Appendix B - Traffic Analysis

INTRODUCTION

This traffic analysis encompasses the area study area defined by the Chesapeake Bay PARS. It evaluates annual trends and unique or significant variations relating to the quantity, characteristics, and routes of the vessels transiting the Chesapeake Bay entrance\(^1\). This analysis does not evaluate coastal traffic that does not transit the mouth of Chesapeake Bay. This analysis was prepared by the USCG Navigation Center for USCG District 5 and USCG Headquarters staff.

MATERIALS

- 2017 and 2018 Vessel AIS track line data downloaded from Marine Cadastre
- 2019 Vessel AIS 5-minute aggregated point data obtained from the USCG Nationwide Automatic Identification System (NAIS)
- Marine Cadastre’s ArcMAP toolbox TrackBuilder 2.1.1\(^2\)
- USCG Standard Workstation running ESRI’s desktop GIS program ArcMAP 10.5.1
- Study area as defined in Agency Docket Number USCG-2019-0862 in the Federal Register

PROCEDURE

The USCG’s Navigation Center (NAVCEN) obtained vessel track data derived from USCG NAIS data of the East Coast of the United States from the Marine Cadastre website (marinecadastre.gov) for calendar years 2017\(^3\) and 2018\(^4\). Vessel track data derived from USCG NAIS were unavailable from Marine Cadastre for calendar year 2019 at the time of this study. Vessel tracks for 2019 were constructed using 5-minute aggregate NAIS point data sets. These data were processed in to vessel tracks using the Marine Cadastre’s Track Builder 2.1.1 tool, and a project file using ESRI’s ArcMap 10.5.1 geographic information system application were created for each calendar year. These data were then filtered and selected for location within the Chesapeake Bay Port Access Route Study Area boundaries.

The track lines were then further refined by selecting only those vessel tracks which crossed the mouth of Chesapeake Bay, as defined by a line drawn slightly inshore of the COLREGS demarcation line, running between Cape Charles and Fisherman’s Island. These data were then joined using a vessel’s Mobile Maritime Selective Identity (MMSI) with the most recent Authoritative Vessel Identification System (AVIS) registry\(^5\). The joined dataset enabled additional filtering necessary to positively identify container ships, as well as filtering of track data by vessel drafts. Track density maps were produced to evaluate anomalies and trends. Anomalies and trends were evaluated by annual and monthly time periods (monthly for pleasure and fishing vessels only) and by vessel type, and draft.

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\(^1\) 33 CFR §80.510  Chesapeake Bay Entrance, VA. A line drawn from Cape Charles Light to Cape Henry Light.
\(^2\) https://coast.noaa.gov/digitalcoast/tools/track-builder.html
\(^3\) https://www.fisheries.noaa.gov/inport/item/54207
\(^4\) https://www.fisheries.noaa.gov/inport/item/59569
\(^5\) Most recent AVIS data file, February 2018
METADATA

Vessel type was determined from one of three available data fields: vessel type as entered in AIS data, or IHS StatCode or vessel service as recorded in the AVIS database. Some vessels were unable to be positively identified and were subsequently coded as “Unknown.” The total number of unknown vessel types was influenced by the age of the AVIS database and AIS operators omitting or improperly coded static data in the user-defined configuration fields of their AIS units.

Vessel draft was determined by correlation of vessel MMSI with authoritative draft data contained in the AVIS database. User-defined draft data were not used to categorize vessel’s in to draft categories. User-defined draft data were not used because this information was present in only 22 to 27% of vessel data records and, when present, is frequently unreliable due to a common error of entering vessel draft in feet when draft measurement are to be entered in meters.

The data do not include vessels that are not outfitted to transmit AIS broadcasts. Fishing vessels participating in a VMS-monitored fishery are not included in the data unless the vessel also broadcasts AIS.

Variability in the selection of total number of track lines transiting the mouth of Chesapeake Bay was discovered during the processing of 2017 data. The variability was caused by discontinuities, or random gaps, in vessel track lines. When these gaps coincide with the line of demarcation to select a track line as being a transit (entrance or departure) the gap would cause the track line to not meet the intersecting criteria and was omitted. Marine Cadastre’s AIS metadata attribute these gaps to AIS signal reception issues caused by ship distance from an AIS signal receiving station. Gaps are also created due to the processing of AIS data in monthly sets and an inability to connect tracks created in a month to adjacent months. Similar discontinuities were discovered in 2018 and 2019 datasets. The variability was quantified for the population of tracks transiting the mouth of Chesapeake Bay. The average variability in the population of tracks over all three years was 11.8%. In terms of vessel transits, the maximum variance in the number of tracks was 629, the minimum variance was 21, and the average over three years was 268. This variability was deemed to be noteworthy with respect to the repeatability and precision of this analysis, however it was determined to be insignificant for the purposes of accuracy and in evaluating trends and traffic composition.

RESULTS

Entrance Transits

The total number of entrance transits by year are provided in Graph 1.0. Graphs 2.0, 3.0, and 4.0 show the total number of ship transits through Chesapeake Bay entrance by vessel type and draft for 2017, 2018, and 2019.
Graph 1.0 – Chesapeake Bay Entrance Ship Transits by Year

Graph 2.0 – Chesapeake Bay Entrance Transits by Ship Type and Draft – 2017
Graph 3.0 – Chesapeake Bay Entrance Transits by Ship Type and Draft - 2018

Graph 4.0 – 2019 Chesapeake Bay Entrance Transits by Ship Type and Draft
Heat Map Trends

Towing, fishing, and pleasure vessels were predominantly distributed nearshore, away from the northern and southern traffic separation scheme (TSS) almost entirely. Merchant shipping and larger vessels followed the TSS, following marked navigation channels resulting in routes which are distributed further offshore. The majority of merchant shipping and deeper draft vessel traffic use the southern deeper water route (CB TSS.)

Shallower draft container vessel transits steadily decreased over the study years. In 2017, 138 container ships with drafts less than 35 feet transited Chesapeake Bay Entrance. In 2018, the number of ships dropped to 13. In 2019 the data showed no record of any container ship with a draft less than 35 feet transiting Chesapeake Bay Entrance.

Seasonal variability was investigated for pleasure and fishing vessel types. Fishing vessel transits of Chesapeake Bay Entrance tended to peak in the fall (October through December) and reached minimum values in winter (January through February.) Additionally, the distribution of track directions were seen to vary over the course of the year with a majority of track lines trending southeasterly from the mouth of the bay along the coast earlier in the year and northeasterly later in the year. Pleasure vessels tended to reach peak transits of Chesapeake Bay Entrance in late summer and early autumn (August through October) and minimal values in Winter and early Spring (January through April.) Charts to visualize this variability were not produced for this analysis.

Deeper draft vessel track lines, and especially deeper draft cargo vessels, approach or depart the CB TSS entrance route by taking a southwest/northeast course which, upon investigation of the underlying bathymetry, appears to be a route intended to follow a naturally occurring deeper water route and avoid crossing a 60-foot isobath that extends from the eastern vicinity of the CB buoy and runs to the northeast toward the C-VOW experimental wind power project. Several least depths contained within the 60-foot isobath are charted at 8 fathoms, or 48 feet. After clearing this area of less than 60-foot depths, vessels then change course to easterly headings, taking them through an offshore wind energy lease area. This vessel behavior is depicted in Figure 1.0 (page B-6) with track data from other cargo vessels with drafts greater than 45 feet track. Note the abrupt course change at the sea buoy (“CB”) as opposed to the typical gradually diverging fan pattern (such as in the vicinity of “NCA” buoy) usually associated with vessel entrances and exits from routing measures. This vessel behavior can be seen in all study years in the container and other cargo ship types.
Other Interesting Trends or Anomalies by Individual Vessel Type Chart Number:

Chart 8.1 – The three highest density/red areas located approximately 5 miles off the North Carolina coast and just south and along the CB TSS represent dredging activities. A block of low-density tracks also located off the North Carolina coast is attributed to US Army Corps of Engineers survey work.

Chart 8.2 – Two vessels are represented in this chart, the aircraft carrier USS GEORGE H.W. BUSH and the fast supply combat ship USNS ARCTIC.

Chart 9.0 – The highest density track lines immediately adjacent to the coast in the vicinity of Rudee Inlet to Cape Henry are small sightseeing excursion vessels. This track signature is also evident in Chart 17.0 and 25.0 for calendar years 2018 and 2019.

Chart 16.1 - Two noticeable blocks of low-density track lines are the result of hydrographic survey work conducted by NOAA Ship FERDINAND HASSLER. Noticeable areas of high density include the tracks of the suction dredge TERRAPIN ISLAND outside and immediately south of the CB TSS as well as apparent survey work conducted by the OSV GERRY BORDELOM, likely in support of a wind energy demonstration project.

Chart 16.2 – One vessel’s track lines (the aircraft carrier USS GEORGE H.W. BUSH) are represented in this plot.
Chart 16.3 – One vessel’s track lines (the Floating Storage, Production, and Offloading (FPSO) ship RAINBOW) are represented in this plot.

Chart 19.0 – Two U.S. Army Corps of Engineers survey vessels EWELL and CATLETT show high density track plots approximately 2 to 4 miles ENE and ESE of Rudee Inlet, VA. These vessels were identified by manual investigation of the heat map anomaly. Other traffic patterns evident in this chart of unknown vessel types are indicative a mix of all vessel types, including deeper draft vessels using the NE cut at the terminus of the CB TSS.

Chart 20.1 – This chart shows container ships in the draft category between 35 and 45 feet instead of vessels less than 35 feet as the numbering convention shows in 2017 and 2018. This change is because the data showed no container ships with drafts less than 35 feet transiting Chesapeake Bay Entrance in 2019.

Chart 24.0 – One vessel, the aircraft carrier USS GEORGE H.W. BUSH, was present in the data for the draft category between 35 and 45 feet. The track line ended at the offshore terminus of the CB TSS, providing no significant data to the traffic distribution. Therefore, a chart of support and other vessel types for the draft category between 35 and 45 feet was omitted and the qualification “no drafts greater than 35 feet” was omitted from the title for this chart. Additional interesting anomalies include the track densities from the OSV JERRY BORDELON leading from the Kitty Hawk Wind Energy Lease Area to shore and survey track lines from the same vessel within the wind lease area. High density areas between the entrance channel and Cape Henry are primarily due to dredging activities.

Vessel Track Density Chart Data Interpretation

Track densities are symbolized using a relative color scale indicating values from low density to high density. The color coding (smaller values are cool/blue in color and larger values are hot/red in color) correspond to a numerical value representing track density. Track density is equal to the cumulative length of all tracks contained within a unit of area, divided by the total number of tracks included in the unit of area. The unit of area used for this study was a circle 66 meters in diameter. The rendering of track density color spectrum is influenced by the total number of tracks for each vessel type. Absolute density values are not provided. This limits the ability to make quantitative comparisons between vessel types using color symbology without first taking in to account the range of values provided in the annual bar charts.

Specific vessel subtypes may influence the rendering of the color scale and introduce an unintentional bias in the density plots. For example, pilot vessels are a subtype within the Support/Other vessel type. Pilot vessels had a significant impact on the density of track lines captured in the Support/Other vessel type group due to their prevalence in the area in the immediate vicinity of the mouth of Chesapeake Bay. As a result, the greatest density for the Support/Other vessel type was heavily biased (hotter colors) toward the pilot boarding area, resulting in a lower density rendering (cooler colors) of Support/Other vessel track lines offshore. Pilot vessels were culled from this category and the result was a more representative rendering of the larger population of support/other vessel type density. Pilot boats were the only vessel sub-type which were specifically culled to provide a higher fidelity representation of track densities within a specific vessel type category. Other vessel subtypes which can skew visualization of track densities include dredging vessels and survey vessels.
When displaying track densities according to vessel type and draft, the first chart in the series is labeled with the qualifier “all drafts.” This qualifier means that vessel track lines were included in this plot regardless of whether draft data was present in the track line records. The distinction “no drafts greater than 35 feet” implies that in the set of track line data that contain reliable draft information, none of the drafts were greater than 35 feet. Theoretically, due to the presence of null drafts in the track line data, there is the possibility that some vessels could have drafts greater than 35 feet but were unable to be identified.

Vessel Track Density Chart Presentation

The following vessel track density (“heat maps”) are presented as individual pages as follows:

Chart 1.0 – Calendar Year 2017 All Ships, All Drafts
Chart 2.0 – Calendar Year 2018 All Ships, All Drafts
Chart 3.0 – Calendar Year 2019 All Ships, All Drafts

2017

Chart 4.0 – Calendar Year 2017 Container Ship Tracks, All Drafts
Chart 4.1 – Calendar Year 2017 Container Ship Tracks, Drafts Less than 35 Feet
Chart 4.2 – Calendar Year 2017 Container Ship Tracks, Drafts between 35 and 45 Feet
Chart 4.3 – Calendar Year 2017 Container Ship Tracks, Drafts Greater than 45 Feet

Chart 5.0 – Calendar Year 2017 Other Cargo Ship Tracks, All Drafts
Chart 5.1 – Calendar Year 2017 Other Cargo Ship Tracks, Drafts Less than 35 Feet
Chart 5.2 – Calendar Year 2017 Other Cargo Ship Tracks, Drafts between 35 and 45 Feet
Chart 5.3 – Calendar Year 2017 Other Cargo Ship Tracks, Drafts Greater than 45 Feet

Chart 6.0 – Calendar Year 2017 Fishing Vessels, All Drafts (No Drafts Greater Than 35 Feet)
Chart 7.0 – Calendar Year 2017 Towing Vessels, All Drafts (No Drafts Greater Than 35 Feet)

Chart 8.0 – Calendar Year 2017 Support/Other Vessels, All Drafts (No Drafts Greater Than 35 Feet)
Chart 8.1 – Calendar Year 2017 Support/Other Vessels, Drafts Less than 35 Feet
Chart 8.2 – Calendar Year 2017 Support/Other Vessels, Drafts between 35 and 45 Feet

Chart 9.0 – Calendar Year 2017 Passenger Vessels, All Drafts (No Drafts Greater Than 35 Feet)
Chart 10.0 – Calendar Year 2017 Pleasure Vessels, All Drafts (No Drafts Greater Than 35 Feet)
Chart 11.0 – Calendar Year 2017 Unknown Vessel Types, No Draft Distinctions

2018

Chart 12.0 – Calendar Year 2018 Container Ship Tracks, All Drafts
Chart 12.1 – Calendar Year 2018 Container Ship Tracks, Drafts Less than 35 Feet
Chart 12.2 – Calendar Year 2018 Container Ship Tracks, Drafts between 35 and 45 Feet
Chart 12.3 – Calendar Year 2018 Container Ship Tracks, Drafts Greater than 45 Feet

Chart 13.0 – Calendar Year 2018 Other Cargo Ship Tracks, All Drafts
Chart 13.1 – Calendar Year 2018 Other Cargo Ship Tracks, Drafts Less than 35 Feet
Chart 13.2 – Calendar Year 2018 Other Cargo Ship Tracks, Drafts between 35 and 45 Feet
Chart 13.3 – Calendar Year 2018 Other Cargo Ship Tracks, Drafts Greater than 45 Feet

Chart 14.0 – Calendar Year 2018 Fishing Vessels, All Drafts (No Drafts Greater than 35 Feet)

Chart 15.0 – Calendar Year 2018 Towing Vessels, All Drafts (No Drafts Greater than 35 Feet)

Chart 16.0 – Calendar Year 2018 Support/Other Vessels, All Drafts
Chart 16.1 – Calendar Year 2018 Support/Other Vessels, Drafts Less than 35 Feet
Chart 16.2 – Calendar Year 2018 Support/Other Vessels, Drafts between 35 and 45 Feet
Chart 16.3 – Calendar Year 2018 Support/Other Vessels, Drafts Greater than 45 Feet

Chart 17.0 – Calendar Year 2018 Passenger Vessels, All Drafts (No Drafts Greater than 35 Feet)

Chart 18.0 – Calendar Year 2018 Pleasure Vessels, All Drafts (No Drafts Greater than 35 Feet)

Chart 19.0 – Calendar Year 2018 Unknown Vessel Types, No Draft Distinctions

2019

Chart 20.0 – Calendar Year 2019 Container Ship Tracks, All Drafts
Chart 20.1 – Calendar Year 2019 Container Ship Tracks, Drafts between 35 and 45 Feet
Chart 20.2 – Calendar Year 2019 Container Ship Tracks, Drafts Greater than 45 Feet

Chart 21.0 – Calendar Year 2019 Other Cargo Ship Tracks, All Drafts
Chart 21.1 – Calendar Year 2019 Other Cargo Ship Tracks, Drafts Less than 35 Feet
Chart 21.2 – Calendar Year 2019 Other Cargo Ship Tracks, Drafts between 35 and 45 Feet
Chart 21.3 – Calendar Year 2019 Other Cargo Ship Tracks, Drafts Greater than 45 Feet

Chart 22.0 – Calendar Year 2019 Fishing Vessels, All Drafts (No Drafts Greater Than 35 Feet)

Chart 23.0 – Calendar Year 2019 Towing Vessels, All Drafts (No Drafts Greater Than 35 Feet)

Chart 24.0 – Calendar Year 2019 Support/Other Vessels, All Drafts

Chart 25.0 – Calendar Year 2019 Passenger Vessels, All Drafts (No Drafts Greater Than 35 Feet)

Chart 26.0 – Calendar Year 2019 Pleasure Vessels, All Drafts (No Drafts Greater Than 35 Feet)

Chart 27.0 – Calendar Year 2019 Unknown Vessel Types, No Draft Distinctions

Pilot Vessels

Chart 28.0 – Pilot Vessels, Calendar Year 2017
Chart 28.1 – Pilot Vessels, Calendar Year 2018
Chart 28.2 – Pilot Vessels, Calendar Year 2019
Chart 5.1 – Calendar Year 2017 Other Cargo Ship Tracks, Drafts Less than 35 Feet

Track Density

High

Low

Nautical Miles

Prepared by: Coast Guard Navigation Center
Data Source: NAIS January 2017 to December 2017

Scale: 1:938,728
GCS: GCS WGS 1984
Datum: WGS 1984
Chart 8.0 – Calendar Year 2017 Support/Other Vessels, All Drafts

Track Density

High

Low

Scale: 1:938,728
GCS: GCS WGS 1984
Datum: WGS 1984

Prepared by: Coast Guard Navigation Center
Data Source: NAIS January 2017 to December 2017
Chart 8.1 – Calendar Year 2017 Support/Other Vessels, Drafts Less than 35 Feet

Track Density

- High
- Low

Prepared by: Coast Guard Navigation Center
Data Source: NAIS January 2017 to December 2017

Scale: 1:938,728
GCS: GCS WGS 1984
Datum: WGS 1984
Chart 12.3 – Calendar Year 2018 Container Ship Tracks, Drafts Greater than 45 Feet

Track Density

High

Low

Prepared by: Coast Guard Navigation Center
Data Source: NAIS January 2018 to December 2018

Scale: 1:938,728
GCS: GCS WGS 1984
Datum: WGS 1984
Chart 13.1 – Calendar Year 2018 Other Cargo Ship Tracks, Drafts Less than 35 Feet

Track Density

High

Low

Prepared by: Coast Guard Navigation Center
Data Source: NAIS January 2018 to December 2018

Scale: 1:938,728
GCS: GCS WGS 1984
Datum: WGS 1984
Chart 13.3 – Calendar Year 2018 Other Cargo Ship Tracks, Drafts Greater than 45 Feet

Track Density

High

Low

Scale: 1:938,728
GCS: GCS WGS 1984
Datum: WGS 1984

Prepared by: Coast Guard Navigation Center
Data Source: NAIS January 2018 to December 2018
Chart 22.0 – Calendar Year 2019 Fishing Vessels, All Drafts (No Drafts Greater Than 35 Feet)

Track Density

High

Low

Scale: 1:938,728
GCS: GCS WGS 1984
Datum: WGS 1984

Prepared by: Coast Guard Navigation Center
Data Source: NAIS January 2019 to December 2019
Chart 23.0 – Calendar Year 2019 Towing Vessels, All Drafts (No Drafts Greater Than 35 Feet)

Track Density

- High
- Low

Nautical Miles

Prepared by: Coast Guard Navigation Center
Data Source: NAIS January 2019 to December 2019

Scale: 1:938,728
Datum: WGS 1984