OCS Study
BOEM 2018-023

Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2017 Annual Report

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Pod of belugas
Northeastern Chukchi Sea
July 2017
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Final Report

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DISCLAIMER

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ABSTRACT

This report describes field activities of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project conducted during summer and fall (1 July–27 October) 2017, and data and analyses used to summarize field activities. Surveys were based in Utqiaġvik (formerly Barrow), Alaska, and Deadhorse, Alaska, and targeted the northeastern and southcentral Chukchi and western Beaufort seas, between 67°N and 72°N latitude, 140°W and 169°W longitude.

Sea ice cover in the study area in 2017 was light compared with historical (pre-2007) sea ice cover. When surveys commenced in early July, sea ice was present in the study area from approximately 143°W to 157°W, and remained there through mid-July. By late July, sea ice persisted only in the central Alaskan Beaufort Sea, but was otherwise absent from the study area. The study area remained ice free from early August through late October, when new ice began forming in shallow nearshore areas in the study area.

A total of 97 survey flights were conducted. The Utqiaġvik-based aerial survey team conducted surveys from 3 July through 25 October 2017, and the Deadhorse-based aerial survey team conducted surveys from 19 July through 10 October 2017. Total combined flight time was 505.7 hours, including 257.9 hours of transect effort. Nearly 128,000 km were flown, with 57,435 km of effort on transect. Surveys were conducted in the western Beaufort Sea in summer (early-July through August) for the sixth consecutive year and in survey block 23 (southcentral Chukchi Sea) for the fourth consecutive year.

There were 4,588 sightings of 98,823 marine mammals observed during all (transect, search, and circling) survey modes, including:

- 764 sightings of 1,303 bowhead whales (*Balaena mysticetus*),
- 440 sightings of 821 gray whales (*Eschrichtius robustus*),
- 10 sightings of 15 humpback whales (*Megaptera novaeangliae*),
- 19 sightings of 30 fin whales (*Balaenoptera physalus*),
- 3 sightings of 3 minke whales (*Balaenoptera acutorostrata*),
- 428 sightings of 2,153 belugas (*Delphinapterus leucas*),
- 1 sighting of 2 killer whales (*Orcinus orca*),
- 2 sightings of 2 harbor porpoises (*Phocoena phocoena*),
- 27 sightings of 28 unidentified cetaceans,
- 749 sightings of 85,330 Pacific walruses (*Odobenus rosmarus divergens)*,
- 93 sightings of 97 bearded seals (*Erignathus barbatus*),
- 1,907 sightings of 8,519 pinnipeds that could not be identified to species, and
- 145 sightings of 520 polar bears (*Ursus maritimus*).

Bowhead whales were seen in all months of the study period. Distribution in the western Beaufort Sea (140°W-157°W) in July and August was on the inner (≤ 50 m depth) and outer (51-200 m depth) continental shelf and over the slope (201-2,000 m depth), then became progressively closer to shore in fall. The bowhead whale sighting rate (whales per transect km) by depth zone between 140°W and 154°W in the western Beaufort Sea was highest in the 51-200 m zone in July, 21-50 m depth zone in August, and the ≤ 20 m depth zone in September and October. Sighting rate by depth zone in the Barrow Canyon area (154°W-157°W) was highest in

the ≤ 20 m depth zone in July, August, and September, and in the 51-200 m depth zone in October. Compared to previous years with light sea ice cover (i.e., 1989, 1990, 1993-2016), bowhead whale sightings (not normalized by survey effort) in the western Beaufort Sea in fall (September-October) were significantly nearer to shore and in shallower water in both the West (148°W-156°W) and East (140°W-148°W) regions. Bowhead whale sightings in the East region in summer (July-August) 2017 were significantly farther from shore and in deeper water than bowhead whale sightings in fall 2017, which is the exact opposite of observations in 2016 but similar to observations in 2012-2015. In the northeastern Chukchi Sea (69°N-72°N, 157°W-169°W), few bowhead whales were seen in July and August. The highest sighting rate in September and October was in the 51-200 m North depth zone. The survey block with the highest overall bowhead whale sighting rate was block 5 in July and August, and block 1 in September and October. The eastern Chukchi Sea survey block with the highest overall sighting rate was block 13.

Spatial models of bowhead whale relative abundance in the western Beaufort Sea were created to examine high-use areas (HUAs) during fall (September-October) 2017 and each month from July through October for the 18-year period from 2000 to 2017. These models accounted for heterogeneous survey effort and group sizes across the survey area. The area of highest predicted relative abundance in fall 2017 was located just outside the barrier islands between approximately 146.5°W and 149°W (north of Deadhorse). High predicted relative abundance was also evident from the barrier islands to approximately 10-30 km offshore between Oliktok Point and the western edge of Camden Bay (~146°W), and in northern Camden Bay from approximately 144°W to 146°W. The estimated median distance-from-shore statistics for the East region (140°W-148°W) in 2000-2017 decreased from 53.4 km in July to 23.7 km in August, 16.1 km in September, and 20.3 km in October. In the West region (148°W-156°W), the 2000-2017 model predicted that the median distance from shore varied from 27.1 km in July to 29.2 km in August, 21.8 km in September, and 28.2 km in October.

Bowhead whales were observed feeding from July through October in the western Beaufort Sea; feeding was not observed in the eastern Chukchi Sea. Oceanographic conditions in summer and fall 2017 were conducive to producing “krill traps” east of Point Barrow, Alaska, that foster bowhead whale feeding in that area, but relatively few bowhead whales were observed there, particularly in fall. Feeding in the “krill trap” area was recorded in late July, representing the earliest date known for krill trap formation. In fall, feeding and milling were most often observed in the central Alaskan Beaufort Sea between Flaxman Island and Harrison Bay (approximately 146°W-151.5°W).

One hundred sixty-one bowhead whale calves were seen in 2017, including 57 calves seen during summer and 104 calves seen in fall. The summer and fall bowhead whale calf ratios (number of calves/number of total whales) were higher than calf ratios in any previous year that ASAMM surveyed from 1982 to 2016. Calf sighting rates (calves per transect km) were also highest in 2017 compared to all previous years.

Gray whales were seen in all months of the study period in the eastern Chukchi Sea. Gray whales were primarily observed within ~40 km of the Alaskan coastline between Point Barrow and Point Lay. Gray whales were also seen from early July through late October from 30 to 120 km offshore, including just south of Hanna Shoal, similar to observations in 2015-2016. Large gray whale aggregations were also seen in the southcentral Chukchi Sea west and southwest of Point Hope. Relatively few gray whales were seen in the area between Point Franklin and Point Barrow, where they have been reliably seen in past years. One gray whale was seen within the confines of Peard Bay. The highest sighting rate by depth zone was in the 51-200 m South depth zone. When the 51-200 m South depth zone was excluded from analysis, the highest sighting rate was in the 51-200 m North depth zone in both summer and fall. Highest sighting rates by month occurred in July, with decreasing monthly sighting rates from August through October. Most gray whales observed were feeding (75%). Eighty-nine gray whale calves were seen, and results from an ongoing study investigating gray whale calf resighting rate using photographic images of flukes indicated that most calf sightings were of unique individuals.

Belugas were sighted primarily in the western Beaufort Sea, with very few sightings in the northeastern Chukchi Sea. Highest sighting rates occurred in July, decreased in August and September, before increasing in October. The highest sighting rates by depth zone were in the >200 m depth zones between 140°W and 154°W, and in the 201-2000 m depth zone near Barrow Canyon. Several moderately large (>10 whales) groups of belugas were sighted in shallow nearshore waters in the western Beaufort Sea where they have been rarely observed in past years.

Additional noteworthy results from the 2017 ASAMM field effort included:

- Humpback whales (10 sightings of 15 whales) were sighted in the southcentral Chukchi Sea from July through October.
- Fin whales (19 sightings of 30 whales), including three calves, were sighted in the southcentral Chukchi Sea from July through October.
- Minke whales (3 sightings of 3 whales) were sighted in the southcentral Chukchi Sea in September and October.
- Killer whales (1 sightings of 2 whales) were sighted in the northeastern Chukchi Sea in September.
- Harbor porpoises (2 sightings of 2 porpoises) were sighted in the central Alaskan Beaufort Sea. One of the porpoises, sighted in July, was within the barrier islands in Stefansson Sound, very near the Liberty Prospect site.
- Walruses were observed in the water and hauled out on ice (particularly near Hanna Shoal) and on land. A walrus haulout was documented on 4 August on a barrier island near Point Lay, which is the earliest date for haulout formation on land in the northeastern Chukchi Sea since that phenomenon began in 2007. The onshore haulout, which varied in size from 500 to 34,500 walruses, persisted until mid-October.
- The sighting rate for unidentified pinnipeds and small unidentified pinnipeds (combined) in the ASAMM study area was more than double any sighting rate since 2009. More than 50 small unidentified pinnipeds were observed inshore of the barrier islands in the central Alaskan Beaufort Sea, and several groups were observed hauled out on barrier islands near Point Franklin and Icy Cape, in the northeastern Chukchi Sea, from mid-July to late August.
- More polar bears were observed in 2017 than in any previous year that ASAMM surveys were conducted. Polar bears were seen from Kaktovik, Alaska, to Point Barrow; no polar bears were seen in the Chukchi Sea or along the Chukchi Sea coastline. All but six polar bears were seen on shore or barrier islands, or swimming within 3 km of land. Four bears

were seen on sea ice, and two bears were observed swimming between 10 and 80 km from shore. The majority of bears were east of Oliktok Point (~150°W). Most polar bears observed nearshore were on or near Cross Island (including the highest single day count ever recorded) or near Kaktovik, but polar bears were also spotted at numerous locations between Point Barrow and Smith Bay, west of Cross Island, and along the coastline of Camden Bay.

Table of Contents

List of Figures

List of Tables

Abbreviations and Acronyms

ADF&G	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center
ARBO	Arctic Region Biological Opinion
ARCWEST	Arctic Whale Ecology Study
ASAMM	Aerial Surveys of Arctic Marine Mammals
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BWASP	Bowhead Whale Aerial Survey Project
C	Celsius
COMIDA	Chukchi Offshore Monitoring in Drilling Area
CPUE	calves per unit effort (index of relative abundance or occurrence)
ECS	Eastern Chukchi Sea
e.g.	for example
ESA	Endangered Species Act
FOV	Field of View
GPS	Global Positioning System
hr	hour
HUA	high-use area
i.e.	that is
km	kilometer
m	meter
max	maximum
min	minimum
MML	Marine Mammal Laboratory (formerly NMML)
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
n_i	number of individuals
n_s	number of sightings
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
No.	number
NSB	North Slope Borough
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
P	probability
PBPUE	polar bear per unit effort
PMEL	Pacific Marine Environmental Laboratory
PPUE	pinnipeds per unit effort (index of relative abundance or occurrence)
s	second
SD	standard deviation

°T	degrees True
Tr	transect
TrC	circling from transect
TrSi	transect sightings
Tr+TrC	transect plus circling from transect
UAF	University of Alaska Fairbanks
UAS	unmanned aerial system
UAV	unmanned aerial vehicle
USC	U.S. Code
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USDOD	U.S. Department of Defense
USDOI	U.S. Department of the Interior
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WPUE	whales or walruses per unit effort (index of relative abundance or occurrence)
Z	standard normal variable

INTRODUCTION

In 1953, the Outer Continental Shelf Lands Act (OCSLA) (43 USC 1331-1356) charged the U.S. Secretary of the Interior with the responsibility of administering minerals exploration within and development of the Outer Continental Shelf (OCS). The Act empowered the Secretary to formulate regulations so that its provisions could be met. The OCSLA Amendments of 1978 (43 USC 1802) established a policy for the management of oil and natural gas in the OCS and for protection of the marine and coastal environments. The amended OCSLA states that the Secretary of the Interior shall conduct studies in areas or regions of sales to ascertain the "environmental impacts on the marine and coastal environments of the Outer Continental Shelf and the coastal areas which may be affected by oil and gas development" (43 USC 1346).

Subsequent to the passage of the OCSLA, the Secretary of the Interior designated the Bureau of Land Management (BLM), U.S. Department of the Interior (USDOI), as the administrative agency responsible for leasing submerged federal lands, and the Conservation Division of the U.S. Geological Survey (USGS) for classifying and evaluating submerged federal lands and regulating exploration and production. In 1982, the U.S. Minerals Management Service (MMS) assumed these responsibilities. The MMS was renamed the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) in 2010. In 2011, the Bureau of Ocean Energy Management (BOEM) assumed responsibilities for administering environmentally and economically responsible development of offshore resources.

A summary of the history of the management recommendations and decisions relevant to natural resource exploration, development, and production in the Alaska OCS and associated effects on marine mammals follows. In June 1978, the BLM entered into a consultation with the National Marine Fisheries Service (NMFS) under Section 7 of the Endangered Species Act (ESA) of 1973 (16 USC 1531-1543). The purpose of the consultation was to determine the likely effects of the proposed Beaufort Sea Oil and Gas Lease Sale on endangered bowhead (*Balaena mysticetus*) and gray (*Eschrichtius robustus*) whales. NMFS determined that insufficient information existed to conclude whether the proposed Beaufort Sea sale was likely to jeopardize the continued existence of bowhead and gray whales. In August 1978, NMFS recommended studies to the BLM that would fill the information needs identified during the Section 7 consultation. Subsequent Biological Opinions for leasing and exploration in the Beaufort Sea (Sales 71, 87, and 97) and the 1988 Arctic Region Biological Opinion (ARBO) used for Beaufort and Chukchi sea sales (Sales 124, 126, 144, and 170) recommended continuing studies of whale distribution and OCS-industry effects on bowhead whales (USDOC, NOAA, NMFS 1982, 1983, 1987, and 1988), in addition to monitoring bowhead whale presence during periods when geophysical exploration and drilling were occurring. The 2006 and 2008 ARBO issued by NMFS for leasing and exploration in the U.S. Beaufort and Chukchi seas, Alaska, and authorizations of small takes under the Marine Mammal Protection Act (MMPA) of 1972 (16 USC 1361-1407) (USDOC, NOAA, NMFS 2008) recommended the following conservation actions:

> MMS and NMFS should continue research to update environmental inventories of marine mammals for the Chukchi Sea. Marine mammal surveys should be continued. MMS should consider a comprehensive program for this purpose which employs aerial and ship based efforts as well as the use of passive acoustics. In particular, the current BWASP

[Bowhead Whale Aerial Survey Project] program should be expanded to include Block 13. MMS should particularly engage in research to describe bowhead whale behavior, movements and distribution, and important habitats in these waters. Efforts should be made to obtain photographs of humpback whales within the area for photo-identification.

MMS should continue research to describe the impact of exploration activities on the migrational movements and feeding behavior of the bowhead whale. Specific plans should be developed and implemented to monitor the cumulative effects of exploration, development, and production on the bowhead whale. These research designs and results should be reviewed annually to ensure that the information collected is addressing the concerns of NMFS and the affected Native communities.

The current ARBO, issued by NMFS in 2013 for oil and gas leasing and exploration activities in the U.S. Beaufort and Chukchi seas over a 14-year period beginning March 2013 and ending in March 2027 (USDOC, NOAA, NMFS 2013), includes the following conservation recommendations:

Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

9. Under the BOEM Environmental Studies Program, consider studies to monitor abundance, trends, habitat use, and productivity of listed species to assist with understanding potential effects of human activities on populations;

10. Under the BOEM Environmental Studies Program, consider specifically [studies] designed to assess abundance, population trends, habitat use, and productivity of ringed and bearded seal populations that may be affected by oil and gas development.

A biological opinion issued in 2015 included conservation recommendations specific to Lease Sale 193 in the northeastern Chukchi Sea (USDOC, NOAA, NMFS 2015), which are in addition to those recommended in the 2013 ARBO.

Following several years when drilling was limited to 1 November through 31 March (USDOI, MMS 1979), variable two-month seasonal drilling restrictions on fall exploratory activity in the joint Federal/State Beaufort Sea sale area were implemented in May 1982. The Diapir Field Sale 87 Notice of Sale (1984) stated that “Bowhead whales will be monitored by the Government, the lessee, or both to determine their locations relative to operational sites as they migrate through or adjacent to the sale area” (USDOI, MMS 1984). Subsequent lease sales in the Beaufort Sea Planning Area (Sales 97, 124, 144, 170, 186, 195, and 202) and Lease Sale 193 in the Chukchi Sea Planning Area did not include a seasonal drilling restriction, but the Notice of Sale for each contained an Information to Lessees clause stating that the “MMS intends to continue its area wide endangered whale monitoring program in the Beaufort Sea during exploration activities” (USDOI, MMS 1988, 1991, 1996, 1998).

To provide information used in Environmental Impact Statements and Environmental Assessments under the National Environmental Policy Act (NEPA) of 1969 (42 USC 4321-4347), and to assure protection of marine mammals under the MMPA and the ESA, the BLM (and, later, MMS) funded numerous studies involving acquisition and analysis of marine mammal and other data, including an endangered whale monitoring plan that required aerial surveys. Information gathered during the monitoring program was used to help determine the extent, if any, of adverse effects on the species. From 1979 to 1987, the BLM and then the MMS (Alaska OCS Region) funded annual monitoring of endangered whales via aerial surveys in arctic waters under Interagency Agreements with the Naval Ocean Systems Center and through subcontracts to SEACO, Inc. (e.g., Ljungblad et al. 1987). The MMS used agency personnel to perform field work and reporting activities for surveys conducted in the western Beaufort Sea on an annual basis from 1987 to 2006 (referred to as the Bowhead Whale Aerial Survey Project, BWASP) (Treacy 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2002a, 2002b; Monnett and Treacy 2005; USDOI, MMS 2008). In 2007, an Interagency Agreement between the MMS (U.S. Department of the Interior) and NMFS (specifically, the Alaska Fisheries Science Center [AFSC], NOAA, U.S. Department of Commerce) was established to authorize the National Marine Mammal Laboratory (NMML, a division of AFSC) to conduct BWASP surveys and assume partial responsibility for the management of the project. In 2008, NMML adopted full responsibility for all aspects of the BWASP surveys and related tasks, with continued funding and co-management by the MMS (now BOEM) (Clarke et al. 2011a, 2011b, 2011c). In 2016, NMML was re-named the Marine Mammal Laboratory (MML).

The Chukchi Offshore Monitoring in Drilling Area (COMIDA) marine mammal aerial survey component was initiated in 2008, via an Interagency Agreement between the MMS and AFSC. These surveys were a continuation of aerial surveys that were conducted by MMS-sponsored contractors from 1982 to 1991 (Ljungblad et al. 1987; Moore and Clarke 1992) and used similar methodology. The goal of the COMIDA aerial surveys was to investigate the distribution and relative abundance of marine mammals in the Chukchi Sea Planning Area during the open water (ice-free) months of June-October, when various species undertake seasonal migrations through the area. The COMIDA study area encompassed the northeastern Chukchi Sea from the shore seaward, 68°N-72°N and 157°W-169°W, and overlaid Lease Sale 193 (offered in February 2008) (Clarke et al. 2011d).

In 2011, an Interagency Agreement between BOEM and AFSC was established to authorize NMML to continue the BWASP and COMIDA studies under the auspices of a single study, Aerial Surveys of Arctic Marine Mammals (ASAMM). The goal of the ASAMM study is to document the distribution and relative abundance of bowhead, gray, and fin whales and other marine mammals in areas of potential seismic surveying, drilling, construction, and production activities in the western Beaufort and eastern Chukchi seas (Clarke et al. 2012, 2013a, 2014, 2015a, 2017a, b). Data from the project shall be used to relate variation in marine mammal distribution or relative abundance to other variables, such as physical oceanographic conditions, indices of potential prey density, and anthropogenic activities, if information on these variables is available.

The objectives of the ASAMM study are to:

1) Monitor the spatial and temporal variability in the density, distribution, and behavior (including calving/pupping, feeding, hauling out) of marine mammals (cetaceans, ice seals, walruses, and polar bears) in the Alaskan Arctic, primarily through line-transect aerial survey data, with supplementary information from aerial photo-identification data;
2) Describe the annual migration of bowhead whales across the U.S. Arctic, including inter-annual variability or long-term trends in the spatial distribution and timing of the migration;
3) Provide near real-time data or derived products, such as graphical data summaries, on marine mammals and environmental conditions in the U.S. Arctic to BOEM and NMFS;
4) Provide information on marine mammal abundance and distribution to Alaska Natives for use in management of subsistence hunts and assessments of anthropogenic impacts on marine mammal resources; and
5) Provide an objective wide-area context for understanding marine mammal ecology in the U.S. Arctic to help inform management decisions and interpret results of other small-scale studies.

METHODS AND MATERIALS

Study Area

The ASAMM study area encompasses the western Beaufort and eastern Chukchi seas (Figure 1), and partially overlaps the Chukchi Sea Planning Area and Beaufort Sea Planning Area but does not completely encompass either. Survey blocks overlay active federal oil and gas lease areas in the Alaskan Arctic, all of which are in the Beaufort Sea (Figure 1). The present study area includes survey blocks 1 through 23 between 140°W and 169°W longitude, and between 67°N and 72°N latitude, and encompasses approximately 242,000 km^2. Survey blocks 1 through 12 (140°W-157°W) comprise the western Beaufort Sea (formerly BWASP) study area, while survey blocks 13 through 23 (157°W-169°W) comprise the eastern Chukchi Sea (formerly COMIDA) study area. Survey block 1a encompasses the area between the barrier islands and the mainland in block 1.

The northern Chukchi Sea is largely ice-covered from late fall through winter, although dramatic environmental changes have reduced modern sea ice extent from historical levels (Wood et al. 2015). In spring, open water leads begin to develop as ambient temperatures increase and warmer water flows northward from the Pacific Ocean through the Bering Sea and Bering Strait. The most nutrient rich waters flow in the Siberian Coastal Current, west of the ASAMM study area. Two less productive water masses, the Alaska Coastal Water and Bering Shelf/Anadyr Water, are found in the eastern Chukchi Sea (Figure 2). Current flow may be with or against the predominant wind direction.

In the Beaufort Sea, the Beaufort Gyre moves surface waters clockwise in the offshore regions. Underlying the gyre is the eastward-flowing Beaufort Undercurrent, which flows subsurface in areas where the sea floor is 51-2,000 m deep and undergoes frequent current reversals to the west (Aagaard 1984; Carmack and MacDonald 2002). In the nearshore shallow waters of the Beaufort inner shelf (≤ 50 m depth), currents tend to follow local wind patterns during periods of open water. In winter, currents are not substantial, even when winds are strong. Based on analysis of modeled sea level and ice motion, wind-driven currents in the Arctic between 1948 and 1996 were found to alternate between anticyclonic and cyclonic circulation, with each regime persisting from five to seven years (Johnson et al. 1999; Proshutinsky and Johnson 1997; Proshutinsky et al. 2015). However, the wind-driven regime has been largely anticyclonic since 1997, with a cyclonic regime observed only in 2009 (Richter-Menge et al. 2011). Intra-annual variation was especially noticeable in 2011-2012, when large-scale circulation was weakly anticyclonic from September 2011 to August 2012, followed by a strong cyclone event that occurred in the first week of August 2012 (Jeffries et al. 2012).

Shorefast ice forms during the fall and may eventually extend up to 50 km offshore by the end of winter (Norton and Weller 1984). The pack ice, which historically included multiyear ice averaging 4 m in thickness with pressure ridges up to 50 m thick (Norton and Weller 1984; Wood et al. 2015), becomes contiguous with new and shorefast ice in late fall. From late November to mid-May, the Beaufort Sea normally remains almost completely covered by ice. In

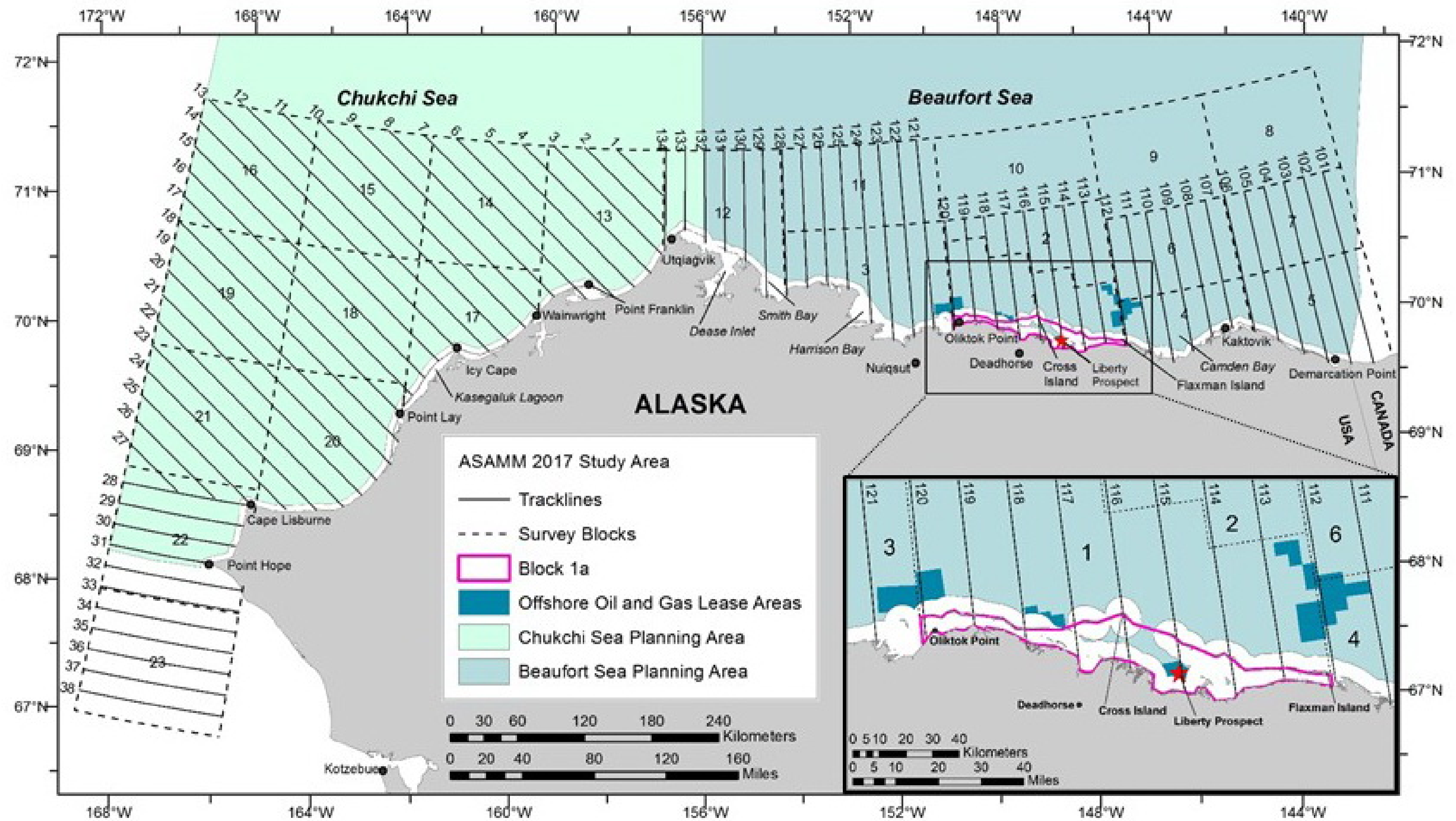

Figure 1. ASAMM study area showing survey blocks, 2017 ASAMM tracklines (numbered), Chukchi Sea Planning Area, Beaufort Sea Planning Area, Liberty Prospect, and active lease areas. The inset provides a zoomed view of survey block 1a, active lease areas, and the Liberty Prospect.

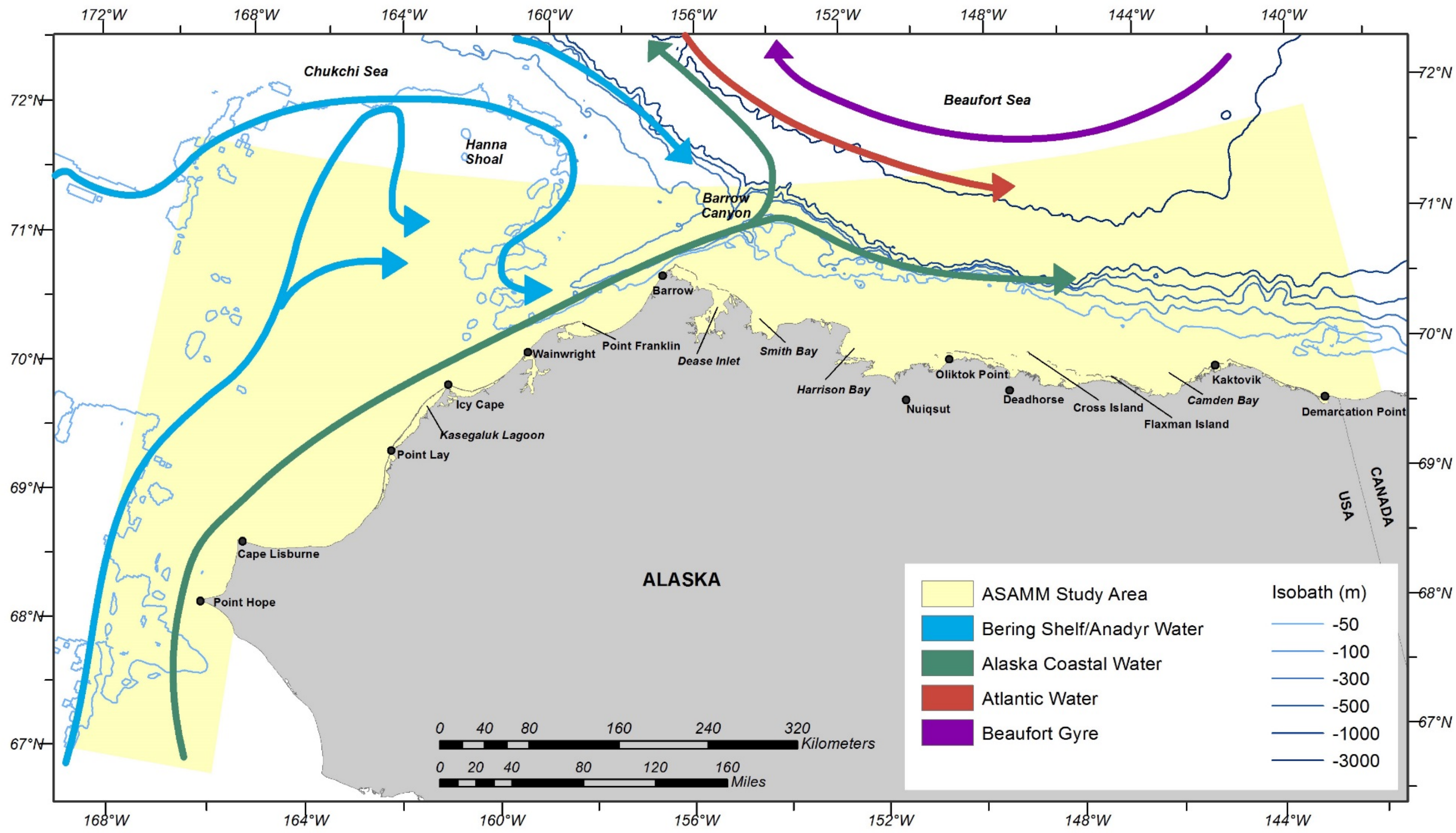

Figure 2. Eastern Chukchi Sea and western Beaufort Sea oceanographic features. Adapted from Citta et al. (2015) and Pickart et al. (2017).

spring, a recurring lead forms just seaward of the stable shorefast ice, followed by decreasing ice concentrations (LaBelle et al. 1983) and large areas of open water in summer. In recent years, the minimum area of the summer ice pack has been shrinking, setting records for new minima in several years, including 2007-2016 (National Snow and Ice Data Center 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016a, b). Since 2007, the open water season has lengthened and the southern edge of the ice pack has been farther from Alaskan coastlines during annual sea ice minima. The decrease in sea ice extent has been correlated with an increase in Arctic Ocean cloud cover (Eastman and Warren 2010).

Local weather patterns affect the frequency and efficacy of marine aerial surveys. The ASAMM study area is in the Arctic climate zone where marine climate data collected from various sources between 1854-1985 indicated that mean air temperatures at western Beaufort Sea coastal locations ranged from -0.9°C to -0.1°C during September and from -9.7°C to -8.5°C during October (Brower et al. 1988). More recently, mean annual air temperatures measured at Utqiaġvik from 1979 to 2012 had warmed by 2.7°C, with greatest warming (6.3°C) occurring in fall (Wendler et al. 2014). The heaviest precipitation (snow and rain) reported by Brower et al. (1988) from historical records occurred in September and October. Although total annual precipitation in the Alaskan Arctic has decreased since the late 1940s (Stafford et al. 2000), Wendler et al. (2014) noted that warmer air holds more water vapor and that there was an increase in precipitation for Utqiaġvik from 1979 to 2014. Wind speeds in September and October are generally higher than during other times of the year, perhaps because the open water and cooling land mass increase thermal instability (Wendler et al. 2009). Wind direction is predominantly easterly, driving the Beaufort Gyre, but winds occasionally shift to being westerly. The occurrence of storms during which at least one hourly reading of wind speed exceeded 15 m/s (approximately Beaufort wind force 7) also increased from 1972 to 2007 (Wendler et al. 2009). Mean annual wind speed recorded at Utqiaġvik from 1972 to 2007 was 5.6 m/s (approximately Beaufort wind force 4) (Wendler et al. 2009).

Sea state also affects visibility during aerial surveys. Visibility in ice-free surface waters in the Beaufort and Chukchi seas is influenced primarily by wind. Ocean waves are generally primarily from the north or east during September and October. Prior to 1997, significant wave heights were reduced by a factor of four from heights that would otherwise be expected during the open water season because pack ice limited fetch. Since 1997, large expanses of open water have been present during some or all of the field season. Corresponding wave heights have been considerably higher during periods of strong wind, obscuring visibility of marine mammals due to wave height, whitecaps, and/or spray.

Equipment

Surveys are flown in Turbo Commander aircraft, provided by Clearwater Air, Inc., and are conducted with highest regard for flight safety. Observers and pilots are linked with a common communication system. The maximum time aloft in the Turbo Commander is approximately 6 hours, including fuel reserve. Onboard safety equipment includes an impact-triggered emergency locator transmitter installed in the aircraft, an 8-person search and rescue life raft equipped with an emergency survival kit, portable personal locator beacons, portable marine and aviation band transceivers, satellite phones, fire containment bag, and immersion suits. All personnel participating in the surveys undergo safety trainings, are thoroughly briefed on aircraft operations, and participate in aircraft egress drills. All personnel wear either flotation or dry suits and are outfitted with Switliks or other personal floatation devices containing emergency equipment. Details related to aviation safety protocols, emergency support services, firearms protocols, and means of mitigating risks to project personnel posed by wildlife encounters on the ground are included in a Safety and Logistics Plan (Appendix G).

Aircraft are equipped with bubble windows that afford primary observers a complete view of the trackline. A removable side window permits unobstructed photography. The pilot and copilot have good forward and side viewing. Each observer is issued a hand-held clinometer for measuring the angle of declination to sighting locations. A laptop computing system is used aboard each aircraft to display, store, and analyze flight and observational data. The computer system is connected to a Garmin Global Positioning System (GPS) with an external antenna, independent of the aircraft GPS. Latitude, longitude, and aircraft altitude from the GPS are transmitted to the data recorder's computer through a universal serial bus (USB) connection. Specialized software developed for ASAMM is used to record data. A custom mapping component of the software permits the data recorder to view sightings relative to the aircraft's trackline in real time. Data are continually backed up to an onboard external hard drive throughout each flight.

In 2017, ASAMM initiated an effort to collect left and right observer Field-of-View (FOV) data that are specific to Turbo Commander aircraft outfitted with bubble windows. The FOV data will provide some of the information required to address availability bias, which needs to be defined if ASAMM data are to be used to derive absolute estimates of density or abundance. Details of this effort are provided in Appendix D.

The USDOI, Bureau of Land Management, Alaska Interagency Coordination Center, South Zone Dispatch, uses Automated Flight-Following for real-time satellite-tracking of ASAMM aircraft. Dispatch personnel monitor current flight status via maps, and hourly updates are communicated from the aircraft to Dispatch via Iridium satellite phones. In addition to these flight-following protocols, onboard transponders are set at discrete identification codes for radar tracking by air-traffic-control personnel.

Survey methods, equipment, and standard procedures have been developed and refined over the duration of the ASAMM project and precursor studies (1979-2016). Additional details of onboard equipment, data collection, and post-field analyses are described in detail elsewhere (e.g., Monnett and Treacy 2005; USDOI, MMS 2008; Clarke et al. 2011a, 2012, 2013a, 2014, 2015a, 2017a, b).

Aerial Survey Design

Surveys are divided into two study areas for logistical reasons and to address objectives specific to each area. Aerial surveys are based out of Utqiaġvik to target the eastern Chukchi Sea study area and out of Deadhorse to target the western Beaufort Sea study area. Survey teams at each location are prepared to conduct surveys in either study area to take full advantage of optimal weather conditions and provide the best coverage possible of the entire ASAMM study area.

The field schedule is designed to maximize survey effort during the open water period in the eastern Chukchi Sea and to monitor bowhead whale habitat use in the western Beaufort Sea during the open water season.

Transects in both study areas are oriented perpendicular to the coastline to cross major bathymetric features, such as Barrow Canyon, Hanna Shoal, and Beaufort Sea shelf and slope, and bowhead whale and beluga migration paths. Coastal transect endpoints in each study area are randomly shifted each year. Transects are generated once at the beginning of the field season and then flown for the duration of the field season (Figure 1). In the Chukchi Sea study area (157°W-169°W), 38 transects are spaced 19 km apart, extending 59 to 313 km offshore. In the Beaufort Sea study area (140°W-157°W), 34 transects are spaced 18 km apart, extending 72 to 177 km offshore. This survey design allows examination of differences in marine mammal distribution and relative density at each unique transect over the course of a field season and theoretically generates uniform coverage throughout the ASAMM study area when multiple years of effort are pooled. This survey design has been used in the Chukchi Sea study area since 2009, and was implemented for the first time in the Beaufort Sea study area in 2017. Transect spacing in the Beaufort Sea study area remained consistent with transect spacing used in 1979-2016, with one transect every 30 minutes (0.5 degrees) of longitude. The survey design also includes a coastal transect located 1 km offshore between Demarcation Bay in the Beaufort Sea and Point Hope in the Chukchi Sea. The coastal transect allows better documentation of nearshore habitat, including pinniped haulouts and polar bear aggregation areas. Note that the adoption of systematic transects in both study areas will make it appear as if less effort has been flown because the same transects are flown numerous times within the year.

Transects are terminated at coastal endpoints located 1 km offshore of the main coastline or barrier islands, when present, with the exception of transects 113-120 in the Beaufort Sea and transect 7 in the Chukchi Sea. Transects 113-120, in survey block 1, are extended inshore to cover the area between the barrier islands and shoreline (referred to as "block 1a") to provide systematic survey coverage of the area around the Liberty Prospect (Figure 1). Transect 7 is extended into Peard Bay to provide systematic coverage within the bay. Transects in the Chukchi Sea study area are truncated at ~168.75°W to avoid overflights of the International Dateline (169°W).

The selection of transects or survey blocks to be flown on a given day is non-random, based on reported or observed weather conditions in the study area, avoidance of recently surveyed areas, the need to deconflict airspace with unmanned aerial vehicles (UAV) and other aerial operations, and avoidance of marine subsistence activities. Surveys are not preferentially conducted in areas or during time periods with a higher likelihood of seeing whales (e.g., based on recent wind conditions, historical ASAMM data, or traditional ecological knowledge). Weather permitting, the project attempts to distribute effort fairly evenly across the entire study area, with the exception of the northeastern Beaufort Sea survey blocks (blocks 8, 9, and 10). Allocations of survey effort in the Beaufort Sea favor coverage of inshore survey blocks 1 through 7, 11, and 12 because bowhead whales were rarely sighted north of these blocks in three decades of previous aerial surveys, and this bowhead whale distribution pattern has been confirmed by satellite telemetry data (Quakenbush et al. 2010b). Survey-effort allocations likely increase the sample size of bowhead whale sightings within high-use areas (HUA), thus increasing the power of statistical analyses within inshore blocks.

Survey Flight Procedures

Surveys are conducted using line-transect methodology (Buckland et al. 2001). A total of two primary observers are stationed, one on each side of the aircraft, at bubble windows that permitted an unobstructed field of vision from the trackline directly below the aircraft to the horizon. The data recorder is primarily responsible for data entry but also functions as a secondary observer. Sightings from primary observers during transect effort are considered "on effort". Except for a few specific circumstances, non-primary observers, which include the data recorder, an occasional "fourth observer", and the pilots, do not mark sightings until those sightings are past abeam of the aircraft. All sightings by non-primary observers are considered "off effort". To maintain consistency of data acquisition between 2017 and previous years, all observers undergo training in ASAMM data collection techniques prior to and during the 2017 field season. Data quality is also enhanced by ensuring that at least two observers on each field team had previous experience conducting ASAMM surveys.

Each survey flight could be divided into a total of five flight types: 1) deadhead, 2) transect, 3) search, 4) circling from transect, and 5) circling from search. During a typical flight, a search or deadhead leg is flown to the targeted transect line. A series of transect lines are then flown, followed by a search or deadhead leg back to the base of operations. Transects are joined together by short search or deadhead legs. Survey effort over land or in areas with zero visibility is also designated as deadhead; deadhead effort is not incorporated into further analyses. During deadhead segments, environmental and sighting data are not manually recorded, although aircraft position data, including latitude, longitude, heading, altitude, and time, are automatically recorded. When large cetaceans are encountered, the aircraft usually diverts from the transect for brief (usually <10 minutes) periods and circles the whales to verify species, observe behavior, improve group size estimates, determine whether calves are present, and, if conditions allow, take photographs. Any new sightings of whales made while circling are recorded as sightings "on circling - transect" and are considered on effort. Sightings made off transect are recorded as sightings "on search" or "on circling - search", and all sightings made off transect, regardless of observer, are considered off effort. Software on the laptop computing system allows for detailed real-time tracking of all effort to minimize chances of duplicate sightings being recorded during circling. Survey speed during transect and search segments is generally 213 km/hr, while survey speed during deadhead is usually in excess of 333 km/hr.

Survey altitudes are chosen to maximize visibility and minimize potential disturbance to marine mammals. All surveys are flown following guidelines prescribed in research permits from NMFS (Permit No. 20465) and the U.S. Fish and Wildlife Service (USFWS; Permit No. MA212570-1). Surveys are generally flown at a target altitude of 365 m in the Chukchi Sea and 458 m in the Beaufort Sea, but can be flown as low as 305 m in either area. When cloud ceilings are consistently less than ~335 m or the wind force is above Beaufort 5, survey flights are redirected to survey blocks or transects with better conditions. Survey flights are aborted when conditions consistently did not meet minimum altitude (305 m) or wind force (Beaufort 5) requirements.

Transects are occasionally adjusted to avoid direct overflights of subsistence activities or of large groups of pinnipeds hauled out on sea ice or along the coast. In those situations, the pilots alert the science team as to the presence of small boats or haulouts prior to overflying and, depending on the situation, transects are truncated or survey altitudes increased. Transects are truncated by 5-8 km whenever small boats are observed to avoid interference with subsistence activities. During the fall subsistence hunt of bowhead whales, a minimum altitude of 458 m is maintained near Pt. Barrow, Cross Island, and Kaktovik. If 458 m cannot be maintained, transects are truncated to avoid a 37-km radius around each whaling area. Transects are adjusted by 3.7 km distance offshore and a minimum altitude of 610 m near coastal walrus haulouts. When walruses are encountered hauled out on sea ice, transects are diverted around the haulouts or survey altitude is increased to a minimum of 458 m. If walruses appear to react to the aircraft after these adjustments are initiated, diversion distances and survey altitudes are increased as needed. Transects are also diverted to avoid direct overflights of haulouts of small pinnipeds on beaches or barrier islands.

When weather and fuel conditions allow, circling is initiated in areas where aggregations of polar bears are known to occur onshore: on Cross Island and in the vicinity of Kaktovik (Figure 1). During circling of these areas, photographic images are collected of as much of the island or coastline as possible and reviewed post-flight to obtain more precise counts of polar bears. Circling is not conducted for more than 15 minutes to reduce potential impacts to polar bears, and is not initiated on polar bears observed on ice or swimming in open water.

Coordination with Resource Users

Manned and Unmanned Aerial Surveys

ASAMM maintains daily contact with operators of all known aircraft operating in offshore and coastal regions.

Subsistence Activity

ASAMM coordinates with the North Slope Borough (NSB) Department of Wildlife Management regarding subsistence activities, and strives to avoid direct overflights of areas where subsistence hunting of marine mammals was taking place. Transect lines are diverted away from coastal villages and from whalers in boats during hunting seasons.

Data Entry

Identical protocols are used to collect data in the two study areas. Customized, menu-driven, data-entry software is used to record all data in Microsoft Access database format. Details on all fields in the historical database are provided in the metadata (USDOC, NOAA, NMFS 2017). Time and location data (date, local time, latitude, longitude, altitude, and aircraft heading) and environmental conditions (sky conditions, visibility [km] and visual impediments, percent sea ice cover, ice type, and Beaufort wind force) are recorded at sightings, during transitions in survey mode (transect, search, or circling), when environmental conditions changed, or at 5-minute (in time) intervals. Time and location only (date, time, latitude, longitude, and altitude) are automatically recorded from the GPS feed every 30 seconds (in time) to provide a detailed record of the flight track. Wind force is recorded according to Beaufort scale (Maloney 2006). Ice type is identified using terminology presented in Naval Hydrographic Office Publication Number 609 (USDOD, Navy, Naval Hydrographic Office 1956). Average sea ice cover within the field of view from the aircraft is estimated as a single percentage, regardless of ice type.

All marine mammal sightings are recorded. Common and scientific names used for marine mammals in this report are taken from Rice (1998). The suite of data recorded for cetacean, walrus, and polar bear sightings includes time, location, environmental conditions, survey mode, species, initial estimate of total number (low, high, and final estimates of group size are recorded as necessary), observer, swim direction (degrees True; cetaceans only), clinometer angle, side of plane, number of "calves" (including bear cubs, walrus calves, and pinniped pups), behavior, sighting cue, habitat, whether it is a same-day repeat sighting, and response to the aircraft. Calves are recorded based on several types of information, including relative size of the animal, proximity to a larger adult, behavior, color, and the observer's judgment. Marine mammal observers and flight crew watch for and record sudden overt changes (e.g., an abrupt dive, course diversion, or cessation of initial observed behavior) in marine mammal behavior that might indicate a response to the survey aircraft. Reduced data subsets are sometimes recorded for non-cetacean marine mammals to expedite data entry but always include time, location, environmental conditions, survey mode, observer name, species, total number, and response to aircraft. In areas of extremely high beluga, walrus, and pinniped density, sightings are lumped together in "30-second" increments, and details pertaining to the sighting are included in notes. On rare occasions, when the density of cetacean sightings is extremely high, unidentified pinnipeds and small unidentified pinnipeds are not recorded. Starting in 2017, the data collection software includes a "hot key" feature enabling rapid data entry for small unidentified pinnipeds, belugas, and walruses. This feature likely results in less lumping and increased recording of unique sightings of these species in high density areas relative to previous years.

The behavior and swim direction of observed whales represents what the group is doing at the time it is first sighted. Behaviors are entered into one of several categories (Table 1). Swim direction, collected only for whales for which the behaviors "swim" and "dive" are recorded, is entered relative to the aircraft's heading and then converted to actual swim direction via a module incorporated into the data collection software. Swim direction is not recorded when the aircraft is circling.

General Data Analyses

Preliminary data review and editing are conducted immediately following each survey flight by project personnel with comprehensive knowledge of the ASAMM database and metadata, with assistance from the observers who participated in the flight. Preliminary analysis is performed in the field after each flight using a customized computer program that provides daily summaries of marine mammal sightings and effort (time and distance on transect, search, circling, and deadhead) and plots the paths of one or more flights by Beaufort wind force. Aerial photographic images are examined opportunistically during post-flight review to confirm or revise group size estimates for polar bears, large pinniped haulouts, and large cetaceans. An additional customized computer program is used for post-season analysis and production of

Table 1. ASAMM operational definitions of observed marine mammal behaviors.

Behavior	Definition
Breach	Animal(s) launching a significant portion of the body above the water surface then falling back down again, creating an obvious splash.
Dead	Animal(s) in water or on beach that is clearly deceased; carcass often but not always bloated, with sloughing skin and accompanied by oil slicks, feeding birds, or scavenging bears.
Dive	Animal(s) changing swim direction or body orientation relative to the water surface, resulting in submergence; may or may not include lifting the tail out of the water.
Feed	Animal(s) diving repeatedly in a fixed area, sometimes with mud streaming from the mouth and/or defecation observed upon surfacing; synchronous diving and surfacing or echelon formations at the surface, with swaths of clearer water behind the whale(s), or surface swimming with mouth agape (bowhead whales); mud plumes streaming from mouths while surfacing (gray whales); mouths open and/or throat grooves extended (balaenopterid whales); bubble nets (humpback whales).
Flipper Slap	Animal(s) striking the water surface with a pectoral flipper.
Hunt	Animal(s) actively pursuing prey.
Log Play	Animal(s) milling or thrashing in association with a floating log.
Mate	Whales in ventral-ventral orientation, often with one or more other whales present to stabilize the mating pair.
Mill	Two or more animals moving slowly at the surface in close proximity (within 100 m) to, but not obviously interacting with, other animals, with varying headings.
Rest	Animal(s) floating at the surface with head, or head and back, exposed, or resting on ice; showing no movement.
Roll	Animal(s) rotating on longitudinal axis.
SAG	Surface Active Group – two or more whales within a body length of each other, interacting and socializing at the surface.
Spy Hop	Whale(s) extending head vertically above the water surface.
Stand	Animal(s) standing upright on ground or ice.
Swim	Animal(s) proceeding forward through the water, propelled by tail or limbs.
Tail Slap	Whale(s) striking the water surface with the tail.
Thrash	Animal(s) exhibiting rapid flexure or gyration in the water.
Underwater Blow	Animal(s) exhaling under water, creating a visible bubble.
Unknown	Behavior not able to be determined, usually due to the sighting occurring at some distance from the aircraft location.
Walk/Run	Animal(s) moving on ground or ice at slow or normal pace (walking) or more rapid pace (running).

figures and tables. Maps are prepared using ArcGIS 10.3.1 (Environmental Systems Resource Institute [ESRI 2014], Redlands, CA) based on Universal Transverse Mercator Zone 5 (central meridian = -154.000000°, latitude of origin = 70.000000°, false easting = 500000.000000, false northing = 0.000000, spheroid = Geodetic Reference System [GRS] 80, scale factor = 0.999600). The Alaskan coastline is adapted from the World Vector Shoreline produced by the U.S. Defense Mapping Agency, now called the National Geospatial-Intelligence Agency.

Data from the Beaufort and Chukchi sea study areas are combined into one large dataset for editing and archiving, and are parsed into smaller subsets for various analyses of sighting rates, relative abundance, swimming direction, and HUAs. Survey effort and observed bowhead whale and gray whale distributions are plotted semimonthly over the study area, and walrus distributions are plotted monthly. All other species distributions are plotted seasonally (July-October). All sightings are shown on most distribution maps regardless of survey mode (e.g., transect, search, or circling), observer type (primary or secondary), or the prevailing environmental conditions (wind force, sea ice cover, etc.) when the sightings were made. As with previous reports in this series (e.g., Monnett and Treacy 2005; USDOI, MMS 2008; Clarke et al. 2012, 2013a, 2014, 2015a, 2017a, b), same-day repeat sightings or sightings of dead marine mammals are not included in summary analyses or maps. Data exclusions are indicated in the captions. Because feeding is likely underreported or recorded as milling, figures showing cetacean feeding occurrence include all sightings reported as feeding and milling, regardless of survey mode, observer type, or prevailing environmental conditions.

Post-processing algorithms estimate the water depth at each sighting and the sighting's distance from shore. The water depth at each sighting in the ASAMM database is derived from the International Bathymetric Chart of the Arctic Ocean Version 3.0 (Jakobsson et al. 2013), which has a pixel resolution of 500 m. The shoreline used to calculate a sighting's distance from shore is "normalized" from the actual shoreline to provide standardized distance-from-shore measurements regardless of the coastline database being used to depict distribution data (Figure 3). The normalized shoreline was redefined in 2011 to better represent the actual coastline of Alaska from 140°W (the easternmost part of the ASAMM study area) to 67°N (the southernmost part of the study area) and to improve representation of bays and barrier islands. The normalized shoreline does not include areas between barrier islands and the mainland. To maintain consistency with the historical database, any sightings within lagoons formed by barrier islands have negative distance-from-shore measurements. The projection used for the normalized shoreline analysis is North American Equidistant Conic, appropriate for distance measurements, with custom projection parameters (central meridian = -154.5°, latitude of origin = 70.5°, standard parallels = 60.5°, 80.5°).

Mean vector headings and circular standard deviations for headings of swimming and diving cetaceans are determined using Oriana statistical software (Rayleigh Test; KCS 2013) for three subareas (Beaufort Sea subarea 140°W-154°W; northeastern Chukchi Sea subarea 69°N-72°N, 154°W-169°W; southcentral Chukchi Sea subarea 67°N-69°N). The 154°W demarcation between the Beaufort and northeastern Chukchi sea subareas for swim direction most closely approximates the natural break between the Beaufort and Chukchi basins. The two subareas delineated for the Chukchi Sea are based on ecosystem differences.

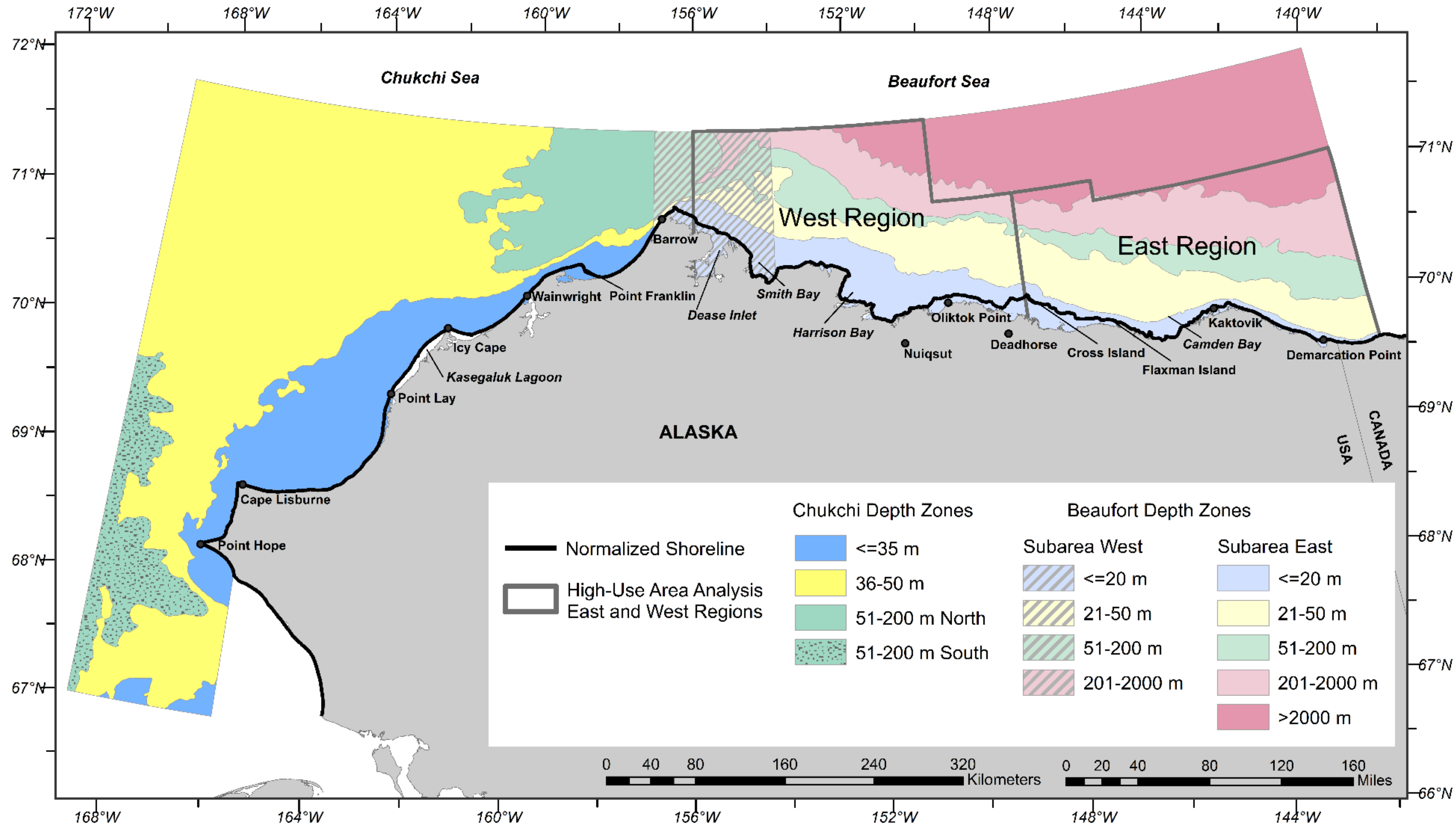

Figure 3. East and West regions and normalized shoreline used in ASAMM bowhead whale high-use area (HUA) analysis, and depth zone subareas used for sighting rate analyses.

Environmental information, including wind speed and direction, cloud ceiling, visibility, temperature, dew point, sea ice cover, and sea surface temperature, is collected from National Weather Service websites and other weather and climate-related web pages for the duration of the field season. Data are collected and stored electronically for specific locations along the northern coast of Alaska (e.g., Point Hope, Cape Lisburne, Point Lay, Wainwright, Utqiaġvik, Alpine, Kuparuk, West Dock, Deadhorse, and Barter Island) and for the broader Chukchi and Beaufort sea regions.

Sea ice information is obtained from the U.S. National Ice Center (2017), where it is available as charts or shapefiles. Sea ice analyses by the National Ice Center uses data from several sources, including Environmental Satellite (ENVISAT) imagery and Moderate Resolution Imaging Spectroradiometer (MODIS), to show sea ice concentration. Summer and fall sea ice conditions in 2017 are categorized as light, moderate, or heavy for use in multiyear analyses. Shapefiles for the Beaufort and Chukchi seas are combined to produce biweekly sea ice concentration maps, included in Appendix A.

Data analysis methods used in this report are largely consistent with previous years' reports, dating back to 2008. One exception involves the distinction between sightings made by primary and secondary observers. Data analyses and figures prior to 2012 using transect data included all transect sightings regardless of observer type (e.g., Clarke et al. 2012). Collection of data denoting primary observers began in 1989, and the ASAMM historical database was amended in 2012 to include a field specifically denoting whether a sighting was made by a primary or secondary observer. In 2017, sightings made by primary observers only are included in most analyses that use on-effort sightings, including sighting rate and central tendency analyses.

Sighting Rate and Relative Abundance Analyses

Sighting rates (number of whales or walruses [WPUE], pinnipeds [PPUE], polar bears [PBPUE], or calves [CPUE] per unit [km] effort) quantify relative abundance by accounting for heterogeneity in survey effort and group size across the study area. Sighting rates are derived for three different spatial scales, each limited to sightings by primary observers. Sighting rates are not corrected for availability or perception bias (Buckland 2001).

To calculate monthly, seasonal, and annual sighting rates per survey block for bowhead whales, gray whales, belugas, and other cetaceans, the number of whales observed is divided by effort (km) per survey block. Although survey blocks are arbitrary geographic areas, they provide a basis for inter-annual comparisons. Effort over land, between barrier islands and the mainland (except for block 1a), and north of the study area (north of 72°N) is not included in the survey block sighting rate analysis to facilitate comparisons with previous years. Effort in block 1a is included in the survey block sighting rate analysis separate from block 1 to ensure that survey block sighting rate analysis remains consistent with previous years.

To calculate monthly, seasonal, and annual sighting rates per depth zone for bowhead whales, gray whales, belugas, and other cetaceans, the number of whales observed is divided by effort (km) per depth zone. Depth zones are defined based on depth data in the International Bathymetric Chart of the Arctic Ocean Version 2.23 (Jakobsson et al. 2008), which has a pixel resolution of 2 km. Depth zone analysis in the western Beaufort Sea study area is computed for two subareas (Figure 3). One subarea spans 154°W-157°W and includes Barrow Canyon and its surrounding area, which has noticeably different bathymetry than the rest of the Beaufort Sea study area. The other subarea for the western Beaufort Sea depth zone analysis spans 140°W-154°W, an area that incorporates a well-defined continental shelf and slope. Beaufort Sea subareas use depth zones of ≤20 m, 21-50 m, 51-200 m, 201-2,000 m, and >2,000 m. Depth zone analysis in the Chukchi Sea uses slightly different depth zones to better reflect the bathymetric features of the area (≤35 m, 36-50 m, and 51-200 m); the 51-200 m depth zone is divided into North and South regions because they are separated by a large expanse of shallower depths (Figure 3). Sighting rate analyses for survey blocks and depth zones use an Equidistant Conic projection (false easting: 0.0; false northing: 0.0; central meridian: -154.5°; first standard parallel: 60.5°; second standard parallel: 80.5°; latitude of origin: 70.5°; linear unit: meter [1.0]). Depth zone sighting rate analysis does not include survey effort flown north of 72°N but does include effort between barrier islands and the mainland in block 1a. Sightings per depth zone are based on geographic placement of sightings within depth zone isobaths, not on the depth associated with each individual sighting in the ASAMM database.

Finally, sighting rate is calculated for fine-scale areas, using a grid consisting of approximately equilateral cells (5 minutes latitude by 15 minutes longitude, roughly 5 km x 5 km) superimposed across the study area. Seasonal (summer and fall) sighting rates are calculated for bowhead whales, gray whales, and belugas for each cell. Sighting rates for walruses are calculated to provide an index of relative abundance prior to and after the formation of an onshore haulout near Point Lay. The fine-scale grid analysis includes effort and animals observed within barrier islands and north of 72°N.

Sighting rates are calculated for each of the three spatial scales described above using sightings and effort on transect (Tr) from primary observers, similar to sighting rate analyses in previous years. In 2017, as in 2014-2016, sighting rate analyses are also conducted using sightings and effort on transect combined with sightings and effort during circling from transect (Tr+TrC) for bowhead whales and gray whales. While the Tr+TrC analysis is a departure from analyses presented in Annual Reports prior to 2014, it encompasses a more robust analysis of relative abundance because additional whales associated with the initial sighting are often seen after circling commences. The Tr+TrC sighting rate analyses are not extended to belugas or walruses because diversions to circling are rarely conducted on beluga or walrus sightings. Indices of relative abundance of bowhead whale and gray whale feeding and milling behaviors, quantified as WPUE, are calculated for the fine-scale grid used Tr+TrC sightings and effort, because many feeding aggregations are identified after circling has been initiated (Zongker 2006).

Analysis of Bowhead Whale High-Use Areas (HUA) in the Beaufort Sea

There is no evidence to suggest that bowhead whales remain in the Beaufort Sea throughout winter; at some point, bowhead whales observed in the Beaufort Sea in summer and fall migrate through the Chukchi Sea to return to wintering areas in the Bering Sea. It was thought that most bowhead whales summered in the eastern Beaufort Sea then actively migrated westward through the western Beaufort Sea in fall (Moore and Reeves 1993). Previous central tendency analyses (e.g., Treacy 2002a; Monnett and Treacy 2005; Clarke et al. 2011b, 2012) defined results as "migratory corridors." However, results of satellite telemetry studies have shown that some bowhead whales crisscross the western Beaufort Sea during summer (Quakenbush et al. 2010b). Furthermore, large dynamic groups of bowhead whales have been documented feeding in the western Alaskan Beaufort Sea as early as July and continuing into October (e.g., Clarke et al. 2015a; 2017b). There is no reliable way, via data collected during line-transect aerial surveys, to differentiate between whales that are actively undergoing a focused, unidirectional, westward fall migration and whales that are crisscrossing the western Beaufort Sea prior to undergoing directed migration.

To acknowledge that some bowhead whales observed in the western Beaufort Sea in summer and fall might not be actively migrating, the term "high-use area", or HUA, is used in lieu of migratory corridor for this report. HUA designation, in this context, describes areas in the western Beaufort Sea where bowhead whales are expected to occur in greatest densities, based on data collected during ASAMM surveys. HUAs can be considered one component used to interpret the relative biological importance of certain areas within the western Beaufort Sea, based on the numbers of whales expected to be present in a given area during a particular month or season. HUAs are not defined based on specific activity states (e.g., migrating or feeding).

Bowhead whale HUAs are analyzed separately for two regions (Figure 3), the boundaries of which correspond roughly to oceanographic patterns and the offshore extent of sampling, described in more detail below. The delineation between East and West regions for this analysis occurs at 148°W, based upon association with the general distribution patterns of water masses. Oceanographic patterns common to waters off northern Alaska are reviewed in Moore and DeMaster (1998). In brief, cold saline Bering Shelf Water and warm fresh Alaska Coastal Water enter the western Beaufort Sea through Barrow Canyon. Both water masses are identifiable on the outer shelf (seaward of 50 m) as the eastward flowing Beaufort Undercurrent (Aagaard 1984). Bering Shelf Water has been traced at least as far east as Barter Island (~143°W), but the Alaska Coastal Water mixes with ambient surface waters as it moves eastward and is not clearly identifiable east of Prudhoe Bay, Alaska (~147°W-148°W).

The northern extent of each region is based upon historical survey effort. The East region extends from 140°W to 148°W and northward from shore to 71.166°N, except between 146°W and 148°W where the region extends to 71.333°N. The eastern boundary (140°W) is the easternmost longitude of the survey blocks. The northern boundary for this region corresponds with the boundaries of blocks 2, 6, and 7 (Figure 1), blocks with sufficient survey effort to support analyses (Treacy 1998). The West region extends from 148°W to 156°W and northward from shore to 72°N, except between 148°W and 150°W where the region extends to 71.333°N due to the layout of block 2. The northern boundary for this region corresponds with the boundaries of blocks 2, 11, and 12 (Figure 1); therefore, sightings north of 72°N are not included. The western cutoff at 156°W limits the analysis to bowhead whales seen in the western Beaufort Sea and minimizes the influence of Barrow Canyon on bowhead whale depth distribution.

Two analyses of bowhead whale HUAs in the western Beaufort Sea are undertaken.

Bowhead Whale Central Tendency – Analysis 1

Non-parametric statistical tests, via the non-parametric Mann-Whitney *U*-test, are used to examine differences in median depth and distance from shore. Treacy (1998) found that median and mean bowhead whale distance from shore values were only slightly different. The non-parametric test is used for these data because distributions generally do not fit assumptions necessary to use the two-sample *t*-test. The variances are not equal between time periods for both depth and distance from shore; in addition, the depth data are considerably skewed and the distance from shore data are slightly skewed, so neither distribution strictly meets the assumption of normality. When assumptions of the *t*-test are seriously violated, the Mann-Whitney *U*-test may be more powerful than the two-sample *t*-test (Hodges and Lehmann 1956; Zar 1984). Statistical tests were undertaken using *Statistica™* StatSoft Version 13.0 and ArcGIS Version 10.3.

Bowhead whale HUA is examined using the median water depth at, and mean and median distance from shore of, whale sightings on transect by primary observers (Houghton et al. 1984). Median distance from shore and depths for bowhead whale sightings in fall 2017, a year with light sea ice cover (National Snow and Ice Data Center, 2017), are compared with analogous values for combined data from previous years having light sea ice cover (i.e., 1989, 1990, 1993-2015; Treacy 1990, 1991, 1994, 1995, 1996, 1997, 1998, 2000, 2002a, 2002b; Monnett and Treacy 2005; USDOI, MMS 2008; Clarke et al. 2011a, 2011b, 2012, 2013a, 2014, 2015a, 2017a, b). Median distance from shore and depths at bowhead whale sightings in summer (July-August) 2017 are compared to bowhead whale sightings in summer 2012-2016 and fall (September-October) 2017.

All bowhead whale sightings made while on transect by primary observers, regardless of distance from the transect line, are included in the non-parametric central tendency analyses. Neither group size nor survey effort (km) is taken into account. Because survey effort is not incorporated in this analysis, sightings are limited to those on transect only (Tr) and do not include those made while circling from transect (TrC) to limit potential biases.

One caveat to the non-parametric analyses is that analyzing bowhead whale HUAs based only on number of sightings may be biased because survey effort often varies spatially both within and across years and because sightings of a single whale are weighted equally to sightings of several whales. Therefore, there may be more sightings in areas with greater transect effort and fewer sightings in areas with less transect effort, even if the density of individuals in the two areas was the same.

Bowhead Whale Central Tendency – Analysis 2

The second method for investigating the central tendency of the fall bowhead whale distribution in the Alaskan Beaufort Sea in 2017 involves a three-step process: 1) constructing spatial models of bowhead whale relative abundance (encounter rate) based on bowhead whale sightings from 2017; 2) applying the spatial relative abundance model to predict the expected number of bowhead whales in every cell of a grid overlying the study area; and 3) using the predicted number of bowhead whales in each cell to compute the median distance from shore of the whales sighted in 2017. As in the central tendency analysis described above, this analysis is based on transect bowhead whale sightings made by primary observers in September and October 2017. This analysis does not account for availability or perception bias. Estimates of median distance from shore are calculated for the East and West regions individually. The analysis is conducted in R version 3.4.3 (R Core Team 2017) using packages *sp* (Pebesma and Bivand 2005; Bivand et al. 2013), *maptools* (Bivand and Lewin-Koh 2017), *raster* (Hijmans 2017), *rgeos* (Bivand and Rundel 2017), *rgdal* (Bivand et al. 2017), and *mgcv* (Wood 2006).

To begin, the western Beaufort Sea study area is partitioned into a 5-km x 5-km grid. This grid resolution was chosen as a compromise between having adequate survey effort and sightings in each cell to construct models, versus maximizing the resolution of the distance from shore data. All geospatial data are projected into an Equidistant Conic projection with the following parameterization: first standard parallel 69.9°; second standard parallel 71.6°; latitude of origin 70.75°; central meridian -148.0°; false easting 0.0; and false northing 0.0. Data extracted for each cell include the total number of whales sighted, the projected x and y coordinates of the midpoint of each cell, and the shortest distance from that midpoint to the normalized shoreline. Bowhead whale relative abundance is modeled as a generalized additive model, parameterized by a negative binomial distribution with a natural logarithmic link function. Quasi-Poisson and Tweedie (Tweedie 1984; Dunn and Smith 2005) models were also considered, but examination of model residuals (Ver Hoef and Boveng 2007) suggest that the negative binomial distribution provided a better fit to the data. The model formula is represented as

$$ln(E(W_i)) = ln(\mu_i) = \alpha + s(X_i, Y_i) + offset(ln(L_i))$$

where

W_i: random variable for the number of individual bowhead whales in cell i, with W_i referring to the associated observations and $E(W_i)$ the expected value (mean) of W_i;

μ_i: number of individual bowhead whales expected to be observed in cell i;

α: intercept;

X_i: projected (equidistant conic) longitude of the midpoint of cell i;

Y_i: projected (equidistant conic) latitude of the midpoint of cell i;

$s(\,)$: smooth function (Wood et al. 2008) of location covariates used to describe bowhead whale relative abundance; this function is parameterized in the model-fitting process;

L_i: length (km) of transect effort in cell i, which was incorporated into the model as a constant (an "offset") to account for spatially heterogeneous survey effort throughout the study area.

The median distance from shore of the fall distribution of bowhead whales in 2017 is estimated using the spatial model to predict the number of individuals likely to be observed in each cell after a uniform amount of transect effort (a constant L_i for all i) was covered throughout the portion of the study area contained within the East and West regions. The magnitude of L_i used in the predictions does not affect the resulting median statistic as long as L_i was constant across all cells, thereby eliminating apparent variability in bowhead whale distribution due only to spatial heterogeneity in survey effort. The predicted number of individuals per cell is cumulated, beginning with the cell closest to the normalized shoreline and ending with the farthest. The median distance from shore is calculated as the distance corresponding to the midpoint of the cell for which one-half of the total predicted number of individuals are assigned to cells located closer to shore and one-half assigned to cells located farther from shore.

This method of estimating the median distance from shore is also applied to ASAMM bowhead whale data from 2000 to 2017 combined. The analysis for the pooled years uses the same data filtering criteria as described above (all bowhead whale sightings made by primary observers on transect) and does not account for availability or perception bias. It includes data from July to October, and a varying-coefficient generalized additive model (Wood 2006) is used to examine the spatial distribution of bowhead whale relative abundance by month. In essence, the varying-coefficient model structure enables estimation of a separate smooth function for each month, allowing both the location and intensity of areas with high or low relative abundance to vary by month. Median distances from shore for the 18-year time period are calculated for the East and West regions separately.

The median is also referred to as the 50^{th} percentile or quantile. An additional analysis undertaken defined the location of bowhead whale HUAs in 2017 alone and in 2000-2017 (all years pooled) based on the locations of the 30^{th}, 40^{th}, 50^{th}, 60^{th}, and 70^{th} percentiles of predicted bowhead whale relative abundance for each column of 5-km x 5-km cells in the East and West regions. For example, in this analysis the location of the 30^{th} percentile in a specific column of cells refers to the location where 30% of the predicted number of bowhead whales would be closer to shore and 70% would be farther offshore. Due to the granularity of the spatial grid used for this analysis, adjacent percentiles may overlap in a single cell in locations where the predicted distribution of bowhead whales changes rapidly with distance from shore. The midpoints of all cells corresponding to the 30^{th} percentile are connected across the entire region to define a linear boundary across the western Beaufort Sea corresponding to the 30^{th} percentile of bowhead whale HUAs, and similarly for the 40^{th}, 50^{th}, 60^{th}, and 70^{th} percentiles.

Multiyear Analyses

To expand the usefulness of ASAMM data collected in 2017, several multiyear analyses were also conducted. The results of some analyses are included in Results (e.g., HUA), and several are referenced in more detail in Discussion. Temporal and spatial parameters for each multiyear analysis are specifically chosen to maximize the amount of relevant information contained in the ASAMM dataset used to address the objectives of the particular analysis. These parameters vary substantially across multiyear analyses due to annual differences in when and where surveys were conducted. For example, multiyear analyses for the northeastern Chukchi Sea include data collected in summer and fall 2009-2017 because survey effort was equivalent during those time periods. Conversely, multiyear analyses for the western Beaufort Sea in summer are usually limited to 2012-2017 because broad-scale summer surveys in that area did not occur prior to 2012. Analyses comparing summer and fall data from the western Beaufort Sea are limited to 2012-2017. Multiyear analyses for the western Beaufort Sea in fall justifiably can, in some situations (e.g., calf ratios), incorporate data from 1982 through 2017. Other applications require sightings from primary observers only and, therefore, incorporate data from only 1989 through 2017, which is when details related to primary observers are recorded in the dataset.

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RESULTS

Environmental Conditions

In 2017, sea ice cover in the area surveyed was extremely light in August, September, and October. When surveys commenced in early July, sea ice remained in the study area from approximately 143°W to 157°W, and remained there through mid-July (Appendix A, Figures A-1 and A-2). By late July, sea ice persisted only in the central Alaskan Beaufort Sea, but was otherwise absent from the study area (Figure A-3). The study area remained ice free from early August through late October (Figures A-4 through A-8), when new ice began forming in shallow nearshore areas in the study area (Figure A-9).

Arctic sea ice extent reached the seasonal minimum on 13 September 2017, and sea ice fell to the eighth lowest daily minimum extent and the seventh lowest monthly average extent since satellite data were first recorded in 1979 (National Snow and Ice Data Center 2017d). To examine interannual variability in bowhead whale and other marine mammal distributions and relative abundance, 2017 data were compared to data from previous years with light sea ice cover.

Observer Experience

Data quality is a direct reflection of the capabilities and experience of the field personnel. In 2017, 15 observers participated in ASAMM surveys. All ASAMM observers were experienced field biologists and most (87%) had previous experience with ASAMM surveys, which ensured consistency in data collection among years. ASAMM field experience ranged from 1 to 23 years (mean = 6.5 years, median = 6 years). Less experienced ASAMM observers were integrated into teams consisting of more experienced ASAMM observers and all observers were provided feedback throughout the field season to help maintain data consistency.

Survey Effort

The ASAMM field season commenced 1 July 2017 and ended 27 October 2017. Survey flights were conducted from 3 July to 25 October (Table 2), corresponding to the summer and fall months when open-water anthropogenic activities occur. Surveys were conducted from one aircraft based in Utqiaġvik from 1 July to 27 October, primarily targeting the northeastern and southcentral Chukchi Sea, and from one aircraft based in Deadhorse from 18 July to 11 October, primarily targeting the western Beaufort Sea. There were 97 survey flights, of which 23 were in July, 27 in August, 28 in September, and 19 in October. Surveys originating on the aircraft based in Utqiaġvik were numbered sequentially starting with 201; surveys originating on the aircraft based in Deadhorse were numbered sequentially starting with 1. On 32 occasions, multiple flights in one day were completed by the same survey team to take advantage of favorable survey conditions. Surveys were conducted concurrently by both survey teams on 21 days. Surveys were conducted on 64% of days during the field season (74 out of 116 days). Surveys were not conducted on 36% of field days (42 out of 116 days) due to weather (36 days)

Table 2. ASAMM aerial survey flight effort in chronological order, 3 July – 25 October 2017, by survey flight and semimonthly time period. Semimonthly totals may not exactly match the sum of individual surveys for the time period due to rounding error. Circling (km) includes circling from transect only.

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
3 Jul	201	567	161	105	305	1,138	2.7	5.4
4 Jul	202	690	82	15	402	1,189	3.1	5.1
6 Jul	203	1,164	97	53	1,007	2,321	5.3	9.2
7 Jul	204	318	0	22	546	885	1.5	3.3
12 Jul	205	484	84	1	527	1,096	2.3	4.6
13 Jul	206	610	205	2	284	1,101	2.8	5.0
14 Jul	207	564	0	83	370	1,017	2.6	4.2
15 Jul	208	501	58	2	1,376	1,937	2.2	6.6
18 Jul	209	131	38	76	573	817	0.6	3.0
19 Jul	1	763	41	82	428	1,314	3.3	5.4
21 Jul	210	475	129	42	243	889	2.0	3.9
21 Jul	2	407	33	50	659	1,149	1.8	4.3
22 Jul	211	620	29	40	1,454	2,143	2.9	7.3
23 Jul	3	440	123	26	630	1,220	2.0	4.9
25 Jul	4	711	10	27	521	1,269	3.2	5.0
26 Jul	212	492	112	0	470	1,074	2.3	4.4
27 Jul	213	568	45	1	522	1,136	2.6	4.5
28 Jul	5	597	0	258	492	1,346	2.6	5.4
28 Jul	214	1,026	40	87	1,000	2,154	4.5	8.4
29 Jul	6	1,331	89	90	854	2,364	5.9	9.4
30 Jul	215	656	48	57	231	993	3.1	4.7
31 Jul	216	529	22	46	171	767	2.3	3.3
31 Jul	7	518	8	26	203	755	2.3	3.1
2 Aug	8	600	75	23	612	1,310	2.7	4.9
4 Aug	217	470	41	122	685	1,318	2.2	5.1
5 Aug	9	692	86	49	362	1,188	3.1	5.0
7 Aug	10	310	71	89	309	779	1.4	3.1
9 Aug	11	542	32	151	377	1,103	2.4	4.5
10 Aug	218	1,348	44	68	406	1,865	6.1	8.5
10 Aug	12	649	4	25	356	1,035	2.8	4.2
11 Aug	219	462	63	164	192	881	2.1	4.1
14 Aug	220	160	0	89	438	687	0.8	2.7
15 Aug	13	574	20	29	450	1,072	2.6	4.4

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
16 Aug	221	1,089	17	3	1,138	2,248	5.0	8.7
16 Aug	14	927	162	116	974	2,179	4.2	8.8
19 Aug	15	339	61	76	804	1,280	1.5	4.9
20 Aug	16	792	82	31	938	1,843	3.6	7.0
21 Aug	222	629	43	1	262	935	2.8	3.9
21 Aug	17	234	0	35	321	590	1.1	2.3
24 Aug	223	574	0	1	527	1,102	2.6	4.3
24 Aug	18	536	58	48	700	1,342	2.4	5.1
25 Aug	224	467	7	5	705	1,184	2.1	4.3
25 Aug	19	550	106	94	322	1,071	2.4	4.5
26 Aug	20	718	0	76	474	1,268	3.2	5.0
27 Aug	225	608	139	49	228	1,024	2.9	4.8
27 Aug	21	756	20	46	323	1,145	3.3	4.8
28 Aug	226	686	337	32	1,456	2,511	3.1	9.3
28 Aug	22	296	30	27	851	1,204	1.3	4.4
29 Aug	227	389	8	1	576	974	1.8	3.6
29 Aug	23	1,020	39	53	337	1,450	4.4	6.0
2 Sep	24	546	0	30	657	1,233	2.4	4.6
3 Sep	228	409	40	97	1,372	1,918	1.9	6.6
3 Sep	25	832	345	56	948	2,181	3.6	8.7
4 Sep	229	461	75	5	339	880	2.0	3.7
8 Sep	230	38	8	241	191	478	0.2	1.9
9 Sep	231	1,392	97	166	343	1,998	6.3	9.1
9 Sep	26	620	153	4	344	1,120	2.8	4.9
10 Sep	232	431	12	3	432	878	1.9	3.3
11 Sep	233	376	69	39	1,291	1,775	1.7	6.2
11 Sep	27	39	32	4	389	463	0.2	1.6
12 Sep	28	319	17	6	492	834	1.4	3.1
13 Sep	234	525	26	3	362	916	2.4	3.8
13 Sep	29	1,338	132	4	1,005	2,479	5.7	9.5
14 Sep	235	807	88	58	377	1,330	3.7	5.8
14 Sep	30	684	558	4	489	1,736	3.1	8.1
15 Sep	31	511	155	24	468	1,159	2.3	4.8
18 Sep	32	258	27	2	469	754	1.2	2.8
19 Sep	236	1,096	7	111	1,150	2,365	5.0	9.1
19 Sep	33	503	143	1	1,045	1,691	2.3	6.4

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
20 Sep	237	1,052	0	49	1,506	2,608	4.8	9.4
20 Sep	34	1,194	278	25	676	2,172	5.5	9.5
21 Sep	35	494	101	2	453	1,050	2.3	4.5
25 Sep	238	791	24	4	421	1,239	3.5	4.9
26 Sep	239	826	136	58	1,455	2,475	3.7	9.5
26 Sep	36	512	87	44	802	1,445	2.3	5.5
27 Sep	240	647	86	1	469	1,203	3.0	5.0
27 Sep	37	78	0	3	610	691	0.3	2.1
30 Sep	241	618	23	43	560	1,244	2.8	5.0
1 Oct	38	159	43	125	297	624	0.8	2.7
2 Oct	242	171	99	44	358	672	0.8	2.8
5 Oct	39	290	63	1	511	865	1.4	3.2
7 Oct	243	1,151	177	92	725	2,145	5.2	8.7
7 Oct	40	1,158	69	99	557	1,883	5.2	7.8
8 Oct	41	84	0	0	654	738	0.4	2.3
9 Oct	244	58	0	1	831	889	0.2	2.5
10 Oct	245	485	7	2	840	1,334	2.2	4.9
10 Oct	42	166	0	95	733	994	0.8	3.3
11 Oct	246	290	55	10	333	688	1.4	2.8
15 Oct	247	725	109	69	716	1,620	3.2	6.2
16 Oct	248	358	12	1	620	991	1.5	3.4
17 Oct	249	407	49	3	283	742	1.8	3.0
18 Oct	250	473	41	97	348	958	2.1	4.1
19 Oct	251	922	107	3	688	1,719	4.1	6.9
22 Oct	252	265	240	9	1,299	1,812	1.2	6.5
23 Oct	253	687	85	5	457	1,233	3.1	5.2
24 Oct	254	820	29	51	886	1,786	3.7	6.8
25 Oct	255	790	110	72	205	1,177	3.6	5.2

Day	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
			Semimonthly Effort Summary				
1-15 Jul	4,898	687	283	4,817	10,684	22.4	43.3
16-31 Jul	9,264	767	908	8,451	19,390	41.2	76.9
1-15 Aug	5,807	436	809	4,187	11,238	26.1	46.3
16-31 Aug	10,610	1,109	694	10,936	23,350	47.7	91.6
1-15 Sep	9,328	1,807	744	9,499	21,378	41.6	85.6
16-30 Sep	8,069	912	343	9,616	18,937	36.6	73.7
1-15 Oct	4,737	622	538	6,555	12,452	21.4	47.3
16-31 Oct	4,722	673	241	4,786	10,418	20.9	41.0
Total	**57,435**	**7,013**	**4,560**	**58,847**	**127,847**	**257.9**	**505.7**

or a combination of weather and aircraft inspections (2 days), hard down days due to survey hour restrictions (2 days), and conducting an FOV flight (2 days).

Survey effort was summarized by hours or kilometers flown in different survey modes. Over 127,000 km were flown during 505.7 hours (Figure 4). A total of 57,435 km of effort on transect was flown during 257.9 hours (Figure 5). Each transect was surveyed completely at least once, with the exception of transect 23 in the southern Chukchi Sea. Transect effort constituted 45% of the total kilometers flown and 51% of the total flight hours. Transect effort combined with circling on transect effort accounted for 50% of the total kilometers flown and 59% of the total flight hours. Thirty-six percent of total survey hours were flown on deadhead, when no survey data are recorded other than time and aircraft position (latitude, longitude, altitude, and heading). Deadhead flight time typically occurred during transits to and from transects, when observers were not actively searching for marine mammals, and were generally at faster speeds (usually >330 km/h). Deadhead was also recorded during several flights when local weather conditions were not conducive to collecting data although, in 2017, only two flights were almost entirely on deadhead due to prevailing poor weather conditions. During an average survey, an aerial survey team covered 1,317 km, ranging from 462 km to 2,608 km. The longer distances required 2-3 flights per survey.

Survey effort (transect, search, and circling) is plotted semimonthly in Figure 6. Survey effort was distributed throughout the ASAMM study area in most months, although regions nearer to communities with infrastructure support, such as fuel and lodging and including Deadhorse, Utqiaġvik, and Kotzebue, were targeted more often than areas farther from those communities (e.g., survey blocks 19-21 and the eastern half of survey blocks 5 and 7). Systematic broad-scale coverage of the western Beaufort Sea in summer (July through August) was conducted for the sixth consecutive year, and included transects extended between the barrier islands and the mainland in block 1 to survey areas near the Liberty Prospect. Survey coverage in the entire ASAMM study area was well distributed in late July, late August, and early September. Survey effort in early July and late October was limited due to the presence of only one survey team, based in Utqiaġvik. In early August and early October, survey coverage was limited due to widespread poor weather conditions throughout the study area. Poor survey conditions also limited coverage to the Chukchi Sea and western Alaskan Beaufort Sea (west of 149°W) in late September, and primarily in the western Beaufort Sea and northern part of the Chukchi Sea study area in late October. During times when there were two aircraft conducting surveys, survey coverage (time and distance) was greatest in late July, when 12 surveys were flown, and lowest in early August and late September when eight surveys were flown.

A coastal transect in the western Beaufort Sea was incorporated into ASAMM survey protocol for the first time in 2017. Portions of the coastal transect in the western Beaufort Sea were surveyed on 13 days between 25 July and 10 October 2017, covering approximately 2,100 km. In previous years, search effort in the western Beaufort Sea was flown opportunistically along the shoreline or barrier islands between transects or when environmental conditions were not conducive to conducting surveys offshore. Portions of the coastal transect in the eastern Chukchi Sea were surveyed on 12 days between 4 July and 18 October, covering approximately 2,800 km.

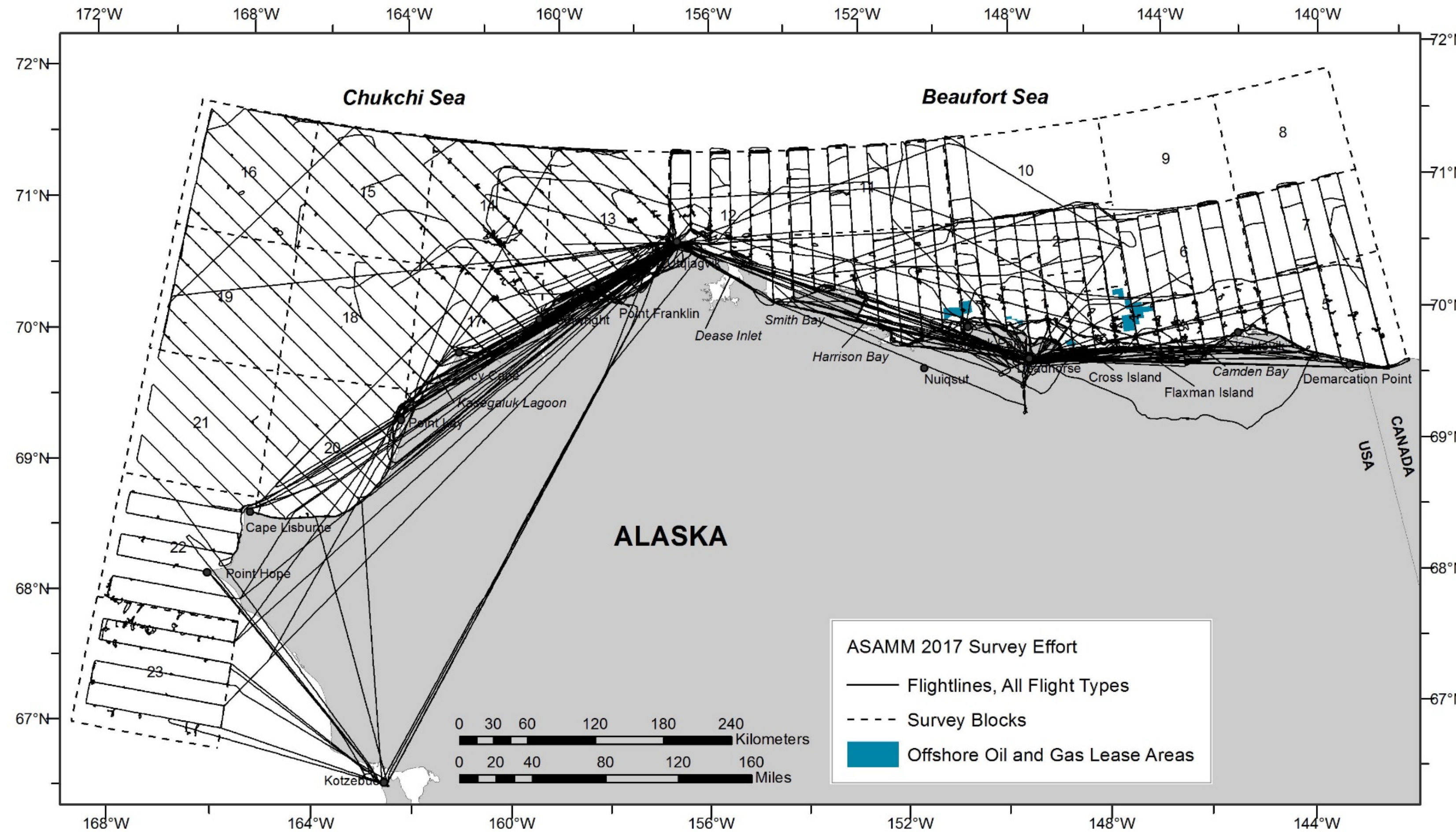


Figure 4. ASAMM 2017 combined flight tracks, all flight types (transect, search, circling, and deadhead).

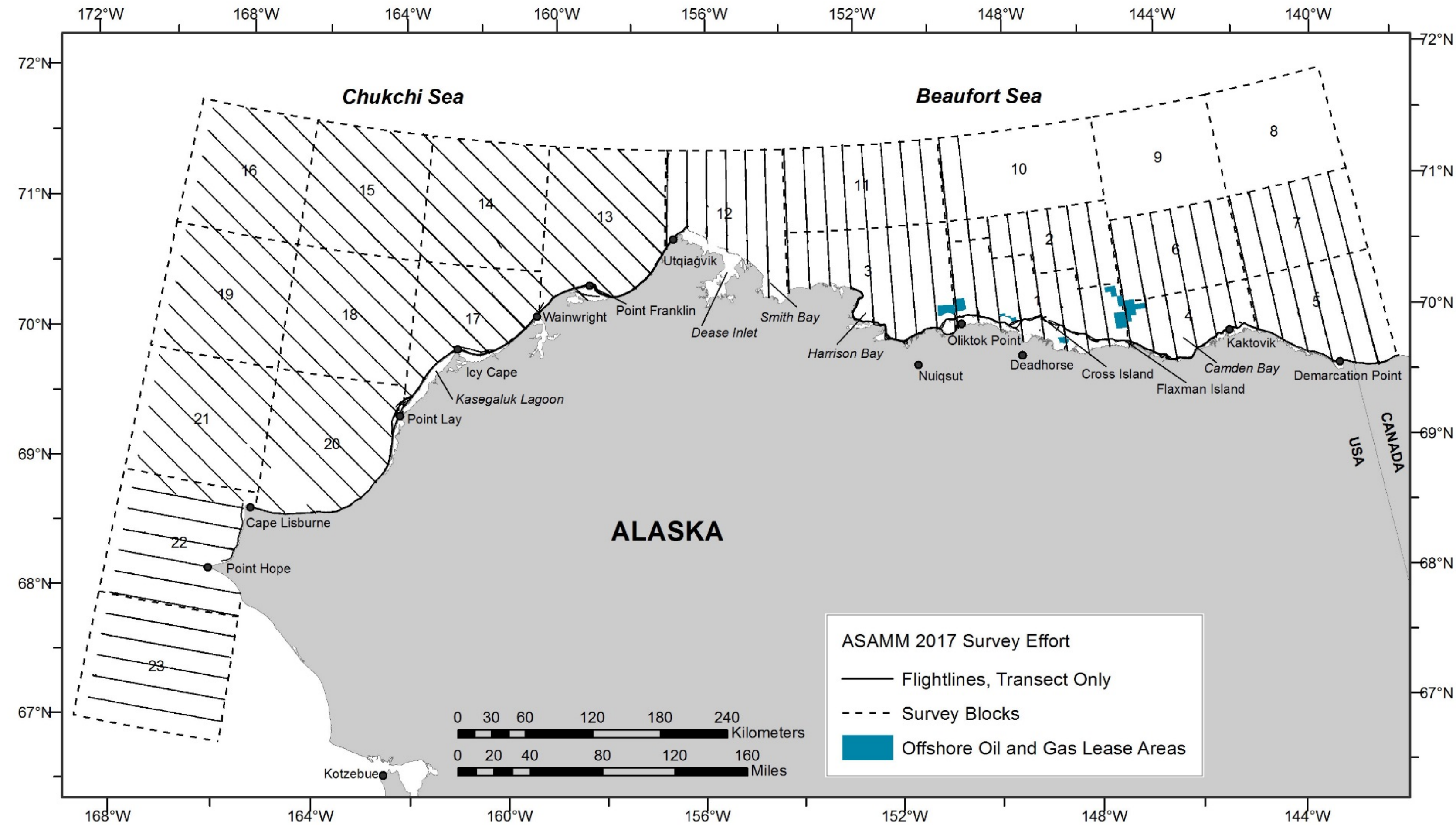


Figure 5. ASAMM 2017 combined flight tracks, transect effort only.

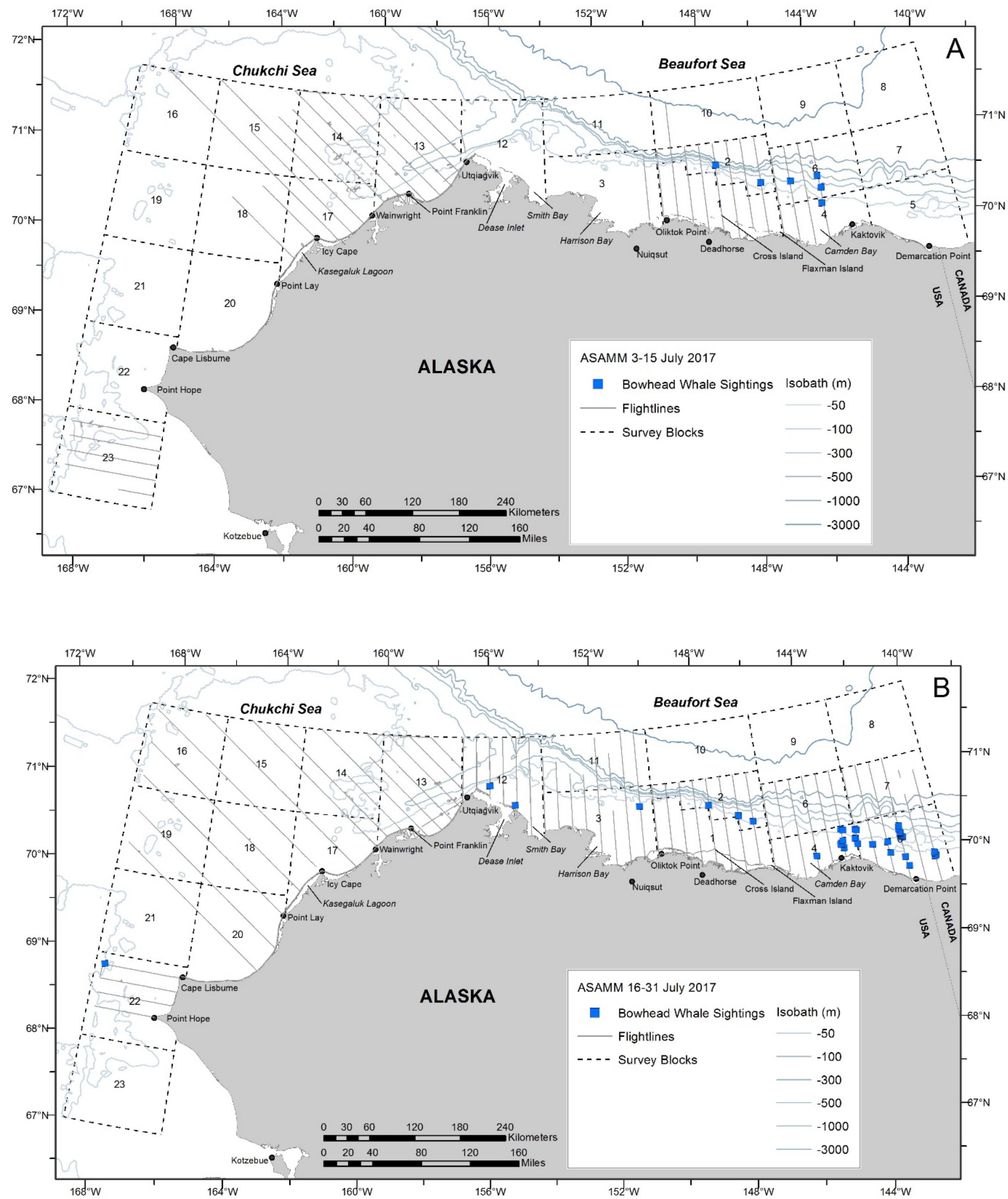
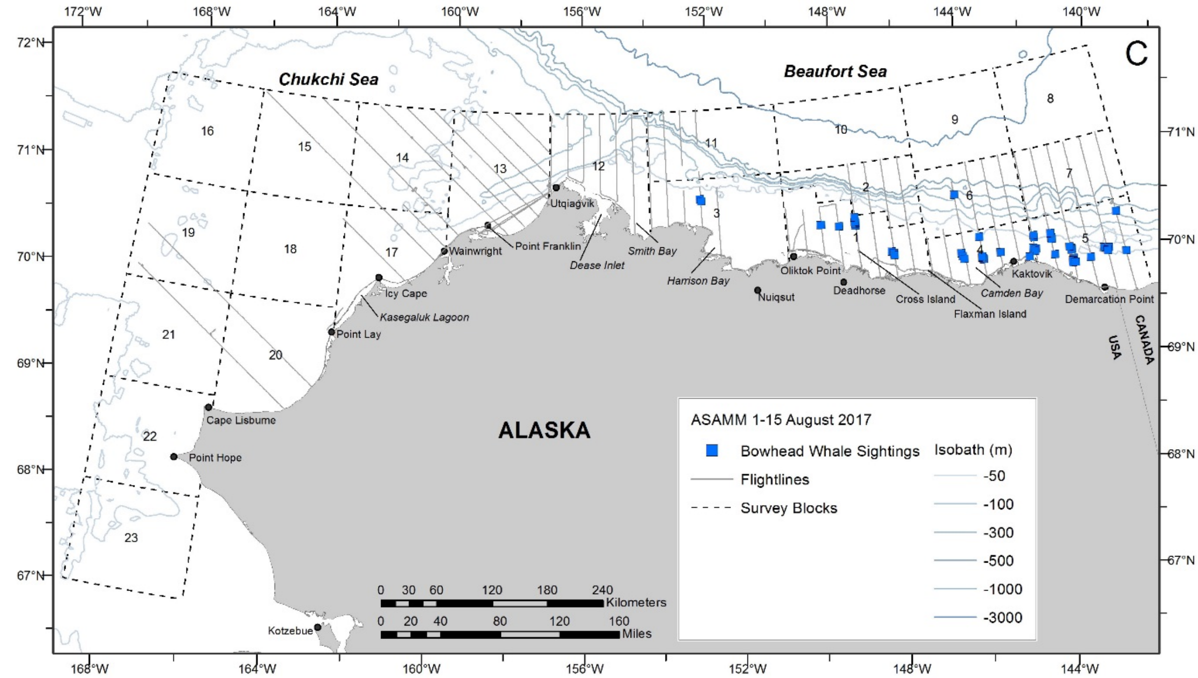


Figure 6. ASAMM 2017 semimonthly bowhead whale sightings, with transect, search, and circling survey effort. A: 3-15 July; B: 16-31 July. Deadhead flight tracks are not shown.



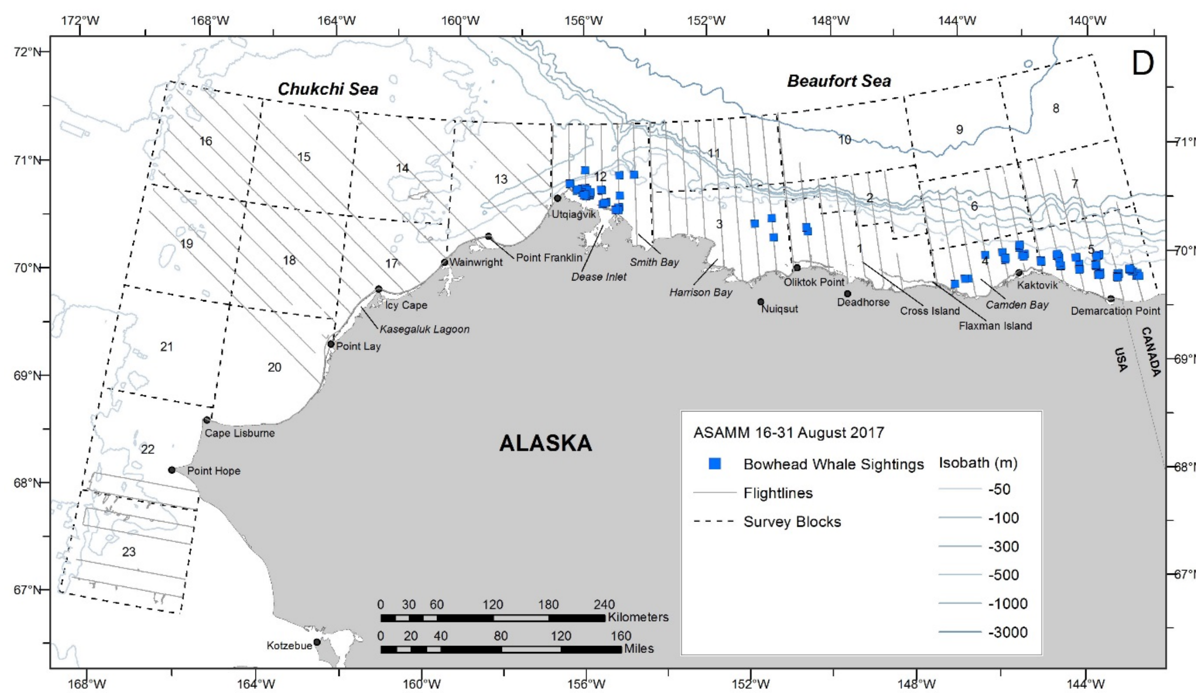
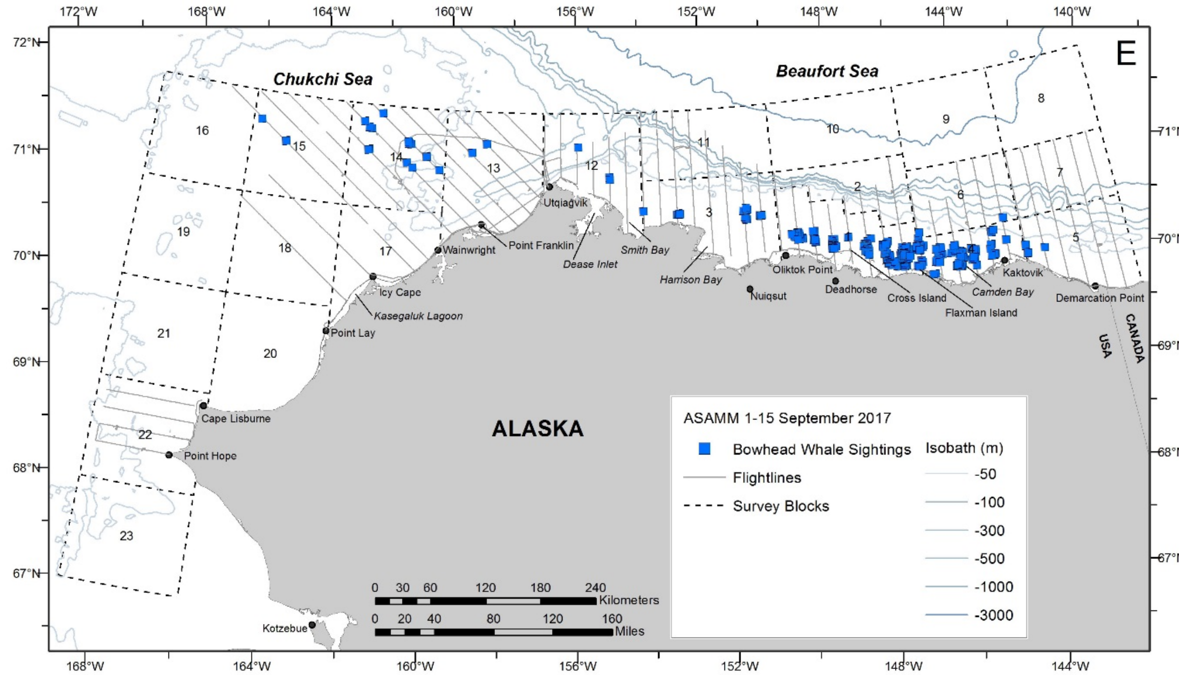


Figure 6 (cont). ASAMM 2017 semimonthly bowhead whale sightings, with transect, search, and circling effort. C: 1-15 August; D: 16-31 August. Deadhead flight tracks are not shown.



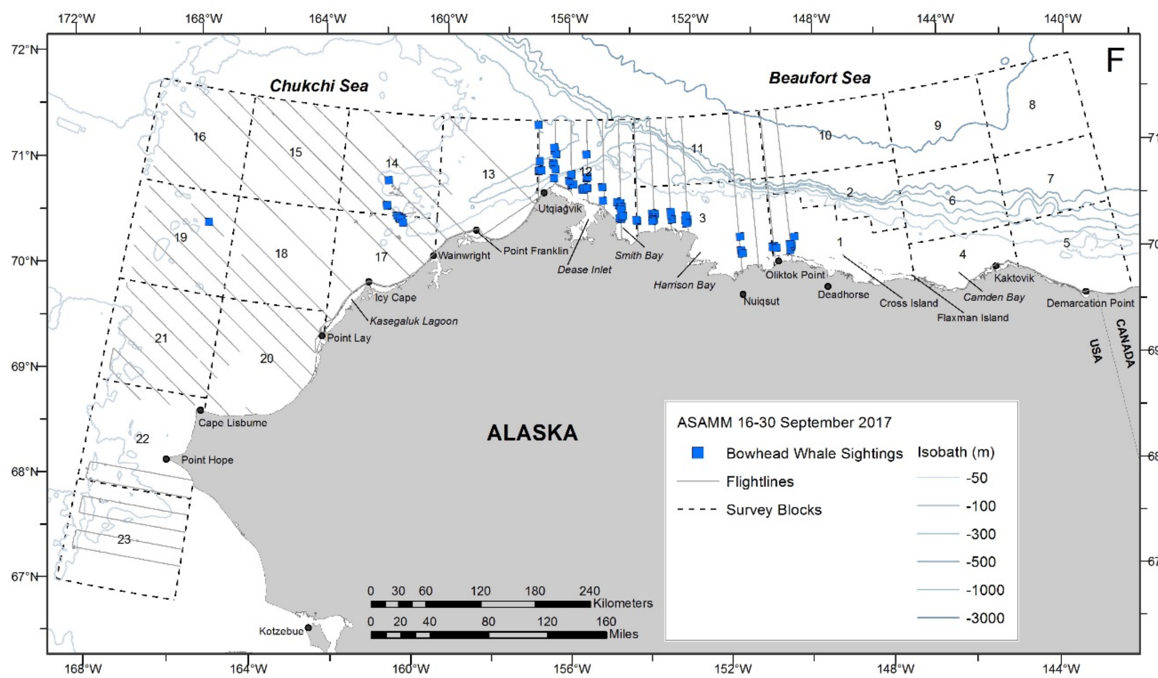
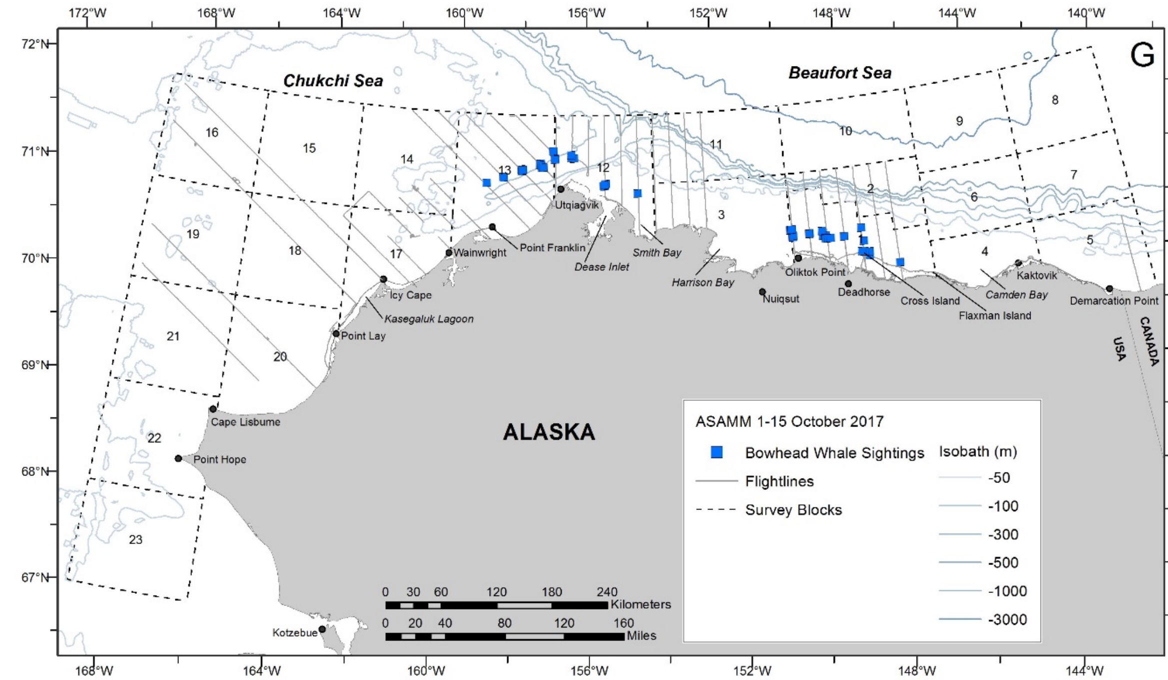


Figure 6 (cont). ASAMM 2017 semimonthly bowhead whale sightings, with transect, search, and circling effort. E: 1-15 September; F: 16-30 September. Deadhead flight tracks are not shown.



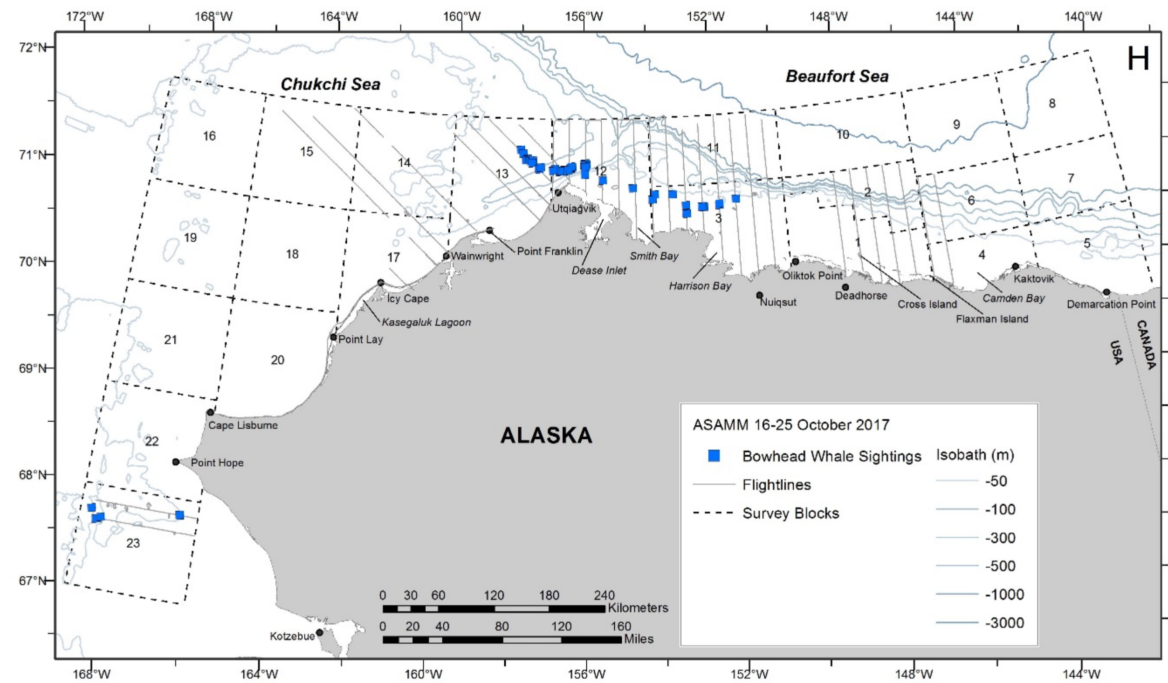


Figure 6 (cont). ASAMM 2017 semimonthly bowhead whale sightings, with transect, search, and circling effort. G: 1-15 October; H: 16-25 October. Deadhead flight tracks are not shown.

Survey effort in 2017 was impacted by poor weather conditions and conducting FOV surveys. Fog, low ceilings, and strong winds curtailed survey effort throughout the field season, but particularly in September when surveys were not conducted by either survey team on 11 of 30 days. In late October, forecasted strong winds encompassing the entire study area led to the 2017 field season ending five days early. The longest period when no ASAMM flights occurred was four days. Mitigating the lack of survey effort during periods of poor weather was achieved by taking full advantage of good weather days to conduct multiple flights in one day.

Flights to collect FOV data were initiated on seven days under a variety of circumstances, including after a survey flight was completed (one day), in lieu of a survey flight when offshore conditions were acceptable (one day), in lieu of a survey flight when offshore conditions were unacceptable (two days), and attempted initially but not completed due to poor conditions at the FOV test site (three days) (Appendix D).

Direct avoidance of subsistence (or possible subsistence) activities, specifically the fall bowhead whale hunt occurring near Kaktovik, Cross Island, Utqiaġvik, and Wainwright, occurred on nine days in 2017. On 21 August, altitude was increased and the survey diverted to a different area to avoid possible subsistence whaling activity near Cross Island. Near Kaktovik, small boat activity was avoided on 3 September by maintaining appropriate lateral distance and minimum altitude, and survey altitude was increased on 23 September. On 7 and 11 October, transects were truncated near Utqiaġvik to avoid potential interference with subsistence whaling. On 25 September and 11, 18, and 23 October, transects were truncated or survey altitude increased near Wainwright to avoid potential interference with subsistence whaling. In all instances, ASAMM was able to conduct surveys in areas adjacent to but not directly overlapping subsistence whaling.

Additional fixed wing surveys supporting sea ice and marginal ice zone research were conducted in the Chukchi and Beaufort seas by researchers using NOAA Twin Otters. A UAV operating near Oliktok Point resulted in small-scale restricted airspace limitations. However, due to frequent communications and daily review of NOTAMs, neither fixed wing nor UAV activities impacted ASAMM survey effort.

Survey coverage was greatest in blocks 13, 14, and 17 in the Chukchi Sea and blocks 12, 1, and 3 in the Beaufort Sea (Figure 7) due, in part, to the proximity of those blocks to Utqiaġvik and Deadhorse. When weather conditions were marginal, survey teams remained relatively close to their bases of operation in case weather conditions started to rapidly worsen. When conditions quickly deteriorated, survey effort was immediately aborted so that survey teams could return safely to base. The higher effort in blocks 12 and 13 is partially due to basing the single survey team at Utqiaġvik before 19 July and after 10 October. Block 23 was surveyed for the fourth consecutive year, with effort in July, August, September, and October. Block 1a was surveyed in all months. Flight lines, associated sea states, and sightings on individual flights are shown in Appendix B.

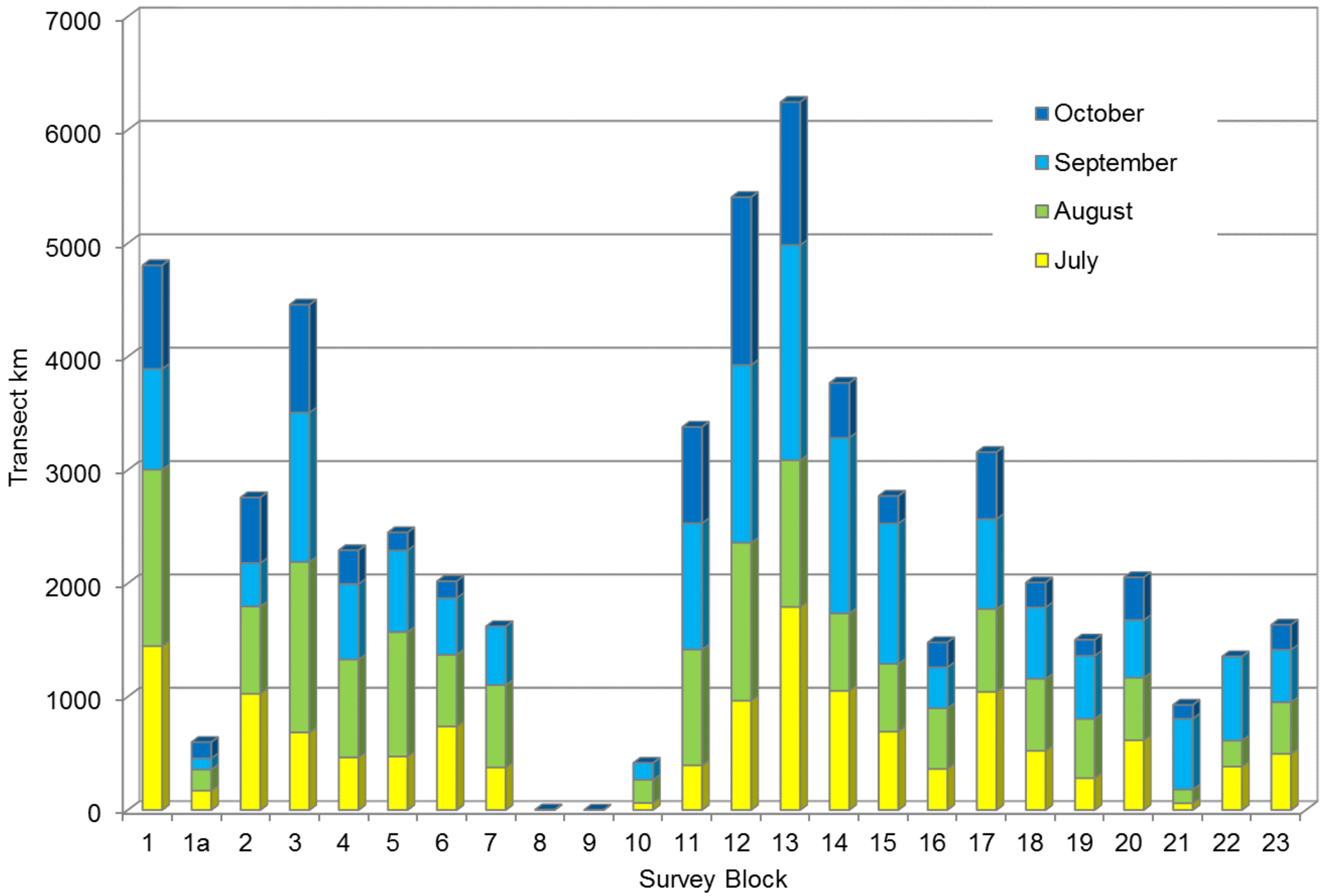


Figure 7. ASAMM 2017 monthly transect survey effort per block.

Cetaceans

Bowhead Whales

BOWHEAD WHALE SIGHTING SUMMARY

During 2017 ASAMM surveys, 764 sightings of 1,303 bowhead whales (*Balaena mysticetus*) of the Western Arctic (also known as the Bering-Chukchi-Beaufort) stock were observed during transect, search, and circling survey modes from July through October (Table 3; Figure 8). This is higher than the average number of bowhead whales (mean = 465; median = 337.5) usually observed in a single year during ASAMM surveys, and is the third highest total observed since 1982 (Clarke et al. 2017b).

One hundred five bowhead whales were seen in July (Figures 6A and 6B). Sightings were widely dispersed in the western Beaufort Sea, with sightings over the slope (201-2,000 m depth), outer continental shelf (51-200 m) and inner continental shelf (≤50 m). No bowhead whales were seen over the basin (>2,000 m depth). Most of the bowhead whales observed in July were east of 148°W. Two bowhead whales were seen in the southcentral Chukchi Sea, approximately 100 km west of Cape Lisburne. The highest number of bowhead whales per survey block in July was in block 5 (n_i = 41). In August, 254 bowhead whales were seen (Figures 6C and 6D). Bowhead whales were observed in the western Beaufort Sea from 140°W to 157°W in slope, outer and inner shelf waters, and in Barrow Canyon between 153.8°W to 156.5°W; no bowhead whales were observed in the Chukchi Sea. The highest number of bowhead whales per survey block in August was in block 5 (n_i = 109). In September, 740 bowhead whales were seen. In the western Beaufort Sea, bowhead whale distribution in September was primarily on the inner shelf (≤50 m depth) and in Barrow Canyon (Figures 6E and 6F). In the Chukchi Sea in September, bowhead whales were observed primarily between 71.2°N and 72°N, with sightings 85-325 km west and northwest of Utqiaġvik; one bowhead whale was seen approximately 250 km west of Wainwright. The greatest number of bowhead whales per survey block in September was in block 1 (n_i = 382). In October, 204 bowhead whales were seen, and distribution in the western Alaskan Beaufort Sea was limited to Barrow Canyon and the inner shelf west of 147°W (Figures 6G and 6H). In the Chukchi Sea, bowhead whale distribution was limited to the Barrow Canyon area and the southcentral Chukchi Sea, where five bowhead whales were seen in late October. The greatest number of bowhead whales per survey block in October was seen in block 1 (n_i = 82). Poor weather conditions and inconsistent survey effort likely influenced observed bowhead whale distribution in October more than other months; there was no survey effort west of 146°W and inconsistent effort in the Chukchi Sea. Bowhead whale sightings in the northeastern Chukchi Sea in September and October 2017 reinforce previous observations from aerial surveys, satellite telemetry (Quakenbush et al. 2010a), and acoustics (Delarue et al. 2011), describing a broad migration route that spreads across the northeastern Chukchi Sea.

Bowhead whales were last observed during the final survey of the year, on 25 October, when 11 whales were seen in blocks 3 and 12, east of Point Barrow. No bowhead whales were observed in block 1a.

Table 3. Summary of ASAMM 2017 cetacean sightings (number of sightings/number of individuals) during all survey modes (transect, search, and circling) in chronological order, 3 July – 25 October 2017, by survey flight and semimonthly time period. Excludes dead and repeat sightings.

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Killer Whale	Harbor Porpoise	Unidentified Cetacean
3 Jul	201	0	25/48	0	0	0	12/35	0	0	0
4 Jul	202	0	9/33	0	0	0	0	0	0	0
6 Jul	203	6/11	0	0	0	0	20/49	0	0	1/1
7 Jul	204	0	0	0	0	0	0	0	0	0
12 Jul	205	0	5/9	0	0	0	2/16	0	0	0
13 Jul	206	0	46/124	0	0	0	0	0	0	1/1
14 Jul	207	0	0	0	0	0	0	0	0	0
15 Jul	208	0	67/106	0	0	0	0	0	0	0
18 Jul	209	0	12/15	0	0	0	0	0	0	1/1
19 Jul	1	3/6	0	0	0	0	56/250	0	1/1	0
21 Jul	210	0	19/49	0	0	0	0	0	0	1/1
21 Jul	2	2/20	0	0	0	0	3/123	0	0	0
22 Jul	211	1/2	0	2/2	1/2	0	0	0	0	0
23 Jul	3	19/33	0	0	0	0	42/134	0	0	0
25 Jul	4	1/1	0	0	0	0	43/134	0	0	0
26 Jul	212	0	3/4	0	0	0	6/27	0	0	1/1
27 Jul	213	0	2/4	0	0	0	0	0	0	0
28 Jul	214	0	4/7	0	0	0	5/262	0	0	0
28 Jul	5	0	0	0	0	0	0	0	0	0
29 Jul	6	17/27	0	0	0	0	64/174	0	0	0
30 Jul	215	0	16/48	0	0	0	0	0	0	0
31 Jul	216	1/4	0	0	0	0	7/34	0	0	0

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Killer Whale	Harbor Porpoise	Unidentified Cetacean
31 Jul	7	1/1	0	0	0	0	7/18	0	0	0
2 Aug	8	8/10	0	0	0	0	32/56	0	0	0
4 Aug	217	0	1/1	0	0	0	0	0	0	0
5 Aug	9	23/28	0	0	0	0	29/126	0	0	0
7 Aug	10	9/14	0	0	0	0	0	0	0	0
9 Aug	11	9/9	0	0	0	0	0	0	0	0
10 Aug	218	0	4/10	0	0	0	13/26	0	0	0
10 Aug	12	2/2	0	0	0	0	8/96	0	0	0
11 Aug	219	0	14/22	0	0	0	0	0	0	0
14 Aug	220	0	0	0	0	0	0	0	0	0
15 Aug	13	3/3	0	0	0	0	4/5	0	0	0
16 Aug	221	0	0	0	0	0	0	0	0	0
16 Aug	14	33/57	0	0	0	0	3/18	0	0	0
19 Aug	15	20/36	0	0	0	0	10/61	0	0	0
20 Aug	16	0	8/9	0	0	0	0	0	0	0
21 Aug	222	0	1/4	0	0	0	0	0	0	0
21 Aug	17	0	0	0	0	0	2/6	0	0	0
24 Aug	223	0	0	0	0	0	0	0	0	0
24 Aug	18	4/5	0	0	0	0	3/15	0	0	0
25 Aug	224	0	0	0	0	0	0	0	0	0
25 Aug	19	19/27	0	0	0	0	6/8	0	0	0
26 Aug	20	0	0	0	0	0	1/3	0	0	0
27 Aug	225	14/56	0	0	0	0	0	0	0	1/1
27 Aug	21	2/2	0	0	0	0	0	0	0	0
28 Aug	226	0	69/131	3/6	7/11	0	0	0	0	4/4
28 Aug	22	2/2	0	0	0	0	0	0	0	0

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Killer Whale	Harbor Porpoise	Unidentified Cetacean
29 Aug	227	0	0	0	0	0	0	0	0	0
29 Aug	23	3/3	0	0	0	0	0	0	0	1/1
2 Sep	24	0	0	0	0	0	0	0	0	0
3 Sep	228	6/7	0	0	0	0	0	0	0	1/1
3 Sep	25	83/138	0	0	0	0	0	0	0	1/1
4 Sep	229	3/4	10/13	0	0	0	0	0	0	0
8 Sep	230	0	1/1	0	0	0	0	0	0	0
9 Sep	231	8/8	8/8	0	0	0	0	0	0	1/1
9 Sep	26	35/72	0	0	0	0	0	0	0	0
10 Sep	232	3/3	0	0	0	0	0	0	0	0
11 Sep	233	0	0	2/2	2/2	0	0	0	0	1/1
11 Sep	27	13/17	0	0	0	0	0	0	0	0
12 Sep	28	2/2	0	0	0	0	0	0	0	0
13 Sep	234	0	0	0	0	0	0	0	0	0
13 Sep	29	7/8	0	0	0	0	1/2	0	0	1/1
14 Sep	235	4/5	2/2	0	0	0	0	0	0	1/1
14 Sep	30	152/305	0	0	0	0	0	0	0	1/1
15 Sep	31	27/40	0	0	0	0	0	0	0	0
18 Sep	32	0	0	0	0	0	2/95	0	0	0
19 Sep	236	0	1/1	0	0	0	0	0	0	0
19 Sep	33	1/1	28/42	0	0	0	0	1/2	0	0
20 Sep	237	0	6/8	0	0	0	0	0	0	0
20 Sep	34	49/68	3/6	0	0	0	0	0	0	3/3
21 Sep	35	23/27	0	0	0	0	0	0	0	0
25 Sep	238	1/1	0	0	0	0	0	0	0	0
26 Sep	239	0	24/44	1/2	1/4	2/2	0	0	0	1/2

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Killer Whale	Harbor Porpoise	Unidentified Cetacean
26 Sep	36	18/20	0	0	0	0	0	0	0	0
27 Sep	240	9/12	5/9	0	0	0	0	0	0	0
27 Sep	37	1/1	0	0	0	0	0	0	0	0
30 Sep	241	1/1	14/19	0	0	0	0	0	0	0
1 Oct	38	8/8	0	0	0	0	0	0	0	0
2 Oct	242	0	6/10	0	0	0	0	0	0	0
5 Oct	39	4/54	0	0	0	0	0	0	0	0
7 Oct	243	14/30	0	0	0	0	0	0	0	2/2
7 Oct	40	12/15	0	0	0	0	0	0	1/1	1/1
8 Oct	41	0	0	0	0	0	0	0	0	0
9 Oct	244	0	0	0	0	0	0	0	0	0
10 Oct	245	0	0	0	0	0	0	0	0	0
10 Oct	42	0	0	0	0	0	0	0	0	0
11 Oct	246	2/4	11/11	0	0	0	0	0	0	0
15 Oct	247	16/23	0	0	0	0	2/20	0	0	0
16 Oct	248	0	0	0	0	0	0	0	0	0
17 Oct	249	12/12	0	0	0	0	4/7	0	0	0
18 Oct	250	25/33	0	0	0	0	0	0	0	0
19 Oct	251	9/9	0	0	0	0	1/60	0	0	0
22 Oct	252	5/5	7/7	2/3	8/11	1/1	0	0	0	2/2
23 Oct	253	0	9/16	0	0	0	1/135	0	0	0
24 Oct	254	0	0	0	0	0	0	0	0	0
25 Oct	255	9/11	0	0	0	0	39/158	0	0	0

Day	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Killer Whale	Harbor Porpoise	Unidentified Cetacean
Semimonthly Summary									
3-15 Jul	6/11	152/320	0	0	0	34/100	0	0	2/2
16-31 Jul	45/94	56/127	2/2	1/2	0	233/1,156	0	1/1	3/3
1-15 Aug	54/66	19/33	0	0	0	86/309	0	0	0
16-31 Aug	97/188	78/144	3/6	7/11	0	25/111	0	0	6/6
1-15 Sep	343/609	21/24	2/2	2/2	0	1/2	0	0	7/7
16-30 Sep	103/131	81/129	1/2	1/4	2/2	2/95	1/2	0	4/5
1-15 Oct	56/134	17/21	0	0	0	2/20	0	1/1	3/3
16-25 Oct	60/70	16/23	2/3	8/11	1/1	45/360	0	0	2/2
TOTAL	764/1,303	440/821	10/15	19/30	3/3	428/2,153	1/2	2/2	27/28

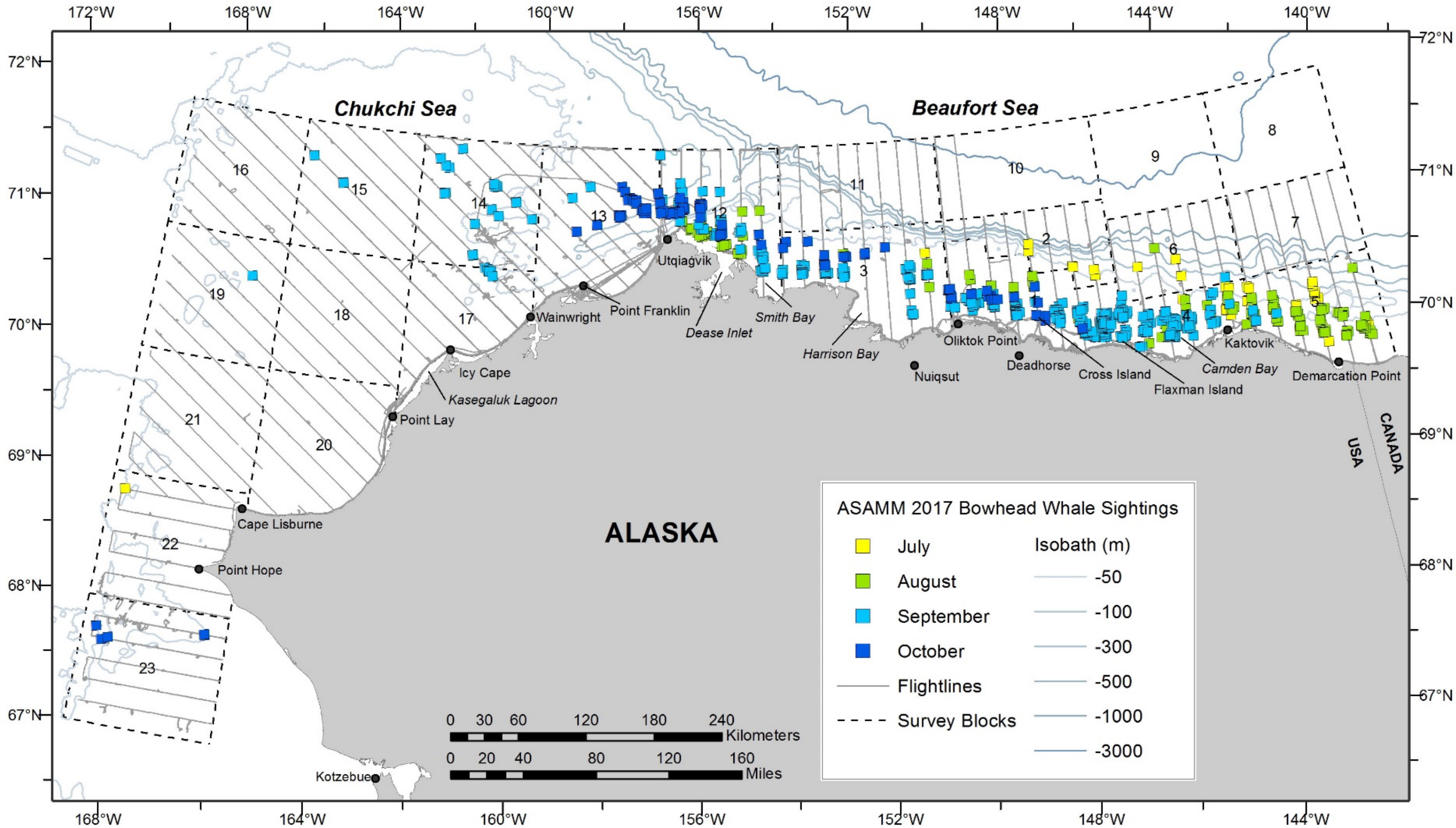


Figure 8. ASAMM 2017 bowhead whale sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Bowhead Whale Sighting Rates

In summer and fall 2017, bowhead whales were seen on transect (Tr) from 140.4°W to 168.7°W. There were 353 sightings of 663 bowhead whales on transect by primary observers, ranging from one whale per sighting (n_s = 240) to 30 whales per sighting (n_s = 1). The highest number of sightings on transect was in block 1 (93 sightings), followed by block 12 (66 sightings) and block 5 (59 sightings). The largest group of bowhead whales on transect (30 whales) was observed on 14 September in block 1. When transect and circling from transect (Tr+TrC) sightings were combined, there were 726 sightings of 1,251 bowhead whales, ranging from one whale per sighting (n_s = 494) to 30 whales per sightings (n_s = 1). The highest number of Tr+TrC sightings was in block 1 (230 sightings), followed by block 4 (133 sightings).

High fine-scale Tr sighting rates (WPUE, 5-km grid) for summer (July-August) were limited to offshore northeast of Kaktovik and north and east of Utqiaġvik (Figure 9A). In fall (September-October), highest fine-scale Tr sighting rates were north of Kaktovik, in Camden Bay, and between Flaxman Island and Cross Island (Figure 9B). Comparisons of Tr and Tr+TrC sighting rates for bowhead whales in summer and fall are included in Appendix E (Figures E-1 and E-2). Summer and fall Tr+TrC sighting rates provide the best representation of on-effort sightings and effort in 2017 and highlight areas of bowhead whale aggregations, particularly in fall (Appendix E, Figure E-2.

Monthly and seasonal shifts in bowhead whale distribution were evident in results of the analysis of sighting rates by survey block. For all months combined, the highest Tr sighting rates per survey block were in block 1 (0.055 WPUE), block 5 (0.035 WPUE), and block 4 (0.035 WPUE), with an overall Tr sighting rate of 0.012 WPUE.

Sighting rates (Tr) in the western Beaufort Sea were low in July in all survey blocks except blocks 5 and 12 (Figure 10). Sighting rate per block in July 2017 did not indicate a predominantly offshore distribution as noted in some previous years. Sighting rates in August were highest in block 5 (0.049 WPUE), block 12 (0.031 WPUE), and block 4 (0.029 WPUE). The Tr sighting rates for summer (July and August combined) were highest in block 5 (0.052 WPUE), block 12 (0.028 WPUE), and block 4 (0.024 WPUE), and overall Tr sighting rate in summer for all blocks combined in the western Beaufort Sea was 0.013 WPUE (Appendix E, Table E-1). Combined Tr sighting rates for fall (September-October) were highest in block 1 (0.141 WPUE), block 4 (0.049 WPUE), and block 12 (0.019 WPUE); overall Tr sighting rate in fall for all blocks combined in the western Beaufort Sea was 0.030 WPUE (Appendix E, Table E-1).

Sighting rates (Tr) in all Chukchi Sea blocks (13-23) in summer were very low (Figure 10); bowhead whales were seen only in block 22 in July. In the Chukchi Sea in fall, the highest Tr sighting rate was 0.008 WPUE in block 13 (Appendix E, Table E-1). The overall Tr sighting rate for all Chukchi Sea survey blocks (13-23) in fall was 0.004 WPUE, which was similar to the overall Tr sighting rate for this area in 2013, 2014, 2015, and 2016 (Clarke et al. 2014, 2015a, 2017a, b) and lower than the Tr sighting rate for this area in 2012 (Clarke et al. 2013a).

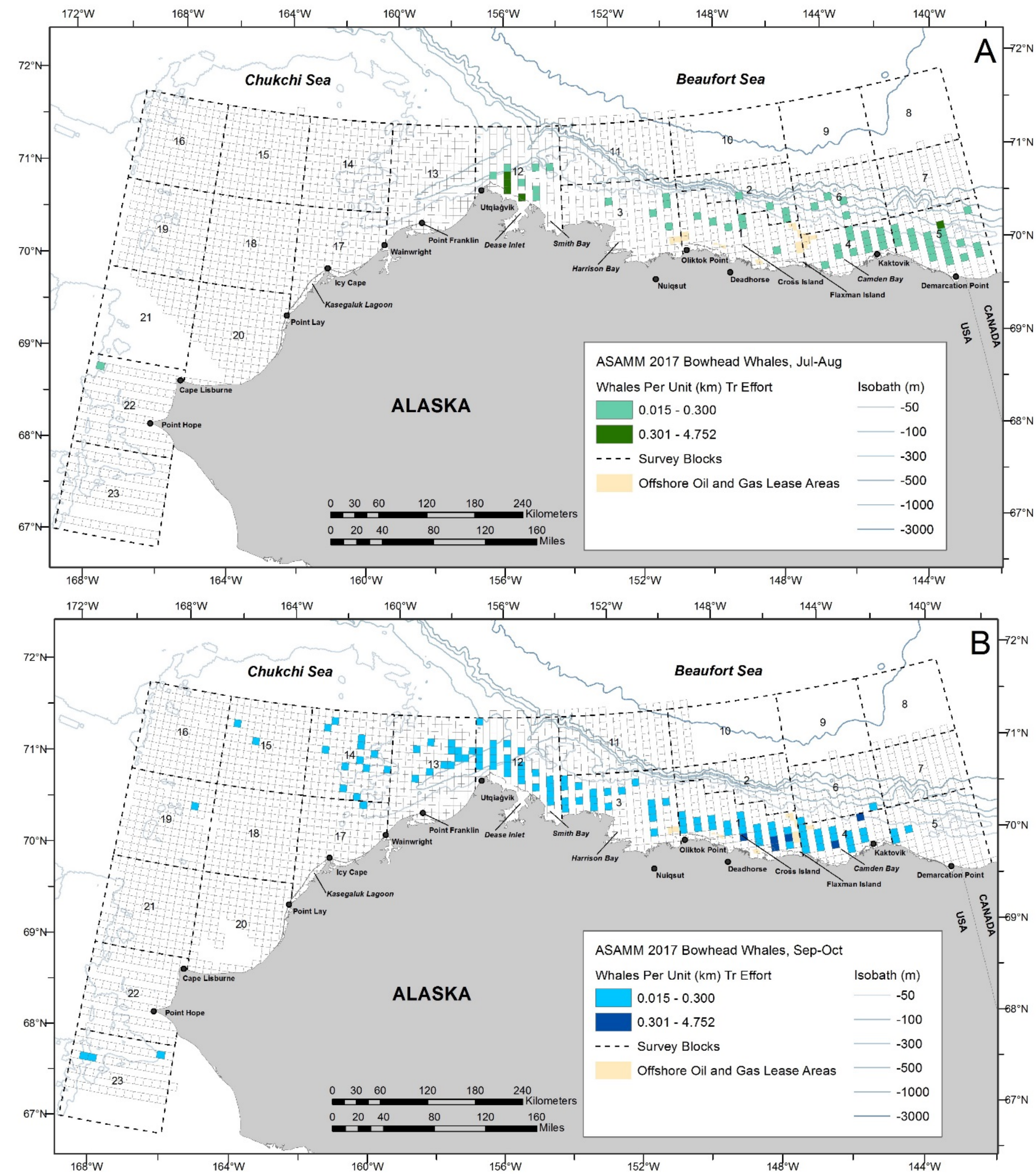


Figure 9. ASAMM 2017 bowhead whale sighting rates (WPUE; transect sightings from primary observers only). A: summer (July-August); B: fall (September-October). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

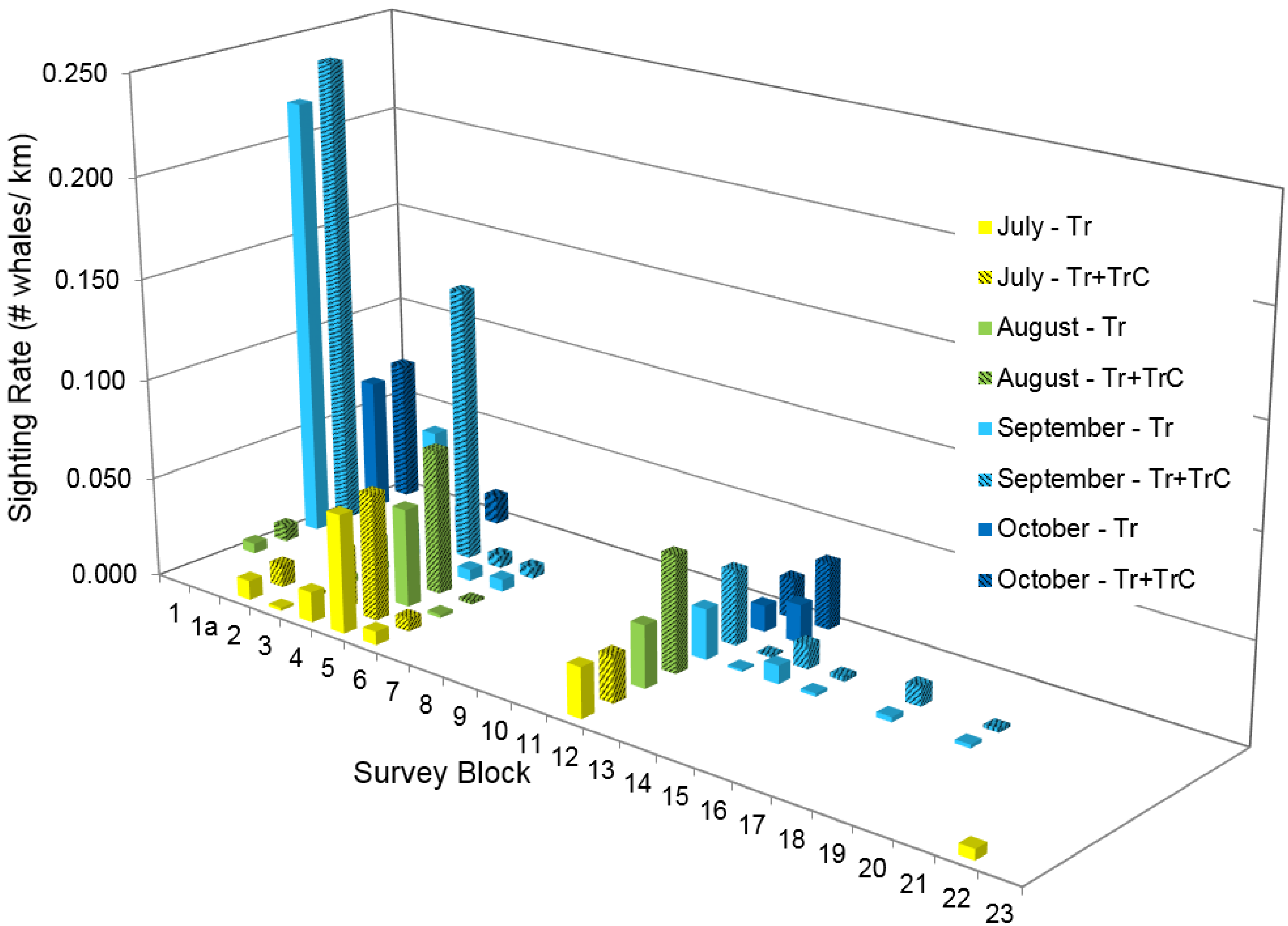


Figure 10. ASAMM 2017 bowhead whale monthly sighting rates (WPUE; sightings from primary observers only) per survey block for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

Sighting rates per block calculated using sightings and effort on transect combined with sightings and effort from circling from transect (Tr+TrC) are a more accurate reflection of bowhead whale relative abundance because they incorporated all on-effort sightings and effort. Sighting rates that included sightings and effort on circling (Tr+TrC) were higher in all survey blocks compared to Tr sighting rates (Figure 10). The highest Tr+TrC monthly sighting rates by block for the entire study area was in block 1 in September (0.236 WPUE) (Appendix E, Table E-2).

For summer months, the highest Tr sighting rates per depth zone (Figure 11; Appendix E, Table E-3) were as follows:

- 51-200 m South depth zone (0.005 WPUE) in the eastern Chukchi Sea subarea (157°W-169°W);
- ≤20 m depth zone (0.117 WPUE) in the western (154°W-157°W) Alaskan Beaufort Sea subarea; and
- 21-50 m depth zone (0.021 WPUE) in the central-eastern (140°W-154°W) Alaskan Beaufort Sea subarea. In July, sighting rate was highest in the 51-200 m depth zone (0.036 WPUE) but decreased significantly there in August (0.009 WPUE).

The shift from highest Tr sighting rates in offshore, deeper water (51-200 m) in July to shallower water (21-50 m) in August in the central-eastern (140°W-154°W) Alaskan Beaufort Sea (Figure 11) has been noted in past years (2012-2015; Clarke et al. 2013a, 2014, 2015a, 2017a) and was especially pronounced in 2016 (Clarke et al. 2017b).

During fall, the highest Tr sighting rates per depth zone (Figure 11; Appendix E, Table E-3) were as follows:

- 51-200 m North depth zone (0.011 WPUE) in the eastern Chukchi Sea subarea (157°W-169°W);
- ≤20 m depth zone (0.031 WPUE) in the western (154°W-157°W) Alaskan Beaufort Sea subarea; and
- ≤20 m depth zone (0.065 WPUE) in the central-eastern (140°W-154°W) Alaskan Beaufort Sea subarea.

In the eastern Chukchi Sea (157°W-169°W) and the central-eastern Alaskan Beaufort Sea (140°W-154°W) subareas, sighting rates per depth zone were consistent from September to October. In the western Beaufort Sea (154°W-157°W) subarea, the highest sighting rate per depth zone shifted from the ≤20 m zone in September to the 51-200 m North zone in October.

Sighting rates per depth zone calculated using sightings and effort on transect and circling from transect (Tr+TrC) were usually higher in all depth zones compared to Tr sighting rates in both summer and fall (Figure 11). High monthly Tr+TrC sighting rates by depth were in the shallowest depth zone (≤20 m) in the western Alaskan Beaufort Sea in August and depth zones ≤50 m in the western Alaskan Beaufort Sea in September (Figure 11; Appendix E, Table E-4).

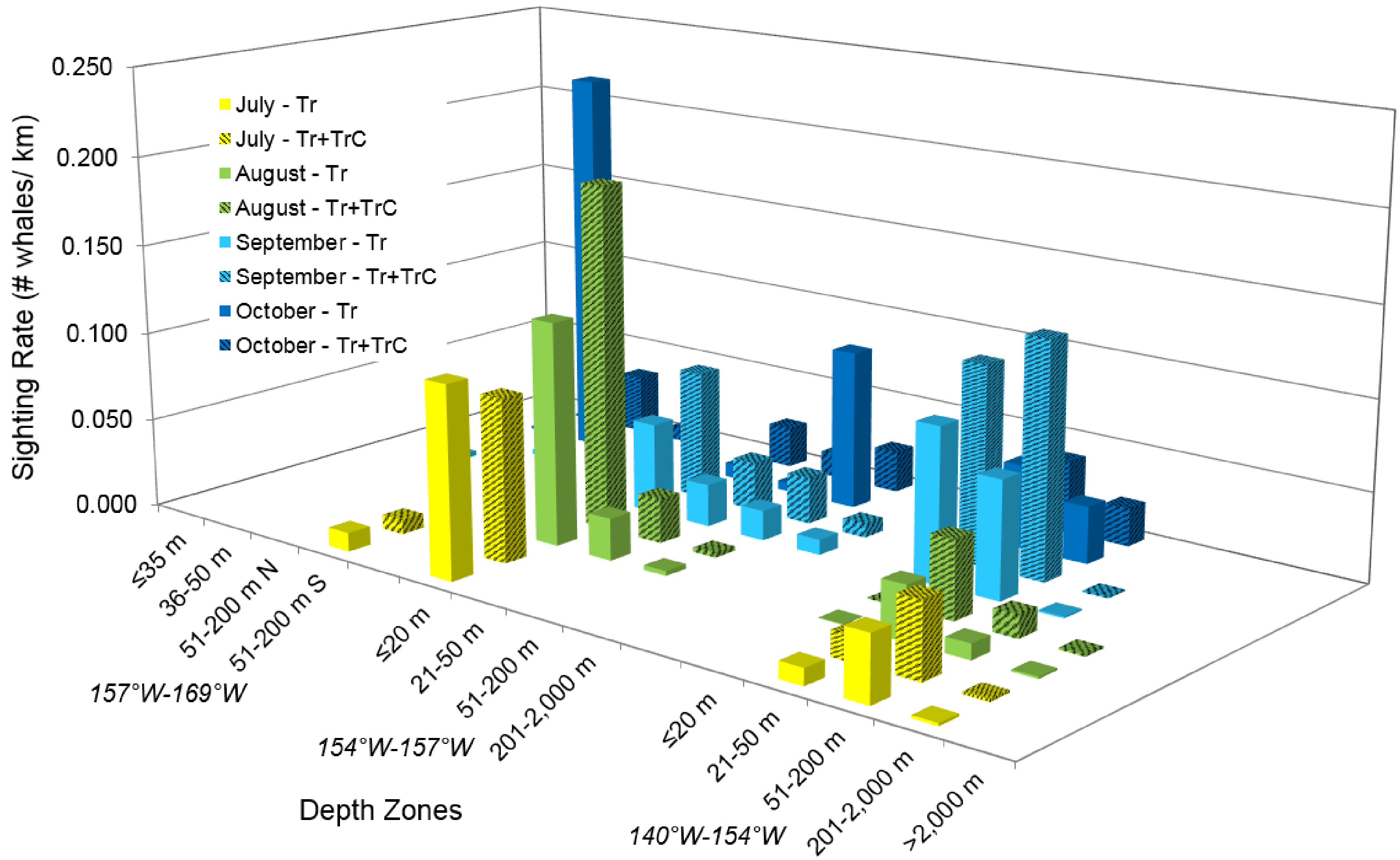


Figure 11. ASAMM 2017 bowhead whale monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

Bowhead Whale Sea Ice Associations

Most bowhead whales (98%, n_i = 1,273) were observed in 0% sea ice cover (Table 4). Sixteen bowhead whales (1%) were sighted in 1-10% sea ice cover, 12 bowhead whales (1%) were sighted in 11-40% sea ice cover, and two bowhead whales (<1%) were sighted in 60-80% sea ice cover. Most bowhead whales observed in areas of sea ice were seen in July and early August in the central Alaskan Beaufort Sea (144°W to 151°W), where broken floe sea ice remained (Appendix A, Figures A-3 and A-4), or in late October in the western Alaskan Beaufort Sea (152°W to 156°W), where new grease ice was forming (Figure A-9).

Bowhead Whale Behaviors

Bowhead whale behaviors observed during all survey modes (i.e., transect, search, and circling) and by primary and secondary observers in 2017 are summarized in Table 5. The behavior most often recorded was swimming (47%, n_i = 613), followed by feeding (25%, n_i = 323), resting (16%, n_i = 203), milling (7%, n_i = 91), and diving (3%, n_i = 43). Feeding behavior was likely underreported due to the difficulty of identifying this behavior for animals feeding on benthic or mid-water prey; milling was recorded in situations where obvious evidence of feeding was not directly observed but was suspected. Nine whales were recorded exhibiting display behaviors, including breaching (eight whales) and log playing (one whale). Fifteen whales were recorded as engaging in surface active group (SAG) behavior. Behavior was recorded as unknown for six whales, likely because the sightings were too far away to determine a behavior. Twenty-three bowhead whales (2% of all bowhead whales sighted) appeared to respond to the survey aircraft; all reacted by diving.

Seasonal differences were observed in bowhead whale swim direction. There were too few swim direction data to conduct statistical analysis for bowhead whales in the southcentral Chukchi Sea in summer or fall and in the northeastern Chukchi Sea in summer. In the western Beaufort Sea, bowhead whale swim direction was not clustered around any heading in summer. The mean vector swim direction was 252°T, but headings were scattered in all directions (Rayleigh Z = 0.581, P = 0.559, 59 observations). In fall, bowhead whale swim direction was significantly clustered in a northwesterly heading in the western Beaufort Sea (294°T; Rayleigh Z = 4.348, P = 0.013, 64 observations) and westerly in the northeastern Chukchi Sea (264°T; Rayleigh Z = 4.399, P = 0.012, 69 observations).

Bowhead Whale Calves

Out of the 1,303 bowhead whales sighted, 161 were identified as calves (Figure 12). Most calves (n_i = 118, 73%) were sighted after circling was initiated and likely would not have been observed if circling had not commenced. Calves were seen from early July through late October, distributed from 140°W to 158°W. Calves were seen in the eastern Alaskan Beaufort Sea (140°W-148°W) in July, with several seen offshore in >50 m water depth. Calf distribution in August was limited to east of 144°W, in shallower water depths closer to shore. Distribution was most widespread in September, extending from ~143°W to 157°W, with the exception of Harrison Bay. Calf sightings in October were limited to the western Alaskan Beaufort and northeastern Chukchi seas (146.5°W-158°W). Overall, most calves (96%) were seen in the

Table 4. ASAMM 2017 semimonthly summary of bowhead whales (number of sightings/number of individuals) observed during all survey modes (transect, search, and circling), by percent sea ice cover at sighting location. Excludes dead and same-day repeat sightings.

Percent Sea Ice Cover	1-15 Jul	16-31 Jul	1-15 Aug	16-31 Aug	1-15 Sep	16-30 Sep	1-15 Oct	16-30 Oct	Total
0	0	42/88	51/63	97/188	343/609	103/131	56/134	51/60	743/1273
1-5	2/3	3/6	1/1	0	0	0	0	3/3	9/13
6-10	1/1	0	2/2	0	0	0	0	0	3/3
11-20	0	0	0	0	0	0	0	4/4	4/4
21-30	1/2	0	0	0	0	0	0	1/2	2/4
31-40	1/4	0	0	0	0	0	0	0	1/4
41-50	0	0	0	0	0	0	0	0	0
51-60	0	0	0	0	0	0	0	1/1	1/1
61-70	0	0	0	0	0	0	0	0	0
71-80	1/1	0	0	0	0	0	0	0	1/1
TOTAL	6/11	45/94	54/66	97/188	343/609	103/131	56/134	60/70	764/1,303

Table 5. ASAMM 2017 semimonthly summary of bowhead whales (number of sightings/number of individuals) observed during all survey modes (transect, search, and circling), by behavioral category. SAG = surface active group. Excludes dead and same-day repeat sightings.

Behavior	1-15 Jul	16-31 Jul	1-15 Aug	16-31 Aug	1-15 Sep	16-30 Sep	1-15 Oct	16-31 Oct	Total
Breach	0	0	0	0	2/2	1/1	3/3	2/2	8/8
Dive	1/1	2/2	2/2	10/15	12/18	4/5	0	0	31/43
Feed	0	2/17	0	12/66	49/167	8/9	9/62	2/2	82/323
Log play	0	0	0	1/1	0	0	0	0	1/1
Mill	0	3/18	2/6	3/6	14/46	3/8	1/2	2/5	28/91
Rest	1/4	14/23	13/13	9/13	98/137	2/3	6/7	3/3	146/203
SAG	0	0	0	0	1/2	1/3	2/10	0	4/15
Swim	4/6	23/33	37/45	62/87	163/233	83/101	35/50	51/58	458/613
Unknown	0	1/1	0	0	4/4	1/1	0	0	6/6
TOTAL	6/11	45/94	54/66	97/188	343/609	103/131	56/134	60/70	764/1,303

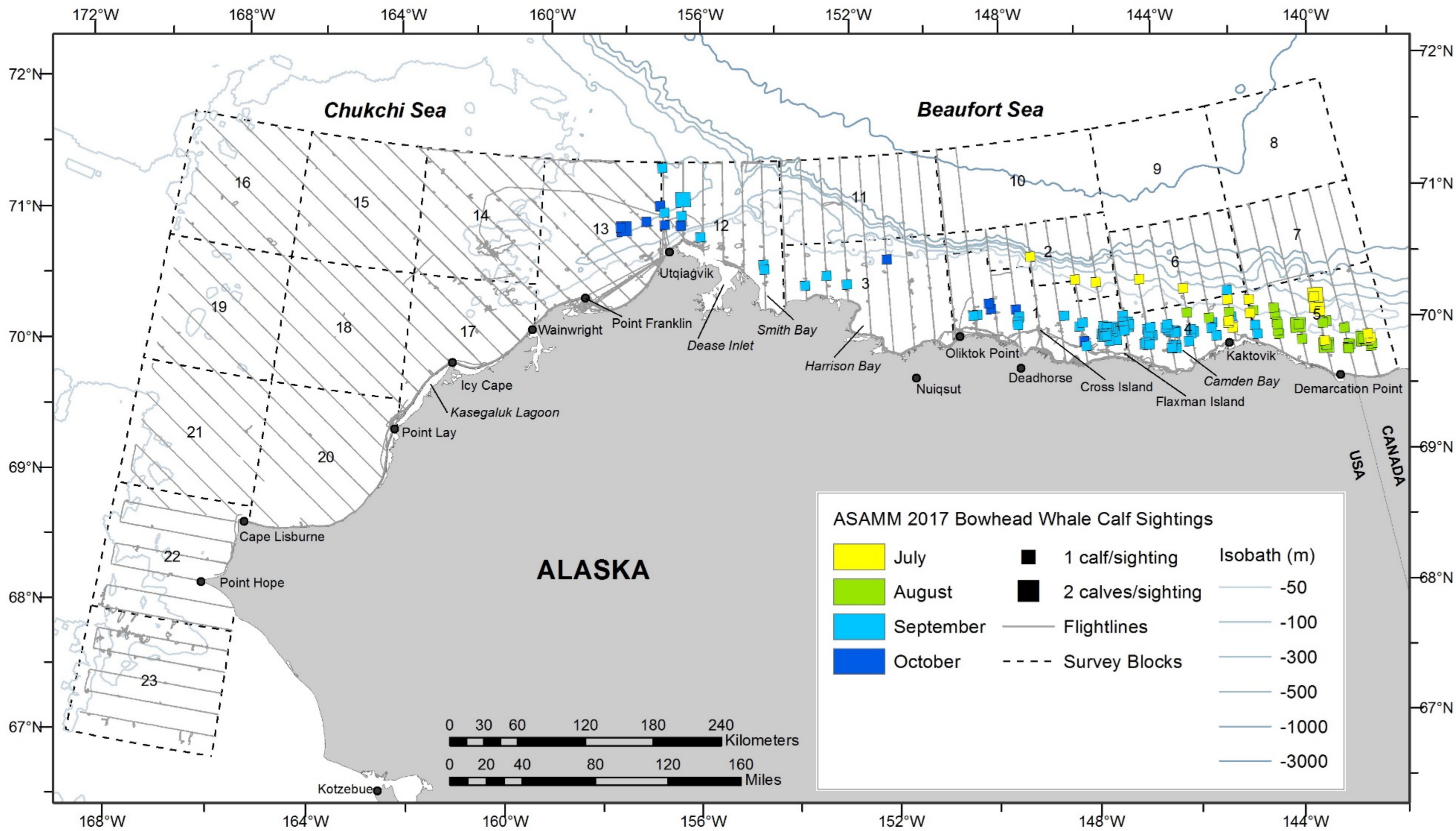


Figure 12. ASAMM 2017 bowhead whale calf sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

western Beaufort Sea. Calves were observed with adult bowhead whales that were diving, feeding, milling, resting, swimming, and engaging in SAG behavior. Three of the calves appeared to be nursing. There were four sightings of an adult bowhead whale with two calves. Thirty-seven calves were sighted without a closely associated adult, although in most of those cases (n_i = 31) adult whales were in the general vicinity.

Seasonal differences were apparent in bowhead whale calf distribution and calf ratio. Fifty-seven bowhead whale calves (35%) were sighted during summer months in the western Beaufort Sea between 140°W and 148°W. The summer calf ratio (number of calves/number of total whales) was 0.159. One hundred four bowhead whale calves (65%) were sighted during fall months, distributed from 142.8°W to 158°W. Most of the bowhead calves seen in fall were on the shelf in the western Beaufort Sea; six calves were seen in the northeastern Chukchi Sea, all in October. The calf ratio during fall was 0.110.

Bowhead Whale Feeding

Bowhead whale feeding behavior, which includes sightings reported as milling, was observed from late July through late October 2017. During summer months (July-August), feeding behavior was documented on five days in the western Alaskan Beaufort Sea (140°W-147°W) at depths ranging from 29 m to 62 m (10 km to 53 km from shore), and on four days east of Utqiaġvik (154°W-157°W) at depths ranging from 6 m to 174 m (1 km to 25 km from shore) (Figure 13A). In fall (September-October), feeding behavior was observed on 12 days in the western Beaufort Sea (Figure 13B). Water depths at sightings of feeding whales in fall in the western Beaufort Sea ranged from 6 m to 151 m (1 km to 53 km from shore). Bowhead whale feeding was not observed in the Chukchi Sea. Sighting rates (Tr+TrC) for feeding and milling bowhead whales in summer and fall are shown in Figure 14. Highest sighting rates were east of Utqiaġvik in summer and in the central Alaskan Beaufort Sea in fall.

The area between roughly Cape Halkett and Point Barrow (~152.5°W-157°W) encompasses a well-documented bowhead whale feeding area (Moore and Reeves 1993; Mocklin et al. 2011; Shelden et al. 2017) that has been linked to upwelling winds and the formation of a “krill trap” (Ashjian et al. 2010). In 2017, surveys were conducted in this area on 19 days, and bowhead whales were observed on 16 days that surveys were conducted. To limit data biases, surveys were not preferentially conducted on days with a higher likelihood of seeing bowhead whales, based on recent wind conditions. Of the bowhead whales that were observed between Point Barrow and Cape Halkett, 40% (n_i = 113) were recorded as feeding or milling. Bowhead whales were observed feeding on 10 of the 16 days (Figure 15). In summer, 75% (n_i = 88) of whales observed in this area were feeding, including moderately large aggregations (≥ 20 whales) observed in late July (Flight 2) and late August (Flights 15 and 225). In September and October, most of the bowhead whales observed in this area were swimming; only 15% (n_i = 25) were feeding.

Wind conditions recorded at Utqiaġvik in 2017 suggest that the krill trap was active for longer periods of time during the summer months (Figure 16). Surveys were conducted during krill trap active periods on 13 days in 2017, and bowhead whales were observed feeding/milling during eight of those surveys: 21 July (n_i = 20), 31 July (n_i = 4), 19 August (n_i = 21), 27 August

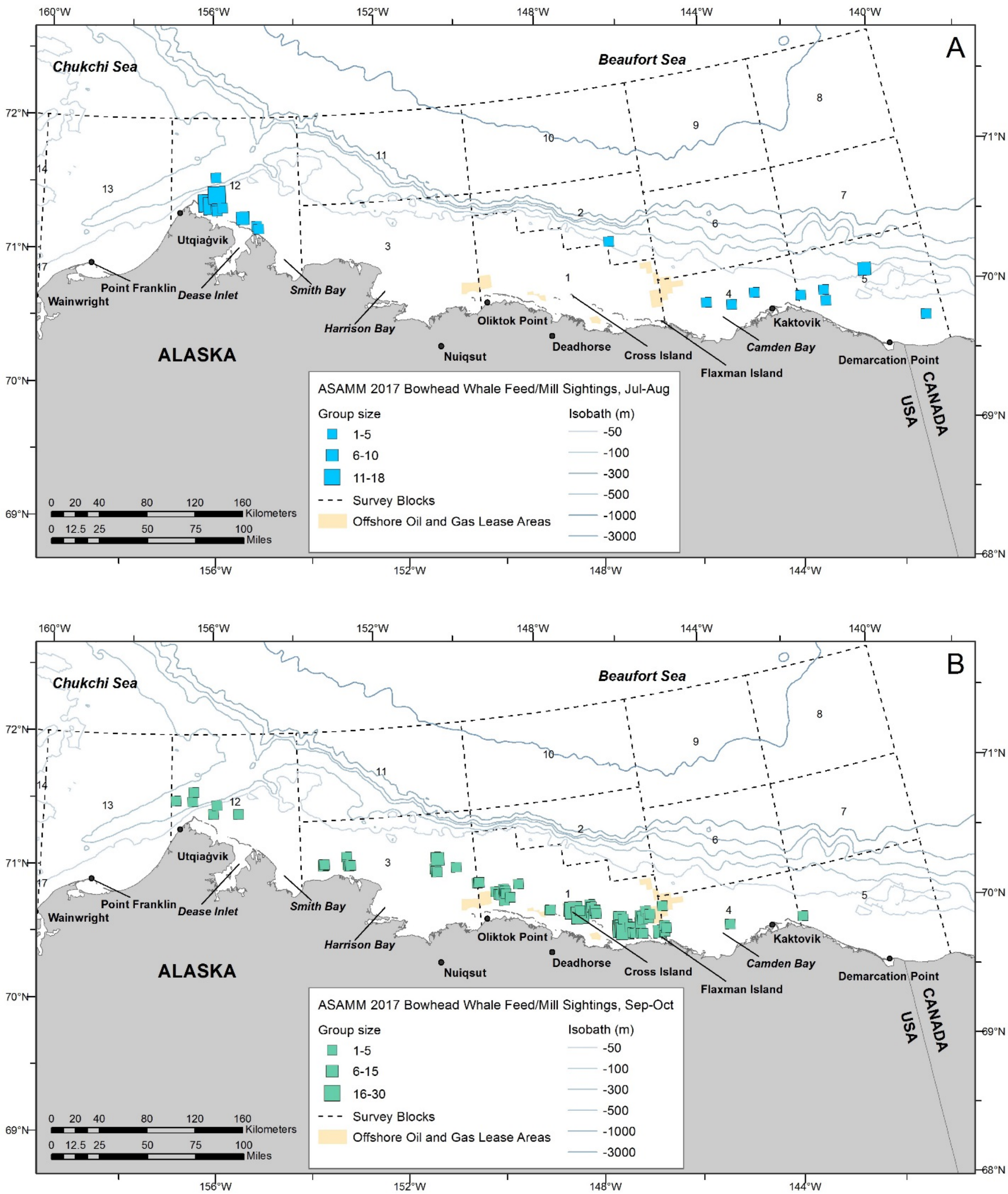


Figure 13. ASAMM 2017 bowhead whale feeding and milling sightings, all survey modes (transect, search, and circling). A: summer (July-August); B: fall (September-October).

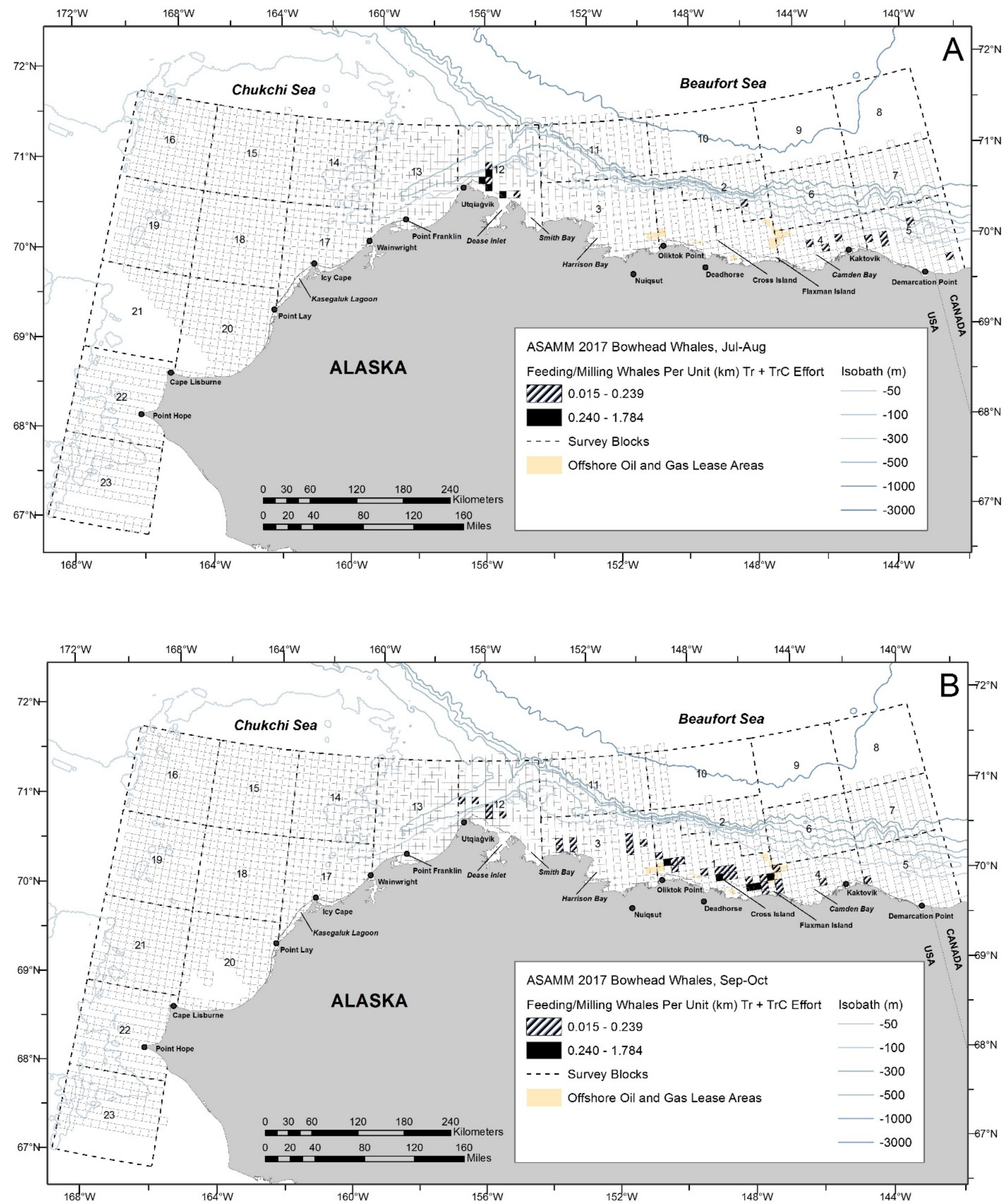


Figure 14. ASAMM 2017 bowhead whale feeding and milling sighting rates (WPUE; Tr+TrC sightings from primary observers only). A: summer (July-August); B: fall (September-October). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

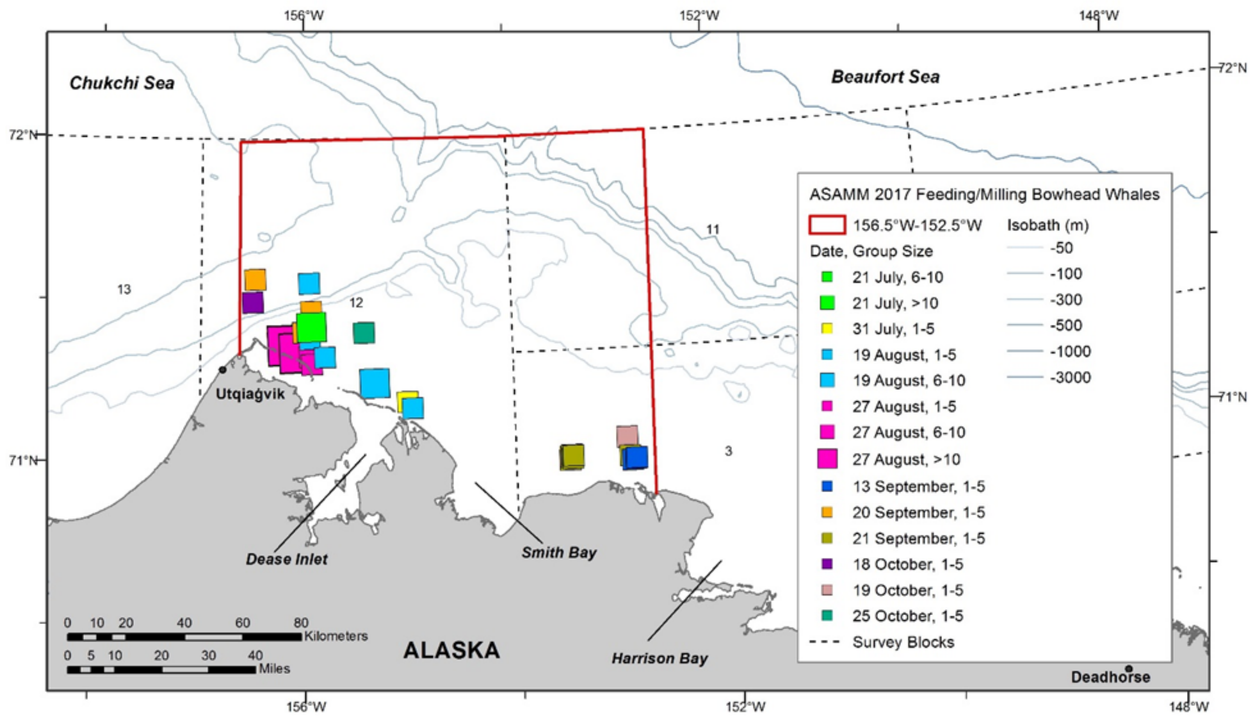


Figure 15. ASAMM 2017 feeding and milling bowhead whale sightings near Utqiaġvik (152.5°W-157°W), all survey modes (transect, search, and circling), July-October.

(n_i = 43), 13 September (n_i = 3), 20 September (n_i = 8), 21 September (n_i = 7), and 25 October (n_i = 3). Five surveys were conducted during upwelling periods, and bowhead whales were observed feeding/milling during two of those surveys: 18 October (n_i = 3) and 19 October (n_i = 1).

Bowhead whales were commonly seen feeding at depths <50 m in the central Alaskan Beaufort Sea (146°W-150°W) from early September to mid-October (Figure 13B). During that time period, feeding whales were seen on six of the seven surveys that were conducted in the area. Feeding was not observed in this area in July or August, despite 11 surveys.

Bowhead Whale Central Tendency – Analysis 1

Distribution of Bowhead Whales, Summer 2017, Relative to Summer Bowhead Whale Distribution in Previous Years with Light Sea Ice Cover

Bowhead whale distribution in the western Beaufort Sea in summer (July-August) 2017, based on transect (Tr) sightings from primary and secondary observers, shared similarities with the distribution of Tr sightings observed in summer in previous years having light sea ice cover (i.e., 1982, 1986, 1987, 1989, 1990, 1993-2016) (Figure 17).

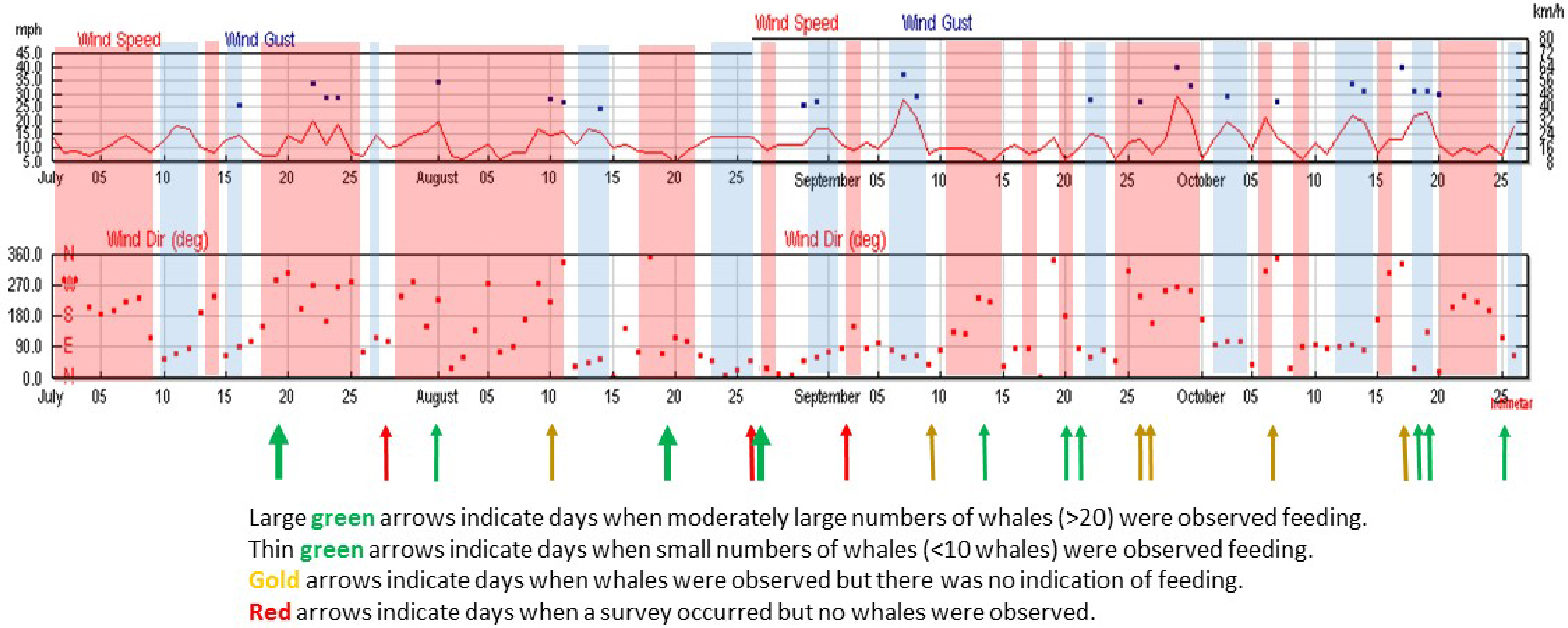


Figure 16. Wind speed and direction near Utqiaġvik from 1 July to 27 October, 2017. Upwelling periods, when winds are from the E quadrant, are shown as blue stripes. Red stripes depict krill trap active periods, which occur when winds are from the SW or W quadrants or when winds are weak in any direction. White stripes are transitional periods. Wind data are from Weather Underground (2017) and compiled by S. Okkonen (UAF). Note that wind speeds are slightly different scales for July-August (mph) and September-October (km/h).

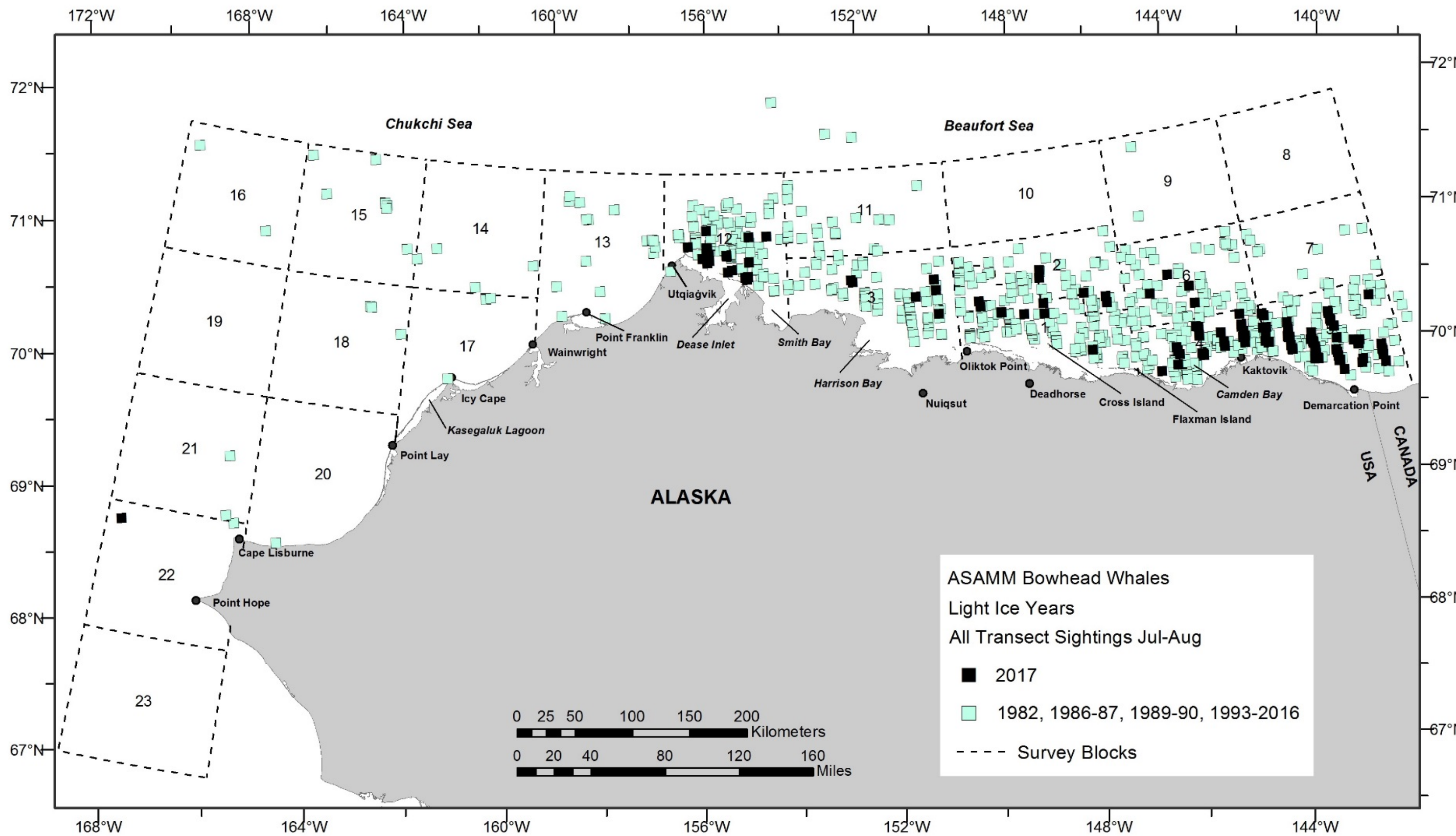


Figure 17. ASAMM bowhead whale sightings on transect, July-August, in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2016, and 2017. Includes all sightings on transect made by primary and secondary observers.

In the East region, mean depth at bowhead whale sightings made on transect by primary observers in summer 2017 was 57 m (SD = 65.7 m, range 17-418 m) and median depth was 43 m (Table 6). In the West region, mean depth was 25 m (SD = 30.0 m, range 6-174 m) and median depth was 18 m.

In the East region, mean and median distances to the normalized shoreline from bowhead whale sightings made on transect by primary observers in summer 2017 were 30.0 km (SD = 16.9 km) and 25.8 km, respectively (Table 6). In the West region, mean and median distances to the normalized shoreline were 21.9 km (SD = 16.5 km) and 18.0 km, respectively.

To evaluate whether significant displacements occurred in western Beaufort Sea bowhead whale HUAs during summer 2017 compared to previous years with light sea ice cover, estimates of median depth at sightings and distance of sightings from the normalized shoreline were compared with pooled data from previous years. Survey effort during summer in the western Beaufort Sea prior to 2012 was sporadic and inconsistent, so testing for differences was limited to sightings in summer 2012-2016 and 2017.

A Mann-Whitney *U*-test of significant difference of medians indicated that bowhead whales sighted on transect by primary observers in summer 2017 in the East region were significantly closer to shore (median distance from shore = 25.8 km; $Z = 1.976$, $P = 0.0482$) than bowhead whales sighted in 2012-2016 (median distance from shore = 36.5 km) (Table 6); there was no significant difference in median depths between 2017 (43 m depth) and 2012-2016 (43 m). In the West region, bowhead whales were in significantly shallower water (median depth = 18 m; $Z = -3.072$, $P = 0.0021$) and significantly closer to shore (median distance from shore = 18.0 km; $Z = 3.371$, $P = 0.0075$) than bowhead whales sighted in 2012-2016 (median depth = 23 m; median distance from shore 32.2 km) (Table 6).

The apparent shift in bowhead whale distribution in summer appears to be between months. A Mann-Whitney *U*-test of significant difference in medians indicated that bowhead whales were significantly farther from shore and in deeper water in July 2017 compared to August 2017. The median depth in July was 47 m compared to 36 m in August ($Z = -3.631$, $P = 0.0003$), and the median distance from shore was 36.5 km in July compared to 23.7 km in August ($Z = 3.050$, $P = 0.0023$). Similar results were found in summer 2012-2014 and 2016, but not in summer 2015 (Clarke et al. 2017b).

Distribution of Bowhead Whales During Summer and Fall Months, 2017

Summary statistics for bowhead whale data from the western Beaufort Sea in summer (July-August) 2017 were compared to values for fall (September-October) 2017 (Table 6). In the East region, bowhead whales sighted on transect in summer were in significantly deeper water (median depth 43 m vs 27 m, $Z = -8.693$, $P < 0.0001$) and significantly farther from shore (median distance 25.8 km vs 15.0 km, $Z = 6.232$, $P < 0.0001$) than bowhead whales sighted on transect in fall. In the West region, median depth and distance from shore were not significantly different for bowhead whales sighted on transect in summer (median depth 18 m, median distance 18 km) and fall (median depth 17 m, median distance 16.1 km). This is similar to what

Table 6. ASAMM central tendency statistics for depth (m) and distance from shore (km) at bowhead whale transect sightings, by season and region in the western Beaufort Sea, 2012-2017. TrSi = number of transect sightings made by primary observers.

2012-2017 Summer, by Region			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Year/Season	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
2017 Summer	East	88	43	57	65.7	17-418	25.8	30.0	16.9	6-86
2012-16 Summer	East	277	43	193	436.6	2-2461	36.5	39.0	27.3	1-134
2017 Summer	West	29	18	25	30.0	6-174	18.0	21.9	16.5	1-61
2012-16 Summer	West	238	23	65	209.5	9-2614	32.2	35.5	21.3	4-124
2012-2017 Summer, by Month			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Year/Season	**Month**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
2017 Summer	Jul	33	47	61	63.0	9-371	36.5	37.2	19.9	5-74
2017 Summer	Aug	84	36	44	59.1	6-418	23.7	24.4	14.5	1-86
2012-2016 Summer	Jul	83	164	468	625.0	13-2614	60.8	61.4	26.1	9-124
2012-2016 Summer	Aug	432	32	70	226.3	6-2461	28.0	32.7	21.7	1-134
2017 Season, by Region			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Season	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
Summer	East	88	43	57	65.7	17-418	25.8	30.0	16.9	6-86
Fall	East	86	27	27.5	10.5	6-67	15.0	15.8	9.9	1-43
Summer	West	29	18	25	30	6-174	18.0	21.9	16.5	1-61
Fall	West	91	17	26	39	7-239	16.1	18.1	10.0	5-49

was observed in 2012-2015, when bowhead whales were consistently seen in deeper water and farther from shore in summer compared to fall, but the exact opposite of observations in 2016 when bowhead whales were in shallower waters and closer to shore in summer (Clarke et al. 2017b).

Distribution of Bowhead Whales, Fall 2017, Relative to Bowhead Whale Distribution in Previous Years with Light Sea Ice Cover

Bowhead whale distribution in the western Beaufort Sea in September-October 2017, based on Tr sightings from primary and secondary observers, shared similarities with the distribution of Tr sightings observed in fall in previous years having light sea ice cover (i.e., 1982, 1986, 1987, 1989, 1990, 1993-2016) (Figure 18).

Summary statistics for bowhead whale data from the western Beaufort Sea in fall (September-October) 1989-2017 are shown in Table 7. Summary statistic results are from sightings made by primary observers only. Limiting sightings for this analysis to only primary observers resulted in the exclusion of greater than 800 sightings, and provides tighter data constraints resulting in a more robust analysis.

In the East region, mean depth at bowhead whale sightings made on transect by primary observers in fall 2017 was 27 m (SD = 10.5 m, range 6-67 m) and median depth was 27.5 m (Table 7). In the West region, mean depth was 26 m (SD = 39.0 m, range 7-239 m) and median depth was 17 m. In the East region, mean and median distances to the normalized shoreline from bowhead whale sightings made on transect by primary observers in September-October 2017 were 15.8 km (SD = 9.9 km) and 15.0 km, respectively (Table 7). In the West region, mean and median distances to the normalized shoreline were 18.1 km (SD = 10.0 km) and 16.1 km, respectively.

To evaluate whether significant displacements occurred in western Beaufort Sea bowhead whale HUAs during fall 2017 compared to previous years with light sea ice cover, estimates of median depth at sighting and distance of sightings from the normalized shoreline were compared with pooled data from previous years.

In fall (September-October) 2017 in the East region, bowhead whale sightings were in significantly shallower water (median depth 27.5 m vs. 38 m, $Z = -7.054$, $P < 0.0001$) and nearer to shore (median distance from shore 15.0 km vs. 22.4 km, $Z = 5.168$, $P < 0.0001$) than in previous years with light sea ice cover. Bowhead whale sightings in the West region in fall 2017 were also in significantly shallower water (median depth 17 m vs. 22 m, $Z = -4.834$, $P < 0.0001$) and nearer to shore (median distance from shore 16.1 km vs. 25.3 km, $Z = 6.181$, $P < 0.0001$) than in previous years with light sea ice cover.

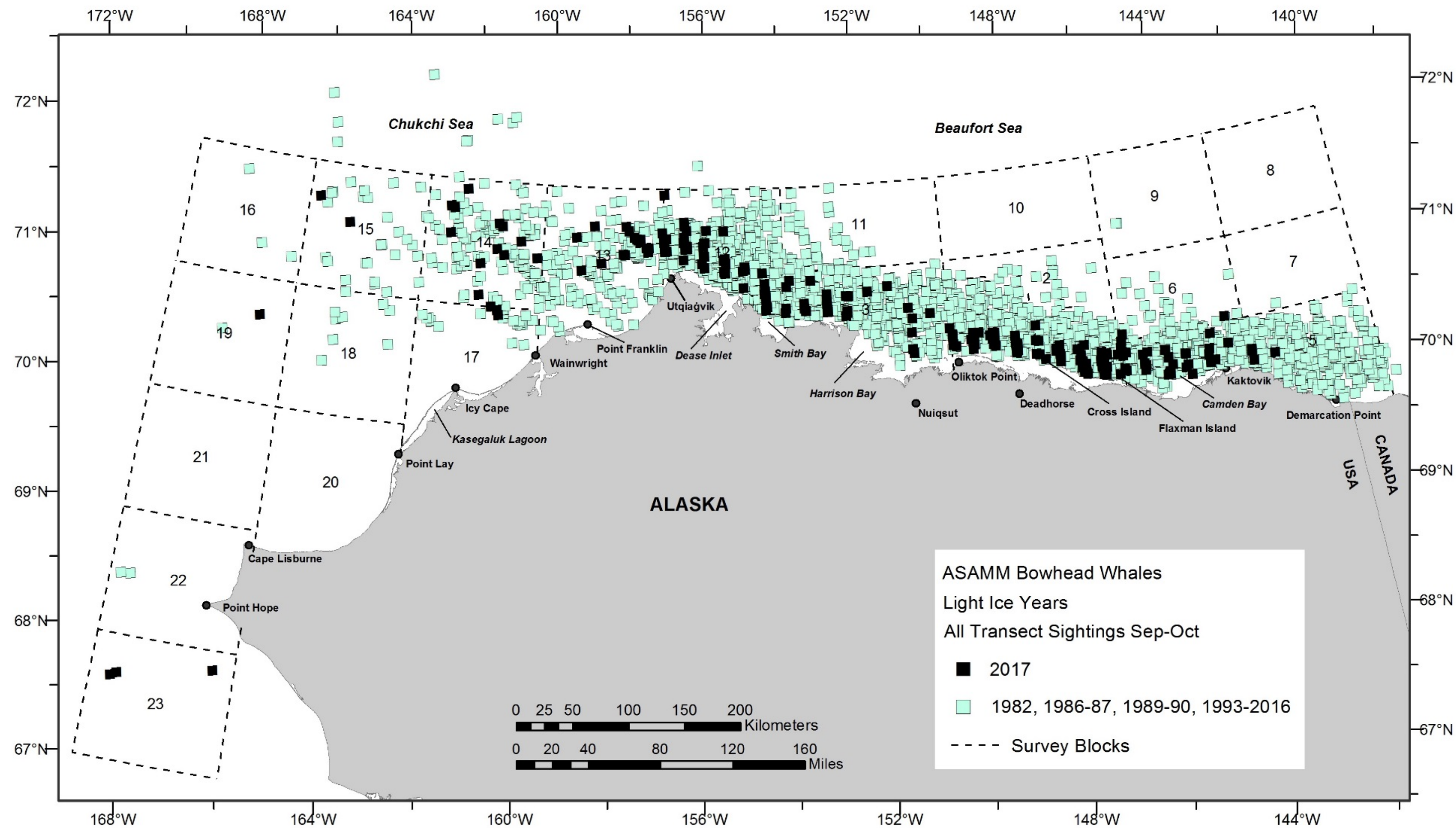


Figure 18. ASAMM bowhead whale sightings on transect, September-October, in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2016, and 2017. Includes all sightings on transect made by primary and secondary observers.

Table 7. ASAMM central tendency statistics for depth (m) and distance from shore (km) at bowhead whale transect sightings in fall (September-October), by year and region in the western Beaufort Sea, 1990-2017. TrSi = number of transect sightings made by primary observers.

			DEPTH (M)				DISTANCE FROM SHORE (KM)			
Year	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
1989	East	1	48	48			43.8	43.8		
	West	6	16	16	6.4	7-24	17.7	18.6	13.6	4-35
1990	East	35	45	45	9.8	25-72	32.2	30.8	11.1	11-53
	West	6	32.5	33	11.6	20-50	30.8	34.2	11.7	24-54
1991	East	6	119.5	120	71.8	44-228	60.3	55.6	14.7	36-72
	West	1	383	383			72.8	72.8		
1992	East	6	47.5	48	7.7	40-59	28.9	30.7	5.6	24-40
	West	6	57	66	20.4	52-106	53.1	52.5	6.7	43-63
1993	East	35	40	57	96.7	11-610	25.5	25.8	11.8	6-64
	West	23	20	22	8.9	12-49	24.3	25.6	11.9	11-61
1994	East	17	45	46	9.1	33-64	27.9	33.1	16.7	11-66
	West	2	12.5	12.5	0.7	12-13	15.0	15.0	6.0	11-19
1995	East	57	43	54	76.1	13-604	27.2	29.8	16.0	3-97
	West	22	30	89	272.5	6-1,308	33.9	35.7	18.9	10-102
1996	East	6	40	41	4.4	34-46	27.7	26.5	6.4	19-33
	West	4	33.5	31	7.6	20-37	37.6	33.5	9.3	20-39
1997	East	15	21	21	7.1	13-33	7.7	9.7	6.7	4-24
	West	65	19	25	19.2	5-100	21.9	24.8	11.0	7-52
1998	East	70	31.5	32.8	10.7	13-56	17.0	19.5	11.4	2-49
	West	71	16	48	235.4	7-2,001	17.1	22.7	18.0	3-118
1999	East	58	50	49	14.3	7-83	34.4	33.3	12.3	4-57
	West	43	29	41	41.9	10-211	29.6	31.9	16.8	6-73
2000	East	19	39	46	18.0	28-101	31.7	31.8	11.1	14-55
	West	15	11	24	42.0	5-173	7.7	15.8	19.0	1-73
2001	East	13	46	44	9.1	28-53	31.8	27.9	10.7	12-41
	West	2	42	42	43.8	11-73	29.6	39.6	43.5	9-70
2002	East	9	25	25	14.3	3-48	8.5	15.1	18.2	0-58
	West	20	24.5	30	20.6	11-88	31.2	33.9	12.6	9-56
2003	East	17	36	35	16.0	12-72	28.4	24.4	16.6	3-46
	West	29	20	50	67.3	12-310	27.2	28.9	15.7	2-72
2004	East	53	40	44	42.5	7-337	21.5	23.4	12.0	5-71
	West	47	24	34	36.5	5-206	22.7	23.6	10.6	5-65
2005	East	16	40.5	39	13.0	13-61	21.5	23.0	13.0	5-40
	West	17	33	60	66.3	12-227	37.3	34.6	16.0	6-55
2006	East	29	44	215	524.2	9-1,966	28.0	34.7	22.5	2-89
	West	28	37.5	45	36.2	4-175	37.0	35.7	18.9	1-67

			DEPTH (M)				DISTANCE FROM SHORE (KM)			
Year	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
2007	East	46	33.5	43	50.3	17-362	20.7	22.9	13.6	5-69
	West	6	23	24	8.6	13-36	24.0	25.2	6.2	18-33
2008	East	24	32	32	6.0	20-43	18.6	20.5	9.6	7-36
	West	32	16.5	18	6.4	7-40	18.1	19.1	10.2	4-52
2009	East	9	21	29	19.4	11-55	6.3	19.9	22.4	3-58
	West	42	17	30	43.6	8-239	16.7	21.7	16.1	4-81
2010	East	43	30	30	11.1	13-49	11.9	14.2	7.7	3-29
	West	25	20	32	34.2	10-189	20.6	26.3	14.8	3-76
2011	East	12	27	31	8.9	22-50	10.7	13.7	6.8	7-27
	West	28	20	26	23.1	15-141	25.5	26.8	10.4	16-64
2012	East	25	35	51	48.8	11-213	24.9	28.5	19.8	6-76
	West	58	29	51	92.5	11-648	31.0	36.4	18.9	8-76
2013	East	20	35.5	36	6.7	24-54	24.7	25.9	10.8	9-45
	West	37	26	72	75.5	6-258	27.7	37.6	25.8	3-87
2014	East	49	20	24	19.1	5-124	7.2	13.9	12.9	1-56
	West	77	19	36	50.4	5-220	22.2	28.6	23.0	2-84
2015	East	24	44.5	87	107.8	6-418	29.2	37.7	25.4	6-85
	West	112	18	19	17.0	5-173	19.5	21.7	13.5	4-69
2016	East	63	36	40	44.4	5-372	19.5	21.3	12.0	4-60
	West	118	44	59	52.4	8-227	46.5	46.6	19.9	9-90
2017	East	86	27.5	27	10.5	6-67	15	15.8	9.9	1-43
	West	91	17	26	39.0	7-239	16.1	18.1	10.0	4-49

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Bowhead Whale Central Tendency – Analysis 2

The 2017 spatial relative abundance model (generalized additive model) for fall (September-October) incorporated 196 bowhead whale sightings of 402 total individuals (Figure 19A). Relative abundance predictions resulting from the generalized additive model applied to the 2017 survey data for the western Beaufort Sea are shown in Figure 19B. The area of highest predicted relative abundance was located just outside the barrier islands between approximately 146.5°W and 149°W (north of Deadhorse). High predicted relative abundance was also evident from the barrier islands to approximately 10-30 km offshore between Oliktok Point and the western edge of Camden Bay (~146°W), and in northern Camden Bay from approximately 144°W to 146°W.

The 2000-2017 model (July-October) incorporated 2,094 bowhead whale sightings of 3,900 individuals. In July, there were 116 bowhead whale sightings (206 individuals) (Figure 20A), all of which were sighted from 2012 to 2017. The majority of the July sightings were located in the East region. Limited sample size in the West region provided minimal information for the spatial model in July (Figure 20B). The spatial model predicted that bowhead whale HUAs were located farthest offshore in July, with the highest relative abundance over the outer continental shelf and slope, approximately 30-90 km offshore, from ~140.5°W to ~143°W.

There were a total of 538 bowhead whale sightings (1,059 individuals) in August (Figure 20C), most of which were from 2012 to 2017. The spatial model predicted that bowhead whale HUAs were closest to shore from 142° to 144°W (north of Kaktovik) (Figure 20D). Three distinct areas had the highest predicted relative abundance in August: an area centered on Kaktovik, 120 km long and extending up to 50 km offshore; north of Nuiqsut, 15-60 km offshore; and north of Dease Inlet, from the barrier islands to 50 km offshore.

The model incorporated 1,075 bowhead whale sightings (1,945 individuals) in September (Figure 20E) and 365 sightings (690 individuals) in October (Figure 20G). In September, bowhead whale relative abundance was highest, and HUAs located closest to shore, from Dease Inlet to Smith Bay, and just outside the barrier islands from ~146.5°W to ~148°W (Figure 20F). In October, the highest predicted abundance was from Dease Inlet to Smith Bay, with relatively high abundance extending to the mouth of Barrow Canyon and nearshore northwest of Cape Halkett, and patches of high relative abundance outside the barrier islands from ~146°W to ~149.5°W and north of Kaktovik (Figure 20H). The HUA in October was farther offshore north of Camden Bay and Smith Bay than in September.

The estimated median distance-from-shore statistics for fall 2017 that were derived using the spatial model were 8.9 km for the East region and 10.4 km for the West region (Table 8). The model-derived results were 6.1 km closer to shore in the East region and 5.7 km closer to shore in the West region compared to the results from the analysis of bowhead whale sightings that were unadjusted for transect effort or group size (median values of 15.0 km and 16.1 km, respectively; Table 7).

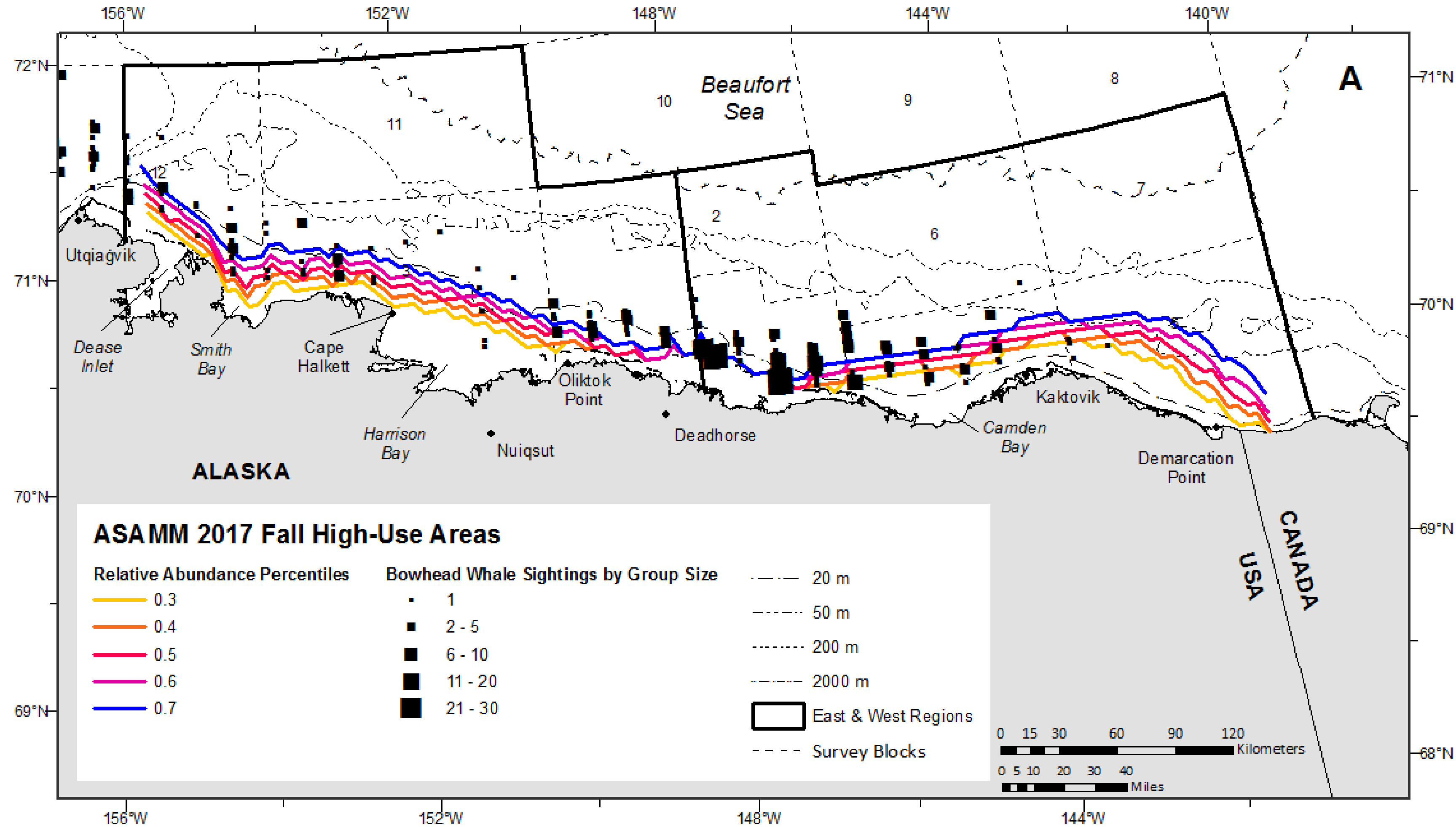


Figure 19. ASAMM September and October 2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea. A: Transect sightings. The bowhead whale high-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

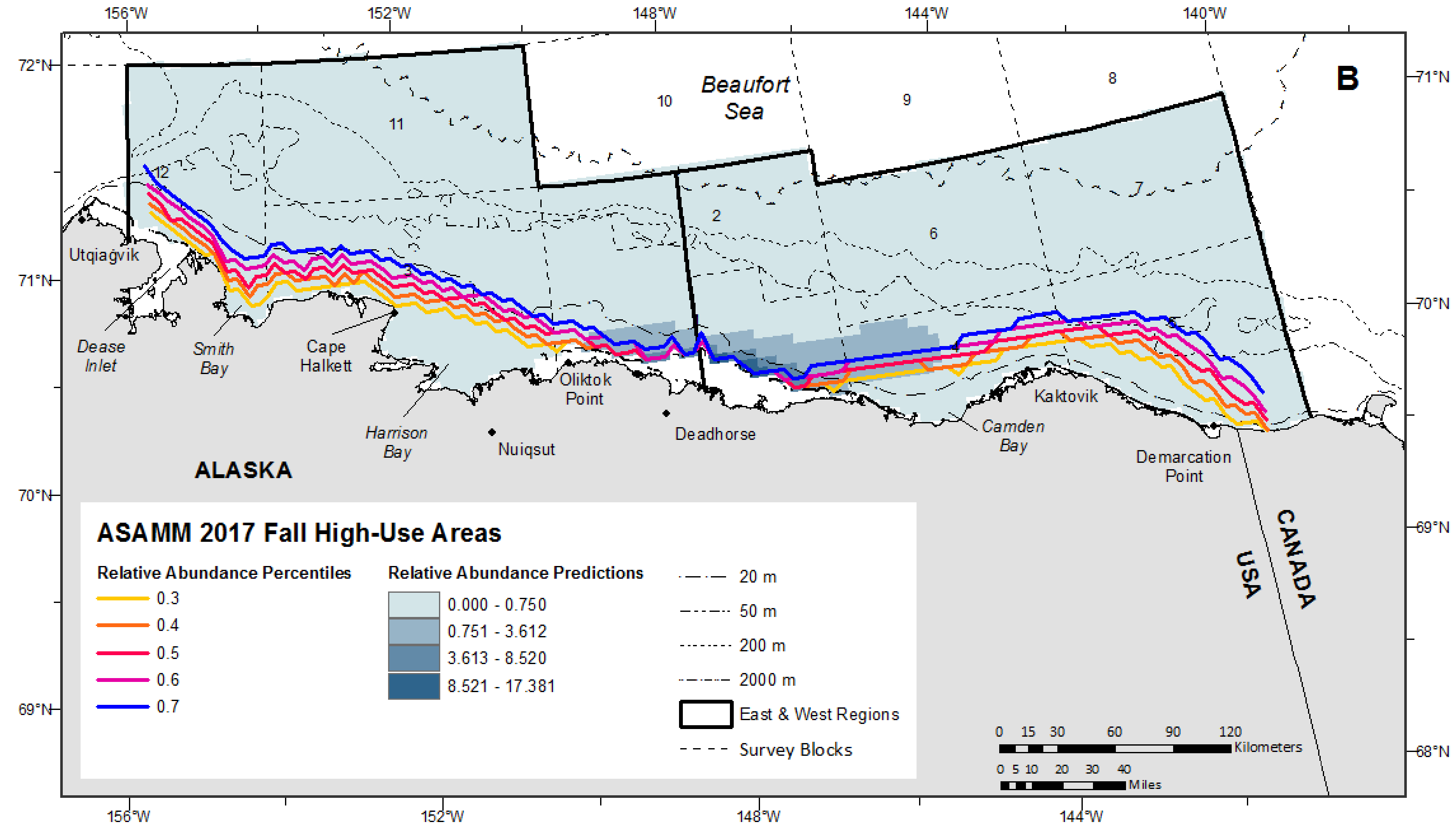


Figure 19 (cont.). ASAMM September and October 2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea. B: Predicted relative abundance. The bowhead whale High-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

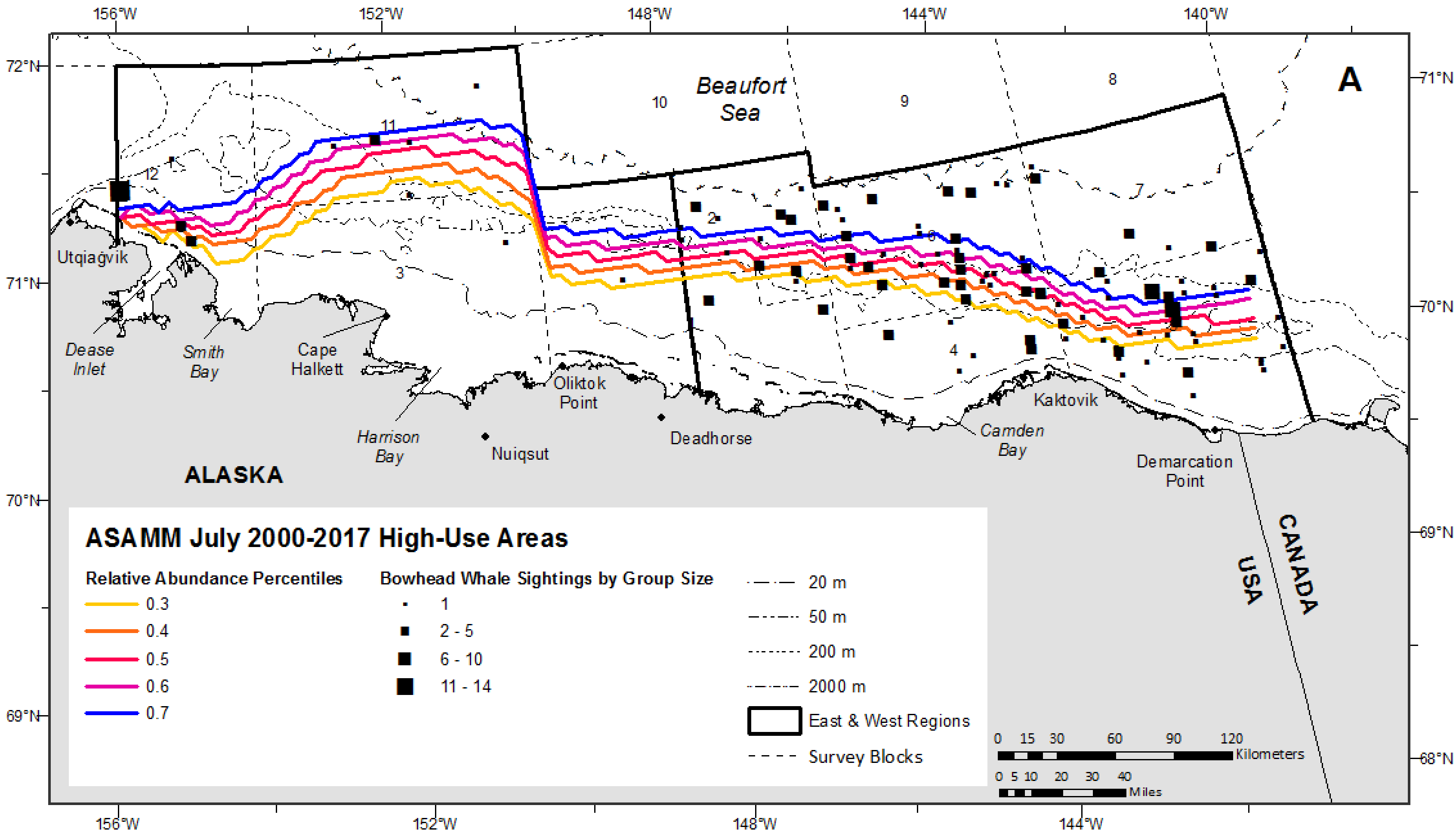


Figure 20. ASAMM 2000-2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. A: July sightings. The bowhead whale High-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

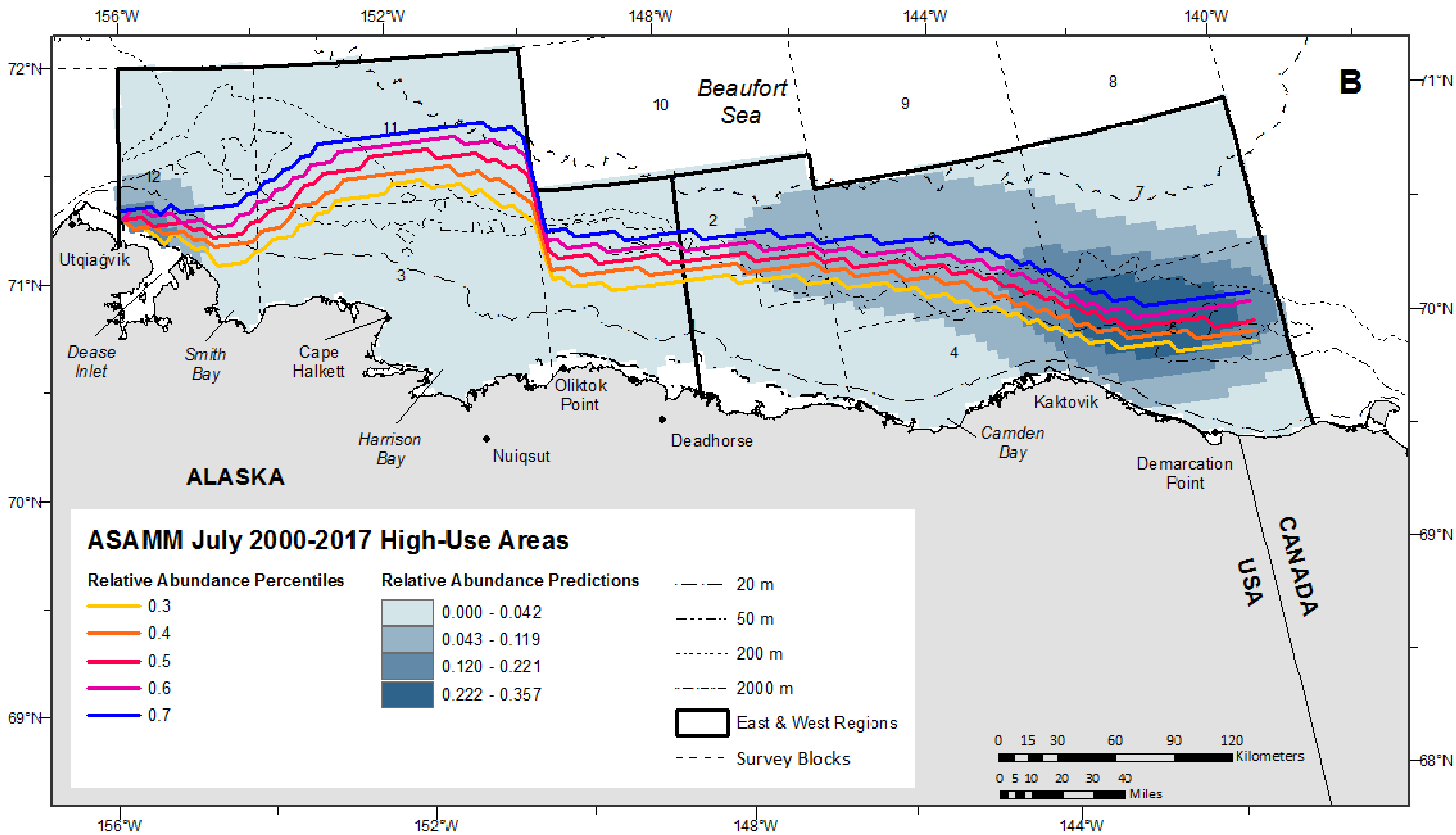


Figure 20 (cont.). ASAMM 2000-2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. B: July predicted relative abundance. Predictions are not corrected for perception or availability bias. The bowhead whale High-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

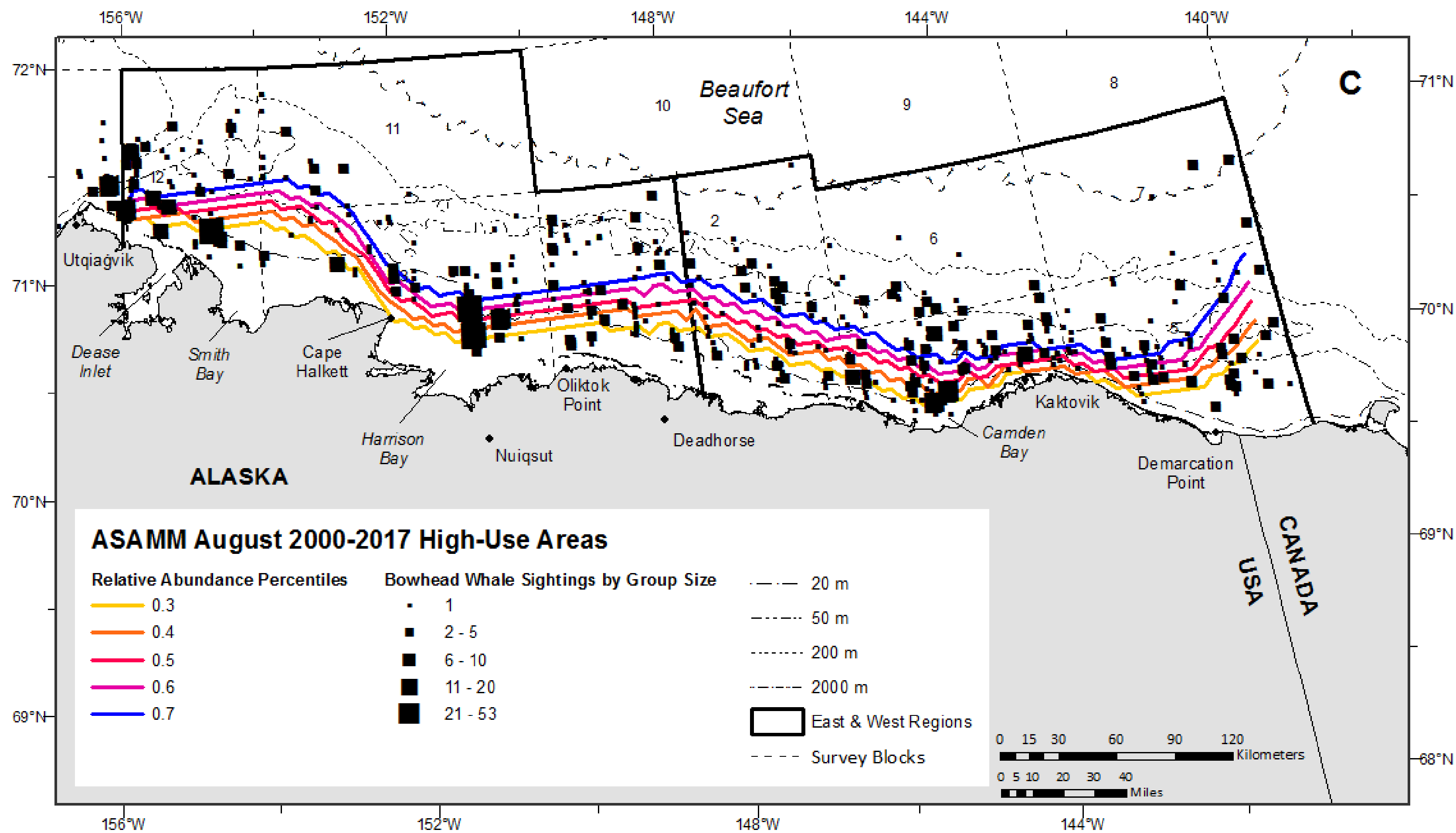


Figure 20 (cont.). ASAMM 2000-2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. C: August sightings. The bowhead whale High-use area is represented by distribution percentiles (30^{th}, 40^{th}, 50^{th}, 60^{th}, and 70^{th}), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

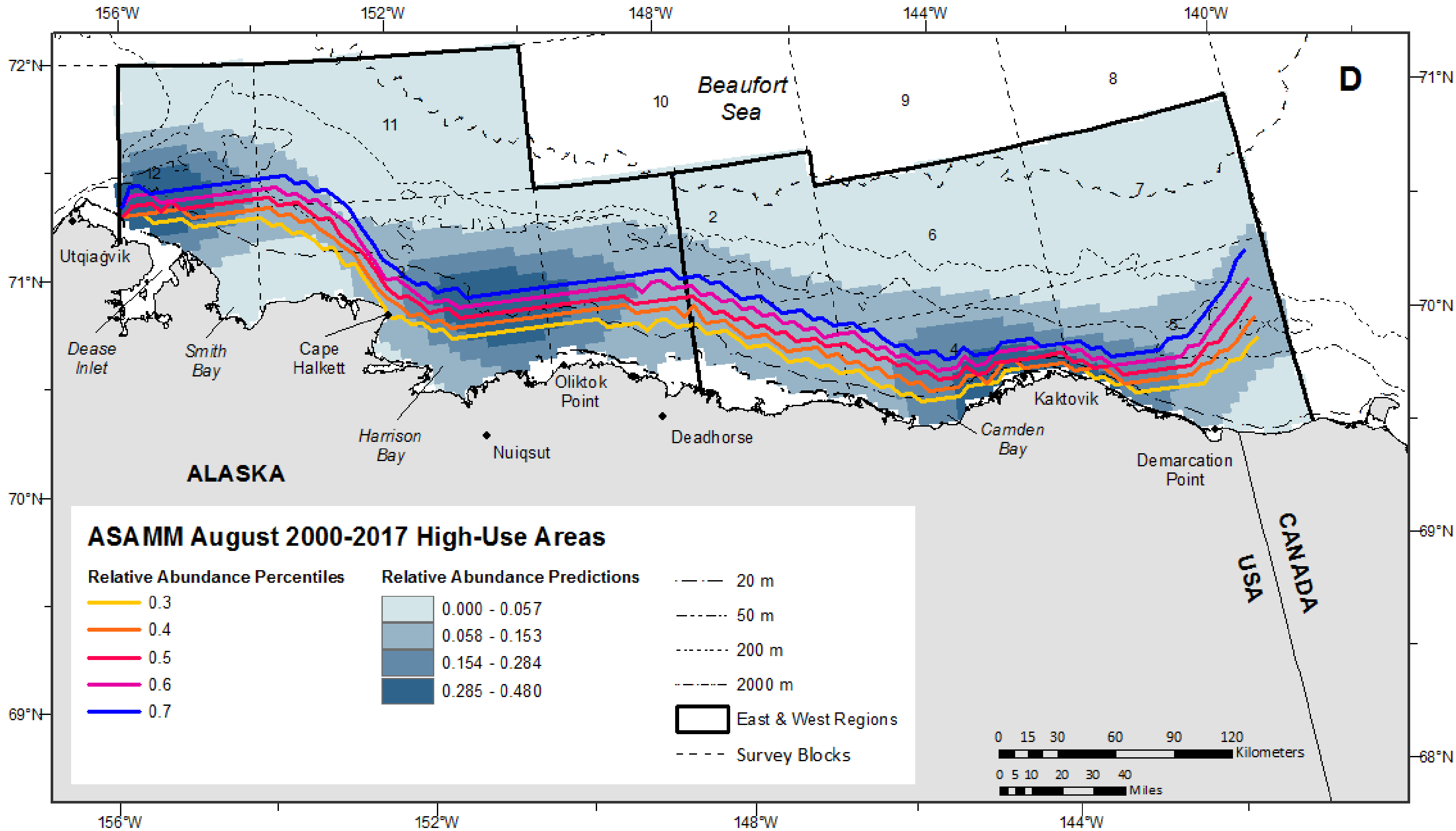


Figure 20 (cont.). ASAMM 2000-2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. D: August predicted relative abundance. Predictions are not corrected for perception or availability bias. The bowhead whale High-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

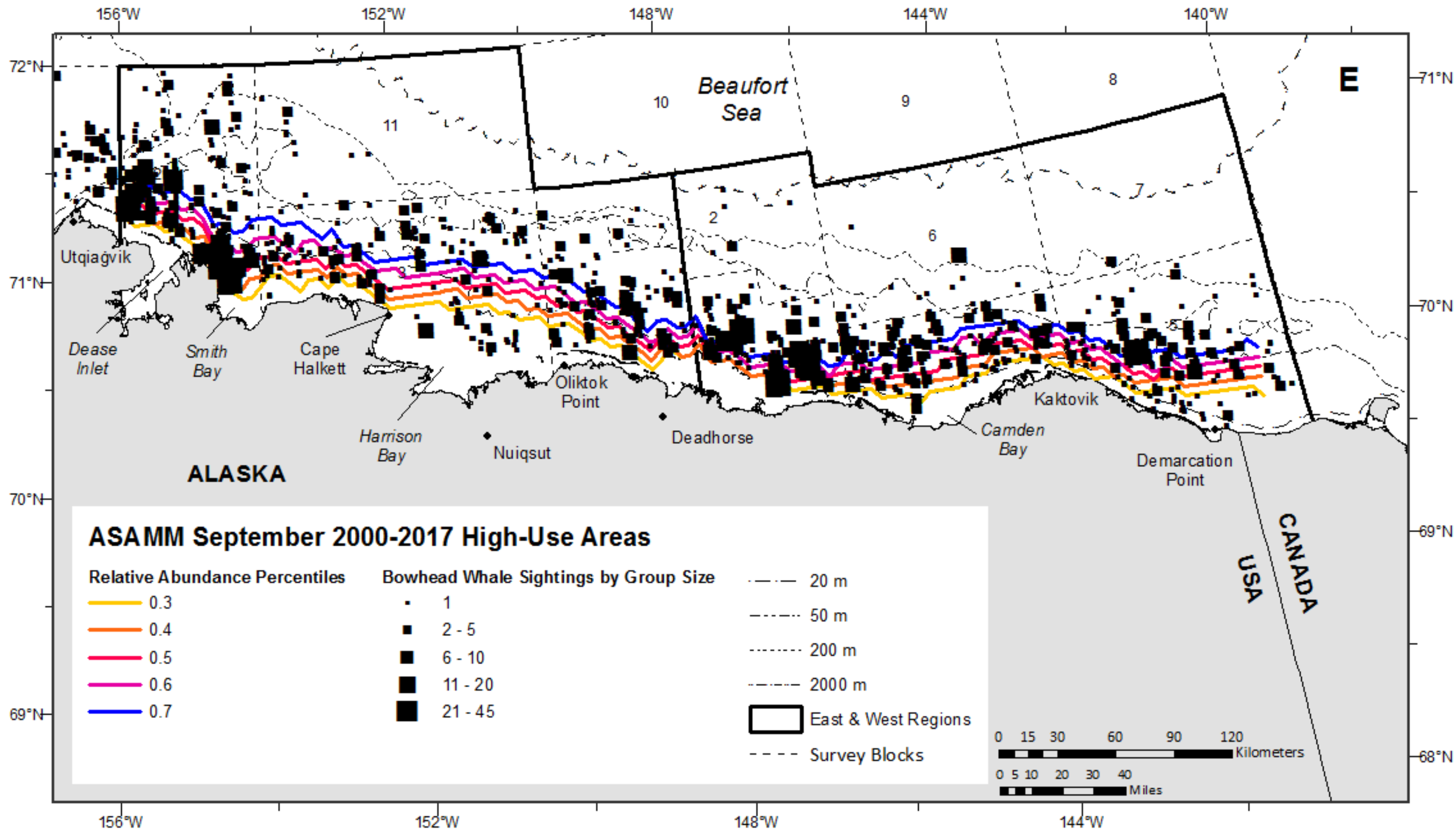


Figure 20 (cont.). ASAMM 2000-2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. E: September sightings. The bowhead whale High-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

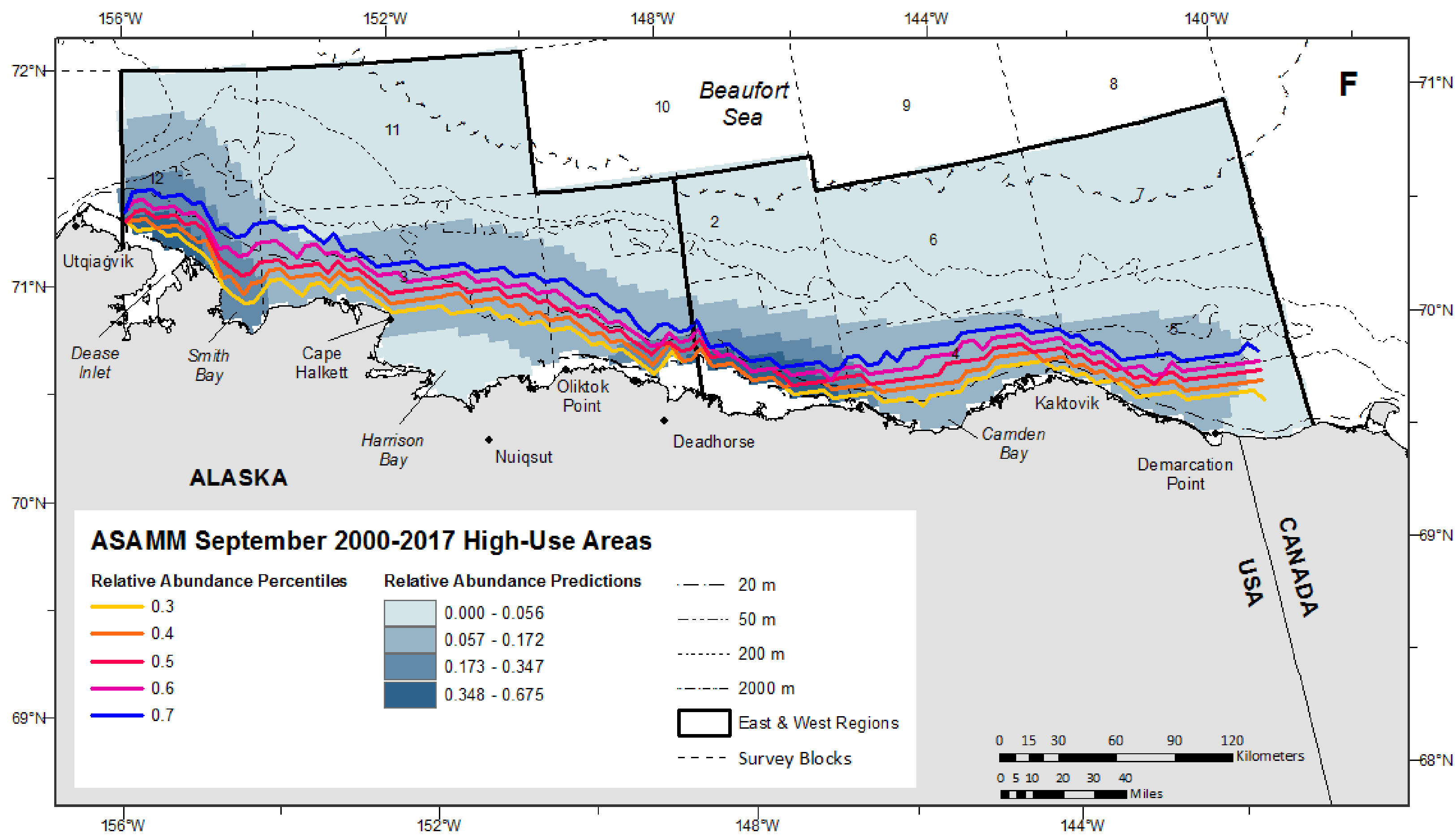


Figure 20 (cont.). ASAMM 2000-2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. F: September predicted relative abundance. Predictions are not corrected for perception or availability bias. The bowhead whale High-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

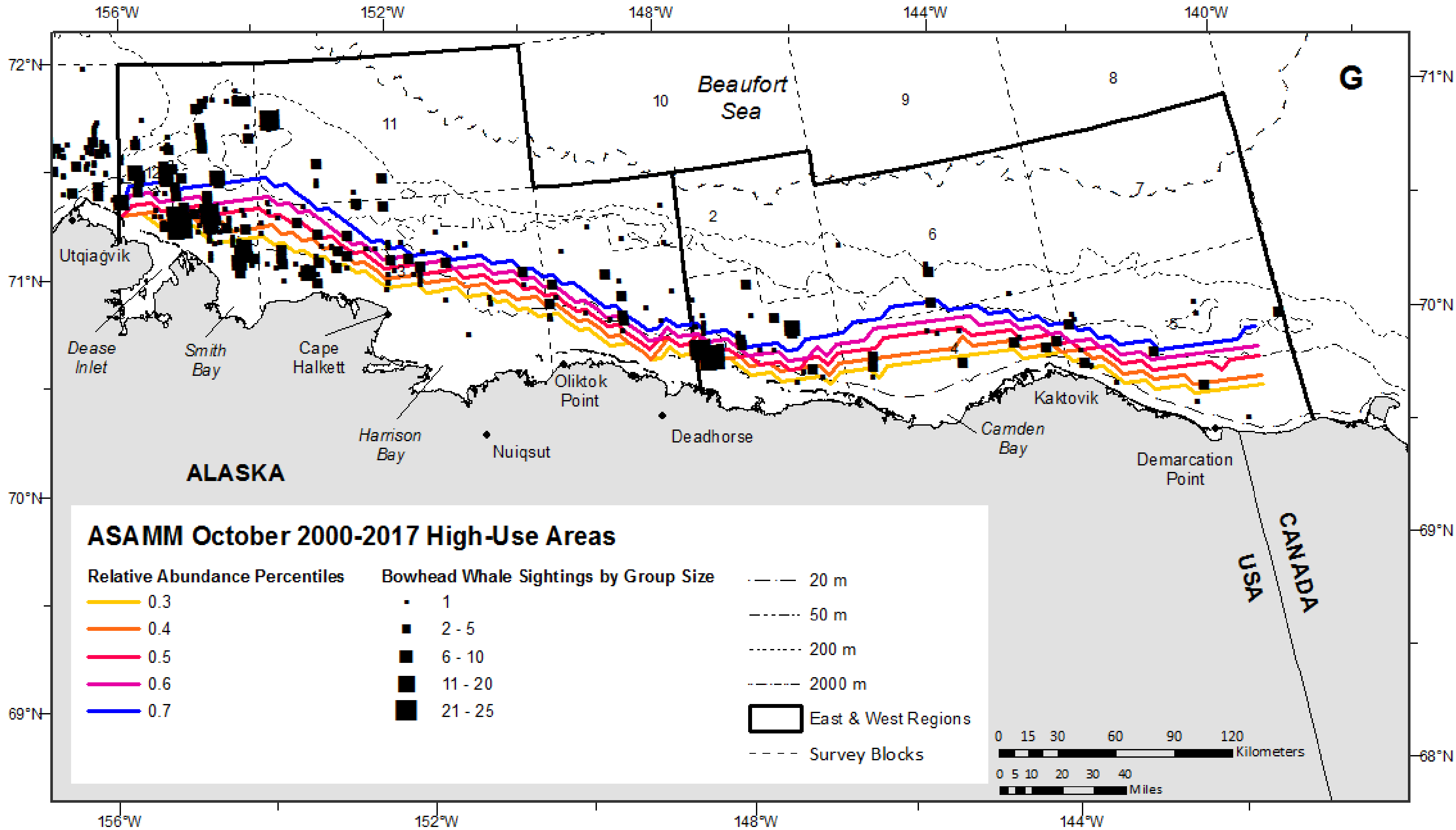


Figure 20 (cont.). ASAMM 2000-2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. G: October sightings. The bowhead whale High-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

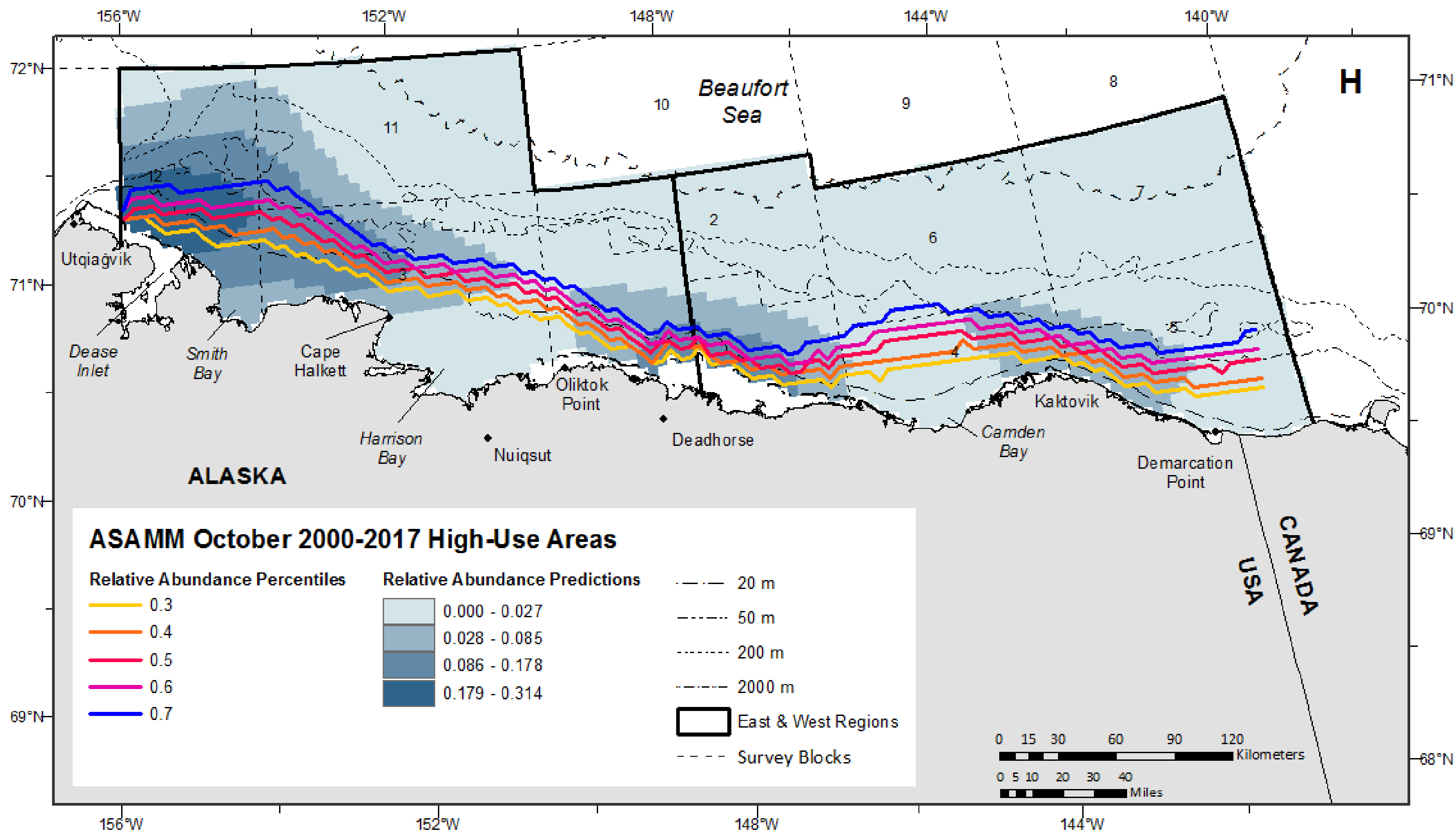


Figure 20 (cont.). ASAMM 2000-2017 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. H: October predicted relative abundance. Predictions are not corrected for perception or availability bias. The bowhead whale High-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

Table 8. Percentiles of bowhead whale predicted distribution (km) from the spatial model for the West and East regions of the ASAMM study area. For 2017, the predictions correspond to September and October combined. Monthly predictions are provided for 2000-2017.

	WEST REGION (KM)					**EAST REGION (KM)**				
	2017	**2000-2017**				**2017**	**2000-2017**			
Percentile	**Sep-Oct**	**Jul**	**Aug**	**Sep**	**Oct**	**Sep-Oct**	**Jul**	**Aug**	**Sep**	**Oct**
30th	5.5	12.4	19.0	11.4	16.7	4.2	39.8	13.2	8.7	11.3
40th	7.8	18.7	24.0	15.8	22.5	5.9	46.7	18.4	12.0	15.5
50th	10.4	27.1	29.2	21.8	28.2	8.9	53.4	23.7	16.1	20.3
60th	15.0	39.4	33.9	28.4	33.9	13.3	59.8	30.2	20.8	25.8
70th	20.0	58.3	39.4	35.5	40.4	19.5	67.1	37.7	26.5	32.5

The estimated median distance-from-shore statistics for the East region in 2000-2017, derived using the spatial model, decreased from 53.4 km in July to 23.7 km in August, 16.1 km in September, and 20.3 km in October (Table 8). In the West region, the 2000-2017 model predicted that the median distance from shore varied from 27.1 km in July to 29.2 km in August, 21.8 km in September, and 28.2 km in October (Table 8).

Gray Whales

GRAY WHALE SIGHTING SUMMARY

During the 2017 ASAMM surveys, 440 sightings of 821 gray whales (*Eschrichtius robustus*) of the Eastern North Pacific stock were observed in the study area during all survey modes (transect, search and circling) (Table 3). Gray whales were seen in all months in the eastern Chukchi Sea (Figure 21). In the northeastern Chukchi Sea, gray whales were seen nearshore (<40 km) from Point Barrow to Point Lay. Gray whales were seen from early July through mid-October in the northern part of block 17 and southern part of block 14, between 30 and 120 km offshore and just south of Hanna Shoal. Two gray whales were seen offshore approximately 345 km west of Utqiaġvik and there were five sightings of 25 gray whales at the northern edge of the study area, near 72°N. In the southcentral Chukchi Sea, gray whales were seen offshore approximately 60-140 km southwest of Point Hope, a known gray whale and benthic hotspot (Grebmeier et al. 2015; Kuletz et al. 2015). Few gray whales were seen between Point Lay and Cape Lisburne. One gray whale was seen in Peard Bay on one day in late July; based on photo identification, this gray whale was not one of the gray whales observed in Peard Bay in 2016. No gray whales were seen east of Point Barrow. Locations of gray whale sightings during semimonthly periods are shown in Figure 22.

Gray whale distribution in 2017 (all sightings regardless of survey mode or observer type) was generally similar to that documented from 2008 to 2016 and in earlier years with light sea ice coverage, with a few exceptions:

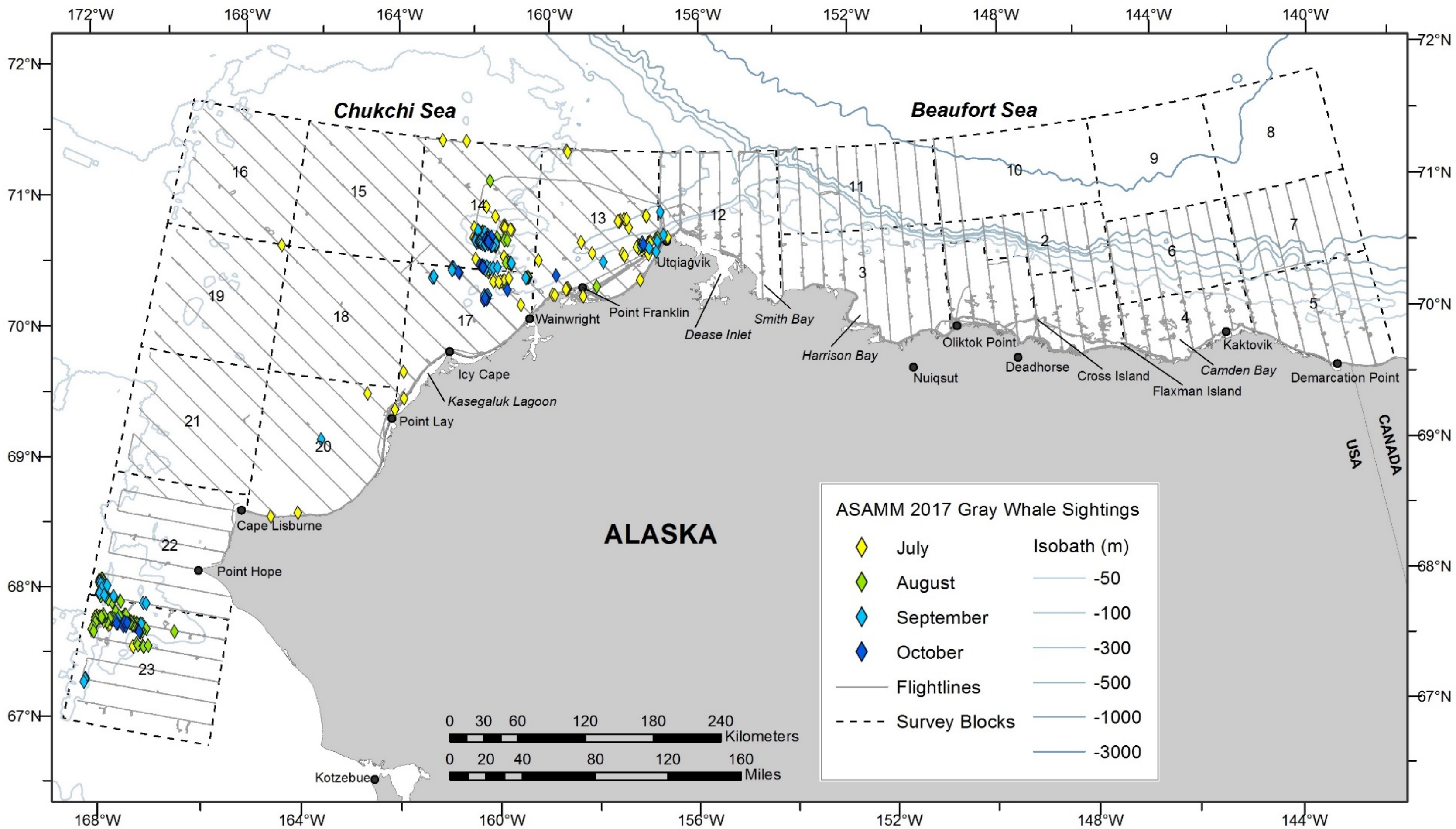


Figure 21. ASAMM 2017 gray whale sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

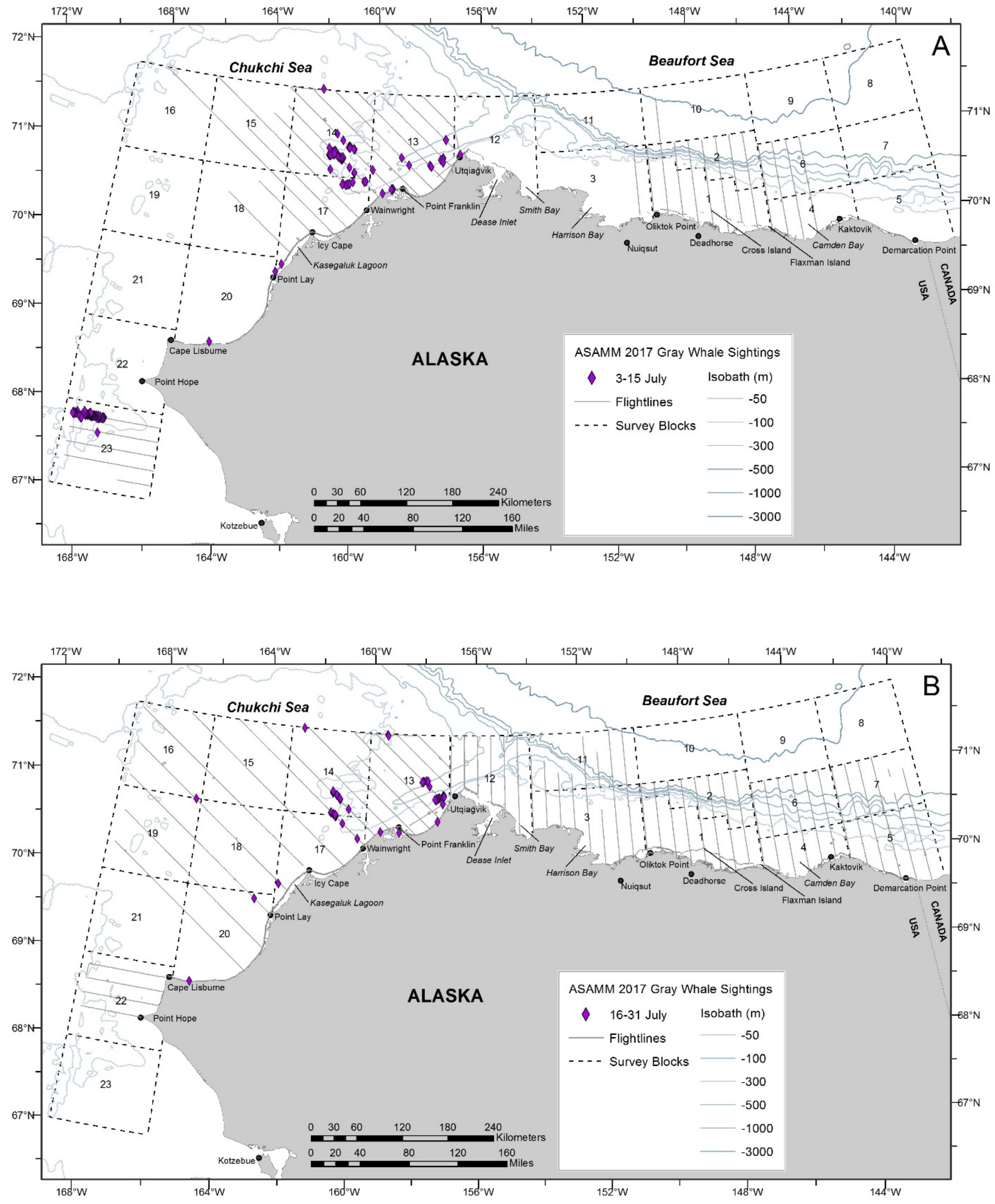


Figure 22. ASAMM 2017 semimonthly gray whale sightings, with transect, search, and circling effort. A: 3-15 July; B: 16-31 July. Deadhead flight tracks are not shown.

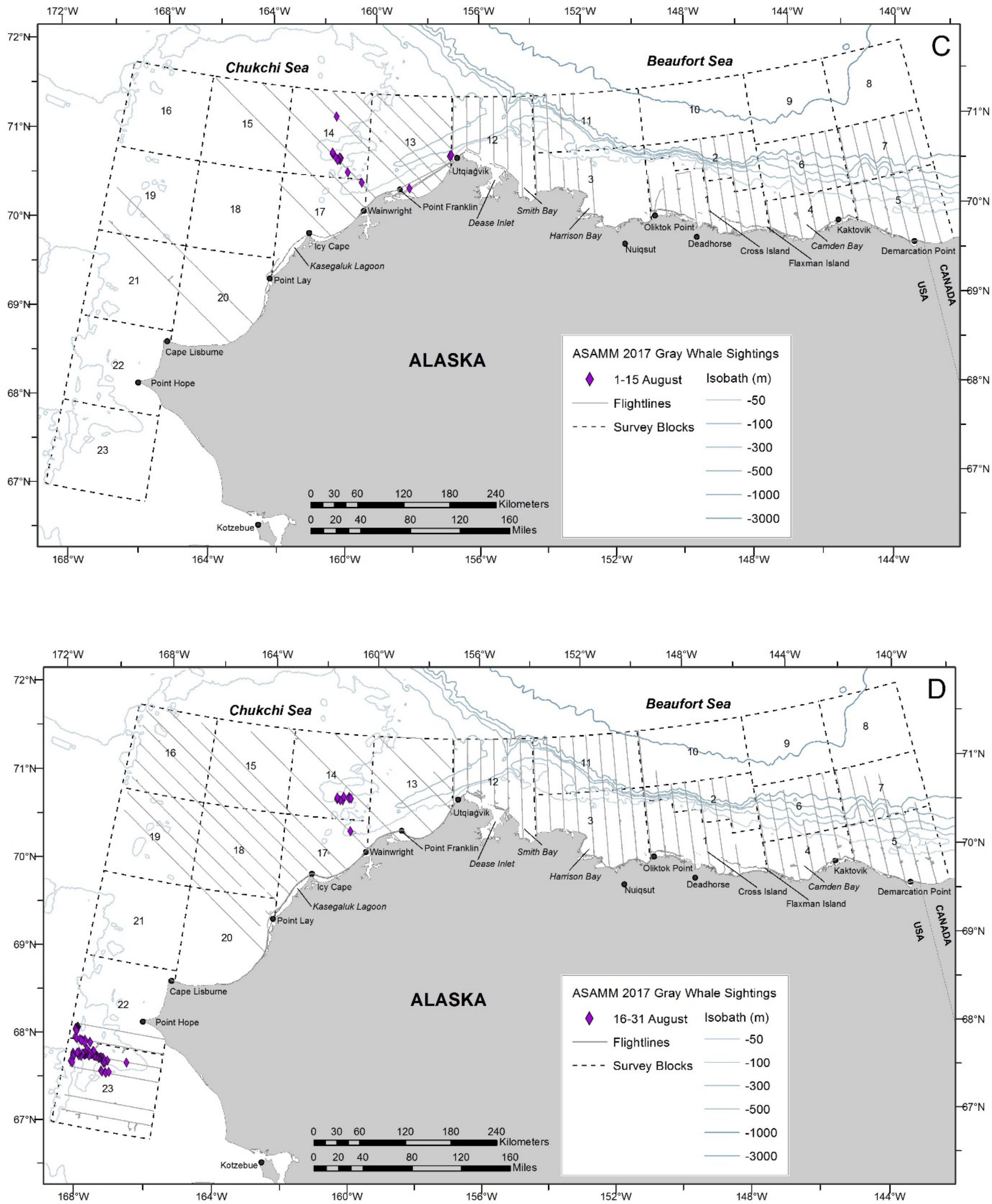
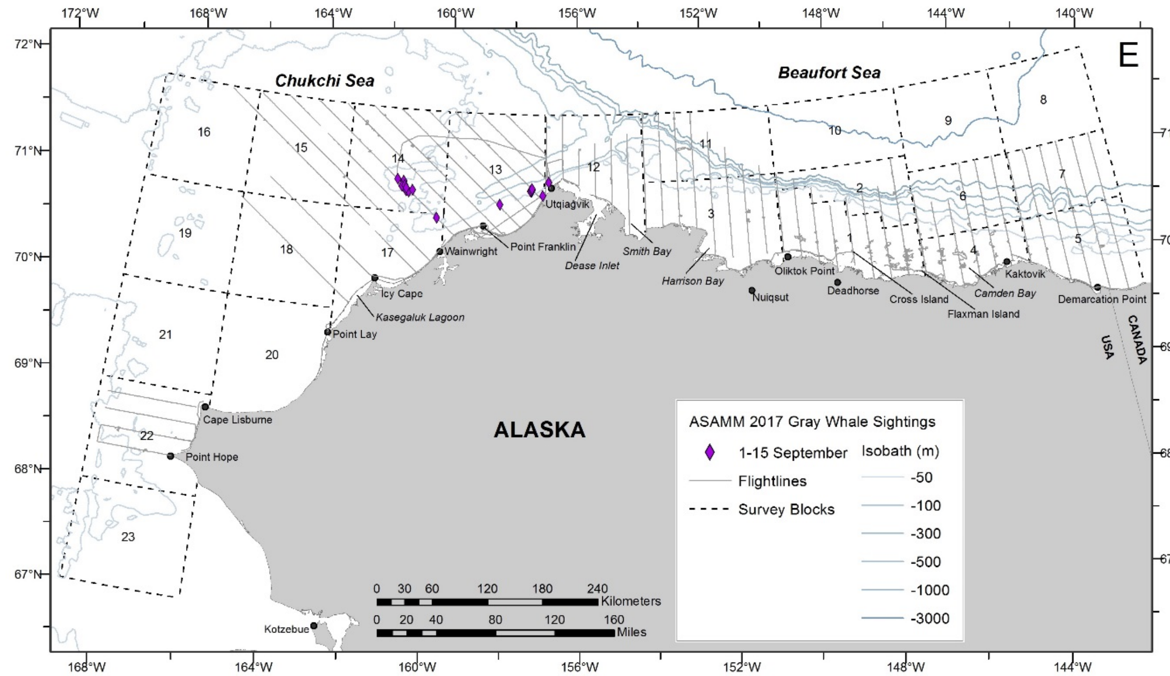


Figure 22 (cont). ASAMM 2017 semimonthly gray whale sightings, with transect, search, and circling effort. C: 1-15 August; D: 16-31 August. Deadhead flight tracks are not shown.



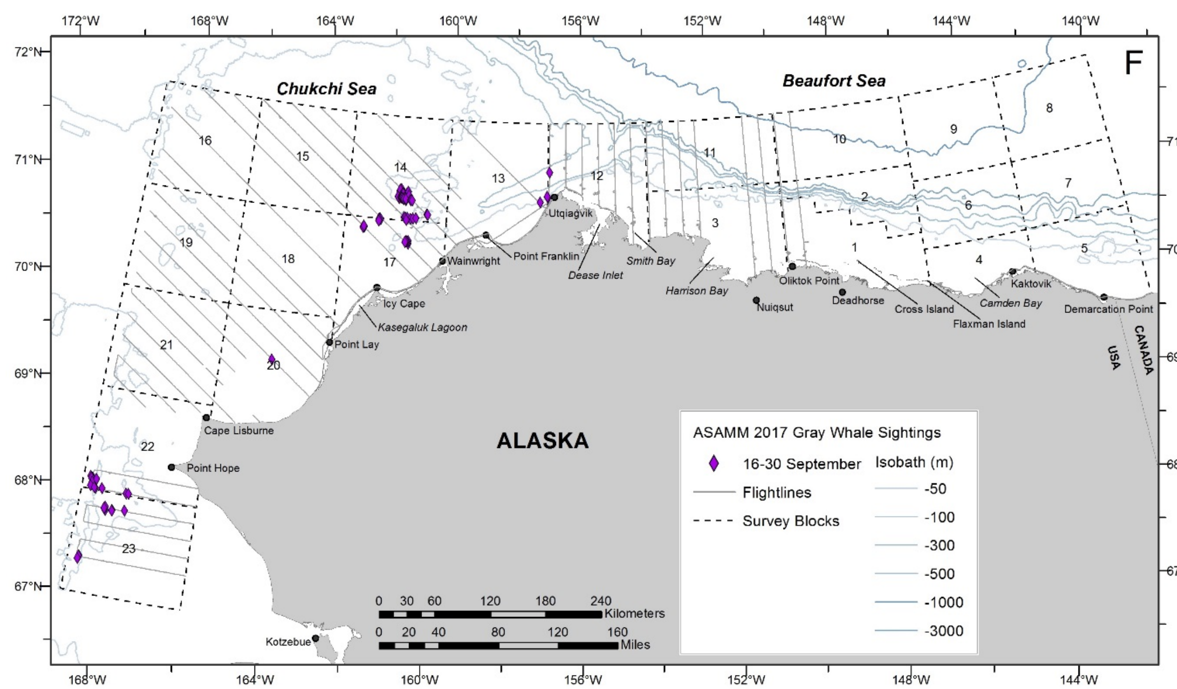


Figure 22 (cont). ASAMM 2017 semimonthly gray whale sightings, with transect, search, and circling effort. E: 1-15 September; F: 16-30 September. Deadhead flight tracks are not shown.

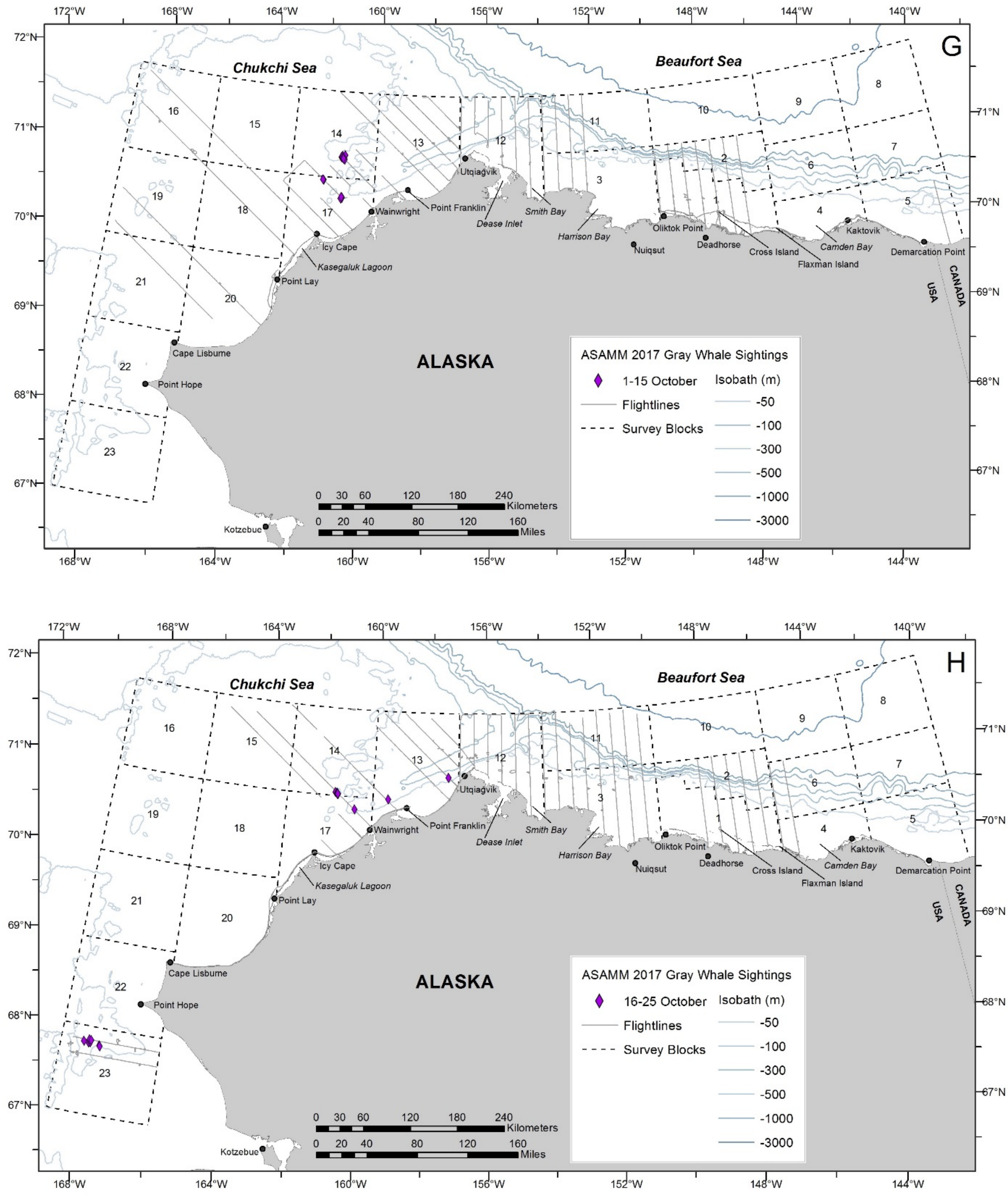


Figure 22 (cont). ASAMM 2017 semimonthly gray whale sightings, with transect, search, and circling effort. G: 1-15 October; H: 16-25 October. Deadhead flight tracks are not shown.

- Gray whales continued to be mostly absent from Hanna Shoal, but were observed immediately south of Hanna Shoal (block 14) in summer and fall.
- Gray whales were not seen in shallow waters directly south of Point Hope.
- Gray whales appeared relatively sparse in the area between Point Franklin and Utqiaġvik, where they have been reliably seen in most years.
- One gray whale was seen in Peard Bay proper during a search survey on 28 July; Peard Bay was systematically surveyed on 8 occasions from 3 July to 23 October and gray whales were not observed during any systematic surveys.

Gray Whale Sighting Rates

In summer and fall 2017, gray whales were seen on transect from 67.3°N to 71.7°N and 156.7°W to 168.8°W. There were 221 sightings of 402 gray whales on transect by primary observers (Appendix E, Table E-5), ranging from one whale per sighting ($n_s = 134$) to 33 whales per sighting ($n_s=1$). The greatest numbers of sightings on transect were in block 23 ($n_s= 91$), block 14 ($n_s = 69$) and block 13 ($n_s = 24$). When transect and circling from transect (Tr+TrC) sightings by primary observers were combined, there were 384 sightings of 701 gray whales (Appendix E, Table E-6), ranging from one whale per sighting ($n_s = 232$) to 33 whales per sighting ($n_s = 1$). The highest number of Tr+TrC sightings was in block 14 (136 sightings), followed by block 23 (132 sightings).

The highest gray whale fine-scale (5-km grid) Tr sighting rates (WPUE) in summer were approximately 30 km northwest of Utqiaġvik, 100 km northwest of Wainwright, and 60-100 km southwest of Point Hope (Figure 23A). In fall, the highest gray whale fine-scale Tr sighting rate (WPUE) was approximately 100 km northwest of Wainwright (Figure 23B). There were few gray whales seen on transect between Utqiaġvik and Point Franklin in summer or fall.

Gray whale sighting rate analyses per survey block and depth zone were limited to the study area west of 154°W to encompass the region where gray whales were predominantly seen in 2017 (and historically). For all months combined, the highest Tr sighting rates per survey block were in block 23 (0.089 WPUE), block 14 (0.028 WPUE), and block 13 (0.014 WPUE). Sighting rates were highest in block 23 in all months except October, when Tr sighting rates were highest in block 14 (Figure 24) (Appendix E, Table E-5).

Monthly Tr sighting rates in 2017 were higher in all months compared to monthly sighting rates in 2009-2016, all years combined (Figure 25). The peak monthly gray whale Tr sighting rate in the eastern Chukchi Sea (154°W-169°W) in 2017 was in July (0.029 WPUE), decreasing by more than one-half in August (0.011 WPUE), September (0.005 WPUE) and October (0.003 WPUE). When Tr sighting rates were calculated separately for the northeastern Chukchi Sea (69°N-72°N, 154°W-169°W) and southcentral Chukchi Sea (67°N-69°N, 166°W-169°W), sighting rates in the northeastern Chukchi Sea were highest in July in 2017 and 2009-2016, but decreased substantially in August 2017 compared to 2009-2016 (Figure 26A). Sighting rates in the southcentral Chukchi Sea in 2017 differed considerably from those in 2009-2016 and from those in the northeastern Chukchi Sea in 2017 (Figure 26B). In the southcentral Chukchi Sea in

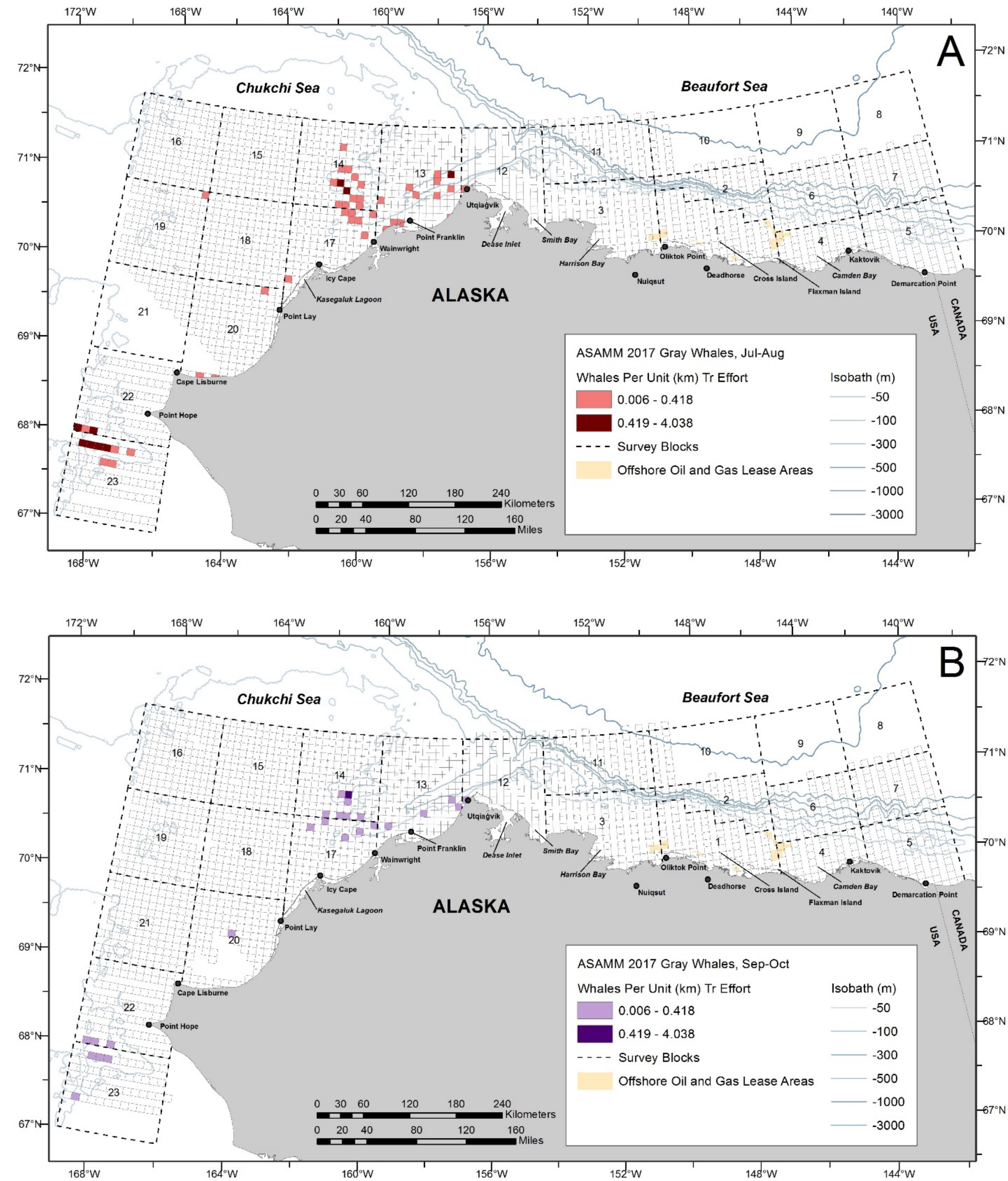


Figure 23. ASAMM 2017 gray whale sighting rates (WPUE; transect sightings from primary observers only), July-August (A) and September-October (B). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

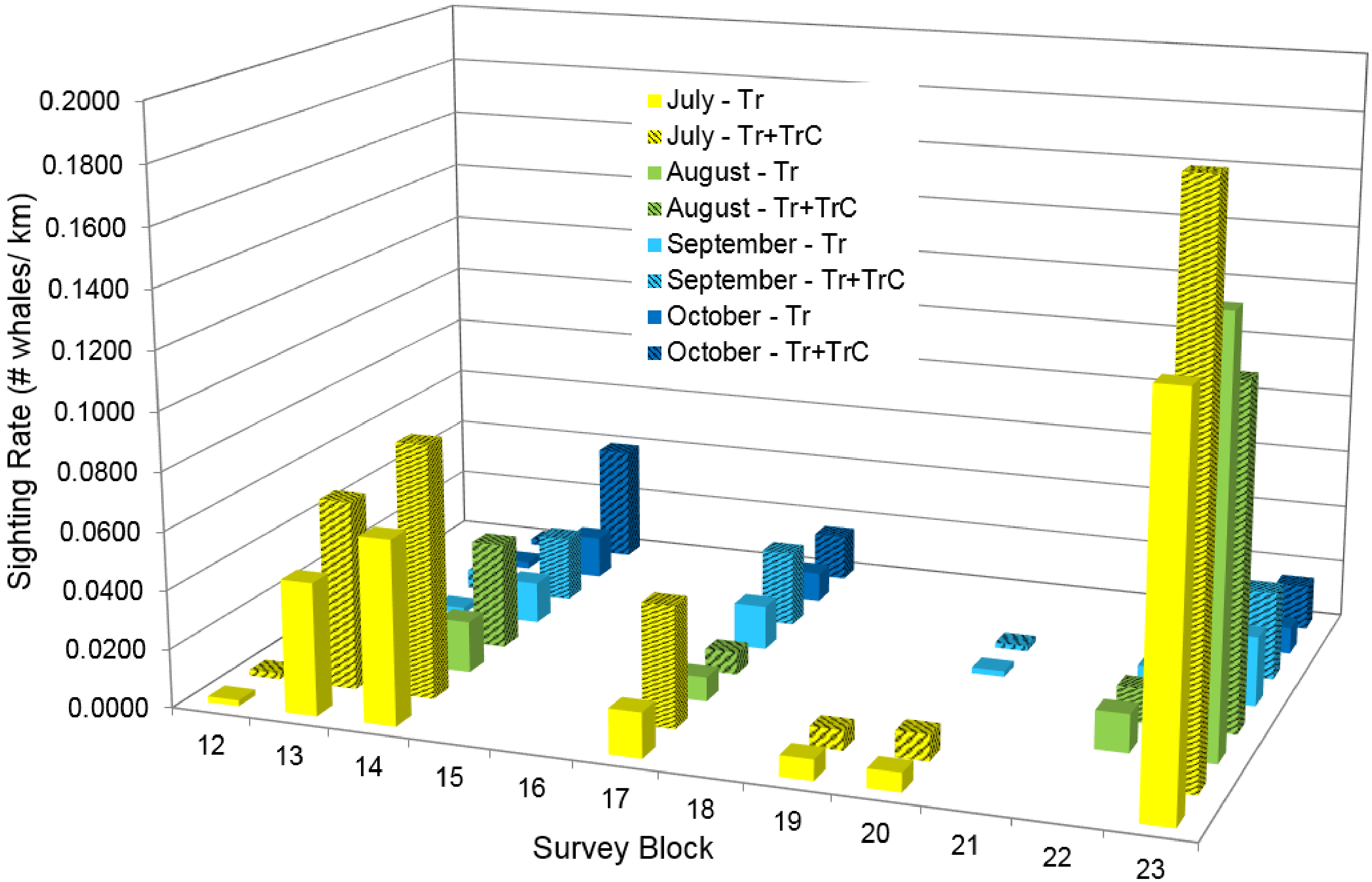


Figure 24. ASAMM 2017 gray whale monthly sighting rates (WPUE; sightings from primary observers only) per survey block for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

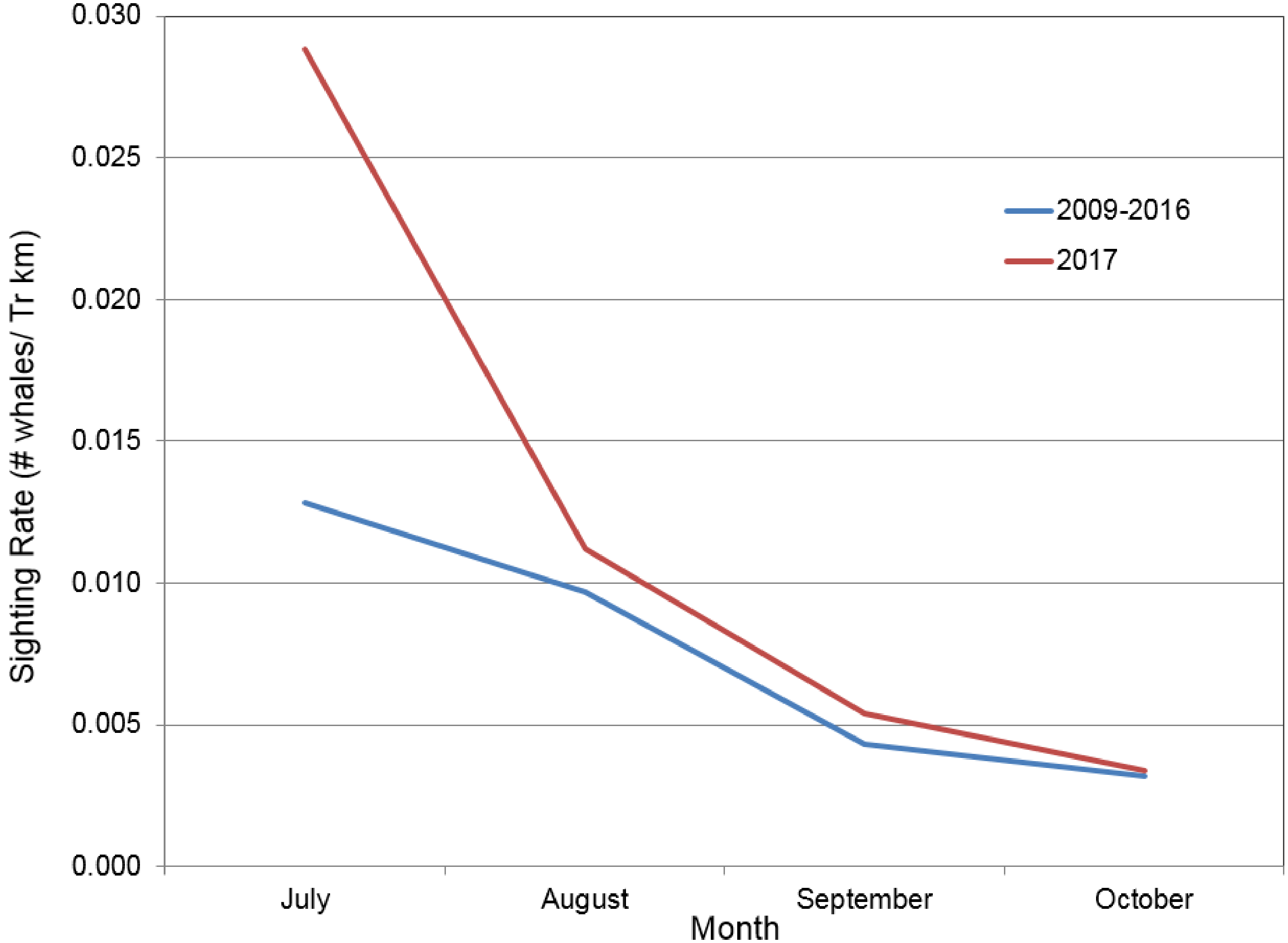


Figure 25. ASAMM gray whale monthly sighting rates (WPUE; transect sightings from primary observers only) in the eastern Chukchi and western Alaskan Beaufort sea (67°N-72°N, 154°W-169°W), 2009-2016 and 2017.

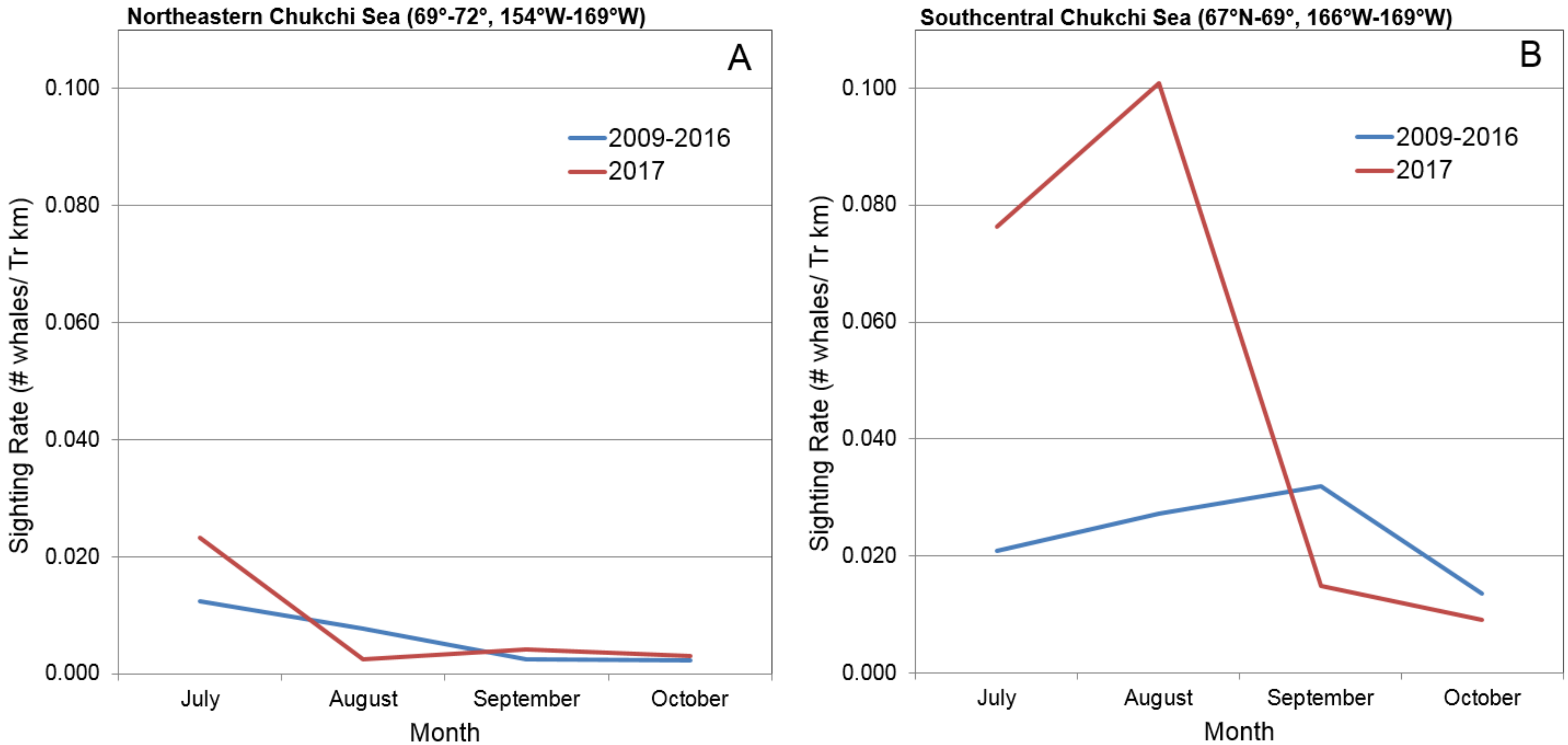


Figure 26. ASAMM gray whale monthly sighting rates (WPUE; transect sightings from primary observers only), 2009-2016 and 2017. A: northeastern Chukchi (and western Alaskan Beaufort Sea) (69°N-72°N, 154°W-169°W); B: southcentral Chukchi Sea (67°N-69°N, 166°W-169°W).

2017, sighting rates were noticeably higher in July and August compared to 2009-2016, and decreased considerably in September. The month in which peak sighting rate occurred in the southcentral Chukchi Sea also differed between time periods, occurring in August 2017 compared to September 2009-2016.

Comparison of Tr and Tr+TrC sighting rates for gray whales in 2017 are included in Appendix E (Figures E-4 and E-5). As with bowhead whale sighting rates, gray whale sighting rates per block using sightings and effort on transect combined with sightings and effort on circling from transect (Tr+TrC) are a more accurate reflection of gray whale relative abundance because they incorporate all on-effort sightings and effort. Sighting rates (Tr+TrC) were higher in nearly all survey blocks compared to Tr sighting rates (Figure 24). The highest Tr+TrC sighting rate was in block 23 in July (0.192 WPUE) (Appendix E, Table E-6).

The highest Tr sighting rate per depth zone in the Chukchi Sea (157°W-169°W) for the entire study period was in the 51-200 m South depth zone (0.119 WPUE) (Appendix E, Table E-7). As in previous years, the high numbers of gray whales observed in the benthic hotspot in the southcentral Chukchi Sea overwhelmed all sighting rate analyses (Figure 27). When the 51-200 m South depth zone was excluded from analysis, the highest Tr sighting rate was in the 51-200 m North depth zone in both summer and fall (Appendix E, Table E-7). When aerial surveys recommenced in the northeastern Chukchi Sea in 2008, gray whale depth zone preference was for shallower water (≤35 m) in the northern Chukchi Sea in summer and deeper water (>35 m) in fall (Clarke et al. 2012, 2013a, 2014, 2015a). However, starting in 2015 and continuing in 2016 and 2017, gray whale preference for deeper water was noted throughout summer and fall.

The highest Tr sighting rate per depth zone in the western Alaskan Beaufort Sea (154°W-157°W) for gray whales for the entire study period was in the 21-50 m zone (0.005 WPUE) (Appendix E, Table E-7). Gray whales were not seen on transect in any other depth zone in the western Alaskan Beaufort Sea.

Sighting rates per depth zone calculated using sightings and effort on transect and on circling from transect (Tr+TrC) were higher in most depth zones compared to Tr sighting rates (Figure 27; Appendix E, Table E-8). The highest Tr+TrC sighting rate was in the 51-200 m South depth zone in July (0.349 WPUE).

Gray whale distribution in 2017 using only Tr sightings overlapped the distribution of Tr sightings observed in previous years having light sea ice cover (Figure 28).

Gray Whale Sea Ice Associations

Most gray whales (99%, $n_i = 814$) were observed in 0% sea ice cover. Sea ice was largely absent from the Chukchi Sea study area by late July (Appendix A, Figure A-3). Gray whales were observed in 40% sea ice cover in early July only.

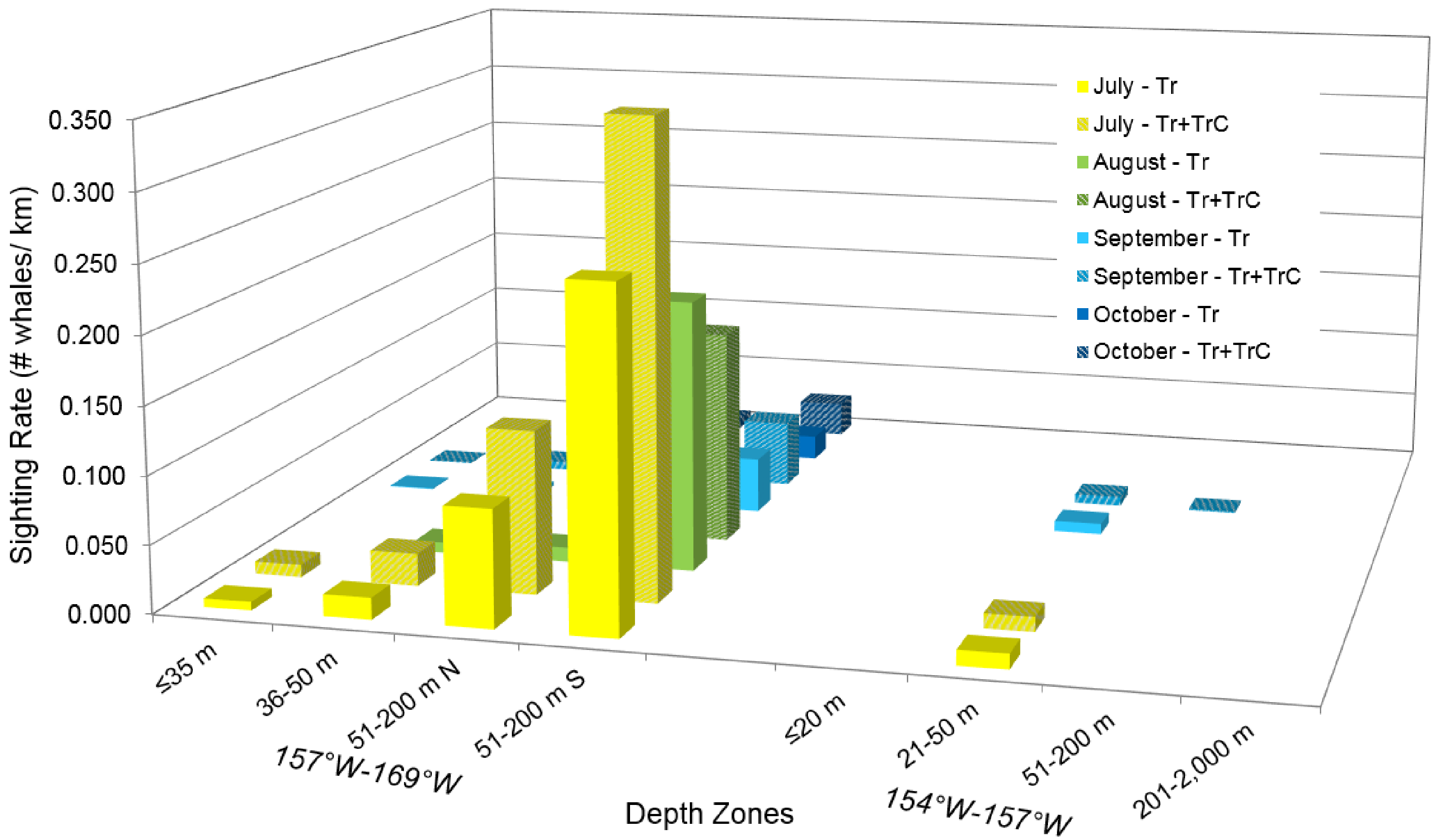


Figure 27. ASAMM 2017 gray whale monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

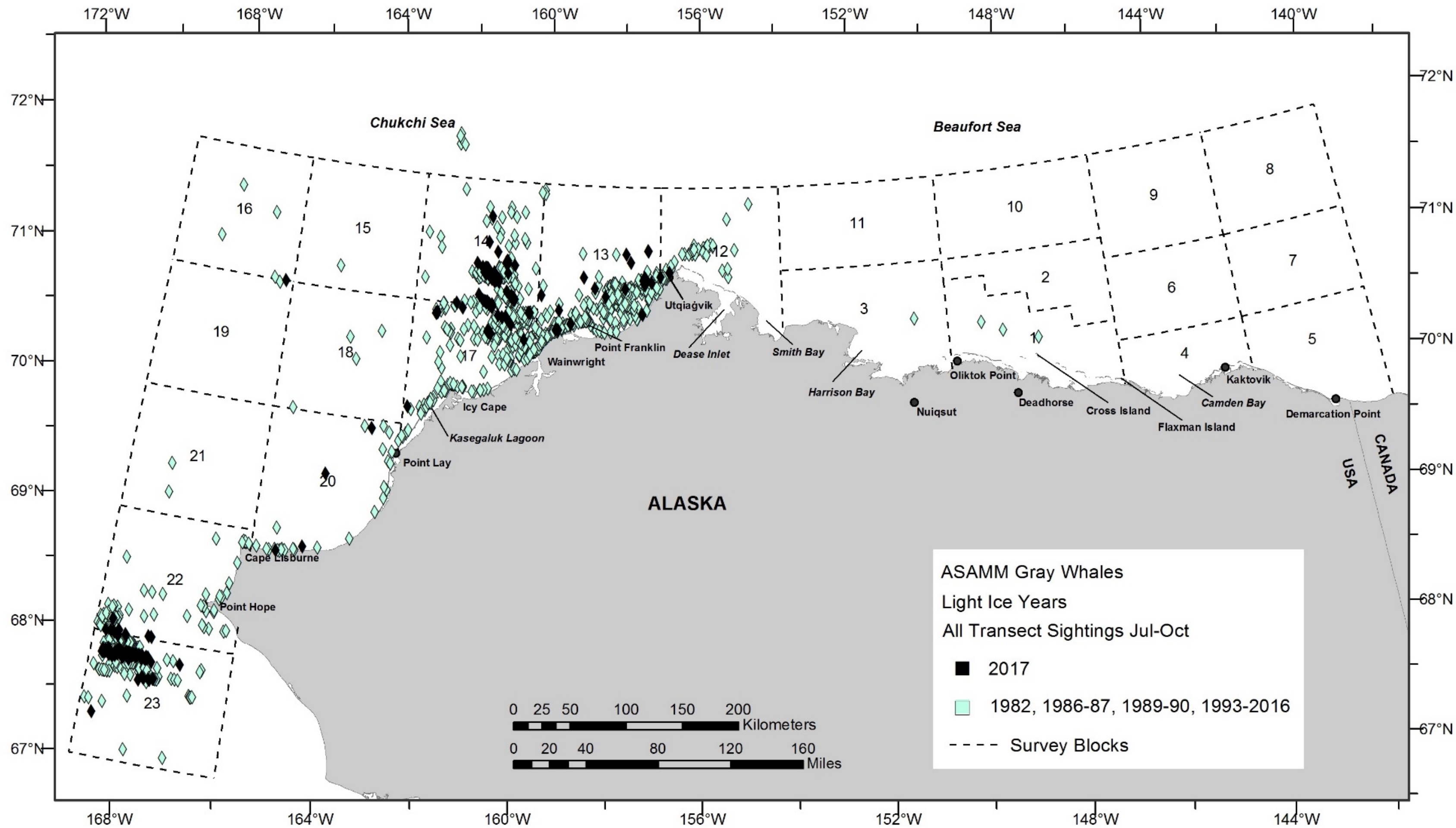


Figure 28. ASAMM gray whale sightings on transect in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2016, and 2017. Includes all sightings on transect made by primary and secondary observers.

Table 9. ASAMM 2017 semimonthly summary of gray whales (number of sightings/ number of individuals) observed during all survey modes (transect, search, and circling), by behavioral category. Excludes dead and same-day repeat sightings.

Behavior	**1-15 Jul**	**16-31 Jul**	**1-15 Aug**	**16-31 Aug**	**1-15 Sep**	**16-30 Sep**	**1-15 Oct**	**16-31 Oct**	**Total**
Breach	0	0	0	0	0	2/3	0	0	2/3
Dive	0	1/1	0	10/11	1/1	0	0	0	12/13
Feed	102/251	30/81	17/31	47/95	12/15	64/106	17/21	12/17	301/617
Mill	0	0	0	1/7	0	1/2	0	0	2/9
Rest	36/50	11/24	0	1/1	1/1	1/1	0	0	50/77
SAG	0	0	0	0	0	1/2	0	0	1/2
Swim	12/17	14/21	2/2	19/30	7/7	12/15	0	4/6	70/98
Unknown	2/2	0	0	0	0	0	0	0	2/2
TOTAL	152/320	56/127	19/33	78/144	21/24	81/129	17/21	16/23	440/821

Gray Whale Behaviors

Behaviors of gray whales observed during all survey modes (transect, search, and circling) in 2017 are summarized in Table 9. The behaviors most often recorded were feeding (75%) and swimming (12%). Resting was recorded for 77 whales (9%). Other behaviors recorded included milling ($n_i = 9$), diving ($n_i = 13$), and breaching ($n_i = 3$). Two gray whales were observed engaging in SAG behavior. Gray whales observed in the southcentral Chukchi Sea (south of 69°N) were primarily feeding (66%), resting (15%), and swimming (12%), and the gray whale observed in Peard Bay was feeding. Fine-scale Tr+TrC sighting rates of feeding and milling gray whales in 2017 are shown in Figure 29. In summer, feeding and milling sighting rates were high west of Utqiaġvik, northwest of Wainwright, and southwest of Point Hope, while in fall the highest sighting rate was limited to northwest of Wainwright only. Gray whales recorded as feeding were likely all feeding in the benthos, as evidenced by the presence of mud plumes. Gray whale feeding was likely underreported due to the difficulty of identifying surface or water column feeding during aerial surveys. Two (<1% of all gray whales seen) gray whales appeared to respond to the aircraft. One of the whales twisted its body toward the location of the aircraft and the other whale, a calf, changed its swim direction.

In 2017, 89 gray whale calves were seen (Figure 30). Most calves ($n_i = 68$, 76%) were sighted after circling was initiated and likely would not have been observed if circling had not commenced. The calf ratio (number of calves/number of total whales) was 0.108, which is higher than calf ratios in 2009-2011, but lower than calf ratios recorded in 2012-2016 (Figure 31). Calf distribution in 2017 overlapped that of adult gray whales temporally and spatially in the northeastern Chukchi Sea but not in the southcentral Chukchi Sea where only four calves were seen. Most calves (61%, $n_i = 54$) were within 50 km of shore, however 35% ($n_i = 31$) were

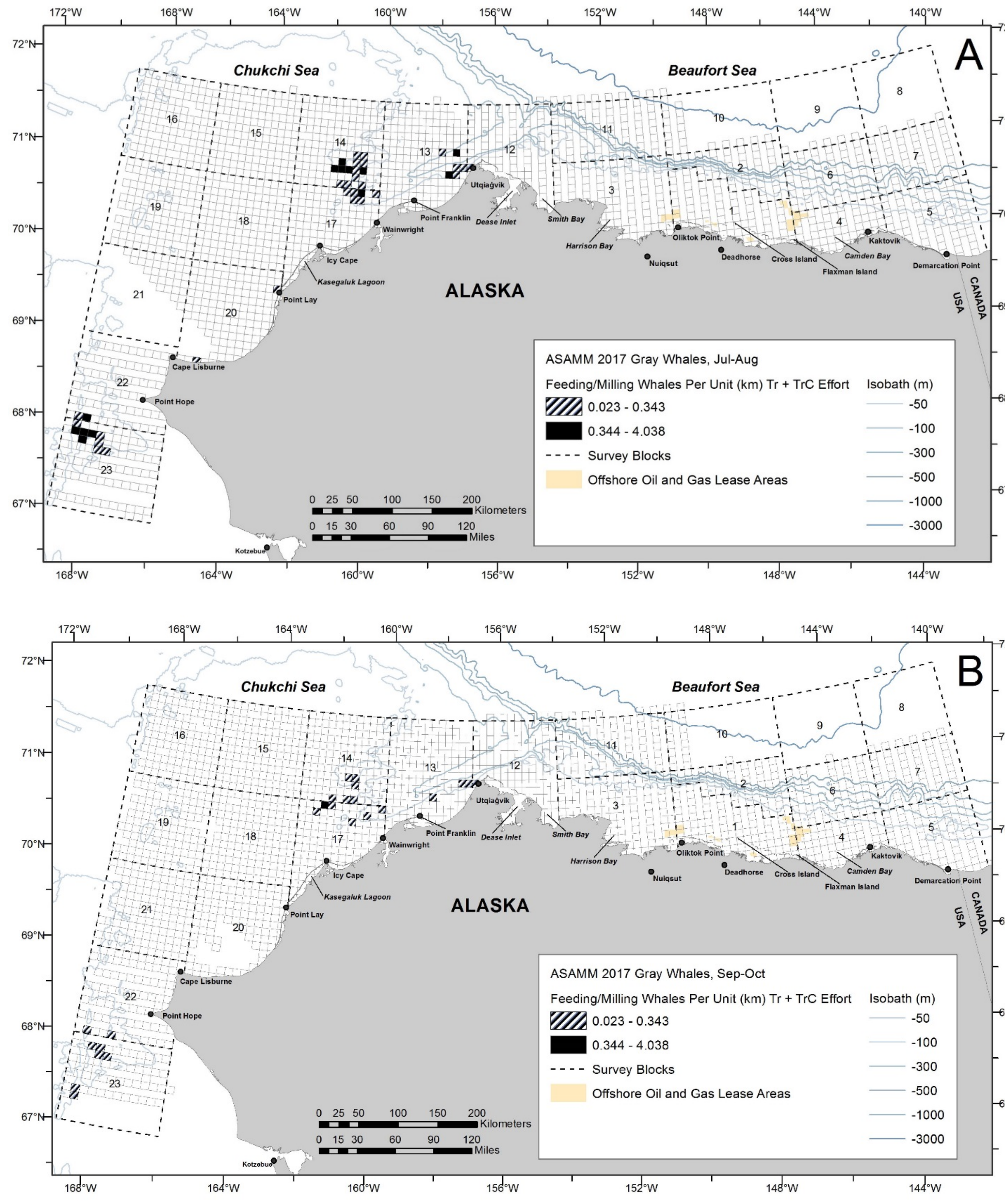


Figure 29. ASAMM 2017 gray whale feeding and milling sighting rates (WPUE; Tr+TrC sightings from primary observers only). A: summer (July-August); B: fall (September-October). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

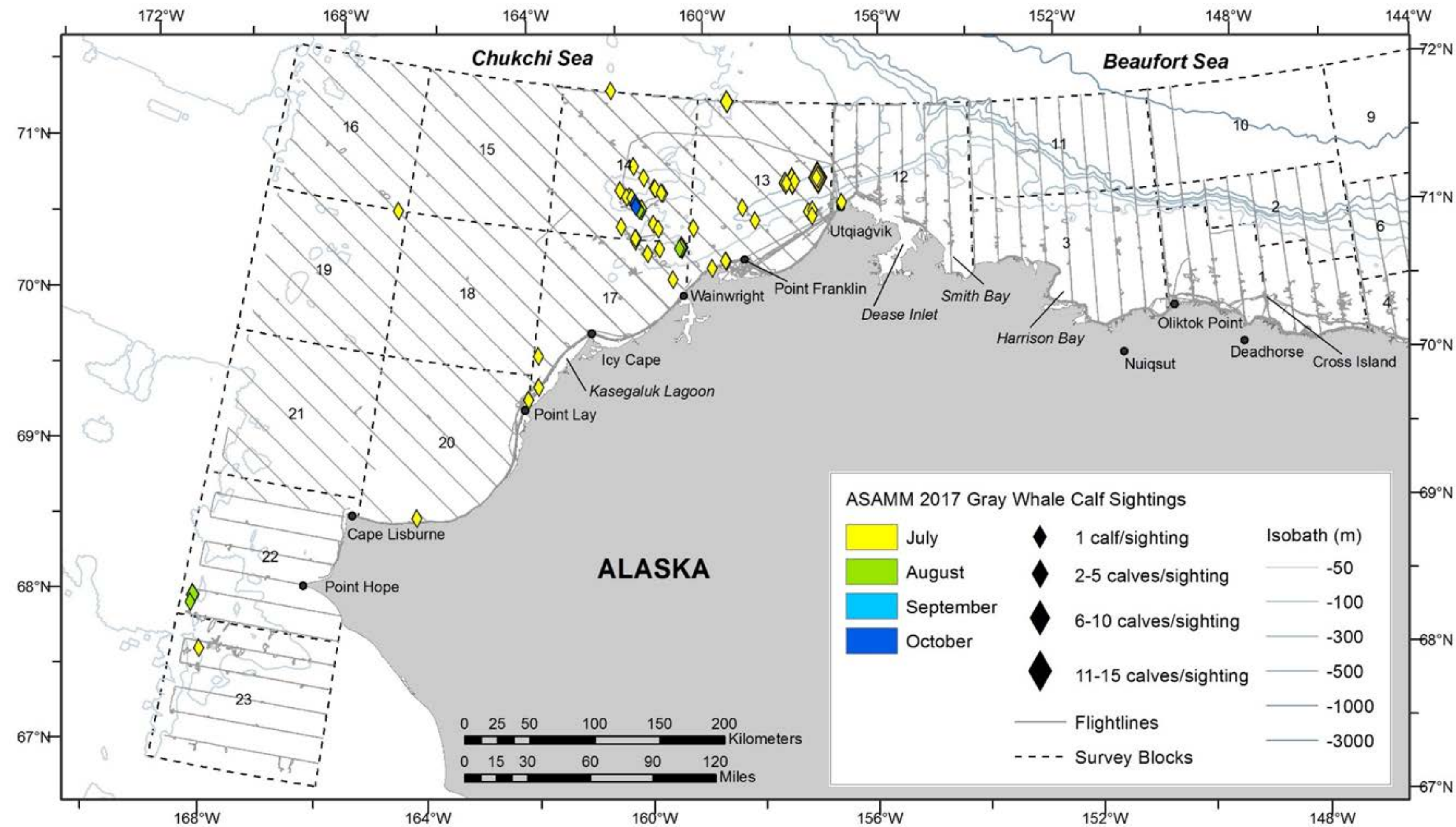


Figure 30. ASAMM 2017 gray whale calf sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

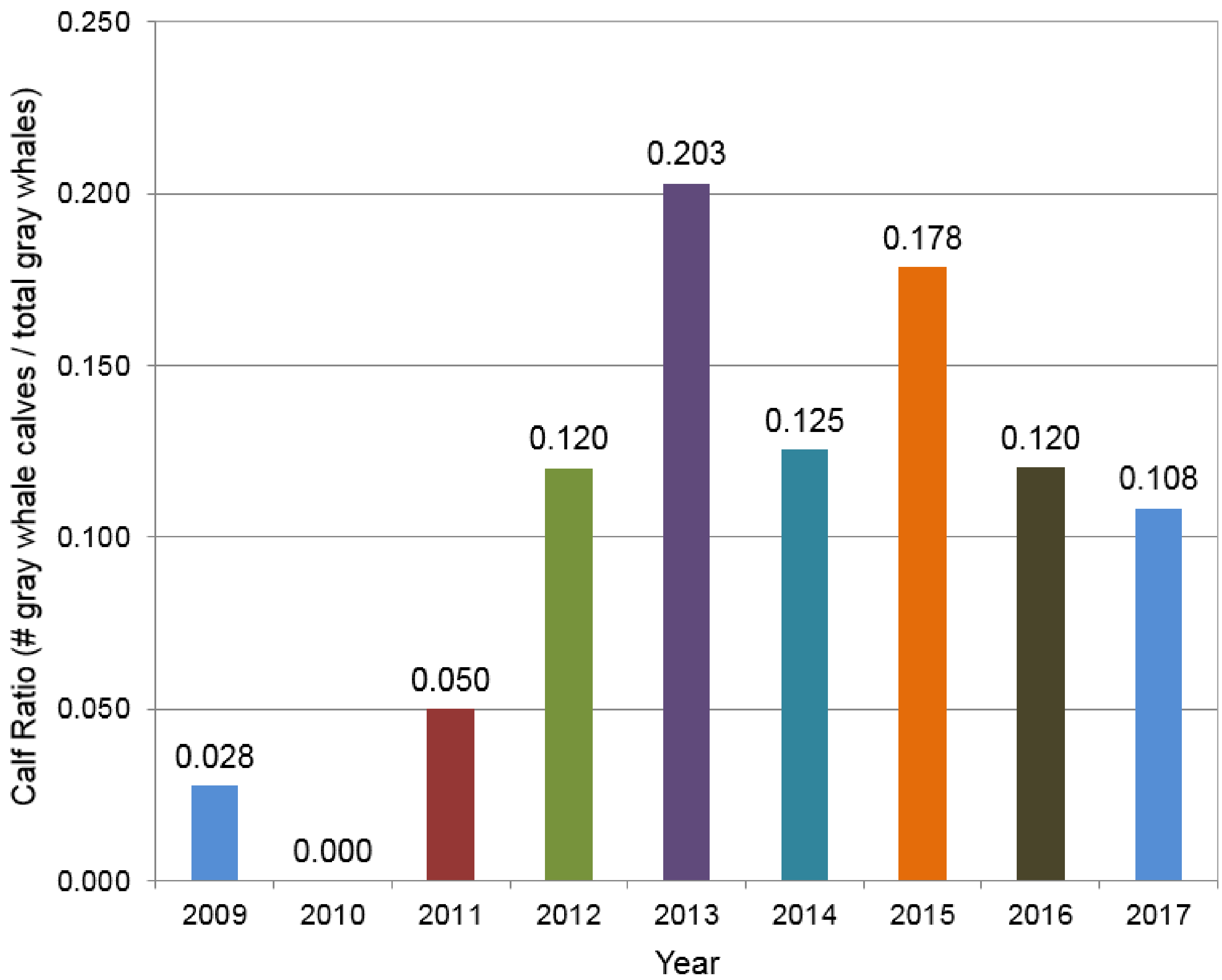


Figure 31. ASAMM gray whale annual calf ratios (number of gray whale calves per total gray whales), 2009-2017.

50-100 km from shore. Two calves were 120 km and one calf was 200 km northwest of Utqiaġvik; one calf was 200 km west-northwest of Wainwright.

In July, 80 calves were observed, seven calves were observed in August, none were seen in September, and two calves were seen in October. On 12 occasions, multiple calves were seen in one day, with the highest daily total on 13 July (34 calves; Appendix B, Flight 206). Some calves may have been sighted on more than one day. However, preliminary analysis of opportunistically collected photo-identification data collected in 2017 indicate that relatively few calves were resighted (Willoughby et al. 2018b; Appendix C).

Gray whale swim direction was not significantly clustered around a mean heading in any month in either the northeastern Chukchi Sea or the southcentral Chukchi Sea. Most gray whales observed during ASAMM are at the far northern extent of the species' range and are feeding, so a lack of directed migratory movement is expected.

Humpback Whales

There were 10 sightings of 15 humpback whales (*Megaptera novaeangliae*) in 2017 (Table 3, Figure 32). Stock affiliation of humpback whales in this region is unknown. Humpback whales were seen in July (n_i = 2), August (n_i = 6), September (n_i = 4), and October (n_i = 3), all in the southcentral Chukchi Sea between 67°N-69°N. None of the humpback whales that were photographed (n_i = 10) were resightings of previous sightings in 2017. Sighting rates were fairly low (<0.002 WPUE) in both summer and fall in all depth zones (Figure 33). Humpback whales were seen in close proximity to bowhead whales and fin whales. Humpback whales were observed feeding (40%), swimming (33%), milling (13%), and diving (13%). None of the humpback whales appeared to respond to the survey aircraft.

Fin Whales

There were 19 sightings of 30 fin whales (*Balaenoptera physalus*) of the Northeast Pacific stock in 2017, including three calves, all in the southcentral Chukchi Sea between 67°N and 69°N (Table 3; Figure 32). Fin whales were seen in July (n_i = 2), August (n_i = 11), September (n_i = 6) and October (n_i = 11). Images of fin whales did not allow determination of potential resightings within 2017. Sighting rates were highest in the 51-200 m South depth zone in fall (Figure 33). Fin whales were seen in close proximity to bowhead whales and humpback whales. Fin whales were observed swimming (57%), feeding (27%), milling (7%), and diving (10%). None of the fin whales appeared to respond to the survey aircraft.

Minke Whales

There were three sightings of three minke whales (*Balaenoptera acutorostrata*) of the Alaska stock in 2017 (Table 3; Figure 32). Minke whales were seen in September and October in the southcentral Chukchi Sea between 67.6°N-68.2°N. None of the minke whales were photographed. Sighting rates were highest in the 51-200 m South depth zone in fall (Figure 33). Minke whales were solitary and not sighted in close proximity to other cetaceans. All minke

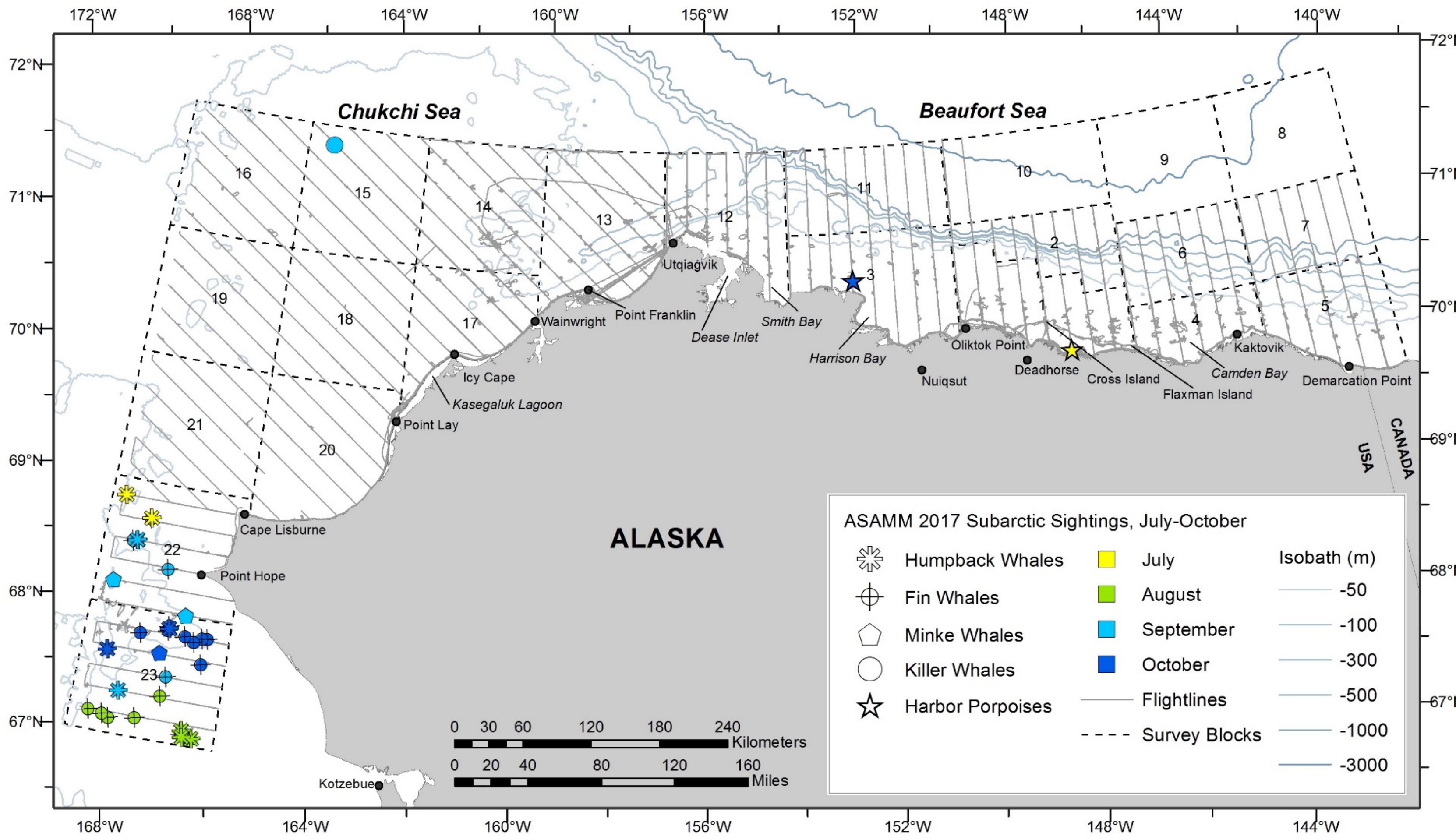


Figure 32. ASAMM 2017 harbor porpoise and humpback, fin, minke, and killer whale sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

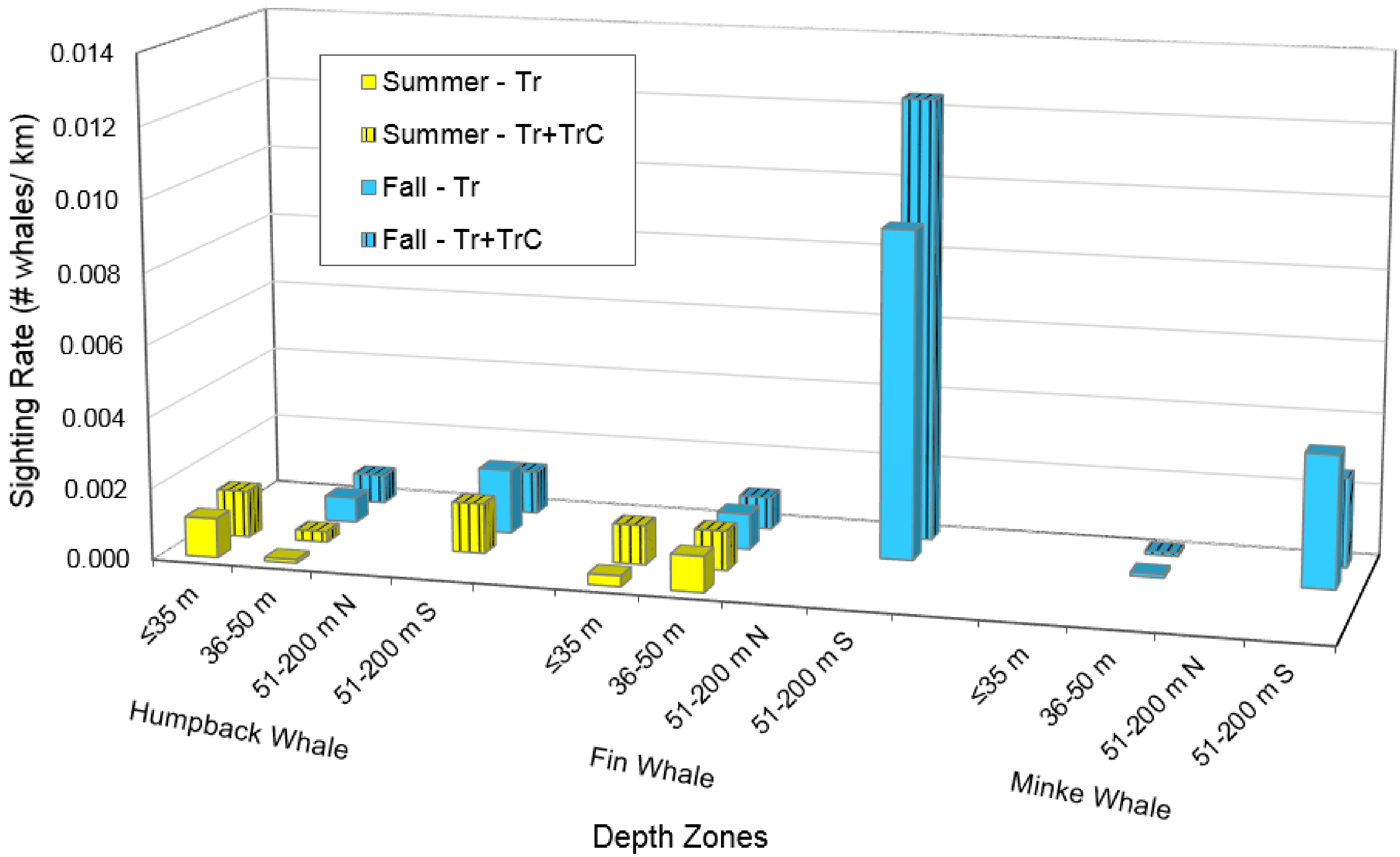


Figure 33. ASAMM 2017 humpback, fin, and minke whale seasonal sighting rates (WPUE; sightings from primary observers only) per depth zone in the eastern Chukchi Sea (67°N-72°N, 157°W-169°W) for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

whales sighted were adults and were swimming. None of the minke whales appeared to respond to the survey aircraft.

Belugas

Beluga Sighting Summary

During the 2017 ASAMM surveys, 428 sightings of 2,153 belugas (*Delphinapterus leucas*) were observed during all survey modes (transect, search, and circling) (Table 3). Beluga stock affiliation is impossible to determine from aerial surveys, and sightings likely included belugas from the Eastern Chukchi Sea (ECS) and Beaufort Sea stocks (Hauser et al. 2014). In the eastern Chukchi Sea, beluga sightings were limited to 15 sightings of 441 whales, most of which were seen in July (Figure 34). There was one sighting of 135 belugas approximately 170 km northwest of Utqiaġvik in late October. Belugas were seen in all months surveyed (July-October) in the western Beaufort Sea (Figure 34), although there were relatively few sightings in September. In the western Beaufort Sea, belugas were seen along the continental slope, with few sightings nearshore. Sightings nearshore, however, did include some moderately large groups, including groups of 17 (23 July), 20 (5 August), and 10 (16 August) observed east of Kaktovik, groups of 10 (24 August) and 45 and 50 (18 September) in Camden Bay, a group of 60 (19 October) near Cape Halkett, and groups totaling 123 belugas (21 July) east of Utqiaġvik. Belugas were seen near Barrow Canyon from July through October. Beluga distribution in 2017 was generally similar to that documented in previous years with light sea ice cover in the western Beaufort Sea (Figure 35). The distribution of the relatively few beluga sightings in the eastern Chukchi Sea in 2017 overlapped that of past years.

Beluga Sighting Rates

In summer and fall 2017, belugas were seen from 69.2°N to 72°N between 140.4°W and 163.4°W. There were 381 sightings of 1,415 belugas on transect by primary observers, ranging from one beluga per sighting ($n_s = 174$) to 60 belugas per sighting ($n_s = 1$). Several of the larger beluga groups were the result of “30-sec” counts. The highest number of sightings on transect per survey block was in block 6 ($n_s = 99$), followed by block 7 ($n_s = 82$), and block 2 ($n_s = 71$). In the western Beaufort Sea, sighting rates were highest in July (0.110 WPUE), decreased in August (0.038 WPUE) and again in September (0.006 WPUE), then increased in October (0.036 WPUE) (Figure 36; Appendix E, Table E-9). In the eastern Chukchi Sea, belugas were seen on transect only in July. Sighting rates likely reflect the presence of the ECS stock in the northeastern Chukchi and western Beaufort seas in summer (July-August) (Hauser et al. 2014). Beluga Tr sighting rates in 2017 were higher than sighting rates in 2011, but lower compared to observations in 2012-2016 (Clarke et al. 2013a, 2014, 2015a, 2017a, b).

Areas of highest fine-scale Tr sighting rates in summer were offshore on the continental slope and in the deepest area surveyed in the western Beaufort Sea (Figure 37). In fall, areas of highest fine-scale Tr sighting rates remained offshore in deep water in the western Beaufort Sea, but also included two areas extremely close to shore due to abnormally large groups observed there in September and October.

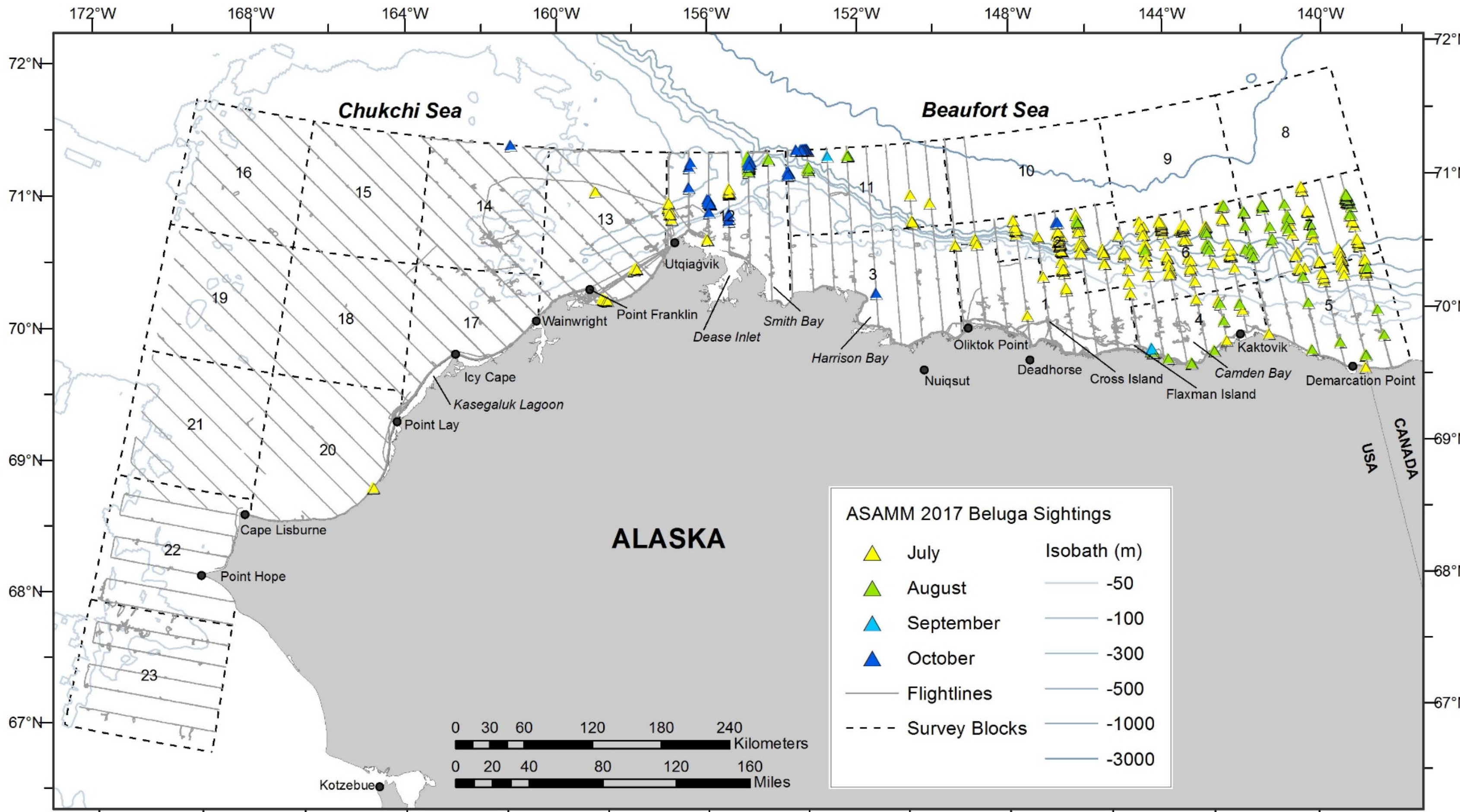


Figure 34. ASAMM 2017 beluga sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

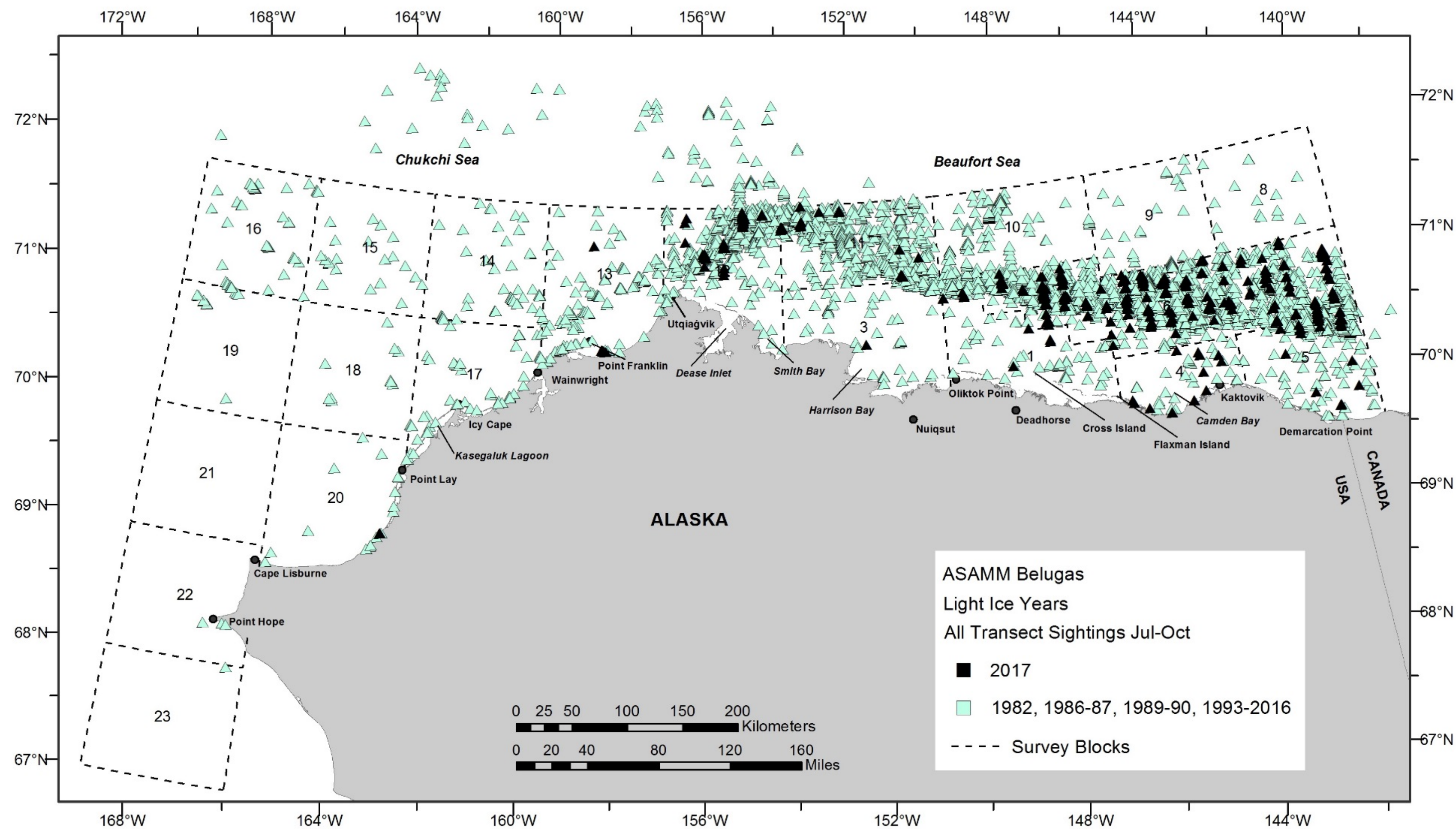


Figure 35. ASAMM beluga sightings on transect in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2016, and 2017. Includes all sightings on transect made by primary and secondary observers.

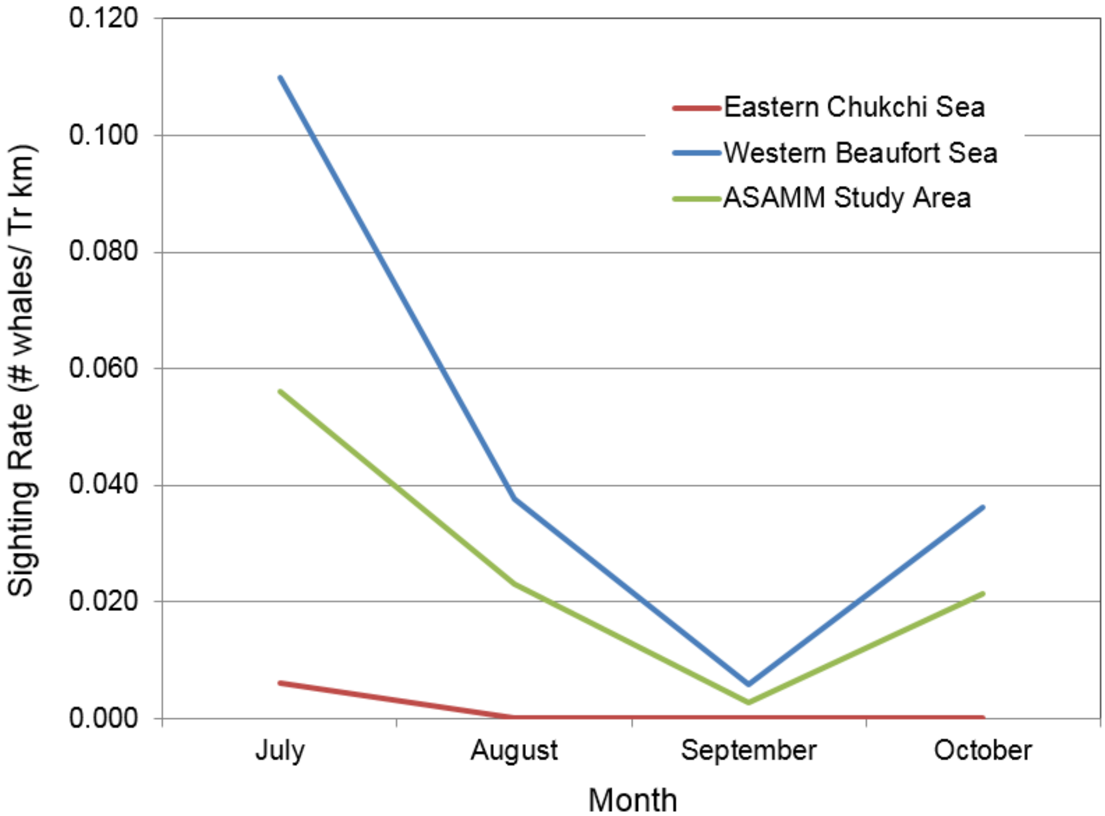


Figure 36. ASAMM 2017 beluga monthly sighting rates (WPUE; transect sightings from primary observers only) in the western Beaufort and eastern Chukchi seas, and in the entire ASAMM study area.

For all months combined, block 6 had the highest Tr sighting rate (0.151 WPUE), followed by block 7 (0.139 WPUE), and block 2 (0.103 WPUE) (Appendix E, Table E-9). Offshore survey blocks located over the continental slope in the western Beaufort Sea (i.e., 2, 6, and 7) generally had higher Tr sighting rates than blocks near shore (i.e., 1, 3, 4 and 5) in summer but not fall (Figure 38).

Beluga Tr sighting rates per depth zone were highest in the 201-2,000 m depth zone near Barrow Canyon (154°W-157°W) and in the >200 m depth zones in the western Beaufort Sea (140°W-154°W) (Figure 39; Appendix E, Table E-10). In the northeastern Chukchi Sea (157°W-169°W), beluga Tr sighting rate per depth zone was highest in the ≤35 m depth zone (Appendix E, Table E-10).

Sighting rates using Tr+TrC sightings and effort were not calculated for belugas because circling from transect was rarely initiated during beluga sightings on transect.

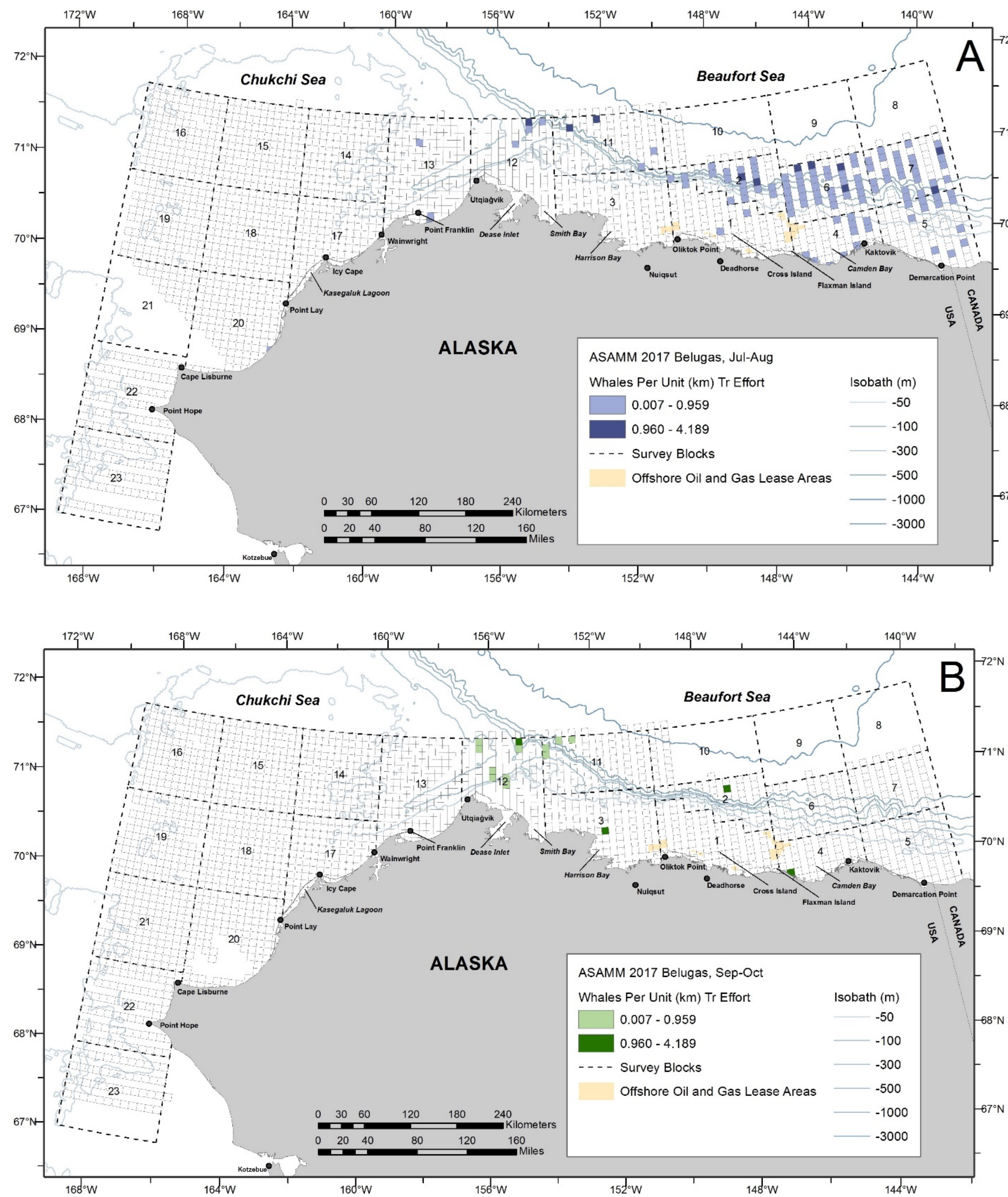


Figure 37. ASAMM 2017 beluga sighting rates (WPUE; transect sightings from primary observers only), July-August (A) and September-October (B). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

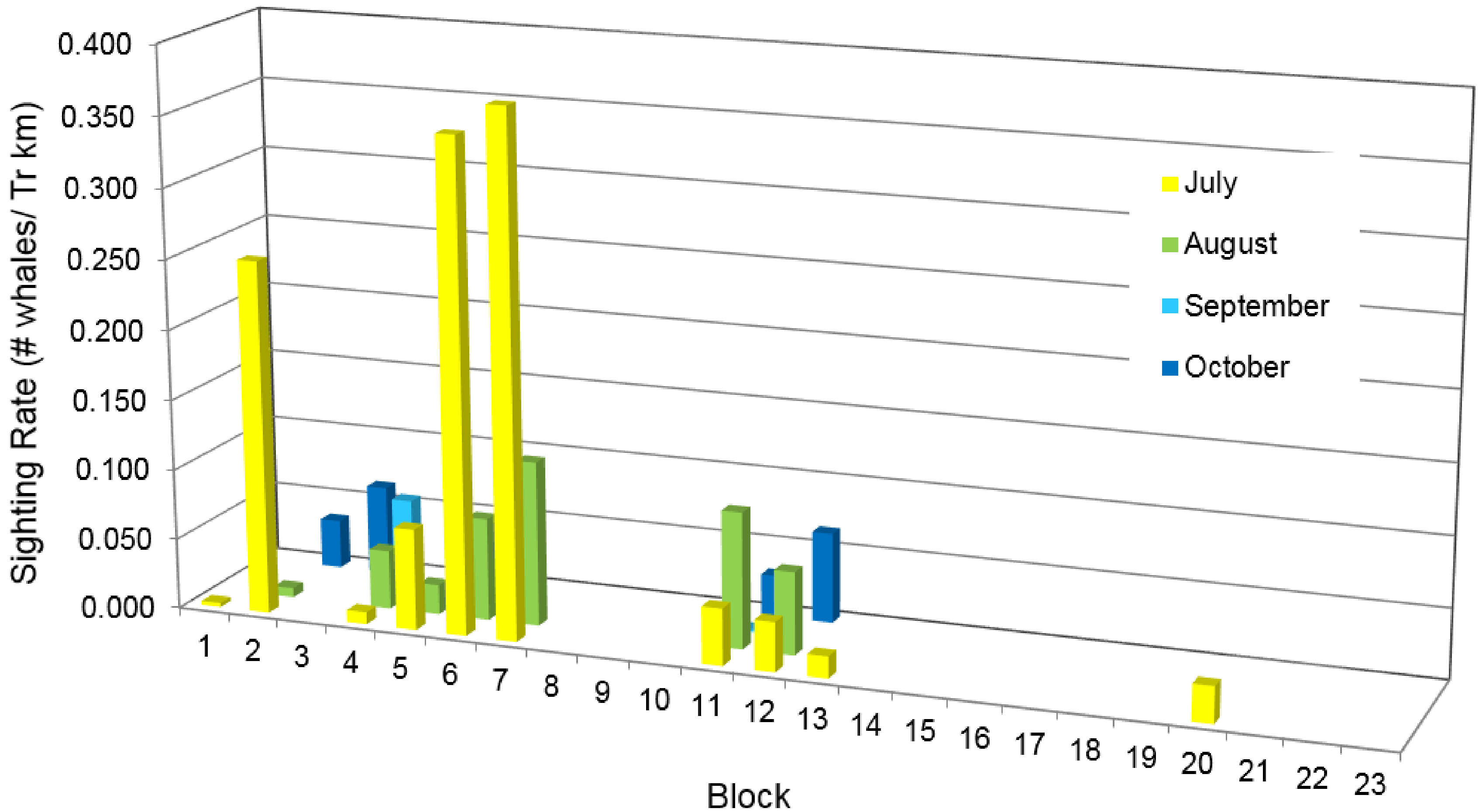


Figure 38. ASAMM 2017 beluga monthly sighting rates (WPUE; sightings from primary observers only) per block for sightings and effort on transect (Tr). Sighting rates of zero were removed from the graph for clarity.

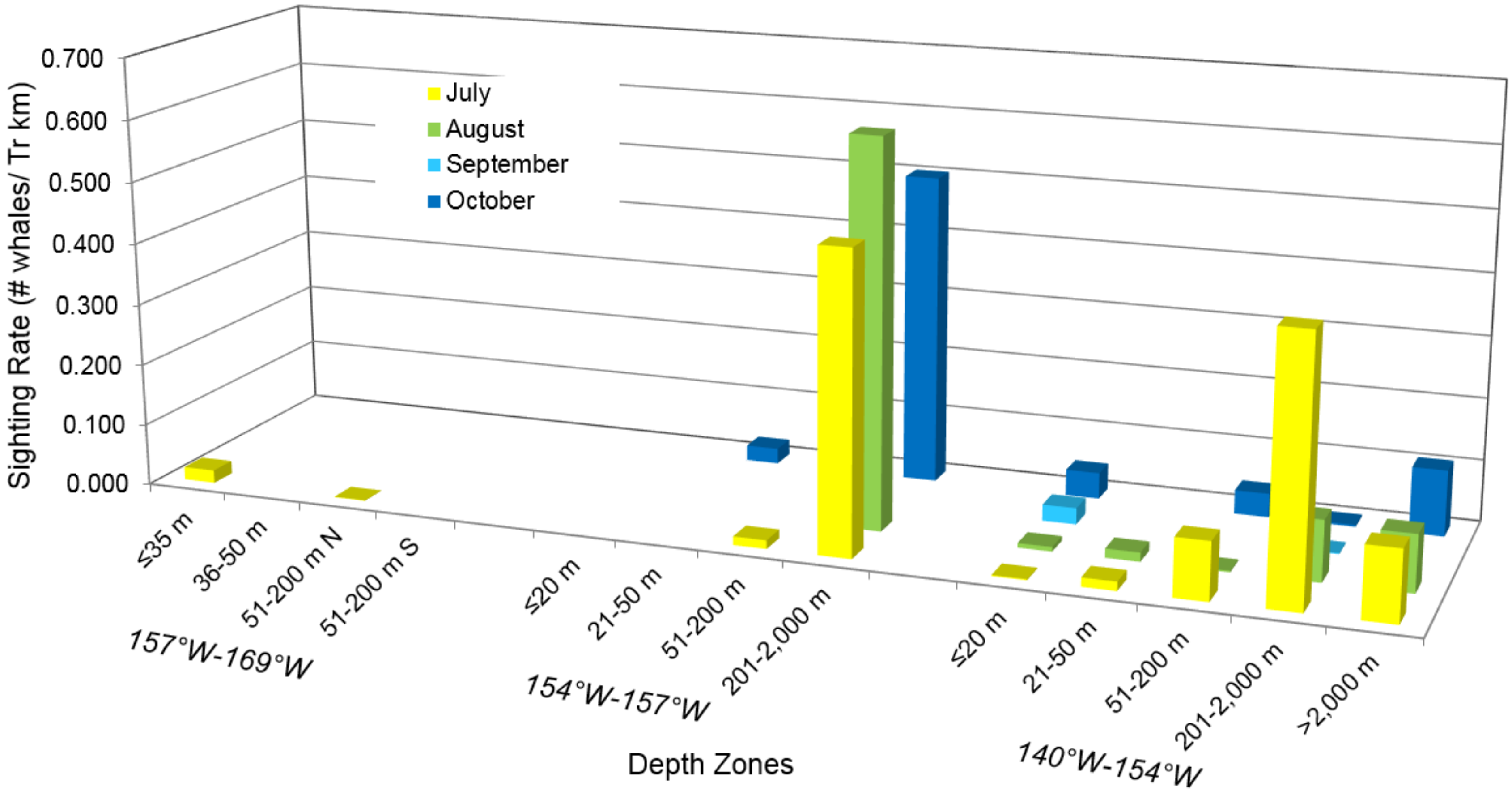


Figure 39. ASAMM 2017 beluga monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr). Sighting rates of zero were removed from the graph for clarity.

Beluga Sea Ice Associations

Belugas were observed in sea ice cover ranging from no ice to 80% broken floe or new-grease ice. Most belugas (80%, n_i = 1,719) were observed in areas with no ice, with 17% (n_i = 362) in 1-20% sea ice cover, and 3% (n_i = 72) in >20% sea ice cover. Sea ice was absent in the western Beaufort Sea study area, where the majority of belugas were seen, by late July (Appendix A, Figure A-3). Sea ice remained largely non-existent in the ASAMM study area until late October, when new-grease ice started forming in shallow areas nearshore (Appendix A, Figure A-9).

Beluga Behaviors

Beluga behaviors observed during all survey modes (transect, search, and circling) in 2017 are summarized in Table 10. The behavior most often recorded was swimming (80%). Milling was recorded for 417 belugas (19%), resting was recorded for nine belugas (<1%), three belugas (<1%) were observed diving, and one beluga (<1%) was playing with a log. Most of the large groups that were observed nearshore in the western Beaufort were swimming, but one group of 60 observed near Cape Halkett was milling. Four belugas (<1%) appeared to respond to the survey aircraft by diving.

Swim direction was evaluated for belugas for different regions and time periods. Swim direction was clustered around a mean heading of 286°T ($Z = 62.113$, $P < 0.0001$, 288 observations) in the western Beaufort Sea (140°W-154°W) in summer. In fall, swim direction in the western Beaufort Sea was significantly clustered around a mean heading of 213°T ($Z = 7.511$, $P < 0.0001$, 22 observations). Mean vector swim directions for belugas in the northeastern Chukchi Sea (154°W-169°W, to incorporate Barrow Canyon) in summer were not significantly clustered around a mean heading. In fall, swim direction for belugas observed between 154°W-169°W was significantly clustered around a mean heading of 53°T ($Z = 7.455$, $P < 0.0001$). Many of the beluga sightings during fall were in the Barrow Canyon area; this heading is roughly "down canyon".

There were 150 sightings of 321 beluga calves observed during all survey modes (transect, search, and circling) (Figure 40). Animals identified as calves likely included belugas up to a few years old. Calves nurse for up to two years but may remain with their mothers after weaning has occurred (Suydam 2009), often forming triads when a new calf is born. Color is not necessarily a good indication of age because beluga calves lighten progressively over time, changing from charcoal gray at birth to blue-gray then light gray before becoming completely white by seven to nine years of age. Beluga calf sightings were scattered across the western Beaufort Sea slope (Figure 40). The largest calf concentrations were between Point Franklin and Utqiaġvik in July and approximately 170 km northwest of Utqiaġvik in October.

Beluga calves may be underrepresented in the dataset because of their small size and the infrequency of circling over beluga sightings.

Table 10. ASAMM 2017 semimonthly summary of belugas (number of sightings/ number of individuals) observed during all survey modes (transect, search, and circling), by behavioral category. Excludes dead and same-day repeat sightings.

Behavior	1-15 Jul	16-31 Jul	1-15 Aug	16-31 Aug	1-15 Sep	16-30 Sep	1-15 Oct	16-31 Oct	Total
Dive	0	0	0	0	0	0	0	1/3	1/3
Log play	0	1/1	0	0	0	0	0	0	1/1
Mill	3/19	17/338	0	0	0	0	0	1/60	21/417
Rest	1/2	4/5	0	1/2	0	0	0	0	6/9
Swim	29/78	211/812	86/309	24/109	1/2	2/95	2/20	43/297	398/1,722
Unknown	1/1	0	0	0	0	0	0	0	1/1
TOTAL	34/100	233/1,156	86/309	25/111	1/2	2/95	2/20	45/360	428/2,153

Killer Whales

There was one sighting of two killer whales (*Orcinus orca*) in 2017 (Table 3; Figure 32). The two adult whales were observed on 19 September, approximately 310 km west of Utqiaġvik in the northeastern Chukchi Sea. The pair of whales was observed swimming belly to belly and upside down, and exhibited SAG behavior. Neither of the killer whales appeared to respond to the survey aircraft.

Harbor Porpoises

There were two sightings of two harbor porpoises (*Phocoena phocoena*) in 2017, both in the central Alaskan Beaufort Sea (Table 3; Figure 32). One harbor porpoise was observed on 19 July within Stefansson Sound, southeast of Prudhoe Bay, and was the only cetacean observed between the barrier islands and the mainland. The other harbor porpoise was sighted on 7 October, approximately 10 km offshore between Cape Halkett and Smith Bay. Both porpoises were observed swimming, and neither appeared to respond to the survey aircraft.

Unidentified Cetaceans

Sightings were recorded as unidentified when a positive species identification was not possible. This usually occurred when an animal dived and could not be resighted or when environmental conditions such as fog, low cloud ceilings, glare, or sea state hindered efforts to relocate the initial sighting. There were 27 sightings of 28 unidentified cetaceans in 2017 (Table 3; Figure 41). Nineteen of the unidentified cetaceans were in the eastern Chukchi Sea, and nine unidentified cetaceans were in the western Beaufort Sea. Two of the unidentified cetaceans were probable bowhead whales, based on their size and darker color. One of the unidentified

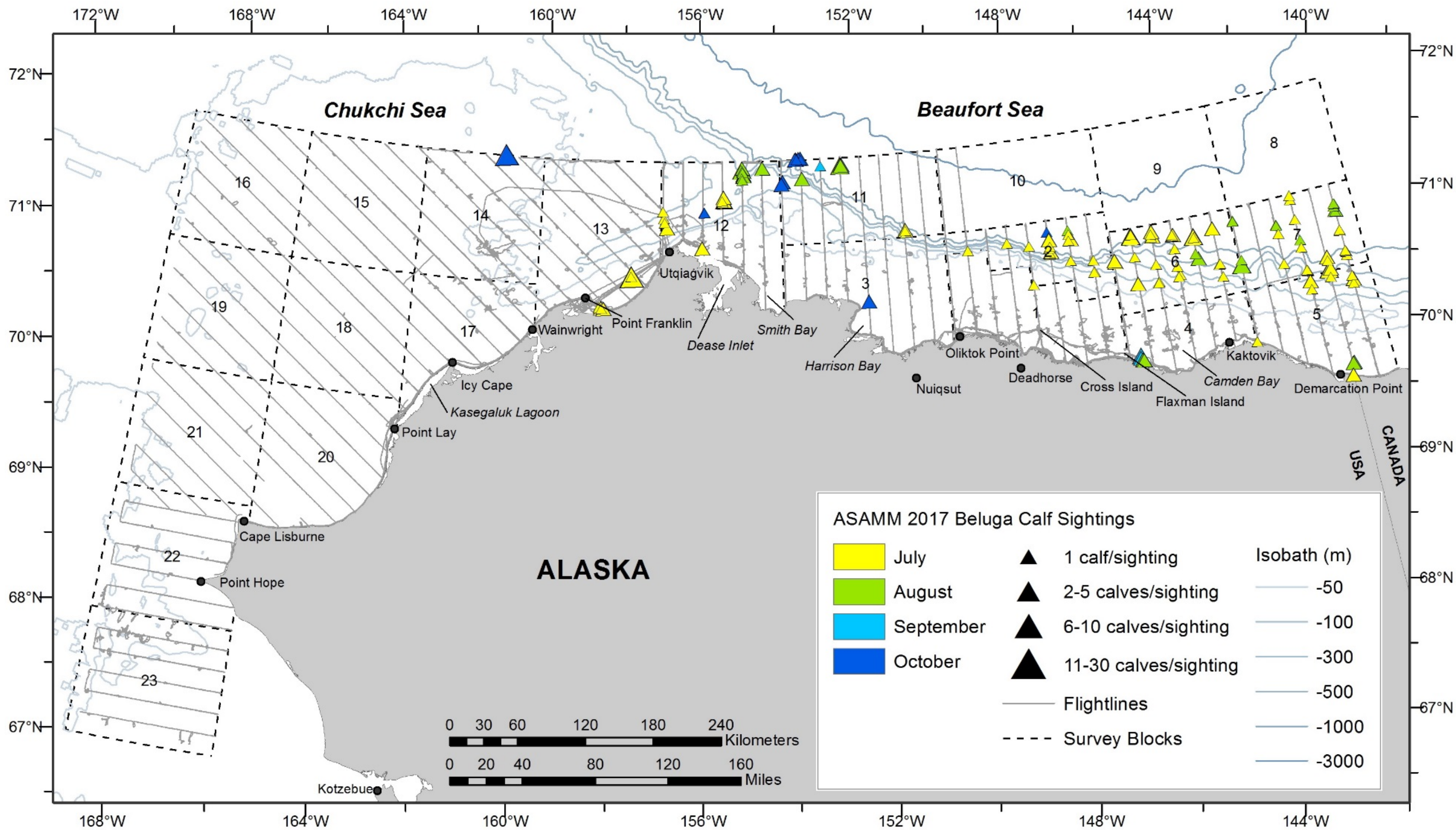


Figure 40. ASAMM 2017 beluga calf sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

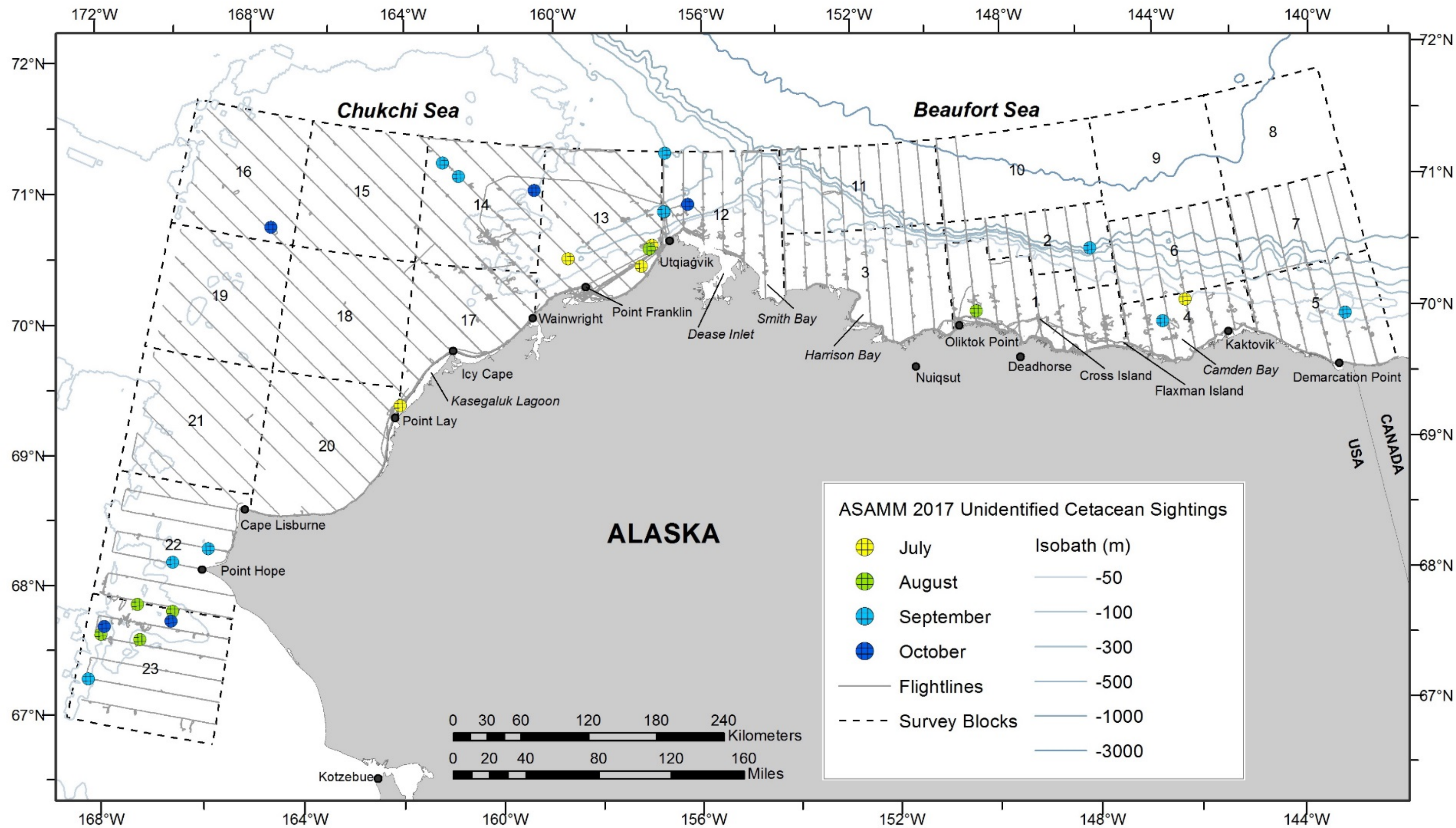


Figure 41. ASAMM 2017 unidentified cetacean sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

cetaceans was likely a gray whale and one was possibly a minke whale. The majority of unidentified cetacean sightings were not seen clearly enough to infer species with any probability.

None of the unidentified cetaceans appeared to respond to the survey aircraft.

Pinnipeds

Walruses

Pacific walruses (*Odobenus rosmarus divergens*) were observed every month in the eastern Chukchi Sea (Figure 42). Excluding dead walruses and walruses that were known to be duplicate sightings within the same day, there were 749 sightings of 85,330 walruses observed from July to October 2017 (Tables 11 and 12). This total is deceptively high because it includes resightings of a large, coastal walrus haulout near Point Lay. When only the highest group size estimate of the haulout is taken into account (n_s = 1, n_i = 34,500), there were 740 sightings of 38,430 walruses in 2017. Excluding sightings of the Point Lay haulout, most walruses (75%, n_i = 2,952 out of 3,930) were sighted in July, with the majority of sightings in the northeastern Chukchi Sea. Relatively few walruses (n_s = 6, n_i = 6) were observed in the western Beaufort Sea, between Point Barrow and 149.92°W.

In early July, most walruses (74%, n_i = 2,061 out of 2,952) were observed hauled out on sea ice that remained in the northeastern Chukchi Sea study area. Several large groups of walruses were observed hauled out on shorefast ice between Point Franklin and Wainwright and on sea ice west of Utqiaġvik (Figure 42A). Sea ice was absent from the northeastern Chukchi Sea study area after mid-July (Appendix A, Figure A-2). In the latter half of July and through August, walruses were observed widely scattered in the northeastern Chukchi Sea between 157°W and 163°W, with several sightings immediately offshore of Point Lay (Figure 42B). In September and October, most walrus sightings were between 160°W and 164°W, and concentrated on Hanna Shoal or near Point Lay; a few walruses were sighted in the southcentral Chukchi Sea (Figures 42C, 42D). Walruses hauled out on sea ice were in groups ranging in size from six to 500 animals. Walruses not hauled out were observed swimming, resting, milling, or diving.

On 3 August 2017, the United States Fish and Wildlife Service (USFWS) requested ASAMM investigate village reports that a haulout was forming on a barrier island near Point Lay (J. MacCracken, USFWS, pers comm to J. Clarke, 3 August 2017). An ASAMM survey conducted on 4 August (Appendix B, Flight 217) documented a moderately sized haulout numbering approximately 3,000 walruses located on a barrier island immediately west of Point Lay. The initial position of the haulout was close to (within 2 km) the location of walrus haulouts documented during ASAMM surveys in 2010 (Clarke et al. 2011d), 2013 (Clarke et al. 2014), 2015 (Clarke et al. 2017a), and 2016 (Clarke et al. 2017b), and approximately 6 km south of the haulout location in 2014 (Clarke et al. 2015a). This is the earliest documented haulout at Point Lay since ASAMM surveys commenced in 2009; the previous date for the earliest haulout occurred on 17 August 2011 (Clarke et al. 2012). ASAMM observed the walrus haulout

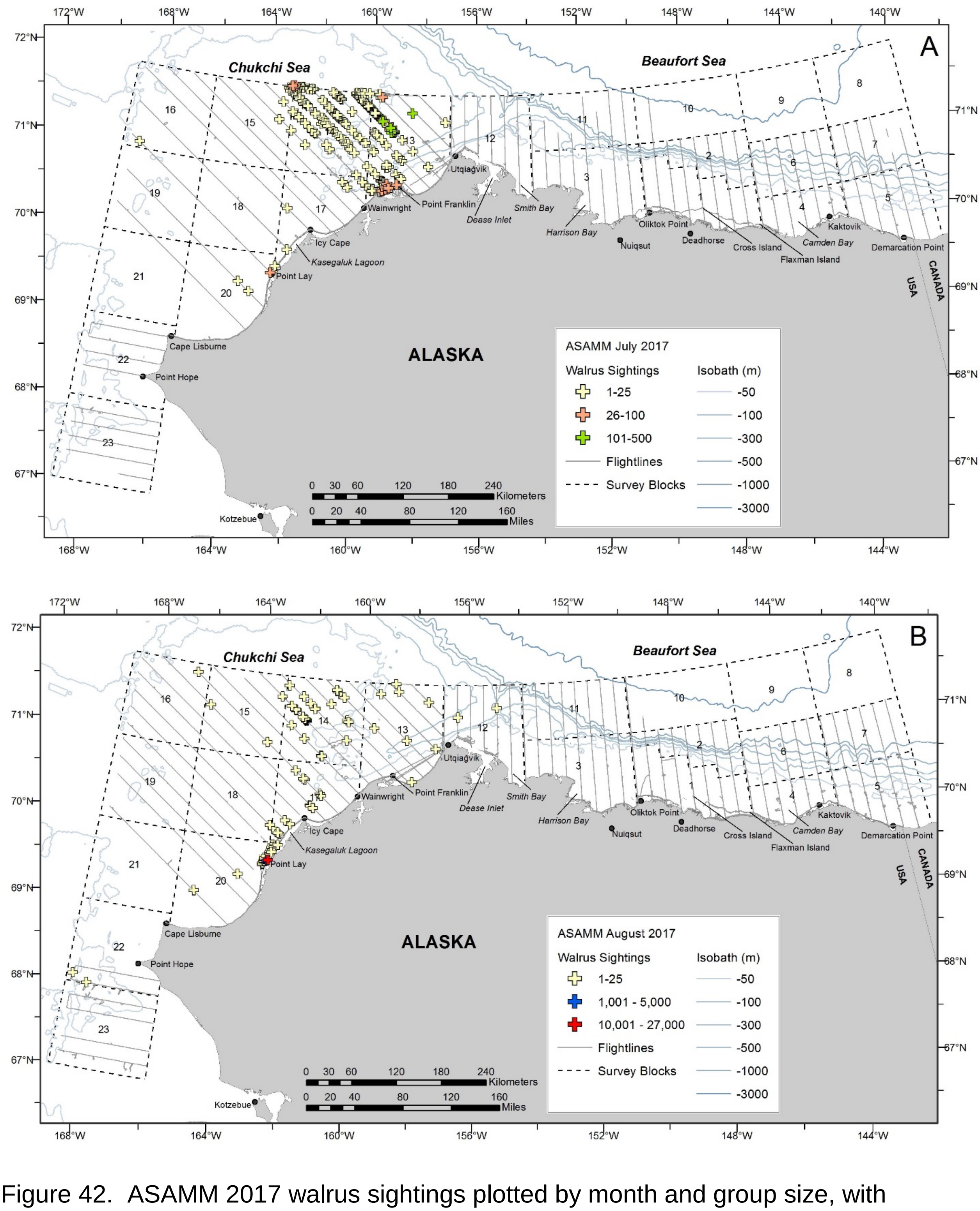
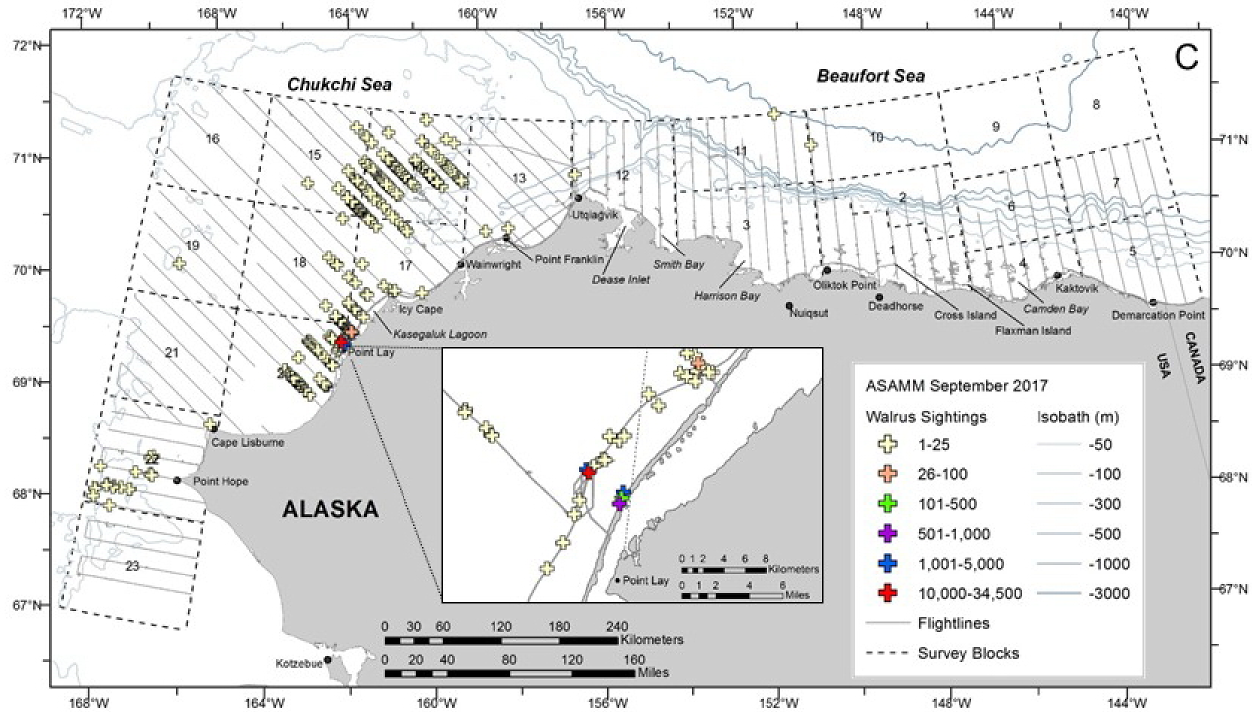


Figure 42. ASAMM 2017 walrus sightings plotted by month and group size, with transect, search, and circling effort. A: July; B: August. Deadhead flight tracks are not shown.



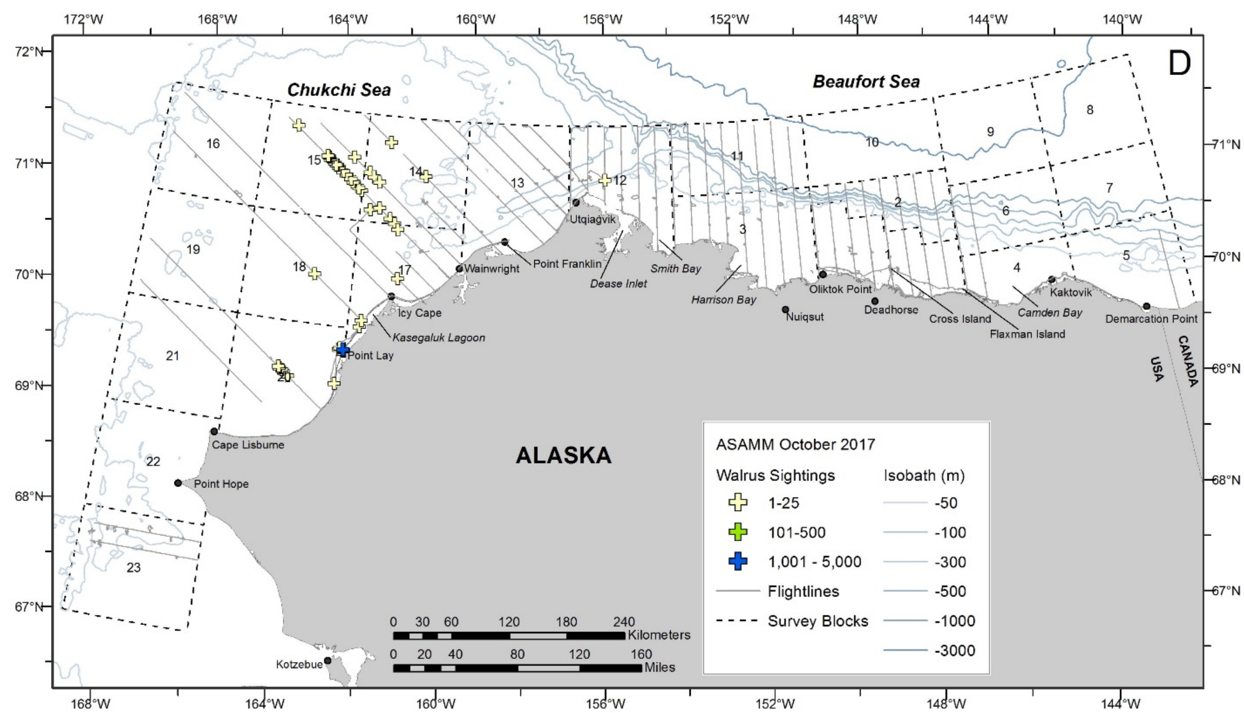


Figure 42 (cont.). ASAMM 2017 walrus sightings plotted by month and group size, with transect, search, and circling effort. C: September; D: October. Deadhead flight tracks are not shown.

Table 11. Summary of ASAMM pinniped and polar bear sightings (number of sightings/number of individuals) during all survey modes (transect, search, and circling) in chronological order, 3 July – 25 October 2017, by survey flight and semimonthly time period. Excludes dead and repeat sightings.

Day	Flight No.	Walrus	Bearded Seal	Unidentified Pinniped*	Polar Bear
3 Jul	201	97/632	8/8	58/75	0
4 Jul	202	14/432	1/1	10/12	0
6 Jul	203	0	2/3	21/75	1/2
7 Jul	204	0	1/1	1/1	0
12 Jul	205	4/21	0	5/1,022	0
13 Jul	206	87/1,707	3/3	23/24	0
14 Jul	207	0	1/1	46/54	0
15 Jul	208	0	0	25/50	0
18 Jul	209	0	6/6	9/83	0
19 Jul	1	0	1/1	45/59	0
21 Jul	210	6/7	2/2	2/2	0
21 Jul	2	0	0	3/3	0
22 Jul	211	0	0	2/2	0
23 Jul	3	0	0	3/3	0
25 Jul	4	0	0	18/22	3/3
26 Jul	212	2/3	0	3/1,400	0
27 Jul	213	2/5	1/1	17/23	0
28 Jul	214	10/83	4/4	18/32	0
28 Jul	5	0	0	1/1	0
29 Jul	6	0	0	38/44	2/2
30 Jul	215	52/62	3/3	27/28	0
31 Jul	216	0	0	12/16	0
31 Jul	7	0	0	2/2	0
2 Aug	8	0	0	9/9	0
4 Aug	217	12/3,022	2/2	12/15	0
5 Aug	9	0	0	33/62	8/10
7 Aug	10	0	0	14/15	0
9 Aug	11	0	0	20/22	16/26
10 Aug	218	11/15	1/1	4/4	0
10 Aug	12	0	0	12/12	4/4
11 Aug	219	15/29	0	0	0
14 Aug	220	0	0	0	0

Day	Flight No.	Walrus	Bearded Seal	Unidentified Pinniped*	Polar Bear
15 Aug	13	0	1/1	4/5	6/22
16 Aug	221	7/10	0	4/8	0
16 Aug	14	0	5/5	38/320	1/1
19 Aug	15	1/1	2/2	36/95	0
20 Aug	16	9/15	9/9	35/165	0
21 Aug	222	12/16	0	7/7	0
21 Aug	17	0	0	2/2	14/28
24 Aug	223	5/7	0	0	0
24 Aug	18	0	0	0	0
25 Aug	224	1/1	0	0	0
25 Aug	19	0	1/1	2/11	4/6
26 Aug	20	0	0	0	2/2
27 Aug	225	1/1	1/1	23/25	1/1
27 Aug	21	0	0	3/8	2/4
28 Aug	226	2/5	0	1/1	0
28 Aug	22	0	0	17/88	0
29 Aug	227	13/27,028	0	2/900	0
29 Aug	23	0	0	3/22	5/22
2 Sep	24	0	0	2/13	3/5
3 Sep	228	7/34,508	4/4	74/109	0
3 Sep	25	0	1/1	43/375	7/13
4 Sep	229	4/9	0	7/8	0
8 Sep	230	1/1	0	0	0
9 Sep	231	5/7	1/1	78/96	1/1
9 Sep	26	0	0	2/3	0
10 Sep	232	24/39	0	0	0
11 Sep	233	7/16	0	0	0
11 Sep	27	0	0	0	0
12 Sep	28	0	0	0	5/6
13 Sep	234	16/42	0	8/8	0
13 Sep	29	0	4/4	79/252	2/75
14 Sep	235	22/53	7/8	319/532	0
14 Sep	30	0	4/4	73/666	4/32
15 Sep	31	0	0	33/114	1/1
18 Sep	32	0	0	0	8/15
19 Sep	236	83/5,818	5/7	45/50	0

Day	Flight No.	Walrus	Bearded Seal	Unidentified Pinniped*	Polar Bear
19 Sep	33	27/36	1/1	50/282	0
20 Sep	237	8/9	1/1	35/41	0
20 Sep	34	2/2	1/1	81/616	1/1
21 Sep	35	0	0	0	0
25 Sep	238	27/4,369	1/1	4/5	0
26 Sep	239	15/58	1/1	52/72	0
26 Sep	36	1/1	1/1	20/188	2/2
27 Sep	240	44/117	1/1	11/15	0
27 Sep	37	0	0	0	0
30 Sep	241	48/87	1/1	29/29	0
1 Oct	38	0	0	1/1	5/29
2 Oct	242	5/6	0	0	0
5 Oct	39	0	0	0	25/92
7 Oct	243	5/6,503	0	6/6	0
7 Oct	40	0	0	3/3	0
8 Oct	41	0	0	4/4	0
9 Oct	244	0	0	0	0
10 Oct	245	5/9	0	0	0
10 Oct	42	0	0	0	8/22
11 Oct	246	0	1/1	15/15	0
15 Oct	247	0	0	9/10	1/72
16 Oct	248	4/503	2/2	27/28	0
17 Oct	249	0	0	0	0
18 Oct	250	0	0	2/3	0
19 Oct	251	0	0	10/11	0
22 Oct	252	0	0	0	0
23 Oct	253	25/34	0	4/4	0
24 Oct	254	0	1/1	27/29	3/19
25 Oct	255	1/1	0	84/102	0

Day	Walrus	Bearded Seal	Unidentified Pinniped*	Polar Bear
		Semimonthly Summary		
1-15 Jul	202/2,792	16/17	189/1,313	1/2
16-31 Jul	72/160	17/17	200/1,720	5/5
1-15 Aug	38/3,066	4/4	108/144	34/64
16-31 Aug	51/27,084	18/18	173/1,652	29/64
1-15 Sep	86/34,675	21/22	718/2,176	23/133
16-30 Sep	255/10,497	13/15	327/1,298	11/18
1-15 Oct	15/6,518	1/1	38/39	39/215
16-31 Oct	30/538	3/3	154/177	3/19
TOTAL	749/85,330	93/97	1,907/8,519	145/520

* Includes sightings designated as "unidentified pinniped" and "small unidentified pinniped".

aggregation(s) during six subsequent surveys, on 29 August; 3, 19, and 25 September; and 7 and 16 October. Group size estimates ranged from 500 (16 October) to 34,500 (3 September). Over the 2.5-month time period that the haulout was documented on the barrier island in summer and fall 2017, the location of the haulout was dynamic, moving approximately 4 km north from the initial location. The final location of the haulout in mid-October was within one km of the initial location. To avoid disturbing the walruses, photographs of the haulout were taken from greater than 3.7 km lateral distance and 2000 m altitude.

Fine-scale Tr sighting rates of walruses observed prior to the formation of the coastal haulout near Point Lay on 4 August were limited to the western half of survey block 13 and most of block 14, which encompasses Hanna Shoal (Figure 43A). Fine-scale Tr sighting rates of walruses observed after the Point Lay haulout was established show the relationship between the haulout location and walrus preferred feeding areas on and near Hanna Shoal (Figure 43B).

There were 83 walruses (representing <1% of all walruses sighted) that appeared to respond to the survey aircraft. Reactions included flushing from ice floes into the water ($n_i = 20$) and diving ($n_i = 63$). No walruses in the large coastal haulout appeared to respond to the survey aircraft.

Other Pinnipeds and Unidentified Marine Mammals

Pinnipeds were distributed throughout most of the study area, primarily on the continental shelf, and during all months (Figure 44). Relatively few pinnipeds were seen in Harrison Bay, seaward of the Beaufort Sea slope, or in offshore blocks in the northeastern Chukchi Sea (blocks 16, 19, 21, and 22). Fifty-three pinnipeds were seen in block 1a, between the barrier islands and the

Table 12. ASAMM 2017 walrus sightings observed during all survey modes (transect, search and circling).

	No. Sightings	No. Individuals
Dead*	29	29
Highest estimate of Point Lay haulout**	1	34,500
Total, excluding repeat sightings	778	85,359
Total, excluding dead and repeat sightings	749	85,330
Total, excluding dead, repeat, & additional Point Lay haulout sightings***	740	38,430

* May include duplicates of carcasses sighted on different survey dates.

** Highest group size estimate was observed on 9/3/2017.

*** Includes only the highest estimate of the Point Lay haulout.

shoreline; these were the only marine mammals other than one harbor porpoise and 16 polar bears seen shoreward of the barrier islands in block 1 despite nearly 600 km of transect effort.

Bearded seals (*Erignathus barbatus*; n_s = 94, n_i = 97) were observed from early July through late October (Table 11, Figure 45). Fewer bearded seals were seen in the western Beaufort Sea (n_i = 28) than in the northeastern Chukchi Sea (n_i = 68); one bearded seal was seen in the southcentral Chukchi Sea. All bearded seals were in the water; none were observed hauled out on ice or the beach. Three bearded seals (3%) responded to the aircraft by diving.

Other pinnipeds were not identifiable to species and were recorded as unidentified pinnipeds (92 sightings of 105 animals) or small unidentified pinnipeds (n_s = 1,815; n_i = 8,414) (Figure 44). Unidentified pinnipeds likely included sightings of ringed (*Pusa hispida*), spotted (*Phoca largha*), ribbon seals (*Histriophoca fasciata*), and bearded seals, in addition to small walruses. Small unidentified pinnipeds included sightings of small pinnipeds (ringed and spotted seals and possibly juvenile bearded seals) only.

Most unidentified pinnipeds were observed in the water swimming, diving, feeding, milling, thrashing, and resting. Small groups of one to nine seals were observed hauled out on sea ice near Utqiaġvik in early July and on new ice forming in the western Beaufort Sea in late October. One group of unidentified pinnipeds (n_i = 70), likely spotted seals, was seen hauled out on a barrier island near Point Franklin in mid-July, and several large groups (of 100-1,000 seals), also likely spotted seals, were seen hauled out on barrier islands near Icy Cape in mid-July, late July, and late August.

Seven hundred thirty-seven unidentified pinnipeds (9% of all unidentified pinnipeds sighted) appeared to respond to the aircraft. Most pinnipeds responded by diving, but three large groups (of 150, 200, and 300 pinnipeds) flushed from haulouts on barrier islands near Icy Cape into

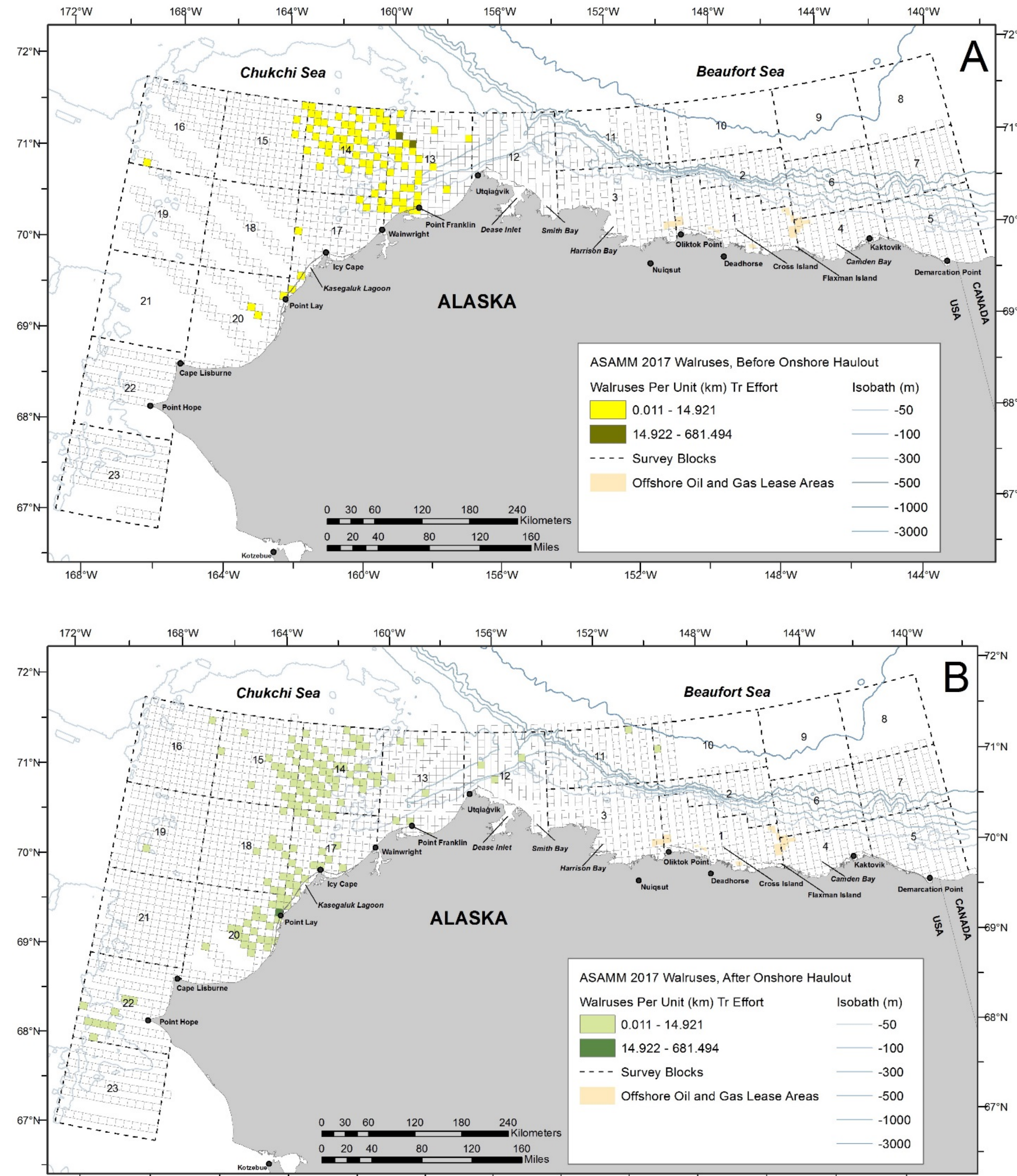


Figure 43. ASAMM 2017 walrus sighting rates (WPUE; transect sightings from primary observers only), 3 July-3 August (prior to the formation of the coastal haulout at Point Lay (A) and 4 August – 25 October (after the coastal haulout had formed at Point Lay (B). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

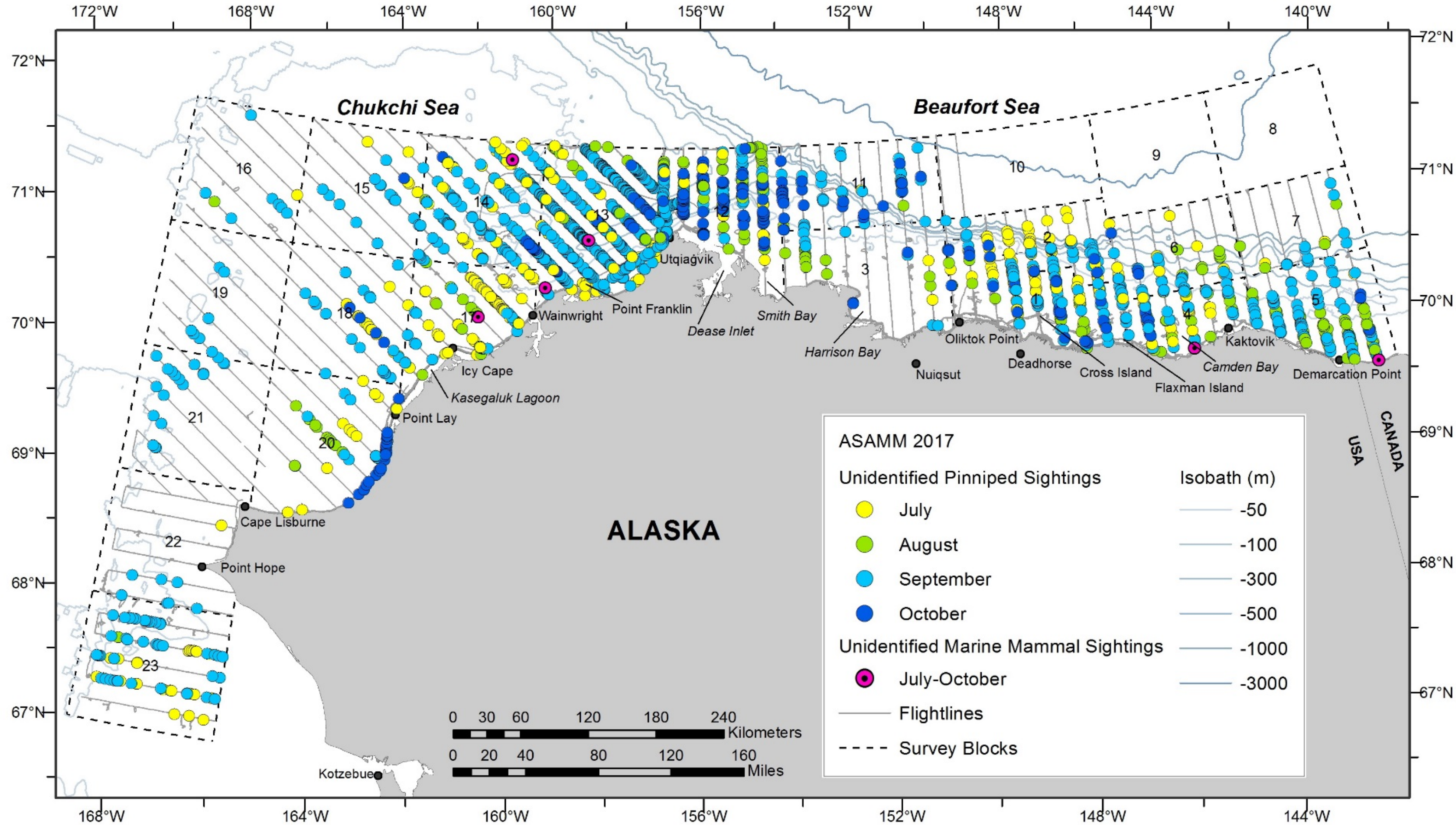


Figure 44. ASAMM 2017 unidentified pinniped (including small unidentified pinniped) and unidentified marine mammal sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

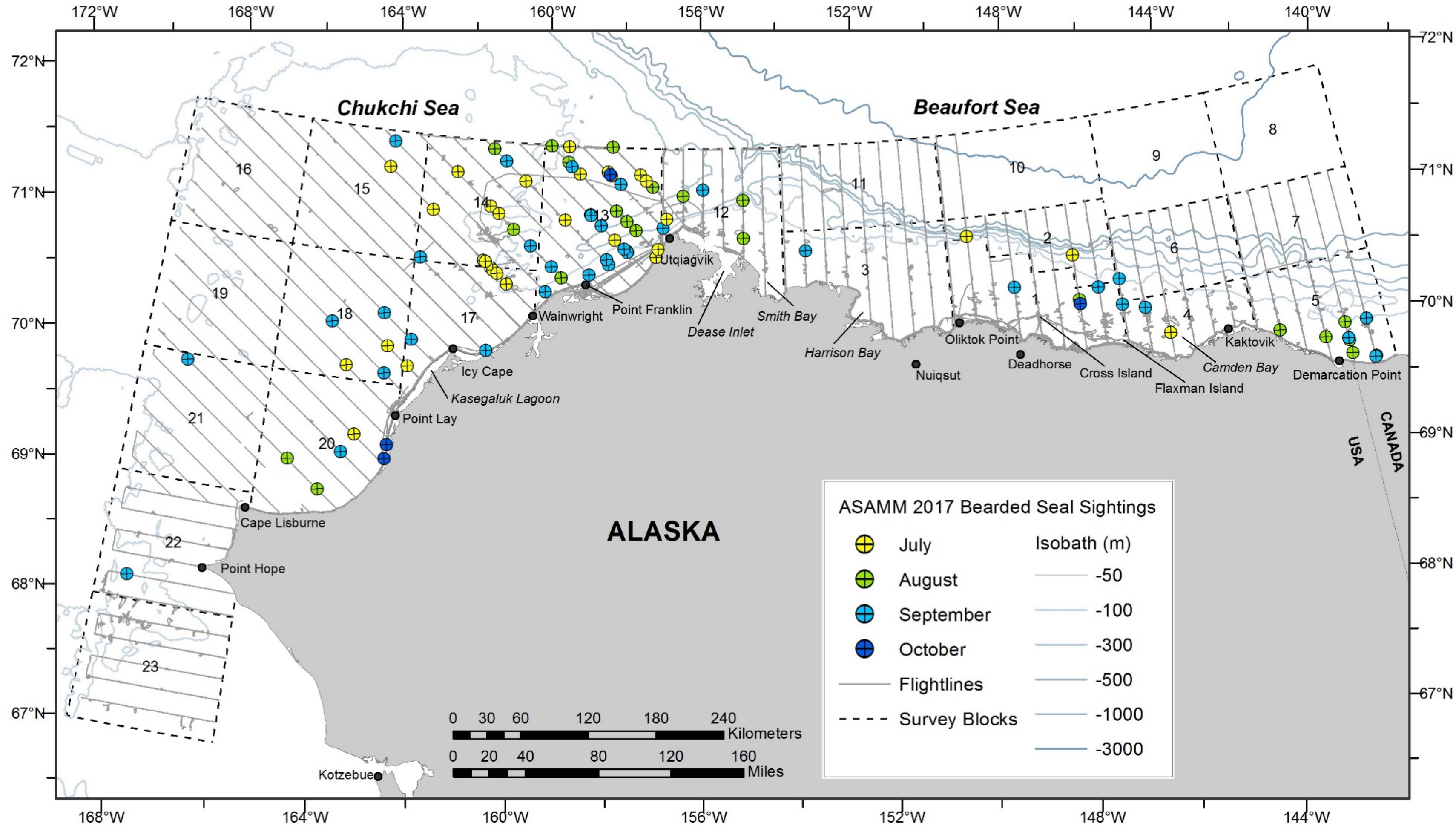


Figure 45. ASAMM 2017 bearded seal sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Kasegaluk Lagoon. In each of those instances, the haulout was positioned on the lagoon side of the barrier island and not detected early enough to divert off the transect to avoid potential reactions to the aircraft.

There were also six sightings of six unidentified marine mammals (Figure 44), which were not seen clearly enough to identify to species with any probability.

Polar Bears

There were 145 sightings of 520 polar bears (*Ursus maritimus*) during ASAMM 2017 (Table 11, Figure 46). All polar bear sightings in 2017 were in the western Beaufort Sea, distributed from just east of Kaktovik to Point Barrow. All but six polar bears were seen on shore or barrier islands, or swimming within 3 km of land. Two polar bears, a sow and cub, were seen on sea ice at a kill site approximately 78 km north of Flaxman Island in early July. One polar bear was observed approximately 80 km offshore north of Deadhorse, swimming in an ice-free area in late July. One polar bear was observed swimming approximately 10 km from shore northeast of Cross Island in mid-August, and two bears were observed about 12 km from shore on new ice that had formed in late October. There were 6 sightings of 7 polar bears in July, 63 sightings of 128 polar bears in August, 34 sightings of 151 polar bears in September, and 42 sightings of 234 polar bears in October. Some polar bears were undoubtedly resightings of bears seen on previous flights, especially at known aggregation areas.

Several polar bears (n_s = 31; n_i = 85 bears) were seen within approximately 20 km of the village of Kaktovik, between 5 August and 10 October (Figure 46). These polar bears were observed prior to (n_s = 3; n_i = 5; 5 August) and after (n_s = 28; n_i = 80 bears; 15 September and 10 October) Kaktovik's fall bowhead whale subsistence hunt. Aggregations of polar bears have been seen near Kaktovik in past years, particularly after the fall subsistence hunt, although aggregations were not observed there during ASAMM surveys in 2015.

Polar bears (n_s = 19; n_i = 297) were seen on or near (within 3 km) Cross Island, northeast of Deadhorse, on 11 days (Figure 46). Cross Island attracts scavenging polar bears because bowhead whale carcasses from fall subsistence harvests are hauled there by whalers from Nuiqsut, Alaska. Polar bears were seen on Cross Island prior to the 2017 subsistence hunt (n_s = 11; n_i = 47; two days in July and three days in August) and after the subsistence hunt (n_s = 8; n_i = 250; two days in September and four days in October).

There were 12 sightings of 16 polar bears south of the barrier islands in block 1a, either in the water or along the shoreline.

The remaining polar bears, excluding bears seen offshore or near Kaktovik or Cross Island or in block 1a, were sighted on barrier islands or the shoreline between Point Barrow and Kaktovik. Eight polar bears were seen between Point Barrow and Cape Halkett, 28 polar bears were seen between Cape Halkett and Prudhoe Bay (north of Deadhorse), and 80 polar bears were seen between Prudhoe Bay and Camden Bay.

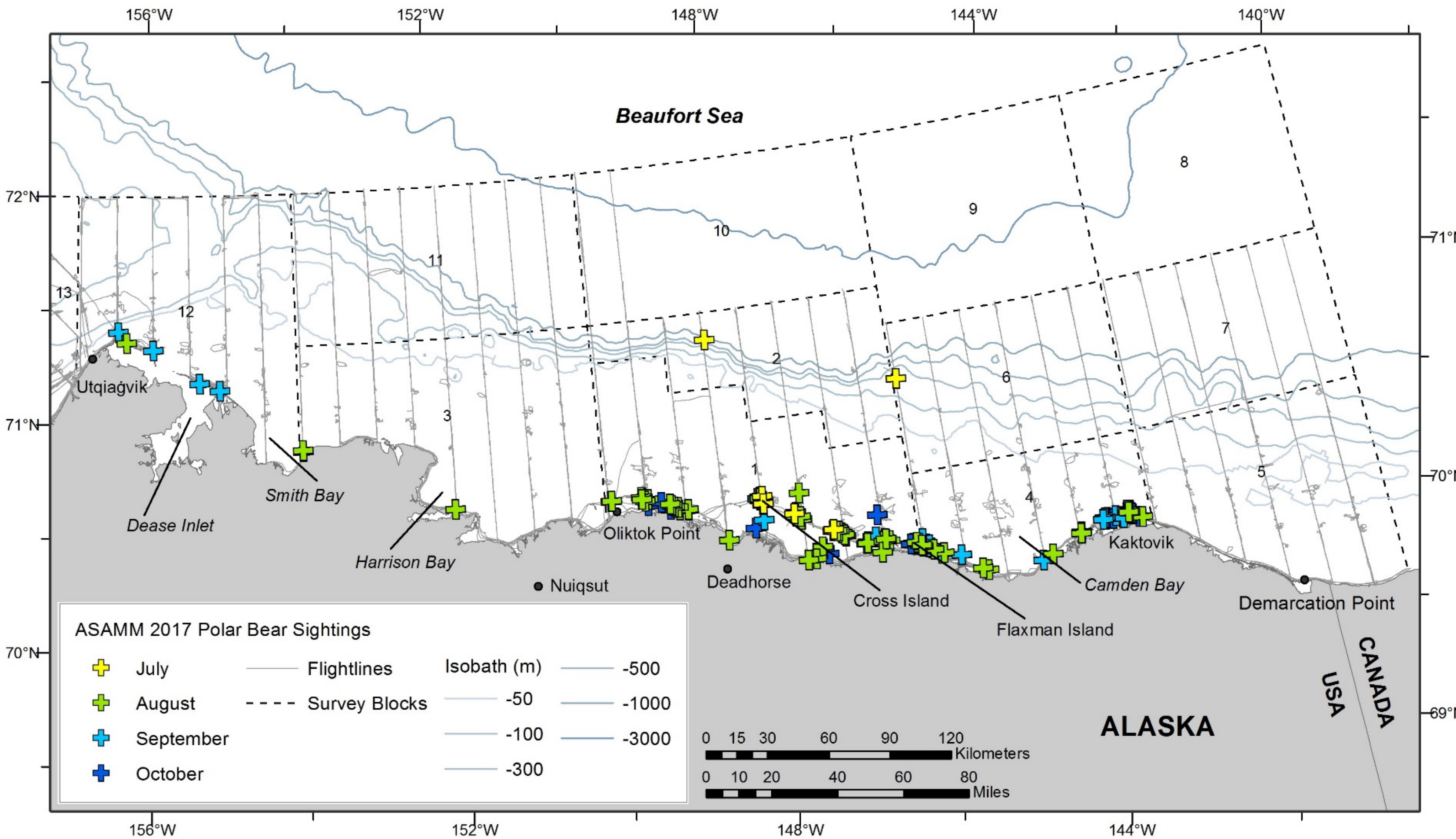


Figure 46. ASAMM 2017 polar bear sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Polar bears were observed hunting, milling, resting, running, standing, swimming, and walking. The majority of bears (90%) sighted did not respond to the survey aircraft. Fifty bears (10%) did appear to react to the survey aircraft. Thirty-two bears looked up, nine bears ran, seven bears started walking, one bear stood, and one bear that was swimming a few kilometers offshore of a barrier island dived.

Beginning in 2012, photographs were opportunistically taken of polar bears on Cross Island and near Kaktovik and analyzed post-flight to more accurately count the total number of bears (Clarke et al. 2013a). In some of these instances, the final group size more than doubled the initial estimate once the photo analysis was completed. Furthermore, photographic images from the ASAMM aircraft often did not capture the entire area of a location (e.g., all of Cross Island or Bernard Spit), so polar bears that were present at a location but not photographed were not included in the revised total number, and the revised total was still considered an underestimate. In 2017, there were six opportunities to photograph Cross Island. Photographs were taken of Cross Island on 15 August, 13 September, and 1, 5, 15, and 24 October. Although the entire island was not photographed on any of those dates, final group size estimates changed based on post-flight image analysis. On five of the six days, final group size increased; on 13 September, final group size actually decreased based on image analysis. These results confirm that initial polar bear counts at known polar bear aggregation areas such as Cross Island or near Kaktovik are often, but not always, underestimates that should be verified by post-flight image analysis whenever possible.

Dead Marine Mammals

There were 60 sightings of 60 dead marine mammals in 2017 (Table 13), although five of the cetacean carcasses and one of the walrus carcasses were repeats of earlier observations in 2017, and one cetacean carcass was a repeat sighting of a bowhead carcass initially documented in 2016 (Appendix B, Flight 205). Most (93%) of the carcasses were observed in the Chukchi Sea. Excluding 2017 repeat sightings, 28 of the carcasses observed were walruses, one carcass was a bearded seal, and 17 of the carcasses were cetaceans, including bowhead whales (n_s = 2; n_i = 2), gray whales (n_s = 6; n_i = 6), belugas (n_s = 1; n_i = 1), and unidentified cetaceans (n_s = 8; n_i = 8). Four carcasses were in advanced states of decomposition and not identifiable beyond “marine mammal”. Four carcasses were identified as pinnipeds. Thirty-five of the carcasses were observed in open water and 25 were on the beach or barrier islands.

Level A stranding forms were completed by field teams and forwarded to personnel at the NSB Department of Wildlife Management (all sightings), NMFS (cetaceans and ice seals) and USFWS (walruses).

Table 13. ASAMM 2017 dead marine mammal sightings, all survey modes (transect, search, and circling).

Flight No.	Date	Latitude (°N)	Longitude (°W)	Species	No. Individuals	Habitat
201	3-Jul-17	70.9178	-157.7517	walrus	1	open water
201	3-Jul-17	70.9084	-159.2322	walrus	1	open water
205	12-Jul-17	68.8608	-165.3489	walrus	1	open water
205	12-Jul-17	68.8945	-165.0287	walrus	1	open water
205	12-Jul-17	69.8332	-162.9977	bearded seal	1	open water
205	12-Jul-17	70.9244	-157.5958	bowhead whale**	1	beach
210	21-Jul-17	71.1422	-157.0877	walrus	1	beach
210	21-Jul-17	71.9907	-158.6839	walrus	1	open water
211	22-Jul-17	70.2463	-168.2953	walrus	1	open water
212	26-Jul-17	68.8661	-165.9441	walrus	1	beach
212	26-Jul-17	69.7970	-163.0253	unidentified pinniped	1	beach
212	26-Jul-17	69.8571	-162.9308	unidentified pinniped	1	beach
212	26-Jul-17	69.8539	-162.9298	unidentified pinniped	1	beach
212	26-Jul-17	70.1399	-162.4405	walrus	1	beach
212	26-Jul-17	70.3166	-161.9263	walrus	1	barrier island
212	26-Jul-17	70.4447	-160.5513	walrus	1	barrier island
212	26-Jul-17	70.9052	-158.8612	walrus	1	barrier island
212	26-Jul-17	70.8735	-158.5500	gray whale	1	open water
212	26-Jul-17	70.8216	-158.1443	gray whale	1	beach
212	26-Jul-17	70.9248	-157.5833	bowhead whale	1	beach
213	27-Jul-17	71.2641	-165.6930	gray whale	1	open water
213	27-Jul-17	71.3462	-167.5874	unidentified cetacean	1	open water
213	27-Jul-17	70.8770	-165.7521	unidentified cetacean	1	open water
213	27-Jul-17	70.6189	-164.5494	unidentified cetacean	1	open water
214	28-Jul-17	70.1188	-164.3970	walrus	1	open water
214	28-Jul-17	70.4864	-167.5984	unidentified marine mammal	1	open water
214	28-Jul-17	70.9324	-162.6282	walrus	1	open water
216	31-Jul-17	71.6940	-154.4792	walrus	1	open water
216	31-Jul-17	71.7644	-154.9557	walrus	1	open water
219	11-Aug-17	70.7058	-159.8740	gray whale	1	beach
219	11-Aug-17	70.7389	-159.7733	gray whale	1	beach
220	14-Aug-17	70.8769	-158.6767	unidentified cetacean	1	beach

Flight No.	Date	Latitude (°N)	Longitude (°W)	Species	No. Individuals	Habitat
221	16-Aug-17	70.5237	-166.8747	walrus	1	open water
221	16-Aug-17	71.3300	-168.6083	walrus	1	open water
14	16-Aug-17	69.8950	-140.4430	beluga	1	open water
221	16-Aug-17	70.4242	-164.6903	walrus	1	open water
221	16-Aug-17	71.6216	-167.9691	walrus	1	open water
16	20-Aug-17	71.3735	-159.2585	walrus	1	open water
222	21-Aug-17	70.7412	-159.7753	gray whale*	1	beach
18	24-Aug-17	70.5518	-151.8258	walrus	1	beach
224	25-Aug-17	71.1244	-168.5178	walrus	1	open water
225	27-Aug-17	71.6412	-154.4692	unidentified cetacean	1	open water
226	28-Aug-17	68.0217	-168.8051	gray whale	1	open water
227	29-Aug-17	68.8710	-166.0397	unidentified pinniped	1	beach
227	29-Aug-17	70.7110	-159.8557	gray whale*	1	beach
227	29-Aug-17	70.7385	-159.7802	gray whale*	1	beach
229	4-Sep-17	71.2705	-163.0750	walrus	1	open water
229	4-Sep-17	71.6597	-162.7303	unidentified cetacean	1	open water
231	9-Sep-17	71.0250	-157.3294	walrus	1	beach
233	11-Sep-17	68.6257	-166.2313	unidentified marine mammal	1	beach
234	13-Sep-17	70.7413	-159.7747	gray whale*	1	beach
234	13-Sep-17	70.8985	-158.9177	walrus	1	beach
234	13-Sep-17	71.0167	-157.3207	walrus	1	beach
235	14-Sep-17	71.0198	-157.3432	walrus*	1	open water
238	25-Sep-17	70.6968	-168.5246	unidentified marine mammal	1	open water
239	26-Sep-17	67.4854	-168.7428	unidentified marine mammal	1	open water
241	30-Sep-17	71.7423	-166.7015	bowhead whale	1	open water
241	30-Sep-17	71.6812	-161.1866	unidentified cetacean	1	open water
242	2-Oct-17	70.9554	-161.8569	walrus	1	open water
243	7-Oct-17	71.3796	-167.9161	unidentified cetacean	1	open water

* Repeat sighting from earlier 2017 survey
** Repeat sighting from 2016 survey

Accomplishments and Outreach

Data from ASAMM 2017 were shared throughout the field season with researchers and interested parties within BOEM and other agencies:

- Daily reports of flight and sighting information were posted to the ASAMM project website (USDOC, NOAA, NMFS 2017).
- Ice data, including photos of representative sea ice cover, were sent to the National Weather Service Ice Desk, Alaska Center for Climate Assessment and Policy, NOAA National Ocean Service, U.S. Coast Guard (USCG), USFWS, University of Alaska Fairbanks (UAF), Old Dominion University, Pacific Marine Environmental Laboratory (PMEL), NOAA National Marine Fisheries Service, National Aeronautics and Space Administration, and BOEM.
- Biweekly effort and sighting summary figures were sent to BOEM, NMFS, PMEL, Alaska Department of Fish and Game (ADF&G), NSB, USCG, BLM, USGS, USFWS, Canadian Department of Fisheries and Oceans, and UAF to provide an overview of data collected.
- Biweekly walrus sighting figures showing distribution and group size were sent to researchers at BOEM, NMFS, USFWS, USGS, ADF&G, NSB, and the Alaska SeaLife Center.
- Biweekly polar bear sighting figures were sent to BOEM, NMFS, USFWS, USGS, ADF&G, and NSB.
- Cetacean sighting data were shared with UAF and Woods Hole Oceanographic Institution (WHOI) to assist with underwater glider research.
- All Level A stranding forms (52 total forms) were sent to the relevant agencies: NMFS, NSB, and the Alaska Marine Advisory Program received forms for cetaceans and ice seals, and USFWS, NSB, and the Alaska Marine Advisory Program received forms for walruses.

Community outreach in 2017 included:

- Meeting with the NSB Search and Rescue to familiarize them with our project.
- Coordinating with the UIC North Slope Science Liaison and AEWC Administrative Manager to assist with communicating with the communities of Kaktovik and Nuiqsut during the fall bowhead whale hunt.
- Communication with Principal Investigators of vessel-based research operating in the study area.
- Posting daily reports to the ASAMM project website within ~24-48 hrs after completion of each ASAMM flight.

Marine mammal photos taken by ASAMM personnel in 2017 were shared with interested parties in the federal, state, and local government (including NOAA, BOEM, NSB, ADF&G, USFWS, and USGS), media, and non-governmental organizations. Media efforts were coordinated through NOAA and BOEM Public Affairs Offices.

ASAMM provided subsets of the 1982-2016 database to several research groups planning or conducting various studies in, or near, the ASAMM study area. These groups included, but were not limited to BOEM, NMFS Alaska Regional Office, PMEL, NMFS Protected Resources Division, USFWS, Duke University, UAF, and NSB.

Results from the 2017 ASAMM field season were presented at several venues, including:

Brower, A.A., A. Willoughby, J. Clarke, M. Ferguson, C. Accardo, L. Barry, V. Beaver, L. Ganley, S. Hanlan, and K. Pagan. 2018. Polar bear occurrence on the western Beaufort Sea coast, summer and fall 2017. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2018.

Clarke, J.T., M.C. Ferguson, A.A. Brower, and A.L Willoughby. 2018. Bowhead whale calves in the western Beaufort Sea, 2012-2017. Paper SC/67b/AWMP3 presented to the IWC Scientific Committee, April 2018 (unpublished), Bled, Slovenia.

Clarke, J.T., M.C. Ferguson, A.A. Brower, A.L. Willoughby, C. Sims, C. Accardo, L. Barry, V. Beaver, M. Foster, L. Ganley, J. Gatzke, S. Hanlan, K. Pagan, and K. Vale-Vasilev. 2018. The kids are alright – bowhead whale calves in the western Beaufort Sea, 2012-2017. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2018.

Ferguson, M.C. and J.T. Clarke. 2018. Update on analysis of ASAMM 2016 data to derive a "minimum population estimate" for the Bering-Chukchi- Beaufort bowhead whale stock. Paper SC/67b/AWMP16 presented to the IWC Scientific Committee, April 2018 (unpublished), Bled, Slovenia.

Hay, M. 2018. Marine mammal data collection and reporting software written with ArcObjects and .NET. Poster: ESRI International User's Conference, San Diego, CA, July 2018.

Stimmelmayr, R., J.C. George, A. Willoughby, J. Clarke, M. Ferguson, G. Sheffield, K. Stafford, A. Von Duyke, T. Sformo, B. Person, L. Sousa, B. Tudor, and R. Suydam. 2018. 2017 health report for the Bering-Chukchi-Beaufort seas bowhead whales – preliminary findings. Paper SC/67b/AWMP8 presented to the IWC Scientific Committee, April 2018 (unpublished), Bled, Slovenia.

Willoughby, A.L., J.T. Clarke, M.C. Ferguson, R. Stimmelmayr, and A.A. Brower. 2018. Bowhead whale carcasses in the eastern Chukchi and western Beaufort seas, 2009-2017. Paper SC/67b/AWMP2 presented to the IWC Scientific Committee, April 2018 (unpublished), Bled, Slovenia.

Willoughby, A.L., M.C. Ferguson, J.T. Clarke, A.A. Brower, C. Accardo, L. Barry, V. Beaver, M. Foster, S. Hanlan, K. Pagan, C. Sims, and K. Vale-Vasilev. 2018. Photo-identification of gray whales in the Eastern Chukchi Sea, summer and fall 2017. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2018.

A complete listing of publications, posters, and oral presentations from the ASAMM project from 2017 (not included in Clarke et al. 2017b) to 2018 is included in Appendix C.

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DISCUSSION

Unique Observations in 2017

- Feeding bowhead whales were observed on 21 July immediately east of Point Barrow. Wind conditions suggest that a "krill trap" was in effect, representing the earliest known date for these to occur.
- More bowhead whale calves were sighted in 2017 than in any previous year of ASAMM surveys. Fifty-seven calves were seen during summer months and 104 calves were seen during fall months. Calf ratios and sighting rates were higher than any previous year.
- A harbor porpoise was observed between the barrier islands and the mainland in the central Alaskan Beaufort Sea. This is the only cetacean that has been observed by ASAMM within the barrier islands.
- A record number of polar bears were observed along the Alaskan Beaufort Sea coast. Polar bears were seen at well-known aggregation areas, including Cross Island and near Kaktovik, but were also observed at several locations between Point Barrow and Kaktovik. Seventy-four bears were counted on Cross Island on 13 September, which is the highest single-day count recorded there during ASAMM surveys.
- A large walrus haulout was documented on a barrier island near Point Lay on 4 August, and remained in place until at least 16 October. This represents the earliest recorded date and longest duration of a coastal haulout in the northeastern Chukchi Sea.
- Pinniped sighting rate was double that of any previous year, 2009-2016.
- Systematic transects were used in the Beaufort Sea study area for the first time. Thirty-four transects were spaced 18 km apart, and extended between 82 and 177 km offshore. Transect spacing ensured that there was one transect per one-half degree of longitude, which will allow data from 2017 (and future years) to be seamlessly integrated with data from previous years.

Summary

Sea ice conditions in the study area in 2017 were similar to conditions observed in most recent years. Sea ice was largely absent from the northeastern Chukchi Sea study area by early July and remained in the western Alaskan Beaufort Sea through late July before receding north of 72°N. Environmental conditions related to large expanses of relatively warm water overlaid by colder air temperatures include low cloud ceilings, fog, and high sea states. These conditions were often encountered in 2017, but did not adversely affect overall survey effort relative to previous years.

Total and transect survey effort in 2017 was similar to other years with equivalent field periods (2012-2016) (Figure 47). Total effort was greater in 2012, 2015, and 2016. Broad-scale aerial surveys were conducted regularly in the western Beaufort Sea in summer (July-August) in 2017 for the sixth consecutive year. Due to poor weather conditions, surveys were not conducted for four consecutive days in mid-July and five consecutive days at the end of October; the field season ended early due to inclement weather. Since 2012, there have been relatively few instances when ASAMM surveys were not possible during extended periods. In 2013, the only extended period when surveys could not be conducted was in the first half of October, when the partial federal government shutdown forced a temporary cessation of ASAMM surveys for 19 days (Clarke et al. 2014). There were two extended periods in 2014 (7 days in mid-September and 10 days in mid-October) and one extended period in 2015 (12 days in mid-July) when surveys could not be conducted because of poor weather conditions (Clarke et al. 2015a, 2017a, b). The geographic immensity of the study area, combined with the flexibility of having two survey teams based at different locations and the ability of the ASAMM survey aircraft to transit to distant parts of the study area at speeds in excess of 330 km/hr, has permitted ASAMM to focus on areas where weather conditions were most amenable to surveying. This has resulted in the most pragmatic use of ASAMM flight hours and assets annually.

Surveys were conducted in block 1a, encompassing the area between the barrier islands and the shoreline in block 1, in all months in 2017 to provide systematic survey coverage of the area around Liberty Prospect. Survey effort in this relatively small area totaled 357 Tr km in summer and 242 Tr km in fall. One harbor porpoise, 53 small unidentified pinnipeds, and 16 polar bears were seen in block 1a.

Bowhead whales were distributed from 140°W to 169°W. Sighting rates in the western Beaufort Sea in 2017 were lowest in July, increased slightly in August, increased considerably in September, and decreased substantially in October (Figure 48). The overall Tr sighting rate in the western Beaufort Sea in September 2017 was 0.039 (WPUE), which is the highest September sighting rate since 2012 and is surpassed only by the sighting rate recorded in August 2016, when nearly 500 bowhead whales were sighted during a single survey (Clarke et al. 2017b). Bowhead whale sighting rate per depth zone in the western Beaufort Sea in September 2017 was overwhelmingly in shelf (≤50 m) water (Appendix A, Table E-3). The only previous year with a higher sighting rate by depth zone (in the ≤20 m depth zone) was in 2014, when feeding bowhead whales were observed from early September to early October from 140°W to 150°W (Clarke et al. 2015a). In that year, upwelling favorable winds, combined with record high freshwater river discharge, may have aggregated prey in abundances and densities sufficient

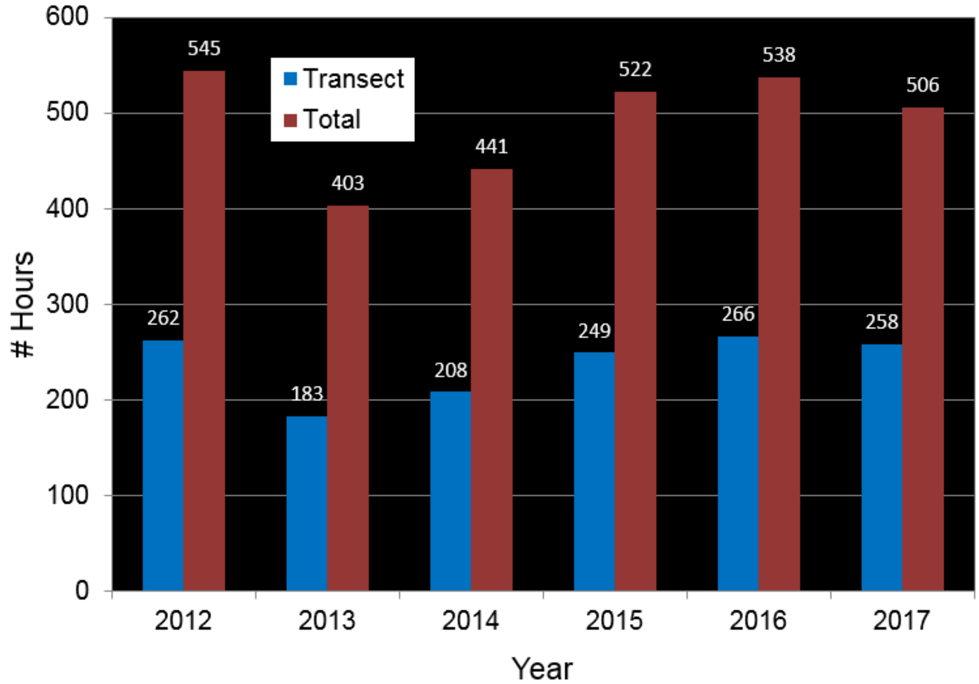


Figure 47. ASAMM transect and total survey hours, 2012-2017.

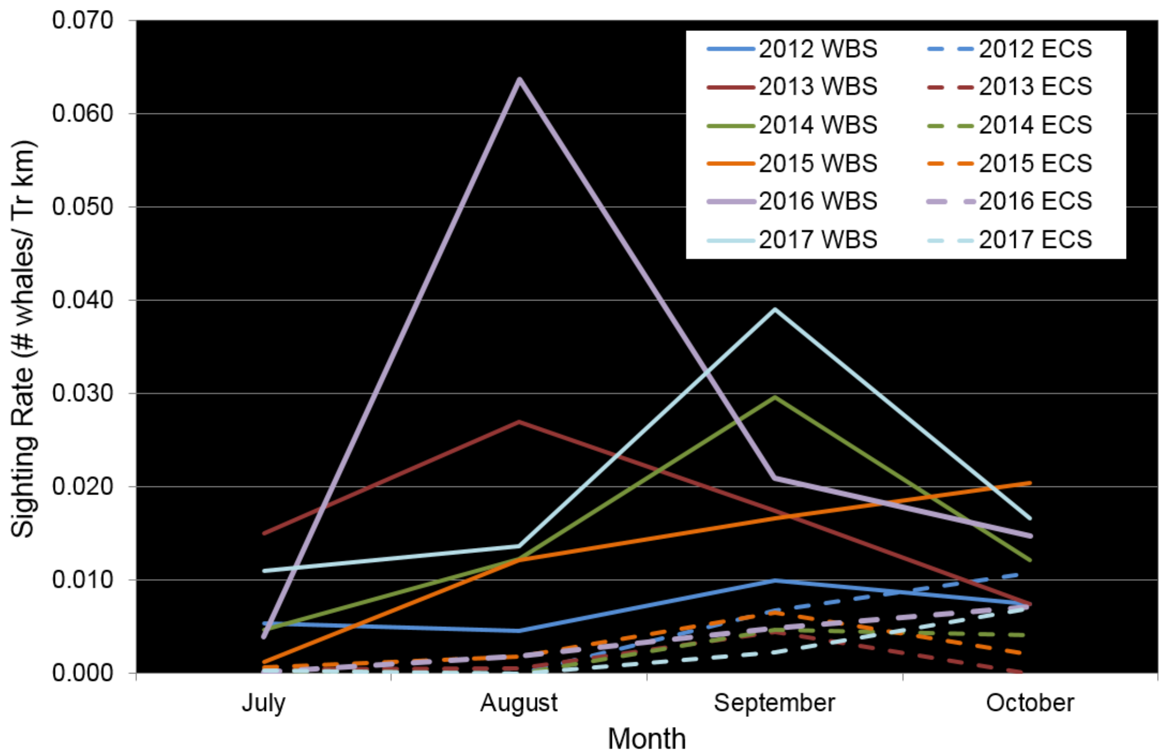


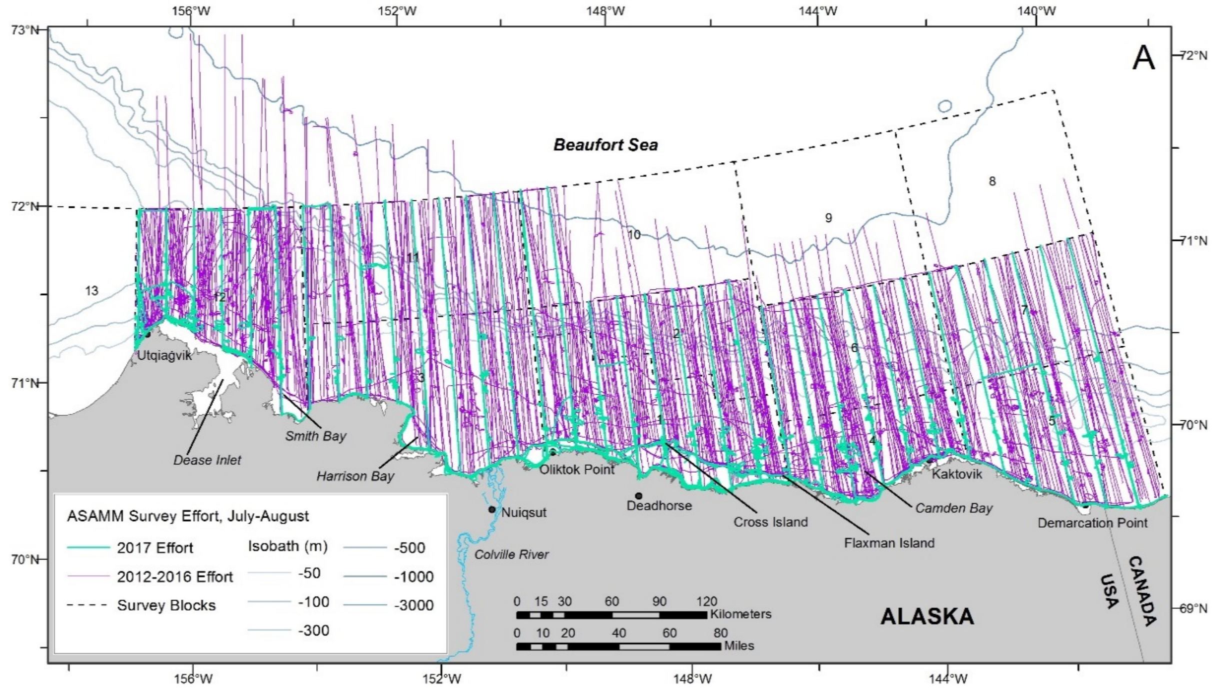
Figure 48. ASAMM bowhead whale monthly sighting rates (transect sightings from primary observers only) in the eastern Chukchi (ECS) and western Beaufort (WBS) seas, 2012-2017.

to support nearshore feeding by large numbers of bowhead whales over an extended period of time (Okkonen et al. 2016). Similar conditions, including anomalously high freshwater discharges from the Sagavanirktok and Kuparuk rivers between 1 September and 10 October (USGS 2018) and favorable wind conditions, were also present in 2017 (S. Okkonen, UAF, pers. comm to J. Clarke, 28 February 2018).

Survey coverage in the western Beaufort Sea in summer 2017 was temporally and geographically similar to survey coverage in 2012-2017 (Figure 49A), but bowhead whale distribution differed from previous years (Figure 49B). Distribution and sighting rate per survey block in July (Appendix E, Table E-1) did not indicate a predominantly offshore distribution observed in some previous years, as relatively few bowhead whales were seen in offshore survey blocks 2, 6, and 7. Several bowhead whales were seen in July, feeding in nearshore waters between Point Barrow and Smith Bay, an area where a “krill trap” is known to occur. The krill trap forms when upwelling-favorable winds from the east are followed by relaxed winds or winds from the west that retain and aggregate krill on the shallow shelf (Ashjian et al. 2010). The krill trap that was in effect on 21 July (Figure 16) represents the earliest documentation of this phenomenon; prior to this sighting, the earliest detected krill trap from either aerial surveys or small boat surveys was in late August. Survey effort in this area in late July has been infrequent, which may be why krill traps have not been documented during this period before. It is also possible that oceanographic conditions, including a record rate of summer sea ice retreat in the Chukchi Sea in spring 2017 (National Snow and Ice Data Center 2017a), may have played a role. Sighting rate was actually higher in this area (survey block 12) in summer 2017 than in fall 2017 (Appendix E, Table E-1), in contrast to 2012-2016 when sighting rates were higher in block 12 in fall (Clarke et al. 2013a, 2014, 2015a, 2017a, b). The relatively large number of whales observed in this area in July 2017 likely also affected the July 2000-2017 HUA results (Figure 20B) in the western Alaskan Beaufort Sea. Relative abundance predictions were noticeably closer to shore compared to previous years combined (e.g., July 2000-2016, Clarke et al. 2017b) because there was only one previous sighting in the area.

Bowhead whale distribution in summer 2017 in the eastern Chukchi Sea was also unlike that observed in past years (Figure 50). Despite broad-scale survey coverage (Figure 6A-D), there was only one sighting of two bowhead whales, and that sighting was in the southcentral Chukchi Sea. In summer of most previous years, bowhead whale sightings were scattered in offshore areas west and southwest of Utqiaġvik, AK. Bowhead whale use of offshore areas in the Chukchi Sea in summer has been documented by satellite telemetry data (Quakenbush et al. 2013), albeit with low sample sizes, and detected via passive acoustic recorders (Clark et al. 2015).

Bowhead whale distribution in the western Beaufort Sea in fall overlaid the general distribution observed in past years with light sea ice cover (Figure 18), with a few notable differences in distribution. Bowhead whales were relatively scarce east of 143°W (four sightings of four whales on transect). Offshore survey effort east of 143°W was largely limited to the first two weeks of September due to persistent poor weather conditions, but the coastal transect between Demarcation Bay and Kaktovik was surveyed on three occasions (12 and 18 September, 5 October) and no bowhead whales were seen. There was also a void of bowhead sightings in



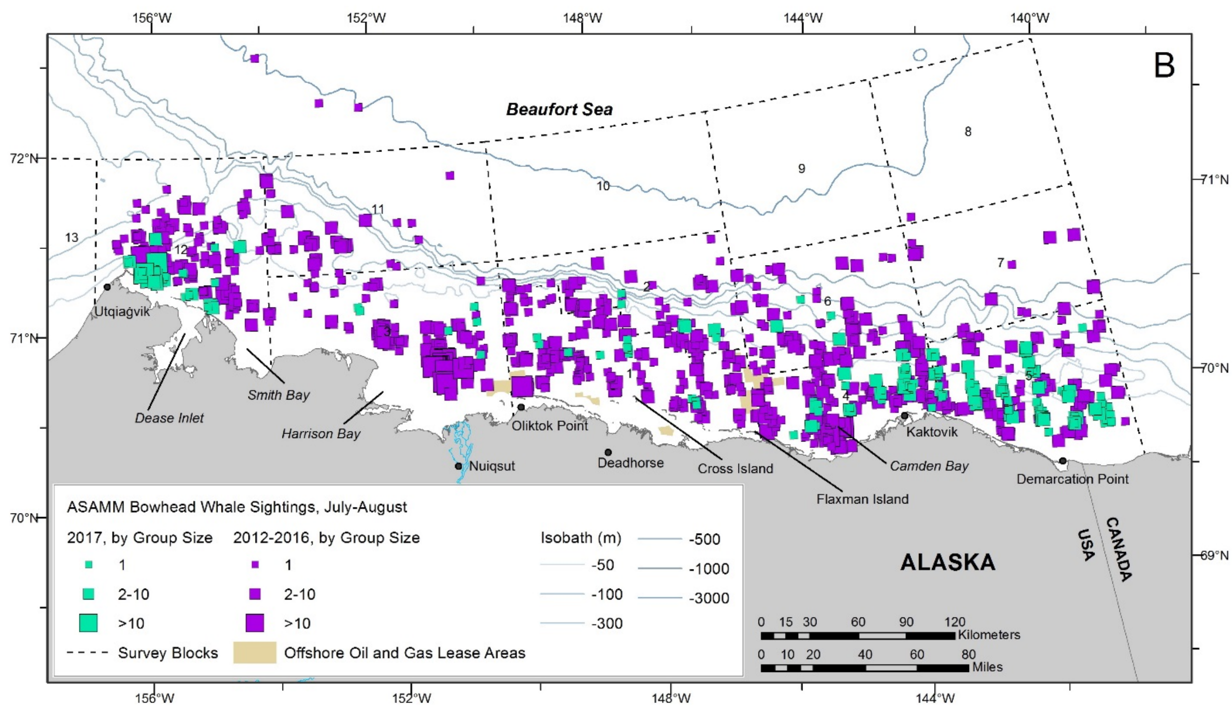


Figure 49. ASAMM 2012-2016 and 2017 summer (July-August) survey effort and bowhead whale sightings. A: survey effort, all survey modes (transect, search, and circling); B: bowhead whale sightings, by group size, all survey modes.

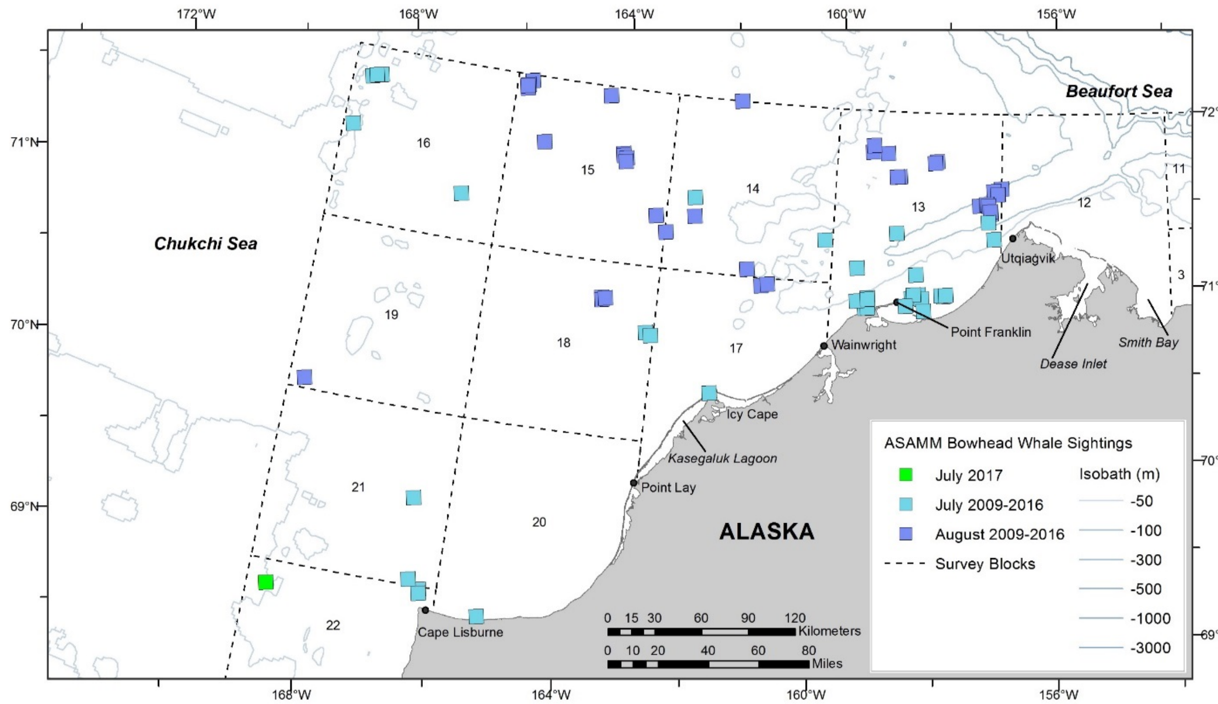


Figure 50. ASAMM bowhead whale distribution in the northeastern Chukchi Sea, July and August, 2009-2016, and 2017.

western Harrison Bay and near Cape Halkett (west of Harrison Bay, ~70.8°N, 150.2°W). Bowhead whales were in significantly shallower water and nearer to shore in both East and West regions compared to previous years with light sea ice cover, and a comparison of sighting rates per depth zone illustrates the extent of the difference (Figure 51). Bowhead whale distribution per depth zone in fall 2017 in the central-eastern Alaskan Beaufort Sea (140°W-154°W) was primarily in the ≤20 m depth zone, where sighting rate (0.065 WPUE) was higher than any sighting rate recorded in 2009-2016 regardless of depth zone; sighting rate was also high in the 21-50 m depth zone (Figure 51A). In the western Alaskan Beaufort Sea (154°W-157°W), sighting rates were comparatively low in all depth zones (Figure 51B), only surpassing those in 2011 and 2016. The western Alaskan Beaufort Sea is a well-documented bowhead whale feeding area. This area has been identified as a bowhead whale core-use area in fall based on satellite tag data collected from 2006 to 2012 (Citta et al. 2015) and a summer and fall bowhead whale hotspot based on aerial survey data collected from 2007 to 2012 (Kuletz et al. 2015). The formation of a krill trap in this area often leads to increased sighting rates due to the presence of feeding bowhead whales (Clarke et al. 2017a). Conditions for the formation of krill traps occurred in fall 2017 (Figure 16), but relatively few whales were observed.

Bowhead whale distribution in the northeastern Chukchi Sea in fall 2017 overlaid the distribution observed from 2009 through 2016, and continued to suggest a broad migratory corridor heading southwest across the northeastern Chukchi Sea, with little use of the nearshore area between Icy Cape and Cape Lisburne. These results are corroborated with data from satellite telemetry (Quakenbush et al. 2010a, 2013) and passive acoustics (Hannay et al. 2013). In this region, bowhead whale habitat preference continued to skew towards deeper water (51-

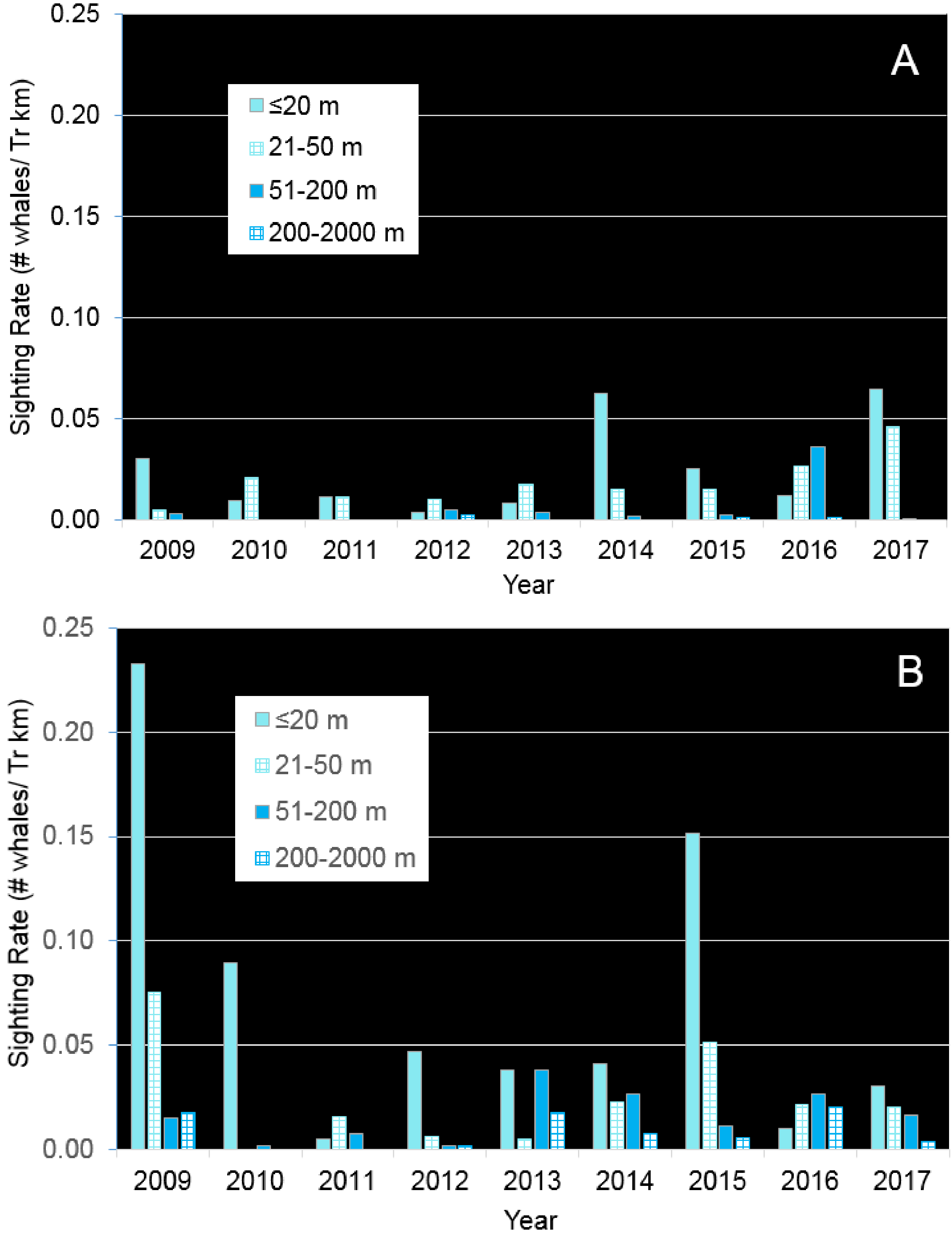


Figure 51. ASAMM bowhead whale sighting rates (transect sightings from primary observers only) per depth zone, fall (September-October) 2009-2017, in the central-eastern Alaskan Beaufort Sea (140°W to154°W) (A) and the western Alaskan Beaufort Sea (154°W to157°W) (B).

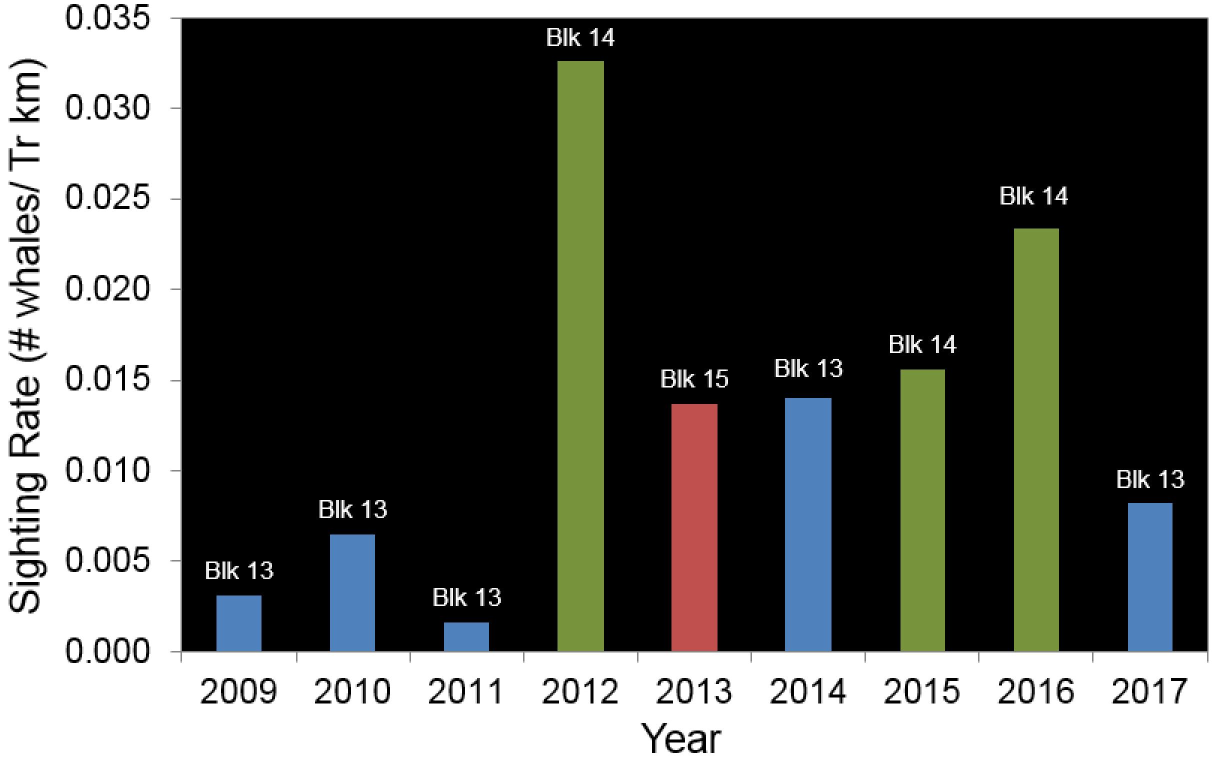


Figure 52. Annual maxima of ASAMM bowhead whale sighting rates (WPUE; transect sightings from primary observers only) in fall, by survey block, in the eastern Chukchi Sea, 2009-2017.

200 m) in fall, similar to observations in 2009-2016 (Clarke et al. 2017b). The highest fall sighting rate for bowhead whales in the northeastern Chukchi Sea was in block 13 in 2009, 2010, 2011, 2014, and 2017, block 14 in 2012, 2015, and 2016, and block 15 in 2013 (Figure 52). Block 13 encompasses the area first encountered by most bowhead whales exiting the western Beaufort Sea during the fall migration, so the high sighting rates there are expected. The high sighting rate in block 15 in 2013 is somewhat perplexing, but it is worth mentioning that surveys were conducted in the northeastern Chukchi Sea only in September in 2013 due to the federal government partial shutdown in October (Clarke et al. 2014). The distribution and abundance of bowhead whales in October 2013 remains unknown. Finally, two of the three years during which fall sighting rates were highest in block 14 (2012 and 2015) were years during which offshore exploratory drilling occurred (Bisson et al. 2013; Ireland and Bisson 2016); there were no drilling activities in 2017.

Spatial modeling of bowhead whale HUAs from data collected since 2000, when signs of a regime shift in the Arctic first became apparent (Maslanik et al. 2011; Kortsch et al. 2012; Overland et al. 2013), showed clear monthly differences in bowhead whale distribution across the western Beaufort Sea from July through October. July and August data were primarily collected in 2012-2017 due to the lack of summer surveys in the earlier years of the time series. In July, HUAs were located over the outer continental shelf and slope, the farthest offshore of the four months examined. The HUAs in August identified three patches of relatively high abundance, located offshore of Kaktovik, Nuiqsut, and Dease Inlet. The spatial patterns in relative abundance in September were similar to those for October, with the highest predicted values located outside the barrier islands from ~146°W to ~149°W and on the shelf southeast of Barrow Canyon. The October model identified nearshore waters north of Kaktovik as a third area of moderately high relative abundance. Compared to October, HUAs for September were closer to shore north of Camden Bay and Smith Bay. In the West region, relative abundance predictions from the spatial model built on only 2017 transect data from fall (September and October data pooled) were more similar to 2015 than 2016, suggesting that the whales' distance from shore in 2017 had returned to the "typical" pattern that we expected based on decades of aerial surveys in this region.

The 2017 bowhead whale calf ratios (number of calves/number of total whales) for summer, fall, and summer and fall combined were each higher than seasonal or annual bowhead whale calf ratios in any previous year (Figure 53). Since 1982, most bowhead whale calves (73%) have been observed during ASAMM in the western Beaufort Sea (Stimmelmayr et al. 2018), which may in part be due to the scarcity of survey effort in the eastern Chukchi Sea, particularly from 1992-2007. Calf distribution is generally similar to the distribution of all bowhead whales sighted in summer and fall (Stimmelmayr et al. 2018). Bowhead whale calf sighting rates (calves per unit effort, CPUE) in the western Beaufort Sea were highest in 2017 (0.0023 CPUE), followed by 2016 (0.0021 CPUE) and 2013 (0.0019 CPUE) (Clarke et al. 2018b). Bowhead whale calf occurrence likely reflects geographic and temporal variation in the interannual use of the western Beaufort Sea by different bowhead whale size classes, as suggested by Koski and Miller (2009). The Western Arctic bowhead whale stock is in good physical condition, as determined from an analysis of body condition of subadult bowhead whales harvested by Inupiat whalers (George et al. 2015). The Western Arctic stock also has increased in population size in the last decade (Givens et al. 2013, 2017), perhaps because increased body condition may have improved rates of survival and reproduction. Increased body condition, rate of survival, and reproduction may be related to the overall reduction of summer sea ice, increased duration of open water, changes in upwelling potential, and higher primary productivity (Harwood et al. 2015). Continued collection of bowhead whale data in summer and fall in the western Beaufort Sea in future years should shed light on whether the exceptionally high calf ratios of 2013, 2016, and 2017 or the comparatively lower calf ratios of 2012, 2014 and 2015 are more representative of the 'new' Arctic.

Gray whale distribution in 2017 appeared similar to that seen in recent years with similar survey coverage (2009-2016), but there were a few differences. In 2017, gray whale preference was for waters 51-200 m deep in summer (July-August) and fall (September-October) in the northeastern Chukchi Sea (Appendix E, Table E-7). In many past years, gray whale preference in summer has either been skewed towards shallow (≤35 m depth) waters (2012, 2013, 2014) or distributed amongst all depths (2009, 2015) (Clarke et al. 2011d, 2012, 2013a, 2014, 2015a, 2017a, b). However, in summer 2010 and 2011, habitat preference was for deeper (51-200 m) water more than any other depth zone. Use of deeper water was intensified in 2016 and was particularly noticeable in 2017. ASAMM and other researchers have reliably observed gray whales in the region between Icy Cape and Point Barrow, extending from the shoreline to approximately 90 km offshore, encompassed by ASAMM survey blocks 13, 14, and 17. In this area, gray whales, including cow-calf pairs, have been seen from July through October, primarily shoreward and

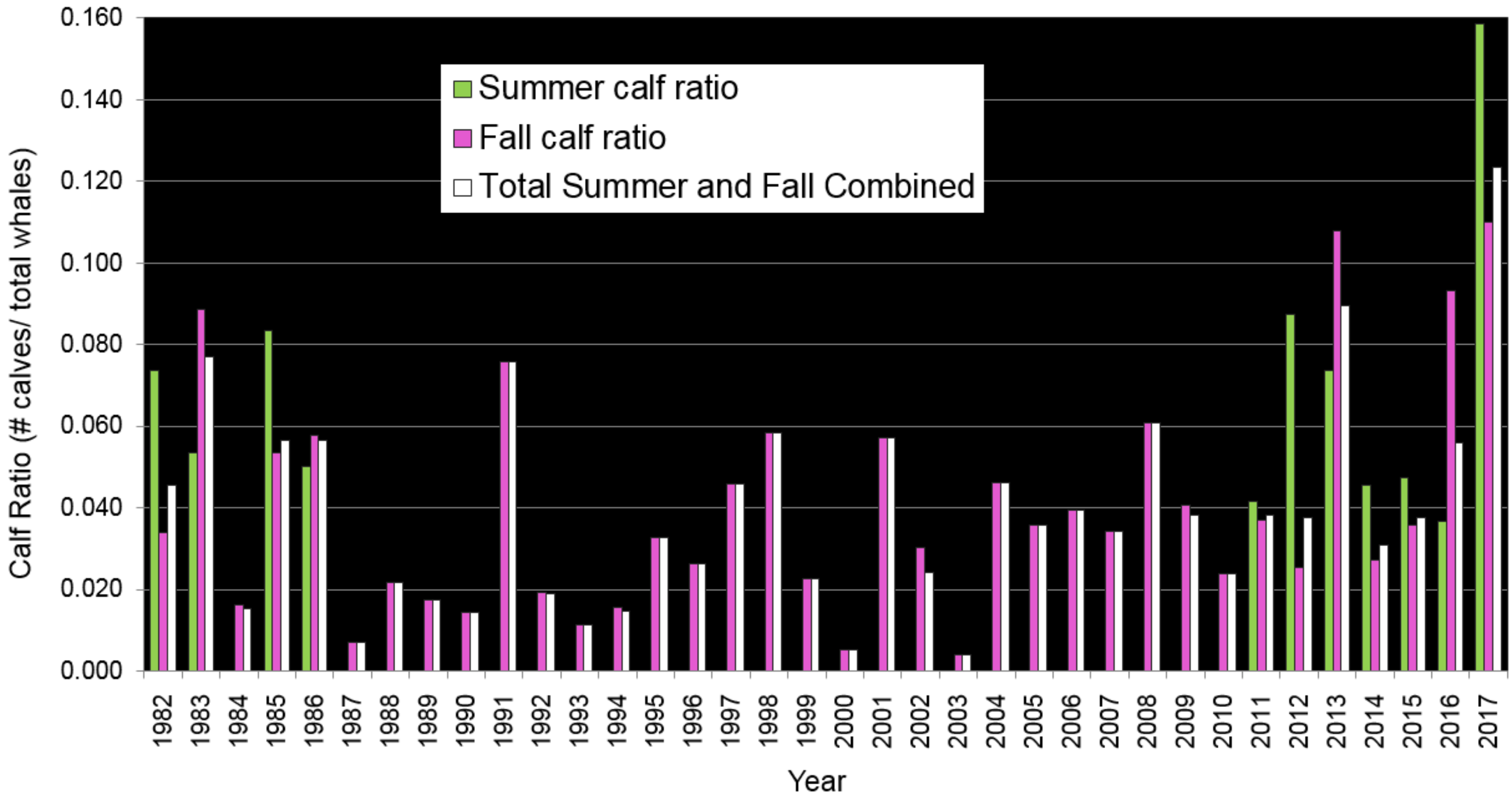


Figure 53. ASAMM bowhead whale calf ratios (number of calves/number of total whales), in summer (July-August pooled), fall (September-October pooled), and summer and fall combined, 1982-2017. Ratios are for the entire ASAMM study area.

south of Barrow Canyon (Clarke et al. 2016), at depths ≤50 m where preferred benthic prey are found in highest abundances (Brower et al. 2017). In 2009 and 2012-2015, gray whales were distributed primarily between Point Franklin and Utqiaġvik, within a few kilometers of the shoreline between Point Lay and Utqiaġvik, and within ~45 km of shore northwest of Wainwright; a relatively small number of gray whales were found in the southern part of block 14. In 2010-2011 and 2016-2017, fewer gray whales were seen between Point Lay and Utqiaġvik and there were almost no sightings close to shore south of Wainwright; however, gray whales were found in greater numbers offshore in the southern part of block 14. The shift offshore was reflected in substantially higher sighting rates in block 14 during all months in 2010-2011 and 2016-2017 compared to 2009 and 2012-2015 (Figure 54).

The primary gray whale behavior observed in the northeastern Chukchi Sea is feeding. Gray whale distribution is closely associated with prey availability including, but not limited to, benthic amphipods (Brower et al. 2017). Intense feeding on dense amphipod patches, for example, between Barrow Canyon and the adjacent Alaskan shoreline, in early summer may reduce the density of available gray whale prey there. Unlike amphipods in temperate areas, high latitude amphipods tend to have slow maturation and low growth rates, long generation times, and low production to biomass ratios (Highsmith and Coyle 1992). If amphipod patches between Barrow Canyon and the shoreline were depleted by early summer in some years, gray whales may have dispersed to adjacent feeding areas to take advantage of relatively high density prey patches elsewhere. Sighting rate in the northeastern Chukchi Sea (e.g., blocks 13, 14, and 17 combined) was highest in 2016 and remained comparatively high in 2017 (Figure 55), when the shift in distribution to farther offshore was particularly pronounced, perhaps necessitating foraging over a broader area. Also worth noting is that, for the second consecutive year since dedicated summer and fall surveys commenced in the northeastern Chukchi Sea in 2008, a gray whale was sighted within the confines of Peard Bay. Despite hundreds of survey overflights of Peard Bay, neither gray whales nor mud plumes, which are indicators of gray whale presence, had ever been seen in Peard Bay before 2016. Changing hydrographic conditions or earlier sea ice melt may be changing ecosystem processes that lead to the location and abundance of amphipods. Continued broad-scale aerial surveys in the northeastern Chukchi Sea will help identify gray whale foraging patterns in relation to climate change.

The importance of the northeastern Chukchi Sea to gray whale calves has persevered for several decades and is possibly increasing. Maher (1960) noted that several gray whales taken between July and September by hunters from the villages of Wainwright and Utqiaġvik in the 1950s were calves of the year, based on length measurements. Based on ASAMM data, gray whale calf occurrence in the eastern Chukchi Sea has been inconsistent among years. Gray whale calves have been seen in 15 of the 20 years that ASAMM aerial surveys have been conducted in the region with some regularity (1982-1991, 2008-2017); sightings of more than one gray whale calf per year were recorded in only 9 of the 20 years (Clarke et al. 1989, 2012, 2013a, 2014).

Gray whale calf occurrence in the eastern Chukchi Sea in 2017 was relatively high, following high calf occurrence in 2012-2016 (Clarke et al. 2013a, 2014, 2015a, 2017a, b). When calf sightings were corrected for survey effort, the gray whale calf Tr sighting rate in 2017 was

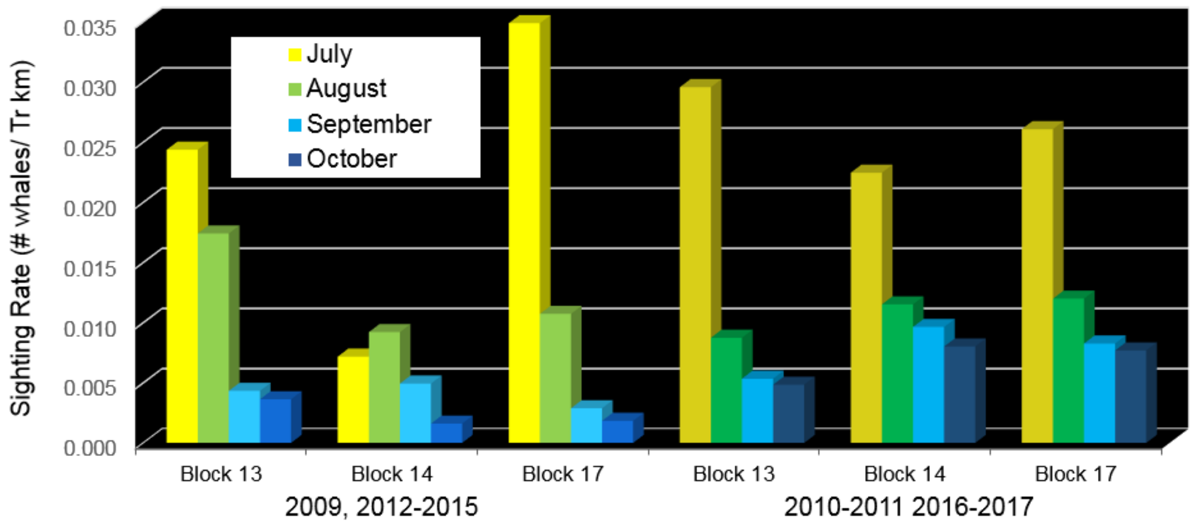


Figure 54. Gray whale sighting rates (WPUE; transect sightings from primary observers only) in blocks 13, 14, and 17 in the northeastern Chukchi Sea, July-October, 2009 and 2012-2015 combined compared to 2010-2011 and 2016-2017 combined.

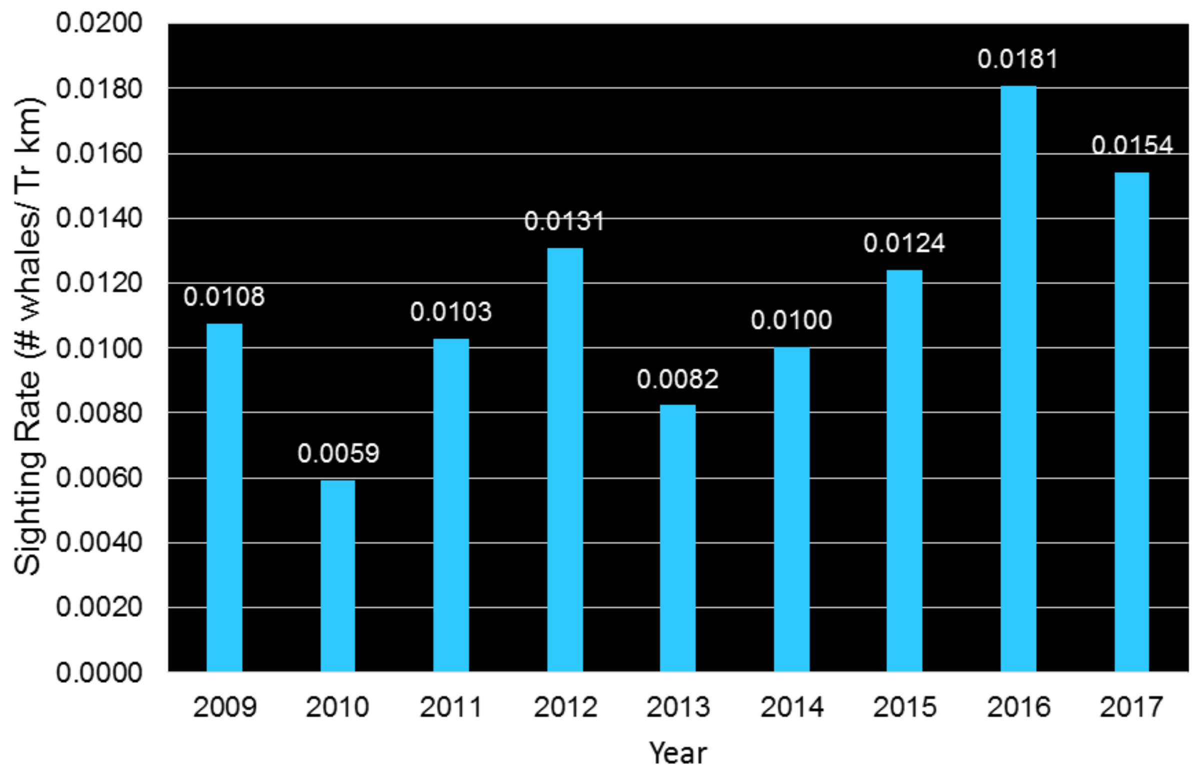


Figure 55. Gray whale annual sighting rates (WPUE; transect sightings from primary observers only) in the northeastern Chukchi Sea (blocks 13, 14, and 17 combined), July-October, 2009-2017.

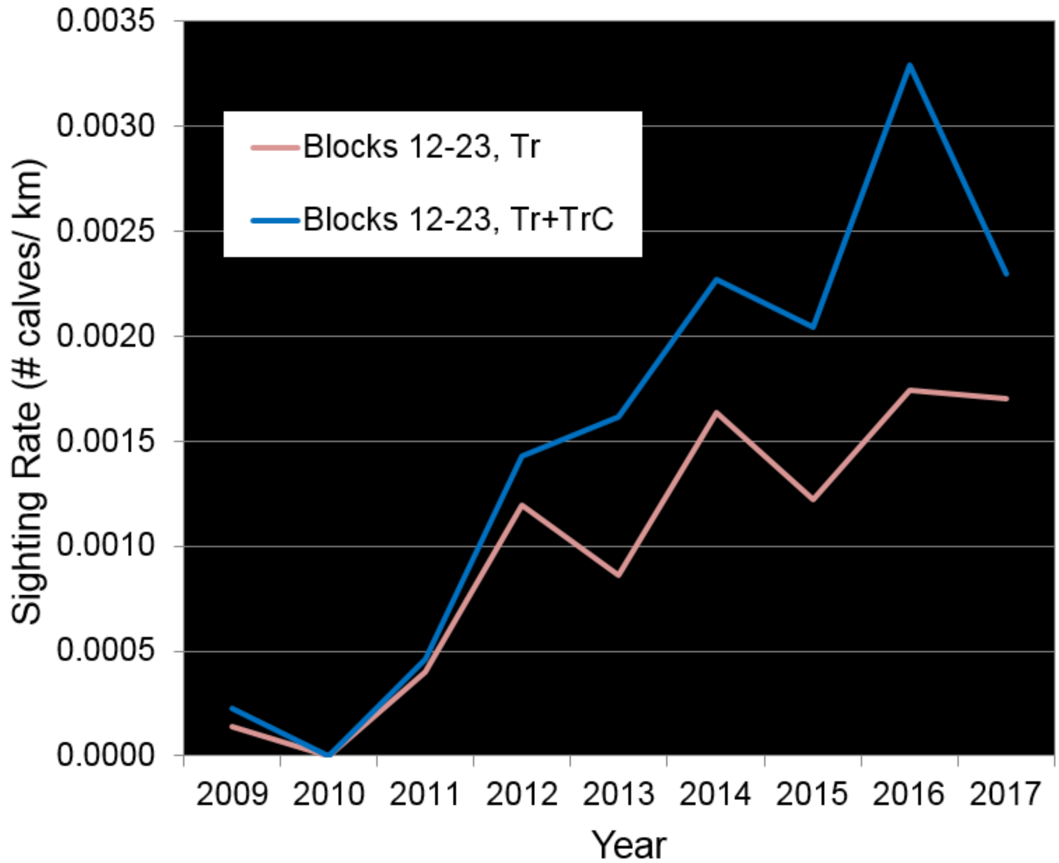


Figure 56. ASAMM gray whale calf sighting rates (transect sightings from primary observers only), 2009-2017, for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC).

0.0017 CPUE, which was similar to the Tr sighting rate in 2016 and higher than annual gray whale calf Tr sighting rates from 2009 to 2015 (Figure 56). July remained the month when most calves were seen. Weaning likely takes place in late summer or early fall (Sumich 1986); therefore, all gray whales identified during ASAMM as calves based on significantly smaller size and close association with an adult were likely calves of the year. It is also possible that small gray whales seen in late August or September that were not closely associated with an adult may have been calves of the year that had already been weaned, but they were not identified as such and were not included in the calf count.

In 2017, ASAMM dedicated greater effort towards collecting opportunistic photographs of gray whale cow-calf pairs, with a particular focus on fluke imagery. Gray whales, including calves, can be individually identified in photographs, which have nearly always been collected from vessels (e.g., Calambokidis et al. 2002; Bradford et al. 2011) and, more recently, from drones (Press 2015). Identification during systematic aerial surveys is nearly impossible if photographs are not collected. In 2017, photographs were taken of 63% of the sightings where calves were observed (Willoughby et al. 2018b; Appendix C). Within that subset of data, image analysis documented 49 calves, of which 35 were identifiable using skin pigmentation, scarring, or mottling. Only one of those 35 calves was resighted on a different date, indicating that calf resights in the eastern Chukchi Sea may not be common and that high calf sighting rates documented by ASAMM are not inflated by resights. ASAMM gray whale calf counts in the eastern Chukchi Sea are consistent with counts of cow-calf pairs documented during the northward spring migration off the central California coast by NMFS Southwest Fisheries Science Center (through 2016; Perryman et al. 2017) and off the southern California coast by the Los Angeles Chapter American Cetacean Society (A. Schulman-Janiger, ACS/LA, pers. comm. to A. Willoughby, 10 March 2018) (Figure 57). Calf counts may be related to favorable foraging conditions from 2011 to 2017, resulting in higher reproductive success. It is also possible that more gray whale cow-calf pairs are migrating to the eastern Chukchi Sea if there is reduced productivity on favored foraging grounds elsewhere, or increased inter- or intra-specific competition in other cow-calf habitat.

In 2014, the ASAMM study area was expanded to include regular surveys from July through October in block 23 (67°-68°N), allowing multiyear comparisons of data collected in the southcentral Chukchi Sea (blocks 22 and 23). This area southwest of Point Hope encompasses a known gray whale hotspot (Kuletz et al. 2015), with high benthic biomass (Moore et al. 2003; Bluhm et al. 2007; Grebmeier et al. 2015) and one of the Distributed Biological Observatory (DBO) transect lines. Gray whales have been sighted in this area during aerial and vessel surveys conducted in summer and fall since at least the 1980s (e.g., Moore 2000), but dedicated survey effort has been rare. In 2017, gray whales were sighted in this benthic hotspot from mid-July through mid-October. Gray whales in this area overlapped temporally but not spatially with humpback, fin, and minke whales, similar to 2015 (Clarke et al. 2017a), but the opposite of what was observed during all months from 2009 to 2012 (Clarke et al. 2013b) and in August 2016 (Clarke et al. 2017b).

Distributions of large whales in the southcentral Chukchi Sea are likely related to water masses (including Bering Shelf Water, Anadyr Water, and Alaska Coastal Water), which collectively produce sharp temperature and salinity gradients between 166°W and 168°W at ~67.5°N (Eisner et al. 2013). Sharp density gradients can aggregate zooplankton and fishes that feed on zooplankton. Analysis of data from the DBO will undoubtedly reveal oceanographic and biological parameters that may have influenced gray whale and other large whale distributions and densities in 2017.

Beluga distribution in the ASAMM study area in 2017 remained similar to the distribution observed over the past 30 years (Figure 35), although the several moderately large (>10 whales) groups of belugas sighted in shallow nearshore waters in the western Beaufort Sea rarely have been observed in past years. It is well known that ASAMM effort does not document the full extent of beluga range in the eastern Chukchi and western Beaufort seas (Stafford et al. 2017). Aerial survey effort conducted north of the current ASAMM study area from 1989 to 1991 (Moore and Clarke 1992) and in 2016 (Clarke et al. 2017b), results from beluga satellite telemetry efforts (e.g., Richard et al. 2001; Suydam et al. 2001; Hauser et al. 2014, 2015), and acoustic detections (Moore et al. 2012) indicate that belugas regularly traverse the eastern Chukchi and western Beaufort seas much farther north than the current ASAMM study area. Moore et al. (2012) reported beluga calls recorded from May through August 2009 on a passive

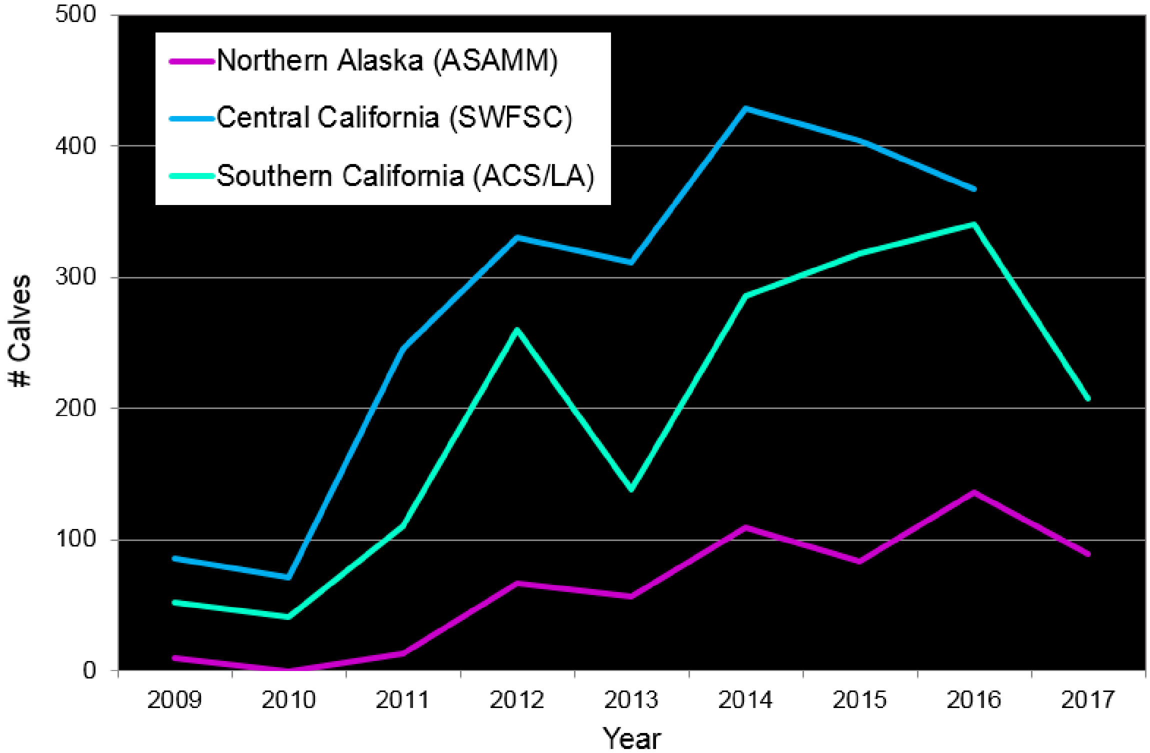


Figure 57. ASAMM gray whale calf counts in the eastern Chukchi Sea off northern Alaska, summer and fall 2009-2017, ACS/LA calf counts off southern California, spring 2009-2017, and SWFSC calf counts off central California, spring 2009-2016. Calf counts from central California in 2017 are still under analysis.

acoustic recorder moored on the Chukchi Plateau (75.1°N, 168°W), more than 340 km north of the ASAMM study area.

Two stocks of belugas, the ECS and the Beaufort Sea (BS) stocks, are found in the ASAMM study area in fall (Hauser et al. 2014). These two stocks combined likely may comprise ~60,000 belugas (Hill and DeMaster, 1999; Muto et al. 2016; Lowry et al. 2017), all of which presumably migrate through the western Beaufort and eastern Chukchi seas each fall. Although beluga habitat extends north to at least 76.5°N, ASAMM data allow for inter-year comparisons of distribution and relative density within the ASAMM study area. Compared to 2012-2016, the beluga sighting rate in 2017 in the western Beaufort Sea was within the normal range in July, decreased to lower than previously observed in August, decreased further in September, before eventually increasing to within normal range in October (Figure 58A). The overall fall beluga sighting rate in the western Beaufort Sea was less than half the sighting rates in 2009, 2014, and 2015 (Figure 58B), but much higher than sighting rates in 2008, 2010, 2012, and 2016. Where the belugas were in September 2017 is unknown. Hauser et al. (2016) used satellite telemetry and passive acoustic data to determine that ECS belugas had significantly delayed migrations out of the western Beaufort Sea in 2002-2012 (late period) compared to 1993-2002 (early period), with median migration dates delayed from 6 October to 8 November (Table 1 in Hauser et al.

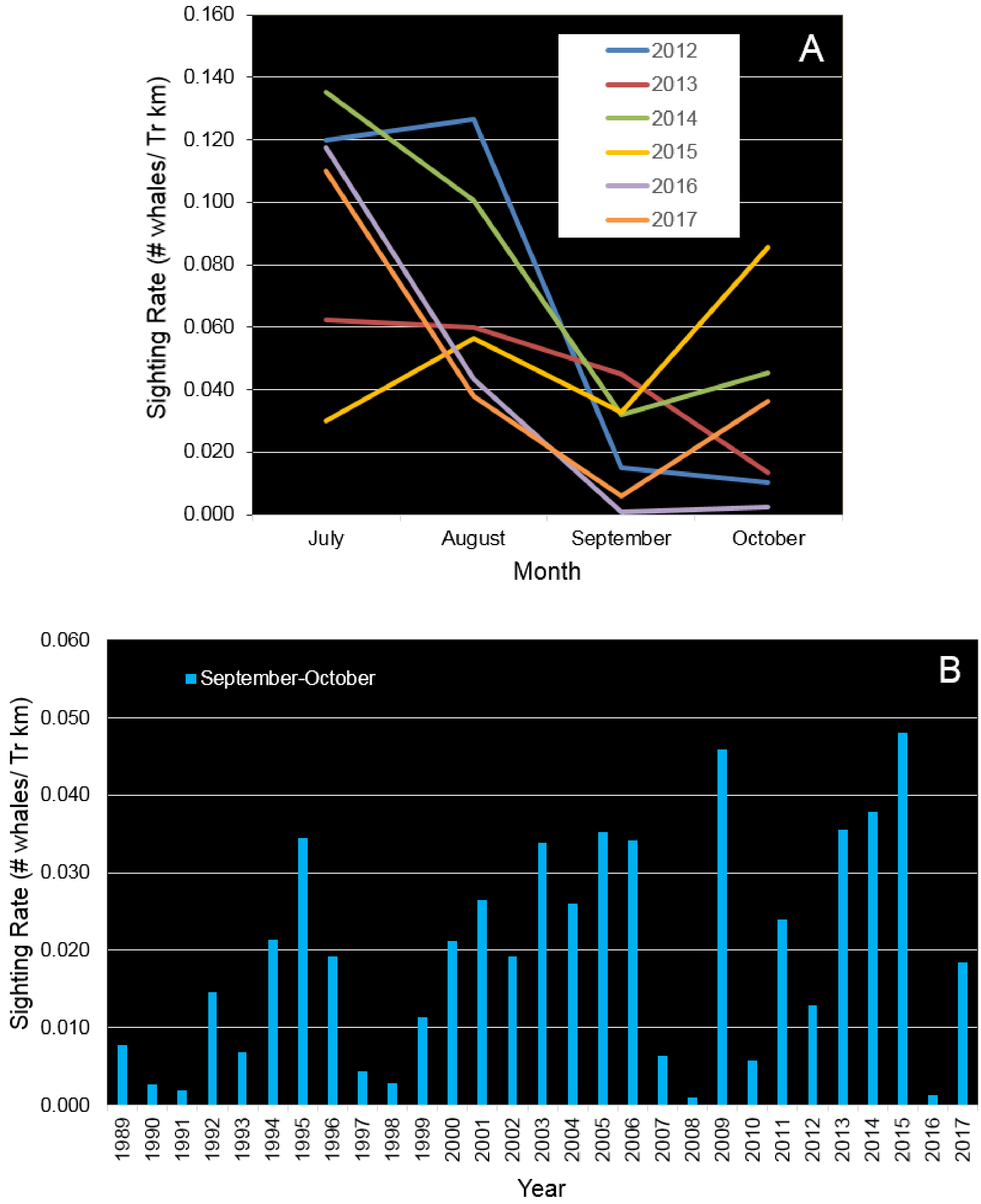


Figure 58. ASAMM beluga sighting rates (transect sightings from primary observers only). A: monthly sighting rates in the western Beaufort Sea (140°W-157°W), 2012-2017; B: fall (September-October combined) sighting rates in the western Beaufort Sea, 1989-2017.

2016). Migration dates for BS belugas had not changed significantly between early and late periods, with median migration dates for belugas from the eastern Beaufort Sea into the western Beaufort Sea occurring in early September in both early and late periods. The absence of beluga satellite tag data since 2012 makes it difficult to determine if low beluga sighting rates in September 2017 were related to delayed migration timing of either or both stocks.

Beluga distribution and depth preference in the ASAMM western Beaufort Sea study area have not perceptibly changed over 35 years. Analysis of ASAMM data from 1982 to 1991 indicated a strong preference for continental slope habitat, which remained unchanged in data from 2009 to 2016 (Clarke et al. 2018a). Sea ice preference did appear to change over time, from a preference for heavy ice in 1982-1991 to a preference for open water/light ice in 2009-2016. However, this is likely due to the change in sea ice conditions between the two time periods. It is likely that the relationship of belugas to sea ice cover in the western Beaufort Sea reflected differences in the geographic distribution of sea ice rather than the geographic distribution of belugas, suggesting that sea ice may not be a good habitat indicator for belugas in this region. Hauser et al. (2016) found that ECS and BS belugas had non-uniform phenological responses to shifts in regional sea ice freeze-up in fall: ECS beluga migration was associated with the onset of freeze-up while BS beluga migration was not. Sea ice characteristics, including sea ice concentration and proximity to sea ice edge (15% concentration) and pack ice (90% concentration), were not found to be the strongest predictors of monthly habitat use by either ECS or BS beluga populations, although ice edge proximity was an important predictor for ECS and BS males and ECS females (Hauser et al. 2017). Hauser et al. (2017) also found that depth, slope, and proximity to bathymetric features like Barrow Canyon were greater influences on seasonal habitat selection than sea ice. Finally, Hauser et al. (2018) found that summer distribution of ECS belugas may be more related to bathymetric features, and that sea ice likely has a limited effect on beluga habitat selection, although sea ice may indirectly impact foraging opportunities.

Marine mammal data collected during the 2017 ASAMM field season provide a vital contribution to the overall understanding of marine mammal ecosystems in the eastern Chukchi and western Beaufort seas. In addition to continuing to document bowhead whale, gray whale, and beluga distribution, relative abundance, and habitat use during summer and fall, important information was also obtained in 2017 relating to unique situations and other species. Harbor porpoises, and minke, humpback, fin, and killer whales seasonally inhabit arctic and subarctic habitats (Suydam and George 1992; Higdon and Ferguson 2009, 2011; Laidre and Heide-Jørgensen 2012; Clarke et al. 2013b; Christman and Aerts 2015), and have been increasingly encountered in the eastern Chukchi Sea since 2009 (Brower et al. 2018a). As in 2009-2016, most observations of these species in 2017 were limited to the southcentral Chukchi Sea (Figure 59). Killer whales were seen in the northeastern Chukchi Sea, and harbor porpoises were seen in the western Beaufort Sea.

This is the seventh consecutive year that ASAMM has documented minke whales in the northeastern Chukchi Sea (Clarke et al. 2012, 2013a, 2014, 2015a, 2017a, b; Brower et al. 2018a). Minke whales were also sighted in summer 2009, summer and fall 2012, fall 2013, and summer 2014 in the northeastern Chukchi Sea during marine mammal vessel-based surveys conducted by the oil industry (Brueggeman 2010; Bisson et al. 2013; Aerts et al. 2013; Smultea

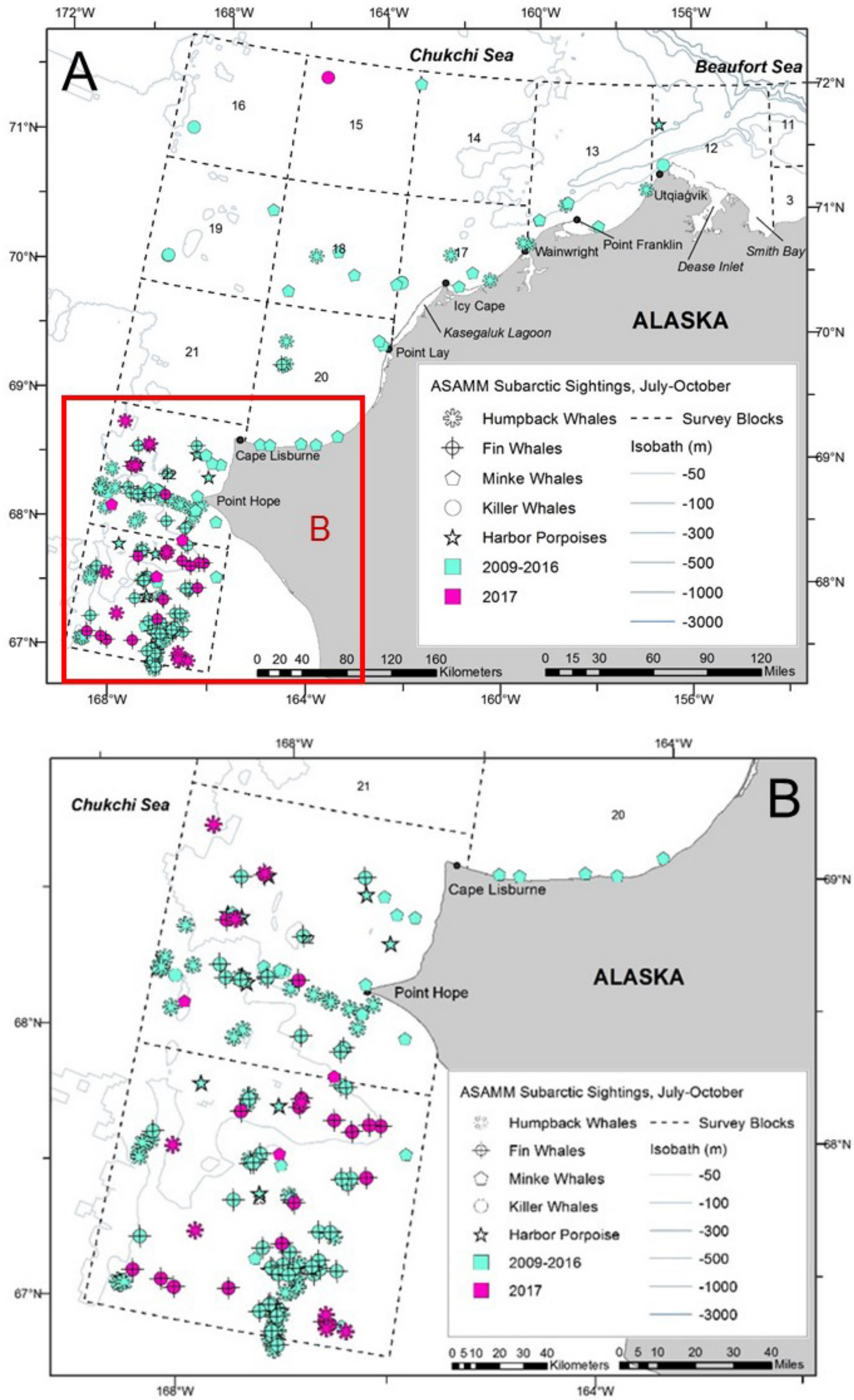


Figure 59. ASAMM subarctic cetacean distribution (transect, search, and circling), July-October, 2009-2017. A: eastern Chukchi Sea. B: southcentral Chukchi Sea.

et al. 2014; C. Christman, CLC Research, pers. comm. to J. Clarke, 27 February 2014). Dave Roseneau (USFWS) reported seeing one to three minke whales per year near Cape Lisburne from 1995 to 2009 (pers. comm. to J. Denton, BOEM, 15 October 2010). Minke whales were encountered from 2010 to 2012 during marine mammal surveys conducted in the southern Chukchi Sea (from the Bering Strait to 69°N) (Clarke et al. 2013b), although less frequently than either humpback or fin whales. One minke whale was sighted southeast of Point Hope during the Arctic Whale Ecology study (ARCWEST) in mid-September 2014 (NMML/RACE/PMEL 2014).

Humpback whales have been frequently encountered since 2009 in the southern Chukchi Sea (from Bering Strait to 69°N) (Clarke et al. 2013b; Brower et al. 2018a). Humpback whales are occasionally observed in the western Beaufort (Hashagen et al. 2009) or northeastern Chukchi seas (Clarke et al. 2011d, 2013a), but their occurrence is not regular or frequent. One humpback whale was seen associated with a group of gray whales in shelf waters off Point Barrow in 2009 (Shelden et al. 2017). Five humpback whales were seen north of 69°N during ASAMM surveys in 2012 (Clarke et al. 2013a). One humpback whale was seen west of Utqiaġvik in summer 2012 during oceanographic surveys conducted by the oil industry (L. Aerts, LAMA Ecological, pers. comm. to J. Clarke, 12 April 2013). Two humpback whales were seen in the northeastern Chukchi Sea by industry observers in fall 2013 (Smultea et al. 2014).

Fin whales occur regularly in the northern Bering Sea (Moore et al. 2002) and have been documented every year since 2010 in the southern Chukchi Sea (from Bering Strait to 69°N) (Clarke et al. 2013b; Brower et al. 2018). Fin whales were the most common acoustically detected species in the Chukchi Sea during the September-October 2014 ARCWEST cruise (NMML/RACE/PMEL 2014), with all detections in the southcentral Chukchi Sea. Fin whale occurrence in the northeastern Chukchi Sea remains rare, with two sightings in 2013 (Clarke et al. 2014; L. Aerts, LAMA Ecological, pers comm. to J. Clarke, 10 February 2014) and one sighting in 2008 (Clarke et al. 2011d). Fin whale calls detected near Barrow Canyon in August 2012 represent the farthest north visual or acoustic fin whale detection in the Pacific Arctic (Crance et al. 2015).

Humpback, fin, minke, and gray whales are frequently seen in close proximity to one another, particularly in the southern Chukchi Sea in the well-documented benthic hotspot. Although feeding is not always directly observed of humpback, fin, and minke whales during ASAMM surveys, it is likely that foraging opportunities are the main reason large whales migrate to the southern Chukchi Sea. While gray whales are known to feed pelagically, in the southern Chukchi Sea they appear to be mainly benthic feeders as evidenced by the presence of mud plumes. Balaenopterid whales, on the other hand, likely feed on pelagic euphausids and small schooling fishes such as capelin and sand lance, as documented in other parts of their range. Close temporal and spatial association between humpback, fin, and minke whales may indicate that these sympatric species use trophic niche partitioning, similar to that documented in the Gulf of Alaska (Witteveen and Wynne 2016) and Gulf of St. Lawrence (Gavrilchuk et al. 2014). Determining exactly how habitat and prey resources are partitioned among humpback, fin, and minke whales would likely require site-specific ship surveys combining simultaneous prey sampling for species identification, prey abundance estimation using active acoustics, and visual observations, similar to research reported in Laidre et al. (2010).

Humpback, fin, and minke whales were not sighted in the eastern Chukchi Sea study area during aerial surveys conducted in 1982-1991 (Moore and Clarke 1992; Brower et al. 2018a). Increasingly frequent sightings of these species in the eastern Chukchi Sea by ASAMM and other researchers reinforce the possibility of the species expanding (or perhaps re-inhabiting) their range in the Pacific Arctic. The occurrence and relative abundance of balaenopterids in the eastern Chukchi Sea may provide important information about marine ecosystem shifts (Moore 2016). The seasonal occurrence of humpback, fin, and minke whales, in addition to bowhead and gray whales, in the ASAMM study area underscores the importance of carefully investigating all cetacean sightings to confirm species identification.

Killer whales have been documented, sporadically, in the eastern Chukchi Sea. Hunters from Utqiaġvik and biologists from the NSB report that a few killer whales are seen each year in the Point Barrow area (George et al. 1994). Killer whales are known predators of gray whale calves (Barrett-Leonard et al. 2011), and ARCWEST documented a killer whale predatory attack on a gray whale calf near Wainwright in September 2013 (NMML, unpublished data; B. Rone, NMML-AFSC, pers. comm. to A. Brower, 18 December 2013). One of the male killer whales documented near Utqiaġvik during ASAMM surveys in August 2012 had been sighted on numerous occasions near False Pass, Unimak Island, in the Aleutian Island chain (Clarke et al. 2013a), which is prime territory for hunting gray whales. Killer whales also prey on belugas (Shelden et al. 2003; O'Corry-Crowe et al. 2016) and narwhals (Campbell et al. 1988). ASAMM documented killer whales near Utqiaġvik and northwest of Point Hope in 2012 (Clarke et al. 2013a), but not during surveys in 2009-2011 and 2013-2015. ARCWEST acoustically detected killer whales in the southcentral Chukchi Sea in September 2014 near the benthic hotspot (NMML/RACE/PMEL 2014). Killer whales were also detected acoustically at several recorders in the northeastern Chukchi Sea in summer 2010 (Delarue et al. 2011). Killer whales were not seen during aerial surveys conducted nearshore by the oil industry from 2006 to 2010 (Thomas and Koski 2011) but were seen during the Chukchi Sea Environmental Studies Program (CSESP) in 2008 (Aerts et al. 2013) and 2012 (L. Aerts, LAMA Ecological, pers. comm. to J. Clarke, 12 April 2013). The occurrence of killer whales in the Arctic is expected to continue to increase with decreasing sea ice cover (Higdon and Ferguson 2009).

Harbor porpoise distribution extends north to Point Barrow and the offshore areas of the northeastern Chukchi Sea (Muto et al. 2017), and occasional sightings in the western Beaufort Sea indicate that their range may be expanding. The harbor porpoise sighted by ASAMM in July 2017 was very close (within 2 km) to the location of the planned Liberty Prospect (Figure 32), and is perhaps the first record of a harbor porpoise inside the barrier islands in the central Alaskan Beaufort Sea. Harbor porpoises were seen in the central Beaufort Sea in fall 2007 (one sighting each, north and northeast of Prudhoe Bay) and in summer-fall 2008 (one sighting each, north of Flaxman Island and north of Oliktok) during aerial surveys conducted by contractors for Shell (Christie et al. 2010). Harbor porpoises are observed slightly more often in the northeastern Chukchi Sea, but are still relatively rare. Despite the uptick in research in the northeastern Chukchi Sea since 2008, there have been relatively few harbor porpoise sightings. During thousands of kilometers of CSESP vessel survey effort between 2008 and 2014, only 27 harbor porpoises were seen, primarily in the northeastern Chukchi Sea (Aerts et al. 2013; Christman et al. 2015). Aerial surveys conducted along the northwestern Alaskan coastline in 2006-2008 and 2010 by contractors for Shell yielded four harbor porpoise sightings (Thomas and

Koski 2011). Observers on ARCWEST cruises in 2013 and 2014 reported a few (<10) sightings in the southern Chukchi Sea (Friday et al. 2016) and ASAMM observed one harbor porpoise during thousands of kilometers flown prior to 2016. Suydam and George (1992) reported nine records of live and dead harbor porpoises near Point Barrow, Alaska, from 1985 to 1991. The relative paucity of sightings may indicate that harbor porpoises are not densely distributed in the eastern Chukchi Sea. However, harbor porpoises are small and often do not stay at the surface very long, making them difficult to see during either vessel surveys or aerial surveys conducted at >305 m altitude, particularly in sea states that are ≥ Beaufort 2.

A coastal walrus haulout on a barrier island west of Point Lay formed on 4 August 2017. This is the earliest date for a coastal haulout to form since onshore haulouts were first documented along the northeastern Chukchi Sea coast in 2007. The estimated number of walruses at the Point Lay haulout varied considerably over the 2.5 months of use in 2017, similar to what was documented in previous years (Figure 60). The use of coastal haulouts in the Chukchi Sea has been linked to receding summer sea ice; sea ice extent in the Chukchi Sea in June, July, and August 2017 was historically low (National Snow and Ice Data Center 2017a, b, c). Of note, while sea ice extent in August remained above that observed in 2012 and 2007 for the entire Arctic, retreat continued in the western Beaufort and northern Chukchi seas.

ASAMM surveys are not designed to continuously monitor coastal walrus haulouts, and most observations of coastal haulouts have been opportunistic (e.g., data collected during transits to or from targeted survey areas elsewhere). Walrus coastal haulout data collected by ASAMM have demonstrated the dynamic nature of coastal haulouts within short periods of time. In 2014, an ASAMM survey near the Point Lay haulout yielded an estimate of 35,000 walruses, while a photographic survey six hours later on that same day estimated that the haulout was significantly smaller (20,300) as walruses presumably left to feed offshore (Battaile et al. 2017). Similarly, estimates from ASAMM surveys conducted within one or two days of each other in 2010 and 2011 also showed large fluctuations in group sizes. The use of photographs, even those taken obliquely from a distance greater than 4 km offshore, has proven to be an effective means of estimating haulout size in lieu of direct overflights that have a higher likelihood of causing disturbance to walruses, and further enhance the utility of ASAMM for documenting the haulout. Opportunistic surveys of coastal walrus haulouts are not the best way to document haulout characteristics, but are definitely better than no documentation at all. All public dissemination of walrus sighting information was coordinated through USFWS, the federal agency responsible for managing walruses. Walruses will likely increase their use of coastal haulouts (Jay et al. 2012). Unmanned aerial systems (UAS) may be a better means of documenting the dynamic nature of walrus haulout formation with greater regularity.

Sighting rates of unidentified pinnipeds plus small unidentified pinnipeds (number of pinnipeds per transect km) by primary observers in the ASAMM study area in 2017 were higher than sighting rates in 2009-2016 (Figure 61). These sightings constituted the majority of non-walrus pinniped sightings (>99%) collected during ASAMM surveys. The cause of this apparent increase in the sighting rate of non-walrus pinnipeds is unknown. The two leading hypotheses are: 1) the new “hot key” feature in the ASAMM survey software that facilitates entry of “small unidentified pinniped” sightings and could lead to more reliable recording of this species category; and 2) the density of small pinnipeds in the ASAMM study area during the ASAMM

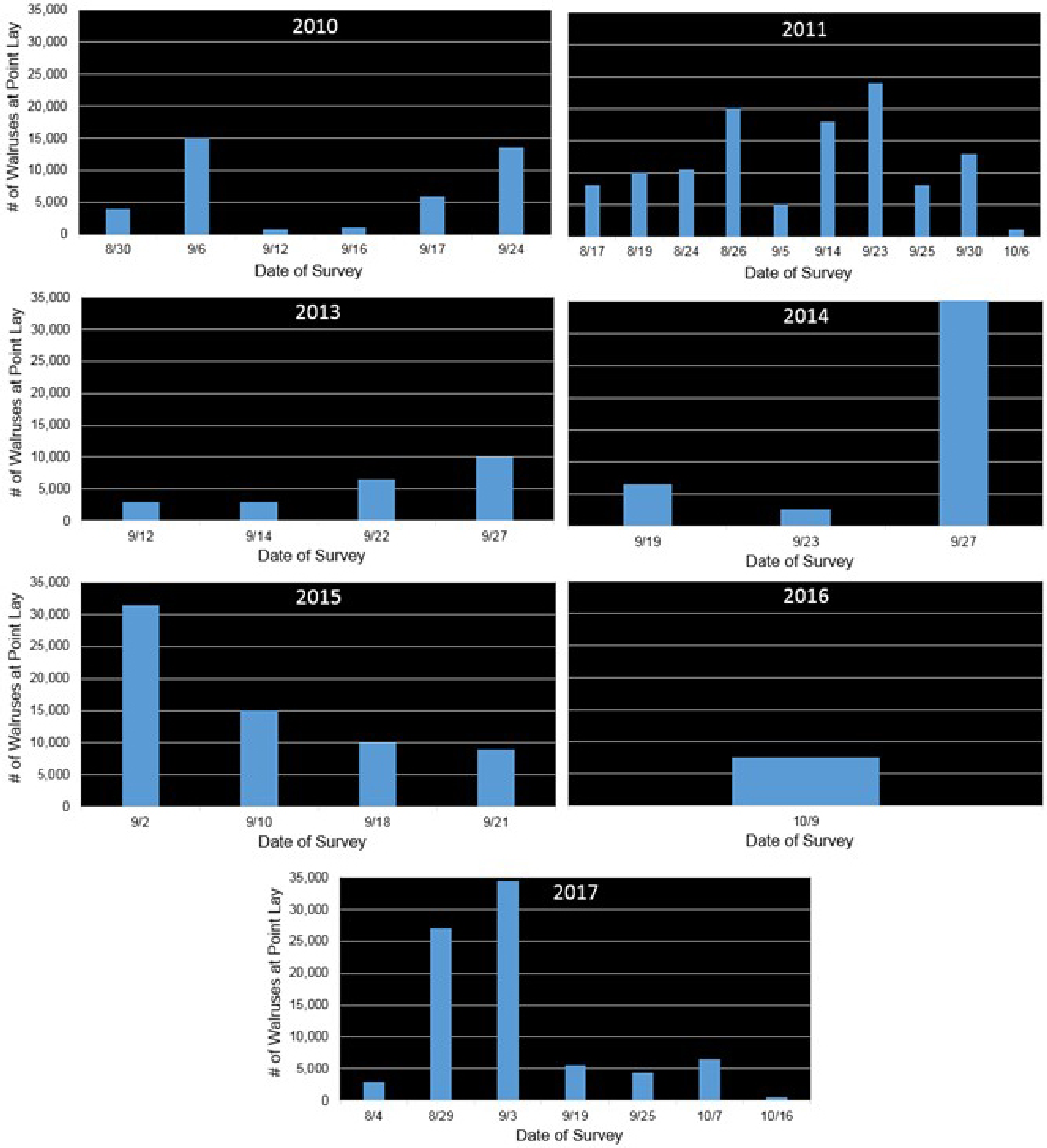


Figure 60. Daily walrus group size estimates and dates of coastal haulouts near Point Lay, 2010-2017. Walruses hauled out near Icy Cape but not at Point Lay in 2009; walruses did not haul out at any location along the northeastern Chukchi Sea coastline in 2012.

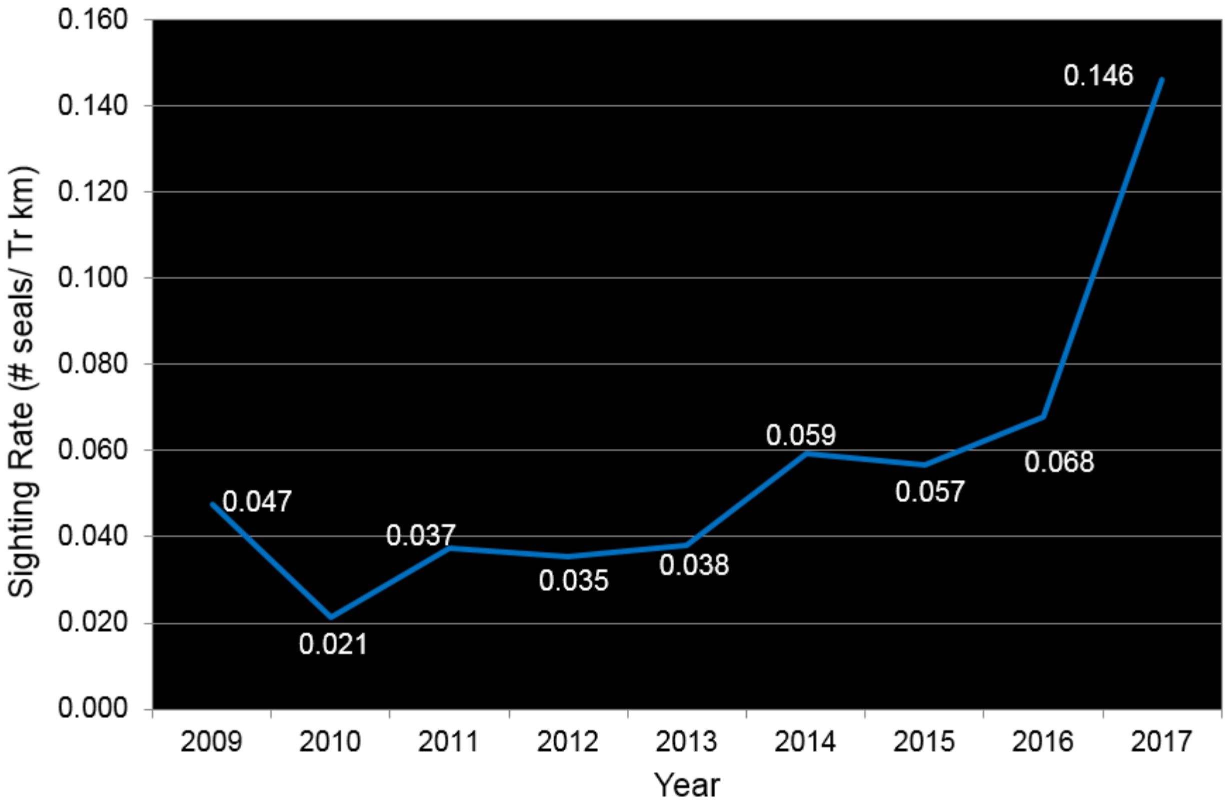


Figure 61. ASAMM unidentified pinniped and small unidentified pinniped (combined) annual sighting rates (transect sightings from primary observers only), 2009-2017.

field season was higher in 2017 than in previous years, possibly due to variability in prey resources within or outside the ASAMM study area. Streamlining pinniped data entries in the ASAMM survey program was a significant improvement, perhaps rendering these data more useful to studies that target ice seals. Continued collection of pinniped distribution data during ASAMM might help future researchers to better understand ice seal distribution during ice-free months.

The distributions of ringed, spotted, and bearded seals overlap in the western Beaufort and northeastern Chukchi seas (Lowry et al. 1998; Boveng et al. 2009; Muto et al. 2016). Behaviors and physical characteristics of small pinnipeds observable from the survey altitude of the ASAMM aircraft (365-458 m) are not distinguishable enough to allow positive species identification (MML, unpublished data; D. Rugh and D. Withrow, MML-AFSC, pers. comm. to J. Clarke, 8 December 2009). To be able to better identify pinnipeds to species, ASAMM would likely need to conduct surveys at lower altitudes, which could negatively impact observations of other species and increase incidental takes. Incorporating a high resolution camera system for continuous collection of digital images during ASAMM surveys is another possible means of increasing the ability to identify pinnipeds to species. However, results from surveys conducted specifically to collect digital images of ice seals still had problems with species misidentification, particularly spotted seals (McClintock et al. 2015). Images in the McClintock study were taken from a lower altitude (300 m) than target ASAMM altitudes, and were limited to seals that were hauled out on ice, which provided better visibility compared to pinnipeds in water. Furthermore, preliminary results from images collected from a vertical camera installed during 2015 ASAMM surveys are not promising. Post-flight processing is time intensive, and the images do not have the resolution to distinguish between spots or rings on seals in water (K. Leonard, LGL, pers. comm. to M. Ferguson, 25 January 2017).

Polar bear sightings increased substantially in 2017 compared to previous years. Most polar bears (98%) were seen on land or within 2 km of shore in the western Beaufort Sea (140°-157°W). In 2017, 510 bears were sighted in this area, which is almost double that of previous years (2012-2016) with effort during the same July-October time period (range: 33 bears in 2013 to 272 bears in 2016). Polar bears were also sighted on shore earlier in 2017 compared to previous years. Four polar bears were sighted along the Beaufort coast in July 2017; no polar bears were sighted in this area in July of previous years. In addition to the high numbers of polar bears documented on the Beaufort Sea coast, there were also record numbers of polar bears documented on Cross Island in 2017. On 13 September 2017, 74 bears were counted on Cross Island; prior to that, the highest count on Cross Island by ASAMM in a single day was 48 bears in 2014. Significant increases in polar bear counts also occurred on Wrangel Island, Chukotka, Russia. A three-year collaborative study of polar bears in the Wrangel Island State Nature Reserve was initiated by the Russian Federation and the United States in 2017. Nearly 600 individual polar bears were observed, which is more than three times greater than the number of bears observed there during a pilot study conducted in 2016 (E. Regehr, University of Washington Polar Science Center, pers. comm. to A. Brower, 15 March 2018).

Increased polar bear sightings in 2017 may be related to summer sea ice extent; by early September 2017, sea ice in parts of the Beaufort Sea had retreated farther north than in any other year since sea ice satellite records began in 1979 (National Snow and Ice Data Center 2017d). However, greater survey effort along the Beaufort Sea coast likely also affected polar bear sightings in 2017. Within 2 km of the Beaufort Sea coast, approximately 6,000 km were flown (transect, search, and circling effort) in 2017, compared to ~1,000 km in 2012 with a steady increase to ~4,000 km in 2016. Survey effort steadily increased due to the addition of coastal search effort, beginning in 2015, and surveying within the barrier islands within block 1, beginning in 2016. Sighting rates of polar bears (number of polar bears per transect, search, and circling km) were compared for bears sighted on shore or within 2 km of shore of the Beaufort Sea coast for three regions: Cross Island, Barter Island (includes Barter Island and Bernard and Jago spits), and the rest of the Beaufort Sea coast (does not include Cross or Barter Islands) (Brower et al. 2018b; Appendix C). The highest sighting rate in the Cross Island region was in 2017 (1.617 PBPUE [PBPUE = polar bears per unit effort]), followed by 2014 (1.295 PBPUE). The highest sighting rate in the Beaufort Sea coast region was also in 2017 (0.024 PBPUE), followed by 2014 (0.022 PBPUE). The highest sighting rate in the Barter Island region was in 2012 (0.777 PBPUE), followed by 2016 (0.719 PBPUE).

Care needs to be taken when analyzing ASAMM polar bear data due to effort inconsistencies. ASAMM survey design has had minor tweaks over the years, some of which are better suited for coastal polar bear data collection (e.g., adding coastal survey effort). Many factors affect ASAMM polar bear data: amount of coastal survey effort per month and year, weather conditions at known congregation areas during ASAMM surveys of those areas (e.g., fog, snow showers, or snow on the ground that camouflages bears), survey constraints such as time aloft and fuel reserves, and whether photographs of the congregation areas were taken.

Changes to the arctic marine environment observed over the past several decades (increasing mean annual temperatures, increasing mean annual wind speed, increasing storm frequency, decreasing annual sea ice thickness and extent; Wendler et al. 2009) accelerated in the 2000s (Walsh 2008), perhaps most noticeably in the record-low sea ice extent observed in 2007 and again in 2012 (National Snow and Ice Data Center 2007, 2012). Future arctic summer and fall seasons are predicted to have continued decreasing sea ice cover and younger ice, and associated climatic impacts (e.g., Simmonds et al. 2008). These changes have likely impacted or will impact most marine mammal species (Kovacs et al. 2011). Comparisons of marine mammal distributions over periods spanning more than 35 years (1982-2017) should be interpreted with caution because different ecological mechanisms could have been acting during different periods over the duration of the study.

Ongoing interest in sea ice distribution and movement, ice forecasting, and the relationship of sea ice to marine mammals and other biological communities has expanded ASAMM's impact. Because ASAMM has such a large study area and collects visual data in regions where no one else does, it has become a useful platform for collecting aerial digital photographs of sea ice. These images are shared throughout the field season with multiple institutions to assist with ground-truthing remotely-sensed sea ice data and train ice analysts. These associations, ongoing since 2010, underscore the multidisciplinary nature of ASAMM and render it more than simply a "marine mammal survey".

Management Use of Real-Time Field Information

BOEM issues various permits to industry for gas and oil exploration, including open water and on-ice seasonal vessel-based geophysical permits for exploration using array(s) of deep-seismic airguns; vessel-based geological-geophysical permits for shallow-seismic exploration using airguns; on-ice geophysical permits using VIBROSEIS technology; both vessel-based and on-ice geological permits for obtaining core samples; and permits to drill for gas and oil. Summaries of ASAMM aerial survey data in the form of daily reports were made available to representatives of oil companies, the NSB Department of Wildlife Management, federal agencies, and the general public on a near real-time basis to encourage data transfer and enhance management via a website maintained by AFSC (USDOC, NOAA, NMFS 2017).

Management Use of Interannual Monitoring

This BOEM-sponsored marine mammal monitoring study began in 1979 and has continued every year up to the present. While some aspects of this study have been updated, the data collected have remained remarkably consistent (especially data from 1982 to 2017), thus permitting many direct comparisons across years. Such continuous, long-term, broad-scale, aerial monitoring of large whale migration and associated marine mammal communities is indeed unique. In addition to the accomplishments specifically mentioned in Results, the ASAMM historical dataset has been used by industry, government, and academic entities (e.g., Schick and Urban 2000; Manly et al. 2007; Givens et al. 2010; Okkonen et al. 2011, 2017;

Christman et al. 2013; Clarke et al. 2013b, 2015b, 2016, 2018a, b; Stafford et al. 2013, 2017; Schonberg et al. 2014; Ferguson et al. 2015, 2018a, b; Grebmeier et al. 2015; Kuletz et al. 2015; Satterthwaite-Phillips et al. 2016; Battaile et al. 2017; Brower et al. 2017, 2018; Lowry et al. 2017; Druckenmiller et al. 2017; Young et al. 2017; Willoughby et al. 2018a, c; Angliss et al. 2018; Stimmelmayr et al. 2018) to better understand, manage, and conserve arctic resources.

ASAMM data are critical to addressing near real-time management concerns and aid in future planning. Without current, reliable data, BOEM and other agencies, including NOAA and the Department of Defense, would be more vulnerable to litigation, and their ability to make management decisions about future anthropogenic activities in this region during summer and fall would likely be delayed.

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APPENDIX A: ICE CONCENTRATION MAPS, 2017

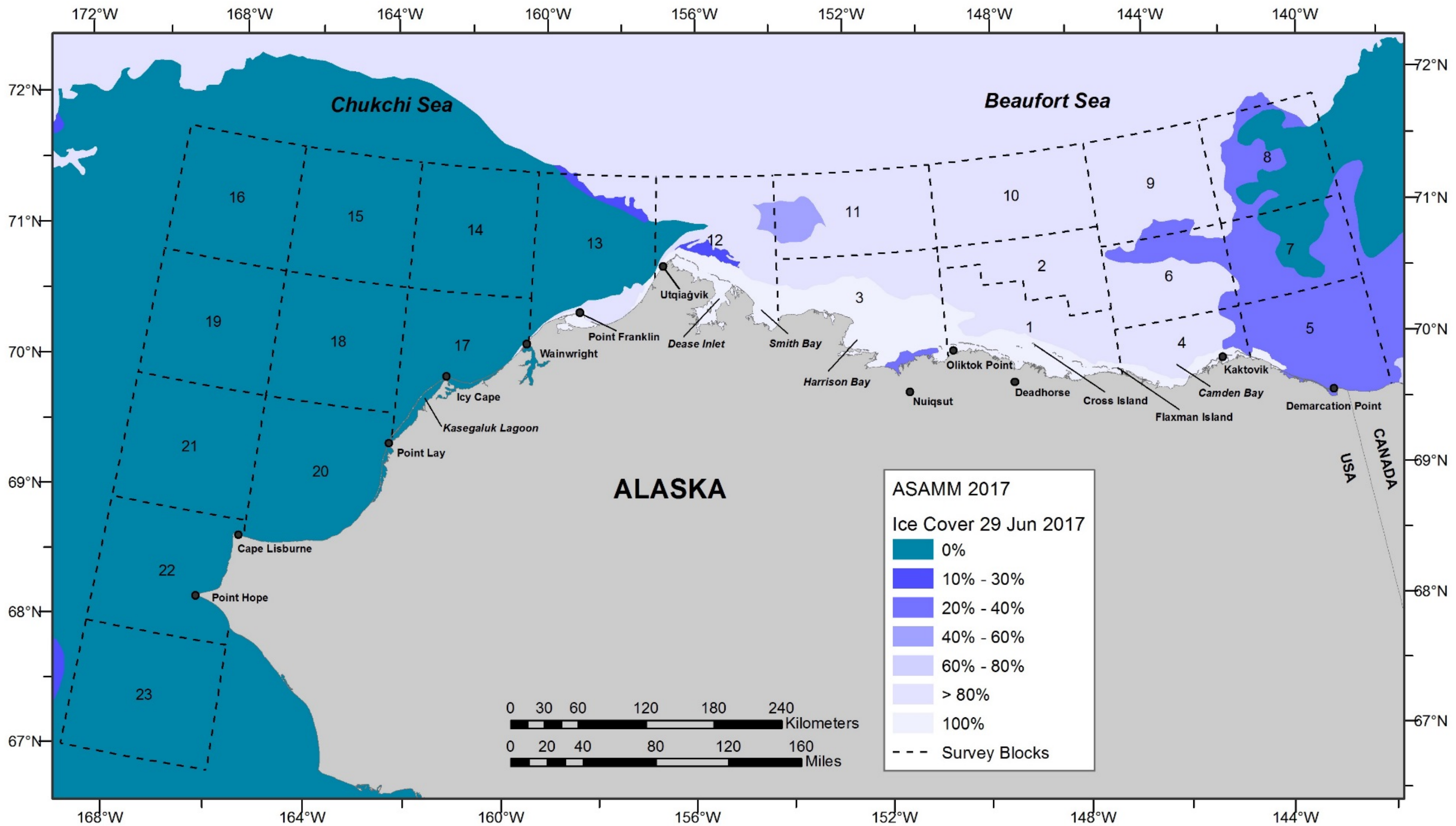


Figure A-1. Ice concentrations in the eastern Chukchi and western Beaufort seas, 29 June 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

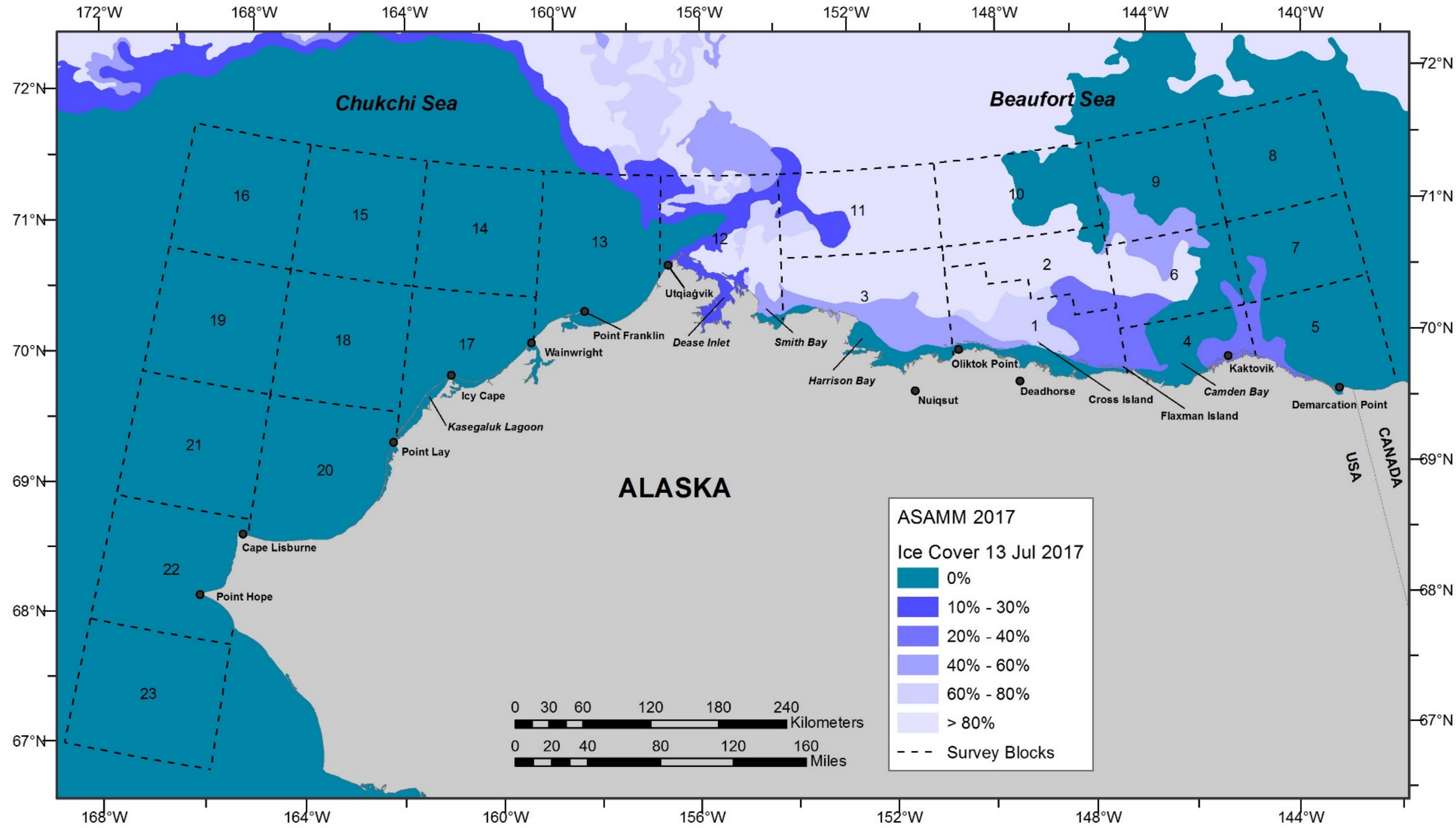


Figure A-2. Ice concentrations in the eastern Chukchi and western Beaufort seas, 13 July 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

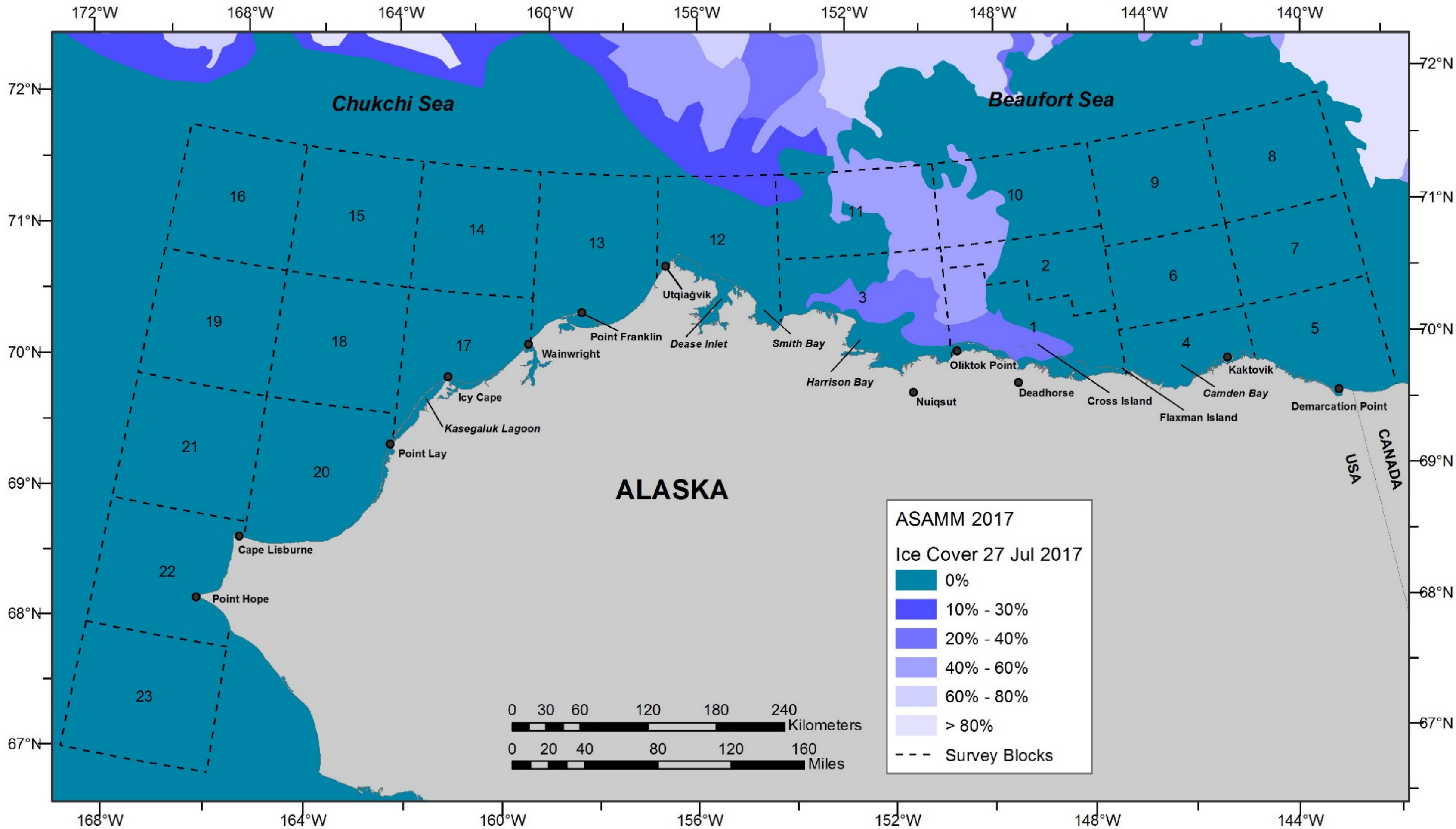


Figure A-3. Ice concentrations in the eastern Chukchi and western Beaufort seas, 27 July 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

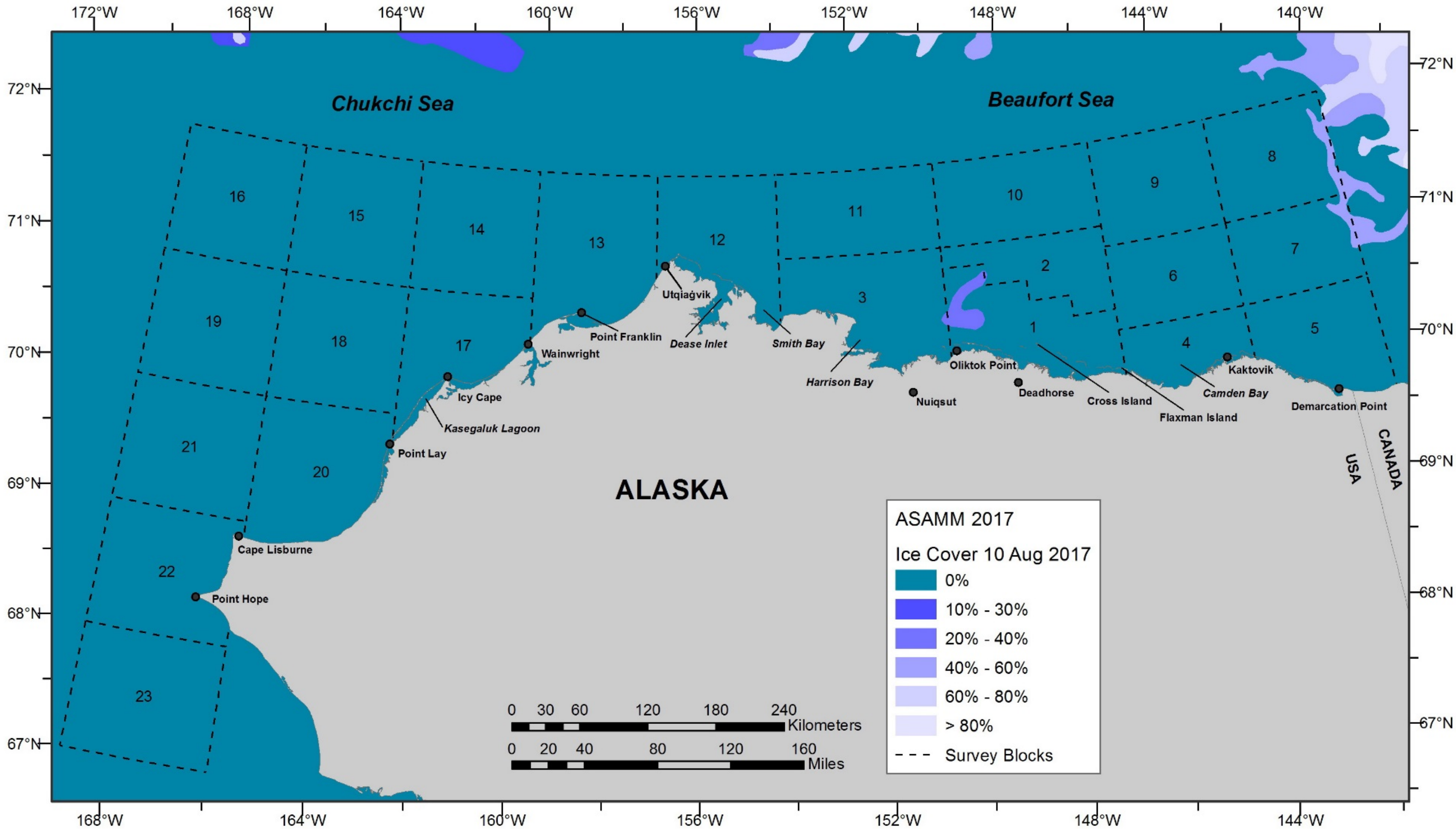


Figure A-4. Ice concentrations in the eastern Chukchi and western Beaufort seas, 10 August 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

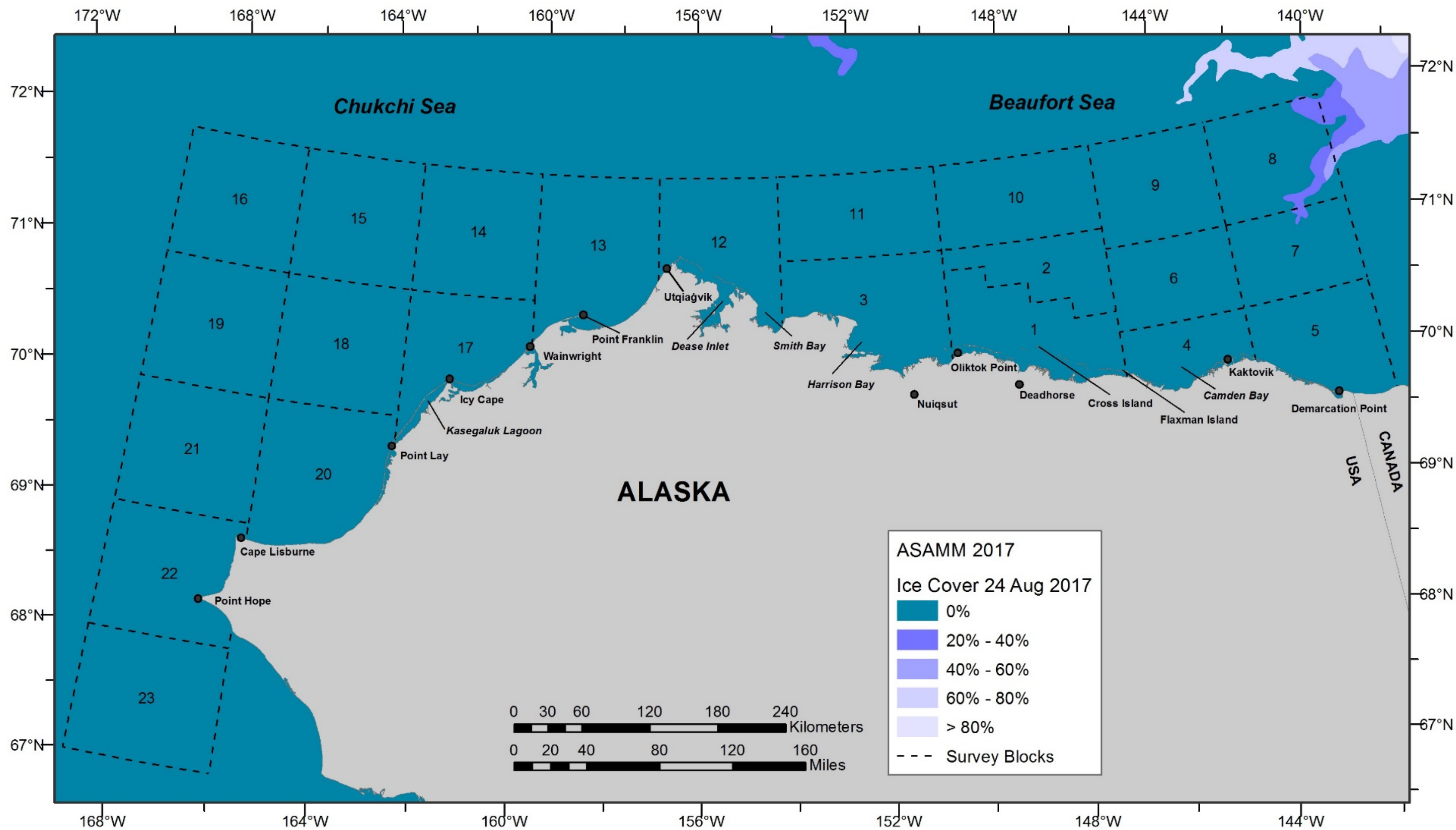


Figure A-5. Ice concentrations in the eastern Chukchi and western Beaufort seas, 24 August 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

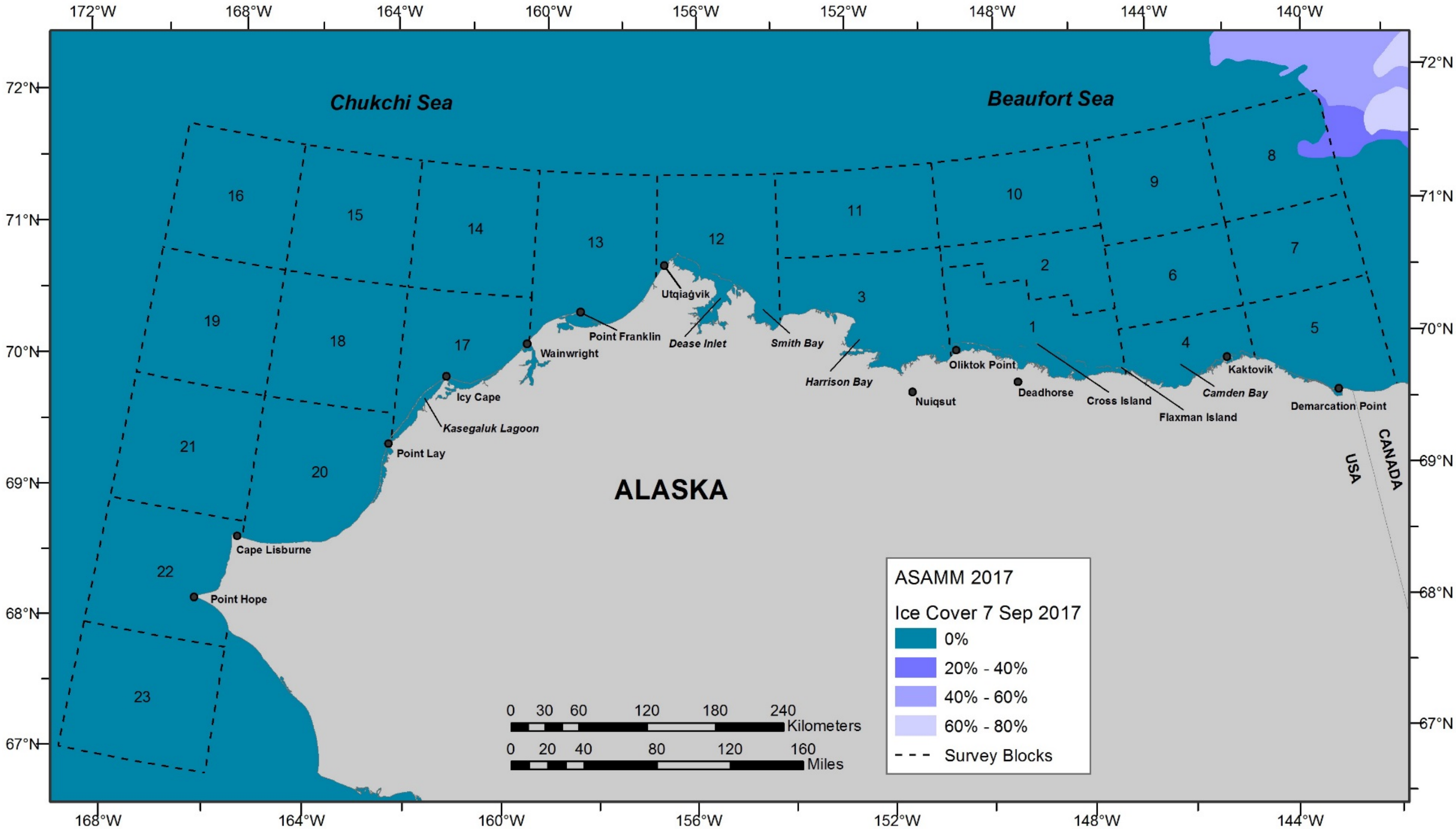


Figure A-6. Ice concentrations in the eastern Chukchi and western Beaufort seas, 7 September 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

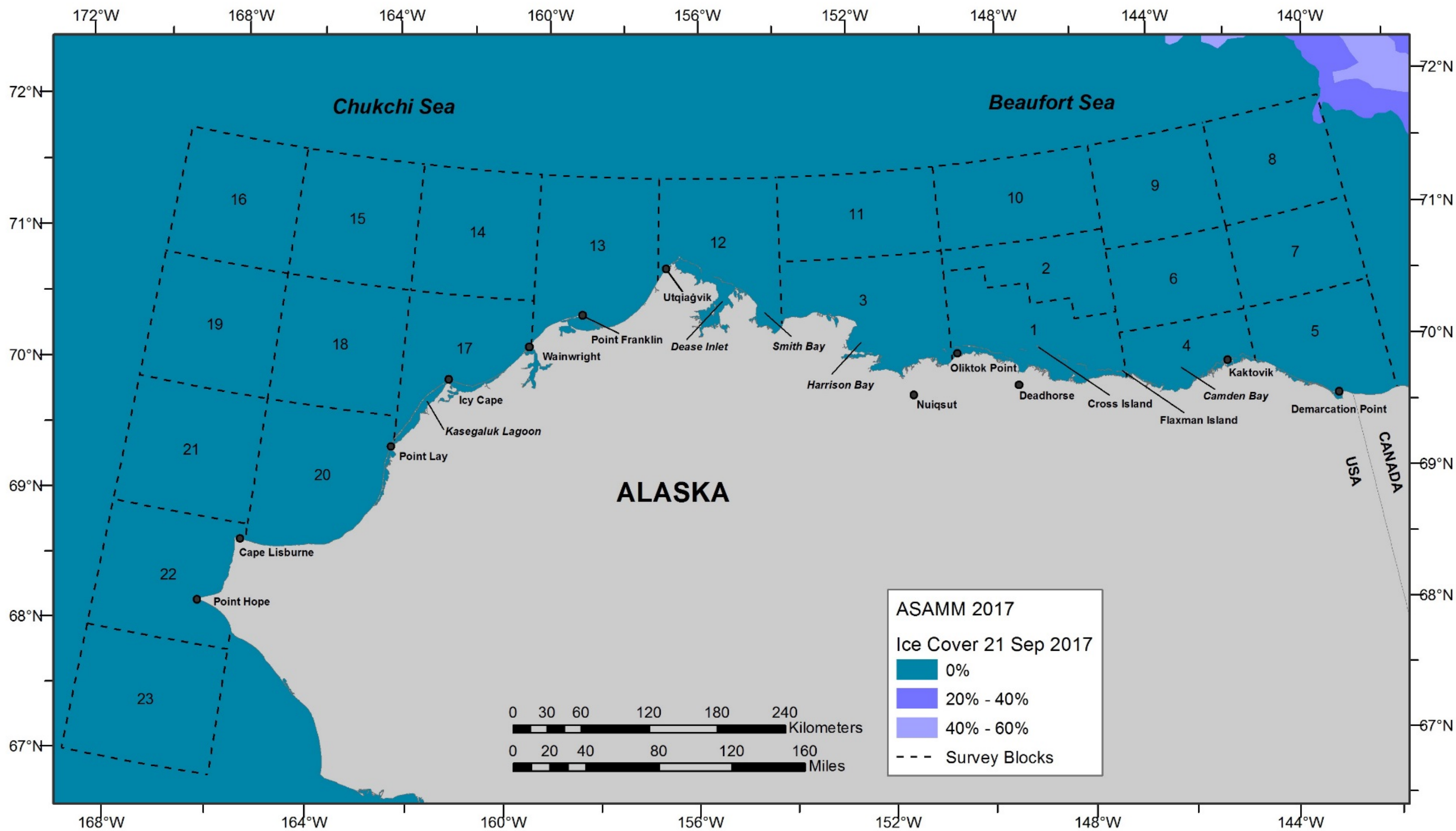


Figure A-7. Ice concentrations in the eastern Chukchi and western Beaufort seas, 21 September 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

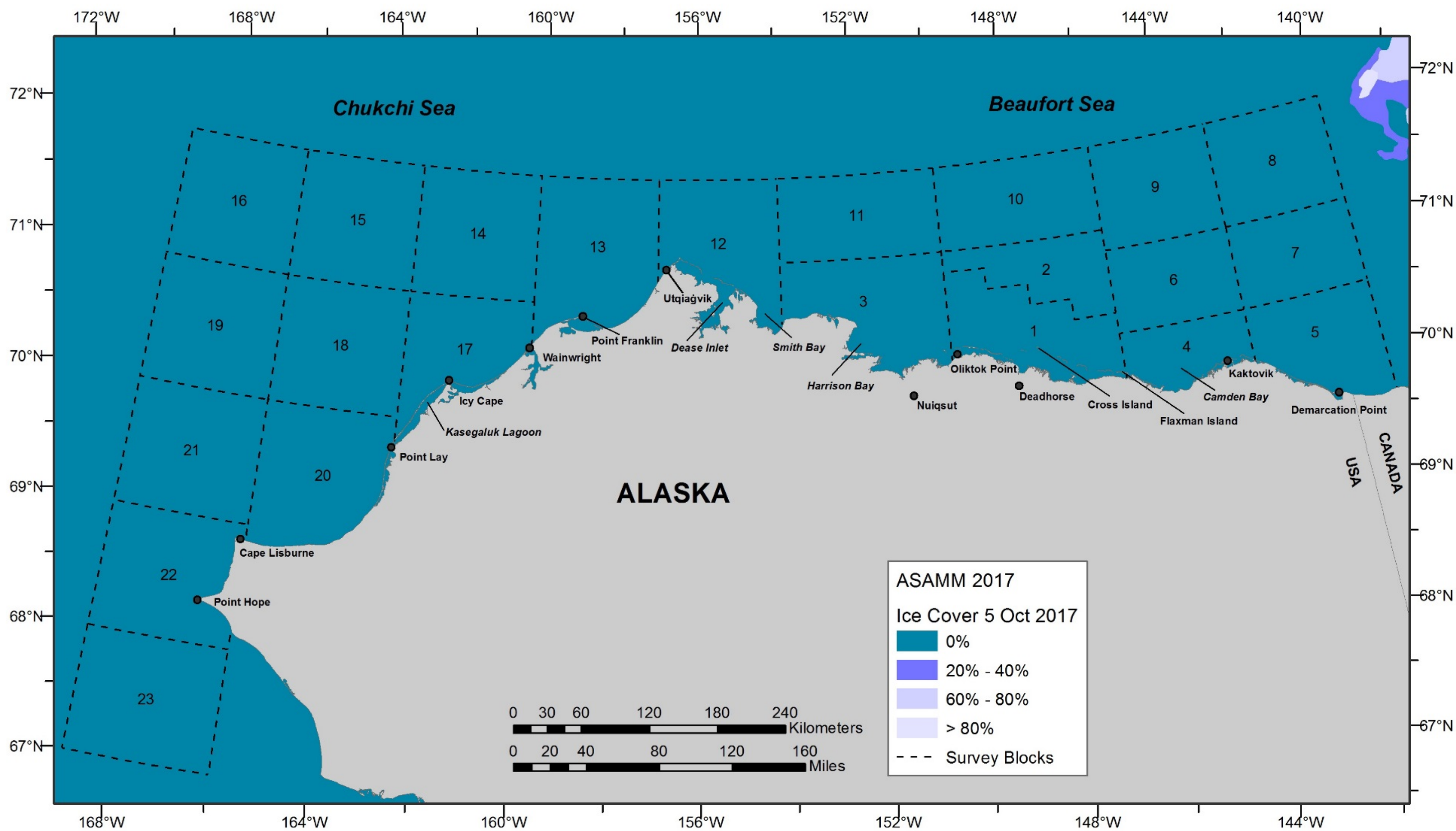


Figure A-8. Ice concentrations in the eastern Chukchi and western Beaufort seas, 5 October 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

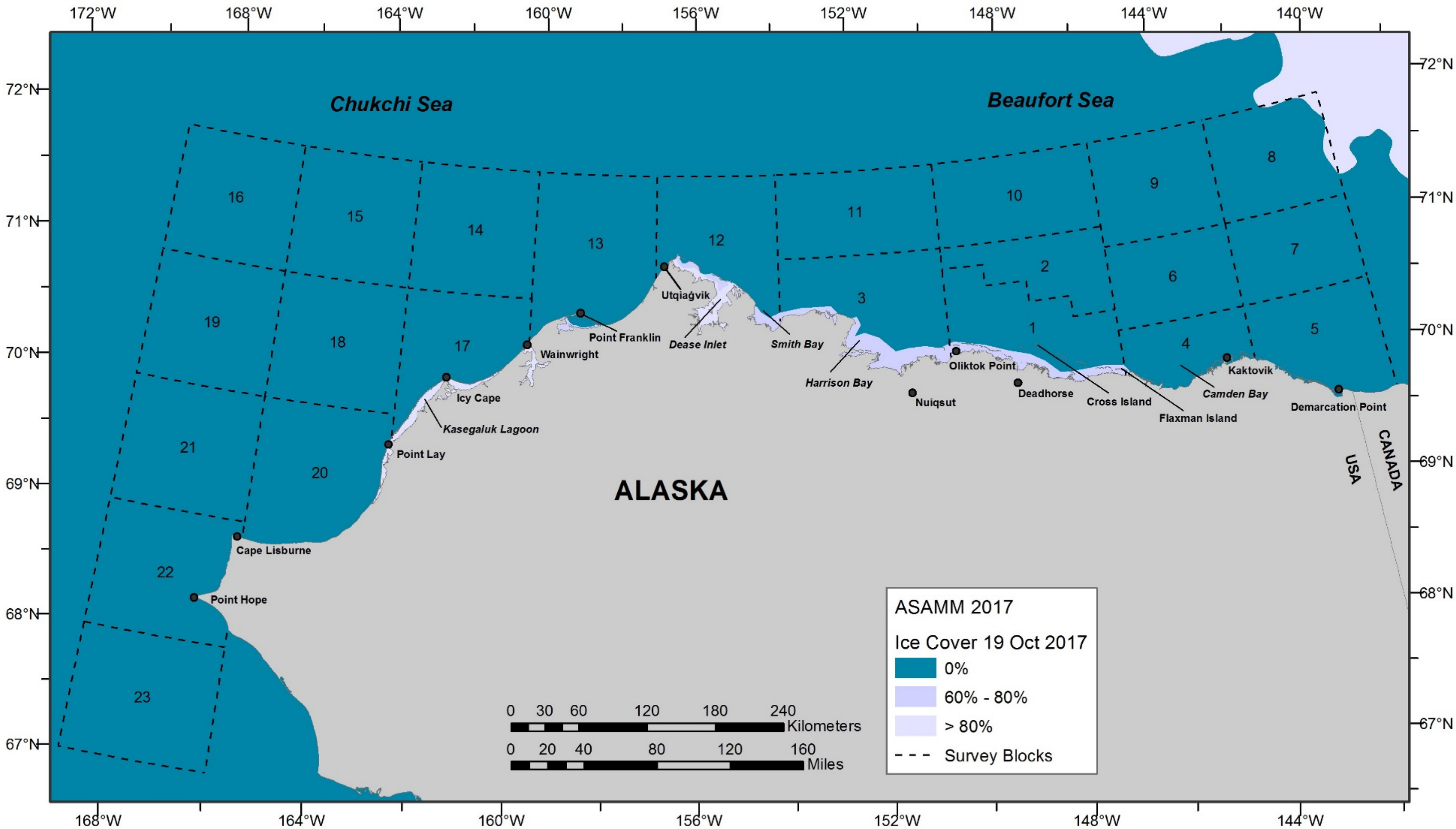


Figure A-9. Ice concentrations in the eastern Chukchi and western Beaufort seas, 19 October 2017. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2017).

APPENDIX B: DAILY FLIGHT SUMMARIES, 2017

3 July 2017, Flight 201

Flight was a complete survey of transects 1, 3, 5, and 7. Survey conditions included clear to partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 0-3 sea states. Sea ice cover was 0-87% broken floe in the area surveyed. Sightings included gray whales (including 15 calves), belugas (including 5 calves), walruses, bearded seals, unidentified pinnipeds, small unidentified pinnipeds, and unidentified marine mammals.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
201	7/3/2017 12:52	71.477	156.878	beluga	swim	14	2	12
201	7/3/2017 12:53	71.482	156.886	beluga	swim	1	0	12
201	7/3/2017 12:54	71.522	156.917	beluga	mill	2	1	12
201	7/3/2017 12:54	71.524	156.936	beluga	swim	1	0	12
201	7/3/2017 12:55	71.547	156.919	beluga	swim	2	0	12
201	7/3/2017 12:55	71.554	156.942	beluga	swim	8	1	12
201	7/3/2017 12:55	71.561	156.949	beluga	swim	1	0	12
201	7/3/2017 12:56	71.569	156.972	beluga	swim	1	0	12
201	7/3/2017 12:56	71.572	156.976	beluga	swim	1	0	12
201	7/3/2017 12:57	71.605	156.958	beluga	swim	1	0	12
201	7/3/2017 12:57	71.608	156.961	beluga	swim	2	1	12
201	7/3/2017 13:45	71.681	158.791	beluga	swim	1	0	13
201	7/3/2017 14:02	71.278	157.389	gray whale	feed	3	0	13
201	7/3/2017 14:02	71.262	157.405	gray whale	feed	3	0	13
201	7/3/2017 14:03	71.252	157.421	gray whale	feed	1	0	13
201	7/3/2017 14:05	71.254	157.466	gray whale	feed	4	0	13
201	7/3/2017 14:07	71.255	157.483	gray whale	feed	2	1	13
201	7/3/2017 14:08	71.266	157.395	gray whale	feed	2	1	13
201	7/3/2017 14:11	71.224	157.395	gray whale	feed	2	1	13
201	7/3/2017 17:24	71.181	158.618	gray whale	swim	2	1	13
201	7/3/2017 17:32	71.265	158.902	gray whale	swim	2	1	13
201	7/3/2017 18:16	72.004	161.949	gray whale	feed	4	1	0
201	7/3/2017 19:02	71.499	161.302	gray whale	rest	2	1	14
201	7/3/2017 19:07	71.428	161.062	gray whale	rest	1	1	14
201	7/3/2017 19:16	71.362	160.816	gray whale	feed	2	1	14
201	7/3/2017 19:16	71.349	160.840	gray whale	feed	1	0	14
201	7/3/2017 19:16	71.361	160.799	gray whale	feed	2	1	14
201	7/3/2017 19:16	71.349	160.803	gray whale	feed	1	0	14
201	7/3/2017 19:17	71.344	160.802	gray whale	feed	1	0	14
201	7/3/2017 19:24	71.330	160.627	gray whale	feed	2	1	14
201	7/3/2017 19:27	71.334	160.659	gray whale	feed	2	1	14
201	7/3/2017 19:39	71.107	159.923	gray whale	rest	2	1	13
201	7/3/2017 19:54	70.892	159.182	gray whale	swim	2	1	13

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
201	7/3/2017 19:55	70.892	159.188	gray whale	swim	1	0	13
201	7/3/2017 19:56	70.898	159.164	gray whale	swim	1	0	13
201	7/3/2017 19:56	70.895	159.202	gray whale	swim	2	1	13
201	7/3/2017 19:57	70.888	159.217	gray whale	swim	1	0	13

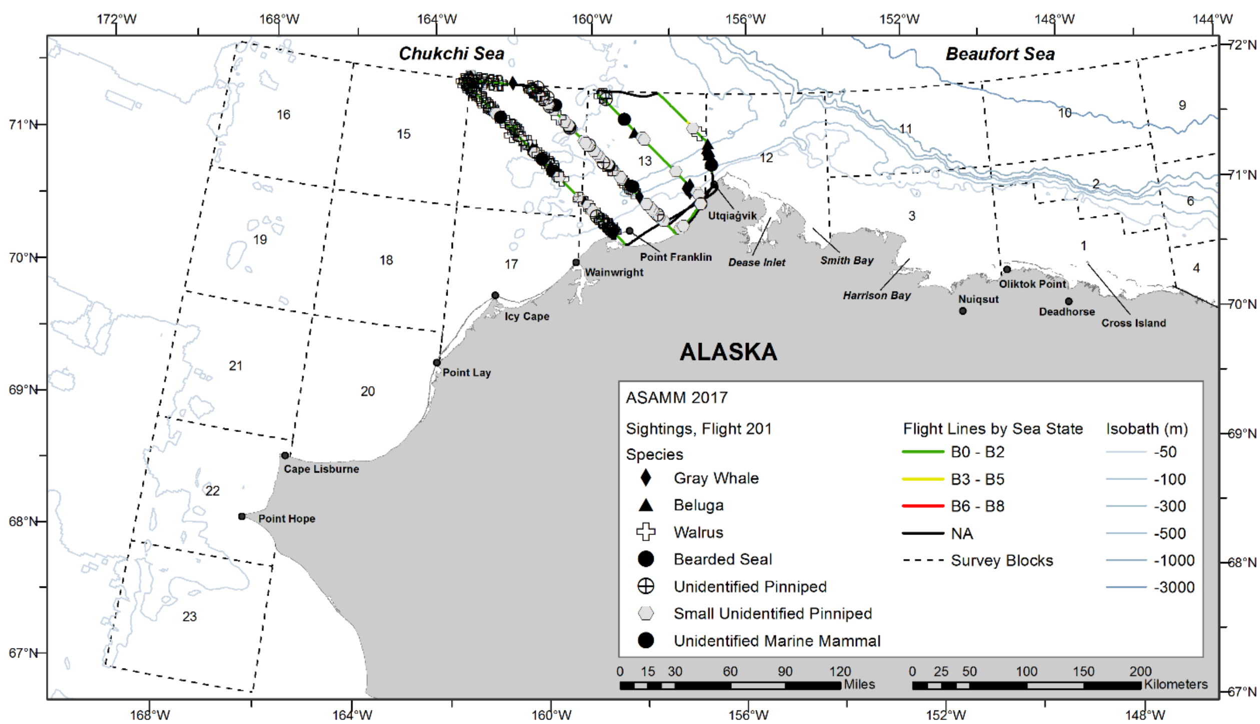
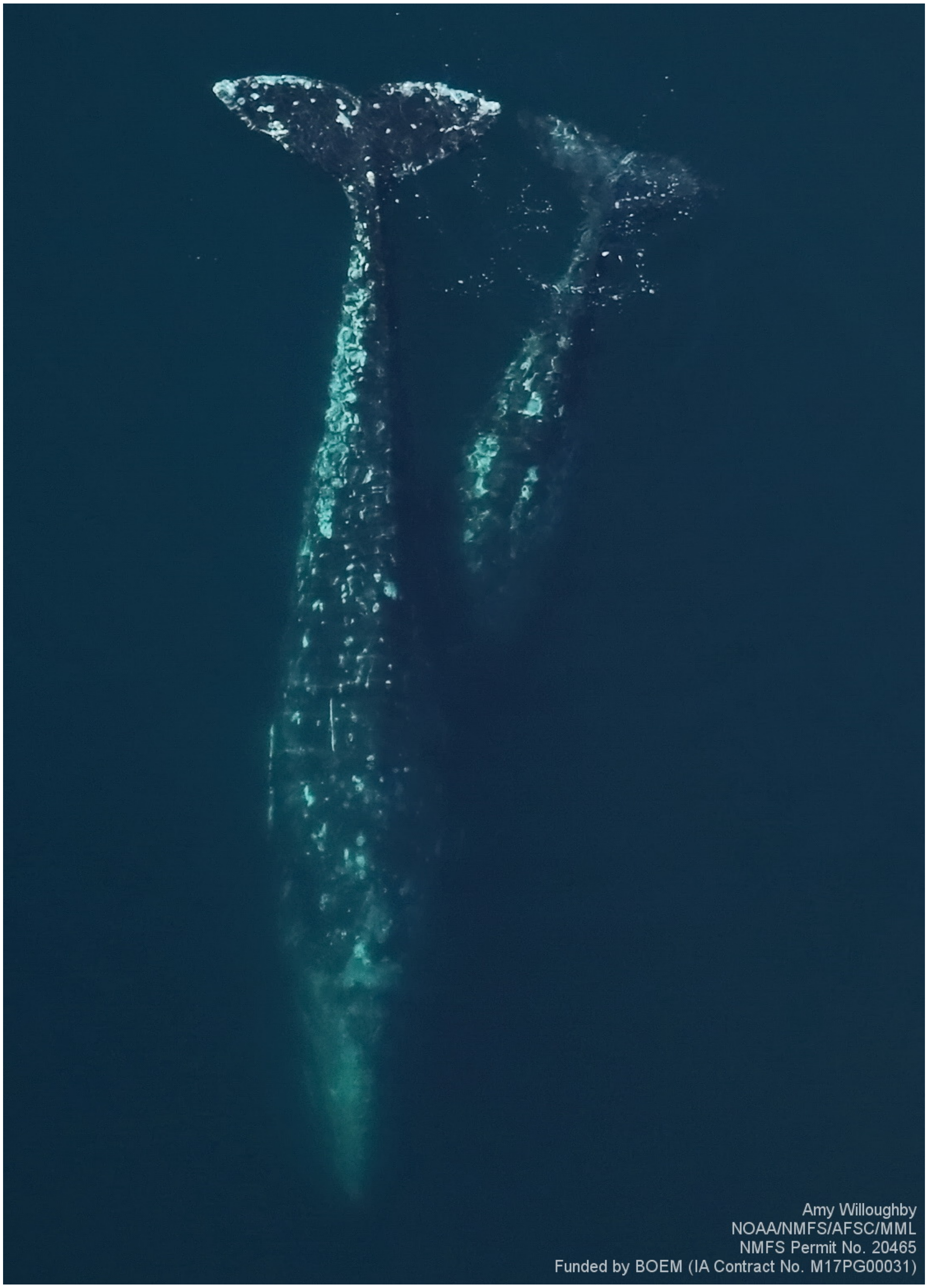


Figure B-1. Flight 201 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



Gray whale cow-calf pair sighted approximately 140 km west of Utqiaġvik, Alaska, during ASAMM flight 201, 3 July 2017.

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4 July 2017, Flight 202

Flight was a partial survey of transects 9, 11, 13, and 15, and the coastal transect from south of Wainwright to south of Utqiaġvik. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, haze, low ceilings, and precipitation), and Beaufort 1-5 sea states. Sea ice cover was 0-55% broken floe in the area surveyed. Sightings included gray whales (including 3 calves), walruses, one bearded seal, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
202	7/4/2017 10:21	70.917	160.758	gray whale	feed	1	0	17
202	7/4/2017 10:21	70.917	160.801	gray whale	feed	1	0	17
202	7/4/2017 10:22	70.925	160.723	gray whale	feed	1	0	17
202	7/4/2017 10:23	70.928	160.719	gray whale	feed	2	0	17
202	7/4/2017 10:32	70.949	160.610	gray whale	feed	16	1	17
202	7/4/2017 10:39	70.908	160.845	gray whale	feed	3	1	17
202	7/4/2017 10:42	70.923	160.953	gray whale	feed	4	0	17
202	7/4/2017 10:44	70.914	160.982	gray whale	feed	3	0	17
202	7/4/2017 10:54	71.078	161.451	gray whale	feed	2	1	14

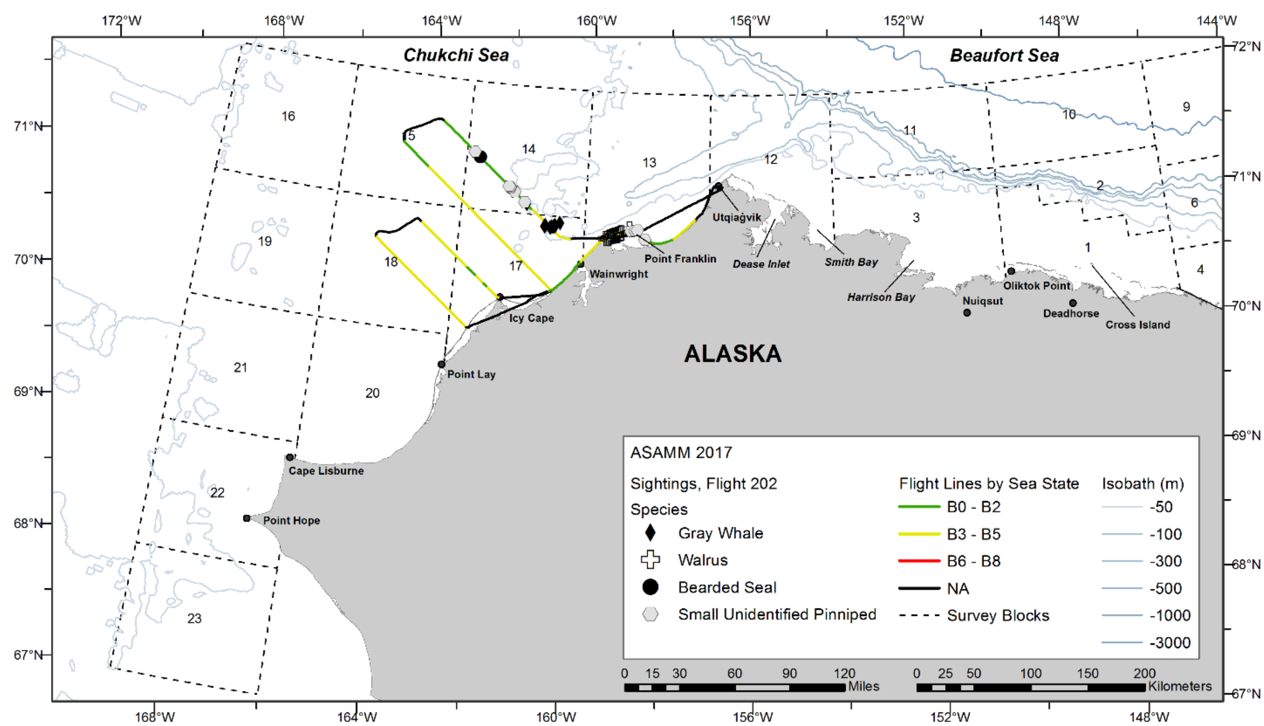


Figure B-2. Flight 202 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Nicely marked gray whale, one of a loosely aggregated feeding group of 16 whales sighted approximately 45 km northwest of Wainwright, Alaska, during ASAMM flight 202, 4 July 2017. Skin patterns on flukes can be used to identify individual gray whales, and his whale has nicely contrasted fluke pigmentation.

6 July 2017, Flight 203

Flight was a survey of portions of blocks 1, 2, 4, and 6. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare), and Beaufort 0-3 sea states. Sea ice cover was 0-90% broken floe and grease/new ice in the area surveyed. Sightings included bowhead whales (including 4 calves), belugas (including 7 calves), one unidentified cetacean, bearded seals, one unidentified pinniped, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
203	7/6/2017 10:48	70.438	144.504	bowhead whale	dive	1	0	4
203	7/6/2017 10:52	70.453	144.478	unid cetacean	swim	1	0	4
203	7/6/2017 10:57	70.473	144.477	beluga	swim	1	0	4
203	7/6/2017 11:01	70.614	144.421	beluga	swim	1	0	6
203	7/6/2017 11:02	70.620	144.428	bowhead whale	swim	2	1	6
203	7/6/2017 11:08	70.706	144.471	beluga	mill	2	0	6
203	7/6/2017 11:08	70.709	144.475	beluga	swim	1	0	6
203	7/6/2017 11:08	70.721	144.478	beluga	swim	4	1	6
203	7/6/2017 11:09	70.757	144.486	bowhead whale	swim	1	0	6
203	7/6/2017 11:12	70.785	144.421	beluga	swim	1	0	6
203	7/6/2017 11:35	70.944	144.950	beluga	swim	1	0	6
203	7/6/2017 11:39	70.836	144.970	beluga	swim	1	0	6
203	7/6/2017 11:41	70.784	144.959	beluga	unknown	1	0	6
203	7/6/2017 11:41	70.782	144.954	beluga	swim	1	0	6
203	7/6/2017 11:42	70.738	144.943	beluga	swim	5	0	6
203	7/6/2017 11:43	70.723	144.963	beluga	swim	3	0	6
203	7/6/2017 11:43	70.721	144.963	beluga	swim	2	0	6
203	7/6/2017 11:43	70.712	144.968	beluga	swim	2	1	6
203	7/6/2017 11:43	70.702	144.982	beluga	swim	2	1	6
203	7/6/2017 12:35	70.725	145.491	beluga	swim	13	2	6
203	7/6/2017 12:35	70.755	145.425	bowhead whale	swim	2	1	6
203	7/6/2017 12:41	70.831	145.481	beluga	rest	2	0	6
203	7/6/2017 13:14	70.695	145.958	beluga	swim	2	0	6
203	7/6/2017 13:53	70.793	146.465	bowhead whale	rest	4	1	2
203	7/6/2017 13:56	70.875	146.447	beluga	swim	2	1	2
203	7/6/2017 13:56	70.875	146.474	beluga	swim	2	1	2
203	7/6/2017 16:41	71.070	147.939	bowhead whale	swim	1	1	2

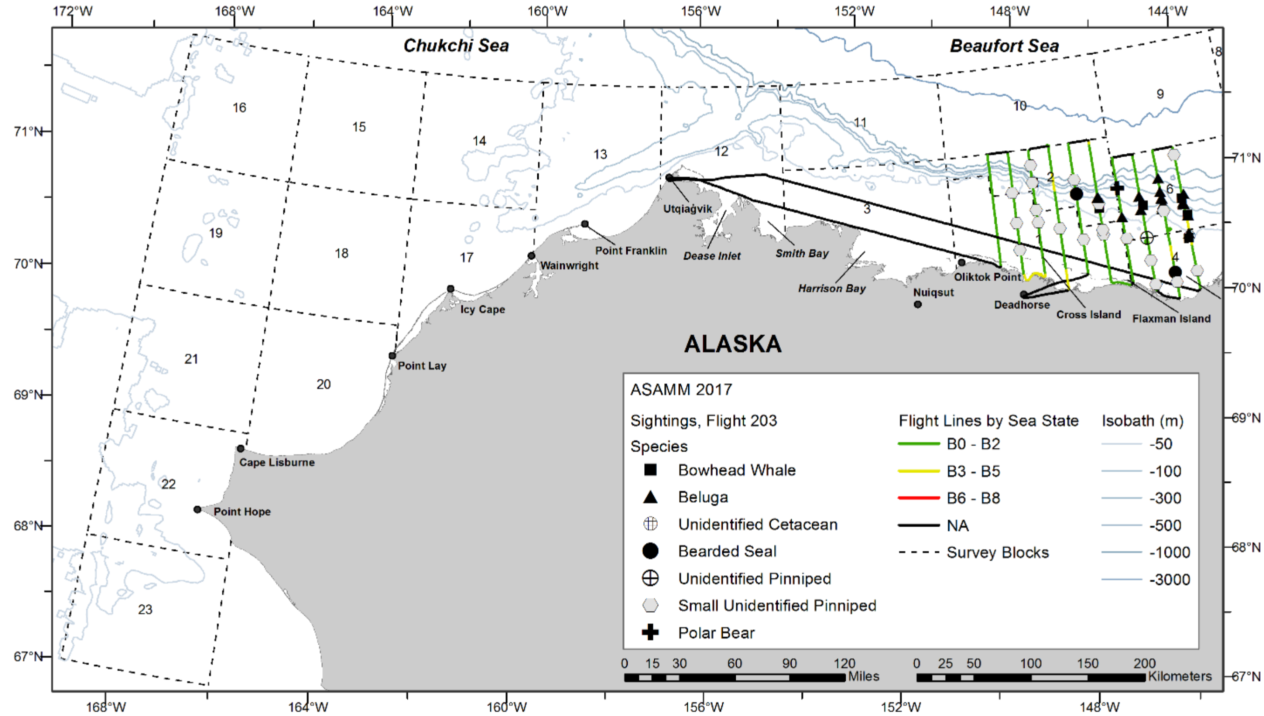
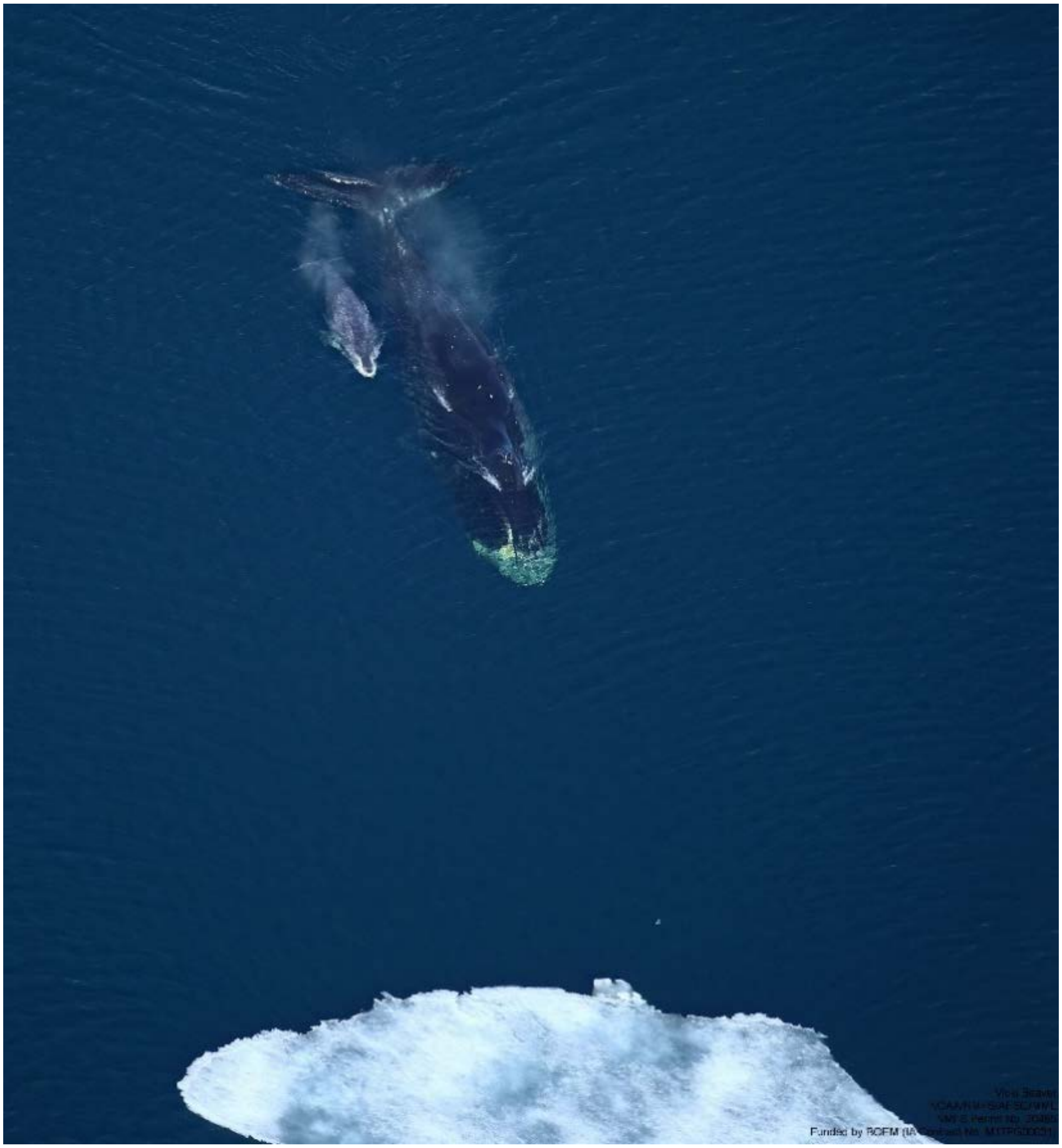


Figure B-3. Flight 203 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



Bowhead whale cow-calf pair sighted in the Beaufort Sea approximately 65 km northeast of Deadhorse, Alaska, during ASAMM flight 203, 6 July 2017.

7 July 2017, Flight 204

Flight was a survey of portions of blocks 1, 2, 3, and 10. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with fog and glare), and Beaufort 0-2 sea states. Sea ice cover was 0-90% broken floe in the area surveyed. Sightings included one bearded seal and one unidentified pinniped.

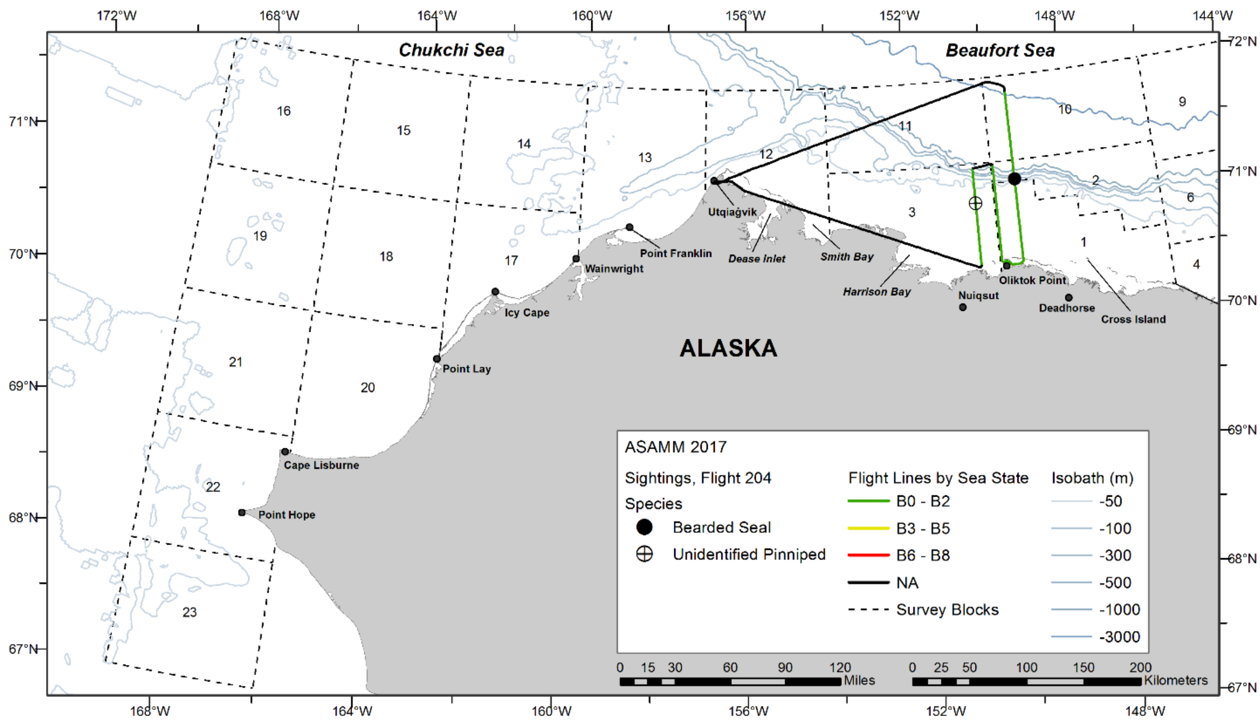


Figure B-4. Flight 204 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

12 July 2017, Flight 205

Flight was the coastal transect from Cape Lisburne to Point Barrow. Survey conditions included clear to partly cloudy skies, 0 km to unlimited visibility (with fog and glare), and Beaufort 2-4 sea states. Sea ice cover was 0-1% broken floe in the area surveyed. Sightings included one bowhead whale carcass, gray whales (including 4 calves), belugas, walruses, and small unidentified pinnipeds. Two haulouts, of approximately 400 and 600 small unidentified pinnipeds, were observed on barrier islands near and east of Icy Cape. The bowhead whale carcass was a resight of a carcass originally sighted in 2016, during ASAMM surveys on 13 July and 10 September.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
205	7/12/2017 13:31	68.923	164.883	gray whale	rest	2	1	20
205	7/12/2017 13:53	69.223	163.420	beluga	swim	1	0	20
205	7/12/2017 13:53	69.227	163.403	beluga	mill	15	0	20
205	7/12/2017 14:13	69.829	163.004	gray whale	feed	2	1	20
205	7/12/2017 14:23	69.924	162.826	gray whale	swim	1	1	17
205	7/12/2017 15:19	70.840	159.530	gray whale	swim	2	0	13
205	7/12/2017 15:50	70.924	157.596	bowhead whale	dead	1	0	13
205	7/12/2017 16:08	71.323	156.770	gray whale	feed	2	1	12

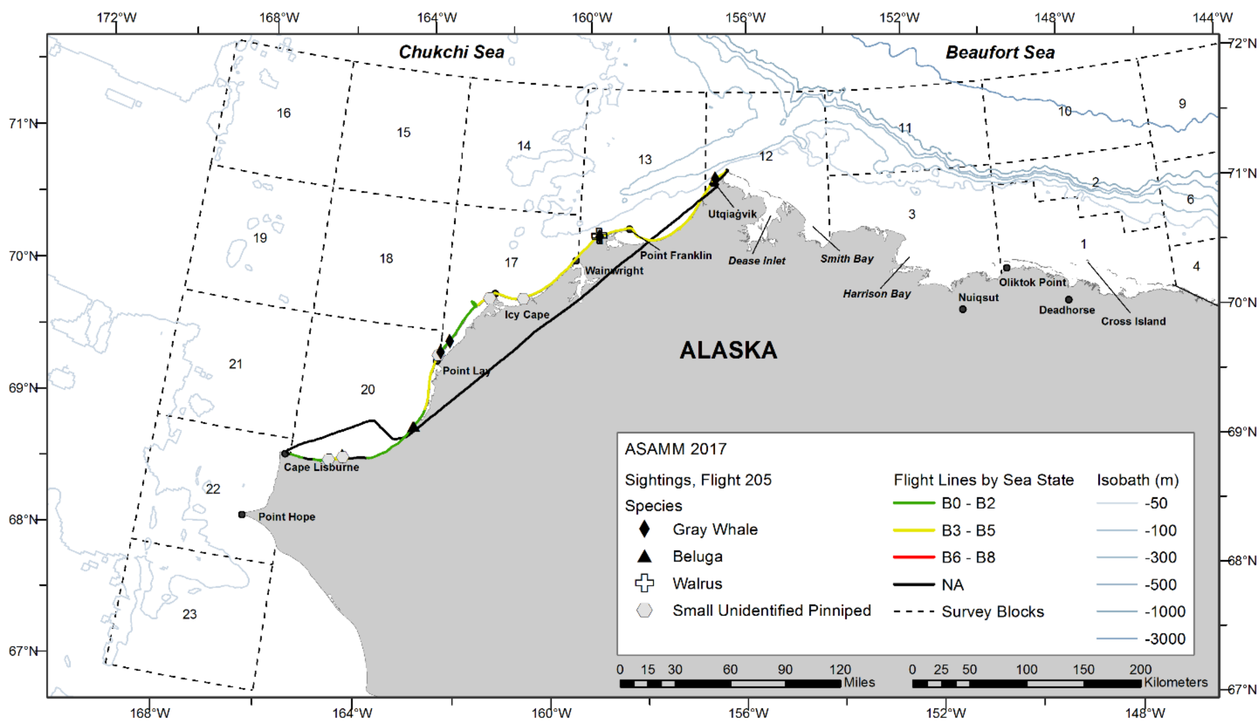


Figure B-5. Flight 205 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

The bowhead whale carcass in the left image was photographed by ASAMM on 10 September 2016 and the carcass in the right image was photographed during, ASAMM flight 205, 12 July 2017 in the same location. Despite the change in body orientation between last September and now, the carcasses are presumed to be the same whale based on location and decomposition.

Gulls descend onto a baitball (possibly capelin) sighted approximately 37 km southwest of Utqiaġvik, Alaska, ASAMM flight 205, 12 July 2017. About 20 additional baitballs were seen between this location and Utqiaġvik.

13 July 2017, Flight 206

Flight was a complete survey of transects 2, 4, and 6 and a partial survey of transect 8. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 1-3 sea states. Sea ice cover was 0-27% broken floe in the area surveyed. Sightings included gray whales (including 34 calves), one unidentified cetacean, walruses, bearded seals, unidentified pinnipeds, small unidentified pinnipeds, and one unidentified marine mammal.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
206	7/13/2017 11:33	70.959	160.207	gray whale	feed	1	0	17
206	7/13/2017 11:34	70.967	160.141	gray whale	feed	4	1	17
206	7/13/2017 11:38	70.966	160.158	gray whale	feed	5	2	17
206	7/13/2017 11:45	71.056	160.584	gray whale	feed	1	0	14
206	7/13/2017 11:45	71.061	160.576	gray whale	rest	1	0	14
206	7/13/2017 11:52	71.116	160.772	gray whale	feed	2	1	14
206	7/13/2017 11:58	71.200	161.060	gray whale	feed	2	1	14
206	7/13/2017 11:58	71.208	161.069	gray whale	feed	1	0	14
206	7/13/2017 11:58	71.209	161.075	gray whale	feed	1	0	14
206	7/13/2017 11:59	71.208	161.114	gray whale	feed	2	1	14
206	7/13/2017 12:02	71.212	161.077	gray whale	feed	1	0	14
206	7/13/2017 12:04	71.222	161.012	gray whale	feed	2	0	14
206	7/13/2017 12:06	71.233	161.024	gray whale	feed	1	0	14
206	7/13/2017 12:08	71.216	161.102	gray whale	feed	1	0	14
206	7/13/2017 12:08	71.219	161.127	gray whale	feed	2	1	14
206	7/13/2017 12:08	71.221	161.130	gray whale	feed	2	1	14
206	7/13/2017 12:08	71.227	161.100	gray whale	feed	1	0	14
206	7/13/2017 12:09	71.232	161.166	gray whale	feed	2	1	14
206	7/13/2017 12:10	71.227	161.189	gray whale	feed	1	0	14
206	7/13/2017 12:10	71.243	161.233	gray whale	feed	1	0	14
206	7/13/2017 12:10	71.245	161.239	gray whale	feed	1	0	14
206	7/13/2017 12:11	71.257	161.360	gray whale	feed	1	0	14
206	7/13/2017 12:11	71.285	161.287	gray whale	feed	1	0	14
206	7/13/2017 12:12	71.294	161.304	gray whale	feed	1	0	14
206	7/13/2017 12:12	71.289	161.326	gray whale	feed	4	1	14
206	7/13/2017 12:12	71.292	161.334	gray whale	feed	3	1	14
206	7/13/2017 12:13	71.299	161.335	gray whale	feed	1	0	14
206	7/13/2017 12:14	71.294	161.324	gray whale	feed	3	0	14
206	7/13/2017 12:21	71.287	161.394	gray whale	feed	2	1	14
206	7/13/2017 12:24	71.278	161.436	gray whale	rest	1	0	14
206	7/13/2017 12:25	71.265	161.468	gray whale	feed	1	0	14
206	7/13/2017 12:26	71.259	161.464	gray whale	feed	1	0	14

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
206	7/13/2017 12:26	71.258	161.461	gray whale	feed	1	0	14
206	7/13/2017 12:26	71.261	161.440	gray whale	feed	1	0	14
206	7/13/2017 12:27	71.245	161.545	gray whale	feed	1	0	14
206	7/13/2017 12:28	71.239	161.503	gray whale	feed	1	0	14
206	7/13/2017 12:28	71.245	161.481	gray whale	feed	4	0	14
206	7/13/2017 12:28	71.256	161.394	gray whale	feed	2	0	14
206	7/13/2017 12:29	71.267	161.354	gray whale	feed	1	0	14
206	7/13/2017 12:32	71.326	161.550	gray whale	rest	2	1	14
206	7/13/2017 13:43	71.125	159.288	unid cetacean	rest	1	0	13
206	7/13/2017 14:16	71.183	157.859	gray whale	swim	1	0	13
206	7/13/2017 14:16	71.186	157.862	gray whale	swim	1	0	13
206	7/13/2017 14:20	71.171	157.817	gray whale	swim	1	0	13
206	7/13/2017 15:31	71.490	157.313	gray whale	feed	5	1	13
206	7/13/2017 15:31	71.490	157.302	gray whale	feed	33	15	13
206	7/13/2017 15:33	71.490	157.299	gray whale	feed	16	5	13

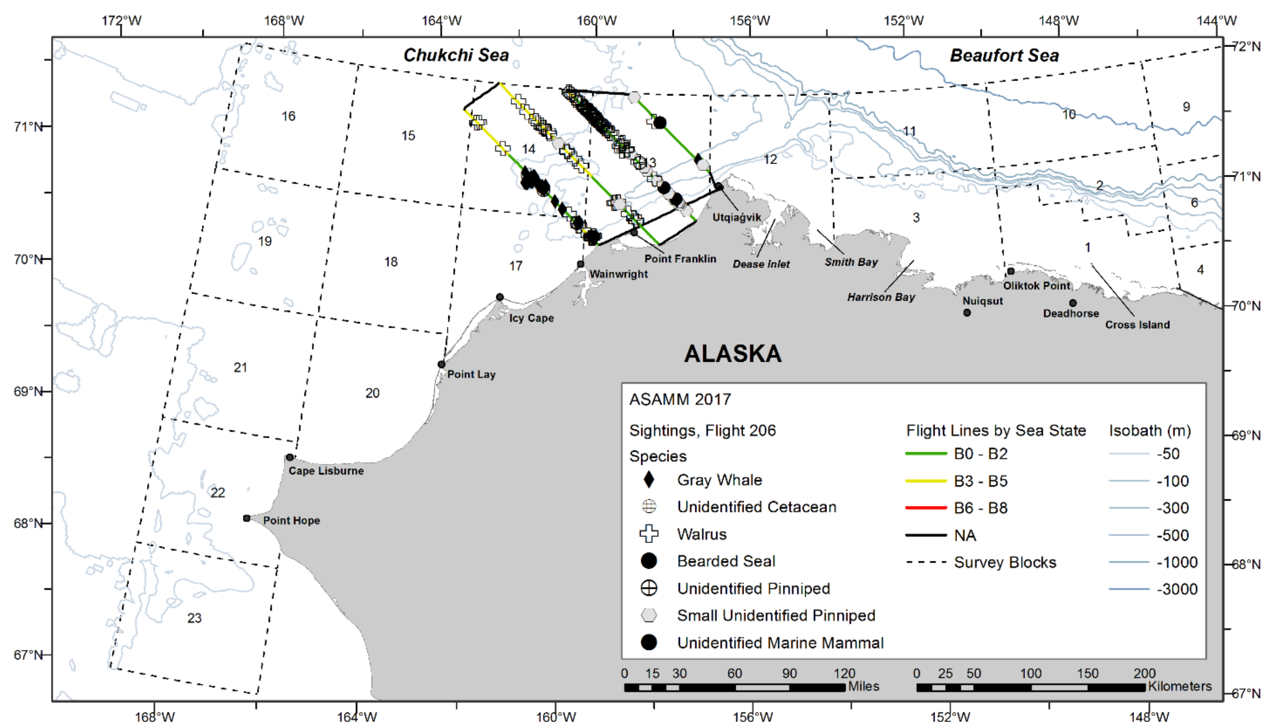


Figure B-6. Flight 206 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

This group of three was part of a larger group of 33 gray whales observed feeding approximately 30 km northwest of Utqiaġvik, Alaska, during ASAMM flight 206, 13 July 2017. The whale at the surface, a calf, is ventral (or belly) side up.

This well-barnacled gray whale was also part of the larger group of 33 gray whales observed feeding approximately 30 km northwest of Utqiaġvik, Alaska, during ASAMM flight 206, 13 July 2017.

14 July 2017, Flight 207

Flight was a complete survey of transects 10 and 12, and search effort in Peard Bay and nearshore south of Utqiaġvik. Survey conditions included partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 0-4 sea states. No sea ice was observed in the area surveyed. Sightings included one bearded seal, unidentified pinnipeds, and small unidentified pinnipeds.

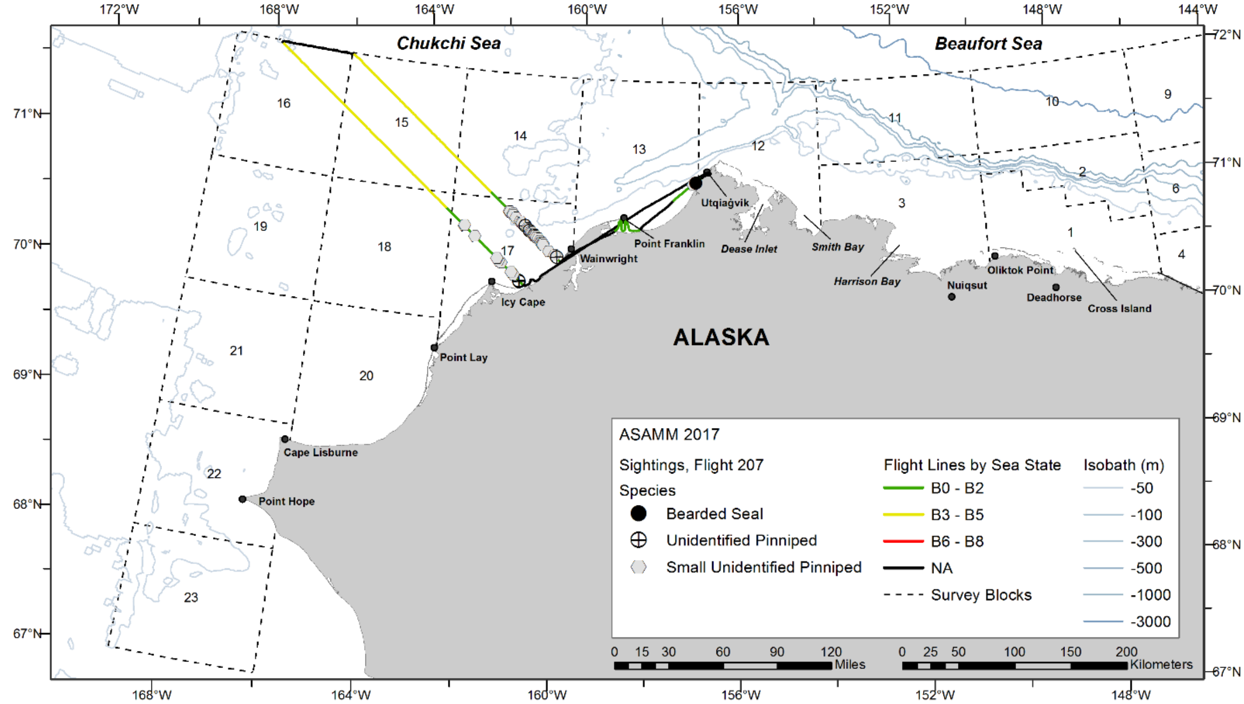


Figure B-7. Flight 207 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

15 July 2017, Flight 208

Flight was a complete survey of transects 34, 35, 36, and 37 and a partial survey of transect 38. Survey conditions included overcast skies, <1 km to unlimited visibility (with glare and precipitation), and Beaufort 0-3 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including 1 calf) and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
208	7/15/2017 11:08	67.851	167.772	gray whale	feed	1	0	23
208	7/15/2017 11:08	67.842	167.791	gray whale	rest	1	0	23
208	7/15/2017 11:08	67.852	167.807	gray whale	feed	1	0	23
208	7/15/2017 11:08	67.852	167.814	gray whale	feed	1	0	23
208	7/15/2017 11:08	67.836	167.817	gray whale	feed	1	0	23
208	7/15/2017 11:09	67.839	167.851	gray whale	feed	1	0	23
208	7/15/2017 11:10	67.856	167.891	gray whale	feed	1	0	23
208	7/15/2017 11:11	67.835	167.900	gray whale	feed	1	0	23
208	7/15/2017 11:11	67.829	167.928	gray whale	rest	1	0	23
208	7/15/2017 11:12	67.829	167.925	gray whale	feed	1	0	23
208	7/15/2017 11:12	67.828	167.925	gray whale	feed	3	0	23
208	7/15/2017 11:13	67.832	167.946	gray whale	rest	1	0	23
208	7/15/2017 11:13	67.833	167.948	gray whale	rest	2	0	23
208	7/15/2017 11:13	67.833	167.982	gray whale	rest	2	0	23
208	7/15/2017 11:13	67.830	167.987	gray whale	rest	1	0	23
208	7/15/2017 11:13	67.826	167.977	gray whale	rest	1	0	23
208	7/15/2017 11:15	67.860	167.956	gray whale	feed	2	0	23
208	7/15/2017 11:15	67.854	168.004	gray whale	feed	1	0	23
208	7/15/2017 11:16	67.857	168.030	gray whale	feed	1	0	23
208	7/15/2017 11:16	67.843	168.046	gray whale	rest	2	0	23
208	7/15/2017 11:16	67.854	168.065	gray whale	rest	2	0	23
208	7/15/2017 11:16	67.853	168.091	gray whale	feed	1	0	23
208	7/15/2017 11:16	67.847	168.102	gray whale	rest	1	0	23
208	7/15/2017 11:17	67.845	168.116	gray whale	rest	1	0	23
208	7/15/2017 11:17	67.841	168.119	gray whale	feed	1	0	23
208	7/15/2017 11:17	67.855	168.144	gray whale	rest	1	0	23
208	7/15/2017 11:17	67.852	168.144	gray whale	feed	1	0	23
208	7/15/2017 11:17	67.834	168.166	gray whale	unknown	1	0	23
208	7/15/2017 11:17	67.845	168.178	gray whale	feed	2	0	23
208	7/15/2017 11:17	67.846	168.188	gray whale	feed	2	0	23
208	7/15/2017 11:18	67.852	168.201	gray whale	feed	1	0	23
208	7/15/2017 11:18	67.842	168.216	gray whale	rest	1	0	23
208	7/15/2017 11:18	67.866	168.235	gray whale	feed	2	0	23
208	7/15/2017 11:18	67.848	168.266	gray whale	rest	2	0	23

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
208	7/15/2017 11:19	67.859	168.242	gray whale	rest	1	0	23
208	7/15/2017 11:19	67.867	168.221	gray whale	feed	3	0	23
208	7/15/2017 11:19	67.878	168.201	gray whale	feed	5	0	23
208	7/15/2017 11:22	67.841	168.282	gray whale	feed	1	0	23
208	7/15/2017 11:22	67.846	168.284	gray whale	feed	1	0	23
208	7/15/2017 11:22	67.849	168.300	gray whale	rest	1	0	23
208	7/15/2017 11:22	67.845	168.310	gray whale	rest	2	0	23
208	7/15/2017 11:23	67.850	168.328	gray whale	feed	4	0	23
208	7/15/2017 11:23	67.835	168.352	gray whale	feed	2	0	23
208	7/15/2017 11:23	67.843	168.366	gray whale	rest	1	0	23
208	7/15/2017 11:23	67.851	168.375	gray whale	feed	1	0	23
208	7/15/2017 11:23	67.884	168.397	gray whale	unknown	1	0	23
208	7/15/2017 11:24	67.846	168.438	gray whale	feed	1	0	23
208	7/15/2017 11:24	67.822	168.469	gray whale	rest	1	0	23
208	7/15/2017 11:25	67.814	168.490	gray whale	feed	2	0	23
208	7/15/2017 11:25	67.807	168.488	gray whale	feed	6	0	23
208	7/15/2017 11:26	67.803	168.487	gray whale	feed	1	0	23
208	7/15/2017 11:26	67.796	168.484	gray whale	rest	2	1	23
208	7/15/2017 11:26	67.802	168.455	gray whale	feed	5	0	23
208	7/15/2017 11:28	67.836	168.566	gray whale	feed	1	0	23
208	7/15/2017 11:29	67.869	168.619	gray whale	feed	1	0	23
208	7/15/2017 11:29	67.840	168.636	gray whale	rest	2	0	23
208	7/15/2017 11:29	67.839	168.638	gray whale	rest	1	0	23
208	7/15/2017 11:30	67.844	168.675	gray whale	rest	1	0	23
208	7/15/2017 11:30	67.849	168.682	gray whale	rest	1	0	23
208	7/15/2017 11:30	67.838	168.685	gray whale	feed	1	0	23
208	7/15/2017 11:30	67.838	168.719	gray whale	feed	2	0	23
208	7/15/2017 11:30	67.833	168.727	gray whale	rest	1	0	23
208	7/15/2017 11:30	67.838	168.732	gray whale	rest	1	0	23
208	7/15/2017 11:30	67.849	168.737	gray whale	feed	3	0	23
208	7/15/2017 11:30	67.833	168.740	gray whale	rest	3	0	23
208	7/15/2017 11:30	67.834	168.747	gray whale	rest	1	0	23
208	7/15/2017 11:46	67.666	167.889	gray whale	rest	1	0	23

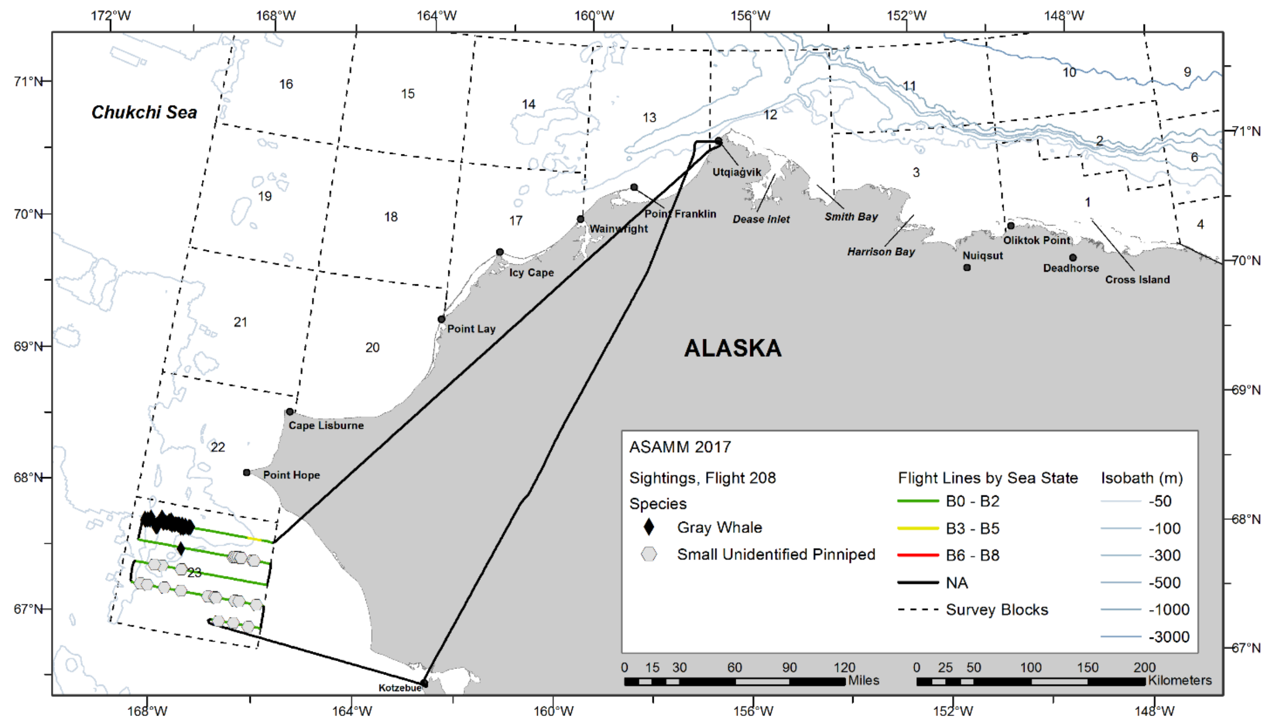


Figure B-8. Flight 208 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

18 July 2017, Flight 209

Flight was a partial survey of transects 9 and 15. Survey conditions included overcast skies, 0 km to unlimited visibility (with fog), and Beaufort 1-2 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including 2 calves), one unidentified cetacean, bearded seals, one unidentified pinniped, and small unidentified pinnipeds. A small group of approximately 70 small unidentified pinnipeds was hauled out on a barrier island near Point Franklin.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
209	7/18/2017 11:00	71.028	161.296	gray whale	feed	1	0	14
209	7/18/2017 11:02	71.030	161.285	gray whale	feed	2	0	14
209	7/18/2017 11:06	71.010	161.200	gray whale	rest	1	0	14
209	7/18/2017 11:06	71.008	161.170	gray whale	feed	1	0	14
209	7/18/2017 11:08	71.005	161.131	gray whale	rest	1	0	14
209	7/18/2017 11:11	71.006	161.118	gray whale	rest	1	0	14
209	7/18/2017 11:13	70.988	161.125	gray whale	dive	1	0	17
209	7/18/2017 11:13	70.990	161.108	gray whale	swim	1	0	17
209	7/18/2017 11:14	70.988	161.127	gray whale	swim	2	1	17
209	7/18/2017 11:20	70.911	160.850	gray whale	rest	1	0	17

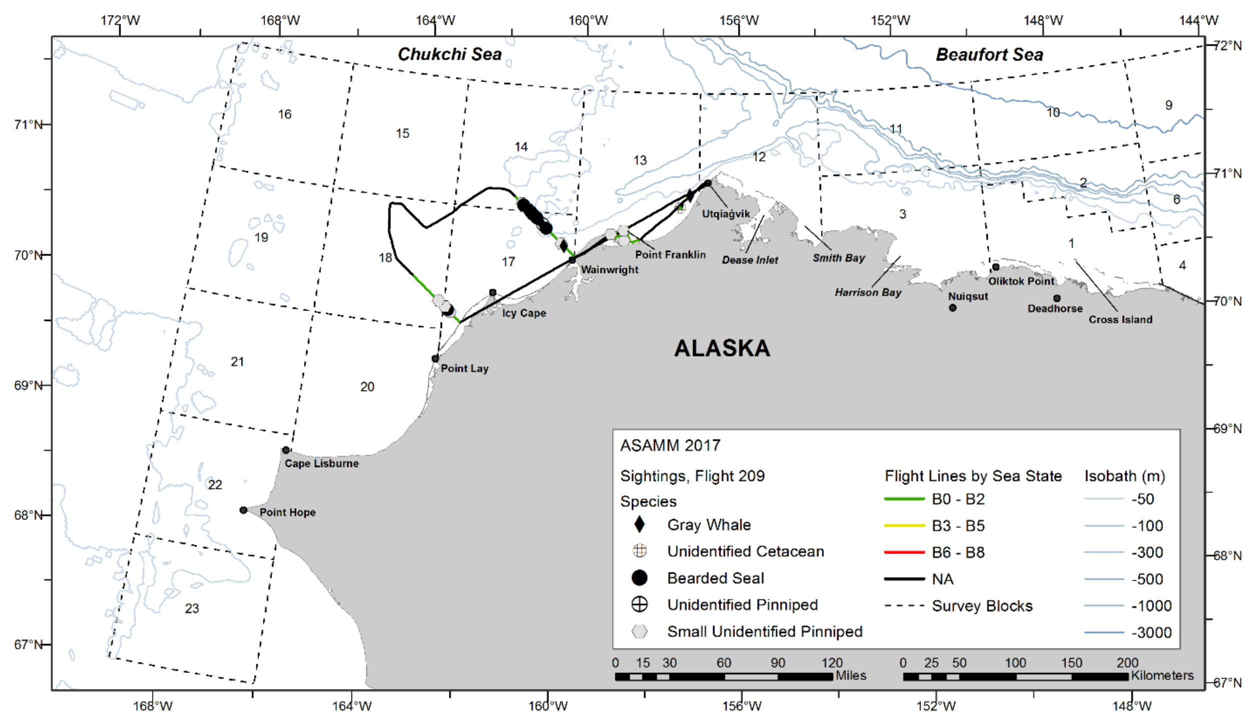


Figure B-9. Flight 209 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 July 2017, Flight 1

Flight was a survey of portions of blocks 1 and 2. Survey conditions included partly cloudy skies, <1 km to unlimited visibility (with fog and glare), and Beaufort 0-3 sea states. Sea ice cover was 0-70% broken floe in the area surveyed. Sightings included bowhead whales (including 1 calf), belugas (including 25 calves), one harbor porpoise, one bearded seal, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
1	7/19/2017 12:08	71.173	149.966	beluga	swim	1	0	2
1	7/19/2017 12:08	71.170	149.968	beluga	swim	1	0	2
1	7/19/2017 12:58	71.179	149.444	beluga	swim	2	1	2
1	7/19/2017 12:58	71.202	149.475	beluga	swim	1	0	2
1	7/19/2017 13:47	70.561	148.445	beluga	swim	1	0	1
1	7/19/2017 14:07	71.201	148.478	beluga	swim	2	1	2
1	7/19/2017 14:08	71.227	148.445	beluga	swim	1	0	2
1	7/19/2017 14:08	71.236	148.469	beluga	swim	1	0	2
1	7/19/2017 14:08	71.238	148.427	beluga	swim	4	0	2
1	7/19/2017 14:08	71.243	148.473	beluga	swim	2	0	2
1	7/19/2017 14:09	71.265	148.480	beluga	rest	2	0	2
1	7/19/2017 14:10	71.317	148.499	beluga	swim	3	0	2
1	7/19/2017 14:20	71.169	147.965	beluga	swim	1	0	2
1	7/19/2017 14:21	71.155	147.947	beluga	swim	2	1	2
1	7/19/2017 14:25	71.011	147.968	bowhead whale	swim	1	0	2
1	7/19/2017 14:31	70.845	147.952	beluga	swim	2	1	2
1	7/19/2017 14:53	70.239	147.467	harbor porpoise	swim	1	0	1
1	7/19/2017 15:16	70.715	147.458	beluga	swim	1	0	1
1	7/19/2017 15:16	70.734	147.461	beluga	swim	1	0	1
1	7/19/2017 15:20	70.853	147.448	beluga	swim	2	0	2
1	7/19/2017 15:22	70.945	147.475	beluga	rest	1	0	2
1	7/19/2017 15:24	71.016	147.408	beluga	swim	1	0	2
1	7/19/2017 15:24	71.020	147.420	beluga	swim	1	0	2
1	7/19/2017 15:24	71.023	147.428	beluga	swim	4	0	2
1	7/19/2017 15:24	71.029	147.449	beluga	swim	7	0	2
1	7/19/2017 15:25	71.034	147.453	beluga	swim	6	0	2
1	7/19/2017 15:26	71.067	147.465	beluga	swim	2	1	2
1	7/19/2017 15:26	71.072	147.468	beluga	swim	2	1	2
1	7/19/2017 15:26	71.073	147.446	beluga	swim	4	0	2
1	7/19/2017 15:26	71.076	147.466	beluga	swim	4	1	2
1	7/19/2017 15:26	71.081	147.446	beluga	swim	2	0	2
1	7/19/2017 15:26	71.084	147.446	beluga	swim	21	4	2
1	7/19/2017 15:26	71.086	147.433	beluga	swim	2	0	2

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
1	7/19/2017 15:26	71.101	147.494	beluga	swim	1	0	2
1	7/19/2017 15:27	71.104	147.485	beluga	swim	1	0	2
1	7/19/2017 15:27	71.112	147.448	beluga	swim	4	0	2
1	7/19/2017 15:27	71.116	147.466	beluga	swim	2	1	2
1	7/19/2017 15:27	71.126	147.446	beluga	swim	2	1	2
1	7/19/2017 15:28	71.141	147.383	beluga	swim	9	0	2
1	7/19/2017 15:28	71.151	147.455	beluga	swim	20	0	2
1	7/19/2017 15:28	71.159	147.494	beluga	swim	6	0	2
1	7/19/2017 15:29	71.179	147.455	beluga	swim	28	3	2
1	7/19/2017 15:29	71.180	147.455	beluga	swim	8	3	2
1	7/19/2017 15:39	71.291	146.970	beluga	swim	3	0	2
1	7/19/2017 15:41	71.210	146.933	beluga	swim	1	0	2
1	7/19/2017 15:41	71.200	146.948	beluga	swim	2	1	2
1	7/19/2017 15:41	71.195	146.930	beluga	swim	2	0	2
1	7/19/2017 15:42	71.162	146.924	beluga	swim	23	3	2
1	7/19/2017 15:43	71.154	146.972	beluga	swim	3	1	2
1	7/19/2017 15:45	71.066	146.919	beluga	swim	10	0	2
1	7/19/2017 15:45	71.059	146.976	beluga	swim	6	0	2
1	7/19/2017 15:45	71.054	146.888	beluga	swim	4	0	2
1	7/19/2017 15:45	71.053	146.903	beluga	swim	7	0	2
1	7/19/2017 15:45	71.051	146.933	beluga	swim	4	0	2
1	7/19/2017 15:46	71.040	146.972	beluga	swim	2	0	2
1	7/19/2017 15:46	71.037	146.954	beluga	swim	12	0	2
1	7/19/2017 15:47	70.993	146.989	beluga	swim	2	1	2
1	7/19/2017 15:47	70.984	146.984	beluga	swim	1	0	2
1	7/19/2017 15:51	70.846	146.965	bowhead whale	feed	3	0	2
1	7/19/2017 15:55	70.837	146.950	bowhead whale	swim	2	1	2

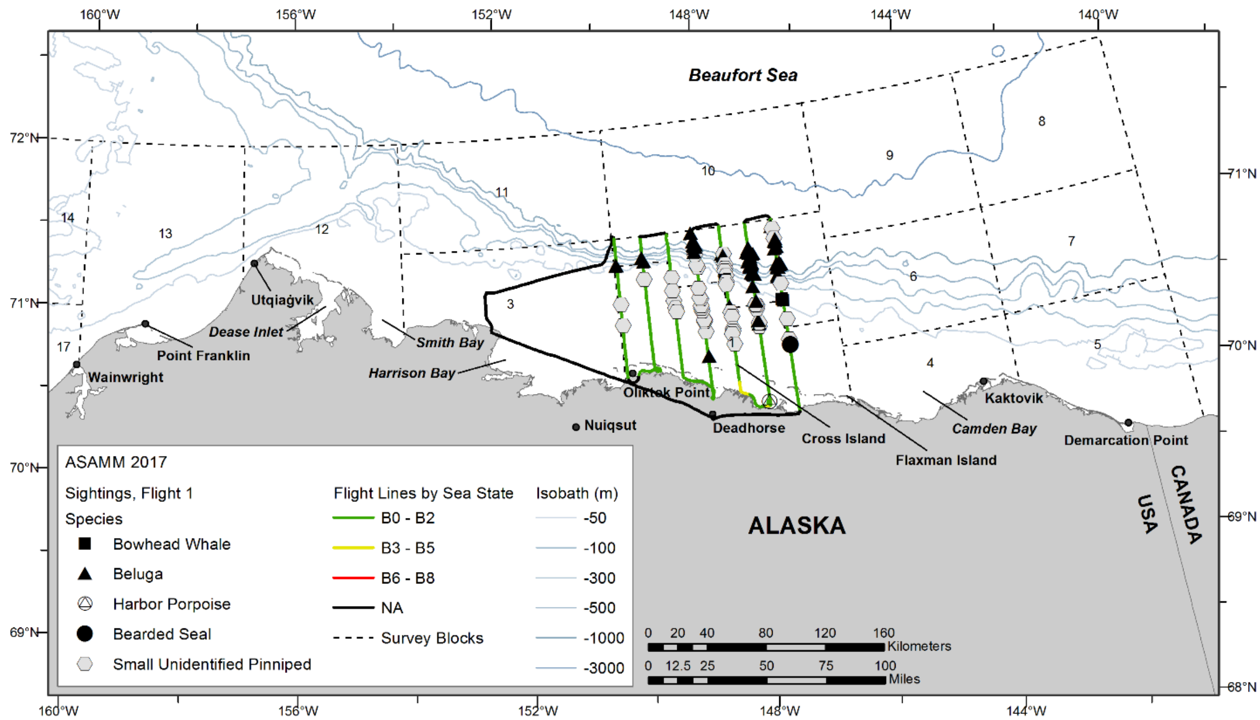


Figure B-10. Flight 1 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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21 July 2017, Flight 210

Flight was a complete survey of transects 1 and 3 and a partial survey of transects 5 and 7. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with glare and low ceilings), and Beaufort 3-6 sea states. Sea ice cover was 0-6% broken floe in the area surveyed. Sightings included gray whales (including 11 calves), one unidentified cetacean, walruses, bearded seals, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
210	7/21/2017 15:09	71.255	157.235	unid cetacean	swim	1	0	13
210	7/21/2017 15:11	71.271	157.251	gray whale	feed	2	0	13
210	7/21/2017 15:12	71.284	157.225	gray whale	feed	1	0	13
210	7/21/2017 15:12	71.288	157.193	gray whale	feed	1	0	13
210	7/21/2017 15:13	71.276	157.199	gray whale	feed	1	0	13
210	7/21/2017 15:15	71.263	157.355	gray whale	swim	1	0	13
210	7/21/2017 15:15	71.263	157.362	gray whale	rest	2	0	13
210	7/21/2017 15:19	71.257	157.402	gray whale	feed	2	0	13
210	7/21/2017 15:19	71.249	157.431	gray whale	feed	1	0	13
210	7/21/2017 15:20	71.251	157.472	gray whale	swim	1	0	13
210	7/21/2017 15:22	71.231	157.482	gray whale	swim	2	0	13
210	7/21/2017 15:22	71.241	157.522	gray whale	feed	1	0	13
210	7/21/2017 15:29	71.395	157.736	gray whale	swim	1	0	13
210	7/21/2017 15:32	71.460	157.854	gray whale	feed	15	7	13
210	7/21/2017 15:36	71.460	157.792	gray whale	swim	2	1	13
210	7/21/2017 15:51	71.454	157.949	gray whale	swim	2	0	13
210	7/21/2017 15:51	71.444	157.971	gray whale	rest	2	1	13
210	7/21/2017 15:54	71.443	158.007	gray whale	rest	7	2	13
210	7/21/2017 15:54	71.442	158.007	gray whale	rest	2	0	13
210	7/21/2017 16:21	71.986	159.357	gray whale	feed	3	0	13

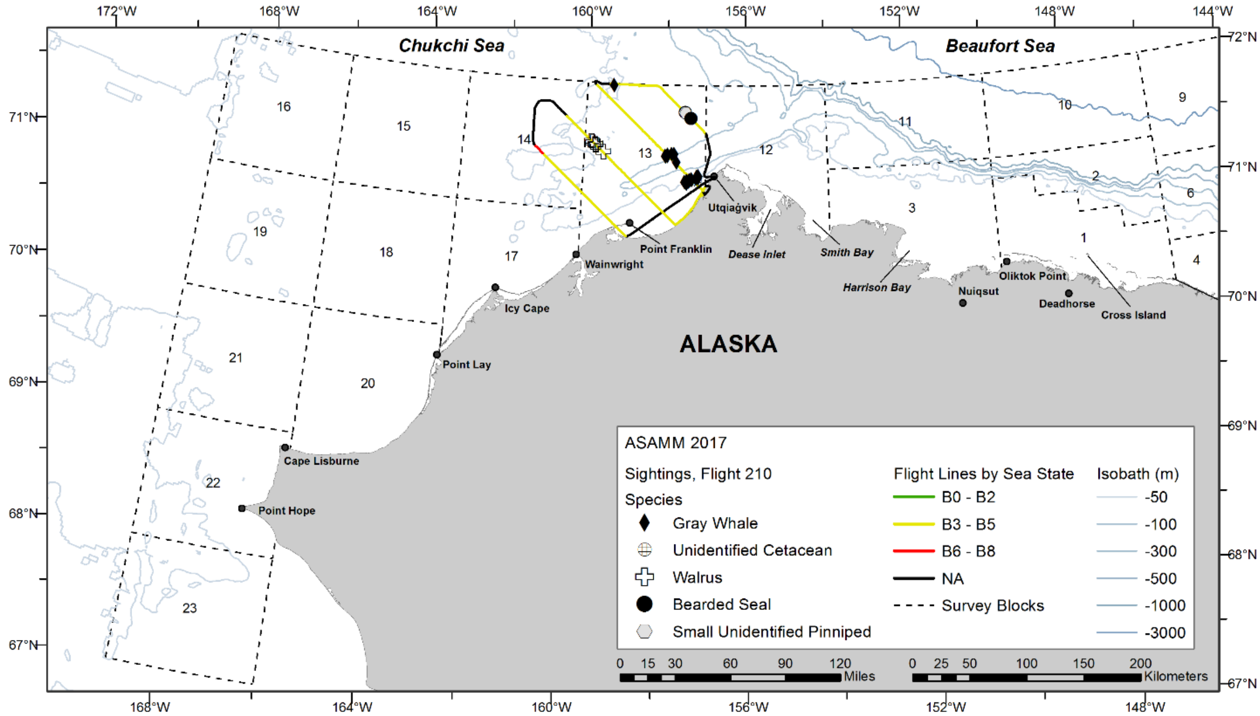

Figure B-11. Flight 210 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

21 July 2017, Flight 2

Flight was a survey of portions of block 12. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare and low ceilings), and Beaufort 0-5 sea states. Sea ice cover was 0-40% broken floe in the area surveyed. Sightings included bowhead whales, belugas (including 5 calves), and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
2	7/21/2017 16:19	71.425	155.958	bowhead whale	mill	6	0	12
2	7/21/2017 16:20	71.423	155.935	bowhead whale	feed	14	0	12
2	7/21/2017 16:36	71.318	155.984	beluga	swim	7	0	12
2	7/21/2017 16:36	71.318	155.996	beluga	swim	81	5	12
2	7/21/2017 16:36	71.320	156.005	beluga	swim	35	0	12

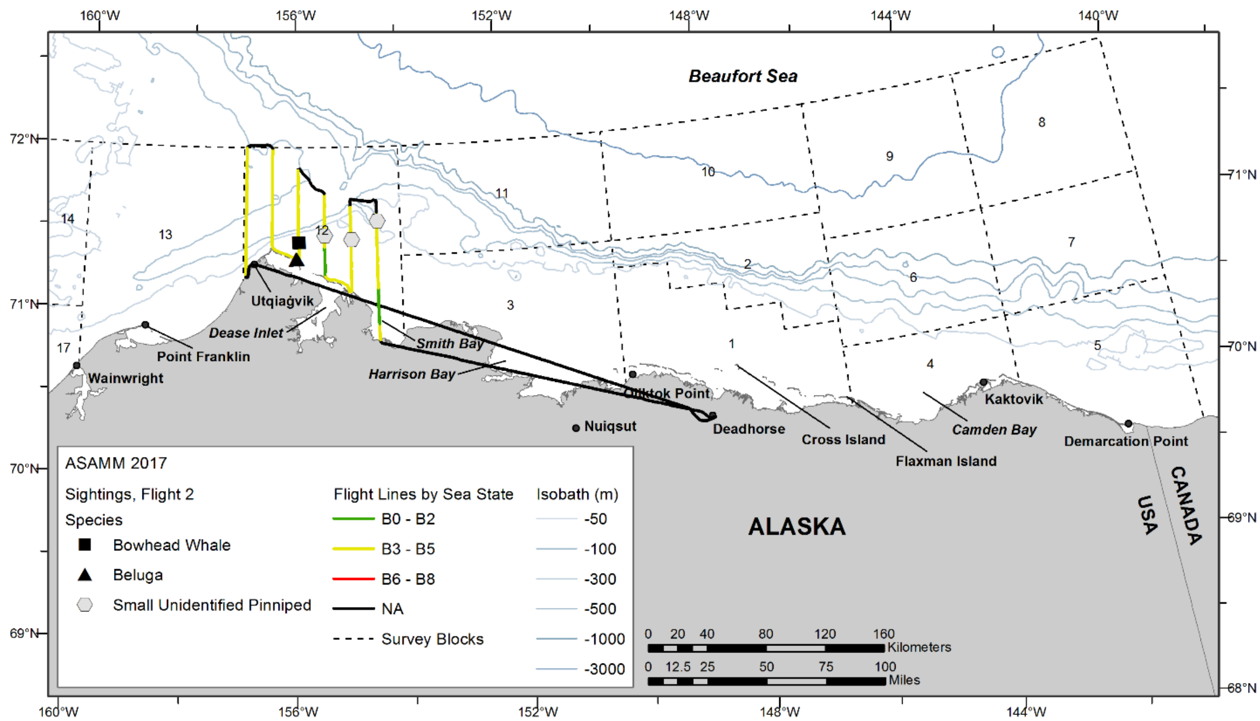

Figure B-12. Flight 2 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Three bowhead whales in a feeding group sighted approximately 20 km northeast of Point Barrow, Alaska, during ASAMM flight 2, 21 July 2017.

Bowhead whale feeding group sighted approximately 20 km northeast of Point Barrow, Alaska, during ASAMM flight 2, 21 July 2017.

Two bowhead whales in a feeding group sighted approximately 20 km northeast of Point Barrow, Alaska, during ASAMM flight 2, 21 July 2017. The whale on the right is on its side with its mouth open, showing its baleen; only the rostrum of the whale on the left is showing above water.

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22 July 2017, Flight 211

Flight was a complete survey of transects 21, 28, 29, 30, and 31. Survey conditions included partly cloudy to overcast skies, 3 km to unlimited visibility (with glare and low ceilings), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, humpback whales, fin whales (including 1 calf), one unidentified pinniped, and one small unidentified pinniped.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
211	7/22/2017 11:01	68.867	168.693	bowhead whale	swim	2	0	22
211	7/22/2017 11:04	68.860	168.698	humpback whale	swim	1	0	22
211	7/22/2017 11:21	68.712	168.075	fin whale	feed	2	1	22
211	7/22/2017 11:23	68.718	168.071	humpback whale	feed	1	0	22

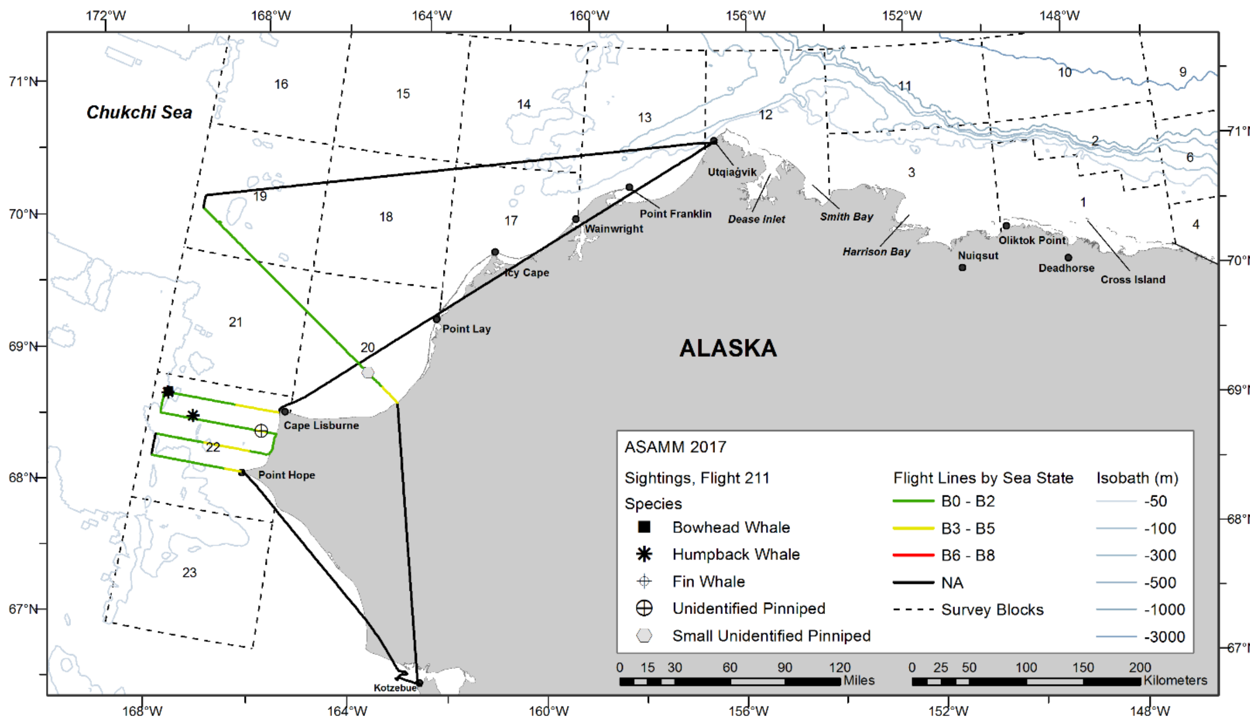

Figure B-13. Flight 211 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Birds fly above a feeding humpback whale sighted approximately 80 km west of Cape Lisburne, Alaska, during ASAMM flight 211, 22 July 2017.

23 July 2017, Flight 3

Flight was a survey of portions of blocks 5 and 7. Survey conditions included overcast skies, 0 km to unlimited visibility (with fog, haze, and low ceilings), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 10 calves), belugas (including 32 calves), and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
3	7/23/2017 12:31	69.898	140.466	bowhead whale	swim	1	1	5
3	7/23/2017 12:37	69.907	140.414	bowhead whale	rest	2	1	5
3	7/23/2017 12:41	69.931	140.449	bowhead whale	swim	1	0	5
3	7/23/2017 12:43	69.945	140.454	bowhead whale	swim	1	1	5
3	7/23/2017 12:57	70.367	140.472	beluga	swim	2	1	5
3	7/23/2017 12:57	70.382	140.473	beluga	swim	1	0	5
3	7/23/2017 12:58	70.394	140.468	beluga	swim	7	2	5
3	7/23/2017 12:58	70.419	140.464	beluga	swim	1	0	5
3	7/23/2017 12:59	70.423	140.468	beluga	swim	1	0	5
3	7/23/2017 12:59	70.427	140.463	beluga	swim	2	1	5
3	7/23/2017 13:00	70.479	140.434	beluga	swim	1	0	5
3	7/23/2017 13:00	70.484	140.418	beluga	swim	1	0	5
3	7/23/2017 13:03	70.594	140.455	beluga	swim	2	1	7
3	7/23/2017 13:03	70.600	140.464	beluga	swim	1	0	7
3	7/23/2017 13:04	70.618	140.446	beluga	swim	2	1	7
3	7/23/2017 13:04	70.627	140.464	beluga	swim	2	1	7
3	7/23/2017 13:04	70.631	140.470	beluga	swim	2	1	7
3	7/23/2017 13:05	70.654	140.473	beluga	swim	1	0	7
3	7/23/2017 13:08	70.757	140.455	beluga	swim	1	0	7
3	7/23/2017 13:09	70.792	140.477	beluga	swim	2	1	7
3	7/23/2017 13:09	70.800	140.476	beluga	swim	1	1	7
3	7/23/2017 13:13	70.942	140.467	beluga	swim	1	0	7
3	7/23/2017 13:29	70.615	140.943	beluga	swim	4	3	7
3	7/23/2017 13:30	70.604	140.945	beluga	mill	2	0	7
3	7/23/2017 13:30	70.591	140.942	beluga	swim	1	0	7
3	7/23/2017 13:30	70.588	140.936	beluga	swim	2	1	7
3	7/23/2017 13:31	70.555	140.938	beluga	swim	1	0	7
3	7/23/2017 13:32	70.537	140.937	beluga	swim	1	0	7
3	7/23/2017 13:32	70.531	140.944	beluga	swim	1	0	7
3	7/23/2017 13:32	70.528	140.931	beluga	swim	3	0	7
3	7/23/2017 13:32	70.521	140.927	beluga	swim	12	3	7
3	7/23/2017 13:33	70.513	140.956	beluga	swim	37	9	7
3	7/23/2017 13:33	70.494	140.960	beluga	swim	1	0	5
3	7/23/2017 13:33	70.488	140.961	beluga	swim	1	0	5

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
3	7/23/2017 13:34	70.483	140.962	beluga	swim	1	0	5
3	7/23/2017 13:34	70.481	140.972	beluga	swim	1	0	5
3	7/23/2017 13:34	70.474	140.962	beluga	swim	1	0	5
3	7/23/2017 13:34	70.455	140.959	beluga	swim	1	1	5
3	7/23/2017 13:36	70.407	140.979	beluga	swim	1	0	5
3	7/23/2017 14:00	69.661	141.029	beluga	swim	17	2	5
3	7/23/2017 14:09	69.862	141.397	bowhead whale	unknown	1	0	5
3	7/23/2017 14:18	69.975	141.456	bowhead whale	rest	2	1	5
3	7/23/2017 14:30	70.207	141.394	bowhead whale	rest	2	1	5
3	7/23/2017 14:31	70.216	141.420	bowhead whale	swim	1	0	5
3	7/23/2017 14:32	70.216	141.402	bowhead whale	rest	1	0	5
3	7/23/2017 14:36	70.210	141.470	bowhead whale	swim	1	0	5
3	7/23/2017 14:38	70.256	141.439	bowhead whale	swim	1	0	5
3	7/23/2017 14:40	70.261	141.456	bowhead whale	swim	1	0	5
3	7/23/2017 14:41	70.269	141.446	bowhead whale	mill	8	2	5
3	7/23/2017 14:47	70.315	141.452	bowhead whale	swim	1	0	5
3	7/23/2017 14:49	70.333	141.448	bowhead whale	swim	2	1	5
3	7/23/2017 14:52	70.349	141.429	bowhead whale	swim	4	2	5
3	7/23/2017 14:56	70.396	141.464	beluga	swim	3	1	5
3	7/23/2017 14:57	70.422	141.462	beluga	swim	1	0	5
3	7/23/2017 14:57	70.429	141.446	beluga	swim	1	0	5
3	7/23/2017 14:58	70.462	141.462	beluga	swim	6	2	5
3	7/23/2017 15:05	70.531	141.979	beluga	swim	1	0	7
3	7/23/2017 15:05	70.531	141.947	beluga	swim	3	0	7
3	7/23/2017 15:15	70.201	141.932	bowhead whale	dive	1	0	5
3	7/23/2017 15:16	70.193	141.939	bowhead whale	swim	1	0	5
3	7/23/2017 15:21	70.061	141.924	bowhead whale	dive	1	0	5

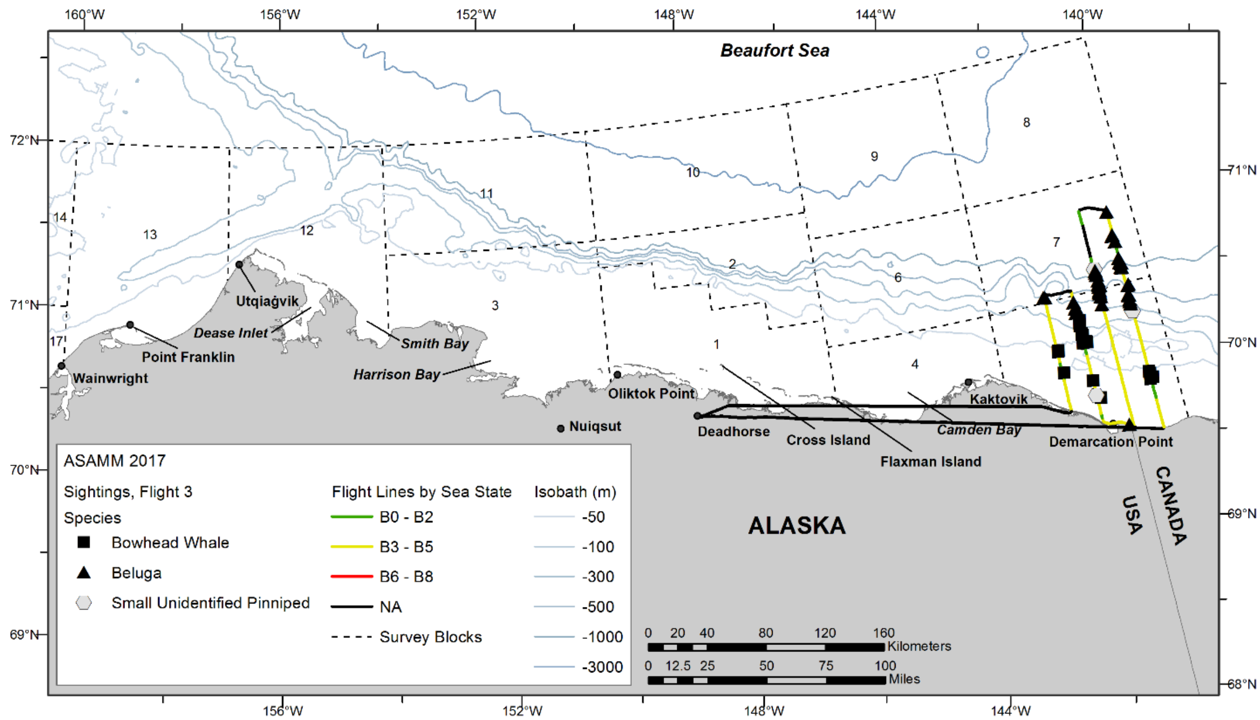

Figure B-14. Flight 3 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale cow-calf pair sighted approximately 120 km east of Kaktovik, Alaska, during ASAMM flight 3, 23 July 2017.

As this bowhead whale cow-calf pair dives simultaneously, entanglement scars on the cow's peduncle are visible. This pair was sighted approximately 120 km east of Kaktovik, Alaska, during ASAMM flight 3, 23 July 2017.

25 July 2017, Flight 4

Flight was a survey of portions of blocks 1, 2, 4 and 6, and the coastal transect from the eastern side of block 1 to approximately 30 km northwest of Nuiqsut. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with glare and low ceilings), and Beaufort 1-4 sea states. Sea ice cover was 0-15% broken floe in the area surveyed. Sightings included one bowhead whale, belugas (including 31 calves), small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
4	7/25/2017 15:39	70.827	144.968	beluga	swim	1	0	6
4	7/25/2017 15:39	70.832	144.951	beluga	log play	1	0	6
4	7/25/2017 15:40	70.850	144.964	beluga	swim	2	1	6
4	7/25/2017 15:45	71.031	144.968	beluga	swim	1	0	6
4	7/25/2017 15:45	71.060	144.976	beluga	swim	1	0	6
4	7/25/2017 15:45	71.062	144.977	beluga	swim	1	0	6
4	7/25/2017 15:46	71.069	144.970	beluga	swim	2	1	6
4	7/25/2017 15:46	71.075	144.951	beluga	swim	6	2	6
4	7/25/2017 15:46	71.081	144.961	beluga	swim	1	0	6
4	7/25/2017 15:46	71.092	144.965	beluga	swim	2	1	6
4	7/25/2017 15:46	71.099	144.962	beluga	swim	1	0	6
4	7/25/2017 15:47	71.103	144.949	beluga	swim	1	0	6
4	7/25/2017 15:47	71.105	144.957	beluga	swim	1	0	6
4	7/25/2017 15:47	71.112	144.954	beluga	swim	12	3	6
4	7/25/2017 15:47	71.115	144.955	beluga	swim	1	0	6
4	7/25/2017 15:47	71.128	145.002	beluga	swim	1	0	6
4	7/25/2017 15:54	71.156	145.470	beluga	swim	1	0	6
4	7/25/2017 15:56	71.116	145.447	beluga	swim	2	1	6
4	7/25/2017 15:56	71.114	145.408	beluga	swim	1	0	6
4	7/25/2017 15:56	71.111	145.382	beluga	swim	1	0	6
4	7/25/2017 15:56	71.104	145.456	beluga	swim	25	7	6
4	7/25/2017 15:56	71.102	145.456	beluga	swim	20	7	6
4	7/25/2017 15:58	71.048	145.408	beluga	swim	1	0	6
4	7/25/2017 15:58	71.045	145.451	beluga	swim	1	0	6
4	7/25/2017 16:00	70.970	145.409	beluga	swim	1	0	6
4	7/25/2017 16:01	70.956	145.467	beluga	swim	1	0	6
4	7/25/2017 16:01	70.951	145.476	beluga	swim	1	0	6
4	7/25/2017 16:01	70.945	145.454	beluga	swim	1	0	6
4	7/25/2017 16:01	70.939	145.445	beluga	swim	2	1	6
4	7/25/2017 16:01	70.933	145.443	beluga	swim	1	0	6
4	7/25/2017 16:03	70.892	145.469	beluga	swim	1	0	6
4	7/25/2017 16:03	70.882	145.453	beluga	swim	1	0	6

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
4	7/25/2017 16:46	70.610	145.965	beluga	swim	1	0	6
4	7/25/2017 16:52	70.800	145.932	beluga	rest	1	0	6
4	7/25/2017 16:55	70.910	145.985	beluga	swim	1	0	6
4	7/25/2017 16:55	70.926	145.945	beluga	mill	15	4	6
4	7/25/2017 16:56	70.936	145.958	beluga	mill	10	2	6
4	7/25/2017 16:59	71.073	146.027	beluga	swim	1	0	2
4	7/25/2017 17:20	70.991	146.453	beluga	swim	1	0	2
4	7/25/2017 17:21	70.972	146.432	beluga	swim	1	0	2
4	7/25/2017 17:21	70.969	146.442	beluga	swim	5	1	2
4	7/25/2017 17:21	70.960	146.443	beluga	swim	1	0	2
4	7/25/2017 17:21	70.956	146.442	beluga	swim	1	0	2
4	7/25/2017 17:28	70.745	146.459	bowhead whale	rest	1	0	2

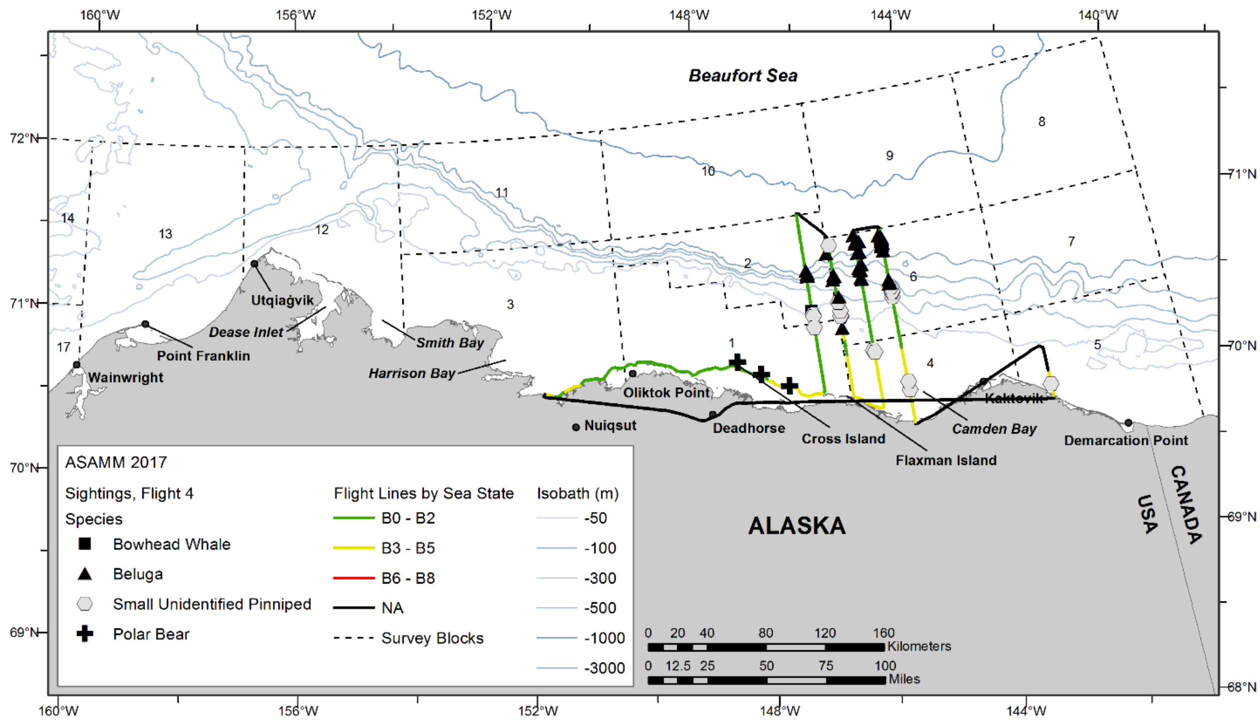

Figure B-15. Flight 4 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

26 July 2017, Flight 212

Flight was the coastal transect from Cape Lisburne to Utqiaġvik. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included one bowhead whale carcass, gray whales (including 1 calf and 2 carcasses), belugas (including 6 calves), one unidentified cetacean, walruses, and small unidentified pinnipeds. Three groups of small unidentified pinnipeds, estimated at approximately 100, 300, and 1000 individuals, were observed hauled out on barrier islands near and east of Icy Cape. The bowhead whale carcass was a resight of a carcass sighted during ASAMM flight 205, 12 July 2017, and originally sighted in 2016.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
212	7/26/2017 18:23	68.863	165.452	gray whale	feed	1	0	20
212	7/26/2017 19:17	69.856	162.977	unid cetacean	swim	1	0	17
212	7/26/2017 20:27	70.837	159.472	gray whale	swim	2	1	13
212	7/26/2017 20:42	70.873	158.550	gray whale	dead	1	0	13
212	7/26/2017 20:46	70.841	158.502	beluga	mill	3	0	13
212	7/26/2017 20:46	70.838	158.487	beluga	mill	5	1	13
212	7/26/2017 20:46	70.837	158.472	beluga	mill	4	0	13
212	7/26/2017 20:47	70.833	158.448	beluga	mill	7	2	13
212	7/26/2017 20:47	70.829	158.424	beluga	mill	2	1	13
212	7/26/2017 20:47	70.826	158.389	beluga	mill	6	2	13
212	7/26/2017 20:50	70.822	158.144	gray whale	dead	1	0	13
212	7/26/2017 20:58	70.925	157.583	bowhead whale	dead	1	0	13
212	7/26/2017 21:03	70.983	157.424	gray whale	swim	1	0	13

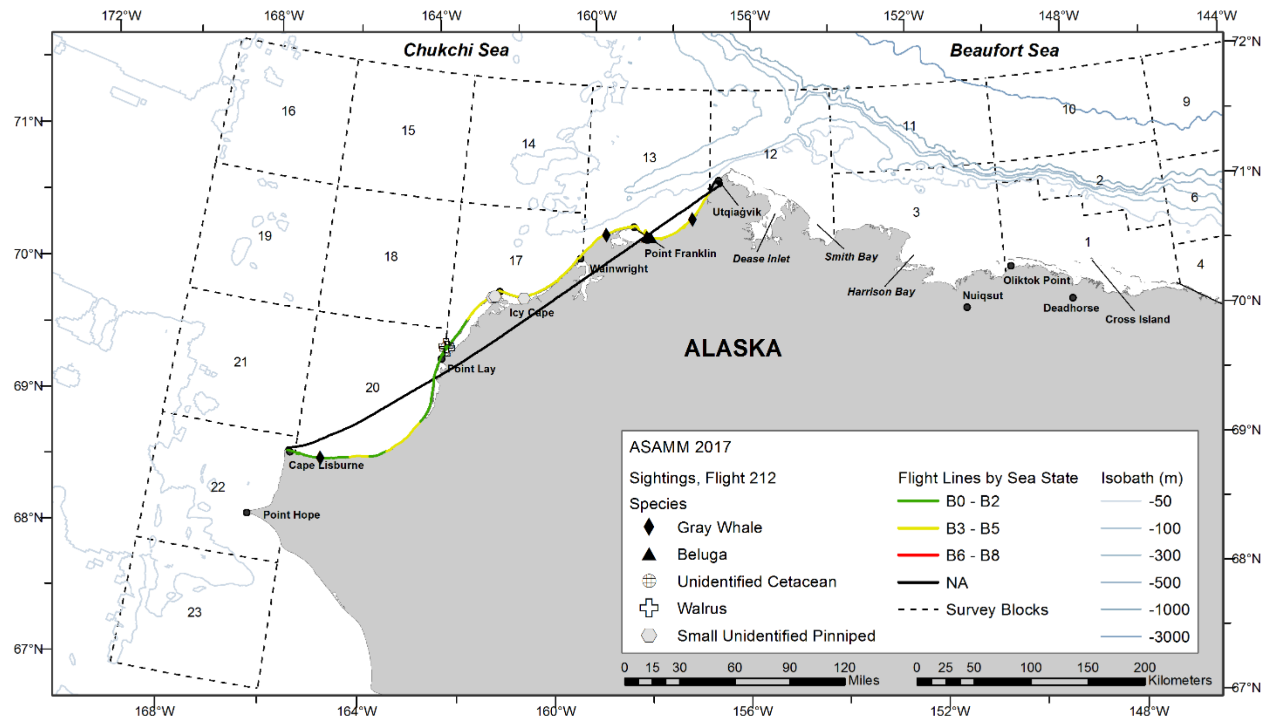

Figure B-16. Flight 212 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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27 July 2017, Flight 213

Flight was a complete survey of transects 13 and 15. Survey conditions included partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including 2 calves and 1 carcass), 3 unidentified cetacean carcasses, walruses, one bearded seal, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
213	7/27/2017 13:33	71.264	165.693	gray whale	dead	1	0	15
213	7/27/2017 14:35	71.346	167.587	unid cetacean	dead	1	0	16
213	7/27/2017 14:57	70.996	166.185	gray whale	swim	2	1	19
213	7/27/2017 15:04	70.877	165.752	unid cetacean	dead	1	0	18
213	7/27/2017 15:20	70.619	164.549	unid cetacean	dead	1	0	18
213	7/27/2017 15:45	70.135	162.904	gray whale	swim	2	1	17

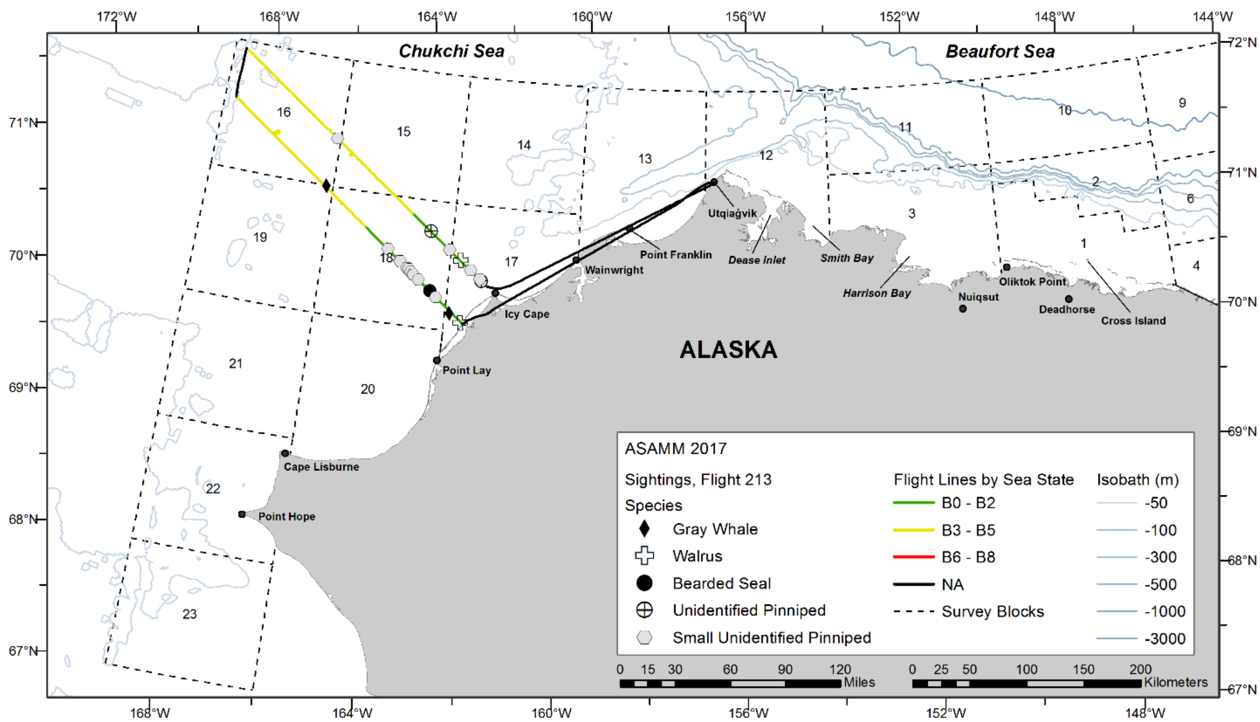

Figure B-17. Flight 213 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

28 July 2017, Flight 214

Flight was a complete survey of transects 9, 11, 17, and 19 and search effort from Point Franklin to Utqiaġvik. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-3 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including 2 calves), belugas (including 31 calves), walruses, bearded seals, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
214	7/28/2017 10:12	69.92916	163.6721	gray whale	swim	1	0	20
214	7/28/2017 14:34	70.83786	158.7929	gray whale	feed	1	0	13
214	7/28/2017 15:05	71.00733	161.1174	gray whale	feed	3	1	14
214	7/28/2017 15:06	71.00677	161.1337	gray whale	feed	2	1	14
214	7/28/2017 17:53	71.07048	157.7828	beluga	swim	3	0	13
214	7/28/2017 17:53	71.07668	157.7687	beluga	swim	1	0	13
214	7/28/2017 17:54	71.09026	157.7259	beluga	swim	3	1	13
214	7/28/2017 17:54	71.08277	157.7077	beluga	mill	250	30	13
214	7/28/2017 17:54	71.0873	157.7174	beluga	swim	5	0	13

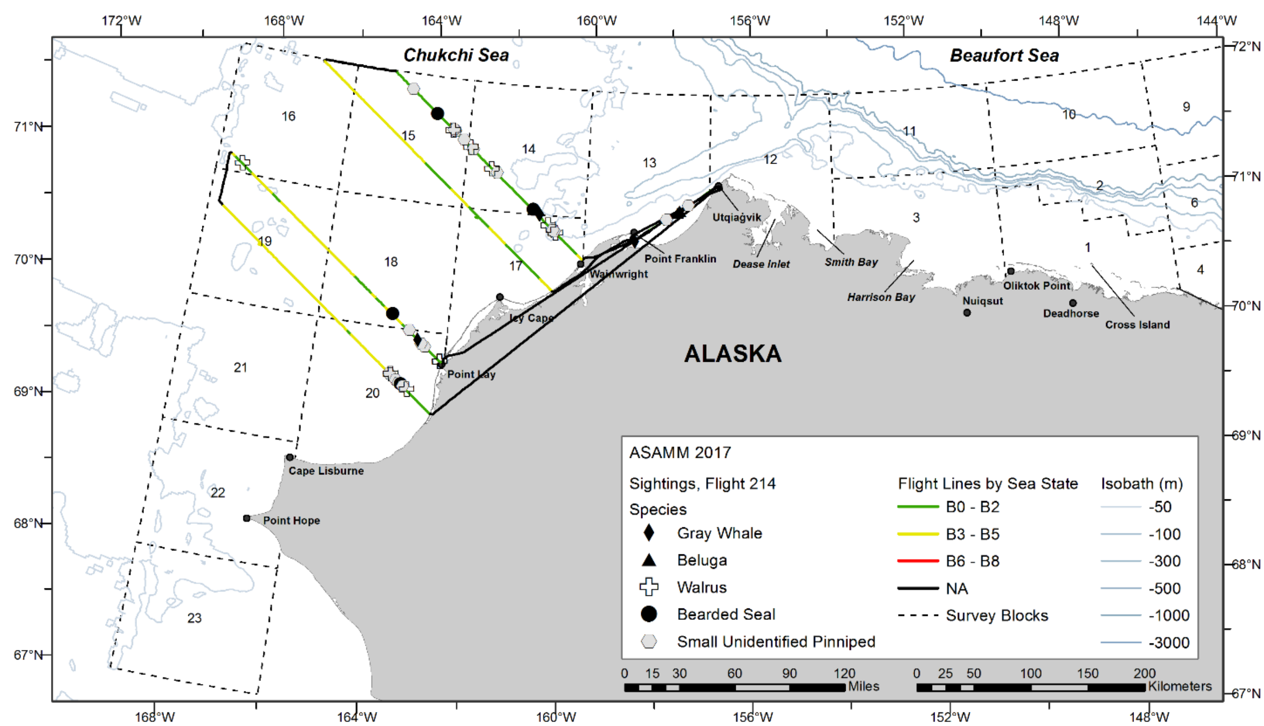

Figure B-18. Flight 214 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale observed feeding within Peard Bay (south of Point Franklin), Alaska, during ASAMM Flight 214, 28 July 2017.

A zoomed out view of a pod of 250 belugas sighted approximately 40 km southwest of Utqiaġvik, Alaska, during ASAMM Flight 214, 28 July 2017.

Small group within a much larger pod of 250 belugas sighted approximately 40 km southwest of Utqiaġvik, Alaska, during ASAMM Flight 214, 28 July 2017.

28 July 2017, Flight 5

Flight was a survey of portions of blocks 3 and 11 and coastal shoreline search in block 1. Survey conditions included partly cloudy skies, 2 km to unlimited visibility (with fog, glare, haze, and low ceilings), and Beaufort 1-6 sea states. Sea ice cover was 0-20% broken floe in the area surveyed. Sightings included one small unidentified pinniped.

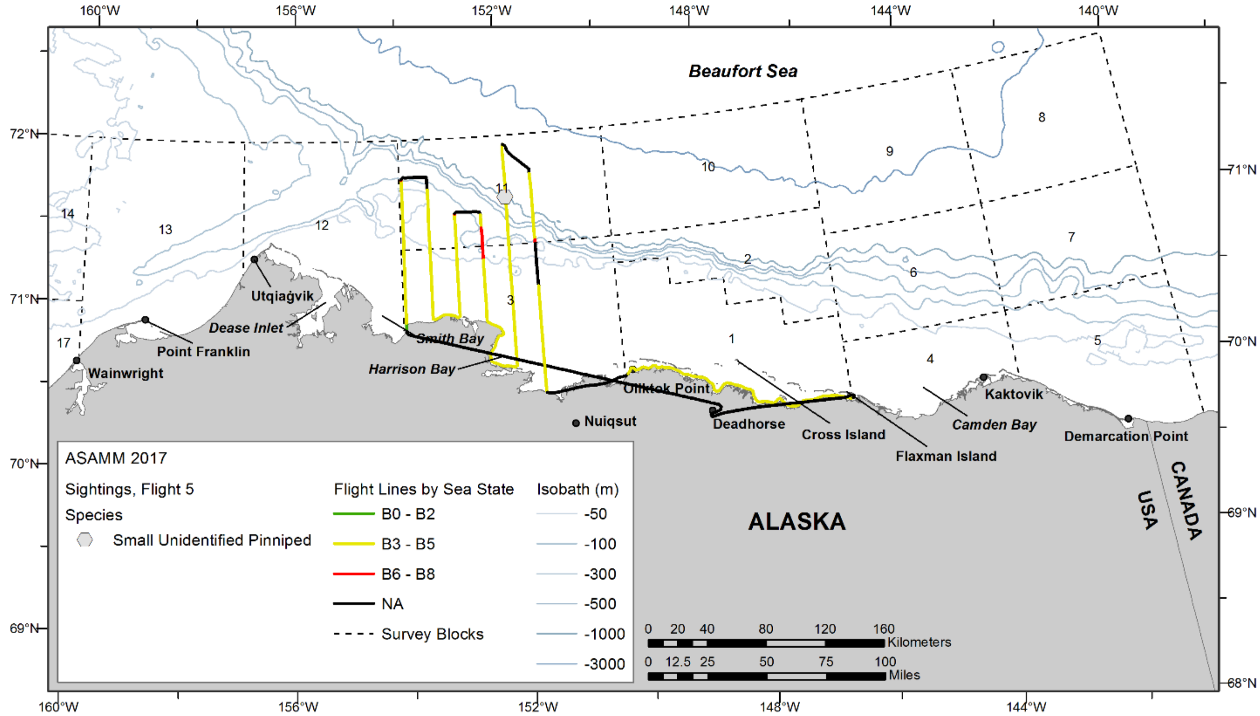

Figure B-19. Flight 5 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

29 July 2017, Flight 6

Flight was a survey of portions of blocks 1, 2, 4, 5, 6, and 7. Survey conditions included clear to partly cloudy skies, 5 km to unlimited visibility (with glare and haze), and Beaufort 1-5 sea states. Sea ice cover was 0-15% broken floe in the area surveyed. Sightings included bowhead whales (including 6 calves), belugas (including 31 calves), small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
6	7/29/2017 10:25	70.205	142.470	bowhead whale	swim	1	0	5
6	7/29/2017 10:25	70.206	142.467	bowhead whale	swim	1	0	5
6	7/29/2017 10:40	70.541	141.981	beluga	swim	2	0	7
6	7/29/2017 10:41	70.531	141.827	beluga	swim	1	0	7
6	7/29/2017 10:46	70.548	141.460	beluga	swim	2	1	7
6	7/29/2017 10:46	70.551	141.452	beluga	swim	2	1	7
6	7/29/2017 10:46	70.555	141.463	beluga	swim	2	1	7
6	7/29/2017 10:52	70.738	141.474	beluga	swim	2	1	7
6	7/29/2017 10:53	70.784	141.471	beluga	swim	6	0	7
6	7/29/2017 10:58	70.953	141.440	beluga	swim	2	0	7
6	7/29/2017 10:58	70.959	141.451	beluga	swim	5	0	7
6	7/29/2017 10:58	70.965	141.458	beluga	swim	12	1	7
6	7/29/2017 10:58	70.965	141.452	beluga	swim	1	0	7
6	7/29/2017 10:58	70.966	141.452	beluga	swim	1	0	7
6	7/29/2017 11:03	71.126	141.463	beluga	swim	2	1	7
6	7/29/2017 11:03	71.129	141.459	beluga	swim	1	0	7
6	7/29/2017 11:03	71.129	141.463	beluga	swim	2	0	7
6	7/29/2017 11:03	71.158	141.451	beluga	swim	2	1	7
6	7/29/2017 11:17	70.888	141.928	beluga	swim	9	1	7
6	7/29/2017 11:19	70.809	141.929	beluga	swim	1	0	7
6	7/29/2017 11:23	70.666	141.908	beluga	swim	1	0	7
6	7/29/2017 11:24	70.646	141.962	beluga	swim	2	1	7
6	7/29/2017 11:24	70.640	141.984	beluga	swim	1	0	7
6	7/29/2017 11:27	70.537	141.941	beluga	swim	1	0	7
6	7/29/2017 12:17	70.430	142.956	bowhead whale	rest	2	1	5
6	7/29/2017 12:25	70.412	142.918	bowhead whale	swim	1	0	5
6	7/29/2017 12:29	70.322	142.996	bowhead whale	swim	2	1	5
6	7/29/2017 12:30	70.318	143.026	bowhead whale	rest	1	0	4
6	7/29/2017 12:37	70.252	142.972	bowhead whale	swim	1	0	5
6	7/29/2017 12:43	70.093	142.983	beluga	swim	2	1	5
6	7/29/2017 12:51	70.238	143.466	bowhead whale	swim	2	1	4
6	7/29/2017 12:54	70.283	143.491	bowhead whale	swim	3	0	4
6	7/29/2017 12:55	70.284	143.545	bowhead whale	rest	2	1	4

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
6	7/29/2017 12:55	70.285	143.549	bowhead whale	rest	2	0	4
6	7/29/2017 12:56	70.299	143.529	bowhead whale	rest	3	1	4
6	7/29/2017 12:57	70.287	143.555	bowhead whale	rest	1	0	4
6	7/29/2017 13:00	70.318	143.465	beluga	swim	1	0	4
6	7/29/2017 13:00	70.327	143.453	bowhead whale	rest	1	0	4
6	7/29/2017 13:07	70.464	143.456	bowhead whale	rest	2	1	4
6	7/29/2017 13:08	70.448	143.379	bowhead whale	rest	1	0	4
6	7/29/2017 13:15	70.654	143.441	beluga	swim	2	1	6
6	7/29/2017 13:18	70.749	143.464	beluga	swim	1	0	6
6	7/29/2017 13:18	70.752	143.479	beluga	swim	2	1	6
6	7/29/2017 13:18	70.754	143.492	beluga	swim	1	0	6
6	7/29/2017 13:18	70.758	143.454	beluga	swim	2	1	6
6	7/29/2017 13:18	70.763	143.505	beluga	swim	1	0	6
6	7/29/2017 13:18	70.765	143.492	beluga	swim	1	0	6
6	7/29/2017 13:19	70.799	143.422	beluga	swim	1	0	6
6	7/29/2017 13:21	70.850	143.484	beluga	swim	1	0	6
6	7/29/2017 13:26	71.042	143.475	beluga	swim	3	2	6
6	7/29/2017 13:27	71.052	143.493	beluga	swim	3	0	6
6	7/29/2017 13:29	71.143	143.456	beluga	swim	2	0	6
6	7/29/2017 13:39	71.022	143.902	beluga	swim	4	0	6
6	7/29/2017 13:39	71.016	143.912	beluga	swim	1	0	6
6	7/29/2017 13:39	71.010	143.927	beluga	swim	9	1	6
6	7/29/2017 13:40	71.006	143.956	beluga	swim	27	6	6
6	7/29/2017 13:40	71.001	143.956	beluga	swim	7	1	6
6	7/29/2017 13:48	70.722	143.919	beluga	swim	1	0	6
6	7/29/2017 13:57	70.426	143.976	beluga	swim	1	0	4
6	7/29/2017 14:06	70.111	143.966	beluga	swim	1	0	4
6	7/29/2017 16:04	70.208	144.462	bowhead whale	swim	1	0	4
6	7/29/2017 16:19	70.733	144.430	beluga	swim	2	1	6
6	7/29/2017 16:21	70.803	144.476	beluga	swim	2	1	6
6	7/29/2017 16:25	70.945	144.459	beluga	swim	2	1	6
6	7/29/2017 16:25	70.946	144.428	beluga	swim	1	0	6
6	7/29/2017 16:25	70.949	144.491	beluga	swim	1	0	6
6	7/29/2017 16:28	71.022	144.505	beluga	swim	1	0	6
6	7/29/2017 16:28	71.022	144.443	beluga	swim	1	0	6
6	7/29/2017 16:28	71.026	144.442	beluga	swim	1	0	6
6	7/29/2017 16:28	71.034	144.531	beluga	swim	1	0	6
6	7/29/2017 16:28	71.040	144.478	beluga	swim	3	0	6
6	7/29/2017 16:28	71.045	144.475	beluga	swim	2	1	6
6	7/29/2017 16:28	71.048	144.450	beluga	swim	2	1	6
6	7/29/2017 16:29	71.053	144.451	beluga	swim	2	2	6

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
6	7/29/2017 16:29	71.057	144.459	beluga	swim	1	1	6
6	7/29/2017 16:29	71.064	144.407	beluga	swim	1	0	6
6	7/29/2017 17:52	70.873	147.468	beluga	swim	1	0	2
6	7/29/2017 17:52	70.875	147.481	beluga	swim	1	0	2
6	7/29/2017 17:52	70.879	147.429	beluga	swim	4	0	2
6	7/29/2017 17:52	70.883	147.491	beluga	swim	7	0	2
6	7/29/2017 17:52	70.886	147.464	beluga	swim	4	0	2

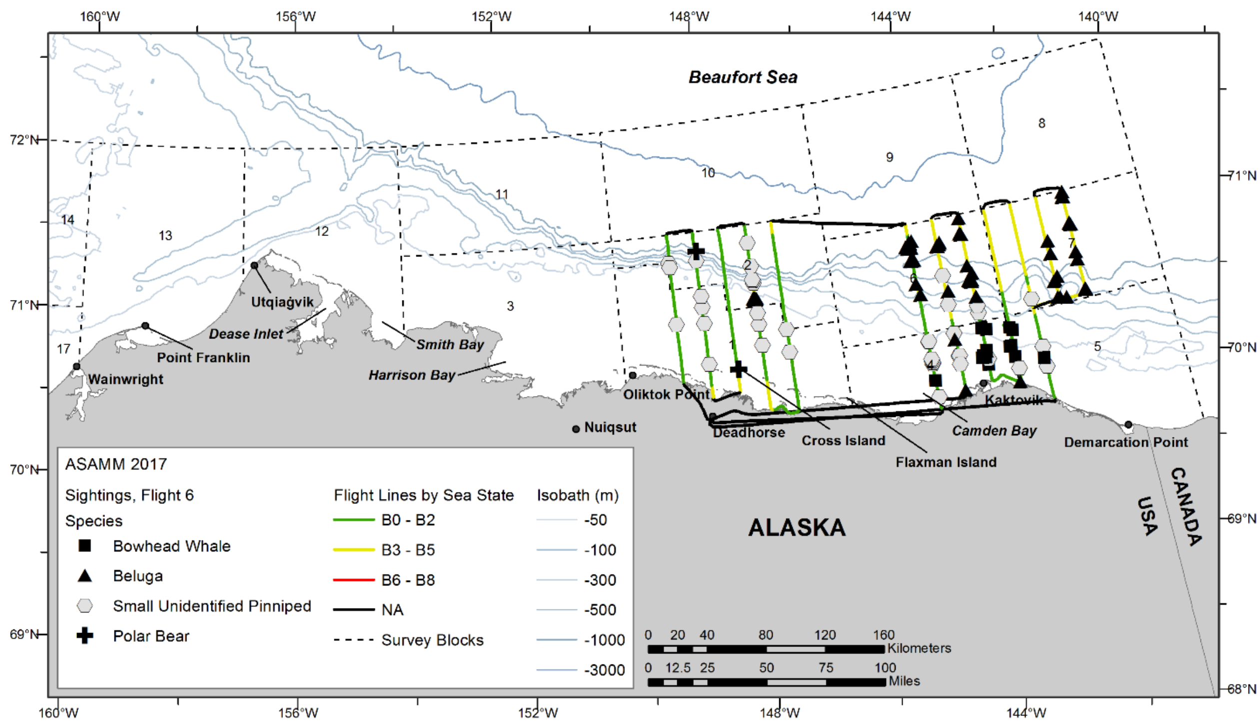

Figure B-20. Flight 6 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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30 July 2017, Flight 215

Flight was a complete survey of transects 2, 4, 6, and 8. Survey conditions included partly cloudy to overcast skies, 3 km to unlimited visibility (with glare and haze), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including 5 calves), walruses, bearded seals, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
215	7/30/2017 15:01	71.085	160.660	gray whale	rest	2	1	14
215	7/30/2017 15:09	71.190	160.999	gray whale	feed	1	0	14
215	7/30/2017 15:09	71.194	161.002	gray whale	feed	1	0	14
215	7/30/2017 15:10	71.203	161.018	gray whale	feed	1	0	14
215	7/30/2017 15:10	71.200	161.002	gray whale	feed	5	0	14
215	7/30/2017 15:14	71.217	161.048	gray whale	feed	1	0	14
215	7/30/2017 15:15	71.215	161.056	gray whale	feed	2	1	14
215	7/30/2017 15:16	71.214	161.038	gray whale	feed	3	0	14
215	7/30/2017 15:19	71.240	161.143	gray whale	feed	1	0	14
215	7/30/2017 15:20	71.244	161.124	gray whale	feed	1	0	14
215	7/30/2017 15:22	71.264	161.276	gray whale	feed	1	0	14
215	7/30/2017 15:22	71.275	161.276	gray whale	feed	6	0	14
215	7/30/2017 15:22	71.283	161.277	gray whale	feed	5	1	14
215	7/30/2017 16:20	71.993	162.554	gray whale	rest	3	0	14
215	7/30/2017 18:28	71.987	159.367	gray whale	feed	12	2	13
215	7/30/2017 18:32	71.976	159.351	gray whale	feed	3	0	13

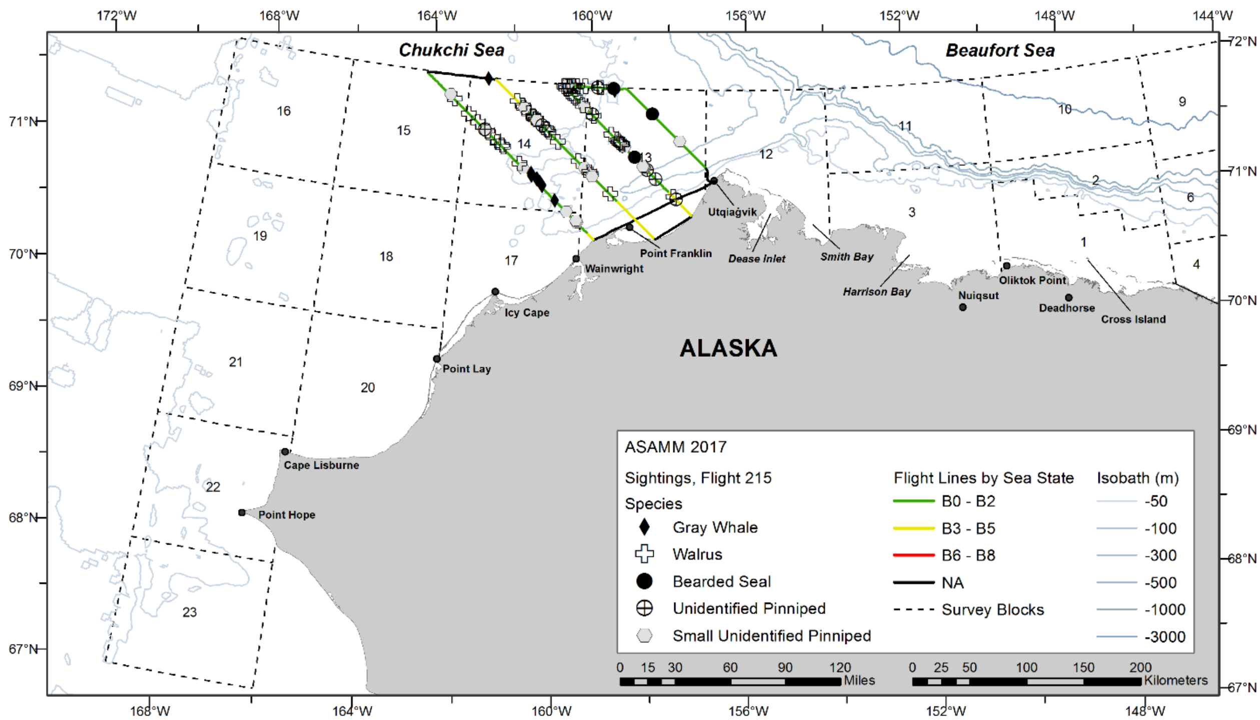

Figure B-21. Flight 215 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

31 July 2017, Flight 216

Flight was a complete survey of block 12. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with fog, glare, and precipitation), and Beaufort 2-4 sea states. Sea ice cover was 0-1% broken floe in the area surveyed. Sightings included bowhead whales, belugas (including 11 calves), unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
216	7/31/2017 17:44	71.189	155.021	bowhead whale	mill	4	0	12
216	7/31/2017 18:06	71.678	155.458	beluga	mill	3	0	12
216	7/31/2017 18:06	71.681	155.459	beluga	mill	2	1	12
216	7/31/2017 18:06	71.682	155.428	beluga	mill	6	3	12
216	7/31/2017 18:07	71.686	155.459	beluga	mill	3	2	12
216	7/31/2017 18:07	71.688	155.447	beluga	mill	7	2	12
216	7/31/2017 18:07	71.693	155.475	beluga	mill	6	1	12
216	7/31/2017 18:08	71.718	155.453	beluga	mill	7	2	12

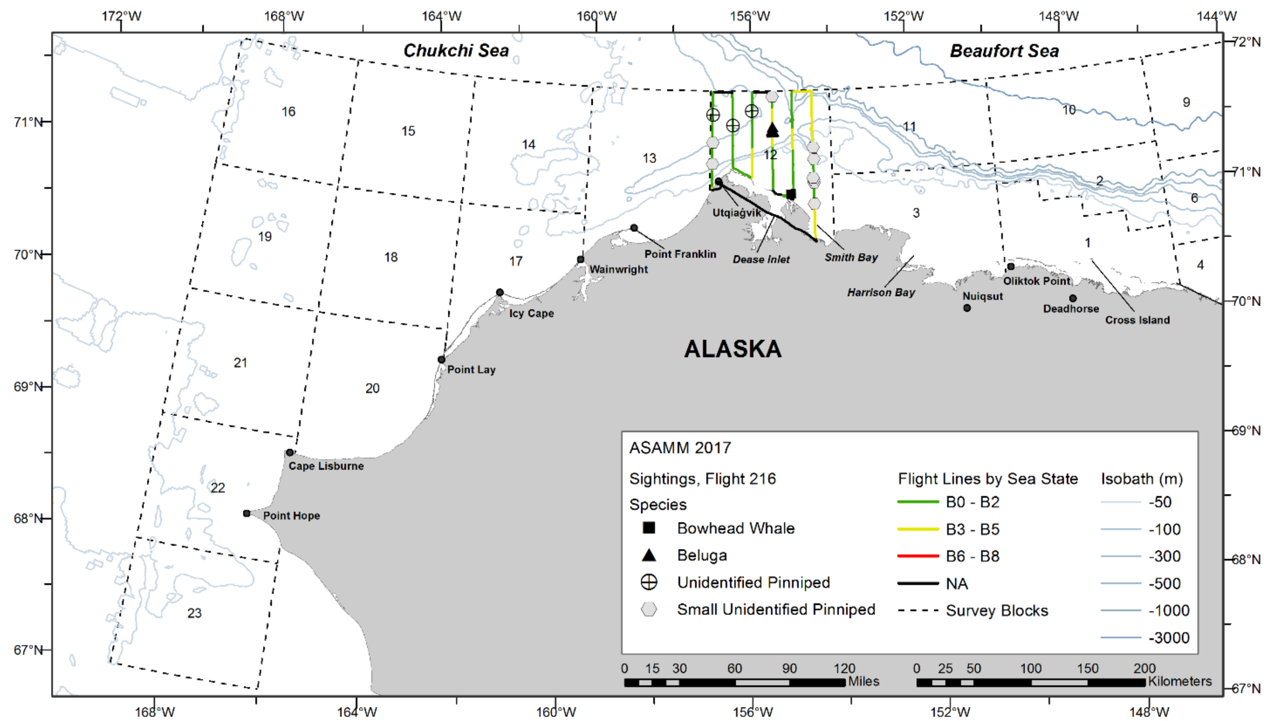

Figure B-22. Flight 216 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

31 July 2017, Flight 7

Flight was a survey of portions of blocks 1, 2, 3, and 11. Survey conditions included partly cloudy skies, 1 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 1-5 sea states. Sea ice cover was 0-20% broken floe in the area surveyed. Sightings included one bowhead whale, belugas (including 4 calves), and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
7	7/31/2017 14:49	71.374	150.919	beluga	swim	6	1	11
7	7/31/2017 14:49	71.386	150.943	beluga	swim	2	1	11
7	7/31/2017 14:49	71.388	150.947	beluga	swim	5	2	11
7	7/31/2017 14:49	71.393	150.967	beluga	swim	1	0	11
7	7/31/2017 14:55	71.599	150.955	beluga	swim	1	0	11
7	7/31/2017 15:25	71.521	150.488	beluga	swim	2	0	11
7	7/31/2017 15:38	71.093	150.476	bowhead whale	swim	1	0	3
7	7/31/2017 16:38	71.163	149.445	beluga	rest	1	0	1

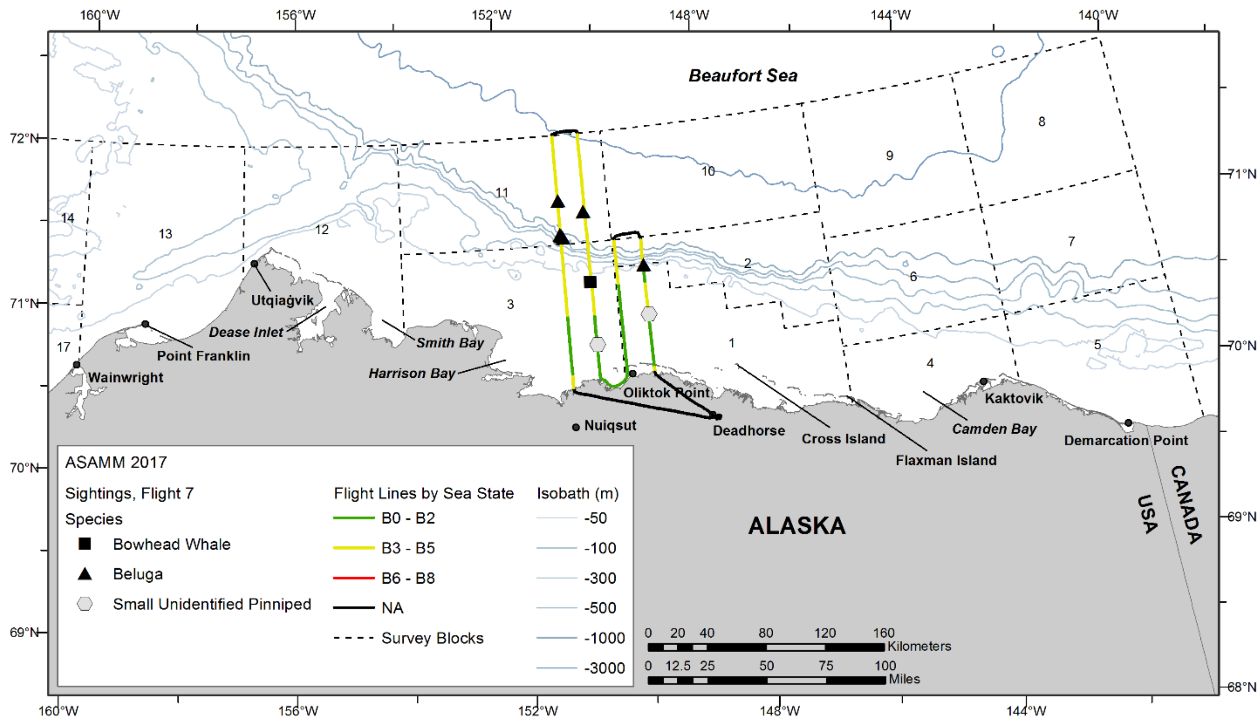

Figure B-23. Flight 7 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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2 August 2017, Flight 8

Flight was a survey of portions of blocks 5 and 7. Survey conditions included partly cloudy skies, unlimited visibility (with glare), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 1 calf), belugas (including 9 calves), small unidentified pinnipeds, and one unidentified marine mammal.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
217	8/4/2017 18:21	70.920	158.474	gray whale	feed	1	0	13

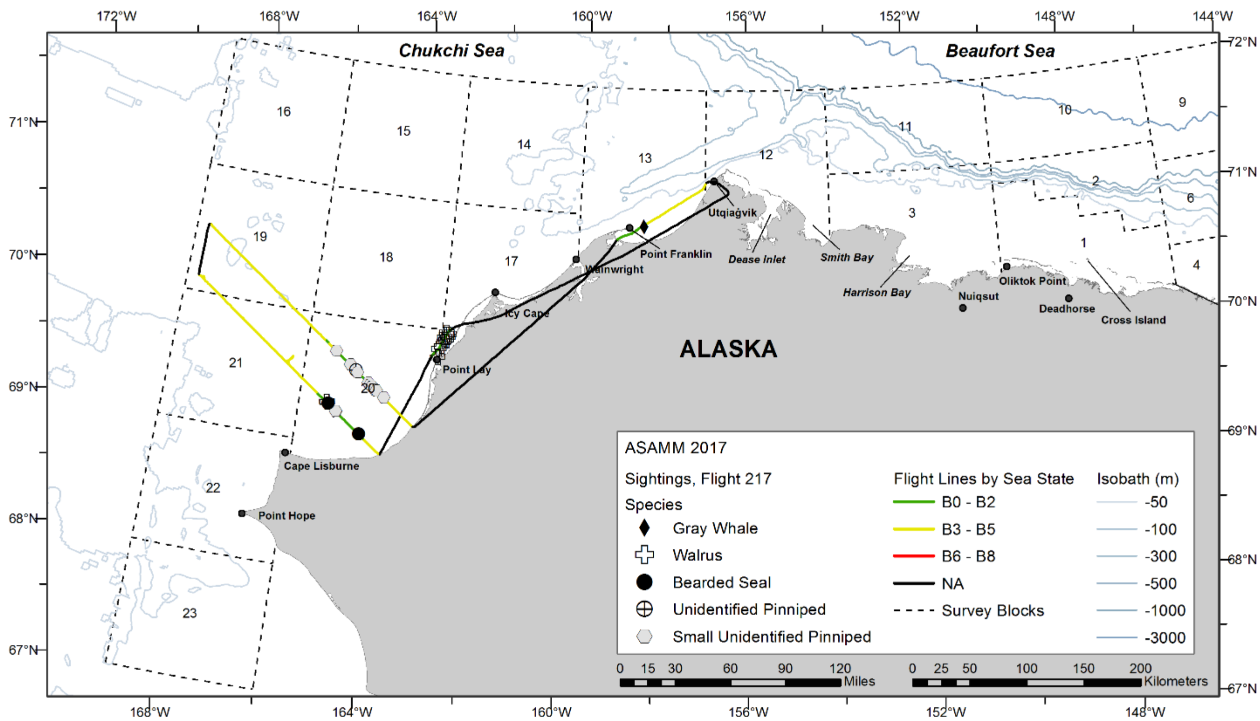

Figure B-25. Flight 217 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

5 August 2017, Flight 9

Flight was a survey of portions of blocks 4, 5, 6, and 7, and the coastal transect from east of Kaktovik to northeast of Deadhorse. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare and precipitation), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 5 calves), belugas (including 20 calves), small unidentified pinnipeds, polar bears, and one unidentified marine mammal.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
9	8/5/2017 11:17	70.259	141.935	beluga	swim	1	0	5
9	8/5/2017 11:21	70.151	141.982	bowhead whale	swim	4	2	5
9	8/5/2017 11:29	70.130	141.943	bowhead whale	swim	1	0	5
9	8/5/2017 11:29	70.123	141.937	bowhead whale	swim	1	0	5
9	8/5/2017 11:29	70.118	141.947	bowhead whale	swim	1	0	5
9	8/5/2017 11:34	70.035	141.937	bowhead whale	swim	1	0	5
9	8/5/2017 11:35	70.016	141.969	bowhead whale	swim	1	0	5
9	8/5/2017 11:36	70.011	141.963	bowhead whale	rest	1	0	5
9	8/5/2017 11:36	70.003	141.967	bowhead whale	swim	1	0	5
9	8/5/2017 11:37	70.003	141.953	bowhead whale	rest	1	0	5
9	8/5/2017 11:38	69.996	141.988	bowhead whale	swim	1	0	5
9	8/5/2017 11:38	69.991	141.912	bowhead whale	swim	2	0	5
9	8/5/2017 11:45	69.898	142.106	beluga	swim	20	0	5
9	8/5/2017 11:56	70.110	142.433	bowhead whale	swim	1	0	5
9	8/5/2017 12:02	70.273	142.435	bowhead whale	rest	1	1	5
9	8/5/2017 12:02	70.275	142.424	bowhead whale	swim	1	0	5
9	8/5/2017 12:06	70.264	142.424	bowhead whale	rest	1	0	5
9	8/5/2017 12:08	70.321	142.431	bowhead whale	swim	2	1	5
9	8/5/2017 12:25	70.792	142.456	beluga	swim	3	0	7
9	8/5/2017 12:26	70.813	142.422	beluga	swim	1	0	7
9	8/5/2017 12:28	70.905	142.409	beluga	swim	1	0	7
9	8/5/2017 12:32	71.056	142.496	beluga	swim	1	0	7
9	8/5/2017 12:33	71.082	142.457	beluga	swim	1	0	7
9	8/5/2017 12:33	71.088	142.466	beluga	swim	1	0	7
9	8/5/2017 12:33	71.090	142.474	beluga	swim	1	0	7
9	8/5/2017 12:43	71.068	142.942	beluga	swim	2	1	7
9	8/5/2017 12:43	71.062	142.946	beluga	swim	2	1	7
9	8/5/2017 12:47	70.954	142.991	beluga	swim	1	0	7
9	8/5/2017 12:52	70.780	142.983	beluga	swim	2	0	7
9	8/5/2017 12:52	70.775	143.100	beluga	swim	1	0	6
9	8/5/2017 12:53	70.751	142.936	beluga	swim	2	1	7
9	8/5/2017 12:53	70.746	142.990	beluga	swim	2	0	7

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
9	8/5/2017 12:54	70.708	142.956	beluga	swim	17	9	7
9	8/5/2017 13:05	70.318	142.919	bowhead whale	rest	1	0	5
9	8/5/2017 13:07	70.337	142.914	bowhead whale	rest	1	1	5
9	8/5/2017 13:12	70.216	143.002	bowhead whale	swim	1	0	4
9	8/5/2017 13:14	70.201	142.926	bowhead whale	dive	1	0	5
9	8/5/2017 13:15	70.185	142.966	bowhead whale	swim	1	0	5
9	8/5/2017 13:21	70.141	143.158	bowhead whale	swim	1	0	4
9	8/5/2017 13:32	70.368	143.503	beluga	swim	18	0	4
9	8/5/2017 13:53	71.143	143.410	beluga	swim	1	0	6
9	8/5/2017 13:53	71.150	143.385	beluga	swim	1	0	6
9	8/5/2017 14:08	70.874	143.982	beluga	swim	2	1	6
9	8/5/2017 14:08	70.871	143.929	beluga	swim	2	0	6
9	8/5/2017 14:08	70.862	143.982	beluga	swim	2	0	6
9	8/5/2017 14:09	70.858	143.982	beluga	swim	2	0	6
9	8/5/2017 14:09	70.832	143.955	beluga	swim	12	3	6
9	8/5/2017 14:10	70.831	143.955	beluga	swim	17	4	6
9	8/5/2017 14:23	70.402	143.949	beluga	swim	1	0	4
9	8/5/2017 14:27	70.264	143.946	beluga	swim	1	0	4
9	8/5/2017 14:28	70.243	143.938	bowhead whale	rest	1	0	4
9	8/5/2017 14:56	70.122	145.702	beluga	swim	8	0	4

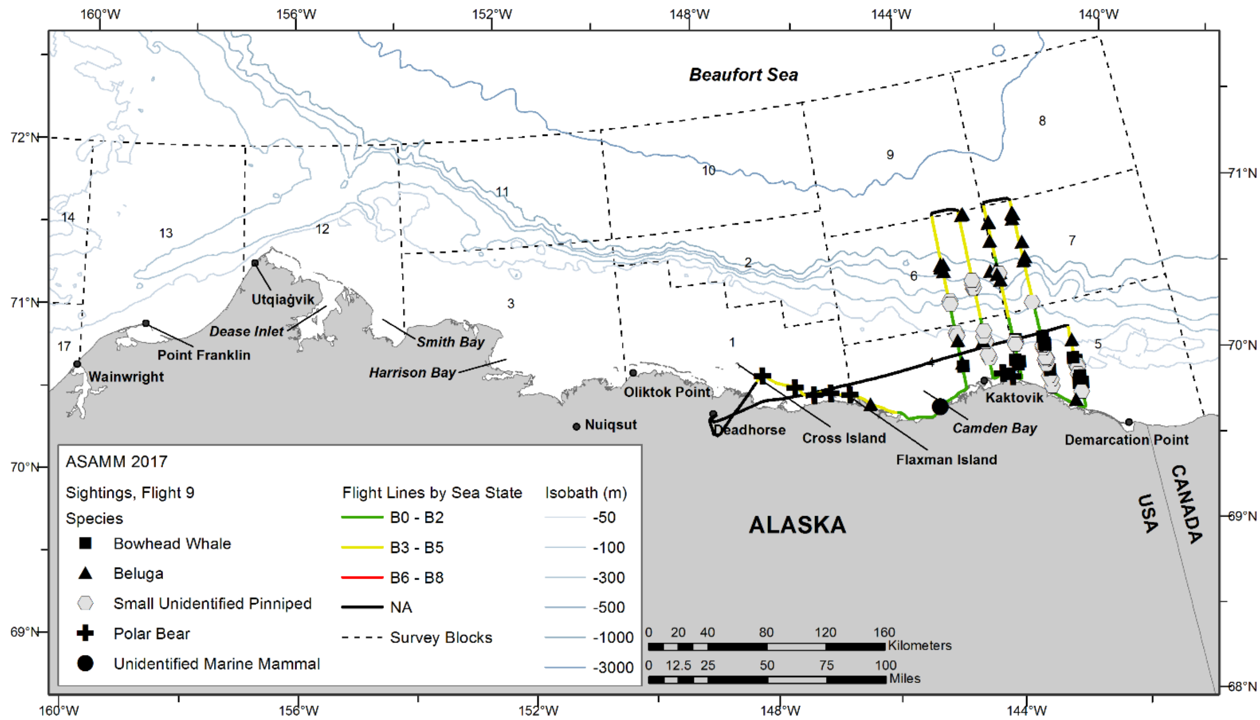

Figure B-26. Flight 9 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Pair of bowhead whale calves observed approximately 60 km east of Kaktovik, Alaska, during ASAMM Flight 9, 5 August 2017. The calves were initially seen alone at the surface, milling and socializing. They were eventually joined by first one adult (see below) and then another adult, presumably the cows.

Adult bowhead whale with two calves observed approximately 60 km east of Kaktovik, Alaska, during ASAMM Flight 9, 5 August 2017.

7 August 2017, Flight 10

Flight was a survey of portions of blocks 4 and 6 and coastal shoreline search from Flaxman Island to east of Deadhorse. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, and haze), and Beaufort 1-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 1 calf) and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
10	8/7/2017 15:54	70.206	144.447	bowhead whale	swim	1	0	4
10	8/7/2017 15:54	70.216	144.451	bowhead whale	swim	1	0	4
10	8/7/2017 15:54	70.225	144.483	bowhead whale	mill	4	0	4
10	8/7/2017 15:56	70.234	144.474	bowhead whale	swim	1	0	4
10	8/7/2017 16:03	70.427	144.454	bowhead whale	swim	2	1	4
10	8/7/2017 16:47	70.875	144.940	bowhead whale	swim	1	0	6
10	8/7/2017 17:05	70.304	145.043	bowhead whale	rest	1	0	4
10	8/7/2017 17:11	70.274	145.026	bowhead whale	mill	2	0	4
10	8/7/2017 17:15	70.245	144.996	bowhead whale	rest	1	0	4

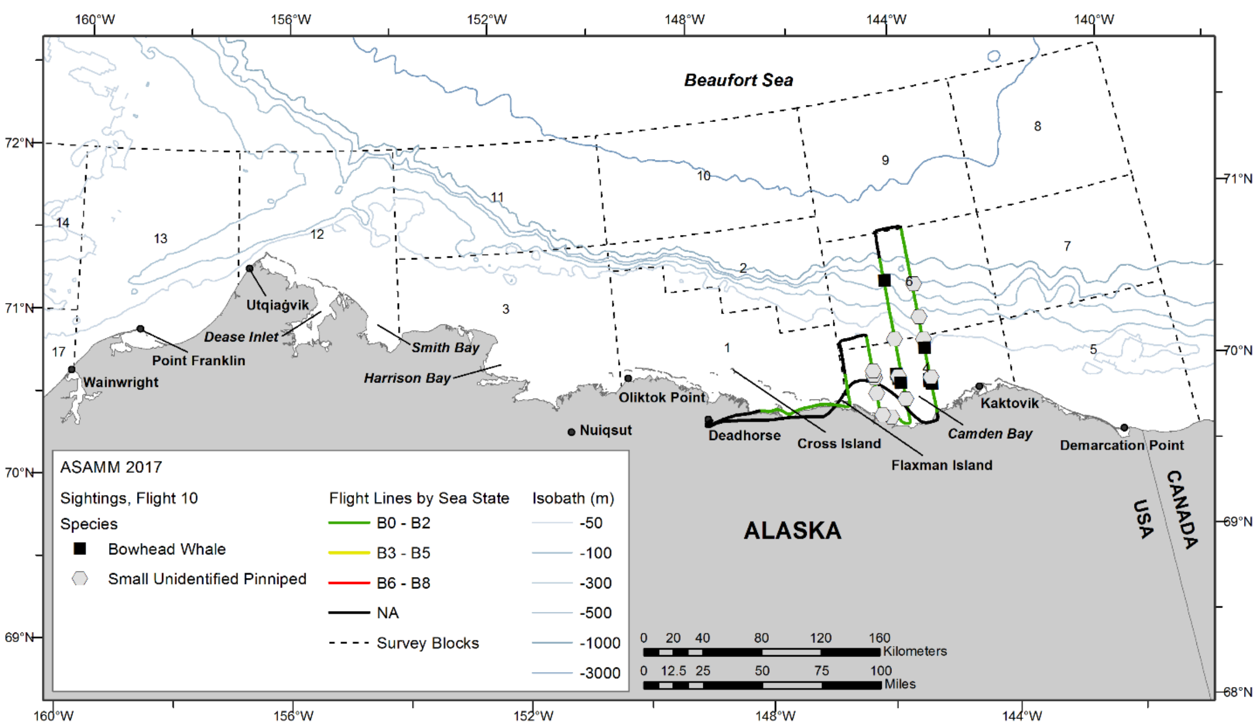

Figure B-27. Flight 10 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

9 August 2017, Flight 11

Flight was a survey of portions of blocks 1, 2, and 4. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with low ceilings and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-10% broken floe in the area surveyed. Sightings included bowhead whales, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
11	8/9/2017 11:42	70.781	148.957	bowhead whale	swim	1	0	1
11	8/9/2017 11:42	70.782	148.968	bowhead whale	rest	1	0	1
11	8/9/2017 12:03	70.745	148.436	bowhead whale	dive	1	0	1
11	8/9/2017 12:33	70.732	147.959	bowhead whale	swim	1	0	1
11	8/9/2017 12:35	70.751	147.950	bowhead whale	swim	1	0	1
11	8/9/2017 12:35	70.759	147.950	bowhead whale	swim	1	0	1
11	8/9/2017 12:35	70.769	147.960	bowhead whale	swim	1	0	1
11	8/9/2017 12:35	70.768	147.967	bowhead whale	swim	1	0	1
11	8/9/2017 12:40	70.812	147.951	bowhead whale	rest	1	0	1

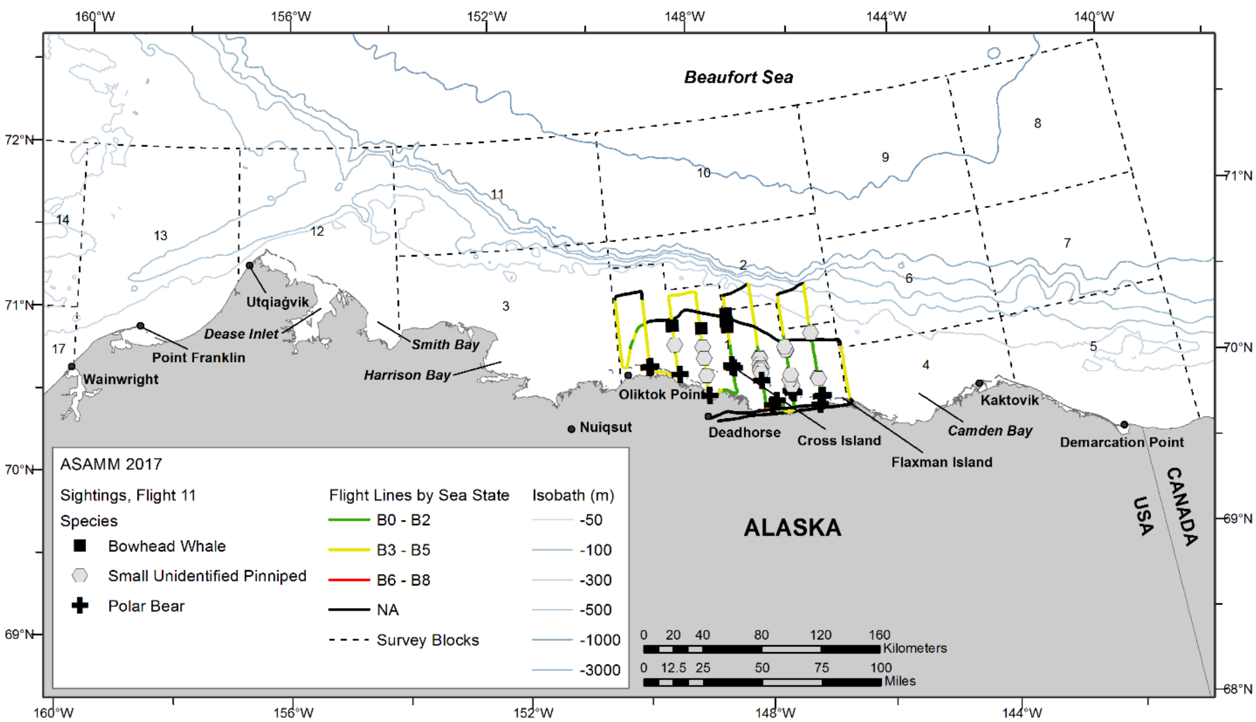

Figure B-28. Flight 11 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

10 August 2017, Flight 218

Flight was a complete survey of transects 1, 2, 3, 4, 5, and 6 and a complete survey of block 12. Survey conditions included partly cloudy to overcast skies, 1 km to unlimited visibility (with fog, glare, haze, low ceilings, and precipitation), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales, belugas (including 7 calves), walruses, one bearded seal, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
218	8/10/2017 9:54	71.311	157.049	gray whale	feed	3	0	13
218	8/10/2017 9:55	71.306	157.057	gray whale	feed	4	0	13
218	8/10/2017 10:04	71.321	157.006	gray whale	feed	2	0	13
218	8/10/2017 13:05	71.706	161.267	gray whale	swim	1	0	14
218	8/10/2017 16:50	71.936	154.936	beluga	swim	1	0	12
218	8/10/2017 16:50	71.929	154.952	beluga	swim	2	1	12
218	8/10/2017 16:50	71.923	154.950	beluga	swim	1	1	12
218	8/10/2017 16:51	71.915	154.942	beluga	swim	2	1	12
218	8/10/2017 16:51	71.908	154.977	beluga	swim	2	0	12
218	8/10/2017 16:52	71.886	154.943	beluga	swim	5	2	12
218	8/10/2017 16:52	71.882	154.965	beluga	swim	1	0	12
218	8/10/2017 16:52	71.877	154.941	beluga	swim	1	0	12
218	8/10/2017 16:52	71.874	154.944	beluga	swim	1	0	12
218	8/10/2017 16:52	71.873	154.970	beluga	swim	2	1	12
218	8/10/2017 16:53	71.858	154.960	beluga	swim	2	1	12
218	8/10/2017 16:53	71.857	154.953	beluga	swim	1	0	12
218	8/10/2017 16:53	71.847	154.958	beluga	swim	5	0	12

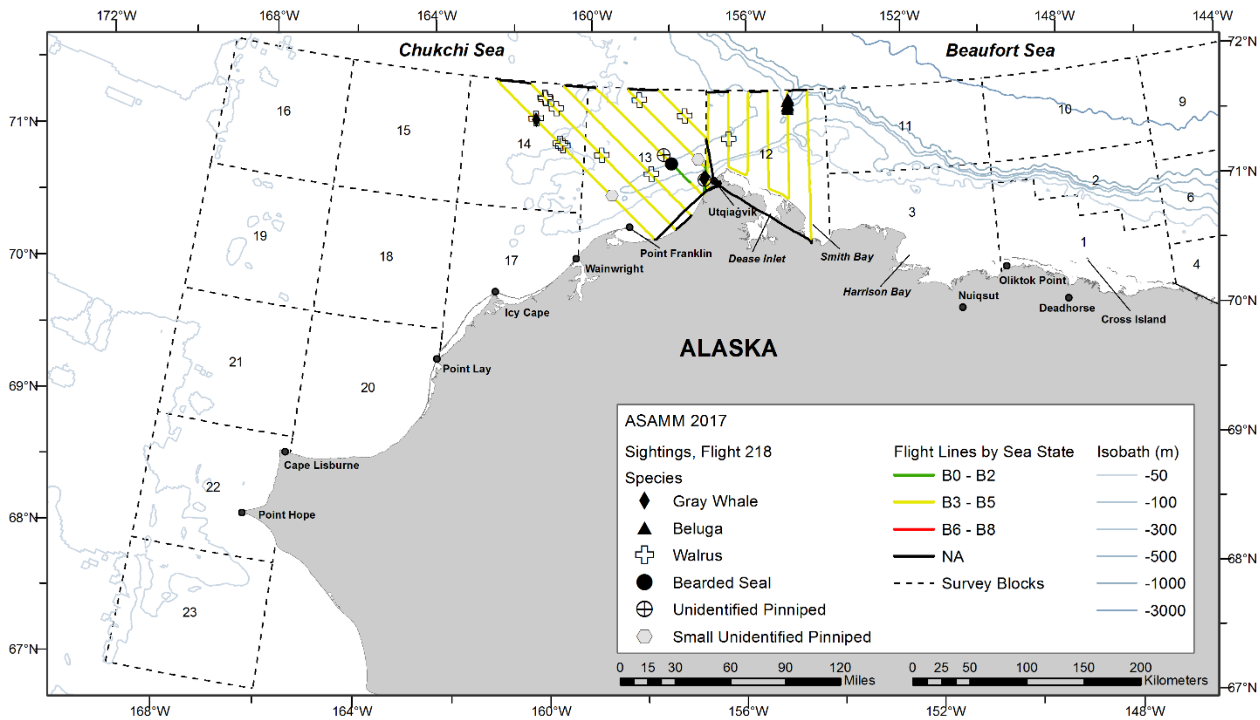

Figure B-29. Flight 218 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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10 August 2017, Flight 12

Flight was a survey of portions of blocks 3 and 11, and the coastal transect from just east of Harrison Bay to north of Deadhorse. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with low ceilings), and Beaufort 2-5 sea states. Sea ice cover was 0-2% broken floe in the area surveyed. Sightings included bowhead whales, belugas (including 18 calves), small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
12	8/10/2017 16:50	71.857	153.473	beluga	swim	1	0	11
12	8/10/2017 16:50	71.851	153.454	beluga	swim	2	0	11
12	8/10/2017 16:50	71.849	153.455	beluga	swim	13	2	11
12	8/10/2017 16:50	71.837	153.449	beluga	swim	2	0	11
12	8/10/2017 18:00	71.947	152.437	beluga	swim	7	3	11
12	8/10/2017 18:01	71.941	152.437	beluga	swim	20	3	11
12	8/10/2017 18:01	71.938	152.451	beluga	swim	12	4	11
12	8/10/2017 18:01	71.937	152.452	beluga	swim	39	6	11
12	8/10/2017 18:23	71.138	152.471	bowhead whale	swim	1	0	3
12	8/10/2017 18:24	71.118	152.436	bowhead whale	swim	1	0	3

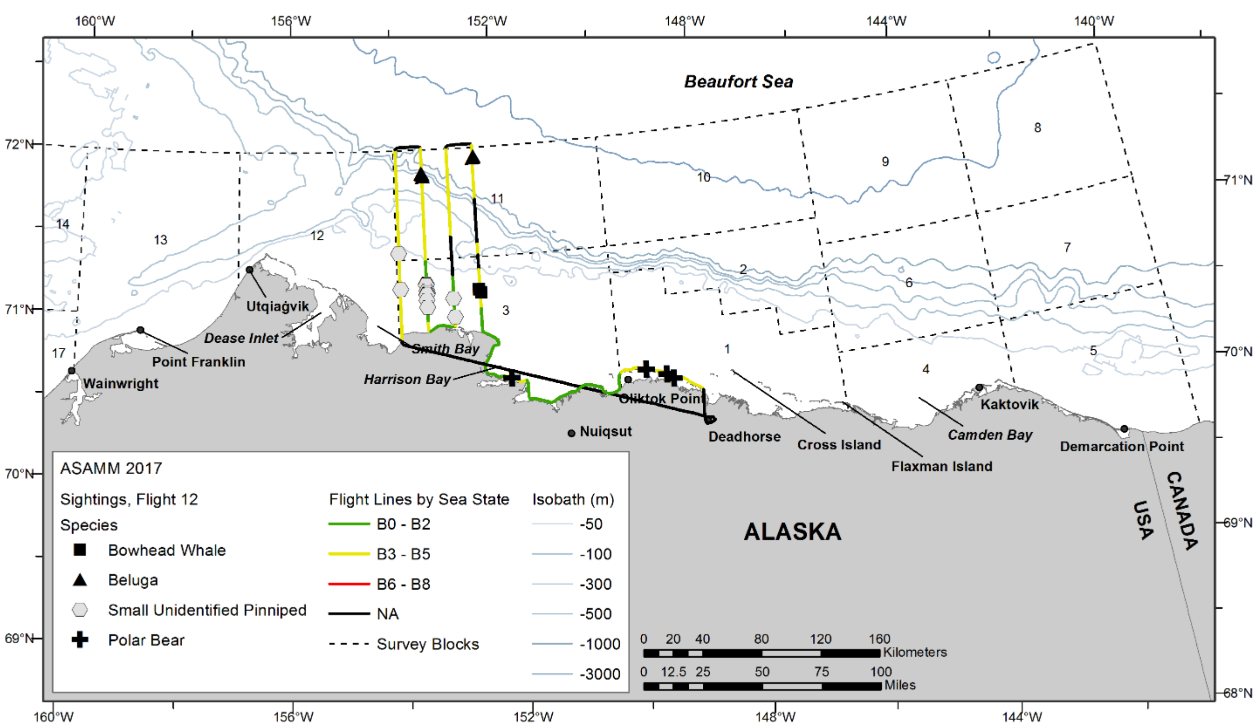

Figure B-30. Flight 12 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

11 August 2017, Flight 219

Flight was a complete survey of transects 8 and 10 and search effort from south of Wainwright to Utqiaġvik. Survey conditions included overcast skies, <1 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 3-5 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including 4 calves and 2 carcasses), and walruses.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
219	8/11/2017 14:20	70.961	160.183	gray whale	feed	2	1	17
219	8/11/2017 14:31	71.070	160.650	gray whale	feed	2	0	14
219	8/11/2017 14:34	71.068	160.705	gray whale	feed	2	0	14
219	8/11/2017 14:45	71.204	161.023	gray whale	feed	2	0	14
219	8/11/2017 14:49	71.216	161.011	gray whale	feed	1	0	14
219	8/11/2017 14:49	71.226	160.994	gray whale	feed	1	0	14
219	8/11/2017 14:51	71.233	161.036	gray whale	feed	2	0	14
219	8/11/2017 14:53	71.210	161.092	gray whale	feed	1	0	14
219	8/11/2017 14:53	71.208	161.103	gray whale	feed	2	0	14
219	8/11/2017 14:57	71.208	161.108	gray whale	feed	2	1	14
219	8/11/2017 15:00	71.203	161.106	gray whale	feed	1	1	14
219	8/11/2017 15:03	71.238	161.196	gray whale	feed	2	1	14
219	8/11/2017 15:05	71.267	161.299	gray whale	swim	1	0	14
219	8/11/2017 15:06	71.285	161.306	gray whale	feed	1	0	14
219	8/11/2017 17:12	70.706	159.874	gray whale	dead	1	0	13
219	8/11/2017 17:15	70.739	159.773	gray whale	dead	1	0	13

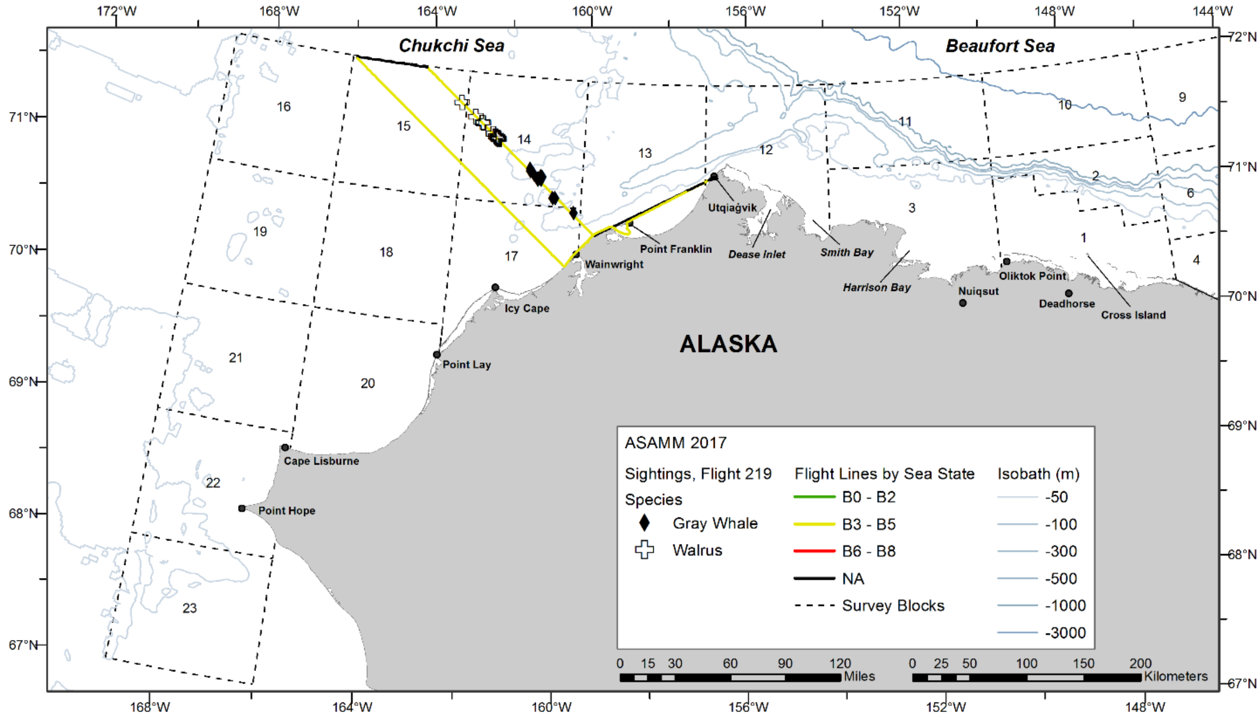

Figure B-31. Flight 219 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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14 August 2017, Flight 220

Flight was a partial survey of transects 9 and 12 and search effort from Peard Bay to Utqiaġvik. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with low ceilings), and Beaufort 4-5 sea states. No sea ice was observed in the area surveyed. Sightings included one unidentified cetacean carcass.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
220	8/14/2017 16:07	70.877	158.677	unid cetacean	dead	1	0	13

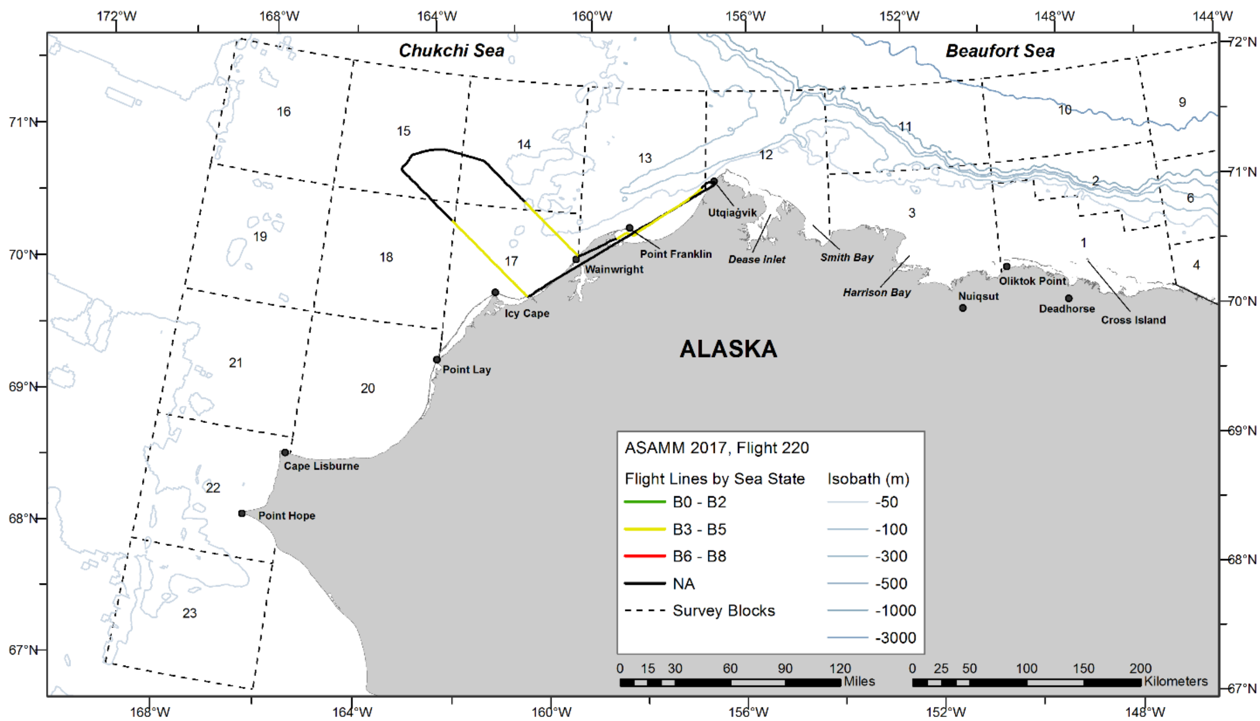

Figure B-32. Flight 220 survey track, depicted by sea state; excludes carcass sighting.

15 August 2017, Flight 13

Flight was a survey of portions of blocks 1, 2, and 3. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare and low ceilings), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, belugas (including 1 calf), one bearded seal, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
13	8/15/2017 16:52	70.434	147.019	bowhead whale	swim	1	0	1
13	8/15/2017 17:41	71.244	146.961	beluga	swim	1	0	2
13	8/15/2017 17:41	71.234	146.952	beluga	swim	2	1	2
13	8/15/2017 17:41	71.234	146.959	beluga	swim	1	0	2
13	8/15/2017 17:42	71.222	146.954	beluga	swim	1	0	2
13	8/15/2017 18:07	70.415	146.955	bowhead whale	swim	1	0	1
13	8/15/2017 18:10	70.396	146.956	bowhead whale	swim	1	0	1

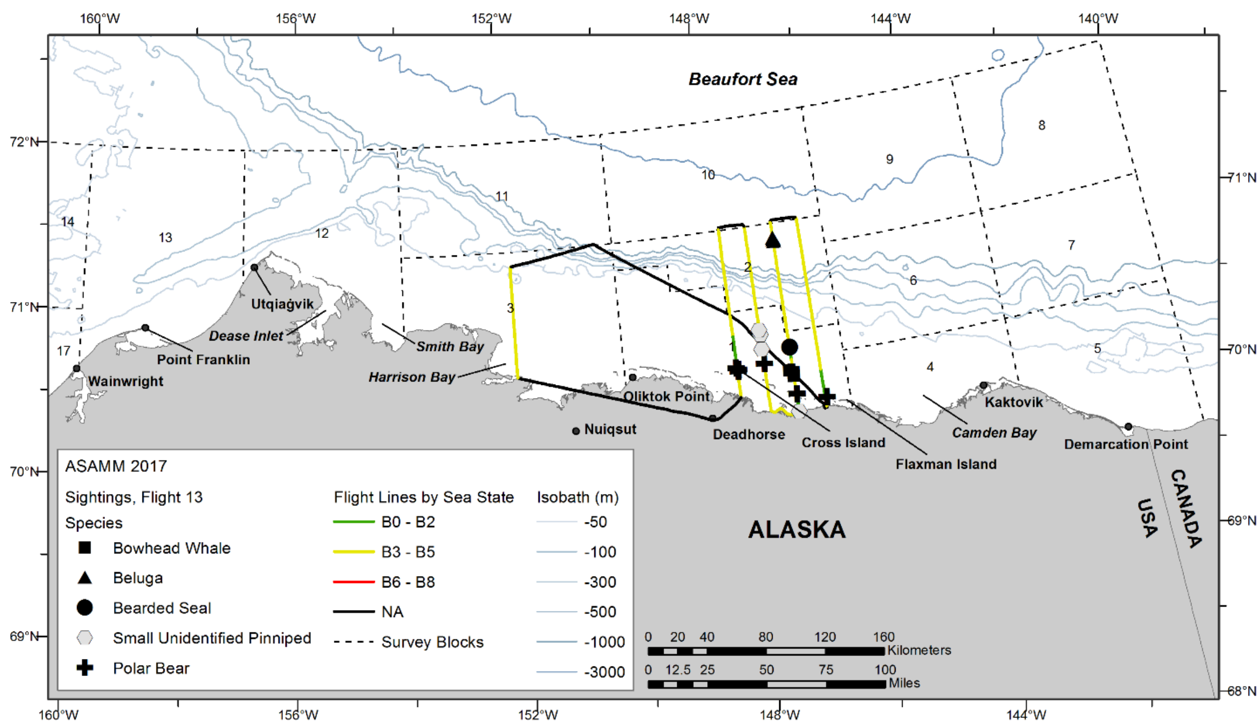

Figure B-33. Flight 13 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Three polar bears observed resting in and around the bone pile on Cross Island, Alaska, during ASAMM Flight 13, 15 August 2017.

This polar bear on Cross Island, Alaska, looks out towards the open water (observed during ASAMM Flight 13, 15 August 2017).

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16 August 2017, Flight 221

Flight was a complete survey of transects 12, 14, 16, and 18. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included walruses and small unidentified pinnipeds.

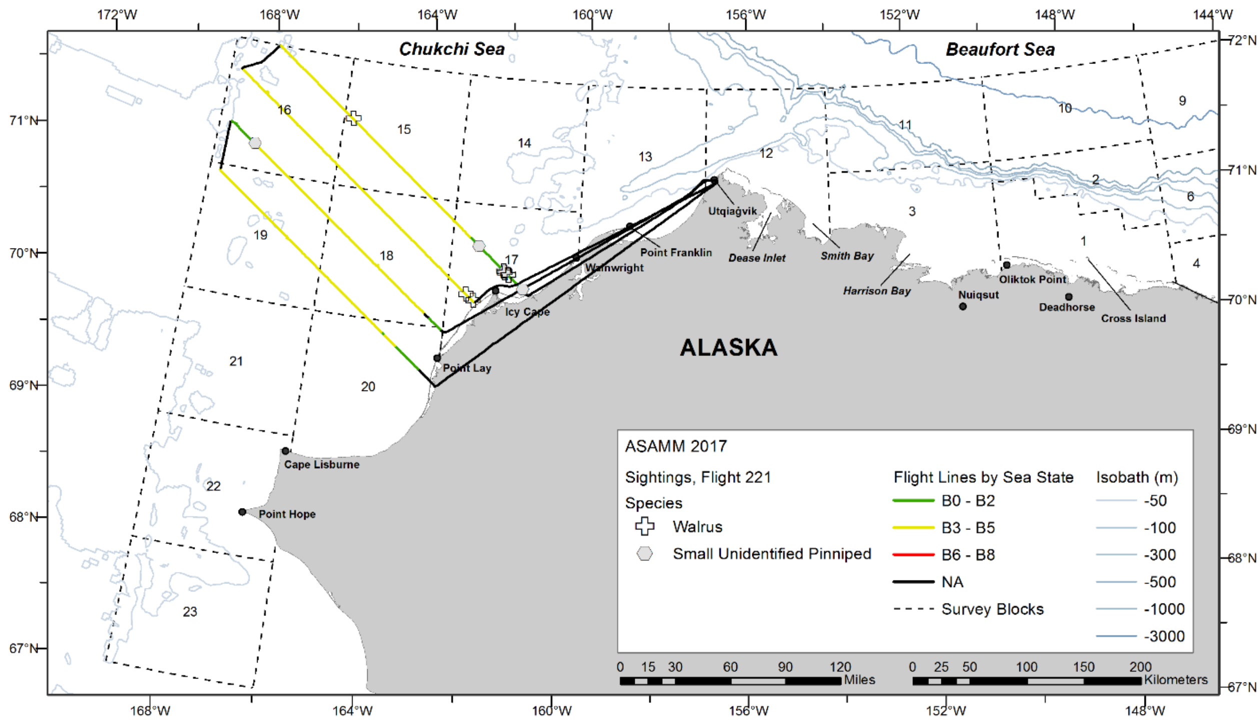

Figure B-34. Flight 221 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

16 August 2017, Flight 14

Flight was a survey of portions of blocks 1, 2, 3, 5, and 7. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with glare, haze, and low ceilings), and Beaufort 1-5 sea states. Sea ice cover was 0-1% broken floe in the area surveyed. Sightings included bowhead whales (including 22 calves), belugas (including 4 calves and 1 carcass), bearded seals, unidentified pinnipeds, small unidentified pinnipeds, and one polar bear.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	8/16/2017 11:31	69.843	140.450	bowhead whale	rest	2	1	5
14	8/16/2017 11:33	69.844	140.420	bowhead whale	swim	1	0	5
14	8/16/2017 11:34	69.860	140.408	bowhead whale	swim	2	1	5
14	8/16/2017 11:38	69.831	140.382	bowhead whale	feed	1	0	5
14	8/16/2017 11:42	69.895	140.443	beluga	dead	1	0	5
14	8/16/2017 11:46	69.889	140.506	bowhead whale	swim	1	1	5
14	8/16/2017 11:47	69.891	140.543	bowhead whale	dive	2	1	5
14	8/16/2017 11:49	69.907	140.553	bowhead whale	swim	1	1	5
14	8/16/2017 11:51	69.921	140.593	bowhead whale	dive	3	2	5
14	8/16/2017 11:53	69.915	140.586	bowhead whale	swim	1	1	5
14	8/16/2017 11:54	69.924	140.581	bowhead whale	swim	2	0	5
14	8/16/2017 12:35	69.907	140.933	bowhead whale	swim	2	0	5
14	8/16/2017 12:35	69.899	140.907	bowhead whale	swim	6	1	5
14	8/16/2017 12:37	69.908	140.932	bowhead whale	swim	1	1	5
14	8/16/2017 12:42	69.881	140.971	bowhead whale	swim	2	1	5
14	8/16/2017 12:43	69.873	140.957	bowhead whale	dive	2	1	5
14	8/16/2017 12:44	69.871	140.965	bowhead whale	rest	1	1	5
14	8/16/2017 12:49	69.757	140.938	beluga	swim	10	2	5
14	8/16/2017 12:49	69.751	140.960	beluga	swim	7	2	5
14	8/16/2017 13:06	69.938	141.469	bowhead whale	dive	2	0	5
14	8/16/2017 13:06	69.941	141.437	bowhead whale	rest	2	1	5
14	8/16/2017 13:09	69.952	141.444	bowhead whale	swim	3	1	5
14	8/16/2017 13:11	69.941	141.412	bowhead whale	swim	1	1	5
14	8/16/2017 13:13	69.956	141.405	bowhead whale	dive	1	0	5
14	8/16/2017 13:15	69.942	141.458	bowhead whale	swim	3	2	5
14	8/16/2017 13:18	69.937	141.431	bowhead whale	swim	4	1	5
14	8/16/2017 13:22	70.024	141.467	bowhead whale	swim	1	0	5
14	8/16/2017 13:22	70.033	141.461	bowhead whale	swim	1	0	5
14	8/16/2017 13:23	70.040	141.480	bowhead whale	dive	1	0	5
14	8/16/2017 13:26	70.116	141.391	bowhead whale	swim	1	0	5
14	8/16/2017 13:28	70.118	141.350	bowhead whale	swim	1	0	5
14	8/16/2017 13:28	70.124	141.312	bowhead whale	swim	1	1	5
14	8/16/2017 13:30	70.114	141.389	bowhead whale	swim	2	1	5

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	8/16/2017 14:21	70.467	141.919	beluga	swim	1	0	5
14	8/16/2017 14:32	70.085	141.921	bowhead whale	swim	1	0	5
14	8/16/2017 14:35	70.034	141.937	bowhead whale	swim	1	0	5
14	8/16/2017 14:35	70.032	141.949	bowhead whale	swim	1	1	5

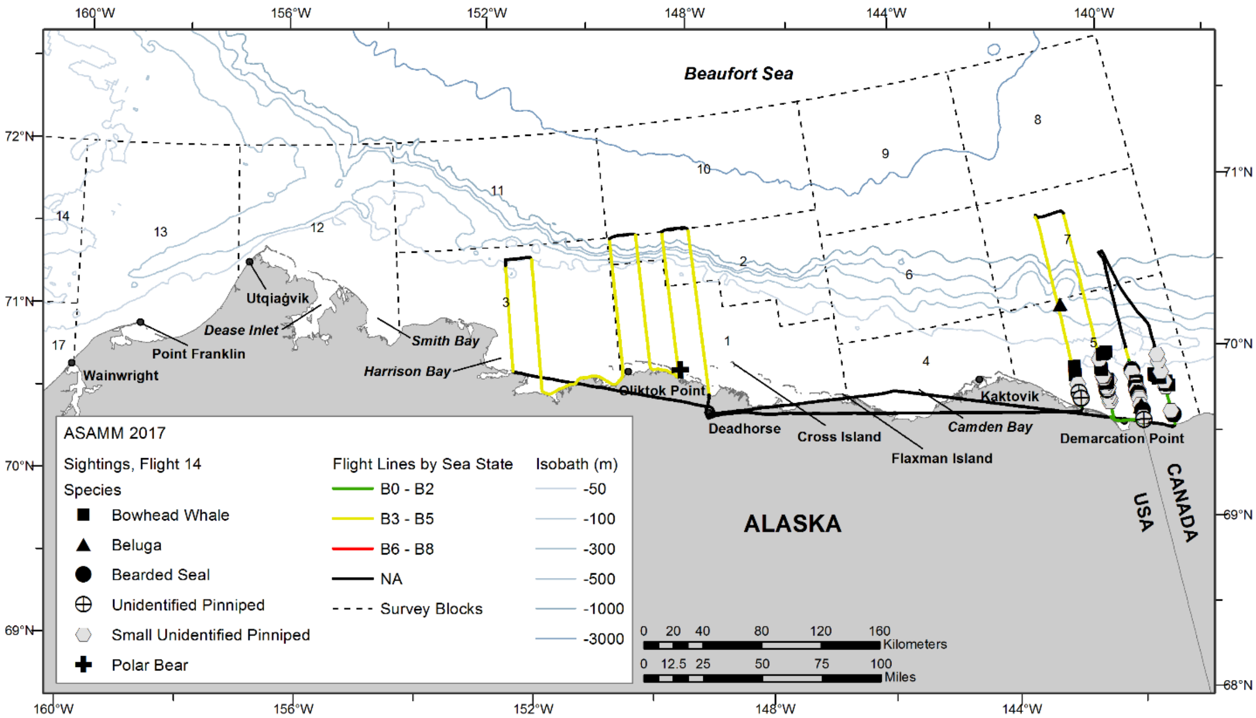

Figure B-35. Flight 14 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 August 2017, Flight 15

Flight was a survey of portions of block 12. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 1-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, belugas (including 13 calves), one walrus, bearded seals, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
15	8/19/2017 16:07	71.937	154.462	beluga	swim	1	0	12
15	8/19/2017 16:07	71.937	154.447	beluga	swim	1	0	12
15	8/19/2017 16:07	71.943	154.453	beluga	swim	19	2	12
15	8/19/2017 16:07	71.944	154.442	beluga	swim	2	0	12
15	8/19/2017 16:15	71.968	154.971	beluga	swim	1	0	12
15	8/19/2017 16:17	71.947	154.967	beluga	swim	8	2	12
15	8/19/2017 16:17	71.945	154.952	beluga	swim	3	0	12
15	8/19/2017 16:18	71.939	154.981	beluga	swim	2	1	12
15	8/19/2017 16:18	71.930	154.957	beluga	swim	22	7	12
15	8/19/2017 16:18	71.918	154.956	beluga	rest	2	1	12
15	8/19/2017 16:39	71.195	154.947	bowhead whale	swim	1	0	12
15	8/19/2017 16:39	71.194	154.958	bowhead whale	swim	1	0	12
15	8/19/2017 16:43	71.196	154.972	bowhead whale	dive	1	0	12
15	8/19/2017 16:44	71.171	154.979	bowhead whale	swim	1	0	12
15	8/19/2017 16:46	71.178	154.989	bowhead whale	dive	1	0	12
15	8/19/2017 16:47	71.169	154.975	bowhead whale	feed	5	0	12
15	8/19/2017 16:49	71.175	155.048	bowhead whale	swim	1	0	12
15	8/19/2017 16:57	71.232	155.441	bowhead whale	dive	1	0	12
15	8/19/2017 16:58	71.248	155.333	bowhead whale	feed	10	0	12
15	8/19/2017 16:59	71.242	155.377	bowhead whale	swim	1	0	12
15	8/19/2017 17:07	71.361	155.458	bowhead whale	swim	1	0	12
15	8/19/2017 17:07	71.367	155.474	bowhead whale	swim	1	0	12
15	8/19/2017 17:41	71.556	155.958	bowhead whale	mill	2	0	12
15	8/19/2017 17:45	71.384	155.953	bowhead whale	feed	1	0	12
15	8/19/2017 17:46	71.323	155.886	bowhead whale	swim	1	0	12
15	8/19/2017 17:48	71.314	155.828	bowhead whale	swim	1	0	12
15	8/19/2017 17:48	71.328	155.809	bowhead whale	feed	3	0	12
15	8/19/2017 17:49	71.330	155.829	bowhead whale	swim	1	0	12
15	8/19/2017 17:49	71.338	155.835	bowhead whale	swim	1	0	12
15	8/19/2017 17:50	71.345	155.797	bowhead whale	swim	1	0	12

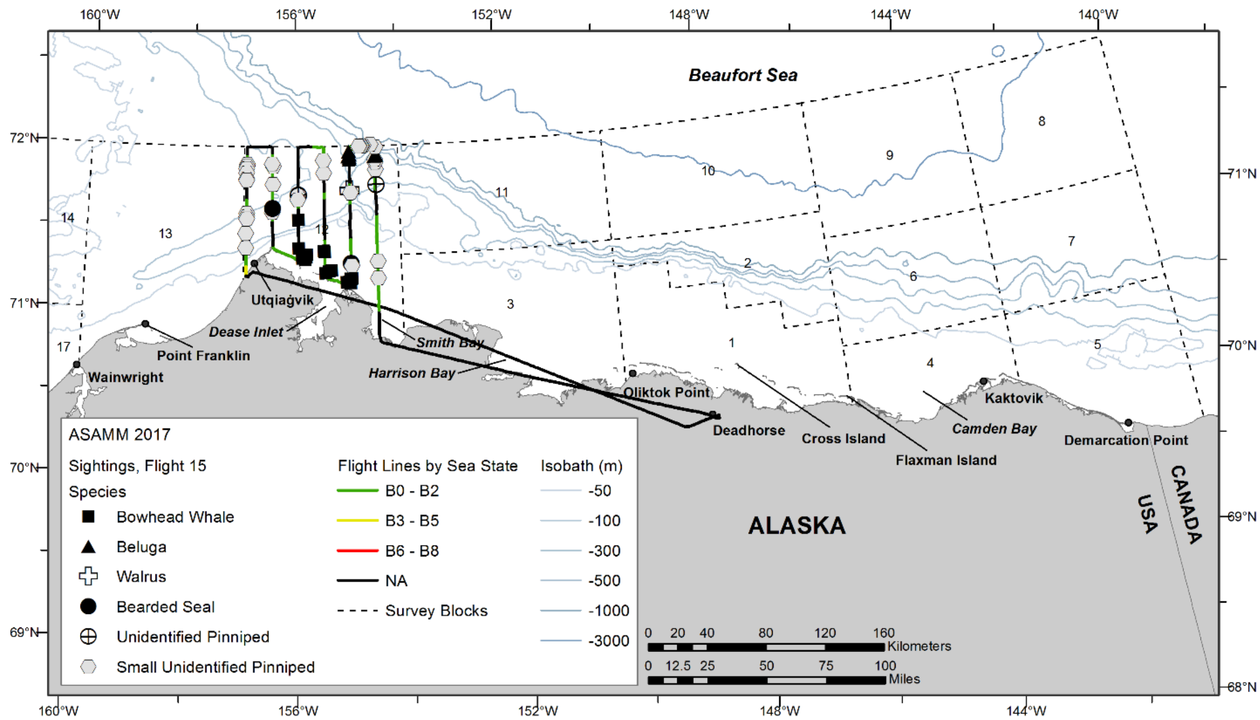

Figure B-36. Flight 15 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

A feeding aggregation of bowhead whales, observed approximately 45 km southeast of Point Barrow, Alaska, during ASAMM Flight 15, 19 August 2017.

Bowhead whales with their baleen plates clearly visible are side feeding, rostrum to rostrum, through murky (food-filled) waters approximately 45 km southeast of Point Barrow, Alaska, during ASAMM Flight 15, 19 August 2017.

20 August 2017, Flight 16

Flight was a complete survey of transects 1, 3, 5, and 7, portions of blocks 3 and 11, and the coastal transect in Harrison Bay. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-3 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales, walruses, bearded seals, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
16	8/20/2017 14:17	71.265	160.778	gray whale	feed	1	0	14
16	8/20/2017 14:20	71.246	160.785	gray whale	feed	1	0	14
16	8/20/2017 14:21	71.247	160.716	gray whale	feed	2	0	14
16	8/20/2017 14:25	71.222	161.016	gray whale	feed	1	0	14
16	8/20/2017 14:26	71.220	161.103	gray whale	feed	1	0	14
16	8/20/2017 14:27	71.229	161.216	gray whale	feed	1	0	14
16	8/20/2017 14:28	71.247	161.210	gray whale	dive	1	0	14
16	8/20/2017 14:30	71.264	160.981	gray whale	feed	1	0	14

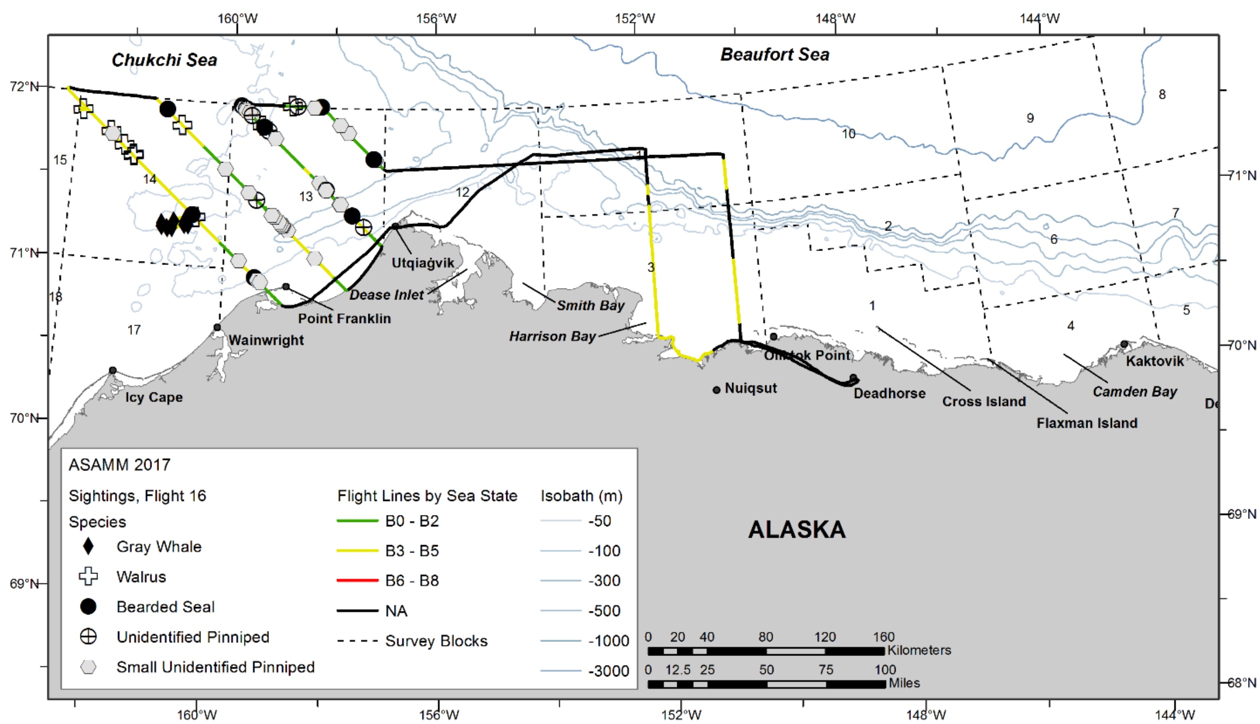

Figure B-37. Flight 16 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

21 August 2017, Flight 222

Flight was a complete survey of transects 9 and 11, and the coastal transect from Wainwright to Utqiaġvik. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, haze, and low ceilings), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including 1 carcass), walruses, small unidentified pinnipeds, and one unidentified marine mammal.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
222	8/21/2017 19:14	70.865	160.652	gray whale	feed	4	0	17
222	8/21/2017 19:35	70.741	159.775	gray whale	dead	1	0	13

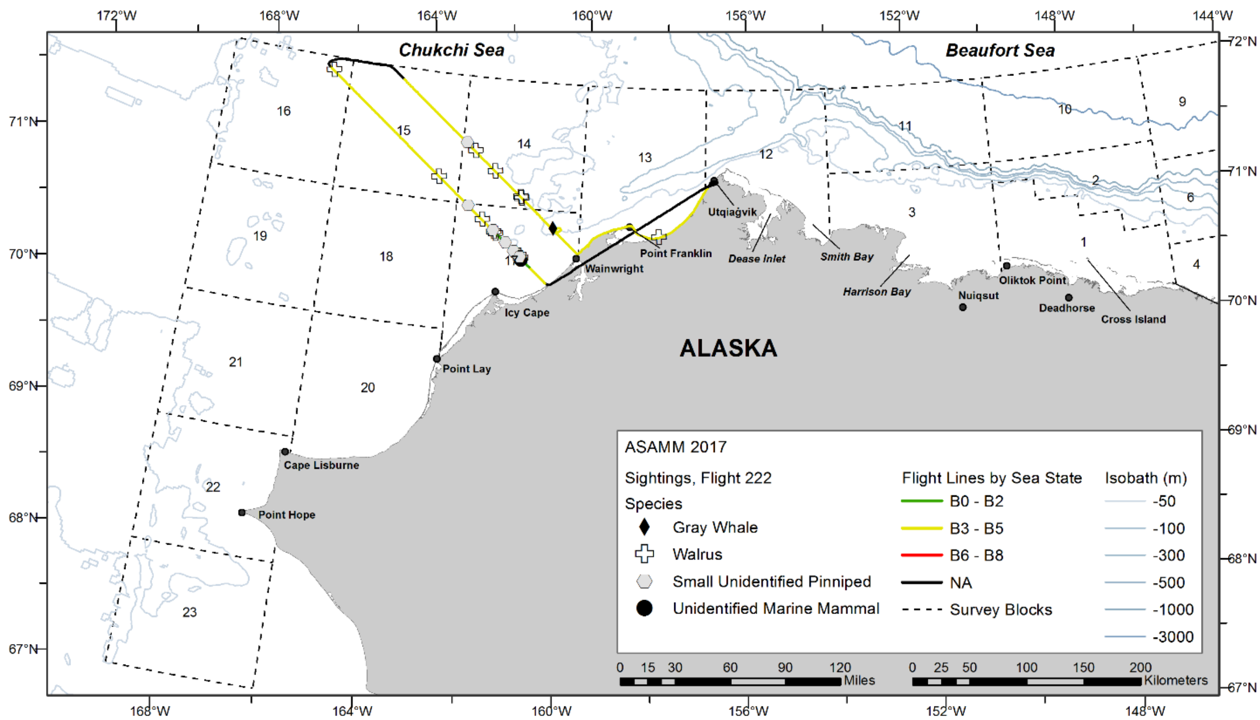

Figure B-38. Flight 222 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

21 August 2017, Flight 17

Flight was the coastal transect from the western side of block 5 to approximately 70 km northwest of Deadhorse. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare and low ceilings), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included belugas, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
17	8/21/2017 17:59	69.990	144.850	beluga	swim	1	0	4
17	8/21/2017 17:59	69.986	144.865	beluga	swim	5	0	4

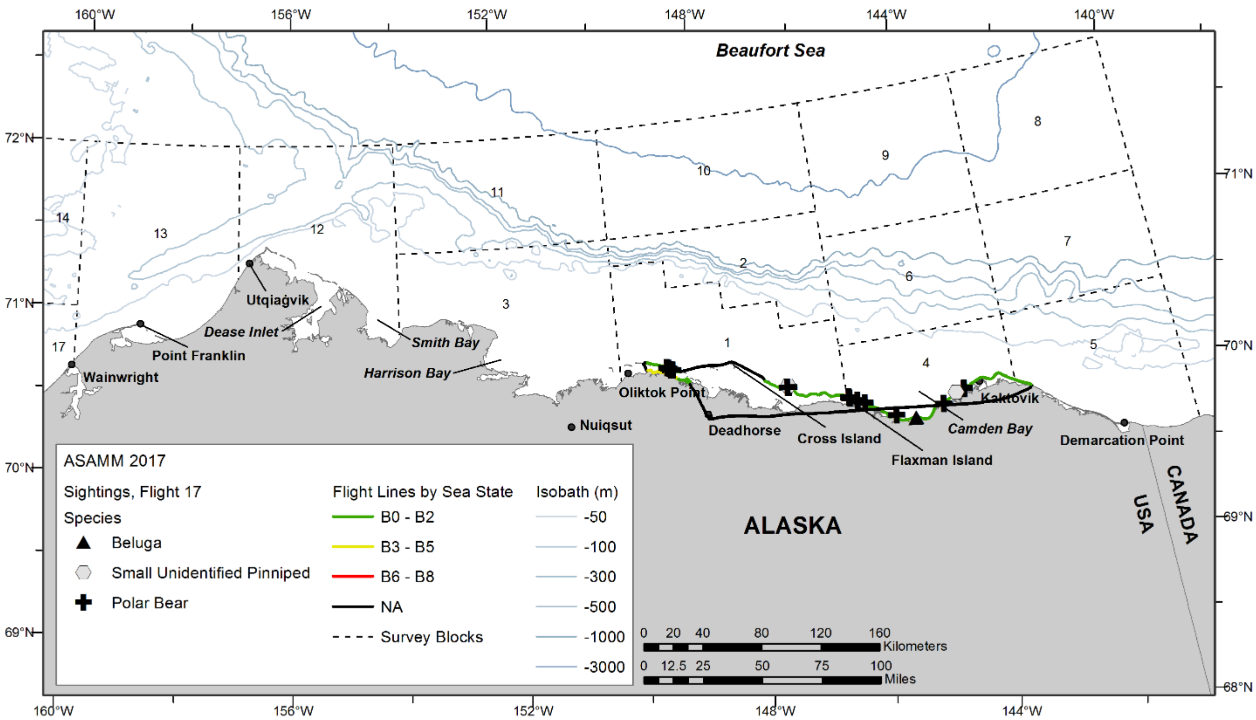

Figure B-39. Flight 17 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 August 2017, Flight 223

Flight was a complete survey of transects 13 and 15. Survey conditions included overcast skies, 0-10 km visibility (with low ceilings and precipitation), and Beaufort 3-5 sea states. No sea ice was observed in the area surveyed. Sightings included walruses.

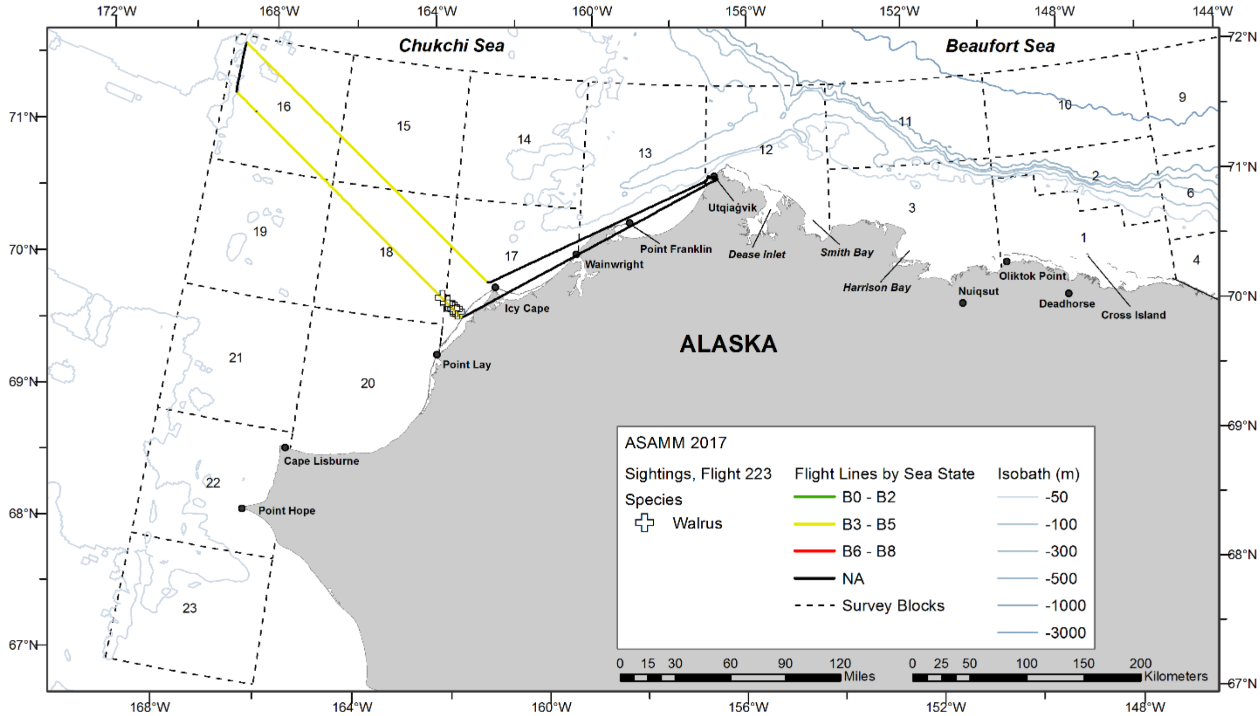

Figure B-40. Flight 223 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 August 2017, Flight 18

Flight was a survey of portions of blocks 3, 4, 6, and 10. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales and belugas (including 5 calves).

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
18	8/24/2017 15:57	70.126	145.684	beluga	swim	4	2	4
18	8/24/2017 15:58	70.119	145.657	beluga	swim	10	3	4
18	8/24/2017 16:02	70.141	145.462	bowhead whale	swim	1	0	4
18	8/24/2017 16:28	70.925	145.460	beluga	swim	1	0	6
18	8/24/2017 17:02	70.169	145.076	bowhead whale	swim	1	0	4
18	8/24/2017 17:07	70.173	145.156	bowhead whale	swim	2	0	4
18	8/24/2017 17:32	70.360	144.472	bowhead whale	swim	1	0	4

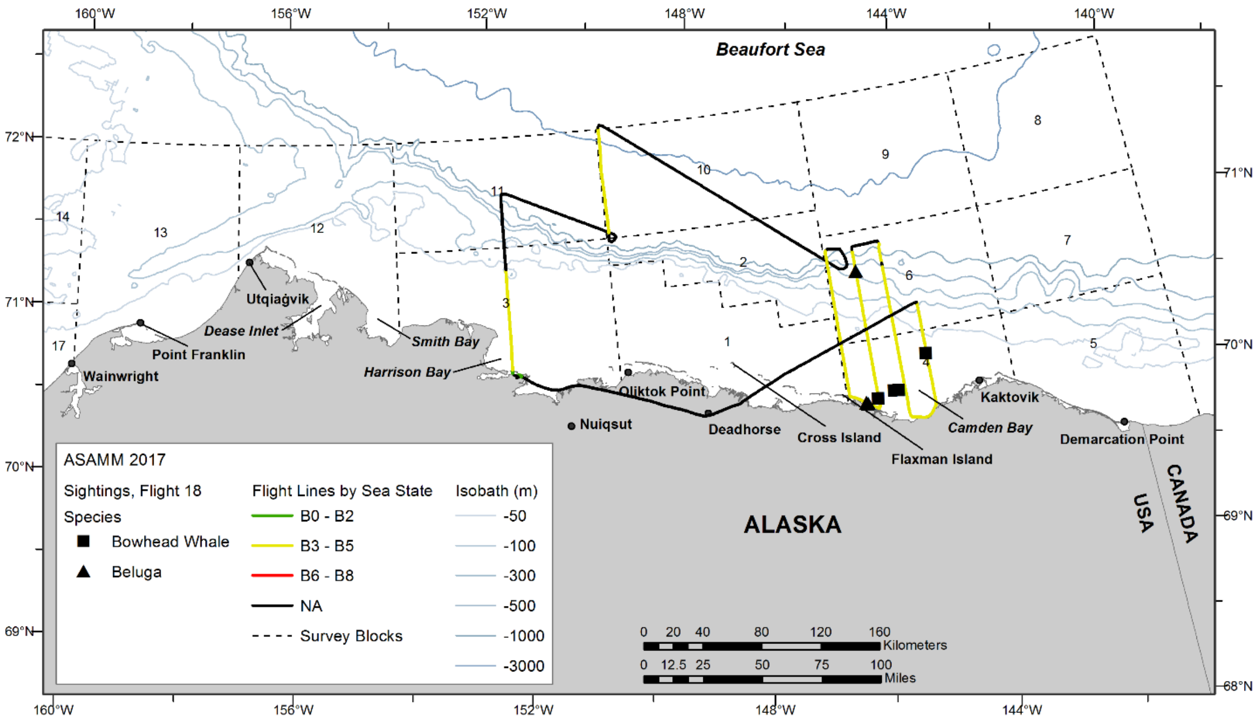

Figure B-41. Flight 18 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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25 August 2017, Flight 224

Flight was a complete survey of transect 19 and a partial survey of transect 17. Survey conditions included partly cloudy skies, 1 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. Sightings included walruses.

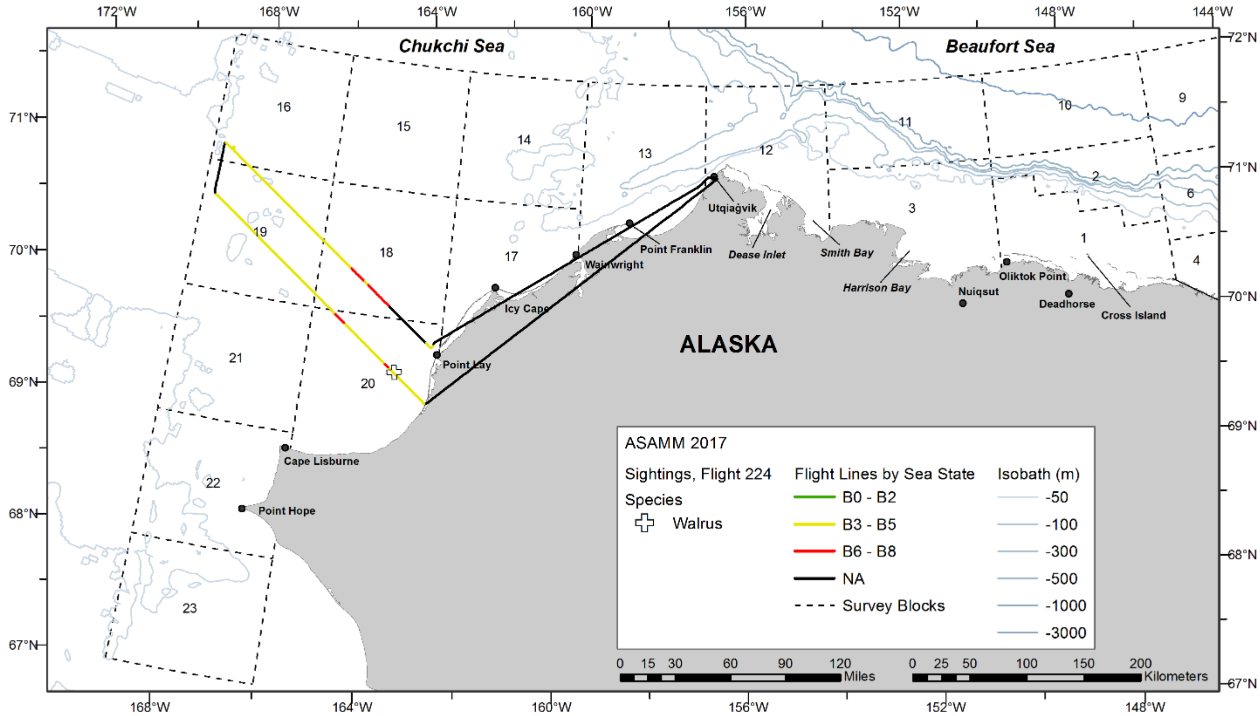


Figure B-42. Flight 224 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

25 August 2017, Flight 19

Flight was a survey of portions of blocks 4, 5, 6, and 7, and the coastal transect from west of Kaktovik to approximately 30 km east of Deadhorse. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare and low ceilings), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 6 calves), belugas, one bearded seal, one unidentified pinniped, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
19	8/25/2017 13:48	70.106	142.435	bowhead whale	feed	2	0	5
19	8/25/2017 13:48	70.109	142.444	bowhead whale	swim	2	1	5
19	8/25/2017 13:50	70.109	142.429	bowhead whale	swim	1	0	5
19	8/25/2017 13:55	70.138	142.454	bowhead whale	rest	2	1	5
19	8/25/2017 13:57	70.205	142.441	bowhead whale	swim	2	1	5
19	8/25/2017 13:57	70.213	142.483	bowhead whale	swim	1	0	5
19	8/25/2017 14:00	70.187	142.431	bowhead whale	mill	2	1	5
19	8/25/2017 14:04	70.227	142.465	bowhead whale	swim	1	0	5
19	8/25/2017 15:05	70.199	142.949	bowhead whale	rest	1	0	5
19	8/25/2017 15:08	70.188	142.952	bowhead whale	feed	1	0	5
19	8/25/2017 15:22	70.288	143.438	bowhead whale	swim	1	0	4
19	8/25/2017 15:27	70.295	143.356	bowhead whale	rest	1	0	4
19	8/25/2017 15:29	70.275	143.403	bowhead whale	rest	1	0	4
19	8/25/2017 15:33	70.365	143.476	bowhead whale	swim	2	1	4
19	8/25/2017 15:34	70.381	143.462	bowhead whale	swim	1	0	4
19	8/25/2017 15:37	70.391	143.444	bowhead whale	swim	1	0	4
19	8/25/2017 16:09	70.982	143.935	beluga	swim	2	0	6
19	8/25/2017 16:09	70.979	143.944	beluga	swim	2	0	6
19	8/25/2017 16:10	70.966	143.930	beluga	swim	1	0	6
19	8/25/2017 16:28	70.353	143.966	bowhead whale	swim	2	1	4
19	8/25/2017 16:31	70.279	143.939	bowhead whale	mill	2	0	4
19	8/25/2017 16:36	70.295	143.918	bowhead whale	swim	1	0	4
19	8/25/2017 16:45	70.050	144.285	beluga	swim	1	0	4
19	8/25/2017 16:45	70.050	144.295	beluga	swim	1	0	4
19	8/25/2017 16:58	70.056	145.362	beluga	swim	1	0	4

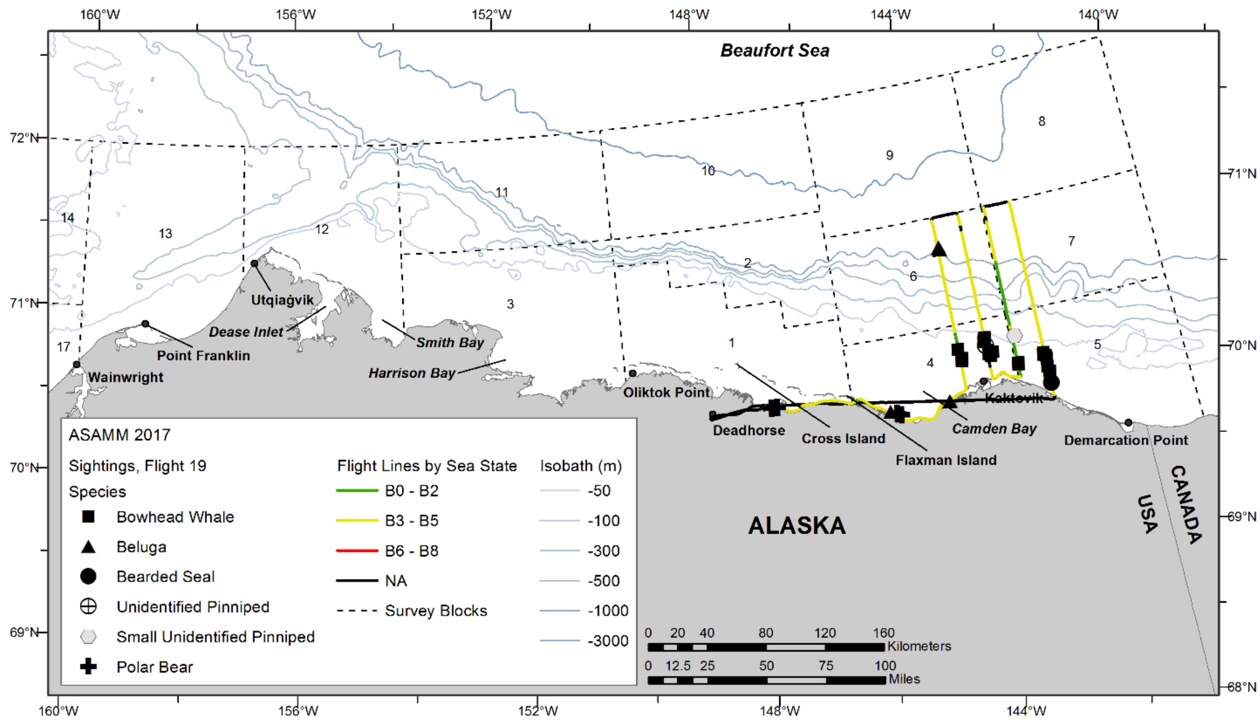


Figure B-43. Flight 19 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Along with many scars from living in a sometimes frozen sea, this heavily marked bowhead whale also carries scars on its peduncle consistent with having been entangled in fishing gear. This whale was observed approximately 20 km northeast of Kaktovik, Alaska, during ASAMM Flight 19, 25 August 2017.

26 August 2017, Flight 20

Flight was a survey of portions of blocks 3 and 11. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included belugas and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
20	8/26/2017 13:00	71.871	153.443	beluga	swim	3	0	11

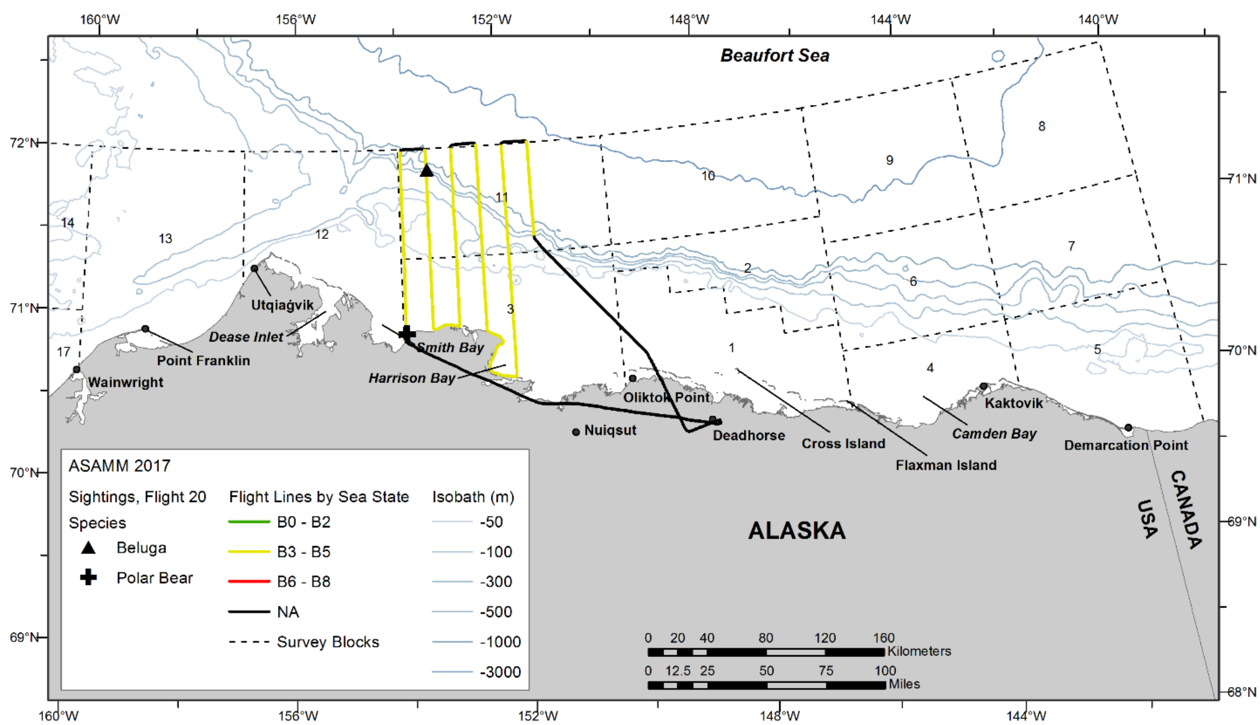


Figure B-44. Flight 20 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Team Beaufort gathers round after a successful survey flight, ASAMM Flight 20, 26 August 2017, out of Deadhorse, Alaska.

27 August 2017, Flight 225

Flight was a complete survey of block 12 and a partial survey of transects 2 and 3. Survey conditions included overcast skies, 0 km to unlimited visibility (with low ceilings and precipitation), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, unidentified cetaceans (including 1 carcass), one walrus, one bearded seal, small unidentified pinnipeds, and one polar bear.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
225	8/27/2017 9:21	71.506	154.484	bowhead whale	rest	2	0	12
225	8/27/2017 9:27	71.641	154.469	unid cetacean	dead	1	0	12
225	8/27/2017 10:01	71.504	154.914	bowhead whale	dive	1	0	12
225	8/27/2017 10:11	71.309	154.918	bowhead whale	log play	1	0	12
225	8/27/2017 11:21	71.367	155.892	bowhead whale	swim	1	0	12
225	8/27/2017 11:23	71.342	156.051	bowhead whale	feed	11	0	12
225	8/27/2017 11:29	71.331	155.958	bowhead whale	feed	1	0	12
225	8/27/2017 11:33	71.365	156.163	bowhead whale	feed	18	0	12
225	8/27/2017 11:35	71.364	156.218	bowhead whale	feed	8	0	12
225	8/27/2017 11:36	71.375	156.191	bowhead whale	swim	1	0	12
225	8/27/2017 11:40	71.307	155.934	bowhead whale	feed	5	0	12
225	8/27/2017 11:42	71.323	155.950	bowhead whale	swim	2	0	12
225	8/27/2017 11:43	71.319	155.991	bowhead whale	swim	2	0	12
225	8/27/2017 11:51	71.432	156.412	bowhead whale	swim	2	0	12
225	8/27/2017 11:53	71.428	156.420	bowhead whale	swim	1	0	12
225	8/27/2017 12:48	71.227	157.304	unid cetacean	dive	1	0	13

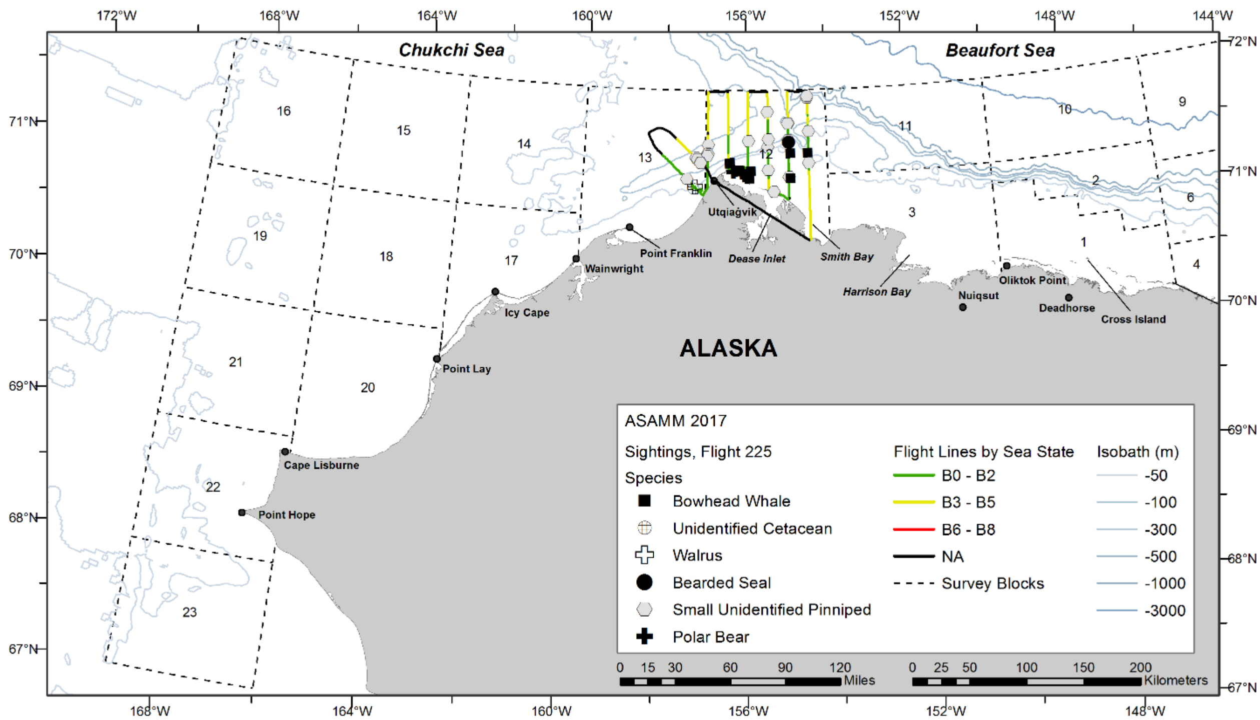
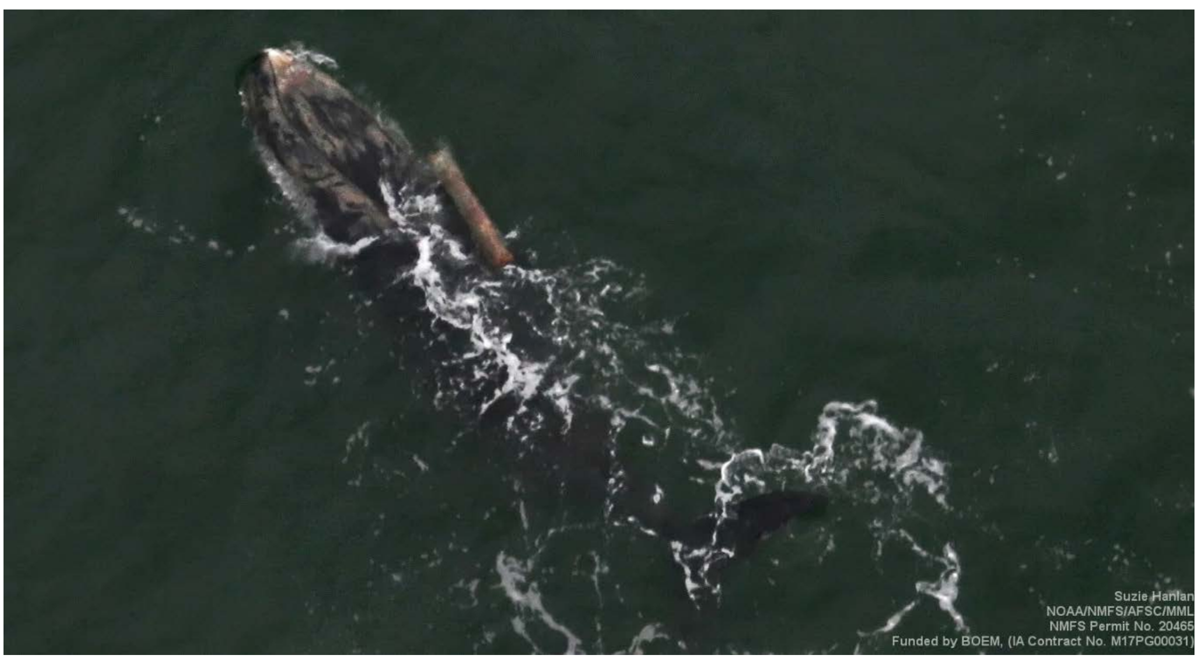


Figure B-45. Flight 225 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



Bowhead whale observed playing with a log, approximately 70 km east of Utqiaġvik, Alaska, during ASAMM Flight 225, 27 August 2017.

Bowhead whales observed skim feeding approximately 25 km east of Utqiaġvik, Alaska, during ASAMM Flight 225, 27 August 2017. These four whales were part of a larger group of 18 whales that were feeding about 3 km north of the barrier islands.

27 August 2017, Flight 21

Flight was a survey of portions of blocks 1, 2, 3, 10, and 11. Survey conditions included overcast skies, 0-10 km visibility (with low ceilings and precipitation), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
21	8/27/2017 11:28	71.006	150.454	bowhead whale	swim	1	0	3
21	8/27/2017 12:59	70.846	149.439	bowhead whale	swim	1	0	1

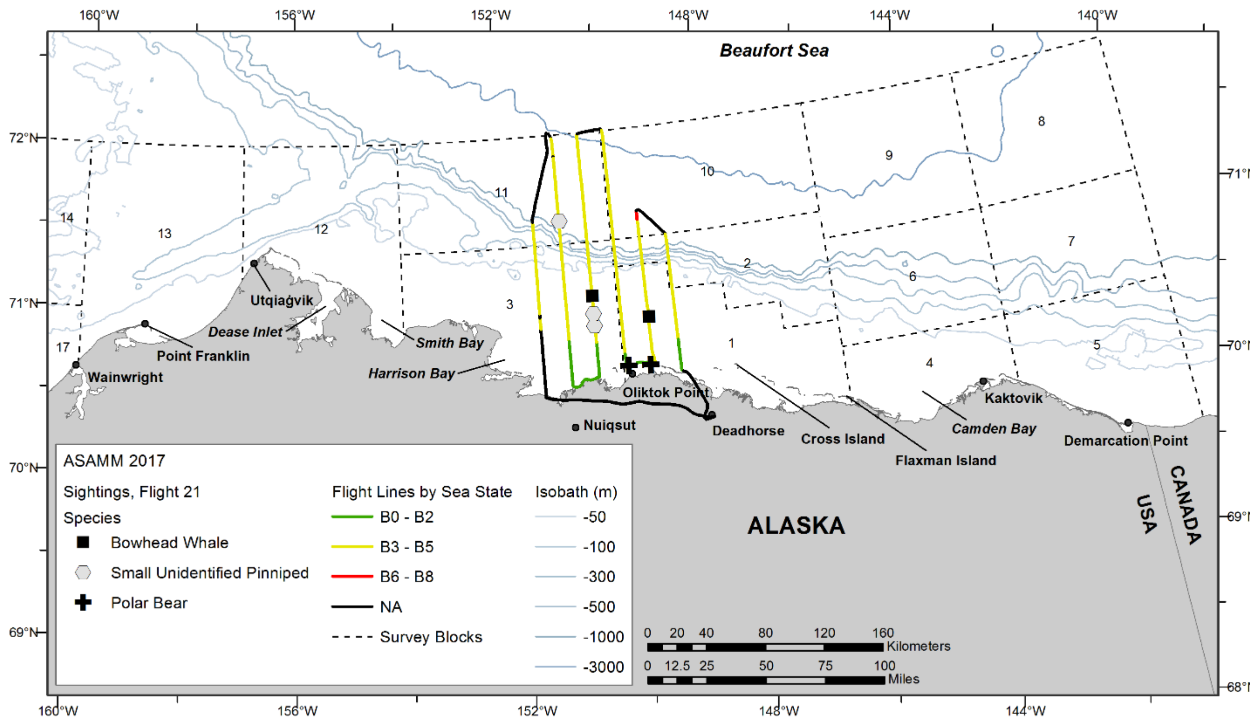


Figure B-46. Flight 21 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

28 August 2017, Flight 226

Flight was a complete survey of transects 32, 33, 34, 35, 37, and 38. Survey conditions included partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including 3 calves and 1 carcass), humpback whales, fin whales (including 1 calf), unidentified cetaceans, walruses, and one small unidentified pinniped.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
226	8/28/2017 13:01	68.144	168.787	gray whale	swim	2	0	22
226	8/28/2017 13:01	68.143	168.799	gray whale	feed	6	2	22
226	8/28/2017 13:08	68.128	168.813	gray whale	swim	1	0	22
226	8/28/2017 13:08	68.128	168.845	gray whale	swim	3	0	22
226	8/28/2017 13:08	68.123	168.813	gray whale	swim	1	0	22
226	8/28/2017 13:08	68.119	168.837	gray whale	swim	1	0	22
226	8/28/2017 13:09	68.115	168.838	gray whale	swim	1	0	22
226	8/28/2017 13:09	68.111	168.848	gray whale	swim	1	0	22
226	8/28/2017 13:09	68.093	168.810	gray whale	dive	2	1	22
226	8/28/2017 13:13	68.026	168.804	gray whale	swim	2	0	22
226	8/28/2017 13:13	68.022	168.805	gray whale	dead	1	0	22
226	8/28/2017 13:17	68.008	168.757	gray whale	swim	1	0	22
226	8/28/2017 13:18	68.008	168.651	gray whale	dive	1	0	22
226	8/28/2017 13:19	68.003	168.581	gray whale	feed	1	0	22
226	8/28/2017 13:20	67.994	168.518	gray whale	swim	1	0	23
226	8/28/2017 13:20	68.013	168.496	gray whale	mill	7	0	22
226	8/28/2017 13:20	67.979	168.489	gray whale	swim	2	0	23
226	8/28/2017 13:25	67.993	168.594	gray whale	feed	5	0	23
226	8/28/2017 13:31	67.999	168.331	gray whale	feed	1	0	23
226	8/28/2017 13:31	67.996	168.320	gray whale	feed	6	0	23
226	8/28/2017 13:37	67.910	168.374	gray whale	feed	2	0	23
226	8/28/2017 13:44	67.988	168.036	unid cetacean	swim	1	0	23
226	8/28/2017 13:59	67.985	167.287	unid cetacean	dive	1	0	23
226	8/28/2017 14:38	67.839	167.089	gray whale	swim	2	0	23
226	8/28/2017 14:48	67.822	167.688	gray whale	swim	1	0	23
226	8/28/2017 14:51	67.786	167.793	gray whale	feed	3	0	23
226	8/28/2017 14:53	67.798	167.751	gray whale	dive	1	0	23
226	8/28/2017 14:53	67.800	167.786	gray whale	dive	1	0	23
226	8/28/2017 14:58	67.844	167.823	gray whale	feed	3	0	23
226	8/28/2017 15:01	67.849	167.895	gray whale	feed	1	0	23
226	8/28/2017 15:02	67.842	167.920	gray whale	dive	1	0	23
226	8/28/2017 15:03	67.836	167.953	gray whale	dive	1	0	23
226	8/28/2017 15:03	67.836	167.984	gray whale	dive	1	0	23

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
226	8/28/2017 15:07	67.844	168.044	gray whale	feed	1	0	23
226	8/28/2017 15:09	67.859	168.100	gray whale	feed	3	0	23
226	8/28/2017 15:10	67.851	168.119	gray whale	feed	1	0	23
226	8/28/2017 15:12	67.848	168.092	gray whale	dive	1	0	23
226	8/28/2017 15:13	67.848	168.123	gray whale	feed	1	0	23
226	8/28/2017 15:15	67.864	168.176	gray whale	feed	1	0	23
226	8/28/2017 15:17	67.877	168.177	gray whale	feed	1	0	23
226	8/28/2017 15:18	67.889	168.184	gray whale	dive	1	0	23
226	8/28/2017 15:18	67.897	168.180	gray whale	feed	1	0	23
226	8/28/2017 15:19	67.899	168.150	gray whale	feed	1	0	23
226	8/28/2017 15:21	67.859	168.212	gray whale	feed	2	0	23
226	8/28/2017 15:23	67.863	168.237	gray whale	feed	4	0	23
226	8/28/2017 15:27	67.880	168.282	gray whale	feed	2	0	23
226	8/28/2017 15:29	67.836	168.280	gray whale	feed	2	0	23
226	8/28/2017 15:32	67.852	168.368	gray whale	feed	3	0	23
226	8/28/2017 15:32	67.846	168.386	gray whale	feed	1	0	23
226	8/28/2017 15:32	67.856	168.408	gray whale	feed	1	0	23
226	8/28/2017 15:32	67.838	168.425	gray whale	feed	1	0	23
226	8/28/2017 15:32	67.845	168.435	gray whale	feed	2	0	23
226	8/28/2017 15:33	67.850	168.454	gray whale	feed	1	0	23
226	8/28/2017 15:33	67.848	168.479	gray whale	feed	1	0	23
226	8/28/2017 15:33	67.815	168.518	gray whale	swim	1	0	23
226	8/28/2017 15:34	67.848	168.579	gray whale	feed	1	0	23
226	8/28/2017 15:34	67.818	168.594	gray whale	swim	2	0	23
226	8/28/2017 15:34	67.856	168.594	gray whale	feed	1	0	23
226	8/28/2017 15:35	67.843	168.627	gray whale	swim	5	0	23
226	8/28/2017 15:35	67.846	168.647	gray whale	feed	1	0	23
226	8/28/2017 15:36	67.836	168.777	gray whale	feed	5	0	23
226	8/28/2017 15:37	67.810	168.771	gray whale	feed	1	0	23
226	8/28/2017 15:38	67.792	168.751	gray whale	feed	3	0	23
226	8/28/2017 15:39	67.754	168.775	gray whale	feed	1	0	23
226	8/28/2017 15:40	67.736	168.797	gray whale	swim	1	0	23
226	8/28/2017 15:40	67.724	168.748	gray whale	swim	1	0	23
226	8/28/2017 15:43	67.700	168.666	unid cetacean	swim	1	0	23
226	8/28/2017 15:52	67.718	167.849	unid cetacean	unknown	1	0	23
226	8/28/2017 15:53	67.693	167.819	gray whale	feed	3	0	23
226	8/28/2017 15:53	67.682	167.788	gray whale	feed	4	0	23
226	8/28/2017 15:54	67.683	167.687	gray whale	rest	1	0	23
226	8/28/2017 15:54	67.677	167.666	gray whale	swim	1	0	23
226	8/28/2017 15:55	67.693	167.580	gray whale	feed	4	0	23
226	8/28/2017 18:41	67.066	166.459	humpback whale	feed	4	0	23

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
226	8/28/2017 18:52	67.117	166.676	humpback whale	dive	1	0	23
226	8/28/2017 18:55	67.082	166.617	fin whale	dive	1	0	23
226	8/28/2017 18:58	67.065	166.651	humpback whale	dive	1	0	23
226	8/28/2017 19:02	67.092	166.679	fin whale	feed	2	0	23
226	8/28/2017 19:17	67.151	167.654	fin whale	feed	1	0	23
226	8/28/2017 19:31	67.118	168.177	fin whale	dive	2	0	23
226	8/28/2017 19:35	67.140	168.316	fin whale	feed	2	1	23
226	8/28/2017 19:45	67.153	168.602	fin whale	swim	2	0	23
226	8/28/2017 20:14	67.354	167.220	fin whale	swim	1	0	23

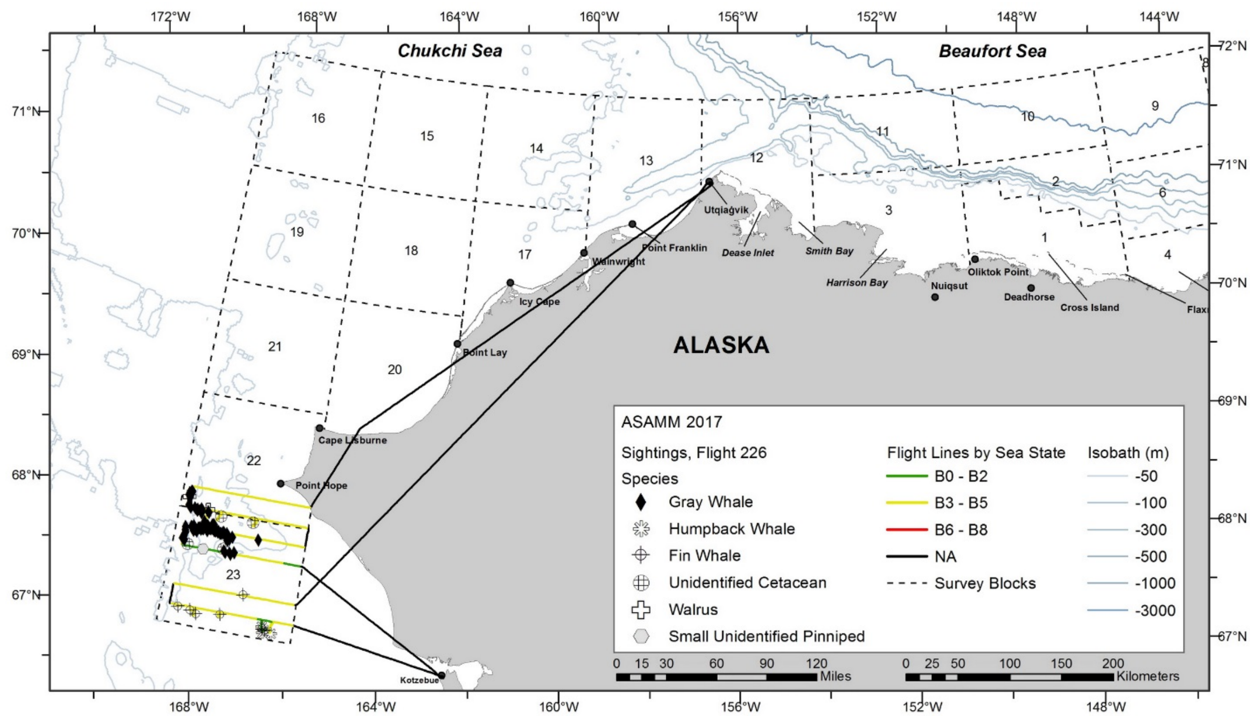
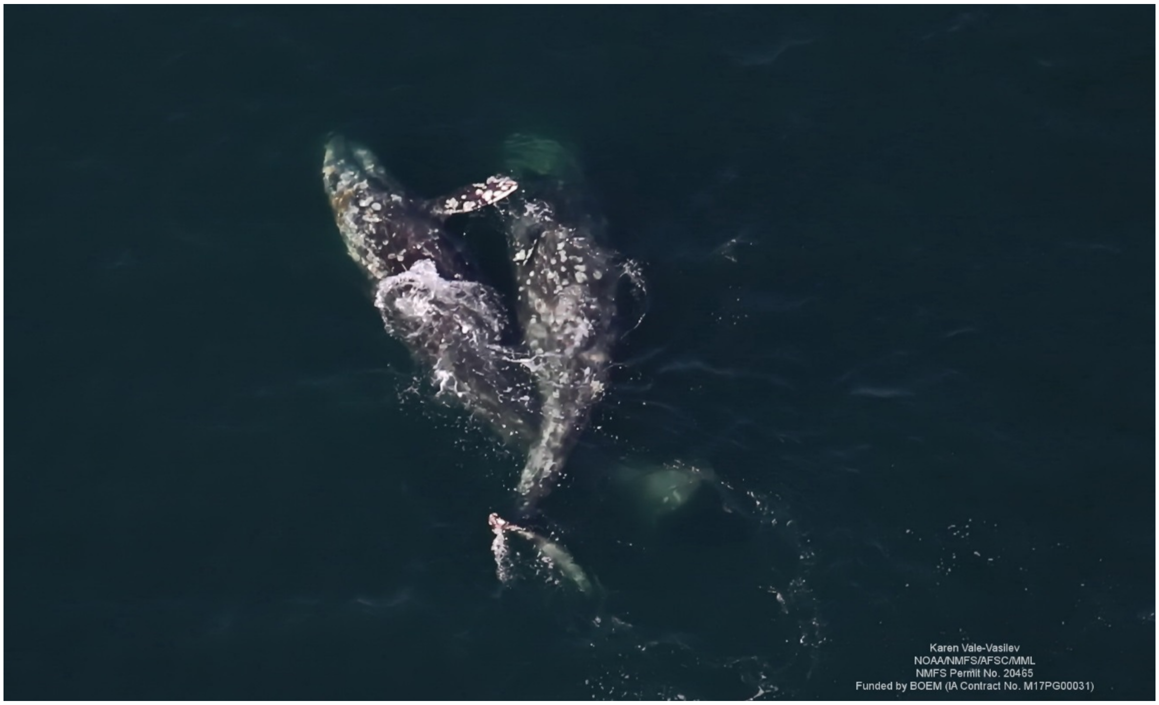


Figure B-47. Flight 226 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



A surface active group (SAG) of gray whales was sighted within a group of seven gray whales observed near the International Dateline, approximately 90 km west of Point Hope, Alaska, during ASAMM Flight 226, 28 August 2017.

A pair of feeding fin whales observed approximately 150 km south of Point Hope, Alaska, during ASAMM Flight 226, 28 August 2017.

Team Chukchi spotted this saildrone, observed approximately 55 km southwest of Point Hope, during ASAMM Flight 226, 28 August 2017. The drone is part of an ocean acidification study and had been north to 75°N and was on its way to rendezvous with the USCG Icebreaker *Healy* (information courtesy of Noah Lawrence-Slavas, NOAA).

28 August 2017, Flight 22

Flight was a survey of portions of blocks 5 and 7. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare and low ceilings), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 1 calf), unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
22	8/28/2017 15:26	70.152	141.950	bowhead whale	rest	1	1	5
22	8/28/2017 15:33	70.153	141.977	bowhead whale	swim	1	0	5

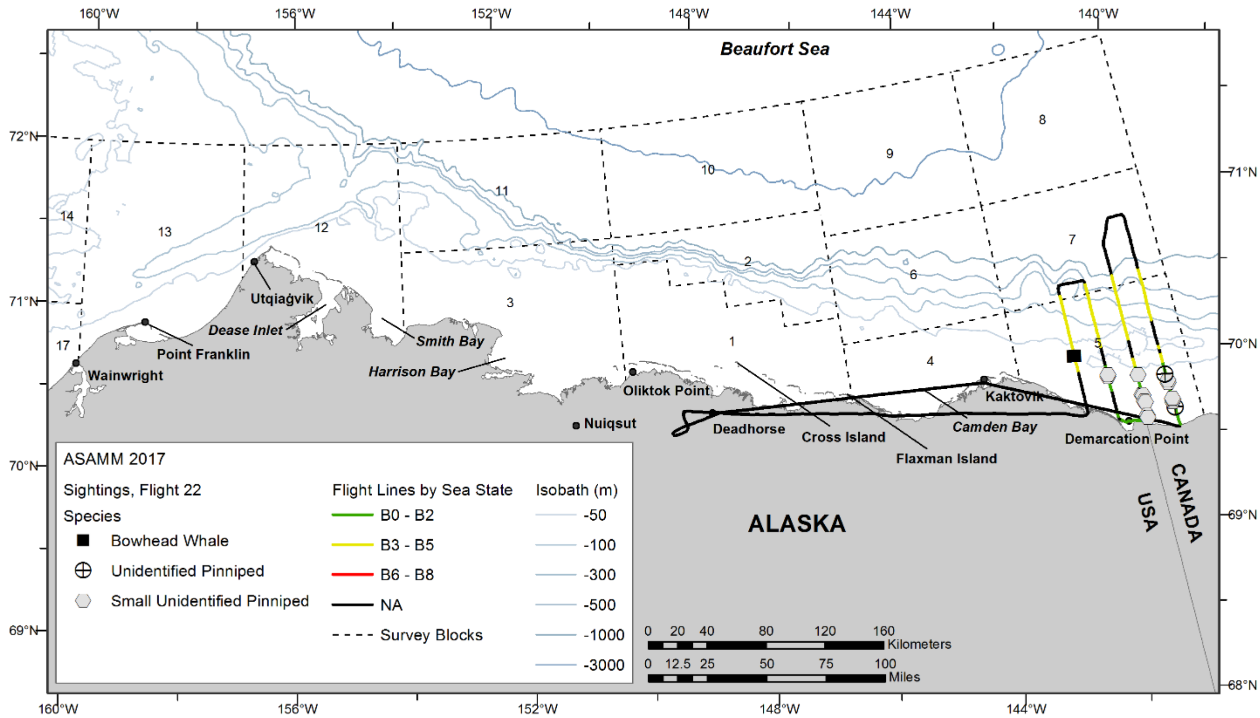


Figure B-48. Flight 22 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

29 August 2017, Flight 227

Flight was the coast transect from Cape Lisburne to east of Point Franklin. Survey conditions included partly cloudy skies, <1 km to unlimited visibility (with low ceilings and precipitation), and Beaufort 4-7 sea states. No sea ice was observed in the area surveyed. Sightings included two gray whale carcasses, walruses, one unidentified pinniped, and small unidentified pinnipeds. The walrus haulout near Point Lay was estimated at approximately 27,000 walruses. Two small unidentified pinniped haulouts, estimated at approximately 400 and 500 pinnipeds, were observed on barrier islands east and southwest of Icy Cape. The gray whale carcasses were resights of carcasses originally sighted during flight 219, 11 August 2017.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
227	8/29/2017 16:26	70.711	159.856	gray whale	dead	1	0	13
227	8/29/2017 16:30	70.739	159.780	gray whale	dead	1	0	13

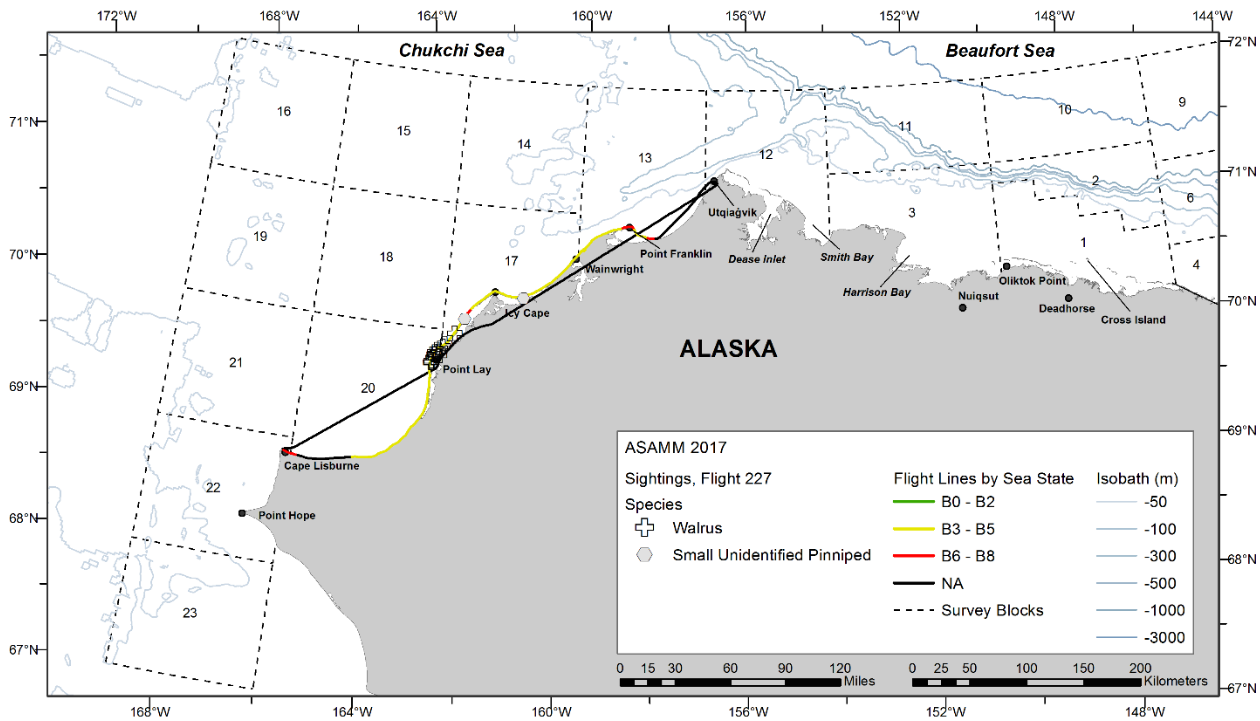


Figure B-49. Flight 227 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

29 August 2017, Flight 23

Flight was a survey of portions of blocks 1, 2, 3, 10, and 11. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, one unidentified cetacean, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
23	8/29/2017 17:20	70.96999	150.9558	bowhead whale	swim	1	0	3
23	8/29/2017 18:30	70.82082	150.4408	bowhead whale	swim	1	0	3
23	8/29/2017 19:41	70.88585	149.4604	bowhead whale	swim	1	0	1

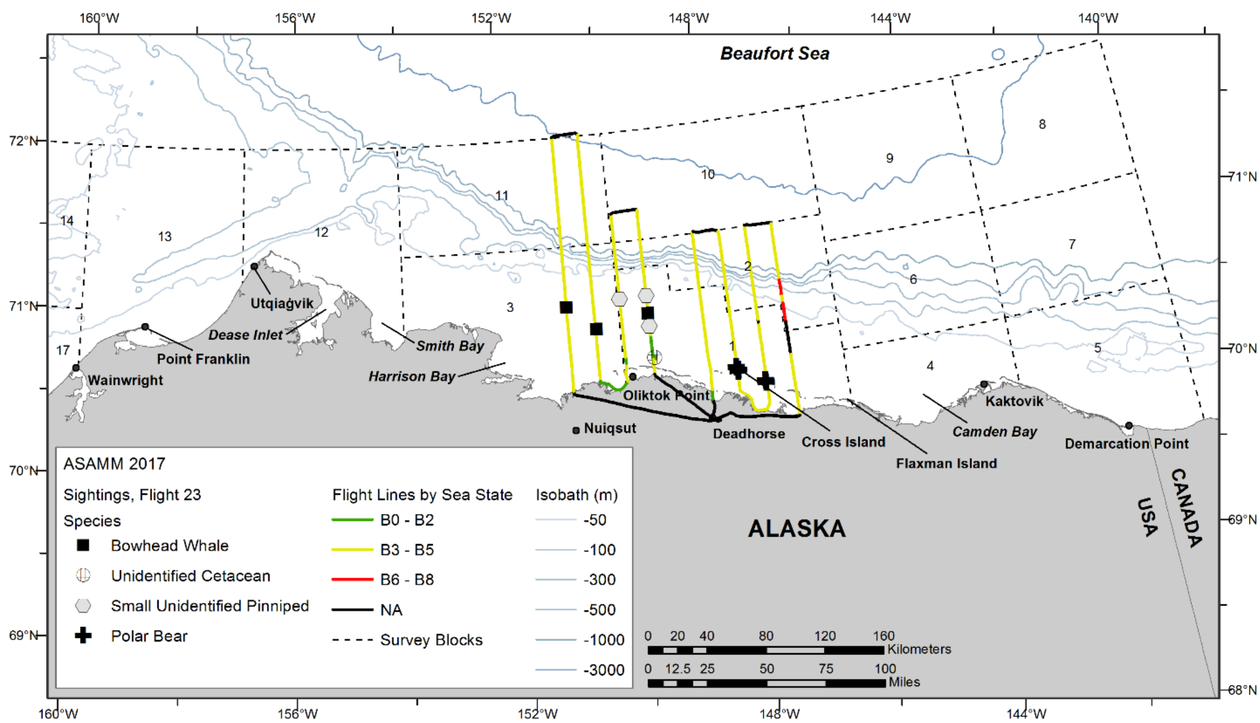


Figure B-50. Flight 23 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

2 September 2017, Flight 24

Flight was a survey of portions of blocks 1, 2, 3, and 11. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog and low ceilings), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included small unidentified pinnipeds and polar bears.

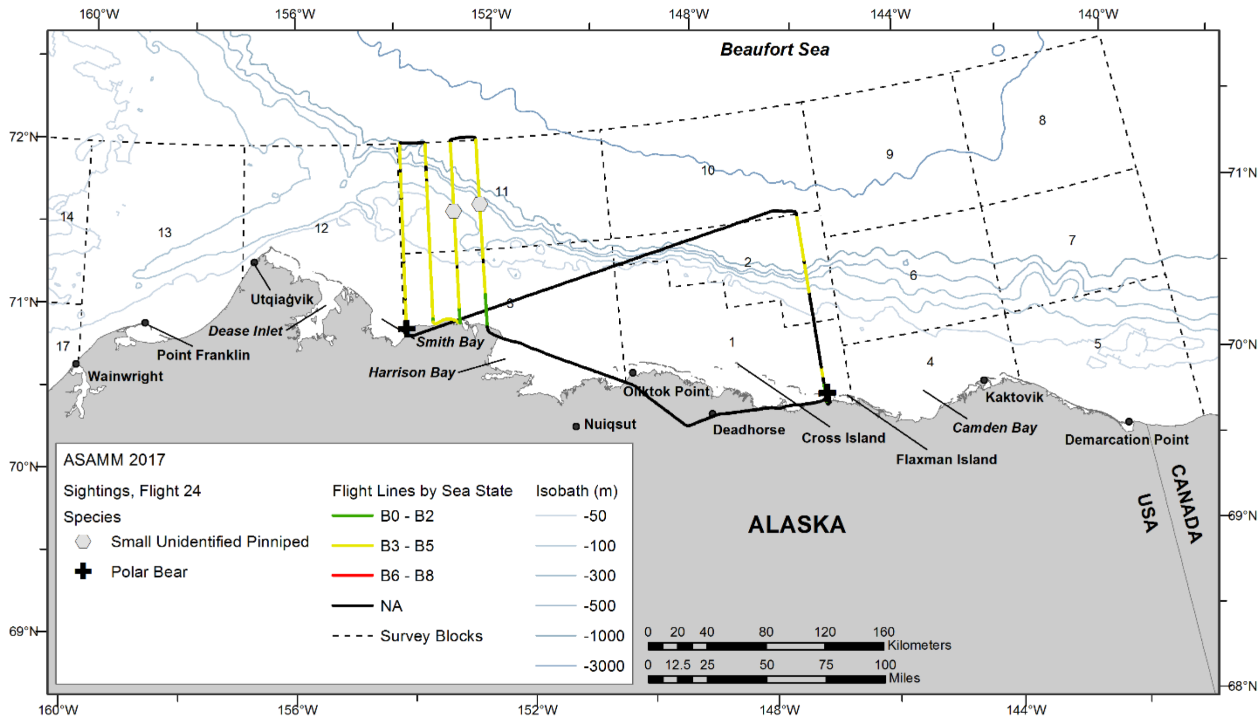


Figure B-51. Flight 24 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

3 September 2017, Flight 228

Flight was a partial survey of transects 4, 6, and 30, a survey of portions of block 12, and short sections of a coastal transect survey from Cape Lisburne to Point Hope and just south of Utqiaġvik. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, one unidentified cetacean, walruses, bearded seals, and small unidentified pinnipeds. The walrus haulout near Point Lay was estimated at approximately 34,500 walruses.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
228	9/3/2017 11:04	68.523	166.769	unid cetacean	swim	1	0	22
228	9/3/2017 15:22	71.533	160.572	bowhead whale	dive	2	0	14
228	9/3/2017 15:25	71.532	160.565	bowhead whale	swim	1	0	14
228	9/3/2017 15:33	71.642	161.068	bowhead whale	swim	1	0	14
228	9/3/2017 15:37	71.652	161.118	bowhead whale	dive	1	0	14
228	9/3/2017 15:38	71.646	161.148	bowhead whale	rest	1	0	14
228	9/3/2017 15:41	71.664	161.157	bowhead whale	swim	1	0	14

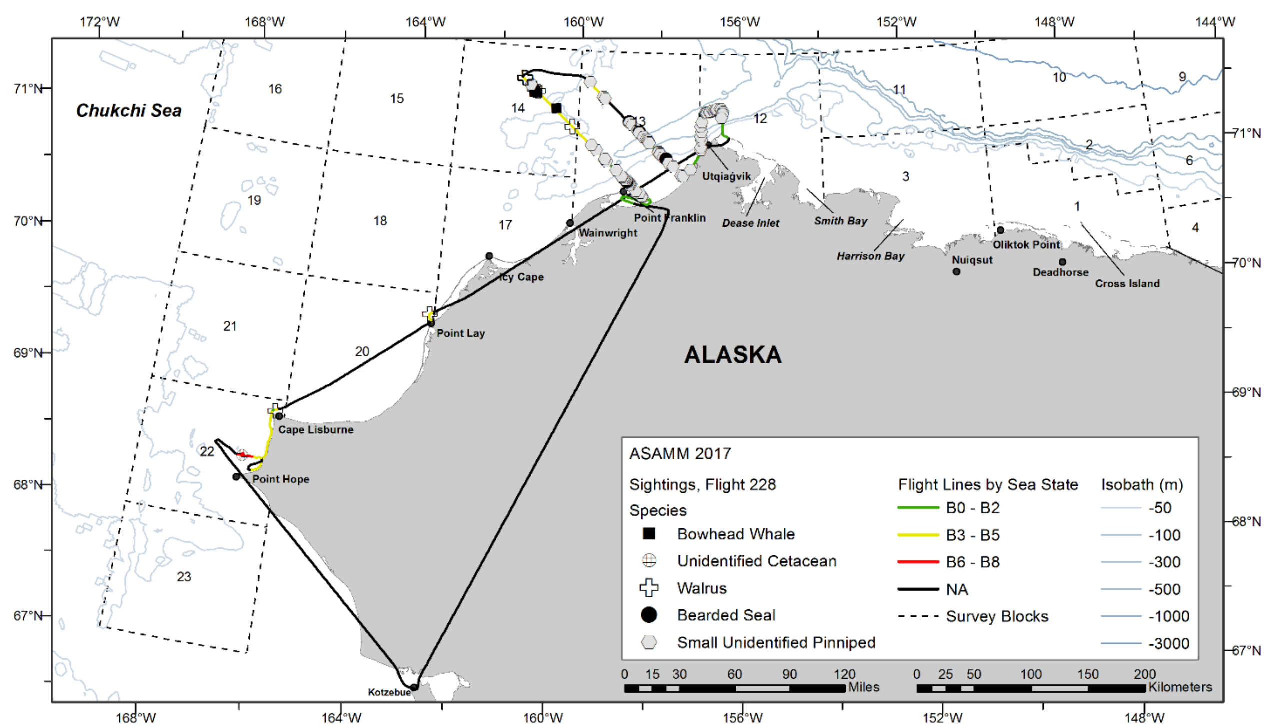


Figure B-52. Flight 228 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

3 September 2017, Flight 25

Flight was a survey of portions of blocks 1, 2, 4, 5, 6, and 7. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 1-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 33 calves), one unidentified cetacean, one bearded seal, unidentified pinnipeds, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
25	9/3/2017 11:00	70.311	144.503	bowhead whale	swim	1	0	4
25	9/3/2017 11:00	70.307	144.485	bowhead whale	swim	1	0	4
25	9/3/2017 11:03	70.281	144.430	bowhead whale	swim	1	0	4
25	9/3/2017 11:04	70.267	144.454	bowhead whale	swim	1	0	4
25	9/3/2017 11:04	70.259	144.457	bowhead whale	swim	2	0	4
25	9/3/2017 11:05	70.262	144.424	bowhead whale	swim	1	0	4
25	9/3/2017 11:06	70.267	144.383	bowhead whale	swim	2	1	4
25	9/3/2017 11:09	70.256	144.444	bowhead whale	swim	4	1	4
25	9/3/2017 11:11	70.274	144.398	bowhead whale	swim	1	0	4
25	9/3/2017 11:11	70.287	144.387	bowhead whale	swim	1	0	4
25	9/3/2017 11:12	70.292	144.432	bowhead whale	swim	2	1	4
25	9/3/2017 11:33	70.168	144.984	bowhead whale	dive	1	0	4
25	9/3/2017 11:33	70.171	144.922	bowhead whale	swim	1	0	4
25	9/3/2017 11:35	70.179	144.842	bowhead whale	swim	1	0	4
25	9/3/2017 11:35	70.191	144.847	bowhead whale	swim	2	1	4
25	9/3/2017 11:36	70.197	144.823	bowhead whale	swim	2	0	4
25	9/3/2017 11:38	70.177	144.829	bowhead whale	swim	2	0	4
25	9/3/2017 11:40	70.186	144.893	bowhead whale	swim	1	0	4
25	9/3/2017 11:42	70.155	144.858	bowhead whale	swim	1	0	4
25	9/3/2017 11:42	70.154	144.845	bowhead whale	swim	1	0	4
25	9/3/2017 11:43	70.165	144.847	bowhead whale	swim	2	1	4
25	9/3/2017 11:46	70.171	144.857	bowhead whale	swim	2	0	4
25	9/3/2017 11:47	70.155	144.903	bowhead whale	swim	1	0	4
25	9/3/2017 11:48	70.166	144.996	bowhead whale	swim	3	0	4
25	9/3/2017 11:50	70.168	144.965	bowhead whale	dive	2	0	4
25	9/3/2017 11:51	70.173	144.949	bowhead whale	dive	2	1	4
25	9/3/2017 11:55	70.304	144.914	bowhead whale	swim	2	1	4
25	9/3/2017 11:55	70.317	145.098	unid cetacean	unknown	1	0	4
25	9/3/2017 11:57	70.305	144.820	bowhead whale	swim	5	1	4
25	9/3/2017 11:59	70.294	144.791	bowhead whale	swim	2	1	4
25	9/3/2017 11:59	70.288	144.822	bowhead whale	swim	2	1	4
25	9/3/2017 12:01	70.287	144.767	bowhead whale	swim	2	0	4
25	9/3/2017 12:03	70.232	144.752	bowhead whale	swim	1	0	4
25	9/3/2017 12:03	70.237	144.778	bowhead whale	swim	1	0	4
25	9/3/2017 12:05	70.272	144.867	bowhead whale	swim	1	0	4
25	9/3/2017 12:08	70.300	145.097	bowhead whale	swim	1	0	4

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
25	9/3/2017 12:09	70.320	144.963	bowhead whale	swim	2	1	4
25	9/3/2017 12:13	70.342	145.010	bowhead whale	dive	2	1	4
25	9/3/2017 12:15	70.367	144.949	bowhead whale	dive	1	0	4
25	9/3/2017 12:49	70.375	145.383	bowhead whale	swim	2	0	4
25	9/3/2017 12:51	70.350	145.413	bowhead whale	swim	2	1	4
25	9/3/2017 12:51	70.353	145.428	bowhead whale	rest	1	1	4
25	9/3/2017 12:52	70.358	145.451	bowhead whale	rest	1	1	4
25	9/3/2017 12:54	70.345	145.366	bowhead whale	swim	1	0	4
25	9/3/2017 12:55	70.331	145.402	bowhead whale	swim	1	0	4
25	9/3/2017 12:55	70.330	145.403	bowhead whale	swim	1	0	4
25	9/3/2017 12:56	70.323	145.410	bowhead whale	swim	2	1	4
25	9/3/2017 12:57	70.336	145.435	bowhead whale	swim	1	1	4
25	9/3/2017 12:58	70.298	145.414	bowhead whale	swim	3	1	4
25	9/3/2017 13:00	70.300	145.353	bowhead whale	swim	1	1	4
25	9/3/2017 13:01	70.318	145.390	bowhead whale	swim	2	1	4
25	9/3/2017 13:03	70.317	145.426	bowhead whale	swim	2	1	4
25	9/3/2017 13:05	70.366	145.365	bowhead whale	rest	2	1	4
25	9/3/2017 13:05	70.366	145.362	bowhead whale	rest	1	0	4
25	9/3/2017 13:08	70.362	145.500	bowhead whale	swim	2	0	4
25	9/3/2017 13:12	70.291	145.488	bowhead whale	swim	1	0	4
25	9/3/2017 13:14	70.272	145.454	bowhead whale	swim	2	0	4
25	9/3/2017 13:17	70.238	145.490	bowhead whale	swim	1	0	4
25	9/3/2017 13:18	70.235	145.506	bowhead whale	swim	1	1	4
25	9/3/2017 13:20	70.233	145.495	bowhead whale	rest	1	0	4
25	9/3/2017 13:20	70.244	145.563	bowhead whale	rest	2	1	4
25	9/3/2017 13:21	70.255	145.528	bowhead whale	rest	2	1	4
25	9/3/2017 13:24	70.233	145.459	bowhead whale	rest	1	1	4
25	9/3/2017 13:32	70.128	145.641	bowhead whale	swim	1	0	4
25	9/3/2017 13:33	70.127	145.699	bowhead whale	swim	1	0	4
25	9/3/2017 13:42	70.400	145.879	bowhead whale	swim	2	0	4
25	9/3/2017 13:45	70.419	145.849	bowhead whale	swim	2	1	4
25	9/3/2017 13:47	70.406	145.927	bowhead whale	swim	1	0	4
25	9/3/2017 13:50	70.494	145.956	bowhead whale	swim	1	1	4
25	9/3/2017 13:50	70.498	145.956	bowhead whale	swim	2	1	4
25	9/3/2017 13:53	70.551	145.907	bowhead whale	swim	2	0	6
25	9/3/2017 15:44	70.323	146.451	bowhead whale	dive	3	0	1
25	9/3/2017 15:44	70.339	146.442	bowhead whale	swim	1	0	1
25	9/3/2017 15:46	70.333	146.403	bowhead whale	dive	1	0	1
25	9/3/2017 15:46	70.351	146.427	bowhead whale	feed	3	1	1
25	9/3/2017 15:49	70.340	146.394	bowhead whale	swim	1	0	1
25	9/3/2017 15:52	70.351	146.457	bowhead whale	swim	8	0	1
25	9/3/2017 15:53	70.360	146.515	bowhead whale	swim	1	0	1
25	9/3/2017 15:54	70.354	146.517	bowhead whale	swim	2	0	1
25	9/3/2017 15:56	70.379	146.526	bowhead whale	swim	2	1	1
25	9/3/2017 15:57	70.385	146.466	bowhead whale	mill	2	0	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
25	9/3/2017 15:59	70.360	146.438	bowhead whale	swim	1	0	1
25	9/3/2017 17:02	70.540	143.424	bowhead whale	swim	1	1	6
25	9/3/2017 17:22	70.222	142.950	bowhead whale	swim	1	1	5

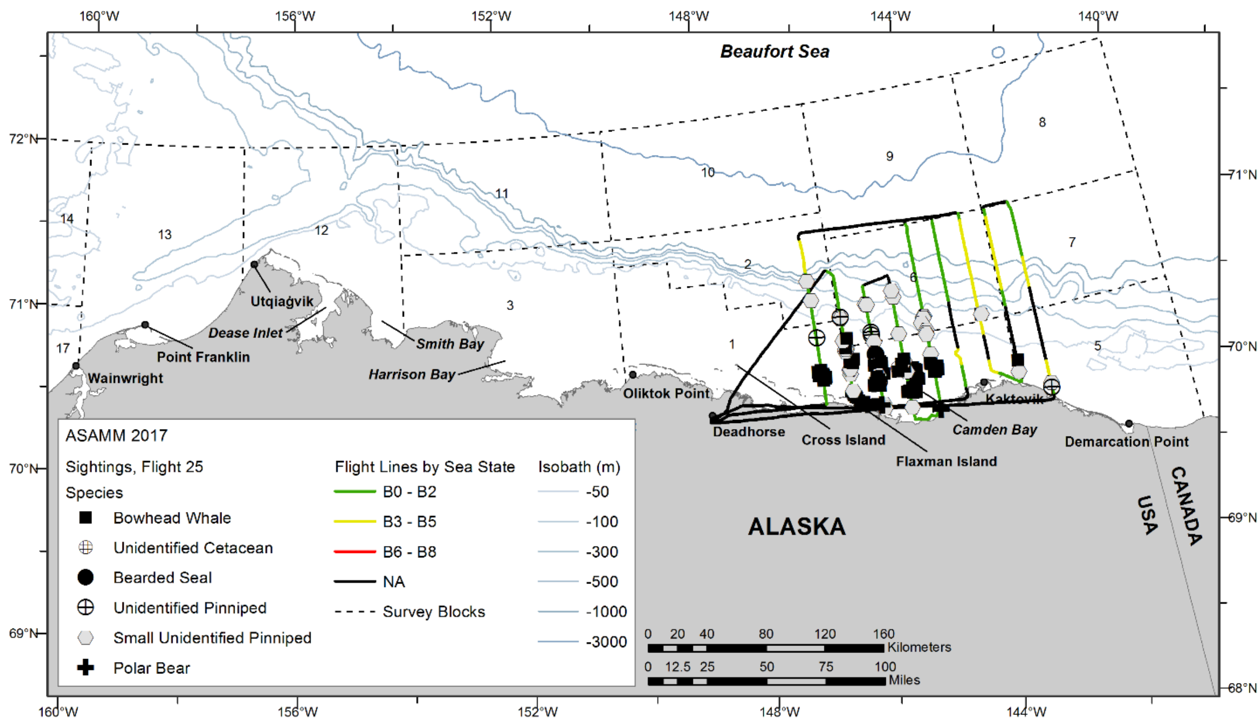


Figure B-53. Flight 25 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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4 September 2017, Flight 229

Flight was a complete survey of transects 8 and 10. Survey conditions included clear to partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, gray whales, one unidentified cetacean carcass, walruses, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
229	9/4/2017 11:23	71.660	162.730	unid cetacean	dead	1	0	14
229	9/4/2017 11:29	71.561	162.363	bowhead whale	swim	1	0	14
229	9/4/2017 11:29	71.560	162.346	bowhead whale	swim	1	0	14
229	9/4/2017 11:31	71.554	162.377	bowhead whale	swim	2	0	14
229	9/4/2017 11:47	71.308	161.458	gray whale	feed	1	0	14
229	9/4/2017 11:49	71.290	161.273	gray whale	feed	2	0	14
229	9/4/2017 11:53	71.296	161.281	gray whale	feed	1	0	14
229	9/4/2017 11:55	71.244	161.323	gray whale	feed	3	0	14
229	9/4/2017 11:59	71.253	161.233	gray whale	feed	1	0	14
229	9/4/2017 12:02	71.210	161.172	gray whale	feed	1	0	14
229	9/4/2017 12:03	71.207	161.193	gray whale	feed	1	0	14
229	9/4/2017 12:05	71.195	161.110	gray whale	feed	1	0	14
229	9/4/2017 12:06	71.213	160.994	gray whale	feed	1	0	14
229	9/4/2017 12:17	70.960	160.209	gray whale	feed	1	0	17

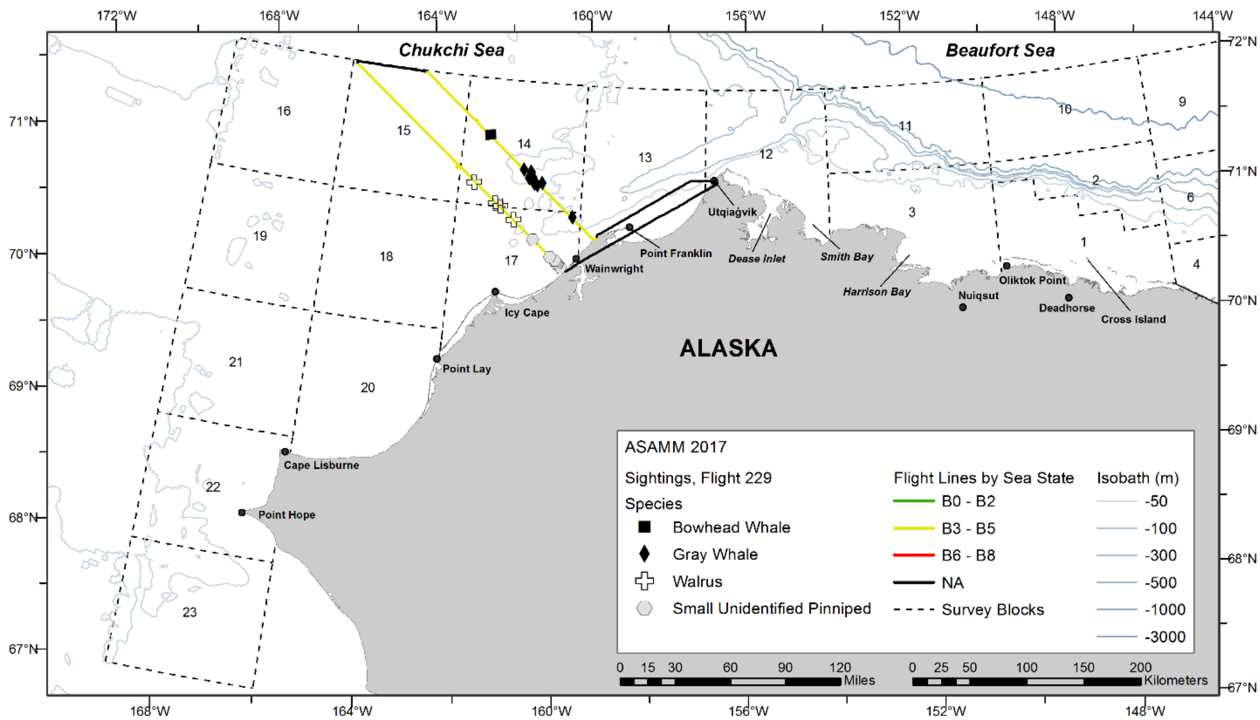

Figure B-54. Flight 229 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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8 September 2017, Flight 230

Flight was a partial survey of transect 8, search effort in Peard Bay, and search effort in blocks 12, 13, 14, and 17. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with low ceilings and precipitation), and Beaufort 4-7 sea states. No sea ice was observed in the area surveyed. Sightings included one gray whale and one walrus.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
230	9/8/2017 16:00	71.229	161.185	gray whale	feed	1	0	14

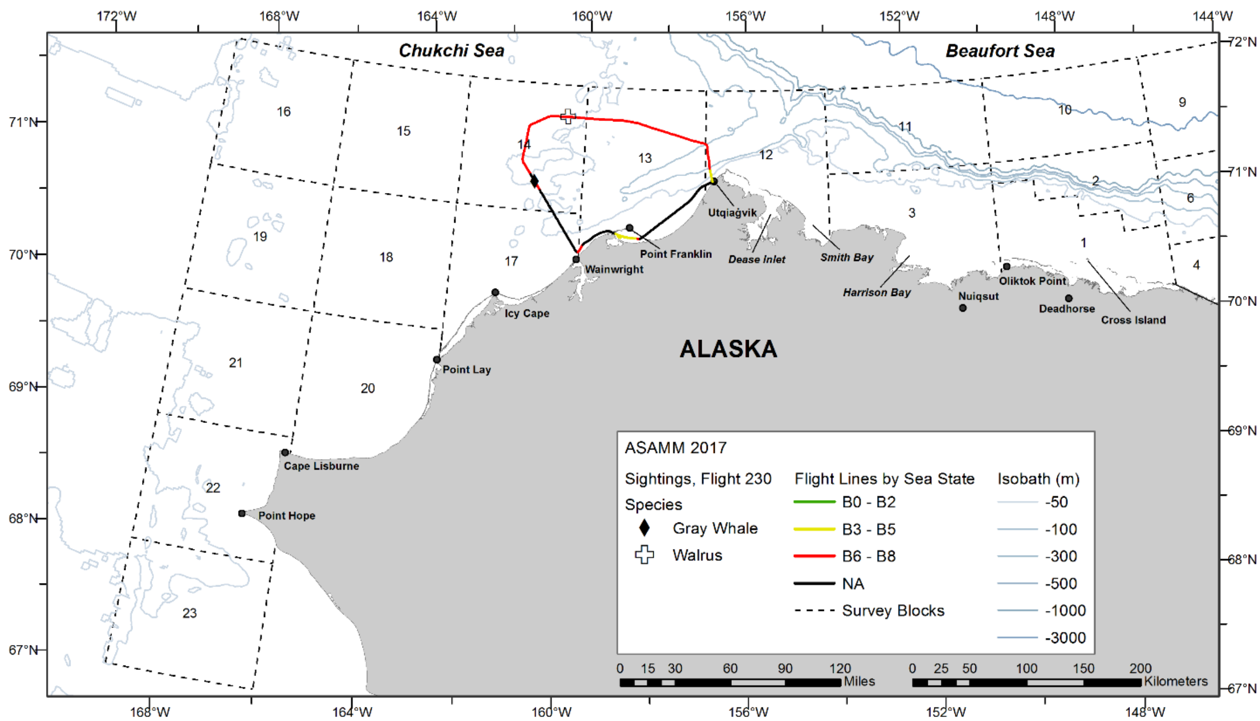

Figure B-55. Flight 230 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

9 September 2017, Flight 231

Flight was a complete survey of transects 2, 3, 4, 5, 6, and 7 and a survey of portions of block 12. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, gray whales, one unidentified cetacean, walruses, one bearded seal, one unidentified pinniped, small unidentified pinnipeds, and one polar bear.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
231	9/9/2017 10:08	71.374	154.957	bowhead whale	swim	1	0	12
231	9/9/2017 10:13	71.352	154.953	bowhead whale	swim	1	0	12
231	9/9/2017 10:50	71.669	155.912	bowhead whale	dive	1	0	12
231	9/9/2017 11:54	71.210	157.047	gray whale	dive	1	0	13
231	9/9/2017 12:03	71.266	157.376	gray whale	swim	1	0	13
231	9/9/2017 12:06	71.253	157.397	gray whale	swim	1	0	13
231	9/9/2017 12:06	71.255	157.412	gray whale	swim	1	0	13
231	9/9/2017 12:06	71.255	157.414	gray whale	swim	1	0	13
231	9/9/2017 12:06	71.256	157.428	gray whale	swim	1	0	13
231	9/9/2017 12:10	71.264	157.397	gray whale	swim	1	0	13
231	9/9/2017 12:11	71.278	157.382	gray whale	swim	1	0	13
231	9/9/2017 12:29	71.688	158.736	bowhead whale	swim	1	0	13
231	9/9/2017 14:36	71.595	159.178	bowhead whale	swim	1	0	13
231	9/9/2017 16:25	71.409	160.151	bowhead whale	swim	1	0	14
231	9/9/2017 16:52	71.919	162.022	bowhead whale	swim	1	0	14
231	9/9/2017 17:20	71.715	162.159	unid cetacean	swim	1	0	14
231	9/9/2017 17:40	71.461	161.168	bowhead whale	swim	1	0	14

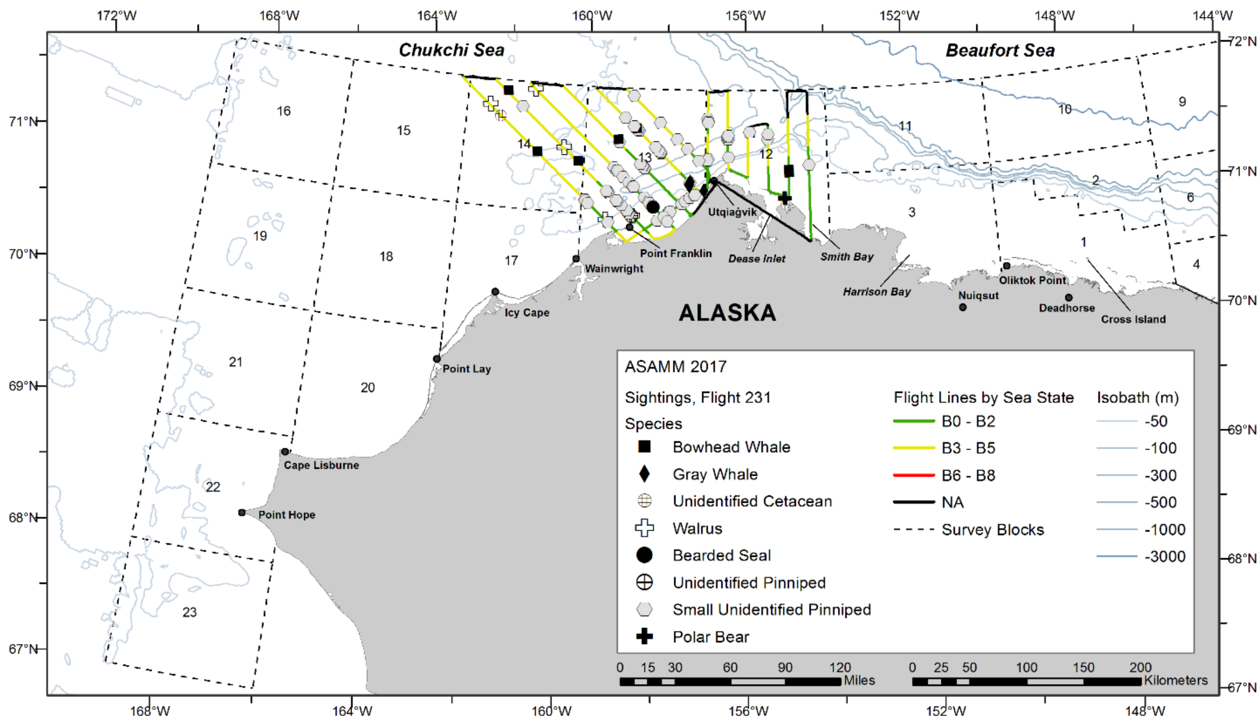

Figure B-56. Flight 231 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

9 September 2017, Flight 26

Flight was a survey of portions of blocks 1, 2, 3, and 11. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 1 calf) and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
26	9/9/2017 12:02	70.891	150.888	bowhead whale	rest	1	0	3
26	9/9/2017 12:03	70.896	150.898	bowhead whale	mill	2	0	3
26	9/9/2017 12:09	70.895	150.913	bowhead whale	mill	4	0	3
26	9/9/2017 12:10	70.903	150.918	bowhead whale	mill	5	0	3
26	9/9/2017 12:11	70.919	150.943	bowhead whale	mill	4	0	3
26	9/9/2017 12:16	70.979	150.976	bowhead whale	swim	1	0	3
26	9/9/2017 12:18	70.985	150.881	bowhead whale	swim	1	0	3
26	9/9/2017 12:20	70.989	150.854	bowhead whale	feed	8	0	3
26	9/9/2017 12:23	71.008	150.895	bowhead whale	mill	2	0	3
26	9/9/2017 12:59	70.921	150.442	bowhead whale	swim	1	0	3
26	9/9/2017 13:01	70.916	150.489	bowhead whale	swim	1	0	3
26	9/9/2017 13:02	70.922	150.496	bowhead whale	swim	1	0	3
26	9/9/2017 13:02	70.917	150.471	bowhead whale	swim	1	0	3
26	9/9/2017 13:03	70.918	150.451	bowhead whale	mill	2	0	3
26	9/9/2017 14:08	70.722	149.422	bowhead whale	swim	1	0	1
26	9/9/2017 14:08	70.718	149.424	bowhead whale	swim	1	0	1
26	9/9/2017 14:08	70.709	149.435	bowhead whale	swim	1	0	1
26	9/9/2017 14:08	70.697	149.429	bowhead whale	feed	1	0	1
26	9/9/2017 14:09	70.682	149.386	bowhead whale	feed	3	0	1
26	9/9/2017 14:12	70.660	149.309	bowhead whale	swim	5	0	1
26	9/9/2017 14:13	70.652	149.304	bowhead whale	feed	4	0	1
26	9/9/2017 14:15	70.655	149.375	bowhead whale	swim	1	0	1
26	9/9/2017 14:16	70.664	149.390	bowhead whale	rest	1	1	1
26	9/9/2017 14:19	70.669	149.439	bowhead whale	rest	1	0	1
26	9/9/2017 14:21	70.692	149.419	bowhead whale	feed	2	0	1
26	9/9/2017 14:22	70.703	149.399	bowhead whale	feed	1	0	1
26	9/9/2017 14:23	70.711	149.432	bowhead whale	feed	1	0	1
26	9/9/2017 14:24	70.718	149.426	bowhead whale	feed	2	0	1
26	9/9/2017 14:25	70.712	149.451	bowhead whale	rest	1	0	1
26	9/9/2017 14:26	70.678	149.511	bowhead whale	feed	1	0	1
26	9/9/2017 14:27	70.687	149.510	bowhead whale	rest	2	0	1
26	9/9/2017 14:27	70.681	149.509	bowhead whale	feed	3	0	1
26	9/9/2017 14:29	70.684	149.549	bowhead whale	feed	4	0	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
26	9/9/2017 14:31	70.707	149.613	bowhead whale	feed	1	0	1
26	9/9/2017 14:34	70.649	149.441	bowhead whale	swim	1	0	1

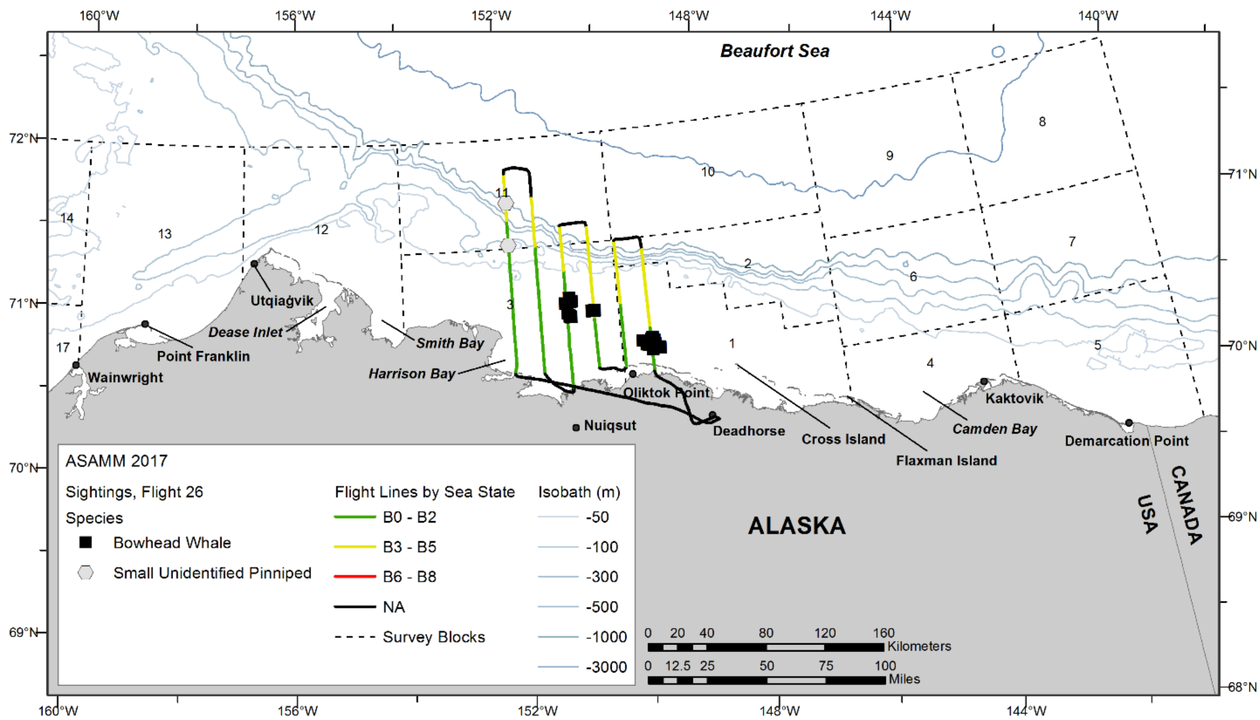

Figure B-57. Flight 26 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

10 September 2017, Flight 232

Flight was a complete survey of transect 11 and a partial survey of transect 9. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales and walruses.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
232	9/10/2017 17:51	71.543	164.917	bowhead whale	swim	1	0	15
232	9/10/2017 17:52	71.539	164.912	bowhead whale	swim	1	0	15
232	9/10/2017 18:03	71.718	165.741	bowhead whale	swim	1	0	15

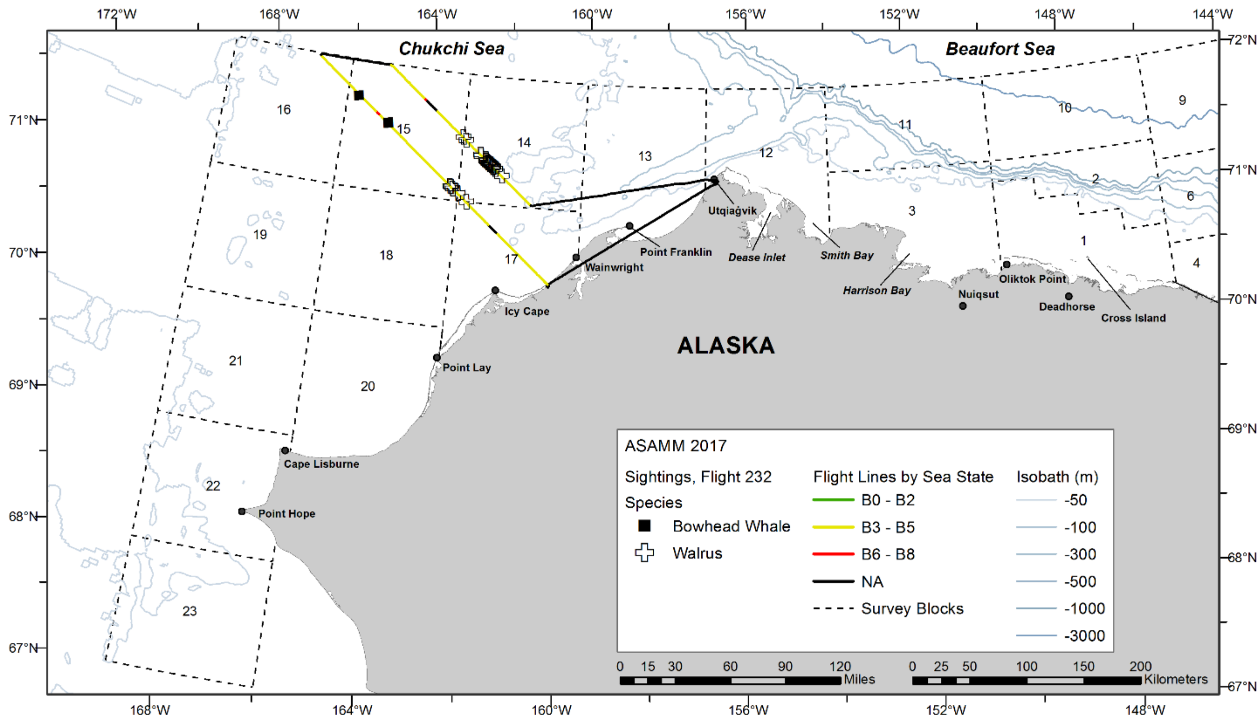

Figure B-58. Flight 232 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

11 September 2017, Flight 233

Flight was a complete survey of transects 28, 29, 30, and 31. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 3-5 sea states. No sea ice was observed in the area surveyed. Sightings included humpback whales, fin whales, one unidentified cetacean, and walruses.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
233	9/11/2017 11:41	68.528	168.270	humpback whale	feed	1	0	22
233	9/11/2017 11:43	68.526	168.283	humpback whale	swim	1	0	22
233	9/11/2017 11:59	68.517	168.369	fin whale	swim	1	0	22
233	9/11/2017 12:24	68.344	167.524	fin whale	feed	1	0	22
233	9/11/2017 12:27	68.368	167.476	unid cetacean	dive	1	0	22

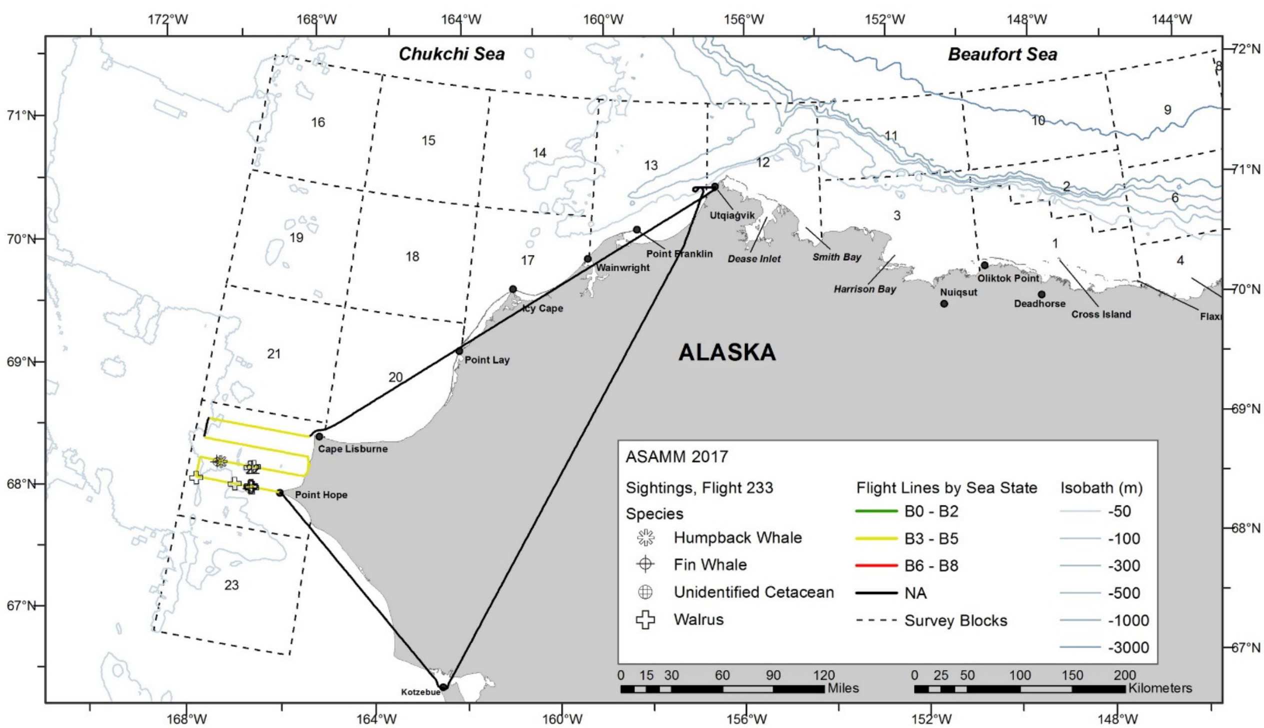

Figure B-59. Flight 233 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

11 September 2017, Flight 27

Flight was a survey of portions of blocks 1 and 4. Survey conditions included overcast skies, 0-10 km visibility (with fog and low ceilings), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 4 calves).

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
27	9/11/2017 16:30	70.607	148.458	bowhead whale	swim	1	0	1
27	9/11/2017 16:31	70.610	148.451	bowhead whale	rest	1	0	1
27	9/11/2017 16:33	70.600	148.412	bowhead whale	swim	2	1	1
27	9/11/2017 16:36	70.607	148.420	bowhead whale	rest	1	0	1
27	9/11/2017 16:36	70.610	148.398	bowhead whale	unknown	1	1	1
27	9/11/2017 16:39	70.591	148.458	bowhead whale	rest	1	0	1
27	9/11/2017 16:40	70.570	148.447	bowhead whale	rest	3	1	1
27	9/11/2017 16:41	70.560	148.452	bowhead whale	rest	1	0	1
27	9/11/2017 16:42	70.553	148.455	bowhead whale	dive	1	0	1
27	9/11/2017 16:42	70.549	148.461	bowhead whale	dive	1	0	1
27	9/11/2017 16:42	70.542	148.457	bowhead whale	rest	2	1	1
27	9/11/2017 16:42	70.541	148.441	bowhead whale	swim	1	0	1
27	9/11/2017 16:43	70.550	148.466	bowhead whale	rest	1	0	1

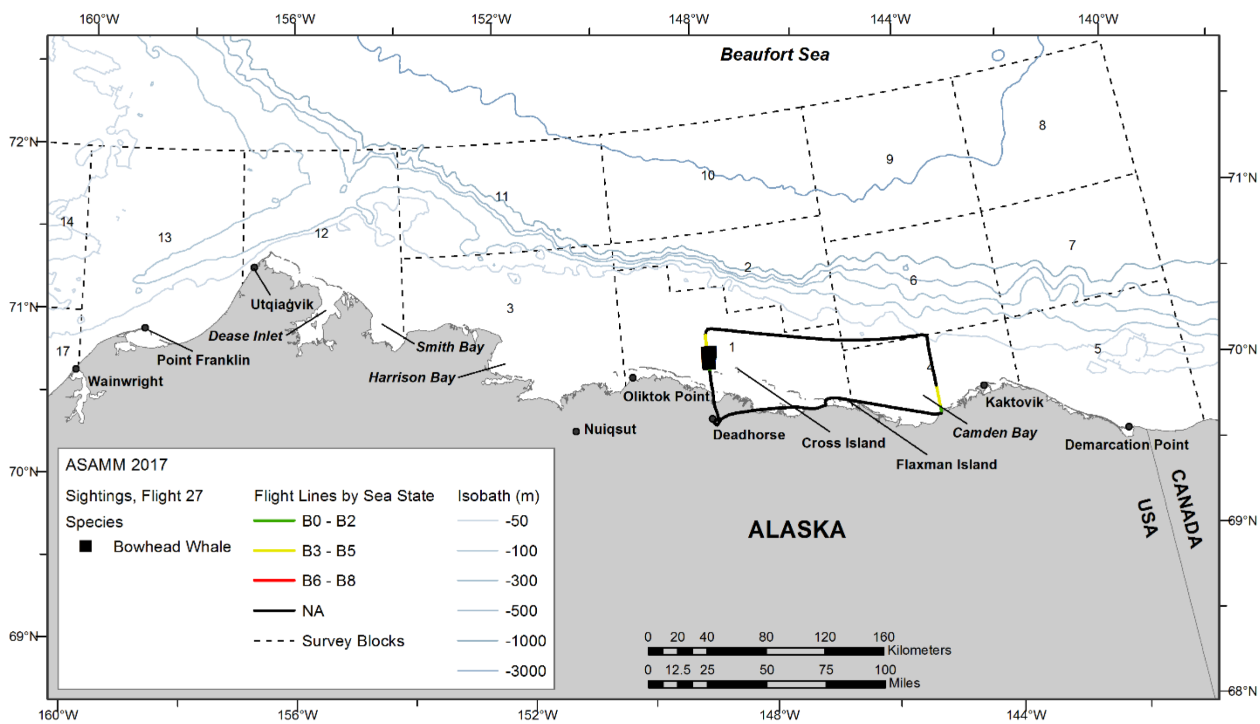

Figure B-60. Flight 27 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

12 September 2017, Flight 28

Flight was a survey of portions of blocks 1 and 2, and the coastal transect from 140°W to west of Demarcation Bay, and from west of Kaktovik to 147°W. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog and glare), and Beaufort 3-7 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
28	9/12/2017 15:32	70.341	146.955	bowhead whale	swim	1	0	1
28	9/12/2017 15:32	70.348	146.954	bowhead whale	swim	1	0	1

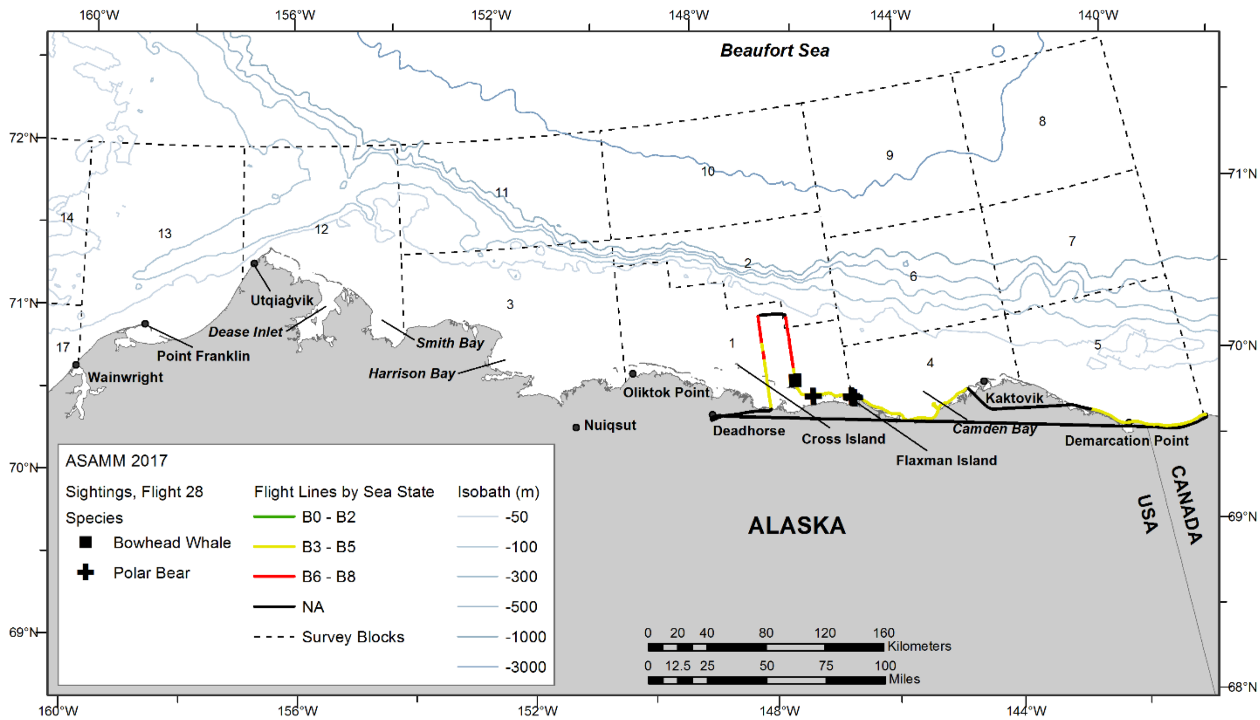

Figure B-61. Flight 28 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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13 September 2017, Flight 234

Flight was a partial survey of transects 13 and 15, and the coastal transect from Icy Cape to south of Utqiaġvik. Survey conditions included overcast skies, 0 km to unlimited visibility (with low ceilings and precipitation), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included one gray whale carcass, walruses, one unidentified pinniped, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
234	9/13/2017 13:41	70.741	159.775	gray whale	dead	1	0	13

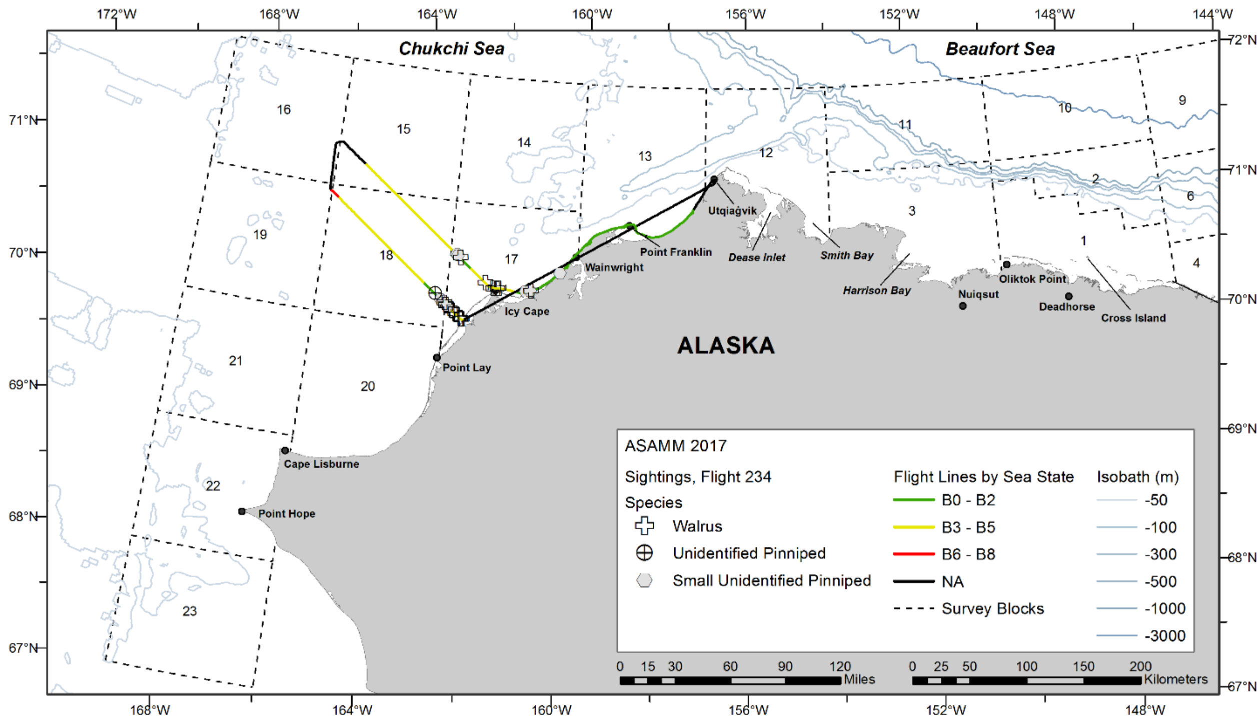

Figure B-62. Flight 234 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

13 September 2017, Flight 29

Flight was a survey of portions of blocks 3, 5, 7, and 11, and the coastal transect from west of Harrison Bay to Cross Island. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, belugas (including 1 calf), one unidentified cetacean, bearded seals, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
29	9/13/2017 11:20	70.069	140.886	unid cetacean	swim	1	0	5
29	9/13/2017 15:42	71.035	153.958	bowhead whale	rest	1	0	3
29	9/13/2017 16:48	70.989	152.950	bowhead whale	rest	2	0	3
29	9/13/2017 16:50	70.988	152.958	bowhead whale	swim	1	0	3
29	9/13/2017 16:51	70.998	152.912	bowhead whale	swim	1	0	3
29	9/13/2017 16:51	70.987	152.907	bowhead whale	feed	1	0	3
29	9/13/2017 16:51	70.990	152.878	bowhead whale	feed	1	0	3
29	9/13/2017 16:51	70.991	152.867	bowhead whale	feed	1	0	3
29	9/13/2017 17:29	71.947	152.957	beluga	swim	2	1	11

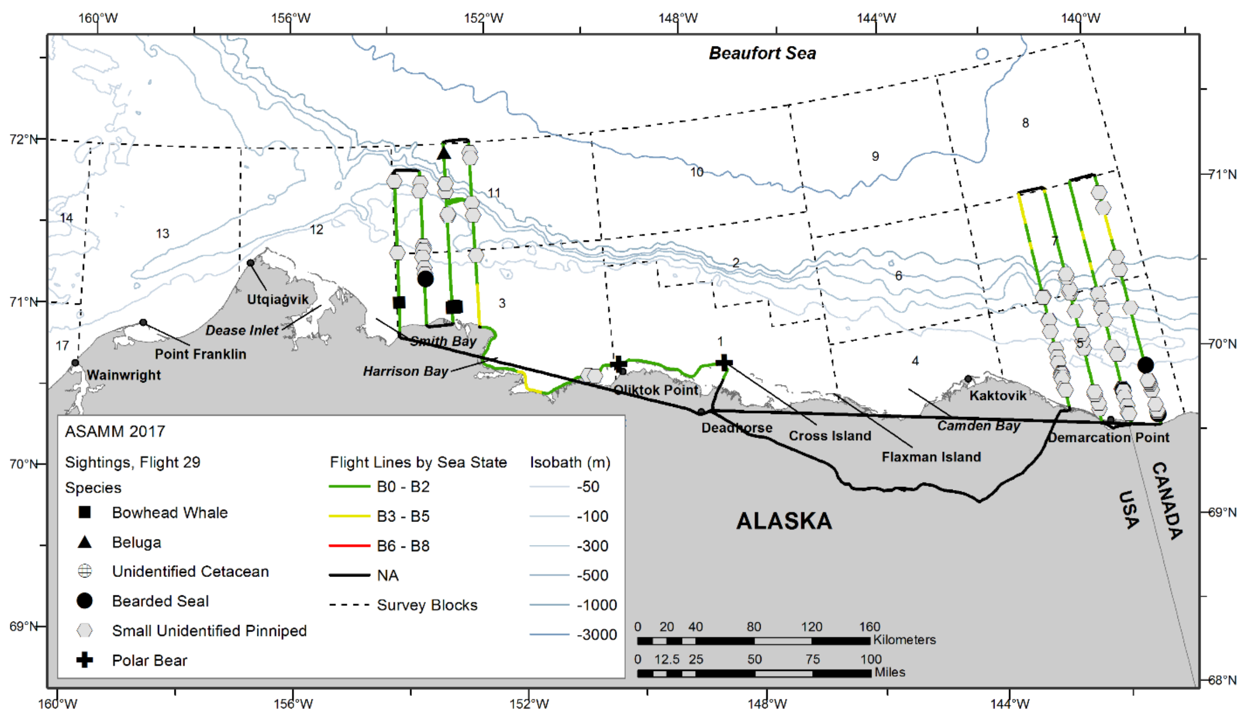

Figure B-63. Flight 29 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

The R/V *Sikuliaq*, sighted approximately 90 km north of Cape Halkett, Alaska, during ASAMM Flight 29, 13 September 2017.

The photographer becomes the photographee? Observe the sleek stylings of ASAMM survey aircraft Commander N690AX, photographed as it circled above fellow researchers on the R/V *Sikuliaq*, ASAMM Flight 29, 13 September 2017.

After three weeks without a single beluga sighting, this cow-calf pair was sighted approximately 120 km northwest of Cape Halkett, Alaska, during ASAMM Flight 29, 13 September 2017.

Polar bears observed feeding and resting among the bone piles on Cross Island, Alaska, during ASAMM Flight 29, 13 September 2017.

14 September 2017, Flight 235

Flight was a complete survey of transects 1, 2, 4, 5, and 7 and a partial survey of transect 3. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with glare, haze, and low ceilings), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, gray whales, one unidentified cetacean, walruses, bearded seals, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
235	9/14/2017 10:30	71.342	156.872	gray whale	rest	1	0	12
235	9/14/2017 16:24	71.415	160.983	bowhead whale	swim	2	0	14
235	9/14/2017 16:53	71.762	162.323	bowhead whale	swim	1	0	14
235	9/14/2017 16:57	71.774	162.406	bowhead whale	swim	1	0	14
235	9/14/2017 16:59	71.807	162.591	unid cetacean	swim	1	0	14
235	9/14/2017 17:03	71.827	162.564	bowhead whale	swim	1	0	14
235	9/14/2017 18:11	71.119	158.342	gray whale	feed	1	0	13

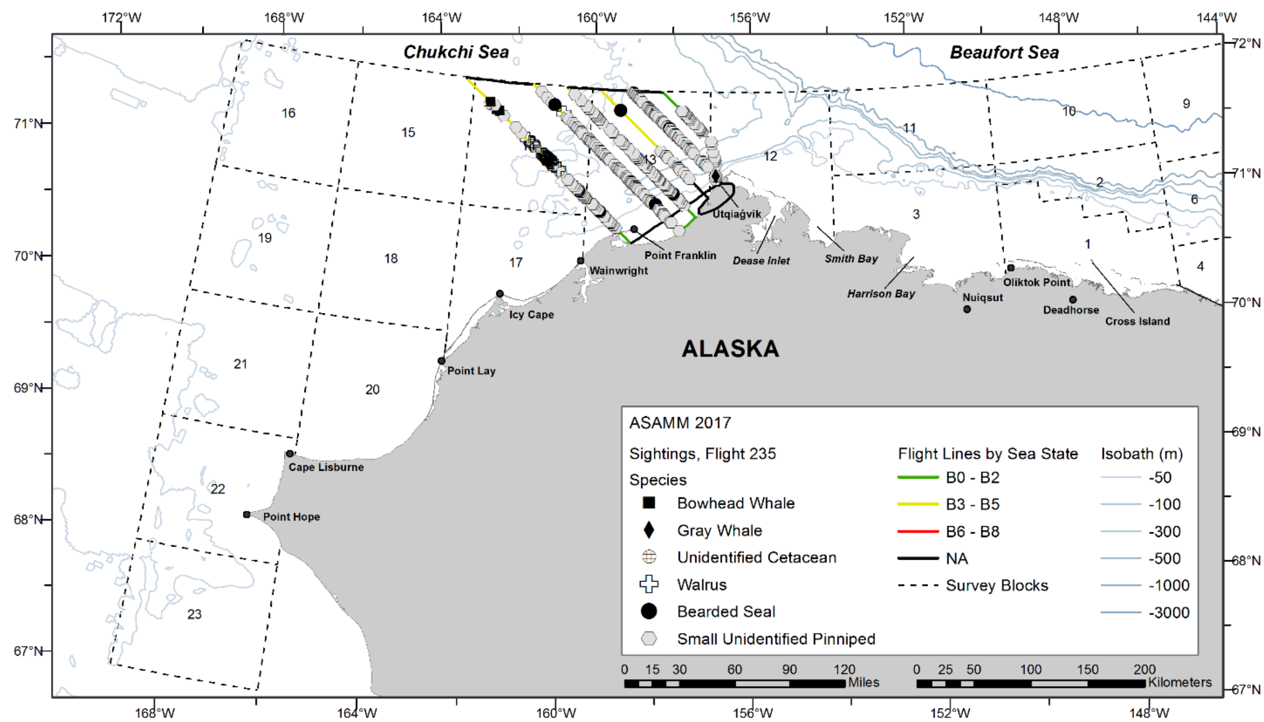

Figure B-64. Flight 235 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

14 September 2017, Flight 30

Flight was a survey of portions of blocks 1, 2, 4, and 6. The easternmost transect in blocks 1 and 2 was surveyed twice in succession to investigate the variability in sightings during replicate transects. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with fog and glare), and Beaufort 1-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 32 calves), one unidentified cetacean, bearded seals, unidentified pinnipeds, small unidentified pinnipeds, and polar bears. During the first survey of the easternmost transect, 63 bowhead whales (including 16 calves) were sighted. During the replicate survey of the same transect, 42 bowhead whales (including 6 calves) were sighted. It is not known how many unique individual bowhead whales were sighted during each survey of this transect, therefore, the total number of bowhead whales presented here may include duplicate sightings.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
30	9/14/2017 9:40	70.261	146.475	bowhead whale	rest	1	0	1
30	9/14/2017 9:41	70.268	146.477	bowhead whale	rest	1	0	1
30	9/14/2017 9:42	70.248	146.467	bowhead whale	feed	1	0	1
30	9/14/2017 9:44	70.290	146.435	bowhead whale	rest	1	0	1
30	9/14/2017 9:44	70.285	146.417	bowhead whale	rest	1	0	1
30	9/14/2017 9:44	70.283	146.418	bowhead whale	rest	1	0	1
30	9/14/2017 9:45	70.269	146.422	bowhead whale	rest	2	0	1
30	9/14/2017 9:45	70.270	146.437	bowhead whale	unknown	1	0	1
30	9/14/2017 9:47	70.287	146.452	bowhead whale	rest	1	0	1
30	9/14/2017 9:48	70.313	146.473	bowhead whale	rest	1	0	1
30	9/14/2017 9:48	70.316	146.374	bowhead whale	swim	2	1	1
30	9/14/2017 9:52	70.318	146.328	bowhead whale	swim	2	0	1
30	9/14/2017 9:54	70.322	146.450	bowhead whale	swim	1	0	1
30	9/14/2017 9:55	70.326	146.489	bowhead whale	mill	3	0	1
30	9/14/2017 9:56	70.332	146.495	bowhead whale	feed	1	0	1
30	9/14/2017 9:58	70.355	146.461	bowhead whale	swim	2	1	1
30	9/14/2017 9:58	70.352	146.450	bowhead whale	rest	1	0	1
30	9/14/2017 9:58	70.344	146.458	bowhead whale	rest	3	0	1
30	9/14/2017 9:59	70.357	146.438	bowhead whale	swim	1	0	1
30	9/14/2017 9:59	70.359	146.409	bowhead whale	rest	2	1	1
30	9/14/2017 10:02	70.339	146.268	bowhead whale	SAG	2	2	1
30	9/14/2017 10:03	70.352	146.273	bowhead whale	swim	1	0	1
30	9/14/2017 10:04	70.354	146.294	bowhead whale	mill	3	0	1
30	9/14/2017 10:04	70.351	146.311	bowhead whale	rest	1	0	1
30	9/14/2017 10:05	70.381	146.248	bowhead whale	mill	5	1	1
30	9/14/2017 10:10	70.363	146.474	bowhead whale	rest	2	1	1
30	9/14/2017 10:10	70.367	146.496	bowhead whale	breach	1	0	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
30	9/14/2017 10:11	70.365	146.484	bowhead whale	rest	1	0	1
30	9/14/2017 10:13	70.366	146.535	bowhead whale	rest	1	0	1
30	9/14/2017 10:13	70.358	146.517	bowhead whale	rest	1	1	1
30	9/14/2017 10:14	70.374	146.416	bowhead whale	swim	2	1	1
30	9/14/2017 10:15	70.378	146.423	bowhead whale	breach	1	0	1
30	9/14/2017 10:16	70.374	146.430	bowhead whale	feed	1	1	1
30	9/14/2017 10:19	70.405	146.472	bowhead whale	swim	1	1	1
30	9/14/2017 10:19	70.409	146.333	bowhead whale	mill	4	2	1
30	9/14/2017 10:21	70.403	146.407	bowhead whale	rest	1	0	1
30	9/14/2017 10:22	70.414	146.404	bowhead whale	rest	1	0	1
30	9/14/2017 10:23	70.405	146.288	bowhead whale	rest	2	1	1
30	9/14/2017 10:27	70.423	146.344	bowhead whale	swim	2	1	1
30	9/14/2017 10:33	70.439	146.453	bowhead whale	swim	1	1	1
30	9/14/2017 11:06	70.986	146.514	unid cetacean	unknown	1	0	2
30	9/14/2017 11:30	70.407	146.407	bowhead whale	rest	1	0	1
30	9/14/2017 11:33	70.422	146.363	bowhead whale	rest	1	0	1
30	9/14/2017 11:34	70.426	146.338	bowhead whale	rest	1	1	1
30	9/14/2017 11:34	70.426	146.327	bowhead whale	rest	1	0	1
30	9/14/2017 11:34	70.434	146.321	bowhead whale	rest	1	0	1
30	9/14/2017 11:35	70.423	146.344	bowhead whale	rest	1	0	1
30	9/14/2017 11:36	70.423	146.369	bowhead whale	swim	2	1	1
30	9/14/2017 11:39	70.379	146.412	bowhead whale	rest	2	1	1
30	9/14/2017 11:39	70.374	146.478	bowhead whale	rest	2	1	1
30	9/14/2017 11:39	70.371	146.451	bowhead whale	rest	1	0	1
30	9/14/2017 11:39	70.363	146.432	bowhead whale	rest	1	0	1
30	9/14/2017 11:41	70.363	146.386	bowhead whale	rest	1	0	1
30	9/14/2017 11:42	70.369	146.431	bowhead whale	rest	3	0	1
30	9/14/2017 11:43	70.377	146.430	bowhead whale	rest	1	0	1
30	9/14/2017 11:43	70.376	146.449	bowhead whale	rest	2	1	1
30	9/14/2017 11:43	70.360	146.435	bowhead whale	rest	3	1	1
30	9/14/2017 11:44	70.366	146.467	bowhead whale	swim	1	0	1
30	9/14/2017 11:44	70.373	146.467	bowhead whale	rest	2	0	1
30	9/14/2017 11:49	70.283	146.454	bowhead whale	rest	1	0	1
30	9/14/2017 11:50	70.278	146.467	bowhead whale	swim	1	0	1
30	9/14/2017 11:52	70.251	146.420	bowhead whale	rest	1	0	1
30	9/14/2017 11:54	70.252	146.508	bowhead whale	feed	2	0	1
30	9/14/2017 11:56	70.260	146.574	bowhead whale	rest	4	0	1
30	9/14/2017 11:58	70.258	146.643	bowhead whale	feed	2	0	1
30	9/14/2017 11:59	70.266	146.689	bowhead whale	feed	4	0	1
30	9/14/2017 12:12	70.285	146.855	bowhead whale	feed	30	0	1
30	9/14/2017 12:18	70.305	146.872	bowhead whale	feed	16	0	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
30	9/14/2017 12:18	70.304	146.926	bowhead whale	feed	16	1	1
30	9/14/2017 12:18	70.305	146.912	bowhead whale	feed	14	0	1
30	9/14/2017 12:19	70.312	146.897	bowhead whale	feed	1	0	1
30	9/14/2017 12:25	70.309	146.734	bowhead whale	feed	3	0	1
30	9/14/2017 12:28	70.341	146.943	bowhead whale	rest	2	0	1
30	9/14/2017 12:28	70.344	146.943	bowhead whale	rest	1	0	1
30	9/14/2017 12:29	70.347	146.922	bowhead whale	swim	1	0	1
30	9/14/2017 12:30	70.360	146.861	bowhead whale	swim	4	0	1
30	9/14/2017 12:31	70.372	146.936	bowhead whale	rest	1	0	1
30	9/14/2017 12:31	70.368	146.869	bowhead whale	rest	2	0	1
30	9/14/2017 12:33	70.366	146.848	bowhead whale	rest	1	0	1
30	9/14/2017 12:34	70.378	146.852	bowhead whale	mill	3	0	1
30	9/14/2017 12:36	70.388	146.920	bowhead whale	feed	6	0	1
30	9/14/2017 12:37	70.402	146.937	bowhead whale	feed	2	0	1
30	9/14/2017 12:37	70.401	146.922	bowhead whale	feed	1	0	1
30	9/14/2017 12:38	70.400	146.988	bowhead whale	swim	1	0	1
30	9/14/2017 12:39	70.406	146.962	bowhead whale	swim	2	0	1
30	9/14/2017 12:39	70.409	146.970	bowhead whale	swim	1	0	1
30	9/14/2017 12:41	70.406	146.988	bowhead whale	swim	1	0	1
30	9/14/2017 12:44	70.439	146.954	bowhead whale	swim	1	0	1
30	9/14/2017 12:47	70.492	147.009	bowhead whale	swim	1	0	1
30	9/14/2017 12:49	70.483	147.009	bowhead whale	swim	1	0	1
30	9/14/2017 12:50	70.477	147.020	bowhead whale	swim	1	0	1
30	9/14/2017 12:50	70.467	147.012	bowhead whale	rest	2	1	1
30	9/14/2017 12:51	70.514	146.850	bowhead whale	swim	4	0	1
30	9/14/2017 12:54	70.494	146.888	bowhead whale	rest	1	0	1
30	9/14/2017 12:55	70.490	146.922	bowhead whale	rest	2	1	1
30	9/14/2017 13:34	70.546	147.428	bowhead whale	swim	1	0	1
30	9/14/2017 13:38	70.568	147.329	bowhead whale	rest	2	1	1
30	9/14/2017 13:40	70.524	147.516	bowhead whale	unknown	1	0	1
30	9/14/2017 13:41	70.522	147.539	bowhead whale	feed	2	0	1
30	9/14/2017 13:42	70.518	147.471	bowhead whale	swim	1	0	1
30	9/14/2017 13:45	70.505	147.521	bowhead whale	feed	2	0	1
30	9/14/2017 13:46	70.501	147.509	bowhead whale	feed	1	0	1
30	9/14/2017 13:48	70.505	147.558	bowhead whale	feed	1	0	1
30	9/14/2017 13:51	70.473	147.440	bowhead whale	feed	1	0	1
30	9/14/2017 13:52	70.470	147.455	bowhead whale	feed	1	0	1
30	9/14/2017 13:52	70.466	147.456	bowhead whale	swim	1	0	1
30	9/14/2017 13:53	70.477	147.465	bowhead whale	swim	1	0	1
30	9/14/2017 13:54	70.471	147.447	bowhead whale	feed	2	0	1
30	9/14/2017 13:55	70.448	147.429	bowhead whale	feed	1	0	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
30	9/14/2017 13:56	70.452	147.433	bowhead whale	swim	1	0	1
30	9/14/2017 13:57	70.448	147.487	bowhead whale	feed	3	0	1
30	9/14/2017 13:58	70.459	147.520	bowhead whale	rest	1	0	1
30	9/14/2017 13:59	70.457	147.536	bowhead whale	feed	1	0	1
30	9/14/2017 14:00	70.443	147.458	bowhead whale	swim	1	0	1
30	9/14/2017 14:01	70.412	147.445	bowhead whale	rest	1	0	1
30	9/14/2017 15:27	70.611	147.975	bowhead whale	swim	1	0	1
30	9/14/2017 16:01	70.547	148.420	bowhead whale	rest	1	0	1
30	9/14/2017 16:02	70.544	148.402	bowhead whale	rest	1	0	1
30	9/14/2017 16:03	70.538	148.365	bowhead whale	rest	1	0	1
30	9/14/2017 16:05	70.532	148.457	bowhead whale	rest	1	0	1
30	9/14/2017 16:05	70.525	148.471	bowhead whale	rest	1	0	1
30	9/14/2017 16:06	70.521	148.454	bowhead whale	feed	3	0	1
30	9/14/2017 16:10	70.521	148.433	bowhead whale	feed	1	0	1
30	9/14/2017 16:27	70.605	148.941	bowhead whale	swim	1	0	1
30	9/14/2017 16:27	70.610	148.950	bowhead whale	rest	1	0	1
30	9/14/2017 16:30	70.625	148.991	bowhead whale	rest	1	0	1
30	9/14/2017 16:30	70.632	148.987	bowhead whale	rest	1	0	1
30	9/14/2017 16:32	70.634	148.954	bowhead whale	swim	1	0	1
30	9/14/2017 16:33	70.627	148.946	bowhead whale	rest	1	0	1
30	9/14/2017 16:36	70.711	148.959	bowhead whale	swim	1	0	1
30	9/14/2017 16:36	70.712	148.933	bowhead whale	swim	1	0	1
30	9/14/2017 16:36	70.714	148.988	bowhead whale	swim	1	0	1
30	9/14/2017 17:28	70.447	145.984	bowhead whale	rest	2	1	4
30	9/14/2017 17:29	70.446	145.991	bowhead whale	rest	1	1	4
30	9/14/2017 17:33	70.412	145.976	bowhead whale	rest	2	1	4
30	9/14/2017 17:35	70.427	145.940	bowhead whale	mill	3	2	4
30	9/14/2017 17:35	70.428	145.944	bowhead whale	rest	1	0	4
30	9/14/2017 17:37	70.433	145.945	bowhead whale	swim	1	0	4
30	9/14/2017 17:37	70.423	145.978	bowhead whale	swim	1	0	4
30	9/14/2017 17:39	70.397	146.080	bowhead whale	swim	2	0	1
30	9/14/2017 17:39	70.388	145.970	bowhead whale	swim	1	0	4
30	9/14/2017 17:41	70.410	146.037	bowhead whale	rest	1	0	1
30	9/14/2017 17:42	70.420	146.041	bowhead whale	swim	1	0	1
30	9/14/2017 17:44	70.381	145.958	bowhead whale	rest	1	0	4
30	9/14/2017 17:44	70.378	145.976	bowhead whale	rest	2	1	4
30	9/14/2017 17:44	70.383	145.970	bowhead whale	rest	2	0	4
30	9/14/2017 17:44	70.384	145.962	bowhead whale	rest	1	0	4
30	9/14/2017 17:49	70.280	145.965	bowhead whale	feed	1	0	4
30	9/14/2017 17:50	70.260	145.937	bowhead whale	feed	1	0	4
30	9/14/2017 17:52	70.238	146.091	bowhead whale	feed	6	0	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
30	9/14/2017 17:53	70.234	145.999	bowhead whale	feed	1	0	4
30	9/14/2017 17:53	70.234	145.981	bowhead whale	feed	1	0	4
30	9/14/2017 17:56	70.224	146.055	bowhead whale	rest	1	0	1

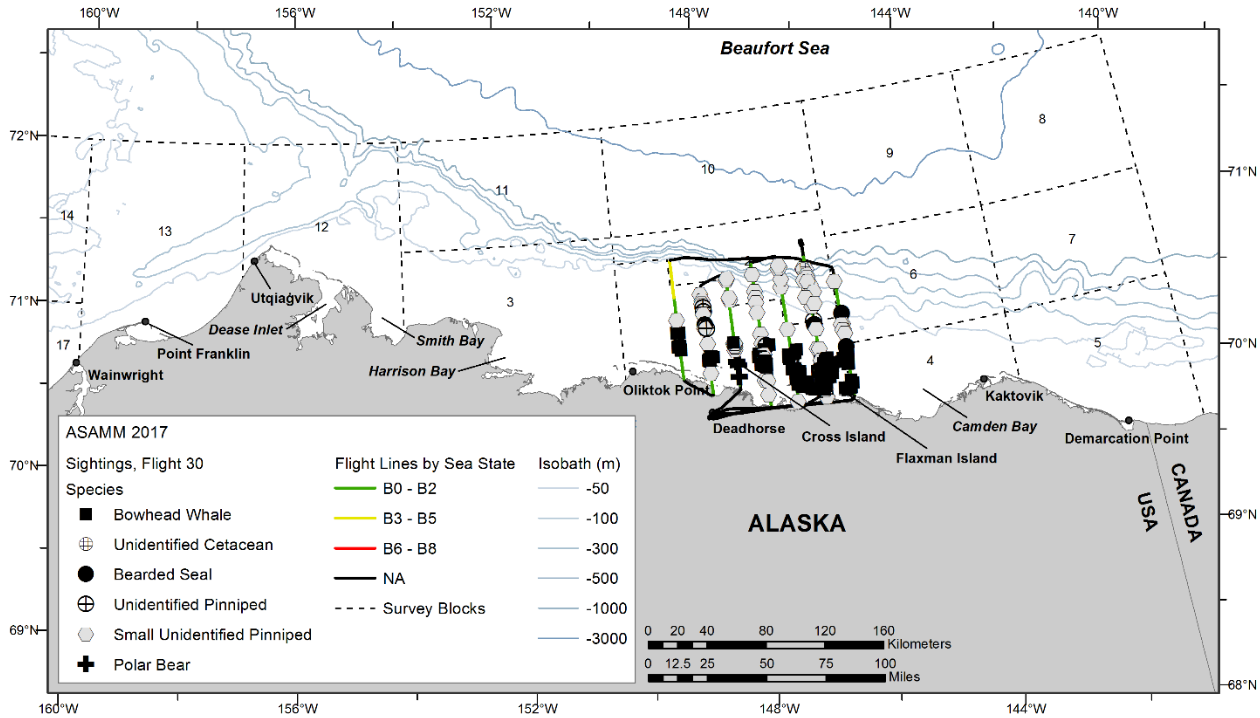

Figure B-65. Flight 30 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale cow and calf sighted during ASAMM Flight 30, 14 September 2017.

15 September 2017, Flight 31

Flight was a survey of portions of blocks 4, 5, 6, and 7. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, and haze), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 9 calves), unidentified pinnipeds, small unidentified pinnipeds, and one polar bear.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
31	9/15/2017 9:54	70.171	142.424	bowhead whale	swim	1	0	5
31	9/15/2017 10:43	70.237	142.944	bowhead whale	swim	1	0	5
31	9/15/2017 10:48	70.148	142.936	bowhead whale	swim	1	1	5
31	9/15/2017 10:51	70.151	142.922	bowhead whale	feed	1	0	5
31	9/15/2017 11:07	70.325	143.456	bowhead whale	swim	2	1	4
31	9/15/2017 11:51	70.429	143.836	bowhead whale	rest	3	0	4
31	9/15/2017 11:52	70.423	143.832	bowhead whale	swim	1	0	4
31	9/15/2017 11:56	70.440	143.770	bowhead whale	rest	2	0	4
31	9/15/2017 12:01	70.311	143.917	bowhead whale	rest	1	0	4
31	9/15/2017 12:02	70.310	143.902	bowhead whale	rest	1	0	4
31	9/15/2017 12:02	70.311	143.917	bowhead whale	rest	3	1	4
31	9/15/2017 12:06	70.268	143.957	bowhead whale	swim	2	1	4
31	9/15/2017 12:08	70.214	143.837	bowhead whale	swim	1	0	4
31	9/15/2017 12:10	70.209	143.857	bowhead whale	rest	1	0	4
31	9/15/2017 12:10	70.210	143.871	bowhead whale	unknown	1	0	4
31	9/15/2017 12:10	70.203	143.881	bowhead whale	swim	2	1	4
31	9/15/2017 12:11	70.210	143.875	bowhead whale	swim	1	0	4
31	9/15/2017 12:14	70.201	143.952	bowhead whale	swim	1	0	4
31	9/15/2017 12:27	70.138	144.428	bowhead whale	swim	1	0	4
31	9/15/2017 12:30	70.201	144.534	bowhead whale	mill	4	1	4
31	9/15/2017 12:31	70.203	144.526	bowhead whale	swim	1	0	4
31	9/15/2017 12:34	70.203	144.456	bowhead whale	swim	1	0	4
31	9/15/2017 12:35	70.220	144.473	bowhead whale	swim	1	0	4
31	9/15/2017 13:02	70.366	144.964	bowhead whale	swim	2	1	4
31	9/15/2017 13:06	70.244	144.835	bowhead whale	swim	1	0	4
31	9/15/2017 13:10	70.192	144.920	bowhead whale	swim	2	1	4
31	9/15/2017 13:12	70.177	144.952	bowhead whale	rest	1	1	4

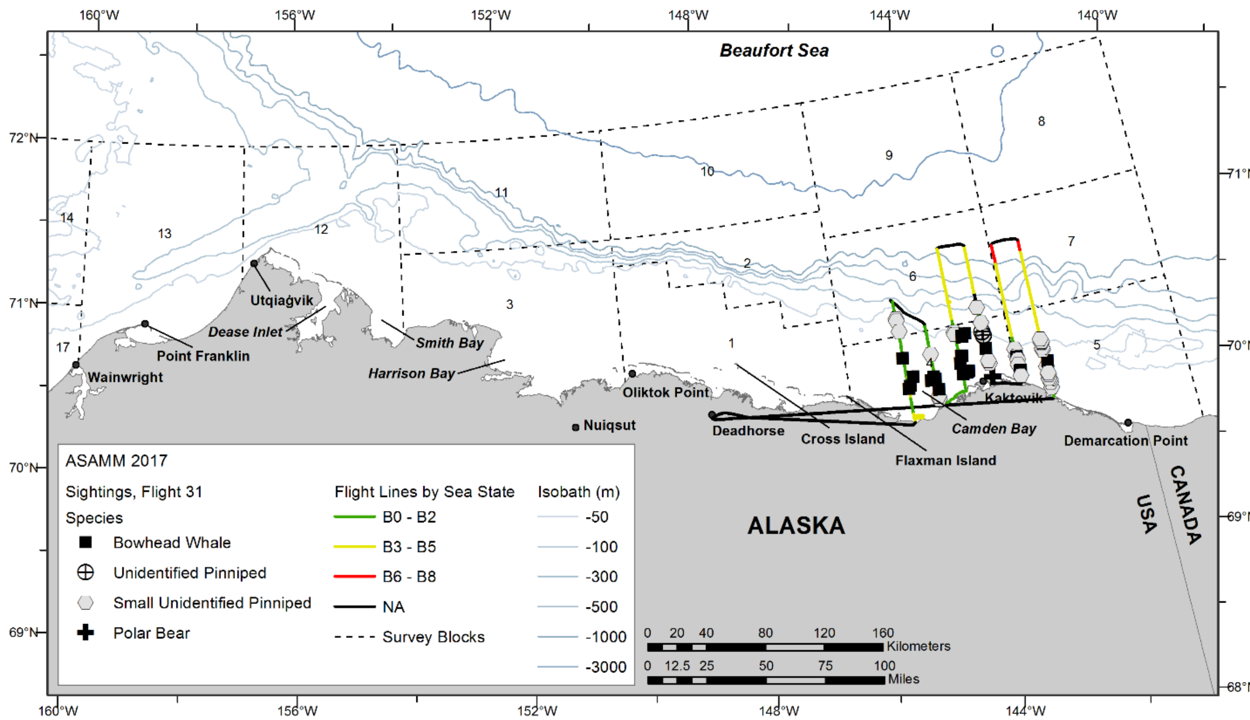

Figure B-66. Flight 31 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

18 September 2017, Flight 32

Flight was the coastal transect from approximately 146°W to east of Demarcation Bay. Survey conditions included clear to partly cloudy skies, 0 km to unlimited visibility (with fog and glare), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included belugas (including 9 calves) and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
32	9/18/2017 18:40	70.142	145.723	beluga	swim	45	3	4
32	9/18/2017 18:41	70.159	145.700	beluga	swim	50	6	4

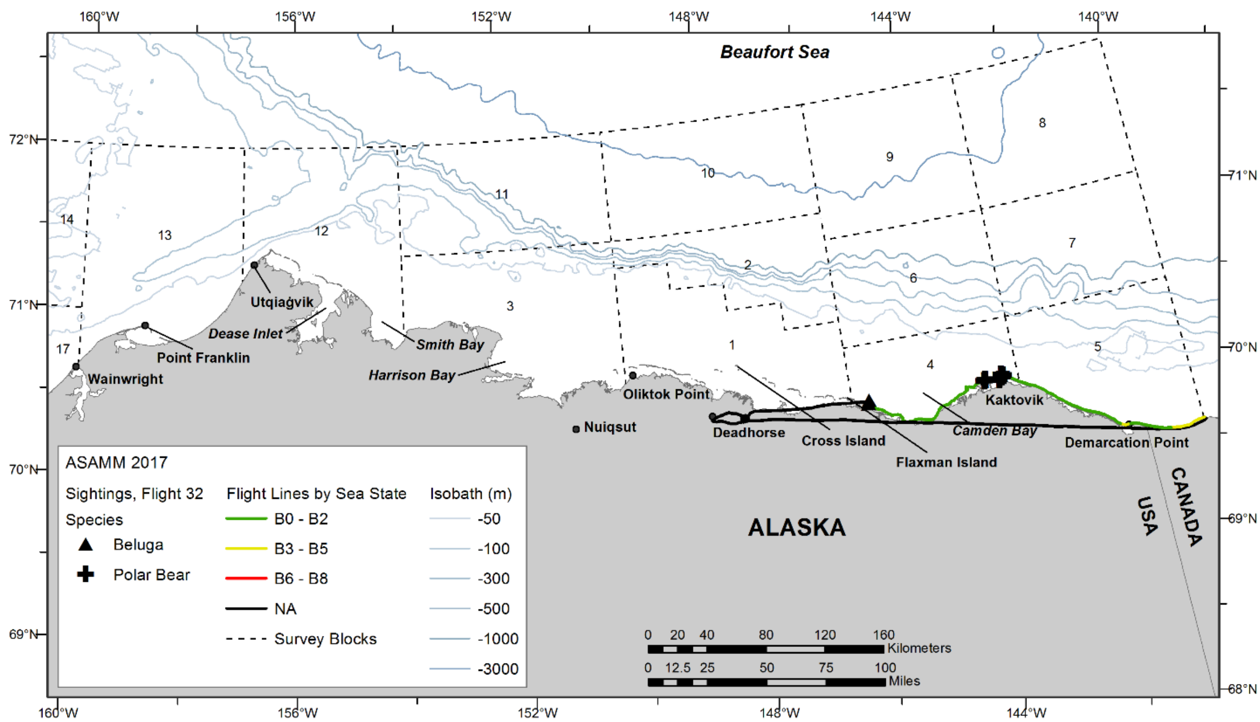

Figure B-67. Flight 32 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 September 2017, Flight 236

Flight was a complete survey of transects 14, 16, 18, and 20. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-5 sea states. No sea ice was observed in the area surveyed. Sightings included one gray whale, walruses, bearded seals, and small unidentified pinnipeds. Walruses hauled out near Point Lay were in three groups totaling 5,600 walruses.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
236	9/19/2017 10:43	69.523	164.588	gray whale	swim	1	0	20

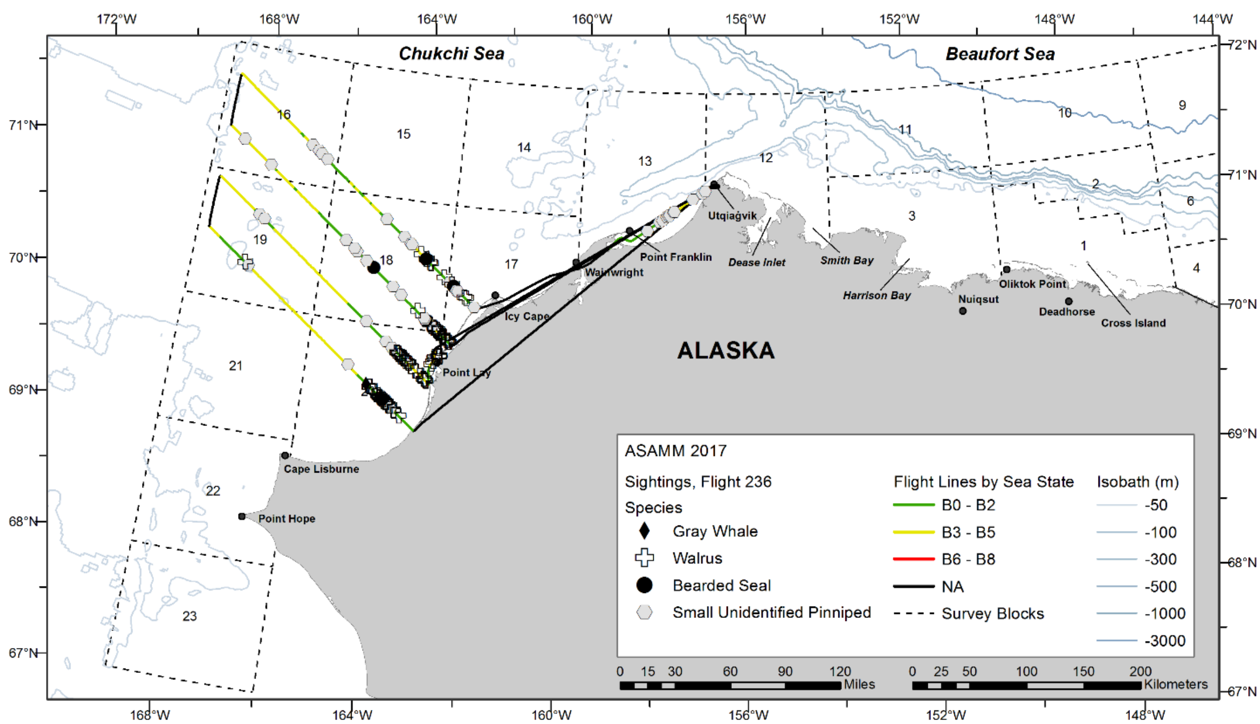

Figure B-68. Flight 236 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 September 2017, Flight 33

Flight was a complete survey of transects 8 and 10 and a survey of portions of block 12. Survey conditions included clear to overcast skies, 1 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included one bowhead whale, gray whales, killer whales, walruses, one bearded seal, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
33	9/19/2017 12:52	71.101	154.441	bowhead whale	dive	1	0	12
33	9/19/2017 16:31	70.776	161.095	gray whale	swim	1	0	17
33	9/19/2017 16:34	70.801	161.087	gray whale	swim	1	0	17
33	9/19/2017 16:37	70.798	161.126	gray whale	feed	3	0	17
33	9/19/2017 16:39	70.797	161.163	gray whale	breach	1	0	17
33	9/19/2017 16:39	70.790	161.183	gray whale	mill	2	0	17
33	9/19/2017 16:57	70.995	161.971	gray whale	feed	1	0	17
33	9/19/2017 16:58	70.995	161.988	gray whale	feed	1	0	17
33	9/19/2017 16:58	70.991	161.976	gray whale	feed	1	0	17
33	9/19/2017 16:59	70.993	161.962	gray whale	feed	1	0	17
33	9/19/2017 17:00	70.990	162.010	gray whale	swim	1	0	17
33	9/19/2017 17:01	70.974	162.010	gray whale	feed	3	0	17
33	9/19/2017 17:47	71.848	165.386	killer whale	swim	2	0	15
33	9/19/2017 18:48	71.297	161.412	gray whale	feed	2	0	14
33	9/19/2017 18:54	71.277	161.456	gray whale	feed	1	0	14
33	9/19/2017 18:54	71.278	161.459	gray whale	feed	2	0	14
33	9/19/2017 18:54	71.281	161.456	gray whale	feed	2	0	14
33	9/19/2017 18:54	71.287	161.434	gray whale	feed	2	0	14
33	9/19/2017 18:54	71.292	161.449	gray whale	feed	2	0	14
33	9/19/2017 18:56	71.259	161.371	gray whale	feed	2	0	14
33	9/19/2017 18:57	71.259	161.334	gray whale	feed	1	0	14
33	9/19/2017 18:57	71.256	161.345	gray whale	feed	1	0	14
33	9/19/2017 18:59	71.253	161.246	gray whale	feed	3	0	14
33	9/19/2017 18:59	71.243	161.263	gray whale	feed	1	0	14
33	9/19/2017 18:59	71.251	161.229	gray whale	feed	1	0	14
33	9/19/2017 19:01	71.248	161.244	gray whale	feed	1	0	14
33	9/19/2017 19:04	71.278	161.202	gray whale	feed	1	0	14
33	9/19/2017 19:05	71.241	161.174	gray whale	feed	2	0	14
33	9/19/2017 19:17	71.071	160.596	gray whale	swim	1	0	14
33	9/19/2017 19:18	71.069	160.579	gray whale	swim	1	0	14

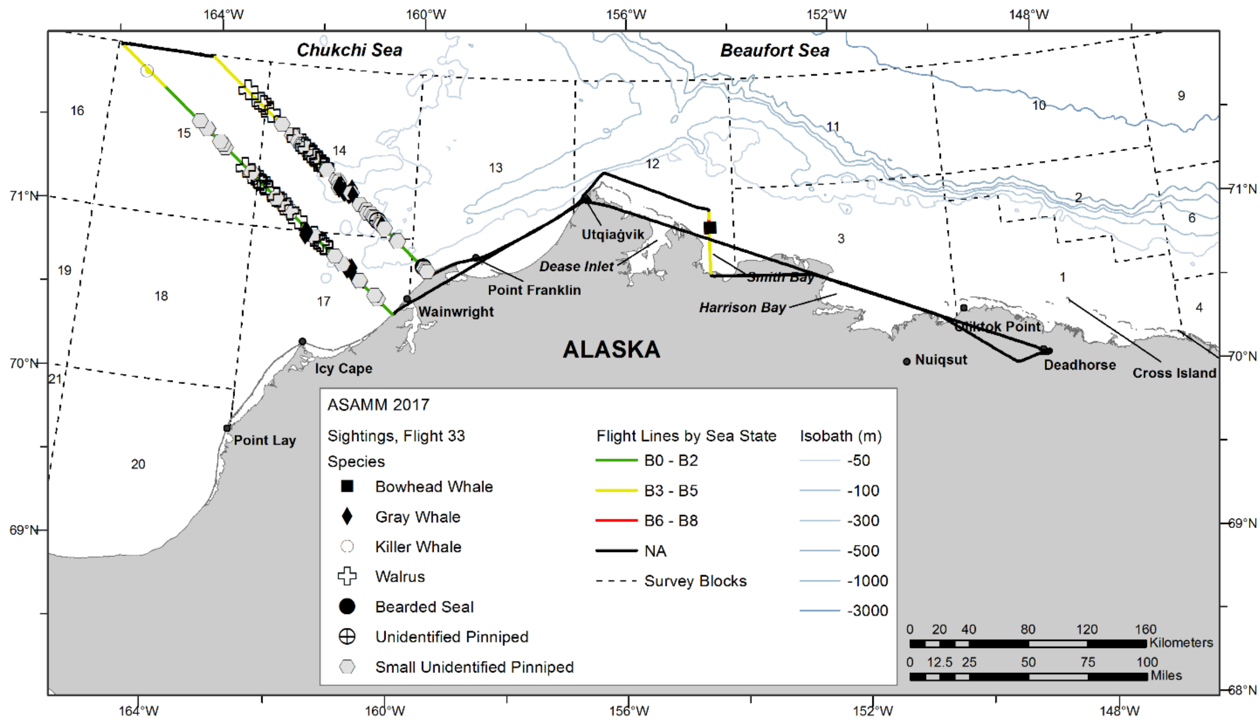

Figure B-69. Flight 33 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

One of two killer whales observed approximately 255 km northwest of Utqiaġvik, Alaska, during ASAMM Flight 33, 19 September 2017.

Pair of killer whales observed approximately 255 km northwest of Utqiaġvik, Alaska, during ASAMM Flight 33, 19 September 2017. The whale that is subsurface is ventral (belly) side up.

20 September 2017, Flight 237

Flight was a complete survey of transects 24, 25, 26, and 27, and a partial survey of transects 9, 21, 22, and 23. Survey conditions included clear to overcast skies, <1 km to unlimited visibility (with glare and precipitation), and Beaufort 1-6 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales, walruses, one bearded seal, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
237	9/20/2017 19:36	71.027	161.265	gray whale	feed	1	0	14
237	9/20/2017 19:37	71.027	161.230	gray whale	feed	1	0	14
237	9/20/2017 19:37	71.026	161.164	gray whale	feed	2	0	14
237	9/20/2017 19:38	71.017	161.078	gray whale	feed	2	0	14
237	9/20/2017 19:39	71.023	161.004	gray whale	swim	1	0	14
237	9/20/2017 19:39	71.028	160.912	gray whale	feed	1	0	14

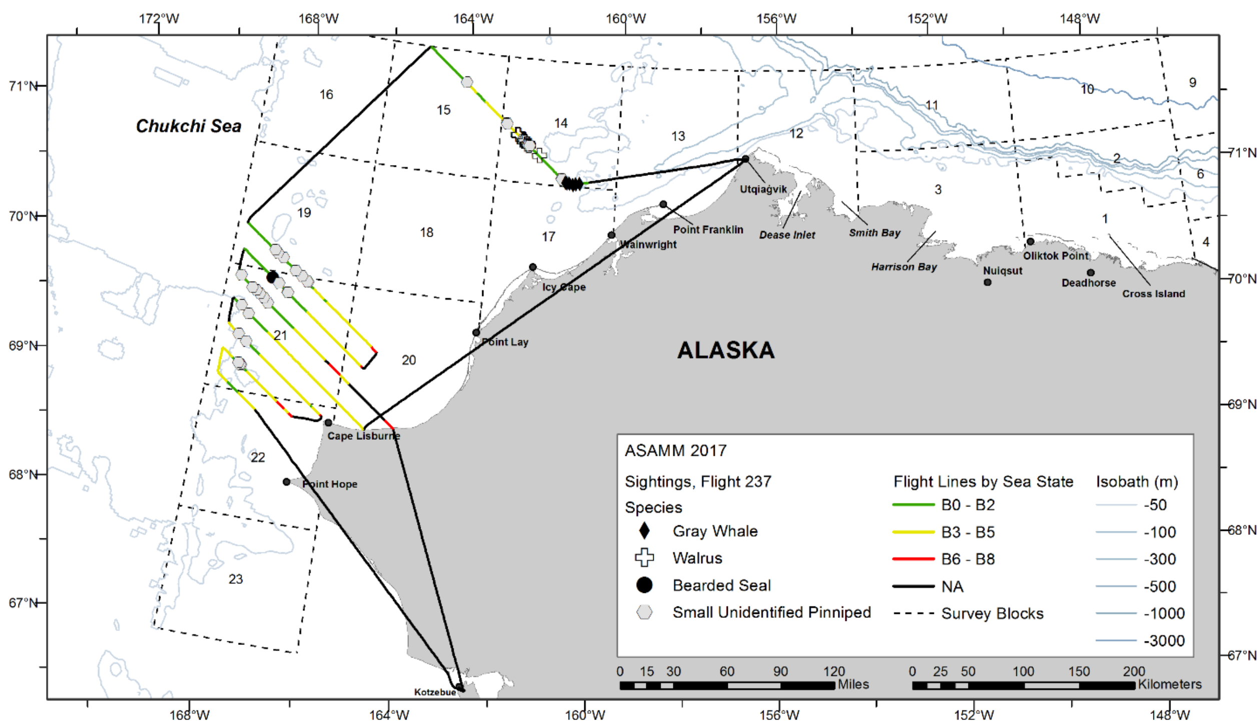

Figure B-70. Flight 237 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

20 September 2017, Flight 34

Flight was a complete survey of block 12 and portions of blocks 1, 2, 3, 10, and 11. Survey conditions included clear to overcast skies, 5 km to unlimited visibility (with glare), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 8 calves), gray whales, unidentified cetaceans, walruses, one bearded seal, one unidentified pinniped, small unidentified pinnipeds, and one polar bear.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
34	9/20/2017 10:26	70.600	149.480	bowhead whale	swim	1	0	1
34	9/20/2017 10:34	70.634	149.442	bowhead whale	feed	2	0	1
34	9/20/2017 10:37	70.648	149.422	bowhead whale	swim	1	0	1
34	9/20/2017 10:38	70.641	149.457	bowhead whale	swim	1	0	1
34	9/20/2017 10:39	70.660	149.473	bowhead whale	swim	3	1	1
34	9/20/2017 10:42	70.729	149.318	bowhead whale	breach	1	0	1
34	9/20/2017 12:12	70.655	149.951	bowhead whale	swim	3	0	1
34	9/20/2017 12:13	70.649	149.961	bowhead whale	dive	2	0	1
34	9/20/2017 12:14	70.658	149.941	bowhead whale	swim	1	0	1
34	9/20/2017 12:17	70.652	149.989	bowhead whale	unknown	1	0	1
34	9/20/2017 12:18	70.638	149.883	bowhead whale	swim	1	0	1
34	9/20/2017 13:55	70.783	150.922	bowhead whale	swim	1	0	3
34	9/20/2017 14:01	70.647	150.928	bowhead whale	swim	1	0	3
34	9/20/2017 14:04	70.617	150.912	bowhead whale	swim	1	0	3
34	9/20/2017 14:06	70.617	150.891	bowhead whale	swim	1	0	3
34	9/20/2017 15:51	71.285	156.998	gray whale	feed	2	0	12
34	9/20/2017 15:54	71.292	157.020	gray whale	feed	3	0	13
34	9/20/2017 16:06	71.523	156.933	unid cetacean	swim	1	0	12
34	9/20/2017 16:12	71.525	156.958	gray whale	swim	1	0	12
34	9/20/2017 16:12	71.526	156.958	unid cetacean	swim	1	0	12
34	9/20/2017 16:25	71.953	156.984	bowhead whale	swim	2	1	12
34	9/20/2017 16:28	71.990	156.944	unid cetacean	dive	1	0	12
34	9/20/2017 16:45	71.706	156.465	bowhead whale	swim	3	2	12
34	9/20/2017 16:48	71.699	156.455	bowhead whale	swim	1	0	12
34	9/20/2017 16:50	71.666	156.416	bowhead whale	swim	1	0	12
34	9/20/2017 16:56	71.574	156.481	bowhead whale	swim	2	1	12
34	9/20/2017 16:56	71.567	156.479	bowhead whale	mill	3	0	12
34	9/20/2017 16:56	71.570	156.484	bowhead whale	swim	1	0	12
34	9/20/2017 16:57	71.580	156.515	bowhead whale	swim	1	0	12
34	9/20/2017 16:59	71.562	156.507	bowhead whale	swim	1	0	12
34	9/20/2017 17:15	71.367	155.955	bowhead whale	dive	1	0	12
34	9/20/2017 17:15	71.372	155.955	bowhead whale	swim	2	0	12
34	9/20/2017 17:17	71.371	155.902	bowhead whale	swim	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
34	9/20/2017 17:17	71.369	155.879	bowhead whale	swim	1	0	12
34	9/20/2017 17:19	71.405	156.017	bowhead whale	mill	3	1	12
34	9/20/2017 17:24	71.461	155.956	bowhead whale	swim	1	0	12
34	9/20/2017 17:25	71.469	155.940	bowhead whale	mill	2	0	12
34	9/20/2017 17:55	71.663	155.476	bowhead whale	swim	1	0	12
34	9/20/2017 18:09	71.329	155.452	bowhead whale	swim	1	0	12
34	9/20/2017 18:11	71.321	155.622	bowhead whale	swim	1	0	12
34	9/20/2017 18:11	71.315	155.600	bowhead whale	swim	1	0	12
34	9/20/2017 18:12	71.340	155.573	bowhead whale	swim	1	0	12
34	9/20/2017 18:14	71.318	155.559	bowhead whale	swim	1	0	12
34	9/20/2017 18:27	71.206	154.984	bowhead whale	swim	1	0	12
34	9/20/2017 18:32	71.340	155.002	bowhead whale	swim	1	0	12
34	9/20/2017 19:23	71.178	154.455	bowhead whale	swim	1	0	12
34	9/20/2017 19:24	71.154	154.481	bowhead whale	swim	1	0	12
34	9/20/2017 19:25	71.171	154.483	bowhead whale	swim	1	0	12
34	9/20/2017 19:25	71.174	154.500	bowhead whale	swim	1	0	12
34	9/20/2017 19:26	71.166	154.523	bowhead whale	swim	1	0	12
34	9/20/2017 19:27	71.193	154.557	bowhead whale	swim	2	0	12
34	9/20/2017 19:30	71.179	154.462	bowhead whale	rest	2	1	12
34	9/20/2017 19:31	71.141	154.451	bowhead whale	swim	2	1	12
34	9/20/2017 19:33	71.140	154.420	bowhead whale	swim	1	0	12
34	9/20/2017 19:34	71.115	154.444	bowhead whale	swim	1	0	12

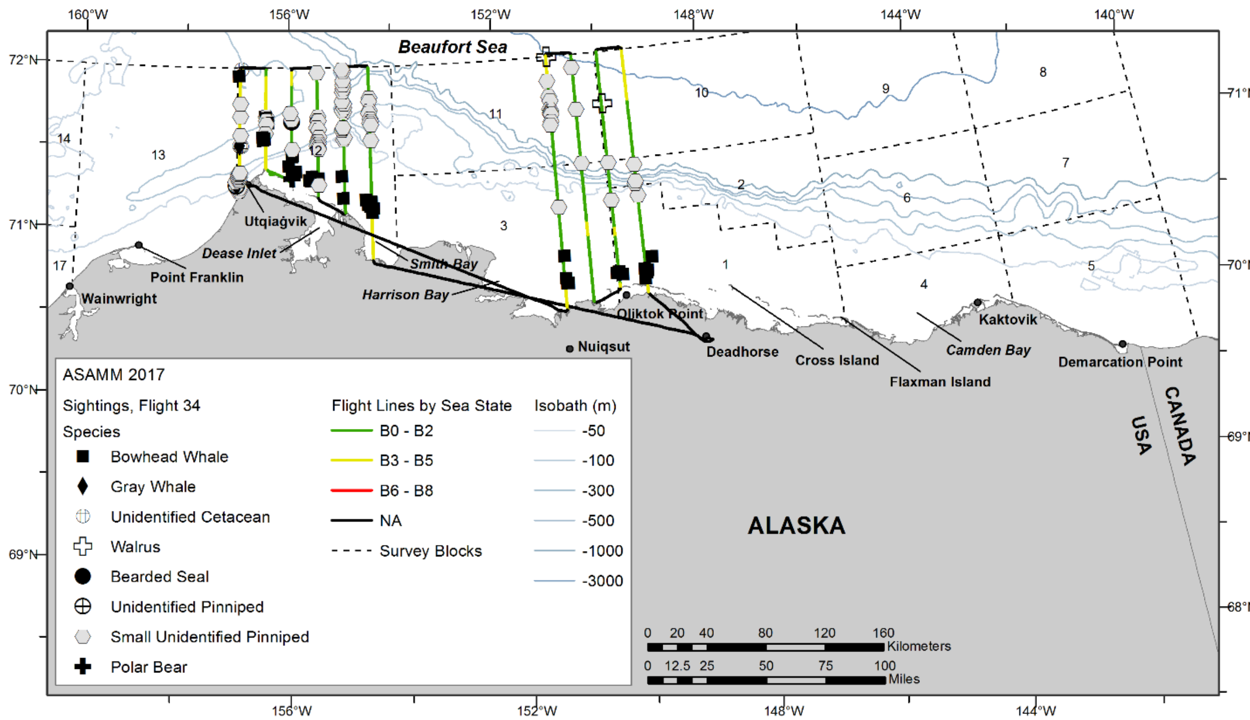

Figure B-71. Flight 34 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

This bowhead whale was observed breaching and flipper and tail slapping approximately 25 km north of a barrier island northwest of Deadhorse, Alaska, during ASAMM Flight 34, 20 September 2017.

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21 September 2017, Flight 35

Flight was a survey of portions of blocks 3 and 11. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 3 calves).

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
35	9/21/2017 10:06	71.000	153.974	bowhead whale	swim	1	0	3
35	9/21/2017 10:07	71.007	153.996	bowhead whale	dive	1	0	3
35	9/21/2017 11:12	71.067	153.509	bowhead whale	swim	1	0	3
35	9/21/2017 11:15	71.056	153.428	bowhead whale	swim	2	0	3
35	9/21/2017 11:17	71.027	153.500	bowhead whale	swim	1	0	3
35	9/21/2017 11:20	71.028	153.500	bowhead whale	swim	1	0	3
35	9/21/2017 11:22	71.009	153.478	bowhead whale	feed	1	0	3
35	9/21/2017 11:22	71.008	153.466	bowhead whale	feed	1	0	3
35	9/21/2017 11:22	71.000	153.476	bowhead whale	feed	1	1	3
35	9/21/2017 11:22	71.005	153.494	bowhead whale	feed	1	0	3
35	9/21/2017 11:26	70.994	153.497	bowhead whale	feed	1	0	3
35	9/21/2017 11:27	70.992	153.505	bowhead whale	rest	1	0	3
35	9/21/2017 11:40	70.997	152.923	bowhead whale	SAG	3	0	3
35	9/21/2017 11:44	70.999	152.929	bowhead whale	feed	1	0	3
35	9/21/2017 11:48	71.041	152.943	bowhead whale	swim	1	0	3
35	9/21/2017 11:52	71.072	152.947	bowhead whale	swim	2	1	3
35	9/21/2017 12:57	70.991	152.454	bowhead whale	feed	1	1	3
35	9/21/2017 12:57	70.981	152.502	bowhead whale	swim	1	0	3
35	9/21/2017 12:59	70.982	152.517	bowhead whale	swim	1	0	3
35	9/21/2017 13:05	70.989	152.526	bowhead whale	swim	1	0	3
35	9/21/2017 13:06	70.975	152.459	bowhead whale	swim	1	0	3
35	9/21/2017 13:07	70.957	152.470	bowhead whale	swim	1	0	3
35	9/21/2017 13:09	70.952	152.496	bowhead whale	swim	1	0	3

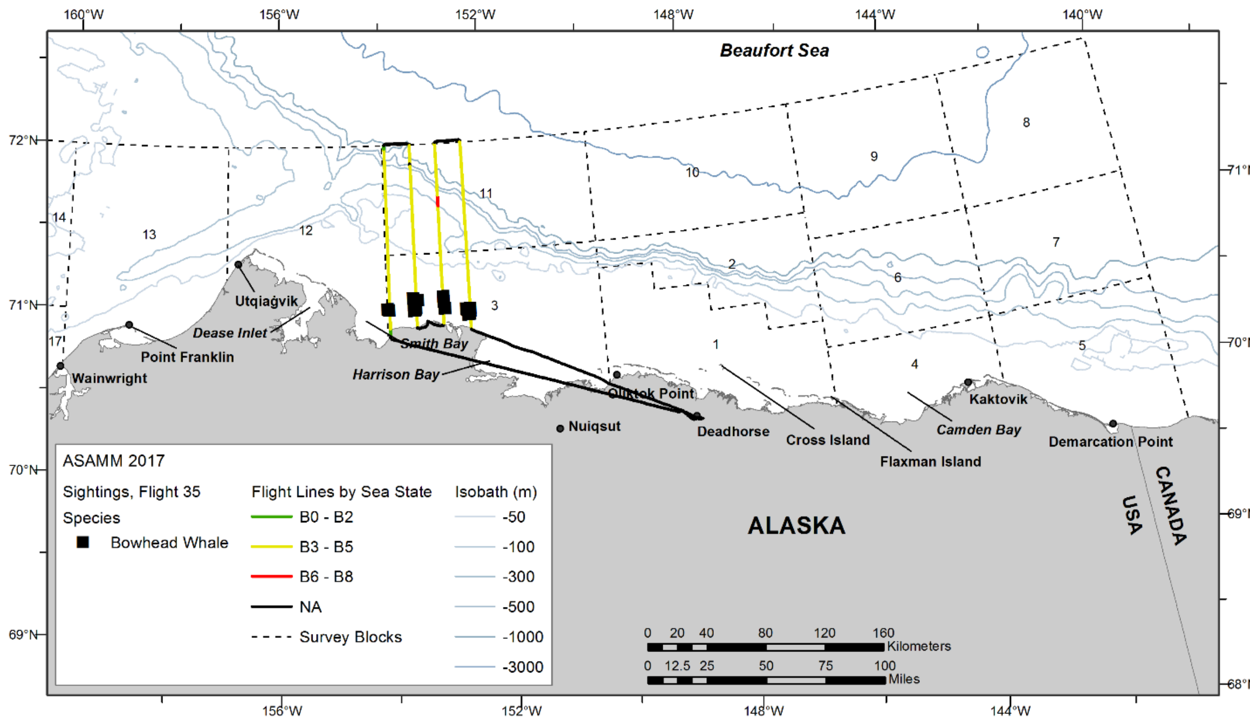

Figure B-72. Flight 35 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

A surface active group (SAG) of bowhead whales sighted approximately 10 km offshore northeast of Smith Bay, Alaska, during ASAMM Flight 35, 21 September 2017.

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25 September 2017, Flight 238

Flight was a complete survey of transect 19, a partial survey of transect 17, and the coastal transect from Point Lay to Utqiaġvik. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included one bowhead whale, walruses, one bearded seal, unidentified pinnipeds, and small unidentified pinnipeds. The walrus haulout near Point Lay was estimated at approximately 4,300 walruses.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
238	9/25/2017 16:01	70.702	166.754	bowhead whale	swim	1	0	19

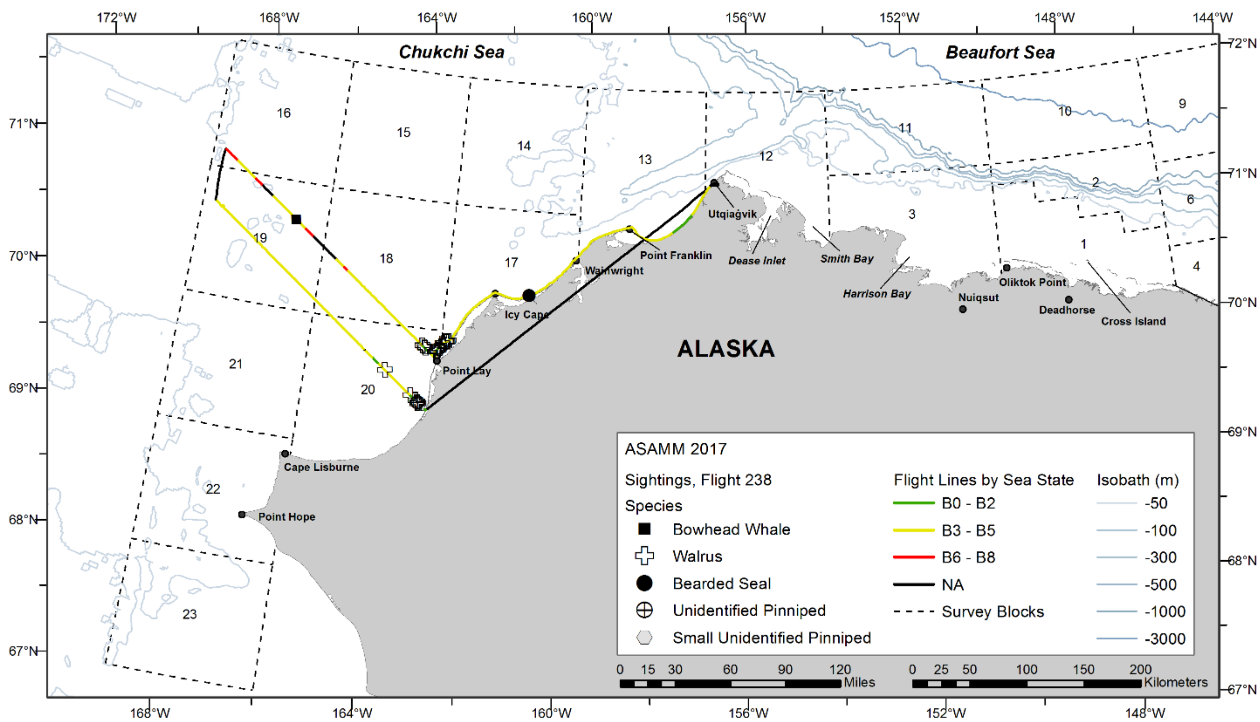


Figure B-73. Flight 238 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

26 September 2017, Flight 239

Flight was a complete survey of transects 3, 32, 33, 34, 35, 36, and 37. Survey conditions included clear to overcast skies, <1 km to unlimited visibility (with glare and low ceilings), and Beaufort 1-5 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales, humpback whales, fin whales, minke whales, unidentified cetaceans, walruses, one bearded seal, one unidentified pinniped, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
239	9/26/2017 11:38	68.185	168.629	minke whale	swim	1	0	22
239	9/26/2017 11:42	68.108	168.795	gray whale	feed	2	0	22
239	9/26/2017 11:42	68.106	168.791	gray whale	feed	2	0	22
239	9/26/2017 11:45	68.109	168.766	gray whale	feed	1	0	22
239	9/26/2017 11:47	68.118	168.827	gray whale	feed	2	0	22
239	9/26/2017 11:49	68.103	168.795	gray whale	feed	1	0	22
239	9/26/2017 11:53	68.067	168.764	gray whale	feed	1	0	22
239	9/26/2017 11:58	68.029	168.783	gray whale	feed	6	0	22
239	9/26/2017 12:04	68.100	168.661	gray whale	feed	1	0	22
239	9/26/2017 12:05	68.014	168.655	gray whale	feed	1	0	22
239	9/26/2017 12:06	68.019	168.679	gray whale	feed	2	0	22
239	9/26/2017 12:08	68.025	168.483	gray whale	swim	1	0	22
239	9/26/2017 12:08	68.023	168.481	gray whale	swim	2	0	22
239	9/26/2017 12:17	68.019	167.842	gray whale	feed	1	0	22
239	9/26/2017 12:18	68.018	167.782	gray whale	swim	2	0	22
239	9/26/2017 12:27	68.011	166.997	minke whale	swim	1	0	22
239	9/26/2017 13:08	67.852	167.807	gray whale	rest	1	0	23
239	9/26/2017 13:16	67.837	168.123	gray whale	feed	1	0	23
239	9/26/2017 13:19	67.831	168.125	gray whale	feed	1	0	23
239	9/26/2017 13:21	67.822	168.292	gray whale	feed	5	0	23
239	9/26/2017 13:22	67.855	168.308	gray whale	feed	1	0	23
239	9/26/2017 13:22	67.839	168.330	gray whale	feed	2	0	23
239	9/26/2017 16:21	67.513	167.171	fin whale	swim	4	0	23
239	9/26/2017 16:52	67.333	168.736	unid cetacean	swim	2	0	23
239	9/26/2017 16:52	67.347	168.717	gray whale	feed	3	0	23
239	9/26/2017 16:58	67.341	168.727	gray whale	feed	2	0	23
239	9/26/2017 17:03	67.318	168.743	gray whale	feed	1	0	23
239	9/26/2017 17:14	67.343	168.078	humpback whale	swim	2	0	23
239	9/26/2017 19:57	71.237	157.221	gray whale	swim	2	0	13

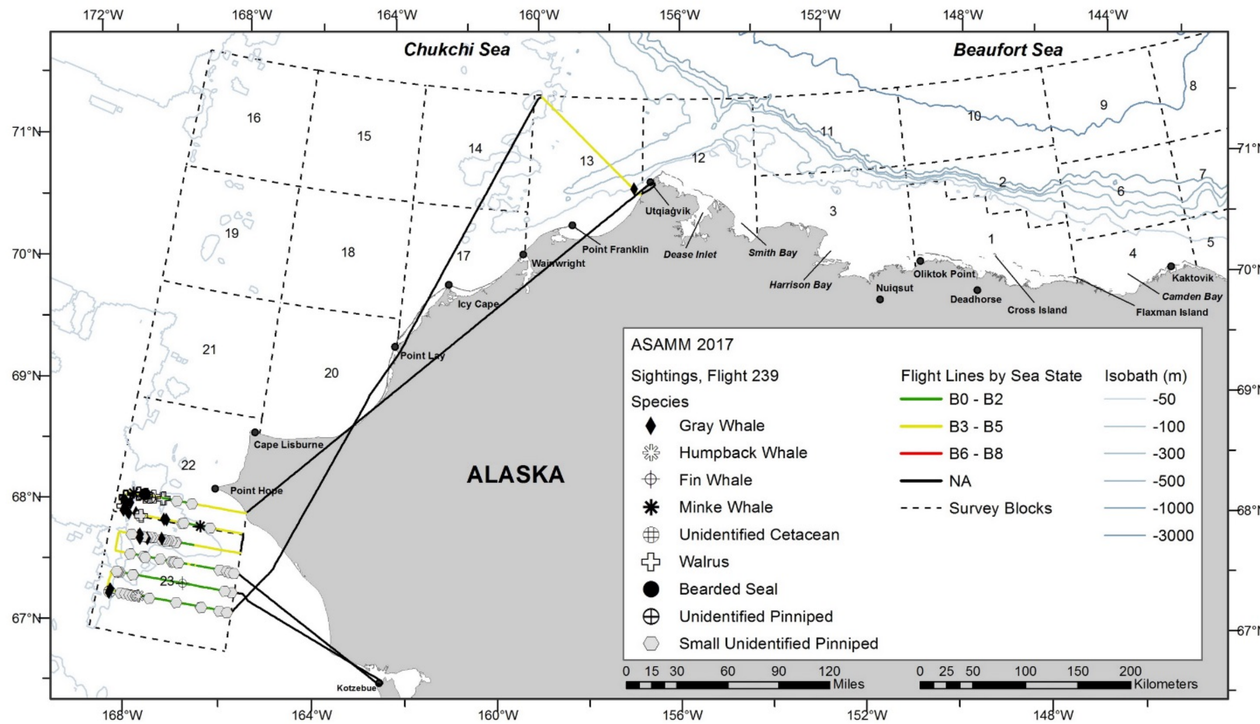
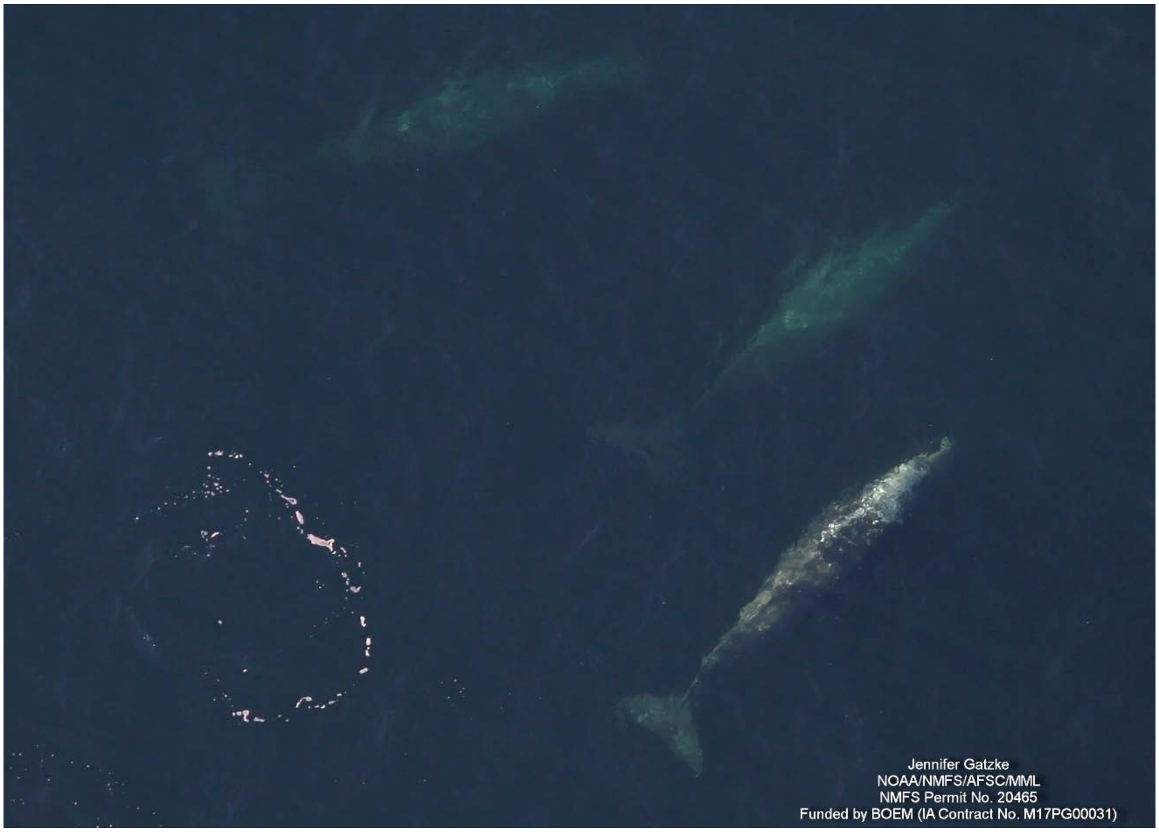
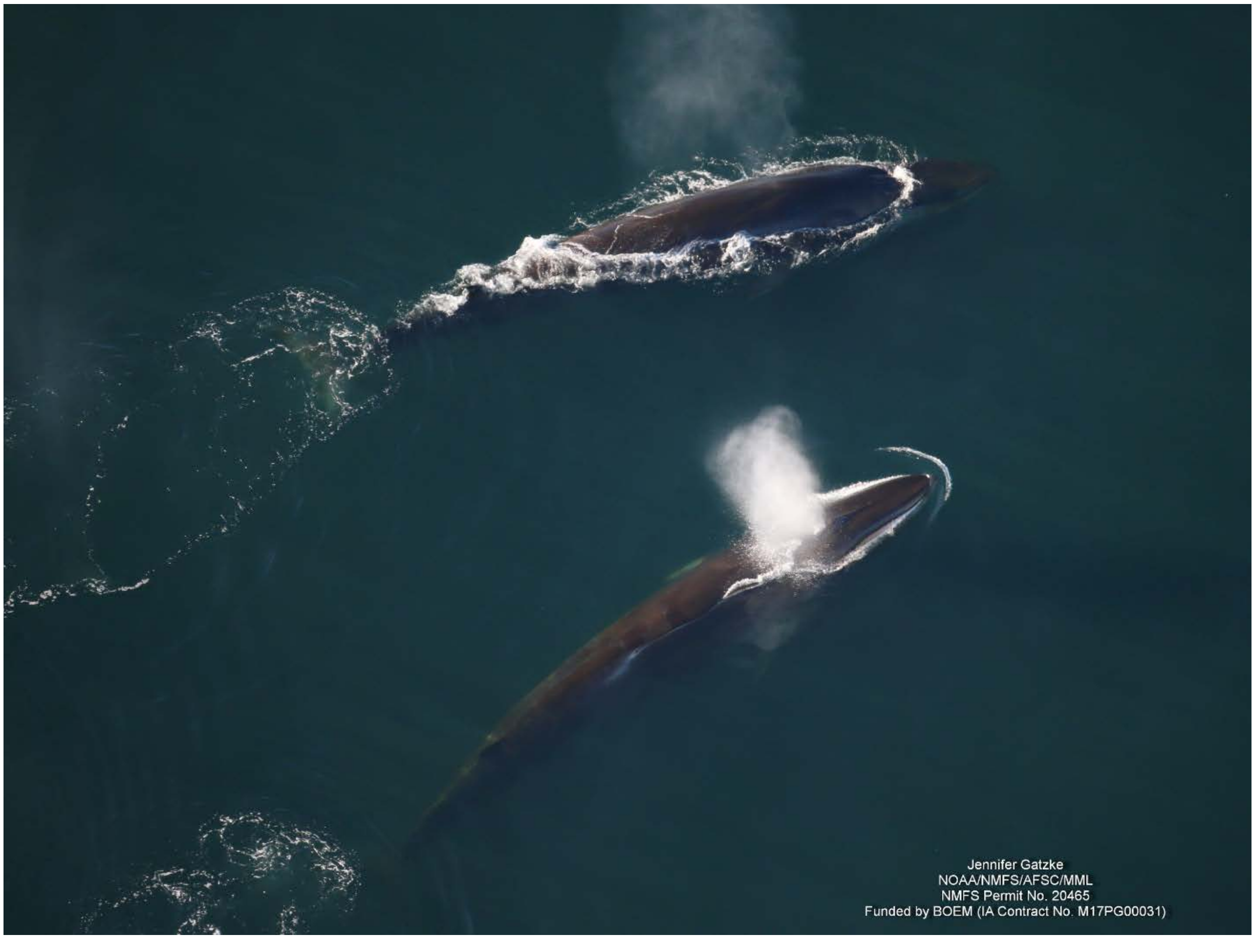


Figure B-74. Flight 239 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



This terrific trio of gray whales resting at varying depths below the surface was observed approximately 80 km southwest of Point Hope, Alaska, during ASAMM Flight 239, 26 September 2017.

The bright white color highlights the length of this humpback whale's pectoral flipper. Observed approximately 125 km south of Point Hope, Alaska, during ASAMM Flight 239, 26 September 2017.



The sleek bodies of these side-by-side fin whales can be seen through calm, clear waters approximately 90 km south of Point Hope, Alaska, observed during ASAMM Flight 239, 26 September 2017.

26 September 2017, Flight 36

Flight was a survey of portions of block 12. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, fog, ice on the window, and precipitation), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Flightlines south of Deadhorse were flown during an attempt to conduct a field-of-view experiment, which was aborted due to strong winds. Sightings included bowhead whales (including 1 calf), one walrus, one bearded seal, small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
36	9/26/2017 11:53	71.023	154.445	bowhead whale	swim	1	0	12
36	9/26/2017 11:56	71.035	154.506	bowhead whale	swim	1	0	12
36	9/26/2017 11:59	71.032	154.465	bowhead whale	swim	1	0	12
36	9/26/2017 12:00	71.048	154.414	bowhead whale	swim	1	0	12
36	9/26/2017 12:03	71.053	154.392	bowhead whale	swim	1	0	12
36	9/26/2017 13:12	71.337	155.473	bowhead whale	swim	1	0	12
36	9/26/2017 13:17	71.429	155.473	bowhead whale	swim	2	0	12
36	9/26/2017 13:17	71.433	155.470	bowhead whale	swim	1	0	12
36	9/26/2017 13:17	71.441	155.446	bowhead whale	swim	1	0	12
36	9/26/2017 14:09	71.432	156.478	bowhead whale	swim	1	0	12
36	9/26/2017 14:12	71.520	156.446	bowhead whale	swim	1	0	12
36	9/26/2017 14:20	71.733	156.471	bowhead whale	swim	1	0	12
36	9/26/2017 14:46	71.599	156.922	bowhead whale	swim	2	1	12
36	9/26/2017 14:54	71.499	156.954	bowhead whale	swim	1	0	12
36	9/26/2017 14:55	71.503	156.938	bowhead whale	swim	1	0	12
36	9/26/2017 14:56	71.508	156.926	bowhead whale	swim	1	0	12
36	9/26/2017 14:57	71.512	156.930	bowhead whale	swim	1	0	12
36	9/26/2017 14:59	71.509	156.874	bowhead whale	swim	1	0	12

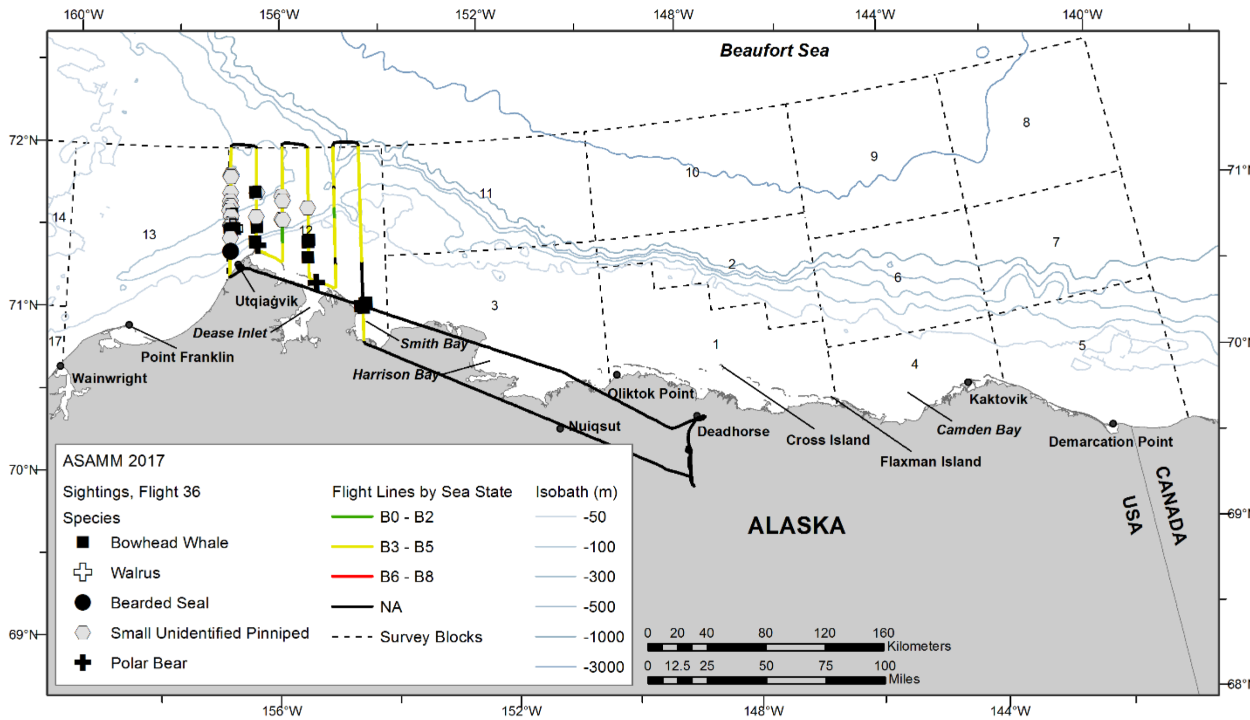


Figure B-75. Flight 36 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

A bowhead whale cow-calf pair sighted approximately 40 km north of Utqiaġvik, Alaska, during ASAMM Flight 36, 26 September 2017.

27 September 2017, Flight 240

Flight was a complete survey of transects 9 and 11 and a partial survey of transect 7. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with glare and low ceilings), and Beaufort 3-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, gray whales, walruses, one bearded seal, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
240	9/27/2017 13:27	70.906	162.423	gray whale	feed	2	0	17
240	9/27/2017 13:27	70.903	162.434	gray whale	feed	2	0	17
240	9/27/2017 13:27	70.900	162.458	gray whale	breach	2	0	17
240	9/27/2017 13:39	70.911	162.427	gray whale	feed	1	0	17
240	9/27/2017 15:38	71.085	161.532	bowhead whale	swim	1	0	14
240	9/27/2017 15:40	71.092	161.535	bowhead whale	swim	1	0	14
240	9/27/2017 15:45	70.997	161.208	bowhead whale	swim	1	0	17
240	9/27/2017 15:46	71.005	161.201	gray whale	SAG	2	0	14
240	9/27/2017 15:49	70.986	161.149	bowhead whale	swim	2	0	17
240	9/27/2017 15:52	70.974	161.055	bowhead whale	swim	1	0	17
240	9/27/2017 15:54	70.969	161.114	bowhead whale	swim	1	0	17
240	9/27/2017 15:54	70.977	161.118	bowhead whale	swim	2	0	17
240	9/27/2017 15:55	70.972	161.098	bowhead whale	swim	2	0	17
240	9/27/2017 15:58	70.935	161.019	bowhead whale	swim	1	0	17

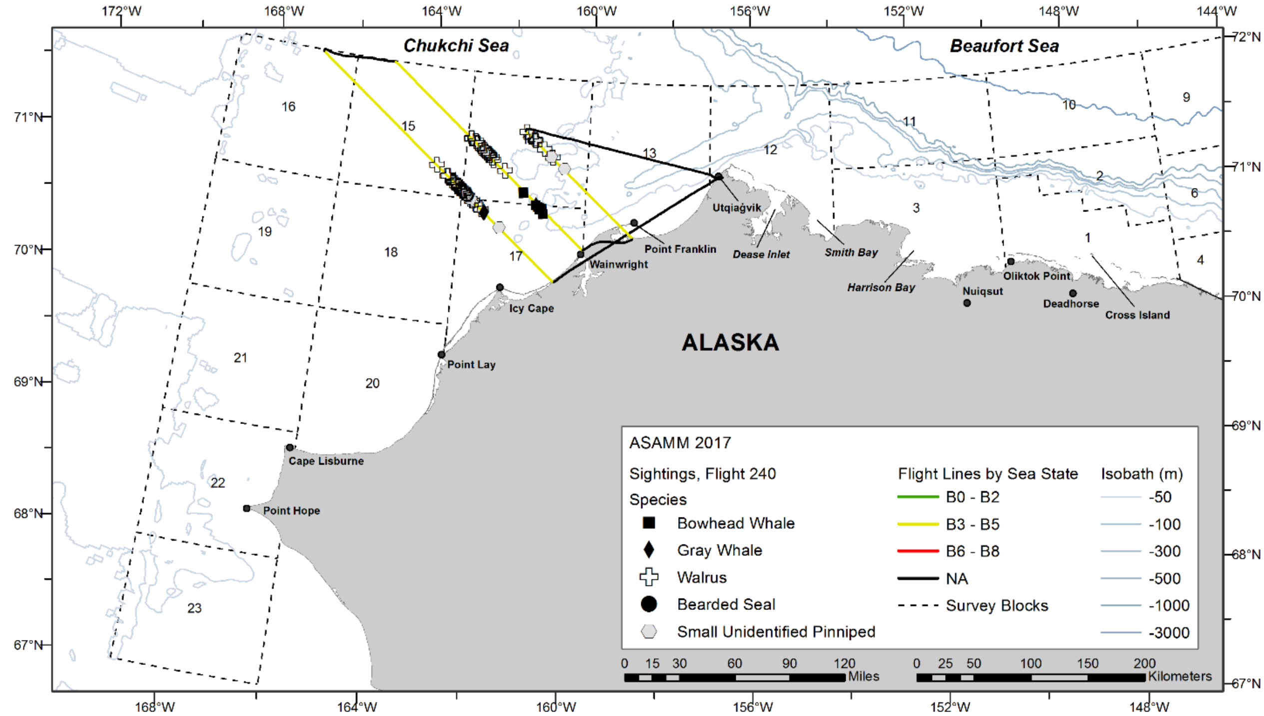


Figure B-76. Flight 240 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

This gray whale appears to hang in the air mid-breach. Observed approximately 70 km northwest of Wainwright, Alaska, during ASAMM Flight 240, 27 September 2017.

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27 September 2017, Flight 37

Flight was a survey of portions of blocks 3 and 11. Survey conditions included clear to partly cloudy skies, 3 km to unlimited visibility (with glare and low ceilings), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. Flightlines south of Deadhorse were flown during an attempt to conduct a field-of-view experiment, which was aborted due to strong winds. Sightings included one bowhead whale.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
37	9/27/2017 11:56	71.027	152.499	bowhead whale	swim	1	0	3

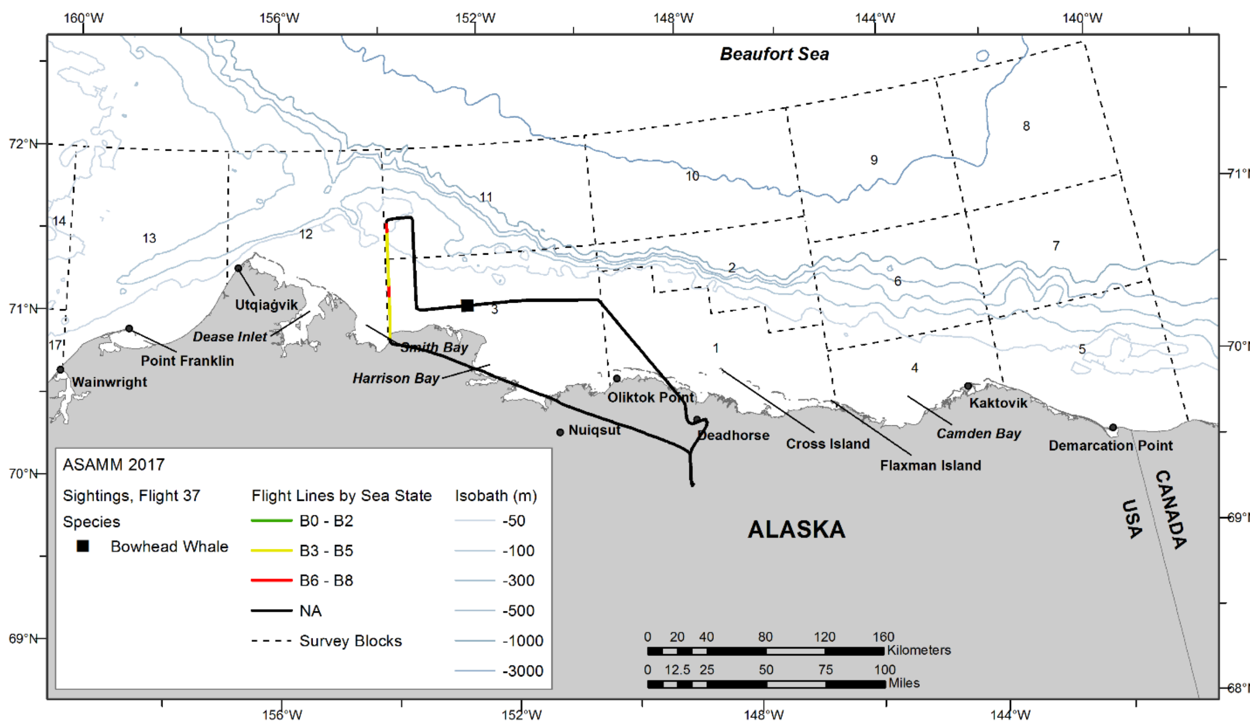

Figure B-77. Flight 37 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

30 September 2017, Flight 241

Flight was a partial survey of transects 6, 8, 10, and 12. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare and low ceilings), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 1 calf carcass), gray whales, one unidentified cetacean carcass, walruses, one bearded seal, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
241	9/30/2017 14:15	71.742	166.702	bowhead whale	dead	1	1	16
241	9/30/2017 15:37	71.207	161.467	gray whale	feed	2	0	14
241	9/30/2017 15:38	71.224	161.495	gray whale	feed	1	0	14
241	9/30/2017 15:40	71.215	161.421	gray whale	feed	1	0	14
241	9/30/2017 15:40	71.229	161.414	gray whale	feed	1	0	14
241	9/30/2017 15:41	71.219	161.401	gray whale	feed	1	0	14
241	9/30/2017 15:42	71.214	161.386	gray whale	feed	1	0	14
241	9/30/2017 15:42	71.211	161.357	gray whale	feed	2	0	14
241	9/30/2017 15:43	71.207	161.325	gray whale	feed	1	0	14
241	9/30/2017 15:43	71.202	161.325	gray whale	feed	3	0	14
241	9/30/2017 15:45	71.196	161.261	gray whale	feed	1	0	14
241	9/30/2017 15:47	71.205	161.258	gray whale	feed	1	0	14
241	9/30/2017 15:49	71.200	161.120	gray whale	feed	2	0	14
241	9/30/2017 15:50	71.195	161.104	gray whale	feed	1	0	14
241	9/30/2017 15:50	71.197	161.066	gray whale	feed	1	0	14
241	9/30/2017 15:58	71.336	161.550	bowhead whale	swim	1	0	14
241	9/30/2017 16:56	71.681	161.187	unid cetacean	dead	1	0	14

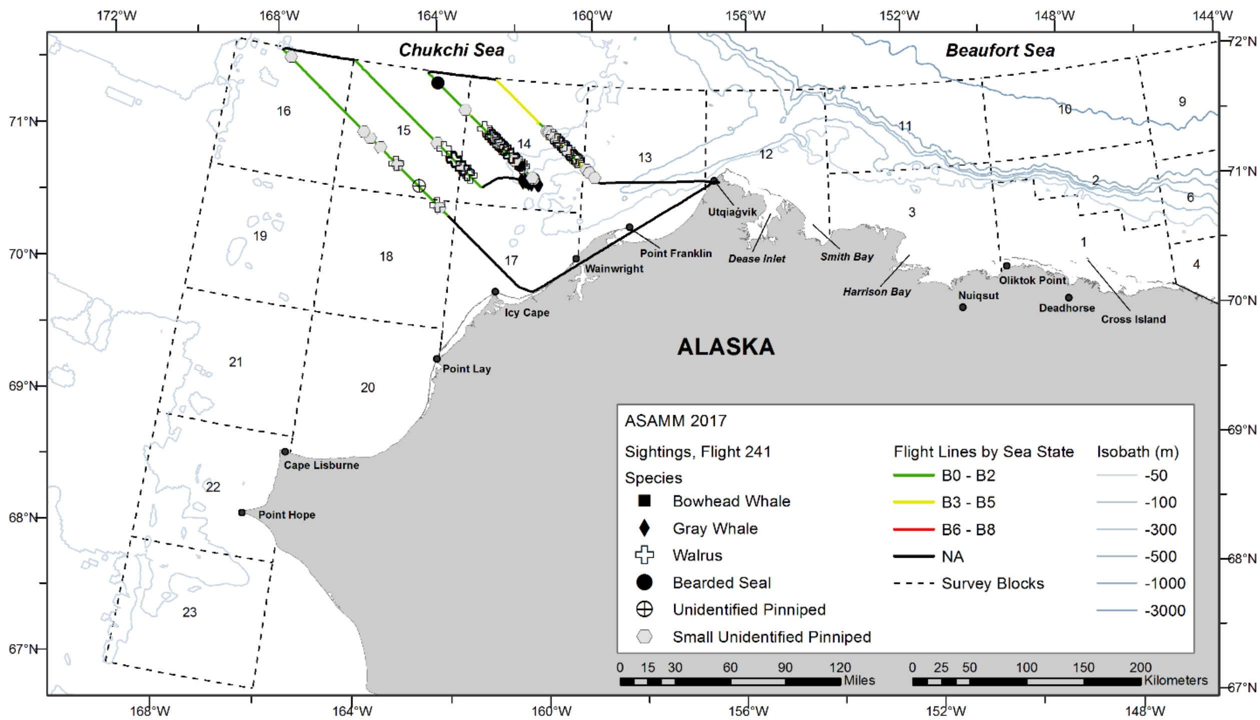

Figure B-78. Flight 241 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

1 October 2017, Flight 38

Flight was a survey of portions of block 1. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, and low ceilings), and Beaufort 1-3 sea states. Sea ice cover was 0-45% grease/new ice in the area surveyed. Flightlines south of Deadhorse were flown during an attempt to conduct a field-of-view experiment, which was aborted due to strong winds. Sightings included bowhead whales, one small unidentified pinniped, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
38	10/1/2017 17:23	70.714	149.951	bowhead whale	swim	1	0	1
38	10/1/2017 17:23	70.725	149.945	bowhead whale	rest	1	0	1
38	10/1/2017 17:25	70.721	149.944	bowhead whale	breach	1	0	1
38	10/1/2017 17:25	70.723	149.956	bowhead whale	rest	1	0	1
38	10/1/2017 17:27	70.734	149.953	bowhead whale	swim	1	0	1
38	10/1/2017 17:47	70.730	149.455	bowhead whale	breach	1	0	1
38	10/1/2017 17:49	70.734	149.457	bowhead whale	breach	1	0	1
38	10/1/2017 17:49	70.732	149.460	bowhead whale	rest	1	0	1

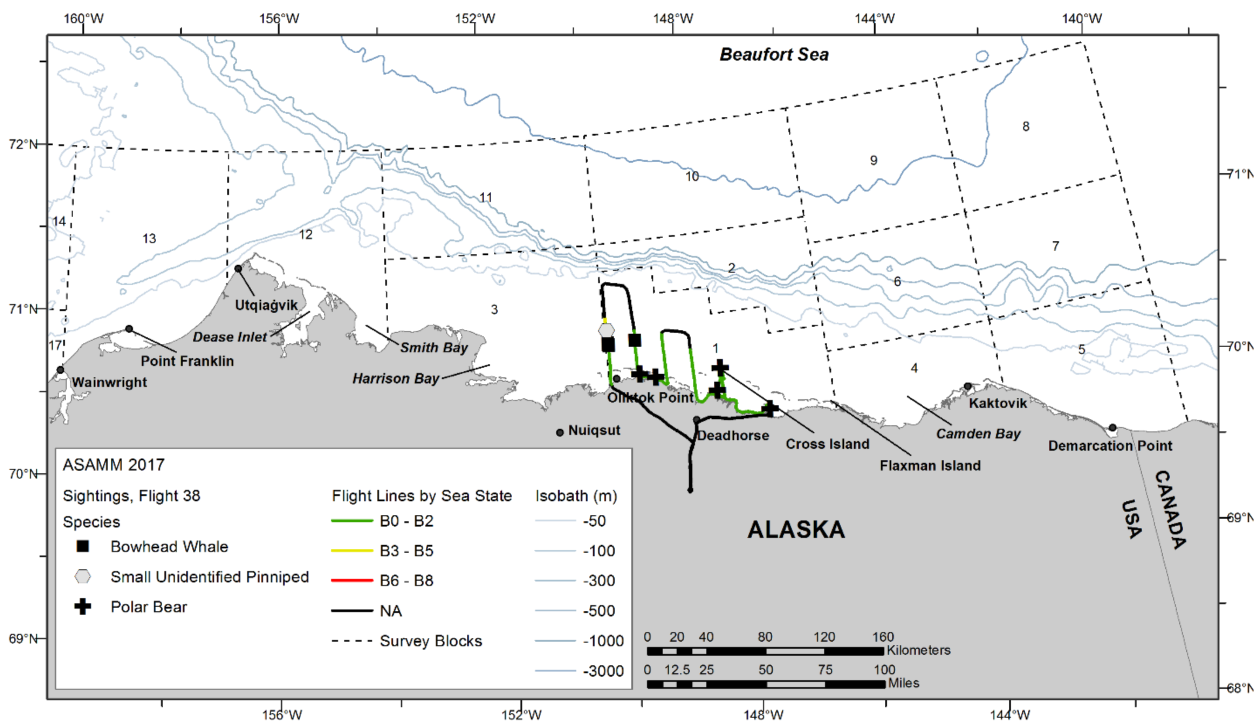

Figure B-79. Flight 38 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bears sighted on Cross Island, Alaska, during ASAMM Flight 38, 1 October 2017.

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2 October 2017, Flight 242

Flight was a partial survey of transects 10, and 12. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare and low ceilings), and Beaufort 4-7 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales and walruses.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
242	10/2/2017 10:35	70.960	161.819	gray whale	feed	4	0	17
242	10/2/2017 10:48	70.962	161.842	gray whale	feed	1	0	17
242	10/2/2017 11:05	70.777	161.123	gray whale	feed	1	0	17
242	10/2/2017 11:08	70.766	161.128	gray whale	feed	1	0	17
242	10/2/2017 11:15	70.760	161.175	gray whale	feed	1	0	17
242	10/2/2017 11:17	70.777	161.144	gray whale	feed	2	0	17

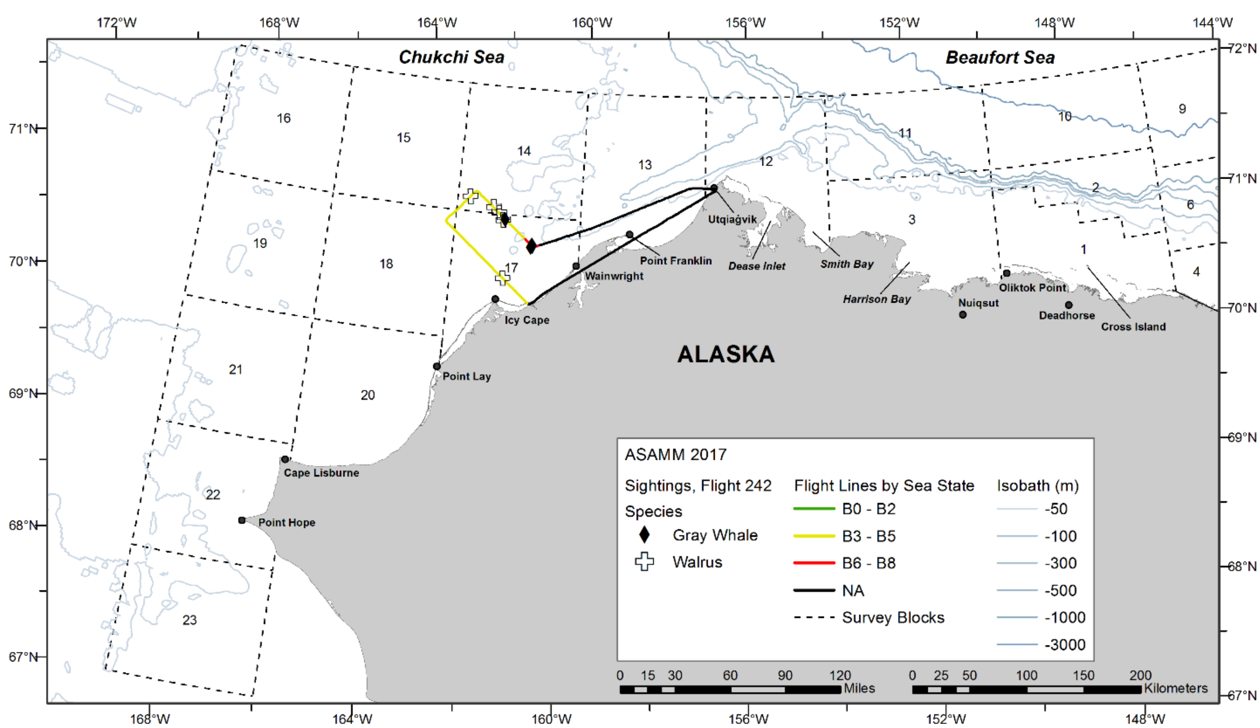

Figure B-80. Flight 242 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

5 October 2017, Flight 39

Flight was the coastal transect from approximately 142°W to 150°W. Survey conditions included overcast skies, 0-10 km visibility (with fog), and Beaufort 2 sea state. No sea ice was observed in the area surveyed. Sightings included bowhead whales and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
39	10/5/2017 12:08	70.451	147.795	bowhead whale	feed	25	0	1
39	10/5/2017 12:15	70.487	147.781	bowhead whale	feed	5	0	1
39	10/5/2017 12:19	70.493	147.923	bowhead whale	feed	16	0	1
39	10/5/2017 12:21	70.502	147.993	bowhead whale	feed	8	0	1

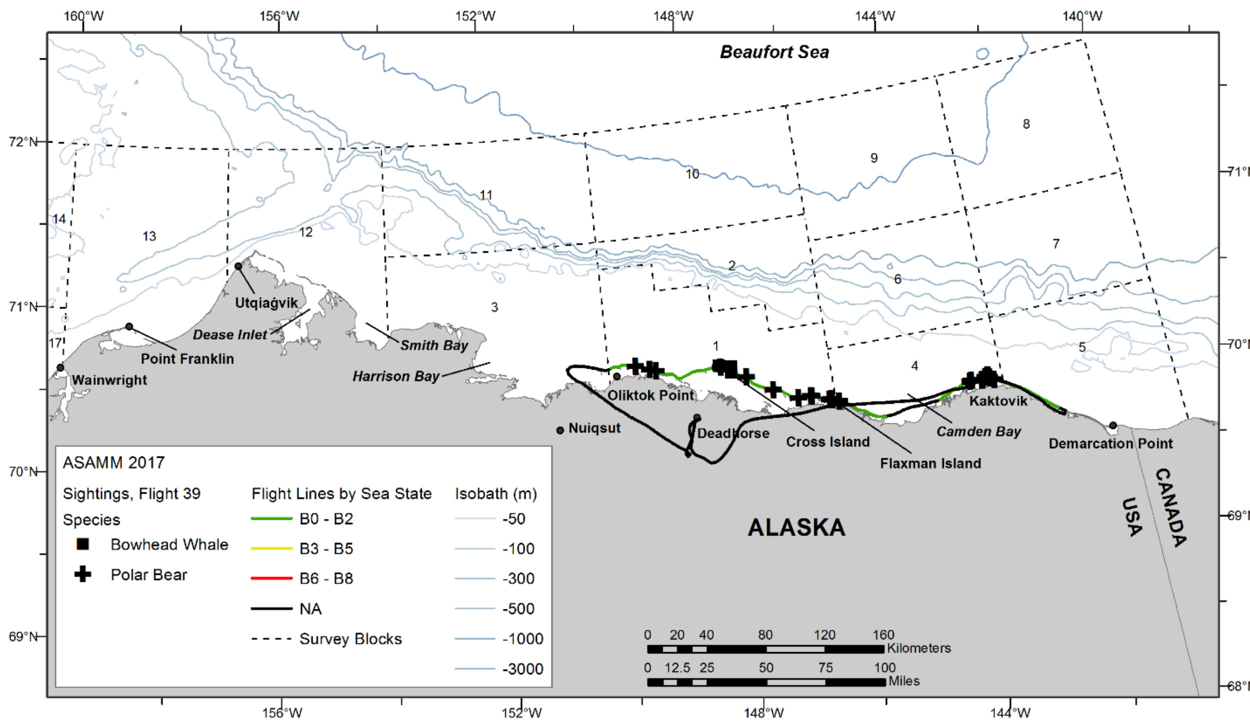

Figure B-81. Flight 39 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bears sighted approximately 10 km east of Barter Island, Alaska, during ASAMM Flight 39, 5 October 2017.

Bowhead whales feeding in echelon formation approximately 5 km east of Cross Island, Alaska, during ASAMM Flight 39, 5 October 2017

7 October 2017, Flight 243

Flight was a complete survey of transects 2, 3, 4, 5, 13, and 15 and the coastal transect near Point Lay. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, ice on the windows, low ceilings, and precipitation), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 3 calves), unidentified cetaceans (including 1 carcass), walruses, unidentified pinnipeds, and small unidentified pinnipeds. Walruses hauled out near Point Lay were in two groups, and estimated at approximately 6,500 walruses.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
243	10/7/2017 12:03	71.115	166.610	unid cetacean	swim	1	0	16
243	10/7/2017 12:28	71.380	167.916	unid cetacean	dead	1	0	16
243	10/7/2017 16:03	71.330	159.028	bowhead whale	swim	2	0	13
243	10/7/2017 16:23	71.653	160.228	unid cetacean	swim	1	0	14
243	10/7/2017 17:17	71.393	158.535	bowhead whale	swim	1	0	13
243	10/7/2017 17:18	71.387	158.525	bowhead whale	swim	1	0	13
243	10/7/2017 17:54	71.464	157.953	bowhead whale	SAG	4	0	13
243	10/7/2017 17:55	71.469	157.939	bowhead whale	SAG	6	2	13
243	10/7/2017 17:55	71.462	157.964	bowhead whale	swim	1	0	13
243	10/7/2017 18:04	71.471	157.996	bowhead whale	swim	2	1	13
243	10/7/2017 18:08	71.452	157.982	bowhead whale	swim	1	0	13
243	10/7/2017 19:01	71.527	157.415	bowhead whale	swim	1	0	13
243	10/7/2017 19:02	71.532	157.407	bowhead whale	rest	1	0	13
243	10/7/2017 19:05	71.518	157.434	bowhead whale	swim	1	0	13
243	10/7/2017 19:06	71.510	157.385	bowhead whale	swim	4	0	13
243	10/7/2017 19:09	71.493	157.373	bowhead whale	swim	2	0	13
243	10/7/2017 19:09	71.493	157.318	bowhead whale	swim	3	0	13

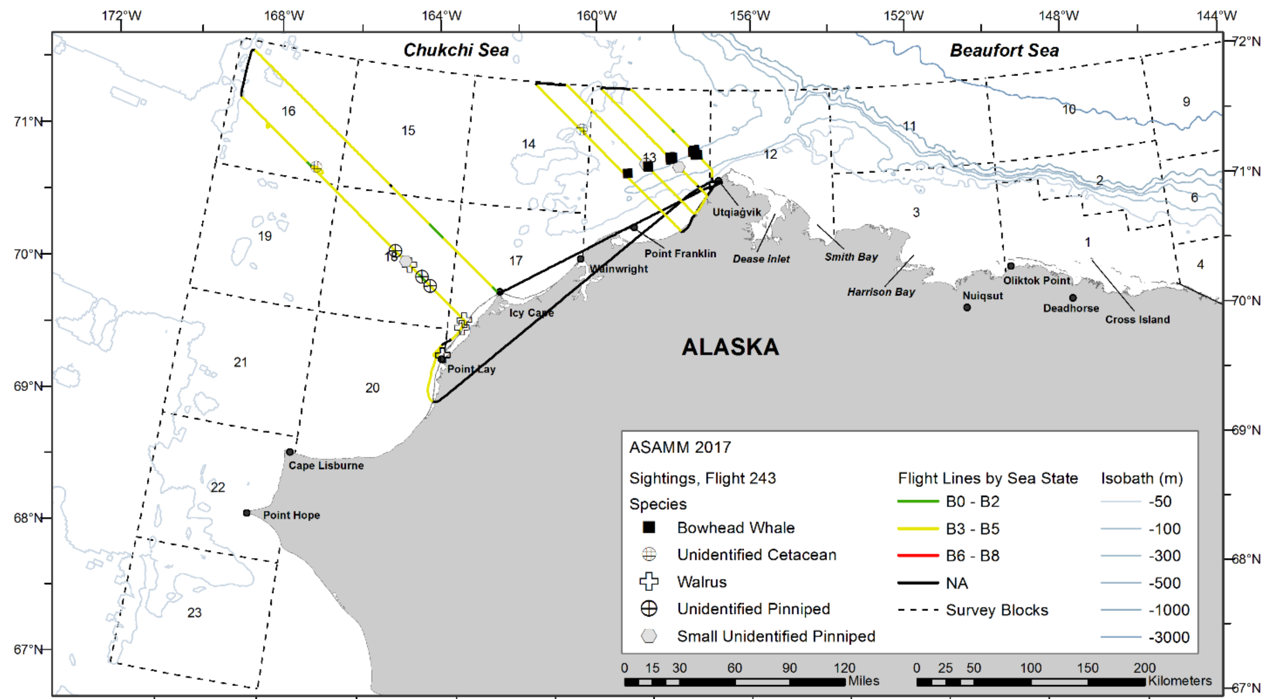

Figure B-82. Flight 243 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Surface active group (SAG) bowhead whales near Barrow Canyon, approximately 40 km west of Utqiaġvik, Alaska, during ASAMM Flight 243, 7 October 2017.

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7 October 2017, Flight 40

Flight was a survey of portions of blocks 3, 11, and 12 and the coastal transect in Harrison Bay. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, ice on the window, low ceilings, and precipitation), and Beaufort 2-5 sea states. Sea ice cover was 0-20% grease/new ice in the area surveyed. Sightings included bowhead whales, one harbor porpoise, one unidentified cetacean, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
40	10/7/2017 10:58	71.236	154.474	bowhead whale	swim	2	0	12
40	10/7/2017 12:07	71.325	155.445	bowhead whale	swim	1	0	12
40	10/7/2017 12:08	71.336	155.430	bowhead whale	swim	1	0	12
40	10/7/2017 12:10	71.313	155.479	bowhead whale	swim	1	0	12
40	10/7/2017 12:10	71.311	155.472	bowhead whale	swim	1	0	12
40	10/7/2017 12:11	71.317	155.496	bowhead whale	swim	2	0	12
40	10/7/2017 12:12	71.324	155.465	bowhead whale	swim	1	0	12
40	10/7/2017 12:59	71.583	156.349	unid cetacean	swim	1	0	12
40	10/7/2017 13:00	71.583	156.392	bowhead whale	swim	2	0	12
40	10/7/2017 13:01	71.594	156.474	bowhead whale	swim	1	0	12
40	10/7/2017 13:02	71.617	156.478	bowhead whale	swim	1	0	12
40	10/7/2017 13:31	71.579	156.968	bowhead whale	swim	1	0	12
40	10/7/2017 13:32	71.572	156.975	bowhead whale	swim	1	0	12
40	10/7/2017 17:51	70.957	152.450	harbor porpoise	swim	1	0	3

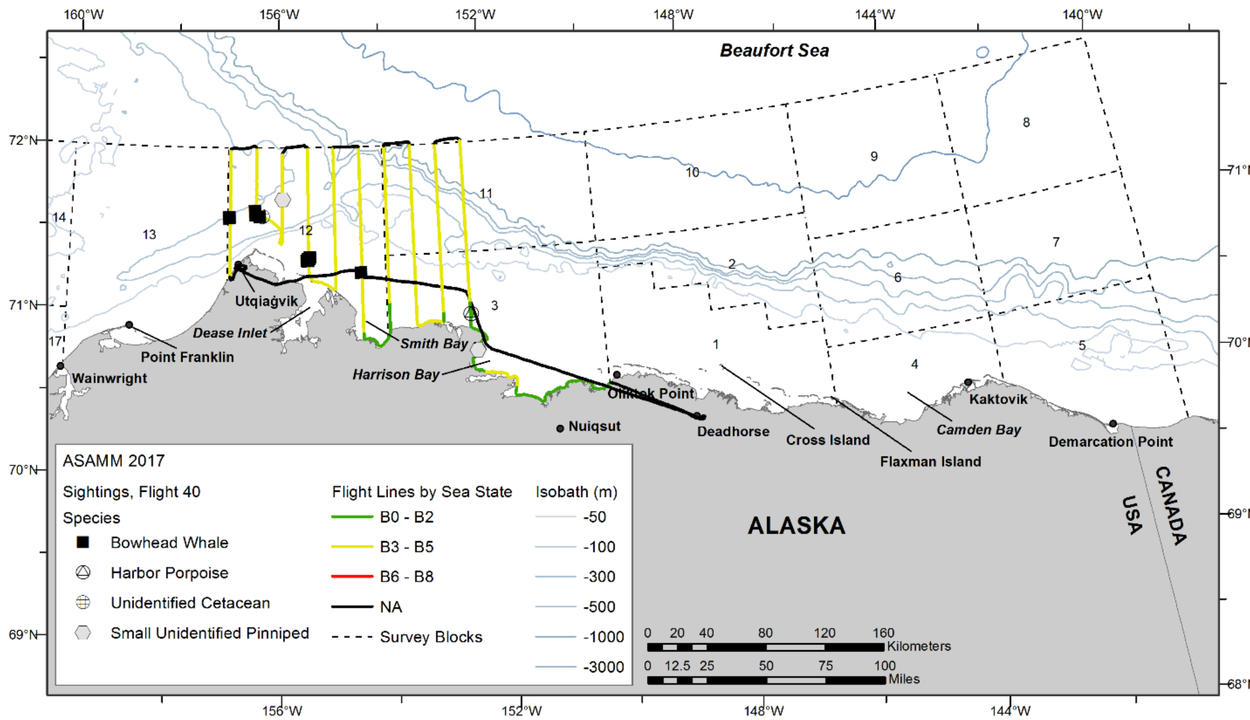


Figure B-83. Flight 40 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

8 October 2017, Flight 41

Flight was a survey of portions of block 5. Survey conditions included overcast skies, 0-5 km visibility (with fog), and Beaufort 1-3 sea states. No sea ice was observed in the area surveyed. Sightings included one unidentified pinniped and small unidentified pinnipeds.

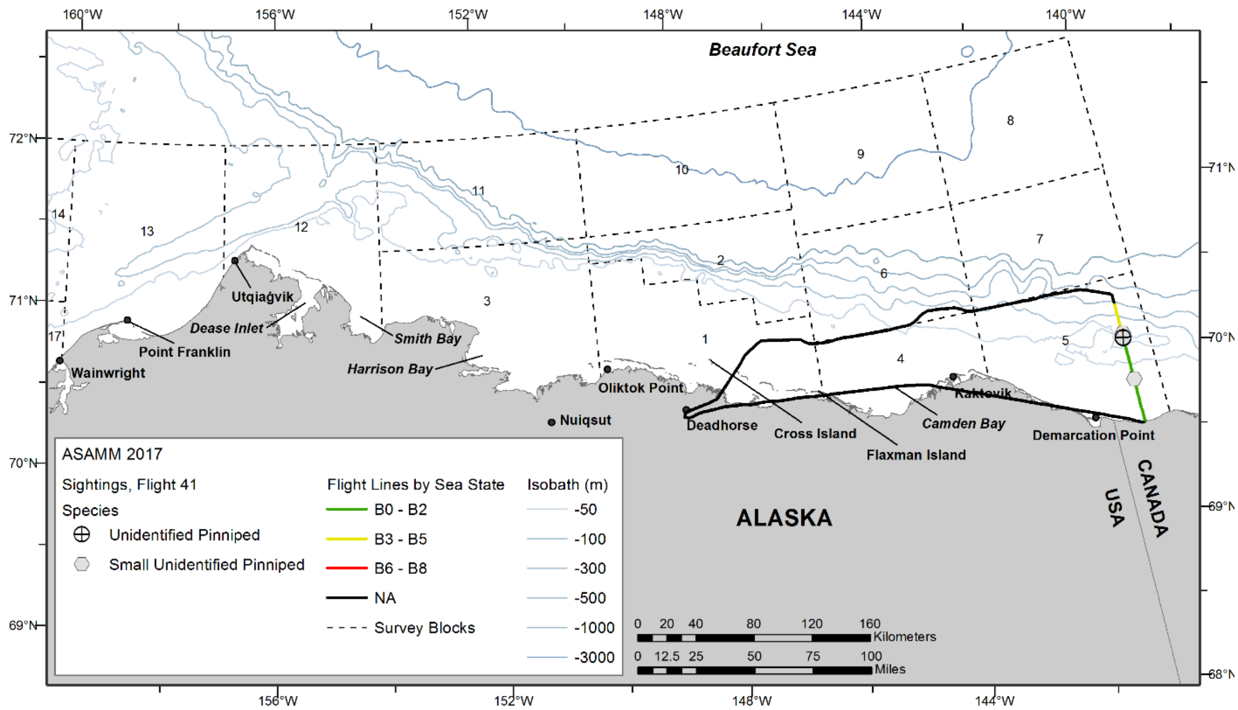


Figure B-84. Flight 41 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

9 October 2017, Flight 244

Flight was a partial survey of transect 11. Survey conditions included clear skies, <1-10 km visibility (with low ceilings), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. There were no marine mammal sightings.

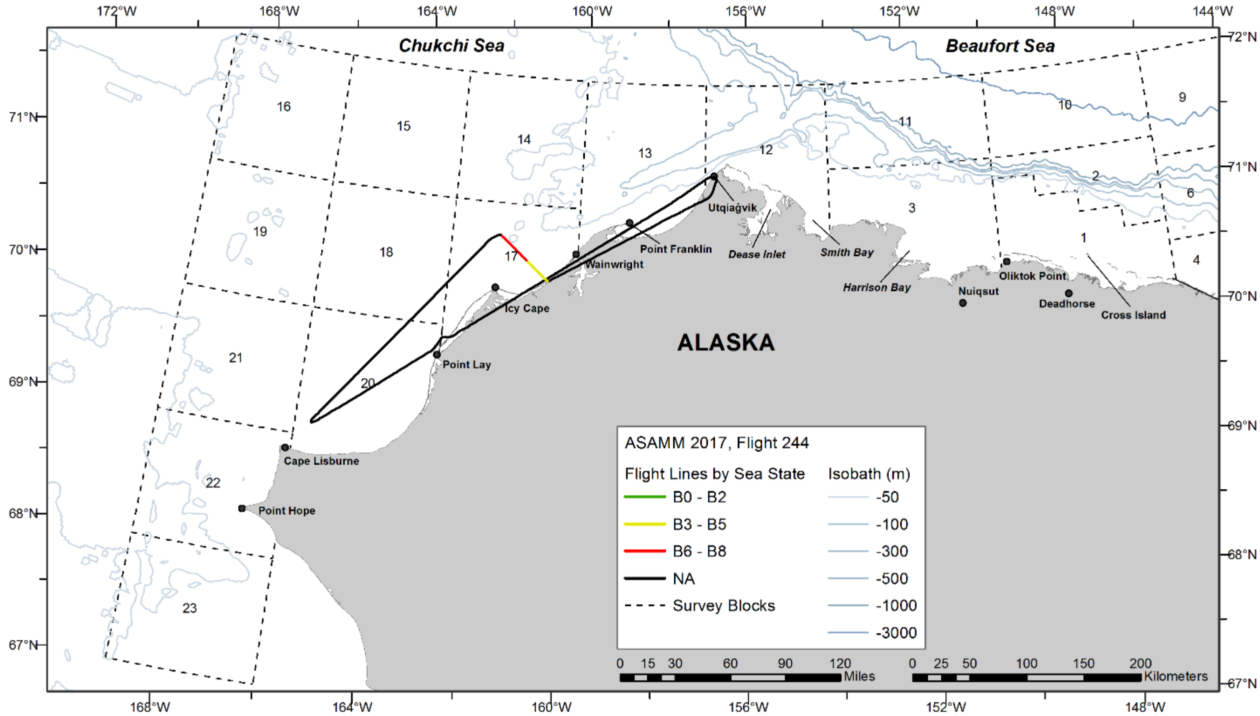


Figure B-85. Flight 244 survey track depicted by sea state.

10 October 2017, Flight 245

Flight was a complete survey of transect 20 and a partial survey of transects 9 and 22. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included walruses.

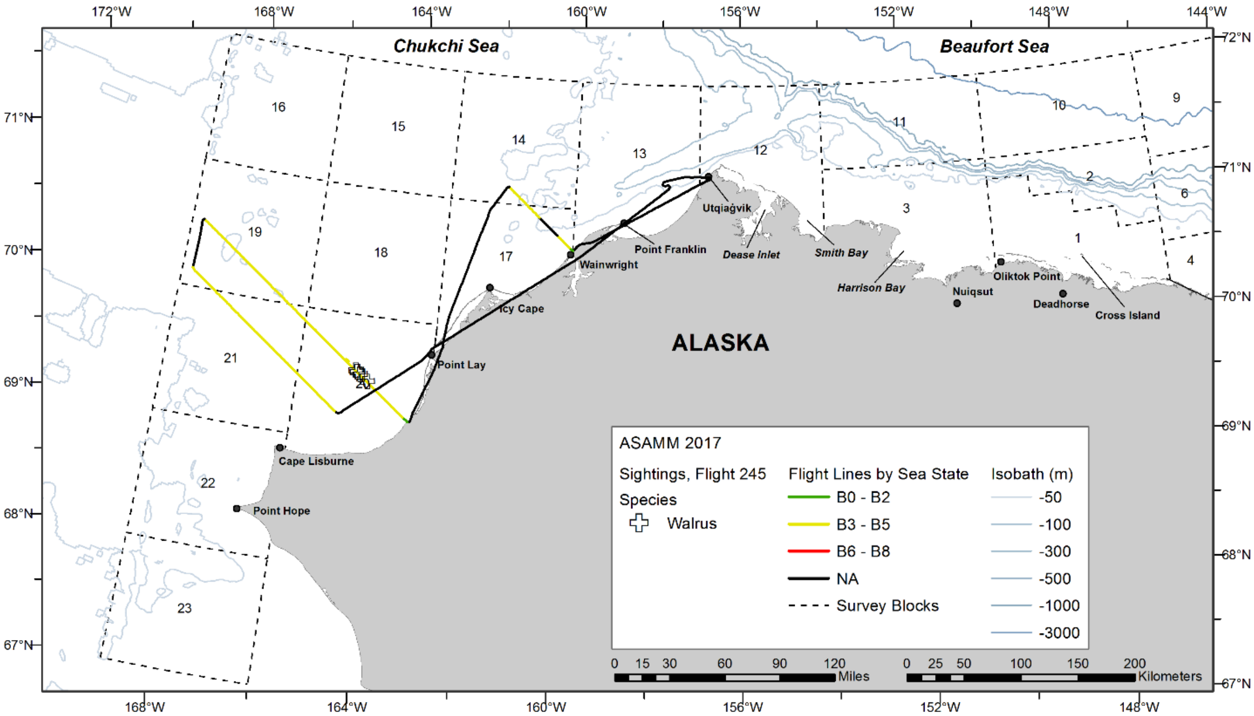


Figure B-86. Flight 245 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

10 October 2017, Flight 42

Flight was a coastal transect and search from approximately 55 km east of Barter Island to approximately 10 km east of Prudhoe Bay. Survey conditions included partly cloudy skies, 0 km to unlimited visibility (with fog), and Beaufort 1-3 sea states. Sea ice cover was 0-70% grease/new ice in the area surveyed. Sightings included polar bears.

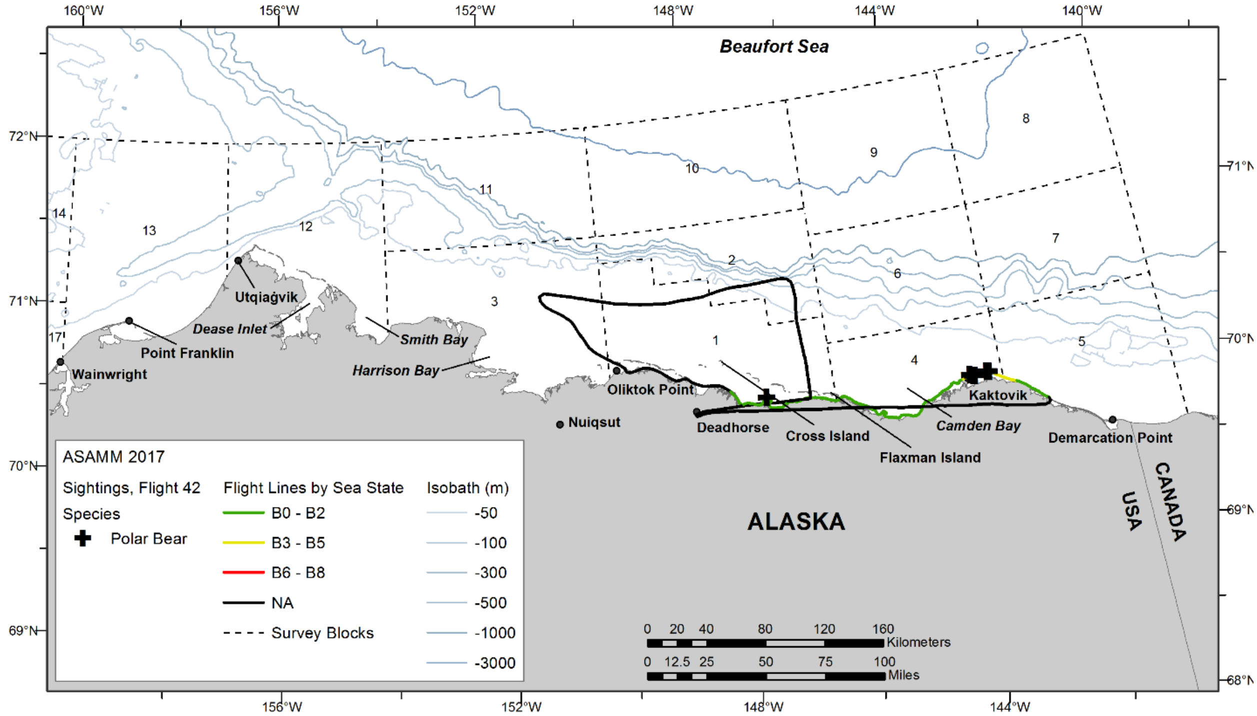


Figure B-87. Flight 42 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

11 October 2017, Flight 246

Flight was a complete survey of transects 1 and 2, and partial survey of transects 7 and 8. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 2 calves), gray whales (including 2 calves), one bearded seal, one unidentified pinniped, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
246	10/11/2017 11:14	71.646	157.023	bowhead whale	swim	2	1	13
246	10/11/2017 11:15	71.653	157.027	bowhead whale	swim	2	1	13
246	10/11/2017 12:57	71.252	161.216	gray whale	feed	1	0	14
246	10/11/2017 12:58	71.253	161.200	gray whale	feed	1	1	14
246	10/11/2017 13:00	71.239	161.249	gray whale	feed	1	0	14
246	10/11/2017 13:02	71.230	161.216	gray whale	feed	1	0	14
246	10/11/2017 13:04	71.263	161.112	gray whale	feed	1	0	14
246	10/11/2017 13:05	71.223	161.176	gray whale	feed	1	0	14
246	10/11/2017 13:06	71.228	161.187	gray whale	feed	1	0	14
246	10/11/2017 13:10	71.218	161.142	gray whale	feed	1	0	14
246	10/11/2017 13:12	71.218	161.138	gray whale	feed	1	0	14
246	10/11/2017 13:13	71.210	161.137	gray whale	feed	1	0	14
246	10/11/2017 13:13	71.224	161.178	gray whale	feed	1	1	14

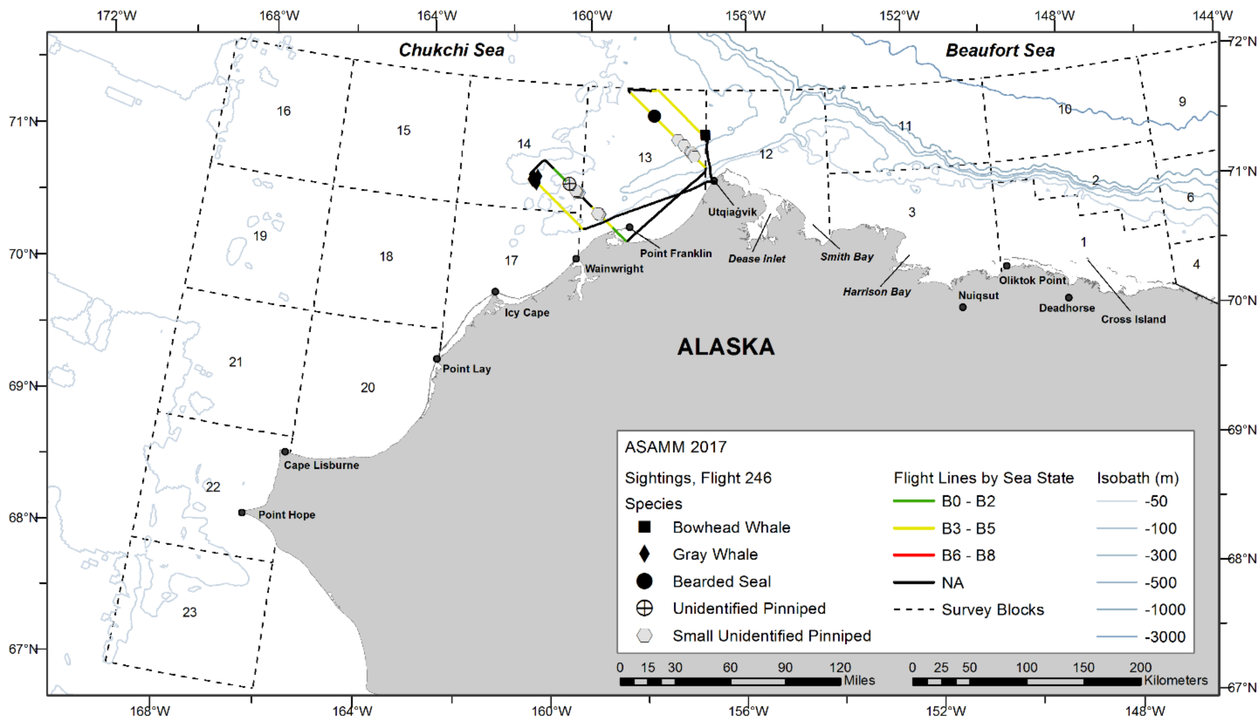
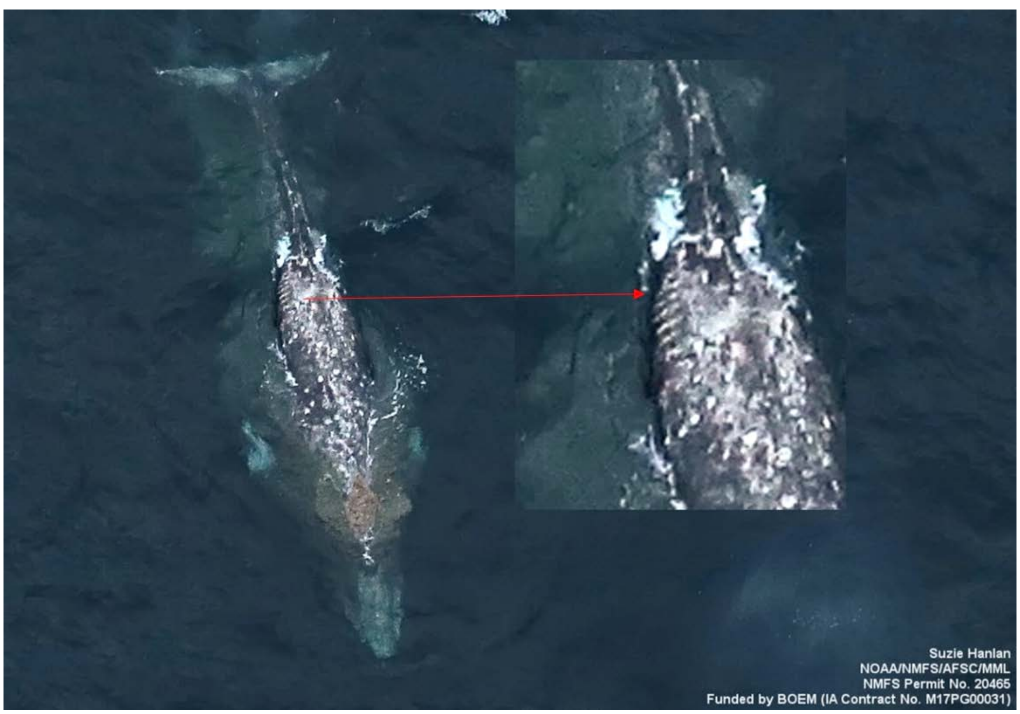


Figure B-88. Flight 246 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



An adult gray whale, with healed watercraft propeller wounds on its right flank, sighted approximately 90 km northwest of Point Franklin, Alaska, during ASAMM Flight 246, 11 October 2017.

15 October 2017, Flight 247

Flight was a survey of portions of blocks 1 and 2. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 0-6 sea states. Sea ice cover was 0-95% grease/new ice in the area surveyed. Sightings included bowhead whales (including 4 calves), belugas (including 1 calf), small unidentified pinnipeds, and polar bears.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
247	10/15/2017 12:58	70.785	150.006	bowhead whale	feed	3	0	3
247	10/15/2017 12:59	70.786	149.986	bowhead whale	feed	1	0	1
247	10/15/2017 13:04	70.787	149.960	bowhead whale	feed	1	0	1
247	10/15/2017 13:05	70.789	149.964	bowhead whale	feed	1	0	1
247	10/15/2017 14:02	70.697	148.987	bowhead whale	swim	1	0	1
247	10/15/2017 14:02	70.696	149.048	bowhead whale	rest	2	1	1
247	10/15/2017 14:05	70.696	149.069	bowhead whale	swim	1	0	1
247	10/15/2017 14:07	70.743	149.082	bowhead whale	feed	2	1	1
247	10/15/2017 14:09	70.672	148.998	bowhead whale	swim	2	0	1
247	10/15/2017 14:10	70.666	148.992	bowhead whale	swim	1	0	1
247	10/15/2017 14:13	70.669	148.929	bowhead whale	rest	1	0	1
247	10/15/2017 14:15	70.666	148.853	bowhead whale	swim	1	0	1
247	10/15/2017 14:41	70.667	148.456	bowhead whale	swim	2	1	1
247	10/15/2017 15:25	70.727	147.936	bowhead whale	swim	1	0	1
247	10/15/2017 15:30	70.599	147.909	bowhead whale	swim	1	0	1
247	10/15/2017 16:19	71.247	147.465	beluga	swim	11	1	2
247	10/15/2017 16:19	71.248	147.432	beluga	swim	9	0	2
247	10/15/2017 16:53	70.343	146.954	bowhead whale	mill	2	1	1

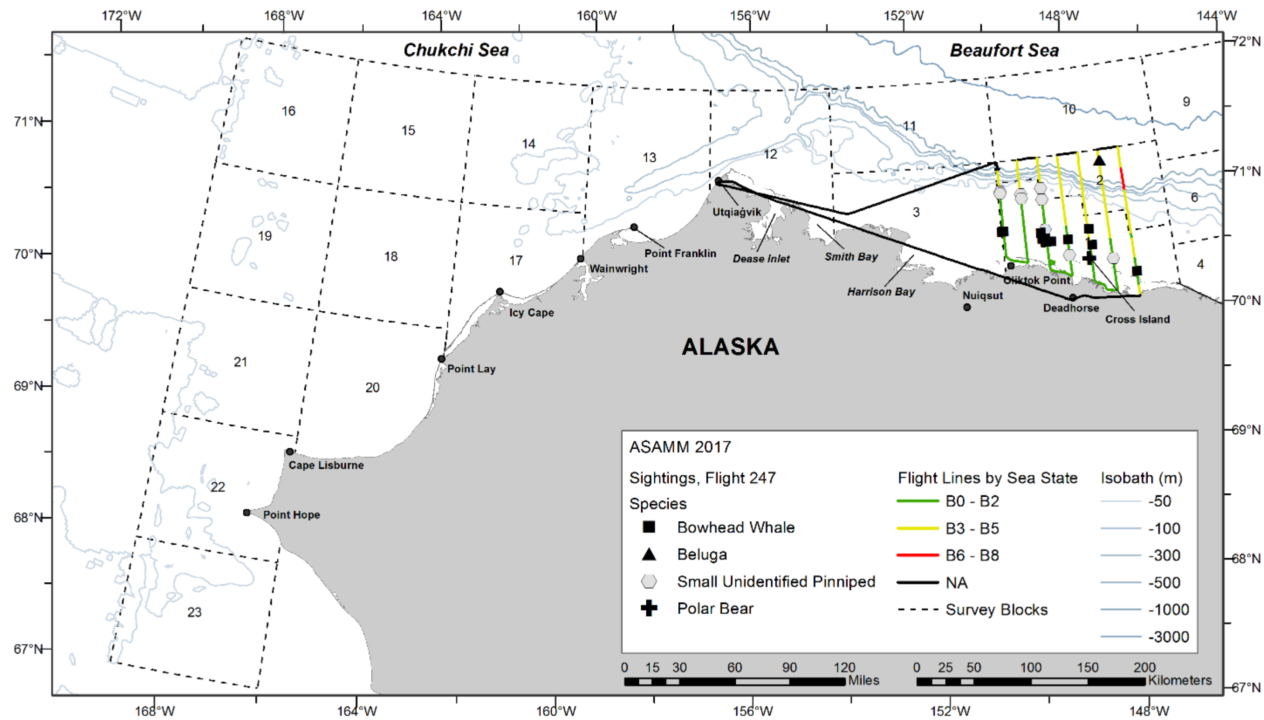


Figure B-89. Flight 247 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bears doing polar bear things, like resting and slow dancing, on Cross Island, Alaska, during ASAMM Flight 247, 15 October 2017.

16 October 2017, Flight 248

Flight was a partial survey of transect 12 and a partial coastal transect from Cape Lisburne to south of Wainwright. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-6 sea states. No sea ice was observed in the area surveyed. Sightings included walruses, bearded seals, unidentified pinnipeds, and small unidentified pinnipeds. The walrus haulout near Point Lay was estimated at approximately 500 walruses.

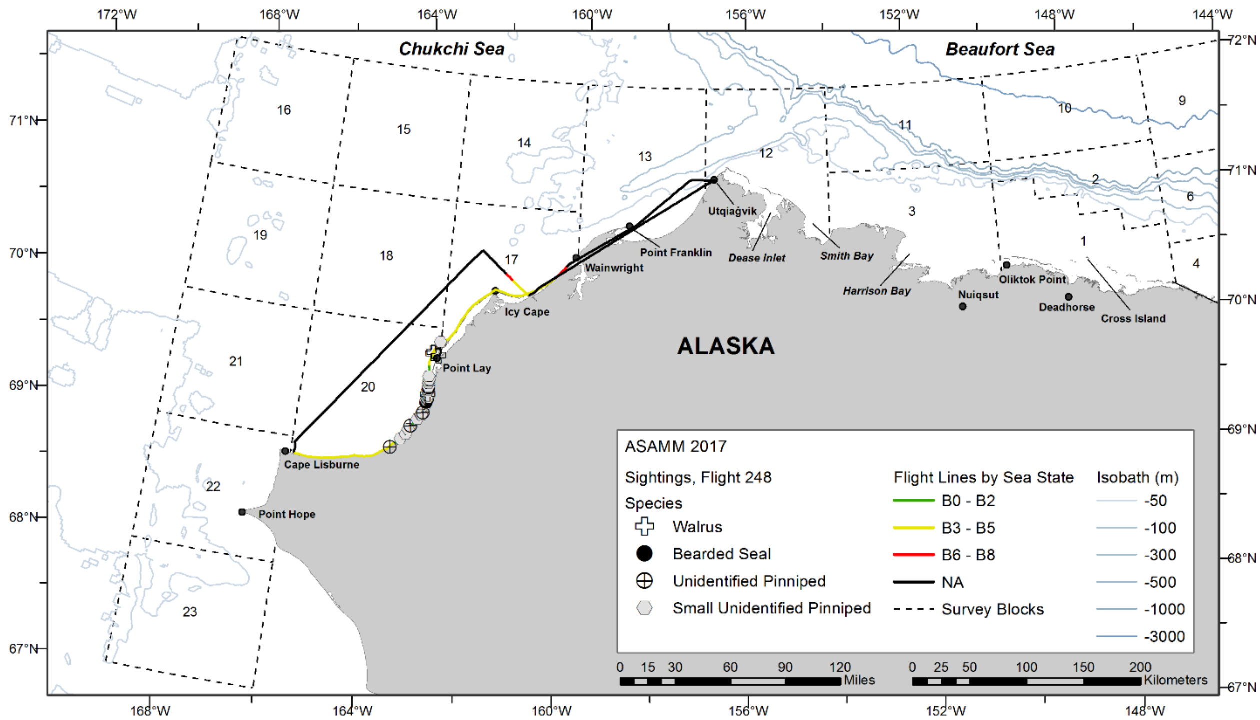


Figure B-90. Flight 248 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

17 October 2017, Flight 249

Flight was a survey of portions of block 12. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with low ceilings and precipitation), and Beaufort 0-6 sea states. Sea ice cover was 0-100% grease/new ice in the area surveyed. Sightings included bowhead whales and belugas.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
249	10/17/2017 13:43	71.461	155.471	beluga	dive	3	0	12
249	10/17/2017 13:46	71.486	155.460	beluga	swim	2	0	12
249	10/17/2017 13:47	71.518	155.459	beluga	swim	1	0	12
249	10/17/2017 14:13	71.629	155.949	beluga	swim	1	0	12
249	10/17/2017 14:14	71.570	155.947	bowhead whale	swim	1	0	12
249	10/17/2017 14:14	71.568	155.962	bowhead whale	swim	1	0	12
249	10/17/2017 14:15	71.557	155.917	bowhead whale	swim	1	0	12
249	10/17/2017 14:18	71.556	155.990	bowhead whale	rest	1	0	12
249	10/17/2017 14:19	71.543	155.984	bowhead whale	swim	1	0	12
249	10/17/2017 14:20	71.536	155.963	bowhead whale	swim	1	0	12
249	10/17/2017 14:20	71.535	155.962	bowhead whale	swim	1	0	12
249	10/17/2017 14:36	71.518	156.412	bowhead whale	swim	1	0	12
249	10/17/2017 14:36	71.523	156.391	bowhead whale	swim	1	0	12
249	10/17/2017 14:37	71.527	156.398	bowhead whale	breach	1	0	12
249	10/17/2017 14:38	71.530	156.365	bowhead whale	swim	1	0	12
249	10/17/2017 14:41	71.537	156.389	bowhead whale	swim	1	0	12

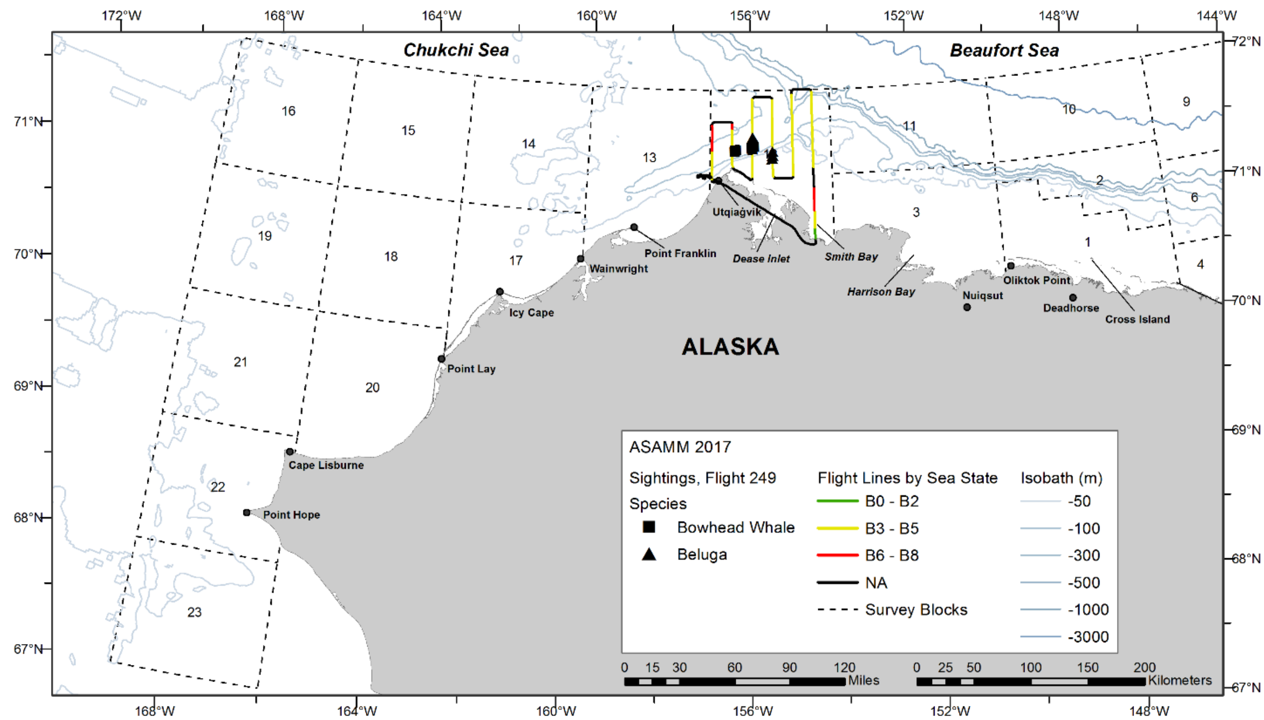


Figure B-91. Flight 249 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

18 October 2017, Flight 250

Flight was a complete survey of transect 2, a partial survey of transects 1, 3, and 4, the coastal transect from just northeast of Point Franklin to Point Barrow, and search effort from Point Franklin to Wainwright and from Point Barrow approximately 30 km northwest to the start of transect 1. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-6 sea states. Sea ice cover was 0-50% grease/new ice in the area surveyed. Sightings included bowhead whales (including 2 calves) and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
250	10/18/2017 13:38	71.493	156.610	bowhead whale	swim	1	0	12
250	10/18/2017 13:39	71.498	156.623	bowhead whale	swim	2	0	12
250	10/18/2017 13:39	71.508	156.587	bowhead whale	swim	1	0	12
250	10/18/2017 13:39	71.507	156.604	bowhead whale	swim	1	0	12
250	10/18/2017 13:40	71.496	156.619	bowhead whale	swim	1	0	12
250	10/18/2017 13:40	71.498	156.624	bowhead whale	swim	2	0	12
250	10/18/2017 13:40	71.506	156.607	bowhead whale	swim	1	0	12
250	10/18/2017 13:41	71.497	156.505	bowhead whale	mill	3	1	12
250	10/18/2017 13:42	71.507	156.476	bowhead whale	swim	1	0	12
250	10/18/2017 13:44	71.491	156.653	bowhead whale	swim	1	0	12
250	10/18/2017 13:45	71.487	156.735	bowhead whale	swim	1	0	12
250	10/18/2017 13:45	71.495	156.724	bowhead whale	swim	3	0	12
250	10/18/2017 14:24	71.695	157.936	bowhead whale	swim	1	0	13
250	10/18/2017 14:26	71.660	157.865	bowhead whale	rest	1	0	13
250	10/18/2017 14:28	71.609	157.729	bowhead whale	swim	1	0	13
250	10/18/2017 14:29	71.603	157.725	bowhead whale	swim	1	0	13
250	10/18/2017 14:29	71.596	157.782	bowhead whale	swim	1	0	13
250	10/18/2017 14:31	71.596	157.660	bowhead whale	swim	1	0	13
250	10/18/2017 14:32	71.587	157.629	bowhead whale	swim	1	0	13
250	10/18/2017 14:33	71.592	157.563	bowhead whale	swim	2	0	13
250	10/18/2017 14:35	71.569	157.578	bowhead whale	swim	1	0	13
250	10/18/2017 14:37	71.525	157.363	bowhead whale	swim	2	1	13
250	10/18/2017 14:38	71.516	157.382	bowhead whale	swim	1	0	13
250	10/18/2017 14:41	71.513	157.357	bowhead whale	swim	1	0	13
250	10/18/2017 14:42	71.528	157.318	bowhead whale	breach	1	0	13

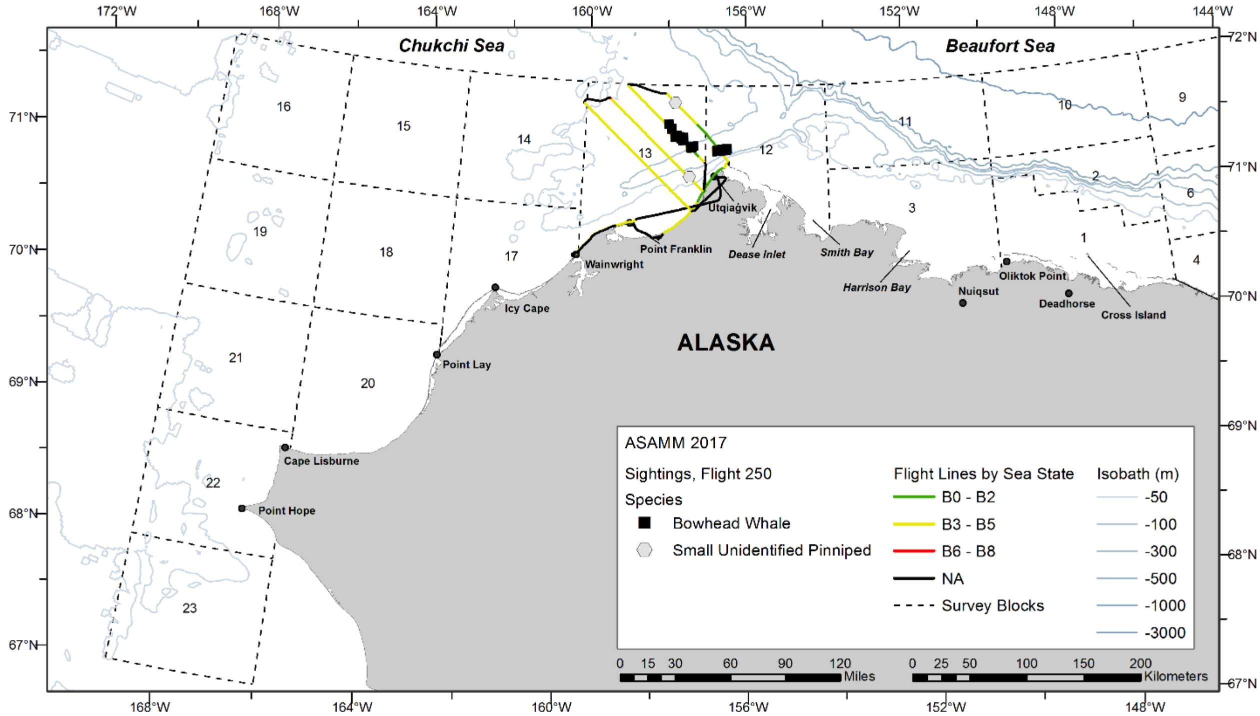


Figure B-92. Flight 250 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 October 2017, Flight 251

Flight was a survey of portions of blocks 3 and11. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 0-3 sea states. Sea ice cover was 0-100% grease/new ice in the area surveyed. Sightings included bowhead whales (including 1 calf), belugas (including 3 calves), and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
251	10/19/2017 11:26	70.849	151.971	beluga	mill	60	3	3
251	10/19/2017 11:44	71.118	151.948	bowhead whale	swim	1	0	3
251	10/19/2017 11:46	71.131	151.943	bowhead whale	swim	1	0	3
251	10/19/2017 12:41	71.167	151.441	bowhead whale	swim	1	1	3
251	10/19/2017 16:34	71.108	152.408	bowhead whale	swim	1	0	3
251	10/19/2017 16:34	71.115	152.445	bowhead whale	swim	1	0	3
251	10/19/2017 16:38	71.113	152.471	bowhead whale	swim	1	0	3
251	10/19/2017 17:29	71.134	152.947	bowhead whale	swim	1	0	3
251	10/19/2017 17:32	71.057	152.948	bowhead whale	feed	1	0	3
251	10/19/2017 17:33	71.054	152.929	bowhead whale	swim	1	0	3

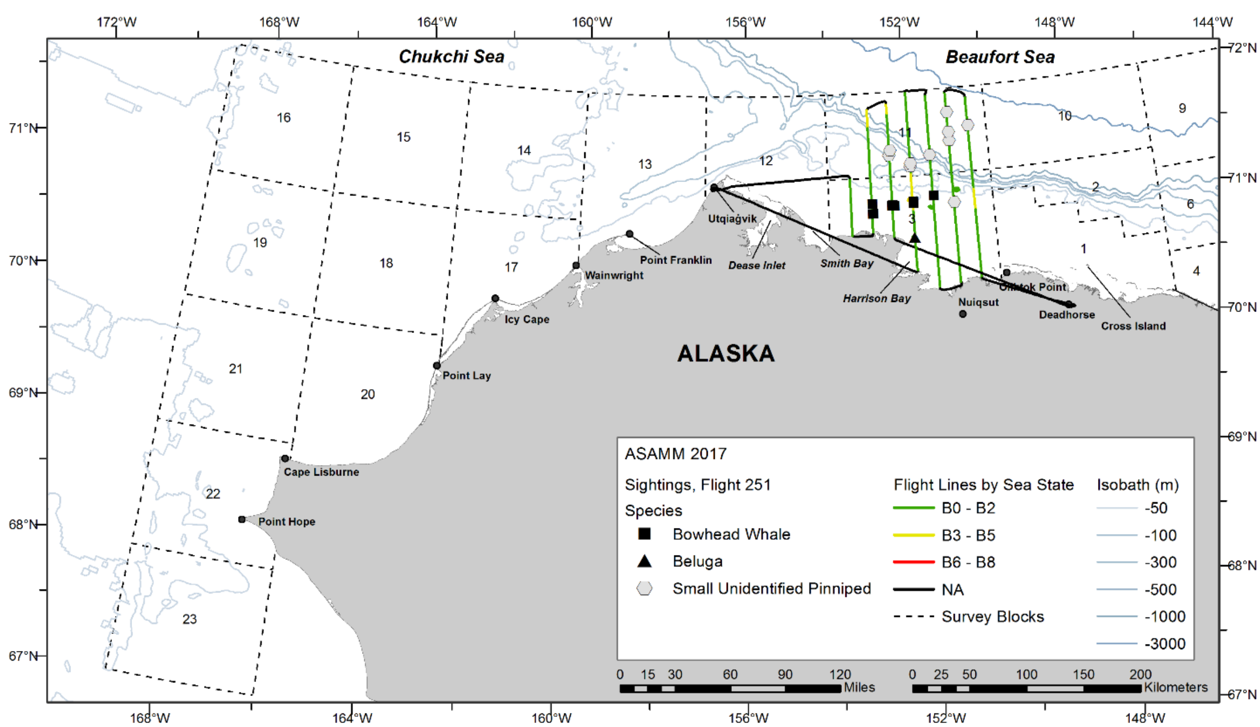
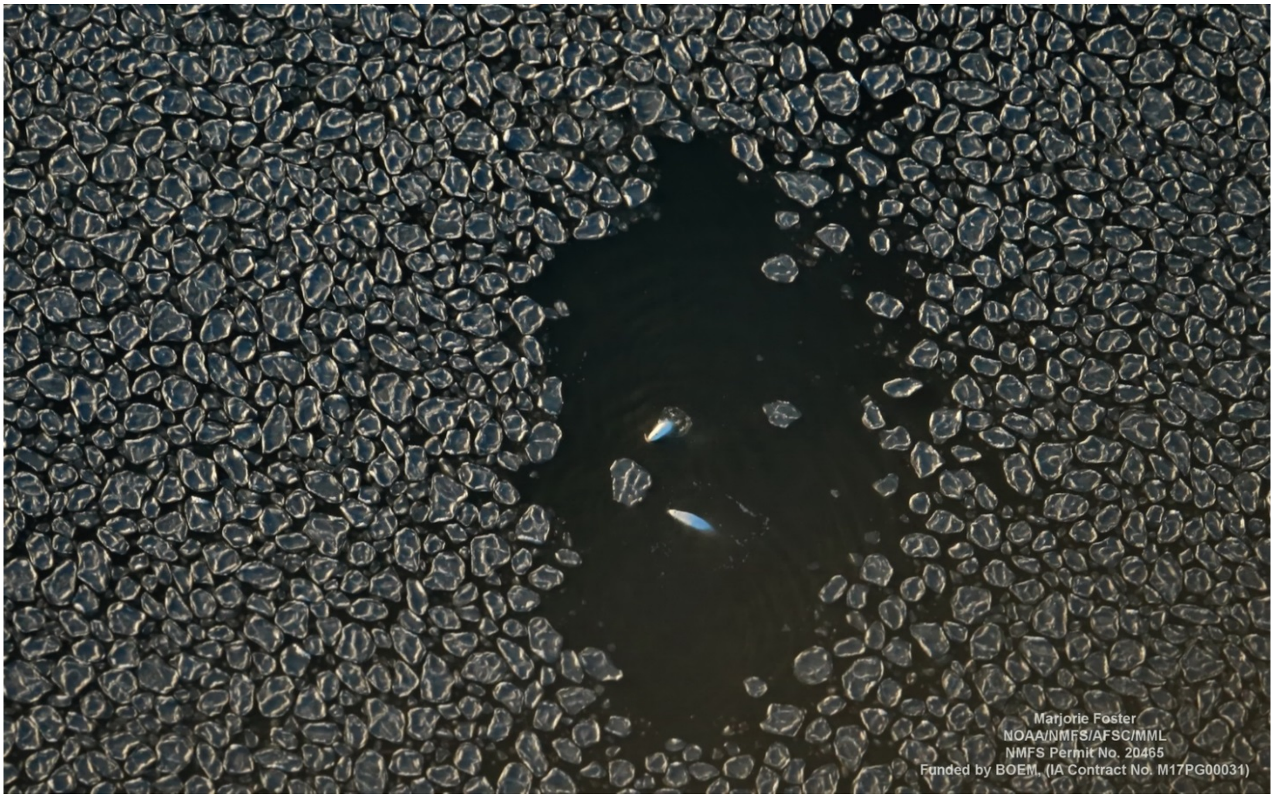


Figure B-93. Flight 251 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



Two belugas, of a larger group of 60, observed in pancake ice east of Cape Halkett, during ASAMM Flight 251, 19 October 2017.

Not even hip and waist deep snow can keep us from taking to the skies in search of Arctic marine mammals! (photo by Suzie Hanlan).

22 October 2017, Flight 252

Flight was a complete survey of transects 34 and 35 and a partial survey of transect 10. Survey conditions included partly cloudy to overcast skies, 1 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, gray whales, humpback whales, fin whales (including 1 calf), one minke whale, and unidentified cetaceans.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
252	10/22/2017 12:42	67.840	166.459	bowhead whale	swim	1	0	23
252	10/22/2017 12:43	67.854	166.451	fin whale	mill	2	0	23
252	10/22/2017 12:45	67.846	166.468	bowhead whale	swim	1	0	23
252	10/22/2017 12:50	67.851	166.565	fin whale	swim	1	0	23
252	10/22/2017 12:53	67.815	166.724	fin whale	swim	2	0	23
252	10/22/2017 12:59	67.846	166.920	fin whale	swim	1	0	23
252	10/22/2017 13:03	67.891	167.277	humpback whale	swim	1	0	23
252	10/22/2017 13:04	67.873	167.288	fin whale	swim	1	0	23
252	10/22/2017 13:06	67.906	167.281	fin whale	swim	2	1	23
252	10/22/2017 13:07	67.906	167.279	unid cetacean	swim	1	0	23
252	10/22/2017 13:17	67.817	167.852	fin whale	swim	1	0	23
252	10/22/2017 13:18	67.799	167.829	gray whale	feed	1	0	23
252	10/22/2017 13:23	67.790	167.817	gray whale	swim	1	0	23
252	10/22/2017 13:31	67.810	168.168	gray whale	feed	1	0	23
252	10/22/2017 13:34	67.815	168.116	gray whale	feed	1	0	23
252	10/22/2017 13:37	67.846	168.149	gray whale	feed	1	0	23
252	10/22/2017 13:38	67.841	168.100	gray whale	feed	1	0	23
252	10/22/2017 13:41	67.820	168.313	gray whale	feed	1	0	23
252	10/22/2017 13:51	67.765	168.635	unid cetacean	unknown	1	0	23
252	10/22/2017 13:52	67.762	168.720	bowhead whale	swim	1	0	23
252	10/22/2017 14:05	67.665	168.561	bowhead whale	rest	1	0	23
252	10/22/2017 14:11	67.644	168.457	humpback whale	mill	2	0	23
252	10/22/2017 14:21	67.691	168.440	bowhead whale	swim	1	0	23
252	10/22/2017 14:39	67.686	167.401	minke whale	swim	1	0	23
252	10/22/2017 14:54	67.652	166.506	fin whale	swim	1	0	23

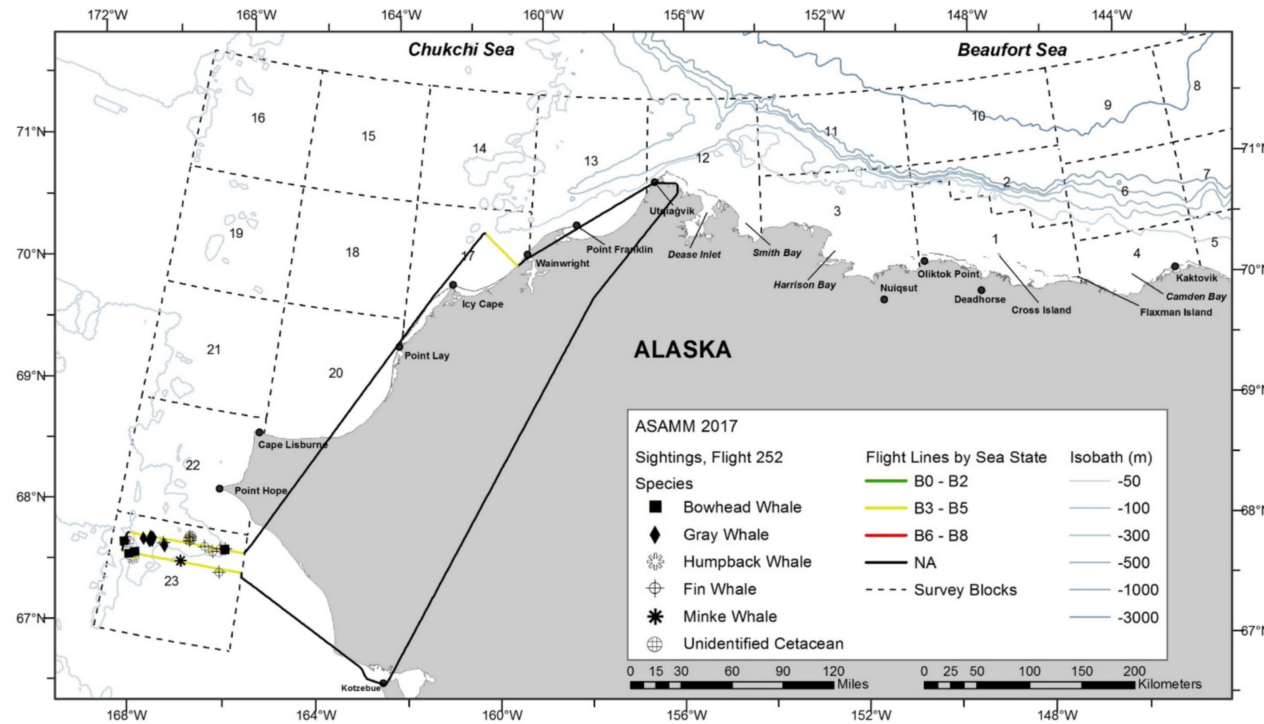


Figure B-94. Flight 252 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

23 October 2017, Flight 253

Flight was a complete survey of transects 3, 7, and 9 and a partial survey of transect 10. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-95% grease/new ice in the area surveyed. Sightings included gray whales, belugas (including 16 calves), walruses, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
253	10/23/2017 13:04	71.035	161.344	gray whale	feed	1	0	14
253	10/23/2017 13:07	71.026	161.290	gray whale	swim	3	0	14
253	10/23/2017 13:09	71.015	161.267	gray whale	feed	1	0	14
253	10/23/2017 13:11	71.020	161.247	gray whale	swim	1	0	14
253	10/23/2017 13:13	71.027	161.266	gray whale	feed	5	0	14
253	10/23/2017 13:14	71.020	161.253	gray whale	feed	1	0	14
253	10/23/2017 13:23	70.856	160.631	gray whale	feed	1	0	17
253	10/23/2017 13:47	70.992	159.473	gray whale	swim	1	0	13
253	10/23/2017 14:59	72.001	160.980	beluga	swim	135	16	0
253	10/23/2017 15:39	71.267	157.363	gray whale	feed	2	0	13

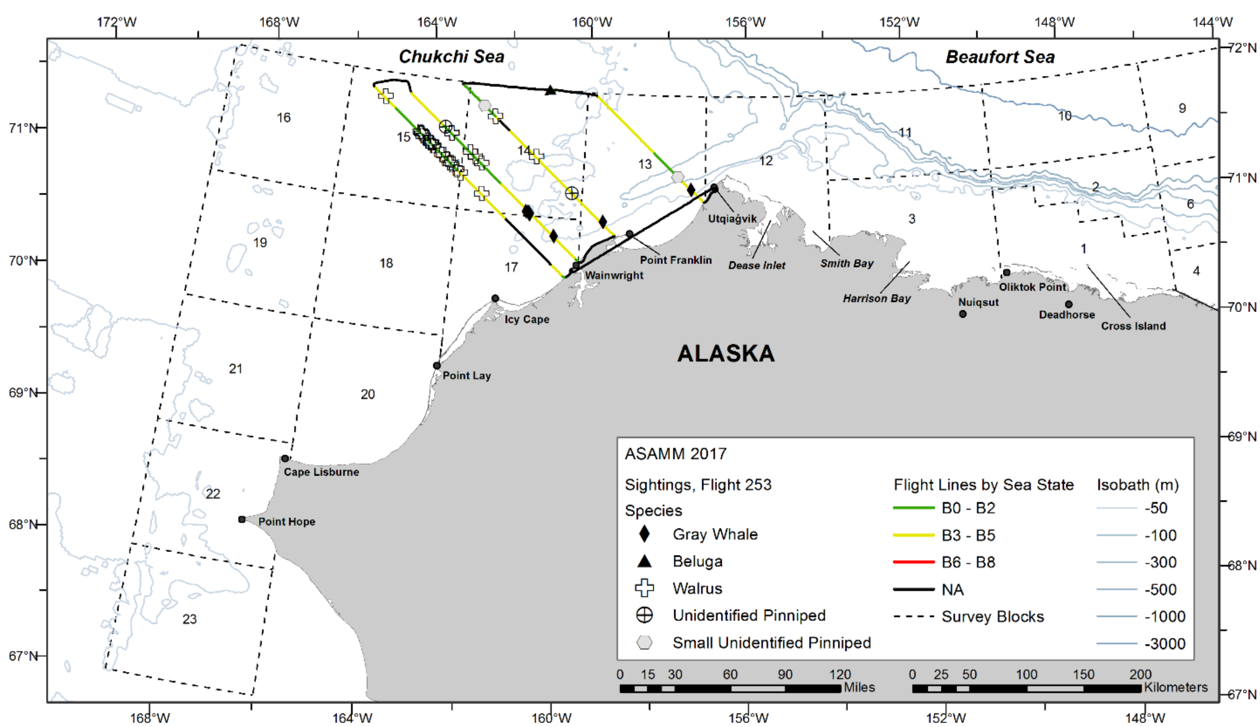


Figure B-95. Flight 253 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 October 2017, Flight 254

Flight was a survey of portions of blocks 1, 2, 4, and 6. Survey conditions included partly cloudy to overcast skies, unlimited visibility (with glare), and Beaufort 0-4 sea states. Sea ice cover was 0-100% grease/new ice in the area surveyed. Sightings included one bearded seal, small unidentified pinnipeds, and polar bears.

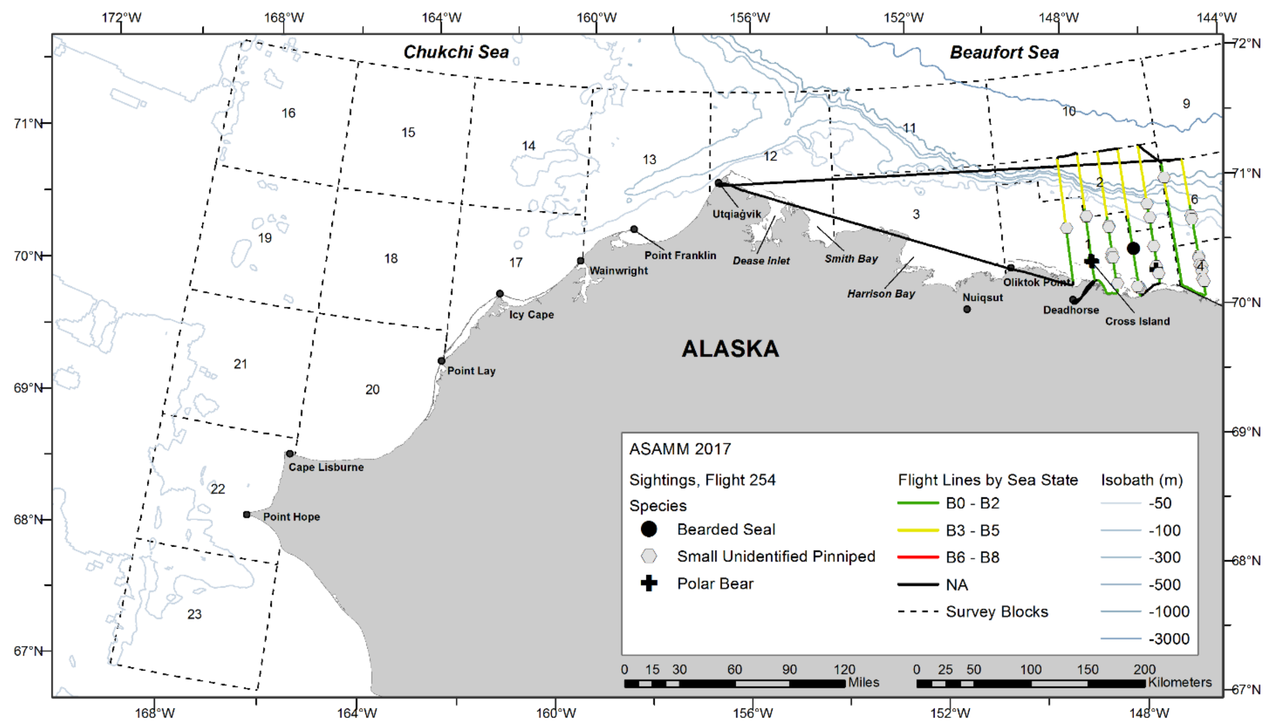


Figure B-96. Flight 254 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

25 October 2017, Flight 255

Flight was a complete survey of block 12 and portions of blocks 3 and 11. Survey conditions included clear to overcast skies, <1 km to unlimited visibility (with glare, ice on window, low ceilings, and precipitation), and Beaufort 0-4 sea states. Sea ice cover was 0-100% grease/new ice in the area surveyed. Sightings included bowhead whales (including 1 calf), belugas (including 26 calves), one walrus, unidentified pinnipeds, and small unidentified pinnipeds.

Cetacean sightings only, all effort (transect, search, circling):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
255	10/25/2017 11:16	71.249	153.331	bowhead whale	swim	2	0	3
255	10/25/2017 11:43	71.999	153.442	beluga	swim	2	1	11
255	10/25/2017 11:44	72.005	153.455	beluga	swim	1	0	0
255	10/25/2017 11:44	72.011	153.475	beluga	swim	8	2	0
255	10/25/2017 11:44	72.008	153.492	beluga	swim	2	0	0
255	10/25/2017 11:44	72.007	153.511	beluga	swim	2	0	0
255	10/25/2017 11:44	72.007	153.530	beluga	swim	7	3	0
255	10/25/2017 11:45	72.006	153.553	beluga	swim	11	1	0
255	10/25/2017 11:45	72.007	153.571	beluga	swim	1	0	0
255	10/25/2017 11:45	72.005	153.591	beluga	swim	4	2	0
255	10/25/2017 11:45	72.006	153.615	beluga	swim	1	0	0
255	10/25/2017 11:45	72.002	153.612	beluga	swim	6	3	0
255	10/25/2017 11:47	72.006	153.741	beluga	swim	1	0	0
255	10/25/2017 11:54	71.837	153.945	beluga	swim	5	0	11
255	10/25/2017 11:54	71.836	153.966	beluga	swim	2	0	11
255	10/25/2017 11:54	71.833	153.969	beluga	swim	2	0	11
255	10/25/2017 11:54	71.831	153.942	beluga	swim	6	2	11
255	10/25/2017 11:54	71.818	153.934	beluga	swim	1	0	11
255	10/25/2017 11:54	71.812	153.979	beluga	swim	7	2	11
255	10/25/2017 12:12	71.255	153.863	bowhead whale	swim	1	0	3
255	10/25/2017 12:20	71.206	153.940	bowhead whale	swim	1	0	3
255	10/25/2017 12:51	71.321	154.526	bowhead whale	swim	1	0	12
255	10/25/2017 13:22	71.937	154.924	beluga	swim	2	0	12
255	10/25/2017 13:22	71.920	154.953	beluga	swim	49	5	12
255	10/25/2017 13:22	71.919	154.957	beluga	swim	2	0	12
255	10/25/2017 13:22	71.913	154.930	beluga	swim	1	0	12
255	10/25/2017 13:22	71.912	154.935	beluga	swim	1	0	12
255	10/25/2017 13:22	71.910	154.896	beluga	swim	2	0	12
255	10/25/2017 13:23	71.896	154.928	beluga	swim	2	0	12
255	10/25/2017 13:23	71.894	154.939	beluga	swim	3	2	12
255	10/25/2017 14:07	71.403	155.431	bowhead whale	feed	1	0	12
255	10/25/2017 14:41	71.632	155.992	beluga	swim	1	0	12
255	10/25/2017 14:41	71.625	155.953	beluga	swim	2	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
255	10/25/2017 14:41	71.614	155.972	beluga	swim	1	0	12
255	10/25/2017 14:41	71.610	155.950	beluga	swim	1	0	12
255	10/25/2017 14:41	71.608	155.928	beluga	swim	7	0	12
255	10/25/2017 14:42	71.604	155.924	beluga	swim	4	1	12
255	10/25/2017 14:42	71.603	155.926	beluga	swim	2	1	12
255	10/25/2017 14:42	71.599	155.919	beluga	swim	4	1	12
255	10/25/2017 14:42	71.596	155.921	beluga	swim	1	0	12
255	10/25/2017 14:44	71.531	155.952	beluga	swim	1	0	12
255	10/25/2017 14:46	71.461	155.975	bowhead whale	swim	1	0	12
255	10/25/2017 15:09	71.726	156.454	beluga	swim	1	0	12
255	10/25/2017 15:13	71.887	156.458	beluga	swim	1	0	12
255	10/25/2017 15:14	71.922	156.419	beluga	swim	1	0	12
255	10/25/2017 15:35	71.502	156.901	bowhead whale	mill	2	1	12
255	10/25/2017 15:36	71.512	156.884	bowhead whale	swim	1	0	12
255	10/25/2017 15:39	71.497	156.947	bowhead whale	swim	1	0	12

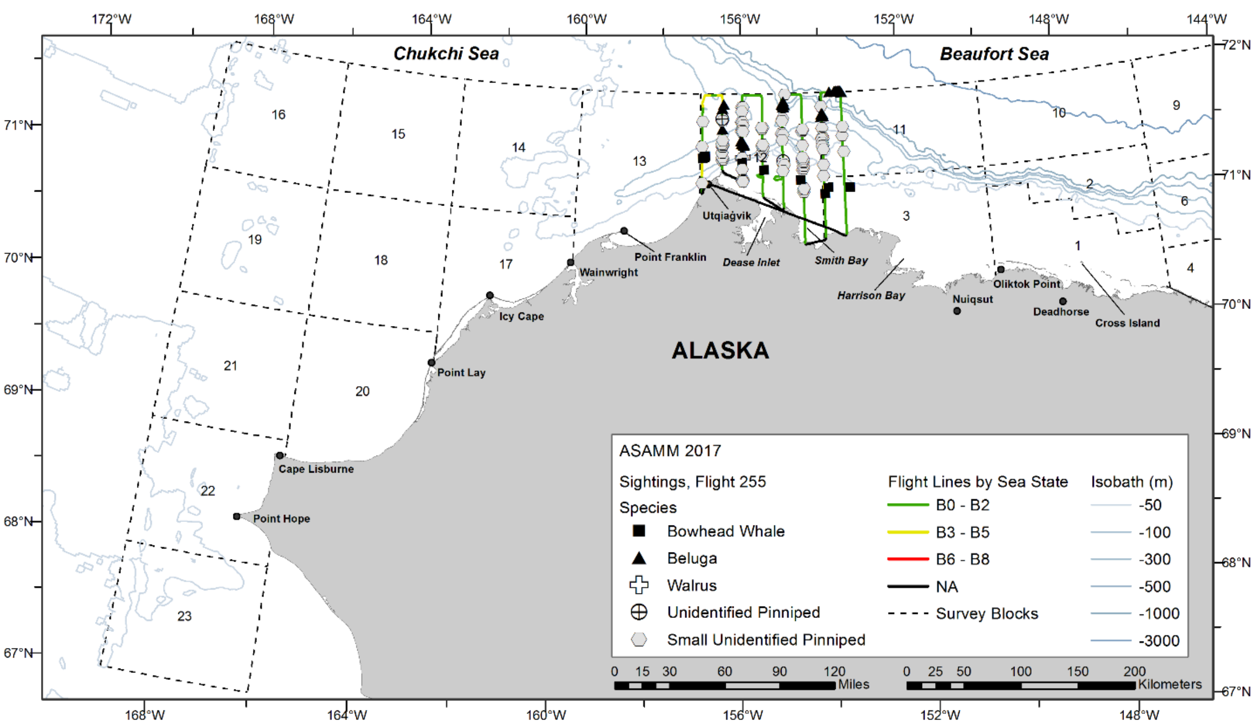


Figure B-97. Flight 255 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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APPENDIX C: PUBLICATIONS, POSTERS, PRESENTATIONS, and MEDIA OUTREACH FROM ASAMM, SPRING 2017- SPRING 2018

List of Publications, Posters and Presentations

Includes material published or produced since the 2016 ASAMM report.

2017

Clarke, J.T., A.A. Brower, M.C. Ferguson, and A.L. Willoughby. 2017. Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2016. Annual Report, OCS Study BOEM 2017-078. Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC3, Seattle, WA 98115-6349.

Ferguson, M.C. and J.T. Clarke. 2017. ASAMM 101: Introduction to the Aerial Surveys of Arctic Marine Mammals Project. Presented during the Review of Arctic Density Models meeting, Duke University, 23-24 May 2017.

Ferguson M.C., G.H. Givens, J.T. Clarke, A.L. Willoughby, A.A. Brower, and J.C. George. 2017. A minimum abundance estimate of BCB bowhead whales in the western Beaufort Sea in late August, 2016. Presented to the 2017 Scientific Committee of the International Whaling Commission. 18pp. SC/67a/AWMP08.

Mannocci, L., A. Boustany, J. Roberts, D. Dunn, P. Halpin, D. Palacios, S. Viehman, J. Moxley, J. Cleary, H. Bailey, S. Bograd, E. Becker, B. Gardner, J. Hartog, E. Hazen, M. Ferguson, K. Forney, B. Kinlan, M. Oliver, C. Perretti, V. Ridoux, S. Teo, and A. Winship. 2017. Temporal resolutions in species distribution models of highly mobile marine animals: Recommendations for ecologists and managers. *Diversity Distribution* 23:1098–1109. https://doi.org/10.1111/ddi.12609

Muto, M.M., V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2017. Alaska marine mammal stock assessments, 2016. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-AFSC-355, 366 p. doi:10.7289/V5/TM-AFSC-355.

Smith, M.A., M.S. Goldman, E.J. Knight, and J.J. Warrenchuk. 2017. *Ecological Atlas of the Bering, Chukchi, and Beaufort Seas*. 2nd edition. Audubon Alaska, Anchorage, AK.

Stimmelmayr, R., J.C. George, A. Brower, J. Clarke, M. Ferguson, A. Von Duyke, G. Sheffield, K. Stafford, T. Sformo, B. Person, L. Sousa, B. Tudor, and R. Suydam. 2017. 2016 health report for the Bering-Chukchi-Beaufort seas bowhead whales - preliminary findings. Presented to the 2017 Scientific Committee of the International Whaling Commission. 21pp. SC/67a/AWMP.

2018

Angliss, R.P., M.C. Ferguson, P. Hall, V. Helker, A. Kennedy, and T. Sformo. 2018. Comparing manned aerial surveys to unmanned aerial surveys for cetacean monitoring in the Arctic: methods and operational results and recommendations. *Journal of Unmanned Vehicle Systems* 6(3): 109-127. DOI 10.1139/juvs-2018-0001.

Brower, A.A., A. Willoughby, J. Clarke, M. Ferguson, C. Accardo, L. Barry, V. Beaver, L. Ganley, S. Hanlan, and K. Pagan. 2018. Polar bear occurrence on the western Beaufort Sea coast, summer and fall 2017. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2018.

Brower, A.A., J.T. Clarke, and M.C. Ferguson. 2018. Increased sightings of subarctic cetaceans in the eastern Chukchi Sea, 2008-2016: population recovery, response to climate change, or increased effort? *Polar Biology*. https://doi.org/10.1007/s00300-018-2257-x.

Clarke, J.T., M.C. Ferguson, A.A. Brower, and A.L Willoughby. 2018. Bowhead whale calves in the western Beaufort Sea, 2012-2017. Paper SC/67b/AWMP3 presented to the IWC Scientific Committee, April 2018 (unpublished), Bled, Slovenia.

Clarke, J.T., M.C. Ferguson, A.A. Brower, A.L. Willoughby, C. Sims, C. Accardo, L. Barry, V. Beaver, M. Foster, L. Ganley, J. Gatzke, S. Hanlan, K. Pagan, and K. Vale-Vasilev. 2018. The kids are alright – bowhead whale calves in the western Beaufort Sea, 2012-2017. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2018.

Clarke, J.T., M.C. Ferguson, A.L. Willoughby, and A.A. Brower. 2018. Bowhead whale and beluga distributions, sighting rates, and habitat associations in the western Beaufort Sea, summer and fall 2009-2016, with a retrospective comparison to 1982-1991. *Arctic* 71(2): 115-136. DOI 10.14430/arctic4713.

Ferguson, M.C. and J.T. Clarke. 2018. Update on analysis of ASAMM 2016 data to derive a “minimum population estimate” for the Bering-Chukchi- Beaufort bowhead whale stock. Paper SC/67b/AWMP16 presented to the IWC Scientific Committee, April 2018 (unpublished), Bled, Slovenia.

Ferguson, M.C., R.P. Angliss, A. Kennedy, B. Lynch, A. Willoughby, V. Helker, A.A. Brower, and J.T. Clarke. 2018. Performance of manned and unmanned aerial surveys for estimating arctic cetacean density and associated uncertainty. *Journal of Unmanned Vehicle Systems* 6(3): 128-154. DOI 10.1139/juvs-2018-0002.

Hay, M. 2018. Marine mammal data collection and reporting software written with ArcObjects and .NET. Poster: ESRI International User’s Conference, San Diego, CA, July 2018.

Stimmelmayr, R., George, J.C., A. Willoughby, J. Clarke, M. Ferguson, G. Sheffield, K. Stafford, A. Von Duyke, T. Sformo, B. Person, L. Sousa, B. Tudor, and R. Suydam. 2018. 2017 health report for the Bering-Chukchi-Beaufort seas bowhead whales – preliminary findings. Paper SC/67b/AWMP8 presented to the IWC Scientific Committee, April 2018 (unpublished), Bled, Slovenia.

Willoughby, A.L., J.T. Clarke, M.C. Ferguson, R. Stimmelmayr, and A.A. Brower. 2018. Bowhead whale carcasses in the eastern Chukchi and western Beaufort seas, 2009-2017. Paper SC/67b/AWMP2 presented to the IWC Scientific Committee, April 2018 (unpublished), Bled, Slovenia.

Willoughby, A.L., M.C. Ferguson, J.T. Clarke, A.A. Brower, C. Accardo, L. Barry, V. Beaver, M. Foster, S. Hanlan, K. Pagan, C. Sims, and K. Vale-Vasilev. 2018. Photo-identification of gray whales in the Eastern Chukchi Sea, summer and fall 2017. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2018.

Willoughby, A.L., M.C. Ferguson, J.T. Clarke, and A.A Brower. 2018. First photographic match of an anomalously white gray whale (*Eschrichtius robustus*) in the northeastern Chukchi Sea, Alaska, and off Baja California, Mexico. *Aquatic Mammals,* 44(1): 7-12. DOI 10.1578/AM.44.1.2018.7.

Snapshots of Media Outreach and Blogs

The Arctic Sounder

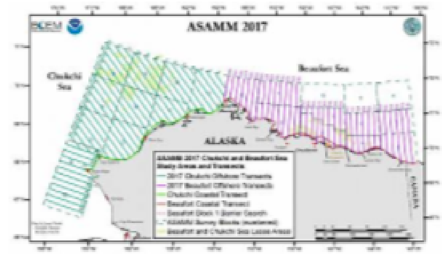
Researchers eye marine mammals in offshore surveys

August 11th | Shady Grove Oliver, The Arctic Sounder

Bowhead whales and other marine mammals are the focus of a four-month survey project this summer in Arctic waters.

Led jointly by the National Oceanic and Atmospheric Administration, the National Marine Fisheries Service, the Alaska Fisheries Science Center, the Department of Interior and the Marine Mammal Laboratory, the Department of Commerce, and the Bureau of Ocean Energy Management, this summer's research is part of a series of years-long studies of the region's biodiversity.

Called the Aerial Surveys of Arctic Marine Mammals, the project aims to gather data about the populations of these animals in the Chukchi and Beaufort Seas, specifically in areas where there is potential for future oil and gas development.



Aerial surveys of Arctic Marine Mammals study area in the northeastern chukchi and western Beaufort seas, including survey transects, survey boundaries, offshore oil and gas lease areas, and bathymetry. - afsc.noaa.gov

Researchers will spend the summer months flying over the region, tallying the number of bowhead, right, fin, and gray whales, belugas, and other marine mammals they see in particular areas. They'll note where they were spotted and what they were doing.

The information they gather will add to an already decades-long data set collected by scientists since 1979.

This project is just the most recent incarnation of a series of research efforts led by this group of agencies over the last three-and-a-half decades. The Bowhead Whale Aerial Survey Project (BWASP) ran from 1979 until 2010 and focused on the bowhead whale migrations through the Beaufort Sea in fall. Around the same time, the Chukchi Offshore Monitoring in Drilling Areas (COMIDA) collected data on summer and fall marine mammal populations in the adjacent sea, starting in 2008.

They've both now been incorporated under the current project.

The annual migration of the bowhead whale still remains the central focus of observations, as researchers hope to better understand how these patterns change from year to year and if there are any long-term trends.

Additionally, the observers will pay attention to the calving and pupping, hauling out, and feeding trends of other species including ice seals, walruses, and polar bears, according to a notice from the organizations leading the project.

They'll also feed "near real-time data and maps to BOEM and NMFS on marine mammals in the Alaskan Arctic, with specific interest in endangered species, such as bowhead whales," the notice stated.

All in all, the project aims to provide baseline and up-to-date data that may be able to better guide management and industry decisions in the years to come.

This year's observations began July 1 and will continue through the end of October. Project participants are writing observation updates that can be found on the Alaska Fisheries Science Center's science blog.

Shady Grove Oliver can be reached at sgoarctic@gmail.com.

http://www.thearcticsounder.com/article/1732researchers_eye_marine_mammals_in_offshore

Three bowhead whales in echelon formation sighted in the July 21st feeding aggregation.
Photo: Laura Ganley, NOAA Fisheries

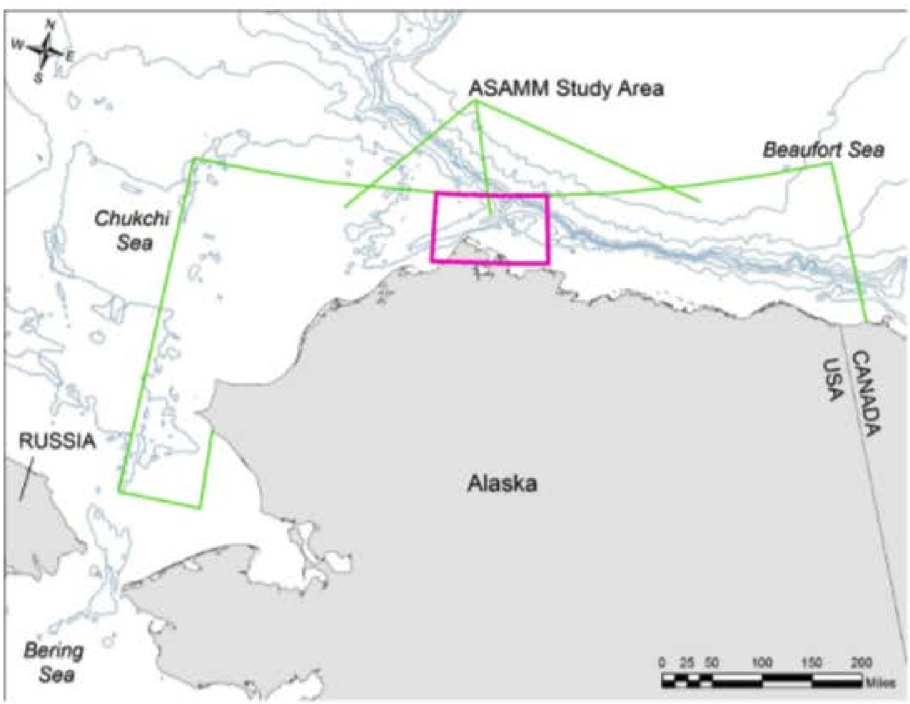
Aerial Surveys of Arctic Marine Mammals

What's Happening

- June 27
- August 1
- August 16
- August 31
- September 28
- October 17
- Field Blogs Home

Evidence for the Earliest "Krill Trap" on Record in the Western Beaufort Sea

The Aerial Surveys of Arctic Marine Mammals (ASAMM) 2017 field season has kicked off and is well underway! ASAMM is funded by the Bureau of Ocean Energy Management (BOEM) Alaska Region and co-managed by BOEM and NOAA. Our team based in Utqiagvik (formerly Barrow), Alaska, has been flying primarily in the Chukchi Sea since July 2nd. Their season is off to a great start, and we'll have more to come on the interesting things they've been seeing in future blogs. Our team based in Deadhorse, Alaska, had their first flight on July 19th and they will focus their survey effort in the Beaufort Sea. The Beaufort team kicked right into action and has already documented outstanding sightings. On July 21st, we were fortunate enough to sight an amazing feeding aggregation of bowhead whales: the earliest documented "krill trap" on record for bowhead whales in the western Beaufort Sea!



The ASAMM study area with the krill trap area boxed in pink.
Figure: NOAA Fisheries

https://www.afsc.noaa.gov/Science_blog/ASAMM_1.htm

Figure 1 - High altitude view of mud plumes from a feeding gray whale observed inside Peard Bay, Alaska during ASAMM-Chukchi flight on 28 July 2017.
Photo: Vicki Beaver, NOAA Fisheries

A Gray Whale in Peard Bay ASAMM – Chukchi Flight on 28 July 2017

The Aerial Surveys of Arctic Marine Mammals (ASAMM) survey team based in Utqiagvik (formerly Barrow), Alaska, had finished their line-transect survey in the northeastern Chukchi Sea on 28 July and were transiting though the Chukchi Sea study area at an altitude of approximately 6,500 ft when they sighted mud plumes left behind by a feeding gray whale. To better document the whale, the aircraft descended to an altitude of ~1,200 ft. The photo shown above (Figure 1) was taken through the observer's viewing window with a cell phone during the descent.

Feeding gray whales are a common sight for the ASAMM-Chukchi team and yet this was a unique sighting because of where the whale was -- inside the confines of Peard Bay (Figure 2). Peard Bay is a relatively small and shallow bay located northeast of Wainwright, Alaska, in the Chukchi Sea. It is approximately 18 miles long at its widest point and approximately 20 feet deep (Figure 3).

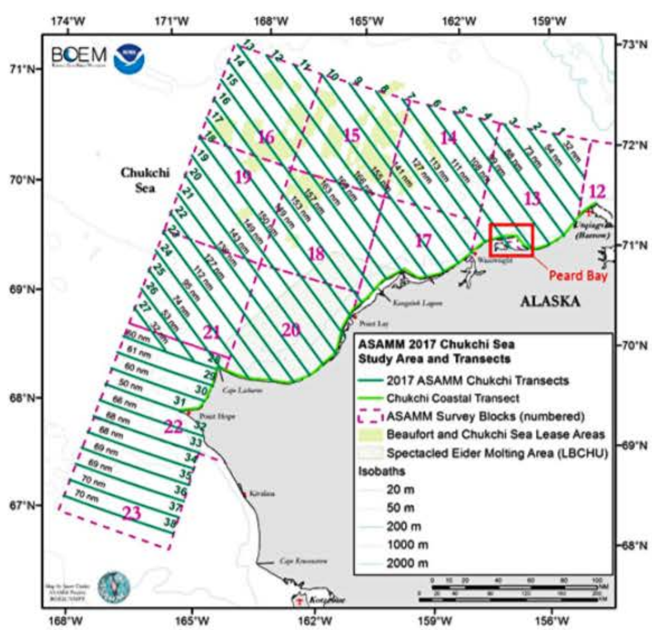


Figure 2. The ASAMM Chukchi Sea study area with Peard Bay highlighted in red.

https://www.afsc.noaa.gov/Science_blog/ASAMM_2.htm

Fin whales feeding in the southeastern Chukchi.
Photo: NOAA Fisheries

Some Days are Diamonds, Some Days are Stone

Welcome back to our update on the Aerial Surveys of Arctic Marine Mammals (ASAMM). Luckily, after a few days of stone and a few days of cubic zirconia, we had a couple diamond days.

A Day of Stone

When we are in the field trying to fly aerial surveys in the Arctic those are the days we sit around monitoring the fickle weather patterns, hoping for an opening in our vast survey area with cloud ceilings of 1100 feet (our minimum requirement) and decent sea states (less than a Beaufort 5 please - that means not too many white caps!).

In the Arctic, weather isn't predictable and often doesn't follow the forecast. So, a "Day of Stone" can mean we start our day off with an optimistic outlook for a survey. The forecast tells us that the ceilings at our home base (Utqiagvik and Deadhorse for us) will lift and stabilize enough for safe launching and return of the survey airplane. Often times, we sit here waiting and watching as the fog rolls in and out of town, effectively grounding us for the day. This has been happening more than we would like.

A Day of Cubic Zirconia

We also have days when we launch a survey and are able to cover our entire survey area, but just have very few whale sightings. This August this happened quite a bit. Even though we get a big "COMPLETE" mark for covering those survey transect lines, the sightings of animals were few and far between at times. That is what I call a 'cubic zirconia', a very nice solid survey day that just lacks sparkle. A zirconia day that covered lots of transect miles over the course of 2 flights without even one sighting of a cetacean! These surveys are hard work, without much excitement, and too many of these types of survey days back to back are a bit hard on team morale.

https://www.afsc.noaa.gov/Science_blog/ASAMM_3.htm

Bowhead whale cow-calf pair, Alaskan Beaufort Sea, August 2016.
Photo: Vicki Beaver, NOAA Fisheries

The Kids Are Alright – Bowhead Whale Calves in the Alaskan Arctic

There are some who might think that baby bowhead whales, known as calves, do not qualify as "cute" or "adorable". Rubbish! Although they may not appear as cuddly as polar bear or walrus babies, bowhead whale calves still pass the "awwwww" test. The universal appeal of baby animals is not the only reason the Aerial Surveys of Arctic Marine Mammals (ASAMM) project expends extra effort to document the presence or absence of bowhead whale calves. Calf data is also used to assist with the general health assessment of a population by determining calving interval (e.g., how often do adult females have calves), measuring calf growth rate over time (e.g., how fast do calves grow), estimating an annual ratio of calves to adults, and calculating calf sighting rates. Some of these assessments require specialized photography methods that ASAMM is not able to incorporate into survey protocol, but many of the assessments directly benefit from data collected by ASAMM.

Most bowhead whale calves are born during the spring migration from wintering areas in the Bering Sea to summering grounds in the Beaufort Sea, usually between the beginning of April and end of May. Calves may be born as early as March and as late as August. Calves-of-the-year that are seen by ASAMM in July and August in the western Beaufort Sea are therefore probably about 3-6 months old. Bowhead whale calves are generally (but not always) light gray and uniformly mottled, with a narrow head in relation to the width of the body, and a stout or rotund body in relation to overall length. Most calves-of-the-year are observed in close association with an adult, who is presumably the mother (or cow). ASAMM also regularly records very small whales, assumed to be calves-of-the-year, alone at the surface, presumably hanging out there while mom feeds subsurface. As calves get older, they spend less time closely associated with their mothers, their skin darkens from light gray to darker gray, and their heads appear proportionately larger and bodies slimmer. Several of these features can be seen in the images in Figures 1 and 2.

https://www.afsc.noaa.gov/Science_blog/ASAMM_4.htm

Belugas sighted approximately 40 km southwest of Utqiagvik, Alaska, in July 2017. *Photo by Lisa Barry, NOAA Fisheries*

Belugas - the "Where's Waldo?" of the ASAMM Study Area

Spring and summer begins the migration of belugas from the Bering Sea into the Chukchi and Beaufort seas, where they will feed, have babies (calves), and shed their skin (molt). Within the Aerial Surveys of Arctic Marine Mammals (ASAMM) study area, two separate stocks of belugas can be found: the Eastern Chukchi Sea (ECS) stock, which spends early summer in and around Kasegaluk Lagoon, and the Beaufort Sea (BS) stock, which spends early summer in the Mackenzie River Delta (Figure 1). During summer (July-August) and fall (September-October), the ASAMM project flies systematic line-transect surveys in the eastern Chukchi Sea and western Beaufort Sea in search of all marine mammals, including belugas. Beluga stocks cannot be differentiated using data collected solely from aerial surveys, but we know from satellite tag results that the ECS and BS stocks remain somewhat segregated in summer and overlap in the fall in the western Beaufort Sea (Hauser et al., 2014).

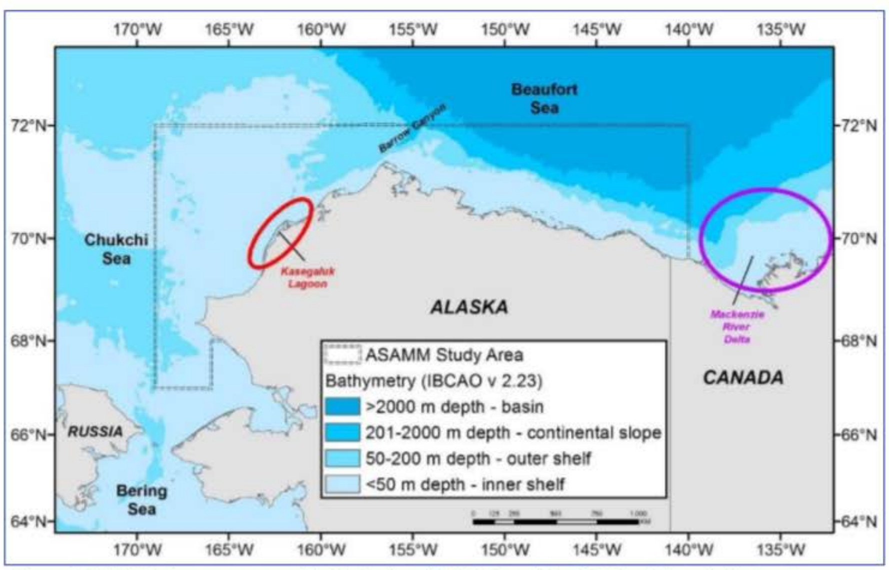
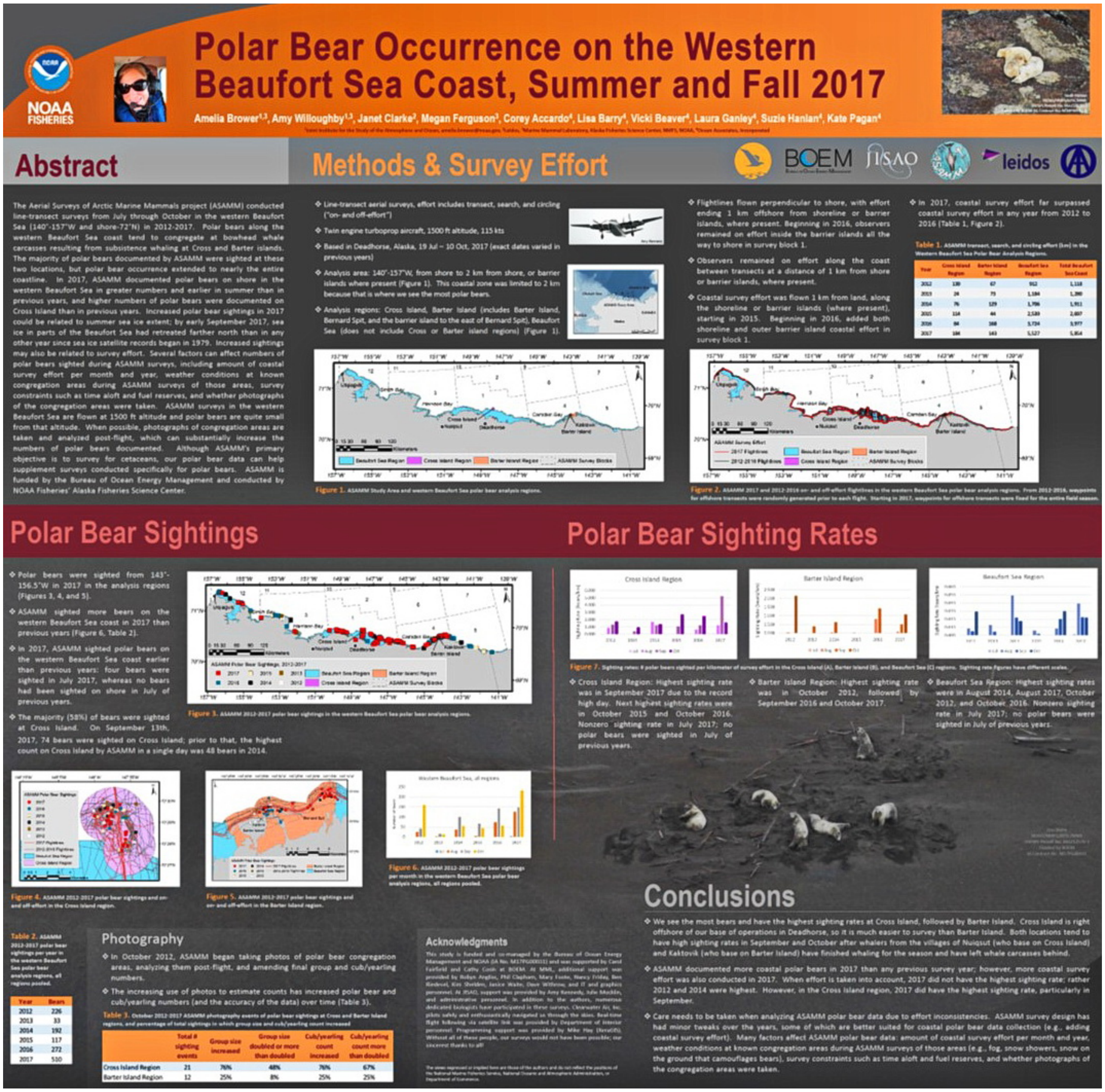


Figure 1. ASAMM study area, areas used by the Eastern Chukchi Sea and Beaufort Sea beluga stocks in early summer, and oceanographic features. *Figure: Janet Clarke, Leidos*

Since the early 1980s, the distribution and relative abundance of belugas have been tracked by the ASAMM project. These data show that the distribution of belugas within the western Beaufort Sea has remained remarkably similar, with belugas primarily distributed over the continental slope, regardless of season (Figure 2). Over the years in the northeastern Chukchi Sea, ASAMM has documented beluga distribution as more dynamic, with belugas in large groups near the coastline in summer (Figure 2A) and spread out across the area during fall (Figure 2B). In most years, belugas appear to follow some identifiable pathways, including the shelf break and Barrow Canyon.

https://www.afsc.noaa.gov/Science_blog/ASAMM_5.htm


Polar Bear Occurrence on the Western Beaufort Sea Coast, Summer and Fall 2017
Amelia Brower1,3, Amy Willoughby1,3, Janet Clarke2, Megan Ferguson3, Corey Accardo4, Lisa Barry4, Vicki Beaver4, Laura Ganley4, Suzie Hanlan4, Kate Pagan4
NOAA FISHERIES
BOEM
JISAO
leidos
Abstract
Methods & Survey Effort
Polar Bear Sightings
Polar Bear Sighting Rates
Conclusions
Photography
Acknowledgments

The Kids Are Alright – Bowhead Whale Calves in the Western Beaufort Sea, 2012-2017

Janet Clarke – Leidos, janet.clarke@leidos.com
Megan Ferguson – Marine Mammal Laboratory, AFSC, NMFS, NOAA
Amelia Brower, Amy Willoughby, Christy Sims – Joint Institute for the Study of the Atmosphere and Ocean
Corey Accardo, Lisa Barry, Vicki Beaver, Marjorie Foster, Laura Ganley, Jennifer Gatzke, Suzie Hanlan, Kate Pagan and Karen Vale-Vasilev – Ocean Associates, Incorporated

Abstract The Aerial Surveys of Arctic Marine Mammals (ASAMM) project, funded by the Bureau of Ocean Energy Management (BOEM) and co-managed by BOEM and NOAA Fisheries, conducted surveys in the western Beaufort Sea (140°W-157°W) from July through October, 2012-2017. Bowhead whale (*Balaena mysticetus*) calves-of-the-year were observed in summer (July-August) and fall (September-October) each year. In summer, calves were distributed primarily in the eastern half of the study area, with highest calf densities east of Kaktovik; the exception was 2016, when calves were distributed throughout the study area. Calf distribution in summer 2013 was in deeper water (>200 m) compared to other years. In fall, calves were broadly distributed throughout the study area, with highest densities in northern Camden Bay and lowest densities east of Kaktovik. Calf distribution did not appear temporally or geographically segregated from the overall population in any given year. Calf ratios (number of calves per number of total whales observed) ranged from 0.037 to 0.160 in summer and 0.027 to 0.115 in fall. Calf sighting rates (number of calves sighted per km surveyed) ranged from <0.001 to 0.003 in summer and <0.001 to 0.006 in fall. Calf totals in 2017 (155 calves) far surpassed any previous year; the next highest calf total was 98 in 2016. Although it is likely that some calves were sighted more than once, calf production was likely very high in 2017. High calf production is one of many positive indicators of the overall health of the Western Arctic stock of bowhead whales.

Methods

- Western Beaufort Sea study area, 140°W-157°W
- Line transect aerial surveys
- Twin turboprop, high wing aircraft with bubble windows
- 1500 ft (457 m) survey altitude
- Fly daily, weather permitting, July through October
- Two primary marine mammal observers, one data recorder
- Survey modes include on effort (transect and circling from transect, Tr+TrC), off effort (search and circling from search), and deadhead
- Circle on most large cetacean sightings to get positive species ID, determine group size, and look for calves

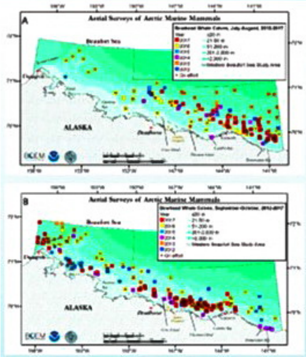


Figure 1. ASAMM bowhead whale calf sightings, summer and fall, 2012-2017.

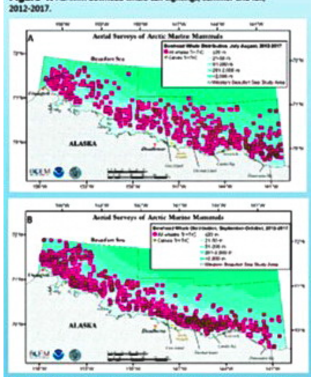


Figure 2. ASAMM on-effort bowhead whale calf sightings relative to all on-effort bowhead whale sightings, summer and fall, 2012-2017.

Summary, 2012-2017

- Bowhead whale calves were seen in all months (July-October) in all years (2012-2017) in the western Beaufort Sea (Figure 1).
- Calf distribution in summer was primarily east of 150°W at depths ranging from 1 to >2,000 m (Figure 1A). Calf distribution in fall was primarily west of 143°W at depths of <50 m, except near Barrow Canyon (Figure 1B).
- Calf distribution largely overlapped that of the overall bowhead whale distribution (Figure 2), with the exception of summer near Barrow Canyon where relatively few calves were seen (Figure 2A).
- A total of 160 bowhead whale calves were seen in summer and 245 calves were seen in fall, 2012-2017. Total calves per year varied from 22 (2012) to 155 (2017).
- Seasonal bowhead whale calf ratios (total calves in proportion to total whales) were highest in summer 2017 and fall 2017 (Figure 3). Intra-annually, summer calf ratio was higher than fall calf ratio in 2012, 2014, 2015, and 2017.
- Seasonal bowhead whale calf sighting rates (# of calves in proportion to effort, Tr+TrC only) were highest in summer 2017 and fall 2017. Calf sighting rates were also relatively high in summer and fall 2013 and 2016 (Figure 4).
- Calves were usually seen in close association with an adult, assumed to be the mom; 16% of calves were sighted unaccompanied by an adult. Many, though not all, of the lone calves were in the general vicinity of adult whales. On five occasions, one adult was accompanied by two calves.

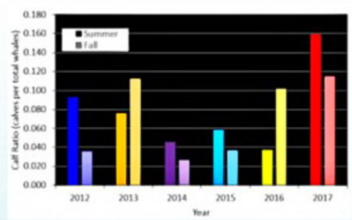


Figure 3. ASAMM bowhead whale calf ratio (number of calves proportional to total whales), western Beaufort Sea, summer and fall, 2012-2017.

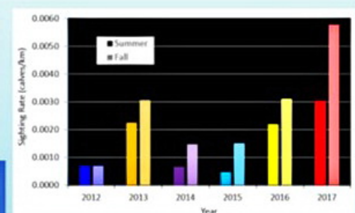


Figure 4. ASAMM bowhead whale calf sighting rate (number of calves proportional to effort, Tr+TrC), western Beaufort Sea, summer and fall, 2012-2017.

Also...

- Bowhead whale calf ratios can vary considerably from year-to-year, but three of the past six years (2013, 2016, 2017) have had some of the highest fall calf ratios since ASAMM surveys began in 1982 (1983 was also high at 0.088 calves per total whales).
- The Western Arctic stock of bowhead whales is in good physical condition (George et al., 2015), and has increased in abundance in the last decade (Givens et al., 2013, 2017). Increased body condition may indicate improved rates of survival and reproduction.

Finally...

- Some bowhead whale calves seen in the western Beaufort Sea may be intra-annual repeats of earlier sightings. Photos are obtained of most bowhead whale calves and will be analyzed (as time permits) to try to determine the proportion of resightings.

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Acknowledgements: ASAMM is funded and co-managed by the Bureau of Ocean Energy Management (IA Nos. M08PG20013, M11PG00033, and M17PG00031), where we appreciate(d) the support of Cathy Coon, Jeff Denton, Carol Fairfield, Chuck Monnett, and Dee Williams. At Alaska Fisheries Science Center, additional support is provided by Robyn Angliss, Stefan Ball, Phil Clapham, Mary Foote, Nancy Friday, Ben Hou, Katie Jaskierny, Billie McCorkle, Stuart Pascua, Monte Pascual, Ben Riedesel, Kim Shelden, and Janice Waite. Aerial surveys were safely and expertly flown by Clearwater Air, Inc. under the direction of Andrew Harcombe. Our sincere appreciation to the dedicated and professional marine mammal observers who endured extreme temperatures, uncomfortable dry suits, and heavy-as-hell Switliks, all while twisting their bodies into unnatural positions for several hours at a time, to collect these data. Real-time monitoring via satellite tracking of survey flights was provided by US Department of the Interior. We are also grateful for the analytical and programming expertise of Mike Hay (Xera GIS). AFSC Graphics assisted with the poster design.

Marine Mammal Data Collection and Reporting Software Written with ArcObjects and .NET

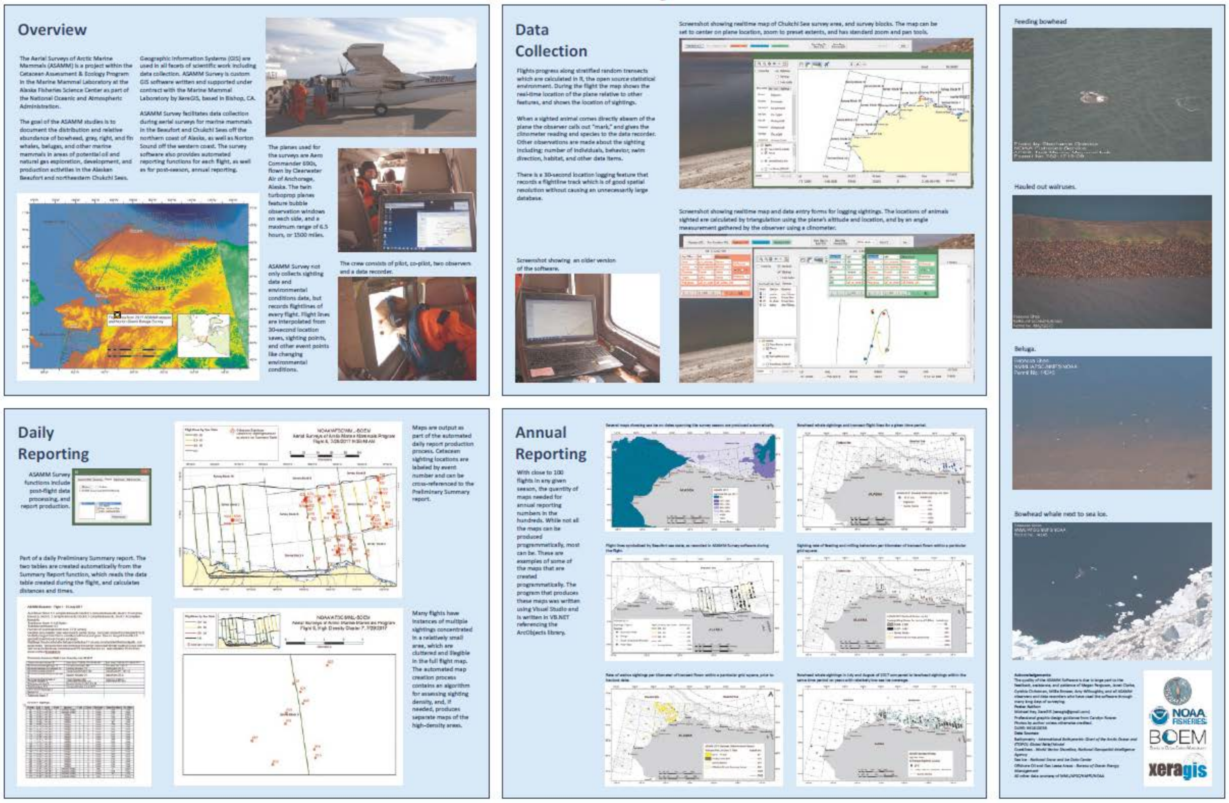

PHOTO-IDENTIFICATION OF GRAY WHALES IN THE EASTERN CHUKCHI SEA, SUMMER AND FALL 2017

Amy Willoughby[1,2] Megan Ferguson[2] Janet Clarke[3] Amelia Brower[1,2] Corey Accardo[4] Lisa Barry[4]
Vicki Beaver[4] Marjorie Foster[4] Suzie Hanlan[4] Kate Pagan[4] Christy Sims[1,2] Karen Vale-Vasilev[4]

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Overview

The eastern Chukchi Sea has important foraging and weaning grounds for gray whale (*Eschrichtius robustus*) cow-calf pairs of the Eastern North Pacific population during summer and fall. It is unknown how many gray whale cow-calf pairs use the eastern Chukchi Sea in any particular year. In an attempt to answer this question, in 2016 the Aerial Surveys of Arctic Marine Mammals (ASAMM) project collected opportunistic photographs of gray whale cow-calf pairs during systematic line-transect surveys conducted in the eastern Chukchi Sea (67°-72°N, 169°-154°W) from July through October. During 2017, ASAMM refined the photographic protocols to focus on images with flukes having skin pigmentation, scarring, notching, and mottling that allowed for a robust comparison and evaluation of images to identify intra-annual resightings of gray whales, including cow-calf pairs. Image analysis indicates that only one gray whale was resighted in photographs obtained in 2017, indicating that gray whale resightings may be fewer than once thought. Furthermore, preliminary results suggest that gray whale fluke images have the potential to be used to derive a mark-recapture estimate of gray whale cow-calf pairs in the ASAMM study area. Knowing how many individual whales are potentially resighted within a single season could be used to strengthen conservation and management efforts relating to, for example, climate change and disturbance from anthropogenic activities that occur in the eastern Chukchi Sea. ASAMM is funded and co-managed by the Bureau of Ocean Energy Management and conducted and co-managed by the National Oceanic and Atmospheric Administration.

Methods & Materials

Study Effort

- Line-transect aerial surveys
- 2 July to 25 October 2017
- Twin engine turboprop aircraft with bubble windows
- Target altitude 1200 ft (366 m)
- Analysis Area: Chukchi Sea blocks 13-23 and Beaufort Sea block 12 (67°-72°N, 169°-154°W)
- Survey Effort: "on effort" (transect and circling from transect), "off effort" (search and circling from search), or deadhead
- ~ 36,825 km flown on effort within the analysis area (Figure 1)

Imagery Collection

- Photography of gray whales occurred while the aircraft was circling to confirm species identification, estimate group size, observe behavior, and determine calf presence
- Canon EOS digital camera with 100-400 mm telephoto lens
- Image frame numbers were recorded with the associated sighting event(s)
- Sighting information included date and time, location, final group size, and number of calves

Figure 1. ASAMM on-effort survey lines, 2017.

Photo Analysis

- The suite of images for each photographed sighting were evaluated in near real-time to identify and select the best fluke image of each individual whale.
- Fluke images were evaluated for image quality using guidance from Stack et al. (2015) and were evaluated based on three criteria. Each criterion was assigned a value of 1 (highest quality) to 5 (poorest quality). The criteria evaluated were:
  1. portion of the fluke visible for identification
  2. angle of the fluke relative to the aircraft
  3. focus clarity of the fluke in the image
- The three criteria values were added together for an overall score. Images with a total score of 3 were considered the highest quality possible and 15 the poorest (Figure 2 and 3). Images that scored >10 were excluded from the matching process.
- Whales that were photographed but whose flukes were not captured in an image or poorly photographed whales (e.g., subsurface whales) were accounted for as being "present" – physically present in photographs but of no use for identification.
- Flukes were analyzed to look for intra-annual resightings with great attention to sightings of calves.

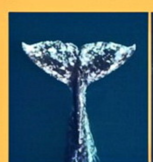

Figure 2. Example of a high quality gray whale fluke image.
Photo by Amy Willoughby, NOAA/NMFS/AFSC/MML, NMFS Permit 20465, Funded by BOEM (IA Contract No. M17PG00031)

Figure 3. Example of a high quality gray whale fluke image. Notice the missing fluke tips and killer whale rake marks.
Photo by Vicki Beaver, NOAA/NMFS/AFSC/MML, NMFS Permit 20465, Funded by BOEM (IA Contract No. M17PG00031)

The recommendations and general content presented in this poster do not necessarily represent the views or official position of the Department of Commerce, the National Oceanic and Atmospheric Administration, or the National Marine Fisheries Service.

Results

Gray Whale Sightings Within the Analysis Area, 2017

- **440** sightings, of which **61** included calves
- **821** total whales, of which **89** were calves
- Gray whale calves were sighted in **July, August, and October,** with July accounting for **90%** of the calf sightings (Table 1)
- **118** of the **440** total sightings were photographed and analyzed, of which **33** included sightings with calves (Tables 1 and 2)
- Photo analysis resulted in **210** identifiable gray whale flukes, of which **179** scored ≤ 10
- **56** calves were recorded in the data associated with photographs – image analysis resulted in documentation of **49** (88%) of available calves, of which **35** had identifiable flukes, and **24** scored ≤ 10 (Table 2)
- **14** photographed calves were in images that did not capture their flukes

Table 1. Gray whale sightings, on and off effort, by month, 67°-72°N, 169°-154°W, 2017

Month	Gray Whale Sightings	Total Gray Whales	Sightings with Calves	Total Calves
July	208	447	53	80
August	97	177	6	7
September	102	153	0	0
October	33	44	2	2
Total	440	821	61	89

Table 2. Summary of sighting data associated with photographed gray whale sightings, on and off effort, by month, 2017

Month	Photographed Sightings	Total Whales	Photographed Sightings with Calves	Total Calves	Fluke Images of Calves	Fluke Images of Calves w/ Score ≤ 10
July	42	166	27	49	30	21
August	32	79	4	5	3	1
September	33	59	0	0	0	0
October	11	16	2	2	2	2
Total	118	320	33	56	35	24

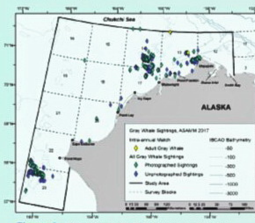

Figure 4. 2017 on- and off-effort gray whale sightings, photographed sightings, and intra-annual match sightings

ASAMM 2017 Intra-annual Matches of Gray Whales

- One adult was sighted and opportunistically photographed with her calf on 21 July 2017 and again on 30 July 2017 (Figure 4).
- A calf was not present in images taken at the second sighting.
- The first sighting was recorded 81 km southeast of the second.
- Fluke images were of low quality and other areas of the whale's body had to be used to confirm the match.

Recap from 2016 Intra-annual Matching of Gray Whales

- Photo analysis resulted in 170 identifiable gray whales, of which 46 were calves.
- One cow-calf pair was sighted and opportunistically photographed on 22 July 2016 and again on 6 August 2016.
- One juvenile was sighted and opportunistically photographed on 22 July 2016 and again on 6 August 2016.

Discussion

- Naturally occurring markers found on gray whale flukes can be captured in imagery taken during ASAMM surveys without sacrificing line-transect data collection and can be used to investigate intra-annual matches.
- Results from 2016 and 2017 intra-annual matching indicate that ASAMM has few repeat sightings of photographed cow-calf pairs throughout the season. However, further monitoring is needed to increase the sample size necessary to make robust inference about gray whale movement patterns in the eastern Chukchi Sea and basic life history parameters.

Photo by Lisa Barry, NOAA/NMFS/AFSC/MML, NMFS Permit 20465, Funded by BOEM (IA Contract No. M17PG00031)

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Available at: https://www.researchgate.net/publication/262451163

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APPENDIX D: ASAMM FIELD-OF-VIEW EFFORTS, 2017

Background

Aerial line-transect survey data have two sources of bias that need to be accounted for in order to derive absolute estimates of density or abundance: availability bias and perception bias. Availability bias refers to animals that are located on or near the transect but cannot be seen because they are underwater or they are too far fore or aft of the aircraft and, therefore, are not in the observers' field of view (FOV). Perception bias refers to animals that are *available* to be seen, but the observers fail to detect them due to high sea states, glare, etc.

Correction factors for perception bias are typically estimated using protocols in which sighting data are simultaneously recorded for two independent observers, one of which might not be human, such as a camera. Mark-recapture methods are used to analyze the data in order to derive the correction factors. Perception bias is not discussed any further here. In order to derive a correction factor for availability bias in line-transect surveys for marine mammals, it is necessary to have behavioral data on the amount of time animals spend at the surface (or within the depth range where they can be seen from the air) and at greater depths where they are invisible to an aerial observer. In addition, the amount of time that an observer has to detect an available object must be known. This can be determined for a given aircraft speed by quantifying the observer's FOV. The FOV is a function of the configuration of the observer's window and varies from one observer to the next due to differences in posture, height, etc. Because the left (port) and right (starboard) bubble windows on the Clearwater Air Turbo Commanders from which ASAMM surveys are conducted are slightly different, ASAMM needs to quantify the left and right FOVs separately. The left windows on all Clearwater Air Turbo Commanders have the same configuration; the configuration of all of the right windows on Clearwater Air's Turbo Commanders is also constant.

During the 2017 field season, the ASAMM project collected data to estimate the dimensions of the survey aircraft's left and right FOVs for the first time in the history of ASAMM. This appendix documents the evolution of ASAMM's FOV protocols, focusing on the latest version of protocols that were in place at the end of the season; provides references to the analytical methods for estimating FOV; summarizes the ASAMM survey effort dedicated to collecting FOV data; provides limited preliminary results; and discusses future ASAMM efforts to estimate FOVs.

Field Methods

Two approaches were used to collect FOV data: dedicated FOV surveys and opportunistic data collection during routine ASAMM surveys. The dedicated FOV surveys consisted of flying pre-defined transects located at varying distances from a pre-specified, stationary target located on land. These flights provided a relatively controlled setting and, therefore, the best scenario to estimate the actual dimensions of the FOV for a target the size of a Conex box (shipping container). The dedicated FOV surveys did not incorporate variability due to species sighting characteristics or marine environmental conditions (e.g., sea state) affecting sightability, but they did incorporate variability among observers. Furthermore, if an observer directs their search forward of the aircraft until the target is sighted and then follows the target until it disappears aft of the aircraft, measurement error in the resulting FOV estimates should be minimal.

Opportunistic data collection during routine ASAMM surveys involved recording the time that a sighting was initially detected, in addition to the routine collection of the time and declination angle of the sighting when the animal was abeam. This opportunistic approach allows examination of inter-species and inter-observer differences in FOV, although the measurement error in the data will be high due to the observers' scanning methods, which are not optimized for detecting available objects immediately when they enter the FOV. Furthermore, the opportunistic approach does not allow quantification of the FOV dimensions aft of the aircraft because the time at which the animal disappears from the FOV is not recorded.

Dedicated FOV Surveys

Protocols for the dedicated FOV surveys were revised several times over the course of the field season, based on feedback from observers and pilots, and on preliminary FOV analytical results. The protocols documented below were in effect at the end of the field season.

To quantify the FOV from the Turbo Commander during dedicated FOV surveys, the aircraft flew short transects spaced varying distances from a stationary object located on land in an area of relatively low air traffic (> 16 km from any airport) in order to minimize distractions and maximize safety. Ideally, the target should be far from standing water that might attract waterfowl in order to minimize disturbance to waterfowl and to minimize chances of a bird striking the aircraft in flight. Furthermore, the transects preferentially should be located on relatively flat terrain so that the GPS altitude readings (which are referenced to sea level) accurately reflect the aircraft's distance above the target.

The Deadhorse-based team selected a white[1] Conex box located off the Haul Road west of Franklin Bluffs for the target (Figures D-1 and D-2; hereafter referred to as the "east target"). The coordinates of the east target, determined by ASAMM GPS on the ground, are 69.914066°N, 148.730833°W.

The Utqiaġvik-based team flew a scouting mission and identified and photographed eight potential targets. Ultimately, FOV transect waypoints were created for the two targets that were considered optimal: a small cabin with a white roof, located on the western shore of Dease Inlet (70.937202°N, 156.270280°W; Figures D-1 and D-3; the "west target"); and two tan containers and a white fuel tank located at Point Lonely Short Range Radar Site (70.910651°N, 153.243647°W). The Point Lonely transects were never flown, and are discussed no further.

The survey goal was to fly transects located 200 m, 500 m, 1000 m, 1500 m, and 3000 m from the target (e.g., Figures D-4a, b). Waypoints for transects located 750 m from each target were also created and could be flown if time and weather permitted. The perpendicular distances from the transects to the target that the aircraft flies do not need to be exact, as long as sufficient waypoint data are collected to determine the location of the flightline during post-processing.

[1] There is a red and a white Conex at the site. During FOV2, observers noted that the white Conex is easier to detect from farther out.

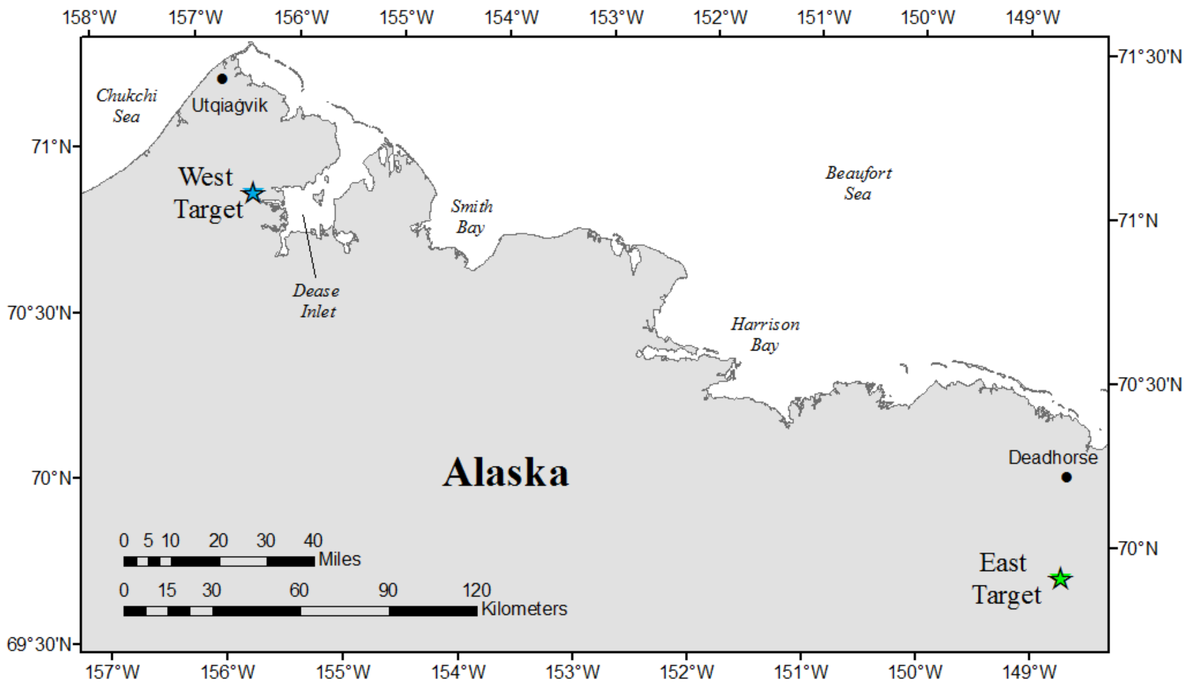

Figure D-1. Location of west and east targets used for ASAMM field-of-view flights during 2017.

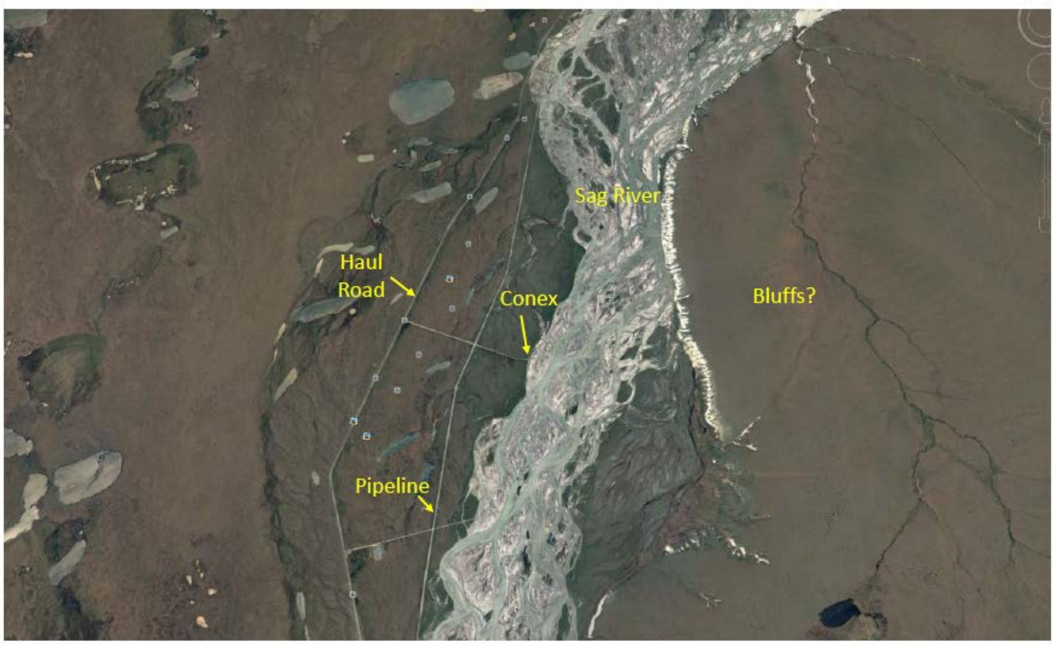

Figure D-2. Google Earth view of the east target (labelled “Conex”) and surrounding features.

Figure D-3. Aerial photograph of the west target from 304.8 m (1000 ft).

Each transect was long enough so that the observer could not see the target at the beginning and end of the transect. The transect waypoints for each location were centered on the targets. The transects located 200 m – 1500 m perpendicular distance from the targets were each 19 km long, and the farthest transects (3000 m from targets) were 30 km long. The transects could be truncated in flight to minimize the amount of time spent unnecessarily scanning empty tundra. These transects could also be lengthened in flight if the target was visible at the start of the transect or was still in view at the end of the transect. Table D-1 provides the transect waypoints for the east target in decimal degrees, degrees, decimal minutes, minutes, and seconds. In the west, two sets of transects were generated, one set oriented along a latitudinal axis (east/west; Table D-2) and a second set oriented along a longitudinal axis (north/south; Table D-3), in order to provide flexibility to fly in a direction least likely to be impacted by winds at the survey altitude.

FOV transects were flown at typical ASAMM survey speed (213 kmh; 115 kts). Maintaining a constant speed on transect is very important if the FOV analysis is based on time lags between when the target is initially detected and when it is located abeam, and between the latter and when the target disappears from view; aircraft speed affects the magnitude of those time lags. Alternatively, the analysis could be based on distances between the target and the three critical points on the transect.

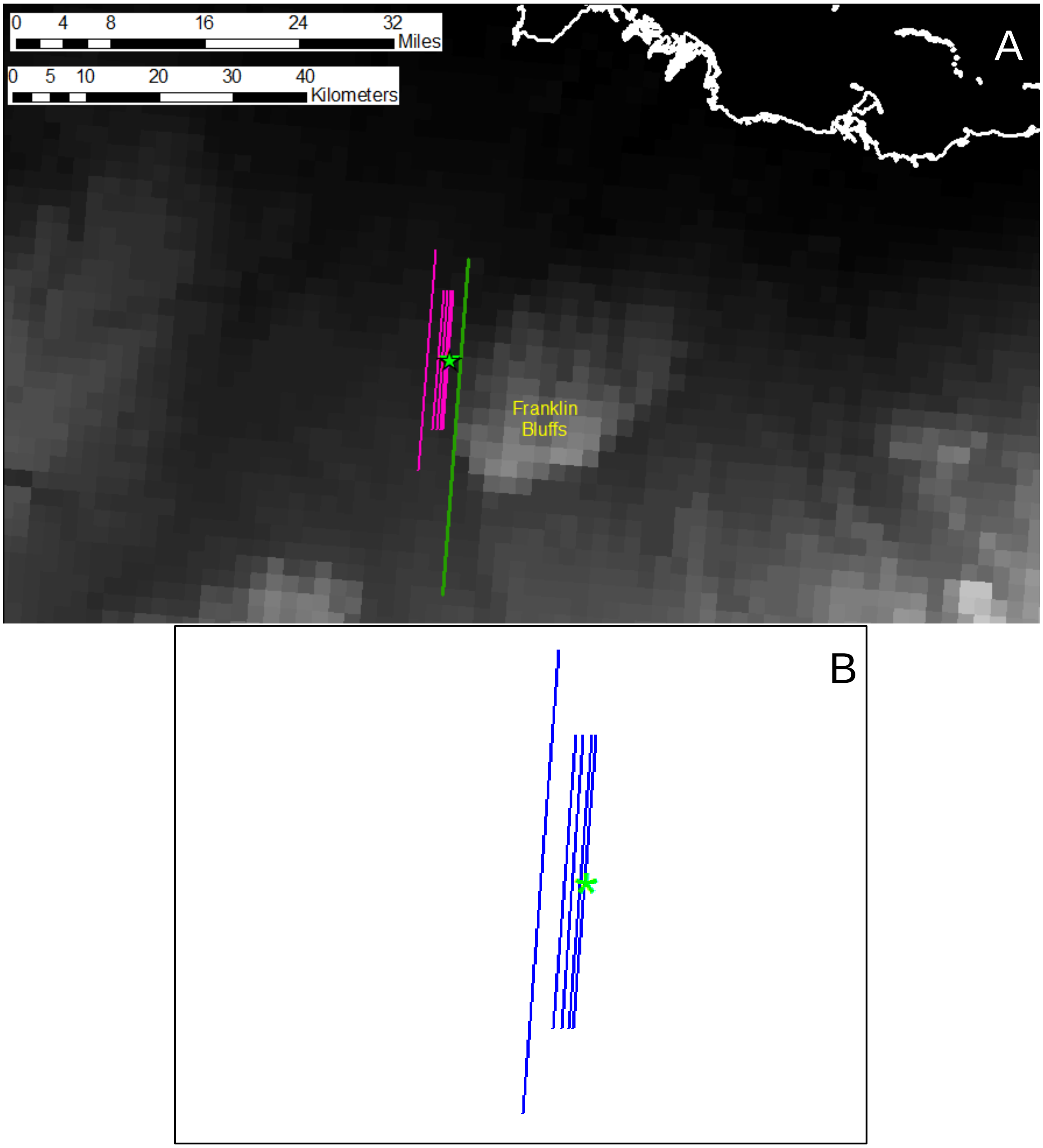

Figure D-4. A) Zoomed out map of the site used for the FOV experiment in the eastern ASAMM study area, located approximately 50 km southwest of Deadhorse and 8 km west of Franklin Bluffs. Grayscale indicates topography (lighter shades refer to higher elevations). The long green line is a reference line, drawn approximately parallel to the axis of Franklin Bluffs, on the western margin of the bluffs, which was used to construct the transects to be flown during the experiment. The east target, a Conex box, is shown as a green star, and the experimental transect lines stretch to the west of the target. B) East FOV transects (blue lines) and target location (green star). The transects are located 200 m, 500 m, 1000 m, 1500 m, and 3000 m perpendicular distance from the target. The 3000-m transect is 30 km long; all other transects are each 19 km long.

Table D-1. Latitude (lat) and longitude (long) of transect waypoints for the east target, in decimal degrees (decdeg), degrees (deg), decimal minutes (dec.min), minutes (min), and seconds (sec).

	lat.decdeg	lat.deg	lat.dec.min	lat.min	lat.sec	long.decdeg	long.deg	long.dec.min	long.min	long.sec
200N	69.99922	69	59.95326	59	57	-148.717	-148	42.99799	42	60
200S	69.82891	69	49.73456	49	44	-148.755	-148	45.32234	45	19
500N	69.99922	69	59.95328	59	57	-148.725	-148	43.47225	43	28
500S	69.82891	69	49.73448	49	44	-148.763	-148	45.79276	45	48
750N	69.99922	69	59.95329	59	57	-148.731	-148	43.86746	43	52
750S	69.82891	69	49.73440	49	44	-148.77	-148	46.18478	46	11
1000N	69.99922	69	59.95328	59	57	-148.738	-148	44.26268	44	16
1000S	69.82891	69	49.73431	49	44	-148.776	-148	46.57679	46	35
1500N	69.99922	69	59.95322	59	57	-148.751	-148	45.05311	45	3
1500S	69.82890	69	49.73408	49	44	-148.789	-148	47.36083	47	22
3000N	70.04851	70	2.910885	2	55	-148.779	-148	46.75494	46	45
3000S	69.77958	69	46.77459	46	46	-148.839	-148	50.36850	50	22

Table D-2. Latitude (lat) and longitude (long) of waypoints for latitudinal (east/west) transects for the west target, in decimal degrees (decdeg), degrees (deg), decimal minutes (dec.min), minutes (min), and seconds (sec).

	lat.decdeg	lat.deg	lat.dec.min	lat.min	lat.sec	long.decdeg	long.deg	long.dec.min	long.min	long.sec
200E	70.93495	70	56.09721	56	6	-155.859	-155	51.53837	51	32
200W	70.93495	70	56.09721	56	6	-156.682	-156	40.89523	40	54
500E	70.93226	70	55.93588	55	56	-155.859	-155	51.54172	51	33
500W	70.93226	70	55.93588	55	56	-156.682	-156	40.89188	40	54
750E	70.93002	70	55.80145	55	48	-155.859	-155	51.54451	51	33
750W	70.93002	70	55.80145	55	48	-156.681	-156	40.88909	40	53
1000E	70.92778	70	55.66701	55	40	-155.859	-155	51.54730	51	33
1000W	70.92778	70	55.66701	55	40	-156.681	-156	40.88630	40	53
1500E	70.92330	70	55.39813	55	24	-155.859	-155	51.55287	51	33
1500W	70.92330	70	55.39813	55	24	-156.681	-156	40.88073	40	53

3000E	70.90929	70	54.55735	54	33	-155.654	-155	39.24668	39	15
3000W	70.90929	70	54.55735	54	33	-156.886	-156	53.18692	53	11

Table D-3. Latitude (lat) and longitude (long) of waypoints for longitudinal (north/south) transects for the west target, in decimal degrees (decdeg), degrees (deg), decimal minutes (dec.min), minutes (min), and seconds (sec).

	lat.decdeg	lat.deg	lat.dec.min	lat.min	lat.sec	long.decdeg	long.deg	long.dec.min	long.min	long.sec
200N	71.07164	71	4.298477	4	18	-156.276	-156	16.54813	16	33
200S	70.80276	70	48.16563	48	10	-156.276	-156	16.54366	16	33
500N	71.07164	71	4.298452	4	18	-156.284	-156	17.04512	17	3
500S	70.80276	70	48.16561	48	10	-156.284	-156	17.03396	17	2
750N	71.07164	71	4.298414	4	18	-156.291	-156	17.45928	17	28
750S	70.80276	70	48.16557	48	10	-156.291	-156	17.44254	17	27
1000N	71.07164	71	4.298360	4	18	-156.298	-156	17.87344	17	52
1000S	70.80276	70	48.16552	48	10	-156.298	-156	17.85111	17	51
1500N	71.07164	71	4.298207	4	18	-156.312	-156	18.70176	18	42
1500S	70.80276	70	48.16537	48	10	-156.311	-156	18.66827	18	40
3000N	71.13884	71	8.330514	8	20	-156.353	-156	21.20375	21	12
3000S	70.73552	70	44.13127	44	8	-156.352	-156	21.10328	21	6

Because ASAMM typically flies transects between 304.8 m and 457.2 m (1000 ft and 1500 ft), the experimental FOV transects were flown at approximately 304.8 m and 457.2 m above the target to determine if altitude affects the FOV measurements.

Ideally, the right and left observers flew the entire set of transects at each altitude three times in order to collect replicate data that can be used to estimate measurement error. In order to differentiate between potential differences due to side-of-plane vs. observer effects, observer A remained in the left window for all three sets of transects at altitude X. Observers shifted positions for the three sets of transects at altitude Y, meaning that observer A observed from the right window for all three sets of transects at altitude Y. In order to get enough replicates to estimate the precision and accuracy of the data, it is best to complete all trials, assuming weather and logistics allow for that long of a flight. To complete the entire experiment, each observer will need to fly 30 transects: five perpendicular distances (200 m, 500 m, 1000 m, 1500 m, 3000 m), three replicates (e.g., a, b, c), and two altitudes (304.8 m and 457.2 m above target). All transects were covered during east FOV flight 2, which lasted approximately 4.3 hrs.
Data recorded into the ASAMM survey program by the data recorder for each transect were: 1) the time and position at which the target first entered the observer's FOV; 2) the time and position at which the target was perpendicular to (abeam) the aircraft; and 3) the time and position at which the target left the observer's FOV. Each mark was consistently labeled in the notes field of the database. For example, "right, first view, 1500m, 1700'" meant "right observer, first view of target, transect located 1500 m perpendicular distance from target, 1700 ft altitude"; similarly, "left, abeam, 200m, 1700'" meant "left observer, target is abeam, transect located 200 m perpendicular distance from target, 1700 ft altitude." The labels in these examples state "1700 ft" altitude instead of "1500 ft" because the east target was located at approximately 60.96 m (195 ft) elevation and the ASAMM GPS uses sea level as the reference, so the altitude data should read approximately 518.16 m (1700 ft) when flying 457.2 m (1500 ft) above the target. If it were known that one mark was "bad" (e.g., the observer detected the target late or the data recorder input the data late), the data recorder included a note with a brief description of what went wrong (e.g., "entered mark late") and that mark was omitted from the FOV analysis. The pilots recorded the three target waypoints listed above when this task did not interfere with their ability to navigate and fly safely.

For the FOV flights, the element of surprise is not necessary. What is more important is the ability to accurately and precisely record the times, locations, and altitudes described above. Perception bias will be computed using other methods. It is essential to be able to accurately define the dimensions of the FOV, with as little error as possible. To maximize the accuracy and precision in the data, the FOV flight should be the first flight of the day. Additionally, the observers should focus all of their attention on detecting and maintaining sight of the target. At the beginning of the transect, the observer should focus all search effort in front of the plane to detect the target as soon as it enters the FOV. The observer should keep their eyes on the target until it disappears from view. Observers should not scan the FOV according to standard ASAMM survey protocols because that likely introduces "noise" (measurement error) into the data. Observers should try to maintain their typical survey "posture" in the window while on transect because head position in the window will affect the FOV.

Lighting, cloud cover, and other atmospheric precipitation may make the target easier or more difficult to detect. For example, during east FOV flight 2, observers noticed that, regardless of altitude, the light and clouds earlier in the day made the target more difficult to detect, whereas later in the day, the evening light (sneaking below the clouds) made the target "pop" and was therefore easier to detect. Based on this feedback, the teams prioritized conducting FOV survey flights 2.5 hours on either side of local noon on days with a high overcast ceiling that was likely to persist throughout the FOV survey.

Opportunistic Data Collection

When practicable in areas of low cetacean density, supplementary sighting data were collected to estimate FOV. Specifically, the exact time of initial sighting, observer name, and side of plane were recorded in a separate sighting entry in the ASAMM survey database. When the animal was abeam, the routine suite of ASAMM sighting data (e.g., Clarke et al. 2017) was collected. For consistency with ASAMM data entry protocols, the initial sighting was recorded as a "repeat" sighting.

Analytical Methods

Preliminary analysis of FOV data followed the methods of Robertson et al. (2015) and are not repeated here.

Results

The Deadhorse-based team flew two successful FOV flights and attempted three FOV flights over the east target and transects between 5 August and 1 October 2017 (Table D-4). Based on the inter-observer variability in preliminary FOV estimates, the number of replicates for each combination of observer and side-of-aircraft was increased from two to three after the first FOV flight. Furthermore, during the first two FOV flights in the east, observers implemented the standard scanning methods employed while surveying for marine mammals offshore. Due to the apparent high variability in the resulting FOV estimates, FOV protocols were revised to maximize the accuracy and precision of the data. The revised protocols recommended that the FOV flight be the first flight of the day if it were flown on a day when two survey flights were conducted, and that it be scheduled to occur 2.5 hours on either side of local noon to minimize biases due to natural lighting (shadows and glare). Furthermore, the observers were instructed to focus attention on detecting and maintaining sight of the target. Specifically, at the start of the transect, observers should focus and search all effort in front of the plane to detect the target as soon as it enters their FOV. Observers should keep the target in focus until it disappears from view. Observers were explicitly told not to scan the FOV like they would during standard offshore surveys for marine mammals because that likely introduces "noise" into the data. Finally, observers were asked to maintain their typical survey posture in the window while on transect during the FOV flights because the position of their heads will affect FOV estimates. The last three FOV flight attempts by the Deadhorse team were aborted due to strong crosswinds at survey altitude, which caused the aircraft to crab, thereby invalidating the data (Table D-4). Crabbing occurs when the nose of the aircraft is not pointed in the direction that the aircraft is moving.

Table D-4. Summary of dedicated field-of-view survey flights conducted during the ASAMM 2017 field season. Flight times refer to the minutes spent in the FOV survey area.

Date	Base Airport	FOV Flight Time (min)	Target	Notes
8/5/2017	Deadhorse	118	East target: Conex boxes near Franklin Bluffs	Flew each transect at 1500 ft above target twice for each observer. Observers did not change sides of the plane during flight. Observers scanned the entire field of view during transects.
8/18/2017	Deadhorse	257	East target: Conex boxes near Franklin Bluffs	First flew each transect at 1500 ft above target three times for each observer. Then, observers changed sides and flew each transect at 1000 ft above target three times for each observer. Observers scanned the entire field of view during transects.
9/26/2017	Deadhorse	45	East target: Conex boxes near Franklin Bluffs	Winds were 22 kts at bearing 252. The aircraft was crabbing. The target was going under the aircraft and crossing to other side of the aircraft while flying the transects. Aborted FOV experiment and began offshore ASAMM survey. FOV data not analyzed.
9/27/2017	Deadhorse	18	East target: Conex boxes near Franklin Bluffs	Winds were 14 kts. Aircraft crabbed 6 degrees. While flying the transect located 1.2 km to the left of the target, the observer on the right side of the aircraft could see the target. FOV flight aborted. Data not analyzed.
10/1/2017	Deadhorse	20	East target: Conex boxes near Franklin Bluffs	Aircraft crabbed 5 degrees. While flying the transect located 1.2 km to the right of the target, the observer on the left side of

				the aircraft could see the target. FOV flight aborted. Data not analyzed.
10/6/2017	Utqiaġvik	106		Scouted for FOV targets near Utqiaġvik. Did not fly FOV transects.
10/8/2017	Utqiaġvik	69	West target: Dease Inlet cabin	FOV flight aborted due to snow and presence of a boat at the FOV target. Data not analyzed.

The Utqiaġvik team flew one mission to scout for FOV targets in the vicinity of Utqiaġvik on 6 October (Table D-4). They attempted an FOV flight of the transects for the west target on 8 October, but snow and the presence of a boat at the FOV target caused the team to return to base (Table D-4). The Utqiaġvik team did not fly any more FOV flights over terrestrial targets in their area due to the high likelihood of encountering subsistence hunters, and the strong desire to avoid disturbing subsistence hunting.

The Utqiaġvik team incorporated the opportunistic FOV data collection protocols into two survey flights, conducted on 23 and 25 October (ASAMM flights 253 and 255). The team determined that it is possible to collect opportunistic FOV data during offshore surveys for marine mammals without compromising ASAMM data quality, and identified several changes to the data collection software that would facilitate future collection of opportunistic FOV data during ASAMM surveys.

Future Directions

To maximize chances of completing an FOV survey under good weather conditions and without disturbing subsistence hunters, ASAMM plans to conduct a dedicated FOV flight in late January, 2018, in southern Alaska. During that time period, the core ASAMM team will be in Anchorage, Alaska, for a conference, so there will not be additional travel costs to conduct the FOV flight. Prior to the start of the 2018 ASAMM field season, the ASAMM Survey software, which is used for collecting ASAMM survey data in flight, will be revised to simplify entering data for initial sightings. Protocols for standard ASAMM offshore surveys in 2018 will incorporate the protocols for collecting opportunistic FOV data in areas with low sighting densities.

Acknowledgments

Special thanks to the ASAMM observers and pilots who enthusiastically flew racetracks around stationary objects on the tundra and provided invaluable feedback on ways to improve the FOV experimental design: Corey Accardo, Lisa Barry, Vicki Beaver, Dirk Bowen, Amelia Brower, Stan Churches, Janet Clarke, Sarah Corbin, Carol Fairfield, Marjorie Foster, Laura Ganley, Griffin Kellar, Suzie Hanlan, Jesse Munday, Kate Pagan, Jake Turner, and Amy Willoughby. We also thank Laura Ganley for providing analytical expertise and sample computer code for analyzing the FOV data. Finally, we thank Debi Palka for lending an ear and offering advice on how to collect opportunistic data during ASAMM offshore surveys as an alternate method for estimating FOV.

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The survey team who flew the second FOV flight of the 2017 ASAMM field season. From left to right in the photo frame: Jacob Turner, Vicki Beaver, Corey Accardo, Lisa Barry, and Griffin Kellar. Photo by Lisa Barry.

APPENDIX E: SIGHTING RATE TABLES and FIGURES, 2017

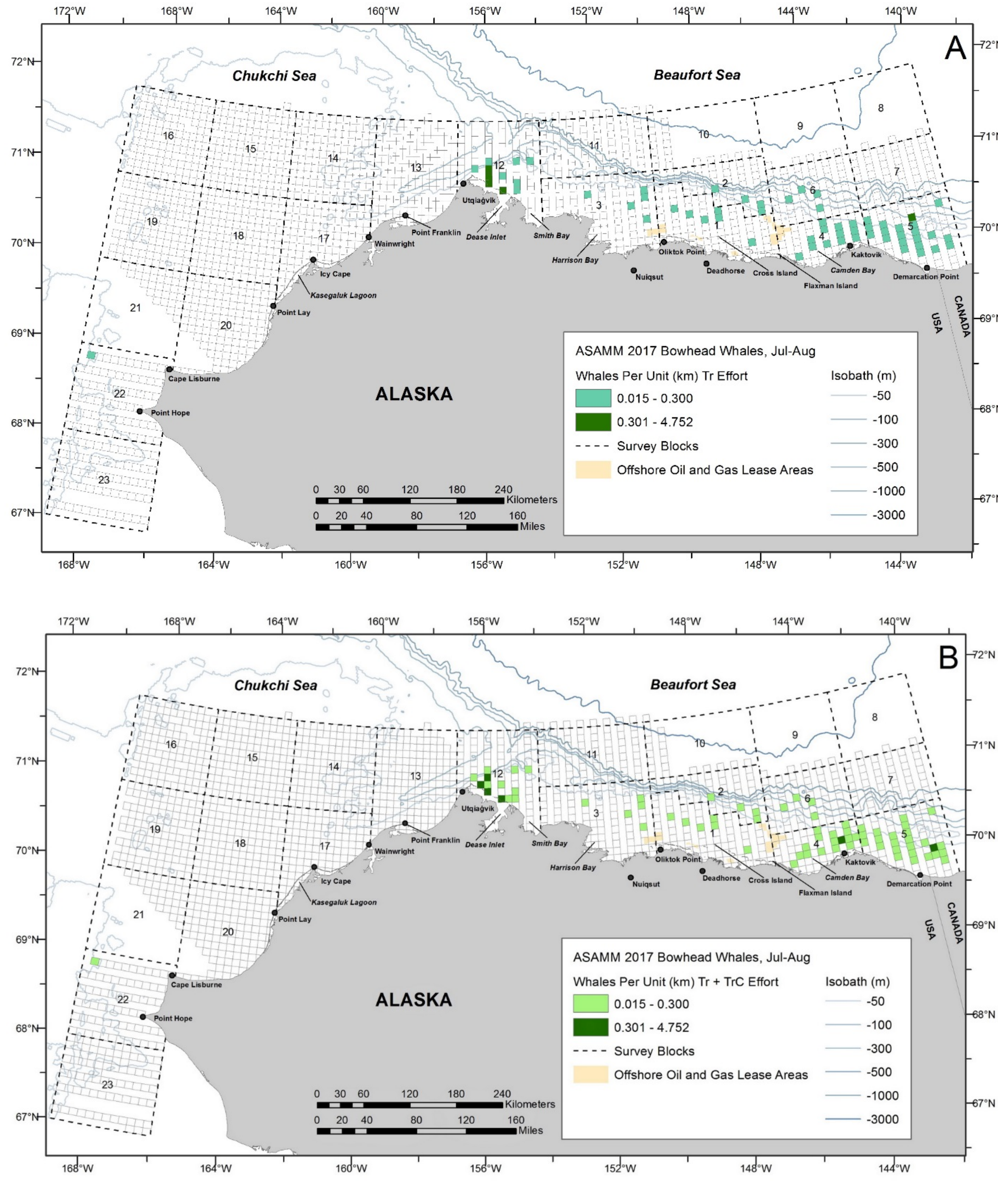

Figure E-1. ASAMM 2017 summer (July-August) bowhead whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

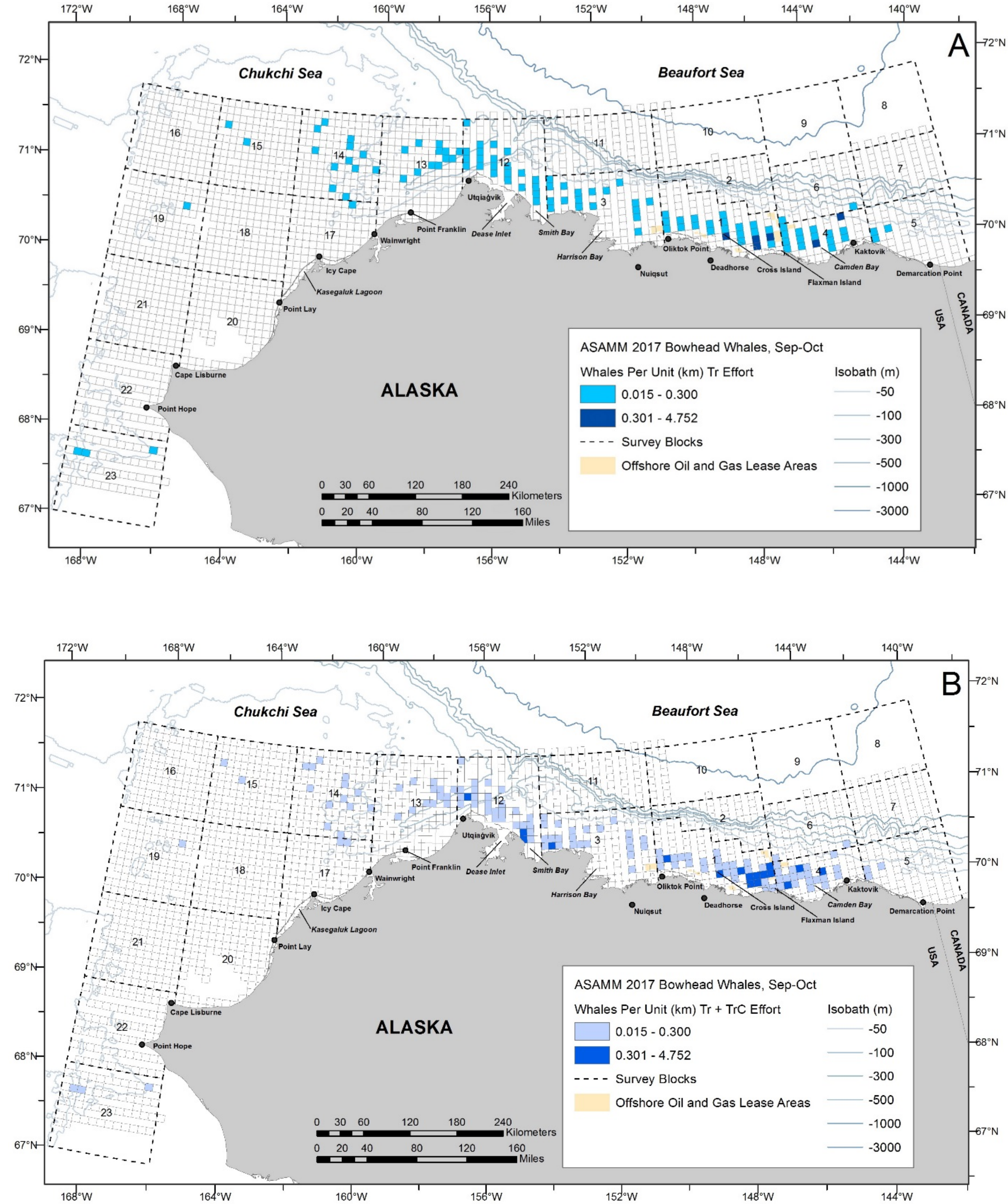

Figure E-2. ASAMM 2017 fall (September-October) bowhead whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

Table E-1. ASAMM 2017 transect (Tr) effort (km), bowhead whale transect sightings (primary observers only), and bowhead whale sighting rate (WPUE = bowhead whales per transect km surveyed) per survey block per month. NA – surveys were not conducted. Minor discrepancies within the table are due to rounding error.

	July				August				Summer			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
1	1,446	0	0	0.0000	1,557	8	8	0.0051	3,003	8	8	0.0027
1a	171	0	0	0.0000	186	0	0	0.0000	357	0	0	0.0000
2	1,026	5	10	0.0097	770	0	0	0.0000	1,796	5	10	0.0056
3	684	1	1	0.0015	1,504	5	5	0.0033	2,189	6	6	0.0027
4	464	4	7	0.0151	864	17	25	0.0289	1,328	21	32	0.0241
5	472	17	28	0.0593	1,098	38	54	0.0492	1,571	55	82	0.0522
6	737	3	5	0.0068	633	1	1	0.0016	1,370	4	6	0.0044
7	376	0	0	0.0000	726	0	0	0.0000	1,102	0	0	0.0000
8	1	0	0	0.0000	0	0	0	NA	1	0	0	0.0000
9	1	0	0	0.0000	1	0	0	0.0000	2	0	0	0.0000
10	62	0	0	0.0000	204	0	0	0.0000	266	0	0	0.0000
11	394	0	0	0.0000	1,022	0	0	0.0000	1,416	0	0	0.0000
12	965	3	24	0.0249	1,393	17	43	0.0309	2,358	20	67	0.0284
13	1,791	0	0	0.0000	1,295	0	0	0.0000	3,086	0	0	0.0000
14	1,052	0	0	0.0000	683	0	0	0.0000	1,735	0	0	0.0000
15	692	0	0	0.0000	598	0	0	0.0000	1,289	0	0	0.0000
16	363	0	0	0.0000	535	0	0	0.0000	898	0	0	0.0000
17	1,042	0	0	0.0000	731	0	0	0.0000	1,774	0	0	0.0000
18	522	0	0	0.0000	636	0	0	0.0000	1,158	0	0	0.0000
19	281	0	0	0.0000	523	0	0	0.0000	804	0	0	0.0000
20	615	0	0	0.0000	551	0	0	0.0000	1,167	0	0	0.0000
21	61	0	0	0.0000	121	0	0	0.0000	181	0	0	0.0000
22	383	1	2	0.0052	229	0	0	0.0000	612	1	2	0.0033
23	495	0	0	0.0000	455	0	0	0.0000	951	0	0	0.0000
Total	**14,096**	**34**	**77**	**0.0055**	**16,315**	**86**	**136**	**0.0083**	**30,411**	**120**	**213**	**0.0070**

	September				October				Fall			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
1	890	73	195	0.2192	913	12	60	0.0657	1,803	85	255	0.1414
1a	100	0	0	0.0000	142	0	0	0.0000	242	0	0	0.0000
2	383	0	0	0.0000	579	0	0	0.0000	961	0	0	0.0000
3	1,317	18	22	0.0167	952	10	13	0.0137	2,270	28	35	0.0154
4	667	31	47	0.0705	297	0	0	0.0000	963	31	47	0.0488
5	720	4	4	0.0056	158	0	0	0.0000	878	4	4	0.0046
6	501	2	3	0.0060	148	0	0	0.0000	649	2	3	0.0046
7	517	0	0	0.0000	0	0	0	NA	517	0	0	0.0000
8	3	0	0	0.0000	0	0	0	NA	3	0	0	0.0000
9	0	0	0	NA	0	0	0	NA	0	0	0	NA
10	149	0	0	0.0000	0	0	0	NA	149	0	0	0.0000
11	1,115	0	0	0.0000	849	0	0	0.0000	1,964	0	0	0.0000
12	1,568	29	39	0.0249	1,481	17	19	0.0128	3,049	46	58	0.0190
13	1,899	2	2	0.0011	1,261	15	24	0.0190	3,160	17	26	0.0082
14	1,550	12	14	0.0090	483	0	0	0.0000	2,033	12	14	0.0069
15	1,239	2	2	0.0016	243	0	0	0.0000	1,481	2	2	0.0014
16	362	0	0	0.0000	219	0	0	0.0000	581	0	0	0.0000
17	793	2	2	0.0025	591	0	0	0.0000	1,384	2	2	0.0014
18	630	0	0	0.0000	219	0	0	0.0000	849	0	0	0.0000
19	557	1	1	0.0018	141	0	0	0.0000	698	1	1	0.0014
20	509	0	0	0.0000	377	0	0	0.0000	886	0	0	0.0000
21	625	0	0	0.0000	122	0	0	0.0000	747	0	0	0.0000
22	742	0	0	0.0000	0	0	0	NA	742	0	0	0.0000
23	463	0	0	0.0000	220	3	3	0.0136	684	3	3	0.0044
Total	**17,297**	**176**	**331**	**0.0191**	**9,396**	**57**	**119**	**0.0127**	**26,692**	**233**	**450**	**0.0169**

Total transect effort (Tr Km) may differ from values in Tables 2 and E-3 because effort between barrier islands and the mainland was not included in the sighting rate per survey block analysis, except for block 1a.

Table E-2. ASAMM 2017 transect (Tr) and circling from transect (TrC) effort (km), bowhead whale transect and circling from transect sightings (primary observers only), and bowhead whale sighting rate (WPUE = bowhead whales per Tr and TrC km surveyed) per survey block per month. NA – surveys were not conducted. Minor discrepancies within the table are due to rounding error.

	July				**August**				**Summer**			
BLOCK	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**
1	1,446	0	0	0.0000	1,635	13	13	0.0080	3,081	13	13	0.0042
1a	193	0	0	0.0000	186	0	0	0.0000	378	0	0	0.0000
2	1,074	6	12	0.0112	770	0	0	0.0000	1,844	6	12	0.0065
3	692	1	1	0.0014	1,544	5	5	0.0032	2,236	6	6	0.0027
4	563	10	17	0.0302	1,057	22	31	0.0293	1,620	32	48	0.0296
5	619	24	39	0.0630	1,490	72	108	0.0725	2,109	96	147	0.0697
6	779	3	5	0.0064	633	1	1	0.0016	1,412	4	6	0.0042
7	376	0	0	0.0000	726	0	0	0.0000	1,102	0	0	0.0000
8	1	0	0	0.0000	0	0	0	NA	1	0	0	0.0000
9	1	0	0	0.0000	1	0	0	0.0000	2	0	0	0.0000
10	62	0	0	0.0000	204	0	0	0.0000	266	0	0	0.0000
11	394	0	0	0.0000	1,022	0	0	0.0000	1,416	0	0	0.0000
12	1,024	3	24	0.0234	1,589	34	92	0.0579	2,613	37	116	0.0444
13	2,142	0	0	0.0000	1,342	0	0	0.0000	3,485	0	0	0.0000
14	1,331	0	0	0.0000	826	0	0	0.0000	2,157	0	0	0.0000
15	700	0	0	0.0000	598	0	0	0.0000	1,297	0	0	0.0000
16	377	0	0	0.0000	549	0	0	0.0000	926	0	0	0.0000
17	1,229	0	0	0.0000	780	0	0	0.0000	2,009	0	0	0.0000
18	541	0	0	0.0000	639	0	0	0.0000	1,179	0	0	0.0000
19	299	0	0	0.0000	546	0	0	0.0000	845	0	0	0.0000
20	677	0	0	0.0000	551	0	0	0.0000	1,228	0	0	0.0000
21	61	0	0	0.0000	145	0	0	0.0000	205	0	0	0.0000
22	406	1	2	0.0049	256	0	0	0.0000	662	1	2	0.0030
23	553	0	0	0.0000	764	0	0	0.0000	1,317	0	0	0.0000
Total	**15,540**	**48**	**100**	**0.0064**	**17,850**	**147**	**250**	**0.0140**	**33,390**	**195**	**350**	**0.0105**

	September				October				Fall			
BLOCK	Tr+TrC Km	Tr+TrC Sightings	Tr+TrC Whales	WPUE	Tr+TrC Km	Tr+TrC Sightings	Tr+TrC Whales	WPUE	Tr+TrC Km	Tr+TrC Sightings	Tr+TrC Whales	WPUE
1	1,611	192	380	0.2359	1,115	25	78	0.0700	2,725	217	458	0.1681
1a	107	0	0	0.0000	156	0	0	0.0000	264	0	0	0.0000
2	400	0	0	0.0000	579	0	0	0.0000	979	0	0	0.0000
3	1,541	47	72	0.0467	1,122	13	16	0.0143	2,663	60	88	0.0330
4	1,147	101	157	0.1369	315	0	0	0.0000	1,463	101	157	0.1073
5	778	5	5	0.0064	158	0	0	0.0000	936	5	5	0.0053
6	534	2	3	0.0056	148	0	0	0.0000	682	2	3	0.0044
7	517	0	0	0.0000	0	0	0	NA	517	0	0	0.0000
8	3	0	0	0.0000	0	0	0	NA	3	0	0	0.0000
9	0	0	0	NA	0	0	0	NA	0	0	0	NA
10	149	0	0	0.0000	0	0	0	NA	149	0	0	0.0000
11	1,166	0	0	0.0000	867	0	0	0.0000	2,033	0	0	0.0000
12	1,864	54	69	0.0370	1,634	29	32	0.0196	3,498	83	101	0.0289
13	2,005	2	2	0.0010	1,446	28	48	0.0332	3,451	30	50	0.0145
14	1,845	19	22	0.0119	581	0	0	0.0000	2,427	19	22	0.0091
15	1,276	3	3	0.0024	243	0	0	0.0000	1,519	3	3	0.0020
16	366	0	0	0.0000	267	0	0	0.0000	633	0	0	0.0000
17	930	6	9	0.0097	698	0	0	0.0000	1,627	6	9	0.0055
18	630	0	0	0.0000	219	0	0	0.0000	849	0	0	0.0000
19	571	1	1	0.0017	141	0	0	0.0000	713	1	1	0.0014
20	525	0	0	0.0000	410	0	0	0.0000	935	0	0	0.0000
21	625	0	0	0.0000	122	0	0	0.0000	747	0	0	0.0000
22	842	0	0	0.0000	0	0	0	NA	842	0	0	0.0000
23	563	0	0	0.0000	459	4	4	0.0087	1,021	4	4	0.0039
Total	**19,996**	**432**	**723**	**0.0362**	**10,680**	**99**	**178**	**0.0167**	**30,676**	**531**	**901**	**0.0294**

Total (Tr+TrC Km) may differ from values in Table E-4 because effort between barrier islands and the mainland was not included in the sighting rate per survey block analysis, except for block 1a.

Table E-3. ASAMM 2017 transect (Tr) effort (km), bowhead whale Tr sightings (primary observers only), and bowhead whale sighting rate (WPUE = bowhead whales per Tr km surveyed) per depth zone per month. NA – surveys were not conducted. Minor discrepancies within the table are due to rounding error.

	July				August				Summer			
DEPTH ZONE	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
157°W-169°W												
≤ 35 m	2,065	0	0	0.0000	1,418	0	0	0.0000	3,483	0	0	0.0000
36-50 m	3,690	0	0	0.0000	3,677	0	0	0.0000	7,368	0	0	0.0000
51-200 m N	1,349	0	0	0.0000	1,028	0	0	0.0000	2,376	0	0	0.0000
51-200 m S	192	1	2	0.0104	234	0	0	0.0000	427	1	2	0.0047
154°W-157°W												
≤ 20 m	224	3	24	0.1070	289	13	36	0.1244	514	16	60	0.1168
21-50 m	180	0	0	0.0000	214	3	5	0.0234	393	3	5	0.0127
51-200 m	505	0	0	0.0000	759	1	2	0.0026	1,263	1	2	0.0016
201-2,000 m	56	0	0	0.0000	131	0	0	0.0000	187	0	0	0.0000
140°W-154°W												
≤ 20 m	1,212	0	0	0.0000	2,210	1	1	0.0005	3,421	1	1	0.0003
21-50 m	2,058	15	19	0.0092	2,641	58	79	0.0299	4,699	73	98	0.0209
51-200 m	835	13	30	0.0359	1,278	8	11	0.0086	2,112	21	41	0.0194
201-2,000 m	1,321	2	2	0.0015	1,786	2	2	0.0011	3,107	4	4	0.0013
>2,000 m	410	0	0	0.0000	663	0	0	0.0000	1,073	0	0	0.0000
TOTAL	**14,097**	**34**	**77**	**0.0055**	**16,327**	**86**	**136**	**0.0083**	**30,424**	**120**	**213**	**0.0070**

	September				October				Fall			
DEPTH ZONE	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
157°W-169°W												
≤ 35 m	1,821	0	0	0.0000	851	0	0	0.0000	2,671	0	0	0.0000
36-50 m	5,530	15	16	0.0029	1,741	2	2	0.0011	7,271	17	18	0.0025
51-200 m N	1,583	4	5	0.0032	1,176	15	24	0.0204	2,759	19	29	0.0105
51-200 m S	434	0	0	0.0000	108	1	1	0.0093	542	1	1	0.0018
154°W-157°W												
≤ 20 m	354	13	18	0.0508	302	2	2	0.0066	656	15	20	0.0305
21-50 m	254	6	6	0.0236	240	3	4	0.0167	494	9	10	0.0202
51-200 m	842	9	14	0.0166	795	12	13	0.0164	1,637	21	27	0.0165
201-2,000 m	117	1	1	0.0085	145	0	0	0.0000	263	1	1	0.0038
140°W-154°W												
≤ 20 m	1,702	53	147	0.0864	1,413	8	54	0.0382	3,115	61	201	0.0645
21-50 m	1,881	74	123	0.0654	1,165	14	19	0.0163	3,046	88	142	0.0466
51-200 m	1,112	1	1	0.0009	598	0	0	0.0000	1,710	1	1	0.0006
201-2,000 m	1,256	0	0	0.0000	679	0	0	0.0000	1,935	0	0	0.0000
>2,000 m	409	0	0	0.0000	188	0	0	0.0000	597	0	0	0.0000
TOTAL	**17,294**	**176**	**331**	**0.0191**	**9,401**	**57**	**119**	**0.0127**	**26,696**	**233**	**450**	**0.0169**

Total transect effort (Tr Km) may differ from values in Tables 2 and E-1 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis, except for block 1a.

Table E-4. ASAMM 2017 transect (Tr) and circling from transect (TrC) effort (km), bowhead whale transect and circling from transect sightings (primary observers only), and bowhead whale sighting rate (WPUE = bowhead whales per Tr and TrC km surveyed) per depth zone per month. NA – surveys were not conducted. Minor discrepancies within the table are due to rounding error.

	July				August				Summer			
DEPTH ZONE	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**
157°W-169°W												
≤ 35 m	2,294	0	0	0.0000	1,486	0	0	0.0000	3,780	0	0	0.0000
36-50 m	3,987	0	0	0.0000	3,946	0	0	0.0000	7,933	0	0	0.0000
51-200 m N	1,786	0	0	0.0000	1,122	0	0	0.0000	2,907	0	0	0.0000
51-200 m S	249	1	2	0.0080	441	0	0	0.0000	690	1	2	0.0029
154°W-157°W												
≤ 20 m	264	3	24	0.0910	436	29	84	0.1926	700	32	108	0.1543
21-50 m	184	0	0	0.0000	242	4	6	0.0248	426	4	6	0.0141
51-200 m	512	0	0	0.0000	773	1	2	0.0026	1,285	1	2	0.0016
201-2,000 m	64	0	0	0.0000	138	0	0	0.0000	202	0	0	0.0000
140°W-154°W												
≤ 20 m	1,234	0	0	0.0000	2,269	1	1	0.0004	3,502	1	1	0.0003
21-50 m	2,229	22	31	0.0139	3,181	97	138	0.0434	5,410	119	169	0.0312
51-200 m	985	20	41	0.0416	1,361	13	17	0.0125	2,346	33	58	0.0247
201-2,000 m	1,344	2	2	0.0015	1,807	2	2	0.0011	3,150	4	4	0.0013
>2,000 m	410	0	0	0.0000	663	0	0	0.0000	1,073	0	0	0.0000
TOTAL	**15,541**	**48**	**100**	**0.0064**	**17,863**	**147**	**250**	**0.0140**	**33,404**	**195**	**350**	**0.0105**

	September				October				Fall			
DEPTH ZONE	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**
157°W-169°W												
≤ 35 m	1,882	0	0	0.0000	886	0	0	0.0000	2,768	0	0	0.0000
36-50 m	5,978	27	32	0.0054	2,014	2	2	0.0010	7,992	29	34	0.0043
51-200 m N	1,777	4	5	0.0028	1,418	28	48	0.0338	3,195	32	53	0.0166
51-200 m S	541	0	0	0.0000	265	2	2	0.0076	806	2	2	0.0025
154°W-157°W												
≤ 20 m	485	28	35	0.0722	346	7	8	0.0231	831	35	43	0.0518
21-50 m	293	7	8	0.0273	289	3	4	0.0138	583	10	12	0.0206
51-200 m	956	18	25	0.0262	854	19	20	0.0234	1,810	37	45	0.0249
201-2,000 m	130	1	1	0.0077	145	0	0	0.0000	276	1	1	0.0036
140°W-154°W												
≤ 20 m	2,264	124	251	0.1109	1,626	15	65	0.0400	3,889	139	316	0.0812
21-50 m	2,782	222	365	0.1312	1,351	23	29	0.0215	4,133	245	394	0.0953
51-200 m	1,196	1	1	0.0008	621	0	0	0.0000	1,816	1	1	0.0006
201-2,000 m	1,302	0	0	0.0000	679	0	0	0.0000	1,981	0	0	0.0000
>2,000 m	409	0	0	0.0000	188	0	0	0.0000	597	0	0	0.0000
TOTAL	**19,994**	**432**	**723**	**0.0362**	**10,683**	**99**	**178**	**0.0167**	**30,677**	**531**	**901**	**0.0294**

Total (Tr+TrC Km) may differ from values in Table E-2 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis, except for block 1a.

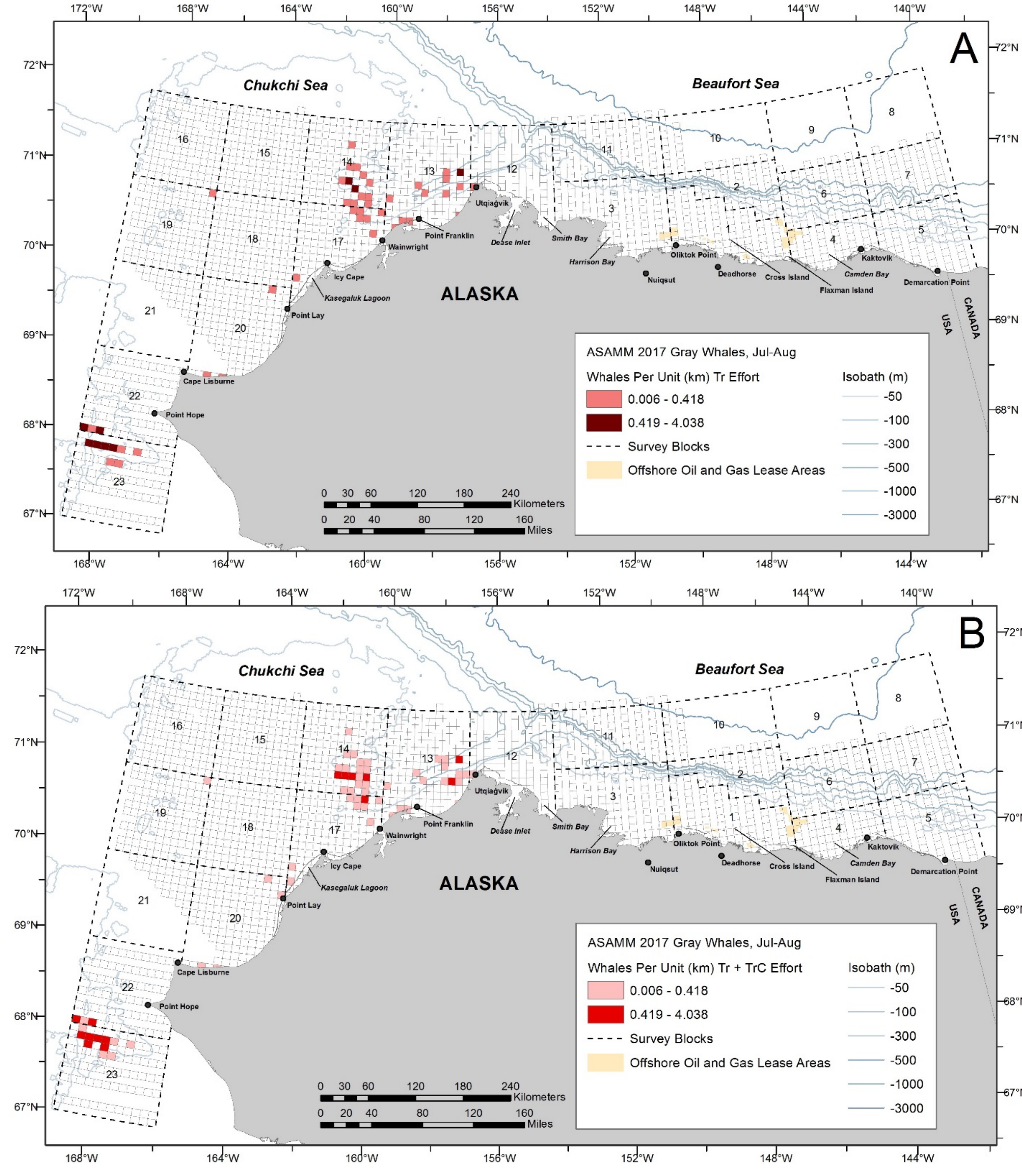

Figure E-3. ASAMM 2017 summer (July-August) gray whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

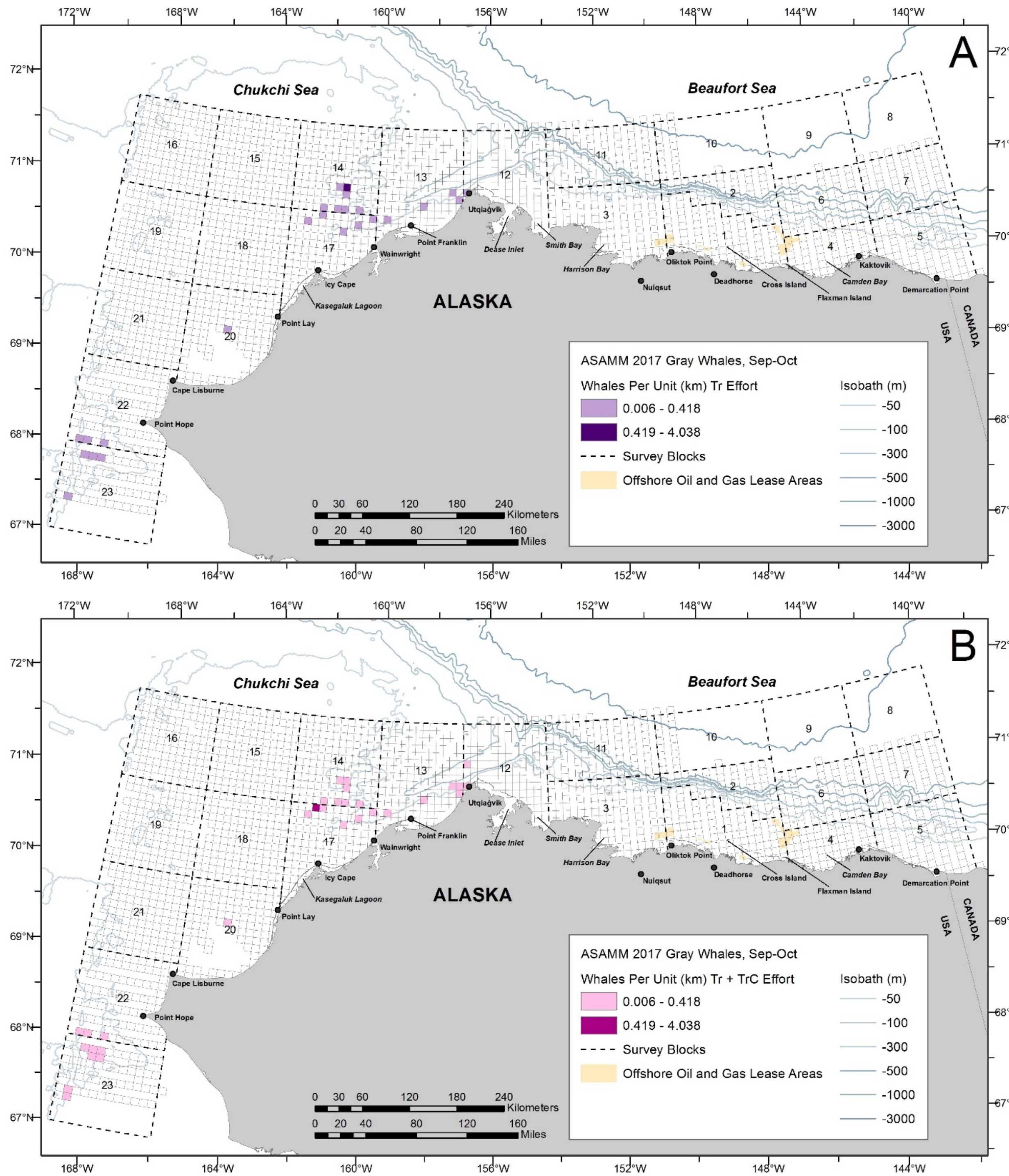

Figure E-4. ASAMM 2017 fall (September-October) gray whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

Table E-5. ASAMM 2017 transect (Tr) effort (km), gray whale transect sightings (primary observers only), and gray whale sighting rate (WPUE = gray whales per transect km surveyed) per survey block per month. NA – surveys were not conducted. Minor discrepancies within the table are due to rounding error.

	July				August				Summer			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
12	965	1	2	0.0021	1,393	0	0	0.0000	2,358	1	2	0.0008
13	1,791	19	81	0.0452	1,295	0	0	0.0000	3,086	19	81	0.0263
14	1,052	39	66	0.0627	683	8	12	0.0176	1,735	47	78	0.0450
15	692	0	0	0.0000	598	0	0	0.0000	1,289	0	0	0.0000
16	363	0	0	0.0000	535	0	0	0.0000	898	0	0	0.0000
17	1,042	9	16	0.0154	731	2	6	0.0082	1,774	11	22	0.0124
18	522	0	0	0.0000	636	0	0	0.0000	1,158	0	0	0.0000
19	281	1	2	0.0071	523	0	0	0.0000	804	1	2	0.0025
20	615	3	4	0.0065	551	0	0	0.0000	1,167	3	4	0.0034
21	61	0	0	0.0000	121	0	0	0.0000	181	0	0	0.0000
22	383	0	0	0.0000	229	3	3	0.0131	612	3	3	0.0049
23	495	50	67	0.1352	455	34	66	0.1450	951	84	133	0.1399
Total	**8,262**	**122**	**238**	**0.0288**	**7,750**	**47**	**87**	**0.0112**	**16,011**	**169**	**325**	**0.0203**

	September				October				Fall			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
12	1,568	1	2	0.0013	1,481	0	0	0.0000	3,049	1	2	0.0007
13	1,899	3	4	0.0021	1,261	2	3	0.0024	3,160	5	7	0.0022
14	1,550	15	22	0.0142	483	7	7	0.0145	2,033	22	29	0.0143
15	1,239	0	0	0.0000	243	0	0	0.0000	1,481	0	0	0.0000
16	362	0	0	0.0000	219	0	0	0.0000	581	0	0	0.0000
17	793	8	12	0.0151	591	3	6	0.0102	1,384	11	18	0.0130
18	630	0	0	0.0000	219	0	0	0.0000	849	0	0	0.0000
19	557	0	0	0.0000	141	0	0	0.0000	698	0	0	0.0000
20	509	1	1	0.0020	377	0	0	0.0000	886	1	1	0.0011
21	625	0	0	0.0000	122	0	0	0.0000	747	0	0	0.0000
22	742	5	7	0.0094	0	0	0	NA	742	5	7	0.0094
23	463	5	11	0.0237	220	2	2	0.0091	684	7	13	0.0190
Total	**10,936**	**38**	**59**	**0.0054**	**5,357**	**14**	**18**	**0.0034**	**16,293**	**52**	**77**	**0.0047**

Total transect effort (Tr Km) may differ from values in Tables 2 and E-7 because effort between barrier islands and the mainland was not included in the sighting rate per survey block analysis.

Table E-6. ASAMM 2017 transect (Tr) and circling from transect (TrC) effort (km), gray whale transect and circling from transect sightings (primary observers only), and gray whale sighting rate (WPUE = gray whales per Tr and TrC km surveyed) per survey block per month. NA – surveys were not conducted. Minor discrepancies within the table are due to rounding error.

	July				August				Summer			
BLOCK	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**
12	1,024	1	2	0.0020	1,589	0	0	0.0000	2,613	1	2	0.0008
13	2,142	42	138	0.0644	1,342	0	0	0.0000	3,485	42	138	0.0396
14	1,331	68	115	0.0864	826	22	30	0.0363	2,157	90	145	0.0672
15	700	0	0	0.0000	598	0	0	0.0000	1,297	0	0	0.0000
16	377	0	0	0.0000	549	0	0	0.0000	926	0	0	0.0000
17	1,229	18	51	0.0415	780	2	6	0.0077	2,009	20	57	0.0284
18	541	0	0	0.0000	639	0	0	0.0000	1,179	0	0	0.0000
19	299	1	2	0.0067	546	0	0	0.0000	845	1	2	0.0024
20	677	4	6	0.0089	551	0	0	0.0000	1,228	4	6	0.0049
21	61	0	0	0.0000	145	0	0	0.0000	205	0	0	0.0000
22	406	0	0	0.0000	256	3	3	0.0117	662	3	3	0.0045
23	553	67	106	0.1916	764	49	89	0.1165	1,317	116	195	0.1481
Total	**9,339**	**201**	**420**	**0.0450**	**8,583**	**76**	**128**	**0.0149**	**17,923**	**277**	**548**	**0.0306**

	September				October				Fall			
BLOCK	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**
12	1,864	2	3	0.0016	1,634	0	0	0.0000	3,498	2	3	0.0009
13	2,005	10	13	0.0065	1,446	2	3	0.0021	3,451	12	16	0.0046
14	1,845	29	41	0.0222	581	17	23	0.0396	2,427	46	64	0.0264
15	1,276	0	0	0.0000	243	0	0	0.0000	1,519	0	0	0.0000
16	366	0	0	0.0000	267	0	0	0.0000	633	0	0	0.0000
17	930	16	24	0.0258	698	7	11	0.0158	1,627	23	35	0.0215
18	630	0	0	0.0000	219	0	0	0.0000	849	0	0	0.0000
19	571	0	0	0.0000	141	0	0	0.0000	713	0	0	0.0000
20	525	1	1	0.0019	410	0	0	0.0000	935	1	1	0.0011
21	625	0	0	0.0000	122	0	0	0.0000	747	0	0	0.0000
22	842	7	10	0.0119	0	0	0	NA	842	7	10	0.0119
23	563	9	17	0.0302	459	7	7	0.0153	1,021	16	24	0.0235
Total	**12,042**	**74**	**109**	**0.0091**	**6,220**	**33**	**44**	**0.0071**	**18,262**	**107**	**153**	**0.0084**

Total (Tr+TrC Km) may differ from values in Table E-8 because effort between barrier islands and the mainland was not included in the sighting rate per survey block analysis.

Table E-7. ASAMM 2017 transect (Tr) effort (km), gray whale transect sightings (primary observers only), and gray whale sighting rate (WPUE = gray whales per transect km surveyed) per depth zone per month. Minor discrepancies within the table are due to rounding error.

	July				August				Summer			
DEPTH ZONE	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
157°W-169°W												
≤ 35 m	2,065	8	13	0.0063	1,418	0	0	0.0000	3,483	8	13	0.0037
36-50 m	3,690	40	59	0.0160	3,677	13	29	0.0079	7,368	53	88	0.0119
51-200 m N	1,349	36	116	0.0860	1,028	6	11	0.0107	2,376	42	127	0.0534
51-200 m S	192	37	48	0.2494	234	28	47	0.2007	427	65	95	0.2227
154°W-157°W												
≤ 20 m	224	0	0	0.0000	289	0	0	0.0000	514	0	0	0.0000
21-50 m	180	1	2	0.0111	214	0	0	0.0000	393	1	2	0.0051
51-200 m	505	0	0	0.0000	759	0	0	0.0000	1,263	0	0	0.0000
201-2,000 m	56	0	0	0.0000	131	0	0	0.0000	187	0	0	0.0000
Total	**8,262**	**122**	**238**	**0.0288**	**7,750**	**47**	**87**	**0.0112**	**16,011**	**169**	**325**	**0.0203**

	September				October				Fall			
DEPTH ZONE	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
157°W-169°W												
≤ 35 m	1,821	1	1	0.0005	851	0	0	0.0000	2,671	1	1	0.0004
36-50 m	5,530	14	19	0.0034	1,741	5	8	0.0046	7,271	19	27	0.0037
51-200 m N	1,583	12	19	0.0120	1,176	7	8	0.0068	2,759	19	27	0.0098
51-200 m S	434	10	18	0.0415	108	2	2	0.0185	542	12	20	0.0369
154°W-157°W												
≤ 20 m	354	0	0	0.0000	302	0	0	0.0000	656	0	0	0.0000
21-50 m	254	1	2	0.0079	240	0	0	0.0000	494	1	2	0.0040
51-200 m	842	0	0	0.0000	795	0	0	0.0000	1,637	0	0	0.0000
201-2,000 m	117	0	0	0.0000	145	0	0	0.0000	263	0	0	0.0000
Total	**10,936**	**38**	**59**	**0.0054**	**5,358**	**14**	**18**	**0.0034**	**16,294**	**52**	**77**	**0.0047**

Total transect effort (Tr km) may differ from values in Tables 2 and E-5 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis.

Table E-8. ASAMM 2017 transect (Tr) and circling from transect (TrC) effort (km), gray whale transect and circling from transect sightings (primary observers only), and gray whale sighting rate (WPUE = gray whales per Tr and TrC km surveyed) per depth zone per month. Minor discrepancies within the table are due to rounding error.

	July				August				Summer			
DEPTH ZONE	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**
157°W-169°W												
≤ 35 m	2,294	14	21	0.0092	1,486	0	0	0.0000	3,780	14	21	0.0056
36-50 m	3,987	59	95	0.0238	3,946	23	42	0.0106	7,933	82	137	0.0173
51-200 m N	1,786	73	215	0.1204	1,122	10	16	0.0143	2,907	83	231	0.0795
51-200 m S	249	54	87	0.3494	441	43	70	0.1587	690	97	157	0.2275
154°W-157°W												
≤ 20 m	264	0	0	0.0000	436	0	0	0.0000	700	0	0	0.0000
21-50 m	184	1	2	0.0109	242	0	0	0.0000	426	1	2	0.0047
51-200 m	512	0	0	0.0000	773	0	0	0.0000	1,285	0	0	0.0000
201-2,000 m	64	0	0	0.0000	138	0	0	0.0000	202	0	0	0.0000
Total	**9,339**	**201**	**420**	**0.0450**	**8,583**	**76**	**128**	**0.0149**	**17,923**	**277**	**548**	**0.0306**

	September				October				Fall			
DEPTH ZONE	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**	**Tr+TrC Km**	**Tr+TrC Sightings**	**Tr+TrC Whales**	**WPUE**
157°W-169°W												
≤ 35 m	1,882	1	1	0.0005	886	0	0	0.0000	2,768	1	1	0.0004
36-50 m	5,978	25	35	0.0059	2,014	16	26	0.0129	7,992	41	61	0.0076
51-200 m N	1,777	30	43	0.0242	1,418	10	11	0.0078	3,195	40	54	0.0169
51-200 m S	541	16	27	0.0499	265	7	7	0.0264	806	23	34	0.0422
154°W-157°W												
≤ 20 m	485	0	0	0.0000	346	0	0	0.0000	831	0	0	0.0000
21-50 m	293	1	2	0.0068	289	0	0	0.0000	583	1	2	0.0034
51-200 m	956	1	1	0.0010	854	0	0	0.0000	1,810	1	1	0.0006
201-2,000 m	130	0	0	0.0000	145	0	0	0.0000	276	0	0	0.0000
Total	**12,042**	**74**	**109**	**0.0091**	**6,218**	**33**	**44**	**0.0071**	**18,260**	**107**	**153**	**0.0084**

Total (Tr+TrC Km) may differ from values in Table E-6 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis.

Table E-9. ASAMM 2017 transect (Tr) effort (km), beluga transect sightings (primary observers only), and beluga sighting rate (WPUE = belugas per transect km surveyed) per survey block per month. NA – surveys were not conducted. Minor discrepancies within the table are due to rounding error.

	July				August				Summer			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
1	1,446	4	4	0.0028	1,557	0	0	0.0000	3,003	4	4	0.0013
1a	171	0	0	0.0000	186	0	0	0.0000	357	0	0	0.0000
2	1,026	65	258	0.2515	770	4	5	0.0065	1,796	69	263	0.1464
3	684	0	0	0.0000	1,504	0	0	0.0000	2,189	0	0	0.0000
4	464	4	4	0.0086	864	8	36	0.0417	1,328	12	40	0.0301
5	472	19	34	0.0720	1,098	8	23	0.0209	1,571	27	57	0.0363
6	737	86	258	0.3502	633	13	46	0.0727	1,370	99	304	0.2220
7	376	42	140	0.3723	726	40	85	0.1170	1,102	82	225	0.2041
8	1	0	0	0.0000	0	0	0	NA	1	0	0	0.0000
9	1	0	0	0.0000	1	0	0	0.0000	2	0	0	0.0000
10	62	0	0	0.0000	204	0	0	0.0000	266	0	0	0.0000
11	394	5	16	0.0406	1,022	9	99	0.0969	1,416	14	115	0.0812
12	965	7	34	0.0352	1,393	22	82	0.0589	2,358	29	116	0.0492
13	1,791	7	28	0.0156	1,295	0	0	0.0000	3,086	7	28	0.0091
14	1,052	0	0	0.0000	683	0	0	0.0000	1,735	0	0	0.0000
15	692	0	0	0.0000	598	0	0	0.0000	1,289	0	0	0.0000
16	363	0	0	0.0000	535	0	0	0.0000	898	0	0	0.0000
17	1,042	0	0	0.0000	731	0	0	0.0000	1,774	0	0	0.0000
18	522	0	0	0.0000	636	0	0	0.0000	1,158	0	0	0.0000
19	281	0	0	0.0000	523	0	0	0.0000	804	0	0	0.0000
20	615	2	16	0.0260	551	0	0	0.0000	1,167	2	16	0.0137
21	61	0	0	0.0000	121	0	0	0.0000	181	0	0	0.0000
22	383	0	0	0.0000	229	0	0	0.0000	612	0	0	0.0000
23	495	0	0	0.0000	455	0	0	0.0000	951	0	0	0.0000
Total	**14,096**	**241**	**792**	**0.0562**	**16,315**	**104**	**376**	**0.0230**	**30,411**	**345**	**1,168**	**0.0384**

	September				October				Fall			
BLOCK	Tr Km	Tr Sightings	Tr Whales	WPUE	Tr Km	Tr Sightings	Tr Whales	WPUE	Tr Km	Tr Sightings	Tr Whales	WPUE
1	890	0	0	0.0000	913	0	0	0.0000	1,803	0	0	0.0000
1a	100	0	0	0.0000	142	0	0	0.0000	242	0	0	0.0000
2	383	0	0	0.0000	579	2	20	0.0346	961	2	20	0.0208
3	1,317	0	0	0.0000	952	1	60	0.0630	2,270	1	60	0.0264
4	667	1	45	0.0675	297	0	0	0.0000	963	1	45	0.0467
5	720	0	0	0.0000	158	0	0	0.0000	878	0	0	0.0000
6	501	0	0	0.0000	148	0	0	0.0000	649	0	0	0.0000
7	517	0	0	0.0000	0	0	0	NA	517	0	0	0.0000
8	3	0	0	0.0000	0	0	0	NA	3	0	0	0.0000
9	0	0	0	NA	0	0	0	NA	0	0	0	NA
10	149	0	0	0.0000	0	0	0	NA	149	0	0	0.0000
11	1,115	1	2	0.0018	849	7	25	0.0294	1,964	8	27	0.0137
12	1,568	0	0	0.0000	1,481	24	95	0.0642	3,049	24	95	0.0312
13	1,899	0	0	0.0000	1,261	0	0	0.0000	3,160	0	0	0.0000
14	1,550	0	0	0.0000	483	0	0	0.0000	2,033	0	0	0.0000
15	1,239	0	0	0.0000	243	0	0	0.0000	1,481	0	0	0.0000
16	362	0	0	0.0000	219	0	0	0.0000	581	0	0	0.0000
17	793	0	0	0.0000	591	0	0	0.0000	1,384	0	0	0.0000
18	630	0	0	0.0000	219	0	0	0.0000	849	0	0	0.0000
19	557	0	0	0.0000	141	0	0	0.0000	698	0	0	0.0000
20	509	0	0	0.0000	377	0	0	0.0000	886	0	0	0.0000
21	625	0	0	0.0000	122	0	0	0.0000	747	0	0	0.0000
22	742	0	0	0.0000	0	0	0	NA	742	0	0	0.0000
23	463	0	0	0.0000	220	0	0	0.0000	684	0	0	0.0000
Total	**17,297**	**2**	**47**	**0.0027**	**9,396**	**34**	**200**	**0.0213**	**26,692**	**36**	**247**	**0.0093**

Total transect effort (Tr Km) may differ from values in Tables 2 and E-10 because effort between barrier islands and the mainland was not included in the sighting rate per survey block analysis, except for block 1a.

Table E-10. ASAMM 2017 transect (Tr) effort (km), beluga Tr sightings (primary observers only), and beluga sighting rate (WPUE = belugas per Tr km surveyed) per depth zone per month. Minor discrepancies within the table are due to rounding error.

	July				**August**				**Summer**			
DEPTH ZONE	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
157°W-169°W												
≤ 35 m	2,065	8	43	0.0208	1,418	0	0	0.0000	3,483	8	43	0.0123
36-50 m	3,690	0	0	0.0000	3,677	0	0	0.0000	7,368	0	0	0.0000
51-200 m N	1,349	1	1	0.0007	1,028	0	0	0.0000	2,376	1	1	0.0004
51-200 m S	192	0	0	0.0000	234	0	0	0.0000	427	0	0	0.0000
154°W-157°W												
≤ 20 m	224	0	0	0.0000	289	0	0	0.0000	514	0	0	0.0000
21-50 m	180	0	0	0.0000	214	0	0	0.0000	393	0	0	0.0000
51-200 m	505	1	7	0.0139	759	0	0	0.0000	1,263	1	7	0.0055
201-2,000 m	56	6	27	0.4829	131	22	82	0.6237	187	28	109	0.5817
140°W-154°W												
≤ 20 m	1,212	2	2	0.0017	2,210	5	16	0.0072	3,421	7	18	0.0053
21-50 m	2,058	15	30	0.0146	2,641	7	39	0.0148	4,699	22	69	0.0147
51-200 m	835	26	78	0.0935	1,278	3	3	0.0023	2,112	29	81	0.0383
201-2,000 m	1,321	166	557	0.4217	1,786	30	175	0.0980	3,107	196	732	0.2356
>2,000 m	410	16	47	0.1146	663	37	61	0.0921	1,073	53	108	0.1007
TOTAL	**14,097**	**241**	**792**	**0.0562**	**16,327**	**104**	**376**	**0.0230**	**30,424**	**345**	**1,168**	**0.0384**

	September				October				Fall			
DEPTH ZONE	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
157°W-169°W												
≤ 35 m	1,821	0	0	0.0000	851	0	0	0.0000	2,671	0	0	0.0000
36-50 m	5,530	0	0	0.0000	1,741	0	0	0.0000	7,271	0	0	0.0000
51-200 m N	1,583	0	0	0.0000	1,176	0	0	0.0000	2,759	0	0	0.0000
51-200 m S	434	0	0	0.0000	108	0	0	0.0000	542	0	0	0.0000
154°W-157°W												
≤ 20 m	354	0	0	0.0000	302	0	0	0.0000	656	0	0	0.0000
21-50 m	254	0	0	0.0000	240	3	6	0.0250	494	3	6	0.0121
51-200 m	842	0	0	0.0000	795	9	16	0.0201	1,637	9	16	0.0098
201-2,000 m	117	0	0	0.0000	145	12	73	0.5027	263	12	73	0.2779
140°W-154°W												
≤ 20 m	1,702	1	45	0.0264	1,413	1	60	0.0425	3,115	2	105	0.0337
21-50 m	1,881	0	0	0.0000	1,165	0	0	0.0000	3,046	0	0	0.0000
51-200 m	1,112	0	0	0.0000	598	6	23	0.0385	1,710	6	23	0.0135
201-2,000 m	1,256	1	2	0.0016	679	1	2	0.0029	1,935	2	4	0.0021
>2,000 m	409	0	0	0.0000	188	2	20	0.1064	597	2	20	0.0335
TOTAL	**17,294**	**2**	**47**	**0.0027**	**9,401**	**34**	**200**	**0.0213**	**26,696**	**36**	**247**	**0.0093**

Total transect effort (Tr Km) may differ from values in Tables 2 and E-9 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis, except for block 1a.

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APPENDIX F: ASAMM CONTRIBUTIONS to the SCIENTIFIC COMMUNITY, 2008-SPRING 2018

The Aerial Surveys of Arctic Marine Mammals (ASAMM) project is critical to understanding the arctic ecosystem and managing arctic natural resources in the past, present, and future.

- ASAMM is the only long-term broad-scale time series of data on marine mammal distribution, relative abundance, and behavior that exists for the Alaskan Arctic (140°-169°W, 68°-72°N, with surveys in adjoining regions in some years). The surveys have been conducted every year since 1979, with remarkably consistent data collection protocols from 1982 to the present.
- Information on marine mammal distribution and relative abundance in the western Beaufort and northeastern Chukchi seas during summer and fall can be reliably obtained only through aerial surveys conducted in these regions during the relevant seasons. This information is needed to generate species-specific estimates of the number of animals that are likely to be affected by future anthropogenic activities that are proposed to occur in the ASAMM study area during summer and fall. This information is required by BOEM and NOAA to fulfill the agencies' obligations under the NEPA, MMPA, and ESA. Without current, reliable data, the agencies will be vulnerable to litigation and their ability to make management decisions about future anthropogenic activities in this region during summer and fall will likely be delayed.
- Colleagues at multiple federal and state agencies, academic institutions, and private companies rely on the data in the ASAMM historical database to make decisions regarding marine mammal conservation and management, and to better understand marine mammal roles in the arctic ecosystem. Results from ASAMM have also been of interest to the general public, and have been communicated through newspaper articles, online blogs and radio interviews. Additional details are provided in Figure F-1 and summary sections below.
- There is minimal time lag between when ASAMM data are collected and when they may be used to inform management decisions. The survey aircraft can use the satellite telephone to convey critical information to contacts on the ground without any delay. This information has proven valuable in reporting walrus distributions and numbers to research vessels searching for walruses to tag and in relaying the exact location and approximate size of mass coastal walrus haulouts to USFWS in order to implement additional protection measures. Furthermore, the first draft of the entire database for each ASAMM flight is available within hours of the end of the survey, providing near real-time information to BOEM and NOAA for use in offshore oil exploration mitigation and oil-spill response drills. The final database is available within a few months of the end of the field season, and this rapid turn-around time has proven valuable in generating abundance estimates for eastern Chukchi Sea belugas and Western Arctic bowhead whales, resulting in a considerable cost savings to the Federal government.
- Due to the inter-annual variability in the arctic ecosystem and observed and expected changes to the ecosystem due to the changing climate, it is critical to survey the region every year to capture the range of ecosystem dynamics.
- The phenology of the arctic ecosystem is changing, with sea ice melt occurring earlier and freeze-up occurring later in the year. One result of the lengthened open water season is a greater period of time during which the arctic marine ecosystem is accessible to human activities with the potential to affect arctic resources, such as vessel traffic and oil

	Daily Reports	Biweekly Maps and Reports	Annual Reports	Maps	Shapefiles	Carcass Data	Sea Ice Photos	Sighting and Effort Data	Expert Input into Management Decisions	Aerial Recon
USCG				x			x			
BOEM	x	x	x	x	x		x	x	x	
USGS	x	x	x	x			x	x		x
NOAA	x	x	x	x	x	x	x	x	x	
USFWS	x	x	x	x		x	x	x		x
US Marine Mammal Commission			x						x	
Alaska Ocean Observing System					x			x		
Arctic ERMA					x			x		
NSB	x	x	x	x		x		x		
Oil & Gas Industry	x	x	x	x			x	x		
OBIS-SEAMAP								x		
Non-Governmental Organizations	x		x					x	x	
Other Researchers	x	x	x	x	x		x	x		x

Figure F-1. Matrix Summarizing ASAMM Products Distributed to Institutions and Agencies, 2008-Present.

and natural gas exploration, development, and production. In order to implement effective marine mammal conservation and management practices, it is important to continue to conduct broad-scale surveys for marine mammals throughout the entire seasonal range in which anthropogenic activities are likely to occur. Currently, ASAMM captures this critical time period from early July through the end of October.

- Weather in the Arctic can be extreme and is highly dynamic in space and time. There is no way to predict when the good weather will occur during the open water season within the ASAMM study area. To maximize the chances of obtaining useful data and be most efficient with limited government resources, best practice is to have ASAMM field teams maintain a constant presence in the study area throughout the open water season. Transits between the study area and home bases in lower latitudes cost money due to increased flight time for the survey aircraft and travel expenses for the aerial observers.
- The U.S. is a member of Arctic Council, and was chair of the Council from 2015 to 2017. The Arctic Council is a high level, intergovernmental forum providing a means for promoting cooperation, coordination and interaction on common issues among the Arctic States, with the involvement of Arctic Indigenous communities and other arctic inhabitants. Sustainable development and environmental protection are particular issues

of concern. Other member nations of the Arctic Council include Canada, Denmark, Finland, Iceland, Norway, Russia, and Sweden, in addition to six Permanent Participants representing Indigenous peoples. ASAMM represents the most extensive marine mammal dataset from any Arctic Council nation, and is an example of the usefulness of a multi-decadal time series.

PUBLISHED PAPERS USING ASAMM/BWASP/COMIDA DATA (ALPHABETIZED):

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VENUES WHERE ASAMM RESULTS WERE PRESENTED (ALPHABETIZED):

Alaska Beluga Whale Committee Workshop, Anchorage, AK. 2012, 2016, 2018. Presentations (3).

Alaska Marine Science Symposium, Anchorage, AK. 2009-2018. Presentations (2), posters (45).

American Cetacean Society, Monterey, CA. 2008. Poster.

Applied Physics Lab, Polar Science Center, Seattle, WA. 2016. Presentation.

Arctic Council/PAME Workshop, Science and tools for developing Arctic MPA Networks, Washington, DC, 2016. Presentation.

Arctic Open Water Meetings, Anchorage, AK. 2009-2013. Presentations (2).

Bering Sea Open Science Meeting, Honolulu, HI. 2014. Poster.

Bowhead Whale Feeding Ecology Study Workshop, Anchorage, AK. 2009. Presentation.

Camden Bay Collaborative Study Workshop, Fairbanks, AK, 2014 and Anchorage, AK, 2016. Presentations (2).

Distributed Biological Observatory Data Workshops, Seattle, WA. 2014, 2016, 2017. Presentations (3).

Duke University, Marine Geospatial Ecology Lab, Durham, NC. 2017. Presentation.

International Whaling Commission Scientific Committee Meeting, Morocco. 2010 and 2017. Reports (3).

Minerals Management Service Information Transfer Meeting, Anchorage, AK. 2008. Presentations (2).

NSB Marine Mammal Observer training class, Barrow, AK. 2009. Presentation.

Ocean Sciences Meeting. 2014 and 2016. Presentations (2), poster (1).

Society for Marine Mammalogy, 2009, 2011, 2015. Presentation (1), posters (2).

United States-Canada North Oil and Gas Forum, Anchorage, AK. 2012. Presentation.

USFWS Workshop on Assessing Pacific Walrus Population Attributes from Coastal Haul-outs, Anchorage, AK. 2012. Presentation.

TIMELINE OF ASAMM MARINE MAMMAL DATA REQUESTS (ALL GRANTED) AND USES (CHRONOLOGICAL):

Feb 2010: Conoco-Phillips requested ASAMM 2008 aerial survey data for use in an Environmental Impact Study.

Mar 2010: Greg Balogh (USFWS) requested an ASAMM 2009 Icy Cape walrus haulout photograph for use in a USFWS Landscape Conservation Cooperative planning document.

Apr 2010: Bill Lorand (SFSU Geographic Information System student) requested the ASAMM 2008-2009 walrus sighting data for use in a Coastal & Marine Applications Geographic Information System course project.

May 2010: Lisa Rotterman (NMFS) requested maps of ASAMM data for potential use in Arctic Incidental Harassment Authorization Biological Opinion.

June 2010: Dave Rugh (NMML) requested maps of ASAMM 2009 effort for use in an informal discussion about NMML arctic surveys with a Naval Officer.

2010: Dan Pendleton (NOAA) requested 1982-2010 ASAMM bowhead whale data for a research project funded by NASA entitled "Forecasting Changes in Habitat Use by Bowhead Whales in Response to Arctic Climate Change: Integration of Physical-Biological Models with Satellite, Biological Survey and Oceanographic Data."

April 2011: Lisanne Aerts (OASIS Environmental) requested ASAMM 1982-2010 sightings within the Olgoonik-Fairweather study area for use in a comparison of aerial sightings with shipboard sightings.

Oct 2011: Joel Kasser and Jeadiz Wiedmer (Van Hall Larenstein, Netherlands BSc students) requested ASAMM walrus sightings from 2008-2010 for use in a thesis project for the Dutch WWF.

2011: Ken Dunton and Susan Schonberg (UT) requested shapefiles of ASAMM 2008-2010 bowhead whale, gray whale, and walrus sightings for comparison with benthic data.

2011: Provided the ASAMM 1979-2010 historical data and associated metadata to OBIS-SEAMAP, a spatially referenced online database, aggregating marine mammal, seabird and sea turtle observation data from across the globe.

2011: NMFS Cetacean Density and Distribution Mapping (CetMap) Working Group requested ASAMM data to conduct a "gap analysis" of cetacean data within the US EEZ.

2012-present: Hajo Eicken and Olivia Lee (UAF) requested ASAMM walrus and sea ice data to investigate walrus use of sparse sea ice habitat and to calibrate remotely sensed sea ice data.

2012: NSB requested data collected during ASAMM surveys conducted in the Alaskan Beaufort Sea in July and August 2012 to calculate a population estimate for the ECS beluga stock.

2012: Alyson Azzara (Committee on the Marine Transportation System) requested use of ASAMM data for an analysis of ship traffic in the Arctic.
Azzara, A., H Wang, and D. Rutherford. 2015. A 10-year projection of maritime activity in the U.S. Arctic Region. Prepared by The International Council on Clean Transportation for the U.S. Committee on the Marine Transportation System.

2012: Amy Merten (NOAA) requested the ASAMM 1979-2012 database and tracklines for use in Arctic ERMA.

2012: Sadie Wright (NOAA) requested the ASAMM bowhead whale sightings from summer 2012 for use in Noise Exposure Analysis section of the 2013 Arctic Biological Opinion.

2013: Lucy Romeo (OSU graduate student) requested ASAMM beluga data to investigate the association between beluga and arctic cod.
Romeo, L.F. “Spatial distribution and the probability of occurrence of beluga whales (*Delphinapterus leucas*) in Alaskan Arctic.” Master’s thesis, Oregon State University, 2014.

2013: Peter Winsor (UAF) requested near real-time ASAMM marine mammal data to inform decisions on deploying an underwater glider equipped with a passive acoustic monitoring device for recording cetacean vocalizations.

2013: John Brandon (Greeneridge Sciences, Inc.) requested ASAMM bowhead whale sighting data for the Point Franklin-Peard Bay region in summer 2009-2012.

2011, 2012, 2013: Sue Moore (NOAA) requested map of ASAMM gray whale and walrus sighting data from 1982-2013 overlying areas covered by the Distributed Biological Observatory.

April 2014: Craig George (NSB) requested map of ASAMM 2013 bowhead whale calf sighting data.

April 2014: Sue Moore (NOAA) requested map of gray whale data (sightings, calves, feeding) to include in discussions at the IWC Workshop “Rangewide review of the population structure and status of North Pacific gray whale.”

2014: Ying-Chih Fang (UAF) requested ASAMM 2010 bowhead and gray whale sighting data for comparison with surface current data in the Chukchi Sea, obtained from high-frequency radar.

2014: Elizabeth Edwards (NOAA) requested ASAMM fin whale sightings for a summary analysis of fin whale global distribution.

October 2014: Craig George (NSB) requested map of ASAMM 2014 bowhead whale Beaufort Sea sighting data to present at quarterly AEWC meeting.

November 2014: Sue Moore (PMEL) requested map of ASAMM 2014 feeding bowhead whale sightings for presentation at SOAR workshop.

November 2014: Chris Krenz (Oceana) and Nathan Walker (Audubon) requested ASAMM 2013 data. ASAMM data were used to produce various documents including:
Oceana and Audubon Alaska. 2015. Marine Mammal Species Core Area Analysis. Juneau and Anchorage, AK.
Satterthwaite-Phillips, D., C. Krenz, G. Gray, and L. Dodd. 2016. Iñuuniałiqput Iḷiḷugu Nunaŋ̣ ŋ̣uanun (Documenting Our Way of Life with Mapping). Northwest Arctic Borough subsistence mapping project. Chapter 4.

December 2014: Alicia Bishop (NMFS Alaska Regional Office) requested estimates of densities, representing the best available science, for ESA listed species in the northeastern Chukchi Sea. This information is to be used in NMFS AKRO’s consultation with BOEM over a proposed action on Lease Sale 193.

2014-2015: ASAMM historical database was used to determine the best study area for the Arctic Aerial Calibration Experiments (Arctic ACEs), a collaboration among BOEM, US Navy, NOAA, and Royal Dutch Shell.

March 2015: Guy Fleischer (AFSC, RACE division) requested the best available estimates of cetacean densities in the Arctic Large Marine Ecosystem for use in an Environmental Assessment.

May 2015: Craig George (NSB) requested information on historical bowhead whale calf ratios and Sue Moore (NOAA) requested 2014 gray whale sighting and abundance information for presentation at International Whaling Commission Scientific Committee meetings.

July-October 2015: Cetacean, walrus and polar bears sightings were shared with BOEM and Shell for discussion during weekly PSO conference.

September 2015: Craig George (NSB) requested near real-time bowhead sighting information to directly assist with satellite tagging project. Three bowhead whales were tagged northwest of Point Barrow on 2 September using information provided by ASAMM for bowhead locations on 1 September.

October 2015: Kate Stafford (PMEL) requested ASAMM 2015 beluga sighting data for presentation at ABWC meetings to be held in November 2015.

October 2015: Craig George (NSB) requested ASAMM 2015 bowhead whale carcass sighting data. More bowhead whale carcasses were seen in 2015 than in any prior year of ASAMM surveys; speculation is increased killer whale predation.

January 2016: Beth Sharp (Hilcorp Alaska) requested information pertaining to the potential of bowhead whales occurring between the mainland and barrier islands in the Alaskan Beaufort Sea.

March 2016: Steve Okkonen (UAF) and Craig George (NSB) requested information on survey effort and bowhead whale sightings at <50 m and >50 depths in the Barrow area.

July 2016: Raphaela Stimmelmayr (NSB) requested polar bear and brown bear sighting records from the ASAMM database, July-October, 1979-2016.

July 2016: Carin Ashjian (WHOI) and Craig George (NSB) requested maps of bowhead and gray whale transect sightings in the Barrow region for inclusion in an NSF proposal for Long Term Ecological Research.

August 2016: Sadie Wright (NMFS) requested near real-time data on marine mammal occurrence in the area of an oil spill drill near Oliktok Point, Beaufort Sea, AK.

May 2017: Don Dragoo (Chukchi Sea area biologist) and Jeff Williams (Alaska Maritime National Wildlife Refuge Manager) requested photos of Cape Lisburne for use in managing the refuge.

May 2017: Martin Robards (Director, Arctic Beringia Program, Wildlife Conservation Society) requested marine mammal photos to be used in an op-ed in Scientific American highlighting the abundance of marine mammals north of Bering Strait during fall.

June 2017: Lori Quakenbush (ADFG) requested photos of belugas to be used in an education and outreach presentation about aerial surveys.

July 2017: Sue Moore (NOAA PMEL) requested photos and flight track from ASAMM-Beaufort Flight 2, 21 July 2017, to be included in a presentation on the "krill trap" that she will present to vessel operators and participants conducting the fall 2017 Arctic EIS cruise.

July 2017: Raphaela Stimmelmayr (NSB) requested information pertaining to unid shark sightings in 2012 and 2017.

July 2017: Sadie Wright (NMFS AKRO) requested recent data on ASAMM sightings near Northstar Island in the Beaufort Sea, to be used in a hypothetical oil spill response drill.

August 2017: Cleridy Lennert-Cody (Inter-American Tropical Tuna Commission) requested an estimate of the cost of conducting ASAMM surveys to be included in: Lennert-Cody, C.E., S.T. Buckland, T. Gerrodette, A. Webb, J. Barlow, P.T. Fretwell, M.N. Maunder, T. Kitakado, J.E. Moore, M.D. Scott, and H.J. Skaug. Review of potential line-transect methodologies for estimating abundance of dolphin stocks in the Eastern Tropical Pacific. *Paper in review: Journal of Cetacean Research and Management.*

September 2017: Willow Hetrick (Fairweather Science) requested gray whale range data for use in an IHA.

2008-present: Level A stranding reports and photos were sent to NSB, NMFS, and USFWS.
2008-present: Marine mammal photos taken during ASAMM have been shared with numerous entities, including WWF, DFO, NOAA HQ, NSB, APR, and Arctic Sounder.
2010-present: Biweekly maps of ASAMM bowhead whale sightings were sent to BOEM, NMFS, NSB, USFWS, USGS, ADFG, USCG.

NON-MARINE MAMMAL DATA COLLECTED:

April 2012: provided ASAMM sea ice observations made in September and October from 2007-2011 to Warren Horowitz (BOEM) to compare and ground-truth remotely sensed sea ice data. Extracted data, created feature classes for import into Geographic Information System, and stored in a file geo-database.
Distributed sea ice photos and data from 2011-2017 to the following:

- NOAA, National Weather Service and Pacific Marine Environmental Laboratory: Ground-truth remotely sensed data, train staff, and include in presentations
- UAF: Examine sparse sea ice habitat for walruses
- BOEM: Manage and plan open water season activities
- USCG: Navigation
- USFWS: Investigate walrus habitat
- USGS: Sea ice reconnaissance during walrus tagging events
- Alaska Center for Climate Assessment and Policy
- Shell: Develop sea ice predictions for ice management during offshore operations

Sea ice data sent to Tom Weingartner (UAF) in September 2013 to provide information about sea ice coverage in offshore areas where a sea glider was to be launched.
Several meteorological instruments were located on shore and locations relayed to project owners for retrieval.
December 2014: marine debris sightings sent to Peter Murphy, Regional Coordinator of NOAA Marine Debris Program, Office of Response and Restoration.
February 2017: Provided ASAMM sea ice imagery from 2014-2015 to Victoria Hill (Old Dominion University, Department of Ocean, Earth and Atmospheric Sciences) to provide visual information about surface sea ice conditions in locations where buoy data overlap.

WALRUS AND POLAR BEAR COLLABORATIONS WITH USFWS AND USGS (CHRONOLOGICAL):

2009-present: Detailed information on ASAMM walrus and polar bear sightings were provided to USFWS to comply with research permit requirements. These data provide USFWS with information useful in Section 7 consultations required under the US ESA.
2009-present: Provided USGS and USFWS with the earliest and most comprehensive information about mass walrus haulouts located on the northeastern Chukchi Sea coast. USFWS used these data to implement management decisions affecting air traffic near the haulouts. USFWS and USGS use these data to study walrus haulout dynamics over time.
2010-2012: Provided ASAMM walrus sighting data, 1982-2011, to USFWS to investigate its utility in estimating walrus population size.

2011-2015: Multiple reconnaissance flights in July to locate walrus haulouts on offshore sea ice to assist USGS in satellite tagging efforts. Positions of large, small-boat-accessible walrus groups and surrounding ice conditions were relayed to biologists onboard the surface ship, resulting in a considerable cost savings to the government and an efficient use of uniquely qualified field personnel.

2014: Coordinated survey time with Brian Battaile and Chad Jay (USGS) to allow for dedicated overflights of walrus haulout at Point Lay and coastal surveys between Point Barrow and Cape Lisburne specifically for photography of haulouts.

2014: Special Agent Ryan Cote (USFWS Office of Law Enforcement) requested ASAMM archived and future Level As for walrus and polar bears to help investigations into potential criminal matters.

2015: Provided USGS updated information on walrus haulout near Point Lay to assist with their planning for overflights of the haulout using a small drone. The haulout needed to be a minimum of 3 nm from the airport in order for the drone to fly.

2015-2017: Incorporated searches of western Beaufort Sea coastline and barrier islands into flight plans, where possible, to search for polar bears; response to USFWS not conducting their biweekly coastal searches as they have in most recent past years.

2017: Michelle St. Martin (USFWS) requested data on all polar bear sightings from 2008-2016. Also provided all polar bear photographs in the ASAMM photo archive.

2017: James MacCracken and Jonathan Snyder (USFWS), and Anthony Fischbach and Chad Jay (USGS) requested recent photos of the coastal walrus haulout at Point Lay, Alaska.

INCIDENTAL HARASSMENT AUTHORIZATIONS THAT USED ASAMM SIGHTING AND EFFORT DATA FOR MARINE MAMMAL DENSITY CALCULATIONS AND TAKE ESTIMATES (CHRONOLOGICAL):

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a proposed open water seismic program in the Chukchi and Beaufort Seas, Alaska, during 2007.

ASRC Energy Services: Revised request for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a proposed marine survey program in the Chukchi Sea, Alaska, in 2007.

BP Exploration: Request for an Incidental Harassment Authorization pursuant to section 101(A)(5) of the MMPA covering incidental harassment of marine mammals during an OBC seismic survey in the Liberty Prospect, Beaufort Sea, Alaska, in 2008.

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a proposed open water seismic and marine survey program in the Chukchi and Beaufort Seas, Alaska, during 2008-2009.

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a proposed open water marine survey program in the Chukchi and Beaufort Seas, Alaska, during 2009-2010.

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with planned 2010 exploration drilling program near Camden Bay in the Beaufort Sea, Alaska.

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with planned 2010 exploration drilling program, Chukchi Sea, Alaska.

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a proposed open water marine survey program in the Beaufort and Chukchi Seas, Alaska, during 2010.

Statoil: Request for an Incidental Harassment Authorization by Statoil to allow incidental harassment of marine mammals during a 3D marine seismic survey in the Chukchi Sea, Alaska, 2010.

US Geological Survey: Request by US Geological Survey for an Incidental Harassment Authorization to allow the incidental take of marine mammals during a marine seismic survey of the Arctic Ocean, August-September 2010.

Statoil: Request by Statoil for an Incidental Harassment Authorization to allow the incidental take of marine mammals during a shallow hazards survey in the Chukchi Sea, Alaska, 2011.

University of Alaska Geophysics Institute: Request by the University of Alaska Geophysics Institute for an Incidental Harassment Authorization to allow the incidental take of marine mammals during a marine geophysical survey by the R/V Marcus G. Langseth in the Arctic Ocean, September-October 2011.

BP Exploration: Incidental Harassment Authorization request for the non-lethal harassment of whales and seals during the Simpson Lagoon OBC seismic survey, Beaufort Sea, Alaska, 2012.

ConocoPhillips: Application for Incidental Harassment Authorization for the non-lethal harassment of cetaceans and seals during exploration drilling activities in the Devil's Paw Prospect, Chukchi Sea, Alaska, 2012.

Ion Geophysical: Request by ION Geophysical for an Incidental Harassment Authorization to allow the incidental take of marine mammals during a marine seismic survey in the Arctic Ocean, October-December, 2012.

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with planned exploration drilling program during 2012 near Camden Bay in the Beaufort Sea, Alaska.

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with planned exploration drilling program during 2012 in the Chukchi Sea, Alaska.

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a proposed open water marine surveys program in the Chukchi Sea, Alaska, during 2013.

SAExploration: Application for the Incidental Harassment Authorization for the Taking of Whales and Seals in Conjunction with the SAE Proposed 3D Seismic Survey in the Beaufort Sea, Alaska, Summer 2013.

SAExploration: Application for the Incidental Harassment Authorization for the Taking of Whales and Seals in Conjunction with the SAE Proposed 3D Seismic Survey in the Beaufort Sea, Alaska, Summer 2014.

BP Exploration: Incidental Harassment Authorization request for the non-lethal harassment of marine mammals during the Prudhoe Bay OBS Seismic Survey, Beaufort Sea, Alaska, 2014.

BP Exploration: Incidental Harassment Authorization request for the non-lethal harassment of marine mammals during the Liberty Geohazard survey, Beaufort Sea, Alaska, 2014.

SAExploration: Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with the SAE's Proposed 3D Seismic Survey in the Beaufort Sea, Alaska, 2015.

Shell Gulf of Mexico, Inc.: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with planned exploration drilling activities during 2015, Chukchi Sea, Alaska.
Hilcorp Alaska: Incidental Harassment Authorization request for the non-lethal harassment of marine mammals during the Liberty Unit geohazard surveys, Beaufort Sea, Alaska, 2015.
Shell Gulf of Mexico, Inc.: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a planned ice overflight survey program in the Chukchi and Beaufort Seas, Alaska, May 2015-April 2016.
SAExploration, Inc.: Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with the SAE's Proposed 3D Seismic Survey in the Beaufort Sea, Alaska, 2016.
Fairweather LLC: Application for Incidental Harassment Authorization for 2016 anchor retrieval program, Chukchi and Beaufort Seas, Alaska.
Quintillion Subsea Operations, LLC: Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with Proposed Alaska Phase of the Quintillion Subsea Project, 2016.
Hilcorp Alaska: Incidental Harassment Authorization request for non-lethal harassment of marine mammals during Liberty Island construction, Beaufort Sea, Alaska, 2017.
NOAA-OPR: Effects of Oil and Gas Activities in the Arctic Ocean. Final Environmental Impact Statement, 2016.
Quintillion Subsea Operations, LLC: Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with the Quintillion Subsea Operations Cable Project, 2017.
SAExploration, Inc.: Application for the Incidental Harassment Authorization for the Taking of Marine Mammals in Conjunction with the SAExploration Proposed 3D Seismic Survey Beaufort Sea, Alaska, 2017.

PRESS RELEASES AND NEWS ARTICLES (ALPHABETICAL):

Baier, C. "Sentinels of Change: Gray whales in the Arctic." AFSC News. March 29, 2016. http://www.afsc.noaa.gov/News/Sentinel_change_gray_whales.htm
Brower, A. 2017. Evidence for the earliest "krill trap" on record in the western Beaufort Sea. ASAMM blog, August 1, 2017. https://www.afsc.noaa.gov/Science_blog/ASAMM_1.htm.
BOEM. 2013. Partnerships in Science: Research on the Alaska OCS. BOEM Ocean Science Vol. 10 (2). April-May-June. http://www.boem.gov/Ocean-Science-2013-Apr-May-Jun/
Clarke, J. 2017. The kids are alright – bowhead calves in the Alaskan Arctic. ASAMM blog, September 28, 2017. https://www.afsc.noaa.gov/Science_blog/ASAMM_4.htm.
David. "Whale Watching – and More – from a Twin Commander". Flight Levels Online. November 12, 2015. http://flightlevelsonline.com/2015/fall-2015/whale-watching-and-more-from-a-twin-commander/
Dawicki, S. "NOAA Northeast Aerial Marine Mammal Team Flies Alaskan Skies." NOAA Fisheries. October 22, 2012.
DeMarban, A. "Bowhead whale deaths mystify observers." Alaska Dispatch News. Oct 9, 2015.
Dunham, M. "Gray Whale Baby Boom is Noted in Alaska and California." Anchorage Daily News. August 2, 2012.

Feidt, A. “Researchers Describe ‘Jaw-Dropping’ Whale Survey Near Point Hope.” APRN Alaska Public Media. November 26, 2012.
Heimbuch, H. “Chukchi Sea Whale Sightings Wow Researchers.” The Arctic Sounder. December 14, 2012.
Hickey, H. “Whales, Ships More Common Through Bering Strait.” University of Washington. 2013. http://www.washington.edu/news/2014/02/26/whales-ships-more-common-through-bering-strait/
Joling, D. 2008. “Nine polar bears seen in open ocean.” Anchorage Daily News. August 22, 2008.
Joling, D. 2012. “Whale Surveys Spot Killer Whales in Alaska Arctic.” Juneau Empire. September 11, 2012.
Joling, D. 2012. “Large Groups of Orcas Sighted in Arctic Ocean off Alaska.” Anchorage Daily News. November 26, 2012.
Joling, D. 2014. “Estimated 35,000 Walrus Come Ashore in Northwest Alaska.” Alaska Dispatch News. September 10, 2015.
Joling, D. 2014. “35,000 Walrus Come Ashore as Arctic Sea Ice Retreats.” The Christian Science Monitor. October 1, 2014.
Joling, D. 2014. “Estimated 35,000 walrus come ashore in Northwest Alaska.” Alaska Dispatch News. September 10, 2015.
Matheson, F. and M. Ferguson. 2013. “NOAA Scientists Document New Walrus Haulout in Alaskan Arctic.” NOAA Fisheries Press Release. http://www.afsc.noaa.gov/NMML/cetacean/research/Walrus-ASAMM2013.php
NOAA Fisheries. 2013. BOEM Funding and NOAA Science Keep an Eye on Marine Mammals in the Arctic. July 29, 2013. http://www.nmfs.noaa.gov/stories/2013/07/7_29_13aerial_surveys_arctic_marine_mammals.html
NSB Department of Wildlife Management. 2012. New and Interesting this Summer. The Towline Vol 4 (2). Fall 2012.
Oliver, Shady Grove. “Researchers eye marine mammals in offshore surveys.” The Arctic Sounder. August 11, 2017.
Rosen, Y. 2014. “Biologists Spot Huge Gathering of Walruses on Beach Near Point Lay.” Alaska Dispatch News. September 30, 2014.
Rosen, Y. 2016. “Walrus congregation in Northwest Alaska apparently short-lived this year.” Alaska Dispatch News. October 12, 2016.
Sims, C. 2017. Some days are diamonds, some days are stone. ASAMM blog, August 31, 2017. https://www.afsc.noaa.gov/Science_blog/ASAMM_3.htm.
Speegle, J. 2013. “NOAA’s Aerial Surveys of Arctic Marine Mammals: No One Flies Where These Scientists Fly.” NOAA Fisheries Press Release. August 2, 2012.
Speegle, J. 2013. “NOAA’s Aerial Surveys of Arctic Marine Mammals Photograph Walrus Haulout Site – Scientists Call Behavior a New Phenomenon.” NOAA Fisheries News Release. September 30, 2013. http://alaskafisheries.noaa.gov/newsreleases/2013/walrushaulout093013.htm
Walrus coastal haulout media teleconference, 1 October 2014. Organized by Julie Speegle. Scientists interviewed: Megan Ferguson (NOAA), Joel Garlich-Miller (USFWS), and Chad Jay (USGS).

Willoughby, A. 2017. A gray whale in Peard Bay, ASAMM-Chukchi Flight on 28 July 2017. ASAMM blog, August 16, 2017. https://www.afsc.noaa.gov/Science_blog/ASAMM_2.htm.
Willoughby, A. 2017. Belugas – the "where's Waldo?" of the ASAMM study area. ASAMM blog, October 17, 2017. https://www.afsc.noaa.gov/Science_blog/ASAMM_5.htm.
NOAA's most popular Facebook and Instagram posts ever resulted from ASAMM's photos of the 2014 walrus haulout at Point Lay. The Facebook photo reached 700,000 people and the Instagram post had over 1,000 "likes."

PAPERS IN REVIEW (ALPHABETICAL):

Ferguson, M.C. and J.T. Clarke. Detecting spatial variability in the autumn migration of the Bering-Chukchi-Beaufort stock of bowhead whales across the Alaskan Beaufort Sea. *Paper in revision.*

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APPENDIX G: SAFETY and LOGISTICS PLAN, 2017

Aerial Surveys of Arctic Marine Mammals: Safety and Logistics Plan
14 June 2017

The Aerial Surveys of Arctic Marine Mammals (ASAMM) project is co-managed by BOEM and the Alaska Fisheries Science Center (AFSC, NOAA Fisheries), conducted by AFSC, and funded by BOEM. The ASAMM survey area covers the eastern Chukchi and western Beaufort seas, from 140° to 169°W and 67° to 72°N (Figure G-1). The 2017 field season will begin on 1 July and run until approximately 31 October, although field operations may cease a few days early depending on weather conditions in the study area. This safety plan provides information about emergency support services, aviation safety protocols, firearms protocols, and protocols for mitigating risks to project personnel posed by wildlife encounters on the ground.

Emergency Support Services at the ASAMM Bases of Operations

ASAMM will operate from two bases, Utqiaġvik and Deadhorse, located on the North Slope of Alaska (Figure G-1). Lodging in Utqiaġvik will be provided by the King Eider Inn, and lodging in Deadhorse will be provided by MagTec. The Utqiaġvik team will be in the field from 1 July until the end of the field season in late October, and the Deadhorse team will be in the field from 18 July to 11 October. One Turbo Commander, operated by Clearwater Air, Inc., will be stationed at each ASAMM base and will be available to ASAMM under an exclusive use contract for the duration of the Utqiaġvik and Deadhorse field seasons.

The primary emergency support services in Utqiaġvik include 9-1-1, the Samuel Simmonds Memorial Hospital, and the North Slope Borough Search and Rescue (NSB SAR) Department. The hospital is an outpatient unit providing emergency clinic and urgent care, among other things. It is open for emergencies 24 hours a day, and accepts non-emergency walk-ins until 4:30 PM. It is located at 7000 Uula St., and the phone number is 907 852 4611. The NSB SAR crew are well-trained and have well-maintained equipment to provide a rapid response. They are available around the clock at 907 852 0401 and 907 852 2822. At the beginning of the ASAMM field season, ASAMM Project Management, along with at least one of the Clearwater Air pilots, will make contact with the NSB SAR to let them know of our presence and activities, including our aircraft type, call sign, emergency frequencies, contact phone numbers, and map of the study area and survey blocks. This visit has a dual purpose: to introduce our project in the event that we should need assistance and to let NSB SAR know that our aircraft and crew could be available for coordination and assistance should the occasion arise for a SAR effort while we are based in Utqiaġvik.

Medical assistance and emergencies in Deadhorse will be handled by the Fairweather Deadhorse Medical Clinic in the Deadhorse Aviation Center (DAC). The clinic is designed to facilitate medevac air transfers, is outfitted with a trauma room, and provides a full spectrum of acute care, emergency medicine, and first aid. The clinic is open to the public and staffed around the clock, 365 days a year. The clinic is located at the western end of the Deadhorse airport, and their phone number is 907 685 1800. Deadhorse is also served by the North Slope Borough Police, who can be reached by calling 9-1-1.

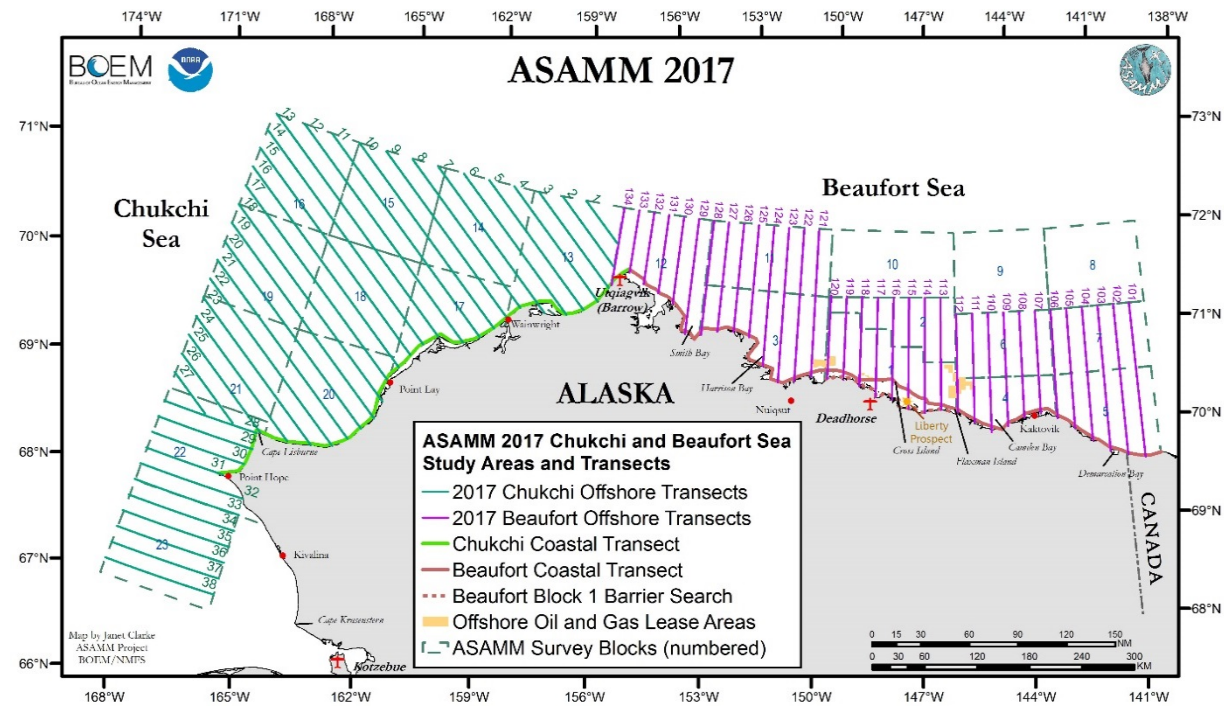

Figure G-1. ASAMM study area and survey blocks with bathymetry, Chukchi Sea and Beaufort Sea coastal transects and 2017 offshore transects, and offshore oil and gas lease areas.

Both Utqiaġvik and Deadhorse are served by commercial jets at least once daily, weather permitting. It is also possible that the ASAMM survey aircraft could be used for an emergency medevac to Anchorage. There are two main hospitals in the Anchorage area, both of which provide emergency services 24 hours a day:

Alaska Regional Hospital	Providence Alaska Medical Center
2801 DeBarr Road	3200 Providence Drive
Anchorage, AK 99508	Anchorage, AK 99508
907 276 1131	907 562 2211

Aviation Safety Protocols

The ASAMM aviation safety protocols are based on training, emergency preparedness, flight following, and reporting, as detailed below.

Training

Each person flying on ASAMM surveys must have a combination of annual, periodic, and one-time trainings.

The ASAMM field teams will ensure that personnel rotating into the field for the first time during the 2017 field season are thoroughly briefed on aircraft operations, have practiced donning the Ice Commander Immersion Suits, and participate in aircraft egress drills. The egress drills will allow each team member the opportunity to practice preparing for and surviving an in-air emergency so that everyone onboard the aircraft knows precisely what their responsibilities

are in an emergency situation. These trainings will review emergency materials, including use of GPS units, satellite phones, PLB, fire suppression bag, fire extinguisher, and aircraft and marine band handheld radios.
The aircraft used during the 2017 season will include Turbo Commander (twin turbine, high fixed-wing) aircraft used during previous ASAMM field seasons. All of the Clearwater Air Pilots in Command (PIC) have previously flown ASAMM surveys from 2011 to 2016. The Clearwater Air Pilots in Command have an average of over 8500 hrs flying experience and considerable experience flying small aircraft in arctic Alaska. Clearwater PICs also conduct a comprehensive Flight Risk Assessment (Figure G-2) as part of survey planning, which incorporates inputs about crew, environment, operations, and aircraft, and allows for inputs from aircraft management.

NOAA's aviation safety policy is available online: (https://sites.google.com/a/noaa.gov/omao-intranet-dev/operations/hq/safety/aviation-safety/safety-training). Annual training for personnel participating in NOAA aerial surveys includes reviewing three of NOAA's aviation safety modules: 1) NOAA Aviation Policy and Procedures; 2) Basic Aviation Safety and Survival; and 3) Aviation Health. In addition, NOAA requires all personnel participating in aerial surveys to complete a water ditching, safety, and survival course once every 5 years; AFSC policy is more stringent, requiring this training once every 3 years due to the remote and harsh environments that our field teams operate in. ASAMM follows AFSC's guidelines for ditching certification. Aerial survey personnel may optionally be trained in the use of helicopter emergency egress devices. Aerial survey personnel must be current in first aid and CPR training. Finally, all aerial survey personnel who conduct NOAA operations in cold environments must have training in aviation safety and cold weather survival.

Under NOAA policy, one-time flights are possible for non-egress-trained individuals ("VIPs") and must be pre-approved by ASAMM Project Management, a NMFS Aviation Safety Officer (Dave Withrow or Megan Ferguson), and Clearwater Air. Individuals requesting to participate in an ASAMM survey must have a mission-applicable reason (e.g., representatives from the NSB, BOEM, NMFS, ADF&G, USGS). Survey flights will not be altered to suit the needs of VIPs (e.g., flying to specific areas for sightseeing), and all VIPs must be made aware that the flight may last in excess of five hours.

Emergency Preparedness
Emergency preparedness for survey flights will be achieved by wearing appropriate clothing, maintaining and having access to necessary emergency gear, being knowledgeable about aviation safety risks, feeling comfortable voicing safety concerns, and having reliable protocols in place that will be followed in the event of an emergency.

During ASAMM surveys, all personnel onboard the aircraft will wear either flight or dry suits and be outfitted with Switliks or other personal floatation devices containing emergency equipment. Onboard safety equipment will include an impact-triggered emergency locator transmitter (ELT) installed in the aircraft, an 8-person search and rescue life raft equipped with an emergency survival kit, PLB, portable marine and aviation band transceivers, satellite telephones, flares, immersion suits, and helicopter emergency egress devices. The emergency satellite telephones and radios will be charged and tested at the beginning of each month during

Risk Assessment Template.xlsx

Clearwater Air
Flight Risk Assessment

Multi-Engine IFR

PIC: **SIC:** **Aircraft:** **Date:**

For single pilot operations use score in parenthesis.

Crew				Total
≤ 10 Hrs in last 30 days		1(3)	1	1
≤ 2000 hrs TT			1	0
≤ 200 hrs in type		2(4)	1	0
Fatigue (Less than 8 hours of sleep)		2(4)	1	0
Divorce / Separation / Death		2(4)	1	0
Illness requiring medication		2(4)	1	0
Crew Total				1

Aircraft			
Inoperative Instruments (MEL)		1	0
Max Gross T/O Weight		2	2
Aircraft Hangared		-2	0
Preflight deicing required		2	2
Weight and Balance Completed		-1	-1
Aircraft Total			3

Environment			
Departure: Vis ≤3 Miles		3	3
Departure: Vis 3-5 Miles		1	0
Icing Conditions Forecast		2	2
Ice on Runway		2	0
Arrival:Precision Approach Available		-2	-2
Fog in Forecast		3	3
Wind ≥ 20 knots		2	2
Arrival Forecast: ≤ Special VFR		4	0
Arrival: Vis ≤ 3 miles		2	0
Arrival Forecast: Night		2	0
Alternate Forecast: Wx ≤ 5mile vis		4	4
Enviroment Total*			12

***If Enviroment total score is ≥15 weather observer must be used.**

Grand Total	**27**
Go	≤23
Manager Approval	23-34
NO GO	>34

PIC Initials: ____________________

Operations			
2nd Survey Flt of the day (≥5.5 Hrs)		3	0
Late departure (after 5pm)		2	0
Reposition Flight		1	0
Max Endurance Survey Flight		3	3
Survey Altitude ≤ 500 ft		4	0
Offshore ≥ 50 miles		3	3
Circling on Target required		2	2
Near/Over Mountainous Terrain		2	0
New Survey Type		1	0
Slow Flight Required ≤ 115kts		3	3
Remote Fueling		2	0
Operations Total			11

Figure G-2. Clearwater Air's Flight Risk Assessment, which is completed prior to every ASAMM survey flight.

the field season. All safety gear will be maintained and inspected according to the manufacturer's instructions.

Safety is everyone's responsibility. Aerial survey team members are encouraged to ask questions or voice concerns if they notice any potential safety hazards. Any team member has the right to "call" (i.e., abort) a flight based on questionable weather conditions or other safety considerations.

Every survey flight will be satellite-tracked in real-time by the Automated Flight Following (AFF) system via SpiderTracks. AFF is software that automatically tracks the location and velocity of specially equipped aircraft, providing this information in near-real-time to dispatchers, aviation managers, and other authorized users. The equipment includes geolocation and data communication devices that use satellite-based technology. As in 2013-2016, the aviation dispatchers from the Alaska Fire Service, Bureau of Land Management, will provide real-time flight following assistance to the project.

Aviation Safety Reporting

Two types of safety reporting mechanisms may be used by ASAMM personnel: SAFECOM reporting is a tool that is maintained by the Department of Interior, and Clearwater Air has their own Safety Management System in place. ASAMM personnel have been instructed that, in the event of an incident, hazard, maintenance, or airspace issue, ASAMM Project Management should be informed immediately.

Department of Interior agencies require that aviation mishaps be reported to the Aviation Safety Communique (SAFECOM) database. Categories of reports include incidents, hazards, maintenance, and airspace. The system uses the SAFECOM Form AMD-34/FS-5700-14 to report any condition, observation, act, maintenance problem, or circumstance with personnel or the aircraft that has the potential to cause an aviation-related mishap. The SAFECOM system is not intended for initiating punitive actions. Submitting a SAFECOM is not a substitute for "on-the-spot" correction(s) to a safety concern. It is a tool used to identify, document, track, and correct safety related issues. A SAFECOM does not replace the requirement for initiating an accident or incident report. The main reporting to SAFECOM is generally by the pilots; however, reporting by observers may also be required at the request of the NOAA Aviation Safety Officer(s), or BOEM representatives. ASAMM Project Management will coordinate with observers, pilots, NOAA Aviation Safety Officer(s), and BOEM representatives to determine the best course of action. The SAFECOM website (https://www.safecom.gov) includes more information; a completed SAFECOM form can be found at https://www.safecom.gov/searchone.asp?ID=16510.

Clearwater has implemented an online Safety Management System for reporting any safety, security, quality, compliance, or environmental concerns that may arise during the season, which is accessible via a link on the Safety tab on Clearwater's webpage (www.clearwaterair.com). Clearwater management encourages ASAMM personnel to utilize this tool to address any aviation safety concerns. The link for reporting concerns can be found at http://clearwatersms.com/MySafety/PublicIssueReporting.aspx.

During an ASAMM flight, if a safety orange object (e.g., life vest, raft, streamer) is sighted or if people are sighted and there is suspicion that they might be in distress (e.g., in the middle of nowhere, waving their arms; smoke signals), ASAMM personnel are instructed to take the following steps:

1) Make a comment in the data to note the position and time of sighting, and include a brief description of what was seen. The pilots will also mark the position on their GPS and, if it is clear that it is an emergency, they will report the sighting to Flight Service.
2) Circle to try to get more information about whether it likely represents a genuine emergency. Descend to a lower altitude and take photographs to get a better look at the scene, if necessary.
3) If it is an emergency and people are in distress:
    a) Contact NSB Search and Rescue, who have an established protocol for dealing with these situations.

b) If the survey aircraft has enough fuel to continue circling, do so. For as long as safety will allow, stay in visual contact with the people in order to update rescuers on the location and status of the emergency.

c) Try to make contact via marine band radio.

4) DO NOT take any measures that would jeopardize the safety of the survey team.

FIREARMS

The ASAMM project does not provide firearms and no personal observer firearms are allowed on the survey aircraft. Clearwater Air's pilots may use their discretion regarding whether they bring personal firearms onto the plane. The King Eider Inn allows firearms in their establishments, but with caution. They ask that the firearms stay unloaded and locked or stowed away while in the hotel. MagTec does not allow personal firearms.

GROUND SAFETY AND BEAR AWARENESS

The North Slope is home to two bear species, polar bears and brown bears. Awareness of their presence and behavior is important for personal safety. Each ASAMM team has bear deterrent devices for carrying during survey flights or when on the ground. Devices include bear bangers and air horns. Situational awareness is the best form of defense. ASAMM provides field personnel with access to a Bear Awareness and Defense Training Manual on the survey laptops. In Utqiaġvik, polar bear sightings are common along the beach and, on occasion, in town. While walking around town it is important to remain aware of surroundings and places to take cover, including flagging down anyone in a vehicle. The King Eider managers usually hear the latest on if/where bears are present. If ASAMM personnel think a bear has gone undocumented, they will report it to the NSB Department of Wildlife Management.

Brown bears are year-round residents in the Deadhorse area and are frequently seen around the camp dumpsters. Walking around Deadhorse is frowned upon, due to the bear presence, industrial activity, and truck traffic in the area. Polar bears are rarely sighted in Deadhorse, are far less habituated to human activity, and may be far more aggressive than resident brown bears. If ASAMM personnel observe any bears anywhere in Deadhorse, they will immediately report the sighting to the NSB police located in SA-10 or to camp managers.

CONTACT INFORMATION

ASAMM Project Management maintains an updated list of emergency contact information for all NOAA employees and contractors participating in ASAMM surveys. Additional emergency contact information is provided in the ASAMM master contact list, which is distributed to all ASAMM personnel.

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APPENDIX H: ASAMM PRODUCTS and WHY BOEM NEEDS THEM

The Aerial Surveys of Arctic Marine Mammals project provide data that are critical to addressing management concerns in near-real time and aid in future planning. Without current, reliable data, BOEM will be vulnerable to litigation and BOEM's ability to make management decisions about future anthropogenic activities in this region during summer and fall will likely be delayed. The columns of Table H-1 identify ten management concerns that ASAMM data have addressed in the past and can address in the future, depending on which field season scenario, presented in the rows of the table, is implemented. Each of the management concerns is described below.

1. Summer bowhead whale distribution and density (number of animals per area) in the western Beaufort Sea can be reliably obtained only through aerial surveys conducted in the western Beaufort Sea during summer. This information is needed to generate estimates of the number of bowhead whales that are likely to be affected by future anthropogenic activities that are proposed to occur in the western Beaufort Sea during summer. This information is required by BOEM to fulfill the Agency's obligations under the NEPA, the MMPA, and the ESA.
2. Fall bowhead whale distribution and density (number of animals per area) in the western Beaufort Sea can be reliably obtained only through aerial surveys conducted in the western Beaufort Sea during fall. This information is needed to generate estimates of the number of bowhead whales that are likely to be affected by future anthropogenic activities that are proposed to occur in the western Beaufort Sea during fall. This information is required by BOEM to fulfill the Agency's obligations under the NEPA, the MMPA, and the ESA.
3. Fall bowhead whale distribution and density (number of animals per area) in the northeastern Chukchi Sea can be reliably obtained only through aerial surveys conducted in the northeastern Chukchi Sea during fall. This information is needed to generate estimates of the number of bowhead whales that are likely to be affected by future anthropogenic activities that are proposed to occur in the northeastern Chukchi Sea during fall. This information is required by BOEM to fulfill the Agency's obligations under the NEPA, the MMPA, and the ESA.
4. Summer gray whale distribution and density (number of animals per area) in the northeastern Chukchi Sea can be reliably obtained only through aerial surveys conducted in the northeastern Chukchi Sea during summer. This information is needed to generate estimates of the number of gray whales that are likely to be affected by future anthropogenic activities that are proposed to occur in the northeastern Chukchi Sea during summer. This information is required by BOEM to fulfill the Agency's obligations under the NEPA and the MMPA.

Table H-1. Management concerns that ASAMM data can address and the field season scenarios required to obtain the necessary data.

Management Concerns	Bowhead Whale Density, W Beaufort Sea, Summer	Bowhead Whale Density, W Beaufort Sea, Fall	Bowhead Whale Density, NE Chukchi, Fall	Gray Whale Density, NE Chukchi Sea, Summer	Gray Whale Density, NE Chukchi Sea, Fall	Beluga Density, W Beaufort Sea, Summer	Beluga Density, W Beaufort Sea, Fall	Seasonal Cetacean Density, SC Chukchi Sea Benthic Hotspot/DBO3 Area	Walrus Distribution, NE Chukchi Sea during Ice Recession	Polar Bear Distribution in NE Chukchi and W Beaufort Seas during Ice Recession
Field Season Scenario										
Full Field Two Aircraft (Chukchi and Beaufort) July-October	x	x	x	x	x	x	x	x	x	x
Partial Field One Aircraft (Chukchi focus) July-October			x	x	x			x	x	only Chukchi
Partial Field One Aircraft (Beaufort focus) July-October	x	x				x	x			only Beaufort
Minimal Field One Aircraft (Chukchi focus) mid-August-October			x		x			only fall	x	only Chukchi in fall
Minimal Field One Aircraft (Beaufort focus) mid-August-October		x					x			only Beaufort in fall

5. Fall gray whale distribution and density (number of animals per area) in the northeastern Chukchi Sea can be reliably obtained only through aerial surveys conducted in the northeastern Chukchi Sea during fall. This information is needed to generate estimates of the number of gray whales that are likely to be affected by future anthropogenic activities that are proposed to occur in the northeastern Chukchi Sea during fall. This information is required by BOEM to fulfill the Agency's obligations under the NEPA and the MMPA.
6. Summer beluga distribution and density (number of animals per area) in the western Beaufort Sea can be reliably obtained only through aerial surveys conducted in the western Beaufort Sea during summer. This information is needed to generate estimates of the number of belugas that are likely to be affected by future anthropogenic activities that are proposed to occur in the western Beaufort Sea during summer. This information is required by BOEM to fulfill the Agency's obligations under the NEPA and the MMPA.
7. Fall beluga distribution and density (number of animals per area) in the western Beaufort Sea can be reliably obtained only through aerial surveys conducted in the western Beaufort Sea during fall. This information is needed to generate estimates of the number of belugas that are likely to be affected by future anthropogenic activities that are proposed to occur in the western Beaufort Sea during fall. This information is required by BOEM to fulfill the Agency's obligations under the NEPA and the MMPA.
8. The southcentral Chukchi Sea is a "benthic hotspot," where high densities of cetaceans, including gray, fin, humpback, and minke whales and harbor porpoise, are found. The seasonal distribution and density of these species in this region can be reliably obtained only through aerial surveys conducted in the region during the season in question. This information is required by BOEM to fulfill the Agency's obligations under the NEPA, the MMPA, and the ESA.
9. Since 2007, summer sea ice in the northeastern Chukchi Sea has receded from primary walrus feeding areas in the northeastern Chukchi Sea, and the animals have hauled out in most years in large groups numbering up to tens of thousands of animals near villages on the northwestern Alaskan coast. These massive coastal haulouts are located far from walruses' primary prey, resulting in additional energetic costs to the animals to feed. Aerial surveys are the only existing method for assessing walrus distribution and density in the northeastern Chukchi Sea during sea ice recession in summer. This information is required by BOEM to fulfill the Agency's obligations under the NEPA and the MMPA, and will become an obligation under the ESA if the species is listed as Threatened or Endangered.
10. Polar bears occupy sea ice and coastal habitat in the northeastern Chukchi and western Beaufort seas year-round. The period of sea ice recession in the summer is a critical period for polar bears because they use the ice as a platform from which to hunt. Polar bear distribution and density in these regions during the open water season can be monitored by aerial surveys. This information is required by BOEM to fulfill the Agency's obligations under the NEPA, MMPA, and ESA.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under US administration.

The Bureau of Ocean Energy Management

As a bureau of the Department of the Interior, the Bureau of Ocean Energy (BOEM) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS) in an environmentally sound and safe manner.

The BOEM Environmental Studies Program

The mission of the Environmental Studies Program (ESP) is to provide the information needed to predict, assess, and manage impacts from offshore energy and marine mineral exploration, development, and production activities on human, marine, and coastal environments.