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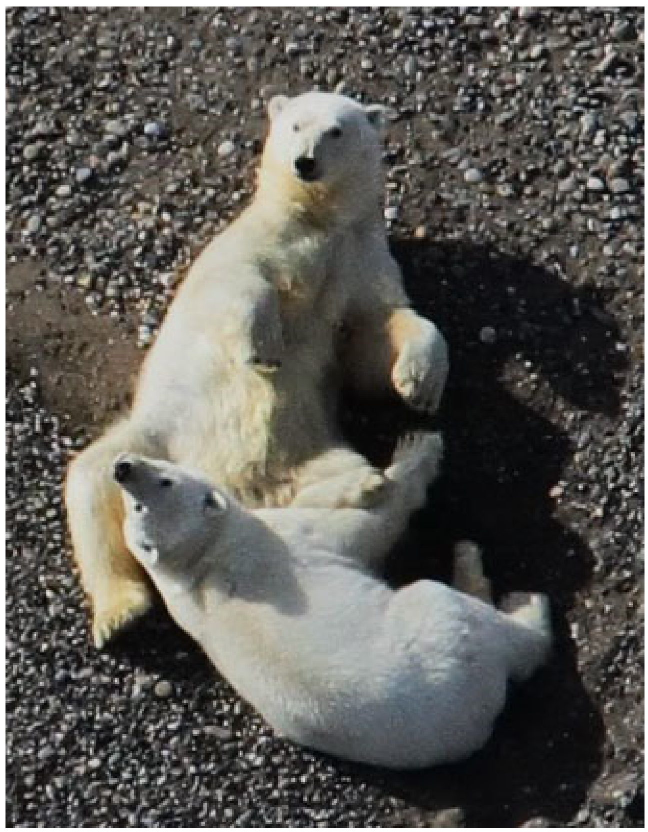
BOEM 2017-078

Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2016 Annual Report



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Pair of polar bears on a barrier island in the Sagavanirktok River, Alaska
August 2016
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Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2016 Final Report

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Prepared under Interagency Agreement M16PG00013

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DISCLAIMER

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Arctic research necessarily relies on cooperation and timely sharing of information to ensure safe and successful operations. We appreciate the cooperation of the agencies, individuals, and entities who assisted or coordinated with the ASAMM team in 2016, including Craig George and Robert Suydam (NSB); Amy Kennedy (Joint Institute for the Study of the Atmosphere and Ocean); King Eider Inn; MagTec; Brooks Camp; Mike Aguilar, Mike Gomez, Matt Parker, and Jake Weber (Precision); Steve Wackowski and Sheyna Wisdom (Fairweather Science); Kevin Doremus, Alex Johnston, and Lindsey Norman (NOAA Aircraft Operations Center); and the crews of the RV *Norsemen II* and the *Aquila*.

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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–31 October) 2016, and data and analyses used to summarize field activities. Surveys were based in Barrow, Alaska, and Deadhorse, Alaska, and targeted the northeastern and southcentral Chukchi and western Beaufort seas, between 67°N and 72°N latitude and 140°W and 169°W longitude. Between 19 July and 20 August, surveys extended up to 111 km north of the usual ASAMM study area to collect information specific to the Eastern Chukchi Sea (ECS) stock of belugas.

Sea ice cover in the study area in 2016 was generally light compared with historical (pre-2007) sea ice cover. When surveys commenced in early July, sea ice remained north of 70°N, and persisted though early August. By late August, sea ice remained near Hanna Shoal, but was otherwise absent from the study area. The remnant sea ice near Hanna Shoal shifted location through late September, moving closer to Point Barrow and into the westernmost Beaufort Sea, and was completely absent by mid-October. By late October, new ice was forming in shallow nearshore areas in the study area.

A total of 108 survey flights were conducted. The Barrow-based aerial survey team conducted surveys from 2 July through 26 October 2016, and the Deadhorse-based aerial survey team conducted surveys from 19 July through 10 October 2016. Total combined flight time was 536.7 hours, including 265.5 hours of transect effort. Over 135,000 km were flown, with 59,291 km of effort on transect. Surveys were conducted in the western Beaufort Sea in summer (mid-July through August) for the fifth consecutive year and in survey block 23 (southcentral Chukchi Sea) for the third consecutive year.

There were 4,286 sightings of 37,430 marine mammals observed during all (transect, search, and circling) survey modes, including:

- 950 sightings of 1,859 bowhead whales (*Balaena mysticetus*),
- 445 sightings of 1,130 gray whales (*Eschrichtius robustus*),
- 13 sightings of 26 humpback whales (*Megaptera novaeangliae*),
- 12 sightings of 17 fin whales (*Balaenoptera physalus*),
- 14 sightings of 16 minke whales (*Balaenoptera acutorostrata*),
- 364 sightings of 1,841 belugas (*Delphinapterus leucas*),
- 5 sightings of 30 killer whales (*Orcinus orca*),
- 10 sightings of 16 harbor porpoises (*Phocoena phocoena*),
- 36 sightings of 43 unidentified cetaceans,
- 817 sightings of 27,755 Pacific walruses (*Odobenus rosmarus divergens)*,
- 21 sightings of 21 bearded seals (*Erignathus barbatus*),
- 1 sighting of 1 ribbon seal (*Histriophoca fasciata*),
- 1,509 sightings of 4,361 unidentified pinnipeds, and
- 89 sightings of 314 polar bears (*Ursus maritimus*).

A record number of bowhead whales were observed in 2016. Bowhead whales were seen in all months of the study period and their distribution changed throughout the season. Distribution in the western Beaufort Sea (140°W-157°W) in July was primarily on the outer continental shelf

(51-200 m depth), shifted to extremely shallow water (≤20 m) in August, then became progressively farther offshore 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, ≤20 m depth zone in August, 21-50 m depth zone in September, and 51-200 m depth zone in October. Sighting rate by depth zone in the Barrow Canyon area (154°W-157°W) was highest in the 21-50 m depth zone in August and September and in the 51-200 m depth zone in October; bowhead whales were not seen in this area in July. Compared to previous years with light sea ice cover (i.e., 1989, 1990, 1993-2015), bowhead whale sightings (not normalized by survey effort) in the western Beaufort Sea in fall (September-October) were significantly farther offshore and in deeper water in the West (148°W-156°W) region, with no significant differences in the East (140°W-148°W) region. Bowhead whale sightings in the West region in summer (July-August) 2016 were significantly closer to shore and in shallower water than bowhead whale sightings in fall 2016, which is the exact opposite of observations from 2012-2015. In the northeastern Chukchi Sea, few bowhead whales were seen in July and August. The highest sighting rate in the northeastern Chukchi Sea 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, block 3 in August, block 4 in September, and block 11 in October. The eastern Chukchi Sea survey block with the highest overall sighting rate was block 14.

Spatial models of bowhead whale relative abundance in the western Beaufort Sea were created to examine high-use areas (HUAs) during fall (September-October) 2016 and each month from July through October for the 17-year period from 2000 to 2016. These models accounted for heterogeneous survey effort and group sizes across the survey area. The spatial model for fall 2016 suggested that the median distribution of bowhead whales was located approximately 30 km closer to shore in the East Region compared to the West Region. Furthermore, the estimated median distance from shore in the West Region in fall 2016 was approximately twice as far offshore compared to the 17-year time series. The spatial model for 2000-2016 suggested that the bowhead whale High Use Are (HUA) was located farthest from shore in July compared to August, September, and October.

Sightings of feeding or milling bowhead whales were particularly noteworthy due to notable presences and absences. A large group of feeding and milling bowhead whales was observed in late August in Harrison Bay between Oliktok Point and Cape Halkett (approximately 150°W to 152°W), an area where bowhead whale feeding has not commonly been observed. Feeding and milling were observed in other areas of the western Beaufort Sea, including Camden Bay and near Kaktovik, Alaska, but relatively few were seen immediately east of Barrow. Oceanographic conditions in summer and fall 2016 were not conducive to producing a “krill trap” that fosters bowhead whale feeding in that area.

One hundred four bowhead whale calves were seen in 2016, including 45 calves seen during July and August in the western Beaufort Sea. The summer bowhead whale calf ratio (number of calves/number of total whales) was lower than summer calf ratios in 2012-2015. The fall bowhead whale calf ratio was the second highest ASAMM has recorded from 1982 to 2015.

Gray whales were seen in all months of the study period in the northeastern Chukchi Sea. Gray whale aggregations 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 50-125 km offshore, including just south of Hanna Shoal, similar to observations in 2015. 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. Two gray whales were seen repeatedly within the confines of Peard Bay, representing the first sightings of gray whales within the bay in the history of ASAMM. 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 and September, and the lowest sighting rate by month was in August. Most gray whales observed (69%) were feeding. One hundred thirty-six gray whale calves were seen, and results from a pilot study investigating gray whale calf resighting rate using photographic images indicated that most calf sightings were of unique individuals.

Additional noteworthy results from the 2016 ASAMM field effort included:

- Surveys were conducted farther north than normal to incorporate deeper-water beluga habitat. In July and August, belugas were observed on the Beaufort Sea slope, beyond the 3,000-m isobath, and in Barrow Canyon. Belugas were almost completely absent in the study area in September and October, producing one of the lowest sighting rates since 1989.
- Humpback whales (13 sightings of 26 whales), including three calves, were sighted in the eastern Chukchi Sea in August and September.
- Fin whales (12 sightings of 17 whales) were sighted in the southcentral Chukchi Sea in August.
- Minke whales (14 sightings of 16 whales) were sighted in the eastern Chukchi Sea in August and September.
- Killer whales (5 sightings of 30 whales), including five calves, were sighted in the northeastern Chukchi Sea on three days in September. Photographic image analysis indicates that the sightings were likely of unique animals.
- Harbor porpoises (10 sightings of 16 porpoises) were sighted in the southcentral Chukchi Sea in July and August, and represent the first sightings of harbor porpoises in this area by ASAMM surveys.
- Walruses were observed in the water and hauled out on ice (particularly near Hanna Shoal) and on land. A walrus haulout, with an estimated maximum group size of 7,500 animals, was observed on a barrier island near Point Lay in early October, and is the latest date for haulout formation on land in the northeastern Chukchi Sea since that phenomena began in 2007.
- One ribbon seal was seen in mid-September northwest of Point Franklin.
- The sighting rate for unidentified pinnipeds (including small unidentified pinnipeds) in the ASAMM study area was the highest recorded since 2009.
- Polar bears were seen from Point Franklin, Alaska, on the Chukchi Sea coast to Demarcation Point, Alaska, on the Beaufort Sea coast. In the Chukchi Sea, polar bears were seen offshore on sea ice, on or within 2 km of shore, and one polar bear was seen swimming in open water approximately 145 km from shore. In the Beaufort Sea, most

polar bears were observed within 2 km of shore or barrier islands. One polar bear was swimming in open water approximately 85 km from shore.

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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
BS	Beaufort Sea
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)
CSPA	Chukchi Sea Planning Area
ECS	Eastern Chukchi Sea
e.g.	for example
ESA	Endangered Species Act
FR	Federal Register
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
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 aircraft 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 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. The Secretary also designated the Conservation Division of the U.S. Geological Survey (USGS) responsible 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.

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 is summarized here. 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 and authorizations of small takes under the Marine Mammal Protection Act (MMPA) (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 (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.

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 of 1972 (16 USC 1361-1407) 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 CSPA 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, 2017). 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;
2) In consultation with BOEM in 2016, identify critical management issues that should be addressed using the ASAMM data in the near future; conduct statistical analyses to provide

recommendations to BOEM on the level of ASAMM survey effort required to address those management issues;

3) Describe the annual migration of bowhead whales across the Alaskan Arctic, including inter-annual variability or long-term trends in the spatial distribution and timing of the migration;
4) Provide near real-time data or derived products, such as graphical data summaries, on marine mammals and environmental conditions in the Alaskan Arctic to BOEM and NMFS;
5) 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
6) Provide an objective wide-area context for understanding marine mammal ecology in the Alaskan 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 all active federal oil and gas lease areas in the Alaskan Arctic, all of which are in the Beaufort Sea (Figure 1). The study area also encompassed 98% of the Alaskan Chukchi Sea federal oil and gas lease areas that were part of Lease Sale 193; those leases were relinquished by the oil and gas industry by spring 2016 and are no longer considered active. 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. In 2016, surveys were also conducted up to 111 km north of the ASAMM study area (Figure 1) to collect data on the Eastern Chukchi Sea (ECS) stock of belugas.

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. In summer, currents are much stronger and may flow either east or west with the prevailing winds. 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

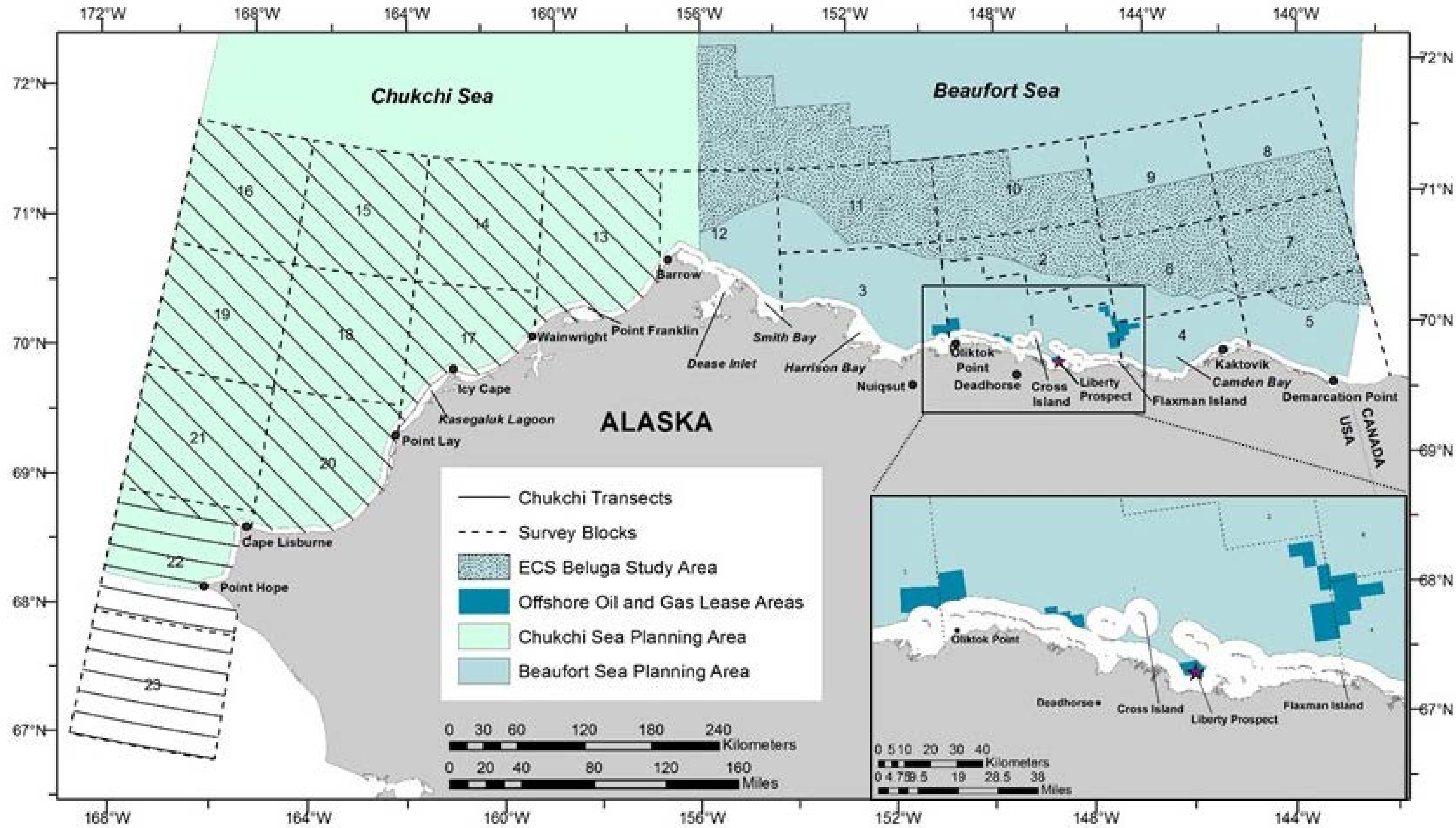


Figure 1. ASAMM study area showing survey blocks, 2016 ASAMM Chukchi Sea transect lines, Eastern Chukchi Sea (ECS) beluga survey area, Chukchi Sea Planning Area, Beaufort Sea Planning Area, Liberty Prospect (inset), and active lease areas. Transect lines in the Beaufort Sea are generated daily and, therefore, not shown.

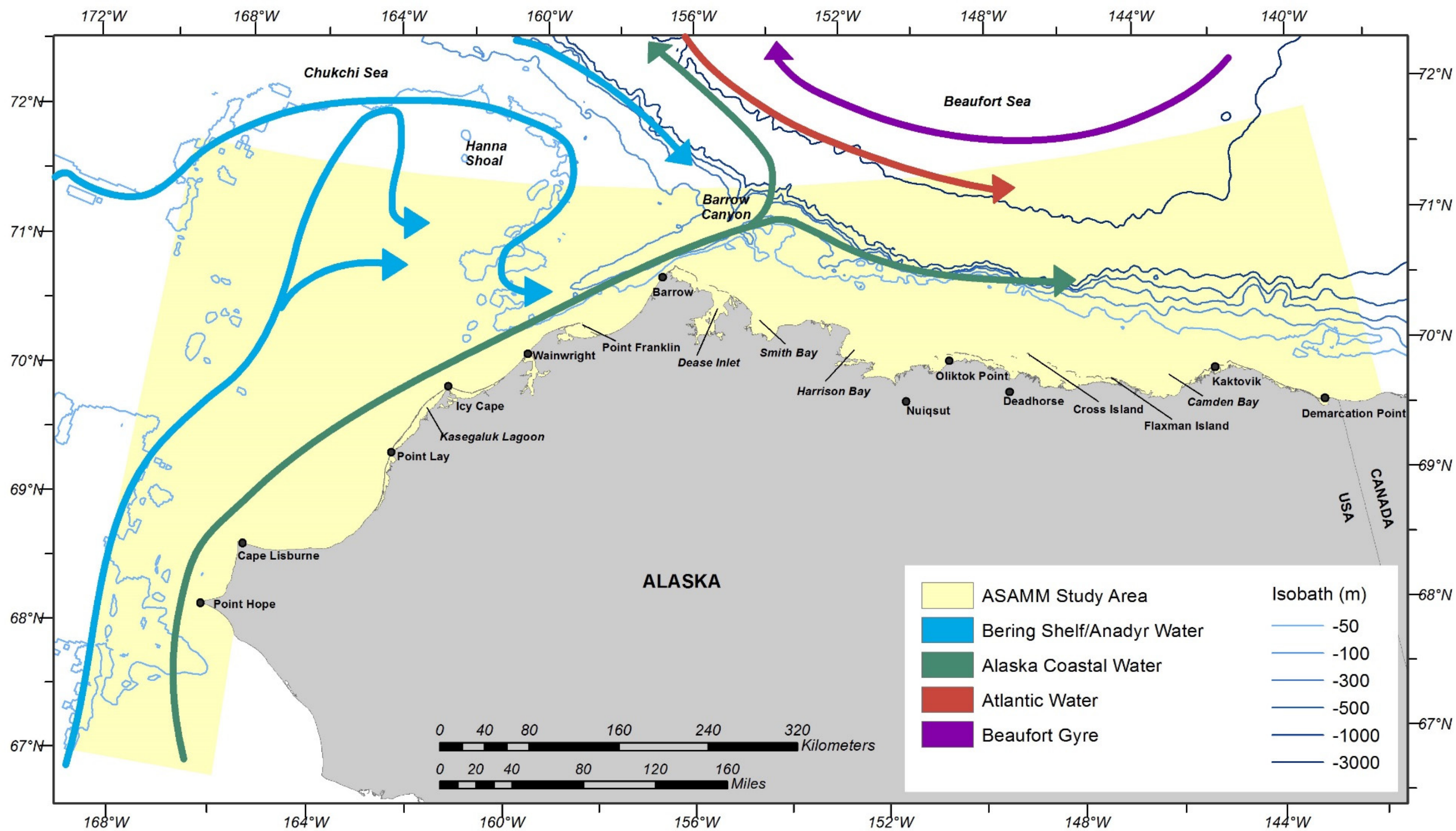


Figure 2. Eastern Chukchi Sea and western Beaufort Sea oceanographic features. Adapted from Citta et al. (2015) and Pickart et al. (2017).

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 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 2007-2015 (National Snow and Ice Data Center 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015). 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 all 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 Barrow 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 Barrow from 1979-2014. 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 Barrow 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 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 were flown in Turbo Commander aircraft, provided by Clearwater Air, Inc., and were conducted with highest regard for flight safety. Observers and pilots were linked with a common communication system. The maximum time aloft in the Turbo Commander was approximately 6 hours, including fuel reserve. Onboard safety equipment included 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, and immersion suits. All personnel participating in the surveys underwent safety trainings, were thoroughly briefed on aircraft operations, and participated in aircraft egress drills. All personnel wore either flotation or dry suits and were 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 were included in a Safety and Logistics Plan (Appendix G).

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

The USDOI, Bureau of Land Management, Alaska Interagency Coordination Center, South Zone Dispatch, used Automated Flight-Following for real-time satellite-tracking of project aircraft. Dispatch personnel monitored current flight status via maps, and hourly updates were communicated from the aircraft to Dispatch via Iridium satellite phones. In addition to these flight-following protocols, onboard transponders were 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 (1979-2015). 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, 2017).

Aerial Survey Design

Surveys were divided into two study areas for logistical reasons and to address objectives specific to each area. Aerial surveys were based out of Barrow to target the eastern Chukchi Sea study area and out of Deadhorse to target the western Beaufort Sea study area. Note that the city of Barrow voted to return to using its traditional Inupiat name, Utqiaġvik, in October 2016, and the name change was approved by the State of Alaska in December 2016. Because the name of the community was Barrow throughout the 2016 field season, we will retain use of that name in this report.

The field schedule was designed to maximize survey effort during the open water time 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 were oriented perpendicular to the coastline to cross major bathymetric features, such as Barrow Canyon, Hanna Shoal, and the Beaufort Sea shelf and slope, and bowhead whale and beluga migration paths. Survey design differed slightly between the two study areas.

In the western Beaufort Sea (140°W-157°W), the survey design focused on survey blocks to maintain consistency with the flight planning protocol established in the Beaufort Sea component of ASAMM in the 1980s. Sets of unique transects were computer-generated prior to each flight for each survey block or set of 2-3 survey blocks (for blocks oriented together on a north-south axis). Transects were derived by dividing each survey block into sections that were 30 minutes of longitude across. One of the minute marks along the northern edge of each section was selected at random and then connected by a straight line to a randomly selected endpoint along the southern edge of the same section. This procedure was followed for all sections of the survey block, resulting in a series of transect lines. The transect lines were then alternately connected at their northernmost or southernmost ends to produce one continuous flight path within each survey block. Transect waypoints were randomly generated before each survey, so that different parts of the survey block were covered on each flight. Allocations of survey effort in the Beaufort Sea favored 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). The purpose of these survey-effort allocations was to increase the sample size of bowhead whale sightings within high-use areas (HUA), thus increasing the power of statistical analyses within inshore blocks.

In 2016, transects extended north of blocks 1 through 7, 11, and 12 to conduct surveys specifically for ECS belugas, which increased the study area by approximately 11,500 km^2. Transects extended to 73°N between 155°W and 156°W, 72.75°N between 154°W and 155°W, 72.5°N between 152°W and 154°W, 72.3°N between 151°W and 152°W, 72°N between 148°W and 151°W, 71.75°N between 146°W and 148°W, and 71.5°N between 140°W and 146°W (Figure 1), to better incorporate beluga habitat in the western Beaufort Sea.

In the eastern Chukchi Sea study area (157°W-169°W), 40 transects were generated once at the beginning of the field season and then flown for the duration of the field season (Figure 1). Transects were parallel to each other and spaced 19 km apart to be consistent with the mean distance between transects in the Beaufort Sea study area. The coastal endpoints for the set of Chukchi Sea transects are randomly shifted each year, while maintaining a consistent orientation to the coast. 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 eastern Chukchi Sea study area when multiple years of effort are pooled. The survey design also included a coastal transect located 1 km offshore between Point Barrow and Point Hope, Alaska. The coastal transect allowed better documentation of nearshore habitat, including pinniped haulouts along the coastline. Transects were truncated at ~168.75°W to avoid overflights of the International Dateline (169°W).

As in past years, transects were terminated at coastal endpoints located 1 km offshore or 1 km shoreward of barrier islands, when present. In 2016, transects in block 1 were extended 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), increasing the study area size by an additional 1,500 km^2.

The selection of transects or survey blocks to be flown on a given day was nonrandom, based on reported or observed weather conditions over 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 were not preferentially conducted in areas or during time periods with a higher likelihood of seeing whales (e.g., based on recent wind conditions). Weather permitting, the project attempted 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), as noted above.

Survey Flight Procedures

A total of two primary observers were stationed 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 was primarily responsible for data entry but also functioned as a secondary observer. Sightings from primary observers during transect effort were considered “on effort”; sightings by the data recorder, pilots, or an occasional fourth observer during transect effort were considered “off effort”. To maintain consistency of data acquisition between 2016 and previous years, all observers underwent training in ASAMM data collection techniques prior to and during the 2016 field season. Data quality was 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 was flown to the targeted survey block (Beaufort Sea) or transect line (Chukchi Sea). A series of transect lines were then flown, followed by a search or deadhead leg back to the base of operations. Survey speed was generally 213 km/hr. Survey effort over land or in areas with zero visibility was designated as deadhead and not incorporated into further analyses. During deadhead segments, environmental and sighting data were not manually recorded, although aircraft position data, including latitude, longitude, heading, altitude, and time, were automatically recorded. Transects were joined together by short search or deadhead legs. When large cetaceans were encountered, the aircraft usually diverted from the transect for brief (usually <10 minutes) periods and circled the whales to verify species, observe behavior, improve group size estimates, determine whether calves were present, and, if conditions allowed, take photographs. Any new sightings of whales made while circling were recorded as sightings “on circling - transect” and were considered on effort. Sightings made off transect were recorded as sightings “on search” or “on circling - search.” Software on the laptop computing system allowed for detailed real-time tracking of all effort to minimize chances of duplicate sightings being recorded during circling.

Survey altitudes were chosen to maximize visibility and minimize potential disturbance to marine mammals. All surveys were flown following guidelines prescribed in research permits from NMFS (Permit No. 14245-04) and the U.S. Fish and Wildlife Service (USFWS; Permit No. MA212570-1). Surveys were generally flown at a target altitude of 365 m in the Chukchi Sea and 458 m in the Beaufort Sea, but could be flown as low as 305 m in either area. When cloud ceilings were less than 305 m or the wind force was above Beaufort 5, survey flights were redirected to survey blocks or transects with better conditions. Survey flights were aborted when conditions consistently did not meet minimum altitude (305 m) or wind force (Beaufort 5) requirements. Survey effort for ECS belugas north of 72°N was not conducted when wind force was greater than Beaufort 4. Transects were truncated by 5-8 km whenever small boats were observed to avoid interference with subsistence activities. During the fall subsistence hunt of bowhead whales, a minimum altitude of 458 m was maintained near Barrow, Cross Island, and Kaktovik. If 458 m could not be maintained, transects were truncated to avoid a 37-km radius around each whaling area.

When weather and fuel conditions allowed, circling was initiated in areas where aggregations of polar bears were known to occur onshore: on Cross Island and in the vicinity of Kaktovik (Figure 1). During circling of these areas, photographic images documenting as much of the island or coastline as possible were taken and reviewed post-flight to obtain more accurate counts of polar bears. Circling was not conducted for more than 15 minutes to reduce potential impacts to polar bears, and was never initiated on polar bears observed on ice or swimming in open water.

Coordination with Resource Users

Manned and Unmanned Aerial Surveys

Detailed communication protocols are currently the only means for deconflicting airspace between UAVs and manned aircraft. Communication protocols were developed to coordinate ASAMM surveys with UAV operations that were conducted in overlapping airspace in 2016, including a daily aerial simultaneous operations (SIMOPs) conference call to deconflict airspace. ASAMM flight planning, both before and during surveys, took into consideration the areas in which UAVs were operating and whether reliable communication could be initiated directly with UAV pilots. ASAMM also maintained daily contact with operators of all aircraft operating in offshore and coastal regions.

Subsistence Activity

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

Communication Centers provided direct information on bowhead whaling activities, and ASAMM communicated daily with these centers regarding survey planning.

Data Entry

Identical protocols were used to collect data in the two study areas. Customized, menu-driven, data-entry software was used to record all data in Microsoft Access database format. 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) were 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) were automatically recorded from the GPS feed every 30 seconds (in time) to provide a detailed record of the flight track. Wind force was recorded according to Beaufort scale (Maloney 2006). Ice type was 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 was estimated as a single percentage, regardless of ice type.

All marine mammal sightings were recorded, with the exception of some unidentified and small unidentified pinnipeds sighted in areas of high cetacean density. 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 included time, location, environmental conditions, survey mode, species, initial estimate of total number (low, high, and final estimates of group size were 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 was a known repeat sighting, and response to the aircraft. Calves were 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. Reduced data subsets were sometimes recorded for non-cetacean marine mammals to expedite data entry but always included time, location, environmental conditions, survey mode, species, total number, and response to aircraft. Marine mammal observers and flight crew watched for and recorded 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.

The behavior and swim direction of observed whales represented what the group was doing at the time it was first sighted. Behaviors were entered into 1 of 17 categories (Table 1). Swim direction, collected only for whales for which the behaviors “swim” and “dive” were recorded, was 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 was not recorded when the aircraft was circling.

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

Behavior	Definition
Breaching	Animal(s) launching upwards such that half to nearly all of the body is above the surface before falling back into the water, usually on its side, creating an obvious splash.
Dead	Animal(s) in water or on beach that is clearly deceased; carcasses often but not always bloated with sloughing skin and accompanied by oil slicks, feeding birds, or scavenging bears.
Diving	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.
Feeding	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-Slapping	Animal(s) floating on side, striking the water surface with pectoral flipper one or many times; usually seen within groups or when the slapping animal is touching another animal.
Log-Playing	Animal(s) milling or thrashing in association with a floating log.
Mating	Ventral-ventral orientation of two whales, often with one or more other whales present to stabilize the mating pair. Mating is often seen within a group of milling whales. Pairs may appear to hold each other with their pectoral flippers and may entwine their tails.
Milling	Animals moving slowly at the surface in close proximity (within 100 m) to other animals, with varying headings; limited to sightings with more than one animal.
Resting	Animal(s) floating at the surface with head, or head and back, exposed, showing no movement.
Rolling	Animal(s) rotating on the longitudinal axis, sometimes associated with mating.
Spy-Hopping	Animal(s) extending head vertically out of the water such that up to one-third of the body is above the surface.
Swimming	Animal(s) proceeding forward through the water, propelled by tail.
Tail-Slapping	Animal(s) floating horizontally or head-downward in the water, waving tail back and forth above the water and striking the water surface; usually seen in group situations.
Thrashing	Animal(s) exhibiting rapid flexure or gyration in the water.
Underwater-Blowing	Animal(s) exhaling while submerged, thus creating a visible bubble.
Unknown	Behavior not able to be determined, usually due to the sighting occurring at some distance from the aircraft location.
Walking/Running	Animal(s) moving on ground or ice at slow or normal pace (walking) or more rapid pace (running).

General Data Analyses

Preliminary data review and editing were conducted immediately following each survey flight by project personnel with comprehensive knowledge of the ASAMM database and metadata. Preliminary analysis was performed in the field after each flight using a customized computer program that provided daily summaries of marine mammal sightings and effort (time and distance on transect, search, circling, and deadhead) and plotted the paths of one or more flights by Beaufort wind force. Aerial photographic images were 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 was used for post-season analysis and production of figures and tables. Maps were 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 was adopted 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 were combined into one large dataset for editing and archiving, and were 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 were plotted semimonthly over the study area. Beluga and walrus distributions were plotted monthly. Humpback whale, fin whale, minke whale, killer whale, harbor porpoise, unidentified cetacean, pinniped, and polar bear distributions were plotted annually (July-October). All sightings were 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, 2017), same-day repeat sightings or sightings of dead marine mammals were 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 estimated the water depth at each sighting and the sighting’s distance from shore. The water depth at each sighting in the ASAMM database was derived from the International Bathymetric Chart of the Arctic Ocean Version 3.0 (Jakobsson et al. 2013), which had a pixel resolution of 500 m. The shoreline used to calculate a sighting’s distance from shore was “normalized” from the actual shoreline to provide a standardization of distance-from-shore measurements regardless of the mapping software 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 approximation of bays and barrier islands. The projection used for the normalized shoreline was 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°).

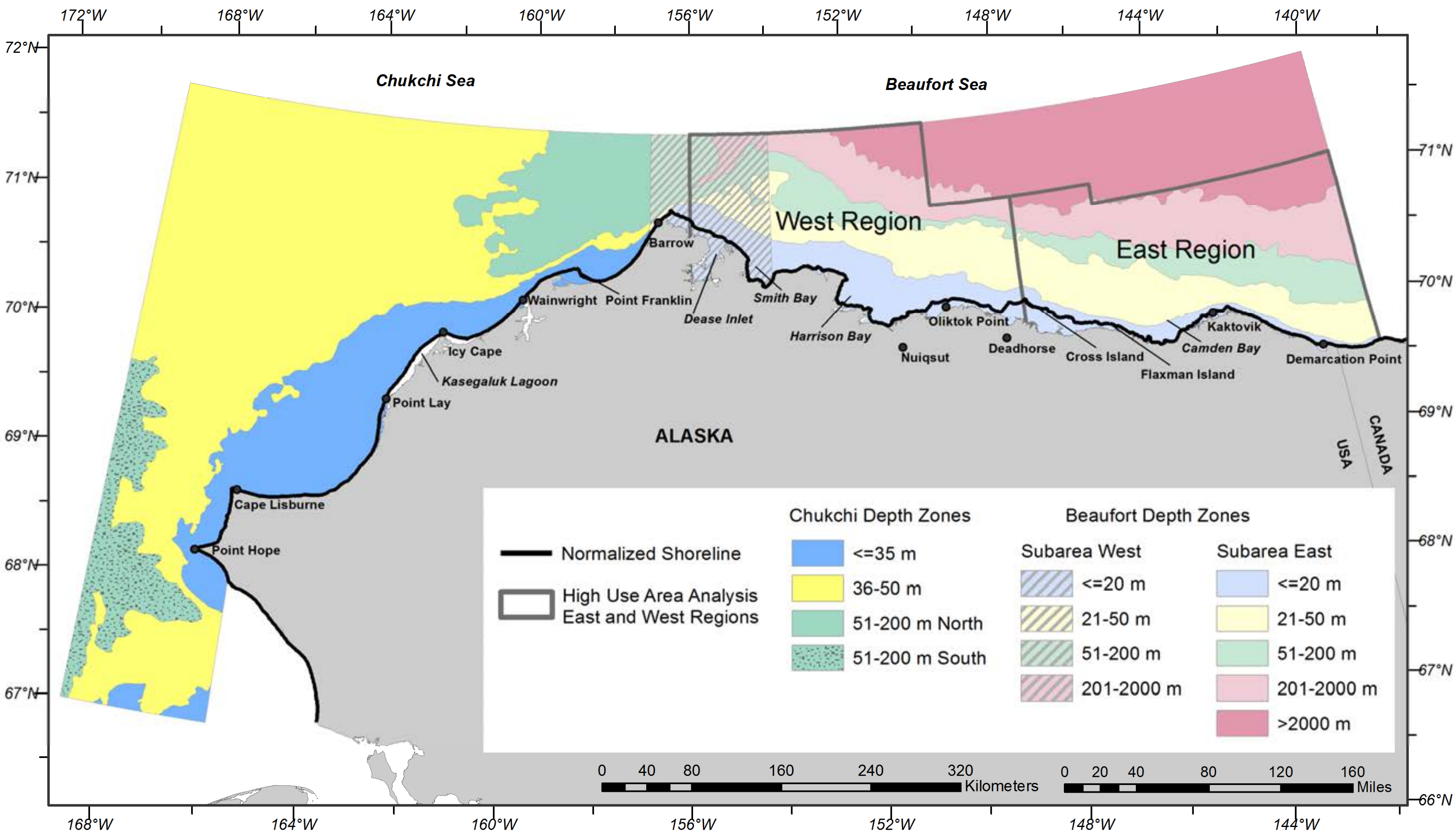


Figure 3. East and West regions and normalized shoreline used in ASAMM bowhead whale high-use area (HUA) analysis, and depth zone subareas used for sighting rate analyses.

Mean vector headings and circular standard deviations for headings of swimming cetaceans were 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 were based on ecosystem differences.

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

Sea ice information was obtained from the U.S. National Ice Center (2016), where it was available as charts or shapefiles. Sea ice analyses by the National Ice Center used 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 2016 were categorized as light, moderate, or heavy for use in multiyear analyses. Shapefiles for the Beaufort and Chukchi seas were 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 made 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 2016, sightings made by primary observers only were included in most analyses that used on-effort sightings, including sighting rate and central tendency analyses.

Sighting Rate and Relative Abundance Analyses

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

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

To calculate monthly and annual sighting rates per depth zone for bowhead whales, gray whales and belugas, the number of whales observed was divided by effort (km) per depth zone. Depth zones were defined based on depth data in the International Bathymetric Chart of the Arctic Ocean Version 2.23 (Jakobsson et al. 2008), which had a pixel resolution of 2 km. Depth zone analysis in the western Beaufort Sea study area was computed for two subareas (Figure 3). One subarea spanned 154°W-157°W and included 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 spanned 140°W-154°W, an area incorporating a well-defined continental shelf and slope. Beaufort Sea subareas used 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 used 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 was 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 used 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 did not include survey effort flown north of 72°N for ECS belugas but did include effort between barrier islands and the mainland in block 1a. Sightings per depth zone were based on geographic placement of sightings within depth zone isobaths, and not on the assigned depth zone for each individual sighting.

Finally, sighting rate was 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 were calculated for bowhead whales and annual sighting rates were calculated for gray whales and belugas for each cell. An index of relative abundance of bowhead whale and gray whale feeding and milling behaviors, quantified as WPUE, was also calculated for the fine-scale grid. The fine-scale grid analysis included effort and whales observed within barrier islands and north of 72°N.

Sighting rates were 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 2016, as in 2014 and 2015, sighting rate analyses were 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 previous 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 were not extended to belugas because diversions to circling were rarely conducted on beluga sightings.

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 Canadian 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). There is no reliable way, via data collected during aerial surveys, to differentiate between whales that are actively undergoing a focused, unidirectional, east-west 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 instead 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 could 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 were not defined based on specific activity states (e.g., migrating or feeding).

Bowhead whale HUAs were 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 were 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 were undertaken.

BOWHEAD WHALE CENTRAL TENDENCY – ANALYSIS 1

Bowhead whale HUA was 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 2016, a year with light sea ice cover (National Snow and Ice Data Center, 2016), were 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, 2015, 2017). Median distance from shore and depths at bowhead whale sightings in summer (July-August) 2016 were compared to bowhead whale sightings in summer 2012-2015 and fall (September-October) 2016.

Nonparametric statistical tests were 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. Further comparisons of subsets of data were based on statistical analyses of median distance from shore and depth at sighting, via the nonparametric Mann-Whitney *U*-test. The nonparametric test was used for these data because distributions generally did not fit assumptions necessary to use the two-sample *t*-test. The variances were not equal between time periods for both depth and distance from shore; in addition, the depth data were considerably skewed and the distance from shore data were slightly skewed, so neither distribution strictly met 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.

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

One caveat to the nonparametric analyses is that analyzing bowhead whale HUAs based only on number of sightings may be biased because survey effort often varied spatially both within and across years and because sightings of a single animal were weighted equally to sightings of several animals. Therefore, there may have been 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 2016 involved a three-step process: 1) constructing spatial models of bowhead whale relative abundance (encounter rate) based on bowhead whale sightings from 2016; 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 2016. As in the central tendency analysis described above, this analysis was based on transect bowhead whale sightings made by primary observers in September and October 2016. This analysis did not account for availability or perception bias. Estimates of median distance from shore were calculated for the East and West regions individually. The analysis was conducted in R version 3.3.2 (R Core Team 2016) using packages *sp* (Pebesma and Bivand 2005; Bivand et al. 2013), *maptools* (Bivand and Lewin-Koh 2016), *raster* (Hijmans 2016), *rgeos* (Bivand and Rundel 2016), *rgdal* (Bivand et al. 2016), and *mgcv* (Wood 2006).

To begin, the western Beaufort Sea study area was 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 were projected into an Equidistant Conic projection with the following parameterization: first standard parallel 69.5°; 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 included 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 was 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) suggested that the negative binomial distribution provided a better fit to the data. The model formula can be 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 2016 was 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 did 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 was cumulated, beginning with the cell closest to the normalized shoreline and ending with the farthest. The median distance from shore was calculated as the distance corresponding to the midpoint of the cell for which one-half of the total predicted number of individuals was 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 was also applied to ASAMM bowhead whale data from 2000-2016 combined. The analysis for the pooled years used the same data filtering criteria as described above (all bowhead whale sightings made by primary observers on transect) and did not account for availability or perception bias. It included data from July to October, and a varying-coefficient generalized additive model (Wood 2006) was 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 17-year time period were calculated for the East and West regions separately.

The median can also be referred to as the 50^{th} percentile or quantile. An additional analysis was undertaken to define the location of bowhead whale HUAs in 2016 alone and in 2000-2016 (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 were 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.

RESULTS

Environmental Conditions

In 2016, sea ice cover in the area surveyed was generally light, particularly in September and October. When surveys commenced in early July, sea ice remained north of 70°N (Appendix A, Figures A-1 and A-2), and persisted though early August (Figure A-3). By late August, sea ice remained near Hanna Shoal, but was otherwise absent from the study area (Figure A-5). The remnant sea ice near Hanna Shoal shifted location (closer to Point Barrow and into the westernmost Beaufort Sea) through late September (Figures A-6 and A-7), and was completely absent by mid-October (Figure A-8). By late October, new ice was forming in shallow nearshore areas in the study area (Figure A-9).

Arctic sea ice extent reached the seasonal minimum on 10 September 2016, and sea ice fell to the second lowest extent since satellite data were first recorded in 1979, tied with 2007 (National Snow and Ice Data Center 2016a, 2016b). To examine interannual variability in bowhead whale and other marine mammal distributions and relative abundance, 2016 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 2016, 19 observers participated in ASAMM surveys. All ASAMM observers were experienced field biologists and had previous experience with ASAMM surveys, which ensured consistency in data collection among years. ASAMM field experience ranged from 2 to 22 years (mean = 6 years, median = 5 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 2016 and ended 31 October 2016. Survey flights were conducted from 2 July to 26 October (Table 2), corresponding to the summer and fall months when open-water anthropogenic activities occur. Surveys were conducted from one aircraft based in Barrow from 1 July to 31 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 108 survey flights, of which 25 were in July, 31 in August, 34 in September, and 18 in October. Surveys originating on the aircraft based in Barrow were numbered sequentially starting with 201; surveys originating on the aircraft based in Deadhorse were numbered sequentially starting with 1. On 31 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 33 days. Surveys were conducted on 62% of possible survey days (75 out of 121 possible days). Surveys were not conducted on 38% of the possible survey days (46 out of 121 possible days)

Table 2. ASAMM aerial survey flight effort in chronological order, 2 July – 26 October 2016, 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.

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
2 Jul	201	227	5	204	85	521	1.0	2.3
6 Jul	202	413	116	41	416	987	1.9	4.0
8 Jul	203	1,025	16	71	832	1,944	4.6	7.6
9 Jul	204	1,001	71	7	1,187	2,266	4.4	8.5
11 Jul	205	516	30	59	185	790	2.4	3.5
13 Jul	206	706	73	121	354	1,254	3.2	5.2
14 Jul	207	707	45	84	834	1,670	3.2	6.4
16 Jul	208	283	17	100	413	814	1.3	3.2
19 Jul	209	517	70	94	1,304	1,984	2.4	7.0
19 Jul	1	9	0	1	366	376	0.1	1.3
20 Jul	210	544	72	2	452	1,070	2.5	4.3
20 Jul	2	92	0	439	774	1,305	0.5	4.9
21 Jul	211	902	66	34	188	1,189	4.1	5.4
21 Jul	3	734	38	1	448	1,222	3.3	4.9
22 Jul	212	278	131	1	548	958	1.2	3.5
24 Jul	213	413	124	57	299	893	1.8	3.7
24 Jul	4	740	4	1	308	1,053	3.4	4.5
25 Jul	214	571	25	4	549	1,149	2.5	4.4
25 Jul	5	1,358	13	9	382	1,761	6.3	7.8
27 Jul	215	300	121	1	314	735	1.3	3.1
27 Jul	6	647	27	1	332	1,007	2.8	4.1
29 Jul	216	451	0	270	143	864	2.0	3.9
29 Jul	7	127	27	239	508	902	0.6	3.7
30 Jul	8	1,038	87	4	1,237	2,365	4.7	9.0
31 Jul	9	254	45	1	555	855	1.2	3.2
2 Aug	217	622	0	0	547	1,170	2.9	4.6
2 Aug	10	453	17	204	307	981	2.1	4.1
3 Aug	218	519	17	2	661	1,198	2.4	4.6
3 Aug	11	22	0	1	809	833	0.1	2.8
5 Aug	219	850	235	151	1,452	2,689	3.6	9.7
5 Aug	12	581	8	172	777	1,537	2.5	5.6
6 Aug	220	200	96	92	338	725	0.9	2.9
6 Aug	13	591	132	56	168	946	2.7	4.4

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
7 Aug	221	565	108	103	384	1,160	2.5	4.6
7 Aug	14	1,212	248	23	581	2,064	5.5	9.0
8 Aug	15	152	27	177	543	898	0.7	3.4
15 Aug	16	0	0	328	384	712	0.0	2.9
16 Aug	222	654	161	75	272	1,162	3.0	5.1
17 Aug	223	292	0	5	658	955	1.3	3.4
17 Aug	17	1,196	186	103	546	2,031	5.5	9.1
20 Aug	224	836	106	40	297	1,279	3.8	5.6
20 Aug	18	528	174	3	450	1,155	2.4	4.9
22 Aug	225	547	102	53	312	1,014	2.5	4.4
22 Aug	19	24	0	0	440	464	0.1	1.5
23 Aug	226	520	79	37	388	1,024	2.4	4.4
24 Aug	227	427	148	1	430	1,005	1.8	4.0
24 Aug	20	394	56	111	234	794	1.8	3.4
25 Aug	228	492	362	18	143	1,016	2.2	4.8
25 Aug	21	997	168	90	1,072	2,327	4.5	9.1
26 Aug	229	420	81	227	476	1,204	1.9	4.8
26 Aug	22	886	293	21	690	1,890	4.1	8.0
27 Aug	230	207	14	197	601	1,017	0.9	3.9
27 Aug	23	750	41	131	308	1,230	3.3	5.2
28 Aug	231	430	186	57	323	996	2.0	4.4
28 Aug	24	347	43	1	651	1,042	1.6	3.9
29 Aug	232	518	402	56	1,603	2,578	2.3	9.0
3 Sep	233	524	138	1	643	1,306	2.4	5.1
3 Sep	25	150	154	34	1,028	1,366	0.7	4.5
5 Sep	234	342	18	223	270	854	1.6	3.7
5 Sep	26	395	0	1	207	603	1.8	2.6
6 Sep	235	327	47	65	343	782	1.4	3.0
6 Sep	27	559	36	149	410	1,153	2.5	4.7
8 Sep	28	336	177	95	396	1,005	1.5	4.3
9 Sep	29	0	0	0	724	724	0.0	2.4
10 Sep	236	571	146	187	182	1,085	2.6	5.0
10 Sep	30	558	65	15	648	1,286	2.6	5.0
11 Sep	237	1,275	71	69	739	2,154	5.8	8.9
11 Sep	31	526	70	33	376	1,004	2.4	4.2
12 Sep	32	428	24	1	624	1,077	2.0	4.0

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
13 Sep	238	971	31	16	242	1,260	4.2	5.4
14 Sep	239	624	12	5	500	1,141	2.8	4.4
14 Sep	33	1,027	32	5	1,006	2,069	4.7	8.1
15 Sep	240	750	83	1	482	1,316	3.3	5.2
15 Sep	34	394	32	18	320	765	1.8	3.2
16 Sep	35	158	19	1	196	373	0.7	1.6
18 Sep	241	331	36	351	1,696	2,414	1.4	8.4
18 Sep	36	130	38	60	1,149	1,376	0.5	4.7
19 Sep	242	685	43	130	295	1,153	3.1	4.9
19 Sep	37	419	63	62	667	1,211	1.9	4.6
20 Sep	243	489	131	113	448	1,181	2.1	4.9
20 Sep	38	1,372	118	152	560	2,202	6.2	9.4
21 Sep	39	553	135	120	453	1,260	2.5	5.3
22 Sep	40	69	0	0	518	587	0.3	1.7
23 Sep	244	262	0	0	783	1,045	1.2	3.5
24 Sep	41	606	138	80	448	1,272	2.8	5.3
25 Sep	245	534	6	25	1,333	1,898	2.2	6.5
25 Sep	42	1,055	124	85	691	1,956	4.7	8.2
26 Sep	246	882	125	78	1,362	2,446	3.9	9.8
26 Sep	43	612	27	62	411	1,112	2.7	4.6
27 Sep	44	464	19	17	790	1,290	2.2	4.9
3 Oct	45	0	0	360	61	421	0.0	1.9
4 Oct	247	125	28	0	412	565	0.6	1.9
7 Oct	46	760	0	93	361	1,214	3.5	5.2
8 Oct	47	162	0	57	304	523	0.8	2.0
9 Oct	248	448	10	2	651	1,112	1.9	4.0
10 Oct	249	1,503	108	20	492	2,123	6.6	8.9
10 Oct	48	1,060	147	119	898	2,223	4.8	9.0
12 Oct	250	576	42	4	1,400	2,022	2.5	7.4
14 Oct	251	426	0	130	1,248	1,804	1.9	6.3
15 Oct	252	498	11	84	147	739	2.2	3.1
16 Oct	253	533	49	96	171	849	2.3	3.7
17 Oct	254	814	22	10	422	1,268	3.6	5.1
18 Oct	255	847	0	40	546	1,432	3.5	5.4
19 Oct	256	512	0	42	657	1,211	2.2	4.4
22 Oct	257	491	61	75	305	932	2.2	3.9

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
23 Oct	258	601	81	121	257	1,059	2.7	4.5
24 Oct	259	940	31	68	1,036	2,076	4.2	8.5
26 Oct	260	532	42	94	144	812	2.4	3.5
Semimonthly Effort Summary								
1-15 Jul		4,595	356	587	3,893	9,432	20.6	37.4
16-31 Jul		9,258	867	1,259	9,120	20,502	41.7	81.6
1-15 Aug		5,767	888	1,309	6,951	14,913	25.8	58.5
16-31 Aug		10,465	2,602	1,226	9,894	24,183	47.1	98.8
1-15 Sep		9,757	1,136	918	9,140	20,950	44.1	83.5
16-30 Sep		8,621	1,022	1,336	11,800	22,776	38.5	88.4
1-15 Oct		5,558	346	869	5,974	12,746	24.8	49.7
16-31 Oct		5,270	286	546	3,538	9,639	22.9	38.8
Total		**59,291**	**7,503**	**8,050**	**60,310**	**135,141**	**265.5**	**536.7**

due to weather (37 days), aircraft maintenance (1 day), or a combination of weather, hard down days due to survey hour restrictions, and aircraft inspections or other maintenance requirements (8 days).

Survey effort was summarized by hours or kilometers flown in different survey modes. Over 135,000 km were flown during 536.7 hours (Figure 4). A total of 59,291 km of effort on transect was flown during 265.5 hours (Figure 5). Transect effort constituted 44% of the total kilometers flown and 49% 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; five flights were almost entirely on deadhead due to prevailing poor weather conditions. During an average survey, an aerial survey team covered 1,247 km, ranging from 373 km to 2,689 km. The longer distances required 2-3 flights per survey.

Survey effort (transect, search, and circling) is plotted semimonthly in Figure 6. In the northeastern Chukchi Sea study area, transects near Chukchi Sea Sale 193 lease areas were targeted more often than areas without Sale 193 lease areas (e.g., survey blocks 20-23). Coverage in early July focused on the northeastern Chukchi Sea study area. From mid-July through mid-October, survey coverage was balanced between the eastern Chukchi Sea and the western Beaufort Sea study areas. Systematic broad-scale coverage of the western Beaufort Sea in summer (mid-July through August) was conducted for the fourth consecutive year, and included transects that extended farther north than usual to survey for ECS belugas, and transects that extended between the barrier islands and the mainland in block 1 to survey areas near the Liberty Prospect. Transect survey coverage in the entire ASAMM study area was well distributed in late July, late August, throughout September, and early October. Survey coverage in early August was limited due to an extended stretch of extremely poor weather, and coverage in late October was limited primarily to areas closest to Barrow and Deadhorse, due to increasingly inclement weather conditions and reduction to one survey team, based in Barrow. During times when there were two aircraft conducting surveys, survey coverage (time and distance) was greatest in late August, when 19 surveys were flown, and lowest in early October when 10 surveys were flown.

Survey coverage was greatest in blocks 13, 14, and 17 in the Chukchi Sea and blocks 12, 3, and 1 in the Beaufort Sea (Figure 7) due, in part, to the proximity of those blocks to Barrow 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 noticeably higher effort in blocks 12 and 13, particularly in October, was partially caused by the aforementioned increasingly inclement weather and basing the single remaining aircraft at Barrow after 10 October. Block 23 was surveyed for the third 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.

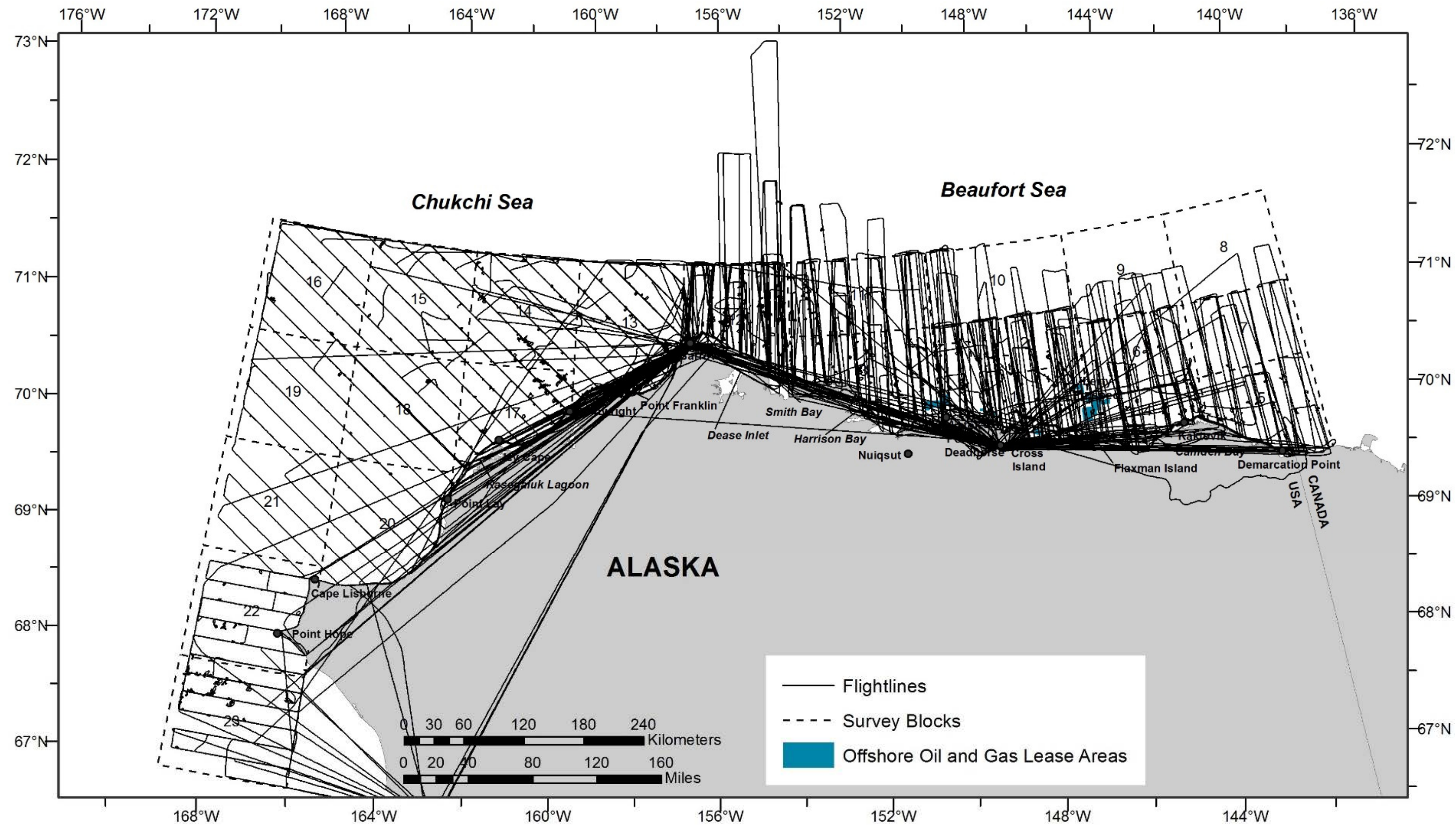


Figure 4. ASAMM 2016 combined flight tracks, all flight types (transect, search, circling, and deadhead). Surveys were flown north of 72°N from 19 July to 20 August to survey additional Eastern Chukchi Sea beluga habitat.

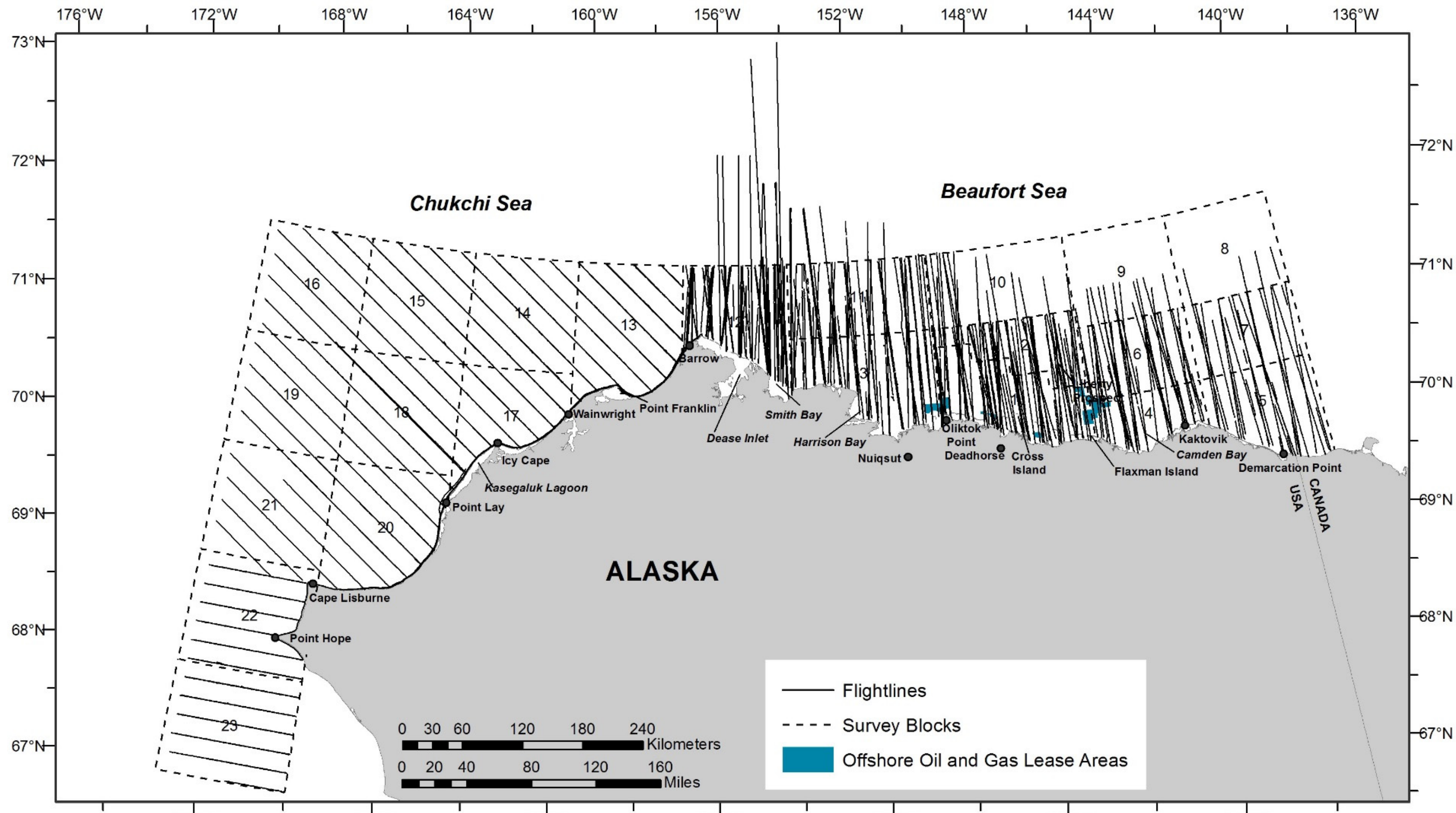


Figure 5. ASAMM 2016 combined flight tracks, transect effort only. Transects were flown north of 72°N from 19 July to 20 August to survey additional Eastern Chukchi Sea beluga habitat.

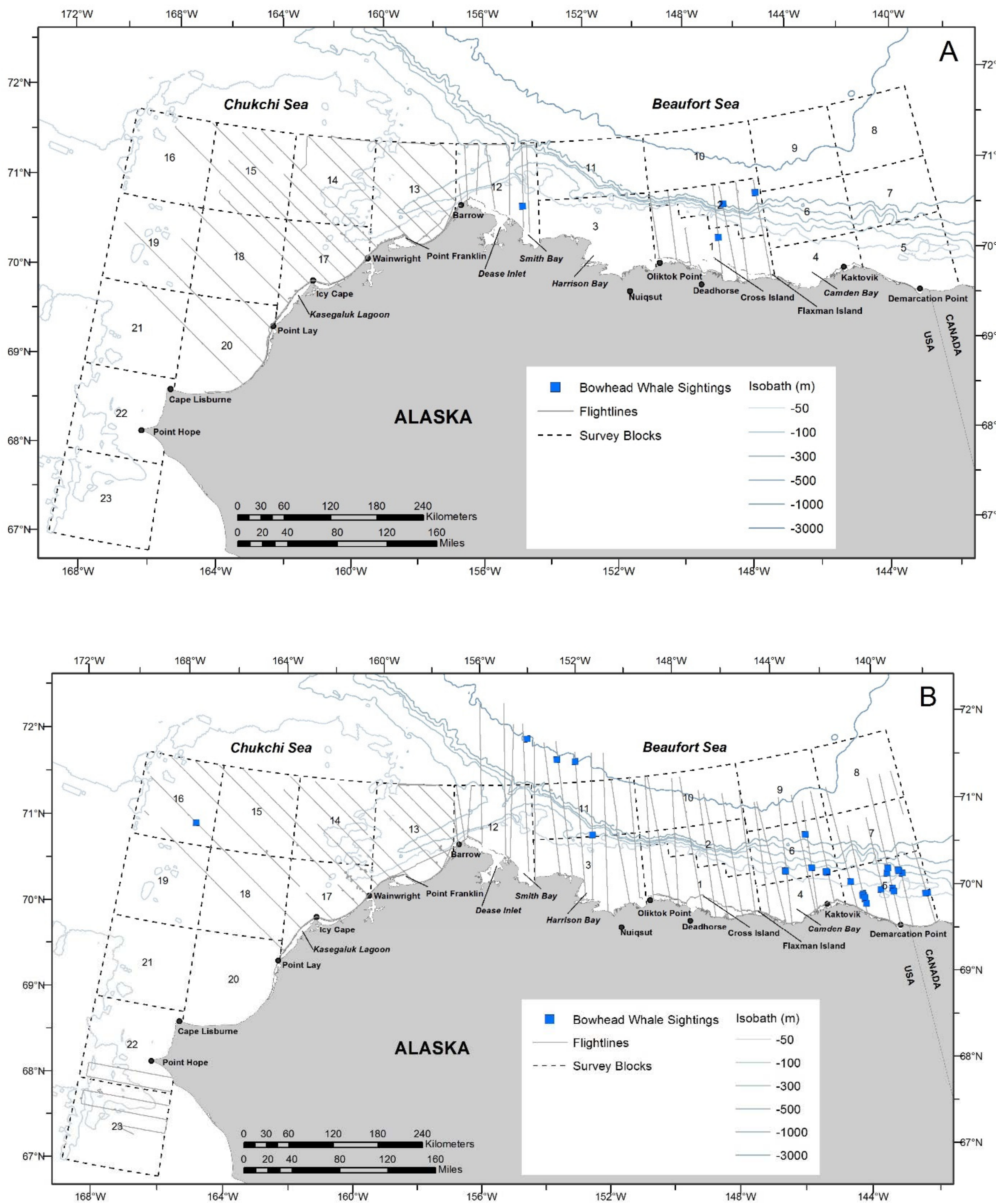
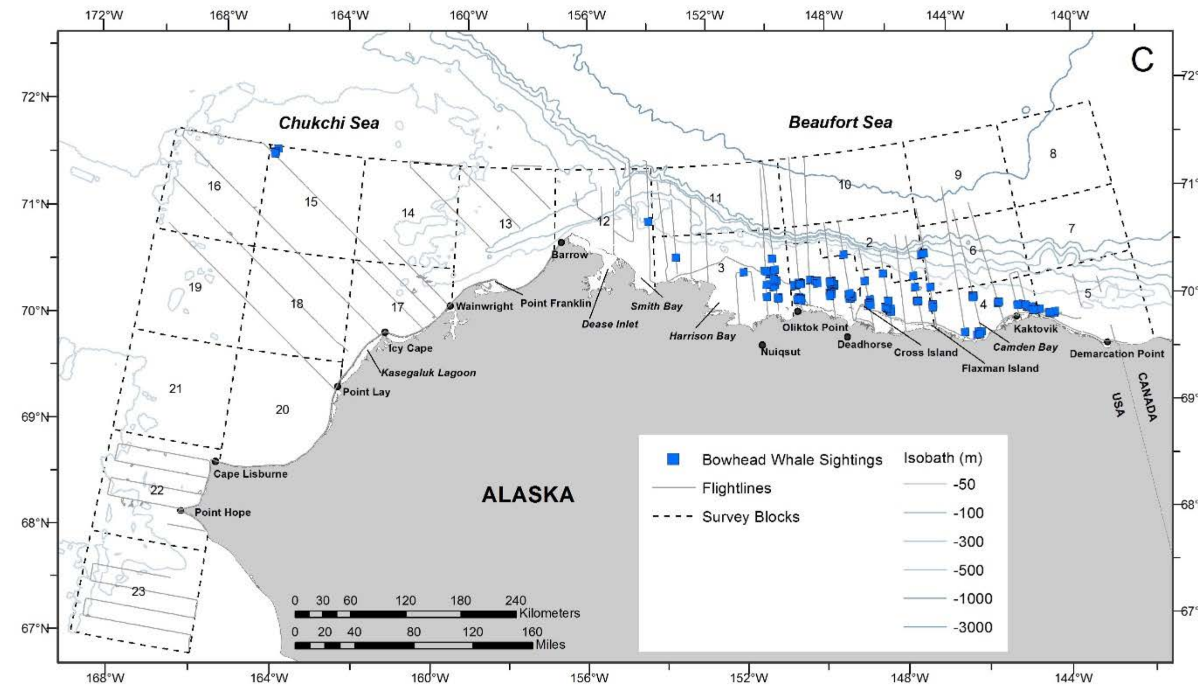


Figure 6. ASAMM 2016 semimonthly bowhead whale sightings, with transect, search, and circling survey effort. A: 2-15 July; B: 16-31 July. Deadhead flight tracks are not shown.



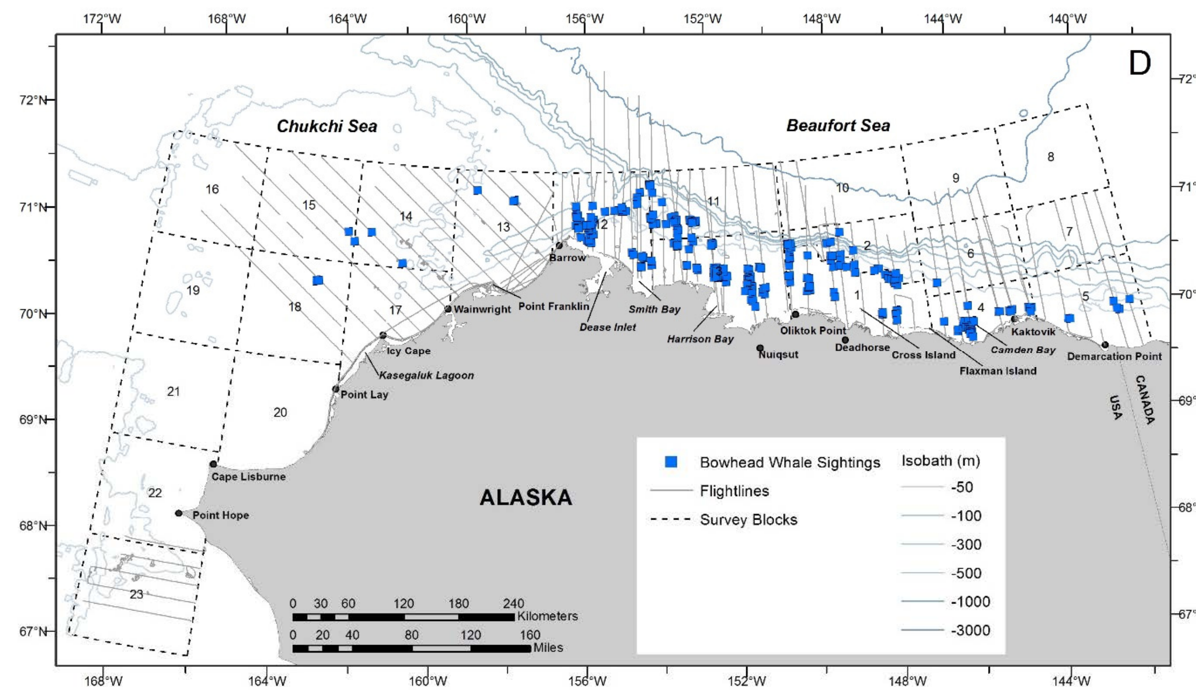
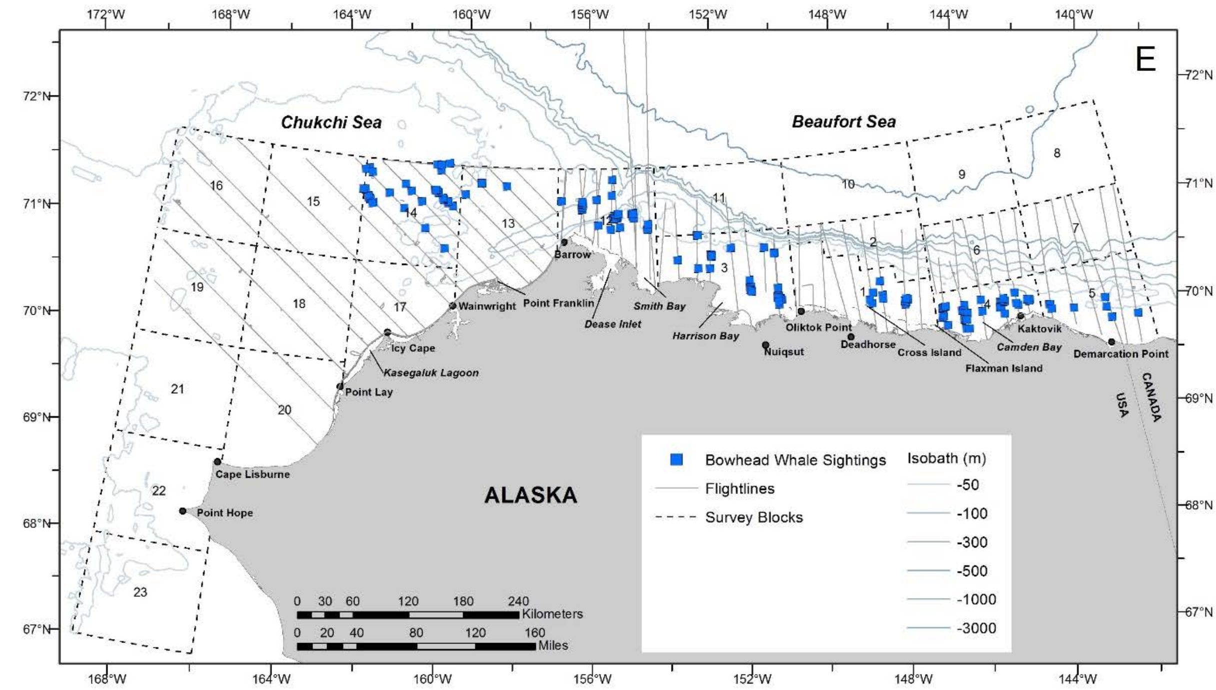


Figure 6 (cont). ASAMM 2016 semimonthly bowhead whale sightings, with transect, search, and circling effort. C: 1-15 August; D: 16-31 August. Deadhead flight tracks are not shown.



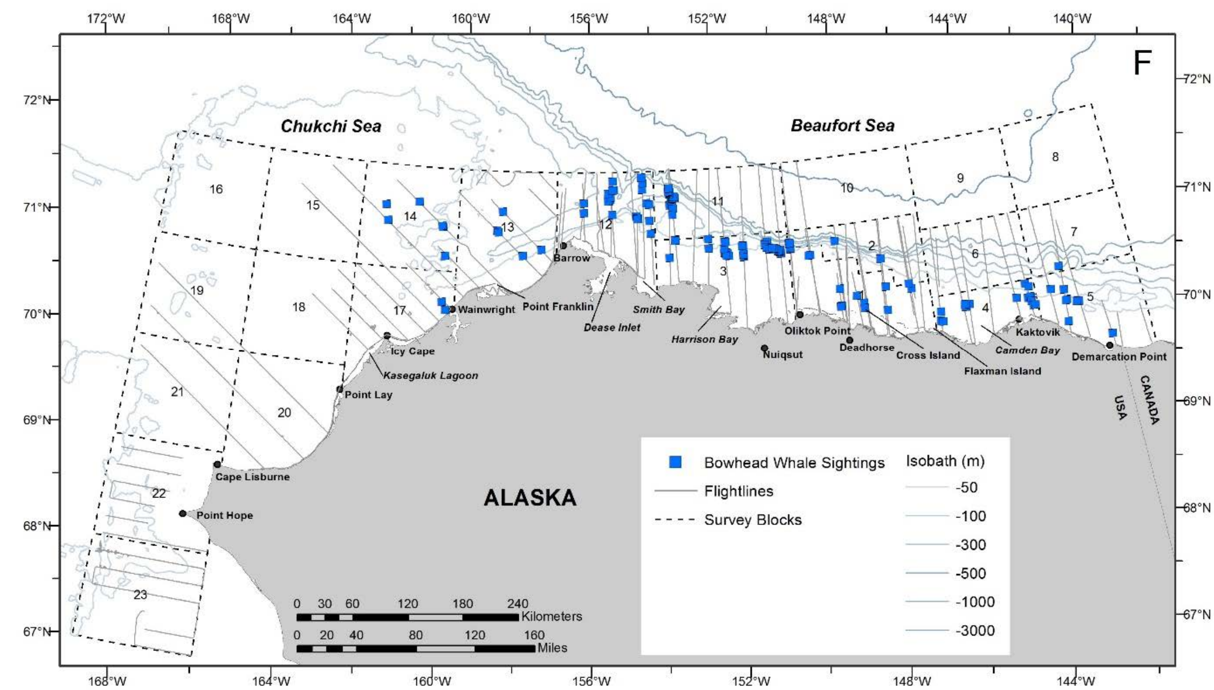
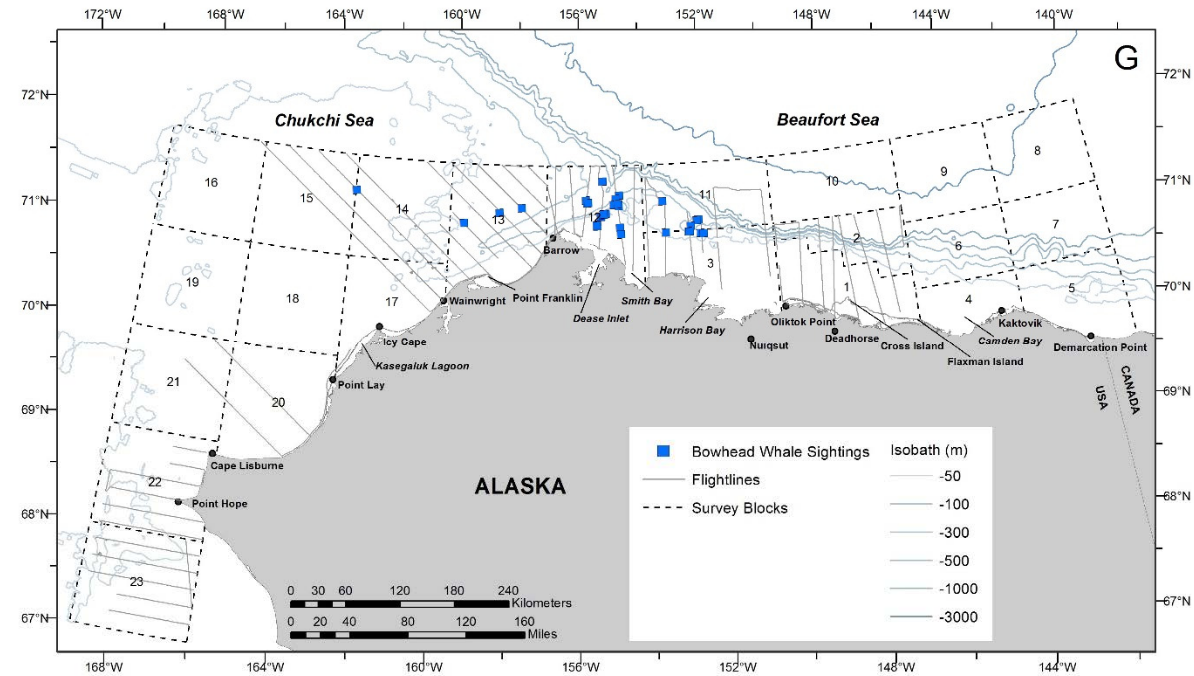


Figure 6 (cont). ASAMM 2016 semimonthly bowhead whale sightings, with transect, search, and circling effort. E: 1-15 September; F: 16-30 September. Deadhead flight tracks are not shown.



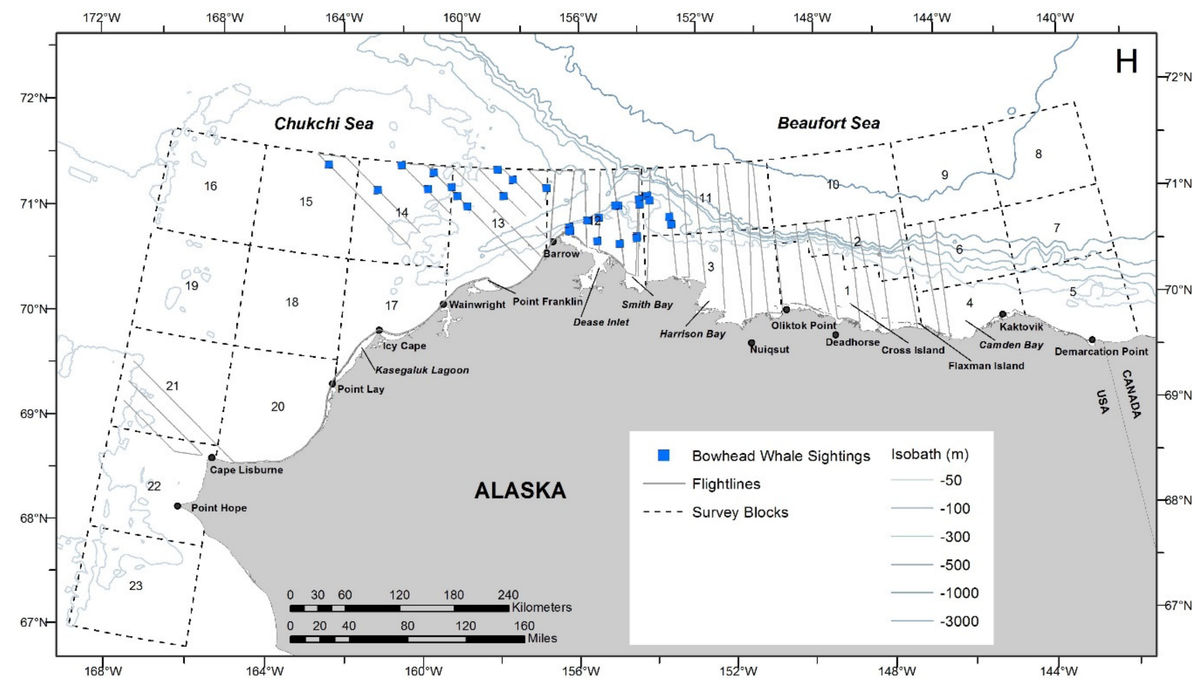


Figure 6 (cont). ASAMM 2016 semimonthly bowhead whale sightings, with transect, search, and circling effort. G: 1-15 October; H: 16-30 October. Deadhead flight tracks are not shown.

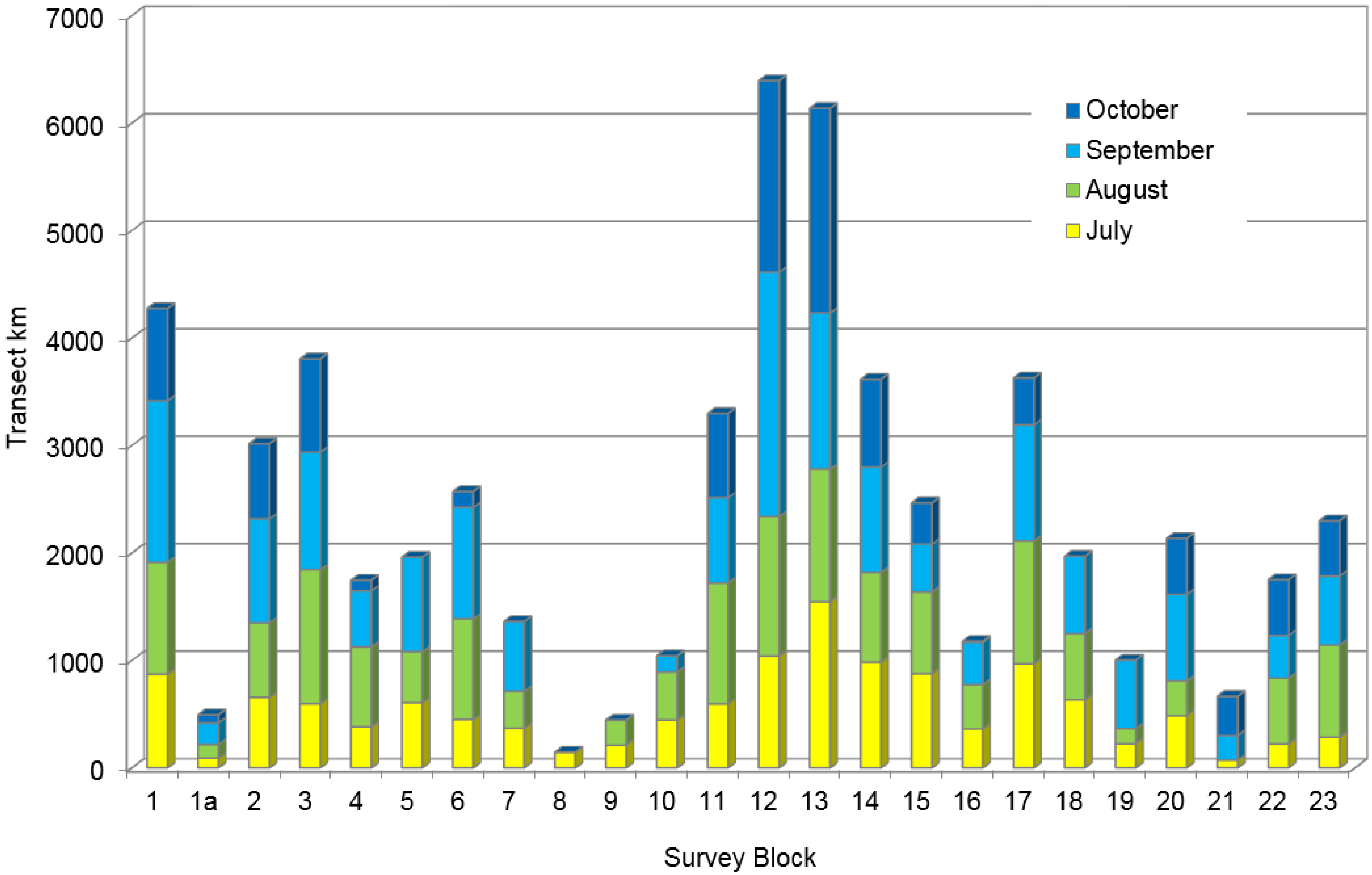


Figure 7. ASAMM 2016 monthly transect survey effort per block. Does not include effort north of 72°N.

Survey effort was impacted by several factors in 2016, including poor weather conditions, avoidance of subsistence activity, and incorporation of ECS beluga habitat. Fog and low ceilings curtailed survey effort in mid-August when no surveys were conducted for 5 days, and in late August-early September and late September-early October, when surveys were not possible for 4 days each time. Strong winds prevented any surveys from being conducted from 27-30 October. Other than those time periods, the longest period when no ASAMM flights occurred was 3 days.

Direct avoidance of subsistence activities, specifically the fall bowhead whale hunt occurring near Barrow, occurred on one day in 2016. On 25 September, transects were diverted to avoid overflights of whalers near Barrow. During the fall bowhead whale subsistence hunts near Cross Island and Kaktovik, ASAMM was able to conduct surveys in areas adjacent to but not directly overlapping subsistence whaling.

The ECS beluga study area, surveyed from 19 July to 20 August, overlapped geographically with parts of several ASAMM survey blocks in the western Beaufort Sea (Figure 1) and also included an area north of the ASAMM study area. During the 33-day ECS beluga study period, 15 surveys were conducted in the ECS beluga study area, with 10 of those surveys, comprising approximately 15 total hours, extending north of the typical ASAMM study area.

Anchors laid during offshore drilling operations conducted by Shell in the Beaufort and Chukchi seas in 2012 and 2015 were removed from drilling sites in July 2016. During anchor retrieval operations, a UAV, operated by Precision Helicopters and based on one of the anchor retrieval ships, was frequently launched to conduct sea ice reconnaissance surveys, augmented occasionally by a fixed wing aircraft. Communication between UAV pilots, fixed wing pilots, and ASAMM was superb, including daily SIMOPs phone calls and review of NOTAMs (Notice to Airmen and Mariners), and there was no impact on ASAMM survey effort. Anchor retrieval operations ended 30 July.

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.

Cetaceans

Bowhead Whales

Bowhead Whale Sighting Summary

During 2016 ASAMM surveys, 950 sightings of 1,859 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 = 441; median = 327) usually observed in a single year, and is the highest total observed during ASAMM surveys conducted since 1982 (Clarke et al. 2016). The high number of bowhead whales sighted was due, in large part, to surveys conducted in the western Beaufort Sea in late July and August, during which 1,197 bowhead whales were seen. Of greatest impact were numerous sightings of bowhead whales (474 sightings of 1,162 whales, or 62.5% of total bowhead whales seen) observed in the western Beaufort Sea in August.

Forty-one bowhead whales were seen in July (Figures 6A and 6B). Sightings were widely dispersed in the western Beaufort Sea, with sightings over the slope (>2,000 m depth), outer continental shelf (51-2000 m) and inner continental shelf (<50 m). One bowhead whale was seen in the northeastern Chukchi Sea, approximately 350 km west of Barrow. The highest number of bowhead whales per survey block in July was in block 5 (n_i = 19); three whales were seen north of 72°N. In August, 1,185 bowhead whales were seen, approximately 1.75 times as many bowhead whales as were seen in July, September, and October 2016 combined (Figures 6C and 6D). Bowhead whales were observed in the western Beaufort Sea from 140°W to 157°W in both outer and inner shelf waters and in Barrow Canyon between 153.8°W to 156.5°W. In the Chukchi Sea, 13 bowhead whales were seen broadly distributed 70-270 km west-northwest of Barrow, and 10 whales were seen approximately 325 km northwest of Barrow on 7 August. The highest number of bowhead whales per survey block in August was in block 3 (n_i = 541). In September, 478 bowhead whales were seen. Bowhead whale distribution in September was primarily on the inner shelf (≤50 m depth) between 140°W and 149°W, but was more broadly distributed on the inner and outer shelf between 149°W and 157°W (Figures 6E and 6F). In the Chukchi Sea in September, bowhead whales were observed primarily between 71.2°N and 72°N, with sightings 25-225 km west and northwest of Barrow; two bowheads were seen approximately 10 km west of Wainwright. The greatest number of bowhead whales per survey block in September was in block 3 (n_i = 117). In October, 175 bowhead whales were seen, and distribution in the western Alaskan Beaufort Sea was limited to the inner and outer shelf west of 152°W (Figures 6G and 6H). In the Chukchi Sea, bowhead whale distribution was predominantly northwest of Barrow, with no sightings south of 71.4°N. The greatest number of bowhead whales per survey block in October was seen in block 12 (n_i = 70). Bowhead whale sightings in the northeastern Chukchi Sea in September and October 2016 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 CSPA.

Table 3. Summary of ASAMM 2016 cetacean sightings (number of sightings/number of individuals) during all survey modes (transect, search, and circling) in chronological order, 2 July – 26 October 2016, 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*
2 Jul	201	0	0	0	0	0	0	0	0	0
6 Jul	202	0	16/33	0	0	0	0	0	0	0
8 Jul	203	0	7/14	0	0	0	0	0	0	0
9 Jul	204	0	19/33	0	0	0	0	0	0	0
11 Jul	205	1/1	2/3	0	0	0	14/86	0	0	0
13 Jul	206	0	21/47	0	0	0	3/298	0	0	0
14 Jul	207	3/4	0	0	0	0	13/38	0	0	0
16 Jul	208	0	2/3	0	0	0	0	0	0	0
19 Jul	209	0	21/36	0	0	0	0	0	2/7	0
19 Jul	1	0	0	0	0	0	0	0	0	0
20 Jul	210	0	4/8	0	0	0	0	0	0	0
20 Jul	2	0	0	0	0	0	1/5	0	0	0
21 Jul	211	1/1	4/4	0	0	0	42/464	0	0	0
21 Jul	3	2/2	0	0	0	0	37/209	0	0	0
22 Jul	212	0	23/70	0	0	0	0	0	0	0
24 Jul	213	0	11/24	0	0	0	0	0	0	1/2
24 Jul	4	1/1	0	0	0	0	1/2	0	0	0
25 Jul	214	1/1	0	0	0	0	0	0	0	0
25 Jul	5	0	1/1	0	0	0	34/99	0	0	0
27 Jul	215	0	16/30	0	0	0	0	0	0	0
27 Jul	6	2/2	0	0	0	0	0	0	0	0
29 Jul	216	0	1/2	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 Jul	7	3/4	0	0	0	0	15/22	0	0	0
30 Jul	8	13/17	0	0	0	0	64/162	0	0	1/1
31 Jul	9	7/8	0	0	0	0	4/5	0	0	0
2 Aug	217	0	0	0	0	0	0	0	0	0
2 Aug	10	5/6	0	0	0	0	0	0	0	0
3 Aug	218	0	0	0	0	0	1/2	0	0	0
3 Aug	11	0	0	0	0	0	0	0	0	0
5 Aug	219	0	10/28	3/9	5/10	11/13	0	0	7/8	5/7
5 Aug	12	1/1	0	0	0	0	5/135	0	0	0
6 Aug	220	0	10/53	0	0	0	0	0	0	0
6 Aug	13	51/56	0	0	0	0	1/9	0	0	1/1
7 Aug	221	4/10	4/8	0	0	0	0	0	0	0
7 Aug	14	59/113	0	0	0	0	65/163	0	0	1/1
8 Aug	15	13/32	0	0	0	0	1/1	0	0	0
15 Aug	16	2/8	0	0	0	0	0	0	0	0
16 Aug	222	1/1	8/10	0	0	0	0	0	0	1/1
17 Aug	223	0	0	0	0	0	0	0	0	0
17 Aug	17	45/80	0	0	0	0	27/52	0	0	0
20 Aug	224	13/17	0	0	0	0	10/36	0	0	0
20 Aug	18	82/136	0	0	0	0	3/4	0	0	0
22 Aug	225	2/2	2/4	0	0	0	0	0	0	1/1
22 Aug	19	0	0	0	0	0	0	0	0	0
23 Aug	226	1/1	5/16	0	0	0	0	0	0	1/1
24 Aug	227	0	6/15	0	0	0	0	0	0	0
24 Aug	20	15/18	0	0	0	0	0	0	0	0
25 Aug	228	56/97	8/10	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*
25 Aug	21	35/56	0	0	0	0	5/8	0	0	1/1
26 Aug	229	3/4	0	0	0	0	0	0	0	0
26 Aug	22	73/498	0	0	0	0	3/18	0	0	1/2
27 Aug	230	1/1	2/2	0	0	0	0	0	0	0
27 Aug	23	20/37	0	0	0	0	0	0	0	0
28 Aug	231	2/4	24/54	0	0	0	0	0	0	1/1
28 Aug	24	4/7	0	0	0	0	0	0	0	0
29 Aug	232	0	33/151	9/16	7/7	2/2	0	0	1/1	3/3
3 Sep	233	0	1/1	1/1	0	1/1	0	1/15	0	1/1
3 Sep	25	11/16	17/41	0	0	0	0	0	0	3/4
5 Sep	234	3/3	1/1	0	0	0	0	0	0	0
5 Sep	26	0	0	0	0	0	0	0	0	0
6 Sep	235	0	1/1	0	0	0	0	0	0	0
6 Sep	27	12/16	0	0	0	0	0	0	0	0
8 Sep	28	47/71	0	0	0	0	1/1	0	0	1/1
9 Sep	29	0	0	0	0	0	0	0	0	0
10 Sep	236	26/30	7/14	0	0	0	0	0	0	2/2
10 Sep	30	30/32	6/9	0	0	0	0	0	0	0
11 Sep	237	6/8	7/10	0	0	0	0	0	0	1/1
11 Sep	31	26/31	0	0	0	0	0	0	0	1/1
12 Sep	32	3/5	0	0	0	0	0	0	0	1/1
13 Sep	238	11/13	0	0	0	0	1/1	0	0	0
14 Sep	239	0	0	0	0	0	0	0	0	0
14 Sep	33	5/9	0	0	0	0	0	0	0	0
15 Sep	240	0	0	0	0	0	0	0	0	1/2
15 Sep	34	17/20	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*
16 Sep	35	6/6	0	0	0	0	0	0	0	0
18 Sep	241	0	8/14	0	0	0	0	0	0	0
18 Sep	36	3/3	8/10	0	0	0	0	0	0	1/1
19 Sep	242	7/10	4/4	0	0	0	0	0	0	0
19 Sep	37	19/22	1/4	0	0	0	1/1	0	0	0
20 Sep	243	3/4	2/2	0	0	0	0	2/7	0	1/1
20 Sep	38	24/35	0	0	0	0	1/1	0	0	0
21 Sep	39	20/31	0	0	0	0	1/1	0	0	0
22 Sep	40	0	0	0	0	0	0	0	0	0
23 Sep	244	0	0	0	0	0	0	0	0	0
24 Sep	41	41/69	0	0	0	0	2/4	0	0	0
25 Sep	245	0	0	0	0	0	0	0	0	0
25 Sep	42	33/39	1/1	0	0	0	0	0	0	1/1
26 Sep	246	0	56/208	0	0	0	0	2/8	0	0
26 Sep	43	3/4	0	0	0	0	1/1	0	0	0
27 Sep	44	1/1	0	0	0	0	1/1	0	0	0
3 Oct	45	0	0	0	0	0	0	0	0	0
4 Oct	247	0	9/20	0	0	0	0	0	0	0
7 Oct	46	0	0	0	0	0	0	0	0	0
8 Oct	47	0	0	0	0	0	0	0	0	0
9 Oct	248	0	1/2	0	0	0	0	0	0	0
10 Oct	249	3/5	17/25	0	0	0	0	0	0	2/2
10 Oct	48	38/62	1/1	0	0	0	1/2	0	0	0
12 Oct	250	0	36/93	0	0	0	0	0	0	1/2
14 Oct	251	0	0	0	0	0	0	0	0	0
15 Oct	252	0	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*
16 Oct	253	9/20	0	0	0	0	0	0	0	0
17 Oct	254	5/24	0	0	0	0	0	0	0	0
18 Oct	255	0	0	0	0	0	0	0	0	0
19 Oct	256	0	0	0	0	0	1/2	0	0	0
22 Oct	257	6/15	0	0	0	0	0	0	0	0
23-Oct	258	6/23	1/10	0	0	0	1/4	0	0	0
24 Oct	259	0	0	0	0	0	0	0	0	1/1
26 Oct	260	4/6	0	0	0	0	3/4	0	0	0
					Semimonthly Summary					
1-15 Jul		4/5	65/130	0	0	0	30/422	0	0	0
16-31 Jul		30/36	83/178	0	0	0	198/968	0	2/7	2/3
1-15 Aug		135/226	24/89	3/9	5/10	11/13	73/310	0	7/8	7/9
16-31 Aug		353/959	88/262	9/16	7/7	2/2	48/118	0	1/1	9/10
1-15 Sep		197/254	40/77	1/1	0	1/1	2/2	1/15	0	11/13
16-30 Sep		160/224	80/243	0	0	0	7/9	4/15	0	3/3
1-15 Oct		41/67	64/141	0	0	0	1/2	0	0	3/4
16-31 Oct		30/88	1/10	0	0	0	5/10	0	0	1/1
TOTAL		950/1,859	445/1,130	13/26	12/17	14/16	364/1,841	5/30	10/16	36/43

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

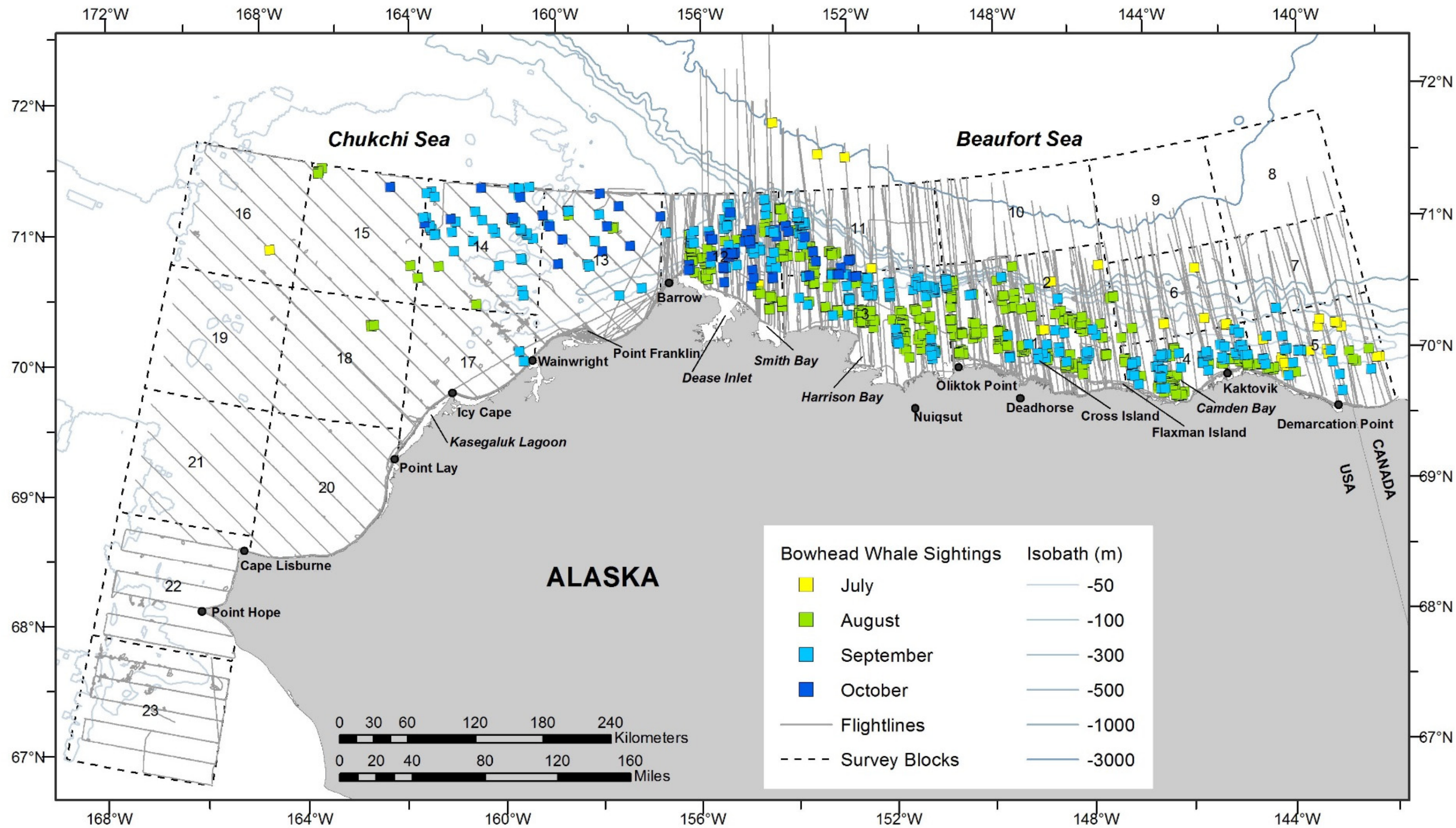


Figure 8. ASAMM 2016 bowhead whale sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown. Surveys were flown north of 72°N from 19 July to 20 August to survey additional Eastern Chukchi Sea beluga habitat.

Bowhead whales were last observed during the final survey of the year, on 26 October, when six whales were seen in block 12 northeast of Point Barrow. No bowhead whales were observed in block 1a.

BOWHEAD WHALE SIGHTING RATES

In summer and fall 2016, bowhead whales were seen on transect (Tr) from 140.1°W to 166.7°W. There were 511 sightings of 963 bowhead whales on transect by primary observers, ranging from one whale per sighting (n_s = 363) to 53 whales per sighting (n_s = 1). The highest number of sightings on transect was in block 3 (101 sightings), followed by block 12 (97 sightings) and block 1 (93 sightings). The largest group of bowhead whales on transect (53 animals) was observed on 26 August in block 3. When transect and circling from transect (Tr+TrC) sightings were combined, there were 890 sightings of 1,757 bowhead whales, ranging from one whale per sighting (n_s = 606) to 55 whales per sightings (n_s = 1).   The highest number of Tr+TrC sightings was in block 3 (187 sightings), followed by block 12 (171 sightings). There were three sightings of single bowhead whales on transect north of the study area (north of 72°N).

High fine-scale Tr sighting rates (WPUE, 5-km grid) for summer (July-August) were scattered throughout the western Beaufort Sea, including near Kaktovik, in and north of Camden Bay, near Oliktok Point, in Harrison Bay, between Harrison and Smith bays, and northeast of Barrow (Figure 9A). In fall (September-October), high fine-scale Tr sighting rates were near Kaktovik, in northern Camden Bay and northern Harrison Bay, offshore near Barrow Canyon in blocks 11 and 12, and on Hanna Shoal in blocks 14 and 15 (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 better represent on-effort sightings and effort in 2016 and better highlight areas of bowhead whale aggregations, particularly in summer (Appendix E, Figure E-1).

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 3 (0.084 WPUE), block 4 (0.067 WPUE), and block 1 (0.028 WPUE), with an overall Tr sighting rate of 0.017 WPUE. Sighting rates (Tr) in the western Beaufort Sea were very low in July in all survey blocks and increased dramatically in August in blocks 1, 2, 3, and 4 (Figure 10). The Tr sighting rates for summer (July and August combined) were highest in block 3 (0.140 WPUE), block 4 (0.057 WPUE), and block 1 (0.051 WPUE) (Appendix E, Table E-1). Sighting rate per block in July 2016 did not indicate a predominantly offshore distribution as noted in previous years; the highest sighting rate was in block 5 (0.025 WPUE) (Figure 10; Appendix E, Table E-1). Sighting rates in August were highest in block 3 (0.208 WPUE), block 1 (0.091 WPUE), and block 4 (0.086 WPUE). Combined Tr sighting rates for fall (September-October) were highest in block 4 (0.086 WPUE), block 3 (0.031 WPUE), and block 5 (0.026 WPUE); overall Tr sighting rate in fall for all blocks combined was 0.013 WPUE (Appendix E, Table E-1).

Sighting rates (Tr) in summer were relatively low in all Chukchi Sea blocks (13-23; Figure 10). In the Chukchi Sea in fall, the highest Tr sighting rate was 0.023 WPUE in block 14 (Appendix E, Table E-1). The overall Tr sighting rate for all Chukchi Sea survey blocks (13-23) in fall was

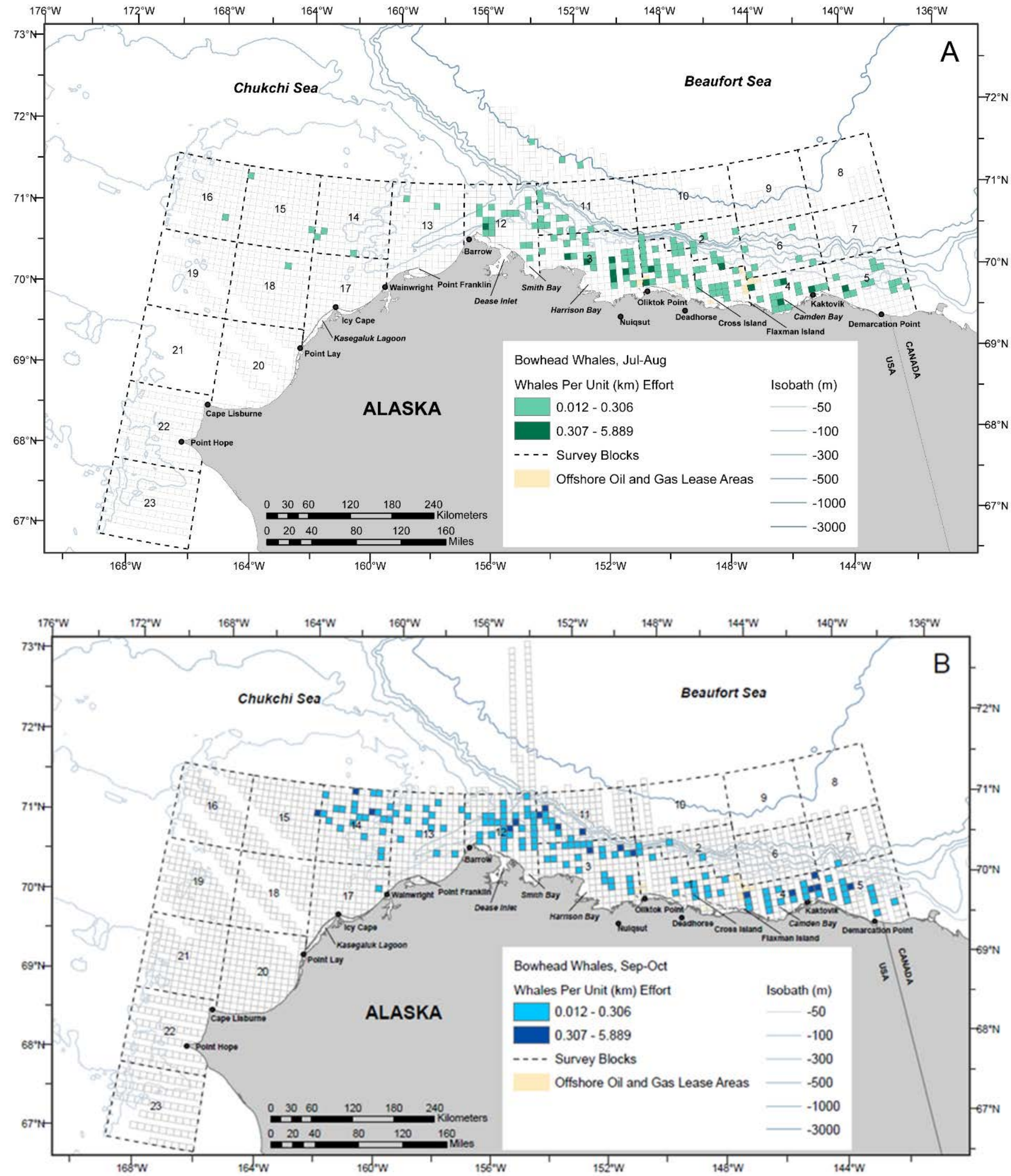


Figure 9. ASAMM 2016 bowhead whale sighting rates (WPUE; transect sightings from primary observers only). A: summer (July-August); B: fall (September-October). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

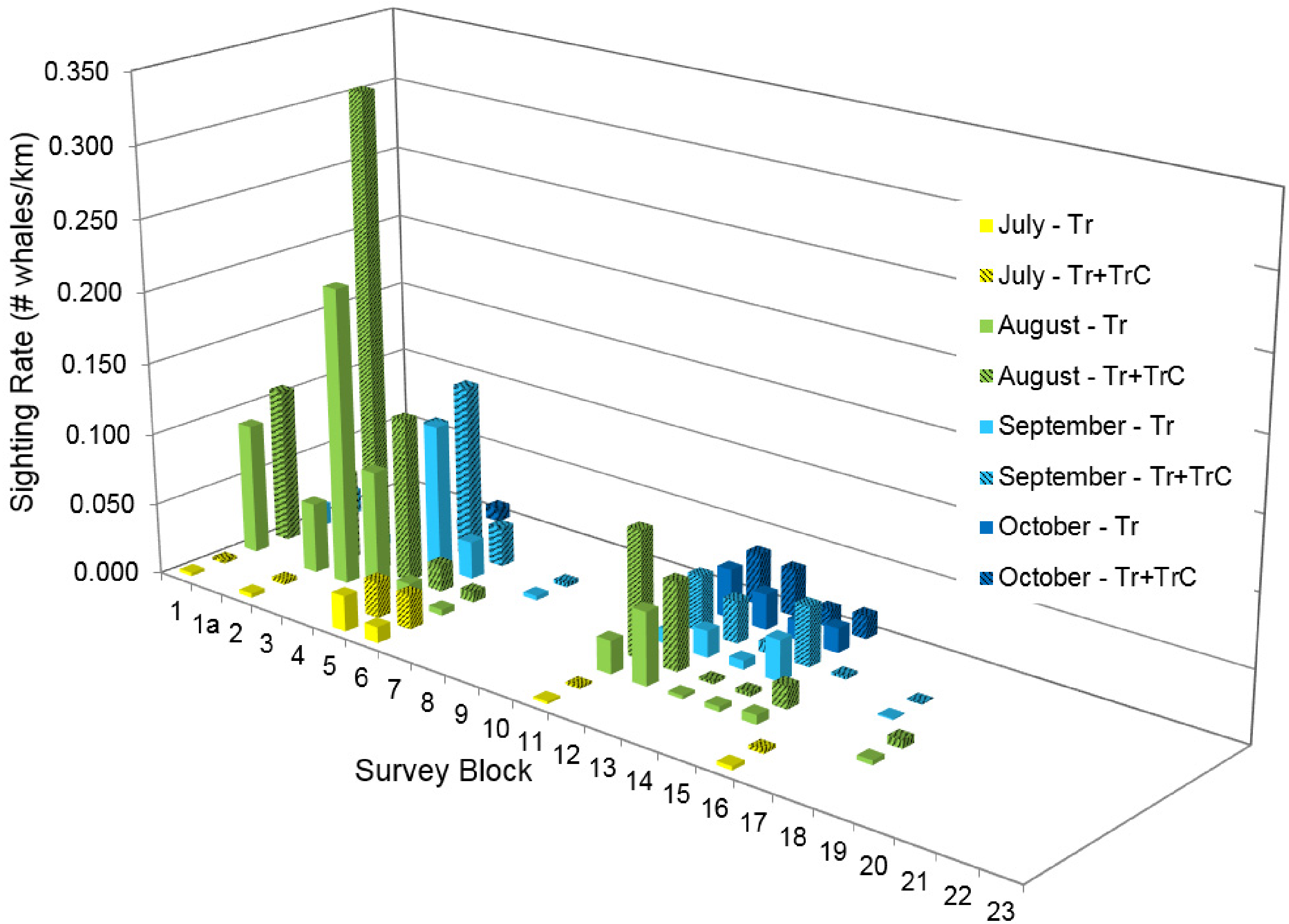


Figure 10. ASAMM 2016 bowhead whale monthly sighting rates (WPUE; sightings from primary observers only) per survey block for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity. Does not include effort north of 72°N.

0.006, which was similar to the overall Tr sighting rate for this area in 2013, 2014, and 2015 (Clarke et al. 2014, 2015a, 2017) and lower than the Tr sighting rate for this area in 2012 (Clarke et al. 2013a).

Sighting rates per block calculated using sightings and effort on transect combined with sightings and effort during 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 were in block 3 in August (0.335 WPUE) and block 4 in September (0.122 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:

- 36-50 m depth zone (0.002 WPUE) in the eastern Chukchi Sea subarea (157°W-169°W);
- 21-50 m depth zone (0.045 WPUE) in the western (154°W-157°W) Alaskan Beaufort Sea subarea; and
- ≤20 m depth zone (0.144 WPUE) in the central-eastern (140°W-154°W) Alaskan Beaufort Sea subarea, influenced by August; sighting rates in July alone were highest in the 51-200 m (0.017 WPUE) depth zone (Figure 11).

The shift from highest Tr sighting rates in offshore, deeper water (51-200 m) in July to shallower water (≤20 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, 2017) but was much more pronounced in 2016.

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 (0.016 WPUE) in the eastern Chukchi Sea subarea (157°W-169°W);
- 51-200 m depth zone (0.026 WPUE) in the western (154°W-157°W) Alaskan Beaufort Sea subarea; and
- 51-200 m depth zone (0.037 WPUE) in the central-eastern (140°W-154°W) Alaskan Beaufort Sea subarea.

High Tr sighting rates in September in both the western (154°W-157°W) and central-eastern (140°W-154°W) Alaskan Beaufort Sea subareas were in the 21-50 m depth zone and shifted to deeper water in October.

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

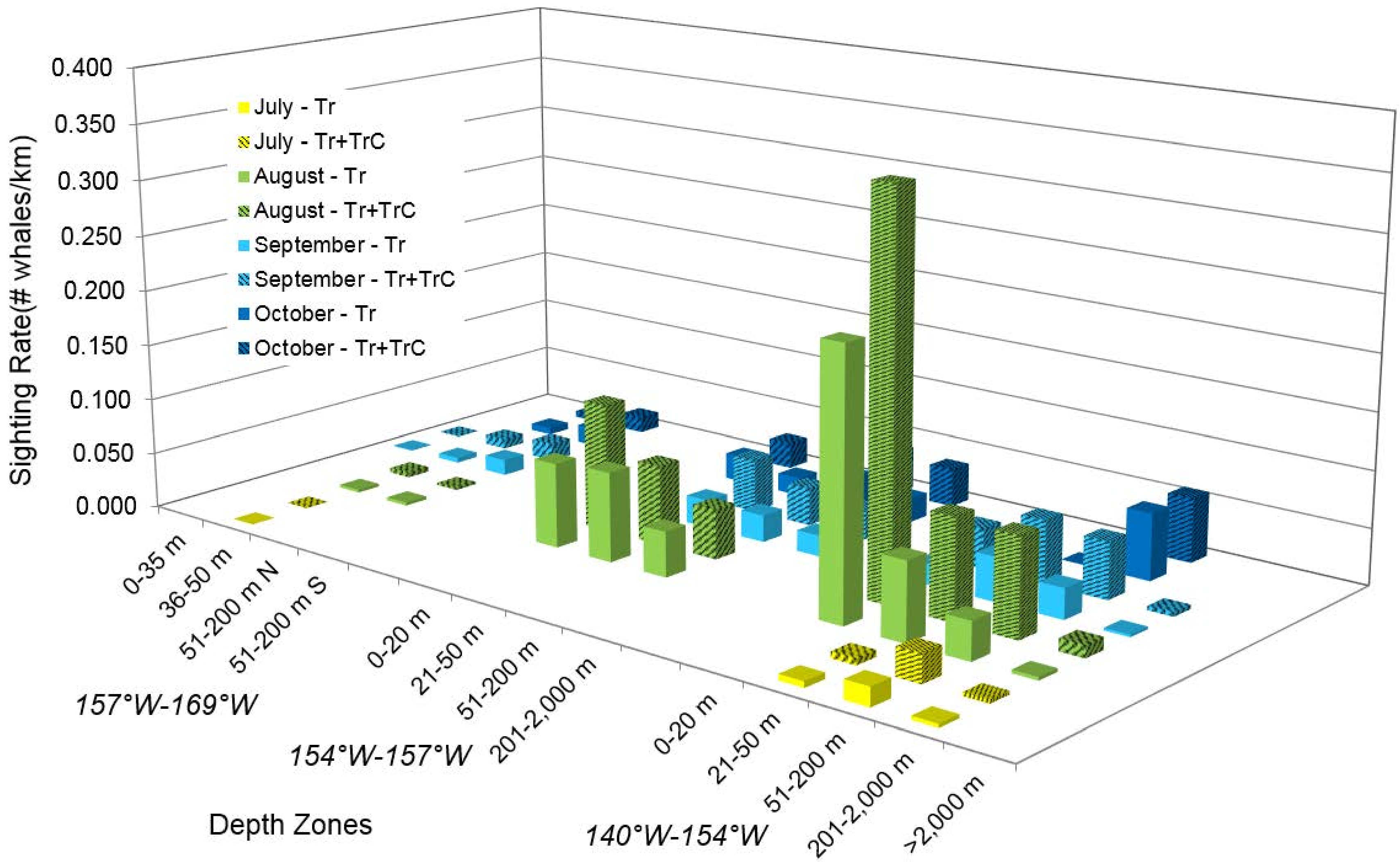


Figure 11. ASAMM 2016 bowhead whale monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity. Does not include effort north of 72°N.

Bowhead Whale Sea Ice Associations

Most bowhead whales (88%, n_i = 1,628) were observed in 0% sea ice cover (Table 4). One hundred seventy-seven bowhead whales (10%) were sighted in 1-10% sea ice cover, 51 bowhead whales (<3%) were sighted in 11-40% sea ice cover, and three bowhead whales (<1%) were sighted in 41-60% sea ice cover. Most bowhead whales observed in areas of sea ice were seen in the western Alaskan Beaufort Sea (west of 151°W) where sea ice remained in some of the study area through late September (Appendix A). Eight whales were seen in 1-30% broken floe sea ice in July in the eastern Alaska Beaufort Sea before sea ice receded from that part of the study area (see Appendix A, Figures A-1 and A-2).

Bowhead Whale Behaviors

Bowhead whale behaviors observed during all survey modes (i.e., transect, search and circling) and by primary and secondary observers in 2016 are summarized in Table 5. The behavior most often recorded was swimming (46%, n_i = 857), followed by feeding (32%, n_i = 598), milling (9%, n_i = 175), resting (9%, n_i = 166), and diving (2%, n_i = 32). 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. Seventeen whales were recorded exhibiting display behaviors, including breaching (11 whales), tail slapping (three whales), log playing (two whales), and head slapping (one whale; differentiated from breaching because only the head exited the water). Behavior was recorded as unknown for 14 whales, likely because the sightings were too far away to determine a behavior. Nine bowhead whales (<1% 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. Bowhead whale swim direction was not clustered around any heading in the northeastern Chukchi in summer or fall. The mean vector swim direction in summer was 218°T and in fall was 286°T, but headings were scattered in all directions in both seasons (Rayleigh Z, summer = 2.386, P = 0.091, 22 observations; fall = 0.887, P = 0.412, 71 observations). In the western Beaufort Sea, bowhead whale swim direction was significantly clustered in a northwesterly heading in summer (307°T; Rayleigh Z = 11.156, P < 0.0001, 141 observations) and westerly in fall (269°T; Rayleigh Z = 4.585, P = 0.01, 84 observations).

Bowhead Whale Calves

Out of the 1,859 bowhead whales sighted, 104 were identified as calves (Figure 12). Most calves (n_i = 79, 76%) were sighted after circling was initiated and likely would not have been observed if circling had not commenced. Calves were seen from late July through mid-October, distributed from 140°W to 164°W. Calves were seen in the eastern Alaskan Beaufort Sea (140°W-144°W) in July, distributed across the entire western Beaufort Sea (140°W-157°W) in August and September, and limited to the western Alaskan Beaufort and northeastern Chukchi seas (152°W-164°W) in October. Most calves (94%) were seen in the western Beaufort Sea. Calves were observed with adult bowhead whales that were feeding, milling, resting, swimming,

Table 4. ASAMM 2016 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	24/29	128/213	313/908	151/197	95/128	41/67	28/86	780/1,628
1-5	0	5/6	4/10	36/47	19/21	47/75	0	0	111/159
6-10	0	0	1/1	1/1	3/5	7/10	0	1/1	13/18
11-20	1/1	0	0	0	6/7	7/7	0	1/1	15/16
21-30	2/3	0	1/1	1/1	2/2	2/2	0	0	8/9
31-40	1/1	1/1	1/1	1/1	15/21	1/1	0	0	20/26
41-50	0	0	0	1/1	0	1/1	0	0	2/2
51-60	0	0	0	0	1/1	0	0	0	1/1
61-70	0	0	0	0	0	0	0	0	0/0
71-80	0	0	0	0	0	0	0	0	0/0
TOTAL	4/5	30/36	135/226	353/959	197/254	160/224	41/67	30/88	950/1,859

Table 5. ASAMM 2016 semimonthly summary of bowhead 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	16-30 Oct	Total
Breach	0	1/1	0	1/3	3/3	2/2	1/1	1/1	9/11
Dive	0	0	0	15/15	6/11	2/2	0	2/4	25/32
Feed	2/3	0	21/53	73/519	8/12	1/4	3/7	0	108/598
Log play	0	0	0	0	2/2	0	0	0	2/2
Mill	0	0	5/18	30/94	7/18	10/29	3/8	1/8	56/175
Rest	1/1	1/1	15/18	46/60	21/26	36/48	8/11	1/1	129/166
Swim	1/1	26/32	93/136	180/254	149/181	109/139	26/40	25/74	609/857
Tail slap	0	1/1	1/1	0	1/1	0	0	0	3/3
Unknown	0	0	0	8/14	0	0	0	0	8/14
Other	0	1/1*	0	0	0	0	0	0	1/1
TOTAL	4/5	30/36	135/226	353/959	197/254	160/224	41/67	30/88	950/1,859

* head slap

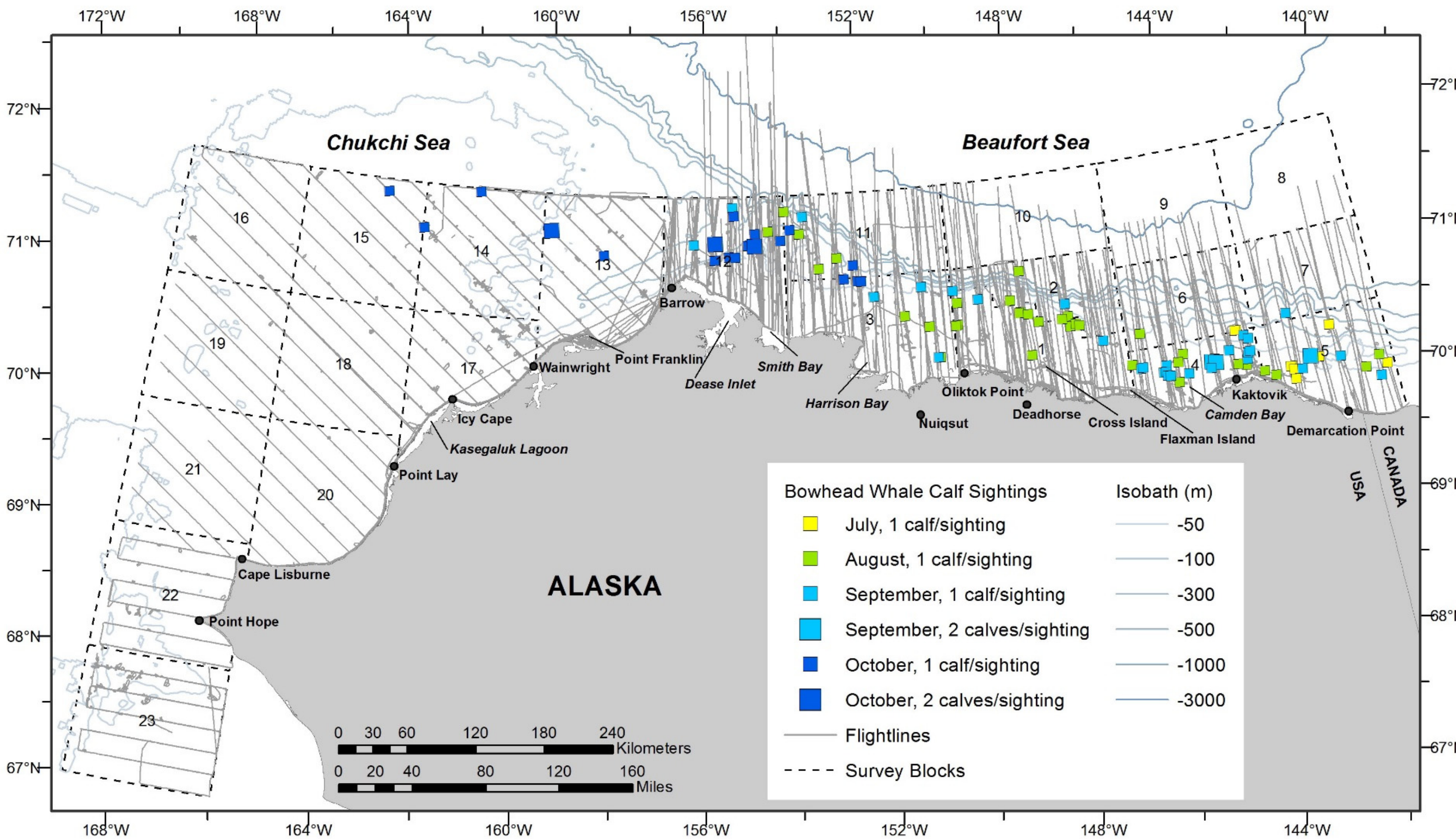


Figure 12. ASAMM 2016 bowhead whale calf sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

and displaying. Three of the calves appeared to be nursing. One adult bowhead whale was sighted initially with two calves, although one of the calves was later observed swimming away from that adult. Ten calves were sighted without a closely associated adult, although in three cases adult whales were in the general vicinity.

Seasonal differences were apparent in bowhead whale calf distribution and calf ratio. Forty-five bowhead whale calves (43%) were sighted during summer months in the western Beaufort Sea between 140°W and 155°W, broadly distributed in nearshore and offshore waters in both July and August. The summer calf ratio (number of calves/number of total whales) was 0.037. This ratio may be biased downward because calves may have been missed on 26 August when several hundred bowhead whales were recorded in a very short amount of time (Appendix B, Flight 22). Fifty-nine bowhead whale calves (57%) were sighted during fall months, distributed from 140.4°W to 164°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 0.093.

Bowhead Whale Feeding

Bowhead whale feeding behavior, which includes sightings reported as milling, was observed from July through October 2016. During summer months (July-August), feeding behavior was documented on 11 days in the western Alaskan Beaufort Sea (142.5°W-156.3°W), at depths ranging from 9 m to 240 m (3 km to 89 km from shore) (Figure 13A), and on one day in the northeastern Chukchi Sea (~163.2°W) at 44 m depth (118 km from shore). In fall (September-October), feeding behavior was observed on 9 days in the western Beaufort Sea and on 4 days in the northeastern Chukchi Sea (Figure 13B). Water depths at sightings of feeding whales in fall in the western Beaufort Sea ranged from 14 m to 227 m (8 km to 71 km from shore) and from 35 m to 50 m (98 km to 149 km from shore) in the northeastern Chukchi Sea. Sighting rates for feeding and milling bowhead whales on transect in summer and fall are shown in Figure 14. Unlike most years, higher feeding and milling sighting rates were calculated for summer than fall.

The area between roughly Cape Halkett and Point Barrow (152.5°W-156.5°W) encompasses a well-documented bowhead whale feeding area (Moore and Reeves 1993; Mocklin et al. 2011) that has been linked to upwelling winds and the formation of a "krill trap" (Ashjian et al. 2010). In 2016, surveys were conducted in this area on 17 days, and bowhead whales were observed on all 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. Only 27% (n_i = 130) of the bowhead whales that were observed between Point Barrow and Cape Halkett were recorded as feeding. Bowhead whales were observed feeding on 7 of the 17 days (Figure 15), and there were few sightings in the krill trap area (≤20 m depth). Aggregations of feeding bowhead whales were seen nearshore on 25 August (Flight 228), when 64% (n_i = 62) of the whales seen were feeding, and 26 August (Flight 22), when 50% (n_i = 9) of the whales seen were feeding. On two days, 20 August (Flights 18 and 224) and 10 October (Flight 48), aggregations of feeding bowhead whales were seen but were considerably farther offshore than the normal krill trap area. Three or fewer feeding whales were seen on 11 July, and 13 and 19 September.

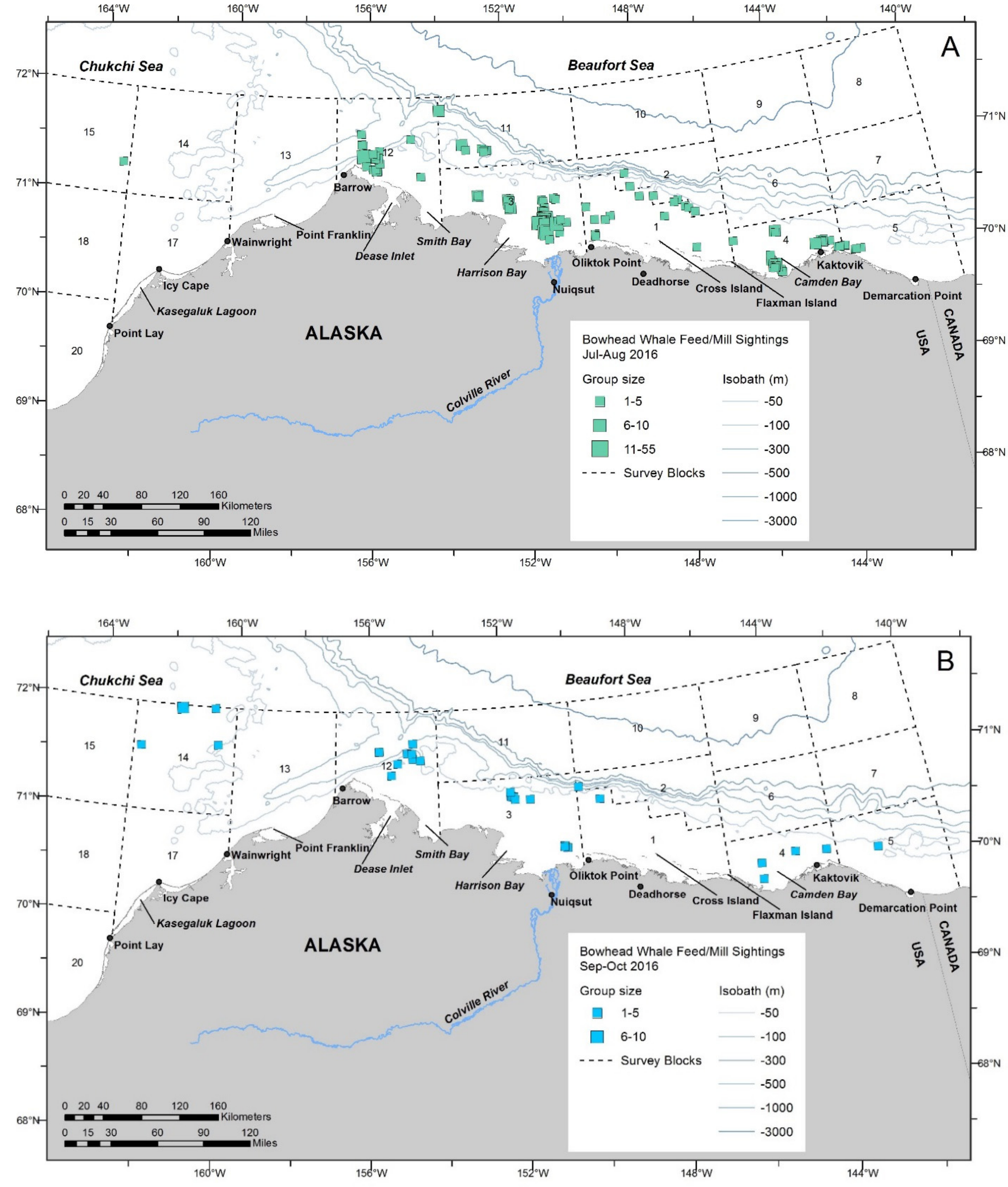


Figure 13. ASAMM 2016 bowhead whale feeding and milling sightings, all survey modes (transect, search, and circling). A: summer (July-August); B: fall (September-October).

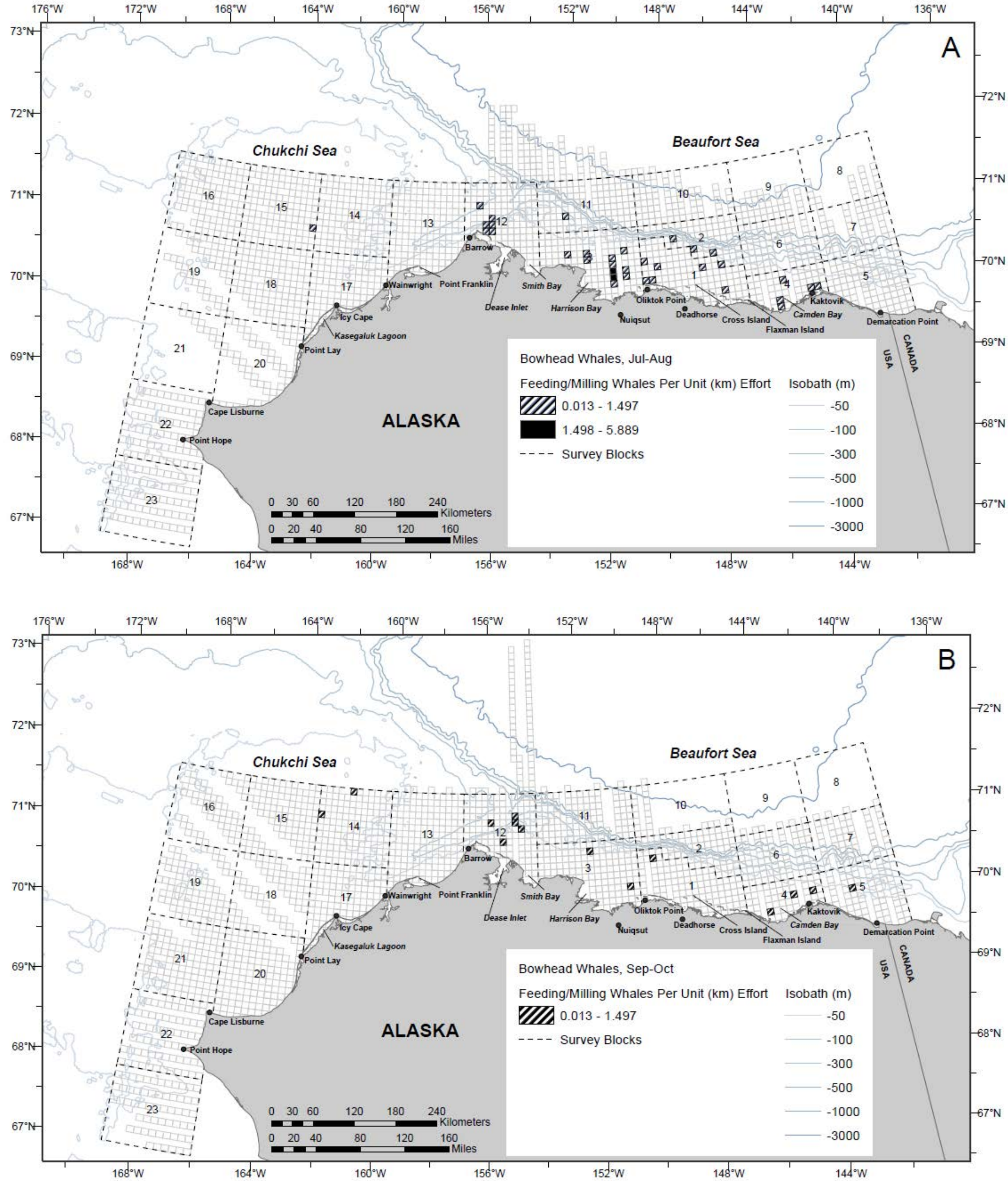


Figure 14. ASAMM 2016 bowhead whale feeding and milling sighting rates (WPUE; transect sightings from primary observers only). A: summer (July-August); B: fall (September-October). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

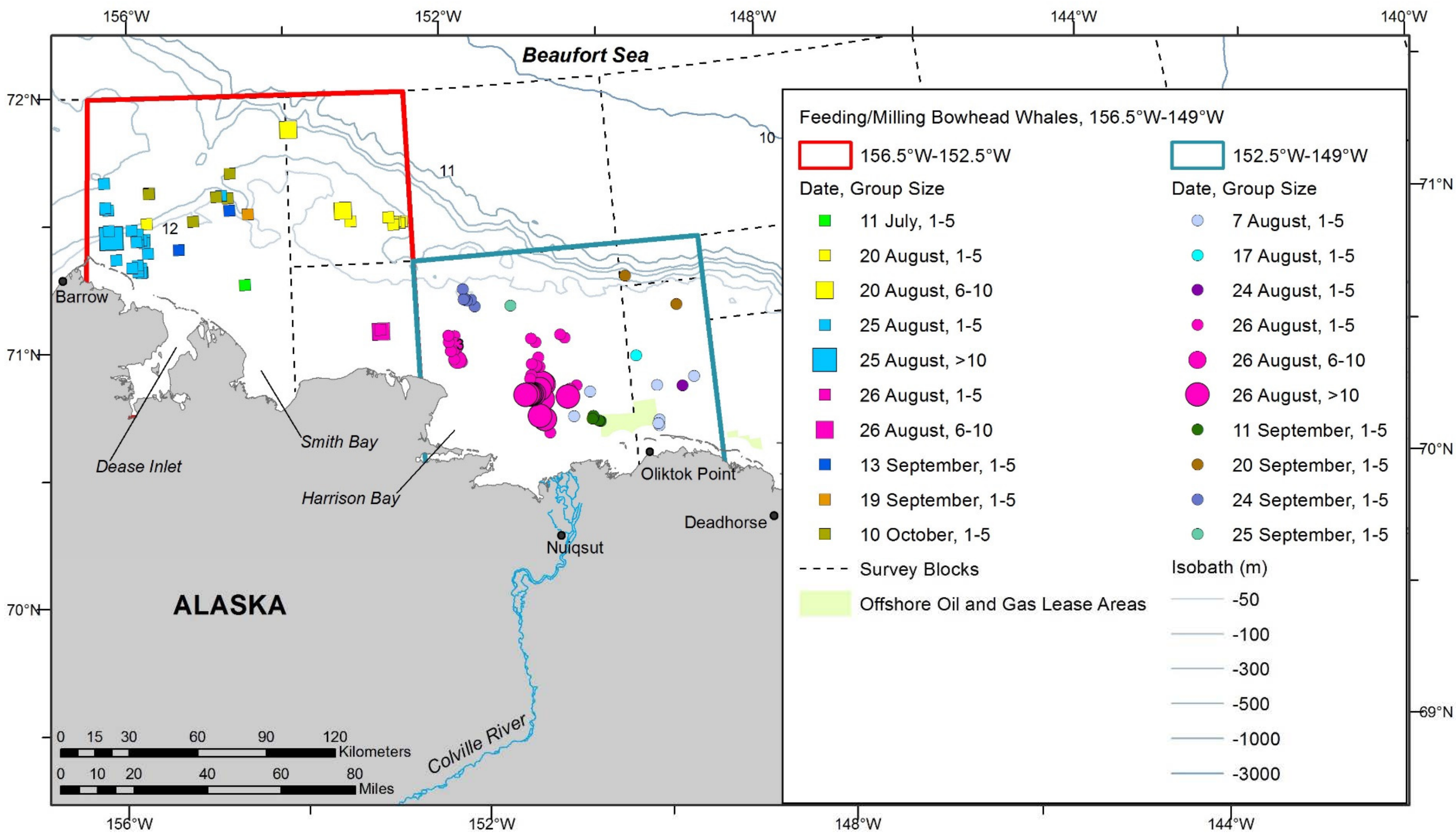


Figure 15. ASAMM 2016 feeding and milling bowhead whale sightings near Barrow (152.5°W-156.5°W) and in Harrison Bay (149°W-152.5°W), all survey modes (transect, search, and circling), July-October.

In contrast, the region immediately east of the krill trap area (149°W-152.5°W, Harrison Bay) was where the majority of feeding whales were seen in 2016. Surveys were conducted in this area on 23 days in 2016, and bowhead whales were observed on 15 of those days. Feeding behavior was observed on 8 days between early August and late September (Figure 15). Notably, sightings on 26 August (Appendix B, Flight 22) accounted for 89% (40 sightings of 435 bowhead whales) of all feeding behavior recorded in this area, and 56% of all feeding behavior recorded in 2016. Bowhead whale feeding previously has not been commonly recorded in Harrison Bay in summer or fall.

BOWHEAD WHALE CENTRAL TENDENCY – ANALYSIS 1

Distribution of Bowhead Whales, Summer 2016 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) 2016, 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, 1993-2015) (Figure 16).

In the East Region, mean depth at bowhead whale sightings made on transect by primary observers in summer 2016 was 95 m (SD = 294.0 m, range 6-2,145 m) and median depth was 38 m (Table 6). In the West Region, mean depth was 46 m (SD = 116.2 m, range 9-1,476 m) and median depth was 22 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 2016 were 28.6 km (SD = 22.3 km) and 20.3 km, respectively (Table 6). In the West Region, mean and median distances to the normalized shoreline were 25.7 km (SD = 20.5 km) and 30.6 km, respectively.

To evaluate whether significant displacements occurred in western Beaufort Sea bowhead whale HUAs during summer 2016 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 2012-2015 and 2016.

A Mann-Whitney *U*-test of significant difference of medians indicated that bowhead whales sighted on transect by primary observers in summer 2016 in the East Region were in significantly shallower water (median depth = 38 m; $Z = -4.611$, $P < 0.0001$) and significantly closer to shore (median distance from shore = 20.3 km; $Z = 4.316$, $P < 0.0001$) than bowhead whales sighted in 2012-2015 (median depth = 48 m; median distance from shore = 39.4 km) (Table 6). In the West Region, there was no significant difference in median depth or distance from shore of bowhead whale sightings between 2016 (22 m depth, 30.6 km from shore) and 2012-2015 (28 m depth, 33.6 km from shore) (Table 6).

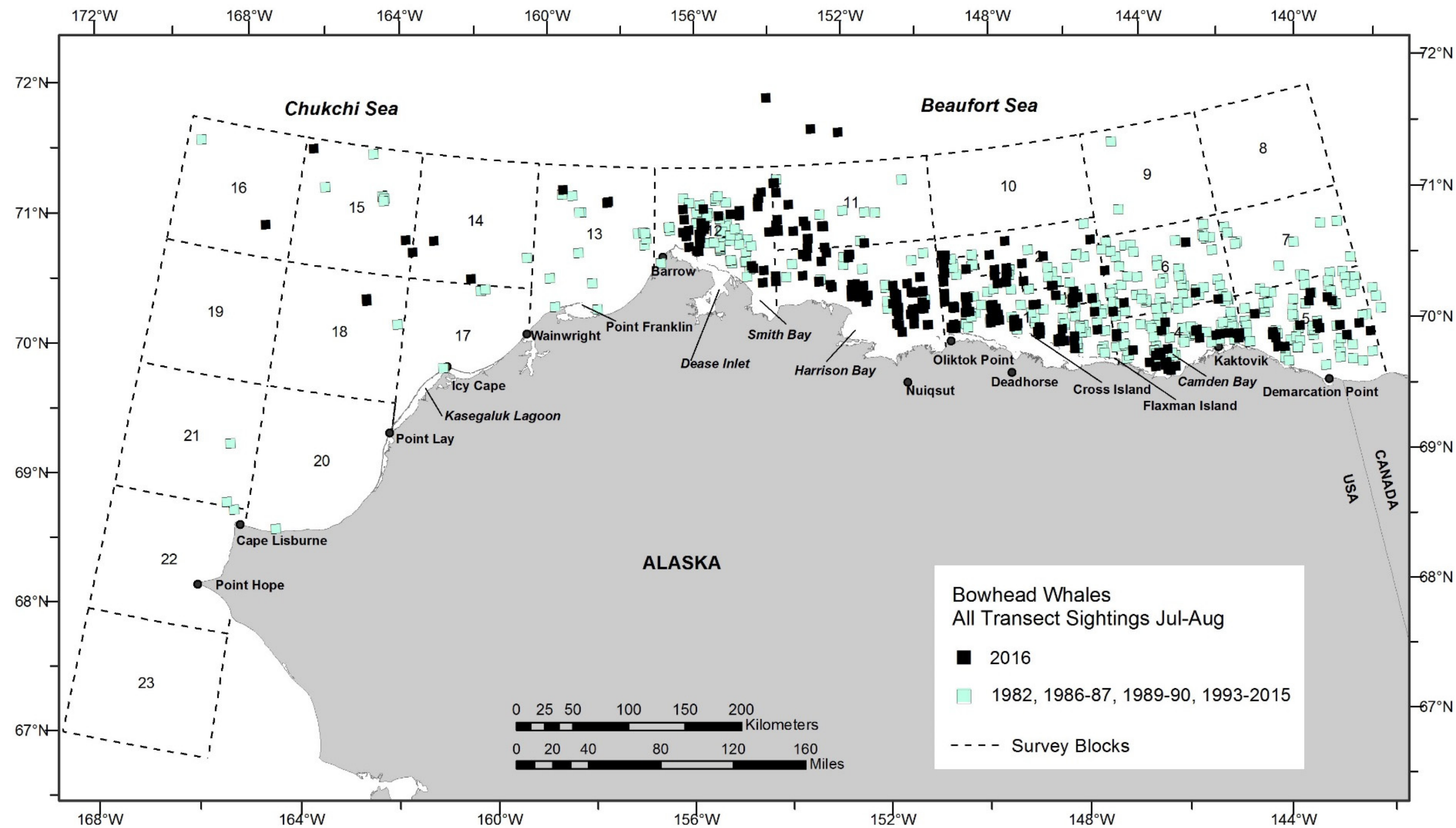


Figure 16. ASAMM bowhead whale sightings on transect, July-August, in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2015, and 2016. Includes all sightings on transect made by primary and secondary observers.

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, 2012-2016. TrSi = number of transect sightings made by primary observers.

2012-2016 Summer, by Region			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Year/Season	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
2016 Summer	East	81	38	95	294.0	6-2,145	20.3	28.6	22.3	3-98
2012-2015 Summer	East	196	48	233	478.3	10-2,461	39.4	43.3	28.10	1-134
2016 Summer	West	169	22	46	116.2	9-1,476	30.6	25.7	20.5	4-89
2012-2015 Summer	West	69	28	113	341.2	10-2,614	33.6	34.8	23.3	5-124
2012-2016 Summer, by Month			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Year/Season	**Month**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
2016 Summer	Jul	21	54	275	544.8	26-2,145	40.9	46.3	25.1	11-98
2016 Summer	Aug	229	24	42	101.2	6-1,476	27.3	32.2	20.6	3-89
2012-2015 Summer	Jul	62	235.5	533	640.9	13-2,614	66.9	66.5	24.6	9-124
2012-2015 Summer	Aug	203	39	101	390.6	10-2,461	29.4	33.3	22.9	1-134
2016 Season, by Region			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Season	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
Summer	East	81	38	95	294	6-2,145	20.3	28.6	22.3	3-98
Fall	East	63	36	40	44.4	5-372	19.5	21.3	12.0	4-60
Summer	West	169	22	46	116.2	9-1,476	30.7	35.7	20.5	4-89
Fall	West	118	44	59	52.4	8-227	46.5	46.6	19.9	9-90

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 2016 compared to August 2016. The median depth in July was 54 m compared to 24 m in August (Z = -5.310, P < 0.0001) and the median distance from shore was 40.9 km in July compared to 27.3 km in August (Z = 2.504, P = 0.0123). Similar results were found in summer 2012-2014, but not in summer 2015 (Clarke et al. 2017).

Distribution of Bowhead Whales During Summer and Fall Months, 2016

Summary statistics for bowhead whale data from the western Beaufort Sea in summer (July-August) 2016 were compared to values for fall (September-October) 2016 (Table 6). In the East Region, depth and distance from shore were not significantly different for bowhead whales sighted on transect in summer (median depth 38 m, median distance 20.3 km) and fall (median depth 36 m, median distance 19.5 km). In the West Region, bowhead whales sighted on transect in summer were in significantly shallower water (median depth 22 m vs 44 m, Z = 4.740, P < 0.0001) and significantly nearer shore (median distance 30.7 km vs 46.5 km, Z = -4.304, P < 0.0001) than bowhead whales sighted on transect in fall. This is the exact opposite of what was observed in 2012-2015, when bowhead whales were consistently seen in deeper water and farther from shore in summer compared to fall.

Distribution of Bowhead Whales, Fall 2016, Relative to Bowhead Whale Distribution in Previous Years with Light Sea Ice Cover

Bowhead whale distribution in the western Beaufort Sea in September-October 2016, based on transect 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, 1993-2015) (Figure 17), particularly in the eastern Alaskan Beaufort Sea (east of 148°W).

Summary statistics for bowhead whale data from the western Beaufort Sea in fall (September-October) 1990-2016 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 2016 was 40 m (SD = 44.4 m, range 5-372 m) and median depth was 36 m (Table 7). In the West Region, mean depth was 59 m (SD = 52.4 m, range 8-227 m) and median depth was 44 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 2016 were 21.3 km (SD = 12.0 km) and 19.5 km, respectively (Table 7). In the West Region, mean and median distances to the normalized shoreline were 46.6 km (SD = 19.9 km) and 46.5 km, respectively.

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, 1990-2016. 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**
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

			DEPTH (M)				DISTANCE FROM SHORE (KM)			
Year	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
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
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

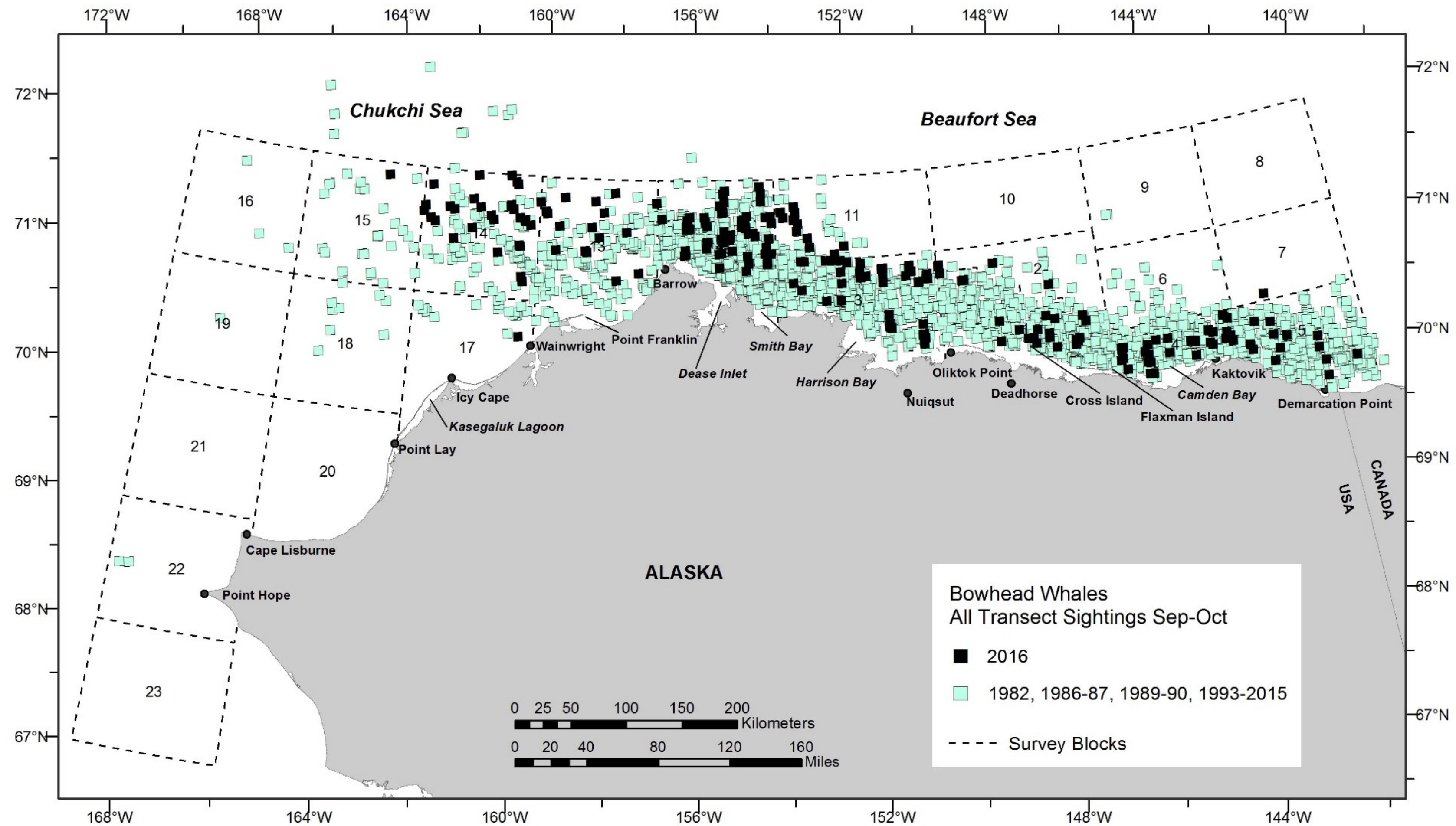


Figure 17. ASAMM bowhead whale sightings on transect, September-October, in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2015, and 2016. Includes all sightings on transect made by primary and secondary observers.

To evaluate whether significant displacements occurred in western Beaufort Sea bowhead whale HUAs during fall 2016 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) 2016 in the East Region, bowhead whale sightings were distributed similarly by depth (median depth 36 m vs. 38 m; $Z = -1.460$, $P = 0.1443$) and distance from shore (median distance from shore 19.5 km vs. 22.9 km; $Z = 1.567$, $P = 0.1170$) compared to bowhead whale sightings in previous years with light sea ice cover. In the West Region, bowhead whale sightings were in significantly deeper water (median depth 44 m vs. 20 m, $Z = 9.079$, $P < 0.0001$) and farther from shore (median distance from shore 46.5 km vs. 23.4 km, $Z = -9.636$, $P = 0.0001$) in fall 2016 than in previous years with light sea ice cover.

BOWHEAD WHALE CENTRAL TENDENCY – ANALYSIS 2

The 2016 spatial relative abundance model (Generalized Additive Model) for fall (September-October) incorporated 191 bowhead whale sightings of 289 total individuals (Figure 18A). Relative abundance predictions resulting from the Generalized Additive Model applied to the 2016 survey data for the western Beaufort Sea are shown in Figure 18B. The highest predicted relative abundance was located approximately 15-120 km offshore between Point Barrow and Harrison Bay (~150^{o}W to ~156^{o}W), and within approximately 60 km of shore in the vicinity of Camden Bay (~142^{o}W to ~145^{o}W). The nearshore area with the lowest predicted relative abundance ranged from Deadhorse to Oliktok Point (~148^{o}W to ~150^{o}W). The HUA was broadest north of Harrison Bay.

The 2000-2016 model (July-October) incorporated 1,779 bowhead whale sightings of 3,287 individuals. In July there were 83 bowhead whale sightings (131 individuals) (Figure 19A), all of which were sighted from 2012 to 2016. 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 19B). 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 60 to 90 km offshore, from ~140.5°W to ~143°W.

There were a total of 452 bowhead whale sightings (923 individuals) in August (Figure 19C), most of which were from 2012 to 2016. The spatial model predicted that bowhead whale HUAs were closest to shore in Camden Bay and northern Harrison Bay (Figure 19D). Three distinct areas had the highest predicted relative abundance in August: 7-30 km from shore in Camden Bay, 30-60 km from shore near Harrison Bay, and 15-50 km from shore in the waters over Barrow Canyon.

The model incorporated 918 bowhead whale sightings (1,635 individuals) in September (Figure 19E) and 326 sightings (598 individuals) in October (Figure 19G). In September, bowhead whale relative abundances were highest, and the HUAs were located closest to shore, from Dease Inlet to Smith Bay, and just outside the barrier islands from ~148°W to ~146.5°W (Figure 19F). 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

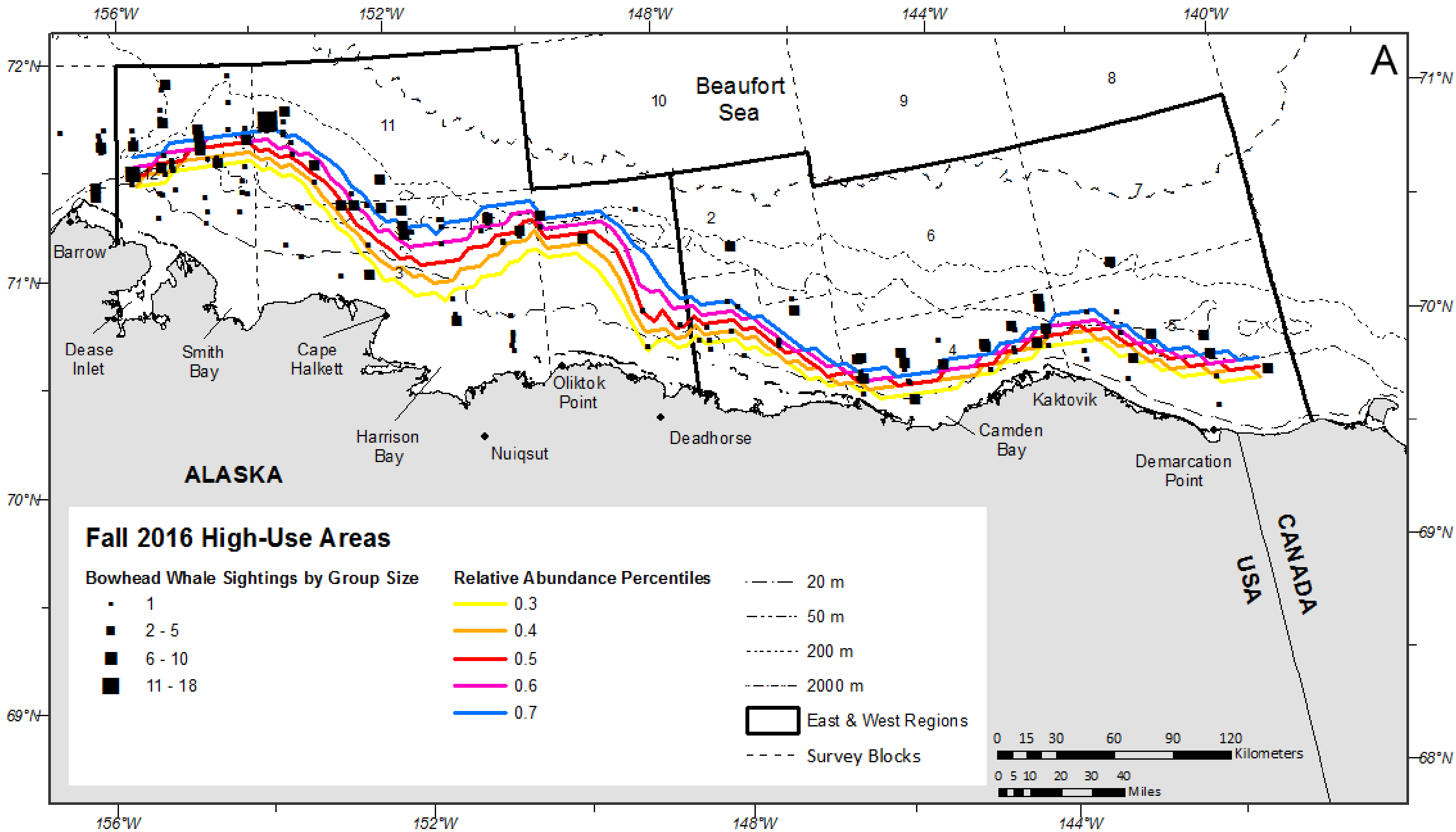


Figure 18. ASAMM September and October 2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance based on a spatial model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea. A: Transect 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.

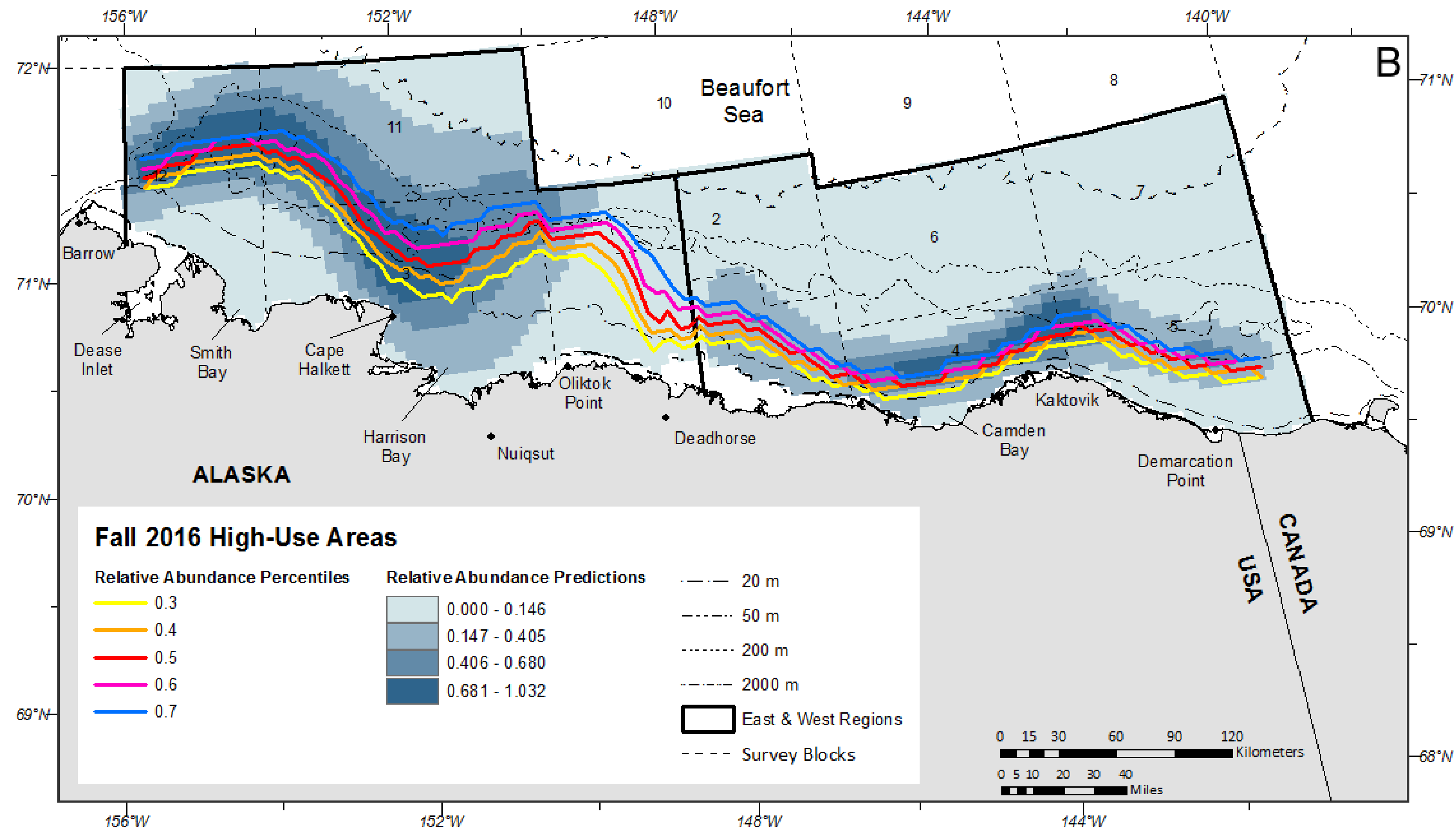


Figure 18 (cont.). ASAMM September and October 2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance based on a spatial model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea. B: Predicted 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.

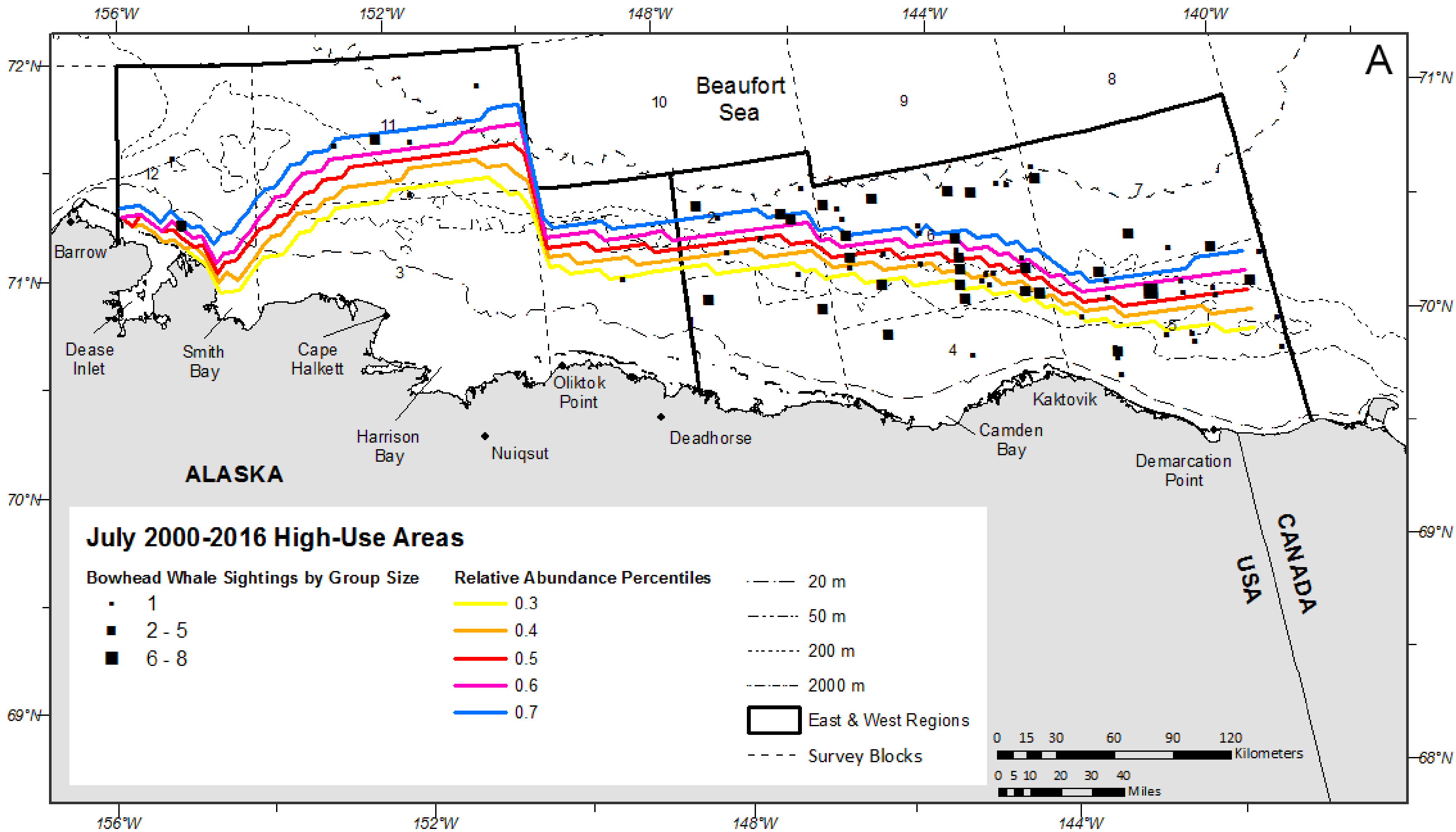


Figure 19. ASAMM 2000-2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. A: July sightings. The bowhead whale High-Use Area is represented by distribution percentiles (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.

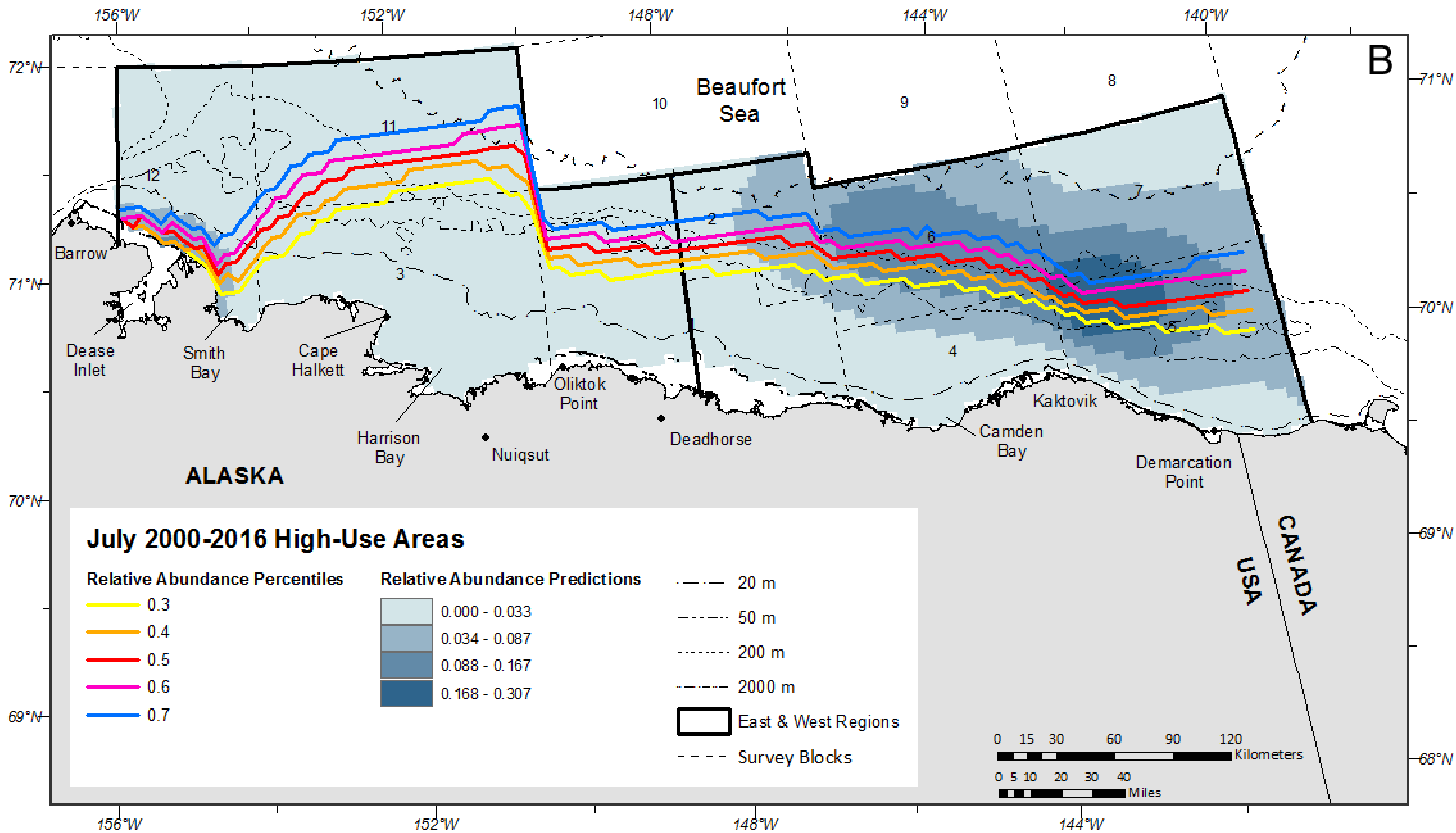


Figure 19 (cont.). ASAMM 2000-2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in 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.

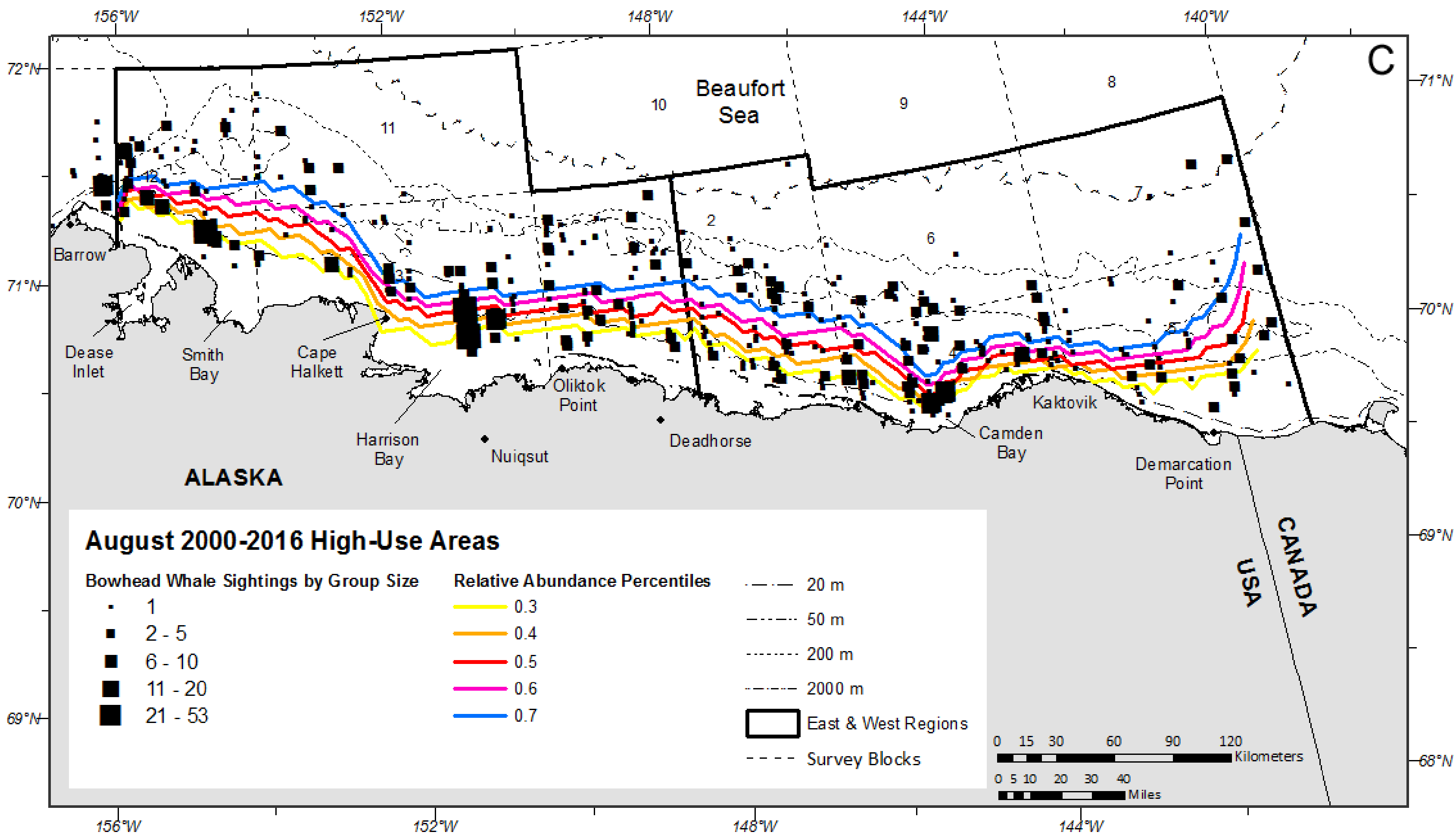


Figure 19 (cont.). ASAMM 2000-2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. C: August sightings. The bowhead whale High-Use Area is represented by distribution percentiles (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.

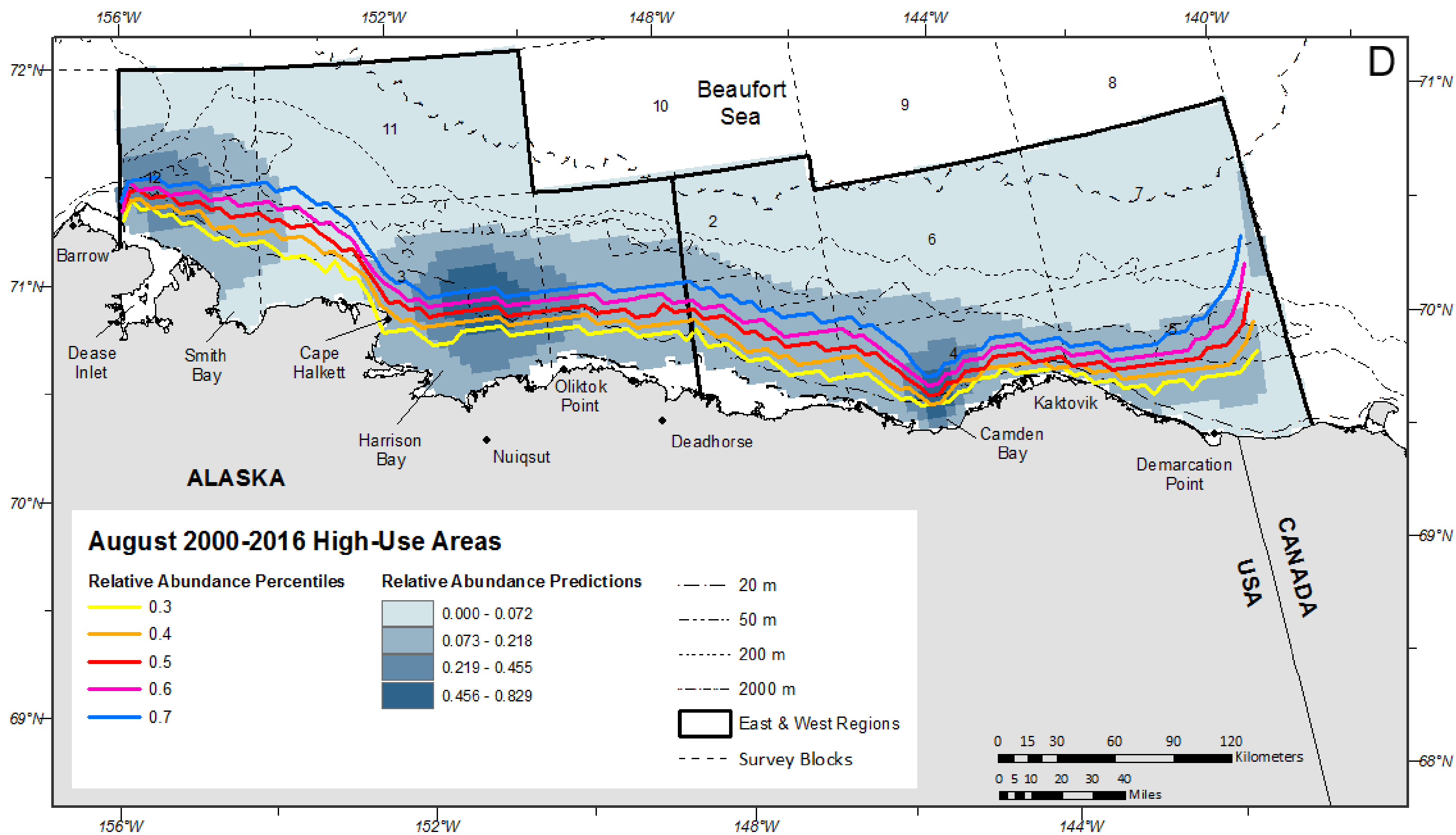


Figure 19 (cont.). ASAMM 2000-2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in 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.

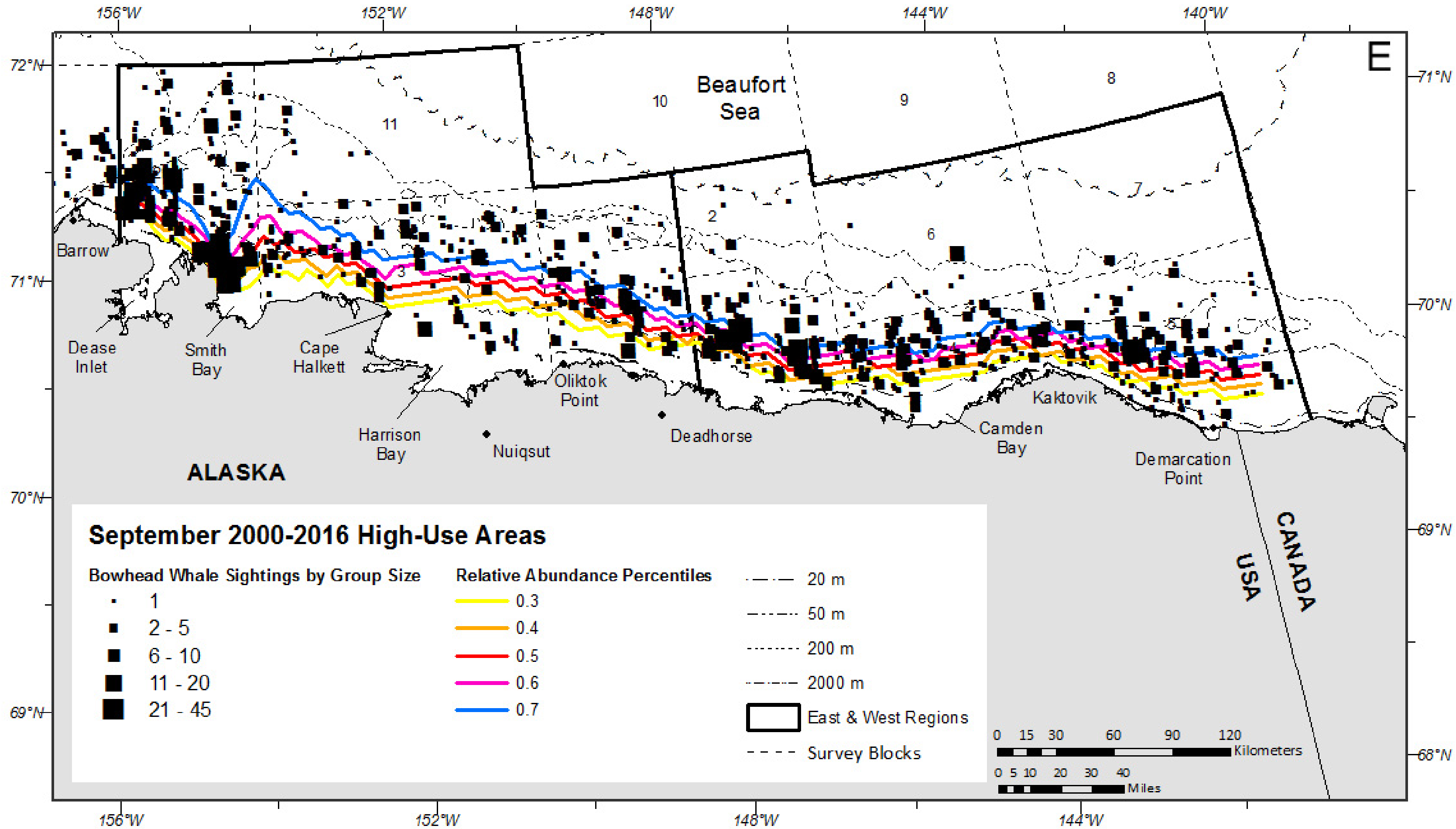


Figure 19 (cont.). ASAMM 2000-2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in 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.

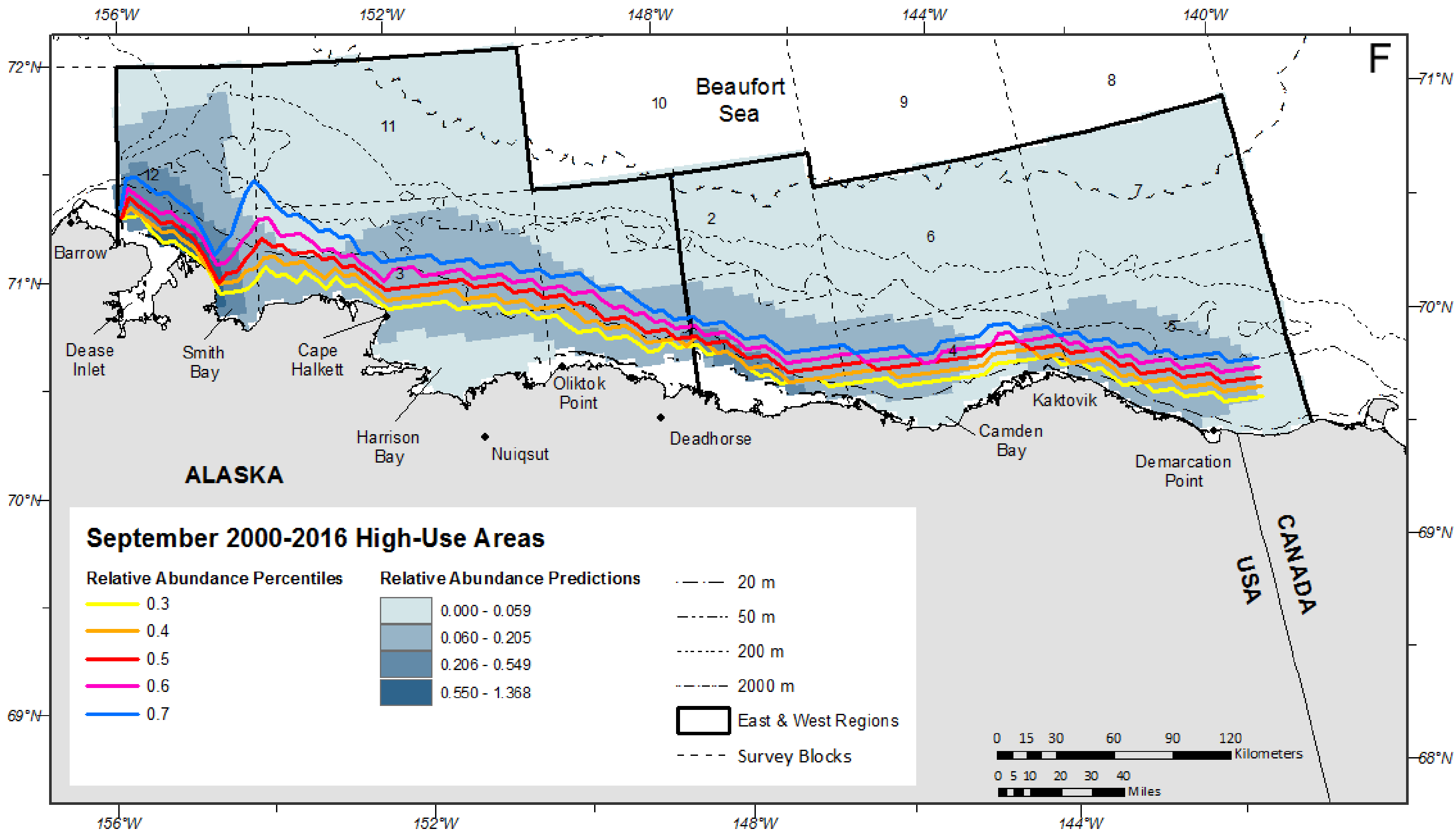


Figure 19 (cont.). ASAMM 2000-2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in 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.

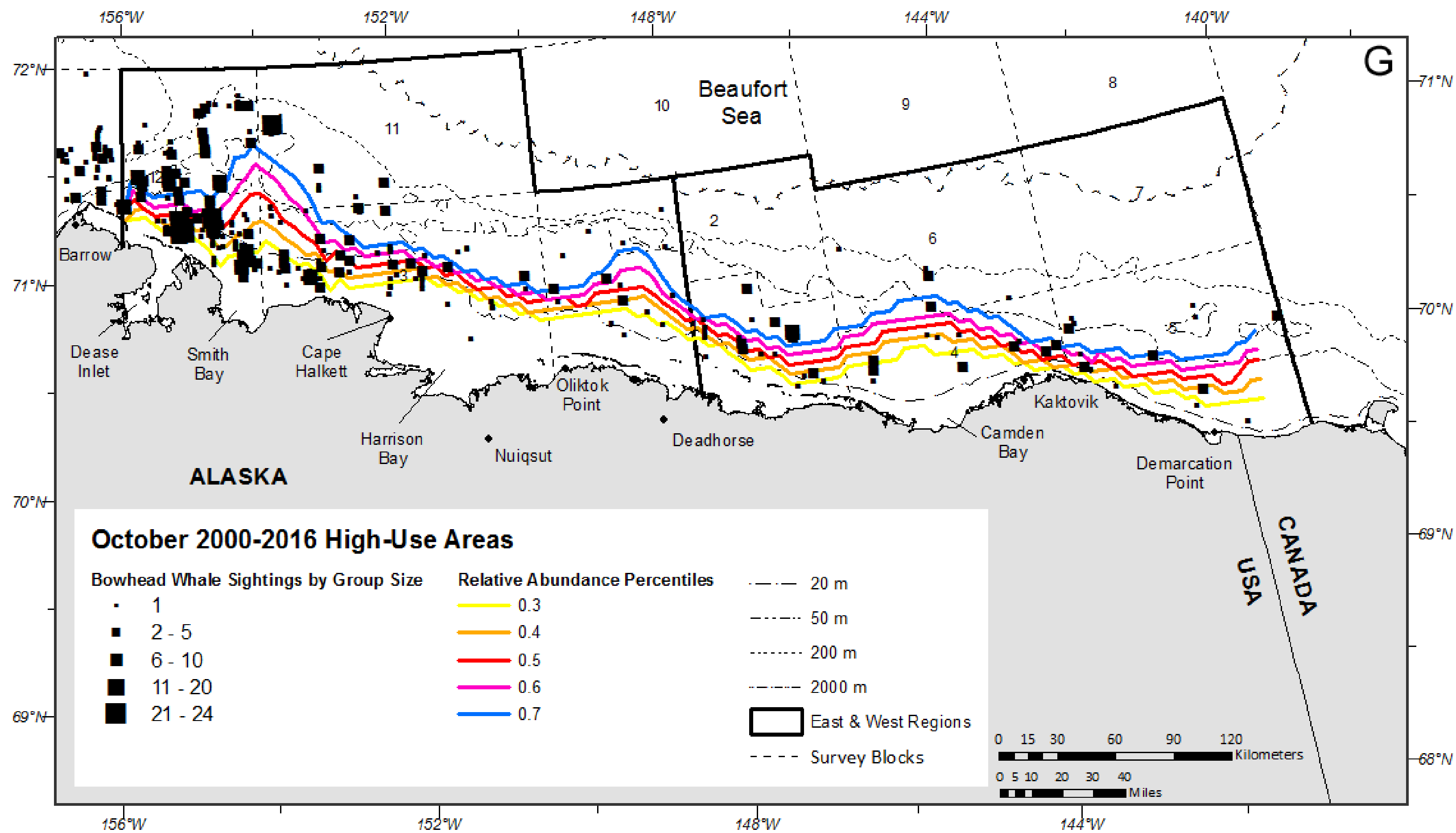


Figure 19 (cont.). ASAMM 2000-2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in 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.

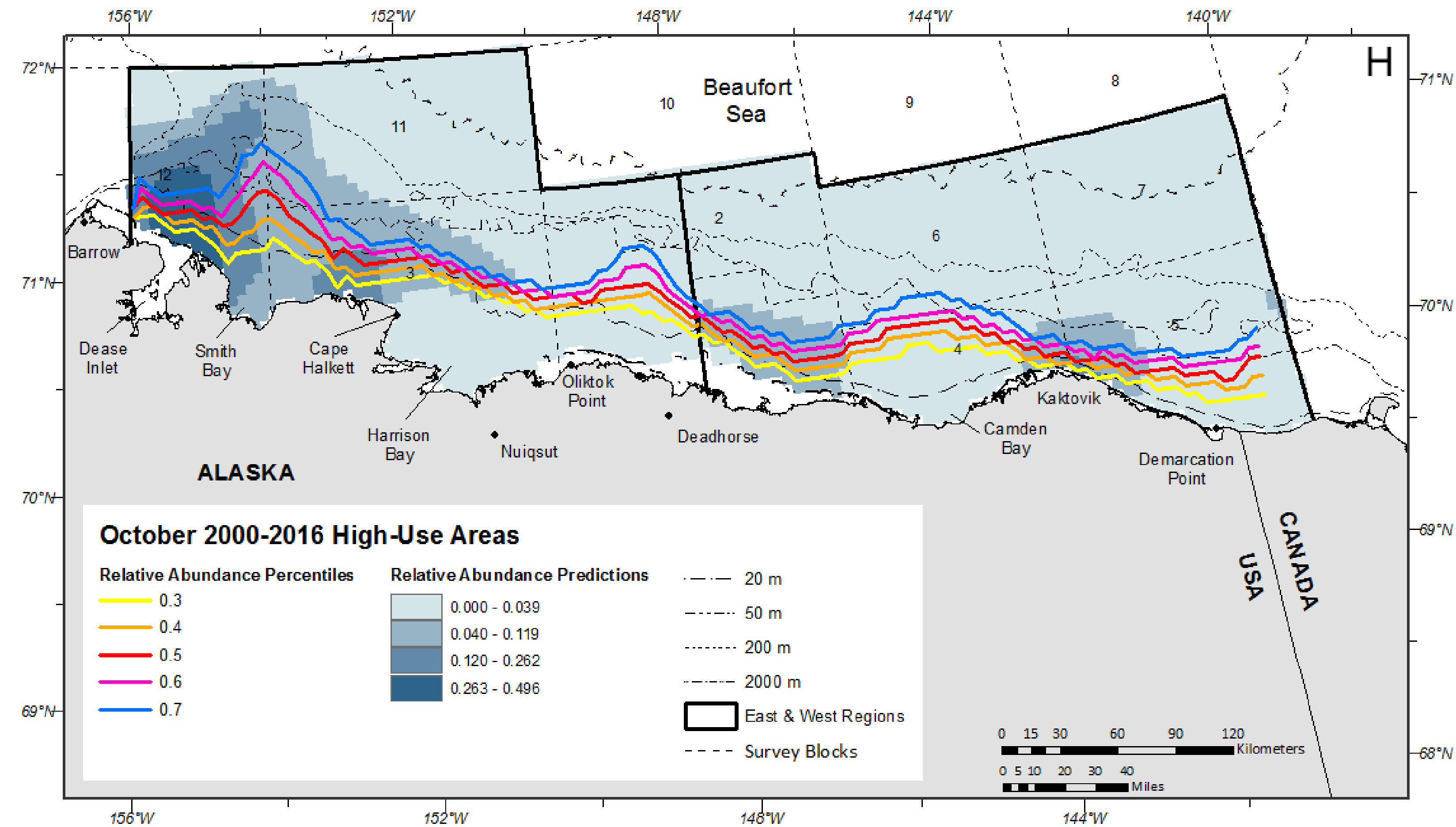


Figure 19 (cont.). ASAMM 2000-2016 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5-km of transect effort in every cell in the western Beaufort Sea in 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 2016, the predictions correspond to September and October combined. Monthly predictions are provided for 2000-2016.

	WEST REGION (KM)					**EAST REGION (KM)**				
	2016	**2000-2016**				**2016**	**2000-2016**			
Percentile	**Sep-Oct**	**Jul**	**Aug**	**Sep**	**Oct**	**Sep-Oct**	**Jul**	**Aug**	**Sep**	**Oct**
30th	37.8	17.5	20.0	10.4	15.4	16.7	46.0	15.4	12.6	13.4
40th	46.0	29.3	25.6	15.2	21.5	20.6	53.9	20.3	16.7	18.2
50th	53.5	44.3	30.1	21.3	27.1	23.7	61.1	25.5	20.7	23.2
60th	60.8	59.6	35.0	28.1	33.3	26.9	68.9	31.8	25.4	28.3
70th	68.2	73.8	40.4	35.8	40.3	30.3	77.3	39.6	30.2	34.7

Halkett, and patches of whales outside the barrier islands from ~146°W to ~148°W and east of Kaktovik (Figure 19H). The HUA in October was farther offshore north of Camden Bay, Harrison Bay, and Smith Bay than in September.

The estimated median distance-from-shore statistics for fall 2016 that were derived using the spatial model were 23.7 km for the East Region and 53.5 km for the West Region (Table 8). The model-derived results were 4.2 km farther offshore in the East Region and 7 km farther offshore 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 19.5 km and 46.5 km, respectively; Table 7).

The estimated median distance-from-shore statistics for the East Region in 2000-2016, derived using the spatial model, decreased from 61.1 km in July to 25.5 km in August, 20.7 km in September, and 23.2 km in October (Table 8). In the West Region, the 2000-2016 model predicted that the median distance from shore decreased from 44.3 km in July to 30.1 km in August, 21.3 km in September, and 27.1 km in October (Table 8).

Gray Whales

Gray Whale Sighting Summary

During the 2016 ASAMM surveys, 445 sightings of 1,130 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 20). In the northeastern Chukchi Sea, gray whales were seen primarily nearshore (<40 km) from Point Barrow to south of Point Lay. Gray whales were seen from late July through mid-October in block 14, between 50 and 100 km offshore and just south of Hanna Shoal. Three sightings of nine gray whales were >345 km west of Barrow. In the southcentral Chukchi Sea, gray whales were seen offshore approximately 80-110 km southwest of Point Hope, a known gray whale and benthic hotspot (Grebmeier et al. 2015; Kuletz et al. 2015). They were also seen north of the benthic hotspot about 30-60 km west of Point Hope. Few gray whales were seen between Point Lay and Cape Lisburne. Several gray whales were seen in the western Alaskan Beaufort Sea, primarily immediately east of Point Barrow near Barrow Canyon. Single gray whales were seen in the central Alaskan Beaufort Sea in July and September. One to two gray whales were seen in Peard Bay proper on 5 days from 6 August to 5 September. Locations of gray whale sightings during semimonthly periods are shown in Figure 21.

Gray whale distribution in 2016 (all sightings regardless of survey mode or observer type) was generally similar to that documented from 2008 to 2015 and in earlier years with light sea ice coverage, with a few exceptions:

- Gray whales continued to be mostly absent from Hanna Shoal, but were observed immediately south of Hanna Shoal (block 14) in all months.
- Gray whales were not seen in shallow waters directly south of Point Hope.
- Gray whales appeared relatively sparser in the area between Point Franklin and Barrow, where they have been reliably seen in most years.
- One to two gray whales were repeatedly seen in Peard Bay proper from 6 August to 5 September.

Gray Whale Sighting Rates

In summer and fall 2016, gray whales were seen on transect from 67.5°N to 71.7°N and 149.2°W to 168.8°W. There were 207 sightings of 450 gray whales on transect by primary observers (Appendix E, Table E-5), ranging from one whale per sighting (n_s=104) to 16 whales per sighting (n_s=1). The greatest numbers of sightings on transect were in block 23 (67 sightings), block 17 (51 sightings) and block 13 (39 sightings). When transect and circling from transect (Tr+TrC) sightings by primary observers were combined, there were 400 sightings of 1,039 gray whales (Appendix E, Table E-6), ranging from one whale per sighting (n_s=177) to 29 whales per sighting (n_s=1). The highest number of Tr+TrC sightings was in block 23 (127 sightings), followed by block 17 (118 sightings).

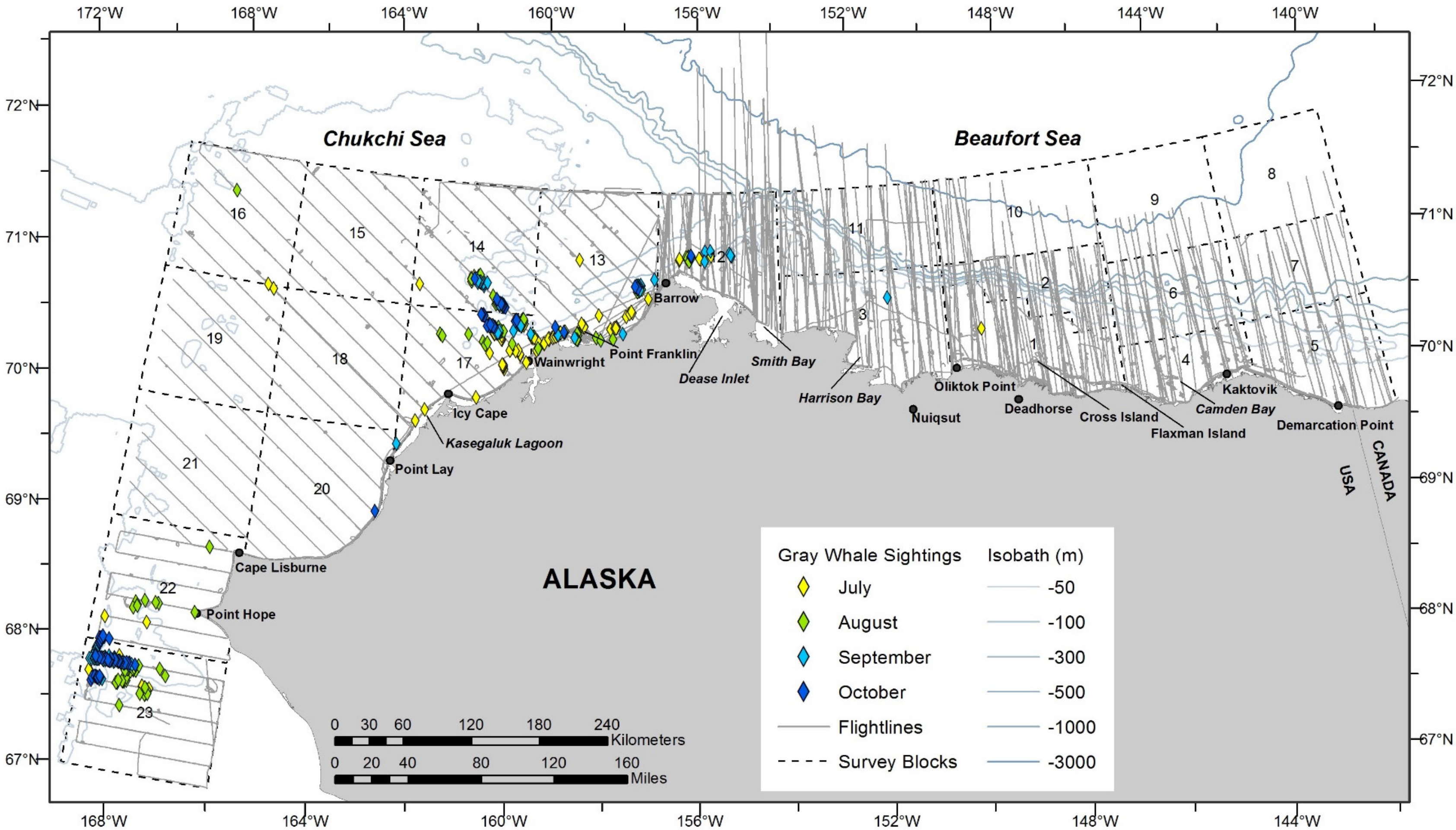


Figure 20. ASAMM 2016 gray whale sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

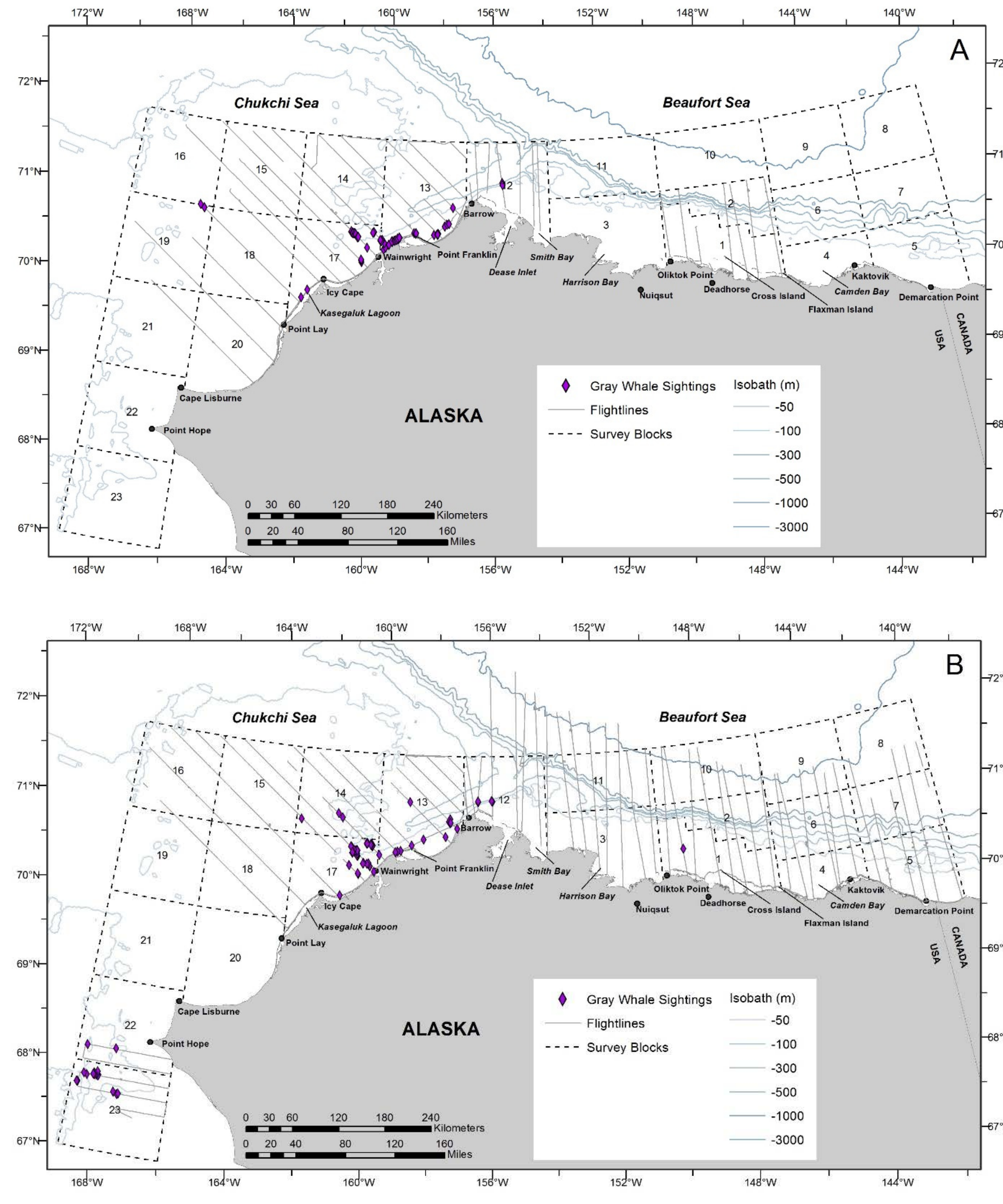
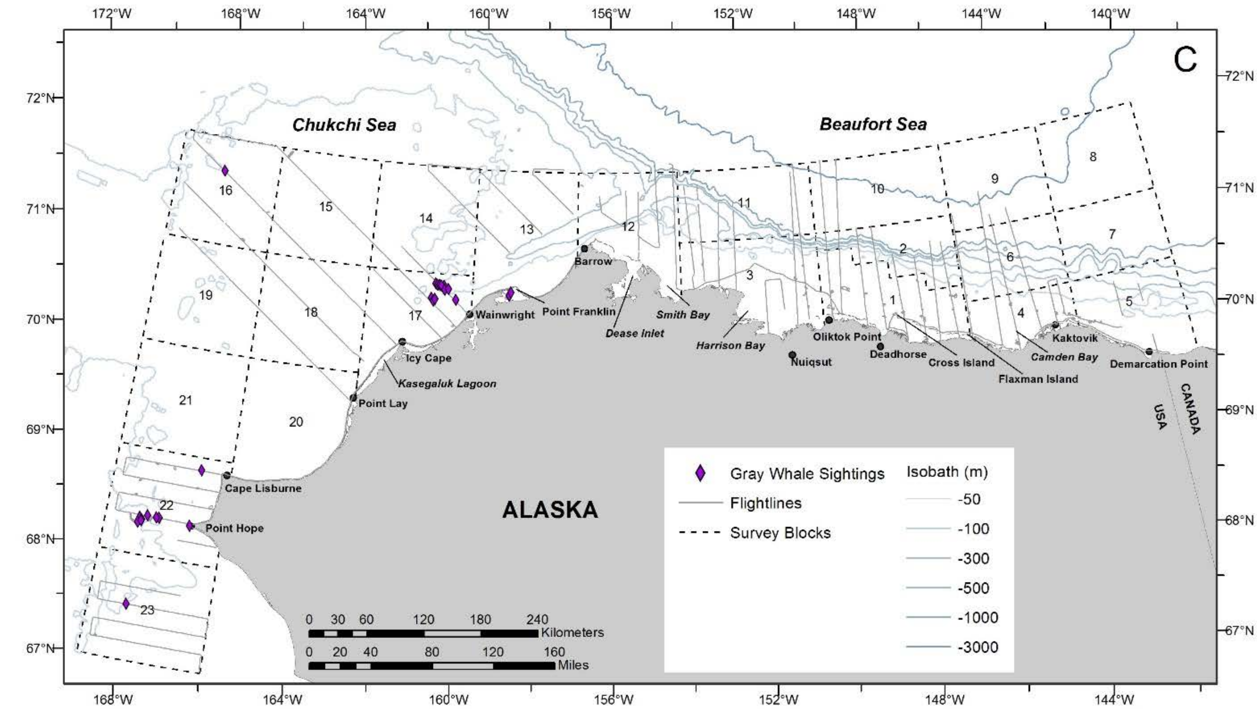


Figure 21. ASAMM 2016 semimonthly gray whale sightings, with transect, search, and circling effort. A: 2-15 July; B: 16-31 July. Deadhead flight tracks are not shown.



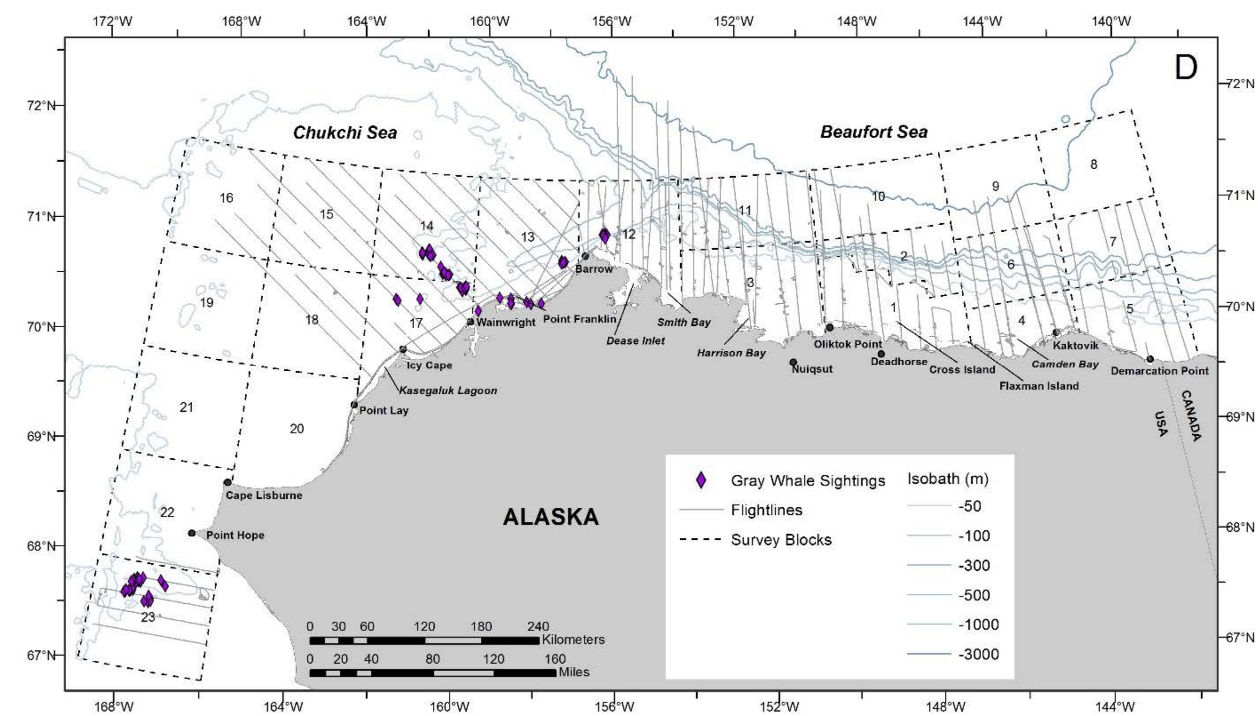


Figure 21 (cont). ASAMM 2016 semimonthly gray whale sightings, with transect, search, and circling effort. C: 1-15 August; D: 16-31 August. Deadhead flight tracks are not shown.

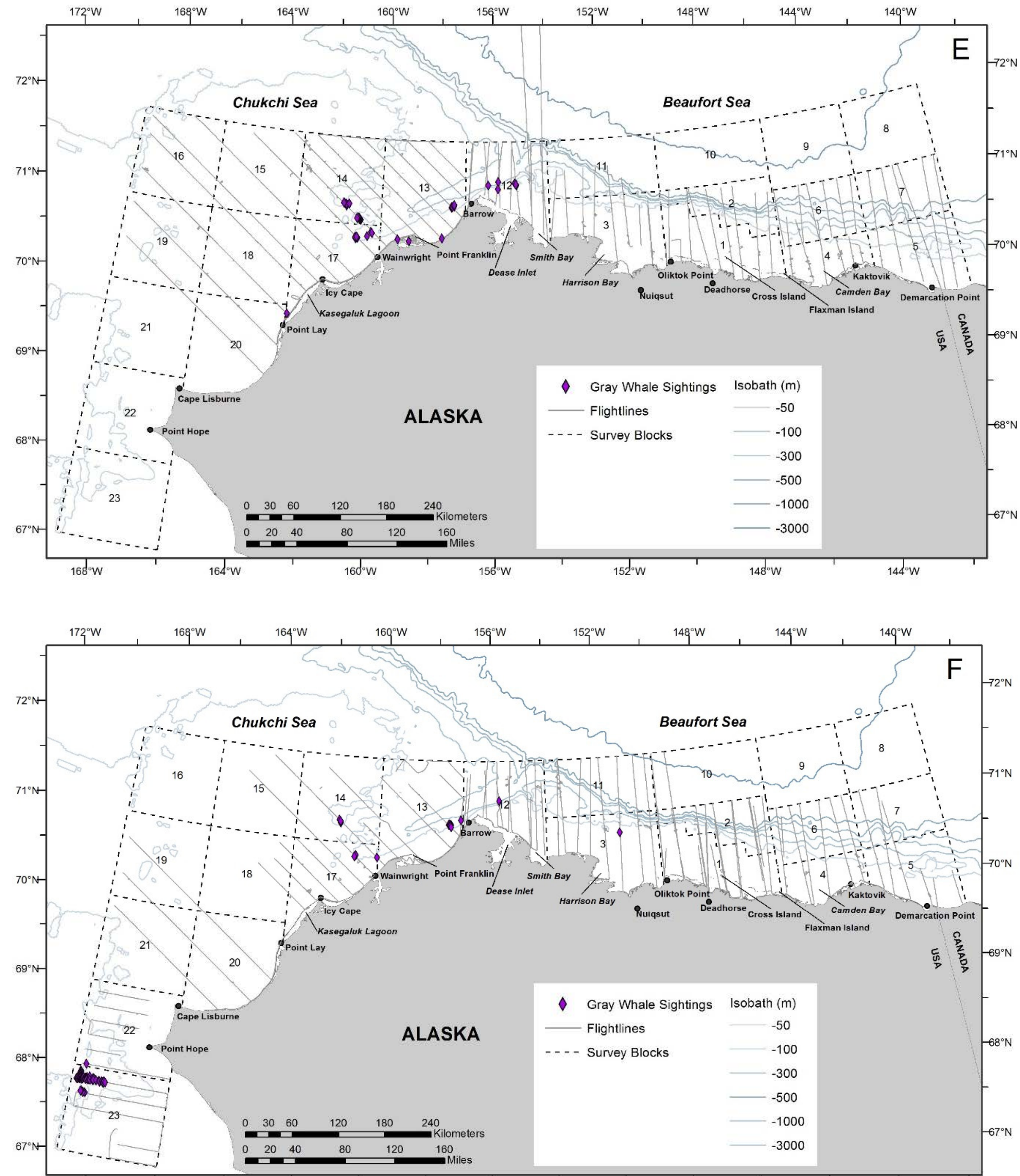
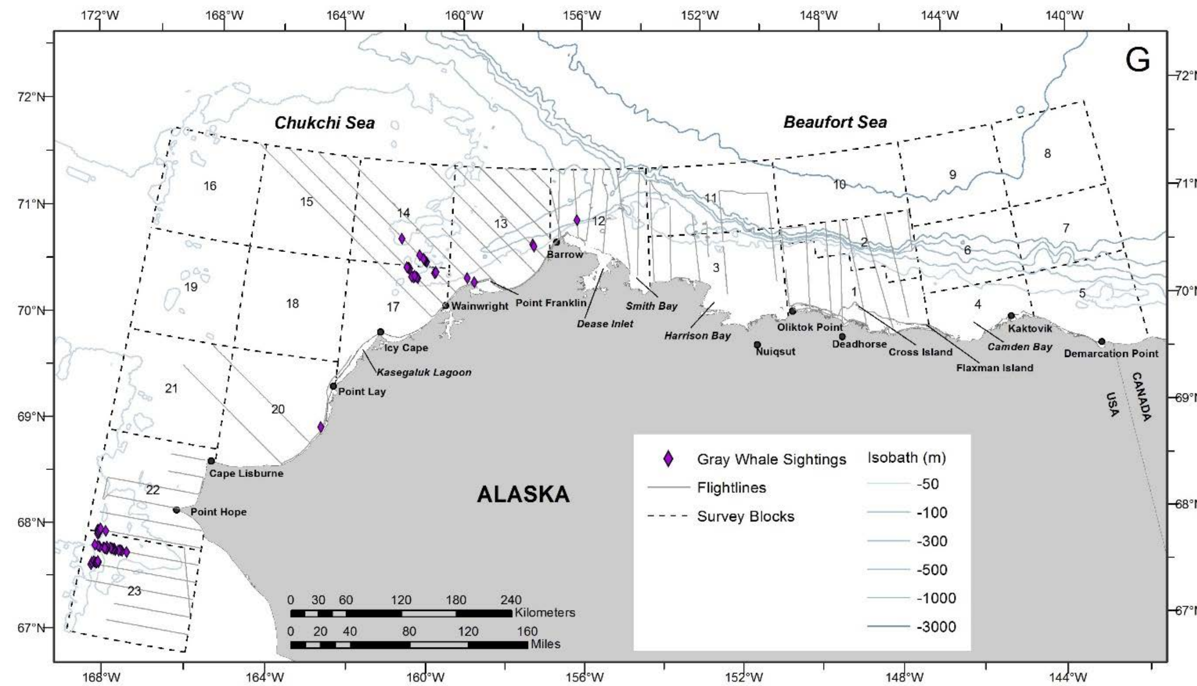


Figure 21 (cont). ASAMM 2016 semimonthly gray whale sightings, with transect, search, and circling effort. E: 1-15 September; F: 16-30 September. Deadhead flight tracks are not shown.



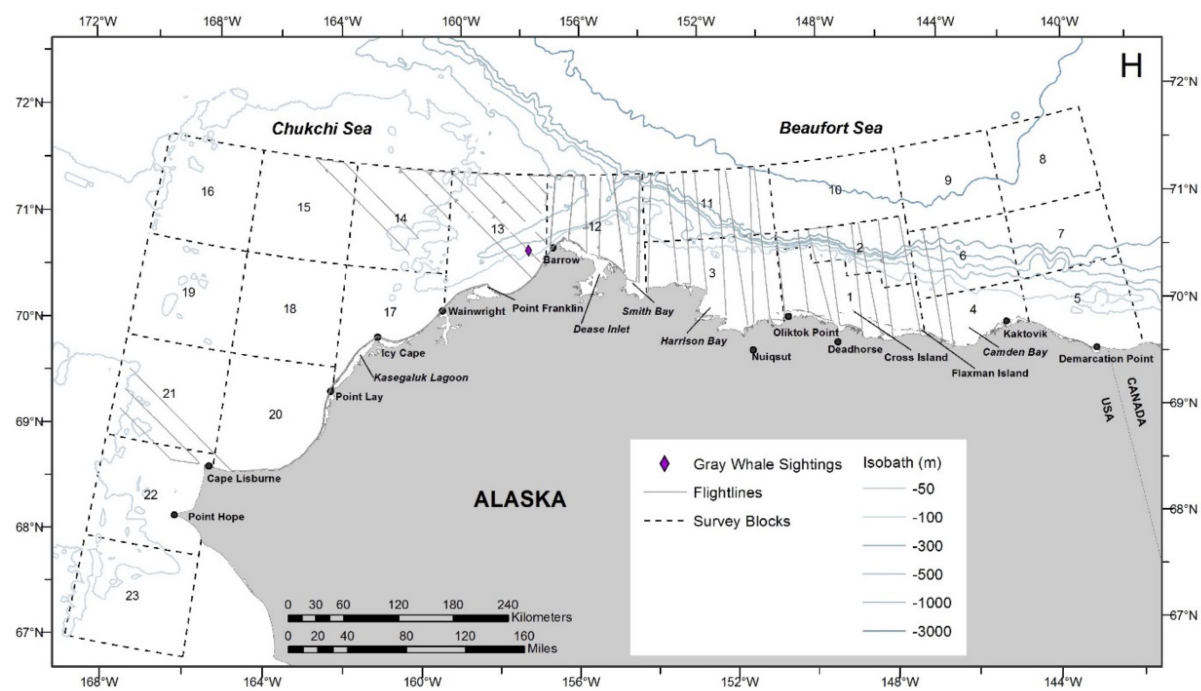


Figure 21 (cont). ASAMM 2016 semimonthly gray whale sightings, with transect, search, and circling effort. G: 1-15 October; H: 16-30 October. Deadhead flight tracks are not shown.

The highest gray whale fine-scale (5-km grid) Tr sighting rates (WPUE) were approximately 30 and 50 km northwest of Wainwright and approximately 90-100 km southwest of Point Hope (Figure 22). There were few gray whales seen on transect between Barrow and Point Franklin.

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 the majority of gray whales were seen in 2016 (and historically). For all months combined, the highest Tr sighting rates per survey block were in block 23 (0.072 WPUE), block 17 (0.031 WPUE), and block 13 (0.015 WPUE). In summer, Tr sighting rates were highest in block 23 (0.034 WPUE), block 17 (0.044 WPUE), and block 13 (0.023 WPUE) (Figure 23). In fall, Tr sighting rates were highest in block 23 (0.109 WPUE), block 14 (0.013 WPUE), and block 17 (0.013 WPUE) (Appendix E, Table E-5).

Monthly Tr sighting rates in 2016 were higher in all months compared to monthly sighting rates in 2009-2015, all years combined (Figure 24). The peak monthly gray whale Tr sighting rate in the eastern Chukchi Sea (154°W-169°W) in 2016 was in July (0.019 WPUE), decreasing by nearly one-half in August (0.010 WPUE), before increasing again in September (0.013) and October (0.012). 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), similar patterns emerged for gray whale Tr sighting rates in the northeastern Chukchi Sea for 2009-2015 and 2016 (Figure 25A), with the exception of the increased sighting rate in October 2016. However, sighting rates in the southcentral Chukchi Sea in 2016 differed considerably from those in 2009-2015 (Figure 25B). Sighting rates were noticeably higher in 2016 in all months except August, increased from August to September, and did not decline dramatically between July and October compared to 2009-2015.

A comparison of Tr and Tr+TrC sighting rates for gray whales in 2016 is included in Appendix E (Figure 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 during 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 all survey blocks compared to Tr sighting rates (Figure 23). The highest Tr+TrC sighting rate was in block 23 in September (0.224 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 (0.104 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 26). 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). Since aerial surveys recommenced in the northeastern Chukchi Sea in 2008, gray whale depth zone preference has typically been 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, 2015). However, in 2015 and again in 2016, gray whale preference for deeper water was noted throughout summer and fall.

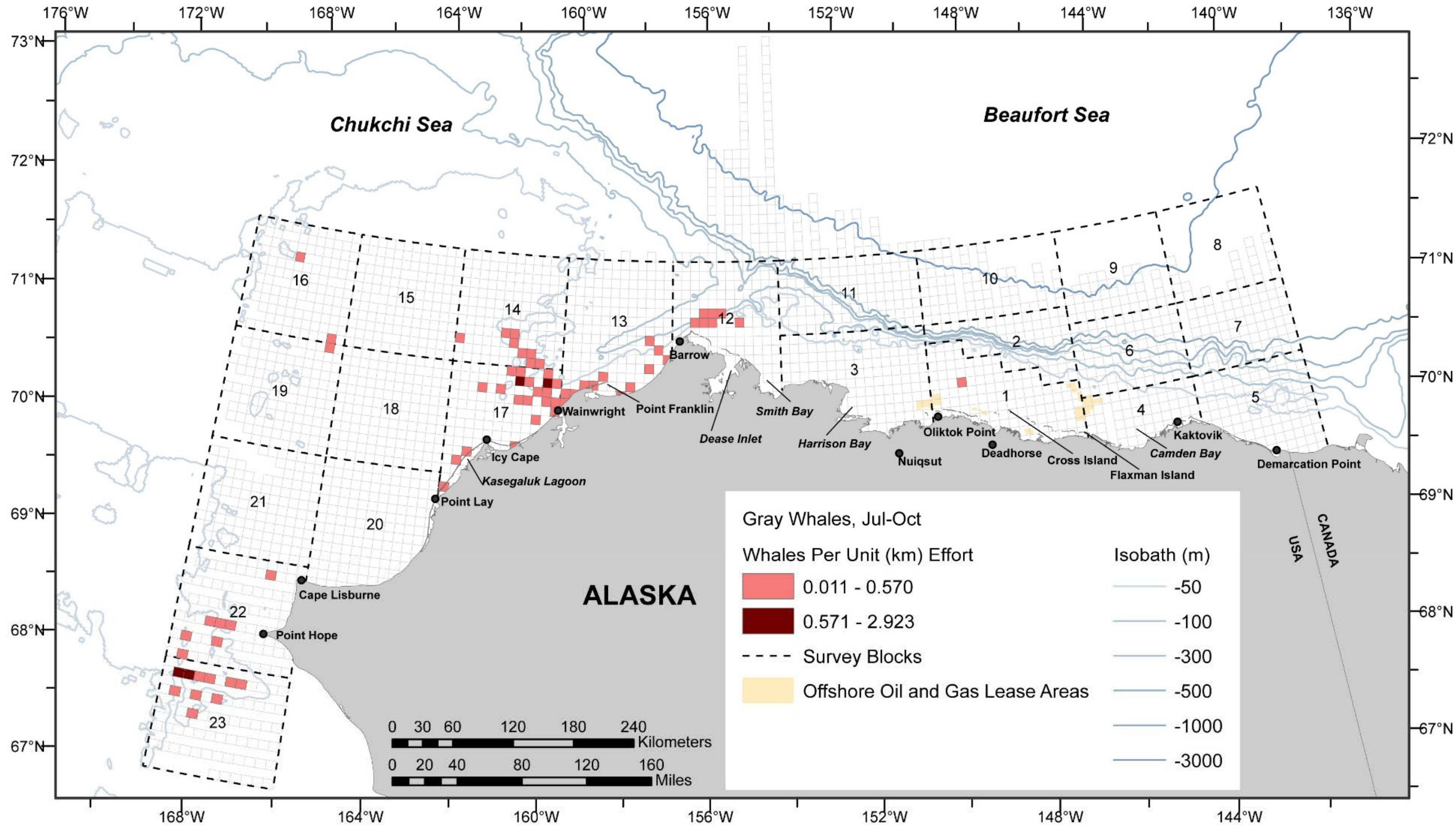


Figure 22. ASAMM 2016 gray whale sighting rates (WPUE; transect sightings from primary observers only), July-October. Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

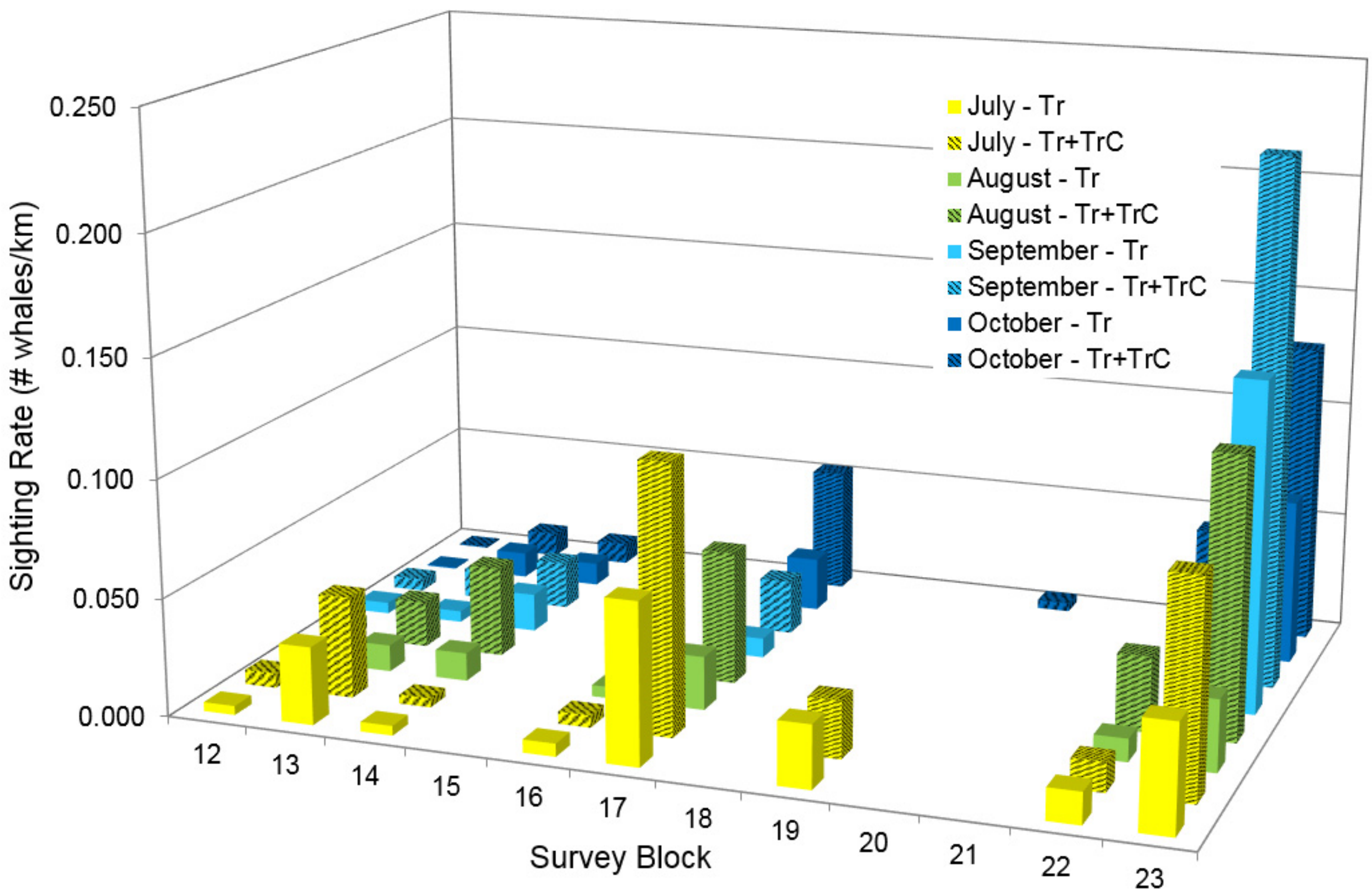


Figure 23. ASAMM 2016 gray whale monthly sighting rates (WPUE; sightings from primary observers only) per survey block for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity. Does not include effort and sightings north of 72°N.

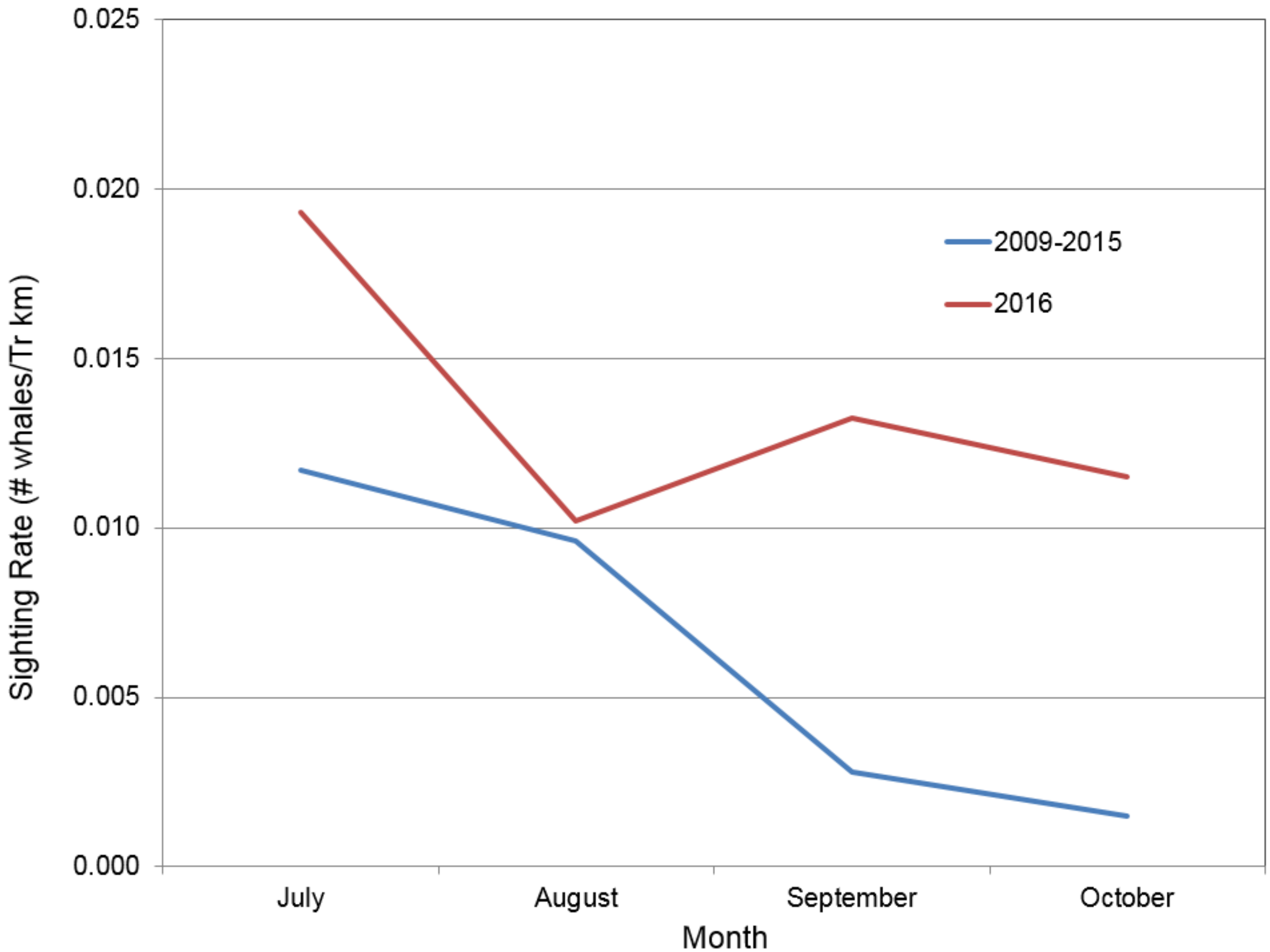


Figure 24. ASAMM gray whale monthly sighting rates (WPUE; transect sightings from primary observers only) in the eastern Chukchi Sea (67°N-72°N, 154°W-169°W), 2009-2015 and 2016. Does not include effort and sightings north of 72°N.

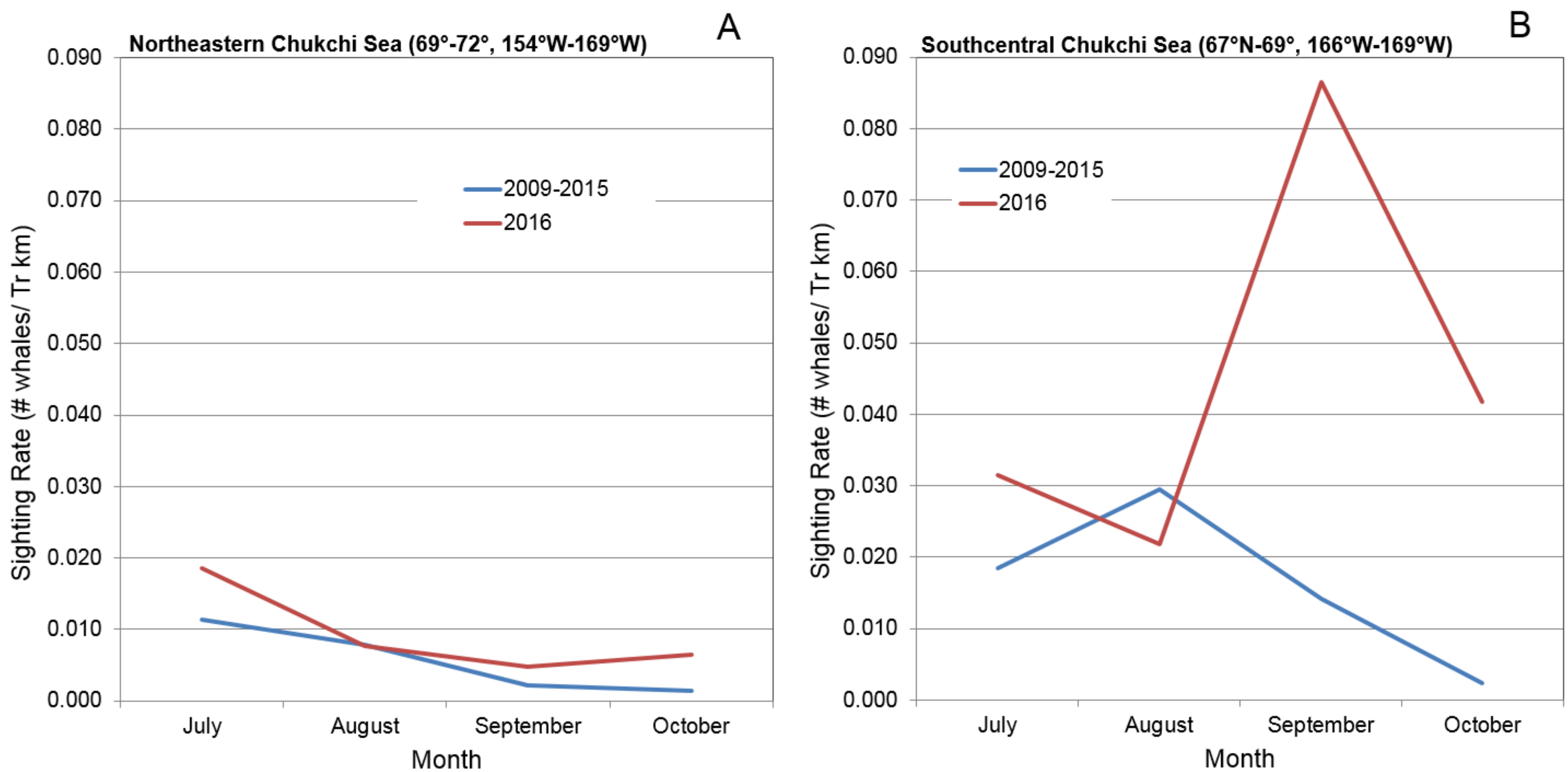


Figure 25. ASAMM gray whale monthly sighting rates (WPUE; transect sightings from primary observers only), 2009-2015 and 2016. A: northeastern Chukchi Sea (69°N-72°N, 154°W-169°W); B: southcentral Chukchi Sea (67°N-69°N, 166°W-169°W). Does not include effort and sightings north of 72°N.

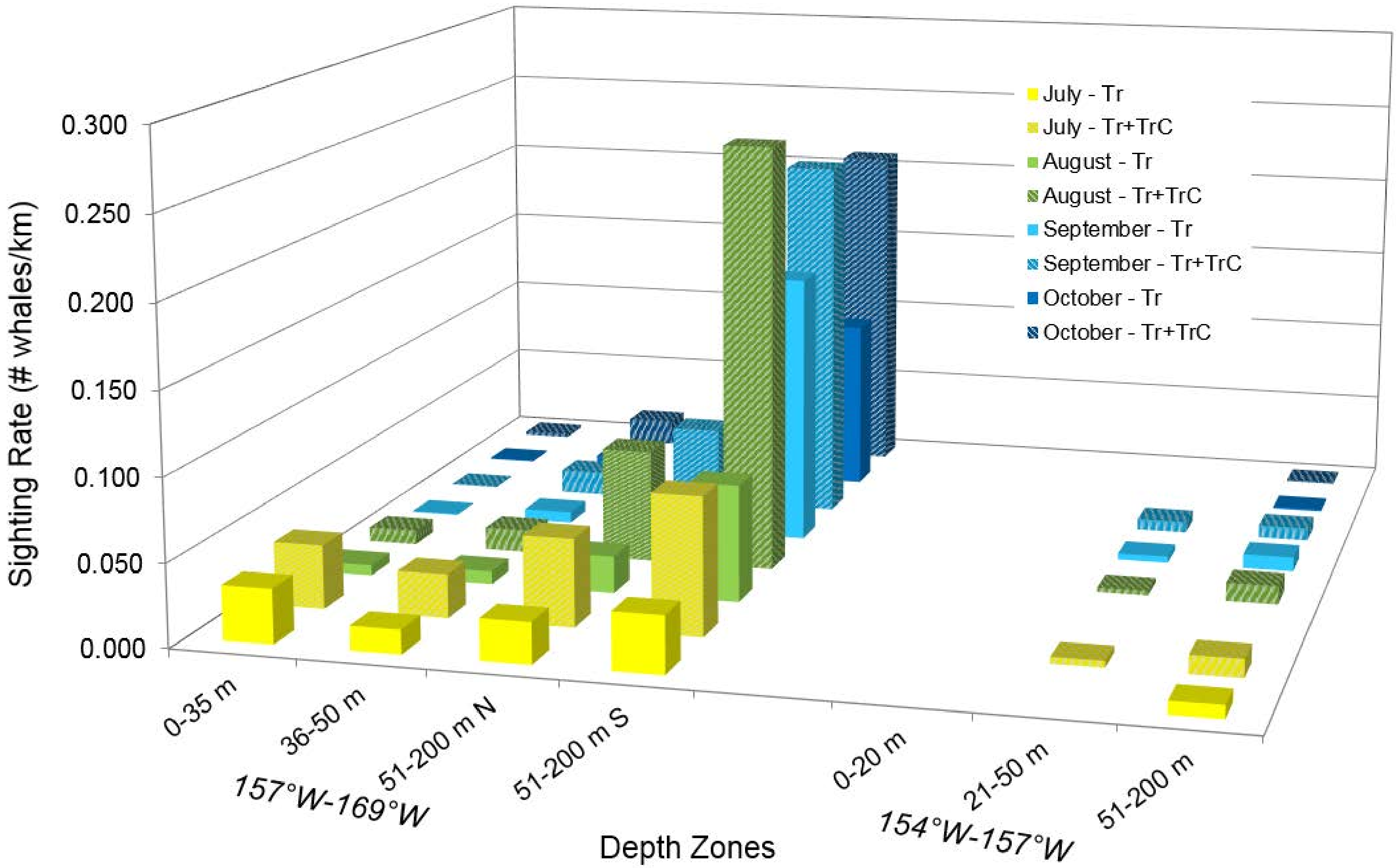


Figure 26. ASAMM 2016 gray whale monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity. Does not include effort and sightings north of 72°N.

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 51-200 m zone (0.005 WPUE) (Appendix E, Table E-7).

Sighting rates per depth zone calculated using sightings and effort on transect and on circling from transect (Tr+TrC) were higher in all depth zones compared to Tr sighting rates (Figure 26; Appendix E, Table E-8). The highest Tr+TrC sighting rate was in the 51-200 m South depth zone in August (0.262 WPUE), when the Tr+TrC sighting rate was 3.5 times greater than the Tr sighting rate.

Gray whale distribution in 2016 using only Tr sightings overlapped the distribution of Tr sightings observed in previous years having light sea ice cover (Figure 27).

Gray Whale Sea Ice Associations

Most gray whales (72%, n_i = 808) were observed in 0% sea ice cover. Sea ice remained in the study area through late September (Appendix A, Figure A-7), and gray whales were observed in areas with sea ice, ranging from 1-60% cover, from July through September. Feeding behavior and calves were observed in areas of up to 50% sea ice cover. Sea ice cover did not appear to be an impediment to gray whale occurrence in 2016.

Gray Whale Behaviors

Behaviors of 1,130 gray whales observed during all survey modes (transect, search and circling) in 2016 are summarized in Table 9. The behaviors most often recorded were feeding (69%) and swimming (22%). Resting was recorded for 51 whales (5%). Other behaviors recorded included milling (n_i = 31 whales), diving (n_i = 8 whales), and rolling (n_i = 4 whales). One gray whale was observed breaching repeatedly (Appendix B, Flight 249). Most of the gray whales seen in early July were recorded as swimming; during all other time periods the predominant behavior was feeding. Gray whales observed in the southcentral Chukchi Sea (south of 69°N) were overwhelmingly feeding (71%), and the 1-2 gray whales seen repeatedly in Peard Bay proper were feeding each time they were sighted. The two gray whales seen east of 154°W were both swimming. Fine-scale Tr sighting rates of feeding and milling gray whales in 2016 are shown in Figure 28, with the highest Tr sighting rates northwest of Wainwright and southwest of Point Hope. 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. For example, two gray whales observed on 6 July (Appendix B, Flight 202) near Point Franklin, Alaska, were recorded as swimming but may have been skim feeding, based on post-flight image analysis that showed their mouths open. None of the gray whales appeared to respond to the aircraft.

In 2016, 136 gray whale calves were seen (Figure 29). Most calves (n_i=110, 81%) 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 0.120, which is similar to calf ratios observed in 2012 and 2014, higher than calf ratios in 2009-2011, but lower than calf ratios recorded in 2013 and 2015 (Figure 30). Calf distribution overlapped that of adult

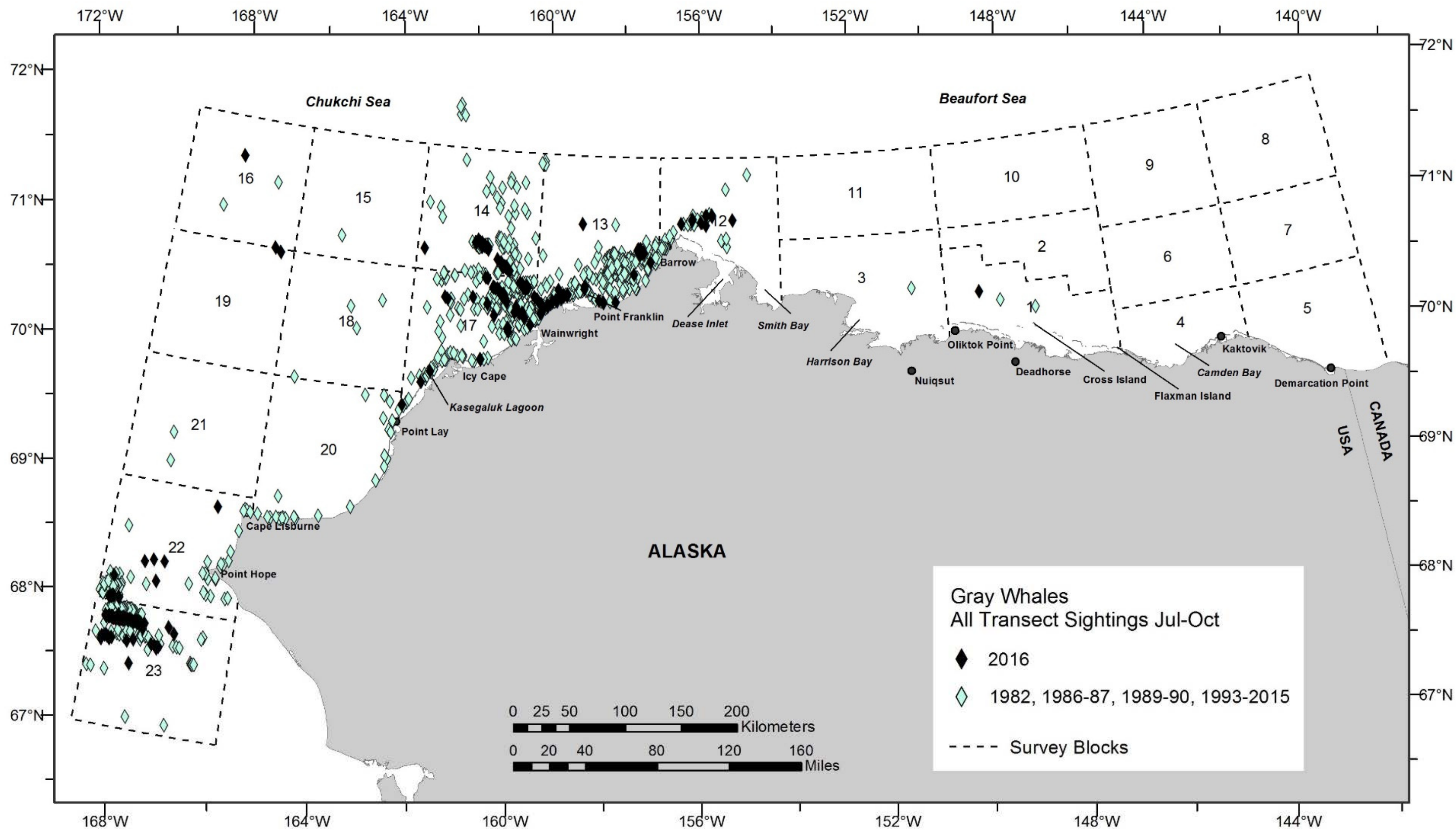


Figure 27. ASAMM gray whale sightings on transect in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2015, and 2016. Includes all sightings on transect made by primary and secondary observers.

Table 9. ASAMM 2016 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
Dive	0	3/4	1/1	0	0	0	2/3	0	6/8
Feed	24/41	49/121	13/60	59/198	31/65	55/182	37/107	1/10	269/784
Mill	0	4/12	0	3/13	0	2/6	0	0	9/31
Rest	0	7/9	0	13/24	0	6/8	8/10	0	34/51
Roll	0	0	1/4	0	0	0	0	0	1/4
Swim	41/89	20/32	9/24	13/27	9/12	17/47	17/21	0	126/252
TOTAL	65/130	83/178	24/89	88/262	40/77	80/243	64/141	1/10	445/1,130

gray whales both temporally and spatially in 2016. Most calves (65%, n_i = 89) were within 40 km of shore, however 19% (n_i = 26) were greater than 50 km from shore. In the southcentral Chukchi Sea (block 22 and 23), 21 calves were sighted, and two calves were sighted east of Point Barrow. One calf was seen approximately 360 km west of Barrow. In July, 89 calves were observed, 47 calves were observed in August, and none were seen in September or October. On 16 occasions, multiple calves were seen in one day, with the highest daily total on 13 July (19 calves; Appendix B, Flight 206). Some calves may have been sighted on more than 1 day. However, preliminary analysis of opportunistically collected photo-identification data collected from 2016 indicate that relatively few calves were resighted.

Gray whale swim direction in the northeastern Chukchi Sea was significantly clustered around a mean heading of 262°T (n_s = 28 observations, Rayleigh Z = 2.89, P = 0.05) in July, but was not clustered around a mean heading in August, September, or October. Gray whale swim direction in the southcentral Chukchi Sea was not significantly clustered around a mean heading. 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 13 sightings of 26 humpback whales (*Megaptera novaeangliae*) in 2016, including three calves (Table 3, Figure 31). Stock affiliation of humpback whales in this region is unknown. Most (96%) of the humpback whales were seen in the southcentral Chukchi Sea on 2 days in August (Appendix B, Flights 219 and 232); one humpback whale was seen in the northeastern Chukchi Sea in early September (Appendix B, Flight 233). Humpback whales seen in the southcentral Chukchi Sea were in close proximity to fin whales, minke whales, gray whales, and harbor porpoises, approximately 40-60 km west of Point Hope in early August and

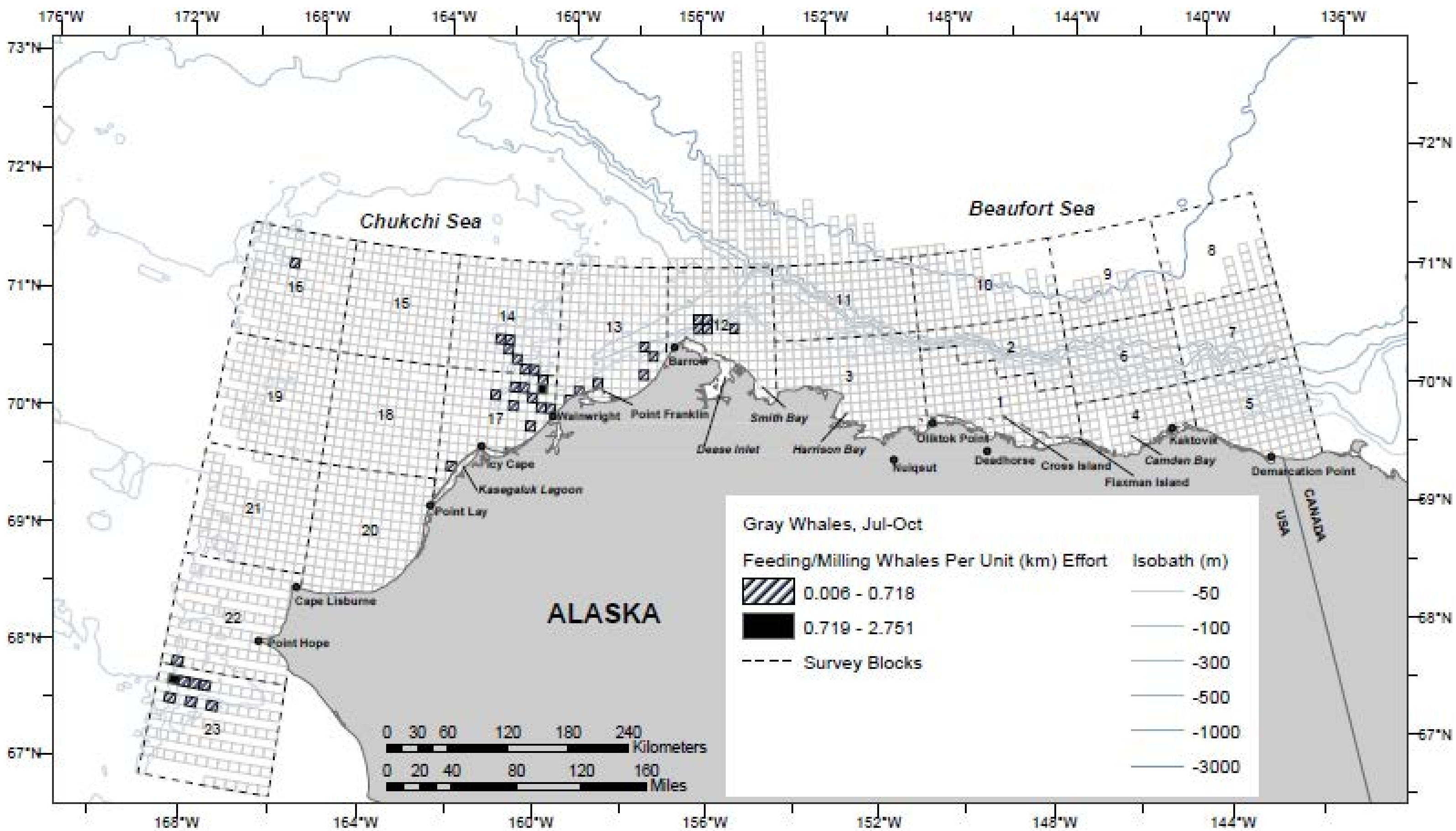


Figure 28. ASAMM 2016 gray whale feeding and milling sighting rates (WPUE; transect sightings from primary observers only). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

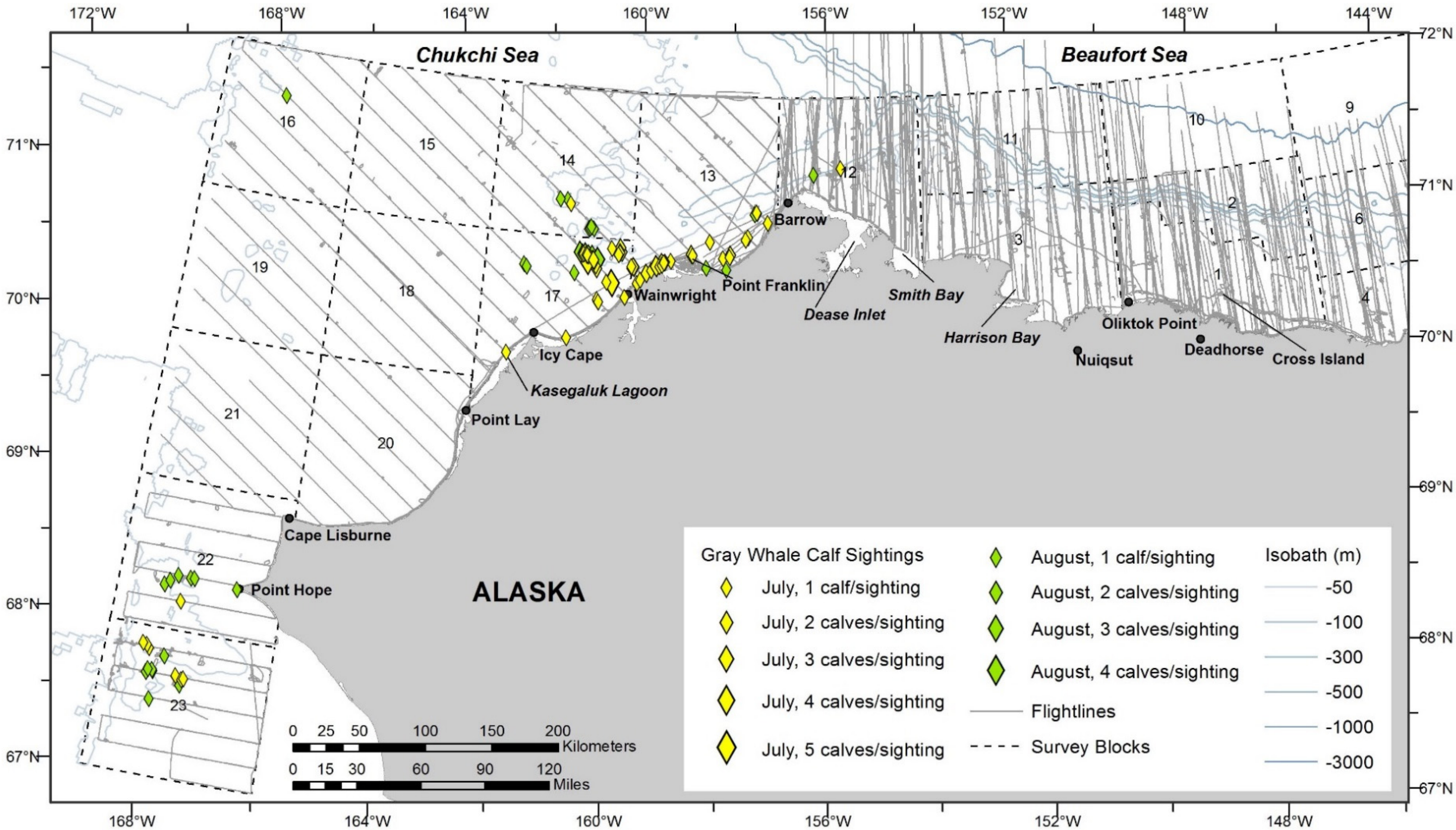


Figure 29. ASAMM 2016 gray whale calf sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

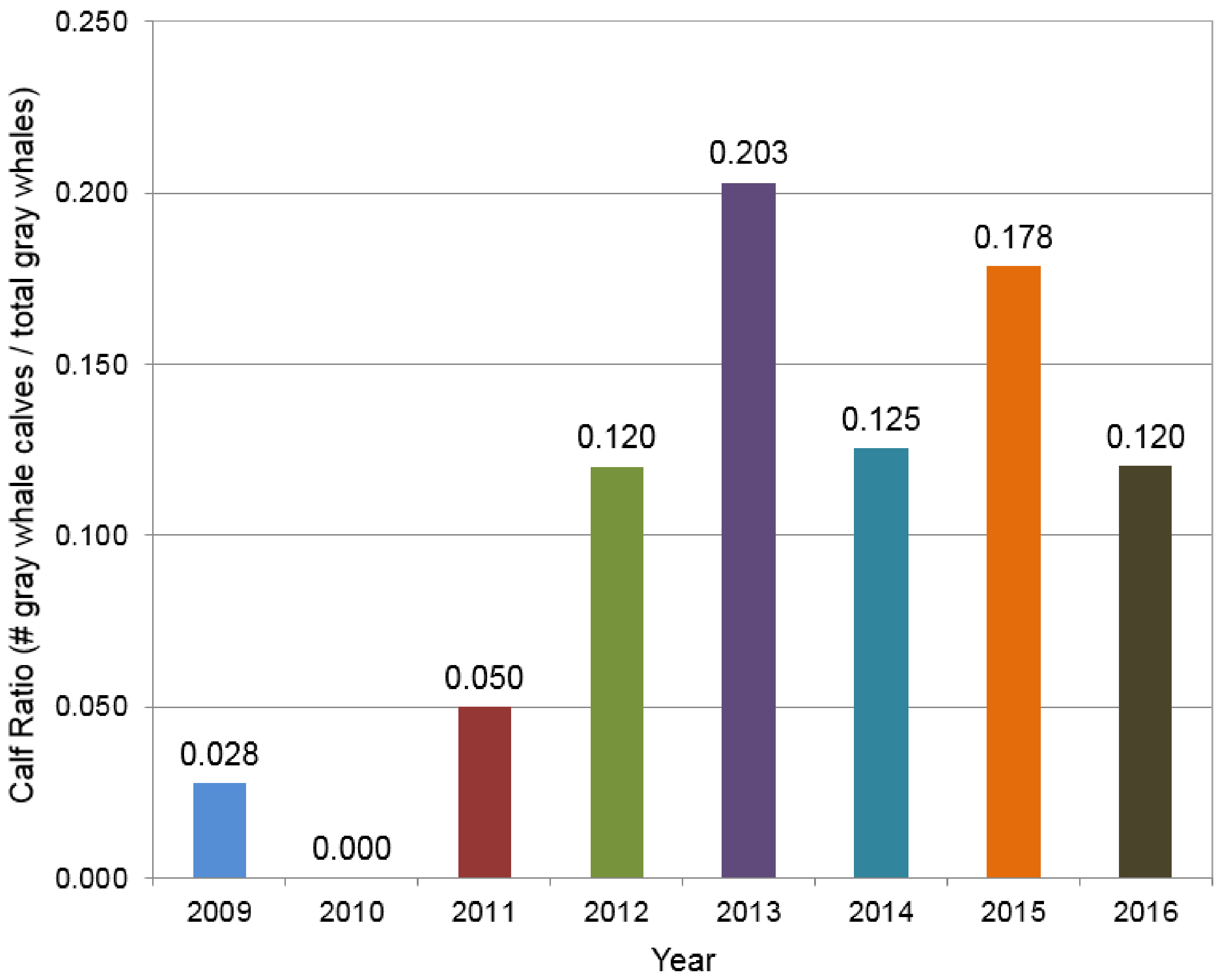


Figure 30. ASAMM gray whale annual calf ratios (number of gray whale calves per total gray whales), 2009-2016.

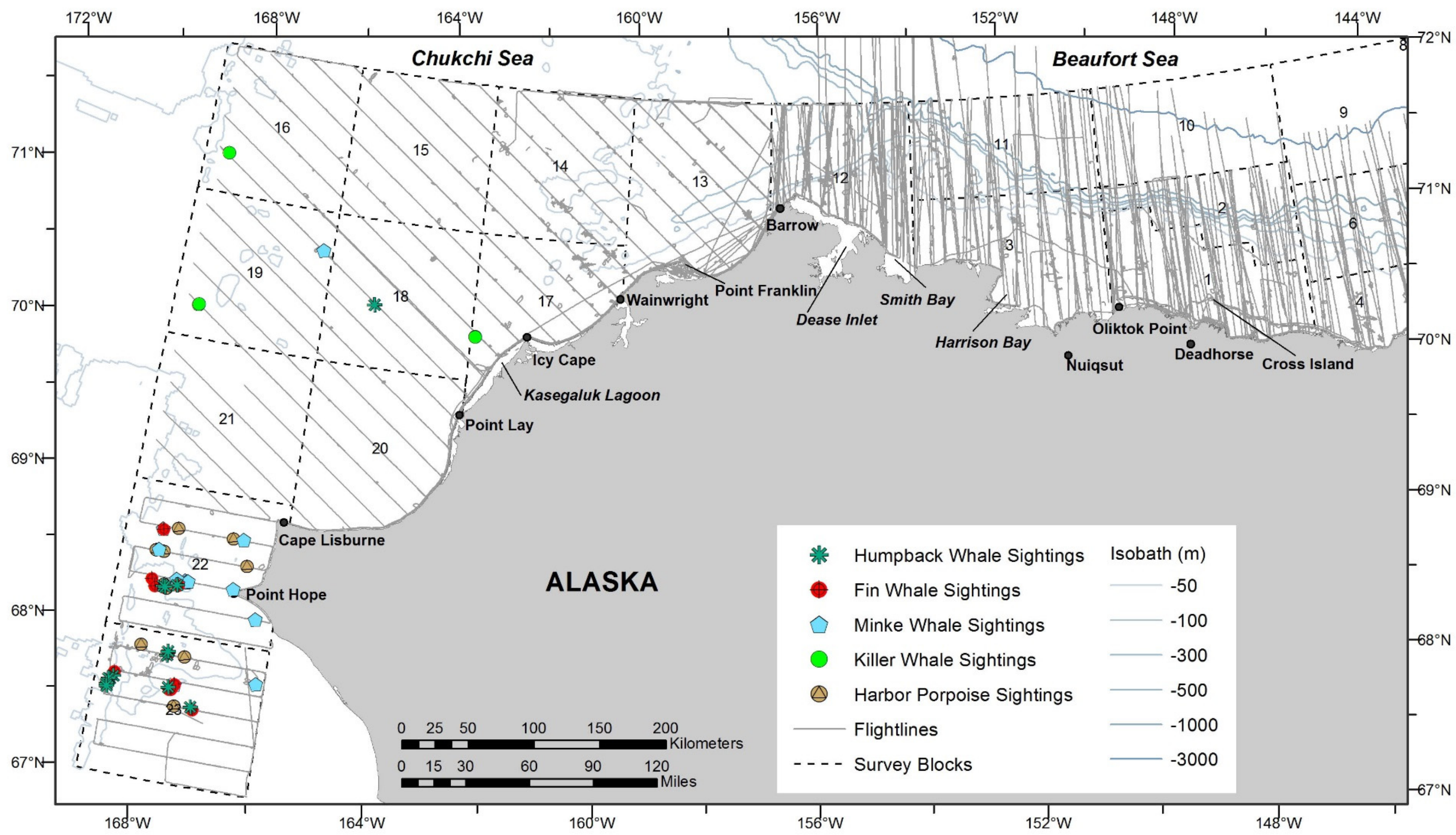


Figure 31. ASAMM 2016 harbor porpoise and humpback, fin, minke, and killer whale sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

65-120 km southwest of Point Hope in late August. The humpback whale seen in early September was approximately 110 km northwest of Point Lay. Humpback whales were observed swimming (77%), resting (19%), and diving (4%). None of the humpback whales appeared to respond to the survey aircraft.

Fin Whales

There were 12 sightings of 17 fin whales (*Balaenoptera physalus*), presumably of the Northeast Pacific stock, in 2016, including one calf, all in the southcentral Chukchi Sea (Table 3; Figure 31). All of the fin whales were seen on 2 days in August (Appendix B, Flights 219 and 232). Fin whales were in close proximity to humpback whales, minke whales, gray whales, and harbor porpoises, approximately 40-65 km west of Point Hope in early August and approximately 65-125 km southwest of Point Hope in late August. Fin whales were observed swimming (71%), feeding (12%), diving (12%), and resting (6%). None of the fin whales appeared to respond to the survey aircraft.

Minke Whales

There were 14 sightings of 16 minke whales (*Balaenoptera acutorostrata*), presumably of the Alaska stock, in 2016 (Table 3; Figure 31). Minke whales were the most broadly distributed balaenopterid cetacean observed, with one sighting in the northeastern Chukchi Sea and scattered sightings in the southcentral Chukchi Sea. Minke whales in the southcentral Chukchi Sea were often in close proximity to humpback whales, fin whales, gray whales, and harbor porpoises, but were also sighted alone near Point Hope. The lone minke whale sighted in the northeastern Chukchi Sea (Appendix B, Flight 233) was in close proximity to an unidentified cetacean that may have also been a minke whale. All minke whales sighted were adults. Minke whales were observed swimming (81%) resting (13%), and diving (6%). None of the minke whales appeared to respond to the survey aircraft.

Belugas

Beluga Sighting Summary

During the 2016 ASAMM surveys, 364 sightings of 1,841 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 ECS and Beaufort Sea stocks (Hauser et al. 2014). In the eastern Chukchi Sea, beluga sightings were limited to 3 sightings of 298 whales approximately 50 km southwest of Barrow in mid-July and 1 sighting of 2 whales approximately 50 km northwest of Point Lay in early August. Belugas were seen in all months surveyed (July-October) in the western Beaufort Sea (Figure 32), although there were relatively few sightings in September and October. In the western Beaufort Sea, belugas were seen along the continental slope, with few sightings nearshore. Surveys were conducted farther north than normal in 2016 to incorporate deeper-water beluga habitat, and belugas were observed on the Beaufort Sea slope and beyond the

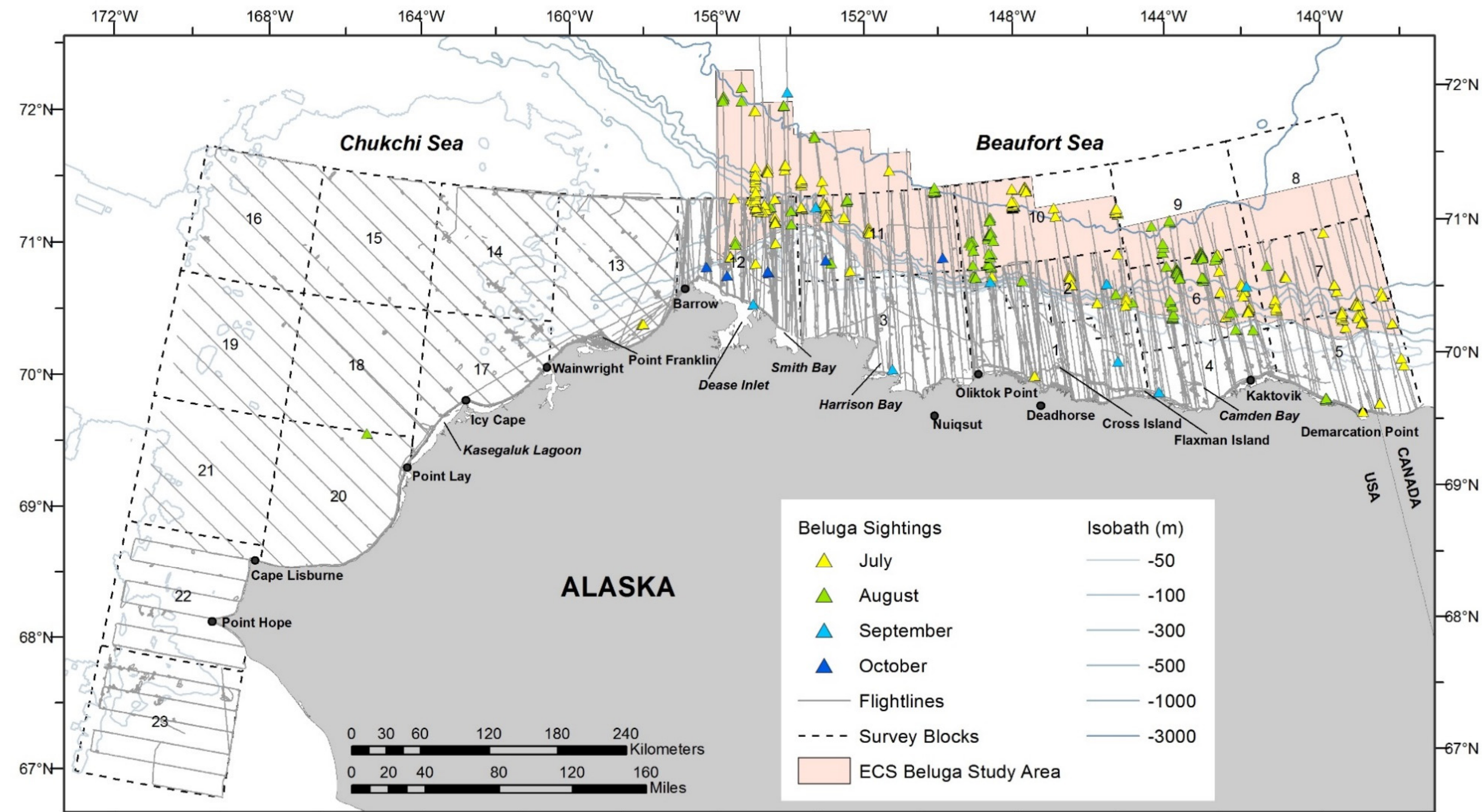


Figure 32. ASAMM 2016 beluga sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

3,000-m isobath in July and August. Belugas were also seen near Barrow Canyon from July through August. In September and October, beluga sightings were scattered from shallow nearshore waters to offshore areas where depths exceeded 3,000 m. Beluga distribution in 2016 was generally similar to that documented in previous years with light sea ice cover in the western Beaufort Sea (Figure 33). The distribution of the relatively few beluga sightings in the eastern Chukchi Sea in 2016 overlapped that of past years.

BELUGA SIGHTING RATES

In summer and fall 2016, belugas were seen from 69.6°N to 72.9°N between 140.1°W and 164.1°W. There were 337 sightings of 1,380 belugas on transect by primary observers, ranging from one beluga per sighting (n_s=150) to 116 belugas per sighting (n_s=1). The highest number of sightings on transect per survey block was in block 6 (69 sightings), followed by block 10 (60 sightings), block 11 (39 sightings), and block 12 (36 sightings). There were 40 sightings north of 72°N. In the western Beaufort Sea (south of 72°N), sighting rates were highest in July, decreased in August, and bottomed out in September and October (Figure 34; Appendix E, Table E-9). This pattern did not change when areas north of 72°N were included in the monthly sighting rate analysis. 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). The nearly complete lack of belugas in September and October 2016 was unexpected because belugas from both the ECS and the Beaufort Sea stock are normally observed migrating through the ASAMM study area in fall enroute to wintering grounds in the Bering Sea. The low Tr sighting rates in the ASAMM study area in September and October 2016 might be indicative of greater abundance north (north of 72°N) or east (east of 140°W) of the ASAMM study area. A survey conducted in mid-September out to 74°N yielded only one sighting of one beluga (Appendix B, Flight 238). Beluga Tr sighting rates in 2016 were higher than sighting rates in 2011, but lower compared to observations in 2012-2015 (Clarke et al. 2013a, 2014, 2015a).

Areas of highest fine-scale Tr sighting rates in the Beaufort Sea were offshore on the continental slope and in the deepest area surveyed (Figure 35).

For all months combined, block 10 had the highest Tr sighting rate (0.135 WPUE), followed by block 6 (0.073 WPUE), block 11 (0.064 WPUE), and block 12 (0.063 WPUE) (Appendix E, Table E-9). Offshore survey blocks located over the continental slope in the western Beaufort Sea (i.e., 2, 6, 7, and 11) generally had higher Tr sighting rates than blocks near shore (i.e., 1, 3, 4 and 5) (Figure 36). The area north of 72°N had a sighting rate of 0.191 during the summer period when surveys were conducted.

Beluga Tr sighting rates per depth zone (south of 72°N) were highest in the 201-2,000 m depth zone near Barrow Canyon (154°W-157°W) and in the western Beaufort Sea (140°W-154°W) (Figure 37; 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).

Beluga Tr sighting rates in the ECS study area were twice to nearly four times as high as sighting rates for blocks 1-12 during summer months (Figure 38), illustrating the importance of Beaufort Sea slope habitat (approximately 200-3,000 m depth) to belugas. In July, 807 belugas were seen

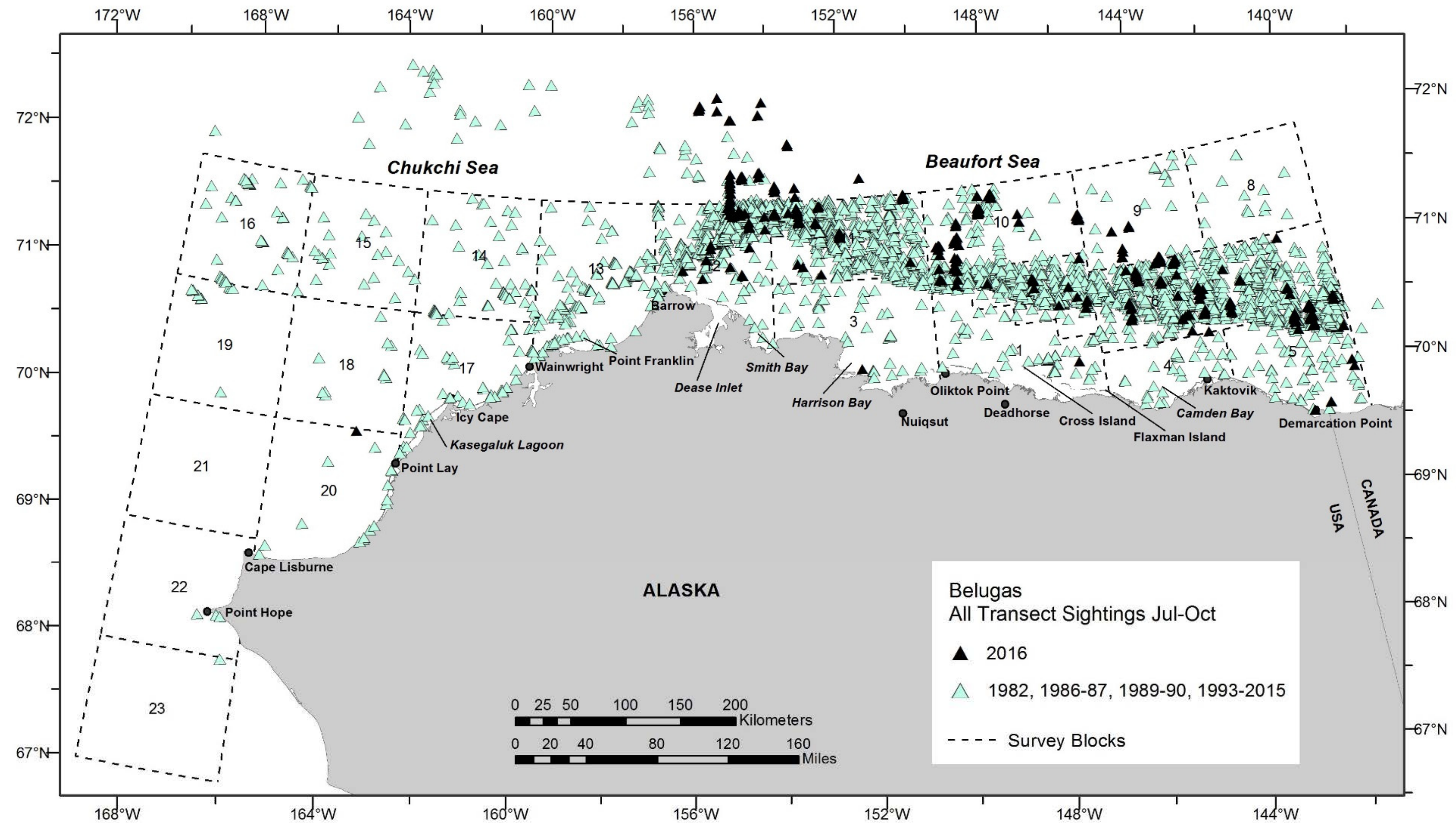


Figure 33. ASAMM beluga sightings on transect in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2015, and 2016. Includes all sightings on transect made by primary and secondary observers.

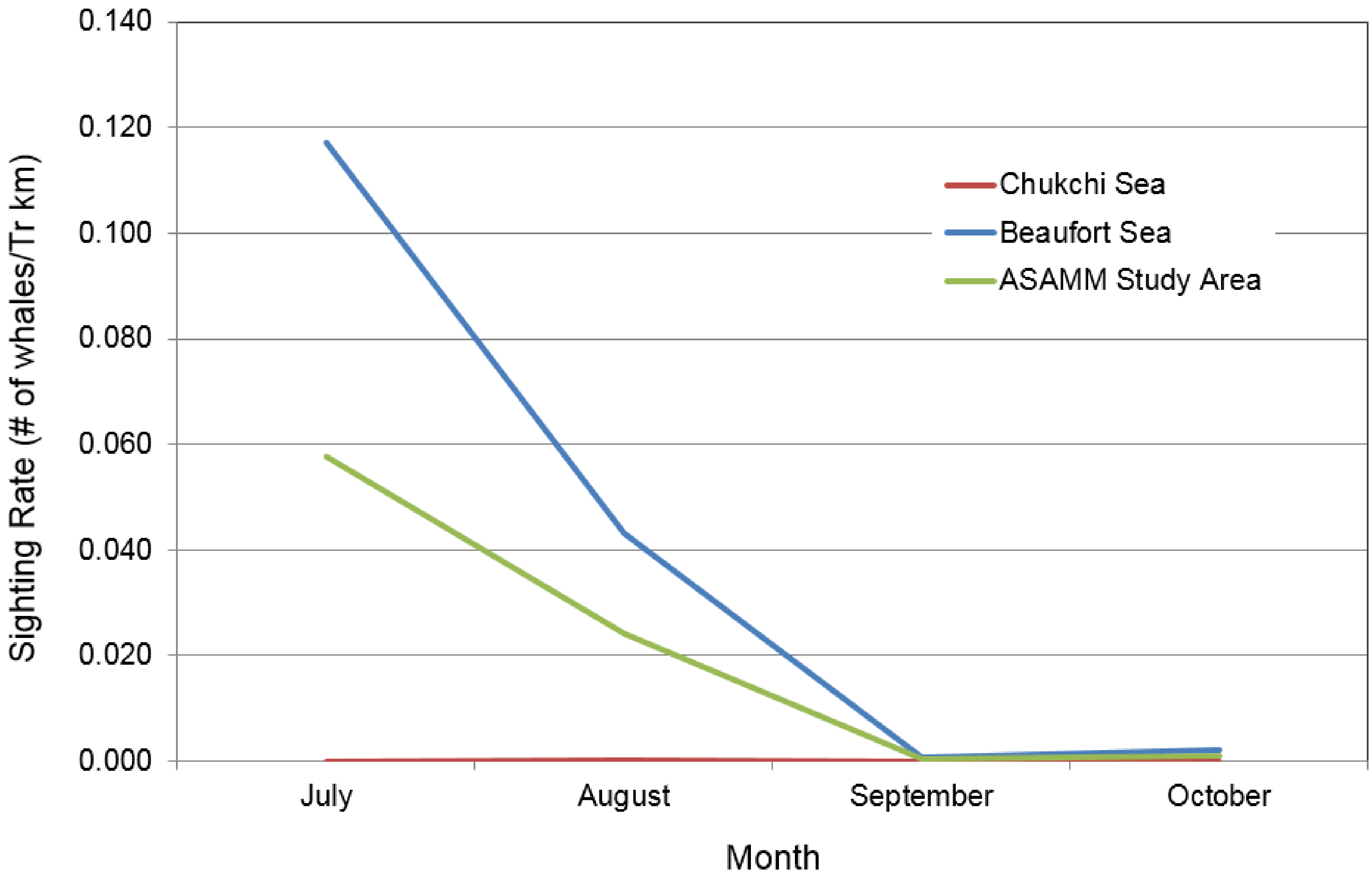


Figure 34. ASAMM 2016 beluga monthly sighting rates (WPUE; transect sightings from primary observers only) in the western Beaufort and eastern Chukchi seas, and in the entire ASAMM study area. Does not include effort and sightings north of 72°N.

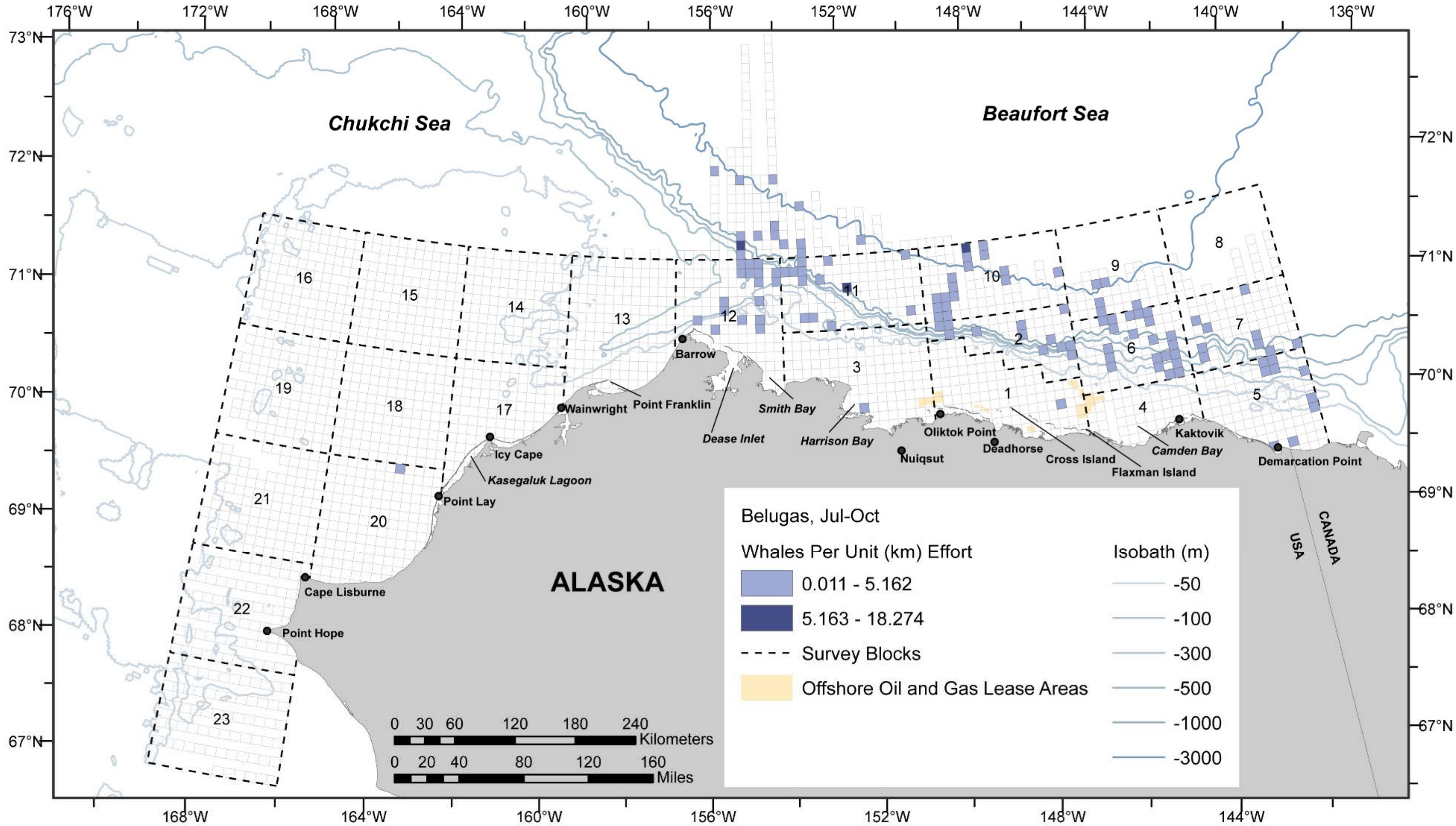


Figure 35. ASAMM 2016 beluga sighting rates (WPUE; transect sightings from primary observers only). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

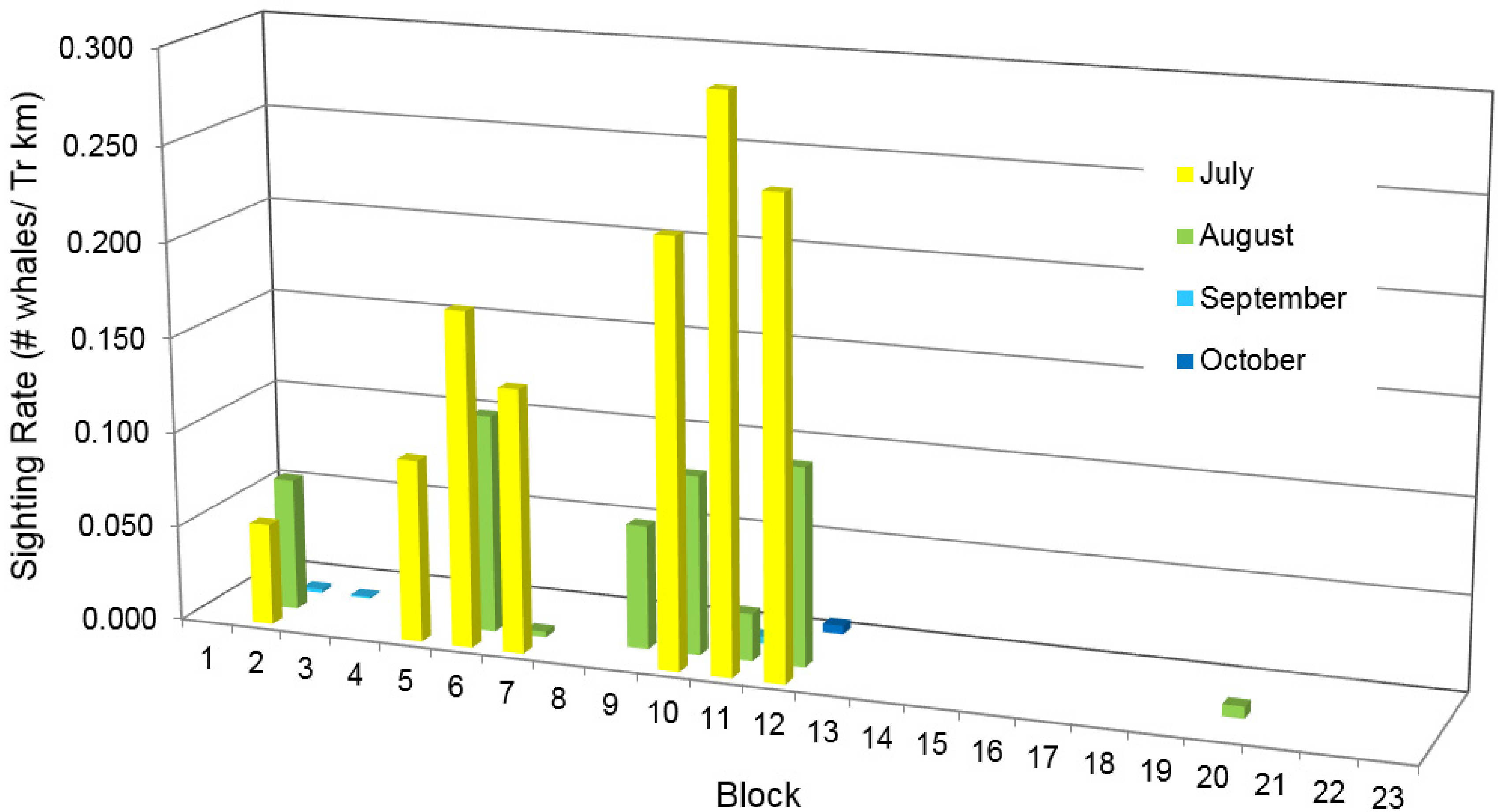


Figure 36. ASAMM 2016 beluga monthly sighting rates (WPUE; sightings from primary observers only) per block for sightings and effort on transect (Tr). Sighting rates of zero were removed from the graph for clarity. Does not include effort and sightings north of 72°N.

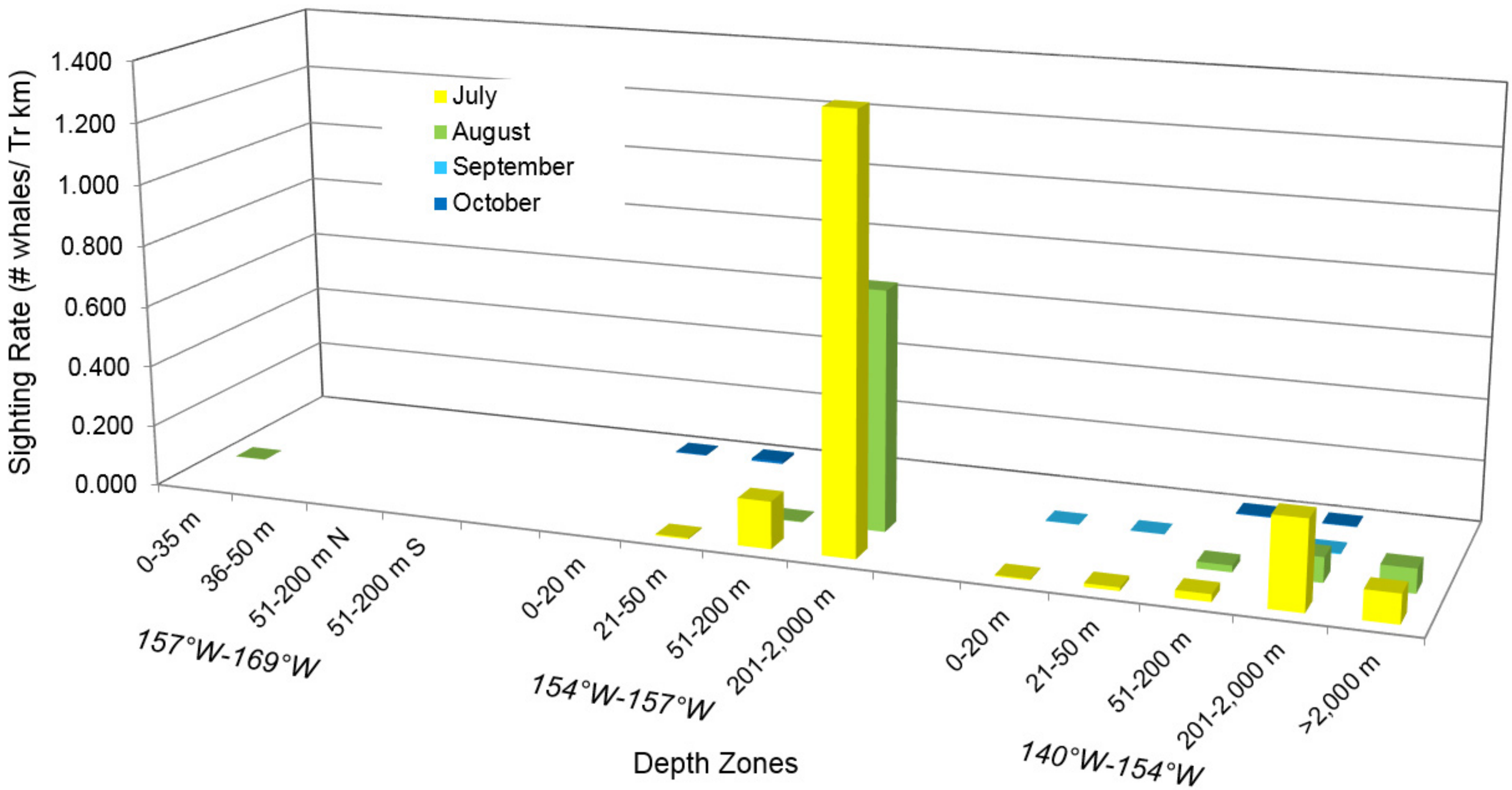


Figure 37. ASAMM 2016 beluga monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr). Sighting rates of zero were removed from the graph for clarity. Does not include effort and sightings north of 72°N.

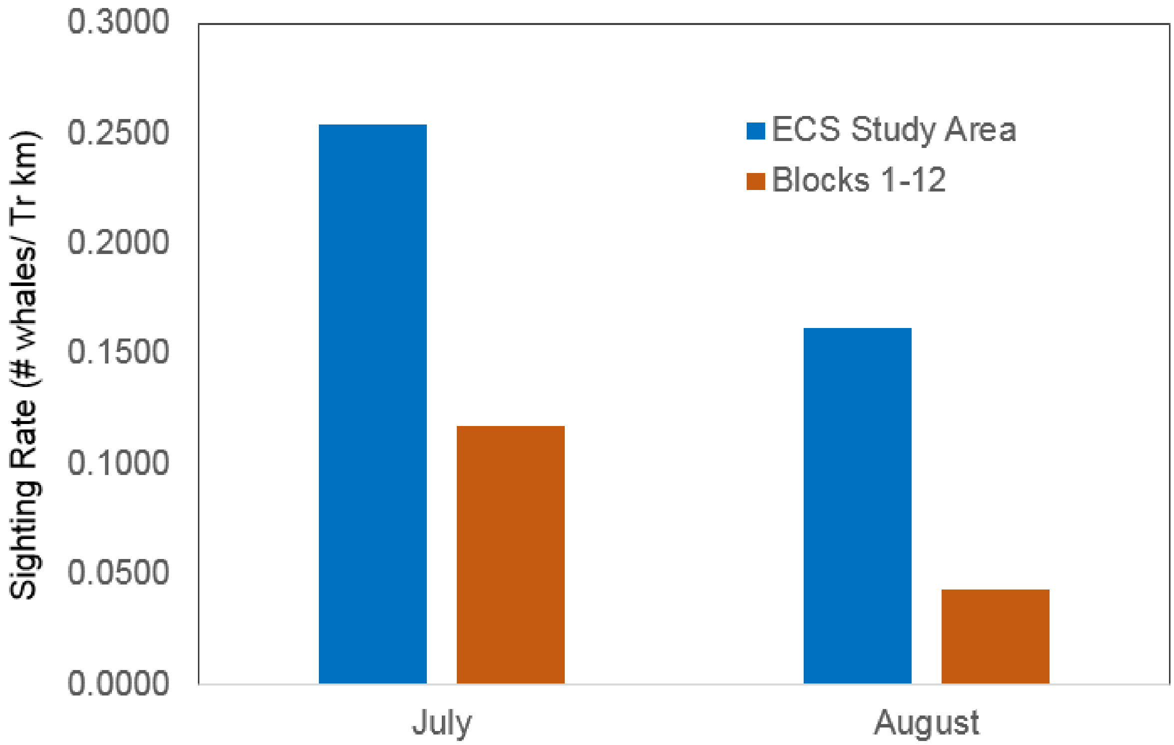


Figure 38. ASAMM 2016 beluga sighting rates on transect (WPUE; sightings from primary observers only) for the Eastern Chukchi Sea (ECS) beluga study area and ASAMM survey blocks 1-12, July and August.

on transect during 3,177 Tr km (0.254 WPUE) in the ECS study area compared to 758 belugas on transect during 6,463 Tr km (0.117 WPUE) in blocks 1-12. Sighting rates were lower in both areas in August (0.161 WPUE in ECS study area; 0.043 WPUE in blocks 1-12) than in July.

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.

Beluga Sea Ice Associations

Belugas were observed in sea ice cover ranging from no ice to 90% broken floe ice. Most belugas (51%, $n_i = 942$) were observed in ≤10% sea ice cover, with 43% ($n_i = 790$) in 11-30% sea ice cover, and 6% ($n_i = 109$) in >30% sea ice cover. Sea ice remained in the ASAMM study area later than it has in recent years (Appendix A, Figure A-1 through A-7). Additional influences on beluga sea ice association in 2016 were the surveys conducted in July and August north of 72°N for ECS belugas. Seventy-two percent ($n_i = 167$) of belugas seen north of 72°N were in >10% ice. Belugas sighted in September and October were all in ≤5% sea ice.

Table 10. ASAMM 2016 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	1/1	0	0	0	1/1
Mill	4/292	18/387	2/9	2/6	0	0	0	0	26/694
Rest	1/2	5/5	2/6	1/1	0	3/3	0	0	12/17
Swim	25/128	175/576	69/295	45/111	1/1	4/6	1/2	5/10	325/1,129
TOTAL	30/422	198/968	73/310	48/118	2/2	7/9	1/2	5/10	364/1,841

Beluga Behaviors

Beluga behaviors observed during all survey modes (transect, search, and circling) in 2016 are summarized in Table 10. The behavior most often recorded was swimming (61%). Milling was recorded for 694 belugas (38%), resting was recorded for 17 belugas (1%), and one beluga was observed diving. Two belugas (<1%), a cow-calf pair, 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 281°T ($Z = 54.497$, $P < 0.0001$, 234 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 276°T ($Z = 4.193$, $P = 0.007$, 5 observations). Mean vector swim directions for belugas in the northeastern Chukchi Sea (154°W-169°W, to incorporate Barrow Canyon) in summer (July-August) or fall (September-October) were not significantly clustered around a mean heading.

There were 89 sightings of 165 beluga calves observed during all survey modes (transect, search, and circling) (Figure 39). Animals identified as calves likely included belugas up to a few years old. Calves nurse for up to 2 years but may remain with their mothers after weaning has occurred (Suydam 2009), often forming triads when a new calf is born. Color is also not 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 7-9 years of age. Beluga calf sightings were scattered across the western Beaufort Sea slope (Figure 39). The largest calf concentrations were northeast of Barrow and between Point Franklin and Barrow.

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

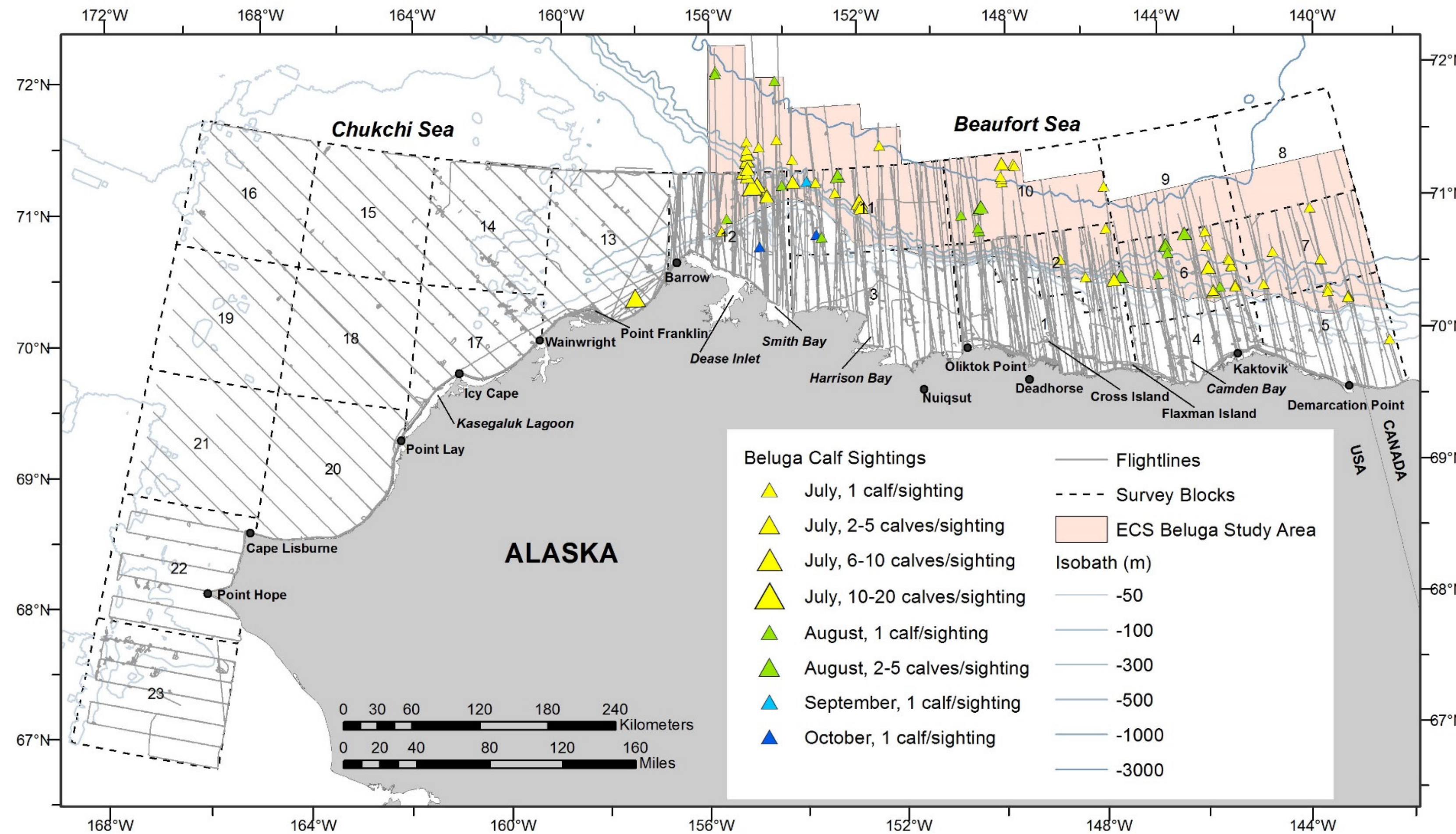


Figure 39. ASAMM 2016 beluga calf sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Killer Whales

There were 5 sightings of 30 killer whales (*Orcinus orca*) in 2016, including 5 calves (Table 3; Figure 31), all in the northeastern Chukchi Sea. Killer whales were observed on 3 days in September, and analysis of photographic images from each day indicates that sightings were likely of unique animals. One group of 15 killer whales, including three calves, was seen on 3 September, approximately 265 km northwest of Icy Cape. Two groups of seven total killer whales, including one calf, were seen on 20 September, approximately 40 km west of Icy Cape. Two groups of eight total killer whales, including one calf, were seen on 26 September, approximately 250 km west of Icy Cape. Killer whales were observed swimming (77%), hunting (13%), and milling (10%). Two of the swimming whales were observed swimming upside-down at the surface, and the hunting whale group appeared to be hunting a seal. None of the killer whales appeared to respond to the survey aircraft.

Harbor Porpoises

There were 10 sightings of 16 harbor porpoises (*Phocoena phocoena*) in 2016, all in the southcentral Chukchi Sea (Table 3; Figure 31). Harbor porpoises were observed on one day in late July and 2 days in August. Harbor porpoises were often in close proximity to humpback whales, fin whales, minke whales, and gray whales, but were also sighted alone. Harbor porpoises were observed swimming (44%), milling (44%), and resting (12%). None of the harbor porpoises appeared to respond to the survey aircraft.

Unidentified Cetaceans and Unidentified Marine Mammals

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 36 sightings of 43 unidentified cetaceans in 2016 (Table 3; Figure 40). Thirty-two of the unidentified cetaceans were in the eastern Chukchi Sea, and 11 unidentified cetaceans were in the western Beaufort Sea. Four of the unidentified cetaceans were probable bowhead whales, based on their size and darker color. Four of the unidentified cetaceans were likely gray whales, three were likely minke whales, and one was possibly a fin or humpback whale, based on size and shape. The majority of unidentified cetacean sightings were not seen clearly enough to identify to species with any probability. There was also one sighting of one unidentified marine mammal (Figure 40), which was not seen clearly enough to identify to species with any probability.

One of the unidentified cetaceans appeared to respond to the survey aircraft by diving.

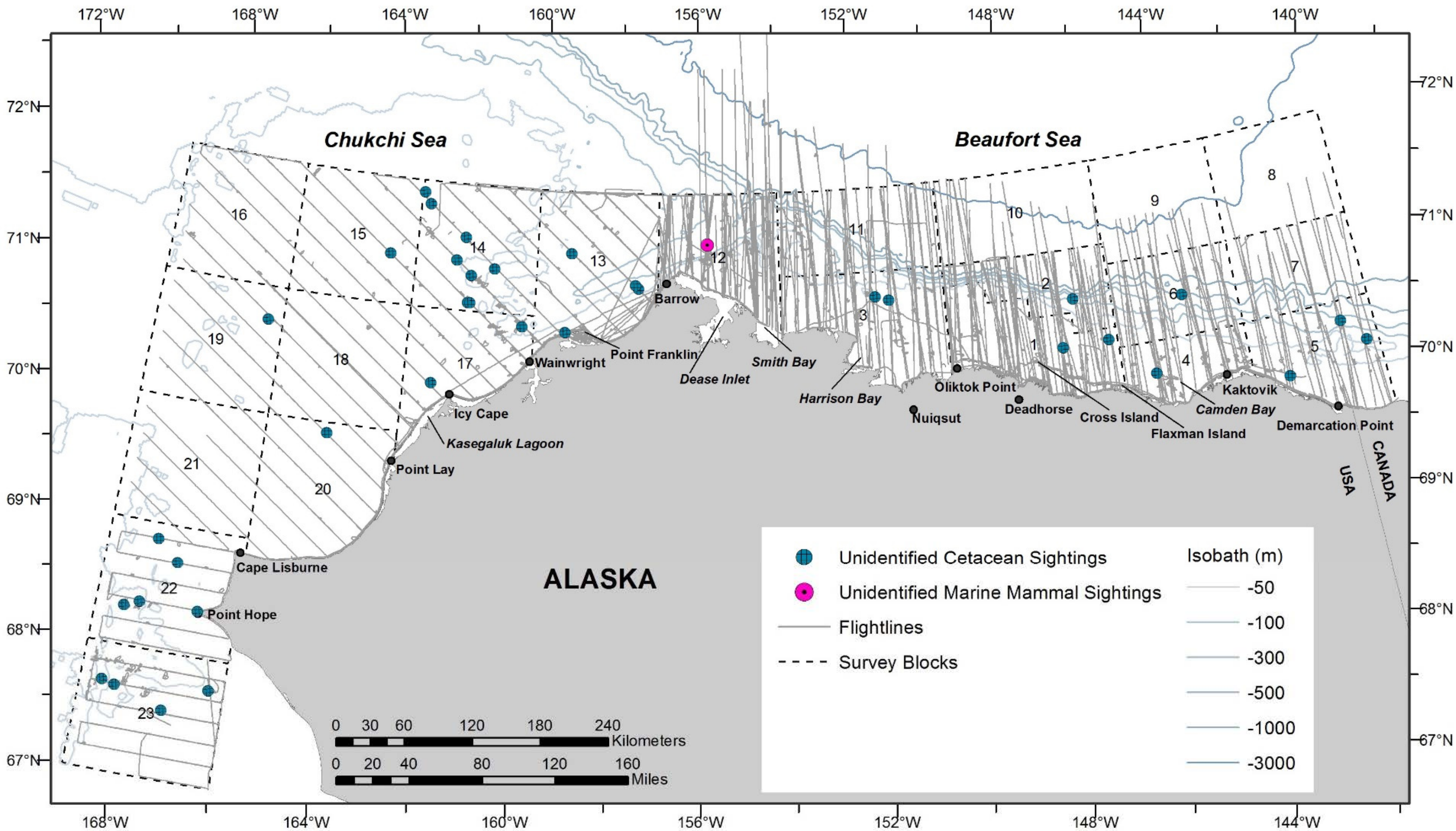


Figure 40. ASAMM 2016 unidentified cetacean and unidentified marine mammal sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Pinnipeds

Walruses

Pacific walruses (*Odobenus rosmarus divergens*) were observed every month in the eastern Chukchi Sea (Figure 41). Excluding dead walruses and walruses that were known to be duplicate sightings within the same day, there were 817 sightings of 27,755 walruses observed from July to October 2016 (Table 11). This total includes one sighting of a moderately large, coastal walrus haulout near Point Lay. Excluding sightings of the Point Lay haulout, most walruses (77%, n_i=15,556) were sighted in July and August, with the majority of sightings in the northeastern Chukchi Sea. Several walruses (26 sightings of 695 animals) were observed in the western Beaufort Sea from Point Barrow east to 152.2°W, the majority of which were in groups of 1-200 that were hauled out on sea ice.

From July through September, when sea ice was still present in the study area, most walruses were observed hauled out on sea ice (91% of total walruses observed from 2 July to 26 September, 273 sightings of 18,322 walruses). In July, several large groups of walruses were observed hauled out on shorefast ice between Point Franklin and Barrow and on sea ice on Hanna Shoal (Figure 41A). In August and September, walruses were observed primarily near Hanna Shoal, where remaining sea ice provided haulout platforms for feeding walruses (Figures 41B, 41C). Walruses hauled out on sea ice were in groups ranging in size from one animal to 1,000 animals. Walruses not hauled out were observed swimming, resting, milling, or diving. In October, when sea ice had receded north and the study area was essentially ice-free (Appendix A, Figures A-8 and A-9), walruses were observed only in open water or hauled out on land.

On 7 October 2016, 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. Snyder, USFWS, pers comm to J. Clarke, 7 October 2016). An ASAMM survey conducted on 9 October (Appendix B, Flight 248) documented a moderately large haulout numbering approximately 7,500 walruses located on a barrier island immediately west of Point Lay, 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), and 2015 (Clarke et al. 2017), and approximately 6 km south of the haulout location in 2014 (Clarke et al. 2015a). Photographs of the haulout were taken from 4.5 km lateral distance and 2000 m altitude. Information shared with ASAMM by USFWS on 11 October indicated that the haulout had been vacated, so no additional surveillance surveys were conducted.

There were 1,881 walruses (representing 6.7% of all walruses sighted) that appeared to respond to the survey aircraft. Reactions included flushing from ice floes into the water (1,712 walruses), diving (168 walruses), and looking up (1 walrus). No walruses in the large coastal haulout appeared to respond to the survey aircraft.

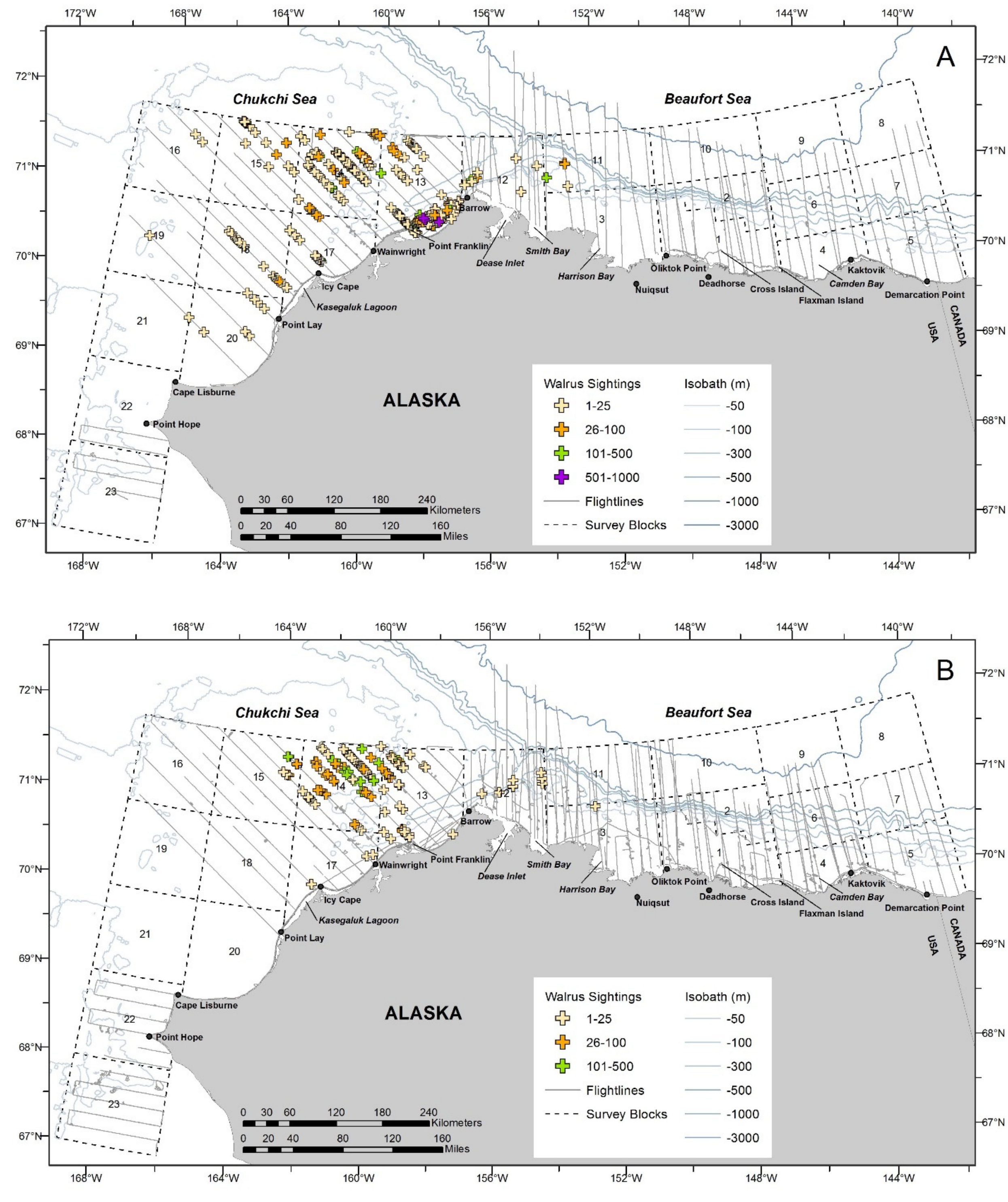
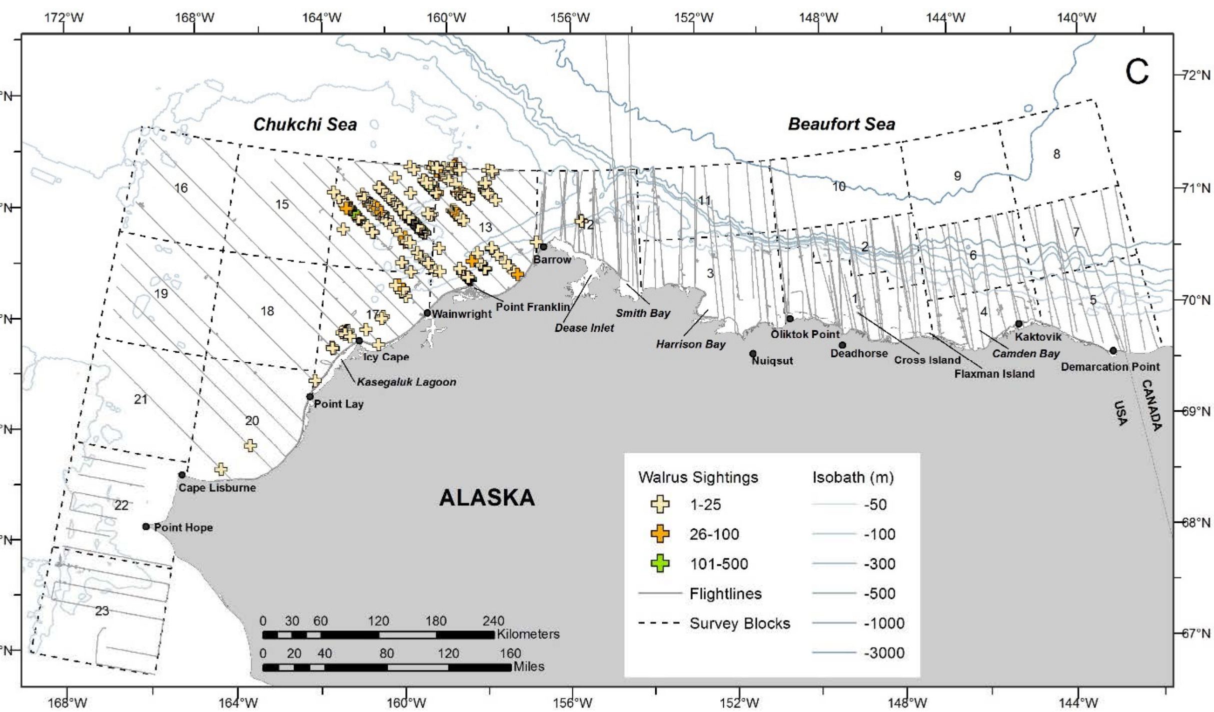


Figure 41. ASAMM 2016 walrus sightings plotted by month and group size, with transect, search, and circling effort. A: July; B: August. Deadhead flight tracks are not shown.



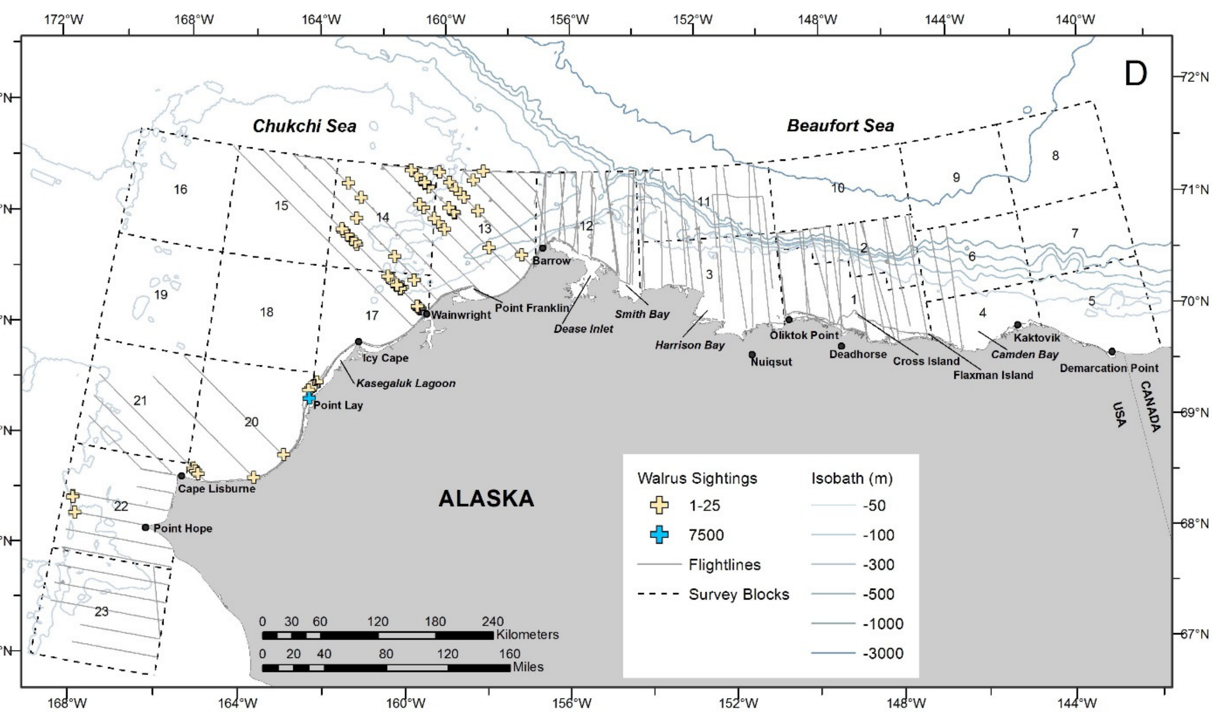


Figure 41 (cont.). ASAMM 2016 walrus sightings plotted by month and group size, with transect, search, and circling effort. C: September; D: October. Deadhead flight tracks are not shown.

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, 2 July – 26 October 2016, by survey flight and semimonthly time period. Excludes dead and repeat sightings.

Day	Flight No.	Walrus	Bearded Seal	Ribbon Seal	Unidentified Pinniped*	Polar Bear
2 Jul	201	9/86	0	0	10/11	0
6 Jul	202	0	0	0	23/41	0
8 Jul	203	65/4,200	0	0	27/31	0
9 Jul	204	20/69	1/1	0	41/70	0
11 Jul	205	0	0	0	1/1	0
13 Jul	206	61/3,220	1/1	0	4/5	0
14 Jul	207	0	1/1	0	26/35	1/1
16 Jul	208	21/900	0	0	2/2	1/1
19 Jul	209	0	0	0	10/12	0
19 Jul	1	0	0	0	0	0
20 Jul	210	9/165	0	0	0	1/1
20 Jul	2	0	0	0	0	0
21 Jul	211	8/446	1/1	0	15/16	0
21 Jul	3	5/227	0	0	7/13	0
22 Jul	212	11/272	0	0	8/9	0
24 Jul	213	3/4	0	0	2/3	1/1
24 Jul	4	0	0	0	1/1	0
25 Jul	214	0	1/1	0	35/237	0
25 Jul	5	0	1/1	0	4/4	0
27 Jul	215	32/201	0	0	2/2	0
27 Jul	6	0	1/1	0	71/189	1/1
29 Jul	216	51/1,301	2/2	0	10/12	2/2
29 Jul	7	0	0	0	6/7	0
30 Jul	8	0	0	0	13/15	0
31 Jul	9	0	0	0	5/5	0
2 Aug	217	1/1	0	0	3/4	0
2 Aug	10	0	1/1	0	1/1	0
3 Aug	218	0	0	0	18/20	0
3 Aug	11	0	0	0	0	0
5 Aug	219	0	0	0	18/24	0
5 Aug	12	34/72	1/1	0	0	0
6 Aug	220	0	0	0	12/16	0

Day	Flight No.	Walrus	Bearded Seal	Ribbon Seal	Unidentified Pinniped*	Polar Bear
6 Aug	13	0	0	0	6/6	0
7 Aug	221	0	0	0	1/1	0
7 Aug	14	0	1/1	0	24/59	1/1
8 Aug	15	0	0	0	10/12	2/9
15 Aug	16	0	0	0	4/4	6/20
16 Aug	222	58/3,209	0	0	7/9	0
17 Aug	223	0	0	0	4/4	0
17 Aug	17	0	1/1	0	14/26	4/4
20 Aug	224	1/7	0	0	42/62	0
20 Aug	18	0	0	0	15/124	0
22 Aug	225	11/161	0	0	8/8	1/1
22 Aug	19	0	0	0	0	0
23 Aug	226	33/966	1/1	0	7/7	0
24 Aug	227	0	1/1	0	47/71	0
24 Aug	20	0	0	0	0	3/4
25 Aug	228	0	0	0	43/195	0
25 Aug	21	0	0	0	44/155	3/46
26 Aug	229	3/3	0	0	7/9	0
26 Aug	22	1/1	0	0	41/570	0
27 Aug	230	2/45	0	0	11/12	0
27 Aug	23	0	0	0	23/301	0
28 Aug	231	0	1/1	0	3/3	0
28 Aug	24	0	0	0	16/58	0
29 Aug	232	0	0	0	34/47	0
3 Sep	233	1/4	0	0	1/2	0
3 Sep	25	28/1,022	0	0	3/3	0
5 Sep	234	32/169	3/3	0	2/2	3/3
5 Sep	26	0	0	0	0	0
6 Sep	235	0	0	0	9/15	1/1
6 Sep	27	0	0	0	0	1/1
8 Sep	28	0	0	0	8/32	5/22
9 Sep	29	0	0	0	0	0
10 Sep	236	81/1,353	2/2	0	23/31	1/1
10 Sep	30	0	0	0	17/127	0
11 Sep	237	67/1,227	0	1/1	21/271	4/4
11 Sep	31	0	0	0	1/11	1/3

Day	Flight No.	Walrus	Bearded Seal	Ribbon Seal	Unidentified Pinniped*	Polar Bear
12 Sep	32	0	0	0	0	0
13 Sep	238	0	0	0	20/31	0
14 Sep	239	3/5	0	0	0	0
14 Sep	33	0	0	0	43/181	0
15 Sep	240	0	0	0	34/44	0
15 Sep	34	0	0	0	1/1	0
16 Sep	35	0	0	0	0	1/1
18 Sep	241	4/6	0	0	0	0
18 Sep	36	0	0	0	0	1/1
19 Sep	242	57/626	0	0	9/12	0
19 Sep	37	3/5	0	0	5/61	4/4
20 Sep	243	29/84	0	0	45/47	0
20 Sep	38	0	0	0	36/115	3/34
21 Sep	39	0	0	0	31/146	12/56
22 Sep	40	0	0	0	11/80	0
23 Sep	244	0	0	0	3/4	0
24 Sep	41	0	0	0	7/7	2/2
25 Sep	245	0	0	0	0	0
25 Sep	42	0	0	0	10/11	0
26 Sep	246	2/8	0	0	23/28	0
26 Sep	43	0	0	0	3/5	4/24
27 Sep	44	0	0	0	4/8	0
3 Oct	45	0	0	0	1/1	5/34
4 Oct	247	23/101	0	0	9/10	0
7 Oct	46	0	0	0	1/1	2/3
8 Oct	47	0	0	0	0	0
9 Oct	248	9/7,515	0	0	19/21	0
10 Oct	249	23/39	0	0	97/111	0
10 Oct	48	0	0	0	71/225	1/9
12 Oct	250	0	0	0	19/20	0
14 Oct	251	3/9	0	0	25/31	0
15 Oct	252	0	0	0	7/7	5/10
16 Oct	253	0	0	0	3/3	3/4
17 Oct	254	0	0	0	3/3	0
18 Oct	255	6/15	0	0	23/24	2/4
19 Oct	256	0	0	0	0	0

Day	Flight No.	Walrus	Bearded Seal	Ribbon Seal	Unidentified Pinniped*	Polar Bear
22 Oct	257	4/5	0	0	1/1	0
23-Oct	258	3/6	0	0	19/19	0
24 Oct	259	0	0	0	52/77	1/1
26 Oct	260	0	0	0	3/3	0
			Semimonthly Summary			
1-15 Jul		155/7,575	3/3	0	132/194	1/1
16-31 Jul		140/3,516	6/6	0	191/527	6/6
1-15 Aug		35/73	3/3	0	97/147	9/30
16-31 Aug		109/4,392	4/4	0	366/1,661	11/55
1-15 Sep		212/3,780	5/5	1/1	183/751	16/35
16-30 Sep		95/729	0	0	187/524	27/122
1-15 Oct		58/7,664	0	0	249/427	13/56
16-31 Oct		13/26	0	0	104/130	6/9
TOTAL		817/27,755	21/21	1/1	1,509/4,361	89/314

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

Other Pinnipeds

Pinnipeds were distributed throughout most of the study area, primarily on the continental shelf (Figure 42). Relatively few pinnipeds were seen in Harrison Bay, seaward of the Beaufort Sea slope, or in the offshore blocks in northeastern Chukchi Sea (blocks 15, 16, 19, and 21). Six pinnipeds were seen in block 1a, between the barrier islands and the shoreline; these were the only marine mammals other than polar bears seen shoreward of the barrier islands in block 1 despite nearly 500 km of Tr effort.

Bearded seals (*Erignathus barbatus*; 21 sightings of 21 seals) were observed from early July through mid-September (Table 11, Figure 42). Fewer bearded seals were seen in the western Beaufort Sea (n_i = 7) than in the eastern Chukchi Sea (n_i = 14). Most bearded seals were in the water; one bearded seal was hauled out on ice in mid-July. One bearded seal responded to the aircraft by diving.

One ribbon seal (*Histriophoca fasciata*) was seen on 11 September, hauled out in 70% sea ice approximately 35 km northwest of Point Franklin (Table 11, Figure 42). Based on very dark coloration, the ribbon seal was likely an adult male. The ribbon seal did not appear to respond to the aircraft.

Other pinnipeds were not identifiable to species and were recorded as unidentified pinnipeds (141 sightings of 162 animals) or small unidentified pinnipeds (1,368 sightings of 4,199 animals)

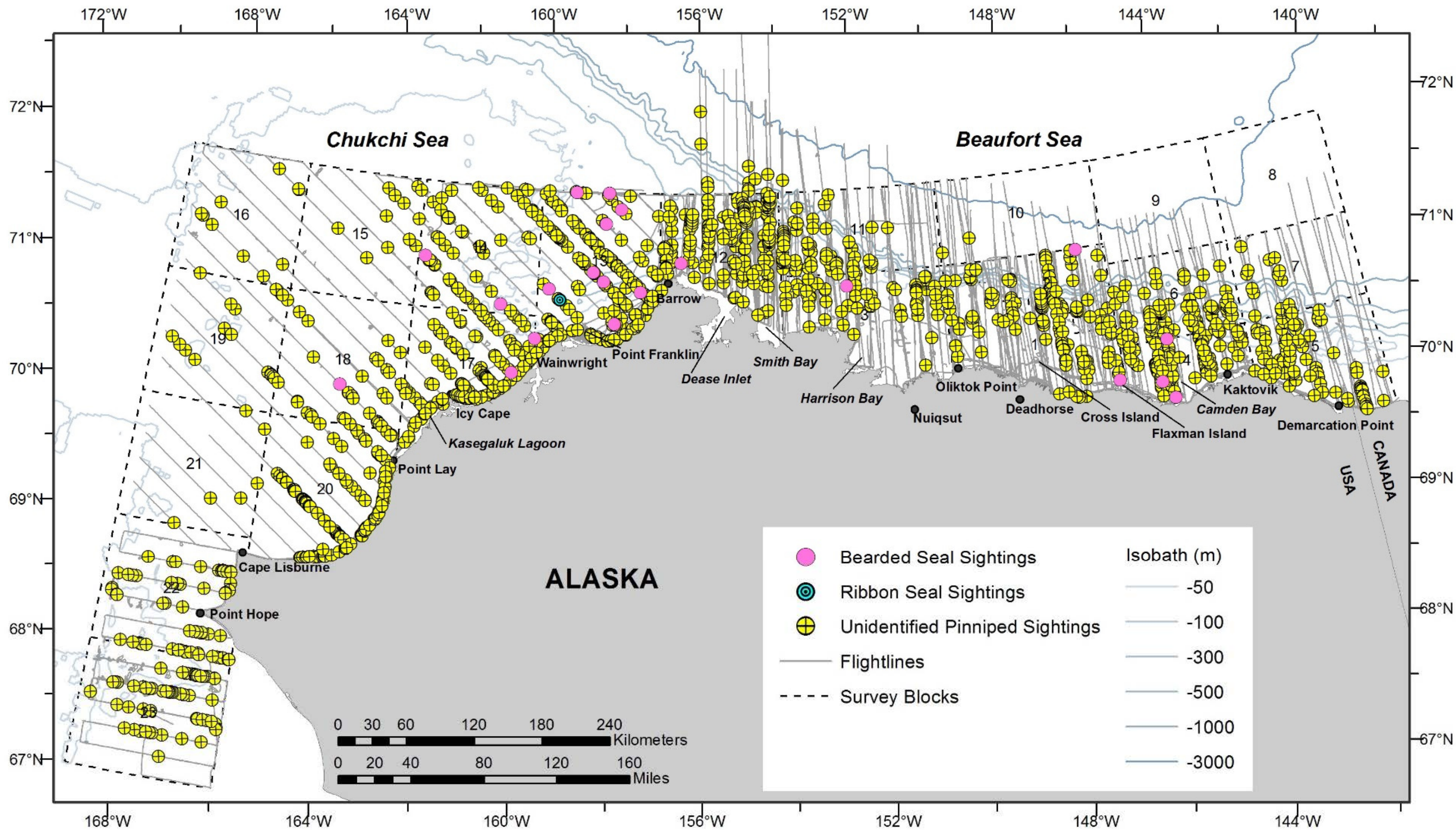


Figure 42. ASAMM 2016 bearded seal, ribbon seal, and unidentified pinniped (including small unidentified pinniped) sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

(Figure 42). Unidentified pinnipeds likely included sightings of ringed (*Pusa hispida*), spotted (*Phoca largha*), 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, and resting. Large numbers of pinnipeds were often seen feeding near feeding bowhead whales. One large group of unidentified pinnipeds, likely spotted seals, was seen hauled out on a barrier island near Icy Cape on 25 July, and several small groups (of 1-100 animals) were seen hauled out on ice in July and again in mid-September.

Two hundred thirty-six unidentified pinnipeds (5% of total) appeared to respond to the aircraft. Most pinnipeds responded by diving, but one group of 25 pinnipeds hauled out on sea ice responded by flushing from the ice.

Polar Bears

There were 89 sightings of 314 polar bears (*Ursus maritimus*) during ASAMM 2016 (Table 11, Figure 43). In the northeastern Chukchi Sea, there were 20 sightings of 24 polar bears from mid-July through mid-October. Most of the bears seen in July, August, and September ($n_i = 14$) were associated with at least 5% sea ice. Nine of the bears observed in September and October were on the beach or swimming within 2 km of shore between Point Franklin and Barrow, and one bear was observed swimming in open water about 145 km from the closest point of land.

In the western Beaufort Sea, there were 69 sightings of 290 polar bears from July through October, most of which (94%) were either on shore or barrier islands, or swimming within 2 km of shore. Seventeen bears were observed >2 km from shore or barrier islands, including two bears observed resting on sea ice and one bear swimming in open water approximately 85 km from the closest point of land. Polar bears were distributed from Point Barrow to east of Demarcation Bay (Figure 43).

There is no coastal transect in the Beaufort Sea, although search effort along the shoreline or barrier islands was often flown between transect lines. Additionally, dedicated coastal search effort over several long stretches of coastline was initiated on five occasions in 2016, and 50 polar bears were recorded during those searches. In general, however, there is less opportunity to observe polar bears along the Beaufort Sea coastline, where they would most likely be seen when the ice edge has receded offshore, than in the Chukchi Sea where a coastal transect is frequently flown.

Several polar bears (24 sightings of 137 bears) were seen near (within approximately 35 km) the village of Kaktovik, both prior to (61 bears observed on 4 days in August) and after (76 bears observed on 2 days in September) 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 (6 sightings of 92 bears) were seen on or near (within 5 km) Cross Island, northeast of Deadhorse, on 4 days. 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 2016 subsistence hunt (13 bears observed on 1 day in mid-August) and after the subsistence hunt (79 bears observed on 2 days in September and 1 day in October).

Excluding polar bears observed on Cross Island, there were 10 sightings of 18 polar bears in block 1a.

Polar bears were observed swimming, walking, running, resting, milling, and feeding. One bear appeared to have cached a carcass in the ice (Appendix B, Flight 236), a behavior considered unusual for polar bears (S. Amstrup, Polar Bears International, pers. comm. to J. Clarke, 18 November 2016). The majority of bears (91%) sighted did not respond to the survey aircraft.

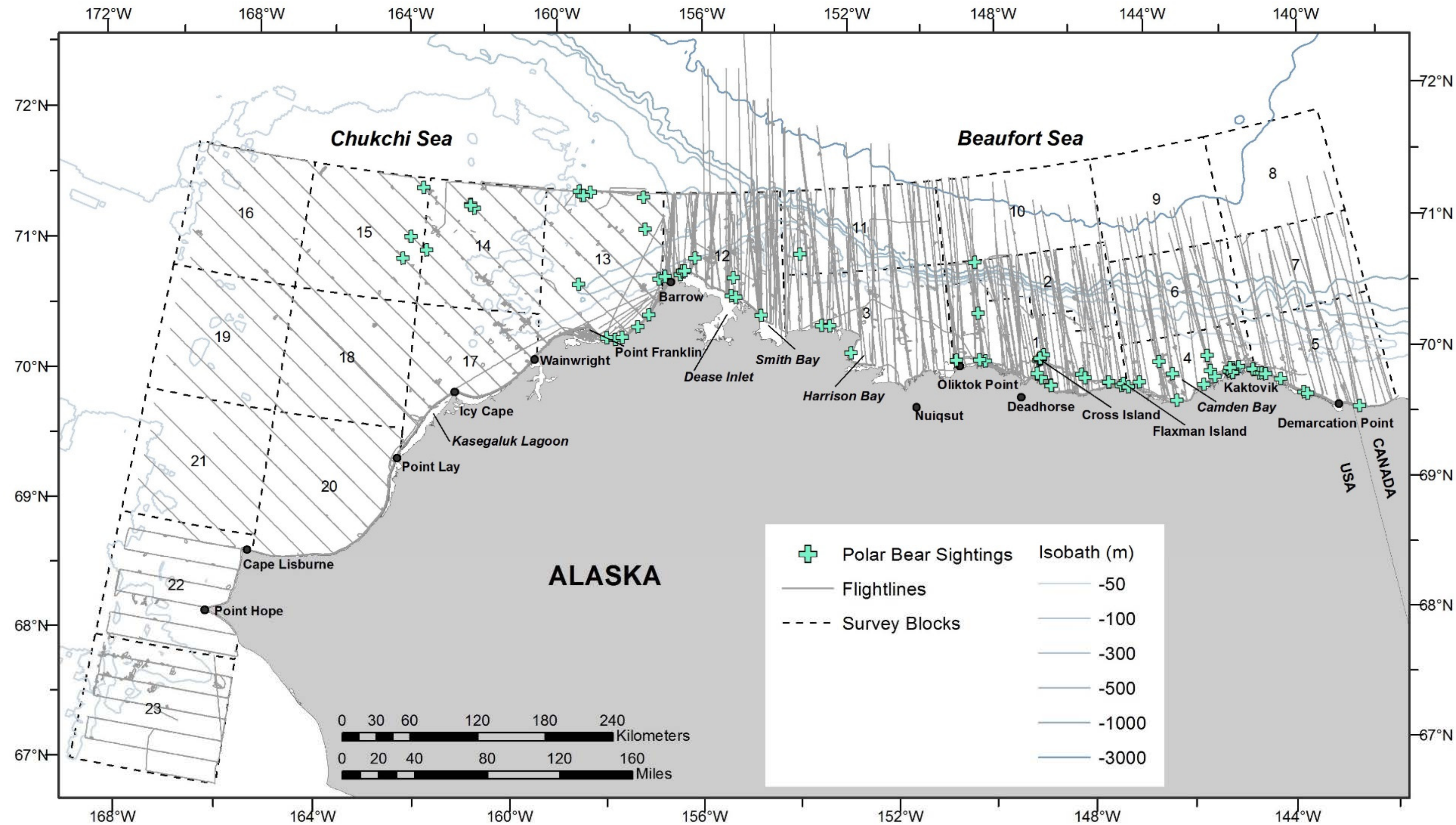


Figure 43. ASAMM 2016 polar bear sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Twenty-seven bears (9%) did appear to react to the survey aircraft. Twenty-one bears looked up, five bears ran, and one bear flushed off sea ice.

Beginning in 2012, photographs were occasionally 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 2016, there were four opportunities to photograph Cross Island. Photographs were taken of Cross Island on 15 August, 20 and 26 September, and 3 October. Although the entire island was not photographed on any of those dates, final group size estimates increased with post-flight image analysis, from 8 to 13, 19 to 32, 1 to 19, and 17 to 30, respectively. Photographs were also taken of polar bears near Kaktovik on 2 days, 25 August and 21 September, and final group sizes increased with post-flight analysis of images, from 8 to 35 and 1 to 36, respectively. These results confirm that initial polar bear counts at known polar bear aggregation areas such as Cross Island or near Kaktovik are likely underestimates that should be verified by post-flight image analysis whenever possible.

Dead Marine Mammals

There were 66 sightings of 72 dead marine mammals in 2016 (Table 12), although 11 of the cetacean carcasses and three of the walrus carcasses were repeats of earlier observations. Most (86%) of the carcasses were observed in the Chukchi Sea. Excluding repeat sightings, 27 of the carcasses observed were walruses and 16 of the carcasses observed were cetaceans, including bowhead whales (five sightings of single animals), gray whales (seven sightings of single animals), and unidentified cetaceans (four sightings of single animals). Four carcasses were in advanced states of decomposition and not identifiable beyond “marine mammal”. Ten carcasses were identified as pinnipeds. Thirty-six of the carcasses were observed in open water, 34 were on the beach or barrier island, and two were on ice.

One bowhead whale carcass was initially sighted in mid-July (Appendix B, Flight 206), floating in open water north of Wainwright, and resighted in mid-September (Appendix B, Flight 236) on the beach between Barrow and Point Franklin, having drifted nearly 90 km. A bowhead carcass initially sighted on 27 August (Appendix B, Flight 23) was resighted on 8 September (Appendix B, Flight 28), and again on 21 September (Appendix B, Flight 39), having drifted southeasterly nearly 330 km.

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 12. ASAMM 2016 dead marine mammal sightings, all survey modes (transect, search, and circling).

Flight No.	Date	Latitude (°N)	Longitude (°W)	Species	No. Individuals	Habitat
202	06-Jul-16	70.33047	-161.8707	gray whale	1	beach
202	06-Jul-16	70.65904	-160.066	unidentified cetacean	1	beach
202	06-Jul-16	70.76117	-159.7137	unidentified pinniped	1	beach
202	06-Jul-16	70.85136	-159.3272	unidentified marine mammal	1	beach
204	09-Jul-16	69.45038	-165.3098	walrus	1	open water
206	13-Jul-16	71.11162	-165.124	walrus	1	open water
206	13-Jul-16	70.84505	-160.0179	bowhead whale	1	open water
209	19-Jul-16	68.00796	-166.5616	walrus	1	open water
209	19-Jul-16	67.86575	-166.5605	unidentified marine mammal	1	open water
210	20-Jul-16	71.02626	-162.2801	walrus	1	broken floes
210	20-Jul-16	71.05741	-163.9207	walrus	1	open water
213	24-Jul-16	70.631	-160.0701	unidentified cetacean*	1	beach
213	24-Jul-16	70.29588	-161.4067	gray whale	1	beach
214	25-Jul-16	71.33957	-167.0108	walrus	1	open water
214	25-Jul-16	70.70359	-166.0423	walrus	1	open water
216	29-Jul-16	71.99091	-158.8187	unidentified pinniped	1	broken floes
217	02-Aug-16	70.65339	-160.0344	unidentified cetacean*	1	beach
218	03-Aug-16	71.07997	-166.7584	walrus	1	open water
219	05-Aug-16	68.86215	-167.4449	gray whale	1	open water
219	05-Aug-16	68.54373	-168.4781	walrus	1	open water
219	05-Aug-16	68.32858	-166.5351	walrus	1	open water
219	05-Aug-16	67.18123	-168.6268	walrus	1	open water
221	07-Aug-16	71.37446	-166.1416	walrus	1	open water
221	07-Aug-16	71.98908	-167.9099	walrus	1	open water
224	20-Aug-16	71.79339	-154.3044	walrus	1	open water
225	22-Aug-16	71.29764	-164.143	unidentified pinniped	1	open water
225	22-Aug-16	70.40032	-160.7506	unidentified pinniped	1	beach
225	22-Aug-16	70.4011	-160.7473	unidentified pinniped	1	beach
225	22-Aug-16	70.47958	-160.4434	gray whale	1	beach
226	23-Aug-16	70.85548	-159.2837	walrus	2	beach
227	24-Aug-16	69.80495	-163.0232	unidentified pinniped	4	beach
227	24-Aug-16	69.8091	-162.999	walrus	2	beach

Flight No.	Date	Latitude (°N)	Longitude (°W)	Species	No. Individuals	Habitat
227	24-Aug-16	70.29553	-161.3992	gray whale*	1	beach
227	24-Aug-16	70.48176	-160.443	gray whale*	1	beach
227	24-Aug-16	70.85641	-159.2712	walrus*	2	beach
227	24-Aug-16	70.86698	-159.2065	walrus	1	beach
227	24-Aug-16	70.88089	-159.0938	walrus	1	beach
228	25-Aug-16	71.96104	-154.4121	walrus	1	open water
22	26-Aug-16	71.76325	-153.5053	walrus	1	open water
23	27-Aug-16	71.49944	-150.1577	bowhead whale	1	open water
230	27-Aug-16	70.86177	-158.3461	unidentified pinniped	1	open water
23	27-Aug-16	70.97021	-146.9223	unidentified cetacean	1	open water
233	03-Sep-16	70.23423	-165.7955	walrus	1	open water
235	06-Sep-16	70.5884	-162.0623	gray whale	1	open water
235	06-Sep-16	70.78555	-159.6746	walrus	1	beach
235	06-Sep-16	70.87022	-159.2075	walrus*	1	beach
235	06-Sep-16	70.82149	-158.1292	unidentified marine mammal	1	beach
235	06-Sep-16	70.8222	-158.1011	walrus	1	beach
27	06-Sep-16	71.04813	-152.843	walrus*	1	open water
28	08-Sep-16	70.45738	-144.0659	unidentified cetacean*	1	open water
28	08-Sep-16	70.66857	-145.3258	bowhead whale*	1	open water
236	10-Sep-16	70.91895	-157.6011	bowhead whale*	1	beach
237	11-Sep-16	71.31124	-165.8086	bowhead whale	1	open water
237	11-Sep-16	71.48584	-163.339	bowhead whale	1	open water
33	14-Sep-16	70.33365	-141.614	bowhead whale	1	open water
240	15-Sep-16	70.29559	-161.4056	gray whale*	1	barrier island
240	15-Sep-16	70.33755	-161.0163	gray whale	1	barrier island
240	15-Sep-16	70.70087	-159.8968	unidentified cetacean*	1	beach
241	18-Sep-16	67.5257	-168.6965	gray whale	1	open water
242	19-Sep-16	70.86152	-159.2552	unidentified cetacean	1	barrier island
243	20-Sep-16	70.69949	-162.6142	unidentified cetacean	1	open water
243	20-Sep-16	70.85685	-162.4744	walrus	1	open water
243	20-Sep-16	70.86549	-159.2633	unidentified cetacean*	1	barrier island
39	21-Sep-16	70.37243	-141.8129	bowhead whale*	1	open water
245	25-Sep-16	68.70469	-167.3708	unidentified marine mammal	1	open water
249	10-Oct-16	70.95103	-160.3454	walrus	1	open water

* Repeat sighting from earlier survey

Accomplishments and Outreach

Data from ASAMM 2016 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 2016).
- 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), Pacific Marine Environmental Laboratory (PMEL), NOAA National Marine Fisheries Service, 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, 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 (66 total forms) were sent to the relevant agencies: NMFS and NSB received forms for cetaceans and ice seals, and USFWS and NSB received forms for walruses.

Community outreach in 2016 included:

- Meeting with the NSB Search and Rescue to familiarize them with our project.
- Sending the Deadhorse and Kaktovik whaling communication centers emails with flight plans prior to and after every survey flight that occurred in the Beaufort Sea during the fall whaling seasons.
- Communication with Principal Investigators of unmanned aircraft projects operating in the study area to minimize risk to both projects.
- 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 2016 were shared with interested parties in the federal, state, and local government (including NOAA, BOEM, NSB, USFWS, and USGS), media, and non-governmental organizations. Media efforts were coordinated through NOAA and BOEM public affairs offices.

ASAMM provided subsets of the 1982-2015 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, UAF, University of Texas, NSB, Shell, and USCG.

Results from the 2016 ASAMM field season were presented at several venues, including:

Brower, A., A. Willoughby, J. Clarke, and M. Ferguson. 2017. Subarctic cetacean occurrence in the eastern Chukchi Sea, Summer and Fall 2016. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, January 2017.

Clarke, J., M. Ferguson, A. Brower, and A. Willoughby. 2017. Not all are in Canada…. bowhead whales (*Balaena mysticetus*) in the western Beaufort Sea, July-August, 2012-2016. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, January 2017.

Ferguson, M., R.P. Angliss, A. Kennedy, B. Lynch, A. Willoughby, V. Helker, A.A. Brower, and J.T. Clarke. 2017. Comparing estimates of arctic cetacean density derived from manned and unmanned aerial surveys. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, January 2017.

Willoughby, A., M. Ferguson, J. Clarke, and A. Brower. 2017. Opportunistic Photo-identification of Gray Whales in the eastern Chukchi Sea, Summer and Fall 2016. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, January 2017.

A complete listing of publications, posters and oral presentations from the ASAMM project from 2016 to 2017 is included in Appendix C.

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DISCUSSION

Unique Observations in 2016

- The bowhead whale sighting rate in August was more than twice that of any previously recorded August sighting rate and, even more unusual, was greater than 1.5 times as high as any previously recorded sighting rate in September or October. The paramount 2016 survey was conducted on 26 August when 498 bowhead whales were recorded, including a large aggregation of feeding whales observed in Harrison Bay.
- Fall bowhead whale sighting rates were higher in offshore block 11 than in block 12, the latter of which is a well-documented bowhead whale core-use area in most years.
- Bowhead whales were seen north of 72°N in late July during surveys conducted in the ECS beluga study area.
- A bowhead whale with entanglement scars on its peduncle was photographed in the Alaskan Beaufort Sea in August 2016, and subsequently matched to a bowhead whale image from August 1985 that was taken in the Canadian Beaufort Sea.
- A bowhead whale carcass was observed and photographed on three occasions as it drifted eastward across the western Beaufort Sea between 27 August and 21 September.
- Gray whales were observed from 6 August to 5 September in the shallow water confines of Peard Bay proper, where they have never before been seen by ASAMM. The pair of whales (confirmed via post-flight image analysis to be repeated sightings of the same two whales) were feeding.
- Single gray whales were seen in the Alaskan Beaufort Sea in July and September.
- Post-flight image analysis of gray whale cow-calf pairs indicated that most gray whale calves seen by ASAMM are not resightings of previously sighted calves.
- Balaenopterid cetaceans were observed in the southcentral Chukchi Sea in August and in the northeastern Chukchi in early September.
- Additional survey effort targeting ECS beluga summer habitat in the western Beaufort Sea was incorporated seamlessly into ASAMM survey protocol in 2016.
- Belugas were almost entirely absent from the ASAMM study area in September and October.
- Three killer whale groups were seen in the northeastern Chukchi Sea. Post-flight image analysis indicated that the three groups were likely unique animals with low probability of resighting between groups.
- Several small groups of harbor porpoises were seen in the southcentral Chukchi Sea in late July and August.
- One ribbon seal was seen in the northeastern Chukchi Sea.
- A walrus haulout formed in early October near Pt. Lay, the latest date for haulout formation on land in the northeastern Chukchi Sea.
- The sighting rate for unidentified pinnipeds was the highest recorded since 2009.

Summary

Total and transect survey effort in 2016 exceeded effort in other years with equivalent field periods (2013-2015) (Figure 44). Total effort was greater only in 2012, when an additional survey team conducted aerial surveys for ECS belugas in early July (Clarke et al. 2013a). Broad-scale aerial surveys were conducted regularly in the western Beaufort Sea in summer (July-August) in 2016 for the fifth consecutive year. Due to poor weather conditions, surveys were not conducted for 6 consecutive days in mid-August and 5 consecutive days in late September, but there were no other prolonged periods of time (>6 consecutive days) when surveys were not conducted. Since 2012, there have been relatively few instances when ASAMM surveys were not possible during extended periods of time. In 2013, the only extended period of time 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). In 2014, there were two extended periods of time (7 days in mid-September and 10 days in mid-October) and in 2015 there was one extended period of time (12 days in mid-July) when surveys could not be conducted because of poor weather conditions (Clarke et al. 2015a, 2017). 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 for successful surveys. 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 2016 to provide systematic survey coverage of the area around Liberty Prospect. Survey effort in this relatively small area totaled 218 Tr km in summer and 276 Tr km in fall. Six small unidentified pinnipeds and 18 polar bears were seen in block 1a; no cetaceans were seen.

Sea ice conditions in the study area in 2016 were similar to conditions observed in most recent years. Sea ice remained in the northeastern Chukchi Sea study area through late September before receding north of 72°N. In the western Beaufort Sea, sea ice remained in shallow nearshore areas through mid-August, then was largely absent in the study area for most of September. In late September, westerly winds blew ice from the northeastern Chukchi Sea east to approximately 151°W, but that ice was largely gone by early October. The western Beaufort Sea study area remained largely ice free for the remainder of October. 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 2016, but did not adversely affect overall survey effort.

Bowhead whales were distributed from 140°W to 167°W. Sighting rates in the western Beaufort Sea in 2016 were lowest in July, highest in August, dropped considerably in September, and remained low in October (Figure 45). The overall sighting rate in August was 0.064 (WPUE), more than double that of any previous month or year. Bowhead whale sighting rate per depth zone in August 2016 was overwhelmingly in shallow (≤20 m) water (Figure 46). The only previous year with this phenomenon was in 2013 when large groups of feeding bowhead whales were observed in the shallow waters of Camden Bay; 2013 is also the only previous year when

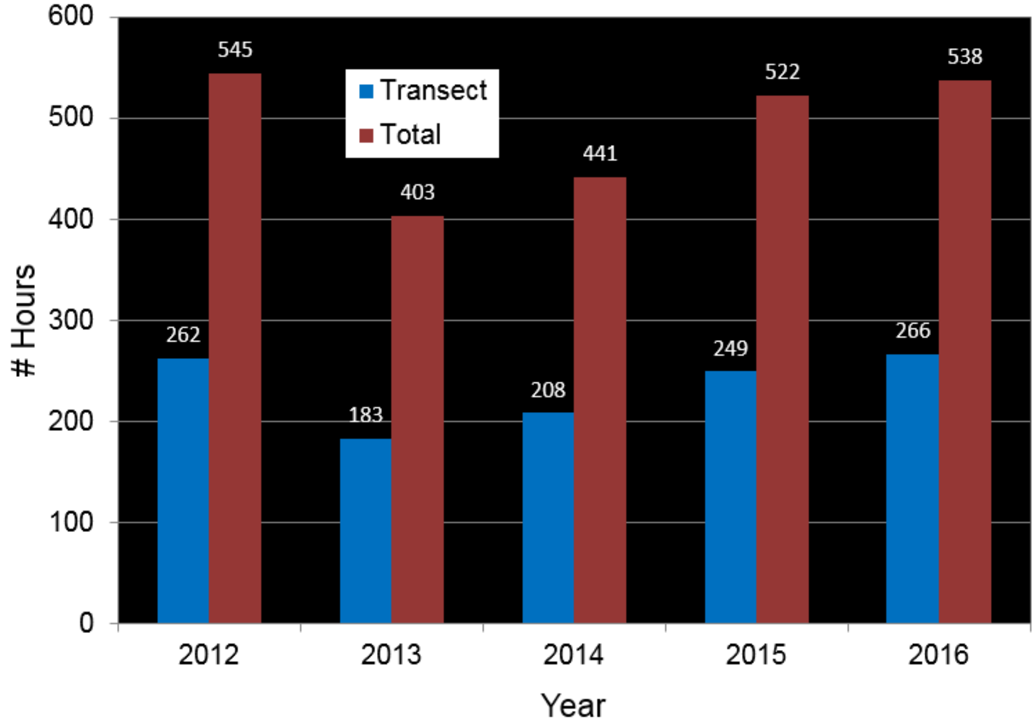


Figure 44. ASAMM transect and total survey hours, 2012-2016.

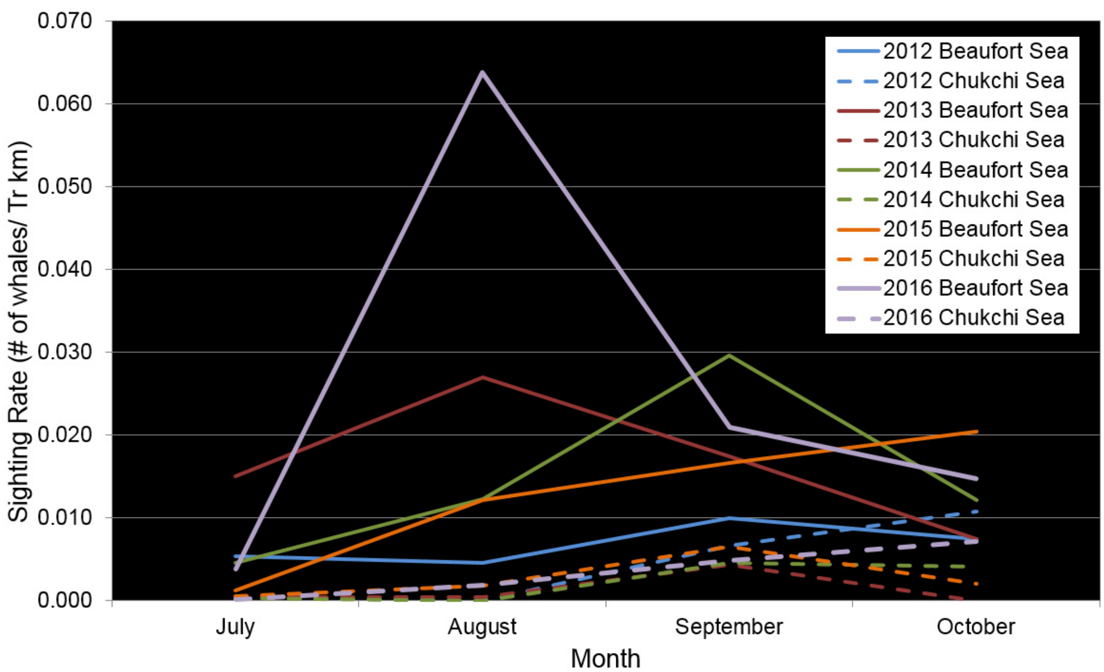


Figure 45. ASAMM bowhead whale monthly sighting rates (WPUE; transect sightings from primary observers only) in the eastern Chukchi and western Beaufort seas, 2012, 2013, 2014, 2015, and 2016. Note that ASAMM effort was limited in October 2013 due to the partial shutdown of the federal government (Clarke et al. 2014).

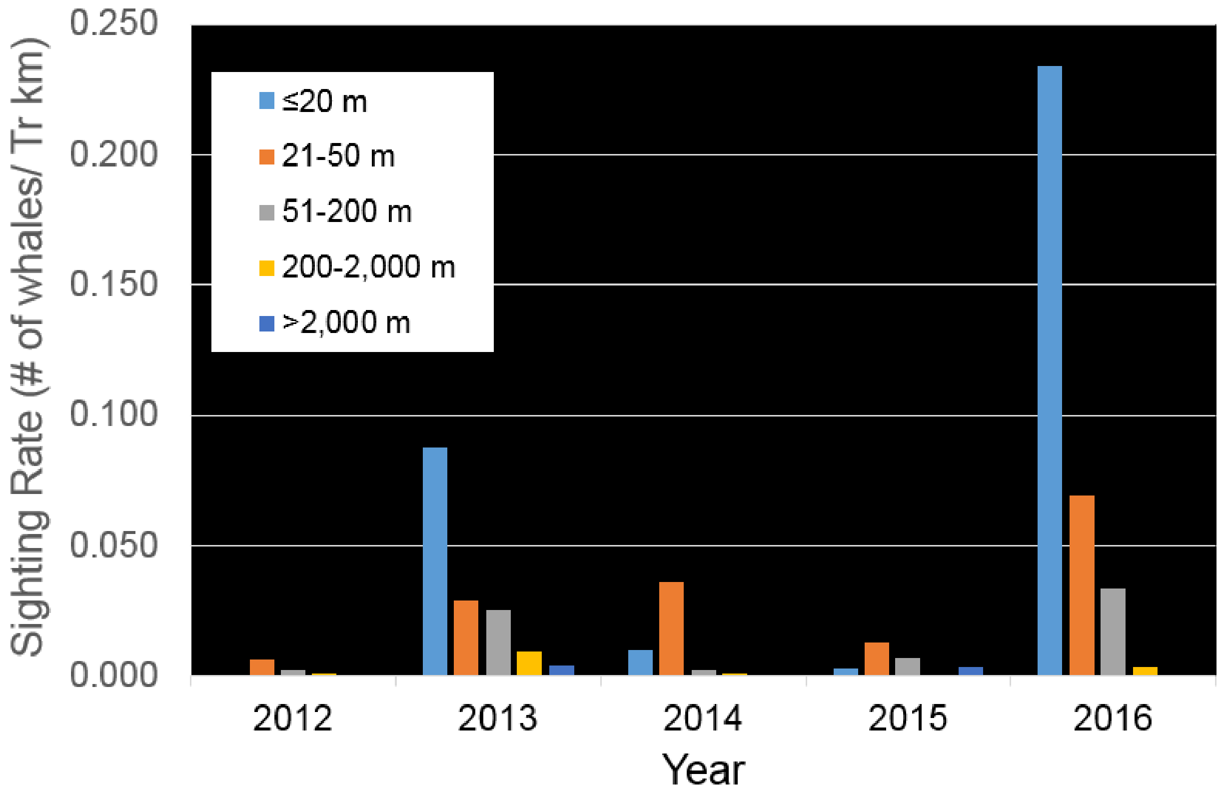


Figure 46. ASAMM bowhead whale sighting rates (WPUE; transect sightings from primary observers only) per depth zone, August, 2012-2016, in the western Beaufort Sea (140°W to154°W).

sighting rates were highest in August. The peak sighting rates observed in August 2013 and August 2016 in the western Beaufort Sea may have been due to fewer feeding opportunities in the Canadian Beaufort Sea. There are four to five recurrent bowhead whale feeding areas in the Canadian Beaufort Sea (Harwood and Smith 2002); the areas used most consistently are the shallow shelves offshore of the Tuktoyaktuk Peninsula and Cape Bathurst (Harwood et al. 2010). Citta et al. (2015) identified these two areas as core-use areas based on bowhead whale satellite telemetry results from 2006 to 2012. In this area, strong upwelling may occur, wherein Pacific-derived, cold, nutrient rich water from Amundsen Gulf is carried onto the Canadian Beaufort shelf (Walkusz et al. 2012). Upwelling is strongest when a northward-flowing current converges near Cape Bathurst (Williams and Carmack 2008), which is a condition that concentrates bowhead whale prey. Upwelling winds were weak or non-existent near Cape Bathurst from mid-July through early August in 2013 and from mid-July through early August in 2016 (Figure 47). One-third of the bowhead whales observed in summer 2013 and 56% of the bowhead whales observed in summer 2016 by ASAMM in the western Beaufort Sea were feeding or milling, suggesting that some bowhead whales may have left the Canadian Beaufort Sea in early summer to search for feeding opportunities elsewhere or may not have even migrated as far east as Tuktoyaktuk or Cape Bathurst. Few bowhead whales were

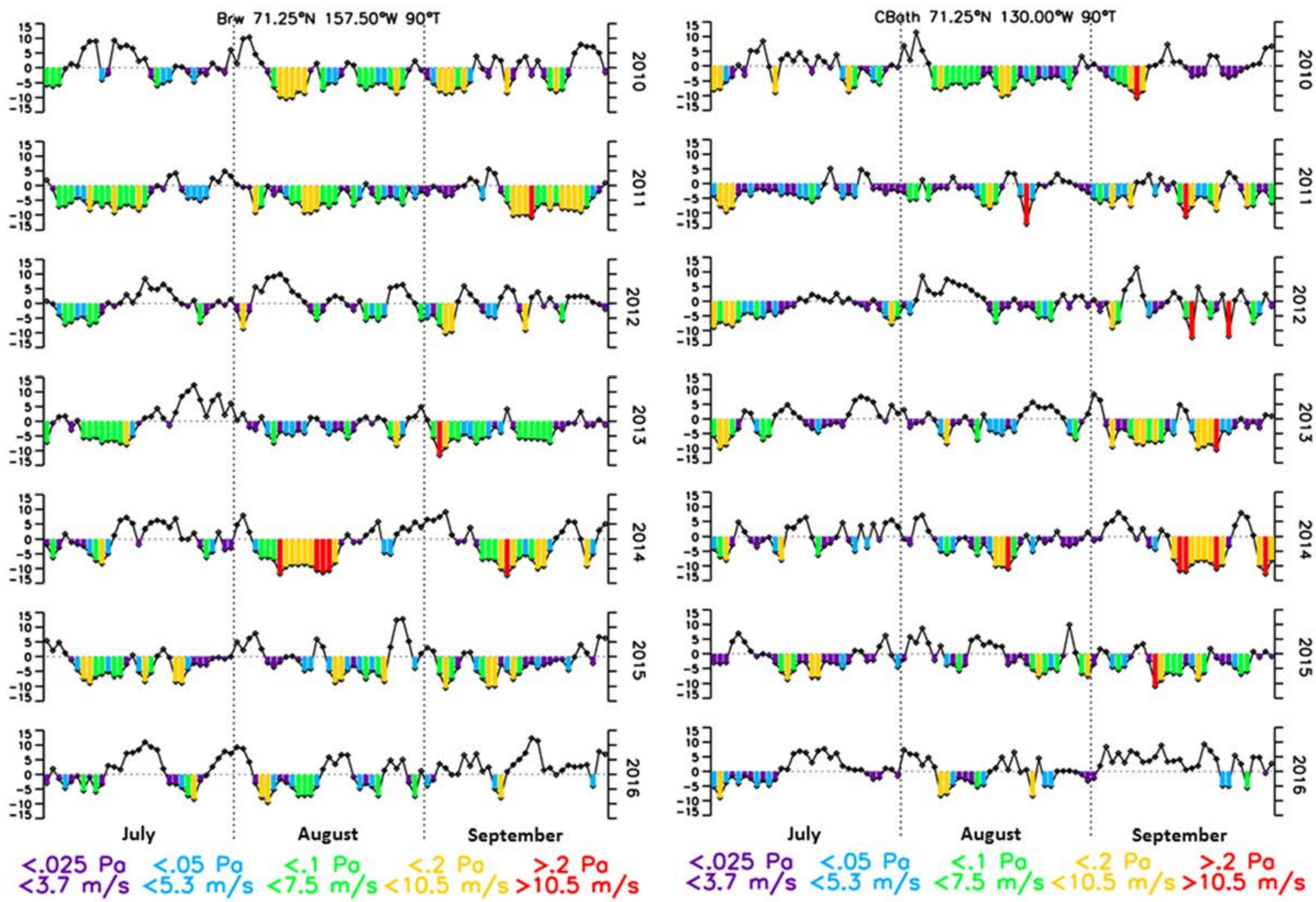


Figure 47. NOAA Earth Science Research Laboratory NCEP Reanalysis wind data from Barrow, Alaska (left), and Cape Bathurst, Canada (right), for July-September, 2010-2016. Negative values represent winds from the east; positive value winds are from the west. Upwelling favorable winds are shown in green, yellow, and red. Data courtesy of S. Okkonen, UAF.

seen by bowhead whale biologists near Tuktoyaktuk in early August 2016 (C. George, pers. comm. to J. Clarke, 7 September 2016).

Survey coverage in the western Beaufort Sea in summer 2016 was temporally and geographically similar to survey coverage in 2012-2015 (Figure 48A), but bowhead whale distribution was significantly different from previous years (Figure 48B). Prior to 2016, most bowhead whale sightings in summer were either east of 150°W or between 154°W and 157°W. In summer 2016, bowhead whales were distributed across the entire western Beaufort Sea, and the highest sighting rate occurred in block 3 (shore to 71.3°N, 150°W-154°W) (0.140 WPUE; Appendix E, Table E-1), an area not known for high sighting rates in any month. Bowhead whales sighted in late August 2016 in the Harrison Bay area of block 3 were mostly feeding (Figure 15), a behavior that had not previously been documented in that area in summer. The exact mechanisms leading to Harrison Bay being an important feeding area in late August 2016 are not known for certain, but freshwater river discharge and upwelling-favorable wind data, and the likely resultant frontal system, provide some indication. Freshwater discharge from the Colville River in late August 2016 was eight times greater than the 13-year mean for that time period (S. Okkonen, pers. comm. to J. Clarke, 3 October 2016), which produced a large oceanographic front offshore, and possibly served to aggregate bowhead whale prey. A comparison of satellite photos from late August 2015 and late August 2016 show a large front in 2016, although cloud cover obscured the area on most days. Furthermore, winds recorded at West Dock near Prudhoe Bay in late August 2016 were also upwelling-favorable (MML, unpublished data). Similar conditions were observed in the central Alaskan Beaufort Sea in September 2014 (Okkonen et al. 2017) when high numbers of feeding bowhead whales were observed near shore between 144°W and 150°W.

Bowhead whale distribution in summer 2016 in the northeastern Chukchi Sea overlapped that observed in past years (Figure 49). Sightings were scattered in offshore areas west and southwest of Barrow, similar to the distribution observed in summer 2015 (Clarke et al. 2017). Habitat use, based on summer sighting rates, indicated a preference for the 36-50 m depth zone, which differed from summer 2009 to 2015 when the preferred habitat was the 51-200 m depth zone (Clarke et al. 2016c). Sighting rates in August in the eastern Chukchi Sea were slightly higher in 2016 (0.0019 WPUE) than in 2015 (0.0018 WPUE), but still substantially lower than sighting rates in fall. 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 17), with some notable differences in distribution and sighting rates. The most significant differences were in the western Alaskan Beaufort Sea (west of 148°W), where bowhead whales were in significantly deeper water and farther from shore in 2016 compared to past light ice years. The bowhead whale sighting rate was actually higher in offshore block 11 (0.022 WPUE) than in block 12 (0.021 WPUE), a situation encountered in only 2 prior years (1992 and 1995) (Figure 50). Furthermore, the highest bowhead whale sighting rate in block 12 (154°W-157°W) in 2016 was in the 51-200 m depth zone (Appendix E, Table E-3), comprising areas farther from shore and in Barrow Canyon. Bowhead whale preference for deeper water areas was also noted by Barrow whalers who had to

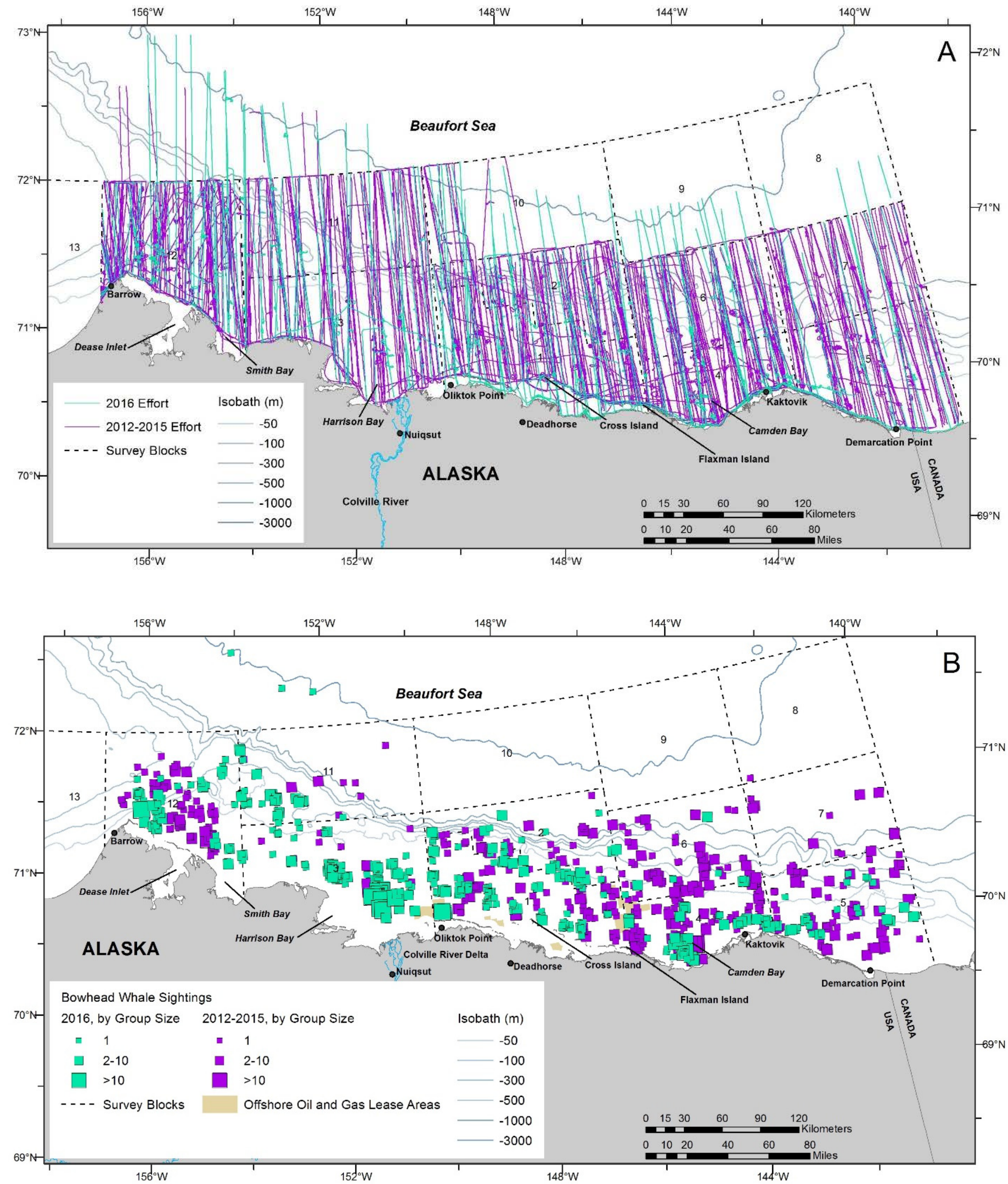


Figure 48. ASAMM 2012-2015 and 2016 summer (July-August) survey effort and bowhead whale sightings. A: survey effort, all survey modes (transect, search, and circling); B: bowhead whale sightings, by group size, all survey modes.

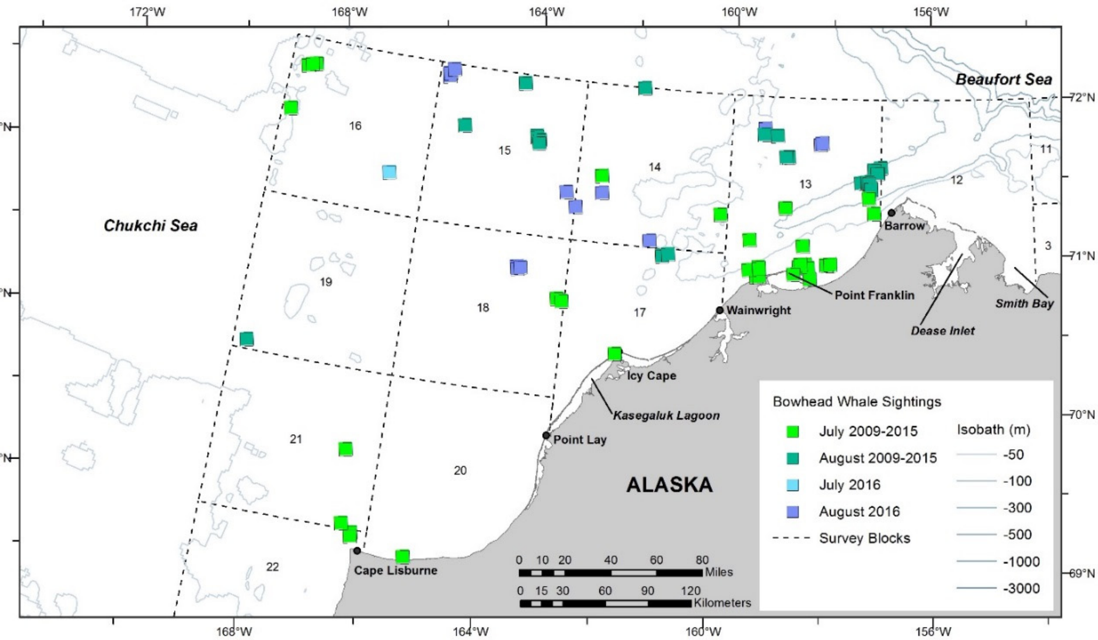


Figure 49. ASAMM bowhead whale distribution in the northeastern Chukchi Sea, July and August, 2009-2015, and 2016.

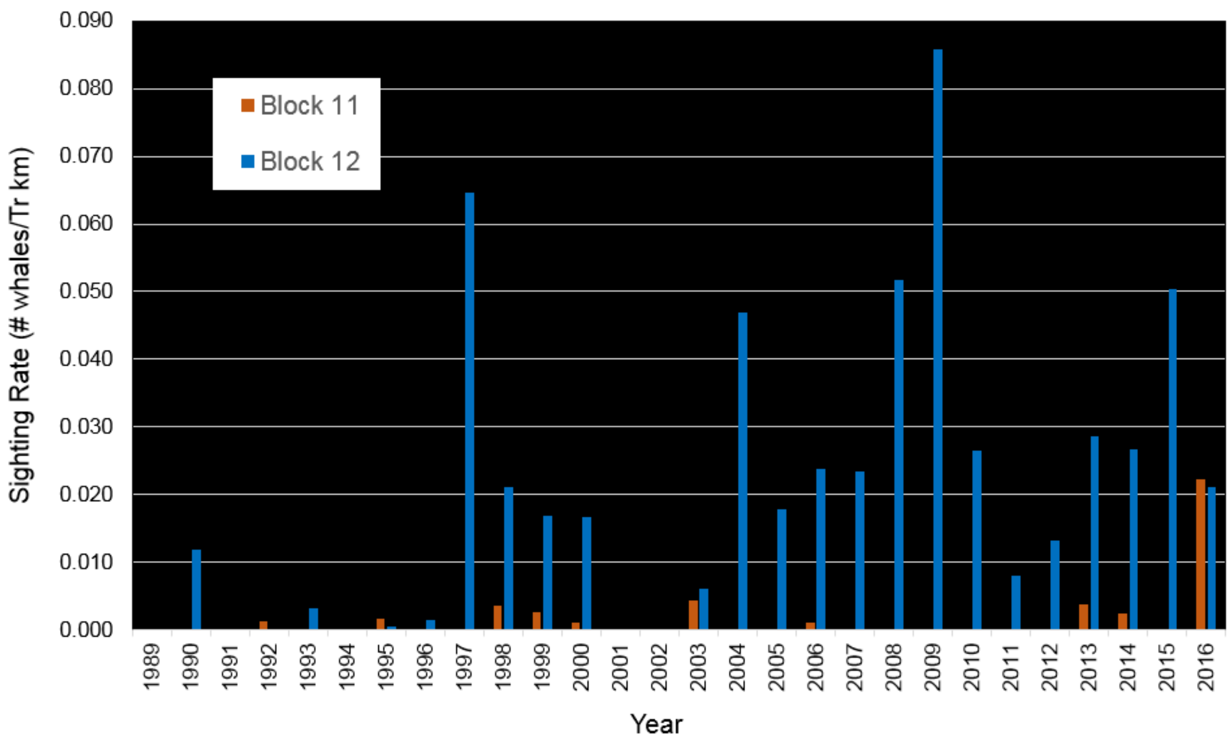


Figure 50. ASAMM bowhead whale sighting rates (WPUE; transect sightings from primary observers only) for survey blocks 11 and 12, fall 1989-2016. Sighting rates of zero were removed from the graph for clarity.

travel farther north during the fall bowhead whale hunt (C. George, pers. comm. to J. Clarke, 5 October 2016). The area east of Point Barrow is a well-documented bowhead whale feeding area. It 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 the shallow nearshore areas east of Point Barrow relies on upwelling-favorable winds from the east followed by relaxed winds that retain and aggregate krill on the shallow shelf (Ashjian et al. 2010). There were few days with upwelling-favorable winds recorded near Barrow in September 2016 (Figure 47), suggesting fewer feeding opportunities in fall. Moderately high numbers of bowhead whales were observed feeding in this area on 25 August (Figure 15), which coincided with relaxed winds succeeding upwelling-favorable winds (Figure 47).

Bowhead whale distribution in the northeastern Chukchi Sea in fall 2016 overlaid the distribution observed from 2009 through 2015, 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). Bowhead whale habitat preference continued to skew towards deeper water (51-200 m) in fall, similar to observations from 2009 to 2015 (Clarke et al. 2016c). The highest fall sighting rate for bowhead whales in the northeastern Chukchi Sea was in block 13 in 2009, 2010, 2011, and 2014, block 14 in 2012, 2015, and 2016, and block 15 in 2013 (Figure 51). 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), but there were no drilling activities in 2016.

There were two construction-related activities in the northeastern Chukchi Sea in 2016, including anchor retrieval at Chukchi Sea drill sites in July and deployment of a subsea fiber optic cable system by Quintillion from July through October. The fiber optic cable deployment project also extended into the western Beaufort as far east as Oliktok Point. Marine mammal monitoring and mitigation reports from these projects include summary sighting figures and tables (Blees et al. 2017; McFarland et al. 2016). The degree to which marine mammal sighting data were quality-checked prior to report publication is not known. Unverified sighting data from those projects, therefore, are not referenced further in this report.

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 2012-2016 due to the lack of summer surveys in the earlier years of the time

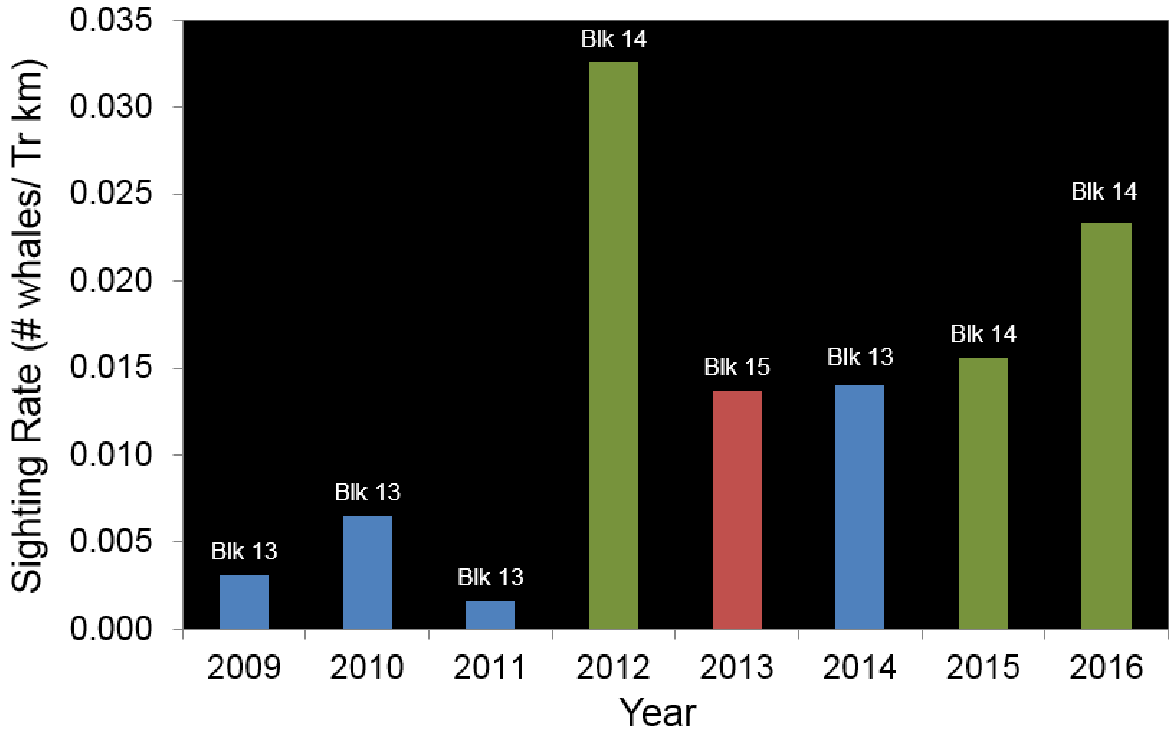


Figure 51. Annual maxima of ASAMM bowhead whale sighting rates (WPUE; transect sightings from primary observers only) in fall, by survey block, in the eastern Chukchi Sea, 2009-2016.

series. In July, the 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: Camden Bay and shallow waters in the vicinity of Barrow Canyon, two patches that were also evident in the analysis ending in 2015 (Clarke et al. 2017), and a third patch located north of Harrison Bay, due to the unprecedented sightings there in 2016. The spatial patterns in relative abundance in September were similar to those for October, with the highest predicted values located east of Kaktovik, outside the barrier islands from ~146°W to ~148°W, and on the shelf southeast of Barrow Canyon. Compared to October, HUAs for September were closer to shore north of Camden Bay, Harrison Bay, and Smith Bay. Relative abundance predictions from the spatial model built on only 2016 transect data from September and October (both months pooled) were noticeably different in the West Region compared to previous years, suggesting that the HUAs were twice as distant from shore in the West Region and approximately the same distance from shore in the East Region compared to the 17-year time series from 2000 to 2016.

The bowhead whale calf ratio (number of calves/number of total whales) in summer 2016 (0.037) was lower than calf ratios observed in summer 2012, 2013, 2014, and 2015, but the fall calf ratio was the second highest recorded since 1982 (Figure 52). The low calf ratio in summer 2016 may have been due to the inability to accurately record calves during one survey in late August when nearly 500 bowhead whales were seen in a relatively small area and time period. Bowhead whale calf occurrence likely reflects annual variation, as suggested by Koski and

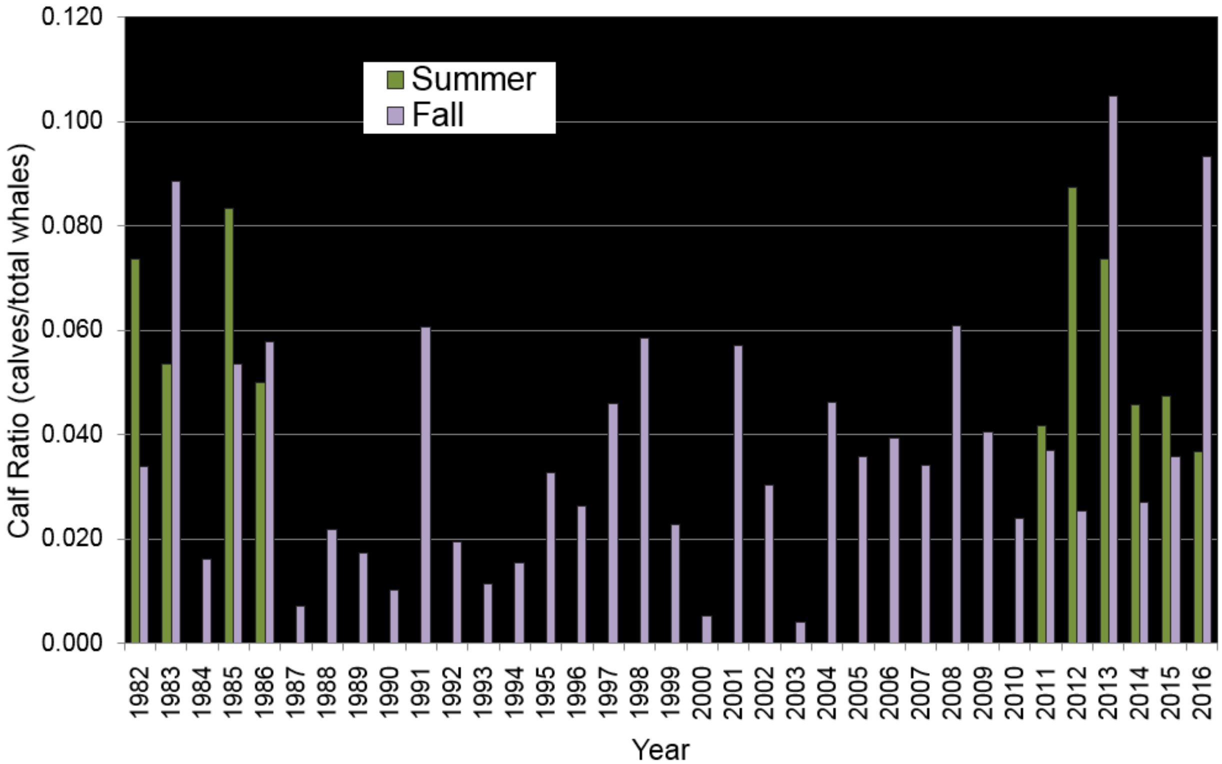


Figure 52. ASAMM bowhead whale calf ratios (number of calves/number of total whales), in summer (July-August) and fall (September-October), 1982-2016. Ratios are for the ASAMM study area.

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 has also increased in population size in the last decade (Givens et al. 2013), 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, or 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 fall 2013 and fall 2016 or the comparatively lower calf ratios of fall 2014 and fall 2015 are more representative.

Other notable ASAMM bowhead whale observations in 2016 included:

- Three bowhead whales were seen north of 72°N in late July, in an area that is not surveyed by ASAMM in most years. Those sightings, together with ASAMM historical sightings north of 72°N (Moore et al. 2000), satellite telemetry data (Quakenbush et al. 2013), and passive acoustic data (Moore et al. 2012), underscore the certainty that bowhead habitat extends beyond the confines of the ASAMM study area.

- A bowhead whale photographed on 20 August 2016 (Appendix B, Flight 18) about 120 km northeast of Barrow was re-identified from a photo taken on 3 August 1985 in Amundsen Gulf, south of Banks Island, Northwest Territories, Canada (L. Vate Brattstrom, pers. comm. to A. Brower, 20 January 2017). The image from 2016 shows scars likely from entanglement on the whale's peduncle.
- A bowhead whale carcass was resighted three times between late August and late September 2016, drifting over 300 km in 26 days (Figure 53). The decomposing carcass was first sighted on 27 August 2016, approximately 135 km northwest of Cross Island. The same carcass was located again on 8 September, approximately 60 km northeast of Flaxman Island. On 21 September, the further decomposed carcass was resighted approximately 75 km northeast of Kaktovik. Photographs and locations of the carcass sighting were shared with NSB DWM and NMFS, providing valuable information about carcass drift and decomposition. The carcass also provided a tasty food source for numerous birds!

Gray whale distribution in 2016 was generally similar to that seen in recent years with similar survey coverage (2009-2015), with a few exceptions. In 2016, gray whale preference was for shallow (≤35 m) waters in summer (July-August) in the northeastern Chukchi Sea (Figure 54A), similar to observations from 2012 to 2015. Prior to 2012, gray whale habitat preference, based on sighting rates per depth zone, was fairly equal between shallow (≤35 m) and deeper (>35 m) waters in summer. Gray whale preference for shallow water did not extend into fall in 2016 (Figure 54B) as it did in 2015, and instead shifted to deeper water similar to what was observed from 2009 to 2014.

ASAMM and other researchers have reliably observed gray whales in the region between Icy Cape and Point Barrow, extending from the shoreline to ~90 km offshore, encompassed by ASAMM survey blocks 13, 14, and 17. In this area, gray whales, including cow-calf pairs, are seen from July through October, primarily shoreward and south of Barrow Canyon (Clarke et al. 2016c), at depths <50 m where preferred benthic prey are found in highest abundances (Brower et al. 2017). From 2009 to 2014, gray whales were distributed primarily between Point Franklin and Barrow, within a few kilometers of the shoreline between Icy Cape and Barrow, and within ~45 km of shore northwest of Wainwright (Figure 55A). In 2015 and 2016, the distribution of gray whales appeared to shift offshore to ~25 to 90 km northwest of Wainwright (Figure 55B). The shift offshore was reflected in substantially higher sighting rates in block 14 during all months in 2015-2016 compared to 2009-2014 (Figure 56). The primary behavior of gray whales observed in the northeastern Chukchi Sea is feeding, and 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 2015 and 2016, gray whales may have dispersed to adjacent feeding areas to take advantage of relatively high density prey patches elsewhere. Gray whales feeding in the northeastern part of block 17 and southeastern part of block 14 were likely taking advantage of dense amphipod patches, which were identified in that area in 2009-2010 and 2012

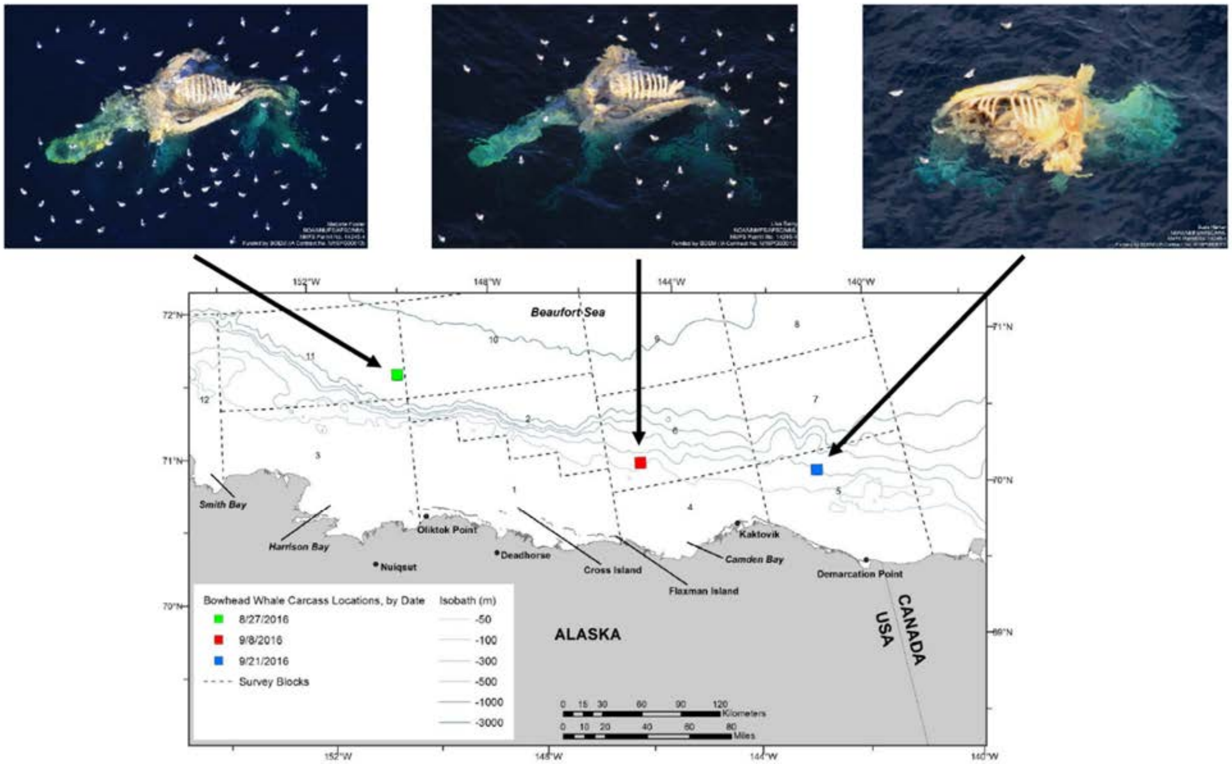


Figure 53. Locations and images of the bowhead whale carcass sighted three times between 27 August and 21 September.

(Brower et al. 2017, Schonberg et al. 2014), and which may have persisted in 2015 and 2016. It is also possible that gray whales were more abundant in the northeastern Chukchi Sea in 2015-2016, necessitating foraging over a broader area. Sighting rate was higher in 2015-2016 than in 2009-2014 in every month and block except block 13 in September (Figure 56). Also worth noting is that, for the first time since dedicated summer and fall surveys commenced in the northeastern Chukchi Sea in 2008, a pair of gray whales was sighted on numerous occasions in 2016 within the confines of Peard Bay proper. 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.

Two gray whales recorded as swimming during ASAMM Flight 202 on 6 July 2016 may have been surface skim feeding. Post-flight image analysis revealed that the two gray whales were at the surface with their mouths open slightly. Surface feeding by gray whales is undoubtedly underreported during aerial surveys due to the difficulty in detecting, in real-time, subtle behaviors such as slightly open mouths, and water column feeding is essentially impossible to detect. It is likely that some of the gray whales recorded as swimming, diving, resting, or milling are actually actively feeding on pelagic prey. Gray whales have been documented feeding on

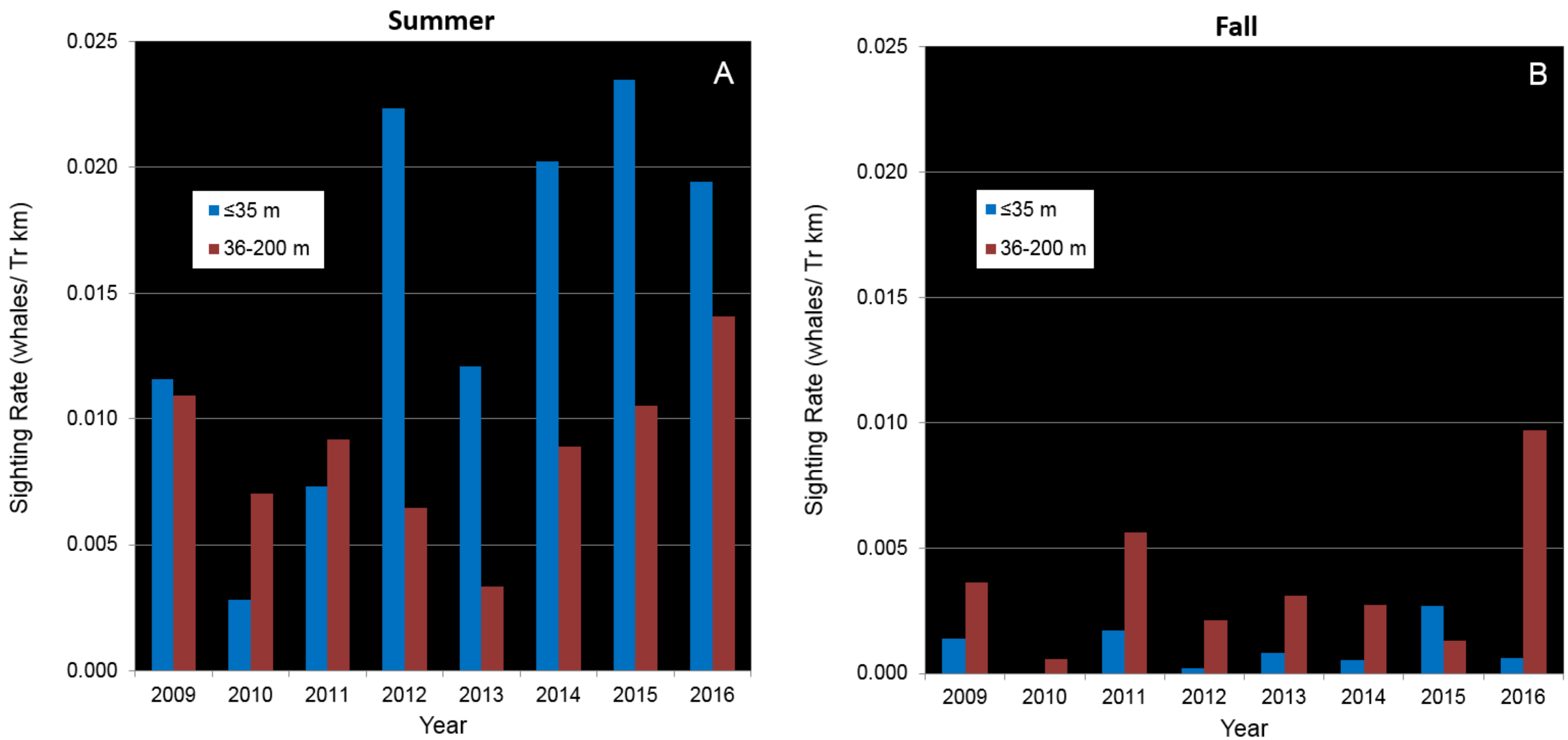


Figure 54. Gray whale sighting rates (WPUE; transect sightings from primary observers only) in shallow (≤35 m) and deep (>35 m) zones of the northeastern Chukchi Sea (69°N to 72°N, 157°W to 169°W), 2009-2016. A: summer (July-August); B: fall (September-October). Includes sightings and effort in the ≤35 m, 36-50 m, and 51-200 m North depth zones.

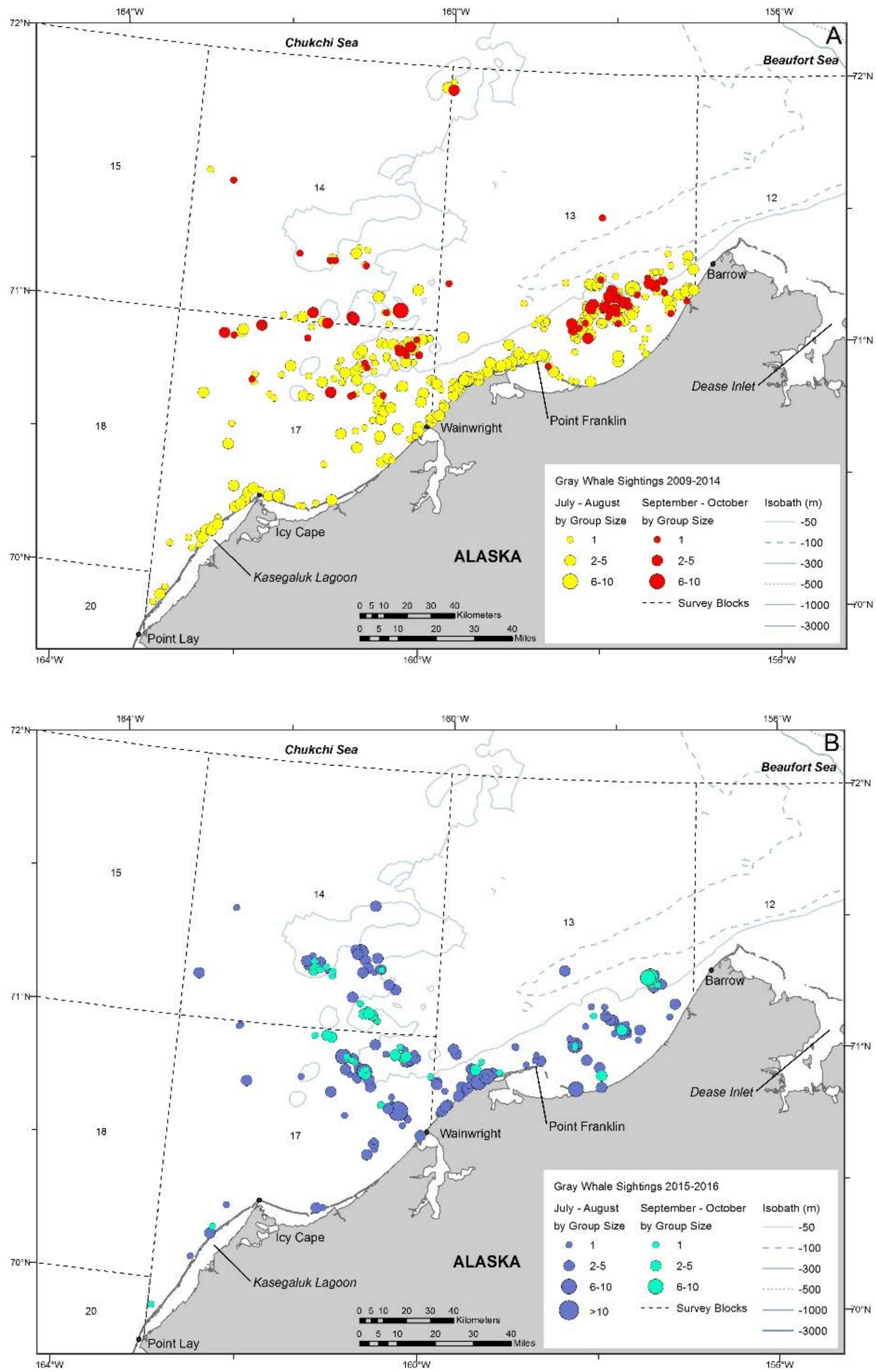


Figure 55. ASAMM gray whale distribution (transect sightings from primary observers only) in the northeastern Chukchi Sea, 2009-2014 (A); and 2015-2016 (B).

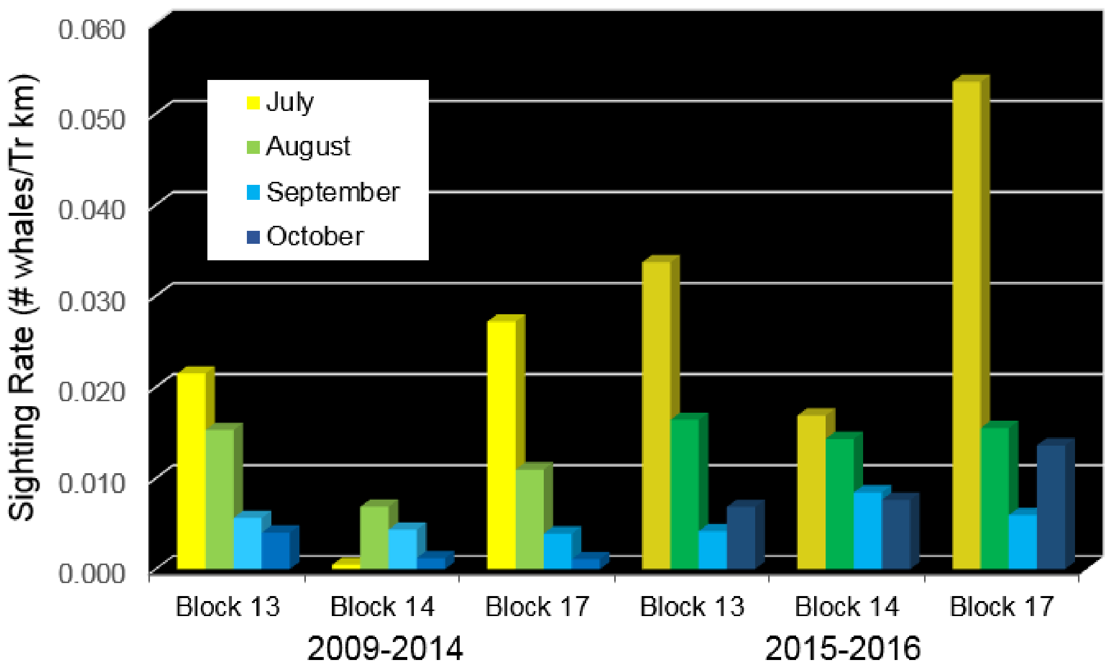


Figure 56. Gray whale sighting rates (WPUE; transect sightings from primary observers only) in blocks 13, 14, and 17 in the northeastern Chukchi Sea, July-October, 2009-2014 and 2015-2016.

pelagic prey elsewhere in their range, including on mysids and crab larvae in Clayoquot Sound, Vancouver Island, British Columbia (Feyrer and Duffus 2011), and on euphausiids in Monterey Bay, California (Benson et al. 2000).

Single gray whales were seen northeast of Oliktok Point (July) and north of Harrison Bay (September) in 2016. Photos were not obtained of both sightings so there is no way to know if the September sighting was the same whale as that observed in July. Gray whales have been recorded in the Beaufort Sea previously (e.g., Clarke et al. 2015a; Iwahara et al. 2016; Rugh and Fraker 1981), but sightings are relatively infrequent, especially considering the amount of survey effort conducted in the area since the early 1980s.

Gray whale calf occurrence in the eastern Chukchi Sea has been inconsistent among years. In the 19 years that aerial surveys have been conducted in the region with some regularity (1982-1991, 2008-2016), gray whale calves have been seen in 14 of those years and sightings of more than one gray whale calf per year were recorded in only 9 of the 19 years (Clarke et al. 1989, 2012, 2013a, 2014). Maher (1960) noted that several gray whales taken by hunters in the 1950s from the villages of Wainwright and Barrow were calves of the previous winter, so the importance of the northeastern Chukchi Sea to gray whale calves has persevered for several decades and is possibly increasing.

Gray whale calf occurrence in the eastern Chukchi Sea in 2016 continued an upward trend, following high calf occurrence in 2012-2015 (Clarke et al. 2013a, 2014, 2015a, 2017). When calf sightings were corrected for survey effort, the gray whale calf transect sighting rate in 2016 (number of calves per Tr km) was 0.0017, which is higher than all gray whale calf sighting rates from 2009 to 2015 (Figure 57). Calf sighting rate using sightings and effort on transect combined with sightings and effort from circling from transect (Tr+TrC), which is a more accurate reflection of relative abundance because it incorporates all on-effort sightings and effort, was 0.0033. 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 2016, ASAMM dedicated greater effort towards collecting opportunistic photographs of gray whale cow-calf pairs. Gray whales, including calves, can be individually identified in photographs, which have nearly always been collected from vessels (e.g., Bradford et al. 2011; Calambokidis et al. 2002) and, more recently, from drones (Press 2015). Identification during systematic aerial surveys is difficult if photographs are not regularly collected. In 2016, photographs were taken of 47% of the cow-calf pairs observed (Willoughby et al. 2017). Within that subset of data, image analysis documented 61 calves, of which 46 were identifiable using skin pigmentation, scarring, or mottling. Only one of those 46 calves was resighted on a different date, which indicates 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. The increase in gray whale calf occurrence that ASAMM has found in the eastern Chukchi Sea is consistent with the NMFS Southwest Fisheries Science Center counts of cow-calf pairs documented during the northward spring migration off the California coast (Figure 58) (USDOC, NOAA, NMFS, SWSFC 2015). The increase in calf occurrence may be related to favorable foraging conditions from 2011 to 2015, 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 in other cow-calf habitat or increased inter- or intra-specific competition on favored foraging grounds.

In 2014, the ASAMM study area was expanded to include regular surveys from July through October in block 23, allowing multiyear comparisons of data collected in the southcentral Chukchi Sea (blocks 22 and 23). This area 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 transect lines sampled for the Distributed Biological Observatory effort. 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 2016, gray whales were sighted in the southcentral Chukchi Sea from mid-July through mid-October. Gray whales were sighted in the offshore area between Cape Lisburne and Point Hope only in early August 2016; gray whales were not seen during surveys conducted there in late September and mid-October 2016, although survey conditions were poor. Gray whales were seen in the benthic hotspot region southwest of Point Hope from mid-July through mid-October. In 2016, gray whales in this area overlapped temporally and spatially with harbor porpoises and humpback, fin, and minke whales in August, and with harbor porpoises in late July. This differs from 2015, when gray whales overlapped temporally but not spatially with humpback, fin, and

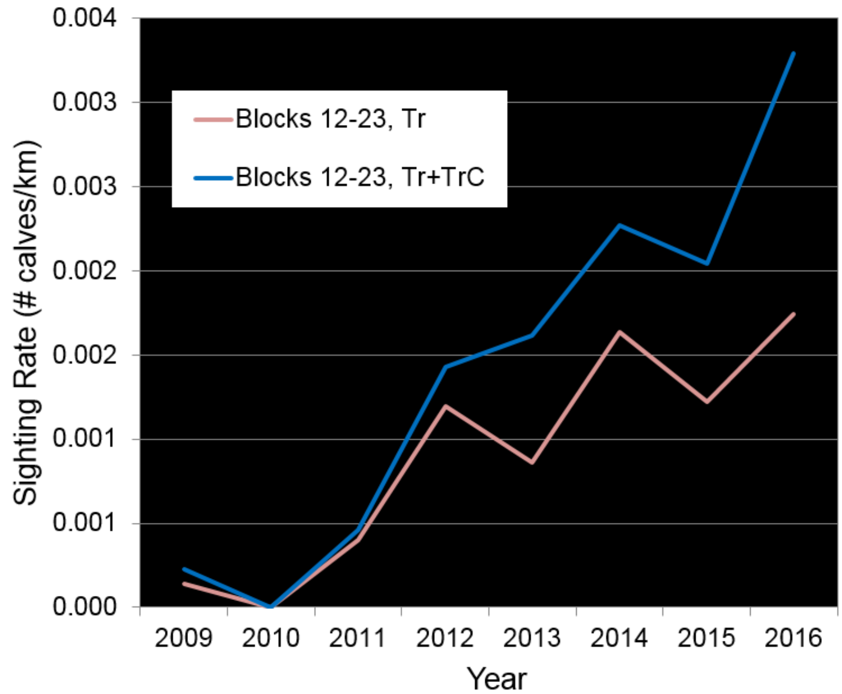


Figure 57. ASAMM gray whale calf sighting rates (transect sightings from primary observers only), 2009-2016 for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC).

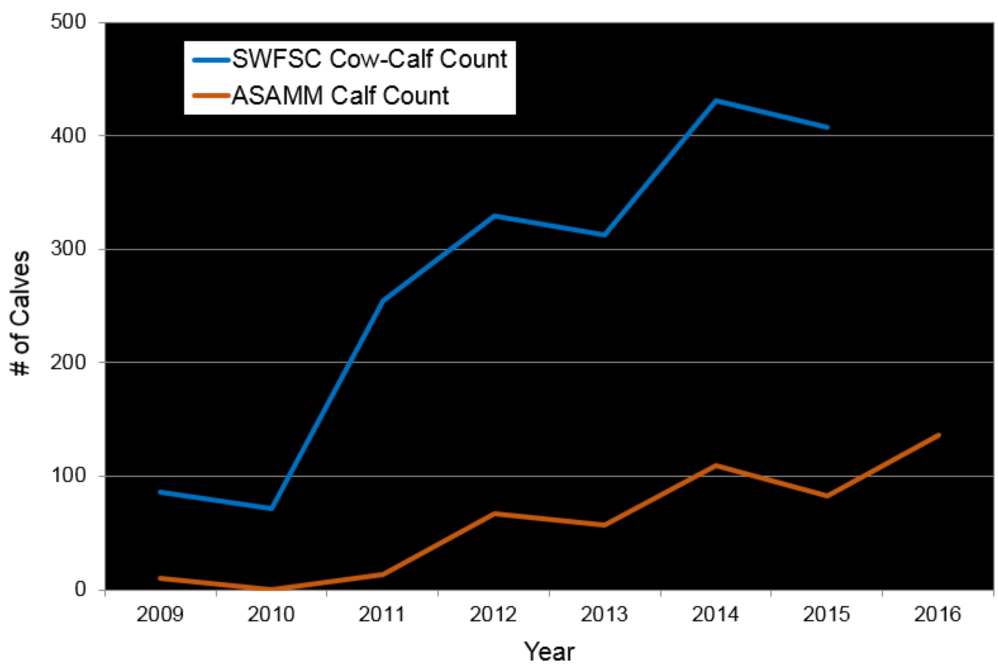


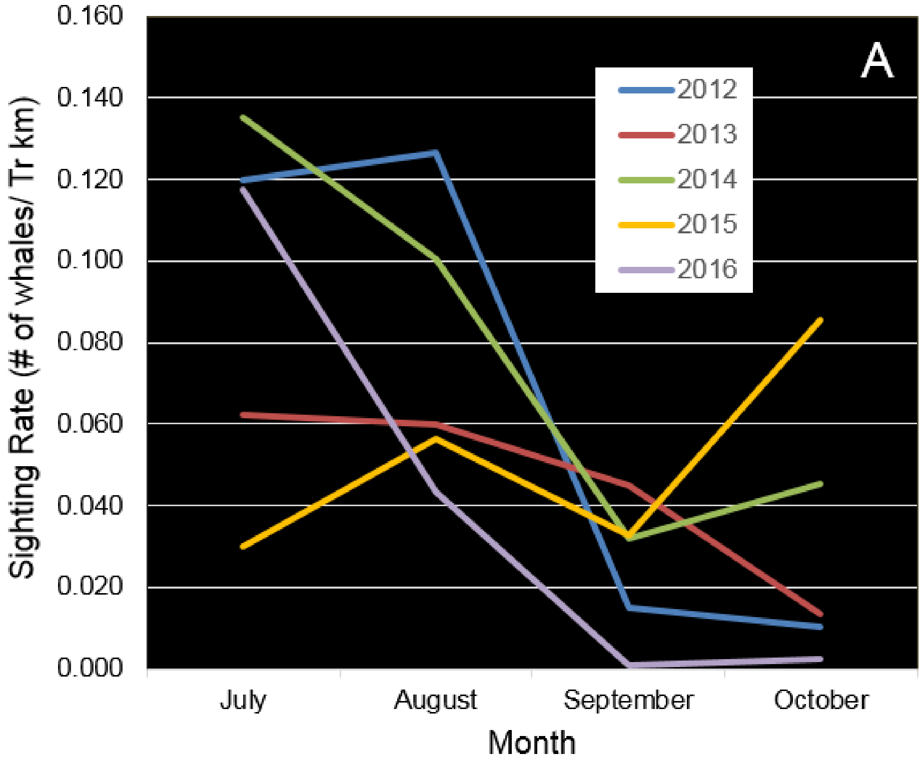
Figure 58. ASAMM gray whale calf counts in the eastern Chukchi Sea, 2009-2016, and SWFSC cow-calf pair counts off northern California, 2009-2015. Calf counts from northern California in 2016 are not available from SWFSC.

minke whales (Clarke et al. 2017). Gray whales previously have been recorded in close proximity to humpback and fin whales in the southern Chukchi Sea (Clarke et al. 2013b) and humpback and bowhead whales in the northeastern Chukchi Sea (Clarke et al. 2014).

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 Distributed Biological Observatory effort will undoubtedly reveal oceanographic and biological parameters that may have influenced gray whale and other large whale distributions and densities in 2016.

Beluga distribution in the ASAMM study area in 2016 remained similar to the distribution observed over the past 30 years (Figure 33). Survey area and effort from 19 July through 20 August 2016 incorporated more of the Beaufort Sea slope habitat (covering depths approximating 200-3,000 m between 140°W and 156°W), which ECS belugas are known to utilize in summer (Hauser et al. 2014). The increase in the ASAMM study area was not intended to encompass all ECS beluga summer habitat, which is known to extend much farther north (Suydam et al. 2001), but was instead a compromise between sampling additional ECS beluga habitat and maintaining adequate sampling of the standard ASAMM study area. Aerial survey effort conducted north of the current ASAMM study area from 1989 to 1991 (Moore and Clarke 1992), results from beluga satellite telemetry efforts (e.g., Hauser et al. 2014, 2015; Richard et al. 2001; Suydam et al. 2001), 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 acoustic recorder moored on the Chukchi Plateau (75.1°N, 168°W), more than 340 km north of the ASAMM study area. Between 19 July and 20 August, 5,433 Tr kilometers were flown in the ECS study area (see Figure 32), resulting in sightings of 1,171 belugas, which represents 84% of the total Tr belugas recorded for July-October combined. The sighting rate in the ECS beluga habitat (depths >200 m; 0.216 WPUE) was more than 14 times greater than the Tr beluga sighting rate in the western Beaufort Sea in summer at depths ≤200 m (0.015 WPUE).

Belugas were nearly completely lacking from the ASAMM study area in fall 2016 (Figure 34). 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). Together, these two stocks likely comprise >40,000 belugas (Muto et al. 2016), all of which presumably migrate through the western Beaufort and eastern Chukchi seas each fall. As noted above, ASAMM does not survey the entirety of beluga habitat, which can extend north to at least 76.5°N, but the habitat that is surveyed each year allows for inter-year comparisons of distribution and relative density. Compared to 2012-2015, the beluga sighting rate in 2016 in the western Beaufort Sea was within the normal range in July, decreased to lower than previously observed in August, and decreased to nearly zero in September and October (Figure 59A). The only other year when fall beluga sighting rates were this low was 2008 (Figure 59B), when ASAMM survey effort in areas of preferred habitat (i.e., >50 m depth) was nearly half what it was in 2016. Where the belugas were in fall 2016 is unknown. Hauser et al. (2016) used satellite telemetry and passive acoustic data to determine



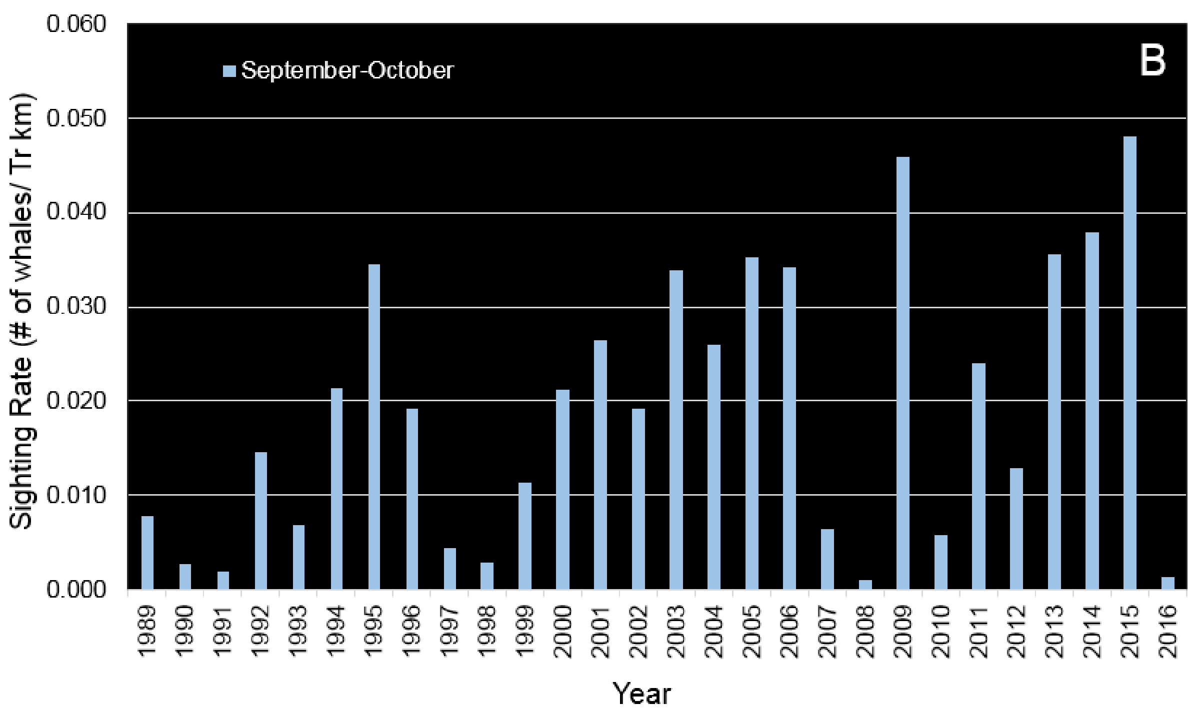


Figure 59. ASAMM beluga sighting rates (transect sightings from primary observers only). A: monthly sighting rates in the western Beaufort Sea (140°W-157°W), 2012-2016; B: fall (September-October combined) sighting rates in the western Beaufort Sea, 1989-2016.

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. 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 fall 2016 were related to delayed migration timing of either or both stocks.

Sea ice may impact beluga behavior and distribution, but the extent of this impact is not clearly understood. 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. O'Corry-Crowe et al. (2016) analyzed beluga genetic and sighting data and found that, while belugas are tolerant of a wide variety of ice conditions, anomalous spring and summer sea ice conditions may significantly impact beluga habitat use. 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. Sea ice may have an important indirect effect on beluga behavior and migration timing by influencing prey availability and changing predation risk. O'Corry-Crowe et al. (2016) noted that killer whales were present in Kotzebue Sound in late July 2007, preying on BS belugas that had uncharacteristically moved into the sound. In the eastern Canadian Arctic, decreasing sea ice duration and extent may be allowing killer whales to access the Arctic more often because previous "choke points", areas of sea ice blockage in narrow straits between islands, no longer persist throughout summer (Higdon and Ferguson 2009). Although killer whales are occasionally observed in the eastern Chukchi Sea (George et al. 1994), 2016 was the first year that unique killer whale groups were observed on multiple days during ASAMM surveys. Although all ASAMM killer whale sightings occurred in September, killer whales may have been present throughout the open water season and may have provoked evasive behaviors by belugas similar to those observed of narwhals in the eastern Canadian Arctic (Breed et al. 2017). In that study, killer whales and narwhals were synchronously tracked via satellite telemetry, and narwhals altered their behavior and distribution by heading closer to shore and maintaining transit behavior in lieu of resident behavior when killer whales were within ~100 km. It is worth noting that belugas were very rarely observed by ASAMM in 2016 in the extreme nearshore areas of either the western Beaufort or the eastern Chukchi seas, and also worth noting that belugas were largely absent at Point Lay in summer 2016, where the ECS stock normally congregates to feed, calve, and molt.

Marine mammal data collected during the 2016 ASAMM field effort 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 2016 relating to unique situations and other species. Harbor porpoise, and minke, humpback, fin, and killer whales seasonally inhabit arctic and subarctic habitats (Higdon and Ferguson 2009, 2011; Laidre and Heide-Jørgensen 2012; Suydam and George 1992; Clarke et al. 2013b; Christman and Aerts 2015). Observations of these species in 2016 were limited mostly to the southcentral Chukchi Sea. All killer whales, one humpback whale, and one minke whale were seen in the northeastern Chukchi Sea; no sightings of these species occurred in the western Beaufort Sea.

This is the sixth consecutive year that ASAMM has documented minke whales in the northeastern Chukchi Sea (Clarke et al. 2012, 2013a, 2014, 2015a, 2017). 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; Smultea et al. 2014; Aerts et al. 2013; 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 ARCWEST study 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), possibly due to increased research in the area, population recovery from commercial whaling, or responses to oceanographic changes (Appendix C, Brower et al. 2017). 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. 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 Barrow 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). 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 highly 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 during 1982 to 1991 (Moore and Clarke 1992). 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 and documenting all cetacean sightings to confirm species identification.

Killer whales have been documented, sporadically, in the eastern Chukchi Sea. Hunters from Barrow 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 (MML, unpublished data; B. Rone, MML-AFSC, pers. comm. to A. Brower, 18 December 2013). One of the male killer whales documented near Barrow 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 (O'Corry-Crowe et al. 2016; Shelden et al. 2003) and narwhals (Campbell et al. 1988). ASAMM documented killer whales near Barrow 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 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. 2016). Suydam and George (1992) reported on nine records of live and dead harbor porpoises near Point Barrow, Alaska, from 1985 to 1991. 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, 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 from 2006 to 2008 and in 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. 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 vessel surveys or aerial surveys conducted at >305 m altitude, particularly in sea states that are ≤ Beaufort 2.

A coastal walrus haulout near Point Lay formed in early October 2016, the latest date for a haulout to form since onshore haulouts were first documented along the northwestern Alaskan coast in 2007. The Point Lay haulout existed for only a few days, as did a haulout that formed near Cape Lisburne in early October (M. MacKay, Saltwater, Inc., pers. comm. to J. Clarke, 2 October 2016). Sea ice remained near Hanna Shoal well into late September 2016, providing offshore resting platforms for feeding walruses. ASAMM collaborated closely with biologists from USGS and USFWS to ensure that the coastal haulout was monitored in a manner that was not disruptive to the walruses. The initial haulout size estimate of 1,500 walruses was revised, after post-flight analysis of images, to 7,500 walruses. 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. In 2014, ASAMM estimated that an onshore walrus haulout near Point Lay contained 35,000 walruses, based on post-flight image analysis of an obliquely obtained image (Clarke et al. 2015). A more detailed analysis of that photo revised the number of walruses at the haulout to 38,000, or within 8% of the original estimate (Battaile et al. 2017). 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 and small unidentified pinnipeds combined (number of pinnipeds per transect km) in the ASAMM study area in 2016 were higher than sighting rates in 2009-2015 (Figure 60). These sightings of pinnipeds that were not identified to species constituted the majority of non-walrus pinniped sightings (>99%) collected during ASAMM surveys. 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 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

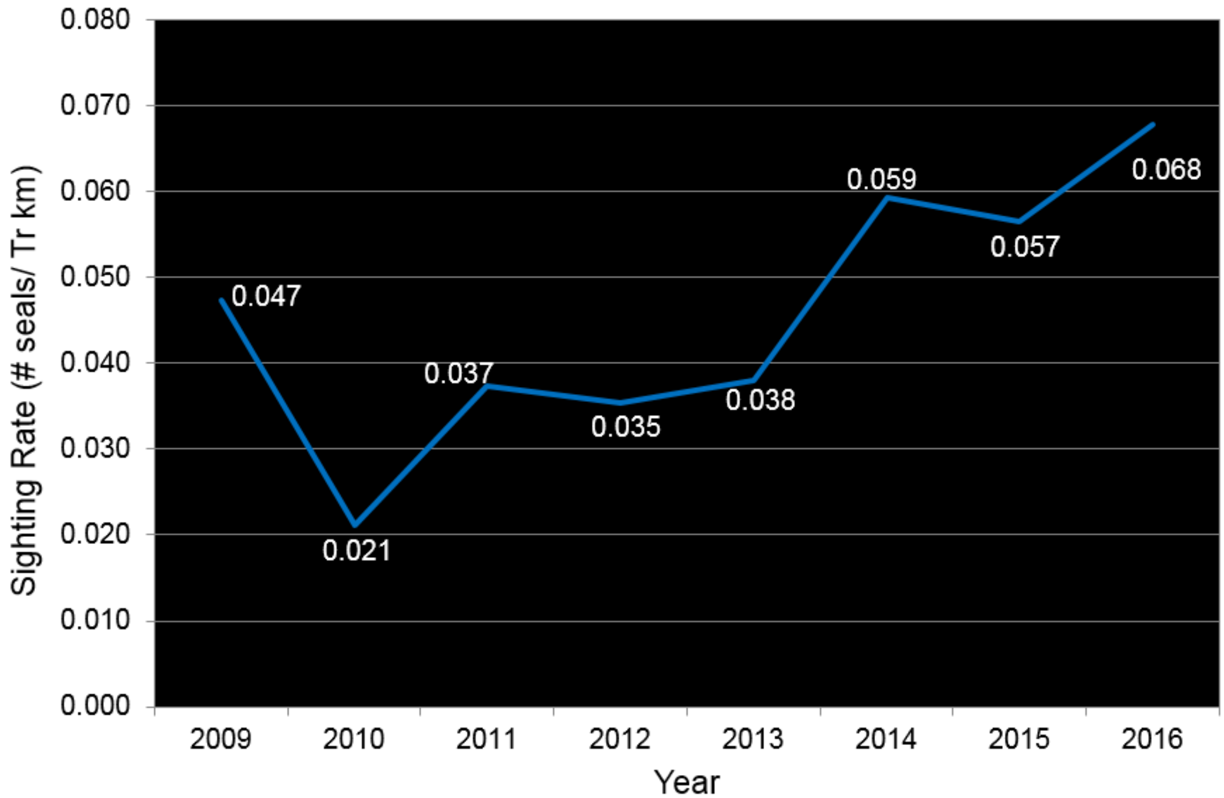


Figure 60. ASAMM unidentified pinniped (includes small unidentified pinnipeds) annual sighting rates (transect sightings from primary observers only), 2009-2016.

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. Manual post-flight processing is time intensive, auto-detection software for visual imagery in in development but not yet reliable for detecting arctic marine mammals, 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).

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 time periods spanning more than three decades (1982-2016) should be interpreted with caution because different ecological mechanisms could have been acting at different time 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 petroleum exploration, including open water and on-ice seasonal vessel-based geophysical permits for exploration using arrays 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 petroleum 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 2016).

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 2016), 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; Schonberg et al. 2014; Stafford et al. 2013, 2017; Ferguson et al. 2015; Grebmeier et al. 2015; Kuletz et al. 2015; Satterthwaite-Phillips et al. 2016; Battaile et al. 2017; Brower et al. 2017; Druckenmiller et al. 2017; Stafford et al. 2017; Young et al. 2017) to better understand, manage, and conserve arctic resources.

ASAMM data are critical to addressing management concerns in near-real time and aid in future planning. Without current, reliable data, BOEM 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. A summary of ten management concerns that ASAMM data have addressed in the past and can continue to address in the future, depending on future field season implementation, is included in Appendix H.

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APPENDIX A: 2016 ICE CONCENTRATION MAPS

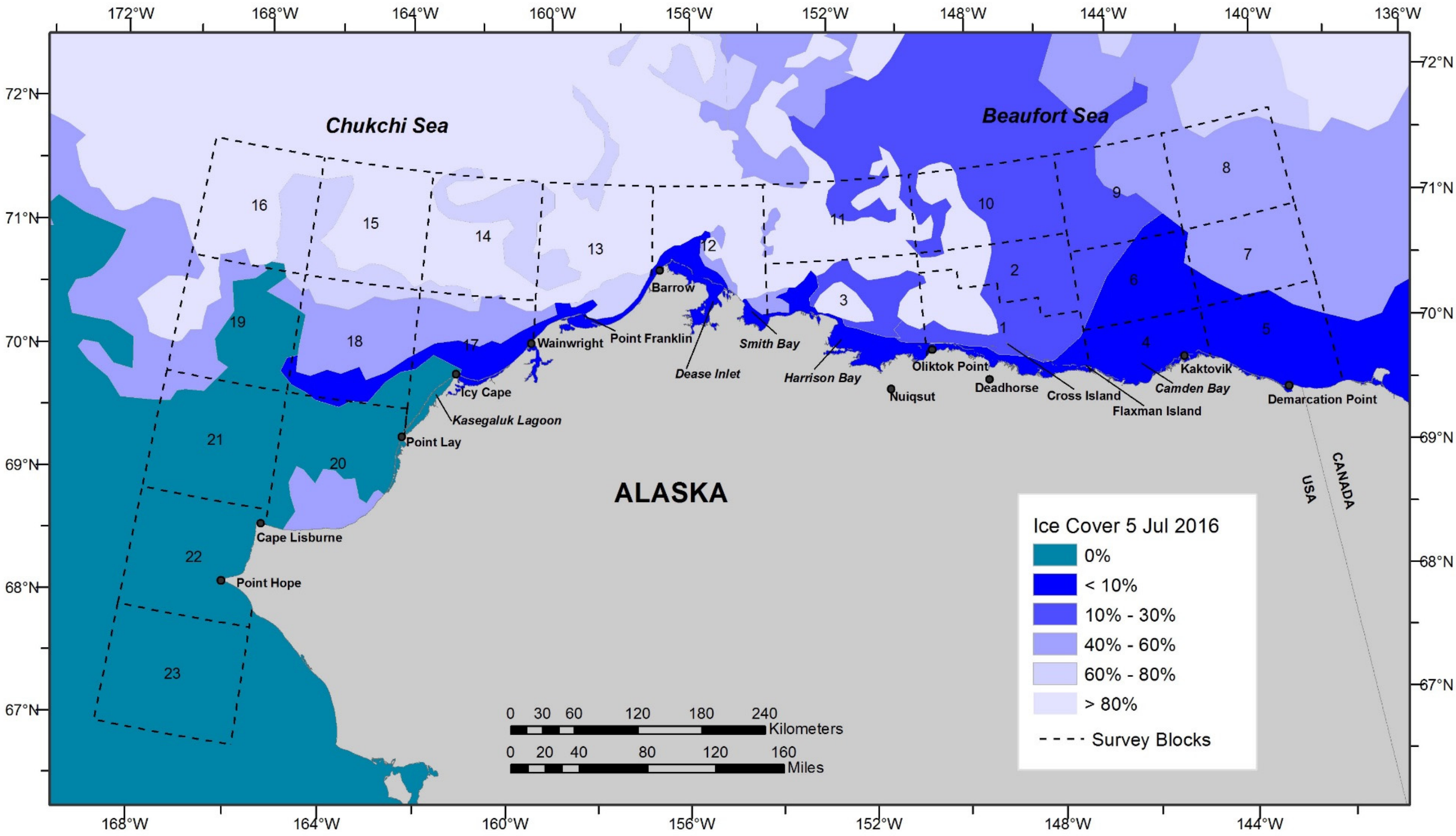

Figure A-1. Ice concentrations in the eastern Chukchi and western Beaufort seas, 5 July 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

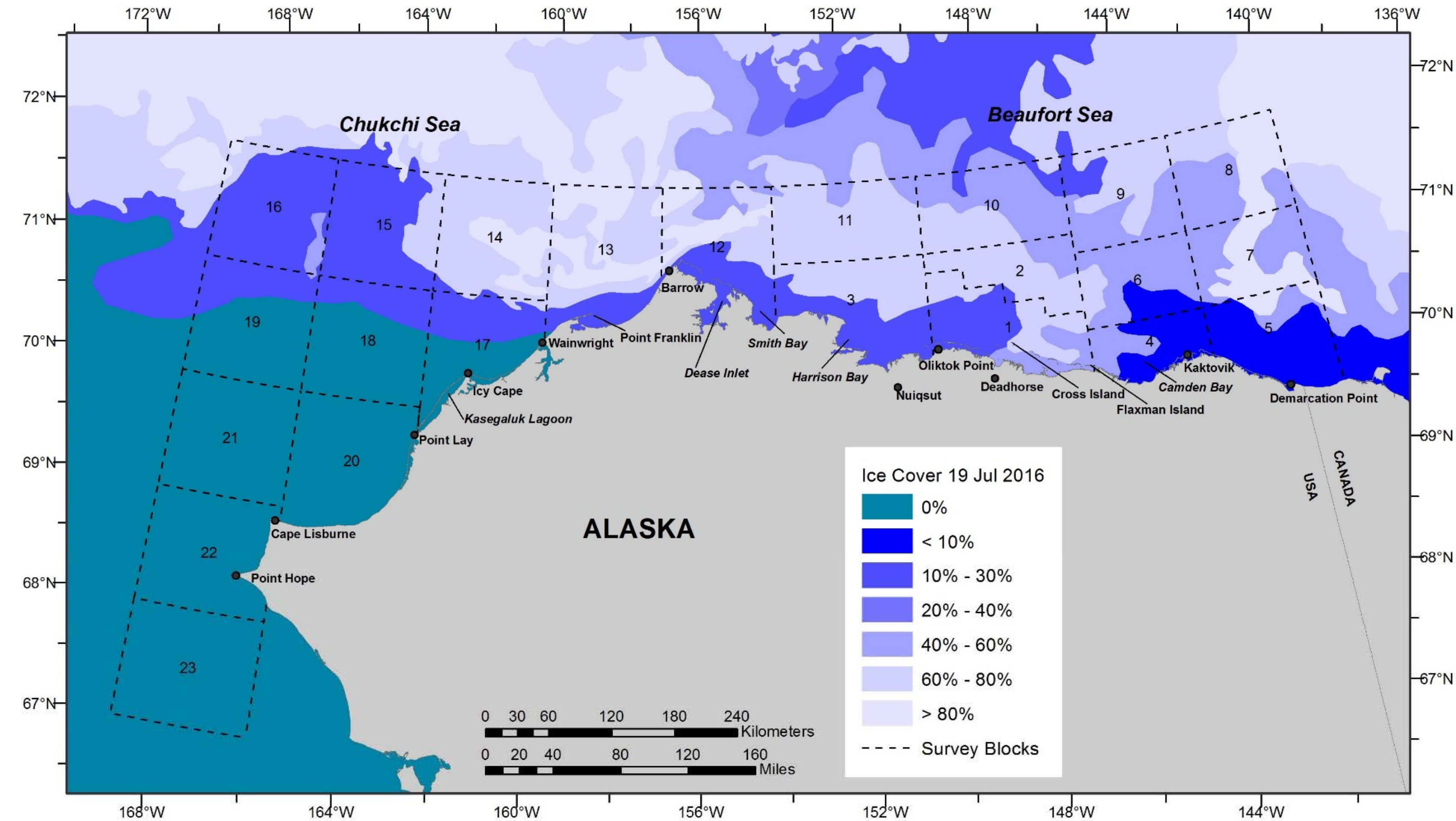

Figure A-2. Ice concentrations in the eastern Chukchi and western Beaufort seas, 19 July 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

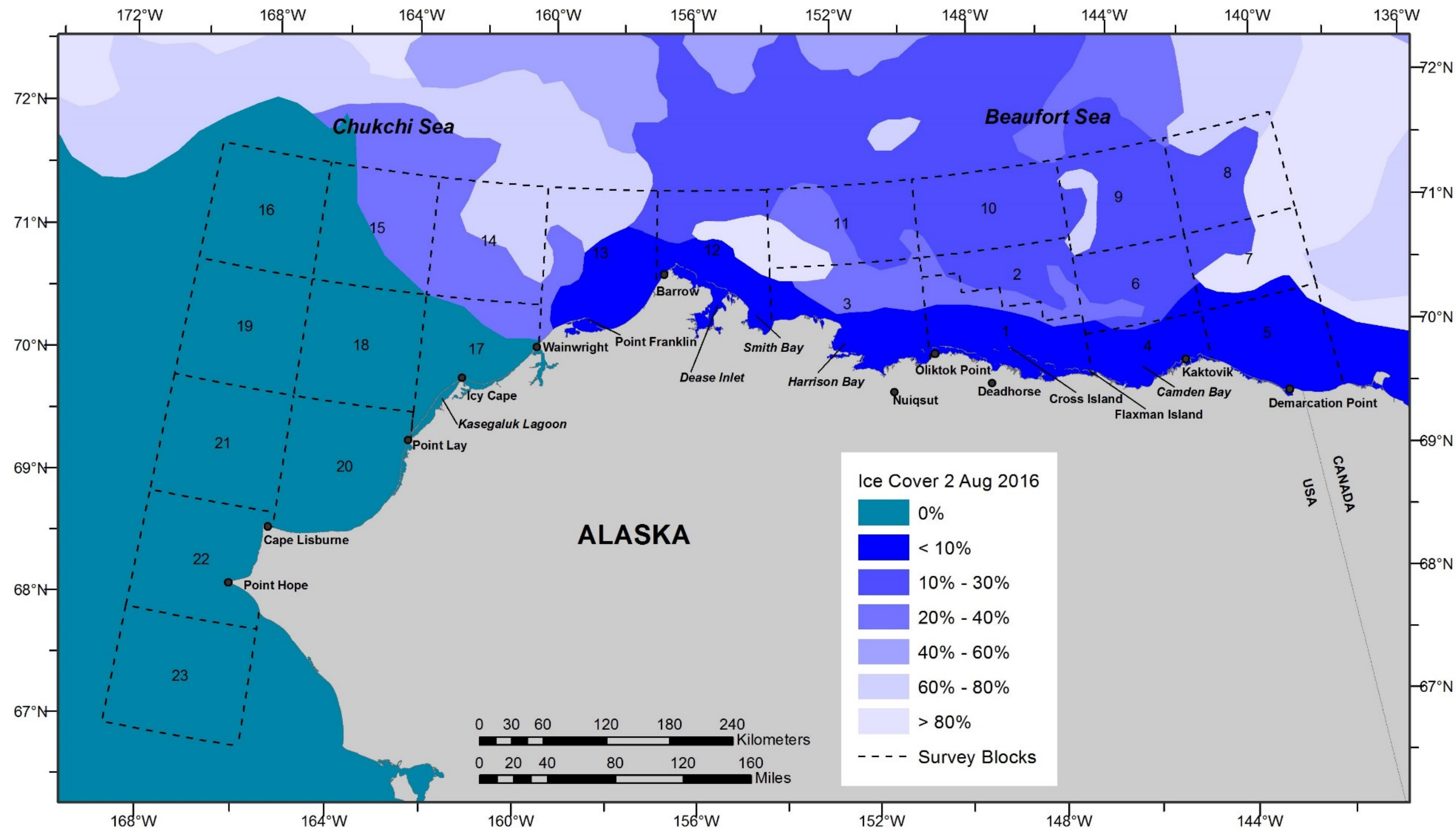

Figure A-3. Ice concentrations in the eastern Chukchi and western Beaufort seas, 2 August 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

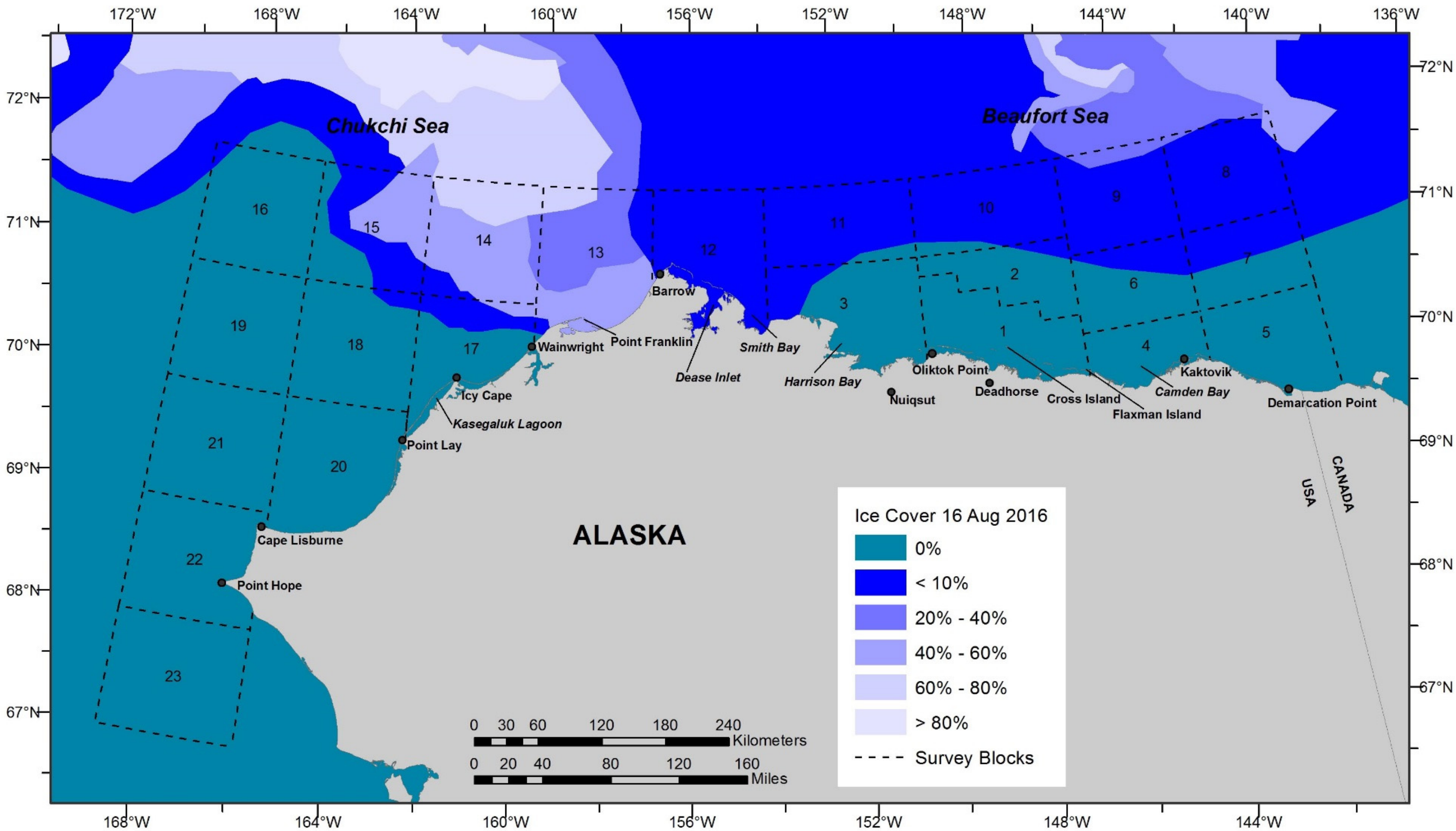

Figure A-4. Ice concentrations in the eastern Chukchi and western Beaufort seas, 16 August 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

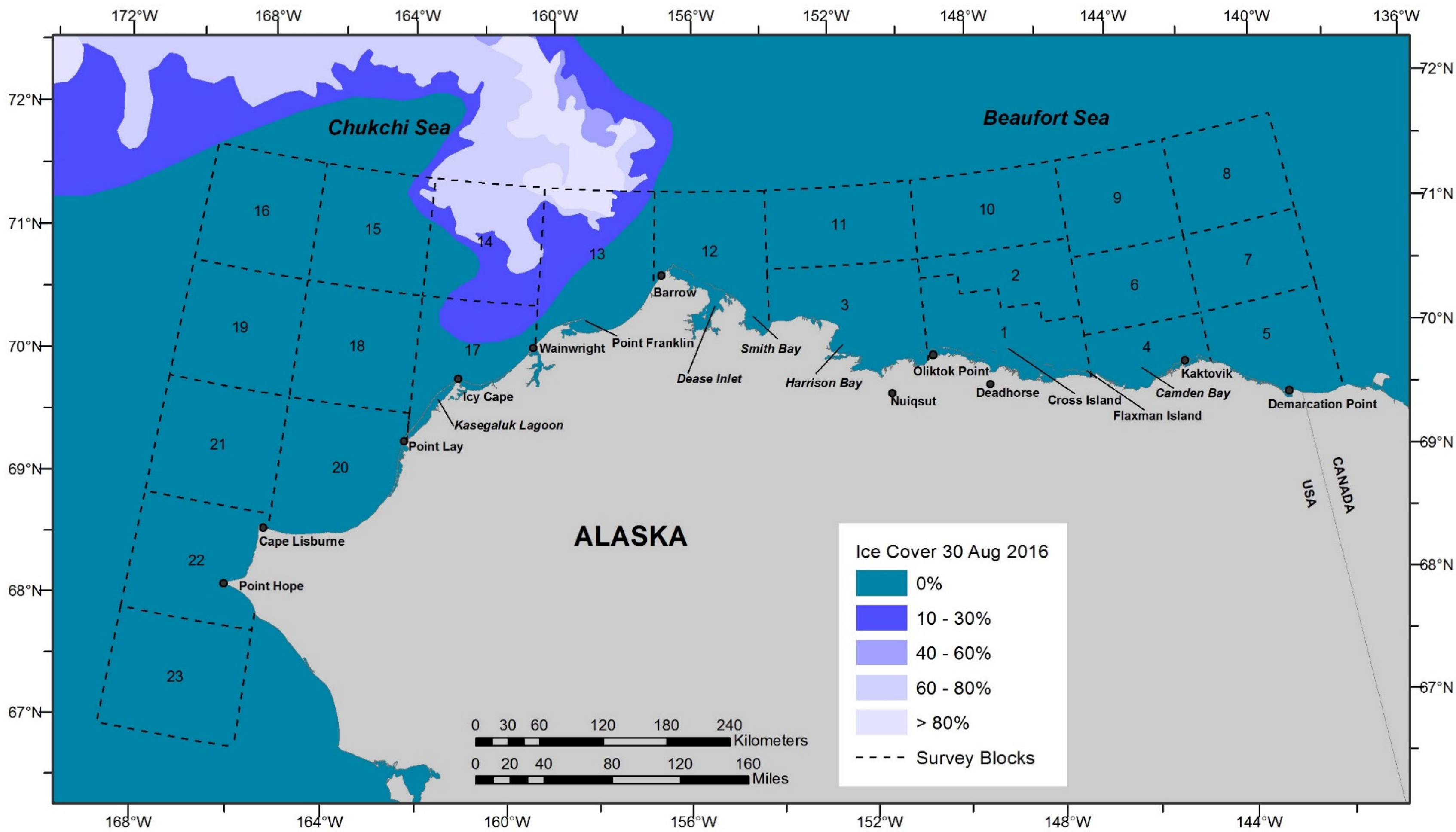

Figure A-5. Ice concentrations in the eastern Chukchi and western Beaufort seas, 30 August 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

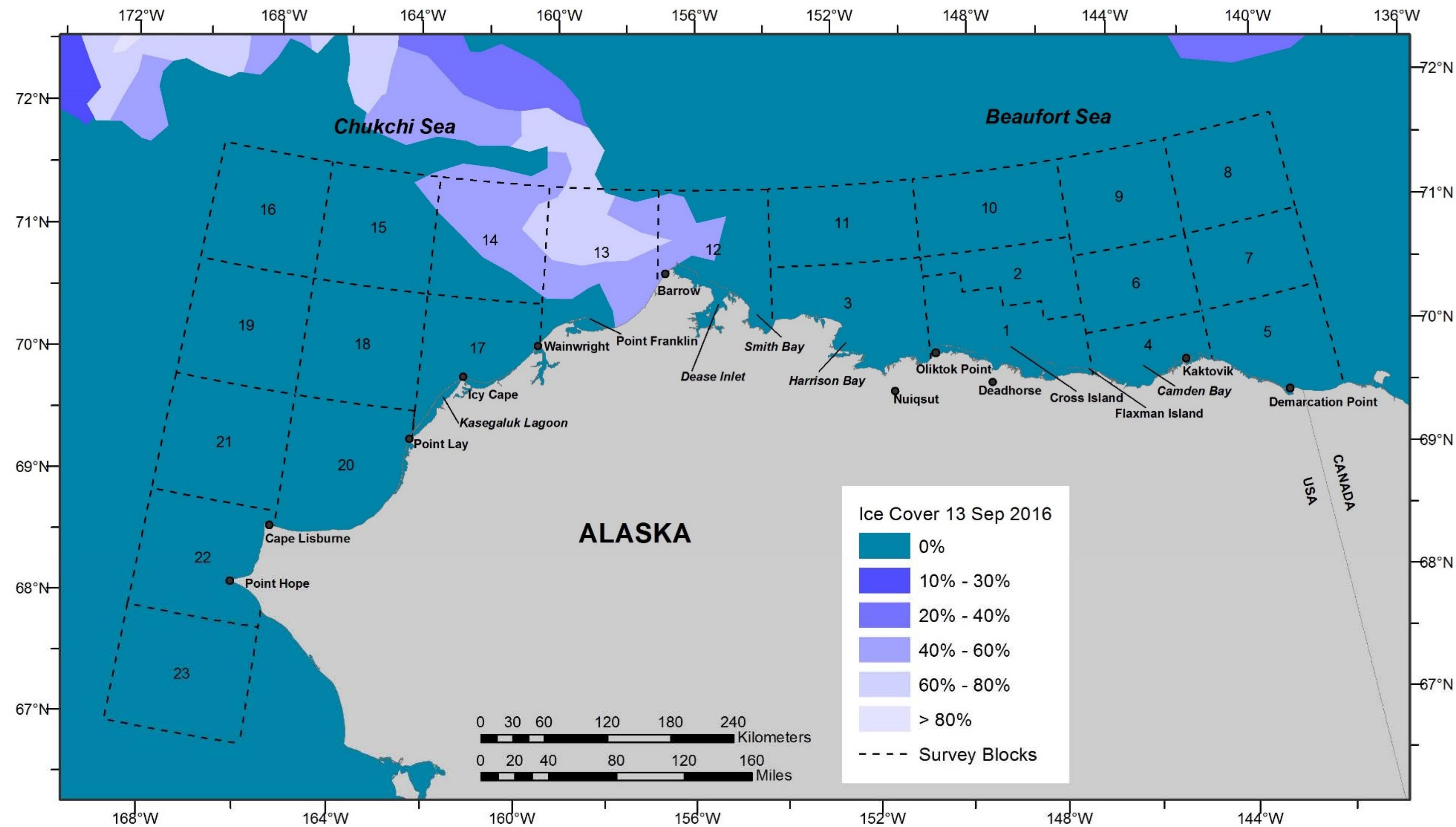

Figure A-6. Ice concentrations in the eastern Chukchi and western Beaufort seas, 13 September 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

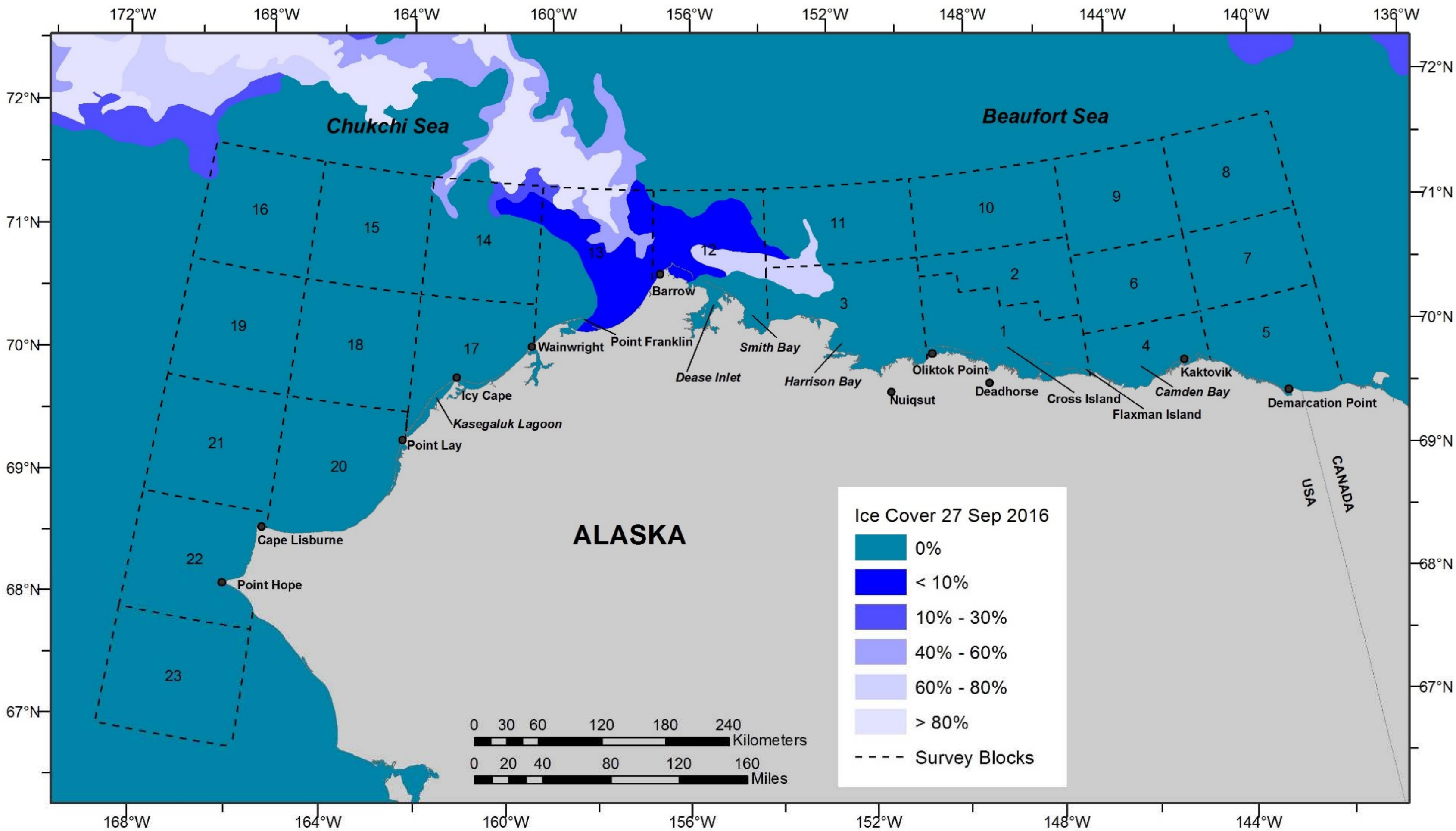

Figure A-7. Ice concentrations in the eastern Chukchi and western Beaufort seas, 27 September 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

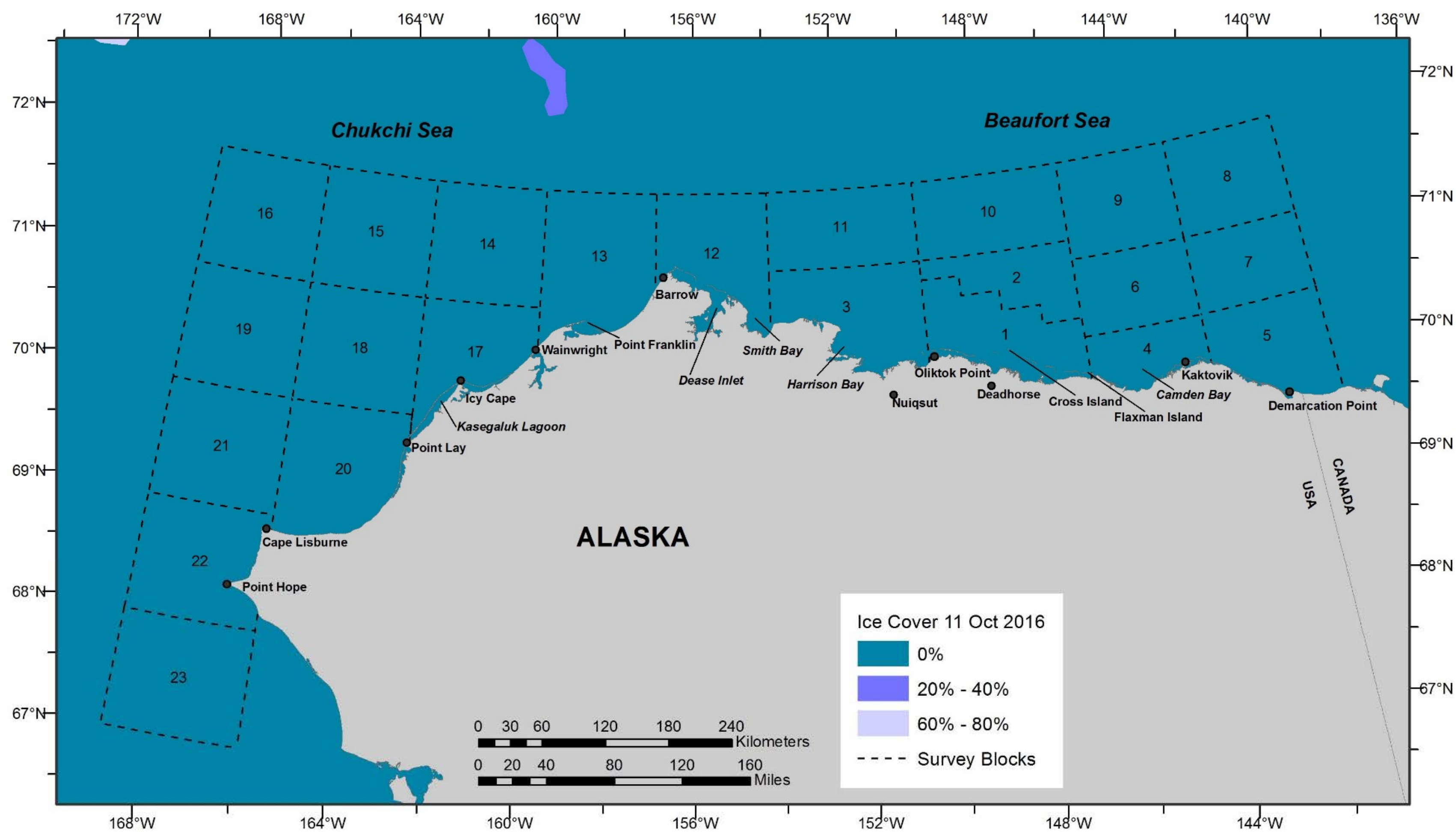

Figure A-8. Ice concentrations in the eastern Chukchi and western Beaufort seas, 11 October 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

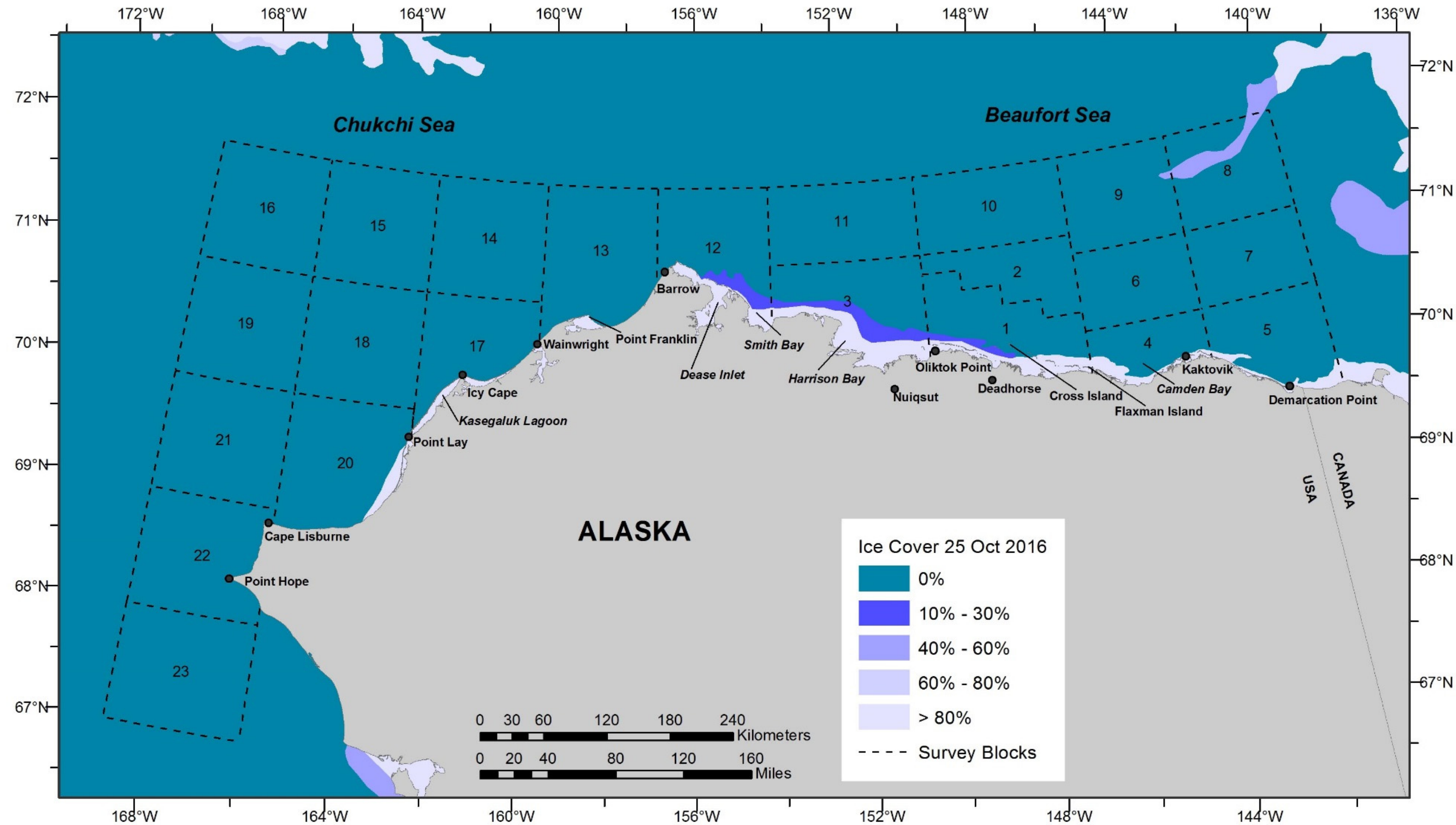

Figure A-9. Ice concentrations in the eastern Chukchi and western Beaufort seas, 25 October 2016. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2016).

APPENDIX B: 2016 DAILY FLIGHT SUMMARIES

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2 July 2016, Flight 201

Flight was a complete survey of transects 1 and 3, partial survey of transects 5 and 7, and the coastal transect from Point Franklin to Barrow. Survey conditions included partly cloudy skies, <1 km to unlimited visibility (with fog, glare, and haze), and Beaufort 0-2 sea states. Sea ice cover was 13-95% broken floe in the area surveyed. Sightings included walruses (including one calf), one unidentified pinniped, and small unidentified pinnipeds.

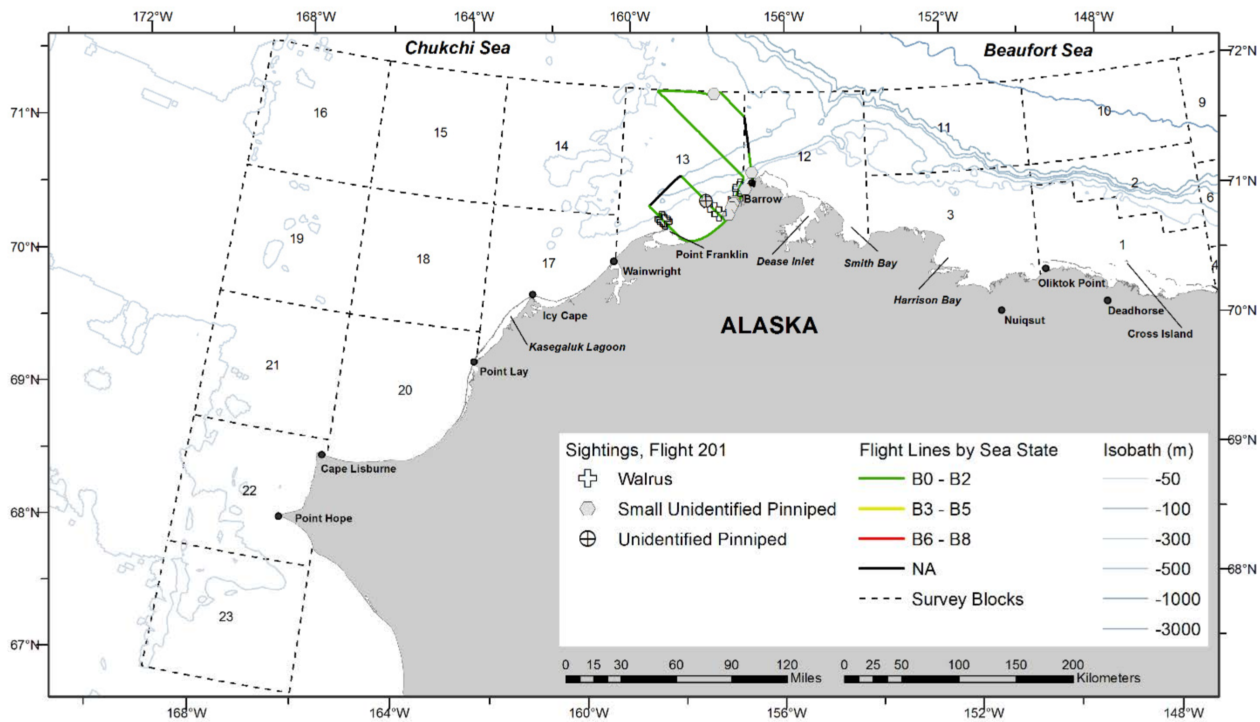

Figure B-1. ASAMM Flight 201 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

6 July 2016, Flight 202

Flight was a coastal transect survey from east of Cape Lisburne to Barrow. Survey conditions included partly cloudy skies, 3 km to unlimited visibility (with fog and glare), and Beaufort 1-4 sea states. Sea ice cover was 0-20% broken floe in the area surveyed. Sightings included gray whales (including 13 calves and 1 carcass), one unidentified cetacean carcass, one unidentified pinniped carcass, one unidentified marine mammal carcass, and small unidentified pinnipeds. The unidentified cetacean carcass was resighted during Flights 213, 217, and 240.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
202	7/6/2016 18:32	70.093	162.586	gray whale	feed	1	0	17
202	7/6/2016 18:39	70.187	162.395	gray whale	swim	2	1	17
202	7/6/2016 18:53	70.330	161.871	gray whale	dead	1	0	17
202	7/6/2016 19:20	70.659	160.066	unid cetacean	dead	1	0	17
202	7/6/2016 19:24	70.721	159.877	gray whale	swim	2	1	13
202	7/6/2016 19:26	70.744	159.817	gray whale	swim	2	1	13
202	7/6/2016 19:31	70.778	159.707	gray whale	swim	1	0	13
202	7/6/2016 19:31	70.781	159.696	gray whale	feed	5	2	13
202	7/6/2016 19:37	70.812	159.599	gray whale	swim	2	1	13
202	7/6/2016 19:38	70.823	159.587	gray whale	swim	1	0	13
202	7/6/2016 19:40	70.818	159.605	gray whale	swim	1	0	13
202	7/6/2016 19:41	70.830	159.513	gray whale	swim	1	0	13
202	7/6/2016 19:41	70.835	159.480	gray whale	swim	6	3	13
202	7/6/2016 19:44	70.842	159.434	gray whale	swim	2	1	13
202	7/6/2016 19:48	70.851	159.383	gray whale	swim	2	1	13
202	7/6/2016 19:49	70.856	159.400	gray whale	feed	1	0	13
202	7/6/2016 19:51	70.869	159.330	gray whale	swim	2	1	13
202	7/6/2016 19:52	70.869	159.344	gray whale	swim	2	1	13

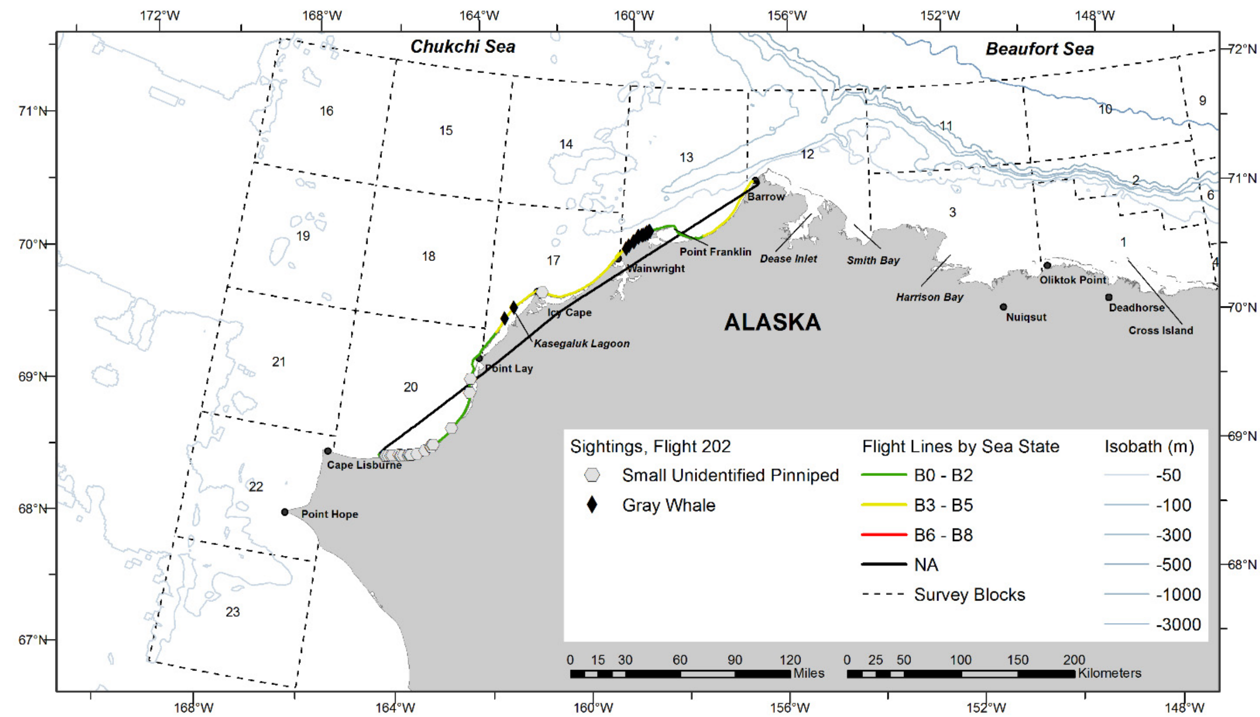

Figure B-2. ASAMM Flight 202 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

This pair of gray whales, observed near Point Franklin, Alaska, during ASAMM Flight 202, 6 July 2016, was recorded as swimming. Post-flight photographic image review showed that the larger whale had its mouth open, possibly indicating surface skim feeding, and illustrating the difficulty of detecting surface (or water column) feeding during aerial surveys.

8 July 2016, Flight 203

Flight was a complete survey of transects 4, 6, and 11, and a partial survey of transects 9, 16, and 18. 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 0-90% broken floe in the area surveyed. Sightings included gray whales (including one calf), walruses, unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
203	7/8/2016 11:19	71.234	157.471	gray whale	feed	2	0	13
203	7/8/2016 14:09	71.004	166.473	gray whale	swim	2	0	16
203	7/8/2016 14:10	70.974	166.330	gray whale	swim	5	0	19
203	7/8/2016 14:10	70.973	166.326	gray whale	swim	1	0	19
203	7/8/2016 15:26	70.558	160.621	gray whale	feed	1	0	17
203	7/8/2016 15:27	70.578	160.635	gray whale	swim	2	1	17
203	7/8/2016 15:27	70.589	160.635	gray whale	swim	1	0	17

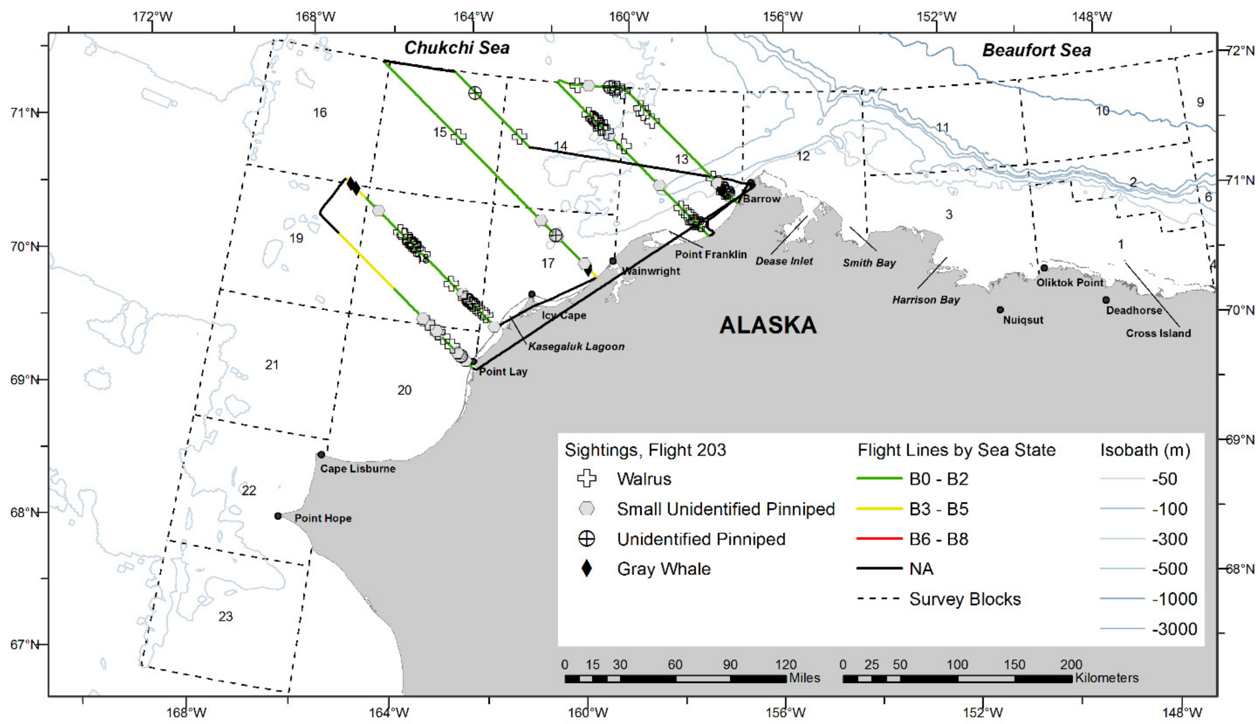

Figure B-3. ASAMM Flight 203 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whales swimming subsurface approximately 183 km northwest of Point Lay, Alaska, during ASAMM Flight 203, 8 July 2016.

9 July 2016, Flight 204

Flight was a complete survey of transects 10, 13, and 20, partial survey of transect 22, and the coastal transect south of Point Lay. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-5 sea states. Sea ice cover was 0-85% broken floe in the area surveyed. Sightings included gray whales (including nine calves), walruses (including one carcass), one breaded seal, one unidentified pinniped, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
204	7/9/2016 19:44	70.905	161.049	gray whale	feed	1	0	17
204	7/9/2016 19:45	70.900	161.047	gray whale	feed	2	0	17
204	7/9/2016 19:46	70.897	161.010	gray whale	feed	2	1	17
204	7/9/2016 19:46	70.891	161.026	gray whale	feed	2	1	17
204	7/9/2016 19:47	70.900	161.057	gray whale	feed	2	0	17
204	7/9/2016 19:47	70.903	161.057	gray whale	feed	1	0	17
204	7/9/2016 19:47	70.907	161.053	gray whale	feed	2	0	17
204	7/9/2016 19:48	70.894	161.004	gray whale	swim	2	1	17
204	7/9/2016 19:50	70.890	160.952	gray whale	swim	2	1	17
204	7/9/2016 19:51	70.889	160.962	gray whale	swim	2	0	17
204	7/9/2016 19:51	70.888	160.994	gray whale	feed	1	0	17
204	7/9/2016 19:54	70.886	160.937	gray whale	feed	2	1	17
204	7/9/2016 19:54	70.884	160.908	gray whale	feed	2	1	17
204	7/9/2016 19:55	70.887	160.926	gray whale	swim	2	1	17
204	7/9/2016 19:56	70.877	160.893	gray whale	feed	1	0	17
204	7/9/2016 19:58	70.853	160.792	gray whale	swim	1	0	17
204	7/9/2016 19:58	70.842	160.820	gray whale	feed	1	0	17
204	7/9/2016 19:58	70.850	160.791	gray whale	feed	4	2	17
204	7/9/2016 20:02	70.733	160.459	gray whale	feed	1	0	17

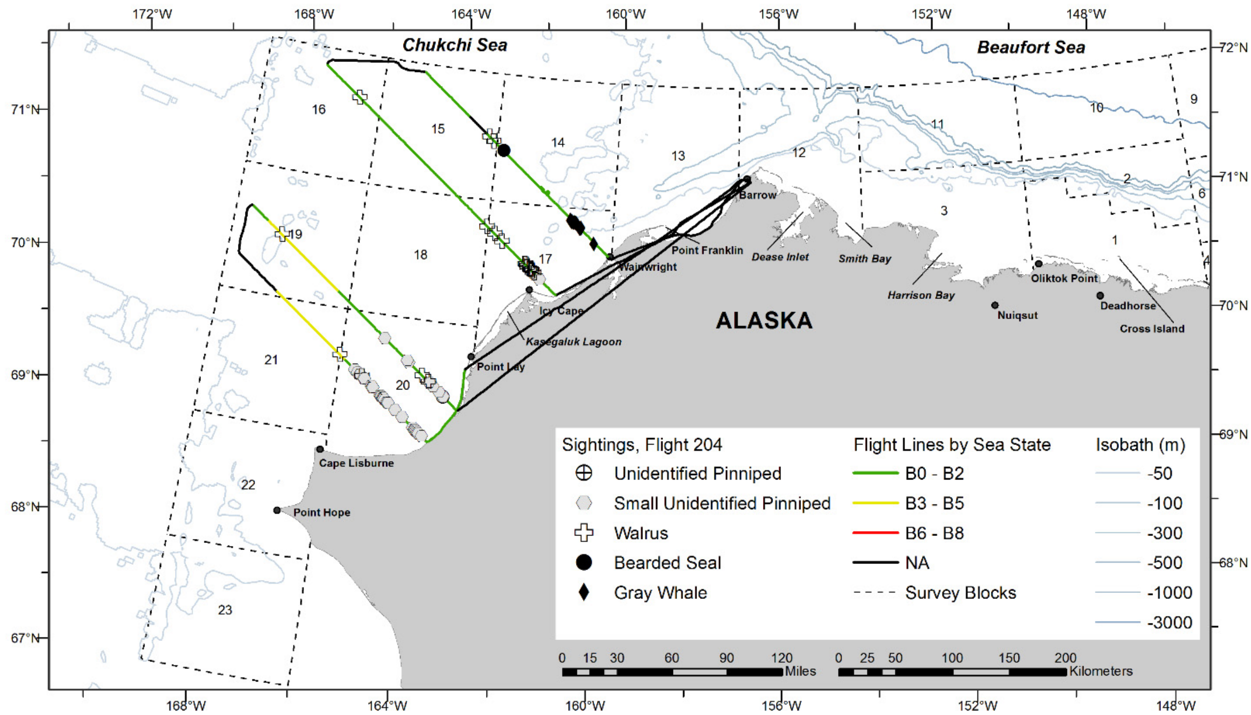

Figure B-4. ASAMM Flight 204 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

11 July 2016, Flight 205

Flight was a survey of block 12. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with fog and glare), and Beaufort 1-3 sea states. Sea ice cover was 5-90% broken floe in the area surveyed. Sightings included one bowhead whale, gray whales (including one calf), belugas (including eight calves), and one small unidentified pinniped.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
205	7/11/2016 17:53	71.990	154.542	beluga	swim	1	0	12
205	7/11/2016 17:57	71.845	154.550	beluga	mill	2	1	12
205	7/11/2016 17:58	71.816	154.546	beluga	swim	7	1	12
205	7/11/2016 17:59	71.811	154.543	beluga	swim	7	1	12
205	7/11/2016 17:59	71.808	154.547	beluga	swim	22	3	12
205	7/11/2016 17:59	71.802	154.545	beluga	swim	1	0	12
205	7/11/2016 18:04	71.642	154.557	beluga	swim	1	0	12
205	7/11/2016 18:18	71.267	154.568	bowhead whale	feed	1	0	12
205	7/11/2016 18:54	71.960	155.037	beluga	swim	1	0	12
205	7/11/2016 18:54	71.971	155.035	beluga	swim	1	0	12
205	7/11/2016 18:55	71.984	155.108	beluga	swim	1	0	12
205	7/11/2016 18:56	71.987	155.146	beluga	swim	2	1	12
205	7/11/2016 19:00	71.997	155.570	beluga	swim	1	0	12
205	7/11/2016 19:18	71.545	155.673	beluga	swim	37	0	12
205	7/11/2016 19:18	71.530	155.687	gray whale	swim	2	1	12
205	7/11/2016 19:19	71.539	155.682	beluga	swim	2	1	12
205	7/11/2016 19:25	71.501	155.677	gray whale	feed	1	0	12

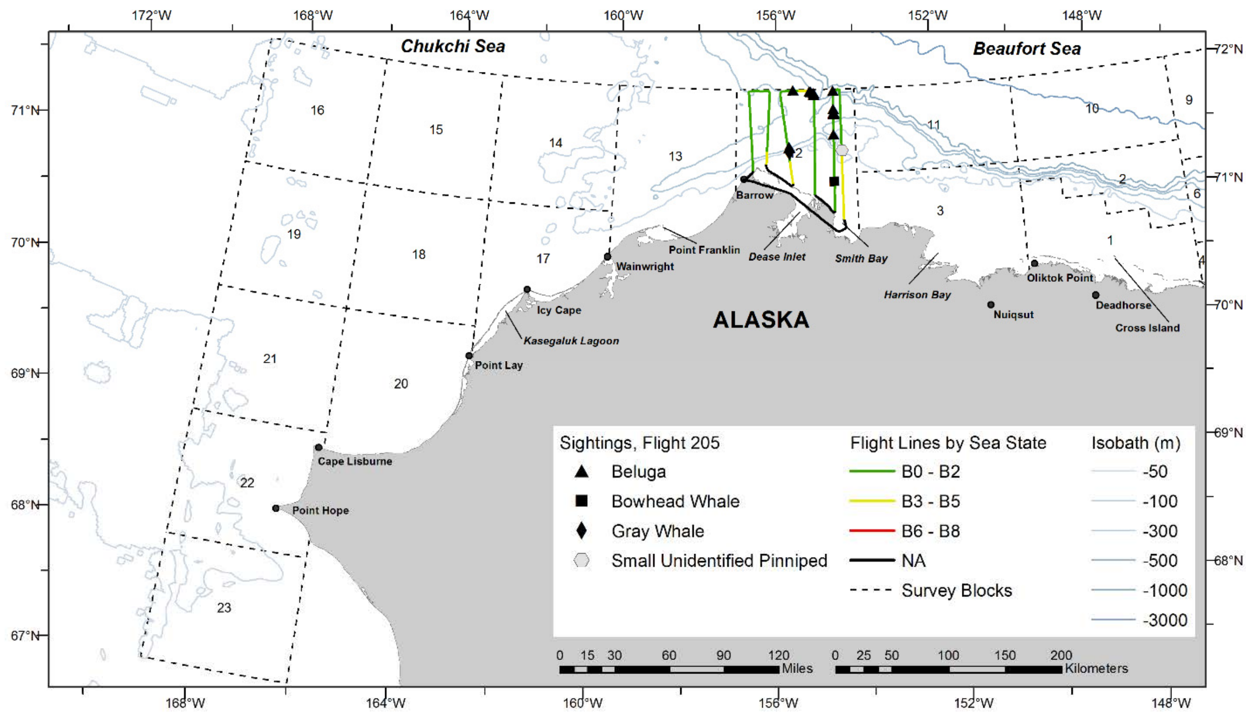

Figure B-5. ASAMM Flight 205 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

The 2016 ASAMM-Chukchi inaugural survey team wearing their new flight suits. From left to right: Corey Accardo, Tomo Spaic (pilot), Amy Willoughby, Lisa Barry, and Stan Churches (pilot).

13 July 2016, Flight 206

Flight was a complete survey of transect 7 and partial survey of transects 9, 12, and 14. Survey conditions included clear to partly cloudy skies, unlimited visibility (with glare), and Beaufort 2-6 sea states. Sea ice cover was 0-90% broken floe in the area surveyed. Sightings included one bowhead whale carcass, gray whales (including 19 calves), belugas (including 21 calves), walruses (including one carcass), one bearded seal, unidentified pinnipeds, and small unidentified pinnipeds. The bowhead whale carcass was resighted during Flight 236.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
206	7/13/2016 12:03	70.796	159.859	gray whale	swim	1	0	13
206	7/13/2016 12:05	70.829	159.962	gray whale	swim	2	1	13
206	7/13/2016 12:06	70.830	159.941	gray whale	swim	2	1	13
206	7/13/2016 12:08	70.820	160.006	gray whale	swim	2	1	17
206	7/13/2016 12:09	70.820	159.965	gray whale	swim	4	2	13
206	7/13/2016 12:11	70.830	160.008	gray whale	swim	5	1	17
206	7/13/2016 12:13	70.845	160.018	bowhead whale	dead	1	0	17
206	7/13/2016 12:18	70.919	160.249	gray whale	feed	2	1	17
206	7/13/2016 12:18	70.906	160.280	gray whale	feed	2	1	17
206	7/13/2016 13:51	70.930	158.828	gray whale	feed	1	0	13
206	7/13/2016 13:51	70.931	158.765	gray whale	swim	2	1	13
206	7/13/2016 13:51	70.930	158.765	gray whale	swim	3	1	13
206	7/13/2016 13:51	70.924	158.784	gray whale	swim	4	2	13
206	7/13/2016 13:57	70.926	158.755	gray whale	swim	2	1	13
206	7/13/2016 14:05	70.914	158.125	gray whale	swim	2	1	13
206	7/13/2016 14:07	70.923	158.019	gray whale	swim	1	0	13
206	7/13/2016 14:08	70.933	157.978	gray whale	swim	2	1	13
206	7/13/2016 14:08	70.929	157.978	gray whale	swim	4	2	13
206	7/13/2016 14:09	70.923	157.995	gray whale	swim	2	1	13
206	7/13/2016 14:13	70.016	157.754	gray whale	swim	1	0	13
206	7/13/2016 14:14	71.041	157.671	gray whale	swim	2	1	13
206	7/13/2016 14:14	71.047	157.602	gray whale	feed	1	0	13

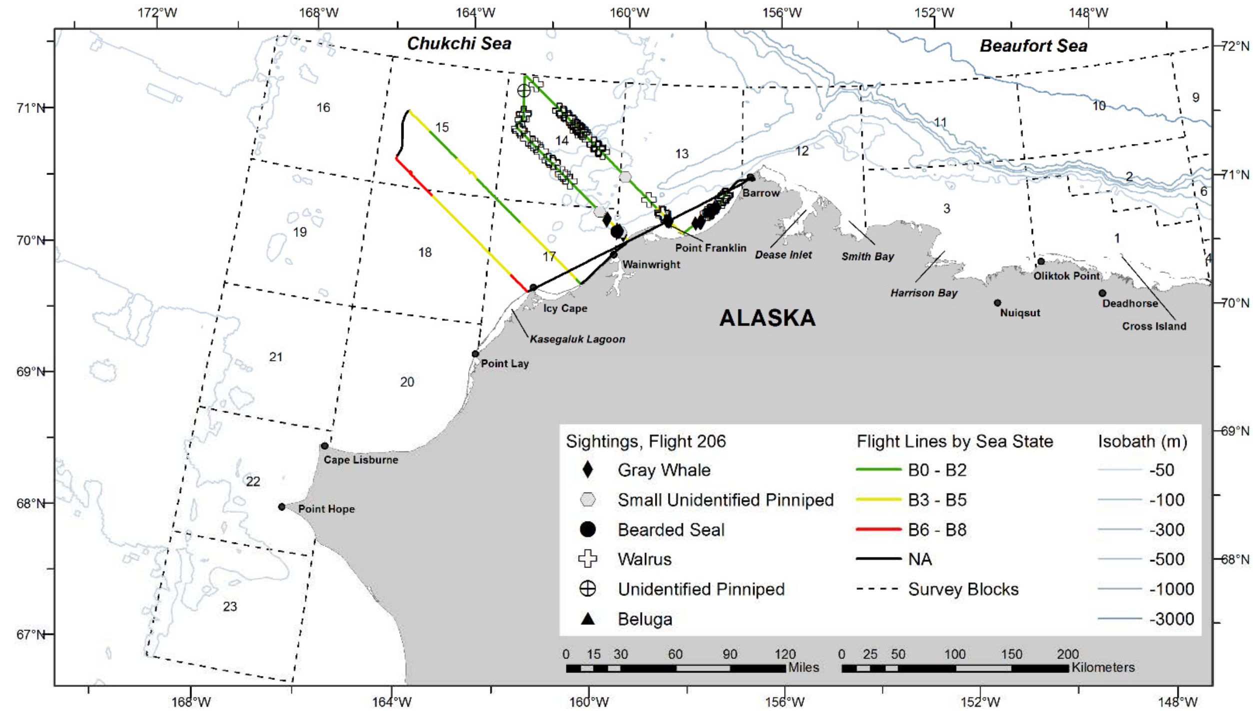

Figure B-6. ASAMM Flight 206 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

14 July 2016, Flight 207

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 0-90% broken floe in the area surveyed. Sightings included bowhead whales, belugas (including seven calves), one bearded seal, one unidentified pinniped, small unidentified pinnipeds, and one polar bear.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
207	7/14/2016 15:14	71.259	149.292	beluga	swim	1	0	2
207	7/14/2016 16:35	70.719	147.725	bowhead whale	feed	2	0	1
207	7/14/2016 17:01	71.190	147.431	beluga	swim	1	0	2
207	7/14/2016 17:01	71.189	147.428	beluga	swim	2	0	2
207	7/14/2016 17:01	71.184	147.402	beluga	swim	1	0	2
207	7/14/2016 17:01	71.179	147.409	beluga	swim	2	0	2
207	7/14/2016 17:02	71.169	147.414	beluga	swim	1	0	2
207	7/14/2016 17:03	71.110	147.407	beluga	swim	5	1	2
207	7/14/2016 17:04	71.092	147.394	bowhead whale	rest	1	0	2
207	7/14/2016 17:08	71.111	147.399	beluga	swim	3	0	2
207	7/14/2016 18:01	70.943	146.856	beluga	mill	2	1	2
207	7/14/2016 18:22	71.295	146.178	beluga	swim	5	1	2
207	7/14/2016 18:26	71.164	146.184	bowhead whale	swim	1	0	2
207	7/14/2016 18:36	70.950	146.143	beluga	swim	1	0	2
207	7/14/2016 18:36	70.932	146.152	beluga	rest	2	0	2
207	7/14/2016 18:38	70.888	146.199	beluga	swim	12	4	2

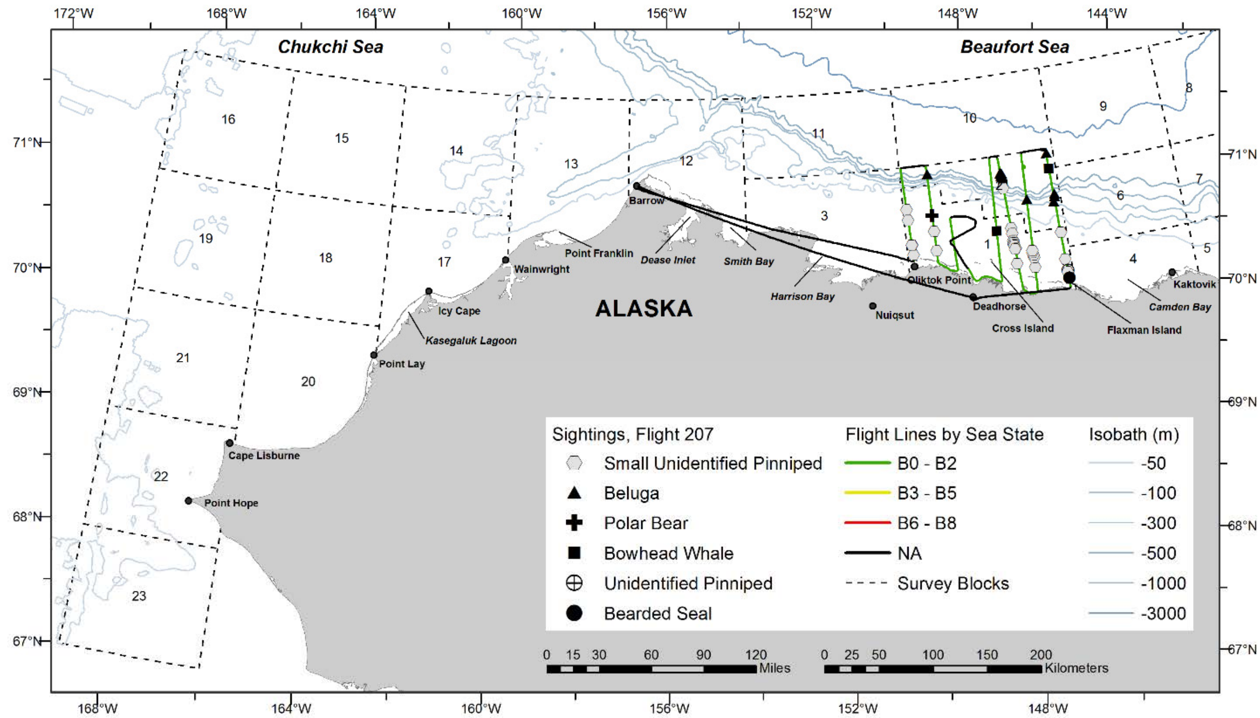

Figure B-7. ASAMM Flight 207 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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16 July 2016, Flight 208

Flight was a complete survey of transects 1 and 3 and partial survey of transects 5 and 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 20-88% broken floe in the area surveyed. Sightings included gray whales (including one calf), walruses, unidentified pinnipeds, and one polar bear.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
208	7/16/2016 14:49	71.059	157.620	gray whale	feed	2	1	13
208	7/16/2016 15:11	71.454	158.940	gray whale	swim	1	0	13

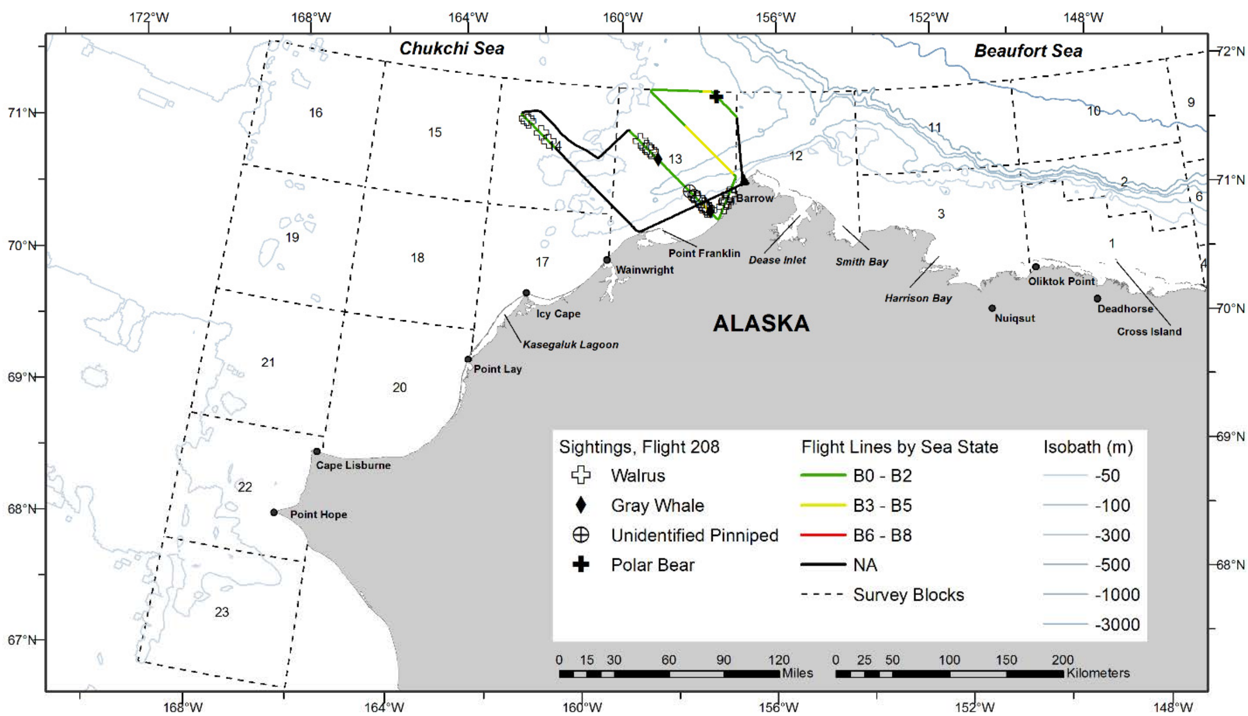

Figure B-8. ASAMM Flight 208 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 July 2016, Flight 209

Flight was a complete survey of transects 33, 34, 35, and 36, and partial survey of transect 37. Survey conditions included partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 1-3 sea states. No sea ice was observed in the area survived. Sightings included gray whales (including eight calves), harbor porpoises, one walrus carcass, one unidentified marine mammal carcass, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
209	7/19/2016 11:24	68.206	167.819	gray whale	rest	2	1	22
209	7/19/2016 11:37	68.189	168.721	gray whale	swim	1	0	22
209	7/19/2016 12:38	67.865	167.492	harbor porpoise	mill	5	0	23
209	7/19/2016 12:54	67.870	168.207	gray whale	feed	1	0	23
209	7/19/2016 12:55	67.871	168.235	gray whale	feed	1	0	23
209	7/19/2016 12:56	67.857	168.218	gray whale	feed	2	1	23
209	7/19/2016 12:57	67.863	168.268	gray whale	feed	2	0	23
209	7/19/2016 12:57	67.878	168.267	gray whale	swim	2	1	23
209	7/19/2016 12:58	67.882	168.263	gray whale	feed	3	0	23
209	7/19/2016 12:58	67.907	168.251	gray whale	feed	2	0	23
209	7/19/2016 12:59	67.896	168.299	harbor porpoise	mill	2	0	23
209	7/19/2016 12:59	67.884	168.339	gray whale	feed	3	1	23
209	7/19/2016 13:00	67.877	168.322	gray whale	feed	1	0	23
209	7/19/2016 13:01	67.862	168.334	gray whale	dive	1	0	23
209	7/19/2016 13:01	67.867	168.370	gray whale	rest	1	0	23
209	7/19/2016 13:04	67.850	168.561	gray whale	swim	2	0	23
209	7/19/2016 13:05	67.861	168.657	gray whale	rest	1	0	23
209	7/19/2016 13:09	67.752	168.801	gray whale	feed	1	0	23
209	7/19/2016 13:11	67.752	168.824	gray whale	swim	1	0	23
209	7/19/2016 13:27	67.704	167.671	gray whale	mill	3	1	23
209	7/19/2016 13:28	67.706	167.666	gray whale	swim	2	1	23
209	7/19/2016 13:30	67.686	167.552	gray whale	swim	2	1	23
209	7/19/2016 13:31	67.695	167.519	gray whale	swim	2	1	23

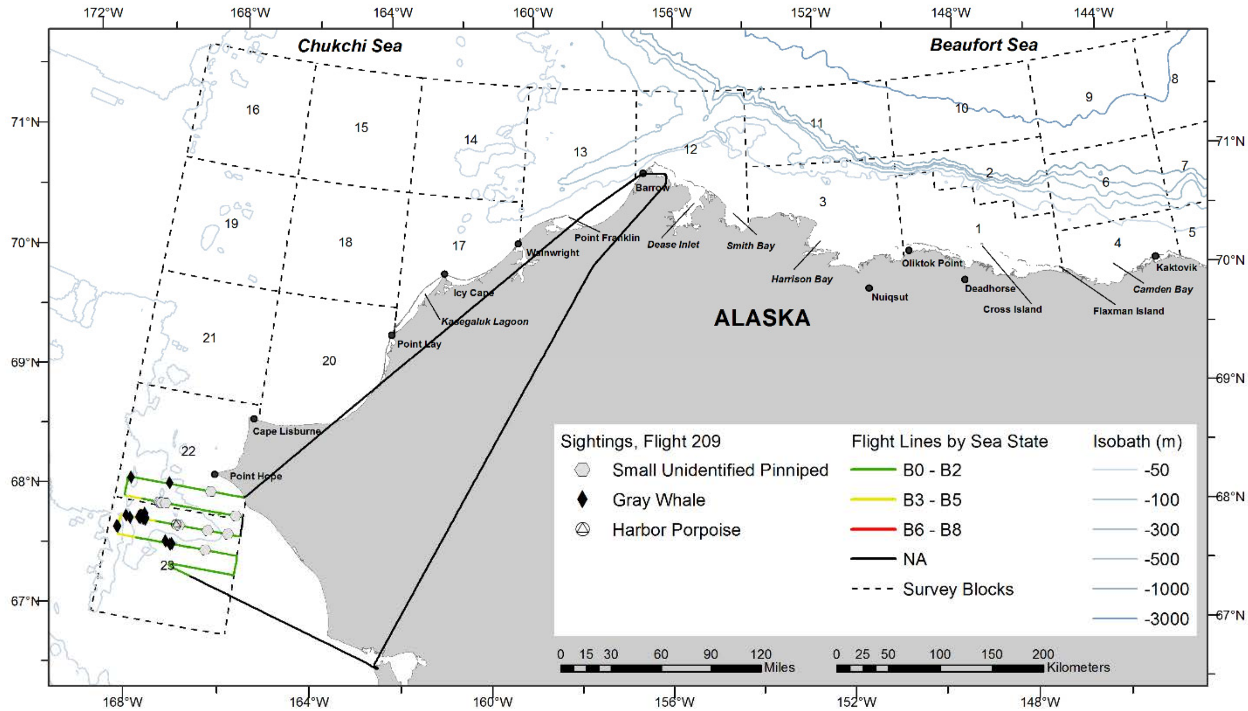

Figure B-9. ASAMM Flight 209 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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19 July 2016, Flight 1

Flight was a survey of portions of block 4. Survey conditions included overcast skies, 0 km to <1 km visibility (with low ceilings), and Beaufort 3-4 sea states. Sea ice cover was 15-60% broken floe in the area surveyed. No sightings were observed.

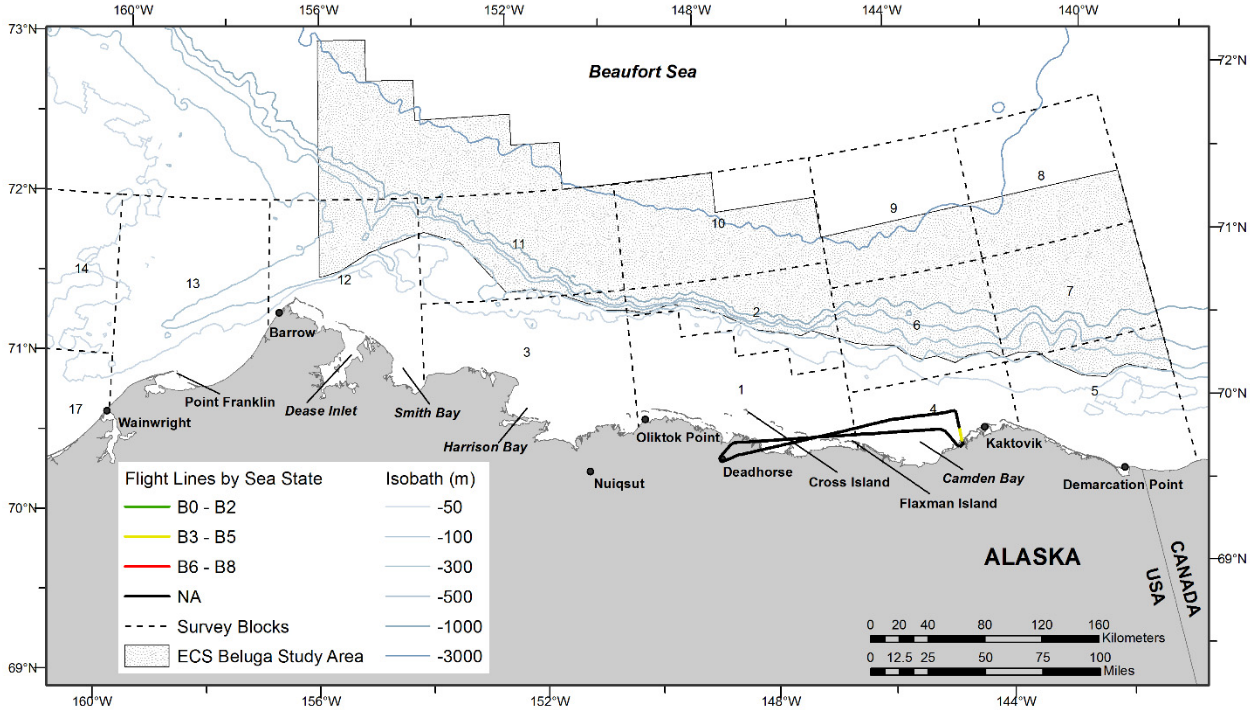

Figure B-10. ASAMM Flight 1 survey track, depicted by sea state.

20 July 2016, Flight 210

Flight was a complete survey of transects 11 and 13. Survey conditions included partly cloudy skies, 0 km to unlimited visibility (with glare and low ceilings), and Beaufort 2-6 sea states. Sea ice cover was 0-60% broken floe in the area surveyed. Sightings included gray whales (including two calves), walruses (including two carcasses), and one polar bear.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
210	7/20/2016 11:21	70.582	160.653	gray whale	feed	2	1	17
210	7/20/2016 11:22	70.593	160.662	gray whale	feed	2	1	17
210	7/20/2016 11:32	70.678	160.990	gray whale	dive	1	0	17
210	7/20/2016 11:59	71.166	162.828	gray whale	swim	3	0	14

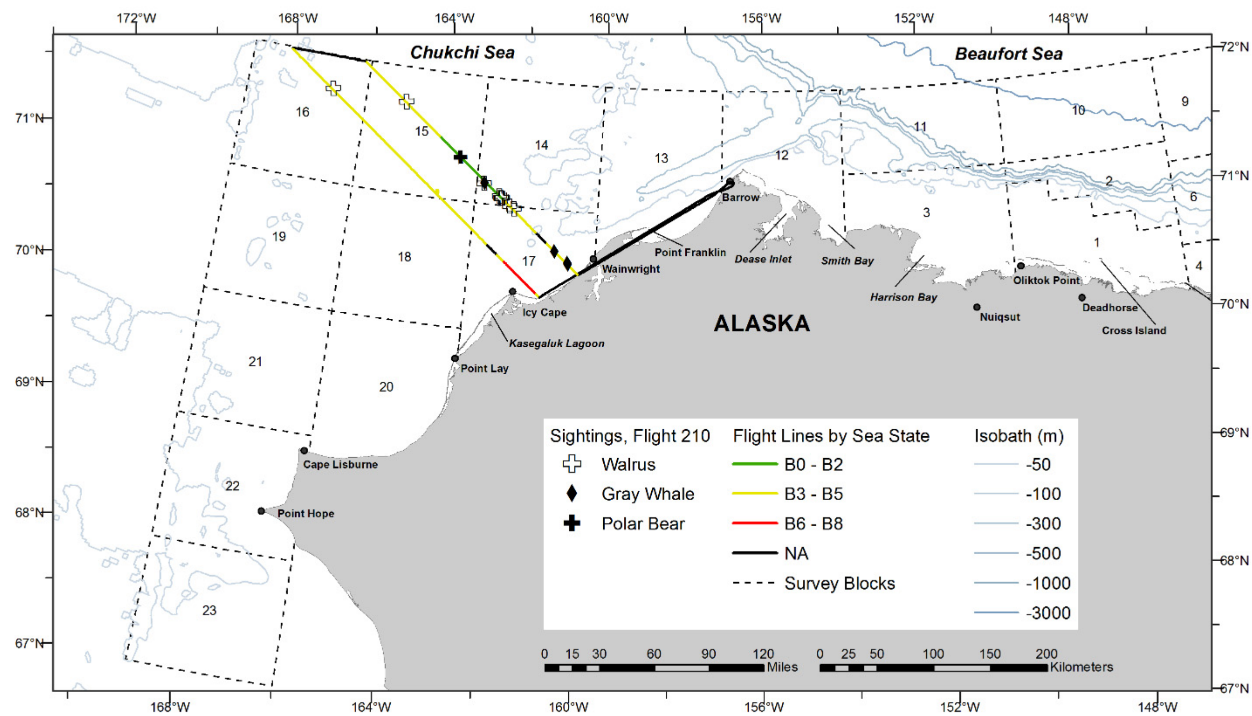

Figure B-11. ASAMM Flight 210 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale cow-calf pair sighted approximately 25 km southwest of Wainwright, Alaska, during ASAMM Flight 210, 20 July 2016.

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20 July 2016, Flight 2

Flight was a survey of portions of block 4 and a coastal search survey from east of the US/Canada border to Oliktok Point. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, and low ceilings), and Beaufort 2-7 sea states. Sea ice cover was 0-87% broken floe in the area surveyed. Sightings included belugas.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
2	7/20/2016 16:48	70.445	148.560	beluga	swim	5	0	1

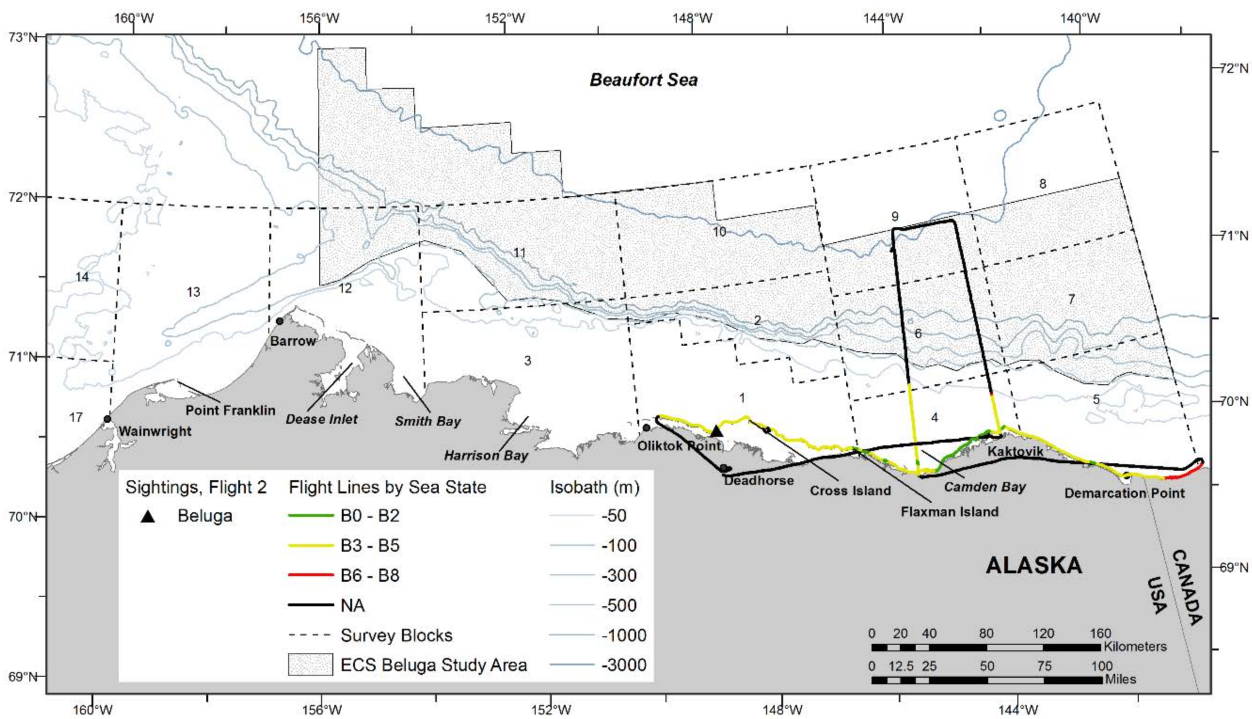

Figure B-12. ASAMM Flight 2 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

21 July 2016, Flight 211

Flight was a survey of block 12. Transects extended north of block 12 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included clear to partly cloudy skies, unlimited visibility (with glare), and Beaufort 0-3 sea states. Sea ice cover was 10-90% broken floe in the area surveyed. Sightings included one bowhead whale, gray whales, belugas (including 45 calves), walruses, one bearded seal, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
211	7/21/2016 10:23	72.213	154.262	beluga	swim	2	0	0
211	7/21/2016 10:24	72.247	154.272	beluga	swim	4	0	0
211	7/21/2016 10:24	72.253	154.243	beluga	swim	3	1	0
211	7/21/2016 10:33	72.549	154.091	bowhead whale	swim	1	0	0
211	7/21/2016 11:02	72.226	154.699	beluga	swim	10	0	0
211	7/21/2016 11:02	72.219	154.733	beluga	mill	2	0	0
211	7/21/2016 11:03	72.212	154.725	beluga	rest	1	0	0
211	7/21/2016 11:03	72.208	154.711	beluga	swim	3	0	0
211	7/21/2016 11:03	72.205	154.715	beluga	mill	7	0	0
211	7/21/2016 11:03	72.198	154.702	beluga	swim	2	1	0
211	7/21/2016 11:10	71.945	154.808	beluga	swim	3	0	12
211	7/21/2016 11:10	71.936	154.817	beluga	swim	6	0	12
211	7/21/2016 11:11	71.920	154.732	beluga	swim	1	0	12
211	7/21/2016 11:11	71.915	154.770	beluga	rest	1	0	12
211	7/21/2016 11:11	71.901	154.764	beluga	mill	98	8	12
211	7/21/2016 11:12	71.888	154.843	beluga	swim	2	0	12
211	7/21/2016 11:12	71.888	154.891	beluga	mill	114	20	12
211	7/21/2016 11:50	71.487	155.060	beluga	rest	1	0	12
211	7/21/2016 12:03	71.894	154.990	beluga	mill	3	0	12
211	7/21/2016 12:03	71.904	154.970	beluga	rest	1	0	12
211	7/21/2016 12:04	71.915	155.040	beluga	swim	1	0	12
211	7/21/2016 12:04	71.921	154.998	beluga	mill	4	0	12
211	7/21/2016 12:04	71.925	155.029	beluga	rest	1	0	12
211	7/21/2016 12:04	71.938	155.015	beluga	swim	1	0	12
211	7/21/2016 12:05	71.950	155.047	beluga	swim	1	0	12
211	7/21/2016 12:05	71.956	155.011	beluga	swim	4	0	12
211	7/21/2016 12:05	71.957	155.053	beluga	swim	4	0	12
211	7/21/2016 12:05	71.968	155.027	beluga	mill	26	2	12
211	7/21/2016 12:05	71.970	155.104	beluga	swim	20	0	12
211	7/21/2016 12:06	71.987	155.027	beluga	swim	4	1	12
211	7/21/2016 12:07	72.018	155.046	beluga	swim	1	0	0
211	7/21/2016 12:07	72.030	155.026	beluga	mill	16	3	0

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
211	7/21/2016 12:08	72.043	155.025	beluga	mill	4	0	0
211	7/21/2016 12:09	72.085	155.025	beluga	mill	9	2	0
211	7/21/2016 12:09	72.094	155.024	beluga	mill	23	2	0
211	7/21/2016 12:10	72.127	155.024	beluga	mill	14	1	0
211	7/21/2016 12:11	72.146	155.023	beluga	mill	17	2	0
211	7/21/2016 12:12	72.169	155.023	beluga	mill	18	0	0
211	7/21/2016 12:12	72.178	155.023	beluga	mill	22	1	0
211	7/21/2016 12:13	72.205	155.022	beluga	mill	6	0	0
211	7/21/2016 12:14	72.242	155.016	beluga	mill	2	1	0
211	7/21/2016 12:28	72.681	155.019	beluga	swim	1	0	0
211	7/21/2016 12:28	72.681	154.987	beluga	swim	1	0	0
211	7/21/2016 13:38	71.483	155.968	gray whale	feed	1	0	12
211	7/21/2016 13:41	71.477	155.940	gray whale	feed	1	0	12
211	7/21/2016 13:57	71.470	156.464	gray whale	swim	1	0	12
211	7/21/2016 13:57	71.478	156.462	gray whale	swim	1	0	12

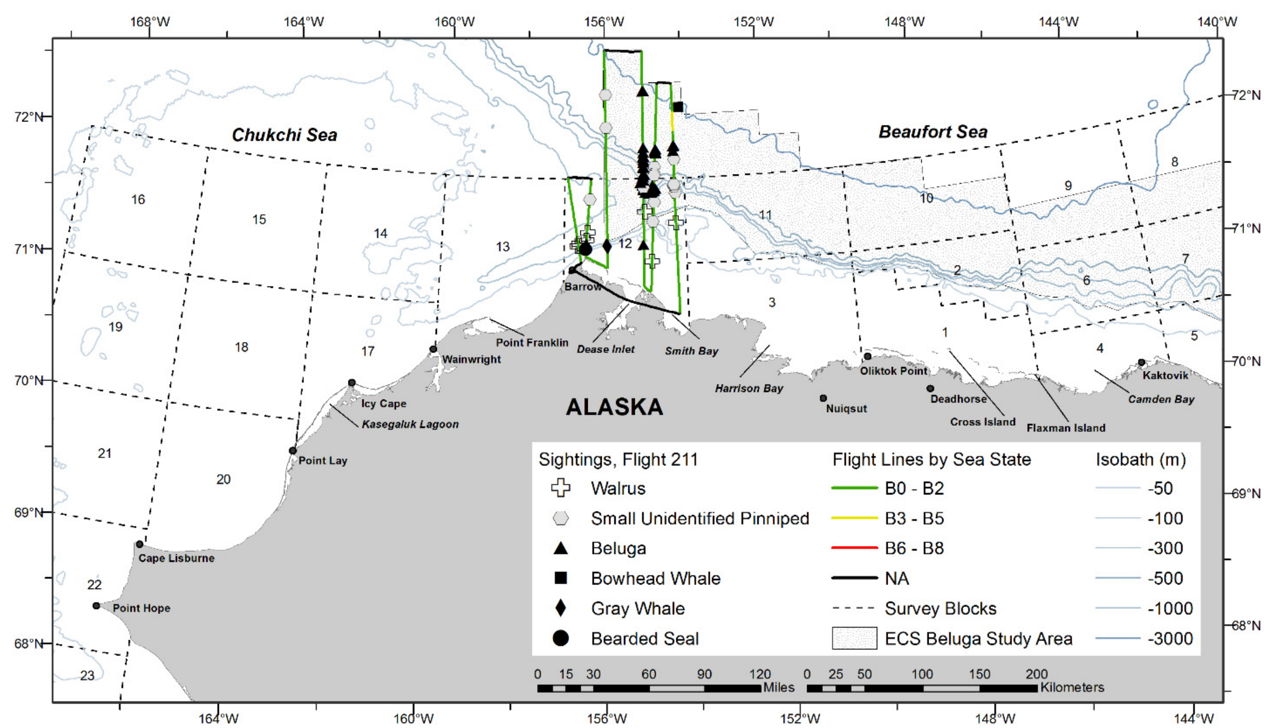

Figure B-13. ASAMM Flight 211 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

21 July 2016, Flight 3

Flight was a survey of portions of blocks 3 and 11. Transects extended north of block 11 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included clear to partly cloudy skies, 2 km to unlimited visibility (with glare and low ceilings), and Beaufort 0-4 sea states. Sea ice cover was 0-87% broken floe in the area surveyed. Sightings included bowhead whales, belugas (including 15 calves), walruses, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
3	7/21/2016 16:46	71.899	153.857	beluga	swim	6	0	11
3	7/21/2016 16:46	71.906	153.864	beluga	swim	1	0	11
3	7/21/2016 16:46	71.908	153.882	beluga	swim	6	0	11
3	7/21/2016 16:46	71.914	153.863	beluga	swim	1	0	11
3	7/21/2016 16:46	71.916	153.879	beluga	swim	48	3	11
3	7/21/2016 16:52	72.090	153.852	beluga	swim	3	1	0
3	7/21/2016 16:52	72.106	153.878	beluga	swim	2	0	0
3	7/21/2016 16:53	72.109	153.847	beluga	swim	1	0	0
3	7/21/2016 16:53	72.123	153.841	beluga	swim	4	0	0
3	7/21/2016 16:53	72.135	153.857	beluga	swim	6	0	0
3	7/21/2016 16:53	72.136	153.855	beluga	swim	4	0	0
3	7/21/2016 17:19	72.114	153.323	beluga	swim	1	0	0
3	7/21/2016 17:21	72.042	153.318	beluga	swim	2	0	0
3	7/21/2016 17:24	71.948	153.303	beluga	swim	3	0	11
3	7/21/2016 17:24	71.932	153.277	beluga	swim	8	0	11
3	7/21/2016 17:25	71.926	153.261	beluga	swim	2	0	11
3	7/21/2016 17:26	71.925	153.272	beluga	swim	1	0	11
3	7/21/2016 17:26	71.916	153.222	beluga	swim	6	0	11
3	7/21/2016 17:29	71.921	153.272	beluga	swim	1	0	11
3	7/21/2016 17:29	71.901	153.287	beluga	swim	2	1	11
3	7/21/2016 17:29	71.900	153.264	beluga	swim	2	0	11
3	7/21/2016 17:30	71.879	153.254	beluga	swim	1	0	11
3	7/21/2016 17:31	71.843	153.265	beluga	swim	1	0	11
3	7/21/2016 17:31	71.839	153.268	beluga	swim	5	0	11
3	7/21/2016 17:31	71.834	153.220	beluga	swim	2	0	11
3	7/21/2016 17:31	71.830	153.232	beluga	swim	4	0	11
3	7/21/2016 17:31	71.827	153.277	beluga	swim	1	0	11
3	7/21/2016 17:31	71.826	153.274	beluga	swim	3	0	11
3	7/21/2016 18:21	71.398	152.740	beluga	swim	1	0	11
3	7/21/2016 18:34	71.810	152.806	beluga	swim	2	1	11
3	7/21/2016 18:35	71.826	152.820	beluga	swim	4	0	11
3	7/21/2016 18:49	72.285	152.948	bowhead whale	swim	1	0	0

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
3	7/21/2016 19:11	72.248	152.234	bowhead whale	tail slap	1	0	0
3	7/21/2016 19:27	71.731	152.207	beluga	swim	48	6	11
3	7/21/2016 19:27	71.721	152.217	beluga	swim	1	0	11
3	7/21/2016 19:28	71.704	152.216	beluga	swim	4	0	11
3	7/21/2016 19:28	71.693	152.221	beluga	swim	2	1	11
3	7/21/2016 19:28	71.691	152.216	beluga	swim	8	0	11
3	7/21/2016 19:28	71.686	152.186	beluga	swim	12	2	11

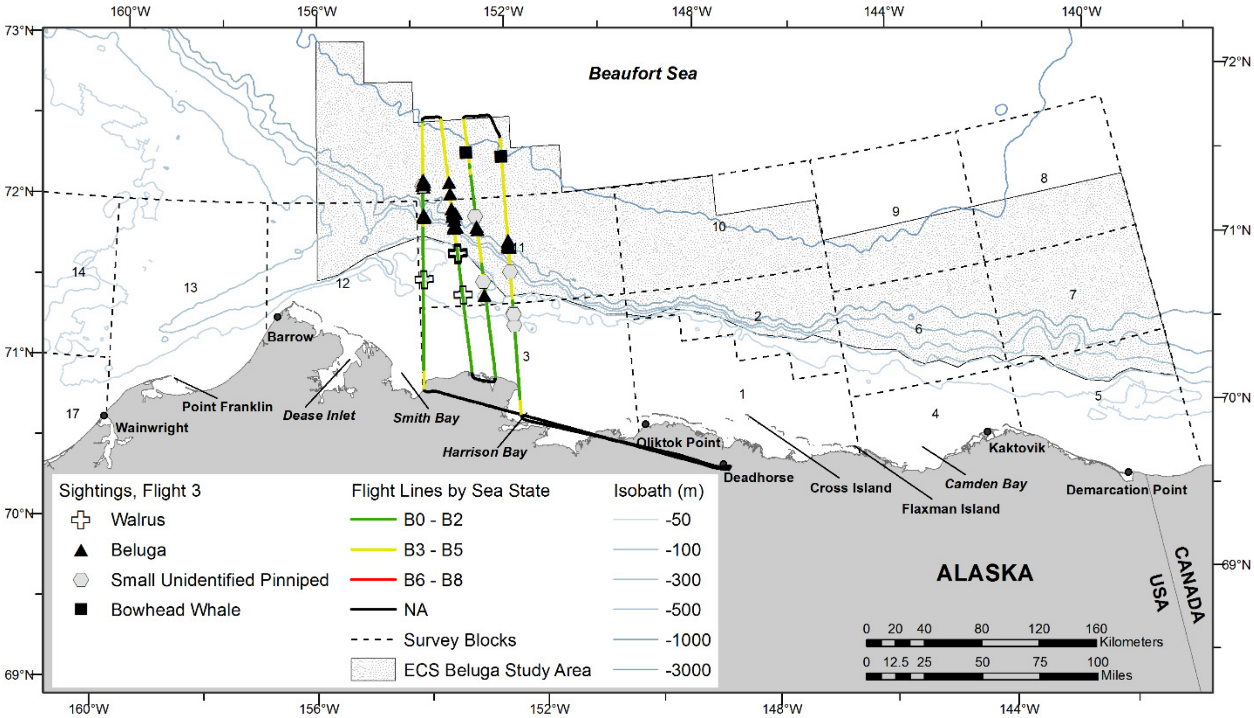

Figure B-14. ASAMM Flight 3 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Belugas sighted at the northern boundary of Block 11, during ASAMM Flight 3, 21 July 2016.

A well-marked bowhead whale sighted north of block 11, in waters >2000 ft deep, during ASAMM Flight 3, 21 July 2016.

Bowhead whale sighted tail slapping north of block 11, in waters >2000 ft deep during ASAMM Flight 3, 21 July 2016. A fecal cloud is visible in the water near the whale.

Same bowhead whale as photographed above, ASAMM Flight 3, 21 July 2016.

22 July 2016, Flight 212

Flight was a complete survey of transect 10 and partial survey of transect 12. Survey conditions included clear skies, unlimited visibility (with glare), and Beaufort 1-5 sea states. Sea ice cover was 0-60% broken floe in the area surveyed. Sightings included gray whales (including 18 calves), walruses, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
212	7/22/2016 9:37	70.678	160.265	gray whale	feed	1	0	17
212	7/22/2016 9:38	70.683	160.266	gray whale	rest	1	0	17
212	7/22/2016 9:40	70.716	160.312	gray whale	feed	1	0	17
212	7/22/2016 9:40	70.708	160.377	gray whale	feed	14	5	17
212	7/22/2016 9:48	70.716	160.499	gray whale	mill	3	1	17
212	7/22/2016 9:51	70.709	160.510	gray whale	feed	1	0	17
212	7/22/2016 9:55	70.794	160.717	gray whale	mill	4	2	17
212	7/22/2016 9:56	70.799	160.740	gray whale	swim	1	0	17
212	7/22/2016 9:56	70.793	160.737	gray whale	feed	2	0	17
212	7/22/2016 9:56	70.791	160.718	gray whale	swim	1	0	17
212	7/22/2016 10:03	70.820	160.741	gray whale	mill	2	1	17
212	7/22/2016 10:04	70.815	160.743	gray whale	feed	1	0	17
212	7/22/2016 10:06	70.847	160.784	gray whale	feed	2	1	17
212	7/22/2016 10:06	70.853	160.810	gray whale	feed	3	1	17
212	7/22/2016 10:07	70.855	160.738	gray whale	feed	1	0	17
212	7/22/2016 10:07	70.857	160.744	gray whale	feed	1	0	17
212	7/22/2016 10:08	70.858	160.752	gray whale	feed	1	0	17
212	7/22/2016 10:11	70.860	160.858	gray whale	feed	5	2	17
212	7/22/2016 10:13	70.837	160.888	gray whale	feed	2	0	17
212	7/22/2016 10:13	70.831	160.907	gray whale	feed	13	4	17
212	7/22/2016 10:13	70.827	160.917	gray whale	feed	4	0	17
212	7/22/2016 10:22	70.896	160.947	gray whale	feed	4	1	17
212	7/22/2016 10:24	70.896	160.976	gray whale	feed	2	0	17

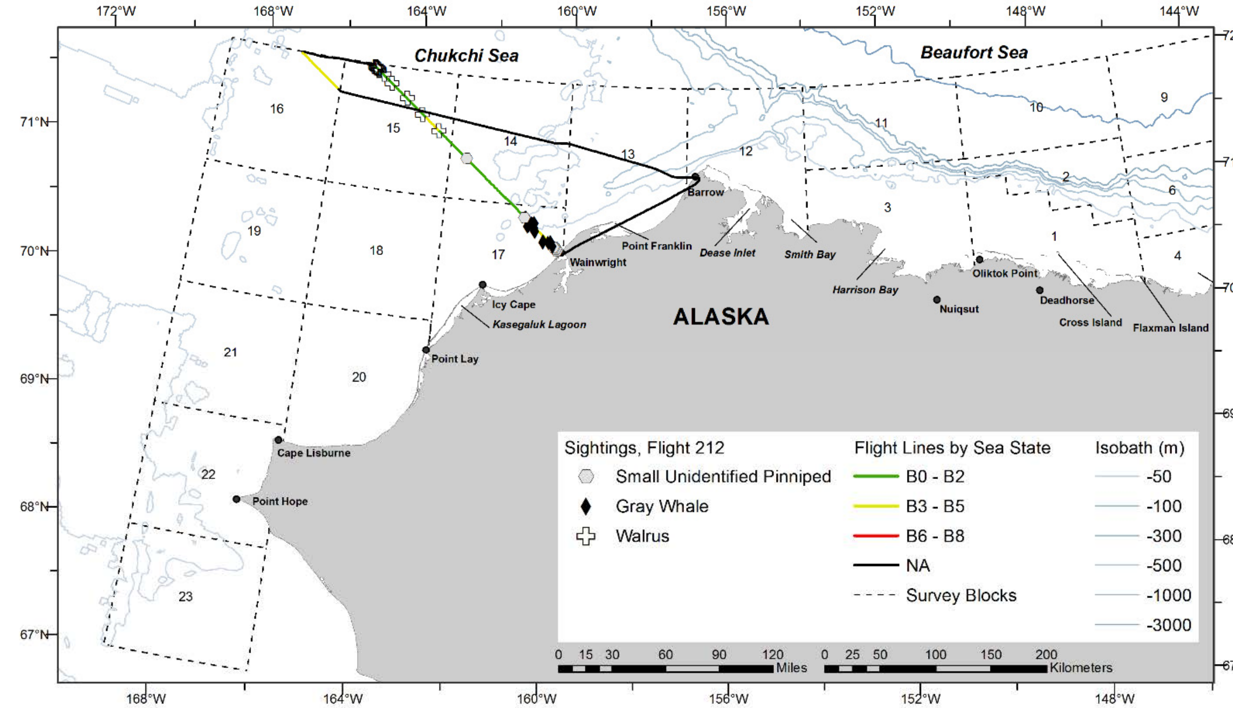

Figure B-15. ASAMM Flight 212 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 July 2016, Flight 213

Flight was a complete survey of transect 2, partial survey of transect 4, and the costal transect from Barrow to Icy Cape. Survey conditions included clear skies, <1 km to unlimited visibility (with fog and glare), and Beaufort 1-6 sea states. Sea ice cover was 0-80% broken floe in the area surveyed. Sightings included gray whales (including eight calves and one carcass), unidentified cetaceans (including one carcass), walruses, small unidentified pinnipeds, and one polar bear. The gray whale carcass was resighted during Flights 227 and 240. The unidentified cetacean carcass was previously sighted during Flight 202, and resighted during Flights 217 and 240.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
213	7/24/2016 13:52	71.268	157.466	gray whale	feed	2	0	13
213	7/24/2016 13:52	71.239	157.518	gray whale	feed	1	0	13
213	7/24/2016 13:58	71.221	157.472	gray whale	feed	2	0	13
213	7/24/2016 14:00	71.226	157.455	gray whale	feed	2	1	13
213	7/24/2016 14:06	71.160	157.215	gray whale	swim	2	1	13
213	7/24/2016 14:36	70.882	159.206	gray whale	swim	2	1	13
213	7/24/2016 14:42	70.874	159.318	gray whale	dive	2	1	13
213	7/24/2016 14:48	70.861	159.387	gray whale	feed	6	2	13
213	7/24/2016 14:48	70.860	159.396	gray whale	feed	1	0	13
213	7/24/2016 15:04	70.622	160.108	gray whale	swim	2	1	17
213	7/24/2016 15:22	70.319	161.229	gray whale	feed	2	1	17
213	7/24/2016 15:28	70.296	161.407	gray whale	dead	1	0	17

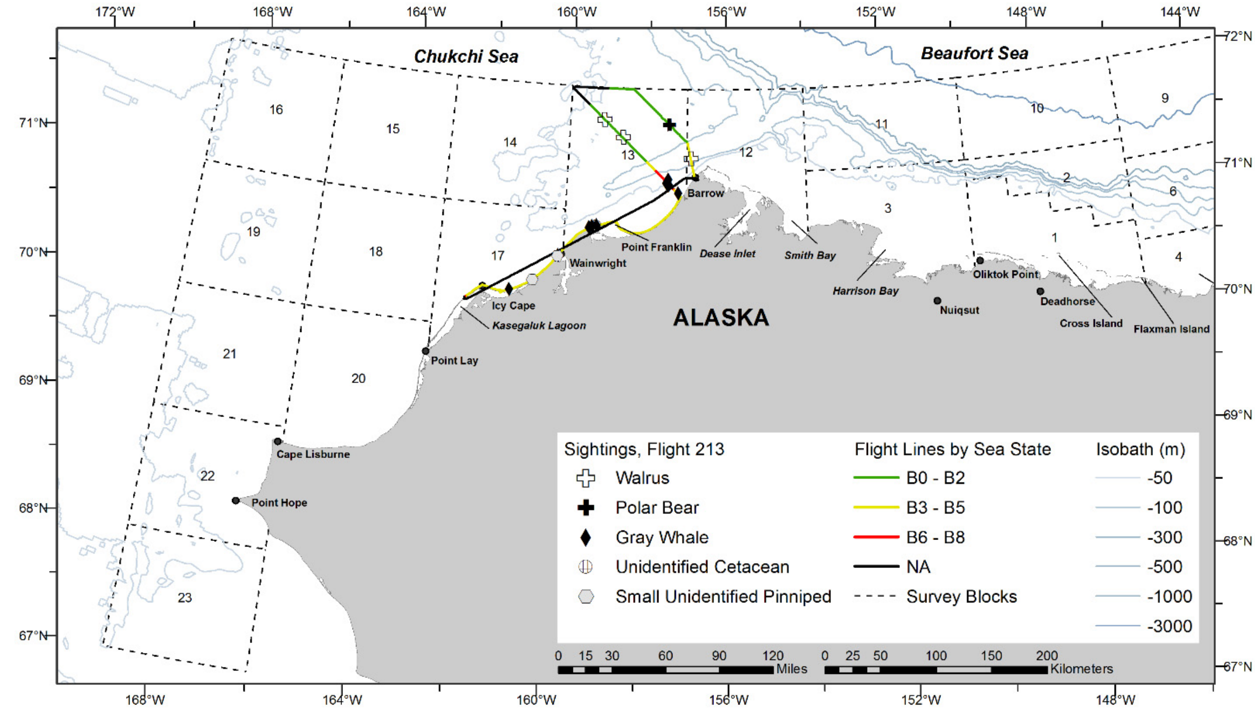

Figure B-16. ASAMM Flight 213 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 July 2016, Flight 4

Flight was a survey of portions of blocks 3 and 11. Transects extended north of block 11 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included clear skies, <1 km to unlimited visibility (with glare and low ceilings), and Beaufort 1-6 sea states. Sea ice cover was 0-93% broken floe in the area surveyed. Sightings included one bowhead whale, belugas (including one calf), and one small unidentified pinniped.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
4	7/24/2016 14:08	71.350	151.759	bowhead whale	swim	1	0	11
4	7/24/2016 14:34	72.163	151.595	beluga	swim	2	1	0

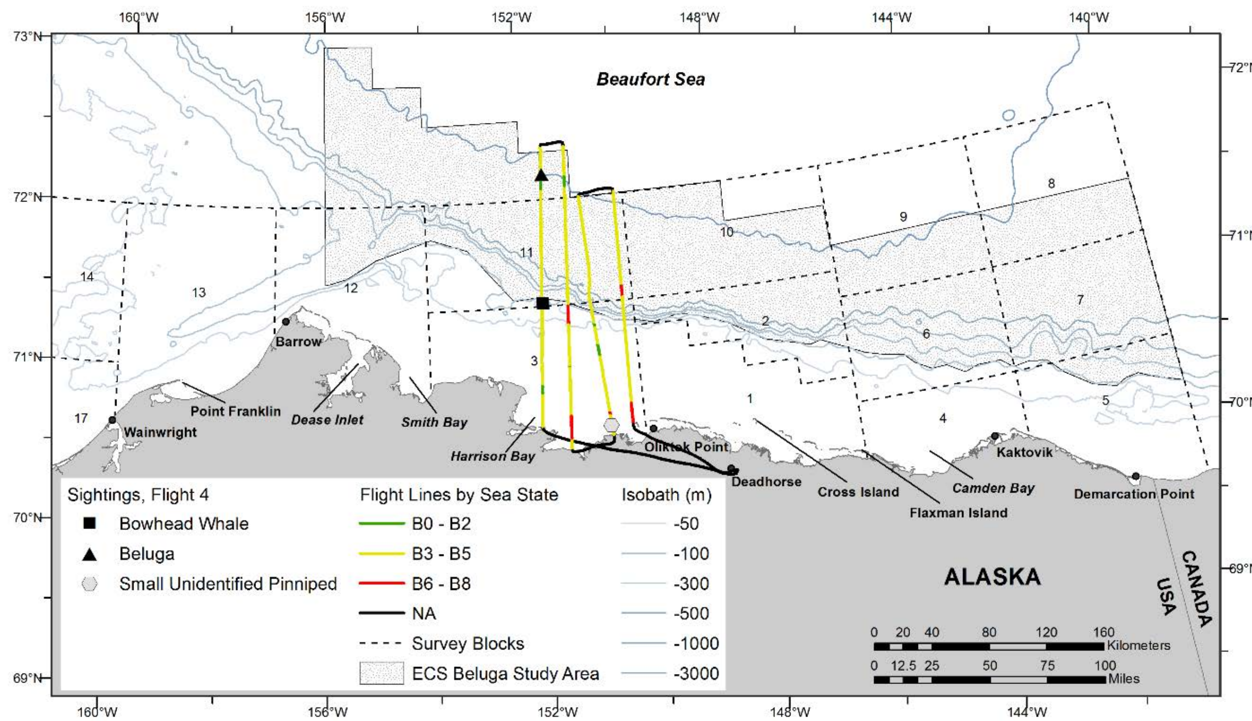

Figure B-17. ASAMM Flight 4 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

25 July 2016, Flight 214

Flight was a complete survey of transect 15, partial survey of transect 17, and the coastal transect from Point Lay to Icy Cape. Survey conditions included overcast skies, <1 km to unlimited visibility (with glare and low ceilings), and Beaufort 2-3 sea states. There was no sea ice in area surveyed. Sightings included one bowhead whale, two walrus carcasses, one bearded seal, one unidentified pinniped, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
214	7/25/2016 11:53	71.262	166.688	bowhead whale	rest	1	0	16

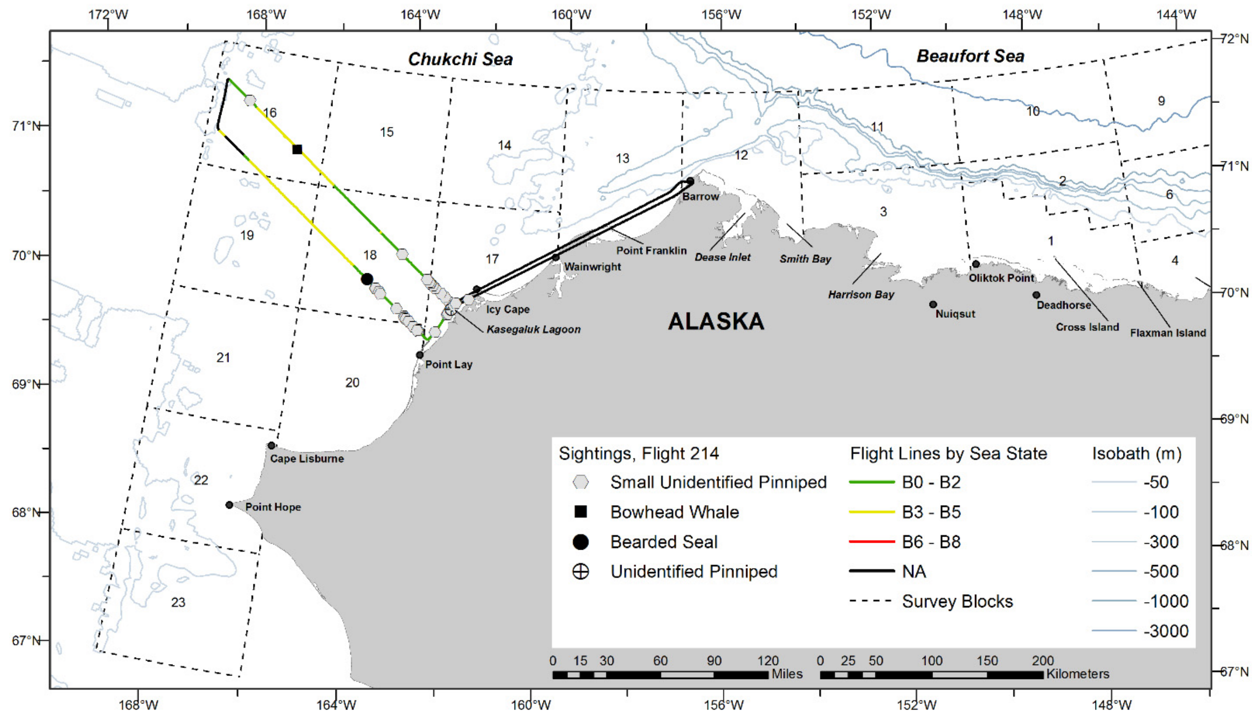

Figure B-18. ASAMM Flight 214 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

25 July 2016, Flight 5

Flight was a survey of blocks 1 and 2, and portions of block 10. Transects extended into block 10 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included clear to partly cloudy skies, 0 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 0-6 sea states. Sea ice cover was 0-90% broken floe in the area surveyed. Sightings included one gray whale, belugas (including 10 calves), one bearded seal, one unidentified pinniped, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
5	7/25/16 10:36	71.604	-146.019	beluga	swim	2	0	10
5	7/25/16 10:37	71.614	-146.061	beluga	swim	1	0	10
5	7/25/16 10:37	71.615	-146.051	beluga	swim	1	0	10
5	7/25/16 10:37	71.615	-146.005	beluga	swim	3	0	10
5	7/25/16 10:37	71.622	-146.059	beluga	swim	1	0	10
5	7/25/16 10:37	71.623	-146.056	beluga	swim	9	1	10
5	7/25/16 10:38	71.641	-146.059	beluga	swim	2	0	10
5	7/25/16 10:38	71.652	-146.026	beluga	swim	2	0	10
5	7/25/16 12:32	71.730	-147.563	beluga	swim	3	0	10
5	7/25/16 12:34	71.664	-147.547	beluga	swim	4	0	10
5	7/25/16 16:03	70.797	-149.187	gray whale	swim	1	0	1
5	7/25/16 17:06	71.770	-148.584	beluga	swim	1	0	10
5	7/25/16 17:06	71.774	-148.580	beluga	swim	1	0	10
5	7/25/16 17:06	71.775	-148.578	beluga	swim	2	1	10
5	7/25/16 17:06	71.778	-148.590	beluga	swim	1	0	10
5	7/25/16 17:06	71.780	-148.554	beluga	swim	4	0	10
5	7/25/16 17:06	71.783	-148.533	beluga	swim	2	0	10
5	7/25/16 17:06	71.785	-148.546	beluga	swim	1	0	10
5	7/25/16 17:06	71.788	-148.557	beluga	swim	1	0	10
5	7/25/16 17:06	71.791	-148.583	beluga	swim	1	0	10
5	7/25/16 17:06	71.800	-148.580	beluga	swim	2	1	10
5	7/25/16 17:07	71.812	-148.547	beluga	swim	1	0	10
5	7/25/16 17:07	71.817	-148.525	beluga	swim	1	0	10
5	7/25/16 17:07	71.821	-148.586	beluga	swim	2	1	10
5	7/25/16 17:10	71.917	-148.537	beluga	swim	13	1	10
5	7/25/16 17:10	71.921	-148.536	beluga	swim	19	3	10
5	7/25/16 17:19	71.925	-148.198	beluga	swim	1	0	10
5	7/25/16 17:19	71.921	-148.219	beluga	swim	2	0	10
5	7/25/16 17:19	71.915	-148.207	beluga	swim	8	0	10
5	7/25/16 17:19	71.909	-148.232	beluga	swim	2	1	10
5	7/25/16 17:19	71.908	-148.237	beluga	swim	1	0	10

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
5	7/25/16 17:19	71.906	-148.244	beluga	swim	1	0	10
5	7/25/16 17:20	71.890	-148.183	beluga	swim	1	0	10
5	7/25/16 17:20	71.889	-148.204	beluga	swim	2	1	10
5	7/25/16 17:20	71.887	-148.194	beluga	swim	1	0	10

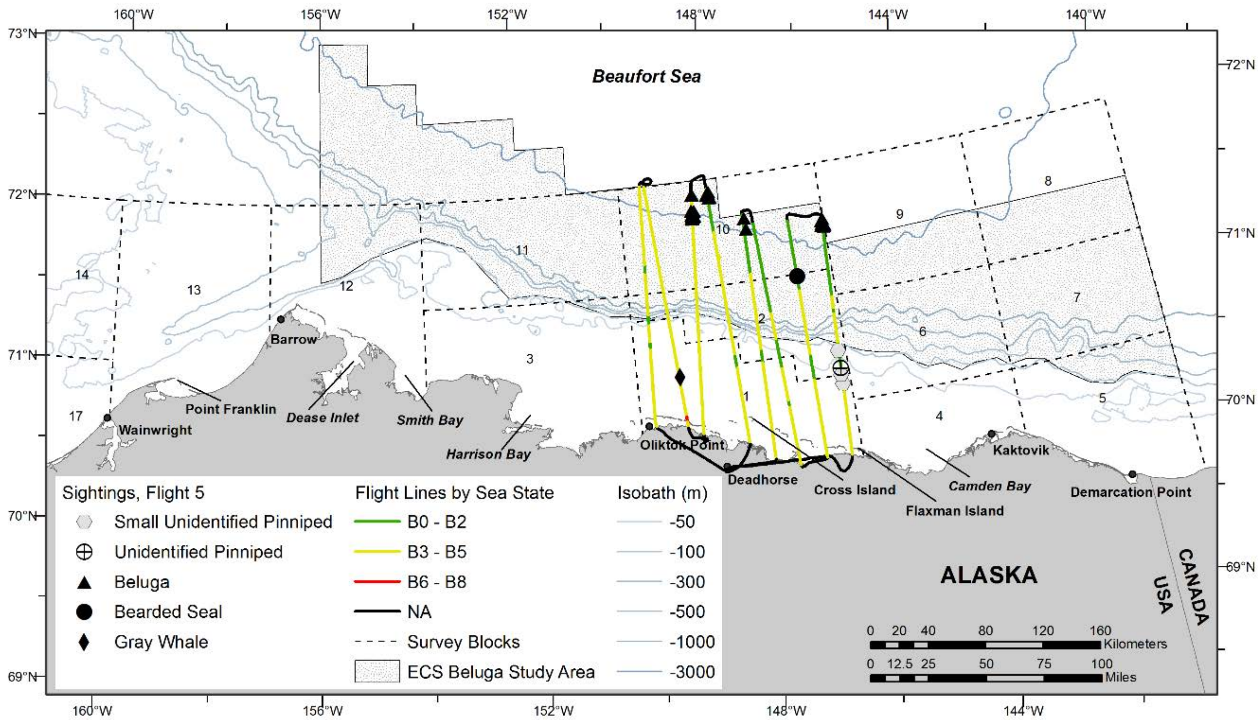

Figure B-19. ASAMM Flight 5 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

27 July 2016, Flight 215

Flight was a complete survey of transect 7 and partial survey of transect 9. Survey conditions included overcast skies, <1-10 km visibility (with low ceilings and precipitation), and Beaufort 1-2 sea states. Sea ice cover was 10-80% broken floe in the area surveyed. Sightings included gray whales (including eight calves), walruses, and unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
215	7/27/2016 10:20	70.820	159.953	gray whale	swim	2	1	13
215	7/27/2016 10:30	70.914	160.222	gray whale	rest	2	0	17
215	7/27/2016 10:30	70.916	160.215	gray whale	feed	5	2	17
215	7/27/2016 10:31	70.925	160.205	gray whale	feed	1	0	17
215	7/27/2016 10:37	70.943	160.245	gray whale	feed	3	2	17
215	7/27/2016 10:42	70.929	160.251	gray whale	feed	2	1	17
215	7/27/2016 10:42	70.931	160.281	gray whale	feed	1	0	17
215	7/27/2016 10:43	70.934	160.284	gray whale	feed	1	0	17
215	7/27/2016 10:50	70.950	160.393	gray whale	rest	1	0	17
215	7/27/2016 10:50	70.951	160.403	gray whale	feed	1	0	17
215	7/27/2016 10:52	70.945	160.427	gray whale	feed	5	1	17
215	7/27/2016 10:52	70.938	160.418	gray whale	feed	1	0	17
215	7/27/2016 10:53	70.944	160.416	gray whale	feed	1	0	17
215	7/27/2016 11:08	71.226	161.353	gray whale	feed	2	1	14
215	7/27/2016 11:13	71.272	161.513	gray whale	rest	1	0	14
215	7/27/2016 12:29	70.950	158.821	gray whale	swim	1	0	13

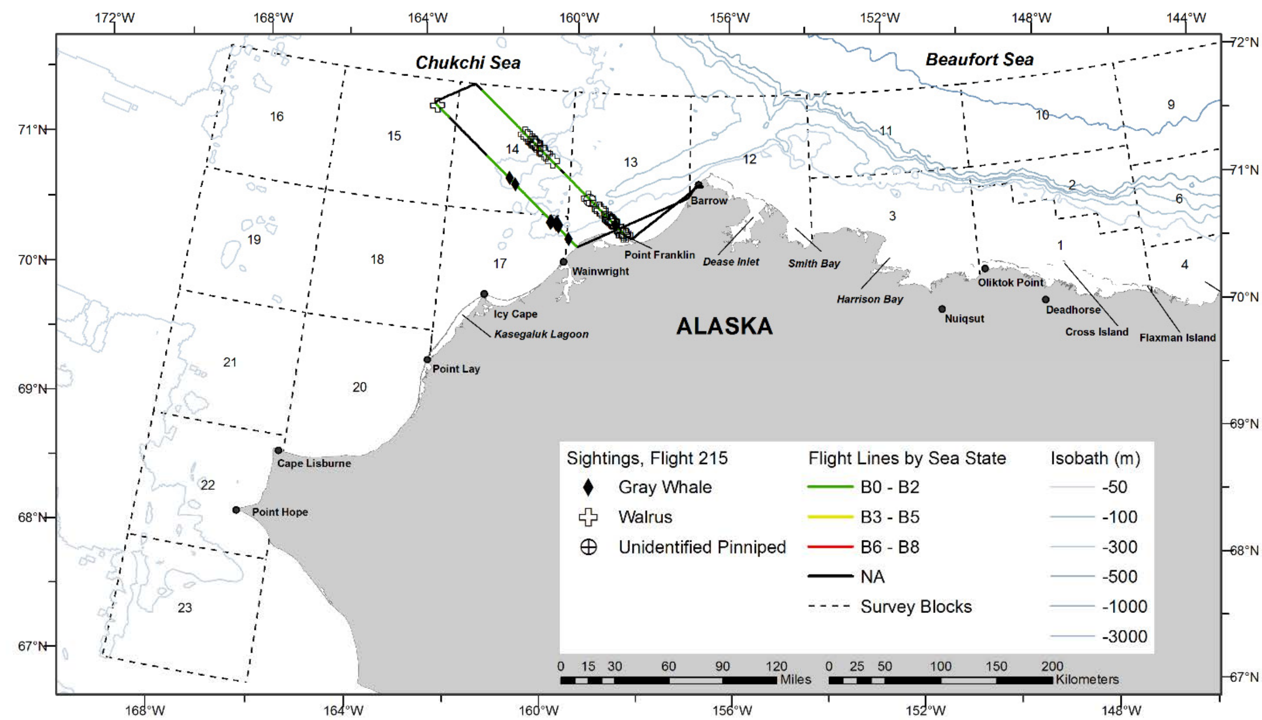

Figure B-20. ASAMM Flight 215 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale cow-calf pair sighted approximately 30 km northwest of Wainwright, Alaska, during ASAMM Flight 215, 27 July 2016.

Gray whale cow-calf pair sighted approximately 30 km northwest of Wainwright, Alaska, during ASAMM Flight 215, 27 July 2016.

Two feeding gray whales with mud plumes and a cow-calf pair sighted approximately 30 km northwest of Wainwright, Alaska, during ASAMM Flight 215, 27 July 2016.

27 July 2016, Flight 6

Flight was a survey of portions of blocks 4, 6, and 9. Transects extended into block 9 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included partly cloudy skies, 5 km to unlimited visibility (with glare and haze), and Beaufort 0-4 sea states. Sea ice cover was 0-75% broken floe in the area surveyed. Sightings bowhead whales, one bearded seal, small unidentified pinnipeds, and one polar bear.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
6	7/27/2016 12:15	70.619	144.872	bowhead whale	swim	1	0	6
6	7/27/2016 12:15	70.613	144.863	bowhead whale	swim	1	0	6

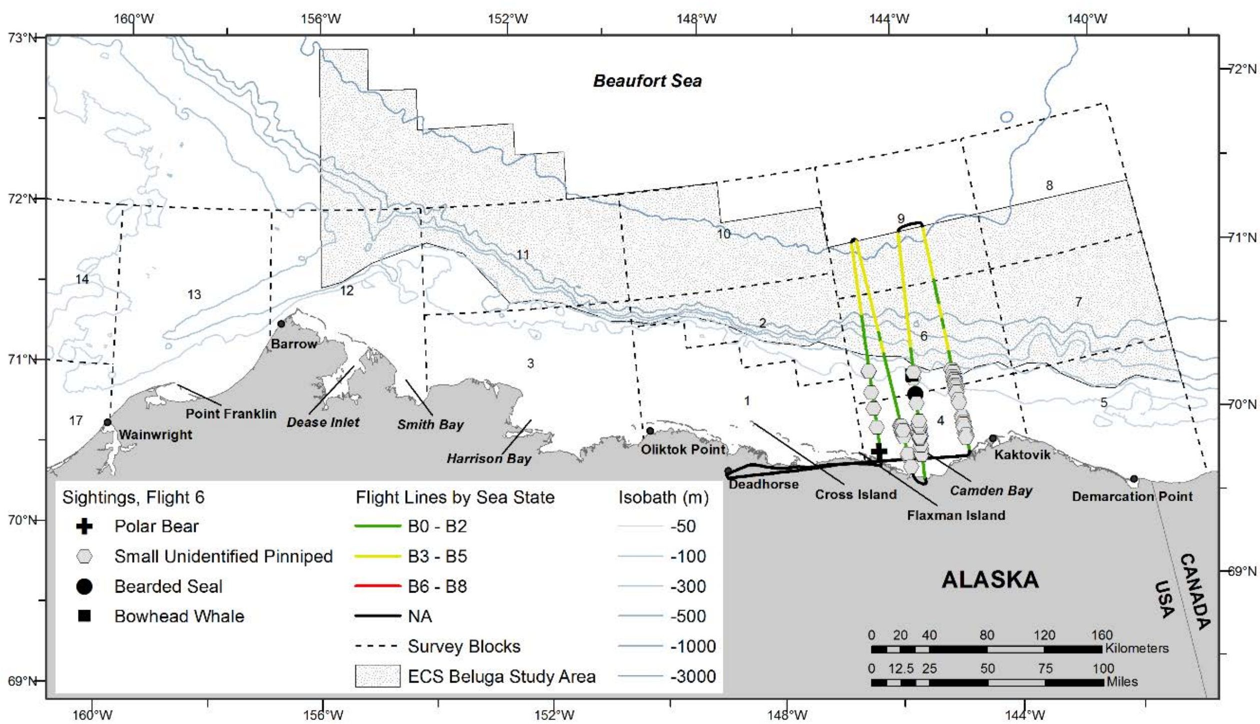

Figure B-21. ASAMM Flight 6 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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29 July 2016, Flight 216

Flight was a complete survey of transects 3 and 8, and partial survey of transects 1, 5, and 6. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, precipitation, and low ceilings), and Beaufort 1-5 sea states. Sea ice cover was 4-80% broken floe in the area surveyed. Sightings included gray whales (including one calf), walruses, bearded seals, unidentified pinnipeds (including one carcass), small unidentified pinnipeds, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
216	7/29/2016 14:35	71.022	158.412	gray whale	swim	2	1	13

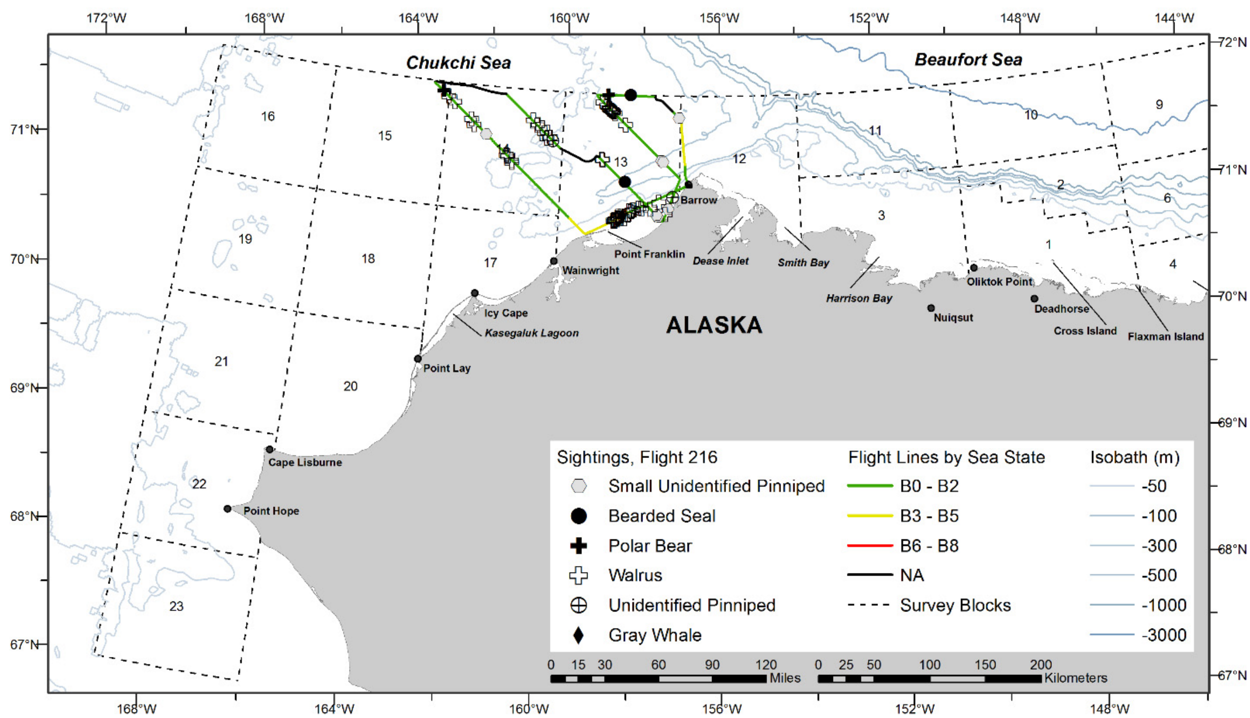


Figure B-22. ASAMM Flight 216 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

29 July 2016, Flight 7

Flight was a survey of portions of block 5 and a coastal search survey from approximately 142.5ºW to 148ºW. Survey conditions included overcast skies, 0-10 km visibility (with low ceilings and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-55% broken floe in the area surveyed. Sightings included bowhead whales (including one calf), belugas (including five calves), and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
7	7/29/2016 12:15	69.965	140.140	beluga	swim	2	1	5
7	7/29/2016 12:16	69.976	140.097	bowhead whale	swim	1	0	5
7	7/29/2016 12:18	69.981	140.162	bowhead whale	swim	2	1	5
7	7/29/2016 12:23	70.022	140.155	beluga	swim	1	0	5
7	7/29/2016 12:32	70.300	140.139	beluga	swim	3	0	5
7	7/29/2016 12:32	70.302	140.140	beluga	swim	2	0	5
7	7/29/2016 12:32	70.304	140.140	beluga	swim	1	0	5
7	7/29/2016 12:45	70.444	140.828	beluga	swim	1	0	5
7	7/29/2016 12:45	70.437	140.774	beluga	swim	1	0	5
7	7/29/2016 12:45	70.434	140.879	beluga	swim	1	0	5
7	7/29/2016 12:46	70.429	140.843	beluga	swim	1	0	5
7	7/29/2016 12:46	70.429	140.835	beluga	swim	1	0	5
7	7/29/2016 12:46	70.417	140.879	beluga	swim	1	0	5
7	7/29/2016 12:47	70.379	140.804	beluga	swim	2	1	5
7	7/29/2016 12:47	70.377	140.814	beluga	swim	2	1	5
7	7/29/2016 12:47	70.372	140.815	beluga	swim	1	1	5
7	7/29/2016 12:47	70.368	140.826	beluga	swim	2	1	5
7	7/29/2016 12:50	70.284	140.789	bowhead whale	swim	1	0	5

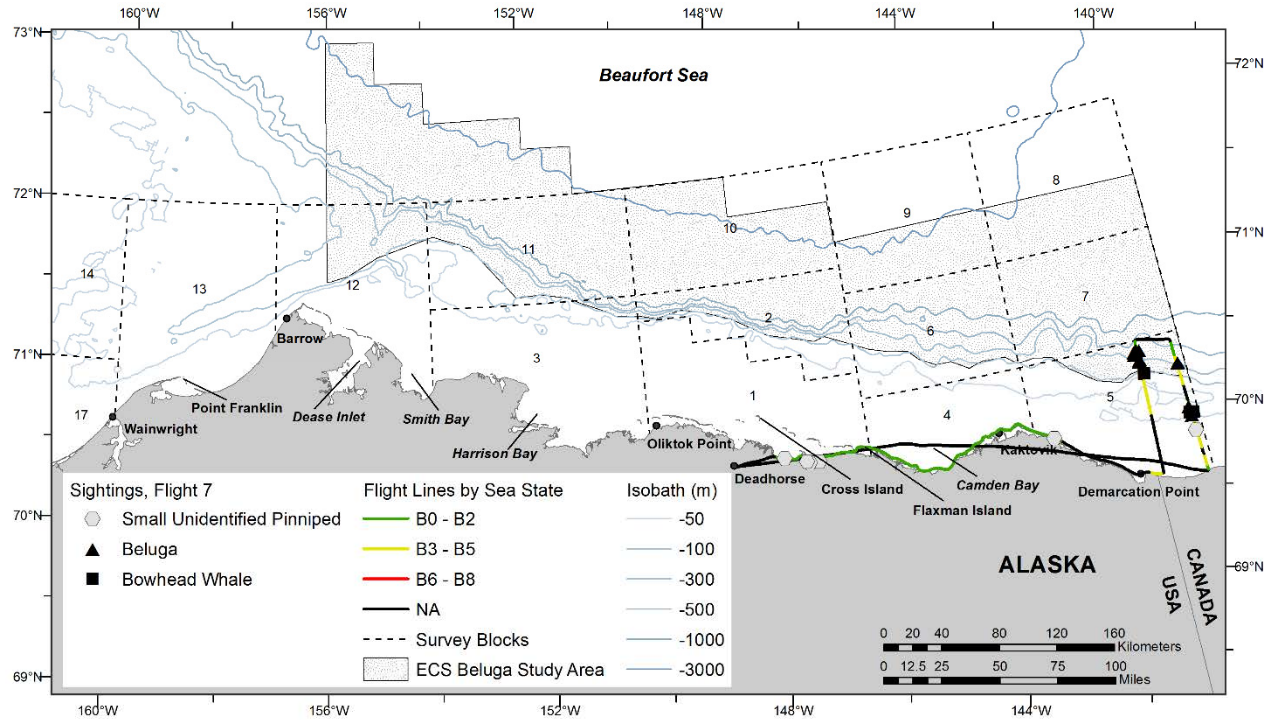


Figure B-23. ASAMM Flight 7 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

30 July 2016, Flight 8

Flight was a survey of portions of blocks 4, 5, 6, 7, 8, and 9. Transects extended into blocks 8 and 9 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with fog, glare, haze, low ceilings, and precipitation), and Beaufort 1-6 sea states. Sea ice cover was 0-77% broken floe in the area surveyed. Sightings included bowhead whales (including four calves), belugas (including 21 calves), one unidentified cetacean, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
8	7/30/2016 10:59	70.527	140.190	beluga	swim	1	0	7
8	7/30/2016 10:59	70.534	140.206	beluga	swim	1	0	7
8	7/30/2016 11:00	70.566	140.206	beluga	swim	1	0	7
8	7/30/2016 11:59	70.538	140.811	beluga	swim	2	0	7
8	7/30/2016 11:59	70.535	140.831	beluga	swim	1	0	7
8	7/30/2016 11:59	70.533	140.818	beluga	swim	2	0	7
8	7/30/2016 11:59	70.526	140.812	beluga	swim	1	0	7
8	7/30/2016 11:59	70.523	140.815	beluga	swim	1	0	7
8	7/30/2016 11:59	70.521	140.869	beluga	swim	1	0	7
8	7/30/2016 11:59	70.518	140.869	beluga	swim	3	0	7
8	7/30/2016 11:59	70.513	140.820	beluga	swim	1	0	7
8	7/30/2016 11:59	70.513	140.781	beluga	swim	1	0	7
8	7/30/2016 11:59	70.509	140.821	beluga	swim	5	0	7
8	7/30/2016 12:04	70.343	140.770	unid cetacean	swim	1	0	5
8	7/30/2016 12:08	70.321	140.870	bowhead whale	swim	1	0	5
8	7/30/2016 12:10	70.331	140.902	bowhead whale	swim	1	0	5
8	7/30/2016 12:30	69.729	140.882	beluga	swim	12	0	5
8	7/30/2016 12:30	69.724	140.882	beluga	swim	5	0	5
8	7/30/2016 12:39	69.695	141.299	beluga	swim	3	0	5
8	7/30/2016 12:51	70.099	141.233	bowhead whale	swim	1	0	5
8	7/30/2016 12:55	70.136	141.246	bowhead whale	swim	1	0	5
8	7/30/2016 13:03	70.329	141.313	bowhead whale	breach	1	0	5
8	7/30/2016 13:08	70.366	141.216	beluga	swim	1	0	5
8	7/30/2016 13:09	70.386	141.243	bowhead whale	swim	1	1	5
8	7/30/2016 13:14	70.426	141.259	beluga	swim	2	0	5
8	7/30/2016 13:14	70.432	141.217	beluga	swim	5	0	5
8	7/30/2016 13:15	70.450	141.255	beluga	swim	2	1	5
8	7/30/2016 13:15	70.464	141.252	beluga	swim	1	0	5
8	7/30/2016 13:16	70.477	141.230	beluga	swim	1	0	5
8	7/30/2016 13:16	70.479	141.226	beluga	swim	2	1	5
8	7/30/2016 13:16	70.490	141.227	beluga	swim	1	0	5

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
8	7/30/2016 13:16	70.496	141.203	beluga	swim	1	0	5
8	7/30/2016 13:21	70.657	141.209	beluga	swim	2	0	7
8	7/30/2016 13:23	70.708	141.226	beluga	swim	6	1	7
8	7/30/2016 13:23	70.709	141.239	beluga	swim	1	0	7
8	7/30/2016 13:23	70.713	141.227	beluga	swim	3	1	7
8	7/30/2016 13:34	71.125	141.187	beluga	swim	2	1	7
8	7/30/2016 16:25	70.330	142.639	bowhead whale	swim	1	0	5
8	7/30/2016 16:35	70.622	142.693	beluga	swim	2	1	7
8	7/30/2016 16:35	70.630	142.697	beluga	swim	1	0	7
8	7/30/2016 16:36	70.644	142.698	beluga	swim	2	0	7
8	7/30/2016 16:37	70.678	142.685	beluga	swim	2	0	7
8	7/30/2016 16:37	70.688	142.709	beluga	swim	2	0	7
8	7/30/2016 16:38	70.708	142.677	beluga	swim	2	0	7
8	7/30/2016 17:28	70.887	143.378	beluga	swim	2	1	6
8	7/30/2016 17:28	70.873	143.375	beluga	swim	2	1	6
8	7/30/2016 17:28	70.862	143.362	beluga	swim	1	0	6
8	7/30/2016 17:29	70.826	143.330	beluga	swim	1	0	6
8	7/30/2016 17:30	70.823	143.354	beluga	swim	2	1	6
8	7/30/2016 17:30	70.820	143.394	beluga	swim	1	0	6
8	7/30/2016 17:30	70.818	143.349	beluga	swim	2	1	6
8	7/30/2016 17:31	70.784	143.394	beluga	swim	1	0	6
8	7/30/2016 17:34	70.691	143.313	beluga	swim	2	0	6
8	7/30/2016 17:34	70.671	143.336	beluga	swim	1	0	6
8	7/30/2016 17:34	70.666	143.350	beluga	swim	5	1	6
8	7/30/2016 17:34	70.665	143.353	beluga	swim	2	1	6
8	7/30/2016 17:35	70.661	143.375	beluga	swim	17	0	6
8	7/30/2016 17:35	70.659	143.371	beluga	swim	2	0	6
8	7/30/2016 17:35	70.656	143.366	beluga	mill	2	1	6
8	7/30/2016 17:39	70.505	143.402	bowhead whale	swim	2	1	6
8	7/30/2016 17:40	70.502	143.399	bowhead whale	swim	2	1	6
8	7/30/2016 17:40	70.506	143.431	bowhead whale	swim	2	1	6
8	7/30/2016 17:41	70.516	143.419	bowhead whale	swim	1	0	6
8	7/30/2016 18:16	70.594	143.902	bowhead whale	swim	1	0	6
8	7/30/2016 18:18	70.653	143.902	beluga	swim	3	2	6
8	7/30/2016 18:18	70.655	143.907	beluga	swim	2	1	6
8	7/30/2016 18:18	70.657	143.903	beluga	swim	2	1	6
8	7/30/2016 18:19	70.674	143.824	beluga	swim	1	0	6
8	7/30/2016 18:24	70.847	143.913	beluga	swim	9	2	6
8	7/30/2016 18:25	70.854	143.905	beluga	swim	1	0	6
8	7/30/2016 18:31	71.001	143.892	bowhead whale	swim	2	0	6
8	7/30/2016 18:36	71.018	143.833	beluga	swim	2	1	6

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
8	7/30/2016 18:39	71.122	143.832	beluga	swim	1	0	6
8	7/30/2016 18:39	71.128	143.819	beluga	swim	2	0	6
8	7/30/2016 18:39	71.129	143.804	beluga	swim	2	1	6
8	7/30/2016 18:40	71.137	143.832	beluga	swim	5	0	6
8	7/30/2016 18:40	71.144	143.796	beluga	swim	1	0	6
8	7/30/2016 18:40	71.147	143.796	beluga	swim	6	0	6

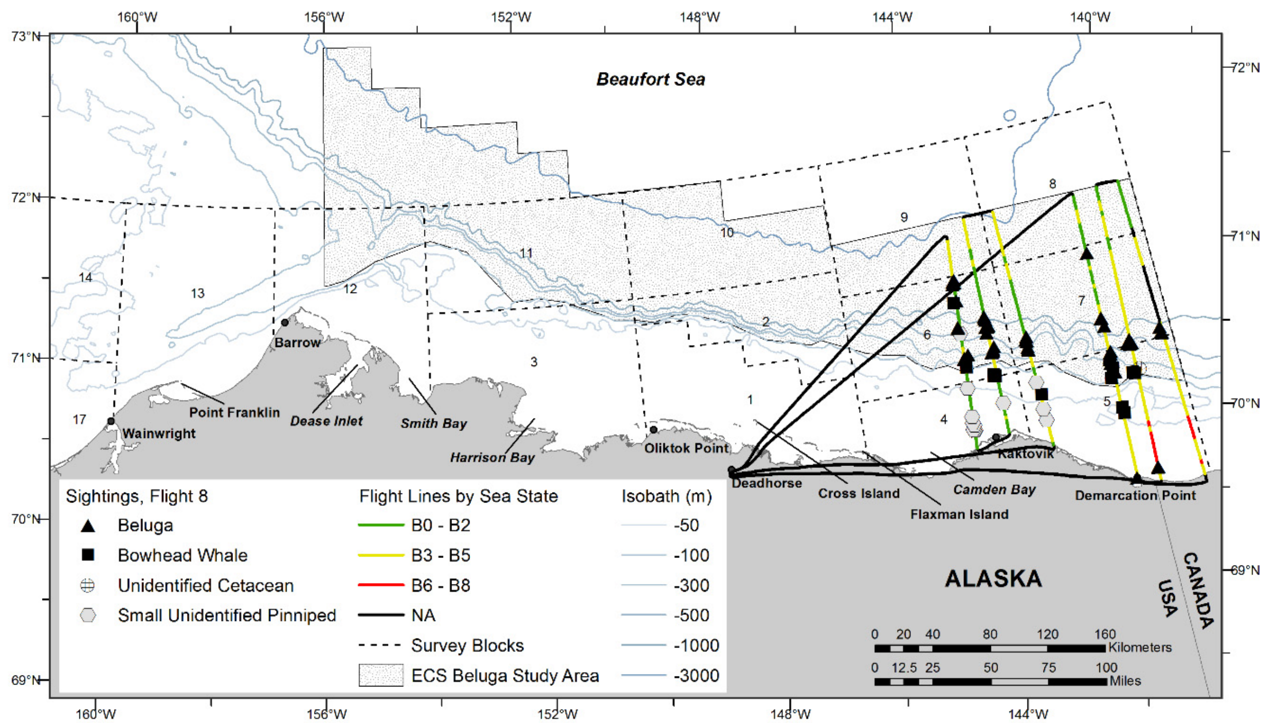


Figure B-24. ASAMM Flight 8 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

31 July 2016, Flight 9

Flight was a survey of portions of blocks 5 and 7. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, haze, and low ceilings), and Beaufort 2-6 sea states. Sea ice cover was 0-90% broken floe in the area surveyed. Sightings included bowhead whales (including five calves), belugas (including one calf), and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
9	7/31/2016 14:04	70.159	141.654	bowhead whale	head slap	1	1	5
9	7/31/2016 14:48	70.869	142.320	beluga	swim	1	0	7
9	7/31/2016 14:48	70.865	142.308	beluga	swim	1	0	7
9	7/31/2016 14:48	70.862	142.321	beluga	swim	1	0	7
9	7/31/2016 14:48	70.858	142.305	beluga	swim	2	1	7
9	7/31/2016 15:10	70.158	142.309	bowhead whale	swim	1	0	5
9	7/31/2016 15:13	70.139	142.336	bowhead whale	swim	2	1	5
9	7/31/2016 15:16	70.133	142.305	bowhead whale	swim	1	1	5
9	7/31/2016 15:18	70.108	142.274	bowhead whale	swim	1	1	5
9	7/31/2016 15:20	70.090	142.284	bowhead whale	swim	1	0	5
9	7/31/2016 15:22	70.033	142.274	bowhead whale	swim	1	1	5

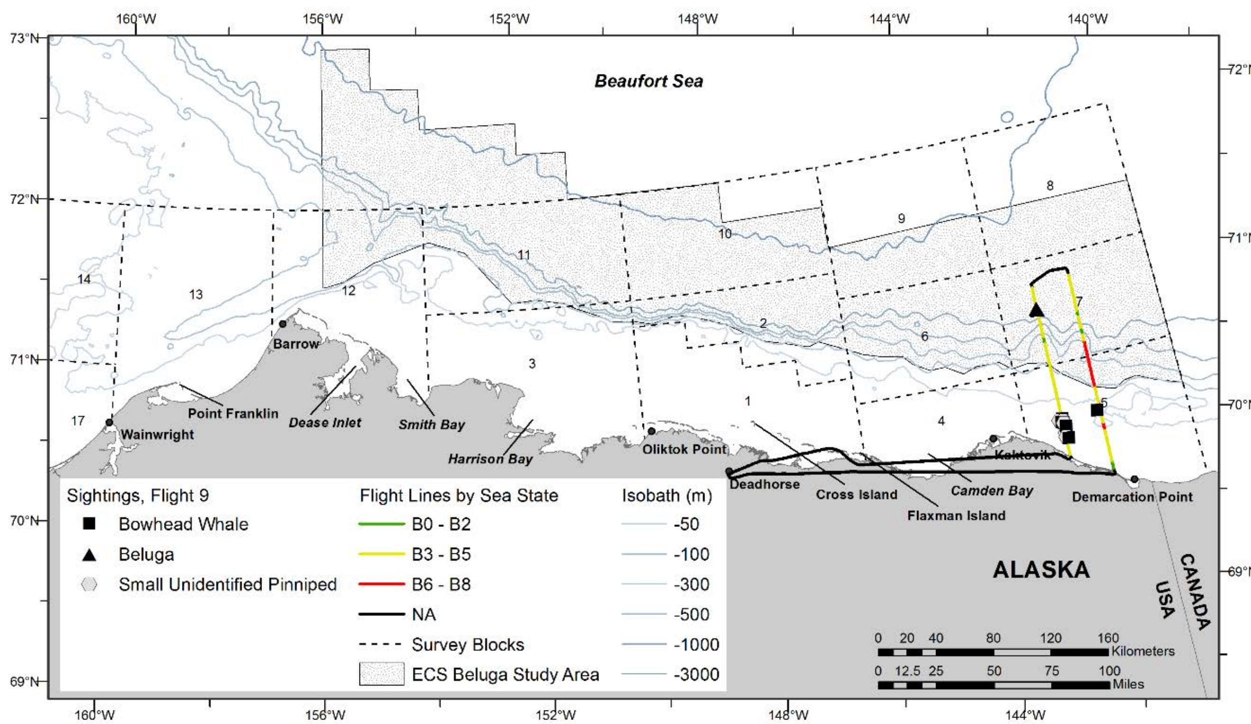


Figure B-25. ASAMM Flight 9 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

2 August 2016, Flight 217

Flight was a survey of the coastal transect from south of Point Hope to Barrow. Survey conditions included overcast skies, <1 km to unlimited visibility (with low ceilings and precipitation), and Beaufort 2-5 sea states. Sea ice cover was 0-60% broken floe in the area surveyed. Sightings included one unidentified cetacean carcass, one walrus, and small unidentified pinnipeds. The unidentified cetacean carcass was previously documented during ASAMM Flight 202 and 213, and was resighted during Flight 240.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
217	8/2/2016 17:03	70.653	160.034	unid cetacean	dead	1	0	17

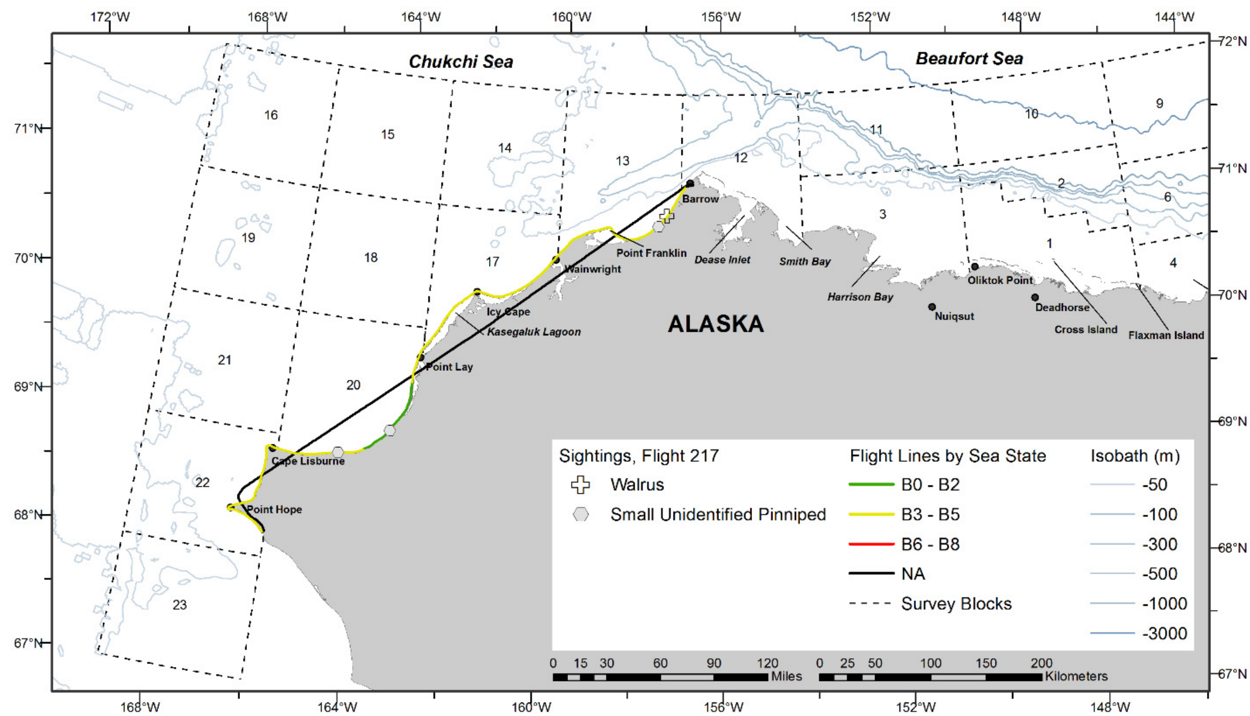


Figure B-26. ASAMM Flight 217 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

2 August 2016, Flight 10

Flight was a survey of portions of blocks 3 and 11. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, and low ceilings), and Beaufort 2-7 sea states. Sea ice cover was 0-83% broken floe in the area surveyed. Sightings included bowhead whales (including one calf), one bearded seal, and one small unidentified pinniped.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
10	8/2/2016 14:24	70.755	149.869	bowhead whale	swim	1	0	1
10	8/2/2016 14:24	70.768	149.881	bowhead whale	swim	1	0	1
10	8/2/2016 14:32	70.898	150.575	bowhead whale	swim	2	1	3
10	8/2/2016 16:02	71.120	153.336	bowhead whale	rest	1	0	3
10	8/2/2016 17:39	70.935	151.334	bowhead whale	swim	1	0	3

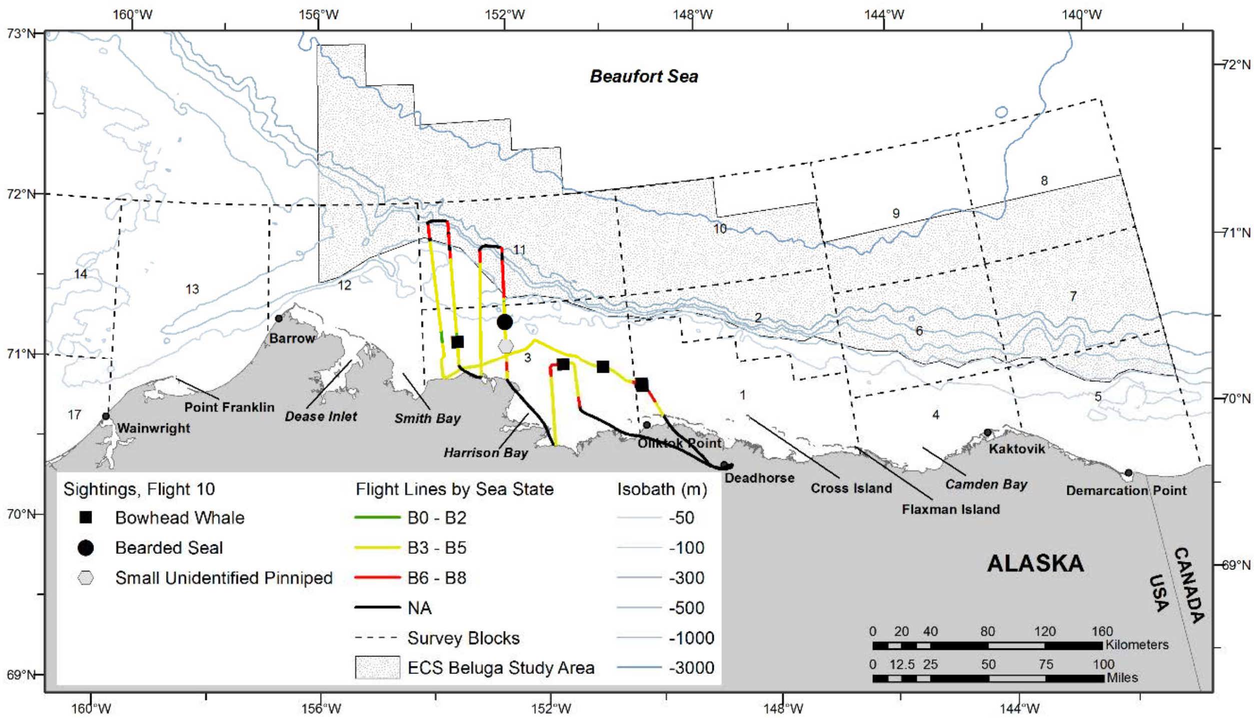


Figure B-27. ASAMM Flight 10 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

3 August 2016, Flight 218

Flight was a complete survey of transects 16 and 18. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-3 sea states. Sea ice cover was 0-1% broken floe in the area surveyed. Sightings included belugas, one walrus carcass, unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
218	8/3/2016 12:47	69.983	164.058	beluga	swim	2	0	20

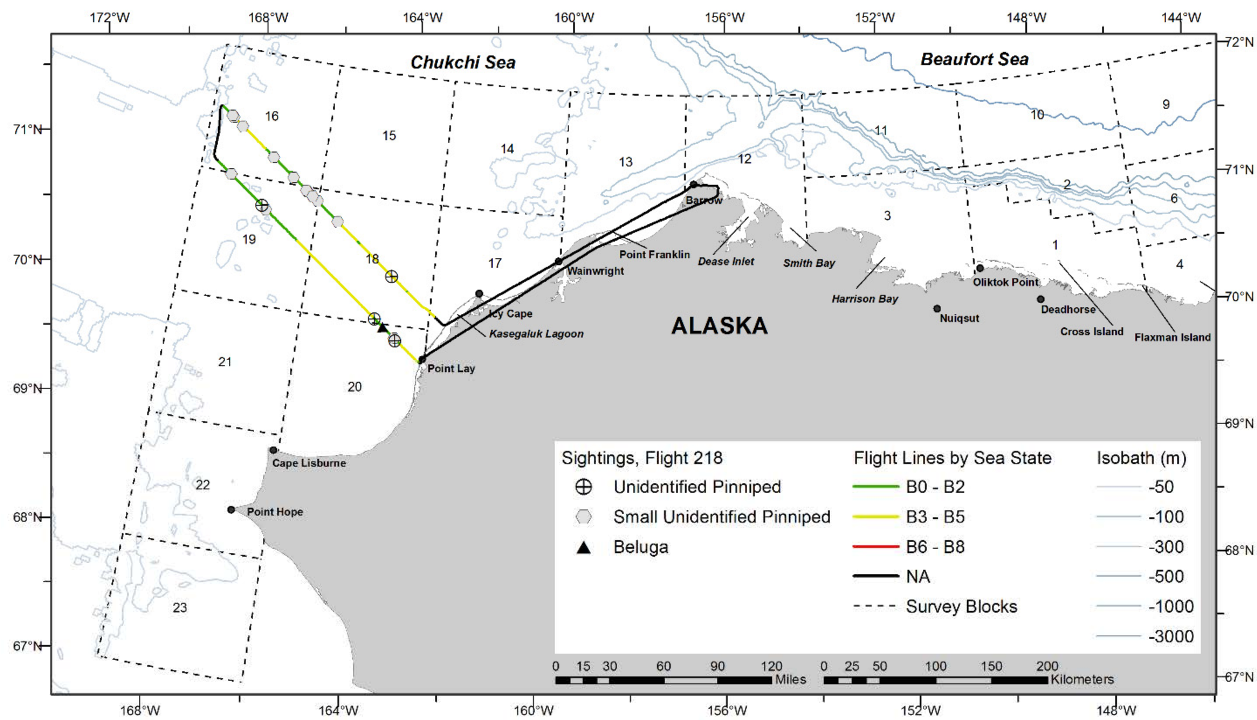


Figure B-28. ASAMM Flight 218 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

3 August 2016, Flight 11

Flight was a survey of portions of block 12. Survey conditions included partly cloudy skies, 0-3 km visibility (with low ceilings), and Beaufort 3 sea state. Sea ice cover was 0-5% broken floe in the area surveyed. No sightings were observed.

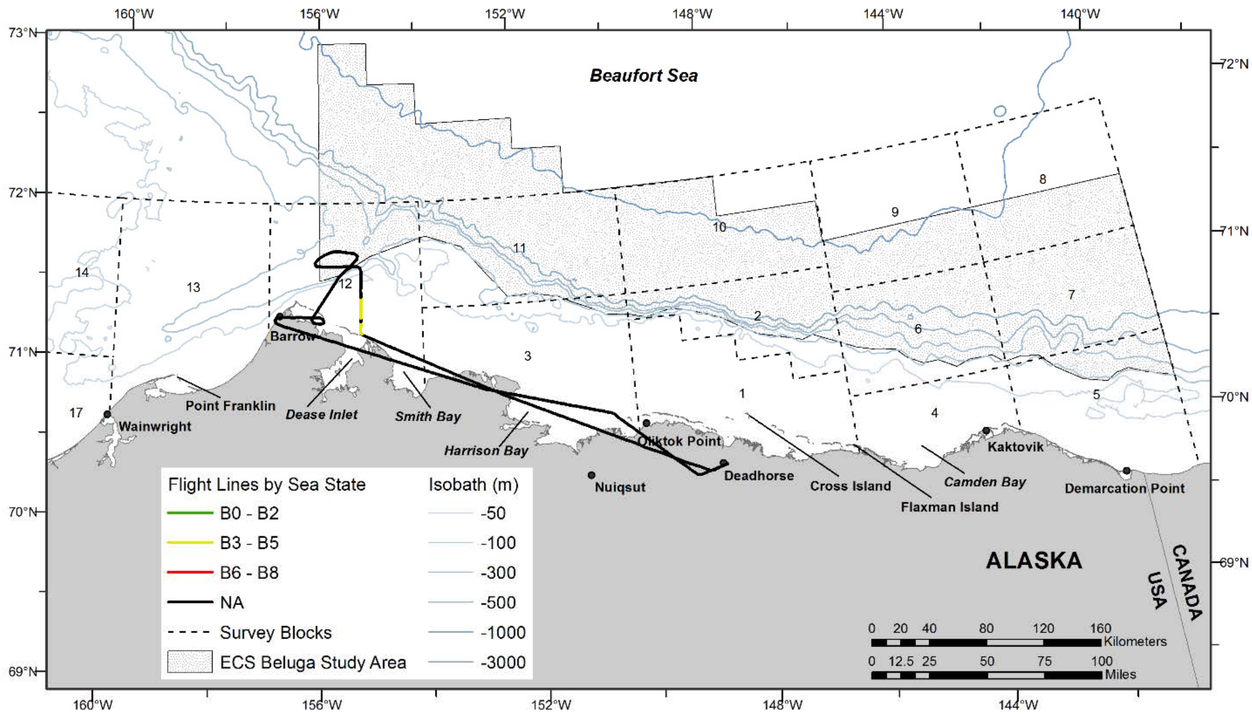


Figure B-29. ASAMM Flight 11 survey track, depicted by sea state.

5 August 2016, Flight 219

Flight was a complete survey of transects 29, 30, 31, 32, 37, 38, and 39, and partial survey of transects 33 and 36. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare), and Beaufort 1-5 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including seven calves and one carcass), fin whales (including one calf), humpback whales, minke whales, harbor porpoises, unidentified cetaceans, three walrus carcasses, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
219	8/5/2016 11:37	68.880	166.780	gray whale	swim	1	0	22
219	8/5/2016 11:44	68.862	167.445	gray whale	dead	1	0	22
219	8/5/2016 11:51	68.874	167.936	unid cetacean	swim	1	0	22
219	8/5/2016 12:13	68.688	168.304	fin whale	swim	4	1	22
219	8/5/2016 12:15	68.689	168.323	minke whale	swim	1	0	22
219	8/5/2016 12:23	68.713	168.032	harbor porpoise	swim	1	0	22
219	8/5/2016 12:30	68.714	167.434	unid cetacean	swim	1	0	22
219	8/5/2016 12:34	68.709	166.994	harbor porpoise	swim	1	0	22
219	8/5/2016 12:36	68.712	166.807	minke whale	swim	1	0	22
219	8/5/2016 12:58	68.542	166.660	harbor porpoise	rest	1	0	22
219	8/5/2016 13:14	68.541	168.221	harbor porpoise	swim	1	0	22
219	8/5/2016 13:15	68.549	168.323	minke whale	swim	1	0	22
219	8/5/2016 13:19	68.543	168.367	harbor porpoise	swim	1	0	22
219	8/5/2016 13:32	68.309	168.405	unid cetacean	swim	2	0	22
219	8/5/2016 13:34	68.347	168.346	fin whale	swim	1	0	22
219	8/5/2016 13:36	68.303	168.263	fin whale	swim	1	0	22
219	8/5/2016 13:44	68.348	168.129	gray whale	swim	1	0	22
219	8/5/2016 13:45	68.358	168.087	unid cetacean	swim	1	0	22
219	8/5/2016 13:46	68.312	168.117	humpback whale	swim	4	0	22
219	8/5/2016 13:49	68.299	168.163	gray whale	swim	10	1	22
219	8/5/2016 13:52	68.306	168.108	fin whale	swim	3	0	22
219	8/5/2016 13:53	68.308	168.077	humpback whale	swim	1	0	22
219	8/5/2016 13:54	68.299	168.043	harbor porpoise	swim	2	0	22
219	8/5/2016 13:56	68.318	168.086	gray whale	swim	1	0	22
219	8/5/2016 13:56	68.330	168.079	gray whale	swim	3	1	22
219	8/5/2016 13:56	68.324	168.099	harbor porpoise	rest	1	0	22
219	8/5/2016 14:01	68.373	167.946	gray whale	swim	2	1	22
219	8/5/2016 14:02	68.371	167.902	minke whale	swim	1	0	22
219	8/5/2016 14:02	68.332	167.862	humpback whale	swim	4	0	22
219	8/5/2016 14:04	68.335	167.841	fin whale	swim	1	0	22
219	8/5/2016 14:06	68.341	167.862	minke whale	dive	1	0	22

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
219	8/5/2016 14:08	68.372	167.714	gray whale	swim	2	1	22
219	8/5/2016 14:09	68.369	167.707	minke whale	swim	1	0	22
219	8/5/2016 14:09	68.370	167.687	minke whale	swim	3	0	22
219	8/5/2016 14:09	68.371	167.644	gray whale	swim	2	1	22
219	8/5/2016 14:10	68.363	167.732	minke whale	rest	1	0	22
219	8/5/2016 14:12	68.372	167.735	minke whale	swim	1	0	22
219	8/5/2016 14:22	68.373	166.843	minke whale	swim	1	0	22
219	8/5/2016 14:22	68.362	166.830	unid cetacean	swim	2	0	22
219	8/5/2016 14:24	68.349	166.854	gray whale	roll	4	1	22
219	8/5/2016 14:39	68.196	166.356	minke whale	swim	1	0	22
219	8/5/2016 18:24	67.522	168.058	gray whale	swim	2	1	23

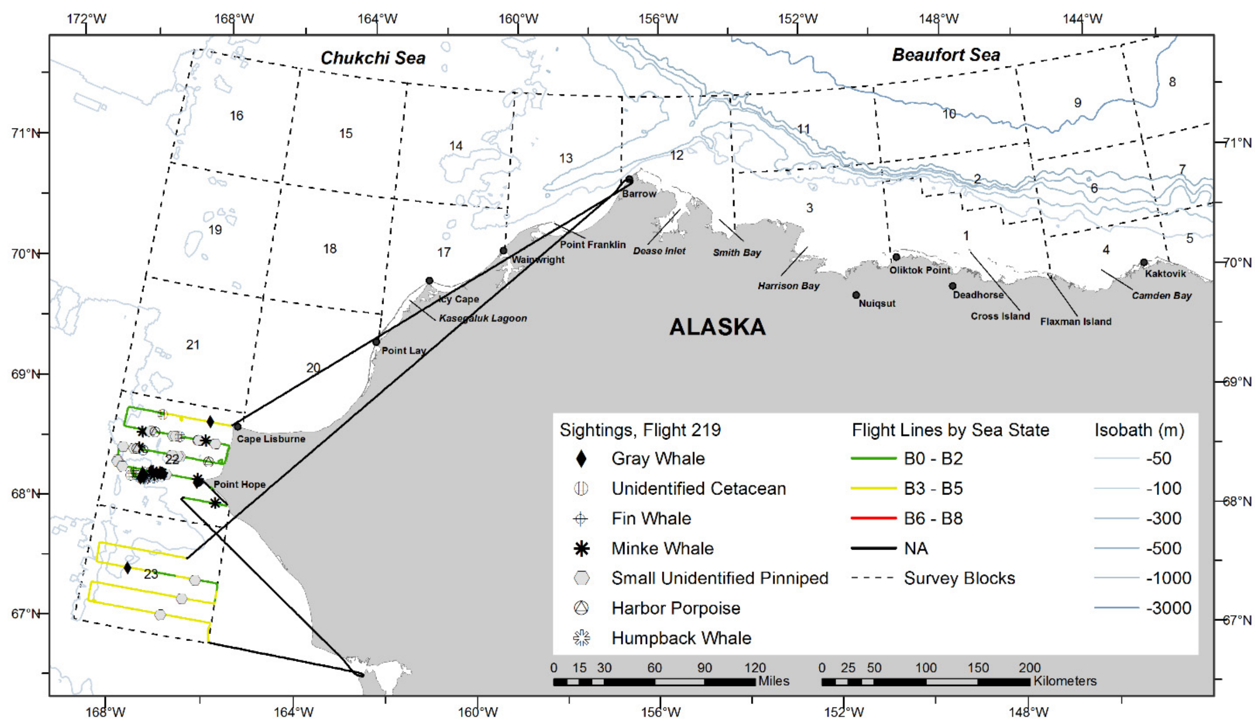
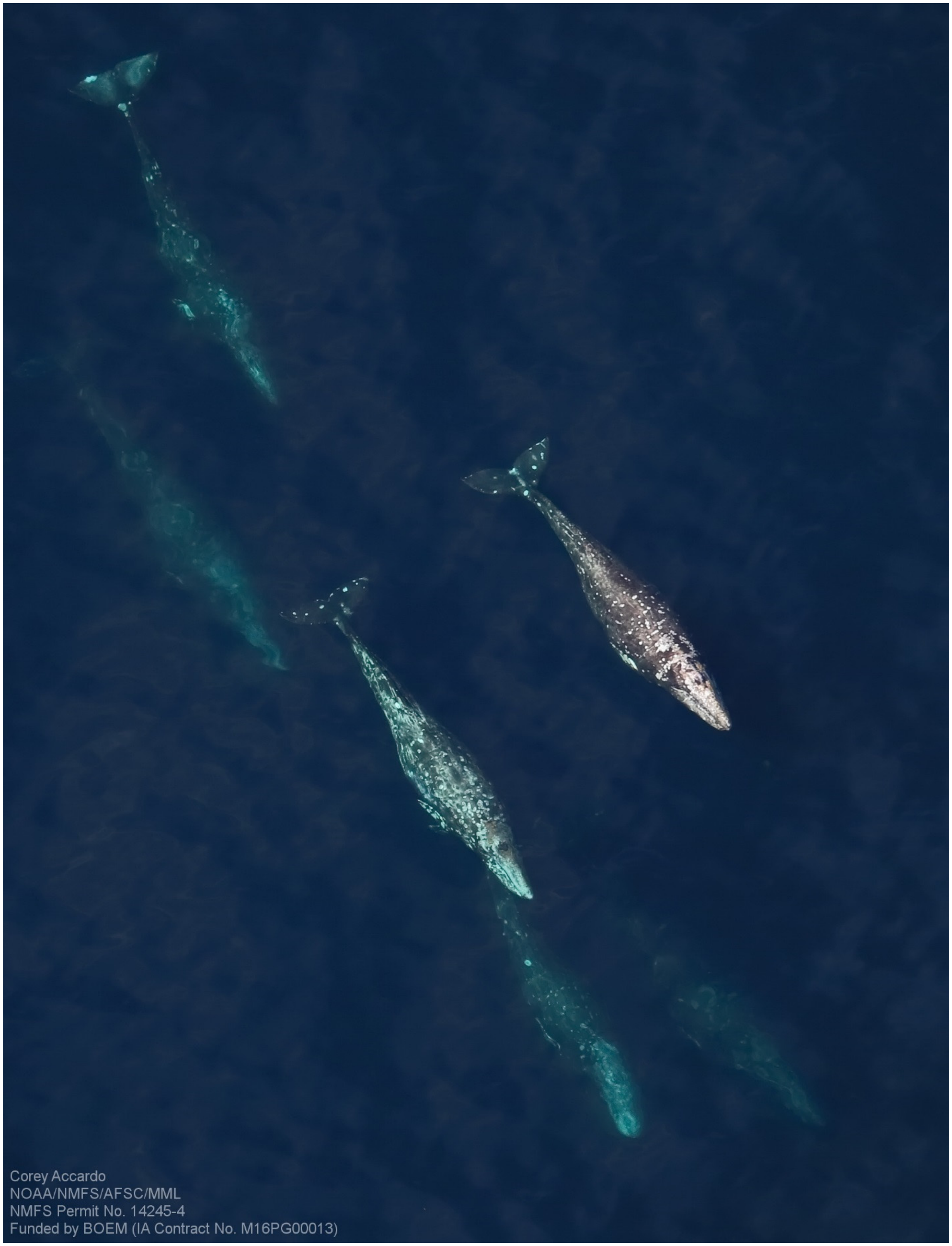


Figure B-30. ASAMM Flight 219 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Fin whale cow-calf pair approximately 90 km west of Cape Lisburne, Alaska, during ASAMM Flight 219, 5 August 2016.

Humpback whale “flying” approximately 50 km west of Point Hope, Alaska, during ASAMM Flight 219, 5 August 2016.



Gray whales traveling approximately 55 km west of Point Hope, Alaska, during ASAMM Flight 219, 5 August 2016.

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5 August 2016, Flight 12

Flight was a survey of portions of block 12 and partial survey of transects 2, 4, and 6. Survey conditions included clear to partly cloudy skies, 5-10 km visibility (with glare and haze), and Beaufort 1-8 sea states. Sea ice cover was 0-80% broken floe in the area surveyed. Sightings included one bowhead whale, belugas (including two calves), walruses, and one bearded seal.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
12	8/5/2016 15:52	71.481	154.127	bowhead whale	swim	1	0	12
12	8/5/2016 16:03	71.787	154.144	beluga	swim	1	0	12
12	8/5/2016 16:06	71.889	154.142	beluga	swim	4	1	12
12	8/5/2016 16:21	71.924	154.652	beluga	rest	5	0	12
12	8/5/2016 17:06	71.663	155.553	beluga	swim	116	0	12
12	8/5/2016 17:07	71.636	155.551	beluga	swim	9	1	12

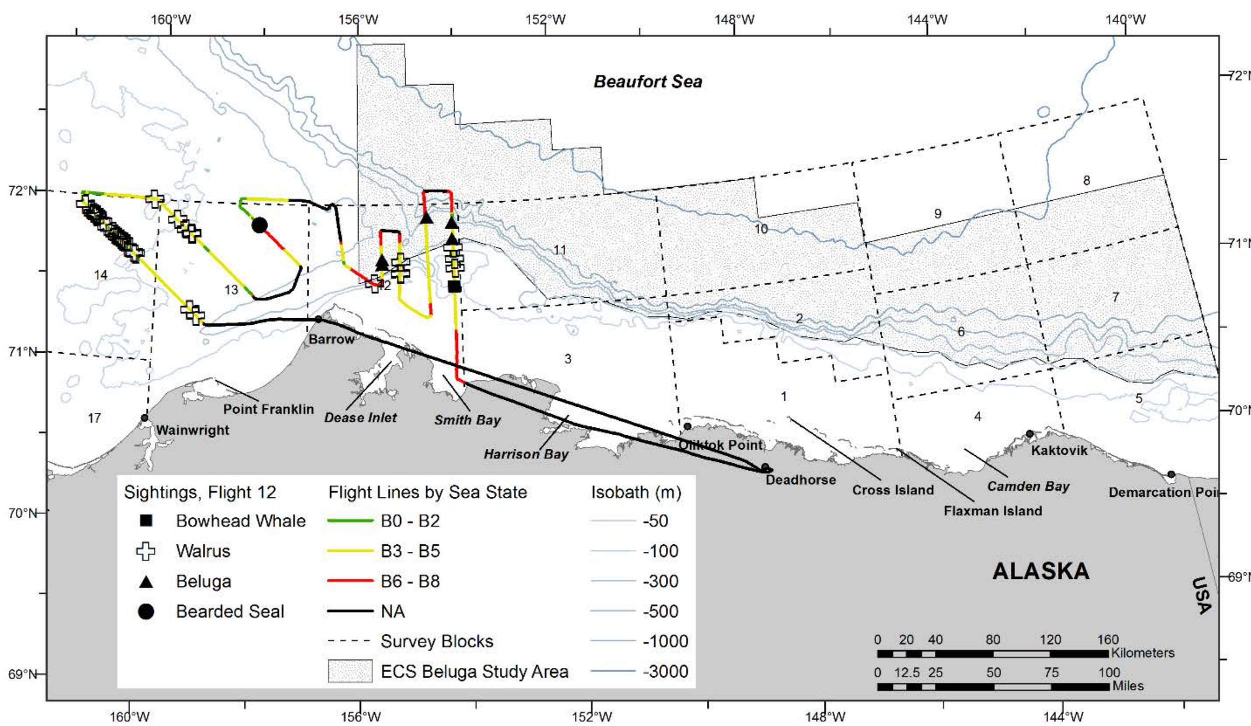


Figure B-31. ASAMM Flight 12 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

6 August 2016, Flight 220

Flight was a partial survey of transects 10 and 12. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 2-5 sea states. Sea ice cover was 0-15% broken floe in the area surveyed. Sightings included gray whales (including 17 calves), unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
220	8/6/2016 15:20	70.900	161.063	gray whale	feed	8	3	17
220	8/6/2016 15:28	70.889	161.019	gray whale	feed	7	2	17
220	8/6/2016 15:33	70.889	160.951	gray whale	feed	5	3	17
220	8/6/2016 15:35	70.885	160.899	gray whale	feed	5	2	17
220	8/6/2016 15:36	70.886	160.822	gray whale	feed	6	2	17
220	8/6/2016 15:42	70.849	160.803	gray whale	feed	7	1	17
220	8/6/2016 15:50	70.856	160.699	gray whale	feed	9	4	17
220	8/6/2016 16:01	70.760	160.469	gray whale	dive	1	0	17
220	8/6/2016 16:22	70.830	158.948	gray whale	feed	1	0	13
220	8/6/2016 16:25	70.858	158.899	gray whale	feed	1	0	13

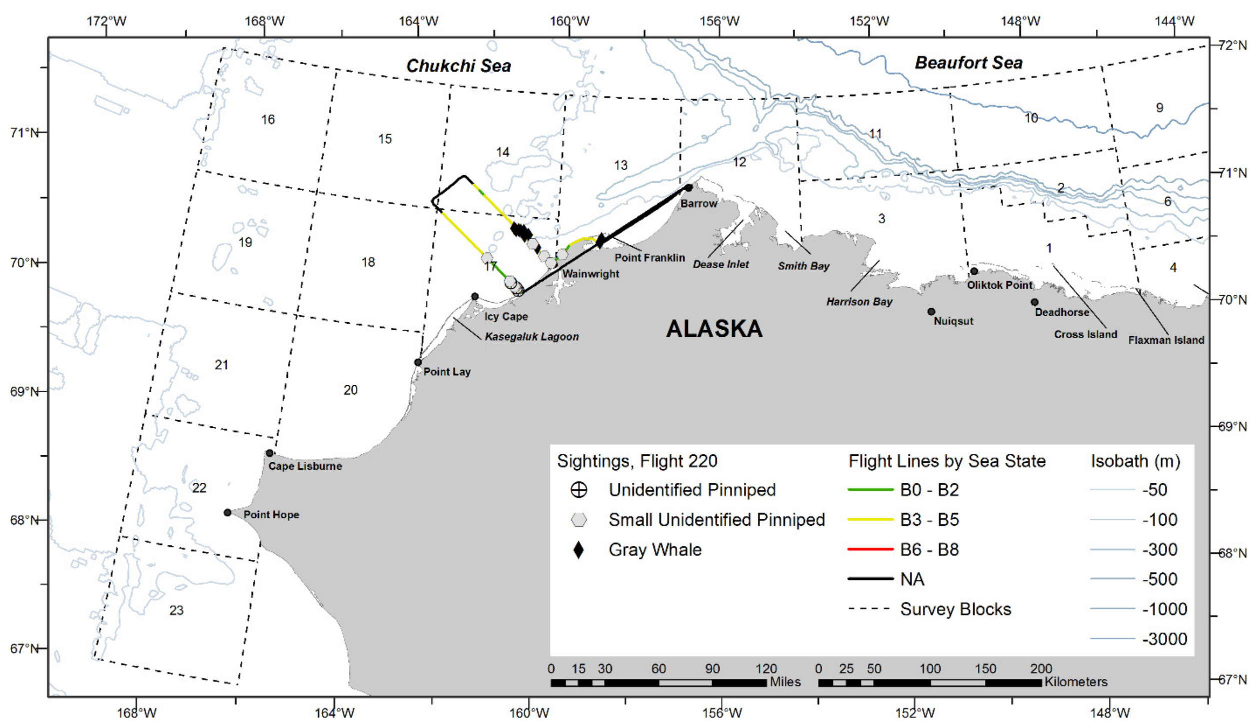


Figure B-32. ASAMM Flight 220 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale cow-calf pair sighted approximately 50 km northeast of Wainwright, Alaska, during ASAMM Flight 220, 6 August 2016.

One of two gray whales observed feeding within Peard Bay (south of Point Franklin), Alaska, during ASAMM Flight 220, 6 August 2016. These sightings represent ASAMM's first records of gray whales in Peard Bay.

6 August 2016, Flight 13

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

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
13	8/6/2016 12:49	70.445	146.369	bowhead whale	rest	1	0	1
13	8/6/2016 12:49	70.455	146.371	bowhead whale	rest	1	0	1
13	8/6/2016 12:50	70.452	146.350	bowhead whale	rest	1	0	1
13	8/6/2016 12:52	70.448	146.342	bowhead whale	rest	1	0	1
13	8/6/2016 12:56	70.575	146.213	unid cetacean	unknown	1	0	1
13	8/6/2016 13:04	70.590	146.370	bowhead whale	swim	1	0	1
13	8/6/2016 13:09	70.699	146.367	bowhead whale	swim	1	0	2
13	8/6/2016 13:21	70.988	146.375	beluga	swim	9	0	2
13	8/6/2016 14:08	70.398	147.200	bowhead whale	swim	1	0	1
13	8/6/2016 14:09	70.400	147.181	bowhead whale	swim	1	0	1
13	8/6/2016 14:09	70.410	147.202	bowhead whale	rest	1	0	1
13	8/6/2016 14:11	70.388	147.170	bowhead whale	rest	1	0	1
13	8/6/2016 14:14	70.417	147.169	bowhead whale	rest	1	0	1
13	8/6/2016 14:16	70.422	147.251	bowhead whale	rest	1	0	1
13	8/6/2016 14:16	70.430	147.268	bowhead whale	swim	1	0	1
13	8/6/2016 14:18	70.441	147.299	bowhead whale	swim	1	0	1
13	8/6/2016 14:21	70.496	147.195	bowhead whale	swim	1	0	1
13	8/6/2016 14:30	70.768	147.233	bowhead whale	swim	2	1	1
13	8/6/2016 14:56	70.720	147.799	bowhead whale	swim	1	0	1
13	8/6/2016 15:02	70.536	147.726	bowhead whale	swim	1	0	1
13	8/6/2016 15:03	70.506	147.719	bowhead whale	swim	1	0	1
13	8/6/2016 15:03	70.503	147.777	bowhead whale	swim	1	0	1
13	8/6/2016 15:06	70.496	147.765	bowhead whale	rest	1	0	1
13	8/6/2016 15:06	70.496	147.760	bowhead whale	swim	1	0	1
13	8/6/2016 15:09	70.478	147.738	bowhead whale	swim	4	0	1
13	8/6/2016 15:35	70.568	148.323	bowhead whale	swim	1	0	1
13	8/6/2016 15:35	70.570	148.269	bowhead whale	rest	1	0	1
13	8/6/2016 15:35	70.585	148.225	bowhead whale	swim	2	1	1
13	8/6/2016 15:36	70.601	148.263	bowhead whale	swim	1	0	1
13	8/6/2016 15:38	70.610	148.308	bowhead whale	swim	1	0	1
13	8/6/2016 15:38	70.612	148.317	bowhead whale	swim	1	0	1
13	8/6/2016 15:39	70.621	148.293	bowhead whale	swim	1	0	1
13	8/6/2016 15:50	71.002	148.320	bowhead whale	swim	1	0	2
13	8/6/2016 16:23	70.762	148.768	bowhead whale	swim	1	0	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
13	8/6/2016 16:24	70.757	148.804	bowhead whale	swim	1	0	1
13	8/6/2016 16:24	70.755	148.823	bowhead whale	swim	1	0	1
13	8/6/2016 16:24	70.738	148.811	bowhead whale	swim	1	0	1
13	8/6/2016 16:24	70.736	148.777	bowhead whale	swim	1	0	1
13	8/6/2016 16:24	70.727	148.703	bowhead whale	tail slap	1	0	1
13	8/6/2016 16:25	70.713	148.737	bowhead whale	swim	1	0	1
13	8/6/2016 16:26	70.715	148.711	bowhead whale	swim	1	0	1
13	8/6/2016 16:28	70.725	148.728	bowhead whale	swim	1	0	1
13	8/6/2016 16:29	70.724	148.766	bowhead whale	swim	1	0	1
13	8/6/2016 16:29	70.724	148.779	bowhead whale	swim	1	0	1
13	8/6/2016 16:29	70.701	148.793	bowhead whale	swim	1	0	1
13	8/6/2016 16:30	70.674	148.809	bowhead whale	swim	1	0	1
13	8/6/2016 16:31	70.664	148.824	bowhead whale	swim	1	0	1
13	8/6/2016 16:31	70.654	148.814	bowhead whale	swim	1	0	1
13	8/6/2016 16:31	70.653	148.862	bowhead whale	swim	1	0	1
13	8/6/2016 16:31	70.649	148.829	bowhead whale	swim	1	0	1
13	8/6/2016 16:31	70.639	148.833	bowhead whale	swim	1	0	1
13	8/6/2016 16:32	70.635	148.810	bowhead whale	swim	1	0	1
13	8/6/2016 16:32	70.619	148.870	bowhead whale	swim	1	0	1

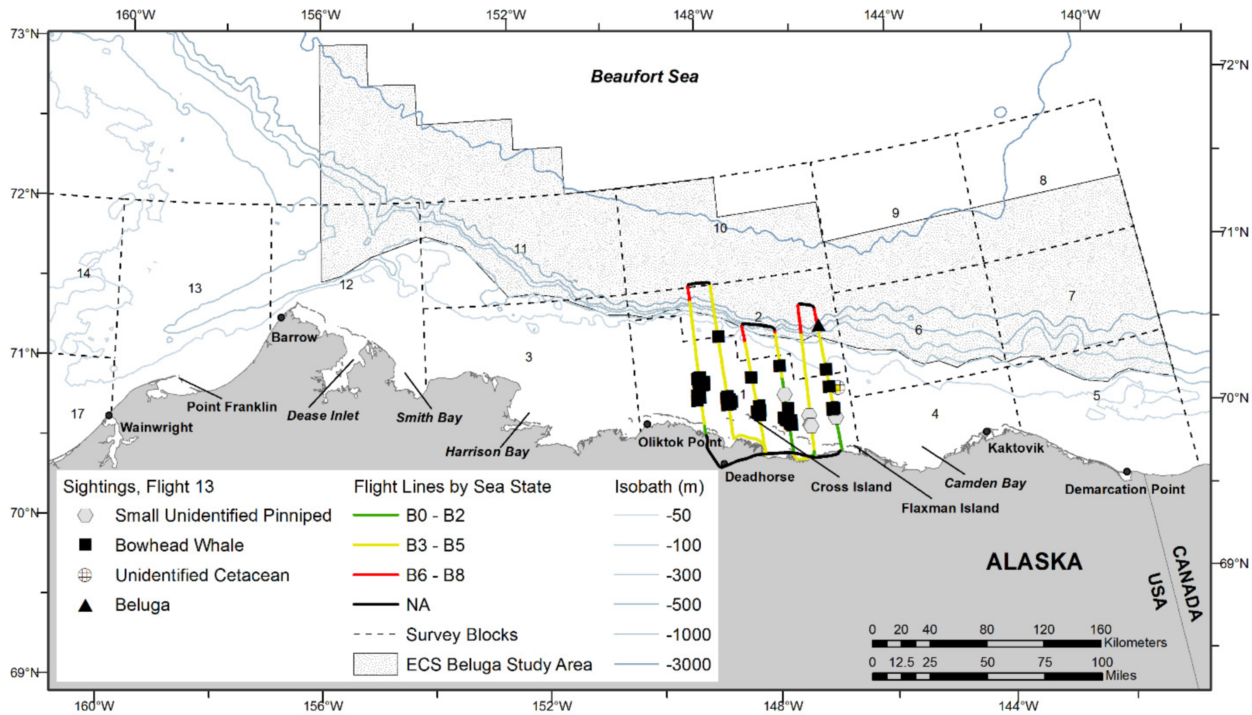


Figure B-33. ASAMM Flight 13 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

7 August 2016, Flight 221

Flight was a complete survey of transects 11 and 14. Survey conditions included partly cloudy skies, unlimited visibility (with glare), and Beaufort 2-5 sea states. Sea ice cover was 0-40% broken floe in the area surveyed. Sightings included bowhead whales, gray whales (including two calves), two walrus carcasses, and one small unidentified pinniped.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
221	8/7/2016 11:08	71.685	167.638	gray whale	feed	2	1	16
221	8/7/2016 11:58	71.920	165.810	bowhead whale	rest	2	0	15
221	8/7/2016 12:04	71.969	165.738	bowhead whale	swim	6	0	15
221	8/7/2016 12:12	71.941	165.805	bowhead whale	swim	1	0	15
221	8/7/2016 12:12	71.933	165.816	bowhead whale	rest	1	0	15
221	8/7/2016 13:09	70.764	161.168	gray whale	feed	2	1	17
221	8/7/2016 13:10	70.738	161.110	gray whale	feed	1	0	17
221	8/7/2016 13:11	70.755	161.061	gray whale	feed	3	0	17

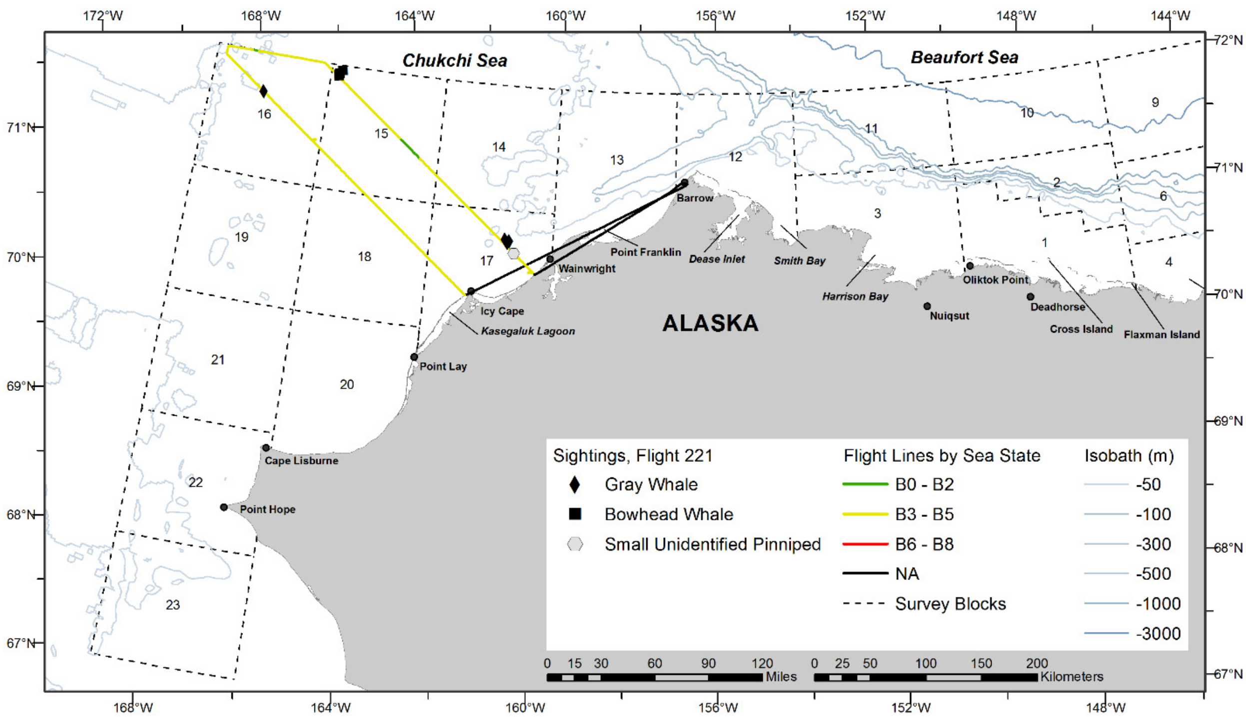


Figure B-34. ASAMM Flight 221 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whales sighted approximately 325 km northwest of Barrow, Alaska, during ASAMM Flight 221, 7 August 2016.

7 August 2016, Flight 14

Flight was a survey of portions of blocks 1, 2, 3, 4, 6, 9, 10, and 11. Transects extended into blocks 9 and 10 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. 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 0-10% broken floe in the area surveyed. Sightings included bowhead whales (including three calves), belugas (including 13 calves), one unidentified cetacean, one bearded seal, small unidentified pinnipeds, and one polar bear.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	8/7/2016 10:20	70.797	149.400	bowhead whale	swim	1	0	1
14	8/7/2016 10:24	70.786	149.244	bowhead whale	mill	2	0	1
14	8/7/2016 10:25	70.785	149.220	bowhead whale	swim	2	0	1
14	8/7/2016 10:27	70.781	149.195	bowhead whale	swim	1	0	1
14	8/7/2016 10:28	70.756	149.200	bowhead whale	swim	1	0	1
14	8/7/2016 10:47	71.329	149.287	beluga	swim	13	0	2
14	8/7/2016 10:47	71.339	149.288	beluga	swim	1	0	10
14	8/7/2016 10:48	71.352	149.377	beluga	swim	1	0	10
14	8/7/2016 10:48	71.357	149.327	beluga	swim	2	0	10
14	8/7/2016 10:49	71.408	149.278	beluga	swim	1	0	10
14	8/7/2016 10:49	71.414	149.291	beluga	swim	2	1	10
14	8/7/2016 10:50	71.431	149.237	beluga	swim	1	0	10
14	8/7/2016 10:50	71.441	149.307	beluga	swim	2	1	10
14	8/7/2016 10:54	71.558	149.286	beluga	rest	1	0	10
14	8/7/2016 10:54	71.578	149.283	beluga	swim	1	0	10
14	8/7/2016 10:55	71.582	149.255	beluga	swim	2	1	10
14	8/7/2016 10:55	71.587	149.240	beluga	swim	1	0	10
14	8/7/2016 11:26	71.553	149.691	beluga	swim	4	1	10
14	8/7/2016 11:26	71.548	149.696	beluga	swim	1	0	10
14	8/7/2016 11:26	71.547	149.659	beluga	swim	1	0	10
14	8/7/2016 11:26	71.543	149.755	beluga	swim	1	0	10
14	8/7/2016 11:26	71.543	149.717	beluga	swim	1	0	10
14	8/7/2016 11:27	71.522	149.711	beluga	swim	1	0	10
14	8/7/2016 11:28	71.477	149.679	beluga	swim	1	0	10
14	8/7/2016 11:31	71.365	149.727	beluga	swim	1	0	10
14	8/7/2016 11:34	71.273	149.717	beluga	swim	14	0	2
14	8/7/2016 11:34	71.272	149.749	beluga	mill	7	0	2
14	8/7/2016 11:35	71.267	149.692	beluga	swim	1	0	2
14	8/7/2016 11:35	71.265	149.690	beluga	swim	1	0	2
14	8/7/2016 11:49	70.783	149.721	bowhead whale	swim	1	0	1
14	8/7/2016 11:50	70.782	149.739	bowhead whale	rest	3	0	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	8/7/2016 11:50	70.778	149.710	bowhead whale	swim	1	0	1
14	8/7/2016 11:50	70.774	149.735	bowhead whale	swim	1	0	1
14	8/7/2016 11:50	70.771	149.701	bowhead whale	swim	1	0	1
14	8/7/2016 11:51	70.770	149.680	bowhead whale	swim	5	0	1
14	8/7/2016 11:52	70.766	149.696	bowhead whale	feed	2	0	1
14	8/7/2016 11:58	70.642	149.764	bowhead whale	swim	1	0	1
14	8/7/2016 11:58	70.631	149.711	bowhead whale	feed	2	0	1
14	8/7/2016 11:58	70.628	149.768	bowhead whale	swim	1	0	1
14	8/7/2016 11:59	70.620	149.822	bowhead whale	swim	1	0	1
14	8/7/2016 11:59	70.617	149.729	bowhead whale	feed	3	0	1
14	8/7/2016 11:59	70.609	149.786	bowhead whale	swim	1	0	1
14	8/7/2016 11:59	70.609	149.717	bowhead whale	feed	2	0	1
14	8/7/2016 12:03	70.623	149.810	bowhead whale	swim	13	0	1
14	8/7/2016 12:22	70.657	150.367	bowhead whale	swim	1	0	3
14	8/7/2016 12:22	70.660	150.388	bowhead whale	swim	1	0	3
14	8/7/2016 12:25	70.651	150.383	bowhead whale	swim	2	1	3
14	8/7/2016 12:29	70.788	150.440	bowhead whale	swim	1	0	3
14	8/7/2016 12:30	70.785	150.454	bowhead whale	swim	1	0	3
14	8/7/2016 12:32	70.767	150.495	bowhead whale	mill	3	0	3
14	8/7/2016 12:34	70.821	150.397	bowhead whale	swim	1	0	3
14	8/7/2016 12:36	70.841	150.462	bowhead whale	swim	1	0	3
14	8/7/2016 12:40	70.925	150.450	bowhead whale	swim	1	0	3
14	8/7/2016 12:40	70.931	150.413	bowhead whale	swim	1	0	3
14	8/7/2016 12:44	71.043	150.459	bowhead whale	swim	1	0	3
14	8/7/2016 13:13	71.959	150.492	beluga	swim	1	0	11
14	8/7/2016 13:13	71.963	150.493	beluga	swim	3	0	11
14	8/7/2016 13:13	71.969	150.466	beluga	swim	1	0	11
14	8/7/2016 13:13	71.970	150.470	beluga	swim	1	0	11
14	8/7/2016 13:13	71.975	150.509	beluga	swim	1	0	11
14	8/7/2016 13:14	71.999	150.484	beluga	swim	1	0	11
14	8/7/2016 13:47	70.932	150.710	bowhead whale	swim	2	0	3
14	8/7/2016 13:48	70.924	150.666	bowhead whale	swim	3	0	3
14	8/7/2016 13:55	70.795	150.696	bowhead whale	swim	1	0	3
14	8/7/2016 13:58	70.677	150.711	bowhead whale	mill	2	0	3
14	8/7/2016 16:02	70.293	144.079	bowhead whale	rest	1	0	4
14	8/7/2016 16:02	70.302	144.041	bowhead whale	swim	1	0	4
14	8/7/2016 16:05	70.299	144.065	bowhead whale	swim	1	0	4
14	8/7/2016 16:05	70.299	144.047	bowhead whale	swim	1	0	4
14	8/7/2016 16:22	70.823	144.308	unid cetacean	unknown	1	0	6
14	8/7/2016 16:30	70.971	144.263	beluga	swim	2	0	6
14	8/7/2016 16:30	70.987	144.240	beluga	swim	3	0	6

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	8/7/2016 16:30	70.989	144.253	beluga	swim	1	0	6
14	8/7/2016 16:30	70.989	144.255	beluga	swim	1	0	6
14	8/7/2016 16:30	70.990	144.233	beluga	swim	1	0	6
14	8/7/2016 16:30	70.997	144.270	beluga	swim	9	0	6
14	8/7/2016 16:35	71.143	144.315	beluga	swim	6	2	6
14	8/7/2016 16:35	71.147	144.304	beluga	swim	5	0	6
14	8/7/2016 16:50	71.110	144.833	beluga	swim	2	0	6
14	8/7/2016 16:51	71.093	144.821	beluga	swim	1	0	6
14	8/7/2016 16:51	71.090	144.843	beluga	swim	1	0	6
14	8/7/2016 16:51	71.086	144.821	beluga	swim	4	2	6
14	8/7/2016 16:51	71.081	144.843	beluga	swim	1	0	6
14	8/7/2016 16:51	71.078	144.835	beluga	swim	1	0	6
14	8/7/2016 16:51	71.075	144.828	beluga	swim	4	1	6
14	8/7/2016 16:51	71.075	144.853	beluga	swim	1	0	6
14	8/7/2016 16:51	71.068	144.827	beluga	swim	1	0	6
14	8/7/2016 16:52	71.046	144.815	beluga	swim	1	0	6
14	8/7/2016 16:53	71.029	144.791	beluga	mill	2	0	6
14	8/7/2016 16:53	71.020	144.802	beluga	swim	2	1	6
14	8/7/2016 17:12	70.409	144.753	bowhead whale	mill	9	0	4
14	8/7/2016 17:12	70.398	144.751	bowhead whale	mill	2	0	4
14	8/7/2016 17:14	70.404	144.730	bowhead whale	swim	2	1	4
14	8/7/2016 17:16	70.393	144.747	bowhead whale	swim	1	0	4
14	8/7/2016 17:32	70.051	144.698	bowhead whale	swim	1	0	4
14	8/7/2016 17:33	70.046	144.774	bowhead whale	feed	2	0	4
14	8/7/2016 17:34	70.055	144.782	bowhead whale	feed	2	0	4
14	8/7/2016 17:42	70.027	144.833	bowhead whale	swim	1	0	4
14	8/7/2016 17:46	70.026	144.745	bowhead whale	feed	2	0	4
14	8/7/2016 17:46	70.030	144.759	bowhead whale	feed	2	0	4
14	8/7/2016 17:57	70.075	145.160	bowhead whale	swim	1	0	4
14	8/7/2016 18:17	70.721	145.137	beluga	swim	4	0	6
14	8/7/2016 18:17	70.729	145.144	beluga	swim	6	0	6
14	8/7/2016 18:17	70.733	145.150	beluga	swim	5	0	6
14	8/7/2016 18:18	70.741	145.133	beluga	swim	5	0	6
14	8/7/2016 18:18	70.757	145.104	beluga	swim	4	0	6
14	8/7/2016 18:20	70.815	145.100	beluga	swim	1	0	6
14	8/7/2016 18:20	70.827	145.096	beluga	swim	6	0	6
14	8/7/2016 18:21	70.855	145.133	beluga	swim	1	0	6
14	8/7/2016 18:22	70.868	145.122	beluga	swim	2	1	6
14	8/7/2016 18:30	71.132	145.061	beluga	swim	1	0	6
14	8/7/2016 18:33	71.241	145.086	beluga	swim	1	0	9
14	8/7/2016 18:33	71.246	145.097	beluga	swim	1	0	9

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	8/7/2016 18:34	71.284	145.050	beluga	swim	1	0	9
14	8/7/2016 18:35	71.312	145.047	beluga	swim	1	0	9
14	8/7/2016 19:05	70.902	145.962	bowhead whale	swim	1	0	6
14	8/7/2016 19:05	70.894	145.952	bowhead whale	swim	1	0	6
14	8/7/2016 19:06	70.902	146.015	beluga	swim	5	2	2
14	8/7/2016 19:08	70.889	146.032	bowhead whale	swim	2	0	2
14	8/7/2016 19:09	70.895	145.949	bowhead whale	swim	2	0	6
14	8/7/2016 19:19	70.564	145.923	bowhead whale	swim	1	0	6
14	8/7/2016 19:27	70.388	145.931	bowhead whale	swim	1	1	4
14	8/7/2016 19:28	70.396	145.923	bowhead whale	swim	2	0	4
14	8/7/2016 19:35	70.390	145.940	bowhead whale	feed	4	0	4
14	8/7/2016 19:35	70.367	145.949	bowhead whale	swim	3	0	4

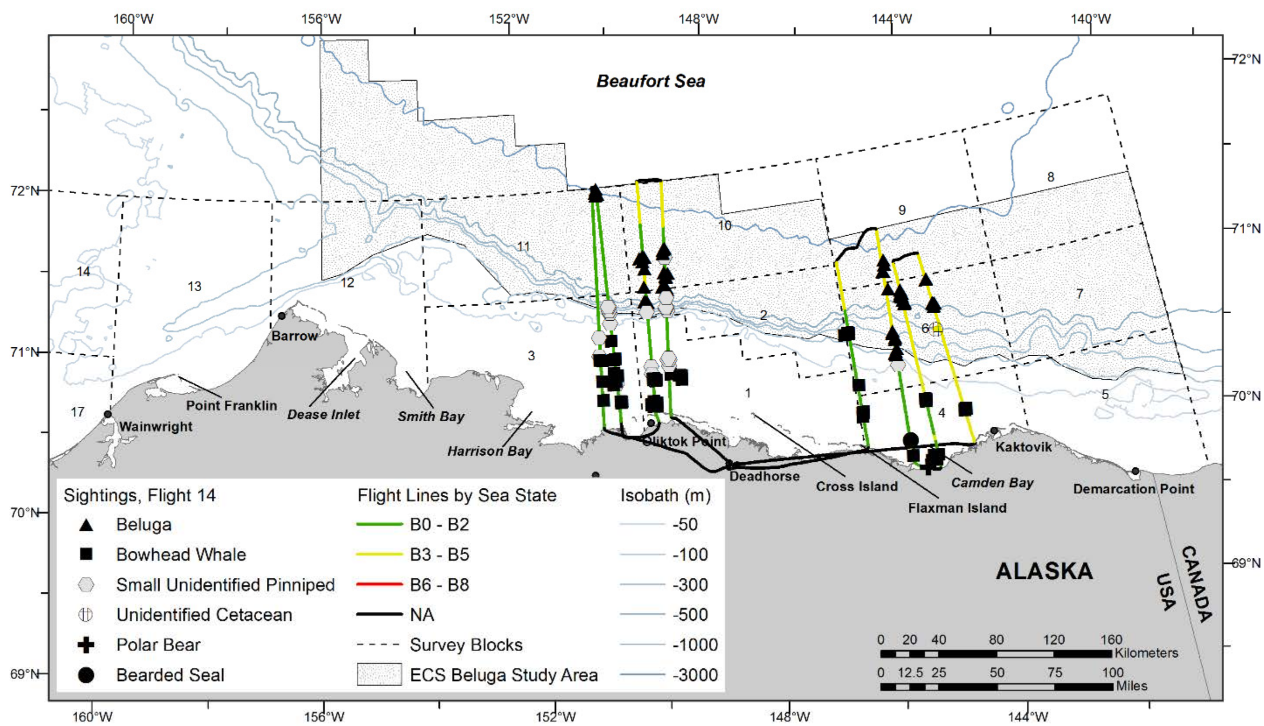


Figure B-35. ASAMM Flight 14 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Surface-feeding bowhead whale sighted approximately 30 km north of Flaxman Island, Alaska, during ASAMM Flight 14, 7 August 2016.

Bowhead whale with mud-covered rostrum sighted approximately 30 km north of Flaxman Island, Alaska, during ASAMM Flight 14, 7 August 2016.

Polar bear sighted on barrier island approximately 30 km west of Kaktovik, Alaska, during ASAMM Flight 14, 7 August 2016.

8 August 2016, 15 Flight

Flight was a survey of portions of blocks 4, 5, and 6. Survey conditions included partly cloudy to overcast skies, 0-10 km 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 four calves), belugas, small unidentified pinnipeds, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
15	8/8/2016 11:49	70.079	142.569	bowhead whale	swim	1	0	5
15	8/8/2016 11:51	70.097	142.530	bowhead whale	feed	1	0	5
15	8/8/2016 11:53	70.094	142.675	bowhead whale	feed	1	0	5
15	8/8/2016 11:54	70.096	142.700	bowhead whale	feed	2	1	5
15	8/8/2016 12:03	70.098	142.659	bowhead whale	feed	3	0	5
15	8/8/2016 12:09	70.148	142.940	bowhead whale	feed	2	1	5
15	8/8/2016 12:09	70.153	142.942	bowhead whale	feed	1	0	5
15	8/8/2016 12:19	70.187	143.152	bowhead whale	swim	6	0	4
15	8/8/2016 12:24	70.201	143.281	bowhead whale	swim	1	0	4
15	8/8/2016 12:24	70.224	143.324	bowhead whale	feed	3	1	4
15	8/8/2016 12:36	70.511	143.338	beluga	swim	1	0	6
15	8/8/2016 12:49	70.233	143.532	bowhead whale	feed	6	0	4
15	8/8/2016 12:50	70.241	143.511	bowhead whale	feed	3	1	4
15	8/8/2016 12:52	70.233	143.534	bowhead whale	feed	2	0	4

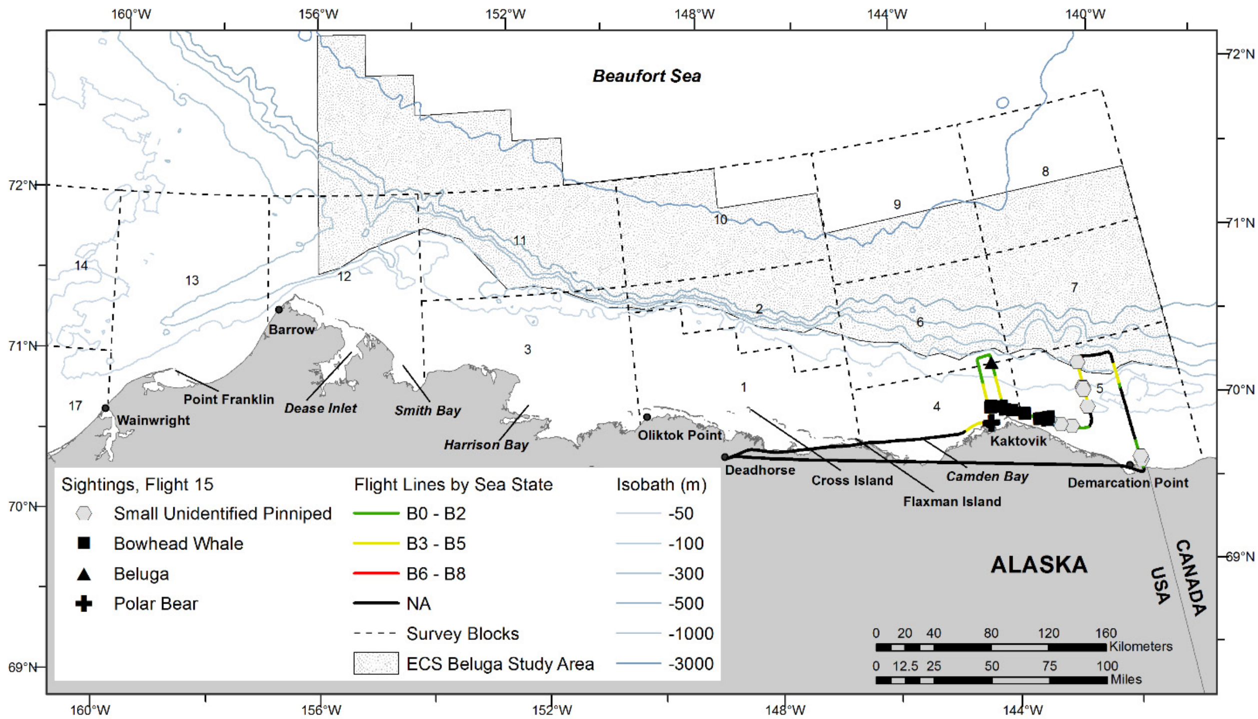


Figure B-36. ASAMM Flight 15 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale cow-calf pair sighted approximately 20 km northeast of Kaktovik, Alaska, during ASAMM Flight 15, 8 August 2016.

15 August 2016, Flight 16

Flight was a coastal search survey from Demarcation 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 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, small unidentified pinnipeds, and polar bears (including three cubs).

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
16	8/15/2016 17:16	70.157	143.136	bowhead whale	feed	4	0	4
16	8/15/2016 17:19	70.151	143.089	bowhead whale	feed	4	0	4

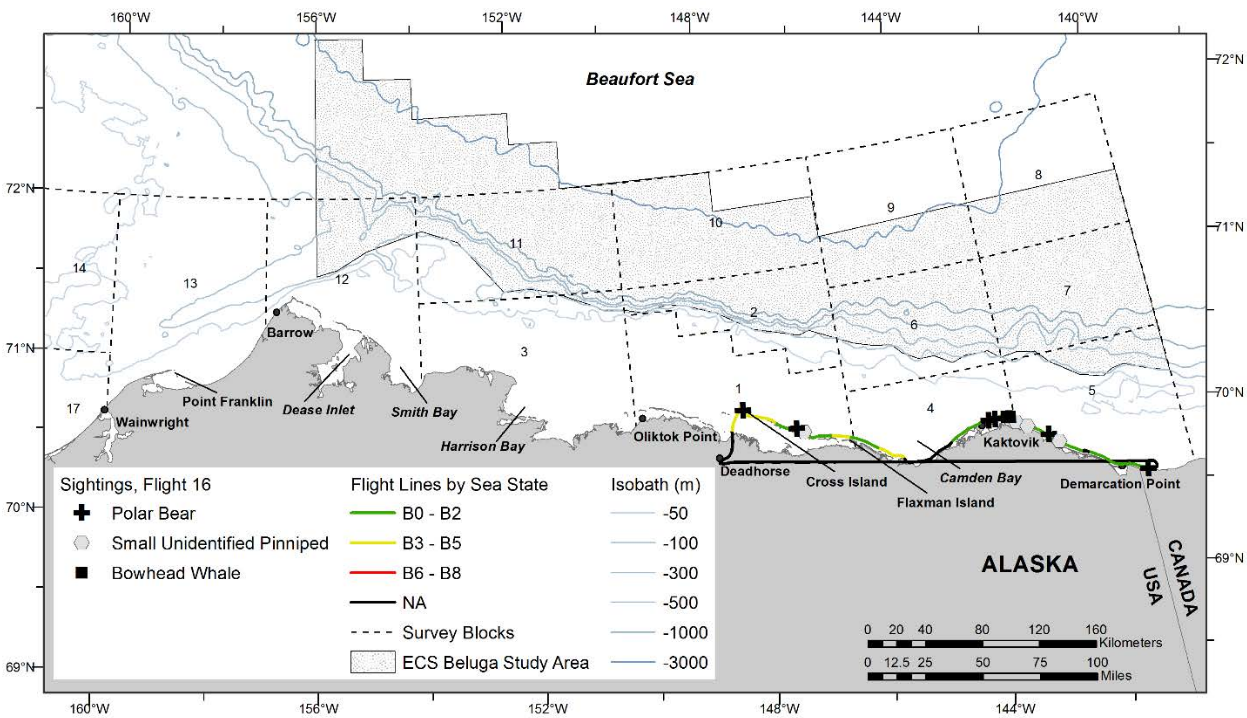


Figure B-37. ASAMM Flight 16 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bears sighted on Cross Island, Alaska, during ASAMM Flight 16, 15 August 2016.

16 August 2016, Flight 222

Flight was a complete survey of transects 3, 5, 7, and 9. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and iced windows), and Beaufort 1-4 sea states. Sea ice cover was 0-80% broken floe in the area surveyed. Sightings included one bowhead whale, gray whales (including one calf), one unidentified cetacean, walruses, unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
222	8/16/2016 14:47	70.871	158.919	gray whale	feed	1	0	13
222	8/16/2016 15:09	70.942	160.352	gray whale	feed	1	0	17
222	8/16/2016 15:16	70.917	160.336	gray whale	feed	1	0	17
222	8/16/2016 15:23	70.949	160.413	gray whale	feed	1	0	17
222	8/16/2016 15:24	70.948	160.381	gray whale	feed	1	0	17
222	8/16/2016 15:35	71.128	161.006	gray whale	feed	2	0	14
222	8/16/2016 15:47	71.230	161.369	gray whale	feed	1	0	14
222	8/16/2016 15:53	71.251	161.418	gray whale	swim	2	1	14
222	8/16/2016 18:08	71.507	159.167	unid cetacean	swim	1	0	13
222	8/16/2016 19:03	71.723	158.187	bowhead whale	swim	1	0	13

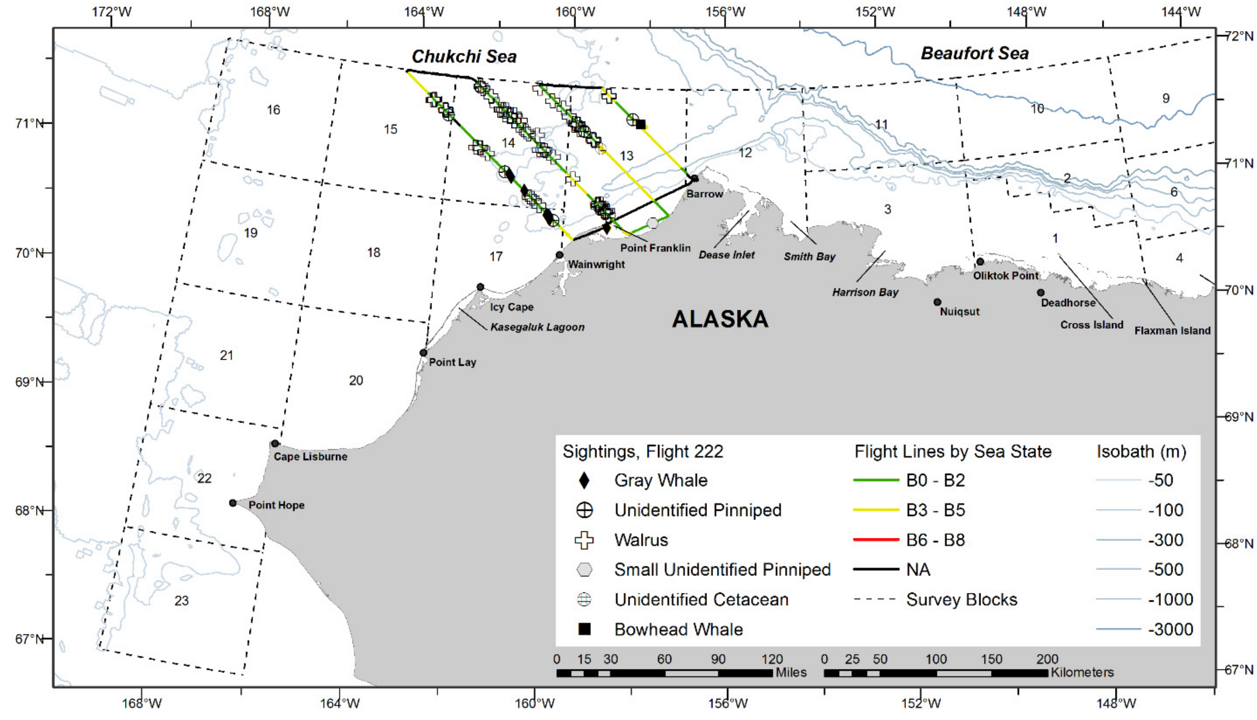


Figure B-38. ASAMM Flight 222 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

17 August 2016, Flight 223

Flight was a partial survey of transects 11, 13, and 15. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, and low ceilings), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included small unidentified pinnipeds.

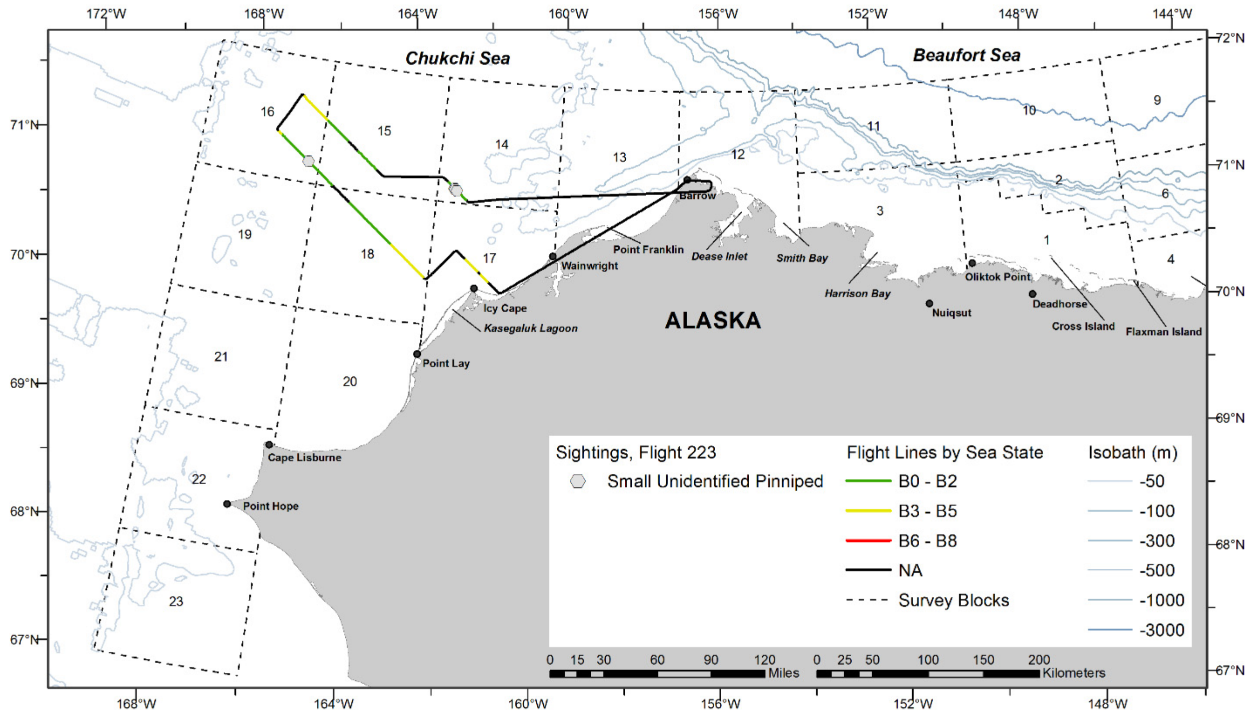


Figure B-39. ASAMM Flight 223 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

17 August 2016, Flight 17

Flight was a survey of portions of blocks 1, 2, 4, 6, 9, and 10. Transects extended into blocks 9 and 10 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included partly cloudy to overcast skies, visibility <1 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 eight calves), belugas (including seven calves), one bearded seal, small unidentified pinnipeds, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
17	8/17/2016 11:09	70.207	143.134	bowhead whale	swim	1	0	4
17	8/17/2016 11:09	70.206	143.078	bowhead whale	swim	1	0	4
17	8/17/2016 11:13	70.215	143.158	bowhead whale	swim	1	0	4
17	8/17/2016 11:14	70.198	143.122	bowhead whale	swim	1	0	4
17	8/17/2016 11:16	70.170	143.127	bowhead whale	swim	1	0	4
17	8/17/2016 11:26	70.228	143.631	bowhead whale	swim	3	0	4
17	8/17/2016 11:37	70.544	143.733	beluga	rest	1	0	6
17	8/17/2016 11:40	70.678	143.721	beluga	swim	4	1	6
17	8/17/2016 11:41	70.682	143.763	beluga	swim	1	0	6
17	8/17/2016 11:53	71.109	143.875	beluga	swim	1	0	6
17	8/17/2016 11:54	71.134	143.847	beluga	swim	2	0	6
17	8/17/2016 12:19	71.194	144.183	beluga	swim	1	0	9
17	8/17/2016 12:19	71.186	144.154	beluga	swim	1	0	9
17	8/17/2016 12:19	71.182	144.189	beluga	swim	2	0	9
17	8/17/2016 12:19	71.176	144.189	beluga	swim	1	0	9
17	8/17/2016 12:19	71.173	144.162	beluga	swim	1	0	9
17	8/17/2016 12:20	71.168	144.192	beluga	swim	2	0	9
17	8/17/2016 12:20	71.160	144.178	beluga	swim	2	0	6
17	8/17/2016 12:20	71.160	144.155	beluga	swim	1	0	6
17	8/17/2016 12:20	71.157	144.154	beluga	swim	1	0	6
17	8/17/2016 12:20	71.145	144.170	beluga	swim	2	0	6
17	8/17/2016 12:21	71.144	144.164	beluga	swim	7	0	6
17	8/17/2016 13:07	70.098	144.902	bowhead whale	feed	16	0	4
17	8/17/2016 13:28	70.348	144.871	bowhead whale	rest	2	1	4
17	8/17/2016 14:06	71.470	144.781	beluga	swim	1	0	9
17	8/17/2016 14:06	71.483	144.781	beluga	swim	1	0	9
17	8/17/2016 14:12	71.463	145.240	beluga	swim	1	0	9
17	8/17/2016 16:59	70.826	149.919	bowhead whale	dive	1	0	1
17	8/17/2016 17:01	70.890	149.905	bowhead whale	mill	2	1	1
17	8/17/2016 17:01	70.891	149.910	bowhead whale	swim	3	0	1
17	8/17/2016 17:04	70.884	149.946	bowhead whale	rest	2	1	1

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
17	8/17/2016 17:05	70.888	149.937	bowhead whale	rest	1	0	1
17	8/17/2016 17:11	70.987	149.898	bowhead whale	swim	1	0	1
17	8/17/2016 17:14	71.053	149.843	bowhead whale	swim	2	0	1
17	8/17/2016 17:14	71.055	149.854	bowhead whale	swim	1	0	1
17	8/17/2016 17:14	71.061	149.863	bowhead whale	rest	2	1	1
17	8/17/2016 17:19	71.122	149.848	bowhead whale	swim	1	0	1
17	8/17/2016 17:20	71.138	149.843	bowhead whale	swim	1	0	1
17	8/17/2016 17:20	71.159	149.811	bowhead whale	swim	1	0	1
17	8/17/2016 17:22	71.158	149.786	bowhead whale	rest	1	0	1
17	8/17/2016 17:22	71.168	149.780	bowhead whale	swim	1	0	2
17	8/17/2016 17:24	71.194	149.845	bowhead whale	rest	2	0	2
17	8/17/2016 17:24	71.197	149.787	bowhead whale	rest	1	0	2
17	8/17/2016 17:24	71.200	149.878	bowhead whale	swim	1	0	2
17	8/17/2016 17:26	71.195	149.863	bowhead whale	rest	1	0	2
17	8/17/2016 17:26	71.194	149.857	bowhead whale	rest	1	0	2
17	8/17/2016 17:26	71.192	149.848	bowhead whale	swim	2	0	2
17	8/17/2016 17:51	71.721	149.174	beluga	swim	1	0	10
17	8/17/2016 17:51	71.706	149.182	beluga	swim	1	0	10
17	8/17/2016 17:52	71.695	149.191	beluga	swim	1	0	10
17	8/17/2016 17:54	71.607	149.199	beluga	swim	1	0	10
17	8/17/2016 17:55	71.601	149.187	beluga	swim	8	5	10
17	8/17/2016 17:55	71.587	149.209	beluga	swim	1	0	10
17	8/17/2016 17:57	71.537	149.164	beluga	swim	3	0	10
17	8/17/2016 18:11	71.067	149.316	bowhead whale	swim	1	0	1
17	8/17/2016 18:18	70.849	149.407	bowhead whale	swim	1	0	1
17	8/17/2016 18:18	70.840	149.347	bowhead whale	swim	1	0	1
17	8/17/2016 18:27	70.727	149.347	bowhead whale	swim	1	0	1
17	8/17/2016 19:00	70.925	148.591	bowhead whale	swim	1	0	1
17	8/17/2016 19:03	70.992	148.641	bowhead whale	swim	1	0	1
17	8/17/2016 19:04	71.035	148.619	bowhead whale	swim	1	0	2
17	8/17/2016 19:06	71.030	148.574	bowhead whale	swim	1	0	2
17	8/17/2016 19:07	71.033	148.585	bowhead whale	mill	2	1	2
17	8/17/2016 19:12	71.160	148.709	bowhead whale	feed	4	0	2
17	8/17/2016 19:12	71.170	148.584	bowhead whale	rest	1	0	2
17	8/17/2016 19:16	71.197	148.570	beluga	swim	3	0	2
17	8/17/2016 19:48	71.254	148.282	bowhead whale	swim	2	1	2
17	8/17/2016 19:57	71.037	148.326	bowhead whale	swim	1	0	2
17	8/17/2016 19:59	70.983	148.349	bowhead whale	swim	1	0	1
17	8/17/2016 20:00	70.931	148.368	bowhead whale	swim	3	1	1
17	8/17/2016 20:00	70.927	148.396	bowhead whale	rest	2	1	1
17	8/17/2016 20:02	70.932	148.359	bowhead whale	mill	2	0	1

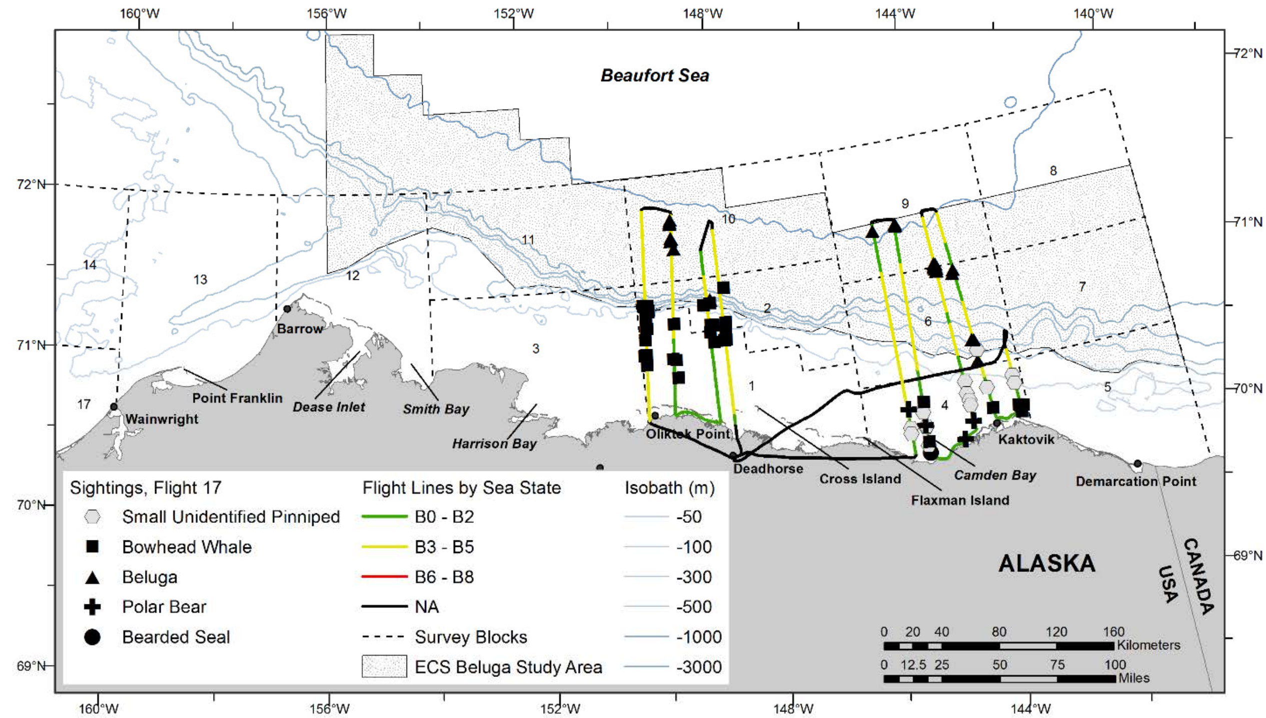


Figure B-40. ASAMM Flight 17 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whales feeding near Camden Bay, Alaska, during ASAMM Flight 17, 17 August 2016.

Bowhead whales feeding in echelon formation near Camden Bay, Alaska, during ASAMM Flight 17, 17 August 2016.

20 August 2016, Flight 224

Flight was a survey of portions of block 12. Transects extended north of block 12 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with glare, iced windows, and precipitation), and Beaufort 2-4 sea states. Sea ice cover was 0-30% broken floe in the area surveyed. Sightings included bowhead whales, belugas (including three calves), walruses (including one carcass), unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
224	8/20/2016 13:34	71.078	154.316	bowhead whale	swim	1	0	12
224	8/20/2016 13:34	71.080	154.323	bowhead whale	swim	1	0	12
224	8/20/2016 13:37	71.074	154.324	bowhead whale	rest	1	0	12
224	8/20/2016 13:40	71.068	154.320	bowhead whale	rest	3	0	12
224	8/20/2016 13:47	71.176	154.284	bowhead whale	swim	2	0	12
224	8/20/2016 13:49	71.160	154.247	bowhead whale	swim	1	0	12
224	8/20/2016 13:50	71.168	154.276	bowhead whale	rest	1	0	12
224	8/20/2016 14:10	71.800	154.299	bowhead whale	swim	1	0	12
224	8/20/2016 14:45	72.714	154.229	beluga	mill	2	0	0
224	8/20/2016 14:45	72.717	154.238	beluga	swim	3	1	0
224	8/20/2016 14:45	72.718	154.227	beluga	swim	3	0	0
224	8/20/2016 15:33	71.216	154.589	bowhead whale	rest	2	0	12
224	8/20/2016 15:38	71.194	154.535	bowhead whale	swim	1	0	12
224	8/20/2016 16:08	71.619	155.388	bowhead whale	swim	1	0	12
224	8/20/2016 16:46	72.761	155.350	beluga	swim	3	0	0
224	8/20/2016 16:50	72.867	155.345	beluga	swim	2	0	0
224	8/20/2016 17:03	72.800	155.814	beluga	swim	5	1	0
224	8/20/2016 17:04	72.789	155.838	beluga	swim	9	0	0
224	8/20/2016 17:04	72.783	155.851	beluga	swim	3	0	0
224	8/20/2016 17:04	72.777	155.824	beluga	swim	4	1	0
224	8/20/2016 17:05	72.764	155.847	beluga	swim	2	0	0
224	8/20/2016 17:40	71.537	155.732	bowhead whale	swim	1	0	12
224	8/20/2016 17:43	71.512	155.757	bowhead whale	feed	1	0	12

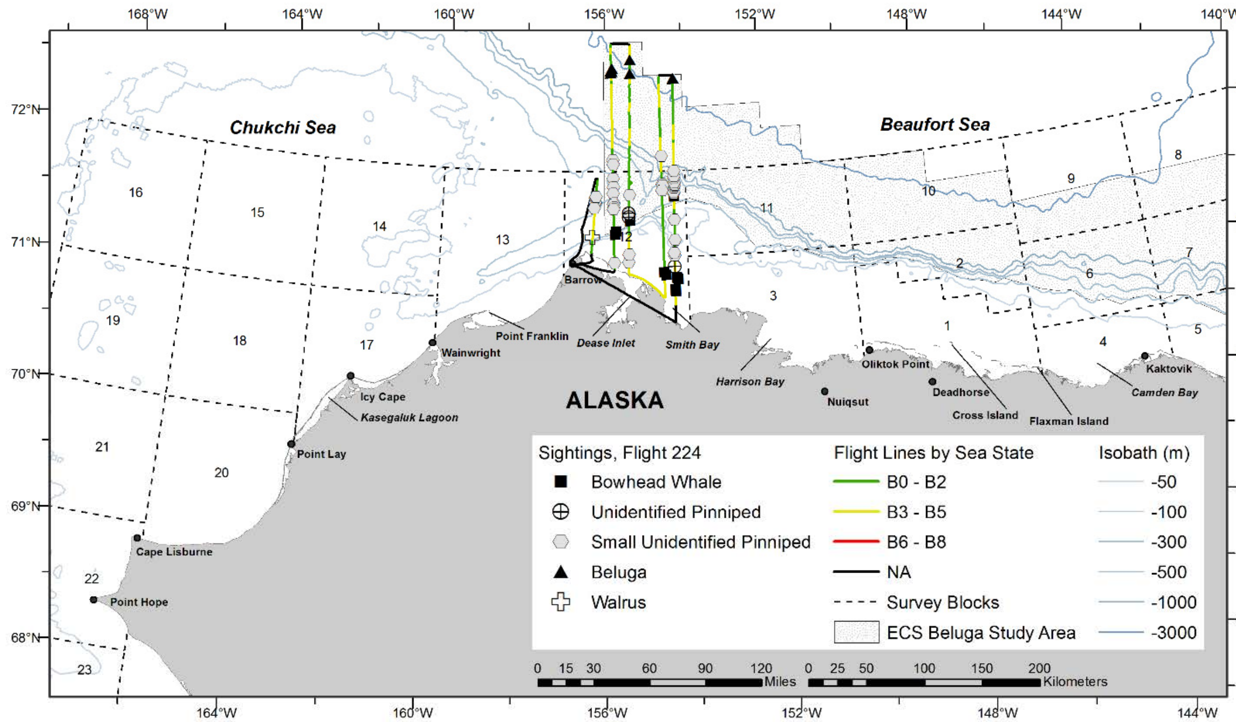


Figure B-41. ASAMM Flight 224 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

20 August 2016, Flight 18

Flight was a survey of portions of blocks 3 and 11. Transects extended north of block 11 to incorporate survey effort specific to the Eastern Chukchi Sea beluga stock. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 2-4 sea states. Sea ice cover was 0-7% broken floe in the area surveyed. Sightings included bowhead whales (including three calves), belugas (including one calf), and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
18	8/20/2016 15:00	71.085	153.998	bowhead whale	swim	1	0	3
18	8/20/2016 15:00	71.085	154.009	bowhead whale	swim	1	0	12
18	8/20/2016 15:02	71.126	154.005	bowhead whale	swim	2	0	12
18	8/20/2016 15:05	71.129	154.003	bowhead whale	swim	1	0	12
18	8/20/2016 15:19	71.486	153.898	bowhead whale	swim	1	0	11
18	8/20/2016 15:19	71.486	153.904	bowhead whale	swim	1	0	11
18	8/20/2016 15:19	71.490	153.915	bowhead whale	swim	1	0	11
18	8/20/2016 15:19	71.493	153.894	bowhead whale	swim	1	0	11
18	8/20/2016 15:20	71.492	153.861	bowhead whale	swim	2	0	11
18	8/20/2016 15:20	71.489	153.826	bowhead whale	swim	1	0	11
18	8/20/2016 15:20	71.488	153.814	bowhead whale	swim	1	0	11
18	8/20/2016 15:23	71.483	153.920	bowhead whale	swim	1	0	11
18	8/20/2016 15:26	71.533	153.939	bowhead whale	swim	1	0	11
18	8/20/2016 15:26	71.555	153.938	bowhead whale	swim	1	0	11
18	8/20/2016 15:27	71.558	153.960	bowhead whale	swim	1	0	11
18	8/20/2016 15:27	71.557	153.970	bowhead whale	swim	1	0	11
18	8/20/2016 15:27	71.555	153.979	bowhead whale	swim	1	0	11
18	8/20/2016 15:27	71.551	153.985	bowhead whale	swim	1	0	11
18	8/20/2016 15:27	71.549	153.982	bowhead whale	swim	1	0	11
18	8/20/2016 15:27	71.553	153.956	bowhead whale	swim	1	0	11
18	8/20/2016 15:28	71.542	153.977	bowhead whale	swim	2	0	11
18	8/20/2016 15:30	71.576	153.903	bowhead whale	swim	1	0	11
18	8/20/2016 15:37	71.792	153.907	bowhead whale	swim	1	0	11
18	8/20/2016 15:40	71.868	153.976	bowhead whale	rest	1	0	11
18	8/20/2016 15:40	71.869	153.944	bowhead whale	swim	1	0	11
18	8/20/2016 15:41	71.873	153.972	bowhead whale	swim	1	0	11
18	8/20/2016 15:41	71.872	153.975	bowhead whale	mill	6	1	11
18	8/20/2016 15:41	71.872	153.978	bowhead whale	swim	2	0	11
18	8/20/2016 15:43	71.867	153.981	bowhead whale	swim	1	0	11
18	8/20/2016 15:43	71.867	153.968	bowhead whale	swim	1	0	11
18	8/20/2016 15:45	71.862	153.963	bowhead whale	swim	3	0	11
18	8/20/2016 16:13	72.474	153.470	beluga	swim	1	0	0

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
18	8/20/2016 16:14	72.457	153.463	beluga	swim	1	0	0
18	8/20/2016 16:41	71.553	153.249	bowhead whale	swim	1	0	11
18	8/20/2016 16:41	71.545	153.250	bowhead whale	swim	1	0	11
18	8/20/2016 16:43	71.538	153.323	bowhead whale	swim	2	0	11
18	8/20/2016 16:43	71.537	153.340	bowhead whale	swim	1	0	11
18	8/20/2016 16:43	71.537	153.342	bowhead whale	swim	3	0	11
18	8/20/2016 16:45	71.541	153.349	bowhead whale	swim	1	0	11
18	8/20/2016 16:46	71.546	153.336	bowhead whale	mill	8	0	11
18	8/20/2016 16:50	71.517	153.195	bowhead whale	swim	2	0	11
18	8/20/2016 16:50	71.507	153.205	bowhead whale	swim	2	0	11
18	8/20/2016 16:50	71.505	153.195	bowhead whale	swim	1	0	11
18	8/20/2016 16:52	71.513	153.194	bowhead whale	swim	2	0	11
18	8/20/2016 16:57	71.500	153.239	bowhead whale	mill	2	0	11
18	8/20/2016 16:58	71.491	153.266	bowhead whale	swim	1	0	11
18	8/20/2016 17:01	71.467	153.201	beluga	swim	2	1	11
18	8/20/2016 17:03	71.415	153.157	bowhead whale	swim	2	0	11
18	8/20/2016 17:03	71.413	153.159	bowhead whale	swim	2	0	11
18	8/20/2016 17:03	71.411	153.169	bowhead whale	swim	1	0	11
18	8/20/2016 17:04	71.426	153.160	bowhead whale	swim	1	0	11
18	8/20/2016 17:04	71.429	153.172	bowhead whale	swim	1	0	11
18	8/20/2016 17:05	71.413	153.159	bowhead whale	swim	1	1	11
18	8/20/2016 17:06	71.391	153.194	bowhead whale	swim	2	0	11
18	8/20/2016 17:09	71.338	153.178	bowhead whale	swim	1	0	11
18	8/20/2016 17:31	71.018	152.631	bowhead whale	swim	1	0	3
18	8/20/2016 17:33	71.037	152.662	bowhead whale	swim	1	0	3
18	8/20/2016 17:33	71.035	152.650	bowhead whale	swim	1	0	3
18	8/20/2016 17:42	71.295	152.724	bowhead whale	swim	1	0	3
18	8/20/2016 17:43	71.335	152.753	bowhead whale	swim	1	0	11
18	8/20/2016 17:48	71.501	152.756	bowhead whale	swim	1	0	11
18	8/20/2016 17:48	71.506	152.793	bowhead whale	swim	1	0	11
18	8/20/2016 17:48	71.509	152.771	bowhead whale	mill	2	0	11
18	8/20/2016 17:51	71.492	152.729	bowhead whale	swim	1	0	11
18	8/20/2016 17:51	71.488	152.709	bowhead whale	mill	4	1	11
18	8/20/2016 17:51	71.483	152.685	bowhead whale	swim	4	0	11
18	8/20/2016 17:52	71.483	152.653	bowhead whale	swim	3	0	11
18	8/20/2016 17:52	71.484	152.633	bowhead whale	mill	3	0	11
18	8/20/2016 17:52	71.484	152.626	bowhead whale	rest	1	0	11
18	8/20/2016 17:52	71.485	152.618	bowhead whale	swim	1	0	11
18	8/20/2016 17:52	71.490	152.606	bowhead whale	mill	2	0	11
18	8/20/2016 17:53	71.492	152.605	bowhead whale	swim	1	0	11
18	8/20/2016 17:53	71.494	152.605	bowhead whale	swim	1	0	11

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
18	8/20/2016 17:53	71.496	152.611	bowhead whale	swim	1	0	11
18	8/20/2016 17:53	71.484	152.641	bowhead whale	mill	3	0	11
18	8/20/2016 17:54	71.491	152.690	bowhead whale	mill	2	0	11
18	8/20/2016 17:55	71.480	152.717	bowhead whale	mill	5	0	11
18	8/20/2016 18:19	71.270	152.162	bowhead whale	swim	1	0	3
18	8/20/2016 18:19	71.264	152.144	bowhead whale	swim	1	0	3
18	8/20/2016 18:21	71.262	152.131	bowhead whale	swim	7	0	3
18	8/20/2016 18:21	71.261	152.138	bowhead whale	swim	1	0	3
18	8/20/2016 18:21	71.245	152.179	bowhead whale	swim	1	0	3
18	8/20/2016 18:29	70.986	152.166	bowhead whale	rest	2	0	3
18	8/20/2016 18:29	70.982	152.143	bowhead whale	swim	1	0	3
18	8/20/2016 18:33	70.934	152.170	bowhead whale	swim	1	0	3

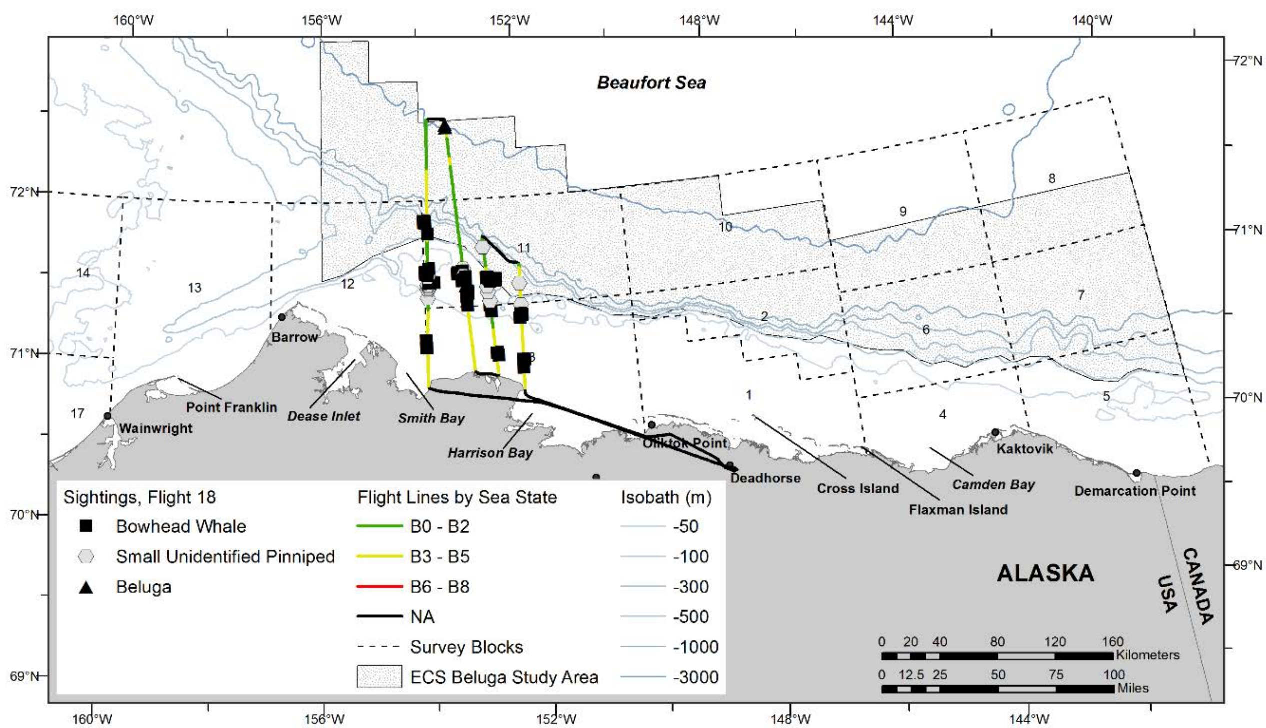
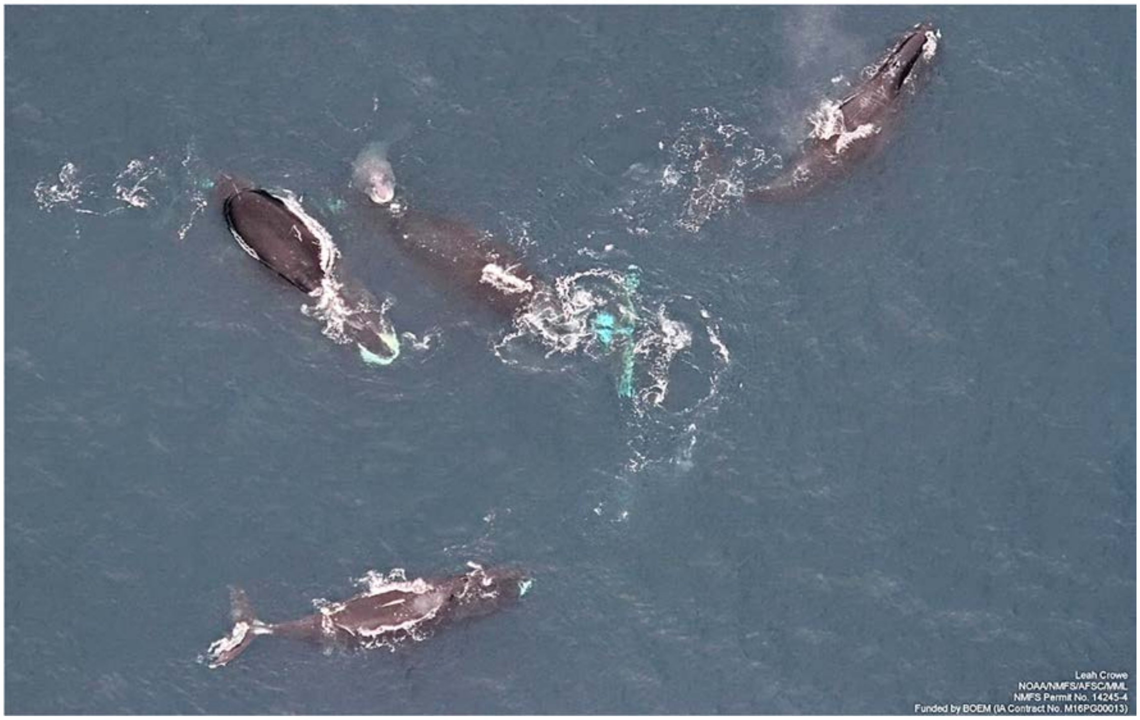


Figure B-42. ASAMM Flight 18 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



Five bowhead whales (including one calf) sighted near the mouth of Barrow Canyon during ASAMM Flight 18, 20 August 2016.

Bowhead whale with entanglement scars on its peduncle and fluke sighted near the mouth of Barrow Canyon during ASAMM Flight 18, 20 August 2016.

A group of five bowhead whales sighted milling at the water's surface. The whale in the lower right of the image is sloughing skin. Body contact was also observed during this sighting approximately 70 km northwest of Cape Halkett, during ASAMM Flight 18, 20 August 2016.

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22 August 2016, Flight 225

Flight was a complete survey of transects 10 and 12, the coast transect south of Wainwright, and search effort nearshore between Point Franklin and Barrow. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-6 sea states. Sea ice cover was 0-50% broken floe in the area surveyed. Sightings included bowhead whales, gray whales (including two calves and one carcass), one unidentified cetacean, walruses, unidentified pinnipeds (including three carcasses), one small unidentified pinniped, and one polar bear. The gray whale carcass was resighted during Flight 227.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
225	8/22/2016 13:56	71.043	161.491	bowhead whale	rest	1	0	14
225	8/22/2016 14:04	71.067	161.642	unid cetacean	swim	1	0	14
225	8/22/2016 14:22	71.317	162.499	bowhead whale	rest	1	0	14
225	8/22/2016 16:11	70.793	162.203	gray whale	feed	2	1	17
225	8/22/2016 16:19	70.778	162.148	gray whale	swim	2	1	17
225	8/22/2016 16:54	70.480	160.443	gray whale	dead	1	0	17

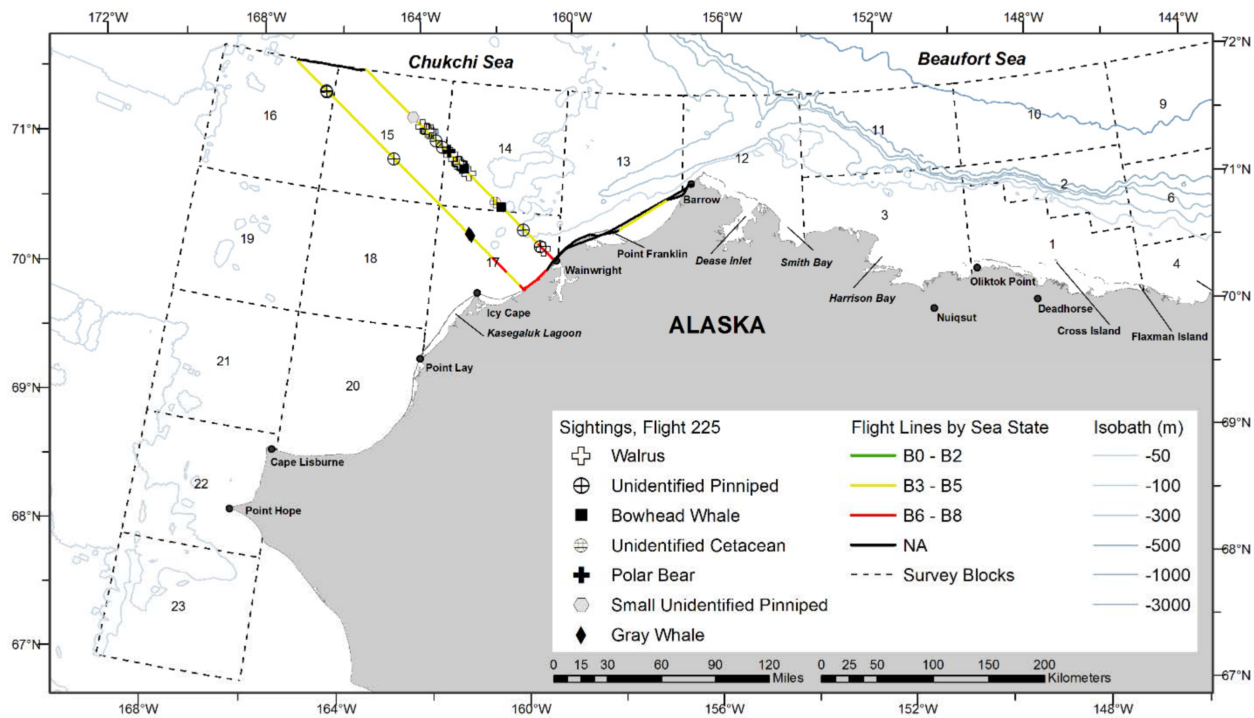


Figure B-43. ASAMM Flight 225 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale cow-calf pair sighted approximately 80 km west of Wainwright, Alaska, during ASAMM Flight 225, 22 August 2016.

22 August 2016, Flight 19

Flight was a survey of portions of block 3. Survey conditions included overcast skies, <1-5 km visibility (with low ceilings), and Beaufort 5-6 sea states. No sea ice was observed in the area surveyed. No sightings were observed.

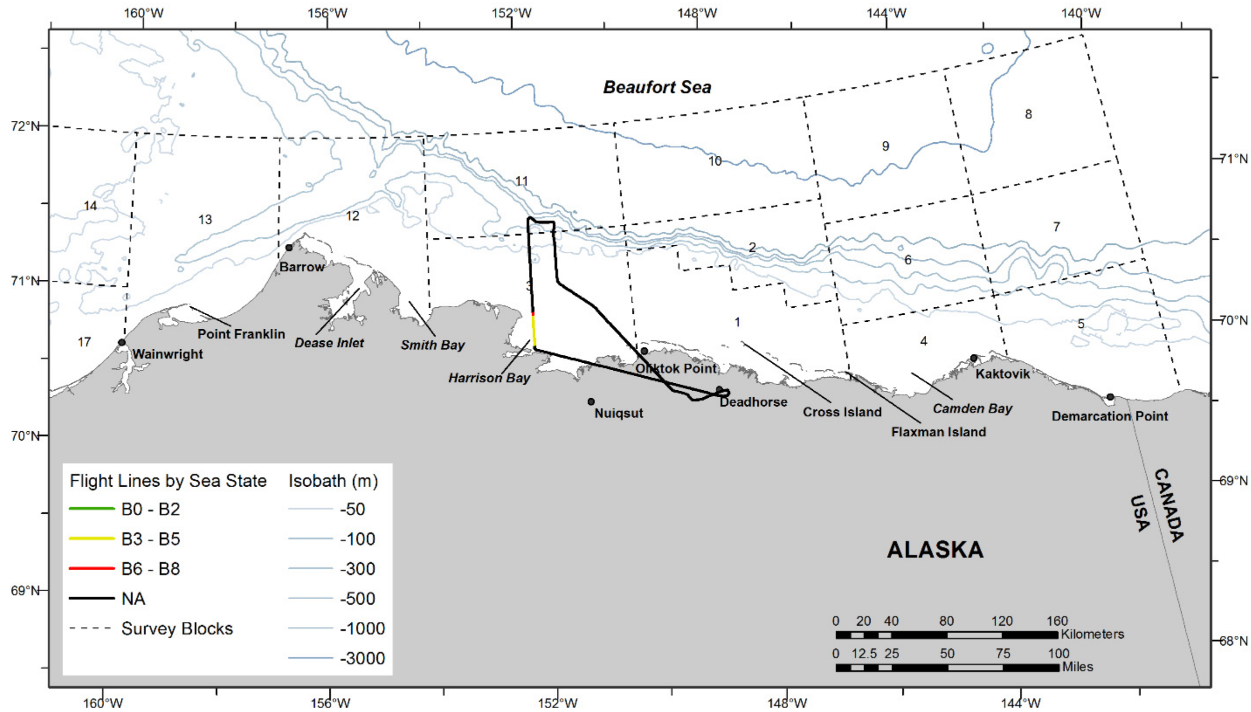


Figure B-44. ASAMM Flight 19 survey track, depicted by sea state.

23 August 2016, Flight 226

Flight was a complete survey of transects 2 and 4 and partial survey of transects 6 and 8. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 1-6 sea states. Sea ice cover was 0-80% broken floe in the area surveyed. Sightings included one bowhead whale, gray whales (including two calves), one unidentified cetacean, walruses (including two carcasses), one bearded seal, unidentified pinnipeds, and small unidentified pinnipeds. The two walrus carcasses were resighted during Flights 227 and 235.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
226	8/23/2016 10:24	71.801	159.350	bowhead whale	rest	1	0	13
226	8/23/2016 10:50	71.247	157.487	unid cetacean	dive	1	0	13
226	8/23/2016 10:50	71.243	157.484	gray whale	feed	1	0	13
226	8/23/2016 10:59	71.216	157.490	gray whale	feed	5	1	13
226	8/23/2016 11:11	71.234	157.383	gray whale	feed	2	0	13
226	8/23/2016 11:12	71.227	157.433	gray whale	feed	2	0	13
226	8/23/2016 11:15	71.225	157.441	gray whale	feed	5	1	13

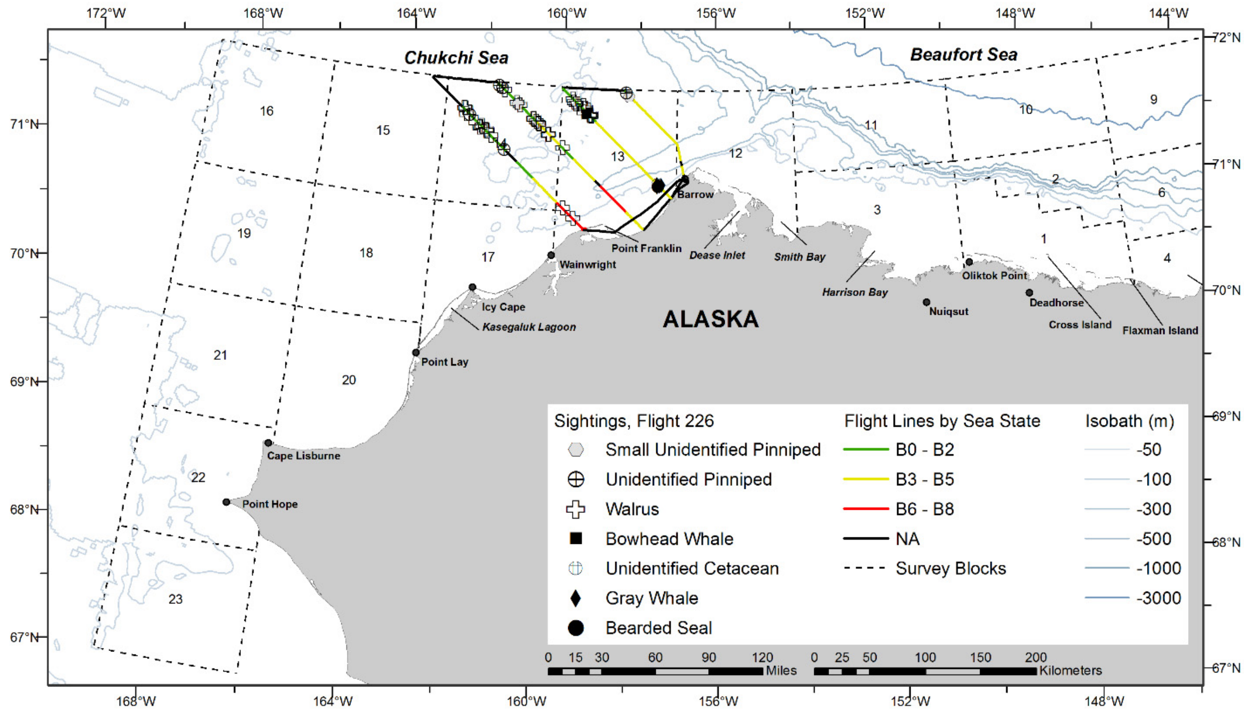


Figure B-45. ASAMM Flight 226 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 August 2016, Flight 227

Flight was a partial survey of transect 11 and the coastal transect from south of Point Lay to Point Barrow. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with glare and low ceilings), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including two calves and two carcasses), six walrus carcasses, one bearded seal, unidentified pinnipeds (including four carcasses), and small unidentified pinnipeds. One of the gray whale carcasses was previously sighted during Flight 213 and resighted on Flight 240; the second gray whale carcass was previously sighted during Flight 225. Two of the four walrus carcasses were previously documented during Flight 226 and resighted during Flight 235.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
227	8/24/2016 18:43	70.296	161.399	gray whale	dead	1	0	17
227	8/24/2016 18:55	70.482	160.443	gray whale	dead	1	0	17
227	8/24/2016 19:05	70.738	159.842	gray whale	swim	2	0	13
227	8/24/2016 19:15	70.874	159.240	gray whale	swim	1	0	13
227	8/24/2016 19:34	70.821	158.907	gray whale	feed	2	0	13
227	8/24/2016 19:40	70.844	158.466	gray whale	mill	2	1	13
227	8/24/2016 19:45	70.826	158.349	gray whale	feed	6	0	13
227	8/24/2016 19:54	70.837	158.050	gray whale	swim	2	1	13

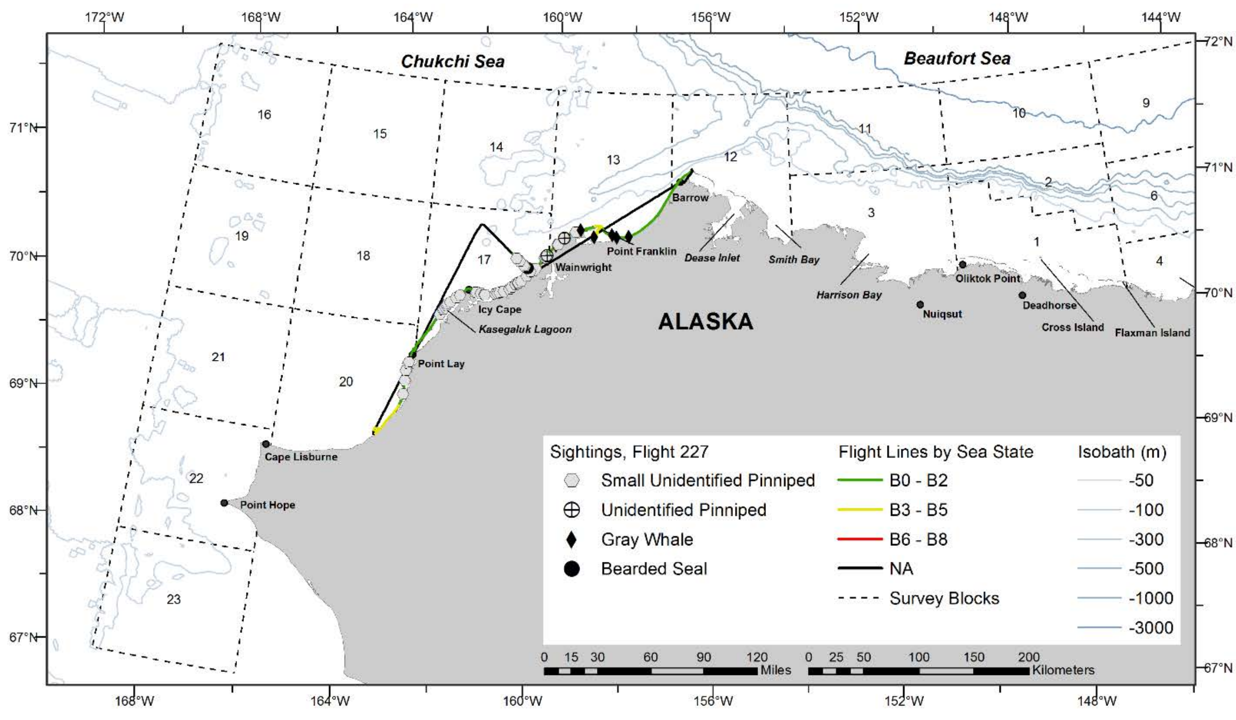


Figure B-46. ASAMM Flight 227 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Pair of gray whales sighted approximately 10 km northeast of Wainwright, Alaska, during ASAMM Flight 227, 24 August 2016

24 August 2016, Flight 20

Flight was a survey of portions of block 1. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with fog and glare), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales and polar bears (including one cub).

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
20	8/24/2016 13:17	70.421	146.930	bowhead whale	swim	1	0	1
20	8/24/2016 13:18	70.414	146.897	bowhead whale	dive	1	0	1
20	8/24/2016 13:19	70.388	146.956	bowhead whale	mill	3	0	1
20	8/24/2016 13:21	70.384	146.951	bowhead whale	swim	1	0	1
20	8/24/2016 13:22	70.383	146.946	bowhead whale	swim	1	0	1
20	8/24/2016 13:26	70.325	146.960	bowhead whale	swim	1	0	1
20	8/24/2016 13:46	70.399	147.337	bowhead whale	swim	1	0	1
20	8/24/2016 13:48	70.408	147.348	bowhead whale	swim	1	0	1
20	8/24/2016 13:49	70.420	147.329	bowhead whale	swim	1	0	1
20	8/24/2016 15:01	70.679	148.672	bowhead whale	swim	1	0	1
20	8/24/2016 15:04	70.632	148.654	bowhead whale	swim	1	0	1
20	8/24/2016 15:26	70.724	149.448	bowhead whale	swim	1	0	1
20	8/24/2016 15:27	70.755	149.394	bowhead whale	feed	2	0	1
20	8/24/2016 15:28	70.757	149.377	bowhead whale	swim	1	0	1
20	8/24/2016 15:30	70.764	149.352	bowhead whale	swim	1	0	1

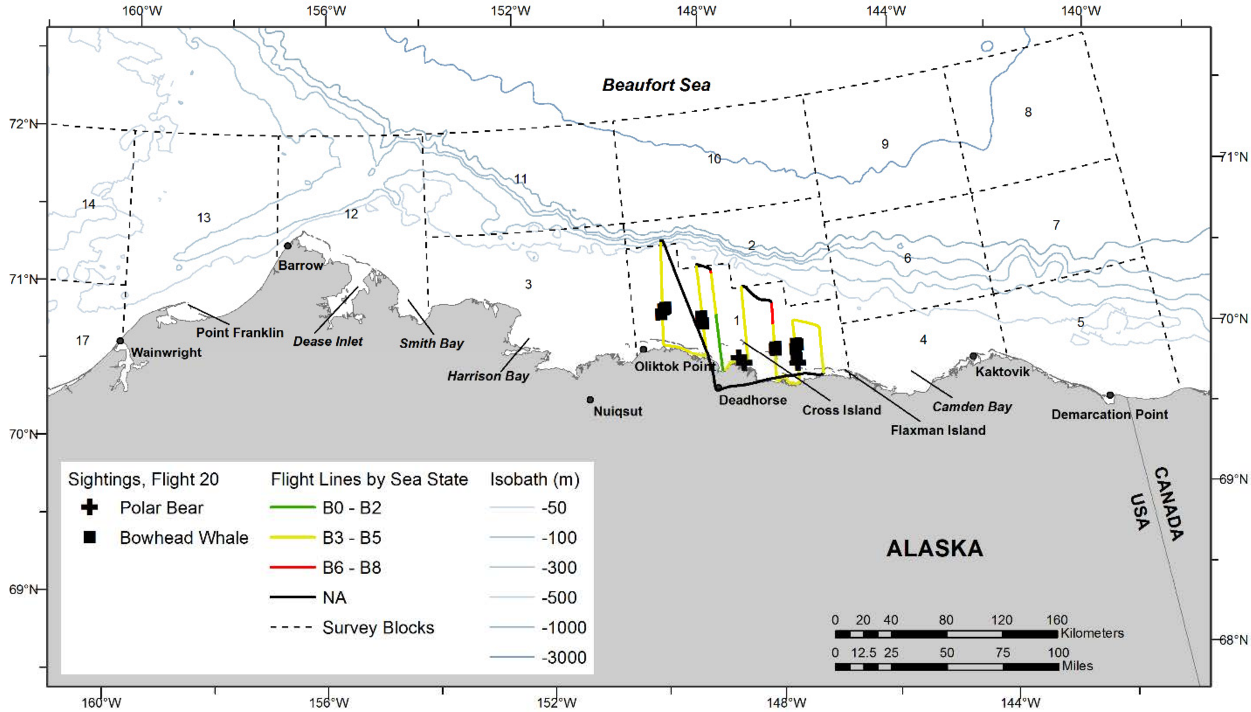


Figure B-47. ASAMM Flight 20 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

25 August 2016, Flight 228

Flight was a survey of block 12. Survey conditions included partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including two calves), gray whales (including one calf), one walrus carcass, unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
228	8/25/2016 15:04	71.671	156.285	bowhead whale	feed	1	0	12
228	8/25/2016 15:08	71.590	156.258	bowhead whale	swim	1	0	12
228	8/25/2016 15:10	71.575	156.271	bowhead whale	mill	3	0	12
228	8/25/2016 15:10	71.566	156.237	bowhead whale	feed	4	0	12
228	8/25/2016 15:16	71.578	156.221	bowhead whale	rest	1	0	12
228	8/25/2016 15:18	71.571	156.271	bowhead whale	feed	1	0	12
228	8/25/2016 15:19	71.573	156.260	bowhead whale	rest	1	0	12
228	8/25/2016 15:24	71.505	156.142	bowhead whale	dive	1	0	12
228	8/25/2016 15:25	71.499	156.172	gray whale	feed	1	0	12
228	8/25/2016 15:25	71.491	156.166	gray whale	feed	1	0	12
228	8/25/2016 15:29	71.518	156.143	bowhead whale	rest	1	0	12
228	8/25/2016 15:34	71.476	156.181	bowhead whale	swim	1	0	12
228	8/25/2016 15:36	71.488	156.286	bowhead whale	dive	1	0	12
228	8/25/2016 15:36	71.486	156.224	bowhead whale	mill	2	0	12
228	8/25/2016 15:37	71.498	156.238	gray whale	feed	1	0	12
228	8/25/2016 15:40	71.492	156.247	gray whale	swim	1	0	12
228	8/25/2016 15:44	71.486	156.280	gray whale	feed	1	0	12
228	8/25/2016 15:44	71.493	156.296	gray whale	feed	1	0	12
228	8/25/2016 15:46	71.485	156.265	gray whale	feed	3	1	12
228	8/25/2016 15:48	71.468	156.199	bowhead whale	rest	2	0	12
228	8/25/2016 15:48	71.462	156.205	bowhead whale	dive	1	0	12
228	8/25/2016 15:48	71.458	156.202	bowhead whale	feed	19	0	12
228	8/25/2016 15:51	71.458	156.220	gray whale	swim	1	0	12
228	8/25/2016 16:00	71.372	156.138	bowhead whale	mill	2	0	12
228	8/25/2016 16:06	71.336	155.893	bowhead whale	dive	1	0	12
228	8/25/2016 16:06	71.341	155.939	bowhead whale	feed	3	0	12
228	8/25/2016 16:10	71.350	155.874	bowhead whale	mill	2	0	12
228	8/25/2016 16:11	71.326	155.871	bowhead whale	feed	3	0	12
228	8/25/2016 16:11	71.338	155.829	bowhead whale	feed	1	0	12
228	8/25/2016 16:12	71.324	155.815	bowhead whale	feed	1	0	12
228	8/25/2016 16:12	71.322	155.820	bowhead whale	feed	1	0	12
228	8/25/2016 16:13	71.321	155.830	bowhead whale	feed	1	0	12
228	8/25/2016 16:14	71.316	155.818	bowhead whale	rest	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
228	8/25/2016 16:15	71.341	155.871	bowhead whale	feed	1	0	12
228	8/25/2016 16:17	71.398	155.869	bowhead whale	swim	1	0	12
228	8/25/2016 16:18	71.404	155.802	bowhead whale	rest	1	0	12
228	8/25/2016 16:20	71.396	155.746	bowhead whale	feed	2	0	12
228	8/25/2016 16:22	71.441	155.849	bowhead whale	swim	1	0	12
228	8/25/2016 16:23	71.448	155.865	bowhead whale	feed	1	0	12
228	8/25/2016 16:25	71.451	155.804	bowhead whale	rest	1	0	12
228	8/25/2016 16:25	71.448	155.825	bowhead whale	feed	1	0	12
228	8/25/2016 16:25	71.438	155.791	bowhead whale	mill	2	0	12
228	8/25/2016 16:26	71.451	155.788	bowhead whale	feed	1	0	12
228	8/25/2016 16:28	71.443	155.867	bowhead whale	feed	1	0	12
228	8/25/2016 16:28	71.442	155.887	bowhead whale	feed	1	0	12
228	8/25/2016 16:30	71.463	155.905	bowhead whale	dive	1	0	12
228	8/25/2016 16:33	71.472	155.873	bowhead whale	mill	3	0	12
228	8/25/2016 16:35	71.485	155.861	bowhead whale	swim	1	0	12
228	8/25/2016 16:35	71.491	155.878	bowhead whale	rest	1	0	12
228	8/25/2016 16:38	71.488	155.949	bowhead whale	mill	2	0	12
228	8/25/2016 16:40	71.494	155.830	bowhead whale	swim	1	0	12
228	8/25/2016 16:43	71.565	155.828	bowhead whale	swim	2	0	12
228	8/25/2016 16:48	71.675	155.769	bowhead whale	dive	1	0	12
228	8/25/2016 17:18	71.628	155.090	bowhead whale	swim	1	0	12
228	8/25/2016 17:53	71.619	154.863	bowhead whale	swim	1	0	12
228	8/25/2016 17:55	71.615	154.823	bowhead whale	rest	2	0	12
228	8/25/2016 17:58	71.619	154.742	bowhead whale	dive	1	0	12
228	8/25/2016 18:00	71.639	154.845	bowhead whale	dive	1	0	12
228	8/25/2016 18:01	71.618	154.832	bowhead whale	mill	3	1	12
228	8/25/2016 18:03	71.637	154.846	bowhead whale	swim	1	0	12
228	8/25/2016 18:04	71.657	154.860	bowhead whale	swim	1	0	12
228	8/25/2016 18:29	71.751	154.367	bowhead whale	swim	1	0	12
228	8/25/2016 18:31	71.721	154.390	bowhead whale	rest	2	1	12
228	8/25/2016 18:35	71.684	154.393	bowhead whale	swim	1	0	12

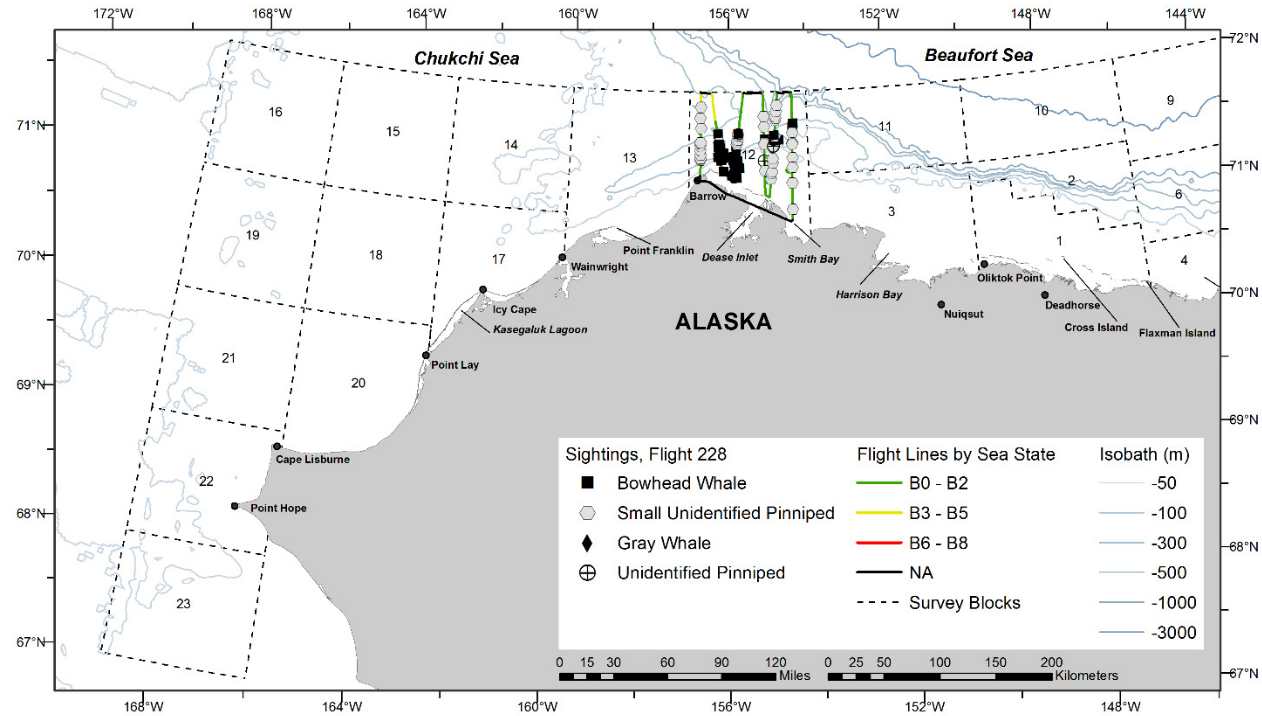


Figure B-48. ASAMM Flight 228 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale cow-calf pair sighted approximately 80 km northeast of Barrow, Alaska, during ASAMM Flight 228, 25 August 2016.

Part of a larger group of nineteen bowhead whales sighted feeding approximately 30 km northeast of Barrow, Alaska, during ASAMM Flight 228, 25 August 2016.

25 August 2016, Flight 21

Flight was a survey of portions of blocks 4, 5, 6, and 7. Survey conditions included partly to overcast cloudy skies, 0 km to unlimited visibility (with fog, glare, and precipitation), and Beaufort 1-4 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including two calves), belugas, one unidentified cetacean, unidentified pinnipeds, small unidentified pinnipeds, and polar bears (including six cubs).

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
21	8/25/16 12:30	69.851	-142.052	beluga	mill	4	0	5
21	8/25/16 12:30	69.866	-142.036	beluga	swim	1	0	5
21	8/25/16 12:30	69.861	-142.050	beluga	swim	1	0	5
21	8/25/16 12:30	69.865	-142.043	beluga	swim	1	0	5
21	8/25/16 12:35	70.013	-142.210	unid cetacean	swim	1	0	5
21	8/25/16 12:38	70.023	-142.118	bowhead whale	swim	2	0	5
21	8/25/16 12:41	70.018	-142.075	bowhead whale	swim	1	0	5
21	8/25/16 13:17	70.980	-142.690	beluga	swim	1	0	7
21	8/25/16 14:51	70.220	-143.720	bowhead whale	feed	6	0	4
21	8/25/16 14:53	70.210	-143.683	bowhead whale	swim	1	0	4
21	8/25/16 17:06	70.235	-144.030	bowhead whale	swim	1	0	4
21	8/25/16 17:06	70.232	-143.999	bowhead whale	swim	2	0	4
21	8/25/16 17:56	70.197	-144.813	bowhead whale	unknown	1	0	4
21	8/25/16 17:57	70.177	-144.859	bowhead whale	swim	4	0	4
21	8/25/16 18:00	70.192	-144.907	bowhead whale	swim	1	0	4
21	8/25/16 18:00	70.192	-144.912	bowhead whale	swim	1	0	4
21	8/25/16 18:01	70.193	-144.929	bowhead whale	swim	2	1	4
21	8/25/16 18:01	70.193	-144.940	bowhead whale	swim	1	0	4
21	8/25/16 18:03	70.186	-144.789	bowhead whale	swim	4	0	4
21	8/25/16 18:05	70.156	-144.998	bowhead whale	feed	1	0	4
21	8/25/16 18:13	70.147	-145.021	bowhead whale	feed	1	0	4
21	8/25/16 18:15	70.143	-145.021	bowhead whale	feed	1	0	4
21	8/25/16 18:16	70.141	-144.971	bowhead whale	feed	2	0	4
21	8/25/16 18:16	70.140	-144.970	bowhead whale	swim	1	0	4
21	8/25/16 18:16	70.123	-144.954	bowhead whale	feed	2	0	4
21	8/25/16 18:18	70.109	-144.924	bowhead whale	swim	2	0	4
21	8/25/16 18:20	70.096	-144.926	bowhead whale	feed	1	0	4
21	8/25/16 18:20	70.090	-144.889	bowhead whale	feed	1	0	4
21	8/25/16 18:21	70.083	-144.907	bowhead whale	feed	1	0	4
21	8/25/16 18:22	70.076	-144.939	bowhead whale	feed	1	0	4
21	8/25/16 18:23	70.040	-144.888	bowhead whale	swim	1	0	4
21	8/25/16 18:32	70.119	-145.284	bowhead whale	unknown	1	0	4

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
21	8/25/16 18:33	70.137	-145.259	bowhead whale	swim	1	0	4
21	8/25/16 18:35	70.162	-145.112	bowhead whale	unknown	2	0	4
21	8/25/16 18:36	70.180	-145.026	bowhead whale	unknown	2	0	4
21	8/25/16 18:39	70.203	-144.993	bowhead whale	feed	1	0	4
21	8/25/16 18:39	70.204	-145.008	bowhead whale	swim	1	0	4
21	8/25/16 18:39	70.197	-145.009	bowhead whale	swim	1	0	4
21	8/25/16 18:40	70.207	-145.062	bowhead whale	swim	2	0	4
21	8/25/16 19:32	70.622	-145.633	bowhead whale	swim	2	1	6
21	8/25/16 19:47	70.236	-145.621	bowhead whale	swim	1	0	4

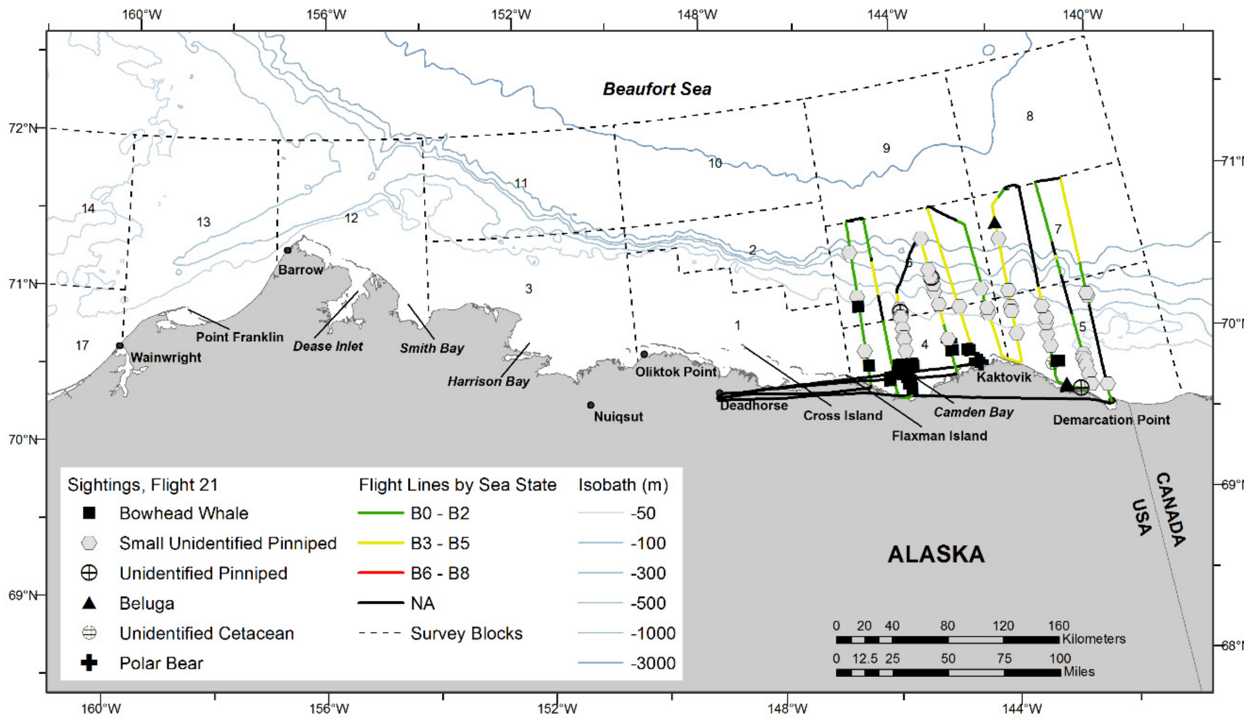
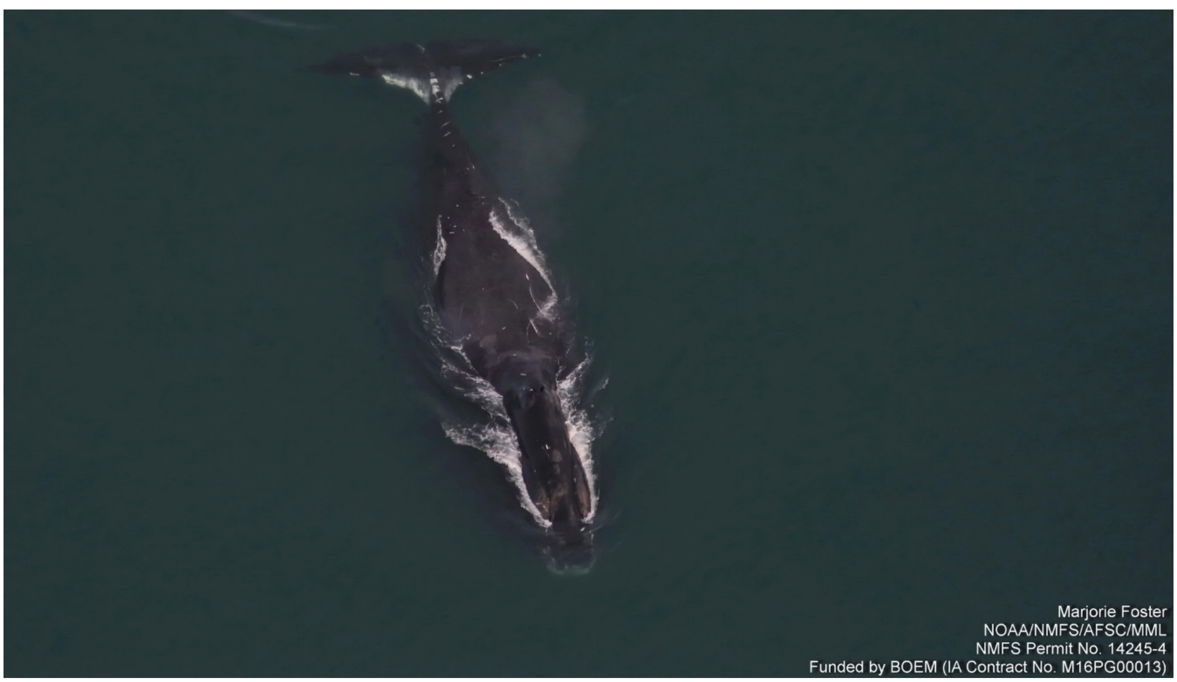


Figure B-49. ASAMM Flight 21 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bears resting on the tundra near Kaktovik, Alaska, sighted during ASAMM Flight 21, 25 August 2016.



Bowhead whale sighted swimming at the water's surface near Camden Bay, Alaska, during ASAMM Flight 21, 25 August 2016.

26 August 2016, Flight 229

Flight was a partial survey of transects 14 and 16 and nearshore search effort from Icy Cape to Barrow. Survey conditions included partly cloudy skies, <1-10 km visibility (with glare, haze, and low ceilings), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, walruses, one unidentified pinniped, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
229	8/26/2016 12:51	70.795	163.970	bowhead whale	rest	1	0	18
229	8/26/2016 12:51	70.781	163.962	bowhead whale	rest	1	0	18
229	8/26/2016 13:09	70.793	163.905	bowhead whale	rest	2	0	18

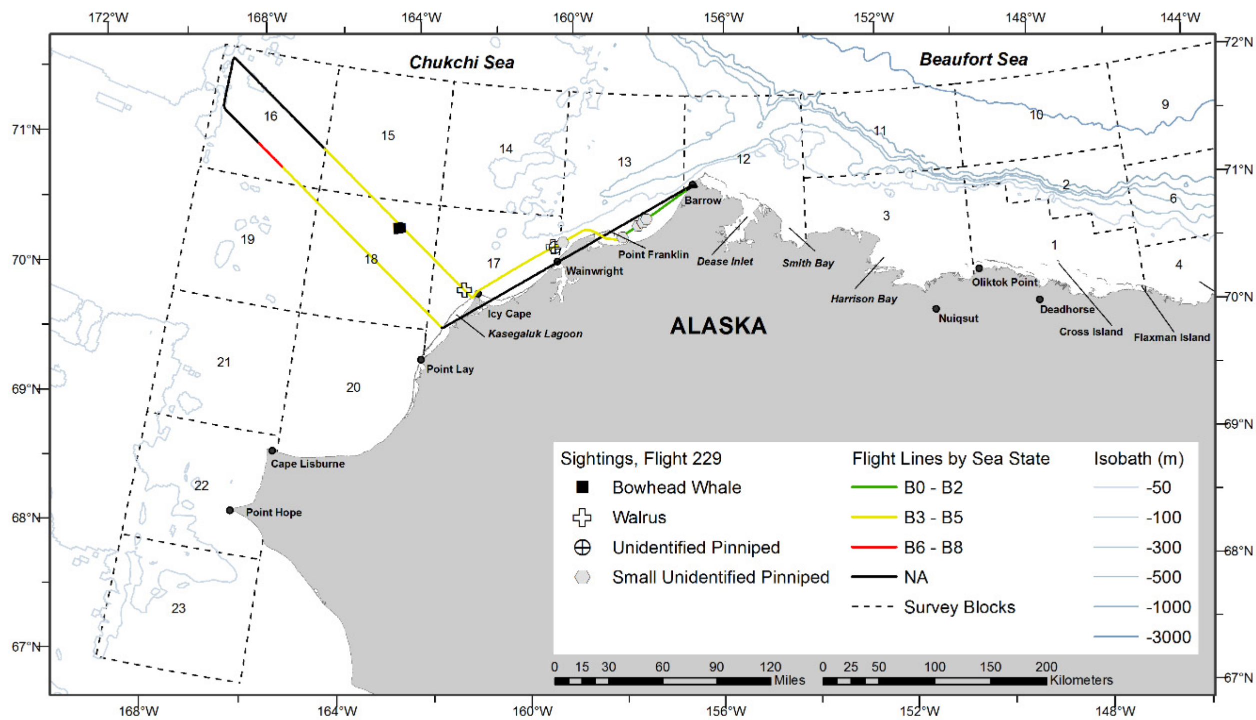


Figure B-50. ASAMM Flight 229 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

26 August 2016, Flight 22

Flight was a survey of portions of blocks 3 and 11. Survey conditions included partly cloudy to overcast skies, 3 km to unlimited visibility (with glare and haze), and Beaufort 0-3 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including two calves), belugas (including three calves), unidentified cetaceans, walruses (including one carcass), unidentified pinnipeds, and small unidentified pinnipeds. The walrus carcass was resighted during Flight 27.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
22	8/26/2016 13:20	71.480	153.523	bowhead whale	swim	1	0	11
22	8/26/2016 13:29	71.694	153.617	bowhead whale	swim	2	1	11
22	8/26/2016 14:09	71.289	153.311	bowhead whale	dive	1	0	3
22	8/26/2016 14:10	71.272	153.212	bowhead whale	rest	1	0	3
22	8/26/2016 14:11	71.258	153.216	bowhead whale	rest	1	0	3
22	8/26/2016 14:11	71.261	153.198	bowhead whale	swim	1	0	3
22	8/26/2016 14:11	71.263	153.190	bowhead whale	swim	1	0	3
22	8/26/2016 14:33	71.066	152.945	bowhead whale	feed	6	0	3
22	8/26/2016 14:33	71.071	152.946	bowhead whale	feed	3	0	3
22	8/26/2016 14:41	71.226	152.857	bowhead whale	swim	1	0	3
22	8/26/2016 15:04	71.943	152.727	beluga	swim	11	2	11
22	8/26/2016 15:04	71.953	152.729	beluga	swim	2	0	11
22	8/26/2016 15:04	71.957	152.704	beluga	swim	5	1	11
22	8/26/2016 15:43	71.031	152.134	bowhead whale	feed	3	0	3
22	8/26/2016 15:43	71.027	152.057	bowhead whale	mill	2	0	3
22	8/26/2016 15:43	71.015	152.101	bowhead whale	swim	1	0	3
22	8/26/2016 15:44	71.016	152.065	bowhead whale	swim	6	0	3
22	8/26/2016 15:44	71.020	152.046	bowhead whale	swim	4	0	3
22	8/26/2016 15:48	71.001	152.086	bowhead whale	swim	6	0	3
22	8/26/2016 15:51	71.005	152.131	bowhead whale	feed	3	0	3
22	8/26/2016 15:53	71.004	152.142	bowhead whale	swim	1	0	3
22	8/26/2016 15:53	70.981	152.066	bowhead whale	feed	2	0	3
22	8/26/2016 15:54	70.969	152.115	bowhead whale	feed	3	0	3
22	8/26/2016 15:54	70.970	152.083	bowhead whale	swim	1	0	3
22	8/26/2016 15:54	70.970	152.081	bowhead whale	swim	3	0	3
22	8/26/2016 15:54	70.970	152.081	bowhead whale	feed	4	0	3
22	8/26/2016 15:55	70.991	152.073	bowhead whale	mill	9	0	3
22	8/26/2016 15:58	70.924	151.991	bowhead whale	feed	2	0	3
22	8/26/2016 15:59	70.928	152.036	bowhead whale	feed	1	0	3
22	8/26/2016 15:59	70.933	152.040	bowhead whale	feed	1	0	3
22	8/26/2016 15:59	70.935	152.044	bowhead whale	feed	6	0	3
22	8/26/2016 16:01	70.936	152.083	bowhead whale	feed	4	0	3

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
22	8/26/2016 18:29	70.881	151.815	bowhead whale	swim	1	0	3
22	8/26/2016 18:32	70.934	151.763	bowhead whale	swim	2	0	3
22	8/26/2016 18:32	70.937	151.876	bowhead whale	swim	1	0	3
22	8/26/2016 18:33	70.945	151.832	bowhead whale	rest	1	0	3
22	8/26/2016 18:33	70.944	151.812	bowhead whale	rest	1	0	3
22	8/26/2016 18:33	70.944	151.811	bowhead whale	rest	1	0	3
22	8/26/2016 18:33	70.942	151.777	bowhead whale	swim	1	0	3
22	8/26/2016 18:35	70.935	151.784	bowhead whale	swim	1	0	3
22	8/26/2016 18:36	70.980	151.872	bowhead whale	swim	1	0	3
22	8/26/2016 18:38	71.013	151.859	bowhead whale	rest	1	0	3
22	8/26/2016 18:42	71.136	151.688	unid cetacean	unknown	2	0	3
22	8/26/2016 19:44	70.995	151.145	bowhead whale	feed	2	1	3
22	8/26/2016 19:49	70.980	151.094	bowhead whale	feed	3	0	3
22	8/26/2016 19:52	70.928	151.122	bowhead whale	dive	1	0	3
22	8/26/2016 19:52	70.919	151.073	bowhead whale	feed	1	0	3
22	8/26/2016 19:53	70.906	151.143	bowhead whale	swim	1	0	3
22	8/26/2016 19:55	70.896	151.153	bowhead whale	swim	5	0	3
22	8/26/2016 19:55	70.895	151.157	bowhead whale	feed	2	0	3
22	8/26/2016 19:57	70.887	151.109	bowhead whale	feed	2	0	3
22	8/26/2016 19:57	70.882	151.068	bowhead whale	feed	1	0	3
22	8/26/2016 19:58	70.884	151.103	bowhead whale	feed	1	0	3
22	8/26/2016 19:59	70.853	151.175	bowhead whale	feed	2	0	3
22	8/26/2016 20:03	70.846	151.156	bowhead whale	dive	1	0	3
22	8/26/2016 20:04	70.818	151.059	bowhead whale	feed	44	0	3
22	8/26/2016 20:04	70.814	151.044	bowhead whale	feed	17	0	3
22	8/26/2016 20:08	70.839	151.195	bowhead whale	feed	5	0	3
22	8/26/2016 20:11	70.795	151.097	bowhead whale	feed	19	0	3
22	8/26/2016 20:11	70.790	151.096	bowhead whale	feed	10	0	3
22	8/26/2016 20:12	70.778	151.169	bowhead whale	feed	52	0	3
22	8/26/2016 20:12	70.778	151.194	bowhead whale	feed	30	0	3
22	8/26/2016 20:12	70.778	151.210	bowhead whale	feed	55	0	3
22	8/26/2016 20:12	70.778	151.221	bowhead whale	feed	11	0	3
22	8/26/2016 20:12	70.778	151.237	bowhead whale	feed	20	0	3
22	8/26/2016 20:13	70.777	151.269	bowhead whale	feed	15	0	3
22	8/26/2016 20:18	70.753	151.066	bowhead whale	feed	11	0	3
22	8/26/2016 20:23	70.691	151.116	bowhead whale	feed	53	0	3
22	8/26/2016 20:28	70.677	151.063	bowhead whale	feed	16	0	3
22	8/26/2016 20:32	70.621	151.008	bowhead whale	feed	2	0	3
22	8/26/2016 20:49	70.732	150.696	bowhead whale	dive	1	0	3
22	8/26/2016 20:50	70.756	150.766	bowhead whale	feed	12	0	3
22	8/26/2016 20:51	70.786	150.728	bowhead whale	feed	3	0	3

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
22	8/26/2016 20:51	70.796	150.649	bowhead whale	feed	1	0	3
22	8/26/2016 20:57	71.001	150.790	bowhead whale	feed	4	0	3
22	8/26/2016 21:00	71.000	150.763	bowhead whale	breach	3	0	3
22	8/26/2016 21:06	70.988	150.738	bowhead whale	feed	1	0	3

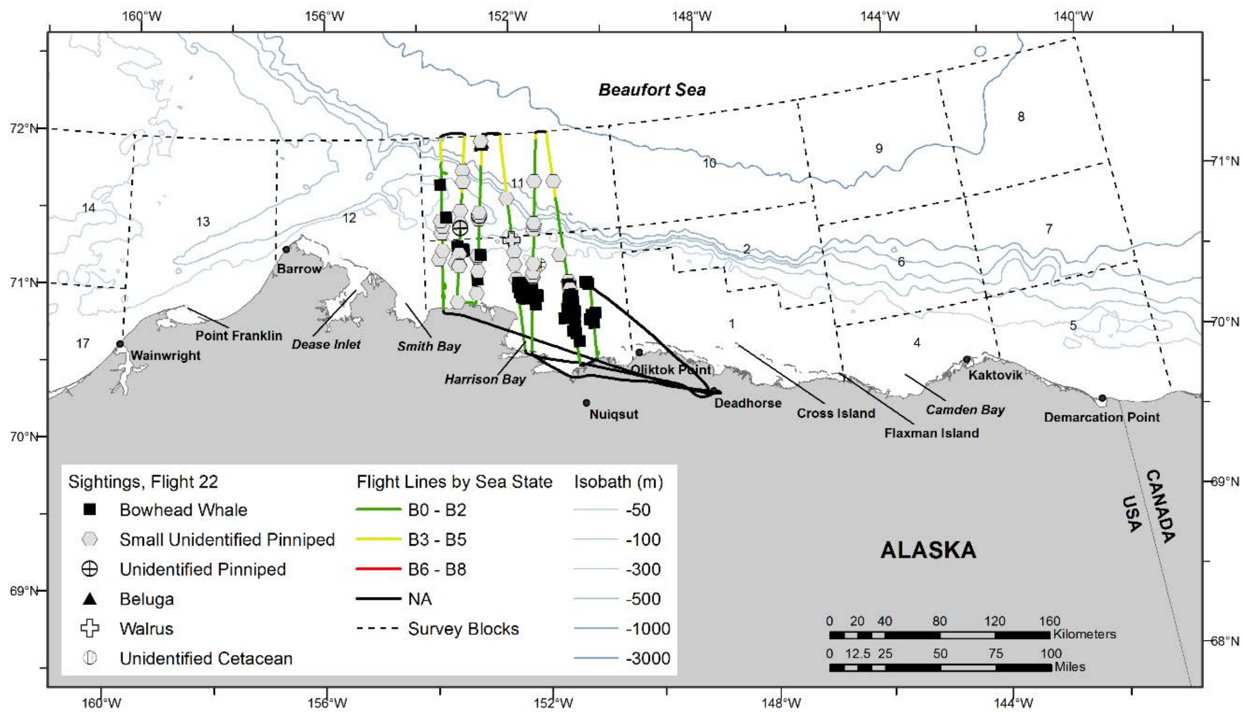


Figure B-51. ASAMM Flight 22 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale cow-calf pair sighted approximately 125 kilometers north of Smith Bay, Alaska, during ASAMM Flight 22, 26 August 2016.

Breaching bowhead whale sighted approximately 60 kilometers northeast of Cape Halkett, Alaska, during ASAMM Flight 22, 26 August 2016.

Part of a large feeding aggregation observed in the northern part of Harrison Bay, Alaska, during ASAMM Flight 22, 26 August 2016. Each water disturbance is a bowhead whale or group of whales feeding at the water's surface. One hundred and eighty-three bowhead whales were counted in <2 minutes.

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27 August 2016, Flight 230

Flight was a complete survey of transect 1, partial survey of transects 3, 11, and 13, and search effort from Peard Bay to transect 1. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, haze, and low ceilings), and Beaufort 2-5 sea states. Sea ice cover was 0-35% broken floe in the area surveyed. Sightings included one bowhead whale, gray whales, walruses, unidentified pinnipeds (including one carcass), and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
230	8/27/2016 9:56	70.812	161.527	gray whale	feed	1	0	17
230	8/27/2016 11:29	70.826	158.926	gray whale	feed	1	0	13
230	8/27/2016 12:44	71.713	158.223	bowhead whale	swim	1	0	13

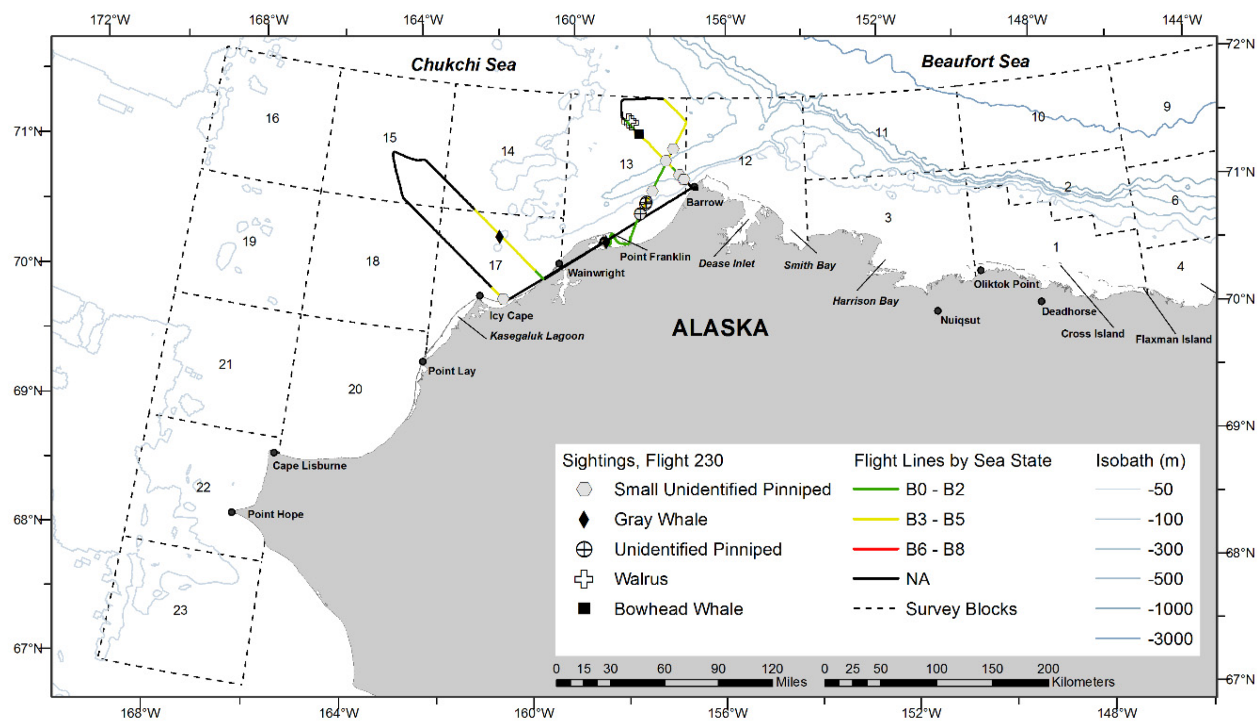


Figure B-52. ASAMM Flight 230 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale sighted feeding inside of Peard Bay, Alaska, during ASAMM Flight 230, 27 August 2016. This same whale was photographed feeding inside of Peard Bay during ASAMM Flight 220 on 6 August 2016.

27 August 2016, Flight 23

Flight was a survey of portions of blocks 2, 3, 10, and 11. Survey conditions included clear skies, <1 km to unlimited visibility (with fog and glare), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including six calves and one carcass), one unidentified cetacean carcass, and small unidentified pinnipeds. The bowhead whale carcass was resighted during Flights 28 and 39. The unidentified cetacean carcass was resighted during Flight 28.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
23	8/27/2016 10:49	71.499	150.158	bowhead whale	dead	1	0	11
23	8/27/2016 13:21	70.909	148.195	bowhead whale	swim	2	1	1
23	8/27/2016 13:26	70.841	147.975	bowhead whale	swim	2	1	2
23	8/27/2016 13:34	70.917	147.958	bowhead whale	mill	5	0	2
23	8/27/2016 13:38	71.058	147.936	bowhead whale	swim	1	0	2
23	8/27/2016 14:06	70.849	147.293	bowhead whale	mill	2	0	2
23	8/27/2016 14:06	70.848	147.260	bowhead whale	rest	1	1	2
23	8/27/2016 14:12	70.833	147.402	bowhead whale	mill	3	1	2
23	8/27/2016 14:16	70.783	147.101	bowhead whale	feed	2	1	1
23	8/27/2016 14:18	70.771	147.018	bowhead whale	rest	1	0	1
23	8/27/2016 14:18	70.762	147.020	bowhead whale	mill	2	1	1
23	8/27/2016 14:19	70.740	147.007	bowhead whale	swim	1	0	1
23	8/27/2016 14:21	70.729	146.926	bowhead whale	rest	1	0	2
23	8/27/2016 14:22	70.706	146.865	bowhead whale	swim	1	0	2
23	8/27/2016 14:24	70.661	146.797	bowhead whale	unknown	1	0	1
23	8/27/2016 14:25	70.686	146.848	bowhead whale	rest	1	0	2
23	8/27/2016 14:26	70.719	146.840	bowhead whale	unknown	1	0	2
23	8/27/2016 14:26	70.720	146.852	bowhead whale	mill	3	0	2
23	8/27/2016 14:26	70.723	146.712	bowhead whale	unknown	3	0	2
23	8/27/2016 14:26	70.727	146.815	bowhead whale	dive	1	0	2
23	8/27/2016 14:27	70.776	146.782	bowhead whale	unknown	3	0	2
23	8/27/2016 14:33	70.970	146.922	unid cetacean	dead	1	0	2

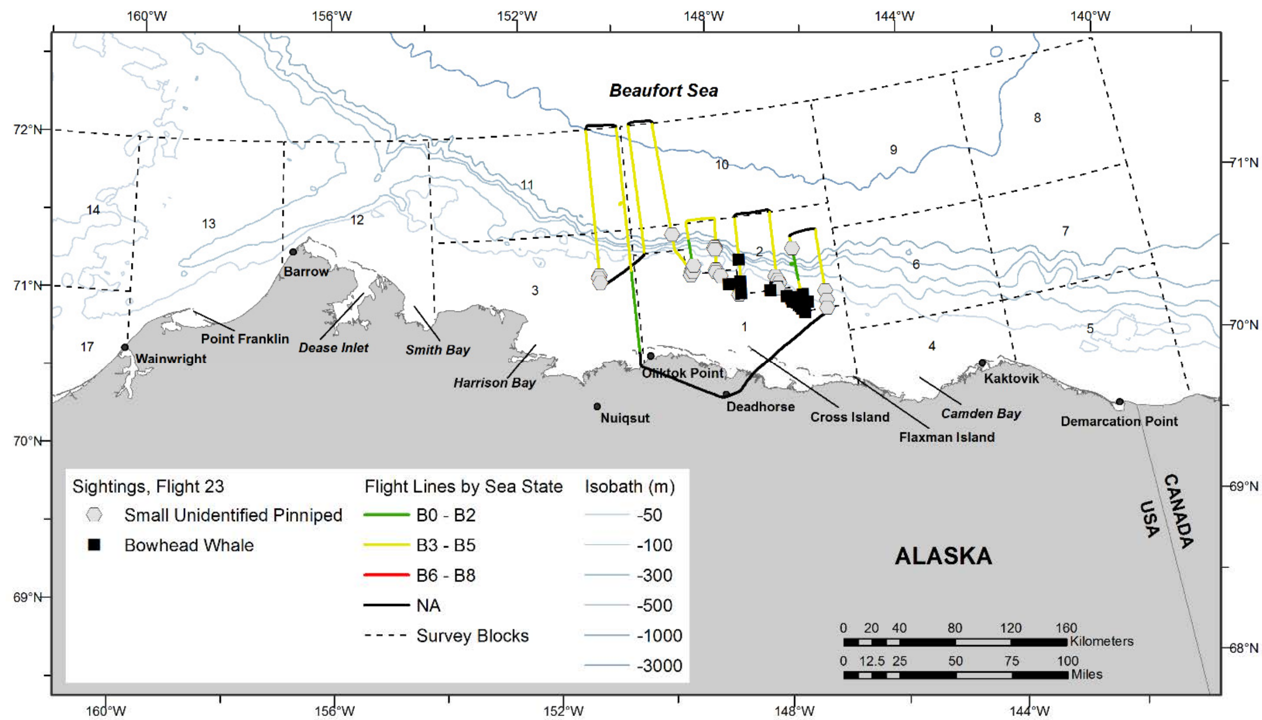


Figure B-53. ASAMM Flight 23 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Well-marked bowhead whale sighted near the water's surface, during ASAMM Flight 23, 27 August 2016.

28 August 2016, Flight 231

Flight was a complete survey of transect 9, partial survey of transect 11, and search effort between Point Franklin and Barrow. Survey conditions included partly cloudy to overcast skies, <1-5 km visibility (with fog, glare, haze, and low ceilings), and Beaufort 2-6 sea states. Sea ice cover was 0-3% broken floe in the area surveyed. Sightings included bowhead whales, gray whales (including six calves), one unidentified cetacean, one bearded seal, unidentified pinnipeds, and one small unidentified pinniped.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
231	8/28/2016 10:13	71.209	162.984	bowhead whale	rest	1	0	14
231	8/28/2016 10:19	71.297	163.193	bowhead whale	mill	3	0	15
231	8/28/2016 10:28	71.392	163.651	unid cetacean	dive	1	0	15
231	8/28/2016 11:34	71.252	161.576	gray whale	feed	2	1	14
231	8/28/2016 11:41	71.228	161.568	gray whale	feed	1	0	14
231	8/28/2016 11:43	71.246	161.573	gray whale	feed	1	0	14
231	8/28/2016 11:50	71.240	161.400	gray whale	feed	1	0	14
231	8/28/2016 11:53	71.242	161.349	gray whale	feed	1	0	14
231	8/28/2016 11:55	71.235	161.265	gray whale	feed	1	0	14
231	8/28/2016 12:00	71.274	161.397	gray whale	feed	1	0	14
231	8/28/2016 12:00	71.286	161.365	gray whale	feed	2	0	14
231	8/28/2016 12:03	71.223	161.327	gray whale	feed	1	0	14
231	8/28/2016 12:10	71.072	160.868	gray whale	feed	1	0	14
231	8/28/2016 12:11	71.070	160.855	gray whale	feed	2	0	14
231	8/28/2016 12:12	71.069	160.835	gray whale	swim	2	1	14
231	8/28/2016 12:17	71.053	160.843	gray whale	rest	4	0	14
231	8/28/2016 12:20	71.066	160.932	gray whale	feed	11	1	14
231	8/28/2016 12:23	71.074	160.906	gray whale	rest	1	1	14
231	8/28/2016 12:23	71.080	160.890	gray whale	swim	2	1	14
231	8/28/2016 12:26	71.063	160.734	gray whale	feed	1	0	14
231	8/28/2016 12:28	71.057	160.774	gray whale	feed	2	0	14
231	8/28/2016 12:34	70.932	160.236	gray whale	feed	1	0	17
231	8/28/2016 12:36	70.947	160.249	gray whale	feed	1	0	17
231	8/28/2016 12:36	70.950	160.219	gray whale	feed	1	0	17
231	8/28/2016 12:37	70.958	160.246	gray whale	swim	2	1	17
231	8/28/2016 12:38	70.950	160.271	gray whale	feed	5	0	17
231	8/28/2016 12:38	70.963	160.226	gray whale	feed	7	0	17

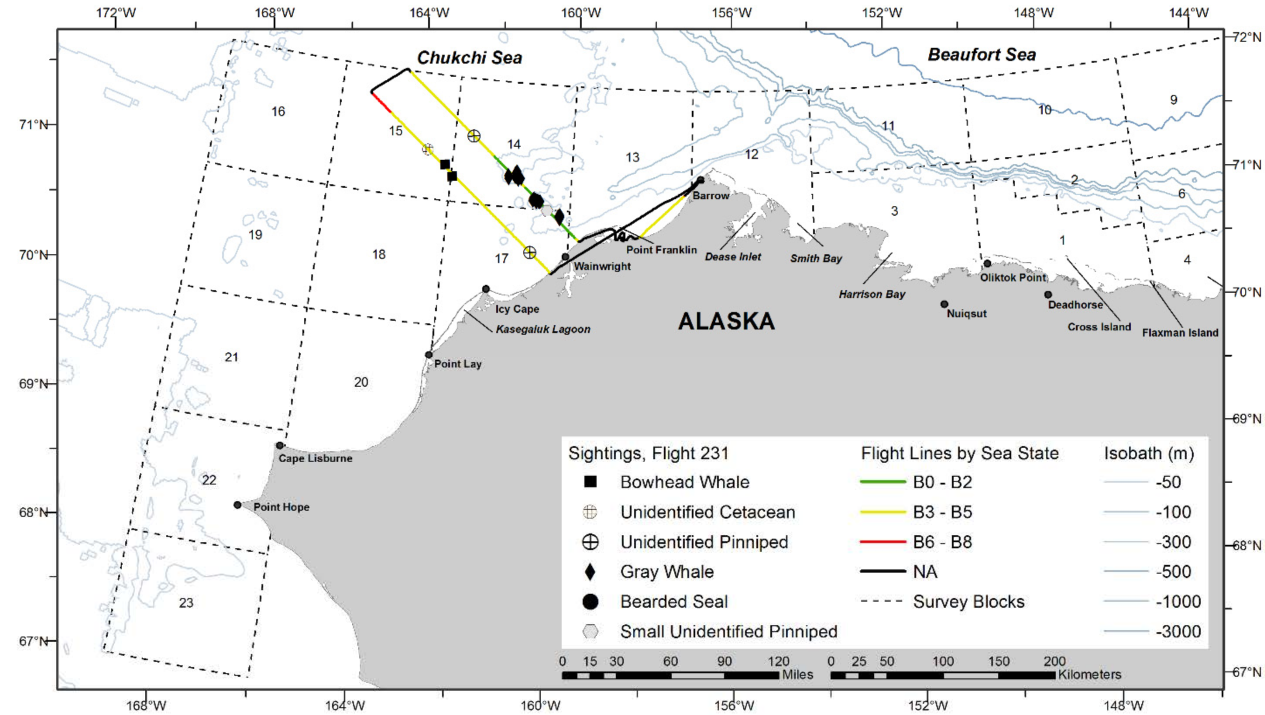


Figure B-54. ASAMM Flight 231 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

28 August 2016, Flight 24

Flight was a survey of portions of blocks 5 and 7. Survey conditions included clear skies, unlimited visibility (with glare), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including two calves) and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
24	8/28/2016 11:33	70.061	140.299	bowhead whale	swim	2	1	5
24	8/28/2016 12:45	70.082	140.753	bowhead whale	swim	1	0	5
24	8/28/2016 12:50	69.992	140.651	bowhead whale	rest	2	1	5
24	8/28/2016 12:52	70.009	140.707	bowhead whale	swim	2	0	5

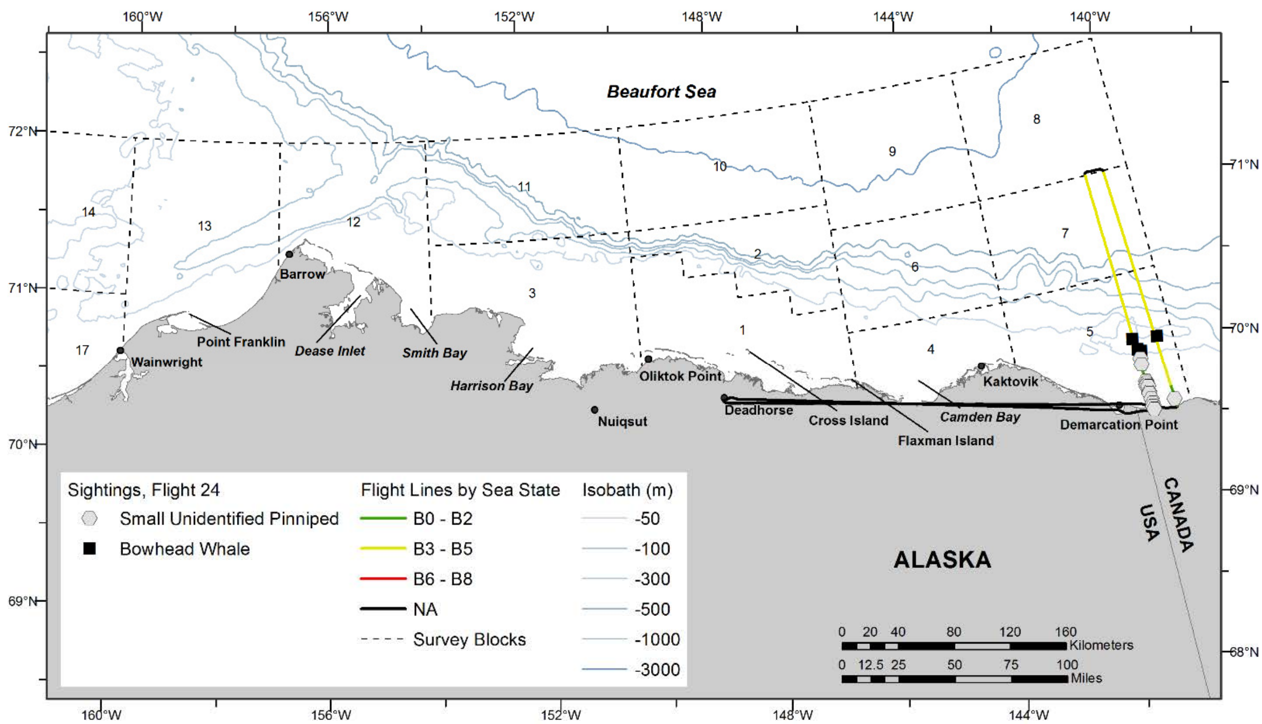


Figure B-55. ASAMM Flight 24 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale cow-calf pair sighted approximately 40 km north of Demarcation Point, Alaska, ASAMM Flight 24, 28 August 2016.

Bowhead whale fluke photographed during ASAMM Flight 24, 28 August 2016.

29 August 2016, Flight 232

Flight was a complete survey of transects 36, 37, and 38, and partial survey of transects 34 and 35. Survey conditions included clear to partly cloudy skies, 0 km to unlimited visibility (with fog, glare, and haze), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales (including seven calves), fin whales, humpback whales (including three calves), minke whales, one harbor porpoise, unidentified cetaceans, unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
232	8/29/2016 11:25	67.677	167.552	gray whale	feed	5	0	23
232	8/29/2016 11:27	67.672	167.585	fin whale	feed	1	0	23
232	8/29/2016 11:31	67.670	167.587	minke whale	swim	1	0	23
232	8/29/2016 11:34	67.648	167.614	fin whale	swim	1	0	23
232	8/29/2016 11:36	67.648	167.577	gray whale	feed	2	1	23
232	8/29/2016 11:37	67.641	167.595	gray whale	feed	1	0	23
232	8/29/2016 11:39	67.632	167.663	fin whale	dive	1	0	23
232	8/29/2016 11:41	67.641	167.691	gray whale	rest	1	0	23
232	8/29/2016 11:41	67.645	167.682	humpback whale	dive	1	0	23
232	8/29/2016 11:44	67.635	167.636	fin whale	feed	1	0	23
232	8/29/2016 11:46	67.653	167.537	gray whale	feed	2	0	23
232	8/29/2016 11:47	67.698	167.599	gray whale	rest	1	0	23
232	8/29/2016 11:54	67.715	168.067	gray whale	mill	8	0	23
232	8/29/2016 11:54	67.713	168.099	gray whale	rest	2	0	23
232	8/29/2016 11:56	67.735	168.059	gray whale	swim	2	0	23
232	8/29/2016 11:56	67.731	168.062	gray whale	rest	2	0	23
232	8/29/2016 11:59	67.711	168.090	gray whale	rest	2	1	23
232	8/29/2016 12:02	67.725	168.013	gray whale	mill	3	0	23
232	8/29/2016 12:04	67.730	168.084	gray whale	swim	3	0	23
232	8/29/2016 12:05	67.748	168.029	gray whale	feed	21	0	23
232	8/29/2016 12:05	67.748	168.028	gray whale	feed	23	0	23
232	8/29/2016 12:11	67.716	168.098	gray whale	feed	29	1	23
232	8/29/2016 12:15	67.696	168.194	gray whale	rest	4	1	23
232	8/29/2016 12:16	67.702	168.191	gray whale	feed	2	0	23
232	8/29/2016 12:17	67.693	168.215	gray whale	swim	5	0	23
232	8/29/2016 12:19	67.717	168.173	gray whale	rest	3	2	23
232	8/29/2016 12:22	67.681	168.281	unid cetacean	swim	1	0	23
232	8/29/2016 12:30	67.680	168.676	fin whale	swim	1	0	23
232	8/29/2016 12:33	67.648	168.679	humpback whale	swim	2	1	23
232	8/29/2016 12:38	67.627	168.733	humpback whale	swim	2	0	23
232	8/29/2016 12:40	67.628	168.755	humpback whale	swim	1	0	23
232	8/29/2016 12:42	67.589	168.772	humpback whale	swim	2	1	23

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
232	8/29/2016 12:43	67.575	168.761	humpback whale	swim	2	1	23
232	8/29/2016 13:03	67.526	167.523	harbor porpoise	swim	1	0	23
232	8/29/2016 13:06	67.537	167.233	humpback whale	rest	4	0	23
232	8/29/2016 13:08	67.549	167.226	unid cetacean	dive	1	0	23
232	8/29/2016 13:14	67.523	167.199	fin whale	dive	1	0	23
232	8/29/2016 16:18	67.763	166.335	unid cetacean	unknown	1	0	23
232	8/29/2016 16:27	67.764	166.159	minke whale	rest	1	0	23
232	8/29/2016 16:47	67.815	167.236	gray whale	rest	1	0	23
232	8/29/2016 16:56	67.861	167.366	gray whale	rest	1	0	23
232	8/29/2016 17:02	67.855	167.806	humpback whale	rest	1	0	23
232	8/29/2016 17:06	67.869	167.794	fin whale	rest	1	0	23
232	8/29/2016 17:07	67.881	167.800	humpback whale	swim	1	0	23
232	8/29/2016 17:13	67.815	167.865	gray whale	feed	5	0	23
232	8/29/2016 17:14	67.856	167.812	gray whale	rest	1	0	23
232	8/29/2016 17:17	67.813	167.915	gray whale	feed	4	0	23
232	8/29/2016 17:17	67.852	167.952	gray whale	feed	1	0	23
232	8/29/2016 17:19	67.799	167.968	gray whale	rest	1	0	23
232	8/29/2016 17:21	67.828	168.024	gray whale	feed	1	0	23
232	8/29/2016 17:22	67.814	168.021	gray whale	feed	2	0	23
232	8/29/2016 17:24	67.816	168.041	gray whale	feed	1	0	23
232	8/29/2016 17:25	67.801	168.082	gray whale	feed	7	0	23
232	8/29/2016 17:27	67.822	167.926	gray whale	feed	4	1	23
232	8/29/2016 17:28	67.836	167.902	gray whale	feed	1	0	23

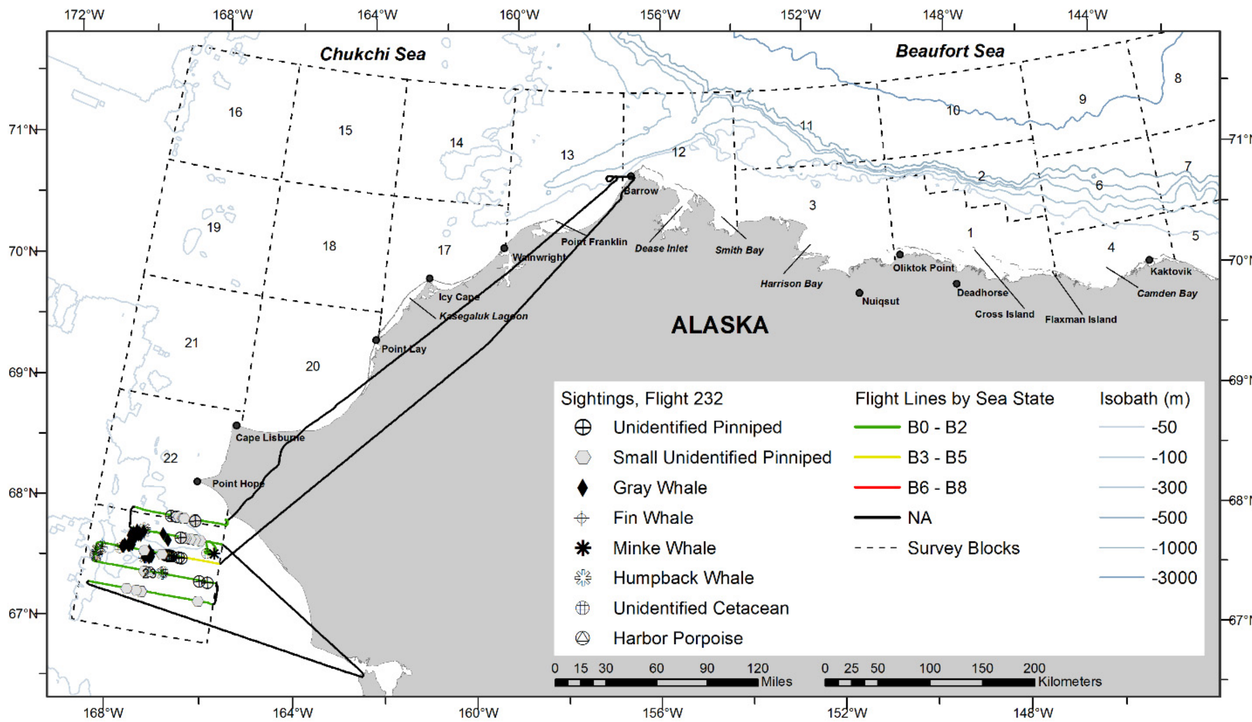


Figure B-56. ASAMM Flight 232 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Fin whale sighted feeding approximately 80 km southwest of Point Hope, Alaska, during ASAMM Flight 232, 29 August 2016. This fin whale was in a clustered group of cetaceans including gray whales, fin whales, one humpback whale, and one minke whale.

Humpback whale sighted approximately 80 km southwest of Point Hope, Alaska, during ASAMM Flight 232, 29 August 2016.

Adult gray whale with two closely associated calves sighted approximately 90 km southwest of Point Hope, Alaska, during ASAMM Flight 232, 29 August 2016. This triad was within a larger cluster of >100 gray whales.

3 September 2016, Flight 233

Flight was a complete survey of transects 17 and 19. Survey conditions included clear skies, unlimited visibility (with glare), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. Sightings included one gray whale, one humpback whale, one minke whale, killer whales (including three calves), one unidentified cetacean, walruses (including one carcass), and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
233	9/3/2016 11:36	71.268	168.503	killer whale	swim	15	3	16
233	9/3/2016 12:28	70.737	166.364	unid cetacean	unknown	1	0	19
233	9/3/2016 12:37	70.735	166.211	minke whale	swim	1	0	19
233	9/3/2016 12:59	70.423	165.014	humpback whale	swim	1	0	18
233	9/3/2016 13:32	69.896	162.963	gray whale	swim	1	0	17

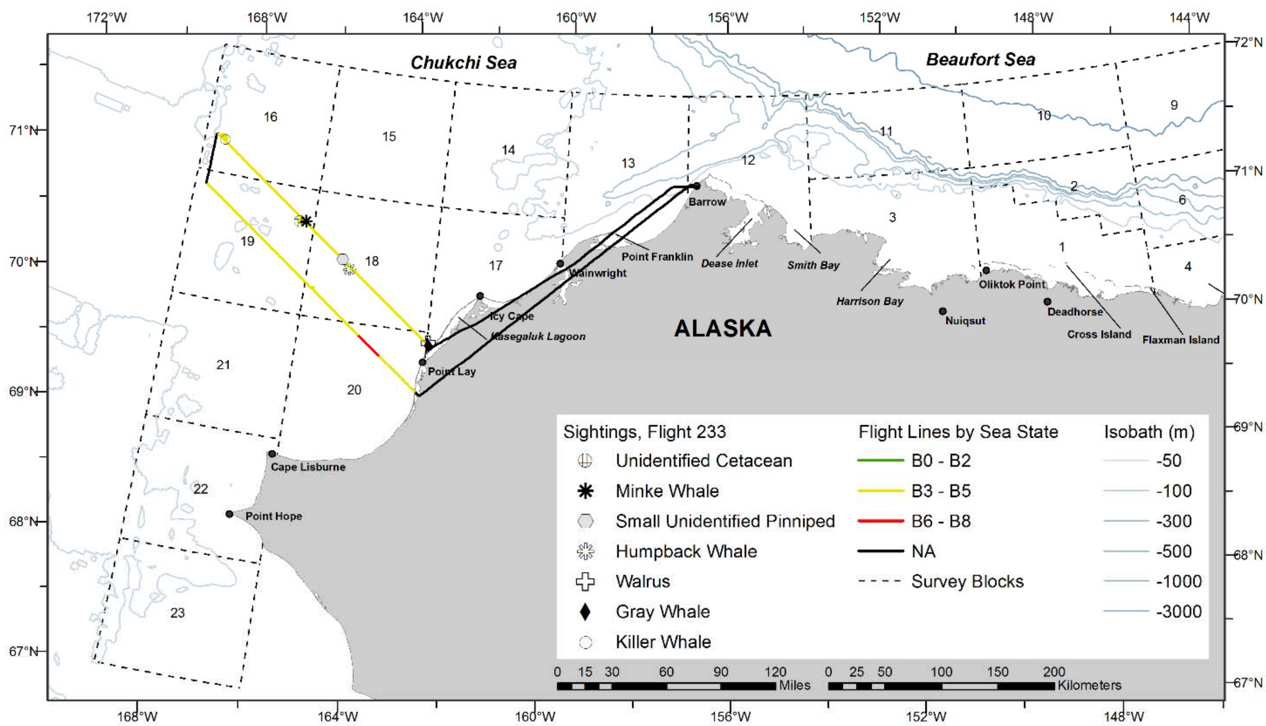
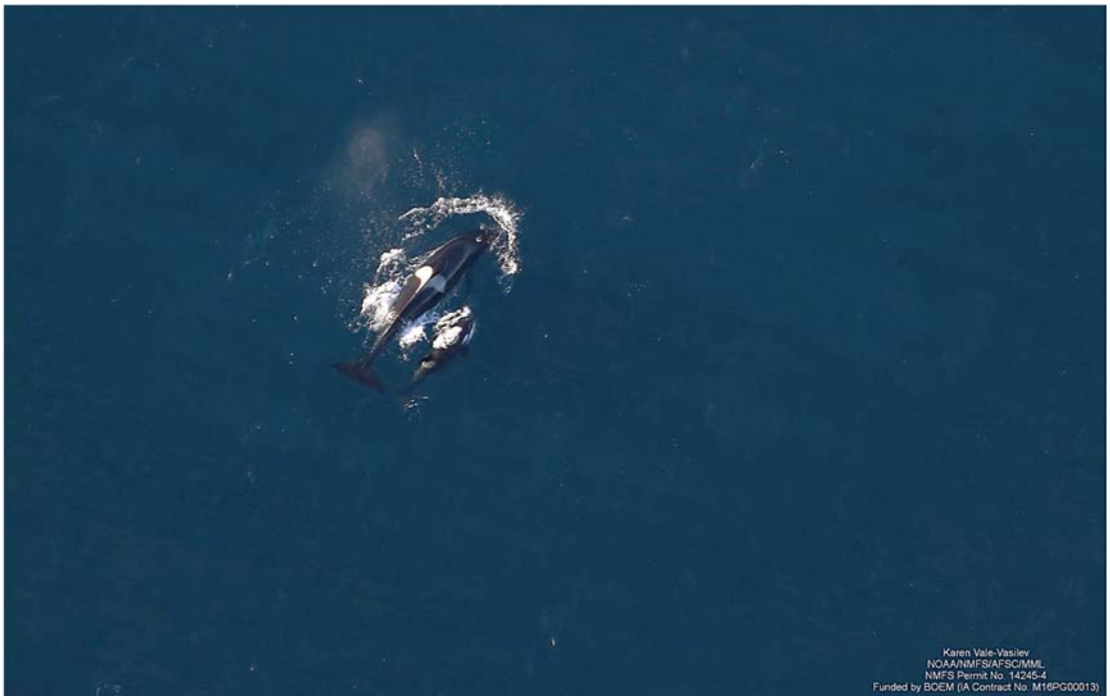


Figure B-57. ASAMM Flight 233 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



One of three killer whale cow-calf pairs sighted approximately 420 km west of Barrow, Alaska, during ASAMM Flight 233, 3 September 2016.

Adult minke whale sighted swimming approximately 230 km west of Wainwright, Alaska, during ASAMM Flight 233, 3 September 2016.

3 September 2016, Flight 25

Flight was a partial survey of transect 9. Survey conditions included clear skies, unlimited visibility (with glare), and Beaufort 2-3 sea states. Sea ice cover was 0-45% broken floe in the area surveyed. Sightings included bowhead whales, gray whales, unidentified cetaceans, walruses, unidentified pinnipeds, and one small unidentified pinniped.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
25	9/3/2016 12:41	70.918	160.332	gray whale	feed	2	0	17
25	9/3/2016 12:43	70.906	160.292	gray whale	feed	14	0	17
25	9/3/2016 12:43	70.906	160.292	unid cetacean	swim	1	0	17
25	9/3/2016 12:47	70.866	160.458	gray whale	feed	1	0	17
25	9/3/2016 12:55	71.051	160.723	gray whale	swim	1	0	14
25	9/3/2016 12:55	71.055	160.749	gray whale	feed	3	0	14
25	9/3/2016 12:56	71.052	160.759	gray whale	swim	2	0	14
25	9/3/2016 13:00	71.066	160.761	gray whale	feed	3	0	14
25	9/3/2016 13:01	71.074	160.774	gray whale	feed	1	0	14
25	9/3/2016 13:01	71.073	160.801	gray whale	feed	1	0	14
25	9/3/2016 13:01	71.076	160.821	gray whale	feed	4	0	14
25	9/3/2016 13:01	71.068	160.857	gray whale	feed	2	0	14
25	9/3/2016 13:07	71.201	161.262	gray whale	feed	1	0	14
25	9/3/2016 13:09	71.220	161.260	gray whale	feed	1	0	14
25	9/3/2016 13:10	71.222	161.270	gray whale	feed	1	0	14
25	9/3/2016 13:11	71.227	161.173	gray whale	feed	2	0	14
25	9/3/2016 13:14	71.234	161.341	gray whale	feed	1	0	14
25	9/3/2016 13:15	71.232	161.365	gray whale	feed	1	0	14
25	9/3/2016 13:18	71.283	161.617	unid cetacean	dive	2	0	14
25	9/3/2016 13:26	71.393	162.005	unid cetacean	swim	1	0	14
25	9/3/2016 13:36	71.570	162.661	bowhead whale	swim	1	0	14
25	9/3/2016 13:37	71.561	162.688	bowhead whale	swim	1	0	14
25	9/3/2016 13:43	71.596	162.774	bowhead whale	swim	1	0	14
25	9/3/2016 13:46	71.595	162.781	bowhead whale	mill	2	0	14
25	9/3/2016 13:46	71.604	162.782	bowhead whale	swim	1	0	14
25	9/3/2016 13:47	71.599	162.773	bowhead whale	swim	5	0	14
25	9/3/2016 13:48	71.616	162.827	bowhead whale	rest	1	0	14
25	9/3/2016 13:49	71.628	162.830	bowhead whale	swim	1	0	14
25	9/3/2016 14:00	71.686	162.947	bowhead whale	swim	1	0	14
25	9/3/2016 14:00	71.689	162.944	bowhead whale	swim	1	0	14
25	9/3/2016 14:01	71.691	163.018	bowhead whale	swim	1	0	15

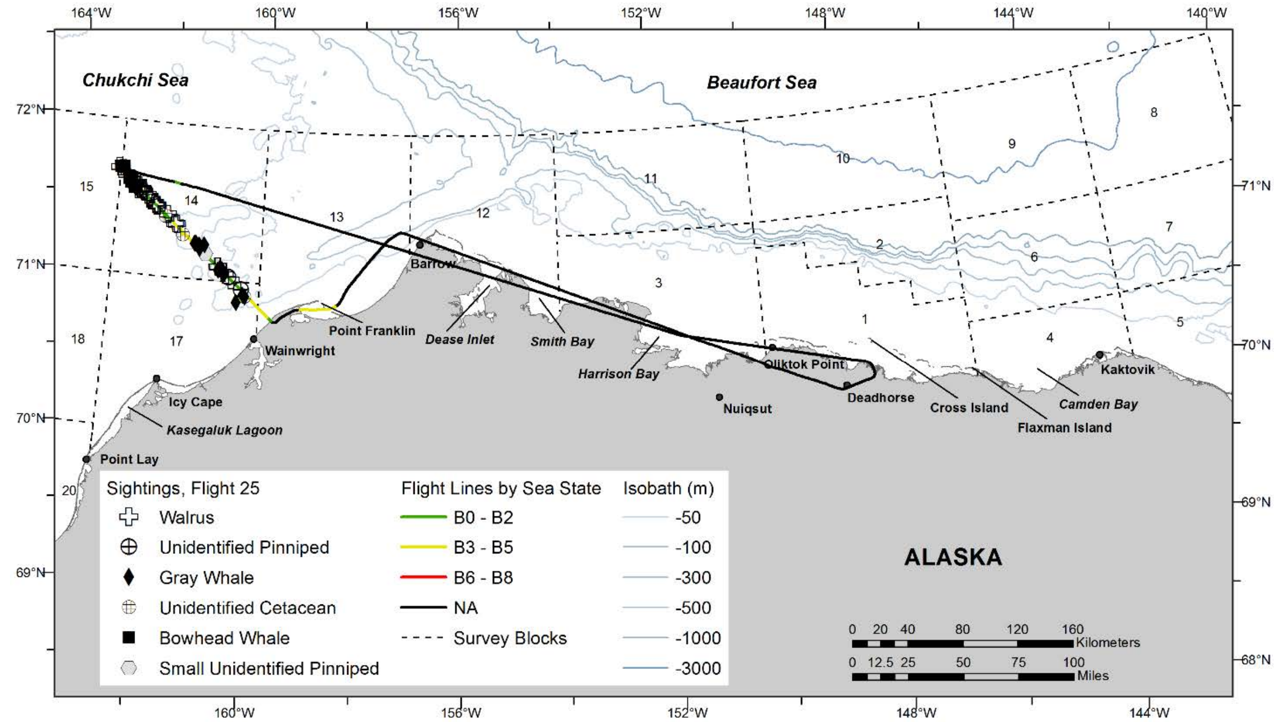


Figure B-58. ASAMM Flight 25 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

5 September 2016, Flight 234

Flight was a partial survey of transects 3 and 5 and a complete survey of transect 7. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-6 sea states. Sea ice cover was 0-90% broken floe in the area surveyed. Sightings included bowhead whales, one gray whale, walruses, bearded seals, one unidentified pinniped, one small unidentified pinniped, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
234	9/5/2016 14:00	71.818	158.582	bowhead whale	rest	1	0	13
234	9/5/2016 15:23	71.777	161.727	bowhead whale	swim	1	0	14
234	9/5/2016 15:27	71.715	161.525	bowhead whale	swim	1	0	14
234	9/5/2016 16:13	70.836	158.977	gray whale	feed	1	0	13

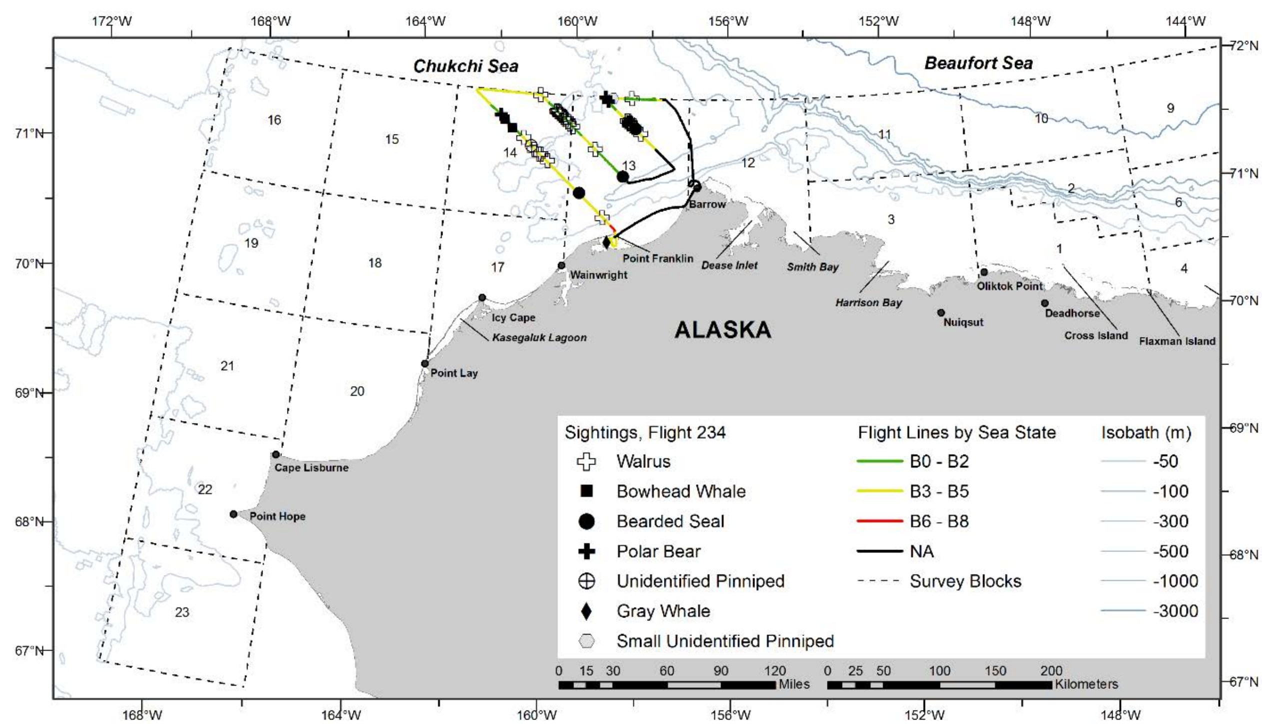


Figure B-59. ASAMM Flight 234 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale sighted feeding inside Peard Bay, Alaska, during ASAMM Flight 234, 5 September 2016.

5 September 2016, Flight 26

Flight was a survey of portions of blocks 1 and 2. Survey conditions included partly cloudy skies, 0 km to unlimited visibility (with glare, haze, low ceilings, and precipitation), and Beaufort 3-5 sea states. No sea ice was observed in the area surveyed. No sightings were observed.

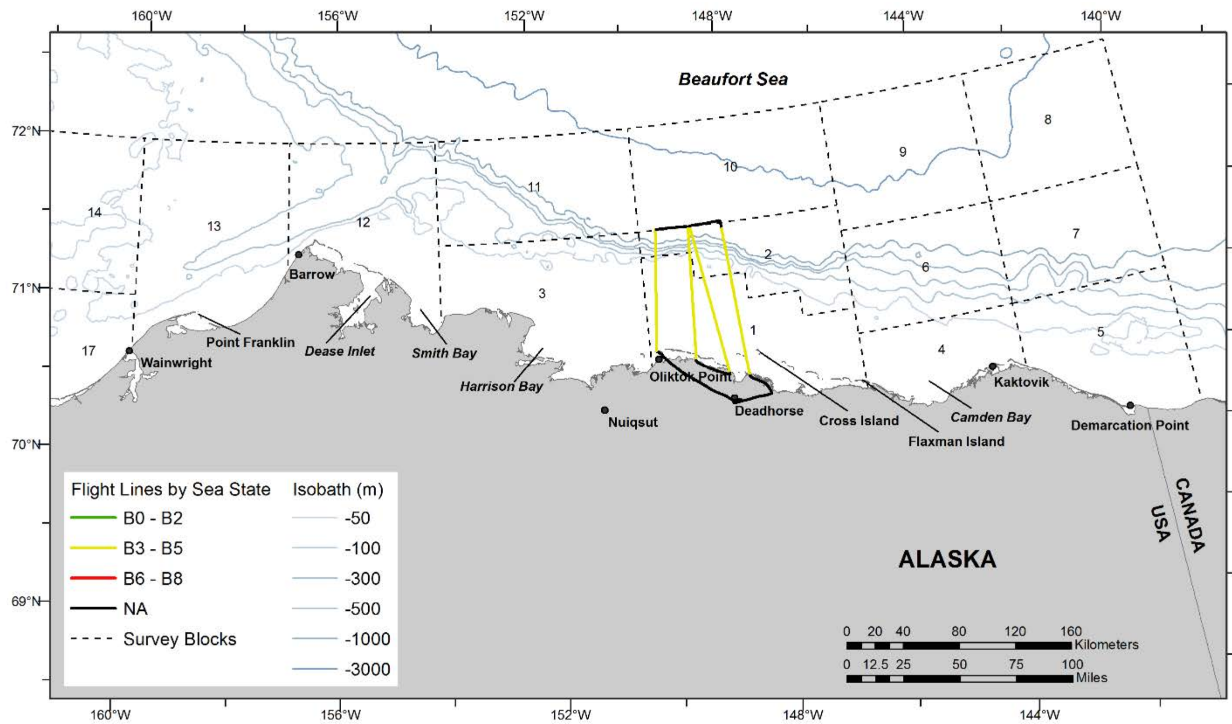


Figure B-60. ASAMM Flight 26 survey track, depicted by sea state.

6 September 2016, Flight 235

Flight was a partial survey of transects 13 and 15 and the coastal transect from east of Icy Cape to Barrow. 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 gray whales (including one carcass), three walrus carcasses, one unidentified marine mammal carcass, unidentified pinnipeds, small unidentified pinnipeds, and one polar bear. Two of the three walrus carcasses were previously documented during Flights 226 and 227.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
235	9/6/2016 10:44	70.588	162.062	gray whale	dead	1	0	17
235	9/6/2016 11:29	70.852	159.383	gray whale	swim	1	0	13

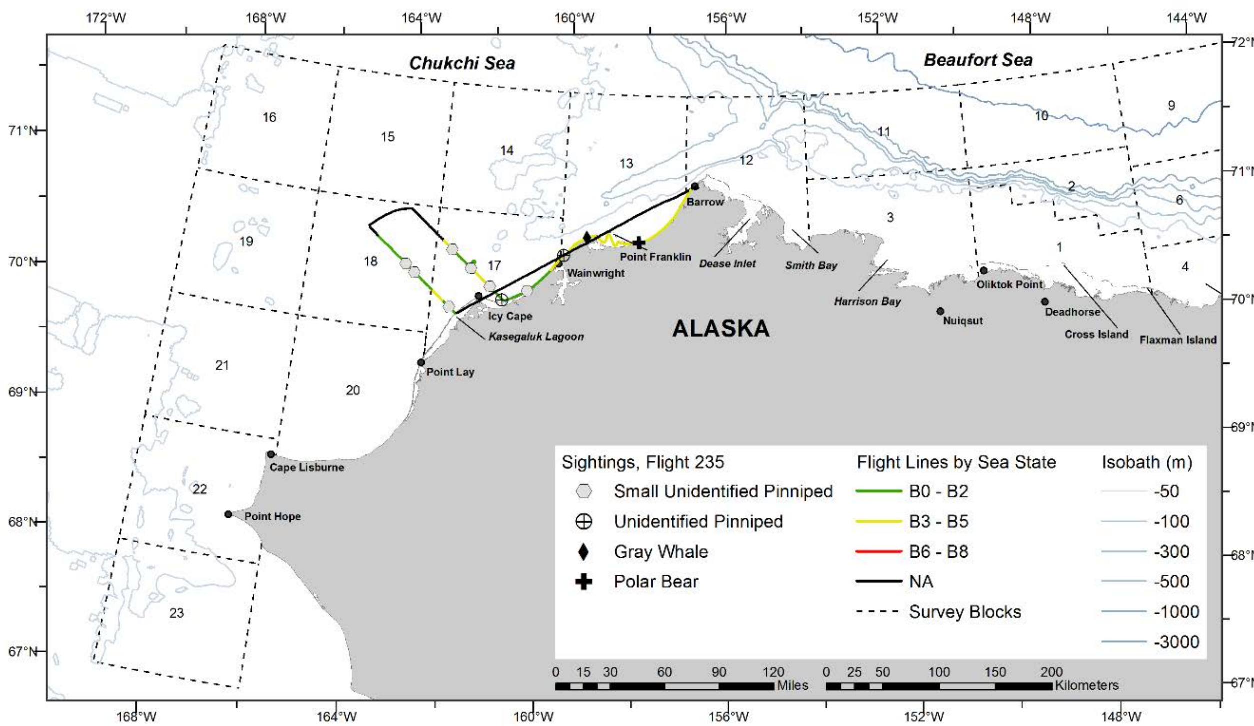


Figure B-61. ASAMM Flight 235 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

6 September 2016, Flight 27

Flight was a survey of portions of blocks 3, 11, and 12, and coastal search survey from Cape Halkett to the eastern border of block 3. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, haze, iced windows, low ceilings, and precipitation), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales, one walrus carcass, and one polar bear. The walrus carcass was previously sighted during Flight 22.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
27	9/6/2016 11:37	71.094	153.380	bowhead whale	swim	1	0	3
27	9/6/2016 11:51	71.000	152.779	bowhead whale	swim	1	0	3
27	9/6/2016 12:06	71.323	152.756	bowhead whale	rest	2	0	3
27	9/6/2016 12:06	71.327	152.741	bowhead whale	rest	1	0	3
27	9/6/2016 12:06	71.324	152.741	bowhead whale	rest	2	0	3
27	9/6/2016 12:06	71.322	152.741	bowhead whale	rest	1	0	3
27	9/6/2016 12:37	71.132	152.378	bowhead whale	swim	1	0	3
27	9/6/2016 12:38	71.119	152.365	bowhead whale	swim	1	0	3
27	9/6/2016 12:38	71.121	152.356	bowhead whale	log play	1	0	3
27	9/6/2016 12:42	71.108	152.359	bowhead whale	swim	2	0	3
27	9/6/2016 12:42	71.117	152.345	bowhead whale	swim	1	0	3
27	9/6/2016 12:48	70.994	152.421	bowhead whale	dive	2	0	3

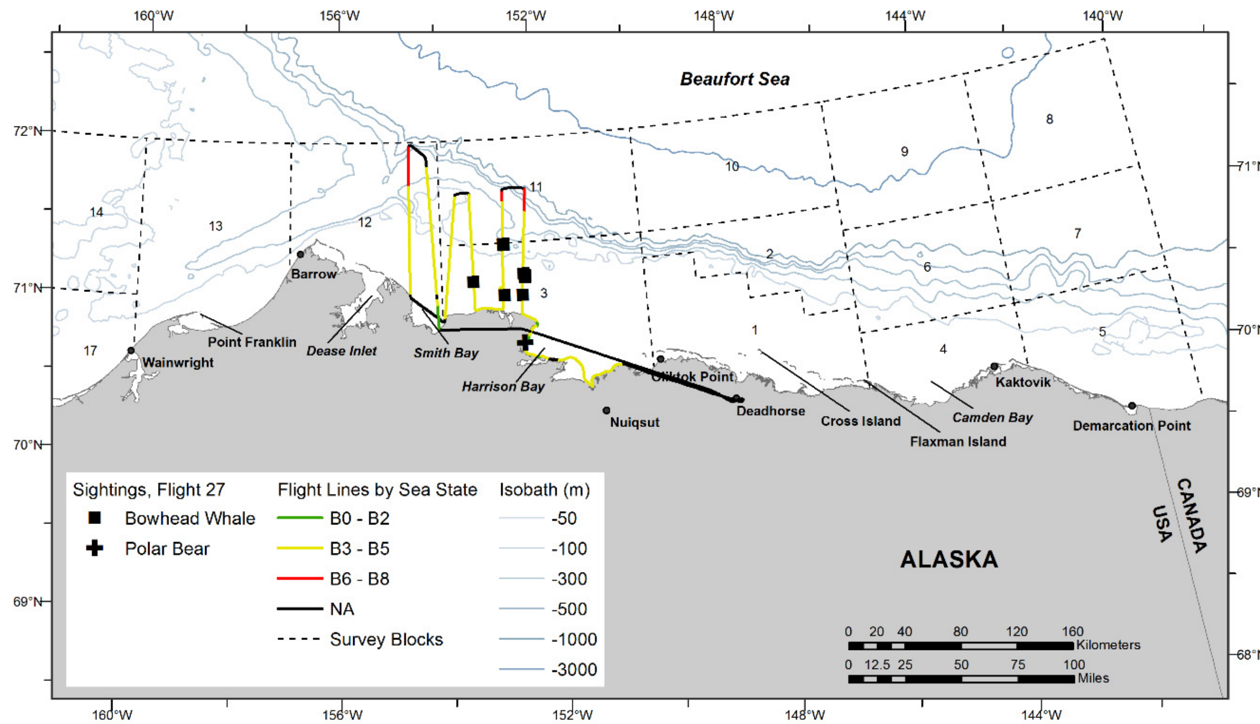


Figure B-62. ASAMM Flight 27 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale (on its side) sighted playing with a log approximately 30 km north of Cape Halkett, Alaska, during ASAMM Flight 27, 6 September 2016.

8 September 2016, Flight 28

Flight was a survey of portions of blocks 4 and 6. Survey conditions included partly cloudy to overcast skies, 1 km to unlimited visibility (with glare, haze, and low ceilings), and Beaufort 1-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 15 calves and one carcass), one beluga, unidentified cetaceans (including one carcass), one unidentified pinniped, small unidentified pinnipeds, and polar bears. The bowhead whale carcass was previously sighted during Flight 23 and resighted during Flight 39. The unidentified cetacean carcass was previously sighted during Flight 23.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
28	9/8/2016 17:32	70.268	143.291	bowhead whale	swim	1	0	4
28	9/8/2016 17:32	70.266	143.273	bowhead whale	mill	3	1	4
28	9/8/2016 17:33	70.255	143.299	bowhead whale	swim	1	0	4
28	9/8/2016 17:36	70.275	143.342	bowhead whale	swim	1	0	4
28	9/8/2016 17:48	70.241	143.628	bowhead whale	swim	1	0	4
28	9/8/2016 17:50	70.261	143.676	bowhead whale	swim	1	0	4
28	9/8/2016 17:53	70.364	143.662	bowhead whale	swim	2	1	4
28	9/8/2016 18:03	70.457	144.066	unid cetacean	dead	1	0	4
28	9/8/2016 18:10	70.305	144.121	bowhead whale	mill	4	2	4
28	9/8/2016 18:11	70.300	144.036	bowhead whale	swim	1	0	4
28	9/8/2016 18:11	70.296	144.021	bowhead whale	swim	1	0	4
28	9/8/2016 18:11	70.294	144.027	bowhead whale	swim	2	2	4
28	9/8/2016 18:12	70.298	144.105	bowhead whale	swim	2	0	4
28	9/8/2016 18:14	70.267	144.114	bowhead whale	dive	5	0	4
28	9/8/2016 18:15	70.255	144.136	bowhead whale	swim	1	1	4
28	9/8/2016 18:15	70.250	144.151	bowhead whale	swim	3	0	4
28	9/8/2016 18:16	70.251	144.138	bowhead whale	swim	1	0	4
28	9/8/2016 18:17	70.248	144.126	bowhead whale	swim	1	0	4
28	9/8/2016 18:20	70.297	143.997	bowhead whale	swim	1	0	4
28	9/8/2016 18:20	70.304	143.983	bowhead whale	dive	1	0	4
28	9/8/2016 18:22	70.321	144.013	bowhead whale	log play	1	0	4
28	9/8/2016 18:23	70.332	144.011	bowhead whale	swim	1	0	4
28	9/8/2016 18:29	70.183	144.055	bowhead whale	dive	1	0	4
28	9/8/2016 18:51	70.246	144.667	bowhead whale	swim	2	1	4
28	9/8/2016 18:56	70.361	144.654	bowhead whale	swim	1	0	4
28	9/8/2016 19:18	70.669	145.326	bowhead whale	dead	1	0	6
28	9/8/2016 19:32	70.339	145.155	bowhead whale	swim	2	1	4
28	9/8/2016 19:35	70.289	145.243	bowhead whale	rest	2	1	4
28	9/8/2016 19:38	70.290	145.187	bowhead whale	swim	2	1	4
28	9/8/2016 19:40	70.261	145.164	bowhead whale	swim	1	1	4
28	9/8/2016 19:41	70.250	145.238	unid cetacean	swim	1	0	4

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
28	9/8/2016 19:42	70.253	145.100	bowhead whale	mill	2	1	4
28	9/8/2016 19:45	70.202	145.214	bowhead whale	rest	1	0	4
28	9/8/2016 19:46	70.195	145.195	bowhead whale	swim	2	0	4
28	9/8/2016 19:47	70.199	145.192	bowhead whale	rest	1	0	4
28	9/8/2016 19:47	70.206	145.206	bowhead whale	swim	1	0	4
28	9/8/2016 19:48	70.199	145.175	bowhead whale	swim	1	0	4
28	9/8/2016 19:50	70.195	145.154	bowhead whale	swim	1	0	4
28	9/8/2016 19:52	70.112	145.212	bowhead whale	swim	2	0	4
28	9/8/2016 19:55	70.105	145.121	bowhead whale	feed	1	0	4
28	9/8/2016 20:09	70.174	145.711	bowhead whale	breach	1	0	4
28	9/8/2016 20:13	70.175	145.765	beluga	dive	1	0	4
28	9/8/2016 20:15	70.255	145.830	bowhead whale	swim	2	0	4
28	9/8/2016 20:15	70.266	145.785	bowhead whale	swim	1	0	4
28	9/8/2016 20:17	70.283	145.799	bowhead whale	swim	1	0	4
28	9/8/2016 20:20	70.341	145.774	bowhead whale	swim	1	0	4
28	9/8/2016 20:20	70.342	145.783	bowhead whale	swim	1	0	4
28	9/8/2016 20:20	70.349	145.750	bowhead whale	swim	2	1	4
28	9/8/2016 20:21	70.351	145.744	bowhead whale	swim	1	0	4
28	9/8/2016 20:24	70.355	145.694	bowhead whale	swim	2	1	4
28	9/8/2016 20:24	70.356	145.689	bowhead whale	swim	1	0	4

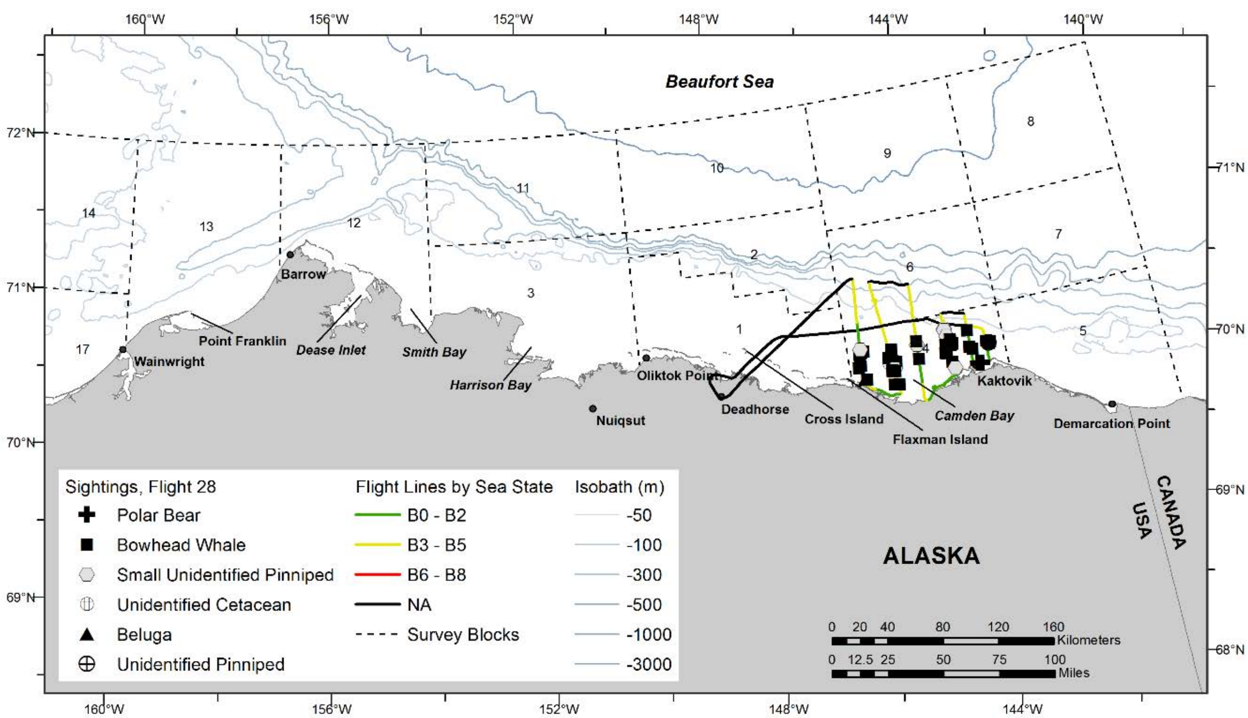


Figure B-63. ASAMM Flight 28 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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9 September 2016, Flight 29

Deadhead flight to block 5 looking for environmental conditions within survey parameters. Low ceilings and strong winds precluded survey effort. No sightings were observed.

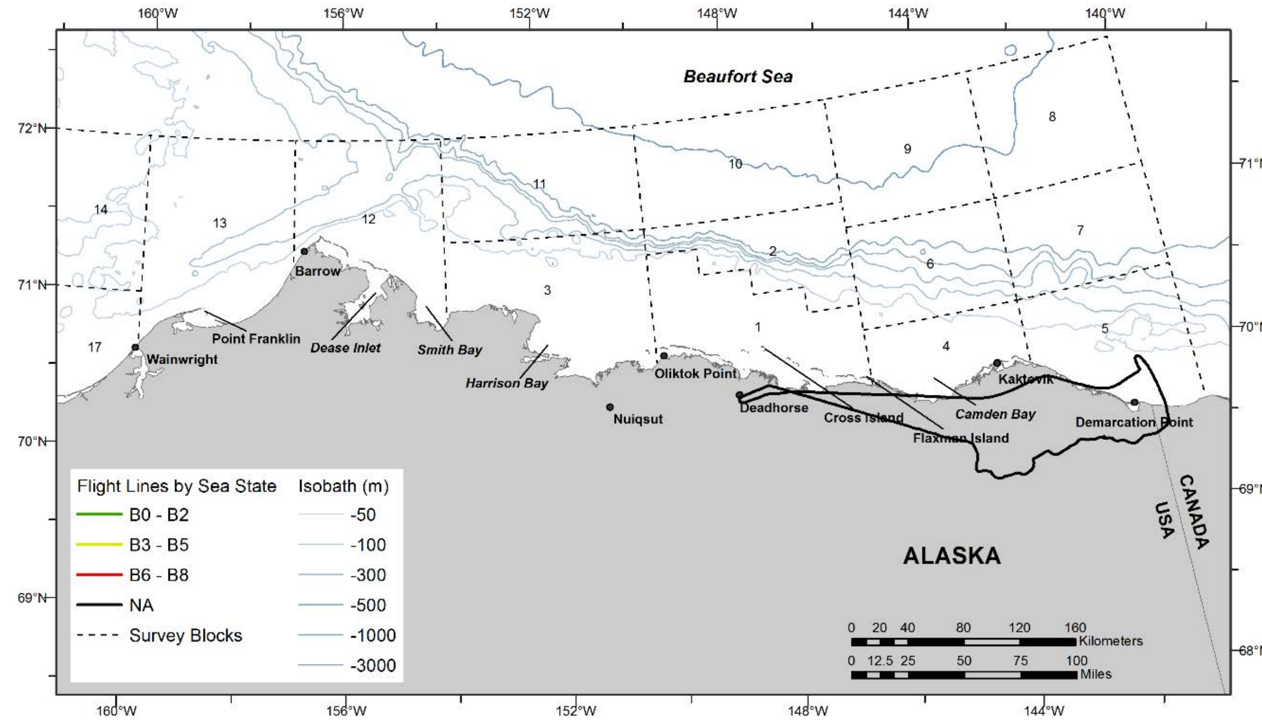


Figure B-64. ASAMM Flight 29 survey track, depicted by sea state.

10 September 2016, Flight 236

Flight was a complete survey of transects 2, 4, 6, and 8 and search effort in Peard Bay. Survey conditions included partly cloudy to overcast skies, 1 km to unlimited visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-85% broken floe in the area surveyed. Sightings included bowhead whales (including one carcass), gray whales, unidentified cetaceans, walruses, bearded seals, unidentified pinnipeds, small unidentified pinnipeds, and one polar bear. The bowhead whale carcass was previously documented during Flight 206.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
236	9/10/2016 13:00	71.838	159.380	bowhead whale	swim	1	0	13
236	9/10/2016 13:01	71.834	159.361	bowhead whale	swim	1	0	13
236	9/10/2016 13:01	71.835	159.362	bowhead whale	swim	2	0	13
236	9/10/2016 13:33	71.240	157.508	gray whale	feed	2	0	13
236	9/10/2016 13:33	71.240	157.495	gray whale	feed	2	0	13
236	9/10/2016 13:33	71.244	157.473	gray whale	swim	1	0	13
236	9/10/2016 13:39	71.253	157.413	gray whale	swim	2	0	13
236	9/10/2016 13:39	71.265	157.401	gray whale	feed	1	0	13
236	9/10/2016 13:39	71.269	157.408	gray whale	feed	3	0	13
236	9/10/2016 13:54	70.919	157.601	bowhead whale	dead	1	0	13
236	9/10/2016 14:01	70.881	157.823	gray whale	feed	2	0	13
236	9/10/2016 14:44	71.599	160.223	bowhead whale	dive	1	0	14
236	9/10/2016 14:47	71.625	160.367	bowhead whale	rest	1	0	14
236	9/10/2016 14:49	71.639	160.379	bowhead whale	swim	1	0	14
236	9/10/2016 14:51	71.654	160.505	bowhead whale	tail slap	1	0	14
236	9/10/2016 14:52	71.652	160.508	bowhead whale	feed	2	0	14
236	9/10/2016 14:54	71.657	160.522	bowhead whale	swim	1	0	14
236	9/10/2016 14:55	71.667	160.539	bowhead whale	swim	1	0	14
236	9/10/2016 14:59	71.717	160.688	bowhead whale	swim	1	0	14
236	9/10/2016 14:59	71.724	160.707	bowhead whale	swim	1	0	14
236	9/10/2016 15:01	71.739	160.756	bowhead whale	swim	1	0	14
236	9/10/2016 15:01	71.746	160.783	bowhead whale	swim	1	0	14
236	9/10/2016 15:01	71.745	160.795	bowhead whale	swim	1	0	14
236	9/10/2016 15:02	71.739	160.782	bowhead whale	swim	1	0	14
236	9/10/2016 15:02	71.737	160.764	bowhead whale	swim	1	0	14
236	9/10/2016 15:03	71.745	160.784	bowhead whale	swim	1	0	14
236	9/10/2016 15:32	71.904	162.963	unid cetacean	dive	1	0	14
236	9/10/2016 15:35	71.902	162.882	bowhead whale	swim	1	0	14
236	9/10/2016 15:37	71.884	162.994	bowhead whale	swim	2	0	14
236	9/10/2016 15:39	71.884	162.992	bowhead whale	swim	1	0	14
236	9/10/2016 15:42	71.862	162.791	bowhead whale	swim	1	0	14

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
236	9/10/2016 15:44	71.815	162.785	unid cetacean	swim	1	0	14
236	9/10/2016 15:53	71.681	162.194	bowhead whale	swim	1	0	14
236	9/10/2016 16:02	71.542	161.709	bowhead whale	swim	2	0	14
236	9/10/2016 16:12	71.365	161.015	bowhead whale	swim	1	0	14
236	9/10/2016 16:20	71.182	160.391	bowhead whale	rest	1	0	14

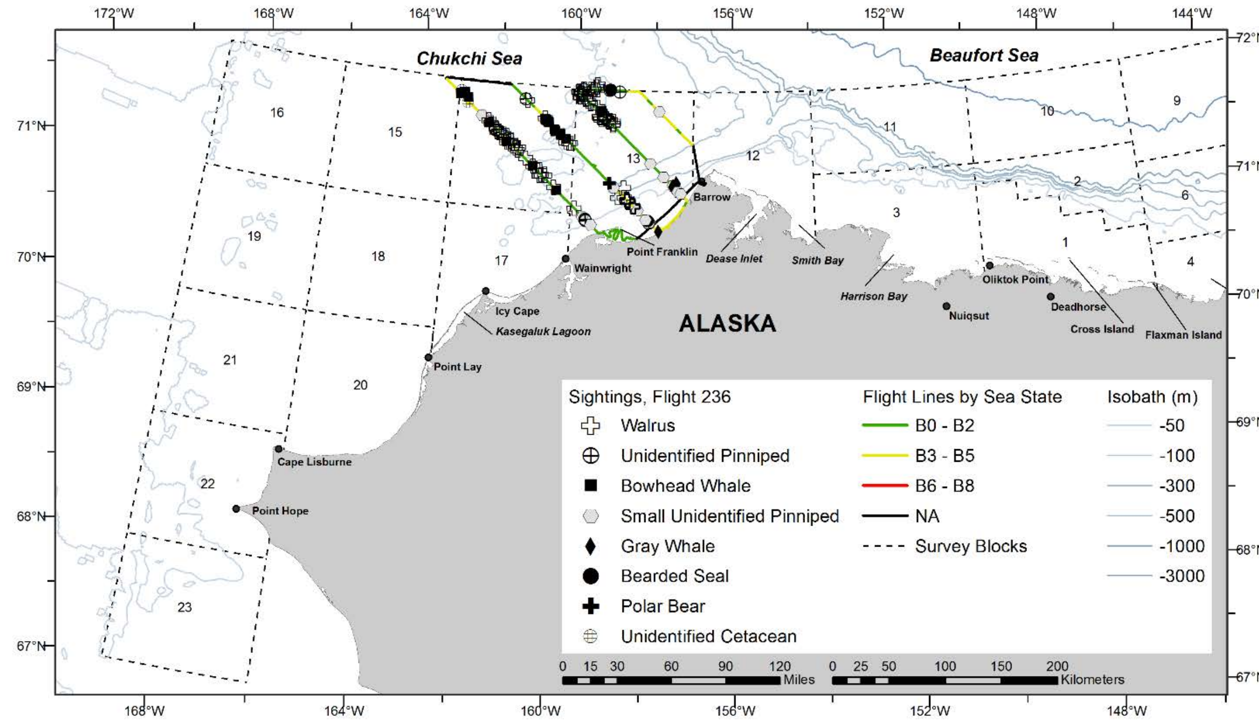
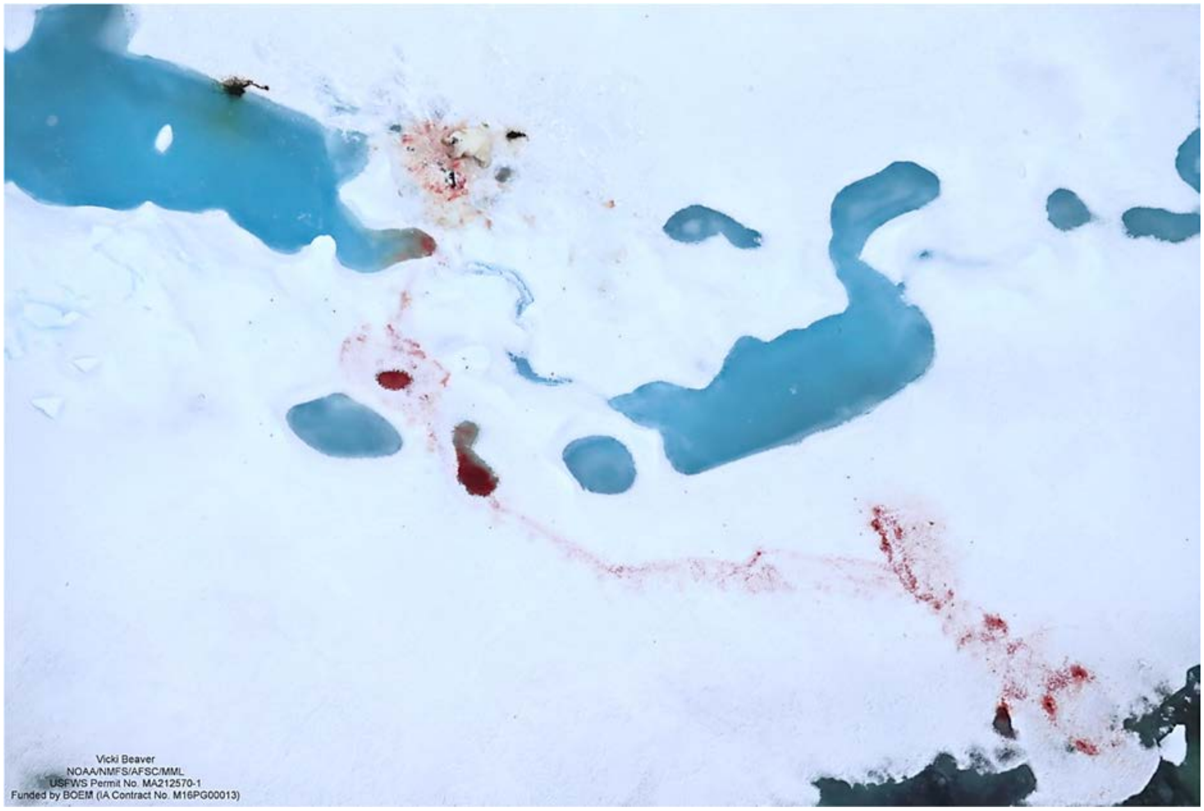


Figure B-65. ASAMM Flight 236 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



Polar bear doing what it takes to survive in the Arctic! Sighted approximately 40 km north of Point Franklin in an area of 40% broken floe sea ice, during ASAMM Flight 236, 10 September 2016. The original sighting was the kill site; the polar bear was discovered during post-flight image processing.

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10 September 2016, Flight 30

Flight was a survey of block 12. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with 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 bowhead whales (including one calf), gray whales, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
30	9/10/2016 14:46	71.399	154.261	bowhead whale	swim	1	0	12
30	9/10/2016 14:46	71.402	154.244	bowhead whale	swim	1	0	12
30	9/10/2016 14:50	71.453	154.233	bowhead whale	swim	1	0	12
30	9/10/2016 15:53	71.428	155.098	bowhead whale	swim	1	0	12
30	9/10/2016 15:56	71.499	155.164	gray whale	feed	1	0	12
30	9/10/2016 15:57	71.513	155.174	bowhead whale	swim	1	0	12
30	9/10/2016 15:57	71.515	155.187	bowhead whale	swim	1	0	12
30	9/10/2016 15:57	71.517	155.217	bowhead whale	swim	1	0	12
30	9/10/2016 15:57	71.534	155.155	bowhead whale	rest	1	0	12
30	9/10/2016 15:58	71.531	155.194	bowhead whale	swim	1	0	12
30	9/10/2016 15:58	71.534	155.217	bowhead whale	swim	1	0	12
30	9/10/2016 15:58	71.537	155.214	bowhead whale	swim	1	0	12
30	9/10/2016 15:59	71.540	155.254	bowhead whale	swim	1	0	12
30	9/10/2016 16:01	71.518	155.223	gray whale	feed	1	0	12
30	9/10/2016 16:01	71.519	155.221	bowhead whale	breach	1	0	12
30	9/10/2016 16:02	71.507	155.184	gray whale	swim	1	0	12
30	9/10/2016 16:03	71.515	155.238	bowhead whale	swim	1	0	12
30	9/10/2016 16:03	71.527	155.262	bowhead whale	swim	1	0	12
30	9/10/2016 16:03	71.527	155.283	bowhead whale	swim	2	0	12
30	9/10/2016 16:04	71.520	155.293	bowhead whale	swim	1	0	12
30	9/10/2016 16:04	71.514	155.288	bowhead whale	swim	1	0	12
30	9/10/2016 16:09	71.557	155.152	bowhead whale	swim	1	0	12
30	9/10/2016 16:09	71.560	155.130	bowhead whale	swim	1	0	12
30	9/10/2016 16:36	71.700	155.803	bowhead whale	swim	1	0	12
30	9/10/2016 16:43	71.537	155.828	gray whale	feed	3	0	12
30	9/10/2016 16:45	71.457	155.838	gray whale	swim	1	0	12
30	9/10/2016 16:59	71.498	156.184	gray whale	feed	2	0	12
30	9/10/2016 17:03	71.602	156.248	bowhead whale	swim	1	0	12
30	9/10/2016 17:04	71.610	156.251	bowhead whale	rest	1	0	12
30	9/10/2016 17:04	71.609	156.254	bowhead whale	rest	1	0	12
30	9/10/2016 17:05	71.623	156.247	bowhead whale	rest	2	1	12
30	9/10/2016 17:06	71.636	156.238	bowhead whale	swim	1	0	12
30	9/10/2016 17:06	71.655	156.221	bowhead whale	swim	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
30	9/10/2016 17:07	71.661	156.229	bowhead whale	swim	1	0	12
30	9/10/2016 17:08	71.677	156.236	bowhead whale	swim	1	0	12
30	9/10/2016 17:31	71.687	156.874	bowhead whale	swim	1	0	12

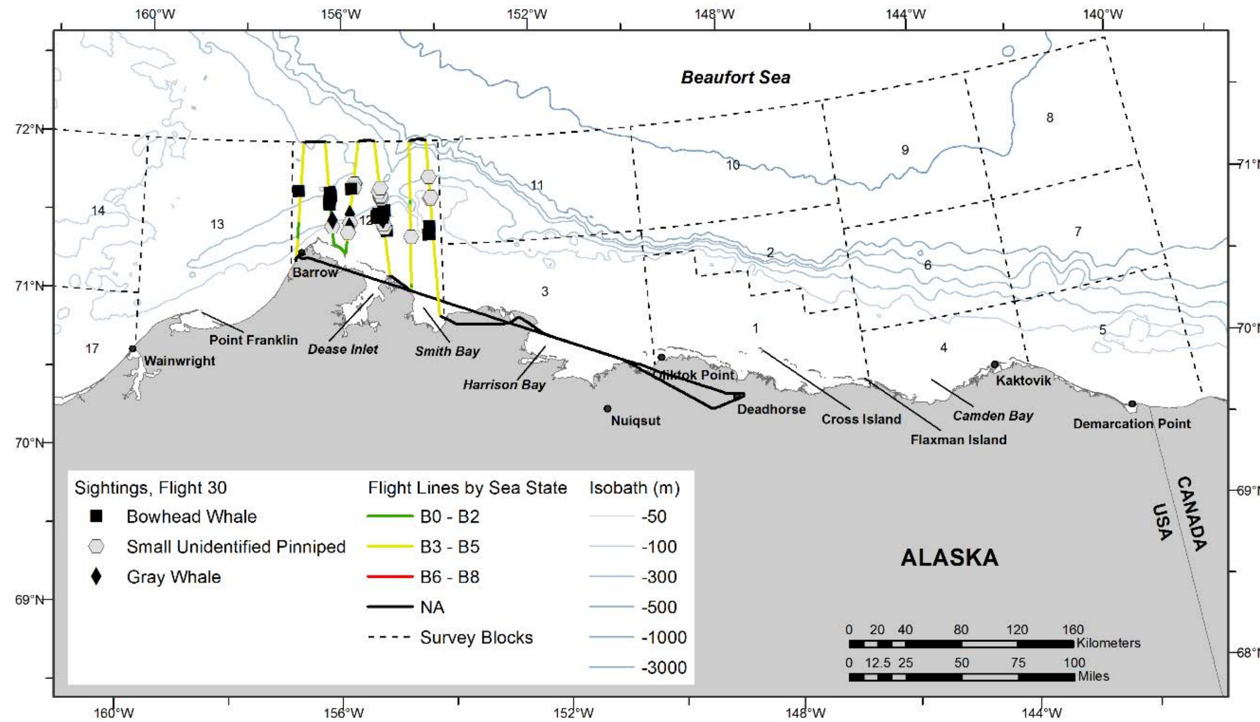

Figure B-66. ASAMM Flight 30 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

11 September 2016, Flight 237

Flight was a complete survey of transects 3, 5, 7, 10, 12, and 14. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-5 sea states. Sea ice cover was 0-75% broken floe in the area surveyed. Sightings included bowhead whales (including two carcasses), gray whales, one unidentified cetacean, walruses, one ribbon seal, unidentified pinnipeds, small unidentified pinnipeds, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
237	9/11/2016 12:13	71.311	165.809	bowhead whale	dead	1	0	15
237	9/11/2016 15:20	70.841	160.789	gray whale	feed	2	0	17
237	9/11/2016 15:22	70.846	160.804	gray whale	feed	2	0	17
237	9/11/2016 15:22	70.841	160.840	gray whale	feed	1	0	17
237	9/11/2016 15:23	70.835	160.861	gray whale	feed	2	0	17
237	9/11/2016 15:23	70.842	160.862	gray whale	feed	1	0	17
237	9/11/2016 15:24	70.846	160.877	gray whale	feed	1	0	17
237	9/11/2016 15:26	70.852	160.822	gray whale	swim	1	0	17
237	9/11/2016 15:35	71.067	161.599	unid cetacean	swim	1	0	14
237	9/11/2016 15:59	71.486	163.339	bowhead whale	dead	1	0	15
237	9/11/2016 16:58	71.624	161.174	bowhead whale	swim	1	0	14
237	9/11/2016 18:18	71.718	159.850	bowhead whale	swim	1	0	13
237	9/11/2016 18:30	71.938	160.662	bowhead whale	swim	1	0	14
237	9/11/2016 18:32	71.989	160.798	bowhead whale	swim	1	0	14
237	9/11/2016 18:36	71.991	160.650	bowhead whale	mill	3	0	14
237	9/11/2016 18:41	72.008	160.401	bowhead whale	swim	1	0	0

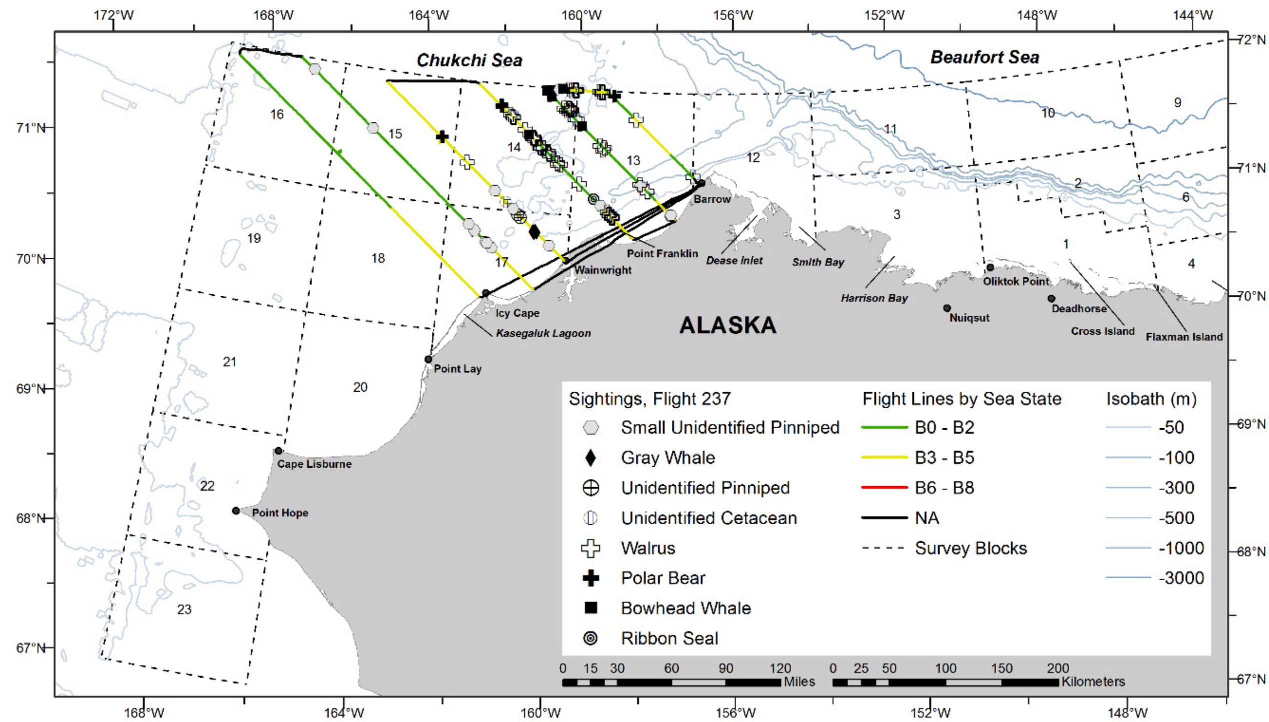

Figure B-67. ASAMM Flight 237 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

11 September 2016, Flight 31

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, haze, iced windows, low ceilings, and precipitation), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including one calf), one unidentified cetacean, small unidentified pinnipeds, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
31	9/11/2016 9:43	70.496	147.777	bowhead whale	dive	1	0	1
31	9/11/2016 9:44	70.537	147.829	bowhead whale	breach	1	0	1
31	9/11/2016 9:48	70.601	147.713	bowhead whale	swim	1	0	1
31	9/11/2016 10:32	70.703	147.462	bowhead whale	swim	1	0	1
31	9/11/2016 10:38	70.570	147.314	unid cetacean	breach	1	0	1
31	9/11/2016 10:44	70.563	147.434	bowhead whale	rest	1	0	1
31	9/11/2016 10:45	70.527	147.441	bowhead whale	swim	1	0	1
31	9/11/2016 11:11	70.439	146.832	bowhead whale	swim	1	0	1
31	9/11/2016 11:12	70.462	146.790	bowhead whale	rest	1	0	1
31	9/11/2016 11:15	70.478	146.821	bowhead whale	swim	1	0	1
31	9/11/2016 11:15	70.486	146.739	bowhead whale	swim	1	0	1
31	9/11/2016 11:16	70.498	146.785	bowhead whale	rest	1	0	1
31	9/11/2016 12:43	70.595	150.465	bowhead whale	swim	1	0	3
31	9/11/2016 12:44	70.643	150.429	bowhead whale	swim	1	0	3
31	9/11/2016 12:45	70.653	150.435	bowhead whale	swim	2	0	3
31	9/11/2016 12:45	70.652	150.428	bowhead whale	mill	2	1	3
31	9/11/2016 12:45	70.651	150.418	bowhead whale	mill	2	0	3
31	9/11/2016 12:45	70.648	150.404	bowhead whale	feed	2	0	3
31	9/11/2016 12:45	70.640	150.417	bowhead whale	swim	1	0	3
31	9/11/2016 12:46	70.638	150.380	bowhead whale	swim	1	0	3
31	9/11/2016 12:47	70.641	150.419	bowhead whale	swim	1	0	3
31	9/11/2016 12:48	70.667	150.477	bowhead whale	feed	1	0	3
31	9/11/2016 12:48	70.671	150.484	bowhead whale	feed	1	0	3
31	9/11/2016 12:48	70.676	150.452	bowhead whale	swim	1	0	3
31	9/11/2016 12:49	70.666	150.483	bowhead whale	swim	1	0	3
31	9/11/2016 12:50	70.661	150.498	bowhead whale	feed	2	0	3
31	9/11/2016 12:54	70.755	150.461	bowhead whale	swim	1	0	3

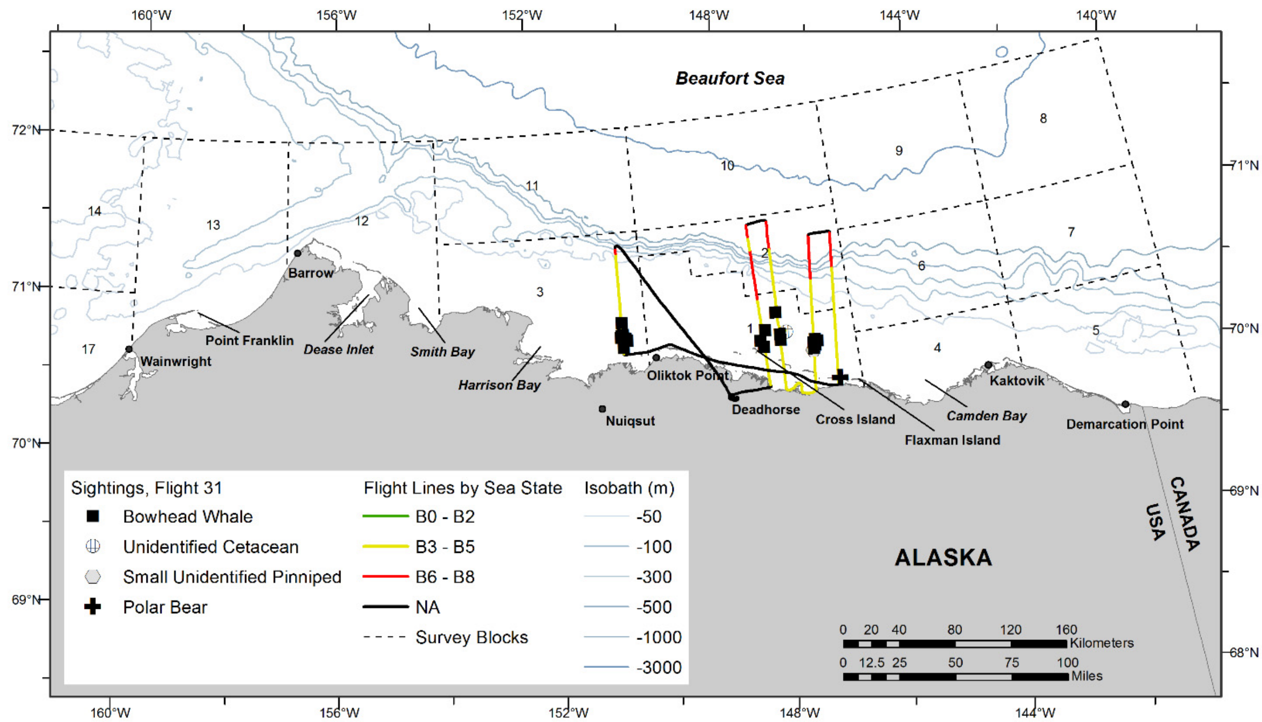

Figure B-68. ASAMM Flight 31 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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12 September 2016, Flight 32

Flight was a survey of portions of blocks 5 and 7. Survey conditions included partly cloudy to overcast skies, 3 km to unlimited visibility (with glare, haze, and low ceilings), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including two calves) and one unidentified cetacean.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
32	9/12/2016 10:19	69.898	140.362	bowhead whale	rest	2	1	5
32	9/12/2016 10:29	70.149	140.290	unid cetacean	swim	1	0	5
32	9/12/2016 12:02	69.921	141.101	bowhead whale	swim	1	0	5
32	9/12/2016 12:10	70.123	141.160	bowhead whale	swim	2	1	5

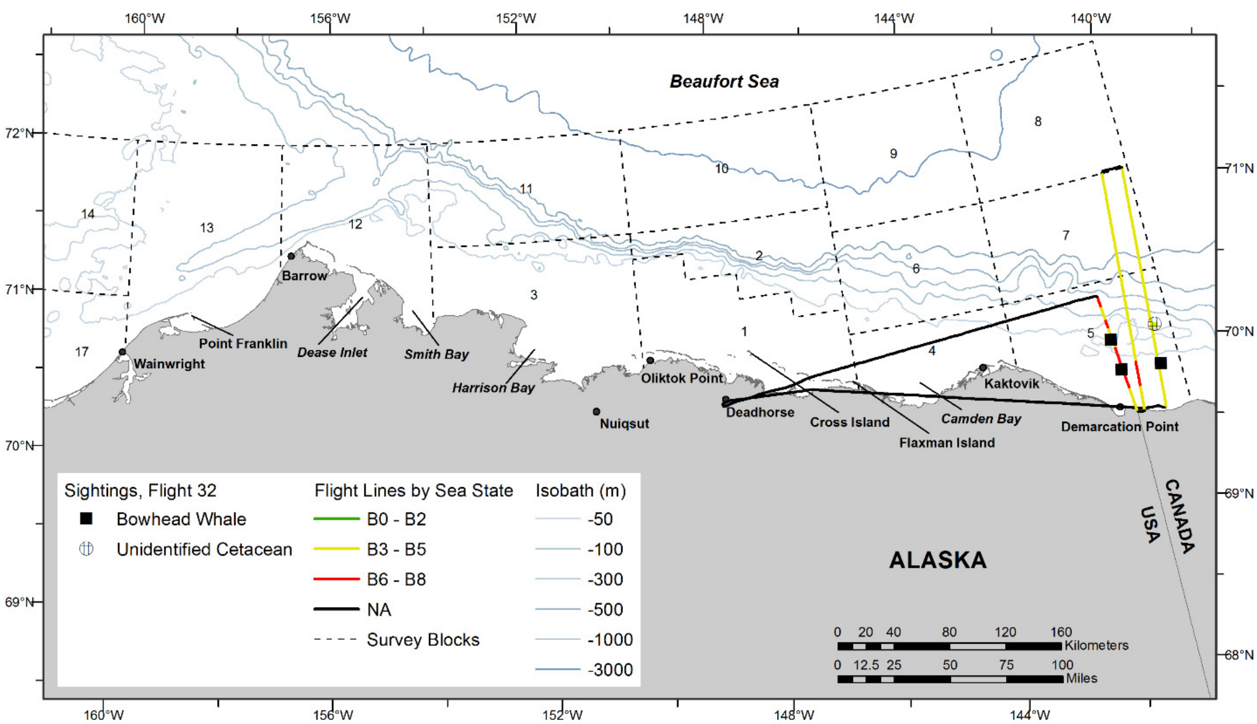

Figure B-69. ASAMM Flight 32 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

13 September 2016, Flight 238

Flight was a survey of portions of block 12; the two easternmost transects were extended north to 74°N to assess beluga distribution north of the study area. Survey conditions included partly cloudy to overcast skies, <1-10 km 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 beluga, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
238	9/13/2016 14:29	72.820	154.128	beluga	swim	1	0	0
238	9/13/2016 16:15	71.564	154.673	bowhead whale	swim	1	0	12
238	9/13/2016 16:15	71.555	154.673	bowhead whale	swim	2	0	12
238	9/13/2016 16:17	71.561	154.733	bowhead whale	feed	2	0	12
238	9/13/2016 16:17	71.548	154.708	bowhead whale	swim	1	0	12
238	9/13/2016 16:18	71.534	154.704	bowhead whale	swim	1	0	12
238	9/13/2016 16:19	71.517	154.662	bowhead whale	swim	1	0	12
238	9/13/2016 16:21	71.558	154.666	bowhead whale	rest	1	0	12
238	9/13/2016 16:49	71.410	155.369	bowhead whale	feed	1	0	12
238	9/13/2016 17:02	71.739	155.323	bowhead whale	swim	1	0	12
238	9/13/2016 17:06	71.890	155.312	bowhead whale	swim	1	0	12
238	9/13/2016 17:28	71.449	155.749	bowhead whale	swim	1	0	12

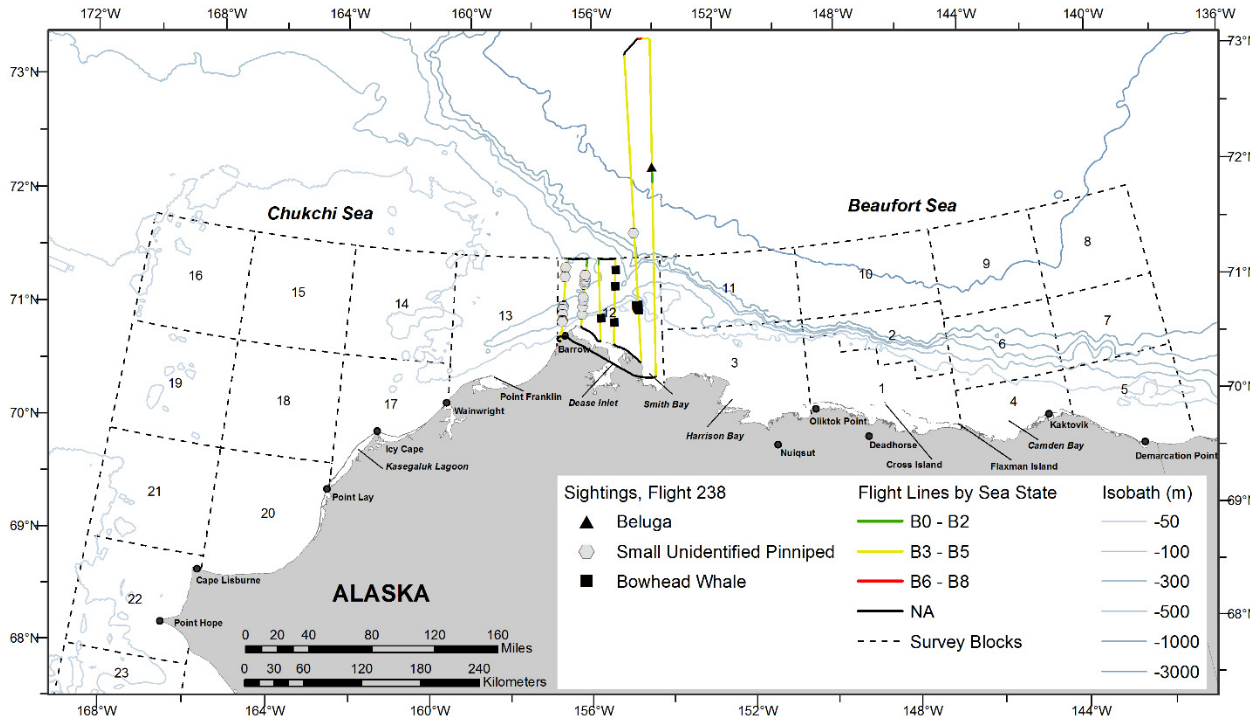

Figure B-70. ASAMM Flight 238 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale feeding (note the mud on the rostrum) approximately 40 km east of Point Barrow, Alaska, during ASAMM Flight 238, 13 September 2016.

14 September 2016, Flight 239

Flight was a complete survey of transects 15 and 17 and the coastal transect from approximately 25 km south of Icy Cape to approximately 30 km south of Wainwright. 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.

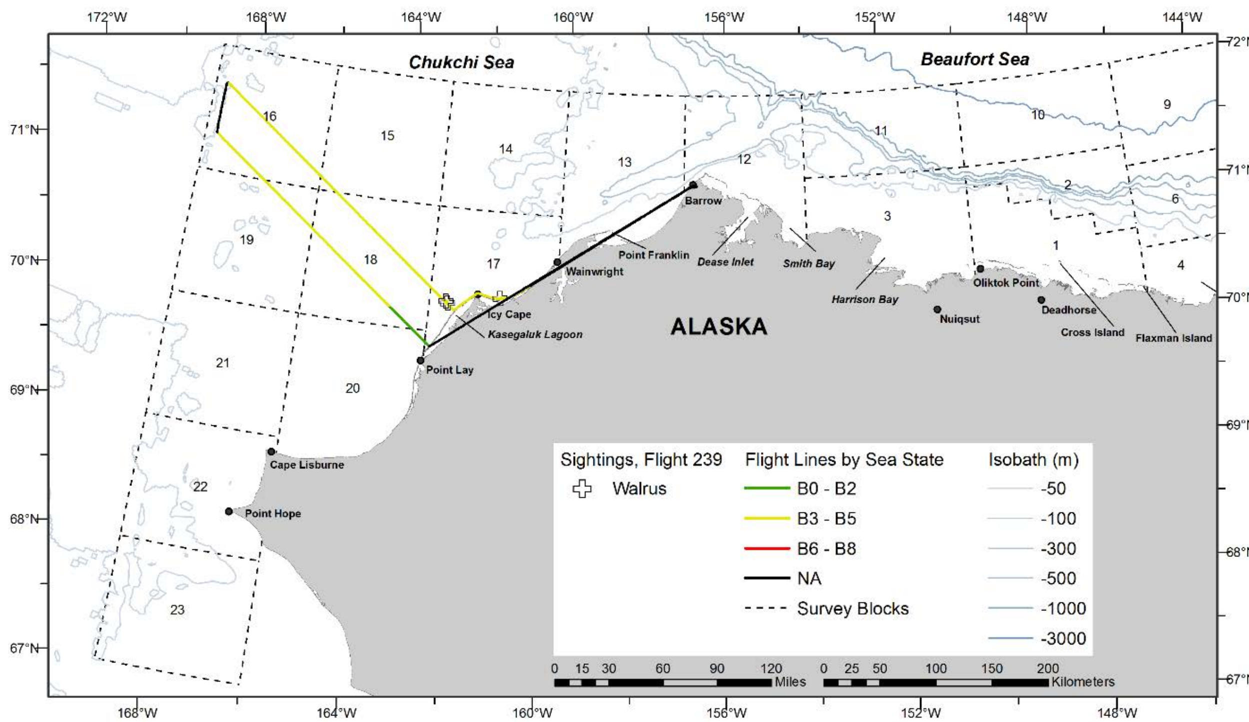

Figure B-71. ASAMM Flight 239 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

14 September 2016, Flight 33

Flight was a complete survey of block 6 and portions of blocks 5 and 7. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, haze, iced windows, low ceilings, and precipitation), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including one calf and one carcass), unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
33	9/14/2016 10:11	70.032	141.185	bowhead whale	swim	4	0	5
33	9/14/2016 11:17	70.334	141.614	bowhead whale	dead	1	0	5
33	9/14/2016 11:50	70.097	142.084	bowhead whale	swim	2	1	5
33	9/14/2016 12:58	70.181	142.752	bowhead whale	swim	1	0	5
33	9/14/2016 13:00	70.178	142.727	bowhead whale	swim	1	0	5
33	9/14/2016 13:01	70.135	142.715	bowhead whale	swim	1	0	5

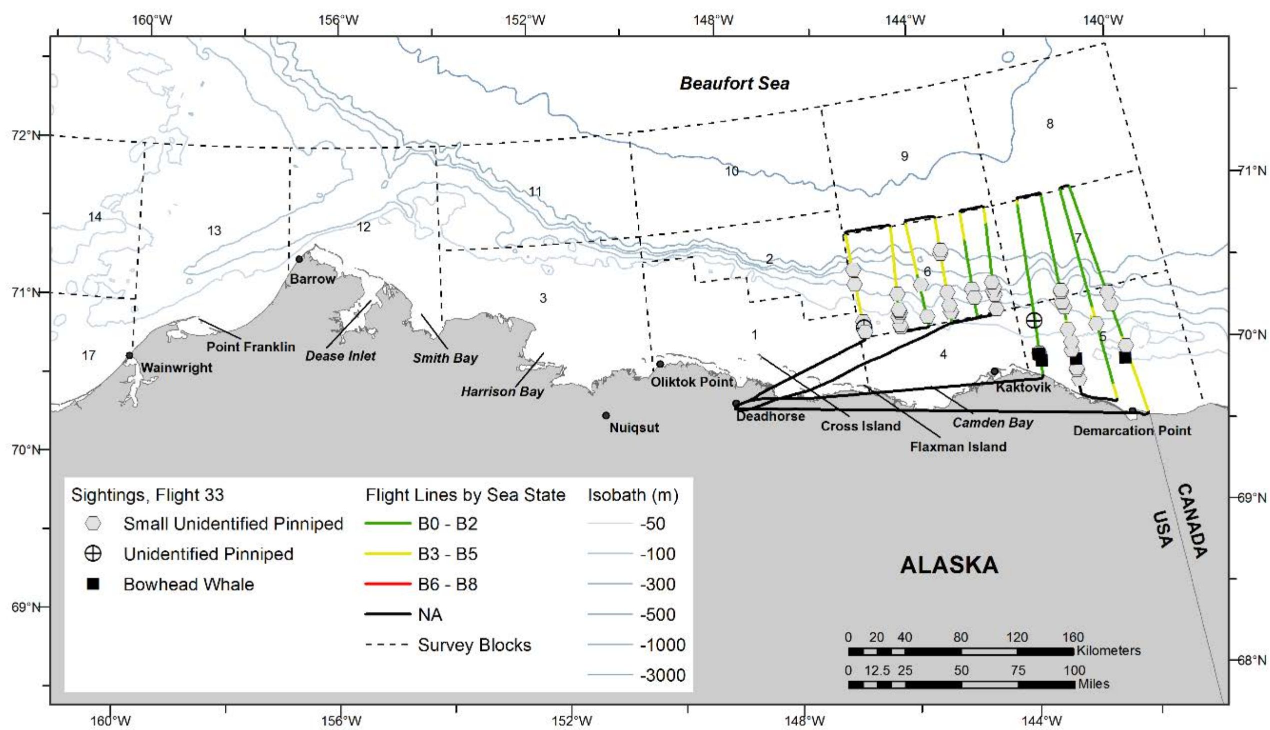

Figure B-72. ASAMM Flight 33 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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15 September 2016, Flight 240

Flight was a complete survey of transects 19 and 21 and the coastal transect from 30 km south of Point Lay to Point Franklin, Alaska. 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 two gray whale carcasses, unidentified cetaceans (including one carcass), one unidentified pinniped, and small unidentified pinnipeds. One of the gray whale carcasses was previously documented during Flights 213 and 227. The unidentified cetacean carcass was previously documented during Flights 202, 213, and 217.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
240	9/15/2016 16:12	70.296	161.406	gray whale	dead	1	0	17
240	9/15/2016 16:17	70.338	161.016	gray whale	dead	1	0	17
240	9/15/2016 15:02	69.916	164.606	unid cetacean	swim	2	0	20
240	9/15/2016 16:37	70.701	159.897	unid cetacean	dead	1	0	13

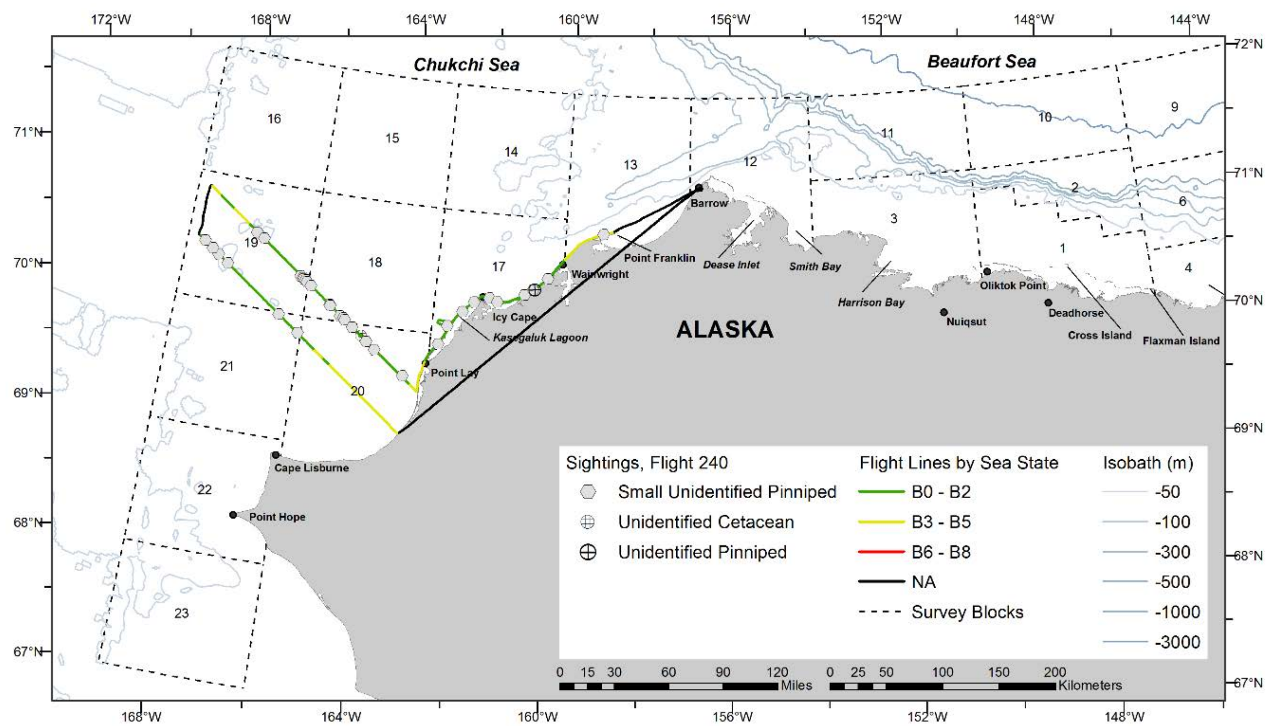

Figure B-73. ASAMM Flight 240 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

15 September 2016, Flight 34

Flight was a survey of portions of blocks 1, 3, and 11. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, iced windows, and low ceilings), and Beaufort 2-6 sea states. Sea ice cover was 0-17% grease/new ice in the area surveyed. Sightings included bowhead whales and one small unidentified pinniped.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
34	9/15/2016 10:12	71.179	151.769	bowhead whale	swim	1	0	3
34	9/15/2016 10:59	70.855	151.276	bowhead whale	swim	1	0	3
34	9/15/2016 11:04	70.785	151.260	bowhead whale	swim	1	0	3
34	9/15/2016 11:04	70.777	151.245	bowhead whale	swim	1	0	3
34	9/15/2016 11:04	70.775	151.250	bowhead whale	swim	3	0	3
34	9/15/2016 11:04	70.774	151.260	bowhead whale	swim	1	0	3
34	9/15/2016 11:04	70.777	151.277	bowhead whale	swim	1	0	3
34	9/15/2016 11:05	70.785	151.278	bowhead whale	swim	1	0	3
34	9/15/2016 11:05	70.788	151.251	bowhead whale	swim	1	0	3
34	9/15/2016 11:05	70.781	151.242	bowhead whale	swim	1	0	3
34	9/15/2016 11:06	70.761	151.280	bowhead whale	rest	1	0	3
34	9/15/2016 11:06	70.753	151.258	bowhead whale	swim	2	0	3
34	9/15/2016 11:08	70.741	151.233	bowhead whale	swim	1	0	3
34	9/15/2016 11:25	71.155	150.774	bowhead whale	swim	1	0	3
34	9/15/2016 11:31	71.099	150.468	bowhead whale	swim	1	0	3
34	9/15/2016 11:31	71.093	150.486	bowhead whale	swim	1	0	3
34	9/15/2016 11:46	70.622	150.468	bowhead whale	swim	1	0	3

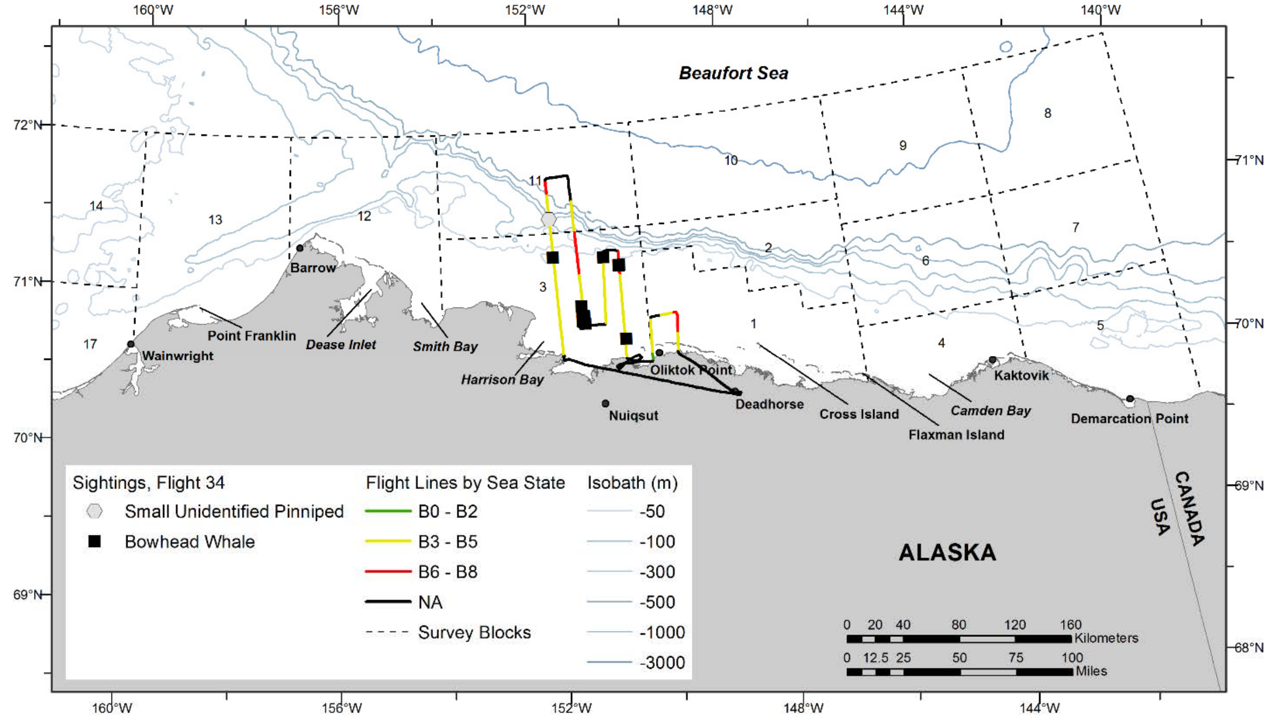

Figure B-74. ASAMM Flight 34 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

16 September 2016, Flight 35

Flight was a survey of portions of block 1. Survey conditions included overcast skies, <1-10 km visibility (with iced windows and low ceilings), and Beaufort 3-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales and one polar bear.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
35	9/16/2016 11:04	70.546	148.612	bowhead whale	rest	1	0	1
35	9/16/2016 11:05	70.539	148.623	bowhead whale	rest	1	0	1
35	9/16/2016 11:06	70.541	148.630	bowhead whale	rest	1	0	1
35	9/16/2016 11:07	70.538	148.631	bowhead whale	rest	1	0	1
35	9/16/2016 11:13	70.712	148.606	bowhead whale	swim	1	0	1
35	9/16/2016 11:31	70.623	148.144	bowhead whale	swim	1	0	1

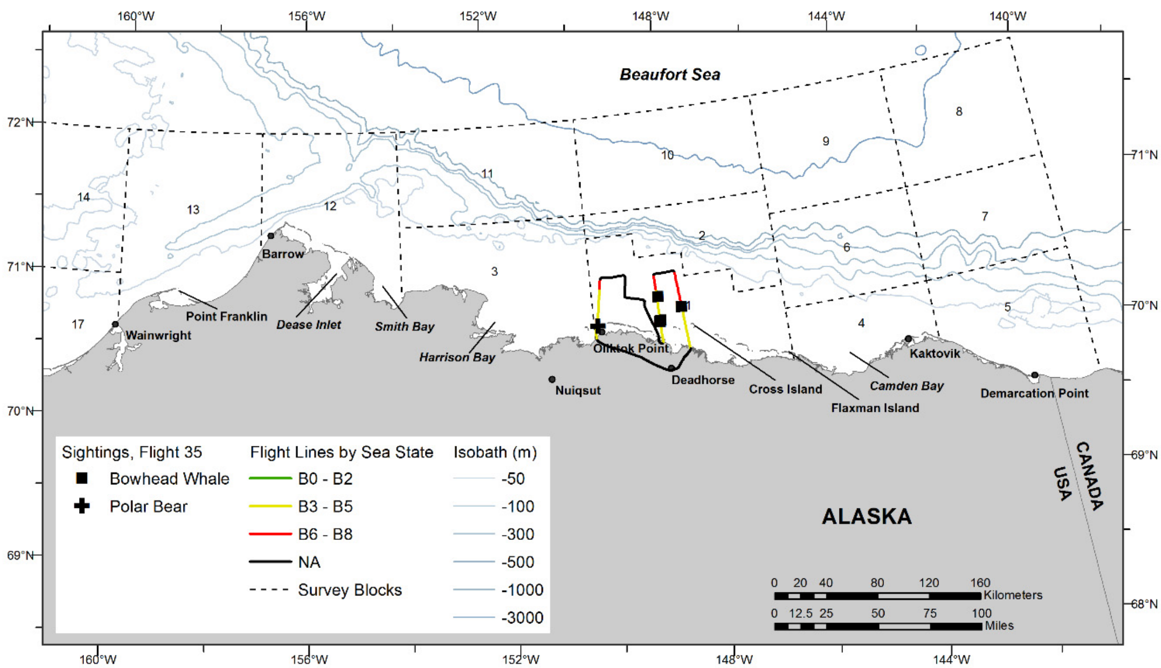

Figure B-75. ASAMM Flight 35 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

18 September 2016, Flight 241

Flight was a complete survey of transects 35, 36, and 37, and partial survey of transects 2, 3, 39, and 40. Survey conditions included partly cloudy to overcast skies, 2-10 km visibility (with glare and precipitation), and Beaufort 2-8 sea states. Sea ice cover was 0-50% broken floe in the area surveyed. Sightings included gray whales (including one carcass) and walruses.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
241	9/18/2016 12:34	67.859	168.671	gray whale	feed	1	0	23
241	9/18/2016 12:34	67.861	168.655	gray whale	swim	3	0	23
241	9/18/2016 12:38	67.863	168.572	gray whale	feed	2	0	23
241	9/18/2016 12:39	67.865	168.455	gray whale	feed	1	0	23
241	9/18/2016 12:42	67.878	168.347	gray whale	feed	1	0	23
241	9/18/2016 12:43	67.876	168.321	gray whale	feed	3	0	23
241	9/18/2016 12:45	67.860	168.347	gray whale	feed	1	0	23
241	9/18/2016 12:47	67.859	168.259	gray whale	swim	2	0	23
241	9/18/2016 13:43	67.526	168.697	gray whale	dead	1	0	23

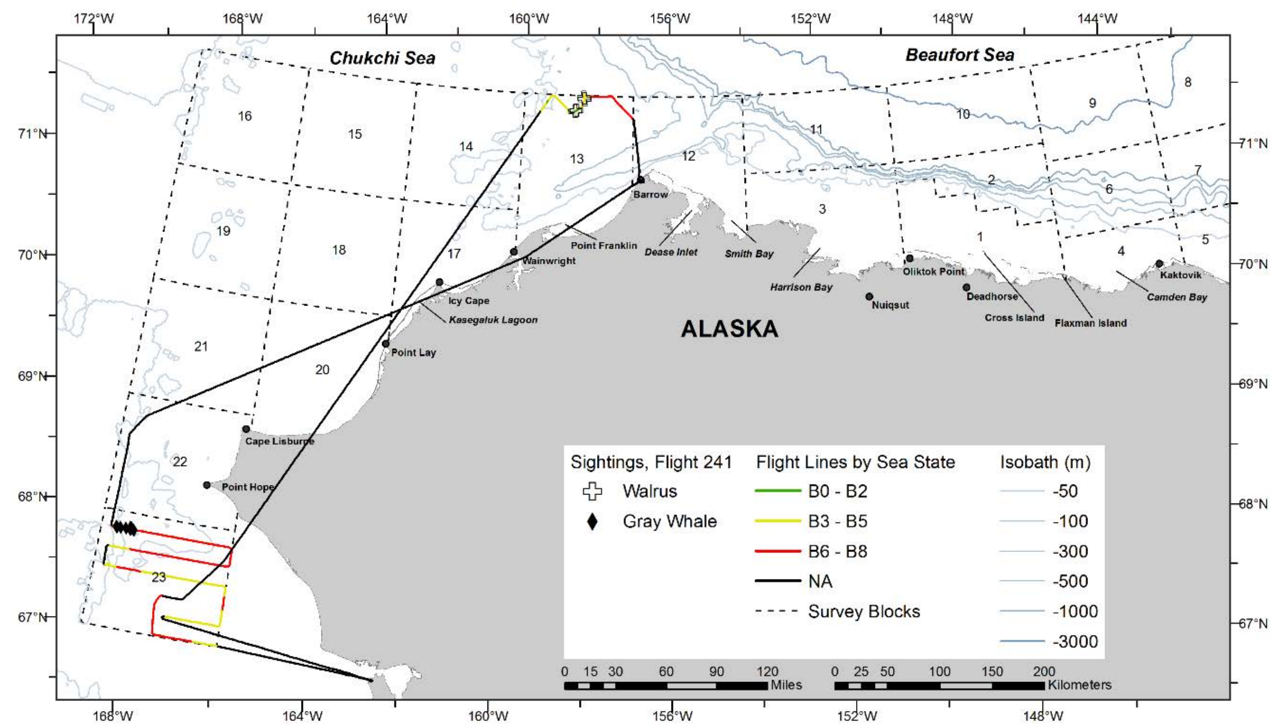

Figure B-76. ASAMM Flight 241 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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18 September 2016, Flight 36

Flight was a partial survey of transects 2 and 4. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with glare, haze, iced windows, and low ceilings), and Beaufort 3-8 sea states. Sea ice cover was 1-55% broken floe in the area surveyed. Sightings included bowhead whales, gray whales, one unidentified cetacean, and one polar bear.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
36	9/18/2016 12:12	71.600	162.260	bowhead whale	swim	1	0	14
36	9/18/2016 12:39	71.606	158.659	bowhead whale	dive	1	0	13
36	9/18/2016 12:54	71.272	157.561	unid cetacean	rest	1	0	13
36	9/18/2016 12:57	71.259	157.520	gray whale	swim	1	0	13
36	9/18/2016 12:57	71.264	157.493	gray whale	feed	1	0	13
36	9/18/2016 12:59	71.254	157.466	gray whale	feed	1	0	13
36	9/18/2016 13:00	71.260	157.432	gray whale	feed	1	0	13
36	9/18/2016 13:02	71.245	157.455	bowhead whale	swim	1	0	13
36	9/18/2016 13:03	71.249	157.444	gray whale	feed	1	0	13
36	9/18/2016 13:03	71.247	157.468	gray whale	feed	2	0	13
36	9/18/2016 13:04	71.232	157.428	gray whale	feed	1	0	13
36	9/18/2016 13:15	71.313	157.076	gray whale	feed	2	0	13

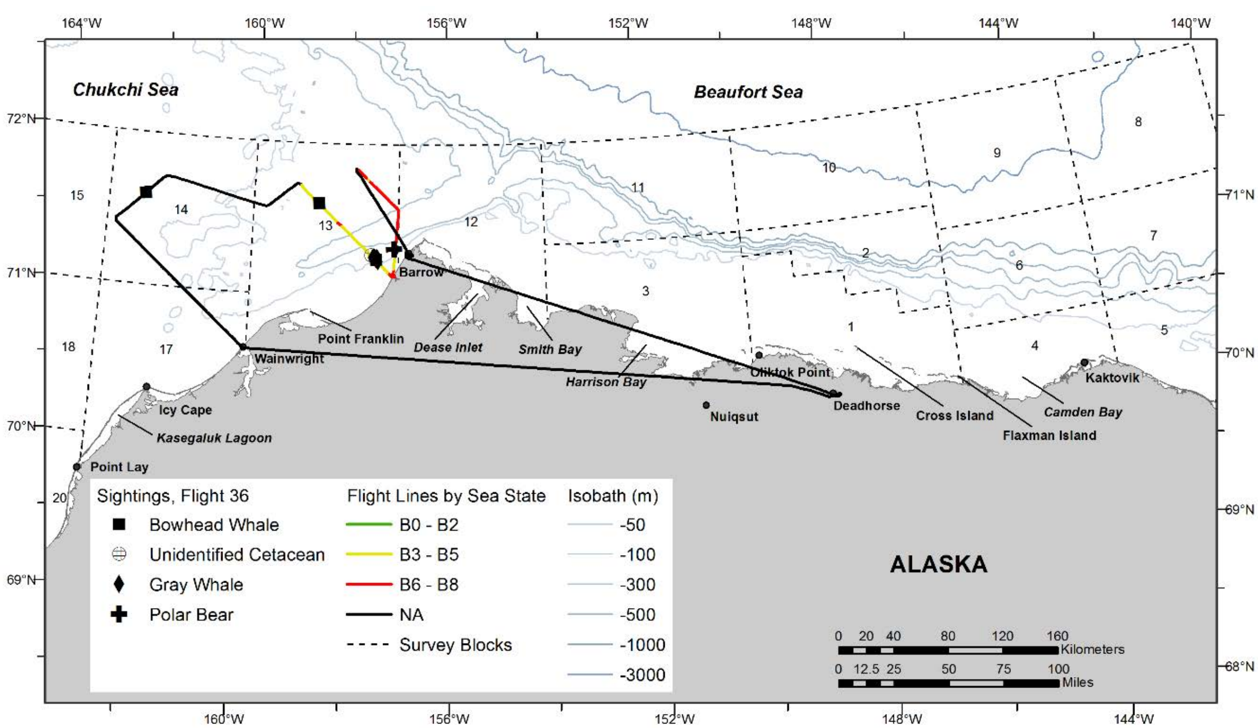

Figure B-77. ASAMM Flight 36 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 September 2016, Flight 242

Flight was a complete survey of transect 9, partial survey of transects 5, 7, and 11, and search effort in Peard Bay. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-6 sea states. Sea ice cover was 0-75% broken floe in the area surveyed. Sightings included bowhead whales, gray whales, one unidentified cetacean carcass, walruses, and small unidentified pinnipeds. The unidentified cetacean carcass was resighted during Flight 243.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
242	9/19/2016 11:37	71.448	162.161	bowhead whale	swim	1	0	14
242	9/19/2016 11:47	71.254	161.459	gray whale	feed	1	0	14
242	9/19/2016 11:50	71.221	161.415	gray whale	feed	1	0	14
242	9/19/2016 11:52	71.238	161.414	gray whale	feed	1	0	14
242	9/19/2016 12:10	70.847	160.035	gray whale	rest	1	0	17
242	9/19/2016 12:21	70.862	159.255	unid cetacean	dead	1	0	13
242	9/19/2016 13:03	71.425	160.463	bowhead whale	rest	1	0	14
242	9/19/2016 13:04	71.434	160.484	bowhead whale	rest	1	0	14
242	9/19/2016 13:16	71.653	161.247	bowhead whale	swim	1	0	14
242	9/19/2016 13:55	71.418	158.814	bowhead whale	rest	3	0	13
242	9/19/2016 13:58	71.405	158.774	bowhead whale	swim	2	0	13
242	9/19/2016 14:08	71.182	158.011	bowhead whale	swim	1	0	13

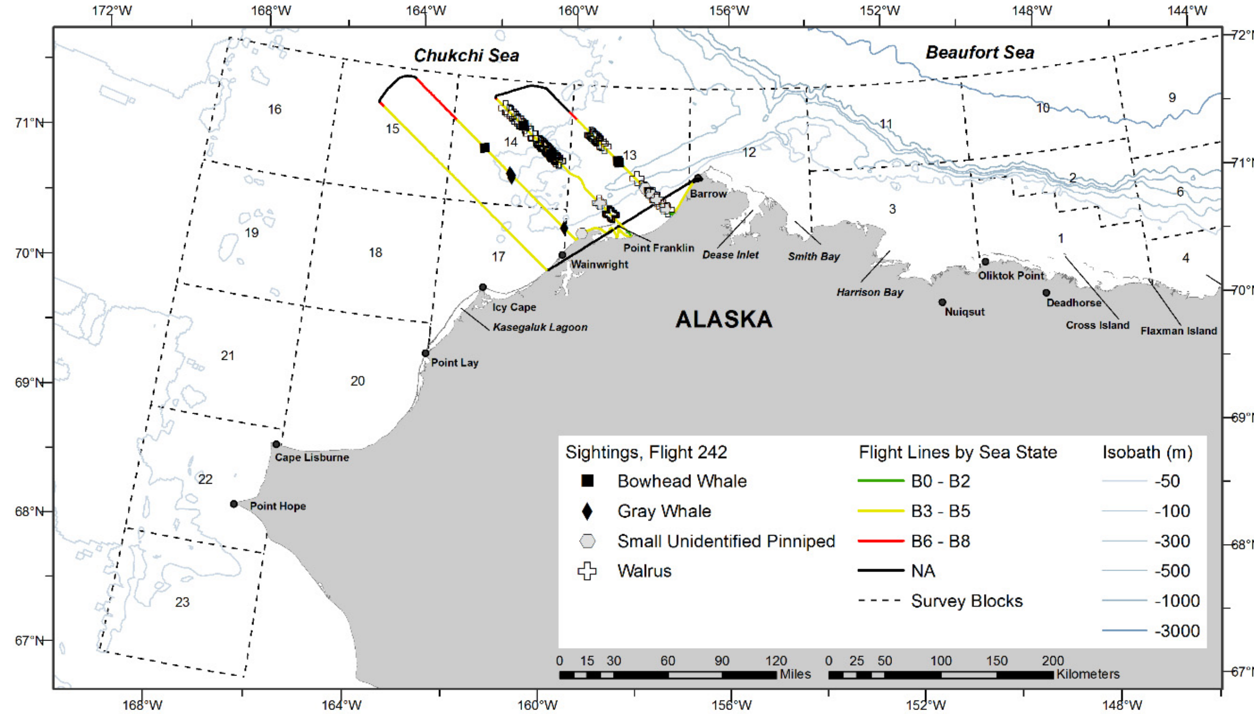

Figure B-78. ASAMM Flight 242 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 September 2016, Flight 37

Flight was a survey of portions of block 12. Survey conditions included partly cloudy skies, <1 km to unlimited visibility (with glare, haze, and low ceilings), and Beaufort 1-6 sea states. Sea ice cover was 0-80% broken floe in the area surveyed. Sightings included bowhead whales, gray whales, one beluga, walruses, one unidentified pinniped, small unidentified pinnipeds, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
37	9/19/2016 15:40	71.396	154.126	bowhead whale	swim	1	0	12
37	9/19/2016 15:45	71.521	154.157	bowhead whale	swim	1	0	12
37	9/19/2016 16:02	71.567	154.558	bowhead whale	swim	1	0	12
37	9/19/2016 16:03	71.544	154.508	bowhead whale	mill	2	0	12
37	9/19/2016 16:04	71.541	154.496	bowhead whale	swim	1	0	12
37	9/19/2016 16:06	71.546	154.530	bowhead whale	swim	1	0	12
37	9/19/2016 16:07	71.541	154.524	bowhead whale	swim	1	0	12
37	9/19/2016 16:31	71.167	155.140	beluga	swim	1	0	12
37	9/19/2016 16:44	71.586	155.297	bowhead whale	rest	1	0	12
37	9/19/2016 16:50	71.735	155.352	bowhead whale	rest	2	0	12
37	9/19/2016 16:50	71.738	155.366	bowhead whale	swim	1	0	12
37	9/19/2016 16:50	71.738	155.374	bowhead whale	swim	1	0	12
37	9/19/2016 16:52	71.739	155.395	bowhead whale	swim	1	0	12
37	9/19/2016 16:52	71.729	155.394	bowhead whale	swim	1	0	12
37	9/19/2016 16:53	71.721	155.382	bowhead whale	swim	1	0	12
37	9/19/2016 16:55	71.716	155.407	bowhead whale	swim	2	0	12
37	9/19/2016 16:57	71.752	155.333	bowhead whale	swim	1	0	12
37	9/19/2016 16:59	71.793	155.405	bowhead whale	swim	1	0	12
37	9/19/2016 17:16	71.539	155.685	gray whale	swim	4	0	12
37	9/19/2016 17:44	71.605	156.167	bowhead whale	swim	1	0	12
37	9/19/2016 17:47	71.700	156.167	bowhead whale	swim	1	0	12

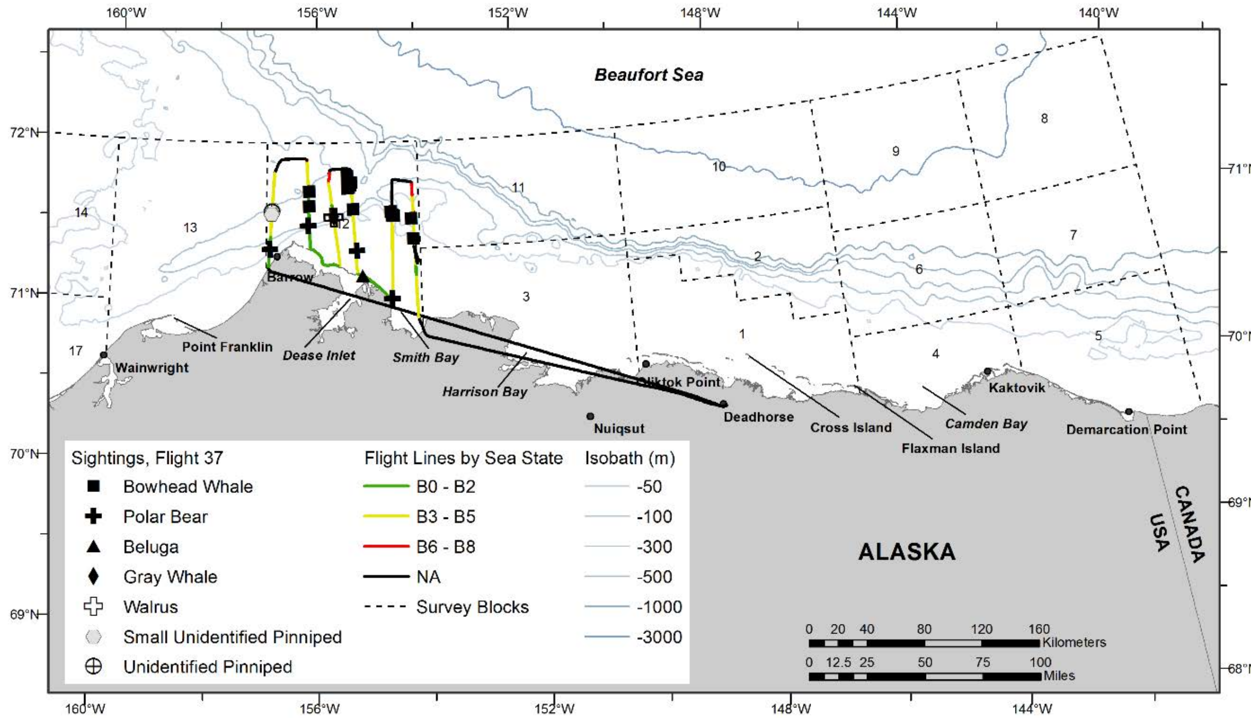

Figure B-79. ASAMM Flight 37 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

20 September 2016, Flight 243

Flight was a partial survey of transects 8, 10, 12, 13, 14, and 15. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-3 sea states. Sea ice cover was 0-1% broken floe in the area surveyed. Sightings included bowhead whales, gray whales, killer whales (including one calf), unidentified cetaceans (including two carcasses), walruses (including one carcass), unidentified pinnipeds, and small unidentified pinnipeds. One of the unidentified cetacean carcasses was previously documented during Flight 242.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
243	9/20/2016 10:13	70.299	162.919	killer whale	feed	4	0	17
243	9/20/2016 10:16	70.296	162.916	killer whale	mill	3	1	17
243	9/20/2016 11:11	70.406	162.345	unid cetacean	swim	1	0	17
243	9/20/2016 11:47	70.699	162.614	unid cetacean	dead	1	0	17
243	9/20/2016 12:48	70.622	160.245	bowhead whale	swim	1	0	17
243	9/20/2016 12:58	70.698	160.365	bowhead whale	swim	1	0	17
243	9/20/2016 13:10	70.857	160.790	gray whale	feed	1	0	17
243	9/20/2016 13:10	70.841	160.834	gray whale	swim	1	0	17
243	9/20/2016 13:36	71.144	160.358	bowhead whale	swim	2	0	14
243	9/20/2016 13:55	70.865	159.263	unid cetacean	dead	1	0	13

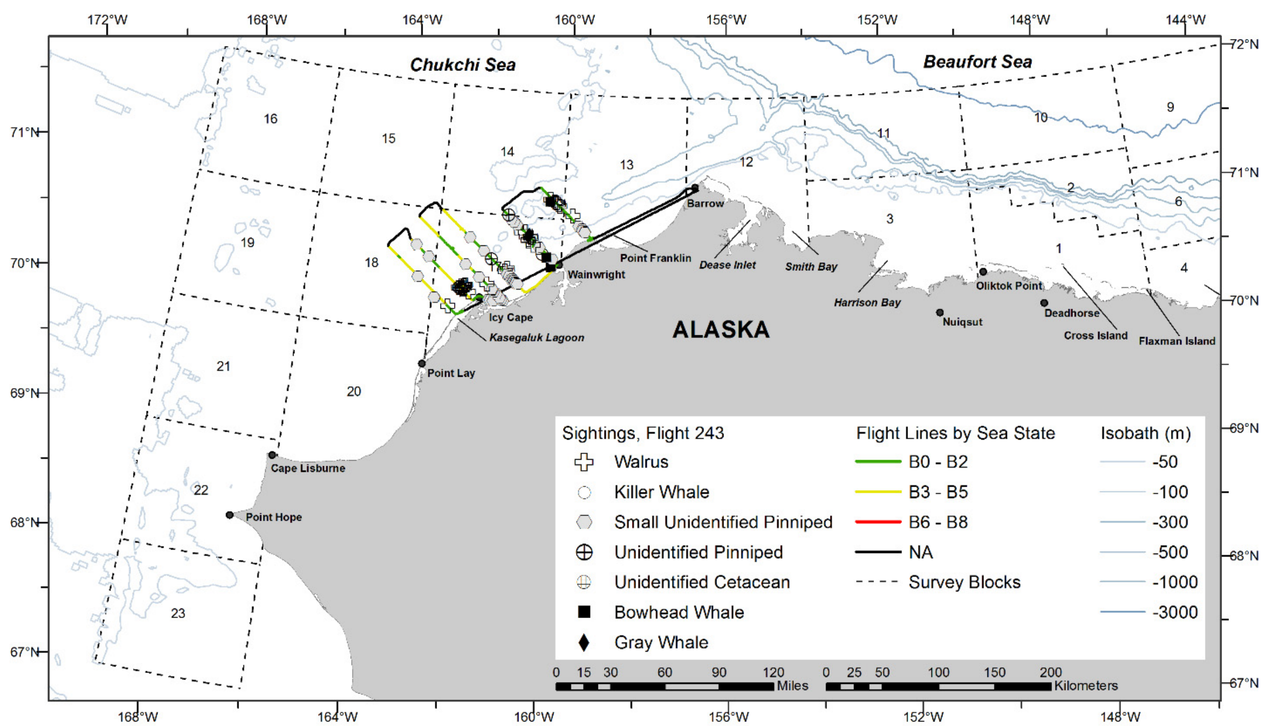

Figure B-80. ASAMM Flight 243 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Killer whales sighted approximately 40 km west of Icy Cape, Alaska, during ASAMM Flight 243, 20 September 2016.

Gray whale sighted approximately 35 km northwest of Wainwright, Alaska, during ASAMM Flight 243, 20 September 2016

Bowhead whales sighted approximately 60 km north of Wainwright, Alaska, during ASAMM Flight 243, 20 September 2016.

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20 September 2016, Flight 38

Flight was a survey of blocks 1 and 2 and portions of blocks 4 and 6. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare and haze), and Beaufort 1-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including three calves), one beluga, unidentified pinnipeds, small unidentified pinnipeds, and polar bears (including 12 cubs).

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
38	9/20/2016 9:59	71.149	149.936	bowhead whale	swim	1	0	1
38	9/20/2016 9:59	71.159	149.948	bowhead whale	swim	2	1	1
38	9/20/2016 10:01	71.169	149.942	bowhead whale	swim	1	0	2
38	9/20/2016 10:05	71.205	149.960	bowhead whale	swim	2	0	2
38	9/20/2016 10:05	71.214	149.943	bowhead whale	swim	1	0	2
38	9/20/2016 10:06	71.205	149.941	bowhead whale	mill	2	0	2
38	9/20/2016 10:25	71.074	149.359	bowhead whale	feed	4	1	1
38	9/20/2016 10:25	71.069	149.413	bowhead whale	swim	1	0	1
38	9/20/2016 11:22	71.179	148.589	bowhead whale	swim	1	0	2
38	9/20/2016 13:18	70.671	147.261	bowhead whale	swim	1	0	1
38	9/20/2016 13:27	70.444	147.303	bowhead whale	swim	1	0	1
38	9/20/2016 13:56	70.616	146.522	bowhead whale	swim	2	1	1
38	9/20/2016 13:58	70.666	146.580	bowhead whale	swim	1	0	1
38	9/20/2016 14:11	71.079	146.559	beluga	swim	1	0	2
38	9/20/2016 16:31	70.255	145.829	bowhead whale	swim	1	0	4
38	9/20/2016 16:31	70.261	145.831	bowhead whale	swim	1	0	4
38	9/20/2016 16:33	70.248	145.769	bowhead whale	swim	2	0	4
38	9/20/2016 16:40	70.345	145.782	bowhead whale	rest	2	0	4
38	9/20/2016 17:58	70.368	144.943	bowhead whale	swim	1	0	4
38	9/20/2016 18:00	70.353	145.063	bowhead whale	rest	2	0	4
38	9/20/2016 18:01	70.348	145.050	bowhead whale	swim	2	0	4
38	9/20/2016 18:03	70.359	145.030	bowhead whale	swim	1	0	4
38	9/20/2016 18:04	70.373	145.049	bowhead whale	swim	1	0	4
38	9/20/2016 18:04	70.378	145.046	bowhead whale	swim	1	0	4
38	9/20/2016 18:05	70.372	145.077	bowhead whale	swim	1	0	4

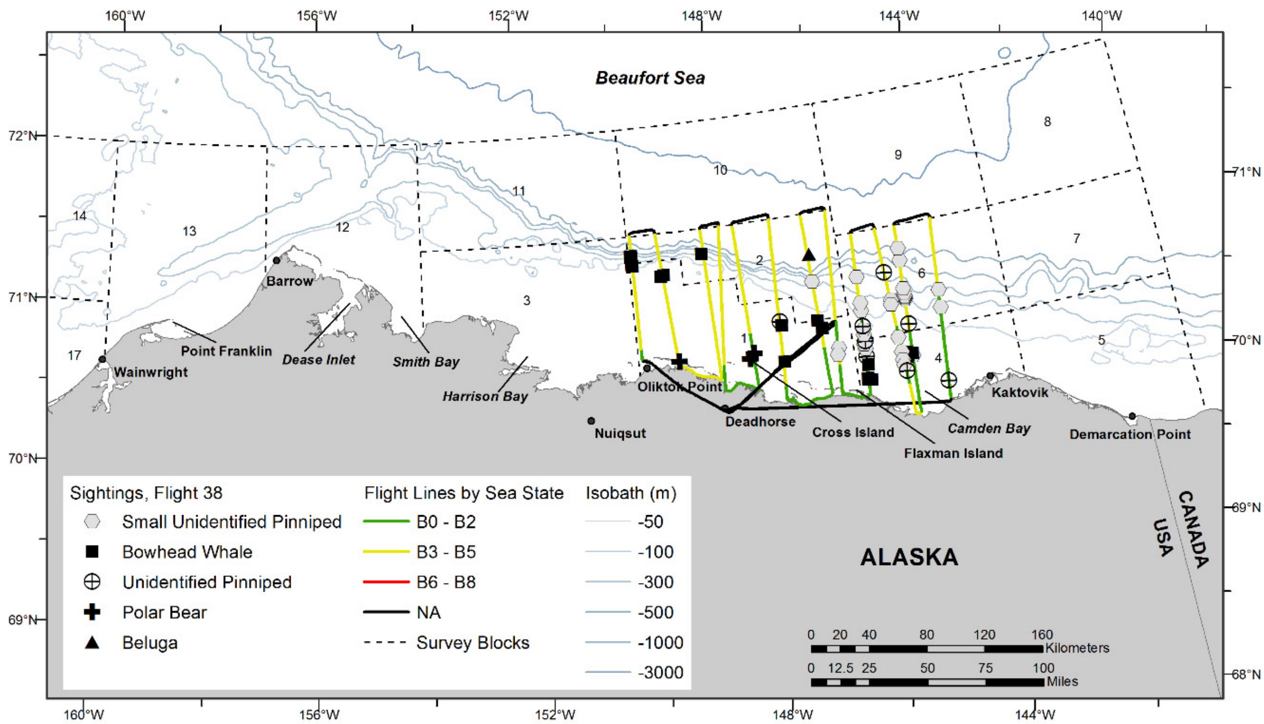

Figure B-81. ASAMM Flight 38 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bear sow and two cubs frolicking near Cross Island, Alaska, during ASAMM Flight 38, 20 September 2016.

21 September 2016, Flight 39

Flight was a survey of portions of blocks 4, 5, 6, and 7. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare and haze), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including seven calves and one carcass), one beluga, unidentified pinnipeds, small unidentified pinnipeds, and polar bears (including eight cubs). The bowhead whale carcass was previously documented during Flight 23 and 28.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
39	9/21/2016 10:24	70.338	143.565	bowhead whale	swim	1	0	4
39	9/21/2016 11:04	70.858	143.270	beluga	rest	1	0	6
39	9/21/2016 11:16	70.456	143.250	bowhead whale	swim	2	1	4
39	9/21/2016 11:23	70.425	143.165	bowhead whale	swim	2	1	4
39	9/21/2016 11:32	70.317	143.239	bowhead whale	swim	3	1	4
39	9/21/2016 11:37	70.310	143.170	bowhead whale	swim	1	0	4
39	9/21/2016 11:38	70.320	143.157	bowhead whale	swim	1	0	4
39	9/21/2016 11:38	70.323	143.176	bowhead whale	swim	2	1	4
39	9/21/2016 11:40	70.281	143.162	bowhead whale	swim	1	0	4
39	9/21/2016 11:42	70.238	143.134	bowhead whale	swim	1	0	4
39	9/21/2016 11:44	70.238	143.076	bowhead whale	swim	1	0	4
39	9/21/2016 12:08	70.349	142.547	bowhead whale	swim	1	0	5
39	9/21/2016 12:59	70.551	142.184	bowhead whale	swim	2	1	7
39	9/21/2016 13:13	70.321	142.185	bowhead whale	swim	1	0	5
39	9/21/2016 13:17	70.219	142.160	bowhead whale	swim	1	0	5
39	9/21/2016 13:19	70.214	142.200	bowhead whale	swim	1	0	5
39	9/21/2016 13:26	70.008	142.256	bowhead whale	rest	1	0	5
39	9/21/2016 13:46	70.183	141.861	bowhead whale	mill	5	2	5
39	9/21/2016 13:47	70.180	141.843	bowhead whale	swim	2	0	5
39	9/21/2016 13:51	70.173	141.839	bowhead whale	dive	1	0	5
39	9/21/2016 13:57	70.181	141.900	bowhead whale	swim	1	0	5
39	9/21/2016 14:03	70.372	141.813	bowhead whale	dead	1	0	5

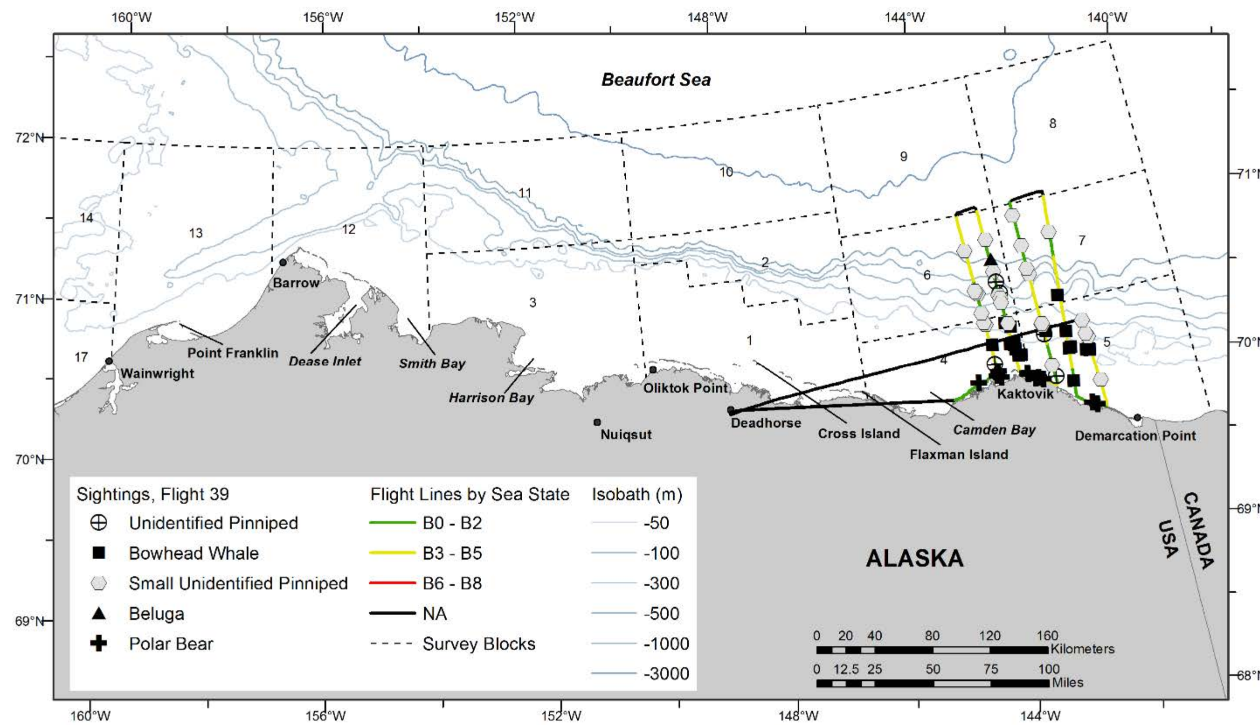

Figure B-82. ASAMM Flight 39 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bear sow and three cubs sighted on the tundra near Kaktovik, Alaska, during ASAMM Flight 39, 21 September 2016.

Polar bear snuggle pile sighted on the tundra near Kaktovik, Alaska, during ASAMM Flight 39, 21 September 2016.

Bowhead whale cow-calf pair, sighted approximately 37 km northeast of Kaktovik, Alaska, during ASAMM Flight 39, 21 September 2016. The cow is heavily scarred.

22 September 2016, Flight 40

Flight was a survey of portions of blocks 5 and 7. Survey conditions included partly cloudy to overcast skies, unlimited visibility, and Beaufort 1-2 sea states. No sea ice was observed in the area surveyed. Sightings included unidentified pinnipeds and small unidentified pinnipeds.

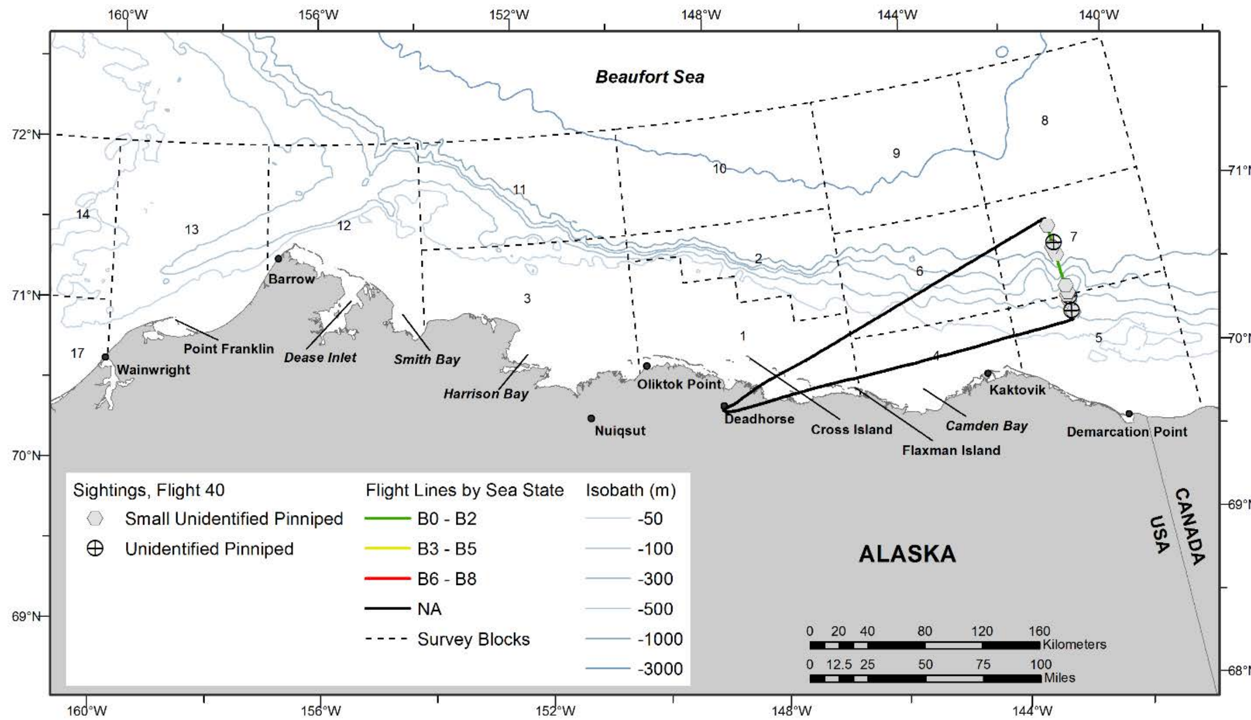

Figure B-83. ASAMM Flight 40 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

23 September 2016, Flight 244

Flight was a complete survey of transect 20. Survey conditions included partly cloudy 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 small unidentified pinnipeds.

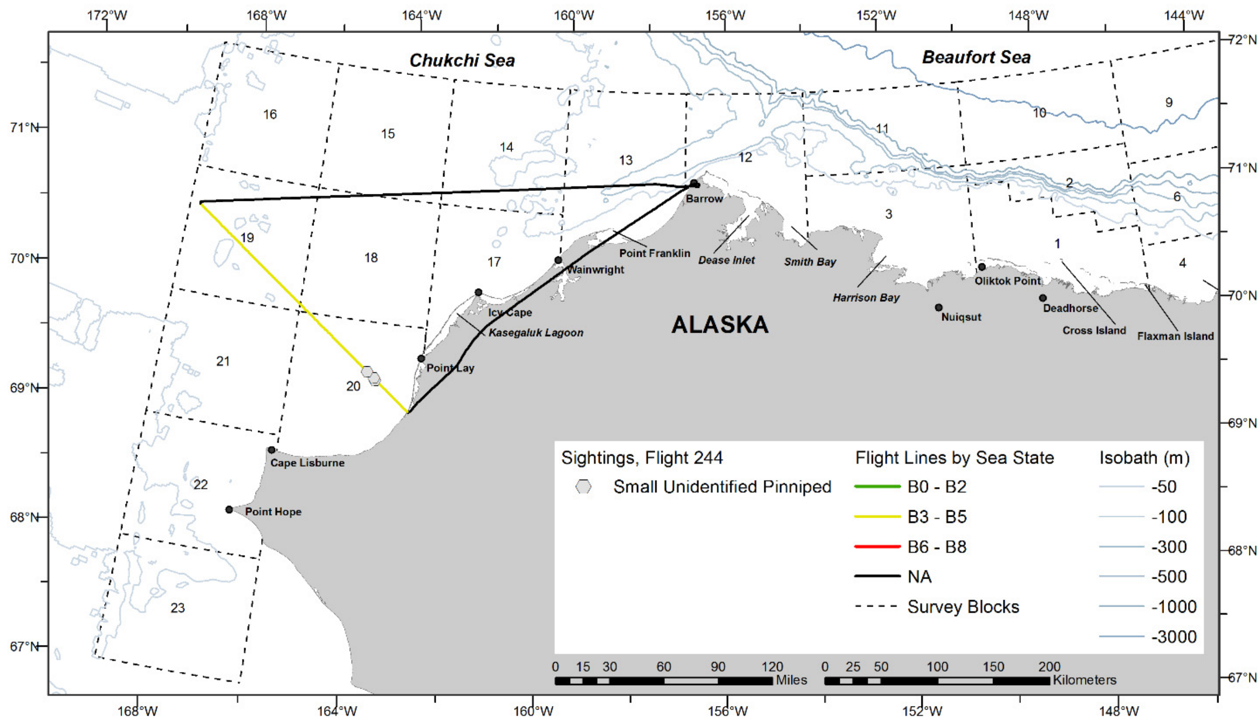

Figure B-84. ASAMM Flight 244 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 September 2016, Flight 41

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, haze, low ceilings, and precipitation), and Beaufort 2-4 sea states. Sea ice cover was 0-45% broken floe in the area surveyed. Sightings included bowhead whales (including two calves), belugas (including one calf), unidentified pinnipeds, small unidentified pinnipeds, and polar bears.

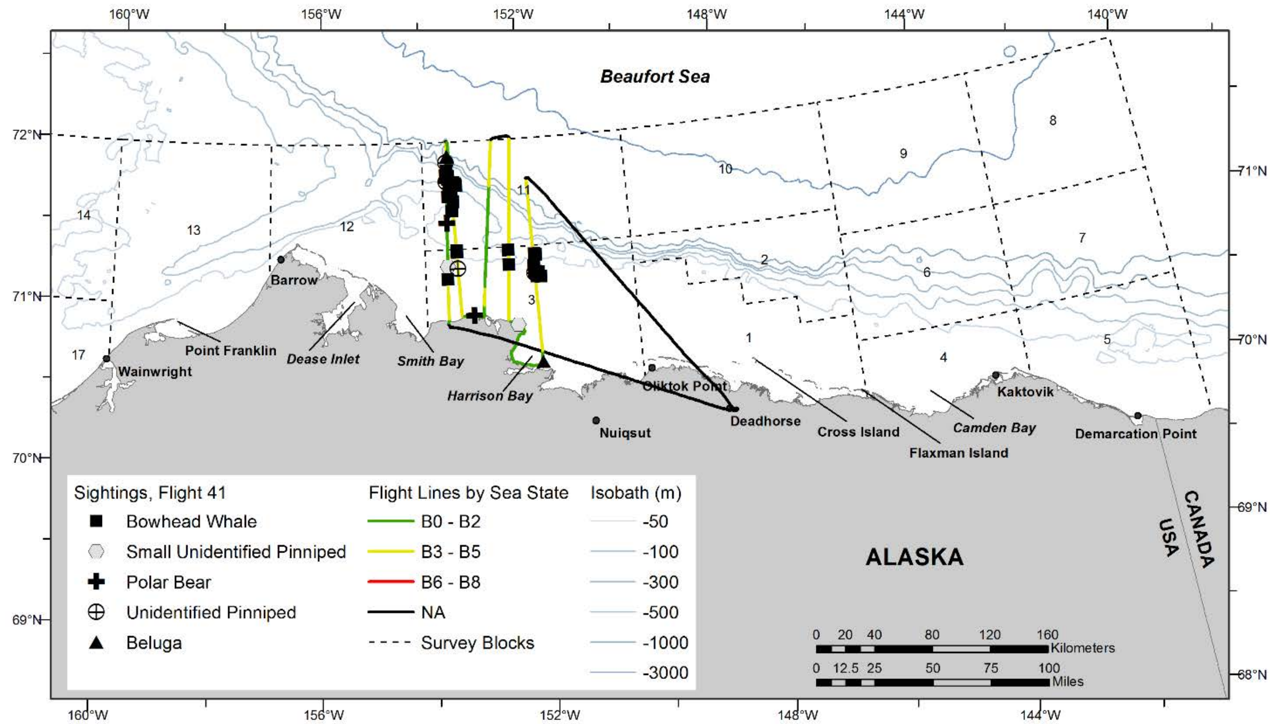

Figure B-85. ASAMM Flight 41 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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25 September 2016, Flight 245

Flight was a partial survey of transects 29, 30, 31, 32, and 33, and the coastal transect from Cape Lisburne to Point Lay and Point Franklin to Barrow. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, haze, low ceilings, and precipitation), and Beaufort 2-7 sea states. Sea ice cover was 0-5% broken floe in the area surveyed. Sightings included a carcass of an unidentified marine mammal.

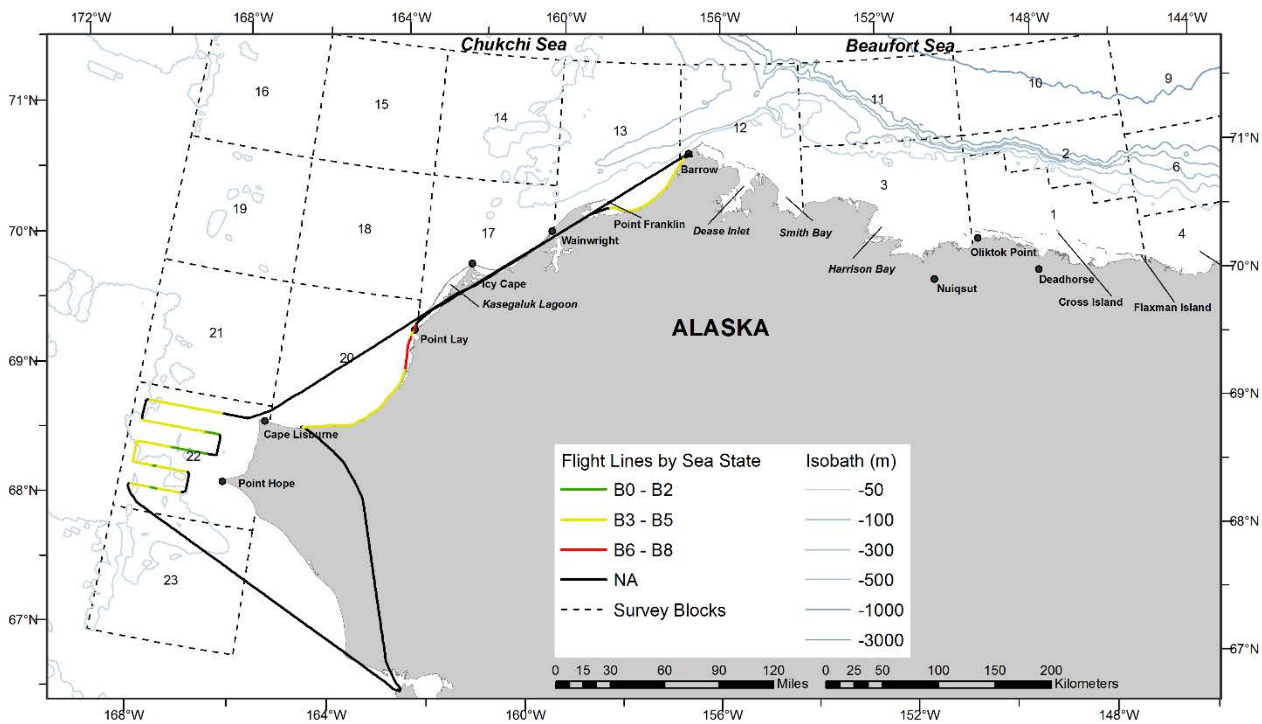

Figure B-86. ASAMM Flight 245 survey track, depicted by sea state.

25 September 2016, Flight 42

Flight was a survey of portions of blocks 3, 11, and 12. Survey conditions included partly cloudy skies, 2 km to unlimited visibility (with glare, haze, low ceilings, and precipitation), and Beaufort 2-5 sea states. Sea ice cover was 0-27% broken floe or grease/new ice in the area surveyed. Sightings included bowhead whales (including two calves), one gray whale, one unidentified cetacean, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
42	9/25/2016 10:32	71.116	150.236	bowhead whale	rest	1	0	3
42	9/25/2016 10:34	71.136	150.260	bowhead whale	swim	1	0	3
42	9/25/2016 10:34	71.142	150.261	bowhead whale	swim	2	0	3
42	9/25/2016 10:34	71.149	150.272	bowhead whale	swim	1	0	3
42	9/25/2016 10:35	71.144	150.303	bowhead whale	swim	2	0	3
42	9/25/2016 10:38	71.165	150.358	bowhead whale	swim	1	0	3
42	9/25/2016 10:39	71.168	150.428	bowhead whale	swim	1	0	3
42	9/25/2016 10:39	71.162	150.425	bowhead whale	swim	1	0	3
42	9/25/2016 10:40	71.174	150.424	bowhead whale	swim	2	0	3
42	9/25/2016 10:40	71.176	150.466	bowhead whale	swim	1	0	3
42	9/25/2016 10:43	71.155	150.246	bowhead whale	swim	1	0	3
42	9/25/2016 11:38	71.234	150.670	bowhead whale	swim	1	0	3
42	9/25/2016 11:39	71.246	150.617	bowhead whale	swim	1	0	3
42	9/25/2016 11:41	71.216	150.692	bowhead whale	swim	2	1	3
42	9/25/2016 11:44	71.189	150.639	bowhead whale	swim	1	0	3
42	9/25/2016 11:45	71.171	150.561	bowhead whale	swim	1	0	3
42	9/25/2016 12:38	71.117	151.358	bowhead whale	rest	1	0	3
42	9/25/2016 12:38	71.130	151.358	bowhead whale	mill	2	0	3
42	9/25/2016 12:39	71.113	151.379	gray whale	swim	1	0	3
42	9/25/2016 12:39	71.101	151.360	unid cetacean	swim	1	0	3
42	9/25/2016 12:41	71.139	151.348	bowhead whale	swim	1	0	3
42	9/25/2016 12:43	71.191	151.355	bowhead whale	swim	1	0	3
42	9/25/2016 12:45	71.228	151.365	bowhead whale	swim	1	0	3
42	9/25/2016 12:45	71.229	151.345	bowhead whale	swim	1	0	3
42	9/25/2016 12:45	71.225	151.376	bowhead whale	swim	1	0	3
42	9/25/2016 16:14	71.819	155.286	bowhead whale	rest	1	0	12
42	9/25/2016 16:16	71.827	155.223	bowhead whale	rest	1	0	12
42	9/25/2016 16:18	71.826	155.257	bowhead whale	rest	1	0	12
42	9/25/2016 16:21	71.912	155.266	bowhead whale	rest	2	1	12
42	9/25/2016 17:27	71.694	154.234	bowhead whale	breach	1	0	12
42	9/25/2016 17:31	71.678	154.148	bowhead whale	breach	1	0	12
42	9/25/2016 17:39	71.824	154.351	bowhead whale	swim	1	0	12
42	9/25/2016 17:40	71.886	154.336	bowhead whale	rest	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
42	9/25/2016 17:45	71.943	154.370	bowhead whale	swim	1	0	12
42	9/25/2016 17:46	71.944	154.363	bowhead whale	swim	1	0	12

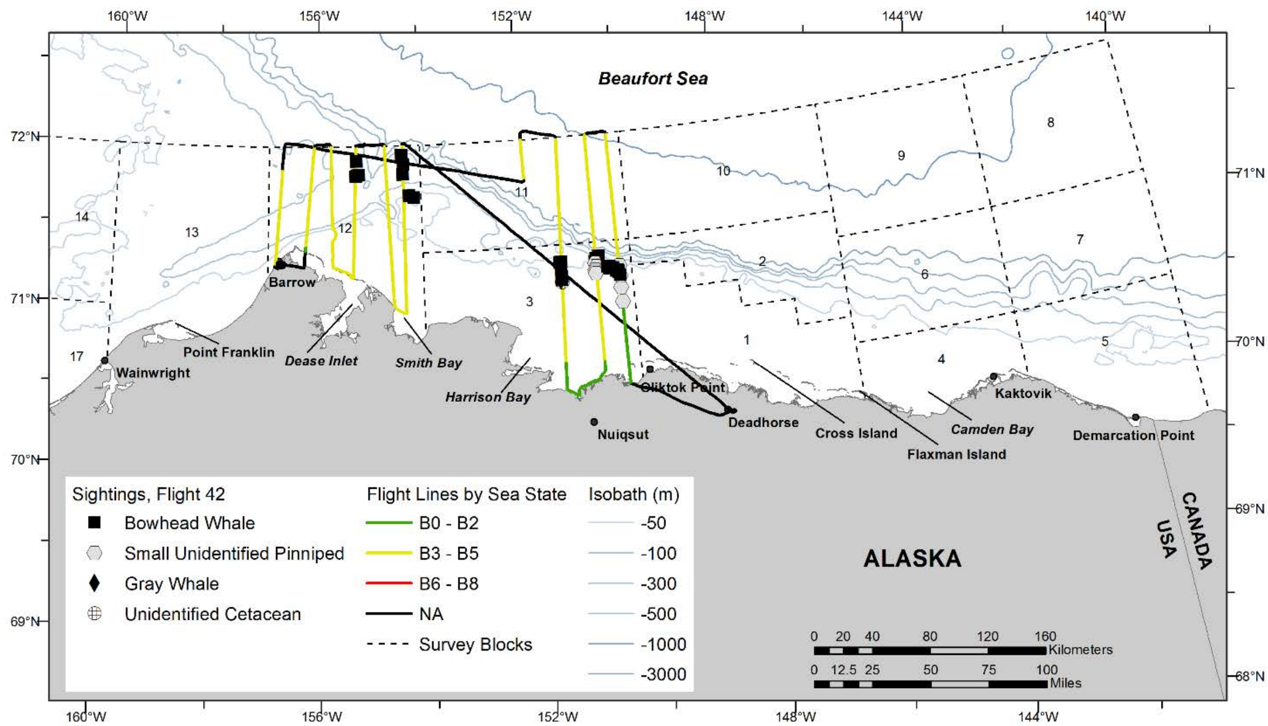

Figure B-87. ASAMM Flight 42 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

26 September 2016, Flight 246

Flight was a complete survey of transects 22, 24, 34, 35, 36, and 37. Survey conditions included partly cloudy to overcast skies, visibility <1 km to unlimited visibility (with glare and precipitation), and Beaufort 2-4 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales, killer whales (including one calf), walruses, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
246	9/26/2016 11:43	68.027	168.644	gray whale	swim	2	0	22
246	9/26/2016 11:47	67.936	168.763	gray whale	feed	1	0	23
246	9/26/2016 11:48	67.920	168.749	gray whale	feed	1	0	23
246	9/26/2016 11:49	67.890	168.767	gray whale	feed	1	0	23
246	9/26/2016 11:49	67.890	168.728	gray whale	feed	4	0	23
246	9/26/2016 11:50	67.901	168.729	gray whale	swim	2	0	23
246	9/26/2016 11:51	67.897	168.783	gray whale	rest	1	0	23
246	9/26/2016 11:52	67.910	168.749	gray whale	feed	1	0	23
246	9/26/2016 11:52	67.923	168.750	gray whale	feed	2	0	23
246	9/26/2016 11:53	67.902	168.740	gray whale	swim	2	0	23
246	9/26/2016 11:55	67.881	168.734	gray whale	feed	1	0	23
246	9/26/2016 11:55	67.873	168.738	gray whale	swim	3	0	23
246	9/26/2016 11:56	67.859	168.751	gray whale	swim	12	0	23
246	9/26/2016 11:56	67.859	168.750	gray whale	feed	7	0	23
246	9/26/2016 11:58	67.864	168.800	gray whale	swim	3	0	23
246	9/26/2016 11:58	67.859	168.796	gray whale	feed	4	0	23
246	9/26/2016 11:59	67.859	168.729	gray whale	feed	2	0	23
246	9/26/2016 11:59	67.857	168.710	gray whale	swim	3	0	23
246	9/26/2016 12:05	67.838	168.850	gray whale	feed	3	0	23
246	9/26/2016 12:05	67.844	168.811	gray whale	feed	3	0	23
246	9/26/2016 12:06	67.846	168.770	gray whale	feed	7	0	23
246	9/26/2016 12:06	67.847	168.745	gray whale	feed	8	0	23
246	9/26/2016 12:06	67.848	168.712	gray whale	feed	13	0	23
246	9/26/2016 12:06	67.849	168.685	gray whale	feed	4	0	23
246	9/26/2016 12:07	67.855	168.663	gray whale	feed	5	0	23
246	9/26/2016 12:07	67.867	168.638	gray whale	feed	4	0	23
246	9/26/2016 12:08	67.866	168.600	gray whale	feed	3	0	23
246	9/26/2016 12:08	67.862	168.580	gray whale	feed	1	0	23
246	9/26/2016 12:08	67.852	168.577	gray whale	feed	13	0	23
246	9/26/2016 12:10	67.860	168.515	gray whale	feed	4	0	23
246	9/26/2016 12:11	67.875	168.534	gray whale	feed	6	0	23
246	9/26/2016 12:11	67.871	168.542	gray whale	feed	3	0	23
246	9/26/2016 12:11	67.862	168.532	gray whale	feed	3	0	23

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
246	9/26/2016 12:15	67.851	168.522	gray whale	feed	2	0	23
246	9/26/2016 12:19	67.855	168.530	gray whale	mill	2	0	23
246	9/26/2016 12:20	67.856	168.473	gray whale	feed	2	0	23
246	9/26/2016 12:20	67.889	168.462	gray whale	swim	2	0	23
246	9/26/2016 12:20	67.851	168.442	gray whale	feed	1	0	23
246	9/26/2016 12:21	67.862	168.378	gray whale	feed	1	0	23
246	9/26/2016 12:21	67.850	168.350	gray whale	feed	16	0	23
246	9/26/2016 12:22	67.858	168.335	gray whale	rest	3	0	23
246	9/26/2016 12:24	67.861	168.253	gray whale	rest	1	0	23
246	9/26/2016 12:25	67.860	168.157	gray whale	rest	1	0	23
246	9/26/2016 12:25	67.850	168.135	gray whale	swim	2	0	23
246	9/26/2016 12:26	67.855	168.142	gray whale	rest	1	0	23
246	9/26/2016 12:27	67.863	168.071	gray whale	feed	5	0	23
246	9/26/2016 12:28	67.852	168.042	gray whale	feed	1	0	23
246	9/26/2016 12:28	67.855	168.024	gray whale	feed	1	0	23
246	9/26/2016 12:28	67.847	168.015	gray whale	feed	1	0	23
246	9/26/2016 12:28	67.867	168.009	gray whale	feed	3	0	23
246	9/26/2016 12:30	67.857	167.965	gray whale	swim	2	0	23
246	9/26/2016 13:26	67.699	168.518	gray whale	mill	4	0	23
246	9/26/2016 13:31	67.702	168.569	gray whale	feed	9	0	23
246	9/26/2016 13:33	67.697	168.576	gray whale	swim	2	0	23
246	9/26/2016 13:34	67.711	168.633	gray whale	feed	6	0	23
246	9/26/2016 13:36	67.709	168.654	gray whale	feed	8	0	23
246	9/26/2016 17:13	70.221	168.495	killer whale	swim	1	0	19
246	9/26/2016 17:14	70.228	168.492	killer whale	swim	7	1	19

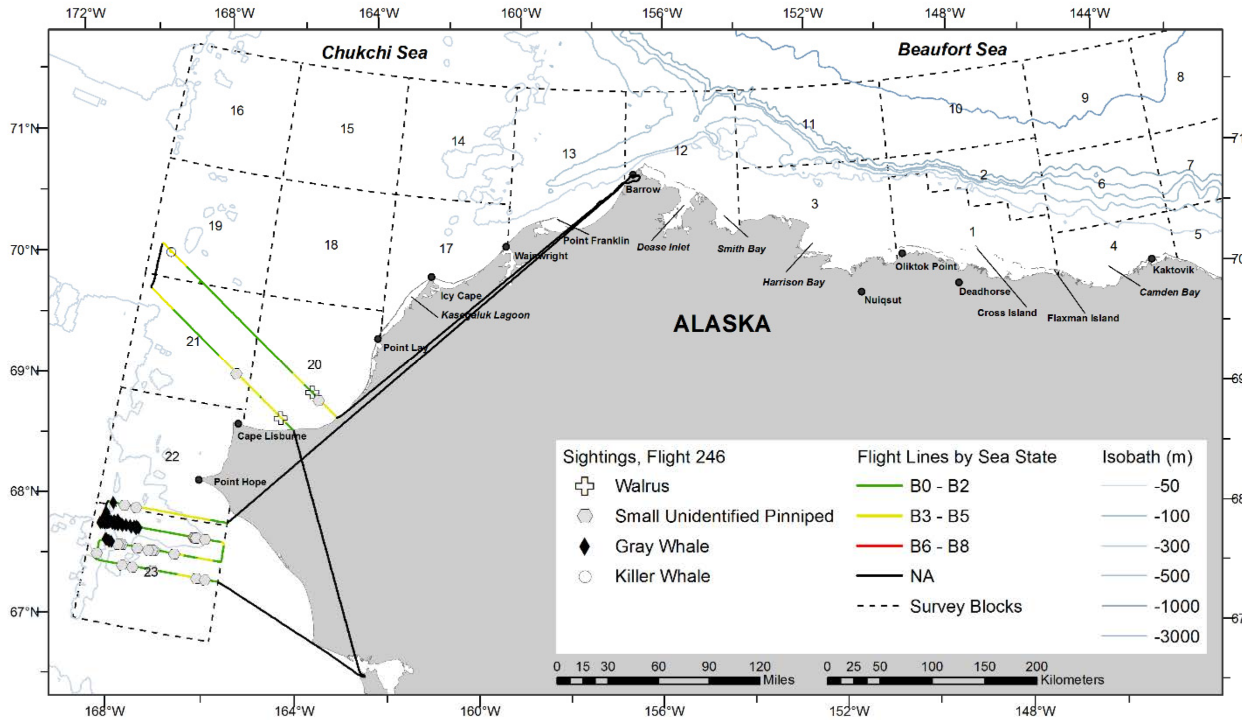

Figure B-88. ASAMM Flight 246 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Pair of surface active gray whales observed in the southern Chukchi Sea, during ASAMM Flight 246, 26 September 2016.

Killer whale with its dorsal fin flopped over to the right side and the tip curled under; one of a group of seven killer whales, observed approximately 220 km northwest of Point Lay, Alaska, during ASAMM Flight 246, 26 September 2016.

26 September 2016, Flight 43

Flight was a survey of portions of blocks 1, 2, and 6. Survey conditions included overcast skies, <1 km to unlimited visibility (with fog, haze, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including one calf), one beluga, small unidentified pinnipeds, and polar bears (including seven cubs).

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
43	9/26/2016 12:10	70.544	147.955	bowhead whale	swim	1	0	1
43	9/26/2016 12:19	70.496	147.958	bowhead whale	rest	1	0	1
43	9/26/2016 12:56	70.949	147.295	bowhead whale	swim	2	1	2
43	9/26/2016 13:45	70.465	146.584	beluga	swim	1	0	1

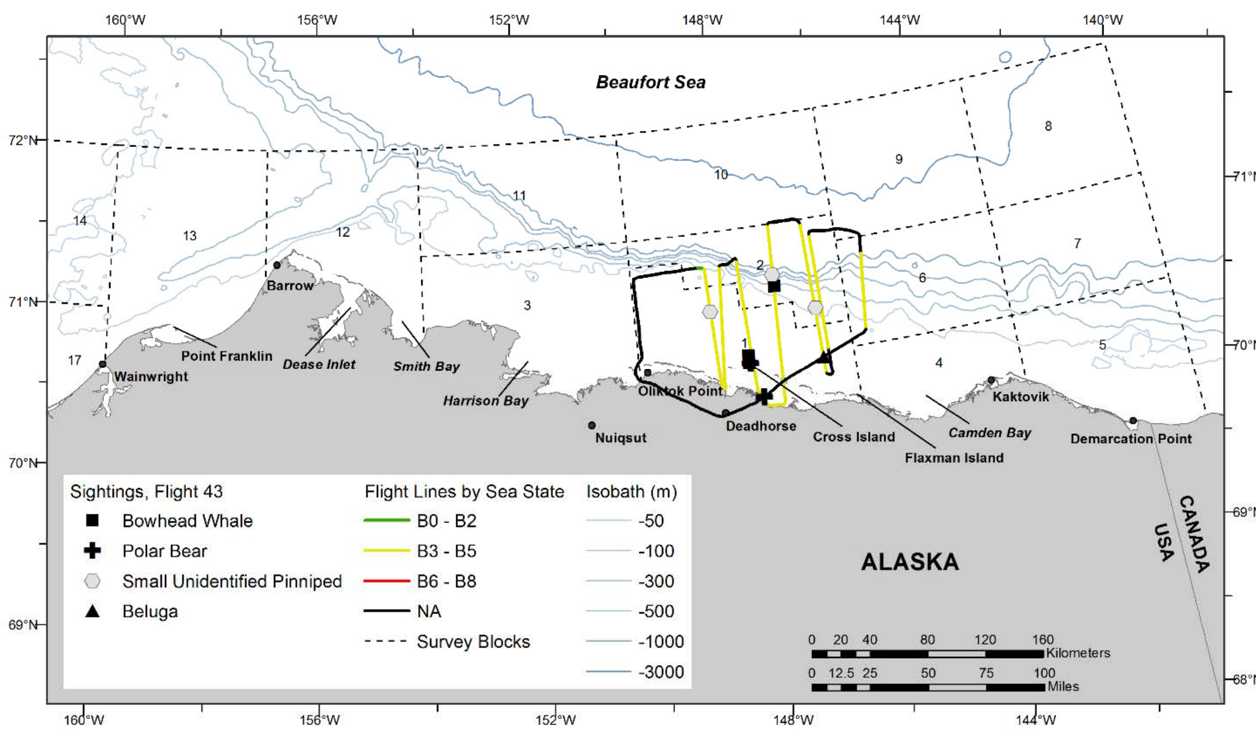

Figure B-89. ASAMM Flight 43 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

27 September 2016, Flight 44

Flight was a survey of portions of blocks 1, 2, 5, and 10. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-6 sea states. Sea ice cover was 0-1% broken floe in the area surveyed. Sightings included one bowhead whale, one beluga, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
44	9/27/2016 12:26	69.794	141.127	bowhead whale	rest	1	0	5
44	9/27/2016 14:12	71.219	149.344	beluga	rest	1	0	2

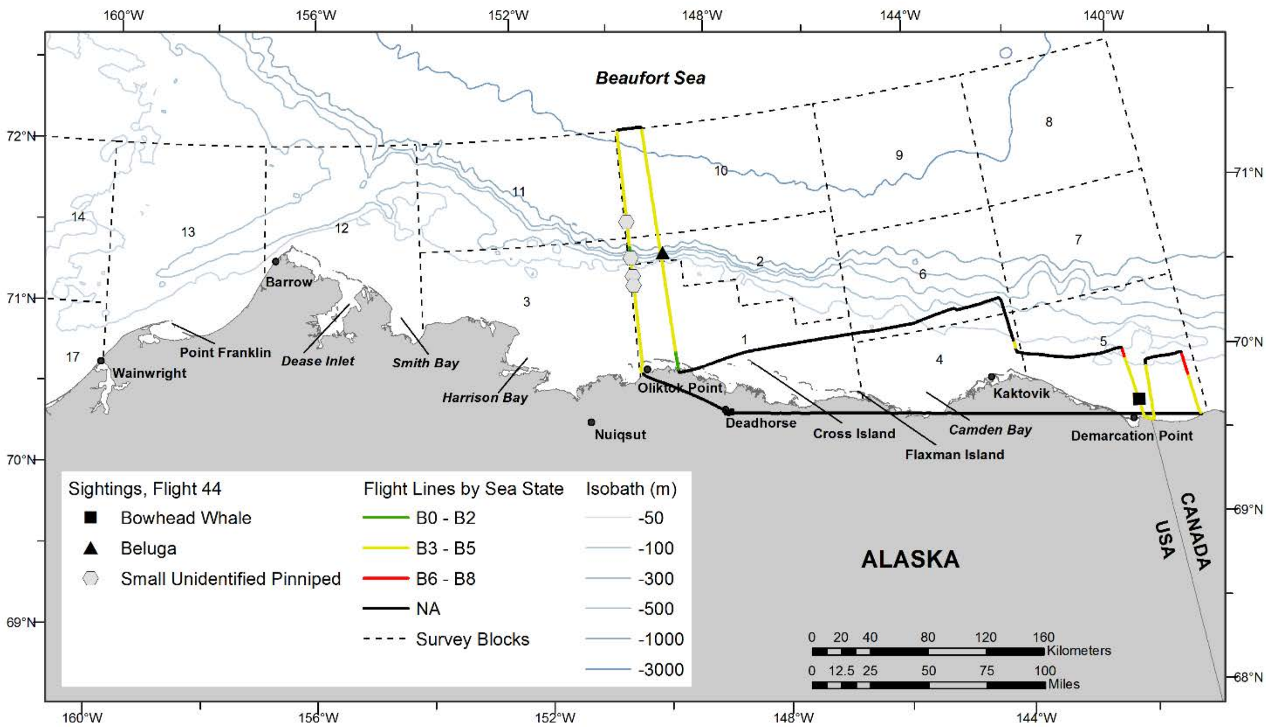

Figure B-90. ASAMM Flight 44 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

3 October 2016, Flight 45

Flight was a coastal search survey of block 1. Survey conditions included clear skies, 2 km to unlimited visibility (with fog and glare), and Beaufort 2-4 sea states. Sea ice cover was 0-25% shorefast ice in the area surveyed. Sightings included one small unidentified pinniped and polar bears (including six cubs).

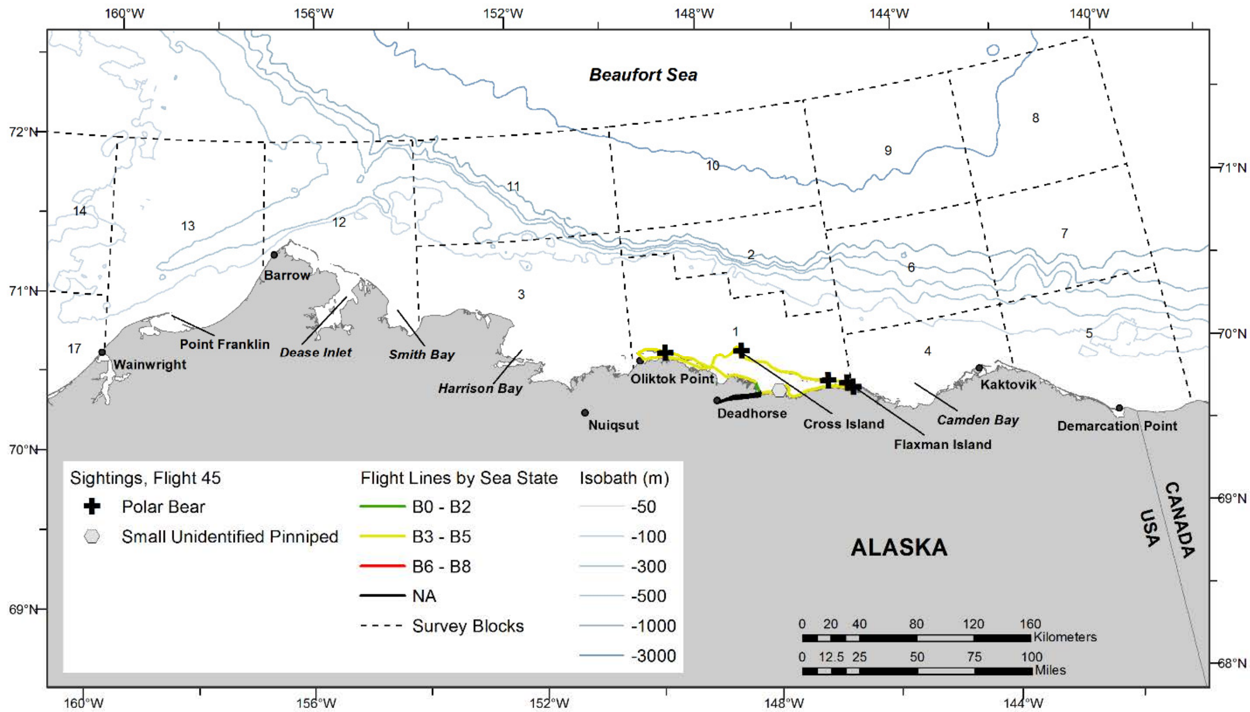

Figure B-91. ASAMM Flight 45 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

4 October 2016, Flight 247

Flight was a partial survey of transect 10. Survey conditions included partly cloudy to overcast skies, 3-10 km visibility (with haze), and Beaufort 2-3 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales, walruses, one unidentified pinniped, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
247	10/4/2016 11:33	70.893	161.013	gray whale	feed	1	0	17
247	10/4/2016 11:35	70.892	161.058	gray whale	feed	4	0	17
247	10/4/2016 11:36	70.886	161.046	gray whale	feed	1	0	17
247	10/4/2016 11:37	70.889	161.104	gray whale	feed	2	0	17
247	10/4/2016 11:41	70.971	161.213	gray whale	swim	2	0	17
247	10/4/2016 11:42	70.977	161.204	gray whale	rest	1	0	17
247	10/4/2016 11:42	70.968	161.186	gray whale	swim	1	0	17
247	10/4/2016 11:44	70.973	161.241	gray whale	feed	5	0	17
247	10/4/2016 11:46	70.976	161.266	gray whale	swim	3	0	17

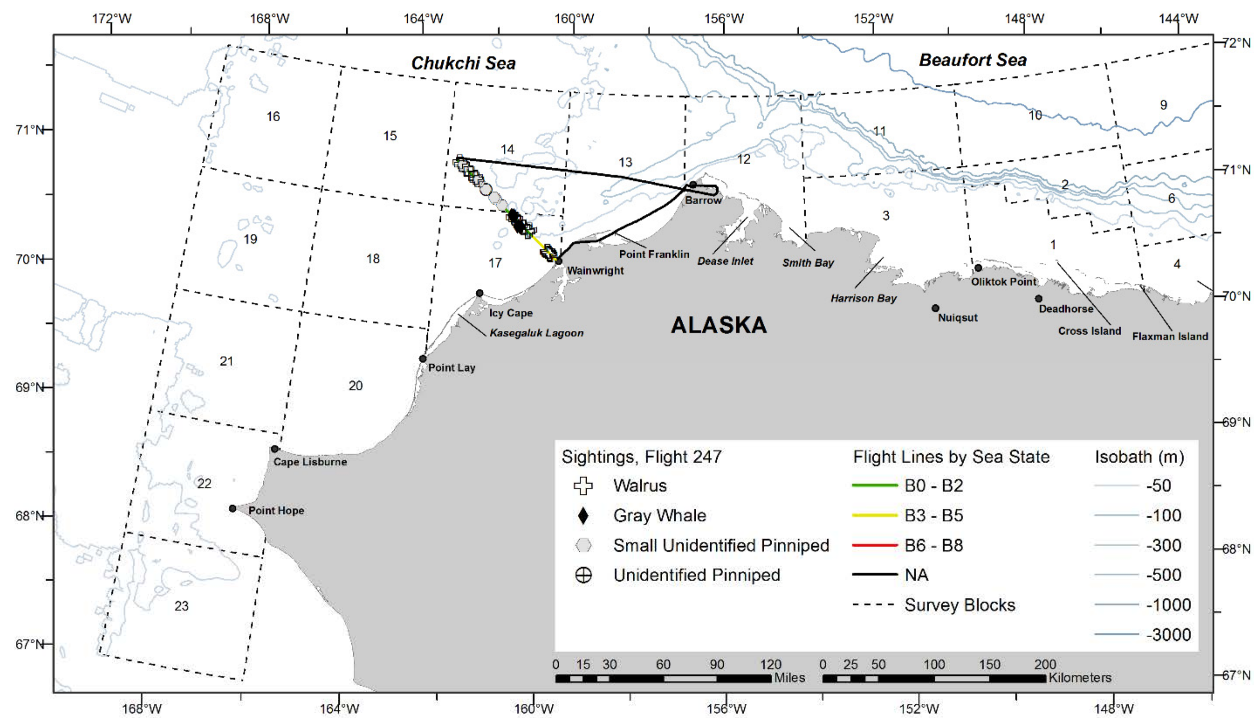

Figure B-92. ASAMM Flight 247 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

7 October 2016, Flight 46

Flight was a survey of portions of blocks 1 and 2. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 3-7 sea states. No sea ice was observed in the area surveyed. Sightings included one unidentified pinniped and polar bears.

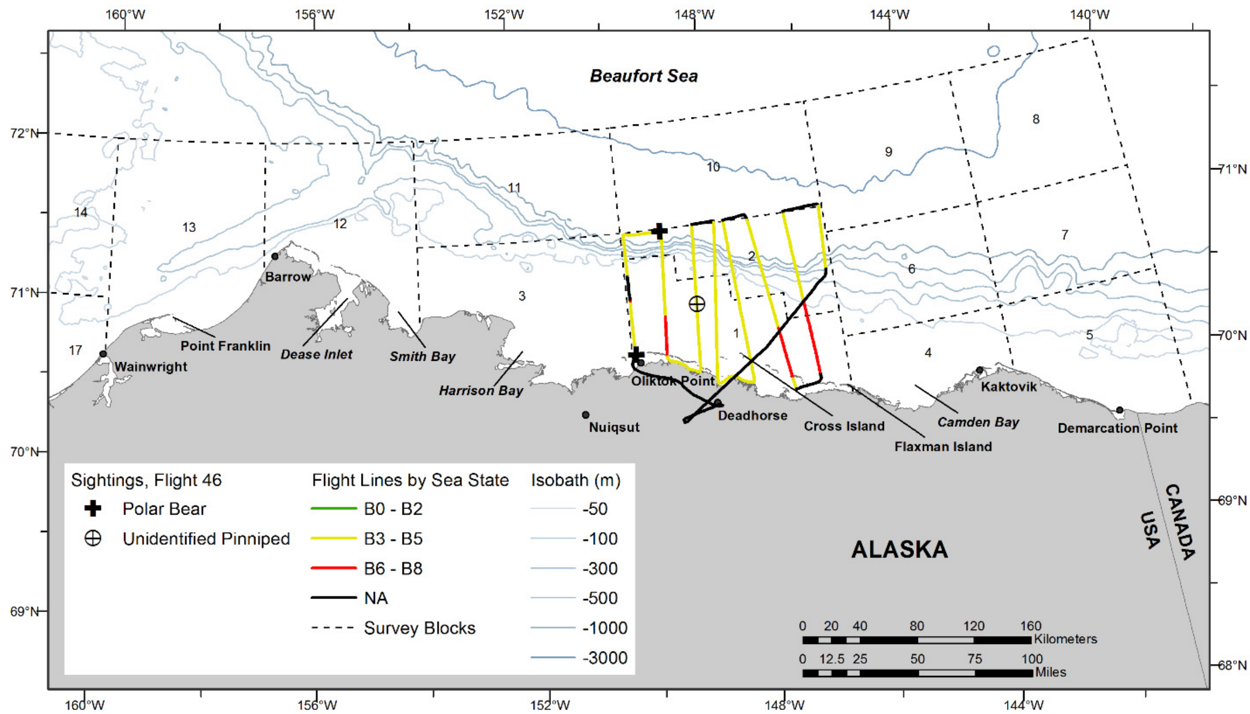

Figure B-93. ASAMM Flight 46 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

8 October 2016, Flight 47

Flight was a survey of portions of blocks 3 and 11. Survey conditions included partly cloudy to overcast skies, 0-5 km visibility (with glare and low ceilings), and Beaufort 6-8 sea states. No sea ice was observed in the area surveyed. No sightings were observed.

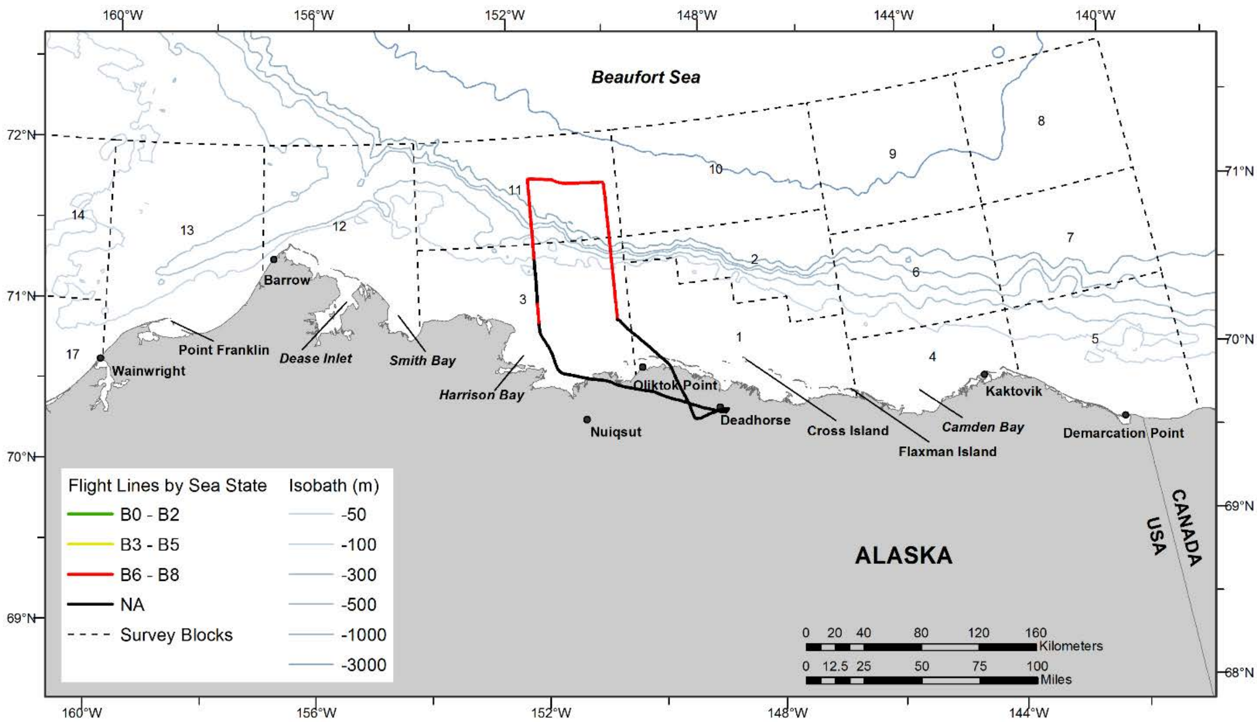

Figure B-94. ASAMM Flight 47 survey track, depicted by sea state.

9 October 2016, Flight 248

Flight was a partial survey of transects 21 and 23 and the coastal transect from approximately 30 km north of Point Lay to Ledyard Bay. Survey conditions included partly cloudy skies, 3 km to unlimited visibility (with glare and haze), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales, walruses, unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
248	10/9/2016 12:08	69.347	163.273	gray whale	feed	2	0	20

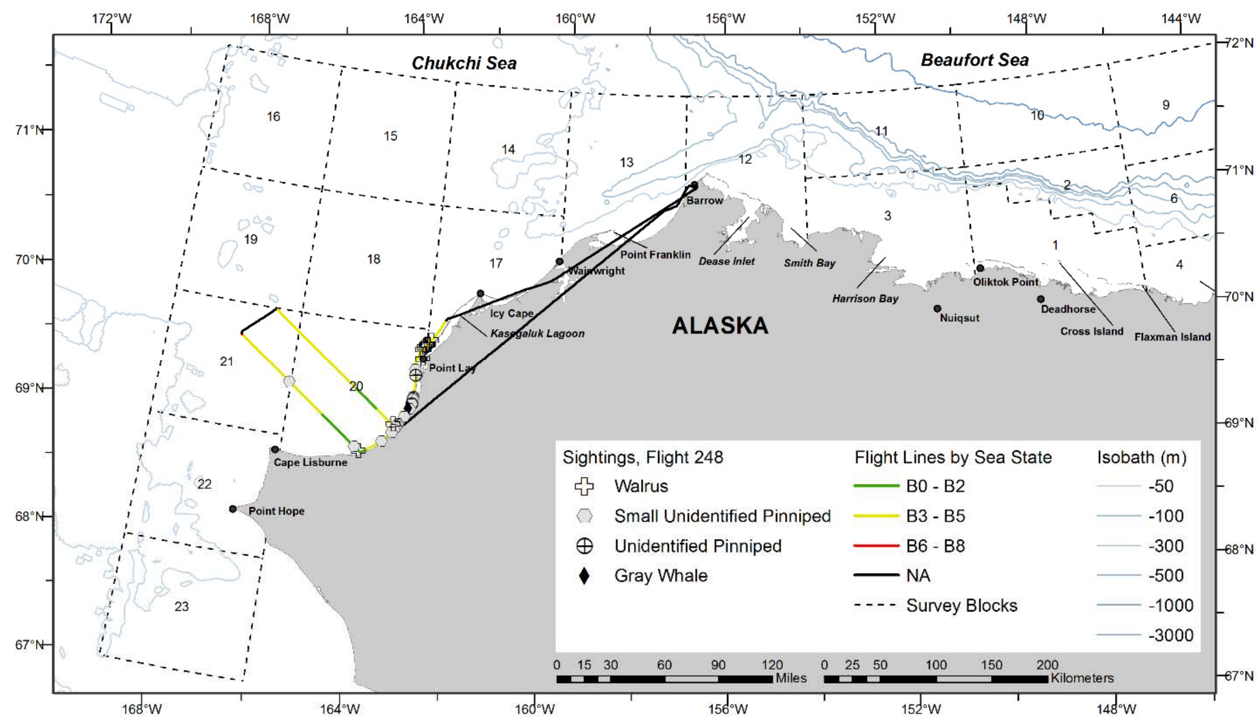

Figure B-95. ASAMM Flight 248 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

One of two gray whales seen feeding approximately 60 km south of Point Lay, Alaska, during ASAMM Flight 248, 9 October 2016.

10 October 2016, Flight 249

Flight was a complete survey of transects 4, 5, 8, 9, 10, and 11, partial survey of transects 6 and 7, and the coastal transect between Wainwright and Peard Bay. Survey conditions included clear to overcast skies, 3 km to unlimited visibility (with glare and haze), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including two calves), gray whales, unidentified cetaceans, walruses (including one carcass), unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
249	10/10/2016 10:21	70.882	160.919	gray whale	swim	1	0	17
249	10/10/2016 10:21	70.889	160.952	gray whale	feed	1	0	17
249	10/10/2016 10:22	70.901	161.019	gray whale	feed	1	0	17
249	10/10/2016 12:50	70.878	159.240	gray whale	swim	1	0	13
249	10/10/2016 14:19	71.526	158.469	bowhead whale	swim	2	1	13
249	10/10/2016 14:41	71.263	157.519	gray whale	feed	8	0	13
249	10/10/2016 14:50	71.245	157.481	gray whale	swim	1	0	13
249	10/10/2016 16:13	70.951	160.408	gray whale	feed	1	0	17
249	10/10/2016 16:15	70.944	160.431	gray whale	swim	1	0	17
249	10/10/2016 16:19	70.952	160.395	gray whale	swim	1	0	17
249	10/10/2016 16:25	71.044	160.695	gray whale	rest	1	0	14
249	10/10/2016 16:26	71.057	160.738	gray whale	rest	1	0	14
249	10/10/2016 16:26	71.059	160.750	gray whale	feed	1	0	14
249	10/10/2016 16:26	71.066	160.779	gray whale	rest	1	0	14
249	10/10/2016 16:26	71.071	160.799	gray whale	swim	2	0	14
249	10/10/2016 16:28	71.106	160.911	gray whale	swim	1	0	14
249	10/10/2016 16:34	71.251	161.490	gray whale	feed	1	0	14
249	10/10/2016 16:51	71.646	162.969	bowhead whale	swim	2	1	14
249	10/10/2016 17:35	71.578	161.819	unid cetacean	swim	1	0	14
249	10/10/2016 17:48	71.350	161.050	unid cetacean	swim	1	0	14
249	10/10/2016 18:13	70.914	159.455	gray whale	swim	1	0	13
249	10/10/2016 18:51	71.412	159.560	bowhead whale	swim	1	0	13

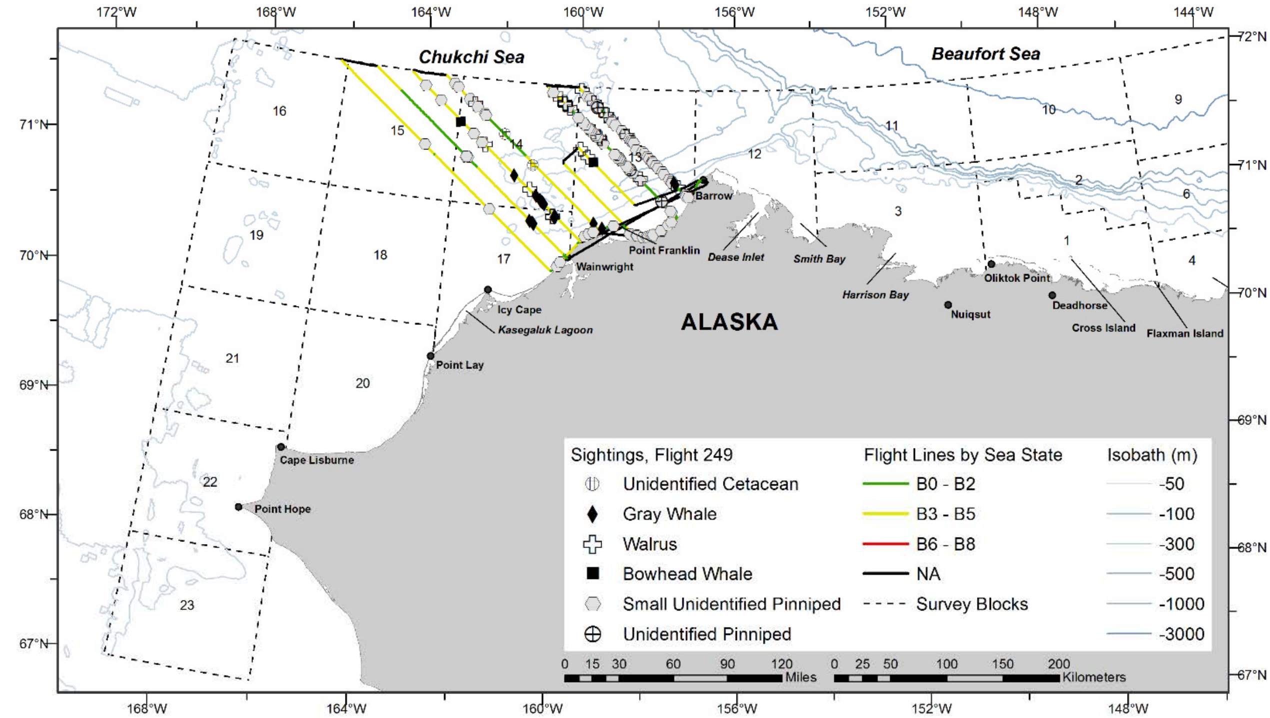

Figure B-96. ASAMM Flight 249 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

10 October 2016, Flight 48

Flight was a survey of portions of blocks 3, 11, and 12, and complete survey of transects 1, 2, and 3. Survey conditions included clear to partly cloudy skies, 0 km to unlimited visibility (with fog, glare, and haze), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including 14 calves), one gray whale, belugas (including one calf), unidentified pinnipeds, small unidentified pinnipeds, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
48	10/10/2016 10:59	71.300	152.226	bowhead whale	swim	2	1	3
48	10/10/2016 11:04	71.294	152.143	bowhead whale	swim	2	1	3
48	10/10/2016 11:10	71.433	152.275	bowhead whale	swim	2	0	11
48	10/10/2016 11:11	71.431	152.280	bowhead whale	rest	1	0	11
48	10/10/2016 11:13	71.425	152.328	bowhead whale	swim	2	1	11
48	10/10/2016 11:24	71.374	152.523	bowhead whale	swim	1	0	11
48	10/10/2016 11:28	71.322	152.607	bowhead whale	rest	2	0	3
48	10/10/2016 11:28	71.320	152.565	bowhead whale	swim	2	1	3
48	10/10/2016 12:04	71.322	153.303	bowhead whale	swim	1	0	3
48	10/10/2016 12:11	71.493	153.323	beluga	swim	2	1	11
48	10/10/2016 12:15	71.633	153.377	bowhead whale	swim	2	0	11
48	10/10/2016 13:49	71.705	154.720	bowhead whale	mill	2	1	12
48	10/10/2016 13:53	71.672	154.841	bowhead whale	swim	2	0	12
48	10/10/2016 13:55	71.620	154.844	bowhead whale	rest	2	1	12
48	10/10/2016 13:55	71.615	154.792	bowhead whale	swim	1	0	12
48	10/10/2016 13:55	71.614	154.798	bowhead whale	swim	1	0	12
48	10/10/2016 13:57	71.614	154.893	bowhead whale	mill	2	1	12
48	10/10/2016 14:00	71.613	154.748	bowhead whale	swim	2	1	12
48	10/10/2016 14:00	71.609	154.754	bowhead whale	mill	4	2	12
48	10/10/2016 14:01	71.598	154.744	bowhead whale	swim	1	0	12
48	10/10/2016 14:03	71.619	154.769	bowhead whale	swim	3	0	12
48	10/10/2016 14:10	71.384	154.713	bowhead whale	swim	1	0	12
48	10/10/2016 14:13	71.319	154.687	bowhead whale	swim	1	0	12
48	10/10/2016 15:37	71.403	155.424	bowhead whale	swim	1	0	12
48	10/10/2016 15:38	71.411	155.439	bowhead whale	swim	1	0	12
48	10/10/2016 15:43	71.498	155.305	bowhead whale	swim	1	0	12
48	10/10/2016 15:44	71.494	155.294	bowhead whale	rest	2	0	12
48	10/10/2016 15:48	71.512	155.237	bowhead whale	swim	1	0	12
48	10/10/2016 15:49	71.525	155.173	bowhead whale	breach	1	0	12
48	10/10/2016 15:49	71.525	155.151	bowhead whale	swim	1	0	12
48	10/10/2016 15:49	71.519	155.183	bowhead whale	feed	1	0	12
48	10/10/2016 15:50	71.522	155.217	bowhead whale	swim	2	1	12
48	10/10/2016 16:02	71.846	155.242	bowhead whale	rest	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
48	10/10/2016 16:02	71.846	155.243	bowhead whale	swim	2	1	12
48	10/10/2016 16:20	71.659	155.769	bowhead whale	rest	1	0	12
48	10/10/2016 16:23	71.630	155.731	bowhead whale	feed	4	2	12
48	10/10/2016 16:24	71.633	155.724	bowhead whale	feed	2	0	12
48	10/10/2016 16:24	71.634	155.695	bowhead whale	rest	1	0	12
48	10/10/2016 16:45	71.507	156.174	gray whale	feed	1	0	12
48	10/10/2016 17:37	71.577	157.773	bowhead whale	rest	1	0	13

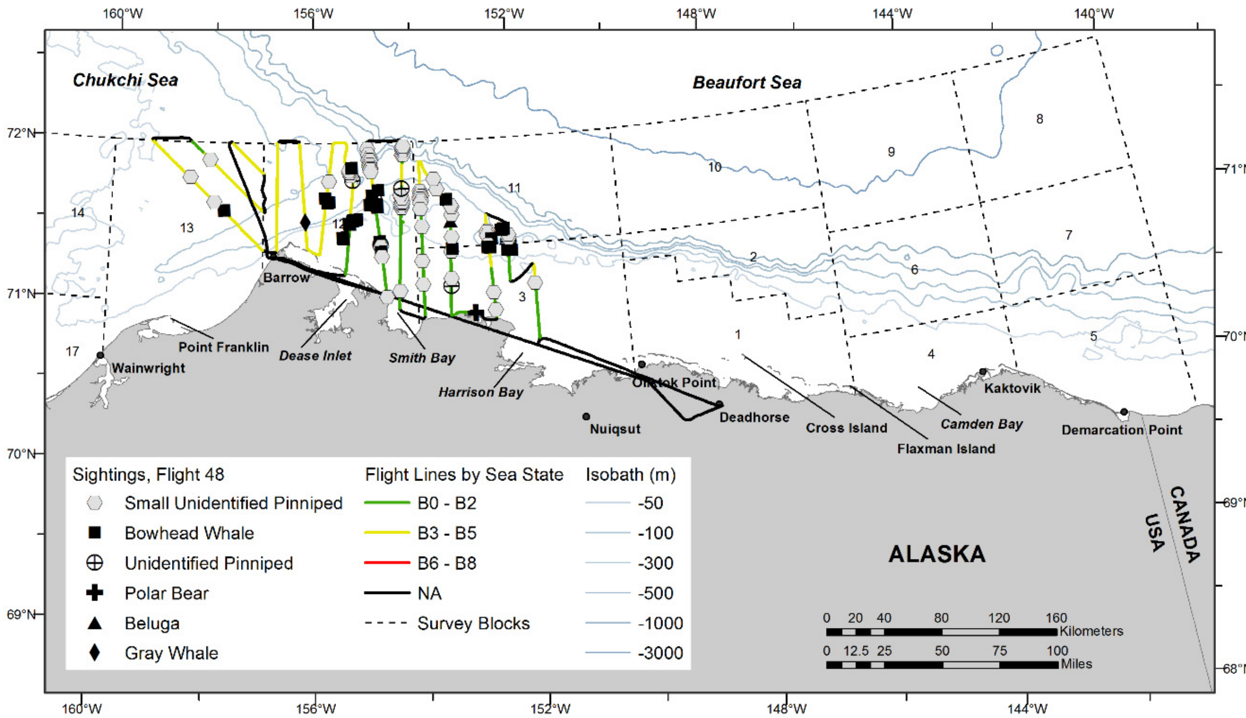

Figure B-97. ASAMM Flight 48 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

12 October 2016, Flight 250

Flight was a complete survey of transects 33, 34, 35, 36, and 37. Survey conditions included partly cloudy skies, 5 km to unlimited visibility (with glare and iced windows), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included gray whales, unidentified cetaceans, one unidentified pinniped, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
250	10/12/2016 11:49	68.016	168.732	gray whale	rest	1	0	22
250	10/12/2016 11:49	68.014	168.736	gray whale	rest	1	0	22
250	10/12/2016 11:51	68.001	168.688	gray whale	feed	8	0	22
250	10/12/2016 11:51	68.000	168.688	gray whale	feed	7	0	22
250	10/12/2016 11:52	67.980	168.711	gray whale	feed	5	0	23
250	10/12/2016 11:52	67.981	168.720	gray whale	feed	6	0	23
250	10/12/2016 11:53	67.996	168.708	gray whale	rest	1	0	23
250	10/12/2016 11:53	67.997	168.704	gray whale	feed	5	0	23
250	10/12/2016 11:54	68.021	168.698	gray whale	rest	3	0	22
250	10/12/2016 11:54	68.034	168.669	gray whale	feed	1	0	22
250	10/12/2016 11:56	68.023	168.528	gray whale	dive	2	0	22
250	10/12/2016 12:49	67.858	167.892	gray whale	dive	1	0	23
250	10/12/2016 12:51	67.862	168.022	gray whale	swim	1	0	23
250	10/12/2016 12:51	67.866	168.068	gray whale	swim	1	0	23
250	10/12/2016 12:51	67.859	168.107	gray whale	feed	2	0	23
250	10/12/2016 12:52	67.857	168.193	gray whale	swim	1	0	23
250	10/12/2016 12:53	67.867	168.217	gray whale	swim	1	0	23
250	10/12/2016 12:53	67.866	168.249	gray whale	swim	1	0	23
250	10/12/2016 12:53	67.868	168.301	gray whale	swim	1	0	23
250	10/12/2016 12:54	67.868	168.327	gray whale	feed	1	0	23
250	10/12/2016 12:54	67.857	168.404	gray whale	feed	1	0	23
250	10/12/2016 12:55	67.873	168.415	gray whale	feed	1	0	23
250	10/12/2016 12:55	67.853	168.429	gray whale	feed	1	0	23
250	10/12/2016 12:55	67.859	168.500	gray whale	feed	5	0	23
250	10/12/2016 12:57	67.857	168.464	gray whale	feed	10	0	23
250	10/12/2016 13:00	67.858	168.601	gray whale	feed	3	0	23
250	10/12/2016 13:00	67.858	168.604	gray whale	feed	5	0	23
250	10/12/2016 13:01	67.866	168.653	gray whale	feed	1	0	23
250	10/12/2016 13:02	67.867	168.735	gray whale	feed	2	0	23
250	10/12/2016 13:07	67.676	168.736	gray whale	feed	1	0	23
250	10/12/2016 13:07	67.697	168.722	gray whale	feed	2	0	23
250	10/12/2016 13:08	67.710	168.672	gray whale	feed	1	0	23
250	10/12/2016 13:09	67.702	168.620	gray whale	feed	3	0	23
250	10/12/2016 13:10	67.705	168.603	gray whale	feed	3	0	23

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
250	10/12/2016 13:11	67.708	168.555	unid cetacean	dive	2	0	23
250	10/12/2016 13:12	67.710	168.556	gray whale	feed	3	0	23
250	10/12/2016 13:12	67.719	168.569	gray whale	feed	1	0	23

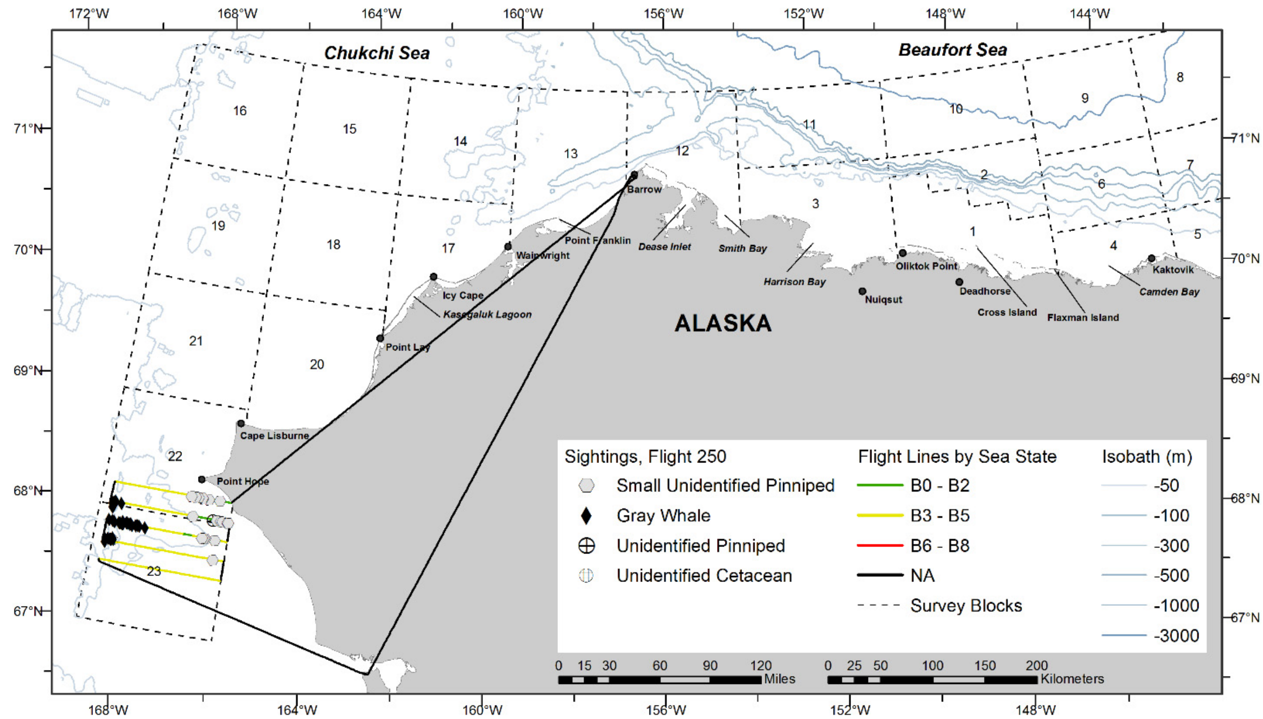

Figure B-98. ASAMM Flight 250 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

14 October 2016, Flight 251

Flight was a complete survey of transects 31 and 32 and partial survey of transects 29, 30, 38, and 39. Survey conditions included clear skies, <1 km to unlimited visibility (with glare and low ceilings), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included walruses, unidentified pinnipeds, and small unidentified pinnipeds.

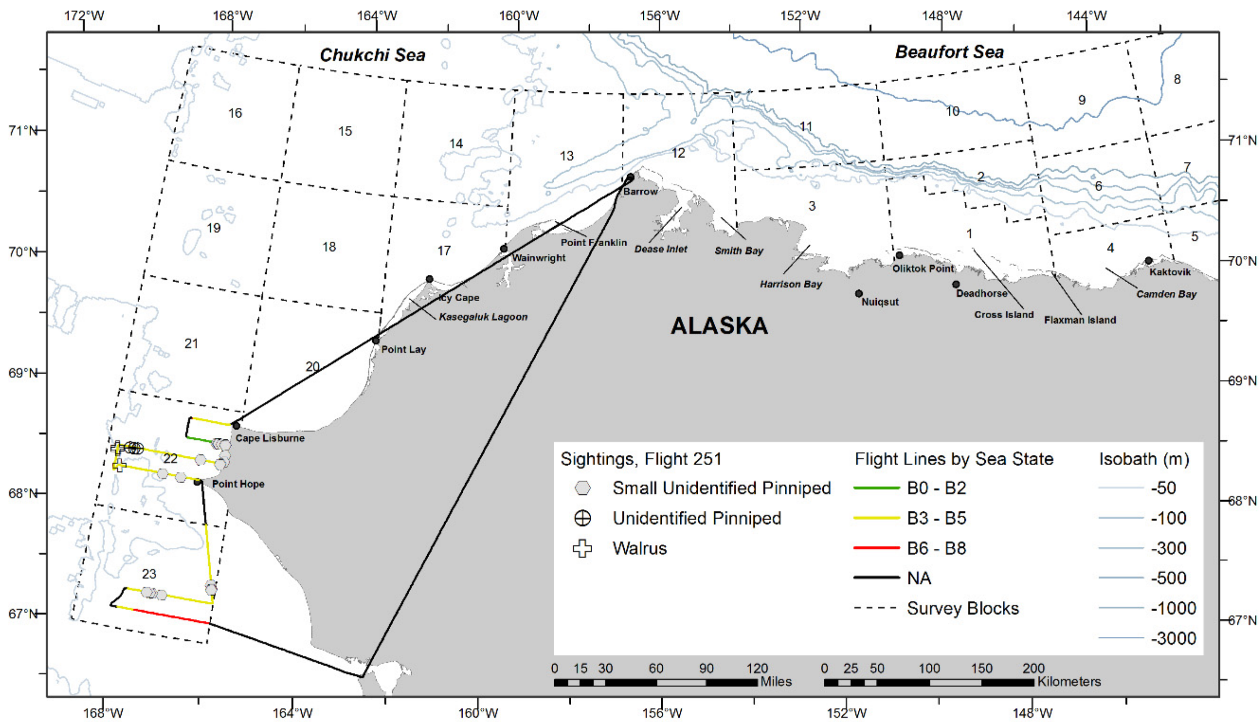

Figure B-99. ASAMM Flight 251 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

15 October 2016, Flight 252

Flight was a complete survey of transects 1, 2, 3, and 4, partial survey of transect 5, and the coastal transect from Point Franklin to Point Barrow. Survey conditions included overcast skies, <1 km to unlimited visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included small unidentified pinnipeds and polar bears (including two cubs).

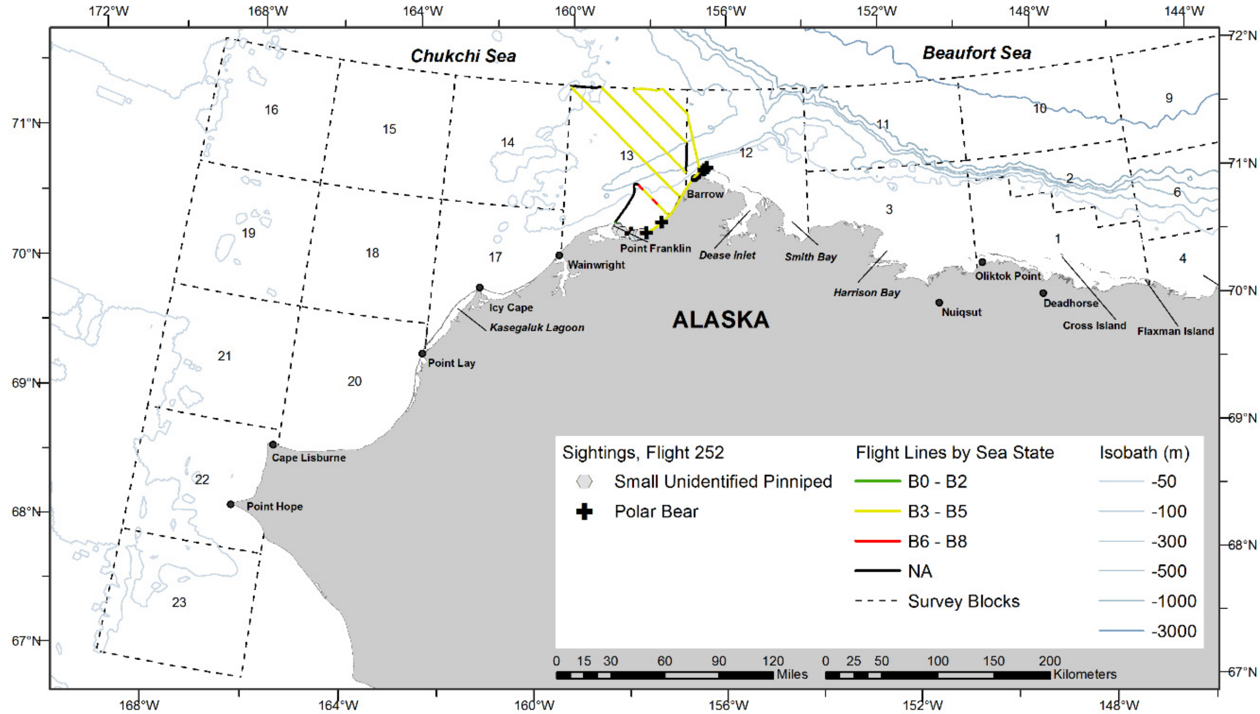

Figure B-100. ASAMM Flight 252 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

16 October 2016, Flight 253

Flight was a survey of block 12. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility (with glare), and Beaufort 2-6 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including three calves), small unidentified pinnipeds, and polar bears.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
253	10/16/2016 15:48	71.433	156.287	bowhead whale	swim	3	0	12
253	10/16/2016 15:52	71.398	156.274	bowhead whale	swim	1	0	12
253	10/16/2016 15:52	71.393	156.301	bowhead whale	dive	2	0	12
253	10/16/2016 16:08	71.500	155.731	bowhead whale	swim	7	1	12
253	10/16/2016 16:51	71.524	155.376	bowhead whale	swim	2	1	12
253	10/16/2016 17:28	71.638	154.767	bowhead whale	swim	1	0	12
253	10/16/2016 17:29	71.641	154.847	bowhead whale	swim	1	0	12
253	10/16/2016 17:55	71.698	154.110	bowhead whale	rest	1	0	12
253	10/16/2016 17:56	71.646	154.089	bowhead whale	swim	2	1	12

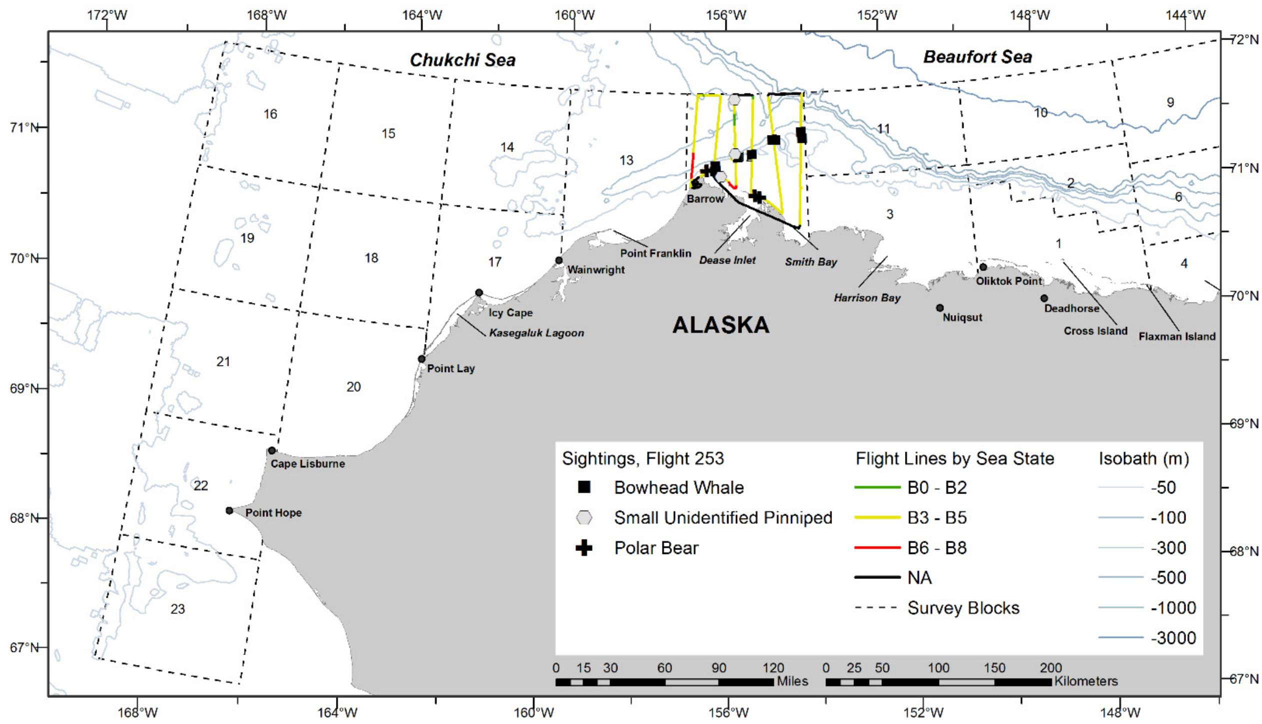

Figure B-101. ASAMM Flight 253 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

17 October 2016, Flight 254

Flight was a survey of portions of blocks 3 and 11. Survey conditions included overcast skies, 2 km to unlimited visibility (with precipitation), and Beaufort 1-6 sea states. Sea ice cover was 0-95% grease/new ice in the area surveyed. Sightings included bowhead whales (including one calf) and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
254	10/17/2016 10:35	71.682	153.784	bowhead whale	swim	1	0	11
254	10/17/2016 10:36	71.728	153.839	bowhead whale	swim	1	0	11
254	10/17/2016 10:36	71.729	153.845	bowhead whale	swim	18	1	11
254	10/17/2016 11:08	71.512	153.185	bowhead whale	swim	3	0	11
254	10/17/2016 11:13	71.435	153.133	bowhead whale	swim	1	0	11

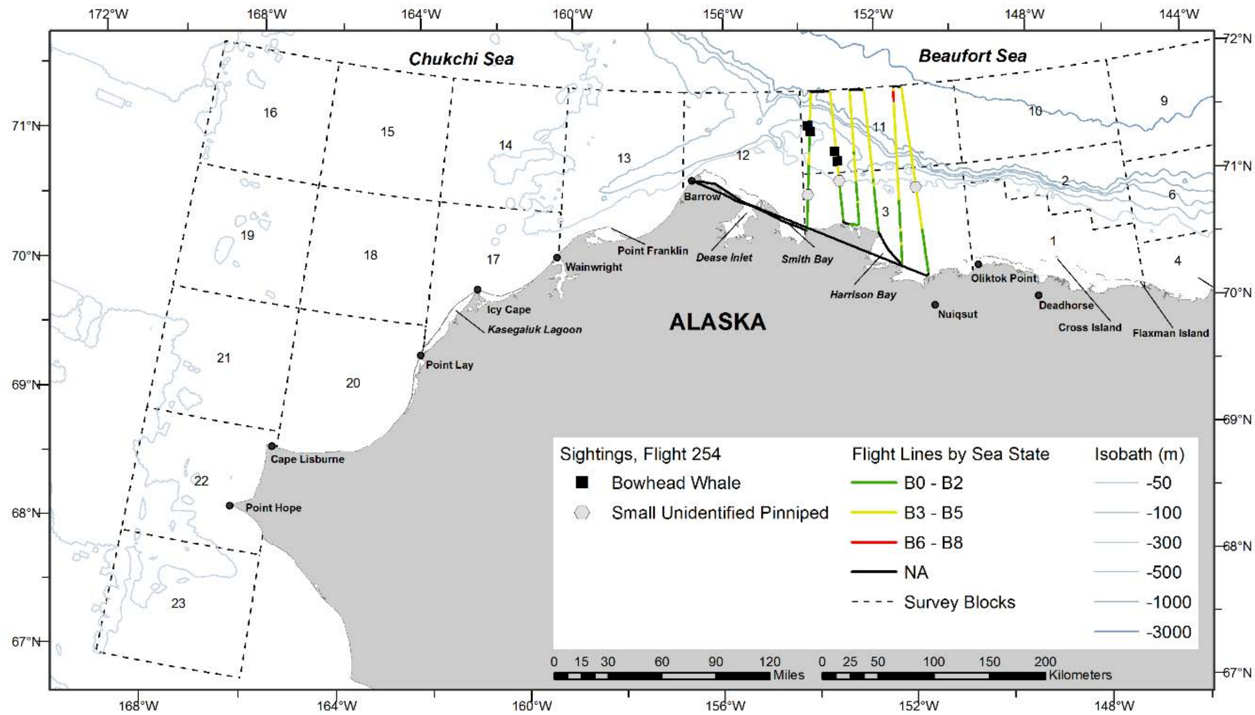

Figure B-102. ASAMM Flight 254 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

18 October 2016, Flight 255

Flight was a compete survey of transects 25, 26, and 27, and the coastal transect from Cape Lisburne to Point Barrow. Survey conditions included overcast skies, 5 km to unlimited visibility (with glare and low ceilings), and Beaufort 2-6 sea states. Sea ice cover was 0-85% grease/new ice in the area surveyed. Sightings included walruses, small unidentified pinnipeds, and polar bears (including two cubs).

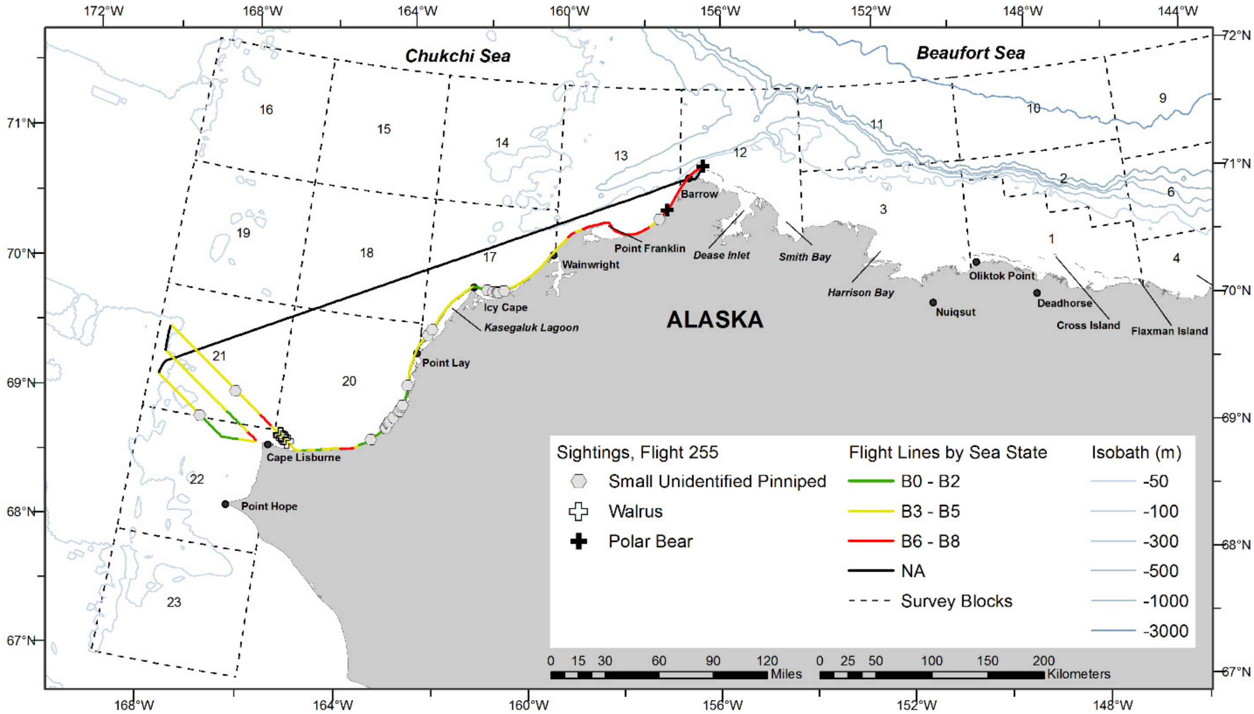

Figure B-103. ASAMM Flight 255 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 October 2016, Flight 256

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 glare and low ceilings), and Beaufort 1-6 sea states. Sea ice was 0-100% grease/new ice in the area surveyed. Sightings included belugas.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
256	10/19/2016 15:25	71.445	150.447	beluga	swim	2	0	11

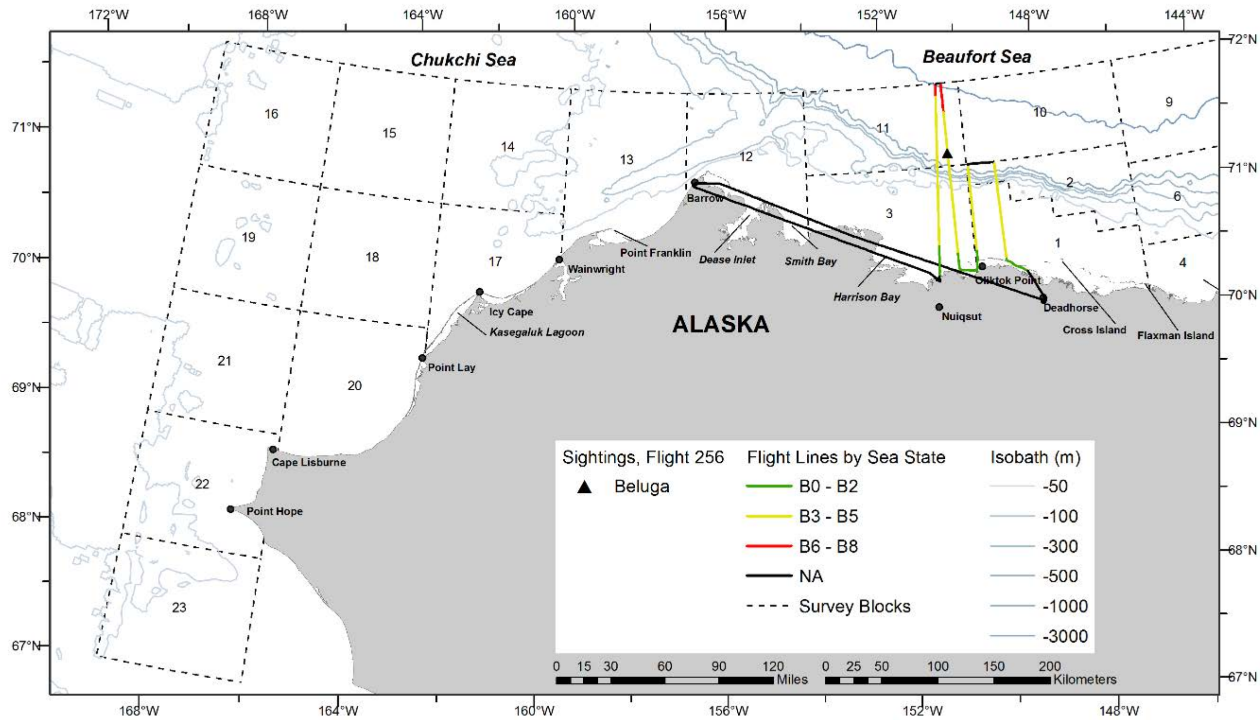

Figure B-104. ASAMM Flight 256 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

22 October 2016, Flight 257

Flight was a complete survey of transect 5 and partial survey of transects 6, 8, and 9. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. No sea ice was observed in the area surveyed. Sightings included bowhead whales (including two calves), walruses, and one small unidentified pinniped.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
257	10/22/2016 11:50	71.898	163.948	bowhead whale	swim	3	1	15
257	10/22/2016 12:26	71.700	162.325	bowhead whale	swim	1	0	14
257	10/22/2016 13:04	71.753	160.755	bowhead whale	swim	1	0	14
257	10/22/2016 13:19	71.971	161.639	bowhead whale	mill	8	1	14
257	10/22/2016 13:38	71.921	160.612	bowhead whale	swim	1	0	14
257	10/22/2016 13:52	71.608	159.482	bowhead whale	swim	1	0	13

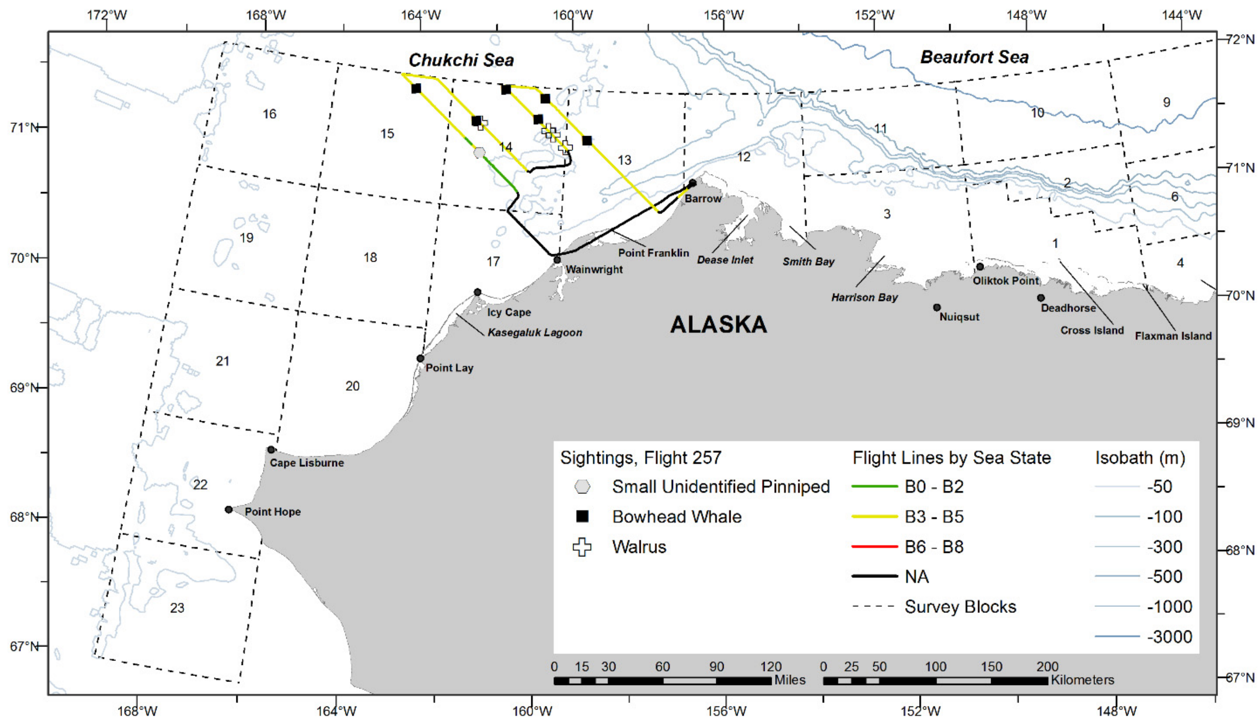

Figure B-105. ASAMM Flight 257 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

23 October 2016, Flight 258

Flight was a complete survey of transects 1, 2, 3, 4, and 5, and 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 2-6 sea states. Sea ice cover was 0-20% grease/new ice in the area surveyed. Sightings included bowhead whales (including two calves), gray whales, belugas, walruses, unidentified pinnipeds, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
258	10/23/2016 13:56	71.705	159.818	bowhead whale	swim	16	2	13
258	10/23/2016 14:03	71.791	160.007	bowhead whale	swim	1	0	14
258	10/23/2016 14:55	71.257	157.546	gray whale	feed	10	0	13
258	10/23/2016 15:25	71.728	158.367	bowhead whale	dive	2	0	13
258	10/23/2016 15:49	71.985	158.586	bowhead whale	swim	2	0	13
258	10/23/2016 15:56	71.890	158.089	bowhead whale	swim	1	0	13
258	10/23/2016 16:14	71.815	157.020	bowhead whale	swim	1	0	13
258	10/23/2016 17:00	71.461	156.277	beluga	swim	4	0	12

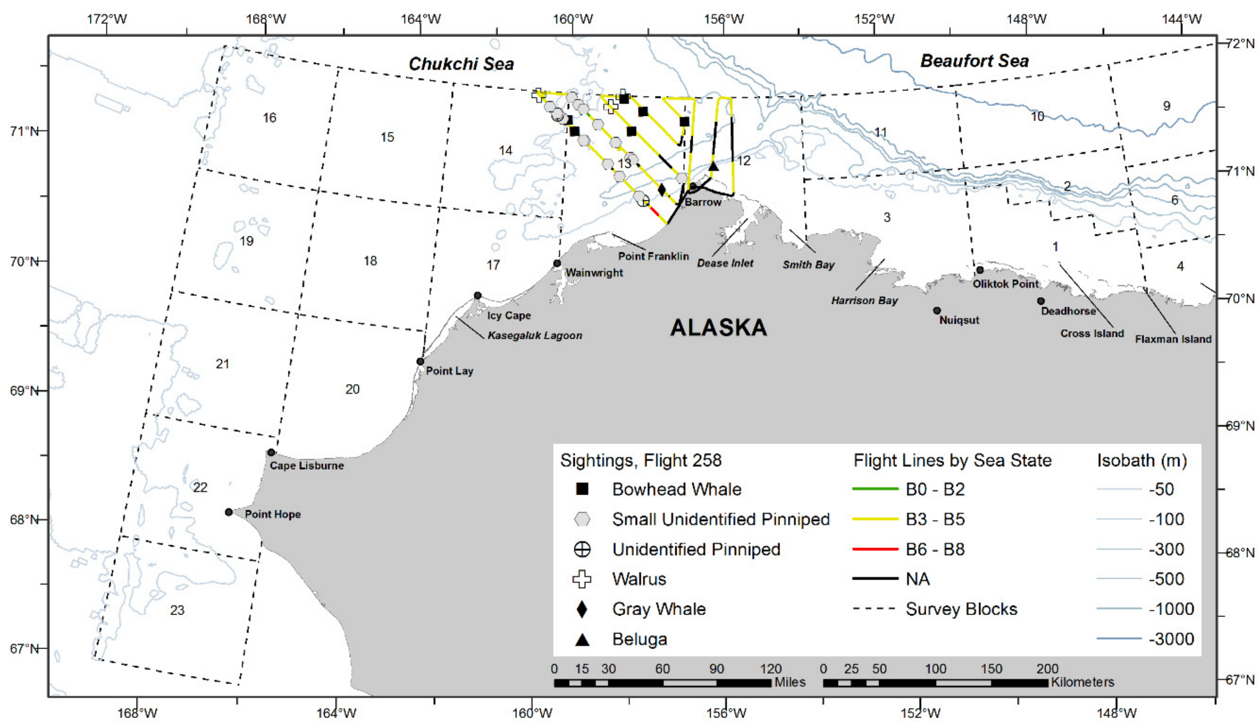

Figure B-106. ASAMM Flight 258 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 October 2016, Flight 259

Flight was a survey of portions of blocks 1, 2, 4, and 6. Survey conditions included clear to partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 0-5 sea states. Sea ice cover was 0-100% shorefast and grease/new ice in the area surveyed. Sightings included one unidentified cetacean, small unidentified pinnipeds, and one polar bear.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
259	10/24/2016 14:13	70.940	146.917	unid cetacean	swim	1	0	2

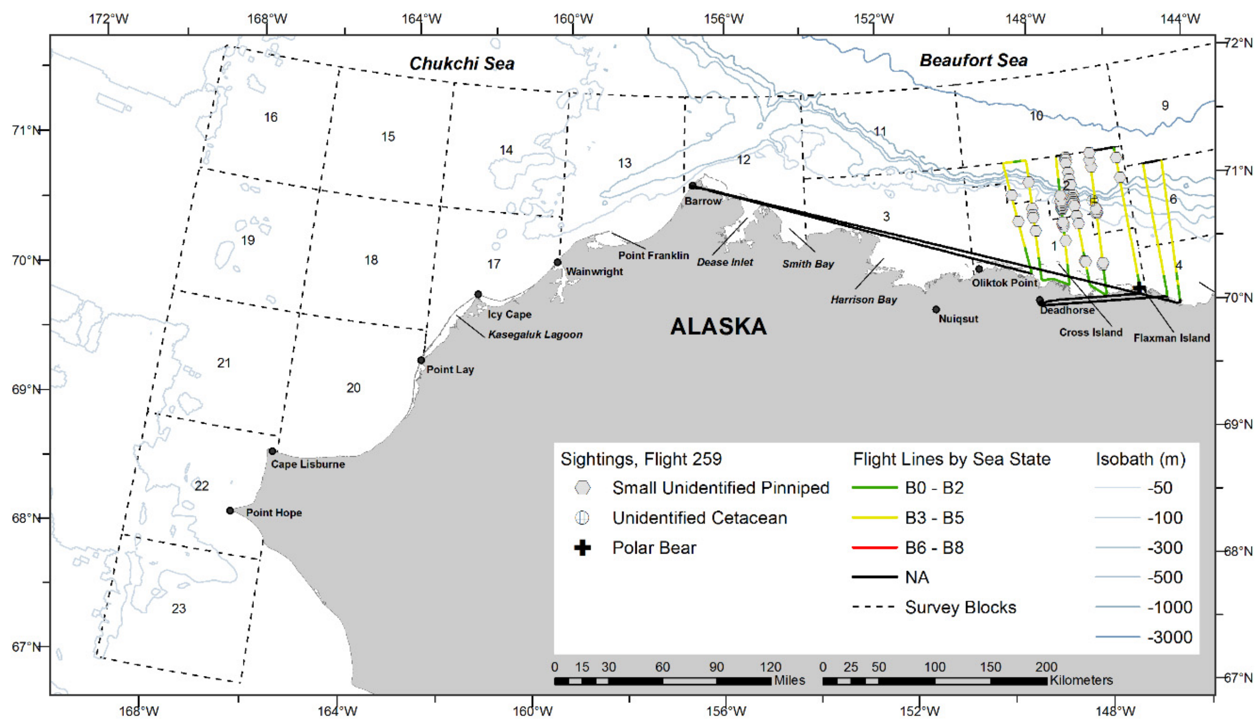

Figure B-107. ASAMM Flight 259 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

26 October 2016, Flight 260

Flight was a survey of block 12. Survey conditions included clear to partly cloudy skies, unlimited visibility (with glare), and Beaufort 1-6 sea states. Sea ice cover was 0-95% grease/new ice in the area surveyed. Sightings included bowhead whales, belugas (including one calf), and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
260	10/26/2016 13:28	71.394	155.770	beluga	swim	1	0	12
260	10/26/2016 14:09	71.293	155.425	bowhead whale	swim	1	0	12
260	10/26/2016 14:30	71.263	154.750	bowhead whale	breach	1	0	12
260	10/26/2016 14:39	71.411	154.743	beluga	swim	2	1	12
260	10/26/2016 14:39	71.421	154.763	beluga	swim	1	0	12
260	10/26/2016 15:21	71.329	154.211	bowhead whale	swim	3	0	12
260	10/26/2016 15:27	71.315	154.219	bowhead whale	swim	1	0	12

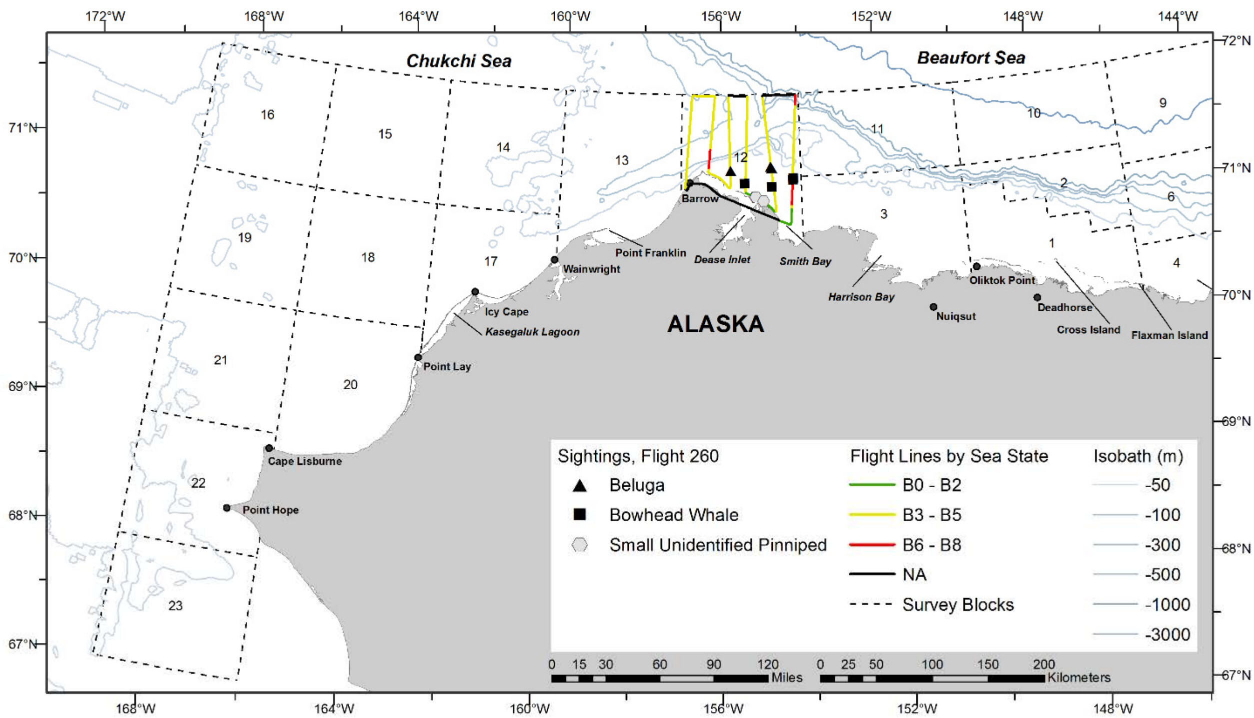

Figure B-108. ASAMM Flight 260 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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APPENDIX C: PUBLICATIONS, POSTERS, PRESENTATIONS, and MEDIA OUTREACH FROM ASAMM 2016-2017

LIST OF PUBLICATIONS, POSTERS AND PRESENTATIONS

2016

Clarke, J., A. Kennedy, and M. Ferguson. 2016. Bowhead and gray whale distributions, sighting rates, and habitat associations in the eastern Chukchi Sea, summer and fall 2009-15, with a retrospective comparison to 1982-91**.** *Arctic* 69(4):359-377.

2017

Battaile, B.C., C.V. Jay, M.S. Udevitz, A.S. Fischbach. 2017. Evaluation of a method using survey counts and tag data to estimate the number of Pacific walruses (*Odobenus rosmarus divergens*) using a coastal haulout in northwestern Alaska. *Polar Biology* DOI 10.1007/s00300-016-2060-5

Brower, A., M. Ferguson, S. Schonberg, S. Jewett, and J. Clarke. 2017. Gray whale distribution relative to benthic invertebrate biomass and abundance: northeastern Chukchi Sea, 2009-2012. *Deep-Sea Research II* DOI 10.1016/j.dsr2.2016.12.007.

Brower, A., A. Willoughby, J. Clarke, M. Ferguson. 2017. Subarctic cetacean occurrence in the Eastern Chukchi Sea, summer and fall 2016. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2017.

Clarke, J., A. Brower, M. Ferguson, and A. Willoughby. 2017. Distribution and relative abundance of marine mammals in the eastern Chukchi and western Beaufort seas, 2015. Annual report, OCS Study BOEM 2017-019. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC, Seattle, WA 98115-6349.

Clarke, J., M. Ferguson, A. Brower, A. Willoughby. 2017. Not all are in Canada...bowhead whales (*Balaena mysticetus*) in the Western Beaufort Sea, July-August, 2012-2016. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2017.

Druckenmiller, M.L., J.J. Citta, M.C. Ferguson, J.T. Clarke, J.C. George, and L. Quackenbush. 2017. Trends in sea-ice cover within bowhead whale habitats in the Western Arctic. *Deep-Sea Research II.*

Ferguson, M., R. Angliss, V. Helker, A. Kennedy, B. Lynch, A. Willoughby, A. Brower, and J. Clarke. 2017. Comparing estimates of arctic cetacean density derived from manned and unmanned aerial surveys. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2017.

Lowry, L.F., M.C.S. Kingsley, D.D.W. Hauser, J. Clarke, and R. Suydam. 2017. Aerial survey estimates of abundance of the eastern Chukchi Sea stock of beluga whales (Delphinapterus leucas) in 2012. *Arctic* 70(3): 273-286.

Okkonen, S., J. Clarke, and R. Potter. 2017. Relationship between high river discharge, upwelling events, and bowhead whale (*Balaena mysticetus*) occurrence in the central Alaskan Beaufort Sea. *Deep Sea Research II* DOI: 10.1016/j.dsr2.2016.11.015.

Stafford, K.M., M.C. Ferguson, D.D.W. Hauser, S.R. Okkonen, C.L. Berchok, J.J. Citta, J.T. Clarke, E.C. Garland, J. Jones, and R.S. Suydam. 2017. Beluga whales in the western Beaufort Sea: current state of knowledge on timing, distribution, habitat use and environmental drivers. *Deep-Sea Research II* DOI 10.1016/j.dsr2.2016.11.017.

Willoughby, A.L., M.C. Ferguson, J.T. Clarke, A.A. Brower. 2017. Opportunistic photo-identification of gray whales in the Eastern Chukchi Sea, summer and fall 2016. Poster: Alaska Marine Science Symposium, Anchorage, AK, January, 2017.

Young, J.K., B.A. Black, J.T. Clarke, S.V. Schonberg, and K.H. Dunton. 2017. Abundance, biomass and caloric content of Chukchi Sea bivalves and association with Pacific walrus (*Odobenus rosmarus divergens*) relative density and distribution in the northeastern Chukchi Sea. *Deep-Sea Research* II. DOI 10.1016/j.dsr2.2017.04.017.

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Arctic

Walrus congregation in Northwest Alaska apparently short-lived this year

Author: Yereth Rosen Updated: January 11 Published October 12, 2016

A congregation of walruses spotted on a Northwest Alaska beach Friday numbered about 6,000, but the animals had departed within days and were probably heading out on their fall migration, the U.S. Fish and Wildlife Service said on Tuesday.

The walruses are likely swimming south to coastal haulout areas in Chukotka, Russia, Joel Garlich-Miller, a Fish and Wildlife walrus biologist said in a statement issued by the agency.

The walruses were gone from the barrier island on the eastern Chukchi Sea coast as of Monday, the Fish and Wildlife Service said.

About 1,500 to 3,000 walruses in two groups congregate on a barrier island haulout Sunday near Point Lay in northwestern Alaska. (Jessica Taylor / NOAA / NMFS / AFSC / MML)

The beach site, near the Inupiat village of Point Lay in northwestern Alaska, has often been crowded with walruses in late summer and early fall in recent years as Arctic sea ice has diminished. It is part of a wider pattern of Pacific walrus behavior observed as the Arctic climate warms.

But this year's congregation was smaller than the tens of thousands of animals hauled out in past years. It was also much later; the crowds of up to 40,000 walruses previously had started forming in mid- to late August before the autumn migration south, the Fish and Wildlife Service said.

The behavior has been a nearly annual ritual since 2007, when the summer ice retreated to what was, at the time, a record-low minimum. This year's ice extent was also low, tying 2007 for what's now the second-lowest mark in the satellite record, but some patches of sea ice persisted in the eastern Chukchi Sea, helping the animals avoid the need to come ashore.

Walruses use floating ice to rest, generally away from predators, in between dives to forage for food on the sea floor. The Hanna Shoal area in the eastern Chukchi — a 100-mile-long bump on the sea floor that creates an area of shallow waters — is a preferred foraging site, with large amounts of the clams, snails and other fish that walruses eat.

Biologists believe that the lingering ice allowed walruses to stay in the Hanna Shoal area, said Fish and Wildlife Service spokeswoman Andrea Medeiros.

"It just happened to be that there was enough ice for them to hang out," she said.

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AFSC News

March 29, 2016

Sentinels of Change: Gray Whales in the Arctic

Gray whales are now making their great annual migration to Arctic feeding grounds. What they find there may be changing.

Gray whales do things differently.

Gray whales look different, swim farther, and fight more fiercely than other whales.

They owe their distinctive mottled look to a coat of crustaceans that can weigh up to 400 pounds. Their swim from Alaska to Baja and back may be the longest annual migration of any mammal. And they were named "devilfish" by whalers who watched them charge and smash boats to defend themselves and their calves.

But perhaps what sets gray whales apart most is their eating habits. Gray whales are the only baleen whales that feed primarily on the bottom of the ocean.

Aerial view of a gray whale near the ice edge with mud plume from bottom feeding. Photo credit: Vicki Beaver, NOAA Fisheries. NMFS Permit No. 14245. Funded by the Bureau of Ocean Energy Management (IA Contract No. M11PG00033).

Other baleen whales strain plankton from the water column. A gray whale dives to the bottom, turns on its side, scoops the top inches of sediment into its mouth, and strains small animals from it, especially amphipods, small shrimp-like creatures that are the favorite food of gray whales in the Arctic. A telltale plume of mud shows where a gray whale fed on the bottom.

That's what gray whales usually do. But scientists have learned that with gray whales, you can't count on usual. Most migrate, but some don't. And most gray whales bottom feed, but if there is better eating in the water column, they will feed there instead.

It may be this flexible, opportunistic approach to life that has kept the species swimming through multiple warming and cooling phases during their 2.5 million years on the planet.

That's why marine mammal scientist Amelia Brower is keeping an eye on them.

"Climate change is real and it's happening fast. The Arctic is the area of the world that is changing fastest. Comparing where gray whales are and how they behave over time may provide insight into how the ecosystem is changing," says Brower. "Gray whales may be important sentinels of ecosystem changes to come."

A Moveable Feast

Climate warming affects high latitudes faster and more dramatically than the rest of the earth. Melting away the sea ice cover exposes more ocean area and alters the entire ecosystem.

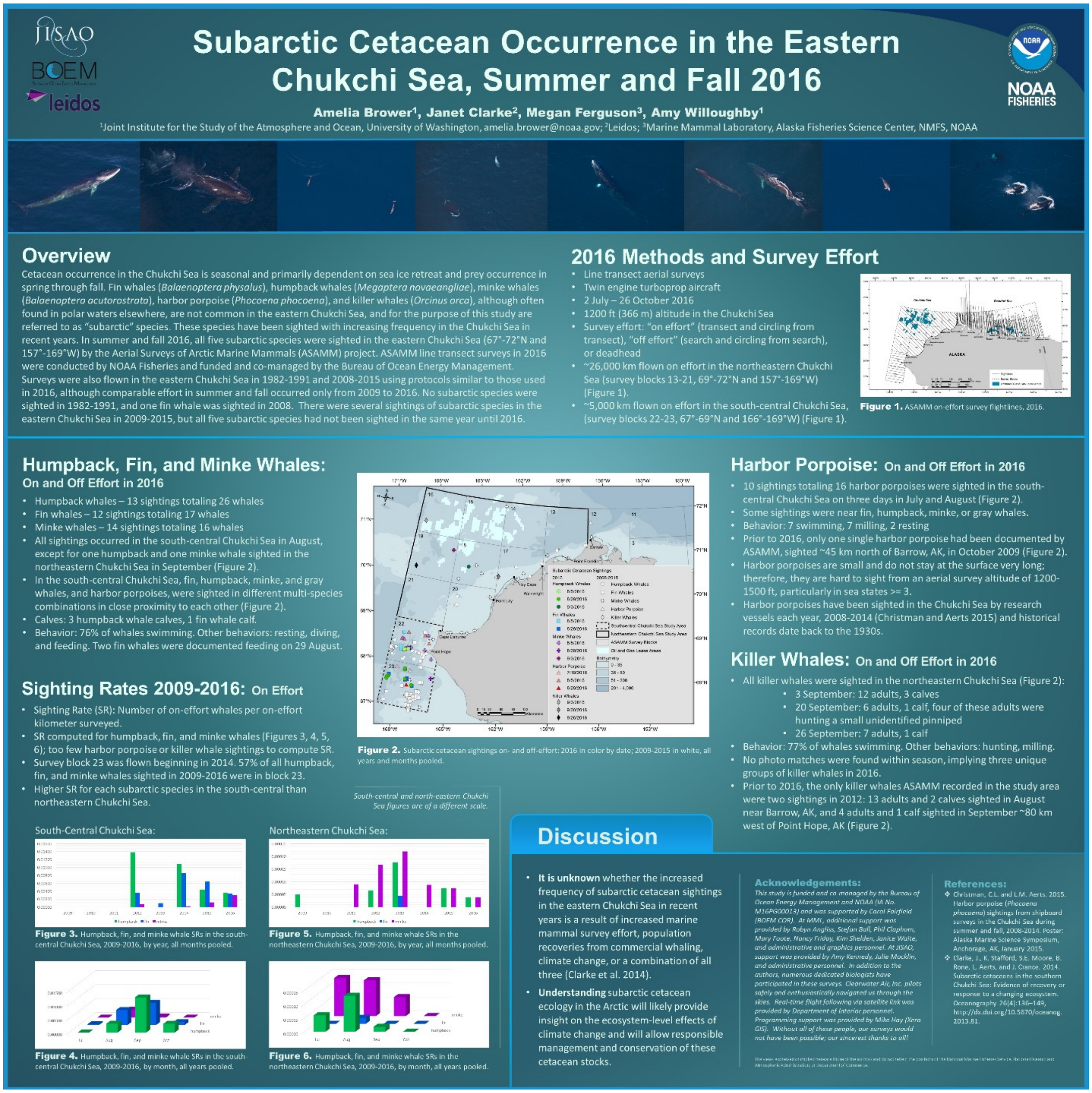
One way that sea ice affects the ecosystem is through its influence on the spring bloom of phytoplankton, microscopic algae that are the base of the ocean food web.

Loss of sea ice changes the ecosystem from the bottom up.

The gray whale's Arctic foraging grounds under "normal" cold conditions with late sea ice retreat (left video), and as they might appear in future warm years with early ice retreat (right video).

www.afsc.noaa.gov/News/Sentinel_change_gray_whales.htm

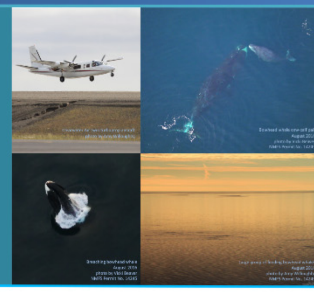
POSTER PRESENTATIONS:



Not All Are in Canada… Bowhead Whales (*Balaena mysticetus*) in the Western Beaufort Sea, July-August, 2012-2016

Janet Clarke – Leidos, janet.clarke@leidos.com **Megan Ferguson** – Marine Mammal Laboratory, AFSC, NMFS, NOAA
Amelia Brower and **Amy Willoughby** – Joint Institute for the Study of the Atmosphere and Ocean

Abstract Aerial surveys were conducted during summer (18 July through 31 August), 2012-2016, in the western Beaufort Sea (140°W-157°W, north to 72°N) as part of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project. ASAMM is funded and co-managed by BOEM, and conducted and co-managed by NOAA. Results from these surveys have expanded our knowledge of bowhead whale distribution, relative density, and behavior in the western Beaufort Sea during summer, a season when the majority of bowhead whales were largely assumed to be feeding in the eastern Beaufort Sea. More than 67,000 km of transect effort (including circling on transect) were flown, resulting in sightings of 1,912 bowhead whales. While every summer was unique, 2016 had the highest sighting rate (whales per transect kilometer; sighting rate was more than double that of any previous year), greatest percentage of sightings of feeding and milling whales (57%), and broadest distribution in the western Beaufort Sea. Seasonal feeding opportunities in the eastern and western Beaufort Sea are likely important drivers of bowhead whale distribution and relative density. Favorable feeding conditions for bowhead whales are variable both intra- and inter-annually, and dependent on oceanographic conditions including upwelling events, water temperature, and freshwater river discharge. These variables are investigated using remotely-sensed data to determine potential relationships with bowhead whale distribution and density. Annual collection of data on bowhead whales, physical and biological oceanography, and anthropogenic activities in the Beaufort Sea remains essential for managing arctic resources and understanding the arctic ecosystem as it continues to undergo climate-driven changes.



Methods

- Western Beaufort Sea study area, 140°W-157°W
- Line transect aerial surveys
- Twin turboprop, high wing aircraft
- 1500 ft (457 m) survey altitude
- Fly every day, weather permitting, mid-July through August
- Two primary marine mammal observers, one data recorder
- Survey modes include on effort (transect and circling from transect), off effort (search and circling from search), and deadhead
- Circle on most cetacean sightings to get positive species ID, determine group size, and look for calves

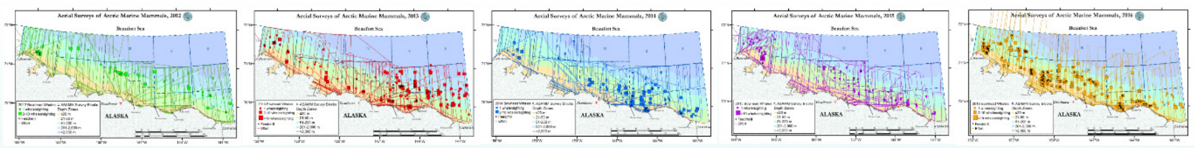


Figure 1. Annual survey effort (all survey modes) and bowhead whale sightings, July-August, 2012-2016.

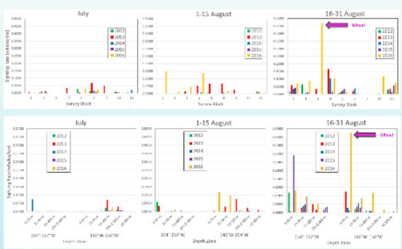


Figure 2. Annual sighting rates (on-effort whales/km) per survey block (blocks 1-7, 11, 12) (top) and depth zone (bottom) for July, early August and late August. Depth zones were demarcated at 154°W to differentiate a known bowhead whale core-use area near Point Barrow (Citta et al., 2015) from the rest of the western Beaufort Sea.

Not all polar bears are in Canada either. This pair was seen on an island in the Sag River Delta in August 2016. Really has nothing to do with this poster but it is my favorite from 2016 so I included it anyway.

References

Citta, J.J., L.T. Quakenbush, S.R. Okkonen, M.L. Druckenmiller, W. Maslowski, J. Clement-Kinney, J.C. George, H. Brower, R.J. Small, C.J. Ashjian, L.A. Harwood, and M.P. Heide-Jørgensen. 2015. Ecological characteristics of core-use areas used by Bering-Chukchi-Beaufort (BCB) bowhead whales, 2006-2012. *Progress in Oceanography* 136: 201-222.

Okkonen, S., J. Clarke, and R. Potter. 2016. Relationships among high river discharges, upwelling events, and bowhead whale (*Balaena mysticetus*) occurrence in the central Alaskan Beaufort Sea. *Deep-Sea Research II*.

Summary, 2012-2016

- Survey effort in blocks 1-7, 11 and 12 was fairly uniform across all years (Figure 1). While overall bowhead whale distribution was similar across all years, subtle differences existed between years. Distribution was most expansive in 2016.
- Sighting rates per survey block generally increased from July to late August, and varied considerably between years (Figure 2), with highest sighting rates in 2016. The sighting rate in block 3 (Harrison Bay) in late August 2016 was three times greater than any other sighting rate by block. Harrison Bay is not generally considered prime bowhead whale habitat.
- The area immediately east of Point Barrow (154°W-157°W) is a known bowhead whale feeding area when upwelling winds aggregate prey. Sighting rates throughout summer were highest in the ≤20 m depth zone in this area in every year except 2013 (Figure 2).
- From 140°W to 154°W, sighting rates were highest in depth zones 51-2,000 m in July and depth zones ≤200 m in early August. In late August, highest sighting rates were in the 21-50 m depth zone in 2012, 2014, and 2015, and in the ≤20 m depth zone in 2013 and 2016. Sighting rates in late August 2016 were three times higher than in any other year or depth zone (Figure 2).

2016 – What the Heck Happened?

- Oceanographic data available via remote sensing provide some preliminary insight into possible factors leading to the early influx of bowhead whales into the western Beaufort Sea and their unprecedented numbers in Harrison Bay in summer 2016.
- Lack of upwelling-favorable winds near Cape Bathurst (a bowhead whale core-use area; Citta et al., 2015) from early July through early August 2016 (Figure 3, magenta box) may have prompted bowhead whales to exit the eastern Beaufort Sea in search of better feeding opportunities.
- Most (75%) of the bowhead whales seen in late August 2016 in the Harrison Bay region were feeding (Figure 1). Freshwater discharge from the Colville River in late August was eight times greater than the 13-year mean (Figure 4), which could have produced a large oceanographic front and possibly served to aggregate bowhead whale prey. Winds recorded at West Dock near Prudhoe Bay in late August 2016 were also upwelling-favorable. A comparison of satellite photos from August 2015 and August 2016 shows some indication of a large front in 2016, although cloud cover obscured the area most days. Similar conditions were observed in the central Alaskan Beaufort Sea in September 2014 (Okkonen et al., 2016).

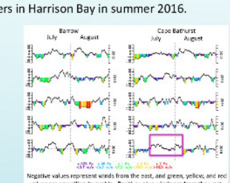


Figure 3. NOAA Earth Science Research Laboratory NCEP Reanalysis wind data from Barrow, Alaska, and Cape Bathurst, Canada, for July and August, 2012-2016. Data courtesy of S. Okkonen, UAF.

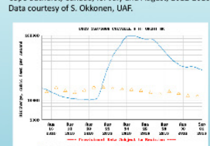


Figure 4. USGS Colville River discharge in late August 2016. Data courtesy of S. Okkonen, UAF.

Acknowledgements: ASAMM was funded and co-managed by the Bureau of Ocean Energy Management (IA Nos. M11PG00033 and M08PG20013), where we appreciated the support of Jeff Denton, Carol Fairfield, Chuck Monnett, and Dee Williams. At AFSC, additional support was provided by Robyn Angliss, Phil Clapham, Stefan Ball, Mary Foote, Nancy Friday, Kim Shelden, Janice Waite, and administrative and travel personnel. 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 suited-up and contorted their bodies into bubble windows for several hours at a time. 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.

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.

Points to Ponder, Ruminate, Mull, Contemplate, Chew On, Dream About…

- Bering-Chukchi-Beaufort bowhead whales do not <u>all</u> remain in the eastern (Canadian) Beaufort Sea in summer.
- Bowhead whale distribution and habitat preference in the western Beaufort Sea can vary substantially between years.
- Ephemeral feeding opportunities likely play a major role in determining the size and location of bowhead whale aggregations in summer.
- The oceanographic conditions that produce feeding opportunities (e.g., upwelling-favorable winds, freshwater discharge, fronts) in the western Beaufort Sea do not occur regularly or predictably.
- When real-time sampling near bowhead whale feeding aggregations is not possible, remotely sensed data must be relied upon to infer physical oceanographic parameters.

Comparing Estimates of Arctic Cetacean Density Derived from Manned and Unmanned Aerial Surveys

Megan C Ferguson*, Robyn P Angliss*, Van Helker – Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA
Amy Kennedy, Bob Lynch, Amy Willoughby, Amelia A Brower – Joint Institute for the Study of the Atmosphere and the Ocean
Janet T Clarke – Leidos

*Corresponding authors Megan.Ferguson@noaa.gov & Robyn.Angliss@noaa.gov

Abstract

Manned aerial surveys have been used successfully for decades to collect data to infer cetacean distribution and density. Unmanned aerial systems (UAS) have potential to augment or replace some manned aerial surveys for cetaceans in the future. To ascertain the utility of UAS for such missions, however, it is first necessary to define the specific scientific objective(s) and then compare the cost-benefit of alternative platforms and methodologies. NOAA led and conducted such a direct comparison of aerial surveys for cetaceans near Barrow, Alaska, during late summer 2015 via a collaborative effort that included the Bureau of Ocean Energy Management, US Navy, North Slope Borough Department of Wildlife Management, and Shell. We conducted a three-way comparison among visual observations made by human marine mammal observers aboard a Turbo Commander operated by Clearwater Air, Inc; imagery autonomously collected by a Nikon D810 camera system mounted on the belly of the Turbo Commander; and imagery collected by a similar camera system on a remotely-controlled ScanEagle operated by the Naval Surface Warfare Center Dahlgren Division. The platforms each conducted five flights within a 16,800 km^2 study area. Surveys from manned and unmanned platforms did not directly overlap geographically and temporally to maintain safety of flight; the two platforms operated as close as safely possible. The Turbo Commander collected 44,849 images in 26.7 flight hours, during which marine mammal observers simultaneously collected sighting data. The ScanEagle collected 24,600 images in 21.8 flight hours. Manual image processing and analysis by marine mammal photo analysts required 332.5 total hours, averaging 6.9 hours to analyze one flight hour, which involved reviewing every third image. In total, 8 bowhead whales (*Balaena mysticetus*) and 16 belugas (*Delphinapterus leucas*) were identified in the images from the Turbo Commander. Fifteen bowhead whales, six belugas, and three gray whales (*Eschrichtius robustus*) were identified in the UAS images. Sixty-one bowhead whales, 54 belugas, 9 gray whales, and 48 unidentified cetaceans were sighted by the marine mammal observers aboard the Turbo Commander. Resulting density estimates and associated coefficients of variation, logistical requirements, and costs of the three survey methods are discussed.

Objective: 3-way Comparison

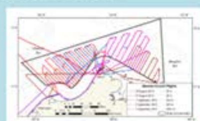
Marine mammal observers in the manned aircraft

Digital photographs from cameras mounted in the belly of the manned aircraft

Digital photographs from cameras mounted to the unmanned aerial vehicle (UAV)

Key Operational Results

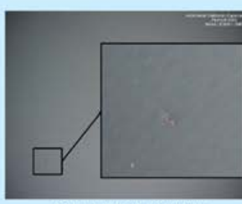
UAS survey flights conducted between 26 August and 6 September 2015



Manned aircraft flights conducted between 29 August and 7 September 2015

- UAV and manned aircraft observations of whales were limited by the same weather conditions
- Unlike the UAV, the manned aircraft could transit through precipitation to access areas with better weather
- UAV collected 24,600 images in 21.8 flight hrs
- Manned aircraft flew 26.7 hrs, collecting 44,849 images while marine mammal observers recorded visual line-transect data

- Manual processing and analysis of images from both aircraft required 332.5 hrs to review every third image (~6.9 hrs post-processing per flight hr)
- Image resolution was sufficient to differentiate bowhead whales, gray whales, belugas, and walruses. Higher resolution would be necessary to distinguish species with similar sighting characteristics.



Bowhead whale sighted in an image taken by the UAV camera

Analytical Results

Table 1. Number of whales detected, effective area covered, estimated total number of whales, and coefficient of variation (CV) of the estimated total number of whales in the west and east survey areas based on imagery data collected by the UAS and manned aircraft, and on marine mammal observer (MMO) data. *The numbers of sightings in this table represent the subset of the total number of sightings made within the boundaries of the west and east survey areas, in Beaufort Sea State ≤ 5 (bowhead and gray whales) or ≤ 4 (belugas), during level flight over the designated transect lines. The marine mammal observer sightings were limited to those made by primary observers.

	West Survey Area				East Survey Area			
	Images		MMOs		Images		MMOs	
	UAS	Manned Aircraft	Historical Dataset for ESW*	Limited Dataset for ESW*	UAS	Manned Aircraft	Historical Dataset for ESW*	Limited Dataset for ESW*
Bowhead Whales								
# Whales Detected*	3	2	9	9	6	4	12	12
Area Covered (km^2)	525.4	646.0	1989.8	3729.7	448.5	645.9	5231.8	3257.7
Estimated Total # Whales	35	19	27	40	89	32	36	51
CV(Whales)	0.77	0.71	0.46	0.51	0.53	0.45	0.34	0.41
Belugas								
# Whales Detected*	0	0	0	0	6	13	22	22
Area Covered (km^2)	525.4	646.0	2046.0	983.5	448.5	645.9	1663.4	798.6
Estimated Total # Whales	0	0	0	0	69	87	138	181
CV(Whales)					1.02	0.67	0.73	0.76
Gray Whales								
# Whales Detected*	1	0	0	0	2	0	0	0
Area Covered (km^2)	525.4	646.0	■	■	448.5	645.9	■	■
Estimated Total # Whales	10	0	0	0	23	0	0	0
CV(Whales)	1.04				1.01			

[illegible]

- Human observers effectively searched a much larger area than was captured in the digital images from either aircraft. The effective strip half-width (ESW) derived from the historical dataset was estimated to be 1000 m for bowhead whales and 601 m for belugas. The ESW derived from the limited dataset was 655 m for bowhead whales and 422 m for belugas. The strip widths for the cameras in the UAS and manned aircraft at 305 m survey altitude were 547 m and 521 m, respectively.
- Variability in the estimated total number of whales, measured by CV, was almost always lower for estimates derived from the human observer data than from either imagery dataset
- The resulting CVs were higher than expected because of sample size. Weather limited the number of hours we expected to fly based on previous aerial surveys conducted in the study area

Conclusions

- Conducting UAS and manned aircraft flights safely in close proximity (within ~ 15 nmi) and at the same altitude was challenging, even though technological and procedural methods for deconfliction were implemented.
- The UAS survey and associated data processing and analysis was approximately ten times more expensive than the comparable conventional manned aerial survey, data processing, and analyses. We expect that costs will decline as long range UAS surveys for cetaceans become established over time.
- Image processing was a significant challenge. Automated solutions are needed to reduce the time and cost of this task.
- The physical footprint, permitting, and personnel needs of the ScanEagle® UAS required substantial advance planning.
- Cetacean density and abundance can be estimated using imagery data. The resulting CVs will depend partially on sample size, which was considerably lower in our study for the imagery data due to the narrower strip width.
- The larger effective strip width for the marine mammal observers is particularly valuable for surveys in which the goal is to maximize the number of detections in the survey area.

Acknowledgments

[illegible]

Opportunistic Photo-identification of Gray Whales in the Eastern Chukchi Sea, Summer and Fall 2016

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Megan Ferguson Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA
Janet Clarke Leidos
Amelia Brower Joint Institute for the Study of the Atmosphere and Ocean

NOAA FISHERIES BOEM leidos JISAO ASAMM

Overview

The eastern Chukchi Sea serves as important foraging and weaning grounds for gray whale (*Eschrichtius robustus*) cow-calf pairs of the Eastern Pacific population during summer and fall. However, it is unknown how many gray whale cow-calf pairs use the eastern Chukchi Sea in any particular year. Individual gray whales are identifiable using skin pigmentation, scarring, and mottling on the whale's body. Using photos to identify individuals could provide a way to account for intra-annual resightings of gray whales, including cow-calf pairs. This knowledge could be used to strengthen conservation, management, and response plans related to anthropogenic activities and climate change.

The distribution and relative abundance of gray whales in the eastern Chukchi Sea (67°-72°N, 169°-155°W) have been documented annually from July through October since 2009 by systematic line-transect aerial surveys conducted as part of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project. 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. In 2016, opportunistic photo-identification data were collected during ASAMM surveys. Analysis of images collected in 2016 indicates that aerial photographs of gray whales can produce identification quality images of gray whales. Although further sampling and analysis are needed, these preliminary data hold promise for deriving a mark-recapture estimate of gray whale cow-calf pairs in the ASAMM study area.

Methods & Materials

Study Area and Effort

- Line-transect aerial surveys
- 2 July to 30 October 2016
- Twin engine turboprop aircraft
- Target altitude 1200 ft (366 m)
- Chukchi Sea blocks 13-23 and Beaufort Sea block 12
- Survey Effort: "on effort" (transect and circling from transect), "off effort" (search and circling form search), or deadhead
- ~ 33,300 km flown on effort within blocks 12-23 (Figure 1)

Photo Data Collection

- Opportunities to obtain photos 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 for the associated sighting event(s).
- Sighting information included location, total group size, number of calves

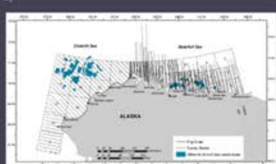

Figure 1. ASAMM on-effort survey lines, 2016.

Photo Analysis

- IMATCH was used to evaluate, rate, categorize, and sort images.
- The suite of images for each photographed sighting were evaluated for overall quality (i.e., match-ability) and assigned a rating of either poor, fair, good, or excellent.
- Individual whales from each sighting were identified.
- The best images displaying a whale's head, body, fluke, scars, and skin mottling were selected as "representative" images and 1-6 representative images were assigned per individual. Poorly photographed whales (e.g., subsurface whales) that could not be assigned representative images were accounted for as being "present" – physically present in photographs but of no use for identification.
- Representative images were further evaluated for quality and assigned a quality rating of either low, medium, or high.
- Sightings with calves were analyzed to look for resights of individuals.

Results

Gray Whale Sightings In the Eastern Chukchi Sea, 2016

- 443 sightings, of which 106 included calves
- 1,128 total whales, of which 136 were calves
- Gray whale calves were sighted in July and August, with the greatest number occurring in July (Table 1)
- Photo analysis resulted in 170 identifiable gray whales
- 86 of the 443 total sightings were photographed and analyzed, of which 50 included sightings with calves (Tables 1 and 2)
- 75 calves were recorded in the data associated with photographs – image analysis resulted in documentation of 61 (81%) calves, of which 46 were identifiable (Table 2), and assigned representative images
- 15 photographed calves were accounted for as only "present" (Table 2)

Figure 2. 2016 on- and off-effort gray whale sightings, photographed sightings, and inta-annual match sightings.

Table 1. Gray whale sightings, on and off effort, by month, bocks 12-23, 2016

Month	Gray Whale Sightings	Total Gray Whales	Sightings with Calves	Total Calves
July	147	307	70	89
August	112	351	36	47
September	119	319	0	0
October	65	151	0	0
Total	**443**	**1128**	**106**	**136**

Table 2. Summary of photographed gray whale sightings, on and off effort, by month, 2016

Month	Photographed Sightings	Total Whales	Photographed Sightings with Calves	Total Calves	Identifiable Calves
July	36	117	32	46	27
August	36	111	18	29	19
September	12	22	0	0	0
October	2	10	0	0	0
Total	**86**	**260**	**50**	**75**	**46**

Intra-annual Matches of Gray Whales

- One cow-calf pair was sighted and opportunistically photographed on 22 July 2016, Flight 212, and again on 6 August 2016, Flight 220. The second sighting was recorded 29 km northwest of the first.
- One juvenile was sighted and opportunistically photographed on 22 July 2016, Flight 212, and again on 6 August 2016, Flight 220 (Figure 3). The second sighting was 6.6 km north-northwest of the first sighting.
- In both instances, the whales appear to have remained in the same general area approximately 40 km offshore from Wainwright, Alaska.

Figure 3. Juvenile gray whale inta-annual match photo taken on 22 July 2016, Flight 212 (A), and the same Whale photographed on 6 August 2016, Flight 220 (B). Note the difference in body condition.

The overall image quality assigned to the suite of photos associated with this intra-annual match of the juvenile was good.

The representative images (Figure 3 A and B) received a rating of medium quality.

Discussion

Naturally occurring markers found on gray whales can be captured in imagery taken during ASAMM surveys without sacrificing line-transect data collection and can be used to determine intra-annual matches.

Further monitoring and refinement to the methodology will be required to determine if this exercise indicates that ASAMM has few repeat sightings of cow-calf pairs throughout the season. Possible refinements to methodology and protocol could include: collecting images from dedicated locations (e.g., designated transect lines or blocks that cover known gray whale hot spots), staying on a sighting until all animals for that sighting have been photographed (specifically those with calves), and conducting near real-time photo identification analysis and matching.

References: *IMATCH 3.3 Digital Asset Management Solutions, Germany 1998, software available for download at https://www.photools.com/imatch/*

Acknowledgements

The ASAMM project was funded and co-managed by the Bureau of Ocean Energy Management and NOAA (IA No. M11PG00031), and supported by Carol Fairfield (current BOEM COR). At MML, support was provided by [illegible]

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APPENDIX D: 2016 SHELL ANCHOR RETRIEVAL – ASAMM COMMUNICATIONS PROTOCOL

Aerial Coordination Call Contact List

Daily aerial UAS/manned flight aviation calls will occur from July 2, 2016 until Shell Anchor Retrieval project end (approximately August 31, 2016, exact date TBD). The call-in information is provided below:

Phone Number: [redacted]
Passcode: [redacted]

Radio channel (monitored during UAS ops off the Aiviq): **121.5 (Guard)** and **122.8 (CTAF)**. ASAMM pilots always monitor **121.5**, and the primary air-to-air com channel is **122.8**.

The Clearwater aircraft (all Aero Commander 690 aircraft) that will be flying for ASAMM this year are:

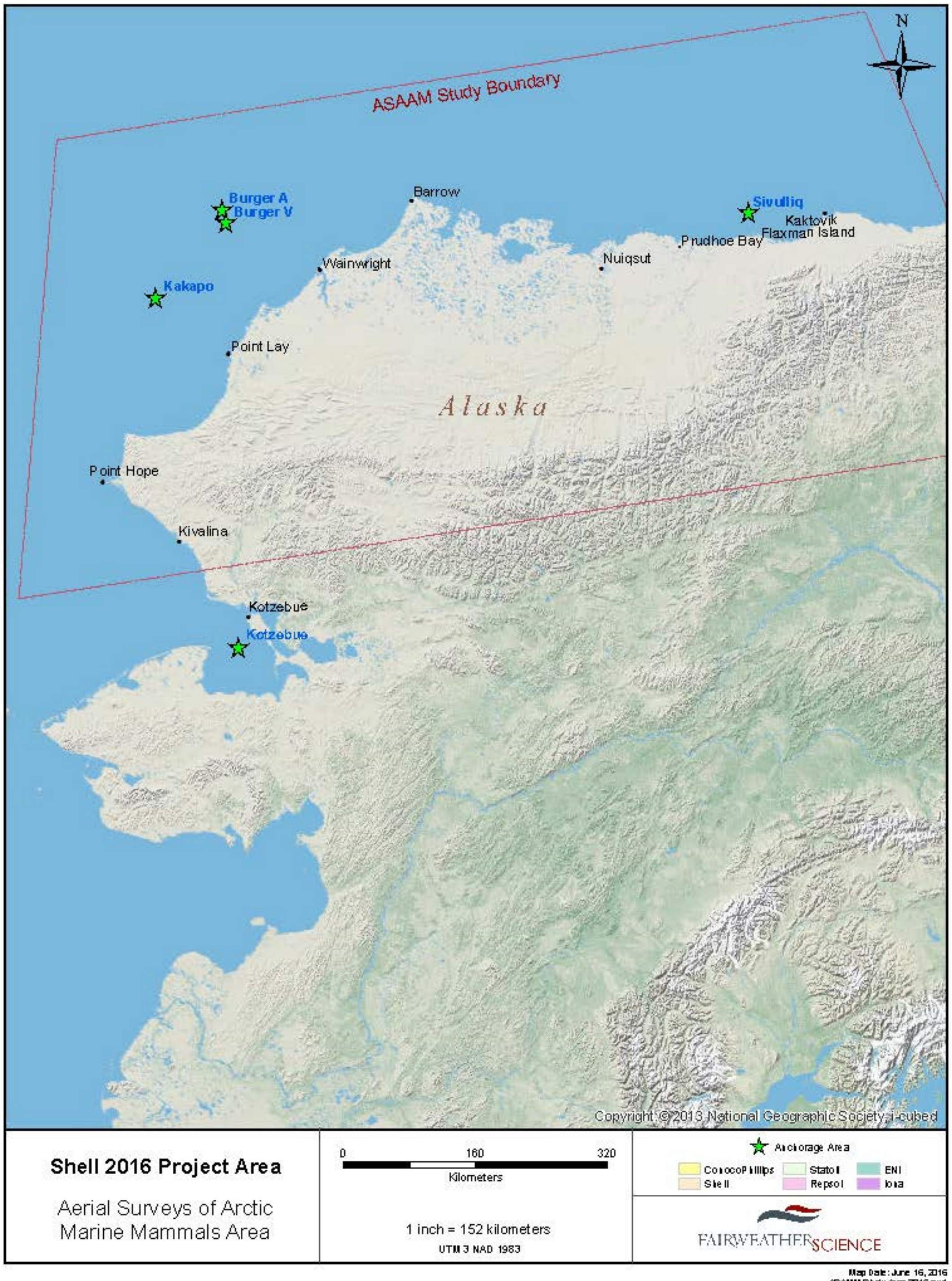
- N840TW
  - TW primary sat phone = [redacted]
  - TW backup sat phone = [redacted]

- N690AX
  [redacted]AX primary sat phone = [redacted]
  - AX backup sat phone = [redacted]

- N222ME (might fill in on occasion)
  - ME primary sat phone = [redacted]
  - ME backup sat phone = [redacted]

Real time location for ECO vessels can be viewed at:
http://share.findmespot.com/shared/faces/viewspots.jsp?glId=0xE6Tixk1yICIu0zm4muSsQ6MmTnPpEcx

A map of the ASAMM project boundary in relation to the mooring locations/where the UAS may be flown is shown below.



ASAAM Study Boundary
N
Burger A
Burger V
Kakapo
Barrow
Wainwright
Point Lay
Point Hope
Kivalina
Kotzebue
Kotzebue
Sivulliq
Kaktovik
Flaxman Island
Prudhoe Bay
Nuiqsut
Alaska
Copyright © 2013 National Geographic Society, i-cubed
Shell 2016 Project Area
Aerial Surveys of Arctic Marine Mammals Area
0
160
320
Kilometers
1 inch = 152 kilometers
UTM 3 NAD 1983
Anchorage Area
ConocoPhillips
Statoil
ENI
Shell
Repsol
Iona
FAIRWEATHER SCIENCE
Map Date: June 16, 2016
ASAAM Study Area 2016.mxd

Provided below is a draft chain of command flow chart should an UAS flight be requested by the vessel crew. This provides for scenarios including:

1. if the morning call has already occurred and a flight is requested, and
2. if the morning call has not already occurred and a flight is requested.

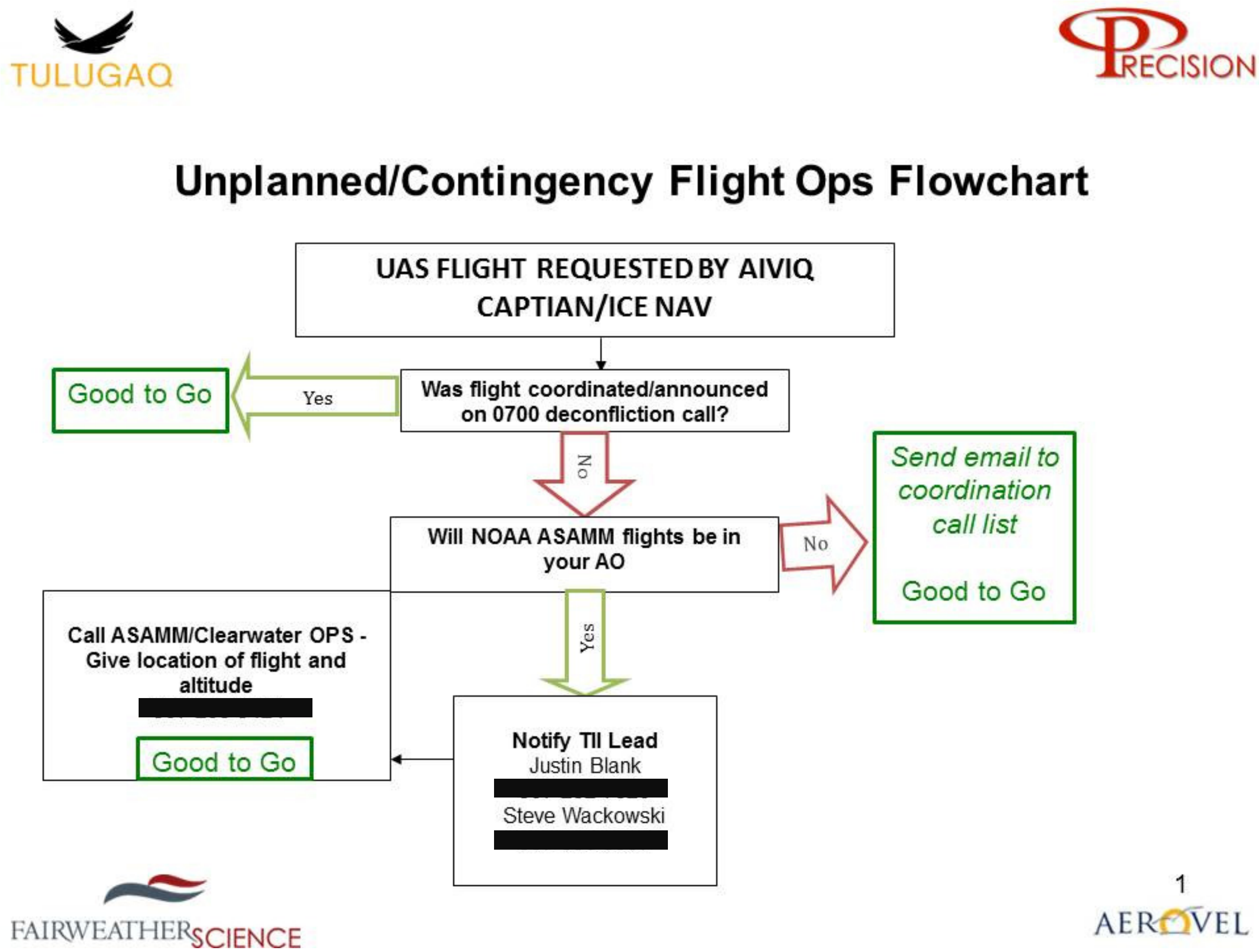


Table 1: Contact Information

Title	Name	Office/Cell #	Email
Fairweather Science/Tulugaq II			
Project Manager	Justin Blank	O: [redacted] C: [redacted]	[redacted]
Project Manager/Tulugaq	Steve Wackowski	O: [redacted] C: [redacted]	[redacted]
Operations Manager	Sheyna Wisdom	O: [redacted] C: [redacted]	[redacted]
Precision			
Vice President	Matt Parker	O: [redacted] C: [redacted]	[redacted]
Operations Manager	Mike Gomez	O: [redacted] C: [redacted]	[redacted]
Operations Chief Pilot	Chris Hofheins	O: [redacted] C: [redacted]	[redacted]
Aiviq Site Lead	Mike Aguilar	O: [redacted] C: [redacted]	[redacted]
Aiviq PIC Program Lead	Jake Weber	O: [redacted] C: [redacted]	[redacted]

Table 1 continued: Contact Information

Title	Name	Office/Home/Cell #	Email
Clearwater Air			
President	Andy Harcombe	**C:** [redacted]	[redacted]
Chief Pilot	Jacob Turner	**C:** [redacted]	[redacted]
Pilot	Stan Churches	**C:** [redacted]	[redacted]
Pilot	Channing Wilson	**C:** [redacted]	[redacted]
ASAMM			
ASAMM Project Coordinator	Megan Ferguson	**O:** [redacted] **C:** [redacted]	[redacted]
ASAMM Project Lead	Janet Clarke	**C:** [redacted]	[redacted]

APPENDIX E: 2016 SIGHTING RATE TABLES AND FIGURES

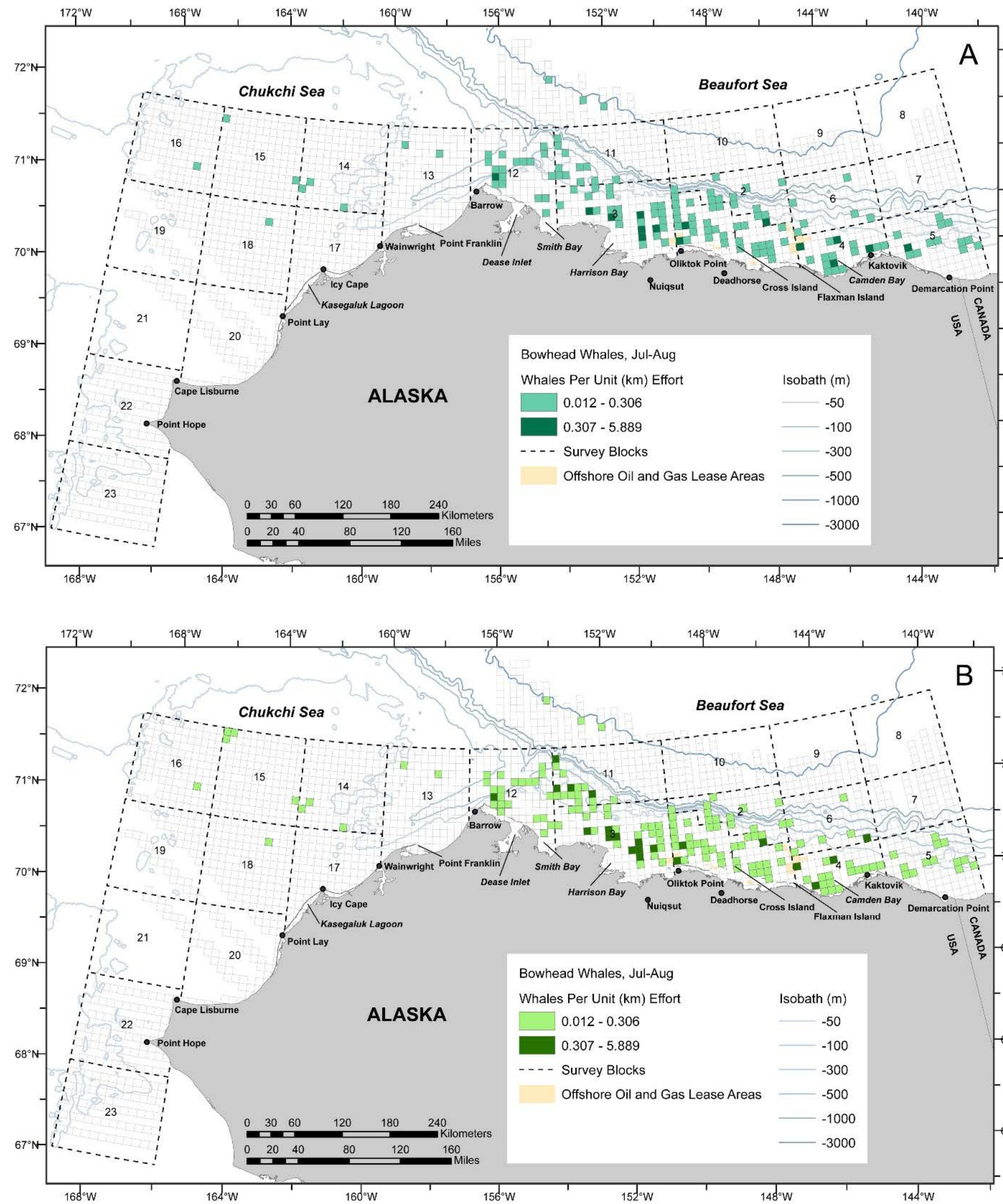


Figure E-1. ASAMM 2016 summer (July-August) bowhead whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

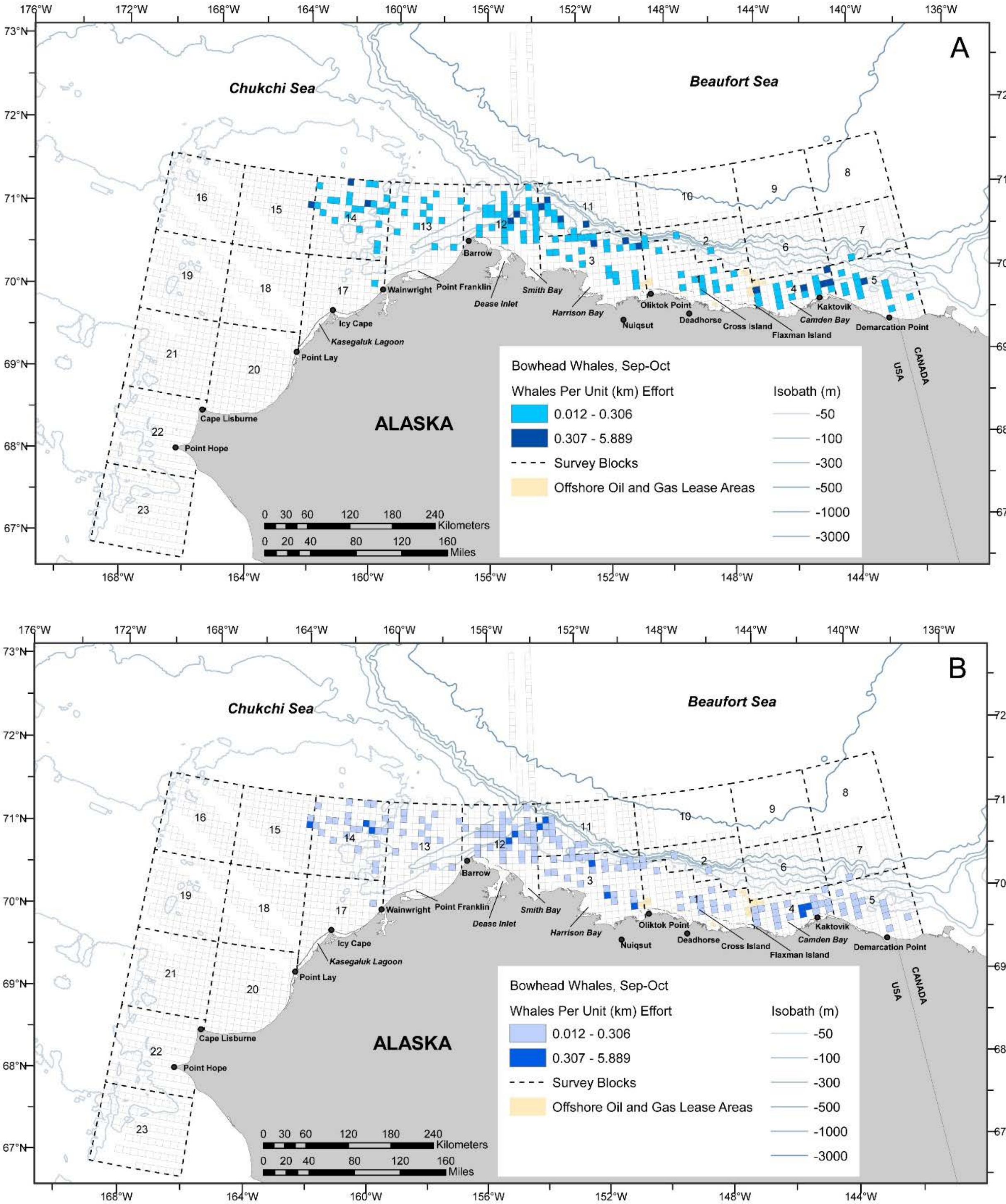


Figure E-2. ASAMM 2016 fall (September-October) bowhead whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

Table E-1. ASAMM 2016 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	872	1	2	0.0023	1,043	73	95	0.0911	1,914	74	97	0.0507
1a	90	0	0	0.0000	127	0	0	0.0000	218	0	0	0.0000
2	657	2	2	0.0030	693	18	34	0.0491	1,350	20	36	0.0267
3	598	0	0	0.0000	1,247	56	259	0.2077	1,845	56	259	0.1404
4	383	0	0	0.0000	743	27	64	0.0862	1,126	27	64	0.0568
5	606	14	15	0.0247	475	4	7	0.0147	1,081	18	22	0.0204
6	449	3	5	0.0111	937	3	4	0.0043	1,386	6	9	0.0065
7	369	0	0	0.0000	343	0	0	0.0000	712	0	0	0.0000
8	144	0	0	0.0000	0	0	0	NA	144	0	0	0.0000
9	212	0	0	0.0000	231	0	0	0.0000	443	0	0	0.0000
10	444	0	0	0.0000	448	0	0	0.0000	892	0	0	0.0000
11	596	1	1	0.0017	1,125	21	26	0.0231	1,721	22	27	0.0157
12	1,041	0	0	0.0000	1,297	36	66	0.0509	2,338	36	66	0.0282
13	1,546	0	0	0.0000	1,234	3	3	0.0024	2,780	3	3	0.0011
14	984	0	0	0.0000	835	3	3	0.0036	1,819	3	3	0.0016
15	876	0	0	0.0000	761	2	5	0.0066	1,637	2	5	0.0031
16	363	1	1	0.0028	413	0	0	0.0000	776	1	1	0.0013
17	969	0	0	0.0000	1,143	0	0	0.0000	2,112	0	0	0.0000
18	634	0	0	0.0000	615	2	2	0.0033	1,249	2	2	0.0016
19	225	0	0	0.0000	142	0	0	0.0000	366	0	0	0.0000
20	485	0	0	0.0000	325	0	0	0.0000	810	0	0	0.0000
21	70	0	0	0.0000	0	0	0	NA	70	0	0	0.0000
22	223	0	0	0.0000	612	0	0	0.0000	835	0	0	0.0000
23	286	0	0	0.0000	857	0	0	0.0000	1,143	0	0	0.0000
Total	**13,124**	**22**	**26**	**0.0020**	**15,645**	**248**	**568**	**0.0363**	**28,769**	**270**	**594**	**0.0206**

	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	1,501	19	23	0.0153	858	0	0	0.0000	2,360	19	23	0.0097
1a	201	0	0	0.0000	75	0	0	0.0000	276	0	0	0.0000
2	967	4	6	0.0062	699	0	0	0.0000	1,666	4	6	0.0036
3	1,093	41	54	0.0494	866	4	7	0.0081	1,959	45	61	0.0311
4	521	35	53	0.1017	97	0	0	0.0000	619	35	53	0.0856
5	880	13	23	0.0261	0	0	0	NA	880	13	23	0.0261
6	1,038	0	0	0.0000	147	0	0	0.0000	1,186	0	0	0.0000
7	650	1	2	0.0031	0	0	0	NA	650	1	2	0.0031
8	2	0	0	0.0000	0	0	0	NA	2	0	0	0.0000
9	1	0	0	0.0000	0	0	0	NA	1	0	0	0.0000
10	151	0	0	0.0000	1	0	0	0.0000	152	0	0	0.0000
11	792	6	8	0.0101	786	7	27	0.0344	1,577	13	35	0.0222
12	2,275	38	42	0.0185	1,781	23	44	0.0247	4,056	61	86	0.0212
13	1,453	7	9	0.0062	1,903	8	25	0.0131	3,356	15	34	0.0101
14	980	25	28	0.0286	816	6	14	0.0172	1,796	31	42	0.0234
15	445	0	0	0.0000	383	0	0	0.0000	828	0	0	0.0000
16	394	0	0	0.0000	8	0	0	0.0000	402	0	0	0.0000
17	1,079	1	1	0.0009	436	0	0	0.0000	1,516	1	1	0.0007
18	721	0	0	0.0000	0	0	0	NA	721	0	0	0.0000
19	636	0	0	0.0000	0	0	0	NA	636	0	0	0.0000
20	804	0	0	0.0000	520	0	0	0.0000	1,324	0	0	0.0000
21	231	0	0	0.0000	364	0	0	0.0000	595	0	0	0.0000
22	398	0	0	0.0000	517	0	0	0.0000	915	0	0	0.0000
23	642	0	0	0.0000	513	0	0	0.0000	1,155	0	0	0.0000
Total	**17,856**	**190**	**249**	**0.0139**	**10,772**	**48**	**117**	**0.0109**	**28,628**	**238**	**366**	**0.0128**

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.
Does not include three sightings of three bowhead whales north of 72°N.

Table E-2. ASAMM 2016 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	886	1	2	0.0023	1,375	106	149	0.1084	2,261	107	151	0.0668
1a	90	0	0	0.0000	127	0	0	0.0000	218	0	0	0.0000
2	694	2	2	0.0029	778	27	48	0.0617	1,472	29	50	0.0340
3	598	0	0	0.0000	1,604	99	537	0.3348	2,202	99	537	0.2439
4	383	0	0	0.0000	1,068	61	123	0.1151	1,452	61	123	0.0847
5	740	17	19	0.0257	540	6	10	0.0185	1,280	23	29	0.0227
6	500	8	12	0.0240	971	5	7	0.0072	1,470	13	19	0.0129
7	369	0	0	0.0000	343	0	0	0.0000	712	0	0	0.0000
8	144	0	0	0.0000	0	0	0	NA	144	0	0	0.0000
9	212	0	0	0.0000	231	0	0	0.0000	443	0	0	0.0000
10	450	0	0	0.0000	448	0	0	0.0000	897	0	0	0.0000
11	612	1	1	0.0016	1,294	68	115	0.0889	1,906	69	116	0.0608
12	1,116	0	0	0.0000	1,776	68	109	0.0614	2,892	68	109	0.0377
13	1,809	0	0	0.0000	1,485	3	3	0.0020	3,294	3	3	0.0009
14	1,044	0	0	0.0000	1,063	3	3	0.0028	2,107	3	3	0.0014
15	907	0	0	0.0000	839	5	13	0.0155	1,747	5	13	0.0074
16	382	1	1	0.0026	454	0	0	0.0000	837	1	1	0.0012
17	1,333	0	0	0.0000	1,418	0	0	0.0000	2,751	0	0	0.0000
18	634	0	0	0.0000	696	3	4	0.0057	1,329	3	4	0.0030
19	246	0	0	0.0000	142	0	0	0.0000	387	0	0	0.0000
20	493	0	0	0.0000	357	0	0	0.0000	850	0	0	0.0000
21	70	0	0	0.0000	0	0	0	NA	70	0	0	0.0000
22	238	0	0	0.0000	812	0	0	0.0000	1,050	0	0	0.0000
23	340	0	0	0.0000	1,288	0	0	0.0000	1,628	0	0	0.0000
Total	**14,292**	**30**	**37**	**0.0026**	**19,108**	**454**	**1121**	**0.0587**	**33,400**	**484**	**1,158**	**0.0347**

	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	1,624	23	28	0.0172	858	0	0	0.0000	2,482	23	28	0.0113
1a	201	0	0	0.0000	75	0	0	0.0000	276	0	0	0.0000
2	1,007	6	9	0.0089	730	0	0	0.0000	1,737	6	9	0.0052
3	1,310	83	116	0.0886	895	5	9	0.0101	2,204	88	125	0.0567
4	802	66	98	0.1222	97	0	0	0.0000	900	66	98	0.1089
5	1,004	17	28	0.0279	0	0	0	NA	1,004	17	28	0.0279
6	1,050	0	0	0.0000	147	0	0	0.0000	1,197	0	0	0.0000
7	667	1	2	0.0030	0	0	0	NA	667	1	2	0.0030
8	2	0	0	0.0000	0	0	0	NA	2	0	0	0.0000
9	1	0	0	0.0000	0	0	0	NA	1	0	0	0.0000
10	151	0	0	0.0000	1	0	0	0.0000	152	0	0	0.0000
11	872	22	34	0.0390	832	9	30	0.0361	1,704	31	64	0.0376
12	2,485	66	73	0.0294	1,965	37	64	0.0326	4,450	103	137	0.0308
13	1,609	9	12	0.0075	2,035	8	25	0.0123	3,645	17	37	0.0102
14	1,241	43	52	0.0419	887	6	14	0.0158	2,127	49	66	0.0310
15	474	1	1	0.0021	410	0	0	0.0000	884	1	1	0.0011
16	461	0	0	0.0000	8	0	0	0.0000	469	0	0	0.0000
17	1,339	1	1	0.0007	491	0	0	0.0000	1,831	1	1	0.0005
18	747	0	0	0.0000	0	0	0	NA	747	0	0	0.0000
19	686	0	0	0.0000	0	0	0	NA	686	0	0	0.0000
20	852	0	0	0.0000	531	0	0	0.0000	1,383	0	0	0.0000
21	231	0	0	0.0000	364	0	0	0.0000	595	0	0	0.0000
22	406	0	0	0.0000	528	0	0	0.0000	934	0	0	0.0000
23	773	0	0	0.0000	545	0	0	0.0000	1,319	0	0	0.0000
Total	**19,993**	**338**	**454**	**0.0227**	**11,400**	**65**	**142**	**0.0125**	**31,395**	**403**	**596**	**0.0190**

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.
Does not include three sightings of three bowhead whales north of 72°N.

Table E-3. ASAMM 2016 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												
0-35 m	1,638	0	0	0.0000	1,746	0	0	0.0000	3,384	0	0	0.0000
36-50 m	3,543	1	1	0.0003	3,898	7	10	0.0026	7,441	8	11	0.0015
51-200 m N	1,248	0	0	0.0000	1,026	3	3	0.0029	2,274	3	3	0.0013
51-200 m S	232	0	0	0.0000	268	0	0	0.0000	500	0	0	0.0000
154°W-157°W												
0-20 m	179	0	0	0.0000	252	13	19	0.0754	431	13	19	0.0440
21-50 m	228	0	0	0.0000	302	4	24	0.0796	529	4	24	0.0453
51-200 m	503	0	0	0.0000	570	19	23	0.0403	1,074	19	23	0.0214
201-2,000 m	130	0	0	0.0000	173	0	0	0.0000	303	0	0	0.0000
140°W-154°W												
0-20 m	764	0	0	0.0000	1,220	68	286	0.2344	1,984	68	286	0.1441
21-50 m	1,481	6	8	0.0054	2,222	99	154	0.0693	3,703	105	162	0.0437
51-200 m	781	12	13	0.0166	1,303	31	44	0.0338	2,084	43	57	0.0274
201-2,000 m	1,209	3	4	0.0033	1,643	4	5	0.0030	2,852	7	9	0.0032
>2,000 m	1,187	0	0	0.0000	1,023	0	0	0.0000	2,210	0	0	0.0000
TOTAL	**13,125**	**22**	**26**	**0.0020**	**15,645**	**248**	**568**	**0.0363**	**28,770**	**270**	**594**	**0.0206**

	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												
0-35 m	2,000	1	1	0.0005	1,415	0	0	0.0000	3,416	1	1	0.0003
36-50 m	4,142	17	19	0.0046	2,169	6	14	0.0065	6,312	23	33	0.0052
51-200 m N	1,249	15	18	0.0144	1,509	8	25	0.0166	2,759	23	43	0.0156
51-200 m S	391	0	0	0.0000	367	0	0	0.0000	758	0	0	0.0000
154°W-157°W												
0-20 m	503	0	0	0.0000	378	6	9	0.0238	881	6	9	0.0102
21-50 m	518	13	13	0.0251	362	5	6	0.0166	881	18	19	0.0216
51-200 m	1,040	22	25	0.0240	855	11	25	0.0292	1,895	33	50	0.0264
201-2,000 m	214	3	4	0.0187	185	1	4	0.0216	399	4	8	0.0201
140°W-154°W												
0-20 m	1,289	21	24	0.0186	708	0	0	0.0000	1,997	21	24	0.0120
21-50 m	2,664	72	104	0.0390	1,244	1	1	0.0008	3,907	73	105	0.0269
51-200 m	1,363	23	37	0.0271	555	10	33	0.0595	1,918	33	70	0.0365
201-2,000 m	1,818	3	4	0.0022	759	0	0	0.0000	2,578	3	4	0.0016
>2,000 m	674	0	0	0.0000	264	0	0	0.0000	938	0	0	0.0000
TOTAL	**17,867**	**190**	**249**	**0.0139**	**10,772**	**48**	**117**	**0.0109**	**28,639**	**238**	**366**	**0.0128**

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.
Does not include three sightings of three bowhead whales north of 72°N.

Table E-4. ASAMM 2016 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												
0-35 m	1,943	0	0	0.0000	1,942	0	0	0.0000	3,885	0	0	0.0000
36-50 m	3,853	1	1	0.0003	4,584	11	20	0.0044	8,438	12	21	0.0025
51-200 m N	1,412	0	0	0.0000	1,449	3	3	0.0021	2,862	3	3	0.0010
51-200 m S	288	0	0	0.0000	578	0	0	0.0000	865	0	0	0.0000
154°W-157°W												
0-20 m	179	0	0	0.0000	404	33	46	0.1139	583	33	46	0.0789
21-50 m	250	0	0	0.0000	381	7	27	0.0709	631	7	27	0.0428
51-200 m	540	0	0	0.0000	811	28	36	0.0444	1,351	28	36	0.0266
201-2,000 m	146	0	0	0.0000	180	0	0	0.0000	327	0	0	0.0000
140°W-154°W												
0-20 m	764	0	0	0.0000	1,647	116	579	0.3516	2,411	116	579	0.2401
21-50 m	1,528	7	9	0.0059	2,881	170	259	0.0899	4,409	177	268	0.0608
51-200 m	922	19	23	0.0250	1,516	76	132	0.0871	2,438	95	155	0.0636
201-2,000 m	1,263	3	4	0.0032	1,712	10	19	0.0111	2,975	13	23	0.0077
>2,000 m	1,202	0	0	0.0000	1,023	0	0	0.0000	2,226	0	0	0.0000
TOTAL	**14,292**	**30**	**37**	**0.0026**	**19,109**	**454**	**1121**	**0.0587**	**33,400**	**484**	**1,158**	**0.0347**

	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												
0-35 m	2,228	1	1	0.0004	1,437	0	0	0.0000	3,665	1	1	0.0003
36-50 m	4,606	34	41	0.0089	2,298	6	14	0.0061	6,904	40	55	0.0080
51-200 m N	1,500	19	24	0.0160	1,671	8	25	0.0150	3,171	27	49	0.0155
51-200 m S	485	0	0	0.0000	393	0	0	0.0000	878	0	0	0.0000
154°W-157°W												
0-20 m	507	0	0	0.0000	420	7	10	0.0238	927	7	10	0.0108
21-50 m	589	25	28	0.0476	435	9	12	0.0276	1,024	34	40	0.0391
51-200 m	1,160	36	39	0.0336	908	18	35	0.0385	2,068	54	74	0.0358
201-2,000 m	229	5	6	0.0262	202	3	7	0.0346	432	8	13	0.0301
140°W-154°W												
0-20 m	1,409	40	50	0.0355	708	0	0	0.0000	2,117	40	50	0.0236
21-50 m	3,154	120	176	0.0558	1,244	1	1	0.0008	4,398	121	177	0.0402
51-200 m	1,617	53	82	0.0507	660	13	38	0.0575	2,278	66	120	0.0527
201-2,000 m	1,846	5	7	0.0038	759	0	0	0.0000	2,605	5	7	0.0027
>2,000 m	674	0	0	0.0000	264	0	0	0.0000	938	0	0	0.0000
TOTAL	**20,004**	**338**	**454**	**0.0227**	**11,400**	**65**	**142**	**0.0125**	**31,404**	**403**	**596**	**0.0190**

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.
Does not include three sightings of three bowhead whales north of 72°N.

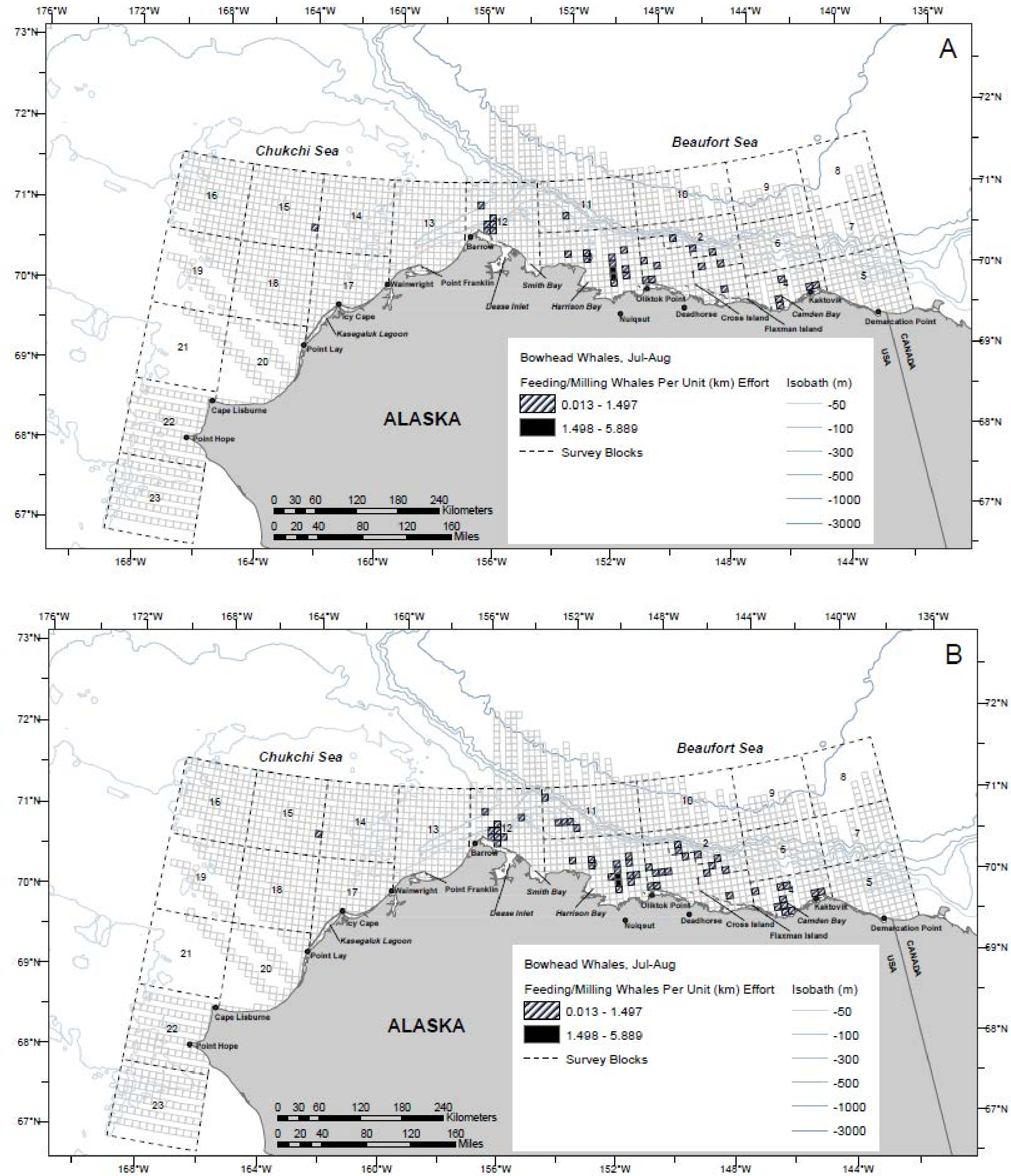


Figure E-3. ASAMM 2016 summer (July-August) feeding and milling bowhead whale sighting rates (WPUE; from primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

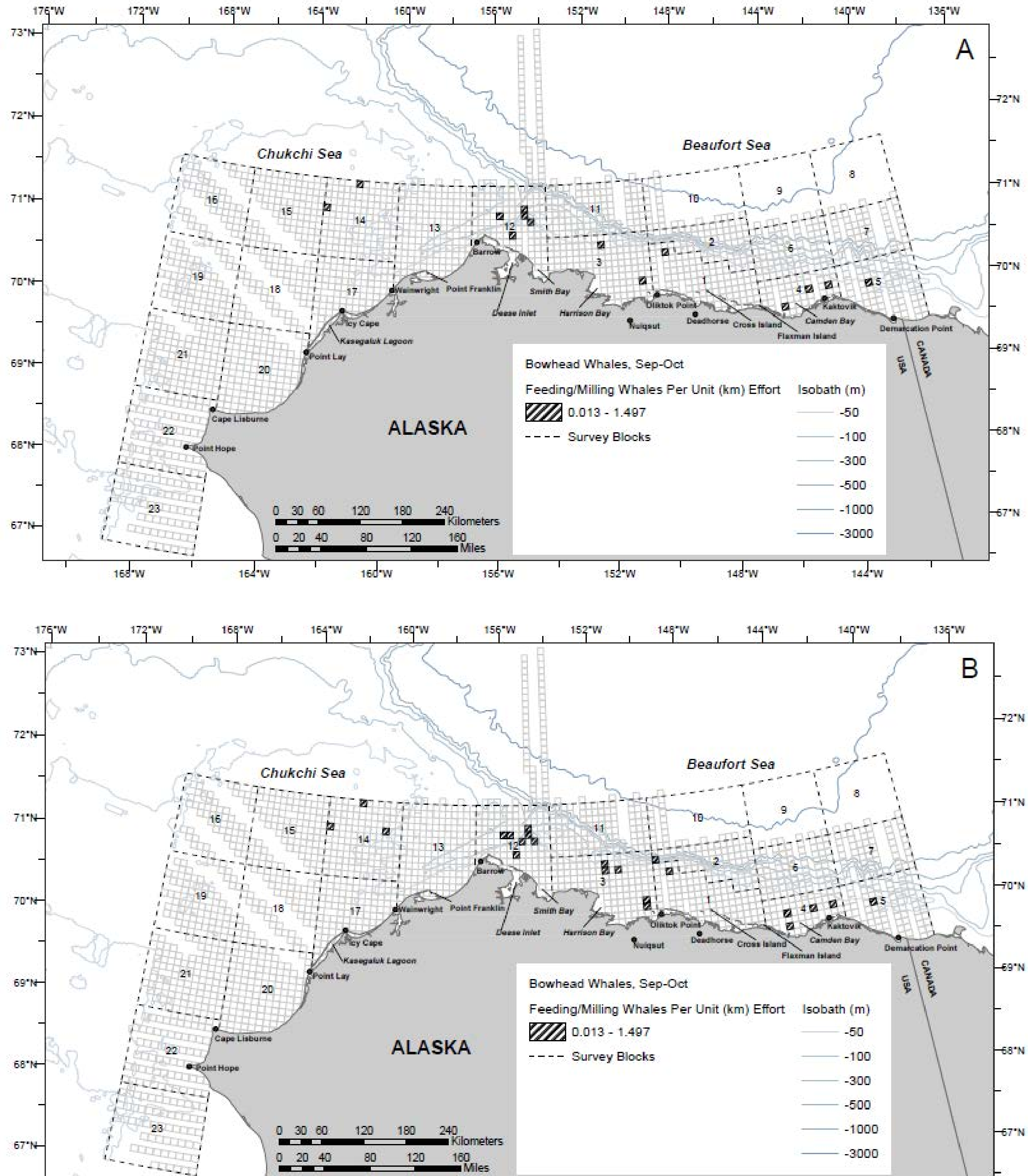


Figure E-4. ASAMM 2016 fall (September-October) feeding and milling bowhead whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

Table E-5. ASAMM 2016 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	1,041	3	4	0.0038	1,297	0	0	0.0000	2,338	3	4	0.0017
13	1,546	24	51	0.0330	1,234	6	14	0.0113	2,780	30	65	0.0234
14	984	2	4	0.0041	835	7	10	0.0120	1,819	9	14	0.0077
15	876	0	0	0.0000	761	0	0	0.0000	1,637	0	0	0.0000
16	363	1	2	0.0055	413	1	2	0.0048	776	2	4	0.0052
17	969	29	66	0.0681	1,143	8	26	0.0227	2,112	37	92	0.0436
18	634	0	0	0.0000	615	0	0	0.0000	1,249	0	0	0.0000
19	225	2	6	0.0267	142	0	0	0.0000	366	2	6	0.0164
20	485	0	0	0.0000	325	0	0	0.0000	810	0	0	0.0000
21	70	0	0	0.0000	0	0	0	NA	70	0	0	0.0000
22	223	2	3	0.0134	612	4	6	0.0098	835	6	9	0.0108
23	286	8	13	0.0455	857	8	26	0.0304	1,143	16	39	0.0341
Total	**7,703**	**71**	**149**	**0.0193**	**8,234**	**34**	**84**	**0.0102**	**15,936**	**105**	**233**	**0.0146**

	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	2,275	5	11	0.0048	1,781	1	1	0.0006	4,056	6	12	0.0030
13	1,453	4	7	0.0048	1,903	5	21	0.0110	3,356	9	28	0.0083
14	980	10	16	0.0163	816	7	8	0.0098	1,796	17	24	0.0134
15	445	0	0	0.0000	383	0	0	0.0000	828	0	0	0.0000
16	394	0	0	0.0000	8	0	0	0.0000	402	0	0	0.0000
17	1,079	7	9	0.0083	436	7	10	0.0229	1,516	14	19	0.0125
18	721	0	0	0.0000	0	0	0	NA	721	0	0	0.0000
19	636	0	0	0.0000	0	0	0	NA	636	0	0	0.0000
20	804	0	0	0.0000	520	0	0	0.0000	1,324	0	0	0.0000
21	231	0	0	0.0000	364	0	0	0.0000	595	0	0	0.0000
22	398	0	0	0.0000	517	4	7	0.0135	915	4	7	0.0076
23	642	30	90	0.1402	513	21	36	0.0701	1,155	51	126	0.1091
Total	**10,058**	**56**	**133**	**0.0132**	**7,242**	**45**	**83**	**0.0115**	**17,300**	**101**	**216**	**0.0125**

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.
Does not include one sighting of one gray whale in block 1.

Table E-6. ASAMM 2016 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	1,116	6	7	0.0063	1,776	8	10	0.0056	2,892	14	17	0.0059
13	1,809	36	78	0.0431	1,485	10	29	0.0195	3,294	46	107	0.0325
14	1,044	2	4	0.0038	1,063	20	41	0.0386	2,107	22	45	0.0214
15	907	0	0	0.0000	839	0	0	0.0000	1,747	0	0	0.0000
16	382	1	2	0.0052	454	1	2	0.0044	837	2	4	0.0048
17	1,333	67	152	0.1140	1,418	22	80	0.0564	2,751	89	232	0.0843
18	634	0	0	0.0000	696	0	0	0.0000	1,329	0	0	0.0000
19	246	2	6	0.0244	142	0	0	0.0000	387	2	6	0.0155
20	493	0	0	0.0000	357	0	0	0.0000	850	0	0	0.0000
21	70	0	0	0.0000	0	0	0	NA	70	0	0	0.0000
22	238	2	3	0.0126	812	9	26	0.0320	1,050	11	29	0.0276
23	340	17	31	0.0911	1,288	34	153	0.1188	1,628	51	184	0.1130
Total	**8,613**	**133**	**283**	**0.0329**	**10,329**	**104**	**341**	**0.0330**	**18,942**	**237**	**624**	**0.0329**

	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	2,485	7	13	0.0052	1,965	1	1	0.0005	4,450	8	14	0.0031
13	1,609	13	20	0.0124	2,035	5	21	0.0103	3,645	18	41	0.0112
14	1,241	15	25	0.0201	887	7	8	0.0090	2,127	22	33	0.0155
15	474	0	0	0.0000	410	0	0	0.0000	884	0	0	0.0000
16	461	0	0	0.0000	8	0	0	0.0000	469	0	0	0.0000
17	1,339	14	31	0.0232	491	15	26	0.0529	1,831	29	57	0.0311
18	747	0	0	0.0000	0	0	0	NA	747	0	0	0.0000
19	686	0	0	0.0000	0	0	0	NA	686	0	0	0.0000
20	852	0	0	0.0000	531	1	2	0.0038	1,383	1	2	0.0014
21	231	0	0	0.0000	364	0	0	0.0000	595	0	0	0.0000
22	406	0	0	0.0000	528	7	23	0.0436	934	7	23	0.0246
23	773	47	173	0.2239	545	29	70	0.1284	1,318	76	243	0.1844
Total	**11,304**	**96**	**262**	**0.0232**	**7,764**	**65**	**151**	**0.0194**	**19,068**	**161**	**413**	**0.0217**

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.
Does not include one sighting of one gray whale in block 1 and one sighting of one gray whale in block 3.

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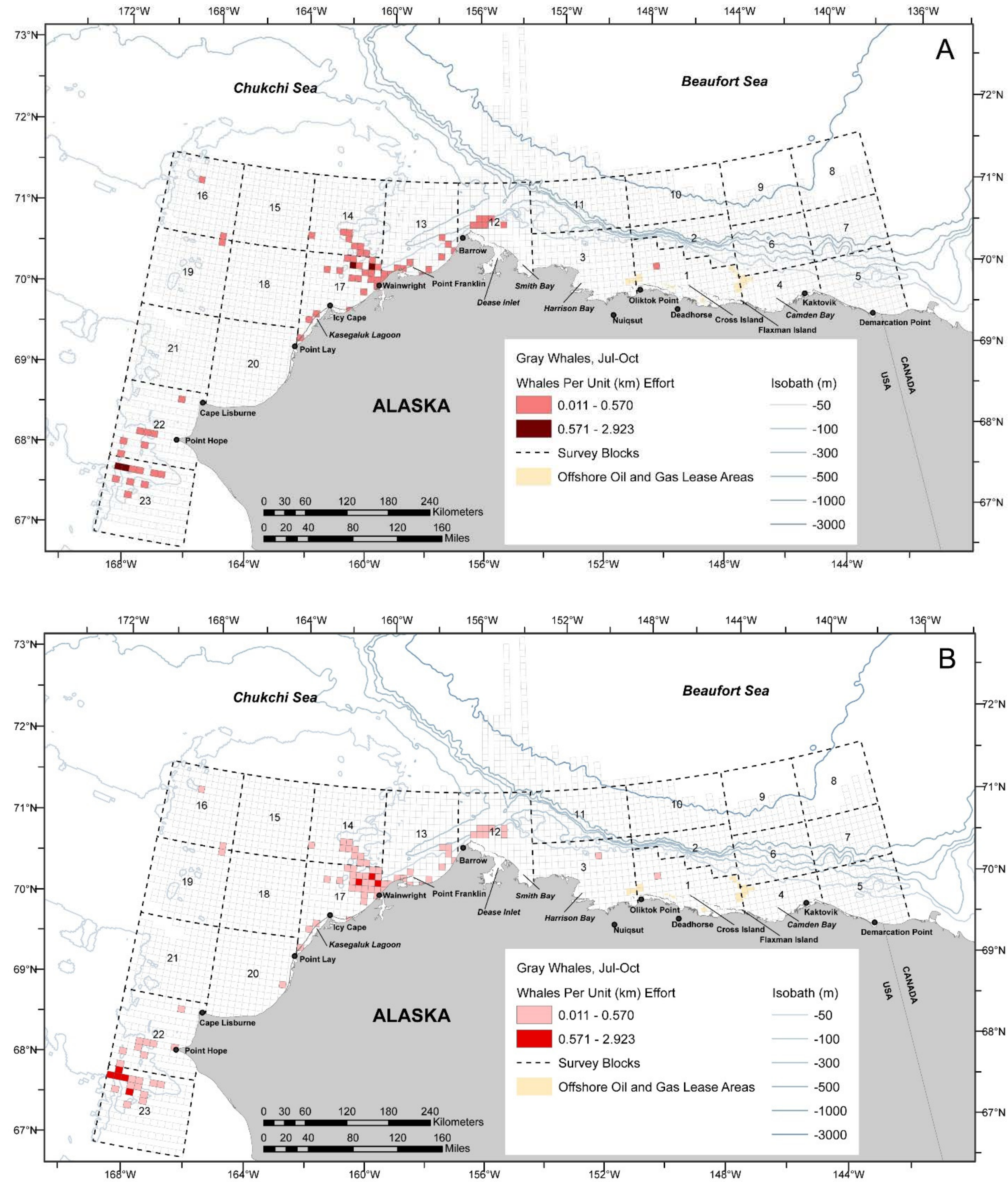

Figure E-5. ASAMM 2016 gray whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

Table E-7. ASAMM 2016 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. 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												
0-35 m	1,638	28	54	0.0330	1,746	4	11	0.0063	3,384	32	65	0.0192
36-50 m	3,543	18	52	0.0147	3,898	13	31	0.0080	7,441	31	83	0.0112
51-200 m N	1,248	16	31	0.0248	1,026	11	23	0.0224	2,274	27	54	0.0237
51-200 m S	232	6	8	0.0345	268	6	19	0.0709	500	12	27	0.0541
154°W-157°W												
0-20 m	179	0	0	0.0000	252	0	0	0.0000	431	0	0	0.0000
21-50 m	228	0	0	0.0000	302	0	0	0.0000	529	0	0	0.0000
51-200 m	503	3	4	0.0079	570	0	0	0.0000	1,074	3	4	0.0037
201-2,000 m	130	0	0	0.0000	173	0	0	0.0000	303	0	0	0.0000
Total	**7,703**	**71**	**149**	**0.0193**	**8,234**	**34**	**84**	**0.0102**	**15,936**	**105**	**233**	**0.0146**

	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												
0-35 m	2,000	1	1	0.0005	1,415	1	1	0.0007	3,416	2	2	0.0006
36-50 m	4,142	11	28	0.0068	2,169	10	15	0.0069	6,312	21	43	0.0068
51-200 m N	1,249	17	28	0.0224	1,509	10	27	0.0179	2,759	27	55	0.0199
51-200 m S	391	22	65	0.1661	367	23	39	0.1062	758	45	104	0.1371
154°W-157°W												
0-20 m	503	0	0	0.0000	378	0	0	0.0000	881	0	0	0.0000
21-50 m	518	2	2	0.0039	362	0	0	0.0000	881	2	2	0.0023
51-200 m	1,040	3	9	0.0087	855	1	1	0.0012	1,895	4	10	0.0053
201-2,000 m	214	0	0	0.0000	185	0	0	0.0000	399	0	0	0.0000
Total	**10,058**	**56**	**133**	**0.0132**	**7,242**	**45**	**83**	**0.0115**	**17,300**	**101**	**216**	**0.0125**

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.
Does not include one sighting of one gray whale east of 154°W.

Table E-8. ASAMM 2016 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. 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												
0-35 m	1,943	38	75	0.0386	1,942	6	17	0.0088	3,885	44	92	0.0237
36-50 m	3,853	42	102	0.0265	4,584	24	63	0.0137	8,438	66	165	0.0196
51-200 m N	1,412	33	75	0.0531	1,449	36	100	0.0690	2,862	69	175	0.0611
51-200 m S	288	14	24	0.0833	578	30	151	0.2615	865	44	175	0.2022
154°W-157°W												
0-20 m	179	0	0	0.0000	404	0	0	0.0000	583	0	0	0.0000
21-50 m	250	1	1	0.0040	381	1	1	0.0026	631	2	2	0.0032
51-200 m	540	5	6	0.0111	811	7	9	0.0111	1,351	12	15	0.0111
201-2,000 m	146	0	0	0.0000	180	0	0	0.0000	327	0	0	0.0000
Total	**8,613**	**133**	**283**	**0.0329**	**10,329**	**104**	**341**	**0.0330**	**18,942**	**237**	**624**	**0.0329**

	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												
0-35 m	2,228	1	1	0.0004	1,437	2	3	0.0021	3,665	3	4	0.0011
36-50 m	4,606	16	67	0.0145	2,298	19	36	0.0157	6,904	35	103	0.0149
51-200 m N	1,500	38	72	0.0480	1,671	12	29	0.0174	3,171	50	101	0.0319
51-200 m S	485	34	109	0.2250	393	31	82	0.2086	878	65	191	0.2176
154°W-157°W												
0-20 m	507	0	0	0.0000	420	0	0	0.0000	927	0	0	0.0000
21-50 m	589	4	4	0.0068	435	0	0	0.0000	1,024	4	4	0.0039
51-200 m	1,160	3	9	0.0078	908	1	1	0.0011	2,068	4	10	0.0048
201-2,000 m	229	0	0	0.0000	202	0	0	0.0000	432	0	0	0.0000
Total	**11,304**	**96**	**262**	**0.0232**	**7,764**	**65**	**151**	**0.0194**	**19,067**	**161**	**413**	**0.0217**

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.
Does not include two sightings of two gray whales east of 154°W.

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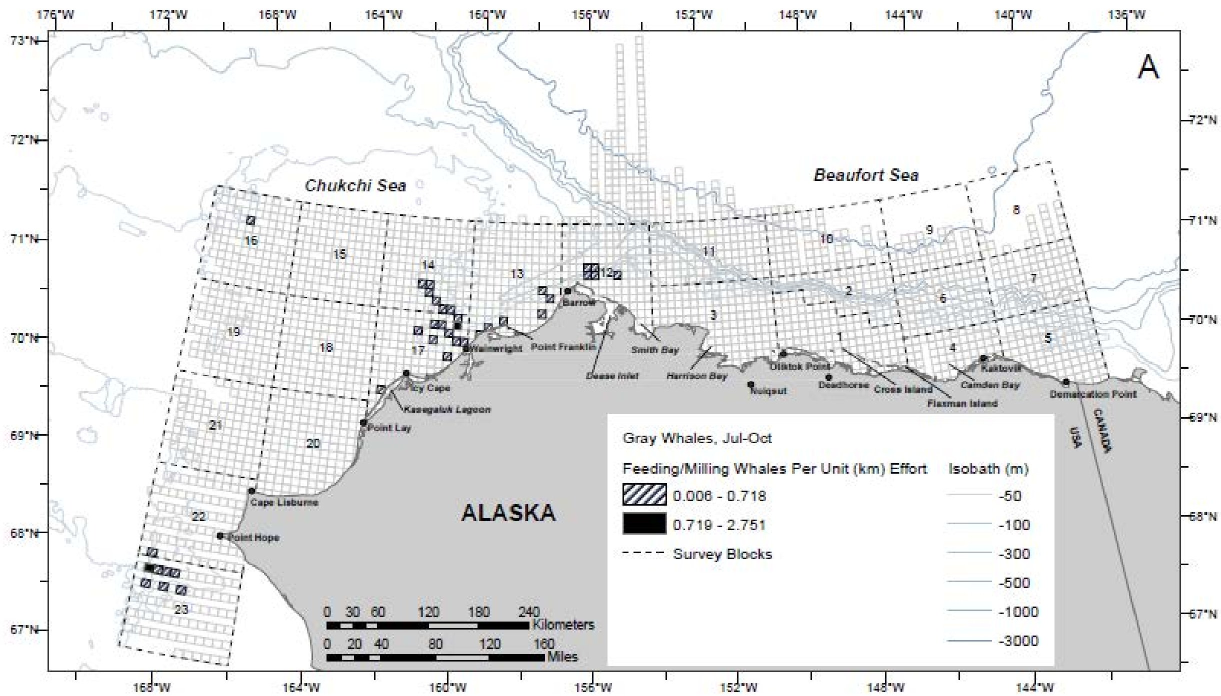

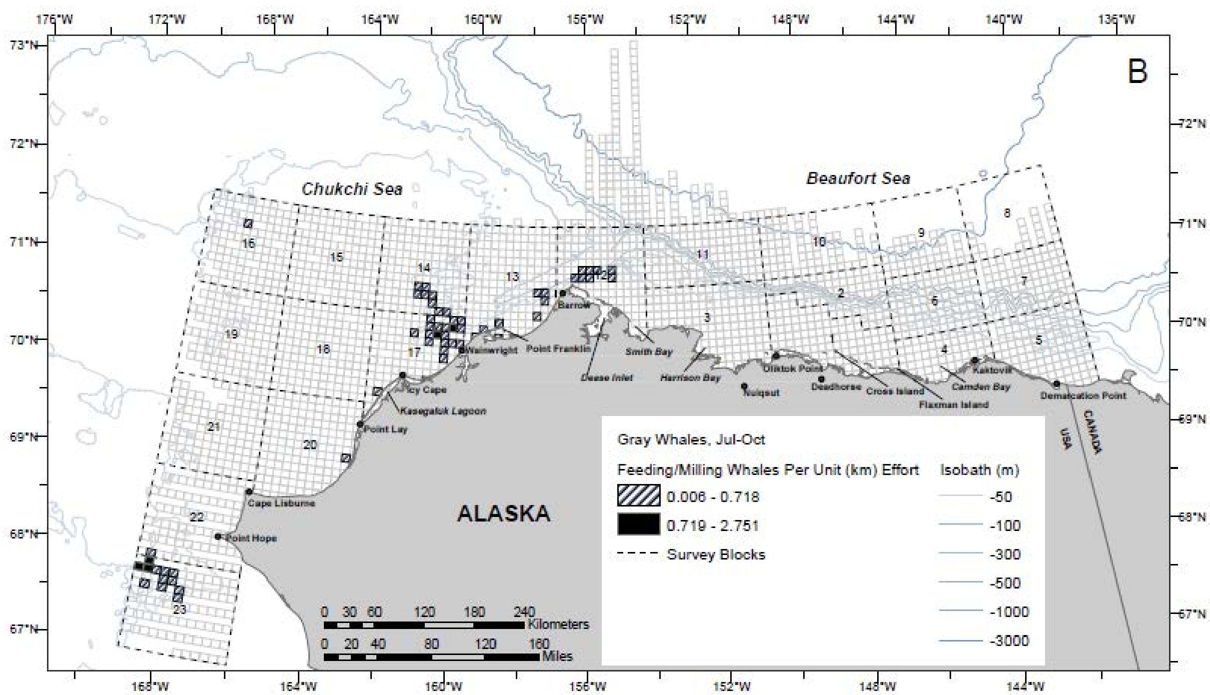

Figure E-6. ASAMM 2016 feeding and milling gray whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without cell outlines.

Table E-9. ASAMM 2016 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	872	0	0	0.0000	1,043	0	0	0.0000	1,914	0	0	0.0000
1a	90	0	0	0.0000	127	0	0	0.0000	218	0	0	0.0000
2	657	12	35	0.0533	693	7	48	0.0693	1,350	19	83	0.0615
3	598	0	0	0.0000	1,247	0	0	0.0000	1,845	0	0	0.0000
4	383	0	0	0.0000	743	0	0	0.0000	1,126	0	0	0.0000
5	606	27	58	0.0957	475	0	0	0.0000	1,081	27	58	0.0537
6	449	27	79	0.1758	937	41	107	0.1142	1,386	68	186	0.1342
7	369	28	51	0.1381	343	1	1	0.0029	712	29	52	0.0730
8	144	0	0	0.0000	0	0	0	NA	144	0	0	0.0000
9	212	0	0	0.0000	231	13	15	0.0648	443	13	15	0.0339
10	444	34	99	0.2229	448	26	42	0.0938	892	60	141	0.1581
11	596	26	177	0.2968	1,125	10	28	0.0249	1,721	36	205	0.1191
12	1,041	27	259	0.2488	1,297	5	135	0.1041	2,338	32	394	0.1685
13	1,546	0	0	0.0000	1,234	0	0	0.0000	2,780	0	0	0.0000
14	984	0	0	0.0000	835	0	0	0.0000	1,819	0	0	0.0000
15	876	0	0	0.0000	761	0	0	0.0000	1,637	0	0	0.0000
16	363	0	0	0.0000	413	0	0	0.0000	776	0	0	0.0000
17	969	0	0	0.0000	1,143	0	0	0.0000	2,112	0	0	0.0000
18	634	0	0	0.0000	615	0	0	0.0000	1,249	0	0	0.0000
19	225	0	0	0.0000	142	0	0	0.0000	366	0	0	0.0000
20	485	0	0	0.0000	325	1	2	0.0062	810	1	2	0.0025
21	70	0	0	0.0000	0	0	0	NA	70	0	0	0.0000
22	223	0	0	0.0000	612	0	0	0.0000	835	0	0	0.0000
23	286	0	0	0.0000	857	0	0	0.0000	1,143	0	0	0.0000
Total	**13,124**	**181**	**758**	**0.0578**	**15,645**	**104**	**378**	**0.0242**	**28,769**	**285**	**1,136**	**0.0395**

	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	1,501	1	1	0.0007	858	0	0	0.0000	2,360	1	1	0.0004
1a	201	0	0	0.0000	75	0	0	0.0000	276	0	0	0.0000
2	967	2	2	0.0021	699	0	0	0.0000	1,666	2	2	0.0012
3	1,093	1	1	0.0009	866	0	0	0.0000	1,959	1	1	0.0005
4	521	0	0	0.0000	97	0	0	0.0000	619	0	0	0.0000
5	880	0	0	0.0000	0	0	0	NA	880	0	0	0.0000
6	1,038	1	1	0.0010	147	0	0	0.0000	1,186	1	1	0.0008
7	650	0	0	0.0000	0	0	0	NA	650	0	0	0.0000
8	2	0	0	0.0000	0	0	0	NA	2	0	0	0.0000
9	1	0	0	0.0000	0	0	0	NA	1	0	0	0.0000
10	151	0	0	0.0000	1	0	0	0.0000	152	0	0	0.0000
11	792	1	3	0.0038	786	2	4	0.0051	1,577	3	7	0.0044
12	2,275	0	0	0.0000	1,781	4	8	0.0045	4,056	4	8	0.0020
13	1,453	0	0	0.0000	1,903	0	0	0.0000	3,356	0	0	0.0000
14	980	0	0	0.0000	816	0	0	0.0000	1,796	0	0	0.0000
15	445	0	0	0.0000	383	0	0	0.0000	828	0	0	0.0000
16	394	0	0	0.0000	8	0	0	0.0000	402	0	0	0.0000
17	1,079	0	0	0.0000	436	0	0	0.0000	1,516	0	0	0.0000
18	721	0	0	0.0000	0	0	0	NA	721	0	0	0.0000
19	636	0	0	0.0000	0	0	0	NA	636	0	0	0.0000
20	804	0	0	0.0000	520	0	0	0.0000	1,324	0	0	0.0000
21	231	0	0	0.0000	364	0	0	0.0000	595	0	0	0.0000
22	398	0	0	0.0000	517	0	0	0.0000	915	0	0	0.0000
23	642	0	0	0.0000	513	0	0	0.0000	1,155	0	0	0.0000
Total	**17,856**	**6**	**8**	**0.0004**	**10,772**	**6**	**12**	**0.0011**	**28,628**	**12**	**20**	**0.0007**

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.
Does not include 40 sightings of 224 belugas north of 72°N.

Table E-10. ASAMM 2016 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. 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												
0-35 m	1,638	0	0	0.0000	1,746	1	2	0.0011	3,384	1	2	0.0006
36-50 m	3,543	0	0	0.0000	3,898	0	0	0.0000	7,441	0	0	0.0000
51-200 m N	1,248	0	0	0.0000	1,026	0	0	0.0000	2,274	0	0	0.0000
51-200 m S	232	0	0	0.0000	268	0	0	0.0000	500	0	0	0.0000
154°W-157°W												
0-20 m	179	0	0	0.0000	252	0	0	0.0000	431	0	0	0.0000
21-50 m	228	1	1	0.0044	302	0	0	0.0000	529	1	1	0.0019
51-200 m	503	7	77	0.1529	570	1	1	0.0018	1,074	8	78	0.0726
201-2,000 m	130	19	181	1.3872	173	4	134	0.7749	303	23	315	1.0382
140°W-154°W												
0-20 m	764	1	3	0.0039	1,220	0	0	0.0000	1,984	1	3	0.0015
21-50 m	1,481	2	17	0.0115	2,222	0	0	0.0000	3,703	2	17	0.0046
51-200 m	781	6	19	0.0243	1,303	8	28	0.0215	2,084	14	47	0.0226
201-2,000 m	1,209	108	348	0.2879	1,643	45	133	0.0810	2,852	153	481	0.1687
>2,000 m	1,187	37	112	0.0944	1,023	45	80	0.0782	2,210	82	192	0.0869
TOTAL	**13,125**	**181**	**758**	**0.0578**	**15,645**	**104**	**378**	**0.0242**	**28,770**	**285**	**1,136**	**0.0395**

	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												
0-35 m	2,000	0	0	0.0000	1,415	0	0	0.0000	3,416	0	0	0.0000
36-50 m	4,142	0	0	0.0000	2,169	0	0	0.0000	6,312	0	0	0.0000
51-200 m N	1,249	0	0	0.0000	1,509	0	0	0.0000	2,759	0	0	0.0000
51-200 m S	391	0	0	0.0000	367	0	0	0.0000	758	0	0	0.0000
154°W-157°W												
0-20 m	503	0	0	0.0000	378	1	1	0.0026	881	1	1	0.0011
21-50 m	518	0	0	0.0000	362	2	3	0.0083	881	2	3	0.0034
51-200 m	1,040	0	0	0.0000	855	1	4	0.0047	1,895	1	4	0.0021
201-2,000 m	214	0	0	0.0000	185	0	0	0.0000	399	0	0	0.0000
140°W-154°W												
0-20 m	1,289	1	1	0.0008	708	0	0	0.0000	1,997	1	1	0.0005
21-50 m	2,664	1	1	0.0004	1,244	0	0	0.0000	3,907	1	1	0.0003
51-200 m	1,363	0	0	0.0000	555	1	2	0.0036	1,918	1	2	0.0010
201-2,000 m	1,818	4	6	0.0033	759	1	2	0.0026	2,578	5	8	0.0031
>2,000 m	674	0	0	0.0000	264	0	0	0.0000	938	0	0	0.0000
TOTAL	17,867	6	8	0.0004	10,772	6	12	0.0011	28,639	12	20	0.0007

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.
Does not include 40 sightings of 224 belugas north of 72°N.

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APPENDIX F: ASAMM CONTRIBUTIONS TO THE SCIENTIFIC COMMUNITY, 2008-2016

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-1and 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. assumed the two-year chairmanship of the Arctic Council in 2015. 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.

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Venues Where ASAMM Results were Presented (Alphabetized):

Alaska Beluga Whale Committee Workshop, Anchorage, AK. 2012. Presentation.

Alaska Marine Science Symposium, Anchorage, AK. 2009-201

65. Presentations (2), posters (38).

American Cetacean Society, Monterey, CA. 2008. Poster.

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. Presentation.

International Whaling Commission Scientific Committee Meeting, Morocco. 2010. Reports (2).

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.

Distributed Biological Observatory Data Workshops, Seattle, WA. 2014, 2016. Presentationd (2).

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 Nunaŋ ŋ uanun (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.

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 2011-2016 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.

2015-2016: 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.

INCIDENTAL HARASSMENT AUTHORIZATIONS THAT USED ASAMM SIGHTING AND EFFORT DATA FOR MARINE MAMMAL DENSITY CALCULATIONS AND TAKE ESTIMATES:

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.

BP Exploration: Request for an Incidental Harassment Authorization pursuant to section 101(A)(5) of the MMPAion covering incidental harassment of marine mammals during and 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.

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.

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.

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.

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

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/

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.

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.

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.

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).

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."

Joling, D. 2014. "Estimated 35,000 walrus come ashore in Northwest Alaska." Alaska Dispatch News. September 10, 2015.

DeMarban, A. "Bowhead whale deaths mystify observers." Alaska Dispatch News. October 9, 2015.

PAPERS IN PREPARATION OR IN REVIEW (ALPHABETICAL):

Brower, A.B., J.T. Clarke, M.C. Ferguson. *In review*. Increased sightings of subarctic cetaceans in the eastern Chukchi Sea, 2008-2016: population recovery, response to climate change, or increased effort? Submitted to *Polar Biology*.

Clarke, J.T., M.C. Ferguson, A.L. Willoughby, and A.A. Brower. In review. 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 1982-91. Submitted to *Arctic*. Reviewer comments received.

Clarke et al. Bowhead whales in the western Beaufort Sea in summer. *Analysis in prep*.

Clarke et al. Relationship between large whale occurrence and physical oceanography during the open water season in the northeastern Chukchi Sea, 2010-2016. *Paper in prep*.

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.*

Ferguson, M., R. Angliss, A. Kennedy, B. Lynch, A. Willoughby, V. Helker, A. Brower, and J. Clarke. Comparing the performance of manned and unmanned aerial platforms to study arctic cetaceans. *Analysis in prep.*

Ferguson et al. Density of bowhead whales, gray whales, and belugas in the northeastern Chukchi and western Beaufort Seas from geographically-explicit habitat models. *Analysis in prep.*

Mannocci L., A. Boustany, J. Roberts, H. Bailey, S. Bograd, E. Becker, J. Cleary, B. Gardner, J. Hartog, E. Hazen, M. Ferguson, K. Forney, B. Kinlan, J. Moxley, M. Olliver, D. Palacios, C. Peretti, V. Ridoux, S. Teo, S. Viehman, A. Winship, D. Dunn, and P. Halpin. *In review*. Habitat models of marine predators: a question of time? *Diversity and Distributions*.

Willoughby, A.L., M.C. Ferguson, J.T. Clarke, and A.A. Brower. *Accepted*. First photographic match of an anomalously white gray whale (*Eschrichtius robustus*) on summering grounds in the northeastern Chukchi Sea and wintering grounds in Baja California, Mexico. *Aquatic Mammals.*

APPENDIX G: SAFETY AND LOGISTICS PLAN, 2016

Aerial Surveys of Arctic Marine Mammals: Safety and Logistics Plan
27 June 2016

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˚ – 169˚W, 67˚ – 72˚N (Figure G-1). The 2016 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. From 19 July – 20 August, some survey effort will be focused on habitat for Eastern Chukchi Sea (ECS) belugas, located over the continental slope (100 – 3000 m isobaths, extending up to 73˚N offshore of Point Barrow) in the western Beaufort Sea, to collect data for an updated ECS beluga abundance estimate. 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, Barrow and Deadhorse, located on the North Slope of Alaska (Figure G-1). Lodging in Barrow will be provided by the King Eider Inn, and lodging in Deadhorse will be provided by MagTec. The Barrow 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 – 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 Barrow and Deadhorse field seasons.

The primary emergency support services in Barrow 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 Barrow.

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.

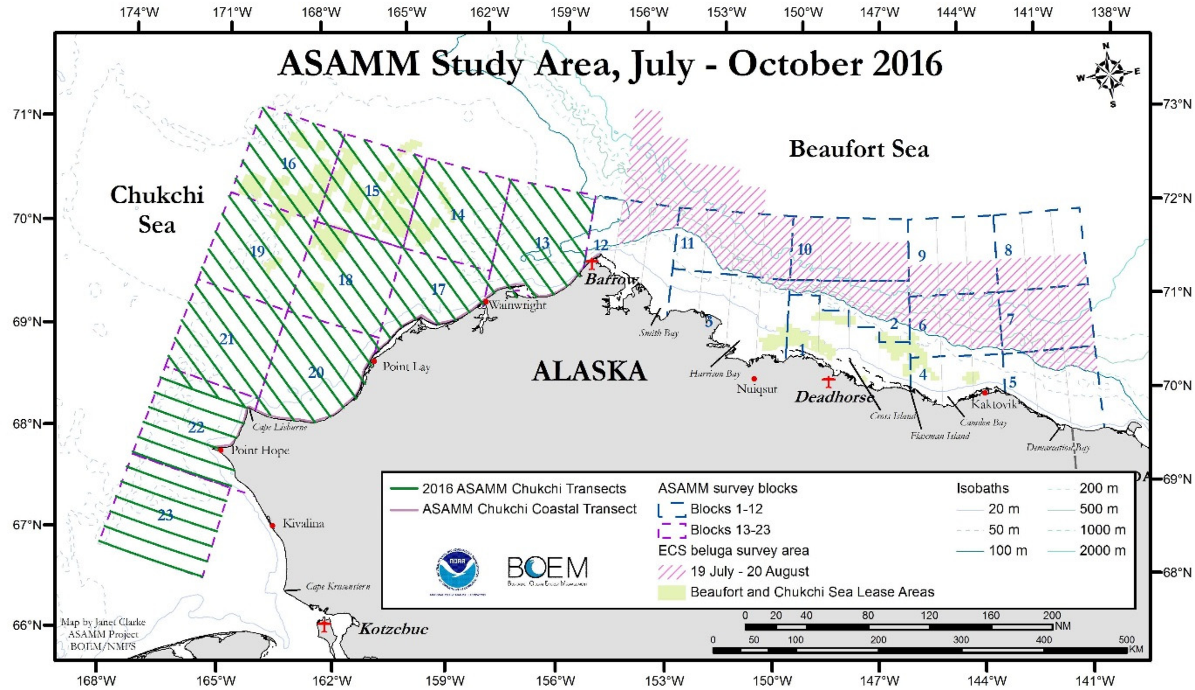

Figure G-1. ASAMM study area and survey blocks with bathymetry, Chukchi Sea coastal transect and 2016 offshore transects, Beaufort Sea survey blocks and Eastern Chukchi Sea (ECS) beluga survey area, and offshore oil and gas lease areas.

Both Barrow 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.

<u>Training</u>

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 2016 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, Personal Locator Beacon (PLB), and aircraft and marine band handheld radios.

The aircraft used during the 2016 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 2011-2015. The Clearwater Air Pilots in Command have an average of over 8,500 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

Risk Assessment Template.xlsx

Clearwater Air **Multi-Engine IFR**

Flight Risk Assessment

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.

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 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 a system 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 2013-2015, the aviation dispatchers from the Alaska Fire Service, Bureau of Land Management, will provide real-time flight following assistance to the project. See the document entitled “Flight Following Procedures and Emergency Contact Numbers for the Aerial Surveys of Arctic Marine Mammals (ASAMM) Project conducted by NOAA Fisheries/Marine Mammal Laboratory (MML)” for complete details on ASAMM’s flight following and emergency protocols. Emergency reporting procedures internal to MML are provided in the “Emergency Notification Plan for 2016 MML Field Operations.”

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 Barrow, 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. Autumn 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 autumn. 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 autumn. This information is required by BOEM to fulfill the Agency's obligations under the NEPA, the MMPA, and the ESA.
3. Autumn 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 autumn. 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 autumn. 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. Autumn 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 autumn. 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 autumn. 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. Autumn 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 autumn. 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 autumn. 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.