TRACKING THE MARINE TRANSPORTATION SYSTEM WITH THE NATIONAL AUTOMATIC IDENTIFICATION SYSTEM

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Innovations in Freight Data Workshop

10 April 2019

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ERDC Engineer Research and Development Center

US Army Corps of Engineers ®

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DEPARTMENT OF TRANSPORTATION UNITED STATES OF AMERICA

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MOTIVATION

1. US Army Corps of Engineers (USACE) Navigation Mission: To provide safe, reliable, efficient, effective and environmentally sustainable waterborne transportation systems for movement of commerce, national security needs, and recreation.

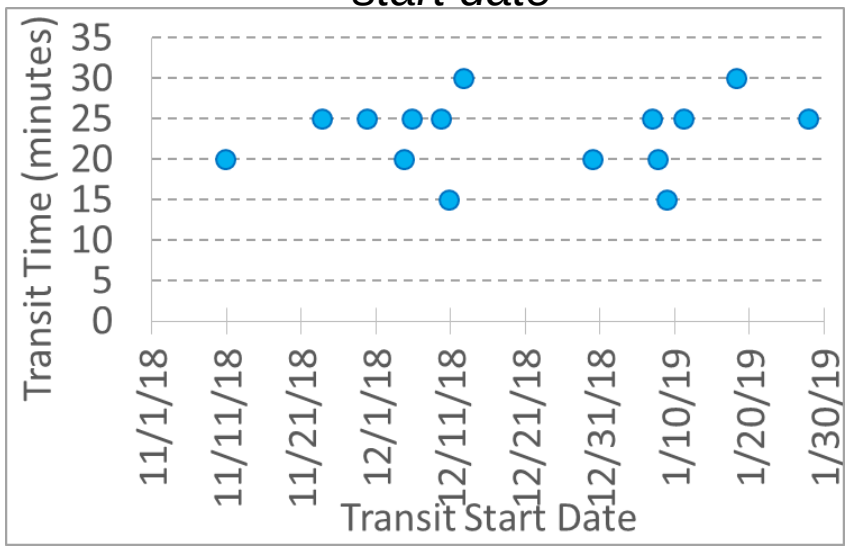
2. The USACE needs quantitative and statistically robust metrics to support its Navigation Mission.

Wilson Lock auxiliary chamber

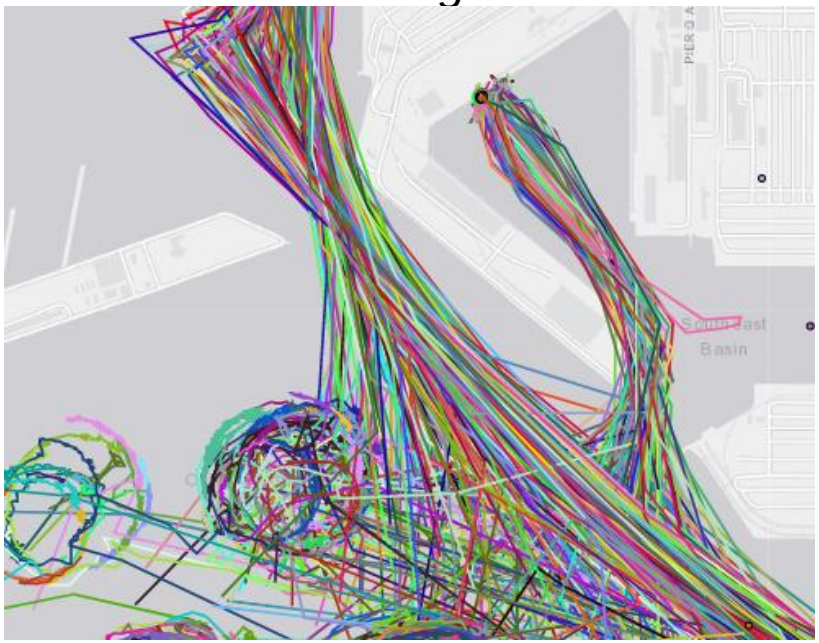
OBJECTIVE:

- Provide waterway transportation statistics
  - For waterway managers and stakeholders
  - Inform **Who, What**, **Where**, **When**, and **Why** of waterway transits
  - Available for **planning**, in **real-time**, and in **retrospect**

Vessel transit times by transit start date



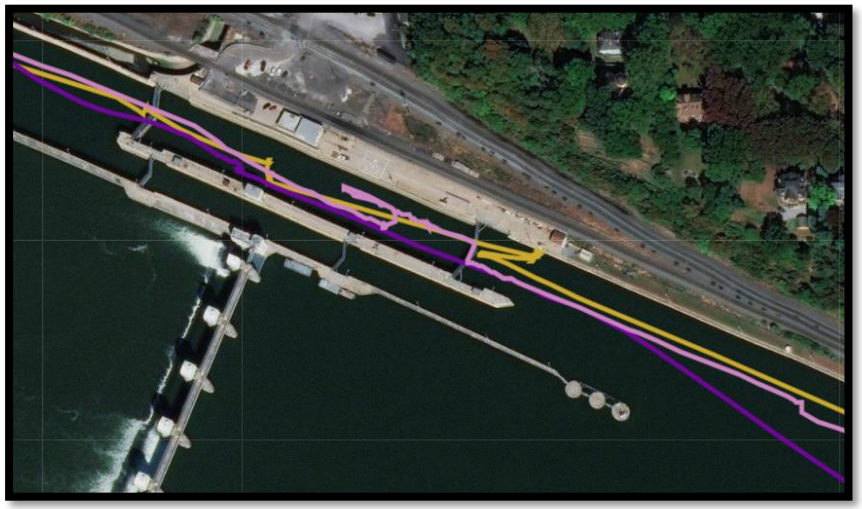
Tanker ship transits in Port of Long Beach



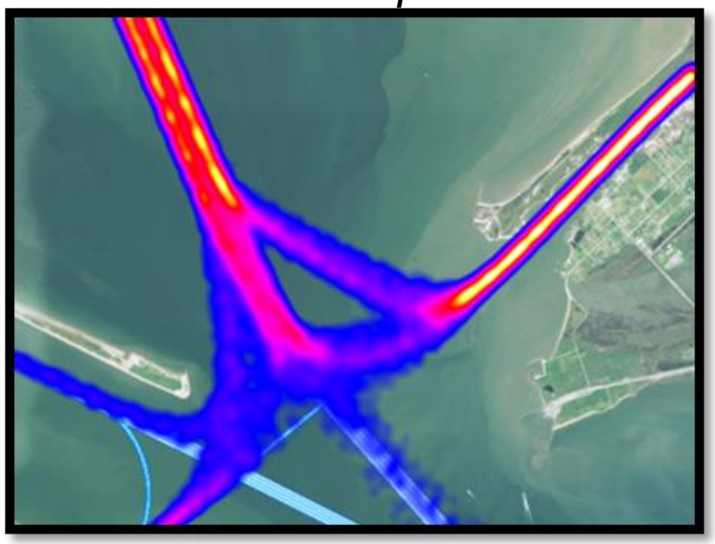
EXAMPLE APPLICATIONS OF THE STATISTICS

- How long do vessels spend at anchorage?
- What variables affect vessel transit time?
- Where are system bottlenecks?
- Has MTS LOS changed over time or after an event?
- How much delay did an incident cause?

Vessel transits at Emsworth lock



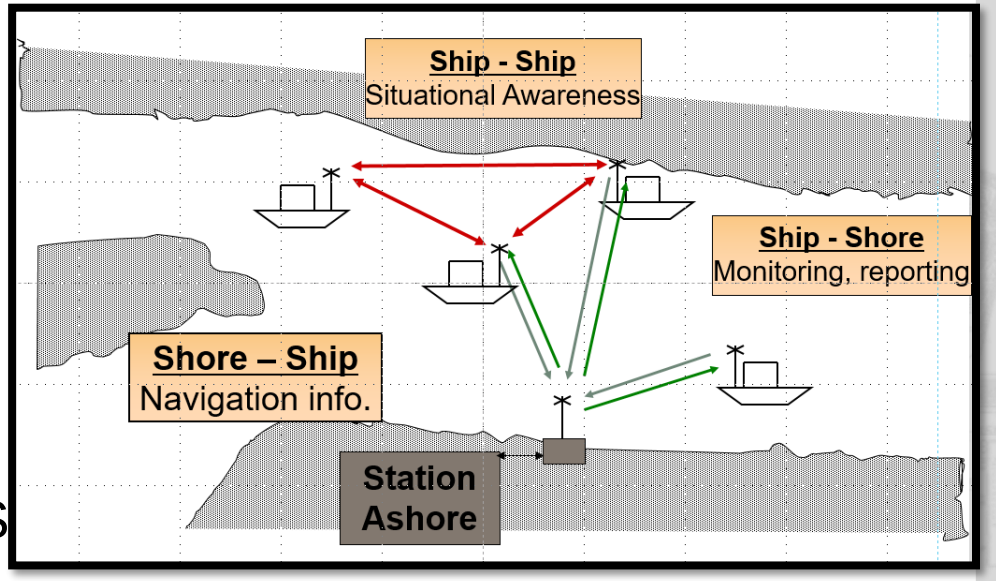
AIS signal mapping at Houston Ship Channel



DATA : AUTOMATIC IDENTIFICATION SYSTEM (AIS)

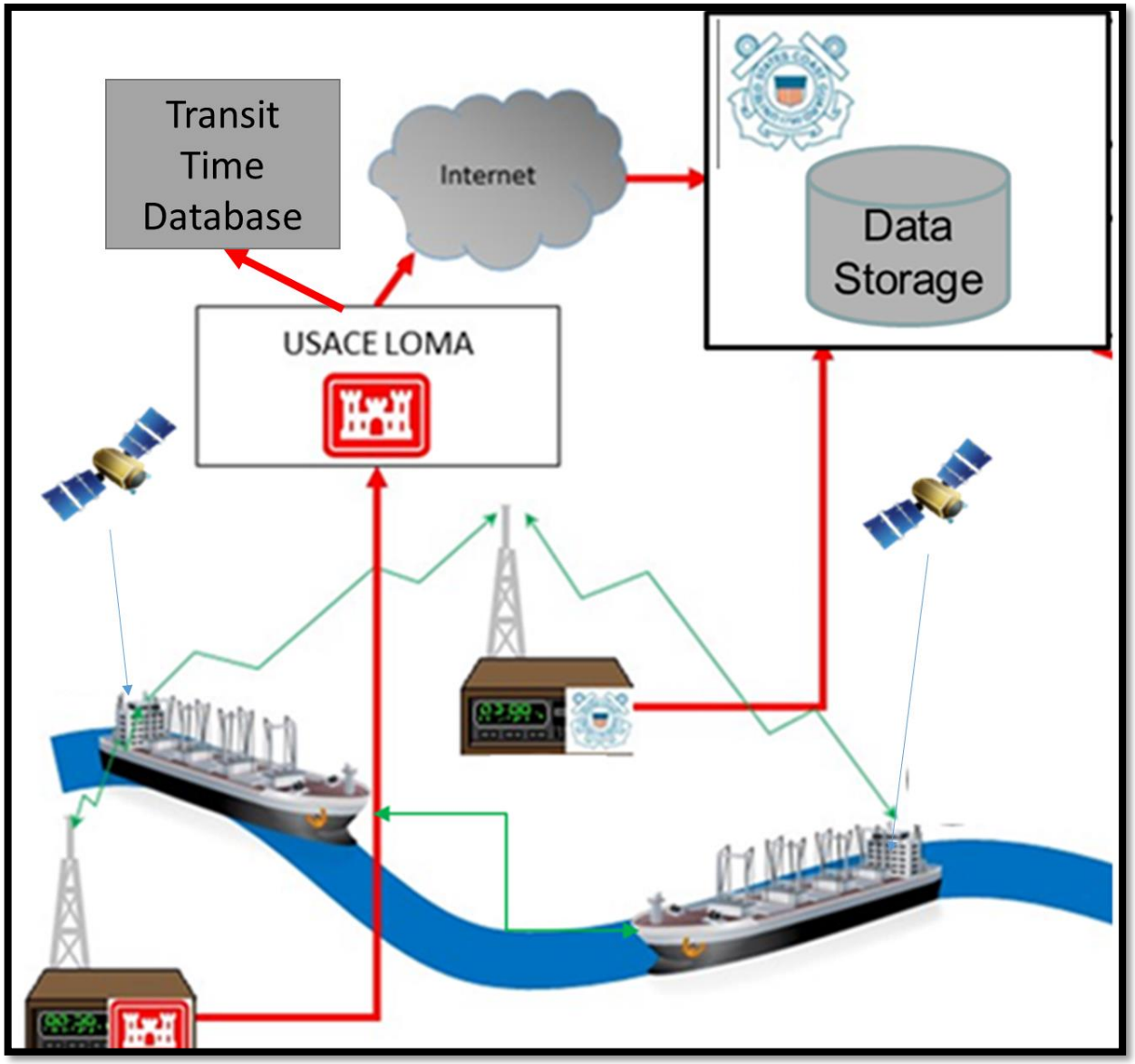
- AIS is a real-time shipboard broadcast system
- Set up for safety, security, and situational awareness
- Information broadcasted:
  - Vessel identification
  - Vessel characteristics
  - Time stamp
  - Location (Lat/Lon) from GPS
  - Speed over ground
- Broadcasts are every few seconds
- Almost all commercial vessels carry AIS
- Receivers are set up along the coastal ports, inland waterways, and Great Lakes collect the broadcasted information
- Satellites can collect the information at sea and internationally

AIS illustration

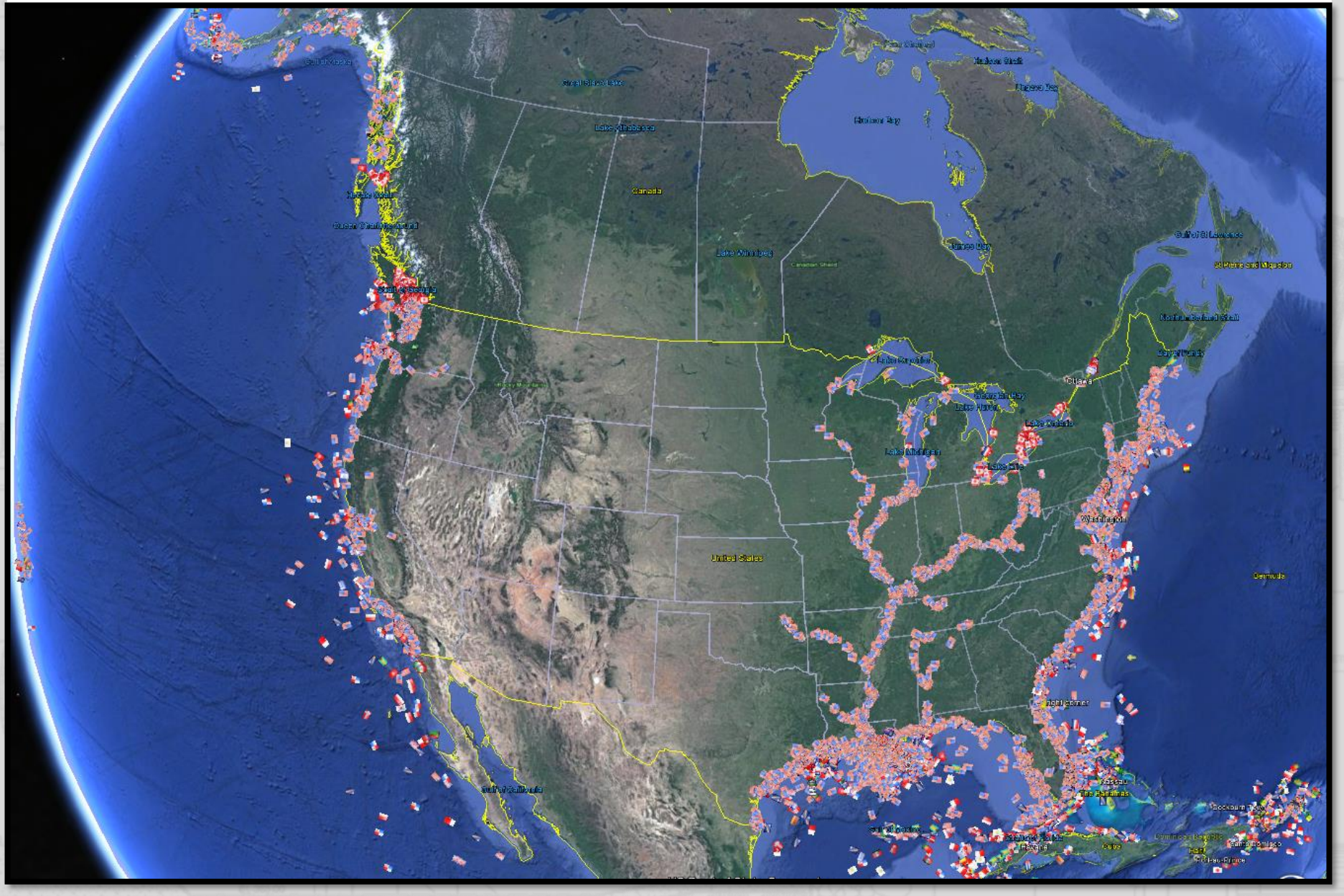


NATIONAL AUTOMATIC IDENTIFICATION SYSTEM (NAIS)

The USCG NAIS consists of an integrated system of AIS receiver sites, data storage, processing, and networking infrastructure.



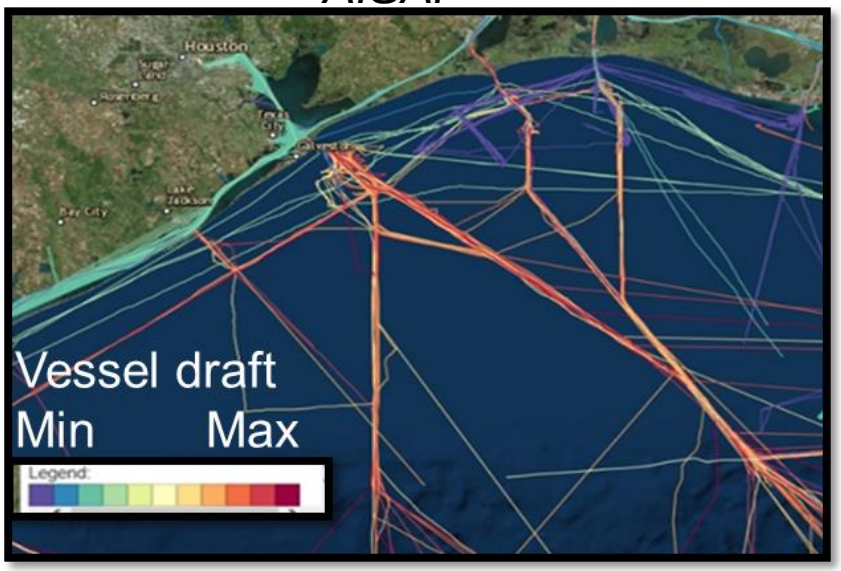
NAIS RECEIVER COVERAGE ILLUSTRATION



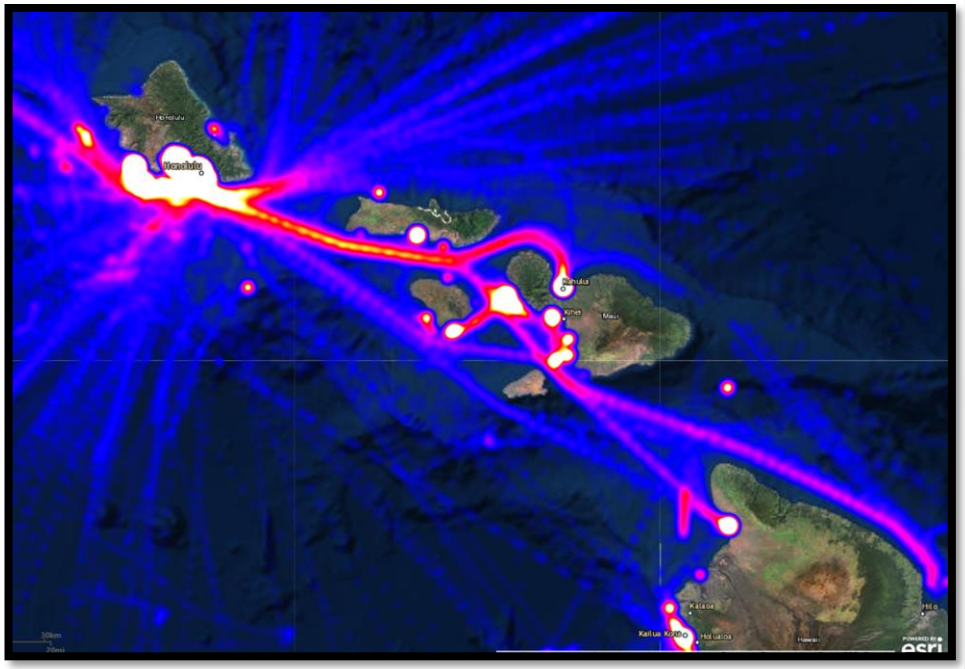
AIS DATA ACCESSIBILITY

- AIS data is available from a variety of sources:
  - For federal agencies:
    - USACE provides a web based tool (AISAP) for accessing and analyzing NAIS data
    - Can contact the USCG directly
  - Commercially available (free & paid subscriptions)
  - Can collect yourself

Vessel tracks by draft developed by AISAP

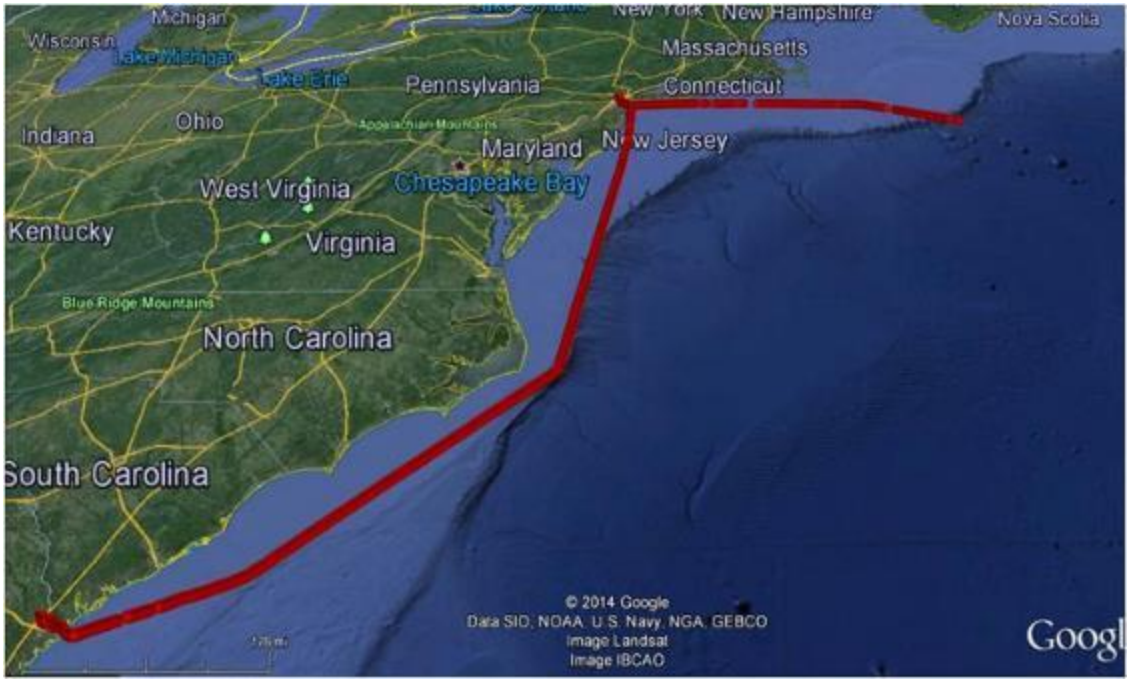


AIS Relative Density Plot developed by AISAP Jan 2019 data



INFERRING TRANSITS FROM AIS DATA

Vessel docked at a port in Bayonne, NJ 12/29/14



Vessel AIS position reports from 12/27/14 through 1/4/15

INFERRING TRANSITS FROM AIS DATA CONTINUED

Bayonne, NJ

Savannah, GA

Estimated travel time = 2 days, 1 hour, and 25 minutes

TX_DTTM	LAT	LON	AOI
12/28/2014 19:30	40.6701	-74.0783	Bayonne
⋮	⋮	⋮	Bayonne
12/31/2014 3:50	40.6679	-74.0750	Bayonne
1/2/2015 5:15	32.1295	-81.1391	Savannah
1/2/2015 5:20	32.1295	-81.1391	Savannah
⋮	⋮	⋮	Savannah
1/4/2015 15:45	32.1294	-81.1389	Savannah

Consecutive entries with different AOI flags indicate an inferred transit between respective locations

METHOD TO SYSTEMATICALLY ESTIMATE TRANSIT TIMES FROM AIS DATA

1. Establish the waterway network
   a. Locate origins and destinations (O-Ds)
   b. Segment the waterway between the O-Ds into links
2. Access Automatic Identification System (AIS) data via the live, national LOMA feed
3. Analyze AIS data to identify vessel transits and associated transit times
4. Identify and remove transit time outliers
5. Estimate statistics

Waterway segmentation location examples:

- Confluences with other waterways,
- Around navigation locks
  - 2 miles upstream to 2 miles downstream of a lock
  - 5 miles upstream to 5 miles downstream of a lock
- Boundaries of dock terminals and mooring areas
- Boundaries of caution areas
- Boundaries of vessel transit data coverage

MONITORING OUR NAVIGABLE WATERWAYS VIA TRANSIT TIMES

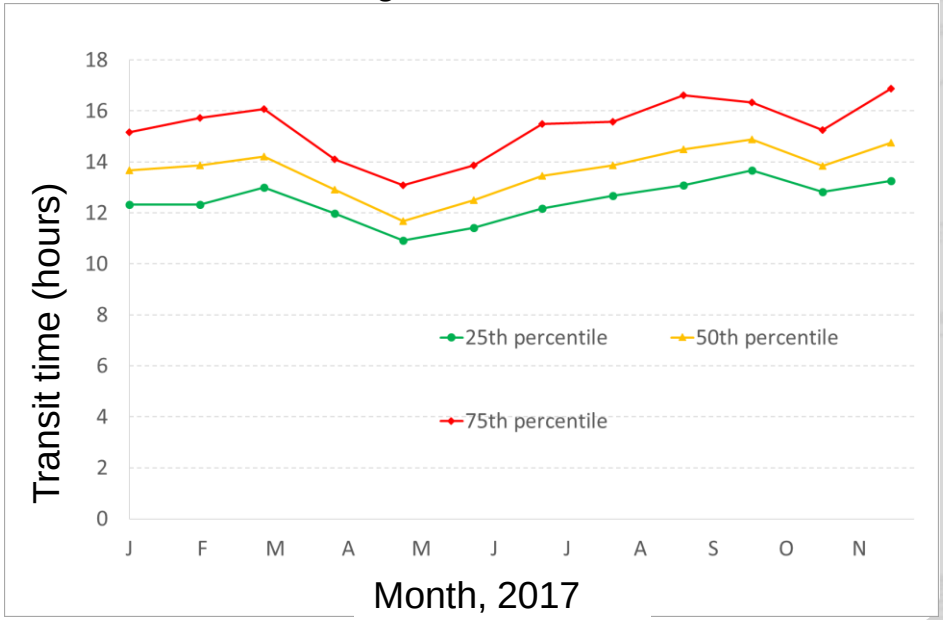
Tool Details:

- Provides waterway transit statistics
  - At both reach (link) level and for O-D pairs
- Updated daily
- Accessible online
- Available to the public
- Applicable to both inland and coastal waterways

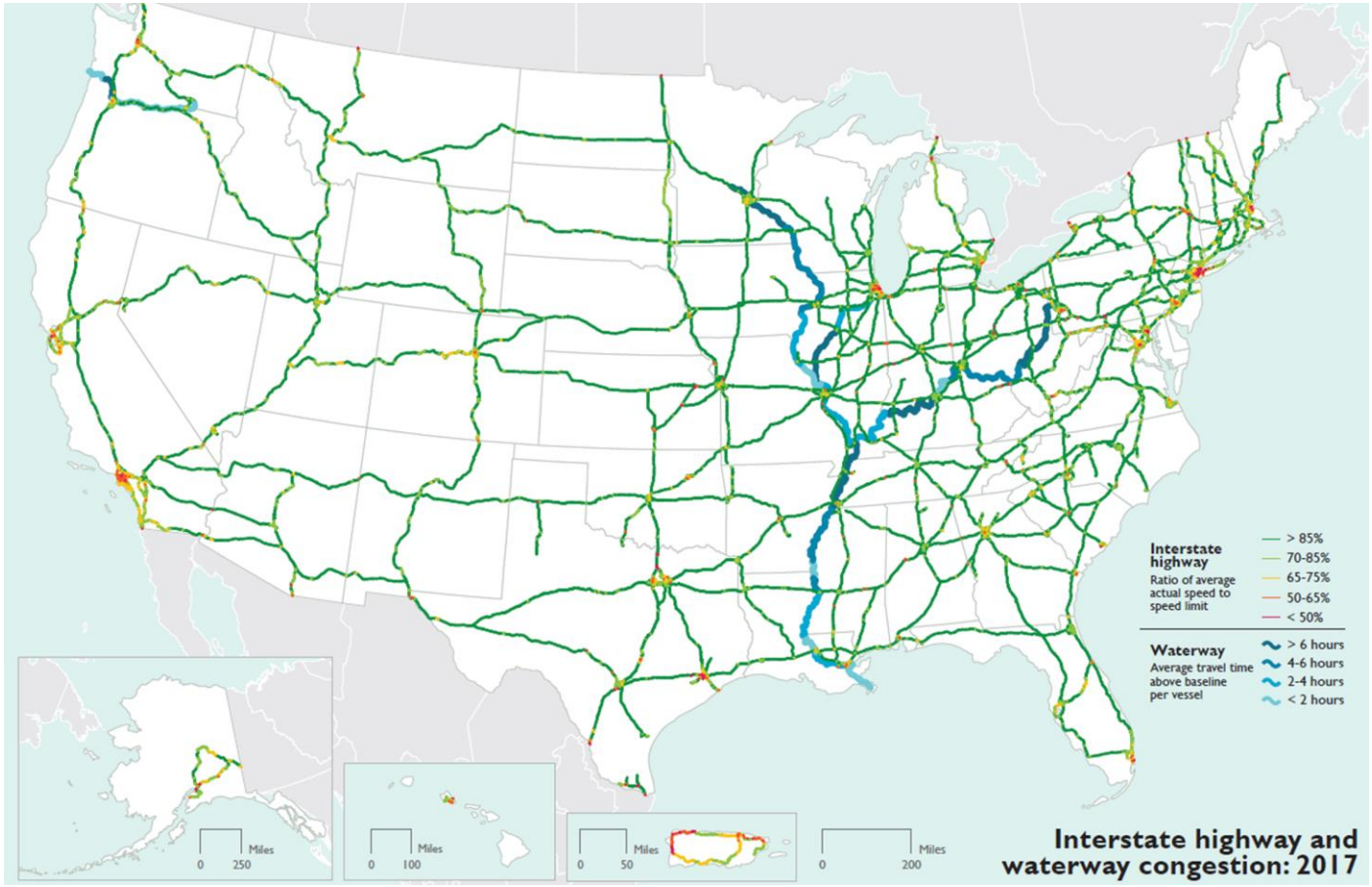
Statistics Provided:

- Number of transits
- Average transit time
- 25th, 50th (median), and 75th percentile transit time
- Median speed
- Actual transit times versus expected transit times

Monthly vessel transit times on the Lower MS River, Vicksburg to Old River Lock, 2017



AVERAGE TRAVEL TIME ABOVE BASELINE PER VESSEL EXAMPLE RESULTS, 2017



Waterway data reflects only segments for which data was available; special tabulation (2018), U.S. Army Corps of Engineers (USACE) and BTS from Automated Identification System (AIS) and Navigable Waterways, USACE; special tabulation (2018), BTS from National Performance Management Research Dataset (NPMRDS), Regional Integrated Transportation Information System (RITIS)

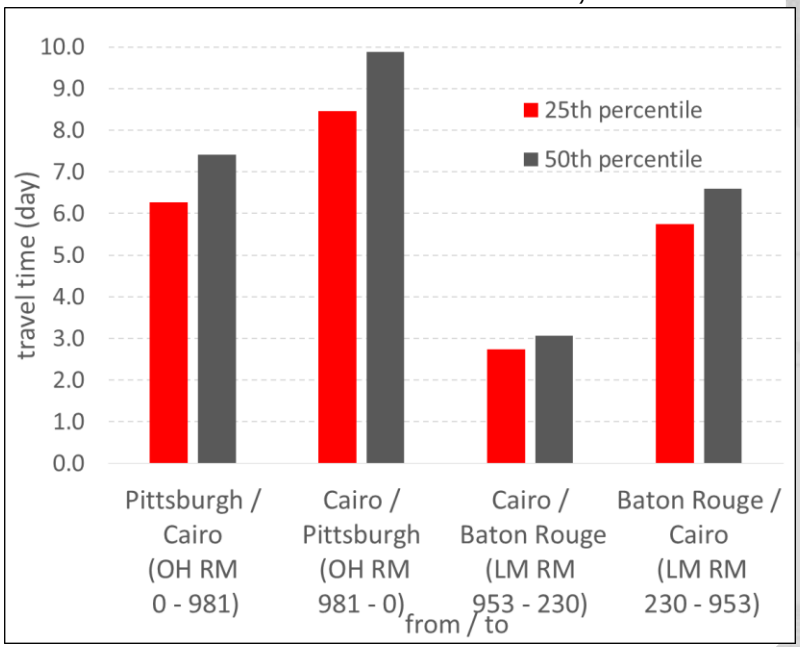
WHY TRANSIT TIMES

- Travel times enable waterway stakeholders and policy makers to **quickly** and **easily**:
  - Understand the state of the system
  - See changes in the system
  - Make informed decisions
- Quantitative performance measure
- Voyage planning capabilities for stakeholders
- Estimated time of arrival calculations

OH R transit time stats, 2014

from \ to	RM 0	RM 40
RM 0	25th 50th 75th	9.5 13.5 20.0
RM 40	12.5 16.5 22.5	

OH R & LM R transit time stats, 2017



ACCESSING THE RESULTS

- Available via publically available web portal or via web services (Fall 2019)

Select the waterway reach starting point and destination for which you want travel time estimates.

Choose starting point:

RM 0 Ohio River's Upstream End / Port of Pittsburgh Upstream Boundary
RM 1 Emsworth L&D: 5 miles upstream
RM 4 Emsworth L&D: 2 miles upstream
RM 8 Emsworth L&D: 2 miles downstream

Choose destination:

RM 0 Ohio River's Upstream End / Port of Pittsburgh Upstream Boundary
RM 1 Emsworth L&D: 5 miles upstream
RM 4 Emsworth L&D: 2 miles upstream
RM 8 Emsworth L&D: 2 miles downstream

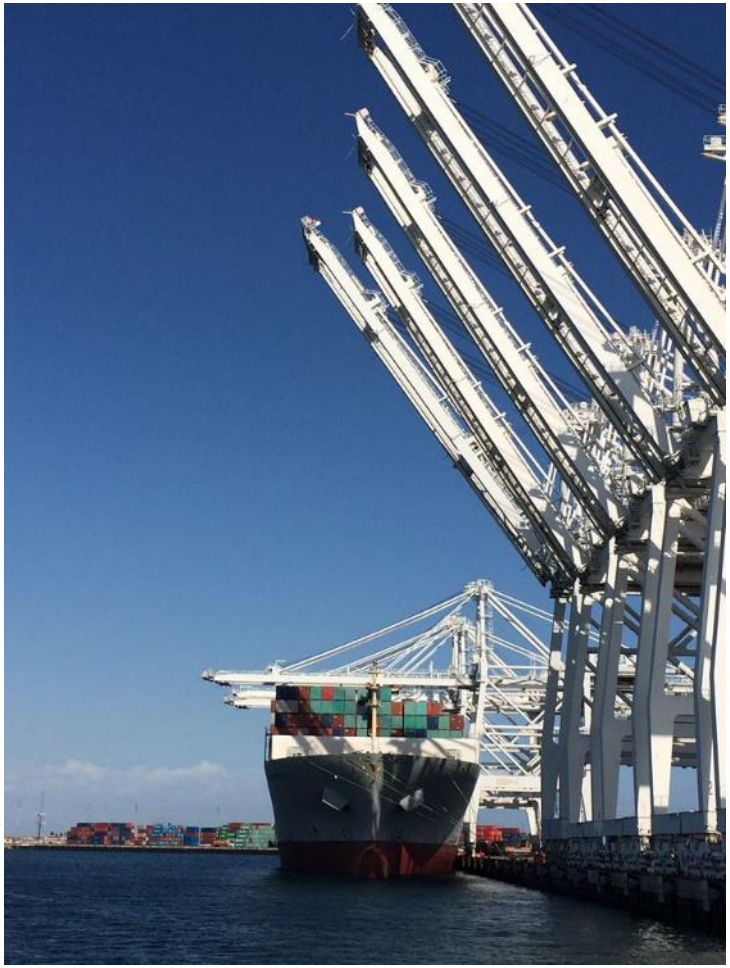
Choose time period:

October 2018

SU	MO	TU	WE	TH	FR	SA
30	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3
4	5	6	7	8	9	10

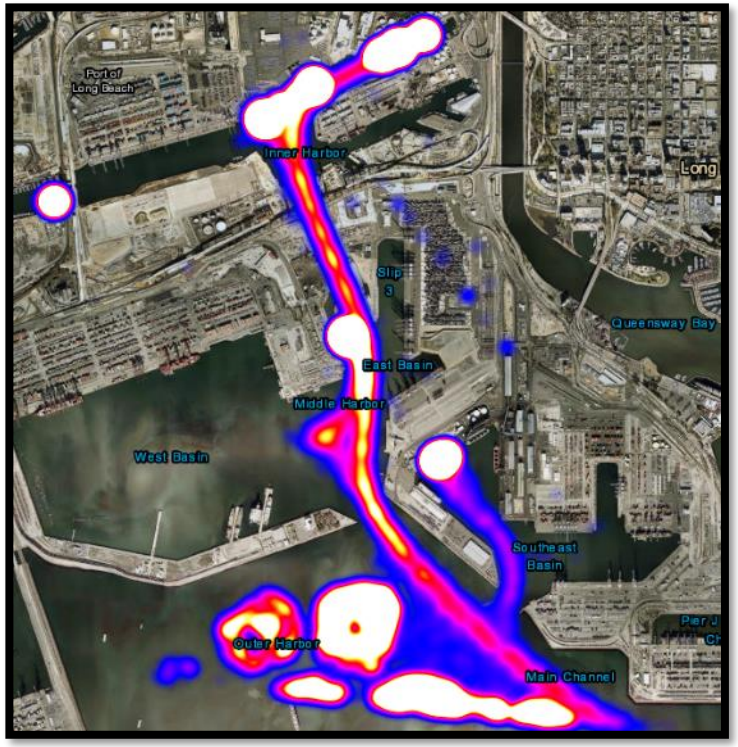
PORT DWELL TIMES

- Estimate how long vessels spend at port
  - Can be broken down into anchorage time, channel transit time, terminal dwell time, etc.
- Applications:
  - Understand waterway usage
  - Determine effects of events or O&M decisions on vessel traffic
  - Identify changes over time
  - Help inform capacity calculations
  - Multi-modal supply chain applications



AIS POSITION REPORT DENSITY MAP FOR PORT INFORMATION

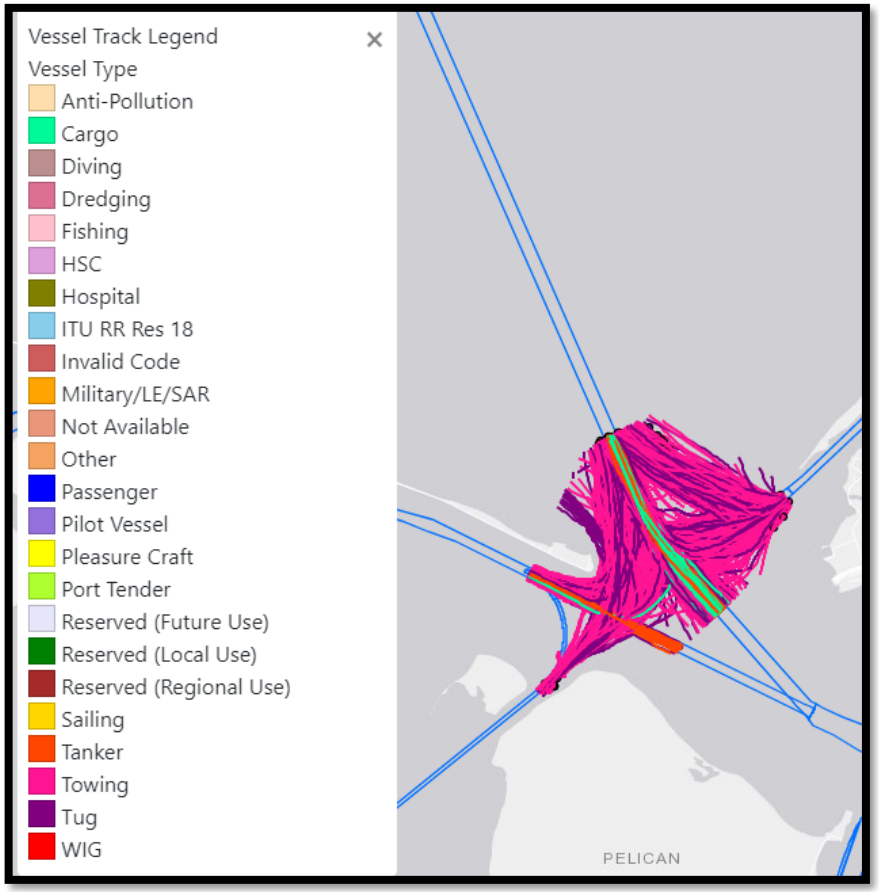
Port of Long Beach
Tanker Vessel Heat Map



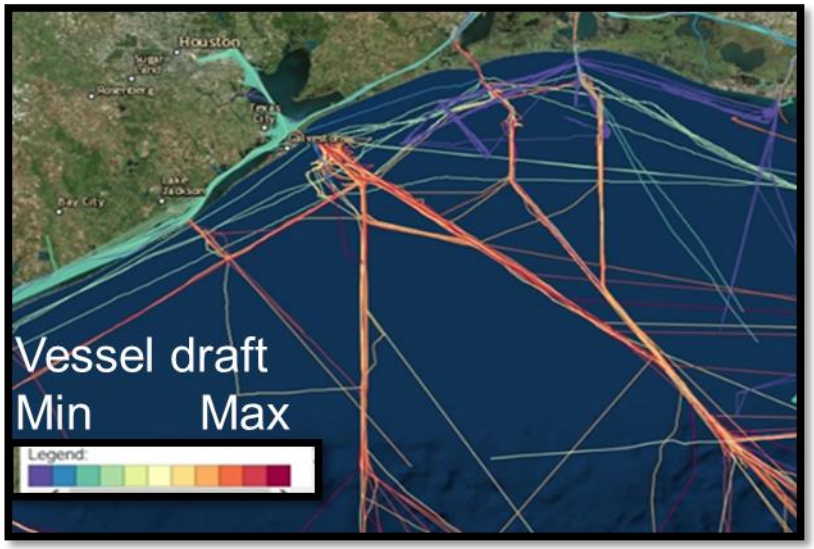
Port of Long Beach
Cargo Vessel Heat Map

AIS DATA VISUALIZED FOR PORT INFORMATION

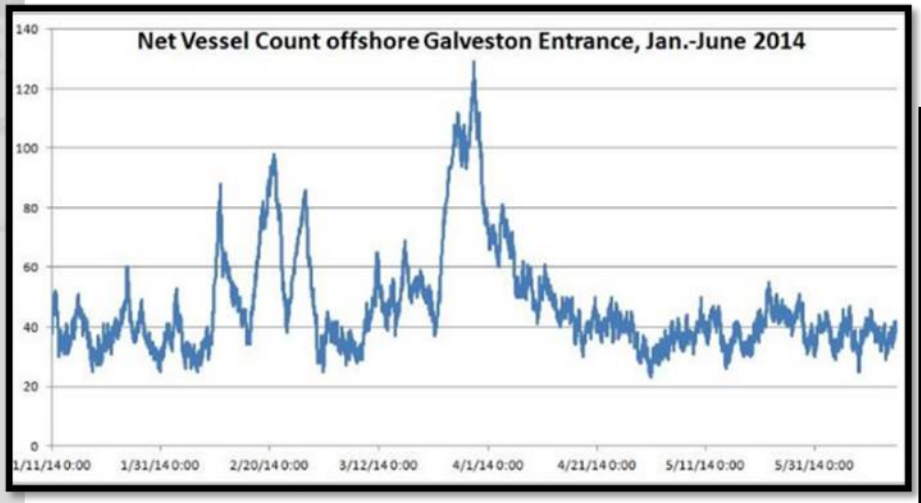
Channel Usage



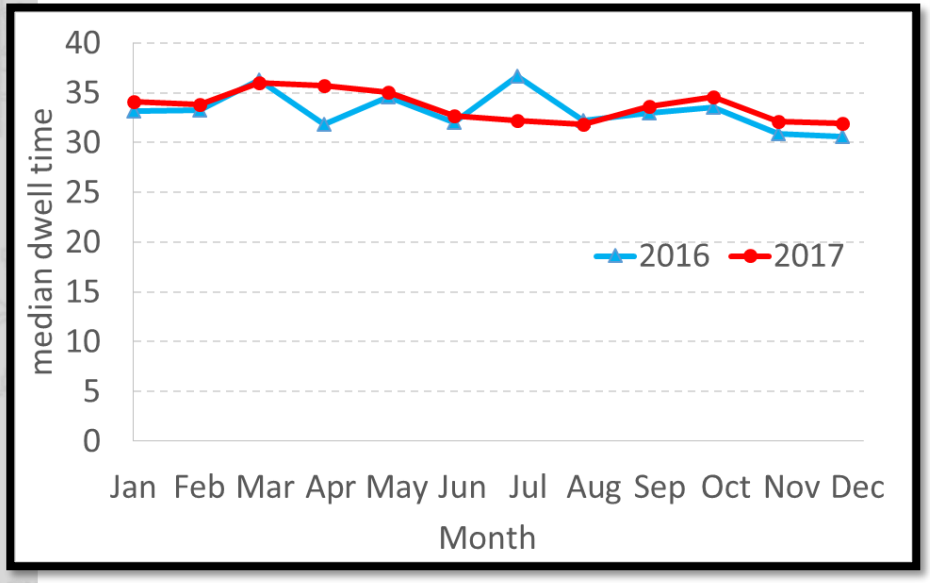
Connected Ports



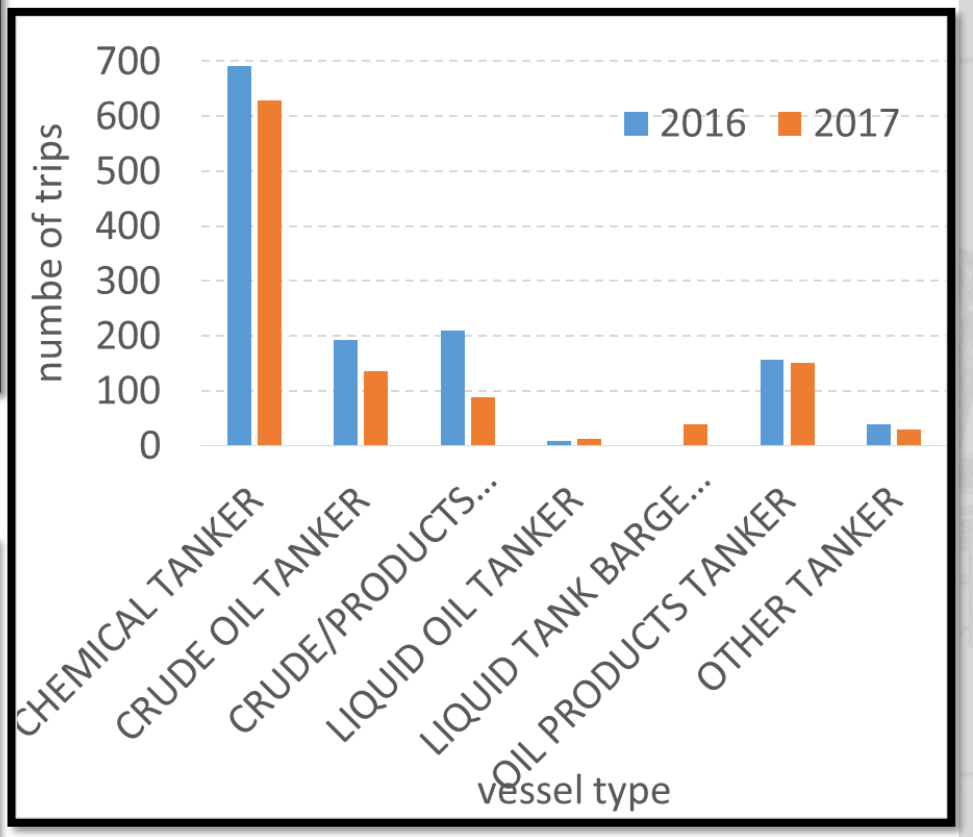
AIS DATA ANALYZED FOR PORT INFORMATION



Vessel Counts off of Galveston Entrance, Jan-Jun 2014



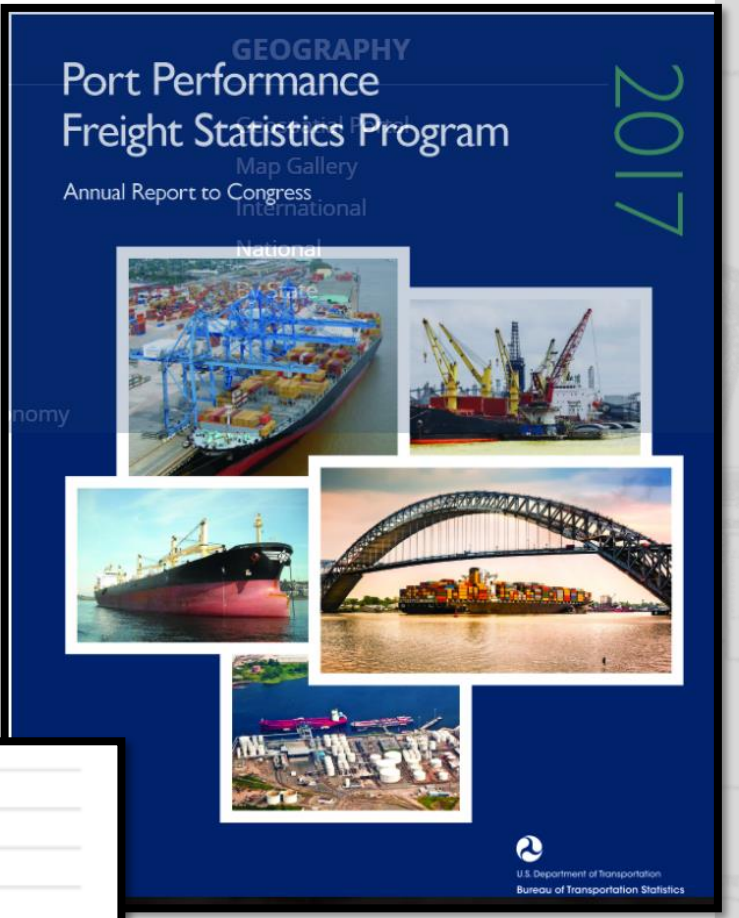
Median vessel dwell time by month, 2016 & 2017, Port of NYNJ

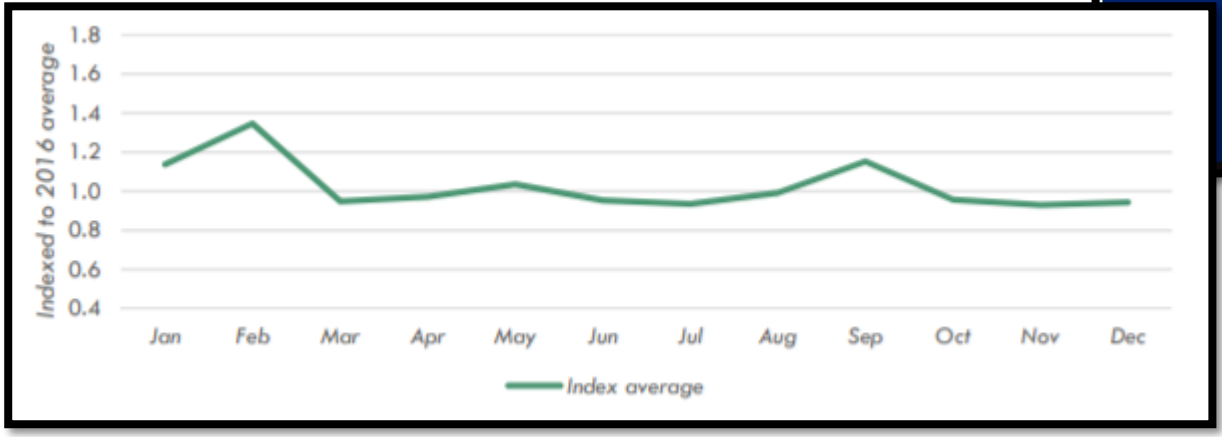


Number of trips to a terminal by tankers by type, 2016 & 2017, Port of NYNJ

PORT PERFORMANCE FREIGHT STATISTICS PROGRAM: ANNUAL REPORT TO CONGRESS

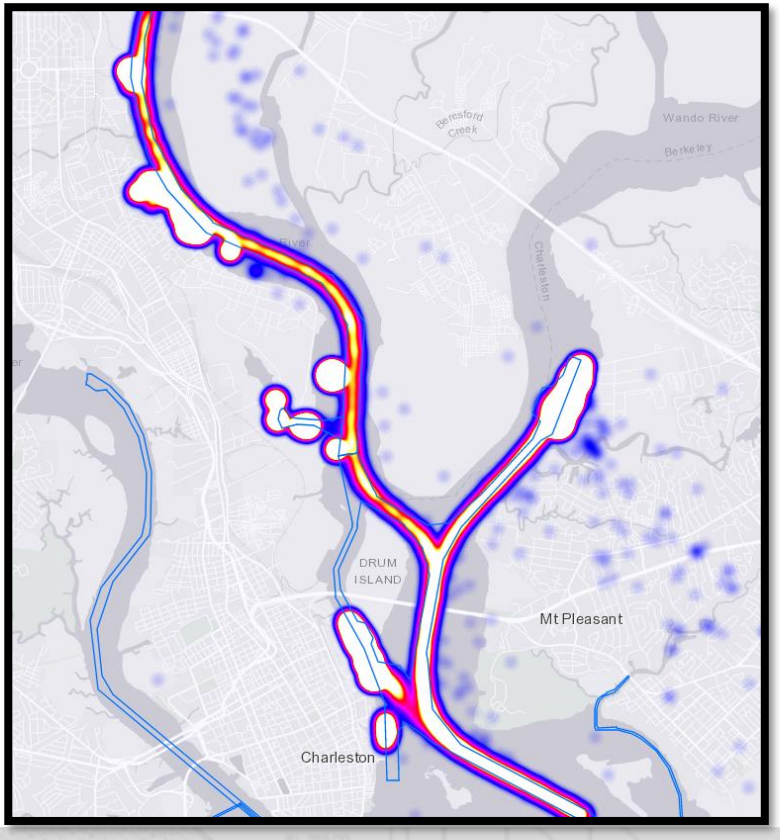
- Published by USDOT Bureau of Transportation Statistics
- USACE is a contributor
- Publically available
- Provides port dwell time, throughput, and capacity statistics
- https://www.bts.gov/port-performance-2017

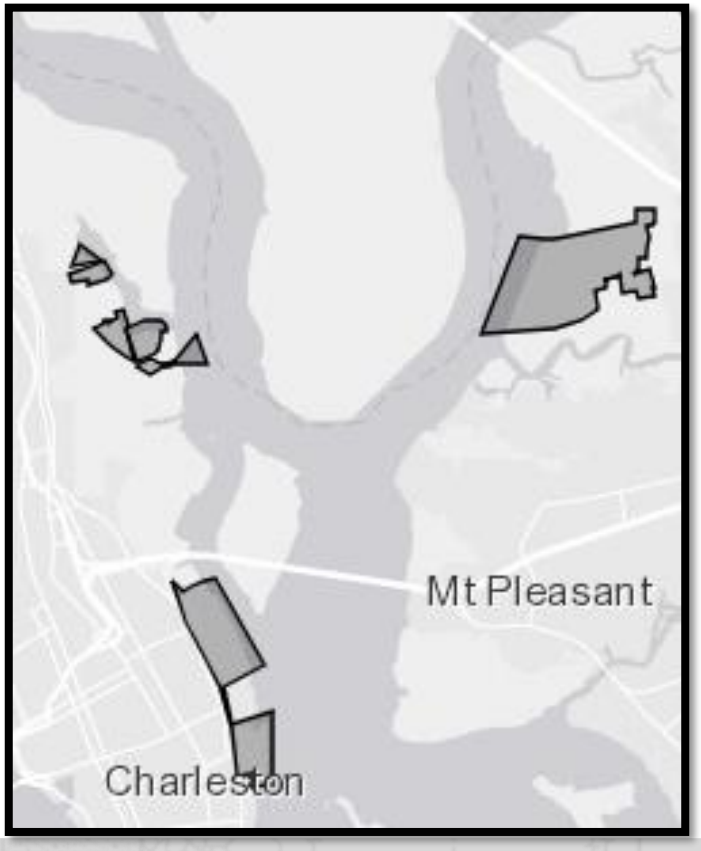




METHOD TO DERIVE DWELL TIME STATISTICS USING AIS DATA

1. Acquire AIS data for your study area and study time period
2. Geofence your port area
3. Create AIS position report density plot to identify terminals
4. Geofence terminal areas





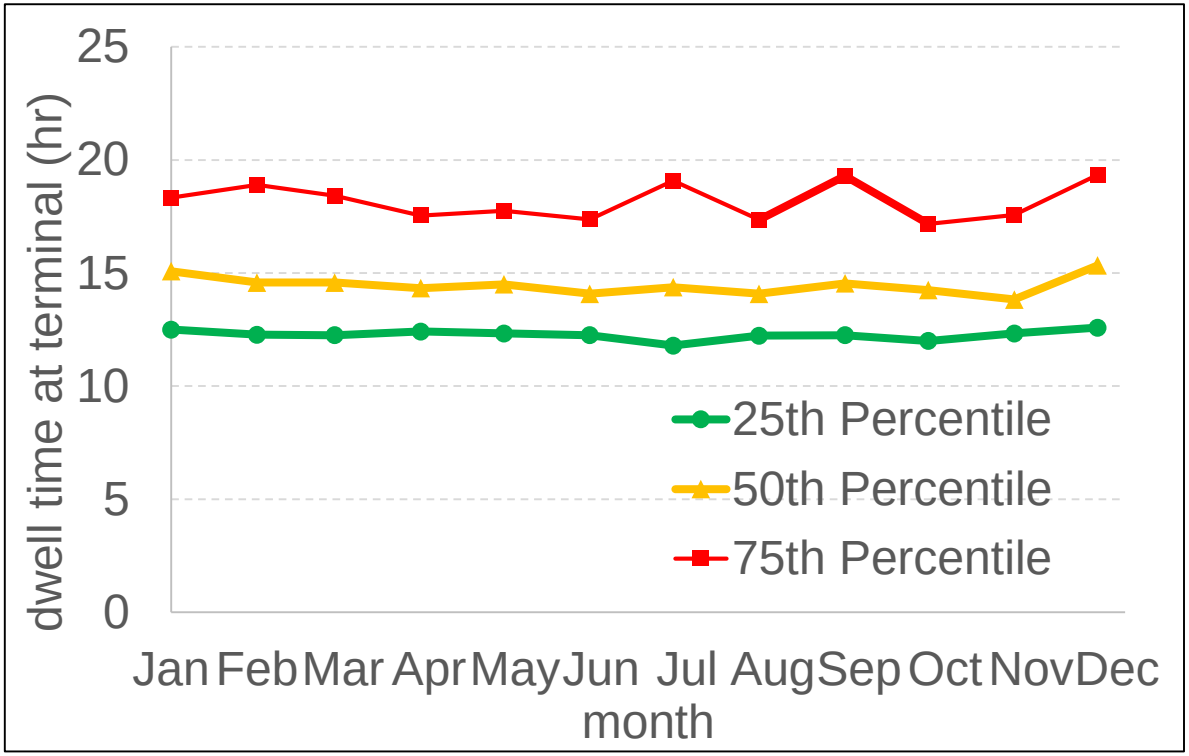
METHOD TO DERIVE DWELL TIME STATISTICS USING AISAP continued

5. Filter on all vessel position reports within each terminal geofence
6. For each vessel, identify “entrance” report and “exit” report
7. Estimate dwell time as difference between entrance report time stamp and exit report time stamp

Vessel Name	Vessel Type	Entrance Time (UTC)	Exit Time (UTC)	Dwell Time
AAA	Cargo	10/10/2017 2:25	10/11/2017 10:40	1 08:15:00
BBB	Cargo	1/5/2017 13:15	1/5/2017 21:10	0 07:55:00

METHOD TO DERIVE DWELL TIME STATISTICS USING AISAP continued

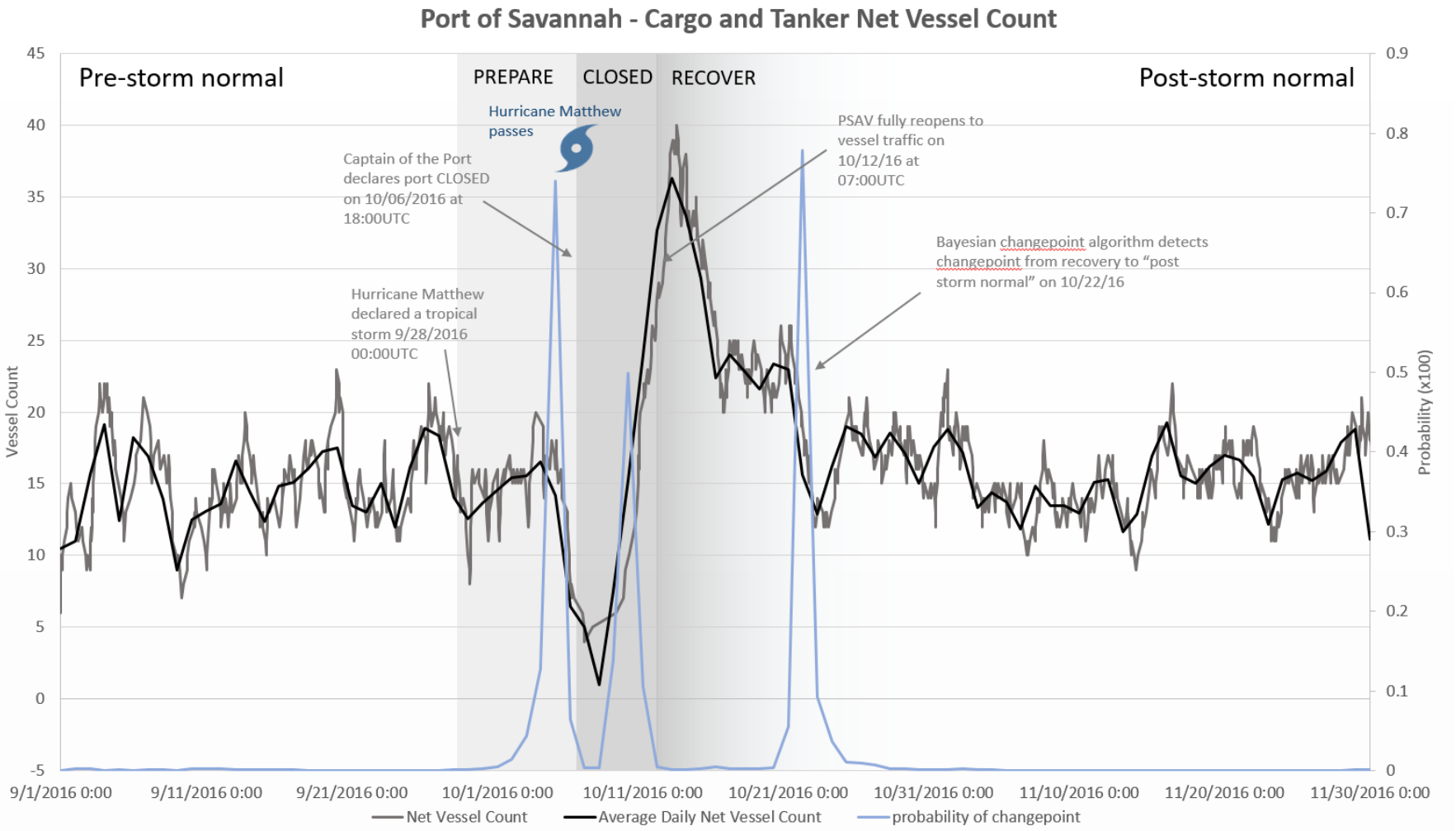
8. Calculate dwell time statistics from the individual vessels' dwell time estimates



RESILIENCY

- USACE defines resilience as “the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions”
- AIS data can be mined to establish pre-disturbance “normal” LOS, estimate recovery time, and evaluative post-disturbance LOS

RESILIENCY STUDIES EXAMPLE
HURRICANE MATTHEW 2016 – NET VESSEL COUNT



POC: Katherine Touzinsky Chambers
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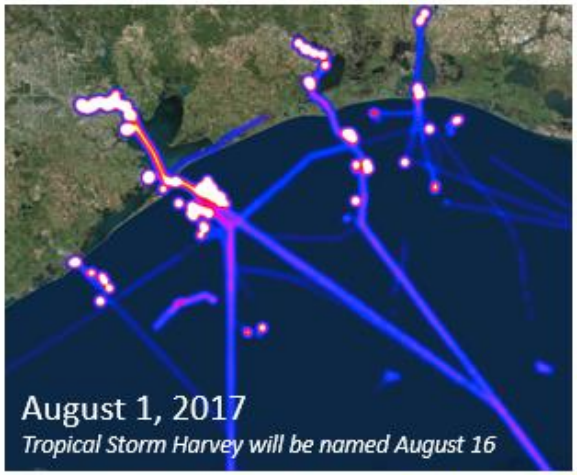
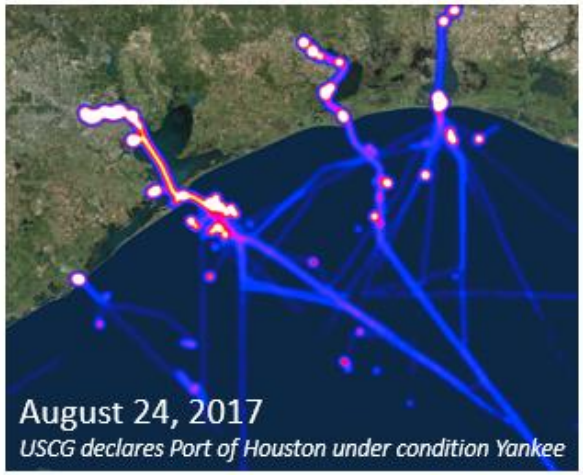
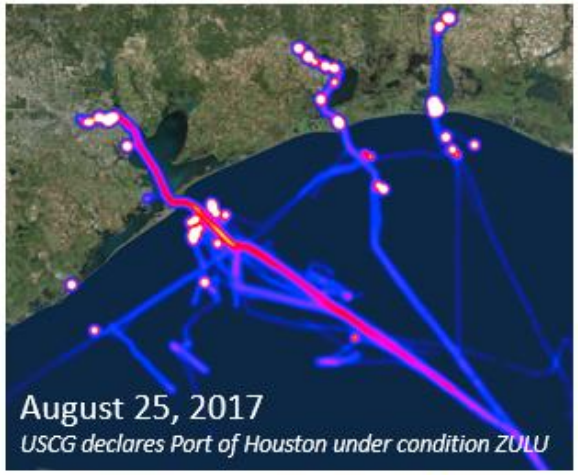
HURRICANE HARVEY 2017 VESSEL LOCATIONS

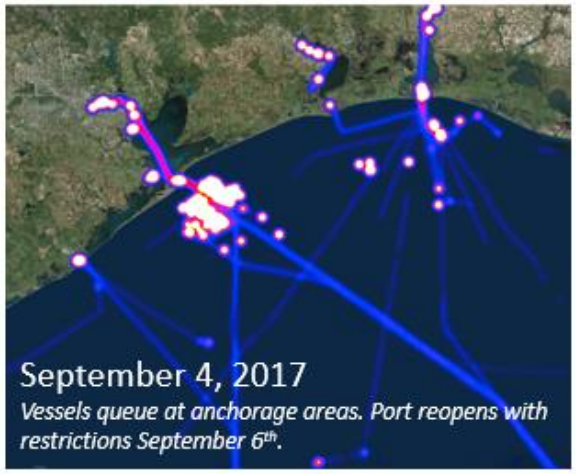
Hurricane Harvey Cargo and Tanker Vessel Signal Density Plots

Created with ERDC Automatic Identification System Analysis Package (AISAP)









ERDC Navigation Data Performance Team: Katherine Touzinsky, Kenneth N. Mitchell, Patricia Dijoseph, Marin Kress

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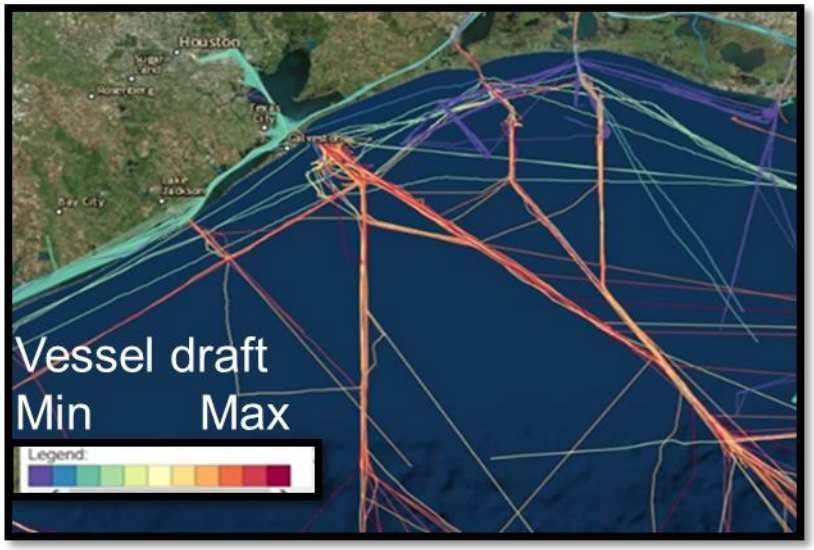
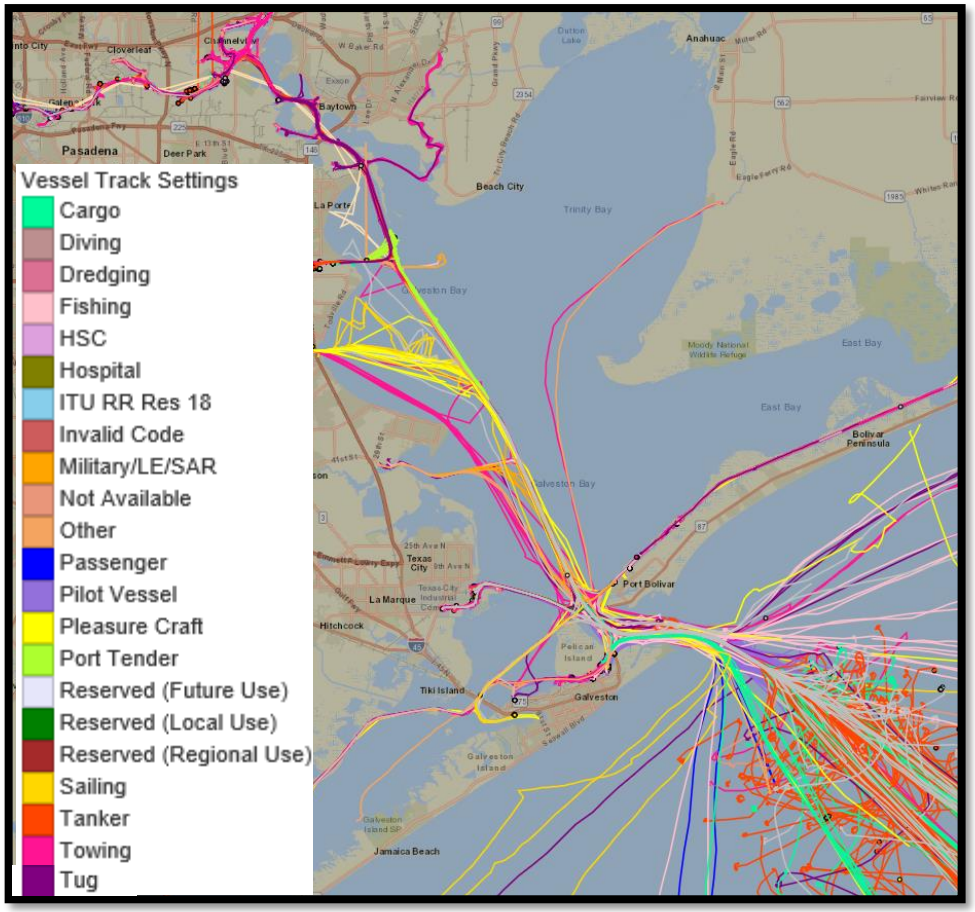
Katherine.F.Touzinsky@usace.army.mil

AISAP VESSEL TRACK LINES EXAMPLES



vessel tracks by draft

vessel tracks by draft



vessel tracks by vessel type

SUMMARY:

- Vessel transit data (such as AIS data) can be analyzed for waterway transit statistics
- Statistics can aid waterway users
  - Voyage planning and reduced delays
- Can inform what vessels are transiting in an area
- Can inform where vessels are transiting
  - Are they utilizing the channel
  - Where are they coming from and going to
- Can inform when vessels are transiting
  - Seasonal or environmental factor (e.g., water level, weather)
  - When anchor or transit and for how long
- Provide quantifiable waterway performance monitoring
  - Identify changes and causes
  - Quantify effects of O&M actions or events
  - Resiliency studies

THANK YOU

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