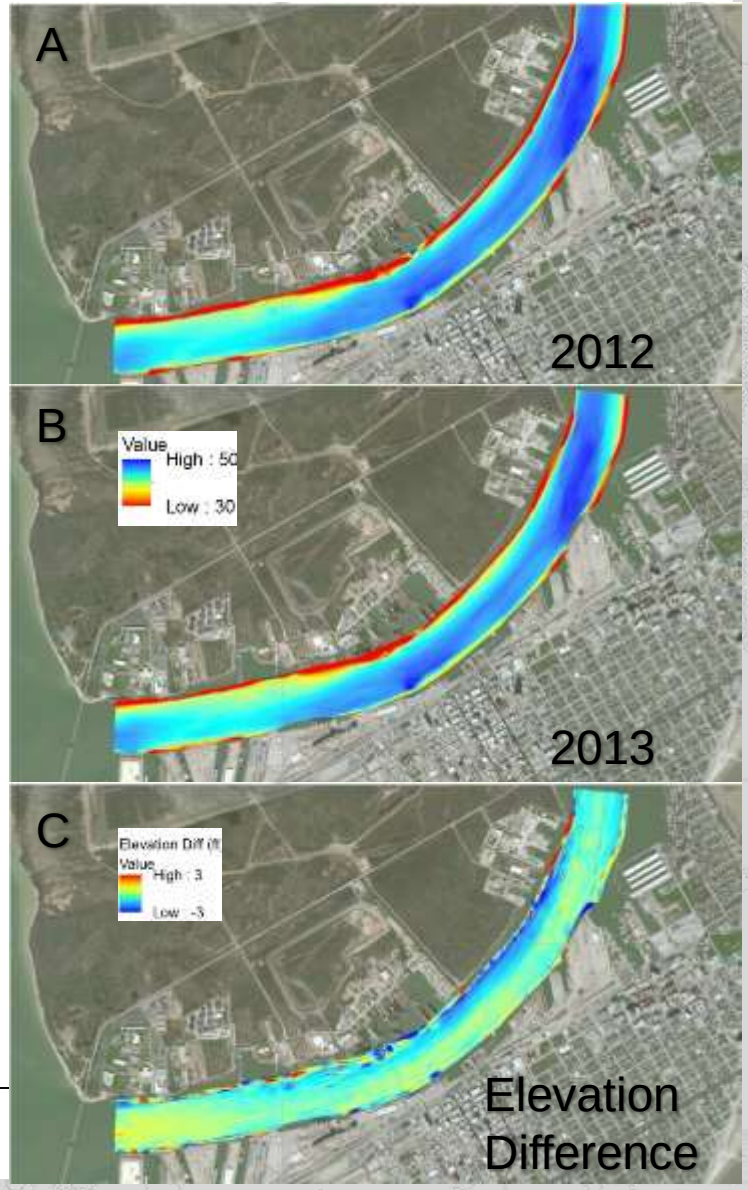
e-Hydro – Bathymetry Raster



TOOLS FOR MONITORING AND ANALYZING THE MARINE TRANSPORTATION SYSTEM

Corps Shoaling Analysis Tool

- *What will the channels look like in the future?*
- Use historical survey data from eHydro and generate difference grid sets between dredging events
- Predict average shoaling rates and dredging requirements per channel reach
- Report volumes at different depth/time intervals and shoaling rates
- *Efficiently process large spatial datasets*



COLLISION AND GROUNDING RISK ASSESSMENT IN US COASTAL PORTS

Port managers need to objectively & quantitatively identify locations of risks exist for collision and grounding

- Make quantitative comparisons of risk across channels & ports.
- Support channel improvement decisions.

Cost effective method uses data collected via existing business process: Nationwide Automatic Identification System (NAIS).

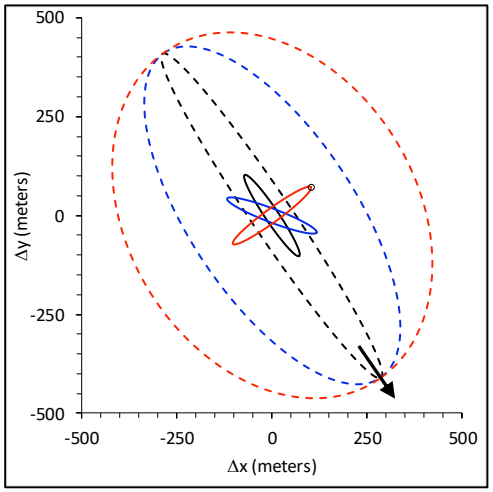
Collision risk assessment:

- Inventory ship domain violations (SDVs) at 30-second intervals.
- Calculate SDV frequency in each navigation channel reach.

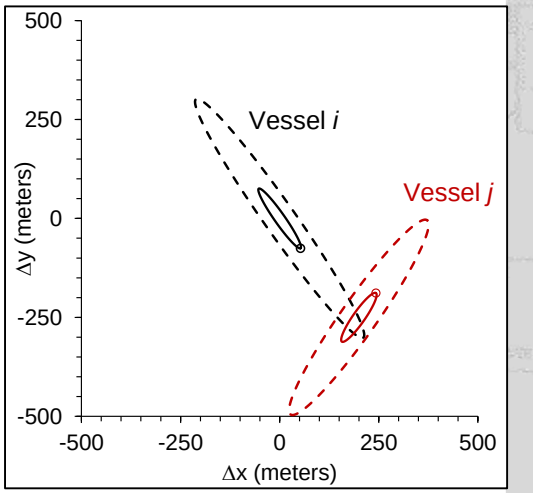
Ship domains are modified Fuji domains:

- Elliptical shape
- Dynamic dimensions:
- Major axis: 4 × vessel length.
- Minor axis: 3 × swept path.

Ship domain



SDV



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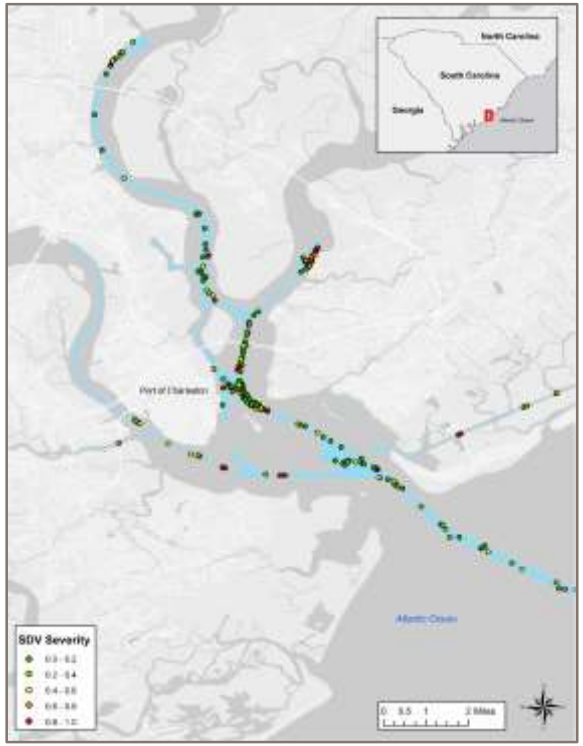
DEMONSTRATION: CHARLESTON HARBOR, 2014 DATA

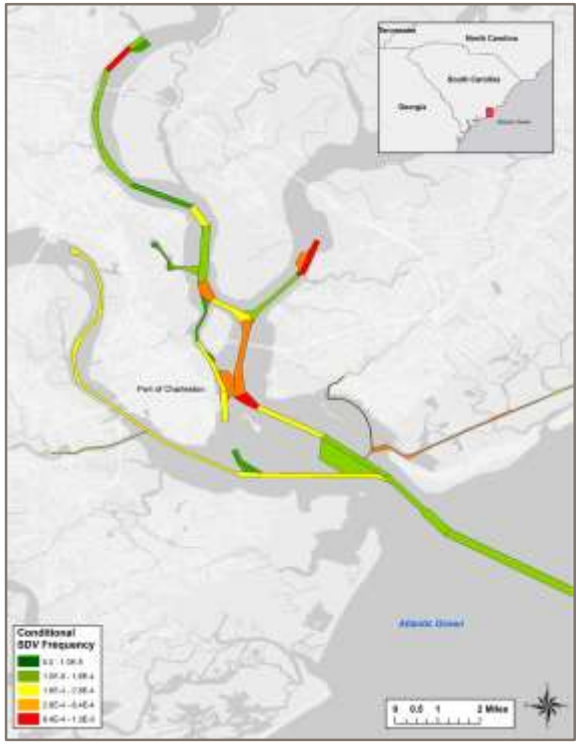
An analysis of SDV frequency can be used to make quantitative comparisons of risk between navigation channels and coastal ports.

- SDVs are 9.3 times more likely in Horse Reach than in Rebellion Reach

(a) SDV location & severity



(b) SDV frequency map

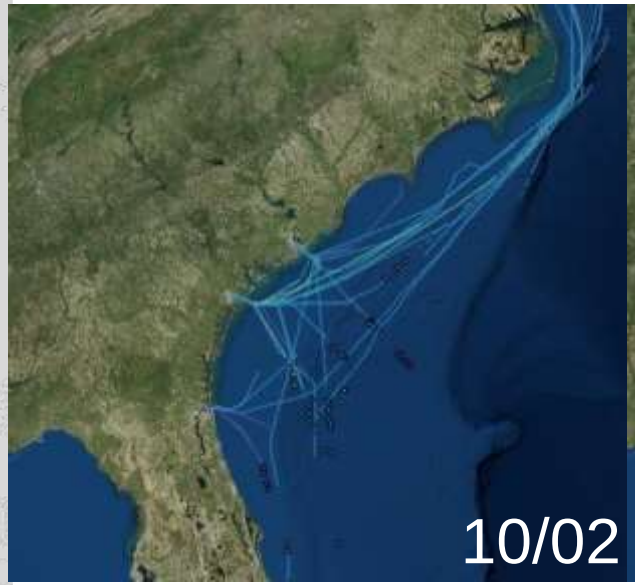


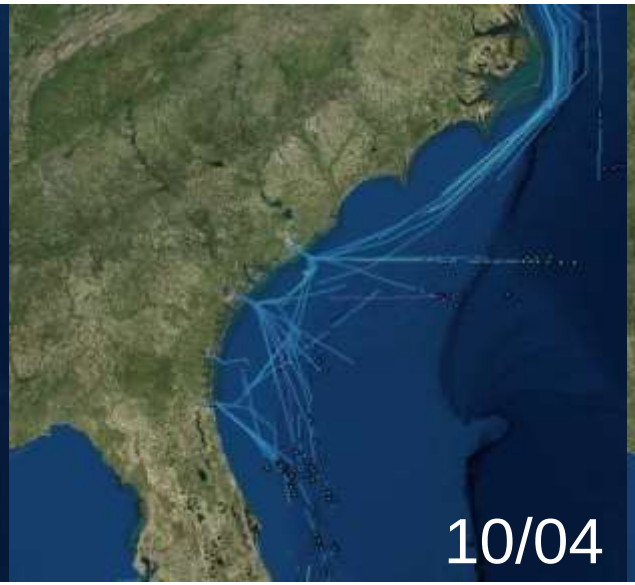
(c) SDV frequency table

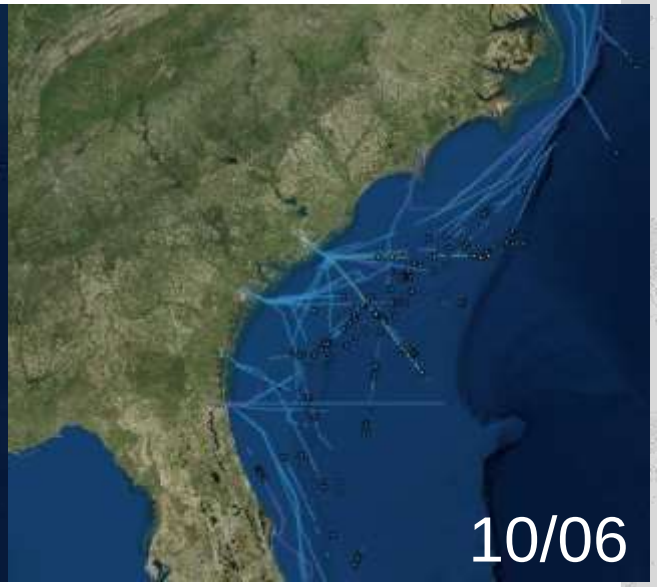
Reach #	Reach Name	All vessels
5	HORSE REACH	1.33E-03
25	PORT TERMINAL REACH	1.27E-03
17	WANDO RIVER UPPER	1.09E-03
6	HOG ISLAND REACH	8.41E-04
13	CUSTOMHOUSE REACH	7.24E-04
39	REACH 21 (Intracoastal Waterway)	5.75E-04
8	MYERS BEND	4.66E-04
18	WANDO RIVER TURNING	4.62E-04
4	BENNIS REACH	2.83E-04
41	REACH 23 (Intracoastal Waterway)	2.60E-04
7	DRUM ISLAND REACH	2.53E-04
28	ASHLEY RIVER REACH 1	2.45E-04
20	DANIEL ISLAND BEND	2.14E-04
11	LOWER TOWN CREEK REACH	2.12E-04
38	REACH 20 (Intracoastal Waterway)	2.12E-04
10	TIDEWATER REACH	2.03E-04
1	HARBOR ENTRANCE CHANNEL	1.62E-04
2	MT. PLEASANT REACH	1.61E-04
3	REBELLION REACH	1.43E-04
9	ANCHORAGE BASIN A	1.26E-04
19	DANIEL ISLAND REACH	1.08E-04
22	NAVY YARD REACH	1.01E-04
26	ORDNANCE REACH	9.27E-05
35	LOWER SHIPYARD RIVER	9.16E-05
16	WANDO RIVER LOWER	7.10E-05
23	NORTH CHARLESON REACH	6.27E-05
24	FILBIN CREEK REACH	6.15E-05
--	OTHER REACHES	0.00E+00
All navigation channels		2.84E-04

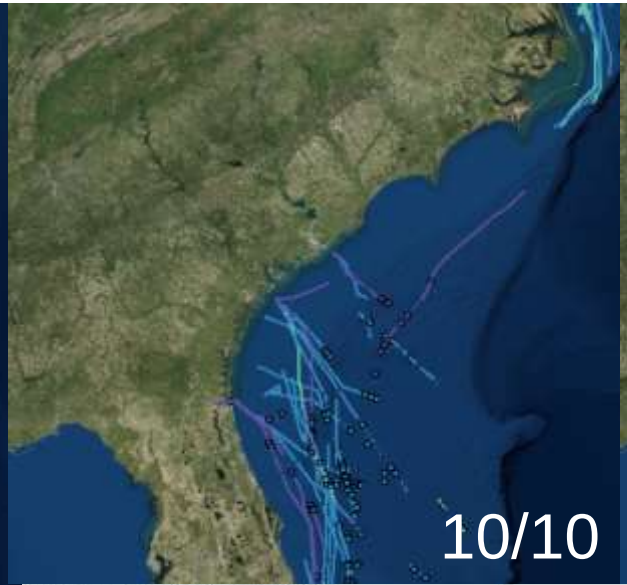
STORM IMPACT ANALYSIS – HURRICANE MATTHEW

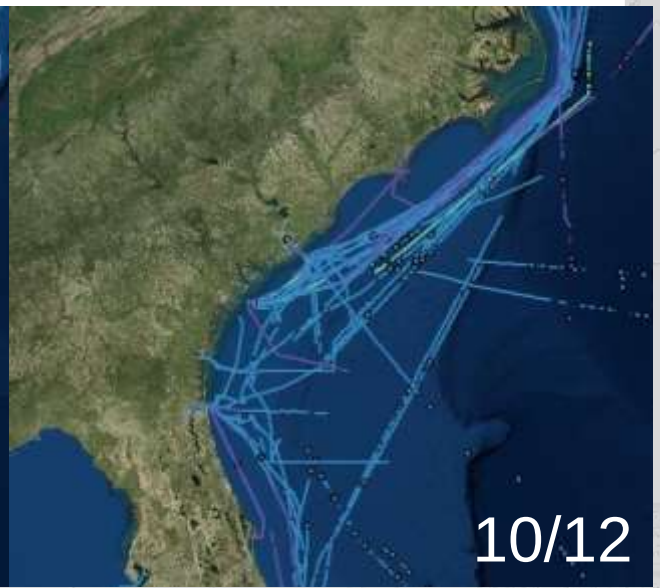
Vessel Tracks











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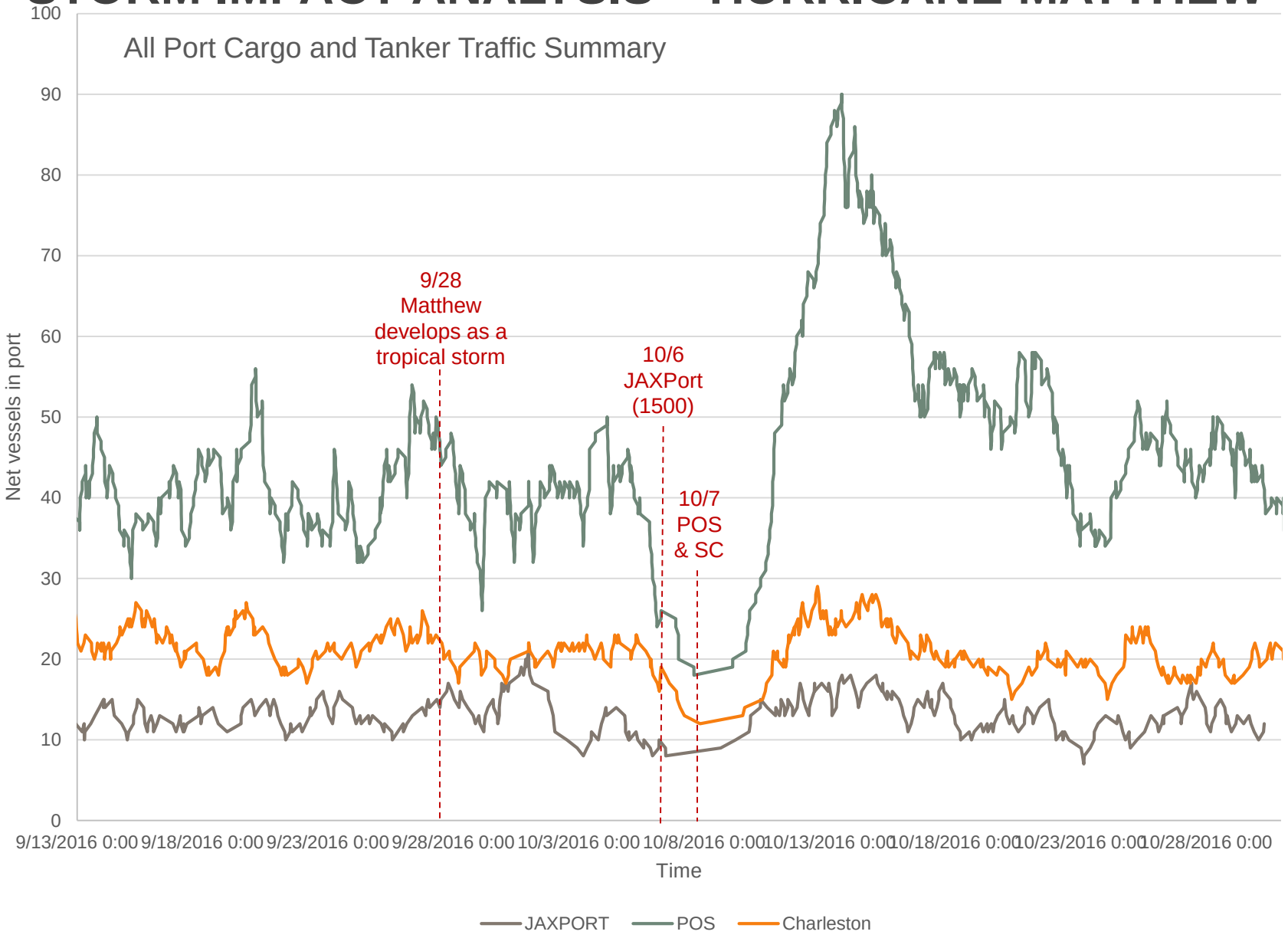
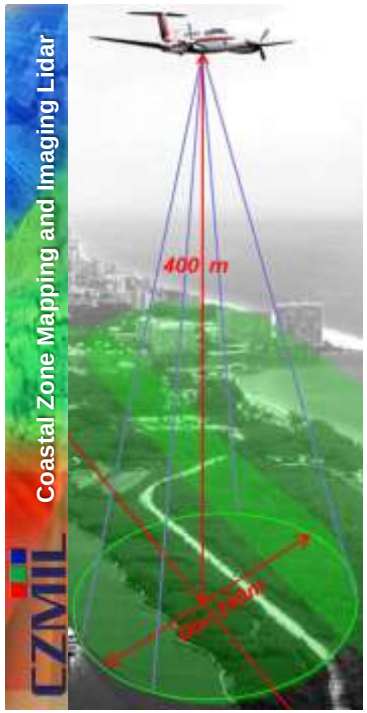


COASTAL MAPPING – COASTAL IMPACTS OF HURRICANE IRMA

Hurricane impacts are regional and multi-faceted.

Many tools for assessing hurricane impacts measure single phenomena, cover small areas, and/or are qualitative

- Beach profile surveys
- Boat surveys
- Terrestrial/mobile lidar
- Aerial nadir/oblique photography
- Still photos from vehicles, helicopters, or airplanes
- UAS imagery/point clouds



3rd generation coastal mapping and tactical charting system
Collects bathymetry up to 60 m
Engineering scale survey accuracy

- CZMIL provides a rapid, multi-sensor approach for hurricane damage assessments
  - Lidar elevations and depths
  - Aerial photography for visual context
  - Hyperspectral imagery for detailed feature identification and extraction
  - Minimal personnel/logistical footprint in immediate impact area
  - Data products delivered within days of collection by ftp and web services, including change detection

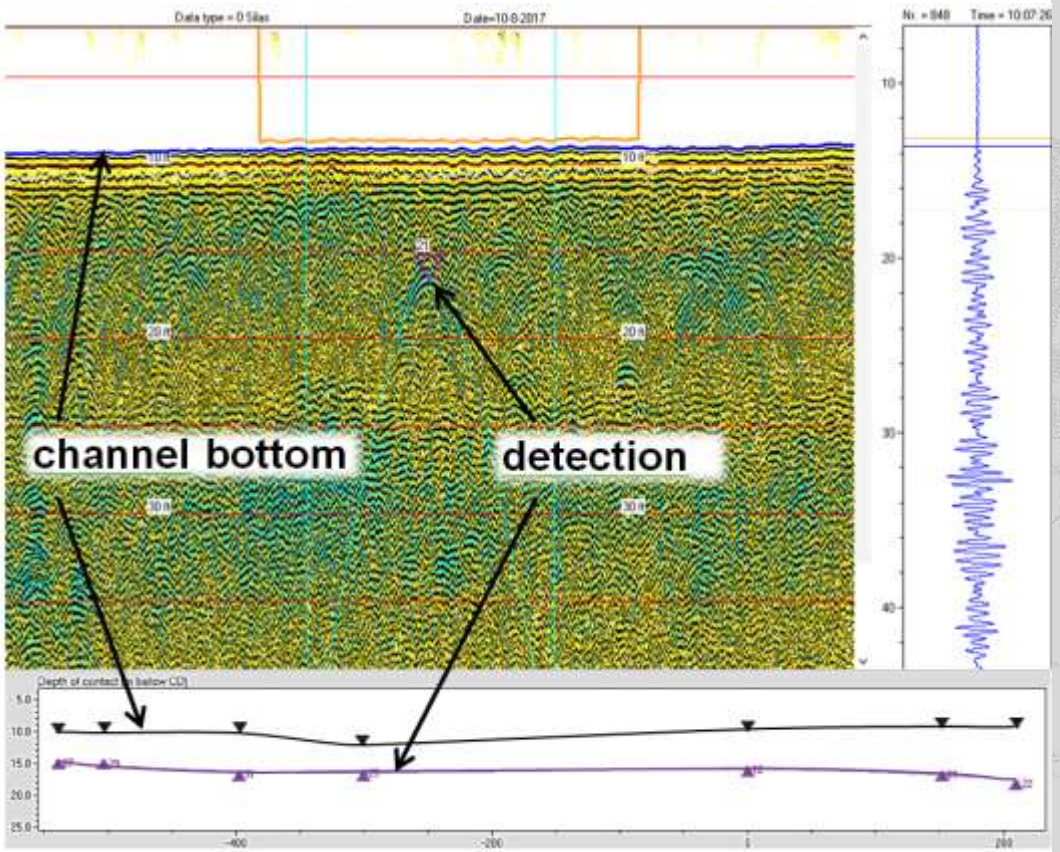
- Post-Irma survey area
  - 540 miles in 21 survey days

In ports and harbors, CZMIL data can help quantify

- Channel shoaling
- Damage to
  - coastal structures
  - port infrastructure
  - dredged material placement areas
- Debris quantities/type
- Shoreline erosion

PIPELINE AND UTILITY DETECTION

- Problem
  - Dangers associated with dredging near submerged buried pipelines
  - USACE has no internal ability for detection
  - Difficulty with pipeline owner keeping updated surveys
- Objective
  - Reduce ops costs by eliminating Corps contracted detection surveys.
  - Increase safety by using high quality detection methods
- Status
  - Stema Sub-bottom profiling system acquired, integrated and trained.
  - Data collection and full evaluation is planned for FY18.



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UAS INSPECTIONS

Unmanned inspection capability of penstocks.

(semi) Autonomous operation in the penstock with obstacle / collision avoidance

Captures imagery for condition assessment

Modifications to software could allow operation in other confined / limited access spaces

Field test, Center Hill Dam, TN

The gate, May testing

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UNMANNED SHALLOW WATER SURVEY VESSEL

Remote control operation
- Shallow water
- Constricted locations

Applications
- Bathymetry
- Obstructions
- Scour detection
- Piling assessments

Dimensions
- 10 feet long
- 4 feet wide
- 6-8 inch draft

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NAVIGATION – STREAMLINED SHIP SIMULATIONS

SMART planning has pushed ship simulation into the PED phase of a project

Feasibility **L**evel **S**hip **S**imulation **P**rogram

- Low-resolution model
- Completed in as little as six weeks
- Sets up PED ship simulation for success
- Unfeasible alternatives are eliminated or modified

- Successful **FLSSP** studies
  - Long Beach
  - Norfolk
  - Seattle
  - Mobile

- Cost effective (around $100K)
- Uses existing models
- Final product is a Memorandum for the Record (MFR)

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NAVIGATION – STREAMLINED SHIP SIMULATIONS

CASE STUDY – LONG BEACH, CA

First 2-phase study since SMART planning inception (SEP 2016)

- Attended by:
  - Engineers and planners from SPL
  - Long Beach pilots

Scaled back for Feasibility

- 1.5 Days for Feasibility validation
- Project specific Feasibility approach
  - Low-res model
  - Existing currents model
  - Heavily relying on pilot input to identify problem areas
  - Entirely deepened harbor due to no bank effects

Lessons learned

- The original proposed channel was NOT feasible
- ERDC should review channel alternatives pre FS
- Examine use of existing ship models on database

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VESSEL WAKE PREDICTION TOOL (2014-N-6)

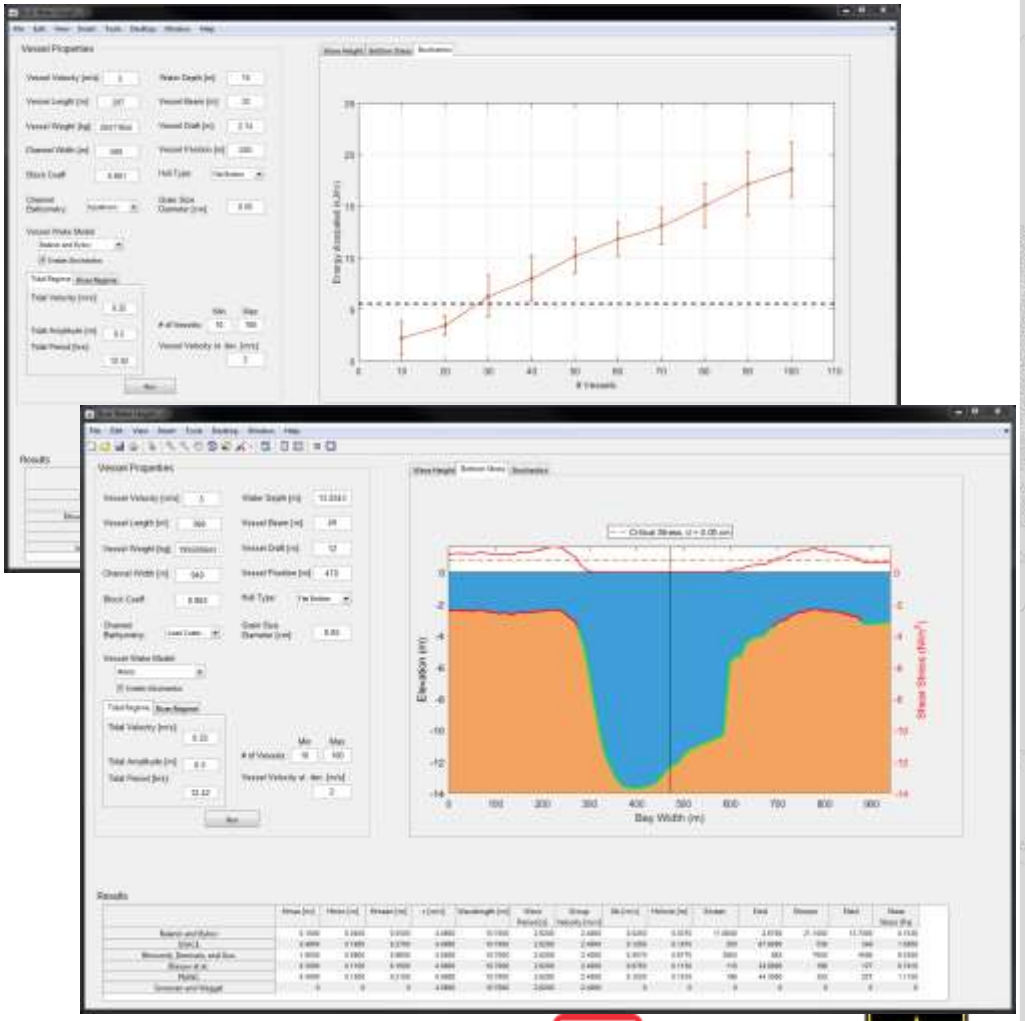
Desktop tool to compute vessel wake in navigable waterways

Vessel wake can lead to shoreline erosion and reduce water quality

- Believe a simple tool would aid decision makers in conducting early assessment of navigation projects for which vessel wake is a concern.
- Provide guidance on navigation practices to reduce wake as an alternative to more expensive shoreline armoring approaches

- Tools needed to:
  - Rapidly assess vessel wake energy dissipation in terms of ambient energy in the system, e.g., tide, river discharge, wind waves
  - Quantify the environmental consequences of changes in vessel traffic patterns

- Desktop tool is in progress



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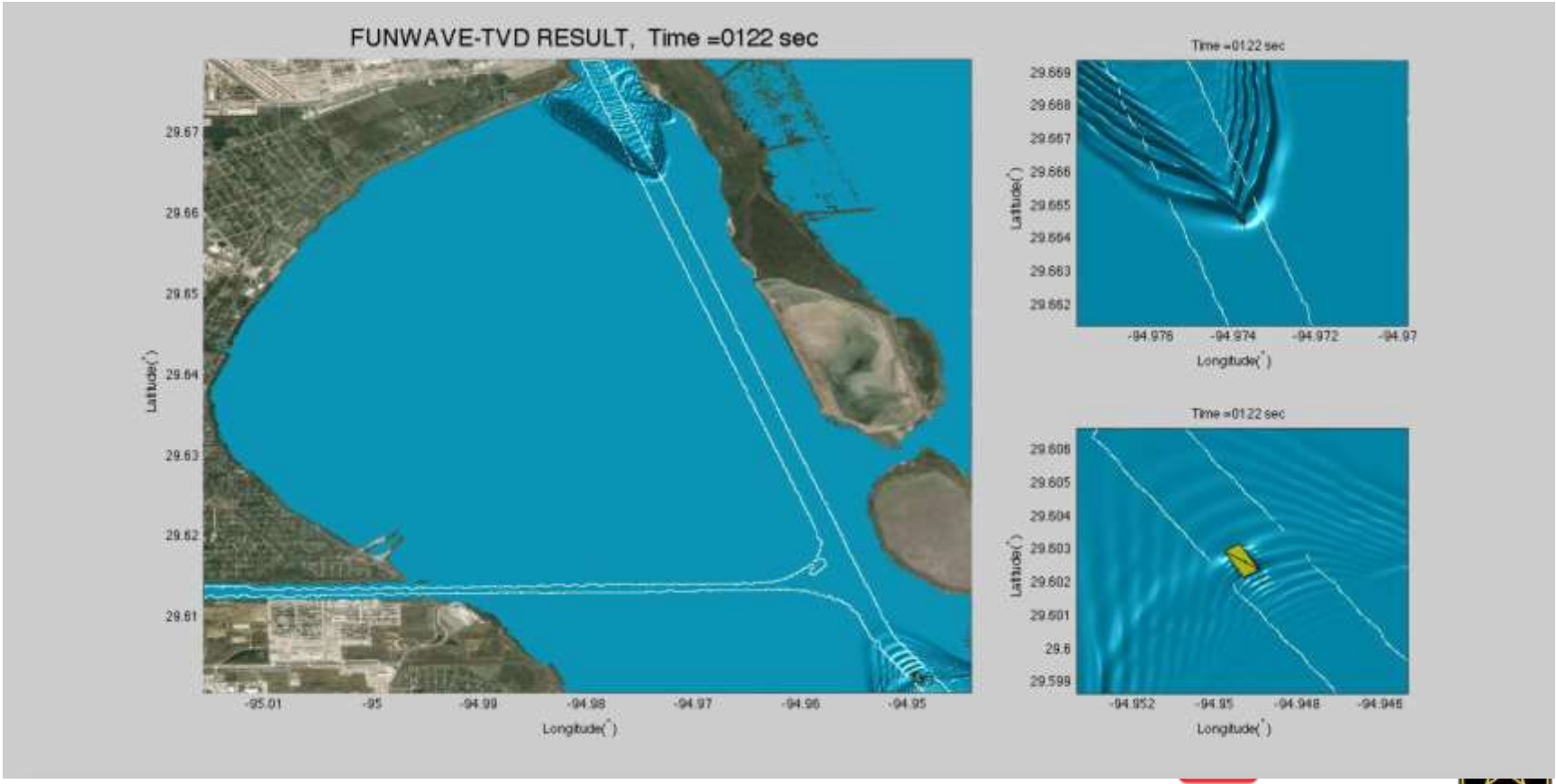
HOUSTON SHIP CHANNEL – MULTIPLE VESSELS

- Field-scale test - shipwake generation in Galveston Ship Channel using a 2-meter resolution rid. The computational domain 7 km x 9 km. Simulations carried out on DoD Supercomputer (Topaz) -- less than an hour of computational time needed!

  Two vessels were specified, moving from the north and south entrances.
  - **Vessel 1**: moving from north to south, is a fast vessel with a critical speed of 13.28 m/s (25.8 knots). The dimension of the vessel is L = 30m and W = 10 m.
  - **Vessel 2**: moves from south to north with a subcritical speed of 6.0 m/s (11.7 knots).



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ENGINEERING WITH NATURE™…

…the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental and social benefits through collaborative processes.

Key Elements:

- Science and engineering that produces operational efficiencies
- Using natural process to maximum benefit
- Broaden and extend the benefits provided by projects
- Science-based collaborative processes to organize and focus interests, stakeholders, and partners

www.engineeringwithnature.org

EWN ACROSS USACE MISSION SPACE

Navigation

- Affordable beneficial use
- Strategic placement of dredged material
- Use of Natural and Nature-Based Features for port resilience
- Enhanced Natural Recovery of contaminated sediments

Flood Risk Management

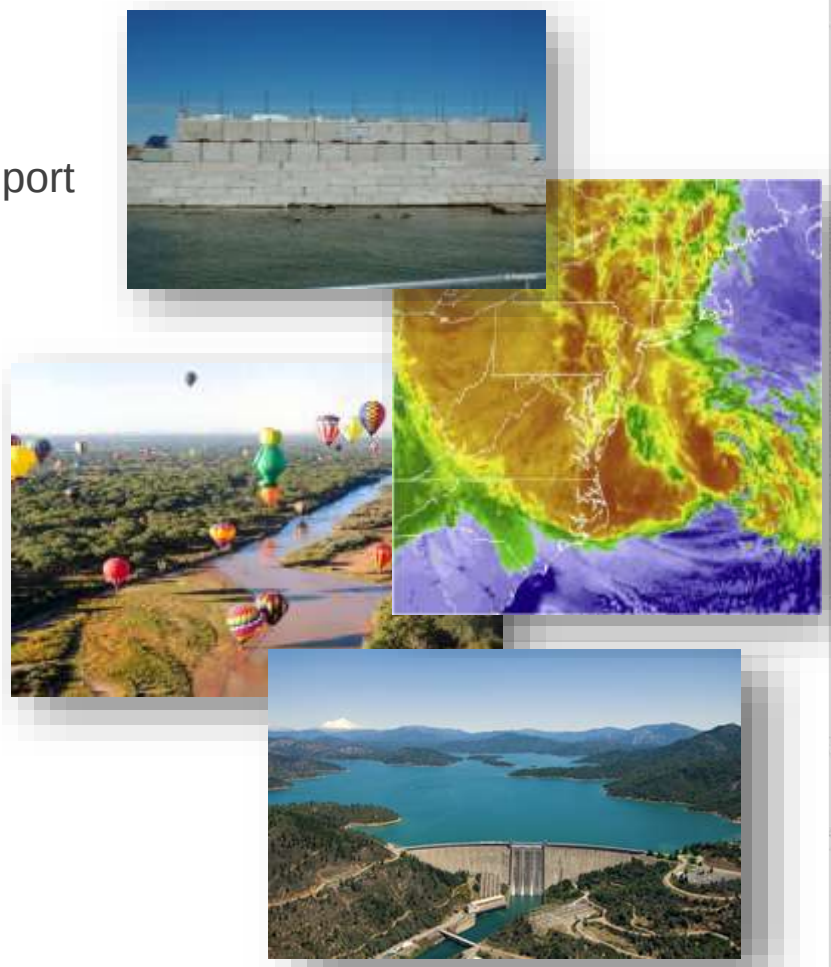
- Natural and Nature-Based Features to support coastal resilience
- Levee setbacks

Ecosystem Restoration

- Ecosystem services supporting engineering function
- “Natural” development of designed features

Water Operations

- Shoreline stabilization using native plants
- Environmental flows and connectivity



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FORT PIERCE CITY MARINA, FLORIDA

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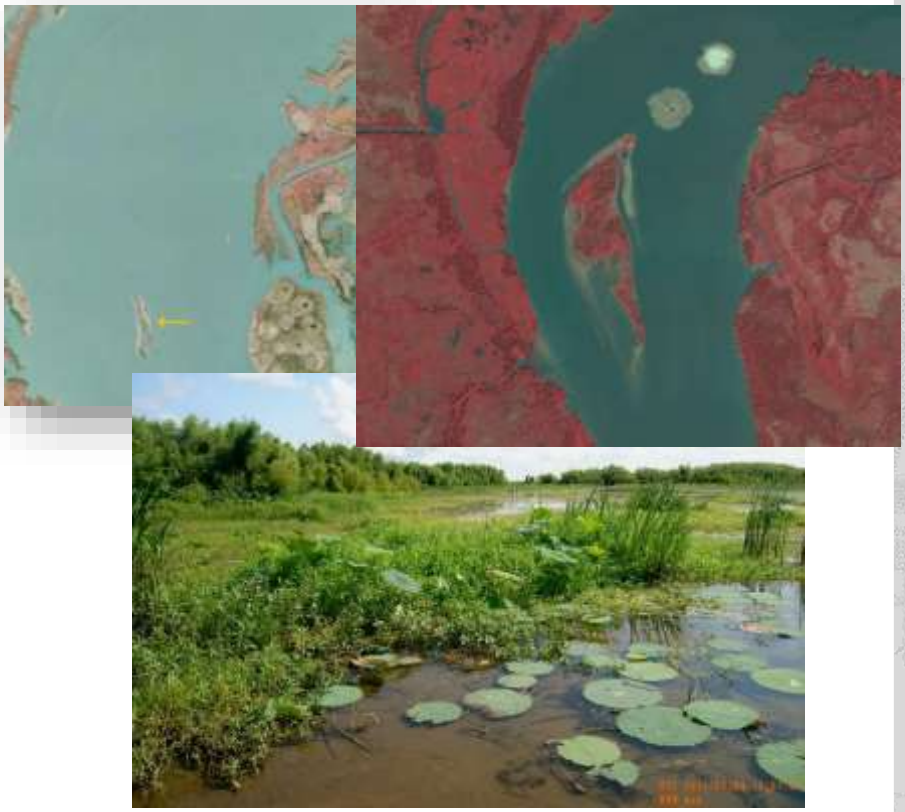
HORSESHOE BEND, ATCHAFALAYA RIVER

- Options for managing dredged material via shore-based wetland creation were exhausted
- Strategic placement of sediment (0.5-1.8 mcy/1-3 yrs) was used to create a ~35 ha island
- Producing significant environmental and engineering benefits
- Project won WEDA's 2015 Award for Environmental Excellence and 2017 Climate Change Adaptation Award



CONCLUSION

USACE R&D is working to address specific problems with an underlying strategy for systems approaches and harmonization of information.

Advancements are helping USACE deliver its navigation mission.

Continued partnerships are essential to delivering and advancing the marine transportation system in a viable manner for the sustainment and growth of the Nation.