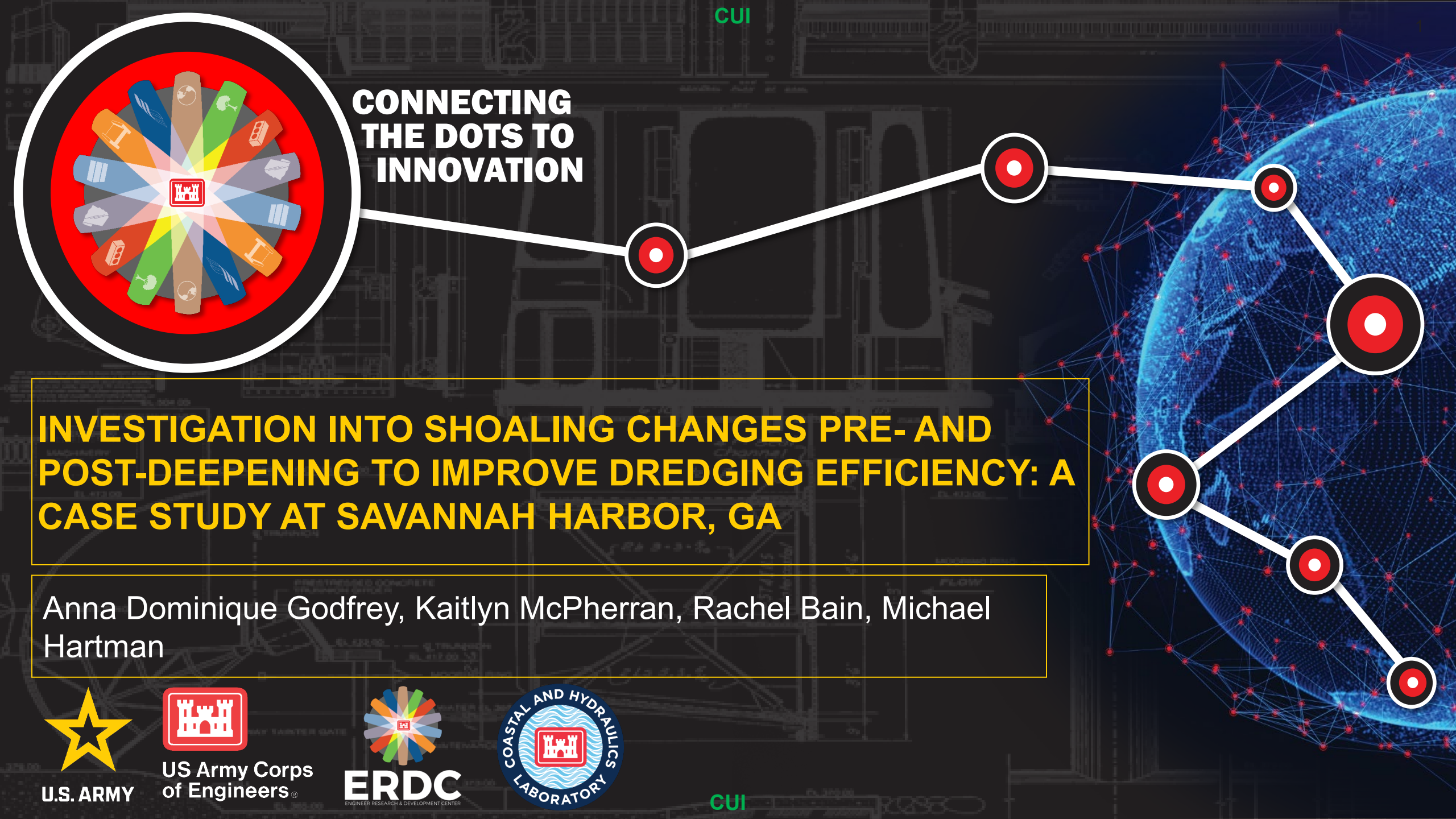
CONNECTING THE DOTS TO INNOVATION



INVESTIGATION INTO SHOALING CHANGES PRE- AND POST-DEEPENING TO IMPROVE DREDGING EFFICIENCY: A CASE STUDY AT SAVANNAH HARBOR, GA

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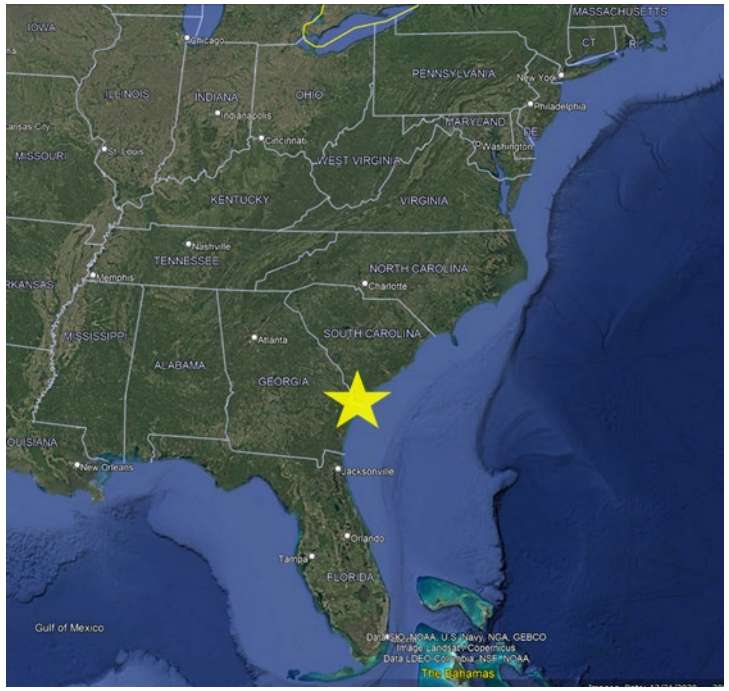
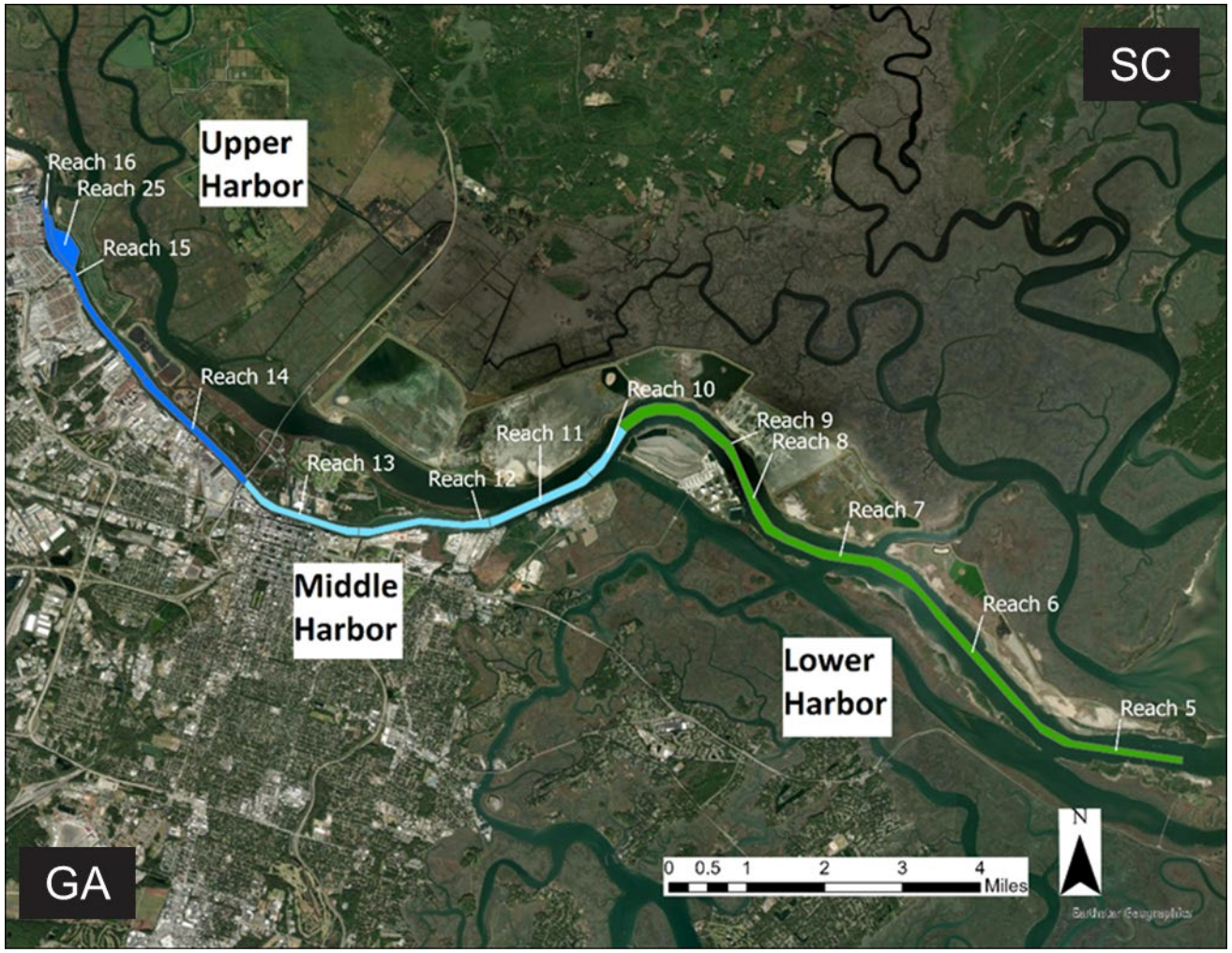
INTRODUCTION

SAVANNAH HARBOR

- Major deep-water port
- Primarily silty and sandy material in harbor
- Savannah Harbor Expansion Project (SHEP) 2022
- Did shoaling increase post-deepening?

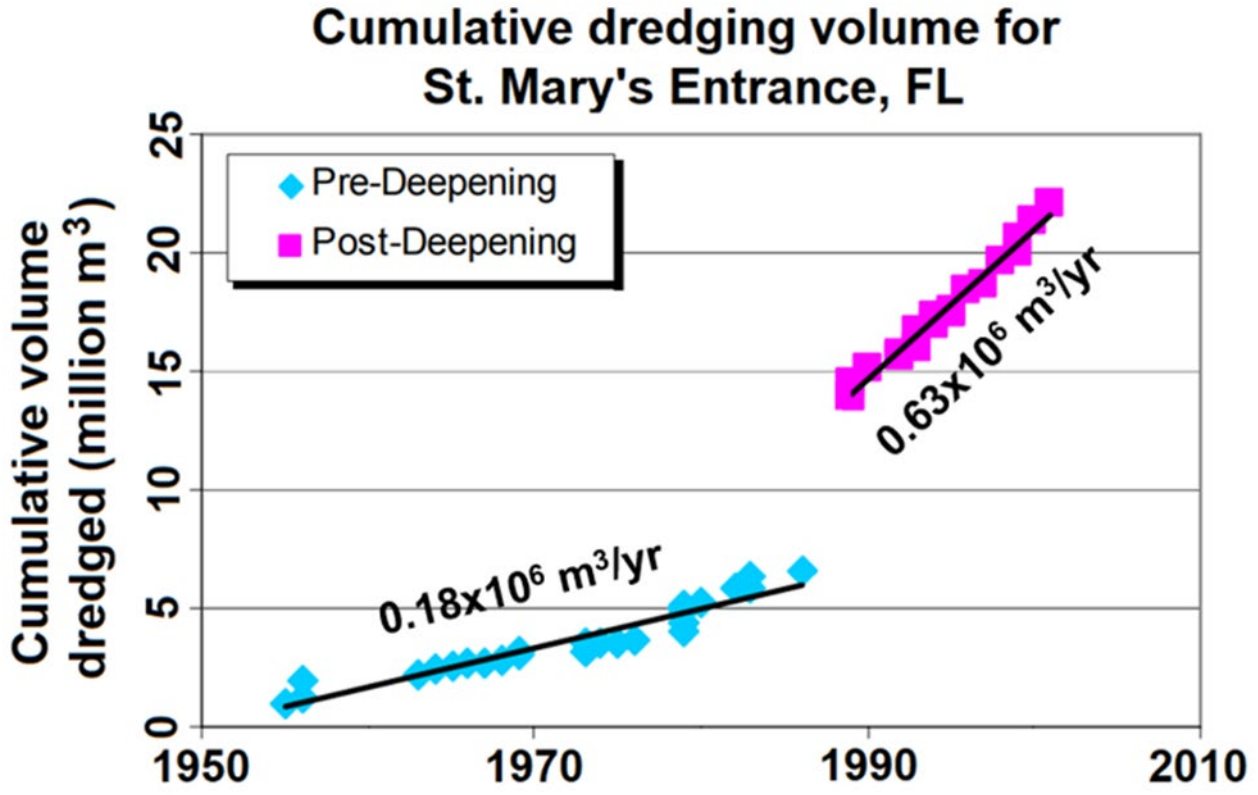




Sections of and National Channel Framework reaches of Savannah Harbor, Georgia discussed in this study.

DOES DEEPENING INCREASE SHOALING?

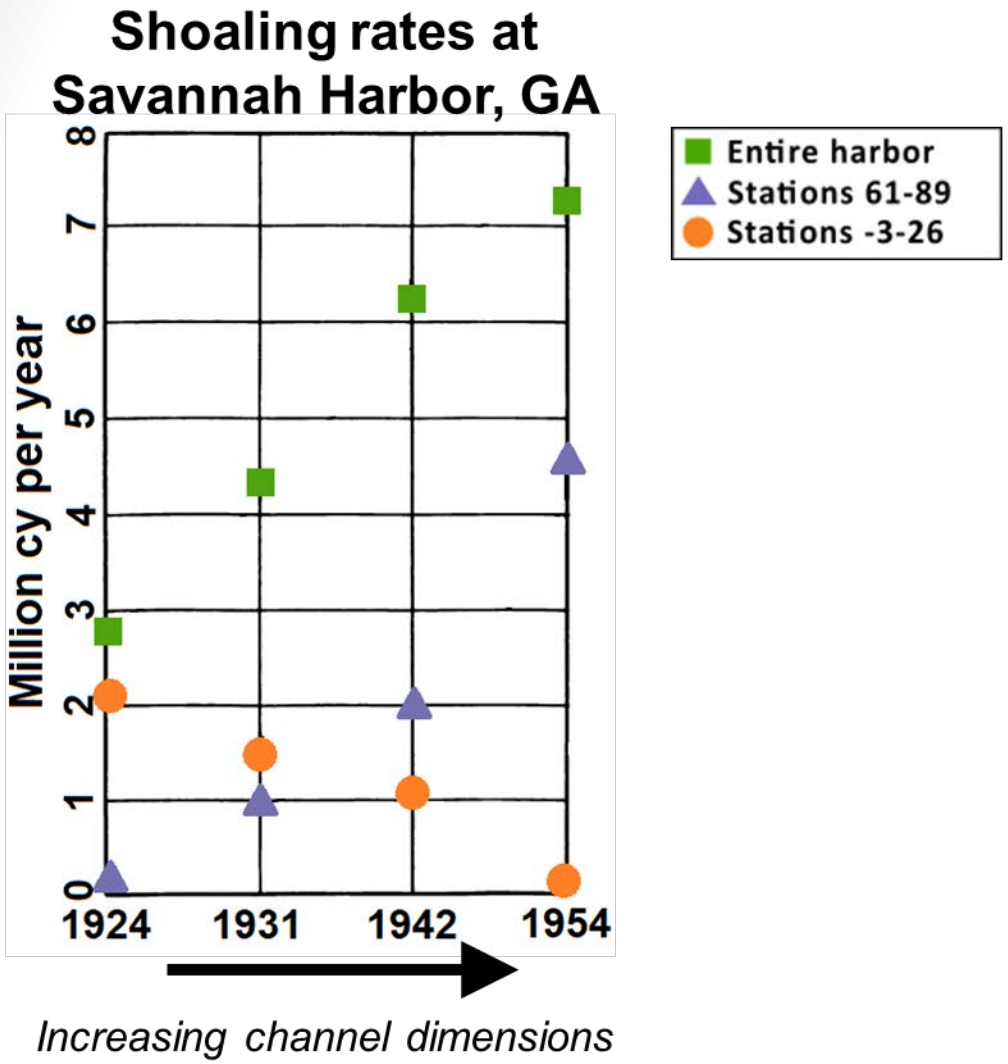
- Widely held assumption that deepening a harbor will lead to increased shoaling
  - Oftentimes, this is the case (ex: Rosati, 2005)



Cumulative dredge volumes pre- and post-deepening in St. Mary's Entrance FL. Figure from Rosati (2005).

HOW DOES DEEPENING AFFECT SHOALING?

- Is this the case everywhere all the time?



Left: Shoaling rates for Savannah Harbor (green), only the upper harbor (purple) and only the lower harbor (orange). Right: Savannah upper harbor (purple) and lower harbor (orange). Data from Simmons (1965). Figures modified from Bain et al., 2024.

WHY DOES IT MATTER?

Savannah Harbor:

- 500k jobs, $33B in income, $2B in taxes in GA and SC (USACE SAS, 2019)
- Top 10 harbors with highest levels of historic shoaling (USACE-HQ, 2021)
- ~5 Mcy/yr to maintain channel (1923-1993) (SHLTMS, 1996)

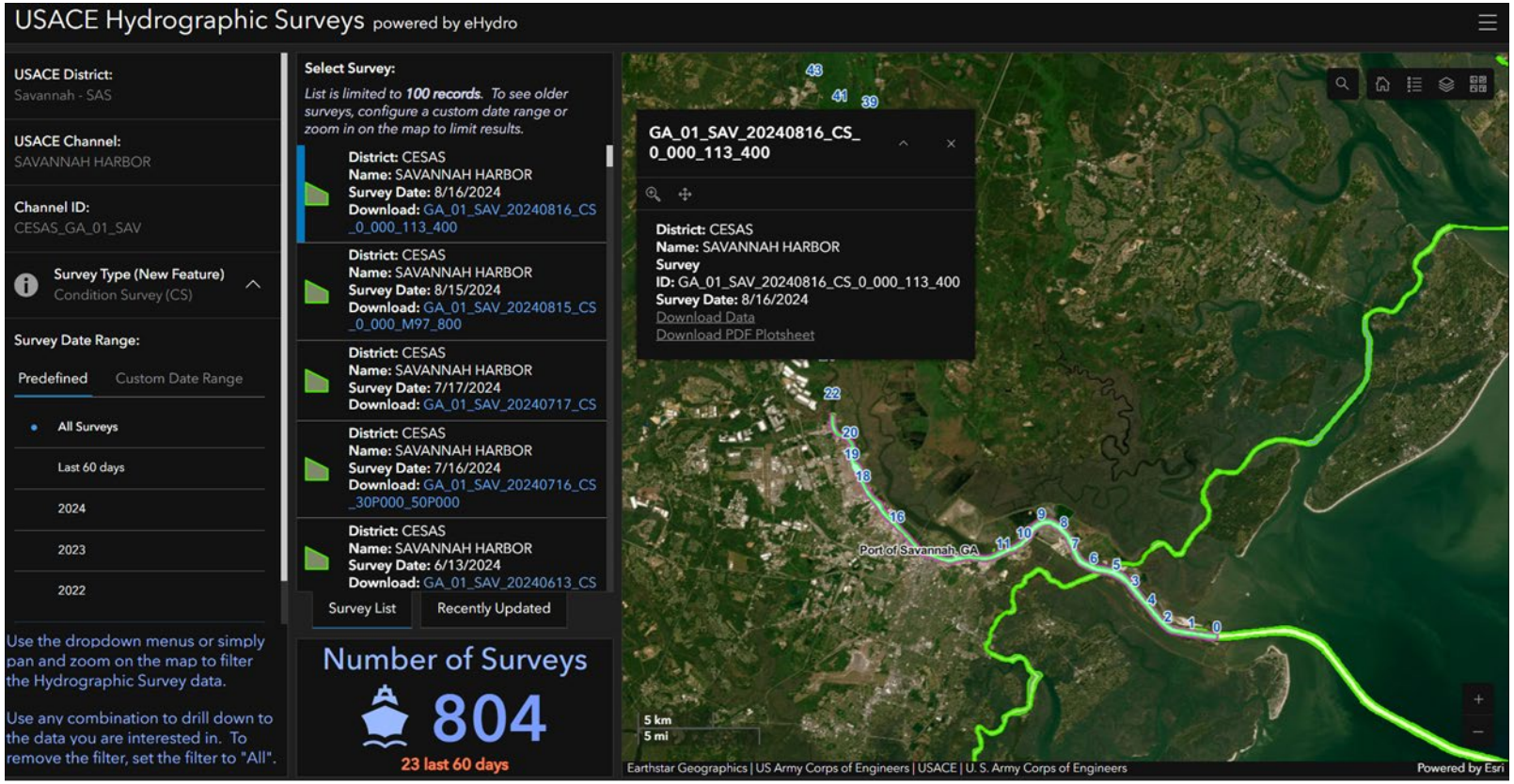
Goals:

- Improve dredging efficiency
- Reduce O&M costs
- Use 70% of dredge material beneficially by 2030

Need estimation of increased dredging maintenance volumes and dredging cycle for the deepened channel

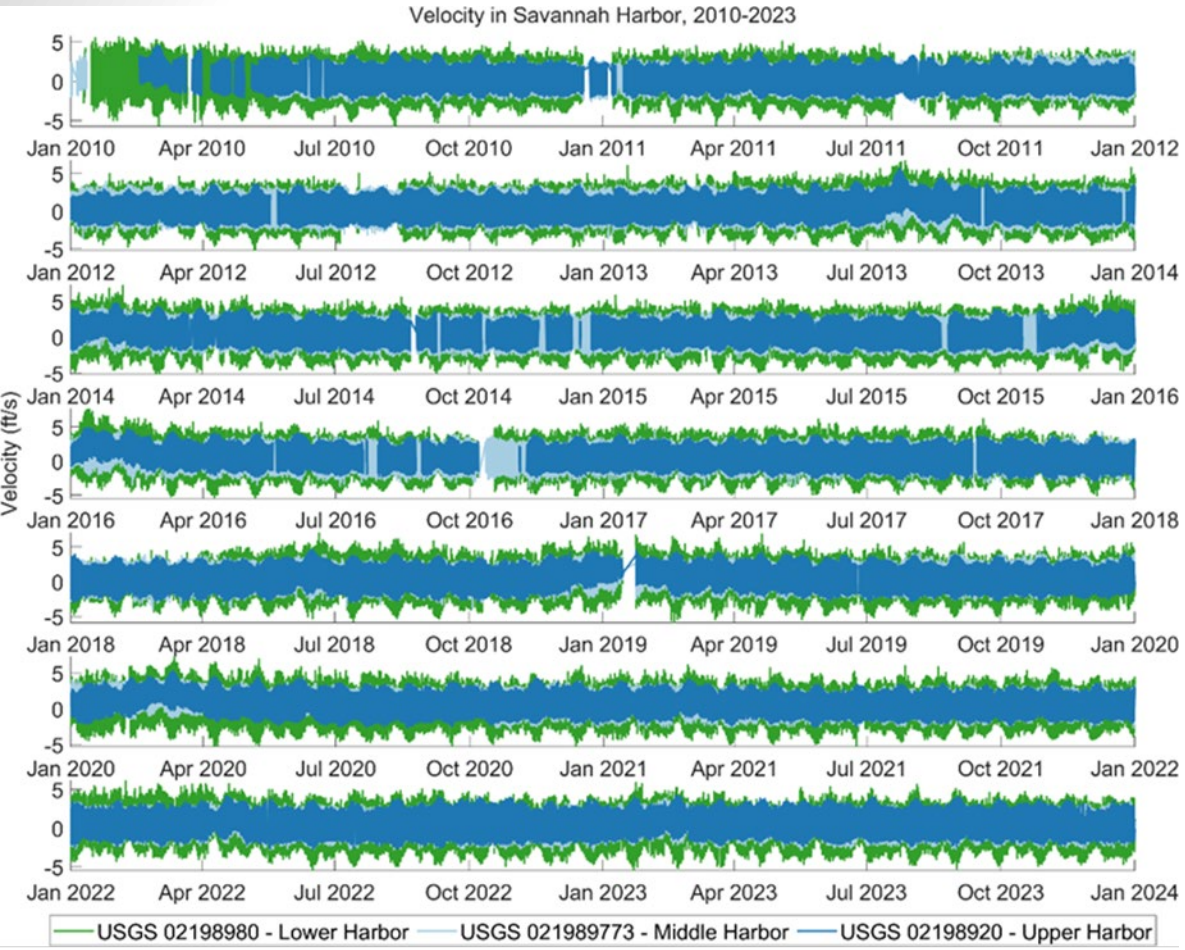
AVAILABLE DATA

- Historical Reports
- Historic Dredging Volumes
- District Hydrographic Surveys (eHydro)
- USGS Water Monitoring Gage Data
- Historic Sediment Data

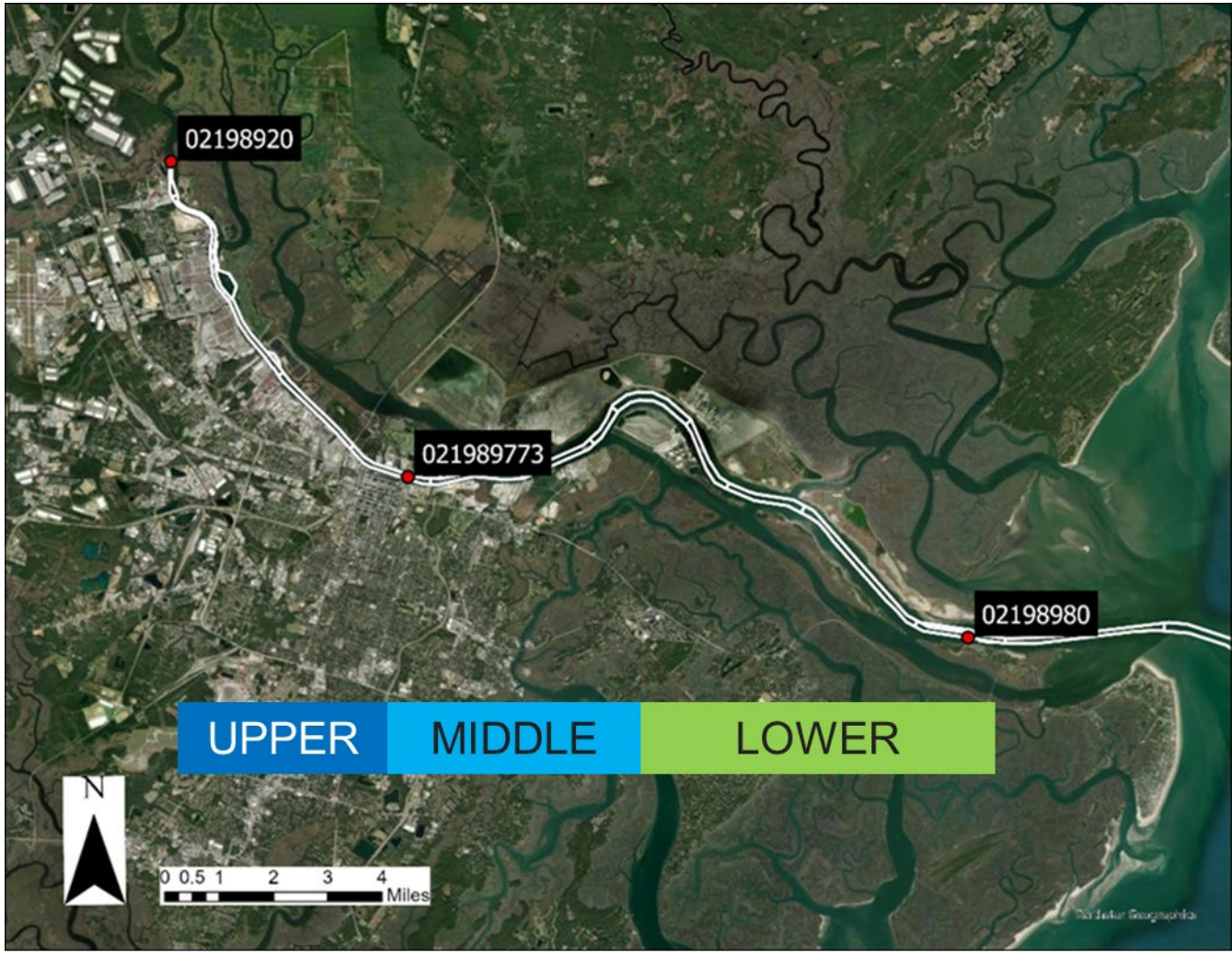


USACE eHydro webtool for accessing District hydrographic channel survey data.

WATER DATA



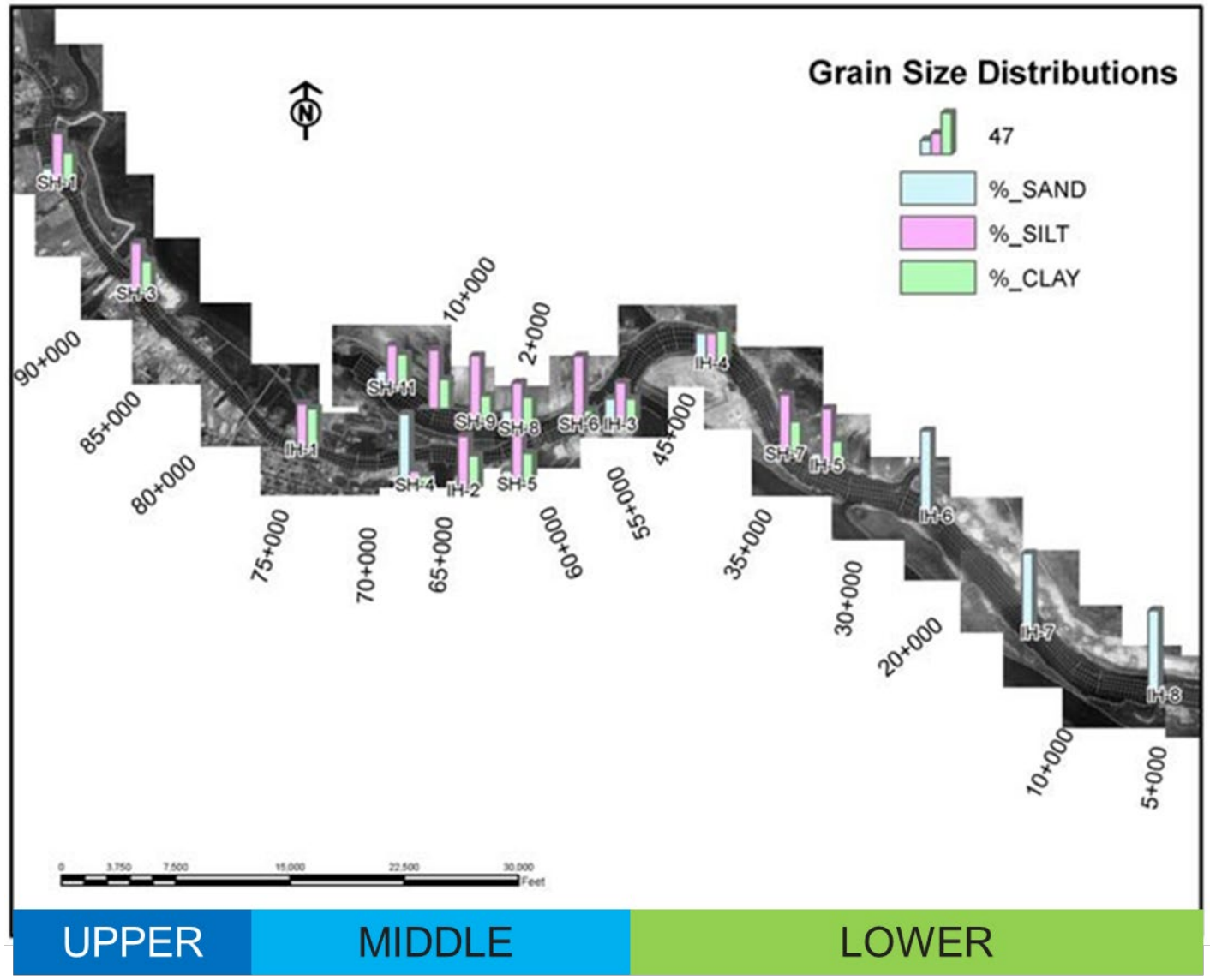
Flow velocities in Savannah Harbor (ft/s) (2010-2024).



USGS water monitoring gage station locations.

SEDIMENT DATA

- Upper and middle harbor have high silt and clay content
  - Remains suspended as fluid mud (low density shoal)
  - Fluid mud layer may be pushed upstream by deepening
- Lower harbor is primarily sandy
  - Imported by flood tidal currents



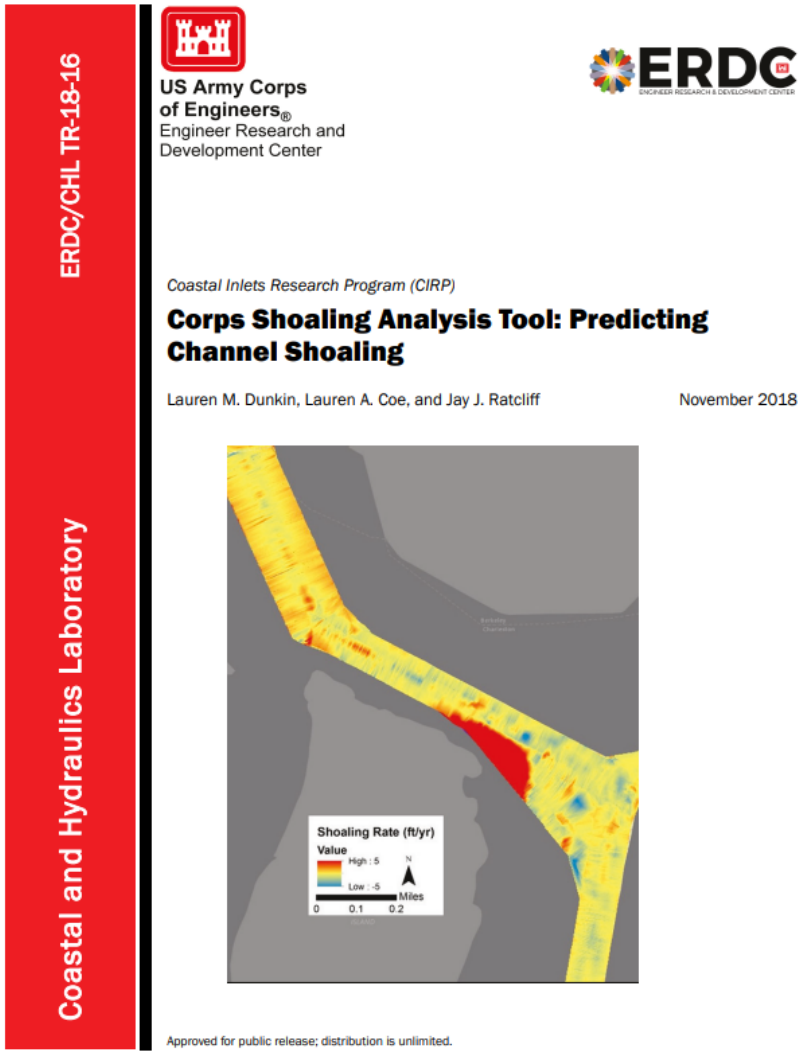
Grain size distributions for Savannah Harbor (Figure from Sedimentation Analysis, 2009).

ANALYSES

CORPS SHOALING ANALYSIS TOOL (CSAT)

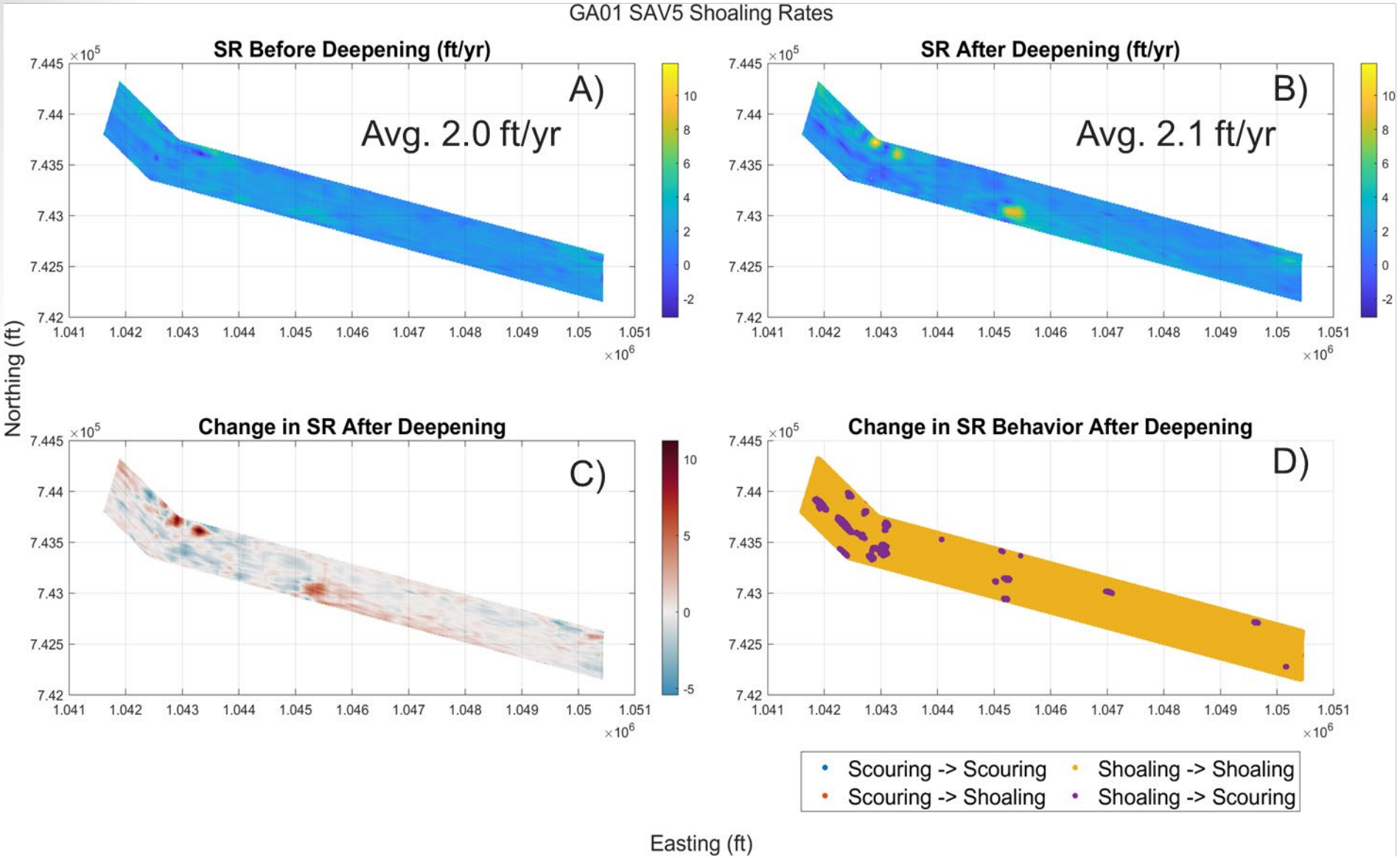
- Hindcast algorithm
- Calculates shoaling rates and volumes using historical channel surveys (eHydro)
- Uses shoaling rates to predict future dredging volumes
- Shoaling rate grids can be used to identify hot spots

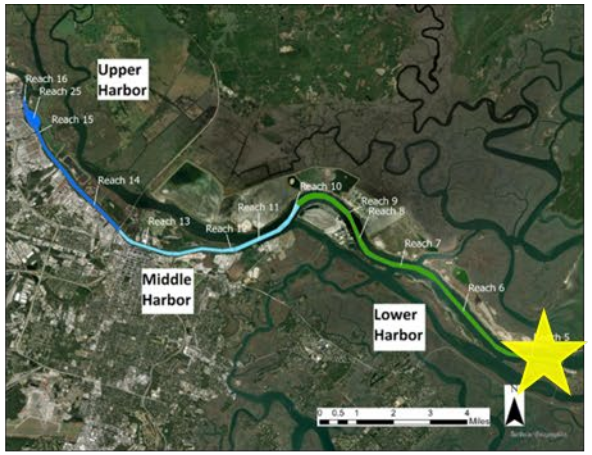
- In this study
  - Calculated shoaling rates by NCF reach pre- and post-deepening



https://cirp.usace.army.mil/products/csat.php

CSAT, LOWER REACH

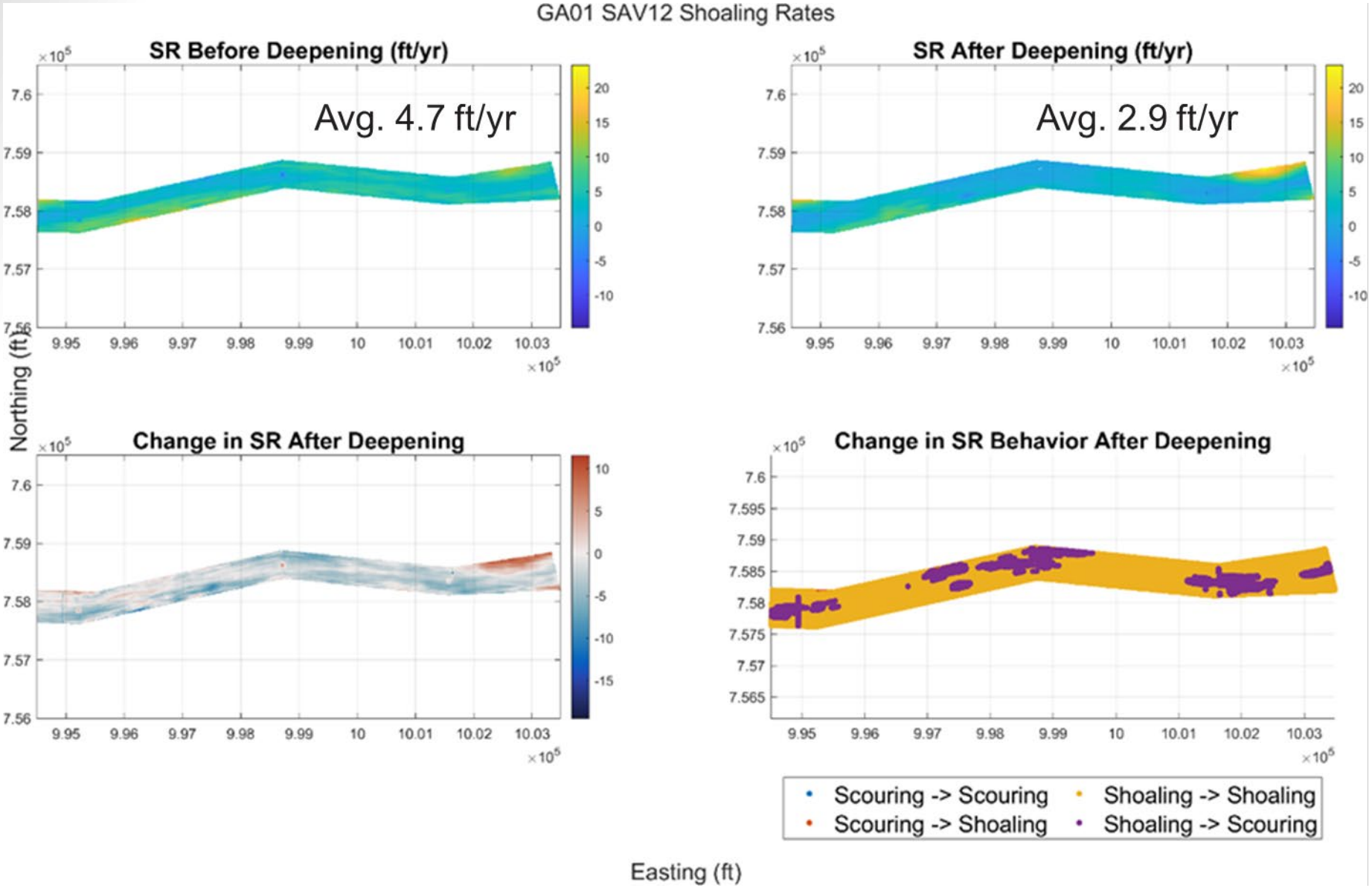


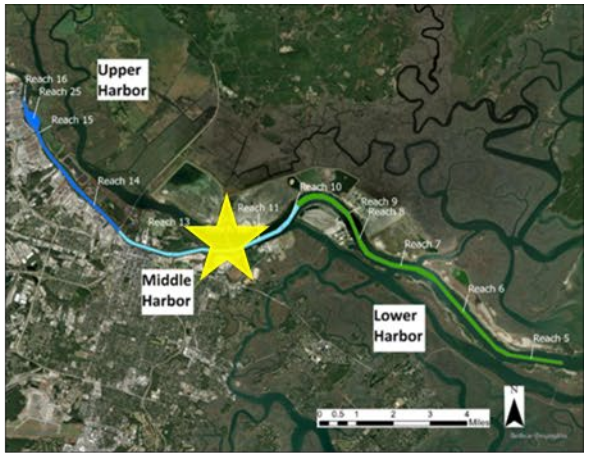


LOWER

Shoaling rates in Reach 5 (Lower Harbor) before (A) and after (B) deepening. Change in shoaling rate after deepening (C). (D) Change in shoaling behavior after deepening.

CSAT, MIDDLE REACH

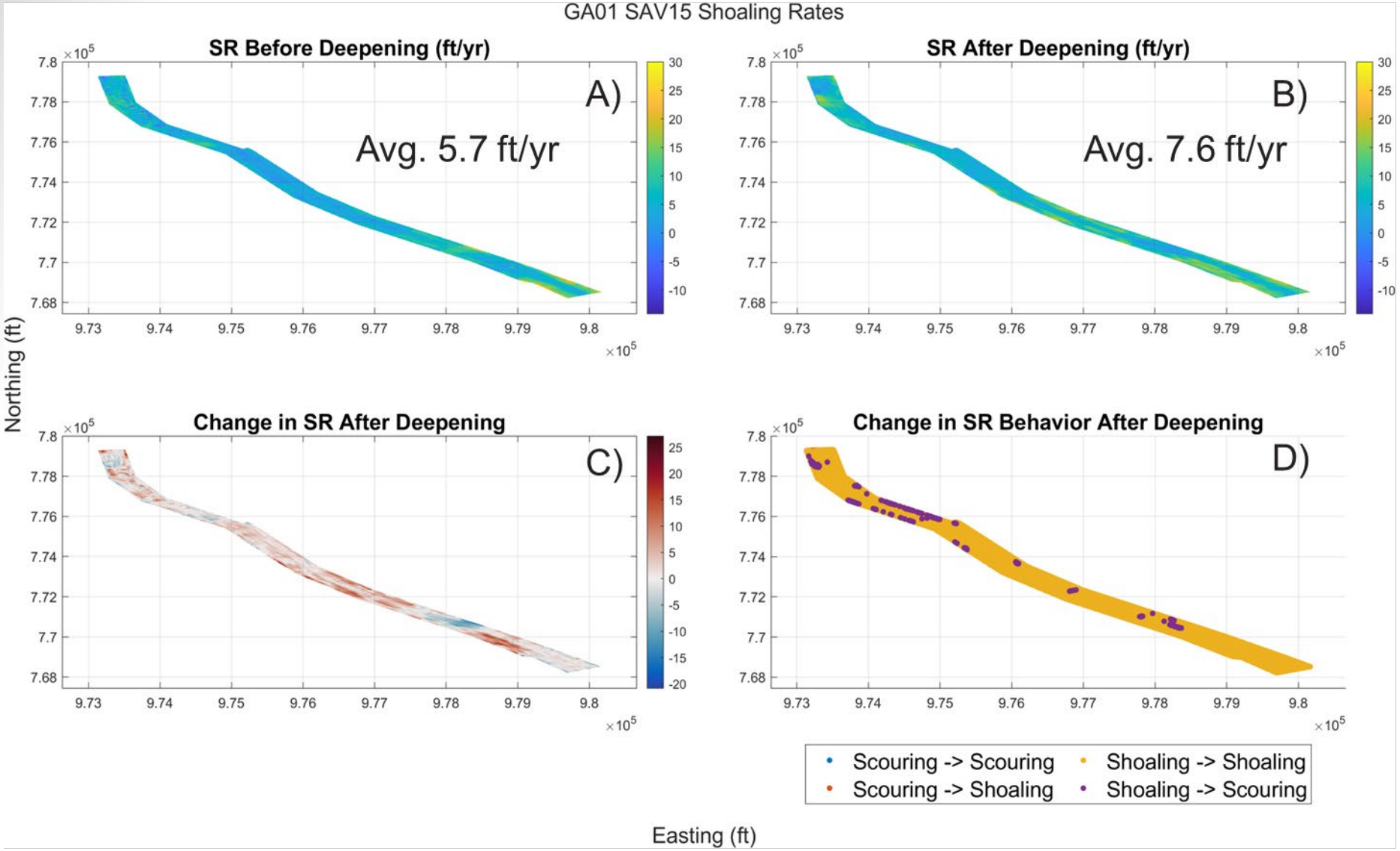


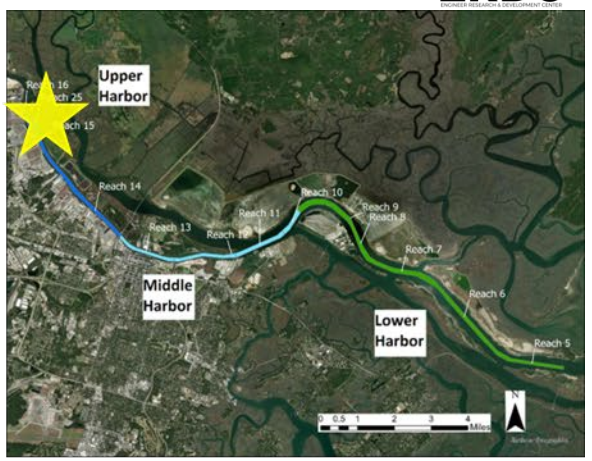


MIDDLE

Shoaling rates in Reach 12 (Middle Harbor) before (A) and after (B) deepening. Change in shoaling rate after deepening (C). (D) Change in shoaling behavior after deepening.

CSAT, UPPER REACH



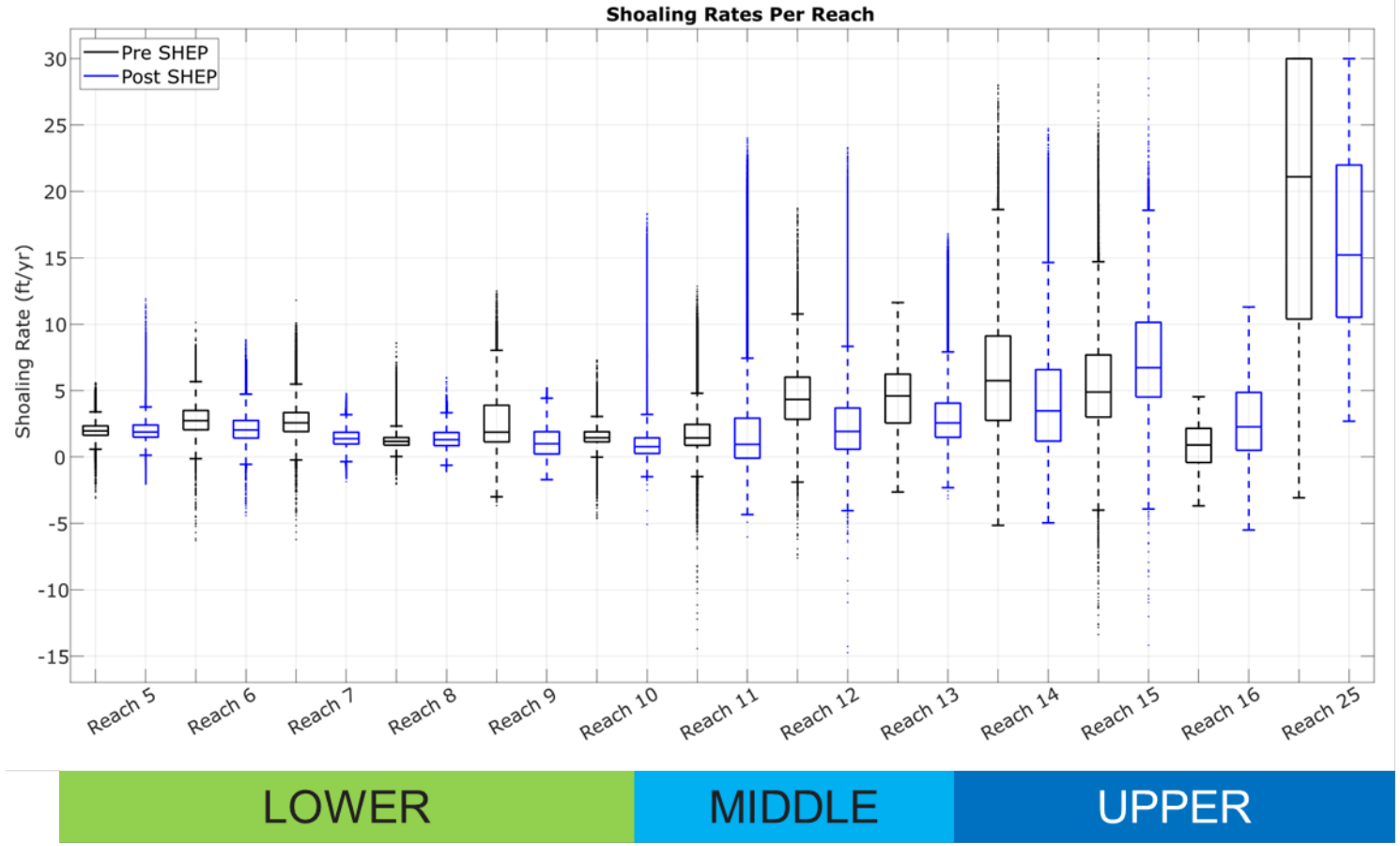


UPPER

Shoaling rates in Reach 15 (Upper Harbor) before (A) and after (B) deepening. Change in shoaling rate after deepening (C). (D) Change in shoaling behavior after deepening.

SHOALING RATES PER REACH

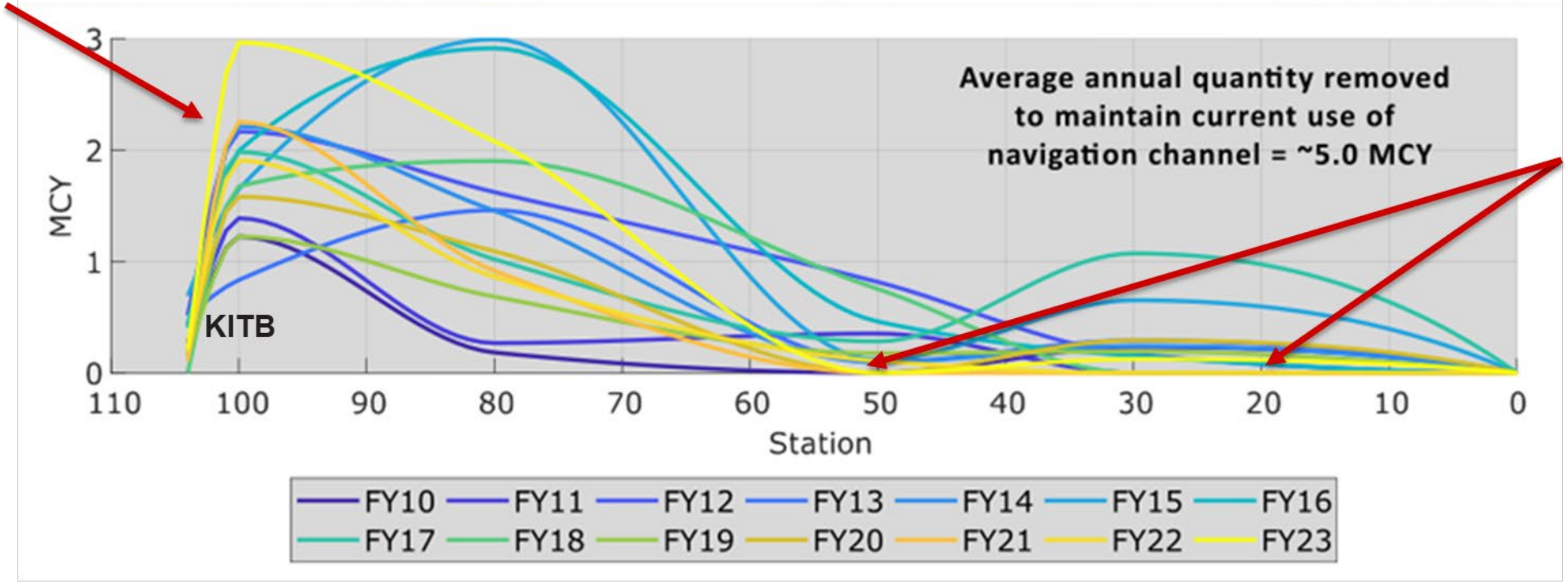
- Variability (range of shoaling rates) increases upstream
  - Especially post-SHEP
  - Reaches 5, 8, 10-12, 15, and 16
- Median increased post-SHEP
  - Reaches 8, 15, 16
- Positively skewed
  - Especially post-SHEP
  - Reaches 5, 6, 8-16, and 25



Shoaling rate change per reach pre- and post-deepening. The boxes are the 25th, 50th, and 75th percentile of all shoaling rates calculated within a reach, and the whiskers represent the minimum and maximum value within 1.5 times the interquartile range.

HISTORIC DREDGING VOLUMES

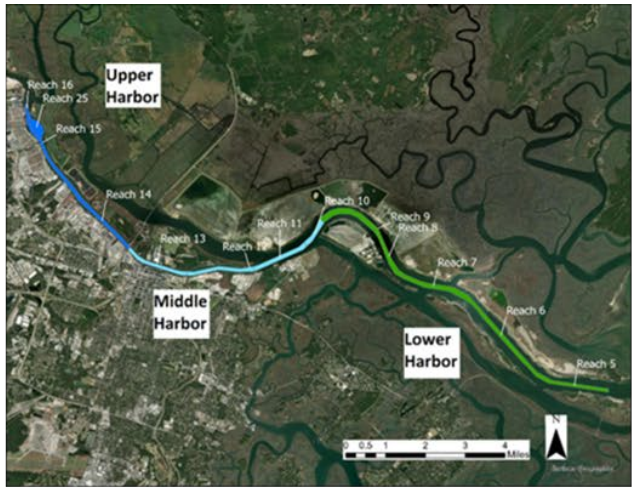
KITB acts as a sediment trap

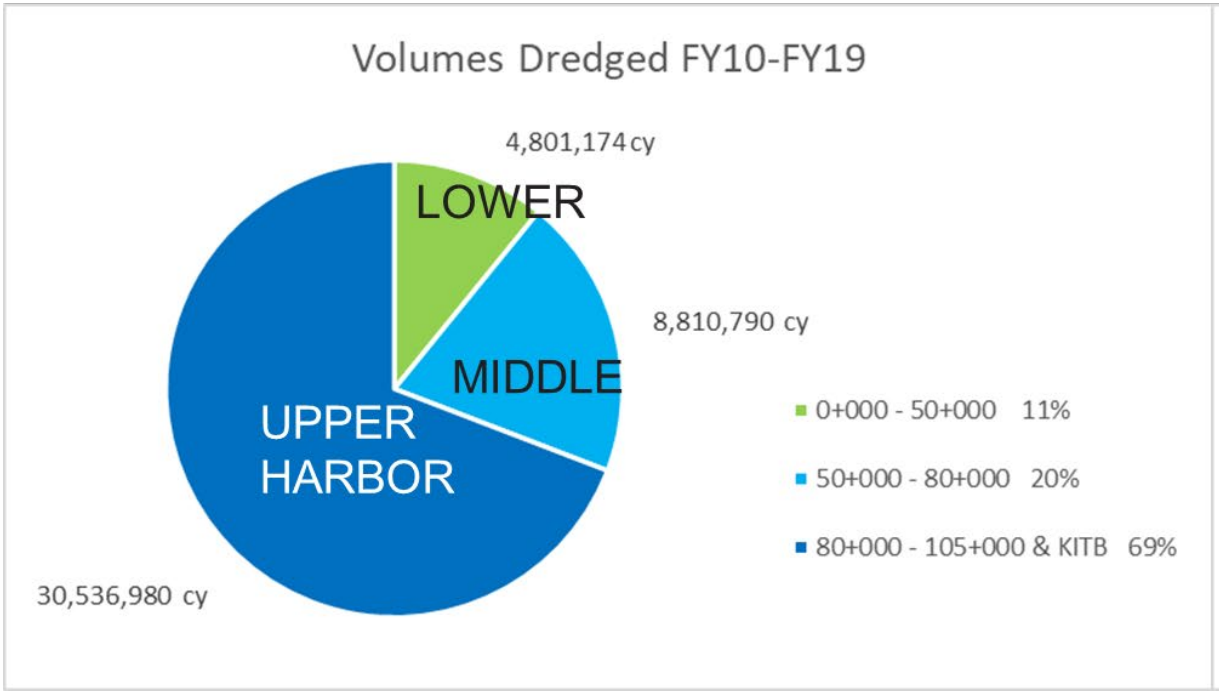


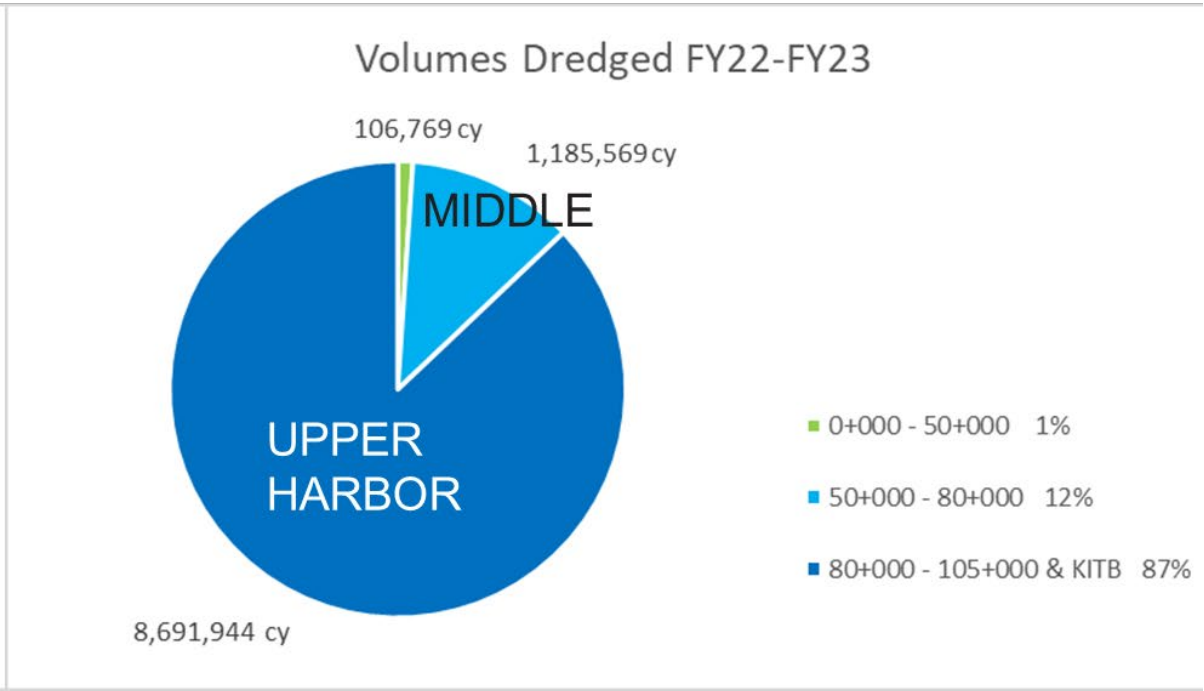
Decrease in dredging volumes in lower and middle harbor

Dredge volumes (MCY) along Savannah Harbor by fiscal year.

HISTORIC DREDGING VOLUMES, CONT.

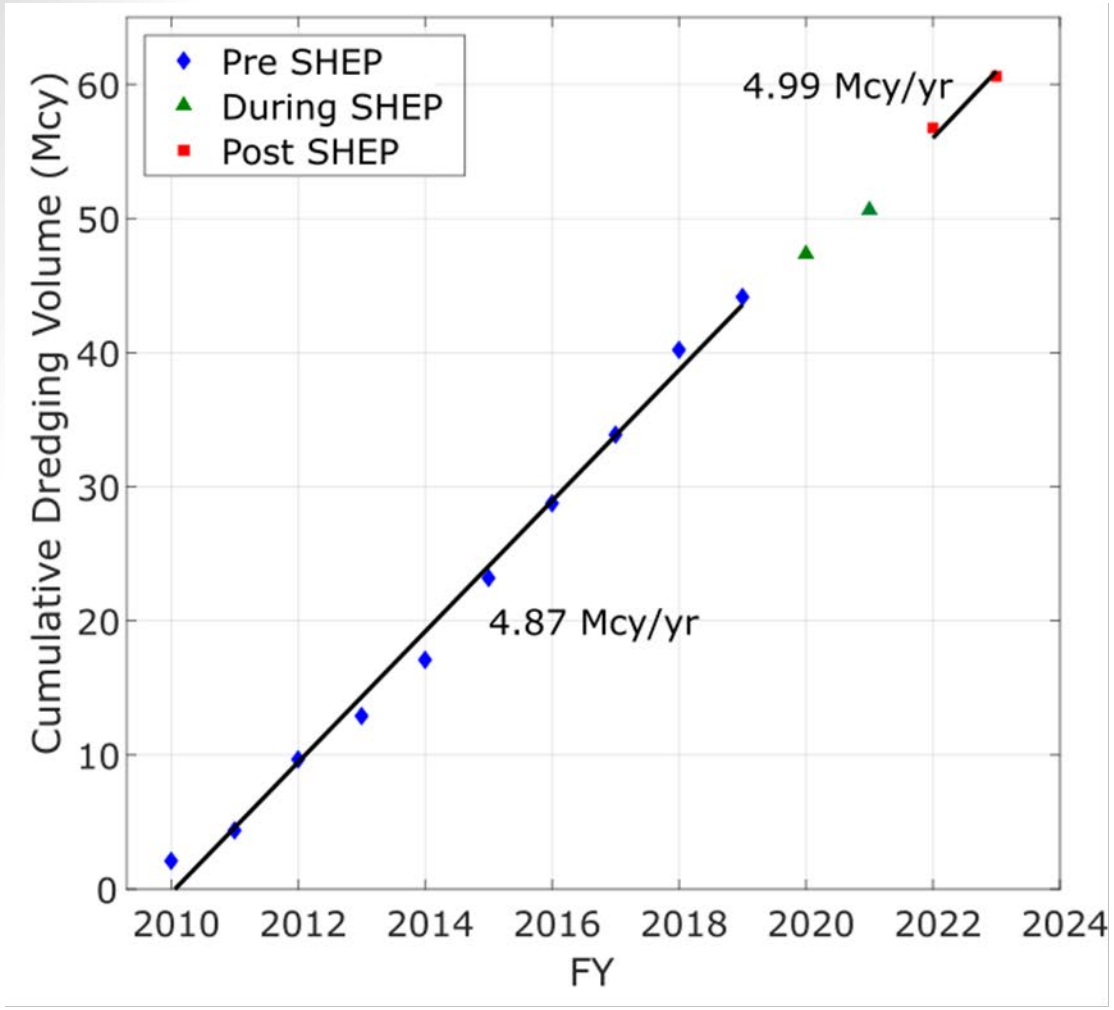




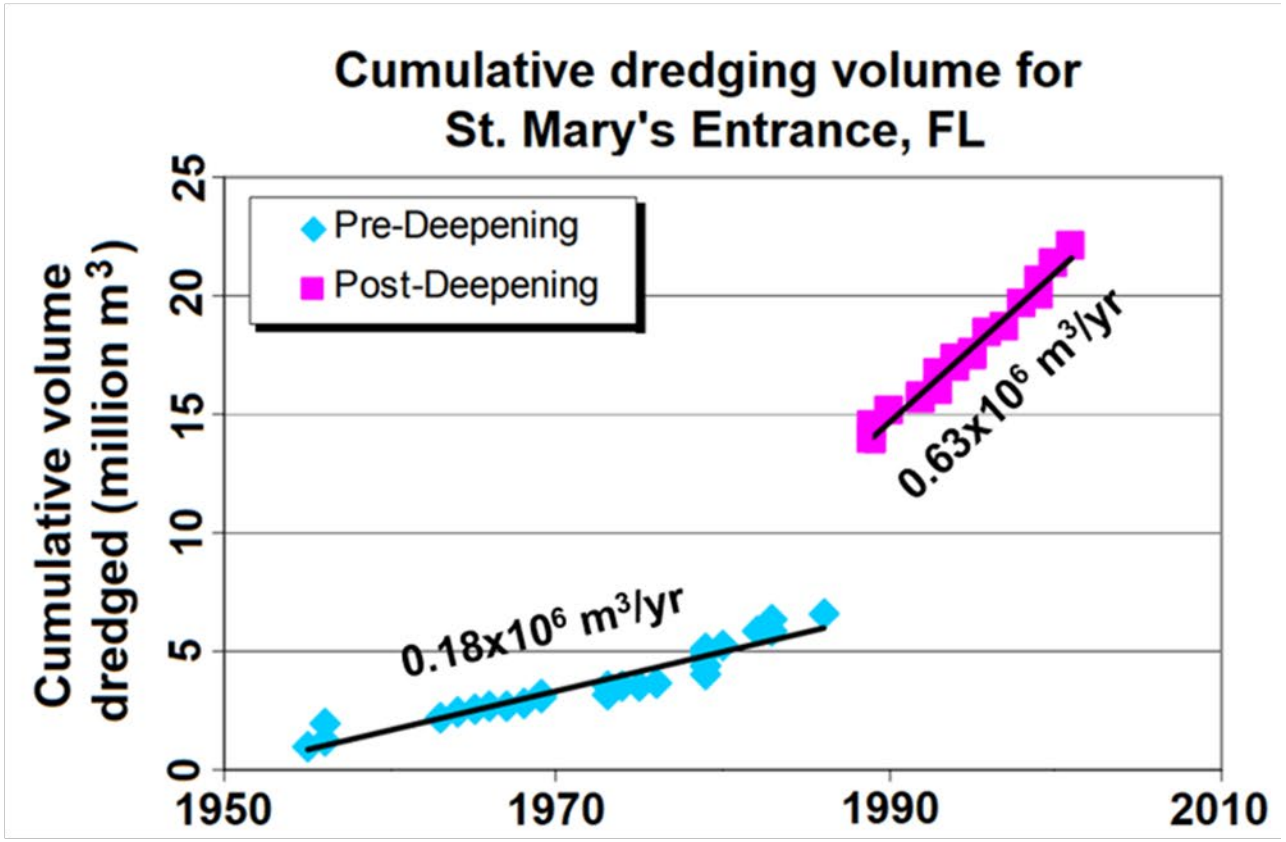


Volumes dredged by harbor section (upper, middle, lower) before (left) and after (right) deepening. FY20 and FY21 are not included as the channel was in process of being deepened.

DREDGING VOLUMES



Cumulative dredging volumes (million cubic yards per year) for Savannah Harbor. A linear trend line has been fitted to the pre- and post-SHEP data. The slopes of the lines are indicated.



Cumulative dredging volumes (million cubic yards per year) for St. Mary's Entrance, FL. A linear trend line has been fitted to the pre- and post-deepening data. The slopes of the lines are indicated.

2.45% increase (left) vs 250% increase (right)

CONCLUSIONS

- Dredging rates have only increased 2.45% post-deepening
  - Major increase in dredging volumes in the upper harbor specifically

- Overall shoaling rates have not increased significantly
  - Shoaling patterns within Savannah Harbor have changed, with more shoaling occurring in the upper harbor and less in the middle and lower harbor
  - Specific hydrodynamic and geomorphologic processes driving these smaller scale changes are not well understood in Savannah Harbor

- New equilibrium?

- Potential future work
  - Salinity intrusion and fluid mud study
  - More data collection post-deepening
  - Entrance channel – lengthened (not enough pre-SHEP survey data)
  - Effects of ship wakes on sedimentation patterns

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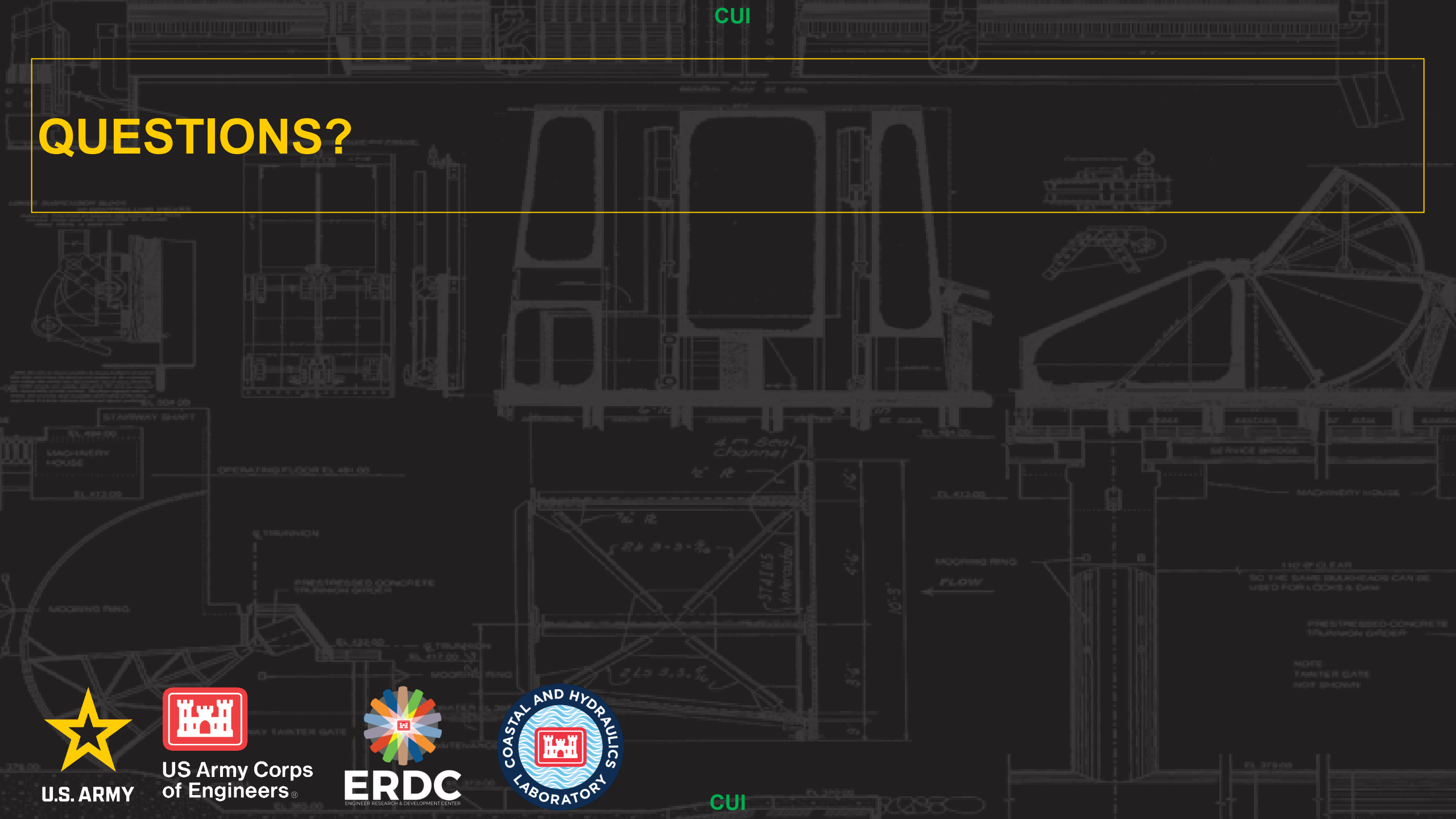
QUESTIONS?



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