PORTFOLIO-SCALE INFRASTRUCTURE ANALYSIS USING AIS DATA: VESSEL ENCROACHMENT VOLUME IN SOUTH ATLANTIC DIVISION
COASTAL NAVIGATION PORTFOLIO MANAGEMENT

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COASTAL INLETS RESEARCH PROGRAM

FY22 IN PROGRESS REVIEW

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CIRP — Mission Support · Technology Transfer · Research & Development

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CHL COASTAL & HYDRAULICS LABORATORY

ERDC — Engineer Research and Development Center

DISCOVER | DEVELOP | DELIVER   1

Problem Statement

- **USACE currently quantifies supply of service (dredging volume) without quantifying demand (encroaching sediment volume) when managing navigation channels. Legacy KPIs (tonnage, cargo value) send funds to projects based on size. Demand-side indicators are necessary for effective management.**
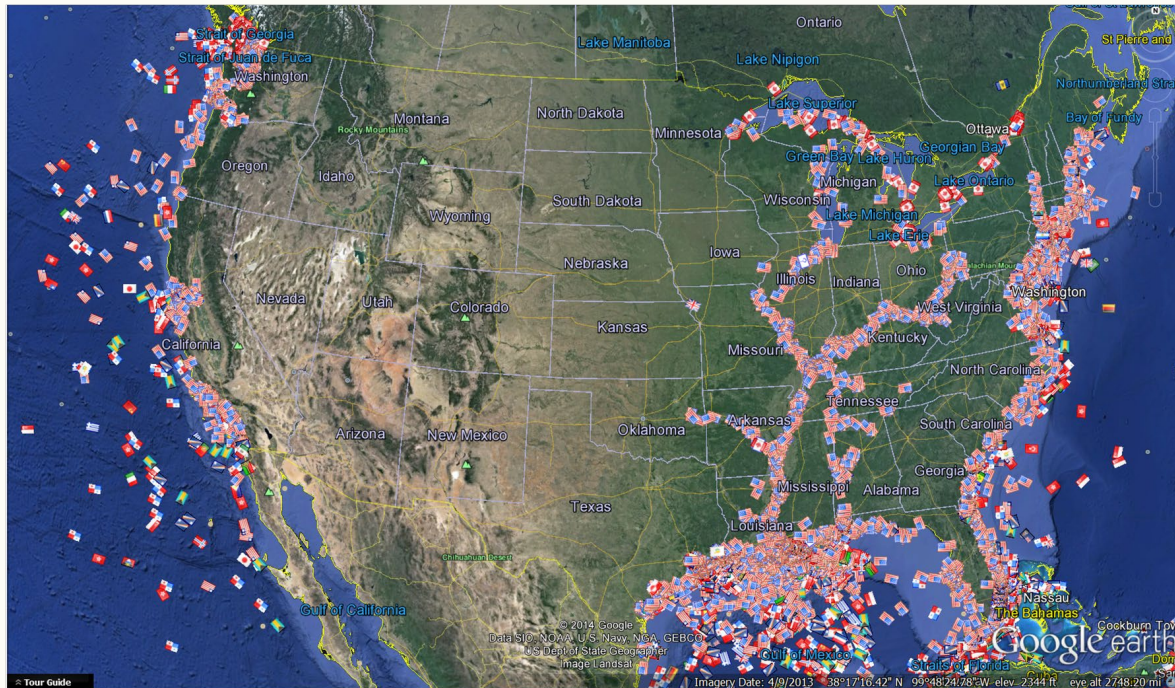
- **SoN's:**
  - **2017-N-52 Further Development of CPT and AIS software products**
  - **2016-N-14 Long-term modeling of coastal structure functionality**
  - **2015-N-15 - Integration of national and local monitoring datasets to support navigation and operations projects**
  - **2015-N-34 - Incorporating methods to evaluate length of navigation channel required for safe and efficient travel of two-way traffic in ship simulations**
  - **2015-N-38 - AIS investigation of Dredge Behavior**
  - **2015-N-40 - Reducing the need for dredging**

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Capability and Strategic Impact Statement

CNPM**:** Advance ***objective, quantitative,*** and ***systems-based*** approaches to management of the Corps' large coastal navigation portfolio of projects.

Legacy metrics tell managers that large volumes of cargo are carried on waterways of varying depth by vessels of varying draft.

Vessel Encroachment Volume tells waterway managers ***where*** and ***how much*** sediment ***impedes*** navigating vessels**.**
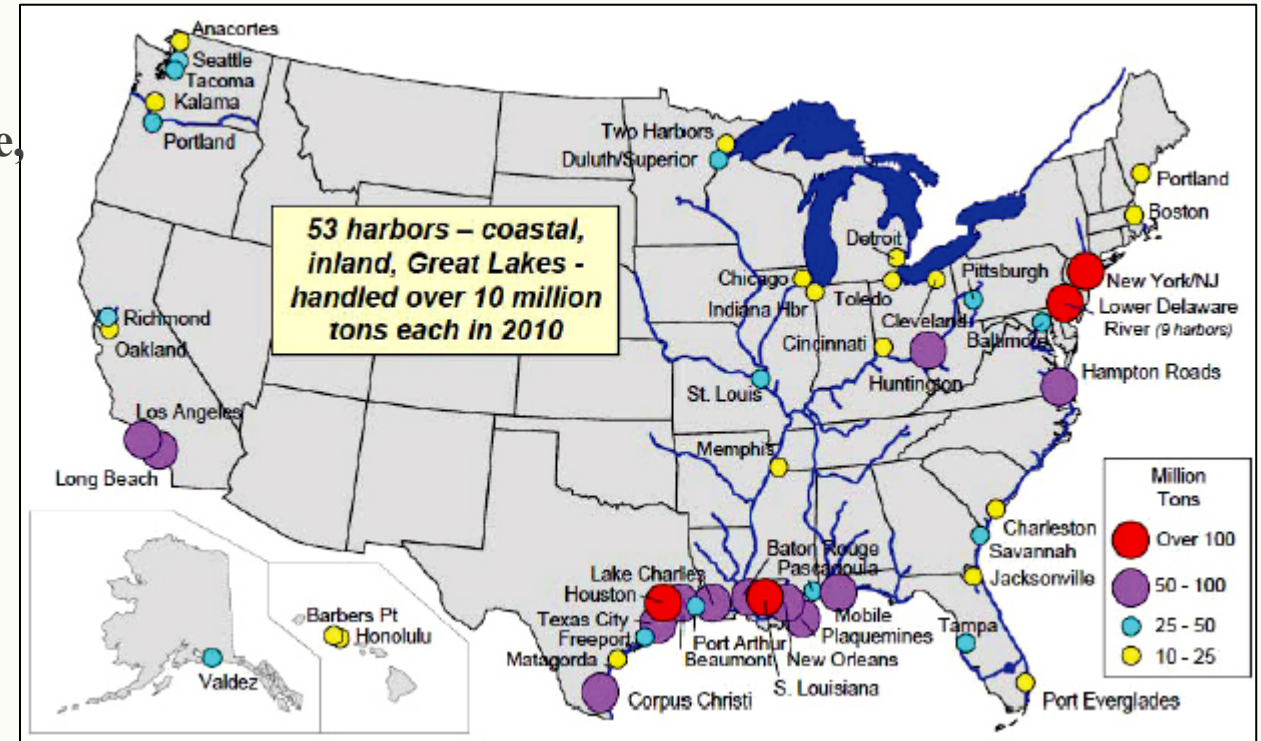
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Why this matters.

- **USACE NAVIGATION MISSION:**
  - To provide *safe*, *reliable*, *efficient*, *effective* and *environmentally sustainable* waterborne transportation systems for movement of commerce, national security needs, and recreation.
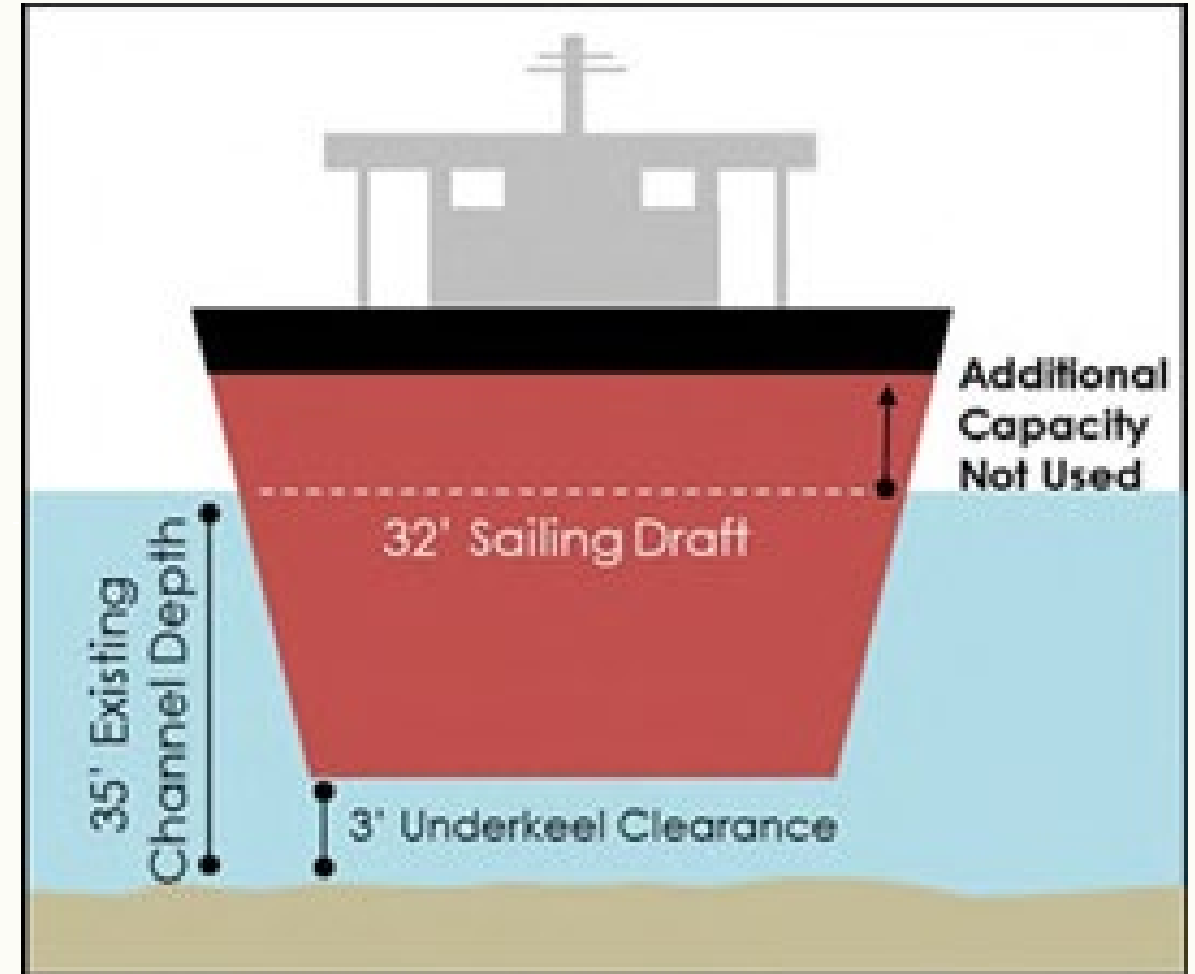
- **Money:**
  - **USACE spends about $1.5B annually on dredging.**
  - *Legacy* **cargo tonnage/value KPIs reward projects for being large, but don't actively allocate resources for maximum impact to navigation mission objectives.**
  - **~10% "found money" in the dredging budget through managing** *Underkeel Clearance* **via** *Vessel Encroachment Volume*.

53 harbors – coastal, inland, Great Lakes - handled over 10 million tons each in 2010

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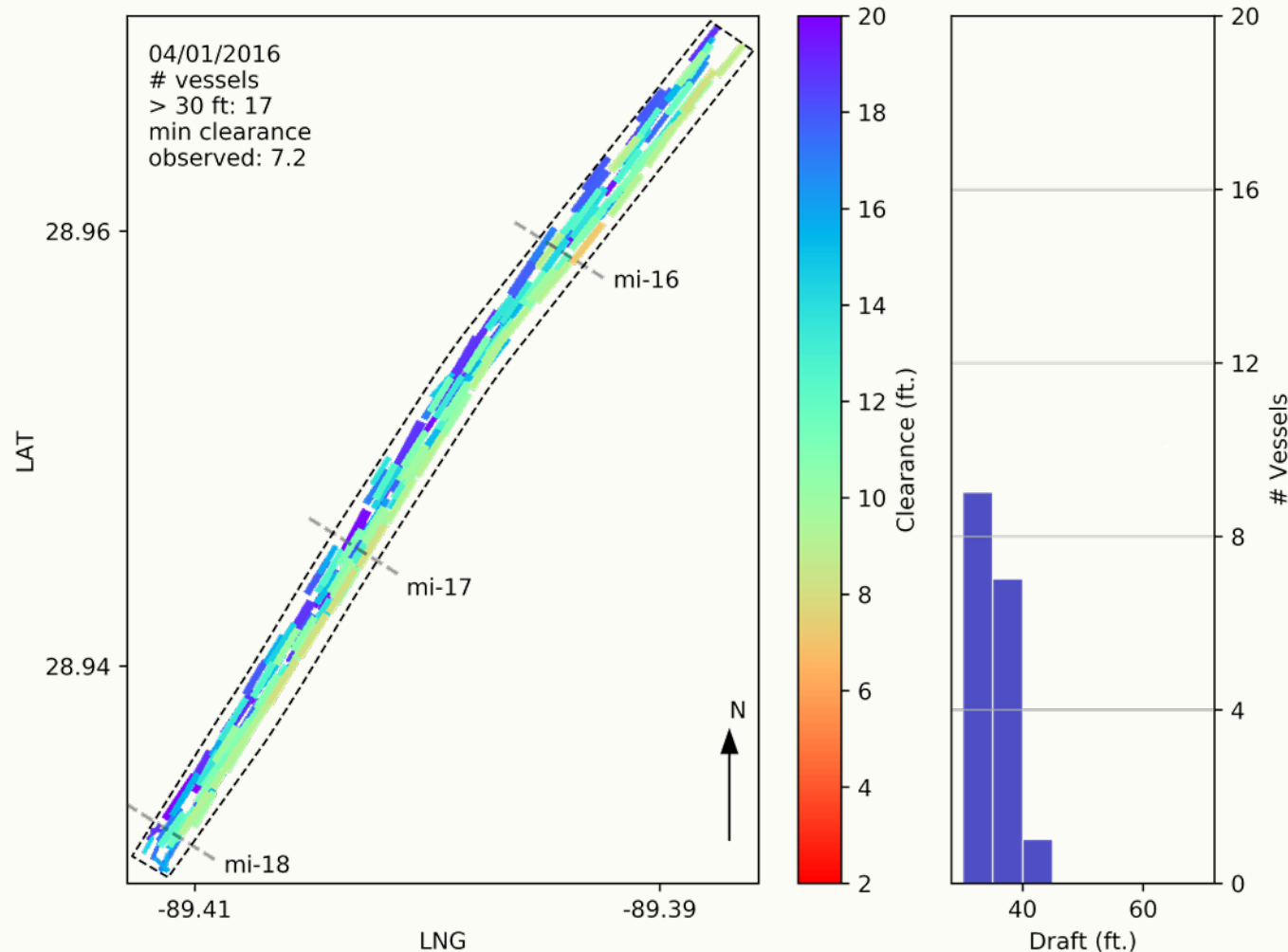
Improved Metrics: Underkeel Clearance

- Marine Cadastre AIS:
  - LAT/LNG.
  - Time (1-min res.).
  - Ship ID.
  - Backup for vessel horiz. dimensions.
  - Backup for vessel type.
- AVIS list:
  - Vessel horiz. dimensions.
  - Vessel type.
- Vessel draft – Foreign Vessel Entrances & Clearances (IWR 2018).
  - This controls recency of data we can provide.
- Bathymetry - eHydro survey data.
- WL data - NOAA tide stations.
- For entire U.S. we know:
  - Who, what, when, where for ships.
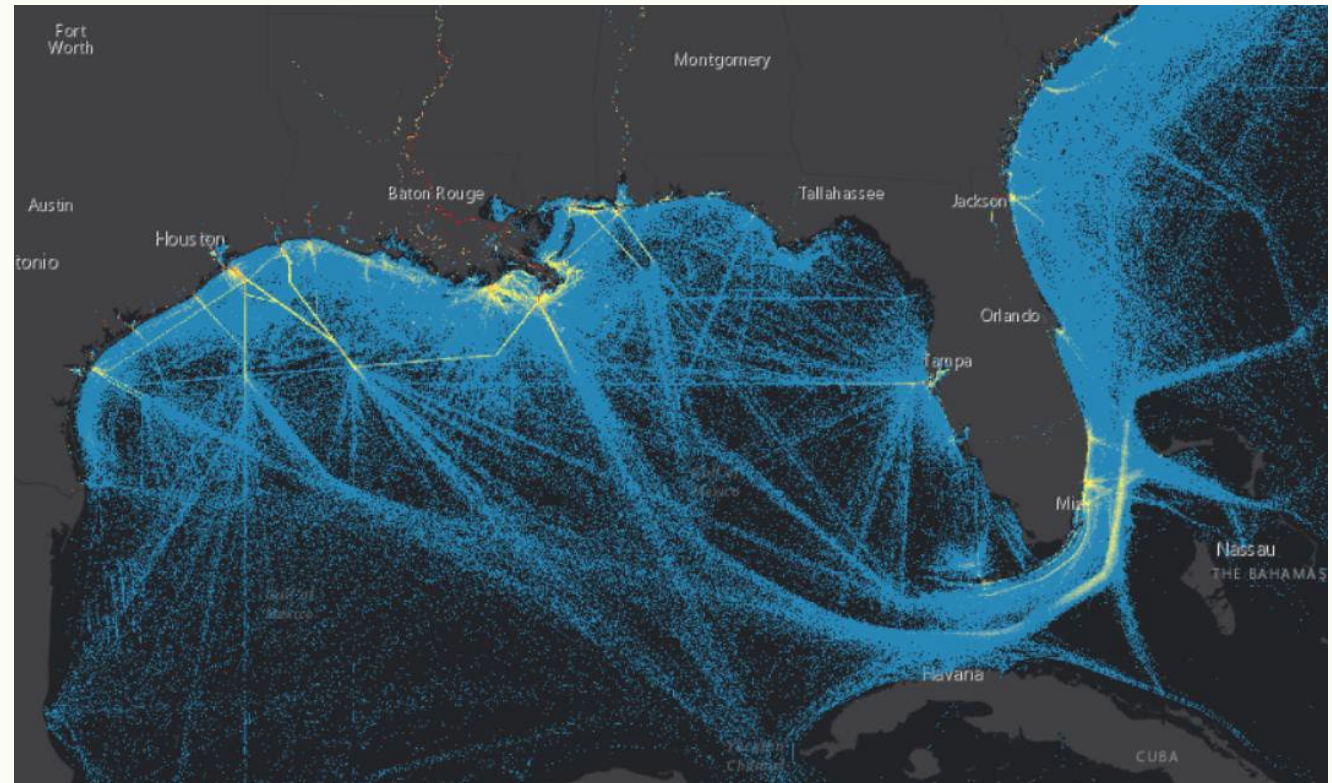 - Available depth.
  - How deep ships are drafting.

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Improved Metrics: Underkeel Clearance

04/01/2016
vessels
> 30 ft: 17
min clearance
observed: 7.2

- Marine Cadastre (AIS).
  - Spatio-temporal record of commercial vessels.
  - Useful for variety of waterway maintenance issues.
  - Near-total coverage of USACE waterways.
- Bathymetry - eHydro survey data.
- WL data - NOAA tide stations.
- Vessel draft – Foreign Vessel Entrances & Clearances (IWR 2018).
- For entire U.S. we know:
  - Who, what, when, where for ships.
  - Available depth.
  - How deep ships are drafting.

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FY22 Reimbursable: Vessel Encroachment Volume

- $275k reimbursable with SAD to fill the CIRP $ gap
- *Leveraged* previous CIRP under-keel clearance work for a management case
- Presented our work to SAD/SAJ staff
- Explicitly directed not to "do ERDC stuff"
- Rewarded with follow-on $250k reimbursable

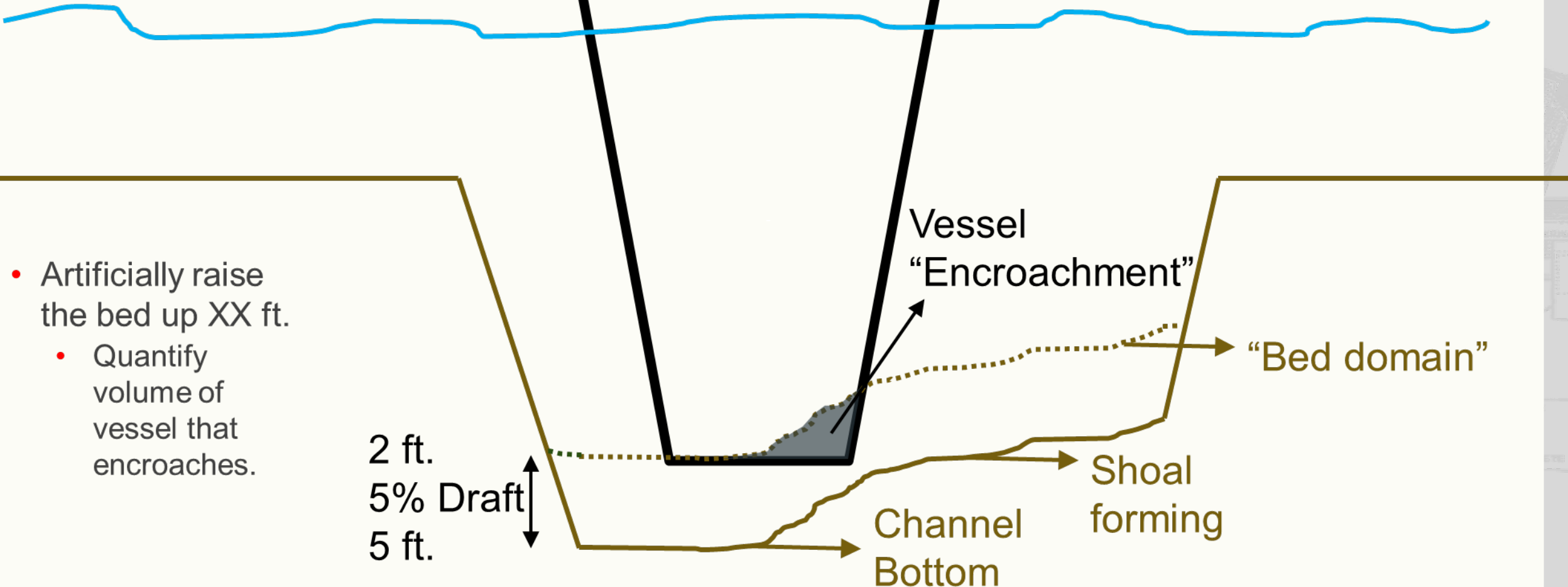US Army Corps of Engineers • Engineer Research and Development Center • Coastal and Hydraulics Laboratory

FY22 CIRP Effort: Vessel Encroachment Volume

- Did "ERDC stuff", *leveraging* CIRP $ gap SAD reimbursable
- Initiated:
  - JP: quantifying Ranking Ports by Vessel Demand for Depth (ASCE Waterways)
  - TR: New Metrics for Managing Waterways
  - Presentation: Managing Navigation Channels with Observed Vessel Usage (Coastal Sediments)
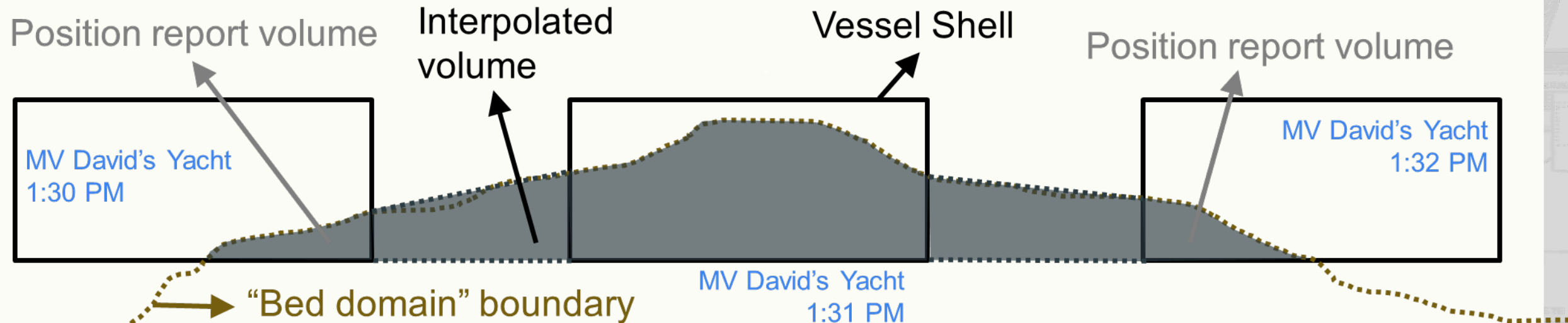 - Integration of VEV into Nav Portal

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"Vessel Encroachment Volume"

- Inspiration from ship domain violations.
  - Not very many collisions.
  - Compare "close calls".

Vessel "Encroachment"

"Bed domain"

- Artificially raise the bed up XX ft.
  - Quantify volume of vessel that encroaches.

2 ft.
5% Draft
5 ft.

Shoal forming

Channel Bottom

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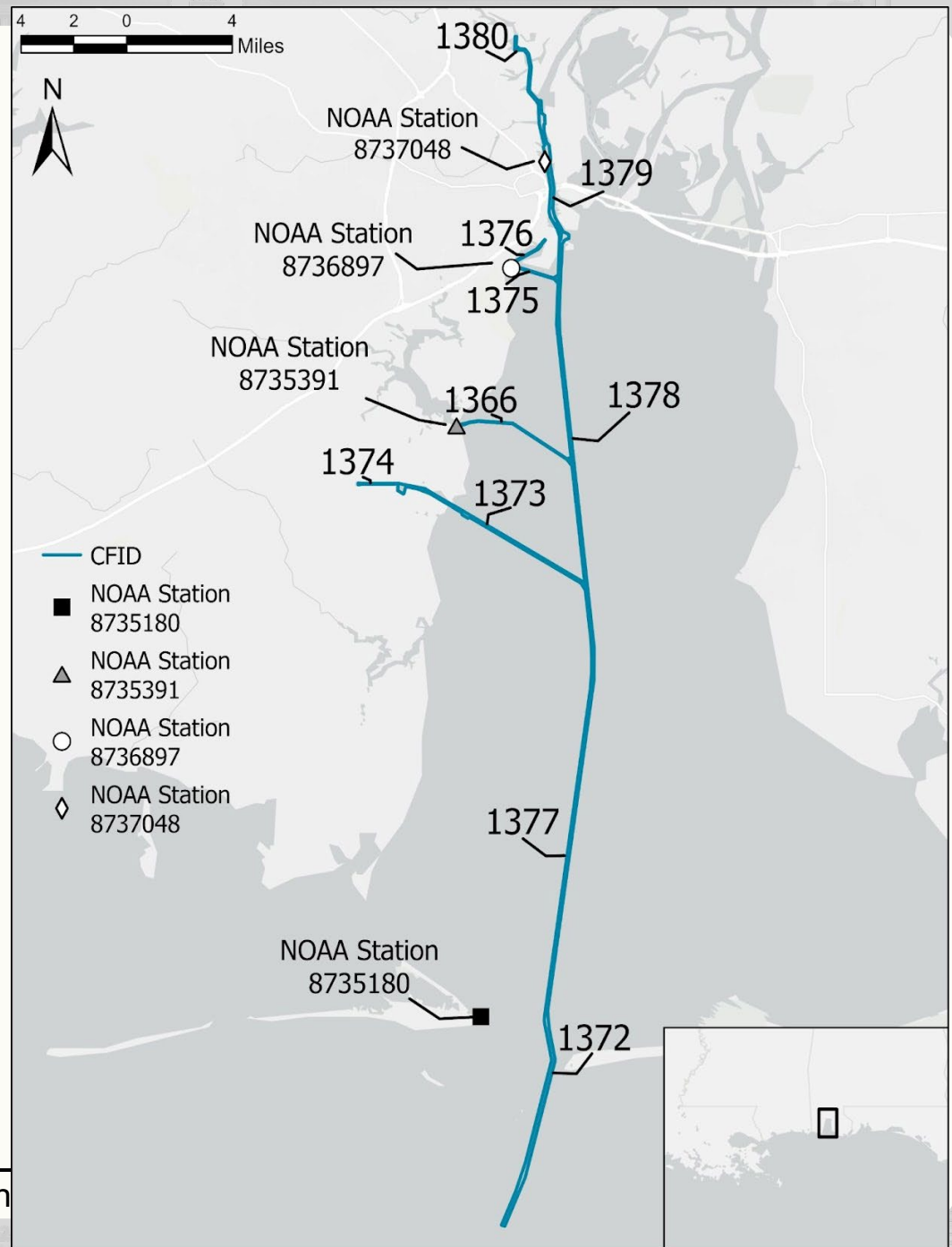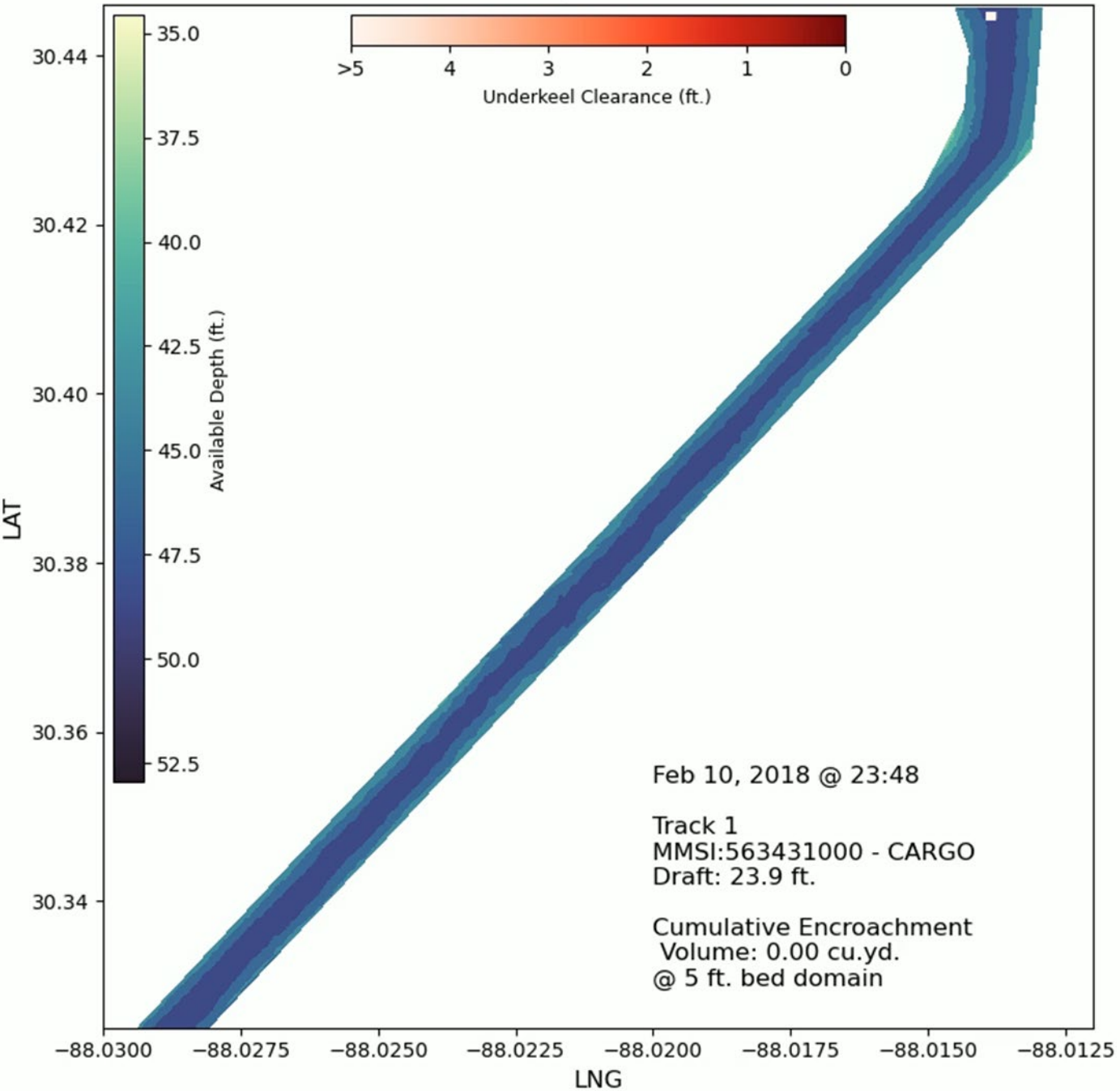
"Vessel Encroachment Volume"

- Compute volume for each vessel position report.
- Interpolate between reports for each transit.

- Wind up with an "encroachment volume" for each transit.
- Sum these up for each day, month, year, port.

- Takes into account effect of multiple transits

Position report volume

Interpolated volume

Vessel Shell

Position report volume

MV David's Yacht
1:30 PM

MV David's Yacht
1:32 PM

"Bed domain" boundary

MV David's Yacht
1:31 PM

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Mobile, AL: CF1377

Feb 10, 2018 @ 23:48

Track 1
MMSI:563431000 - CARGO
Draft: 23.9 ft.

Cumulative Encroachment
Volume: 0.00 cu.yd.
@ 5 ft. bed domain
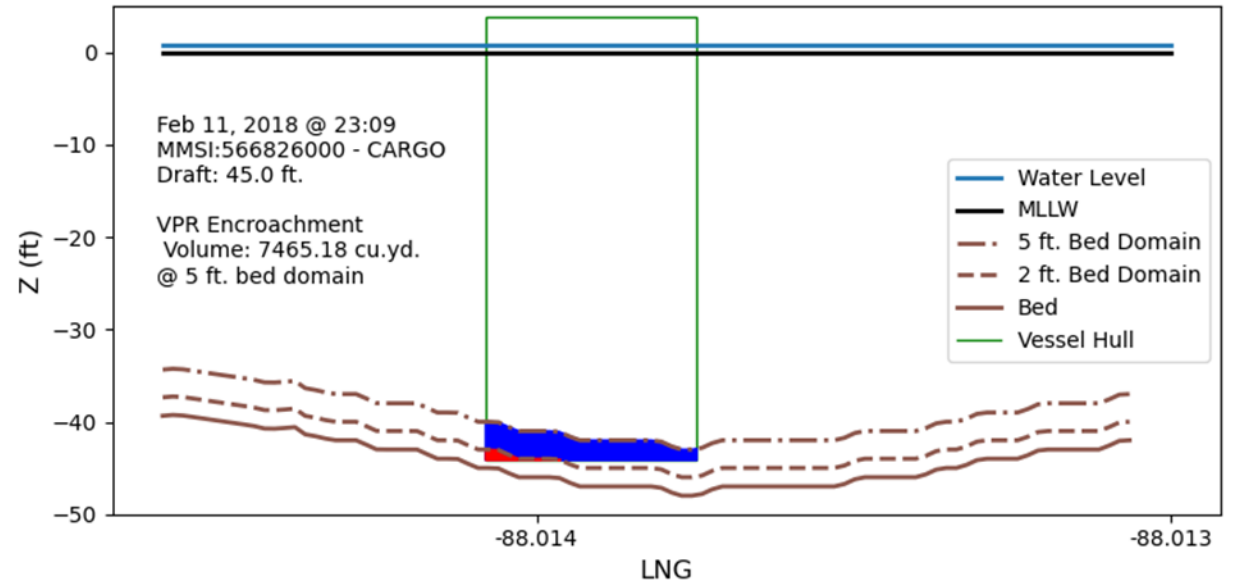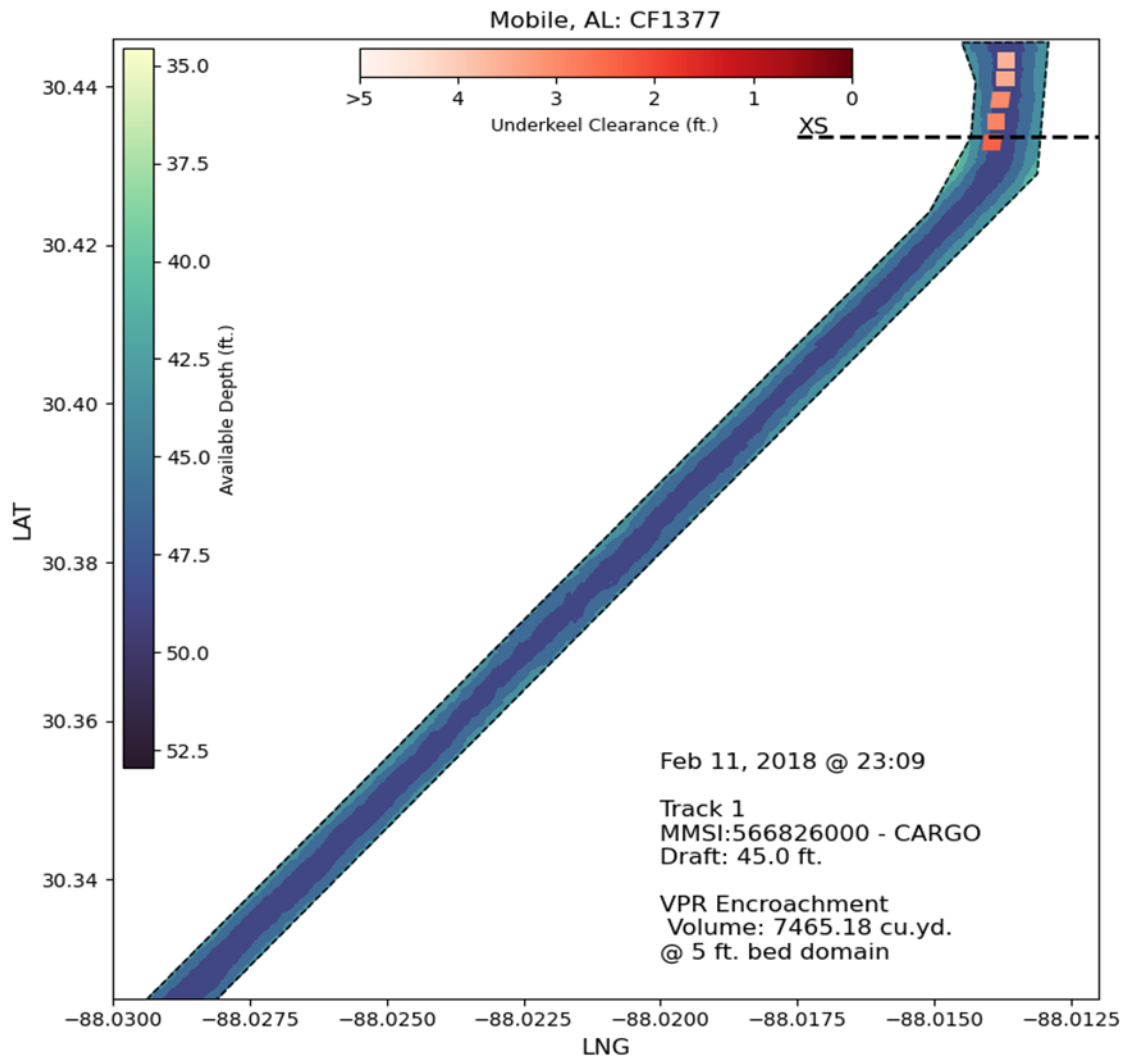
Improved Metrics: Vessel Encroachment Volume

- Shaded blue – vessel encroachment volume (VEV) for 5 ft. bed domain.
- Shaded red – VEV for 2 ft. bed domain.

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Results: Volume & Cost for 2ft VEV / ET

- USACE dredges substantially more to prevent sediment from encroaching into vessel transits depending on location.

- USACE pays substantially more to prevent sediment from encroaching into vessel transits depending on location.

- Is the cost to obtain the same service in different locations justifiable?

Port	Avg. 2 ft. VEV (*Mcy X T*)	Avg. 2 ft. ET (#)	Avg. Dredge Vol. (*Mcy*)	Avg. Annual Cost ($M)	Avg. Dredge Vol./Avg. 2 ft. VEV	Avg. Cost/Avg. 2 ft. ET ($1000/ *ET*)
Mobile, AL	5.85	125	4.6	$7.80	0.78	$62.40
Savannah, GA & Brunswick, GA[1]	8.05	600	7.4	$34.20	0.92	$57.00
Tampa, FL	1.43	59	0.5	$10.30	0.37	$174.58
Pascagoula, MS	0.01	6	0.4	$1.40	35	$233.33
Port Everglades, FL[2]	0	3	0	$0.00	N/A	$0.00
Charleston, SC	0.46	31	2	$9.40	4.35	$303.23
Jacksonville, FL	0.08	14	0.6	$16.20	6.88	$1,157.14
San Juan, PR	0.43	28	0.2	$1.70	0.35	$60.71
Miami, FL[2]	0	3	0	$0.00	N/A	$0.00
Wilmington, NC	0.42	26	3.9	$21.60	9.23	$830.77
Canaveral, FL	0.02	3	0.3	$3.30	12.5	$1,100.00
Palm Beach, FL	0.01	2	0.1	$3.20	12.5	$1,600.00

[1]Savannah, GA and Brunswick, GA are combined in DIS - the avg. 2 ft. VEV and ET values are summed here for comparison. [2]No dredging is recorded in DIS for 2015-2018.

Port	Avg. 2 ft. VEV (*Mcy X T*)	Avg. dVEV (*Mcy X T*)	Avg. 2 ft. ET (#)	Avg. Dredge Vol. (*Mcy*)	Avg. Annual Cost ($M)	Avg. Dredge Vol./Avg. 2 ft. VEV	Avg. Cost/Avg. 2 ft. ET ($1000/ *ET*)
Southwest Pass, LA[1]	0.86	23.69	113	56.0[2]	$131.00[2]	65.12	$1,159.29

[1]Does not include 2018. [2]Actual/projected dredge volumes and actual/projected costs found in USACE (2017) were used.

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Results: dVEV ranking.

- Incremental dredging reductions have differing potential impacts based on location.

- This provides the setup for a potential objective function for dredge optimization modeling.

Port	Avg. dVEV $Mcy \, X \, T$ (*Rank*)	Avg. 2 ft. VEV $Mcy \, X \, T$ (*Rank*)	Avg. Annual Cost ($M)
Mobile, AL	58.2 (*1*)	5.85 (*2*)	$7.80
Savannah, GA	38.17 (*2*)	7.19 (*1*)	$34.20[1]
Tampa, FL	10.18 (*3*)	1.43 (*3*)	$10.30
Pascagoula, MS	0.24 (*10*)	0.01 (*10*)	$1.40
Port Everglades, FL	0.15 (*11*)	0 (*13*)	$0.00
Charleston, SC	2.38 (*7*)	0.46 (*5*)	$9.40
Jacksonville, FL	2.17 (*8*)	0.08 (*8*)	$16.20
San Juan, PR	3.66 (*4*)	0.43 (*6*)	$1.70
Miami, FL	0.09 (*12*)	0 (*12*)	$0.00
Wilmington, NC	3.24 (*5*)	0.42 (*7*)	$21.60
Canaveral, FL	0.35 (*9*)	0.02 (*9*)	$3.30
Brunswick, GA	2.99 (*6*)	0.86 (*4*)	$34.20[1]
Palm Beach, FL	0.03 (*13*)	0.01 (*11*)	$3.20

[1]Savannah, GA and Brunswick, GA are combined in DIS - the avg. 2 ft. VEV and ET values are summed here for comparison. [2]No dredging is recorded in DIS for 2015-2018.

Summary

FY22 Major Advances in Capability

- **Major improvements to metrics.**
  - ► **Vessel Encroachment Volume**
  - ► **Vessel Encroachment Volume/Transit**
  - ► **Vessel Encroachment Volume/E.Transit**
  - ► **dVEV 5-2 metrics.**

FY23 Major Products & Collaborations

- **MVD Presentation (4/7)**
- **NDM VEV Poster**
- **Storyboard!**
- **The next top 10 ports (FY23)**
- **Follow-on SAJ reimbursable ($250k)**

Planned Outyear Products/Advances

- **Full integration with Nav Portal viewer**
- **Integration with dredge optimization model**
- **Reduced latency through near-real time implementation**

FY22 Major Products & Collaborations

- **JP submitted to ASCE Waterways**
- **TR submitted to internal review**
- **Initial integration with Nav Portal**

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