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Port Performance Freight Statistics Program

HANDBOOK OF METHODS

Metric:
Dry Bulk Cargo
(Top 25 List Calculation)

Background

The *Fixing American's Surface Transportation (FAST) Act* requires the Port Performance Freight Statistics Program (PPFSP) to report on the top 25 ports as measured by dry bulk cargo tonnage. The data are included in the PPFSP *Annual Reports.*

Dry bulk cargo tonnage refers to the weight of solid, dry cargo, commonly shipped in vessels designed for such cargo (dry bulk vessels). Examples of dry bulk commodities include coal, ores, and grain.

Concept

Dry bulk is not a standard categorization for tonnage statistics. Therefore, the Bureau of Transportation Statistics (BTS) used the 2016 methodology developed with the U.S. Army Corps of Engineers (USACE) and Maritime Administration (MARAD) for the PPFSP 2016 *Annual Report*. This methodology was approved by the PPFSP Working Group to identify the top 25 dry bulk ports.

Methods

Dry bulk cargo was defined as any cargo carried in dry bulk vessels. The 13 International Classification of Ships by Type (ICST) codes listed in Table 1 were identified as dry bulk cargo vessels. This list of vessel categories was accepted, without adjustments, by the Working Group.

Table 1: ICST Codes Used to Identify Dry Bulk Cargo Vessels

ICST Code	Description
220	Other bulk carrier
221	Ore carrier
222	Bulk/container carrier
229	Other bulk carrier
340	Dry cargo barge
341	Deck barge
342	Hopper barge
343	Lash-Seabee barge
344	Open dry cargo barge
345	Covered dry cargo barge
349	Other dry cargo barge not elsewhere included
600	Other lakers
601	Lakers--bulk carriers

BTS calculated the 2016 tonnage for every commodity handled at U.S. ports on those vessel types, using the cargo database compiled and maintained by the USACE Waterborne Commerce Statistics Center (WCSC). The results were used to identify the top 25 dry bulk ports.

Data Sources

The 2016 WCSC tonnage data were obtained using a special tabulation completed in 2017. The ICST system was produced by the ad hoc International Advisory Group on Maritime Statistics and was last revised in 1994.[1]

[1] http://www.imsf.info/media/1081/icst-94.pdf

Uses and Limitations

Table 2 provides the top 25 ports for dry bulk cargo, as included in the PPFSP 2017 *Annual Report*.

Table 2: List of Top 25 Dry Bulk Ports
(Alphabetical Order)

Port
Baltimore, MD
Baton Rouge, LA
Chicago, IL
Cleveland, OH
Corpus Christi, TX
Detroit, MI
Duluth-Superior, MN & WI
Houston, TX
Huntington – Tristate, KY, OH, & WV
Indiana Harbor, IN
Kalama, WA
Longview, WA
Mobile, AL
New Orleans, LA
New York and New Jersey, NY & NJ
Pittsburgh, PA
Port of Plaquemines, LA
Port of South Louisiana, LA
Port of Virginia, VA
Portland, OR
Ports of Cincinnati and Northern KY, OH & KY
Seattle, WA
St. Louis, MO & IL
Tampa, FL
Two Harbors, MN

This methodology has inherent limitations. Using vessel classes to identify dry bulk cargo is likely imperfect due to the overlap in commodities shipped on various vessel types. For instance, ICST vessel code 222 “Bulk/container carrier” likely includes vessels that could have carried cargo in containers as well as in bulk.

The unavoidable imprecision in this approach could lead to inaccuracies in tonnage estimates among similarly ranked ports.

Metric: Containerized Cargo (Top 25 List Calculation)

Background

The *FAST Act* requires the PPFSP to report data on containerized cargo throughput and capacity for the top 25 ports as measured in twenty-foot equivalent units (TEU) of container cargo. The data are included in the PPFSP *Annual Reports.*

Concept

The top 25 container ports were selected based on TEU throughput data published by the USACE WCSC. Container throughput for this purpose was calculated by totaling:

- *Loaded* and *empty* containers inbound from a *domestic origin*
- *Loaded* and *empty* containers outbound to a *domestic destination*
- *Loaded* containers inbound from a *foreign origin*
- *Loaded* containers outbound to a *foreign destination*

Empty containers shipped to or from foreign locations were omitted from the measurement of TEU throughput for the purpose of identifying the top 25 container ports as they are not reported in the WCSC container dataset.

A secondary identification process was implemented for ports in Alaska and Hawaii following the discovery of questionable reporting of TEU statistics by a company that served ports in the two States.

Data Sources

The top 25 container ports were selected using TEU throughput data published by USACE WCSC. USACE compiles these data differently for domestic and foreign cargo. Domestic freight flows are reported directly from manifest data (under Federal law, vessel-operating companies must report domestic waterborne commercial vessel movements directly to USACE). Foreign waterborne cargo data are derived from several other sources, including U.S. Customs and Border Protection, the U.S. Census Bureau, and the Port Import Export Reporting Service.

While there exist other sources of data on TEU throughput, BTS chose to select the top 25 container ports using data from the WCSC for several reasons. The WCSC container dataset is freely available to the public, updated annually, and reported in a consistent manner for all ports across the Nation, including single-terminal ports, multi-terminal ports, State-operated port authorities, multi-State entities, and river ports with terminals spread over a wide area. The dataset therefore meets the recommendations articulated by Section 6018 of the *FAST Act* and the PPFSP Working Group that PPFSP data be timely, nationally consistent, and readily accessible to the public.

Methods

The top 25 container ports were identified based on USACE WCSC container throughput statistics.

Uses and Limitations

Table 3 lists the top 25 ports for container cargo, as included in the PPFSP 2017 *Annual Report.*

Table 3: List of Top 25 Container Ports by TEU (*Alphabetical Order*)

Port
Anchorage, AK
Baltimore, MD
Boston, MA
Charleston, SC
Honolulu, HI
Houston, TX
Jacksonville, FL
Kahului, HI
Ketchikan, AK
Long Beach, CA
Los Angeles, CA
Miami, FL
Mobile, AL
New Orleans, LA
New York, NY & NJ
Oakland, CA
Philadelphia, PA
Port Everglades, FL
Port of Virginia, VA
San Juan, PR
Savannah, GA
Seattle, WA
Tacoma, WA
Wilmington, DE
Wilmington, NC

The use of USACE data that excludes foreign empty containers shipped to or from foreign locations to identify the top 25 container ports results in a list that may differ from one based on total TEU handled. Despite this fact, the availability of a nationally consistent source in the USACE data makes it the best option for selecting the top 25 container ports for the PPFSP.

Reported Container Cargo Capacity and Throughput

Concept

While the data source and methodology to select the top 25 container ports do not include foreign empty containers, capacity and throughput data in the port profiles include all loaded and empty containers to reflect the impact of total container volume on terminal operations. The work performed by container terminals, motor carriers, and railroads depends more on the number of containers than on the TEU volume.

Data Sources

As the USACE WCSC container cargo dataset does not include foreign empty TEU, a more complete tabulation of TEU provided by the American Association of Port Authorities (AAPA) is used in the port profiles (see Appendix A of the PPFSP 2017 *Annual Report)*.

AAPA publishes container statistics from data released by the ports, which BTS verified with data available from port authorities and terminal operators. These sources were used in cases where AAPA container statistics were unavailable.

Some port data are presented differently due to characteristics of the underlying sources.

Container statistics at the following ports were presented on an October through September fiscal year basis (as opposed to calendar year): Everglades, Honolulu, and Jacksonville.

Inbound and outbound statistics at the Port of Philadelphia include both loaded and empty containers.

Inbound and outbound statistics for the Port of Ketchikan use USACE figures; as this port had no foreign cargo, the omission of empty foreign containers in the dataset has no impact. The Port of Miami uses a load factor of 75 percent to estimate the inbound and outbound TEU count, with the remaining 25 percent of handled TEU estimated to be empty. The TEU count for the Port of Mobile is based on a 1.82 multiplier that the terminal operator applies to its lift count.

The Northwest Seaport Alliance (NWSA) is the port authority that governs the Ports of Seattle and Tacoma. USACE WCSC statistics report on the two ports as separate entities and they are recorded as such in the PPFSP 2017 *Annual Report* list of top 25 ports by TEU. Container statistics from AAPA for 2016 are only available as a combined figure for the two ports, and NWSA does not release container cargo volume statistics for the individual ports.

BTS estimated the division of TEU counts between the two ports based on the ratios in USACE WCSC data. The foreign loaded TEU counts for the Ports of Seattle and Tacoma were calculated based on the ratio of foreign loaded containers between the two ports reported by USACE WCSC. As the USACE WCSC statistics do not include foreign empty containers, the same ratio was also applied to the empty international cargo reported by the NWSA. As NWSA reports domestic cargo only as a total, the ratio of total (loaded plus empty) domestic containers between Seattle and Tacoma as reported by USACE WCSC was applied to the NWSA domestic statistics.

Metric: Vessel Calls

Background

A vessel call is a single visit to a terminal or port by a waterborne vessel. The annual number of vessel calls provides insight into port throughput.

Concept

The vessel call metric indicates:

1) the total number of cargo vessel calls that each port handled in 2016 and the change in calls from 2015,
2) the share of total for five categories of vessel calls and the change for each category from 2015,
3) average TEU handled during international container vessel calls at each port, and
4) average dry bulk tonnage during both dry bulk barge and non-barge dry bulk vessel calls.

The vessel call metric aligns with *Annual Report* throughput statistics that categorize cargo into three types (TEU, overall tonnage, dry bulk tonnage). Dry bulk vessels and other freight vessel categories have been further split between barges and other vessels. Vessel call counts reflect each barge call, so flotillas of barges can result in high vessel counts that overshadow non-barge vessel calls. Separating barges from other vessels therefore allows for a better understanding of trends in non-barge vessels.

Methods

Vessel calls are reported as a total number for 2016 and the change from 2015. Vessel calls are also shown by percentage of total, as divided into five categories of vessels based on the ICST codes listed below in Table 4, 5, 6, 7, and 8. This method excludes ferries, cruise, and other passenger vessels. The five categories include:

1. **Container**: Vessels identified as carrying containers. A container vessel is usually a cellular container ship loaded and unloaded using shoreside container cranes. Some ports handle containers on general cargo vessels, roll-on/roll-off (Ro/Ro) vessels, and/or barges. These vessel calls are not included in the container vessel counts unless they are specifically classified as container vessels, as it is not feasible to identify which of the other vessel calls carry containers (see ICST Code 338, Ro/Ro Container)

2. **Dry bulk**: Non-barge vessels identified as carrying dry bulk cargo. The method for selecting dry bulk vessel types (described in this Handbook of Methods as well as in Section 2 of the PPFSP 2017 *Annual Report*) was developed to quantify dry bulk port cargo volumes and to select the top 25 dry bulk ports. BTS selected 13 types of vessels to measure dry bulk cargo tonnage and dry bulk vessel calls. Six of the 13 types are self-propelled or otherwise classified as non-barge vessels and are included in this list.

3. **Dry bulk barge**: The remaining seven vessel types that were identified as carrying dry bulk cargo and as barges.

4. **Other freight**: All other vessels that predominantly handle freight and are not assigned as container or dry bulk vessels, and are not barges. These include crude oil tankers, liquefied natural gas (LNG) tankers, chemical tankers, general cargo vessels, and vehicle or Ro/Ro carriers. The combination of "Other freight vessel" calls and "Other freight barge" calls

represent overall cargo tonnage minus container and dry bulk cargo tonnage.

5. **Other freight barge**: Barge vessels that were identified as carrying non-containerized, non-dry bulk freight cargo.

Vessels that either do not or rarely carry cargo, but play a role in the movement of cargo at ports, such as tugs and push boats, were not included in the vessel call analysis. The high number of support vessel movements can hide trends in the other five categories.

The following tables show the assignment of ICST codes to the five vessel categories used in the *Annual Report*. The acronym NEI stands for Not Elsewhere Included.

Table 4 ICST Codes Used to Identify Container Vessels

ICST Code	Description
310	Container
338	Ro/Ro Container

Table 5 ICST Codes Used to Identify Dry Bulk Vessels (Non-Barge)

ICST Code	Description
220	Other Bulk Carrier
221	Ore Carrier
222	Bulk/Container Carrier
229	Other Bulk Carrier
600	Other Lakers
601	Lakers--Bulk Carriers

Table 6 ICST Codes Used to Identify Dry Bulk Barge Vessels

ICST Code	Description
340	Dry Cargo Barge
341	Deck Barge
342	Hopper Barge
343	Lash-Seabee Barge
344	Open Dry Cargo Barge
345	Covered Dry Cargo Barge
349	Other Dry Cargo Barge NEI

Table 7 ICST Codes Used to Identify "Other Freight Vessels"

ICST Code	Description
110	Other Oil Tanker
111	Crude Oil Tanker
112	Crude/Products Tanker
113	Oil Products Tanker
114	Oil/Chemical Tanker
120	Chemical Tanker
130	Other Liquefied Gas Carrier
131	LPG Carrier
132	LNG Carrier
139	Other Liquefied Gas Carrier
150	Other Tanker
151	Asphalt, Bitumen Tanker
152	Molasses Tanker
153	Vegetable Oil Tanker
159	Other Tanker NEI
199	Liquid Other Tanker
210	Other Bulk/Oil Carrier
211	Ore/Bulk/Oil
212	Oil/Ore
213	Bulk/Oil
320	Other Specialized Carrier
321	Barge Carrier
322	Chemical Carrier
323	Irradiated Fuel Carrier
324	Livestock Carrier
325	Vehicle Carrier
330	Other General Cargo
331	Reefer
333	Other Ro/Ro Cargo
334	General Cargo/Passenger NEI
335	General Cargo-Single Deck NEI
336	General Cargo-Multi Deck NEI
339	General Cargo / Container
602	Lakers--General Cargo

Table 8 ICST Codes Used to Identify "Other Freight Barge"

ICST Code	Description
140	Other Tank Barge
141	Single Hull Tanker Barge
142	Double Hull Tanker Barge
143	Tank Barge Double Sided
144	Tank Barge Double Bottomed
149	Other Tank Barge

Average TEU per Container Vessel Call

To further examine TEU throughput, the PPFSP 2017 *Annual Report* includes a measurement of average TEU handled during international container vessel calls at each port. The metric is calculated by dividing the 2016 total TEU handled by the number of 2016 non-U.S.-flag container ship vessel calls reported by MARAD at each port. This metric may overestimate the average TEU per container vessel call at ports with large numbers of U.S. flag (Jones Act) vessel calls.

Average Dry Bulk Tonnage per Dry Bulk Vessel Call

The PPFSP 2017 *Annual Report* includes a measurement of average dry bulk tonnage during dry bulk vessel calls. The metric is calculated by dividing the 2016 dry bulk tonnage by the number of 2016 dry bulk vessel calls as defined in the method used for selecting dry bulk vessel types.

Use of "N/A" and "U"

The report uses "N/A" to signify that a data point was not applicable in the following cases:

- **Container Vessel Call Percentage Change, 2015 to 2016**: Several ports did not have data within this category or had zero container vessel calls in 2015 or 2016. These ports are mostly bulk ports with minor or no container operations or facilities. N/A was used for ports that had very few container vessel calls or else had missing data for 2015, even if data for 2016 was available. For example, if a port reported one container vessel call in 2014 and two calls in 2015, a single container vessel call difference is not meaningful (despite a calculated 100 percent increase).

- **Other Freight Percentage Change, 2015 to 2016:** Similar to the above example, some ports had no data for certain vessel type calls in 2015 or 2016.

- **Average TEU per Container Vessel Call:** TEU data were collected only for ports on the top 25 TEU list. Although container vessel call data for other ports were available, the metric was not applicable outside the top 25 container ports or ports without 2016 TEU in the numerator.

- **Average Dry Bulk Tonnage per Dry Bulk Vessel Call:** N/A was used for ports that reported fewer than five dry bulk vessel calls in 2016, regardless of dry bulk tonnage. This measure may not be meaningful at ports with thousands of other, non-dry bulk vessel calls.

The report uses "U" to signify that data were unavailable in the following cases:

- **Average Dry Bulk Tonnage per Dry Bulk Vessel Call:** Five ports did not have available data for 2016 dry bulk tonnage as they were not in the top 100 for the year. Although dry bulk vessel call data were available, the average was not applicable for those five ports.

Data Sources

Vessel calls were tabulated by USACE WCSC using 2015 and 2016 data.

2016 dry bulk cargo tonnage data were obtained from the USACE WCSC, as calculated by special tabulation in 2017.

Container volumes were obtained from the AAPA's Port Industry Statistics, North America Free Trade Agreement Region Container Traffic, as of October 2017. Additional data provided by port authorities and terminal operators were used when AAPA data were incomplete or were based on fiscal rather than calendar year.

Uses and Limitations

The port profiles included in the PPFSP 2017 *Annual Report* display total cargo vessel calls in 2016 and the change from 2015 to allow for context and comparison between ports. The profiles also include a pie chart to illustrate 2016 vessel call shares for each port.

The average TEU per vessel provides insight into the throughput and function of each port. This metric also links to Section 4.2 of the PPFSP 2017 *Annual Report*, which discusses average container vessel capacity. Comparing throughput with capacity can provide insight into container vessel capacity utilization.

As described above, several metrics included in the PPFSP 2017 *Annual Report* are reported as N/A or U to reflect issues in collecting or displaying various data points. Average TEU per container vessel data for the Ports of Anchorage, Honolulu, Kahului, Ketchikan, and San Juan were not included due to the complex mix of foreign and domestic vessels and types that serve those ports. These ports are also served by a mix of container vessels and barges that can also carry non-container cargo.

Metric: Vessel Dwell Times

Background

Vessel dwell time refers to the continuous time a vessel spends within a defined geographic area. When applied to terminal berth areas within coastal ports, vessel dwell time can be used as a proxy metric for time spent in port securing the vessel, discharging or loading cargo, and other activities. In the context of the PPFSP, vessel dwell times at coastal port terminals provide insight into the relationship between vessel size, cargo volumes, and throughput.

To support this vessel dwell time analysis, researchers with the U.S. Army Engineer Research and Development Center (ERDC) processed and analyzed archival vessel position reports from calendar year 2016. The vessel position data were acquired via the U.S. Coast Guard's (USCG) Nationwide Automatic Identification System (NAIS). The geo-fenced watch areas used to define the port terminal areas were provided to the ERDC team by the BTS Office of Spatial Analysis and Visualization.

Concept

The dwell time analysis uses geo-fenced watch areas demarcated by the port terminal polygons and archival Automatic Identification System (AIS) vessel position reports to generate a wealth of useful information. The large number of observations allows for calculation of meaningful summary statistics for each port area. These include mean dwell times and distributions by quartile.

Methods

Vessel Calls

Vessel calls within a bounded port area are determined by identifying each instance of a unique vessel entering in, stopping in, and subsequently exiting the defined watch zones. Short-duration events are filtered out from consideration. Examples of short-duration events include brief harbor tug visits or vessel transits that skirt the outer portions of the watch zone.

ICST

The broadcast AIS messages from each vessel include a general ship type field selected by the operator and include labels such as Cargo, Tanker, Tug, Tow, and Passenger vessel types. Notably, there are no separate AIS broadcast classifications for container ships, vehicle carriers, or for the various sub-types of tanker vessels. To overcome this limitation, another field in the broadcast AIS message, the International Maritime Organization (IMO) ship identification number, is used to match the vessel identities and types in a separate inventory of vessels compiled by the ERDC team from the U.S. Customs Vessels Entrances and Clearances. This inventory is available via the USACE Navigation Data Center.[2] This data set includes the ICST codes that provide classifications for container vessels, chemical tankers, and LNG carriers, among others of interest to the PPFSP. Vessels broadcasting via AIS with an invalid or blank IMO field were manually matched using the vessel name that is also included in the AIS message. The ICST matching process allows for the AIS-derived vessel call and dwell time measures for each port area to be categorized across 42 possible vessel classifications.

[2] http://www.navigationdatacenter.us/data/dataclen.htm

Dwell Time Statistics

Dwell times are estimated by taking the difference between the date-time stamps of the first and last AIS position reports defining a vessel call. Summary statistics and percentiles can then be calculated based on the available dwell time observations at each port for all of calendar year 2016. The dwell time summary statistics listed in Table 9 are provided for container vessel calls at mainland U.S. ports.

Table 9 Dwell Time Summary Statistics and Descriptions

Statistic	Description
Mean (Average)	The sum of dwell times divided by the number of vessel calls.
25th Percentile Dwell Time	The dwell time value that exceeds 25% of the observed vessel dwell times.
75th Percentile Dwell Time	The dwell time value that exceeds 75% of the observed vessel dwell times.
Inter-Quartile Range	The 50% of records between the 25th (1st quartile) and 75th (4th quartile) percentiles

Data Sources

The AIS data standard is set by the International Telecommunication Union. The 27 message types embedded within the AIS broadcast include vessel name, maritime mobile service identity (MMSI) number (a unique nine-digit code used internationally to identify a ship or coast radio station), AIS ship type, discrete time-stamped position (latitude/longitude) records, and vessel operating parameters such as speed, course over ground, heading, and rate of turn.

To support the PPFSP, archival AIS position reports from the USCG's NAIS, were accessed by the ERDC team via a suite of web services provided USACE through a standing inter-agency security agreement. The ERDC-developed Automatic Identification System Analysis Package (AISAP) was used to compile and filter all vessel position records contained within the NAIS archive during calendar year 2016 for the ports featured in this report. To keep data transfer and computational times manageable, the vessel position histories were sampled at 5-minute intervals.

Uses and Limitations

Not all vessels found within the AIS record could be matched via the IMO number, as discussed previously. In most cases, the unmatched vessels were harbor tugs and other U.S.-flagged vessels that do not have IMO numbers. Since IMO registry is mandatory for all cargo ships of at least 300 gross tons, nearly all commercial vessels of interest to the PPFSP can be matched via this process, with only a few inconsistencies typically identified at each port location for the entirety of 2016.

AIS messages are broadcast over very high frequency (VHF) band range and can be subject to disruptions from terrain or weather events. Likewise, equipment problems with the onboard AIS transceiver units or the shore-based NAIS receiving towers can occasionally cause interruptions in coverage for individual vessels or within particular areas. During interruptions, some vessel call events may be missed completely, or interruptions may cause the associated dwell time observations to be cut short if they happen to span the time period when the vessel entered or exited the geo-fenced watch area. Signal disruptions or software issues may also sometimes lead to inaccurate geo-coordinates for some position reports, causing vessels docked at terminals to appear to briefly "leave" the confines of the geo-fenced terminal area. Absent any quality control steps, these issues with position accuracy manifest themselves as multiple calls (by the same vessel), when in fact only one has occurred.

Table 10 summarizes three filter thresholds used to post-process the vessel call event counts and dwell time observations derived from the geo-fenced port terminal boundaries and the NAIS archival data.

Table 10 Vessel Call and Dwell Time Post-Processing Filters

Filter	Time
Minimum dwell time considered (vessel call not recorded otherwise)	2 hours
Minimum time between consecutive vessel call events (combined into single event otherwise)	2 hours
Maximum gap in position report record spanning entry/exit for valid dwell time observation	1 hour

One key assumption for the dwell time evaluation is that vessels of all types require a minimum of 2 hours inside the terminal boundary to constitute a valid observation wherein cargo could be discharged or loaded. This threshold filters out cases wherein vessels are merely passing through the terminal area or maneuvering for transit elsewhere within the port area. Multiple, consecutive dwell time events by the same vessel are combined into a single entry if less than 2 hours elapse between them. The duration of this new, combined entry is based on the respective start and end times of the first and last observed dwell time events, and thus spans any coverage gaps. The last entry in Table 10 refers to instances where there was more than a 1-hour gap prior to the first observation of a vessel position report within the geo-fenced terminal area, or more than a 1-hour gap after the last observation within the area. These cases are counted as valid vessel call events, but the associated dwell time observations are not included in the statistical analysis. For most port areas, between 1 and 3e percent of vessel call observations are screened out from the summary statistics calculation due to these gaps in the coverage record.

Container Vessel Dwell Times

The analysis of container vessel dwell times included additional filtering steps, as shown in Table 11. Because it takes between 1 and 3 hours to secure a container vessel on arrival and prepare it for departure, calls of less than 4 hours were deemed too brief for significant container cargo transfer. Calls of over 120 hours were considered anomalies, possibly due to delays unrelated to cargo handling, and were not considered.

Table 11 Container Vessel Dwell Time Post-Processing Filters

Filter	Time
Minimum dwell time considered (vessel call excluded otherwise)	4 hours
Maximum dwell time considered (vessel call excluded otherwise)	120 hours

To assign vessel TEU capacities, vessel names were compared with fleet listings compiled by BlueWater Reporting[3] and internet sources such as Containership-Info.[4] Vessels were limited to geared or cellular container ships; barges or Ro/Ro vessels handling containers would not have comparable dwell times.

The final database used for the container vessel dwell time analysis in this report included 18,500 usable records. Some May 2016 data for the Ports of Long Beach and Los Angeles were unavailable due to AIS equipment downtime for part of the month.

[3] https://www.bluewaterreporting.com/compair/default.htm

[4] http://www.containership-info.com

Container Vessel Dwell Time Indexes

Analysis of the average port dwell time data indicated that the volume of containers handled in an average vessel call is a primary factor. Since that average varies widely between ports, the expected dwell time varies as well. To provide a meaningful metric for dwell time variability within each port, a dwell time index was developed by dividing monthly averages by the annual average for each port. These indexes are then presented graphically in the port profiles, with monthly averages.

Definition: Port Terminal Polygons

Background

Port terminal polygons are digital geospatial boundaries for port facilities. They were defined using AIS vessel position data in a geographic information system (GIS) overlaid on publicly available satellite maps and then used to calculate key metrics included in the PPFSP 2017 *Annual Report.*

The purpose of this effort was to:

1) utilize cross-verifying data sources to create a GIS polygon layer reflecting the location, time, and ship details of cargo vessels at berth; and
2) identify and demarcate, with a repeatable and nationally consistent methodology, the land and waterside extent of port facilities where cargo is stored or transferred to other transport modes.

The scope of the project was limited to cargo handling terminals at the nation's top container ports as identified from USACE WCSC data. All the polygons created for the PPFSP were drawn in ArcGIS by the BTS Office of Spatial Analysis and Visualization.

No nationally consistent methodology, framework, or best practices previously existed for drawing port terminal polygons. In broad terms, the framework for including port terminal polygons in the PPFSP was established in three steps:

- First, the team analyzed AIS data showing where vessel activity occurred over the past year in the context of ancillary data such as terminal maps, satellite imagery, and land use shapefiles.
- Second, the team created polygon shapefiles around the terminals where both cargo handling facilities and cargo activity exist.
- Third, the team shared the shapefiles with ERDC to be used in conjunction with the ERDC's AISAP. The results were then used to generate performance measures used in the PPFSP 2017 *Annual Report.*

While a shared protocol was followed to create the polygons, differences in port and channel layouts required flexible interpretation of the guidelines. The steps presented in this document should then be considered best, but very general, practices. Ultimately, AIS data determine the shape and size of each boundary, and each polygon exists to provide specific information about a given port terminal or facility.

Querying and Filtering the Initial Data

AIS data associated with each port was acquired via the NAIS and provided to the team by USACE in the form of comma-separated values (CSV) files. The files were parsed into monthly files using a query that retained only AIS data from vessels with a navigation status of moored and a speed of zero. Filtering data by these parameters ensures that the dataset is limited to information from vessels that are truly stationary and therefore reasonably able to load or unload cargo.

Using ArcMap, the monthly AIS files were joined to a CSV file containing information provided by USACE for individual cargo vessels by their MMSI numbers. This process provided additional detail for each AIS data point including vessel name, the confirmed MMSI number, ship type, and ship subtype.

All data points for non-cargo vessels were removed from the dataset. Those data points left unmatched by MMSI number were removed from consideration to limit the influence of human error on the analytical process.

Drawing the Polygons

In ArcMap, the cleaned files were converted to points, and overlaid onto satellite imagery base maps. Additional data pertaining to port facilities, including coordinates for thousands of docks in the United States and their structural and usage attributes (commodity processed, owner, operator, and name), were obtained through the USACE Master Docks Plus database (which contains 40,000 port-and-waterway facilities and other navigation points of interest), converted to points, and added to the ArcMap document. Each port contains multiple docks and each eventual port terminal polygon contains at least one dock.

Clusters of AIS data points within a reasonable distance of dock facilities were identified. For the purposes of this project, AIS clusters are defined as 10 or more transmissions from the same vessel within close proximity. Although many clusters contain 100+ pings, the lower limit of 10 ensures that a vessel is stopped at a given terminal.

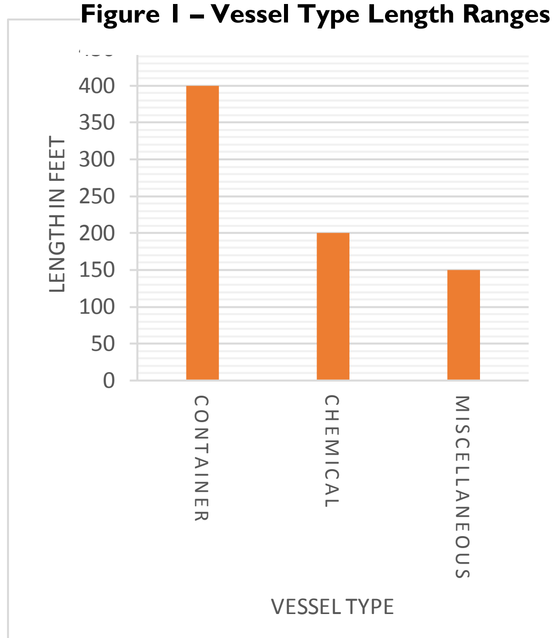
The boundaries of port terminal polygons were then drawn in ArcGIS around individual docks or terminals that contained at least one AIS cluster. Where Master Docks Plus points existed, polygons were linked in the underlying database according to the listed owner or operator, and were presumed to be handling similar cargo types. Where no Master Docks Plus point existed, USACE was notified and secondary sources were used to identify ownership. If this process was fruitless, the polygon was drawn without associated ownership information. This process provides the PPFSP the opportunity to complete analysis at both the port and terminal level.

As stated above, a shared protocol was followed, but differences in port and channel layouts require flexible interpretation of the guidelines. The distance that port terminal polygons extend into the channel from physical dock structures, visible through satellite imagery, is a prime example of this flexibility. The different standards for water-side polygon boundaries for three general terminal types are described below and shown in Figure 1:

1. **Container terminals**: Polygons may extend 400 feet from the edge of the waterside boundary of the dock. This measurement can be reduced if the dock shares a boundary with an adjacent terminal or if the channel is particularly narrow. This ensures no erroneous capture of vessels moored in the channel.

2. **Oil and chemical terminals:** Polygons may extend 150 to 200 feet from the waterside boundary as these terminals are often located in narrower channel areas. Oil and chemical docks may also be floating berths located further from the visible waterside dock boundary and connected via piping to a processing area. In such cases, the polygon must be shaped appropriately to capture any AIS data present.

Figure 1 – Vessel Type Length Ranges



3. **Miscellaneous cargo terminals:** Polygons may extend 150-250 feet from the waterside boundary. These docks may be equipped to handle one of several cargo types including break-bulk, dry bulk, and Ro/Ro cargoes. As with the oil and chemical facilities, these facilities are often found in narrower channels or inner parts of the port.

The landside portions of the port terminal polygons were drawn to cover each terminal's loading areas as well as storage and processing facilities. Landside boundaries were drawn to follow internal or access roads and stop at any major roads, railways, or developed areas that are far away from the water and not part of another port terminal.

In many cases, port terminal polygons were drawn adjacent to each other. In this situation, it is appropriate to align the waterside borders if AIS data extends into water at a similar distance, and align the landside borders if the boundaries follow the same human-made features. In many ports, terminals that process the same or similar commodities are located adjacent. The process of aligning boundaries and the nature of AIS data may result in having AIS clusters that span two or more polygons. This should not affect the results of the PPFSP's 2017 *Annual Report*.

Metric:
Container Terminal Minimum Project Depth

Background

Channel depth limits the sailing draft (the vertical distance between the waterline and keel) of vessels that can call at a port. Container terminals are faced with greater channel depth requirements as the size of containerships increases. Multiple terminals within the same port may have different channel depths as different USACE Federal navigation projects cover the route between open water and each terminal.

Concept

USACE constructs and maintains Federal navigation projects to an authorized depth as specified in congressional legislation. Not all channels are constructed or maintained to their exact authorized dimensions. Maintained depths may be less than authorized due to a number of factors. In some cases, limited annual budget allocations may have precluded maintaining the entire navigation project to full authorized dimensions; this is particularly true when the initial deepening results in significantly higher-than-expected sediment loads accumulating in the channel. In other cases, the difference is temporary, pending completion of ongoing channel deepening activities, which can require several years depending on the scope of the required dredging.

As channel depths vary over the course of the year, any reporting of actual depths risks being out of date shortly after publication. The profiles for the top 25 container ports therefore detail the minimum Federal navigation project depth encountered on the way to each terminal.

Methods

BTS worked with USACE to develop protocols that treated all terminals equally. The primary source for determining the minimum Federal navigation project depth for each terminal was the project dimensions tabulated from USACE surveys by the Office of Coast Survey (OCS) at the National Oceanic and Atmospheric Administration (NOAA) and presented in nautical charts. The path between terminal and open water was plotted for each container terminal, and the Federal navigation projects along that path were identified. The Mean Lower Low Water (MLLW) depth for each Federal navigation project along a given path was recorded, and the minimum depth encountered along each path was assigned as the minimum project depth for the terminal. Turning basins were not included unless a path used them on the way to a terminal.

A number of nautical charts did not contain MLLW depth details for the relevant Federal navigation projects. In these instances, other mapping products were consulted, including BookletCharts produced by NOAA that contained text descriptions of the projects encountered and USACE hydrographic surveys that provided project depths in the descriptive notes or overlaid on the map itself.

Several terminals are located at ports with natural deep-water channels, and project information was not available for the path that connected those terminals to open water. In those cases, the profiles report N/A for the minimum project depth.

A representative of USACE subsequently confirmed the paths and depths.

Table 12 is an example of the data compiled for the South Florida Container Terminal at the Port of Miami. The minimum Federal navigation project depth included in the terminal's profile was 50 feet.

Table 12 Example of Channel Depth Data Tabulated for South Florida Container Terminal, Port of Miami

Project Name	Depth MLLW (feet)
South Ship Channel	50
Government Cut	50
Bar Cut	52
Outer Bar Cut	52

Data Sources

The primary source for the project dimensions were charts released by OCS at NOAA.[5] These charts typically indicate the width (in feet), length (in miles) and the MLLW depth (in feet) of mapped Federal navigation projects. Where OCS charts did not contain project details, BTS used secondary sources including USACE hydrographic surveys[6] and descriptive text based on USACE project descriptions included in NOAA's BookletChart maps.[7] USACE performs ongoing channel depth surveys, with new readings incorporated into NOAA and USACE charts and documents. In one instance, the depth alongside a terminal could not be located in any of the printed data sources, and the depth value available on the terminal's web site was instead used.

Uses and Limitations

The ongoing changes in channel depths due to tidal impact or localized shoaling from sediment accumulation mean that the reported minimum project depths are not substitutes for actual controlling depths, and instead provide insight into the size of vessels the terminals can handle. Further, ongoing or recently approved channel deepening projects may not be captured in the charts available. As described above, several terminals reported N/A to reflect issues collecting Federal navigation project depths.

[5] http://www.charts.noaa.gov/InteractiveCatalog/nrnc.shtml
[6] http://navigation.usace.army.mil/Survey/Hydro
[7] https://nauticalcharts.noaa.gov/charts/noaa-raster-charts.html#booklet-charts

Definition: Port Vicinity Maps

Background

The *FAST Act* requires the PPFSP *Annual Reports* to include the top 25 ports as measured by overall cargo tonnage, by TEU of container cargo, and by dry bulk cargo tonnage.

Many ports rank in the top 25 in more than one category. For the PPFSP 2017 *Annual Report,* the three top 25 lists include 49 individual ports altogether. Appendix A of the 2017 A*nnual Report* includes individual profiles for the ports that describe the characteristics and detail the capacity and throughput of each. Each profile also includes a map of the port vicinity.

Concept

The 2017 *Annual Report* expands upon the 2016 edition with revised and expanded port profiles. Previously, the maps included in the profiles pinpointed the port location at the national scale; however, the 2017 *Annual Report* refreshed and enhanced these maps to include local port area detail and infrastructure context where possible. As the exact boundaries of each terminal and port facility are complex and are often unavailable, the term “Port Vicinity” is used to describe the general location of port facilities within the region while still providing insight into the area in which port-related activity is focused.

Methods

Each port vicinity map may include the following elements overlaid on a base map:

- Port vicinity
- Limiting bridges
- State and/or national borders
- Notable roadways
- Inset: regional location
- Inset: bridge list
- Legend, scale, and north arrow

The port vicinity was derived from BTS-generated port and terminal boundaries using AIS data and port website figures and maps. Google satellite imagery was used to verify facility locations at many ports. The shaded vicinity zone was expanded to include the area between the port and terminal boundaries and the water’s edge in order to create a contiguous area. The port vicinity determined the extent and scale of each map.

The source data for the base map included water body names and state and national borders. Bridge points were added manually based on port vicinity and bridge locations. Roadways were imported from gROADSv1 and modified to fit the base map coordinate system.

Data Sources

The port vicinity areas were derived from BTS-generated port and terminal boundaries using 2016 AIS data, plus individual port websites and Google satellite imagery, as of 2017.

Limiting bridges were compiled by USCG and verified using NOAA charts, as of November 2017.

The World Light Gray Base, Web Mercator Auxiliary Sphere (WKID 102100) coordinate system as of November 2017, was imported from Esri, Garmin, HERE, MapmyIndia, INCREMENT P, © OpenStreetMap contributors, and the GIS community.

The gROADSv1 layer was downloaded from the Center for International Earth Science Information Network/Columbia University, and Information Technology Outreach Services/University of Georgia, Global Roads Open Access Data Set, Version 1, as of November 2017.

The inset regional maps port locations were taken from U.S. DOT, BTS, National Transportation Atlas Database 2015, Major_Ports layer, as of November 2016.

Uses and Limitations

The port vicinity maps illustrate the general location of port areas and surrounding facilities, but may not provide exact facility locations. The maps should not be used for further analysis.

For all ports, the port vicinity area was drawn broadly to ensure that no facilities were missed. In some cases, the AIS data differed from port websites and satellite imagery. In these cases, the map included AIS data as part of the strategy to ensure inclusion, and the port vicinity may differ significantly from other port facility maps.

The scale of each map differs based on the extent of the port vicinity. Some ports are compact, with all facilities located close together. Other ports are much larger, such as the Ports of Cincinnati-Northern Kentucky, which extends for over 200 miles along a river. While the mapping process was consistent across ports and tailored to port vicinity extent, the base maps for individual ports vary in level of detail shown.

The limiting bridges included on some port vicinity maps were selected based on air draft and illustrate the potential limits on vessel size. Some bridges were left off maps for improved clarity. Other ports may be limited by bridges that do appear on port vicinity map; these are noted underneath the maps.

For clarity, some State borders are not completely shown. In many cases, a segment of the border is shown to indicate the border location, with an explanation noted underneath the map