



U.S. ARMY

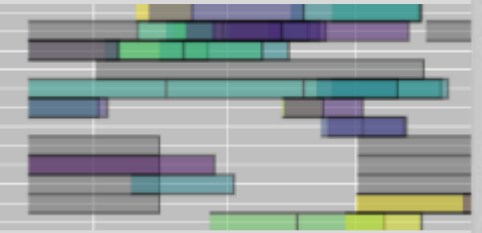
Research Applications for Improving Navigation

Dr. Ned Mitchell
ERDC Coastal and Hydraulics Lab

AAPA Harbors and Navigation Committee Meeting
10 NOV 2022



- Atchafalaya River CDR #1-21
- Atchafalaya Bar Channel HDR #1-20
- Atchafalaya River Miles 17-36 & Devil's Elbow
- Atchafalaya Bar Channels CDR #3-21
- Atchafalaya River Southwest Pass CDR #1-21
- Atchafalaya River Southwest Pass HDR #3-21
- Atchafalaya River Southwest Pass HDR #4-21
- 24 Cutterhead Tenn-Tom
- 24 Cutterhead BW&T
- 24 Cutterhead Biloxi
- 24 Cutterhead GTWW
- MATOC: Ouachita/Black R



US Army Corps of Engineers

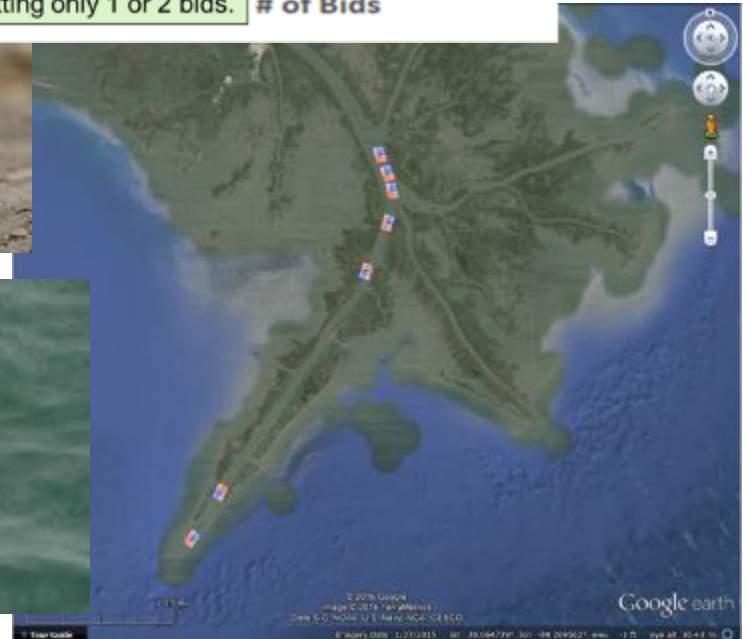
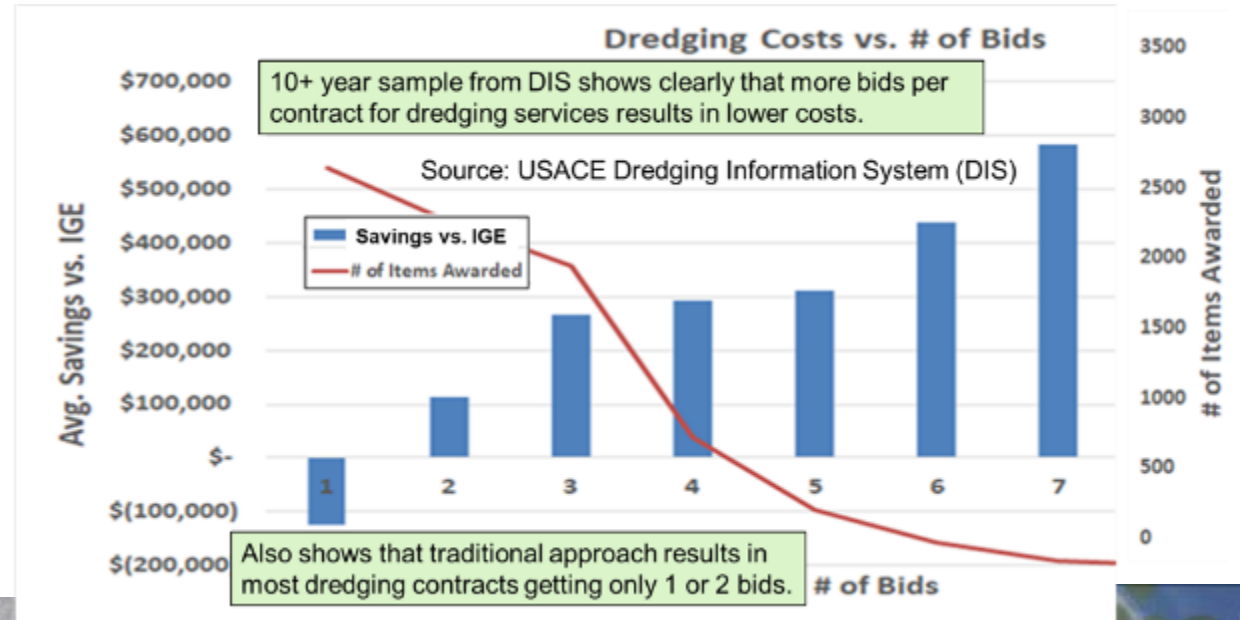


EL 379.00

NEED STATEMENT

- Limited U.S. fleet of hopper and ocean-certified pipeline dredges
- Low # of bids on most dredging contracts → higher costs
- Very little margin for error within overall schedule; small delays can lead to major, cascading disruptions across the country
- Thousands of project-level environmental restrictions for dozens of species, applied incrementally through the decades
- Theoretical “fleet capacity” (# of plants x nominal production rates) does not capture the *When?* and the *Where?* parts of the dredging question.

Dredge Fleet Scheduling Optimization



PROJECT PLAN

Dredge Fleet Scheduling Optimization

What is it?

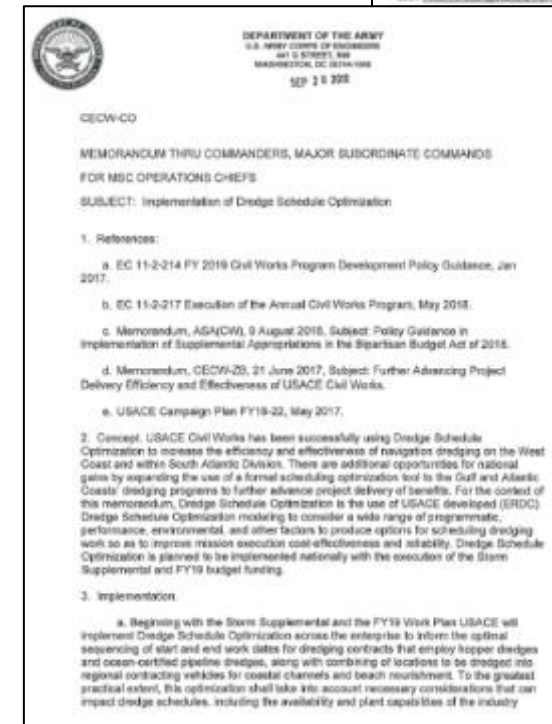
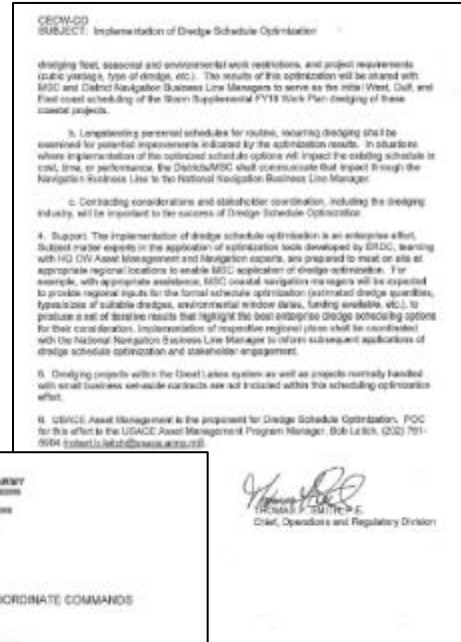
- Capability that assigns the fleet of dredges to specific projects and provides the sequencing of work so as to *maximize* overall productivity while complying with work restrictions and other constraints.

How does it do it?

- Compares project dredging requirements to dredge plant production rates and unit costs
- Considers work window durations relative to time required for specific dredge plants to do the work
- Explores combinations of assignments and sequencing and iterates towards most efficient work plan

Model output:

- Dredge fleet itineraries → minimized mob/demob distances
- Project groupings with regional contracting potential

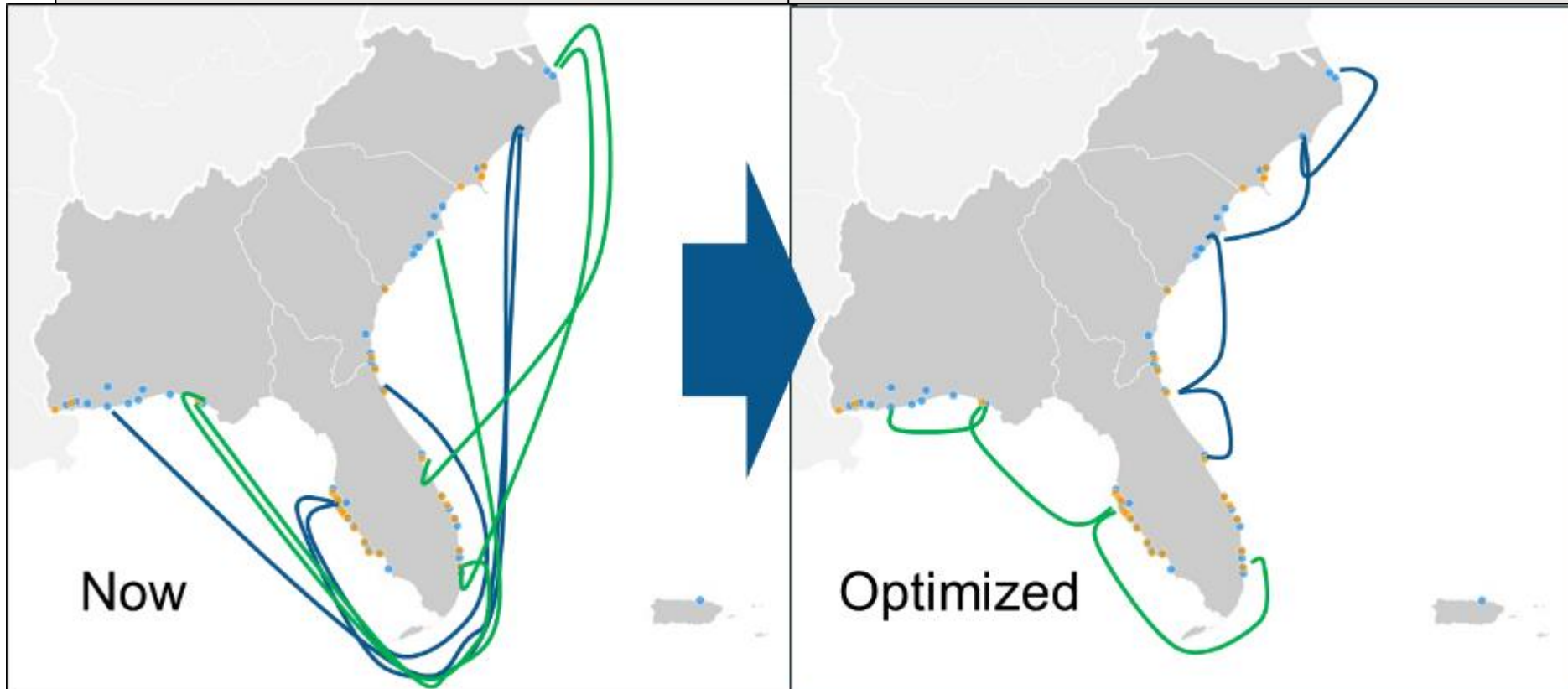


PROJECT PLAN

Dredge Fleet Scheduling Optimization

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

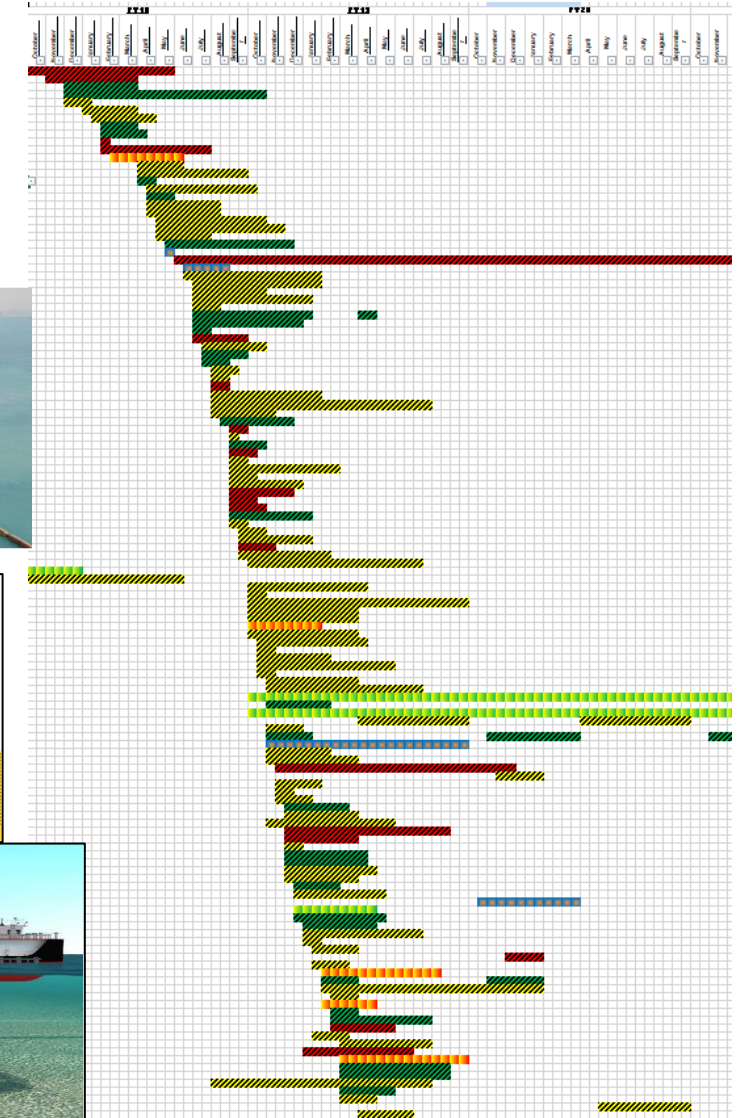
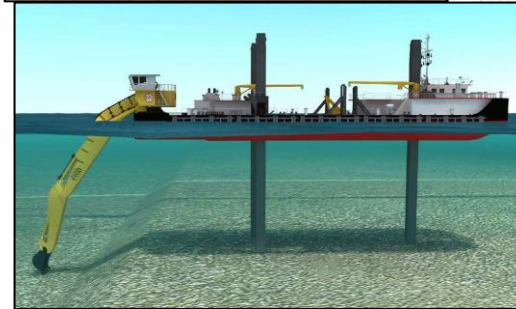
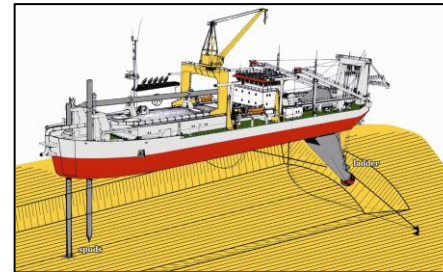
- Minimize mobilization costs → dredge more projects for same amount of funding and in less time
- Better align schedules with env. work windows and dredge plant capabilities



PROJECT PLAN

- Model seeks to dredge as much material as possible within 5-year time horizon → formulated as a job assignment/scheduling problem, solved via constraint programming using interval variables; IBM CPLEX software.
- Model Data Requirements:
 - Project dredging requirements (CY min/max, size/type(s) of dredge) → use rolling 5-yr schedule in DIS
 - Project unit costs and effective production rates (\$/CY; CY/day)
 - Dredge fleet specifications
 - Duration and extent of work restrictions (start/end dates, absolute restriction or partial?)
 - Project budget amounts
 - Distance matrix

Dredge Fleet Scheduling Optimization



Credit: J.B. McWilliams, AECOM

INITIAL FINDINGS

Regional Contract Optimization

Contract	Project	Project Dredge Type	Start	End	Dredging Day	Contract D	15-45m	20-41m	25-50m	25-70m	#03 HUDSO01 HUDSON RIVER NY	#03 SANDY01 SANDY HOOK TO BARN	#03 WELLS01 WELLS HARBOR ME OM	#01 REHOB01 REHOBOTH AND DEWEY	#01 BARNE01 BARNEGAT TO LIT EGG	#01 ATLM01 ATL COAST OF MD	#01 BALHB01 BALTIMORE HARBOR	#02 MANAS01 MANASQUAN TO BARN	#02 SAVAN01 SAVANNAH HBR GA	#02 WILMI012 WILMINGTON HBR NC	#02 MOREH01 MORHEAD CITY HBR	#02 KBECG01 KINGS BAY ENTRANCE	#02 DUVAL01 DUVAL CO SPP FL	#02 JACKS01 JACKSONVILLE HBR FL	#02 BRUNS01 BRUNSWICK HBR GA	#02 STLUC01 ST LUCIE CO SPP SOUTH	#02 FORTP01 FORT PIERCE BEACH FL	#02 FLAGL01 FLAGLER COUNTY SPP	#07 GREAT01 GREAT EGG AI	#07 WILMI01 WILMINGTON HBR NC	#07 GREAT02 GREAT EGG TC	#06 JAMES01 JAMES RIVER CHANNEL	#06 NORFO01 NORFOLK HARBOR VA	#06 STJOH01 ST JOHNS CO SPP FL	#06 PALMB01 PALM BEACH HBR FL			
#01	BARNE01 BARNEGAT TO LIT EGG	Hopper	7/30/2022	3/31/2023	244						4	3	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#01	REHOB01 REHOBOTH AND DEWEY	Hopper	4/1/2023	5/13/2023	42						3	4	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			7/30/2022	5/13/2023	286						0	0	1	4	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#02	BALHB01 BALTIMORE HARBOR	Hopper	1/25/2022	5/31/2022	126						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#02	MANAS01 MANASQUAN TO BARN	Hopper	6/30/2022	2/4/2023	219						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			1/25/2022	2/4/2023	345						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#03	ATLMD01 ATL COAST OF MD	Hopper	3/24/2022	7/2/2022	100						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#03	SANDY01 SANDY HOOK TO BARN	Hopper	8/1/2022	11/21/2022	112						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#03	HUDSO01 HUDSON RIVER NY	Hopper	11/22/2022	12/11/2022	19						1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#03	WELLS01 WELLS HARBOR ME OM	Hopper	12/13/2022	1/4/2023	22						1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			3/24/2022	1/4/2023	253						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#04	STLUC01 ST LUCIE CO SPP SOUTH	Hopper	11/1/2021	12/26/2021	55						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#04	FORTP01 FORT PIERCE BEACH FL	Hopper	12/27/2021	1/18/2022	22						1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#04	FLAGL01 FLAGLER COUNTY SPP	Hopper	1/19/2022	3/15/2022	55						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#04	DUVAL01 DUVAL CO SPP FL	Hopper	3/16/2022	4/24/2022	39						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#04	JACKS01 JACKSONVILLE HBR FL	Hopper	4/25/2022	5/5/2022	10						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			11/1/2021	5/5/2022	181						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

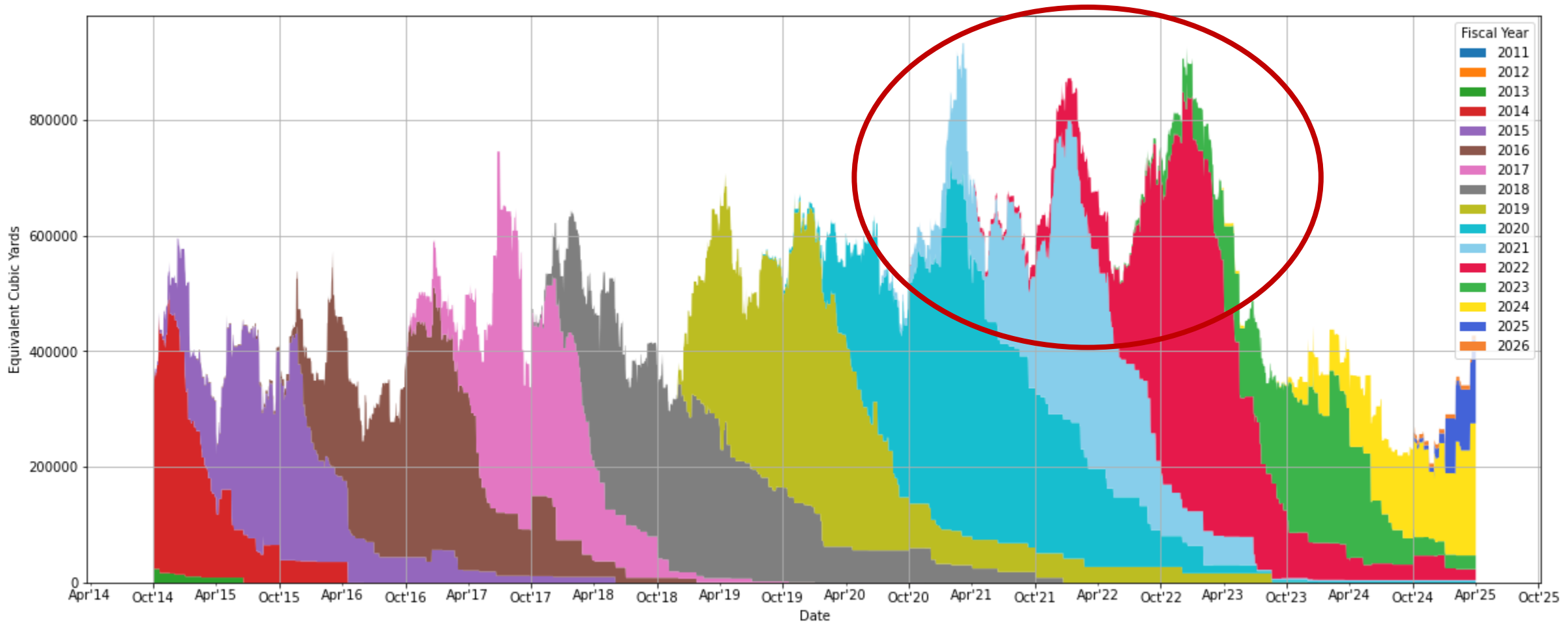
- NAD Hopper
 - HUDSO01 HUDSON RIVER NY
 - SANDY01 SANDY HOOK TO BARN
 - WELLS01 WELLS HARBOR ME OM
- SAD Hopper 1
 - SAVAN01 SAVANNAH HBR GA
 - WILMI012 WILMINGTON HBR NC
 - MOREH01 MORHEAD CITY HBR
 - KBECG01 KINGS BAY ENTRANCE
- SAD Hopper 2
 - STLUC01 ST LUCIE CO SPP SOUTH
 - FORTP01 FORT PIERCE BEACH FL
 - FLAGL01 FLAGLER COUNTY SPP
- Atlantic Interregional Pipeline
 - JAMES01 JAMES RIVER CHANNEL
 - NORFO01 NORFOLK HARBOR VA
 - STJOH01 ST JOHNS CO SPP FL
 - PALMB01 PALM BEACH HBR FL

Support to Regional Contract planning charrettes beginning in FEB 2021.

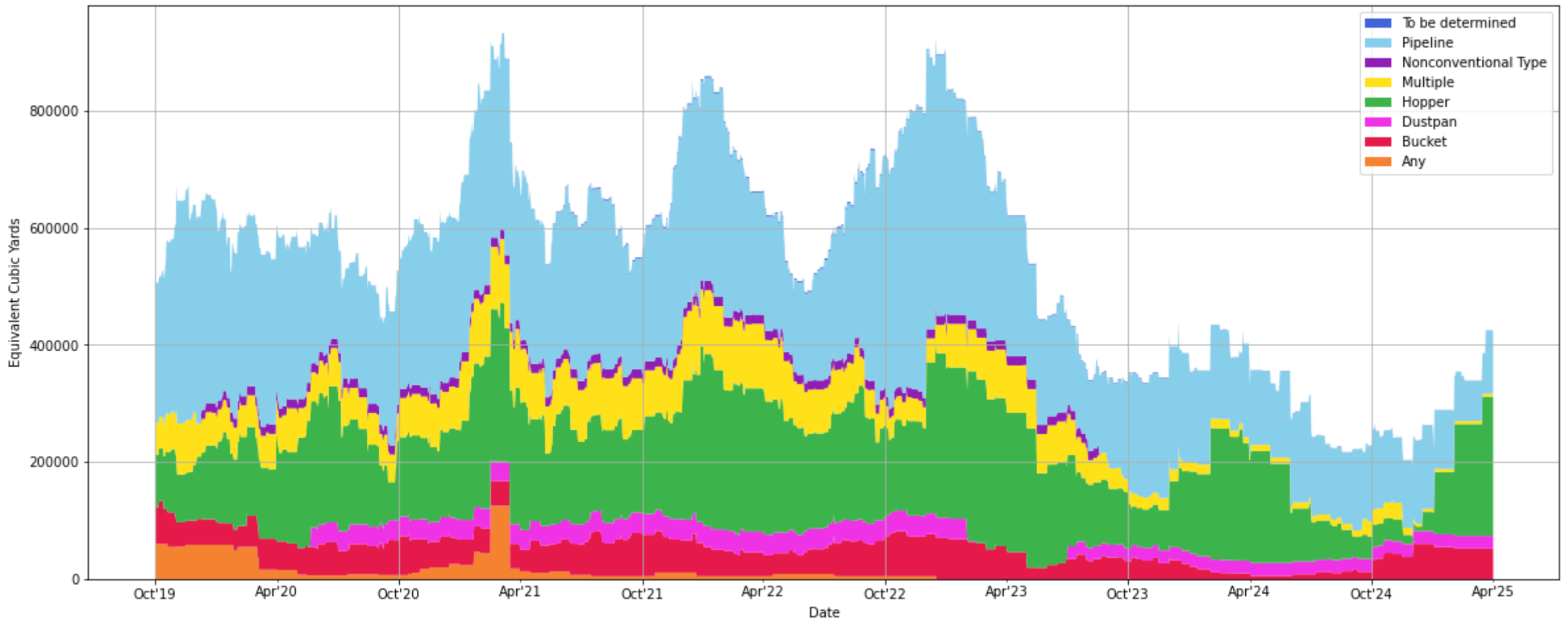
CHALLENGES

- Data management, QA/QC
- Limits of empirical shoaling projections from CSAT; model sensitivity to assumed vessel dimensions
- Model runtimes and overall turnaround
- Synthesizing model output into actionable guidance for decision makers
- Socializing the capability with dredging CoP → convincing people that this improves upon status quo
- Implementation: capability needs to be formally integrated within USACE business practice and made operational

DIS: Daily Demand (CY) by FY



DIS: Daily Demand (CY) by Suggested Dredge Type





Dredge Optimization Strategies

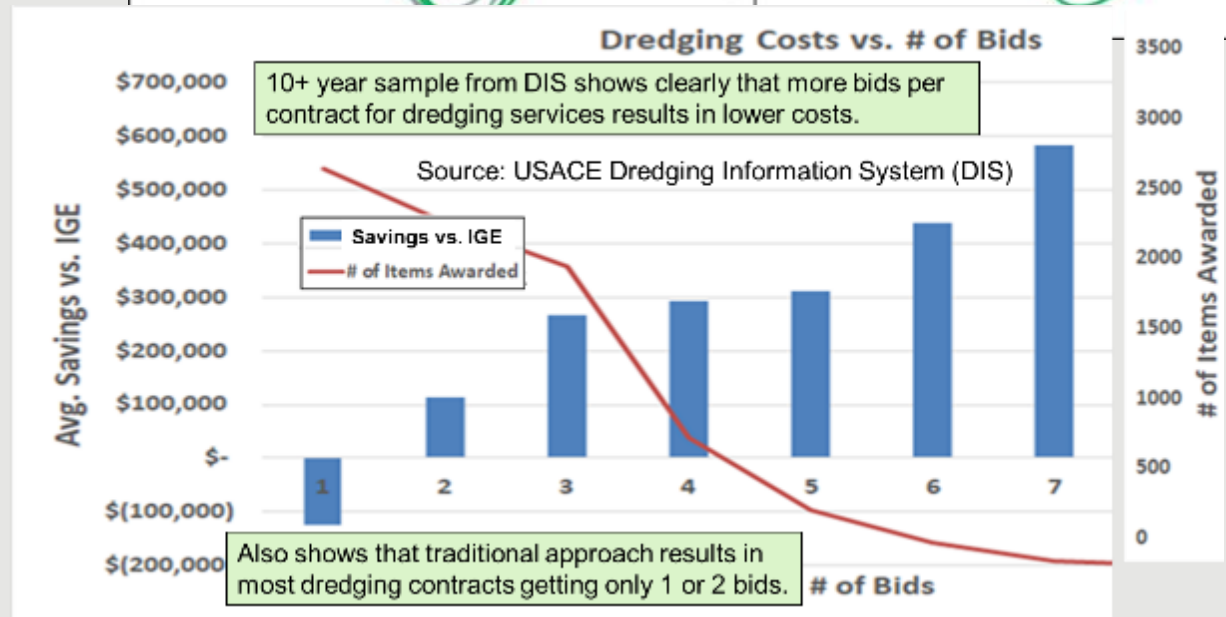
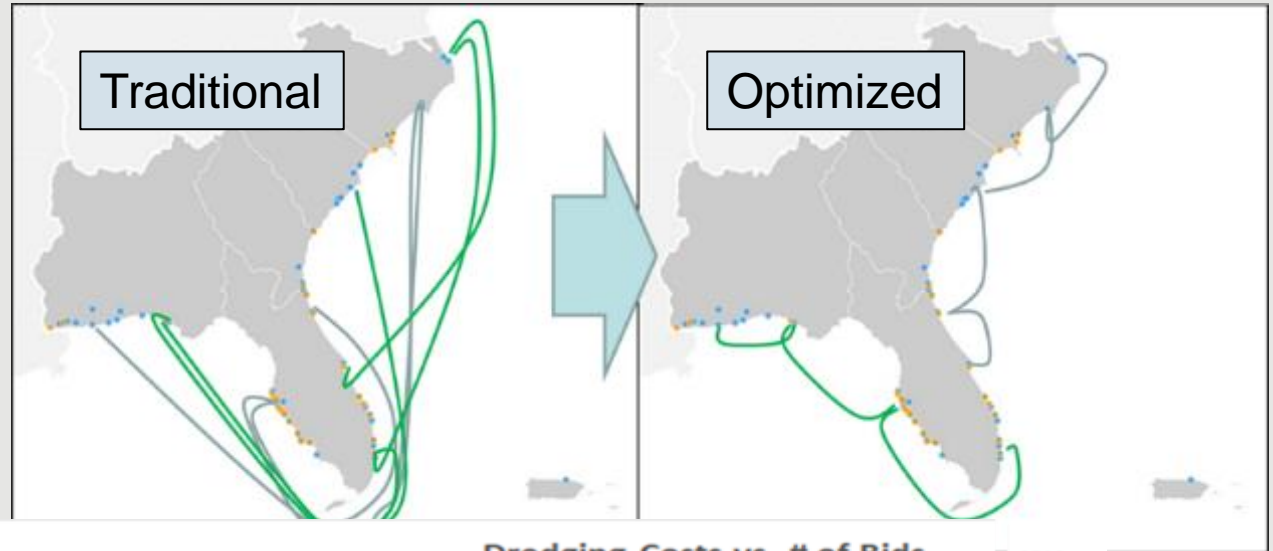


O&M SITE SELECTION, FLEET SCHEDULING, AND REGIONALIZATION

PROBLEMS

- 1)
 - Contracts are not coordinated across Districts and MSCs → low # of bidders hinders competitive pricing
 - Recent increases in NAV budgetary outlays leave little margin for scheduling shifts or delays

- 2)
 - Dredging resource outlays are not rigorously matched to dredging needs → difficult to justify decisions and explain our posture under future contingencies





Dredge Optimization Strategies

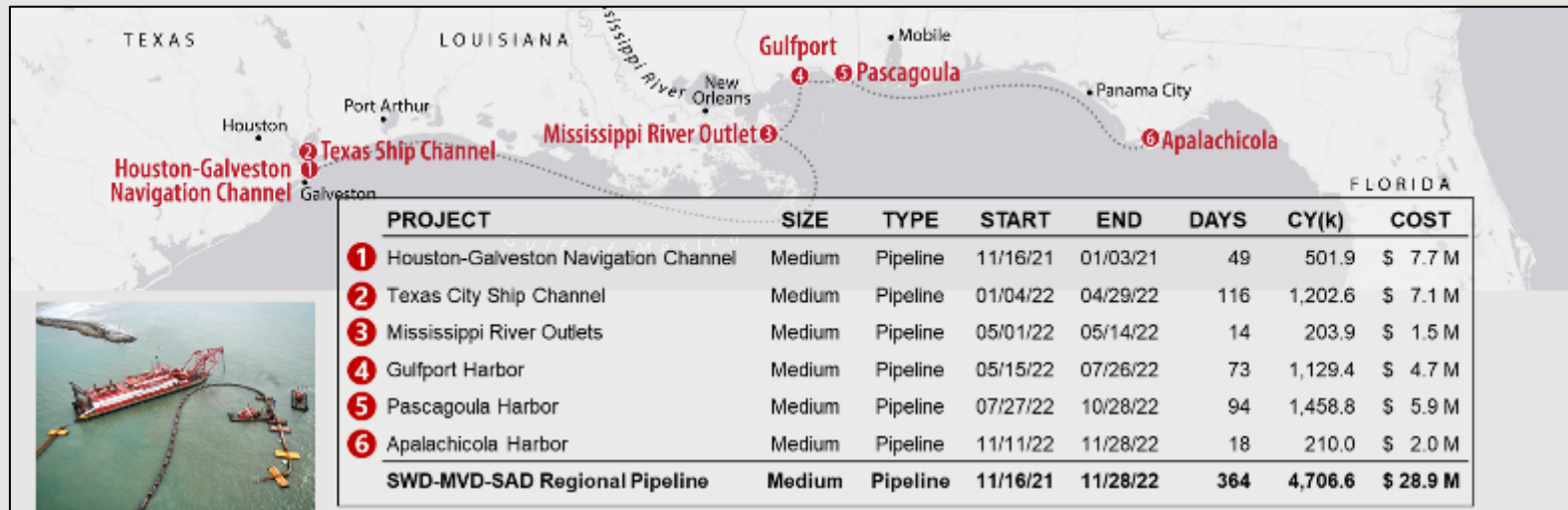
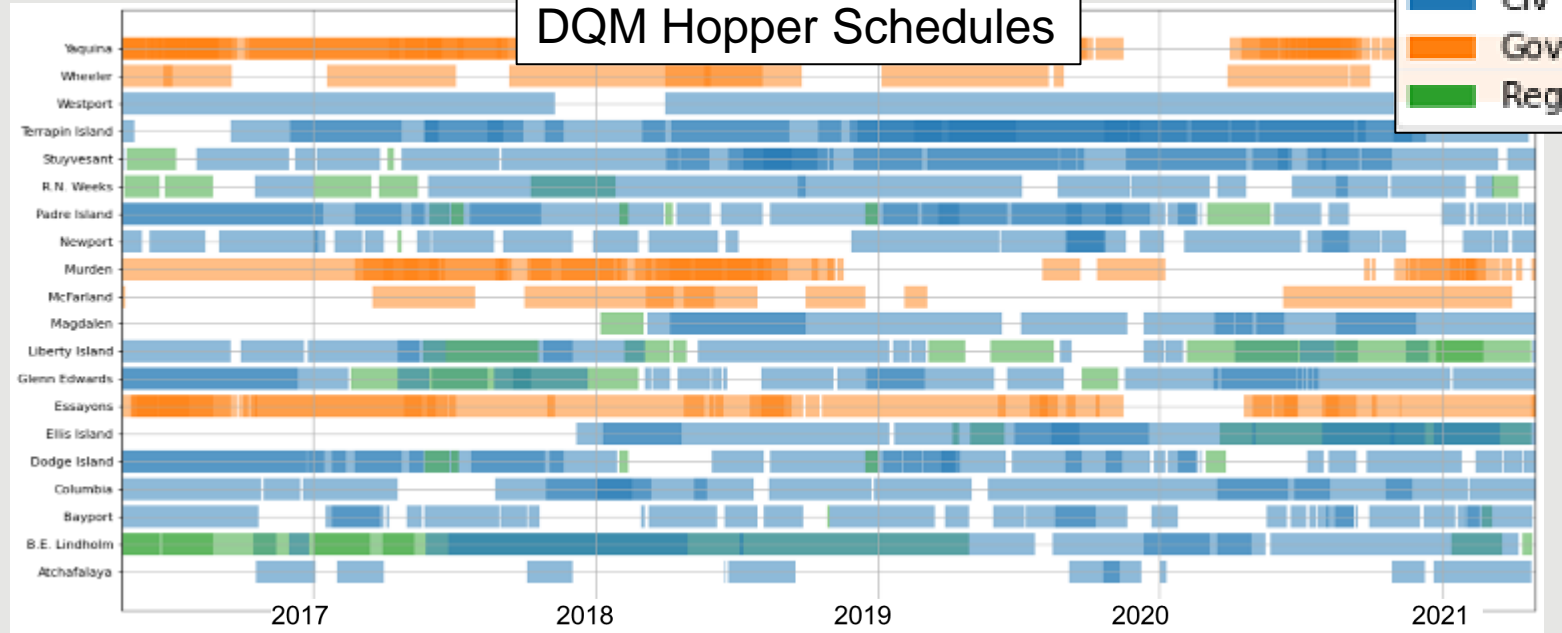


O&M SITE SELECTION, FLEET SCHEDULING, AND REGIONALIZATION

SOLUTION

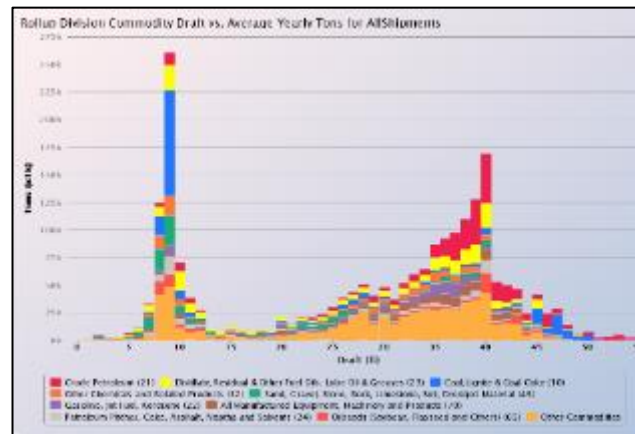
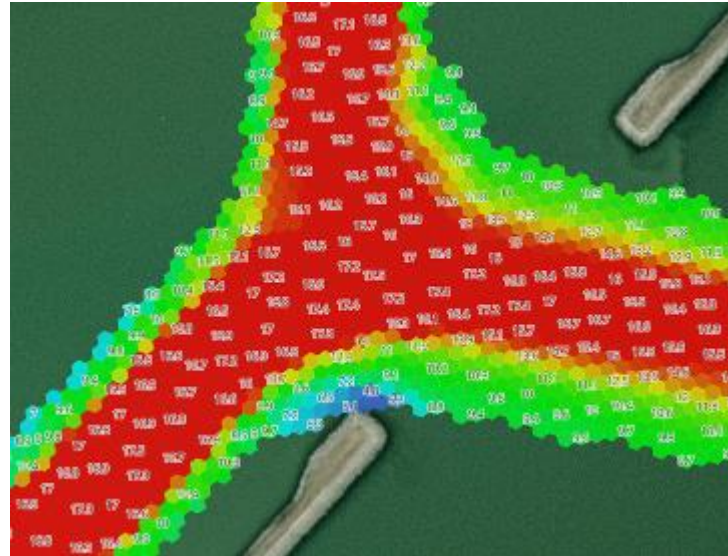
- Mathematical optimization to identify scheduling efficiencies, scale and sequence regional contracts, and reduce costs through increased competition
- Data assimilation across multiple disparate systems (DIS, RMS, DQM, Env. work restrictions, fleet composition/production rates)
- Recommendations for project groupings and sequencing that maximize scheduling efficiencies

DQM Hopper Schedules



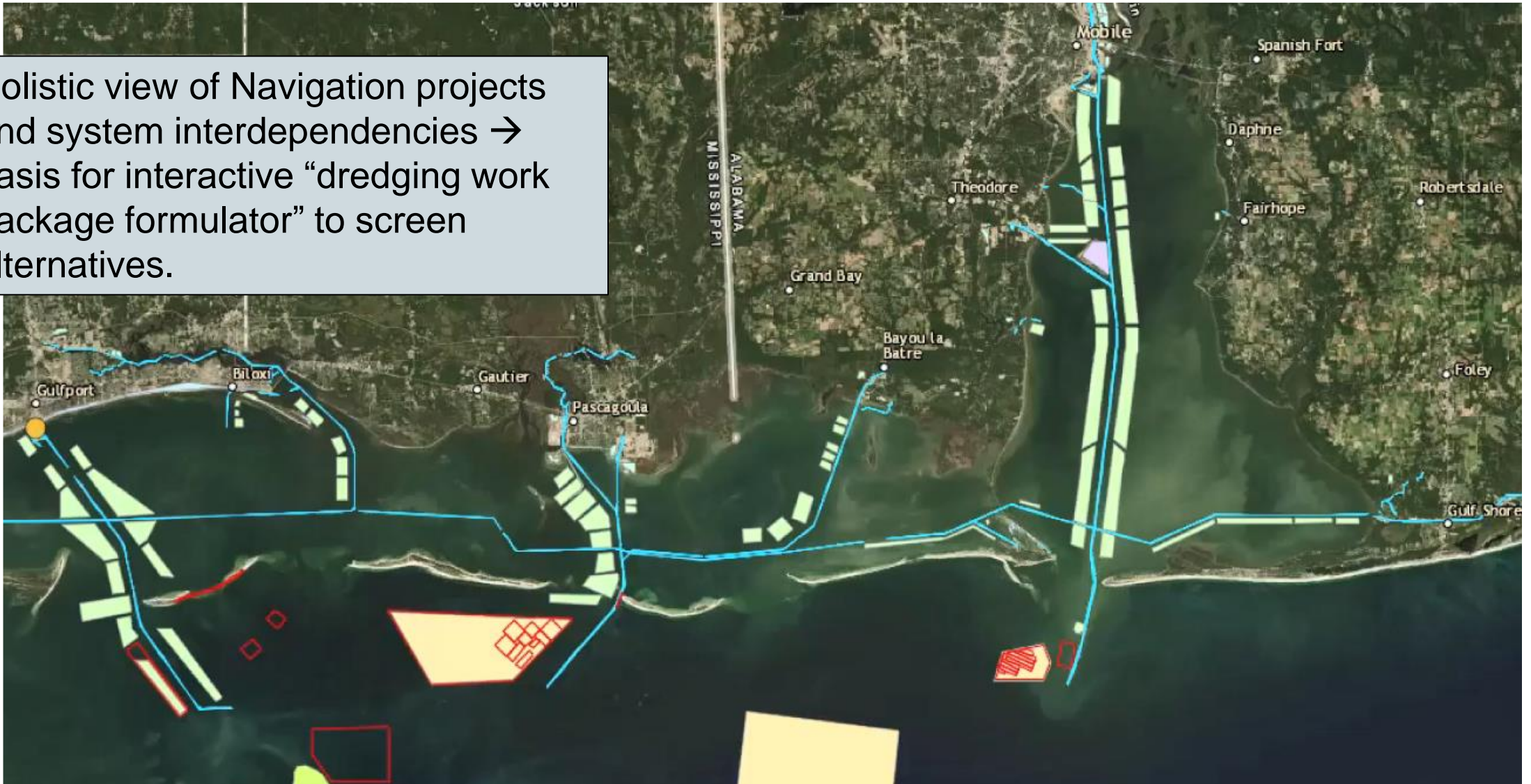
USACE Navigation Portal

- Common geospatial framework for analyzing and visualizing large, enterprise data sets:
 - Hydrographic surveys
 - Dredging Quality Management (DQM)
 - AIS vessel position reports
 - Waterborne Commerce
 - Many others



USACE Navigation Portal

Holistic view of Navigation projects and system interdependencies → basis for interactive “dredging work package formulator” to screen alternatives.



US Army Corps of Engineers • Engineer Research and Development Center

USACE Navigation Portal

Hosted in the USACE Azure L4 Government Cloud

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avg port_density	1.142
count	140

1 of 11

Seattle South Reach
Placement Site

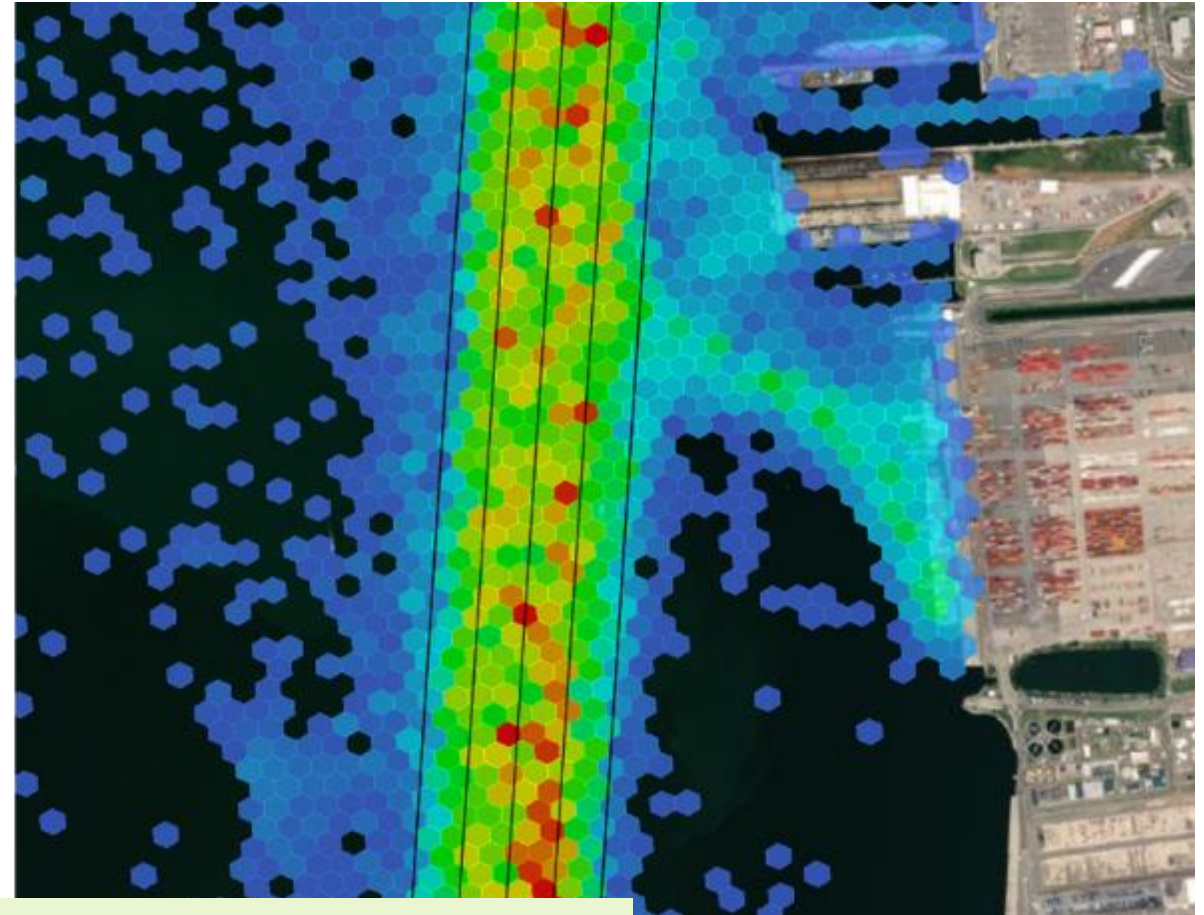
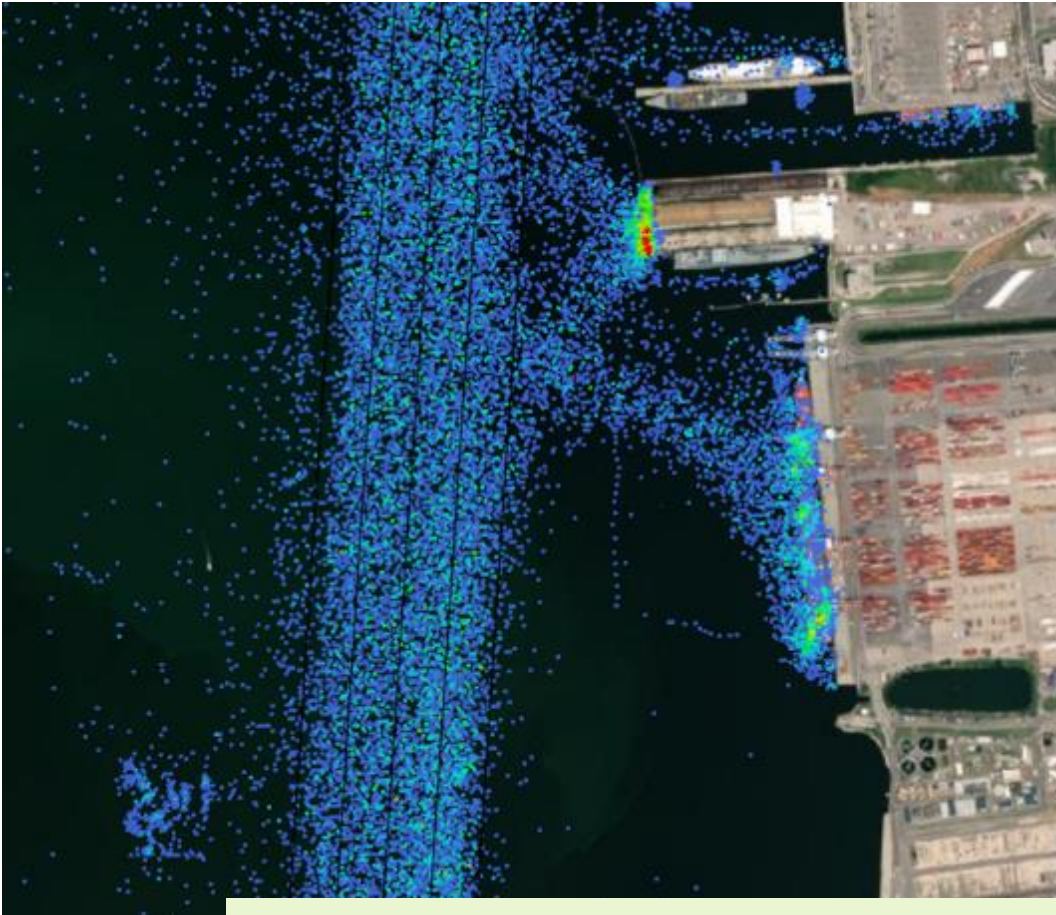
Seattle South Reach
Placement Site

USACE Navigation Portal

The screenshot displays the USACE Navigation Portal interface. At the top, there is a navigation menu with links for About, Business With Us, Mission, Locations, Careers, Media, Library, and Contact. Below this is a search bar and a filter group for 'Hydrographic Surveys Default'. The main content area features a map of a waterway with bathymetry data overlaid. A 'Cross Section' window is open, showing a graph of depth (ft) versus distance. The graph shows a U-shaped profile with a minimum depth of approximately -50.8 feet. A 'Latest Survey Depth Bins' window is also open, showing a bar chart of depth bins with values ranging from -5.0 to -53.7 feet. The interface includes a sidebar with navigation options like Explore, Results, Insights, Layers, Filters, and Data Table. The bottom of the page contains a footer with the US Army Corps of Engineers logo and text: 'Our Mission: The mission of the US Army Corps of Engineers is to deliver vital public and military engineering services; partnering in peace and war to strengthen our nation's security, energize the economy and reduce risks from disasters.' There are also links for Plain Language, Accessibility, Quality Facts, Contact Us, Link Disclaimer, and Privacy & Security.

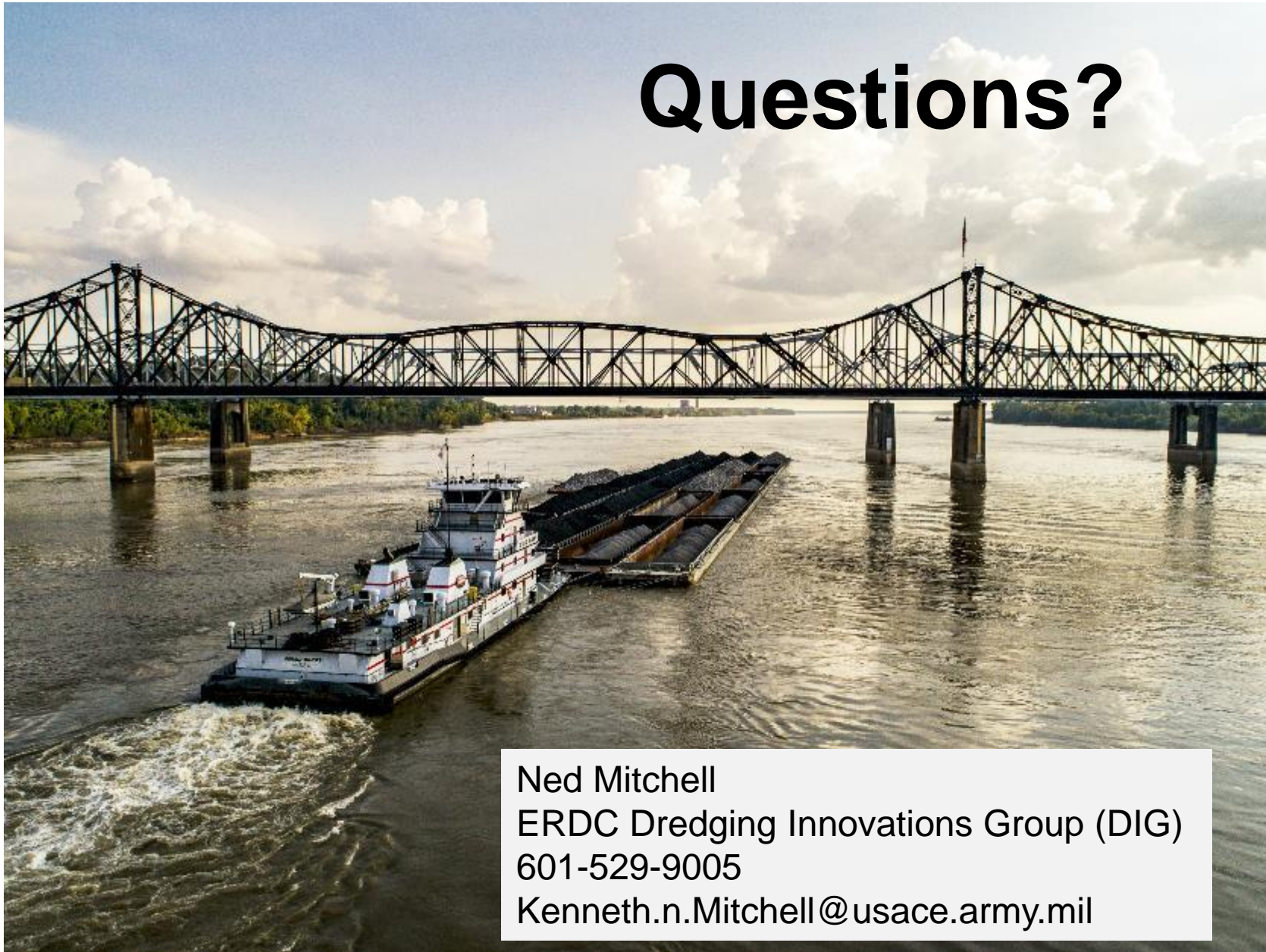
2021 Winner of Elasticsearch Innovation Excellence Award

USACE Navigation Portal



Applying IIJA funds towards a “coastal digital twin” that will automatically apply CSAT forecasts indexed to time of last survey and combined with DQM streaming data.

Questions?



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