NAVIGATION RD&T UPDATE

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Technical Director

- Navigation RD&T Needs & Priorities
- Dredging Optimization
- Quantifying Ship Movement
- Dredged Material Placement
- Data Access and Applications

Harbors & Navigation Committee, AAPA
28 Sep 2018

US Army Corps of Engineers

ERDC
ENGINEER RESEARCH & DEVELOPMENT CENTER

Navigation RD&T Strategic
Needs & Priorities

- **Extend the useful life** of existing navigation infrastructure
- Improve Navigation operations and **Multimodal Freight Flow** through systems optimization
- Design & manage **resilient, sustainable navigation systems**
- Develop and deploy **eNavigation** capabilities

Dredging Portfolio Optimization Strategies

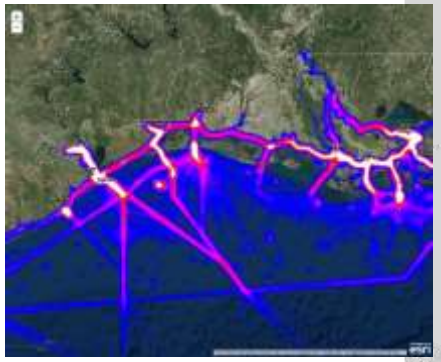
1. Dredging Project Selection

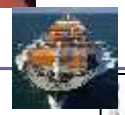
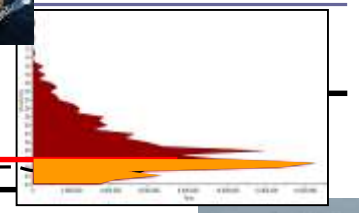
- Dredge more NAV projects by better aligning funding to actual dredging needs
- Recommends optimal maintained depth targets and requisite dredging quantities
- How? Compares cargo drafts to maintained depths and considers cargo shared across projects

2. Dredge Schedule Optimization

- Minimize mobilization costs

  → dredge more NAV projects each year for same amount of funding
- Better align schedules with env. work windows and dredge plant capabilities
- Can be used in whole or in part (regions, big dredges vs. little dredges, big projects vs. little projects, etc.)

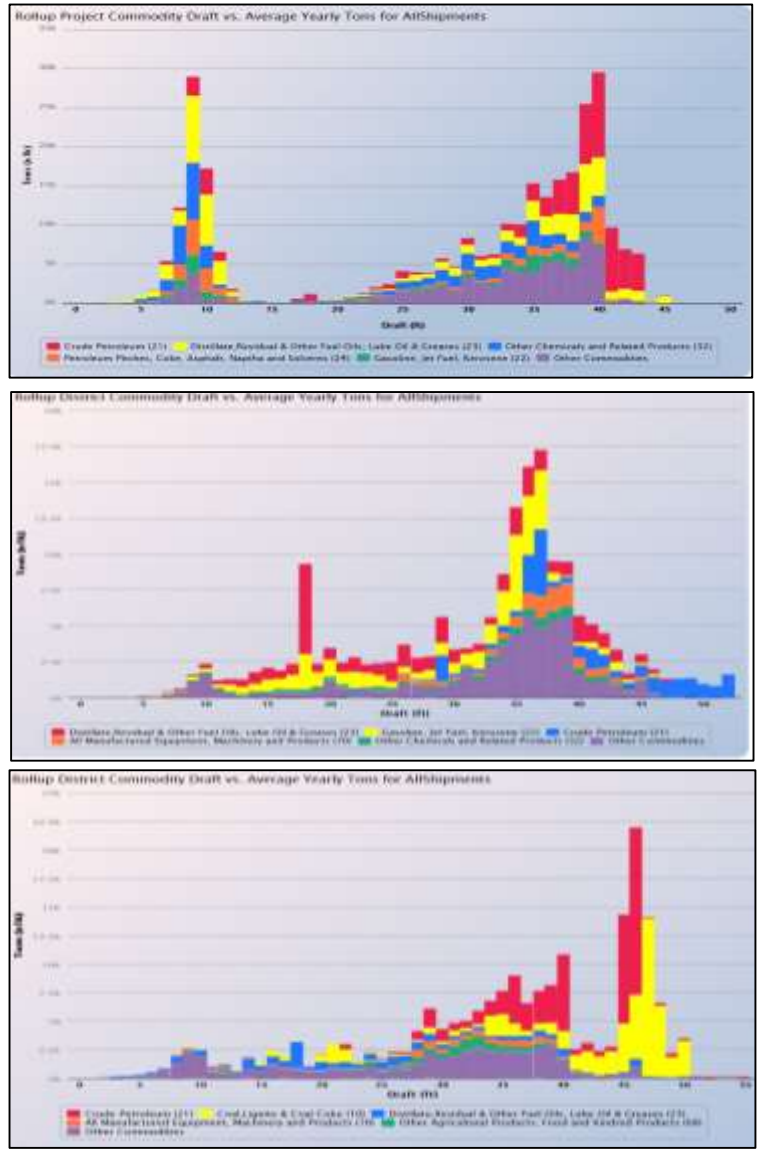





Channel Depths vs. Vessel Drafts

- Historic emphasis on Total Project Tonnage as a metric for dredging work packages has obscured that fact that the deepest maintained depths, i.e. those incurring the majority of O&M dredging costs, in many cases do not handle large percentages of total channel throughput.

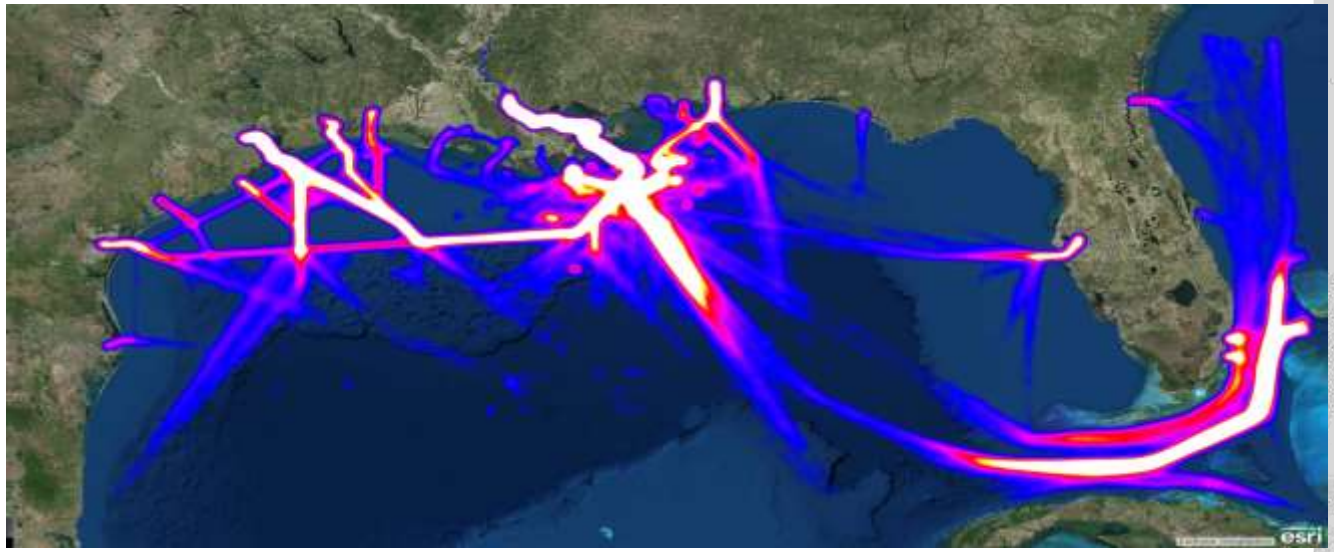
- Data sets and optimization formulations already exist to dramatically improve the portfolio-level cost-effectiveness of O&M dredging:
  - Waterborne Commerce data → dock-to-dock movements of vessels and cargo with draft included
  - E-Hydro → enterprise capability with high-resolution, three-dimensional digital representations of channel conditions
  - CSAT → near-term shoal forecasting to allow for consideration of maintenance dredging deferrals



PI: Ned Mitchell, Ph.D.

Systems-based Portfolio Optimization

Still must account for the inter-connectivity of navigation projects, owing to their shared cargo.

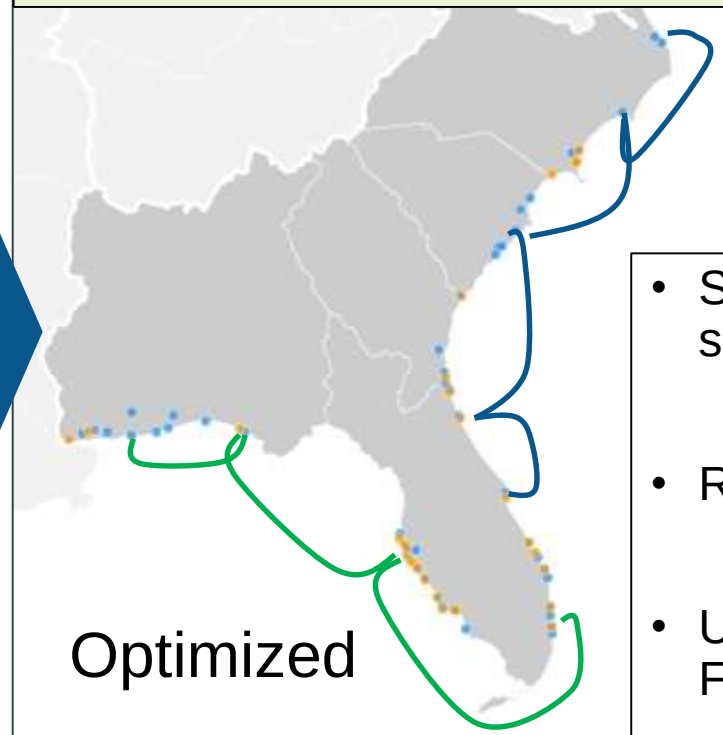


PI: Ned Mitchell, Ph.D.

Dredge Scheduling Optimization

- Schedules are not coordinated formally
- Inefficiencies due to “wasted travel” between projects
- Contributes to low # of bids on some projects

- Minimize mobilization costs → dredge more projects for same amount of funding and in less time
- Better align schedules with env. work windows and dredge plant capabilities

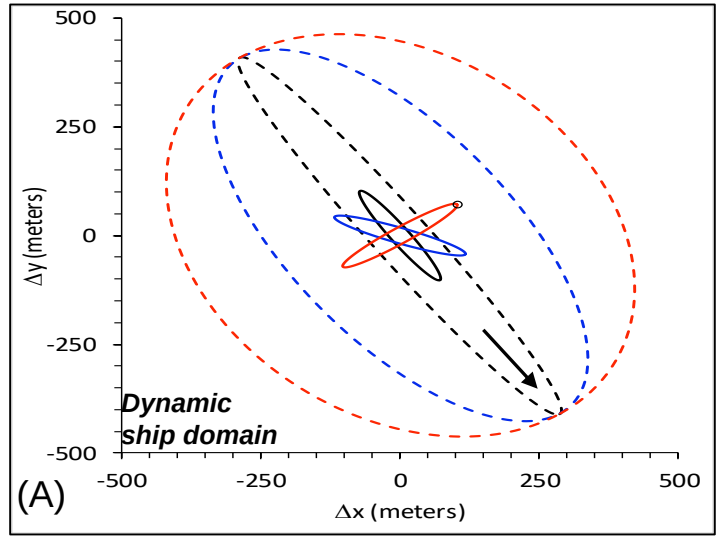


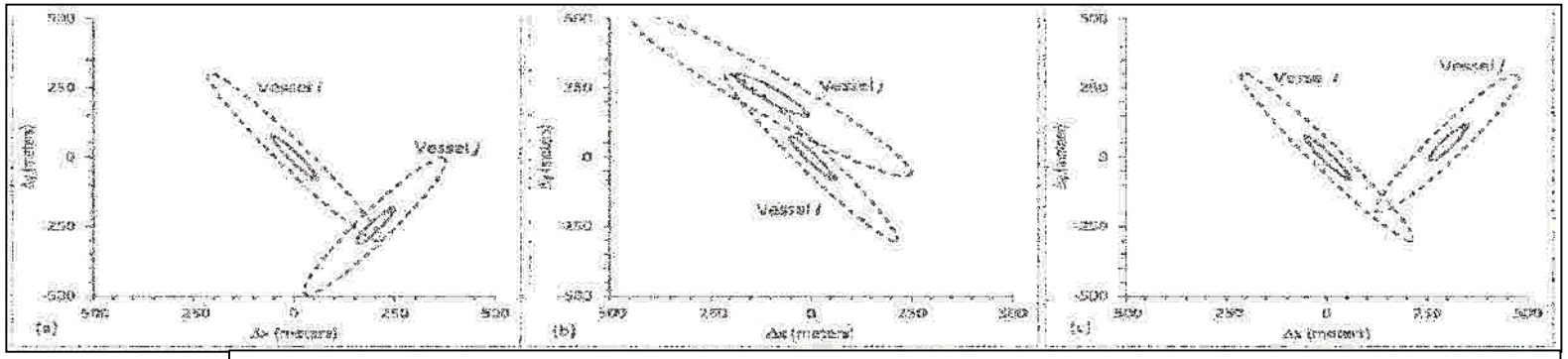
- Successfully used on West Coast since 2014
  - NWD, SPD, and POD
- RSM Pilot in SAD 2016
  - All 5 districts
- Used to support USACE Hopper Fleet Recapitalization Report, 2017

PI: Ned Mitchell, Ph.D.

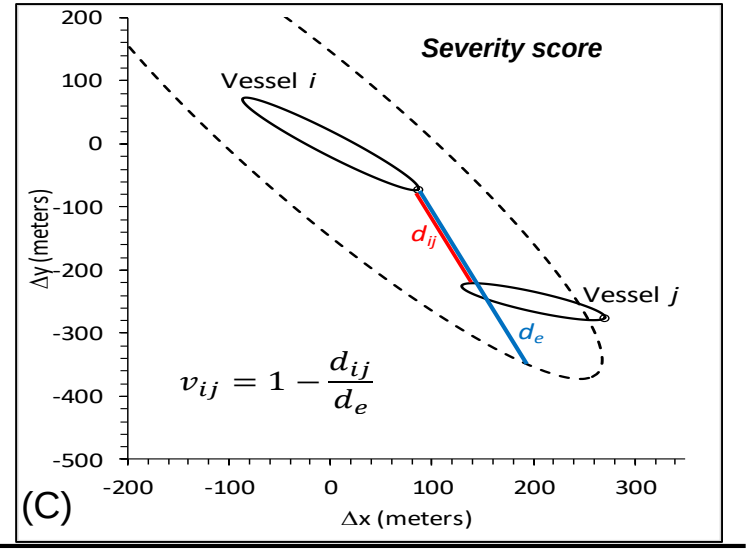
Collision risk assessment based on ship domain

- Dynamic ship domain aligned with course (A).
  - Major axis = 4 × Length
  - Minor axis = 3 × Swept path
- Ship domain violations (SDVs) (B).
  - The perimeter of one vessel penetrates the domain of another.
- SDV severity is based on distance between vessel perimeters (C).





(B): **Ship domain violations**: In panels (a) and (b), vessel *j*'s perimeter penetrates the domain of vessel *i*, resulting in an SDV. Overlapping ship domains, as in (c) do not constitute an SDV.



An objective, quantitative and broadly applicable approach to screening risks

- Consistent, cost-effective implementation across coastal ports.
- Implemented in five navigation projects, ranked by collision risk.
- A vessel in Calcasieu Ship Channel is 4.26 times more likely to be involved in an SDV than in Columbia River, OR.

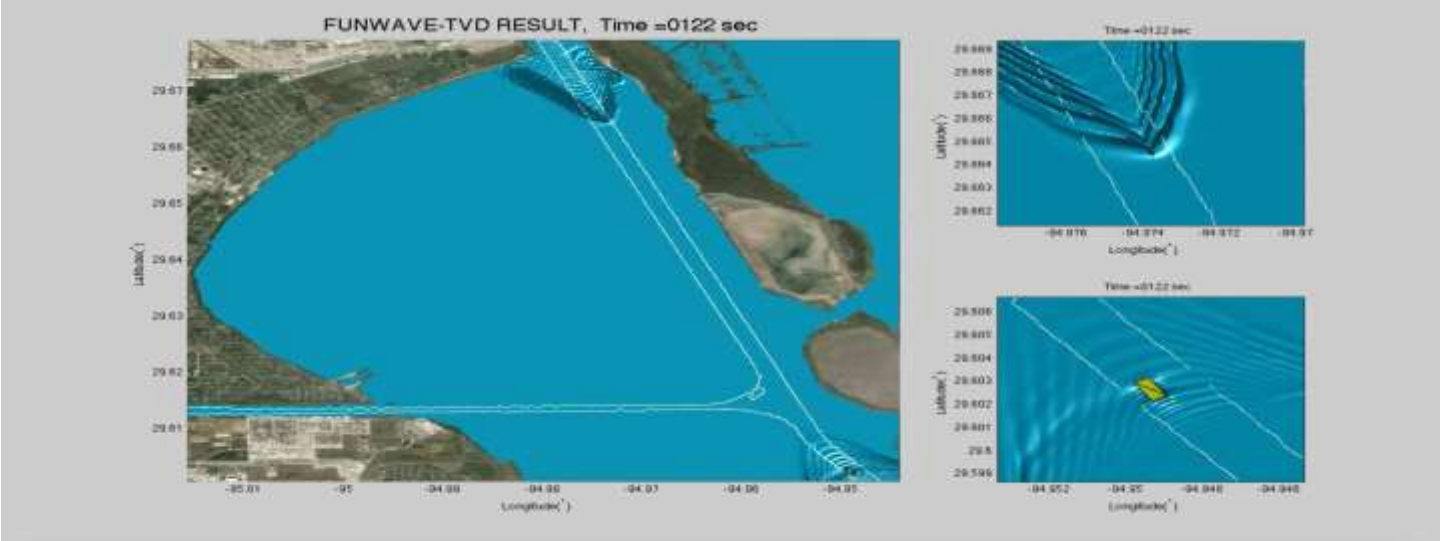
Navigation Project	Passenger (60-69)	Cargo (70-79)	Tanker (80-89)	All vessels
Calcasieu, LA	4.15E-04	1.41E-03	1.80E-03	1.10E-03
Boston, MA	6.06E-04	4.52E-03	2.25E-03	9.32E-04
Jacksonville, FL	2.01E-04	8.98E-04	6.15E-04	8.34E-04
Charleston, SC	1.02E-04	4.38E-04	5.22E-04	2.84E-04
Columbia River	1.07E-04	2.17E-04	9.11E-05	2.58E-04

PI: Martin T. Schultz, Ph.D.

FUNWAVE

FUNWAVE is a shallow water phase-resolving Boussinesq-type numerical wave model that is capable of resolving many nearshore processes such as:

- ✓ nearshore wave propagation & transformation
- ✓ refraction, **diffraction** & nonlinear shoaling
- ✓ wave breaking with **runup** & **overtopping**
- ✓ bottom friction & wave-induced current
- ✓ nonlinear wave-wave & wave-current interactions
- ✓ **partially absorbing/reflecting** inner boundaries
- ✓ **harbor resonance** and **infragravity (IG) waves**
- ✓ **vessel-generated waves** & related sediment transport
- ✓ adaptive mesh refinement (AMR) module – telescoping grids

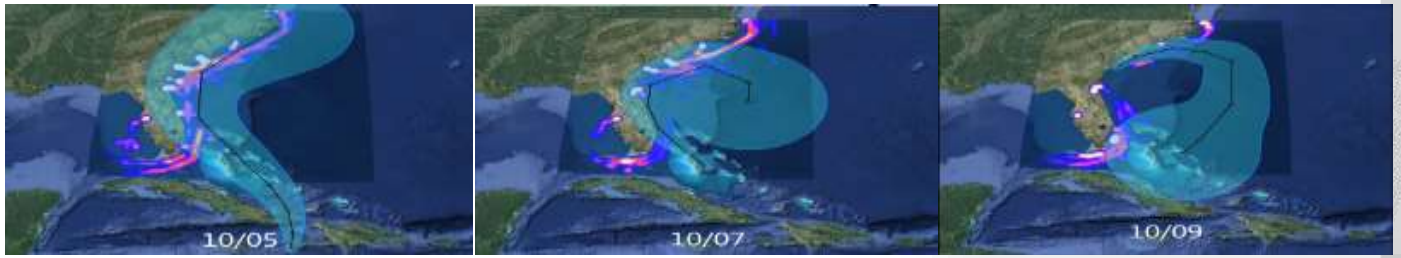


Example Applications:

- Harbor Resonance studies for St. George, St. Paul (Alaska)
- Infragravity (IG) Waves on reefs (Hawaii)
- Breakwater Design for limiting runup and overtopping/inundation (Baltimore District)
- Vessel-generated waves and related sediment transport with morphology change (Houston Ship Channel)

Navigation Resilience

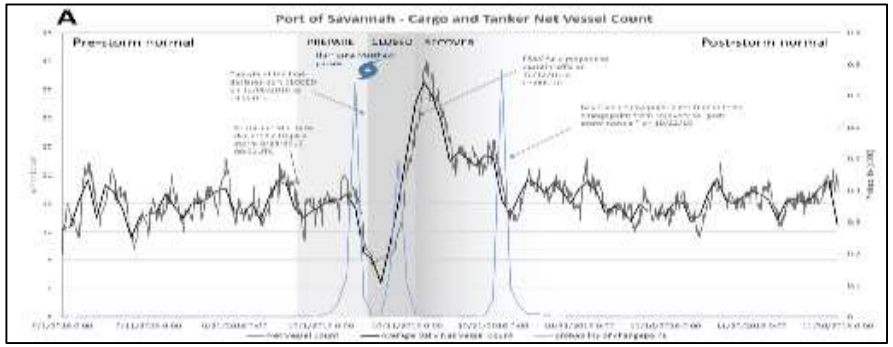
- **Touzinsky, K., Scully, B., Mitchell, K., Kress, M. "Using Empirical Data to Quantify Port Resilience: Hurricane Matthew and the Southeastern Seaboard."** ***ASCE Journal of Waterways, Port, Coastal, and Ocean Engineering: Special Issue on Resiliency*****, MAR 2018.**



- **Evaluated Ports of Jacksonville, Savannah, and Charleston in response to Hurricane Matthew.**

- **Bayesian Changepoint Analysis (BCE) to detect significant changes in system performance via AIS-derived proxy metrics**

→Repeatable framework for evaluating future disruptive events.



Thin Layer Placement

Sed Accretion in TLP marshes (17-01)

Boyd & Gailani

- Problem

pproach

ollect marsh sediment cores in
estored and unrestored marshes and
etermine accretion rates

ompare and contrast the
ccretionary dynamic in restored and
nrestored marshes

Quantification of DM Layer Thickness over Time as Applied in TLP Wetland Nourishment Projects (16-07)

Susan Bailey & Zachary Tyler

- Problem

pproach

Evaluation of field sites

Laboratory testing

Modify PSDDF model guidance as needed

Guidance for Thin Layer Placement of Fine and Coarse Grained Sediment (17-03)

Welp/Piercy

- Problem
  - TLP is experiencing renaissance due to degrading wetlands, SLR, limited dredged material placement alternatives, etc., but there is a dearth of engineering guidance available to the increasing numbers of people want to do it.
- Objective
  - Distill knowledge & information from past, current, and developing TLP projects, and evolving pertinent R&D activities
  - Synthesize into guidance documents designed for use by both USACE and stakeholders to optimize design and construction of TLP projects.

TLP of dredged material at Pepper Creek Delaware

- Approach
  - Conduct lit search to identify existing TLP documentation regarding state-of-practice environmental, ecological, economic, and operational aspects.
  - Compile TLP-related R&D activities
  - Synthesize pertinent aspects into a state-of-the-practice guidance document.

Engineering With Nature Using Vegetation

Tosin Sekoni

- Problem
  - Limited guidance on the use of native plant species in DMPAs and USACE projects.
  - Minimal application of native plant communities in USACE projects.

- Objective
  - Provide guidance on plant community and ecosystem development.
  - Demonstrate the use of vegetation and natural features to support engineering objectives.
  - Provide EWN information to USACE engineers with emphasis on vegetation.

Revetments along Bubblegum Beach, Rehoboth Beach, DE.

- Approach
  - Workshops
  - Demonstration Projects
  - Technical Publications

Developing Guidance for Incorporating Natural and Nature-based features into Engineering Design

Piercy/Swannack

- Problem
  - Increased interest in natural approaches to managing flood risk in conjunction with structural and nonstructural approaches
  - Limited quantified data on use and efficacy
  - No dedicated engineering guidelines on how to design and implement NNBF
- Objective
  - Compile existing NNBF projects within USACE and other agencies
  - Synthesize information on types, success, construction, lessons learned into guidance document (in conjunction with partners)
  - Develop engineering guidance for NNBF incorporation

- Approach
  - Assemble world-experts on use of natural flood risk features
  - Develop framework for NNBF use and identify key coastal and fluvial features to consider
  - Assemble state-of-practice guidelines on use of NNBF

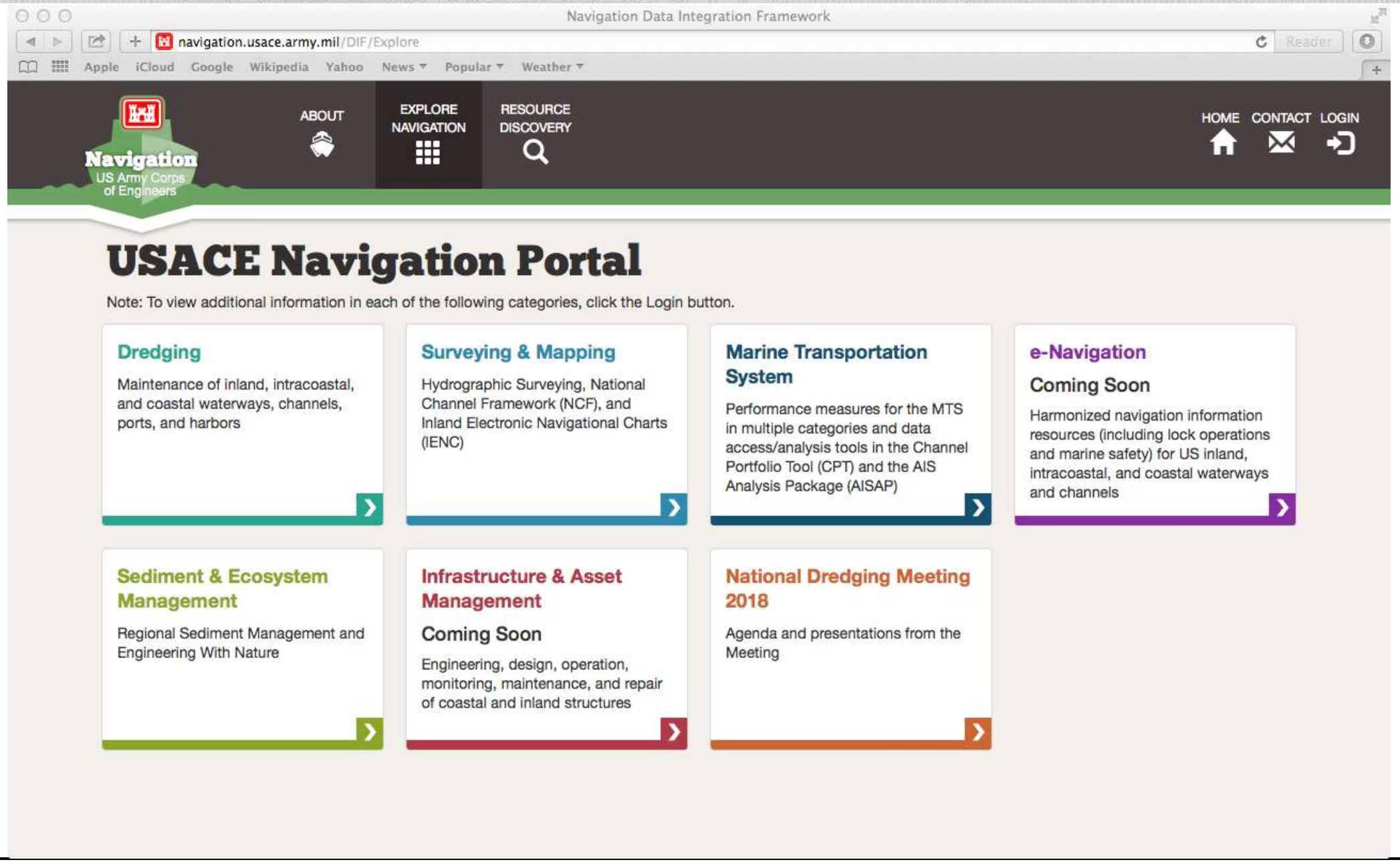
Dredging and Dredged Material Management Decision Support Tool

Safra Altman, Linda Lillycrop

- Problem
  - Need for modern, user friendly evaluation tools which access Corps enterprise databases to improve DMM decision making for Corps Districts, Researchers, non-Corps.

- Objective
  - Improve and update CE-Dredge DST Viewer to operationalize and expand capabilities and nationalize.
  - Add public facing viewer in collaboration with Natural Infrastructure Initiative (NIO Tool)
  - Collaborate w/R,D&T Programs & Districts

- Approach
  - Coordinate with Districts, RD&T programs, non-Corps agencies
  - Utilize/Populate Corps eDatabases
  - Develop web-viewers (Corps and Public) which integrate data and RD&T tool results


Navigation Data Integration Framework
navigation.usace.army.mil/DIF/Explore
Reader
Apple iCloud Google Wikipedia Yahoo News Popular Weather
Navigation
US Army Corps of Engineers
ABOUT
EXPLORE NAVIGATION
RESOURCE DISCOVERY
HOME CONTACT LOGIN
USACE Navigation Portal
Note: To view additional information in each of the following categories, click the Login button.
Dredging
Maintenance of inland, intracoastal, and coastal waterways, channels, ports, and harbors
Surveying & Mapping
Hydrographic Surveying, National Channel Framework (NCF), and Inland Electronic Navigational Charts (IENC)
Marine Transportation System
Performance measures for the MTS in multiple categories and data access/analysis tools in the Channel Portfolio Tool (CPT) and the AIS Analysis Package (AISAP)
e-Navigation
Coming Soon
Harmonized navigation information resources (including lock operations and marine safety) for US inland, intracoastal, and coastal waterways and channels
Sediment & Ecosystem Management
Regional Sediment Management and Engineering With Nature
Infrastructure & Asset Management
Coming Soon
Engineering, design, operation, monitoring, maintenance, and repair of coastal and inland structures
National Dredging Meeting 2018
Agenda and presentations from the Meeting

Selected ERDC Navigation Technical Director

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