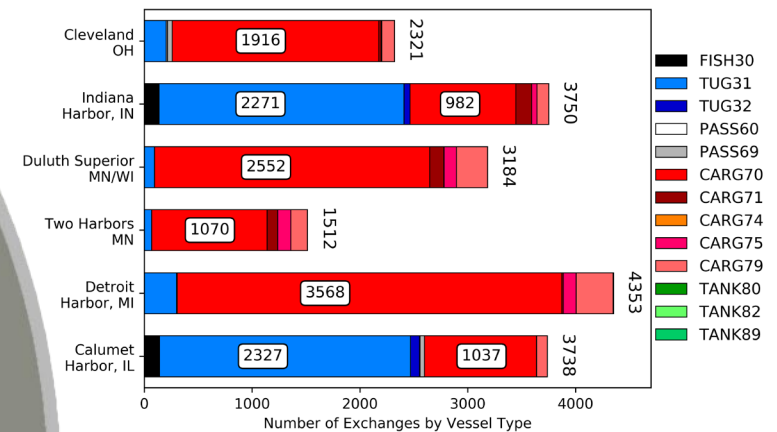# RANKING PORTS BY VESSEL DEMAND FOR DEPTH

David Young, Brandan Scully, Rachel Bain, Sean McGill, Marin Kress, Ashley Elkins

Coastal & Hydraulics Laboratory

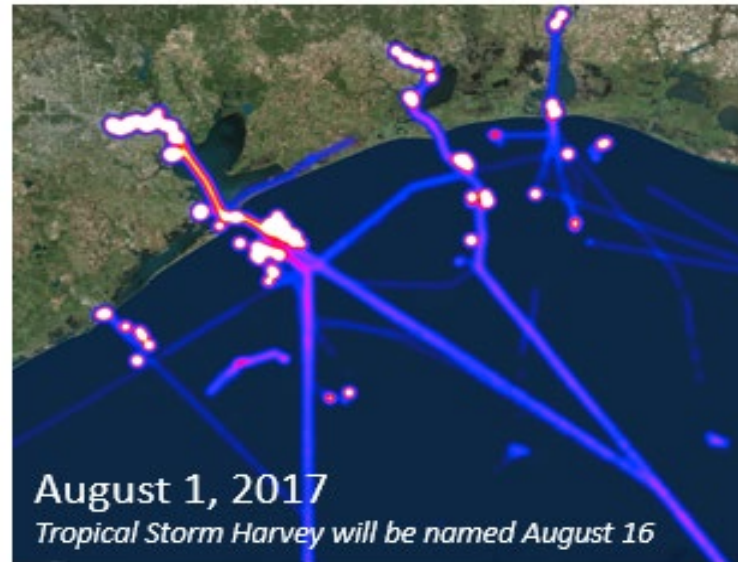US Army Corps of Engineers

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ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

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AIS Data

- Tracking system for vessels.
- Originally an aid to maritime safety.
- Commercial shipping vessels mandated to be equipped with AIS transponder by U.S. Coast Guard.
- Operates on the VHF maritime band.
- Information carried in AIS
    - Position
    - Course-over-ground.
    - Heading.
    - Speed.
    - Vessel type code.
- Marine Cadastre – nationwide, 1 min.
- Many additional applications.
- Scully and Chambers 2019.

August 1, 2017
Tropical Storm Harvey will be named August 16

August 25, 2017
USCG declares Port of Houston under condition ZULU

August 26, 2017
Hurricane Harvey makes landfall at Rockport & becomes a tropical storm over inland Texas

September 4, 2017
Vessels queue at anchorage areas. Port reopens with restrictions September 6th.

Why Does USACE Care?

- USACE is in charge of maintaining waterways.
  - Maintain 25,000 mi. of navigable waterways.
  - > $1.5 billion annually on dredging – single largest civil works O&M expenditure.
  - $350 million per year in SAD alone.
- The U.S. maritime transportation system (MTS) - pillar of the national supply chain (90% of imports/exports).
- $4.6 trillion in economic activity every year.
- Vulnerable to wide range of disruptions.
  - This has been in the news…
- Demands continue to increase.
  - Ships getting larger.
  - Channels required to be deeper and wider.
- AIS tells us what vessels are doing.

Congestion at LA/LB . Image courtesy of westeroverseas.com

Evergreen's Ever Given blocking Suez Canal. Image courtesy of bbc.com.

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The Problem of Money

- Can't maintain all channels to authorized depth with resources available to us.
- Ensure good stewardship of USACE dredging dollars – "most bang for the buck".
- USACE allocates maintenance funding based on:
  - the criticality of a port – tonnage.
  - channel usage - projected by channel design prior to construction/deepening.
  - Impacted navigation - shoaling frequency.
- Historical approach used best information available at the time.
- More tools available now.
- Measure demand for available depth, observe impacted navigation.

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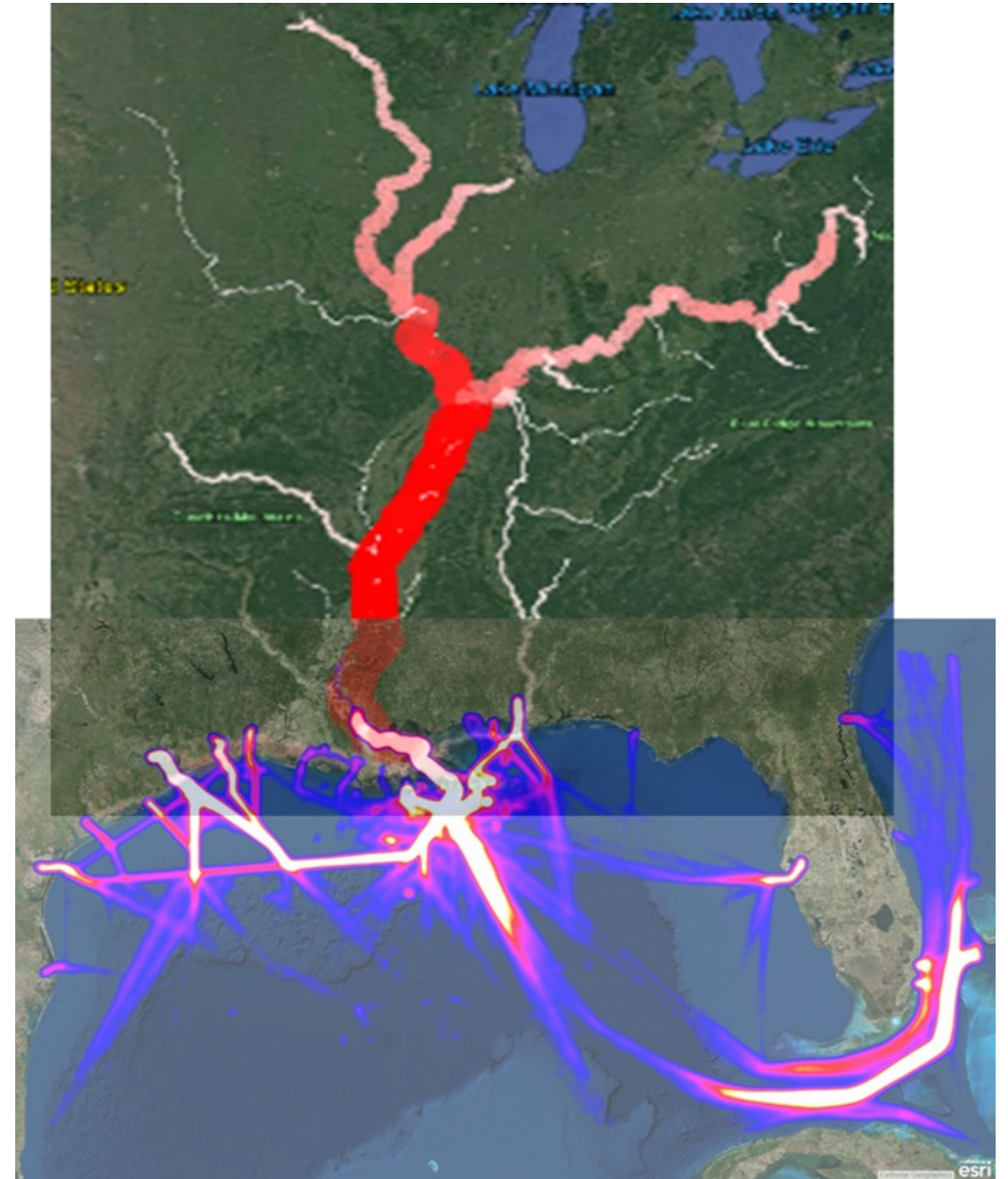
# AIS-derived Metrics for Waterway Maintenance

- Calculate the underkeel clearance.
  - Directly measures benefit of dredging to transiting vessels.
  - Identify channel restriction locations.
  - Conversely, identify areas where shoaling is not impacting vessels.
- Map of the shipping route of every vessel.
  - Volume of traffic by vessel type through time.
  - Describe entire network of port traffic.
  - Use 'connectedness' to describe port importance.
  - Identify overlooked critical ports.
- How <u>important</u> is it to keep this waterway open and <u>how much</u> are vessels taking advantage of our dredging.

- Mobile, AL
- Savannah, GA
- Tampa Bay, FL
- Pascagoula, MS
- Charleston, SC
- Port Everglades, FL
- Jacksonville, FL
- San Juan, PR
- Miami, FL
- Wilmington, NC
- Brunswick, GA
- Palm Beach, FL
- Canaveral, FL

Underkeel Clearance Metrics
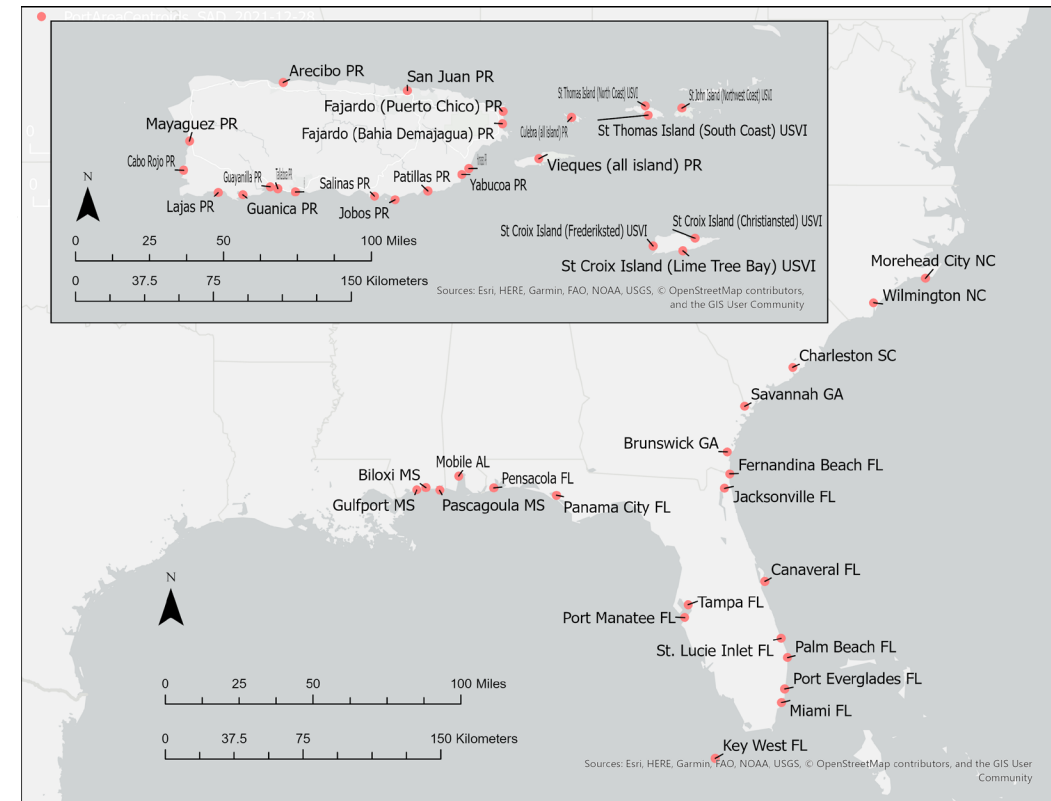
- Vessel Clearance Metrics
- Marine Cadastre AIS:
  - LAT/LNG.
  - Time.
  - Ship ID.
- AVIS list:
  - Vessel horizontal dimensions.
  - Vessel type.
- Vessel draft – Foreign Vessel Entrances & Clearances (IWR 2018).
  - This is controls recency of data we can provide.
- Bathymetry - eHydro survey data.
- WL data - NOAA tide stations.
- For entire U.S., can measure user demand for depth.
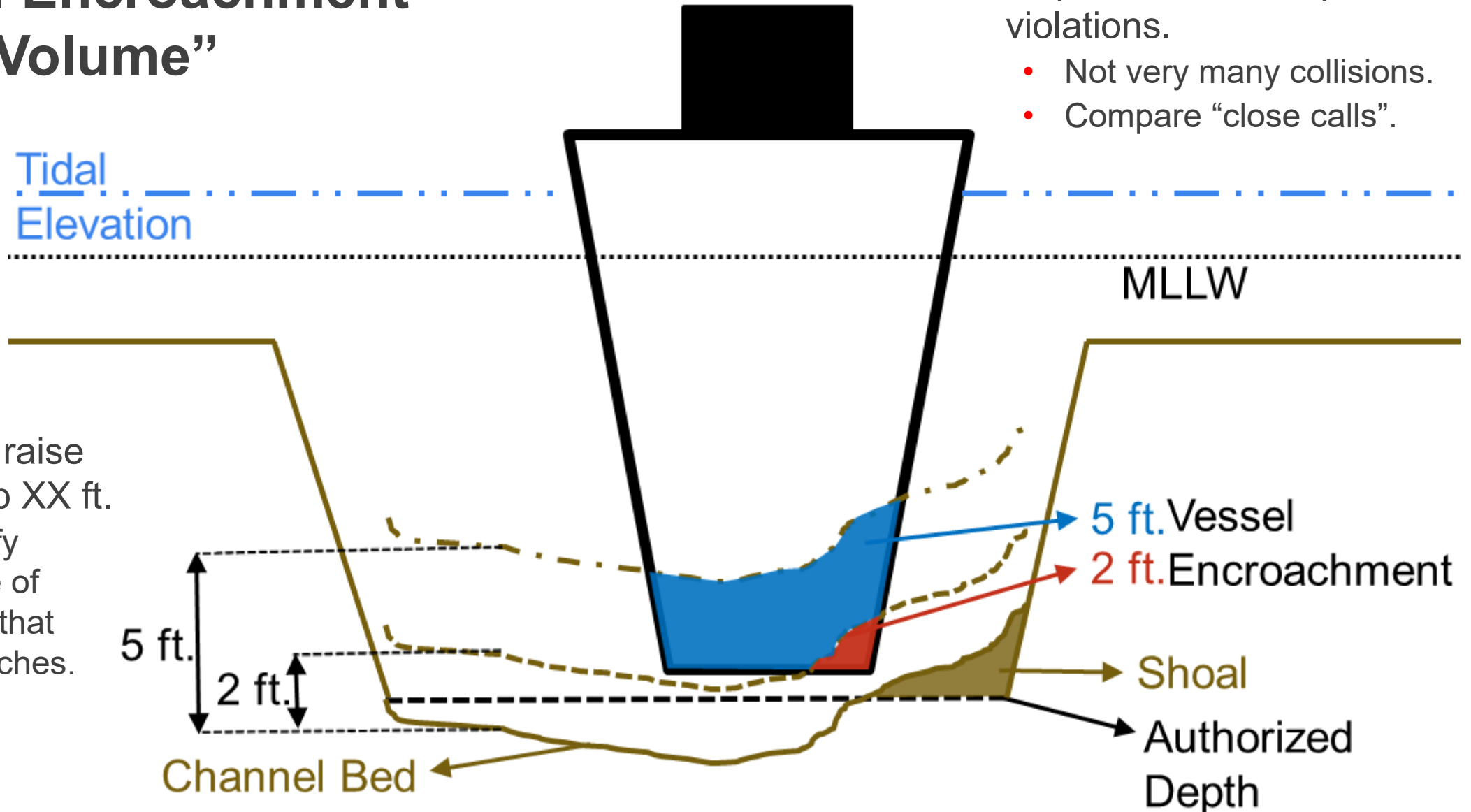- A lot of data (30 TB on HPC).
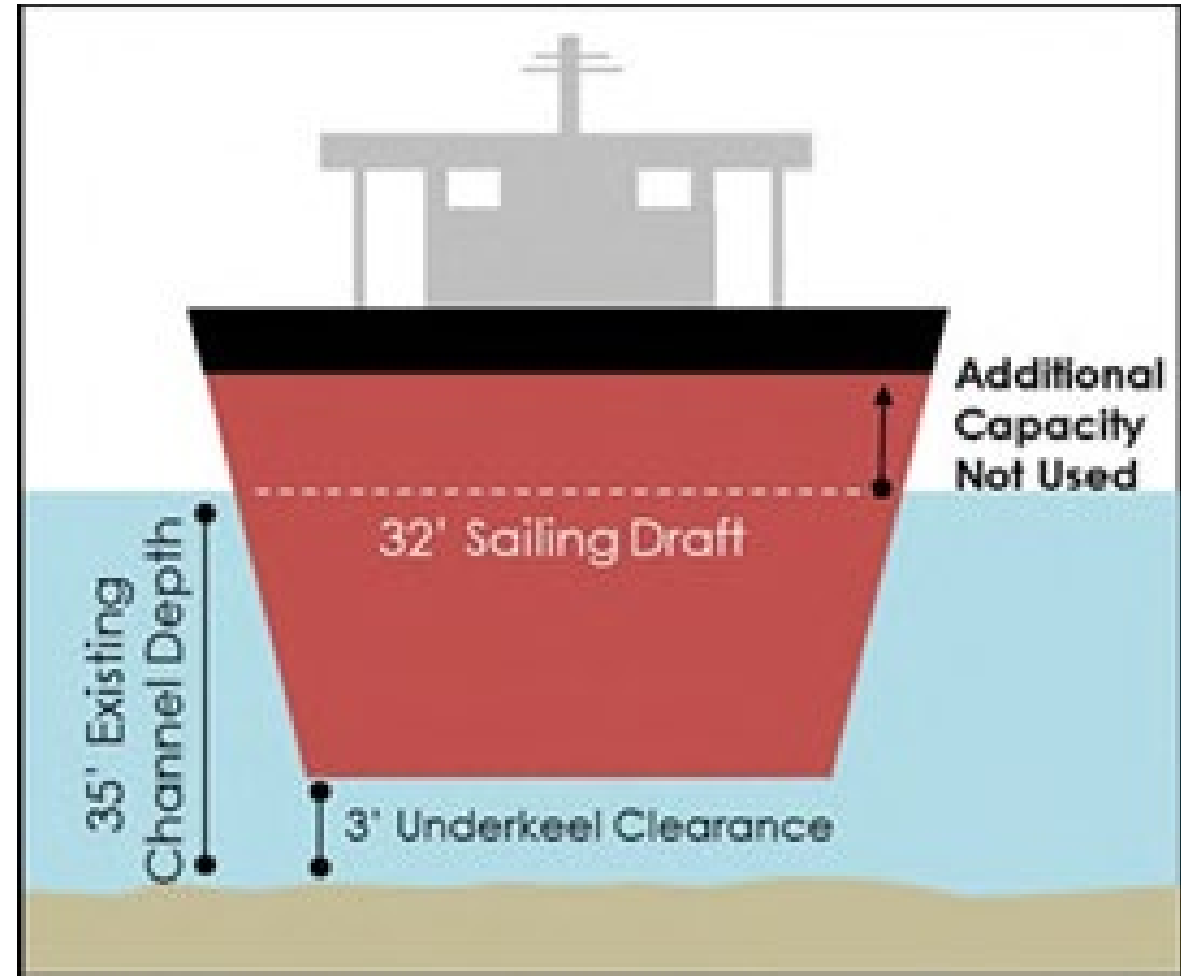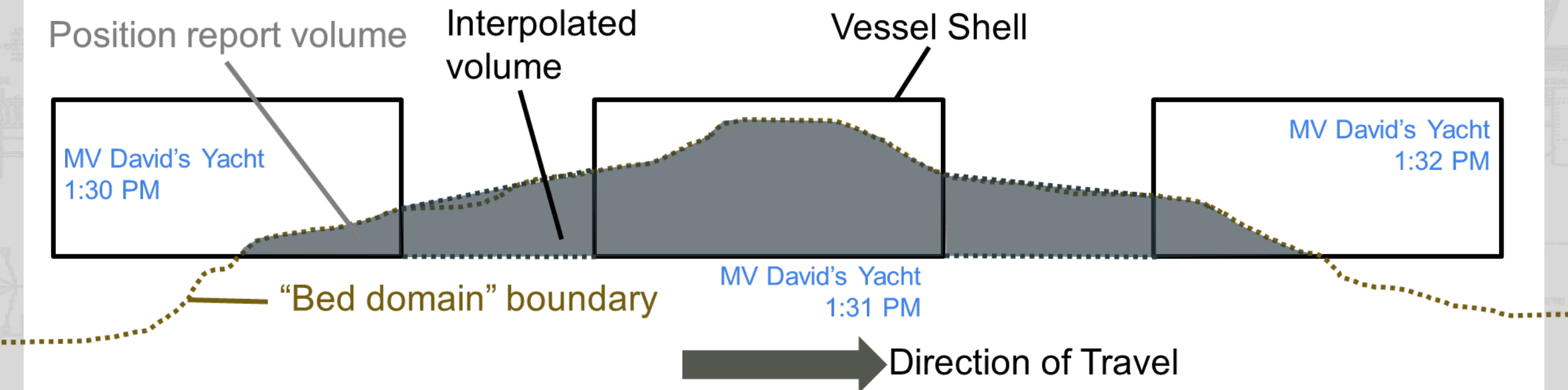
"Vessel Encroachment Volume"

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

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

Tidal Elevation

MLLW

5 ft. Vessel

2 ft. Encroachment

Shoal

Authorized Depth

5 ft.

2 ft.

Channel Bed

"Vessel Encroachment Volume, cont."

- 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.
- Easy to roll up.

Position report volume

Interpolated volume

Vessel Shell

MV David's Yacht
1:30 PM

MV David's Yacht
1:32 PM

"Bed domain" boundary

MV David's Yacht
1:31 PM

Direction of Travel

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So What – Vessel Encroachment Volume

- Think like a company…
- USACE provides a service to carriers.
  - Supply available depth through dredging.
  - Quantify supply through surveys.
  - Know how much it costs.
- Basic economic theory for efficient resource allocation.
  - Not enough to know supply.
  - Need to know user <u>demand</u>.
- Vessel encroachment volume.
  - This is user demand.
  - How much are shippers demanding deepest part of channel.
- 2 ft. vs. 5 ft. – segregate demand by risk of failure.
- Not making decisions, simply informing them (Hatch Act…).

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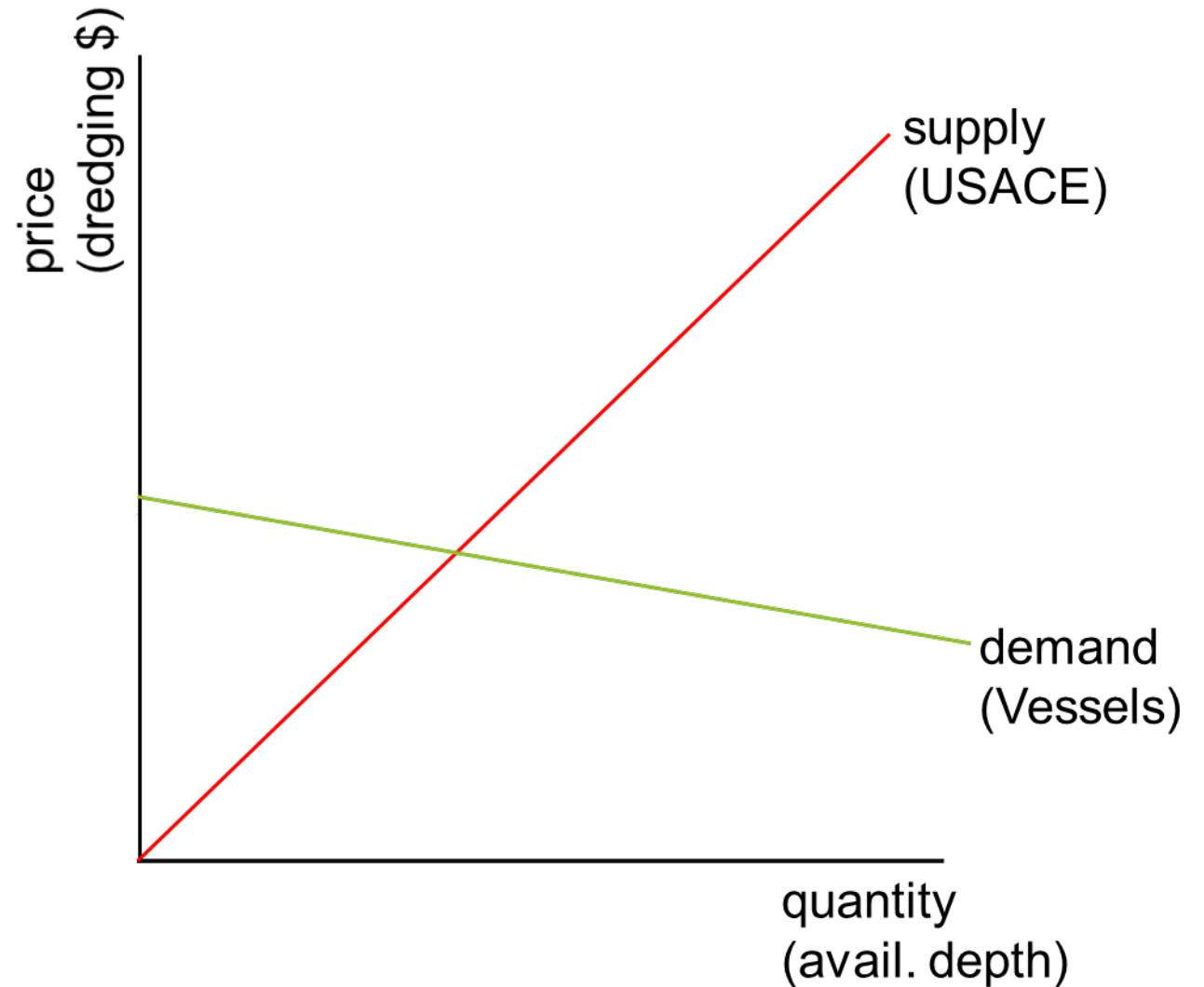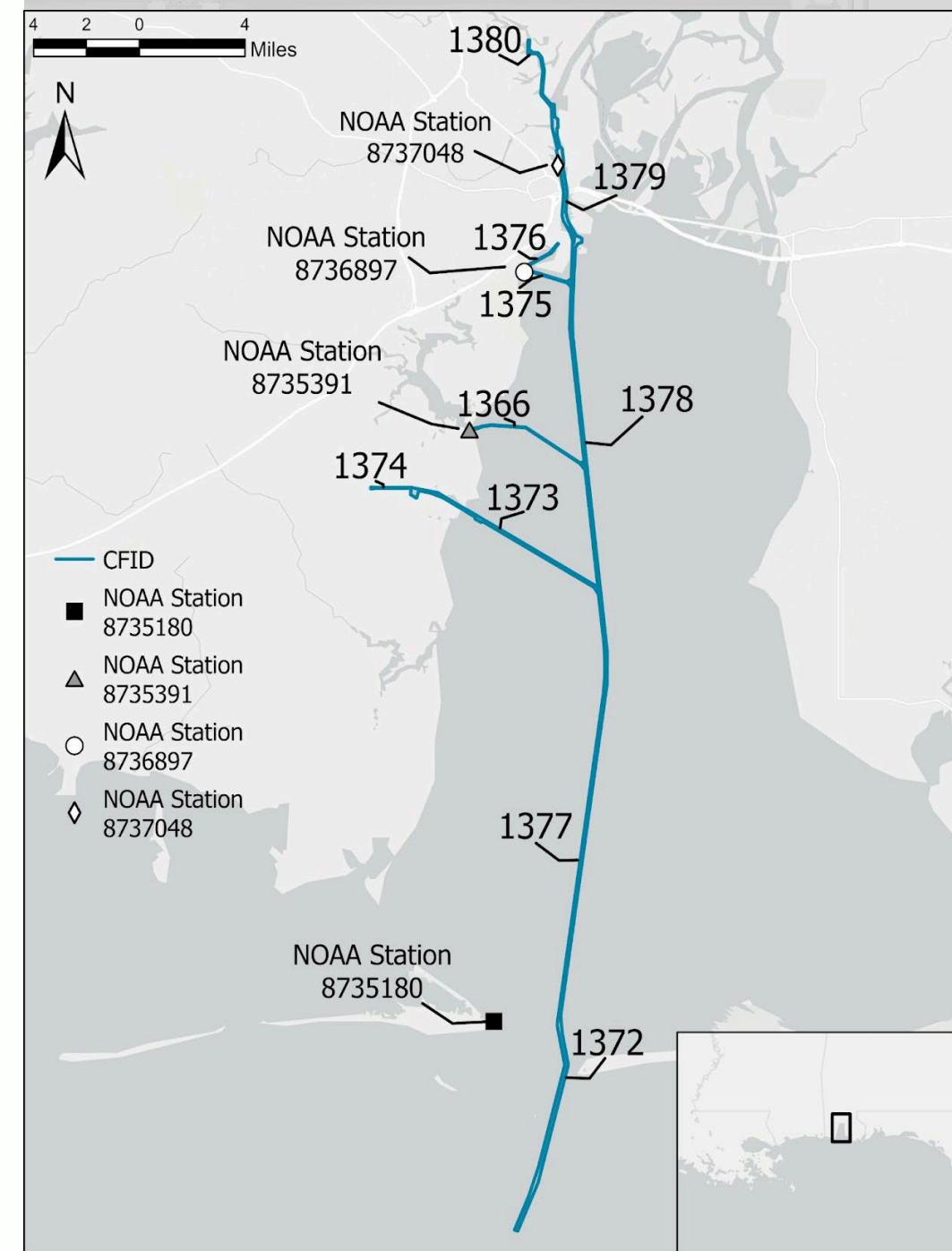
Reimbursable for SAJ

- Calculate for 13 SAD ports.
  - Mobile, AL
  - Savannah, GA
  - Tampa Bay, FL
  - Pascagoula, MS
  - Charleston, SC
  - Port Everglades, FL
  - Jacksonville, FL
  - San Juan, PR
  - Miami, FL
  - Wilmington, NC
  - Brunswick, GA
  - Palm Beach, FL
  - Canaveral, FL

Top 10 in SAD by tonnage

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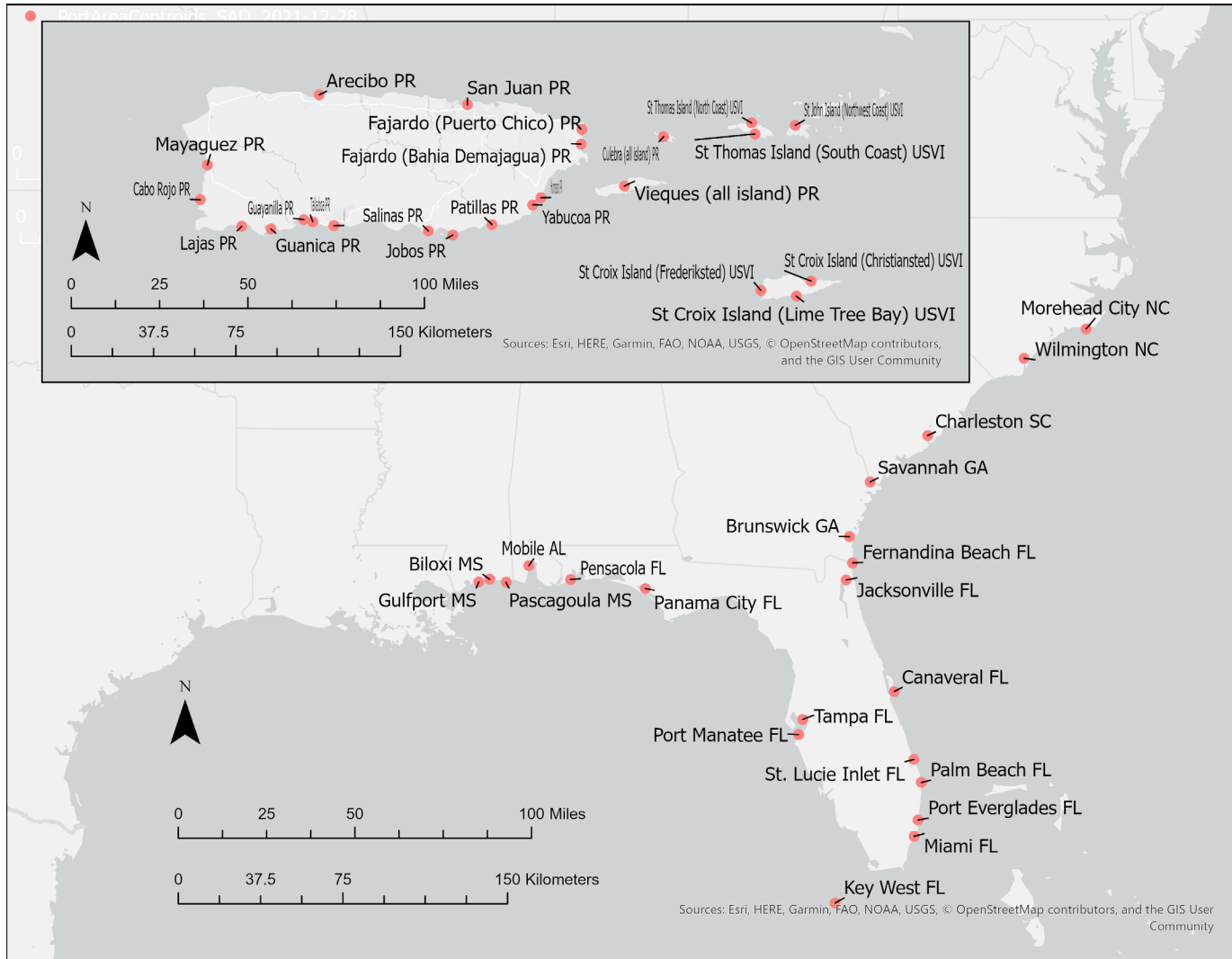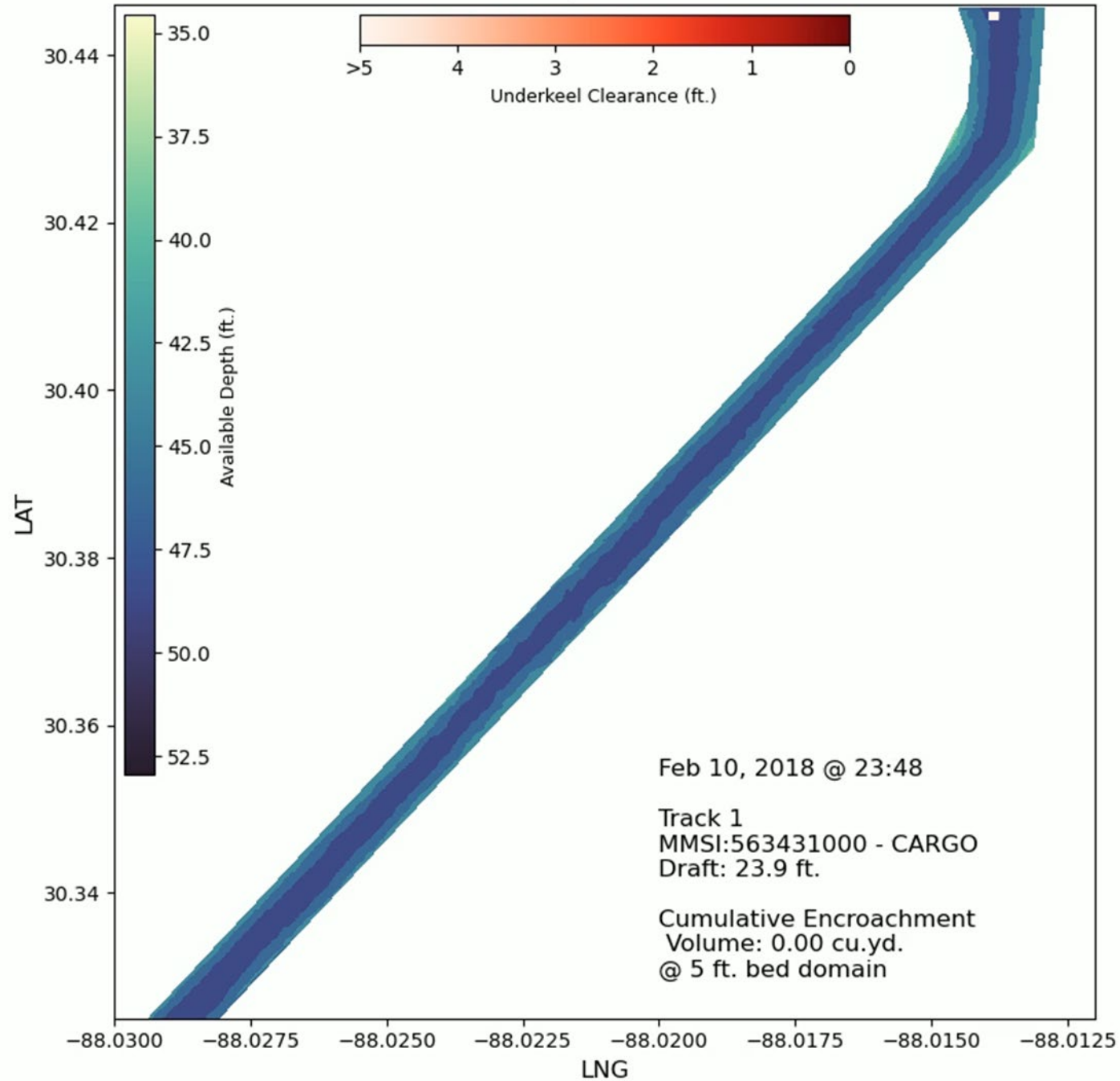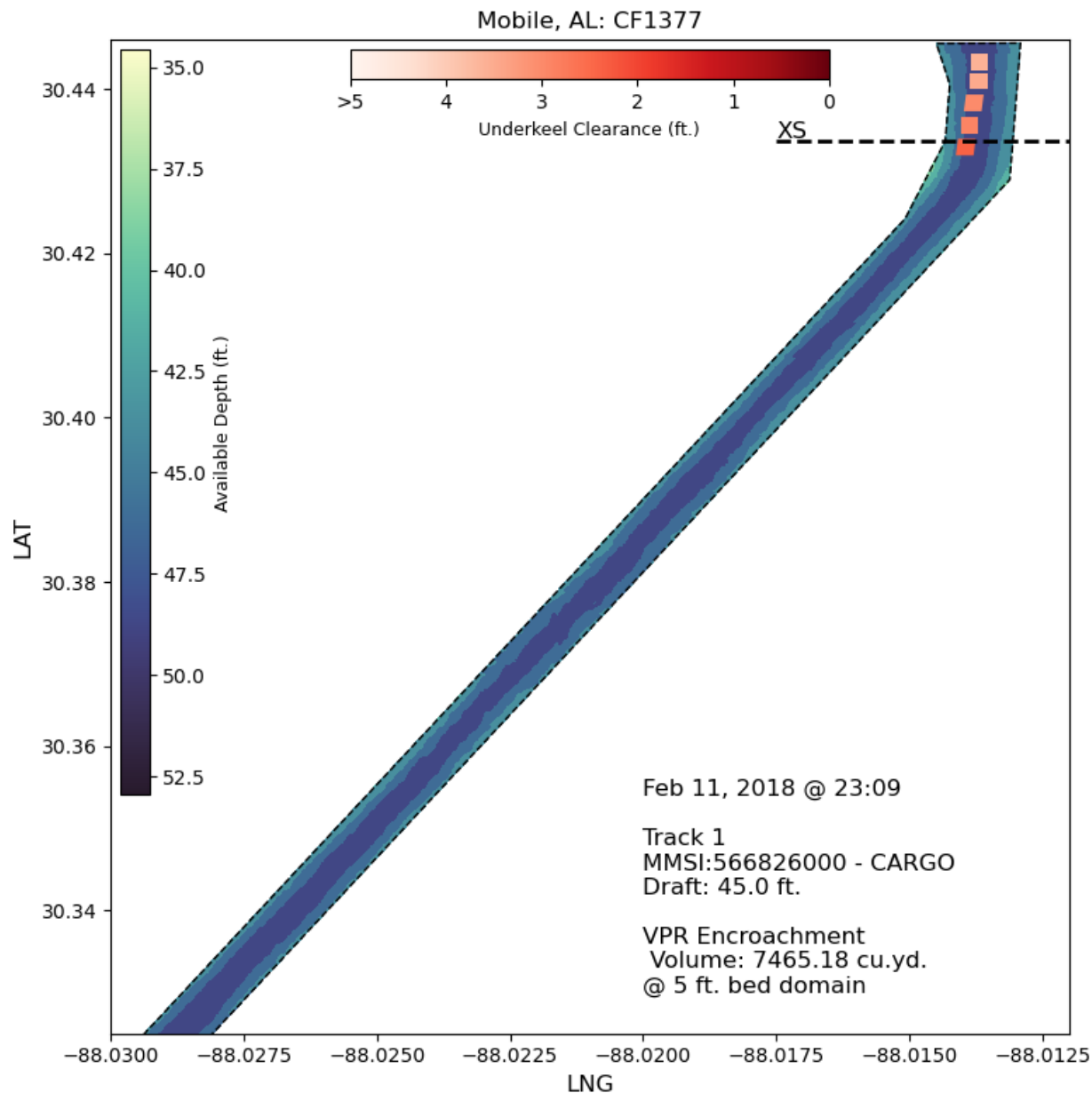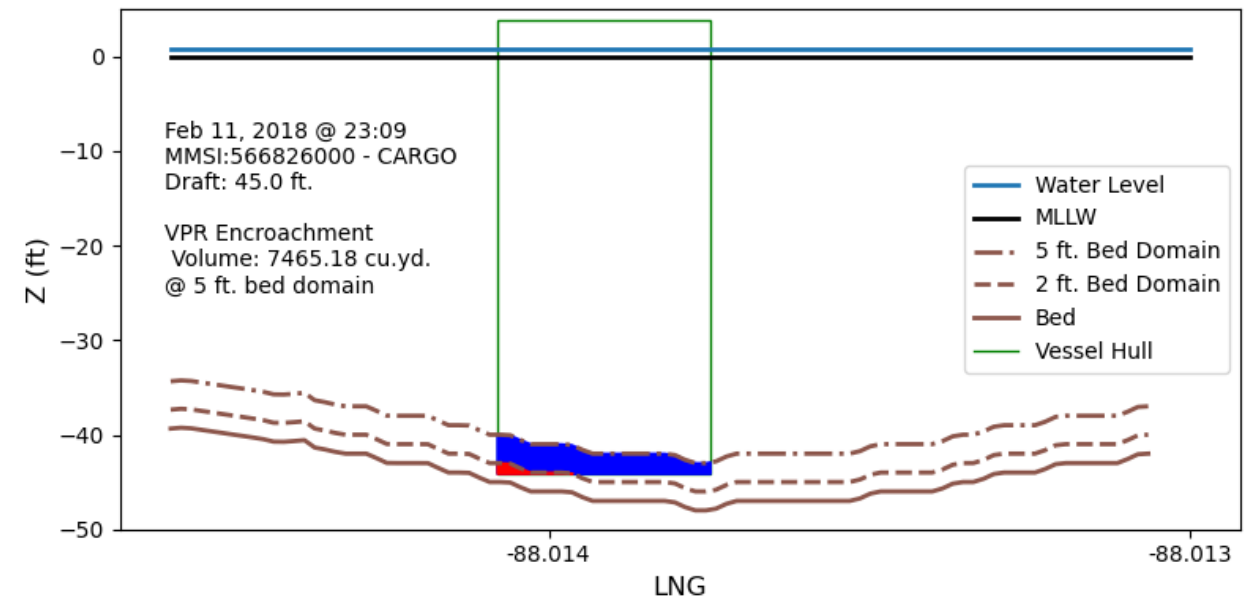
In Cross Section

For cross-section figure above:
- Shaded blue + red – vessel encroachment volume (VEV) for 5 ft. bed domain.
- Shaded red – VEV for 2 ft. bed domain.

Savannah, GA

"Vessel Encroachment Volume" (VEV) at 2 ft. "Bed Domain "per year by CFID (M. cu.yd. X transits)

Year	Transits	Enc. Transits	VEV
2015	2815	644	9.359
2016	2694	526	7.888
2017	2486	354	6.032
2018	2292	311	5.496

- 2nd largest port in SAD by tonnage.
- Has the largest avg. 2 ft. VEV.
- 4th if you normalize by the number of transits that encroach on the bed.

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Port Everglades, FL

"Vessel Encroachment Volume" (VEV) at 2 ft.
"Bed Domain "per year by CFID (M. cu.yd. X transits)

Year	CF2158 - Trans.	CF2158 - Enc. Trans.	CF2158 - VEV	CF2180 - Trans.	CF2180 - Enc. Trans.	CF2180 - VEV
2015	3238	2	0	2506	2	0
2016	3266	3	0.001	2588	0	0
2017	3162	3	0	2543	0	0
2018	3215	2	0.001	2506	0	0

Year	Total - Trans.	Total - Enc. Trans.	Total - VEV
2015	3238	4	0
2016	3266	3	0.001
2017	3162	3	0
2018	3215	2	0.001

- 5th by tonnage.
- 13th by 2 ft. VEV.
- Also 13th if normalized by # encroaching transits.

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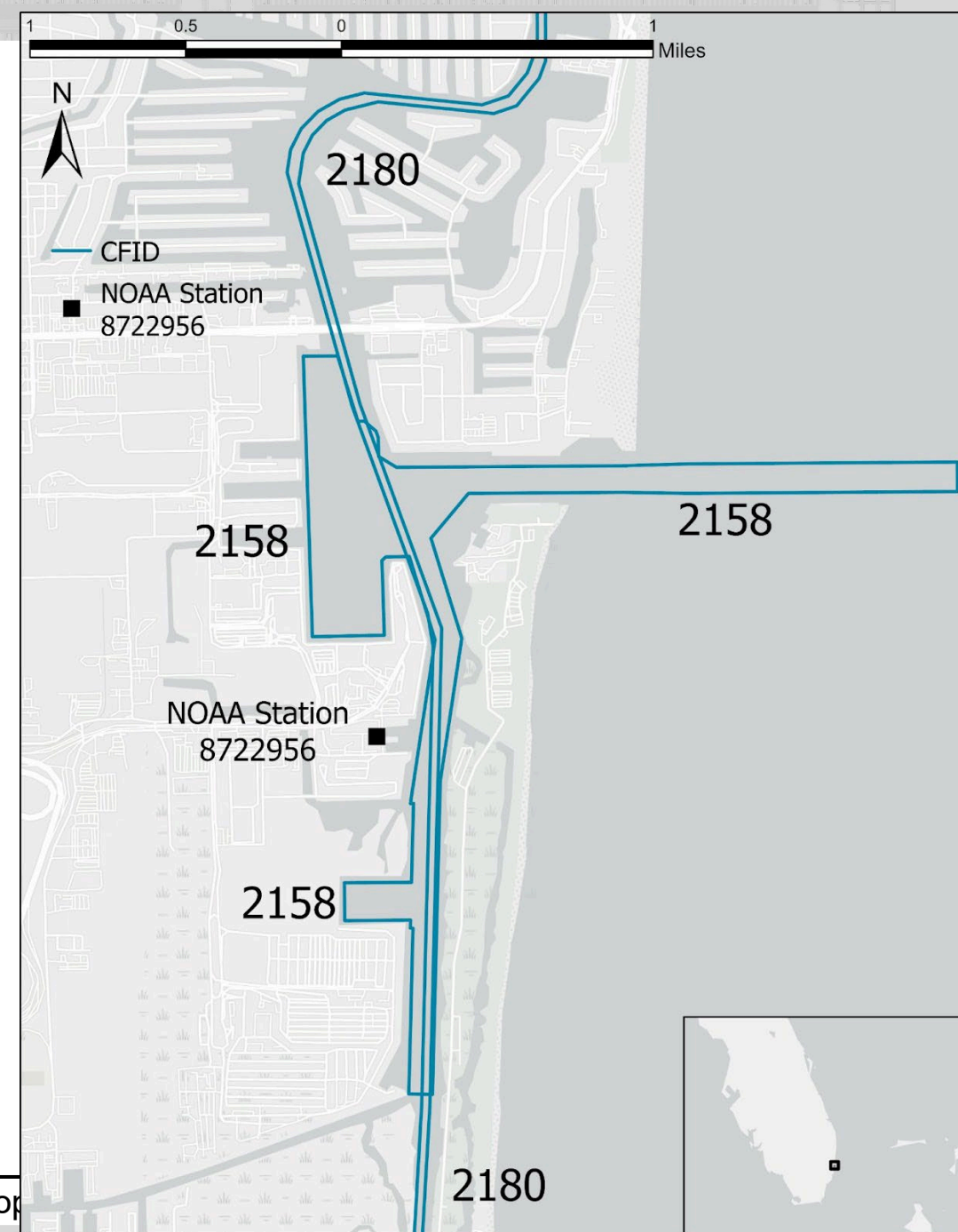
2 ft. Vessel Encroachment Volume for All Ports

Port	Avg. 2 ft. VEV (Mcy × T)	Avg. 2 ft. ET (#)	Avg. 2 ft. VEV per ET (cy)	Rank - 2 ft. VEV (Δ)	Rank - 2 ft. VEV per ET (Δ)
Mobile, AL	5.85	125	46262.58	2 (-1) ⬇	1 (0) ➡
Savannah, GA	7.19	459	16060.1	1 (+1) ⬆	4 (-2) ⬇
Tampa, FL	1.43	59	23417.05	3 (0) ➡	2 (+1) ⬆
Pascagoula, MS	0.01	6	1794.44	10 (-6) ⬇	11 (-7) ⬇
Port Everglades, FL	0	3	208.33	13 (-8) ⬇	13 (-8) ⬇
Charleston, SC	0.46	31	21497.28	5 (+1) ⬆	3 (+3) ⬆
Jacksonville, FL	0.08	14	5265.15	8 (-1) ⬇	9 (-2) ⬇
San Juan, PR	0.43	28	13494.19	6 (+2) ⬆	7 (+1) ⬆
Miami, FL	0	3	437.5	12 (-3) ⬇	12 (-3) ⬇
Wilmington, NC	0.42	26	15001.93	7 (+3) ⬆	5 (+5) ⬆
Canaveral, FL	0.02	3	14975	9 (+2) ⬆	6 (+5) ⬆
Brunswick, GA	0.86	141	5528.51	4 (+8) ⬆	8 (+4) ⬆
Palm Beach, FL	0.01	2	1937.5	11 (+2) ⬆	10 (+3) ⬆

- User demand for bottom 2 ft. of channel.
- Total demand (2 ft. VEV) OR demand per encroaching transit (2 ft. VEV per ET).
- Compare with port's tonnage.
- Pretty chalky at the top (Mobile, Savannah, Tampa).
- Pascagoula and Port Everglades fall the most.

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2 ft. VEV vs. Cost/Amount Dredged

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.

- Alternative management metrics considering user demand.
- Ratio of dredge volume to encroachment volume.
- Dredge $$ per transit within 2 ft. of bed.
  - Purchasing safe transits of deep drafting vessels.
- Smaller values (greener) = greater user demand relative to dredge volume/cost.
- Includes unit cost of dredging.
  - Tampa (2nd to 4th) vs. Pascagoula (13th to 5th).

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dVEV (5 ft. – 2 ft.) 2 ft. VEV Cost to Dredge

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 – this average annual cost represents the sum for both. [2]No dredging expenditure is recorded in DIS for 2015-2018.

- 2 ft. VEV says which ports benefit from additional investment.

- Finite dredging resources available.

- dVEV (5 ft. – 2 ft.) to tell which ports would be least impacted by reduction.
  - How many additional vessels would be impacted if channels shoaled in 3 ft.

- Higher values (redder) = more impact.

- Port Everglades and Miami are great ports!

- Pascagoula example of port with low dVEV and less impact from reduction.

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So What – Underkeel Clearance

- Harbor Maintenance Trust Fund (HMTF)
  - "Obligates exporters, importers, and domestic shippers… to pay 0.125 percent of commercial cargo value".
  - Money goes to maintain federal ports & connecting waterways.
  - Collected $1.8 Billion in 2017.
  - USACE gets a lot of this…
- United States v. United States Shoe Corp. (1998).
  - Supreme Court ruled against U.S.
  - Violates the Export Clause of Constitution.
  - Means that exports don't pay into HMTF.

Syllabus

NOTE: Where it is feasible, a syllabus (headnote) will be released, as is being done in connection with this case, at the time the opinion is issued. The syllabus constitutes no part of the opinion of the Court but has been prepared by the Reporter of Decisions for the convenience of the reader. See *United States* v. *Detroit Timber & Lumber Co.*, 200 U. S. 321, 337.

SUPREME COURT OF THE UNITED STATES

Syllabus

UNITED STATES *v.* UNITED STATES SHOE CORP.

CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

No. 97–372.   Argued March 4, 1998—Decided March 31, 1998

riod April to June 1994 and then filed a protest with the Customs Service alleging that, to the extent the toll applies to exports, it violates the Export Clause, U. S. Const., Art. I, §9, cl. 5, which states: "No Tax or Duty shall be laid on Articles exported from any State." The Customs Service responded to U. S. Shoe with a form letter

What Does That Have to Do With Underkeel Clearance?

- Pace v. Burgess, 92 U. S. 372, 375–376.
  - Export Clause does not rule out "user fee".
  - Example - stamps.
- United States v. United States Shoe Corp. (1998).
  - Problem was connection between service rendered and compensation.
  - Fee has to match use of services.
- Underkeel clearance
  - Available depth is USACE service.
  - This <u>measures</u> how much each ship uses channel depth.
  - Prior to US v. USSC exports paid ~30% of HMTF (Fritelli 2011).
 - $1.8 -> $2.6 Billion per year (mostly to USACE).
  - Makes it "fair".

imposing any tax on exports, *United States v. International Business Machines Corp.*, 517 U. S. 843 *(IBM)*, it does not rule out a "user fee" that lacks the attributes of a generally applicable tax or duty and is, instead, a charge designed as compensation for government-supplied services, facilities, or benefits. see *Pace* v. *Burgess*, 92 U. S. 372, 375–376. The HMT, however, is a tax, and thus violates the Export Clause as applied to exports. Pp. 3–9.

time-tested *Pace* decision. The *Pace* Court upheld a fee for stamps placed on tobacco packaged for export. The stamp was required to prevent fraud, and the charge for it, the Court said, served as "compensation given for services [in fact] rendered." 92 U. S., at 375. In
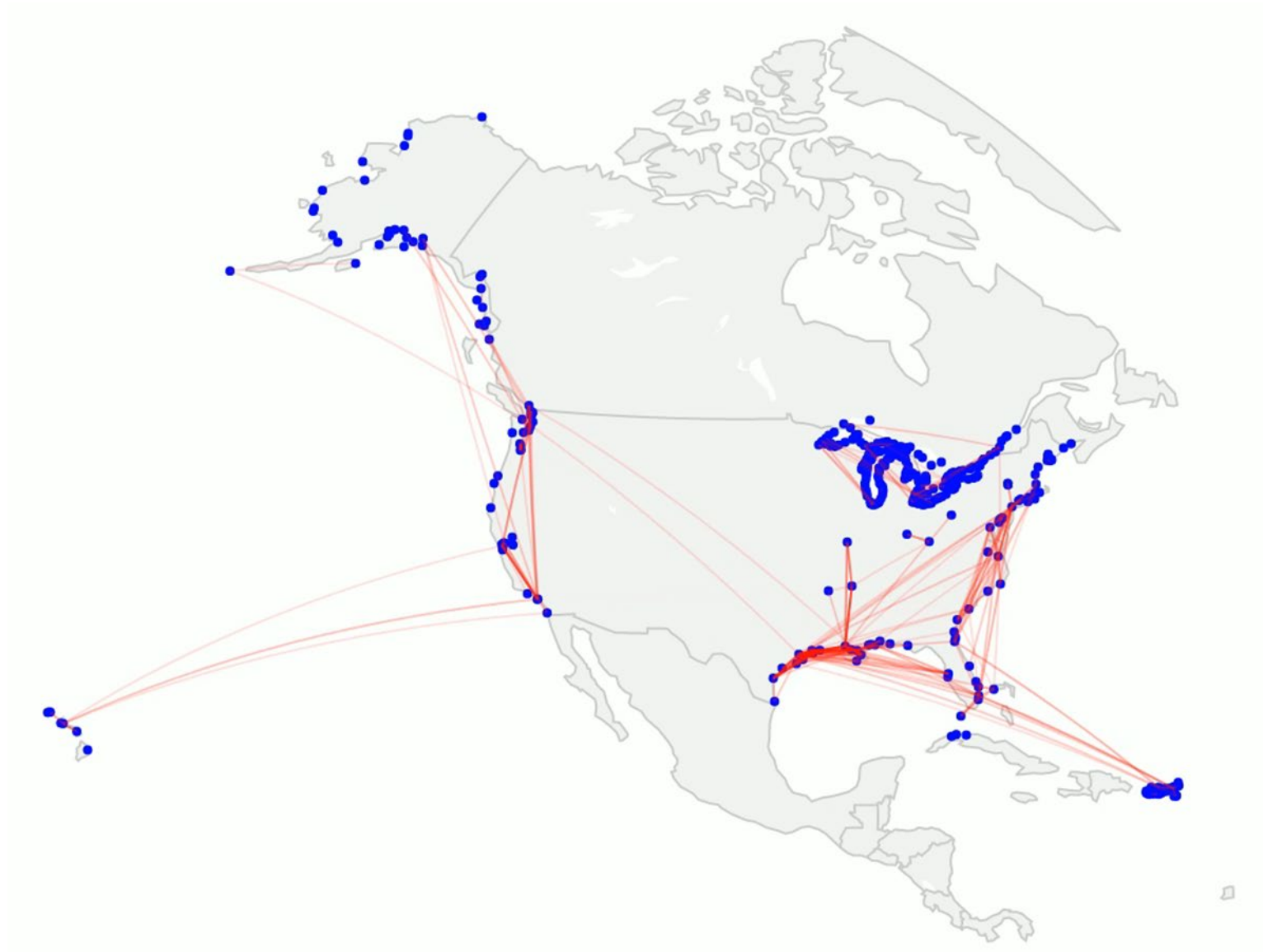
Clause, the connection between a service the Government renders and the compensation it receives for that service must be closer than is present here. Unlike the fee at issue in *Pace*, the HMT *is* deter-

maintenance. It does mean, however, that such a fee must fairly match the exporters' use of port services and facilities. Pp. 7–9.

New Stuff for FY24
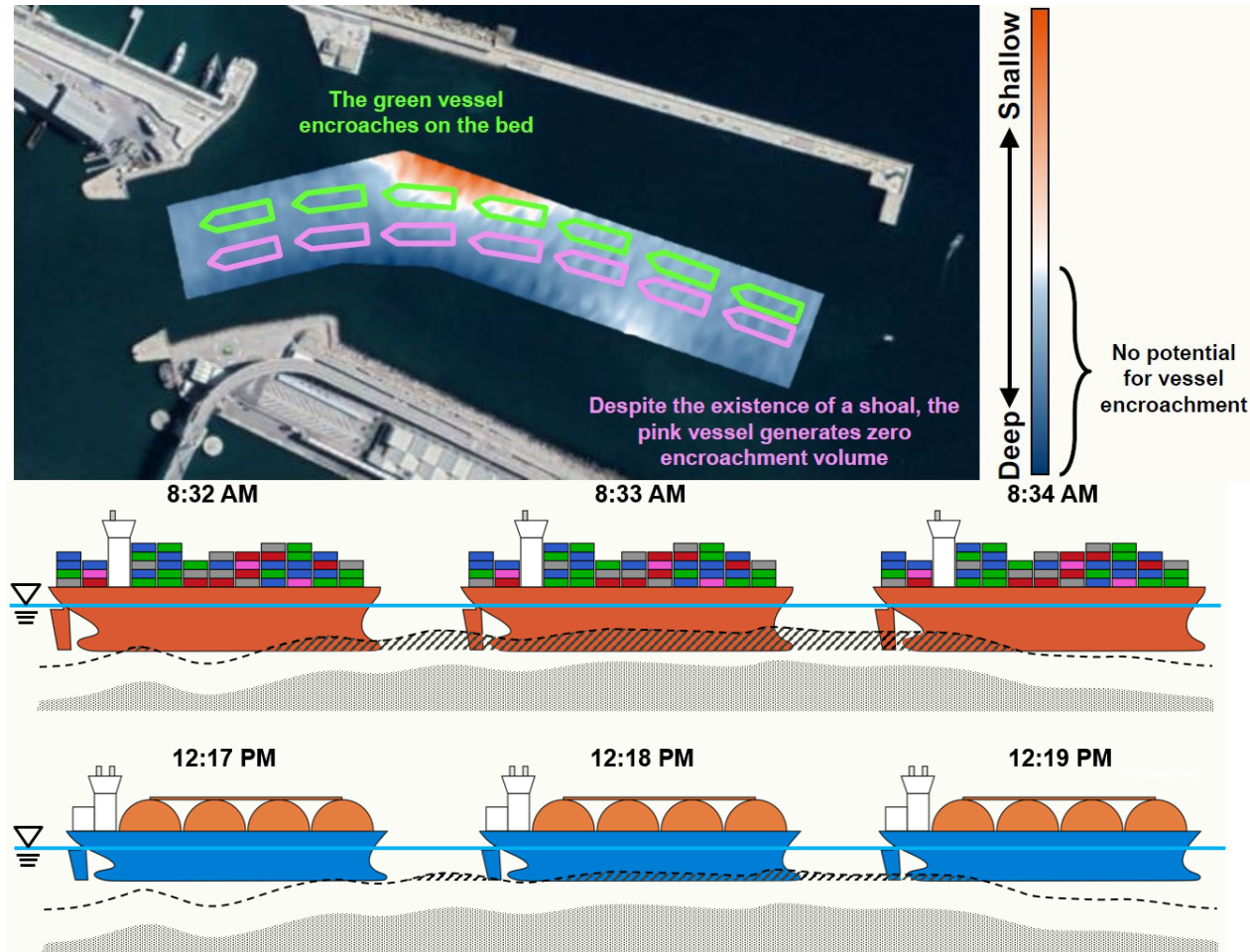
- New reimbursable for SAJ/SAD started this month.
  - Every deep draft port in SAD.
  - Up to 2021 (2022 depending on E&C data).
- Porting to NavPortal Module.
  - Scale up & out to all districts.
- New metrics.
  - Crossover w/ CSAT team.
  - Volume necessary to remove to prevent encroachment.
  - Compare to the volume dredged for dredge efficiency score.

Questions?

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