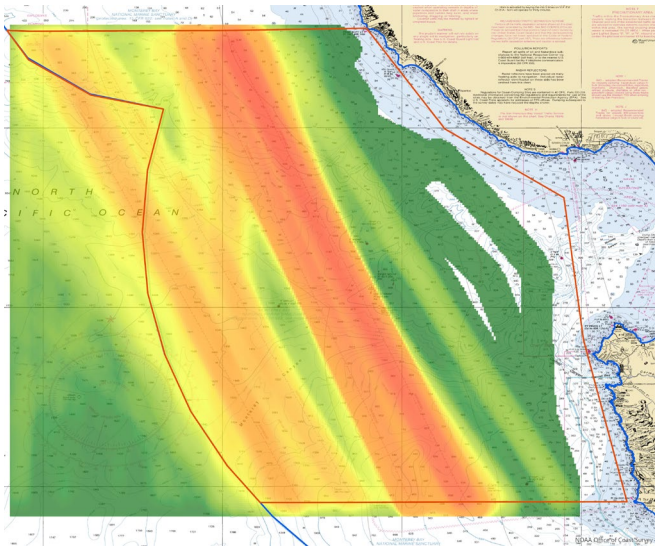
# Monterey Bay National Marine Sanctuary (MBNMS)

# Vessel Traffic Analysis

# January 1 to December 31, 2019

7/13/2020



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# Executive Summary

Monterey Bay National Marine Sanctuary (MBNMS) staff analyzed Automated Information System (AIS) data from Marine Traffic and United States Coast Guard (USCG) to evaluate compliance by cargo vessels and tankers with the International Maritime Organization (IMO) recommended vessel tracks. MBNMS staff set up a customized alert zone between Point Sur and Pigeon Point with a boundary 1.5 nautical miles east of the northbound IMO recommended track and was notified by email by MarineTraffic when a cargo vessel or tanker entered the customized alert zone, coming too close to shore increasing the risk of vessel groundings. This 2019 report evaluates a full year of data and builds on the 2018 report, which focused on analyzing the AIS data between June 1, 2018 and December 21, 2018, by examining monthly deviation rates based on GIS analysis of historical USCG AIS data from 2018 and 2019. MBNMS staff verified 248 inshore deviations in 2019. The majority of the deviating vessels were cargo vessels while 6% were tankers and 17% were vehicle carriers. Most deviating vessels were sailing north to Oakland (OAK) from either Los Angeles (LAX) or Long Beach (LBG). Seven of the 248 deviating vessels were heading south. Every month between 14 and 26 vessels deviated more than 1.5 nm inshore of the easternmost IMO recommended vessel track. The highest number of deviations occurred during the month of October 2019 when 26 vessels transited more than 1.5 nm inshore of the recommended tracks, a deviation rate of 11%. Of the six months of data analyzed for 2018, October 2018 also reflected the highest deviation rate. The 2018 and 2019 analyses revealed the same individual vessels tend to deviate. MBNMS staff will continue to work with District 11 Waterways Management to improve compliance with the recommended tracks to protect Sanctuary resources.

# Background

Vessel traffic was identified as a major issue of concern during designation of MBNMS due to frequent use of nearshore transit routes by ships that posed serious environmental threats to the sanctuary from potential collisions and groundings. An oil spill within MBNMS could severely affect the California sea otter population since the majority of sea otters in the state reside within the sanctuary. The Sanctuary also hosts an abundance of whales, and the National Marine Fisheries Service (NMFS) has identified vessel strikes as a potential threat to the recovery of endangered whales. Therefore, it is vital to better understand and monitor vessel traffic patterns within MBNMS.

In the 1990's the USCG and the National Oceanic and Atmospheric Administration (NOAA) established a working group of key stakeholders, to review existing vessel traffic practices and risks, and recommend a package of strategies which would maximize protection of Sanctuary resources while allowing for the continuation of safe, efficient and environmentally sound transportation. The group's recommendations included implementing offshore tracks for

container ships, bulk freighters, and vessels carrying hazardous materials to reduce the risk of groundings, and organizing those tracks into north-south lanes to reduce the risk of collision. These recommended tracks were ultimately approved by IMO, and implemented in 2000 (See Figure 1).

In 2013, MBNMS resource protection staff, working with a number of government and non-government partners, analyzed vessel patterns within the sanctuary to determine if ships were adhering to the IMO recommended tracks between Point Sur and Pigeon Point. By using cargo and tanker daily AIS data made available through USCG and Naval Postgraduate School (NPS) and in partnership with other federal agencies, MBNMS was able to review and evaluate use of the IMO recommended tracks over a four-year period from September 2009-2012. Up to eight (8) individual cargo vessels deviated more than three (3) nautical miles inshore of the northbound track nearest shore annually. Only one (1) tanker was found deviating inshore from the easternmost northbound track during this time-period and this deviation occurred in 2010.

Access to data about the affiliation and contents of each tank vessel passing through MBNMS would provide critical information for assessing the nature and scope of environmental threats from tanker transits inshore of the easternmost IMO recommended track. The Western States Petroleum Association (WSPA) announced in 1992 that its member's tankers carrying crude oil, black oil, or other persistent liquid cargo in bulk would voluntarily stay at least 50 nautical miles from the California mainland during coastal transits. Reliable information about load status during transits would make it possible to assess how well WSPA vessels are complying with their association's stated commitment. However, WSPA's voluntary commitment only pertains to tankers operated by its members.

The NMFS Southwest Fisheries Science Center (SWFSC) completed density maps for 2009 AIS ship track data and found "all" tankers used the recommended tracks that year (particularly those designated for vessels carrying hazardous cargo in bulk) and noted an especially higher density of hazardous cargos passing through the offshore southbound track. The 2009 data analysis by SWFSC indicated a higher density of cargo vessel transits in the track nearest to shore than in the other three tracks. MBNMS began conducting random daily reviews of AIS data on October 1, 2012 and staff contacted the USCG upon detection of any vessel deviation of more than three (3) nautical miles inshore of the recommended track closest to the mainland (i.e. the northbound track for vessels 300 gross tons and above). The USCG verified the AIS data and contacted the vessel owner/operator if they determined the AIS data confirmed deviation. The AIS analyses indicated a great majority of the large vessels transiting through MBNMS are complying with the IMO recommended tracks.

After completing the 2009-2012 analysis, MBNMS staff continued to track vessel traffic, with a particular focus on cargo vessels and tankers. In 2017, MBNMS staff established an account

with MarineTraffic, an AIS vessel tracking service, and set up an automatic notification system to automate daily reviews. MBNMS staff received an email every time a vessel of any type entered or left a defined nearshore alert zone extending from the mainland to 1.5 nautical miles east of the IMO vessel track nearest shore between Point Sur and Pigeon Point. However, due to the high volume of email alerts received and limited staff resources, systematic analysis of those deviations was not possible. Starting June 1 of 2018, the notification alerts from MarineTraffic were refined to identify "only tankers or cargo vessels" deviating more than 1.5 nautical miles (nm) east of the easternmost northbound track (Note: for the 2009-2012 analysis, MBNMS used 3 nm). The exclusion of other vessels from consideration (e.g. recreational, fishing, research, and government) facilitated sustainable, effective analysis within staffing constraints. The 2018 report analyzed the customized AIS data received from MarineTraffic between June 1, 2018 and December 21, 2018 (a 6-month period interrupted in late December by a lapse of federal appropriations and closure of federal offices). This report analyzes the customized AIS data received from MarineTraffic for all of 2019, from January 1, 2019 to December 31, 2019.

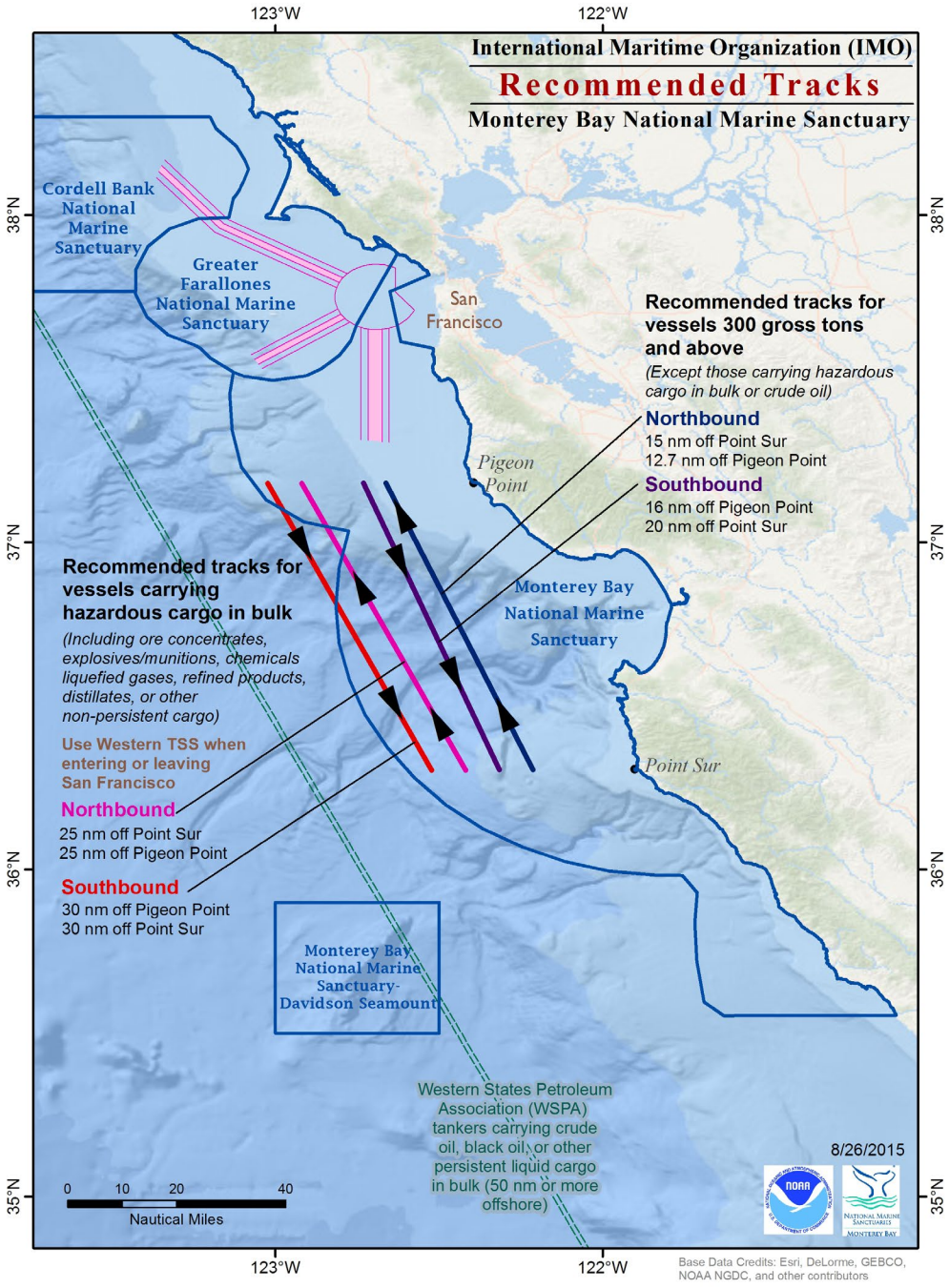


**Figure 1. International Maritime Organization recommended tracks within Monterey Bay National Marine Sanctuary. The San Francisco Traffic Separation Scheme (TSS), shown in pink, was updated June 1, 2013 to reduce whale strikes by ships and improve navigational safety. The four recommended tracks are split between northbound and southbound lanes for vessels >300 tons (blue and purple lines respectfully) and vessels carrying hazardous cargo in bulk such as liquefied gases (pink and orange lines respectfully). The Western States Petroleum Association (WSPA) tankers agreed to transit 50 nm or more offshore (shown by dashed green line).**

# Introduction

AIS data from MarineTraffic and USCG were harnessed to analyze vessel compliance with the IMO recommended tracks In MBNMS (Figure 1). AIS is an automatic tracking system used on ships and by vessel traffic services to identify and locate vessels in a given area by exchanging electronic data with other ships and AIS base stations (Figure 2. The IMO requires AIS be installed aboard all passenger ships; ships of 300 gross tons, or greater, conducting international voyages: cargo vessels of 500 gross tons, or greater, conducting non-international voyages (http://www.imo.org/OurWork/Safety/Navigation/Pages/AIS.aspx). It was originally developed to improve navigational safety and collision avoidance. However, AIS was also developed for other public benefits, so using it to determine compliance with the recommended tracks is within the scope of its original intent.

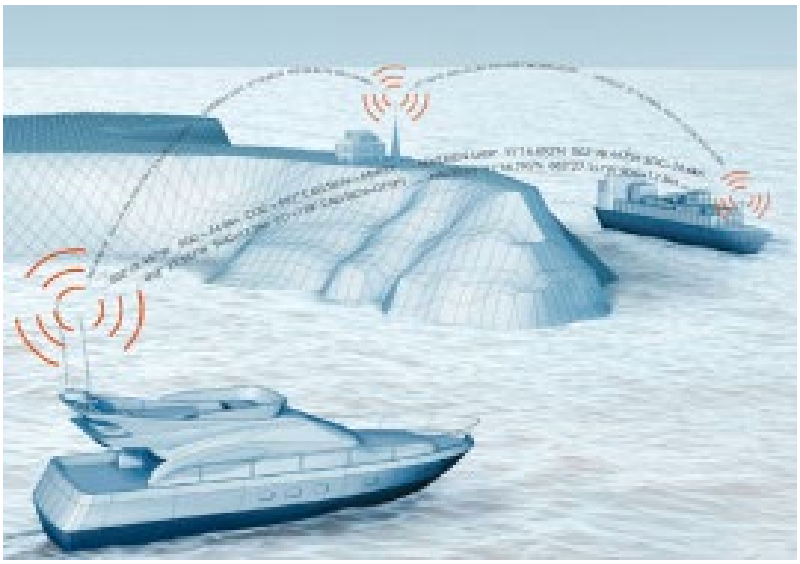

Figure 2. Ship's AIS provide information, such as their identity, ship type, position, speed, and navigational status, automatically to other ships and to coastal authorities (image from http://www.imo.org/en/OurWork/Safety/Navigation/Pages/AIS.aspx)

# Methods

## MarineTraffic AIS Data

From January 1 to December 31, 2019, Sanctuary staff received automatic email notifications from MarineTraffic.com whenever a tanker or cargo vessel deviated more than 1.5 nm inshore from the IMO recommended vessel track which is closest to the mainland between Point Sur and Pigeon Point (i.e. the easternmost northbound IMO recommended vessel track for vessels 300 gross tons and above) (Figure 1). As a MarineTraffic subscriber, MBNMS was able to create

a customized notification polygon named “customized alert zone” extending from the mainland to 1.5 nautical miles east of the easternmost IMO recommended vessel track nearest shore between Point Sur and Pigeon Point (Figure 3). The southern boundary of the customized alert zone extended 13.5 nm offshore from Point Sur and the northern boundary of the customized alert zone extended 11.2 nm offshore from Pigeon Point. Upon notification from MarineTraffic of any vessel traveling more than 1.5 nautical miles inshore from the easternmost northbound IMO recommended vessel track, MBNMS investigated the event to determine the nature and scope of the deviation.

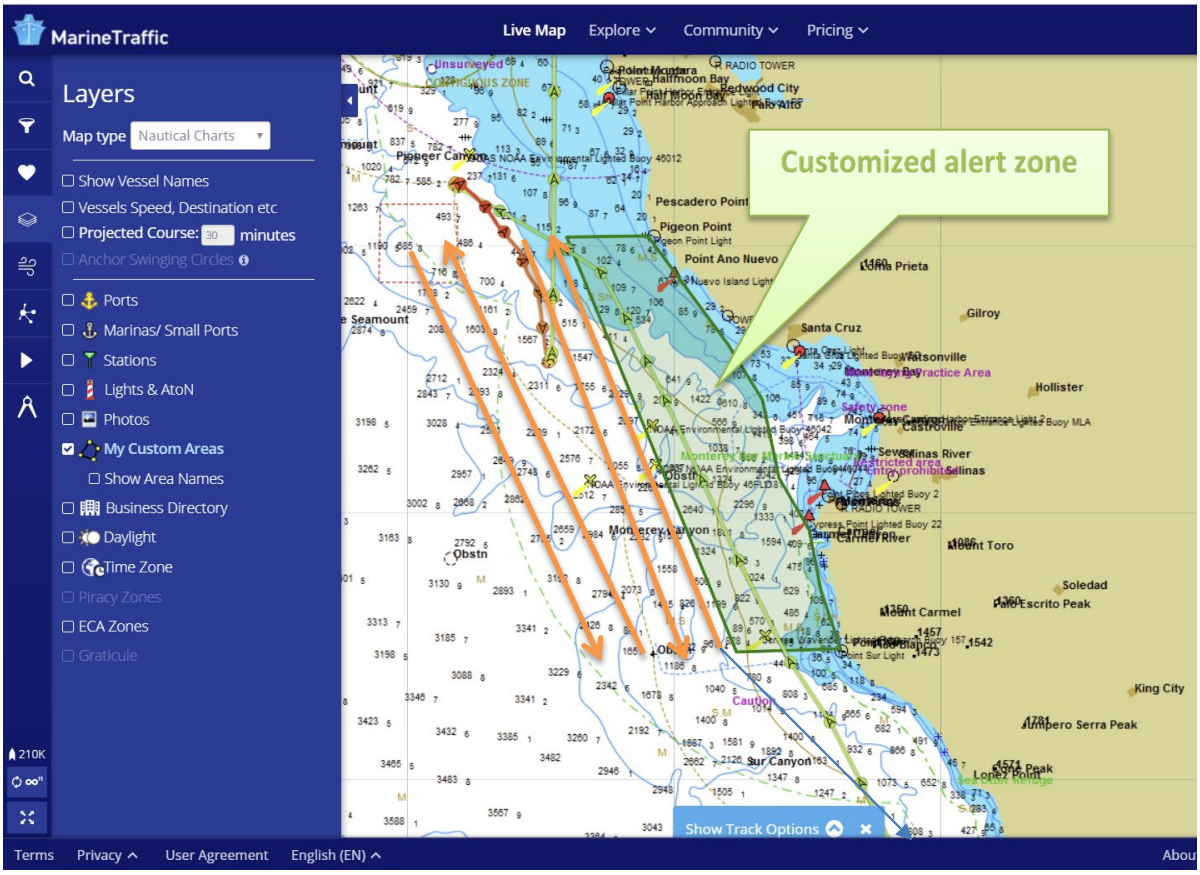


**Figure 3. The " customized alert zone” is shown in green with dark green boundaries bound to the north by Pigeon Point and to the south by Point Sur. The orange lines represent the IMO recommended vessel tracks. The offshore boundary of the customized alert zone is 1.5 nautical miles east of the northbound IMO recommended vessel track for vessels greater than 300 tons not carrying hazardous cargo or crude oil. The vessel track (color coded from green to red signifying from fast speeds to slow speeds) indicates the vessel transited close to Point Sur, traveled east of the northbound lane and then slowed down when it circled around prior to entering the San Francisco Traffic Separation Scheme.**

If a selected vessel type, either a tanker or cargo vessel, entered the customized alert zone, an email notification with the vessel name, latitude and longitude, time, date, vessel speed and heading was sent to the mbnms.permits@noaa.gov and then reviewed by MBNMS Resource Protection staff. The alert information was verified by reviewing the recent vessel track in MarineTraffic. If a deviation was observed, the details were logged in a Google spreadsheet shared with pertinent sanctuary staff. The Google spreadsheet vessel log details include:

- Date from email notification
- Time (UTC) from email notification
- Vessel Name
- Repeat offender (number of x's indicate the number of deviations noted since beginning of the current year)
- Link to a Google Doc which includes a copy of the email notification and screenshot of vessel track from MarineTraffic
- Type (Tanker or Cargo and sub-type, e.g. vehicles carrier or Hazard A)
- If the vessel is laden, partially laden or in ballast.
- Country flag
- IMO number
- Maritime Mobile Service Identity (MMSI) number
- Call Sign
- Location of deviation (e.g. cutting corners or traveling east (inshore) of the recommended track)
- Last known port
- Destination Port
- Position (latitude and longitude) from email notification
- Heading from email notification
- Speed (knots) from email notification
- Company and manger
- Insurer
- If USCG letter was sent or calls to Vessel Traffic Services (VTS) were made
- Comments and notes (includes dates of repeat offenses)
- Link to vessel details on MarineTraffic website.

Occasionally, data from MarineTraffic were verified on the Southwest Environmental Response Management Application (ERMA). ERMA receives real time data and shows tracks for vessels for the last 8 hours, which can be superimposed over extensive natural resource data layers, but analysis capacity is very limited due to the ephemeral nature of the track data.

## Conditions and Considerations (Caveats) for Interpreting Potential IMO Track Non-Compliance Using AIS Data

Below is a list of conditions and considerations (caveats) to take into account when analyzing AIS data for possible deviations from IMO ship track recommendations. The IMO Recommended Tracks are non-regulatory guidelines so the tracks are "recommendations only" and not enforceable by US law. The tracks themselves are beyond the 12-mile territorial sea of the United States, where freedom of navigation is observed by the international community as a matter of common law and the United Nations Convention on the Law of the Sea.

***System Design and Functional Constraints***

Design v. Use - AIS was designed for the purpose of ship-to-ship, ship-to-shore, and shore-to-ship communication of information pertinent to navigational safety, search and rescue, security, etc. AIS was not designed for purposes of various ship tracking applications or retrospective ship track analysis.

Signal Interference - AIS radio signals can be interrupted or shortened by atmospherics (RF propagation) - they are not uniform in broadcast strength or range and are not 100% consistent. Receiver arrays also vary in signal detection capability.

Signal Gap - AIS coastal receivers may be absent or non-functional in some areas, causing incomplete data for the region.

AIS Transmission Crash - Individual AIS transmitters may go off-line due to malfunction, power loss, or manual shut-down.

AIS Position Errors - AIS position information may be skewed due to problems with GPS systems or satellites. If GPS has offset correction (set by navigator on bridge) then AIS transmits wrong vessel's position (equal to offset).

***Misleading AIS Profiles***

Incorrect Operating Status - AIS cargo info is manually entered and is sometimes not updated before leaving port, giving a false status about onboard cargo (e.g. laden vs. un-laden oil cargo). Similarly, "destination" and other manual entry profile data may be outdated.

Incorrect Vessel Type - AIS vessel type categories are designed to describe "operational status" (i.e. towing, cargo, fishing, etc.) - not vessel classification (i.e. research, tug, ferry, etc.). The vessel's crew or the accountable officer are responsible for correctly entering the vessel's type to the vessel's AIS transponder. When R/V Fulmar deploys a tethered sonar, the boat displays on AIS as "towing" and could be interpreted as a tug and barge, rather than a research vessel.

The code 27 could be used as a research vessel classification in AIS, for example, the R/V RACHEL CARSON once appeared on AIS as a "dredge" barge.

False AIS Identity - Military or law enforcement vessels may purposely display false profiles or no profiles for security reasons.

Shared AIS ID - Some shipping companies have used the same MMSI identifier in the past for multiple ships in a fleet to cut registration costs. For example, sometimes ships are transmitting MMSI of 1193046, which is the default MMSI after AIS installation and means the MMSI wasn't updated after installation by the vessel operator. The resulting ship tracks of several vessels with this MMSI can thus appear on AIS as tracks of only one vessel, presenting a confusing and misleading transit pattern.

Data Processing Errors - Computer servers used to log AIS data may go off-line due to power outages or other problems, resulting in incomplete or corrupted data.

***Potential Vessel Course Diversion***

Traffic Diversion - Vessels may divert from IMO tracks to avoid other traffic or wildlife.

Sea State Diversion - Vessels may divert from IMO tracks to adjust for violent sea state and swell attack angles.

Emergency Diversion - Vessels may divert from IMO tracks due to emergencies, such as steering malfunction, on-board fire, medical evacuation, Coast Guard boarding, etc.

Non-WSPA Tanker - An oil tanker may be operating inshore of the voluntary 50-mile line because it does not belong to a WSPA member organization.

Empty Tanker (in ballast) - An oil tanker may be operating inshore of the voluntary 50-mile stand off line because it is empty (in ballast) and thus carries no oil cargo.

## Deviation Rate Calculations

To calculate the rate of deviation by cargo vessels and tankers, MBNMS requested AIS data from USCG (https://www.navcen.uscg.gov/?pageName=dataRequest&dataRequest=aisHistoricalRequestForm) for 6 months in 2018 (which overlaps the MarineTraffic analysis time frame) and all months of 2019. The AIS data was supplied as packets of location coordinates (latitude/longitude) representing sequential 5-minute aggregated positions in Comma Delimited Format (.CSV) files for every month from 06/01/2018 to 12/31/2019 for the following area:

- Upper Left Latitude: 37.19°

- Upper Left Longitude: -121.9°
- Lower Right Latitude: 36.28°
- Lower Right Longitude: -123.06°

This area overlaps the main body of MBNMS around the IMO recommended vessel tracks from Point Sur to Pigeon Point. The USCG historical AIS data request only allows for entering the upper left latitude and longitude and the lower right latitude and longitude so it represented a square rather than the area immediately surrounding the IMO recommended tracks requiring the data to be filtered in GIS, as described below.

***USCG AIS Data - Analysis Steps***

The point data received from USCG binned into monthly CSV files were converted to tracks in ArcGIS Pro using the following steps:

In CSV file:

1. Changed period data to date and time
2. Copied and pasted date and time into separate columns
3. Concatenated the name of the vessel and the date using =CONCATENATE(TEXT(L2, "yyyy-mm-dd")," ", C2)
4. Then double-clicked on the bottom right of top cell with formula to have the formula paste all the way down. Then copied and pasted as values in next column.
5. Removed all Rachel Carson rows (Rachel Carson is a research vessel, not a cargo vessel).

In ArcGIS Pro:

1. Imported points in CSV file by “add data x,y” (XY Table to Point tool)
2. Converted points to lines (i.e. tracks) by using the Data Management tool “Points to Lines” using “Vessel Name and Date” field
3. Selected lines, which intersected with the region of interest since the USCG data request required a rectangular query area and MBNMS has curved boundaries. Clip was not used because the tracks occurring on the same day could inadvertently be split in two due to the curvatures of MBNMS’ boundaries.
4. Exported those selected features and check the attribute table to determine the number of features (tracks of vessels through MBNMS area of interest.)

During data collection for this analysis, the track of a vessel traveling though MBNMS at midnight was reported by MarineTraffic as one transit over consecutive days to avoid a transitional break in the data and resulting gap in the plotted track line. However, the daily number of transits created from the USCG data were separated by consecutive days due to the organic structure of the data and the large size of the data files (approximately 17,000 rows of data per month)(Figure 4). Since consecutive-day transit tracks only occur occasionally within

this analysis and data were acquired from two different sources (deviation data from MarineTraffic and data the tracks are based on from USCG), the rate of deviation should be considered a close estimation rather than an absolute number.

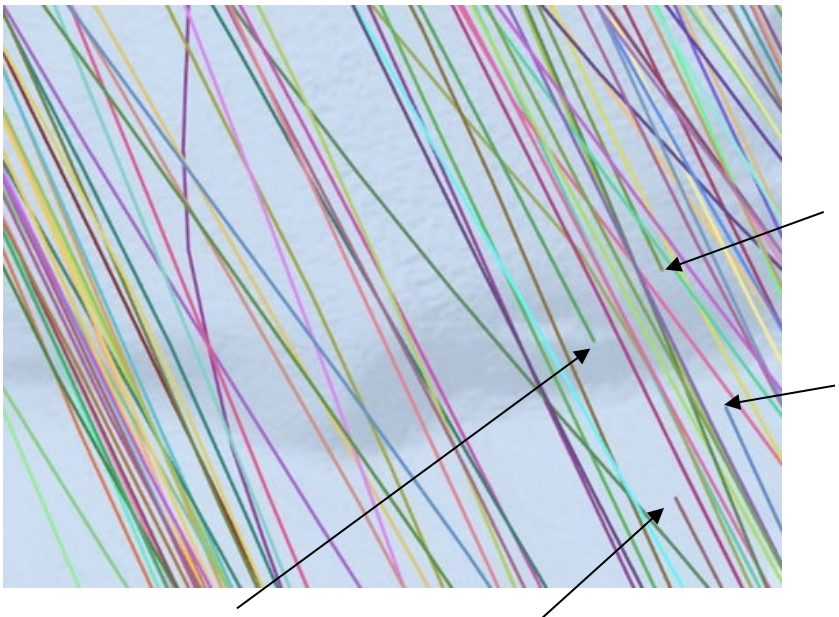

**Figure 4. Example of vessel tracks created in ArcGIS Pro. Note two of the tracks on the right side of the image are not connected. This is due to the vessel traveling through MBNMS at midnight since the tracks are created based on the vessel name and date.**

### *Line Density Calculation in ArcGIS Pro*

The Line Density tool in ArcGIS Pro was used to calculate the density of the 2019 vessel tracks. Conceptually, this tool drew a circle around each raster cell center using the search radius. The length of the portion of each line falling within the circle was multiplied by its Population field value. These figures were summed, and the total was divided by the circle's area.

## Coordinated Action with United States Coast Guard (USCG)

MBNMS staff contacts USCG Vessel Traffic Services (VTS) staff in San Francisco if a vessel is observed in real time to be 10 nm or less from Point Sur or Pigeon Point, and provided with the details. USCG VTS then determines if there is indeed a deviation using their classified AIS data, and then determines whether to contact the vessel operator to alert them regarding the IMO recommended tracks. As follow-up for repeat deviations, USCG VTS sends a letter to the owner of the vessel to bring this issue to their attention.

# Results

### *Vessel Deviations*

Between January 1 and December 31, 2019 MBNMS staff received email notifications from MarineTraffic whenever a large vessel entered the deviation area (i.e. the customized alert zone). A typical notification example is shown below:

> "*Vessel X*" sailed into 'Customized alert zone' Area at:
>
> Time: 2019-09-20 17:14 UTC
>
> Position: 36.32384, -122.1714
>
> Speed/Course: 19.4 knots / 330°

Occasionally, a ship would enter the deviation area at Point Sur, and then sail northwest out of the deviation area and then back into the customized alert zone around Pigeon Point (Figure 5) triggering two separate email notifications from MarineTraffic. However, only one record (i.e. one deviation event) was entered into the Google Spreadsheet since the same ship entered the customized alert zone twice on the same voyage. A total of 248 deviations were verified and logged into the spreadsheet. Table 1 indicates the majority of the deviating vessels were cargo vessels. Fourteen (6%) of the 248 deviating vessels were some type of tanker and 42 vehicle carriers made up 17% of the vessel types deviating (Table 1).

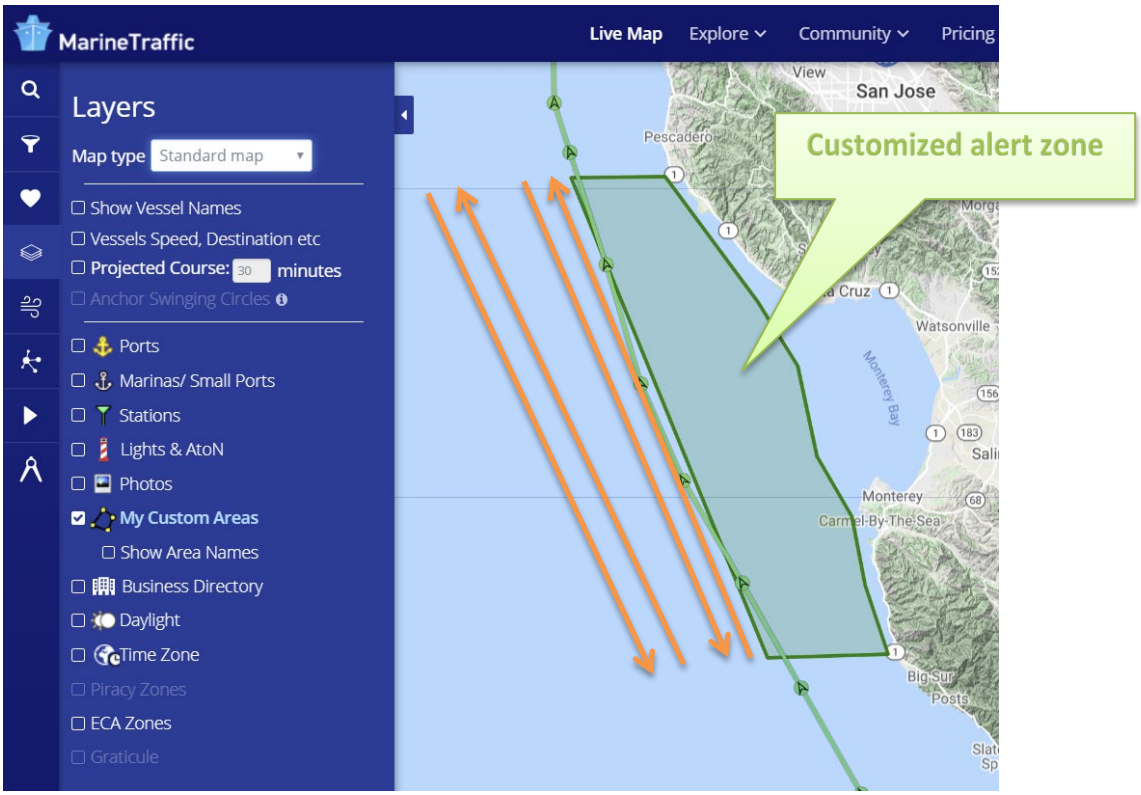


**Figure 5. A typical vessel track represented by the light green line and black arrows within green circles, which indicate when AIS data were received by AIS ground stations. The orange lines represent the IMO recommended tracks. This track shows the vessel entered the customized alert zone, (i.e. the deviation area represented by the light green area with dark green outline) twice, clipping area corners at both Point Sur and Pigeon Point. This event would prompt MarineTraffic to send two (2) email notifications, but only the first email notification details would be entered into the spreadsheet because the same vessel conducted both deviations. However, both notifications would be copied and pasted into each Google Doc linked to the spreadsheet for the deviation record.**

| **Vessel Type** | **Total** |
|---|---|
| Container Ship: Cargo | 71 |
| Container Ship: Cargo - Hazard A (Major) | 84 |
| Container Ship: Cargo - Hazard B | 2 |
| Container Ship: Cargo - Cargo - Hazard C (Minor) | 6 |
| Container Ship: Cargo - Hazard D (Recognizable) | 15 |
| Tanker | 14 |
| Bulk Carrier | 12 |
| Cargo: Self Discharging Bulk Carrier | 2 |
| Vehicles Carrier | 42 |
| **Total number of vessels deviating** | **248** |

**Table 1. Vessel Type according to MarineTraffic of deviating vessels between January 1 to December 31, 2019**

Out of the 248 deviations, 97 vessels only deviated once (Table 2) which means more than half of deviations were due to vessels deviating more than once. One particular individual container ship deviated ten times in 2019.

| Number of vessels | Number of deviations per vessel |
|---:|---|
| 97 | Deviated once |
| 24 | Deviated twice |
| 10 | Deviated three times |
| 7 | Deviated four times |
| 2 | Deviated five times |
| 3 | Deviated six times |
| 1 | Deviated seven times |
| 1 | Deviated ten times |

**Table 2. Number of deviations per vessel.**

Most deviating vessels were heading to Oakland (OAK) with the majority heading north from two main ports, either Los Angeles (LAX) or Long Beach (LBG). Only seven (7) of the 248 deviating vessels were heading south.

Every month between 14 and 26 vessels deviated (Table 3) more than 1.5 nm inshore of the easternmost IMO recommended vessel track. The highest number of deviations occurred during the month of October 2019 when 26 vessels transited inshore for a deviation rate of 11.30 % (Table 3). Of the six months of data analyzed for 2018, October also reflected the highest deviation rate.

| Month | 2019 Number of Vessels deviating (MarineTraffic) | 2019 Daily vessel transits (USCG data) | 2019 Deviation Rate (%) | 2018 Deviation Rate (%) |
|---|---|---|---|---|
| December | 22 | 219 | 10.04 | N/A |
| November | 14 | 206 | 6.80 | 7.14 (16 of 224) |
| **October** | **26** | **230** | **11.30** | **10.57 (24 of 227)** |
| September | 22 | 240 | 9.17 | 7.84 (16 of 204) |
| August | 18 | 224 | 8.04 | 5.37 (13 of 242) |
| July | 19 | 220 | 8.64 | 7.79 (19 of 244) |
| June | 14 | 211 | 6.64 | 6.67 (16 of 240) |
| May | 22 | 227 | 9.69 | N/A |
| April | 21 | 217 | 9.68 | N/A |
| March | 24 | 207 | 11.59 | N/A |
| February | 23 | 238 | 9.66 | N/A |
| January | 23 | 241 | 9.54 | N/A |
| **Total** | **248** | **2680** | **Average rate: 9.23%** | **N/A** |

**Table 3. Number of deviations from the IMO recommended tracks and rate of deviation per month in 2019 and 2018 between Point Sur to Pigeon Point in Monterey Bay National Marine Sanctuary.**

Egregious deviations occurred primarily at Point Sur (see the cluster of dots offshore of Point Sur in Figure 6) since vessels must make a turn at the point and often "shave the corner" to shorten transit time. Twenty-six (26) northbound deviations occurred less than 10 nm from Point Sur and two (2) southbound deviations occurred less than 10 nm from Point Sur. In addition, five (5) egregious deviations were caused by southbound vessels crossing into the customized alert zone at points more distant from Point Sur. Fifty-four (54) vessels clipped the customized alert zone both at Point Sur and Pigeon Point (such as the track shown in Figure 5)

and many vessels set courses significantly east of the northbound lane.

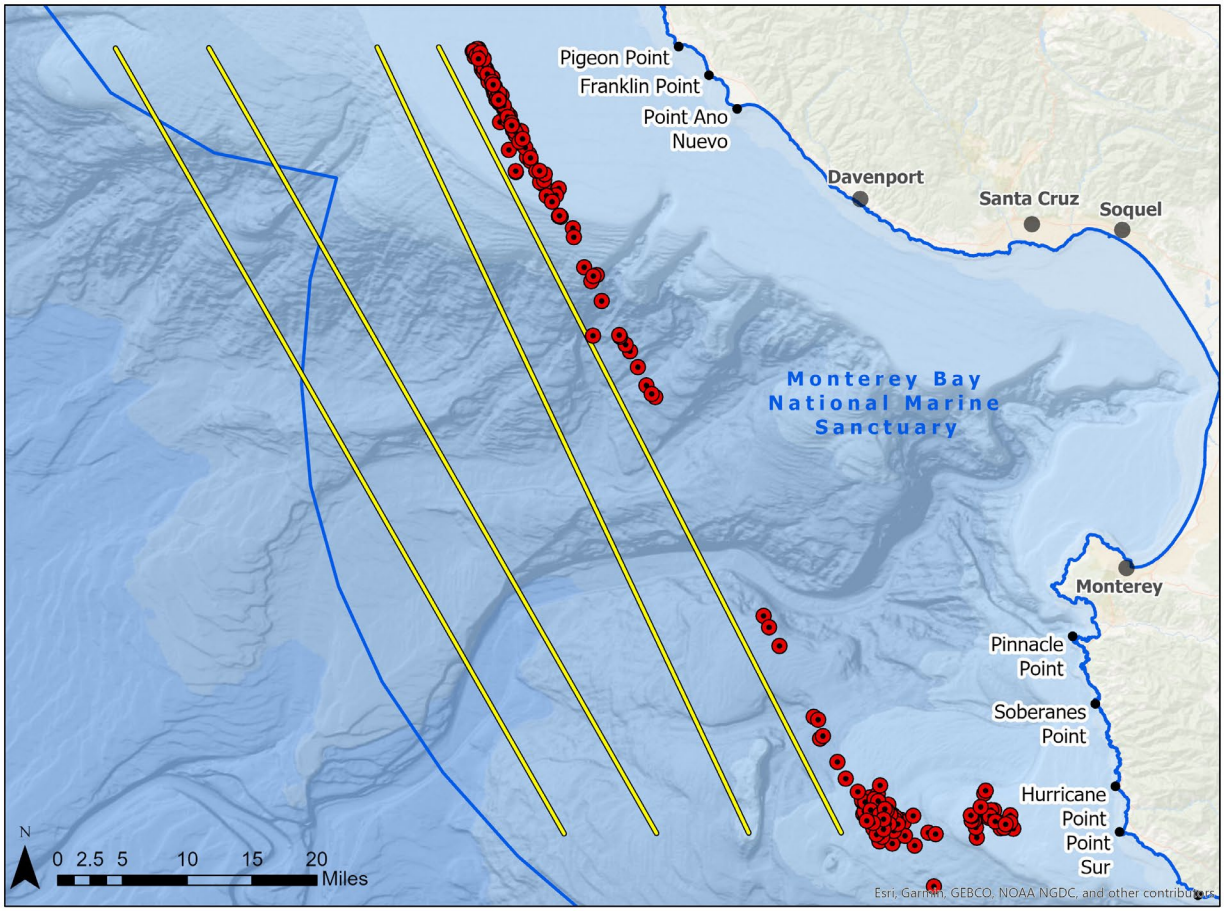


**Figure 6. Locations of initial notification alert from MarineTraffic in 2019 shown as red circles with black centers. The IMO recommended vessel tracks (4 yellow lines) and MBNMS boundary are shown). Some of the initial notification icons are outside of the customized alert zone because they represent the last vessel position recorded by AIS from which the vessel track subsequently crossed through the alert zone en route to the next recorded AIS vessel position somewhere along the track line. Functional characteristics of AIS data collection are explained in the Methods section.**

Egregious deviations also occurred within 10 offshore of Pigeon Point and Año Nuevo due to vessels waiting to enter San Francisco TSS. A laden oil tanker drifted within 7 nm from Pigeon Point in September 2019. This activity prompted ONMS staff to contact SF VTS to contact the vessel yet each time the vessel went offshore, they drifted back inshore over the course of 3 days. On May 15, 2019 a vehicles carrier was 5nm west of Cypress Point moving at 16 knots. The NOAA *R/V Fulmar* was conducting a mission in the center of Monterey Bay and confirmed they could see a large ship in the distance. MBNMS staff spoke to the VTS person in charge; VTS then contacted the ship directly to alert them about the issue of being east of the IMO recommended tracks.

Vessel tracks based on the USCG data were analyzed for the area overlapping with the main body of Monterey Bay National Marine Sanctuary around the IMO recommended vessel tracks from Point Sur to Pigeon Point (Figure 7). The tracks were verified using cross-referencing to the deviation notifications from MarineTraffic. The vessel track density (Figure 8) indicates a majority of the 2,680 vessels traveling though MBNMS between Point Sur and Pigeon Point traveled along the easternmost northbound IMO recommended vessel track.

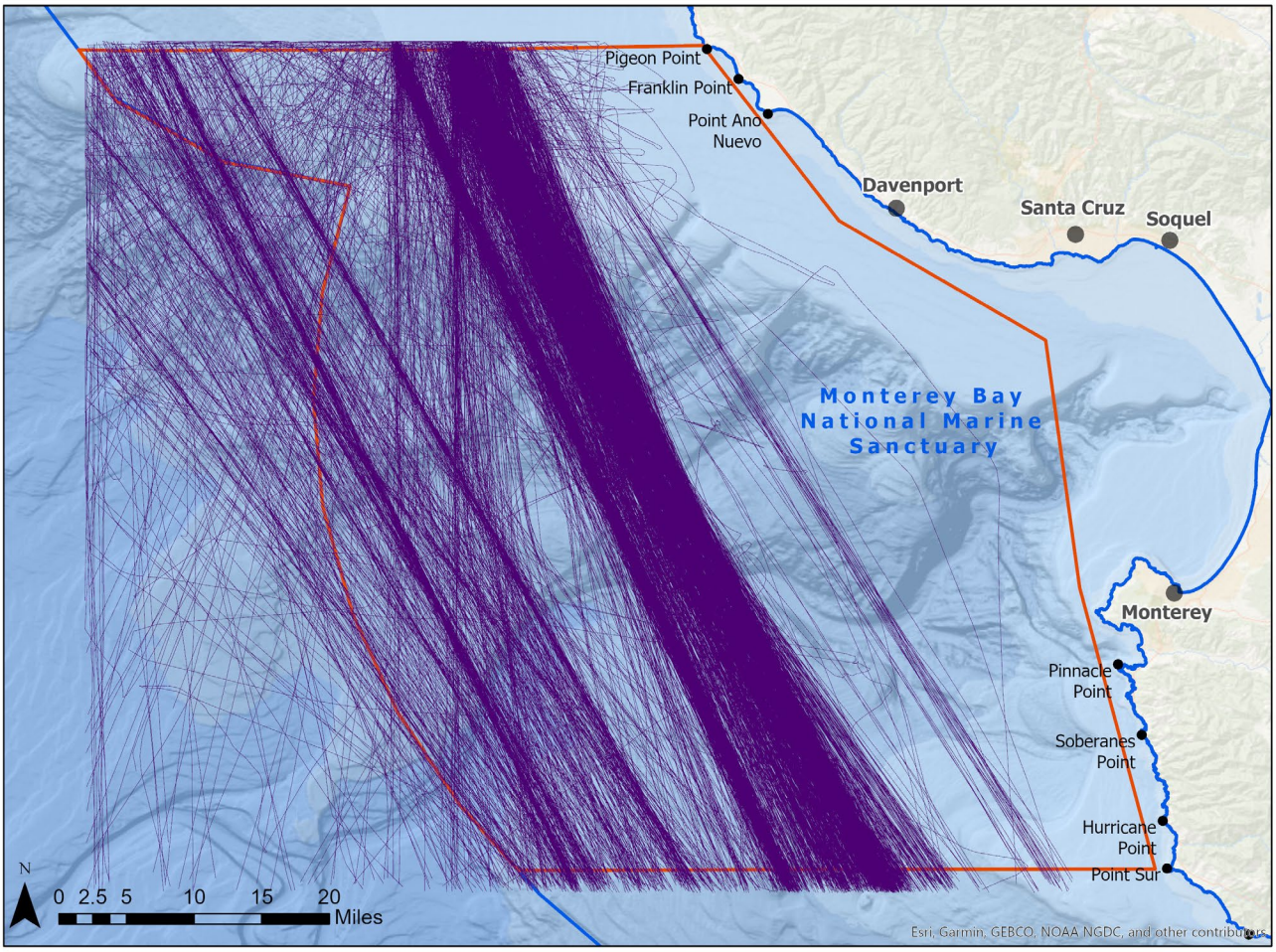


**Figure 7. Tanker and cargo vessel tracks from 2019 USCG AIS data. Vessel tracks are shown in purple within the MBNMS area of interest (red boundary line).**

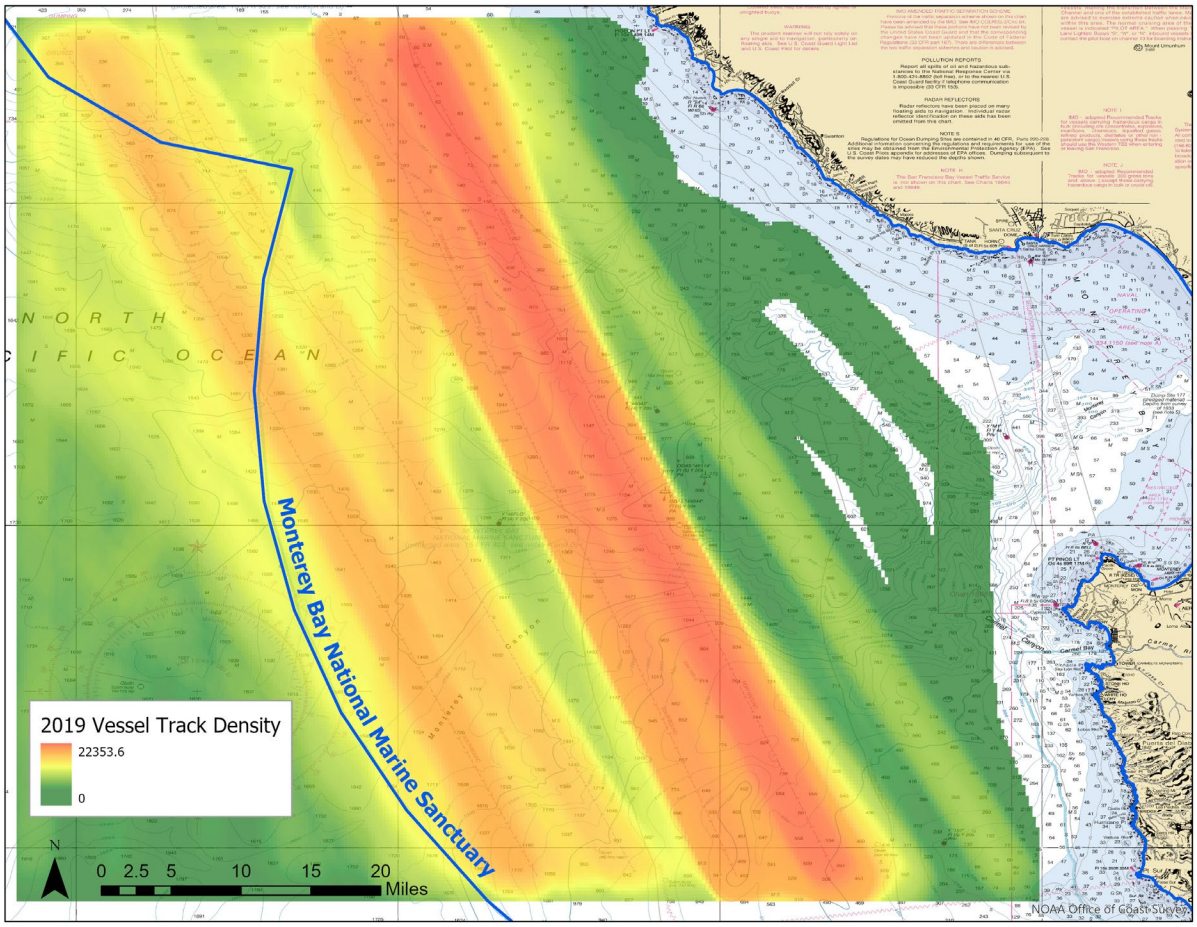


**Figure 8. Vessel track density for 2019 using the line density calculation tool in ArcGIS Pro and derived from the vessel track data shown in Figure 8. Vessel types include cargo vessels and tankers. This indicates the majority of large vessels travel through MBNMS on the easternmost northbound lane to the San Francisco Traffic Separation Scheme.**

### *Vessel Speed*

When entering the customized alert zone, vessel speed was between 0.3 and 22.6 knots. The majority of vessels were traveling between 8.7 and 19.9 knots when entering the customized alert zone (Figure 9). Approximately 20 vessels were traveling at or below 5.2 knots and showed similar navigational patterns offshore of Pigeon Point, which suggested they were waiting to enter the San Francisco Traffic Separation Scheme (TSS). One hundred and eighty-four (184) vessels were traveling at 10 knots or more and 77 of the 248 vessels were traveling at 15 knots or more.

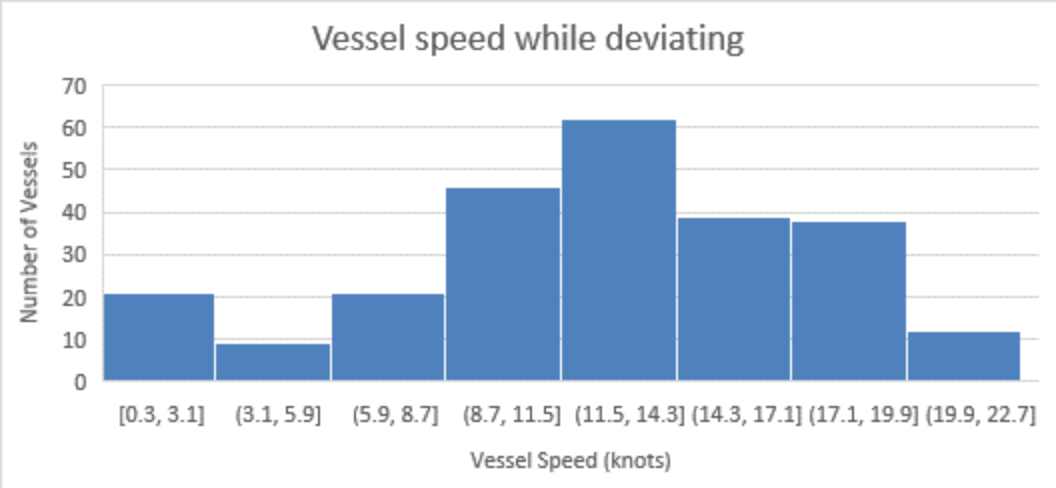


**Figure 9. Histogram of vessel speed while first deviating according to MarineTraffic.**

# Discussion

Acquiring data from USCG and analyzing it in GIS provided MBNMS with the information to address an essential question resulting from the 2018 report: What is the annual rate of inshore deviations? Between approximately 206 and 241 vessels travelled through MBNMS between Point Sur and Pigeon Point every month (Table 3). Monthly deviation rates in 2019 ranged between 6.8 % and 11.59 %, and the average rate of deviation was 9.23 % per month. March and October 2019 had the highest rates of deviations.

The 2018 and 2019 analyses reveal some individual vessels deviate frequently. Available technology allows ship operators to store and replicate routes, which may be one reason for repeat deviations by some vessels. The 2018 analysis showed only one tanker deviated into the customized alert zone between June 1, 2018 and December 21, 2018, however, tankers conducted 14 of the deviations in 2019. Eleven of these deviations by tankers in 2019 took place between June 1 and December 21, the date range analyzed in 2018. In the six months of analysis in 2018, only two vessels deviated while heading south but in 2019 (a full year of analysis); seven vessels deviated inshore while heading south.

Creating vessel tracks and comparing it to nautical charts, also highlights how vessels provide a wide birth to NOAA National Data Buoy Center's Station 46239 (Point Sur) (i.e. CDIP Waverider Buoy 157) located offshore of Point Sur (Figure 11). MBNMS and USCG staff plan to meet in 2020 and will discuss potential messaging to vessel operators to remain west of this data buoy, therefore, reducing potential threats to marine resources at and around Point Sur.

When entering the customized alert zone, 184 of the 248 vessels (74%) were traveling at 10 knots or more. Resource Protection Coordinators from Channel Islands and Cordell Bank

national marine sanctuaries have led the effort to reduce whale ship strikes in California waters. The voluntary vessel speed reduction (VSR) program to lower transit speeds to 10 knots in designated areas continued in 2019 with broadcast of Local Notice to Mariners via USCG and direct communications with ship captains from the Vessel Traffic Service in San Francisco and the Marine Exchange in Long Beach. MBNMS would like to analyze how this incentive-based VSR effort effects speeds of large vessels within MBNMS when the ships are not within the San Francisco Area VSR, but such an effort will require higher resolution time-consuming analysis of several levels of data.

Based on recommendations following the 2013 analysis of vessel compliance with IMO recommended tracks within MBNMS, sanctuary staff worked with the National Data Buoy Center (NDBC) to relocate buoy 46042, located in outer Monterey Bay, west of Moss Landing Harbor. The buoy was only 0.57 nautical miles west of the northbound IMO recommended vessel track for vessels 300 gross tons and above (Figure 10). The close proximity of this buoy to the recommended track had been used as a reason for transiting east of the northbound track, triggering a deviation review and contact by the USCG. However, even though the buoy is now located 3.5 nm east of its original location, and well east of the easternmost northbound IMO recommended vessel track (Figure 11), vessels are still deviating inshore of the northbound IMO recommended lane (Figure 11).

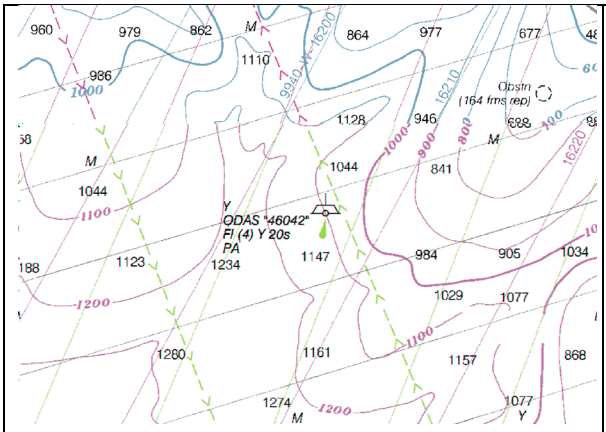


**Figure 10. Section of NOAA Raster Navigational Chart (RNC) showing National Data Buoy Center (NDBC) buoy 46042 in 2013 located west of the northbound IMO recommended track for vessels 300 gross tons and above (pink line with arrows pointing up)**

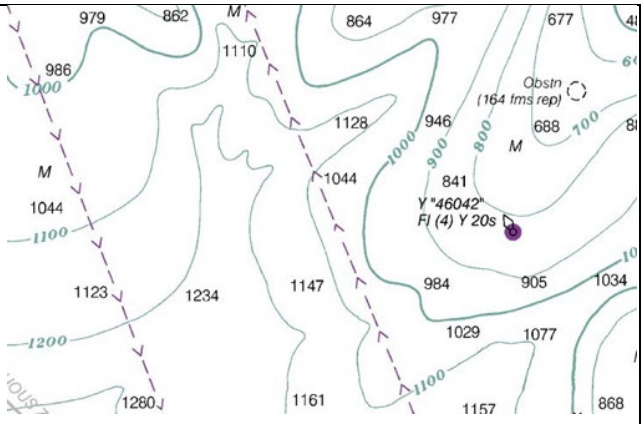


**Figure 11. Section of NOAA Raster Navigational Chart (RNC) showing National Data Buoy Center (NDBC) buoy 46042 after relocation on 8/16/17 to approximately 3 nm east of northbound IMO recommended track for vessels 300 gross tons and above (pink line with arrows pointing up)**

In the 2009-2012 analysis (De Beukelaer et al. 2014), both the NMFS and the NPS analyses indicate cargo vessels tend to cut inshore at the north end of the easternmost IMO

recommended vessel track to enter the San Francisco TSS. This action brings the vessels closer to Pigeon Point as well as other environmentally sensitive areas such as the Año Nuevo State Marine Reserve. It was assumed this practice of corner cutting would decline since the southern San Francisco TSS lane was lengthened June 1, 2013. However, both the 2018 and the 2019 AIS data indicate that the practice continues at previous levels.

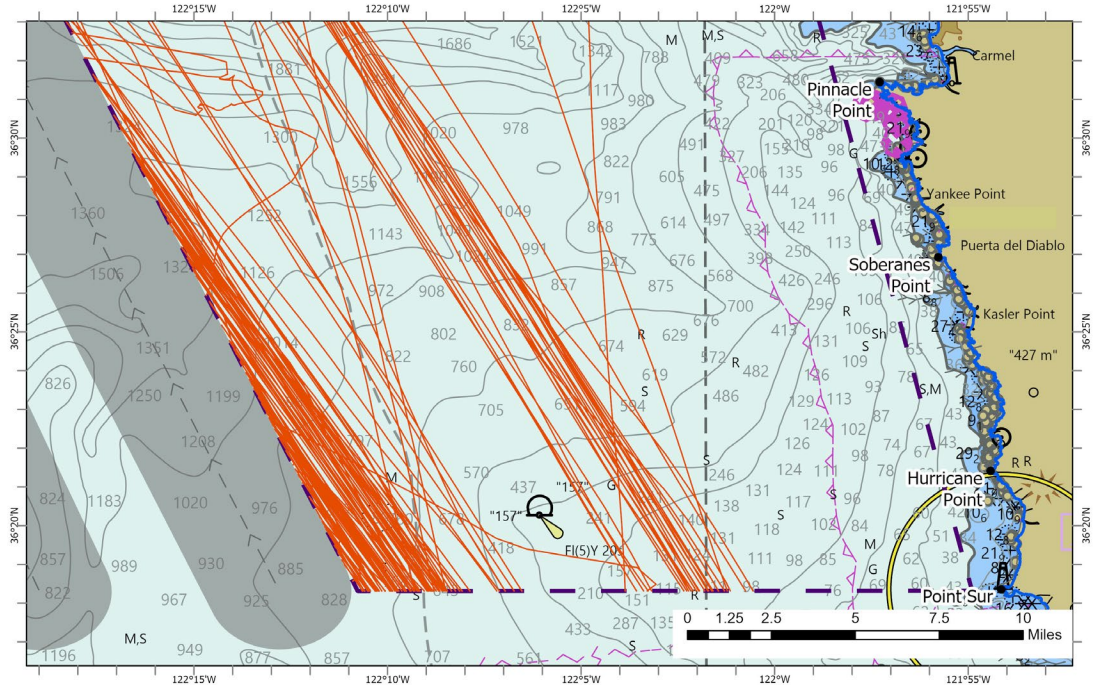


**Figure 12. The 2019 vessel tracks (in orange) clipped to the customized alert zone (in dashed dark purple) indicate vessels provide a wide berth for NOAA National Data Buoy Center Station 46239 (Point Sur)/CDIP Waverider Buoy 157 located at 36°20'34" N 122°5'45" W (pink circle on NOAA Raster Navigational Chart).**

Episodic incident reviews are not time-intensive and can have a significant impact on compliance through a collaborative effort by MBNMS and USCG. Letters sent by the USCG Captain of the Port to owners and operators of non-compliant vessels can provide effective reminders that the recommended tracks were implemented not just for environmental safety in a national marine sanctuary but also for the vessel's safety and reduced legal and financial liabilities in real time. However, in 2019, no notice letters were issued due to staffing changes at USCG and the need to revise collaborative protocols between MBNMS and USCG. MBNMS staff are continuing to gain knowledge and insight about the reasons ships deviate from the IMO recommended vessel tracks (see AIS caveats - Potential Vessel Course Diversion) and can address issues such as research equipment deployed within or near the IMO recommended vessel tracks.

# Next Steps

MBNMS and USCG will meet and discuss continuing their collaborative approach to vessel tracking and compliance in the Sanctuary. MBNMS will open discussion of options for how best to communicate with vessels deviating closer than 10 nm to Point Sur or Pigeon Point and/or vessels deviating repeatedly. Examples include direct notification to a vessel for a deviation in progress and/or issuance of a letter to the owner, manager, and/or insurance company.

## Conduct Outreach

Outreach is a central focus of MBNMS resource protection strategies, and staff will prioritize communicating with the shipping industry to discuss and present these findings and seek collaborative solutions. In addition, MBNMS plans to make the final report available to the public through a variety of ways, some of which are described below:

- Disseminate the final report via website, presentations and listservs.
- Continue to review and ensure the USCG Coast Pilot is up-to-date on MBNMS and recommended track information.
- Contact the Industry to present findings and encourage continued use of recommended tracks.
- If necessary, use "Local Notice to Mariners" for USCG District 11 as appropriate to inform mariners of any changes to the recommended tracks.
- Keep Sanctuary vessel traffic website up-to-date (http://montereybay.noaa.gov/resourcepro/resmanissues/vessels.html).
- Present information at pertinent conferences and meetings, including the MBNMS Sanctuary Advisory Council.
- Continue to work with other sanctuaries and Axiom to develop novel AIS analysis.

# Acknowledgements

Michael Carver, Cordell Bank National Marine Sanctuary, for ideas to implement reviews of AIS data, NPS for providing local AIS stations and data, USCG for following up on potential vessel deviations, The Otter Project/Monterey Coastkeeper for continuing to encourage this analysis, and the partnership behind the MarineCadastre.gov web site which includes the National Oceanic and Atmospheric Administration's Coastal Services Center and the Department of the Interior's Bureau of Ocean Energy Management.

Office of the Director of National Intelligence National Maritime Intelligence-Integration Office (NMIO) for making UNCLASSIFIED S2A (Sealink Advanced Analysis) available to MBNMS in 2019. S2A is a joint Navy-CG system, which NMIO was pushing as a system for the whole of government. It is not new technology, as it has existed at the top-secret level for about 9 years. MBNMS staff took a variety of S2A training classes. S2A was only used for data control check from MarineTraffic before lack of funding made S2A inaccessible late 2019.

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