



U.S. ARMY



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AAPA – HARBORS & NAVIGATION COMMITTEE AND QPI MEETING:

CORPS CHANNEL AVAILABILITY UPDATE

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December 1, 2021



US Army Corps
of Engineers

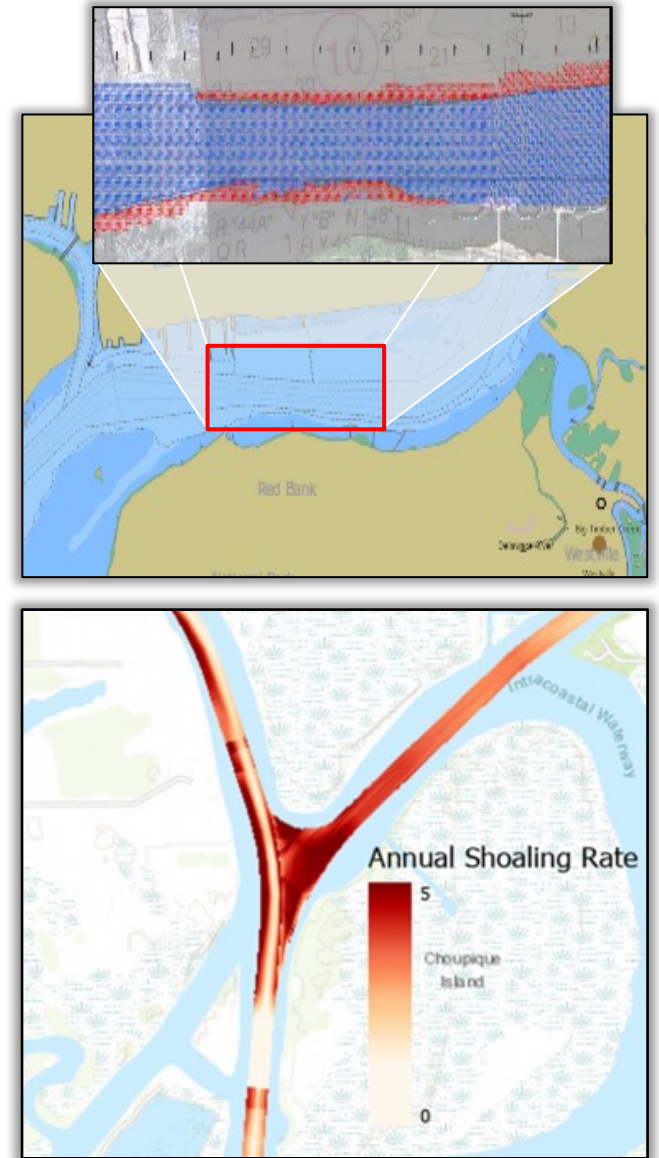


Problem

- Quantitative understanding of navigation channel conditions through time is vital to USACE Navigation Mission readiness.
- Accurate shoaling estimation is critical for designing various aspects of navigation projects:
 - Maintenance dredge volumes and frequency
 - Advanced maintenance depths
 - Dredged material management plans
 - Erosion control and sediment training structures
 - Beneficial use alternatives

Approach

- Integrate enterprise monitoring datasets to support strategic as well as tactical decision making
 - Inferred rates of channel infilling → future shoaling projections
 - Dredging data fusion
 - Enhanced channel availability analysis

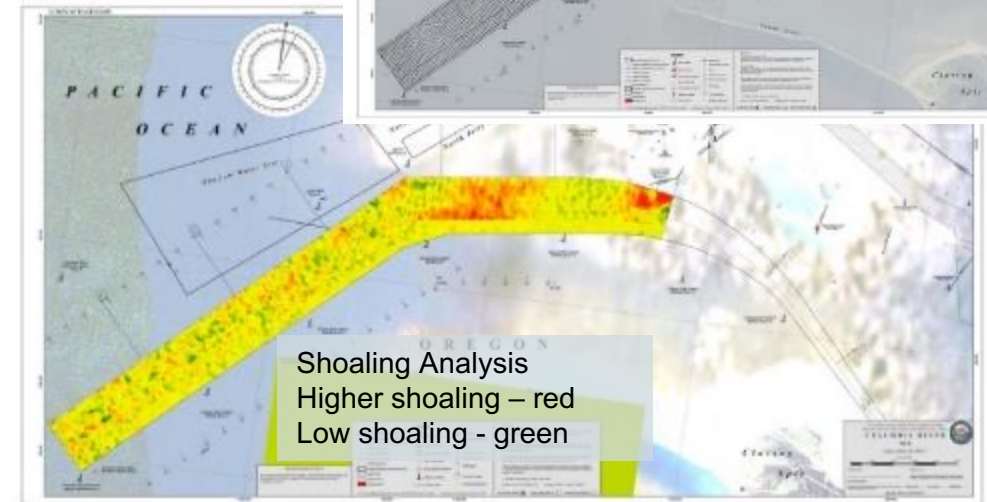
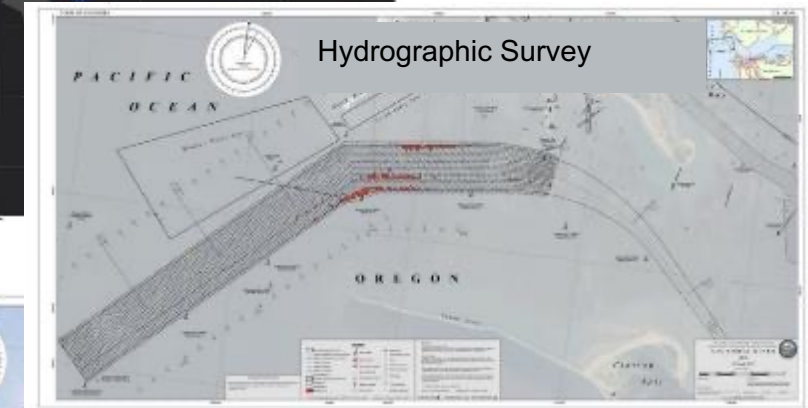
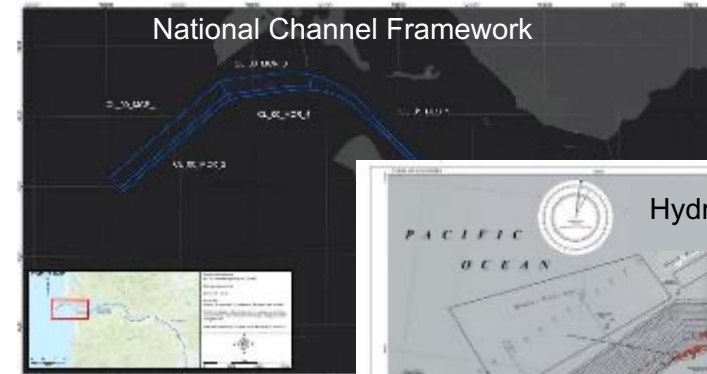


Corps Shoaling Analysis Tool (CSAT)



Description:

- Estimates shoaling rates using archival hydrographic surveys from the Corps' eHydro program
- Corps' National Channel Framework (NCF) provides authorized dimensions for baseline
- Uses the historical shoaling rates to predict future dredging volumes required to maintain various target channel depth increments
- Identifies shoaling 'hot spots' within the navigation channel and other noteworthy spatio-temporal trends
- Shows how shoaling patterns have changed as a result of meteorological events (extratropical storm, rainfall or drought periods), dredge schedule change or dredge type change, etc.



National Channel Framework, hydrographic survey map sheet from eHydro, and the shoaling rate prediction for Columbia River, OR.

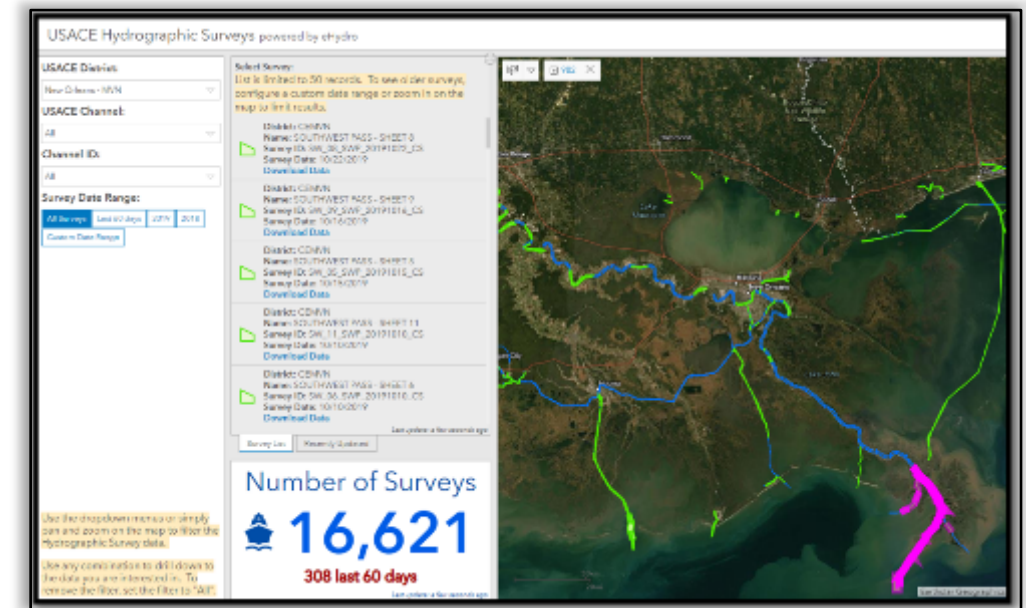
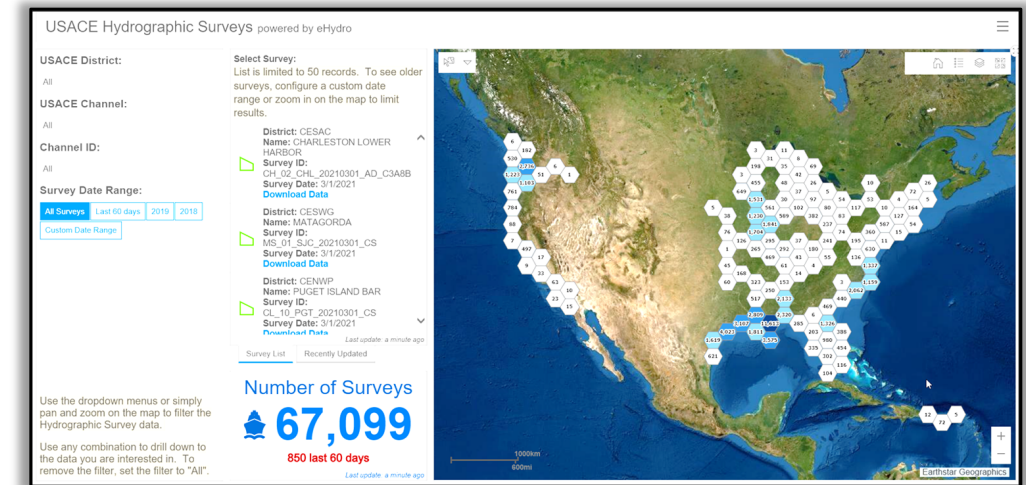
Quick Overview

CSAT:

- Uses hydrographic surveys collected by USACE Districts through time to calculate shoaling
- Runs locally on a desktop, written in Python
 - Loosely modeled after eHydro production workflow
- Produces tabular results + ready for GIS rasters

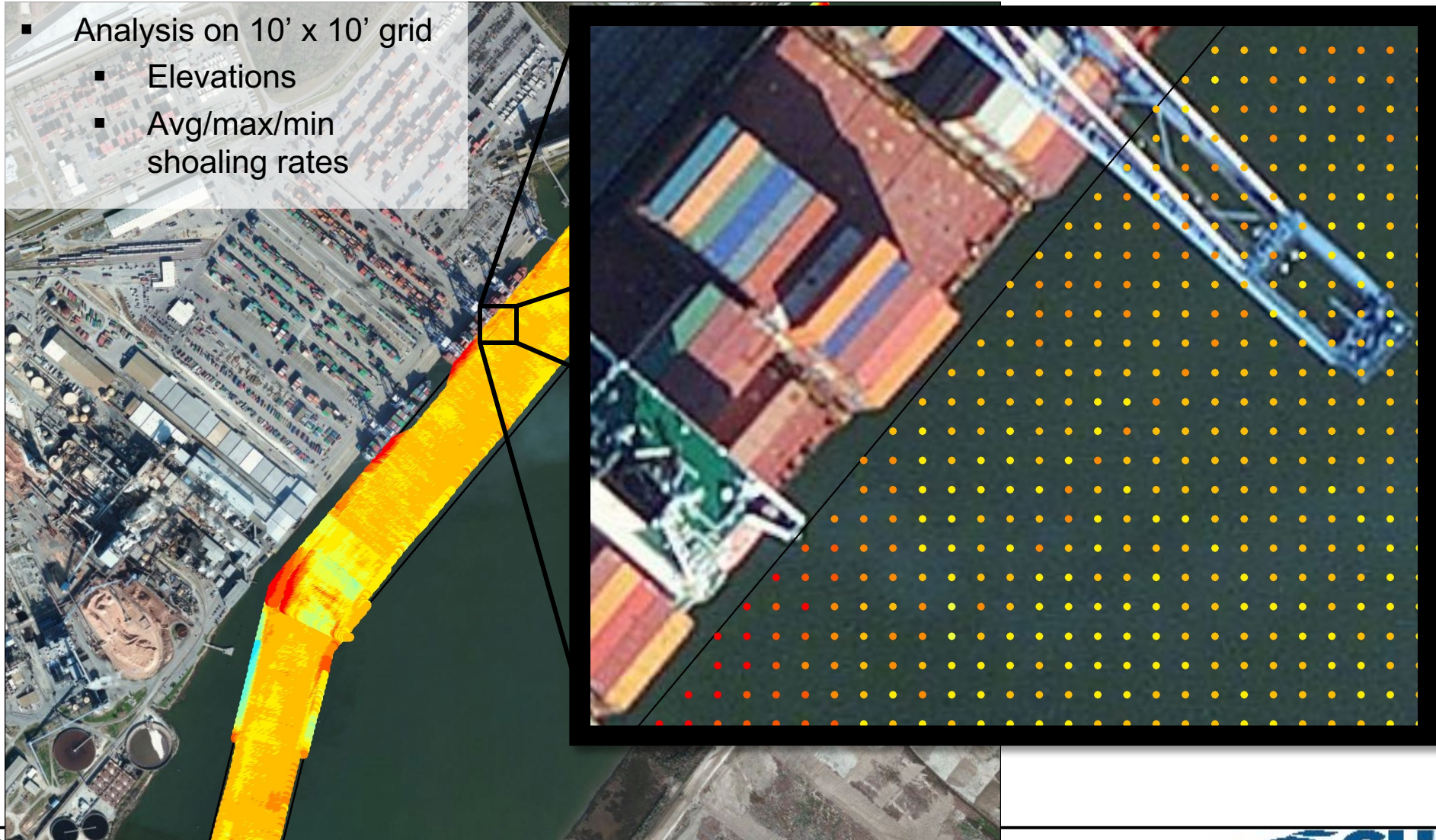
Leverages eHydro Data:

- Single beam and multi-beam surveys
- Over 74,000 surveys to date – USACE wide
 - Over 16,000 surveys for Southwest Pass



Shoaling Analysis on 10ft x 10ft grid

- Analysis on 10' x 10' grid
 - Elevations
 - Avg/max/min shoaling rates



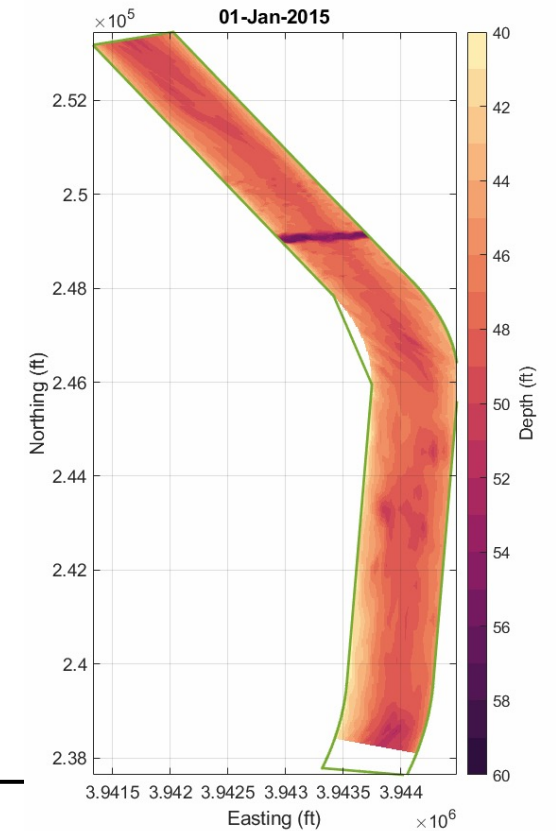
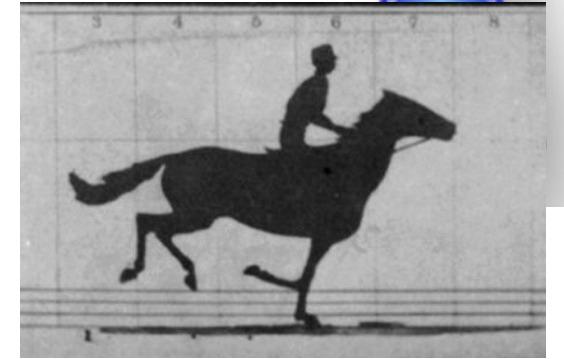
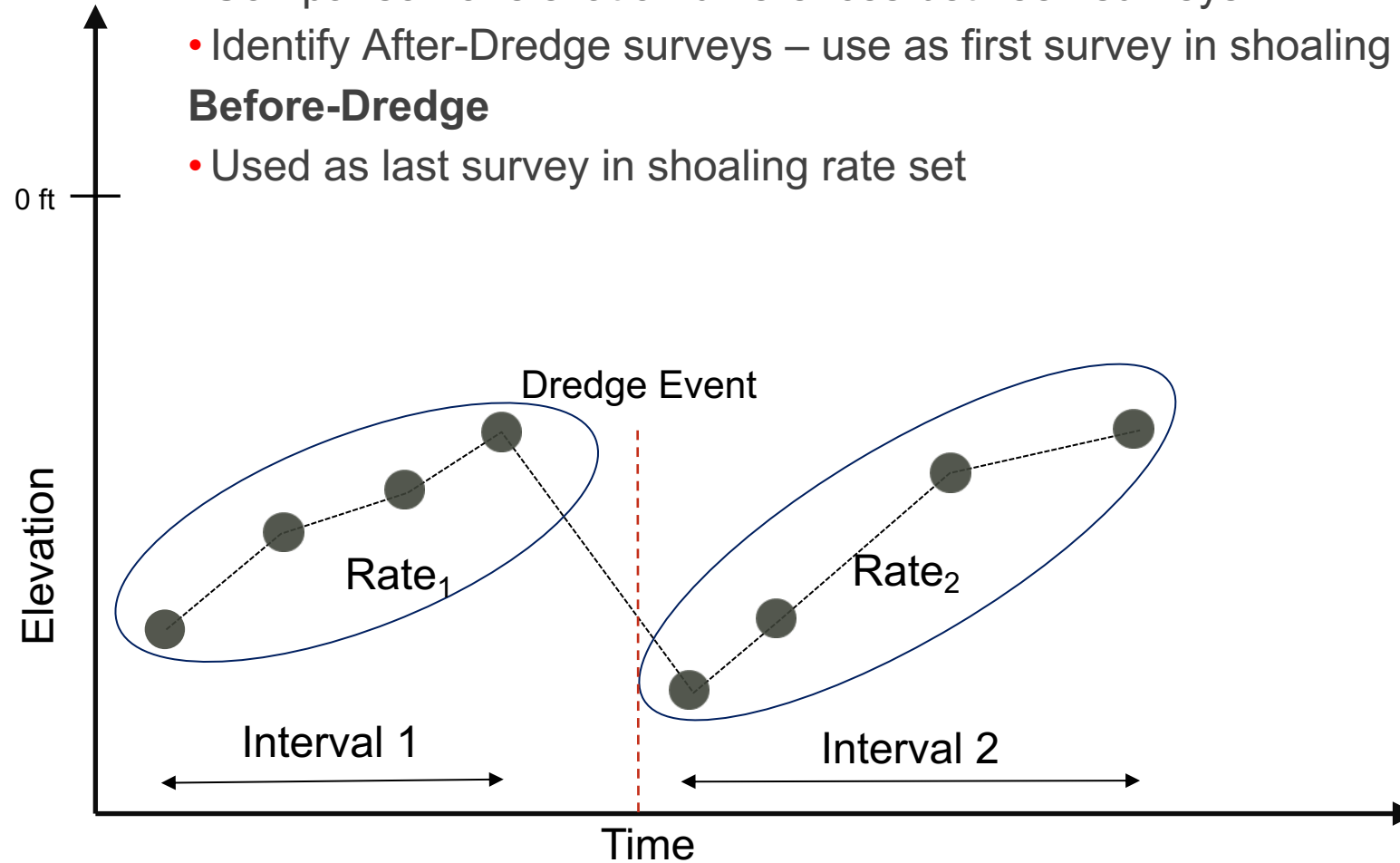
CORPS SHOALING ANALYSIS TOOL (CSAT)

After-Dredge

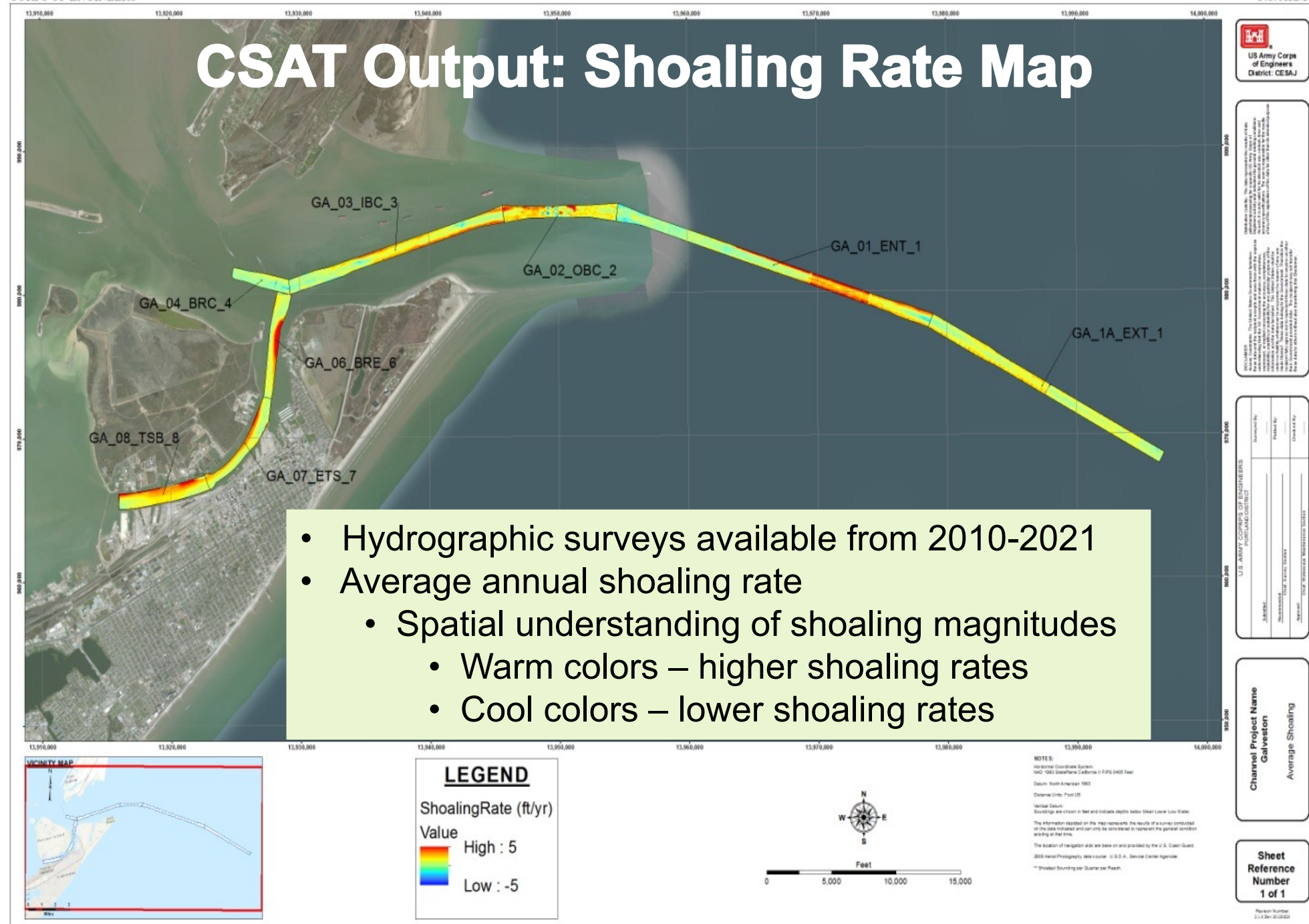
- Comparison of elevation differences between surveys
- Identify After-Dredge surveys – use as first survey in shoaling rate set

Before-Dredge

- Used as last survey in shoaling rate set



CSAT Output: Shoaling Rate Map



- Hydrographic surveys available from 2010-2021
- Average annual shoaling rate
 - Spatial understanding of shoaling magnitudes
 - Warm colors – higher shoaling rates
 - Cool colors – lower shoaling rates



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Submitted By	Reviewed By	Checked By
J. Smith	J. Smith	J. Smith
Task Name: Galveston	Task Name: Galveston	Task Name: Galveston
Approved	Approved	Approved

Channel Project Name
Galveston

Average Shoaling

Sheet Reference
Number 1 of 1

Revision Number
2.0 Rev 20100505





CSAT Output – Volume Tables

- Report volumes at different depth/time intervals (units = 1k CY)

Oakland Harbor (12990)

RelativeDepth	0_Months	6_Months	12_Months	18_Months	24_Months	30_Months	36_Months
VA_s5	0.2	0.3	17.0	111.0	256.6	439.9	651.6
VA_s4	0.4	0.6	37.8	160.5	334.0	543.2	777.2
VA_s3	0.8	1.8	73.3	230.6	435.8	671.4	928.1
VA_s2	1.8	10.4	131.9	330.1	568.2	830.2	1,107.0
VA_s1	8.1	46.4	228.4	470.5	740.0	1,024.5	1,318.2
VA_p0	22.6	131.8	382.5	663.1	956.9	1,258.2	1,564.3
VA_p1	69.9	326.0	618.3	919.4	1,226.1	1,536.1	1,848.5
VA_p2	353.0	646.1	948.6	1,257.0	1,568.7	1,882.7	2,198.1
VA_p3	699.6	1,002.4	1,312.0	1,625.2	1,940.6	2,257.1	2,574.2
VA_p4	1,076.9	1,386.9	1,701.3	2,017.6	2,334.8	2,652.7	2,971.0
VA_p5	1,476.3	1,791.3	2,108.1	2,425.9	2,744.3	3,063.0	3,381.8

0_months column is equivalent to Summary Planning Quantities (SPQs)

CSAT Example Viewer - NAO

Jeff Swallow – NAO – FiNDeR



N40 - Town Point Reach @ Maintained Depth: 40 Feet - SPQ Volumes (Cubic Yards)

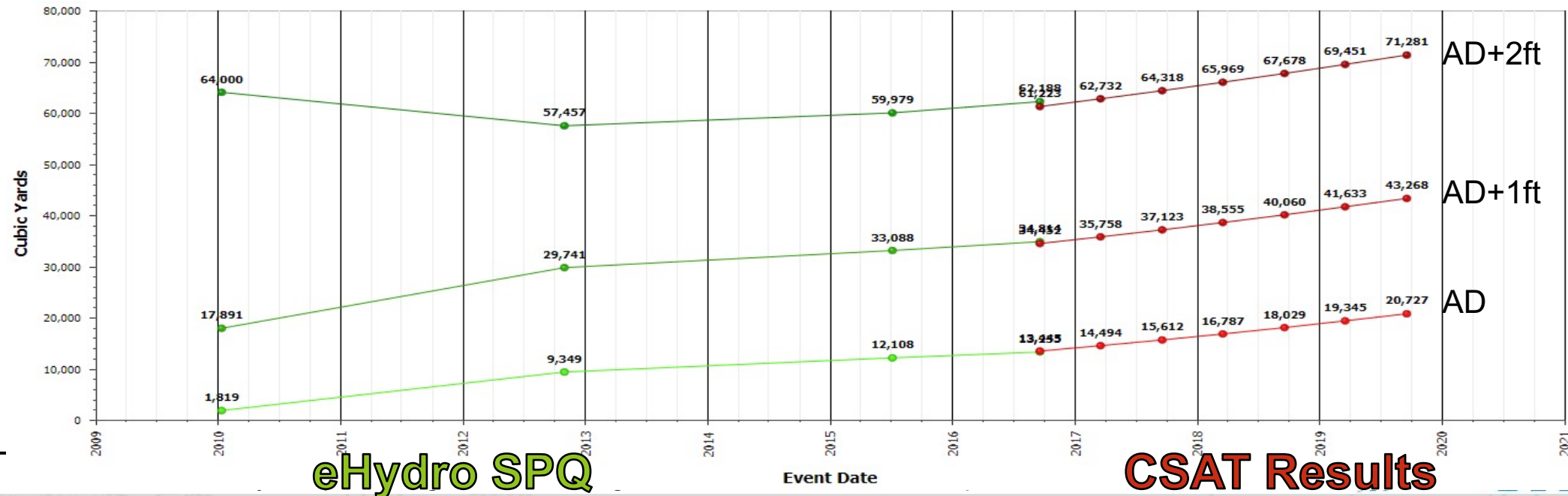
Name	Survey Date	CY to Maint. Depth	CY to Maint. Depth +1'	CY to Maint. Depth +2'
N40 - Town Point Reach	01/12/2010	1,819	17,891	64,000
N40 - Town Point Reach	10/31/2012	9,349	29,741	57,457
N40 - Town Point Reach	07/07/2015	12,108	33,088	59,979
N40 - Town Point Reach	09/19/2016	13,255	34,814	62,188

N40 - Town Point Reach CSAT Projected Volumes (Cubic Yards)

Name	Survey Date	CSAT @ Mnt. Depth	CSAT @ Mnt. Depth +1'	CSAT @ Mnt. Depth +2'
LAMBERTBENDTOPARADISECREEK	09/19/2016	13,445	34,452	61,223
LAMBERTBENDTOPARADISECREEK	03/19/2017	14,494	35,758	62,732
LAMBERTBENDTOPARADISECREEK	09/19/2017	15,612	37,123	64,318
LAMBERTBENDTOPARADISECREEK	03/19/2018	16,787	38,555	65,969
LAMBERTBENDTOPARADISECREEK	09/19/2018	18,029	40,060	67,678

1 - 5 [Next](#)

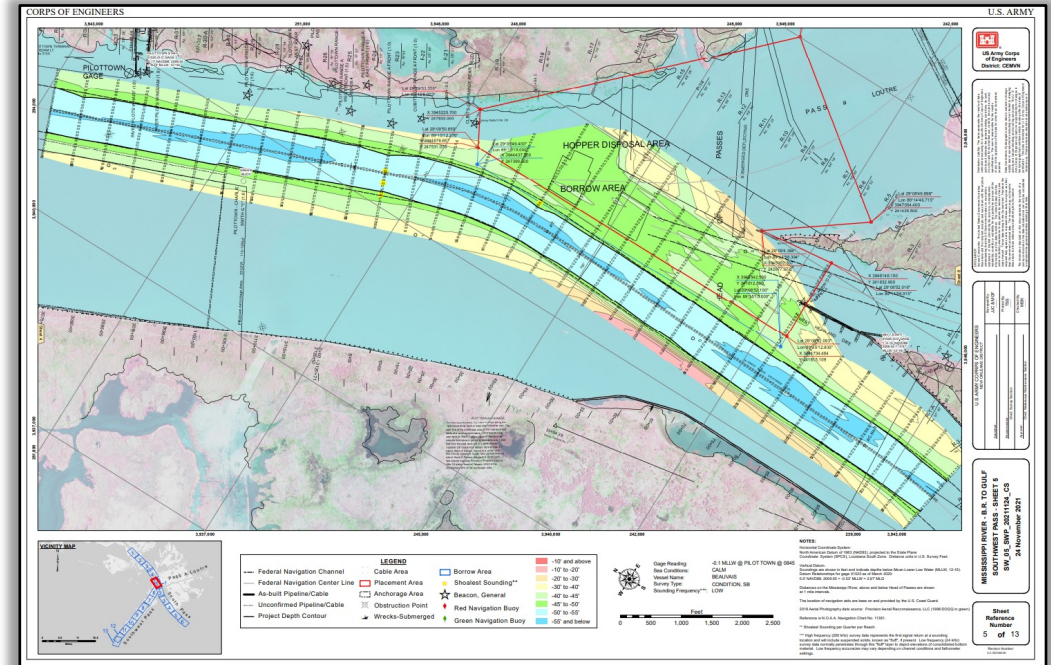
N40 - Town Point Reach @ Maintained Depth: 40 Feet - Spatial Planning Quantities and CSAT Projections (If Available)



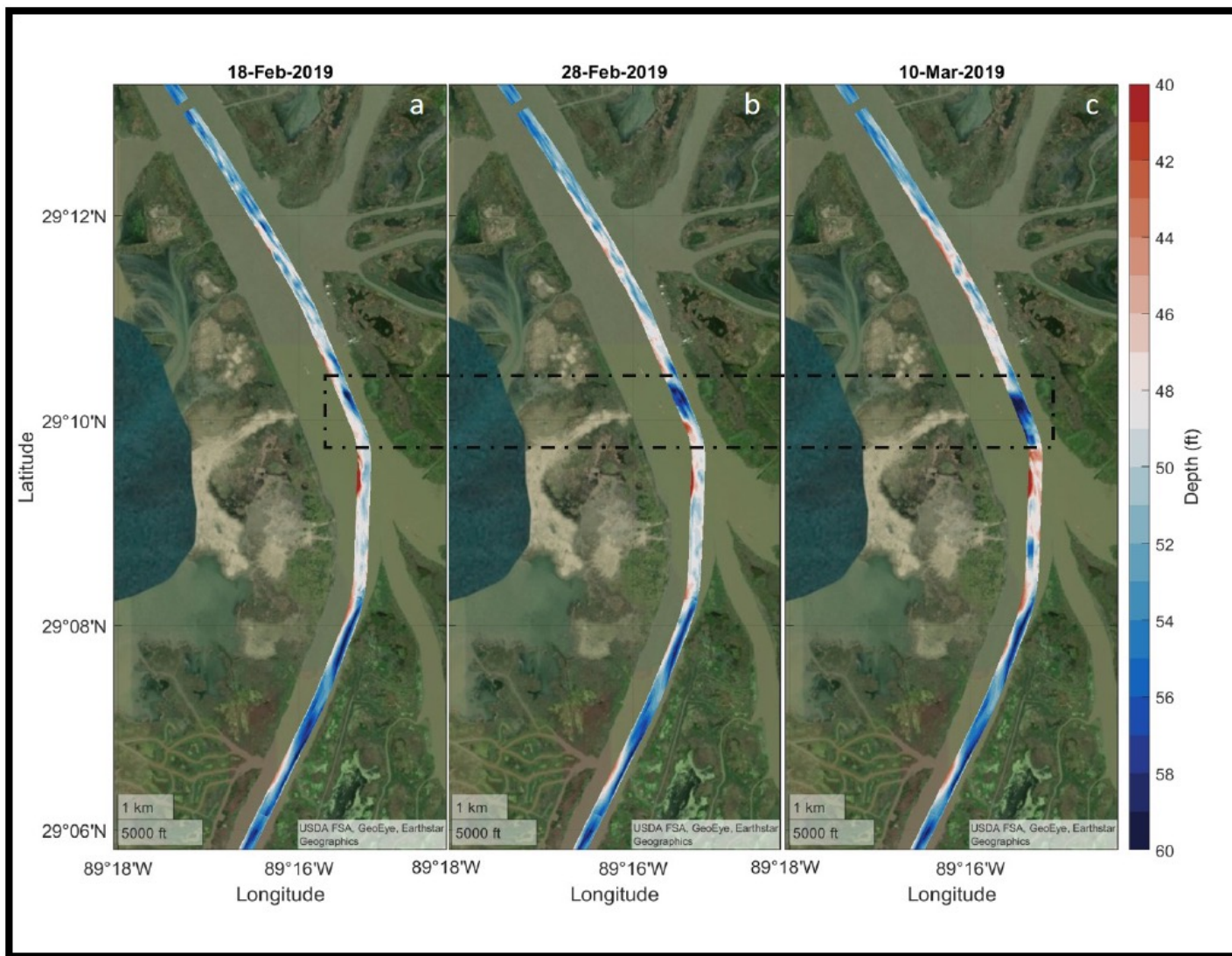
Dredging Data Fusion

- **Hydrographic Survey Data:**
 - eHydro maintained surveys
 - Over 74,000 surveys to date – USACE wide
 - Over 16,000 surveys for Southwest Pass
- **Dredging History Data:**
 - Dredging records from Dredging Quality Management (DQM) for hopper dredges starting in 2015.
 - Cutterhead production from CEMVN

The frequent surveys in Southwest Pass (SWP) allow us to explore channel conditions through time and contextualize dredging operations.



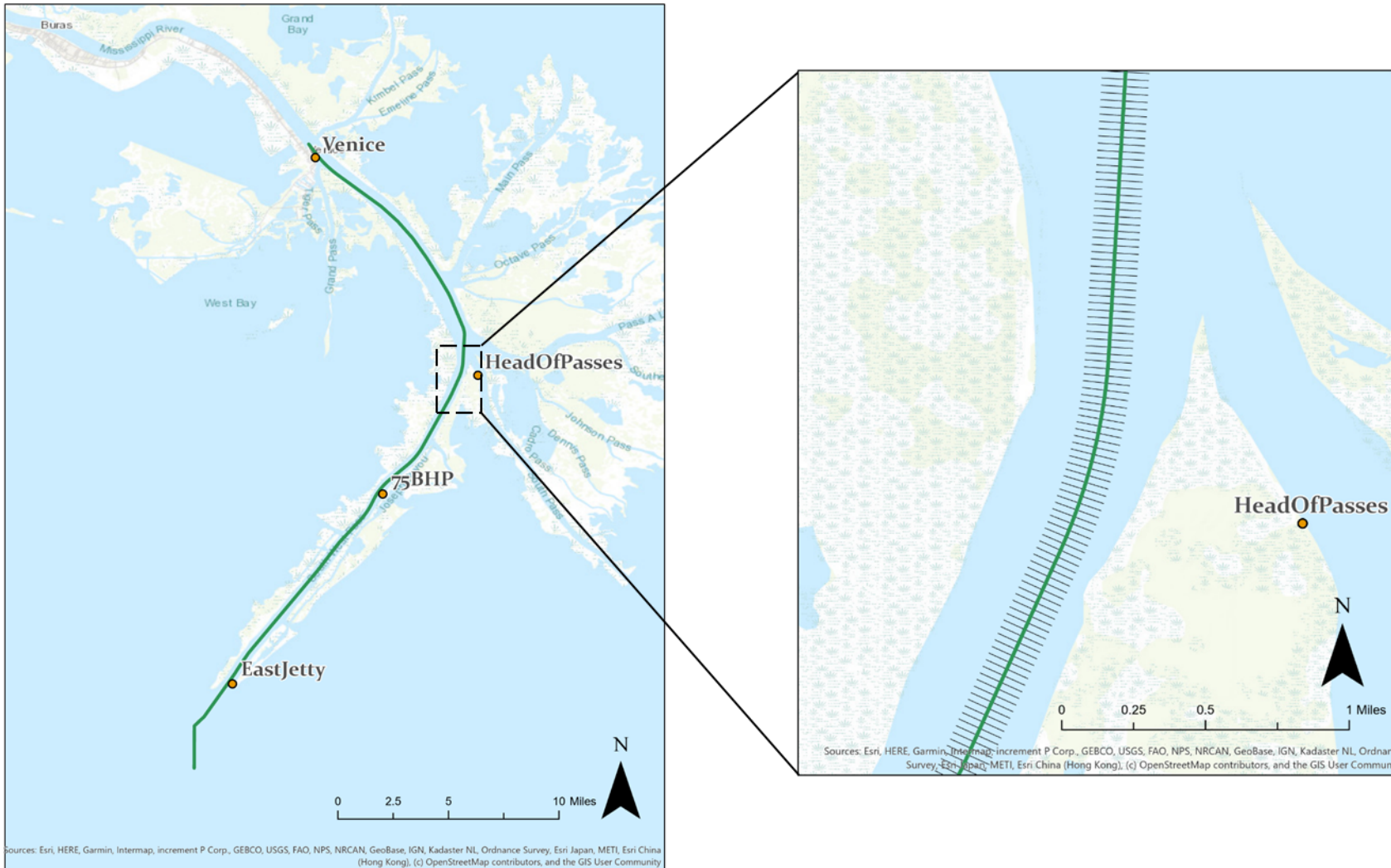
Channel Conditions – Dredging



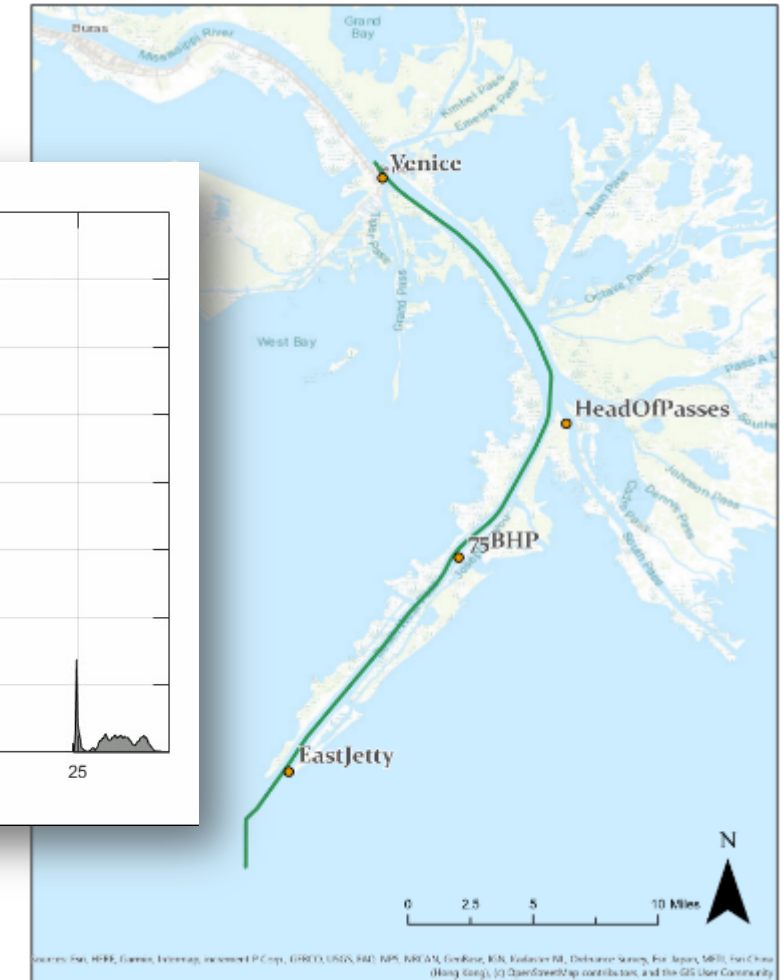
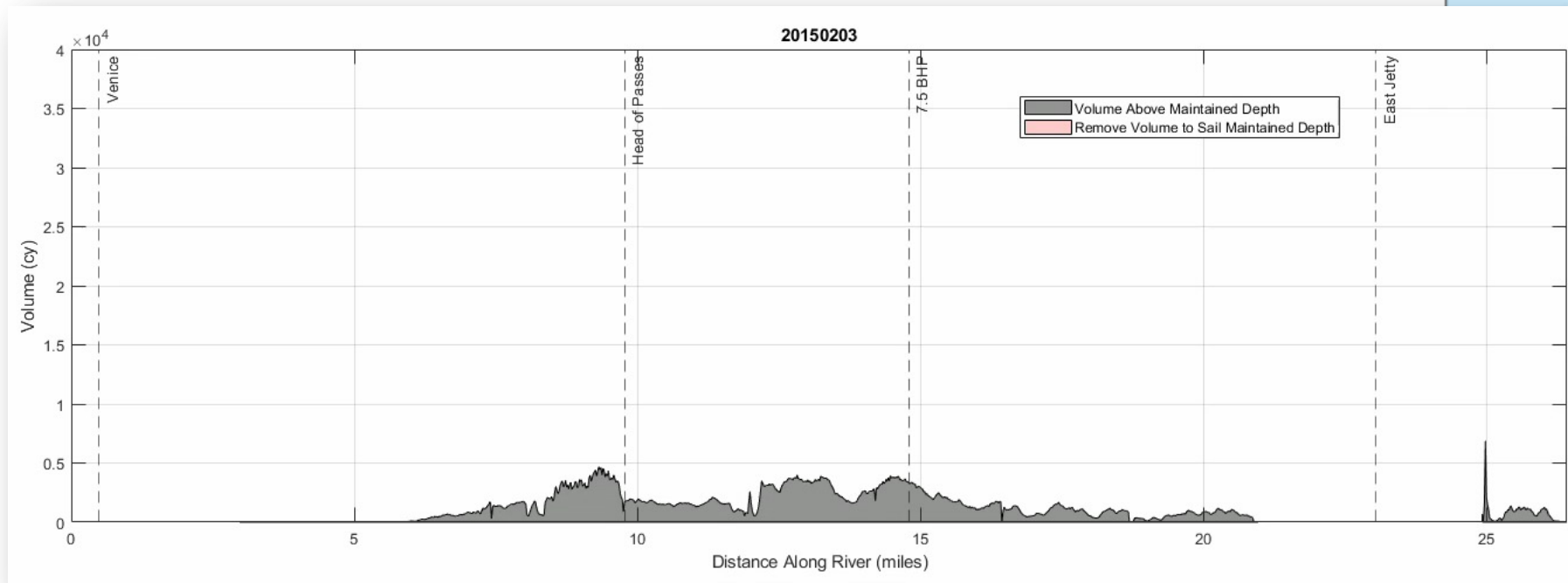
Channel conditions at the Head of Passes at three different dates in 2019:

- a.** When cutterhead dredge arrives on February 18, 2019;
- b.** 10 days later on February 28, 2019 (approximately 357k CY removed); and
- c.** another 10 days later on March 10, 2019 (approximately 362k CY removed).

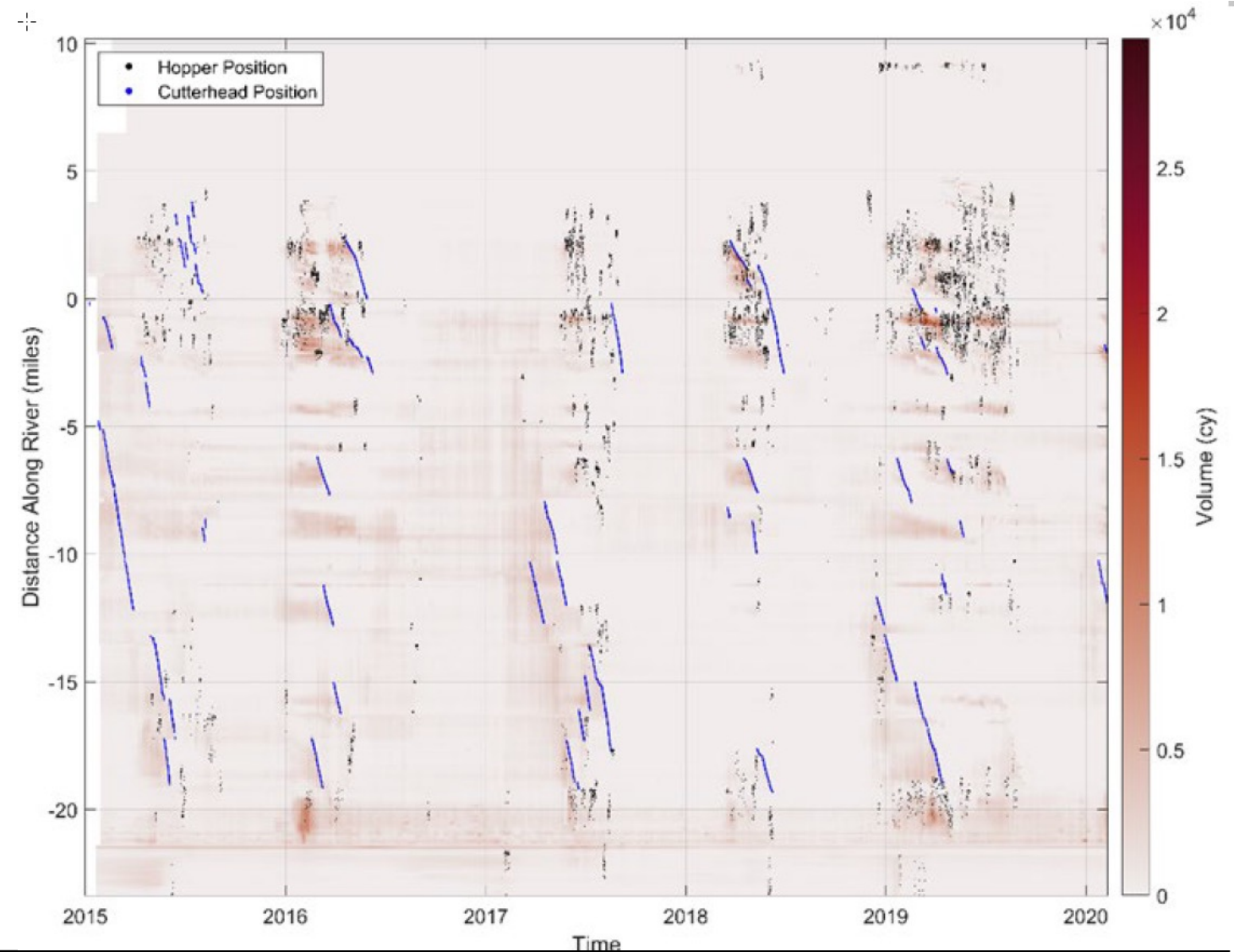
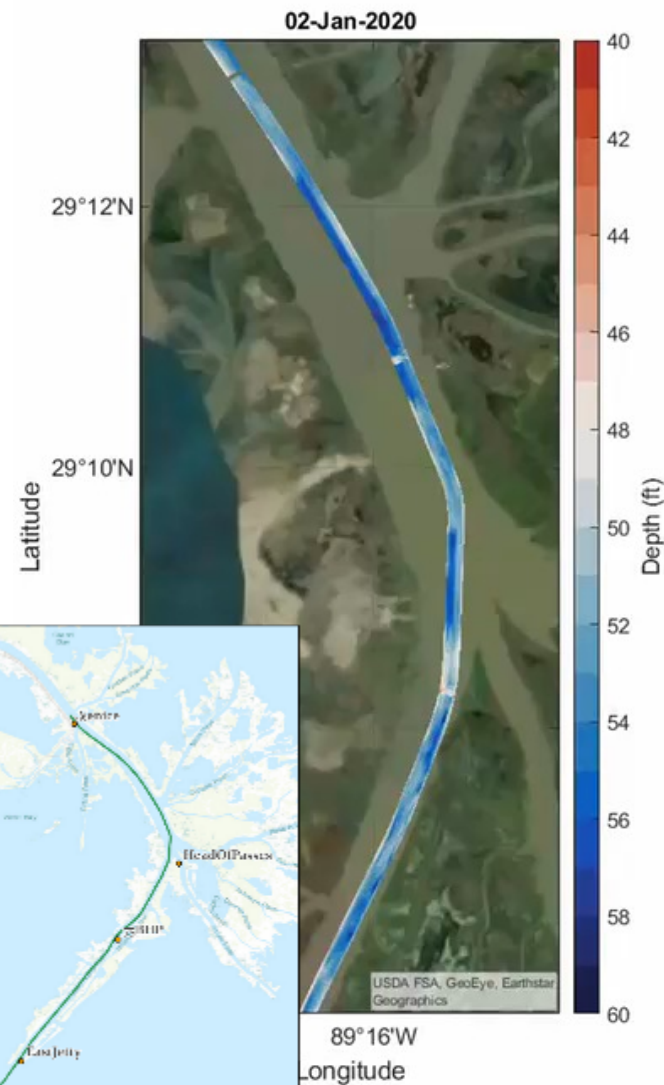
Channel Conditions – Transect Bins



Channel Conditions – Transect Bin Volume



Channel Conditions - Dredging

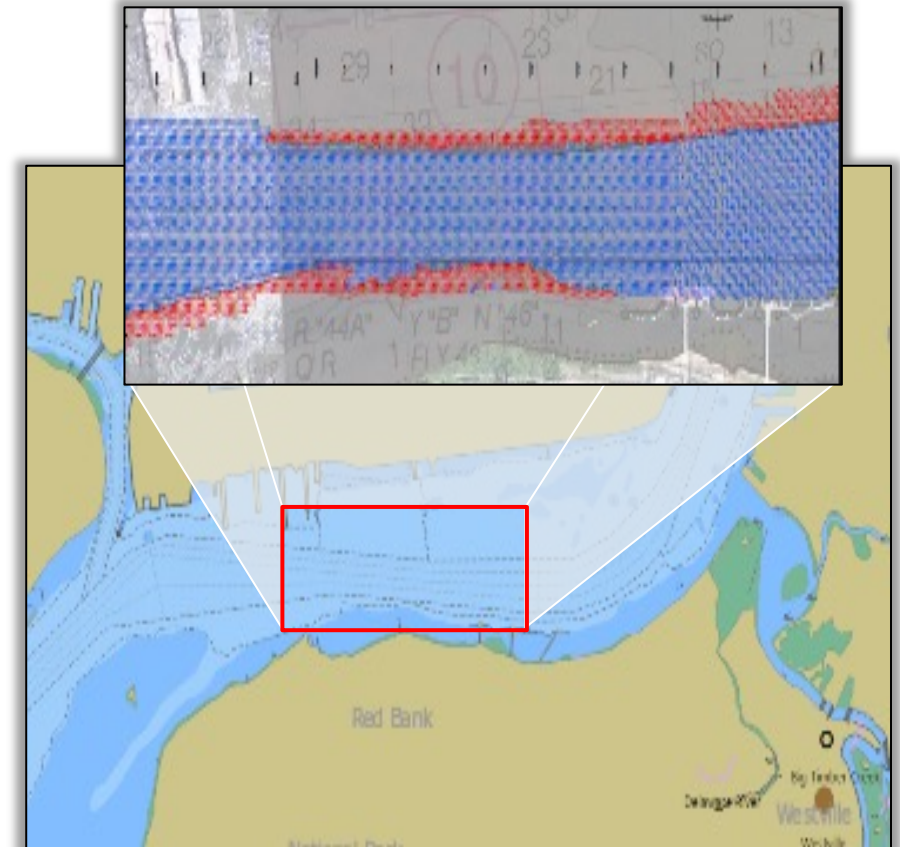


Channel Availability Background

Traditional Channel Availability metric:

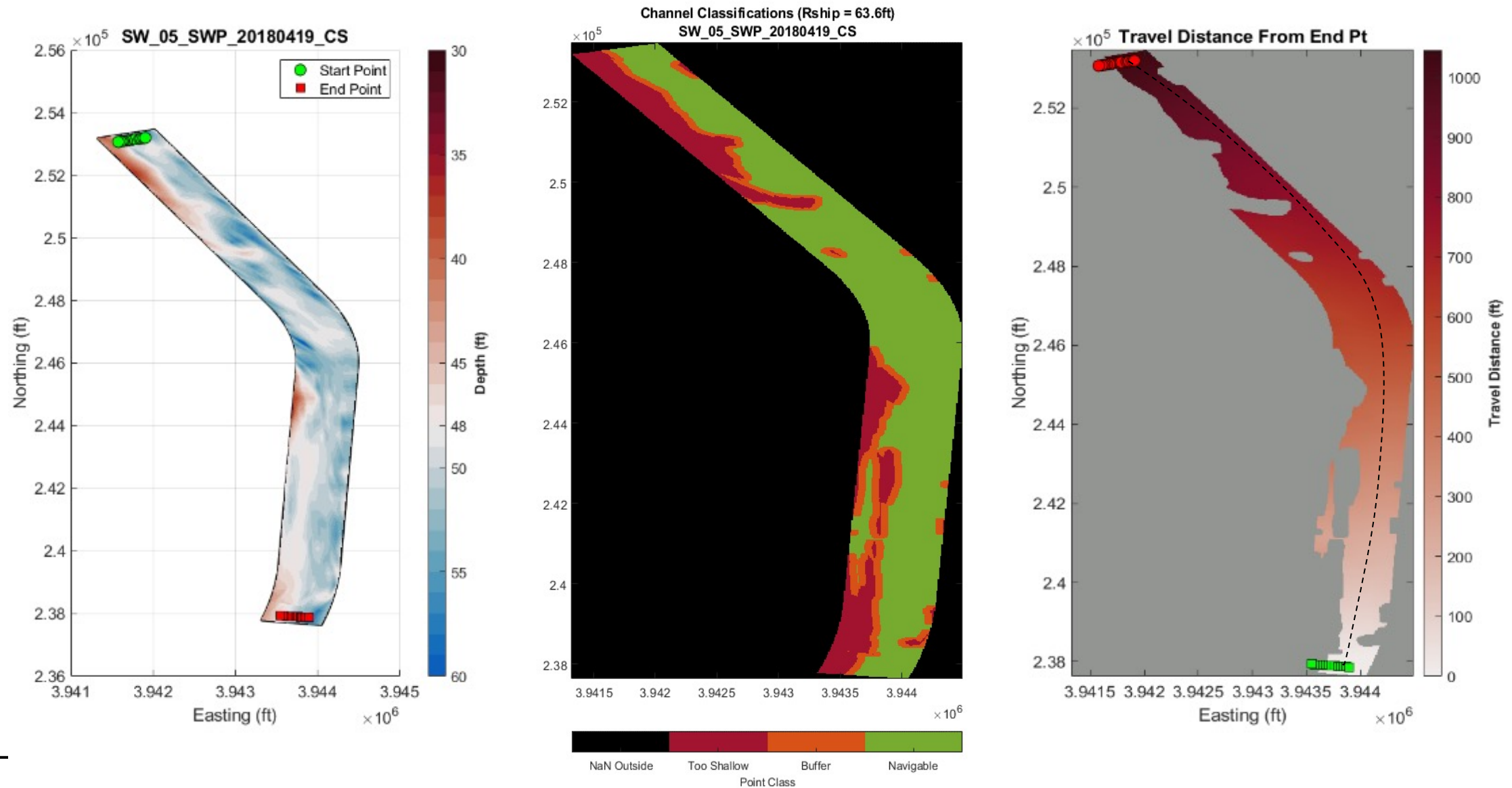
Channel is available if

- **A *single* cubic yard of sediment observed within the authorized channel template is enough to reduce the controlling depth according to traditional metric.**
- **Controlling depth**
 - Shallowest Observed Depth (SOD)
 - Pro: easily implemented
 - Con: 1) very conservative approach
2) does not reflect actual impact of shoals

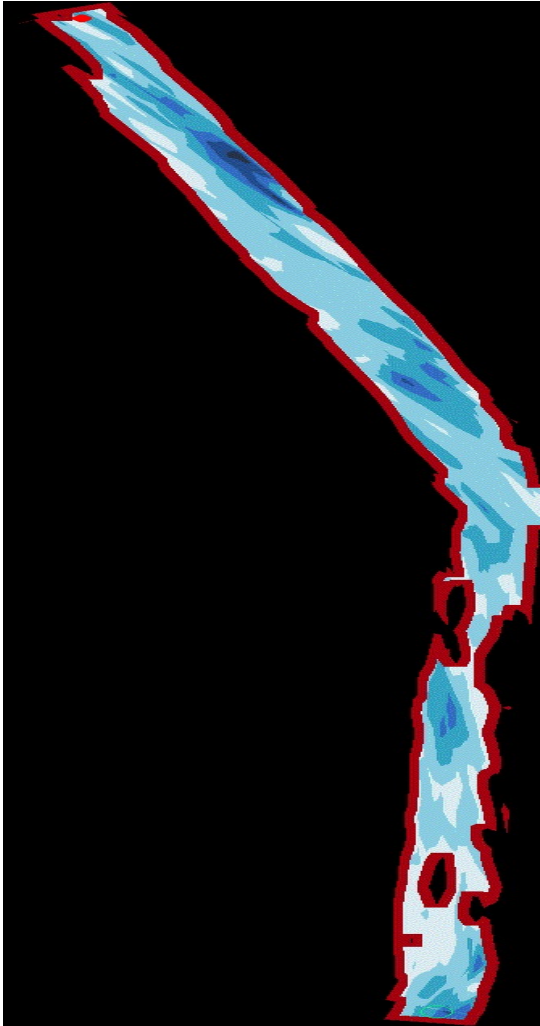


Both the National Channel Framework and eHydro are essential in order to establish any meaningful measure of overall portfolio availability.

Enhanced Channel Availability



Enhanced Channel Availability



Navigability Analysis Overview

- **Explore feasibility of vessels transiting navigation channel**
 - Approximate vessel dimensions using AIS traffic data
 - Constrain pathfinding based on turning restrictions and proximity to shoals
 - If pathfinding can route start → end goal, channel is available
- **Results**
 - Better agreement with real world observations compared to previous method
 - New channel availability permits routing around shoals with enough clearance

INFLUENCE OF NCF REACH SEGMENTATION

We have no way of knowing how the existing NCF segmentation affects the overall % available results → we can't meaningfully gage portfolio availability this way!

Tampa Entrance Channel Example

Reach # = 4
Availability = 75% ,

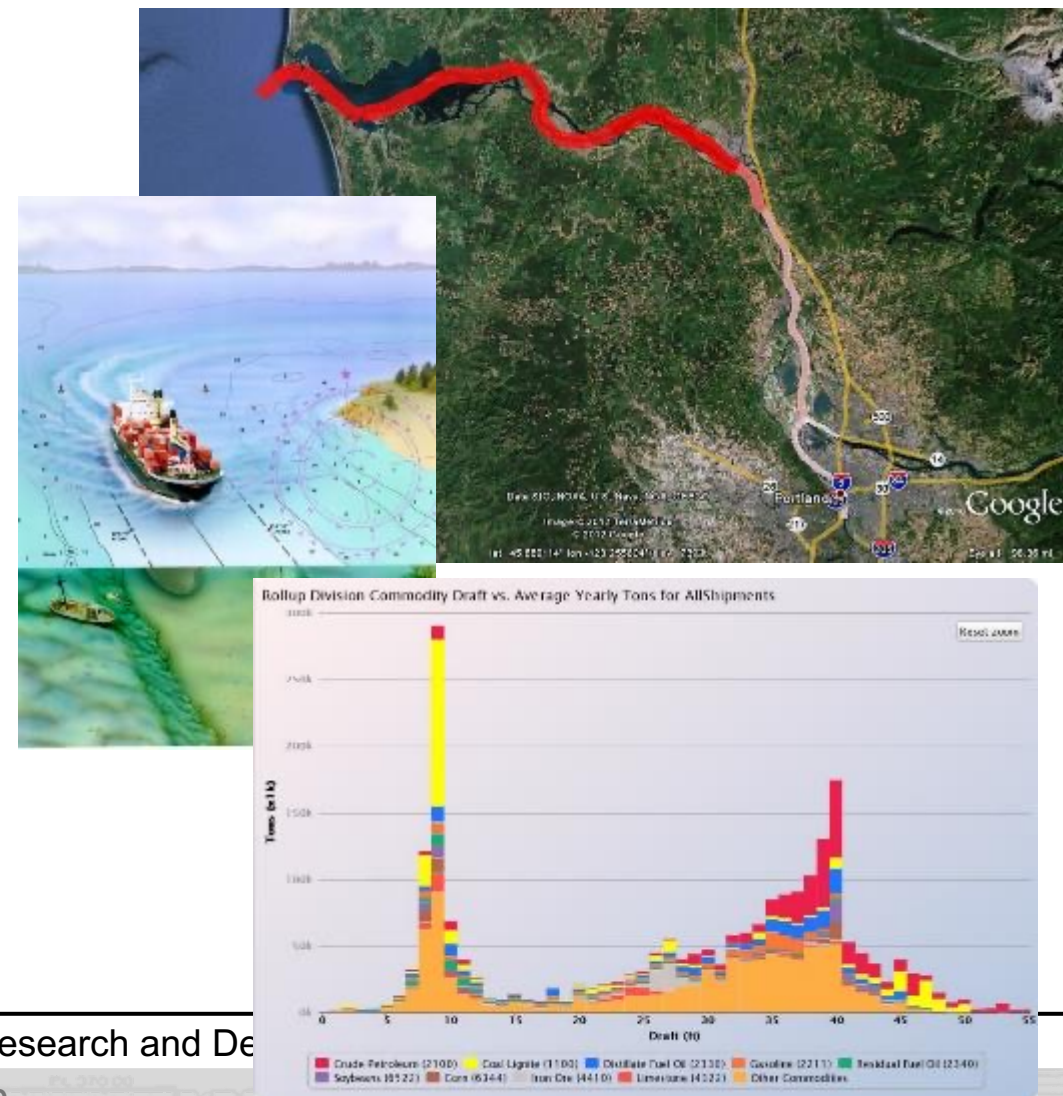
shoal

Channel Profile

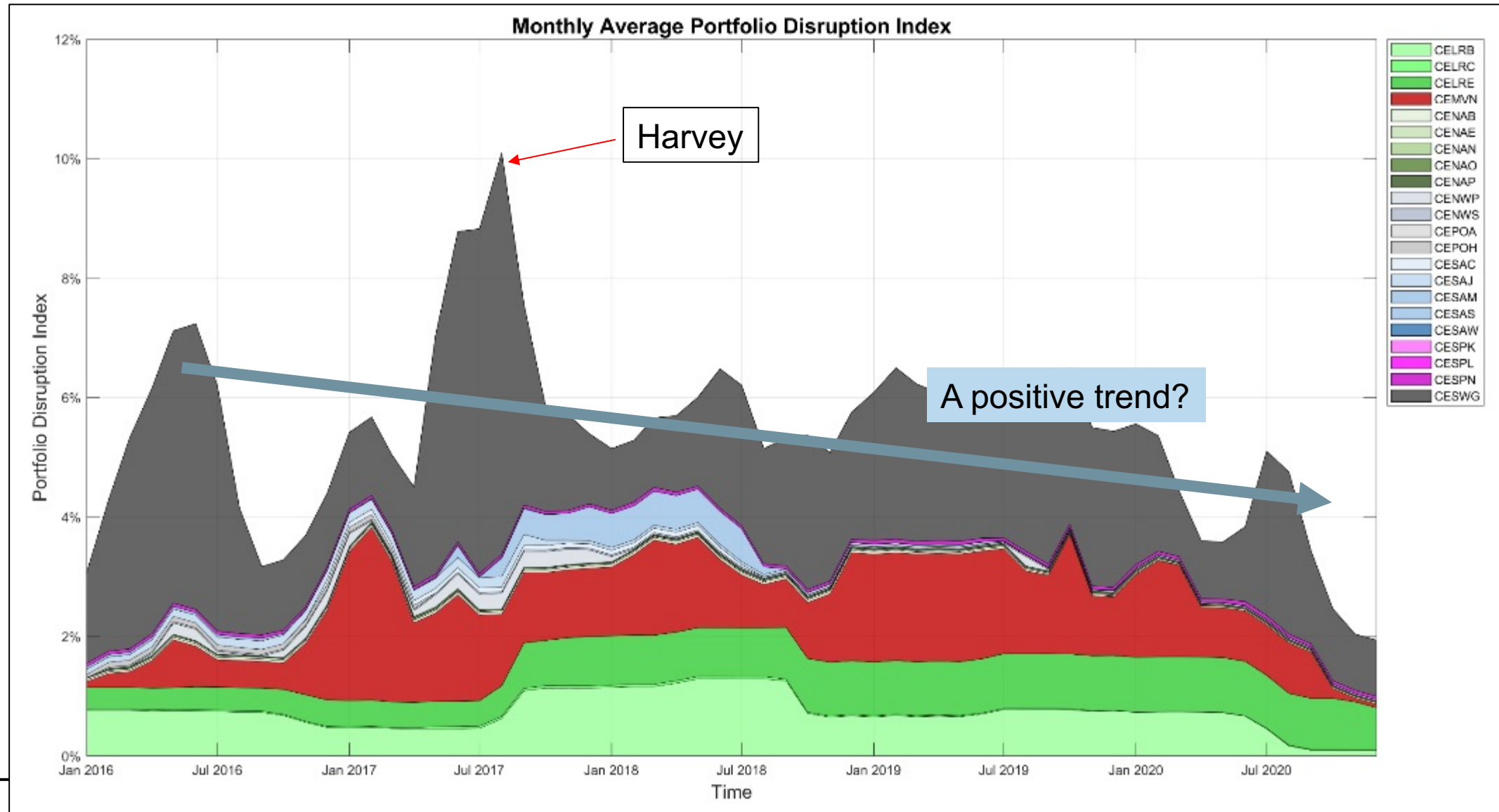
Basemap

New Approach for Defining Availability

- Repurpose the cargo tonnage network flow capability developed for the Selection Optimization model.
- Understands the more significant impact of shoals at high-use, bottleneck reaches relative to those at lower-use locations.
- Channel availability now defined in terms of the % of typical cargo flows that can move without disruption.



Revised Portfolio Availability Trends



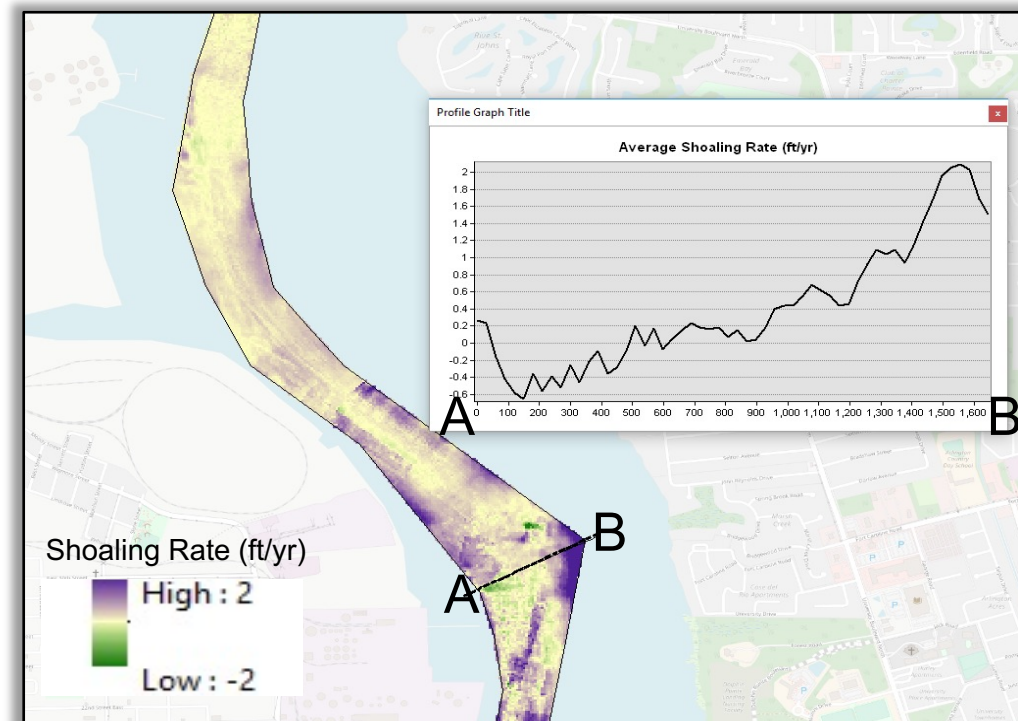
Summary

Successes:

- Analysis of vast collections of enterprise survey data to help better understand the shoaling rate conditions in navigation channels
- Data fusion of hydrographic surveys and dredging records affords decision makers additional perspectives of past dredging activity
- Enhanced channel availability approach represents actual channel conditions better than existing methods

Benefits:

- Products have potential to reduce O&M costs for maintenance of navigation channels.



Questions?

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