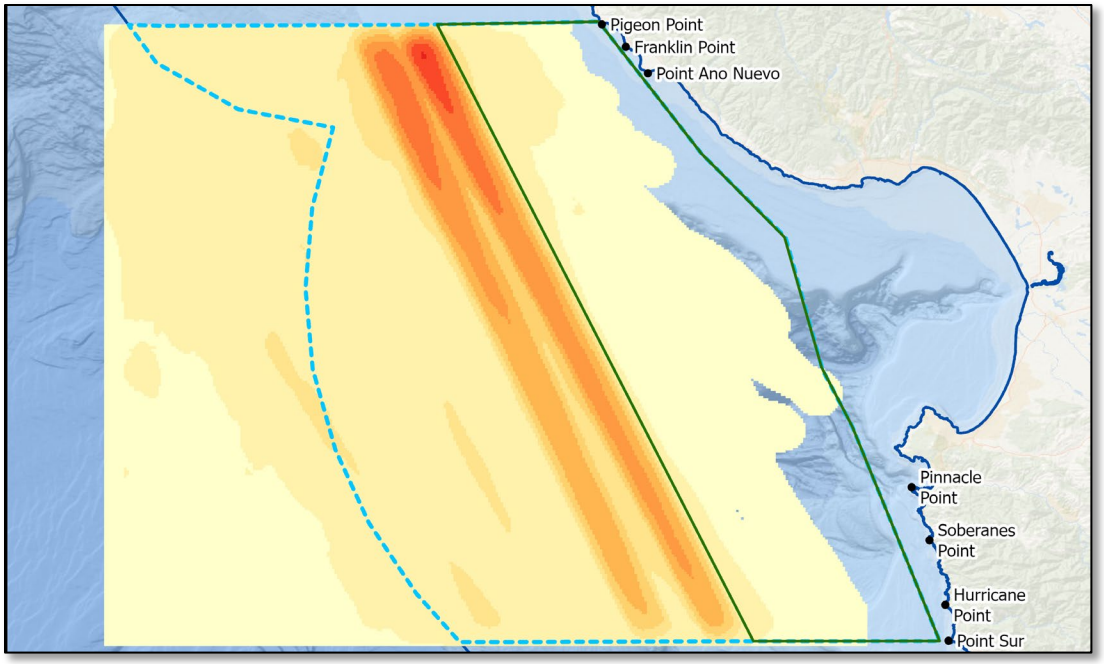
Monterey Bay National Marine Sanctuary (MBNMS)

Vessel Traffic Analysis:

2022



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Executive Summary

Monterey Bay National Marine Sanctuary (MBNMS or sanctuary) staff analyzed Automatic Identification 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 in MBNMS. 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 for vessels 300 gross tons and above and was notified by email by Marine Traffic when a cargo vessel or tanker entered the customized alert zone, coming too close to shore increasing the risk of vessel groundings.

Monthly deviation rates by cargo vessels and tankers through the customized alert zone have decreased every year, from 9.2% in 2019 down to 5.9% in 2022. The number of daily transits were highest in 2021 and lowest in 2022. The vessel track data, which were created in ArcGIS Pro, indicate there was more east to west movement by vessels in 2021. The 2021 and 2022 histograms of vessel speed show a higher number of vessels deviated while going more slowly than in 2019 and 2020. These differences are likely due to the backup in the ports of San Francisco due to labor shortages, COVID restrictions, and other complicating factors.

Vessel speeds were analyzed in a variety of ways to help inform managers about the risk of ship strikes to whales. For example, the results from the Optimized Hot Spot Analysis can be used in the future to determine where there are overlaps between high vessel speeds and whales.

The Marine Traffic AIS data analyses continue to indicate some individual vessels deviate frequently. Available technology allows vessel operators to store and replicate routes, which may be one reason for repeat deviations by some vessels.

In 2021, MBNMS resource protection staff worked closely with USCG to monitor large vessels waiting offshore for anchorage and offloading/onloading in ports around San Francisco Bay. MBNMS and USCG staff met and MBNMS developed a Superintendent Statement to raise awareness of the sensitive resources in MBNMS. In addition, USCG published a Marine Safety/Security Information Bulletin to make mariners more aware of the IMO Recommended Tracks in MBNMS and to remind vessels not to loiter/drift close to the coast. Based on the fact that Resource Protection staff had to contact USCG on only two occasions for egregiously deviating vessels and the low number of deviations in 2022, we believe these tactics had a beneficial impact. MBNMS staff will continue to work with District 11 Waterways Management to improve compliance with the IMO recommended vessel 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 large vessels which 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 critical to better understand and monitor vessel traffic patterns within MBNMS.

In the 1990's, USCG and 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 the IMO, and implemented in 2000 (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 vessels 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 tanker 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 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.

NMFS Southwest Fisheries Science Center (SWFSC) completed density maps for 2009 AIS vessel track data and found "all" tankers used the recommended tracks in 2009 (particularly those designated for vessels carrying hazardous cargo in bulk) and noted an especially higher density of hazardous cargo 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). 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 Marine Traffic, 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 Marine Traffic 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 Marine Traffic 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).

The 2019 report evaluated a full year of data received from Marine Traffic and USCG and expanded the data analyzed in the 2018 report by including monthly deviation rates based on GIS spatial analysis. 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.

The 2020 and 2021 report evaluated two full years of data received from Marine Traffic and USCG and expanded the data analyzed in the 2019 report by including an optimized hot spot analysis, reporting on the load condition, and analyzing differences in vessel speed between when the voluntary NOAA Vessel Speed Reduction program (VSR) was active (between May 1 and November 15) and not active for 2019 and 2020 (see Vessel Speed Analysis section for more information on VSR). In 2020, the mean speed of the vessels traveling through MBNMS was slightly faster mean speed when the VSR was active than when it was not active (12.3 knots and 11.4 knots, respectively). The 2019 data did not show a difference between when the VSR was active or not active. In 2020, only 5 (2%) of the 219 deviating vessels were some type of tanker and 20 vehicle carriers made up 9% of the vessel types deviating. In 2020, four of the five deviating tankers were in ballast and the other one was partially laden. In 2021, 18 (8%) of the 219 deviating vessels were some type of tanker and 30 vehicle carriers made up 14% of the vessel types deviating. In 2021, 24 of the deviating vessels were in ballast, 133 were partially laden, and 62 were laden. Specifically, two tankers of the 18 total deviating tankers were laden and 10 were partially laden, while 6 were in ballast. Monthly deviation rates by cargo vessels and tankers though the customized alert zone in 2019 and 2020 were analogous while the deviation rates in 2021 were lower although the total number of cargo and tanker vessel transits through MBNMS was higher in 2021 than in 2019 and 2020. The vessel track data, which were created in ArcGIS Pro, indicate there was more east to west movement by vessels in 2021. The 2021 histogram of vessel speed shows a higher number of vessels deviated while going more slowly than in 2019 and 2020. These differences are likely due to the backup in the ports of San Francisco due to labor shortages, COVID restrictions, and other complicating factors.

This report evaluates the AIS data for 2022 and compares those analyses to the 2019, 2020 and 2021 data.

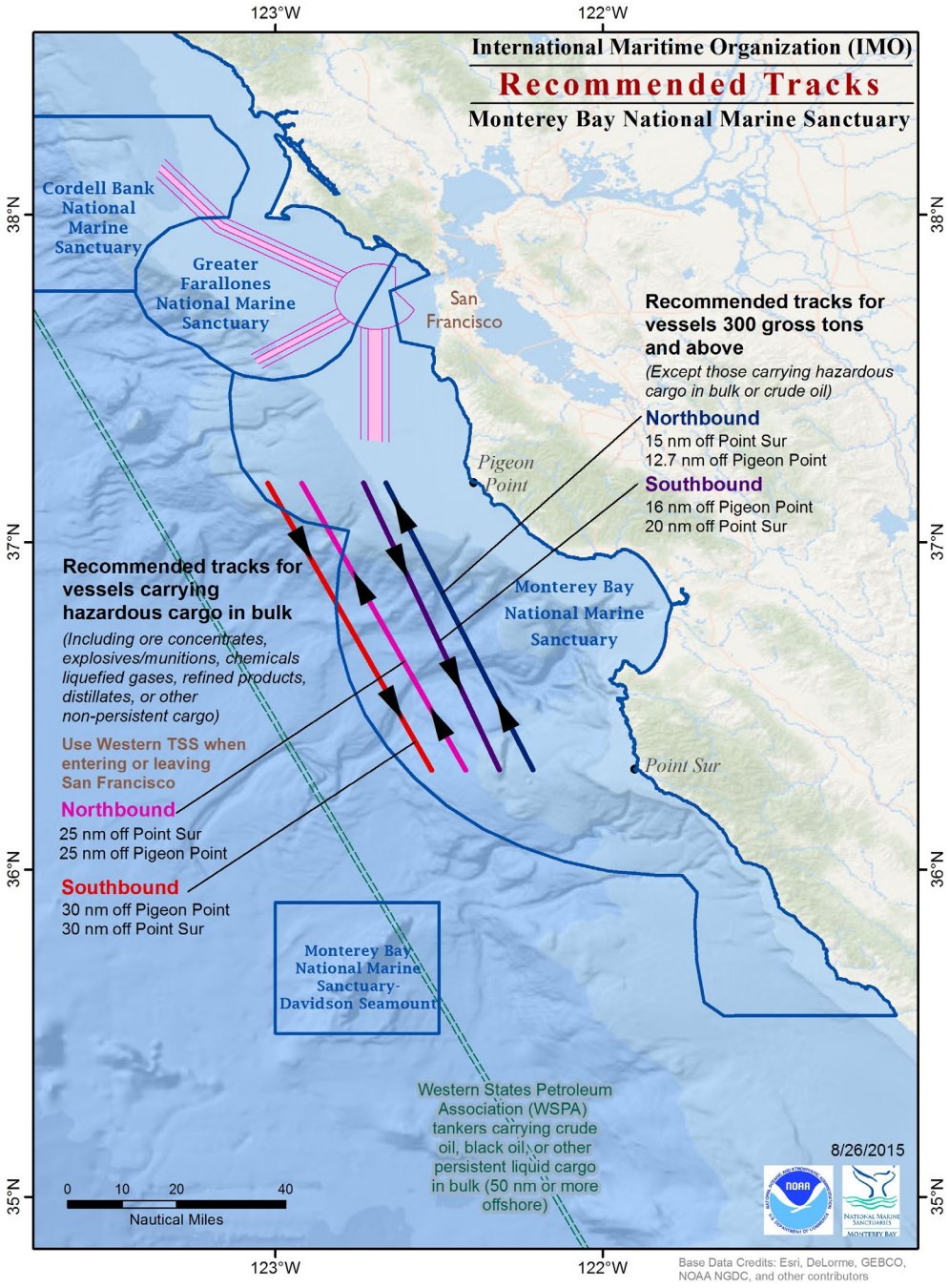

Figure 1. The International Maritime Organization (IMO) recommended tracks within Monterey Bay National Marine Sanctuary. The San Francisco Traffic Separation Scheme (TSS), shown in pink, was updated June 1, 2013 to reduce whale strikes by vessels and improve navigational safety. The four recommended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

Introduction

AIS data from Marine Traffic and USCG were compiled to analyze vessel compliance with the IMO recommended tracks in MBNMS (Figure 1). AIS is an automatic tracking system used on vessels and by vessel traffic services to identify and locate vessels in a given area by exchanging electronic data with other vessels and AIS base stations (Figure 2). It was originally developed to improve navigational safety and collision avoidance. However, AIS was also developed for other public benefits, so using the tool to determine compliance with the recommended tracks is within the scope of its original intent.

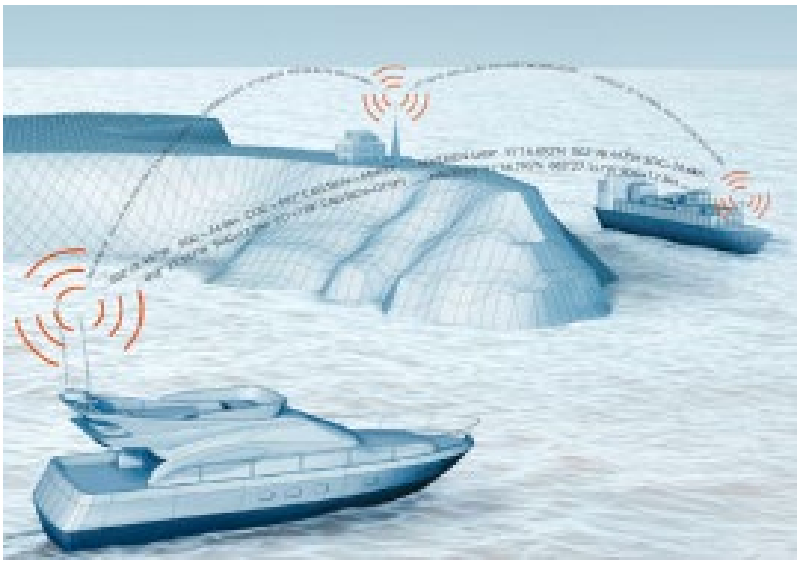

Figure 2. Vessel's AIS provide information, such as their identity, vessel type, position, speed, and navigational status, automatically to other vessels and to coastal authorities (image from http://www.imo.org/en/OurWork/Safety/Navigation/Pages/AIS.aspx)

Methods

Marine Traffic AIS Data

From January 1, 2020 to December 31, 2022, 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 Marine Traffic subscriber, MBNMS staff were 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 Marine Traffic of any vessel traveling more than 1.5 nautical miles inshore from the easternmost northbound IMO recommended vessel track, MBNMS staff investigated the event to determine the nature and scope of the deviation.

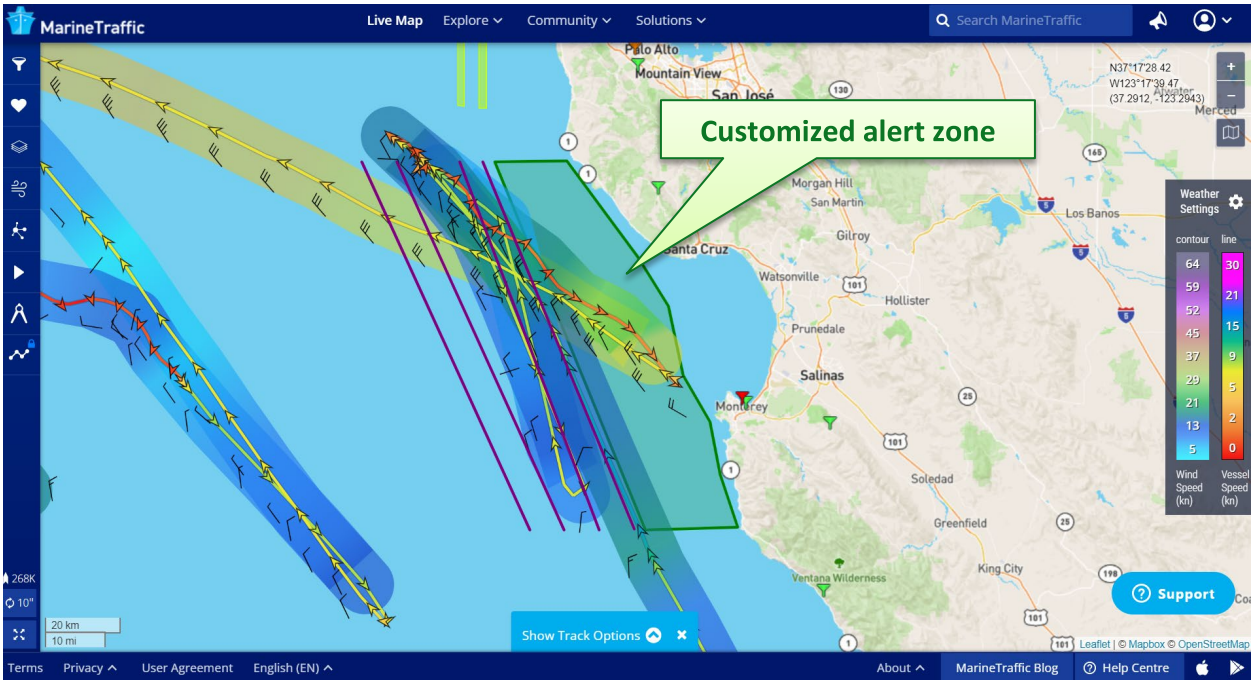

Figure 3. The "customized alert zone" is shown in green with dark green boundaries bound to the north by Pigeon Point and to the south by Point Sur. The purple lines represent the IMO recommended vessel tracks. The offshore boundary of the customized alert zone is 1.5 nautical miles east of the northbound IMO recommended vessel track for vessels greater than 300 tons not carrying hazardous cargo or crude oil. The vessel track is color coded from red to green indicating its speed was between 0 and 9 knots. The vessel speed (in knots) legend is shown on the right of the map, orange is about 2 knots, yellow symbolizes 5 knots, green symbolizes 9 knots, blue is 15 knots and purple about 20 knots and hot pink is 30 knots. This track indicates the vessel drifted in the customized alert zone while offshore of Davenport and drifted within 9 nm of the Monterey Peninsula prior to heading offshore to wait to enter 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 (see more details about the notifications below in the results) 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 Marine Traffic. If a deviation was observed, the details were logged in a Google spreadsheet shared with pertinent sanctuary staff. The Google spreadsheet vessel log details for the 2019, 2020, 2021, and 2022 data include:

- Date from email notification

- Vessel Name
- Repeat offender (number indicate the number of deviations noted since beginning of each individual year)
- Link to a Google Doc which includes a copy of the email notification and screenshot of vessel track from Marine Traffic
- 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
- 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
- If USCG letter was sent or calls to Vessel Traffic Services (VTS) were made
- Comments and notes (include dates of repeat offenses)
- Link to vessel details on Marine Traffic website.

Occasionally, data from Marine Traffic were verified on the Southwest Environmental Response Management Application (ERMA) or PROTEUS (see information below). 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. See Attachment 4 for caveats when working with AIS data.

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 Marine Traffic analysis time frame) and all months of 2019, 2020, 2021, and 2022. 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(I2, "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 Marine Traffic 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 Marine Traffic and data the tracks are based on from USCG), the rate of deviation should be considered a close estimation rather than an absolute number.

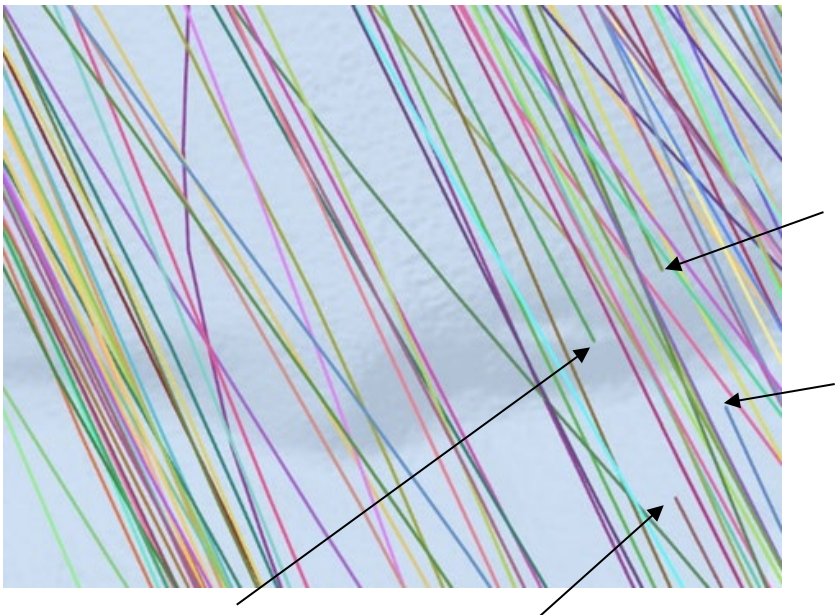

Figure 4. Example of vessel tracks created in ArcGIS Pro. Note two of the tracks on the right side of the image are not connected. This is due to the vessel traveling through MBNMS at midnight since the tracks are created based on the vessel name and date.

Line Density Calculation in ArcGIS Pro

The Line Density tool in ArcGIS Pro was used to calculate the density of the transits through MBNMS when between Point Sur and Pigeon Point. 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.

Vessel Speed Analysis

NOAA with support from the USCG annually issues voluntary Vessel Speed Reduction (VSR) requests which historically go into effect in May off of San Francisco and southern California and end around mid-November or December to align with the migration patterns of the large whales. The goal of these seasonal voluntary VSR zones is to reduce the risk of fatal vessel strikes to endangered blue, fin, and humpback whales within and near Greater Farallones, Cordell Bank, Monterey Bay, and Channel Islands national marine sanctuaries. These species are protected under the Federal Endangered Species Act (16 U.S.C. 1538 et seq.), the Marine Mammal Protection Act (16 U.S.C. 1361 et seq.), and the National Marine Sanctuaries Act (16 U.S.C. 1431 et seq.). Any unauthorized take of whales, even if unintentional, by vessels transiting in U.S. waters violates federal statutes. NOAA and the USCG request all vessels 300

gross registered tons (GRT) or larger reduce speeds to 10-knots when transiting within the designated VSR zones. MBNMS conducted a few different analyses to uncover if VSR requests north and south of the IMO recommended tracks in MBNMS impact the speed at which vessels travel through MBNMS.

Vessel speed while deviating

Histograms of vessel speed while first deviating were developed in Excel for the 2019, 2020, 2021, and 2022 data collected from Marine Traffic. The average speed data and standard deviation for 2020, 2021, and 2022 vessel speed data for vessels entering the customized alert zone were also binned by month.

Vessel speed while traveling through MBNMS between Pigeon Point and Point Sur

The USCG AIS point data includes average speed over 5 minutes (in terms of time, not distance). The data were plotted and vessel speed was analyzed in ArcGIS Pro in a multitude of ways. All the cargo vessel points from 2019, 2020 and 2022 were clipped to a 1.5 nm buffered area of the two most eastern lanes. Cargo vessel data for those years was selected based on vessel track density shown below in the "Results" section. These data were not separated by direction of travel since vessels traveled in both northerly and southerly directions while in both lanes (although more traveled north in the northbound lane and more traveled south in the southbound lane).

The 2020 and 2022 USCG AIS point data for both tankers and cargo vessels was clipped to MBNMS boundaries and maps were developed to show points of ships going 1) equal to or greater than 20 knots, 2) equal to or greater than 15 knots, and 3) equal to or greater than 10 knots. An Optimized Hot Spot Analysis in ArcGIS Pro based on speed for the 2019, 2020, and 2022 data was also completed to show hot spots of low and high-speed values are clustered. The Optimized Hot Spot tool creates a map of statistically significant hot and cold spots using the Getis-ord Gi statistic. Vessel speed was selected as the "Analysis Field" since it can be provided when analyzing point features to determine where high and low values cluster.

Vessel speed while traveling through all MBNMS using Gateway AIS data

March and May 2022 AIS data for all of MBNMS, including Davidson Seamount Management Area, were exported from Gateway (Figure 5). The tracks were overlaid with the tracks made in GIS using the USCG AIS data to confirm the two datasets aligned, which was corroborated for the two analyzed months. Then Rachel Carson tracks were removed to keep it consistent with the USCG data analyzed. A column was added to add a field for distance traveled using "Calculate Geometry" and the following parameters: "Length (geodesic)" as the property, "International nautical miles" as the Length Unit, and the coordinate system of the map "GCS_North_American_1983." The data was exported as a *CSV file and imported into Excel.

Then a new column was created to calculate the distance over the total distance traveled (used both excel and GIS to ensure the total distance was correct) which represents the percentage each segment represents in terms of the distance traveled. Then to calculate the distance weighted average speed for the month, we used the formula:

=SUMPRODUCT(D:D,T:T)/SUM(T:T) where the values in D was SOG and T was the distance/total distance.

Then graphs were developed using insert PivotChart in Excel. SOG is on x axis and then the sum of the distances is in the Y axis. In order to bin the x-axis values, we had to manually create bins and used SUM of SUM of distances in bins.

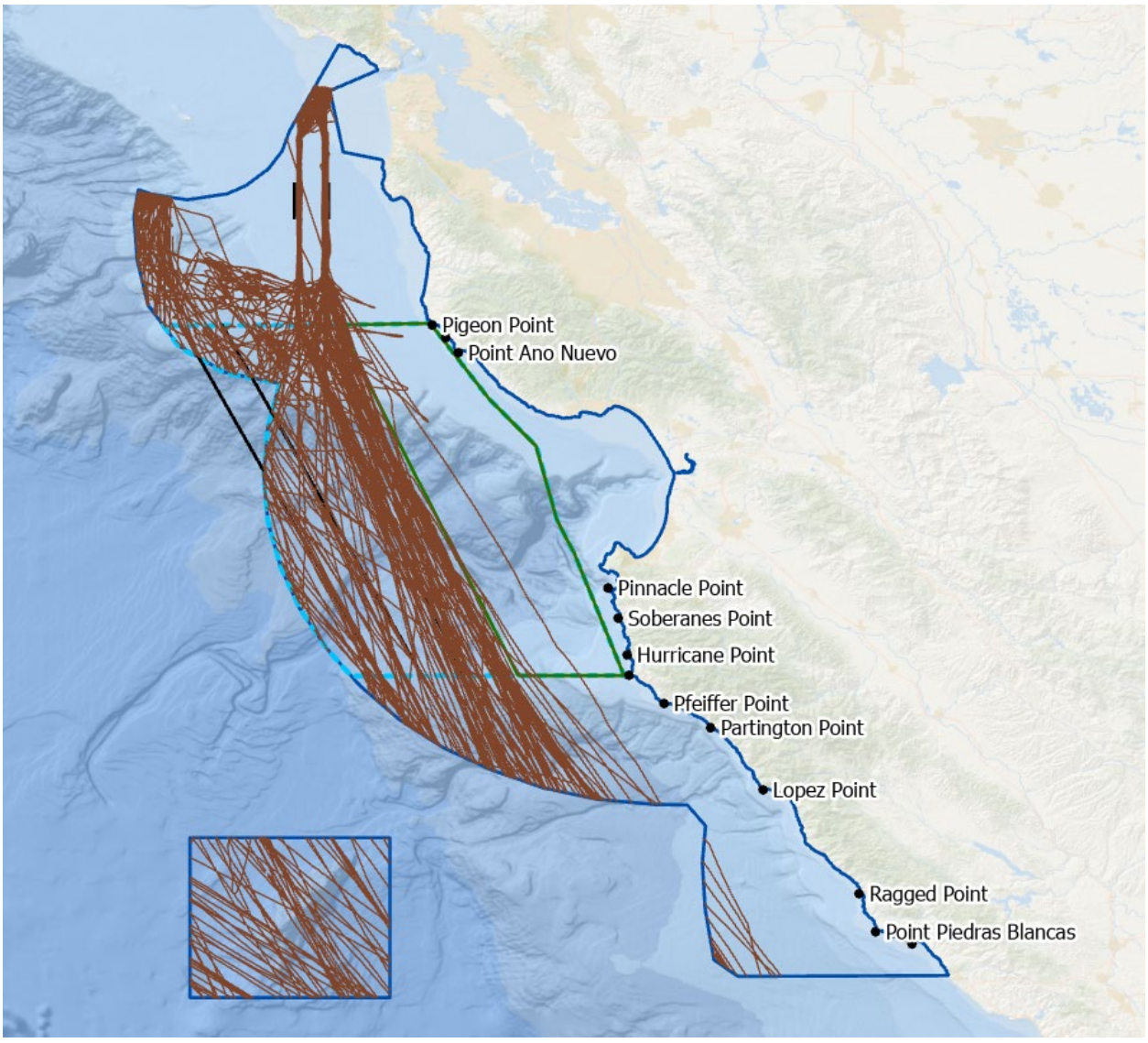

Figure 5. May 2022 cargo vessel and tanker tracks through MBNMS from Gateway data portal.

Coordinated Action with United States Coast Guard (USCG)

MBNMS staff contact USCG Vessel Traffic Services (VTS) staff in San Francisco if a vessel is observed in real time to be 10 nm or less from the coastline. MBNMS staff provides an email with details and a screenshot of the track in Marine Traffic. USCG VTS uses the vessel's identifying information to establish 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. In the past, as follow-up for repeat deviations, USCG VTS sent a letter to the owner of the vessel to bring this issue to their attention.

Results

Vessel Deviations

Between January 1, 2022 and December 31, 2022 MBNMS staff received email notifications from Marine Traffic whenever a large vessel entered the deviation area (i.e. the customized alert zone). Marine Traffic has altered their notifications over the years, e.g. they used to provide the latitude and longitude position in decimal degrees but now they provide it in decimal minutes. In 2022, a typical notification was much more detailed and included time of deviation, location where the vessel entered the customized alert zone, speed, course, source of the position, and voyage information, including the destination, load condition (i.e. laden, partially laden or in ballast), average speed and weather and vessel information such as the type of vessel, the IMO number, the call sign and more. In 2022, the notifications also included a simple map (see Figure 5) of where the vessel first deviated.

Figure 6. Example map included in a Marine Traffic notification. The green icon is the vessel and the red box is the customized alert zone.

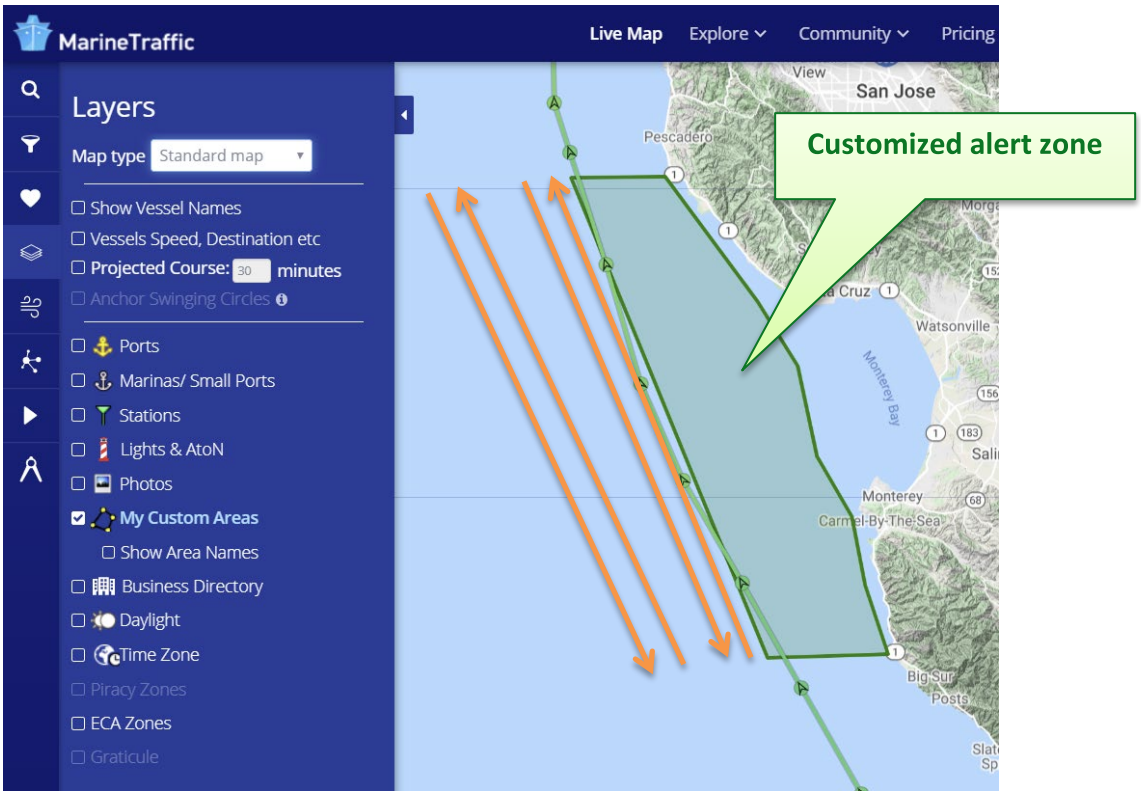

Figure 7. A vessel track of a deviating vessel. The vessel's track is represented by the light green line and black arrows within green circles, which indicate when AIS data were received by AIS ground stations. The orange lines represent the IMO recommended tracks. This track shows the vessel entered 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 Marine Traffic 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.

In 2022, the same vessel would often enter the customized alert zone multiple times. For example, periodically, a vessel enters the customized alert zone at Point Sur, and then sails northwest out of the customized alert zone and then back into the customized alert zone around Pigeon Point (Figure 6) triggering two separate email notifications from Marine Traffic. Another example is shown in Figure 7 of a laden crude oil tanker tracking back and forth over the northern area of the IMO recommended tracks and within the customized alert zone while waiting for over 10 days to enter the San Francisco Traffic Separation Scheme (SF TSS) and Marine Traffic sent nine notifications. However, only one record (i.e. one deviation event) was entered into the Google Spreadsheet event when the same vessel entered the customized alert zone multiple times on the same voyage. In 2022, a total of 120 deviations were verified and logged into the spreadsheet. As noted above, numerous notifications were received for some of these deviations.

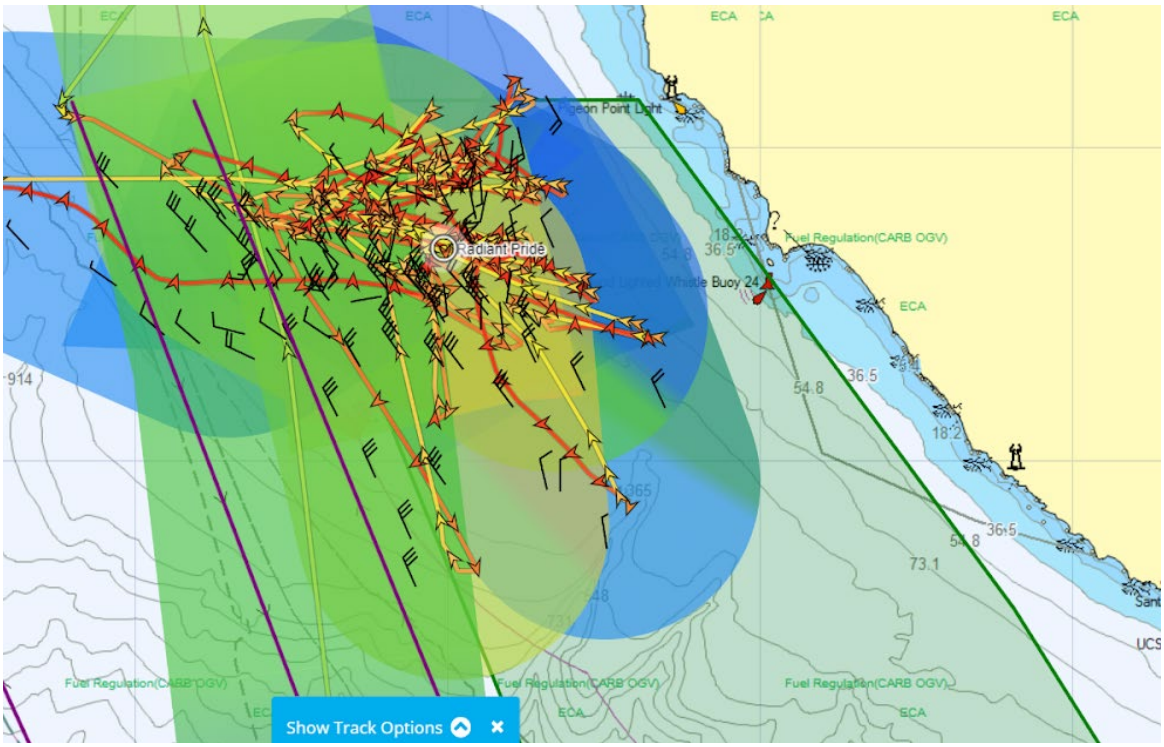

Figure 8. Vessel tracking back and forth over the northern area of the IMO recommended tracks (purple lines) and within the customized alert zone (green box) in April 2022. Wind bars are also shown.

Vessel Type	Total in 2019	Total in 2020	Total in 2021	Total in 2022
Container Ship: Cargo	71	91	59	38
Container Ship: Cargo - Hazard A (Major)	84	58	71	19
Container Ship: Cargo - Hazard B	2	1	6	3
Container Ship: Cargo - Cargo - Hazard C (Minor)	6	8	5	1
Container Ship: Cargo - Hazard D (Recognizable)	15	19	18	7
Tanker	14	5	18	14
Bulk Carrier	12	14	11	14
Cargo: Self Discharging Bulk Carrier	2	3	1	N/A
Vehicles Carrier	42	20	30	24
Total number of vessels deviating	**248**	**219**	**219**	**120**

Table 1. Vessel Type according to Marine Traffic of deviating vessels for 2019, 2020, 2021 and 2022.

Table 1 indicates the majority of the deviating vessels were cargo vessels for all three years analyzed:

- In 2019, 14 (6%) of the 248 deviating vessels were some type of tanker and 42 vehicle carriers made up 17% of the vessel types deviating.

- In 2020, only 5 (2%) of the 219 deviating vessels were some type of tanker and 20 vehicle carriers made up 9% of the vessel types deviating. Forty-two (42) of the deviating vessels were in ballast, 117 were partially laden, 49 were laden, and the rest were unknown. Four of the five deviating tankers were in ballast and the other one was partially laden.
- In 2021, 18 (8%) of the 219 deviating vessels were some type of tanker and 30 vehicle carriers made up 14% of the vessel types deviating. Twenty-four (24) of the deviating vessels were in ballast, 133 were partially laden, and 62 were laden. Specifically, two tankers of the 18 total deviating tankers were laden and 10 were partially laden, while 6 were in ballast.
- In 2022, 14 (12%) of the deviating vessels were some type of tanker and 24 vehicle carriers made up 20% of the vessel types deviating. Twenty-nine (29) of the deviating vessels were in ballast, 61 were partially laden, and 30 were laden. Specifically, three tankers of the 14 total deviating tankers were laden and two were partially laden, while nine were in ballast.

Table 2 reveals how many vessels deviated once or multiple times on an annual basis:

- In 2019, out of the 248 deviations, 97 vessels only deviated once which means more than half of deviations were due to vessels deviating more than once. One particular individual container ship deviated inshore of the IMO tracks ten times in 2019.
- In 2020, out of the 219 deviations, 102 vessels only deviated once so just over half the deviations were due to vessels deviating more than once.
- In 2021 and 2022, however, most vessels deviated only once.

MBNMS is tracking repeat offenders over the years, for example, we've logged multiple annual deviations for at least one vessel in 2018, 2019, 2020, 2021, and 2022.

Number of deviations per vessel	**Number of vessels in 2019**	**Number of vessels in 2020**	**Number of vessels in 2021**	**Number of vessels in 2022**
Deviated once	97	102	142	84
Deviated twice	24	18	25	12
Deviated three times	10	7	5	1
Deviated four times	7	4	1	N/A

Deviated five times	2	3	N/A	N/A
Deviated six times	3	2	N/A	N/A
Deviated seven times	1	N/A	N/A	N/A
Deviated eight times	N/A	2	1	N/A
Deviated nine time	N/A	N/A	N/A	1
Deviated ten times	1	N/A	N/A	N/A

Table 2. Number of deviations per vessel.

In 2019, every month between 14 and 26 vessels deviated (Table 3) more than 1.5 nm inshore of the easternmost IMO recommended vessel track. In 2019, the highest number of deviations occurred during the month of October and the highest percentage deviation rate occurred in March 2019 when 24 vessels transited inshore for a deviation rate of 11.6 % (Table 3).

In 2020, every month between 14 and 24 vessels deviated (Table 4) more than 1.5 nm inshore of the easternmost IMO recommended vessel track. In 2020, the highest number of deviations occurred during the months of January and July and the highest percentage deviation rate occurred in July 2020 when 24 vessels of 202 transited inshore for a deviation rate of 11.9 % (Table 4).

In 2021, every month between 8 and 29 vessels deviated (Table 5) more than 1.5 nm inshore of the easternmost IMO recommended vessel track. In 2021, the highest number of deviations occurred during the months of March, May and June and the highest percentage deviation rate occurred in February 2021 when 26 vessels of 235 transited inshore for a deviation rate of 11.1% (Table 5).

In 2021, the deviation rates were lower but there were more transits through MBNMS. There was unusually high vessel track values for March through July 2021, e.g. in July, 341 transits occurred in some part of MBNMS between Pigeon Point and Point Sur. Lines in GIS indicate a very high density of tracks offshore of Pigeon Point, most likely due to waiting to go into the ports of San Francisco. Attachment 2 combines Table 3, Table 4, Table 5 and Table 6 to allow for direct comparisons.

In 2022, every month between 7 and 16 vessels deviated (Table 6) more than 1.5 nm inshore of the easternmost IMO recommended vessel track. In 2022, the highest number of deviations occurred during the month of March and the highest percentage deviation rate occurred in November and May.

Month	2019 Number of Vessels deviating (Marine Traffic)	2019 Daily vessel transits (USCG data)	2019 Deviation Rate (%)
December	22	219	10.0
November	14	206	6.8
October	26	230	11.3
September	22	240	9.2
August	18	224	8.0
July	19	220	8.6
June	14	211	6.6
May	22	227	9.7
April	21	217	9.7
March	24	207	11.6
February	23	238	9.7
January	23	241	9.5
Total	**248**	**2680**	**Average rate: 9.2%**

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

Month	2020 Number of Vessels deviating (Marine Traffic)	2020 Daily vessel transits (USCG data)	2020 Deviation Rate (%)
December	14	210	6.7
November	13	182	7.1
October	22	202	10.9
September	16	191	8.4
August	16	213	7.5
July	24	202	11.9
June	18	177	10.2
May	18	186	9.7
April	20	209	9.6

March	19	220	8.6
February	15	217	6.9
January	24	220	10.9
Total	**219**	**2429**	**Average rate: 9.0 %**

Table 4. Number of deviations from the IMO recommended tracks and rate of deviation per month in 2020 between Point Sur to Pigeon Point in Monterey Bay National Marine Sanctuary.

Month	**2021 Number of Vessels deviating (Marine Traffic)**	**2021 Daily vessel transits (USCG data)**	**2021 Deviation Rate (%)**
December	11	153	7.2
November	12	186	6.5
October	8	169	4.7
September	14	188	7.4
August	11	217	5.1
July	12	341	3.5
June	29	475	6.1
May	29	418	6.9
April	19	396	4.8
March	29	459	6.3
February	26	235	11.1
January	19	212	9.0
Total	**219**	**3449**	**Average rate: 6.6%**

Table 5. Number of deviations from the IMO recommended tracks and rate of deviation per month in 2021 between Point Sur to Pigeon Point in Monterey Bay National Marine Sanctuary.

Month	**2022 Number of Vessels deviating (Marine Traffic)**	**2022 Daily vessel transits (USCG data)**	**2022 Deviation Rate (%)**
December	11	188	5.9
November	8	106	7.5

October	8	202	4
September	7	139	5
August	8	181	4.4
July	10	148	6.8
June	8	164	4.9
May	13	174	7.5
April	12	199	6
March	16	233	6.9
February	10	156	6.4
January	9	143	6.3
Total	**120**	**2036**	**Average rate: 6%**

Table 6. Number of deviations from the IMO recommended tracks and rate of deviation per month in 2022 between Point Sur to Pigeon Point in Monterey Bay National Marine Sanctuary.

Most deviating vessels were heading to a San Francisco port with the majority heading north from two main ports, either Los Angeles (LAX) or Long Beach (LBG). In 2019, seven (7) of the 248 deviating vessels were heading south, in 2020, 16 of the 219 vessels deviated while heading south and in 2021, seven (7) of the 219 deviating vessels were heading south. In 2022, only two (2) of the 120 deviating vessels were heading south. Deviating while heading south is considered a significant deviation since the southbound IMO recommended track is further offshore than northbound track for 300 gross tons and above.

In 2020, 97 vessels slightly clipped the box at Pigeon Point. Twenty-eight vessels clipped the customized alert zone both at Point Sur and Pigeon Point (such as the track shown in Figure 7) and many vessels set courses significantly east of the northbound lane. Egregious deviations occurred primarily at Point Sur. In 2020, 11 northbound deviations occurred less than 10 nm from Point Sur and two (2) southbound deviations occurred less than 10 nm from Point Sur. In one extreme example, in January 2020, a vehicle carrier (in ballast) sailed by Point Sur at 15.3 knots when only 3.5 nm from the point. Egregious deviations also occurred within 10 nm offshore of Pigeon Point and Año Nuevo due to vessels waiting to enter SF TSS in 2020 and more significantly in 2021.

In 2022, 42 vessels slightly clipped the customized alert zone at Pigeon Point. Seventeen vessels clipped the customized alert zone at both Pigeon Point and Point Sur. Ten vessels were within 10 nm of Point Sur when clipping the customized alert zone. The tracks of at least 37 vessels of

the 120 indicated they deviated within the customized alert zone because they slowed down to enter the SF TSS.

Egregious deviations prompt ONMS staff to contact SF VTS who in turn contacts the vessel with information about the IMO recommended tracks and the importance for protecting MBNMS resources. In 2021, Resource Protection staff contacted USCG on the following occasions:

- February 23, 2021 for a crude oil tanker within 5.3 nm of Año Nuevo and 4.6 nm from Pescadero Point.
- March 18, 2021 for a partially laden cargo vessel within 5.4 nm of Año Nuevo and drifting into Monterey Bay.
- March 21, 2021 for a partially laden cargo vessel less than 7 nm from Monterey Peninsula and within 8.5 nm of Sand Hill Bluff.
- April 9, 2021 for two different cargo vessels, both in ballast but within 10 nm from shore (began deviations on March 28, 2021).
- April 5 and April 9, 2021 for a partially laden cargo ship which came as close as 6.4 nm from Point Lobos (began deviations on March 30, 2021).

In 2022, Resource Protection staff contacted USCG on the following occasions:

- March 9, 2022 for a cargo vessel (Hazard A) which drifted within 8.9 nm from Point Joe.
- April 19, 2022 for a laden crude oil tanker which came within 3.5 nm from Año Nuevo Island.

Vessel track and density analysis

Vessel tracks based on the USCG data were analyzed for all four years for the area overlapping with the main body of MBNMS east and west of the IMO recommended vessel tracks and bound to the south by Point Sur and to the north by Pigeon Point (Figure 9, Figure 10, and Figure 11). The tracks were verified using cross-referencing to the deviation notifications from Marine Traffic. As anticipated, since we are using two separate sources, there were some tracks, which were created using the USCG data, within the customized alert zone and Marine Traffic did not send notifications for a few of those tracks. For example, USCG data indicates Kenneth Carl (a cargo vessel), deviated substantially (3.6 nm from Pigeon Point) on 8/23/20 but no notification was received from Marine Traffic. The vessel tracks and the density maps below indicate a majority of the vessels traveling through MBNMS between Point Sur and Pigeon Point traveled along the easternmost northbound IMO recommended vessel track.

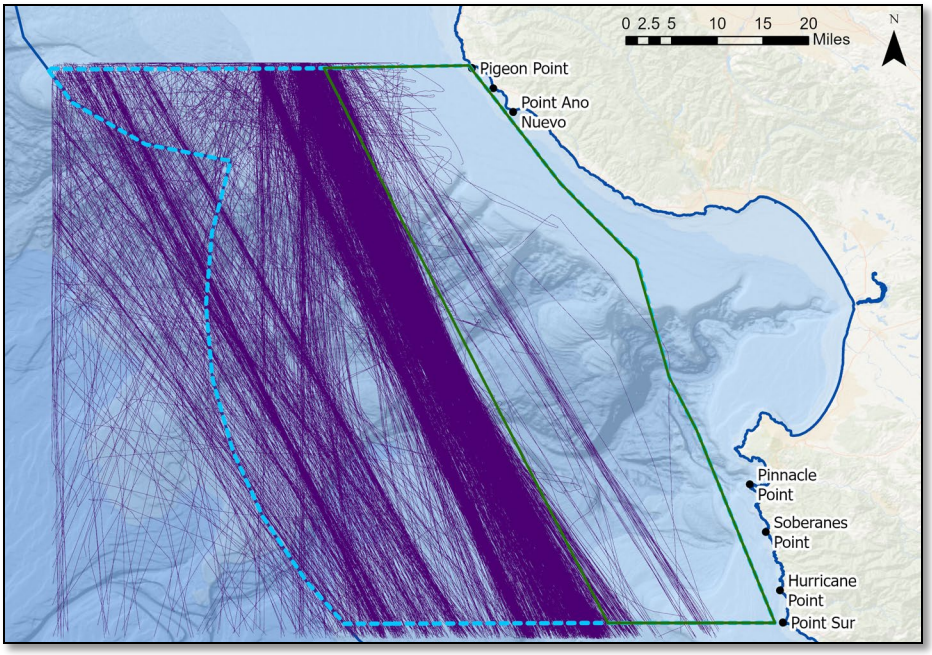

Figure 9. Tanker and cargo vessel tracks from 2019 USCG AIS data. Vessel tracks are shown in purple within the MBNMS area of interest (dashed light blue boundary line) and the customized alert zone (dark green).

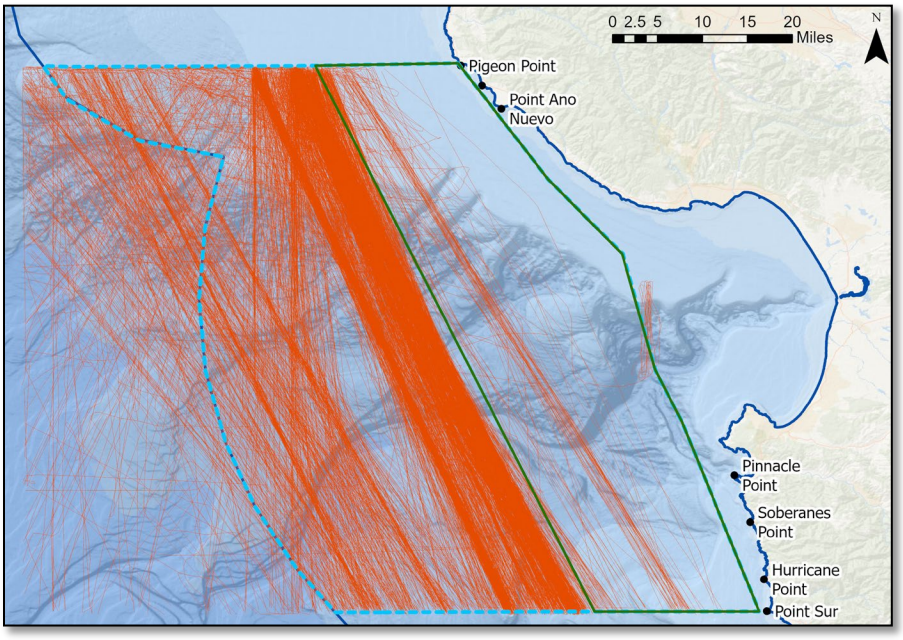

Figure 10. Tanker and cargo vessel tracks from 2020 USCG AIS data. Vessel tracks are shown in flame red within the MBNMS area of interest (dashed light blue boundary line) and the customized alert zone (dark green).

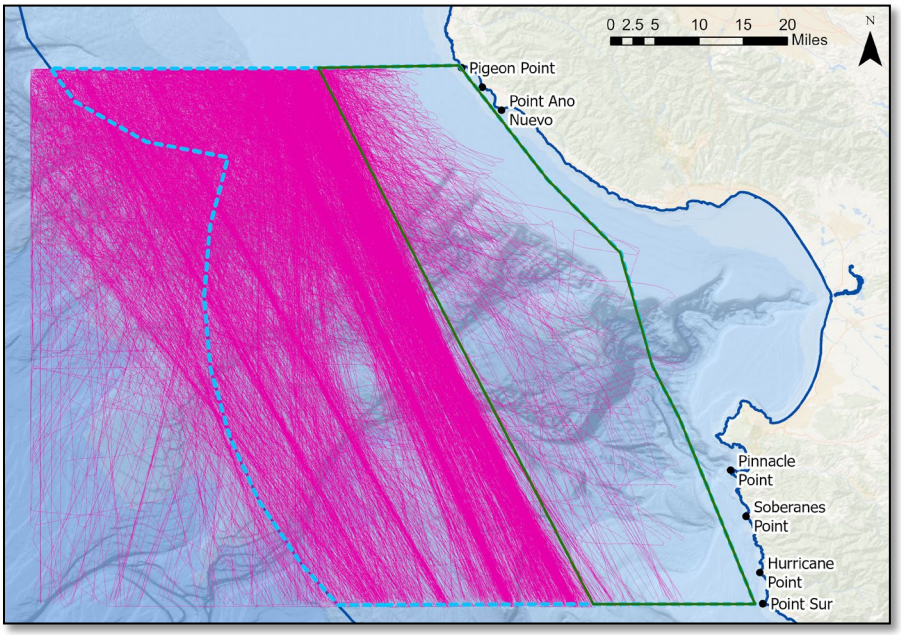

Figure 11. Tanker and cargo vessel tracks from 2021 USCG AIS data. Vessel tracks are shown in peony pink within the MBNMS area of interest (dashed light blue boundary line) and the customized alert zone (dark green).

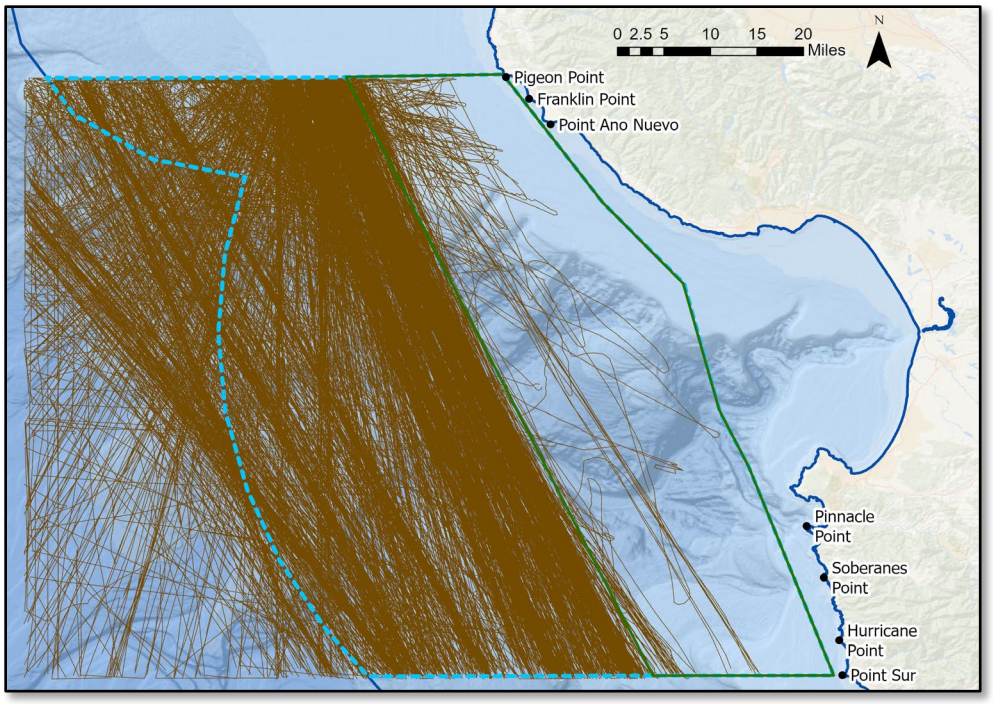

Figure 12. Tanker and cargo vessel tracks from 2022 USCG AIS data. Vessel tracks are shown in brown in the MBNMS area of interest (dashed light blue boundary line) and the customized alert zone (dark green).

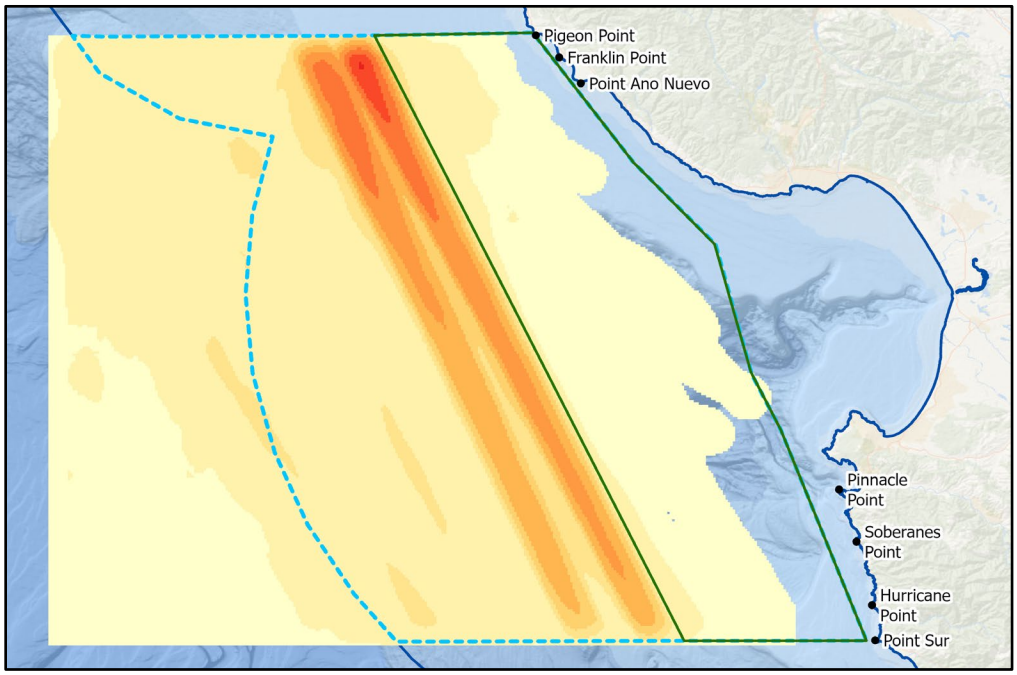

Figure 13. Transiting vessel track density for 2022 using the line density calculations tool in ArcGIS Pro and derived the vessel track data shown in Figure 12. Vessel types include cargo vessels and tankers. See Figure 14 for legend.

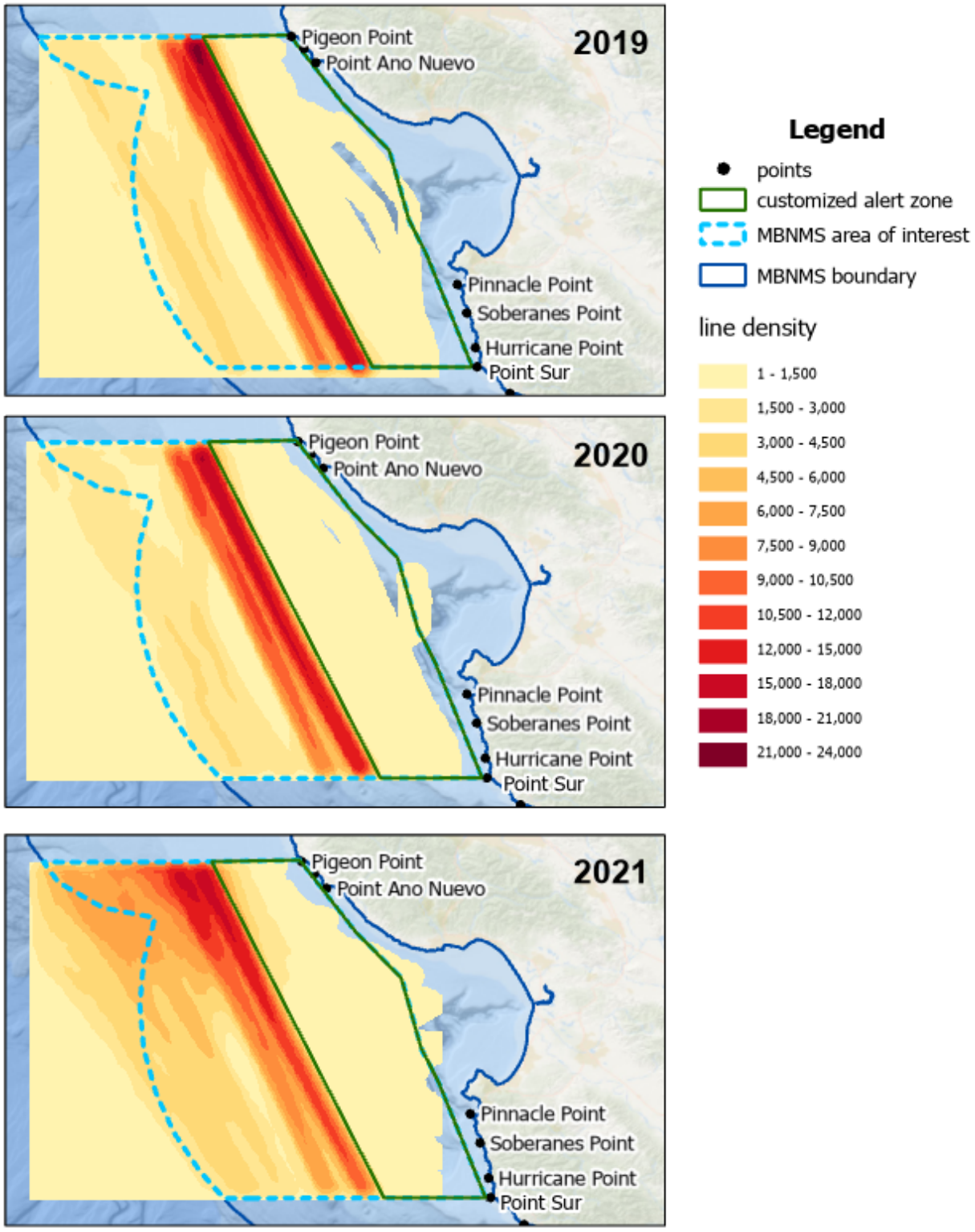

Figure 14. Transiting vessel track density for 2019, 2020 and 2021 using the line density calculation tool in ArcGIS Pro and derived from the vessel track data shown in Figure 9, Figure 10, and Figure 11. Vessel types include cargo vessels and tankers. This indicates the majority of large vessels travel through MBNMS on the easternmost northbound lane to the San Francisco Traffic Separation Scheme.

Vessel Speed while deviating

When entering the customized alert zone, vessel speeds of the deviating vessels were between 0.3 and 22.6 knots in 2019, between 0.6 and 22.3 knots in 2020, between 0.4 and 22 knots in 2021, and between 0.7 and 21.7 knots in 2022. Figure 15, Figure 16, Figure 17 and Figure 18 provide histograms of the vessel speed for the deviating vessels when entering the customized alert zone for each of the four years. The histogram for 2021 does indicate vessel speeds of deviating vessels were different from the prior two years. In 2019, 25 vessels were traveling at or below 5 knots and in 2020, 20 vessels were traveling at 5 knots or below while in 2021, 81 deviating vessels of 219 were traveling at 5 knots or below. In 2022, 35 deviating vessels of 120 were traveling at 5 knots or below. In 2019, 184 vessels of the 248 deviating vessels were traveling at 10 knots or more, in 2020, 166 of the 219 deviating vessels were traveling at 10 knots or more, and in 2021, 98 of the 219 vessels were traveling at 10 knots or more. In 2022, 71 vessels of the 120 deviating vessels were traveling at 10 knots or more.

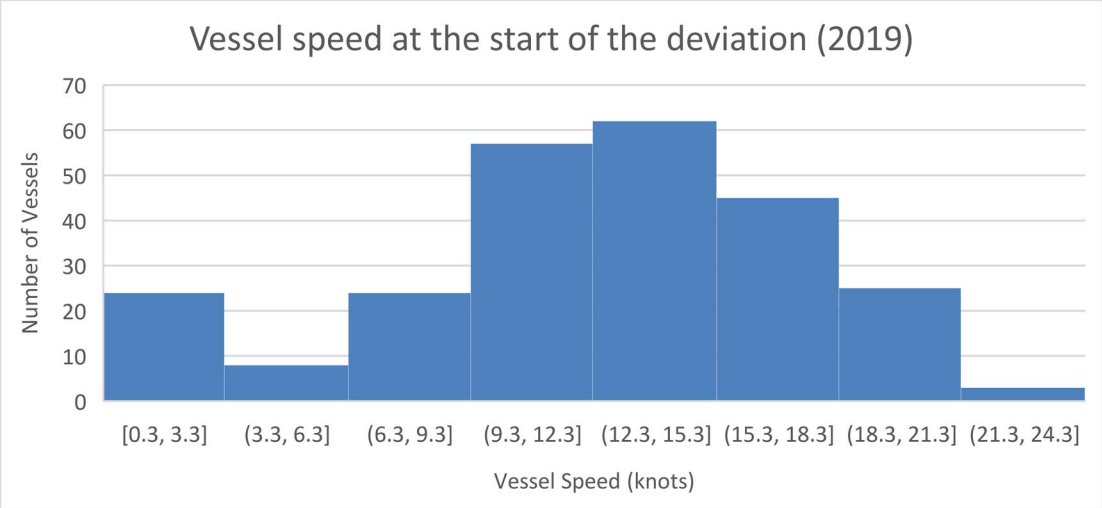

Figure 15. Histogram of vessel speed while first deviating according to 2019 AIS data provided by Marine Traffic (binned in 3 knots but dependent on lowest speed at the start of deviation per year).

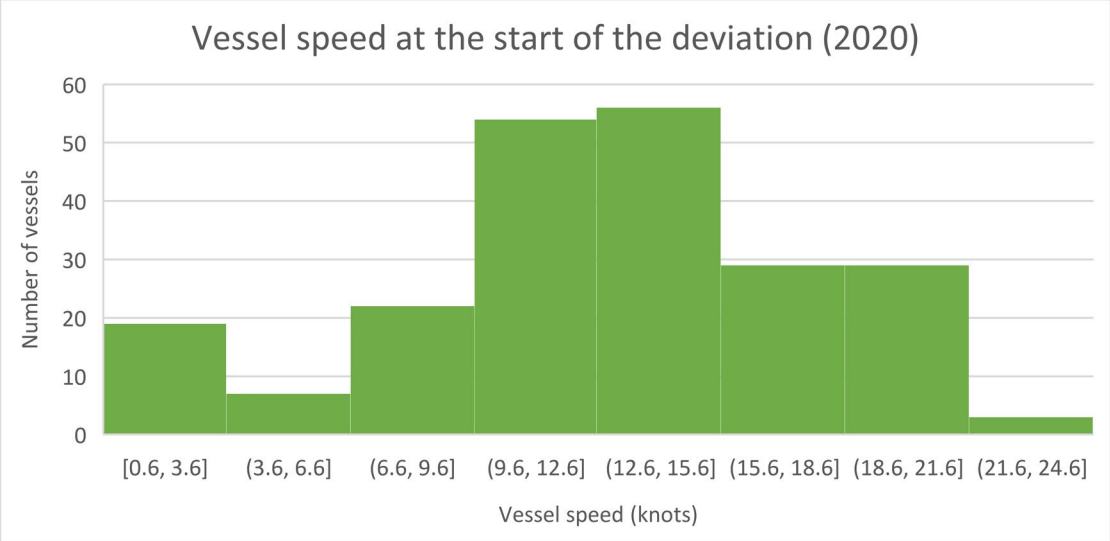

Figure 16. Histogram of vessel speed while first deviating according to 2020 AIS data provided by Marine Traffic (binned in 3 knots but dependent on lowest speed at the start of deviation per year).

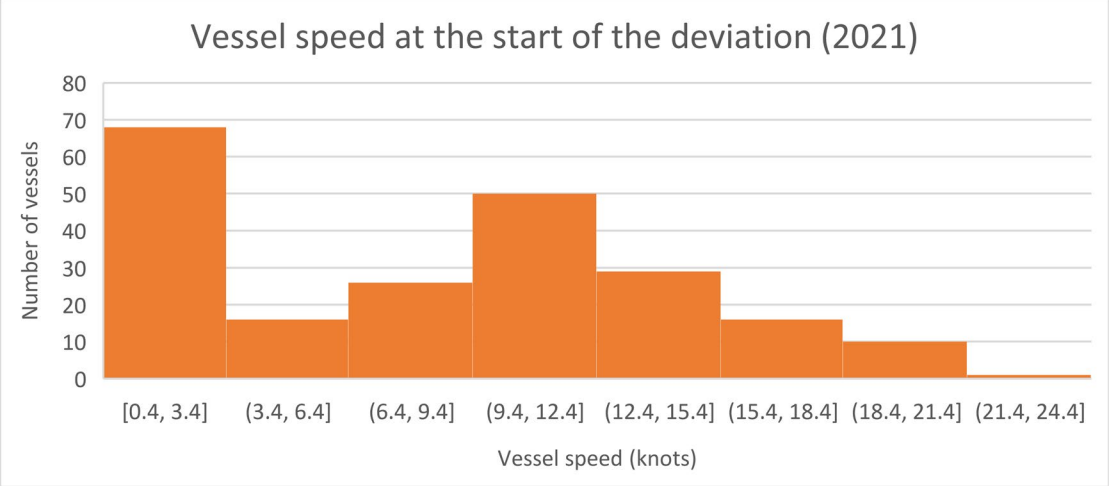

Figure 17. Histogram of vessel speed while first deviating according to 2021 AIS data provided by Marine Traffic (binned in 3 knots but dependent on lowest speed at the start of deviation per year).

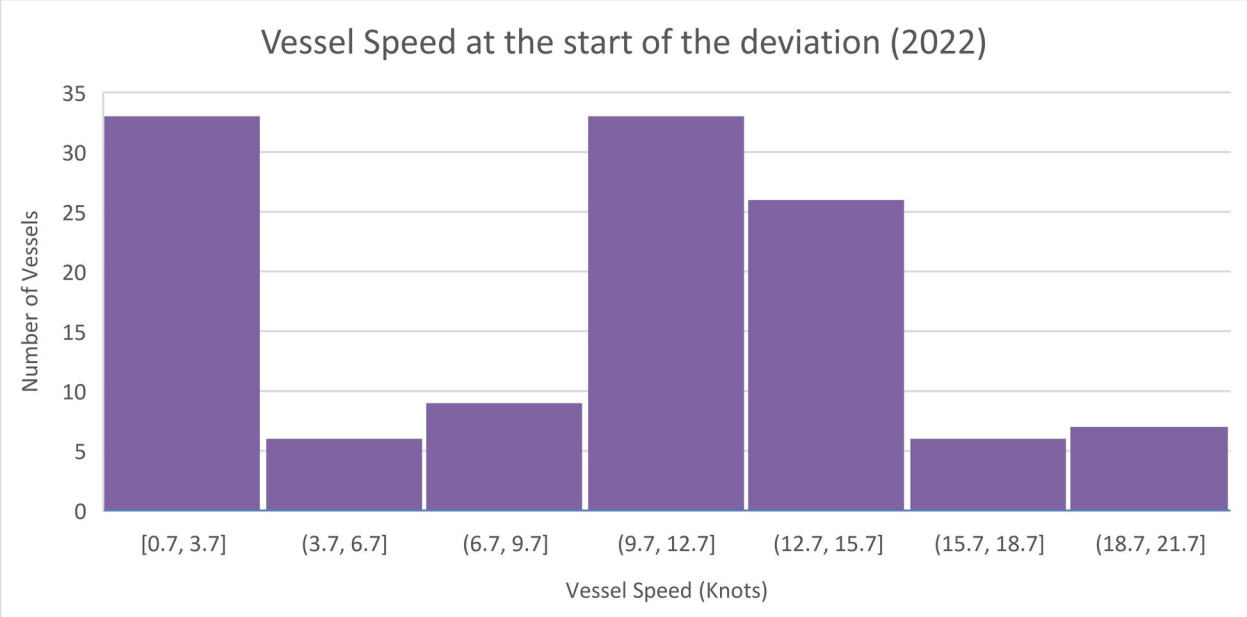

Figure 18. Histogram of vessel speed while first deviating according to 2022 AIS data provided by Marine Traffic (binned in 3 knots but dependent on lowest speed at the start of deviation per year).

Table 7 shows the deviating vessel's average speeds and standard deviation on a monthly basis for 2020, 2021, and 2022. The high standard deviation indicates the data are spread out.

Month	2020	2021	2022
January	Average: 10.9; SD: 5	Average: 10; SD: 5.2	Average: 12.6; SD: 2.4
February	Average: 11.4; SD: 5.6	Average: 8.2; SD: 5.2	Average: 10.0; SD: 6.7
March	Average: 10.6; SD: 4.2	Average: 6.9; SD: 6	Average: 7.7; SD: 6.1
April	Average: 12.4; SD: 4.5	Average: 7.1; SD: 6.4	Average: 7.6; SD: 6.1
May	Average: 11.8; SD: 4.2	Average: 6.6; SD: 5.2	Average: 10.6; SD: 5.4
June	Average: 13.1; SD: 4.8	Average: 6.5; SD: 5.1	Average: 12.1; SD: 5.7
July	Average: 11.8; SD: 5.7	Average: 8.5; SD: 7.3	Average: 8.2; SD: 5.4
August	Average: 14.2; SD: 5.4	Average: 12.5; SD: 6.9	Average: 10.5; SD: 6.5
September	Average: 14.1; SD: 4.6	Average: 14.4; SD: 5.7	Average: 10.9; SD: 4.5
October	Average: 15.9; SD: 5.4	Average:11.3; SD: 6.1	Average: 9.6; SD: 7.1

November	Average: 12.5; SD: 5.6	Average: 9.2; SD: 4.4	Average: 10.0; SD: 8.4
December	Average: 13.8; SD: 2.6	Average: 10.5; SD: 3.2	Average: 9.7; SD: 4.3

Table 7. Vessel speed mean and standard deviation (SD) when first deviating per month

Vessel Speed while traveling through MBNMS

All the cargo vessel points from 2019, 2020, and 2022 were clipped to a 1.5 nm buffered area on either side of the two most eastern lanes and analyzed. The cargo vessel speed in 2021 was not analyzed since the vessel pattern was so different than previous years but 2022 was analyzed and indicated the mean speeds were lower than in 2019 and 2020:

- In 2019, when the VSR was not active (between November 15 and April 30, 2019) there were a total of 34,202 points with a mean speed of 12.53 knots (minimum speed was 0.1 and the maximum speed was 25.1 knots). When VSR was active (between May 1 and November 14, 2019) there were a total of 42,291 points with the mean speed of 12.34 knots (minimum speed was 0.1 and the maximum speed was 24.1 knots).
- In 2020, when VSR was not active (between November 15 and April 30, 2020) there were a total of 31,758 points with the mean speed of 11.44 knots (minimum speed was 0 and the maximum speed was 24.3 knots). When the VSR was active (between May 1 and November 14, 2020) there were a total of 35,026 points with the mean speed of 12.26 knots (minimum speed was 0 and the maximum speed was 24.1 knots).
- In 2022, the VSR was active between May 1 through December 15, 2022. In 2022, when VSR was not active (between December 16 and April 30, 2022) there were a total of 40,258 points with the mean speed of 9.7 knots (minimum speed was 0 and the maximum speed was 22.7 knots). When the VSR was active (between May 1 and December 15, 2022) there were a total of 47,632 points with the mean speed of 10.4 knots (minimum speed was 0 and the maximum speed was also 22.7 knots).

The 2020 USCG AIS point tanker and cargo vessel point data was clipped to MBNMS boundaries and then the total count of unique MMSI numbers was summarized to illustrate how many separate vessels were traveling at certain speeds above 10 knots. Since the unique MMSI numbers were not separated by date, the same ship might have traveled through MBNMS at different speeds so one should not add the numbers of the unique vessels to get a total number over all. Another caveat is one ship could have traveled at a certain speed, e.g. greater than 20 knots, on different days. The analysis revealed there were:

- 4,225 data points with speeds equal to or greater than 20 knots to maximum speed of 24.1 knots and those data points represented 105 unique vessels;

- 20,7555 data points with speeds equal to or greater than 15 knots and less than 20 knots and those data points represented 376 unique vessels; and
- 54,237 data points with speeds equal to or greater than 10 knots and less than 15 knots and those data represented 693 unique vessels.

The 2022 USCG AIS point tanker and cargo vessel point data was also clipped to MBNMS boundaries and then the total count of unique MMSI numbers was summarized to illustrate how many separate vessels were traveling at certain speeds above 10 knots with the same caveats noted above. The total number of 2022 USCG data points within MBNMS was 209,534. The 2022 analysis revealed there were:

- 3,890 data points with speeds equal to or greater than 20 knots to maximum speed of 22.7 knots and those data represented 50 unique vessels;
- 18,714 data points with speeds equal to or greater than 15 knots and less than 20 knots and those data represented 255 unique vessels; and
- 76,802 data points with speeds equal to or greater than 10 knots and less than 15 knots and those data represented 636 unique vessels.

An Optimized Hot Spot Analysis based on speed for the 2020 data was also completed to show hot spots of low and high-speed values are clustered. Figure 15 shows the slow speeds (blue features) are more common in the northern area which is closer to the SF TSS and higher speeds (red features) are prevalent along the whole length of the southbound track for vessels 300 gross tons and above. Also, higher speeds were prevalent along the bottom half, i.e. the southern stretch, of the northbound track for vessels 300 gross tons and above, as well as between the two tracks for the vessels 300 gross tons and above. The Optimized Hot Spot Analysis was also run on the 2019 and 2022 vessel speed data and the results were similar.

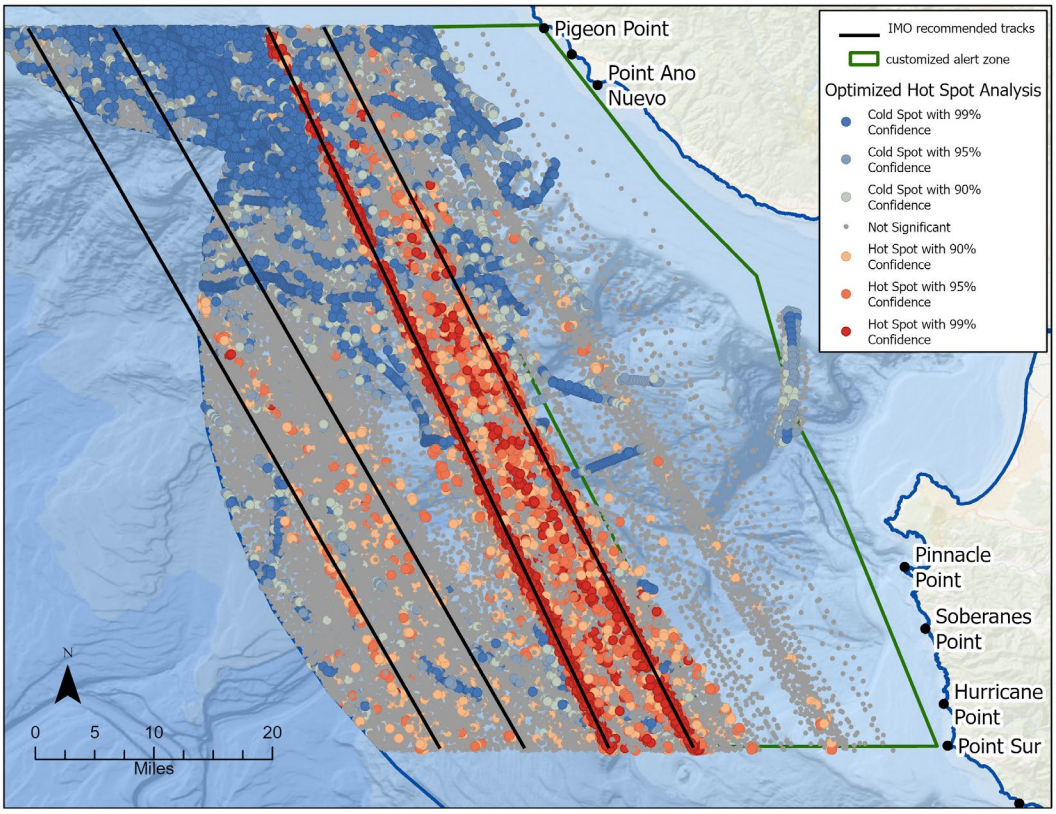

Figure 19. Optimized Hot Spot Analysis to show hot spots where high vessel speeds (red features) of tankers and cargo vessels are clustered and where low vessel speeds (blue features) are clustered while transiting through MBNMS in 2020.

Vessel speed while traveling through all MBNMS using Gateway AIS data

The total distance traveled by tankers and cargo vessels in March 2022 was 21,608.7 nm. The distance weighted average speed was 11.6 knots. The total distance traveled by tankers and cargo vessels in May 2022 was 17,441.8 nm and the distance weighted average speed was 11.3 knots. Both in March and May 2022, the greatest distance was covered while vessels were going between 10.1 and 15 knots (Figure 20 and Figure 21).

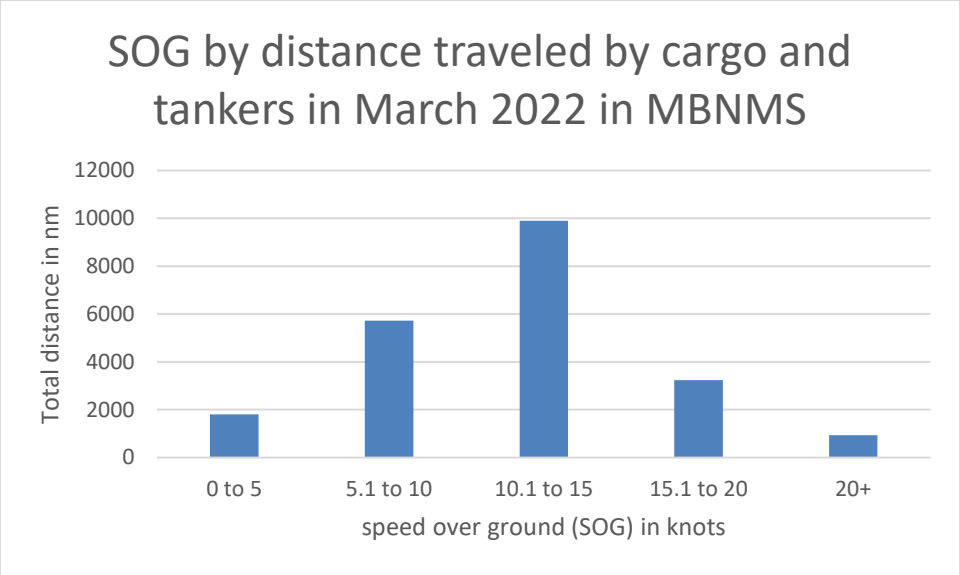

Figure 20. Speed over ground (SOG) by distance in March 2022 in MBNMS

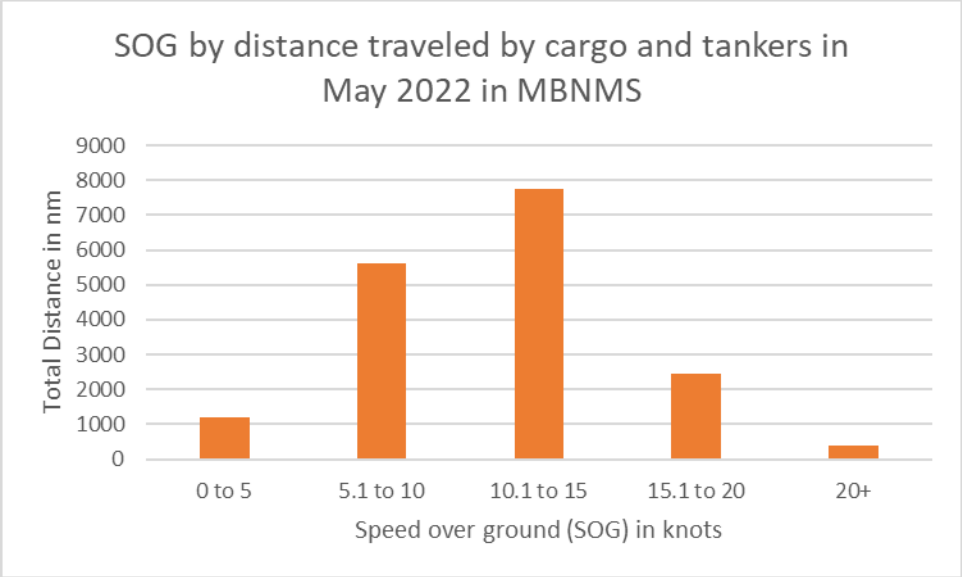

Figure 21. Speed over ground (SOG) by distance in May 2022.

Discussion

Monthly deviation rates in 2019 and 2020 were similar while the deviation rates in 2021 and 2022 were lower. While the deviation rates in 2021 were lower than the previous years, the number of vessel transits was higher in 2021. Also, the number of vessel transits in 2022 was lower than the previous three years. Specifically, there were 2,680 transits in 2019, 2,429 in 2020, 3,449 in 2021, and only 2,036 in 2022. The 2021 histogram of vessel speed also shows a higher number of vessels deviated while going more slowly than in 2019 and 2020. These

differences are likely due to the backup in the ports of San Francisco due to labor shortages, COVID restrictions, and other complicating factors.

The Marine Traffic AIS data analyses from 2019, 2020, and 2021 indicate some individual vessels deviate frequently but more than half of the vessels deviated only once in 2022. Available technology allows vessel operators to store and replicate routes, which may be one reason for repeat deviations by some vessels.

The 2021 tracks (see Figure 11) indicates many vessels sailed within the customized alert zone but not in straight lines as in 2019 (see Figure 9) and 2020 (see Figure 10) so although the deviation rate might have been lower, there were more long term deviations within the customized alert zone in 2021 of vessels drifting more east/west. The density map (Figure 14) indicates the transits through 2021 were slightly different than in 2019 and 2020. In 2021, there was a higher density of transits around the northern area of the IMO recommended tracks. This is also evident in the 2021 tracks map (Figure 11) where the individual track lines are not discernable due to the numerous tracks while in the 2019 and 2020 maps (Figure 9 and Figure 10) the individual tracks in the northern area are still distinct. In 2022, there was less traffic in MBNMS (Figure 13) and the deviation analysis indicated that many of the deviation vessels were waiting to enter the SF TSS. Daily AIS reviews showed more vessels waiting offshore in 2022, which was corroborated with the density and hot spot analyses.

In the beginning of 2021, MBNMS resource protection staff worked closely with USCG to monitor large vessels waiting offshore for anchorage and offloading/onloading in ports of San Francisco. MBNMS and USCG met on March 8, 2021 to discuss the issues. MBNMS developed the Superintendent Statement in mid-April to raise awareness (see attachment 2). Another outreach outcome from the meeting was the USCG Marine Safety/Security Information Bulletin (MSIB) (see attachment 3). The purpose of the MSIB is to make mariners more aware of the IMO Recommended Tracks in MBNMS, so mariners adhere to the tracks while transiting across MBNMS. Also, if the vessels need to wait to enter the port of SF, the vessels know to wait offshore, and not loiter/drift close to the coast. The MSIB was sent out to a number of entities, including the San Francisco Harbor Safety Committee, to raise awareness within the San Francisco Harbor Safety Committee group and the Local Notice to Mariners District Office and consequently, release the information to the public. MBNMS staff hoped its release would mitigate the need to contact and inform vessels so frequently. Based on the monthly deviation numbers for all of 2022 and July to December 2021 (Table 3) as compared to the monthly deviation numbers in 2019 and 2020, the MSIB seems to have had a positive impact. This was also evident in the vessel tracks, for example, Figure 22 shows a partially laden cargo vessel waiting outside MBNMS boundaries in Marine traffic.

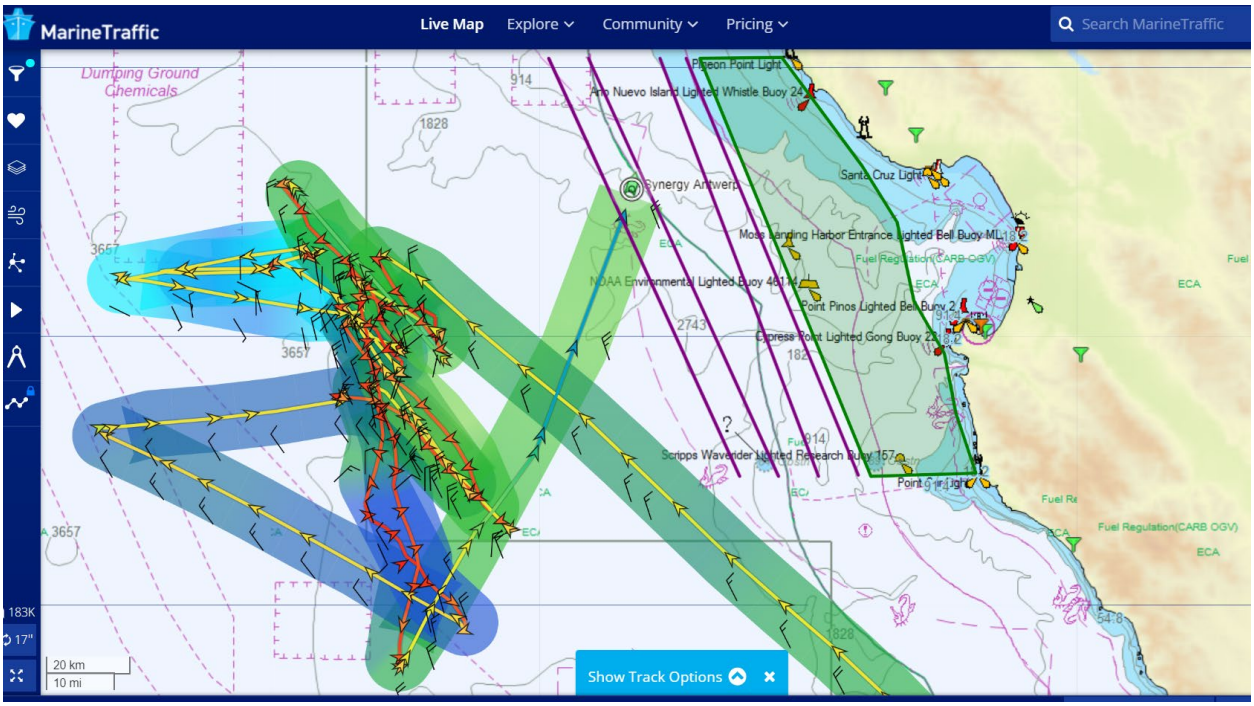

Figure 22. Track of a partially laden cargo vessel on January 31, 2022 shows vessel waiting offshore of MBNMS before entering San Francisco TSS.

Creating vessel tracks and comparing it to nautical charts, also highlights how vessels provide a wide berth to NOAA National Data Buoy Center's Station 46239 (Point Sur) (i.e. CDIP Waverider Buoy 157) located offshore of Point Sur (Figure 23). In August 2020, MBNMS staff discussed moving this buoy with CDIP staff but the CDIP staff wanted to keep the buoy in place to continue collecting data in the same location. The director of the Marine Exchange of Southern California did indicate this was a larger spatial concern than just the issue in MBNMS and it was brought up during the Public Safety Initiative discussions. MBNMS and USCG staff should 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.

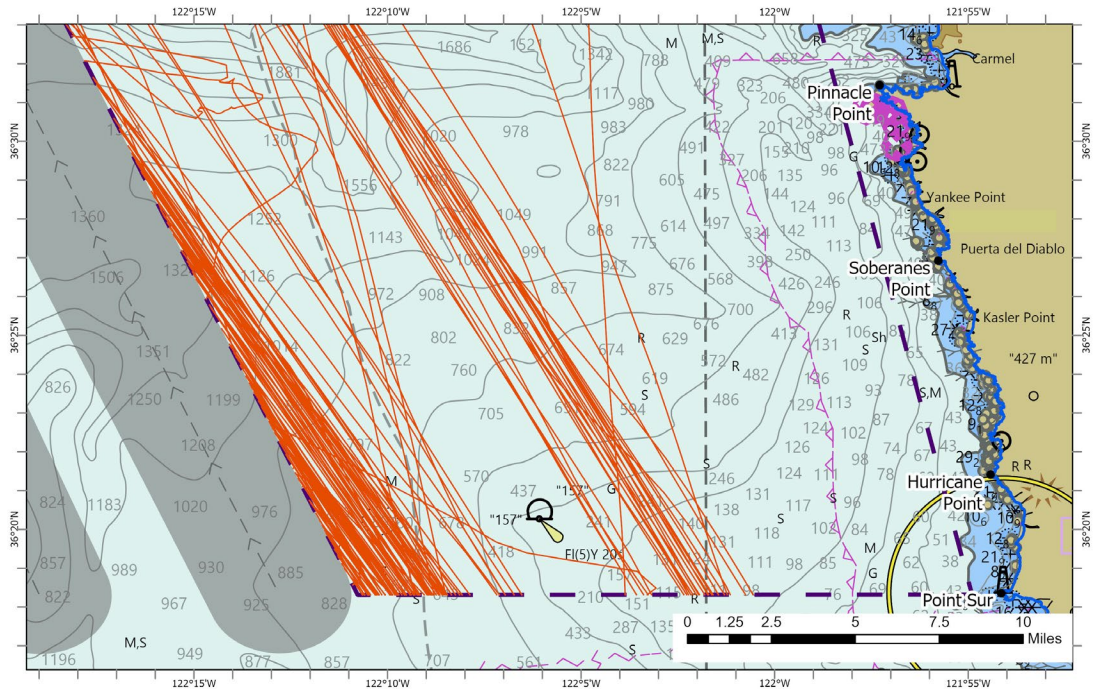

Figure 23. The 2019 vessel tracks (in orange) clipped to the customized alert zone (in dashed dark purple) indicate vessels provide a wide berth for NOAA National Data Buoy Center Station 46239 (Point Sur)/CDIP Waverider Buoy 157 located at 36°20'34" N 122°5'45" W (pink circle on NOAA Raster Navigational Chart).

MBNMS staff conducted a simple statistical analysis on all the 2019 and 2020 point data (original source was USCG and these data were clipped to MBNMS' western boundary and were bound by Point Sur and Pigeon Point) to help determine if there was a difference in vessel speed between when the VSR was active (between May 1 and November 15) and not active (2021 was not included due to the port delays which meant many vessels were lingering at very low speeds in the northern area of the IMO recommended tracks). In 2020, the mean speed of the vessels traveling through MBNMS was a slightly faster mean speed when the VSR was active then when it was not active (12.3 knots and 11.4 knots, respectively). The 2019 data did not show a difference between when the VSR was active or not active.

The average speed at which the vessel first came within the customized alert zone and standard deviation of the average speed on a monthly basis in 2020, 2021 and 2022 were also analyzed. However, this data doesn't indicate significant differences since the speed data were quite spread out as indicated by the large standard deviations. Results from the Optimized Hot Spot Analysis can be used in the future to determine if there is overlap between high vessel speeds and whales to inform where sanctuary managers could focus on reducing the risk of ship strikes to whales.

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, AIS data from the past few years indicate the practice continues.

Episodic incident reviews are not time-intensive and can have a significant impact on compliance through a collaborative effort by MBNMS and USCG. Emails sent by the USCG Captain of the Port to operators of non-compliant vessels can provide effective immediate reminders 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. In 2019 and 2020, USCG did not send any real time emails to deviating vessels due to staffing changes at USCG and the need to revise collaborative protocols between MBNMS and USCG. However, USCG did send real time notifications to deviating vessels in 2021 and 2022 as detailed above. MBNMS staff are continuing to gain knowledge and insight about the reason(s) vessels 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 staff will determine how to best approach the vessels which consistently deviate using the same tracks to sail closer than 10 nm to Point Sur or Pigeon Point. 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.

MBNMS staff will continue to determine if we can switch to PROTEUS for future analysis. The U.S. Naval Research Laboratory (NRL) resurrected UNCLASSIFIED S2A, now known as PROTEUS, in 2020, and has been developing it to meet the needs of the interagency maritime community. Key goals of the PROTEUS Pilot are to showcase the new common operating picture and analytic tools in the user interface and demonstrate how PROTEUS can be a data provider (vessel track feeds) for integration into other systems/user interfaces. PROTEUS provides near-real time global maritime situation awareness. PROTEUS first ingests a multitude of data sources, then aggregates the data and rapidly disseminates high quality vessel tracks along with critical metadata to support analysts, joint warfighters, decision makers and law enforcement officers within the maritime community. The full system environment, comprising a suite of analytical tools, tracks and alerts interface can be accessed simply via a web-browser. MBNMS staff have attended the online live demonstrations of PROTEUS and provided input to NRL.

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 staff 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's 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

Jessica Morten, Resource Protection Specialist of the California Marine Sanctuary Foundation, for providing the Gateway AIS data and providing insights and technical support for the analysis of the Gateway AIS data. Michael Carver, Greater Farallones and Cordell Bank National Marine Sanctuary, for ideas to implement reviews of AIS data, NPS for providing local AIS stations and data, USCG staff for following up on potential vessel deviations, The Otter Project/Monterey Coastkeeper for encouraging this analysis. Thank you to Bridget Hoover, MBNMS Water Quality Coordinator, reviewing this document and providing insights and edits.

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Attachment 1: Number of deviations from the IMO recommended tracks and rate of deviation per month in 2019, 2020, 2021 and 2022 between Point Sur to Pigeon Point in MBNMS. Number of vessels deviating is from Marine Traffic.

	Number of Vessels deviating				**Daily vessel transits (USCG data)**				**Deviation Rate (%)**			
Month	**2019**	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**	**2019**	**2020**	**2021**	**2022**
December	22	14	11	11	219	210	153	188	10.0	6.7	7.2	5.9
November	14	13	12	8	206	182	186	106	6.8	7.1	6.5	7.5
October	26	22	8	8	230	202	169	202	11.3	10.9	4.7	4
September	22	16	14	7	240	191	188	139	9.2	8.4	7.4	5
August	18	16	11	8	224	213	217	181	8.0	7.5	5.1	4.4
July	19	24	12	10	220	202	341	148	8.6	11.9	3.5	6.8
June	14	18	29	8	211	177	475	167	6.6	10.2	6.1	4.8
May	22	18	29	13	227	186	418	174	9.7	9.7	6.9	7.5
April	21	20	19	12	217	209	396	199	9.7	9.6	4.8	6
March	24	19	29	16	207	220	459	233	11.6	8.6	6.3	6.9
February	23	15	26	10	238	217	235	156	9.7	6.9	11.1	6.4
January	23	24	19	9	241	220	212	143	9.5	10.9	9.0	6.3
Total	**248**	**219**	**219**	**120**	**2680**	**2429**	**3449**	**2036**	**9.2%**	**9.0 %**	**6.6%**	**5.9%**

Attachment 2:

April 13, 2021

Superintendent Statement from Monterey Bay National Marine Sanctuary

Sanctuary, Coast Guard monitoring large vessels close to coast

Large vessels such as container ships and oil tankers have been sited close to the Monterey Bay coast over the past few weeks. NOAA's Monterey Bay National Marine Sanctuary is working closely with the U.S. Coast Guard to remind the vessels about advisable routes recommended by the International Maritime Organization (IMO).

Shipping companies are cooperating with the sanctuary's request that large vessels move west of the recommended routes and well offshore while waiting for entry into San Francisco.

The coastline of Monterey Bay National Marine Sanctuary supports a variety of protected habitats and endangered species, including sea otters and leatherback sea turtles. The IMO recommended routes were established in 2000 to enhance the safety and navigation of large vessels (over 300 gross tons) and oil tankers transiting through the sanctuary, as well as to protect sensitive marine environments.

During the past few weeks, up to 12 vessels have been waiting offshore along the San Mateo, Santa Cruz, and Monterey coastlines. Large container ships and some laden oil tankers have not been able to anchor in the Port of Oakland. This has resulted in vessels waiting along the coastline for an opening, stationing close to shore and areas of sensitive habitat. Labor shortages, COVID restrictions, and other complicating factors have contributed to this situation. A similar situation is occurring in the ports of Los Angeles and Long Beach.

Monterey Bay National Marine Sanctuary will continue to work with the U.S. Coast Guard (USCG) and shipping companies to encourage vessels to remain well offshore during this time.

USCG is issuing a Marine Safety Information Bulletin to all mariners.

Dawn Hayes
Acting Superintendent
Monterey Bay National Marine Sanctuary

Attachment 3: Marine Safety/Security Information Bulletin (MSIB)

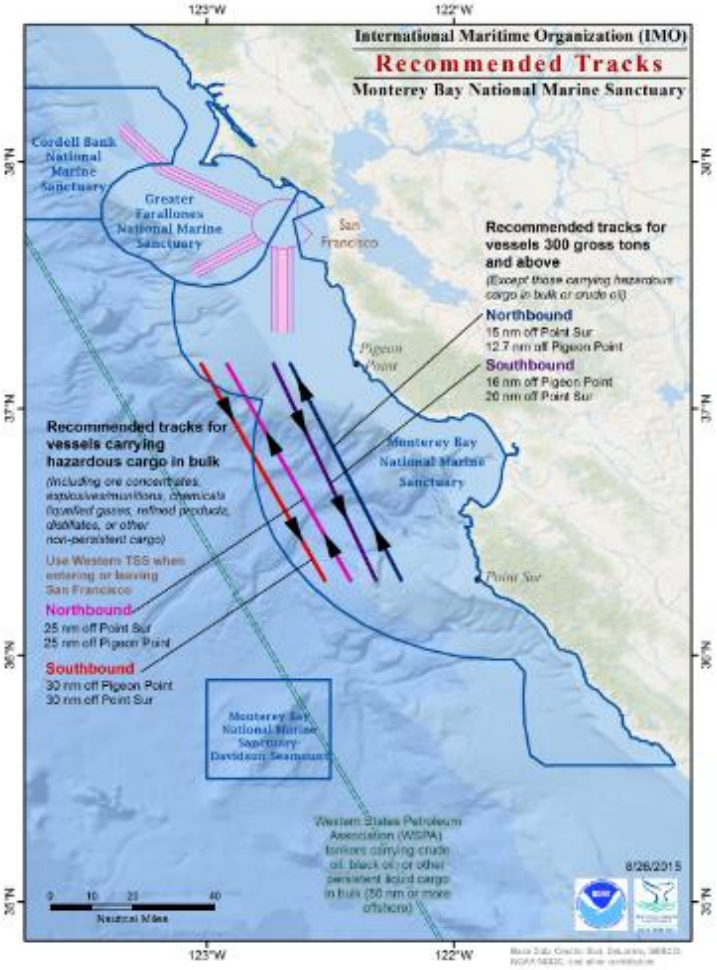
MARINE SAFETY/SECURITY INFORMATION BULLETIN (MSIB) 21-01

10 May 2021

U. S. Coast Guard Sector San Francisco
Department of Homeland Security

IMO Recommended Tracks in Monterey Bay National Marine Sanctuary

US Coast Guard, NOAA and the International Maritime Organization (IMO) established Recommended Tracks in NOAA's Monterey Bay National Marine Sanctuary (MBNMS) in 2000 to enhance the safety and navigation of large vessels (over 300 gross tons) and oil tankers transiting through the sanctuary, as well as to protect sensitive marine environments. Use of the IMO Recommended Tracks will reduce the risk of a spill or collision in a national marine sanctuary and allow a rescue tug to respond should the ship have an emergency. It is recommended that laden tankers transit 50 miles offshore and use the western TSS when entering or leaving San Francisco.



If a vessel is not permitted to enter the Port of San Francisco (SF) for anchorage immediately, it's strongly encouraged vessels stay offshore and west of the IMO Recommended Tracks while waiting for entry into the SF Traffic Separation Scheme (TSS).

Compliance with the IMO Recommended Tracks and this Bulletin will reduce the risk of an incident or marine casualty occurrence in a sensitive marine environment. If you have any questions, please contact the Sector San Francisco Waterways Safety Branch Chief, LT Anthony Solares, at (415) 399-3585.

M. B. BYRD
Captain, U. S. Coast Guard
Captain of the Port

Attachment 4:

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

Below is a list of conditions and considerations (caveats) to consider when analyzing AIS data for possible deviations from IMO vessel 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 vessel tracking applications or retrospective vessel 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 the 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 vessels in a fleet to cut registration costs. For example, sometimes vessels 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 vessel 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.