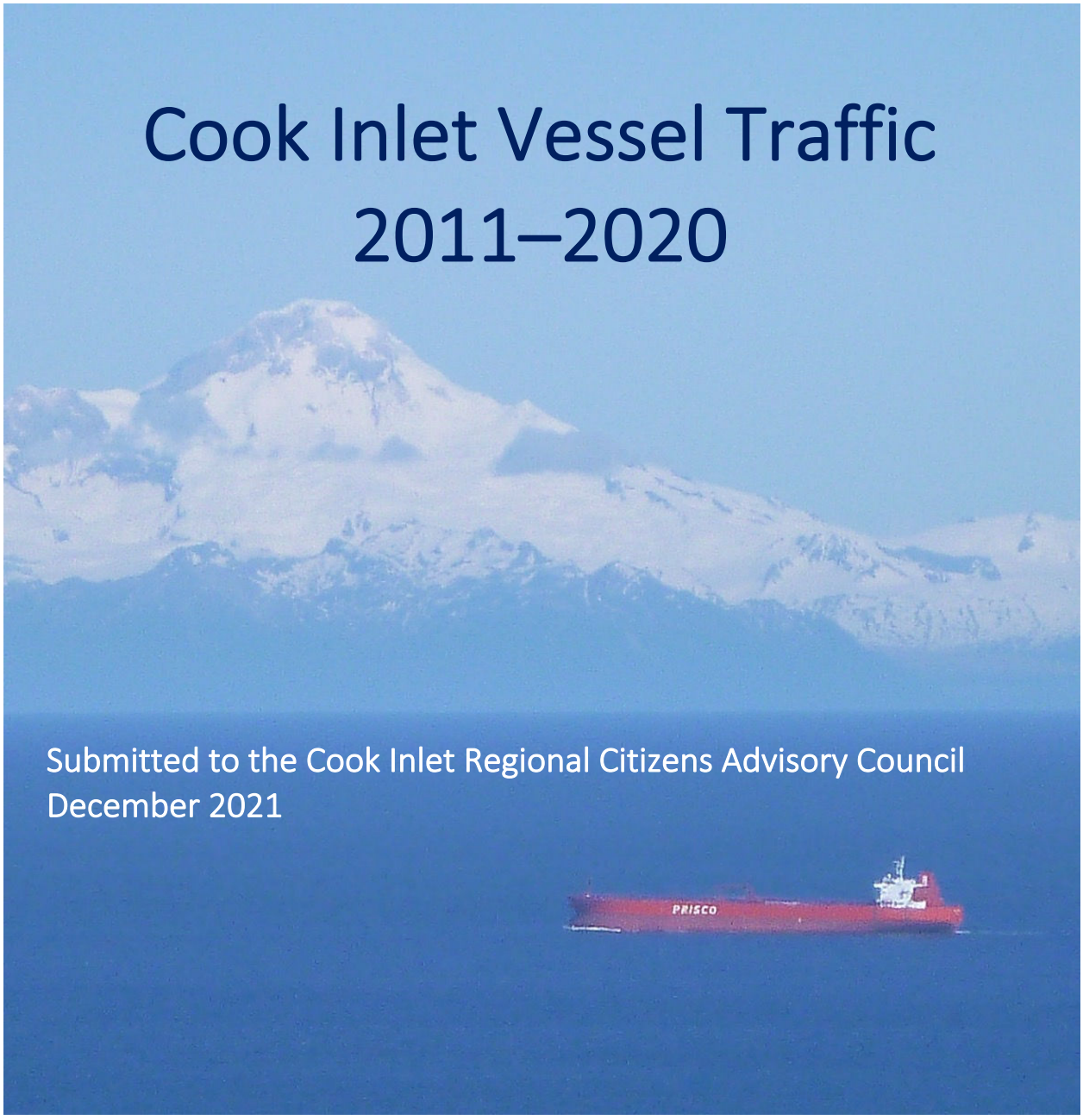
Cook Inlet Vessel Traffic 2011–2020



Submitted to the Cook Inlet Regional Citizens Advisory Council
December 2021

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NUKA RESEARCH

Executive Summary

Cook Inlet Regional Citizens Advisory Council (CIRCAC) contracted Nuka Research and Planning Group (Nuka Research) to produce this report on vessel traffic in Cook Inlet for 2011–2020. Nuka Research used Automatic Identification System (AIS) data to provide a general characterization of vessel movements and estimate oil exposure associated with oil tankers, large cargo ships, oil field vessels, cruise ships and large ferries, and some tugs. This analysis provided the first characterization of traffic since a 2012 study conducted for the Cook Inlet Risk Assessment.

During the 10-year study period, 818 vessels were identified from the AIS transmittals. Even though most fishing vessels in the Inlet are assumed not to use AIS, fishing vessels comprised the largest portion of vessels by type (28%) followed by tankers (21%), then tugs, cargo vessels, other vessels, and finally passenger vessels (3%). When time spent in the Inlet is considered, however, tugs and cargo vessels are the most prominent, with 35 and 31 percent of total operating time respectively. Tankers spend just 5% of total operating time of vessels in the Inlet, one percent less than passenger vessels.

Changes in traffic over the 10-year study period have not indicated significant trends. Annual time spent in the Inlet fluctuates for all vessel types, but the variations are more prominent for some vessel subtypes than others. Oil field and small cargo vessels fluctuate more than large cargo vessels, for example. Time spent by tankers has increased overall. Crude oil tanker movements across the Inlet were eliminated after the Drift River Terminal closed in 2018 and tankers calling at the refinery in Nikiski have decreased from a 2013 high. At the same time, however, more product tankers have been calling at the Port of Alaska in 2019 and 2020, which is assumed to be a result of the closure of the North Pole refinery and an increased demand for jet fuel at Alaska's main airport. As of 2020, the number of foreign-flagged tankers entering the Inlet was almost equal to the number of U.S.-flagged tankers for the first time.

As noted in previous studies, many vessels operating in Cook Inlet do so frequently. Of the vessels considered in this analysis, 46% of operating time over the ten years was attributed to vessels that rarely if ever leave the Inlet and frequent visitors.

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1 Introduction

Cook Inlet Regional Citizens Advisory Council (CIRCAC) commissioned this study to update vessel traffic information for Cook Inlet since the last such analysis was done in 2012 (Eley, 2012) to inform the Cook Inlet Risk Assessment. The study used Automatic Identification System (AIS) data to provide a general characterization of vessel movements and estimate oil exposure associated with oil tankers, large cargo ships, oil field vessels, cruise ships and large ferries, and some tugs. A 10-year dataset provides information from 2011–2020, with notable changes over time discussed.

Background

With its Oil Pollution Act of 1990 mandate to provide advice and a citizen voice to ensure safe oil transportation in Cook Inlet (CIRCAC, 2021), CIRCAC has been both a convenor and participant in efforts to understand and mitigate risks from vessel traffic in Cook Inlet. The first such effort was the 1999 Forum on the Safety of Navigation in Cook Inlet, which identified the need for an emergency rescue vessel and recommended conducting a Cook Inlet marine transportation risk assessment (CIRCAC et al., 1999). CIRCAC hosted a follow-up Navigational Safety Forum in 2007 (Nuka Research and Planning, 2007), then joined the Alaska Department of Environmental Conservation and U.S. Coast Guard to manage the Cook Inlet Risk Assessment from 2011–2014 (Nuka Research and Pearson Consulting, 2015).

The Cook Inlet Risk Assessment began with a study of 2010 Cook Inlet vessel traffic (Eley, 2012). The study used a combination of port call data and AIS, highlighting the fact that 15 ships were the source of 80 percent of the recorded transits. The Cook Inlet Risk Assessment Advisory Panel concluded the assessment by identifying risk reduction options to reduce the likelihood of oil spills and response efforts should one occur. One of these mitigation measures was to close the Drift River Terminal and move oil across the Inlet via a subsea pipeline instead (Nuka Research and Planning Group, 2015). Hilcorp Alaska made this change in 2018, resulting in the elimination of tanker voyages across the Inlet as of 2019 (Dunham, 2021). The resulting change in tanker movements is reflected in this study.

In 2017, Nuka Research and Planning Group and the Marine Exchange of Alaska conducted a small analysis of data from 2016 that was presented to the Cook Inlet Harbor Safety Committee. Conclusions of the overview highlighted two things: 1) a low volume of vessel traffic compared to other ports; and 2) many vessels operating in Cook Inlet are "frequent fliers" which are assumed to be familiar with its conditions and procedures (Nuka Research and Planning Group, 2017).

Geographic scope

Figure 1.1 shows the geographic scope of the project. The three ports designated as "analyzed" are those for which vessel entries and oil calculations were completed. These are the Port of Alaska (Anchorage), Nikiski, and Drift River. The Port of Alaska receives consumer goods and other freight for 90% of the population of Alaska, as well as fuel deliveries for the Ted Stevens International Airport in Anchorage and distribution over land, including for military use (McDowell Group, 2020).

Nikiski is the site of Alaska's largest refinery, currently owned by Marathon. Crude oil primarily from Cook Inlet and Valdez is transported by pipeline from the North Slope, then moved by tanker from the Valdez Marine Terminal to Nikiski. Refined gasoline, diesel fuel, jet fuel, and heating oil leave Nikiski by tanker or are sent to Anchorage and the airport there via subsea pipeline (Econ One Research, Inc., 2015). Drift River is the site of an oil terminal that is no longer in use did operate during the 10-year scope of this

study. The Drift River terminal stored oil produced on the west side of the Inlet for transport to Nikiski via tankers loading at an offshore platform (Dunham, 2021).

In addition to these three primary ports, there are numerous smaller ports around the Inlet; extensive fishing activity; service for passengers, freight, and fuel to Cook Inlet communities both on and off the road system; and offshore oil and gas activities associated with both exploration and production of oil and gas.

There is a marine pilot station in Kachemak Bay, within the southern portion of Cook Inlet, where ships requiring a marine pilot proceed to board or disembark a pilot or pilots (SWAPA, 2020).[1]

[1] Alaska statute exempts several categories of vessels from pilotage requirements. For Cook Inlet, the most relevant exemptions are fishing vessels, those less than 65-feet long or 300 gross tons, tow boats, and most pleasure craft (AS 08.62.180). Vessels that do require a pilot may proceed to and from the pilot station without one as well (12 AAC 56.110).

Figure 1.1 Geographic scope showing Cook Inlet area included in vessel traffic analysis; ports and passage lines are explained further in this section

2 Project Approach

This study builds on the previous analyses of vessel traffic in Cook Inlet, with the intent of capturing information over 10 years using Automatic Identification System (AIS) data. Since the last major study of Cook Inlet traffic, which focused on 2010 data (Eley, 2012), AIS coverage and data quality have improved substantially. While there will always be limitations to this or any other source of information about vessel movements, AIS provides a readily available source of information that can be replicated for periodic updates in the future.

This section introduces the AIS analysis approach used in this study, with more detail on the methodology provided in Appendix A. In addition to the AIS analysis, Section 8 summarizes the information available from public Coast Guard and Alaska Department of Environmental Conservation sources about incidents and spills involving marine vessels in Cook Inlet, including the data sources and limitations.

Vessel types and subtypes

Raw AIS data includes many different vessel types, which may be indicated either through numeric codes or entered by the operator. For this study, vessels are organized into 6 types and 14 associated subtypes, as shown in Table 2.1. Vessel density by subtype is shown in Figure 3.1 based on processing the raw AIS data for all vessels for which even minimal information could be found. Additional characterization of vessels operating in Cook Inlet was done based on purchased or researched vessel particulars as shown in Table 2.1.[2]

[2] This additional level of characterization was not done for fishing vessels, smaller passenger vessels, or "other" vessels such as survey/research vessels or government vessels. Vessel particulars such as size, age, and flag state are not consistently included in AIS and were not consistently available for these vessel types from other sources.

Table 2.1 Vessel types and subtypes used in this analysis, examples, and additional characterization (e.g., size, flag, and year built)

Vessel Types	Subtypes	Examples	Size	Flag	Year Built
Cargo	Large Cargo	Container ships, roll-on/roll-off cargo ships, vehicle carriers, bulk carriers, general cargo, heavy lift cargo, refrigerated cargo ("reefer")	x	x	x
	Oil Field	Oil spill response vessels, offshore supply vessels associated with Cook Inlet oil and gas production	x		x
	Small Cargo	Landing craft other small cargo	x		x
Tanker	Oil Cargo	Chemical/oil products tanker, crude oil tanker	x	x	x
	LNG	LNG tanker	x	x	x
Passenger	AMHS Ferry	State highway system ferries	x		x
	Cruise Ship	Cruise ship	x	x	x
	Small Passenger	Small ferries (e.g., Kachemak Bay ferry), tour boats, crew boats			
Tug	Articulated	Articulated tug	x		x
	Conventional	Pusher, conventional tug	x		x
Fishing	Fishing	Crab/longliner, tender, trawler			
Other	Government	Law enforcement, military			
	Survey/Research	Vessels identified as conducting research or surveys (for government or private sector)			
	Other	Dredging, pleasure craft, yacht, fire-fighting vessel			

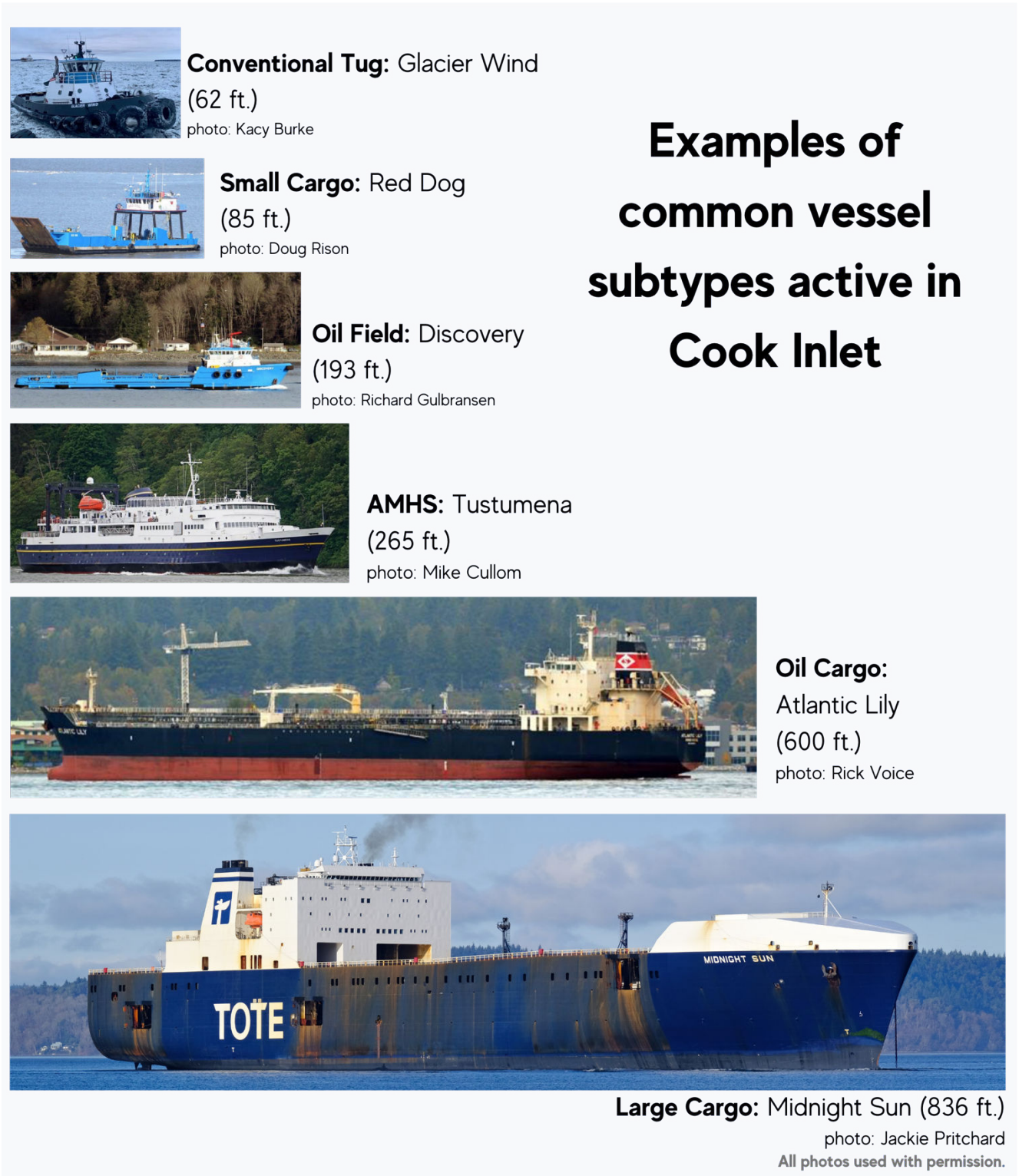

Figure 2.1 Examples of some vessels that are resident in Cook Inlet or visit frequently

Activity at ports and passage lines

Activity at two passage lines and 15 ports is calculated based on the 10-year dataset (see Figure 3.1). Using the AIS data, the number of one-way transits across a passage line or into a circle around a port is counted. These tools are used to quantify changes over time and complement the data shown spatially on the vessel density maps.

Two passage lines are used: Cook Inlet (capturing vessels entering Cook Inlet) and Kachemak Bay (capturing ships moving to and from the pilot station, the ferry, and other traffic into Kachemak Bay). Fifteen ports are included, with petroleum movements analyzed for the Port of Alaska, Nikiski, and Drift River Terminal. The other 12 ports were: Ladd Landing, Port MacKenzie, Trading Bay, Williamsport, Kasilof, Kenai, OSK Dock, Homer, Jakolof Bay, Nanwalek, Port Graham, and Seldovia.

Petroleum analysis

A petroleum analysis was conducted for the following subtypes from Table 2.1:

- Tankers carrying oil cargo (either refined product or crude oil),
- Ships that carried relatively large volumes as fuel (large cargo, cruise ships, Alaska Marine Highway System ferries, or articulated tugs), or
- Oil field supply vessels.

This analysis required additional research to obtain or estimate fuel and cargo capacities, as described in Appendix B. The quantity of oil on board will vary not only by vessel, but also by the nature of the voyage (e.g., making an oil delivery vs. returning from that delivery with empty cargo tanks), or timing during a voyage as fuel is burned. While fuel capacity and cargo capacity remain the same, the actual volume of fuel on board changes. In order to reflect this, some simple assumptions are applied for the purpose of generally understanding oil movement by these vessel subtypes in Cook Inlet: fuel tanks are assumed to be 70%[3] full and the oil cargo tanks are assumed to be 50% full.[4]

Fuel and cargo type are also considered according to two categories: persistent oil (including crude oil and heavy fuel oil) and non-persistent oil (including refined product cargo and marine diesel fuel). The research and assumptions used to assign fuel and cargo capacities of each type are described in more detail in Appendix B.[5]

Whether or not oil cargo or fuel is determined to be persistent or non-persistent depends on a few factors, and was determined by examining vessel tracks. Oil Cargo tankers calling at Nikiski and Drift River were assumed to be carrying persistent oil (crude) while those calling at the Port of Anchorage were

[3] Different values can be used for the assumed fuel volume. We chose to use 70% because this value was used in the Aleutian Islands Risk Assessment vessel traffic study (DNV & ERM-West, Inc., 2010) and have since applied this assumption in studies elsewhere on the Pacific Coast (Nuka Research 2016; Clear Seas, 2020).

[4] As noted in Appendix B, the maximum tanker cargo capacity used is 300,000 bbl (even if a vessel is known to have a larger cargo capacity).

[5] The authors note that this breakdown between persistent and non-persistent is different from the delineation used by both CISPRI and in federal regulations (40 CFR 112 Appendix E), which would include marine diesel as persistent.

assumed to be carrying non-persistent oil (refined products). For vessels that called at, for example, both Nikiski and Anchorage, the track was split accordingly.

Estimated oil carriage (total oil fuel + oil cargo) is displayed on density maps (one for persistent oil and one for non-persistent oil) and used to calculate an overall oil exposure by vessel type throughout the Inlet. This oil exposure as a function of time can be considered a numerical complement to the density maps. While the maps show the average volume of oil present per square nautical mile, the oil exposure calculation shows the oil carriage estimate for a particular vessel subtype multiplied by the time spent in Cook Inlet (total increments of 24 hours) by vessels of that subtype.

Estimated oil movements at the ports of Nikiski, Drift River, and Port of Alaska are also presented. In these cases, only one-way transits are used and oil cargo is therefore assumed to be at 100% of oil cargo capacity. Appendix B discusses the assumptions applied to determine oil cargo capacity.

Data sources and limitations

AIS transmitters on vessels send AIS signals every few seconds (see Appendix A for more details on the data used for this project and the methodology applied in the analysis). AIS signals can be received by other ships, shore receivers, and satellites. Nuka Research obtained the raw AIS data compiled from two sources for this project: shore-station data from the Alaska Marine Exchange were used for 2011–2016[6] and satellite data from exactEarth were provided for 2017–2020. Data from both sources include AIS signals sent from within Cook Inlet.

Nuka Research compiled AIS data to build tracks by combining consecutive transmissions from a single vessel which were used to develop maps of vessel density by vessel type or subtype. (AIS transmissions use dozens of vessel types which were aggregated for simplicity into a set of types and subtypes for this study.)

AIS data transmissions include varied information. The basic details of a vessel's identity, the time, date, and location from which the transmission is sent, and sometimes information about vessel type are transmitted fairly consistently, while other details such as size, length, flag state, cargo capacity, or fuel capacity and type often require additional data purchase or research. Sometimes a vessel's specifications cannot be confirmed even with additional research and so the vessel is excluded from the study.

This study depends on the transmittal and reception of AIS transmittals to capture vessel movements in Cook Inlet. Therefore, if a vessel does not send an AIS signal, it will not be included in the data (e.g., barges or other vessels which are not required to carry AIS, or in case of an AIS transmitter malfunction). Likewise, if an AIS signal is not received and compiled due to a receiver malfunction or gaps in satellite coverage, then a vessel could be missed. Some smaller vessels use an AIS transmitter that sends a weaker signal that is more likely to be missed. Gaps in coverage also occur if a vessel is out of range of a shore-station, or if there is not a satellite overhead.

[6] Data is used from both sources. Most of the data for 2016 had been shared previously with Nuka Research for a 2017 vessel traffic update for the Cook Inlet Harbor Safety Committee. That data is used here again with permission and appreciation.

3 Overview of Vessel Types and Movements

This section generally characterizes the vessel activity in Cook Inlet based on the AIS data for 2011–2020. Figure 3.1 shows vessel tracks for the whole study period for each vessel subtype. Variations across the 10 years are shown in Section 6.

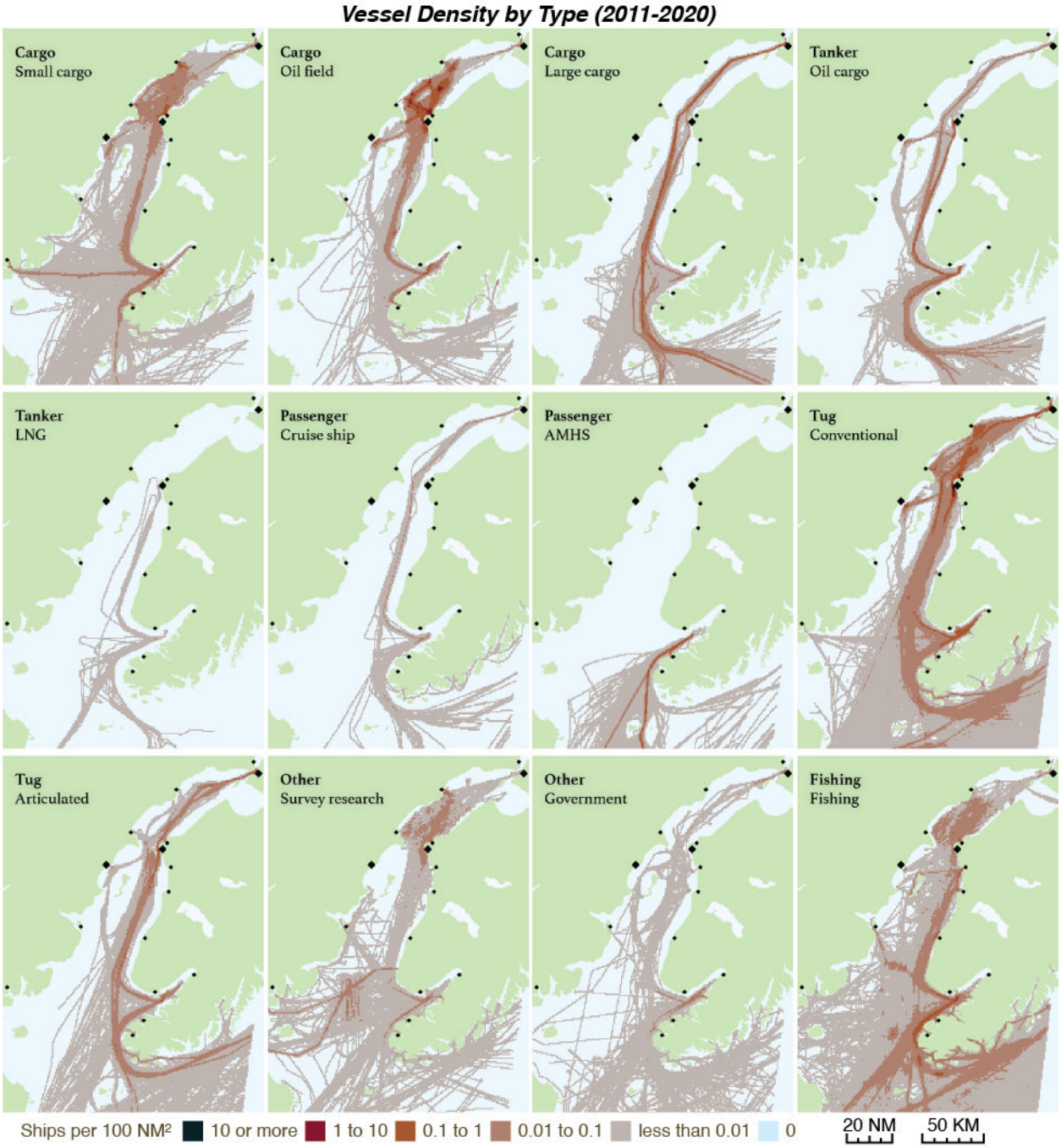

Figure 3.1 Vessel tracks by type and subtype for all 10 years of the study period.

Number of unique vessels

A total of 818 vessels made the tracks shown above in Figure 3.1. Even though many fishing vessels in Cook Inlet do not carry AIS, fishing vessels that were captured in the AIS data still represented the vessel type with the largest number of unique operating vessels (231). Tankers followed with 171 different tankers identified.

Table 3.1 Total number of unique vessels by type and subtype

Vessel Types	Subtypes	Unique Vessels in 10-year Dataset
Cargo	Large Cargo	99
	Oil Field	22
	Small Cargo	17
Tanker	Oil Cargo	168
	LNG	3
Passenger	AMHS Ferry	2
	Cruise Ship	13
	Small Passenger	7
Tug	Articulated	12
	Conventional	135
Fishing	Fishing	231
Other	Government	27
	Survey	10
	Other	72
TOTAL		818

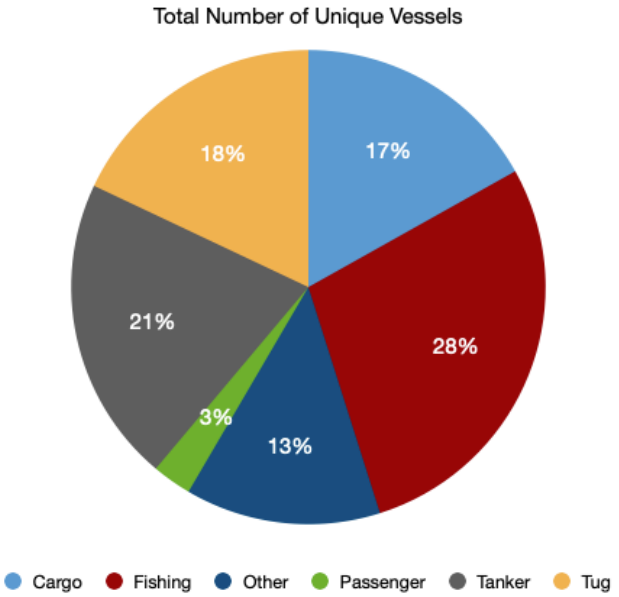

Figure 3.2 Percentage of unique vessels in data set by type

Flag state

Because of Jones Act requirement that vessels traveling between two U.S. ports be constructed and registered in the U.S., many of the vessels operating in Cook Inlet are U.S. flagged. This is assumed to include the following subtypes: Oil Field, Small Cargo, AMHS, Small Passenger, as well as all of the Fishing, Tugs, and other vessel types. The flag states for the Large Cargo, Cruise Ship, Oil Cargo, and LNG tankers

are shown in Table 3.2. Each subtype except LNG tankers has at least one U.S.-flagged vessel that called in Cook Inlet during the 10 years.

Table 3.2 Flag states for Large Cargo, Cruise Ship, Oil Cargo, and LNG Tankers that called into Cook Inlet (2011-2020)

Flag State	Cruise Ship	Large Cargo	LNG	Oil Cargo	Total
Antigua Barbuda		14			14
Bahamas	5		1	2	8
Belgium			1		1
Bermuda	1				1
Cayman Islands				1	1
Croatia				1	1
Cyprus		1		4	5
Denmark				4	4
Egypt		1			1
Gibraltar		1			1
Greece				3	3
Hong Kong, China		29		15	44
India				3	3
Isle of Man				1	1
Israel		1			1
Italy				4	4
Liberia		2		19	21
Malaysia				1	1
Malta	1			5	6
Marshall Islands	1	1	1	48	51
Netherlands	4	3		1	8
Norway				2	2
Norway (Nis)		1			1
Panama		15		19	34
Portugal				1	1
Singapore		3		24	27
St Kits Nevis		1			1
Thailand		1			1
United Kingdom		1			1
United States	1	24	0	9	34
Vietnam				1	1
Grand Total	**13**	**99**	**3**	**168**	**283**

Of the 168 Oil Cargo tankers, 48 were flagged to the Marshall Islands with Singapore next (24). Just 9 Oil Cargo tankers were flagged to the U.S. The U.S.-flagged Oil Cargo tankers generally are traveling to/from Valdez, Alaska or sometimes ports in Washington or California. Their tracks are evident in Figure 3.3, which shows vessel track density for Oil Cargo ships at the entrance to Cook Inlet and in Kachemak Bay. These U.S.-flagged vessels are often frequent visitors to the Inlet and can be seen turning southeast (or more directly south if going to the Lower 48), often using the exact same routes repeatedly (see darker lines in Figure 3.3). Oil Cargo tankers flagged to other countries are typically engaging in trade between Cook Inlet and East Asian ports. These ships can be seen on the map clearly angling west out of Cook Inlet (or into the Inlet *from* the west). Tankers on this route are predominately foreign-flagged.

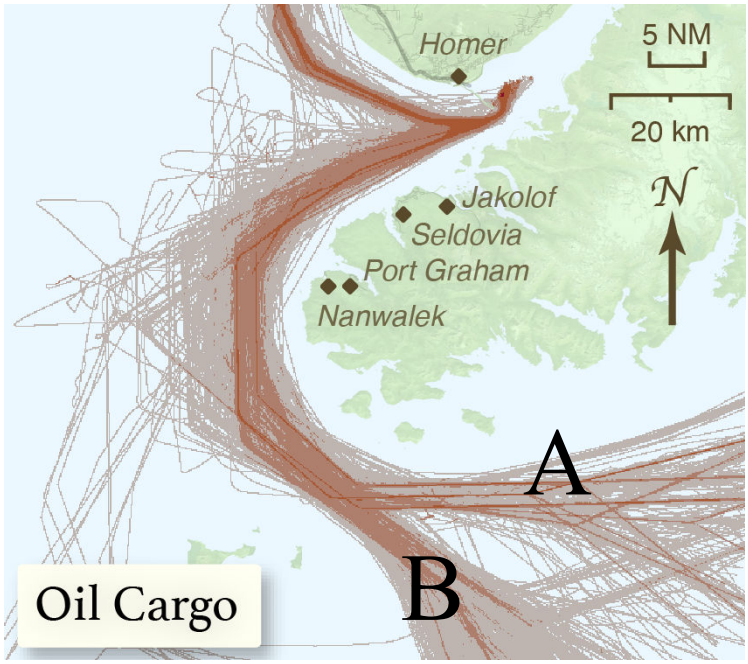

Figure 3.3 Density of Oil Cargo ship tracks entering/leaving Kachemak Bay in southeastern Cook Inlet; darker lines indicate common routes while the split routes just outside the Inlet show the common routes to/from (A) Valdez, Alaska or the Lower 48 and (B) east Asian ports

Year built

Date of construction is presented by decade and varies across the types and subtypes for which age was determined (excluding fishing vessels and Small Passenger). As shown in Figure 3.4, almost all Tankers were constructed since the year 2000, and most Cargo vessels were as well (though a few Large Cargo and Oil Field vessels were built in the 1970s–1990s). Cruise ships in the dataset were built since the 1990s. By contrast, most of the tugs were constructed in the 1970s. The larger vessels that are more likely to be foreign-flagged also tend to be more recently constructed.

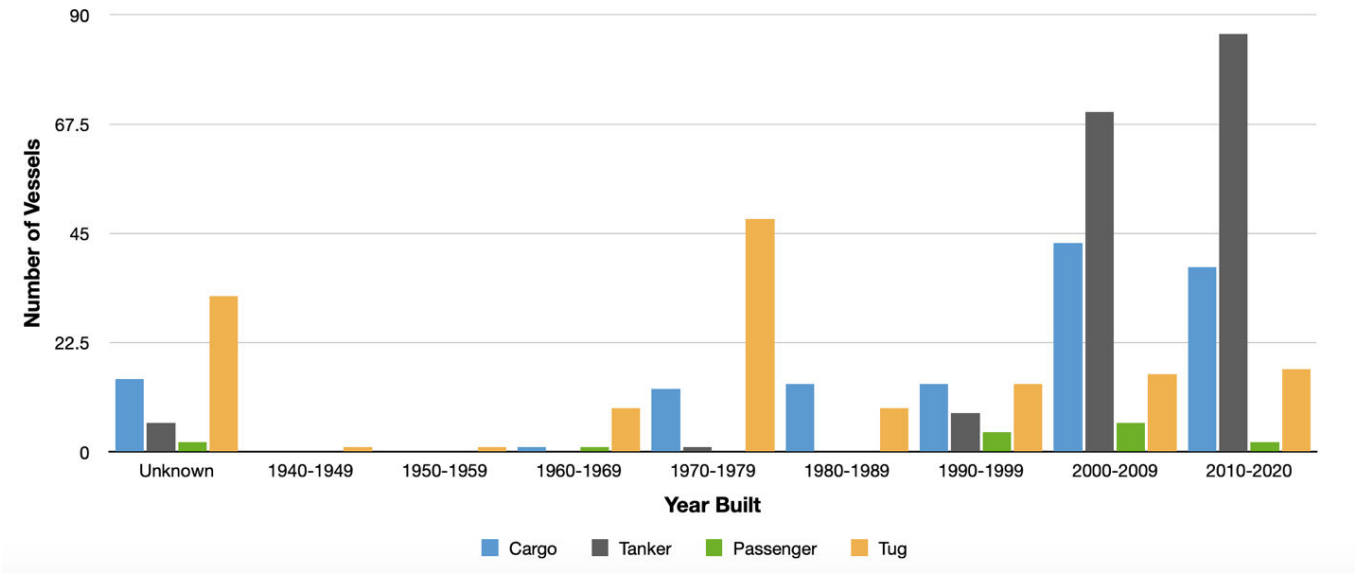

Figure 3.4 Decade of construction for Cook Inlet vessel types

Table 3.3 Decade of construction for Cook Inlet vessel subtypes

Vessel Types	Subtypes	Unknown	1940-1949	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2020
Cargo	Large Cargo	3			1	6	9	7	38	35
	Oil Field	1				5	5	4	5	2
	Small Cargo	11				2		3		1
Tanker	Oil Cargo	6						7	69	86
	LNG					1		1	1	
Passenger	AMHS Ferry				1			1		
	Cruise Ship	2						3	6	2
Tug	Articulated	1				3	1		3	4
	Conventional	31	1	1	9	45	8	14	13	13

Vessel size

Finally, we consider vessel size. Figure 3.5 shows Tankers and Large Cargo ships in deadweight tonnage (DWT). Figure 3.6 shows all non-tank vessels, including Large Cargo here as well, in Gross Tonnage (GT) with other vessels (measured in gross tons, or GT). The Oil Cargo tankers stand out for having the most numerous larger vessels in the dataset. While there was one Very Large Crude Carrier at 312,539 DWT, most tankers in the dataset would be considered either Long Range 1 or 2, to use standard terminology

(EIA, 2014), falling between 45,000 and about 115,000 DWT (Long Range 2 goes up to 160,000 DWT). Large Cargo vessels appear on both graphs to put show the sizes of tankers and cargo vessels in comparison to each other comparison. While they are in the middle-to-smaller size compared to tankers, they are among the larger vessels, along with cruise ships, compared to other vessel subtypes examined.

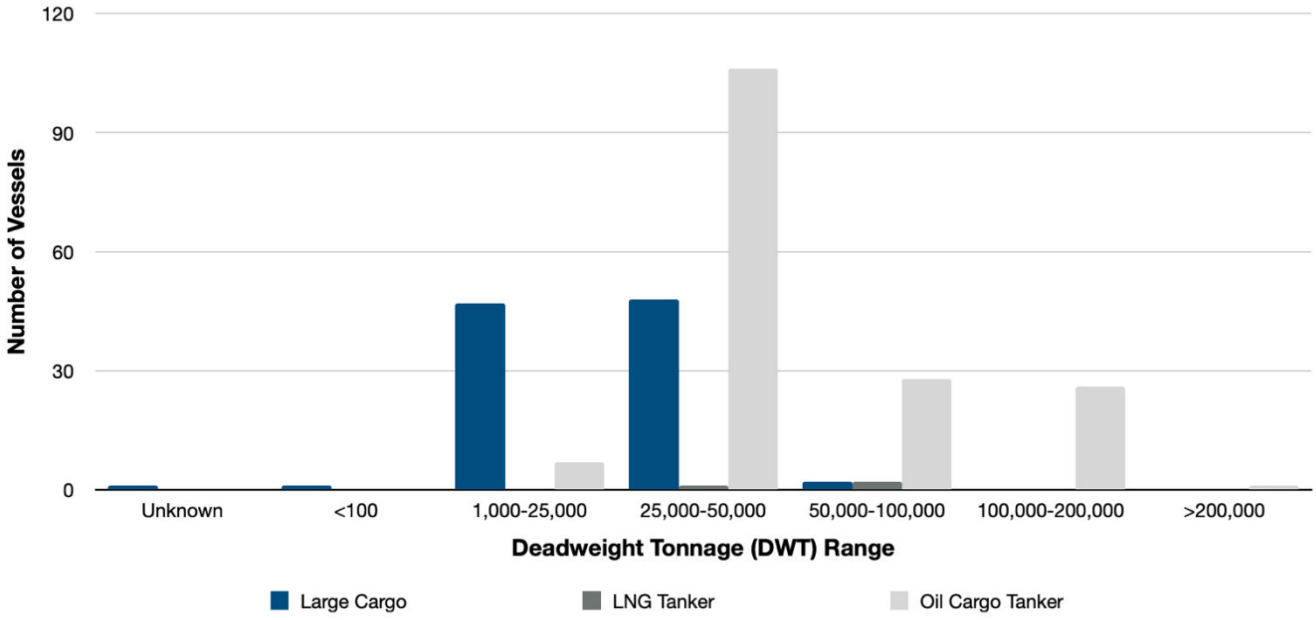

Figure 3.5 Size of Large Cargo, LNG tanker, and Oil Cargo tankers calling in Cook Inlet in deadweight tonnage (DWT)

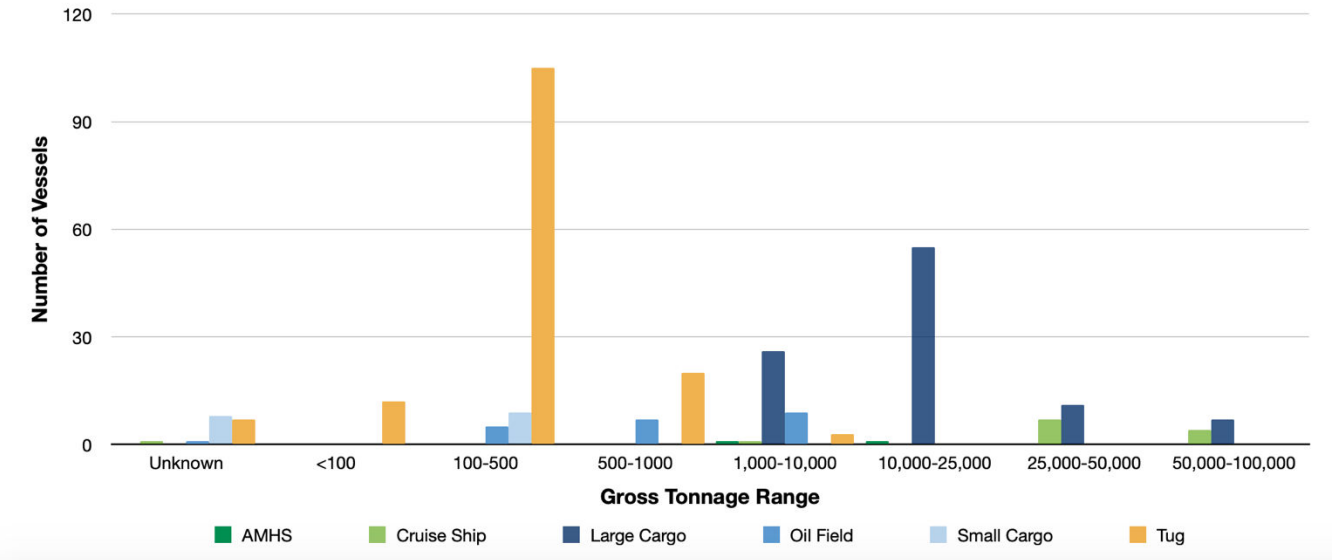

Figure 3.6 Size of other vessels in gross tonnage (GT); with Large Cargo shown on both graphs (which use different units), the relative size of the vessels in the dataset is evident

Fuel capacities

For vessels included in the petroleum analysis, fuel capacities (not oil cargo) were researched or estimated. Table 3.4 shows the minimum, maximum, and average fuel capacities identified. Oil Field vessels, Articulated Tugs, and AMHS ferries are assumed to use only non-persistent fuel. For this study it is assumed that Large Cargo, Cruise Ships, and Oil Cargo tankers use both non-persistent (marine diesel) and persistent (heavy fuel oil) as those are discussed in Section 2. Fuel usage in large ships may have changed with the global implementation of the International Maritime Organization's sulfur cap requirements which took effect in March 2020. However, this study captures 10 years of data and fuel usage is still evolving in response to that requirement. (Also, Cruise Ships were not active during the summer of 2020 due to the Covid-19 pandemic which is the only year of data included in this study after the global sulfur cap requirements took effect.)

Table 3.4 Non-persistent and persistent fuel capacities by vessel type

	Non-Persistent Fuel [GAL.]			Persistent Fuel Capacity [GAL.]		
Vessel Type	Minimum	Maximum	Average	Minimum	Maximum	Average
Cargo						
Large Cargo	392	17,193	2061	0	326,676	14,156
Oil Field	1388	8806	3402	0	0	0
Passenger						
AMHS	1598	5001	3299	0	0	0
Cruise Ship	239	5505	1731	4599	17,586	10,584
Tanker						
Oil Cargo	503	7862	1393	4202	23,448	11,394
Tug						
Articulated	276	4169	2399	0	0	0

4 Vessel Activity: Operating Days, Ports, Passage Lines

While some indication of vessel activity was shown in the maps of the previous section, this section describes vessel activity in terms of operating days, passage line crossings, and port entries.

Operating days

The number of unique vessels does not necessarily indicate anything about how much time they spend in Cook Inlet. Figure 4.1 shows the number of operating days (total increments of 24 hours) calculated for the different vessel types, with the same information shown for each type and subtype in Table 4.1. (Variations over time are discussed in Section 6.)

Tugs and cargo vessels spend the most time in Cook Inlet overall, with the resident vessel subtypes dominating. Twenty-two Oil Field vessels had a total of 4,274 operating days over the 10 years, while 135 Conventional Tugs had 7,255 operating days. While the AMHS Ferries do not top the charts at operating days, it is notable that the 775 operating days recorded represent just two vessels.

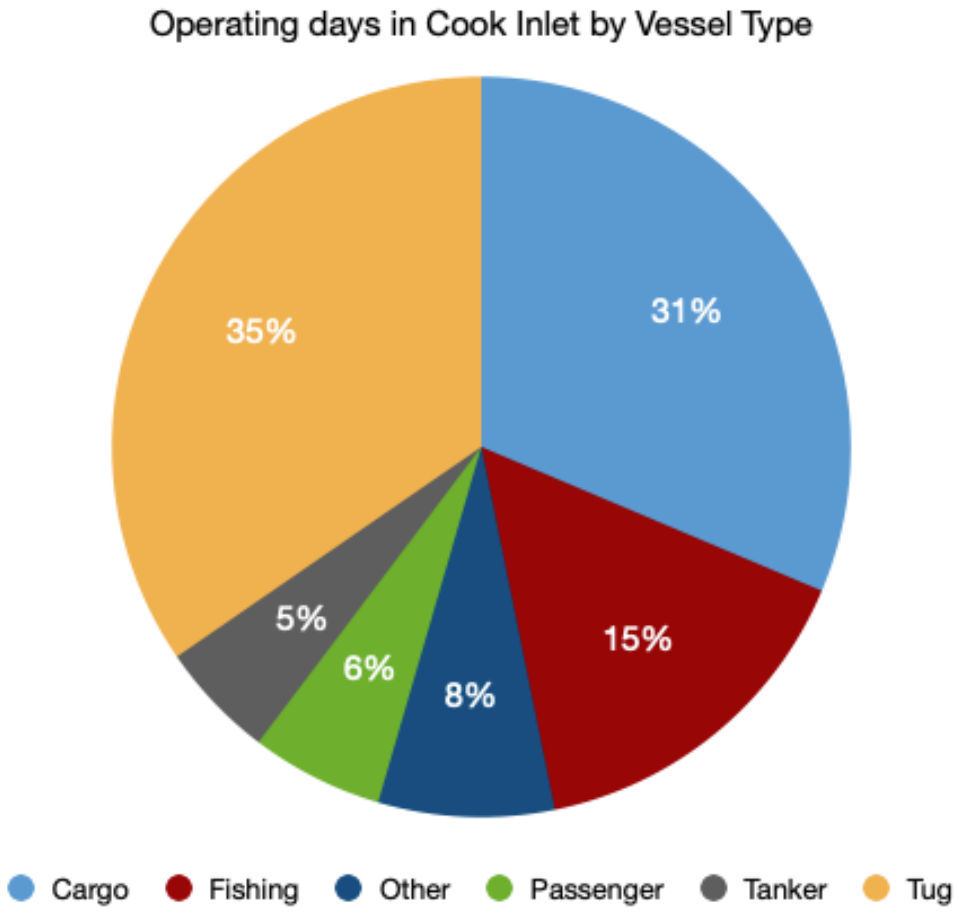

Figure 4.1 Percentage of total operating days by vessel type (2011–2020)

Table 4.1 Number of total operating days by vessel type and subtype (2011-2020)

Vessel Types	Subtypes	Operating Days
Cargo	Large Cargo	2070
	Oil Field	4274
	Small Cargo	1491
Tanker	Oil Cargo	1246
	LNG	30
Passenger	AMHS Ferry	775
	Cruise Ship	116
	Small Passenger	558
Tug	Articulated	1388
	Conventional	7255
Fishing	Fishing	3862
Other	Government	256
	Survey	639
	Other	1030
TOTAL		24,990

Vessels known to the authors to be residents of Cook Inlet (those that rarely leave, if ever) were categorized as Resident Vessels, and account for about 30% of operating days in the dataset total. Vessels that enter and leave the Inlet, but spent more than 200 total days there, account for another 17% of operating days. This reflects findings in previous studies regarding the prevalence of "frequent fliers" in Cook Inlet (Eley, 2012; Nuka Research and Planning Group, 2016).

Table 4.2 Percentage of total operating days by resident and frequent visitors in Cook Inlet (2011-2020)

	Operating Days	Percentage
Resident Vessels	7420	30%
Frequent Visitors	4137	17%
All Other Vessels	13,431	54%

Passage lines

Table 4.3 shows the number of each vessel type and subtype recorded entering Cook Inlet. In this context, this means vessels crossing the Cook Inlet passage line at Kennedy Entrance from south to north. This does *not* include traffic through Shelikoff Strait – which is more typically smaller vessels dominated by fishing – or vessels that are in the Inlet and never leave. Oil Field vessels, for example, represent a high number of operating days but it is uncommon for them to go in or out of the Inlet. On the other hand, Large Cargo vessels have the highest number of crossings but far fewer total operating days than Oil Field, Fishing, or Tug vessels. Large Cargo vessels enter the Inlet, call at a port, and leave. Many of these are on regular routes from the Lower 48.

Table 4.3 Passage line entrances for Cook Inlet and Kachemak Bay by vessel type (2011-2020)

Vessel Type	Cook Inlet Passage Line Entrances (2011–2020)	Kachemak Bay Passage Line Entrances (2011–2020)
Cargo	**2387**	**1747**
Large Cargo	2088	309
Oil Field	66	578
Small Cargo	233	860
Fishing	**1715**	**2480**
Fishing	1715	2480
Other	**351**	**1203**
Government	139	186
Other	124	818
Survey / Research	88	199
Passenger	**1324**	**1445**
AMHS	1202	1202
Cruise Ship	88	154
Small Passenger	34	89
Tanker	**895**	**1777**
LNG	25	47
Oil Cargo	870	1730
Tug	**1593**	**1669**
Articulated	562	529
Conventional	1031	1140

Ports

Figure 4.2 shows number and type of vessel entries recorded (note that *only* tankers were counted at Nikiski due to the difficulty of separating vessels calling at the port from other traffic at that location). The numbers are totals across the 10 years. Variations over time are discussed in Section 6.

Appendices D and E shows the detailed results for these 12 ports over each of the 10 years.

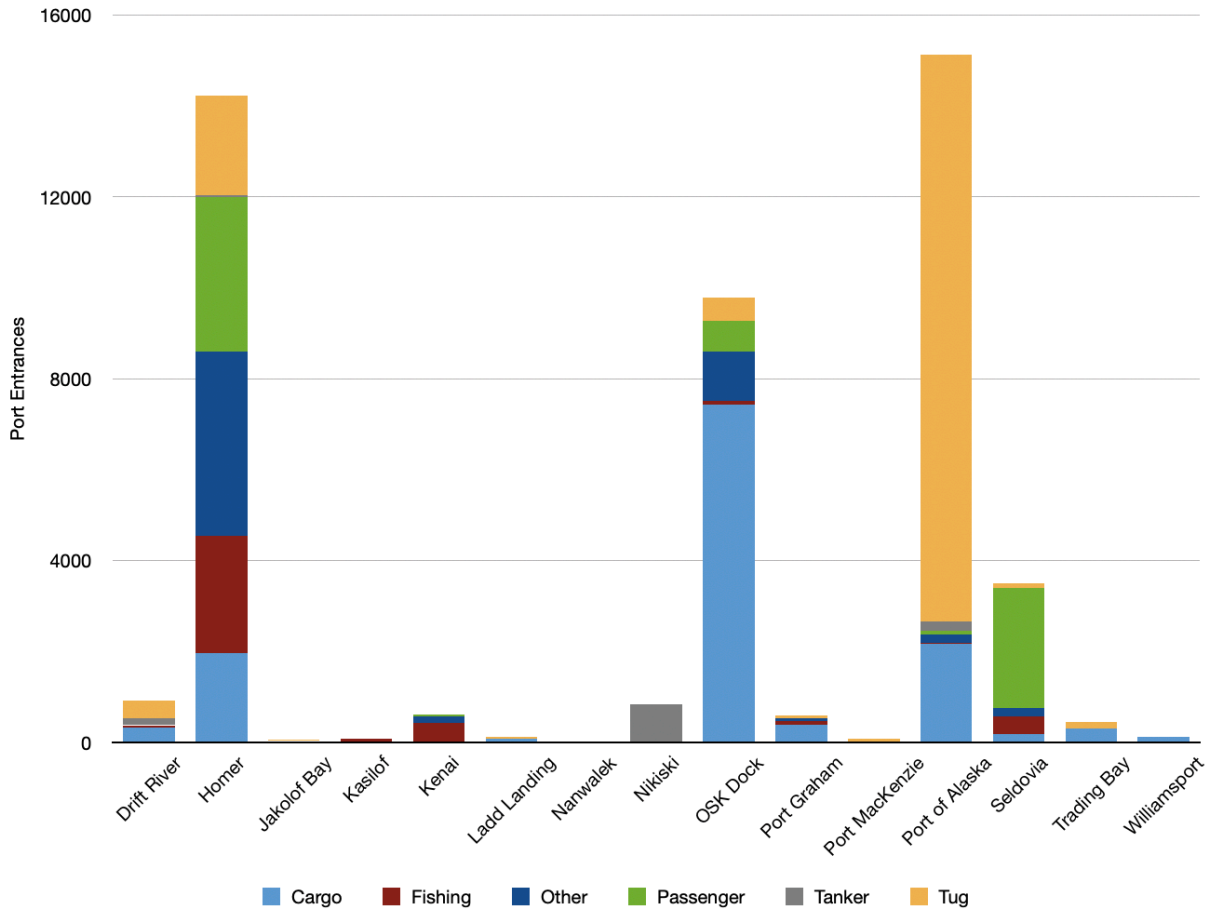

Figure 4.2 Total port entries based on AIS, by vessel type (2011–2020)

5 Petroleum Movement Analysis

Figure 5.1 shows the vessels for which the oil exposure analysis was conducted: Large Cargo, Oil Field, AMHS Ferry, Cruise Ship, and Articulated Tug. These are generally larger vessels and their movements are more restricted to north-south routes to and from the Port of Alaska and Nikiski. Movements across the Inlet are generally either Oil Tankers going to Drift River (when the terminal was still active there) or Oil Field vessels active between Nikiski and the OSK Dock (just north of Nikiski) on the east side of the Inlet, west side oil industry infrastructure in and around Trading Bay, and the offshore platforms there.

Maps in Figures 5.2 and 5.3 show where persistent and non-persistent oil move through Cook Inlet as fuel on vessels in the Oil Cargo tankers, Large Cargo, Oil Field, Cruise Ship, and AMHS subtypes and cargo on Oil Cargo tankers. The "exposure density" displayed on the maps reflects an average barrels of oil per square nautical mile over the 10 years.[7] Persistent oil includes heavy fuel oil used as fuel, but in Cook Inlet the more prominent source is the crude oil tankers. These tankers primarily move between the entrance to Cook Inlet and Nikiski, with a stop at the pilot station in Kachemak Bay. In contrast, non-persistent oil exposure concentrates on the route all the way to the Anchorage area.

[7] As described in Section 3, the estimated volume of oil on a ship is 70% of its total fuel capacity plus 50% oil cargo if the vessel is an Oil Cargo tanker.

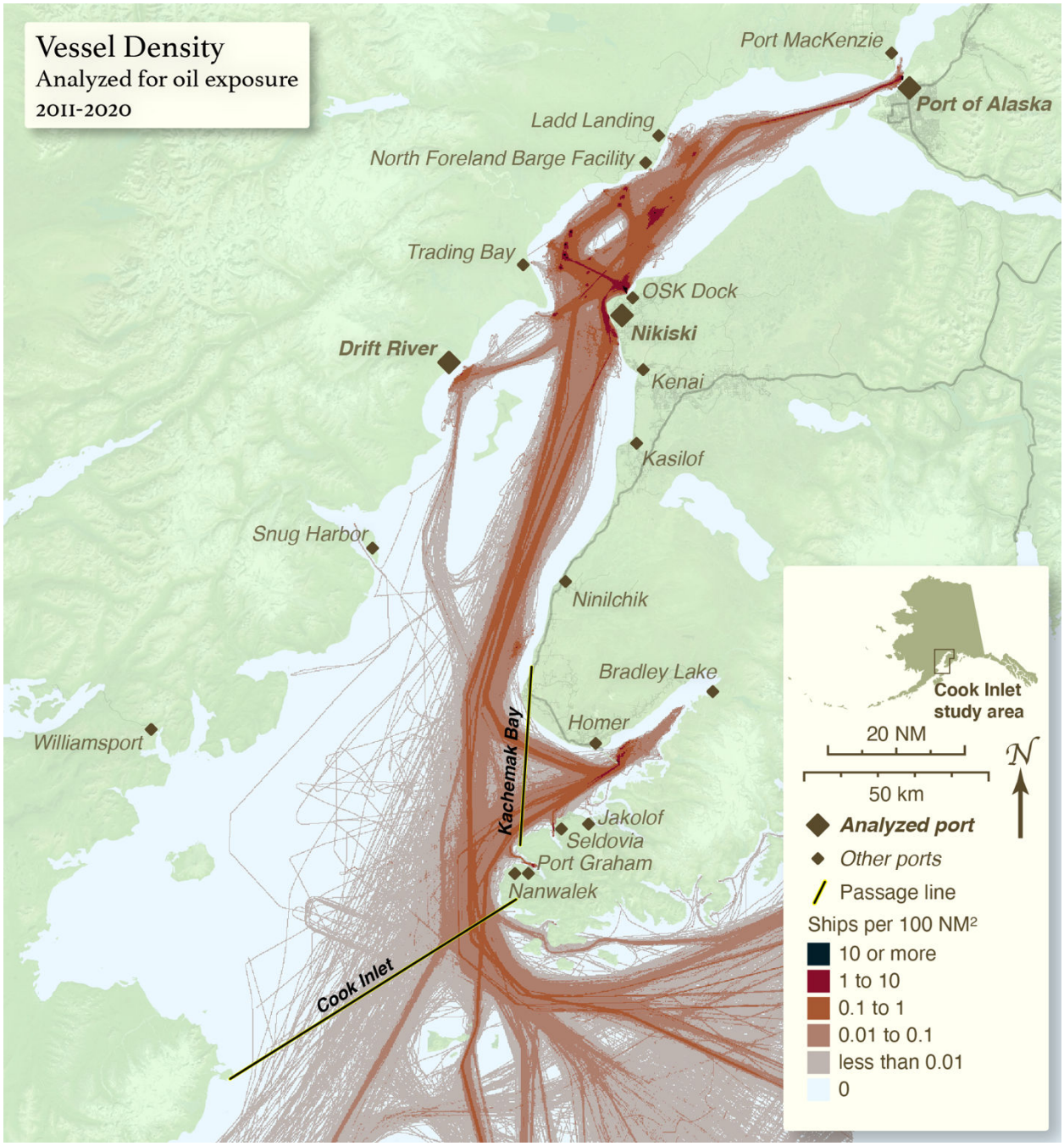

Figure 5.1 Vessels for which the oil exposure analysis was conducted, including Largo Cargo, Oil Field AMHS Ferry, Cruise Ship, and Articulated Tugs

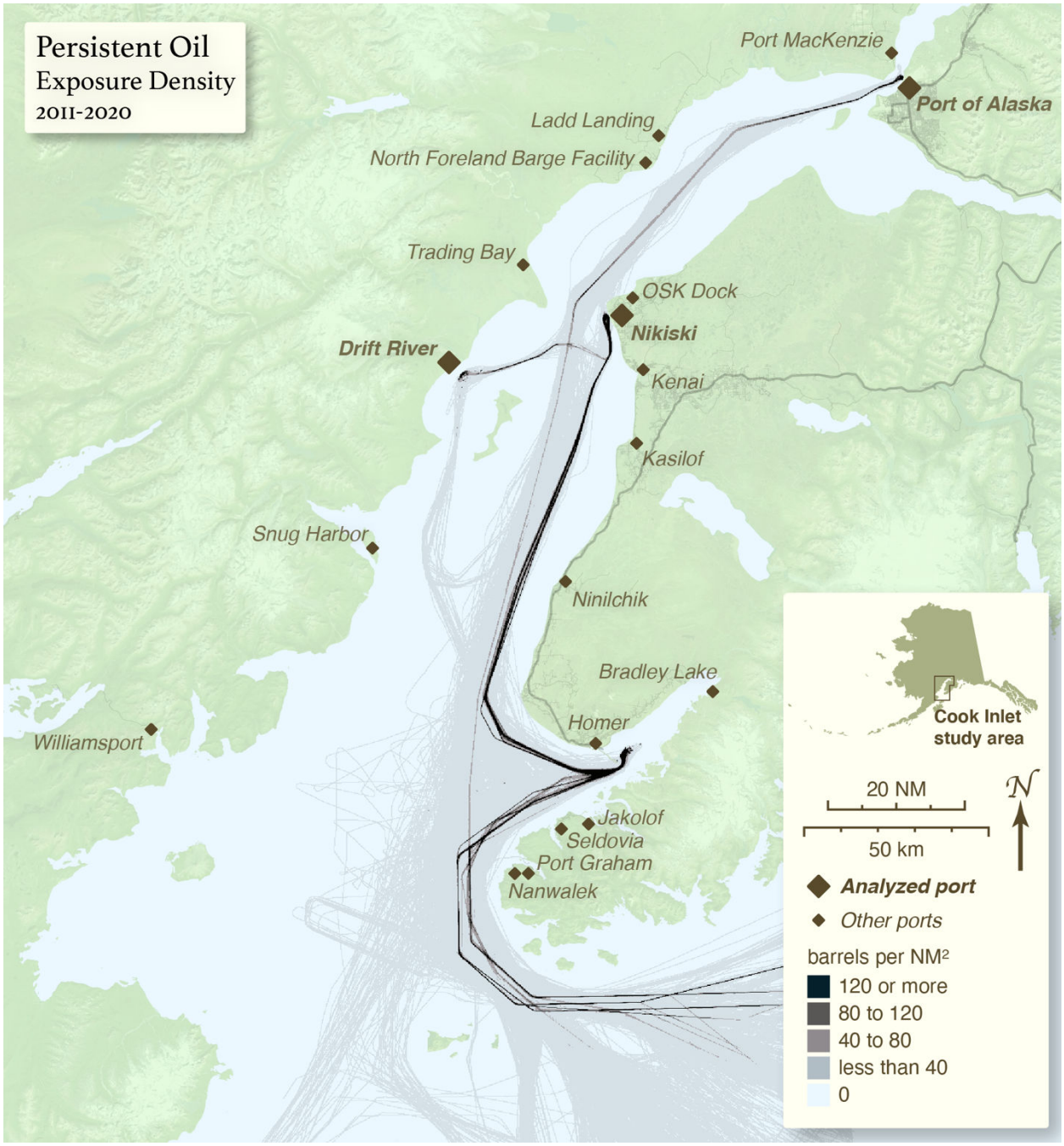

Figure 5.2 Persistent oil exposure density (average barrels per square nautical mile) over 10 years highlight the movement of crude oil to Nikiski, but also include heavy fuel oil used by Large Cargo ships, Cruise Ships, and Oil Cargo tankers

Figure 5.3 Non-persistent oil exposure density (average barrels per square nautical mile) shows the movement of vessels with non-persistent oil more widely dispersed around the Inlet, and the movement of non-persistent oil cargo to the Port of Alaska

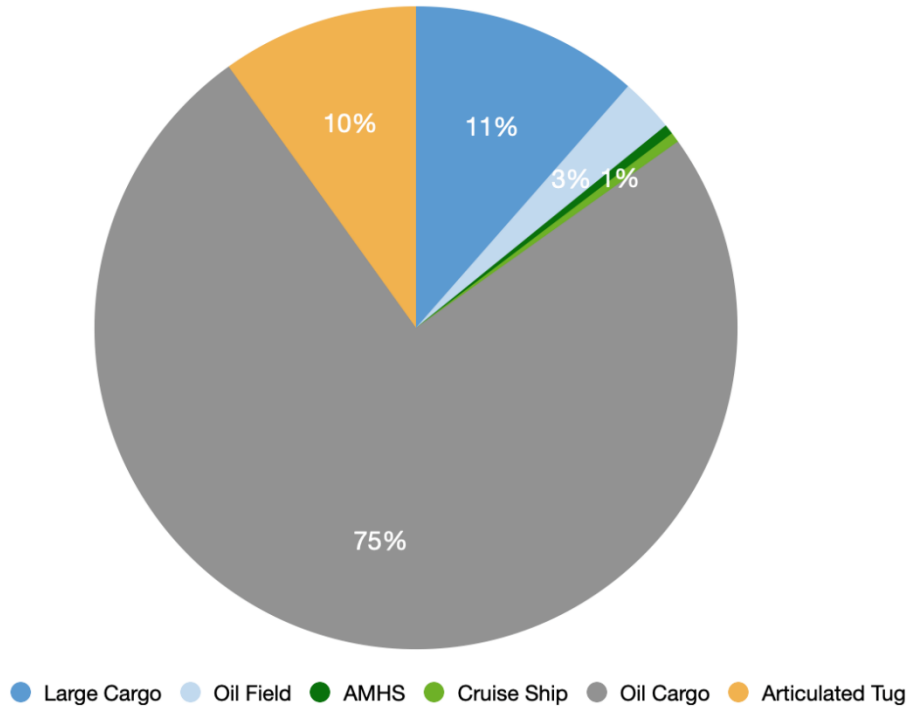

Figure 5.4 Percentage of oil exposure (volume x time) for subtypes in the petroleum analysis

6 Changes Over Time

This section describes the Cook Inlet traffic based on the 2011-2020 AIS dataset. With a 10-year dataset, it is possible to look for changes in activity over time and understand potential trends. Variations in data across the years must still be taken into consideration, particularly since this study combines shore-based AIS with satellite AIS for different years, in addition to there being potential temporal gaps when a station is down.

Operating days

Figure 6.1 shows operating days by vessel type for each year. As described above, tugs, fishing vessels, and oil field vessels (included in Cargo) spend the most time in the Inlet, though that varies across the years for each. There does not appear to be any trend for vessel activity overall or within vessel types or subtypes. Instead, there are changes by year.

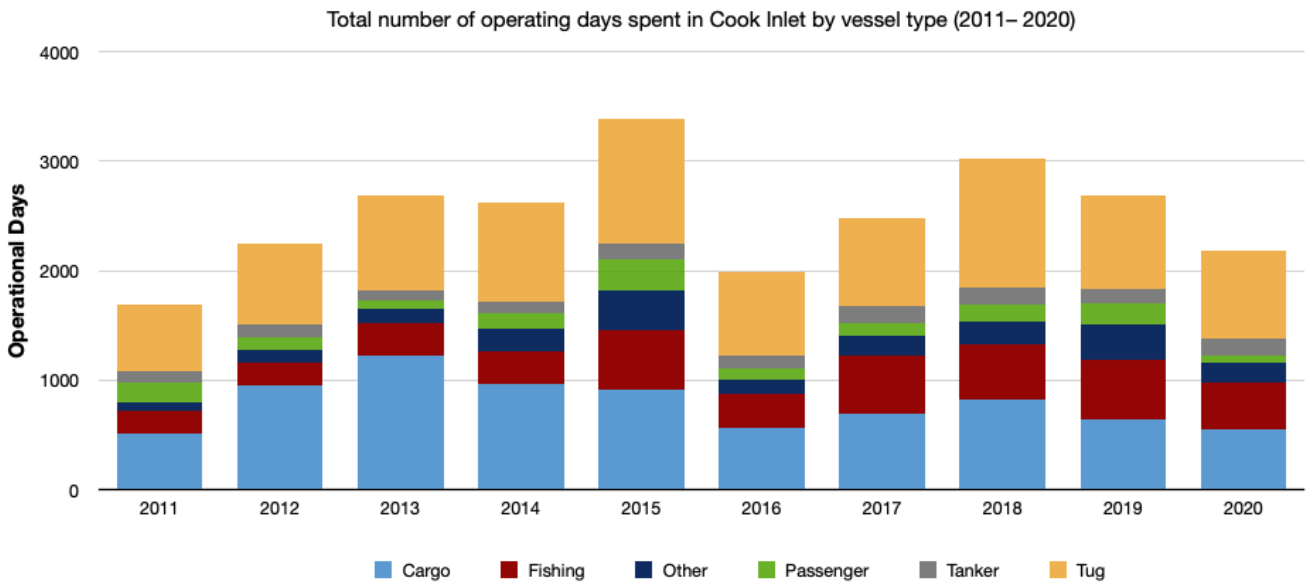

Figure 6.1 Operating days by vessel type each year 2011–2020. The change in fishing vessel operating time in the dataset may well be associated with adoption of AIS technology and/or the source of the data (where satellite coverage captures more of the southeastern portion of the Inlet than was available in shore-station data in the early years of the study).

Table 6.1 shows the number of operating days by vessel subtype. Many of the larger variations in operating time in the graph above can be explained by a spike (or decline) in one of the associated subtypes.

Within the Cargo type, Large Cargo operating days stay between 185 to 228 operating days, while both Oil Field and Small Cargo fluctuate much more. Oil Field vessels were particularly active in 2012-2015 (more than 450 operating days each year). This timing corresponds with Hilcorp Alaska's acquisition of offshore platforms from Chevron (near East Forelands, Granite Point, and Trading Bay) and Marathon (Spark and Spurr), as well as the Drift River Terminal and Christy Lee loading platform as of 2012-2013, two more platforms in 2015, and, finally, the Tyonek Platform in 2016 (Dunham, 2021).

The year 2015 also had relatively high operating hours compared to other years for both conventional tugs and small passenger vessels. Increases for both subtypes may be associated with oil field activity, as examination of maps by vessel type for that year shows the conventional tug activity is elevated around the platforms. The Small Passenger category also included the *Aubree Tara*, a small passenger vessel that may have been being used for wildlife monitoring, as it has been in the Colville Delta area on the North Slope (Lomac-MacNair et al., 2014).

The year 2019 stands out for research/survey vessel activity, with the spike attributed to seismic surveying in the Outer Continental Shelf area that Hilcorp Alaska conducted under a permit from the U.S. Bureau of Ocean Energy Management (BOEM, 2019).

Reduced activity by Small Cargo vessels is assumed to reflect economic activity in the region.

Table 6.1 Total number of operating days spent in Cook Inlet by vessel type and subtype for each year, 2011–2020

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**509**	**957**	**1230**	**967**	**915**	**557**	**689**	**823**	**641**	**548**
Large Cargo	196	205	202	206	210	185	211	213	228	215
Oil Field	258	486	846	607	533	303	372	383	255	230
Small Cargo	55	266	182	153	173	69	106	227	158	103
Fishing	**212**	**200**	**286**	**302**	**541**	**318**	**530**	**501**	**544**	**428**
Fishing	212	200	286	302	541	318	530	501	544	428
Other	**80**	**117**	**132**	**200**	**364**	**122**	**183**	**210**	**328**	**187**
Government	8	9	21	40	24	19	26	34	38	37
Other	60	70	83	102	205	81	101	98	120	111
Survey/Research	12	39	29	58	136	22	56	77	171	39
Passenger	**170**	**119**	**79**	**138**	**291**	**116**	**119**	**162**	**190**	**66**
AMHS	99	85	52	90	79	81	81	91	82	34
Cruise Ship	16	11	1	6	12	12	16	22	20	0
Small Passenger	54	23	26	41	200	23	22	48	88	32
Tanker	**116**	**110**	**98**	**103**	**141**	**115**	**156**	**154**	**132**	**149**
LNG	10	7	0	5	7	0	0	0	0	0
Oil Cargo	106	103	98	98	134	115	156	154	132	149
Tug	**604**	**739**	**859**	**908**	**1139**	**757**	**808**	**1172**	**851**	**806**
Articulated	113	116	122	134	148	144	184	176	118	135
Conventional	491	623	737	774	991	614	625	996	734	671

Cook Inlet passage line

Entrances to Cook Inlet at the passage line used in this analysis provide another way to look at activity over time (Table 6.2). See Kachemak Bay passage line entries in Appendix F.

Table 6.2 Cook Inlet passage line entrances (transits from south-to-north) by type and subtype

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Cargo	**215**	**262**	**250**	**245**	**243**	**241**	**233**	**228**	**248**	**222**	**2387**
Large Cargo	202	207	214	209	212	198	209	205	226	206	2088
Oil Field	3	6	10	10	10	8	4	7	4	4	66
Small Cargo	10	49	26	26	21	35	20	16	18	12	233
Fishing	**133**	**122**	**159**	**145**	**133**	**180**	**212**	**200**	**217**	**214**	**1715**
Fishing	133	122	159	145	133	180	212	200	217	214	1715
Other	**17**	**19**	**28**	**35**	**27**	**32**	**47**	**44**	**56**	**46**	**351**
Government	7	9	11	16	12	13	13	19	17	22	139
Other	8	7	10	12	6	8	22	16	22	13	124
Survey/ Research	2	3	7	7	9	11	12	9	17	11	88
Passenger	**177**	**143**	**87**	**155**	**141**	**146**	**124**	**163**	**139**	**49**	**1324**
AMHS	162	134	86	149	129	136	110	129	121	46	1202
Cruise Ship	12	9	1	5	9	10	12	14	16	0	88
Small Passenger	3	0	0	1	3	0	2	20	2	3	34
Tanker	**83**	**72**	**75**	**75**	**98**	**112**	**101**	**97**	**88**	**94**	**895**
LNG	10	4	0	5	6	0	0	0	0	0	25
Oil Cargo	73	68	75	70	92	112	101	97	88	94	870
Tug	**155**	**168**	**177**	**168**	**172**	**151**	**141**	**152**	**166**	**143**	**1593**
Articulated	45	44	43	55	66	65	77	68	49	50	562
Conventional	110	124	134	113	106	86	64	84	117	93	1031

Petroleum movements

Petroleum movement at the Port of Alaska, Nikiski, and Drift River and the Cook Inlet passage line was also estimated to provide a general characterization of oil movement and changes over time. The tables below total the oil cargo volume and 70% of fuel volume associated with one-way transits (entrances to a port or the Inlet). Note again that oil cargo *loaded* in Nikiski would be non-persistent (refined product) so this is likely an over-estimate of persistent cargo overall.

Table 6.3 Estimated Oil cargo (barrels) at Port of Alaska, Nikiski, and Drift River

Port / Oil Cargo	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
Port of Alaska (Non-Persistent)	4,199,983	2,699,989	1,199,995	4,499,982	8,231,286	7,480,616	7,932,375	9,651,122	7,499,969	11,451,341	6,484,666
Drift River (Persistent)	8,999,963	5,099,979	4,499,982	4,799,980	5,999,976	4,799,980	5,099,979	4,499,982	299,999	-	4,409,982
Nikiski (Persistent)	24,899,899	23,099,906	30,899,874	23,999,902	26,099,894	22,799,907	26,399,892	24,899,899	20,999,914	16,799,932	24,089,902

Table 6.4 Cook Inlet Passage Line Estimated Oil Cargo (barrels)

Cargo Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average
Non-persistent	3,599,985	2,699,989	1,199,995	3,599,985	7,931,287	6,641,693	7,932,375	8,451,127	7,799,968	11,575,647	6,143,205
Persistent	18,299,925	17,699,928	21,299,913	17,399,929	19,499,921	24,599,900	21,599,912	20,399,917	18,599,924	16,499,933	19,589,920

Tanker activity over time

There is no obvious overall trend in tanker operating days or Cook Inlet entrances between 2011–2020 (see Figure 6.2). Tanker movements in the Inlet have changed, however. As shown in Table 6.2 above, the last LNG tankers called in the Inlet in 2015, though there were only a small number (fewer than 10) entries each year. The biggest change in Oil Cargo tanker routes was caused by the closure of the Drift River Terminal as of 2018. Oil produced on the west side of the Inlet is now moved via subsea pipeline (Dunham, 2021), so cross-Inlet transits by tankers are eliminated.

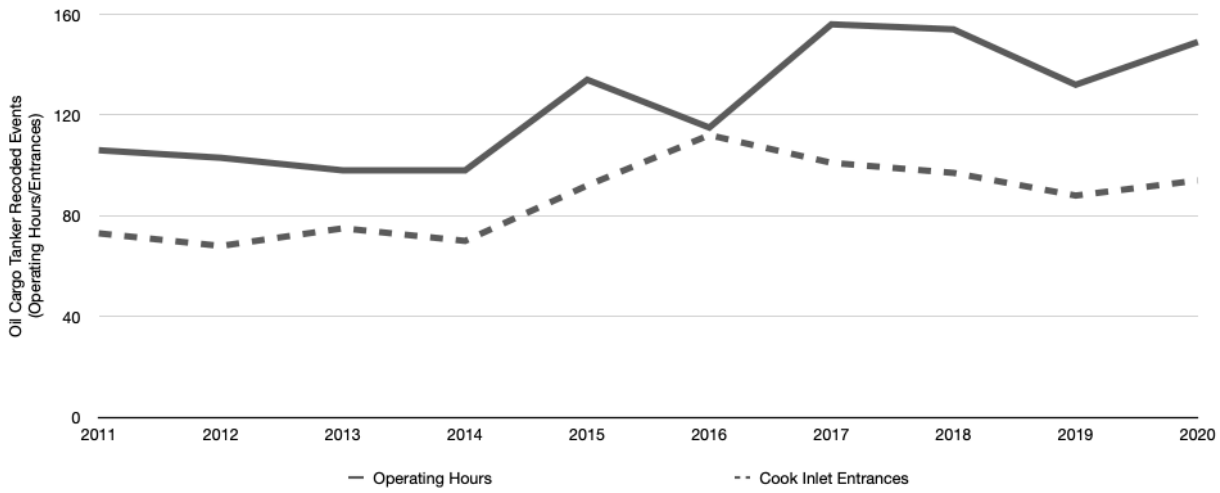

Figure 6.2 Comparison of Oil Cargo tanker operating days and Cook Inlet entrances (based on the Cook Inlet passage line)

Tankers calling at Nikiski have decreased since a high of 103 port entrances in 2013, with some variability until 2017 after which the numbers have decreased consistently. At the same time, tankers calling at the Port of Alaska have fluctuated. Tanker activity at the Port of Alaska was high enough in 2020 that Oil Cargo tanker operating days in the Inlet *increased* that year even without cross-Inlet tanker transits and a decrease in tanker calls at Nikiski. Comparing 2019 and 2020, in fact, shows that there were almost the same number of tanker entrances to the Inlet in each year (Table 6.2) but for the first time in the 10-year dataset there were more foreign-flagged tankers than U.S.-flagged Oil Cargo tankers entering Cook Inlet overall (see Table 6.3). Tanker activity at Nikiski is shown in Table 6.4. The increase in activity at the Port of Alaska is assumed to be related to the closure of the North Pole refinery combined with an increase in cargo jets at the airport. Together, these changes mean that more jet fuel is being shipped through Cook Inlet to the Port of Alaska than was previously.

Appendix G lists the tankers identified as calling at Nikiski between 2011–2020 including their flag state.

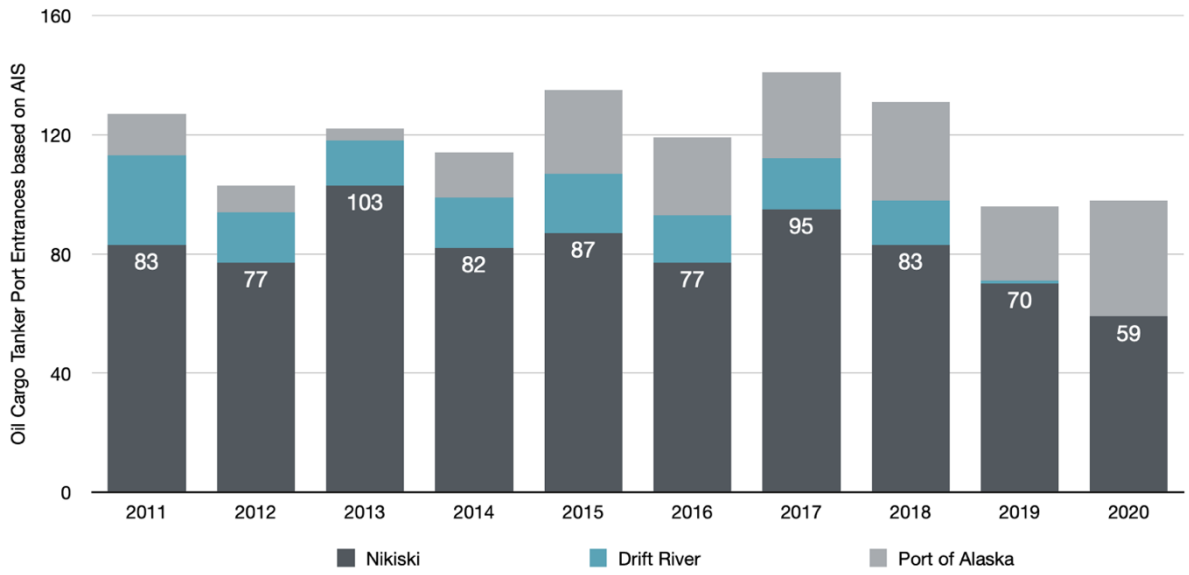

Figure 6.3 Oil Cargo tanker port entrances at Nikiski, Drift River, and Port of Alaska

Table 6.5 Oil Cargo tanker entrances by flag state category (U.S. or non-U.S.) at Cook Inlet passage line

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Non-U.S.	15	19	11	21	29	25	29	32	29	46
U.S.	58	49	64	49	63	80	71	65	59	48

Table 6.6 Oil Cargo tanker port entrances by flag state category (U.S. or non-U.S.) at Nikiski

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Non-U.S.	4	11	8	16	9	6	13	9	3	12
U.S.	79	66	95	66	78	71	82	74	67	47

Table 6.7 Oil Cargo tanker port entrances by flag state category (U.S. or non-U.S.) at Port of Alaska

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Non-U.S.	11	8	4	9	21	19	21	29	26	37
U.S.	3	1	0	6	7	7	7	5	0	2

7 Incidents and Spills

Two public sources were reviewed for information about marine vessel incidents or oil spills in Cook Inlet during the study period as shown in Table 7.1.

Table 7.1 Data sources for spills and incidents

Source	Data Included in this Report	Years Included
Alaska Department of Environmental Conservation (ADEC) spills database (ADEC, 2021)	Reported spills of oil or other hazardous substances larger (spills to water must be reported, regardless of size) AS 46.03.755, AS 46.03.740	2011–2020
U.S. Coast Guard's Marine Information for Safety and Law Enforcement (MISLE) database (USCG, 2015)	Pollution, loss of cargo, property damage, injury/loss of life, and other incidents reported to and investigated by the U.S. Coast Guard	2011–2015

ADEC's spills database had 8 spills larger than 1 barrel, shown in Table 7.2. Most of these spills were associated with vessels that were not included in the dataset, such as a barge or fishing vessels. Dozens of smaller releases were reported, with the majority associated with bilges or hydraulic systems, ranging in size estimates from one ounce to 22 gallons.

Table 7.2 ADEC spills larger than 1 barrel (bbl) from vessels in Cook Inlet, 2011–2020

Vessel(s)	Date	Substance	Volume (gal.)	Cause	Location	In data?
DBL 106	2/29/12	Diesel	600	Valve Failure	Entrance to Cook Inlet	no (barge)
M/V Daniel D Takak	6/14/12	Diesel	100	Hull failure (grounding)	Homer	no
F/V Leading Lady and *F/V Kupreanof*	12/25/12	Diesel	50	Rollover/Capsize	Jakolof Bay	no
M/V Shearwater	7/3/14	Diesel	150	Rollover/Capsize	Kachemak Bay	yes
F/V Lightning	8/4/14	Diesel	225	Fire	Near Kasilof River	no
"Tutka Bay vessel"	7/3/15	Gasoline	70	Sinking	Tutka Bay	n/a

Midnight Sun	2/21/16	Other	400	Other	Port of Alaska	yes
Bob Franco	10/7/19	Ethylene Glycol (Antifreeze)	68	Leak	Nikiski Bay	yes

U.S. Coast Guard data is from 2011–2015, though since records are only made available after any investigation is closed, it is possible that not all incidents from 2015 are included. In that database, which captures a wider range of events than the ADEC data, there were 90 incidents recorded in those 4 years. Table 7.3 summarizes the event "type" (assumed to be roughly equivalent to ADEC's primary cause).

Table 7.3 Vessel incidents in Cook Inlet based on MISLE data, 2011–2015

Event Type	Number of Events
Allision	4
Capsize	1
Collision	1
Damage to Cargo	2
Damage to the Environment (Spills)	51
Fire	1
Flooding	1
Grounding	4
Loss of Electrical Power	2
Material Failure (Vessels)	7
Sinking	3
Vessel Maneuverability	13
Total	90

Looking further at events involving pollution of the environment, Table 7.4 shows the total discharges by substance type, based on the MISLE data. (There are more than shown in Table 7.3 because some releases involve more than one substance type). Data include the ADEC data shown above.

Table 7.4 Spills by substance type in Cook Inlet based on MISLE data, 2011–2015

Spill Substance	Discharge Amount (Gallons)	Number of spills
Brake fluid base mixtures	0.1	1
Bilge slop	9.3	8
Gasoline	0.5	1
Hydraulic fluid or oil	44.3	14
Oil - Crude	0.5	1
Oil - Diesel	684.2	18
Oil - Lubricating	11.1	5
Oil - Motor	0.2	2
Oil, waste/lubricants - possible contaminant	5.3	3
Other oil	0.5	1
Total	**756**	**54**

MISLE data also include reports of property or cargo damage, shown in Table 7.5.

Table 7.5 Incidents involving vessels in Cook Inlet that resulted in property or cargo damage, based on MISLE data, 2011–2015

Vessel	Date	Event
Ivory Queen	2/18/11	Sinking
Horizon Anchorage	6/8/11	Allision
Optimist	6/26/11	Fire
Danica Jaye	7/16/11	Collision
Arctic Bear	7/25/11	Vessel Maneuverability
Perseverance	8/14/11	Allision
Kachemak Voyager	8/16/11	Grounding
Tustumena	9/27/11	Damage to Cargo
Midnight Sun	12/12/11	Damage to Cargo
Vigilant	1/13/12	Vessel Maneuverability
North Star	2/4/12	Material Failure (Vessels)
Daniel D. Takak	6/14/12	Grounding
Katmai	7/20/12	Sinking
Cosmic Wind	9/29/12	Vessel Maneuverability
Nauti Lady	5/2/13	Allision
Nakolo	7/2/13	Vessel Maneuverability
Kennicott	4/13/14	Vessel Maneuverability

8 Conclusion

Changes in traffic over the 10-year study period have not indicated significant trends overall. Annual time spent in the Inlet fluctuates for all vessel types, but the variations are more prominent for some vessel subtypes than others. Oil field and small cargo vessels fluctuate more than large cargo vessels, for example. Time spent by tankers has increased overall. Crude oil tanker movements across the Inlet were eliminated after the Drift River Terminal closed in 2018 and tankers calling at the refinery in Nikiski have decreased from a 2013 high. At the same time, however, more product tankers have been calling at the Port of Alaska in 2019 and 2020, which is assumed to be a result of the closure of the North Pole refinery and an increased demand for jet fuel at Alaska's main airport. As of 2020, the number of foreign-flagged tankers entering the Inlet was almost equal to the number of U.S.-flagged tankers for the first time.

As noted in previous studies, many vessels operating in Cook Inlet do so frequently. Of the vessels considered in this analysis, 46% of operating time over the ten years was attributed to resident vessels (which almost never leave the Inlet, if at all) and frequent visitors.

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Appendix A – AIS Analysis Method

In this study, vessel movement throughout the Cook Inlet is interpreted by looking at entrances into Cook Inlet and Kachemak Bay, ports of call at significant ports, vessel densities over time, and petroleum capacities. Each vessel is categorized by type and other identifying attributes.

Overview of Methodology

Data used to determine vessel attributes, characterize vessel traffic, and describe how petroleum movements came from several sources, including: Automatic Identification System (AIS) data, a download from Marine Traffic, public databases, and data previously gathered by Nuka Research. Data are combined to develop maps and statistics characterizing vessel traffic in Cook Inlet for 2011–2020.

Nuka Research applied the following overall approach to compiling and processing vessel traffic data:

1. Obtain and process AIS data and process
2. Develop Vessel Track Database from processed AIS data
3. Develop Vessel Attribute Database for vessels identified in AIS data
4. Develop report outputs based on combining vessel track and attribute data

Obtain and Process AIS Data

AIS is an automated tracking system used to identify and locate vessels using electronic signals sent from the vessel and received by other ships and receiver stations (on land or satellites). When AIS signals are compiled, data can be used to understand vessel movements in a particular area. Although the AIS requirements have been in force since 2004, receivers have become more widespread since that time, increasing the viability of using AIS data to research or characterize vessel traffic.

There are two types of AIS transmitters: AIS-A and AIS-B. AIS-A transmitters report their position every 2-10 seconds dependent on the vessel's speed and/or course changes (every three minutes or less when at anchor or moored) and the vessel's static and voyage-related information every 6 minutes. Vessels with AIS-A are also capable of text messaging safety-related information and AIS Application Specific Messages. AIS-B transmitters report every three minutes or less when at anchor or moored, but their position is reported less often and at a lower power compared to the AIS-A signals. Voyage-related information is not transmitted from AIS-A. They can receive safety-related text and application specific messages but cannot transmit them (USCG, 2019).

In general, federal regulations (33 CFR 164.46) and International Maritime Organization's (IMO) International Convention for the Safety of Life at Sea (SOLAS) require AIS-A transmitters on the following self-propelled vessels: vessels in commercial service that are 65-feet long or more, towing vessels of 26-feet long or more (also in commercial service), any vessel allowed to carry 150 passengers, or any vessel moving certain dangerous, flammable, or liquid oil cargo in bulk (33 CFR 164.01).

AIS-B can be used in lieu of AIS-A for fishing industry vessels, small passenger vessels, and some dredging vessels. The USCG has the authority to require AIS systems on other vessels for mitigation of safety concerns (USCG, 2019). Other vessels use AIS-B voluntarily. At this time, AIS transmitters are not required on barges, only on most of the tugs towing them. As a result, it is not readily apparent from AIS data what barge is paired with any given tug at any given time.

When an AIS signal is transmitted from the vessel to a receiver, a data point is logged identifying the position of the vessel. Each data point includes the vessel's identity, time, date, location, and limited vessel particulars. AIS transmissions may occur as frequently as every second. The number of data points collected is greater than necessary to accurately characterize where a vessel traveled. In some cases, AIS position data is sparse because of lack of satellite coverage and in other cases too many positions result in an unnecessarily large amount of data.

For this project, Nuka Research obtained data compiled by shore receivers from the Marine Exchange of Alaska for 2011–2016 and data compiled by satellite receivers from exactEarth for 2017–2020.

Develop Vessel Track Database

Nuka Research developed a Vessel Track Database from sequential AIS points for each individual vessel within the study area using a custom program. The program removed records that did not have valid vessel identification, time, latitude, or longitude position data. All data transmitted by vessels with mandatory (Class A) AIS transmitters were kept. Data from Class B transmitters were kept only if it could be verified that the vessel was of a type within the scope of the study. Vessel tracks outside of the study area were excluded. Vessels with 500 or fewer total points in the 10 years of AIS data were also excluded from this analysis.

Data points were grouped by vessel and ordered chronologically. One or more tracks were then built for each vessel using the following method:

1. The first and last points are always kept.
2. Beginning with the first point chronologically, each succeeding point is compared to the previous point. The successive point is excluded if it is less than three minutes since, or closer than 0.2 NM to, the previous point.
3. Tracks are then constructed from the remaining set of points for each vessel. A new track is started if a successive point is greater than 2 hours or 20 NM from the previous point, the designation information provided by the vessel in the AIS signal changes, or the vessel does not move for more than four hours.
4. Tracks are stored in a geo-spatial database and spreadsheet. Each track is identified with a specific vessel based on that vessel's MMSI number and associated with vessel-specific attributes based on the same number.

This process reduces the number of data points associated with each vessel track, while retaining the information necessary to determine where the vessel traveled.

Develop Vessel Attribute Database

The fields provided in the raw AIS data included:

- Base station time stamp
- Call sign
- Vessel name
- Type of ship and cargo

- Maritime Mobile Service Identity (MMSI)
- Draft
- Latitude and Longitude (lat/long)
- Destination
- Navigational status (engine, anchored, sail, fishing)
- Cargo
- Course and speed over ground
- Country or flag state
- IMO number
- Heading

While some of this information is automatically generated (e.g., location, MMSI), other data require manual input by the operator (e.g., destination, cargo, vessel type). Data that require manual input may be entered inconsistently, intermittently, or not at all. In these cases, data are filled in from Nuka Research's Vessel Attribute Database or through additional research.

Nuka Research Vessel Attribute Database

Over more than a decade of work in Alaska, Nuka Research has compiled a database of information on thousands of vessels operating around the state.

As vessels are encountered during different projects, this information is updated to be as accurate as possible. Based on information in this database, Nuka Research estimates oil capacities for vessels where specific data for an individual vessel is not available from other sources. Where this information cannot be obtained for a specific vessel, estimates are made using a regression analysis based on other vessels of similar type and size in the dataset where oil capacity is known.

Additional Research

After the vessel characteristics are populated based on the AIS data and Nuka's Attributes Database, a list of vessels is sent to Marine Traffic (API Look-ups) to purchase vessel data available there. Remaining gaps are filled to the extent possible through additional research through websites such as Tugboat Information (https://www.tugboatinformation.com), Vessel Finder (https://www.vesselfinder.com), Federal Communications Commission (https://wireless2.fcc.gov/UlsApp/UlsSearch/searchShip.jsp), and the U.S. Coast Guard's Vessel Response Plan database (https://homeport.uscg.mil/missions/vrp-status-board).

Develop Report Outputs Based on Combined Vessel Tracks and Vessel Attributes

While information about individual vessel tracks is included in the dataset, for the purpose of presenting the information in the report this is typically shown by vessel type and subtype. Different analytical tools are used to display and quantify vessel traffic movements. Four are used in this study:

- Count of operating days (total number of 24-hour increments spent by vessels of a particular type/subtype; these are not necessarily consecutive days. Signals transmitted from a vessel that

is not moving for an extend period are excluded according to the rules described above, so time spent docked or at anchor is not captured in the total "operating days."

- Passage line crossings (number of times a vessel crosses a "passage line" used as an analytical tripwire to capture vessel movements in both directions)
- Port calls (number of times a vessel enters a polygon drawn around a port area); while polygons were drawn with the intent of only capturing vessels that call at the port, it is possible that vessels passing by the area will also be captured, or that, for example, a docking vessel may enter and leave the polygon as part of what would in reality be considered as a single port call

Port and passage line events are only presented in the report in one direction. These are entrances into the port polygon, entrances to Cook Inlet (transits south-to-north) and entrances into Kachemak Bay (transits west-to-east). For the Port of Alaska, Drift River, and Nikiski, port data were analyzed for possible missed entrances. If a vessel exited a port two consecutive times with a large enough time-stamp difference it was assumed a port call was missed. The assumed missing port call was then added.

Frequently Trading Ships

The total number of operational days for each vessel was determined to identify vessels frequently trading in Cook Inlet. Vessels that spent more than 200 operational days in Cook Inlet over the 10-year period are considered to be "frequent fliers" which include both residents and frequent visitors.

See Appendix C for a list of resident vessels and frequent visitors.

Appendix B – Petroleum Analysis

Vessels included in the petroleum analysis were: Large Cargo, Oil Field, Cruise Ships, Oil Cargo, and Articulated Tugs.

Oil movements were identified as persistent or non-persistent, and the fuel capacities of vessels (the volume they can carry for powering the vessel) was separated from oil cargo capacities (the volume carried for the purpose of being delivered to another facility, which may be crude oil or refined product).

The exact volumes going into each port or crossing a passage line can only be estimated based on the fuel and cargo capacities of vessels. For the purpose of this analysis, fuel capacities are considered to be 70% of the total capacity (the fuel tank will fluctuate over the ship's voyage) and 100% capacity for the cargo for the density maps and overall exposure calculation, or 100% of cargo for port calls (which are one-way entrances to a polygon around the port).

Vessels in Nuka Research's Vessel Attributes Database with known persistent and non-persistent fuel values were identified for each vessel subtype. Oil Field vessels are assumed to carry non-persistent fuel only. Large Cargo, Cruise Ships, and Tankers generally carry both persistent and non-persistent fuels. Where researched information was inconclusive about a ship's fuel tank capacity and the type of fuel used, data about other ships of a similar type and size was assumed to apply to that vessel as well using a regression analysis based on length, DWT, or GT (depending on the vessel type).

AIS data was used to develop passage events, those events marking each vessel voyage when entering Cook Inlet or Kachemak Bay and calling at significant ports. This data was used to identify which tankers made port calls at Port of Alaska, Drift River, or Nikiski. If a tanker went exclusively to the Port of Alaska it was counted as carrying non-persistent cargo. If a tanker went to Drift River or Nikiski exclusively it was counted as carrying persistent cargo.

When a tanker went to the Port of Alaska but also went to Nikiski or Drift River a closer examination of that vessel was conducted. For a tanker in question, the geospatial representation developed from the AIS data was used to identify which tracks went to Anchorage and which ones went to Nikiski or Drift River. A recording system was developed to track which port was called upon during each trip that vessels took into the Inlet. Because the type of cargo is dependent on destination the cargo types are overridden based on this record to consistently track non-persistent vs. persistent cargo.

Known tanker cargo capacities are used, unless the tanker has a cargo capacity larger than 300,000 bbl. In those cases, or if the capacity is unknown, a capacity of 300,000 bbl is used for this study. While the maximum allowed capacity is 499,999 bbl based on state regulatory requirements, 300,000 bbl was used here based on input provided by CIRCAC. Cargo capacity is designated persistent or non-persistent cargo based on its destination as described above.

Appendix C – Resident Vessels and Frequent Visitors

Resident Vessels

Vessel Name	Type	Subtype	Total Operating Days
Bob Franco	Tug	Conventional	1495.3
Resolution	Cargo	Oil Field	804.4
Titan	Cargo	Oil Field	577.2
Perseverance	Cargo	Oil Field	562.6
Champion	Cargo	Oil Field	523.4
Sovereign	Cargo	Oil Field	504.5
Gladys M	Tug	Conventional	430.1
Discovery	Cargo	Oil Field	390.2
Glacier Wind	Tug	Conventional	349.6
Red Dog	Cargo	Small Cargo	346.5
Stellar Wind	Tug	Conventional	344.2
Endeavor	Cargo	Oil Field	305.7
Sand Island	Other	Other	290.3
Kachemak Voyager	Passenger	Small Passenger	270.2
Millennium Star	Tug	Conventional	226.1

Frequent Visitors (> 200 operating days over 10 years)

Vessel Name	Type	Subtype	Total Operating Days
Pacific Wolf	Tug	Articulated	623.2
Tustumena	Passenger	AMHS	600.2
Midnight Sun	Cargo	Large Cargo	460.7
North Star	Cargo	Large Cargo	452.6
Java Sea	Tug	Articulated	337.5
Helenka B	Cargo	Small Cargo	313.2
Matson Anchorage	Cargo	Large Cargo	313.2
Matson Kodiak	Cargo	Large Cargo	309.1
Matson Tacoma	Cargo	Large Cargo	298.3
Overseas Boston	Tanker	Oil Cargo	226.3
Redoubt	Tug	Conventional	203.1

Appendix D – Port Entries by Year at Port of Alaska, Drift River, and Nikiski

Port of Alaska

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total Entrances
Cargo	**213**	**231**	**218**	**211**	**226**	**194**	**213**	**225**	**222**	**210**	**2163**
Large Cargo	198	205	209	206	210	190	208	204	217	201	2048
Oil Field	0	1	1	0	6	1	0	0	0	4	13
Small Cargo	15	25	8	5	10	3	5	21	5	5	102
Fishing	**0**	**1**	**1**	**8**	**5**	**2**	**0**	**10**	**1**	**0**	**28**
Fishing	0	1	1	8	5	2	0	10	1	0	28
Other	**2**	**5**	**31**	**75**	**12**	**3**	**1**	**11**	**25**	**15**	**180**
Government	1	0	1	50	1	1	0	1	0	2	57
Other	1	2	29	23	11	2	1	5	22	13	109
Survey / Research	0	3	1	2	0	0	0	5	3	0	14
Passenger	**11**	**8**	**1**	**4**	**9**	**9**	**10**	**11**	**10**	**1**	**74**
Cruise Ship	11	8	1	4	8	9	10	11	10	0	72
Small Passenger	0	0	0	0	1	0	0	0	0	1	2
Tanker	**14**	**9**	**4**	**15**	**28**	**26**	**29**	**33**	**25**	**39**	**222**
Oil Cargo	14	9	4	15	28	26	29	33	25	39	222
Tug	**1054**	**1305**	**1193**	**1119**	**1313**	**1040**	**1023**	**1207**	**1883**	**1314**	**12451**
Articulated	25	42	31	39	39	41	46	46	27	21	357
Conventional	1029	1263	1162	1080	1274	999	977	1161	1856	1293	12094

Drift River

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**29**	**50**	**23**	**19**	**23**	**25**	**41**	**19**	**99**	**1**
Oil Field	29	32	17	13	18	22	30	19	6	0
Small Cargo	0	18	6	6	5	3	11	0	93	1
Fishing	**3**	**7**	**6**	**6**	**7**	**0**	**0**	**0**	**0**	**0**
Fishing	3	7	6	6	7	0	0	0	0	0
Other	**0**	**13**	**0**	**2**	**2**	**0**	**0**	**1**	**1**	**0**
Government	0	0	0	0	2	0	0	1	0	0
Other	0	13	0	2	0	0	0	0	1	0
Tanker	**30**	**17**	**15**	**17**	**20**	**16**	**17**	**15**	**1**	**0**
Oil Cargo	30	17	15	17	20	16	17	15	1	0
Tug	**32**	**79**	**26**	**33**	**49**	**57**	**55**	**53**	**2**	**0**
Articulated	1	15	2	0	3	7	1	1	0	0
Conventional	31	64	24	33	46	50	54	52	2	0

Nikiski (tankers only)

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tanker	**92**	**82**	**103**	**87**	**93**	**77**	**95**	**83**	**70**	**59**
LNG	9	5	0	5	6	0	0	0	0	0
Oil Cargo	83	77	103	82	87	77	95	83	70	59

Appendix E – Port Entries by Year at 12 Ports

Homer

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**77**	**141**	**371**	**308**	**151**	**115**	**152**	**221**	**237**	**193**
Large Cargo	2		7		3		4		1	4
Oil Field	23	47	202	149	77	24	49	54	66	47
Small Cargo	52	94	162	159	71	91	99	167	170	142
Fishing	**157**	**158**	**231**	**220**	**207**	**274**	**312**	**319**	**350**	**337**
Fishing	157	158	231	220	207	274	312	319	350	337
Other	**255**	**256**	**352**	**460**	**442**	**419**	**329**	**441**	**470**	**643**
Government	11	13	25	31	27	30	17	24	29	43
Other	241	233	301	387	388	357	266	375	383	570
Survey / Research	3	7	26	42	27	32	46	42	58	30
Unknown		3								
Passenger	**366**	**271**	**258**	**355**	**263**	**310**	**380**	**491**	**409**	**298**
AMHS*	278	226	132	263	237	240	198	240	194	80
Cruise Ship	7	5	1	1	7	2	11	10	5	
Small Passenger	81	40	125	91	19	68	171	241	210	218
Tanker					**3**		**26**	**3**	**4**	**1**
Oil Cargo					3		26	3	4	1
Tug	**195**	**218**	**273**	**243**	**248**	**178**	**210**	**238**	**237**	**153**
Articulated	63	50	71	41	38	62	66	66	54	59
Conventional	133	168	202	202	210	116	144	172	183	94

*Ferry port calls are over-estimated here; due to the proximity of the ferry dock to the edge of the circle drawn around the port, it sometimes crosses the line multiple times while docking.

Jakolof Bay

Vessel Type	2017	2018	2019	2020
Cargo			**7**	**19**
Small Cargo			7	19
Fishing				
Fishing				
Other	**1**		**1**	**1**
Other	1		1	1
Passenger				
Small Passenger				
Tug		**2**	**18**	**3**
Articulated				
Conventional		2	18	3

Kasilof

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Fishing	**3**	**1**	**8**	**4**	**12**	**20**	**14**	**2**	**10**	**11**
Fishing	3	1	8	4	12	20	14	2	10	11
Other								**6**	**9**	
Other								6	9	

Kenai

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo					**7**				**2**	
Oil Field									2	
Small Cargo					7					
Fishing	**22**	**28**	**50**	**23**	**74**	**99**	**30**	**31**	**35**	**17**
Fishing	22	28	50	23	74	99	30	31	35	17
Other		**5**	**1**	**12**	**100**	**19**	**1**	**7**		**3**
Government								1		
Other		3		5	92	19		5		3
Survey/Research		2	1	7	8		1	1		

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Passenger					**52**					
Small Passenger					52					
Tug					**12**			**1**		
Conventional					12			1		

Ladd Landing

Vessel Type	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**8**	**7**	**2**	**3**	**2**	**6**	**12**	**25**	**19**
Small Cargo	8	7	2	3	2	6	12	25	19
Tug		**4**	**6**	**5**		**4**	**1**		**5**
Conventional		4	6	5		4	1		5

Nanwalek

Vessel Type	2013	2017	2018	2019	2020
Cargo	**5**	**11**	**4**	**4**	**6**
Small Cargo	5	11	4	4	6
Fishing		**2**	**1**		

Vessel Type	2013	2017	2018	2019	2020
Fishing		2	1		
Other		**1**			
Other		1			
Survey/Research					

OSK Dock

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**272**	**618**	**1107**	**855**	**654**	**557**	**1038**	**1024**	**771**	**524**
Oil Field	218	386	923	726	571	508	990	846	620	454
Small Cargo	54	232	184	129	83	49	48	178	151	70
Fishing	**11**	**17**	**12**	**10**	**29**		**1**	**4**	**4**	
Fishing	11	17	12	10	29		1	4	4	
Other	**59**	**433**	**39**	**40**	**120**	**72**	**64**	**43**	**129**	**81**
Other	57	34	33	32	95	72	55	31	122	81
Survey/ Research	2	399	6	8	25		9	12	7	
Passenger				**61**	**624**					
Small Passenger				61	624					

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tanker							**1**			
Oil Cargo							1			
Tug	**28**	**57**	**126**	**120**	**34**	**24**	**25**	**53**	**11**	**30**
Articulated	3	18	2	3	1	3	2	1		
Conventional	25	39	124	117	33	21	23	52	11	30

Port Graham

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**21**	**50**	**76**	**132**	**47**	**12**	**10**	**12**	**8**	**9**
Large Cargo	2		2							
Oil Field	17	38	48	68	34			1		
Small Cargo	2	12	26	64	13	12	10	11	8	9
Fishing	**17**	**12**	**4**	**6**	**10**	**10**	**2**	**11**	**4**	**7**
Fishing	17	12	4	6	10	10	2	11	4	7
Other		**4**	**6**	**8**	**6**	**10**	**9**	**8**	**5**	**6**
Government			2	3	2	2	1	2	1	2
Other		4	4	4	2	7	4	5	2	4

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Survey/ Research				1	2	1	4	1	2	
Passenger				**1**						**1**
AMHS										
Small Passenger				1						1
Tug	**7**	**5**	**13**	**16**	**4**	**3**	**5**	**6**	**2**	**2**
Articulated	2	2	3	2		2	3	4	1	2
Conventional	5	3	10	14	4	1	2	2	1	

Port MacKenzie

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**1**
Large Cargo	0	0	0	0	0	0	1	0	0	0
Oil Field	0	0	0	1	0	0	0	0	0	1
Small Cargo	7	5	13	16	4	3	5	6	2	2
Other	**2**	**2**	**3**	**2**	**0**	**2**	**3**	**4**	**1**	**2**
Other	5	3	10	14	4	1	2	2	1	0

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tug	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Conventional	0	0	0	0	0	0	0	0	0	0

Seldovia

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**3**	**16**	**14**	**21**	**17**	**23**	**18**	**26**	**12**	**20**
Oil Field	2	1	1	2	1	0	0	0	1	5
Small Cargo	1	15	13	19	16	23	18	26	11	15
Fishing	**39**	**44**	**41**	**37**	**49**	**33**	**10**	**35**	**58**	**55**
Fishing	39	44	41	37	49	33	10	35	58	55
Other	**1**	**6**	**13**	**17**	**15**	**35**	**20**	**25**	**20**	**32**
Government	0	0	1	2	0	1	3	1	0	6
Other	1	6	12	14	15	33	14	22	17	24
Survey / Research	0	0	0	1	0	1	3	2	3	2
Passenger	**307**	**223**	**225**	**235**	**261**	**289**	**227**	**310**	**296**	**261**
AMHS	130	110	71	118	105	119	93	108	97	45

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cruise Ship	0	0	0	0	0	0	0	1	0	0
Small Passenger	177	113	154	117	156	170	134	201	199	216
Tug	**6**	**11**	**24**	**20**	**15**	**2**	**8**	**11**	**4**	**5**
Articulated	3	4	2	1	2	2	3	1	2	5
Conventional	3	7	22	19	13	0	5	10	2	0

Appendix F – Kachemak Bay Passage Line Entries

The table below shows transits from the west-to-east for each vessel type and subtype and each year.

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cargo	**98**	**209**	**330**	**303**	**166**	**106**	**112**	**140**	**151**	**132**
Large Cargo	36	41	30	33	42	22	25	26	31	23
Oil Field	25	43	166	130	69	17	22	35	34	37
Small Cargo	37	125	134	140	55	67	65	79	86	72
Fishing	**187**	**167**	**223**	**219**	**235**	**315**	**290**	**265**	**311**	**268**
Fishing	187	167	223	219	235	315	290	265	311	268
Other	**58**	**55**	**101**	**161**	**139**	**141**	**123**	**107**	**137**	**181**
Government	9	9	12	35	29	17	11	24	13	27
Other	45	42	77	106	91	103	82	53	84	135
Survey / Research	4	4	12	20	19	21	30	30	40	19
Passenger	**187**	**153**	**90**	**163**	**151**	**156**	**132**	**190**	**167**	**56**
AMHS	162	134	88	149	129	138	108	129	119	46
Cruise Ship	22	17	1	9	17	18	22	25	23	0
Small Passenger	3	2	1	5	5	0	2	36	25	10

Vessel Type	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tanker	**168**	**153**	**152**	**149**	**201**	**168**	**209**	**200**	**182**	**195**
LNG	18	8	0	9	12	0	0	0	0	0
Oil Cargo	150	145	152	140	189	168	209	200	182	195
Tug	**191**	**164**	**191**	**173**	**200**	**136**	**142**	**167**	**154**	**151**
Articulated	59	52	45	36	61	59	67	62	41	47
Conventional	132	112	146	137	139	77	75	105	113	104

Appendix G – Tankers Calling at Nikiski (2011–2020)

Name	Flag	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Excel	Belgium				5	6						11
Tulip	Cyprus						1					1
Zaliv Amerika	Cyprus		3	2	4	5	3					17
Zaliv Amurskiy	Cyprus			1								1
Pacific Merchant	Marshall Islands	1										1
Paramount Hydra	Isle Of Man				1							1
Minerva Kythnos	Greece					1						1
Neverland	Italy			1								1
Explorer	Bahamas			1								1
Polar Spirit	Bahamas	9										9
Nectar	Bahamas				1							1
Overseas Boston	United States (USA)	19	32	29	23	40	18	10	12	14	13	210
Marmara Sea	Liberia				5	1						6
Maersk Messina	Singapore		1									1
Mermaid	Liberia	1										1
Undine	Marshall Islands	1										1
Marine Express	Panama				1							1
Shanghai Dawn	Panama			1								1
Kristi Sea	Greece		1									1
Overseas Martinez	United States (USA)	33	18	35	21	19	32	7	9	2	3	179
Florida	United States (USA)								17	20	6	43
Evergreen State	United States (USA)						4	46				50
Liberty Bay	United States (USA)							1				1
Overseas Nikiski	United States (USA)	27	16	31	22	19	17	5				137
American Endurance	United States (USA)							13	17	13	15	58

Name	Flag	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
American Freedom	United States (USA)								19	18	10	47
Ratna Shradha	India	1										1
Atlantic Grace	Hong Kong			1								1
Bls Liwa	Hong Kong				1							1
Atlantic Rose	Hong Kong										1	1
Nord Magic	Denmark								1			1
Challenge Prelude	Hong Kong							1				1
Atlantic Frontier	Hong Kong								1			1
Bunga Kelana Dua	Malaysia				1							1
Gulf Energy	Marshall Islands		5									5
Dht Sophie	Marshall Islands				1							1
Jurkalne	Marshall Islands							3				3
Seaways Visayas	Marshall Islands		1									1
Aris II	Marshall Islands		1									1
Ardmore Endurance	Marshall Islands										1	1
Garnet Express	Marshall Islands										3	3
Sti Tribeca	Marshall Islands										1	1
Ardmore Seavantage	Marshall Islands										1	1
Marlin Ametrine	Marshall Islands										1	1
Navig8 Turquoise	Marshall Islands						1					1
Sea Holly	Marshall Islands							1				1
Aristaios	Marshall Islands							2	2	1		5
Aristoklis	Marshall Islands							4	4			8
Alcyone T	Marshall Islands										1	1
Orpheus	Marshall Islands										1	1
Challenge Prime	Singapore										1	1

Name	Flag	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Fsl Shanghai	Singapore					1						1
Carina	Singapore		1									1
Ross Sea	Singapore						1					1
New Alliance	Liberia		1									1
Daytona	Marshall Islands								1			1
Aqualegend	Liberia		1									1
Sakura Princess	Liberia		1									1
Banda Sea	Liberia			1	1			1				3
Marmara Sea	Liberia					1				1		2
Zaliv Amerika	Liberia							1				1
Clearocean Miracle	Liberia									1		1
Atlantica Breeze	Liberia										1	1
Totals		92	82	103	87	93	77	95	83	70	59	841