OCS Study
BOEM 2017-019

Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2015 Annual Report

U.S. Department of the Interior
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Bowhead whale cow-calf pair, Alaskan Beaufort Sea
July 2015
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Distribution and Relative Abundance of Marine Mammals in the Eastern Chukchi and Western Beaufort Seas, 2015
Final Report

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Prepared under Interagency Agreement M11PG00033

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DISCLAIMER

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ABSTRACT

This report describes field activities of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project conducted during summer and fall (1 July–31 October) 2015 and data 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.

Sea ice cover in the study area in 2015 was generally light compared with historical (pre-2007) sea ice cover. In early July, sea ice in the eastern Chukchi Sea remained north of 71.5°N. By late July, sea ice remained in the Hanna Shoal area, but was otherwise absent from the Chukchi Sea study area. Sea ice persisted in most of the western Beaufort Sea through August. From early September through mid-October, sea ice was largely absent from the ASAMM study area although some grounded ice remained nearshore between Camden Bay and Deadhorse. By late October, new ice was forming in the northern blocks and in shallow nearshore areas in the western Beaufort Sea study area. The northeastern Chukchi Sea study area remained almost completely ice free through late October, with sea ice present only in shallow nearshore areas.

A total of 105 survey flights were conducted. The Barrow-based aerial survey team conducted surveys from 2 July through 30 October 2015, and the Deadhorse-based aerial survey team conducted surveys from 19 July through 8 October 2015. Total combined flight time was 521 hours, including 248 hours of transect survey effort. Over 132,000 km were flown, with 54,016 km of effort on transect. Surveys were conducted in the western Beaufort Sea in summer (mid-July through August) for the fourth consecutive year and in block 23 (southcentral Chukchi Sea) for the second consecutive year.

There were 3,679 sightings of 93,180 marine mammals observed during all (transect, search, and circling) survey modes, including:

- 594 sightings of 1,042 bowhead whales (*Balaena mysticetus*),
- 259 sightings of 465 gray whales (*Eschrichtius robustus*),
- 10 sightings of 17 humpback whales (*Megaptera novaeangliae*),
- 17 sightings of 22 fin whales (*Balaenoptera physalus*),
- 6 sightings of 6 minke whales (*Balaenoptera acutorostrata*),
- 602 sightings of 1,799 belugas (*Delphinapterus leucas*),
- 73 sightings of 87 unidentified cetaceans,
- 556 sightings of 86,229 Pacific walruses (*Odobenus rosmarus divergens),*
- 13 sightings of 13 bearded seals (*Erignathus barbatus*),
- 1,534 sightings of 3,379 unidentified pinnipeds, and
- 15 sightings of 121 polar bears (*Ursus maritimus*).

Bowhead whales were seen in all months of the study period and their distribution by depth zone and survey block changed throughout the season. Distribution in the western Beaufort Sea (140°W-157°W) in July was primarily on the outer continental shelf and slope (51-2,000 m depth). Bowhead whales were seen on the inner continental shelf (≤50 m depth) in August, September, and October. Sighting rate (whales per transect km) by depth zone between 140°W and 154°W in the western Beaufort Sea was highest in the 51-2,000 m zones in July, the 21-50 m

depth zone in August and September, and the ≤20 m depth zone in October. Sighting rate by depth zone in the Barrow Canyon area (154°W-157°W) was highest in the ≤20 m depth zone in August and September and in the 21-50 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, 1993-2014), bowhead whale sightings (not normalized by survey effort) in the western Beaufort Sea in fall (September-October) were in significantly shallower water in the West (148°W-156°W) region and in significantly deeper water in the East (140°W-148°W) region. In the northeastern Chukchi Sea, few bowhead whales were seen in July and August. The highest sighting rate in September and October was in the 51-200 m North depth zone. The highest overall bowhead whale sighting rate per survey block was block 6 in July, block 12 in August and September, and block 3 in October. The eastern Chukchi Sea survey block with the highest overall sighting rate was block 14.

Spatial models of bowhead whale relative abundance (accounting for heterogeneous survey effort) in the western Beaufort Sea were created to examine high-use areas (HUAs) during fall (September-October) 2015 and each month from July through October for the 16-year period from 2000 to 2015. The spatial model for fall 2015 suggested that the median distribution of bowhead whales was located approximately 15 km closer to shore in the West Region compared to the East Region. The spatial model for 2000-2015 suggested that the bowhead whale HUA was located farthest from shore in July compared to August, September, and October. Finally, comparison of the predictions from the two spatial models suggested that bowhead whale HUAs were located closer to shore in the West Region and farther from shore in the East Region in 2015 compared to the 16-year time series from 2000 to 2015.

Sightings of feeding or milling bowhead whales were particularly noteworthy, and were the most frequently observed behaviors. Feeding and milling were most often observed between Cape Halkett and Point Barrow (approximately 152°W to 157°W), particularly between late August and early October. This area is a well-documented bowhead whale feeding area when specific oceanographic conditions produce a "krill trap." Oceanographic conditions and bowhead whale feeding observations in fall 2015 supported the "krill trap" model.

Thirty-nine bowhead whale calves were seen in 2015, including seven 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 similar to that observed in 2014 but lower than summer calf ratios in 2012 and 2013. The fall bowhead whale calf ratio (number of calves/number of total whales) was within the normal range of calf ratios recorded by ASAMM from 1982 to 2014.

Gray whales were seen in all months of the study period in the northeastern Chukchi Sea. Relatively few gray whales were seen in the southcentral Chukchi Sea during limited survey effort in August, September, and October. 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. The highest sighting rate by depth zone was in the ≤35 m depth zone. The highest sighting rate by month occurred in July and decreased sharply through September, rising slightly in October. Most gray whales observed (58%) were feeding. Eighty-three gray whale calves were seen, although some calf sightings may have been repeat sightings.

Additional noteworthy results from the 2015 ASAMM field effort included:

- Humpback whales (10 sightings of 17 whales), including 1 calf, were sighted in the eastern Chukchi Sea in July, August, and October.
- Fin whales (17 sightings of 22 whales) were sighted in the southcentral Chukchi Sea in August and October.
- Minke whales (six sightings of six whales) were sighted in the eastern Chukchi Sea in July, August, and September.
- Beluga distribution in the western Beaufort Sea in summer and fall was centered over the continental slope and Barrow Canyon.
- Walruses were observed in the water and hauled out on ice (particularly near Hanna Shoal) and on land. A walrus haulout on land was observed near Point Lay on four occasions from 2 to 21 September, with an estimated maximum group size of 31,400 animals.
- Polar bears were seen from Wainwright, Alaska, on the Chukchi Sea coast to east of Kaktovik, Alaska, on the Beaufort Sea coast. All but two of the polar bears were observed on land or within 3 km of land; one bear was swimming more than 200 km offshore in the northeastern Chukchi Sea and one bear was more than 25 km offshore in the western Beaufort Sea.

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Abbreviations and Acronyms

ACEs	Aerial Calibration Experiments
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
BOWFEST	Bowhead Whale Feeding Ecology Study
BSPA	Beaufort Sea Planning Area
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
DBO	Distributed Biological Observatory
e.g.	for example
ESA	Endangered Species Act
FR	Federal Register
GAM	Generalized Additive Model

GIS	Geographic Information System
GPS	Global Positioning System
GRS	Geodetic Reference System
hr	hour
HUA	high-use area
i.e.	that is
IBCAO	International Bathymetric Chart of the Arctic Ocean
JISAO	Joint Institute for the Study of the Atmosphere and Ocean
km	kilometer
m	meter
max	maximum
min	minimum
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
n	sample size
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
NSIDC	National Snow and Ice Data Center
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 aerial system
UAV	unmanned aerial vehicle
USB	universal serial bus
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, and the Conservation Division of the U.S. Geological Survey (USGS) for classifying and evaluating submerged federal lands and regulating exploration and production. In 1982, the U.S. Minerals Management Service (MMS) assumed these responsibilities. The MMS was renamed the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) in 2010. In 2011, the Bureau of Ocean Energy Management (BOEM) assumed responsibilities for administering environmentally and economically responsible development of offshore resources.

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, Alaska, 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 2-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 (BSPA) (Sales 97, 124, 144, 170, 186, 195, and 202) and Lease Sale 193 in the Chukchi Sea Planning Area (CSPA) 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. (Ljungblad et al. 1987). The MMS used agency personnel to perform fieldwork 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).

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, right, fin, and gray 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). 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) Describe the annual migration of bowhead whales across the Alaskan Arctic, significant inter-year differences, and long-term trends in the spatial distribution and timing (duration and start date) of the migration.

2) Document relative abundance, spatial and temporal distribution, and behavior (including calving/pupping, feeding, and hauling out) of marine mammals (cetaceans, ice seals, walruses, and polar bears) in the Alaskan Arctic.

3) Provide near real-time data and maps to BOEM and NMFS on marine mammals in the Alaskan Arctic, with specific interest in endangered species, such as bowhead whales.

4) 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.

5) Provide, when requested by BOEM's Representative, limited integrative products such as graphics of summarized observations for use by BOEM analysts in NEPA and ESA analyses and documentation.

6) Provide timely information on environmental conditions, including ice conditions, to organizations (e.g., National Ice Center, Alaska Eskimo Whaling Commission, and BOEM) as directed by BOEM's Representative.

METHODS AND MATERIALS

Study Area

The study area encompasses the western Beaufort and eastern Chukchi seas (Figure 1). Survey blocks overlay Beaufort Sea and Chukchi Sea oil and gas lease sale areas offshore of Alaska. The study area partially overlaps the CSPA and BSPA but does not completely encompass either. The present study 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.

The northern Chukchi Sea is largely ice-covered from late fall through winter. 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 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 bathymetry is 51-2,000 m and undergoes frequent current reversals to the west (Aagaard 1984). In the nearshore shallow waters of the Beaufort inner shelf (≤50 m depth), currents tend to follow local wind patterns. 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 were found to alternate between anticyclonic and cyclonic circulation, with each regime persisting from 5 to 7 years (Proshutinsky and Johnson 1997; Johnson et al. 1999). However, the wind-driven regime has been largely anticyclonic since 1997 (Richter-Menge et al. 2011), with a cyclonic regime observed only in 2009. 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 may include multiyear ice averaging 4 m in thickness with pressure ridges up to 50 m thick (Norton and Weller 1984), 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 2007-2014 (National Snow and Ice Data Center 2007, 2008, 2009, 2010, 2011, 2012,

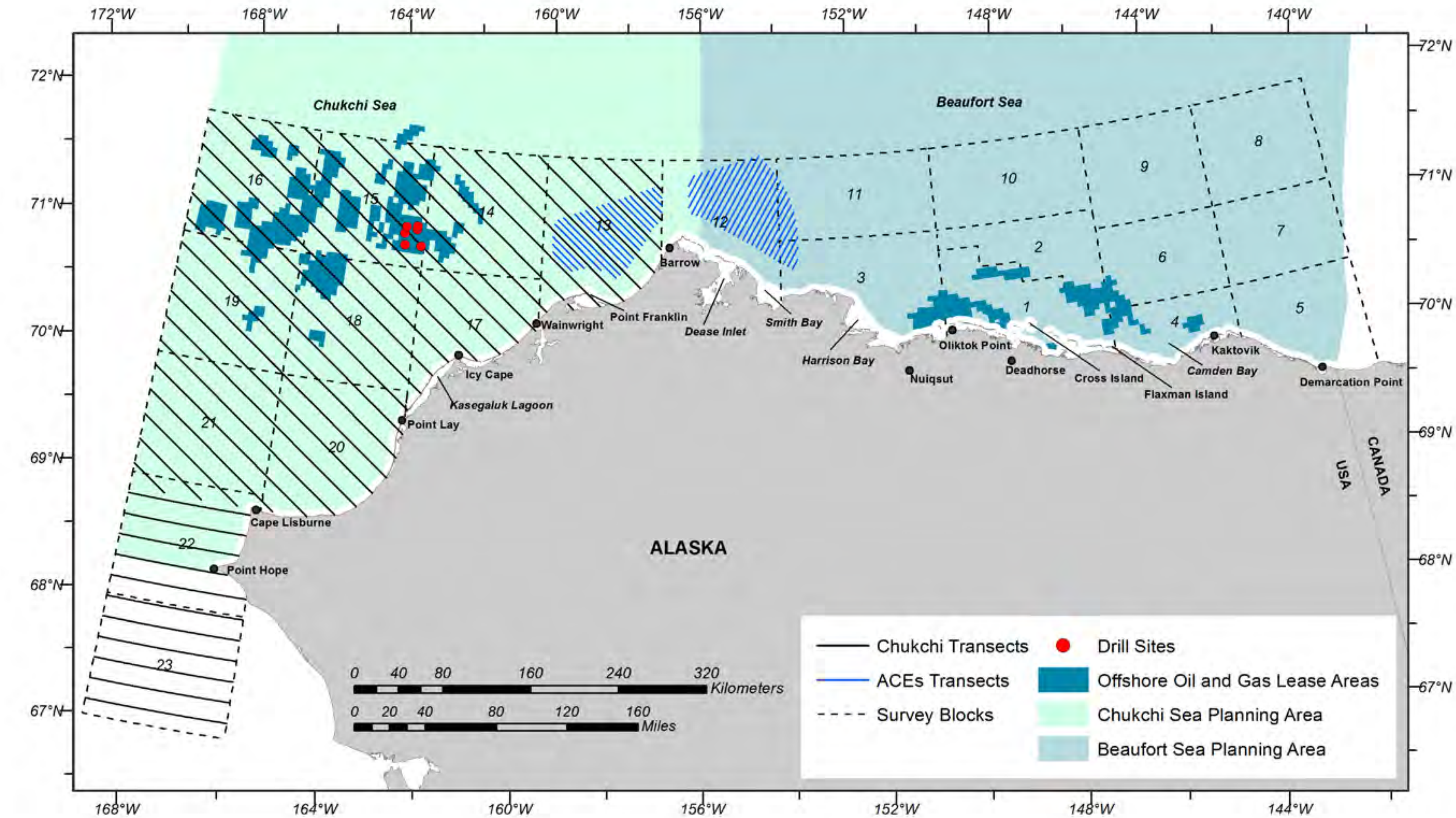


Figure 1. ASAMM study area showing survey blocks, 2015 ASAMM Chukchi Sea transect lines, Arctic ACEs transect lines in east and west Arctic ACEs subareas, Chukchi Sea Planning Area, Beaufort Sea Planning Area, current lease areas, and 2015 drilling sites. Transect lines in the Beaufort Sea are generated daily and, therefore, not shown.

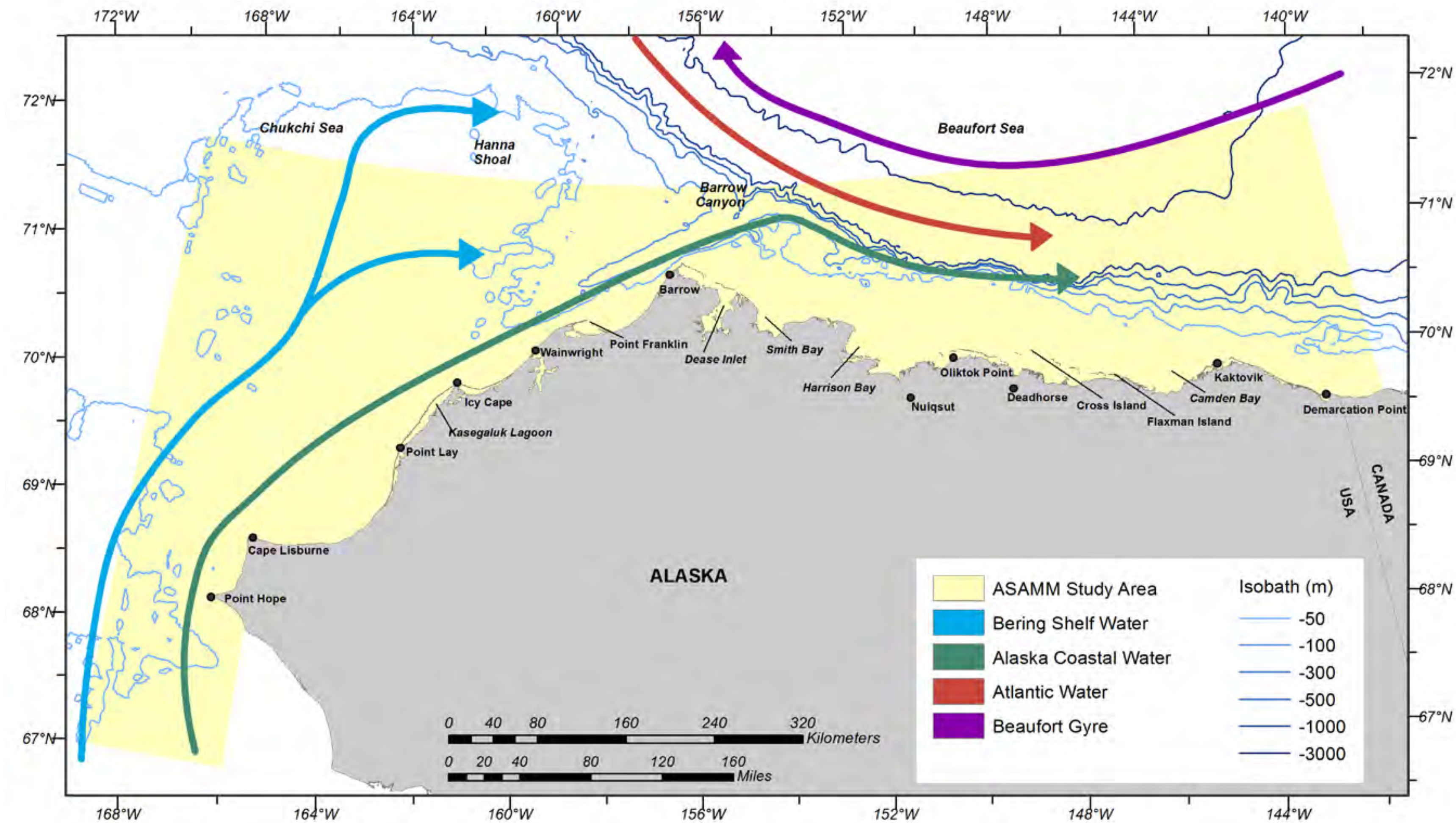


Figure 2. Eastern Chukchi Sea and western Beaufort Sea oceanographic features.

2013a, 2014). 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, with mean air temperatures at western Beaufort Sea coastal locations ranging 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). Mean annual air temperatures measured at Barrow from 1972 to 2007 increased by 2.9°C, likely attributed to circulation changes (increased warm air advection from southern latitudes) or increased infrared back-radiation caused by increased cloudiness, water vapor, or carbon dioxide (Wendler et al. 2009). The heaviest precipitation (snow and rain) occurs in September and October (Brower et al. 1988), but the total annual precipitation in the Alaskan Arctic has decreased since the late 1940s (Stafford et al. 2000). Mean wind speed at Barrow and Barter Island, Alaska, is from 5-6 m/s during September and 5-7 m/s during October (Brower et al. 1988). 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 (Wendler et al. 2009).

Sea state also affects visibility during aerial surveys. Surface waters in the Beaufort and Chukchi seas are 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 6.0 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 flight or dry suits and were outfitted with Switliks or other personal floatation devices containing emergency equipment.

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 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 along 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 (1979-2014). 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).

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. 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 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 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 two 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 the eastern Chukchi Sea study area (157°W-169°W), 39 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 one km offshore between Point Barrow and Point Hope, Alaska. The coastal transect allowed better documentation of nearshore habitat, including pinniped haulouts along the coastline.

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. 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

Each survey flight could be divided into a total of five flight types: 1) deadhead, 2) search, 3) transect, 4) circling from search, and 5) circling from transect. 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. Data were not collected during deadhead segments. Transects were joined together by short search or deadhead legs. When large cetaceans were encountered, the aircraft usually diverted from the trackline for brief (usually <10 minutes) periods and circled the whales to verify species, observe behavior, improve group size estimates, and determine whether calves were present. Any new sightings of whales made while circling were recorded as sightings “on circling” and were considered on effort. Sightings made off transect and not while circling were recorded as sightings “on search.” Software on the laptop computing system allowed for detailed tracking of all effort to avoid duplicate sightings being recorded during circling.

Survey altitudes were chosen to maximize visibility and minimize potential disturbance to marine mammals. 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. 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.

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 recorded as "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 2015 and previous years, all observers underwent training in ASAMM data collection techniques prior to and during the 2015 field season. Data quality was also enhanced by ensuring that at least two observers on each field team had previous experience conducting ASAMM surveys.

Survey Design and Procedures Specific to Arctic ACEs Surveys

In late August and early September 2015, ASAMM coordinated with a UAS (Unmanned Aerial System) study to collect data on large whales in the northeastern Chukchi and western Beaufort seas. The UAS study, known as the Arctic Aerial Calibration Experiments (Arctic ACEs), was a joint effort of NOAA, US Navy, BOEM, and Shell. The overarching objective of Arctic ACEs was to conduct a 3-way comparison of sighting data and derived statistics from the following:

- Observers in the Barrow-based ASAMM aircraft;
- Digital photographs from a camera mounted to the Barrow-based ASAMM aircraft; and
- Digital photographs from a camera mounted to the UAV (Unmanned Aerial Vehicle).

During the joint study time period, the priority for the Barrow-based ASAMM aircraft was to survey transects in the ACEs study area, which was a subarea of the larger ASAMM study area (Figure 1). Transects in the ACEs study area (numbered 201-250) were spaced 4.75 km apart. Survey methods were similar to ASAMM methods with two exceptions: transects were flown at a target altitude of 320 m and circling was never initiated to be consistent with the UAS survey protocol.

Coordination with 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 2015. Protocols included 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. Manned aerial activity was also present in the northeastern Chukchi Sea in support of Shell's 2015 exploration drilling program (USDOC, NOAA, NMFS 2015a). ASAMM maintained daily contact with operators of all aircraft supporting Shell offshore, including fixed wing aircraft conducting photographic surveys near the drill site and helicopters ferrying personnel between the drill site and Barrow.

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 in 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. 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, 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 and walrus calves), 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 other 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 16 categories (Table 1). Swim direction, collected only for whales for which the behavior "swim" was 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.

General Data Analyses

Preliminary data analysis was performed in the field after each flight by a customized computer program that provided daily summaries of marine mammal sightings and effort (time and distance on transect, search, circling, and deadhead). The program also provided options for editing the data file and plotting the paths of one or more flights by Beaufort wind force. An additional customized computer program was used for post-season analysis and production of figures and tables. Maps were prepared using ArcGIS 10.2 (Environmental Systems Resource Institute [ESRI 2012], 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 = 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 Imagery and Mapping 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, 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) being conducted, 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), 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 under-reported 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.

During post-processing of the data, values were estimated for 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 (IBCAO) 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

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 are 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.

software being used to depict distribution data (Figure 3). The normalized shoreline was re-defined 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 analysis 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°).

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 (2015), 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. 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 2015, sightings made by primary observers only were included in most analyses that used on-effort sightings, including sighting rate and central tendency analyses.

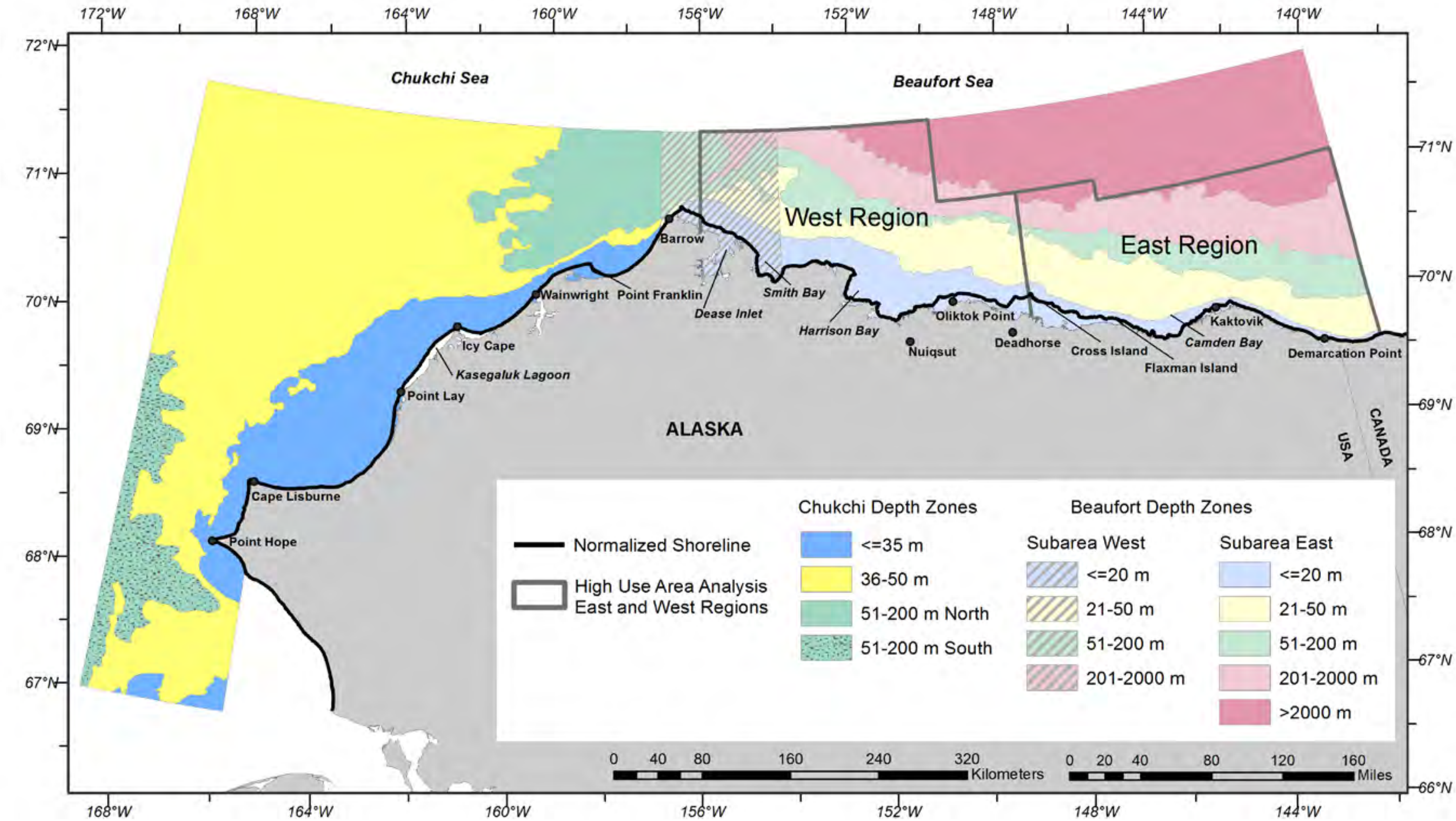


Figure 3. East and West regions and normalized shoreline used in ASAMM bowhead whale high-use area (HUA) analysis, and depth zone subareas used for sighting rate analyses.

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 rate 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, and north of the study area (north of 72°N) was not included in the survey block sighting rate analysis.

To calculate monthly and annual sighting rate per depth zone for bowhead whales, gray whales and belugas, the number of whales observed was divided by effort (km) per depth zone. Depth zone isobaths were defined based on depth data in the International Bathymetric Chart of the Arctic Ocean (IBCAO) 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°; Standard_Parallel_1: 60.5°; Standard_Parallel_2: 80.5°; Latitude_Of_Origin: 70.5°; Linear Unit: Meter [1.0]).

Finally, sighting rate was calculated for fine-scale (5 minutes latitude by 15 minutes longitude) areas, using a grid consisting of approximately equilateral grid cells (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 grid 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 2015, as in 2014, 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. 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. There is no reliable way, via data collected during aerial surveys, to differentiate between whales that were actively undergoing a focused, unidirectional, east-west fall migration and whales that were 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). Two analyses of bowhead whale HUAs in the western Beaufort Sea were undertaken.

Central tendency analyses did not incorporate sighting and effort data collected during Arctic ACEs transects. The limitation on circling from transect during ACEs surveys likely negatively impacted the identification of some whales to species and the ability to accurately estimate group size, which could introduce bias into analyses specifically directed at determining habitat use.

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 2015, a year with light sea ice cover (National Snow and Ice Data Center 2015), were compared with analogous values for combined data from previous years having light sea ice cover (i.e., 1989, 1990, 1993-2014; 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). Median distance from shore and depths at bowhead whale sightings in summer (July-August)

2015 were compared to bowhead whale sightings in summer 2012-2014 and fall (September-October) 2015.

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 subsets of data 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 10.0 and ArcGIS Version 10.1.

All bowhead whale sightings made while on transect (primary observers only, excluding sightings collected during ASAMM surveys of ACEs transects), regardless of distance from the transect line, were included in the non-parametric 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.

Distance from shore and water depth at bowhead whale sightings 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 survey 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 survey blocks 2, 11, and 12 (Figure 1). 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.

One caveat to the nonparametric analyses is that analyzing bowhead whale HUAs based only on number of sightings may be biased because survey effort was often variable 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 2015 involved a three-step process: 1) constructing spatial models of bowhead whale relative abundance (encounter rate) based on bowhead whale sightings from 2015; 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 2015. 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 2015, excluding sightings collected during ASAMM surveys of ACEs transects. 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 3.2.2 (R Core Team 2015) using packages *sp* (Pebesma and Bivand 2005; Bivand et al. 2013), *maptools* (Bivand and Lewin-Koh 2015), *raster* (Hijmans 2015), *rgeos* (Bivand and Rundel 2015), *rgdal* (Bivand et al. 2015), 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 grid cell in order 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 71.5°; latitude of origin 70.5°; central meridian -148.0°; false easting 0.0; and false northing 0.0. Data extracted for each grid cell included the total number of whales sighted, the projected x and y coordinates of the midpoint of each grid cell, and the shortest distance from that midpoint to the normalized shoreline. Bowhead whale relative abundance was modeled as a generalized additive model (GAM), 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 grid 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 grid cell i;

α: intercept;

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

Y_i: projected (equidistant conic) latitude of the midpoint of grid 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 grid cell i, which was incorporated into the model as a constant (an "offset") in order to account for spatially heterogeneous survey effort throughout the study area.

The median distance from shore of the fall distribution of bowhead whales was estimated using the spatial model to predict the number of individuals likely to be observed in each grid 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. Grid cells were ordered by distance from shore, from closest to farthest. The predicted number of individuals per cell was cumulated, beginning with the closest grid cell and ending with the farthest. The median distance from shore was calculated as the distance corresponding to the midpoint of the grid 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 2000-2015 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, excluding sightings collected during 2015 ASAMM surveys of ACEs transects) and did not account for availability or perception bias. It included data from July to October, and varying-coefficient generalized additive models (Wood 2006) were 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 15-year time period were calculated for the East and West regions separately.

The median can also be referred to as the 50th percentile or quantile. An additional analysis was undertaken to define the location of bowhead whale HUAs in 2015 alone and in 2000-2015 (all years pooled) based on the locations of the 30th, 40th, 50th, 60th, and 70th percentiles of predicted bowhead whale relative abundance for each column of 5 km x 5 km grid cells in the East and West regions. For example, in this analysis the location of the 30th 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 grid cell in locations where the predicted distribution of bowhead whales changes rapidly with distance from shore. The midpoints of all cells corresponding to the 30th percentile were connected across the entire region to define a linear boundary across the western Beaufort Sea corresponding to the 30th percentile of bowhead whale HUAs, and similarly for the 40th, 50th, 60th, and 70th percentiles.

RESULTS

Environmental Conditions

In 2015, sea ice cover in the area surveyed was generally light. When surveys commenced in the eastern Chukchi Sea in early July, sea ice remained north of 71.5°N (Appendix A, Figures A-1 and A-2). By late July, sea ice in the Chukchi Sea remained in the Hanna Shoal area (blocks 14 and 15), but was otherwise absent from the Chukchi Sea study area (Figure A-3). Sea ice persisted in most of the western Beaufort Sea through August (Figures A-4 and A-5). Sea ice was largely absent from the entire ASAMM study area from early September through mid-October (Figures A-6 to A-8), although some grounded ice remained nearshore between Camden Bay and Deadhorse. By late October, new ice was forming in the northern blocks and in shallow nearshore areas in the western Beaufort Sea study area (Figure A-9). The northeastern Chukchi Sea study area remained nearly free of ice through late October, with sea ice present only in shallow nearshore areas (Figure A-10).

Arctic sea ice extent reached the seasonal minimum on 11 September 2015, and sea ice fell to the fourth lowest extent since satellite data were first recorded in 1979 (National Snow and Ice Data Center 2015). To examine interannual variability in bowhead whale and other marine mammal distributions and relative abundance, 2015 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 personnel involved. In 2015, 18 observers participated in ASAMM surveys. All ASAMM observers were experienced field biologists and most (94%) had previous experience with ASAMM surveys, which ensured consistency in data collection among years. Previous ASAMM field experience ranged from 1 to 21 years (mean = 5 years, median = 4 years). One observer did not have previous ASAMM experience, but had aerial survey experience conducting right whale surveys. Less experienced ASAMM observers were integrated into teams consisting of 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 2015 and ended 31 October 2015; survey flights were conducted from 2 July to 30 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 30 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 105 survey flights, of which 20 were in July, 33 in August, 32 in September, and 20 in October. Surveys originating on the aircraft

Table 2. ASAMM 2015 flight effort in chronological order, 2 July–30 October 2015, by survey flight and semimonthly time period. Semimonthly totals may not exactly match the sum for the time period due to rounding errors.

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
2 Jul	201	56	8	87	263	413	0.3	1.8
3 Jul	202	504	105	118	175	902	2.3	4.5
4 Jul	203	1,082	261	8	872	2,223	5.0	9.1
5 Jul	204	532	45	1	649	1,226	2.3	4.5
7 Jul	205	444	65	54	675	1,237	2.0	4.7
10 Jul	206	0	0	0	1283	1,283	0.0	3.9
20 Jul	207	78	0	17	708	803	0.4	2.7
21 Jul	208	335	38	56	410	840	1.4	3.5
21 Jul	1	441	71	112	918	1,542	2.0	5.6
22 Jul	209	374	0	189	343	906	1.8	3.7
22 Jul	2	737	0	134	300	1,170	3.5	5.2
24 Jul	3	338	0	126	308	772	1.6	3.2
25 Jul	4	0	0	153	430	584	0.0	2.2
27 Jul	210	158	0	6	497	661	0.7	2.4
27 Jul	5	30	0	2	442	474	0.1	1.5
29 Jul	211	403	71	3	817	1,294	1.9	4.7
29 Jul	6	484	0	372	567	1,423	2.2	5.7
30 Jul	212	1,199	197	85	904	2,385	5.3	9.6
30 Jul	7	479	0	37	409	926	2.2	3.7
31 Jul	8	475	32	94	342	942	2.1	3.8
1 Aug	213	368	17	139	1,693	2,217	1.6	7.4
1 Aug	9	30	0	115	189	334	0.2	1.6
2 Aug	214	67	0	64	231	362	0.3	1.6
2 Aug	10	523	17	110	549	1,199	2.3	4.6
3 Aug	215	344	0	162	1,252	1,758	1.6	6.1
4 Aug	216	499	15	9	357	880	2.1	3.4
4 Aug	11	25	0	1	352	378	0.1	1.3
5 Aug	12	633	0	177	426	1,236	2.9	5.2
6 Aug	217	389	0	249	148	786	1.8	3.5
7 Aug	218	847	105	76	725	1,752	3.9	7.3
9 Aug	219	744	40	97	430	1,311	3.3	5.3

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
9 Aug	13	533	0	202	1077	1,812	2.4	6.6
10 Aug	220	506	45	2	726	1,278	2.3	4.8
11 Aug	221	419	11	15	823	1,267	1.8	4.5
11 Aug	14	326	0	57	984	1,367	1.5	4.9
12 Aug	222	340	6	2	552	899	1.5	3.3
12 Aug	15	15	0	106	668	788	0.1	2.6
14 Aug	16	510	85	81	534	1,210	2.5	5.1
18 Aug	223	313	34	81	428	856	1.5	3.4
19 Aug	224	532	98	87	262	979	2.4	4.3
19 Aug	17	498	0	54	437	989	2.4	4.3
20 Aug	225	703	207	16	268	1,194	3.3	5.4
20 Aug	18	282	0	6	511	800	1.3	3.0
23 Aug	226	288	291	47	1,318	1,944	1.3	6.7
24 Aug	19	299	44	189	347	878	1.3	3.6
25 Aug	20	1,131	170	115	946	2,362	5.1	9.5
26 Aug	227	266	91	110	235	702	1.2	3.2
26 Aug	21	592	93	22	965	1,671	2.6	6.0
29 Aug	228	451	0	145	126	722	2.1	3.2
29 Aug	22	182	0	144	827	1,153	0.8	3.9
30 Aug	229	0	0	34	784	818	0.0	3.0
31 Aug	230	662	4	149	379	1,193	3.0	5.0
31 Aug	23	689	59	102	1,012	1,862	3.2	6.9
1 Sep	231	610	0	195	287	1,092	2.8	4.8
1 Sep	24	771	132	56	621	1,579	3.6	6.5
2 Sep	232	486	64	76	448	1,075	2.3	4.5
7 Sep	233	696	0	283	380	1,359	3.2	6.2
7 Sep	25	379	26	109	951	1,465	1.7	5.4
8 Sep	234	205	76	46	436	764	0.9	3.0
8 Sep	26	392	10	22	474	898	1.8	3.6
9 Sep	27	526	18	51	496	1,091	2.5	4.4
10 Sep	235	9	0	25	771	806	0.1	2.5
13 Sep	236	318	10	3	631	961	1.5	3.5
13 Sep	28	677	63	87	895	1,722	3.1	6.6
16 Sep	237	697	192	147	591	1,627	3.3	7.0
16 Sep	29	1,102	154	111	845	2,212	5.2	9.4

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
17 Sep	238	1,246	0	23	913	2,182	5.8	8.9
18 Sep	239	609	43	104	1,145	1,901	2.9	7.2
18 Sep	30	711	42	117	422	1,292	3.4	5.5
19 Sep	240	609	186	2	473	1,269	2.8	5.4
19 Sep	31	675	8	163	690	1,537	3.3	6.2
20 Sep	32	1,106	0	53	1,245	2,404	5.1	9.1
21 Sep	241	1,110	7	60	1,351	2,528	5.2	9.8
21 Sep	33	456	260	42	774	1,532	2.1	6.0
22 Sep	242	524	0	113	1,493	2,130	2.4	7.5
22 Sep	34	676	36	76	460	1,249	3.2	5.2
23 Sep	35	1,011	106	38	604	1,759	4.7	7.5
25 Sep	243	418	19	45	548	1,030	1.9	3.9
25 Sep	36	586	78	20	653	1,337	2.7	5.1
26 Sep	37	703	28	65	438	1,234	3.3	5.1
27 Sep	244	939	40	61	670	1,709	4.4	7.3
27 Sep	38	521	129	47	792	1,490	2.4	6.0
28 Sep	245	969	46	65	686	1,765	4.6	7.3
29 Sep	39	656	0	130	390	1,176	3.0	4.8
30 Sep	40	155	0	24	473	652	0.7	2.5
2 Oct	41	1,303	60	65	471	1,898	6.1	8.5
3 Oct	246	414	0	54	654	1,121	1.9	4.3
3 Oct	42	665	11	20	624	1,318	3.1	5.0
4 Oct	247	574	52	68	292	986	2.7	4.7
4 Oct	43	880	264	134	578	1,855	4.1	8.3
6 Oct	44	699	5	38	496	1,238	3.2	5.0
8 Oct	45	140	10	52	686	889	0.7	3.1
10 Oct	248	578	56	61	1,338	2,034	2.6	7.3
12 Oct	249	381	90	23	289	782	1.7	3.4
13 Oct	250	101	0	1	324	426	0.5	1.6
14 Oct	251	921	54	1	659	1,635	4.3	6.8
15 Oct	252	493	10	43	1,348	1,895	2.3	6.6
16 Oct	253	817	0	52	378	1,246	3.8	5.2
19 Oct	254	185	0	37	218	440	0.9	1.8
24 Oct	255	489	72	50	1,407	2,018	2.2	7.0
26 Oct	256	504	0	21	216	740	2.2	3.0

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
27 Oct	257	624	24	17	248	912	3.0	4.1
28 Oct	258	541	0	4	582	1,128	2.4	4.4
29 Oct	259	597	12	6	568	1,183	2.8	4.6
30 Oct	260	407	17	37	216	678	1.9	2.9
				Semimonthly Effort Summary				
1-15 Jul		2,618	484	268	3,917	7,284	11.8	28.5
16-31 Jul		5,531	409	1,386	7,395	14,722	25.2	57.5
1-15 Aug		7,118	341	1,664	11,716	20,834	32.1	79.0
16-31 Aug		6,888	1,091	1,301	8,845	18,123	31.5	71.3
1-15 Sep		5,069	399	953	6,390	12,812	23.4	51.0
16-30 Sep		15,479	1,374	1,506	15,656	34,015	72.2	136.6
1-15 Oct		7,149	612	560	7,759	16,077	33.1	64.5
16-31 Oct		4,164	125	224	3,833	8,345	19.1	32.8
Total		**54,016**	**4,835**	**7,862**	**65,511**	**132,212**	**248.4**	**521.2**

based in Barrow were numbered sequentially starting with 201; surveys originating on the aircraft based in Deadhorse were numbered sequentially starting with 1. On 38 occasions, multiple flights in one day were completed by the same survey team to take advantage of favorable survey conditions. Surveys were conducted simultaneously by both survey teams on 29 days. Surveys were conducted on 63% of possible survey days (76 out of 121 possible days). Surveys were not conducted on 37% of the possible survey days (45 out of 121 possible days) due to weather (38 days), aircraft maintenance (1 day), or a combination of weather and aircraft inspections or other maintenance requirements (6 days).

Survey effort was summarized by hours or kilometers flown in different survey modes. Over 132,000 km were flown during 521.2 hours (Figure 4). A total of 54,016 km of effort on transect was flown during 248 hours (Figure 5). Transect effort constituted 41% of the total kilometers flown and 48% of the total flight hours. Forty-two 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 flight, an aerial survey team covered 1,259 km, ranging from 334 km to 2,528 km. The longer distances required 2-3 flights per survey. Transects were truncated at ~168.75°W to avoid overflights of the International Dateline (169°W).

Survey effort (transect, search, and circling) is plotted semimonthly in Figure 6. In the northeastern Chukchi Sea study area, transects near active Chukchi Sea lease areas were targeted more often than areas without active 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. Transect survey coverage in the entire ASAMM study area was well distributed throughout July, August, September, and early October, although survey coverage in the eastern Chukchi Sea in late August and early September was less wide spread than in some recent years due to the requirement for ASAMM to support the Arctic ACEs study near Barrow. Survey coverage in October was limited to areas closest to Barrow and Deadhorse, due to increasingly inclement weather conditions and reduction of survey teams from two to one, based in Barrow. During times when there were two aircraft conducting surveys, survey coverage (time and distance) was greatest in late September, when 21 surveys were flown, and lowest in early September when only 11 surveys were flown.

Survey coverage was greatest in blocks 13, 14, and 17 in the Chukchi Sea and blocks 12, 3, 11, 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 disintegrate. When conditions deteriorated, survey plans were immediately aborted so that survey teams could return safely to base. The noticeably higher effort in blocks 12 and 13, particularly in October, was

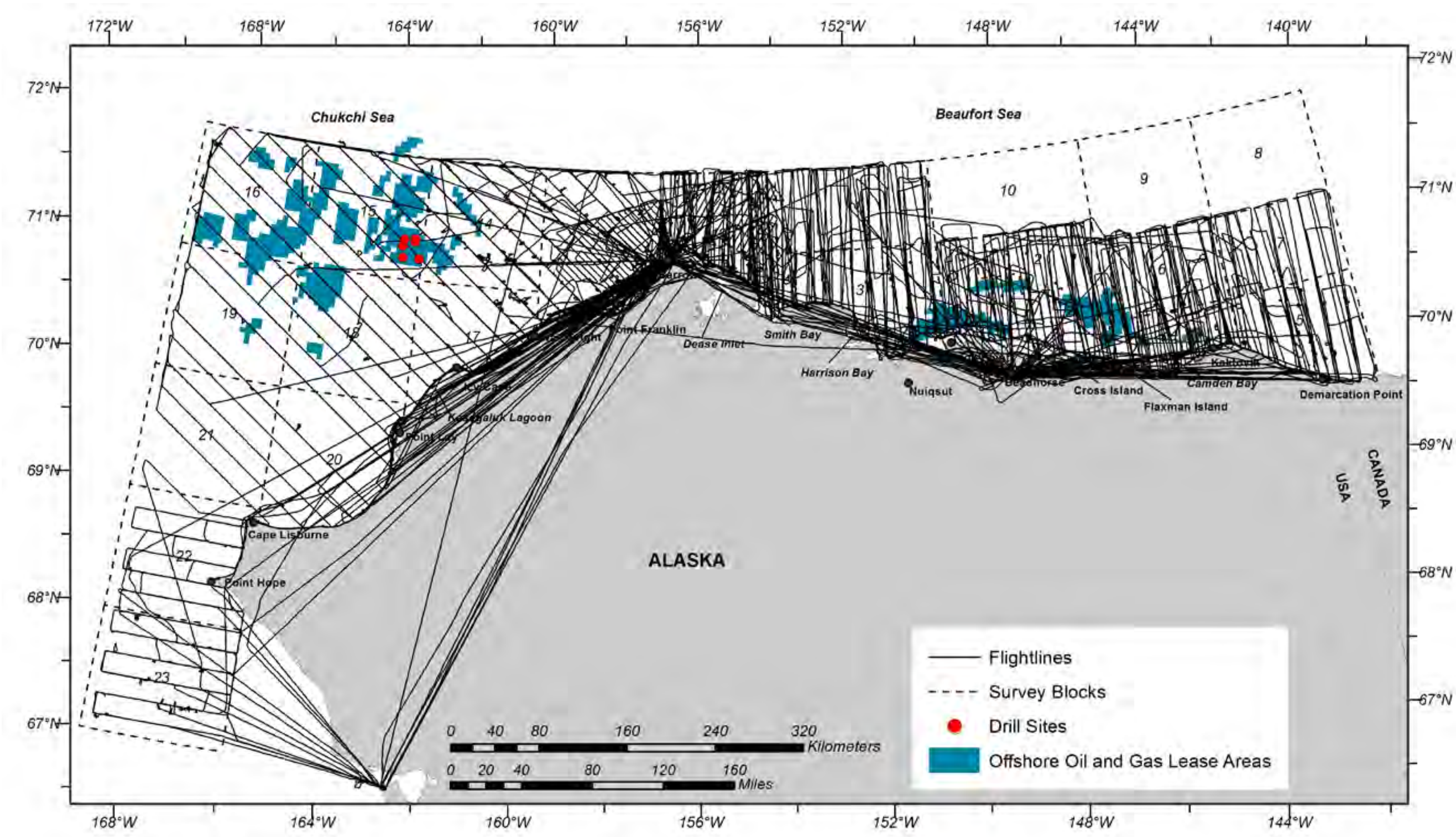


Figure 4. ASAMM 2015 combined flight tracks, all flight types (transect, search, circling, and deadhead).

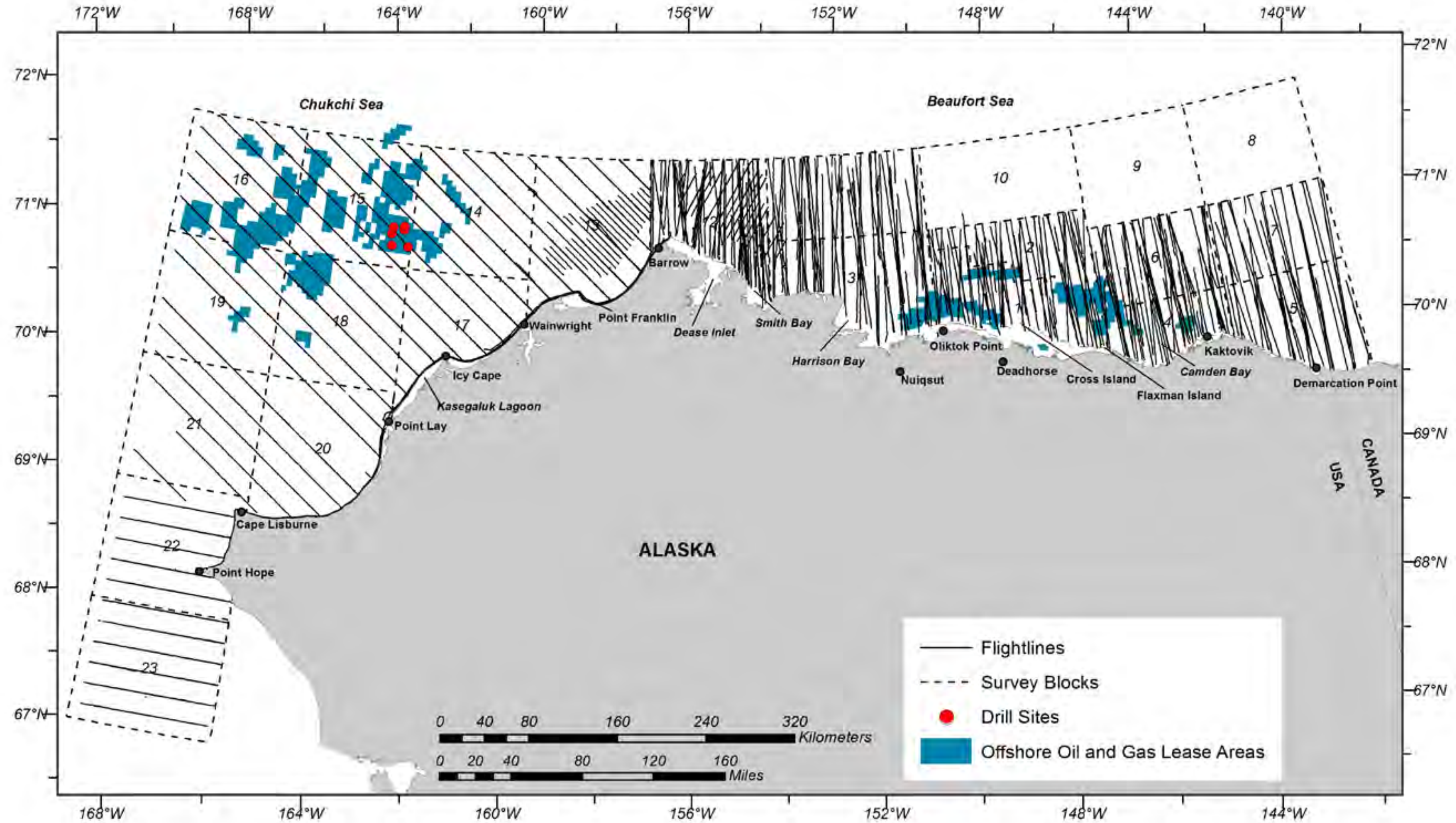


Figure 5. ASAMM 2015 combined flight tracks, transect effort only. No transects were flown north of 72°N.

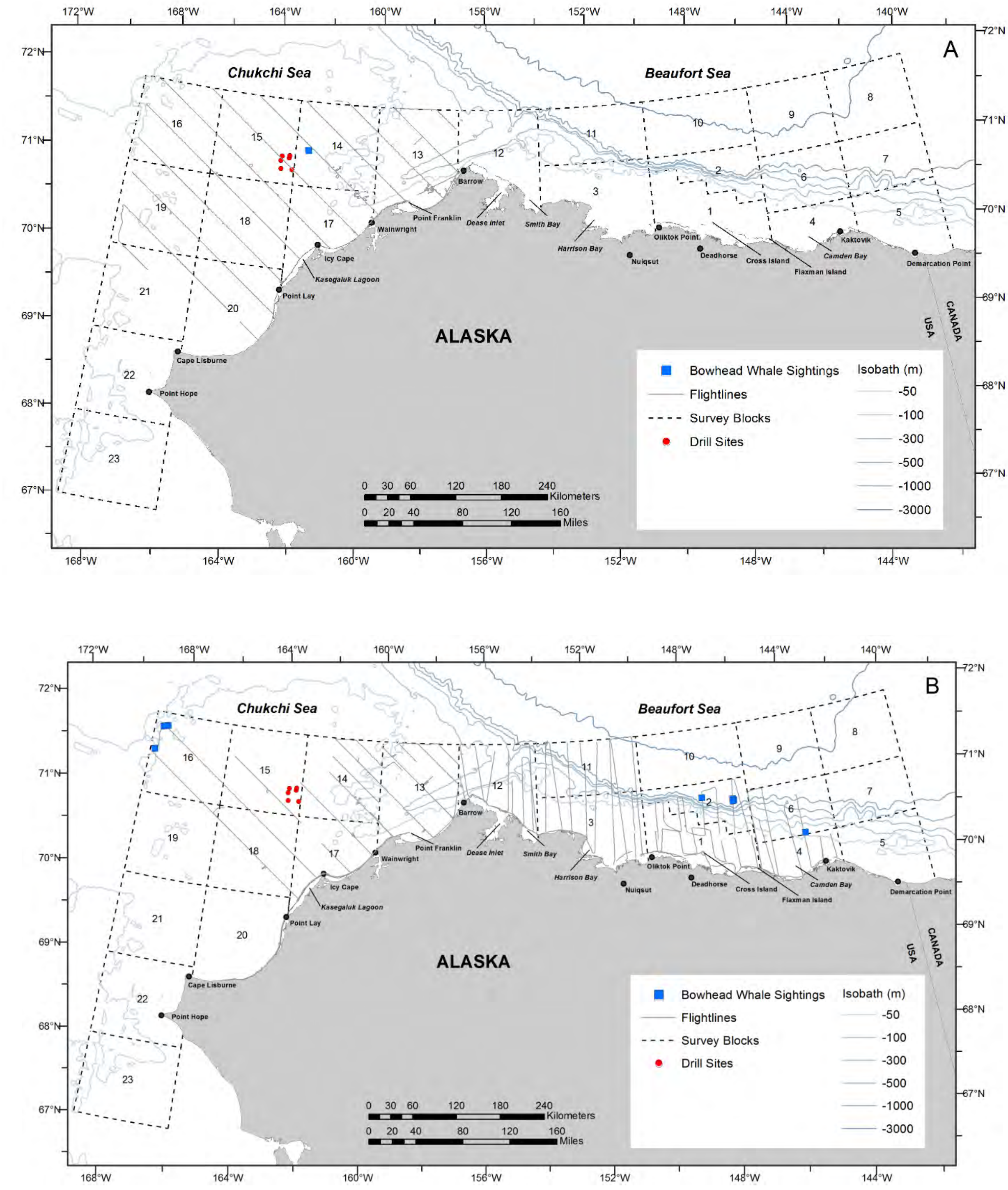
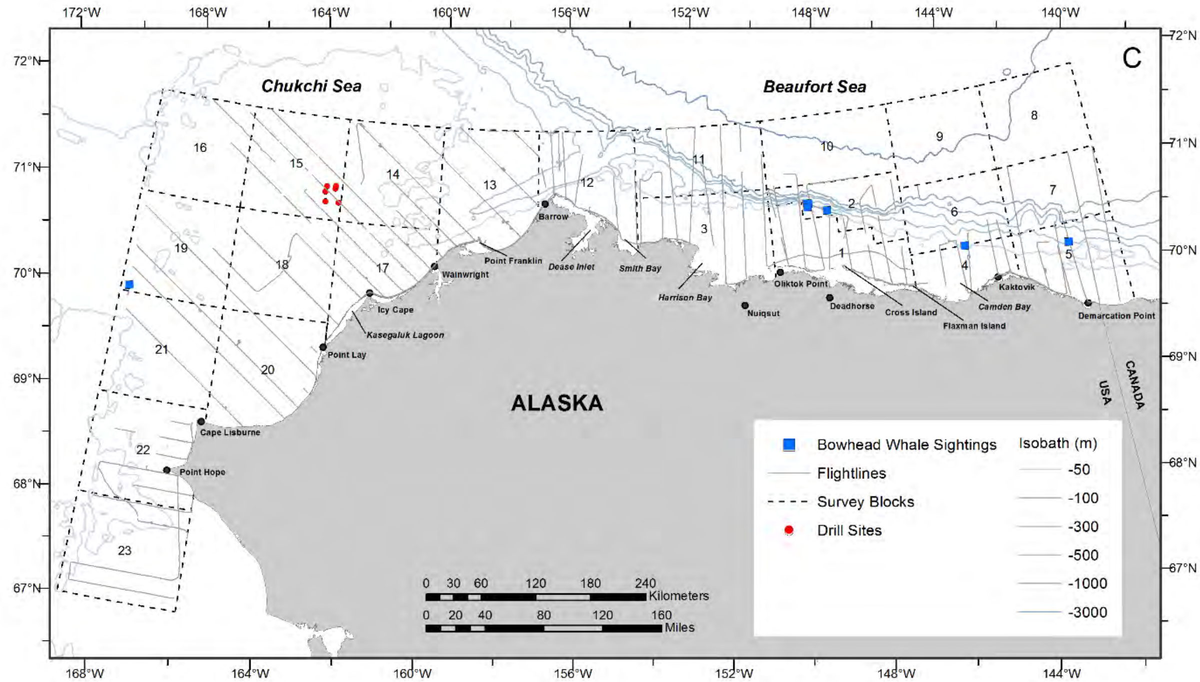


Figure 6. ASAMM 2015 semimonthly bowhead whale sightings, with transect, search, and circling survey effort. A: 2-15 July; B: 16-31 July. Deadhead flight tracks are not shown.



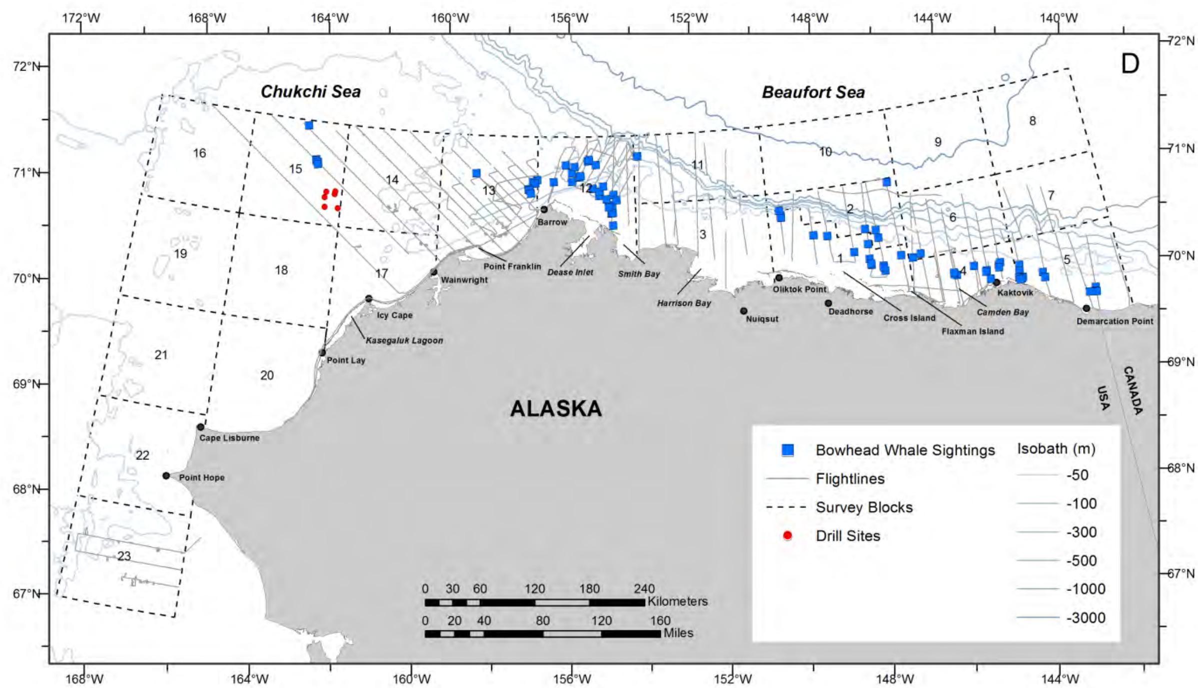


Figure 6 (cont). ASAMM 2015 semimonthly bowhead whale sightings, with transect, search, and circling effort. C: 1-15 August; D: 16-31 August. Deadhead flight tracks are not shown.

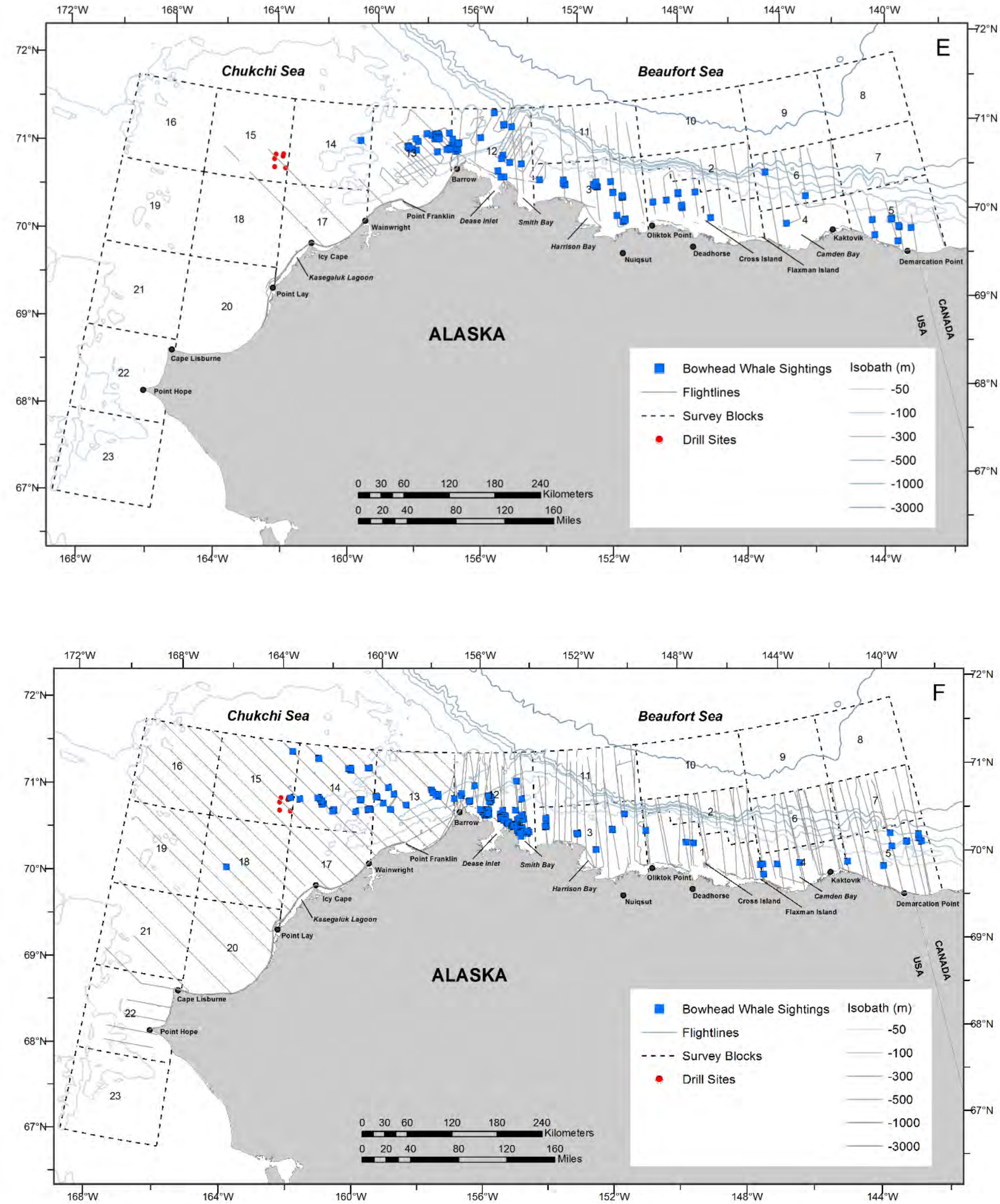
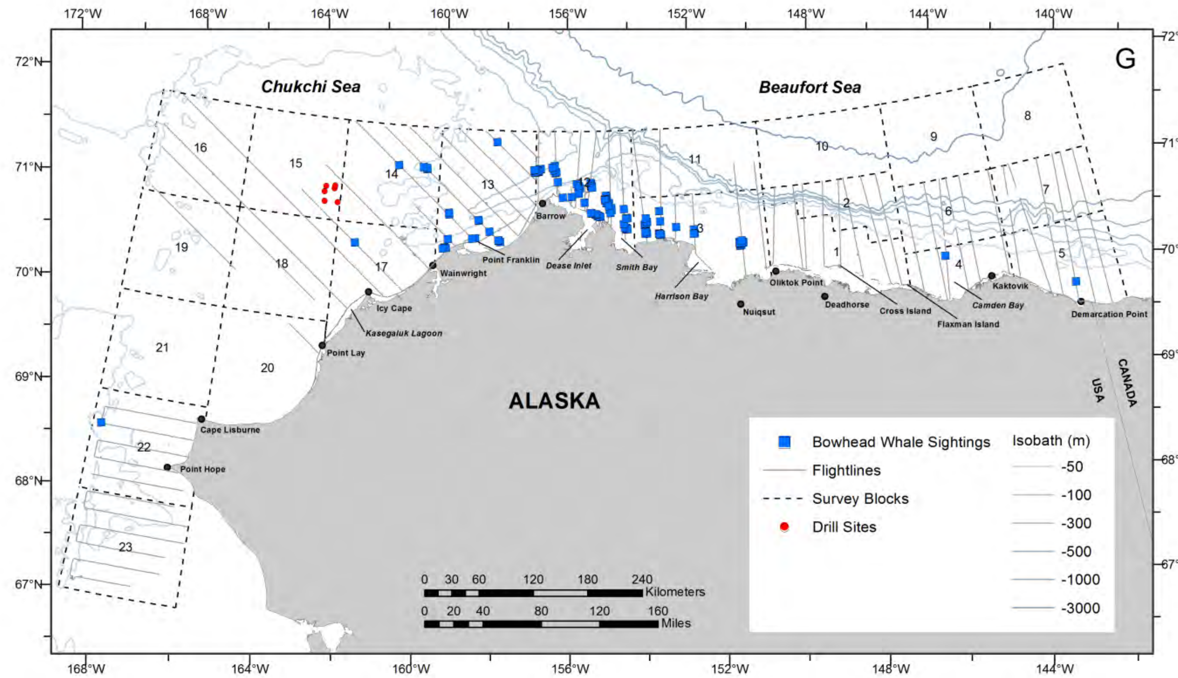


Figure 6 (cont). ASAMM 2015 semimonthly bowhead whale sightings, with transect, search, and circling effort. E: 1-15 September; F: 16-30 September. Deadhead flight tracks are not shown.



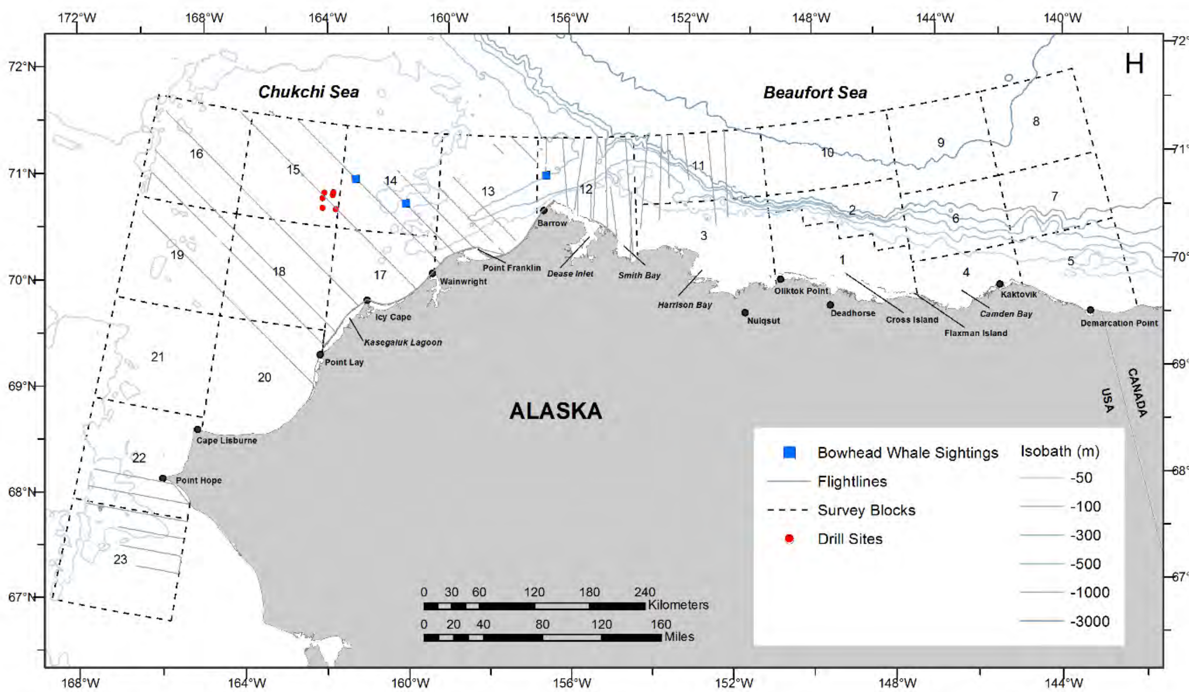


Figure 6 (cont). ASAMM 2015 semimonthly bowhead whale sightings, with transect, search, and circling effort. G: 1-15 October; H: 16-30 October. Deadhead flight tracks are not shown.

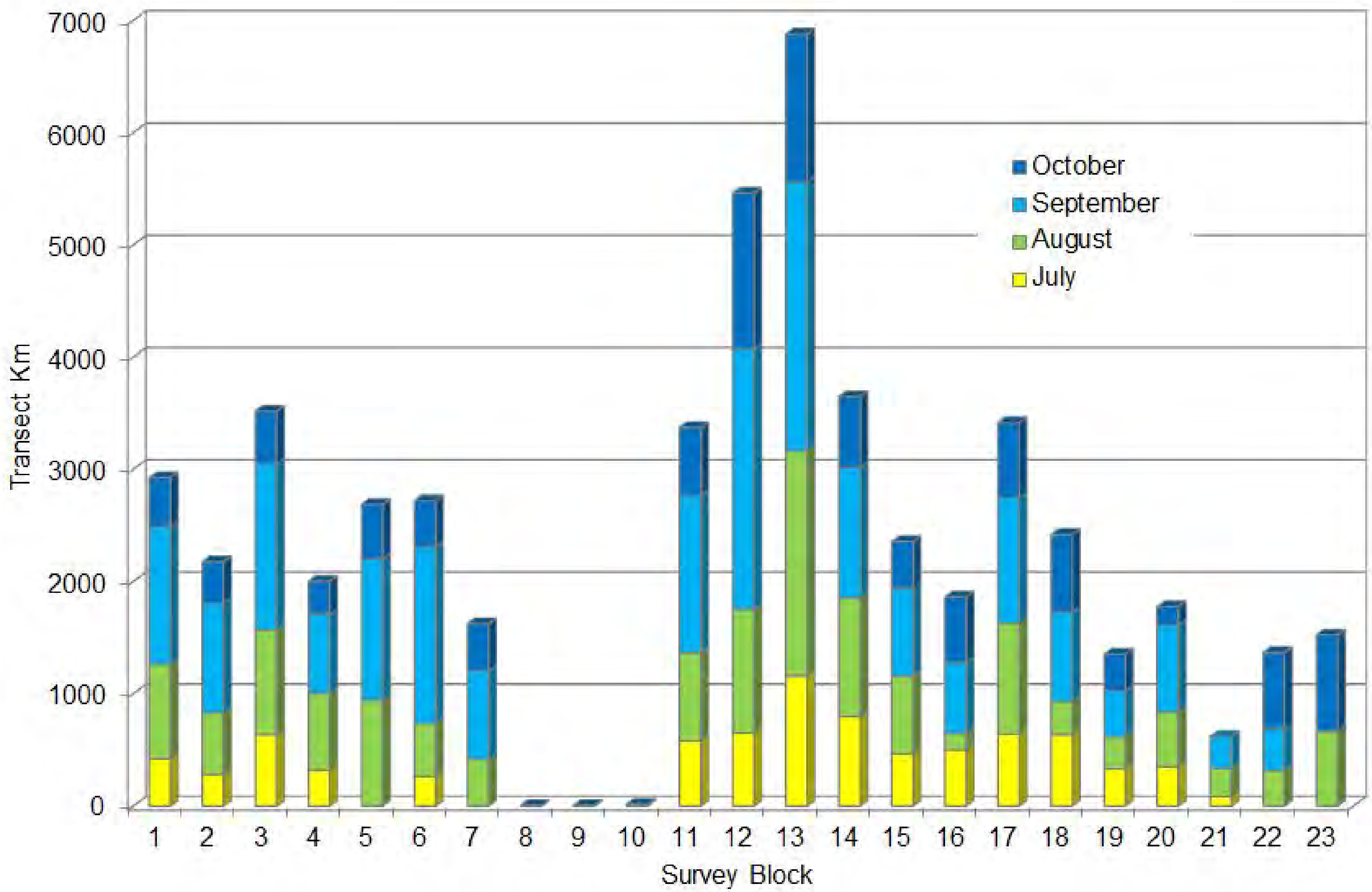


Figure 7. ASAMM 2015 monthly transect survey effort per block.

partially caused by the aforementioned increasingly inclement weather and basing the remaining aircraft at Barrow after 10 October. Block 23 was surveyed for the second consecutive year, but effort was limited to August and October. Surveys in blocks 8 and 9 were not attempted in 2015 because they are lower priority and conditions were rarely favorable for surveying offshore (e.g., strong winds and low visibility). Block 10 also had minimal effort in 2015. Flight lines, associated sea states, and sightings on individual flights are shown in Appendix B.

Survey effort was impacted by several factors in 2015, including weather conditions, airport closures, avoidance of subsistence activity, and participation in the Arctic ACEs study. Periods of poor weather impacted survey effort as it has in some previous years although there was only one extended time period where weather prevented any surveys from occurring. Fog and low ceilings curtailed survey effort in mid-July, when no surveys were conducted for eleven days (one attempted survey on 10 July was entirely deadhead due to lack of acceptable survey conditions). Strong winds prevented any surveys from being conducted from 3-6 September and 20-23 October. Other than those time periods, the longest period when no ASAMM flights occurred was three days.

The Barrow airport underwent maintenance from 17 July to 9 September, during which time the runway closed earlier (2030 hours) than normal (2200 hours). Due to the early airport closure, ASAMM surveys that under normal circumstances could be flown as late as 2145 hours, were curtailed on 4 days (24 July, and 6, 23, and 29 August) and not attempted on two days (18 and 23 July) because by the time survey conditions improved enough, there was not enough time remaining before airport closure to make it worthwhile to launch.

Avoidance of subsistence activities, specifically bowhead whale hunts occurring near Barrow, Cross Island, and Kaktovik, impacted ASAMM surveys on six days in 2015. On 25 August, the inshore portions of transects in block 1 were truncated near Cross Island, and surveys were not conducted in the area of Cross Island at all from 9 to 11 September at the request of Nuiqsut whalers. On 9, 19, and 29 September, the inshore portions of transects near Kaktovik were truncated to avoid overflights of whalers. And on 27 September and 4 October, transects were diverted or truncated to avoid overflights of whalers near Barrow.

Survey effort, both near Barrow and in the overall Chukchi Sea study area, was also impacted by participation of the Barrow-based ASAMM aircraft in the Arctic ACEs study for two weeks in late August and early September. The need to keep that aircraft near Barrow in the event that weather conditions became conducive for the UAV to fly resulted in less survey effort in areas in the eastern Chukchi Sea that were some distance from Barrow. The ACEs study area was positioned 22 km offshore in international airspace, constraints inherent for flying the UAV, which eliminated normal ASAMM survey coverage of nearshore areas in block 13 (northeastern Chukchi Sea) where gray whales are often observed and in block 12 (western Alaskan Beaufort Sea) where bowhead whales are often observed. Furthermore, the Deadhorse-based ASAMM survey aircraft was not allowed to survey in block 12 to simplify aerial deconfliction between ACEs UAV and ASAMM survey aircraft. The lack of survey coverage in nearshore areas is particularly apparent in block 12 in late August (Figure 6D) and block 13 in early September (Figure 6E).

Shell conducted offshore exploratory drilling in the northeastern Chukchi Sea in summer and fall 2015 (Figure 1). The first Shell-contracted vessels supporting offshore drilling passed north of Point Hope on 6 July (Ireland and Bisson 2016). Drill ships and support vessels were present in the northeastern Chukchi Sea from early July to mid-October. A fixed wing aircraft conducted sea ice reconnaissance surveys and photographic surveys in and around the drill site when weather conditions allowed, and helicopters regularly transited between Barrow and the drill site to conduct crew changes. There was no impact on ASAMM survey effort by Shell vessel or aerial activities. Shell vessels departed the northeastern Chukchi Sea on 16 October.

Cetaceans

Bowhead Whales

BOWHEAD WHALE SIGHTING SUMMARY

During 2015 ASAMM surveys, 594 sightings of 1,042 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 = 400; median = 321) usually observed in a single year during ASAMM surveys, and is the fourth highest total observed since 1982 (Clarke et al. 2015a). The high number of bowhead whales sighted was due, in part, to surveys conducted in the western Beaufort Sea in late July and August, during which 148 bowhead whales were seen. Of even greater impact were numerous sightings of bowhead whales (318 sightings of 674 whales, or 65% of total bowhead whales seen) observed from 152°-157°W from late August through early October.

Few bowhead whales were seen in July (Figures 6A and 6B). Sightings were widely dispersed, from the outer continental shelf and slope (51-2,000 m depth) in the central Alaskan Beaufort Sea (144°W-148°W) to offshore in the Chukchi Sea between 71.2°N and 72°N. One bowhead whale was seen approximately 205 km west of Barrow in early July (Figure 6A), and six bowhead whales were seen in the northwesternmost part of the study area, approximately 430 km northwest of Barrow, in late July (Figure 6B). The highest number of bowhead whales per survey block in July was in block 2 (n = 8). In August, bowhead whales were observed in the western Beaufort Sea from 140°W to 150°W in both outer and inner shelf waters and in Barrow Canyon between 153.8°W to 157.3°W (Figures 6C and 6D). In the Chukchi Sea, nine bowhead whales were seen west of Hanna Shoal approximately 250 km west of Barrow, and one bowhead whale was 220 km offshore west of Point Lay. The lack of sightings nearshore east and southeast of Barrow in late August (Figure 6D) was likely related to the complete lack of survey effort in the area due in part to ASAMM coordination with Arctic ACEs. The highest number of bowhead whales per survey block in August was in block 12 (n = 47). Bowhead whale distribution in September was primarily on the inner shelf (≤50 m depth) across the western Beaufort Sea and between 71.2°N and 72°N in the Chukchi Sea, with sightings 25-240 km west of Barrow (Figures 6E and 6F). The greatest number of bowhead whales in September was seen in block 12 (n = 437). Two whales were seen in block 18 in September, approximately 190 km southwest of Wainwright. Bowhead whale distribution in October was primarily on the inner shelf in the western Alaskan Beaufort Sea west of 150°W; only three whales were seen east of 150°W (Figures 6G and 6H). In the Chukchi Sea in October, bowhead whale distribution was predominantly west-southwest of Barrow, with several sightings in early October near Pt. Franklin (Figure 6G). The farthest south bowhead whale sighting occurred on 15 October, approximately 90 km northwest of Point Hope. The greatest number of bowhead whales in October was seen in block 12 (n = 132). Bowhead whale sightings in the northeastern Chukchi Sea in September and October 2015 reinforce previous observations from aerial surveys, satellite telemetry (Quakenbush et al. 2010a), and acoustics (Delarue et al. 2011), describing a broad

Table 3. ASAMM 2015 marine mammal sightings (number of sightings/number of individuals) during all survey modes (transect, search, and circling) in chronological order, 2 July-30 October 2015, by survey flight and semimonthly time period. Excludes sightings of dead animals and same-day repeat sightings.

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Unidentified Cetacean*	Walrus	Bearded Seal	Unidentified Pinniped**	Polar Bear
2 Jul	201	0	7/25	0	0	0	2/2	1/4	25/297	1/1	3/3	0
3 Jul	202	0	21/46	0	0	0	0	2/2	49/10,117	0	7/8	0
4 Jul	203	1/1	19/32	0	0	0	5/6	3/3	28/500	0	83/130	1/1
5 Jul	204	0	1/6	0	0	0	2/8	0	4/302	0	20/28	0
7 Jul	205	0	2/3	1/1	0	0	0	0	1/1	0	6/6	0
10 Jul	206	0	0	0	0	0	0	0	0	0	0	0
20 Jul	207	0	0	0	0	0	0	0	1/1	0	0	0
21 Jul	208	0	6/13	0	0	0	0	0	2/2	0	4/8	0
21 Jul	1	4/8	0	0	0	0	17/38	0	0	0	4/5	0
22 Jul	209	0	0	0	0	0	1/3	0	8/58	0	2/2	0
22 Jul	2	0	0	0	0	0	9/12	0	0	0	0	0
24 Jul	3	0	0	0	0	0	0	0	0	0	2/2	0
25 Jul	4	0	0	0	0	0	0	0	0	0	0	0
27 Jul	210	0	0	0	0	0	1/1	0	4/13	0	1/1	0
27 Jul	5	0	0	0	0	0	0	0	0	0	0	0
29 Jul	211	0	2/4	0	0	0	7/256	0	0	0	11/22	0
29 Jul	6	0	0	0	0	0	3/3	0	0	0	0	0
30 Jul	212	4/6	28/58	0	0	2/2	1/1	1/1	19/282	0	140/303	0
30 Jul	7	0	0	0	0	0	17/30	0	0	0	0	0
31 Jul	8	1/2	0	0	0	0	9/34	0	0	0	2/2	0
1 Aug	213	0	6/16	0	0	1/1	1/1	0	0	0	3/4	0
1 Aug	9	4/5	0	0	0	0	0	0	0	0	0	0
2 Aug	214	0	0	0	0	0	1/1	0	1/1	0	0	0

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Unidentified Cetacean*	Walrus	Bearded Seal	Unidentified Pinniped**	Polar Bear
2 Aug	10	1/1	0	0	0	0	23/60	0	0	0	7/17	1/1
3 Aug	215	0	0	0	0	0	0	0	0	0	0	0
4 Aug	216	0	0	0	0	0	0	0	1/1	0	9/9	0
4 Aug	11	0	0	0	0	0	0	0	0	0	0	0
5 Aug	12	0	0	0	0	0	23/76	0	0	0	0	0
6 Aug	217	0	0	0	0	0	2/4	0	0	0	0	1/1
7 Aug	218	0	16/31	0	0	0	1/1	0	27/101	1/1	34/74	0
9 Aug	219	0	9/18	0	0	0	0	1/1	4/13	0	22/23	0
9 Aug	13	0	0	0	0	0	3/4	0	0	0	0	0
10 Aug	220	0	0	1/1	0	0	0	0	0	0	4/4	0
11 Aug	221	1/1	3/5	0	0	0	0	0	0	0	3/3	0
11 Aug	14	0	0	0	0	0	20/88	0	0	1/1	3/3	0
12 Aug	222	0	3/5	0	0	0	0	0	0	0	4/4	0
12 Aug	15	0	0	0	0	0	0	0	0	0	0	0
14 Aug	16	1/2	0	0	0	0	1/2	1/1	0	0	9/10	0
18 Aug	223	0	8/11	0	0	0	0	1/1	17/7,682	0	0	0
19 Aug	224	1/1	16/25	0	0	0	1/1	1/1	44/339	2/2	91/176	0
19 Aug	17	0	0	0	0	0	26/64	0	0	0	3/3	0
20 Aug	225	1/1	43/63	0	0	0	0	3/3	43/120	0	92/120	0
20 Aug	18	0	0	0	0	0	1/1	0	0	0	0	0
23 Aug	226	0	6/15	2/3	14/18	2/2	0	1/1	0	0	9/9	0
24 Aug	19	4/4	0	0	0	0	0	0	0	0	0	0
25 Aug	20	33/40	0	0	0	0	46/66	1/1	0	0	34/44	2/4
26 Aug	227	9/32	0	0	0	0	11/25	2/3	0	0	6/6	0
26 Aug	21	8/8	0	0	0	0	30/70	0	0	0	25/106	0
29 Aug	228	15/16	0	0	0	0	4/5	21/24	1/1	0	7/7	0
29 Aug	22	0	0	0	0	0	11/38	0	0	0	2/5	0

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Unidentified Cetacean*	Walrus	Bearded Seal	Unidentified Pinniped**	Polar Bear
30 Aug	229	0	0	0	0	0	0	0	0	0	0	0
31 Aug	230	8/12	1/1	0	0	0	0	5/5	38/99	0	57/74	0
31 Aug	23	4/8	3/8	0	0	0	1/1	0	42/361	1/1	5/11	0
1 Sep	231	16/17	0	0	0	0	14/49	8/8	2/2	0	47/128	0
1 Sep	24	29/57	0	0	0	0	19/64	0	0	0	27/60	0
2 Sep	232	0	2/2	0	0	0	0	1/4	48/31,615	0	9/233	0
7 Sep	233	14/16	2/2	0	0	0	0	5/5	0	0	1/5	0
7 Sep	25	6/8	0	0	0	0	0	0	0	1/1	1/1	0
8 Sep	234	19/28	0	0	0	0	0	0	1/1	1/1	27/74	0
8 Sep	26	10/16	0	0	0	0	17/26	0	0	1/1	7/22	1/1
9 Sep	27	2/2	0	0	0	0	6/9	0	0	0	2/16	0
10 Sep	235	0	0	0	0	0	0	0	1/15,000	0	0	0
13 Sep	236	0	0	0	0	0	0	0	0	0	41/50	0
13 Sep	28	8/11	0	0	0	0	11/25	1/1	0	0	6/10	0
16 Sep	237	27/34	2/5	0	0	0	3/4	1/1	22/42	0	22/23	0
16 Sep	29	38/46	0	0	0	0	12/18	0	0	0	0	0
17 Sep	238	0	0	0	0	0	0	0	28/90	0	2/2	0
18 Sep	239	0	14/14	0	0	1/1	0	2/2	21/10,072	0	2/5	0
18 Sep	30	2/2	0	0	0	0	3/4	0	0	0	0	1/20
19 Sep	240	15/17	6/10	0	0	0	5/5	3/4	0	0	11/11	0
19 Sep	31	2/2	0	0	0	0	3/3	0	0	0	1/1	1/2
20 Sep	32	0	0	0	0	0	23/75	0	0	0	0	0
21 Sep	241	2/3	0	0	0	0	1/2	0	18/9,033	0	59/176	0
21 Sep	33	76/187	0	0	0	0	3/4	0	0	0	20/52	0
22 Sep	242	0	0	0	0	0	1/4	0	3/6	0	37/65	0
22 Sep	34	2/2	0	0	0	0	5/8	0	0	0	5/6	0
23 Sep	35	3/4	0	0	0	0	6/14	0	0	0	2/2	3/46

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Unidentified Cetacean*	Walrus	Bearded Seal	Unidentified Pinniped**	Polar Bear
25 Sep	243	0	0	0	0	0	0	0	0	0	6/7	0
25 Sep	36	8/9	0	0	0	0	6/7	0	0	1/1	34/41	0
26 Sep	37	8/10	0	0	0	0	12/15	0	0	0	2/2	0
27 Sep	244	5/5	6/7	0	0	0	0	0	1/2	0	13/62	0
27 Sep	38	56/187	0	0	0	0	35/110	2/3	1/1	0	33/13	0
28 Sep	245	0	0	0	0	0	0	0	14/20	1/1	0	0
29 Sep	39	1/1	0	0	0	0	1/1	0	0	0	0	0
30 Sep	40	0	0	0	0	0	9/19	0	0	0	0	0
2 Oct	41	15/19	0	0	0	0	18/94	1/1	0	0	45/59	3/44
3 Oct	246	0	5/5	0	0	0	0	0	0	0	0	0
3 Oct	42	1/2	0	0	0	0	29/69	0	0	0	41/45	0
4 Oct	247	15/17	0	0	0	0	2/2	0	12/15	0	107/163	0
4 Oct	43	88/162	0	0	0	0	48/227	0	1/1	0	46/147	0
6 Oct	44	1/1	0	0	0	0	6/9	0	0	0	5/7	0
8 Oct	45	4/4	0	0	0	0	0	0	0	0	0	0
10 Oct	248	0	3/11	5/11	1/2	0	0	2/2	0	0	0	0
12 Oct	249	7/9	14/18	0	0	0	1/3	2/4	4/7	1/1	20/21	0
13 Oct	250	1/2	0	0	0	0	0	0	0	0	1/1	0
14 Oct	251	9/10	1/1	0	0	0	4/6	0	6/10	0	38/47	0
15 Oct	252	1/1	0	1/1	0	0	0	0	4/7	0	5/6	0
16 Oct	253	0	0	0	0	0	0	0	3/4	0	20/22	0
19 Oct	254	0	0	0	0	0	0	0	0	0	1/1	0
24 Oct	255	0	0	0	2/2	0	1/1	1/1	5/6	0	6/7	0
26 Oct	256	1/1	0	0	0	0	16/18	0	0	0	4/4	0
27 Oct	257	1/1	4/5	0	0	0	0	0	1/1	0	7/7	1/1
28 Oct	258	0	0	0	0	0	2/2	0	0	0	1/2	0
29 Oct	259	0	0	0	0	0	0	0	1/3	0	23/233	0

Day	Flight No.	Bowhead Whale	Gray Whale	Humpback Whale	Fin Whale	Minke Whale	Beluga	Unidentified Cetacean*	Walrus	Bearded Seal	Unidentified Pinniped**	Polar Bear
30 Oct	260	1/1	0	0	0	0	0	0	0	1/1	33/108	0
						Semimonthly Summary						
1-15 Jul		1/1	50/112	1/1	0	0	9/16	6/9	107/11,217	1/1	119/175	1/1
16-31 Jul		9/16	36/75	0	0	2/2	65/378	1/1	34/356	0	166/345	0
1-15 Aug		7/9	37/75	1/1	0	1/1	75/237	2/2	33/116	2/2	98/151	2/2
16-31 Aug		83/122	77/123	2/3	14/18	2/2	131/271	35/39	185/8,602	3/3	331/561	2/4
1-15 Sep		104/155	4/4	0	0	0	67/173	15/18	52/46,618	3/3	168/599	1/1
16-30 Sep		245/509	28/36	0	0	1/1	128/293	8/10	108/19,266	2/2	249/668	5/68
1-15 Oct		142/227	23/35	6/12	1/2	0	108/410	5/7	27/40	1/1	308/496	3/44
16-30 Oct		3/3	4/5	0	2/2	0	19/21	1/1	10/14	1/1	95/384	1/1
TOTAL		594/1,042	259/465	10/17	17/22	6/6	602/1,799	73/87	556/86,229	13/13	1,534/3,379	15/121

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

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

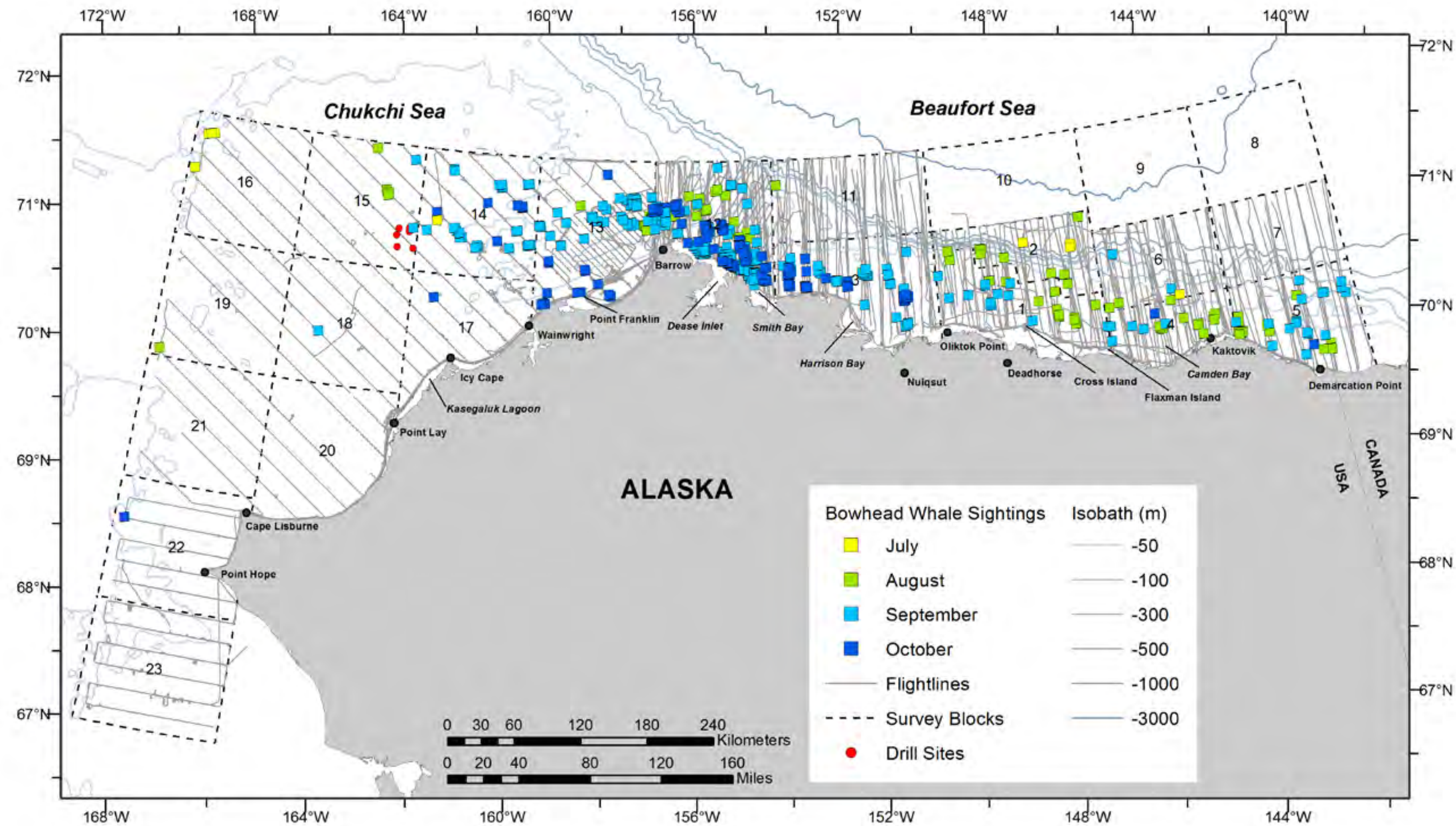


Figure 8. ASAMM 2015 bowhead whale sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

migration route that spreads across the CSPA. Bowhead whales were last observed during the final survey of the year, on 30 October, when one whale was seen approximately 150 km west of Barrow.

Bowhead Whale Sighting Rates

In summer and fall 2015, bowhead whales were seen on transect (Tr) throughout the longitudinal extent of the study area, from 140.2°W to 168.7°W. There were 280 sightings of 468 bowhead whales on transect by primary observers, ranging from 1 whale per sighting (n = 211) to 40 whales per sighting (n = 1). The highest number of sightings on transect was in block 12 (97 sightings), followed by block 3 (44 sightings). The largest group of bowhead whales on transect (40 animals) were observed on 27 September in block 12. When transect and circling from transect (Tr+TrC sightings) were combined, there were 503 sightings of 895 bowhead whales, ranging from 1 whale per sighting (n = 356) to 40 whales per sightings (n = 1). The highest number of Tr+TrC sightings was in block 12 (223 sightings), followed by block 3 (82 sightings).

Highest fine-scale Tr sighting rates (WPUE, 5-km grid) for summer (July-August) and fall (September-October) were in the same general area, between 152°W and 156°W (Figure 9). In summer, highest fine-scale Tr sighting rates were also in offshore blocks 15 and 16 (Figure 9A). 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 2015 and highlight areas of bowhead whale aggregations, particularly in fall (Appendix E, Figure E-2).

Monthly and seasonal shifts in bowhead whale distribution were evident in results of the analysis of sighting rates by survey block. Sighting rates (Tr) in western Alaskan Beaufort Sea and eastern Chukchi Sea blocks (12-14) combined were low in summer and increased substantially in fall (Figure 10), reflecting the expected pattern based on the bowhead fall migration. For all months combined, the highest Tr sighting rates per survey block were in block 12 (0.042 WPUE), block 3 (0.019 WPUE), and block 5 (0.011 WPUE), with an overall Tr sighting rate of 0.009 WPUE. The Tr sighting rates for summer months (July and August combined) were highest in block 12 (0.025 WPUE) and block 1 (0.012 WPUE) (Appendix E, Table E-1), although Tr sighting rates for combined summer months do not completely reflect monthly distribution patterns. Sighting rates (Tr) in July were highest in block 6 (0.008 WPUE) and block 2 (0.007 WPUE) (Figure 10; Appendix E, Table E-1), while Tr sighting rates in August were highest in block 12 (0.039 WPUE) and block 1 (0.018 WPUE), illustrating the shift in abundance from offshore blocks to nearshore blocks from July to August in the western Beaufort Sea. Sighting rates (Tr) in summer were relatively low in all Chukchi Sea blocks (13-23; Figure 10). Combined Tr sighting rates for fall months (September-October) were highest in block 12 (0.050 WPUE), block 3 (0.034 WPUE), block 14 (0.016 WPUE), and block 5 (0.012 WPUE); overall Tr sighting rate in fall for all blocks combined was 0.012 WPUE (Appendix E, Table E-1).

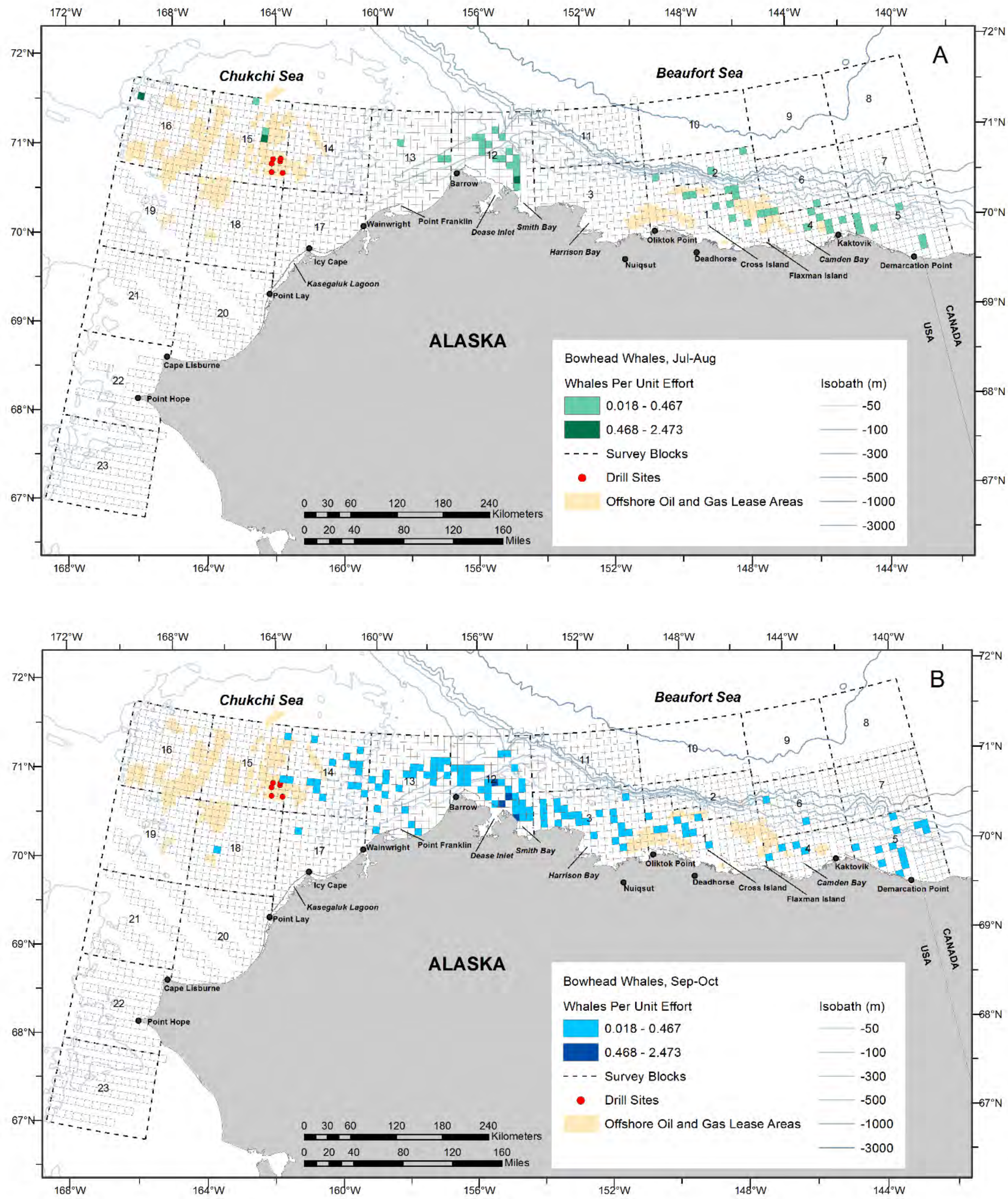


Figure 9. ASAMM 2015 bowhead whale sighting rates (WPUE; transect sightings from primary observers only). A: summer (July-August); B: fall (September-October). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

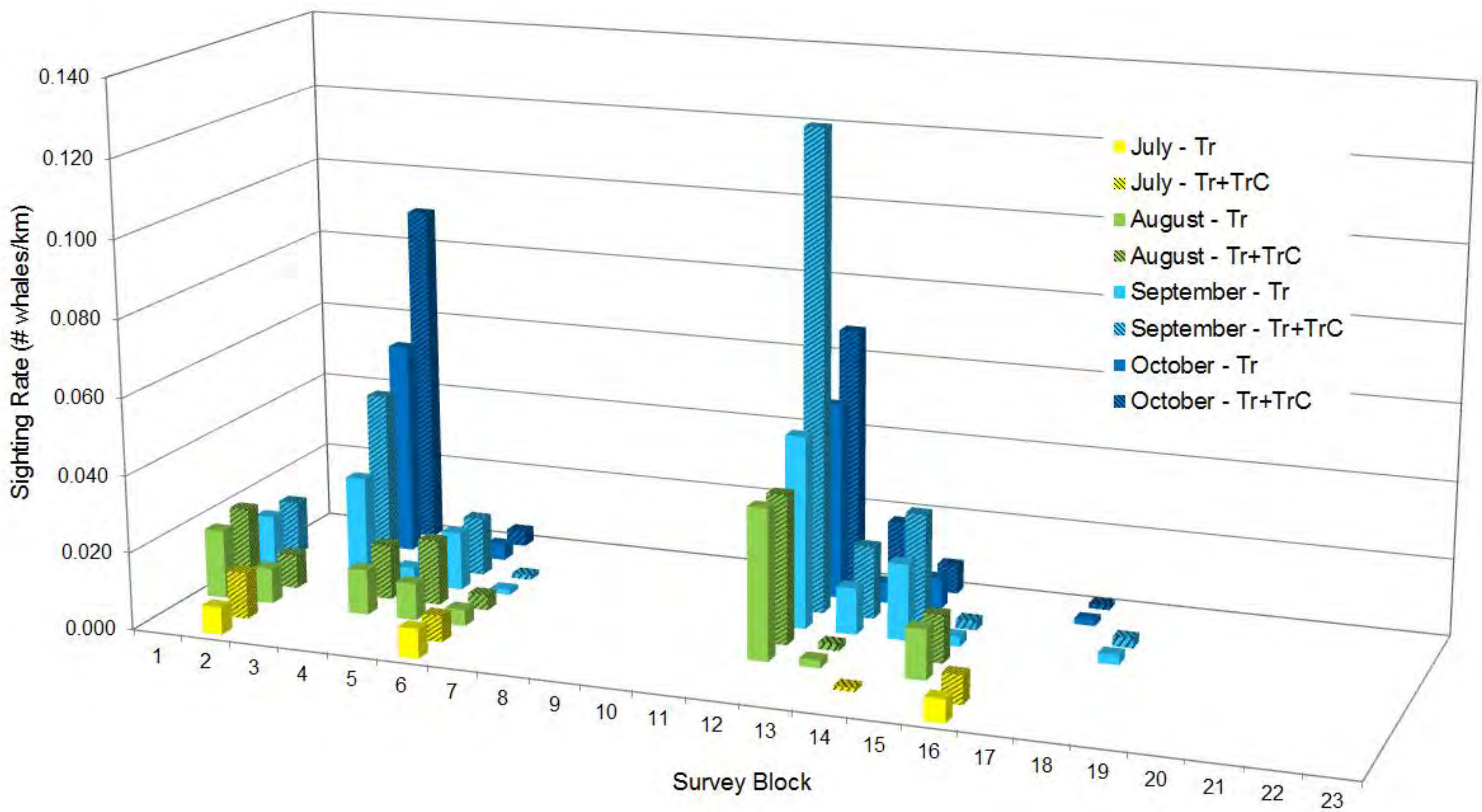


Figure 10. ASAMM 2015 bowhead whale monthly sighting rates (WPUE; sightings from primary observers only) per survey block for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

In the Chukchi Sea in fall, the highest Tr sighting rate was 0.016 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 0.005, which was similar to the overall Tr sighting rate for this area in 2013 and 2014 (Clarke et al. 2014, 2015a) and half the Tr sighting rate for this area in 2012 (Clarke et al. 2013a). There were relatively high sighting rates in block 16 in July and block 15 in August, compared to fall months when bowhead whales were rarely seen well offshore.

Sighting rates per block, calculated using sightings and effort on transect combined with sightings and effort from circling from transect (Tr+TrC), are a more accurate reflection of bowhead whale relative abundance because they incorporated all on-effort sightings and effort. Sighting rates (Tr+TrC) were higher in all survey blocks compared to Tr sighting rates (Figure 10). The highest Tr+TrC sighting rates for the entire study area were in block 12 in September (0.125 WPUE), and block 3 in October (0.089 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);
- ≤20 m depth zone (0.086 WPUE) in the western (154°W-157°W) Alaskan Beaufort Sea subarea; and
- 21-50 m depth zone (0.009 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 (0.005 WPUE) and 201-2,000 m (0.004 WPUE) depth zones (Figure 11).

The shift from higher Tr sighting rates in offshore, deeper water (51-2,000 m) in July to shallower water (21-50 m) in August in the central-eastern (140°W-154°W) Alaskan Beaufort Sea (Figure 11) was also noted in 2012-2014 (Clarke et al. 2013a, 2014, 2015a).

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

- 51-200 m North depth zone (0.013 WPUE) in the eastern Chukchi Sea subarea (157°W-169°W), influenced by sightings near Barrow Canyon;
- ≤20 m depth zone (0.152 WPUE) in the western (154°W-157°W) Alaskan Beaufort Sea subarea; and
- ≤20 m depth zone (0.025 WPUE) in the central-eastern (140°W-154°W) Alaskan Beaufort Sea subarea.

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

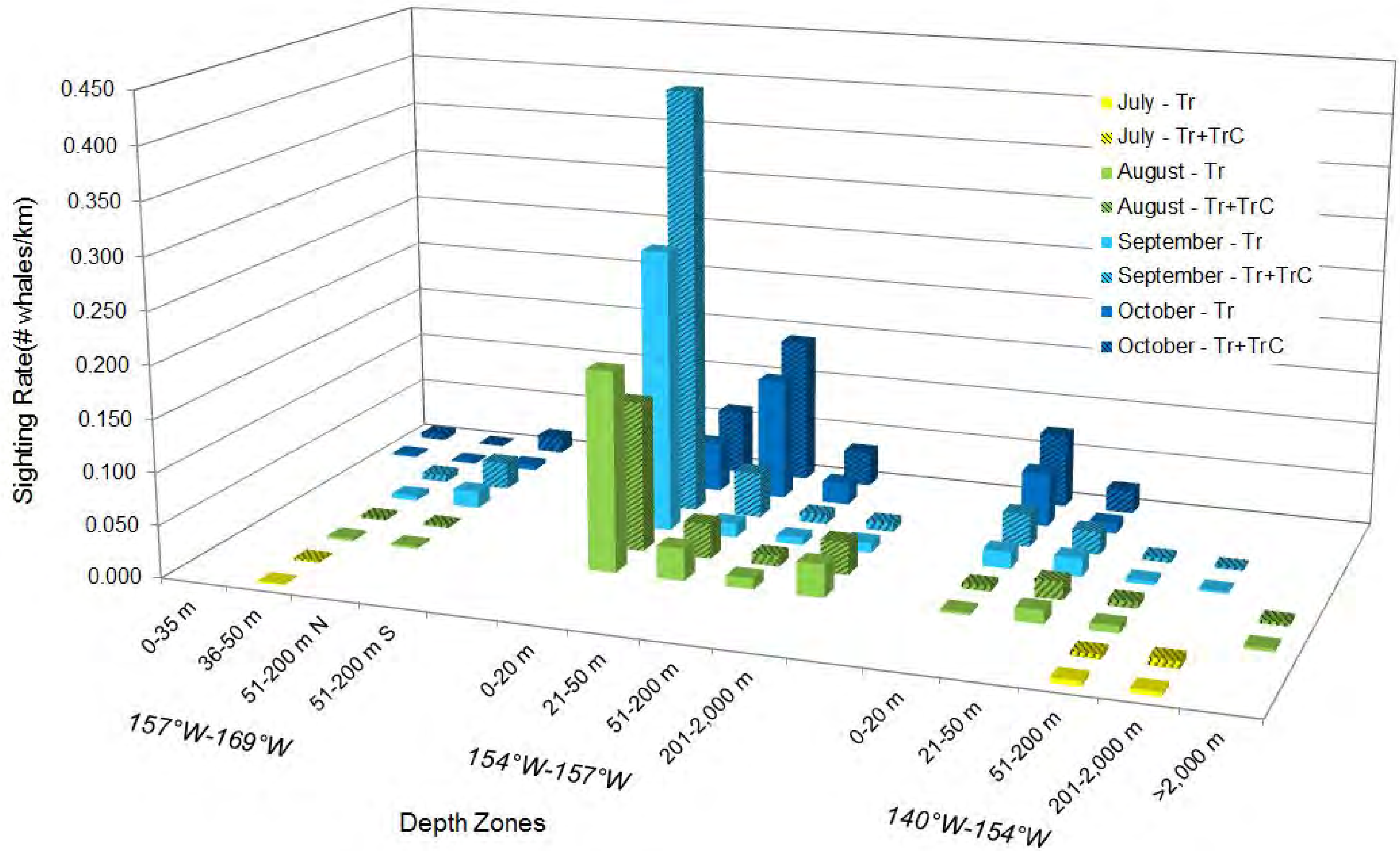


Figure 11. ASAMM 2015 bowhead whale monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

Bowhead Whale Sea Ice Associations

Most bowhead whales (94%, n = 977) were observed in 0% sea ice cover (Table 4). Forty-one bowhead whales (4%) were sighted in 1-10% sea ice cover, 15 bowhead whales (1%) were sighted in 15-40% sea ice cover, and 9 bowhead whales (1%) were sighted in 60-80% sea ice cover. All bowhead whales observed in areas of sea ice were seen in the western Beaufort Sea where sea ice remained in some of the study area through mid-September (Appendix A), with the exception of one whale seen in early July in the northeastern Chukchi Sea before sea ice receded from that part of the study area (see Appendix A, Figure A-1).

Bowhead Whale Behaviors

Behaviors of bowhead whales observed during all survey modes (i.e., transect, search and circling) and by primary and secondary observers in 2015 are summarized in Table 5. The behavior most often recorded was feeding (40%, n = 415), followed by swimming (35%, n = 364) and resting (14%, n = 149). Feeding behavior was likely underreported due to the difficulty of identifying this behavior for animals feeding on benthic or mid-water prey; milling was sometimes recorded in situations where obvious evidence of feeding was not directly observed but was suspected. Milling was recorded for 57 whales (5%) and diving was recorded for 41 whales (4%). Twelve whales were recorded exhibiting display behaviors, including breaching (five whales), flipper slapping (one whale), tail slapping (four whales), and log playing (two whales). Behavior was recorded as unknown for four whales, likely because the sighting was too far away to determine a behavior. Seven bowhead whales (<1% of all bowhead whales sighted) appeared to respond to the survey aircraft; all reactions were 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 21°T and in fall was 275°T, but headings were scattered in all directions in both seasons (Rayleigh Z, summer = 0.369, P = 0.699, 14 observations; fall = 0.109, P = 0.896, 73 observations). In the western Beaufort Sea, bowhead whale swim direction was westerly in both summer and fall. Swimming direction was 282°T in summer (Rayleigh Z = 16.2, P < 0.0001, 28 observations) and 267°T in fall (Rayleigh Z = 8.064, P < 0.0001, 46 observations).

Bowhead Whale Calves

Out of the 1,042 bowhead whales sighted, 39 were identified as calves (Figure 12). Calves were seen from mid-July through mid-October, distributed from 141°W to 161°W. Most calves (90%) were seen in the western Beaufort Sea. Calves were observed with adult bowhead whales that were feeding, milling, resting, and swimming; one adult in a cow-calf pair was observed breaching. One calf was sighted without an adult nearby (Appendix B, Flight 9), but there was extensive cloud cover in the area of the sighting so it is possible the cow was nearby and not seen. Most calves (n = 29, 74%) were sighted after circling was initiated and likely would not have been observed if circling had not commenced.

Table 4. ASAMM 2015 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	5/8	2/2	69/106	88/123	244/508	142/227	3/3	553/977
1-5	0	0	0	8/9	10/22	1/1	0	0	19/32
6-10	0	0	3/4	4/5	0	0	0	0	7/9
11-20	1/1	0	0	2/2	2/2	0	0	0	5/5
21-30	0	0	0	0	3/7	0	0	0	3/7
31-40	0	0	1/2	0	1/1	0	0	0	2/3
41-50	0	0	0	0	0	0	0	0	0
51-60	0	0	1/1	0	0	0	0	0	1/1
61-70	0	3/6	0	0	0	0	0	0	3/6
71-80	0	1/2	0	0	0	0	0	0	1/2
TOTAL	1/1	9/16	7/9	83/122	104/155	245/509	142/227	3/3	594/1,042

Table 5. ASAMM 2015 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	1/2	0	0	0	2/2	1/1	0	4/5
Dive	0	1/1	0	5/5	3/3	13/17	12/15	0	34/41
Feed	0	0	0	2/23	4/9	82/303	32/80	0	120/415
Flipper slap	0	0	0	1/1	0	0	0	0	1/1
Log play	0	0	0	0	0	0	1/2	0	1/2
Mill	0	1/4	0	1/2	0	4/9	16/42	0	22/57
Rest	0	1/1	3/4	20/29	34/53	12/16	43/46	0	113/149
Swim	1/1	5/8	4/5	54/62	62/89	128/158	35/38	3/3	292/364
Tail slap	0	0	0	0	0	1/1	2/3	0	3/4
Unknown	0	0	0	0	1/1	3/3	0	0	4/4
TOTAL	1/1	9/16	7/9	83/122	104/155	245/509	142/227	3/3	594/1,042

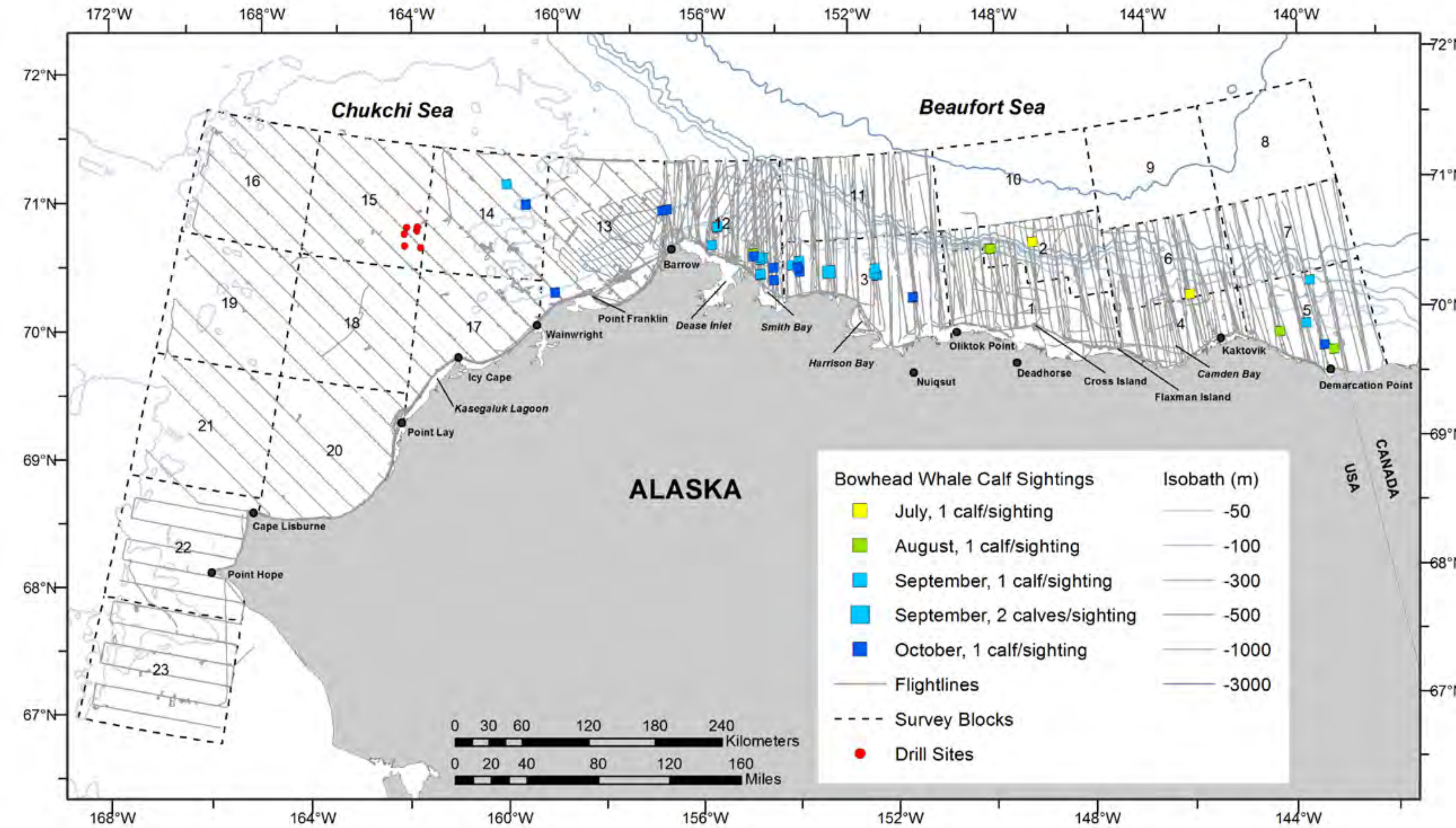


Figure 12. ASAMM 2015 bowhead whale calf sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Seasonal differences were apparent in bowhead whale distribution and calf ratio. Seven of the bowhead whale calves (18%) were sighted during summer months in the western Beaufort Sea, distributed mainly between 141°W and 149°W, offshore over the slope in July and more broadly distributed in nearshore and offshore waters in August. The summer calf ratio (number of calves/number of total whales) was 0.047. Thirty-two of the bowhead whale calves (82%) were sighted during fall months, distributed in the eastern part of the study area (141°W-142°W) and from 150°W to 162°W. Most of the bowhead calves seen in fall were on the shelf in the western Beaufort Sea. Nearly 50% of all calves observed in 2015 were seen between 152°W and 157°W. The calf ratio during fall was 0.036.

Western Beaufort Sea Bowhead Whale Feeding Areas

Bowhead whale feeding behavior, which includes sightings reported as milling, was observed from July through October 2015. During summer months (July-August), feeding behavior was documented on 2 days in the central Alaskan Beaufort Sea (146°W-148°W), at depths ranging from 53 m to 1,664 m (52-81 km from shore) (Figure 13), and on one day in the western Alaskan Beaufort Sea (~154.7°W) at depths ranging from 10 m to 17 m (6-15 km from shore). In fall (September-October), feeding behavior was observed on 6 days in the Alaskan Beaufort Sea and on 2 days in the northeastern Chukchi Sea (Figure 13). Water depths at sightings of feeding whales in fall ranged from 3 m to 101 m (<1 km to 82 km from shore). Sighting rates for feeding and milling bowhead whales on transect in summer and fall are shown in Figure 14. Most feeding whales (95%) were seen from 26 August to 4 October between 152°W and 157°W.

The area between roughly Point Barrow and Cape Halkett (152°W-157°W) encompasses a well-documented bowhead whale feeding area (Moore and Reeves 1993; Mocklin et al. 2011). In 2015, surveys were conducted in this area on 17 occasions. To limit data biases, surveys were not preferentially conducted on days with a higher likelihood of seeing bowhead whales, based on recent wind conditions. Bowhead whales were seen on 10 of the 17 days that surveys were conducted, and were not seen in the area until 26 August. Between 26 August and 4 October, bowhead whales were seen during all eight surveys conducted, with distribution primarily on the shallow shelf within 40 km from shore and in Barrow Canyon (Figure 15A). Four additional ASAMM surveys were conducted in this area from 29 August to 7 September (Appendix A, Flights 228, 229, 231, and 233) in support of the Arctic ACEs collaboration. However, those surveys were conducted without any circling making verification of species and behavior more difficult. Furthermore, ACEs surveys did not extend all the way to shore, eliminating coverage of the nearshore area where the krill trap would be expected to be strongest. Therefore, effort and sightings from those surveys were not included in this analysis.

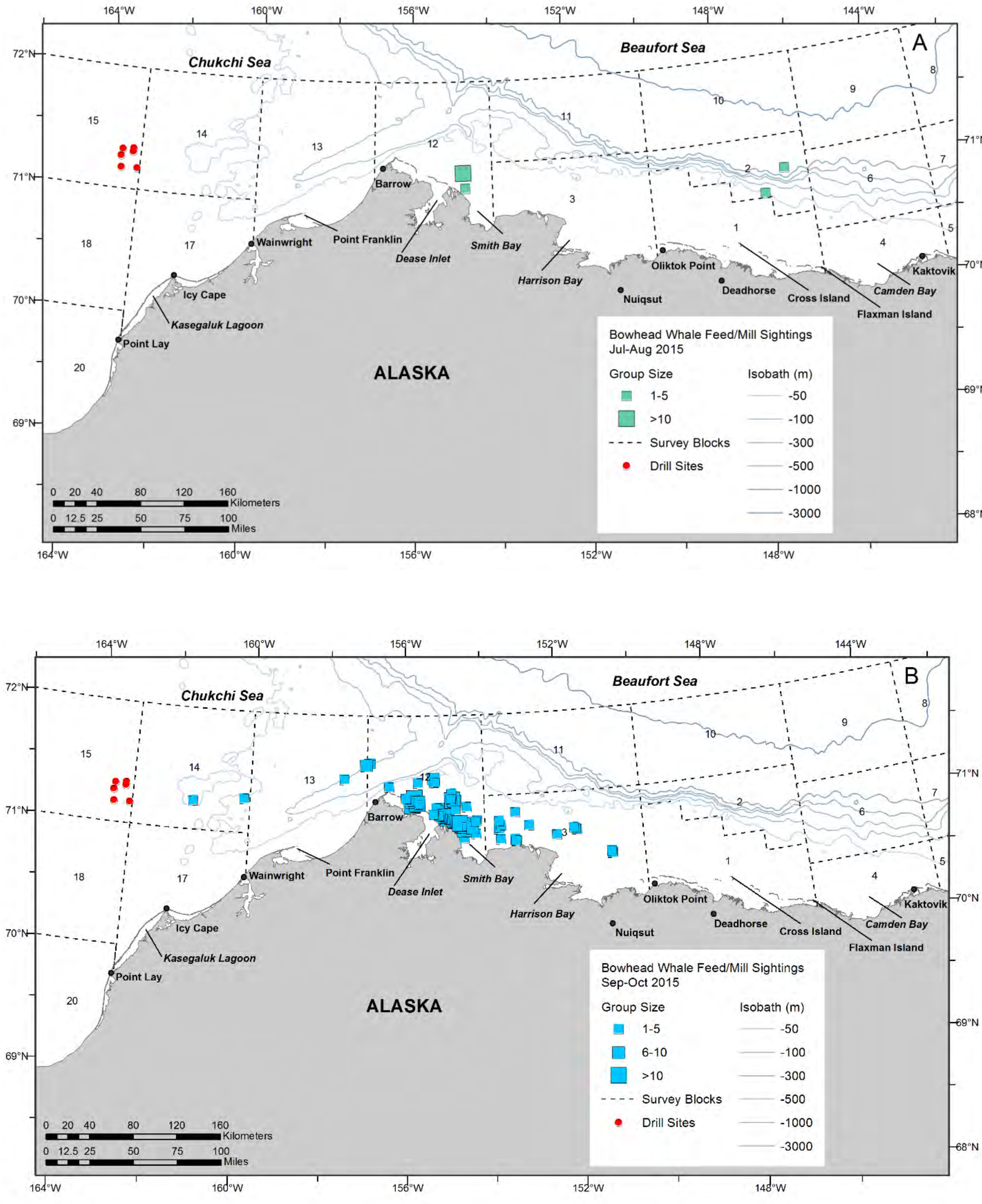


Figure 13. ASAMM 2015 bowhead whale feeding and milling sightings, all survey modes (transect, search, and circling). A: summer (July-August); B: fall (September-October).

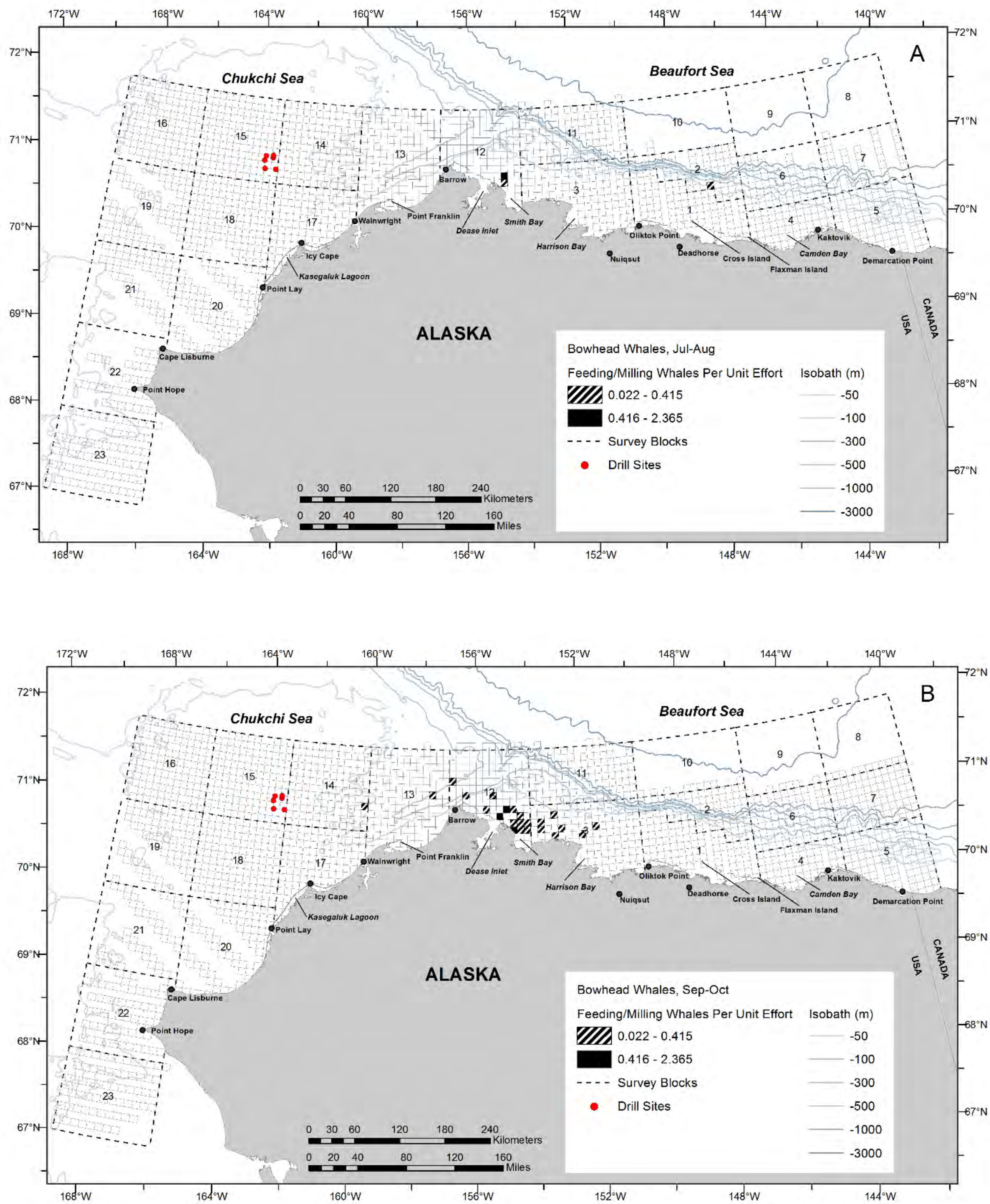


Figure 14. ASAMM 2015 bowhead whale feeding and milling sighting rates (WPUE; transect sightings from primary observers only). A: summer (July-August); B: fall (September-October). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

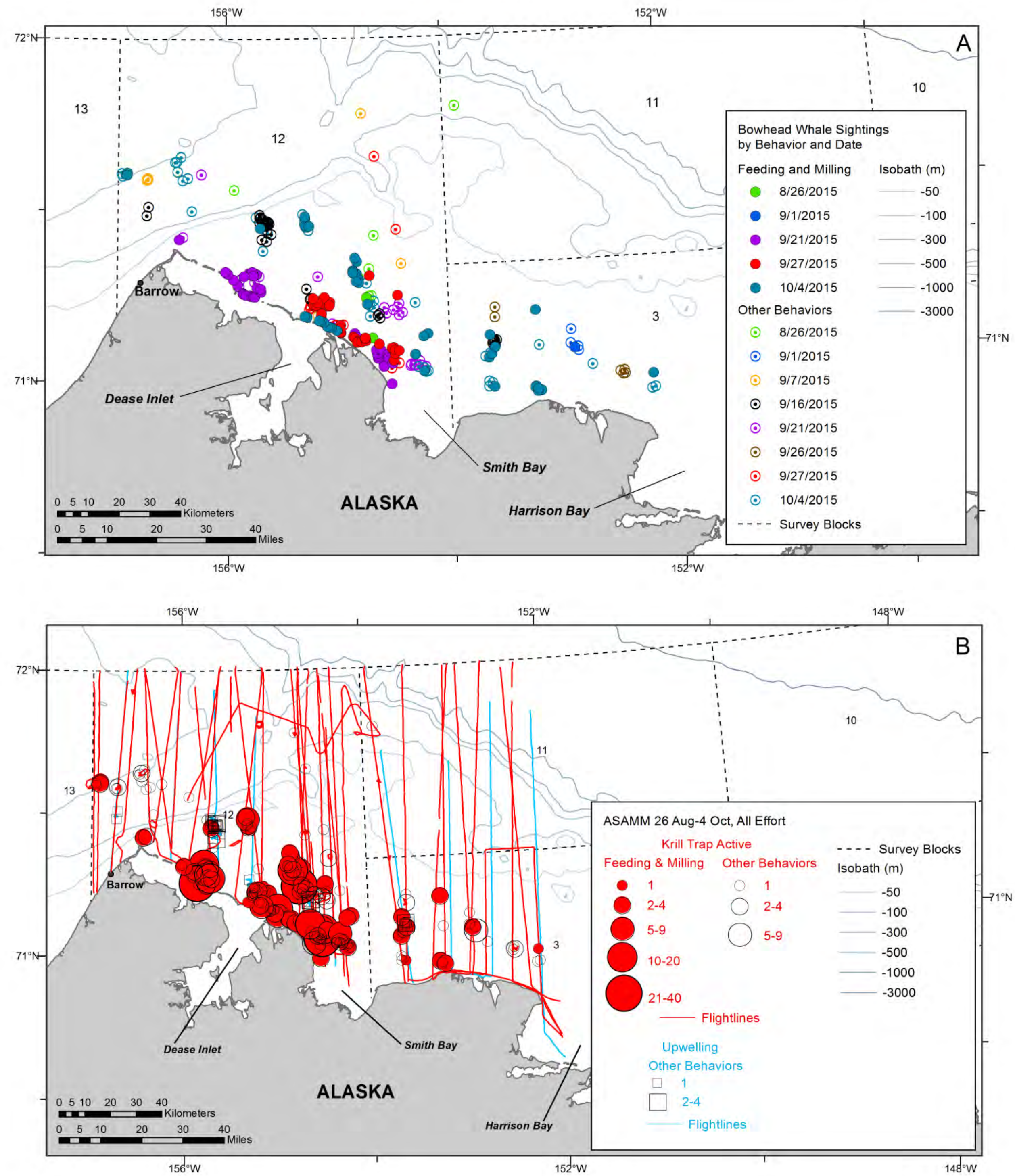


Figure 15. ASAMM 2015 bowhead whale sightings,152°W-157°W, all survey modes (transect, search, and circling), 26 August-4 October. A: Daily sighting locations; B: sighting group sizes and survey effort during krill trap active and upwelling periods. Excludes sightings and effort on ACEs transects.

The density, behavior, and group size distribution of bowhead whales over Barrow Canyon and the Beaufort Sea shelf during late summer and fall exhibit interannual variability that may be partially explained by the presence of dense patches of euphausiids (krill) and copepod prey. The "krill trap" model theorizes that moderate to strong easterly winds cause upwelling that advects prey (krill) onto the shelf, which then become aggregated ("trapped") when wind speed decreases or direction changes to westerly or southwesterly (Ashjian et al. 2010). The model predicts that during upwelling periods, bowhead whales will be found in smaller groups, often in Barrow Canyon, while during krill trap active periods, bowhead whales will be found in larger groups over the shelf. Seven ASAMM surveys were conducted during krill trap active periods in 2015; feeding/milling bowhead whales were observed on five of those surveys: 26 August (23 whales), 1 September (4 whales), 21 September (136 whales), 27 September (172 whales) and 4 October (115 whales) (Figures 15B and 16). A single survey was conducted during the upwelling phase (16 September) and, while moderate numbers of bowhead whales were observed, none were feeding. Comparison of bowhead whale group sizes on krill trap active days with data from surveys conducted five days prior showed that krill trap group sizes were larger, implying that the bowhead whale congregation response was rapid (Figure 17).

BOWHEAD WHALE CENTRAL TENDENCY – ANALYSIS 1

Distribution of Bowhead Whales, Summer 2015, 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) 2015, based on transect sightings (Tr) from primary and secondary observers, did not appear different from the distribution of transect sightings (Tr) observed in summer in previous years having light sea ice cover (i.e., 1982, 1986, 1987, 1989, 1990, 1993-2013) (Figure 18).

In the East Region, mean depth at bowhead whale sightings made on transect by primary observers in summer 2015 was 155 m (SD = 478.3 m, range 18-2,461 m) and median depth was 39.5 m (Table 6). In the West Region, mean depth was 31 m (SD = 13.3 m, range 10-53 m) and median depth was 32 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 2015 were 31.4 km (SD = 21.8 km) and 23.8 km, respectively (Table 6). In the West Region, mean and median distances to the normalized shoreline were 36.5 km (SD = 20.9 km) and 37.7 km, respectively.

To evaluate whether significant displacements occurred in the western Beaufort Sea bowhead whale HUAs during summer 2015 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 2012-2014 and 2015. In 2012-2014, median water depth at bowhead whale sightings made on transect by primary observers was 49 m in the East Region and 28 m in

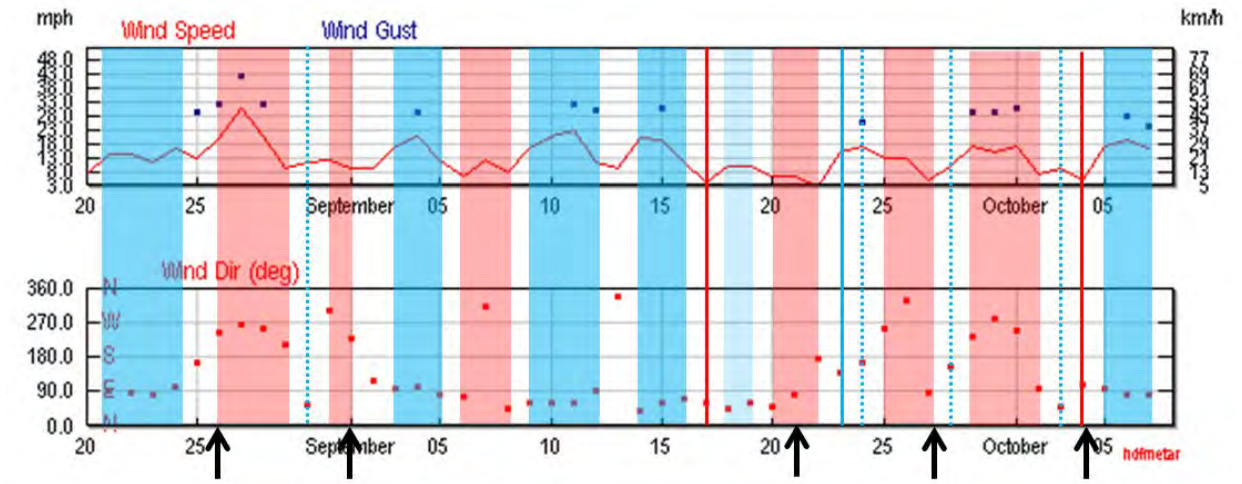


Figure 16. Wind speed and direction near Barrow from 20 August to 5 October, 2015. **Upwelling** periods, when winds are from the E quadrant, are shown as **blue** stripes. **Red** stripes depict **krill trap active** periods, which occur when winds are from the SW or W quadrants or when winds are weak from any direction. The black arrows represent days on which bowhead whales were seen. Wind data are from Weather Underground (Weather Underground 2015). Excludes sightings on ACEs transects.

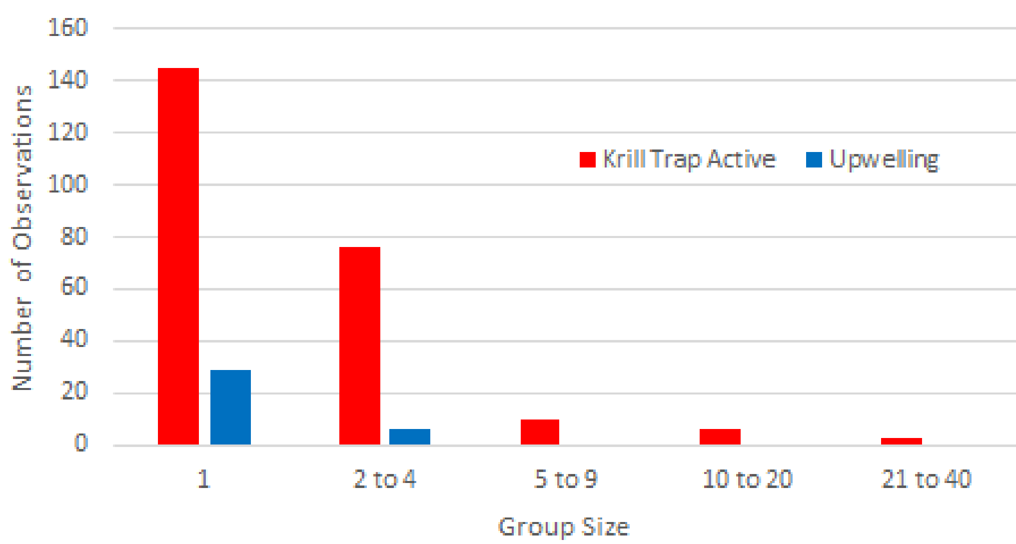


Figure 17. Histogram of observed bowhead whale group sizes, 152°W-157°W, all flight types, during krill trap active and upwelling periods, 26 August – 4 October 2015. During krill trap active periods, the observed mean (2.30 whales) and maximum (40 whales) group sizes were larger than during upwelling periods (mean = 1.24 whales, maximum = 4 whales). Excludes sightings on ACEs transects.

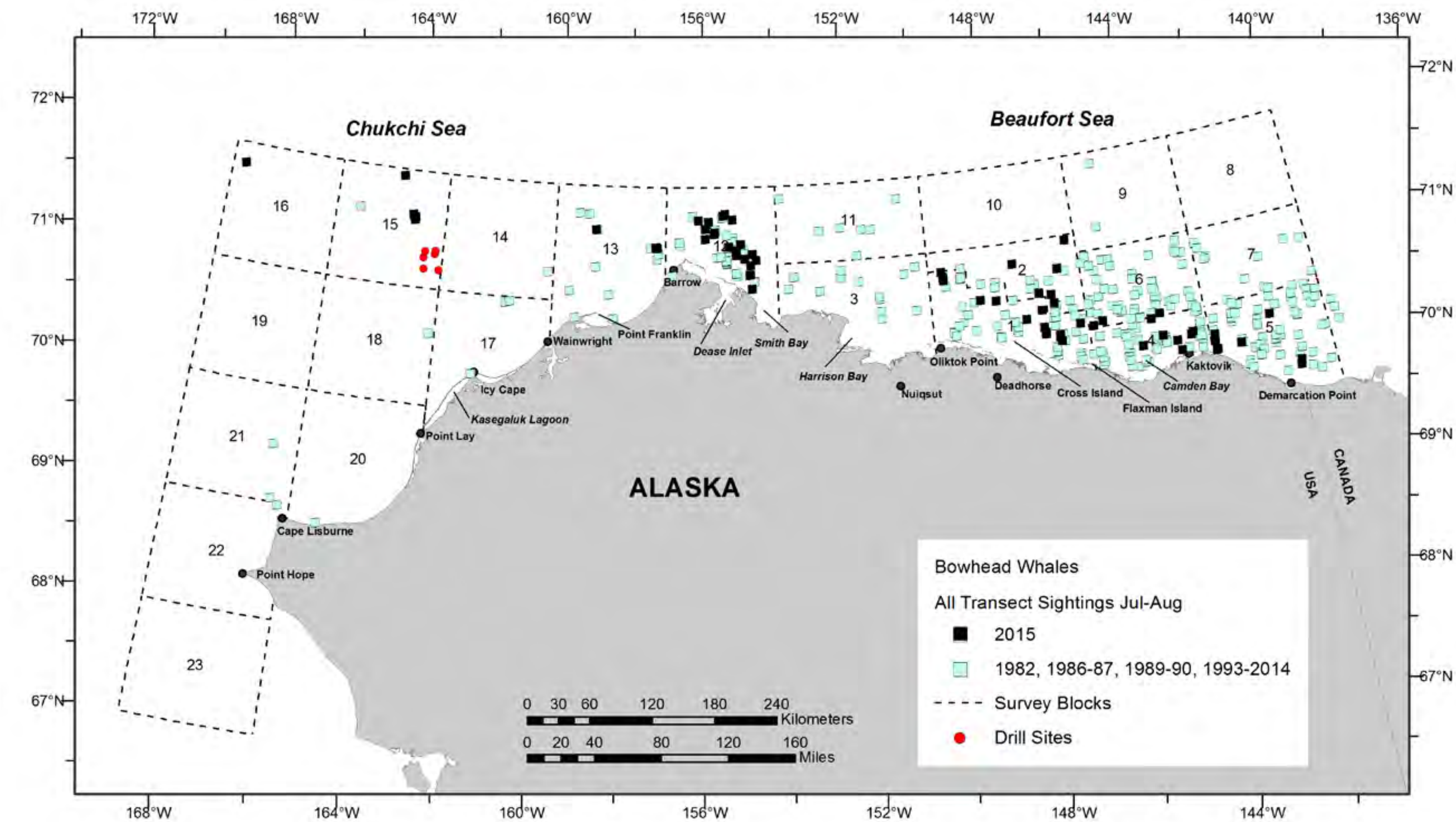


Figure 18. ASAMM bowhead whale sightings on transect, July-August, in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2014, and 2015. Includes all sightings on transect made by primary and secondary observers.

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, 2012-2015. TrSi = number of transect sightings made by primary observers. Excludes sightings made on ACEs transects in 2015.

2012-2015 Summer, by Region			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Year/Season	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
2015 Summer	East	32	39.5	155	478.3	18-2,461	23.8	31.4	21.8	5-108
2012-2014 Summer	East	164	49	248	478.3	10-2,266	42.7	45.6	28.6	1-134
2015 Summer	West	10	32	31	13.3	10-53	37.7	36.5	20.9	6-66
2012-2014 Summer	West	59	28	127	367.6	12-2,614	32.9	34.5	23.9	5-124
2012-2015 Summer, by Month			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Year/Season	**Month**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
2015 Summer	Jul	2	691	691	898.0	56-1,326	59.9	59.9	19.8	46-74
2015 Summer	Aug	40	37.5	97	383.5	10-2,461	24.0	31.2	20.8	5-108
2012-2014 Summer	Jul	60	235.5	527	640.4	13-2,614	66.9	66.7	24.8	9-124
2012-2014 Summer	Aug	163	39	102	290.0	10-2,266	30.2	33.8	23.4	1-134
2015 Season, by Region			**DEPTH (M)**				**DISTANCE FROM SHORE (KM)**			
Season	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
Summer	East	32	39.5	155	478.3	18-2,461	23.8	31.4	21.8	5-108
Fall	East	24	44.5	87	107.8	6-418	29.2	37.7	25.4	6-85
Summer	West	10	32	31	13.3	10-53	37.7	36.5	20.9	6-60
Fall	West	112	18	19	17.0	5-173	19.5	21.7	13.5	4-69

the West Region; the median distance from shore was 42.7 km in the East Region and 32.9 km in the West Region (Table 6).

A Mann-Whitney *U*-test of significant difference of medians indicated that bowhead whales sighted on transect by primary observers in summer 2015 in the East Region were in significantly shallower water (median depth = 39.5 m; Z = 2.3388, P = 0.0193) and significantly closer to shore (median distance from shore = 23.8 km; Z = 2.6557, P = 0.0079) than bowhead whales sighted in 2012-2014 (median depth = 49 m; median distance from shore = 42.7 km) (Table 6). In the West Region, there was no significant difference in median depth or distance from shore of bowhead whale sightings between 2015 (32 m depth, 37.7 km from shore) and 2012-2014 (28 m depth, 32.9 km from shore) (Table 6).

In 2012-2014, the apparent shift in bowhead whale distribution in summer appeared to be between months (Clarke et al. 2015a). There were too few sightings in July 2015 (n = 2) to determine any significant difference between July and August.

Distribution of Bowhead Whales During Summer and Fall Months, 2015

Summary statistics for bowhead whale data from the western Beaufort Sea in summer (July-August) 2015 were compared to values for fall (September-October) 2015 (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 39.5 m, median distance 23.8 km) and fall (median depth 44.5 m, median distance 29.2 km). In the West Region, bowhead whales sighted on transect in summer were in significantly deeper water (median depth 32 m vs 18 m, Z = -2.8046, P = 0.0050) and significantly farther from shore (median distance 37.7 km vs 19.5 km, Z = 2.2540, P = 0.0242) than bowhead whales sighted on transect in fall.

Distribution of Bowhead Whales, Fall 2015, Relative to Bowhead Whale Distribution in Previous Years with Light Sea Ice Cover

Summary statistics for bowhead whale data from the western Beaufort Sea in fall (September-October) 1989-2015 are shown in Table 7. Summary statistic results are from sightings made by primary observers only; primary observers were not identified for the earliest years of the ASAMM project (1982-1988). 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.

Bowhead whale distribution in the western Beaufort Sea in September-October 2015, based on transect sightings (Tr) from primary and secondary observers did not appear different from the distribution of transect sightings (Tr) observed in previous years having light sea ice cover (i.e., 1982, 1986, 1987, 1989, 1990, 1993-2014) (Figure 19). There were relatively few sightings in the East Region (140°W-148°W) compared to some past years and more sightings than in any past year in the West Region (148°W-156°W), but overall bowhead whale transect sightings in 2015 overlaid those from 1982 to 2014.

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, 1989-2015. TrSi = number of transect sightings made by primary observers. Excludes sightings made on ACEs transects in 2015.

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

			DEPTH (M)				DISTANCE FROM SHORE (KM)			
Year	**Region**	**TrSi**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
2001	East	13	46	44	9.1	28-53	31.8	27.9	10.7	12-41
	West	2	42	42	43.8	11-73	29.6	39.6	43.5	9-70
2002	East	9	25	25	14.3	3-48	8.5	15.1	18.2	0-58
	West	20	24.5	30	20.6	11-88	31.2	33.9	12.6	9-56
2003	East	17	36	35	16.0	12-72	28.4	24.4	16.6	3-46
	West	29	20	50	67.3	12-310	27.2	28.9	15.7	2-72
2004	East	53	40	44	42.5	7-337	21.5	23.4	12.0	5-71
	West	47	24	34	36.5	5-206	22.7	23.6	10.6	5-65
2005	East	16	40.5	39	13.0	13-61	21.5	23.0	13.0	5-40
	West	17	33	60	66.3	12-227	37.3	34.6	16.0	6-55
2006	East	29	44	215	524.2	9-1,966	28.0	34.7	22.5	2-89
	West	28	37.5	45	36.2	4-175	37.0	35.7	18.9	1-67
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

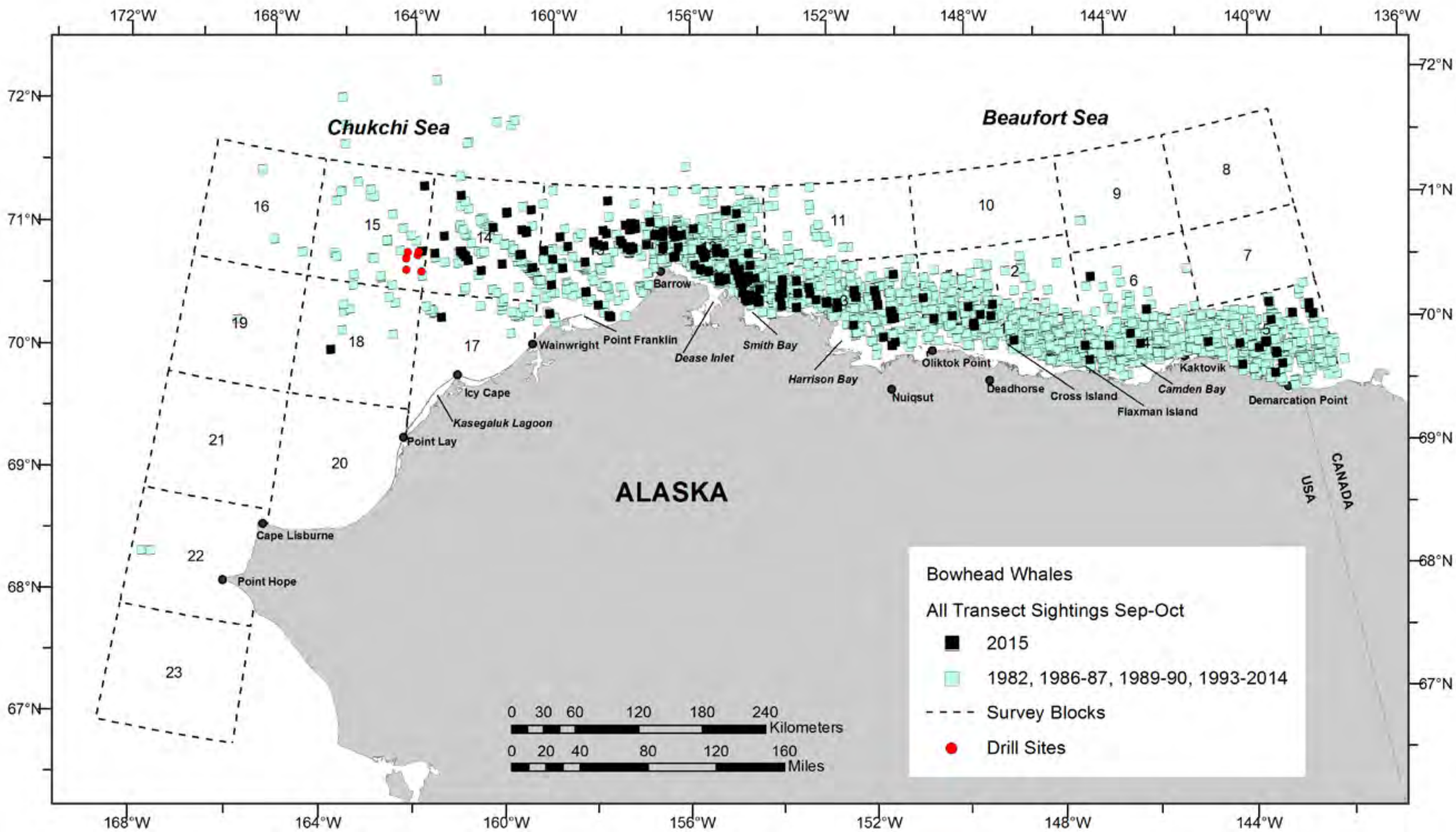


Figure 19. ASAMM bowhead whale sightings on transect, September-October, in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2014, and 2015. Includes all sightings on transect made by primary and secondary observers.

In the East Region, mean depth at bowhead whale sightings made on transect by primary observers in fall 2015 was 87 m (SD = 107.8 m, range 6-418 m) and median depth was 44.5 m (Table 7). In the West Region, mean depth was 19 m (SD = 17.0 m, range 5-173 m) and median depth was 18 m. In the East Region, mean and median distances to the normalized shoreline from bowhead whale sightings made on transect by primary observers in September-October 2015 were 37.7 km (SD = 25.4 km) and 29.2 km, respectively (Table 7). In the West Region, mean and median distances to the normalized shoreline were 21.7 km (SD = 13.5 km) and 19.5 km, respectively.

To evaluate whether significant displacements occurred in western Beaufort Sea bowhead whale HUAs during fall 2015 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. During previous years with light sea ice cover, median water depth at bowhead whale sightings on transect by primary observers was 38 m in the East Region and 21 m in the West Region; the median distance from shore was 22.6 km in the East Region and 23.8 km in the West Region.

In fall (September-October) 2015 in the East Region, bowhead whale sightings were in significantly deeper water (median depth 44.5 m vs. 38 m; $Z = 2.2149$, $P = 0.0268$) and farther from shore (median distance from shore 29.2 km vs. 22.6 km; $Z = -2.3910$, $P = 0.0168$) than bowhead whale sightings in previous years with light sea ice cover. In the West Region, bowhead whale sightings were in significantly shallower water in fall 2015 than in previous years with light sea ice cover (median depth 18 m vs. 21 m, $Z = -5.2726$, $P < 0.0001$) and closer to shore (median distance from shore 19.5 km vs. 23.8 km, $Z = 3.6000$, $P = 0.0003$).

Bowhead Whale Central Tendency – Analysis 2

The 2015 spatial relative abundance model (GAM) for fall (September-October) incorporated 150 bowhead whale sightings of 292 total individuals (Figure 20A). Relative abundance predictions resulting from the GAM applied to the 2015 survey data for the western Beaufort Sea are shown in Figure 20B. The highest predicted relative abundance was located nearshore from Smith Bay to Dease Inlet (~154°W to ~156°W), with relatively high predicted relative abundance nearshore east of Kaktovik (~140°W to ~143°W). The HUA was broadest near the eastern border of the study area, due to sightings north and northeast of Demarcation Point.

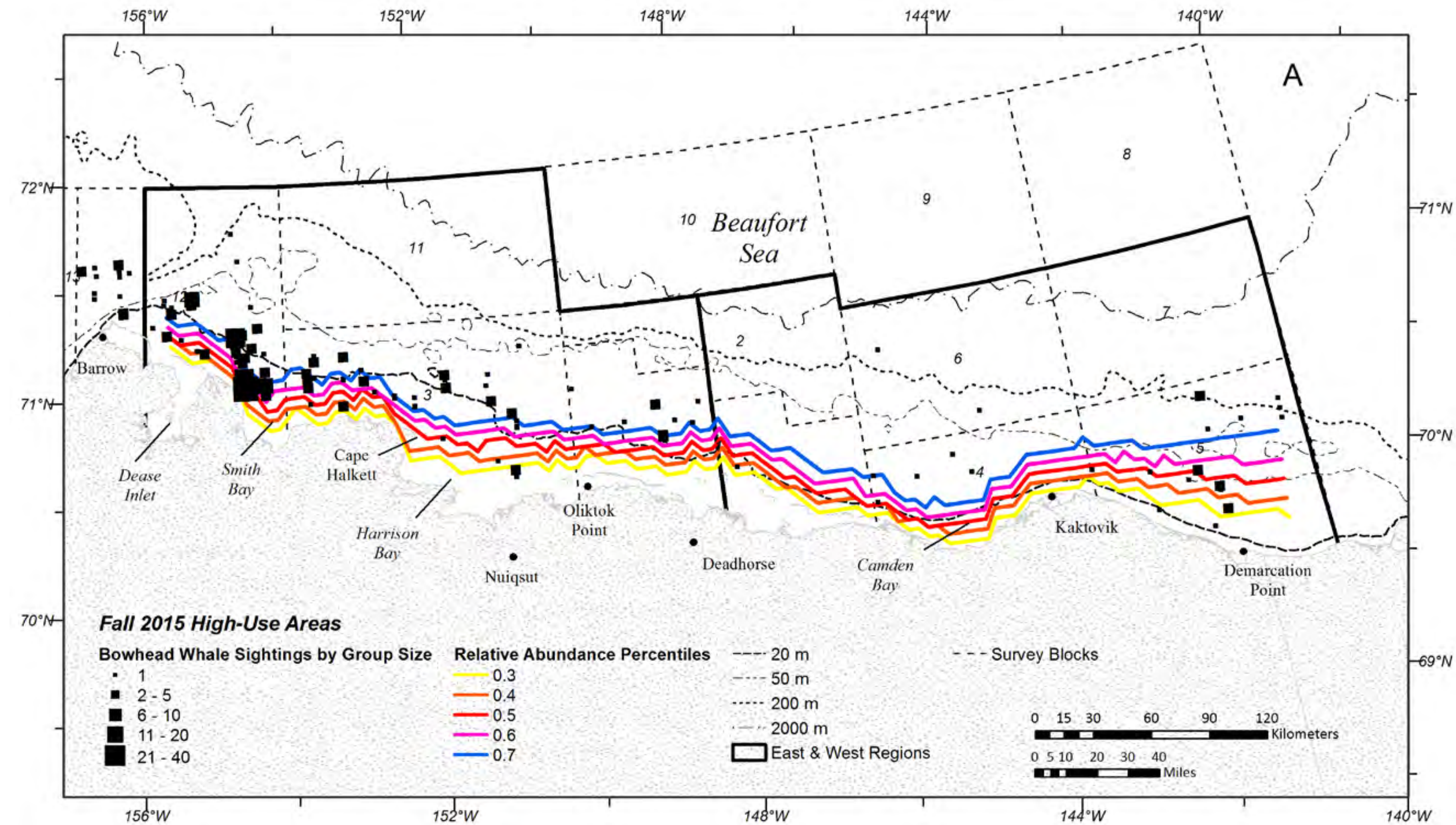


Figure 20. ASAMM September and October 2015 bowhead whale (A) transect sightings (primary observers only) by group size, and (B) predicted relative abundance based on a spatial model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea. The bowhead whale High-Use Area is represented by distribution percentiles (30^{th}, 40^{th}, 50^{th}, 60^{th}, and 70^{th}), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

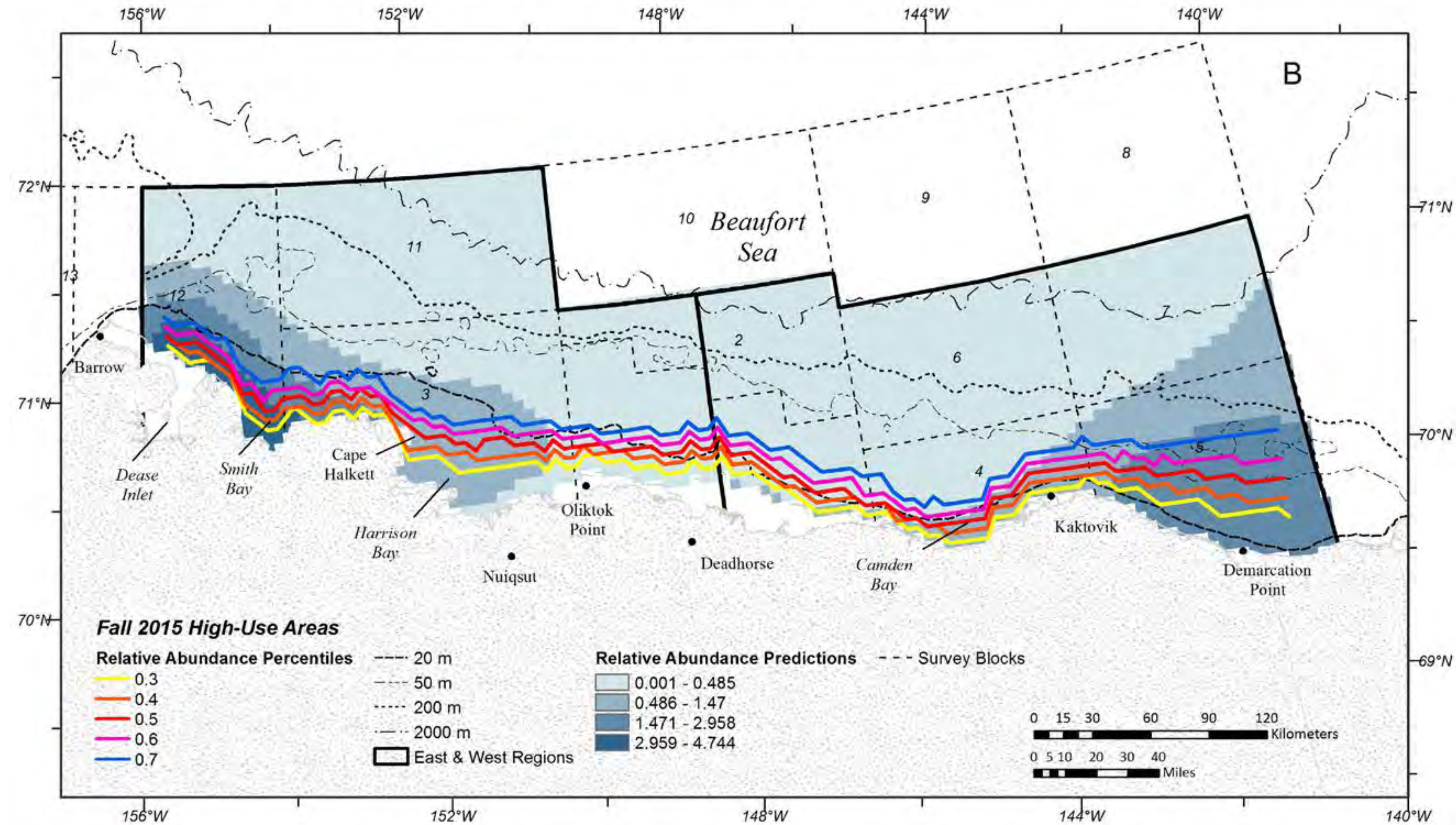


Figure 20 (cont.). ASAMM September and October 2015 bowhead whale (A) transect sightings (primary observers only) by group size, and (B) predicted relative abundance based on a spatial model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea. 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.

The 2000-2015 model (July-October) incorporated 1,329 bowhead whale sightings of 2,418 individuals. In July there were 62 bowhead whale sightings (106 individuals) (Figure 21A), all of which were sighted from 2012 to 2015. 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 21B). 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 ~143.5°W. There were a total of 214 bowhead whale sightings (368 individuals) in August (Figure 21C), most of which were from 2012 to 2015. The spatial model predicted that bowhead whale HUAs were closest to shore near Kaktovik, and were just offshore of the barrier islands near Dease Inlet (~155°W to ~156°W) and from ~145°W to ~148°W (Figure 22D). Areas with highest predicted relative abundance in August were all located nearshore, with highest abundances between Point Barrow and Dease Inlet, and in eastern Camden Bay. In contrast to the predictions from September and October, the August predictions showed high relative abundances extending up to 120 km offshore near the eastern boundary of the study area (140°W).

The model incorporated 761 bowhead whale sightings (1,424 individuals) in September (Figure 21E) and 292 sightings (520 individuals) in October (Figure 21G). The model predicted similar distributions for September and October. In September, bowhead whale relative abundances were highest, and the HUAs were located closest to shore, from Dease Inlet to Smith Bay, just outside the barrier islands from ~149°W to ~146°W, and east of Kaktovik (Figure 21F). In October, highest predicted abundance was from Dease Inlet to Smith Bay, with relatively high abundance extending to northeast of Cape Halkett, and pockets of higher abundance outside the barrier islands from ~149°W to ~146°W and east of Kaktovik (Figure 21H). The HUA in October was farther offshore north of Camden Bay than in September.

The estimated median distance-from-shore statistics for fall 2015 that were derived using the spatial model were 29.6 km for the East Region and 14.5 km for the West Region (Table 8). For the East Region, the model-derived results were very similar to results from the analysis of bowhead whale sightings that were unadjusted for transect effort or group size (median value of 29.2 km; Table 7). For the West Region, the model-derived results placed the median of the bowhead whale distribution slightly farther offshore compared to the unadjusted median (19.5 km; Table 7).

The estimated median distance-from-shore statistics for the East Region in 2000-2015, derived using the spatial model, decreased from 66.6 km in July to 25.8 km in August, 18.8 km in September, and 24.5 km in October (Table 8). In the West Region, the 2000-2015 model predicted that the median distance from shore decreased from 49.9 km in July to 25.7 km in August, 18.6 km in September, and 24.1 km in October (Table 8). These results suggest that the bowhead whale HUAs were located closer to shore in the West Region and farther from shore in the East Region in 2015 compared to the 15-year time series from 2000 to 2015.

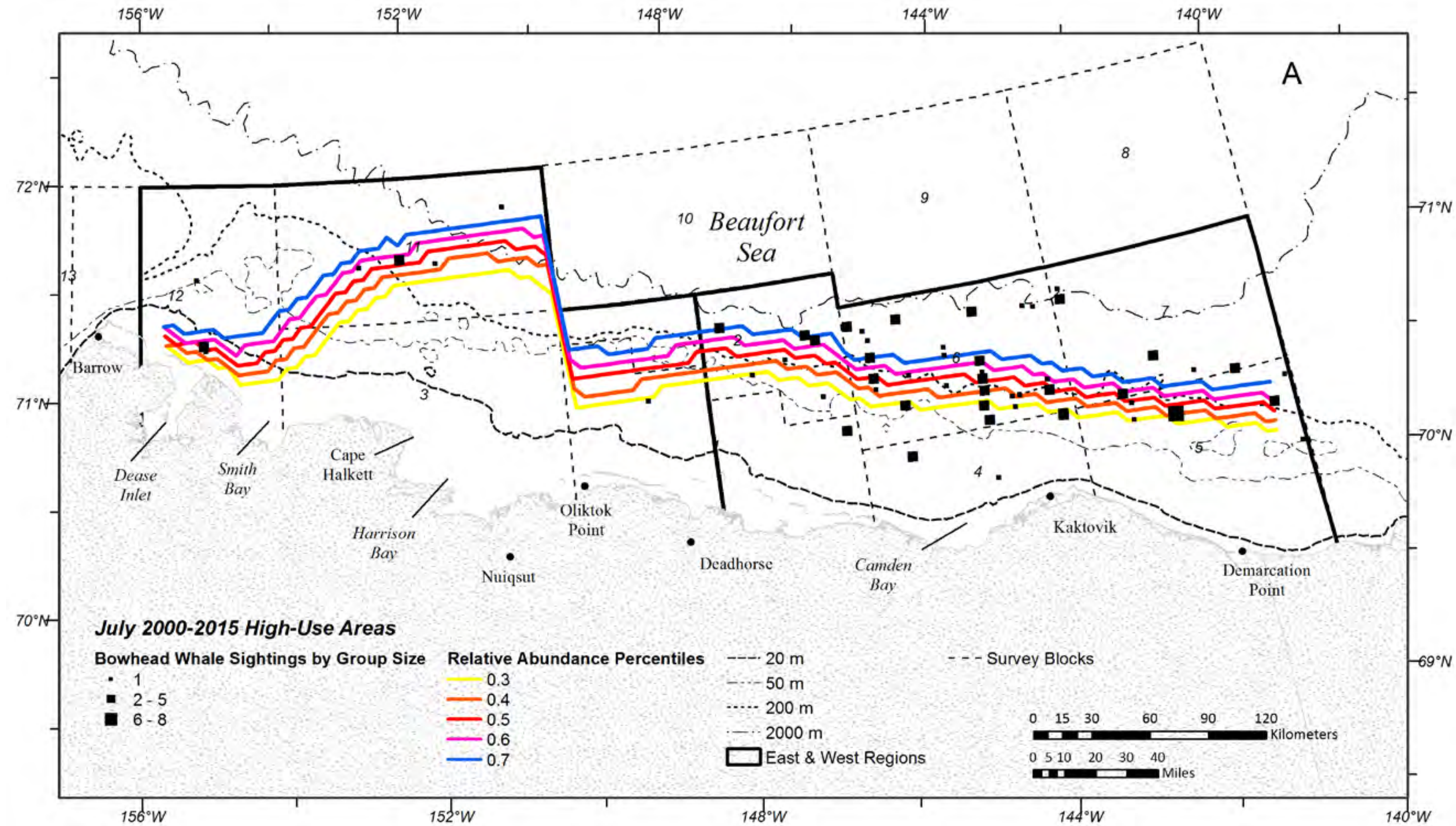


Figure 21. ASAMM 2000-2015 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea in July, August, September, and October. A: July sightings. The bowhead whale High-Use Area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

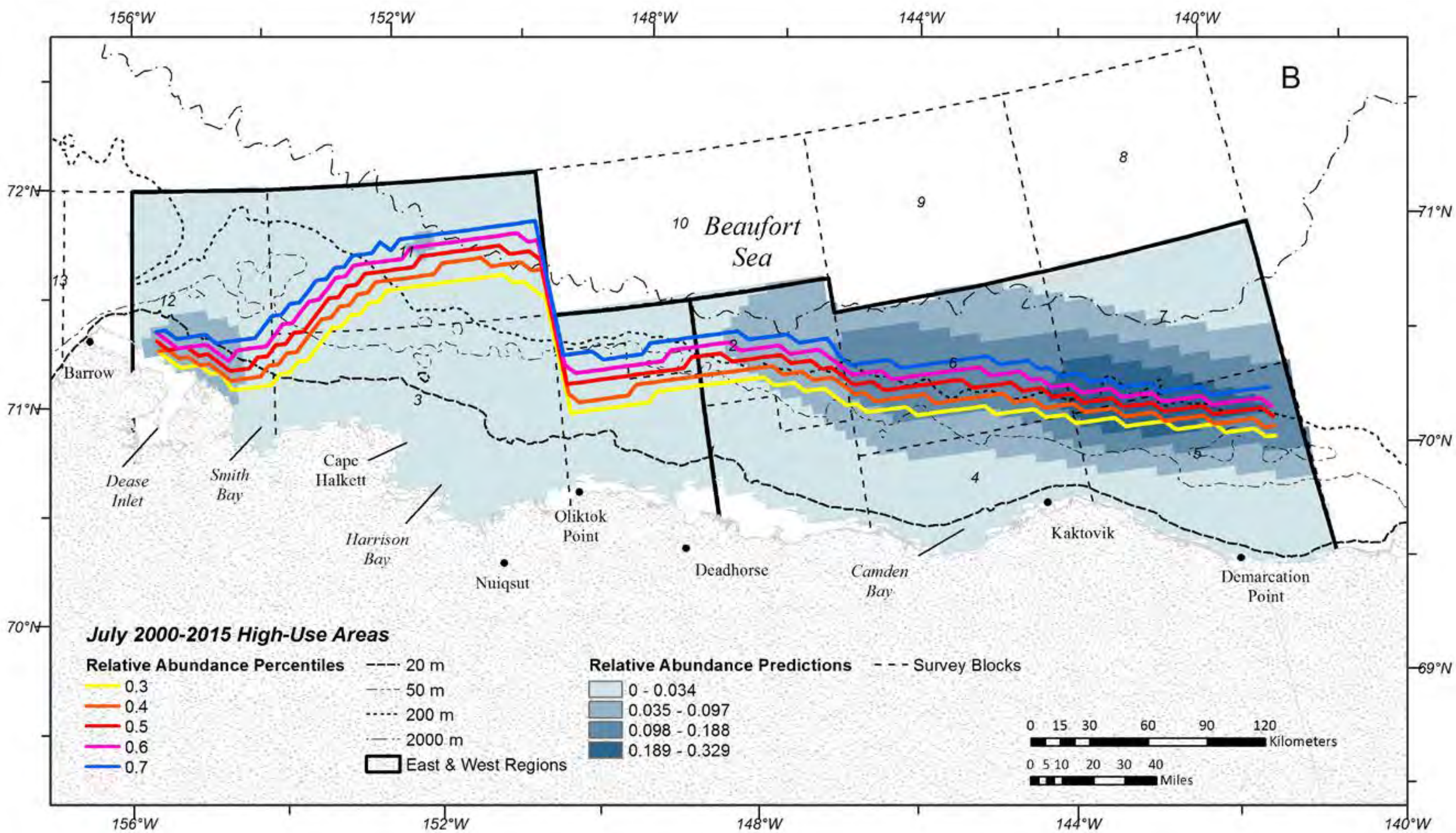


Figure 21 (cont.). ASAMM 2000-2015 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea in 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.

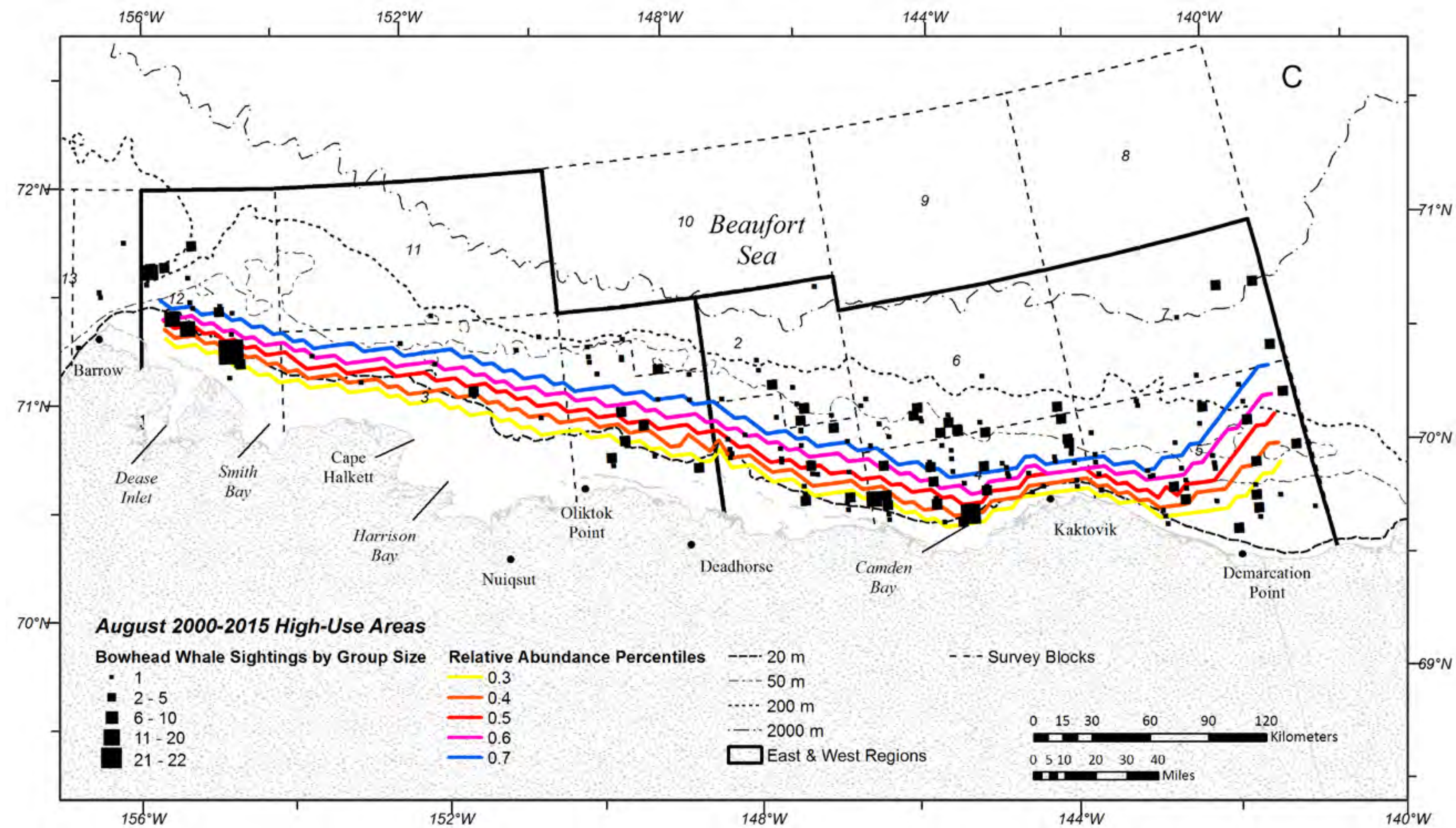


Figure 21 (cont.). ASAMM 2000-2015 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea in 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.

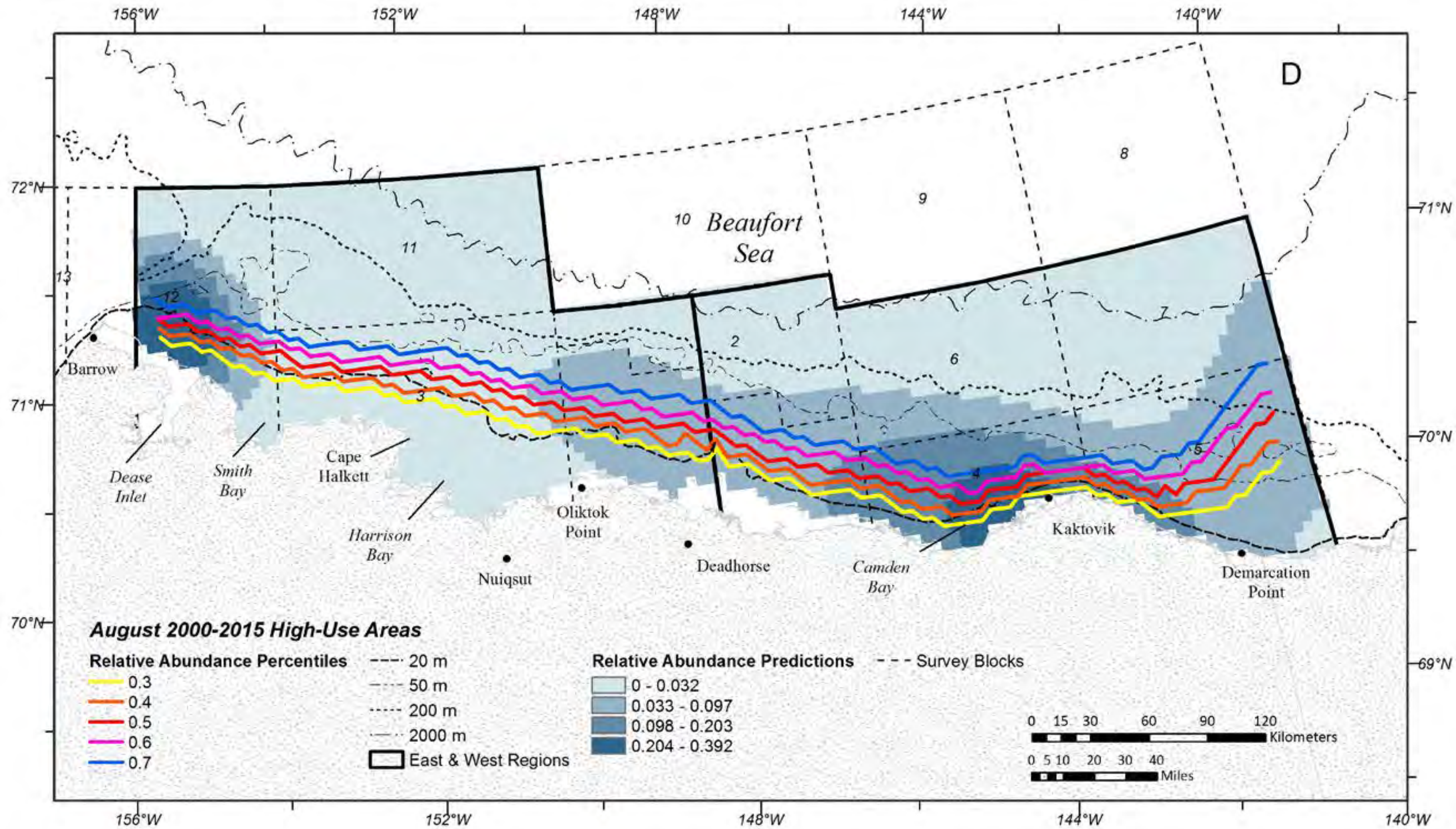


Figure 21 (cont.). ASAMM 2000-2015 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea in 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.

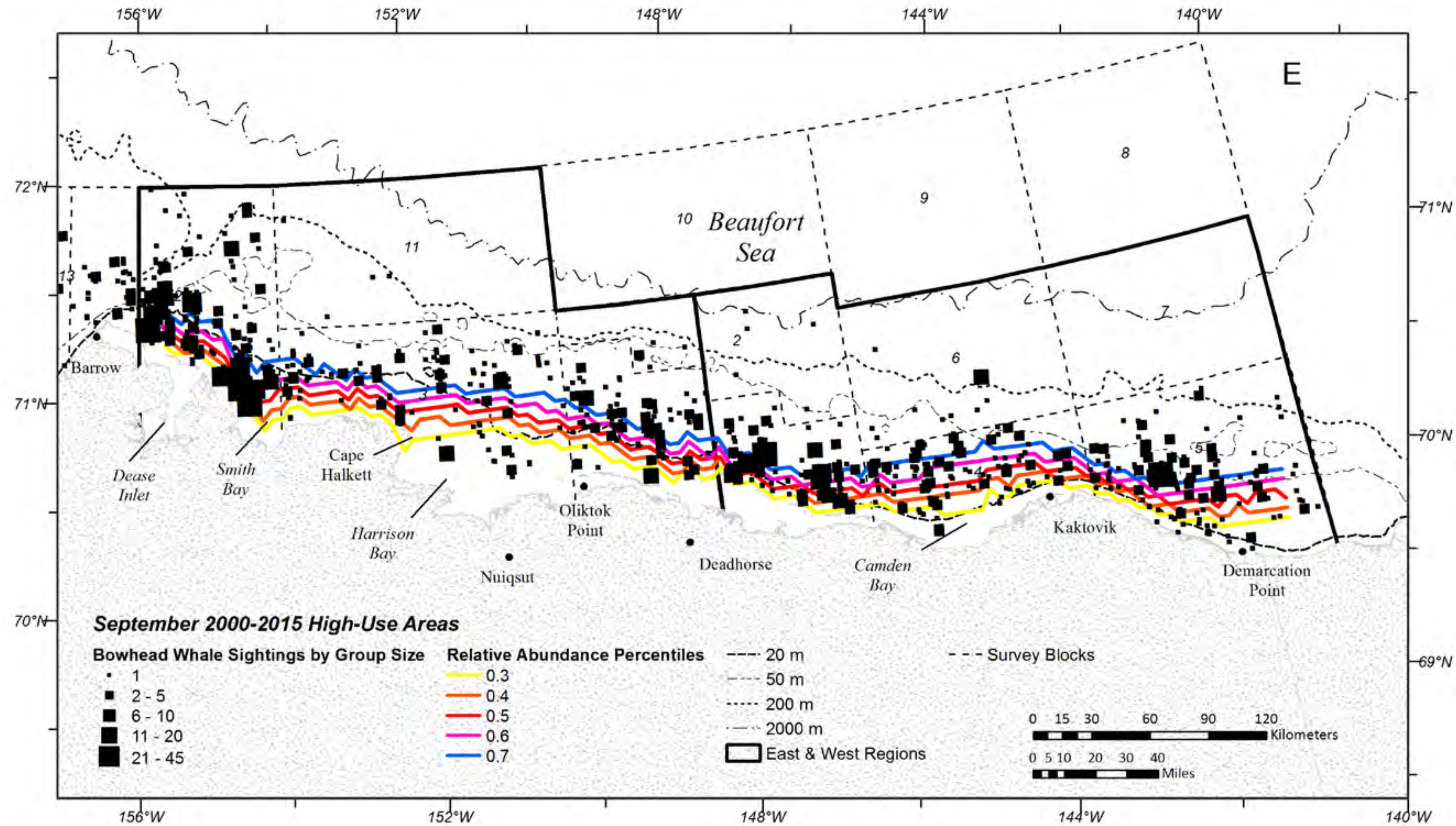


Figure 21 (cont.). ASAMM 2000-2015 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea in 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.

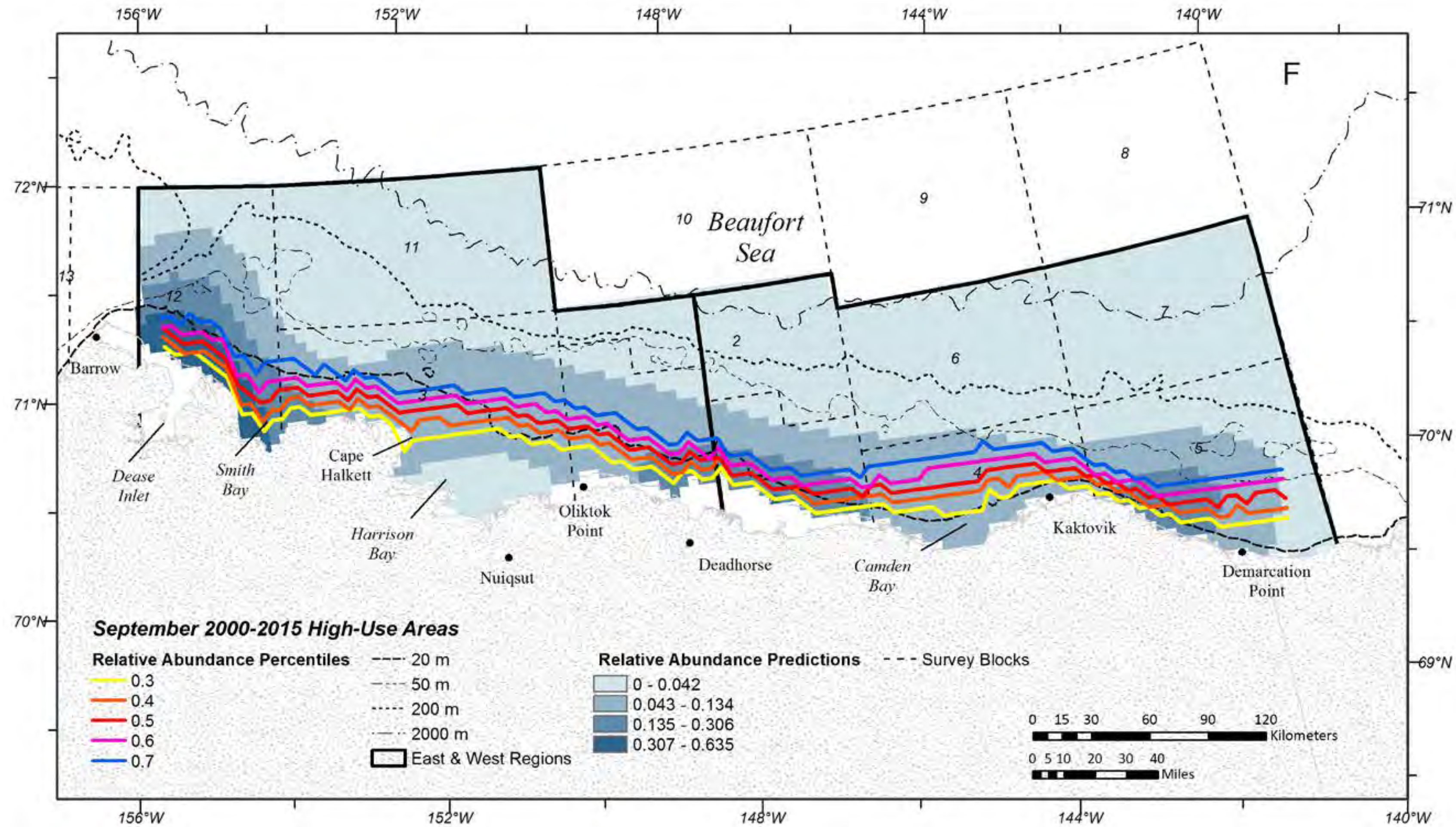


Figure 21 (cont.). ASAMM 2000-2015 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea in 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.

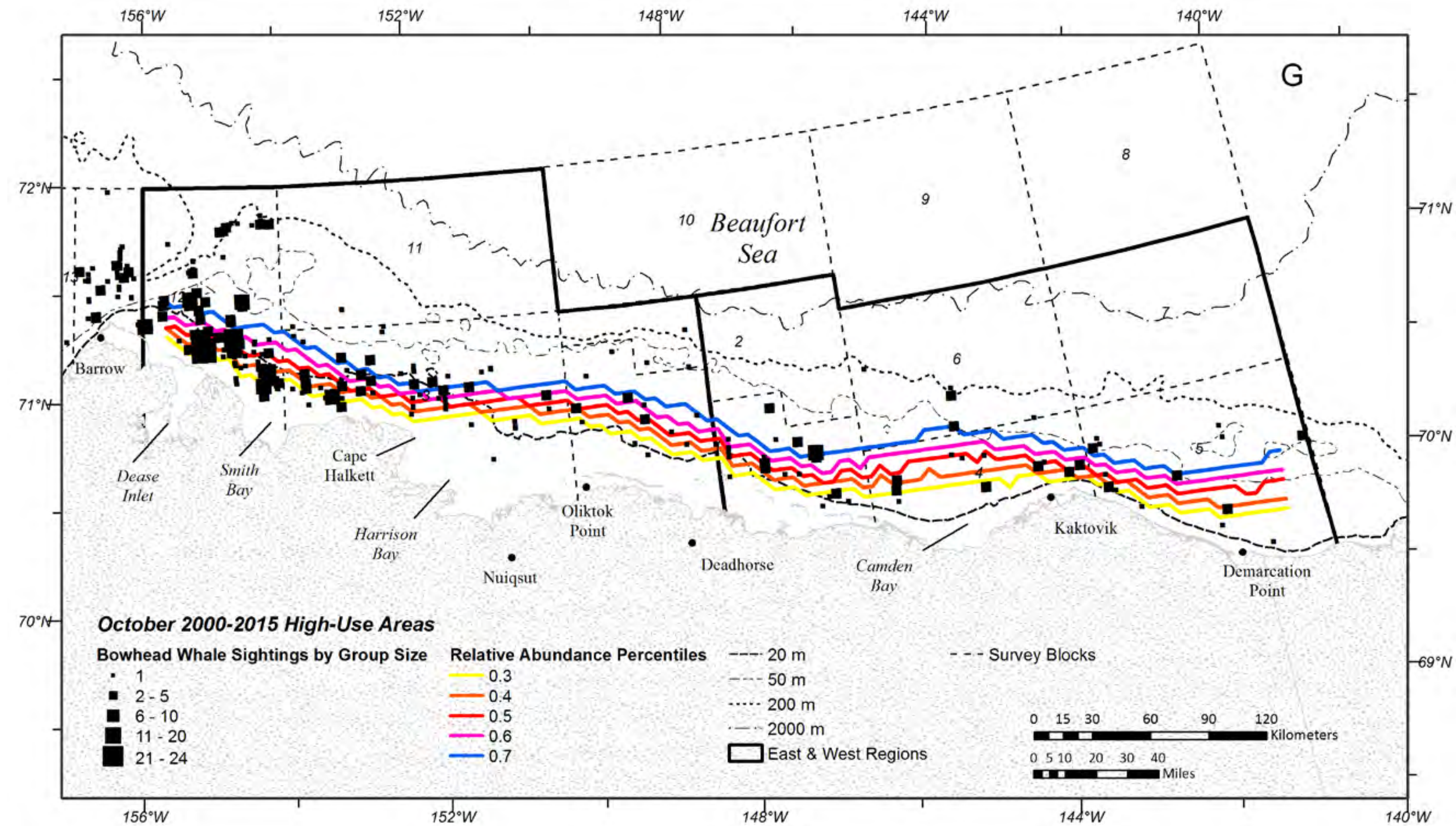


Figure 21 (cont.). ASAMM 2000-2015 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea in 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.

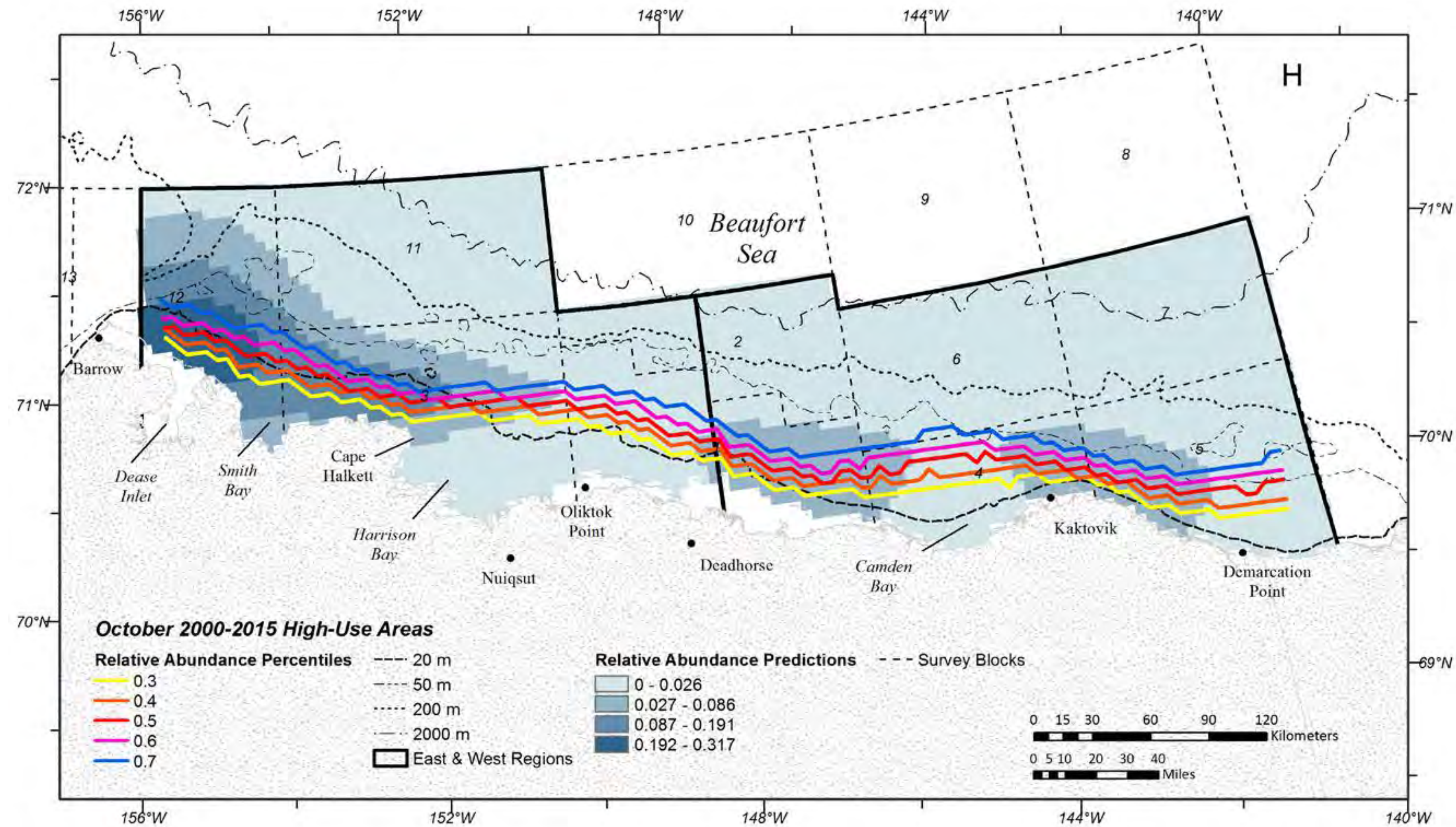


Figure 21 (cont.). ASAMM 2000-2015 bowhead whale transect sightings (primary observers only) by group size and predicted relative abundance, based on a spatial relative abundance model that accounted for effort by assuming a uniform 5 km of transect effort in every cell in the western Beaufort Sea in 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 2015, the predictions correspond to September and October combined. Monthly predictions are provided for 2000-2015.

	WEST REGION (KM)					EAST REGION (KM)				
	2015	2000-2015				2015	2000-2015			
Percentile	Sep-Oct	Jul	Aug	Sep	Oct	Sep-Oct	Jul	Aug	Sep	Oct
30th	8.0	22.5	15.4	9.5	15.0	16.5	55.0	14.5	10.0	14.8
40th	10.7	33.8	20.1	13.7	19.4	22.8	61.1	19.8	14.4	19.6
50th	14.5	49.9	25.7	18.6	24.1	29.6	66.6	25.8	18.8	24.5
60th	18.8	67.7	30.4	23.9	29.4	37.7	72.6	32.5	23.6	30.2
70th	23.6	82.0	36.5	30.3	34.9	47.4	78.6	40.9	29.4	36.5

Gray Whales

Gray Whale Sighting Summary

During the 2015 ASAMM surveys, 259 sightings of 465 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 northeastern Chukchi Sea, and in August and October in the southcentral Chukchi Sea (Figure 22). 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 early July through late October in block 14, between 50 and 125 km offshore and just south of Hanna Shoal. In the southcentral Chukchi Sea, gray whales were seen offshore approximately 50-105 km southwest of Point Hope, a known gray whale and benthic hot spot (Grebmeier et al. 2015; Kuletz et al. 2015), with one sighting nearshore between Cape Lisburne and Point Hope. Dense concentrations of gray whales were not seen in the southcentral Chukchi Sea as they were in 2014 (Clarke et al. 2015a). No gray whales were seen east of 157°W. Locations of gray whale sightings are shown in semimonthly periods in Figure 23.

Gray whale distribution in 2015 (all sightings regardless of survey mode or observer type) was generally similar to that documented from 2008 to 2014 and 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. Prior to 2015, gray whales were rarely seen in this area until late August.
- Gray whales were not seen in shallow waters directly south of Point Hope.
- Large groups of gray whales were not seen offshore west and southwest of Point Hope, likely due in part to the relatively lower survey coverage in this area compared to 2014.

Gray Whale Sighting Rates

In summer and fall 2015, gray whales were seen on transect (Tr) from 67.6°N to 71.5°N and 157.2°W to 168.8°W. There were 107 sightings of 197 gray whales on transect by primary observers (Appendix E, Table E-5), ranging from 1 whale per sighting (n = 54) to 7 whales per sighting (n = 2). The greatest numbers of sightings on transect were in blocks 13 (49 sightings), 17 (25 sightings), and 14 (24 sightings). When transect and circling from transect (Tr+TrC) sightings were combined, there were 212 sightings of 383 gray whales (Appendix E, Table E-6), ranging from 1 whale per sighting (n = 112) to 7 whales per sighting (n = 3). The highest number of Tr+TrC sightings was in block 13 (91 sightings), followed by block 14 (53 sightings).

The highest gray whale fine-scale Tr sighting rates (WPUE, 5-km grid) were nearshore between Barrow and Point Franklin, offshore approximately 150 km west of Barrow, northeast of Cape

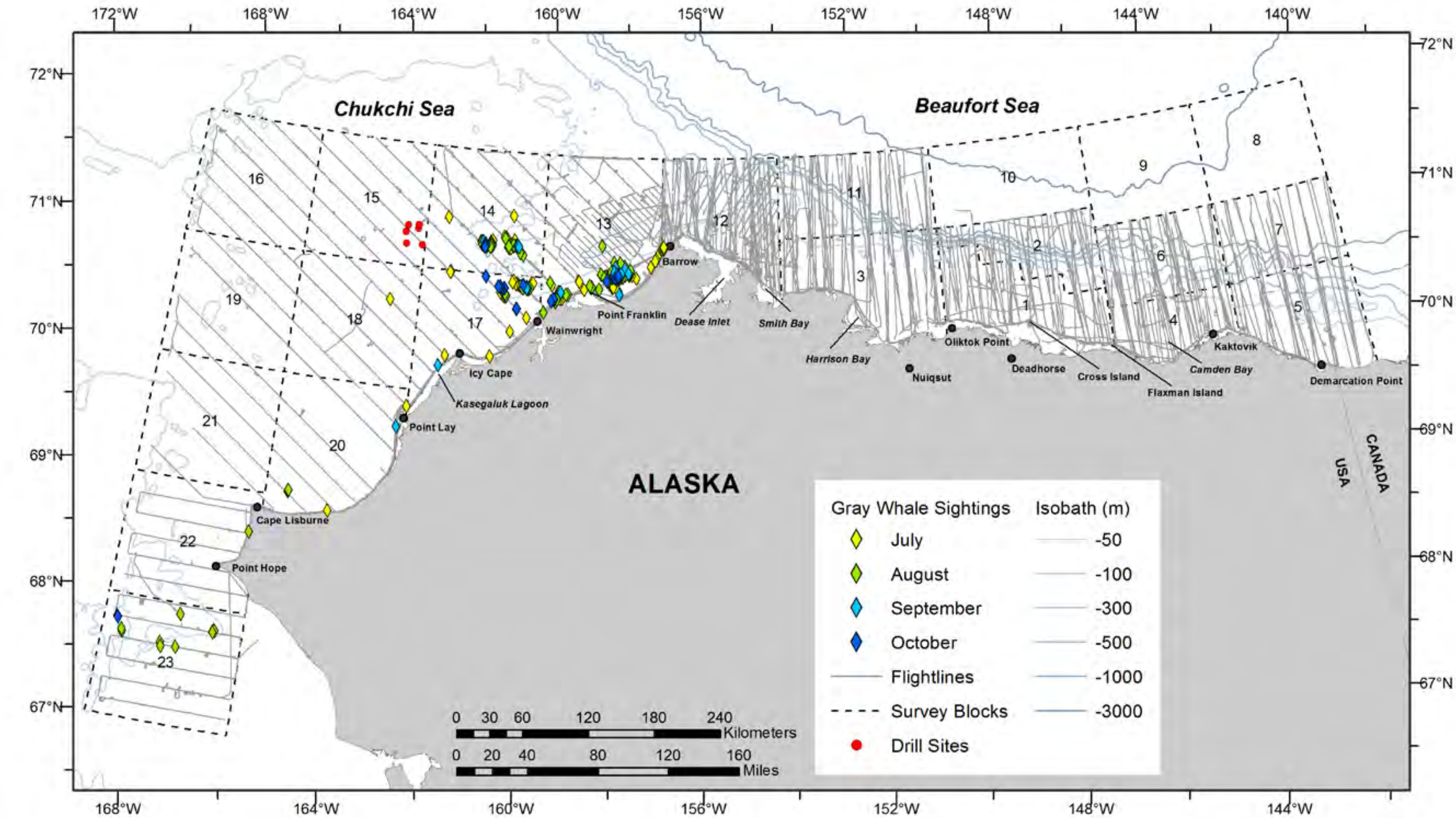
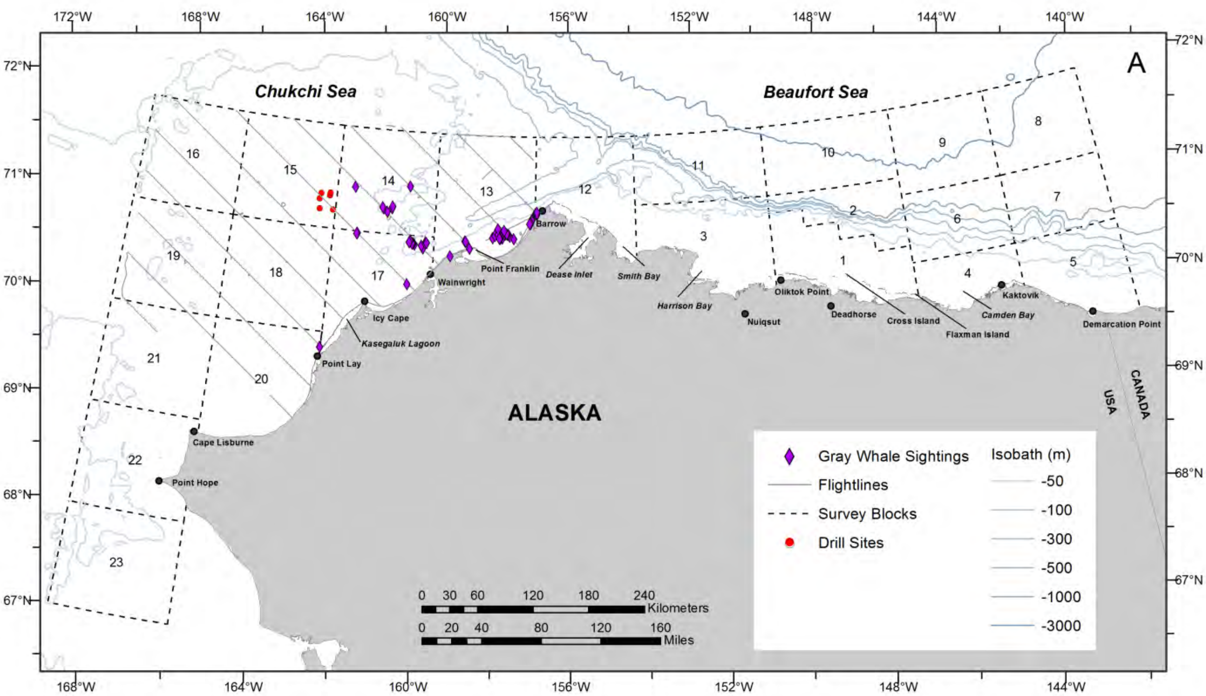


Figure 22. ASAMM 2015 gray whale sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.



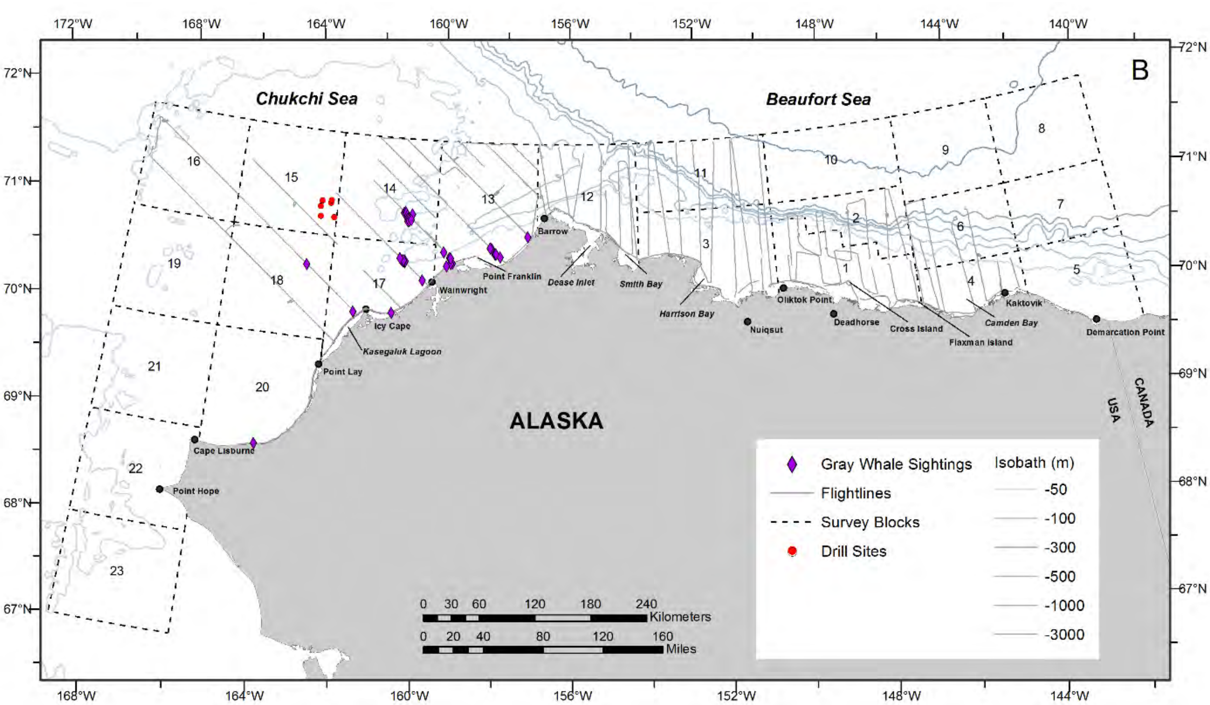
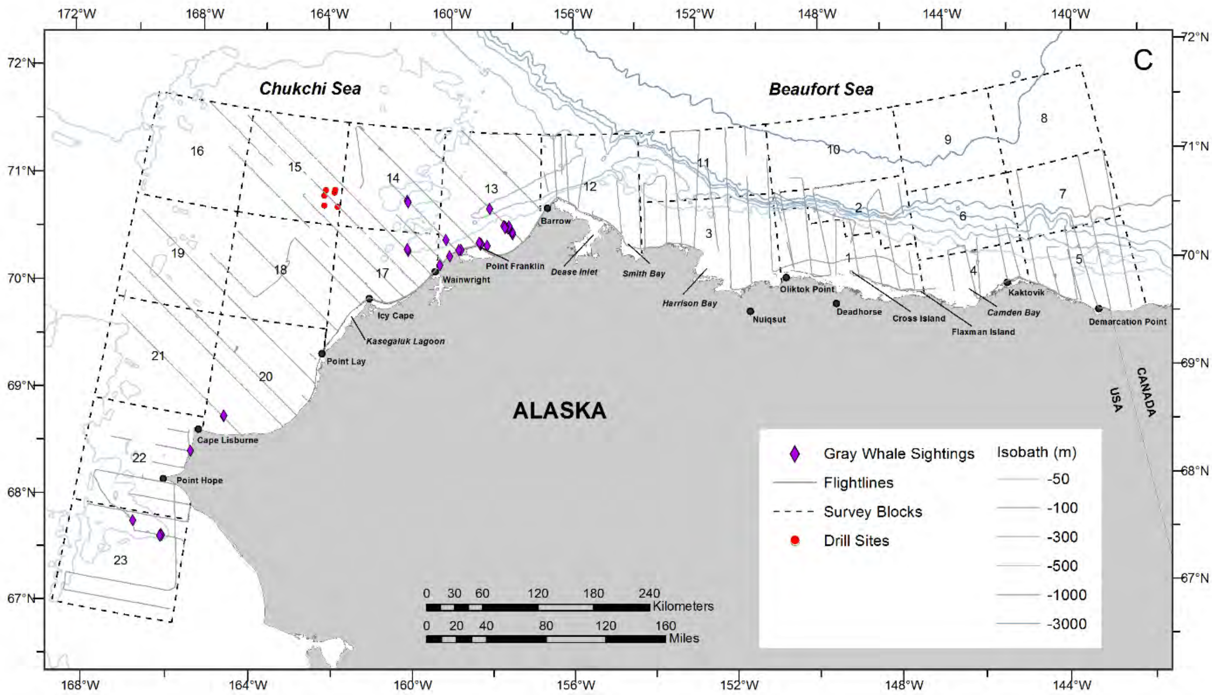


Figure 23. ASAMM 2015 semimonthly gray whale sightings, with transect, search, and circling effort. A: 2-15 July; B: 16-31 July. Deadhead flight tracks are not shown.



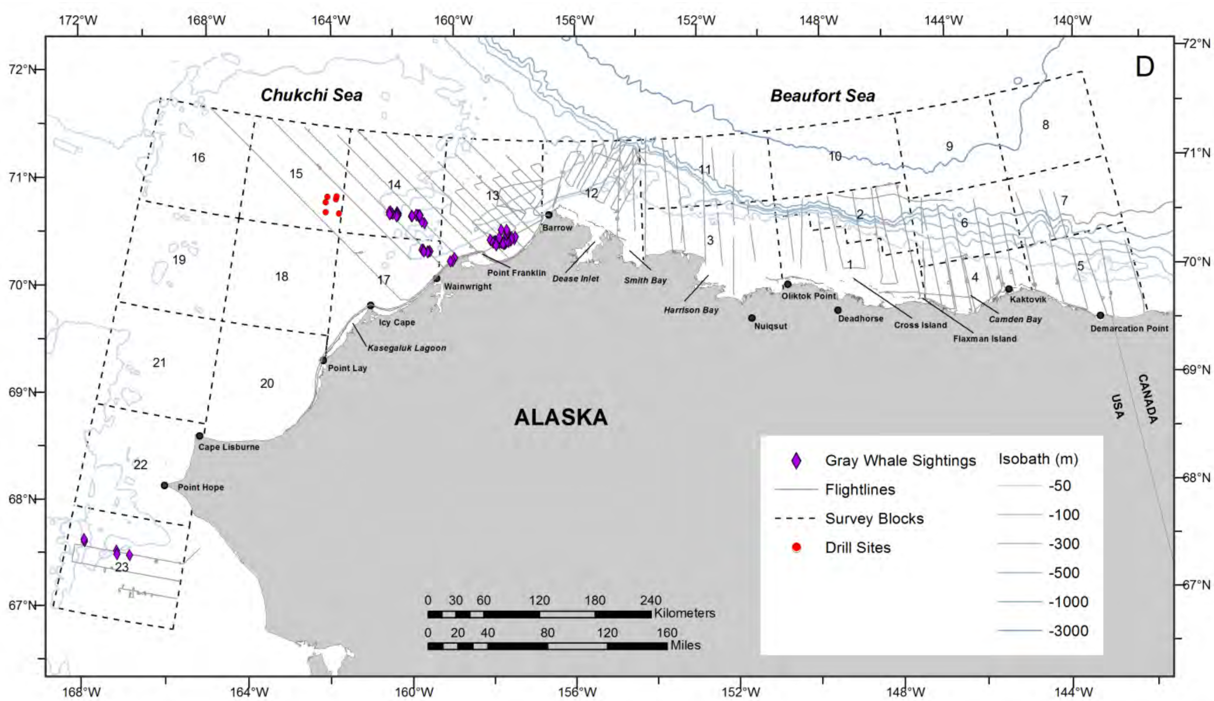
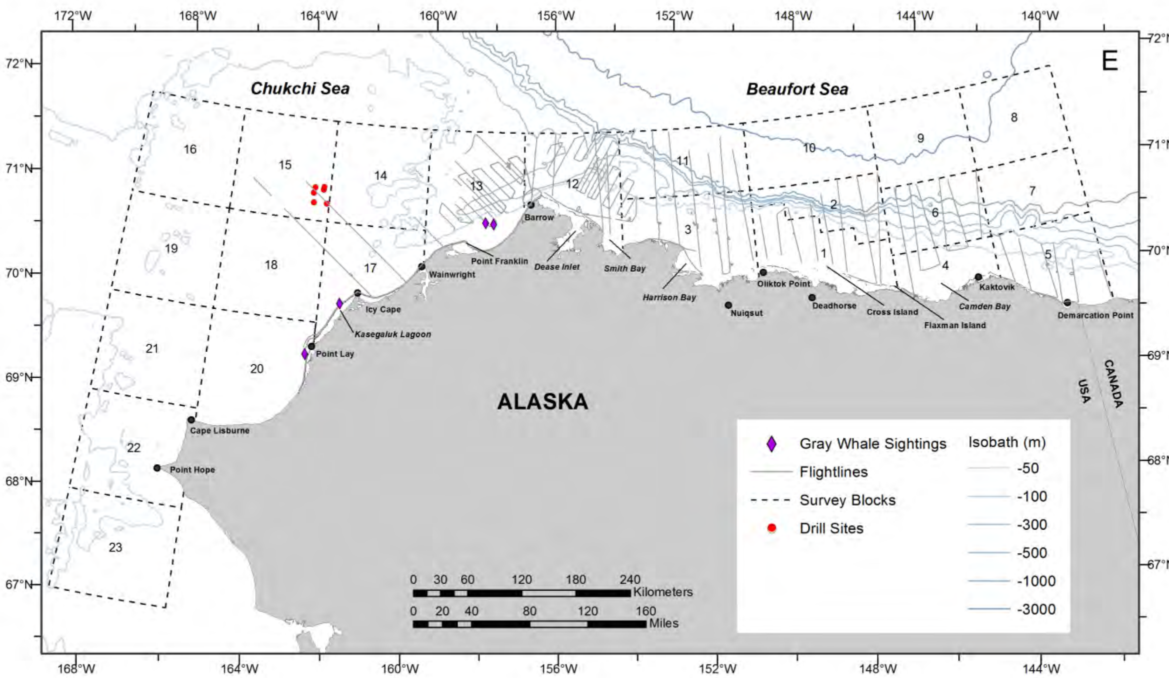


Figure 23 (cont). ASAMM 2015 semimonthly gray whale sightings, with transect, search, and circling effort. C: 1-15 August; D: 16-31 August. Deadhead flight tracks are not shown.



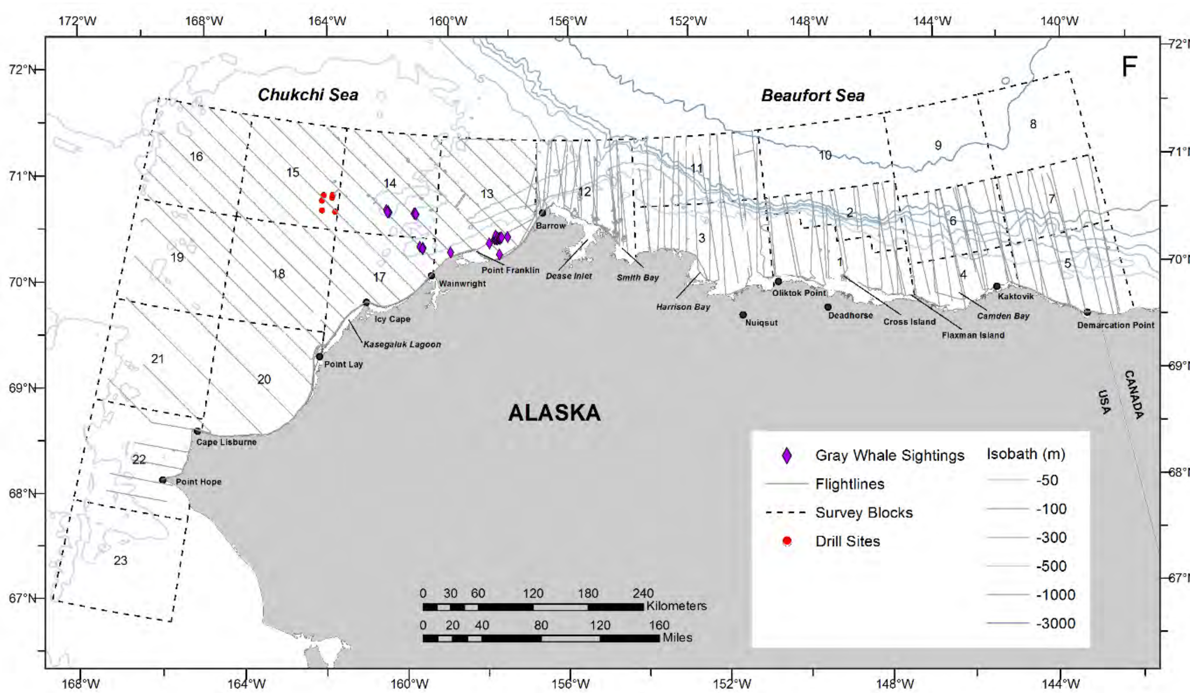
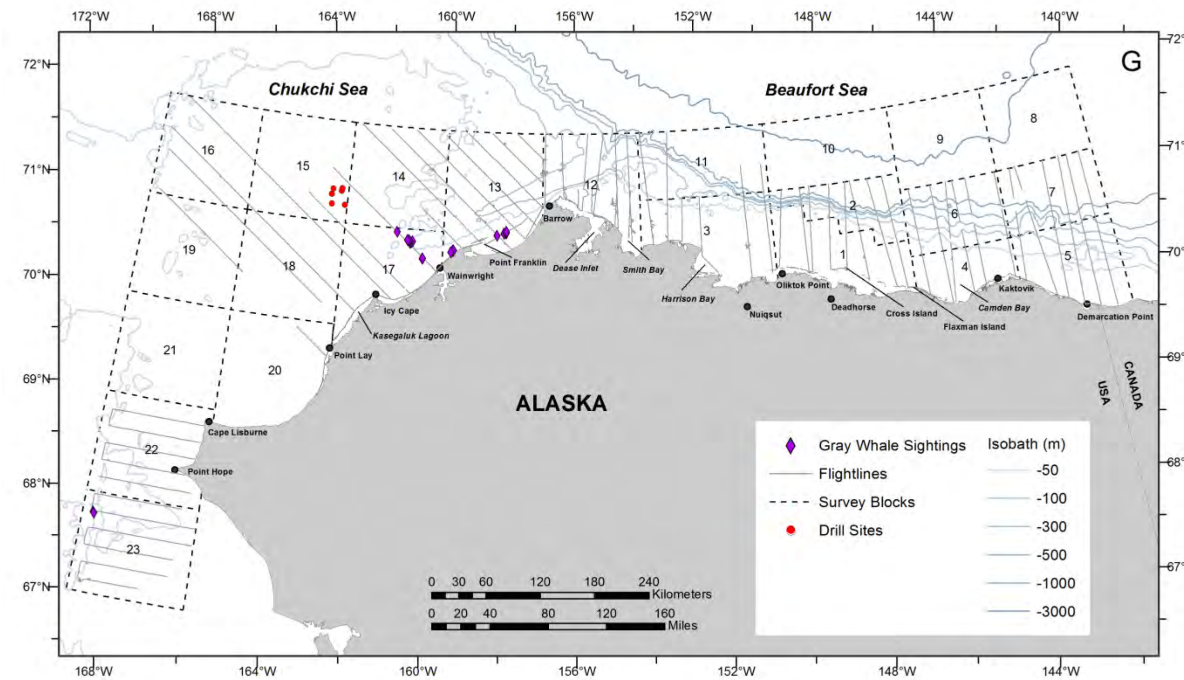


Figure 23 (cont). ASAMM 2015 semimonthly gray whale sightings, with transect, search, and circling effort. E: 1-15 September; F: 16-30 September. Deadhead flight tracks are not shown.



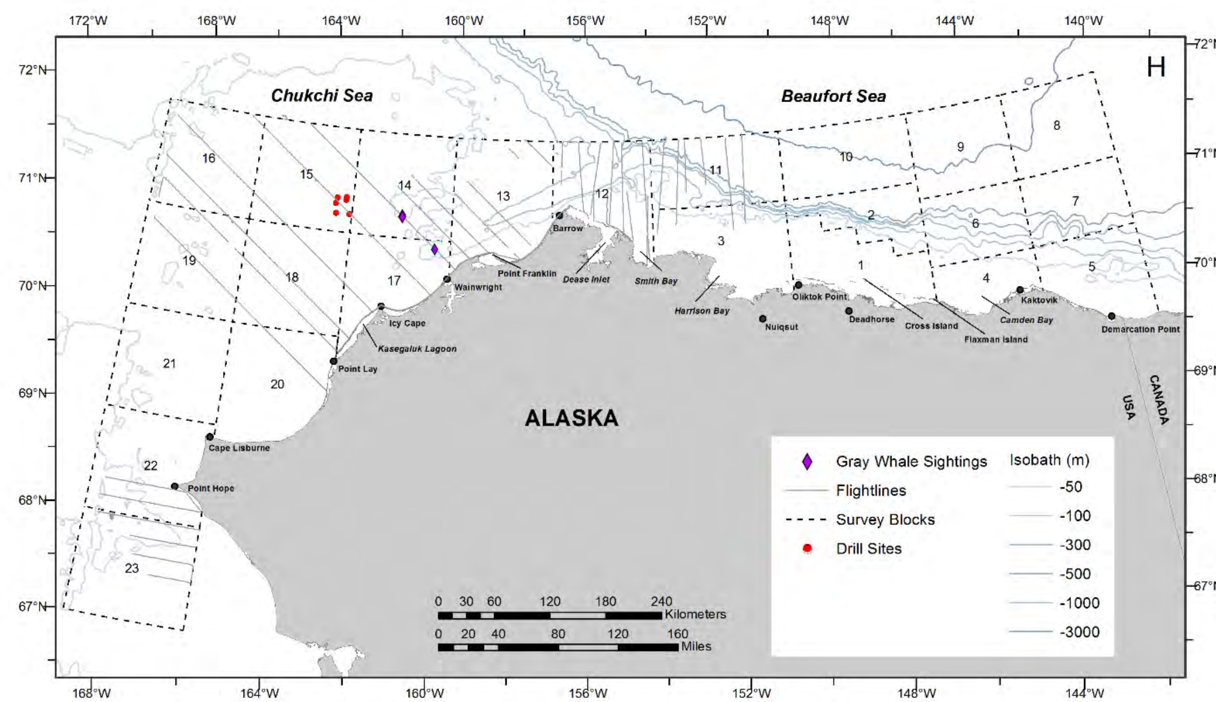


Figure 23 (cont). ASAMM 2015 semimonthly gray whale sightings, with transect, search, and circling effort. G: 1-15 October; H: 16-30 October. Deadhead flight tracks are not shown.

Lisburne, and in the southcentral Chukchi Sea, southwest of Point Hope (Figure 24). A comparison of Tr and Tr+TrC sighting rates for gray whales in 2015 is included in Appendix E (Figure E-5). As is the case with bowhead whales, gray whale Tr+TrC sighting rates better represent on-effort sightings and effort in 2015. Highest fine-scale Tr+TrC sightings rates include the areas mentioned above with the exception of the area northeast of Cape Lisburne.

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 2015 (and historically). For all months combined, the highest Tr sighting rates per survey block were in block 14 (0.013 WPUE), block 13 (0.013 WPUE), and block 17 (0.011 WPUE). Sighting rates (Tr) were highest in block 13 (0.025 WPUE) and block 14 (0.023 WPUE) in summer, and highest in block 17 in fall (0.005 WPUE) (Appendix E, Table E-5). Sighting rates in blocks 22 and 23 were relatively low compared to sighting rates in blocks 13, 14, and 17, and compared with sighting rates in those blocks in 2014 (Clarke et al. 2015a) (Figure 25).

Monthly Tr sighting rates in 2015 were higher in July compared to monthly sighting rates for July in 2009-2014, all years combined (Figure 26). The peak monthly gray whale Tr sighting rate in the western part of the study area (154°W-169°W) in 2015 was in July (0.017 WPUE), decreasing by nearly one-half in August (0.009 WPUE), and dropping off considerably in September and October, similar to that observed from 2008-2014. When Tr sighting rates were calculated separately for the northeastern Chukchi Sea (69°N-72°N, 154°W-169°W) and for the southcentral Chukchi Sea (67°N-69°N, 166°W-169°W) for 2008-2015, similar patterns emerged for gray whale Tr sighting rates in the northeastern Chukchi Sea for 2009-2014 and 2015 (Figure 27A). Sighting rates in the southcentral Chukchi Sea in 2015 reflect the lack of effort in July and September (Figure 27B).

As with bowhead whale sighting rates, gray whale sighting rates per block using sightings and effort on transect (Tr) combined with sightings and effort from 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 25). The highest Tr+TrC sighting rate was in block 17 in July (0.046 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 ≤35 m depth zone (0.012 WPUE) (Appendix E, Table E-7). Sighting rates were typically high in the ≤35 m depth zone, but atypically high in the 51-200 m North depth zone (Figure 28). Since aerial surveys recommenced in the northeastern Chukchi Sea in 2008, gray whale depth zone preference has been for shallower water in the northern Chukchi Sea in summer and deeper water in fall (Clarke et al. 2012, 2013a, 2014, 2015). However, in 2015, gray whale preference for shallower water was noted throughout summer and fall.

Sighting rates per depth zone calculated using sightings and effort on transect and on circling from transect (Tr+TrC) were generally higher in all depth zones compared to Tr sighting rates

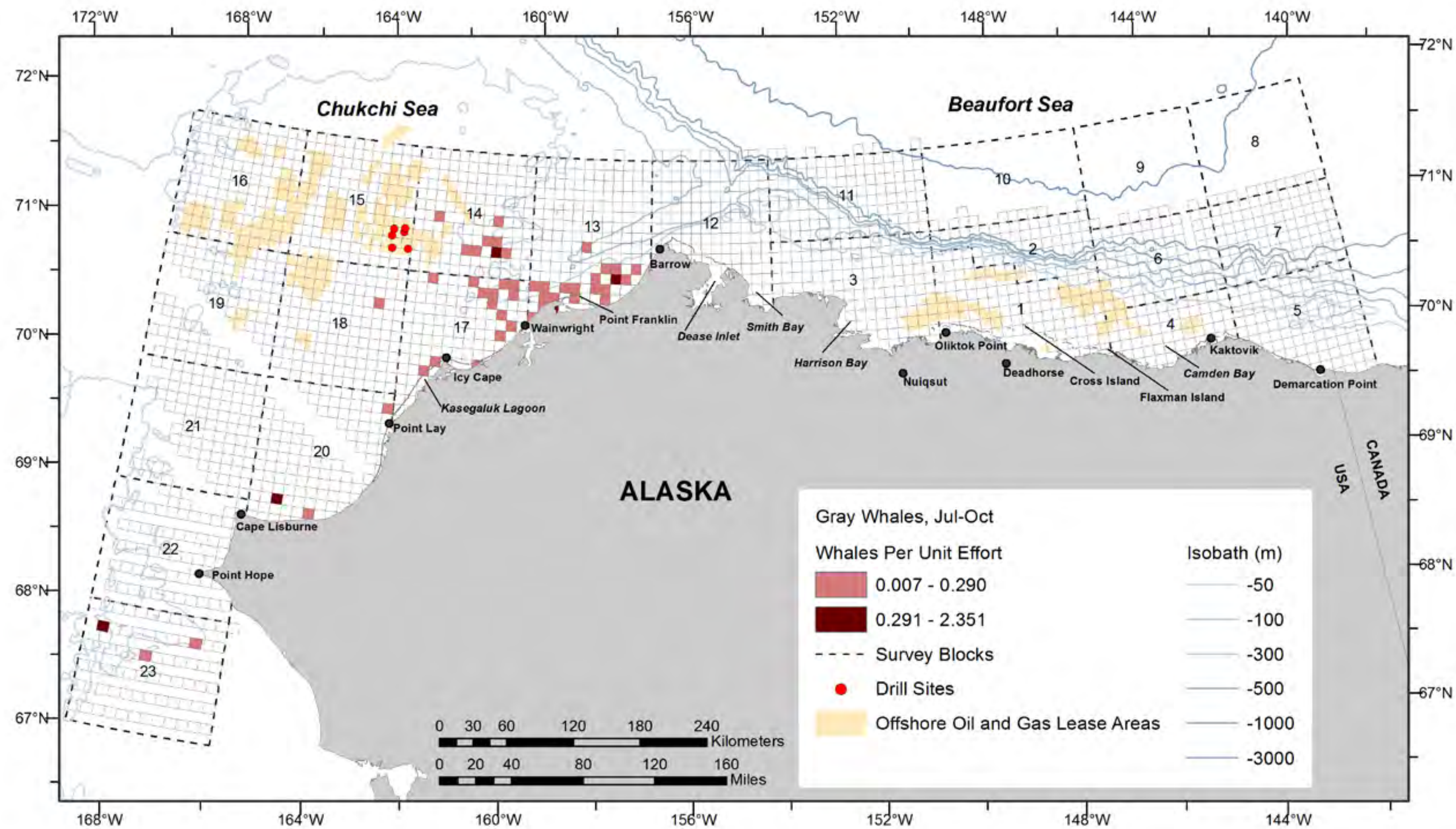


Figure 24. ASAMM 2015 gray whale sighting rates (WPUE; transect sightings from primary observers only), July-October. Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

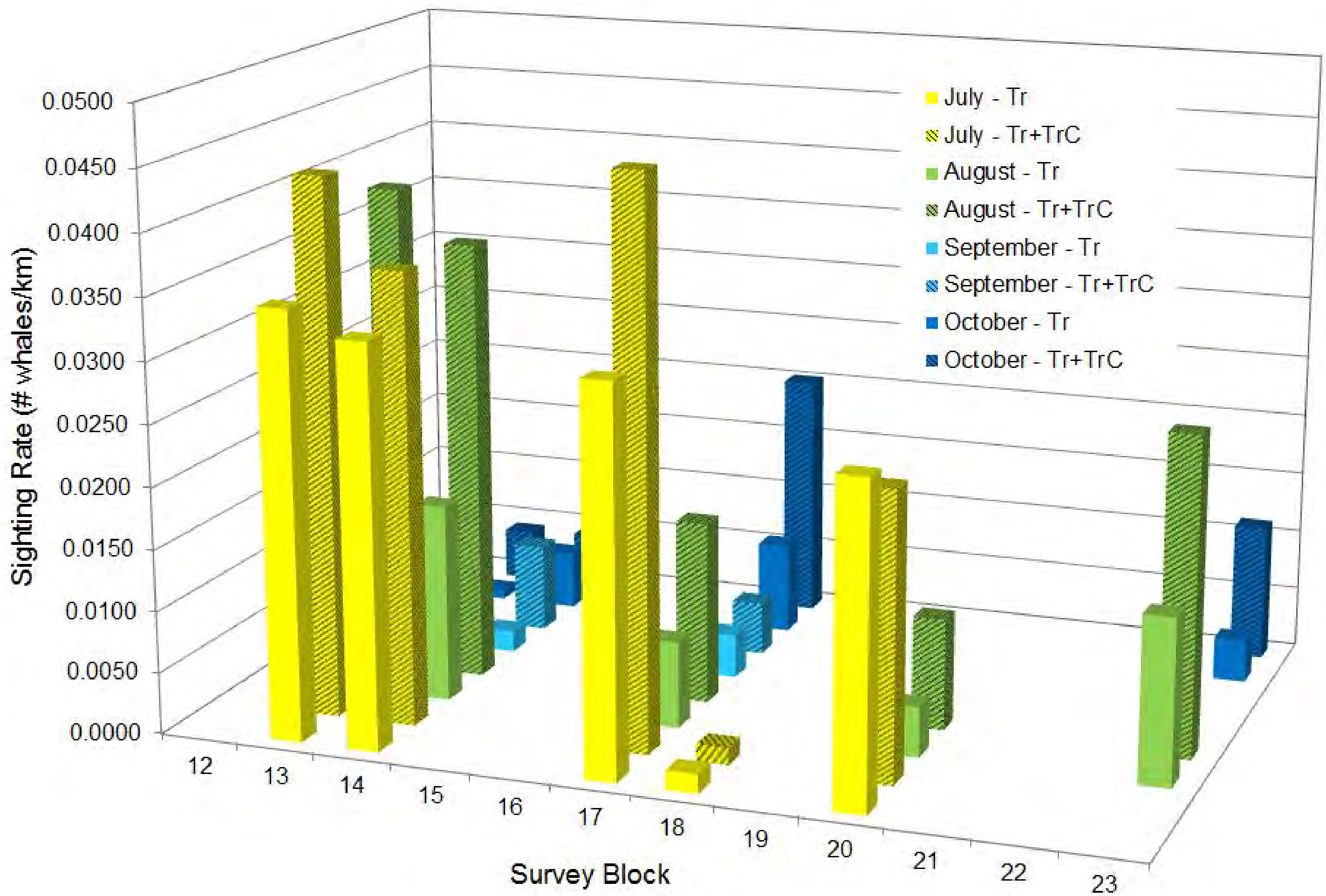


Figure 25. ASAMM 2015 gray whale monthly sighting rates (WPUE; sightings from primary observers only) per survey block for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

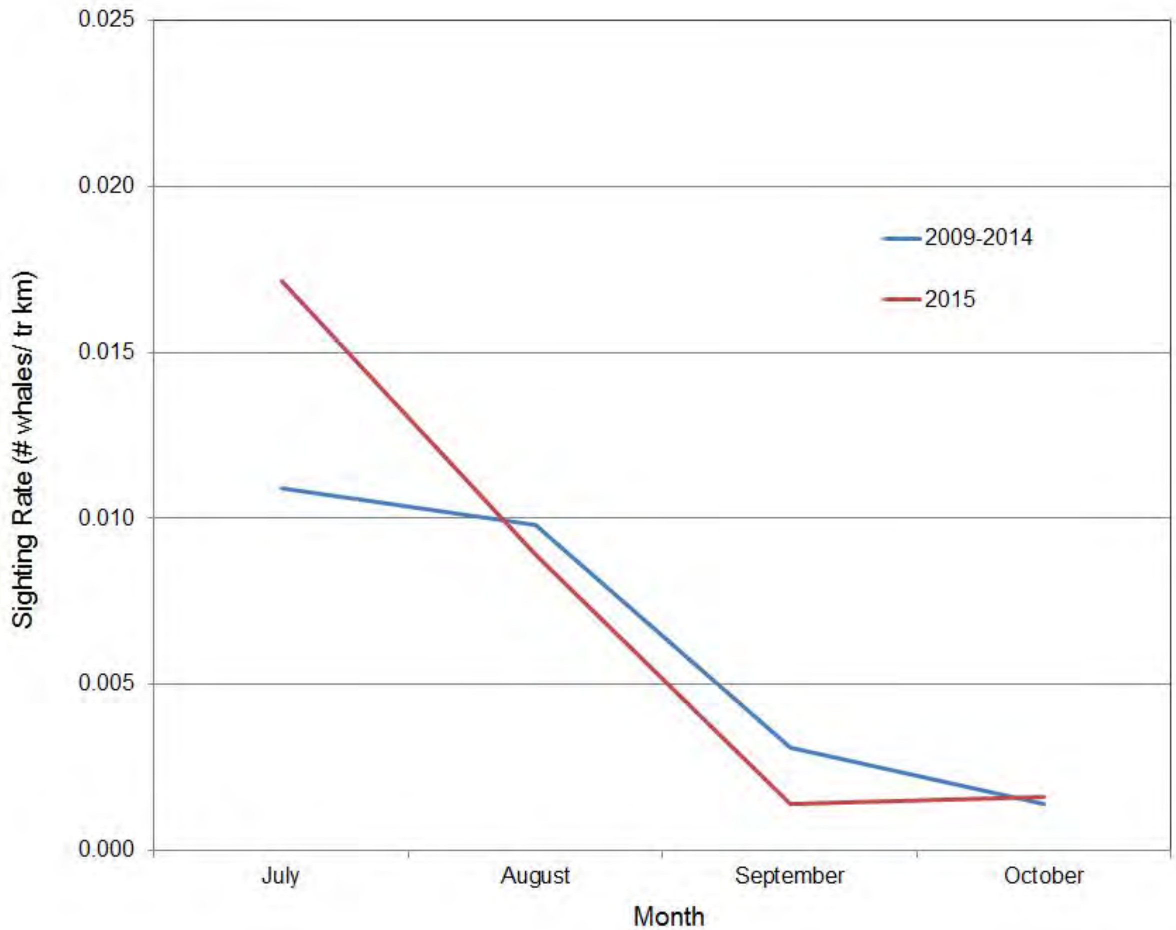


Figure 26. ASAMM gray whale monthly sighting rates (WPUE; transect sightings from primary observers only) in the eastern Chukchi Sea (67°N-72°N, 154°W-169°W), 2009-2014 and 2015.

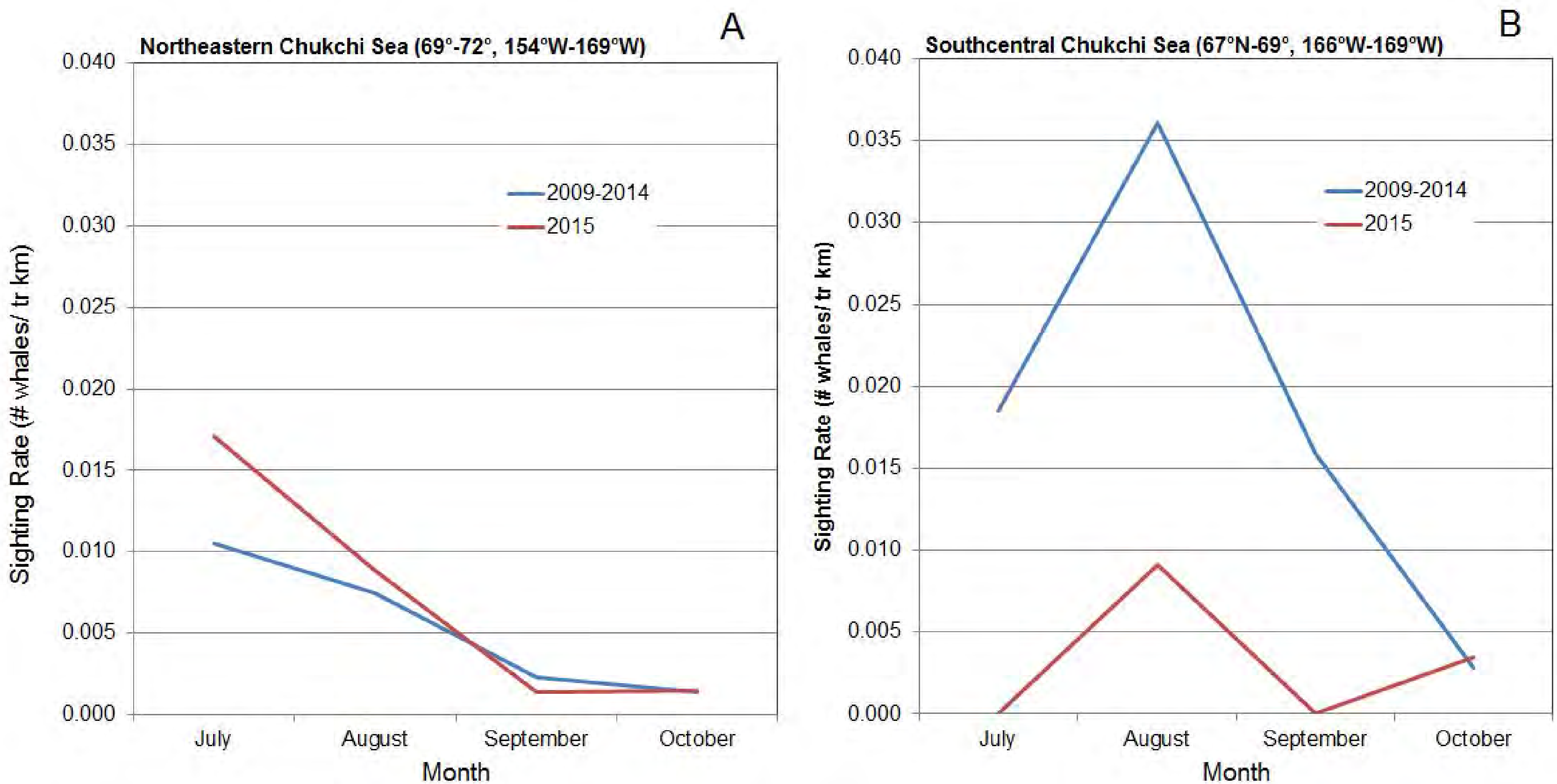


Figure 27. ASAMM gray whale monthly sighting rates (WPUE; transect sightings from primary observers only), 2009-2014 and 2015. A: northeastern Chukchi Sea (69°N-72°N, 154°W-169°W); B: southcentral Chukchi Sea (67°N-69°N, 166°W-169°W).

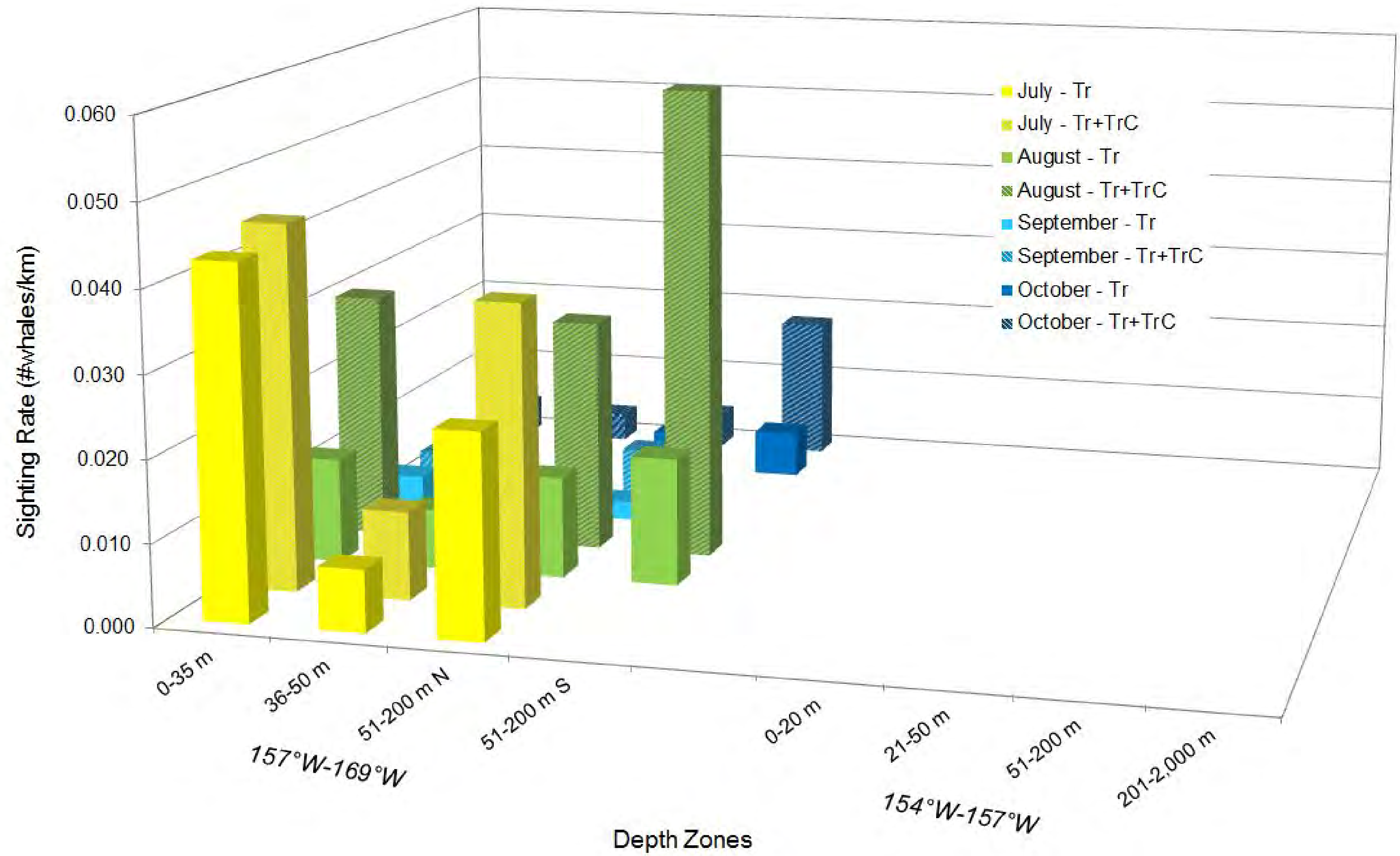


Figure 28. ASAMM 2015 gray whale monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC). Sighting rates of zero were removed from the graph for clarity.

(Figure 28, Appendix E, Table E-8). The highest Tr+TrC sighting rates was in the 51-200 m South depth zone in August.

Gray whale distribution in 2015 using only Tr sightings was not noticeably different from the distribution of Tr sightings observed in previous years having light sea ice cover (Figure 29). More gray whales than usual were sighted south of Hanna Shoal, and relatively few gray whales were seen in the southcentral Chukchi, including nearshore between Point Hope and Cape Lisburne and offshore southwest of Point Hope.

Gray Whale Sea Ice Associations

Most gray whales (95%, n = 442) were observed in 0% sea ice cover. Gray whales were observed in areas with sea ice cover, ranging from 5-25%, in July only. Sea ice remained in the study area until late August (Appendix A, Figure A-4) but mainly in offshore areas where gray whales were rarely observed. Both feeding behavior and calves were observed in areas of up to 25% sea ice cover, and sea ice cover did not appear to be an impediment to gray whale occurrence in 2015.

Gray Whale Behaviors

Behaviors of 464 gray whales observed during all survey modes (transect, search and circling) in 2015 are summarized in Table 9. The behaviors most often recorded were feeding (58%) and swimming (31%). Resting was recorded for 34 whales (7%). Other behaviors recorded included diving (n = 5 whales), milling (n = 6 whales), tail slapping (n = 3 whales), and exhaling underwater (n = 2 whales). Behavior was not recorded for one whale (<1%) that was too far away to definitively identify the behavior. Fine-scale Tr sighting rates of feeding and milling gray whales in 2015 are shown in Figure 30, with the majority of the highest Tr sighting rates in the northeastern Chukchi Sea between Wainwright and Barrow. None of the gray whales observed on transect in the southcentral Chukchi Sea were feeding; only 10% (n = 4) of the total whales seen during all survey modes (transect, search and circling) in 2015 in the southcentral Chukchi Sea were feeding. Most gray whales seen south of 69°N were swimming. None of the gray whales appeared to respond to the aircraft.

Eighty-three gray whale calves were seen in 2015 (Figure 31). Most calves (n = 66, 80%) 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 0.178, which is lower than the ratio observed in 2013 (Clarke et al. 2014) but higher than the ratio recorded for 2009-2012 and 2014 (Clarke et al. 2011d, 2012, 2013a, 2015a) (Figure 32). Calf distribution overlapped that of adult gray whales both temporally and spatially in 2015. Most calves (55%, n = 46) were within 30 km of shore, however 29% (n = 24) were greater than 50 km from shore. Seven calves were sighted in the southcentral Chukchi Sea (block 22 and 23). Gray whale calves were not seen east of Point Barrow. Forty-five calves were observed in July, 35 in August, 1 in September, and 2 in October. On 14 occasions, multiple calves were seen in one day, with the

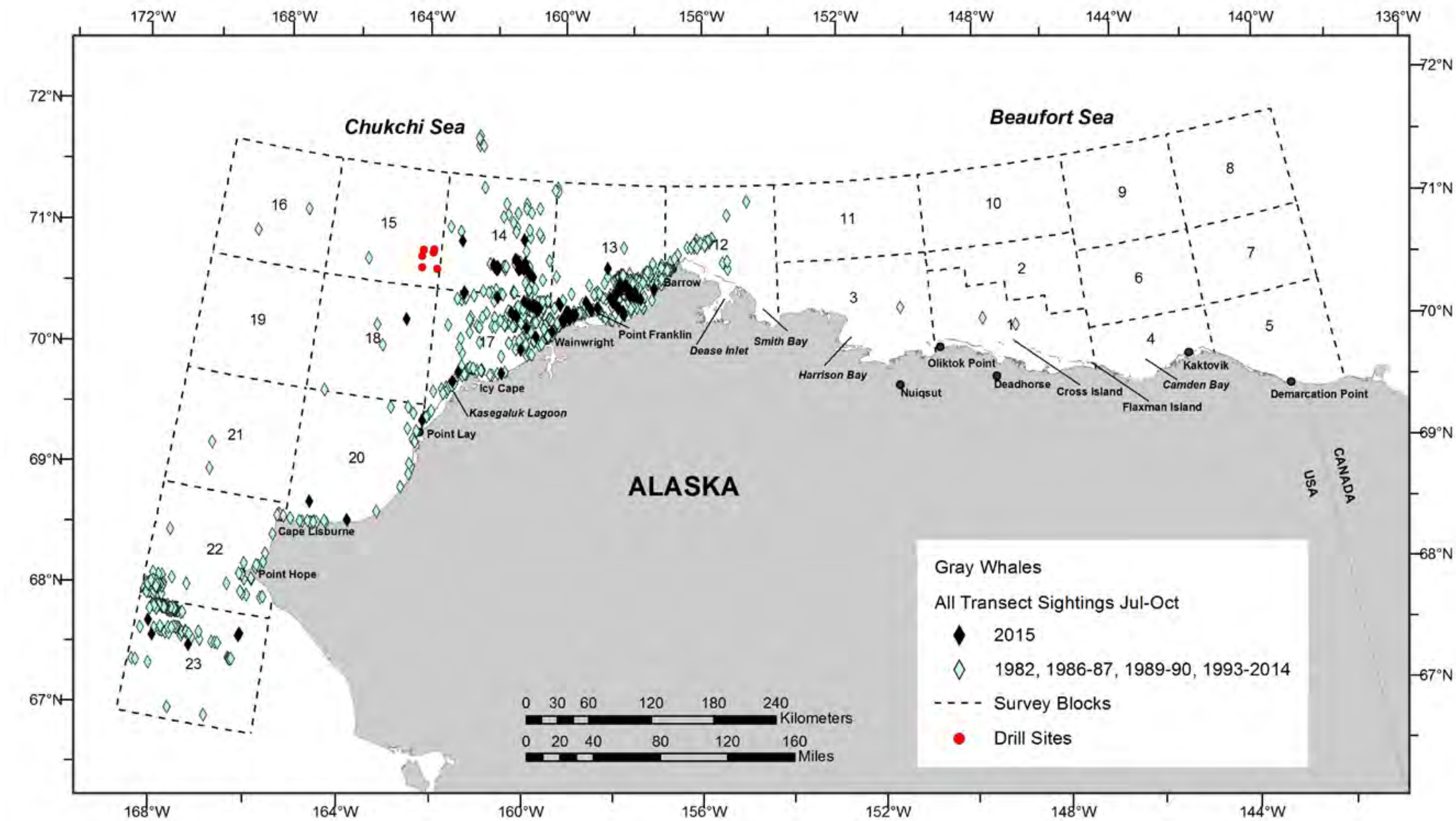


Figure 29. ASAMM gray whale sightings on transect in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2014, and 2015. Includes all sightings on transect made by primary and secondary observers.

Table 9. ASAMM 2015 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	16-30 Oct	Total
Dive	0	0	0	4/4	0	0	1/1	0	5/5
Feed	31/82	4/14	21/41	59/90	3/3	21/25	9/12	1/1	149/268
Mill	0	0	3/6	0	0	0	0	0	3/6
Rest	4/5	11/21	0	2/7	0	0	1/1	0	18/34
Swim	14/23	20/37	13/28	12/22	1/1	7/11	11/20	3/4	81/146
Tail Slap	0	1/3	0	0	0	0	0	0	1/3
Underwater Blow	1/2	0	0	0	0	0	0	0	1/2
Unknown	0	0	0	0	0	0	1/1	0	1/1
TOTAL	50/112	36/75	37/75	77/123	4/4	28/36	23/35	4/5	259/465

highest daily total on 30 July (20 calves; Appendix B, Flight 212). Some calves may have been sighted on more than one day.

Gray whale swim direction in the northeastern Chukchi Sea was not significantly clustered around any heading in any month in the northeastern Chukchi Sea. There were too few data to test for significance in the southcentral Chukchi Sea. Most gray whales observed during ASAMM are at the far northern extent of the species' range and are feeding, so a lack of directed migratory movement is not surprising.

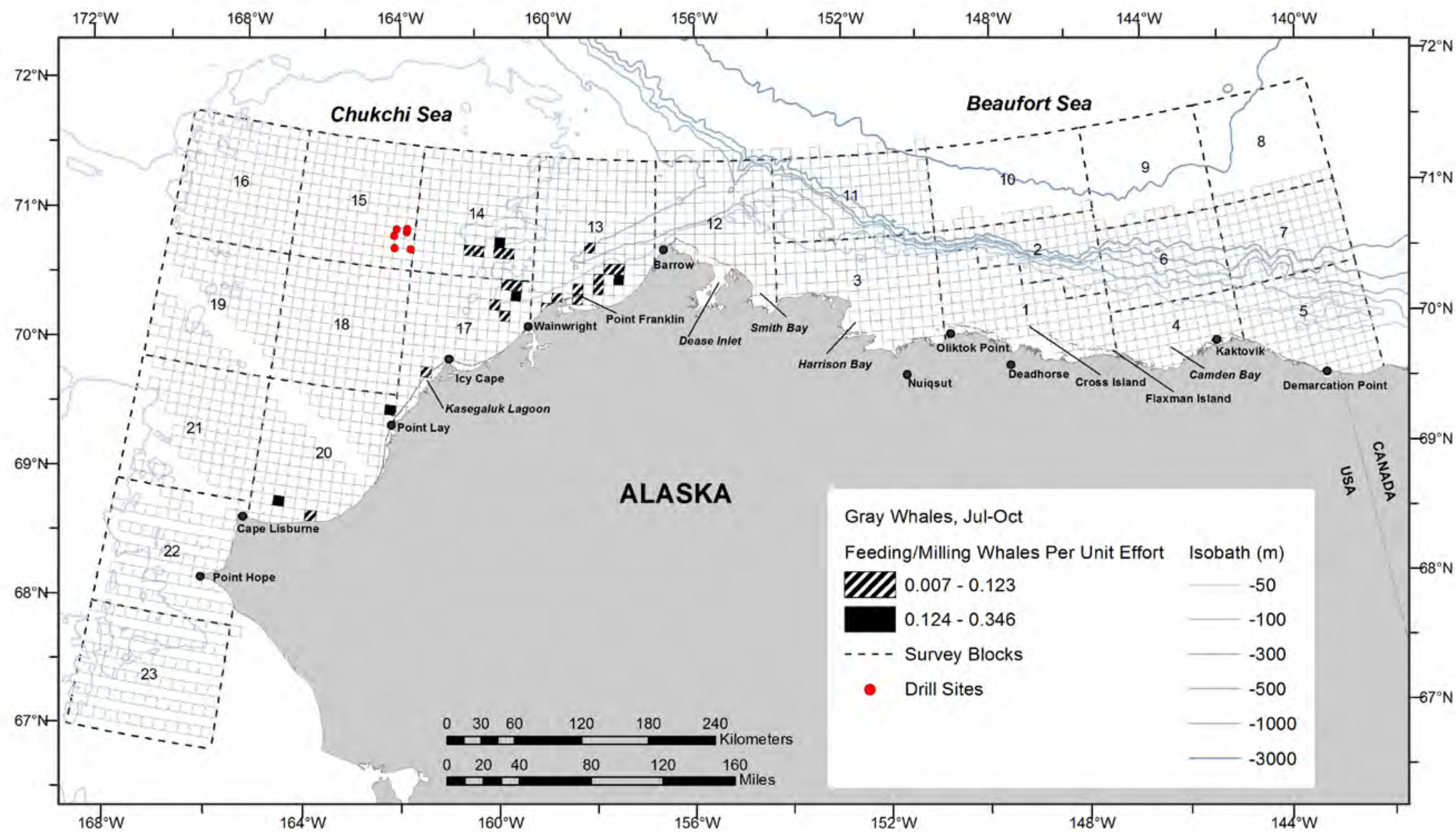


Figure 30. ASAMM 2015 gray whale feeding and milling sighting rates (WPUE; transect sightings from primary observers only). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

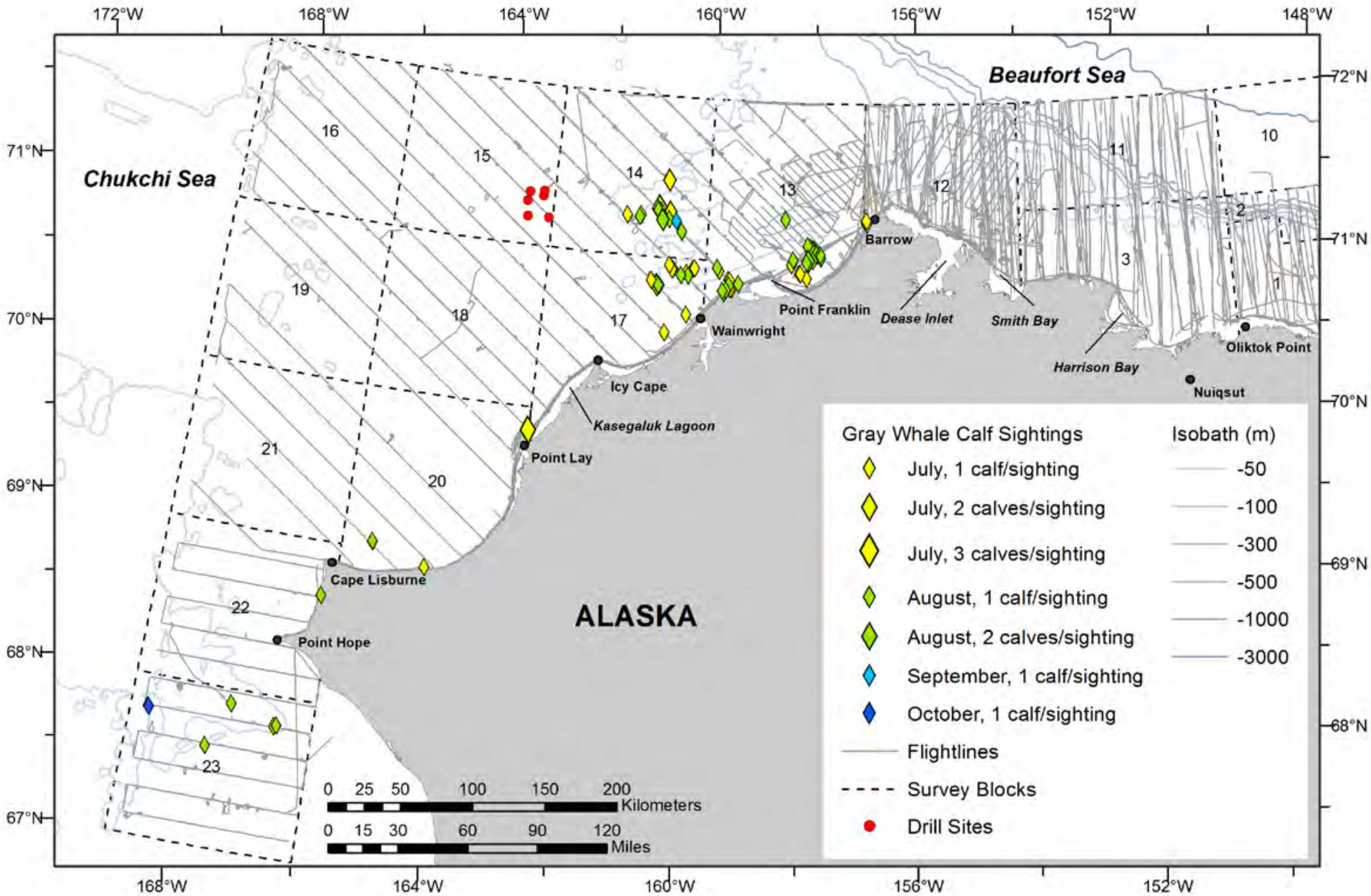


Figure 31. ASAMM 2015 gray whale calf sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

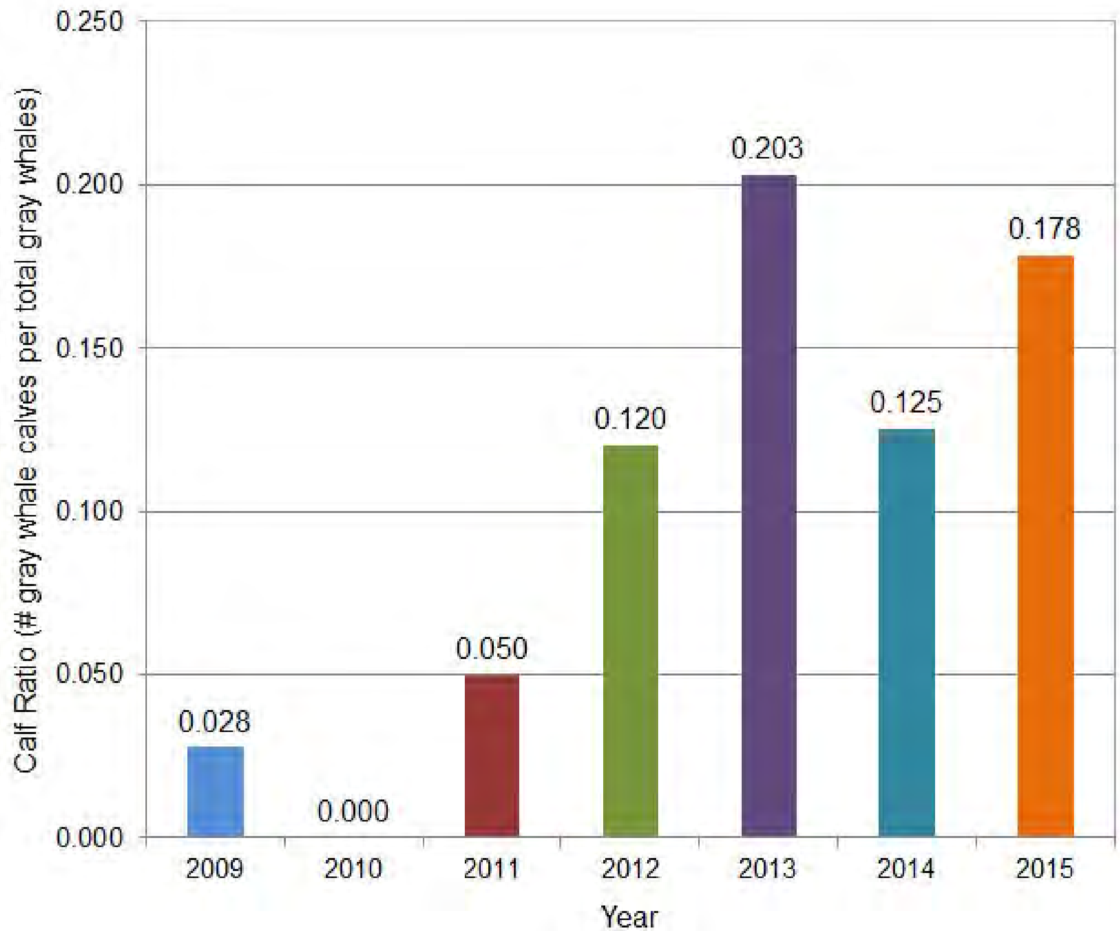


Figure 32. ASAMM gray whale annual calf ratios (number of gray whale calves per total gray whales), 2009-2015.

Humpback Whales

There were 10 sightings of 17 humpback whales (*Megaptera novaeangliae*) in 2015, including one calf (Table 3, Figure 33). Stock affiliation of humpback whales in this region is unknown. Most (88%) of the humpback whales were seen in the southcentral Chukchi Sea in August (n = 3) and October (n = 12). One humpback whale was seen 5 km west of Wainwright in early July (Appendix B, Flight 205) and one was seen approximately 90 km west of Point Lay in mid-August (Appendix B, Flight 220). Three humpback whales seen in late August were in close association with several fin whales and a few gray whales, approximately 120 km south of Point Hope (Appendix B, Flight 226). Humpback whales were observed swimming (76%), feeding (18%), and tail slapping (6%). None of the humpback whales appeared to respond to the survey aircraft.

Fin Whales

There were 17 sightings of 22 fin whales (*Balaenoptera physalus*) of the Northeast Pacific stock in 2015, all in the southcentral Chukchi (Table 3; Figure 33). Most of the fin whales were seen on 23 August (n = 18; Appendix B, Flight 226) in close association with humpback whales, minke whales, and gray whales. Fin whales were distributed approximately 40-140 km south and southwest of Point Hope. All fin whales sighted were adults. Fin whales were observed and swimming (82%), feeding (14%), and diving (4%). None of the fin whales appeared to respond to the survey aircraft.

Minke Whales

There were 6 sightings of 6 minke whales (*Balaenoptera acutorostrata*) of the Alaska stock in 2015 (Table 3; Figure 33). Minke whales were seen on 30 July west of Icy Cape (Appendix B, Flight 212), nearshore between Cape Lisburne and Point Hope on 1 August and 18 September, and 80 and 120 km south of Point Hope on 23 August. All minke whales sighted were adults. None of the minke whales appeared to respond to the survey aircraft.

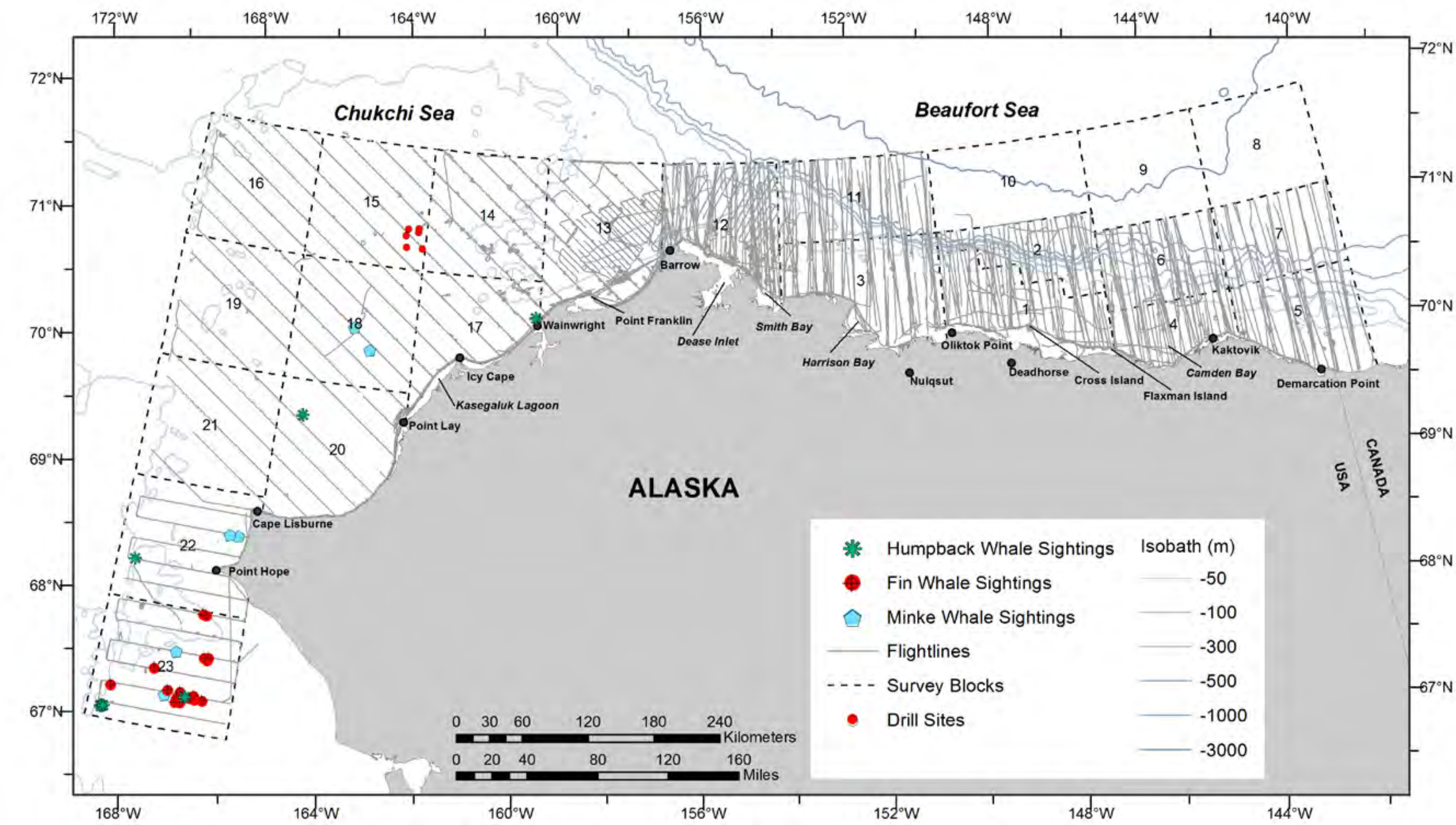


Figure 33. ASAMM 2015 humpback, fin, and minke whale sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Belugas

BELUGA SIGHTING SUMMARY

During the 2015 ASAMM surveys, 602 sightings of 1,799 belugas (*Delphinapterus leucas*) were observed in the study area during all survey modes (transect, search, and circling) (Table 3). Beluga stock affiliation is impossible to determine from aerial surveys, and sightings likely encompassed belugas from the Eastern Chukchi Sea and Beaufort Sea stocks (Hauser et al. 2014). Belugas were seen in all months surveyed (July-October) in the eastern Chukchi and western Beaufort seas (Figure 34). In the eastern Chukchi Sea, belugas were broadly distributed both nearshore, especially near Kasegaluk Lagoon, and up to 190 km offshore. In the western Beaufort Sea, belugas were seen along the continental slope, with several sightings nearshore, particularly in September. Belugas were also seen near Barrow Canyon from July through October. Beluga distribution in 2015 was generally similar to that documented in previous years with light sea ice cover, particularly in the western Beaufort Sea (Figure 35).

BELUGA SIGHTING RATES

In summer and fall 2015, belugas were seen from 67.9°N to 72°N between 140.1°W and 166.6°W. There were 533 sightings of 1,561 belugas on transect by primary observers, ranging from 1 beluga per sighting (n = 324) to 210 belugas per sighting (n = 1). The highest number of sightings on transect per survey block was in block 11 (123 sightings), followed by block 2 (112 sightings), and block 12 (102 sightings). In the eastern Chukchi Sea, the highest beluga Tr sighting rates in 2015 occurred in July, decreased substantially in August, remained low in September, and increased in October (Figure 36, Appendix E, Table E-9). In the western Beaufort Sea, sighting rates were relatively low in July and September, higher in August, and increased considerably in October. Sighting rates likely reflect the presence of the Eastern Chukchi Sea stock in the northeastern Chukchi and western Beaufort seas in summer (July-August) (Hauser et al. 2014). Relatively low Tr sighting rates in the ASAMM study area in September 2015 might be indicative of greater abundance north (north of 72°N) or east (east of 140°W) of the ASAMM study area, while the higher abundance in October may be an indication that belugas were reentering the ASAMM study area. Beluga Tr sighting rates in 2015 were lower compared to observations in 2012-2014, but higher than observations in 2011 (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 Barrow Canyon (Figure 37). In the northeastern Chukchi Sea, areas of highest fine-scale Tr sighting rates were nearshore north of Icy Cape (block 17, based on a single sighting of 210 belugas).

For all months combined, block 10 had the highest Tr sighting rate (0.250 WPUE), however survey coverage was minimal in that block in 2015, and the resulting sighting rate may not be representative. The highest Tr sighting rates per survey block, other than block 10, were in block 2 (0.114 WPUE) and block 11 (0.106 WPUE) (Appendix E, Table E-9). Offshore survey blocks

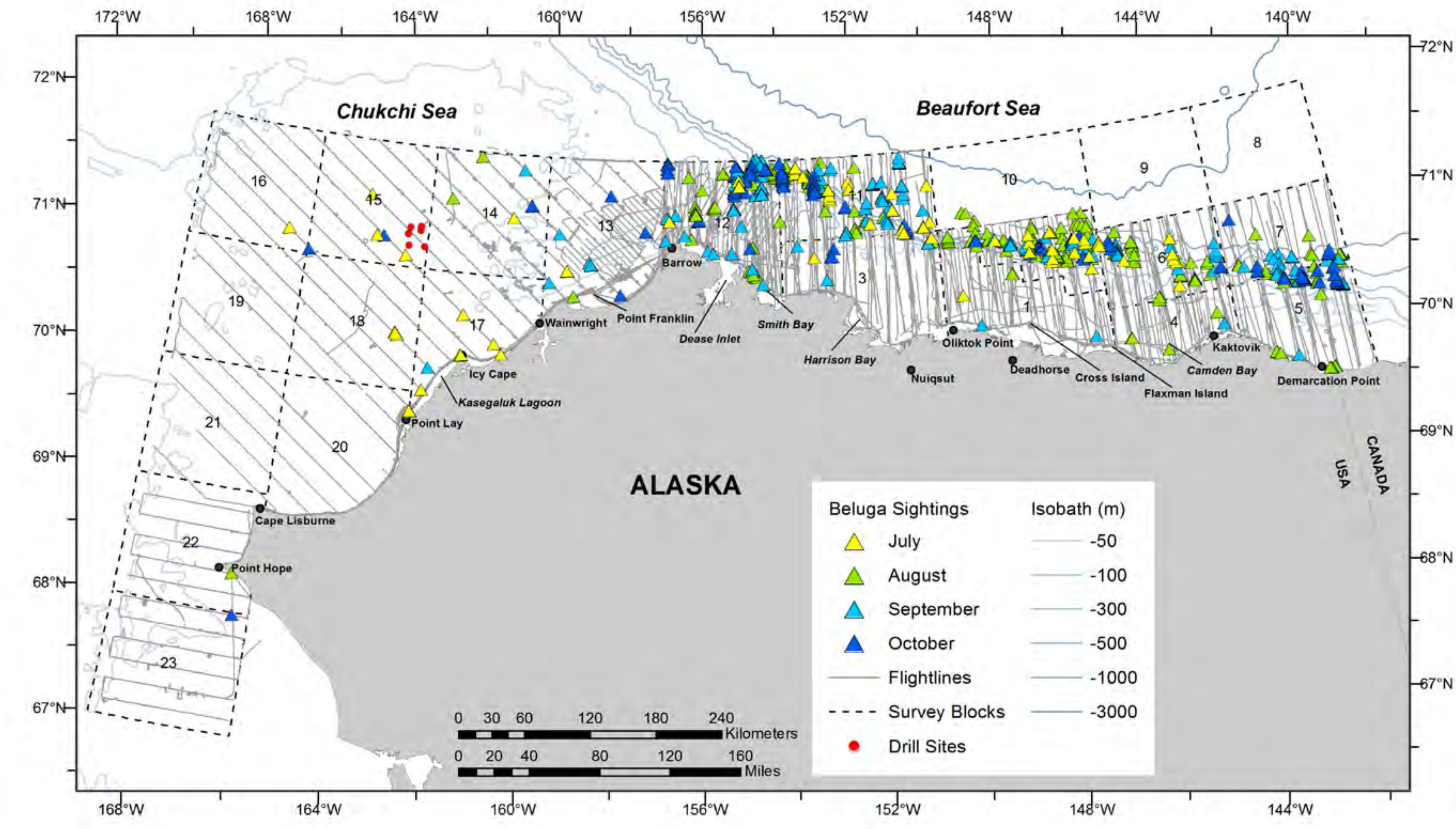


Figure 34. ASAMM 2015 beluga sightings plotted by month, with transect, search, and circling effort. Deadhead flight tracks are not shown.

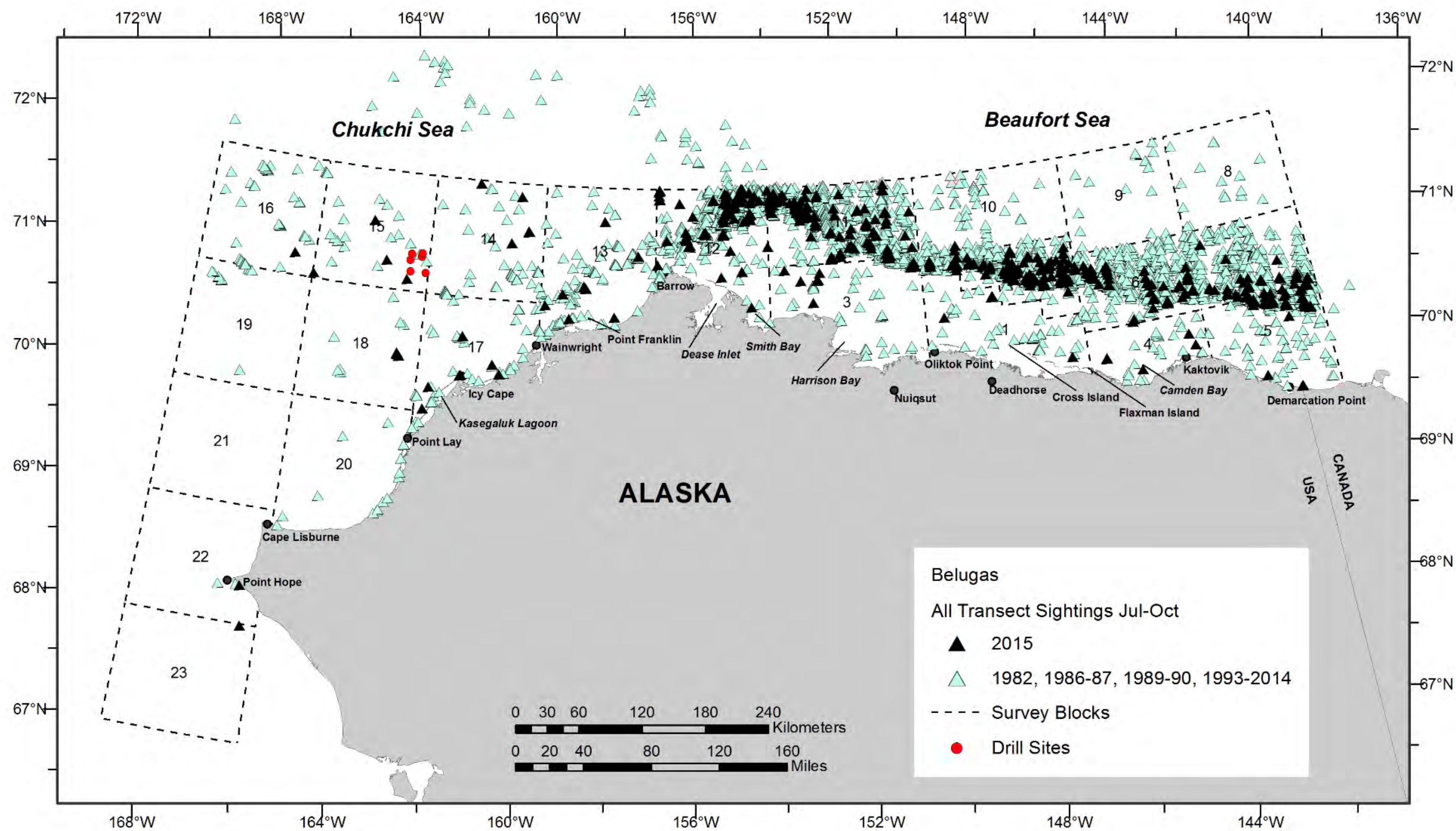


Figure 35. ASAMM beluga sightings on transect in years with light sea ice cover: 1982, 1986-87, 1989-90, 1993-2014, and 2015. Includes all sightings on transect made by primary and secondary observers.

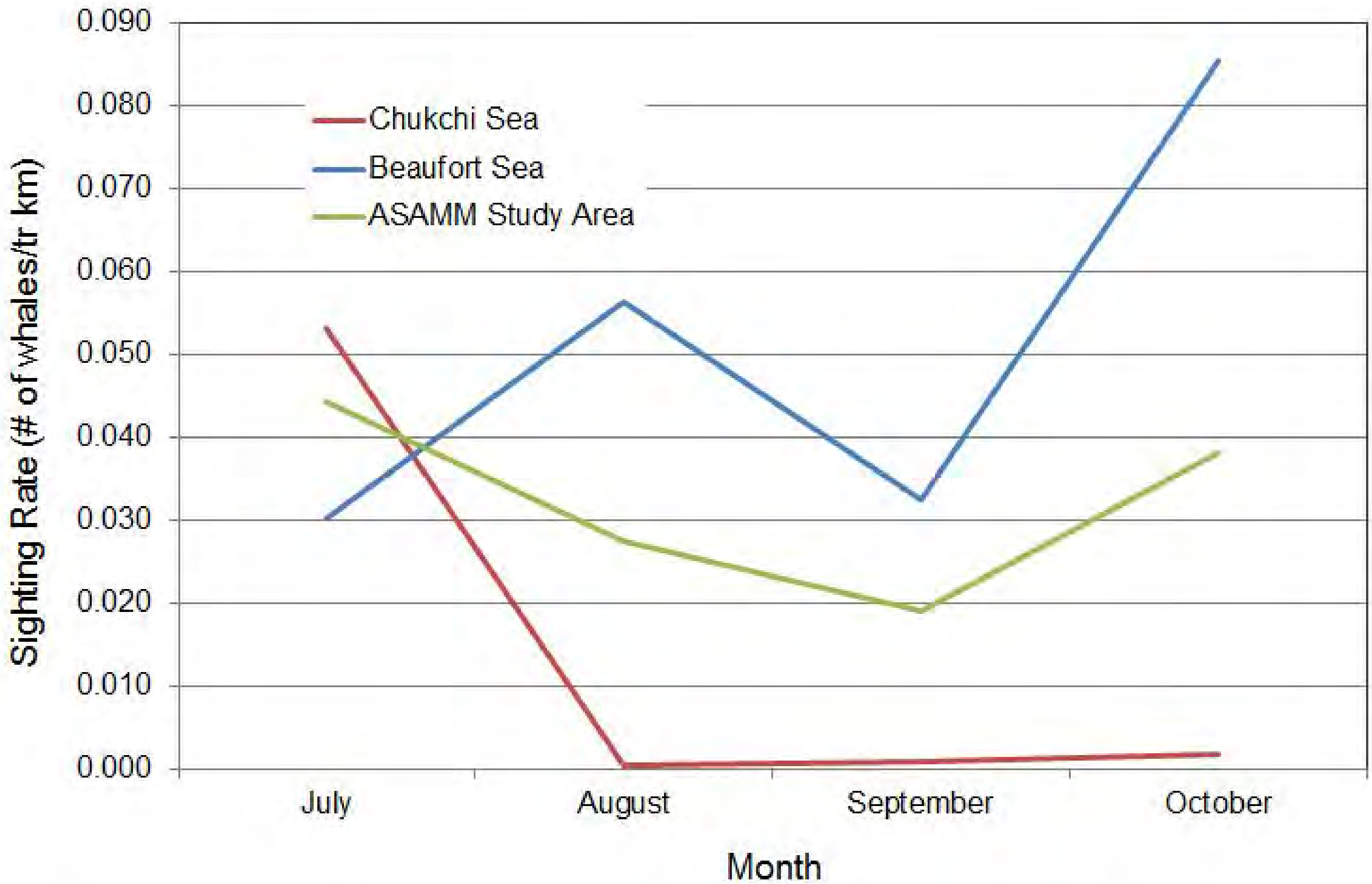


Figure 36. ASAMM 2015 beluga monthly sighting rates (WPUE; transect sightings from primary observers only) in the western Beaufort and eastern Chukchi seas, and in the entire ASAMM study area.

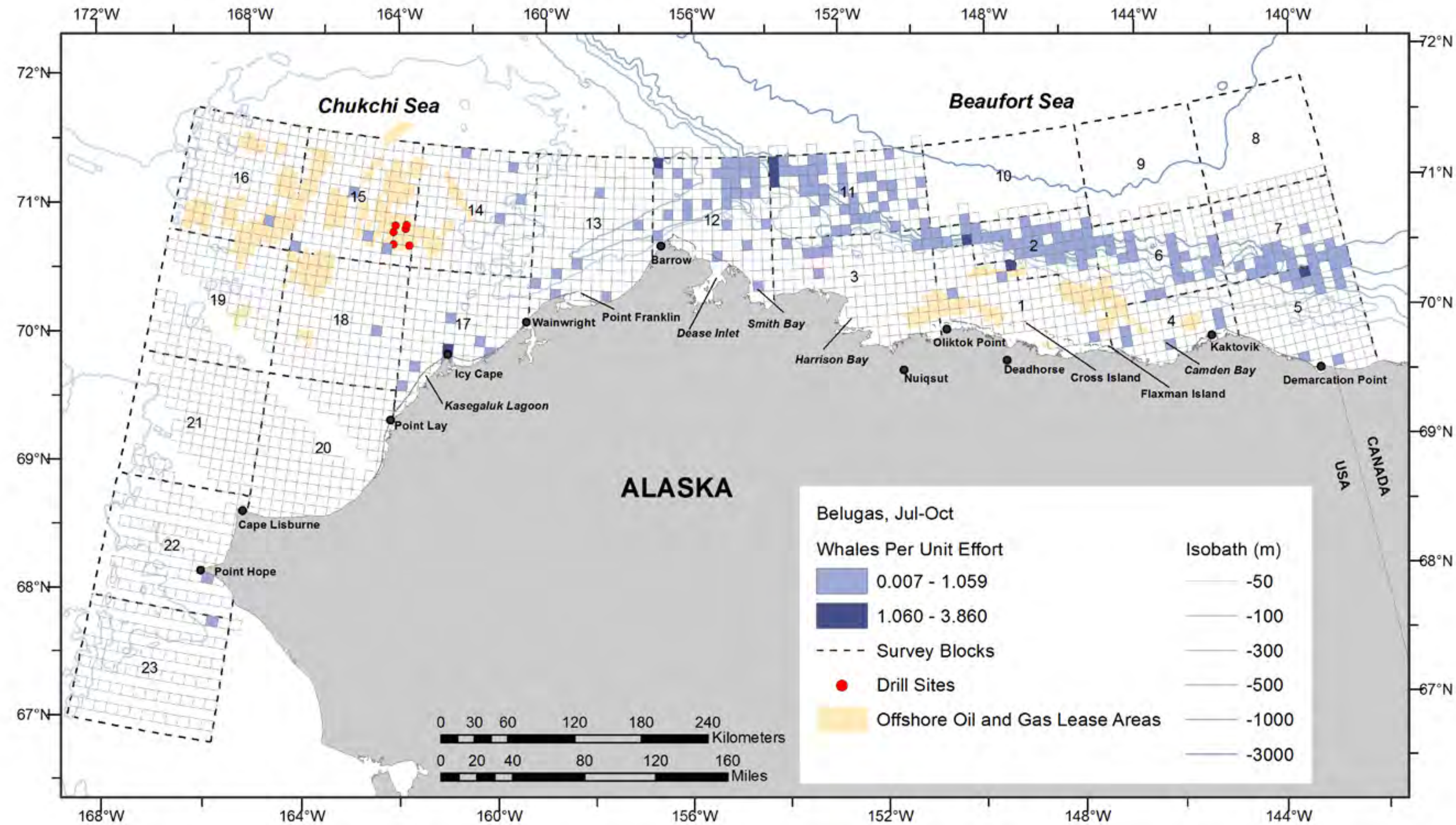


Figure 37. ASAMM 2015 beluga sighting rates (WPUE; transect sightings from primary observers only). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

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 38).

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

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

Beluga Sea Ice Associations

Belugas were observed in sea ice cover ranging from no ice to 99% new and broken floe ice. Most belugas (82%, n = 1,484) were observed in less than 10% sea ice cover. Belugas were observed in association with sea ice cover (1-93% sea ice cover) from July through late-August and towards the end of October (99% sea ice cover) when new sea ice was forming. Sea ice, likely grounded ice, remained in the western Beaufort Sea study area throughout September, just north of the barrier islands east of Deadhorse (Appendix A, Figures A-6 and A-7), and a few belugas were seen near there.

Beluga Behaviors

Behaviors of belugas observed during all survey modes (transect, search, and circling) in 2015 are summarized in Table 10. The behavior most often recorded was swimming (77%). Milling was recorded for 304 belugas (17%), including the only large group of belugas seen in 2015, and resting was recorded for 110 belugas (6%). Four (<1%) belugas appeared to respond to the survey aircraft; three belugas dived and one beluga changed swim direction.

Swim direction was evaluated for belugas for different regions and time periods. The mean vector swim direction for belugas in the northeastern Chukchi Sea (154°W-169°W, to incorporate Barrow Canyon) in summer (July-August) was not significantly clustered around a mean heading. Swim direction was clustered around a mean heading of 290°T ($Z = 14.581$, $P < 0.0001$) in the western Beaufort Sea (140°W-154°W) in summer. In fall (September-October) swim direction was significantly clustered around a mean heading of 280°T ($Z = 8.200$, $P < 0.0001$) in the northeastern Chukchi Sea and 282°T ($Z = 37.772$, $P < 0.0001$) in the western Beaufort Sea.

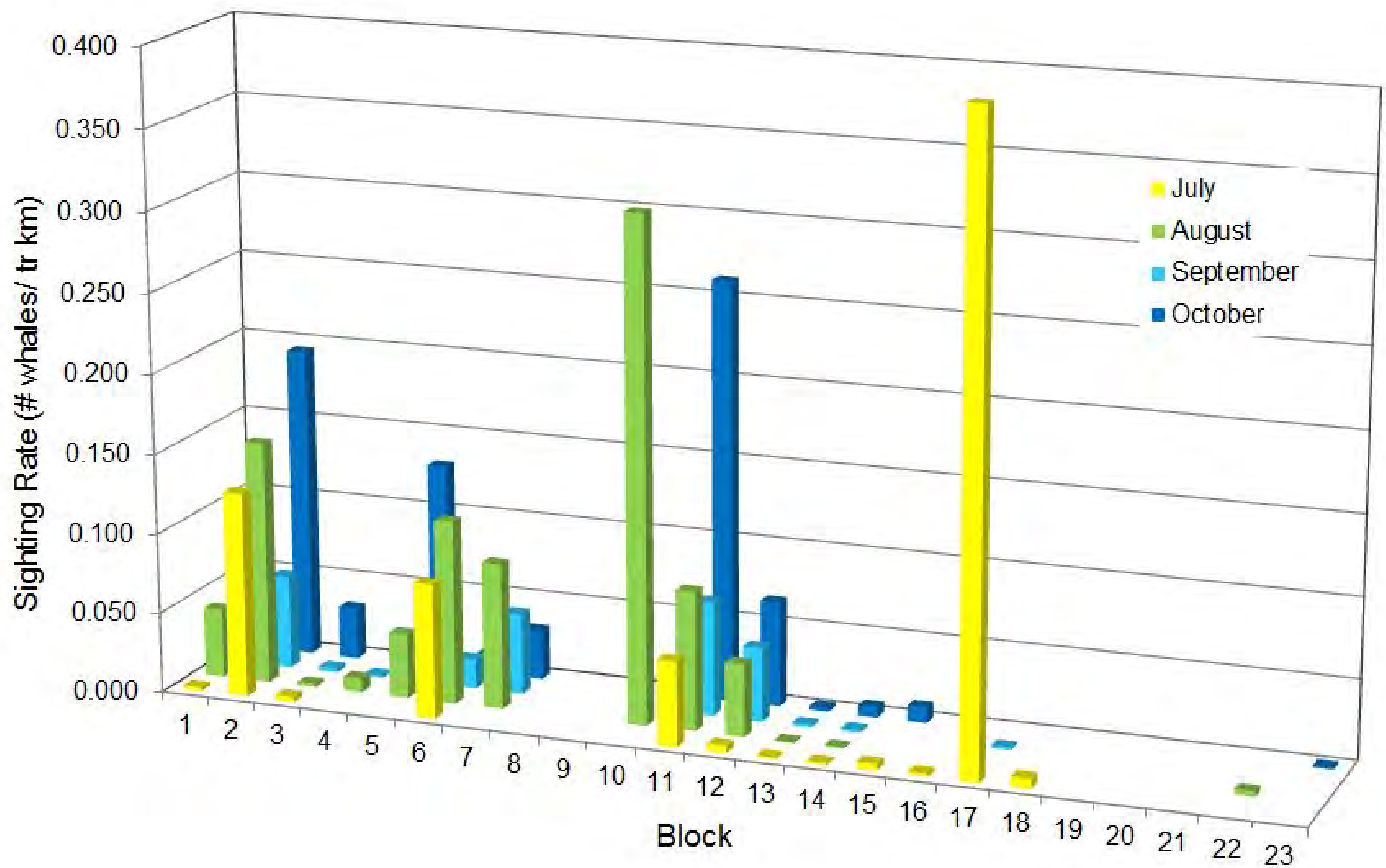


Figure 38. ASAMM 2015 beluga monthly sighting rates (WPUE; sightings from primary observers only) per block for sightings and effort on transect (Tr). Sighting rates of zero were removed from the graph for clarity.

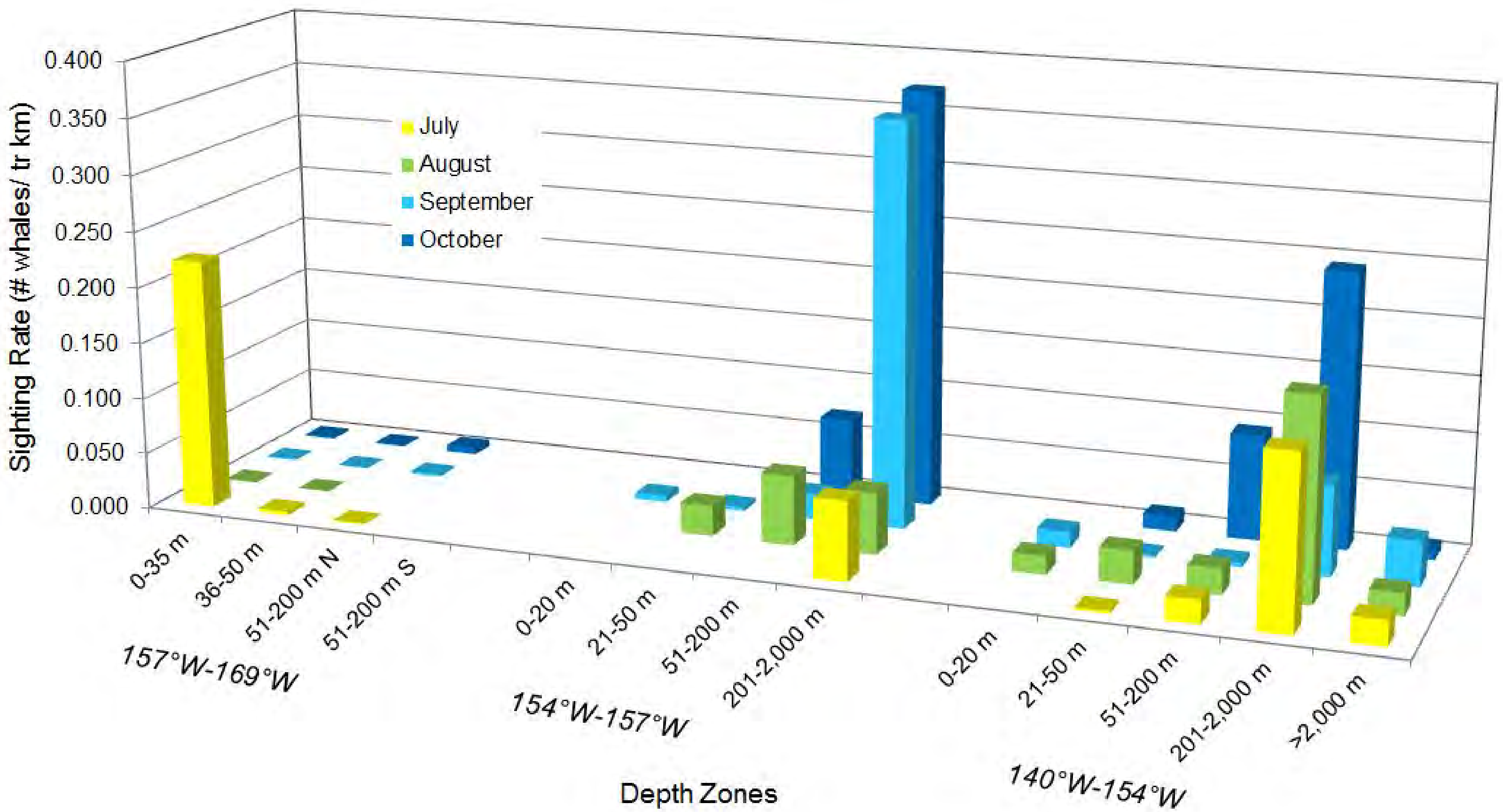


Figure 39. ASAMM 2015 beluga monthly sighting rates (WPUE; sightings from primary observers only) per depth zone for sightings and effort on transect (Tr). Sighting rates of zero were removed from the graph for clarity.

Table 10. ASAMM 2015 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	16-30 Oct	Total
Dive	0	0	2/2	2/2	0	0	1/1	0	5/5
Mill	0	4/230	4/22	3/9	1/7	7/29	2/4	1/3	22/304
Other	0	0	1/1	0	0	0	0	0	1/1
Rest	0	6/6	10/23	11/25	8/23	16/23	8/9	1/1	60/110
Swim	9/16	55/142	58/189	115/235	58/143	105/241	97/396	17/17	514/1,379
TOTAL	9/16	65/378	75/237	131/271	67/173	128/293	108/410	19/21	602/1,799

There were 88 sightings of 121 beluga calves observed during all survey modes (transect, search, and circling). Animals identified as calves likely included belugas up to a few years old. Calves nurse for up to two years but may remain with their mothers after weaning has occurred (Suydam 2009), often forming triads when a new calf is born. Color is 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 40), although a few were seen near barrier islands in the Beaufort Sea. Few calves were seen in the eastern Chukchi Sea, although the largest single sighting of calves was seen near Icy Cape. Beluga calves are likely under-represented in the dataset because of their small size and the infrequency of circling over beluga sightings.

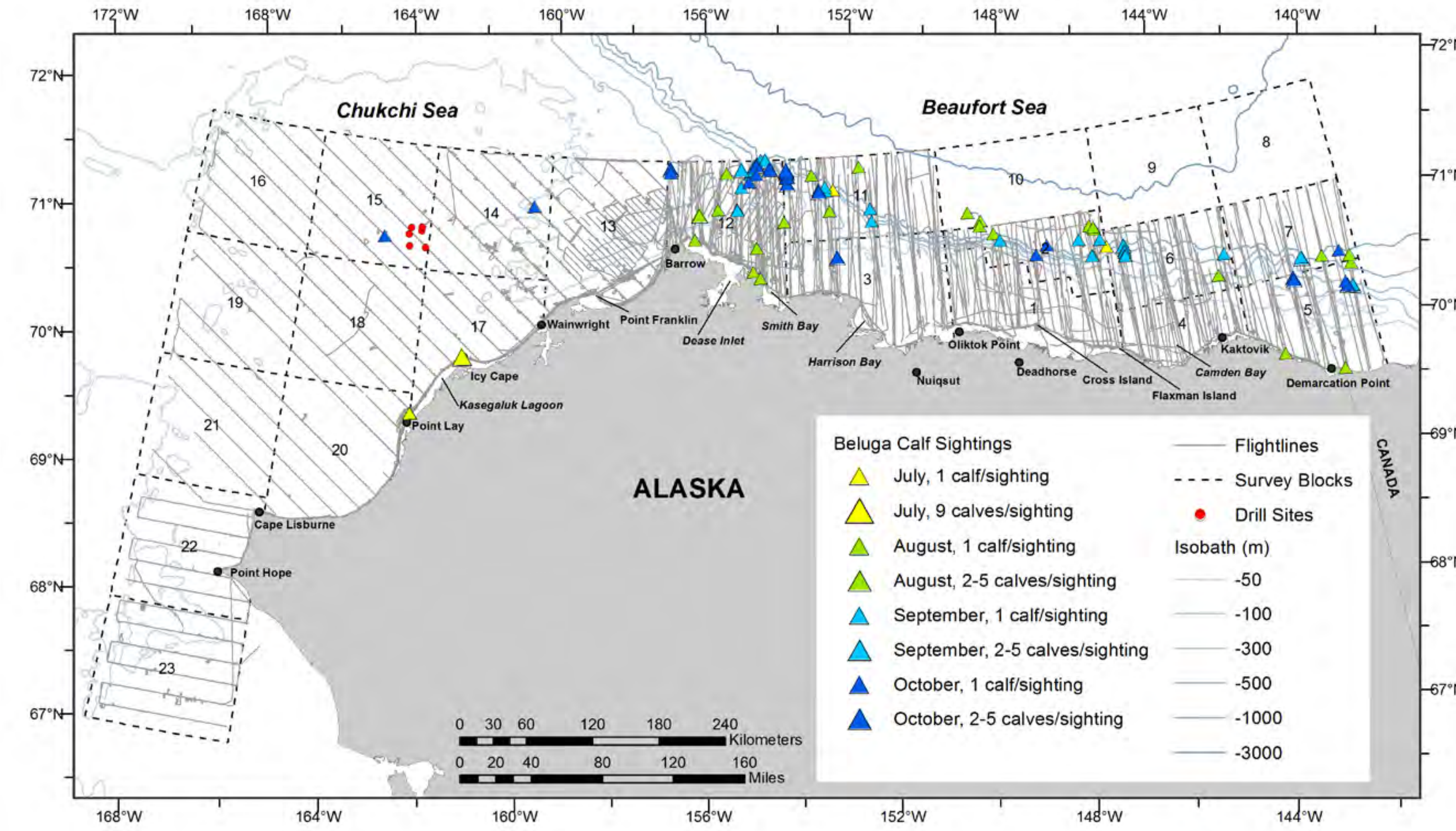


Figure 40. ASAMM 2015 beluga calf sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

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. Circling was not initiated on one occasion in 2015 to avoid potential interference with subsistence hunting and on one occasion to avoid going west of the International Dateline. There were 73 sightings of 87 unidentified cetaceans in 2015 (Table 3; Figure 41). Most of the cetaceans that could not be identified to species (n = 45, 52%) were seen during seven surveys conducted in late August and early September in support of Arctic ACEs. ASAMM surveys of ACEs transects were conducted without any circling making verification of species and behavior more difficult. Forty-six of the unidentified cetaceans were in the eastern Chukchi Sea, and 41 unidentified cetaceans were in the western Beaufort Sea. Fifteen of the unidentified cetaceans were probable bowhead whales, based on their size and darker color. Five unidentified cetaceans were likely gray whales, and two unidentified cetaceans were likely minke whales, based on size and shape. The majority of unidentified cetacean sightings were not seen clearly enough to identify to species with any probability. There were also four sightings of five unidentified marine mammals (Figure 41); none of them were seen clearly enough to identify to species with any probability.

None of the unidentified cetaceans or marine mammals appeared to respond to the survey aircraft.

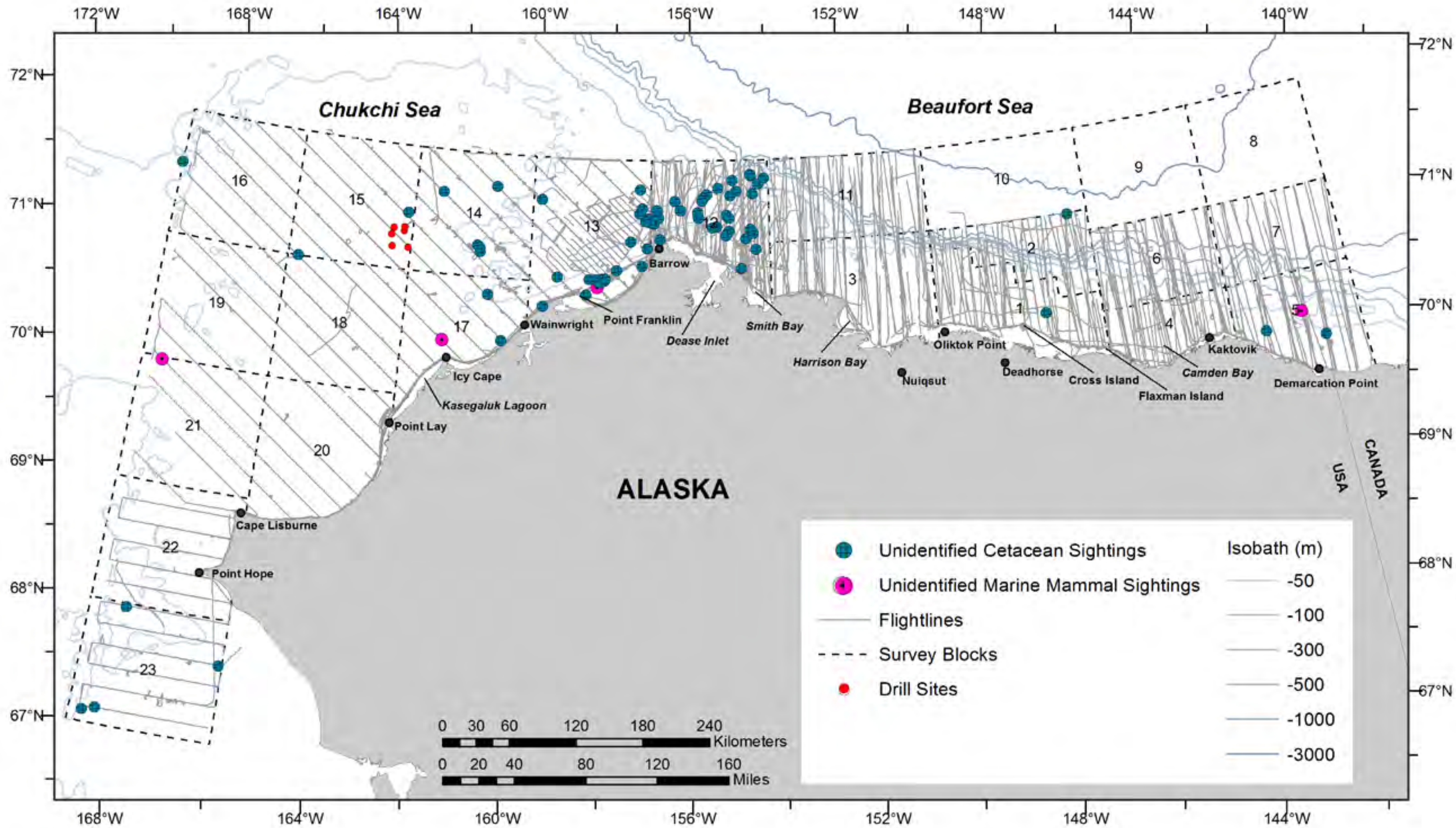


Figure 41. ASAMM 2015 unidentified cetacean and unidentified marine mammal sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Pinnipeds

Walruses

Pacific walruses (*Odobenus rosmarus divergens*) were observed every month in the eastern Chukchi Sea (Figure 42). Excluding dead walruses and walruses that were known to be duplicate sightings within the same day, there were 556 sightings of 86,229 walruses observed from July to October 2015 (Tables 3 and 11). This total is artificially high because it includes resightings of a large, coastal walrus haulout near Point Lay. When only the highest group size estimate of the haulout is taken into account (2 sightings of 31,400 walruses), there were 553 sightings of 52,229 walruses in 2015. Excluding all sightings of the Point Lay haulout, most walruses (97%, n = 20,291) were sighted in July and August, with the majority of sightings in the northeastern Chukchi Sea. A few walruses (five sightings of six animals) were observed in the western Beaufort Sea from Point Barrow east to 155.1°W.

In July through mid-August, when sea ice was still present in the study area, most walruses were observed hauled out on ice (94% of total walruses observed from 2 July to 15 August, 33 sightings of 11,013 walruses). Walruses hauled out on ice were in groups ranging in size from 4 animals to 2,000 animals. Walruses not hauled out were observed swimming, resting, milling, or diving; one walrus was observed playing with a log. In late August, when sea ice had receded north and the study area was essentially ice-free (Appendix A, Figures A-6 and A-7), walruses were observed only in open water and were starting to congregate nearshore. On 18 August (Appendix B, Flight 223), approximately 7,500 walruses were observed less than 1 km from the barrier islands directly west of the village of Point Lay and no walruses were observed onshore. In September, walruses were sighted offshore on Hanna Shoal, and on and near a coastal haulout near Point Lay, which was first documented by ASAMM on 2 September (Appendix B, Flight 232). In October, walrus distribution was similar to September but there were far fewer sightings.

The 2015 haulout was located on a barrier island slightly northwest of Point Lay, close to (within 2 km) the location of walrus haulouts documented during ASAMM surveys in 2010 (Clarke et al. 2011d) and 2013 (Clarke et al. 2014), and approximately 6 km south of the haulout location in 2014 (Clarke et al. 2015a). ASAMM observed the aggregation during four surveys, on 2, 10, 18, and 21 September. Group size estimates ranged from 9,000 to 31,400 individuals. Following a media report documenting a haulout near Point Lay on 23 August 2015 (Goldenberg 2015), subsequent ASAMM flights near Point Lay were flown at greater than 3.7 km lateral distance and at least 610 m altitude, as requested by the U.S. Fish and Wildlife Service (USFWS). Circling near the haulout was also limited to these parameters. Photographs of the haulout near Point Lay were taken from greater than 3.7 km lateral distance and 610 m altitude. The haulout was not observed during a survey conducted near Point Lay on 25 September (Appendix B, Flight 243). In past years, haulouts on shore have dispersed by early October (Clarke et al. 2012).

There were 569 walruses (representing 0.7% of all walruses sighted) that appeared to respond to the survey aircraft. Reactions included flushing from ice floes into the water (508 walruses),

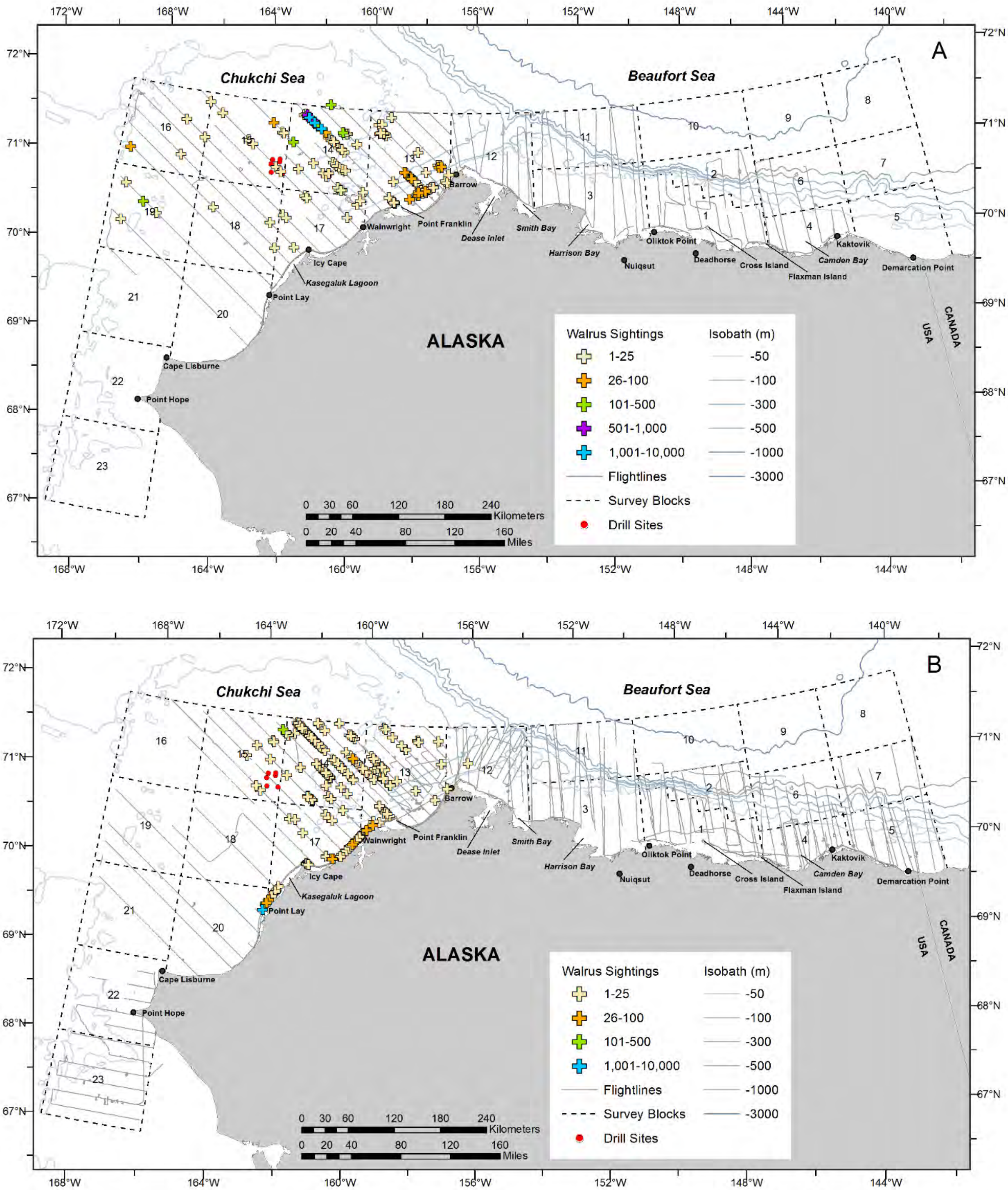
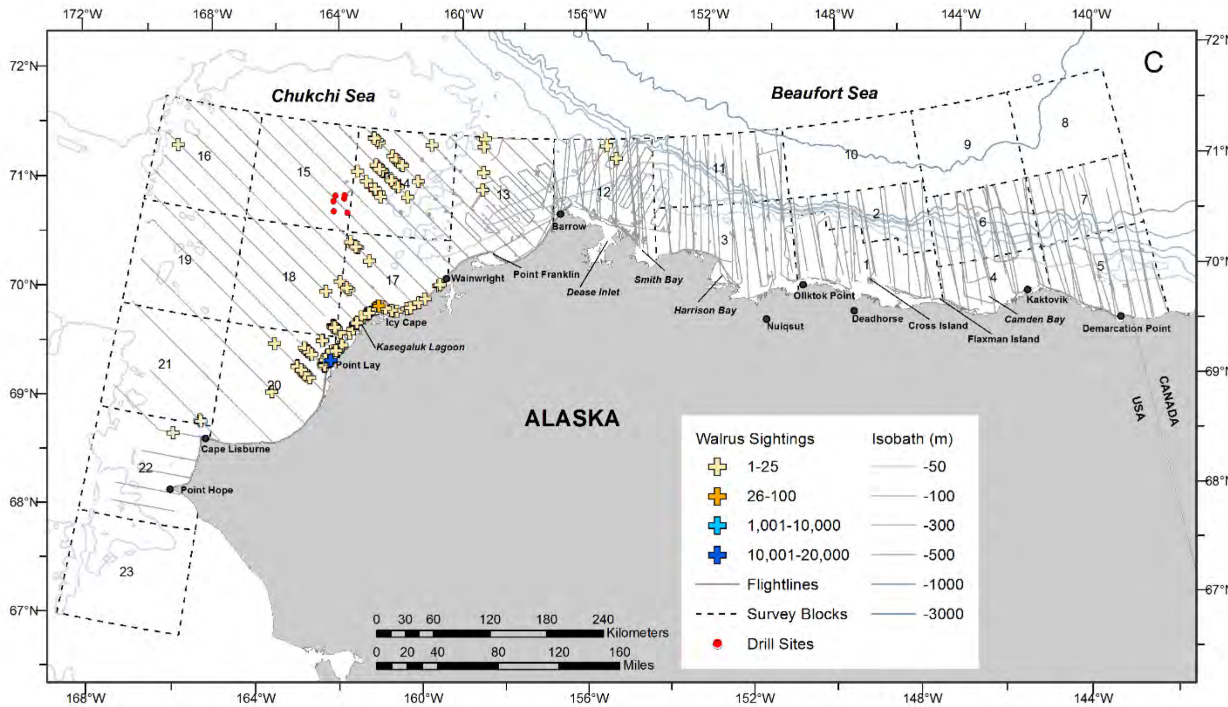


Figure 42. ASAMM 2015 walrus sightings plotted by month, with transect, search, and circling effort. A: July; B: August. Deadhead flight tracks are not shown.



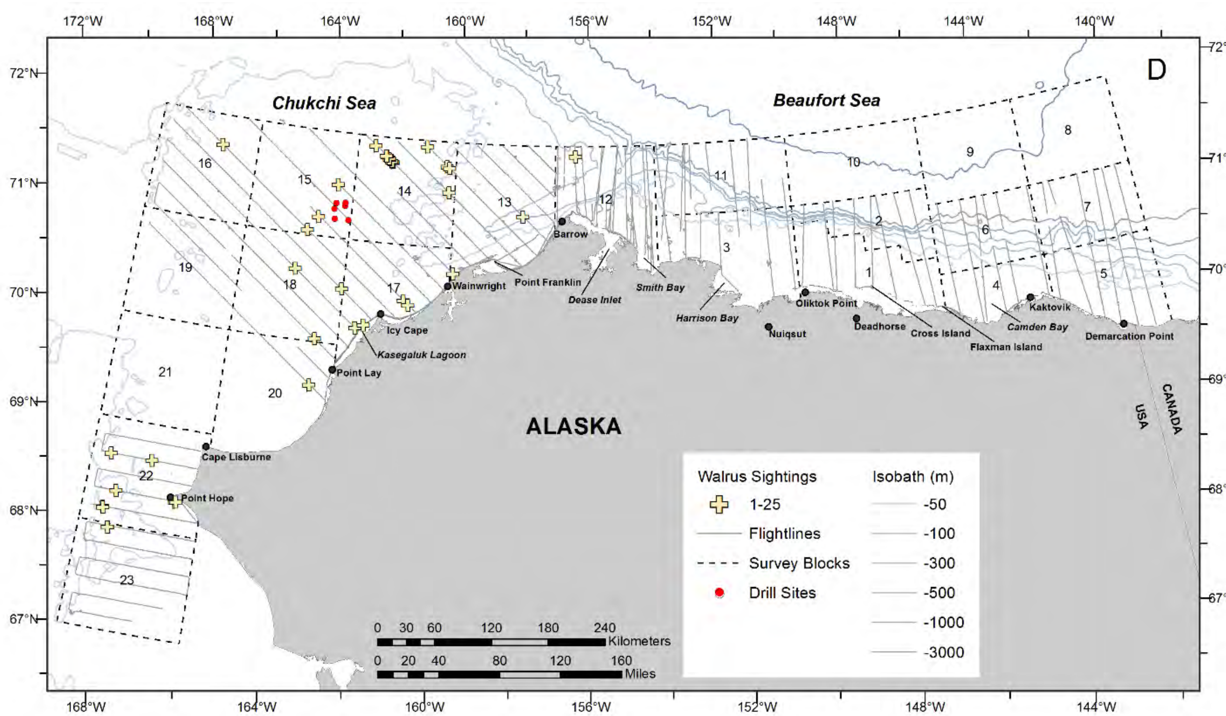


Figure 42 (cont.). ASAMM 2015 walrus sightings plotted by month, with transect, search, and circling effort. C: September; D: October. Deadhead flight tracks are not shown.

Table 11. ASAMM 2015 walrus sightings observed during all survey modes (transect, search, and circling).

	No. Sightings	No. Individuals
Dead*	19	62
Highest estimate of Point Lay haulout**	2	31,400
Total, including all sightings	575	86,291
Total, excluding dead and same-day repeat sightings	556	86,229
Total, excluding dead, same-day repeat, and additional Point Lay haulout sightings***	553	52,229

* May include duplicates of carcasses sighted on different survey dates.
** Highest group size was observed on 9/2/2015. Two groups were sighted in close proximity to each other
*** Includes only the highest estimate of the Point Lay haulout.

diving (60 walruses), and stopping swimming (1 walrus). No walruses in the large coastal haulout appeared to respond to the survey aircraft.

Other Pinnipeds

Pinnipeds were distributed throughout the extent of the study area, primarily on the continental shelf (Figure 43). Relatively few pinnipeds were seen in Harrison Bay, in the northwesternmost areas of the Chukchi Sea study area (block 16), or in Ledyard Bay.

Bearded seals (*Erignathus barbatus*; 13 sightings of single seals) were observed from early July through late October (Figure 43). Most bearded seals were in the water; one bearded seal was hauled out on ice in late October. No bearded seals responded to the aircraft.

Other pinnipeds were not identifiable to species and were recorded as unidentified pinnipeds (231 sightings of 320 animals) or small unidentified pinnipeds (1,303 sightings of 3,059 animals) (Figure 43). The unidentified pinniped categories included sightings of pinnipeds that could not be identified to species due to the short amount of time that the animal was visible and the altitude of the survey aircraft (>305 m). 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. The distributions of ringed, spotted and bearded seals overlap in the western Beaufort Sea (Lowry et al. 1998; Angliss and Allen 2009; Boveng et al.

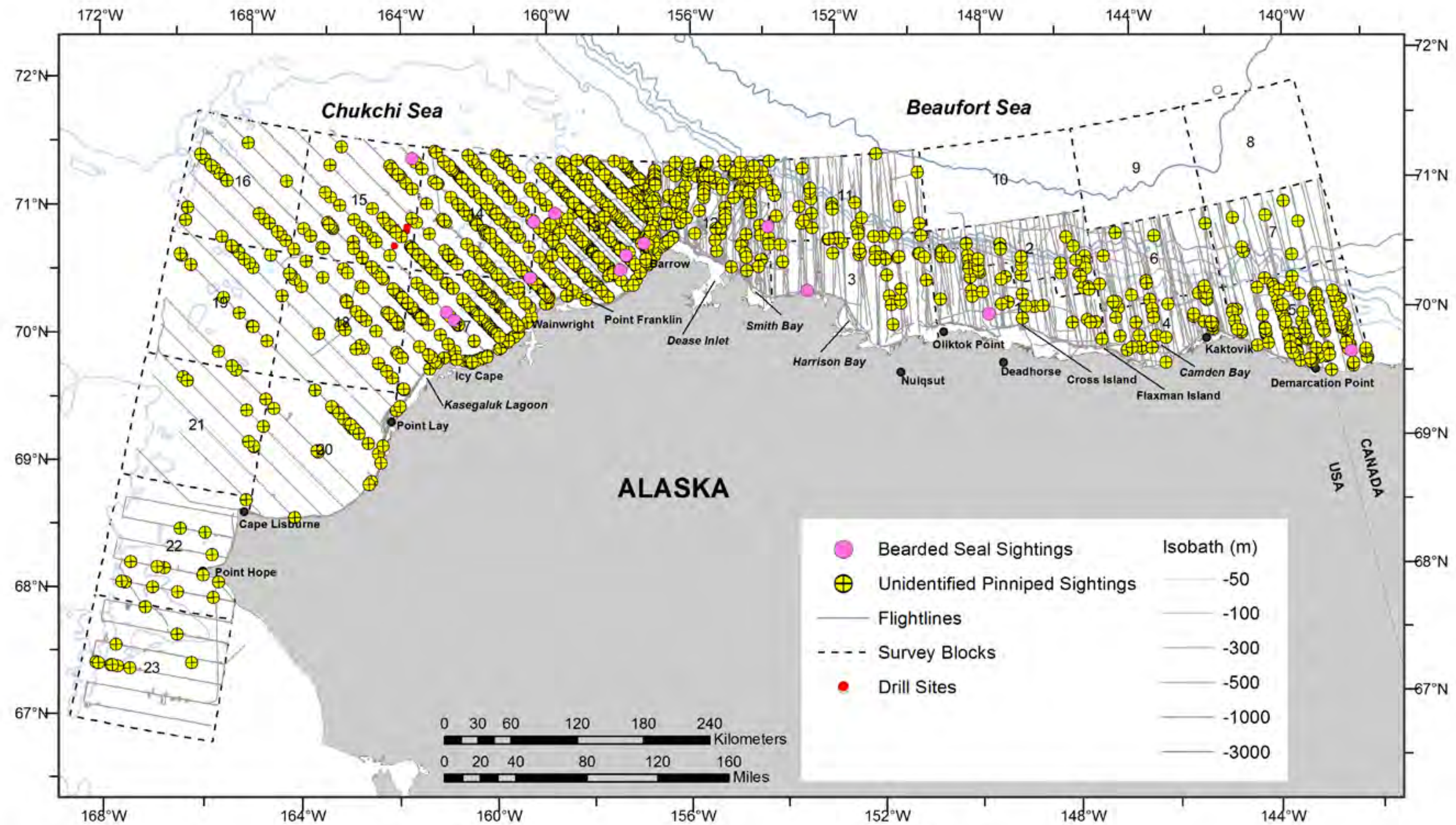


Figure 43. ASAMM 2015 bearded seal and unidentified pinniped (including small unidentified pinniped) sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

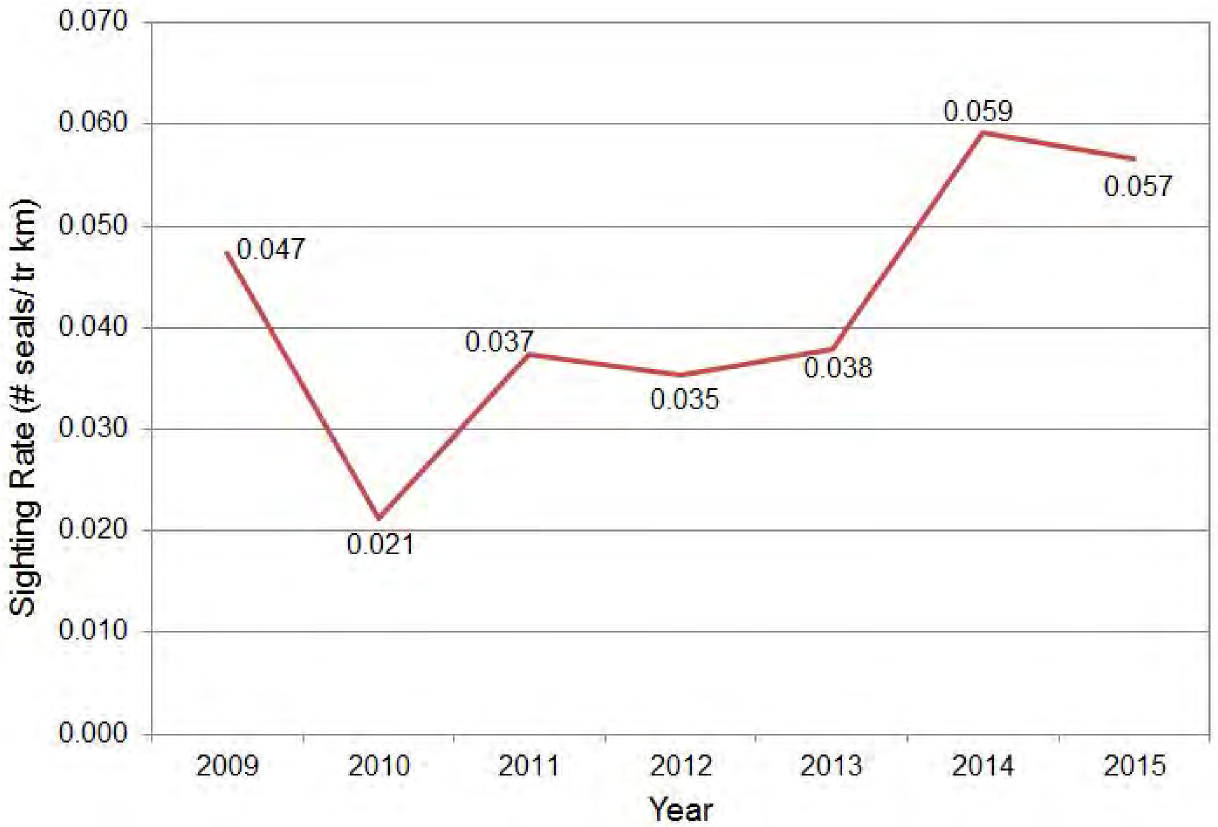


Figure 44. ASAMM unidentified pinniped (includes small unidentified pinnipeds) annual sighting rates (PPUE; transect sightings from primary observers only), 2009-2015.

2009); behaviors and physical characteristics observable from the survey altitude of the ASAMM aircraft are not distinguishable enough to allow positive species identification (NMML, unpublished data; D. Rugh and D. Withrow, NMML-AFSC, pers. comm. to J. Clarke, 8 December 2009).

One large group of unidentified pinnipeds, likely spotted seals, was seen hauled out on a barrier island east of Icy Cape on 2 September, and several small groups (of 1 to 100 animals) were seen hauled out on ice in early July and again in late October. Sighting rates (number of pinnipeds per transect km, PPUE) in 2015 were higher than sighting rates in 2009-2013 and slightly lower than the 2014 sighting rate (Figure 44). When the group of pinnipeds hauled out on land were excluded from analysis, the 2015 sighting rate was 0.052 PPUE.

One hundred thirty-two unidentified pinnipeds (4% of total) appeared to respond to the aircraft. Most pinnipeds responded by diving, but one pinniped hauled out near Icy Cape responded by undulating away from the haulout.

Polar Bears

There were 15 sightings of 121 polar bears (*Ursus maritimus*) during ASAMM 2015 (Figure 45). In the northeastern Chukchi Sea, two sightings of single polar bears were observed. One bear was sighted 214 km from shore, swimming in an area of open water about 6 km from broken floe sea ice, on 4 July. One bear was sighted on shore near Point Franklin on 27 October.

In the western Beaufort Sea, most polar bear sightings were from Oliktok Point to Demarcation Point, with one bear sighted east of Smith Bay (Figure 45). All but one polar bear sighting were nearshore (<3 km from shore or barrier island). One polar bear was seen 27 km north of Oliktok Point on 8 September. There is no coastal transect in the Beaufort Sea, although transits to and from survey blocks were conducted along the shoreline or barrier islands when possible. 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.

A few polar bears (four sightings of seven bears) were seen near and east of Kaktovik. Aggregations of polar bears have been seen near Kaktovik in past years, particularly after the fall subsistence hunt, but aggregations were not observed there during ASAMM surveys in 2015.

Most polar bears (7 sightings of 107 bears) were seen on Cross Island, northeast of Deadhorse. Cross Island attracts scavenging polar bears because bowhead whale carcasses from fall subsistence harvests are hauled to there by villagers from Nuiqsut, Alaska. Polar bears were seen on Cross Island on 3 days: 20 bears (including 2 cubs) on 18 September, 46 bears (including 9 cubs) on 23 September, and 44 bears (including 6 cubs) on 2 October. All polar bear counts on Cross Island were verified post-flight from photographs.

Polar bears were observed swimming, walking, running, resting, and feeding. The majority of bears (99%) sighted did not respond to the survey aircraft. Ten bears (8%) did appear to react to the survey aircraft. Eight bears looked up, one bear sat up, and one bear stood up.

Beginning in 2012, photographs were occasionally taken of polar bears on Cross Island and Bernard Spit near Kaktovik and analyzed post-flight to 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 2015, there were four opportunities to photograph Cross Island. Photographs were taken of Cross Island on 12 August, 18 and 23 September, and 2 October. Post-flight analysis of the images, which included all sides of Cross Island, changed the total number of bears sighted from 8 to 20, 20 to 43, and 4 to 40, respectively, as indicated in the final group size estimate in the ASAMM database. No polar bears were seen on Cross Island on 12 August. 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 photo analysis whenever possible.

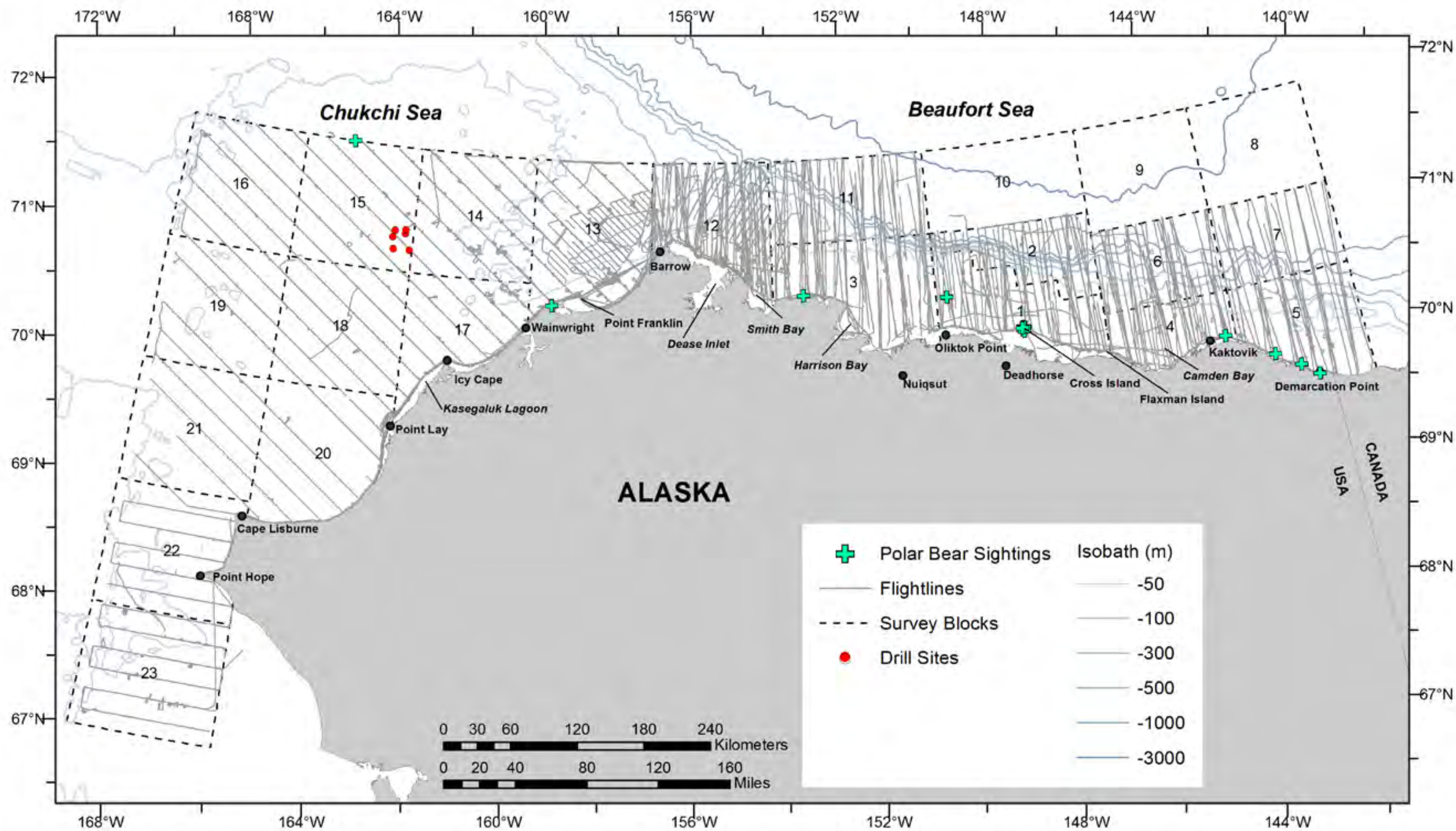


Figure 45. ASAMM 2015 polar bear sightings, with transect, search, and circling effort. Deadhead flight tracks are not shown.

Dead Marine Mammals

There were 49 sightings of 92 dead marine mammals in 2015 (Table 12), although three of the cetacean sightings were repeats of earlier observations. Most (67%) of the carcasses observed were walruses, and most (n = 44) of those were seen in early July and likely represented walruses that had been killed during a stampede event that occurred at the onshore haulout near Point Lay in fall 2014. Twenty-four of the carcasses observed were cetaceans, including bowhead whales (11 sightings of single animals including 1 repeat sighting), gray whales (8 sightings of single animals including 2 repeat sightings), belugas (1 sighting of 1 animal), and unidentified cetaceans (4 sightings of single animals). Three carcasses were in advanced state of decomposition and not identifiable beyond "marine mammal". Three carcasses were identified as pinnipeds. Thirty-one of the carcasses were observed in open water and 61 were on the beach.

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

Table 12. ASAMM 2015 dead marine mammal sightings, all survey modes (transect, search, and circling).

Flight No.	Date	Latitude (°N)	Longitude (°W)	Species	No. Individuals	Habitat
201	02-Jul-15	71.013	-158.304	walrus	1	open water
202	03-Jul-15	71.651	-161.495	walrus	1	open water
203	04-Jul-15	71.043	-160.892	walrus	1	open water
203	04-Jul-15	71.524	-164.391	walrus	1	open water
203	04-Jul-15	70.590	-164.100	walrus	1	open water
203	04-Jul-15	70.616	-164.198	walrus	1	open water
203	04-Jul-15	70.624	-164.231	walrus	1	open water
203	04-Jul-15	71.181	-164.540	walrus	1	open water
203	04-Jul-15	70.865	-163.459	walrus	1	open water
204	05-Jul-15	69.835	-162.972	walrus	44	barrier island
204	05-Jul-15	70.444	-165.240	walrus	1	open water
204	05-Jul-15	70.457	-167.140	walrus	1	open water
205	07-Jul-15	71.201	-157.000	gray whale	1	beach
208	21-Jul-15	71.529	-158.237	unidentified marine mammal	1	open water
219	09-Aug-15	70.602	-164.347	walrus	1	open water
223	18-Aug-15	70.829	-159.475	gray whale	1	beach
223	18-Aug-15	70.875	-159.174	bowhead whale	1	beach
225	20-Aug-15	71.927	-162.512	gray whale	1	open water
226	23-Aug-15	67.647	-167.581	beluga	1	open water
227	26-Aug-15	71.708	-154.239	unidentified pinniped	1	open water
232	02-Sep-15	71.525	-158.965	unidentified pinniped	1	open water
232	02-Sep-15	69.609	-163.169	walrus	1	open water
232	02-Sep-15	70.366	-160.856	unidentified animal	1	barrier island
232	02-Sep-15	70.742	-159.771	gray whale	1	beach
232	02-Sep-15	70.835	-159.434	gray whale	1	beach
232	02-Sep-15	70.915	-158.762	gray whale	1	beach
232	02-Sep-15	70.915	-158.758	unidentified cetacean	1	beach
232	02-Sep-15	70.836	-158.501	walrus	1	barrier island
232	02-Sep-15	70.829	-158.439	unidentified cetacean	1	barrier island
232	02-Sep-15	71.209	-156.995	gray whale	1	beach
239	18-Sep-15	68.378	-166.660	gray whale	1	beach
239	18-Sep-15	69.866	-162.982	walrus	1	beach
239	18-Sep-15	70.073	-162.556	walrus	1	beach
239	18-Sep-15	70.077	-162.535	walrus	1	beach

Flight No.	Date	Latitude (°N)	Longitude (°W)	Species	No. Individuals	Habitat
239	18-Sep-15	70.080	-162.534	walrus	1	beach
241	21-Sep-15	70.789	-168.724	bowhead whale	1	open water
35	23-Sep-15	70.828	-146.731	bowhead whale	1	open water
243	25-Sep-15	70.835	-158.497	unidentified pinniped	1	barrier island
244	27-Sep-15	71.333	-157.123	unidentified cetacean	1	open water
244	27-Sep-15	71.415	-159.031	bowhead whale	1	open water
245	28-Sep-15	71.444	-159.198	bowhead whale	1	open water
247	04-Oct-15	71.281	-158.512	bowhead whale	1	open water
43	04-Oct-15	71.388	-155.454	bowhead whale	1	open water
43	04-Oct-15	71.331	-153.749	bowhead whale	1	open water
43	04-Oct-15	71.601	-153.820	unidentified cetacean	1	open water
251	14-Oct-15	71.274	-166.960	unidentified marine mammal	1	open water
257	27-Oct-15	70.992	-162.354	bowhead whale	1	open water
257	27-Oct-15	71.460	-164.172	bowhead whale	1	open water
257	27-Oct-15	72.017	-165.377	bowhead whale	1	open water

Accomplishments and Outreach

ASAMM incorporated walrus reconnaissance surveys into survey effort in mid-July to assist with USGS satellite tagging efforts.

ASAMM coordinated with the Arctic ACEs project in late August and early September to collect photographic images concurrent with observer data.

Data from ASAMM 2015 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.
- 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), and BOEM.
- Biweekly effort and sighting summary figures were sent to BOEM, NMML, PMEL, Alaska Department of Fish and Game (ADF&G), NSB, USCG, and Shell to provide an overview of data collected.
- Biweekly walrus sighting figures showing distribution and group size were sent to researchers at BOEM, USFWS, USGS, ADF&G, NSB, the Alaska SeaLife Center, and Shell.
- Biweekly polar bear sighting figures were sent to BOEM, USFWS, USGS, ADF&G, NSB, and Shell.
- Cetacean sighting data were shared with UAF and Woods Hole Oceanographic Institution (WHOI) to assist with underwater glider research.
- All Level A stranding forms (46 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 2015 included:

- Meeting with the North Slope Borough Search and Rescue to familiarize them with our project.
- Sending the Deadhorse and Kaktovik Whaling Communication Center 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 NMML website within ~24-48 hrs after completion of each ASAMM flight.

Marine mammal photos taken by ASAMM personnel in 2015 were shared with interested parties in the federal government, media, and non-governmental organizations, including NOAA, BOEM, NSB, USFWS, and USGS. Media efforts were coordinated through NOAA and BOEM Public Affairs Offices.

ASAMM provided subsets of the 1982-2014 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 2015 ASAMM field season were presented at several venues, including:

Berchok, C.A., et al. 2016. DBO presentation. Distributed Biological Observatory Workshop, Seattle, WA, March 2016.

Brower, A., A. Willoughby, J. Clarke, and M. Ferguson. 2016. Gray whale occurrence in the northeastern Chukchi Sea, summer and fall 2015. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, January 2016.

Clarke, J., M. Ferguson, A. Brower, A. Willoughby, and C. Sims. 2016. Occurrence of humpback, fin, and minke whale in the eastern Chukchi Sea, 2008-2015: population recovery, response to climate change, or greater effort? Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, January 2016.

Clarke, J., S. Okkonen, and R. Potter. 2016. Relationships between high river discharge, upwelling events, and bowhead whale (Balaena mysticetus) occurrence in the cenral Alaskan Beaufort Sea. Poster presented at the Ocean Sciences Meeting, New Orleans, LA, February 2016.

Ferguson, M., S. Okkonon, J. Clarke, A. Willoughby, A. Brower, C. Ashjian, and C. George. 2016. Observation of bowhead whale foraging near Barrow, Alaska, in 2015 support the krill trap model. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, January 2016.

Willoughby, A., A. Brower, J. Clarke, and M. Ferguson. 2016. Gray whale calf occurrence in the Chukchi Sea, summer and fall 2015. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, January 2016.

A complete listing of publications, posters and oral presentations from the ASAMM project from 2015 to 2016 is included in Appendix C, including PDF copies of 2015 media reports related to ASAMM. A complete listing of ASAMM contributions to the scientific community from 2008-2016 is included in Appendix F.

DISCUSSION

Conclusions

Total and transect survey effort in 2015 equaled or exceeded effort in other years with equivalent field periods (2013-2014) (Figure 46). Effort was greater only in 2012, when an additional survey team conducted aerial surveys for Eastern Chukchi Sea belugas in early July (Clarke et al. 2013a). When the additional beluga effort was removed, effort was equal in 2012 and 2015. There was one prolonged period of time (11 consecutive days) in 2015 when surveys were not conducted due to weather conditions. The complete inability of ASAMM to conduct any aerial surveys during an extended period of time due to weather is not common. In 2012, there were no extended periods of time when surveys could not be conducted due to weather (Clarke et al. 2013a). 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 (8 days in mid-September and 10 days in mid-October) when surveys could not be conducted due to weather (Clarke et al. 2015a). 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.

Sea ice conditions in 2015 were similar to conditions observed in most recent years. Sea ice remained in the northeastern Chukchi Sea through mid-August and in the western Beaufort Sea through early September before receding north of 72°N. Environmental conditions related to large expanses of relatively warm water overlaid by colder air temperatures include low cloud ceilings, fog, and high sea states. These conditions were often encountered in 2015, but did not adversely affect overall effort except in mid-July.

Broad-scale aerial surveys were conducted regularly in the western Beaufort Sea in summer (July-August) in 2015 for the fourth consecutive year. Bowhead whale distributions in July (on the outer continental slope and shelf; 51-2,000 m depth) and August (on the inner and outer continental shelf and slope; 0-2,000 m depth) 2015 were similar to those observed in summer 2012-2014 (Figure 47B) (Clarke et al. 2013a, 2014, 2015a). Sighting rates in 2015 were similar to those observed in 2014, but remained lower than those observed in summer 2013 (Figure 48). The high sighting rates observed in 2013 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 shallow shelf offshore of the Tuktoyaktuk Peninsula and Cape Bathurst are areas used most consistently (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

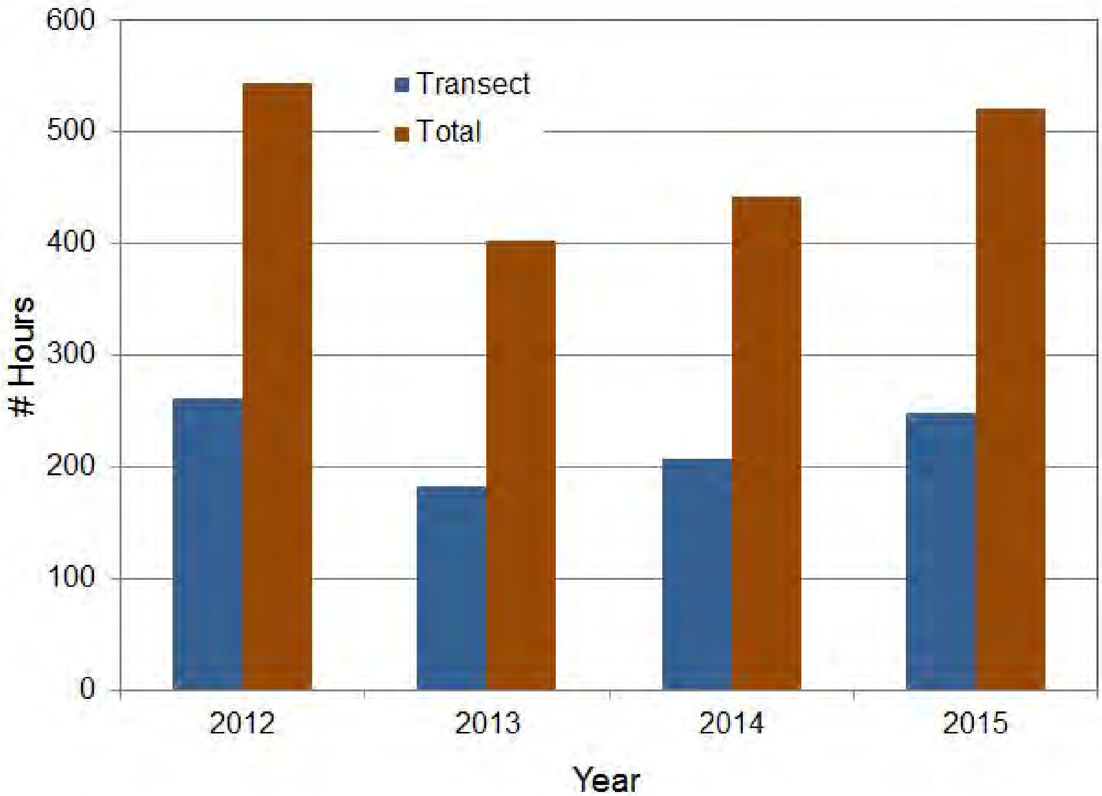


Figure 46. ASAMM transect and total survey hours, 2012-2015.

is a condition that concentrates bowhead whale prey. In 2013, dispersed sea ice remained present near Cape Bathurst until early September (U.S. National Ice Center 2013), suggesting that the northward-flowing current, and associated upwelling winds, were relatively weak in July and August. One-third of the bowhead whales observed by ASAMM in the western Beaufort Sea in summer 2013 were feeding or milling, suggesting that some bowhead whales may not have migrated as far east as the Canadian Beaufort Sea or left that area in early summer to search for feeding opportunities elsewhere. Conversely, in summer 2014 and 2015, sea ice was absent by mid- to late July near the Tuktoyaktuk Peninsula and Cape Bathurst (U.S. National Ice Center 2014, 2015), perhaps indicating the presence of upwelling and favorable bowhead whale feeding opportunities throughout summer.

Survey coverage in the western Beaufort Sea in summer 2012, 2013, 2014, and 2015 was temporally and geographically similar (Figure 47A). Bowhead whale distributions in the western Beaufort Sea (all sightings regardless of effort mode or observer type) in summer 2012, 2013, 2014, and 2015 were also generally similar, with the majority of sightings east of 150°W and between 154°W and 157°W. In 2015, relatively few bowhead whales were seen in block 6 compared with previous summers, although there was also less effort in 2015 (Appendix E, Table 1). Sighting rates in 2015 in the Beaufort Sea were lowest in July, increased into August and September, and peaked in October (Figure 48), which differed from 2012-2014 when sighting rates peak in August or September.

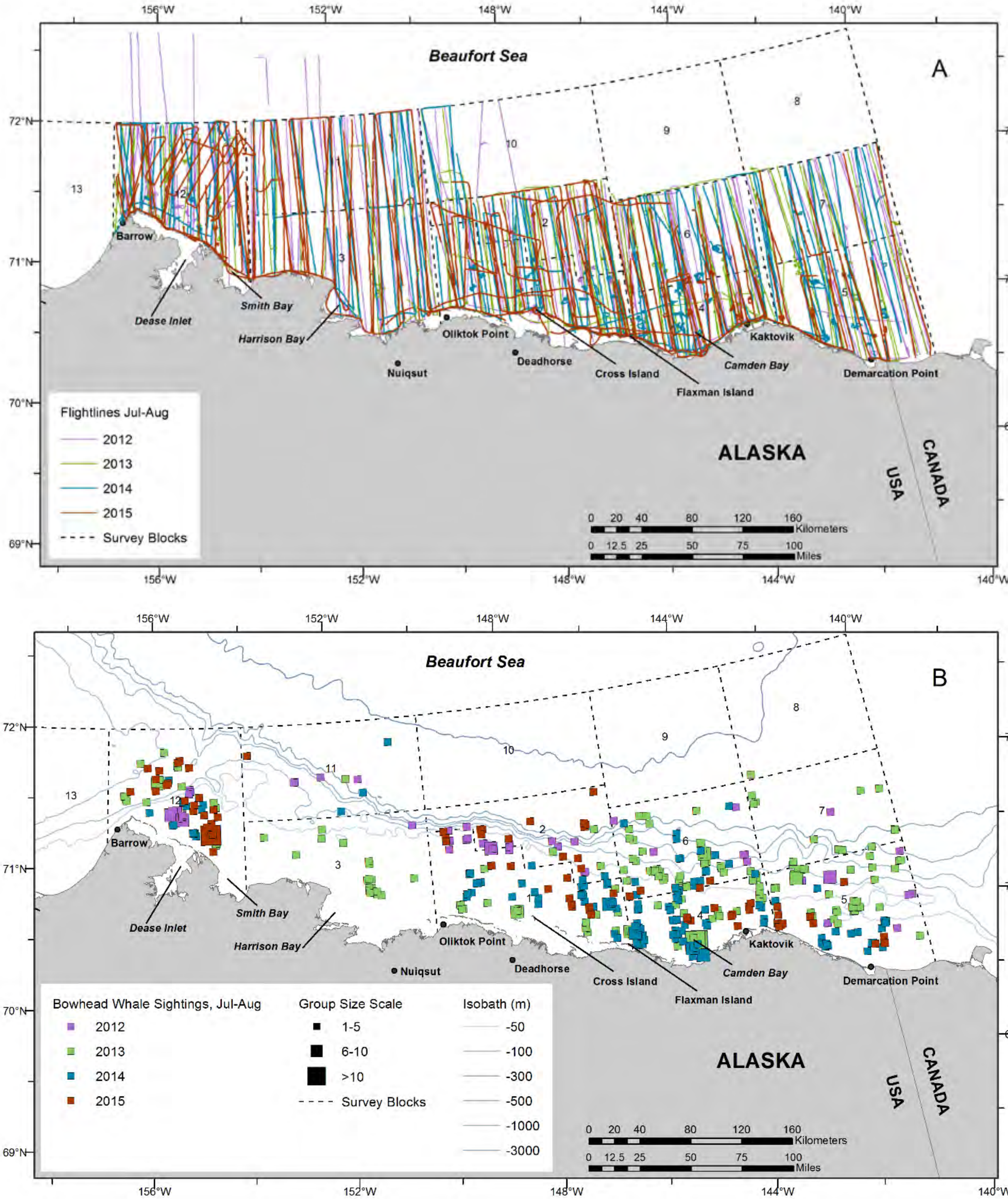


Figure 47. ASAMM 2012-2015 summer (July-August) survey effort and bowhead whale sightings. A: survey effort, all survey modes (transect, search, and circling); B: bowhead whale sightings, by group size, all survey modes.

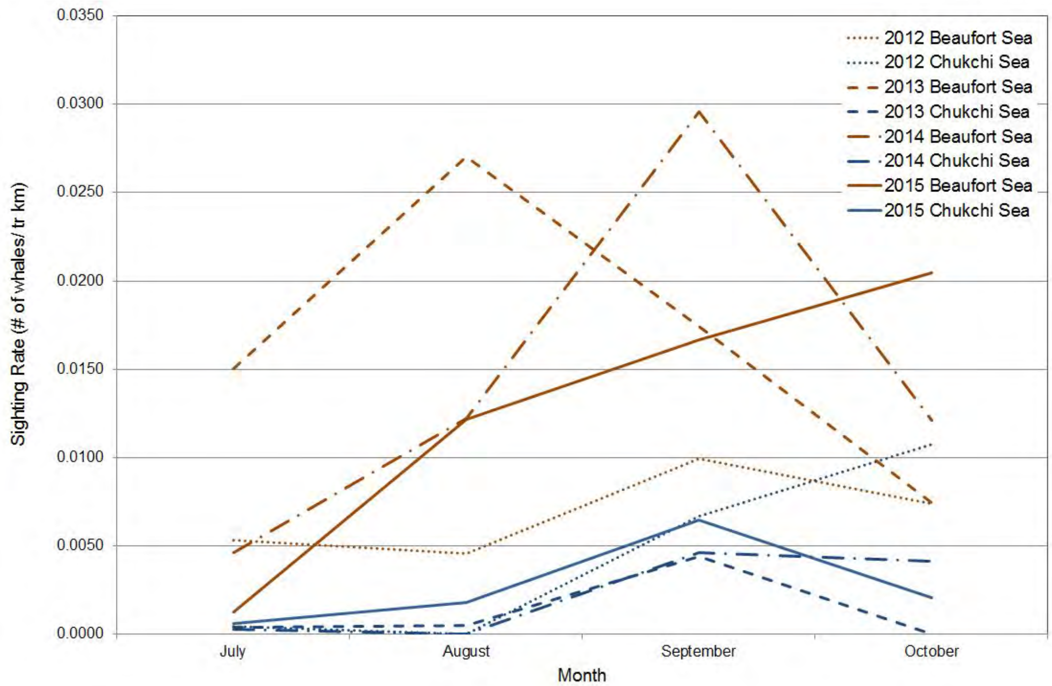


Figure 48. ASAMM bowhead whale monthly sighting rates (WPUE; transect sightings from primary observers only) in the eastern Chukchi and western Beaufort seas, 2012, 2013, 2014, and 2015. Note that ASAMM effort was limited in October 2013 due to the partial shutdown of the federal government (Clarke et al. 2014).

Bowhead whale distribution in the northeastern Chukchi Sea in summer 2015 differed from that observed in past years. There were still relatively few sightings, but several bowhead whales were seen well offshore in regions where they had not previously been seen by ASAMM in summer (Figure 49). 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 northeastern Chukchi Sea in fall 2015 overlay the distribution observed in 2009 through 2014, and continued to suggest a broad migratory corridor heading southwest across the northeastern Chukchi Sea, with little use 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).

The highest fall sighting rate of bowhead whales in the northeastern Chukchi Sea was in block 13 in 2009, 2010, 2011, and 2014, block 14 in 2012 and 2015, and block 15 in 2013 (Figure 50). 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 were not surprising. 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, the two years

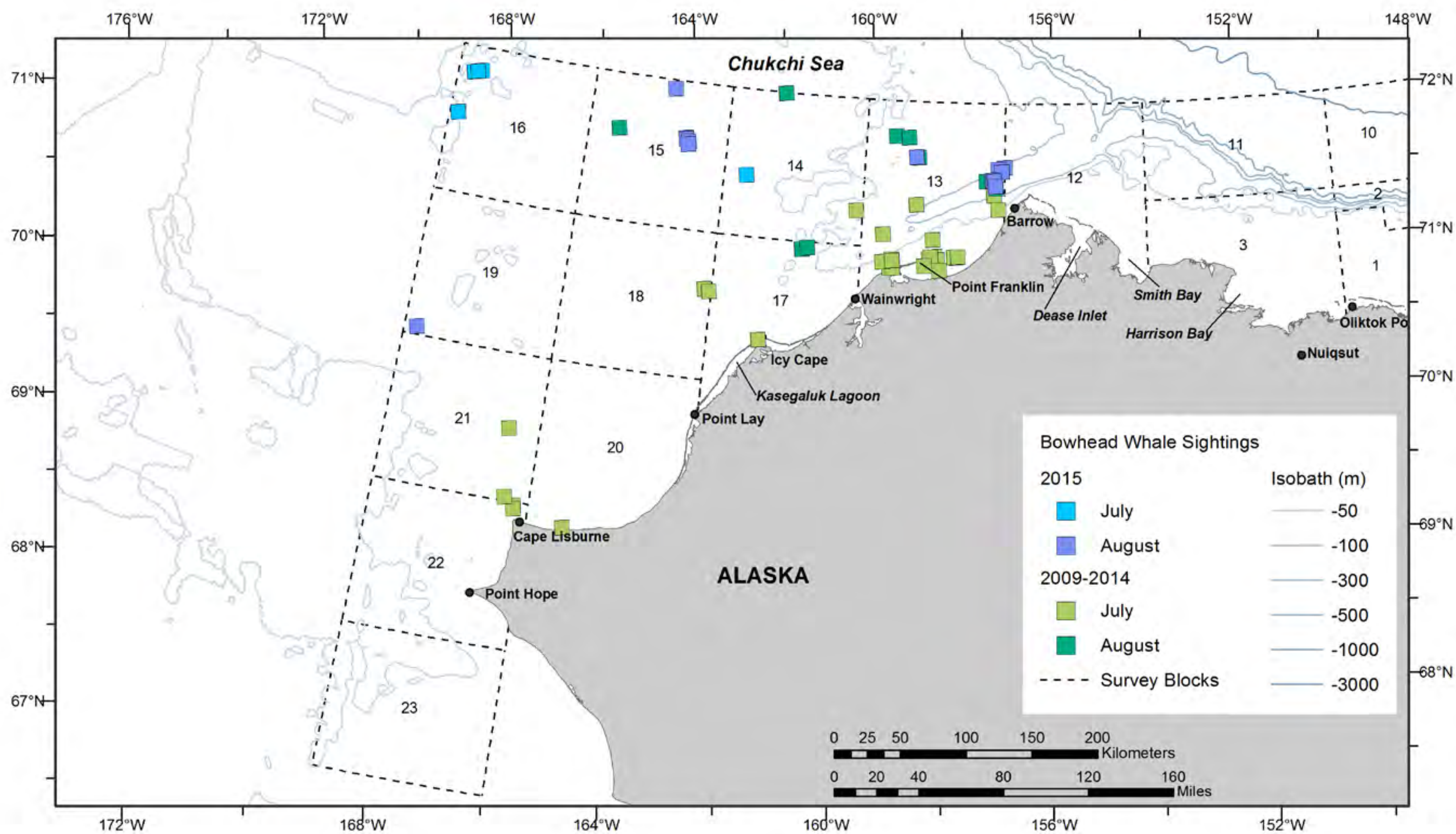


Figure 49. ASAMM bowhead whale distribution in the eastern Chukchi Sea, July and August, 2009-2014, and 2015.

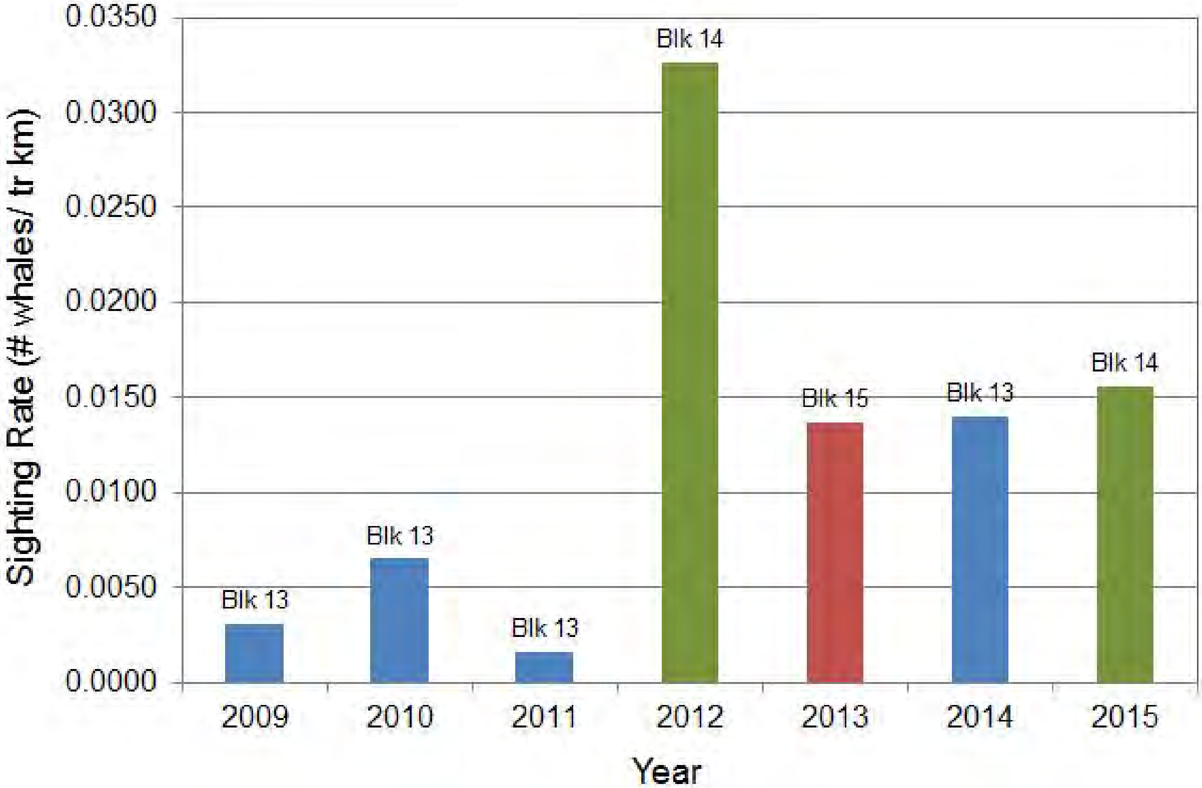


Figure 50. Annual maxima of ASAMM bowhead whale sighting rates (WPUE; transect sightings from primary observers only) in fall, by survey block, in the eastern Chukchi Sea, 2009-2015.

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). The drilling area is immediately west of block 14 (Figure 1). Effects of drilling activities (including support vessels and aircraft) on bowhead whales are difficult to assess from ASAMM data because ASAMM does not specifically target the drilling area. Bowhead whales were sighted by ASAMM observers predominantly east and north of drilling activities in 2012 (Clarke et al. 2013) and 2015. Protected species observers onboard the drilling and support ships also sighted bowhead whales from their vessels (Bisson et al. 2013). Bowhead whales tracked via satellite telemetry in 2012 (Quakenbush et al. 2013) and 2015 (Alaska Department of Fish and Game 2015) were also east or north of the drilling sites. The occurrence of bowhead whales in relatively close proximity to offshore drilling sites could suggest that drilling activity did not present an impediment to bowhead whale migration across the northeastern Chukchi Sea. However, it is also possible that bowhead whales were lingering east of and deflecting north around the drilling activities because of the cumulative impact of all drilling-associated activities, which included a drill ship, up to 14 support vessels, and rotary and fixed-wing aircraft (Bisson et al. 2013; Ireland and Bisson 2016). It is also possible that the high sighting rates in block 14 were caused by an increase in bowhead whales at the surface, perhaps to avoid the increased (or novel) underwater noise (Nowacek et al., 2004). Further focal studies on surfacing behavior are needed on this population to better understand the effects, if any, of drilling activities.

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 2012-2015 due to the lack of summer surveys in the earlier years of the time 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 reflected the high densities of bowhead whales observed in Camden Bay in 2014 and, to a lesser extent, 2013. Although the August HUA analysis was predominantly based on data from 2012 to 2015, it reinforces the patterns described by Moore et al. (1989) for data collected during aerial surveys conducted in 1979-1986. 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 ~149°W, and on the shelf southeast of Barrow Canyon. Compared to October, the HUA for September was closer to shore north of Camden Bay. Relative abundance predictions from the spatial model built on only 2015 transect data from September and October (both months pooled) retained the high density areas east of Kaktovik, and in the vicinity of Barrow Canyon, but not near the barrier islands in the middle of the study area. In addition, the predictions from the 2015 model suggested that the HUAs were closer to shore in the West Region and farther from shore in the East Regions compared to the 15-year time series from 2000 to 2015.

Bowhead whale feeding behavior was nearly absent in the western Beaufort Sea in 2015, with the exception of feeding whales seen on several occasions between Cape Halkett and Point Barrow. In most years, bowhead whale feeding opportunities in the western Beaufort Sea appear to be short-lived, ephemeral, and transient (Citta et al. 2015; Clarke et al. 2014). The occurrence of hundreds of feeding whales in the central Alaskan Beaufort Sea from late August through early October 2014 (Clarke et al. 2015a) was exceptional, and was perhaps related to fronts formed by high freshwater river discharge combined with upwelling favorable winds (Okkonen et al. *in press*). Bowhead whale feeding behavior observed from late August to early October 2015 between Cape Halkett and Point Barrow resulted in the second highest ratio of feeding to total bowhead whales (0.676) in that area, in a time series of annual surveys beginning in 1989 (Appendix C, Ferguson et al. 2016). The highest ratio of feeding to total bowhead whales occurred in 2009 (0.732), the result of a single survey in mid-October during which a few hundred feeding bowhead whales were observed (Clarke et al. 2011d). In both 2009 and 2015, upwelling favorable winds followed by weak or southerly winds produced conditions conducive to energetically efficient feeding by bowhead whales. Of note, all of the bowhead whales harvested near Barrow in 2015 for which stomach contents were examined had been feeding on euphausiids (J. George, NSB DWM, pers. comm. to J. Clarke, 15 February 2016).

The occurrence of feeding bowhead whales has an obvious influence on ASAMM sighting rates. In the Beaufort Sea in fall 2015, the transect sighting rate was four times higher in block 12 compared to blocks 1 through 11 combined (Figure 51). The degree of disparity between sighting rates in these two regions of the western Beaufort Sea was also observed in 1997, 2004, 2008, and 2009 (Figure 51), all years during which bowhead whale feeding aggregations were documented in block 12 (Treacy 1998; Monnett and Treacy 2005; Clarke et al. 2011b, 2011c).

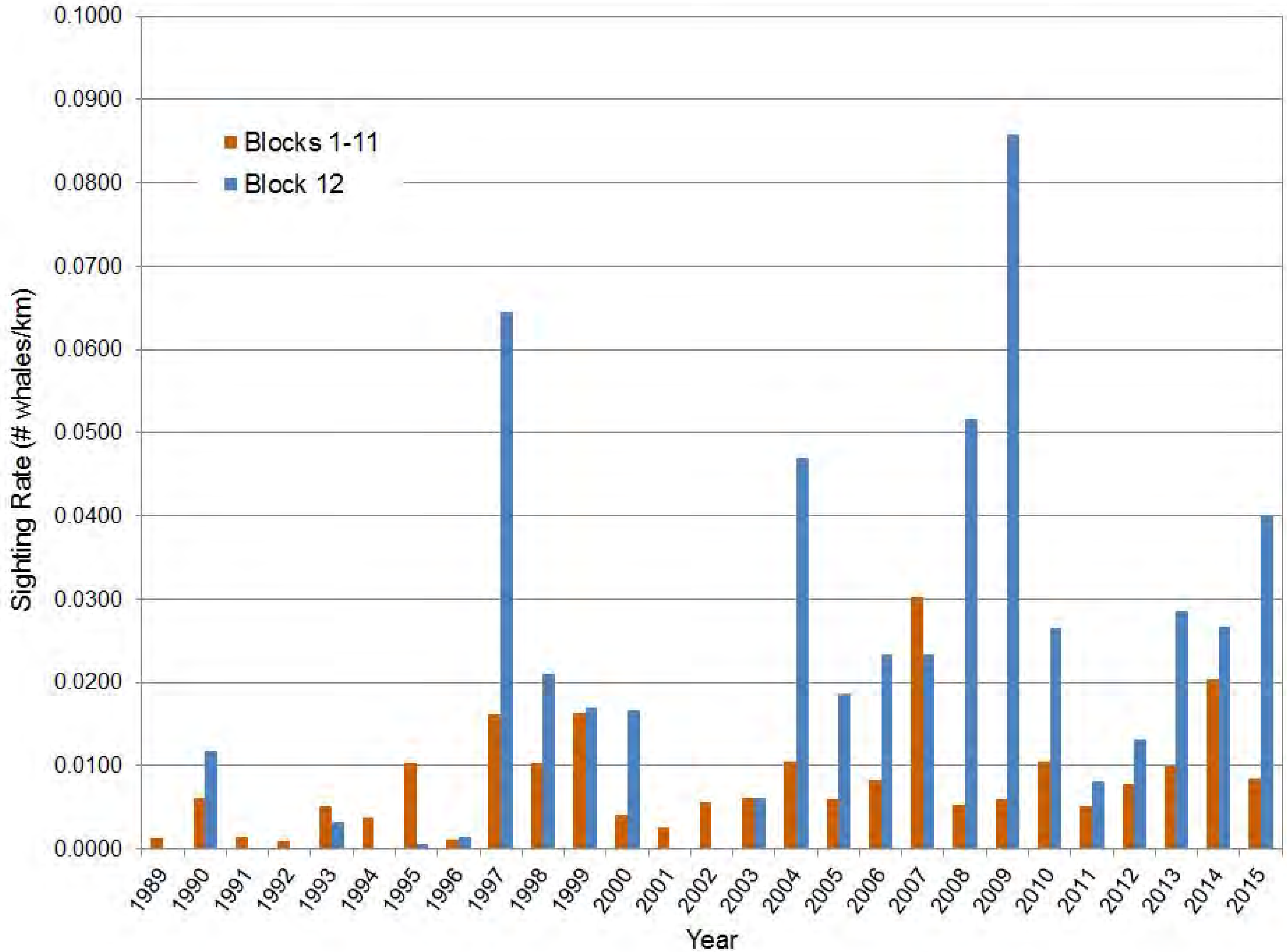


Figure 51. ASAMM bowhead whale sighting rates (WPUE; transect sightings from primary observers only) for survey blocks 1-11 (pooled) and survey block 12 in the western Beaufort Sea, fall 1989-2015. Sighting rates of zero were removed from the graph for clarity.

The bowhead whale calf ratio (number of calves/number of total whales) in summer 2015 (0.047) was lower than calf ratios observed in summer 2012 (0.093) and summer 2013 (0.074) (Clarke et al. 2013a, 2014) but similar to calf ratios recorded during ASAMM surveys in 2014 and in August 1983 and August 1986 (Clarke et al. 1987) (Figure 52). Lower bowhead whale calf occurrence in the western Beaufort Sea in summer 2015 likely reflects annual variation, as suggested by Koski and Miller (2009). The Western Arctic bowhead whale stock is in good physical condition (George et al. 2015), as determined from an analysis of body condition of subadult bowhead whales harvested by Inupiat whalers. 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 and higher primary productivity (Harwood et al. 2015). Continued collection of bowhead whale data in summer and fall in the western Beaufort Sea in future years should shed light on whether the exceptionally high calf ratios of fall 2013 or the comparatively lower calf ratios of fall 2014 and fall 2015 are more representative of the 'new' Arctic.

Gray whale distribution in 2015 was generally similar to that seen in recent years with similar survey coverage (2009-2014), with a few exceptions. Gray whale preference was for shallow (≤35 m) waters in summer (July-August) in the northeastern Chukchi Sea (Figure 53A). 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. In summer 2012-2015, sighting rate analyses showed a clear preference for shallow waters. Unlike previous years, however, gray whale preference for shallow water extended into fall in 2015 (Figure 53B). Also in 2015, gray whales were seen in the southern part of block 14 (immediately south of Hanna Shoal) in all months (Figure 23). Sighting rates in block 14 exceeded those in block 17 and were only slightly less than sighting rates in block 13 in both July and August 2015 (Figure 54). Compared to previous years (2009-2014), sighting rates in July and August 2015 in block 14 were noticeably higher. Gray whale use of the northeastern and southcentral Chukchi Sea is likely closely associated with prey availability including, but not limited to, benthic amphipods. The primary behavior of gray whales observed in 2015 in the eastern Chukchi Sea study area, including block 14, was feeding (Appendix C, Brower et al. 2016). 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 are depleted due to gray whale feeding in early summer, gray whales may then disperse to adjacent feeding areas to take advantage of relatively high density prey patches elsewhere. Gray whales feeding in summer 2015 in the southern part of block 14 were likely taking advantage of dense amphipod patches, which were identified in that area in 2009-2010 (Schonberg et al. 2014) and 2012 (Brower et al. *in press*). Whether amphipod patches were of a similar abundance in summer 2015, or whether more gray whales are migrating to the northeastern Chukchi Sea necessitating foraging over a broader area, is unknown. Changing hydrographic conditions or earlier sea ice melt may be changing ecosystem processes that lead to the location and abundance of amphipods. Continued

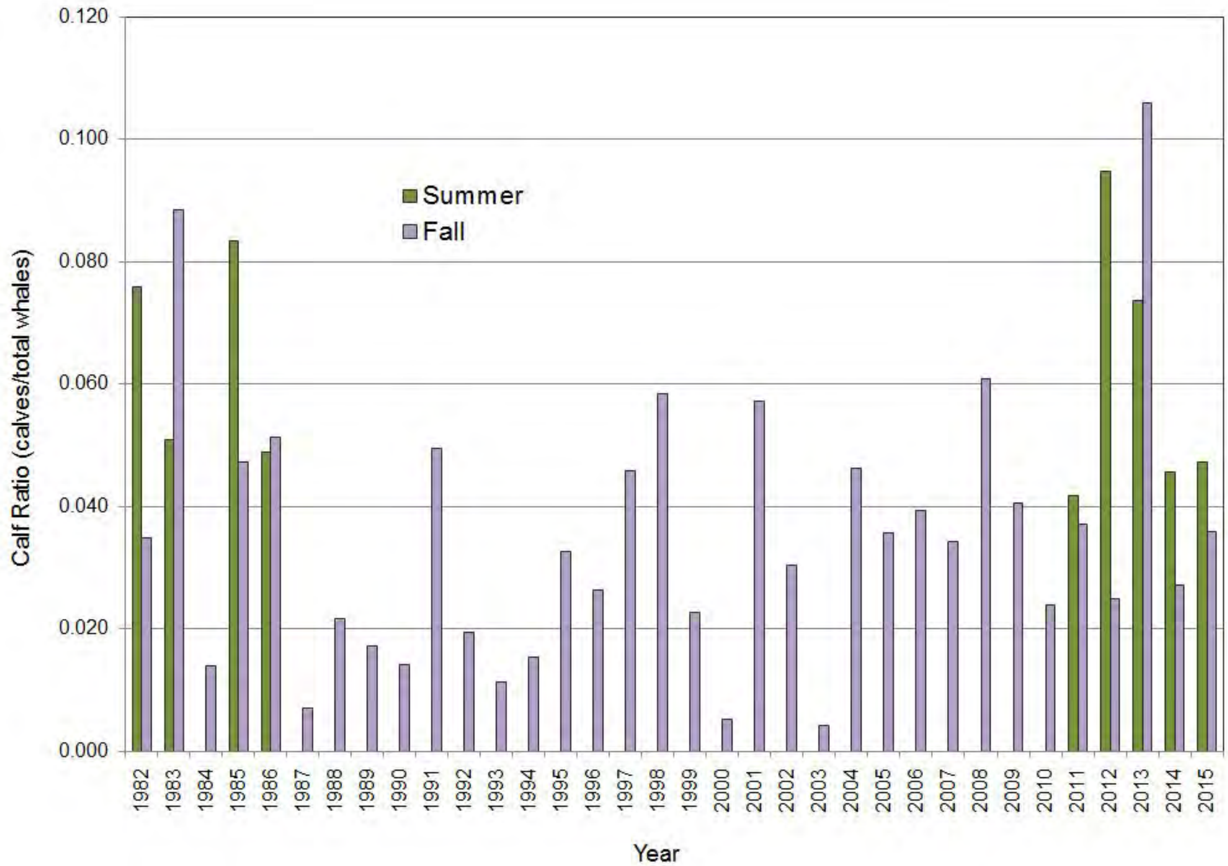


Figure 52. ASAMM bowhead whale calf ratios (number of calves/number of total whales), in summer (July-August) and fall (September-October), 1982-2015. Ratios are for entire ASAMM study area.

broad-scale aerial surveys in the northeastern Chukchi Sea will help identify gray whale foraging patterns in relation to climate change.

Gray whale calf occurrence in the eastern Chukchi Sea in 2015 continued an upward trend, following high calf occurrence in 2012-2014 (Clarke et al. 2013a, 2014, 2015a). When calf sightings were corrected for survey effort, the gray whale calf transect sighting rate in 2015 (number of calves per transect km, CPUE) was 0.0012, which is lower than the transect CPUE observed in 2014 but equal to or higher than gray whale calf sighting rates from 2009-2013 (Figure 55). Calf sighting rates using sightings and effort on transect (Tr) combined with sightings and effort from circling from transect (Tr+TrC) are a more accurate reflection of relative abundance because they incorporate all on-effort sightings and effort. 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. Gray whales, including

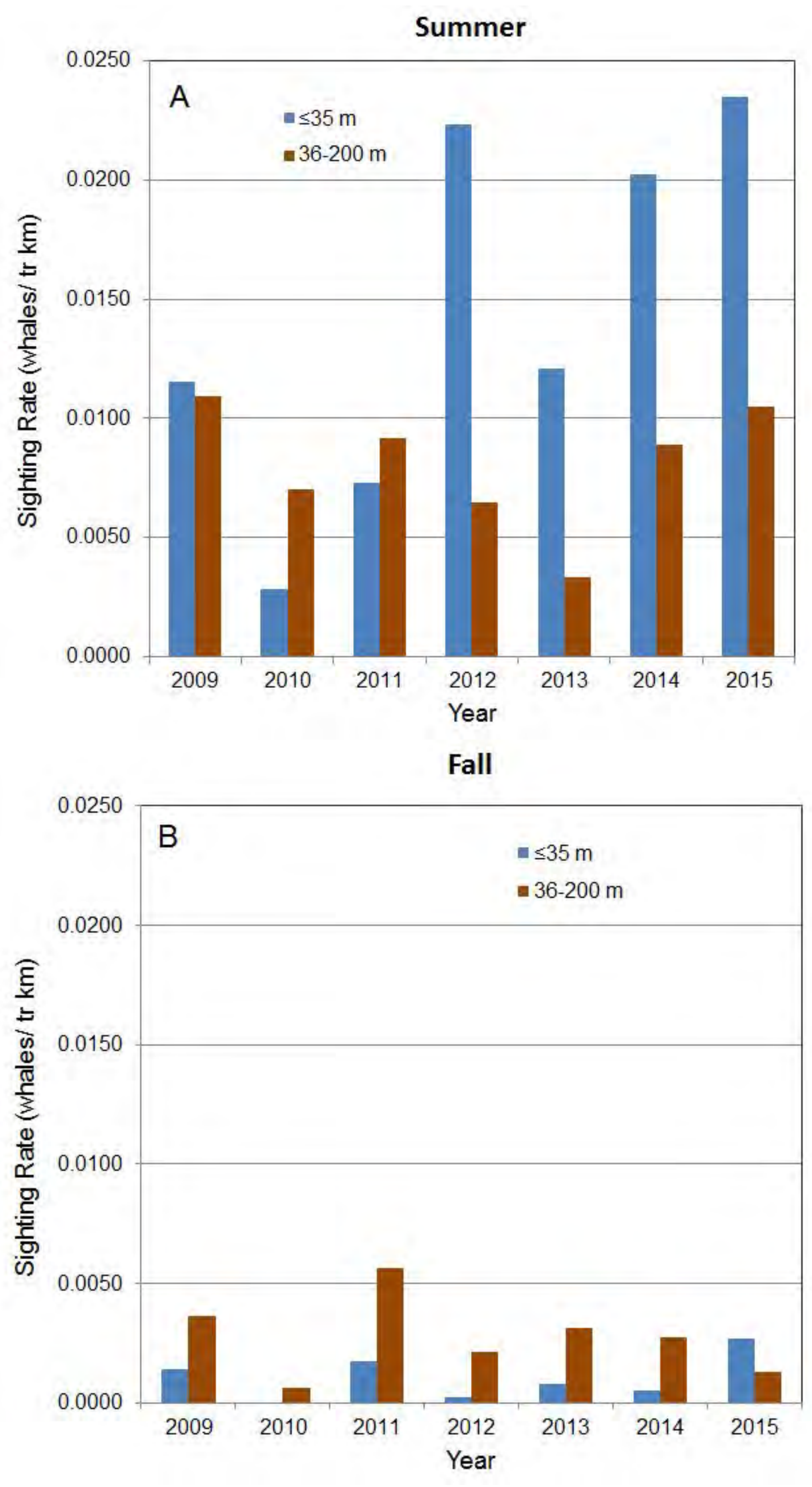


Figure 53. Gray whale sighting rates (WPUE; transect sightings from primary observers only) in shallow (≤35 m) and deep (>35 m) zones of the northeastern Chukchi Sea, 2009-2015. A: summer (July-August); B: fall (September-October). Includes sightings and effort in the ≤35 m, 36-50 m, and 51-200 m North depth zones.

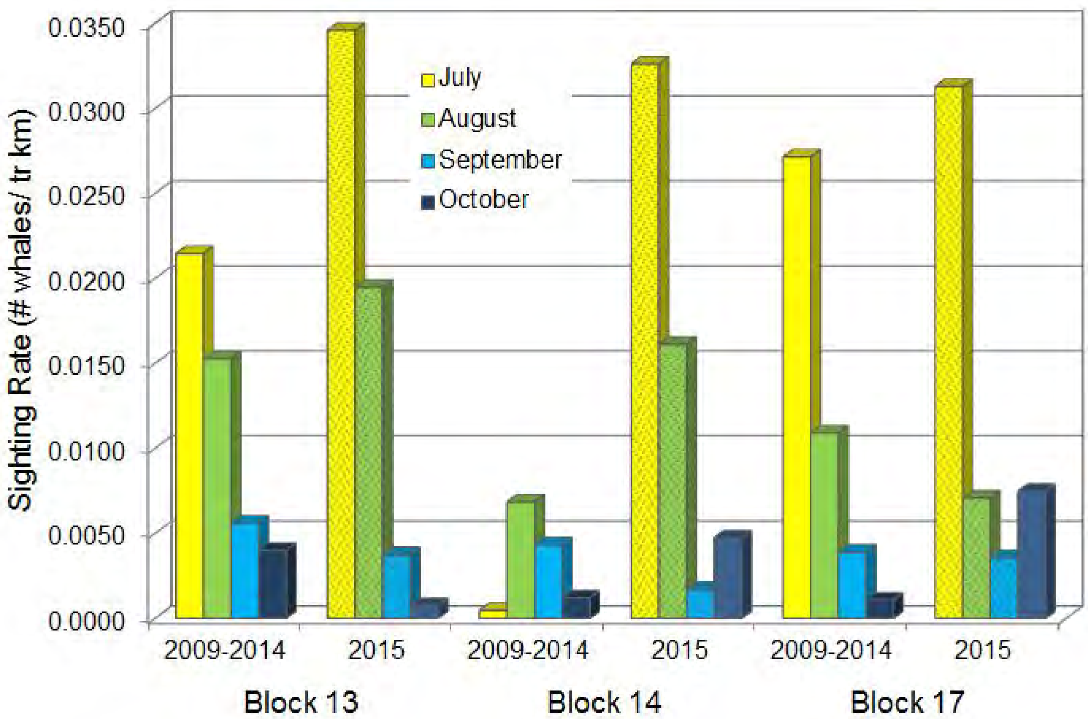


Figure 54. Gray whale sighting rates (WPUE; transect sightings from primary observers only) in blocks 13, 14, and 17 in the northeastern Chukchi Sea, July-October, 2009-2014 and 2015.

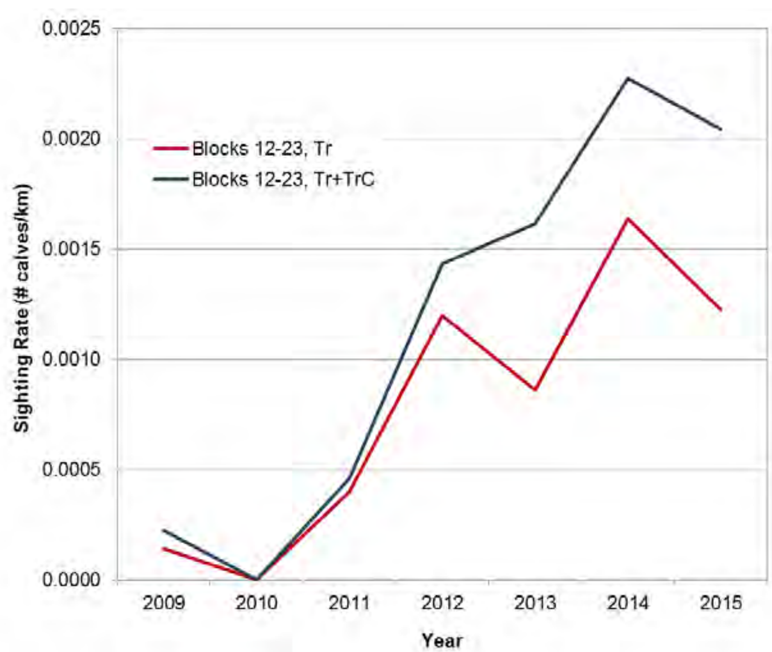


Figure 55. ASAMM gray whale calf sighting rates (WPUE; transect sightings from primary observers only), 2009- 2015 for sightings and effort on transect (Tr) and sightings and effort on transect and circling from transect (Tr+TrC).

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). Identification during systematic aerial surveys is difficult particularly when photographs are not regularly collected. Although some of the calves seen in 2015 were undoubtedly resighted on more than one day, the increase in gray whale calf occurrence found by ASAMM 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 56) (USDOC, NOAA, NMFS, SWSFC 2015). The increase in calf occurrence may be related to favorable foraging conditions from 2011-2014, resulting in higher reproductive success. It is also possible that more gray whale cow-calf pairs are migrating to the eastern Chukchi Sea due to reduced productivity in other cow-calf habitat or increased inter- or intra-specific competition on favored foraging grounds (Appendix C, Willoughby et al. 2016).

Gray whale calf occurrence in the eastern Chukchi Sea has been inconsistent among years. In the 18 years that aerial surveys have been conducted in the region with some regularity (1982-1991, 2008-2015), gray whale calves have been seen in 13 of those years and sightings of more than one gray whale calf per year were recorded in only 8 of the 18 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 likely persevered for several decades.

In 2014, the ASAMM study area was expanded to include regular surveys in block 23 in July through September, so multiyear comparisons of sighting rates in this area are not yet possible. This area encompasses a known gray whale hotspot (Kuletz et al. 2015) with high benthic biomass (Moore et al. 1993; Bluhm et al. 2007; Grebmeier et al. 2015) and one of the transect lines sampled for the DBO 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. ASAMM 2015 results showed that gray whales in this area overlapped temporally but not spatially with humpback, fin, and minke whales, with gray whales preferring deeper water than the latter species. Gray whales have previously been recorded in close association with humpback and fin whales in the southern Chukchi Sea (Clarke et al. 2013b) and with 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 DBO effort will undoubtedly reveal oceanographic and biologic parameters that may have influenced gray whale and other large whale distributions and densities in 2015.

Beluga distribution in the ASAMM study area, south of 72°N, has remained remarkably similar over the past 30 years (Figure 35). Beluga distribution in the western Beaufort Sea was primarily over the continental slope, regardless of season. In fall 2015, a few belugas were also seen in shallow nearshore areas, including Harrison Bay and elsewhere just seaward of barrier

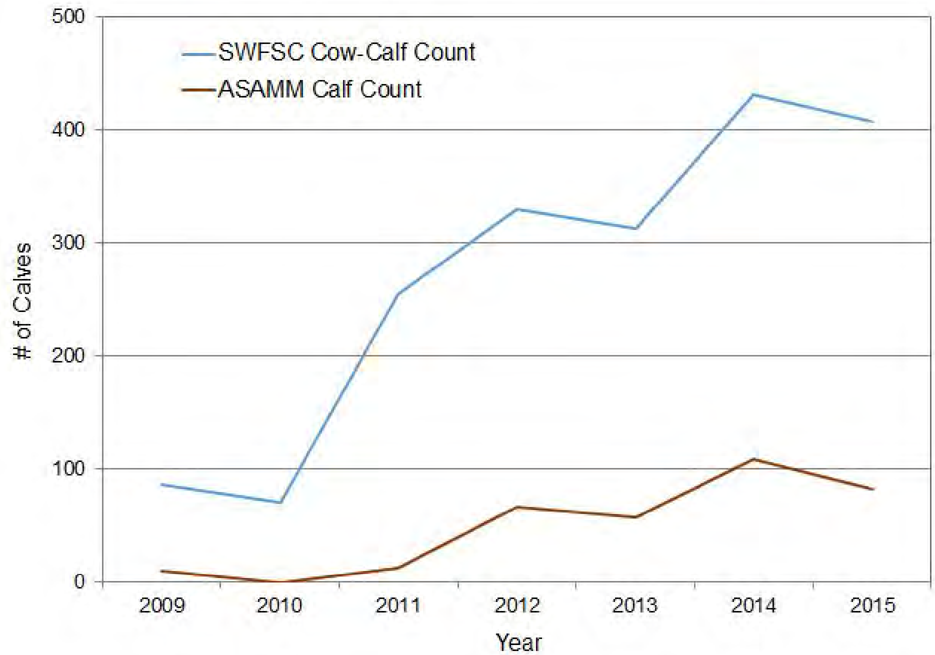


Figure 56. ASAMM gray whale calf counts in the eastern Chukchi Sea and SWFSC cow-calf pair counts off northern California, 2009-2015.

islands. Beluga distribution in the northeastern Chukchi Sea documented by ASAMM in 2015 was similar to observations in 2011 and 2014, when belugas were distributed throughout the Chukchi Sea study area in all months (Clarke et al. 2012, 2015a).

It is likely that ASAMM effort does not document the full extent of beluga range in the eastern Chukchi and western Beaufort seas. 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. Surveys conducted in the late 1980s and early 1990s also suggested that beluga distribution in the Chukchi Sea in fall is bifurcated, with some belugas heading through Barrow Canyon and continuing southwesterly and others heading west-northwest toward the Chukotka coast before heading south (Clarke et al. 1993). Beluga occurrence in Barrow Canyon may be related to the relatively high densities of Arctic cod and other benthic and pelagic fish (Logerwell et al. 2011; Sousa et al. 2014) that comprise beluga diet.

Marine mammal data collected during the 2015 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 during summer and fall, important information was also obtained in 2015 relating to unique situations and other species. Minke, humpback, and fin whales seasonally inhabit arctic and subarctic habitats (Higdon and Ferguson 2011; Laidre and

Heide-Jørgensen 2012; Clarke et al. 2013b). Observations of these species in 2015 were limited mostly to the southcentral Chukchi Sea.

Two minke whales were observed north of 69°N, west of Icy Cape, making this the fifth consecutive year that ASAMM has documented minke whales in the northeastern Chukchi Sea (Clarke et al. 2012, 2013a, 2014, 2015a). 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, Clarke et al. 2016). Humpback whales are occasionally observed in the western Beaufort (Hashagen et al. 2009) or northeastern Chukchi sea (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).

Humpback, fin, and minke whales were not sighted in the eastern Chukchi Sea study area during aerial surveys conducted in 1982-1991 (Moore and Clarke 1992). Continued 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 Arctic. The annual occurrence of humpback, fin, and minke whales in the ASAMM study area underscores the importance of carefully investigating and documenting all cetacean sightings to confirm species identification.

The coastal walrus haulout near Point Lay formed in late August 2015, which was considerably earlier than in 2013 and 2014, when coastal haulout formation occurred in mid-September. Sea ice near Hanna Shoal was absent by late August 2015 and ice recession towards deeper water undoubtedly was a catalyst to the haulout formation. 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. Additionally, 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.

The use of UAS in the Arctic, overlapping temporally and geographically with ASAMM, again presented unique challenges in 2015. ASAMM collaborated with the Arctic ACEs study, which was designed to allow near simultaneous collection of marine mammal sighting data from manned and unmanned aircraft within the west and east Arctic ACEs subareas, which were within the ASAMM study area (Figure 1). Prior to field activity, in-depth planning involving principal investigators, project managers, pilots, and field liaisons, was undertaken, and a detailed communications plan was agreed upon to ensure Arctic ACEs objectives could be met safely and effectively. The communication plan included details on altitudes, separation distances, return-to-base contingencies, and lost link procedures (Appendix D). Planning and coordination continued once the field season commenced, including daily SIMOPs phone calls, joint weather briefings, and face-to-face meetings. Despite the extensive pre- and in-season efforts to coordinate manned and unmanned efforts, there were still breakdowns in communication that led to misunderstandings when the manned and unmanned aircraft were airborne in the same ACEs subarea. As a result, separation distances were increased between the manned and unmanned aircraft and the protocol was modified to ensure that manned and unmanned aircraft were not in the same ACEs subarea at the same time. UAS are difficult to see and there is currently not a standardized way for UAS and manned aircraft to automatically communicate their position to each other to allow real-time flight tracking because UAS rely entirely on operators on ships or land for control and navigation. To improve flight safety by ensuring that all aircraft are visible to each other, technology that automatically broadcasts an aircraft's position and detects other aircraft in the general vicinity, such as Automatic Dependent Surveillance-Broadcast (ADS-B), should be required on all UAS and highly recommended for all manned aircraft, regardless of flight altitude or geographic location. This requirement, together with continuing cooperation between aircraft operators, will be absolutely imperative to ensure that manned and unmanned aerial platforms can continue to operate safely in the Arctic.

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 (1982-2015) 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 the impact of the ASAMM surveys. 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. These associations, ongoing since 2010, underscore the multidisciplinary nature of ASAMM and render it more than simply a "marine mammal survey".

Huntington (2009) identified six areas of human influence that will pose threats to arctic marine mammals and their conservation over the next several decades: climate change, environmental contaminants, offshore oil and gas activities, shipping, hunting, and commercial fisheries. He hypothesized the likely effects of each factor on arctic marine mammals in the future:

- Climate change has the greatest potential impact among the factors considered;
- Industrial development is a "tractable" issue, given stringent regulations and strong enforcement;
- The threat from commercial fishing is the least well understood, but examples of conflict between commercial fisheries and marine mammals in other regions warrant that precautionary measures be taken in the Arctic;
- Hunting ranked relatively low because it is "well understood" and existing management structures are already in place;
- Shipping is likely to have a modest impact, but those impacts could be mitigated or minimized with effective regulation; and
- Chronic environmental contaminants do not appear to pose a "substantial threat", although there are many uncertainties surrounding this issue.

Examined in isolation, each potential threat appears to be manageable. However, Huntington (2009) argues that the combined effects of all six factors "are perhaps the most daunting threat." Considerable information gaps exist in simply understanding the effects of single stressors on individual marine mammals. The uncertainty is magnified in reality, where inference must be broadened to include the effects of multiple stressors on the interconnected biological, physical, chemical, and acoustic aspects of the ecosystem that interact directly and indirectly to affect marine mammal health and fitness. Given the changes observed to date in the physical environment and marine mammal distributions in the Arctic, and the expected increases in anthropogenic pressures on the arctic ecosystem, effective conservation and management of arctic natural resources will require continuous monitoring of those resources. This will help with understanding the variability inherent in the ecosystem, predicting potential effects of anthropogenic activities, and detecting when changes are occurring. To better understand, manage, and conserve the new Arctic, it is essential to continue to actively study the new Arctic.

Management Use of Real-Time Field Information

BOEM issues various permits to industry for gas and oil exploration, including open water and on-ice seasonal vessel-based geophysical permits for exploration using array(s) of deep-seismic airguns; vessel-based geological-geophysical permits for shallow-seismic exploration using airguns; on-ice geophysical permits using VIBROSEIS technology; both vessel-based and on-ice geological permits for obtaining core samples; and permits to drill for gas and oil. Summaries of ASAMM aerial survey data in the form of daily reports were made available to representatives of oil companies, the North Slope Borough 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 2015b).

Management Use of Interannual Monitoring

This BOEM-sponsored bowhead whale 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 recorded have remained remarkably consistent (especially data from 1982 to 2015), thus permitting many direct comparisons across years. Such continuous, long-term, broad-scale, aerial monitoring of a large whale migration and associated marine mammals is indeed unique. In addition to the accomplishments specifically mentioned in the 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; Christman et al. 2013; Clarke et al. 2013b; Schonberg et al. 2014; Stafford et al. 2013; Clarke et al. 2015b; Ferguson et al. 2015; Grebmeier et al. 2015; Kuletz et al. 2015) to better understand, manage, and conserve arctic resources.

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APPENDIX A: 2015 ICE CONCENTRATION MAPS

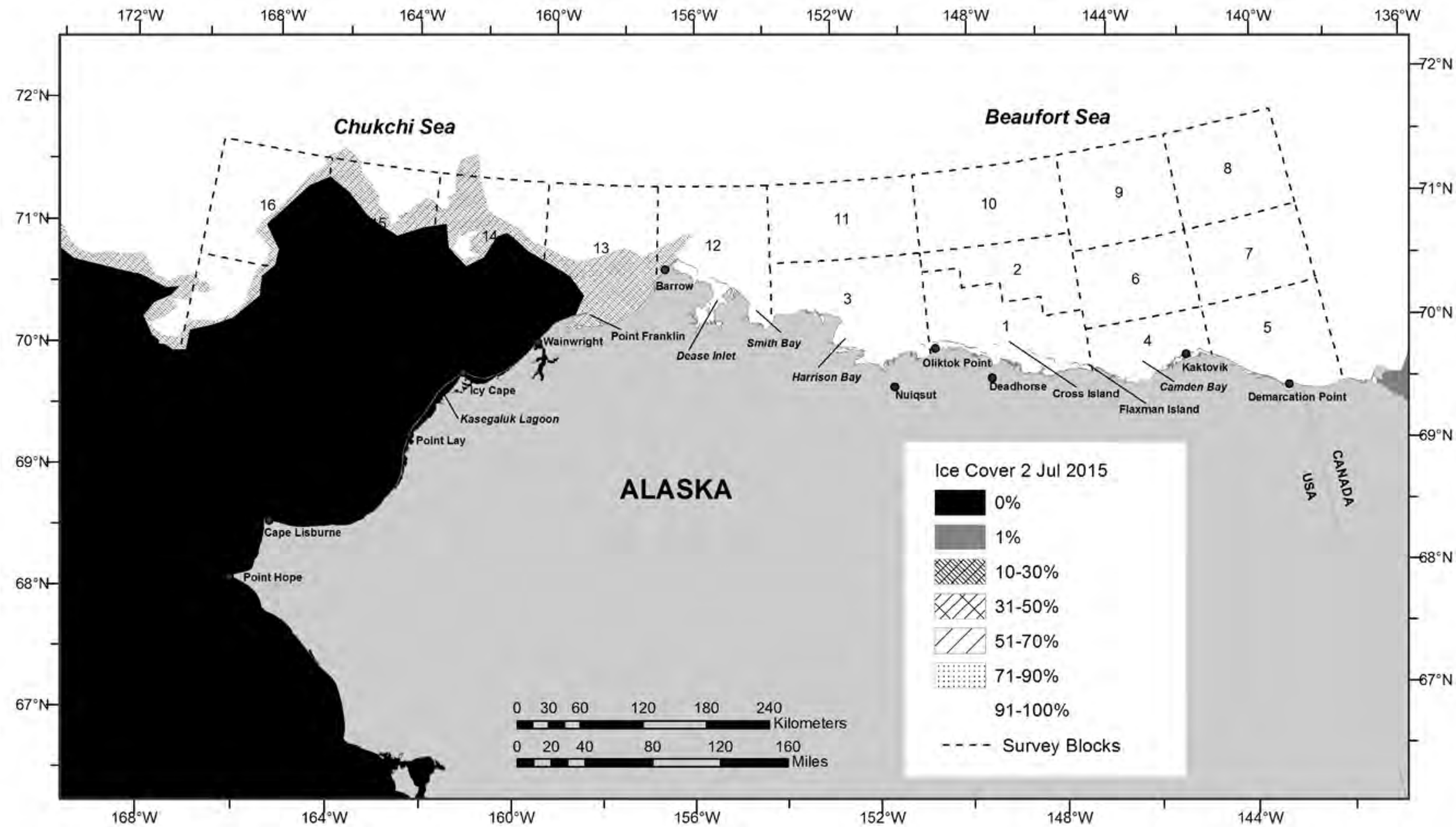

Figure A-1. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 2 July 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

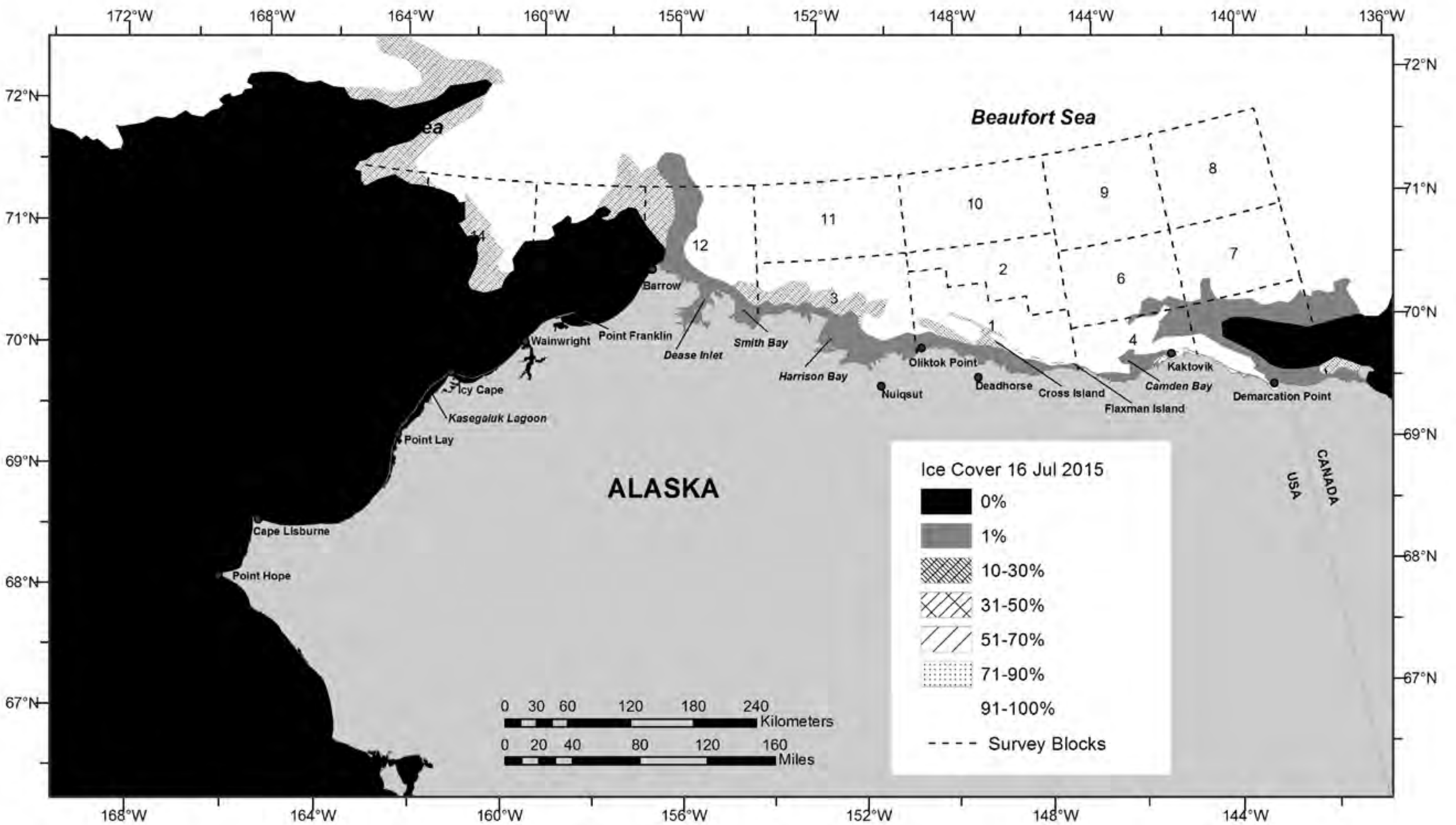

Figure A-2. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 16 July 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

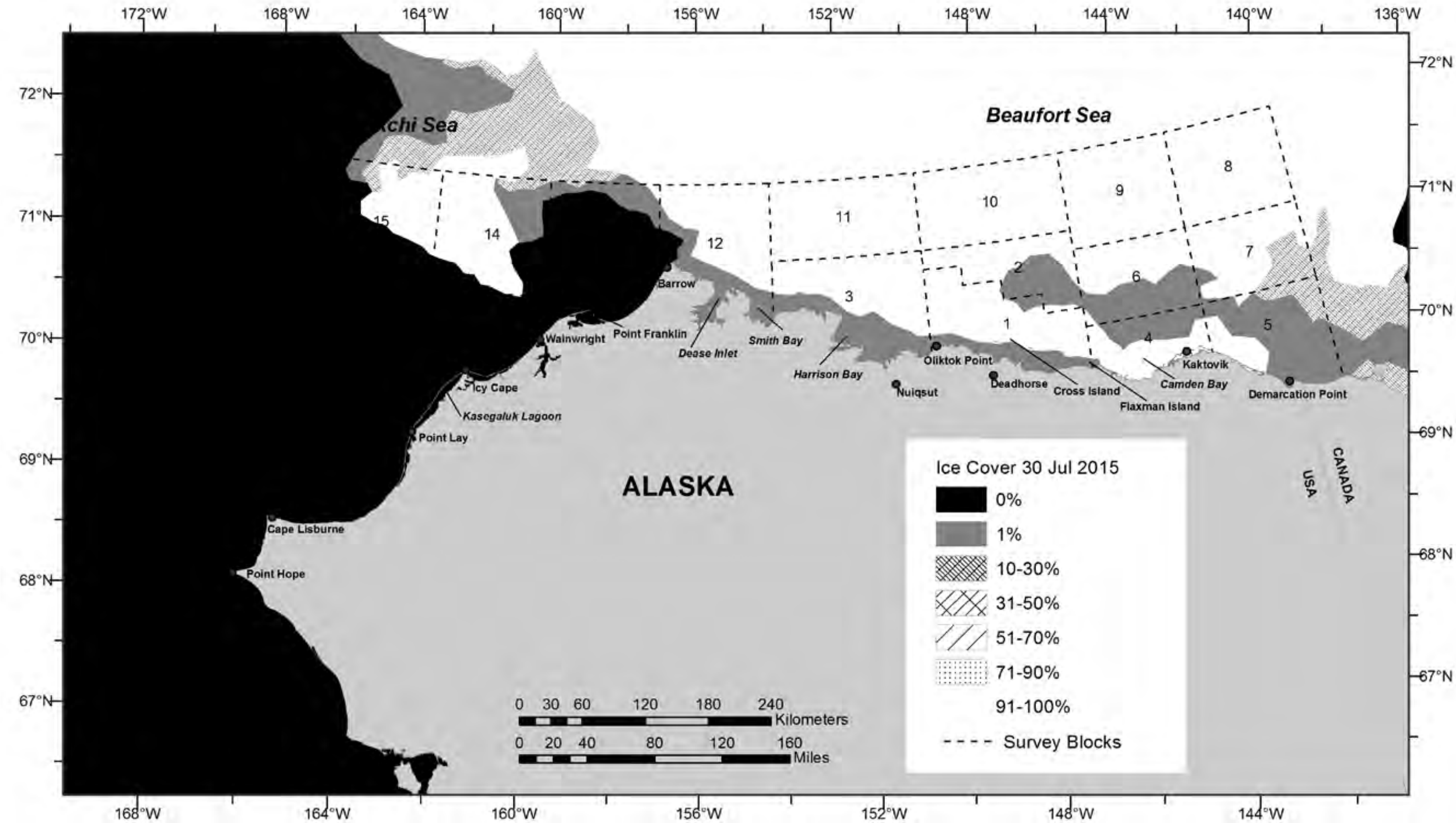

Figure A-3. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 30 July 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

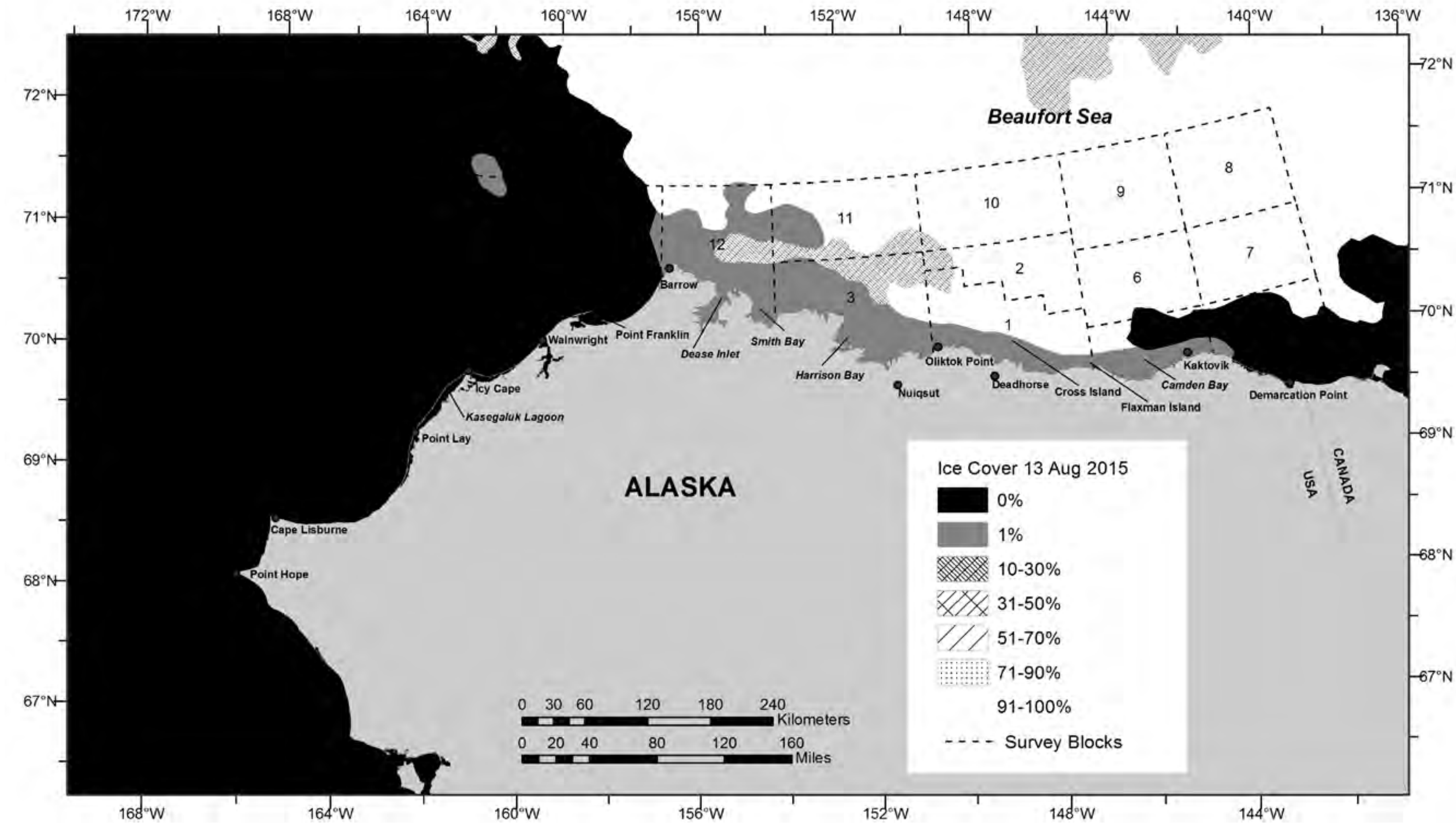

Figure A-4. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 13 August 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

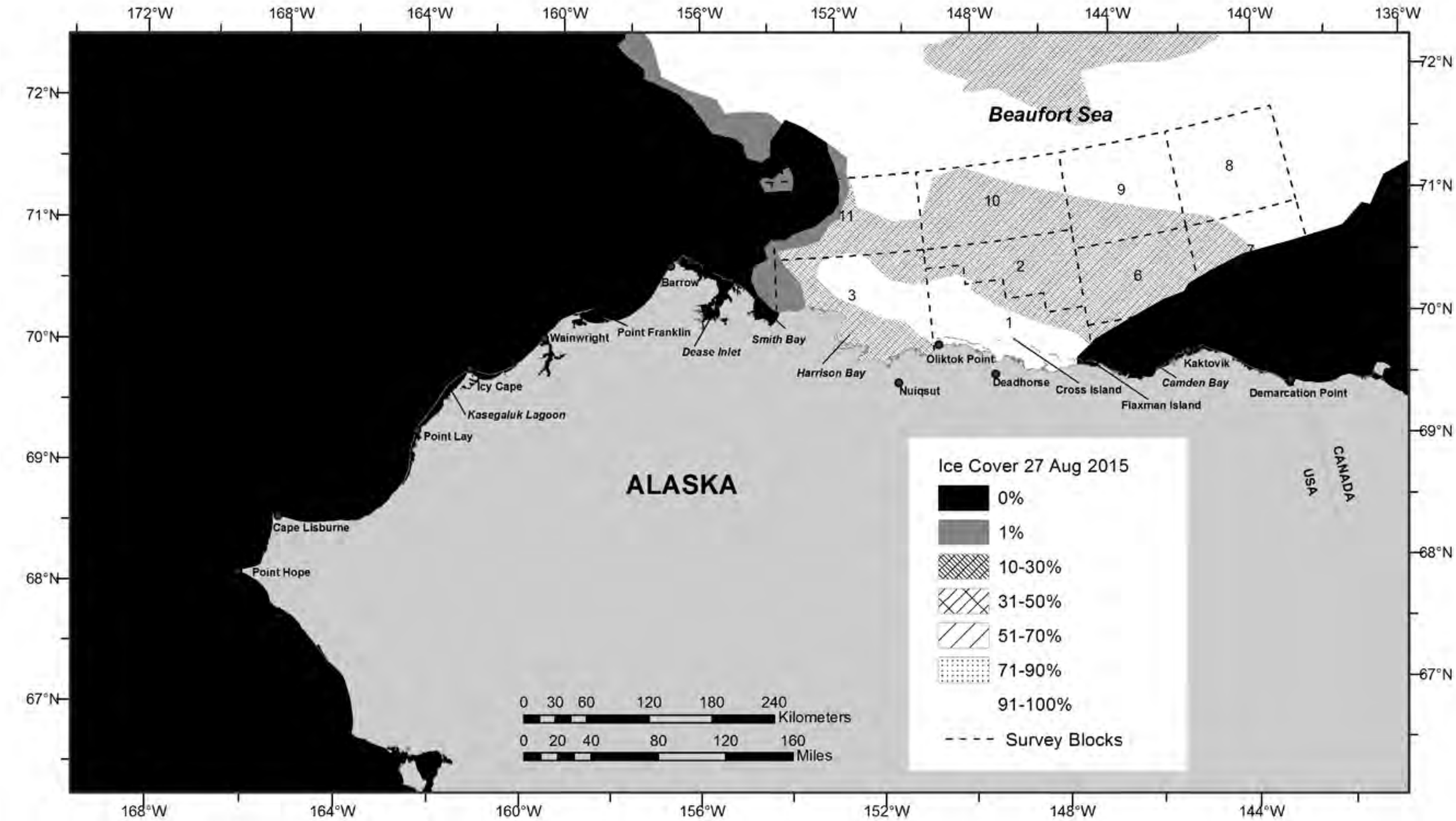

Figure A-5. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 27 August 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

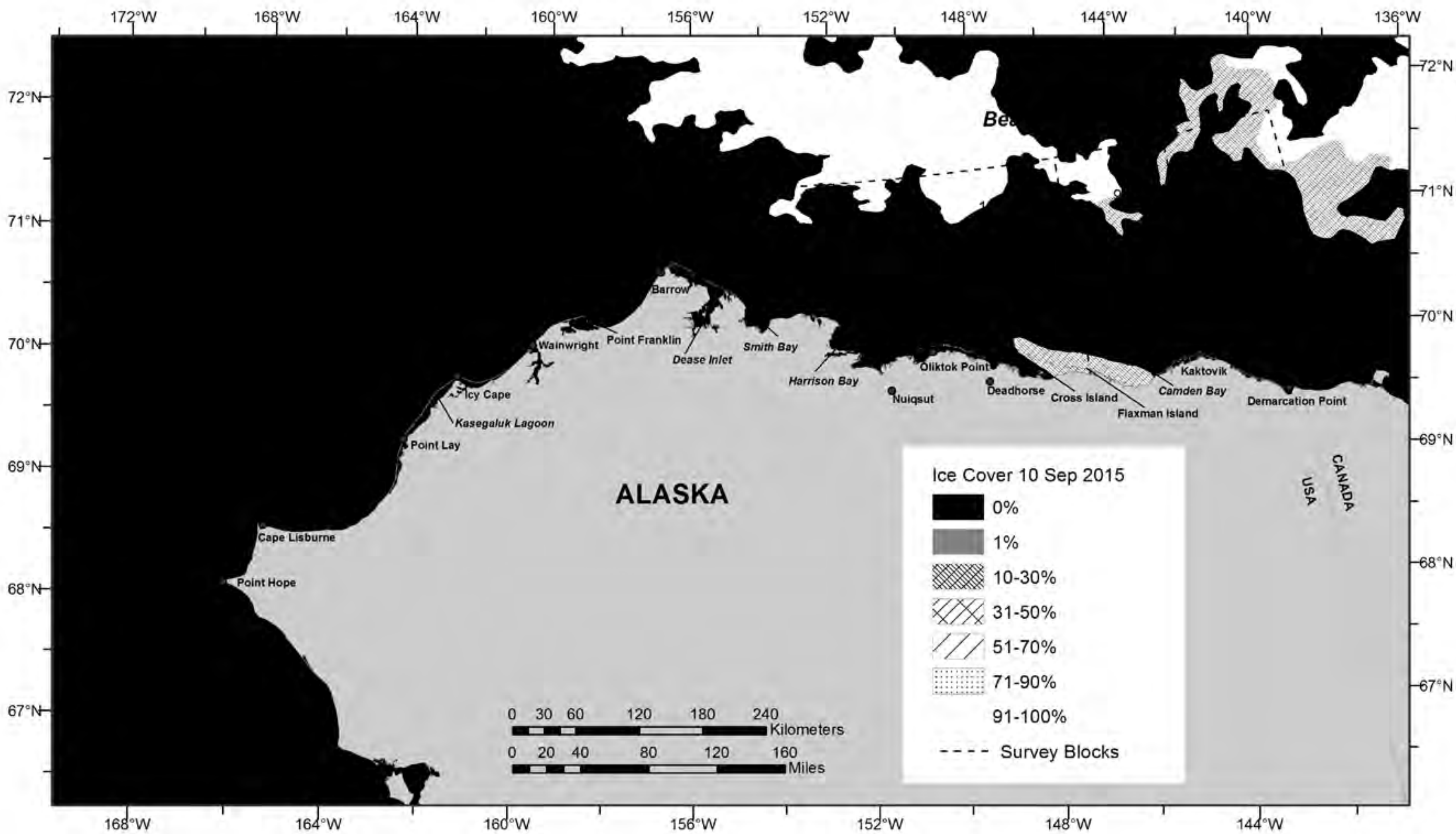

Figure A-6. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 10 September 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

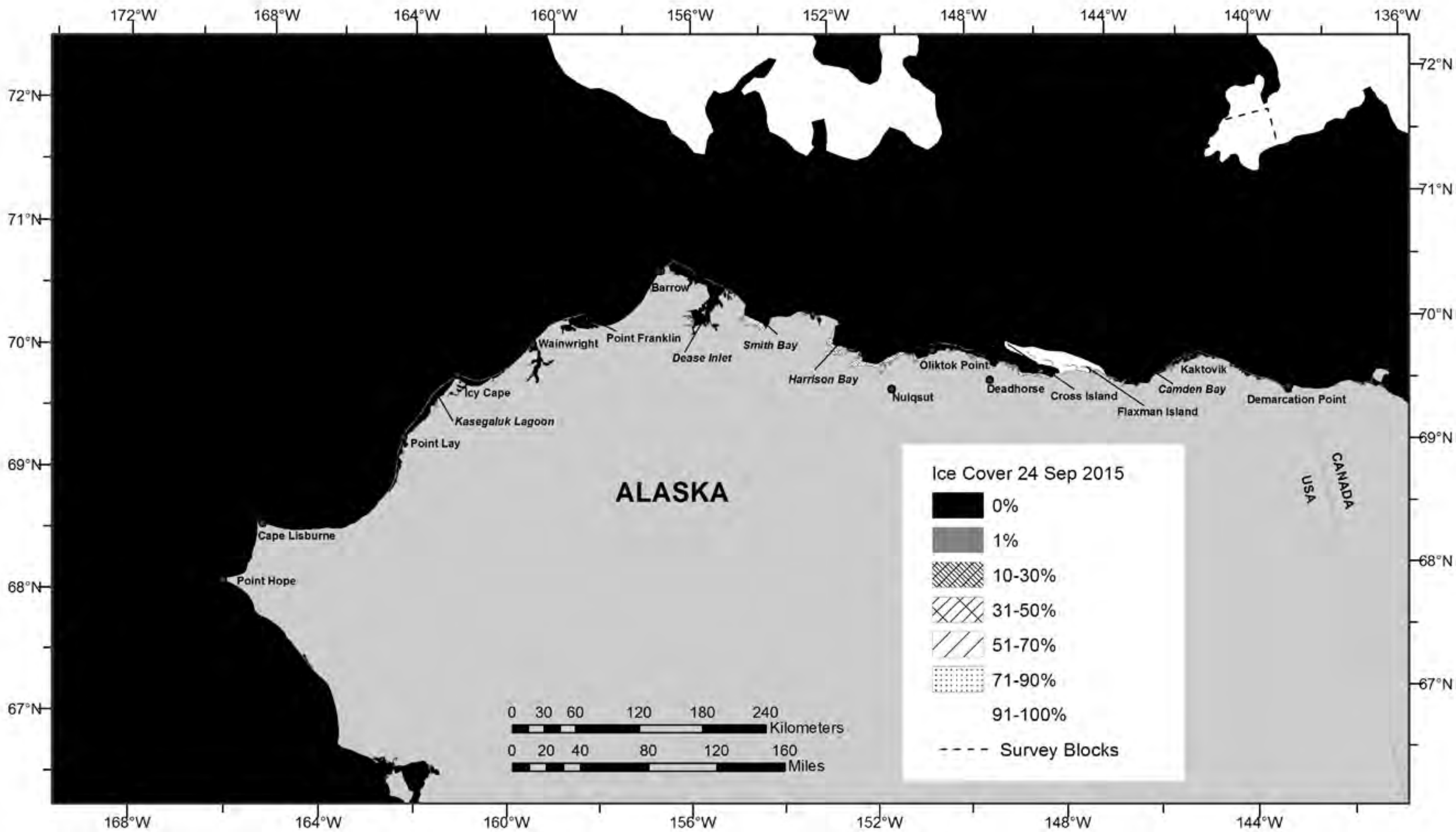

Figure A-7. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 24 September 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

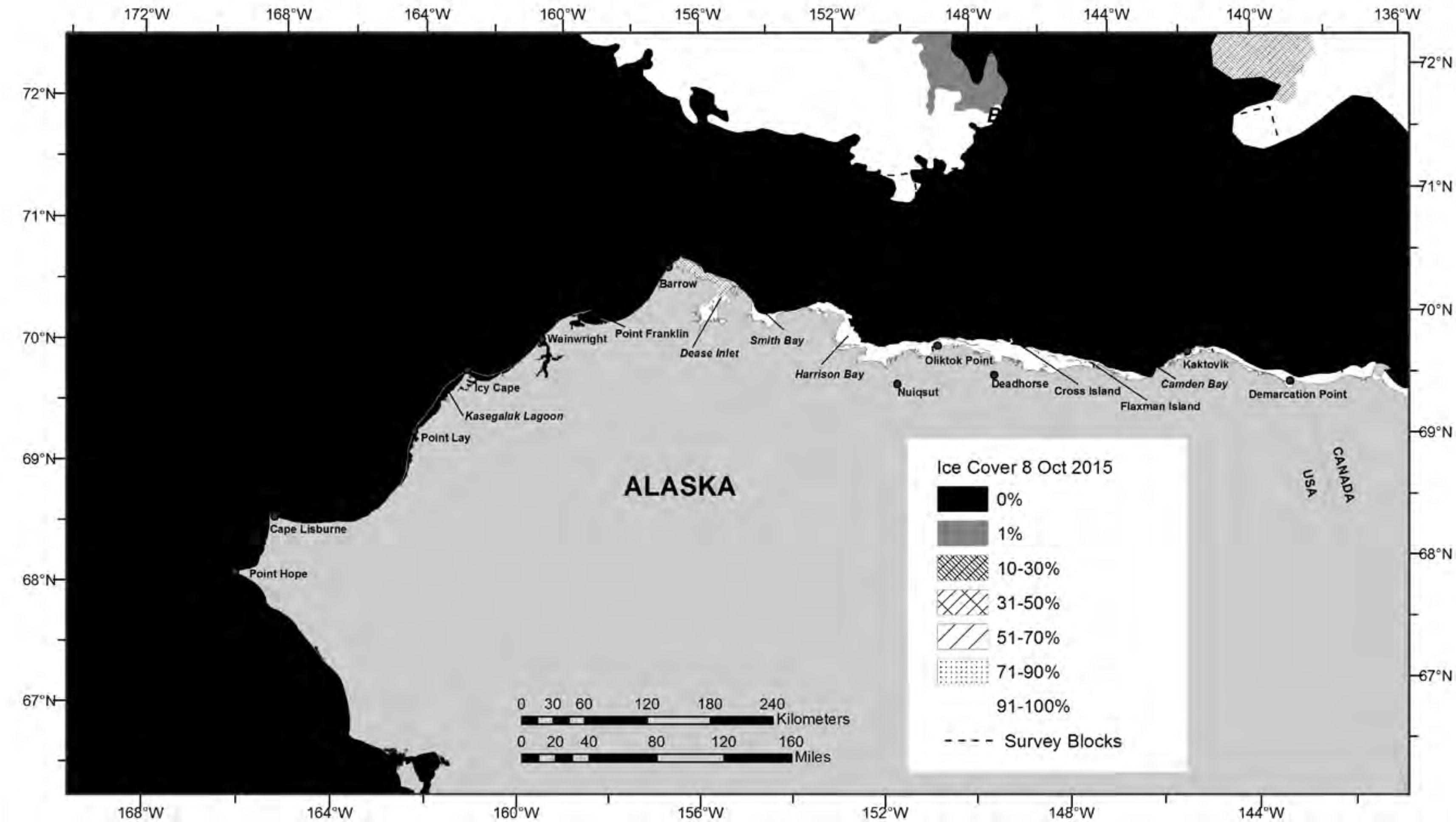

Figure A-8. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 8 October 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

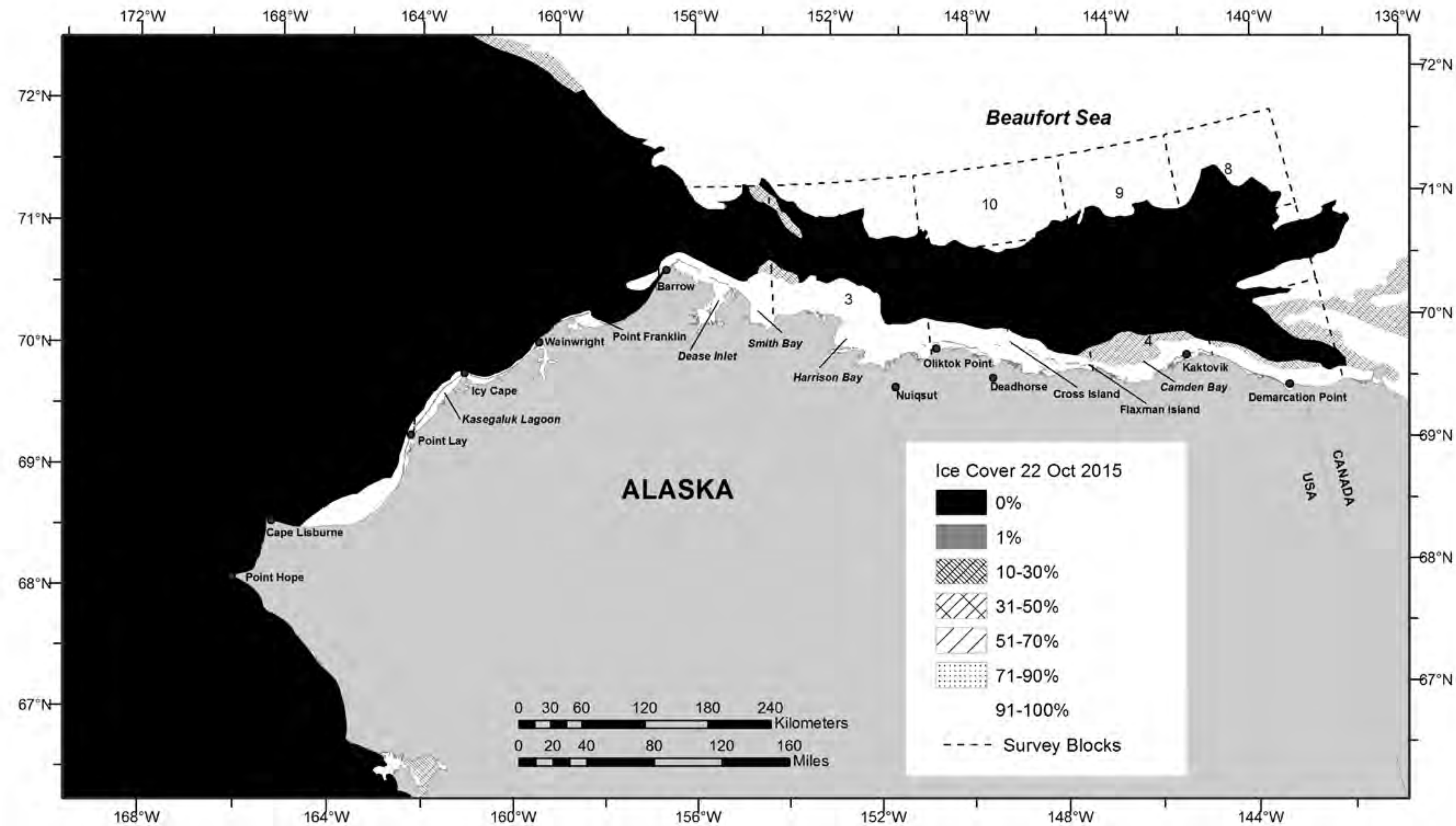

Figure A-9. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 22 October 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

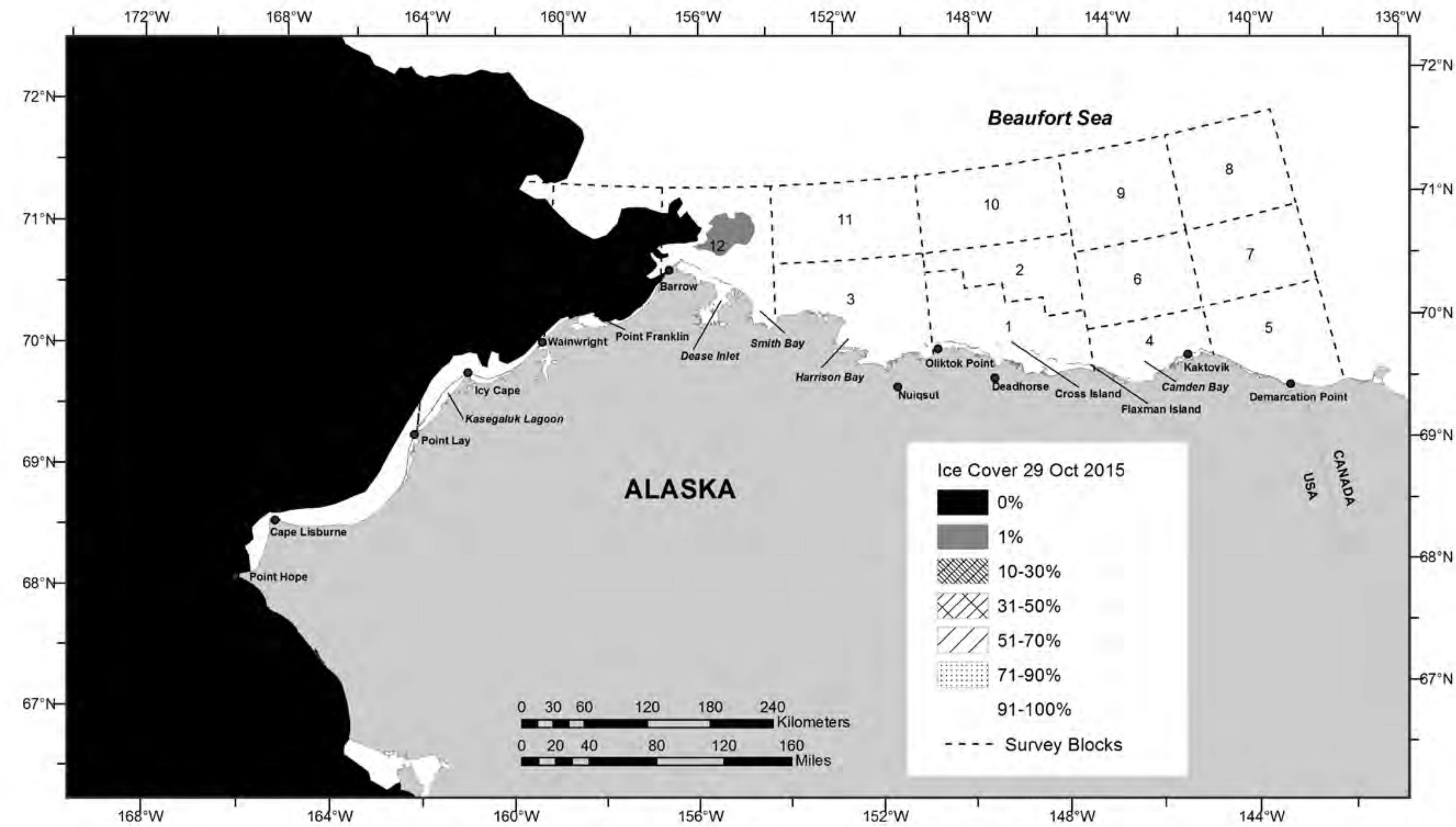

Figure A-10. Ice concentrations in the eastern Chukchi and Alaskan Beaufort seas, 29 October 2015. Sea ice information was obtained from the National Ice Center (U.S. National Ice Center 2015).

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APPENDIX B: 2015 DAILY FLIGHT SUMMARIES

2 July 2015, Flight 201

Flight was a partial survey of transects 1, 3, and 7. Survey conditions included overcast skies, 0-10 km visibility (with fog and low ceilings), and Beaufort 0-3 sea states. Sea ice cover was 0-85% broken floe in the area surveyed. Sightings included gray whales (including two calves), belugas, unidentified cetaceans, walruses (including one carcass), 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
201	7/2/15 15:40	71.080	159.434	beluga	swim	1	0	13
201	7/2/15 15:42	71.083	159.445	beluga	swim	1	0	13
201	7/2/15 15:56	71.015	158.271	unid cetacean	swim	4	0	13
201	7/2/15 15:56	71.023	158.267	gray whale	feed	5	0	13
201	7/2/15 15:58	71.049	158.197	gray whale	feed	2	0	13
201	7/2/15 15:58	71.045	158.194	gray whale	feed	3	0	13
201	7/2/15 16:03	71.058	158.103	gray whale	feed	2	0	13
201	7/2/15 16:07	71.075	157.959	gray whale	feed	6	1	13
201	7/2/15 16:09	71.058	157.906	gray whale	feed	5	1	13
201	7/2/15 16:11	71.055	157.950	gray whale	swim	2	0	13

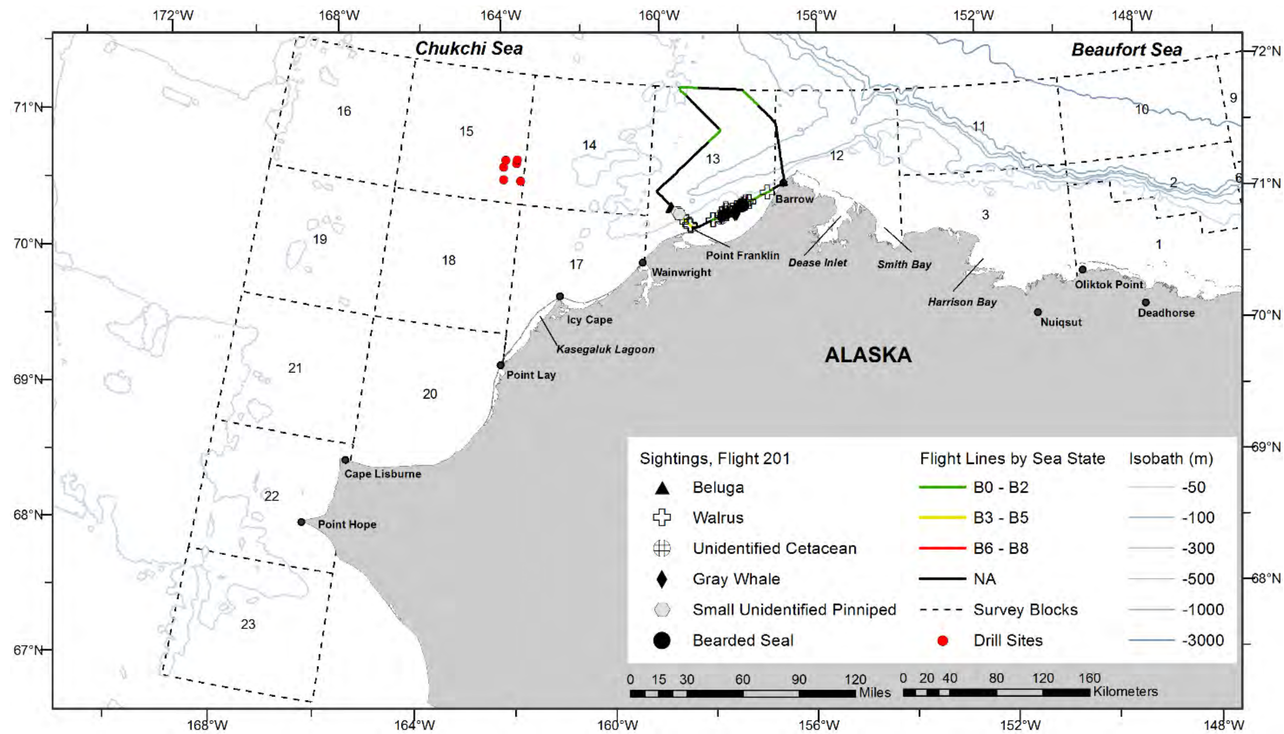

Figure B-1. ASAMM Flight 201 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

3 July 2015, Flight 202

Flight was a complete survey of transects 1, 3, 5, and 7. Survey conditions included partly cloudy to overcast skies, 5-10 km visibility (with glare), and Beaufort 0-4 sea states. Sea ice cover was 0-87% broken and pack floe in the area surveyed. Sightings included gray whales (including seven calves), unidentified cetaceans, 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
202	7/3/15 18:22	71.263	156.997	gray whale	swim	1	0	12
202	7/3/15 18:23	71.259	156.955	gray whale	feed	5	1	12
202	7/3/15 18:25	71.273	156.966	gray whale	feed	3	1	12
202	7/3/15 18:26	71.278	156.957	gray whale	feed	4	1	12
202	7/3/15 18:31	71.201	157.106	gray whale	swim	1	0	13
202	7/3/15 18:35	71.174	157.136	gray whale	swim	1	0	13
202	7/3/15 18:38	71.165	157.167	gray whale	swim	1	0	13
202	7/3/15 18:38	71.155	157.228	unid cetacean	swim	1	0	13
202	7/3/15 18:54	71.019	157.638	gray whale	swim	1	0	13
202	7/3/15 18:58	71.041	157.755	gray whale	feed	1	0	13
202	7/3/15 18:58	71.055	157.787	gray whale	feed	3	0	13
202	7/3/15 19:01	71.059	157.831	gray whale	feed	3	0	13
202	7/3/15 19:01	71.067	157.855	gray whale	feed	2	0	13
202	7/3/15 19:06	71.022	157.980	gray whale	feed	1	0	13
202	7/3/15 19:06	71.029	158.018	gray whale	feed	5	1	13
202	7/3/15 19:07	71.017	158.042	gray whale	feed	2	1	13
202	7/3/15 19:08	71.016	158.059	gray whale	feed	3	0	13
202	7/3/15 19:17	71.093	157.928	gray whale	feed	2	0	13
202	7/3/15 19:23	71.108	158.112	gray whale	feed	1	0	13
202	7/3/15 20:44	71.479	160.813	gray whale	swim	4	2	14
202	7/3/15 21:12	71.049	159.329	unid cetacean	swim	1	0	13
202	7/3/15 21:15	70.979	159.075	gray whale	swim	1	0	13
202	7/3/15 21:16	70.977	159.062	gray whale	swim	1	0	13

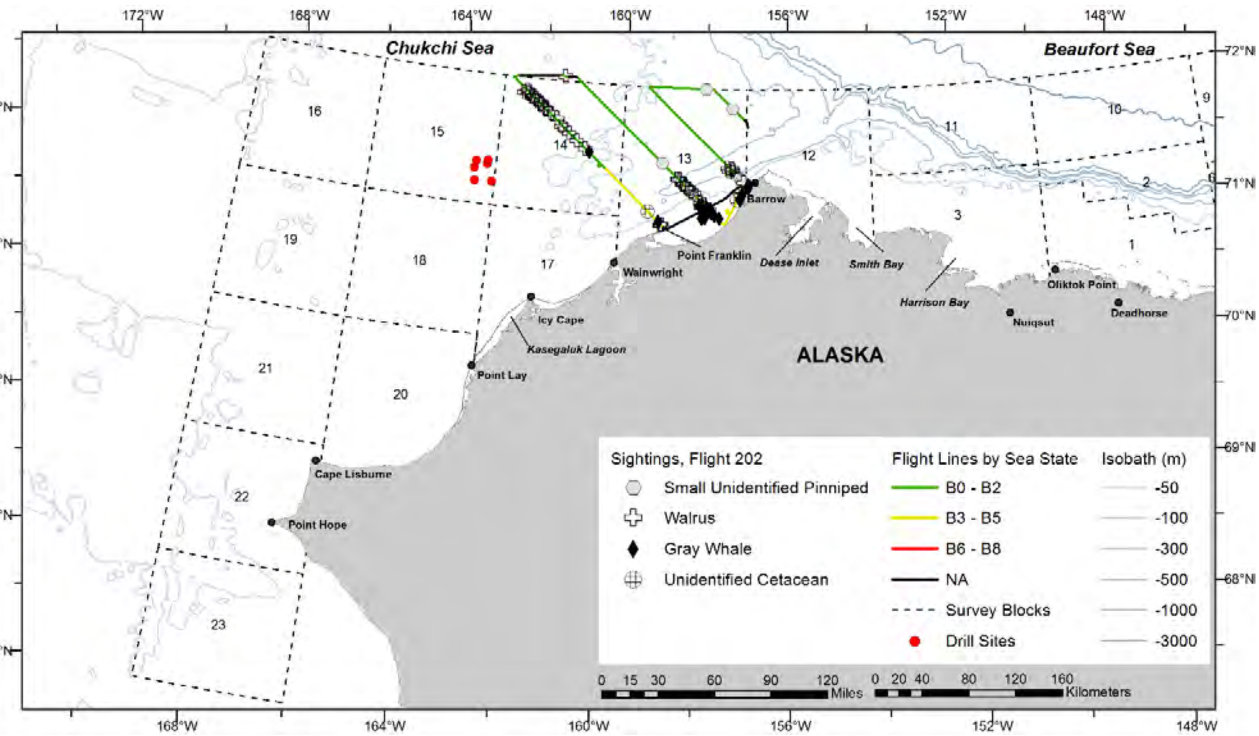

Figure B-2. ASAMM Flight 202 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Two gray whale cow-calf pairs sighted approximately 145 km west of Barrow, Alaska, during ASAMM Flight 202, 3 July 2015.

4 July 2015, Flight 203

Flight was a complete survey of transects 9, 11, 13, and 15. Survey conditions included clear to partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 1-5 sea states. Sea ice cover was 0-75% broken and pack floe in the area surveyed. Sightings included one bowhead whale, gray whales (including nine calves), belugas, unidentified cetaceans, walruses (including seven carcasses), unidentified pinnipeds, 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
203	7/4/15 10:44	70.890	160.316	gray whale	feed	1	0	17
203	7/4/15 10:48	70.913	160.359	gray whale	feed	3	1	17
203	7/4/15 10:52	70.940	160.249	gray whale	feed	3	1	17
203	7/4/15 10:52	70.944	160.213	gray whale	feed	2	1	17
203	7/4/15 10:56	70.922	160.567	gray whale	feed	1	0	17
203	7/4/15 10:58	70.931	160.600	gray whale	feed	1	0	17
203	7/4/15 10:58	70.932	160.623	gray whale	feed	2	1	17
203	7/4/15 10:58	70.929	160.644	gray whale	feed	2	1	17
203	7/4/15 11:05	70.955	160.699	gray whale	rest	2	1	17
203	7/4/15 11:06	70.939	160.729	gray whale	rest	1	0	17
203	7/4/15 11:26	71.219	161.449	gray whale	feed	1	0	14
203	7/4/15 11:30	71.247	161.304	unid cetacean	feed	1	0	14
203	7/4/15 11:30	71.254	161.311	gray whale	swim	2	1	14
203	7/4/15 11:30	71.270	161.296	gray whale	feed	1	0	14
203	7/4/15 11:35	71.248	161.573	gray whale	swim	3	1	14
203	7/4/15 11:36	71.256	161.592	gray whale	rest	1	0	14
203	7/4/15 11:49	71.427	162.469	gray whale	swim	1	0	14
203	7/4/15 11:53	71.423	162.530	bowhead whale	swim	1	0	14
203	7/4/15 13:04	71.559	164.569	beluga	swim	1	0	15
203	7/4/15 13:33	70.987	162.281	gray whale	rest	1	0	17
203	7/4/15 13:33	70.982	162.295	gray whale	swim	1	0	17
203	7/4/15 13:54	70.536	160.704	gray whale	swim	3	1	17
203	7/4/15 13:57	70.508	160.607	unid cetacean	swim	1	0	17
203	7/4/15 16:47	70.440	163.518	beluga	swim	2	0	18
203	7/4/15 16:47	70.458	163.561	beluga	swim	1	0	18
203	7/4/15 16:48	70.468	163.573	beluga	swim	1	0	18
203	7/4/15 17:16	71.010	165.756	unid cetacean	swim	1	0	15
203	7/4/15 17:29	71.188	166.544	beluga	swim	1	0	16

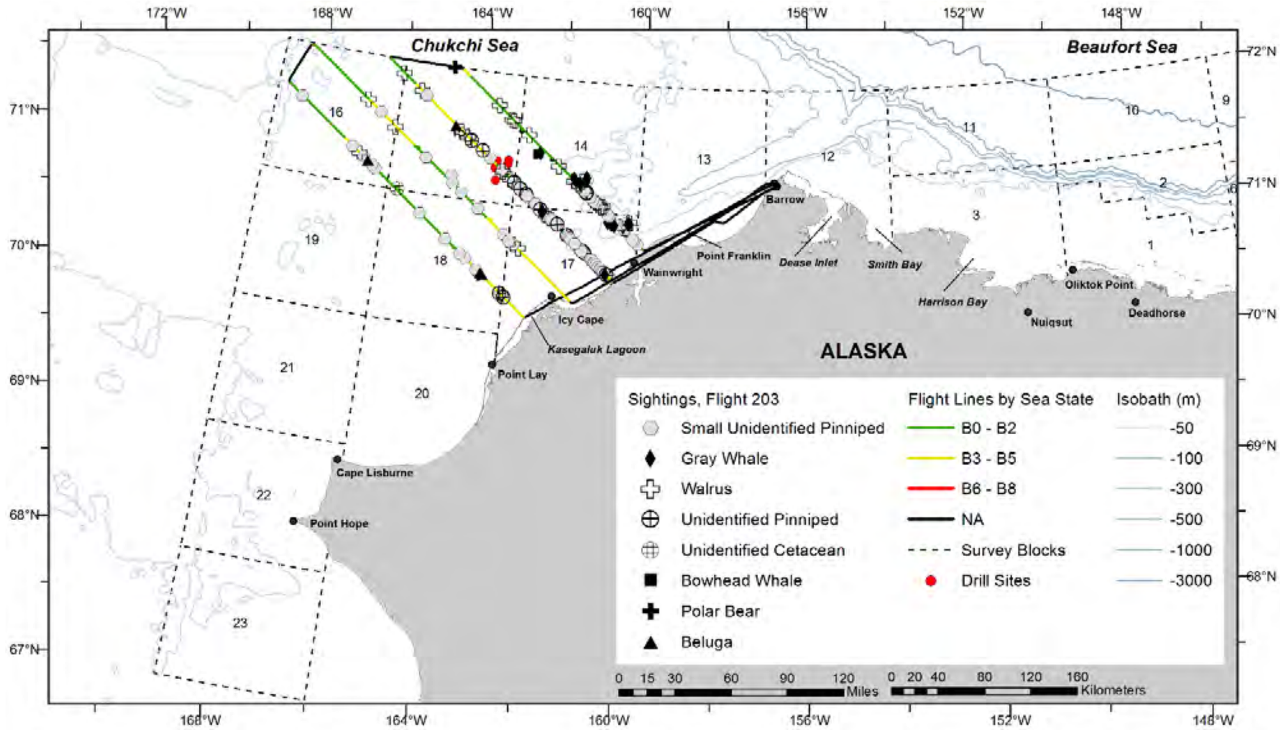

Figure B-3. ASAMM Flight 203 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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5 July 2015, Flight 204

Flight was a complete survey of transects 17 and 19. Survey conditions included clear skies, 5 km to unlimited visibility (with glare), and Beaufort 0-4 sea states. Sea ice cover was 0-75% broken floe in the area surveyed. Sightings included gray whales (including three calves), belugas (including two calves), walruses (including two carcasses), unidentified pinnipeds, and small unidentified pinnipeds. Sightings also included 44 walrus carcasses previously documented near Point Lay during ASAMM Flight 238, 23 September 2014.

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	7/5/15 9:50	69.855	163.020	gray whale	feed	6	3	20
204	7/5/15 9:52	69.833	162.998	beluga	swim	6	1	17
204	7/5/15 9:52	69.839	163.017	beluga	swim	2	1	20

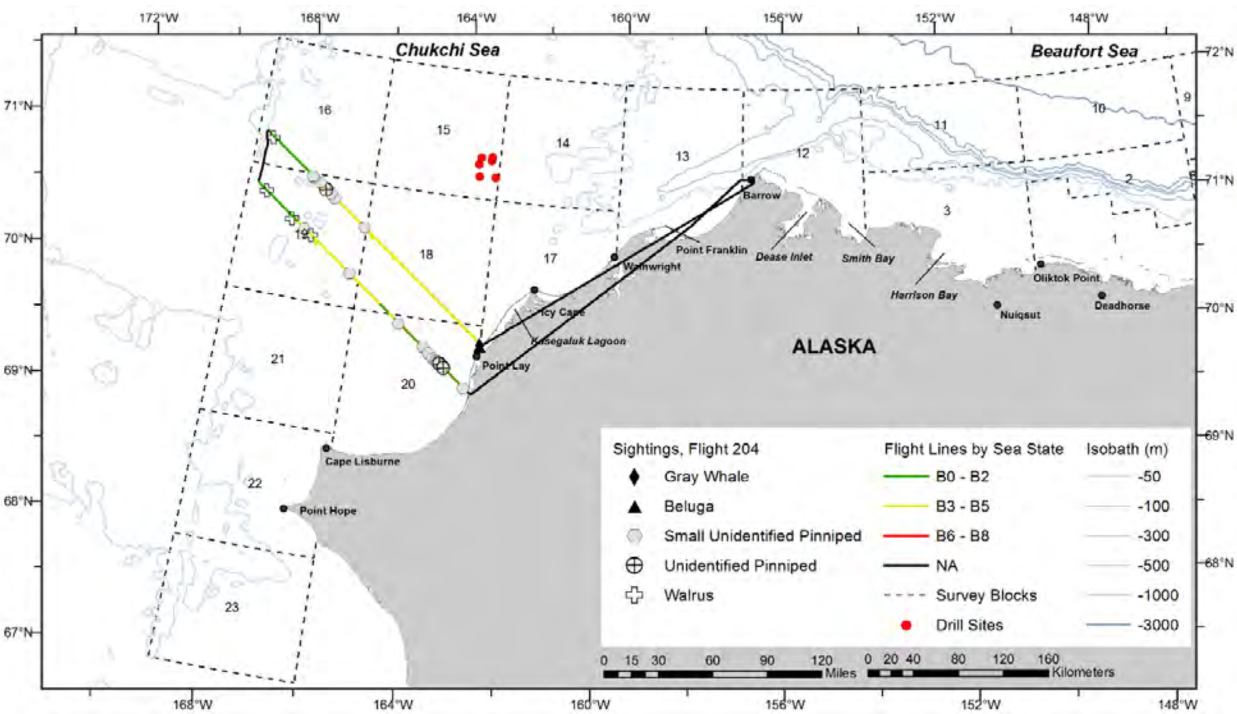

Figure B-4. ASAMM Flight 204 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

7 July 2015, Flight 205

Flight was a complete survey of transect 21, partial survey of transect 23, and the coastal transect from Wainwright to Barrow. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare and smoke from wildfires), and Beaufort 2-5 sea states. Sea ice cover was 0-22% broken floe in the area surveyed. Sightings included gray whales (including one calf and one carcass), one humpback whale, one walrus, one unidentified pinniped, and small unidentified pinnipeds. The carcass was likely a resighting of a gray whale carcass sighted during ASAMM flight 228, 27 August 2014.

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	7/7/15 12:57	70.699	160.096	humpback whale	feed	1	0	17
205	7/7/15 13:17	70.830	159.498	gray whale	underwater blow	2	1	13
205	7/7/15 13:27	70.912	158.934	gray whale	feed	1	0	13
205	7/7/15 13:53	71.201	157.000	gray whale	dead	1	0	13

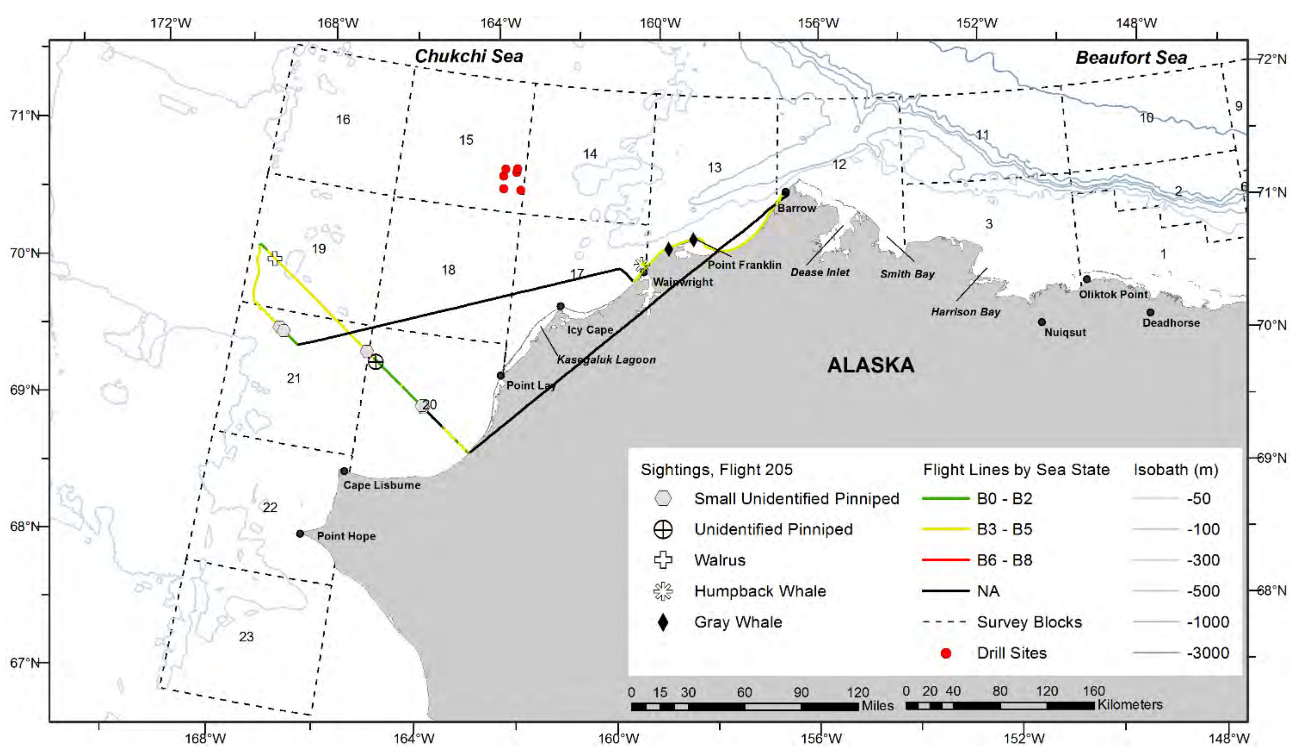

Figure B-5. ASAMM Flight 205 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Feeding humpback whale sightedjust north of Wainwright, Alaska, during ASAMM Flight 205, 7 July 2015.

Cetacean skeleton sighted just south of Barrow, Alaska, during ASAMM Flight 205, 7 July 2015.

10 July 2015, Flight 206

Flight was an attempt to survey in the Chukchi Sea. Survey conditions were poor in the area with extensive low ceilings preventing survey effort. No marine mammals were seen.

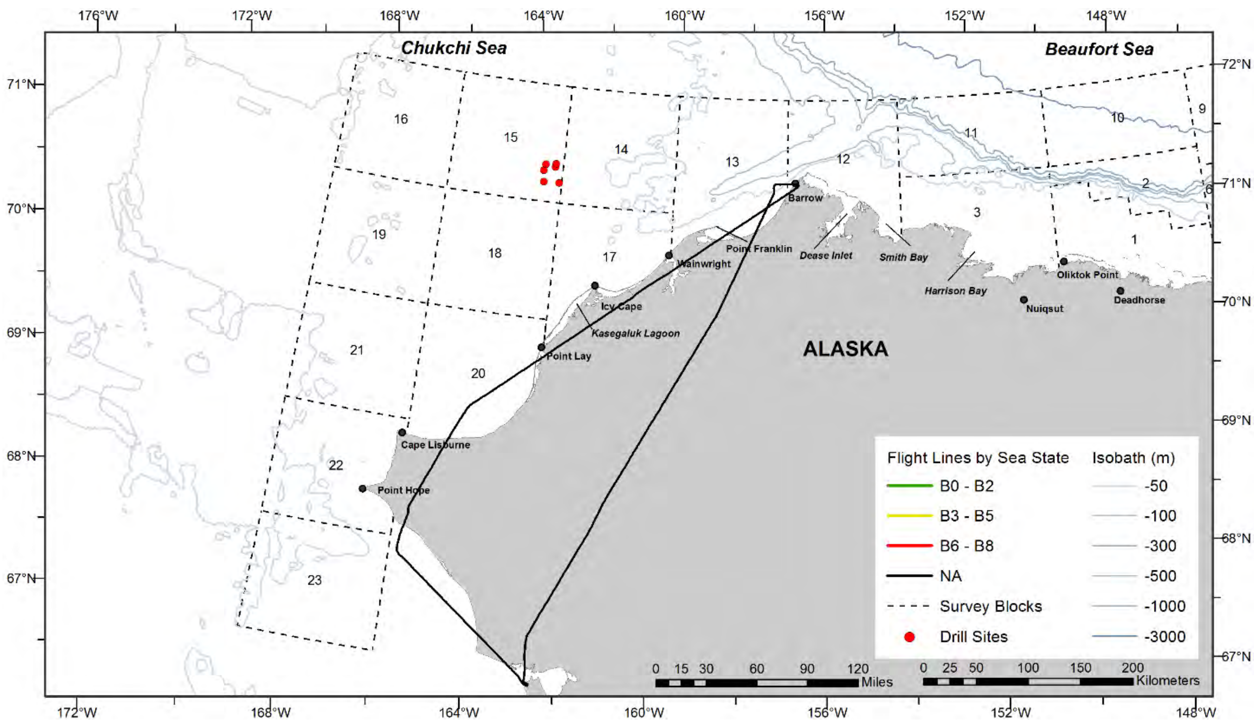

Figure B-6. ASAMM Flight 206 survey track, depicted by sea state.

20 July 2015, Flight 207

Flight was a partial survey of transect 16. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with fog and haze), and Beaufort 3-4 sea states. No sea ice was observed in the area surveyed. Sightings included one walrus.

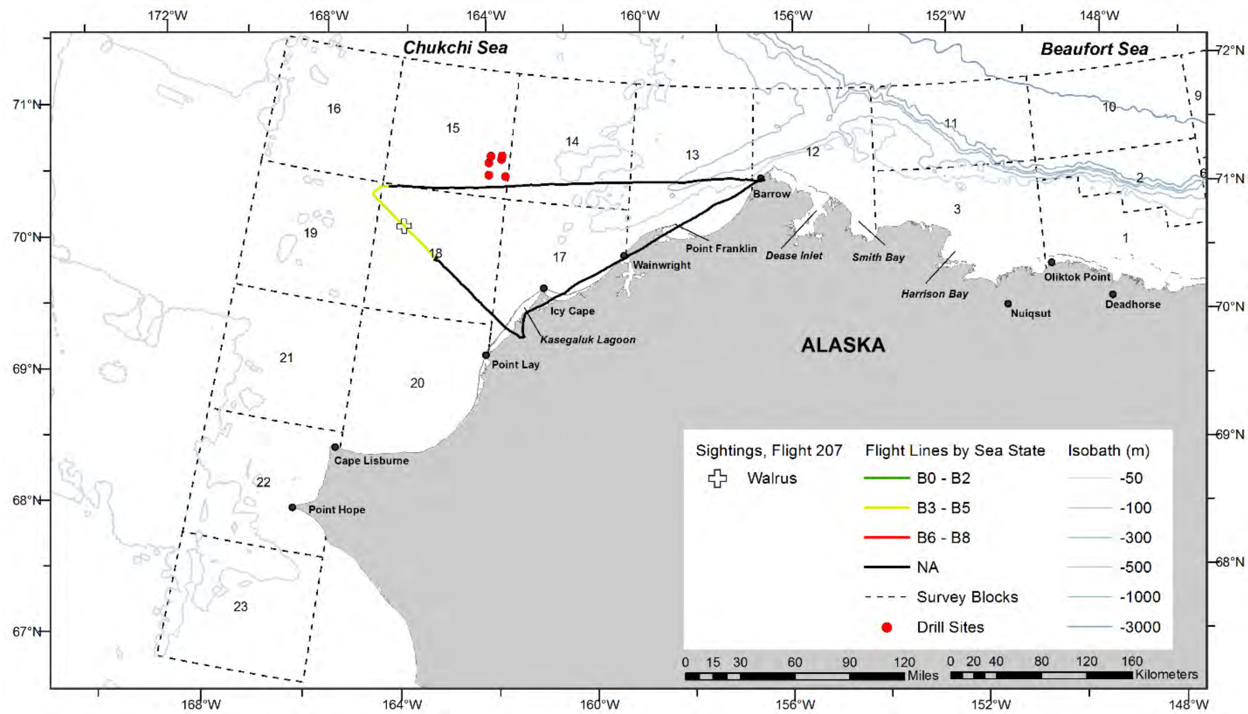

Figure B-7. ASAMM Flight 207 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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21 July 2015, Flight 208

Flight was a partial survey of transects 2, 4, 6, and 8, and the coastal transect from south of Icy Cape to south of Point Franklin. Survey conditions included overcast to partly cloudy skies, 0-10 km visibility (with fog, low ceiling, and glare), and Beaufort 2-6 sea states. Sea ice cover was 0-50% broken floe in the area surveyed. Sightings included gray whales (including two calves), 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
208	7/21/15 15:02	71.112	157.276	gray whale	swim	1	0	13
208	7/21/15 15:16	70.938	158.234	gray whale	swim	2	0	13
208	7/21/15 15:20	70.940	158.225	gray whale	swim	2	1	13
208	7/21/15 16:08	70.835	159.479	gray whale	tail slap	3	0	13
208	7/21/15 16:08	70.830	159.530	gray whale	feed	2	1	13
208	7/21/15 16:13	70.804	159.646	gray whale	swim	3	0	13

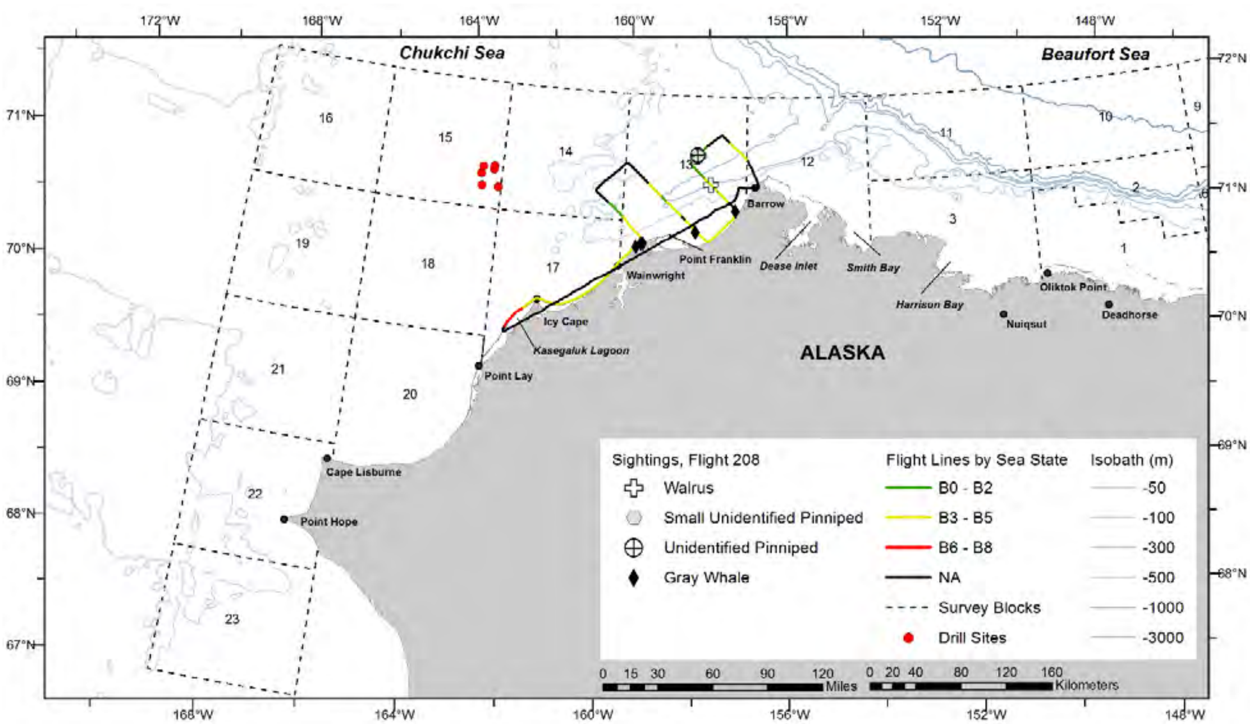

Figure B-8. ASAMM Flight 208 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

21 July 2015, Flight 1

Flight was a survey of portions of blocks 1 and 2. Survey conditions included clear to overcast skies, <1 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 1-5 sea states. Sea ice cover was 17-95% broken floe in the area surveyed. Sightings included bowhead whales (including one calf), 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
1	7/21/15 15:44	70.863	146.266	beluga	swim	3	0	2
1	7/21/15 15:47	70.967	146.282	beluga	mill	6	0	2
1	7/21/15 15:51	71.074	146.341	beluga	swim	1	0	2
1	7/21/15 15:51	71.105	146.343	beluga	swim	2	0	2
1	7/21/15 16:04	71.136	146.579	beluga	rest	1	0	2
1	7/21/15 16:07	71.061	146.588	bowhead whale	mill	4	0	2
1	7/21/15 16:09	71.074	146.555	bowhead whale	rest	1	0	2
1	7/21/15 16:12	71.088	146.581	bowhead whale	swim	1	0	2
1	7/21/15 16:17	71.015	146.627	beluga	swim	10	0	2
1	7/21/15 16:42	70.966	147.219	beluga	swim	2	0	2
1	7/21/15 16:43	70.992	147.202	beluga	swim	2	0	2
1	7/21/15 16:43	70.993	147.197	beluga	swim	1	0	2
1	7/21/15 16:45	71.063	147.177	beluga	swim	1	0	2
1	7/21/15 16:49	71.207	147.148	beluga	swim	2	0	2
1	7/21/15 16:49	71.213	147.174	beluga	swim	2	0	2
1	7/21/15 16:56	71.211	147.726	beluga	swim	1	0	2
1	7/21/15 16:58	71.156	147.739	bowhead whale	swim	2	1	2
1	7/21/15 17:07	71.150	147.726	beluga	swim	1	0	2
1	7/21/15 17:09	71.071	147.748	beluga	rest	1	0	2
1	7/21/15 17:44	71.205	148.581	beluga	swim	1	0	2
1	7/21/15 18:33	70.786	149.529	beluga	rest	1	0	1

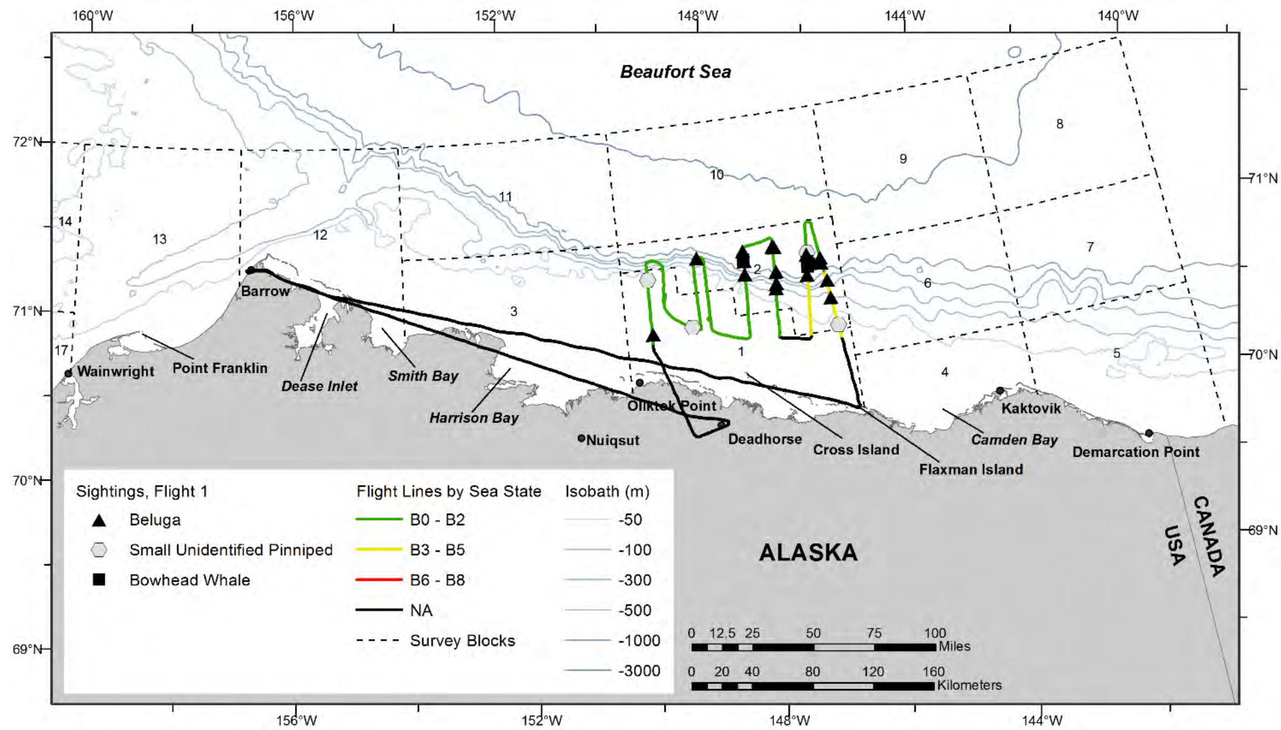

Figure B-9. ASAMM Flight 1 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

22 July 2015, Flight 209

Flight was a partial survey of transects 1, 3, 5, and 6, and portions of block 12. Survey conditions included clear to partly cloudy skies, 3-10 km visibility (with glare and haze), and Beaufort 2-7 sea states. Sea ice cover was 0-95% broken floe in the area surveyed. Sightings included belugas, 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
209	7/22/15 12:01	71.511	156.876	beluga	swim	3	0	12

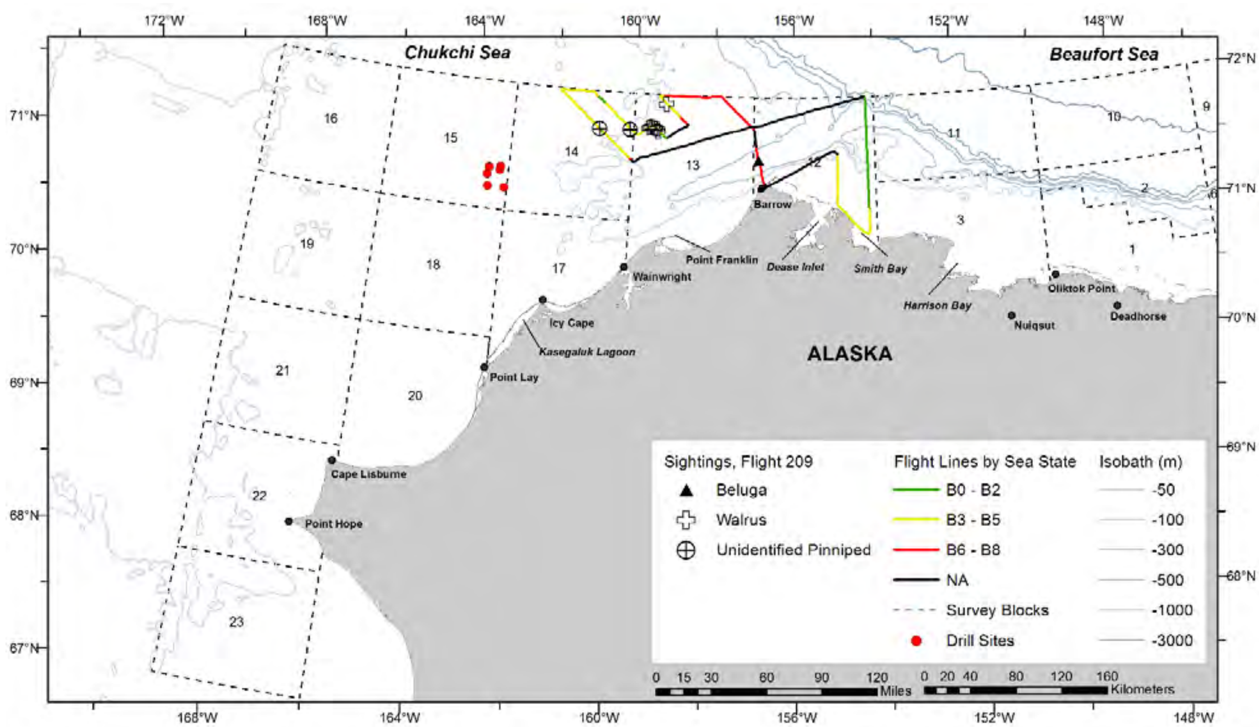

Figure B-10. ASAMM Flight 209 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

22 July 2015, Flight 2

Flight was a survey of portions of blocks 3 and 11 and a coastal search survey from north of Deadhorse to the eastern edge of survey block 3. Survey conditions included clear skies, 5 km to unlimited visibility (with glare and haze), and Beaufort 1-6 sea states. Sea ice cover was 0-94% 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	7/22/15 13:30	71.535	151.101	beluga	swim	2	0	11
2	7/22/15 13:31	71.542	151.107	beluga	swim	1	0	11
2	7/22/15 13:35	71.679	151.085	beluga	swim	2	0	11
2	7/22/15 14:05	71.443	151.707	beluga	swim	2	0	11
2	7/22/15 11:49	71.718	150.167	beluga	swim	1	0	11
2	7/22/15 12:21	71.377	150.891	beluga	swim	1	0	11
2	7/22/15 11:36	71.285	150.173	beluga	rest	1	0	3
2	7/22/15 11:40	71.416	150.180	beluga	swim	1	0	11
2	7/22/15 12:22	71.343	150.871	beluga	swim	1	0	11

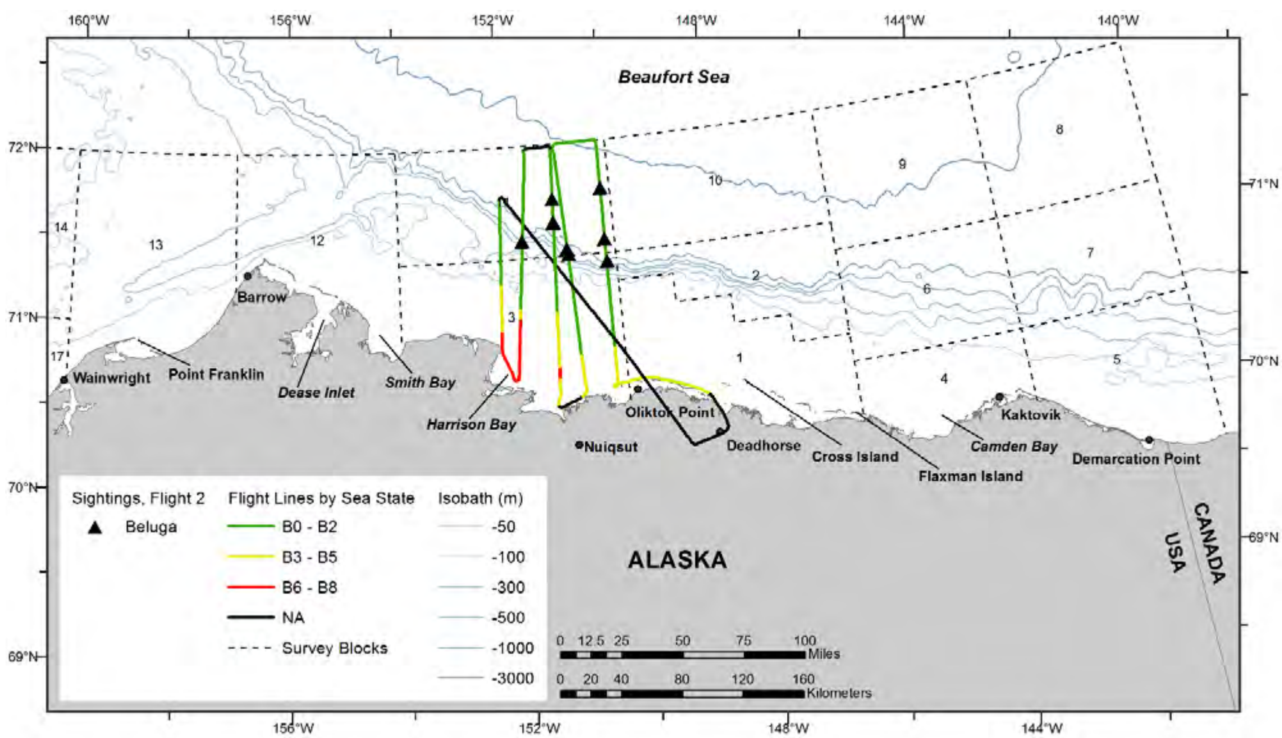

Figure B-11. ASAMM Flight 2 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 July 2015, Flight 3

Flight was a survey of portions of blocks 1, 4, and 6. Survey conditions included clear to partly cloudy skies, <1 km to unlimited visibility (with fog, glare, haze, and low ceilings), and Beaufort 2-7 sea states. Sea ice cover was 11-87% broken floe in the area surveyed. Sightings included small unidentified pinnipeds.

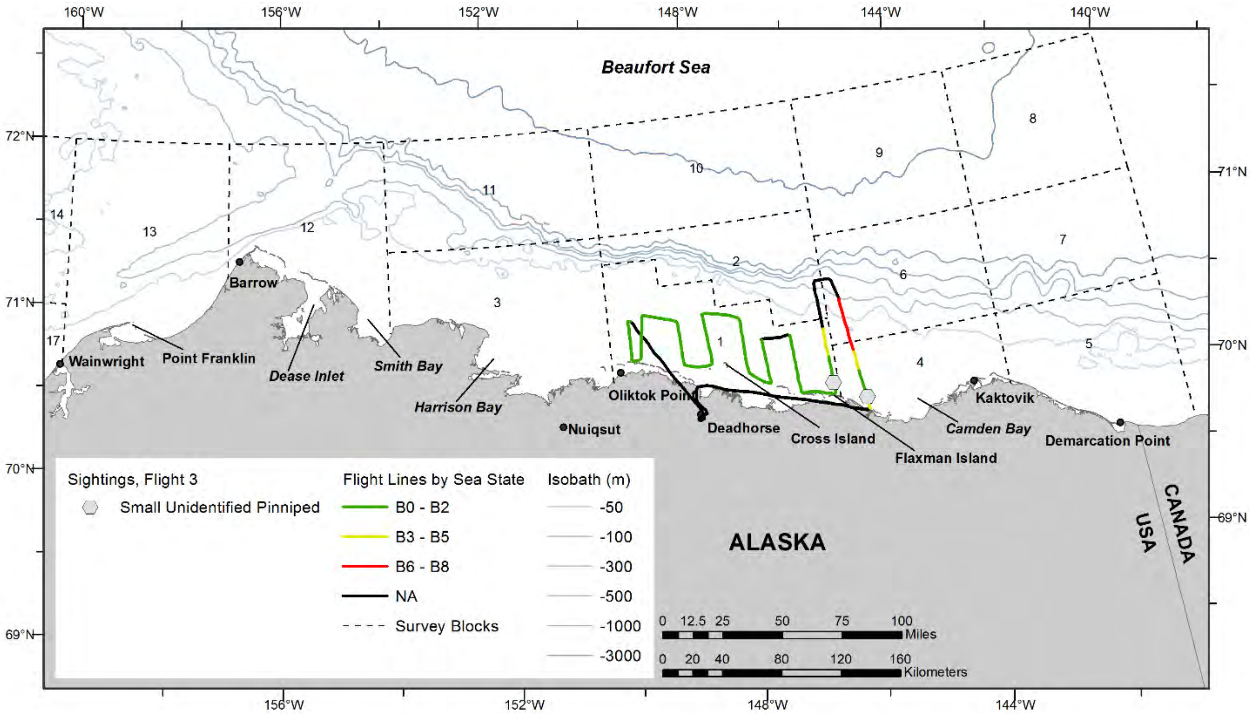

Figure B-12. ASAMM Flight 3 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

25 July 2015, Flight 4

Flight was a coastal search survey from Camden Bay to east of Deadhorse. Survey conditions included clear skies, <1 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 2-3 sea states. Sea ice cover was 1-25% broken floe in the area surveyed. No sightings were observed.

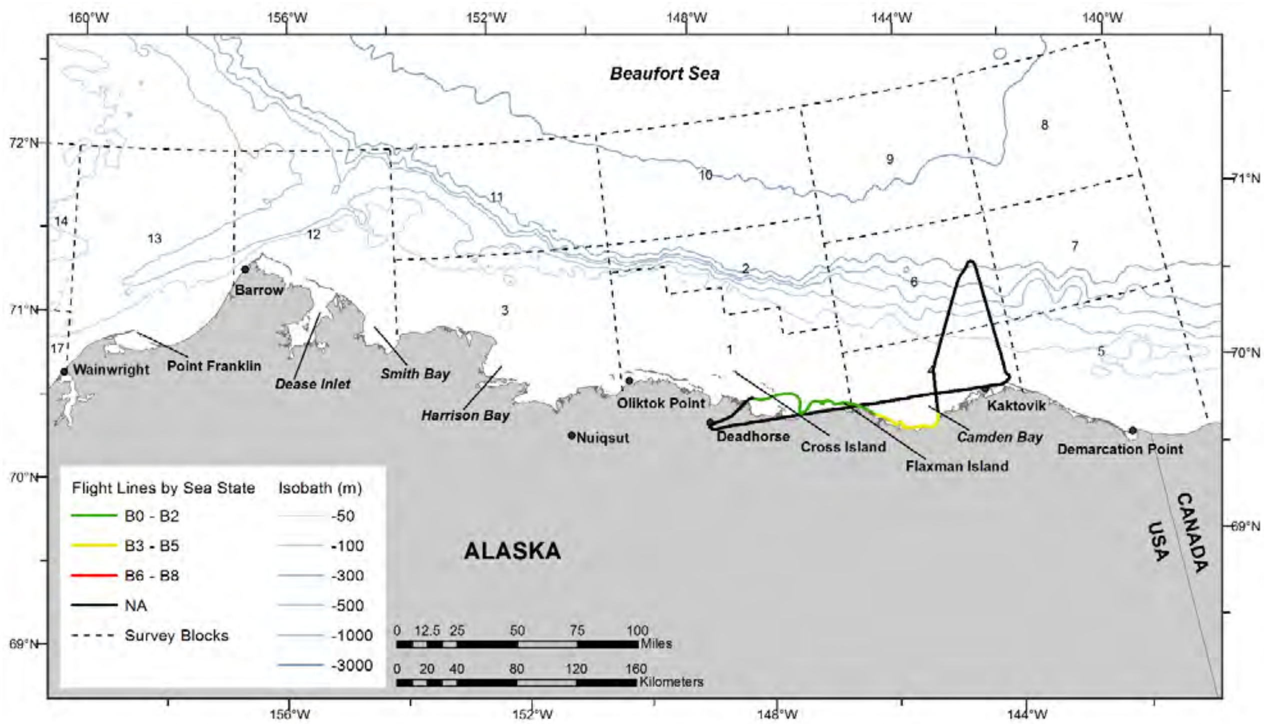

Figure B-13. ASAMM Flight 4 survey track, depicted by sea state.

27 July 2015, Flight 210

Flight was a partial survey of transects 4, 6, and 7. Survey conditions included overcast to partly cloudy skies, 0-3 km visibility (with fog and glare), and Beaufort 3-5 sea states. Sea ice cover was 0-30% broken floe in the area surveyed. Sightings included one beluga, walruses and one 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
210	7/27/15 18:04	71.487	160.871	beluga	swim	1	0	14

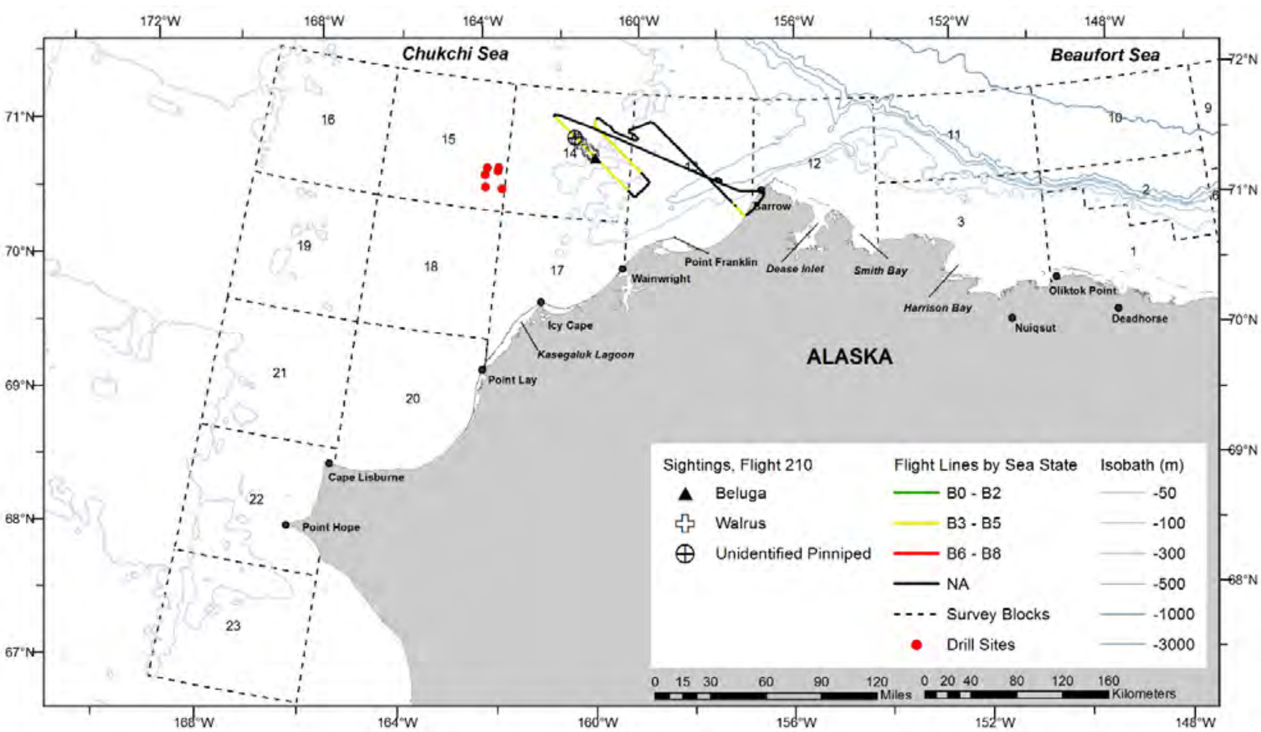

Figure B-14. ASAMM Flight 210 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

27 July 2015, Flight 5

Flight was a survey of portions of block 4. Survey conditions included partly cloudy skies, <1-5 km visibility (with glare and low ceilings), and Beaufort 3-5 sea states. Sea ice cover was 3-17% broken floe in the area surveyed. No sightings were observed.

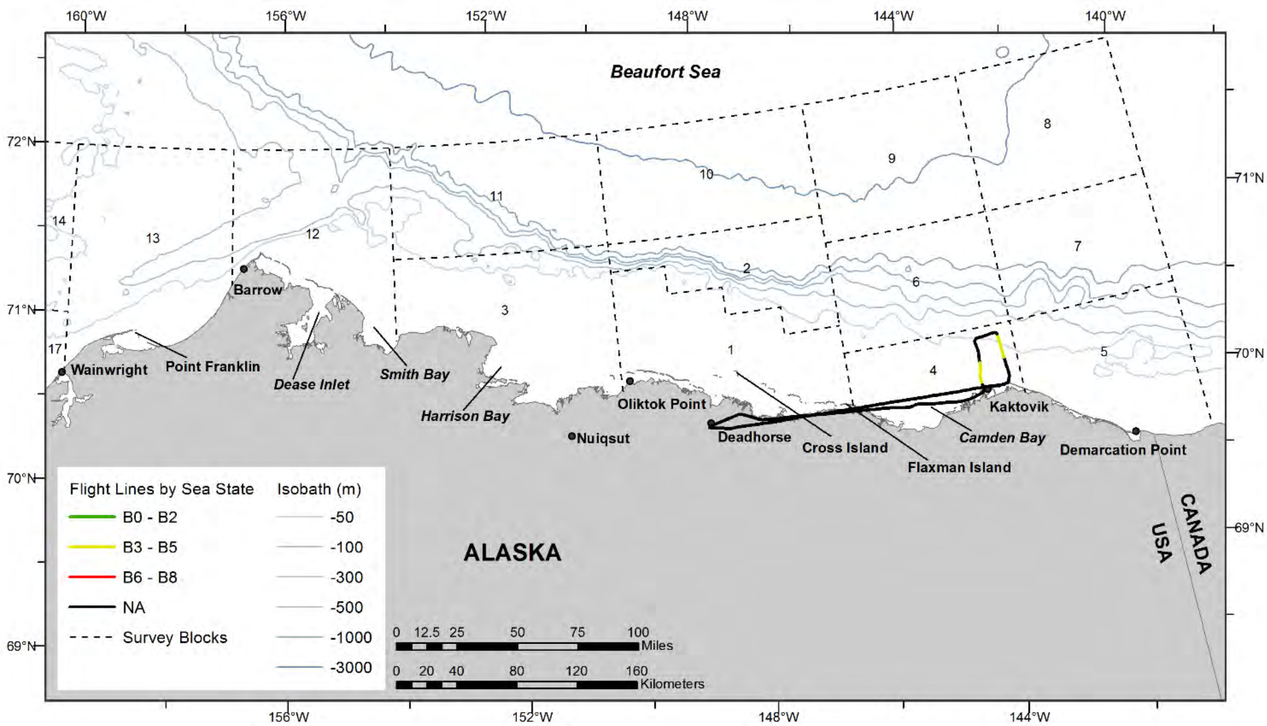

Figure B-15. ASAMM Flight 5 survey track, depicted by sea state.

29 July 2015, Flight 211

Flight was a partial survey of transect 12 and the coastal transect from east of Cape Lisburne to Icy Cape. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog and glare), and Beaufort 1-6 sea states. Sea ice cover was 0-3% broken floe in the area surveyed. Sightings included gray whales (including one calf), belugas (including nine 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
211	7/29/15 15:37	68.931	164.547	gray whale	feed	3	1	20
211	7/29/15 16:39	70.331	161.936	beluga	swim	2	0	17
211	7/29/15 16:39	70.334	161.907	beluga	mill	210	9	17
211	7/29/15 16:54	70.322	161.154	gray whale	swim	1	0	17
211	7/29/15 16:59	70.367	160.946	beluga	swim	40	0	17
211	7/29/15 17:03	70.445	161.141	beluga	swim	1	0	17
211	7/29/15 17:14	70.663	161.944	beluga	swim	1	0	17
211	7/29/15 17:33	71.097	163.537	beluga	swim	1	0	15
211	7/29/15 17:43	71.236	164.306	beluga	swim	1	0	15

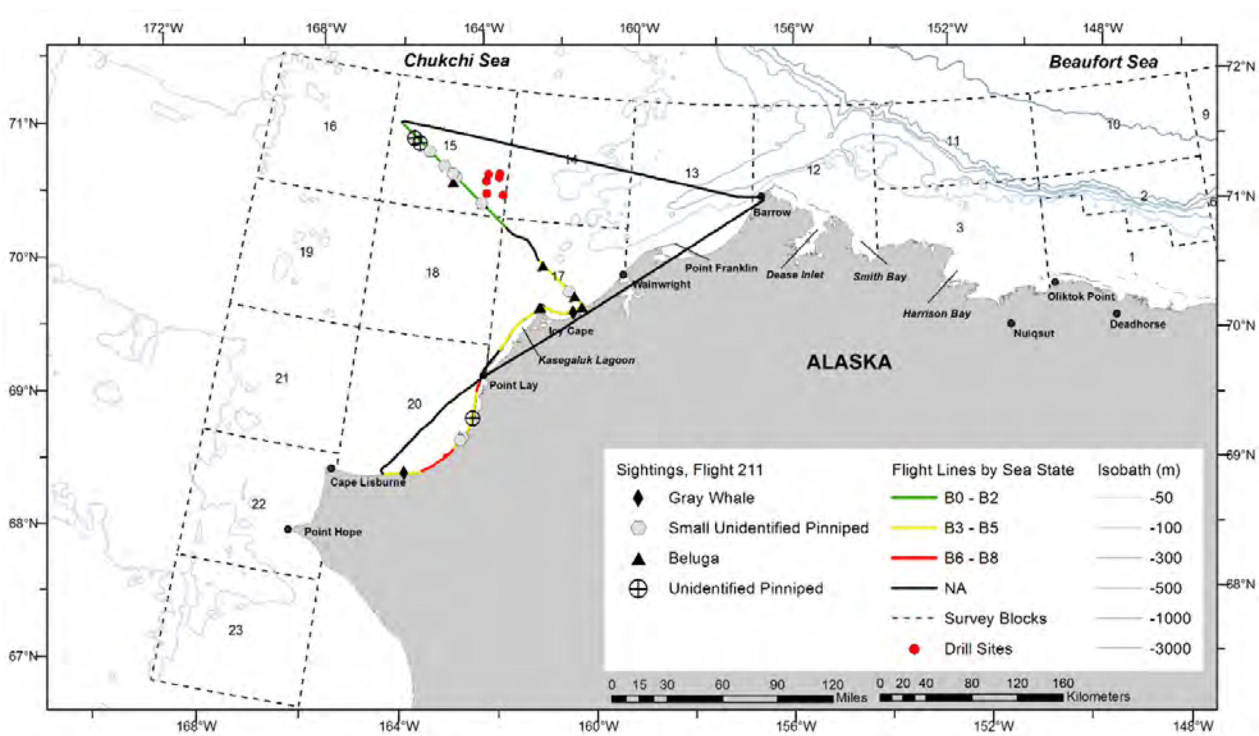

Figure B-16. ASAMM Flight 211 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Belugas sighted milling near Icy Cape, Alaska, during ASAMM Flight 211, 29 July 2015.

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29 July 2015, Flight 6

Flight was a survey of portions of block 12 and a coastal search survey from Deadhorse to Point Barrow. Survey conditions included clear to overcast skies, <1 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 0-4 sea states. Sea ice cover was 0-91% 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
6	7/29/15 18:01	71.841	155.062	beluga	swim	1	0	12
6	7/29/15 18:03	71.806	155.050	beluga	swim	1	0	12
6	7/29/15 18:03	71.798	155.057	beluga	swim	1	0	12

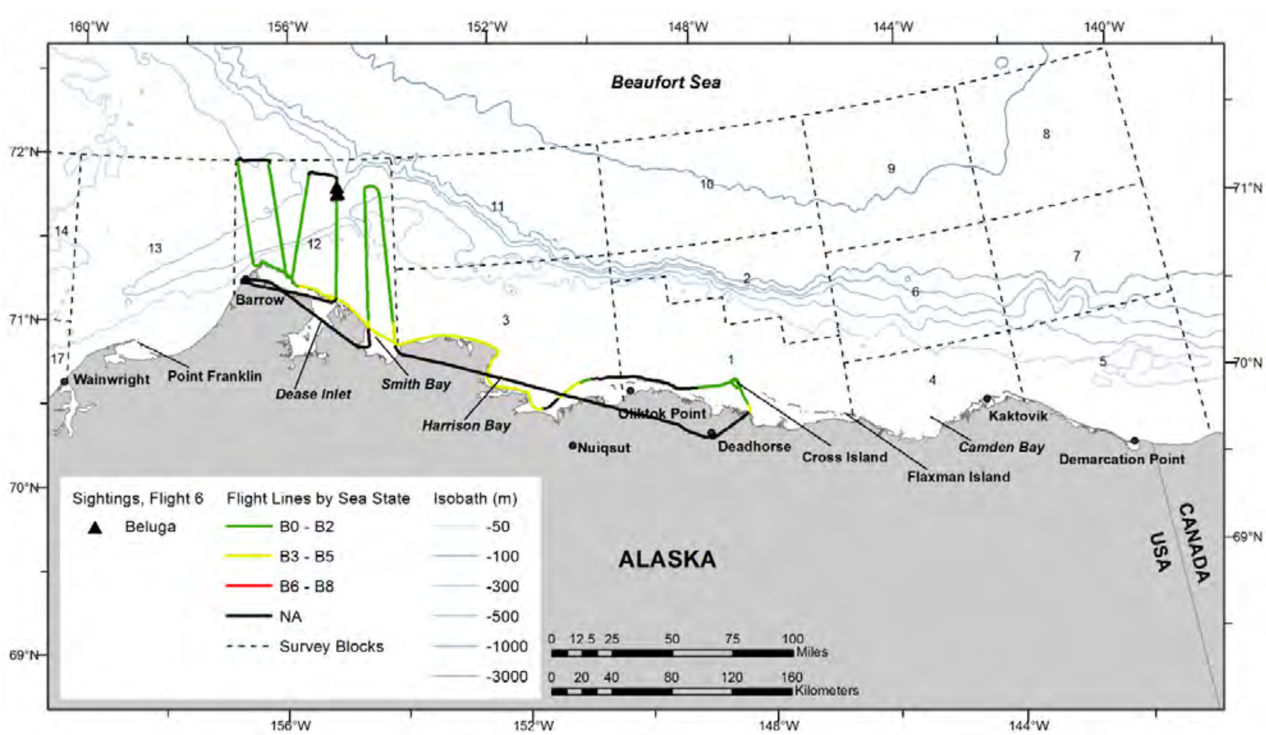

Figure B-17. ASAMM Flight 6 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

30 July 2015, Flight 212

Flight was a complete survey of transects 2, 14, and 16, and partial survey of transects 4, 6, 8, and 10. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 0-5 sea states. Sea ice cover was 0-40% broken floe and new sea ice in the area surveyed. Sightings included bowhead whales, gray whales (including 20 calves), minke whales, one beluga, 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
212	7/30/15 9:20	70.656	160.322	gray whale	swim	1	1	17
212	7/30/15 9:27	70.816	160.876	gray whale	swim	1	0	17
212	7/30/15 9:28	70.823	160.895	gray whale	rest	1	0	17
212	7/30/15 9:28	70.834	160.964	gray whale	swim	1	0	17
212	7/30/15 9:30	70.835	160.877	gray whale	swim	1	0	17
212	7/30/15 9:30	70.827	160.860	gray whale	swim	2	1	17
212	7/30/15 9:31	70.822	160.917	gray whale	swim	4	2	17
212	7/30/15 9:32	70.834	160.910	gray whale	swim	2	1	17
212	7/30/15 9:40	70.853	161.018	gray whale	rest	2	1	17
212	7/30/15 10:28	71.294	160.997	gray whale	rest	1	0	14
212	7/30/15 10:28	71.300	160.954	gray whale	feed	7	3	14
212	7/30/15 10:31	71.289	160.933	gray whale	swim	2	1	14
212	7/30/15 10:33	71.270	160.887	gray whale	feed	2	1	14
212	7/30/15 10:34	71.282	160.746	gray whale	swim	4	2	14
212	7/30/15 10:34	71.241	160.849	gray whale	swim	2	1	14
212	7/30/15 10:35	71.237	160.874	gray whale	rest	1	0	14
212	7/30/15 10:36	71.213	160.871	gray whale	rest	1	0	14
212	7/30/15 10:37	71.217	160.832	gray whale	swim	1	0	14
212	7/30/15 10:41	71.229	160.771	gray whale	swim	1	0	14
212	7/30/15 10:57	70.939	159.749	gray whale	swim	2	1	13
212	7/30/15 11:00	70.886	159.566	gray whale	rest	2	1	13
212	7/30/15 11:01	70.882	159.539	gray whale	rest	2	1	13
212	7/30/15 11:16	70.911	158.080	gray whale	rest	2	1	13
212	7/30/15 11:18	70.940	158.203	gray whale	swim	3	1	13
212	7/30/15 11:23	70.992	158.343	gray whale	rest	1	0	13
212	7/30/15 11:23	70.993	158.378	gray whale	rest	7	1	13
212	7/30/15 15:22	70.301	162.240	gray whale	rest	1	0	17
212	7/30/15 15:40	70.707	163.712	gray whale	swim	1	0	18
212	7/30/15 16:35	71.828	168.661	bowhead whale	swim	3	0	16

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
212	7/30/15 16:43	71.845	168.504	bowhead whale	dive	1	0	16
212	7/30/15 16:45	71.838	168.585	bowhead whale	swim	1	0	16
212	7/30/15 16:58	71.577	169.033	unid cetacean	swim	1	0	0
212	7/30/15 17:02	71.540	168.829	bowhead whale	swim	1	0	16
212	7/30/15 17:57	70.479	164.510	minke whale	swim	1	0	18
212	7/30/15 18:10	70.312	164.069	minke whale	swim	1	0	18
212	7/30/15 18:36	70.018	162.781	beluga	rest	1	0	17

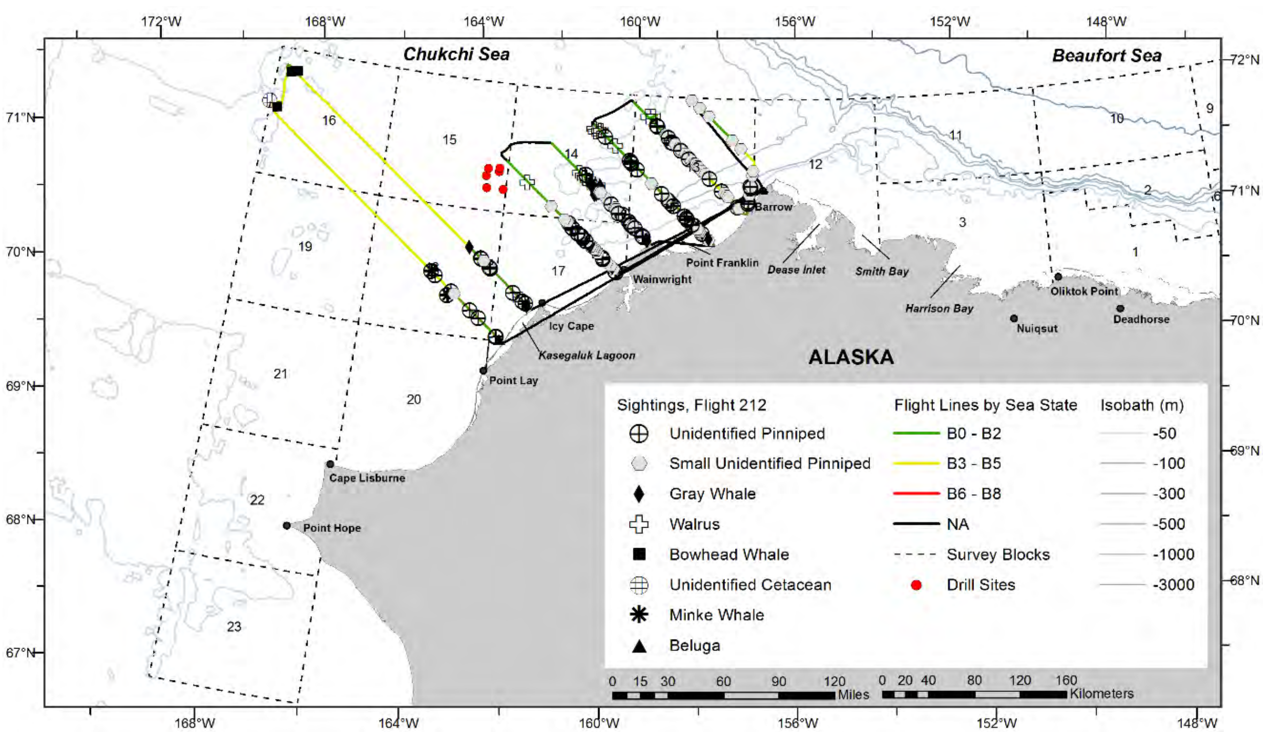

Figure B-18. ASAMM Flight 212 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale cow-calf pair sighting in the northeastern Chukchi Sea during ASAMM Flight 212, 30 July 2015.

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30 July 2015, Flight 7

Flight was a survey of portions of blocks 3 and 11. Survey conditions included clear to overcast skies, <1 km to unlimited visibility (with fog, glare, and haze), and Beaufort 1-5 sea states. Sea ice cover was 2-90% broken floe in the area surveyed. Sightings included belugas (including one calf).

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	7/30/15 14:56	71.883	153.586	beluga	swim	1	0	11
7	7/30/15 14:56	71.884	153.595	beluga	swim	1	0	11
7	7/30/15 14:56	71.890	153.585	beluga	swim	5	0	11
7	7/30/15 14:57	71.929	153.587	beluga	swim	2	0	11
7	7/30/15 14:57	71.936	153.567	beluga	swim	1	0	11
7	7/30/15 15:05	71.862	153.377	beluga	swim	1	0	11
7	7/30/15 15:27	71.195	153.187	beluga	rest	1	0	3
7	7/30/15 16:03	71.656	152.705	beluga	swim	1	0	11
7	7/30/15 16:04	71.669	152.711	beluga	swim	2	0	11
7	7/30/15 16:05	71.692	152.718	beluga	swim	1	0	11
7	7/30/15 16:06	71.737	152.729	beluga	swim	1	0	11
7	7/30/15 16:06	71.739	152.732	beluga	swim	2	0	11
7	7/30/15 16:06	71.742	152.729	beluga	swim	6	1	11
7	7/30/15 16:24	71.798	152.208	beluga	swim	1	0	11
7	7/30/15 16:26	71.736	152.191	beluga	swim	1	0	11
7	7/30/15 16:45	71.382	150.357	beluga	swim	2	0	11
7	7/30/15 16:45	71.377	150.346	beluga	swim	1	0	11

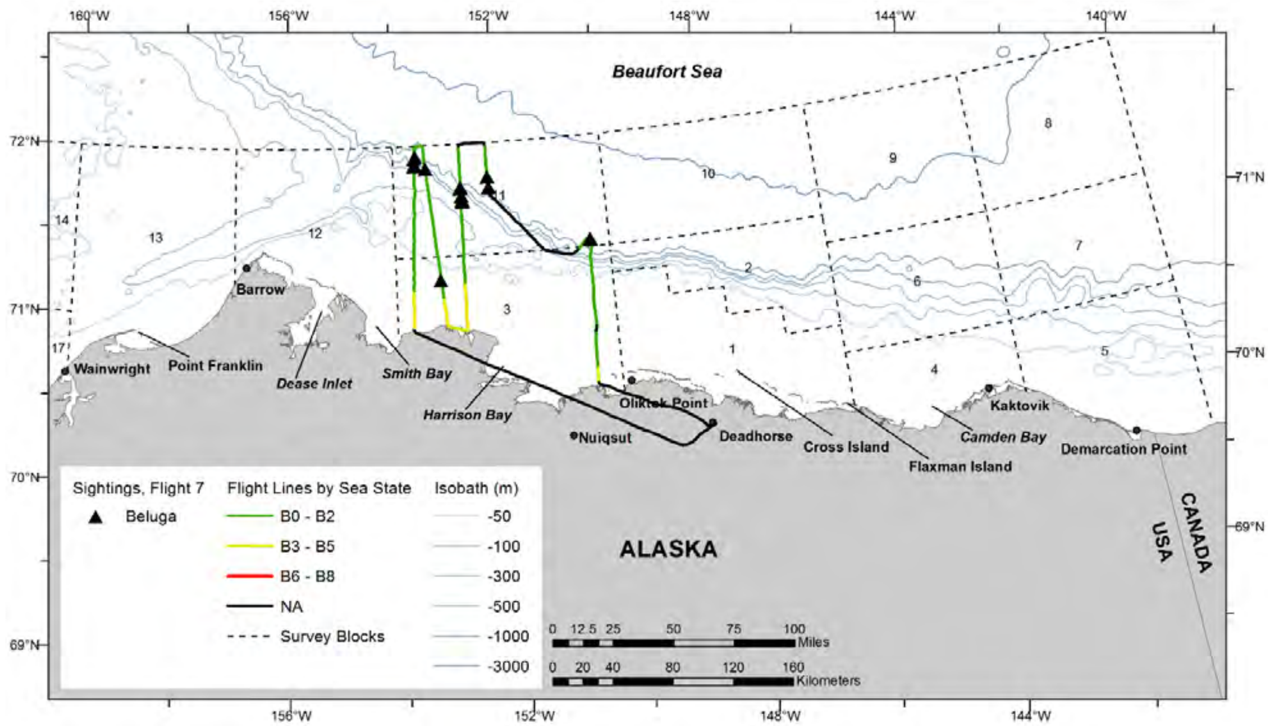

Figure B-19. ASAMM Flight 7 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

31 July 2015, Flight 8

Flight was a survey of portions of blocks 4 and 6. Survey conditions included clear to overcast skies, <1 km to unlimited visibility (with fog, glare, and haze), and Beaufort 1-6 sea states. Sea ice cover was 0-67% broken floe in the area surveyed. Sightings included bowhead whales (including one calf), 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
8	7/31/15 15:11	70.528	144.140	bowhead whale	breach	2	1	6
8	7/31/15 15:22	70.597	144.190	beluga	swim	1	0	6
8	7/31/15 15:27	70.792	144.168	beluga	swim	2	0	6
8	7/31/15 15:27	70.816	144.225	beluga	swim	10	0	6
8	7/31/15 15:29	70.861	144.231	beluga	swim	1	0	6
8	7/31/15 15:32	70.991	144.216	beluga	mill	12	0	6
8	7/31/15 16:41	70.882	145.446	beluga	mill	2	0	6
8	7/31/15 16:57	71.066	145.994	beluga	swim	1	0	6
8	7/31/15 16:57	71.061	145.988	beluga	swim	1	0	6
8	7/31/15 16:58	71.034	145.983	beluga	swim	4	1	6

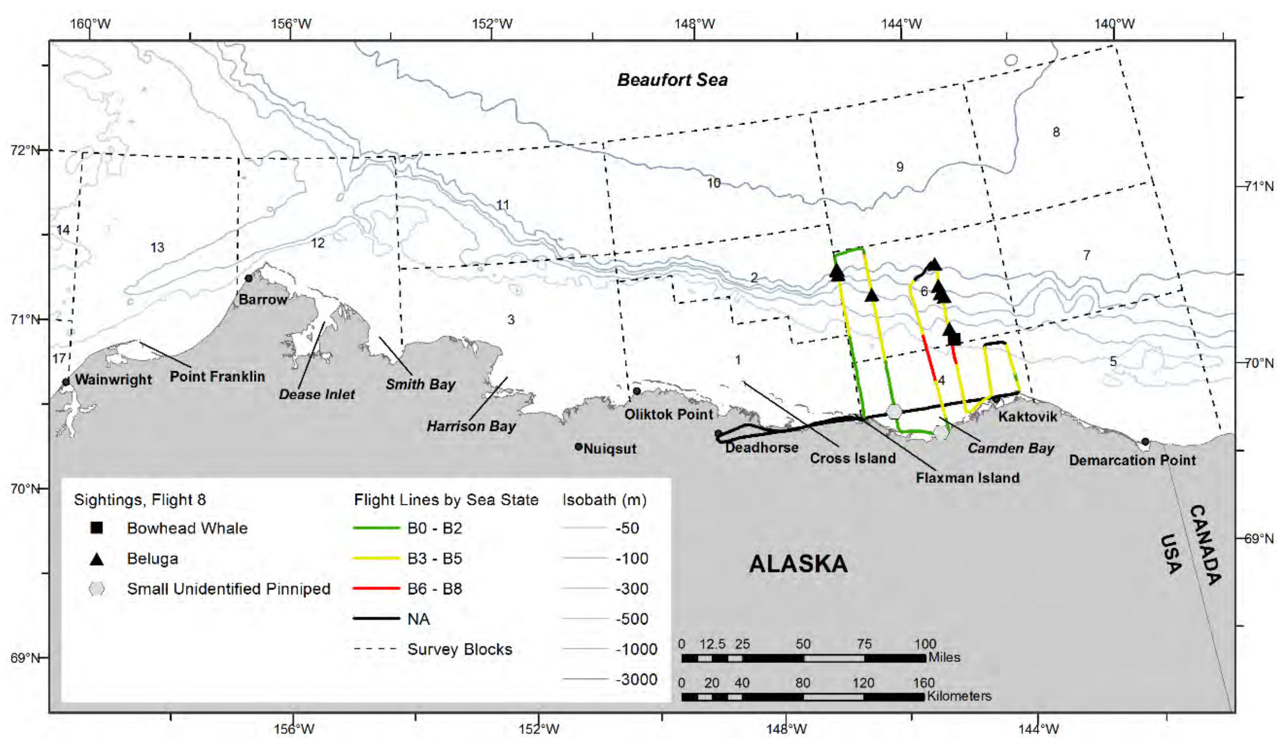

Figure B-20. ASAMM Flight 8 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

1 August 2015, Flight 213

Flight was a complete survey of transects 32 and 34 and partial survey of transects 30, 33, and 35. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, haze, low ceilings, and glare), and Beaufort 2-4 sea states. There was no sea ice observed in the area surveyed. Sightings included gray whales (including four calves), one minke 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
213	8/1/15 13:10	68.666	166.225	gray whale	mill	2	1	22
213	8/1/15 13:14	68.655	166.457	minke whale	swim	1	0	22
213	8/1/15 17:50	67.828	166.618	gray whale	swim	2	0	23
213	8/1/15 17:50	67.812	166.647	gray whale	swim	7	1	23
213	8/1/15 17:51	67.820	166.607	gray whale	swim	2	1	23
213	8/1/15 17:53	67.808	166.648	gray whale	swim	1	0	23
213	8/1/15 18:05	67.910	167.396	gray whale	swim	2	1	23
213	8/1/15 18:46	68.322	166.520	beluga	swim	1	0	22

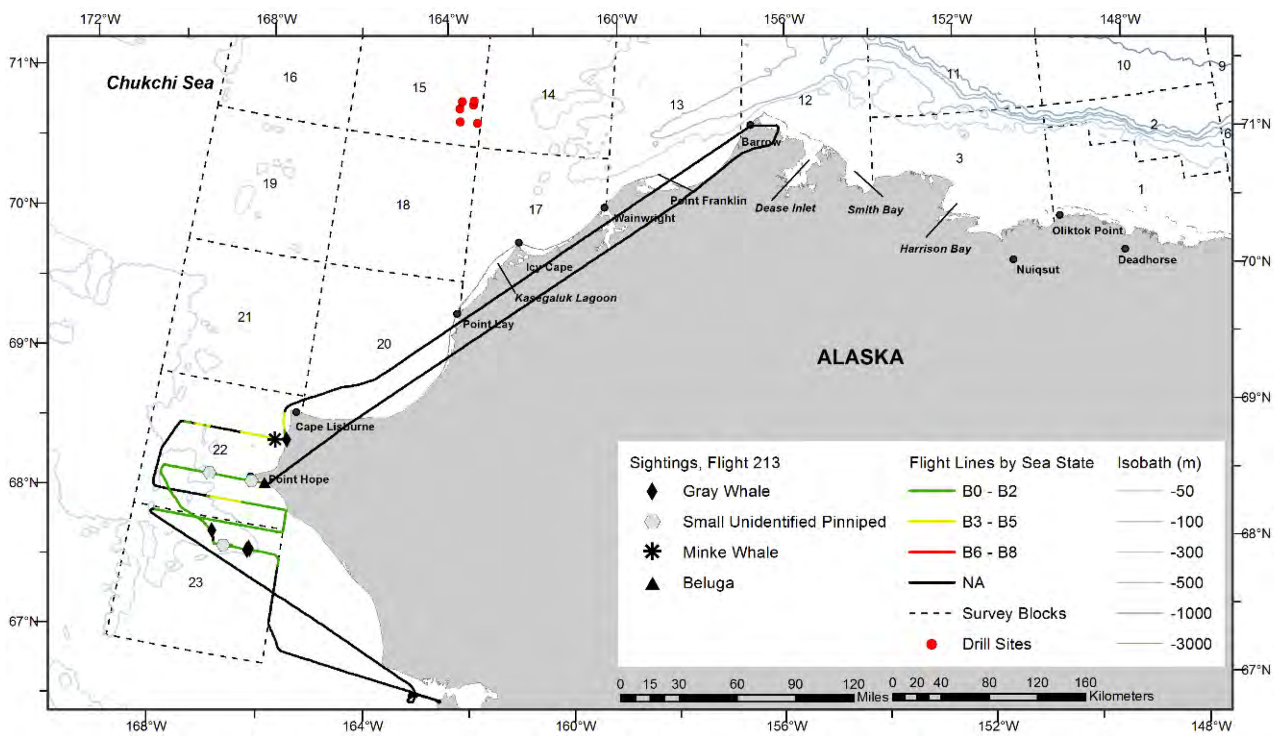

Figure B-21. ASAMM Flight 213 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

1 August 2015, Flight 9

Flight was a survey of portions of blocks 1 and 2. Survey conditions included clear skies, 0-2 km visibility (with fog), and Beaufort 1-4 sea states. Sea ice cover was 0-60% broken floe in the area surveyed. Sightings included bowhead whales (including two calves).

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	8/1/15 16:32	71.148	148.836	bowhead whale	rest	2	1	2
9	8/1/15 16:38	71.145	148.797	bowhead whale	swim	1	1	2
9	8/1/15 16:42	71.110	148.832	bowhead whale	swim	1	0	2
9	8/1/15 16:50	71.056	148.259	bowhead whale	swim	1	0	2

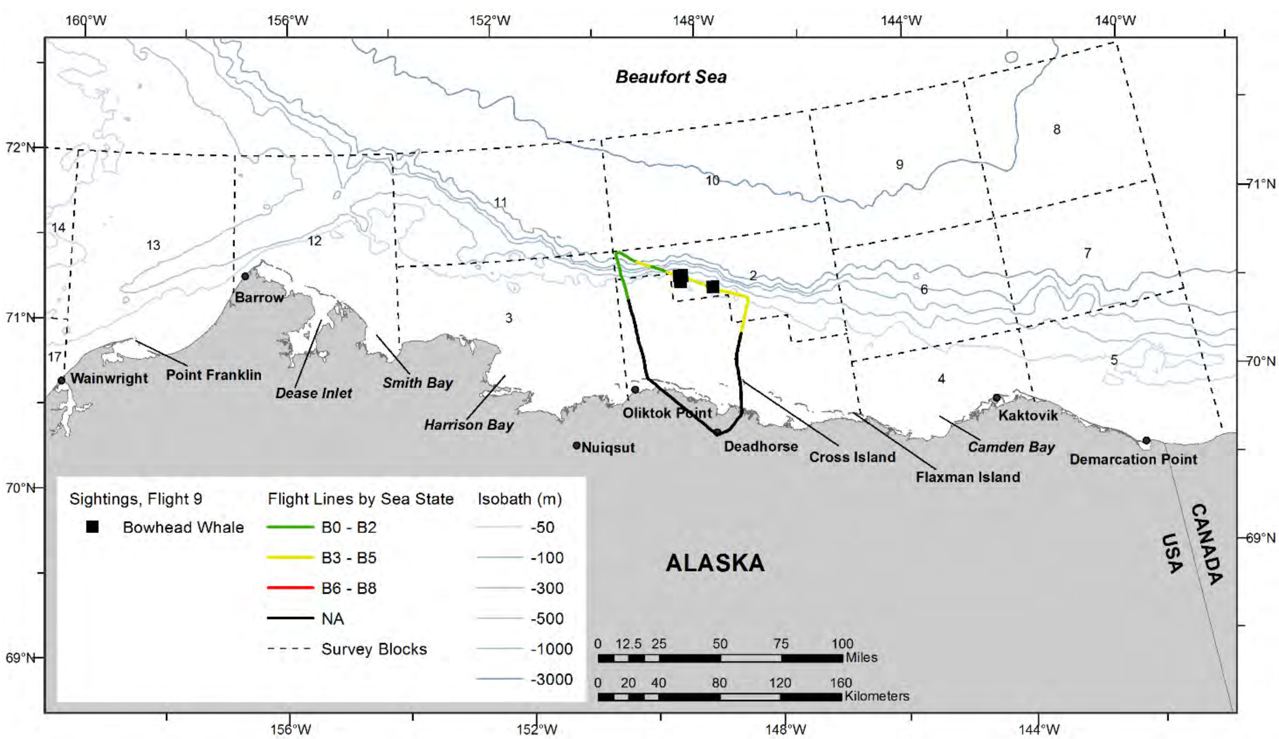

Figure B-22. ASAMM Flight 9 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

2 August 2015, Flight 214

Flight was a partial survey of transect 1 and a survey of portions of block 12. Survey conditions included overcast skies, 0-2 km visibility (with fog), and Beaufort 2-5 sea states. Sea ice cover was 0-60% broken floe in the area surveyed. Sightings included one beluga and one walrus.

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	8/2/15 13:41	71.877	156.379	beluga	swim	1	0	12

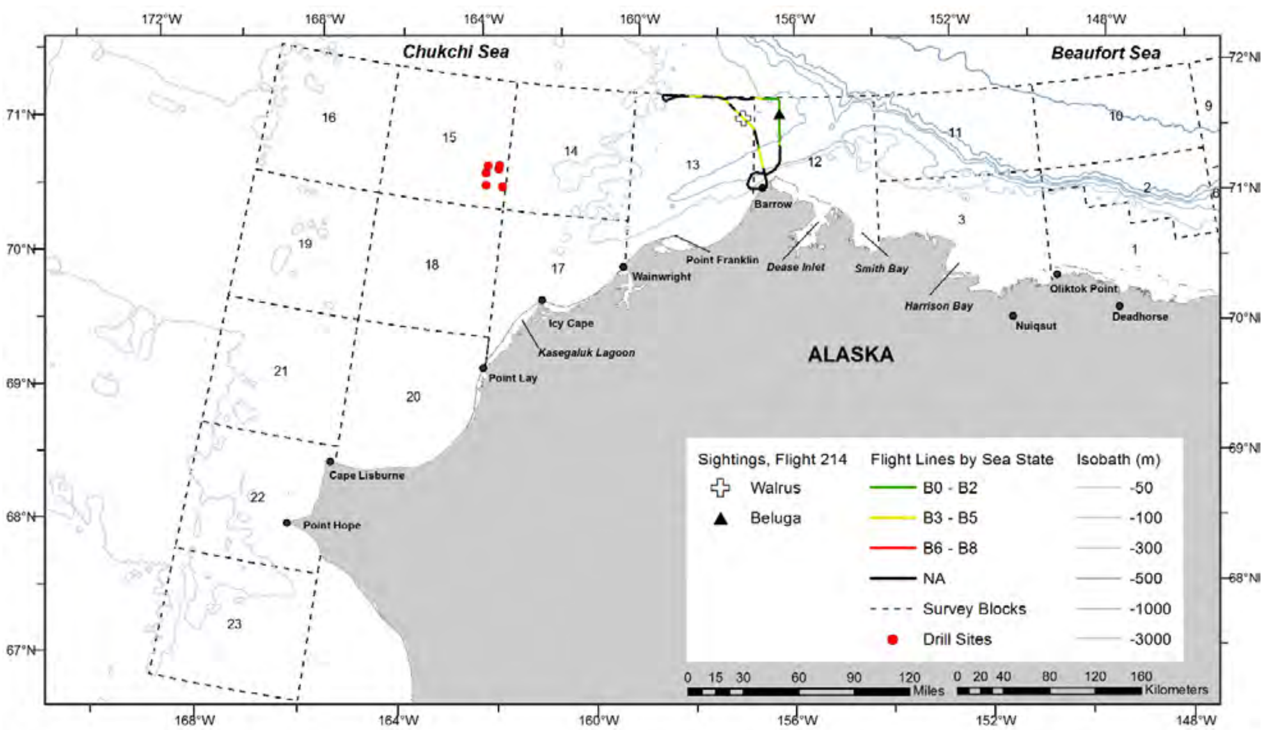

Figure B-23. ASAMM Flight 214 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

2 August 2015, Flight 10

Flight was a survey of portions of blocks 5 and 7. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with fog, glare, haze, and precipitation), and Beaufort 1-5 sea states. Sea ice cover was 0-90% broken floe in the area surveyed. Sightings included one bowhead whale, belugas (including five calves), 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
10	8/2/15 11:27	70.483	140.216	beluga	rest	2	1	5
10	8/2/15 11:29	70.538	140.171	beluga	swim	1	0	7
10	8/2/15 11:29	70.541	140.180	beluga	swim	2	0	7
10	8/2/15 11:29	70.544	140.182	beluga	swim	1	0	7
10	8/2/15 11:29	70.547	140.199	beluga	rest	4	1	7
10	8/2/15 12:07	70.760	140.825	beluga	swim	1	0	7
10	8/2/15 12:12	70.615	140.881	beluga	swim	1	0	7
10	8/2/15 12:12	70.599	140.853	beluga	rest	2	1	7
10	8/2/15 12:15	70.507	140.883	beluga	swim	1	0	7
10	8/2/15 12:17	70.451	140.873	beluga	rest	1	0	5
10	8/2/15 12:19	70.387	140.898	beluga	swim	1	0	5
10	8/2/15 12:19	70.384	140.872	beluga	swim	9	0	5
10	8/2/15 12:20	70.368	140.908	beluga	swim	4	0	5
10	8/2/15 12:23	70.272	140.882	beluga	rest	1	0	5
10	8/2/15 12:41	69.674	140.971	beluga	swim	2	1	5
10	8/2/15 12:41	69.672	140.987	beluga	swim	8	0	5
10	8/2/15 13:03	70.314	141.407	bowhead whale	rest	1	0	5
10	8/2/15 13:12	70.426	141.378	beluga	swim	2	0	5
10	8/2/15 13:12	70.433	141.416	beluga	rest	3	0	5
10	8/2/15 13:12	70.440	141.391	beluga	swim	3	0	5
10	8/2/15 13:24	70.490	141.717	beluga	rest	1	0	5
10	8/2/15 13:25	70.437	141.700	beluga	rest	1	0	5
10	8/2/15 13:50	69.898	142.224	beluga	swim	1	0	5
10	8/2/15 13:50	69.900	142.247	beluga	swim	8	1	5

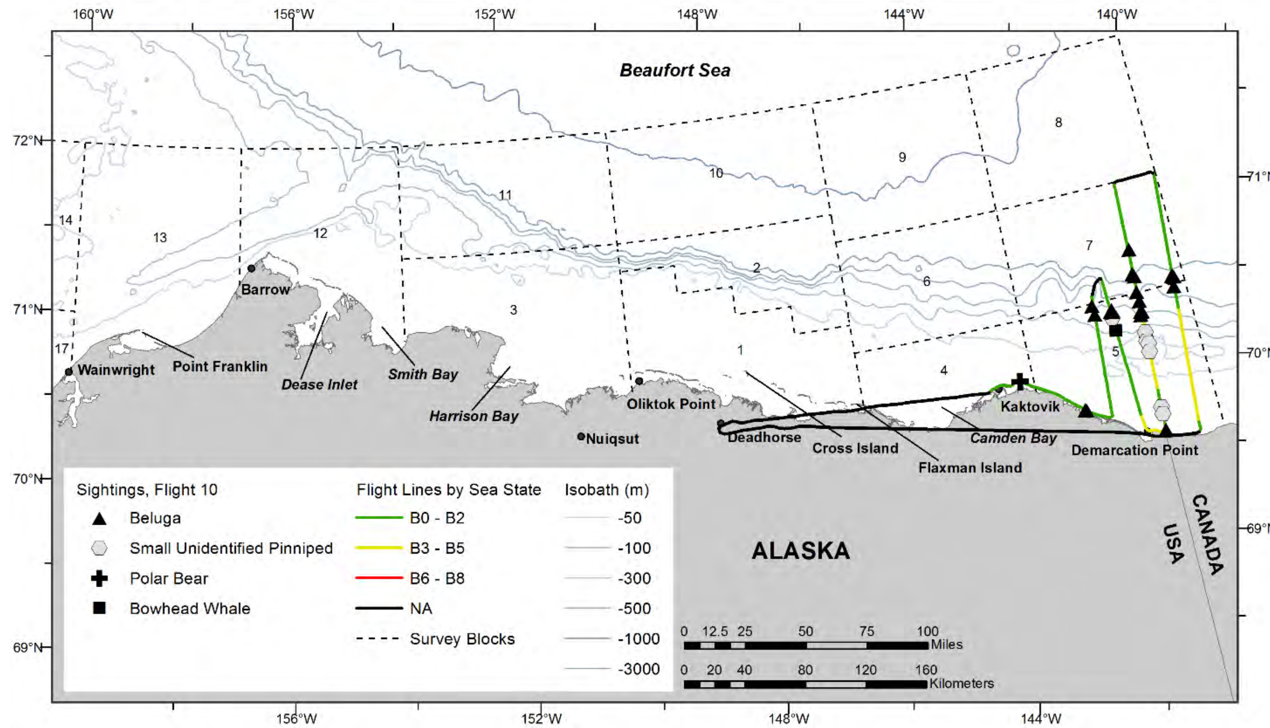

Figure B-24. ASAMM Flight 10 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

3 August 2015, Flight 215

Flight was a complete survey of transects 38 and 39 and partial survey of transects 29, 30, 31, and 32. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, haze, and low ceilings), and Beaufort 2-6 sea states. There was no sea ice observed in the area surveyed. No sightings were observed.

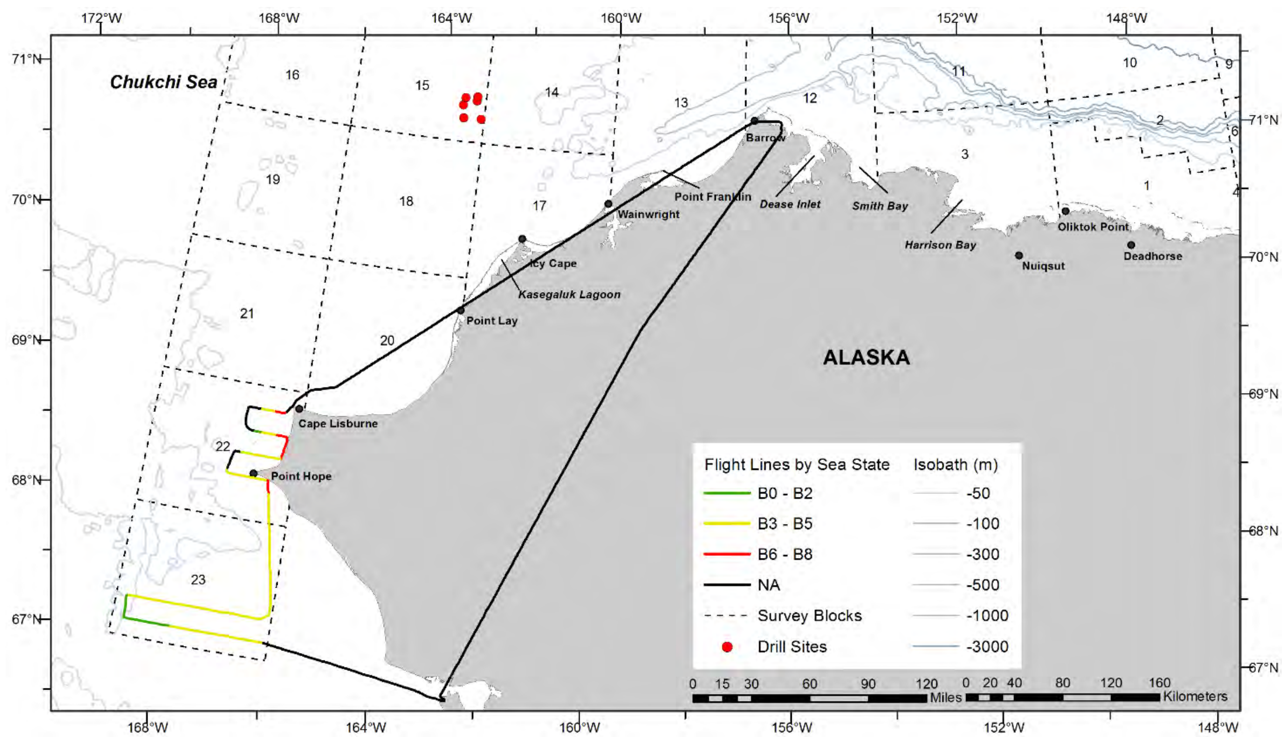

Figure B-25. ASAMM Flight 215 survey track, depicted by sea state.

4 August 2015, Flight 216

Flight was a partial survey of transects 11 and 13 and the coastal transect from Icy Cape to 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. There was no sea ice observed in the area surveyed. Sightings included one walrus and small unidentified pinnipeds.

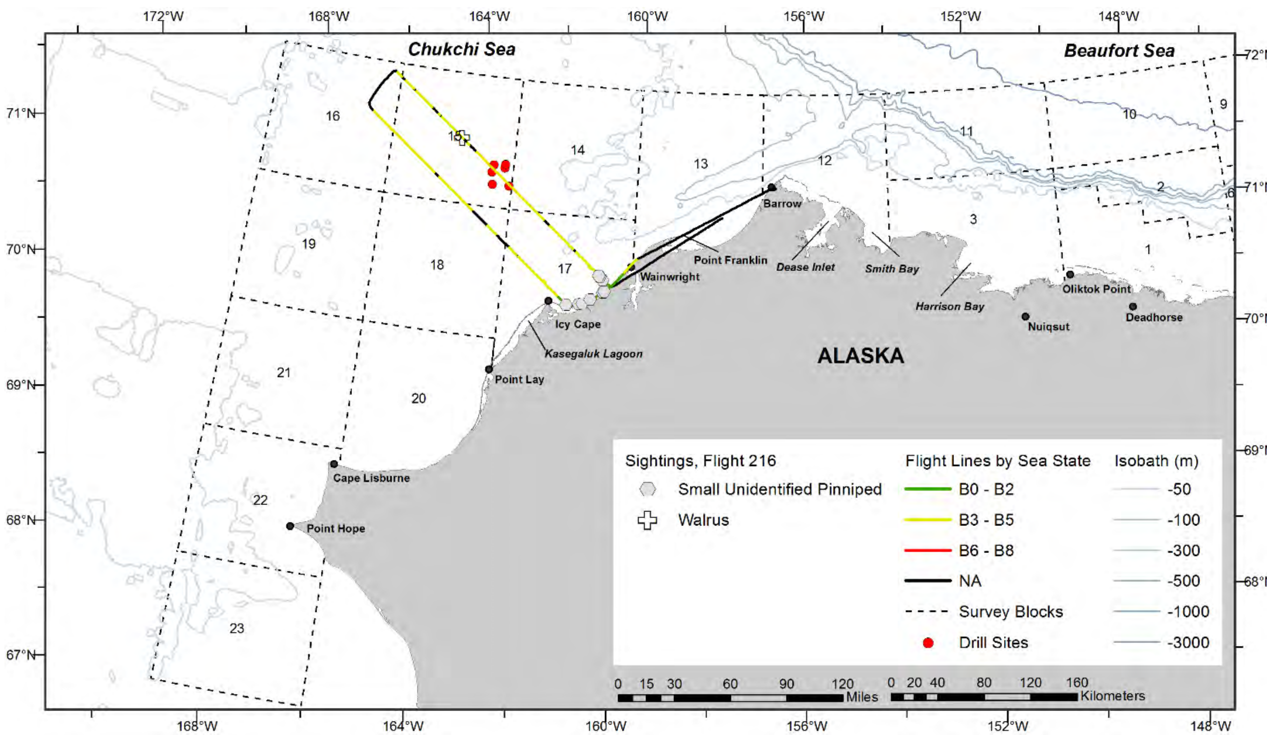

Figure B-26. ASAMM Flight 216 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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4 August 2015, Flight 11

Flight was a survey of portions of block 1. Survey conditions included clear skies, 0-2 km visibility (with fog), and Beaufort 2 sea state. Sea ice cover was 15-80% broken floe in the area surveyed. No sightings were observed.

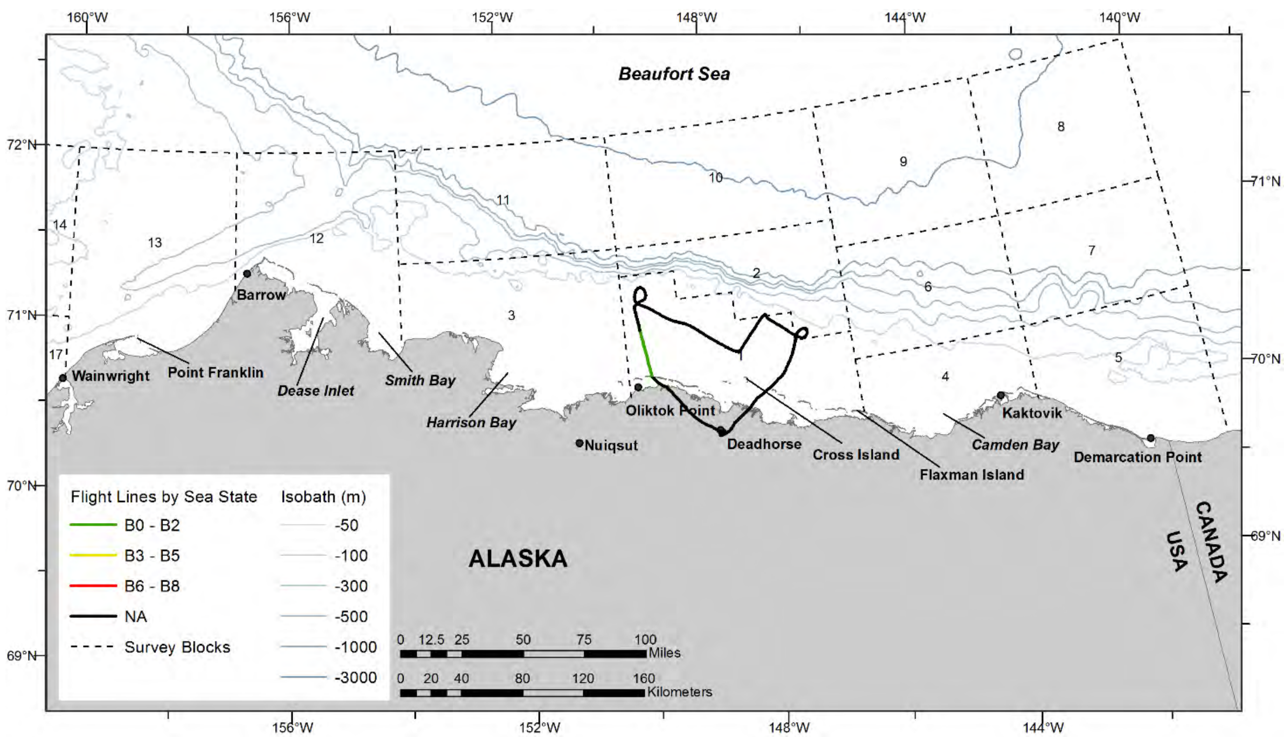

Figure B-27. ASAMM Flight 11 survey track, depicted by sea state.

5 August 2015, Flight 12

Flight was a survey of block 1 and portions of blocks 2 and 10. Survey conditions included clear to overcast skies, 0 km to unlimited visibility (with fog, glare, haze, and low ceilings), and Beaufort 0-3 sea states. Sea ice cover was 3-85% broken floe in the area surveyed. Sightings included belugas (including 5 calves).

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	8/5/15 10:31	71.046	147.268	beluga	swim	1	0	2
12	8/5/15 10:32	71.005	147.238	beluga	swim	1	0	2
12	8/5/15 10:33	70.998	147.244	beluga	swim	1	0	2
12	8/5/15 11:26	70.921	148.235	beluga	swim	30	0	1
12	8/5/15 11:27	70.914	148.252	beluga	swim	6	0	1
12	8/5/15 13:37	71.228	149.735	beluga	rest	6	0	2
12	8/5/15 13:37	71.240	149.753	beluga	swim	1	0	2
12	8/5/15 13:38	71.257	149.763	beluga	swim	1	0	2
12	8/5/15 13:38	71.270	149.757	beluga	dive	1	0	2
12	8/5/15 13:38	71.278	149.762	beluga	swim	1	0	2
12	8/5/15 13:47	71.462	149.336	beluga	swim	6	1	10
12	8/5/15 13:47	71.452	149.244	beluga	swim	1	0	10
12	8/5/15 13:51	71.385	149.039	beluga	swim	2	1	10
12	8/5/15 13:52	71.348	149.066	beluga	swim	2	1	10
12	8/5/15 13:54	71.283	149.046	beluga	swim	1	0	2
12	8/5/15 13:56	71.209	149.054	beluga	swim	1	0	2
12	8/5/15 13:57	71.177	149.067	beluga	swim	1	0	2
12	8/5/15 14:44	71.213	148.755	beluga	swim	1	0	2
12	8/5/15 14:45	71.224	148.722	beluga	swim	1	0	2
12	8/5/15 14:46	71.271	148.752	beluga	swim	2	1	2
12	8/5/15 15:12	71.239	146.200	beluga	swim	1	0	2
12	8/5/15 15:13	71.189	146.224	beluga	swim	4	1	2
12	8/5/15 15:17	71.061	146.212	beluga	swim	4	0	2

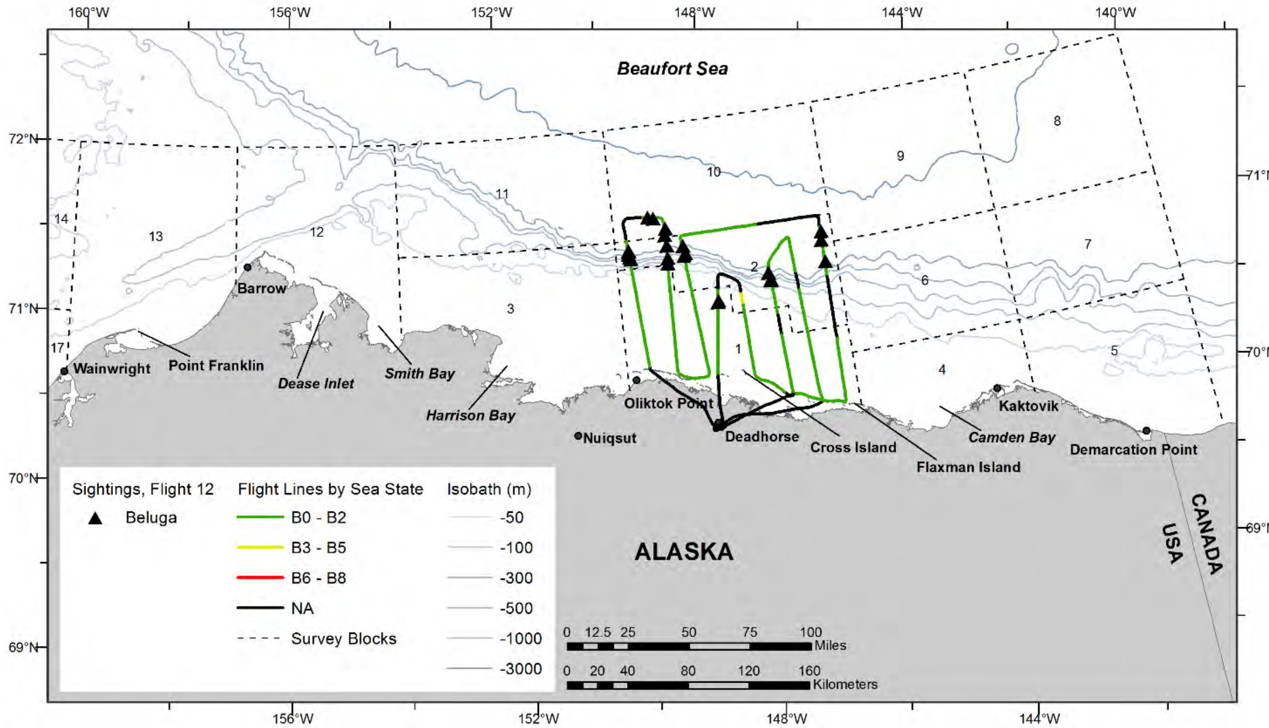

Figure B-28. ASAMM Flight 12 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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6 August 2015, Flight 217

Flight was a survey of portions of blocks 3 and 11 and a coastal search survey from Cape Halkett to Barrow. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with fog, glare, haze, and low ceilings) and Beaufort 2-6 sea states. Sea ice was 0-85% broken floe in the area surveyed. Sightings included belugas (including one calf) 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
217	8/6/15 18:18	71.784	152.975	beluga	rest	2	0	11
217	8/6/15 19:55	71.369	156.296	beluga	swim	2	1	12

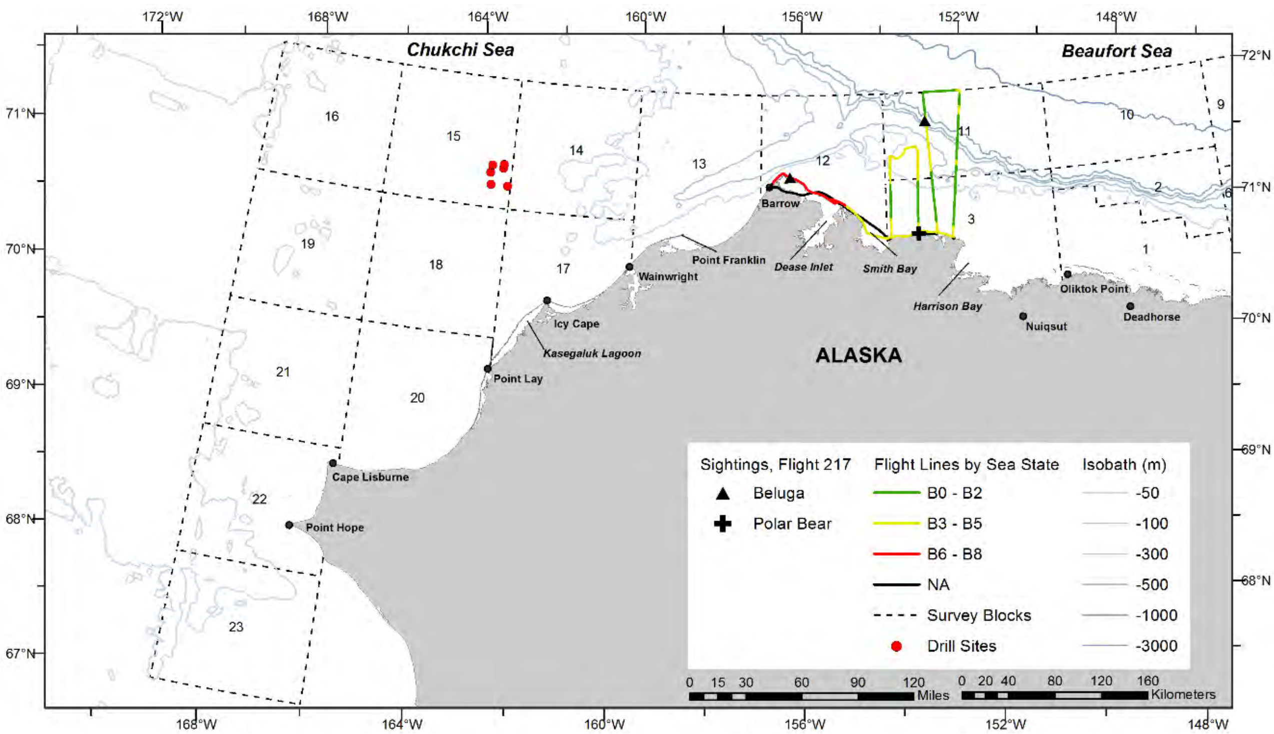

Figure B-29. ASAMM Flight 217 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

7 August 2015, Flight 218

Flight was a complete survey of transects 1, 3, 5, 7, and 10, a partial survey of transect 12, and offshore search effort between transects 7 and 10. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, haze, low ceilings, and precipitation), and Beaufort 2-6 sea states. Sea ice cover was 0-1% broken floe in the area surveyed. Sightings included gray whales (including eight calves), one beluga, walruses, one bearded seal, 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	8/7/15 12:26	70.826	160.877	gray whale	feed	2	1	17
218	8/7/15 12:27	70.842	160.892	gray whale	feed	1	0	17
218	8/7/15 14:41	71.605	162.487	beluga	dive	1	0	14
218	8/7/15 17:20	71.041	157.820	gray whale	feed	4	0	13
218	8/7/15 17:20	71.055	157.844	gray whale	feed	1	0	13
218	8/7/15 17:22	71.041	157.824	gray whale	feed	2	1	13
218	8/7/15 17:24	71.060	157.834	gray whale	feed	3	1	13
218	8/7/15 17:28	71.090	157.910	gray whale	feed	1	0	13
218	8/7/15 17:29	71.093	157.942	gray whale	feed	2	1	13
218	8/7/15 17:29	71.094	157.970	gray whale	feed	2	1	13
218	8/7/15 17:30	71.098	157.940	gray whale	feed	3	0	13
218	8/7/15 17:31	71.116	157.932	gray whale	feed	1	0	13
218	8/7/15 17:33	71.107	158.025	gray whale	feed	2	1	13
218	8/7/15 17:34	71.112	158.055	gray whale	feed	1	0	13
218	8/7/15 17:36	71.115	158.080	gray whale	feed	3	1	13
218	8/7/15 17:37	71.096	158.052	gray whale	feed	1	0	13
218	8/7/15 17:45	71.275	158.524	gray whale	feed	2	1	13

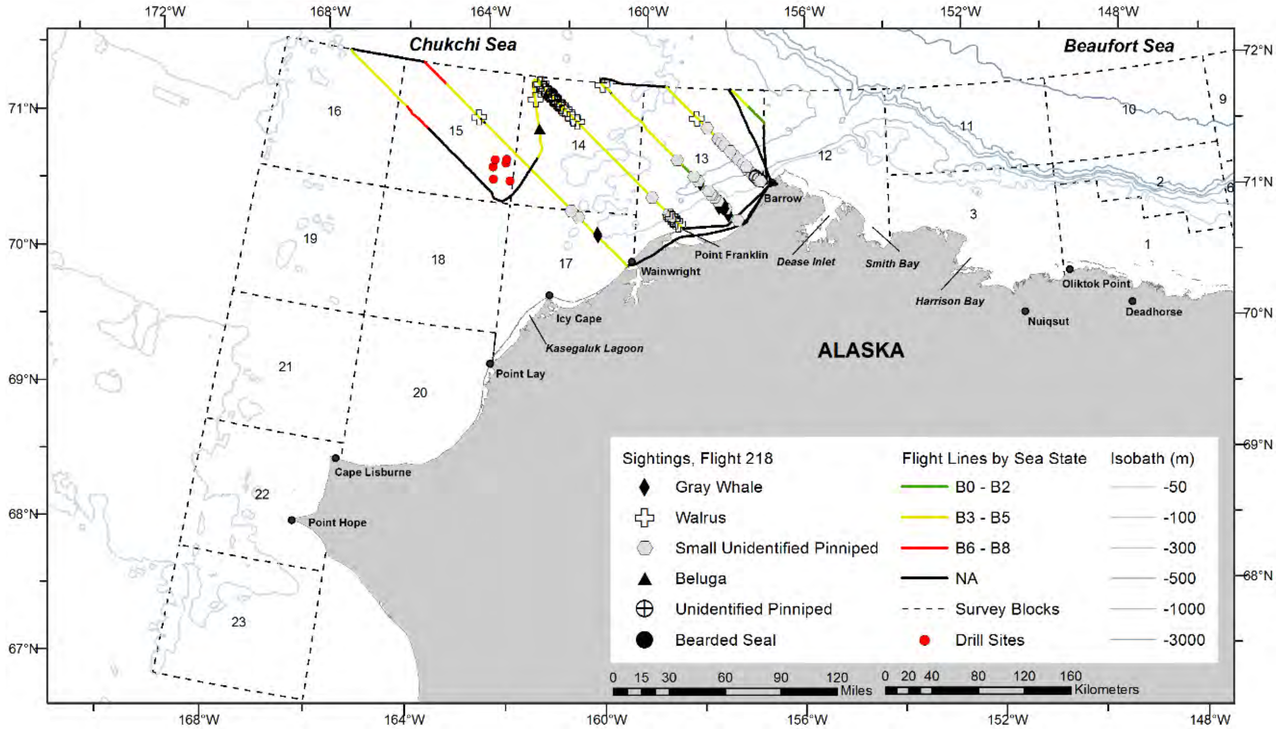

Figure B-30. ASAMM Flight 218 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

9 August 2015, Flight 219

Flight was a partial survey of transects 8, 12, 14, 16, and 18, and a coastal transect survey near Icy Cape and from Point Franklin to Barrow. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with fog, glare, haze, low ceilings, and precipitation), and Beaufort 2-6 sea states. There was no sea ice observed in the area surveyed. Sightings included gray 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
219	8/9/15 13:20	71.308	161.005	gray whale	swim	4	1	14
219	8/9/15 13:23	71.292	160.985	gray whale	swim	2	1	14
219	8/9/15 13:39	70.957	159.785	gray whale	swim	2	1	13
219	8/9/15 13:45	70.868	159.327	gray whale	feed	1	0	13
219	8/9/15 13:52	70.930	158.769	gray whale	feed	2	0	13
219	8/9/15 13:53	70.932	158.754	gray whale	feed	4	0	13
219	8/9/15 13:54	70.938	158.744	gray whale	swim	1	0	13
219	8/9/15 13:57	70.946	158.792	gray whale	feed	1	0	13
219	8/9/15 13:58	70.913	158.602	unid cetacean	swim	1	0	13
219	8/9/15 14:00	70.919	158.560	gray whale	swim	1	0	13

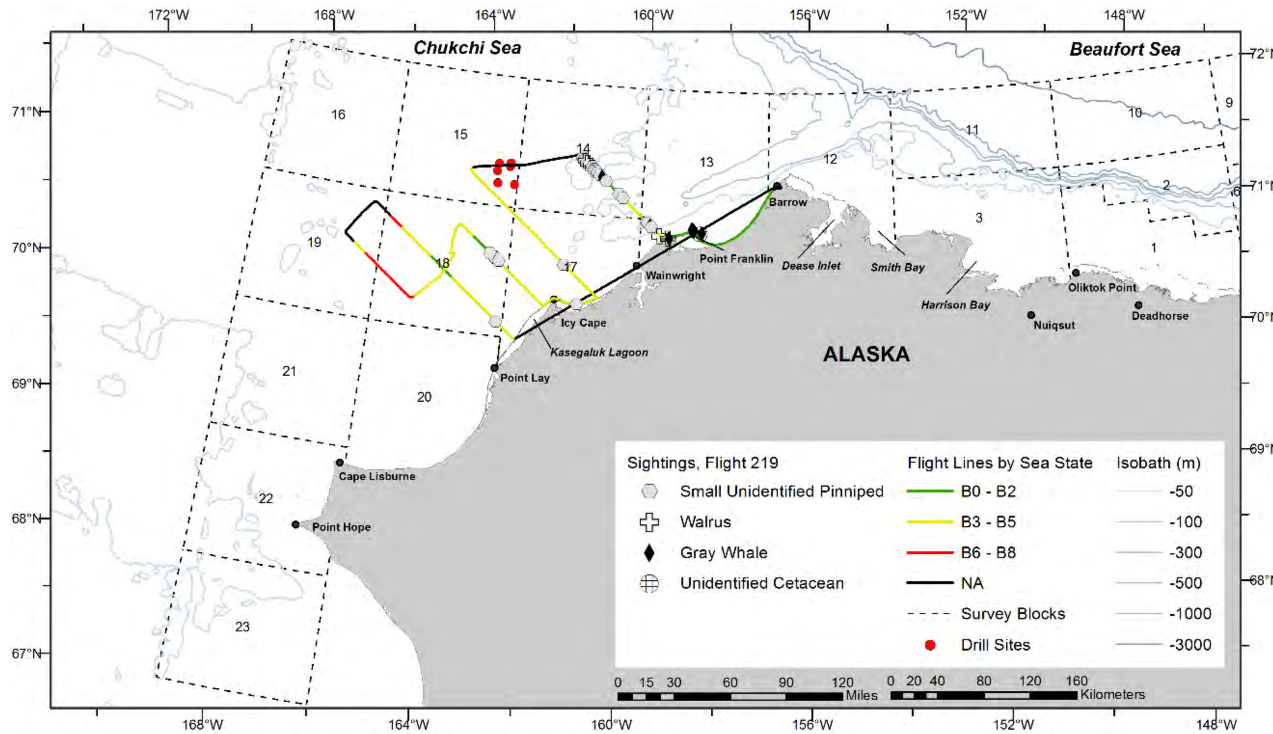

Figure B-31. ASAMM Flight 219 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

9 August 2015, Flight 13

Flight was a survey of portions of blocks 3 and 11 and search effort in block 1. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 0-4 sea states. Sea ice cover was 0-85% 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
13	8/9/15 12:56	71.247	150.143	beluga	swim	2	0	3
13	8/9/15 16:45	71.489	151.356	beluga	swim	1	0	11
13	8/9/15 17:22	71.455	151.866	beluga	swim	1	0	11

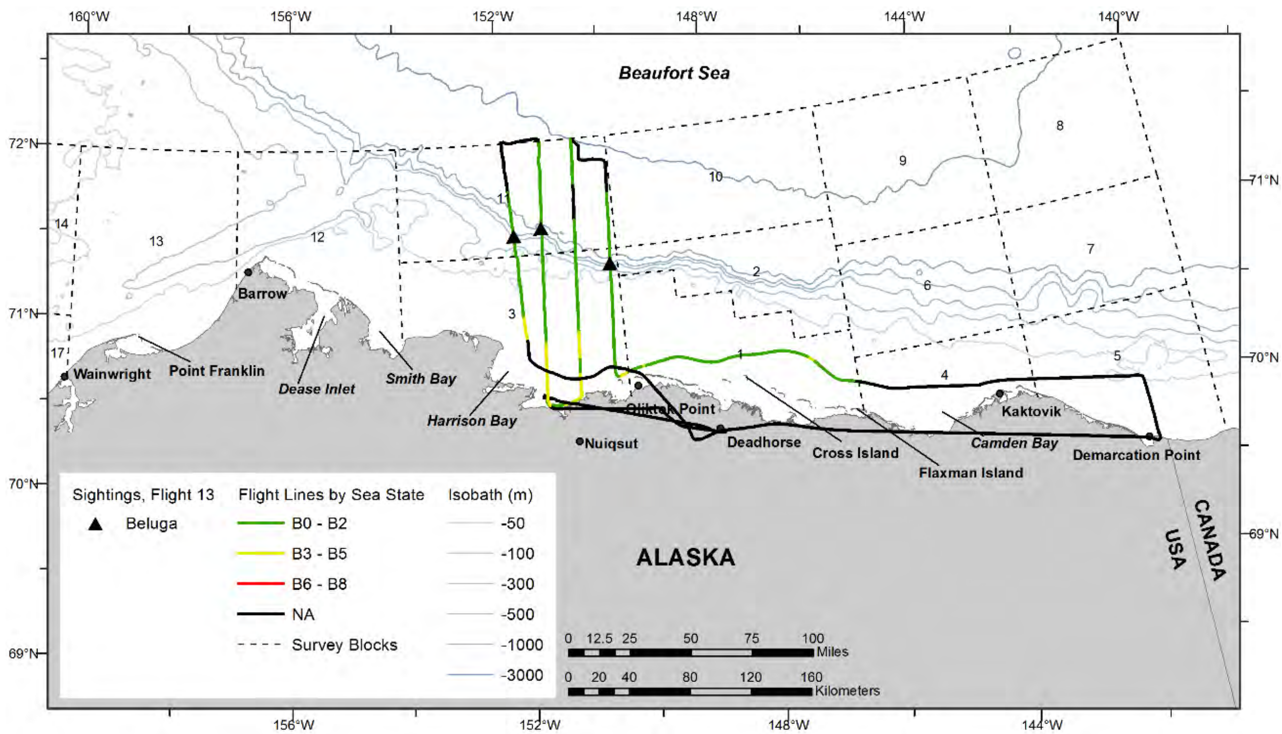

Figure B-32. ASAMM Flight 13 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

10 August 2015, Flight 220

Flight was a complete survey of transects 19 and 21. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, haze, low ceilings, and precipitation), and Beaufort 2-4 sea states. There was no sea ice observed in the area surveyed. Sightings included one humpback whale 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	8/10/15 12:54	69.710	165.425	humpback whale	tail slap	1	0	20

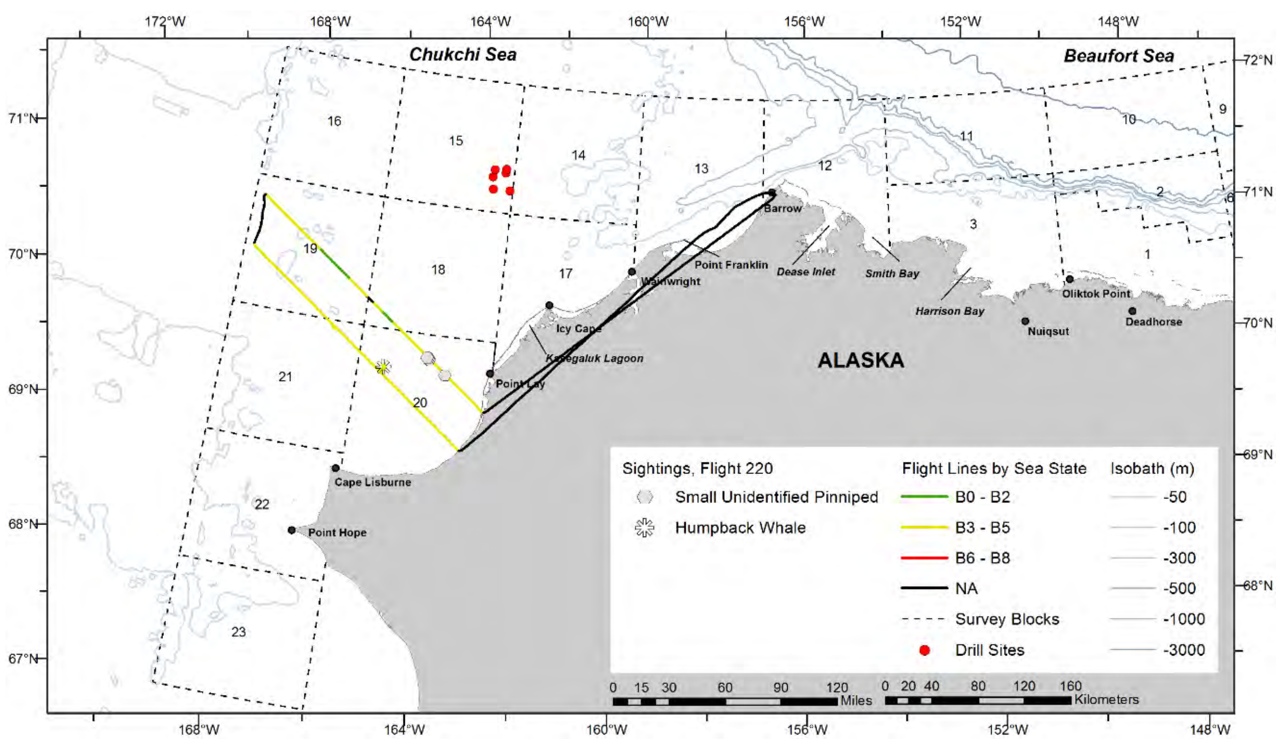

Figure B-33. ASAMM Flight 220 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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11 August 2015, Flight 221

Flight was a complete survey of transects 22 and 24. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with haze, low ceilings, and glare), and Beaufort 2-4 sea states. There was no sea ice in the area surveyed. Sightings included one bowhead whale, gray 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
221	8/11/15 13:04	70.060	168.752	bowhead whale	rest	1	0	19
221	8/11/15 13:52	69.043	165.497	gray whale	mill	2	1	20
221	8/11/15 13:53	69.045	165.492	gray whale	mill	2	1	20
221	8/11/15 13:55	69.050	165.488	gray whale	swim	1	0	20

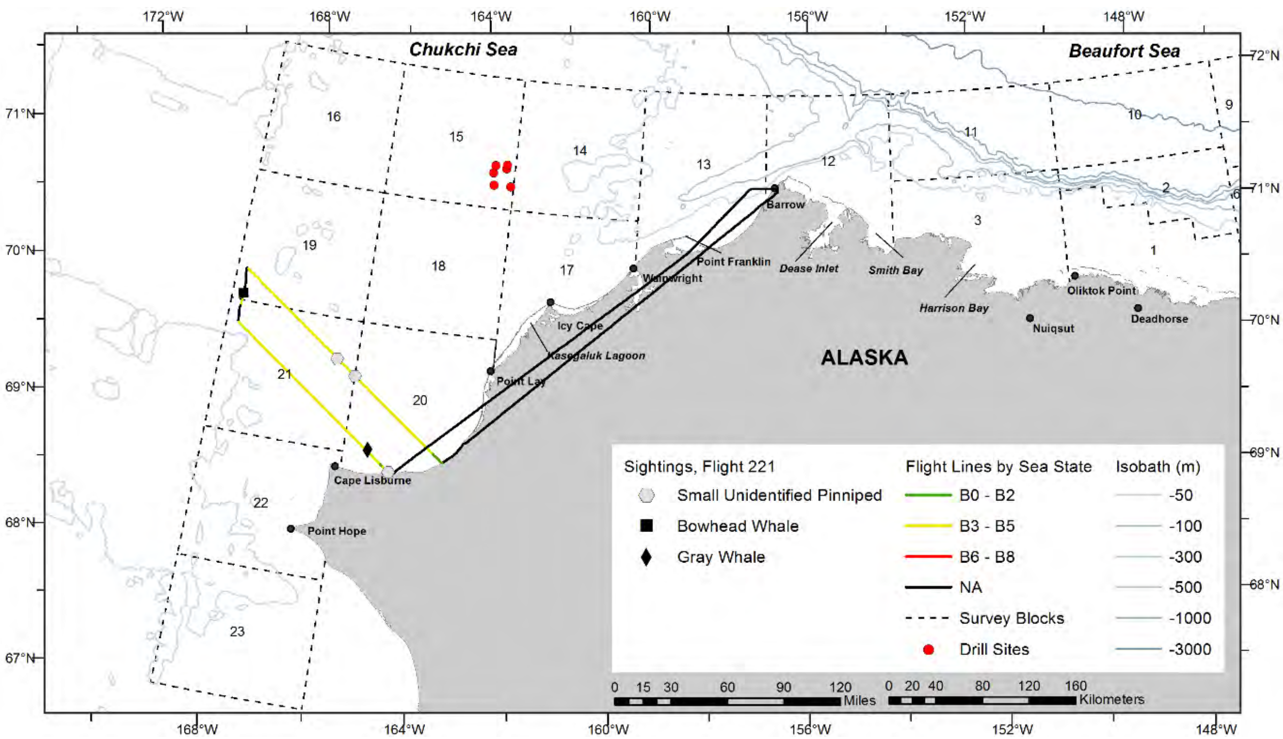

Figure B-34. ASAMM Flight 221 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

11 August 2015, Flight 14

Flight was a survey of portions of block 12. Survey conditions included clear to overcast skies, 0-10 km visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-3 sea states. Sea ice cover was 0-60% broken floe in the area surveyed. Sightings included belugas (including nine calves), 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
14	8/11/15 12:56	71.634	156.211	beluga	swim	2	0	12
14	8/11/15 12:56	71.608	156.180	beluga	swim	1	0	12
14	8/11/15 12:57	71.584	156.211	beluga	swim	4	0	12
14	8/11/15 12:57	71.579	156.189	beluga	swim	2	0	12
14	8/11/15 12:57	71.574	156.191	beluga	swim	3	1	12
14	8/11/15 12:58	71.569	156.188	beluga	mill	15	2	12
14	8/11/15 12:58	71.565	156.189	beluga	swim	4	2	12
14	8/11/15 13:18	71.610	155.704	beluga	mill	3	1	12
14	8/11/15 13:18	71.621	155.731	beluga	breach	1	0	12
14	8/11/15 13:18	71.624	155.709	beluga	swim	1	0	12
14	8/11/15 13:19	71.634	155.688	beluga	mill	2	0	12
14	8/11/15 13:51	71.105	154.833	beluga	mill	2	1	12
14	8/11/15 13:52	71.094	154.771	beluga	swim	1	0	12
14	8/11/15 13:52	71.095	154.756	beluga	swim	1	0	12
14	8/11/15 13:53	71.070	154.738	beluga	swim	2	0	12
14	8/11/15 13:53	71.058	154.700	beluga	swim	20	0	12
14	8/11/15 13:53	71.063	154.670	beluga	swim	20	0	12
14	8/11/15 13:54	71.051	154.657	beluga	swim	2	1	12
14	8/11/15 13:54	71.050	154.640	beluga	swim	1	0	12
14	8/11/15 14:20	71.500	154.017	beluga	swim	1	1	12

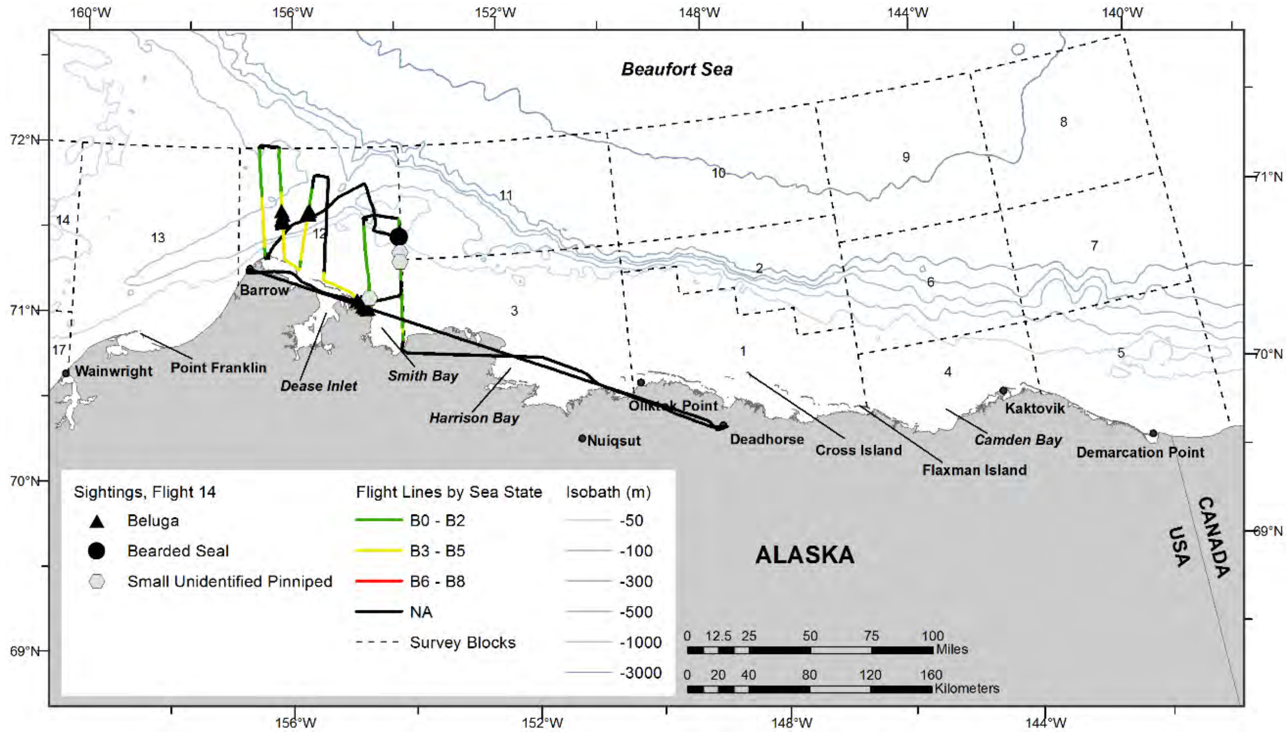

Figure B-35. ASAMM Flight 14 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

12 August 2015, Flight 222

Flight was a partial survey of transects 9, 18, and 20 and the coastal transect from Barrow to Icy Cape. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, haze, low ceilings, and precipitation), and Beaufort 2-6 sea states. There was no sea ice in the area surveyed. Sightings included gray 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
222	8/12/15 15:34	70.864	159.378	gray whale	swim	2	1	13
222	8/12/15 15:37	70.800	159.641	gray whale	feed	2	1	13
222	8/12/15 15:43	70.711	159.914	gray whale	swim	1	0	13

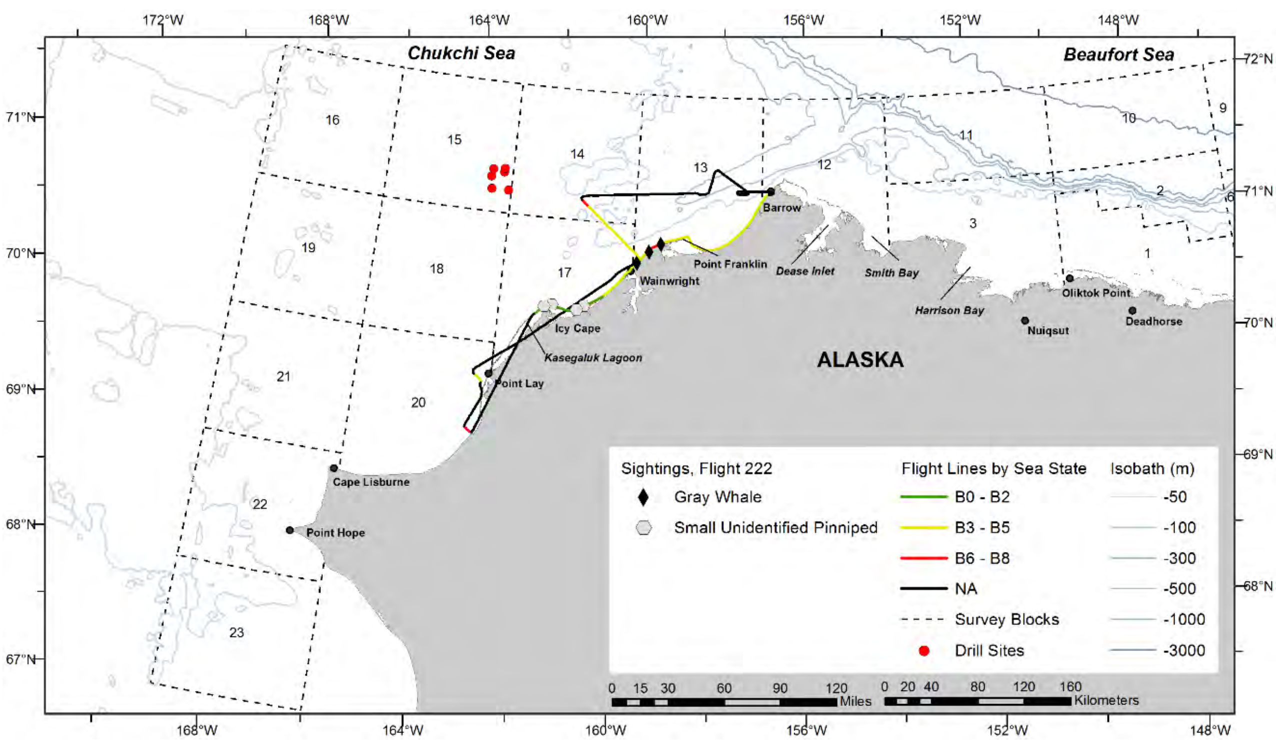

Figure B-36. ASAMM Flight 222 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

12 August 2015, Flight 15

Flight was a survey of a portion of block 6 and a coastal search survey from Flaxman Island to Cross Island. Survey conditions included partly cloudy skies, 0 km to unlimited visibility (with fog and low ceilings), and Beaufort 0-2 sea states. Sea ice cover was 17-80% broken floe in the area surveyed. No sightings were observed.

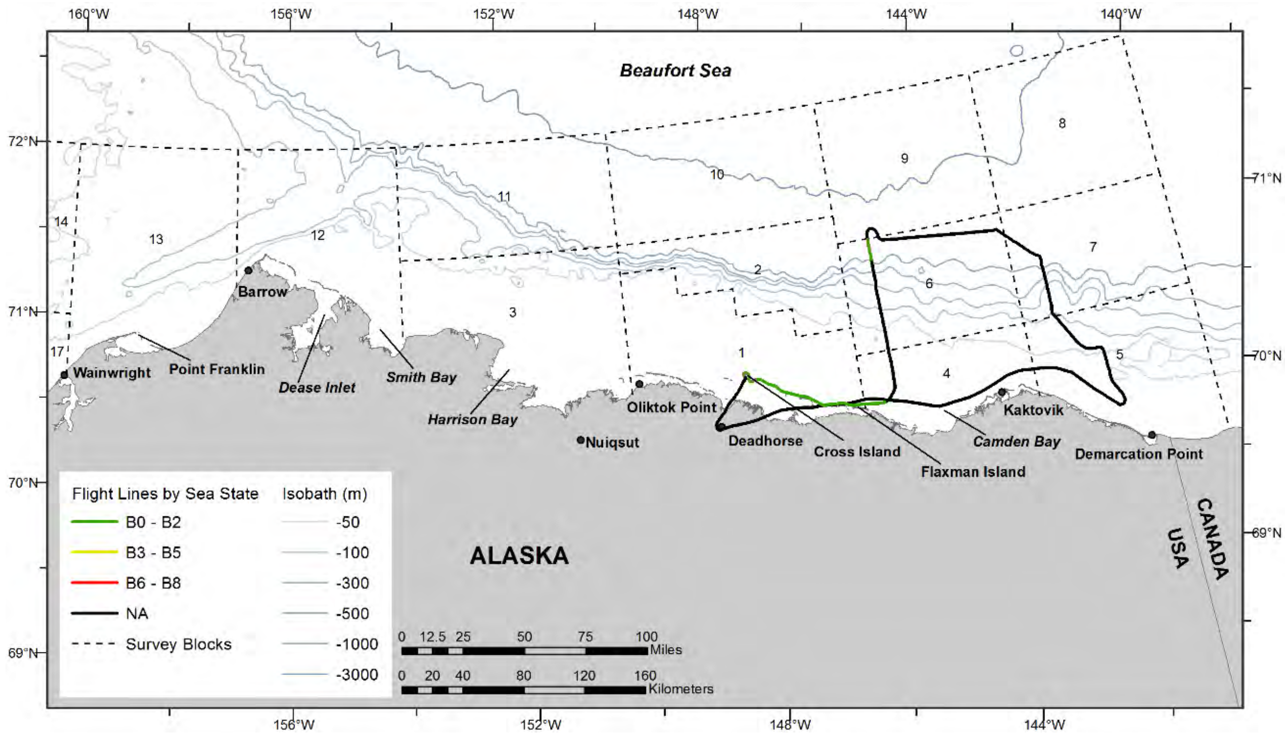

Figure B-37. ASAMM Flight 15 survey track, depicted by sea state.

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14 August 2015, Flight 16

Flight was a survey of portions of blocks 4, 5, 6, and 7. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 0-3 sea states. Sea ice cover was 0-87% broken floe in the area surveyed. Sightings included bowhead whales, belugas, 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
16	8/14/15 15:38	70.098	142.281	unid cetacean	rest	1	0	5
16	8/14/15 17:00	70.659	143.335	beluga	swim	2	0	6
16	8/14/15 17:50	70.495	144.388	bowhead whale	swim	2	0	4

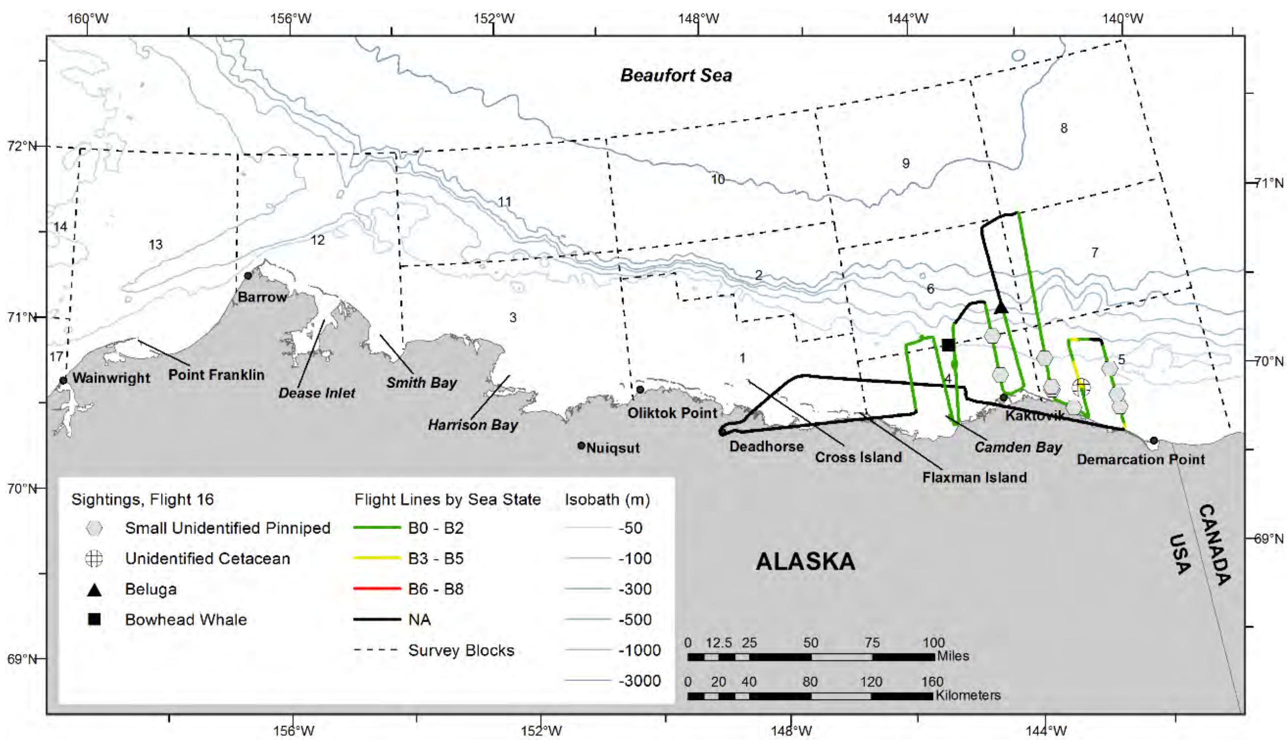


Figure B-38. ASAMM Flight 16 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

18 August 2015, Flight 223

Flight was a survey of the coastal transect from south of Point Lay to Point Franklin and search effort from Point Franklin to Barrow. Survey conditions included partly cloudy to overcast skies, 1 km to unlimited visibility (with glare, haze, and low ceilings), and Beaufort 5-7 sea states. There was no sea ice observed in the area surveyed. Sightings included one bowhead whale carcass, gray whales (including one calf and one carcass), one unidentified cetacean, and walruses. All walruses were sighted in the water, including an estimated 7500 near Point Lay, Alaska.

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
223	8/18/15 12:39	70.829	159.475	gray whale	dead	1	0	13
223	8/18/15 12:47	70.875	159.174	bowhead whale	dead	1	0	13
223	8/18/15 13:01	71.017	158.295	unid cetacean	dive	1	0	13
223	8/18/15 13:02	71.017	158.250	gray whale	feed	1	0	13
223	8/18/15 13:02	71.023	158.260	gray whale	feed	1	0	13
223	8/18/15 13:02	71.020	158.310	gray whale	feed	1	0	13
223	8/18/15 13:03	71.033	158.357	gray whale	feed	2	0	13
223	8/18/15 13:04	71.027	158.396	gray whale	feed	1	0	13
223	8/18/15 13:05	71.024	158.351	gray whale	feed	2	1	13
223	8/18/15 13:06	71.016	158.188	gray whale	feed	2	0	13
223	8/18/15 13:07	71.021	158.158	gray whale	feed	1	0	13

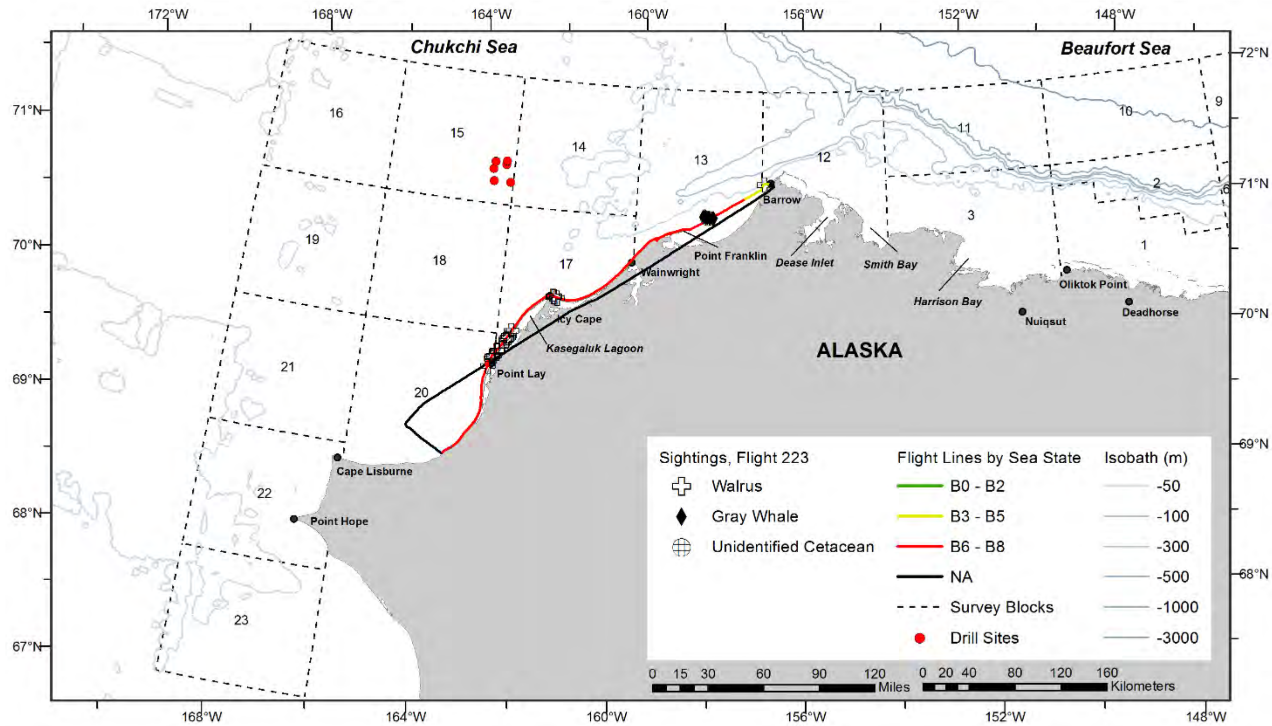


Figure B-39. ASAMM Flight 223 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale carcass sighted on Point Franklin, Alaska, during ASAMM Flight 223, 18 August 2015.

19 August 2015, Flight 224

Flight was a complete survey of transects 4, 6, and 8, and a partial survey of transect 2. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-1% broken floe in the area surveyed. Sightings included one bowhead whale, gray whales (including four calves), one beluga, one unidentified cetacean, walruses, bearded seals, 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	8/19/15 11:42	71.168	160.508	gray whale	swim	2	1	14
224	8/19/15 11:42	71.184	160.590	gray whale	rest	2	0	14
224	8/19/15 11:44	71.241	160.696	gray whale	feed	2	0	14
224	8/19/15 11:45	71.239	160.722	gray whale	feed	1	0	14
224	8/19/15 11:45	71.239	160.766	gray whale	feed	2	1	14
224	8/19/15 11:45	71.242	160.765	gray whale	feed	1	0	14
224	8/19/15 11:49	71.234	160.682	gray whale	feed	1	0	14
224	8/19/15 11:49	71.240	160.652	gray whale	feed	1	0	14
224	8/19/15 11:50	71.239	160.668	gray whale	feed	1	0	14
224	8/19/15 11:53	71.224	160.907	gray whale	feed	2	0	14
224	8/19/15 11:54	71.230	160.889	gray whale	feed	4	2	14
224	8/19/15 12:47	71.968	161.820	beluga	swim	1	0	14
224	8/19/15 13:30	71.039	158.535	unid cetacean	swim	1	0	13
224	8/19/15 13:32	71.039	158.522	gray whale	swim	1	0	13
224	8/19/15 13:34	71.043	158.518	gray whale	feed	2	0	13
224	8/19/15 13:40	71.018	158.437	gray whale	feed	1	0	13
224	8/19/15 13:41	71.001	158.360	gray whale	feed	1	0	13
224	8/19/15 13:41	70.993	158.338	gray whale	feed	1	0	13
224	8/19/15 14:23	71.627	158.907	bowhead whale	rest	1	0	13

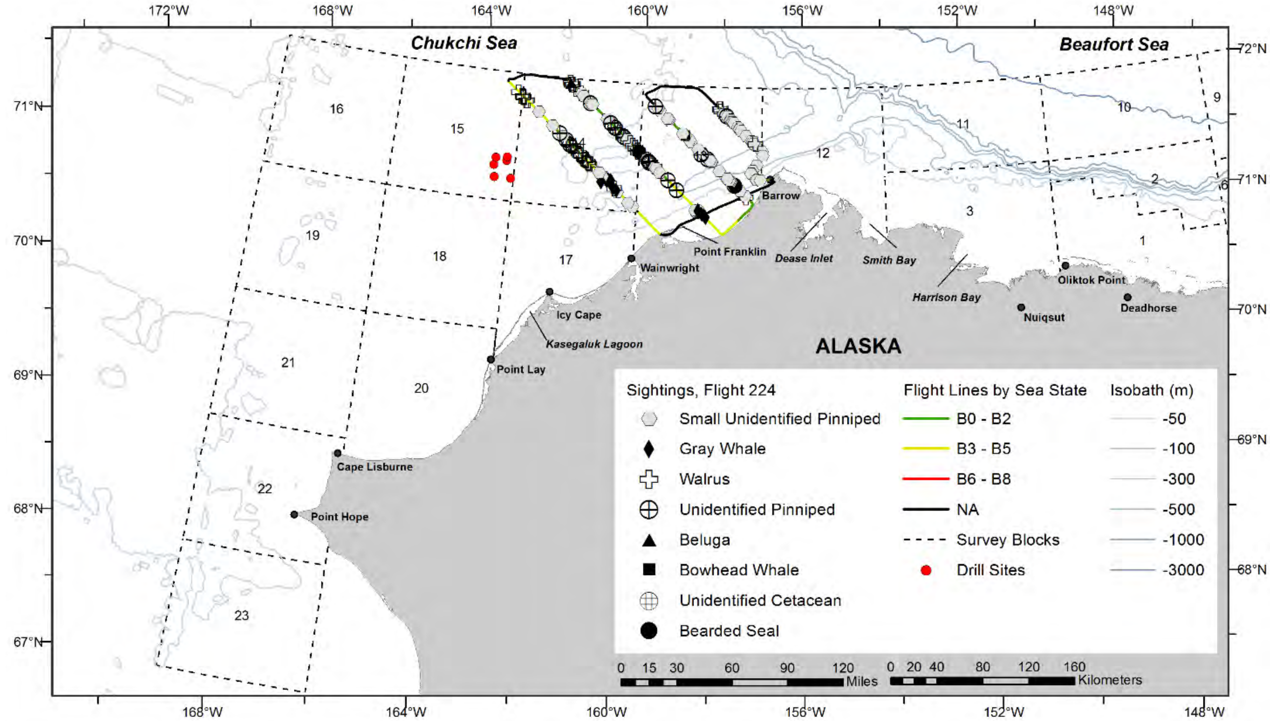
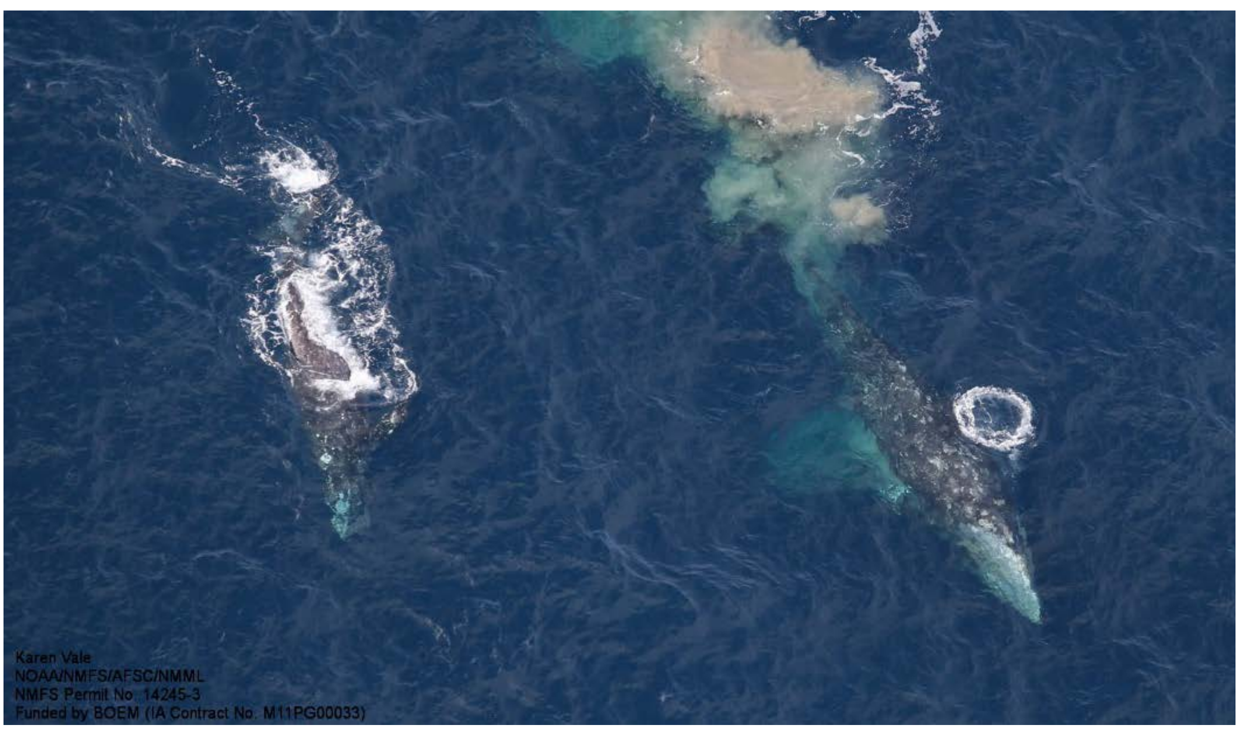


Figure B-40. ASAMM Flight 224 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



Gray whale cow-calf pair sighted approximately 100 km northwest of Pt. Franklin, Alaska, during ASAMM Flight 224, 19 August 2015.

19 August 2015, Flight 17

Flight was a survey of portions of blocks 3 and 11 and a coastal search survey near Oliktok Point. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-70% broken floe in the area surveyed. Sightings included belugas (including three 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
17	8/19/15 17:44	71.849	153.832	beluga	swim	1	0	11
17	8/19/15 17:45	71.876	153.810	beluga	swim	1	0	11
17	8/19/15 17:45	71.882	153.786	beluga	swim	1	0	11
17	8/19/15 17:45	71.885	153.805	beluga	mill	5	0	11
17	8/19/15 17:45	71.889	153.838	beluga	swim	9	0	11
17	8/19/15 17:46	71.910	153.833	beluga	swim	1	0	11
17	8/19/15 17:47	71.938	153.831	beluga	swim	1	0	11
17	8/19/15 17:47	71.951	153.807	beluga	swim	3	0	11
17	8/19/15 17:47	71.951	153.807	beluga	swim	3	0	11
17	8/19/15 17:58	71.873	153.249	beluga	swim	2	0	11
17	8/19/15 17:58	71.870	153.267	beluga	swim	2	1	11
17	8/19/15 17:58	71.855	153.237	beluga	swim	3	0	11
17	8/19/15 17:59	71.847	153.231	beluga	swim	1	0	11
17	8/19/15 17:59	71.829	153.237	beluga	swim	2	0	11
17	8/19/15 18:00	71.820	153.239	beluga	swim	3	0	11
17	8/19/15 18:00	71.811	153.230	beluga	swim	3	0	11
17	8/19/15 18:01	71.778	153.215	beluga	swim	1	0	11
17	8/19/15 18:55	71.573	152.844	beluga	swim	2	1	11
17	8/19/15 19:00	71.729	152.859	beluga	mill	2	0	11
17	8/19/15 19:03	71.812	152.884	beluga	swim	1	0	11
17	8/19/15 19:08	71.974	152.902	beluga	swim	1	0	11
17	8/19/15 19:21	71.913	152.030	beluga	swim	2	1	11
17	8/19/15 19:33	71.557	152.080	beluga	swim	1	0	11
17	8/19/15 19:37	71.413	152.089	beluga	swim	5	0	11
17	8/19/15 19:38	71.406	152.107	beluga	swim	1	0	11
17	8/19/15 19:39	71.378	152.084	beluga	swim	7	0	11

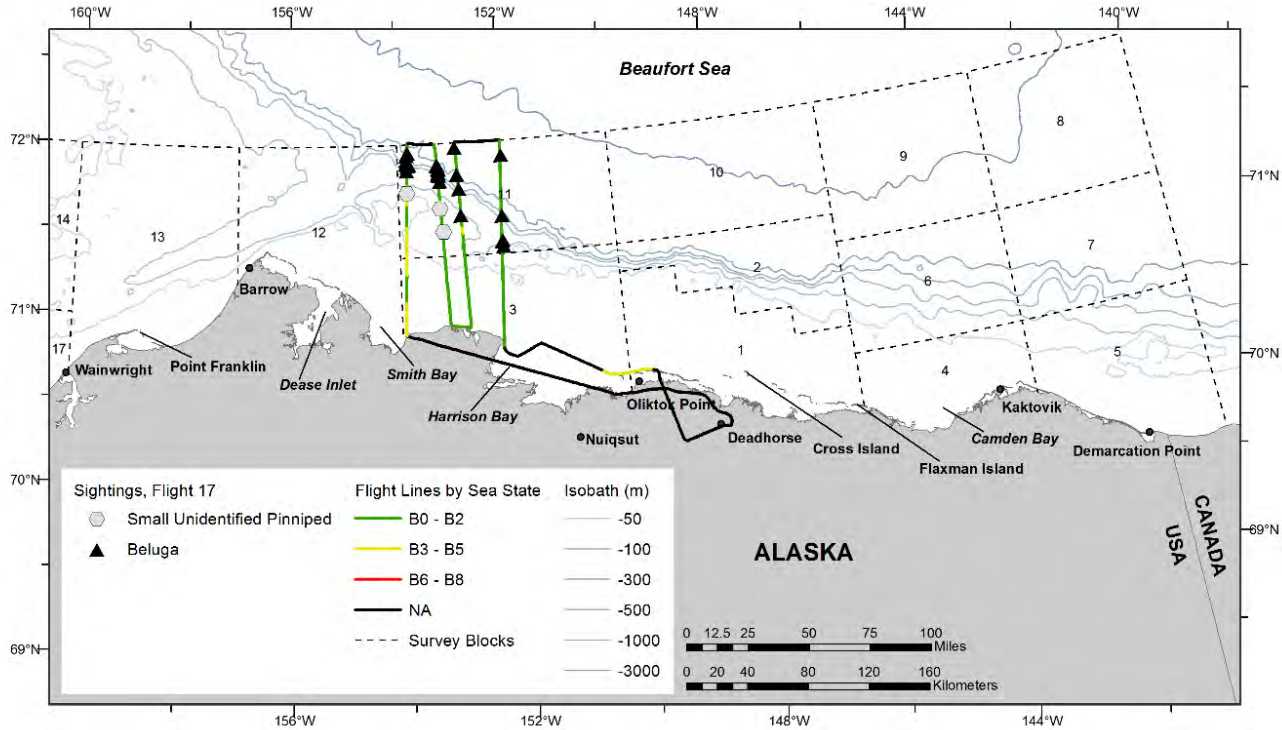


Figure B-41. ASAMM Flight 17 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

20 August 2015, Flight 225

Flight was a complete survey of transects 3, 5, 7, and 9. 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. There was no sea ice observed in the area surveyed. Sightings included one bowhead whale, gray whales (including seven calves and one carcass), unidentified cetaceans, 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
225	8/20/15 10:41	70.902	160.283	gray whale	feed	3	0	17
225	8/20/15 10:43	70.898	160.333	gray whale	feed	2	1	17
225	8/20/15 10:46	70.893	160.357	gray whale	swim	1	0	17
225	8/20/15 10:47	70.911	160.465	gray whale	feed	1	0	17
225	8/20/15 10:48	70.908	160.477	gray whale	feed	1	0	17
225	8/20/15 10:49	70.912	160.484	gray whale	feed	1	0	17
225	8/20/15 10:50	70.910	160.520	gray whale	feed	1	0	17
225	8/20/15 10:53	70.906	160.467	gray whale	swim	1	0	17
225	8/20/15 10:54	70.898	160.465	gray whale	feed	2	1	17
225	8/20/15 11:06	71.215	161.279	unid cetacean	feed	1	0	14
225	8/20/15 11:11	71.240	161.304	gray whale	feed	1	0	14
225	8/20/15 11:12	71.265	161.353	unid cetacean	dive	1	0	14
225	8/20/15 11:13	71.254	161.348	gray whale	feed	1	0	14
225	8/20/15 11:14	71.245	161.345	gray whale	feed	4	0	14
225	8/20/15 11:14	71.244	161.331	gray whale	feed	2	1	14
225	8/20/15 11:14	71.227	161.304	gray whale	dive	1	0	14
225	8/20/15 11:15	71.224	161.337	gray whale	dive	1	0	14
225	8/20/15 11:15	71.215	161.356	gray whale	feed	1	0	14
225	8/20/15 11:18	71.235	161.473	gray whale	feed	1	0	14
225	8/20/15 11:21	71.239	161.521	gray whale	feed	1	0	14
225	8/20/15 11:21	71.242	161.519	gray whale	feed	2	0	14
225	8/20/15 11:21	71.255	161.540	gray whale	feed	1	0	14
225	8/20/15 11:22	71.247	161.580	gray whale	feed	1	0	14
225	8/20/15 11:23	71.229	161.565	gray whale	feed	1	0	14
225	8/20/15 11:58	71.947	164.266	bowhead whale	swim	1	0	15
225	8/20/15 12:21	71.927	162.512	gray whale	dead	1	0	14
225	8/20/15 13:37	71.055	157.811	gray whale	swim	3	0	13
225	8/20/15 13:37	71.080	157.787	gray whale	feed	1	0	13
225	8/20/15 13:37	71.043	157.920	gray whale	feed	1	0	13
225	8/20/15 13:38	71.076	157.897	gray whale	feed	1	0	13

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
225	8/20/15 13:40	71.050	157.904	gray whale	feed	2	0	13
225	8/20/15 13:41	71.027	157.979	gray whale	feed	3	1	13
225	8/20/15 13:44	71.025	158.104	gray whale	feed	2	0	13
225	8/20/15 13:44	71.032	158.126	gray whale	feed	2	0	13
225	8/20/15 13:45	71.019	158.064	gray whale	feed	4	2	13
225	8/20/15 13:46	71.014	158.081	gray whale	feed	1	0	13
225	8/20/15 13:46	71.012	158.090	gray whale	feed	2	1	13
225	8/20/15 13:46	71.011	158.103	gray whale	feed	1	0	13
225	8/20/15 13:46	71.008	158.127	gray whale	feed	1	0	13
225	8/20/15 13:49	71.037	158.018	gray whale	feed	1	0	13
225	8/20/15 13:52	71.120	157.863	unid cetacean	feed	1	0	13
225	8/20/15 13:56	71.104	158.012	gray whale	feed	1	0	13
225	8/20/15 13:56	71.117	158.024	gray whale	feed	1	0	13
225	8/20/15 13:57	71.094	158.043	gray whale	feed	1	0	13
225	8/20/15 13:58	71.117	158.024	gray whale	feed	1	0	13
225	8/20/15 13:58	71.122	158.030	gray whale	feed	1	0	13
225	8/20/15 14:00	71.142	158.044	gray whale	dive	1	0	13
225	8/20/15 14:03	71.142	158.200	gray whale	dive	1	0	13

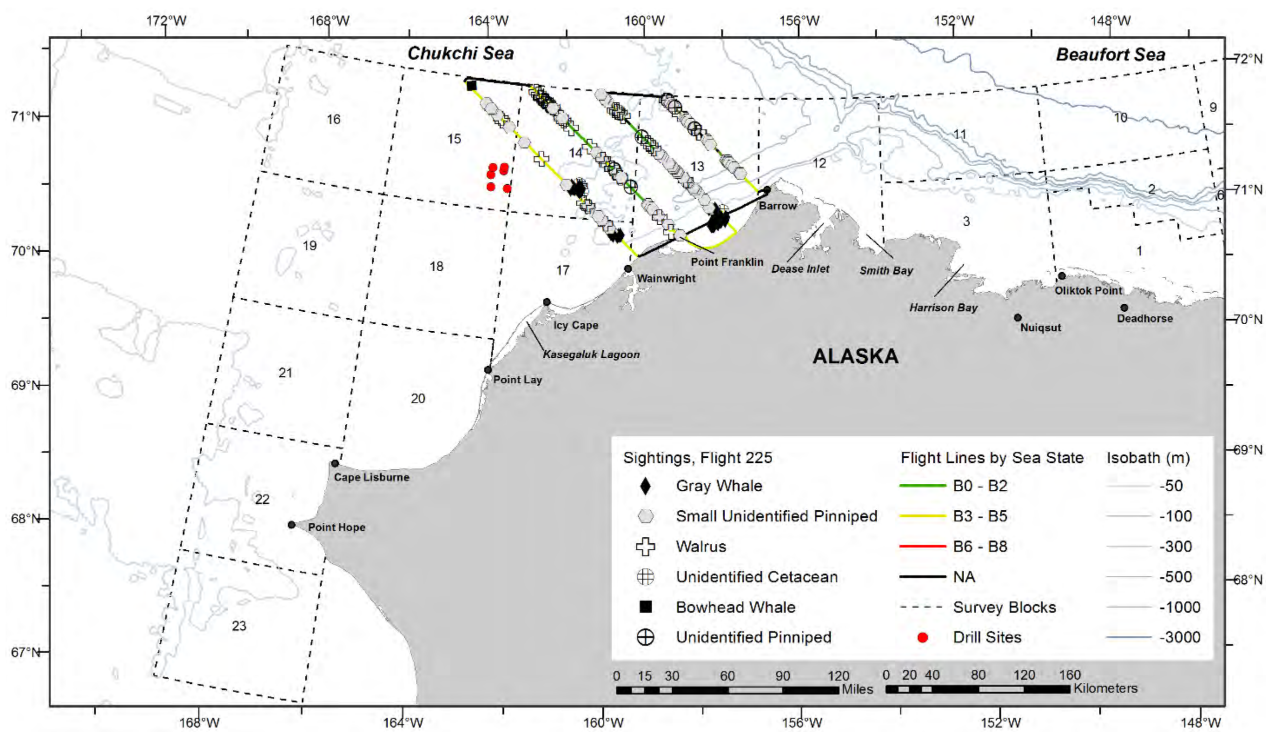


Figure B-42. ASAMM Flight 225 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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20 August 2015, Flight 18

Flight was a survey of portions of blocks 3 and 11. Survey conditions included partly cloudy to overcast skies, 0-5 km visibility (with fog, glare, and low ceilings), and Beaufort 1-4 sea states. Sea ice cover was 0-92% broken floe in the area surveyed. Sightings included one beluga.

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	8/20/15 13:26	71.573	151.158	beluga	swim	1	0	11

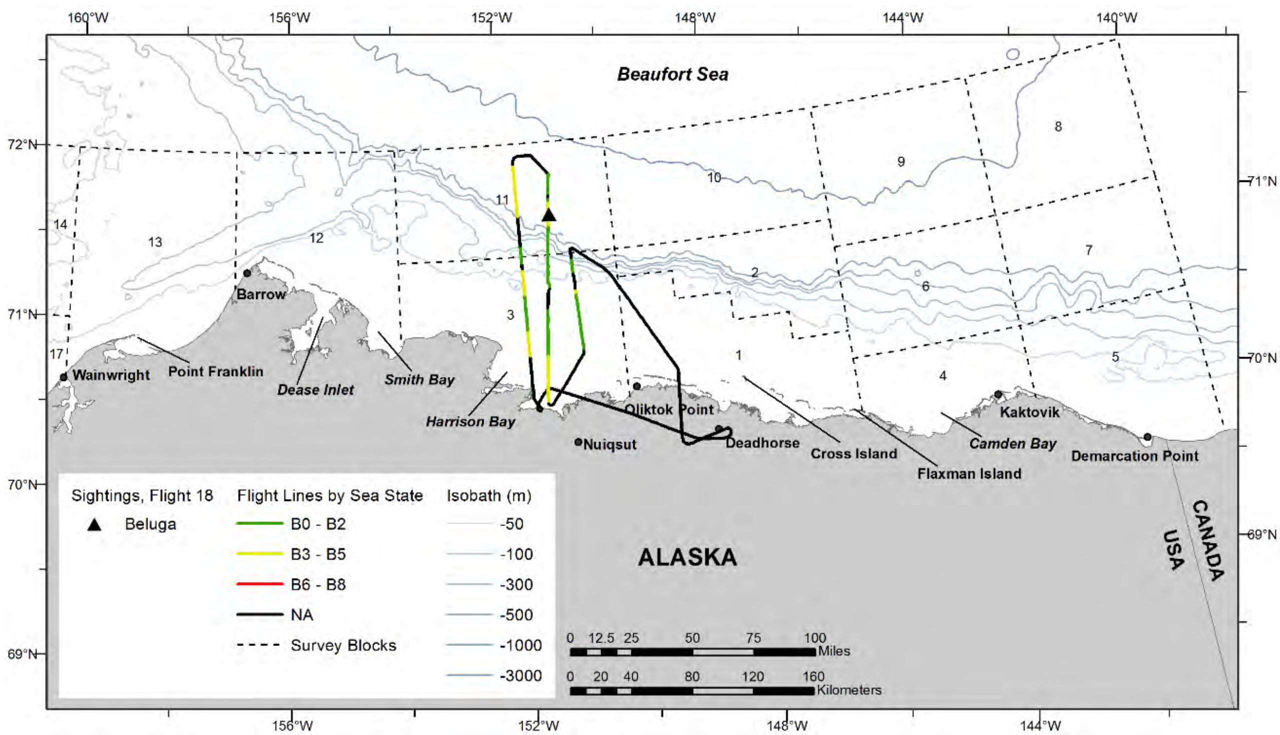

Figure B-43. ASAMM Flight 18 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

23 August 2015, Flight 226

Flight was a complete survey of transects 36 and 37, and partial survey of transect 38. Survey conditions included partly cloudy skies, 5 km to unlimited visibility (with glare), and Beaufort 2-3 sea states. There was no sea ice in the area surveyed. Sightings included gray whales (including one calf), fin whales, humpback whales (including one calf), minke whales, one beluga carcass, one unidentified cetacean, 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
226	8/23/15 14:47	67.639	166.090	unid cetacean	swim	1	0	23
226	8/23/15 14:58	67.617	166.679	fin whale	feed	1	0	23
226	8/23/15 15:08	67.639	166.655	fin whale	swim	1	0	23
226	8/23/15 15:12	67.633	166.746	fin whale	swim	1	0	23
226	8/23/15 15:19	67.645	167.367	minke whale	swim	1	0	23
226	8/23/15 15:22	67.638	167.377	gray whale	swim	2	0	23
226	8/23/15 15:25	67.647	167.581	beluga	dead	1	0	23
226	8/23/15 15:27	67.657	167.718	gray whale	swim	1	0	23
226	8/23/15 15:29	67.625	167.698	gray whale	swim	1	0	23
226	8/23/15 15:30	67.624	167.699	gray whale	swim	2	1	23
226	8/23/15 15:41	67.687	168.566	gray whale	rest	5	0	23
226	8/23/15 15:44	67.707	168.588	gray whale	feed	4	0	23
226	8/23/15 16:11	67.483	167.763	fin whale	swim	1	0	23
226	8/23/15 16:50	67.285	166.646	fin whale	swim	2	0	23
226	8/23/15 16:57	67.283	166.807	fin whale	swim	1	0	23
226	8/23/15 16:59	67.296	166.853	fin whale	swim	1	0	23
226	8/23/15 17:00	67.313	166.835	fin whale	dive	1	0	23
226	8/23/15 17:02	67.287	166.891	fin whale	swim	1	0	23
226	8/23/15 17:04	67.287	167.010	humpback whale	swim	1	0	23
226	8/23/15 17:14	67.287	167.011	humpback whale	swim	2	1	23
226	8/23/15 17:18	67.327	167.127	fin whale	feed	1	0	23
226	8/23/15 17:22	67.275	167.173	fin whale	swim	1	0	23
226	8/23/15 17:30	67.237	167.196	fin whale	swim	2	0	23
226	8/23/15 17:31	67.240	167.101	fin whale	swim	3	0	23
226	8/23/15 17:36	67.325	167.395	fin whale	feed	1	0	23
226	8/23/15 17:41	67.282	167.453	minke whale	swim	1	0	23

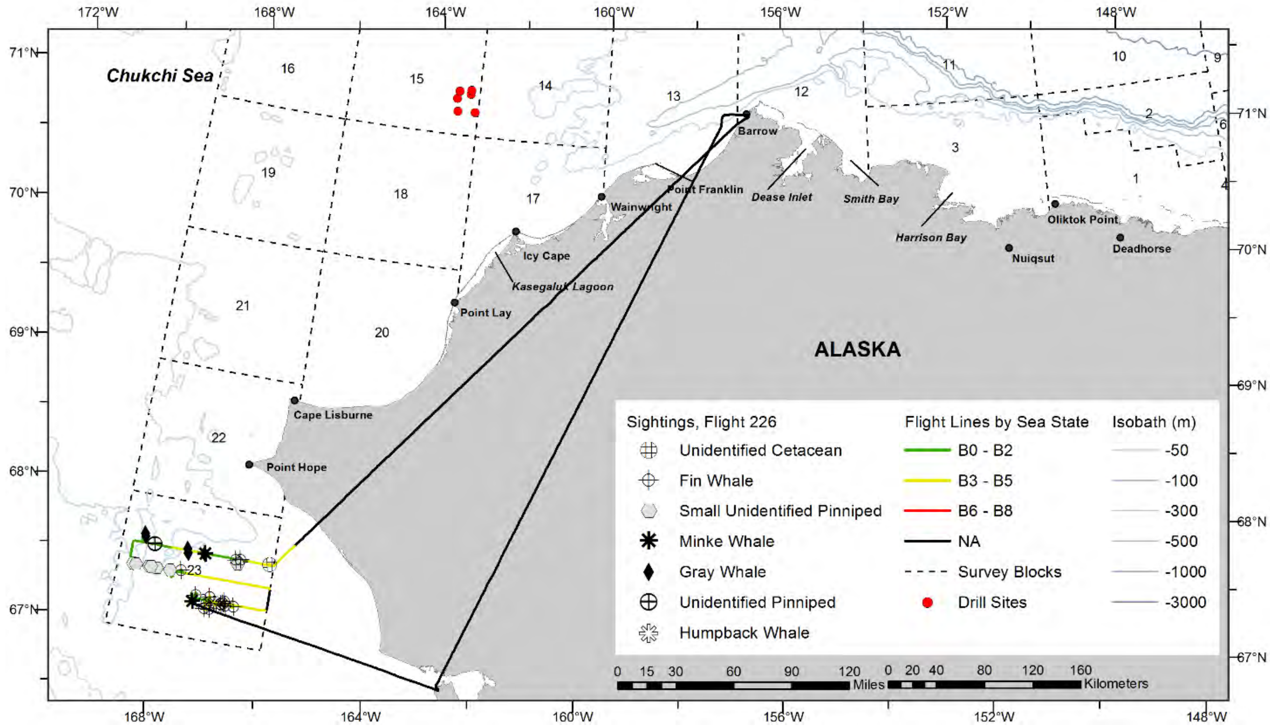

Figure B-44. ASAMM Flight 226 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Fin whale sighted approximately 120 km south of Point Hope, Alaska, during ASAMM Flight 226, 23 August 2015.

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24 August 2015, Flight 19

Flight was a survey of portions of blocks 1, 4, and 6, and a coastal search survey from Camden Bay to northeast of Deadhorse. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, and low ceilings), and Beaufort 2-6 sea states. Sea ice cover was 0-40% broken floe in the area surveyed. Sightings included bowhead whales.

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
19	8/24/15 16:29	70.525	145.877	bowhead whale	swim	1	0	6
19	8/24/15 17:27	70.278	144.708	bowhead whale	swim	1	0	4
19	8/24/15 17:29	70.293	144.766	bowhead whale	swim	1	0	4
19	8/24/15 17:29	70.306	144.773	bowhead whale	swim	1	0	4

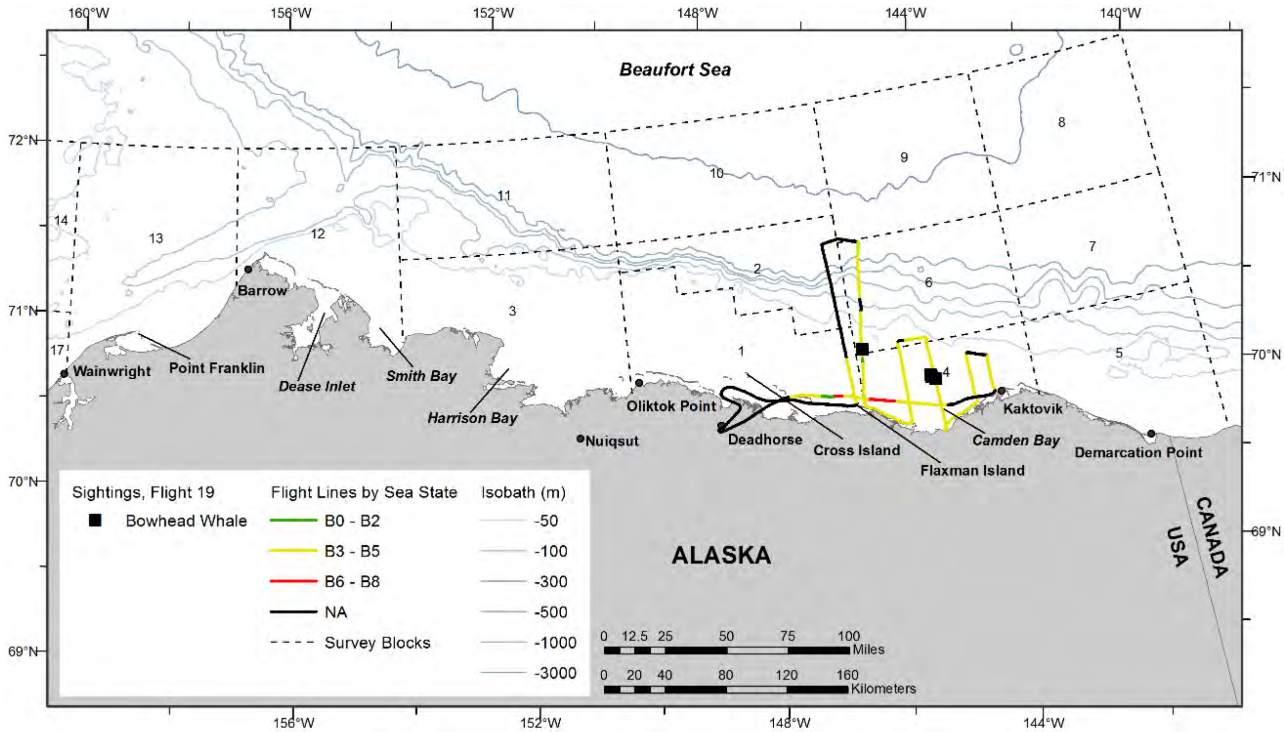

Figure B-45. ASAMM Flight 19 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

25 August 2015, Flight 20

Flight was a survey of portions of blocks 1, 2, 5, and 7. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-6 sea states. Sea ice cover was 0-88% broken floe in the area surveyed. Sightings included bowhead whales (including two calves), belugas, 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
20	8/25/15 11:09	69.869	140.880	bowhead whale	swim	2	0	5
20	8/25/15 11:18	69.831	140.916	bowhead whale	swim	1	0	5
20	8/25/15 11:20	69.825	140.892	bowhead whale	swim	2	0	5
20	8/25/15 11:30	69.665	141.063	beluga	swim	1	0	5
20	8/25/15 11:30	69.669	141.076	beluga	swim	4	0	5
20	8/25/15 11:30	69.672	141.101	beluga	swim	2	0	5
20	8/25/15 11:38	69.837	141.088	bowhead whale	swim	2	1	5
20	8/25/15 12:31	69.881	142.164	beluga	swim	1	0	5
20	8/25/15 12:38	70.131	142.257	bowhead whale	rest	1	0	5
20	8/25/15 12:43	70.080	142.227	bowhead whale	rest	2	1	5
20	8/25/15 13:17	70.251	142.878	bowhead whale	swim	1	0	5
20	8/25/15 13:23	70.194	142.901	bowhead whale	swim	1	0	5
20	8/25/15 13:26	70.119	142.893	bowhead whale	swim	1	0	5
20	8/25/15 13:32	70.134	142.951	bowhead whale	swim	1	0	5
20	8/25/15 13:32	70.135	142.935	bowhead whale	swim	1	0	5
20	8/25/15 13:34	70.128	142.844	bowhead whale	swim	1	0	5
20	8/25/15 13:35	70.122	142.876	bowhead whale	swim	1	0	5
20	8/25/15 13:37	70.110	142.936	bowhead whale	swim	1	0	5
20	8/25/15 15:38	70.565	146.201	bowhead whale	swim	1	0	1
20	8/25/15 15:51	70.944	146.227	beluga	swim	1	0	2
20	8/25/15 15:51	70.960	146.242	beluga	swim	1	0	2
20	8/25/15 15:53	71.004	146.280	beluga	swim	1	0	2
20	8/25/15 15:56	71.138	146.241	beluga	swim	1	0	2
20	8/25/15 16:01	71.294	146.275	bowhead whale	swim	1	0	2
20	8/25/15 16:04	71.328	146.320	beluga	swim	1	0	2
20	8/25/15 16:06	71.335	146.501	unid cetacean	swim	1	0	10
20	8/25/15 16:10	71.335	146.512	beluga	swim	1	0	10
20	8/25/15 16:19	71.193	146.910	beluga	swim	1	0	2
20	8/25/15 16:20	71.147	146.873	beluga	swim	1	0	2
20	8/25/15 16:22	71.090	146.862	beluga	swim	1	0	2
20	8/25/15 16:23	71.081	146.893	beluga	swim	1	0	2

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
20	8/25/15 16:23	71.081	146.867	beluga	swim	1	0	2
20	8/25/15 16:25	71.017	146.827	beluga	swim	2	0	2
20	8/25/15 16:26	70.987	146.854	beluga	swim	1	0	2
20	8/25/15 16:26	70.981	146.859	beluga	swim	1	0	2
20	8/25/15 16:27	70.959	146.863	beluga	swim	1	0	2
20	8/25/15 16:27	70.957	146.829	beluga	swim	1	0	2
20	8/25/15 16:27	70.951	146.844	beluga	swim	1	0	2
20	8/25/15 16:30	70.849	146.837	bowhead whale	swim	1	0	2
20	8/25/15 16:34	70.773	146.791	bowhead whale	swim	1	0	2
20	8/25/15 16:45	70.494	146.756	bowhead whale	swim	1	0	1
20	8/25/15 16:46	70.477	146.761	bowhead whale	swim	2	0	1
20	8/25/15 16:47	70.442	146.739	bowhead whale	dive	1	0	1
20	8/25/15 16:57	70.517	147.113	bowhead whale	swim	1	0	1
20	8/25/15 16:58	70.532	147.111	bowhead whale	flipper slap	1	0	1
20	8/25/15 16:59	70.579	147.139	bowhead whale	swim	1	0	1
20	8/25/15 17:03	70.724	147.126	bowhead whale	swim	1	0	1
20	8/25/15 17:08	70.876	147.145	bowhead whale	mill	2	0	2
20	8/25/15 17:13	70.992	147.057	beluga	swim	1	0	2
20	8/25/15 17:14	70.997	147.050	beluga	rest	1	0	2
20	8/25/15 17:14	71.001	147.060	beluga	rest	2	0	2
20	8/25/15 17:14	71.006	147.089	beluga	swim	1	0	2
20	8/25/15 17:14	71.011	147.078	beluga	rest	2	0	2
20	8/25/15 17:15	71.031	147.093	beluga	swim	1	0	2
20	8/25/15 17:29	71.283	147.611	beluga	swim	1	0	2
20	8/25/15 17:30	71.262	147.601	beluga	swim	1	0	2
20	8/25/15 17:33	71.176	147.604	beluga	swim	1	0	2
20	8/25/15 17:33	71.163	147.609	beluga	swim	1	0	2
20	8/25/15 17:34	71.143	147.583	beluga	swim	1	0	2
20	8/25/15 17:35	71.101	147.626	beluga	swim	1	0	2
20	8/25/15 17:35	71.093	147.608	beluga	swim	1	0	2
20	8/25/15 17:36	71.083	147.619	beluga	dive	1	0	2
20	8/25/15 17:36	71.081	147.633	beluga	swim	1	0	2
20	8/25/15 17:36	71.077	147.588	beluga	swim	1	0	2
20	8/25/15 17:37	71.039	147.610	beluga	swim	1	0	2
20	8/25/15 17:37	71.034	147.616	beluga	swim	8	0	2
20	8/25/15 17:37	71.032	147.593	beluga	swim	3	0	2
20	8/25/15 17:48	70.667	147.558	bowhead whale	swim	1	0	1
20	8/25/15 18:06	70.860	148.283	bowhead whale	swim	1	0	1
20	8/25/15 18:13	71.111	148.330	beluga	swim	1	0	2

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
20	8/25/15 18:15	71.181	148.348	beluga	swim	2	0	2
20	8/25/15 18:15	71.185	148.344	beluga	swim	2	0	2
20	8/25/15 18:15	71.190	148.376	beluga	swim	1	0	2
20	8/25/15 18:15	71.202	148.348	beluga	swim	1	0	2
20	8/25/15 18:33	70.883	148.697	bowhead whale	swim	1	0	1
20	8/25/15 18:34	70.882	148.697	bowhead whale	swim	2	0	1
20	8/25/15 19:05	71.221	149.183	beluga	swim	3	0	2
20	8/25/15 19:18	71.160	149.647	bowhead whale	dive	1	0	1
20	8/25/15 19:19	71.114	149.611	bowhead whale	swim	1	0	1
20	8/25/15 19:20	71.089	149.608	bowhead whale	swim	1	0	1

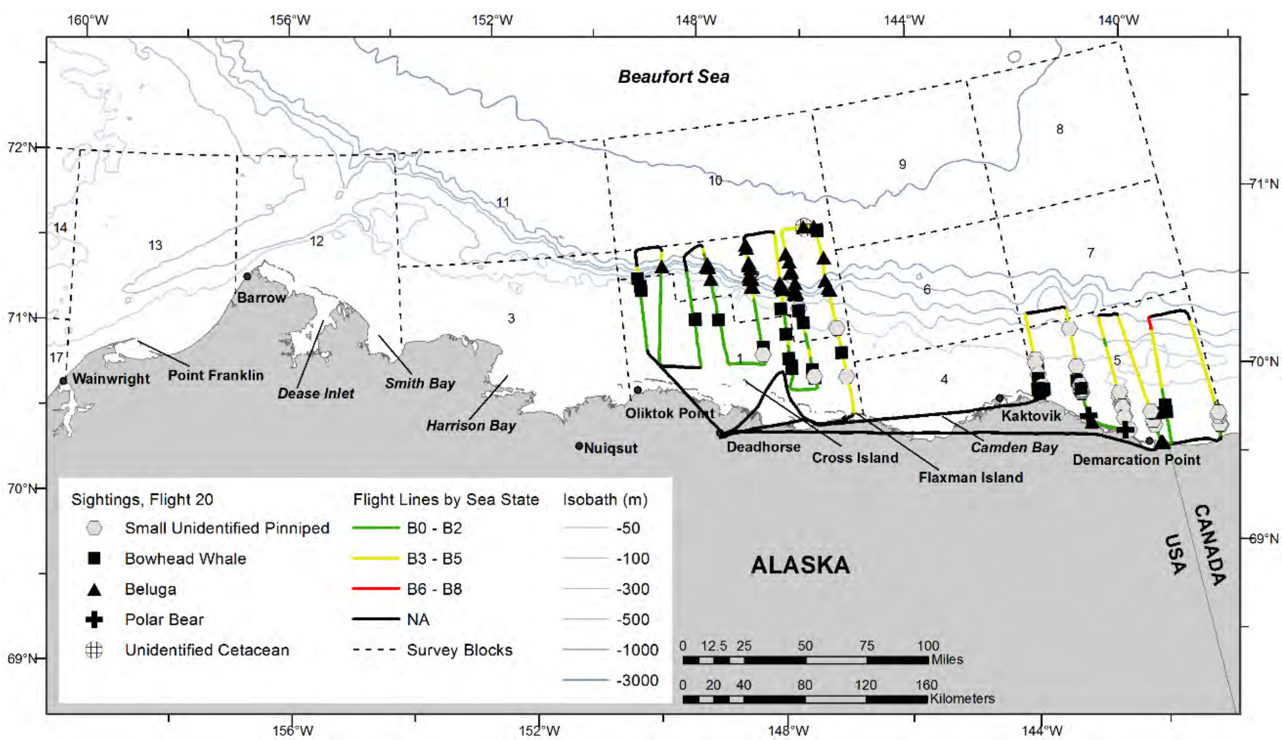

Figure B-46. ASAMM Flight 20 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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26 August 2015, Flight 227

Flight was a partial survey of Arctic ACEs transects 221 and 213 and a survey of portions of block 12. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-7 sea states. Sea ice cover was 0-7% broken floe in the area surveyed. Sightings included bowhead whales (including one calf), belugas (including one calf), unidentified cetaceans, one unidentified pinniped 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
227	8/26/15 9:38	71.561	155.933	bowhead whale	swim	1	0	12
227	8/26/15 9:38	71.549	155.809	unid cetacean	swim	2	0	12
227	8/26/15 9:53	71.809	154.680	beluga	swim	2	0	12
227	8/26/15 10:03	71.872	154.093	beluga	rest	2	0	12
227	8/26/15 10:03	71.873	154.069	beluga	rest	1	0	12
227	8/26/15 10:03	71.872	154.053	beluga	rest	3	0	12
227	8/26/15 10:06	71.796	153.879	bowhead whale	rest	1	0	11
227	8/26/15 10:15	71.859	154.130	beluga	swim	1	0	12
227	8/26/15 10:15	71.865	154.075	beluga	rest	5	0	12
227	8/26/15 10:16	71.880	154.117	beluga	swim	1	0	12
227	8/26/15 10:16	71.888	154.129	beluga	swim	2	0	12
227	8/26/15 10:17	71.939	154.174	beluga	swim	1	0	12
227	8/26/15 10:19	71.893	154.206	beluga	swim	1	0	12
227	8/26/15 10:57	71.126	154.691	bowhead whale	feed	1	0	12
227	8/26/15 10:57	71.136	154.742	unid cetacean	dive	1	0	12
227	8/26/15 11:08	71.244	154.739	bowhead whale	feed	22	1	12
227	8/26/15 11:08	71.247	154.718	bowhead whale	rest	2	0	12
227	8/26/15 11:09	71.249	154.694	bowhead whale	dive	1	0	12
227	8/26/15 11:20	71.294	154.731	beluga	rest	6	1	12
227	8/26/15 11:21	71.327	154.711	bowhead whale	dive	1	0	12
227	8/26/15 11:23	71.311	154.787	bowhead whale	dive	1	0	12
227	8/26/15 11:25	71.303	154.808	bowhead whale	rest	2	0	12
227	8/26/15 11:31	71.424	154.661	bowhead whale	dive	1	0	12

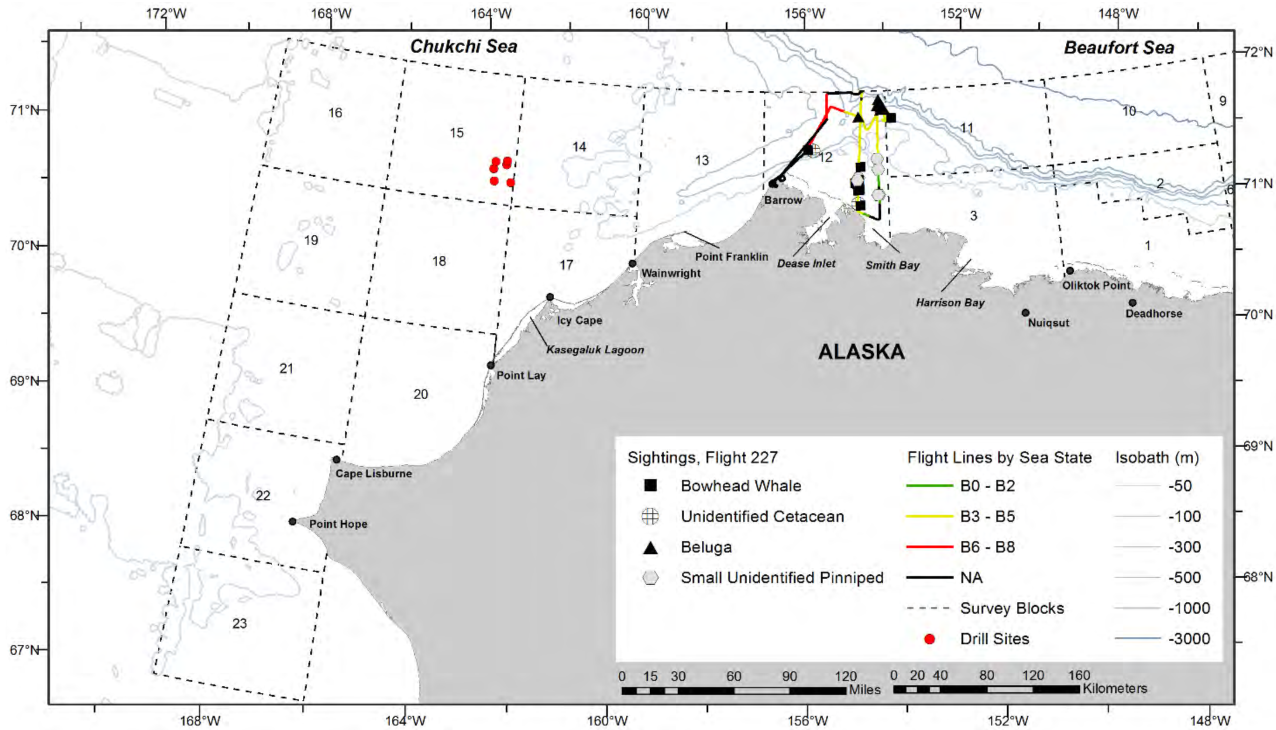

Figure B-47. ASAMM Flight 227 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Skim feeding bowhead whale sighted northwest of Smith Bay, Alaska, during ASAMM Flight 227, 26 August 2015. Another bowhead whale can be seen subsurface to the left of the feeding whale.

26 August 2015, Flight 21

Flight was a survey of block 4 and portions of block 6. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-3 sea states. There was no sea ice observed 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
21	8/26/15 14:30	70.295	143.454	bowhead whale	swim	1	0	4
21	8/26/15 14:34	70.271	143.455	bowhead whale	rest	1	0	4
21	8/26/15 14:36	70.316	143.403	bowhead whale	swim	1	0	4
21	8/26/15 14:36	70.321	143.438	beluga	swim	2	0	4
21	8/26/15 14:45	70.634	143.407	beluga	swim	2	1	6
21	8/26/15 14:48	70.727	143.422	beluga	swim	1	0	6
21	8/26/15 14:48	70.744	143.413	beluga	rest	1	0	6
21	8/26/15 14:57	70.762	143.820	beluga	swim	1	0	6
21	8/26/15 15:01	70.632	143.797	beluga	swim	2	0	6
21	8/26/15 15:01	70.624	143.811	beluga	swim	1	0	6
21	8/26/15 15:02	70.619	143.790	beluga	swim	1	0	6
21	8/26/15 15:02	70.614	143.820	beluga	swim	1	0	6
21	8/26/15 15:02	70.611	143.797	beluga	swim	1	0	6
21	8/26/15 15:12	70.266	143.828	bowhead whale	swim	1	0	4
21	8/26/15 15:13	70.255	143.855	bowhead whale	swim	1	0	4
21	8/26/15 15:20	70.178	143.763	bowhead whale	swim	1	0	4
21	8/26/15 15:37	70.335	144.164	bowhead whale	swim	1	0	4
21	8/26/15 15:47	70.666	144.133	beluga	swim	1	0	6
21	8/26/15 15:47	70.674	144.136	beluga	mill	2	0	6
21	8/26/15 15:47	70.677	144.122	beluga	swim	1	0	6
21	8/26/15 15:51	70.798	144.105	beluga	swim	1	0	6
21	8/26/15 16:17	70.533	144.731	beluga	swim	24	0	6
21	8/26/15 16:18	70.513	144.769	beluga	swim	1	0	6
21	8/26/15 16:24	70.535	144.740	beluga	swim	12	0	6
21	8/26/15 16:37	70.103	144.741	beluga	swim	2	0	4
21	8/26/15 17:13	70.854	145.186	beluga	swim	1	0	6
21	8/26/15 17:13	70.858	145.207	beluga	swim	1	0	6
21	8/26/15 17:15	70.910	145.168	beluga	swim	1	0	6
21	8/26/15 17:16	70.950	145.169	beluga	swim	1	0	6
21	8/26/15 17:17	70.973	145.183	beluga	swim	1	0	6
21	8/26/15 17:17	70.991	145.189	beluga	swim	2	0	6
21	8/26/15 17:18	71.014	145.186	beluga	swim	1	0	6

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
21	8/26/15 17:18	71.018	145.202	beluga	swim	1	0	6
21	8/26/15 17:18	71.022	145.185	beluga	swim	1	0	6
21	8/26/15 17:26	70.953	145.656	beluga	swim	1	0	6
21	8/26/15 17:38	70.552	145.628	bowhead whale	swim	1	0	6
21	8/26/15 17:47	70.250	145.577	beluga	swim	1	0	4
21	8/26/15 17:47	70.245	145.574	beluga	dive	1	0	4

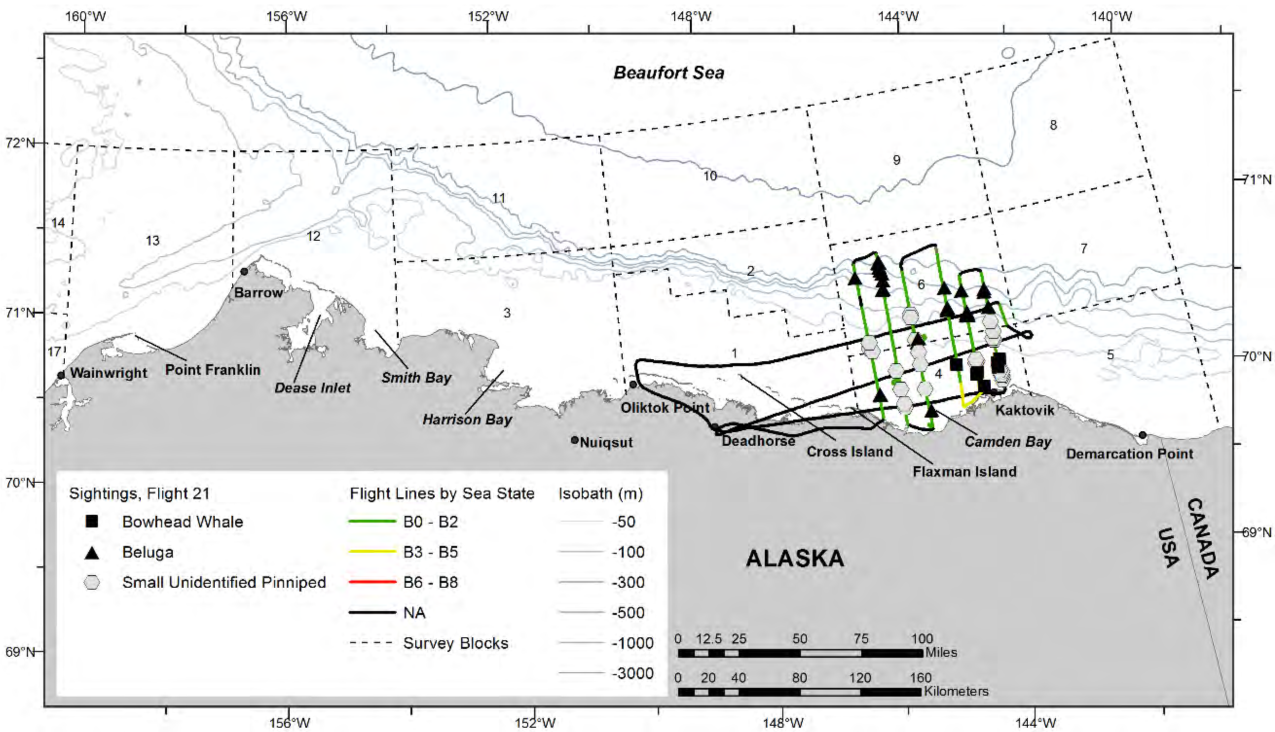

Figure B-48. ASAMM Flight 21 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

29 August 2015, Flight 228

Flight was a complete survey of Arctic ACEs transects 212, 214, 216, 218, 220, 222, 224, and 226, and partial survey of Arctic ACEs transect 210. Survey conditions included partly cloudy skies, 1-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales, belugas (including one calf), unidentified cetaceans, one walrus, and small unidentified pinnipeds. More sightings were recorded as unidentified cetaceans because survey and safety procedures did not allow the aircraft to break track to further investigate sightings while flying Arctic ACEs transects.

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	8/29/15 17:22	71.557	156.499	bowhead whale	rest	1	0	12
228	8/29/15 17:25	71.683	156.412	unid cetacean	rest	1	0	12
228	8/29/15 17:39	71.770	156.026	beluga	rest	1	0	12
228	8/29/15 17:41	71.721	156.119	bowhead whale	rest	1	0	12
228	8/29/15 17:45	71.609	156.272	unid cetacean	rest	1	0	12
228	8/29/15 17:51	71.646	155.937	bowhead whale	swim	1	0	12
228	8/29/15 17:53	71.705	155.852	bowhead whale	swim	1	0	12
228	8/29/15 17:59	71.900	155.478	beluga	swim	1	0	12
228	8/29/15 18:00	71.908	155.467	beluga	swim	2	1	12
228	8/29/15 18:10	71.787	155.307	unid cetacean	swim	1	0	12
228	8/29/15 18:11	71.774	155.395	bowhead whale	swim	1	0	12
228	8/29/15 18:12	71.759	155.442	bowhead whale	swim	1	0	12
228	8/29/15 18:13	71.737	155.600	unid cetacean	swim	1	0	12
228	8/29/15 18:15	71.708	155.683	unid cetacean	swim	1	0	12
228	8/29/15 18:16	71.685	155.725	unid cetacean	swim	1	0	12
228	8/29/15 18:17	71.615	155.668	bowhead whale	rest	1	0	12
228	8/29/15 18:18	71.603	155.693	bowhead whale	rest	1	0	12
228	8/29/15 18:19	71.591	155.825	unid cetacean	swim	1	0	12
228	8/29/15 18:32	71.723	155.188	bowhead whale	rest	2	0	12
228	8/29/15 18:42	72.005	154.587	beluga	swim	1	0	0
228	8/29/15 18:48	71.893	154.479	unid cetacean	swim	2	0	12
228	8/29/15 18:48	71.884	154.469	unid cetacean	swim	2	0	12
228	8/29/15 18:54	71.762	154.842	unid cetacean	swim	1	0	12
228	8/29/15 19:01	71.569	155.100	unid cetacean	dive	1	0	12
228	8/29/15 19:04	71.490	155.297	bowhead whale	rest	1	0	12
228	8/29/15 19:05	71.477	155.357	unid cetacean	rest	1	0	12
228	8/29/15 19:05	71.468	155.458	unid cetacean	breach	2	0	12
228	8/29/15 19:09	71.418	155.102	bowhead whale	swim	1	0	12
228	8/29/15 19:10	71.429	155.061	unid cetacean	swim	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
228	8/29/15 19:10	71.441	155.034	unid cetacean	swim	1	0	12
228	8/29/15 19:10	71.460	155.085	bowhead whale	swim	1	0	12
228	8/29/15 19:12	71.511	154.974	bowhead whale	swim	1	0	12
228	8/29/15 19:21	71.739	154.422	unid cetacean	rest	1	0	12
228	8/29/15 19:29	71.860	154.131	unid cetacean	swim	1	0	12
228	8/29/15 19:32	71.816	154.281	unid cetacean	swim	1	0	12
228	8/29/15 19:48	71.385	154.874	bowhead whale	swim	1	0	12
228	8/29/15 19:54	71.375	154.612	unid cetacean	dive	1	0	12
228	8/29/15 19:54	71.372	154.571	bowhead whale	rest	1	0	12
228	8/29/15 19:56	71.418	154.435	unid cetacean	rest	1	0	12
228	8/29/15 19:56	71.451	154.495	unid cetacean	swim	1	0	12

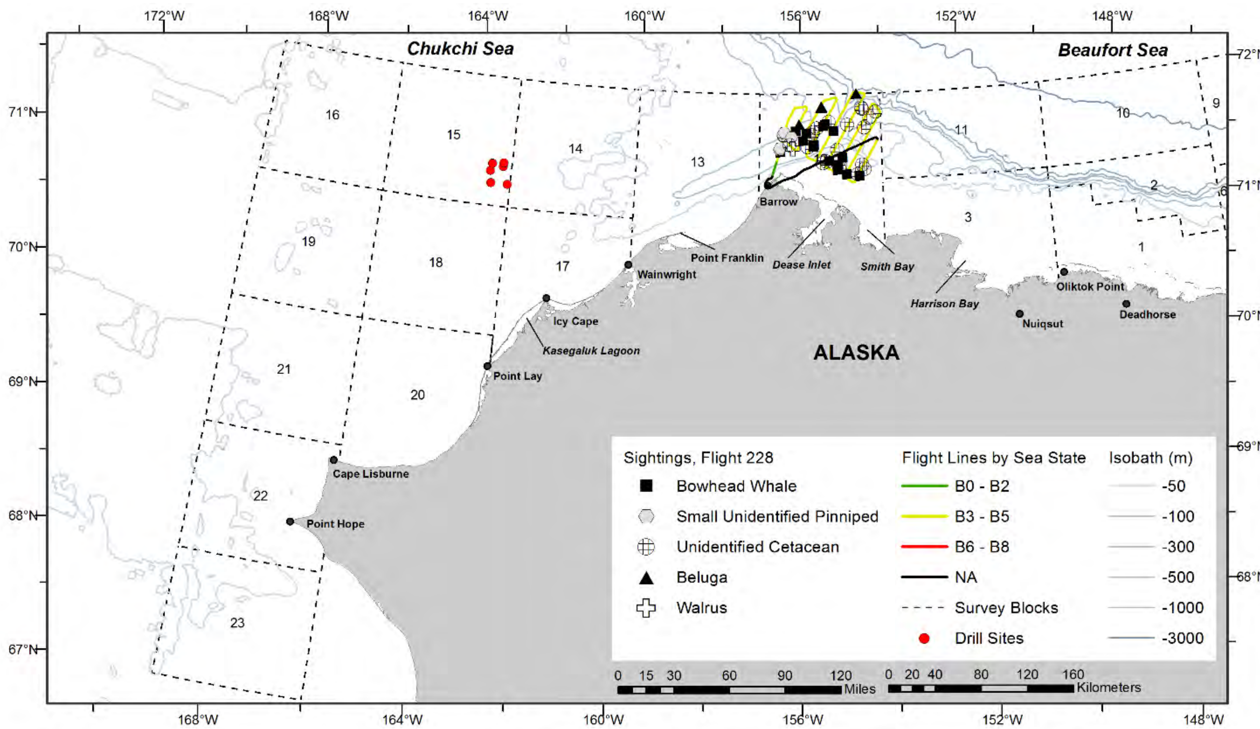

Figure B-49. ASAMM Flight 228 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

29 August 2015, Flight 22

Flight was a survey of portions of blocks 3 and 7 and search effort through the northern portions of blocks 2 and 6. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, and low ceilings), and Beaufort 1-6 sea states. Sea ice cover was 0-3% broken floe in the area surveyed. Sightings included belugas (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
22	8/29/15 12:17	71.233	146.867	beluga	swim	1	0	2
22	8/29/15 12:20	71.241	146.498	beluga	swim	1	0	2
22	8/29/15 12:21	71.237	146.426	beluga	rest	1	0	2
22	8/29/15 12:22	71.225	146.331	beluga	swim	3	1	2
22	8/29/15 12:23	71.208	146.241	beluga	swim	4	1	2
22	8/29/15 12:31	71.125	145.567	beluga	swim	2	0	6
22	8/29/15 13:31	70.536	142.017	beluga	swim	1	0	7
22	8/29/15 13:32	70.560	142.067	beluga	swim	20	0	7
22	8/29/15 13:41	70.874	142.101	beluga	swim	1	0	7
22	8/29/15 13:54	70.664	142.680	beluga	swim	2	0	7
22	8/29/15 13:54	70.654	142.678	beluga	swim	2	0	7

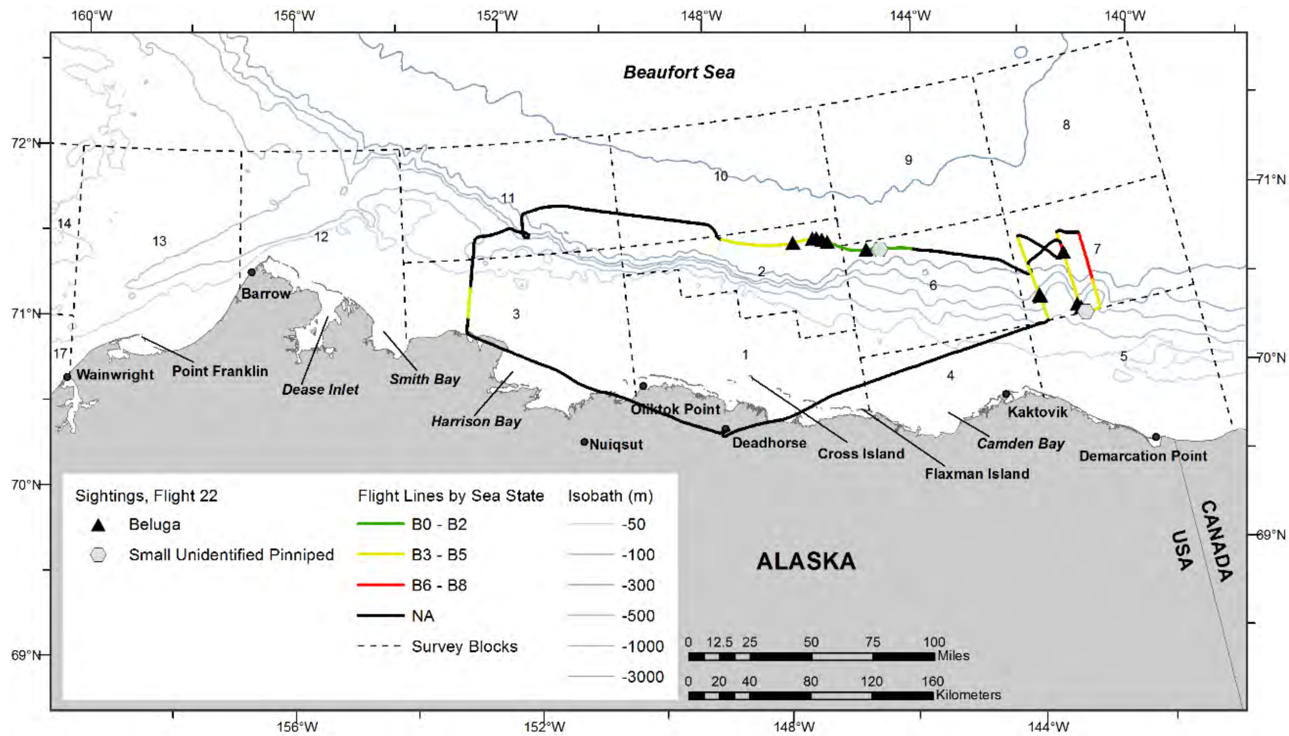

Figure B-50. ASAMM Flight 22 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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30 August 2015, Flight 229

Flight was a search survey to the north of Barrow and an attempt to survey in the Arctic ACEs east and west study areas. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with low ceilings), and Beaufort 4-5 sea states. There was no sea ice observed in the area surveyed. No sightings were observed.

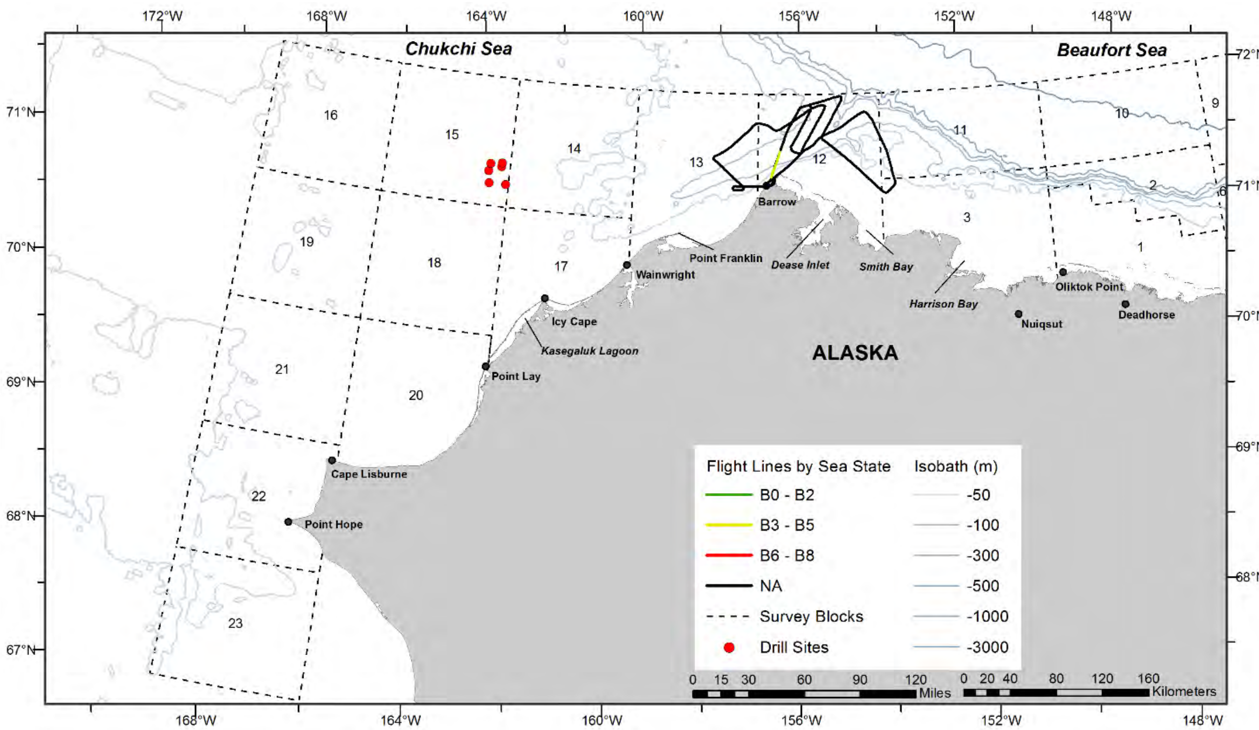

Figure B-51. ASAMM Flight 229 survey track, depicted by sea state.

31 August 2015, Flight 230

Flight was a complete survey of transect 7, Arctic ACEs transects 227, 229, 231, 233, 235, 237, 239, 243, 245, 247, 249, and partial survey of Arctic ACEs transect 241. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-4 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales, one gray whale, unidentified cetaceans, walruses, unidentified pinnipeds, and small unidentified pinnipeds. More sightings were recorded as unidentified cetaceans because survey and safety procedures did not allow the aircraft to break track to further investigate sightings while flying Arctic ACEs transects.

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	8/31/15 15:18	71.574	157.011	bowhead whale	rest	1	0	13
230	8/31/15 15:19	71.559	157.144	bowhead whale	swim	2	0	13
230	8/31/15 15:19	71.541	157.068	bowhead whale	swim	3	0	13
230	8/31/15 15:19	71.540	157.070	unid cetacean	rest	1	0	13
230	8/31/15 15:19	71.541	157.078	bowhead whale	rest	1	0	13
230	8/31/15 15:39	71.483	157.276	bowhead whale	swim	1	0	13
230	8/31/15 15:39	71.484	157.267	bowhead whale	swim	1	0	13
230	8/31/15 15:39	71.476	157.235	bowhead whale	rest	1	0	13
230	8/31/15 15:40	71.442	157.201	bowhead whale	rest	2	0	13
230	8/31/15 17:33	71.066	158.259	gray whale	feed	1	0	13
230	8/31/15 17:34	71.047	158.211	unid cetacean	swim	1	0	13
230	8/31/15 17:34	71.036	158.241	unid cetacean	unknown	1	0	13
230	8/31/15 17:35	71.031	158.341	unid cetacean	unknown	1	0	13
230	8/31/15 17:35	71.041	158.357	unid cetacean	unknown	1	0	13

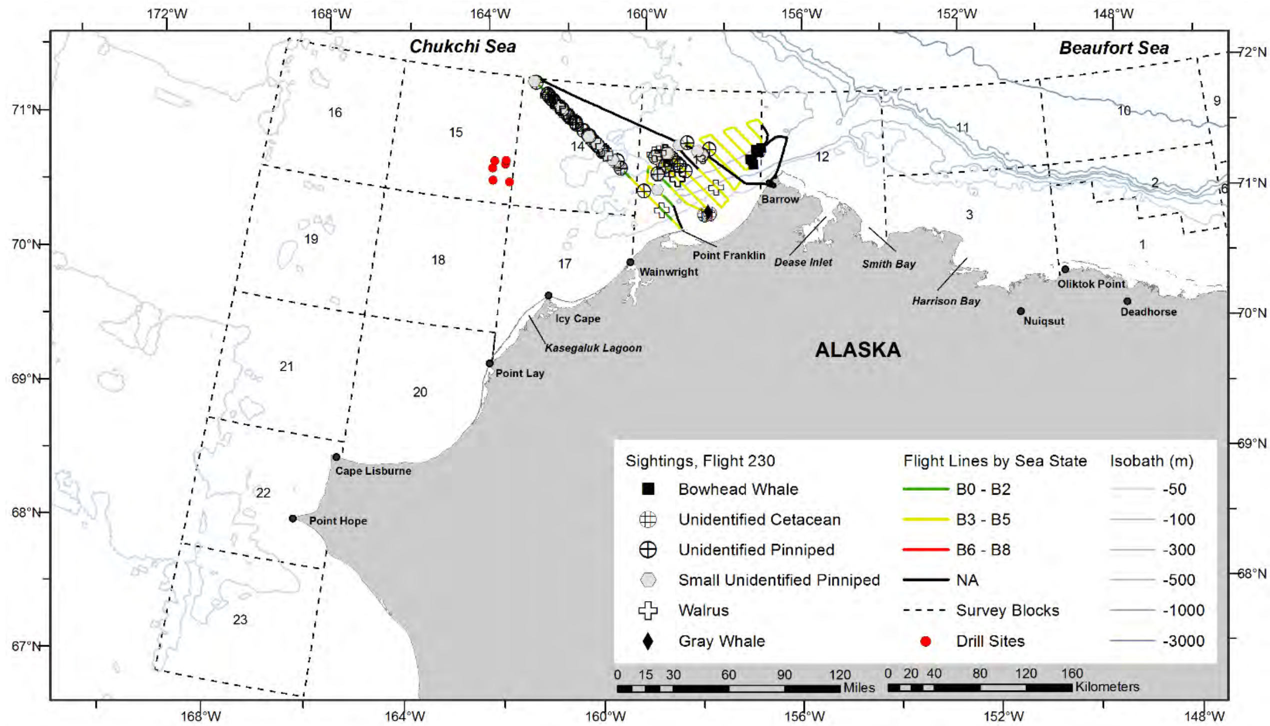

Figure B-52. ASAMM Flight 230 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

31 August 2015, Flight 23

Flight was a complete survey of transect 12, a partial survey of transect 10, the coastal transect from Barrow to south of Wainwright, and search effort that crossed through survey block 13. 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. There was no sea ice observed in the area surveyed. Sightings included bowhead whales, gray whales (including three calves), one beluga, walruses, one bearded seal, 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
23	8/31/15 15:41	70.877	159.252	beluga	swim	1	0	13
23	8/31/15 15:44	70.851	159.552	gray whale	swim	2	1	13
23	8/31/15 15:45	70.822	159.605	gray whale	swim	4	1	13
23	8/31/15 15:49	70.816	159.668	gray whale	swim	2	1	13
23	8/31/15 18:04	71.627	163.900	bowhead whale	swim	1	0	15
23	8/31/15 18:04	71.618	163.896	bowhead whale	rest	4	0	15
23	8/31/15 18:11	71.603	163.837	bowhead whale	swim	1	0	15
23	8/31/15 18:11	71.583	163.843	bowhead whale	rest	2	0	15

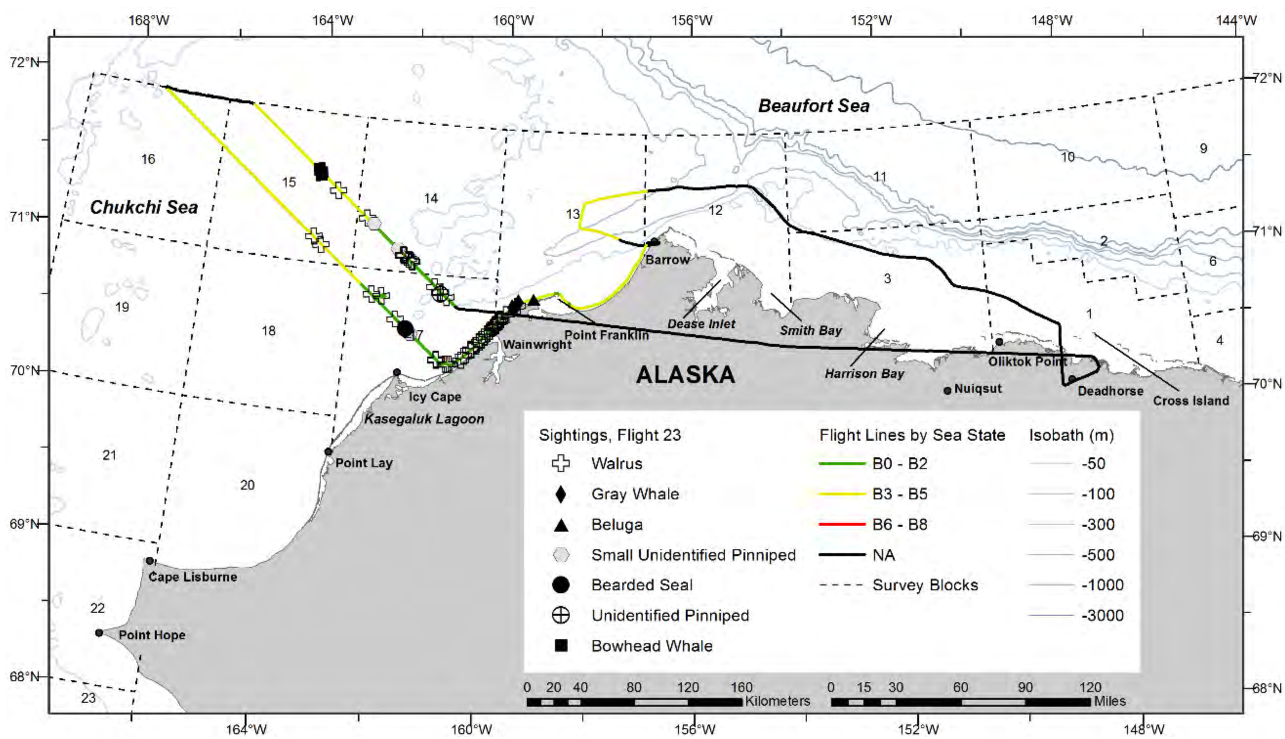

Figure B-53. ASAMM Flight 23 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Two adult bowhead whales sighted approximately 250 km west-northwest of Barrow, Alaska, during ASAMM Flight 23, 31 August 2015.

1 September 2015, Flight 231

Flight was a complete survey of Arctic ACEs transects 212, 214, 216, 222, 224, 226, 228, 230, 232, 234, 236, 238, and a partial survey of Arctic ACEs transects 218, 220, 240, and 242. Survey conditions included overcast skies, 0 km to unlimited visibility (with low ceilings and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales, belugas (including seven calves), unidentified cetaceans, walruses, unidentified pinnipeds, and small unidentified pinnipeds. More sightings were recorded as unidentified cetaceans because survey and safety procedures did not allow the aircraft to break track to further investigate sightings while flying Arctic ACEs transects.

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	9/1/15 9:38	71.496	156.832	bowhead whale	rest	1	0	12
231	9/1/15 9:38	71.500	156.935	unid cetacean	unknown	1	0	12
231	9/1/15 9:38	71.512	156.760	bowhead whale	unknown	1	0	12
231	9/1/15 9:39	71.530	156.862	bowhead whale	swim	2	0	12
231	9/1/15 9:39	71.531	156.869	bowhead whale	rest	1	0	12
231	9/1/15 9:39	71.548	156.818	unid cetacean	unknown	1	0	12
231	9/1/15 9:47	71.775	157.306	unid cetacean	unknown	1	0	13
231	9/1/15 9:58	71.564	156.991	bowhead whale	swim	1	0	12
231	9/1/15 9:59	71.535	157.072	bowhead whale	dive	1	0	13
231	9/1/15 9:59	71.526	157.059	bowhead whale	swim	1	0	13
231	9/1/15 9:59	71.516	157.066	bowhead whale	swim	1	0	13
231	9/1/15 10:00	71.507	157.038	unid cetacean	unknown	1	0	13
231	9/1/15 10:28	71.354	157.518	unid cetacean	unknown	1	0	13
231	9/1/15 12:22	71.657	155.916	bowhead whale	rest	1	0	12
231	9/1/15 12:31	71.951	155.390	bowhead whale	swim	1	0	12
231	9/1/15 12:47	71.805	155.038	bowhead whale	rest	1	0	12
231	9/1/15 12:47	71.809	155.042	bowhead whale	rest	1	0	12
231	9/1/15 12:47	71.810	155.025	bowhead whale	rest	1	0	12
231	9/1/15 12:48	71.847	154.935	unid cetacean	dive	1	0	12
231	9/1/15 12:50	71.897	154.872	beluga	rest	2	1	12
231	9/1/15 12:50	71.908	154.837	beluga	rest	5	1	12
231	9/1/15 12:51	71.924	154.815	beluga	rest	5	0	12
231	9/1/15 12:51	71.923	154.807	beluga	rest	5	1	12
231	9/1/15 12:51	71.944	154.778	beluga	swim	7	0	12
231	9/1/15 12:52	71.963	154.744	beluga	swim	5	1	12
231	9/1/15 12:52	71.975	154.697	beluga	swim	1	0	12
231	9/1/15 12:53	71.993	154.665	beluga	swim	3	0	12
231	9/1/15 12:53	72.007	154.657	beluga	rest	2	0	0
231	9/1/15 12:54	72.021	154.587	beluga	swim	1	0	0

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
231	9/1/15 12:54	72.008	154.584	beluga	rest	2	1	0
231	9/1/15 12:55	72.003	154.464	beluga	swim	7	2	0
231	9/1/15 12:55	72.002	154.448	beluga	swim	2	0	0
231	9/1/15 13:07	71.726	154.997	unid cetacean	swim	1	0	12
231	9/1/15 13:20	71.402	155.122	unid cetacean	dive	1	0	12
231	9/1/15 13:20	71.408	155.146	bowhead whale	swim	1	0	12
231	9/1/15 13:21	71.447	155.096	bowhead whale	swim	1	0	12
231	9/1/15 13:22	71.473	155.024	beluga	swim	2	0	12
231	9/1/15 13:57	71.362	154.854	bowhead whale	swim	1	0	12

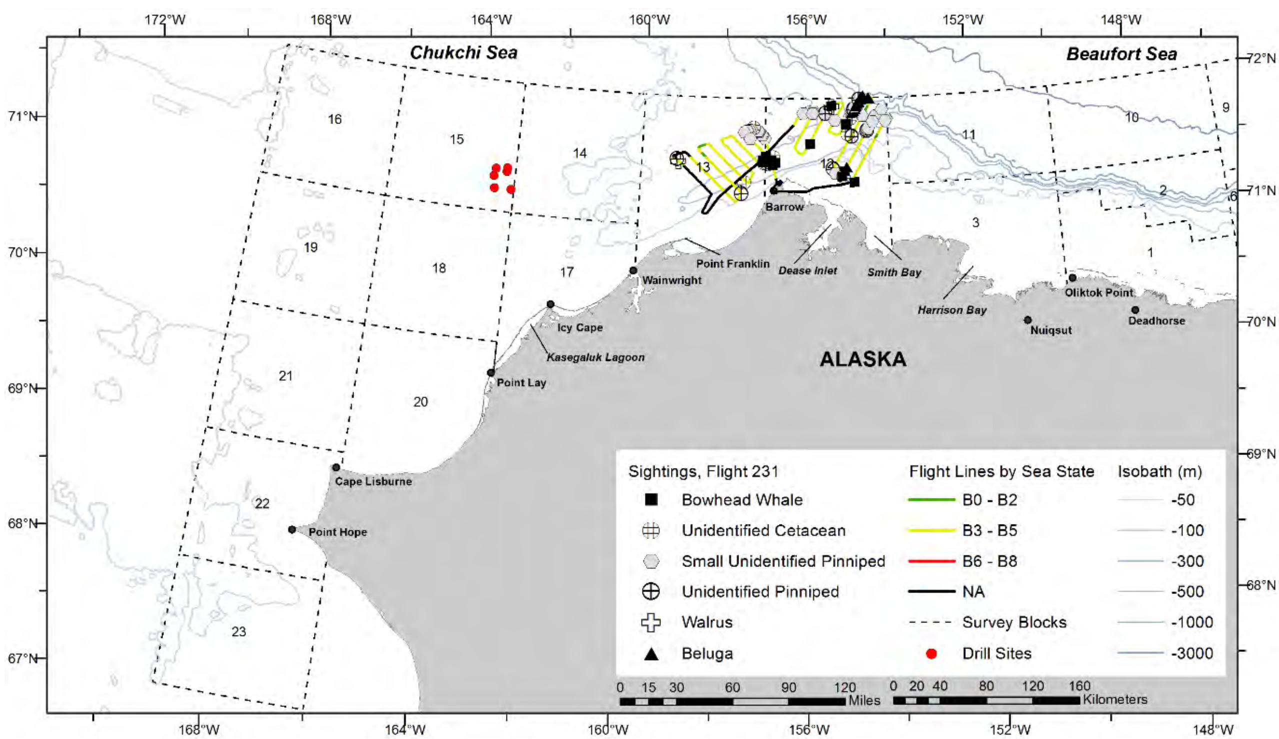

Figure B-54. ASAMM Flight 231 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

1 September 2015, Flight 24

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 fog, glare, and low ceilings), and Beaufort 2-4 sea states. Sea ice cover was 0-60% broken floe in the area surveyed. Sightings included bowhead whales (including six calves), belugas (including three calves), 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
24	9/1/15 11:12	71.006	152.887	beluga	swim	1	0	3
24	9/1/15 11:14	71.077	152.879	bowhead whale	feed	4	2	3
24	9/1/15 11:18	71.078	152.850	bowhead whale	swim	1	0	3
24	9/1/15 11:21	71.067	152.846	bowhead whale	swim	5	0	3
24	9/1/15 11:23	71.089	152.914	bowhead whale	swim	1	0	3
24	9/1/15 11:25	71.130	152.905	bowhead whale	swim	1	0	3
24	9/1/15 11:44	71.735	152.930	beluga	swim	7	1	11
24	9/1/15 11:44	71.747	152.962	beluga	swim	17	0	11
24	9/1/15 11:44	71.756	152.930	beluga	swim	3	0	11
24	9/1/15 11:45	71.761	152.955	beluga	swim	9	0	11
24	9/1/15 11:45	71.767	152.936	beluga	swim	8	1	11
24	9/1/15 11:47	71.830	152.917	beluga	rest	1	0	11
24	9/1/15 11:49	71.909	152.958	beluga	swim	5	0	11
24	9/1/15 12:13	71.388	152.341	beluga	rest	1	0	11
24	9/1/15 12:14	71.386	152.323	beluga	swim	1	0	11
24	9/1/15 12:14	71.363	152.362	beluga	swim	1	0	11
24	9/1/15 14:36	71.021	151.677	bowhead whale	feed	2	1	3
24	9/1/15 14:36	71.023	151.693	bowhead whale	rest	2	1	3
24	9/1/15 14:37	71.025	151.701	bowhead whale	feed	1	0	3
24	9/1/15 14:41	71.026	151.711	bowhead whale	rest	2	0	3
24	9/1/15 14:43	71.038	151.750	bowhead whale	feed	2	1	3
24	9/1/15 14:43	71.038	151.783	bowhead whale	rest	1	0	3
24	9/1/15 14:45	71.050	151.807	bowhead whale	rest	2	0	3
24	9/1/15 14:47	71.052	151.815	bowhead whale	rest	3	0	3
24	9/1/15 14:50	71.059	151.734	bowhead whale	swim	1	0	3
24	9/1/15 14:51	71.080	151.719	bowhead whale	swim	2	1	3
24	9/1/15 15:06	71.568	151.803	beluga	swim	2	1	11
24	9/1/15 15:07	71.616	151.758	beluga	swim	1	0	11
24	9/1/15 15:24	71.571	151.171	beluga	swim	2	0	11
24	9/1/15 15:40	71.069	151.193	bowhead whale	rest	1	0	3
24	9/1/15 15:49	70.943	151.145	bowhead whale	rest	2	0	3

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
24	9/1/15 15:49	70.940	151.130	bowhead whale	rest	1	0	3
24	9/1/15 16:02	70.667	151.061	bowhead whale	rest	1	0	3
24	9/1/15 16:11	70.588	150.860	bowhead whale	rest	1	0	3
24	9/1/15 16:11	70.593	150.860	bowhead whale	rest	1	0	3
24	9/1/15 16:12	70.613	150.778	bowhead whale	rest	2	0	3
24	9/1/15 16:13	70.615	150.779	bowhead whale	rest	2	0	3
24	9/1/15 16:16	70.604	150.792	bowhead whale	rest	5	0	3
24	9/1/15 16:26	70.874	150.817	bowhead whale	rest	1	0	3
24	9/1/15 16:26	70.877	150.803	bowhead whale	rest	1	0	3
24	9/1/15 16:26	70.879	150.800	bowhead whale	rest	4	0	3
24	9/1/15 16:26	70.881	150.831	bowhead whale	swim	1	0	3
24	9/1/15 16:30	70.894	150.810	bowhead whale	rest	4	0	3
24	9/1/15 16:53	71.628	150.813	beluga	swim	1	0	11
24	9/1/15 16:54	71.661	150.800	beluga	swim	1	0	11
24	9/1/15 17:14	71.516	150.329	beluga	swim	1	0	11
24	9/1/15 17:23	71.244	150.263	beluga	swim	1	0	3
24	9/1/15 17:23	71.244	150.275	beluga	swim	1	0	3

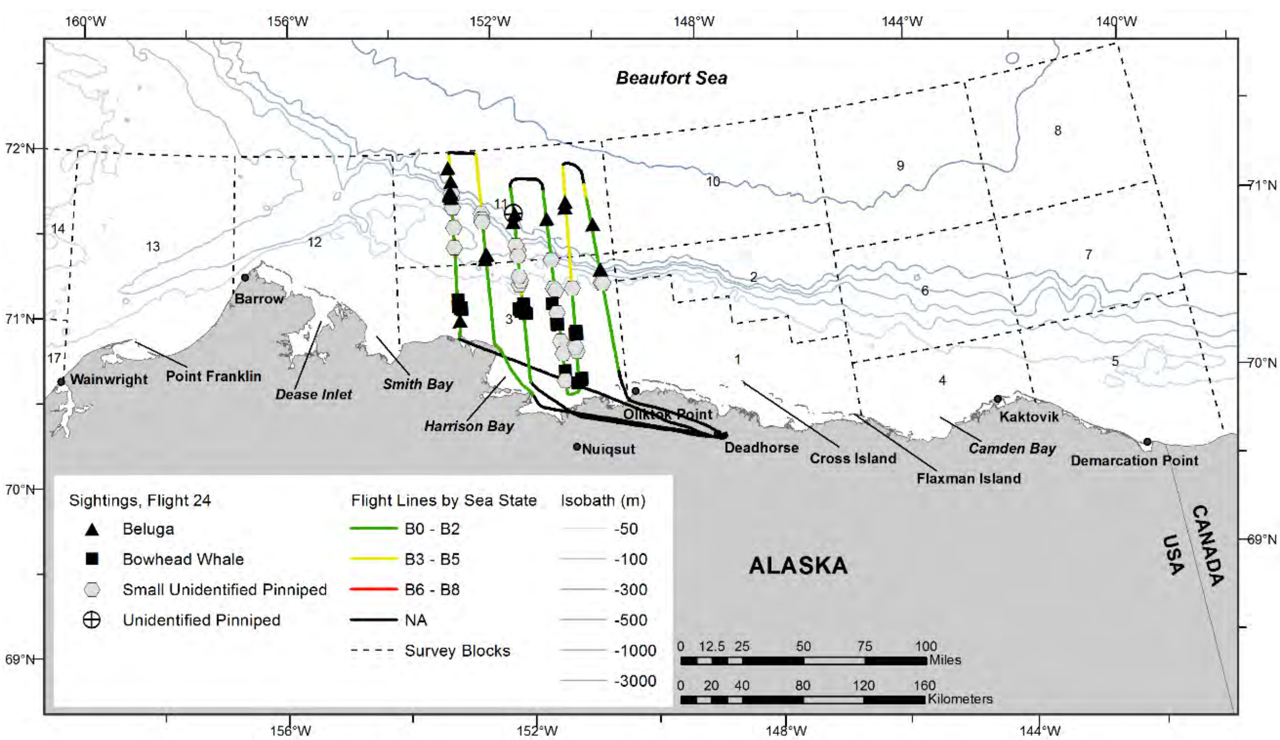

Figure B-55. ASAMM Flight 24 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

2 September 2015, Flight 232

Flight was a complete survey of Arctic ACEs transect 239 and partial survey of Arctic ACEs transect 241 and the ASAMM coastal survey transect from south of Point Lay to Point Barrow. Survey conditions included clear to partly cloudy skies, 0-10 km visibility (with glare, haze, and low ceilings), and Beaufort 2-6 sea states. There was no sea ice observed in the area surveyed. Sightings included gray whales (including 4 carcasses), unidentified cetaceans (including 2 carcasses), walruses (including 2 carcasses), unidentified pinnipeds (including one carcass), and small unidentified pinnipeds. A walrus haulout, estimated at 31,400 walruses, was observed on a barrier island near Point Lay. An unidentified pinniped haulout, estimated at 250 seals, was observed on a barrier island near Icy Cape.

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	9/2/15 16:31	69.681	163.214	gray whale	swim	1	0	20
232	9/2/15 16:54	70.213	162.372	gray whale	feed	1	0	17
232	9/2/15 17:33	70.742	159.771	gray whale	dead	1	0	13
232	9/2/15 17:40	70.835	159.434	gray whale	dead	1	0	13
232	9/2/15 17:50	70.915	158.762	gray whale	dead	1	0	13
232	9/2/15 17:50	70.915	158.758	unid cetacean	dead	1	0	13
232	9/2/15 18:01	70.829	158.439	unid cetacean	dead	1	0	13
232	9/2/15 18:27	71.209	156.995	gray whale	dead	1	0	12
232	9/2/15 18:46	71.297	157.106	unid cetacean	unknown	4	0	13

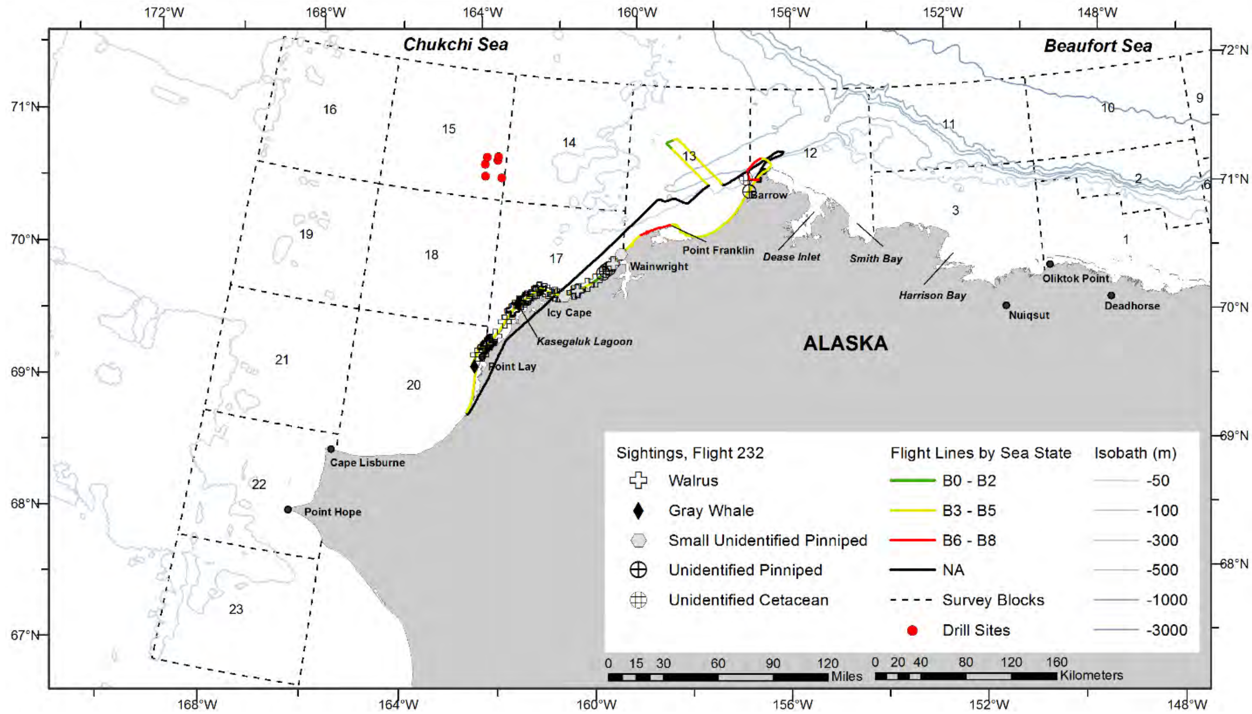

Figure B-56. ASAMM Flight 232 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Gray whale skeleton sighted at Point Franklin, Alaska, during ASAMM Flight 232, 2 September 2015.

7 September 2015, Flight 233

Flight was a complete survey of Arctic ACEs transects 201, 203, 205, 228, 230, 232, 234, 236, a partial survey of Arctic ACEs transects 207, 209, 211, 213, 215, 238, 240, 242, 244, 246, 248, and 250, a partial survey of ASAMM transect 8, and a coastal search survey from Dease Inlet to Point Barrow. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 3-7 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including one calf), gray whales, unidentified cetaceans, and unidentified pinnipeds. More sightings were recorded as unidentified cetaceans because survey and safety procedures did not allow the aircraft to break track to further investigate sightings while flying Arctic ACEs transects.

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	9/7/2015 9:30	71.611	156.871	unid cetacean	unknown	1	0	12
233	9/7/2015 9:30	71.636	156.963	bowhead whale	rest	1	0	12
233	9/7/2015 9:33	71.711	157.086	bowhead whale	rest	1	0	13
233	9/7/2015 9:42	71.622	157.241	unid cetacean	swim	1	0	13
233	9/7/2015 9:48	71.517	157.155	unid cetacean	unknown	1	0	13
233	9/7/2015 9:48	71.52	157.17	bowhead whale	rest	1	0	13
233	9/7/2015 9:50	71.579	157.307	unid cetacean	unknown	1	0	13
233	9/7/2015 9:54	71.641	157.617	bowhead whale	swim	1	0	13
233	9/7/2015 9:54	71.643	157.639	bowhead whale	swim	1	0	13
233	9/7/2015 9:56	71.684	157.749	bowhead whale	swim	1	0	13
233	9/7/2015 9:58	71.699	157.923	bowhead whale	swim	1	0	13
233	9/7/2015 10:06	71.487	157.522	bowhead whale	swim	1	0	13
233	9/7/2015 10:24	71.604	158.249	bowhead whale	swim	1	0	13
233	9/7/2015 10:25	71.633	158.343	bowhead whale	swim	1	0	13
233	9/7/2015 10:33	71.501	158.3	bowhead whale	swim	2	0	13
233	9/7/2015 11:11	71.095	157.924	gray whale	feed	1	0	13
233	9/7/2015 11:15	71.107	158.168	gray whale	feed	1	0	13
233	9/7/2015 15:05	71.545	155.039	unid cetacean	unknown	1	0	12
233	9/7/2015 16:40	71.144	153.777	bowhead whale	swim	2	1	3
233	9/7/2015 17:05	71.191	155.071	bowhead whale	rest	1	0	12
233	9/7/2015 17:13	71.265	155.287	bowhead whale	swim	1	0	12

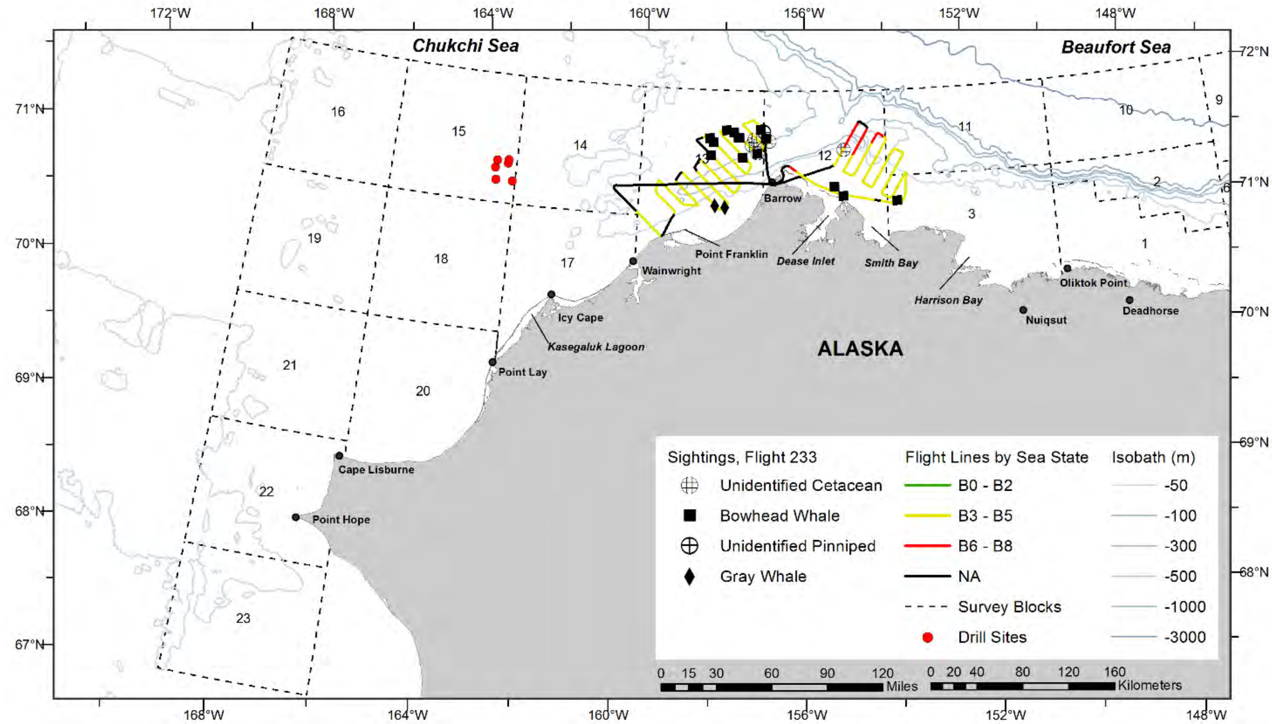

Figure B-57. ASAMM Flight 233 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

An almost all white fluke of bowhead whale cow (calf not visible) sighted northeast of Smith Bay, Alaska, during ASAMM Flight 233, 7 September 2015.

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7 September 2015, Flight 25

Flight was a survey of portions of blocks 1, 6, and 12, and a coastal search survey from the eastern end of Smith Bay to the western side of Harrison Bay. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 2-5 sea states. Sea ice cover was 0-15% broken floe in the area surveyed. Sightings included bowhead whales, 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
25	9/7/15 11:01	71.340	154.417	bowhead whale	swim	2	0	12
25	9/7/15 11:30	71.781	154.750	bowhead whale	rest	1	0	12
25	9/7/15 12:05	71.192	155.177	bowhead whale	swim	1	0	12
25	9/7/15 12:51	71.592	156.726	bowhead whale	rest	1	0	12
25	9/7/15 12:52	71.592	156.738	bowhead whale	swim	1	0	12
25	9/7/15 12:54	71.596	156.726	bowhead whale	rest	2	0	12

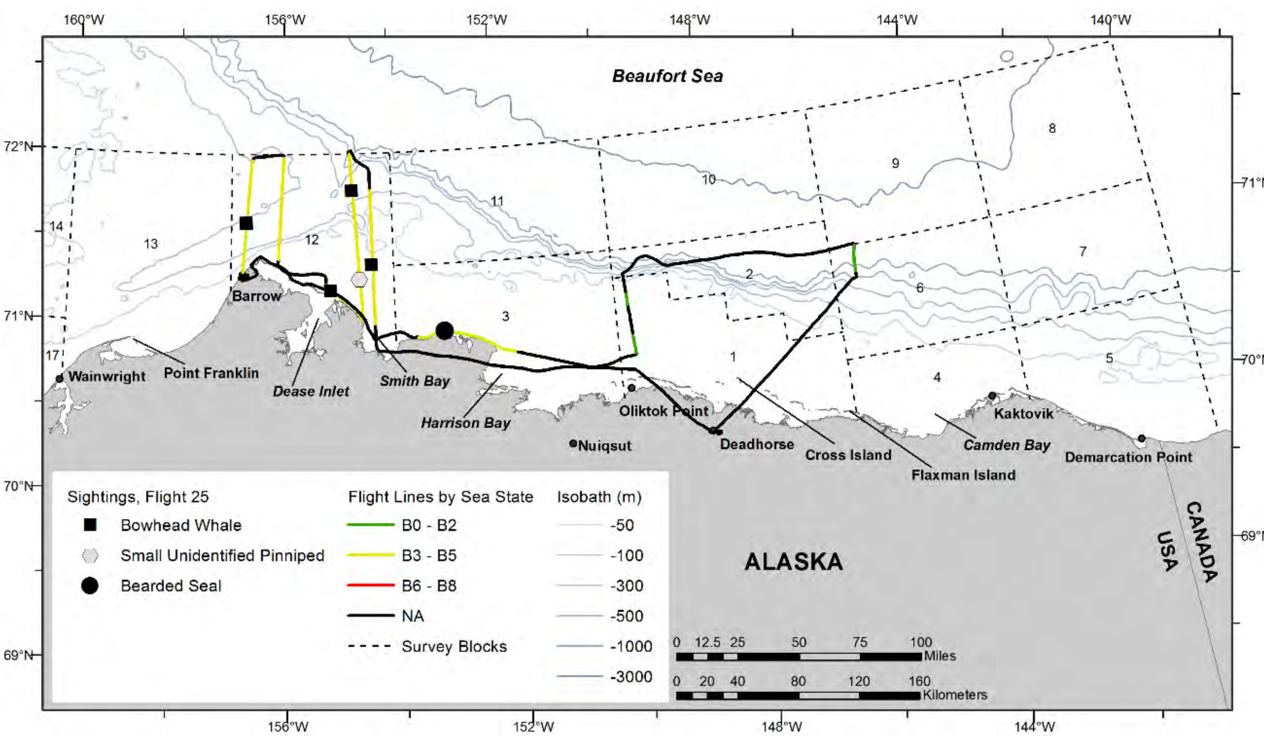

Figure B-58. ASAMM Flight 25 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

8 September 2015, Flight 234

Flight was a partial survey of transects 2, 4, 6, and 8. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 2-4 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales, one walrus, one bearded seal, 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
234	9/8/15 17:30	71.581	160.390	bowhead whale	swim	2	0	14
234	9/8/15 18:13	71.509	158.454	bowhead whale	dive	1	0	13
234	9/8/15 18:19	71.536	158.583	bowhead whale	swim	1	0	13
234	9/8/15 18:20	71.533	158.617	bowhead whale	swim	2	0	13
234	9/8/15 18:20	71.544	158.611	bowhead whale	swim	1	0	13
234	9/8/15 18:20	71.543	158.609	bowhead whale	swim	1	0	13
234	9/8/15 18:22	71.531	158.579	bowhead whale	swim	3	0	13
234	9/8/15 18:54	71.698	157.593	bowhead whale	swim	1	0	13
234	9/8/15 18:54	71.692	157.594	bowhead whale	dive	1	0	13
234	9/8/15 18:54	71.693	157.589	bowhead whale	swim	1	0	13
234	9/8/15 18:55	71.702	157.534	bowhead whale	swim	6	0	13
234	9/8/15 18:59	71.684	157.559	bowhead whale	swim	1	0	13
234	9/8/15 19:00	71.690	157.484	bowhead whale	rest	1	0	13
234	9/8/15 19:03	71.685	157.527	bowhead whale	swim	1	0	13
234	9/8/15 19:04	71.668	157.478	bowhead whale	swim	1	0	13
234	9/8/15 19:05	71.661	157.466	bowhead whale	swim	1	0	13
234	9/8/15 19:07	71.656	157.556	bowhead whale	swim	1	0	13
234	9/8/15 19:08	71.654	157.473	bowhead whale	rest	1	0	13
234	9/8/15 19:09	71.637	157.474	bowhead whale	rest	1	0	13

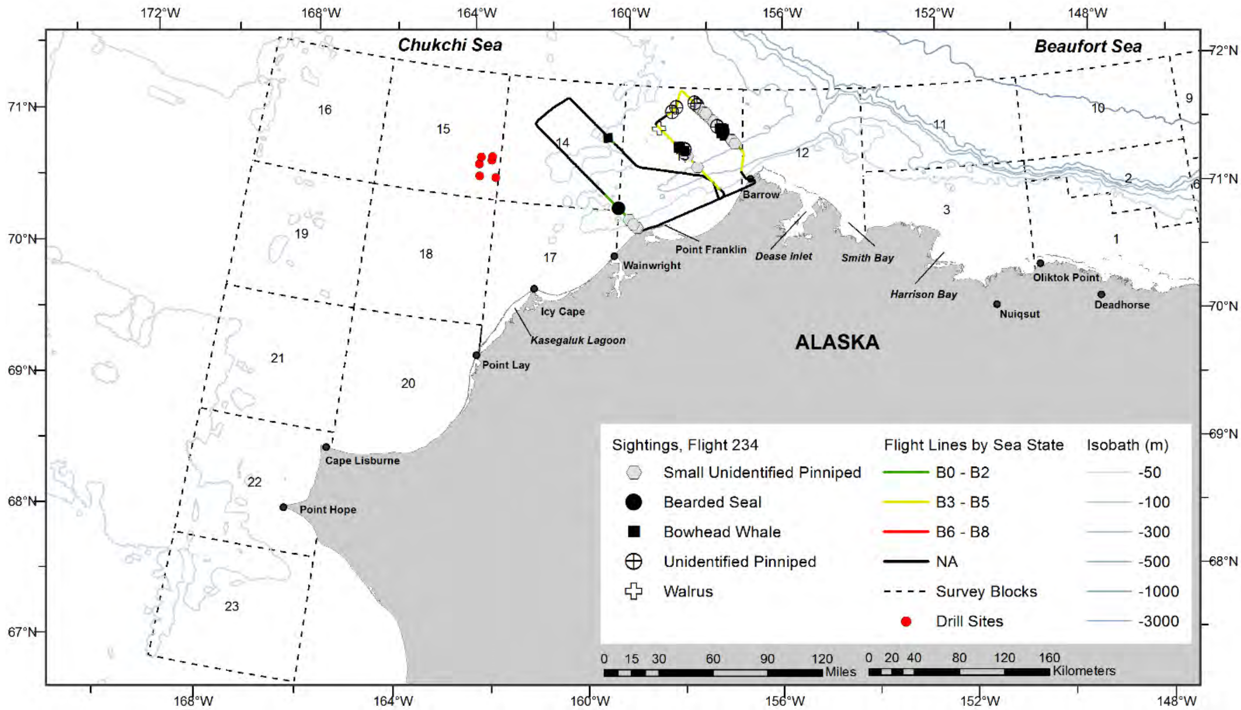

Figure B-59. ASAMM Flight 234 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

8 September 2015, Flight 26

Flight was a survey of portions of blocks 1, 2, 4, and 6. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare and low ceilings), and Beaufort 1-3 sea states. Sea ice cover was 0-40% broken floe in the area surveyed. Sightings included bowhead whales, belugas (including six calves), 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
26	9/8/15 15:09	70.517	147.768	bowhead whale	swim	1	0	1
26	9/8/15 15:28	71.091	147.814	beluga	swim	1	0	2
26	9/8/15 15:28	71.093	147.814	beluga	swim	1	0	2
26	9/8/15 15:28	71.099	147.814	beluga	swim	1	0	2
26	9/8/15 15:28	71.102	147.808	beluga	swim	3	0	2
26	9/8/15 15:29	71.106	147.810	beluga	swim	1	0	2
26	9/8/15 15:29	71.120	147.852	beluga	swim	1	0	2
26	9/8/15 15:53	70.842	148.192	bowhead whale	swim	1	0	1
26	9/8/15 16:12	70.680	148.719	bowhead whale	swim	1	0	1
26	9/8/15 16:13	70.696	148.749	bowhead whale	swim	4	0	1
26	9/8/15 16:13	70.707	148.715	bowhead whale	swim	2	0	1
26	9/8/15 16:18	70.850	148.812	bowhead whale	swim	2	0	1
26	9/8/15 16:18	70.860	148.800	bowhead whale	swim	2	0	1
26	9/8/15 16:41	70.788	149.257	bowhead whale	swim	1	0	1
26	9/8/15 16:54	70.782	149.737	bowhead whale	swim	1	0	1
26	9/8/15 17:33	71.022	145.583	beluga	swim	1	0	6
26	9/8/15 17:33	71.018	145.578	beluga	swim	4	2	6
26	9/8/15 17:34	70.988	145.609	beluga	swim	1	0	6
26	9/8/15 17:34	70.981	145.566	beluga	swim	2	1	6
26	9/8/15 17:34	70.965	145.576	beluga	swim	2	1	6
26	9/8/15 17:34	70.961	145.582	beluga	swim	1	0	6
26	9/8/15 17:35	70.958	145.601	beluga	swim	1	0	6
26	9/8/15 17:35	70.956	145.594	beluga	swim	1	0	6
26	9/8/15 17:35	70.948	145.589	bowhead whale	swim	1	0	6
26	9/8/15 17:35	70.945	145.587	beluga	swim	1	0	6
26	9/8/15 17:35	70.941	145.572	beluga	swim	2	1	6
26	9/8/15 17:35	70.933	145.567	beluga	swim	2	1	6

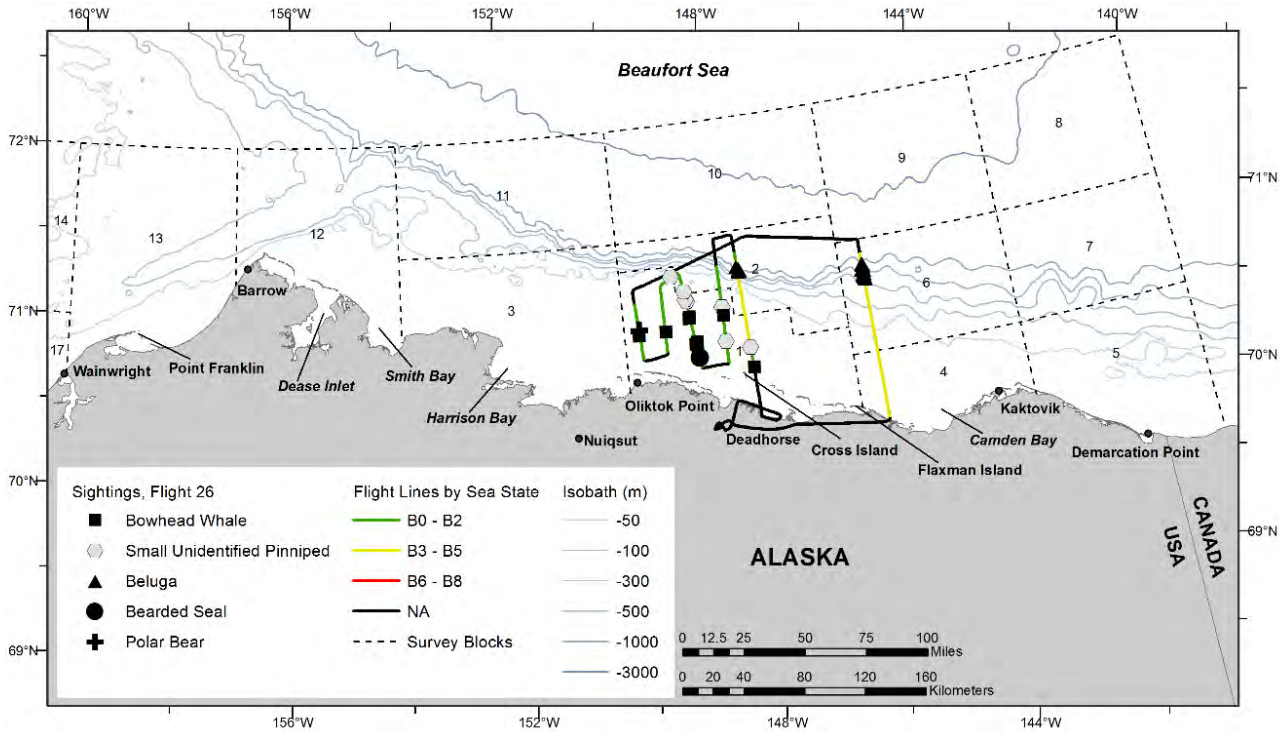

Figure B-60. ASAMM Flight 26 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

9 September 2015, Flight 27

Flight was a survey of block 6 and portions of block 4. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, iced window, low ceilings, and precipitation), and Beaufort 3-6 sea states. Sea ice cover was 0-10% broken floe 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
27	9/9/15 12:04	70.767	143.177	beluga	swim	1	0	6
27	9/9/15 12:05	70.781	143.164	beluga	swim	1	0	6
27	9/9/15 12:05	70.795	143.167	beluga	swim	3	1	6
27	9/9/15 12:06	70.816	143.153	beluga	swim	2	0	6
27	9/9/15 12:08	70.878	143.157	beluga	swim	1	0	6
27	9/9/15 12:57	70.587	144.325	bowhead whale	swim	1	0	6
27	9/9/15 13:11	70.921	144.228	beluga	swim	1	0	6
27	9/9/15 13:59	70.309	145.160	bowhead whale	swim	1	0	4

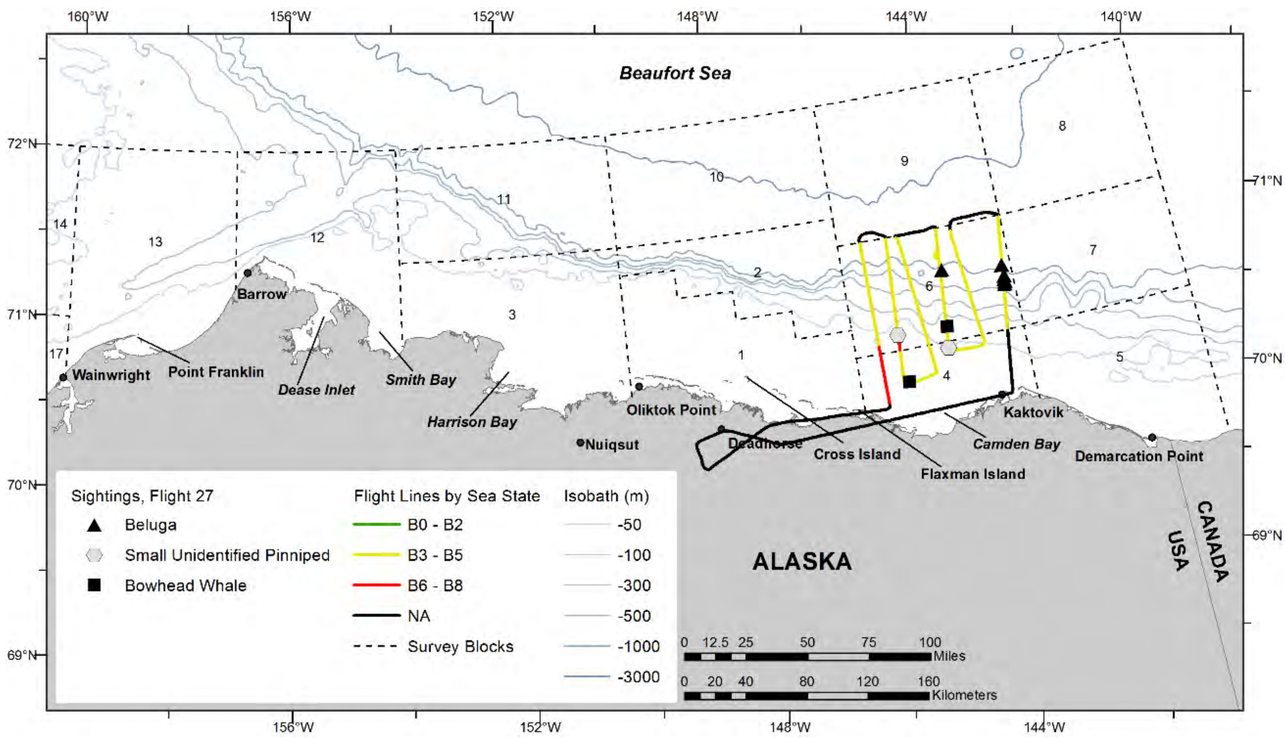

Figure B-61. ASAMM Flight 27 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

10 September 2015, Flight 235

Flight was the coastal transect near Point Lay and Wainwright. Survey conditions included overcast skies, 1-10 km visibility (with low ceilings and precipitation), and Beaufort 5-7 sea states. There was no sea ice observed in the area surveyed. Sightings included walruses. The Point Lay walrus haulout was estimated at approximately 15,000 animals.

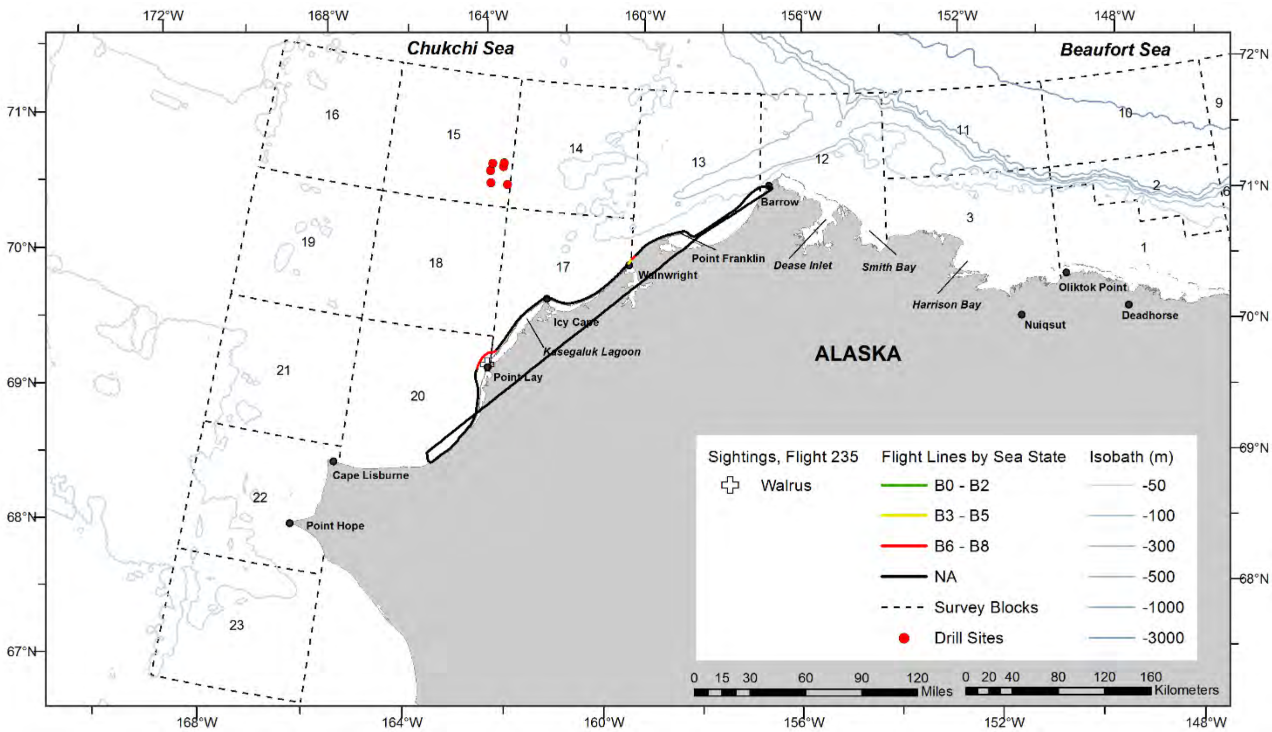

Figure B-62. ASAMM Flight 235 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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13 September 2015, Flight 236

Flight was a partial survey of transects 11 and 13. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 2-3 sea states. There was no sea ice observed in the area surveyed. Sightings included unidentified pinnipeds and small unidentified pinnipeds.

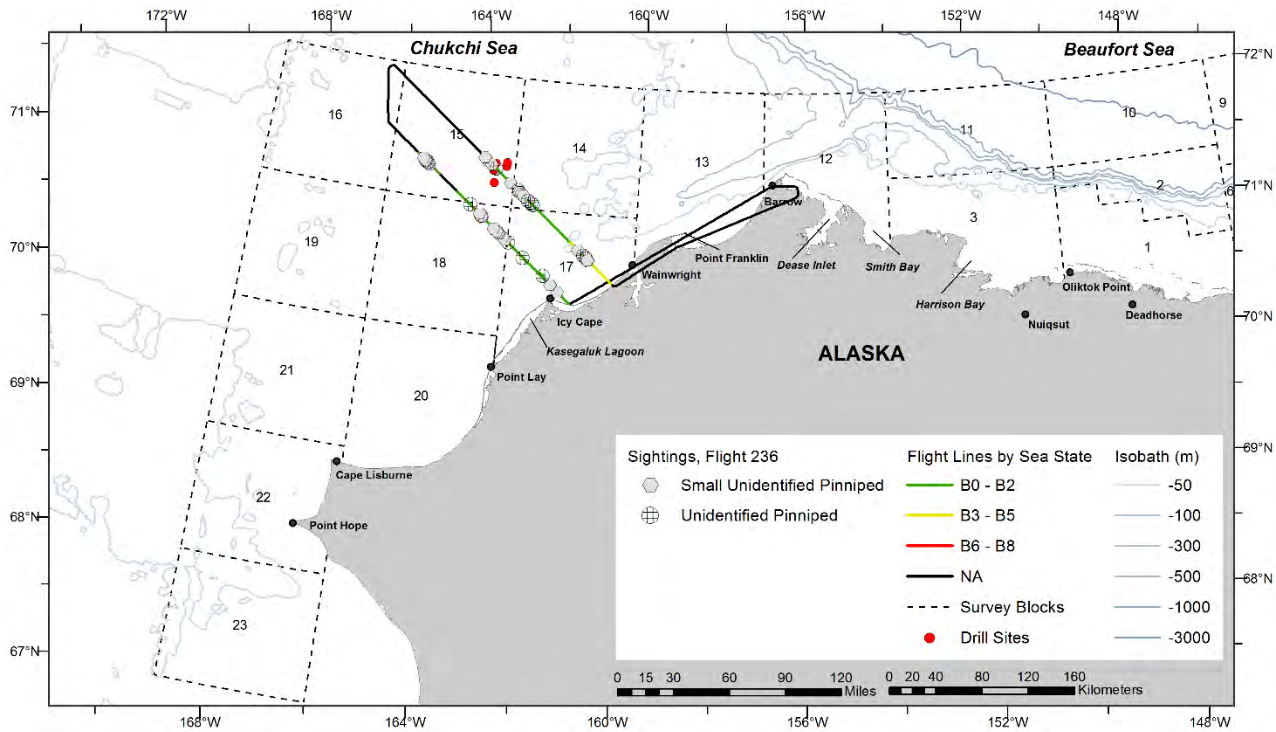

Figure B-63. ASAMM Flight 236 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

13 September 2015, Flight 28

Flight was a survey of portions of blocks 1, 2, and 5. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, low ceilings, and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-60% broken floe and new ice in the area surveyed. Sightings included bowhead whales (including one calf), belugas (including two 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
28	9/13/15 11:35	69.962	140.932	unid cetacean	swim	1	0	5
28	9/13/15 11:36	69.945	140.975	bowhead whale	swim	1	0	5
28	9/13/15 12:04	69.985	141.361	bowhead whale	swim	1	0	5
28	9/13/15 12:05	70.001	141.379	bowhead whale	swim	3	0	5
28	9/13/15 12:25	70.107	141.544	bowhead whale	swim	1	0	5
28	9/13/15 12:25	70.098	141.580	bowhead whale	swim	2	1	5
28	9/13/15 12:46	69.830	141.518	bowhead whale	swim	1	0	5
28	9/13/15 13:00	69.962	142.248	bowhead whale	swim	1	0	5
28	9/13/15 13:06	70.141	142.207	bowhead whale	swim	1	0	5
28	9/13/15 14:25	71.099	146.126	beluga	swim	2	1	2
28	9/13/15 14:52	70.310	146.424	beluga	swim	3	0	1
28	9/13/15 16:35	71.017	147.320	beluga	swim	1	0	2
28	9/13/15 16:39	71.167	147.299	beluga	swim	2	0	2
28	9/13/15 16:56	71.129	146.652	beluga	swim	1	0	2
28	9/13/15 16:56	71.125	146.653	beluga	mill	7	1	2
28	9/13/15 16:56	71.122	146.643	beluga	swim	1	0	2
28	9/13/15 16:56	71.121	146.650	beluga	swim	2	0	2
28	9/13/15 16:56	71.117	146.644	beluga	swim	1	0	2
28	9/13/15 16:56	71.109	146.654	beluga	swim	4	0	2
28	9/13/15 16:56	71.105	146.645	beluga	swim	1	0	2

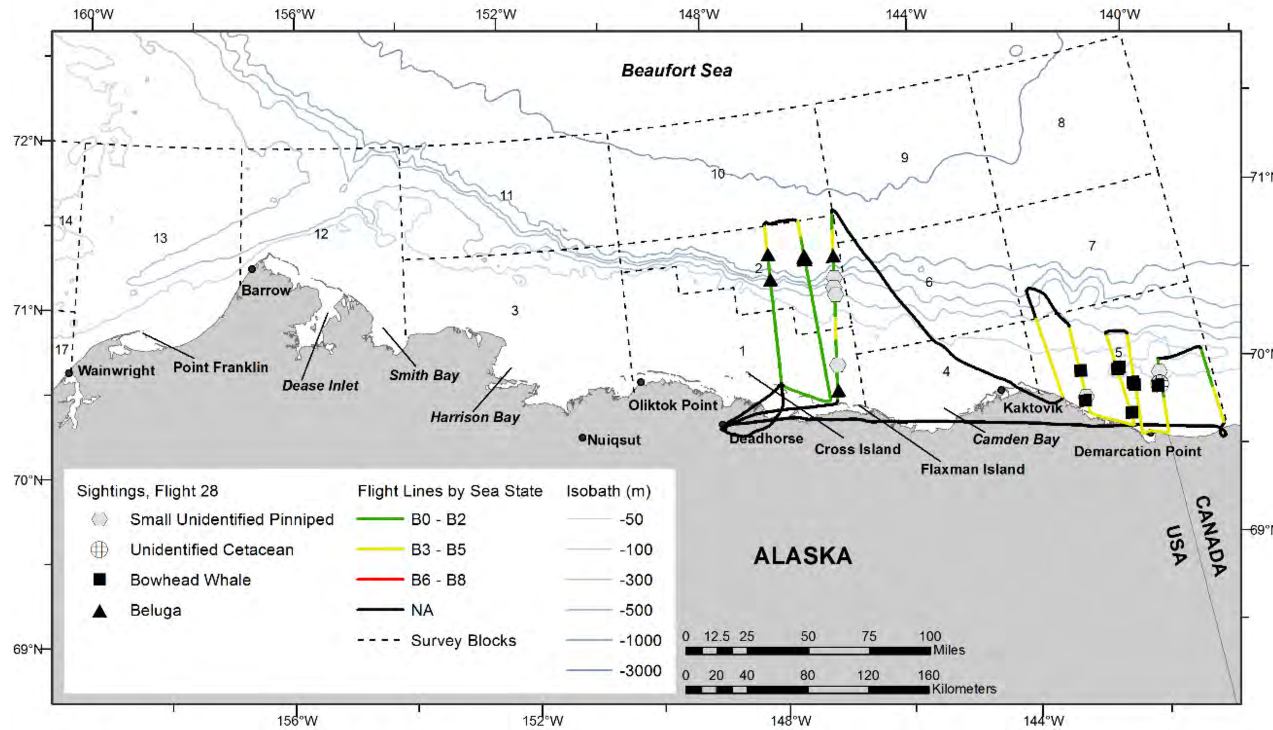

Figure B-64. ASAMM Flight 28 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

16 September 2015, Flight 237

Flight was a complete survey of transects 1, 3, 5, 7, and 9. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, low ceilings, and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales, gray whales, belugas, 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
237	9/16/15 9:23	71.533	156.913	beluga	rest	1	0	12
237	9/16/15 9:23	71.537	156.934	beluga	swim	1	0	12
237	9/16/15 10:16	71.548	157.866	bowhead whale	dive	2	0	13
237	9/16/15 10:50	71.057	157.833	gray whale	swim	2	0	13
237	9/16/15 11:11	71.483	159.261	bowhead whale	dive	1	0	13
237	9/16/15 11:19	71.560	159.488	bowhead whale	swim	1	0	13
237	9/16/15 11:25	71.666	159.804	unid cetacean	dive	1	0	13
237	9/16/15 11:36	71.774	160.304	bowhead whale	dive	1	0	14
237	9/16/15 11:39	71.778	160.262	bowhead whale	swim	1	0	14
237	9/16/15 11:40	71.778	160.249	bowhead whale	swim	1	0	14
237	9/16/15 11:45	71.885	160.673	beluga	swim	2	0	14
237	9/16/15 12:10	71.847	162.225	bowhead whale	swim	1	0	14
237	9/16/15 12:11	71.836	162.217	bowhead whale	dive	1	0	14
237	9/16/15 12:36	71.387	160.525	bowhead whale	swim	1	0	14
237	9/16/15 12:36	71.394	160.482	bowhead whale	swim	1	0	14
237	9/16/15 12:48	71.286	160.188	bowhead whale	swim	1	0	14
237	9/16/15 12:48	71.286	160.160	bowhead whale	mill	2	0	14
237	9/16/15 12:49	71.277	160.202	bowhead whale	swim	1	0	14
237	9/16/15 12:51	71.284	160.132	bowhead whale	rest	2	0	14
237	9/16/15 12:51	71.288	160.132	bowhead whale	rest	2	0	14
237	9/16/15 12:52	71.283	160.123	bowhead whale	rest	1	0	14
237	9/16/15 15:44	71.229	161.509	bowhead whale	dive	2	0	14
237	9/16/15 15:46	71.242	161.478	gray whale	feed	3	0	14
237	9/16/15 15:46	71.241	161.459	bowhead whale	feed	1	0	14
237	9/16/15 15:47	71.251	161.474	bowhead whale	dive	1	0	14
237	9/16/15 15:56	71.306	161.872	bowhead whale	rest	1	0	14
237	9/16/15 15:58	71.301	161.928	bowhead whale	swim	1	0	14
237	9/16/15 15:58	71.300	161.930	bowhead whale	swim	1	0	14
237	9/16/15 16:00	71.334	161.949	bowhead whale	swim	1	0	14
237	9/16/15 16:00	71.340	161.948	bowhead whale	swim	1	0	14
237	9/16/15 16:03	71.355	162.020	bowhead whale	dive	1	0	14

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
237	9/16/15 16:04	71.375	162.064	bowhead whale	swim	3	0	14
237	9/16/15 16:04	71.374	162.105	bowhead whale	rest	1	0	14

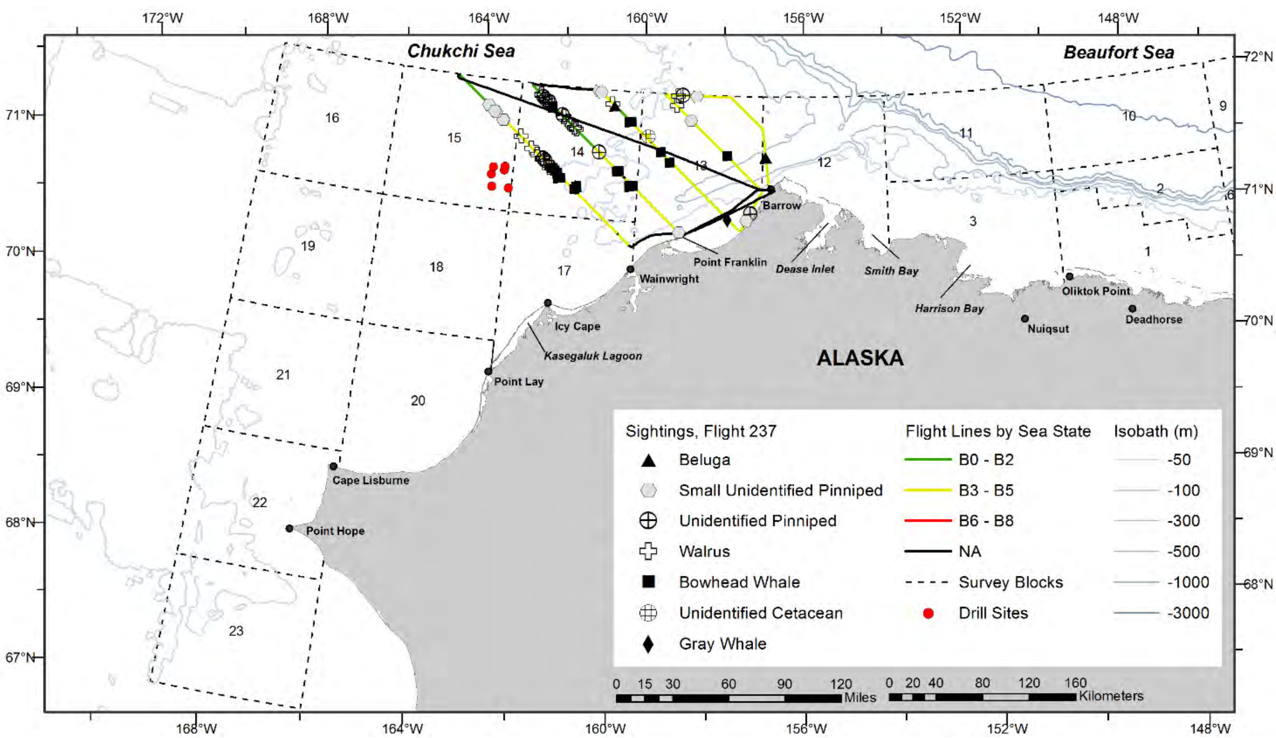

Figure B-65. ASAMM Flight 237 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

16 September 2015, Flight 29

Flight was a survey of portions of blocks 3, 11, and 12. Survey conditions included overcast skies, 0-10 km visibility (with low ceilings and precipitation), and Beaufort 3-4 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including three calves) and belugas (including three calves).

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
29	9/16/15 11:05	71.486	156.734	bowhead whale	swim	1	0	12
29	9/16/15 11:07	71.512	156.719	bowhead whale	swim	1	0	12
29	9/16/15 11:08	71.560	156.721	beluga	swim	1	0	12
29	9/16/15 12:03	71.412	155.638	bowhead whale	swim	2	0	12
29	9/16/15 12:06	71.417	155.682	bowhead whale	swim	1	0	12
29	9/16/15 12:08	71.432	155.596	bowhead whale	swim	1	0	12
29	9/16/15 12:10	71.444	155.635	bowhead whale	tail slap	1	0	12
29	9/16/15 12:11	71.459	155.628	bowhead whale	swim	1	0	12
29	9/16/15 12:11	71.461	155.640	bowhead whale	swim	1	0	12
29	9/16/15 12:15	71.475	155.673	bowhead whale	swim	1	0	12
29	9/16/15 12:15	71.475	155.675	bowhead whale	swim	1	0	12
29	9/16/15 12:15	71.470	155.678	bowhead whale	swim	1	0	12
29	9/16/15 12:17	71.462	155.673	bowhead whale	swim	1	0	12
29	9/16/15 12:18	71.464	155.634	bowhead whale	swim	2	1	12
29	9/16/15 12:18	71.468	155.629	bowhead whale	swim	4	1	12
29	9/16/15 12:21	71.481	155.691	bowhead whale	swim	1	0	12
29	9/16/15 12:21	71.479	155.698	bowhead whale	swim	1	0	12
29	9/16/15 12:21	71.467	155.703	bowhead whale	swim	1	0	12
29	9/16/15 12:22	71.466	155.625	bowhead whale	swim	1	0	12
29	9/16/15 12:22	71.468	155.624	bowhead whale	swim	1	0	12
29	9/16/15 12:24	71.464	155.668	bowhead whale	swim	1	0	12
29	9/16/15 12:25	71.462	155.615	bowhead whale	swim	1	0	12
29	9/16/15 12:25	71.463	155.615	bowhead whale	swim	1	0	12
29	9/16/15 12:32	71.488	155.702	bowhead whale	swim	1	0	12
29	9/16/15 13:01	71.620	155.214	beluga	swim	3	0	12
29	9/16/15 13:01	71.616	155.199	beluga	swim	1	0	12
29	9/16/15 13:01	71.613	155.214	beluga	swim	2	1	12
29	9/16/15 13:01	71.610	155.194	beluga	swim	1	0	12
29	9/16/15 13:02	71.604	155.208	beluga	swim	3	1	12
29	9/16/15 13:13	71.248	155.276	beluga	swim	1	0	12
29	9/16/15 13:13	71.244	155.240	bowhead whale	swim	1	0	12
29	9/16/15 13:13	71.242	155.251	bowhead whale	swim	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
29	9/16/15 13:17	71.272	155.281	bowhead whale	swim	1	0	12
29	9/16/15 13:19	71.216	155.253	bowhead whale	swim	1	0	12
29	9/16/15 13:34	71.183	154.621	bowhead whale	swim	2	0	12
29	9/16/15 13:34	71.191	154.641	bowhead whale	swim	1	0	12
29	9/16/15 13:39	71.196	154.625	bowhead whale	swim	2	0	12
29	9/16/15 16:16	71.104	153.610	bowhead whale	swim	1	0	3
29	9/16/15 16:17	71.106	153.592	bowhead whale	swim	1	0	3
29	9/16/15 16:17	71.103	153.598	bowhead whale	swim	2	1	3
29	9/16/15 16:17	71.100	153.616	bowhead whale	swim	1	0	3
29	9/16/15 16:19	71.093	153.588	bowhead whale	swim	1	0	3
29	9/16/15 16:19	71.108	153.576	bowhead whale	swim	1	0	3
29	9/16/15 19:12	71.470	151.795	beluga	swim	1	0	11
29	9/16/15 19:12	71.472	151.790	beluga	swim	2	1	11
29	9/16/15 19:38	71.482	151.301	beluga	swim	1	0	11
29	9/16/15 19:38	71.459	151.272	beluga	swim	1	0	11
29	9/16/15 19:39	71.434	151.260	beluga	swim	1	0	11
29	9/16/15 19:51	71.018	151.165	bowhead whale	swim	1	0	3
29	9/16/15 19:52	71.011	151.158	bowhead whale	swim	1	0	3

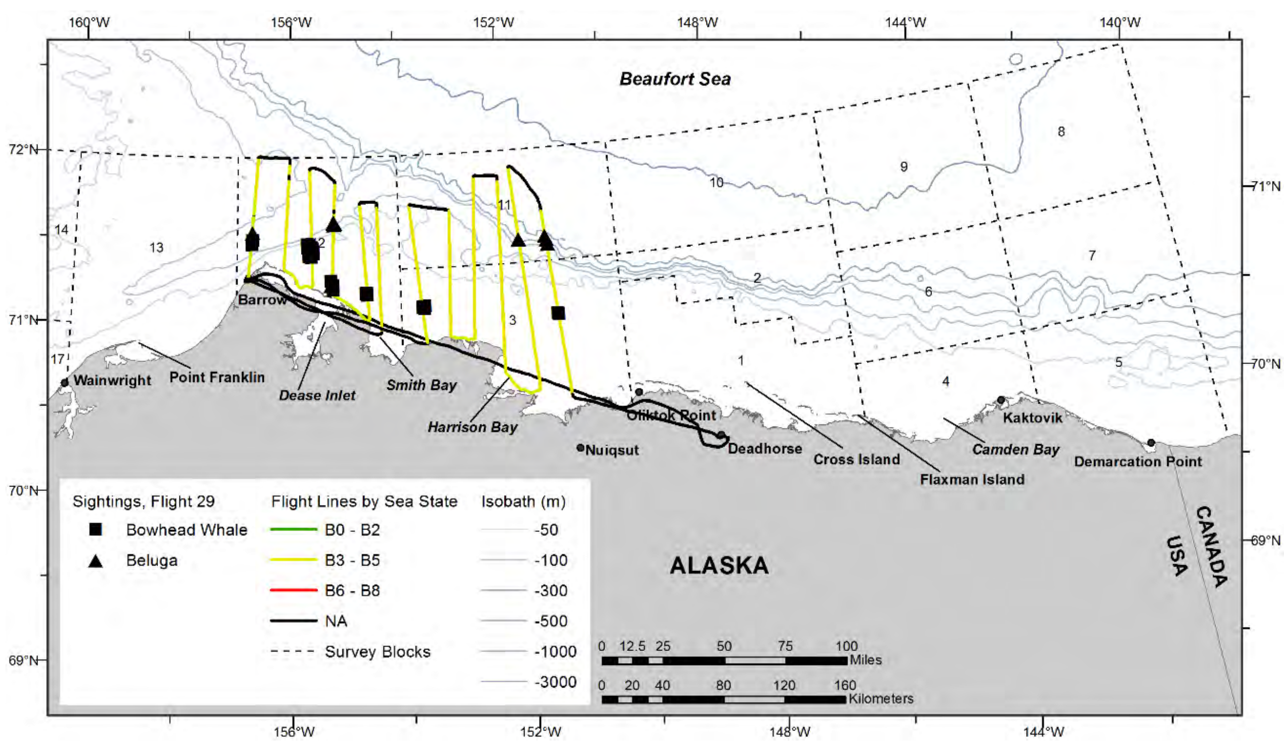

Figure B-66. ASAMM Flight 29 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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17 September 2015, Flight 238

Flight was a complete survey of transects 12, 14, 16, and 18 and the coastal transect from southwest of Wainwright to Barrow. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 1-6 sea states. There was no sea ice observed in the area surveyed. Sightings included walruses and small unidentified pinnipeds.

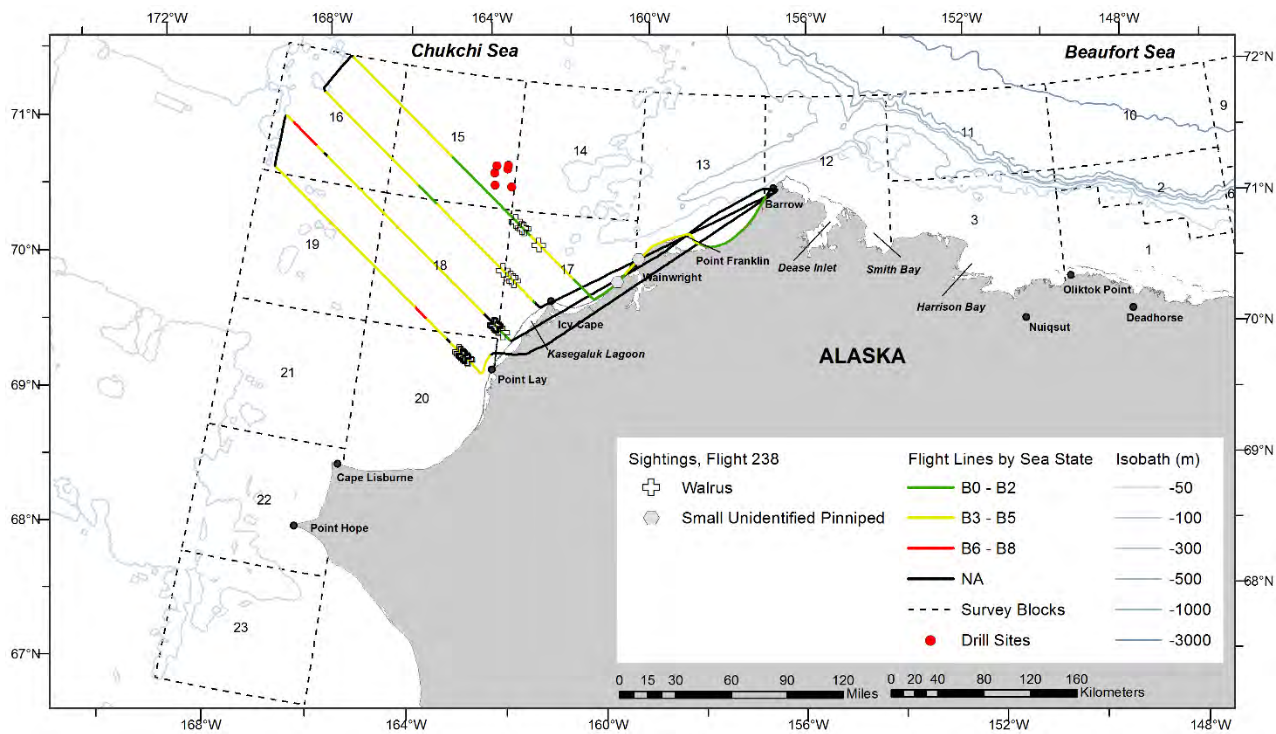

Figure B-67. ASAMM Flight 238 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

18 September 2015, Flight 239

Flight was a partial survey of transects 30, 31, 32, and 33, the coastal transect from Point Hope to the northeast of Icy Cape, and search effort from Point Franklin to Barrow. 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. There was no sea ice observed in the area surveyed. Sightings included gray whales (including one carcass), one minke whale, unidentified cetaceans, walruses (including four carcasses), and unidentified pinnipeds. The Point Lay walrus haulout was estimated at 10,000 animals.

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
239	9/18/15 12:29	68.652	166.646	minke whale	swim	1	0	22
239	9/18/15 16:04	68.378	166.660	gray whale	dead	1	0	22
239	9/18/15 18:29	71.028	158.223	gray whale	feed	1	0	13
239	9/18/15 18:30	71.031	158.217	gray whale	feed	1	0	13
239	9/18/15 18:30	71.029	158.165	gray whale	feed	1	0	13
239	9/18/15 18:30	71.034	158.169	gray whale	feed	1	0	13
239	9/18/15 18:30	71.036	158.184	gray whale	feed	1	0	13
239	9/18/15 18:32	71.055	158.179	gray whale	feed	1	0	13
239	9/18/15 18:32	71.065	158.184	gray whale	feed	1	0	13
239	9/18/15 18:33	71.066	158.188	gray whale	feed	1	0	13
239	9/18/15 18:35	71.029	158.151	unid cetacean	swim	1	0	13
239	9/18/15 18:35	71.031	158.135	gray whale	swim	1	0	13
239	9/18/15 18:35	71.047	158.138	unid cetacean	feed	1	0	13
239	9/18/15 18:35	71.047	158.120	gray whale	swim	1	0	13
239	9/18/15 18:36	71.033	158.075	gray whale	swim	1	0	13
239	9/18/15 18:36	71.043	158.074	gray whale	feed	1	0	13
239	9/18/15 18:36	71.043	158.039	gray whale	feed	1	0	13
239	9/18/15 18:37	71.050	158.015	gray whale	feed	1	0	13

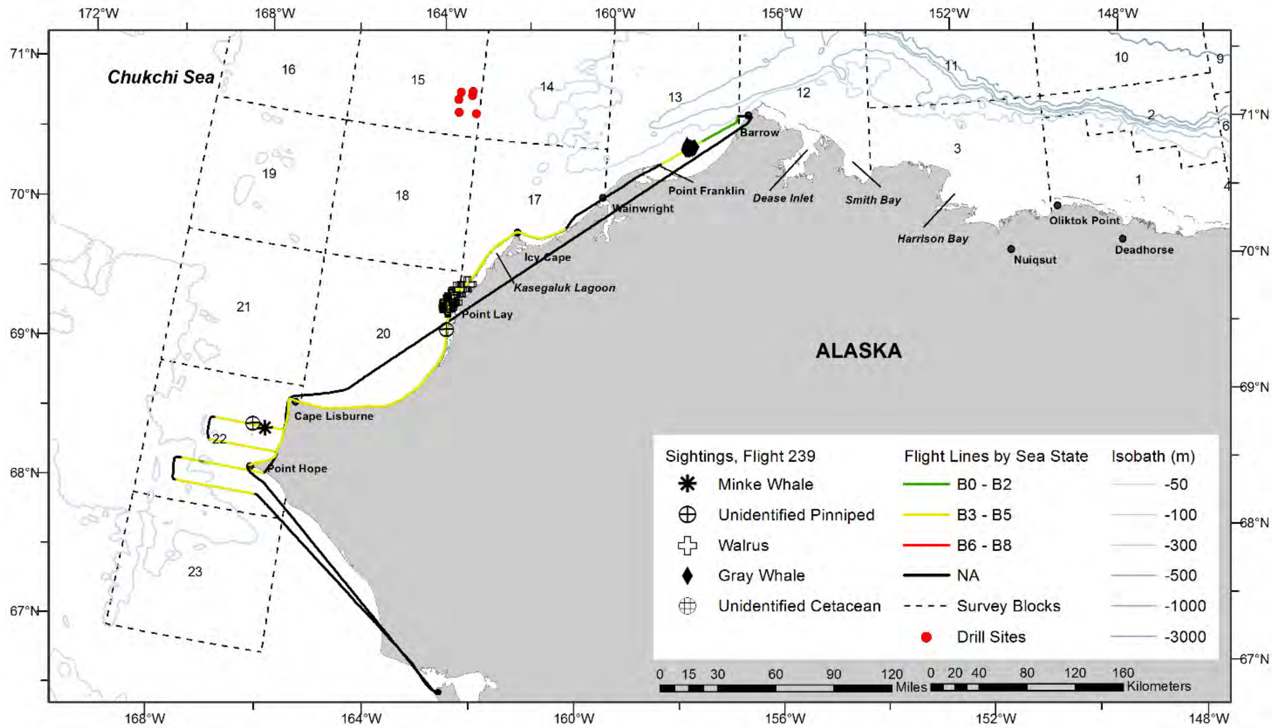

Figure B-68. ASAMM Flight 239 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

18 September 2015, Flight 30

Flight was a survey of portions of blocks 1, 2, 3, and 11. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. Sea ice cover was 0-8% broken floe in the area surveyed. Sightings included bowhead whales, belugas (including one calf), and polar bears (including two 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
30	9/18/15 14:04	70.966	149.945	bowhead whale	swim	1	0	1
30	9/18/15 14:49	70.530	149.155	beluga	swim	1	0	1
30	9/18/15 15:09	70.771	148.534	bowhead whale	swim	1	0	1
30	9/18/15 15:28	71.212	148.607	beluga	swim	2	1	2
30	9/18/15 15:28	71.217	148.594	beluga	swim	1	0	2

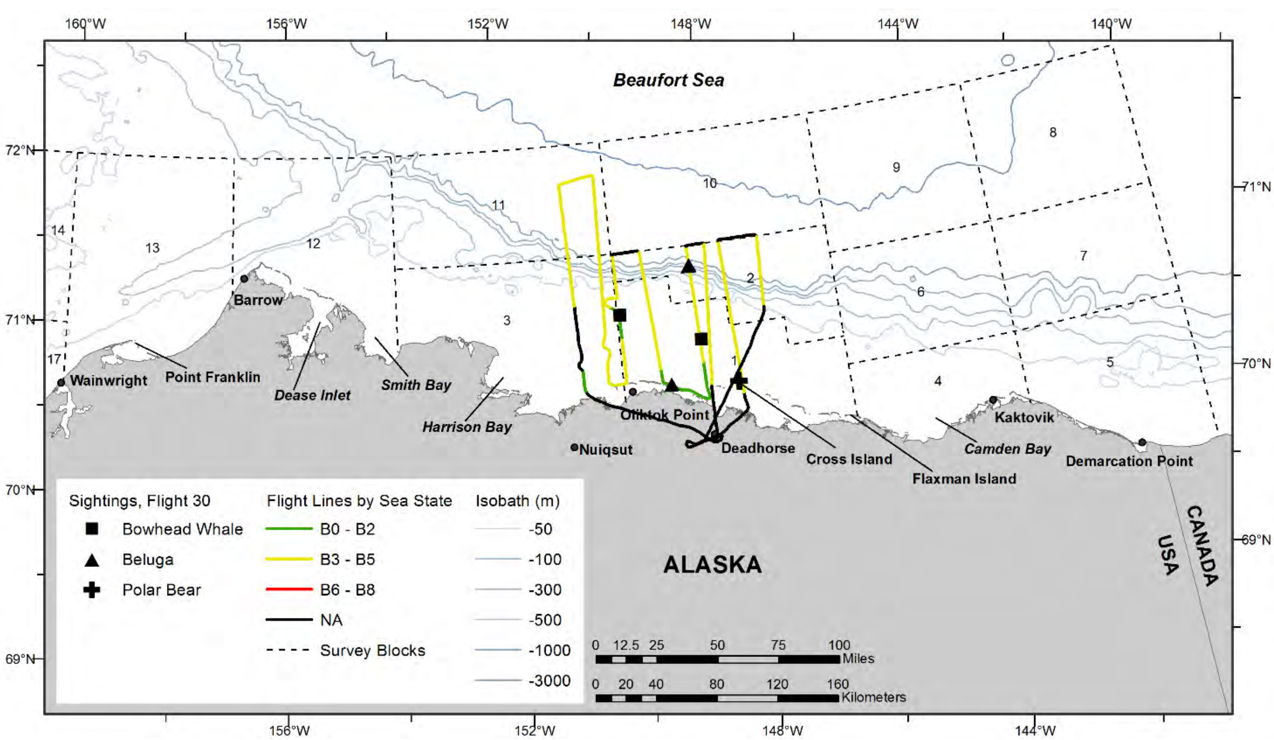

Figure B-69. ASAMM Flight 30 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bears sighted feeding on bowhead whale carcasses on Cross Island, northeast of Deadhorse, Alaska, during ASAMM Flight 30, 18 September 2015.

19 September 2015, Flight 240

Flight was a complete survey of transects 6, 8, and 10. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, iced windows, and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including one calf), gray whales (including one calf), belugas, 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
240	9/19/15 10:36	71.336	162.769	bowhead whale	rest	2	0	14
240	9/19/15 10:40	71.339	163.118	bowhead whale	rest	1	0	15
240	9/19/15 10:49	71.470	163.165	unid cetacean	swim	1	0	15
240	9/19/15 11:40	71.891	163.242	bowhead whale	swim	1	0	15
240	9/19/15 11:54	71.668	162.325	unid cetacean	mill	2	0	14
240	9/19/15 12:19	71.239	160.687	gray whale	feed	1	0	14
240	9/19/15 12:23	71.243	160.652	gray whale	feed	1	0	14
240	9/19/15 12:28	71.231	160.626	gray whale	feed	2	1	14
240	9/19/15 12:29	71.248	160.659	bowhead whale	rest	1	0	14
240	9/19/15 12:43	70.979	159.877	beluga	swim	1	0	13
240	9/19/15 12:47	70.884	159.515	gray whale	swim	3	0	13
240	9/19/15 13:01	70.881	158.055	gray whale	swim	2	0	13
240	9/19/15 13:09	70.988	158.374	gray whale	feed	1	0	13
240	9/19/15 13:19	71.134	158.843	beluga	swim	1	0	13
240	9/19/15 13:20	71.141	158.851	beluga	swim	1	0	13
240	9/19/15 13:20	71.157	158.889	beluga	swim	1	0	13
240	9/19/15 13:26	71.296	159.361	bowhead whale	swim	1	0	13
240	9/19/15 13:26	71.298	159.369	bowhead whale	swim	1	0	13
240	9/19/15 13:34	71.369	159.649	bowhead whale	swim	1	0	13
240	9/19/15 13:36	71.377	159.682	beluga	rest	1	0	13
240	9/19/15 13:39	71.437	159.897	bowhead whale	swim	1	0	13
240	9/19/15 13:44	71.443	159.919	bowhead whale	swim	1	0	13
240	9/19/15 13:44	71.445	159.936	bowhead whale	swim	1	0	13
240	9/19/15 13:45	71.443	159.927	bowhead whale	swim	1	0	13
240	9/19/15 13:59	71.732	160.957	bowhead whale	swim	1	0	14
240	9/19/15 13:59	71.738	160.949	bowhead whale	swim	1	0	14
240	9/19/15 13:59	71.749	160.968	unid cetacean	swim	1	0	14
240	9/19/15 14:00	71.752	161.046	bowhead whale	swim	2	1	14
240	9/19/15 14:06	71.757	160.959	bowhead whale	swim	1	0	14

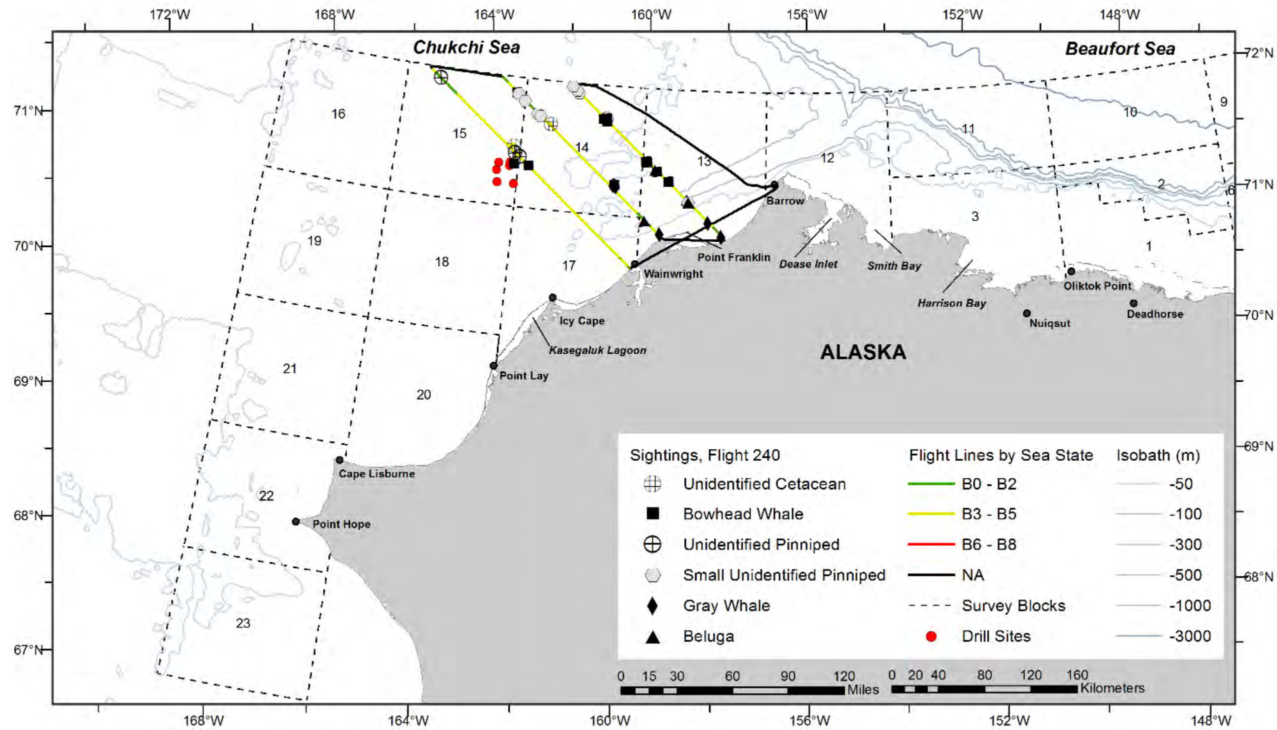

Figure B-70. ASAMM Flight 240 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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19 September 2015, Flight 31

Flight was a survey of portions of blocks 1, 2, 4, and 6, and a coastal search survey from Demarcation Point to east of Kaktovik. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. Sea ice cover was 0-40% broken floe in the area surveyed. Sightings included bowhead whales, belugas, 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
31	9/19/15 14:17	70.734	144.166	beluga	swim	1	0	6
31	9/19/15 15:03	70.316	144.625	bowhead whale	swim	1	0	4
31	9/19/15 15:28	70.346	145.422	bowhead whale	swim	1	0	4
31	9/19/15 18:24	70.961	146.193	beluga	swim	1	0	2
31	9/19/15 18:52	71.081	146.658	beluga	swim	1	0	2

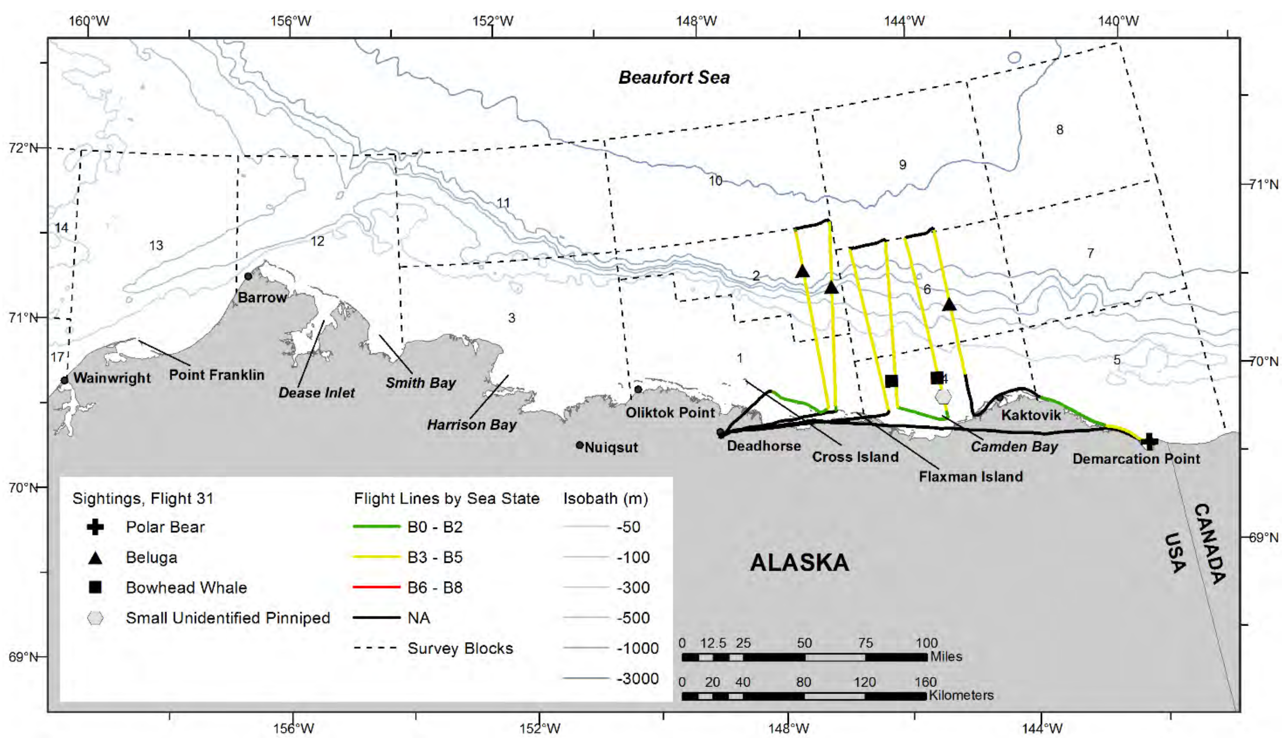

Figure B-71. ASAMM Flight 31 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

20 September 2015, Flight 32

Flight was a survey of blocks 5 and 7 and portions of blocks 4 and 6. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included belugas (including six calves).

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	9/20/15 11:28	70.414	141.346	beluga	swim	2	0	5
32	9/20/15 11:28	70.421	141.347	beluga	swim	1	0	5
32	9/20/15 11:29	70.425	141.362	beluga	swim	1	0	5
32	9/20/15 11:29	70.426	141.329	beluga	swim	1	0	5
32	9/20/15 11:30	70.483	141.338	beluga	swim	1	0	5
32	9/20/15 11:32	70.516	141.348	beluga	swim	1	0	7
32	9/20/15 11:35	70.618	141.342	beluga	swim	13	2	7
32	9/20/15 11:35	70.624	141.348	beluga	swim	9	0	7
32	9/20/15 11:35	70.629	141.357	beluga	swim	3	1	7
32	9/20/15 12:08	70.670	141.663	beluga	swim	1	0	7
32	9/20/15 12:10	70.600	141.681	beluga	swim	1	0	7
32	9/20/15 12:11	70.587	141.704	beluga	swim	1	0	7
32	9/20/15 12:14	70.471	141.667	beluga	swim	1	0	5
32	9/20/15 12:33	69.831	141.744	beluga	swim	14	0	5
32	9/20/15 13:47	70.636	142.559	beluga	swim	1	0	7
32	9/20/15 17:02	70.299	140.324	beluga	swim	1	0	5
32	9/20/15 17:02	70.300	140.298	beluga	swim	4	0	5
32	9/20/15 17:02	70.302	140.308	beluga	swim	9	2	5
32	9/20/15 17:02	70.306	140.302	beluga	swim	5	1	5
32	9/20/15 17:03	70.308	140.298	beluga	swim	1	0	5
32	9/20/15 17:09	70.513	140.255	beluga	mill	2	0	7
32	9/20/15 17:52	70.525	140.553	beluga	swim	1	0	7
32	9/20/15 18:56	70.657	143.303	beluga	swim	1	0	6

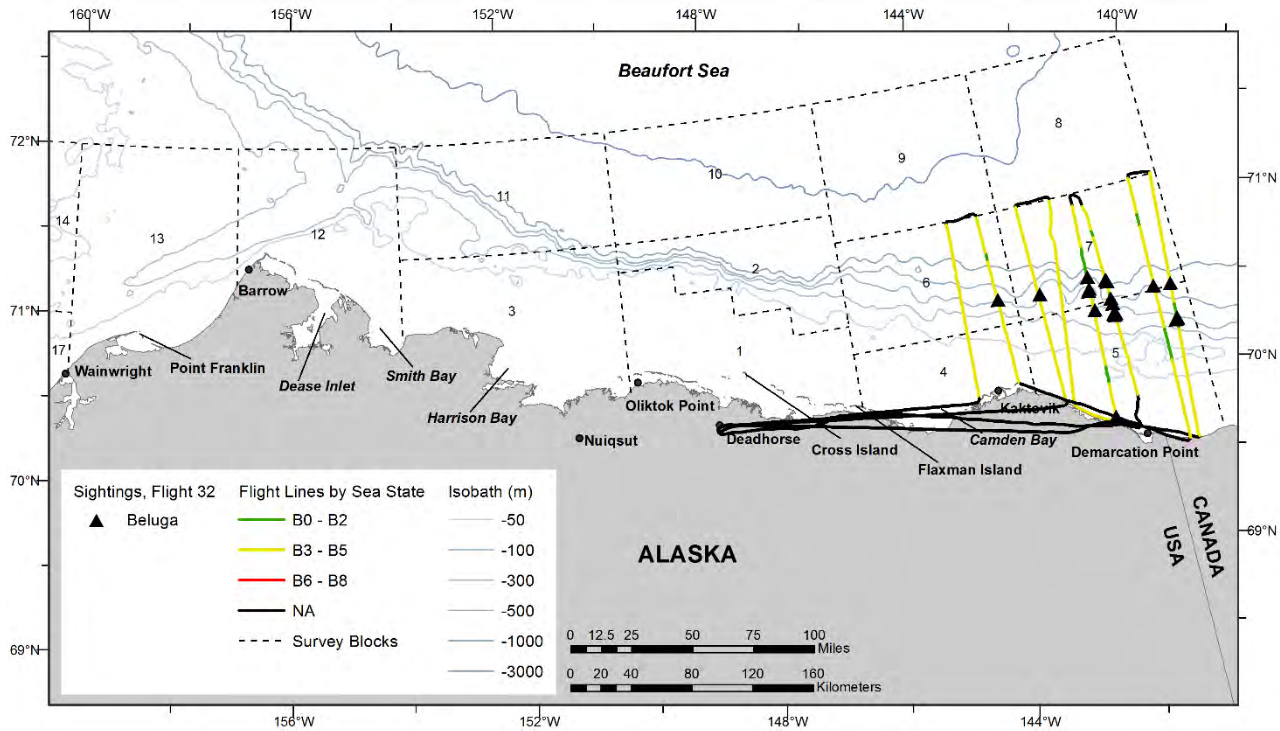

Figure B-72. ASAMM Flight 32 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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21 September 2015, Flight 241

Flight was a complete survey of transects 2, 15, 17, 19, and 21. 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. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including one carcass), belugas, walruses, unidentified pinnipeds, and small unidentified pinnipeds. The Point Lay walrus haulout was estimate at 9,000 animals.

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	9/21/15 10:42	70.418	165.116	bowhead whale	swim	2	0	18
241	9/21/15 12:59	70.206	162.689	beluga	swim	2	0	17
241	9/21/15 14:14	71.451	156.992	bowhead whale	swim	1	0	12
241	9/21/15 17:39	70.789	168.724	bowhead whale	dead	1	0	19

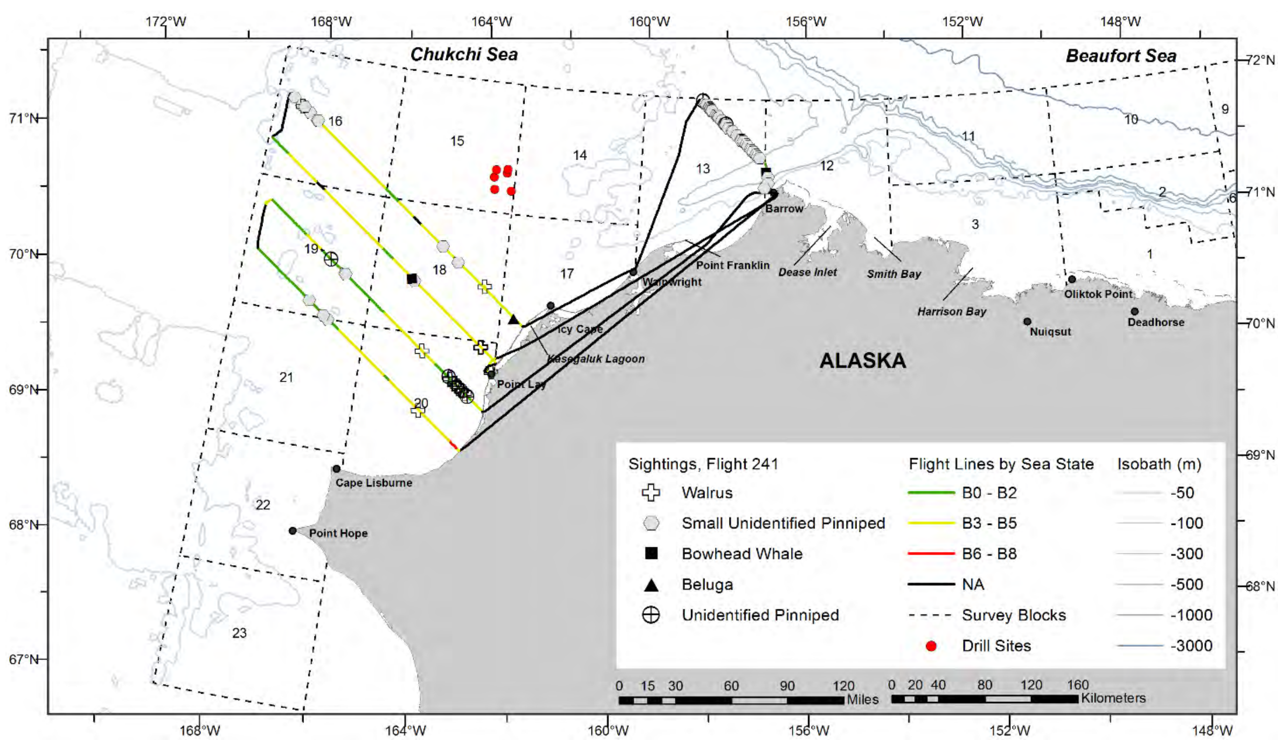

Figure B-73. ASAMM Flight 241 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

21 September 2015, Flight 33

Flight was a survey of portions of block 12. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 1-3 sea states. Sea ice cover was 0-5% new ice in the area surveyed. Sightings included bowhead whales (including six calves), 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
33	9/21/15 12:40	71.039	154.219	bowhead whale	swim	1	0	12
33	9/21/15 12:40	71.042	154.321	bowhead whale	swim	1	0	12
33	9/21/15 12:43	71.026	154.301	bowhead whale	swim	1	0	12
33	9/21/15 12:44	71.046	154.321	bowhead whale	swim	2	0	12
33	9/21/15 12:44	71.043	154.356	bowhead whale	swim	1	0	12
33	9/21/15 12:46	71.044	154.311	bowhead whale	swim	1	0	12
33	9/21/15 12:47	71.046	154.348	bowhead whale	swim	1	0	12
33	9/21/15 12:51	71.042	154.249	bowhead whale	swim	1	0	12
33	9/21/15 12:52	71.056	154.274	bowhead whale	swim	1	0	12
33	9/21/15 13:43	71.206	154.497	bowhead whale	swim	2	1	12
33	9/21/15 13:43	71.196	154.561	bowhead whale	swim	1	1	12
33	9/21/15 13:45	71.214	154.459	bowhead whale	swim	1	0	12
33	9/21/15 13:45	71.224	154.445	bowhead whale	swim	1	0	12
33	9/21/15 13:51	71.213	154.580	bowhead whale	swim	2	1	12
33	9/21/15 13:53	71.191	154.449	bowhead whale	swim	2	0	12
33	9/21/15 13:53	71.198	154.414	bowhead whale	swim	1	0	12
33	9/21/15 13:59	71.071	154.558	bowhead whale	swim	1	1	12
33	9/21/15 13:59	71.068	154.555	bowhead whale	swim	2	0	12
33	9/21/15 14:00	71.060	154.578	bowhead whale	swim	1	0	12
33	9/21/15 14:00	71.046	154.596	bowhead whale	swim	5	0	12
33	9/21/15 14:01	71.058	154.600	bowhead whale	feed	2	0	12
33	9/21/15 14:01	71.060	154.593	bowhead whale	feed	1	0	12
33	9/21/15 14:01	71.061	154.586	bowhead whale	feed	1	0	12
33	9/21/15 14:02	71.042	154.597	bowhead whale	feed	1	0	12
33	9/21/15 14:09	71.066	154.648	bowhead whale	feed	1	0	12
33	9/21/15 14:09	71.073	154.650	bowhead whale	feed	1	0	12
33	9/21/15 14:09	71.080	154.654	bowhead whale	feed	2	0	12
33	9/21/15 14:10	71.091	154.663	bowhead whale	feed	2	0	12
33	9/21/15 14:11	71.091	154.619	bowhead whale	feed	2	0	12
33	9/21/15 14:11	71.086	154.626	bowhead whale	dive	1	0	12
33	9/21/15 14:16	71.079	154.555	bowhead whale	feed	7	1	12
33	9/21/15 14:17	71.067	154.554	bowhead whale	feed	6	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
33	9/21/15 14:18	71.051	154.517	bowhead whale	feed	1	0	12
33	9/21/15 14:20	71.058	154.511	bowhead whale	unknown	1	0	12
33	9/21/15 14:31	70.992	154.529	bowhead whale	feed	2	0	12
33	9/21/15 14:36	71.135	154.855	bowhead whale	feed	1	0	12
33	9/21/15 14:37	71.141	154.852	bowhead whale	feed	1	0	12
33	9/21/15 14:38	71.130	154.835	bowhead whale	feed	2	0	12
33	9/21/15 14:41	71.160	155.057	bowhead whale	swim	1	0	12
33	9/21/15 14:41	71.170	155.055	bowhead whale	swim	1	0	12
33	9/21/15 14:43	71.216	155.135	bowhead whale	swim	1	0	12
33	9/21/15 14:48	71.308	155.178	bowhead whale	swim	1	0	12
33	9/21/15 15:34	71.316	155.732	bowhead whale	feed	1	0	12
33	9/21/15 15:34	71.309	155.709	bowhead whale	swim	2	0	12
33	9/21/15 15:35	71.292	155.753	bowhead whale	swim	5	0	12
33	9/21/15 15:36	71.319	155.802	bowhead whale	feed	2	0	12
33	9/21/15 15:36	71.322	155.776	bowhead whale	feed	20	1	12
33	9/21/15 15:36	71.318	155.765	bowhead whale	feed	3	0	12
33	9/21/15 15:37	71.315	155.763	bowhead whale	feed	3	0	12
33	9/21/15 15:37	71.312	155.766	bowhead whale	feed	3	0	12
33	9/21/15 15:39	71.323	155.772	bowhead whale	feed	1	0	12
33	9/21/15 15:39	71.313	155.763	bowhead whale	feed	2	0	12
33	9/21/15 15:43	71.317	155.809	bowhead whale	feed	1	0	12
33	9/21/15 15:47	71.311	155.848	bowhead whale	feed	1	0	12
33	9/21/15 15:47	71.311	155.848	bowhead whale	feed	1	0	12
33	9/21/15 15:47	71.300	155.885	bowhead whale	dive	2	0	12
33	9/21/15 15:48	71.279	155.892	bowhead whale	swim	1	0	12
33	9/21/15 15:48	71.272	155.883	beluga	swim	2	0	12
33	9/21/15 15:49	71.261	155.858	bowhead whale	feed	2	0	12
33	9/21/15 15:49	71.259	155.850	bowhead whale	feed	30	0	12
33	9/21/15 15:49	71.256	155.830	bowhead whale	feed	1	0	12
33	9/21/15 15:49	71.253	155.792	bowhead whale	dive	1	0	12
33	9/21/15 15:50	71.252	155.778	bowhead whale	feed	1	0	12
33	9/21/15 15:50	71.251	155.762	bowhead whale	feed	1	0	12
33	9/21/15 15:50	71.251	155.754	bowhead whale	feed	1	0	12
33	9/21/15 15:50	71.251	155.749	beluga	swim	1	0	12
33	9/21/15 15:50	71.251	155.749	bowhead whale	swim	2	0	12
33	9/21/15 15:51	71.265	155.695	bowhead whale	feed	2	0	12
33	9/21/15 15:51	71.274	155.713	bowhead whale	feed	12	0	12
33	9/21/15 15:51	71.278	155.732	bowhead whale	feed	3	0	12
33	9/21/15 15:54	71.273	155.696	bowhead whale	feed	3	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
33	9/21/15 15:57	71.285	155.906	bowhead whale	feed	1	0	12
33	9/21/15 15:57	71.301	155.946	bowhead whale	feed	1	0	12
33	9/21/15 15:58	71.317	155.995	bowhead whale	feed	4	0	12
33	9/21/15 15:58	71.324	156.017	bowhead whale	feed	1	0	12
33	9/21/15 16:05	71.418	156.439	bowhead whale	feed	2	0	12
33	9/21/15 16:05	71.424	156.402	bowhead whale	dive	2	0	12
33	9/21/15 16:11	71.606	156.234	bowhead whale	rest	1	0	12
33	9/21/15 16:49	71.352	156.960	beluga	swim	1	0	12

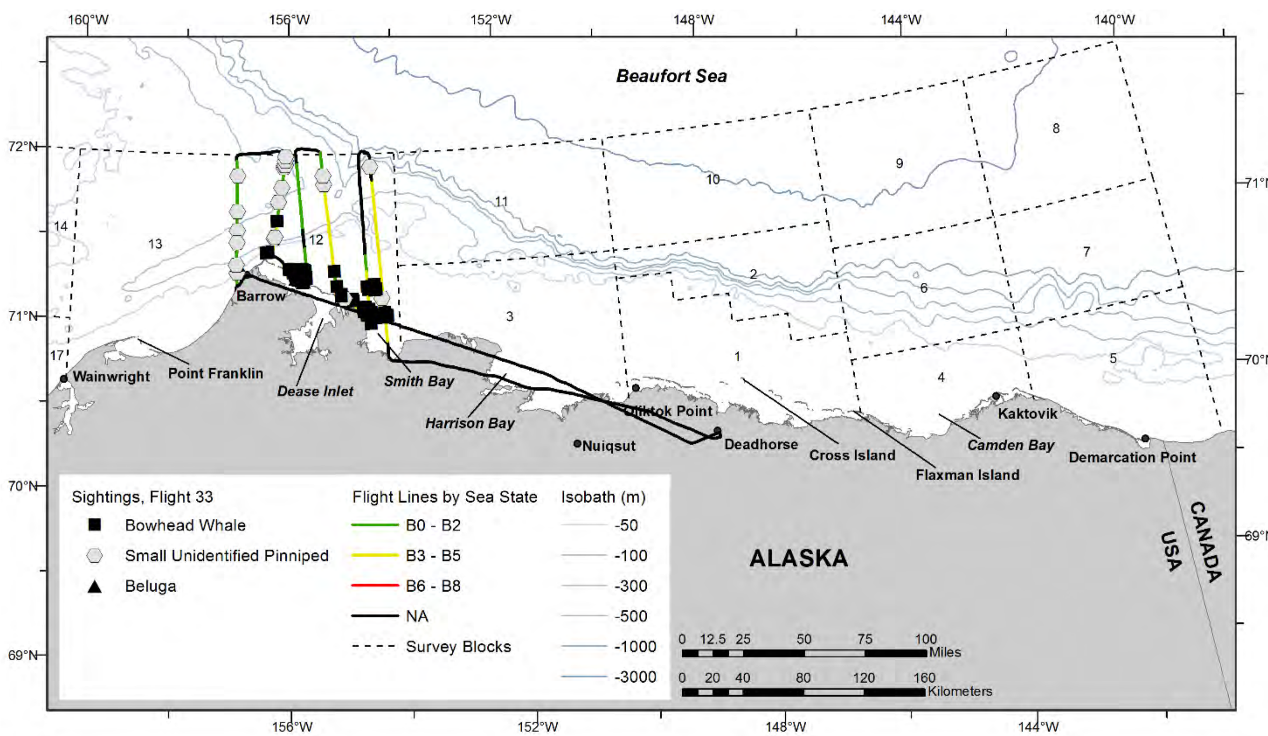

Figure B-74. ASAMM Flight 33 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale cow-calf pair sighted in the western Alaskan Beaufort Sea, approximately 75 km east of Barrow, during ASAMM Flight 33, 21 September 2015.

Bowhead whales echelon side skim feeding sighted in the western Alaskan Beaufort Sea, approximately 35 km east of Barrow, Alaska, during ASAMM Flight 33, 21 September 2015. These whales were part of a larger group of 20 feeding bowhead whales.

22 September 2015, Flight 242

Flight was a complete survey of transects 4, 23, and 27, and a partial survey of transect 25. Survey conditions included partly cloudy to overcast skies, unlimited visibility (with glare and low ceilings), and Beaufort 1-6 sea states. There was no sea ice in the area surveyed. Sightings included 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
242	9/22/15 17:24	71.395	156.475	beluga	mill	4	0	12

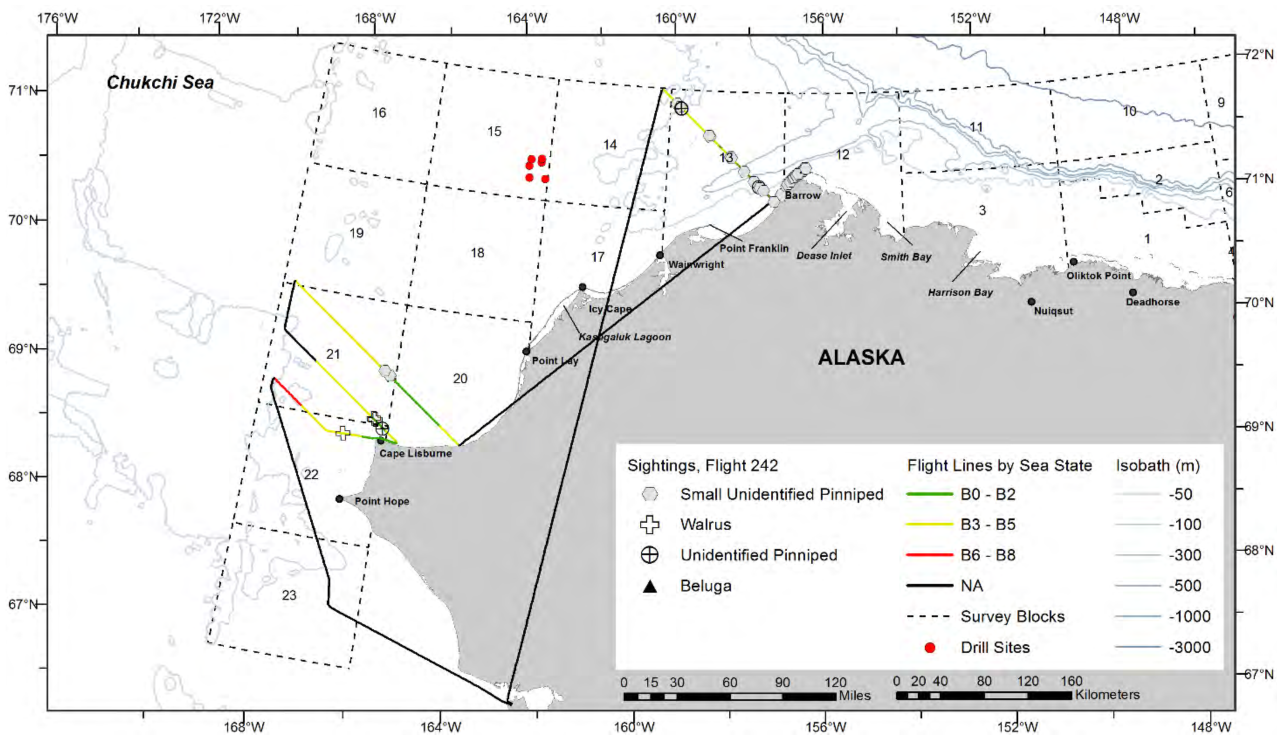

Figure B-75. ASAMM Flight 242 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

22 September 2015, Flight 34

Flight was a survey of portions of blocks 1, 2, 3, and 11. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, iced windows, low ceilings, and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-90% grease/new ice in the area surveyed. Sightings included bowhead whales, 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
34	9/22/15 13:06	71.188	150.668	bowhead whale	swim	1	0	3
34	9/22/15 15:47	71.174	148.175	beluga	swim	1	0	2
34	9/22/15 15:47	71.172	148.207	beluga	rest	4	0	2
34	9/22/15 15:47	71.161	148.188	beluga	rest	1	0	2
34	9/22/15 15:47	71.157	148.207	beluga	rest	1	0	2
34	9/22/15 15:48	71.149	148.199	beluga	rest	1	0	2
34	9/22/15 16:00	70.747	148.268	bowhead whale	swim	1	0	1

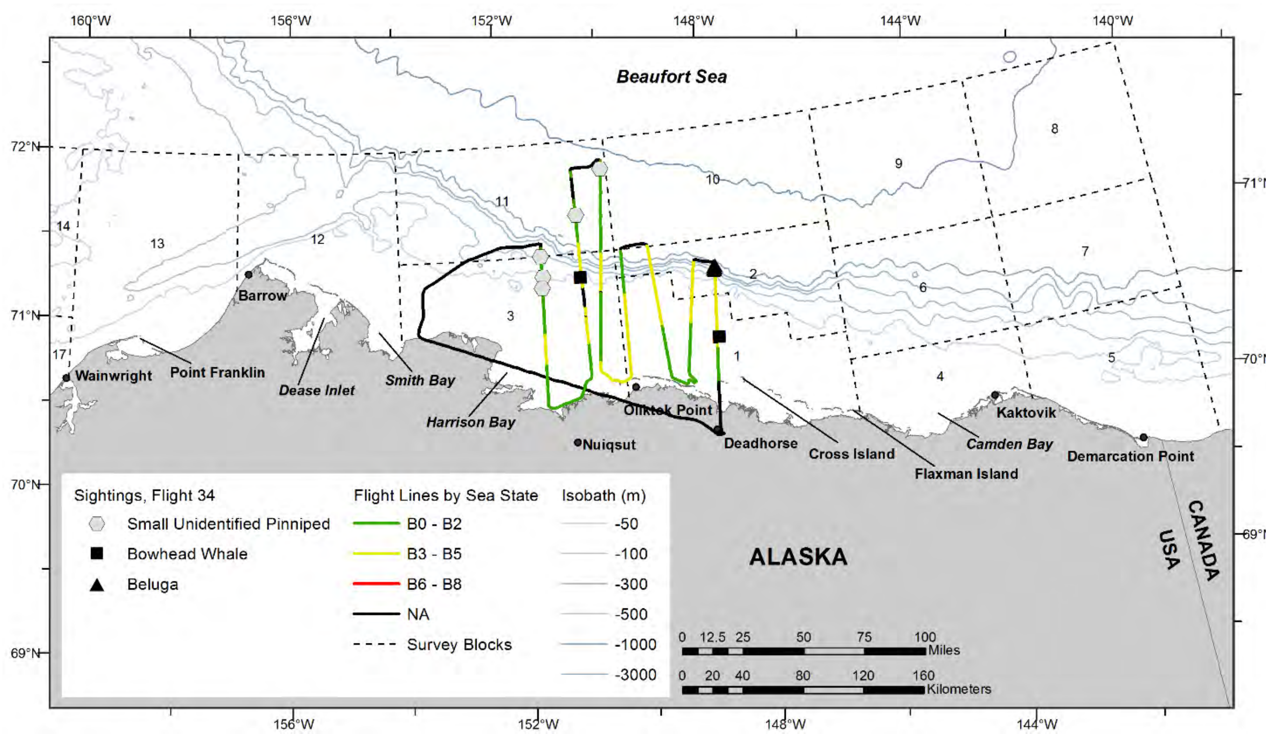

Figure B-76. ASAMM Flight 34 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

23 September 2015, Flight 35

Flight was a survey of block 4 and portions of blocks 1, 2, and 6. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with fog, glare, iced windows, low ceilings, and precipitation), and Beaufort 1-5 sea states. Sea ice cover was 0-50% new and broken floe ice in the area surveyed. Sightings included bowhead whales (including one carcass), belugas (including two calves), small unidentified pinnipeds, and polar bears (including nine 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
35	9/23/15 11:35	70.828	146.731	bowhead whale	dead	1	0	2
35	9/23/15 11:49	71.099	146.607	beluga	rest	1	0	2
35	9/23/15 12:08	71.043	146.385	beluga	rest	1	0	2
35	9/23/15 12:09	71.036	146.387	beluga	mill	3	0	2
35	9/23/15 12:10	70.986	146.368	beluga	swim	1	0	2
35	9/23/15 12:10	70.982	146.366	beluga	mill	6	1	2
35	9/23/15 12:10	70.981	146.386	beluga	mill	2	1	2
35	9/23/15 15:03	70.255	145.954	bowhead whale	breach	1	0	4
35	9/23/15 15:05	70.246	145.966	bowhead whale	breach	1	0	4
35	9/23/15 15:14	70.380	146.006	bowhead whale	breach	1	0	1
35	9/23/15 15:21	70.375	145.924	bowhead whale	swim	2	0	4

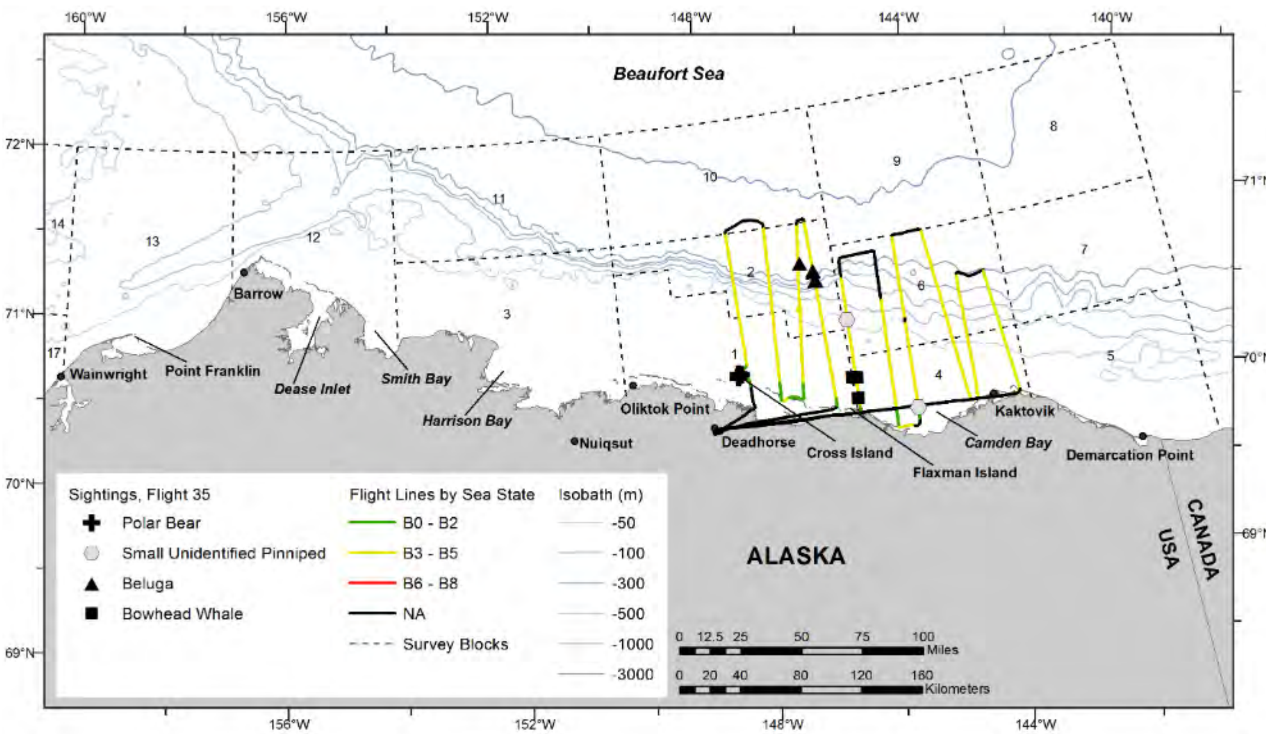

Figure B-77. ASAMM Flight 35 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Polar bears sighted walking on Cross Island, northeast of Deadhorse, Alaska, during ASAMM Flight 35, 23 September 2015.

Polar bears spread out across Cross Island, northeast of Deadhorse, Alaska, during ASAMM Flight 35, 23 September 2015. How many bears can you find?

Dead bowhead whale sighted floating in the western Alaskan Beaufort Sea, approximately 90 km northeast of Deadhorse, Alaska, during ASAMM Flight 35, 23 September 2015.

Young bowhead whale sighted chin breaching in the western Alaskan Beaufort Sea, approximately 90 km east-northeast of Deadhorse, Alaska, during ASAMM Flight 35, 23 September 2015.

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25 September 2015, Flight 243

Flight was the coastal transect survey from Cape Lisburne to approximately 40 km southwest of Barrow. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-3 sea states. There was no sea ice observed in the area surveyed. Sightings included unidentified pinnipeds (including one carcass) and small unidentified pinnipeds.

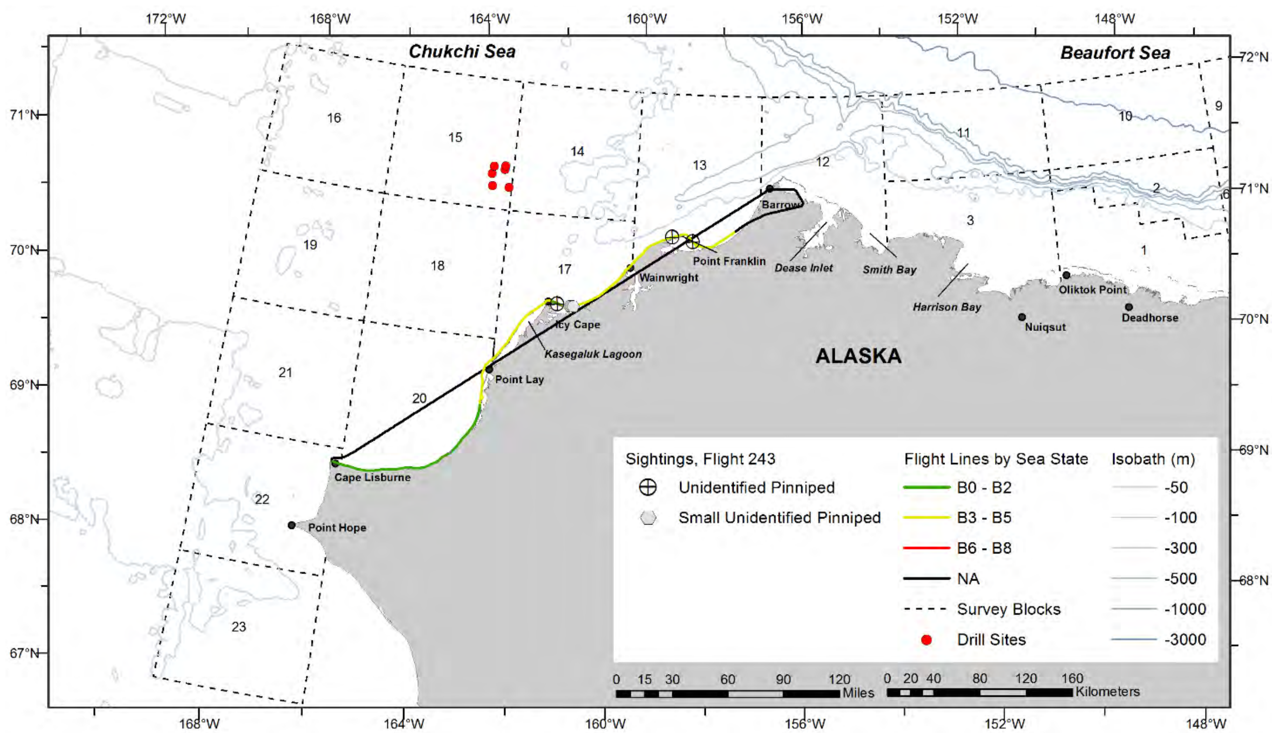

Figure B-78. ASAMM Flight 243 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

25 September 2015, Flight 36

Flight was a survey of portions of blocks 5 and 7. Survey conditions included clear to partly cloudy skies, <1 km to unlimited visibility (with fog, glare, haze, and low ceilings), and Beaufort 2-7 sea states. There was no sea ice observed ice in the area surveyed. Sightings included bowhead whales (including one calf), belugas, 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
36	9/25/15 10:36	70.237	140.251	bowhead whale	swim	1	0	5
36	9/25/15 10:42	70.284	140.314	bowhead whale	swim	1	0	5
36	9/25/15 10:45	70.330	140.284	bowhead whale	unknown	1	0	5
36	9/25/15 11:29	70.283	140.749	bowhead whale	swim	1	0	5
36	9/25/15 11:31	70.281	140.783	bowhead whale	swim	1	0	5
36	9/25/15 12:15	70.271	141.313	bowhead whale	swim	1	0	5
36	9/25/15 12:20	70.426	141.256	bowhead whale	swim	2	1	5
36	9/25/15 13:09	70.679	141.848	beluga	swim	1	0	7
36	9/25/15 13:11	70.640	141.795	beluga	rest	1	0	7
36	9/25/15 13:15	70.567	141.803	beluga	rest	1	0	7
36	9/25/15 13:16	70.523	141.786	beluga	swim	1	0	7
36	9/25/15 13:16	70.516	141.821	beluga	swim	1	0	7
36	9/25/15 13:16	70.512	141.813	beluga	swim	2	0	7
36	9/25/15 13:31	70.066	141.760	bowhead whale	swim	1	0	5

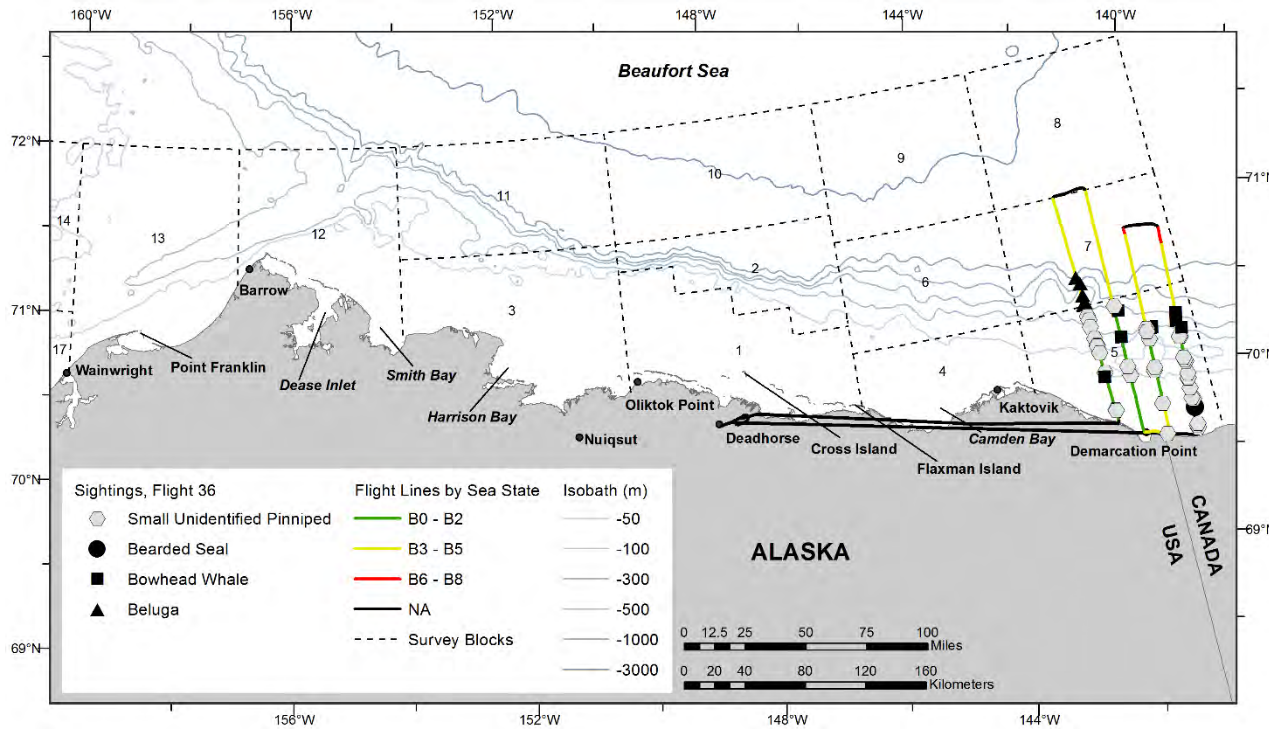

Figure B-79. ASAMM Flight 36 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

26 September 2015, Flight 37

Flight was a survey of portions of blocks 3 and 11. Survey conditions included overcast skies, 0-10 km visibility (with fog, low ceilings, and precipitation), and Beaufort 1-3 sea states. Sea ice cover was 0-75% grease/new ice in the area surveyed. Sightings included bowhead whales (including one calf), 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
37	9/26/15 14:32	71.105	153.604	bowhead whale	swim	1	0	3
37	9/26/15 14:35	71.175	153.586	bowhead whale	rest	2	1	3
37	9/26/15 14:39	71.204	153.583	bowhead whale	dive	1	0	3
37	9/26/15 14:41	71.293	153.603	beluga	swim	1	0	3
37	9/26/15 16:18	71.903	152.651	beluga	swim	2	0	11
37	9/26/15 16:18	71.921	152.635	beluga	swim	2	0	11
37	9/26/15 16:54	71.002	152.445	bowhead whale	swim	1	0	3
37	9/26/15 16:54	71.000	152.480	bowhead whale	swim	1	0	3
37	9/26/15 16:55	70.993	152.440	bowhead whale	swim	2	0	3
37	9/26/15 16:59	70.991	152.458	bowhead whale	swim	1	0	3
37	9/26/15 17:20	70.789	151.811	bowhead whale	swim	1	0	3
37	9/26/15 17:51	71.760	151.558	beluga	swim	1	0	11
37	9/26/15 17:51	71.764	151.570	beluga	swim	1	0	11
37	9/26/15 17:52	71.767	151.555	beluga	swim	2	0	11
37	9/26/15 17:52	71.771	151.553	beluga	swim	1	0	11
37	9/26/15 18:07	71.775	151.350	beluga	swim	1	0	11
37	9/26/15 18:11	71.661	151.341	beluga	swim	1	0	11
37	9/26/15 18:11	71.652	151.355	beluga	swim	1	0	11
37	9/26/15 18:11	71.639	151.364	beluga	swim	1	0	11
37	9/26/15 18:12	71.622	151.332	beluga	swim	1	0	11

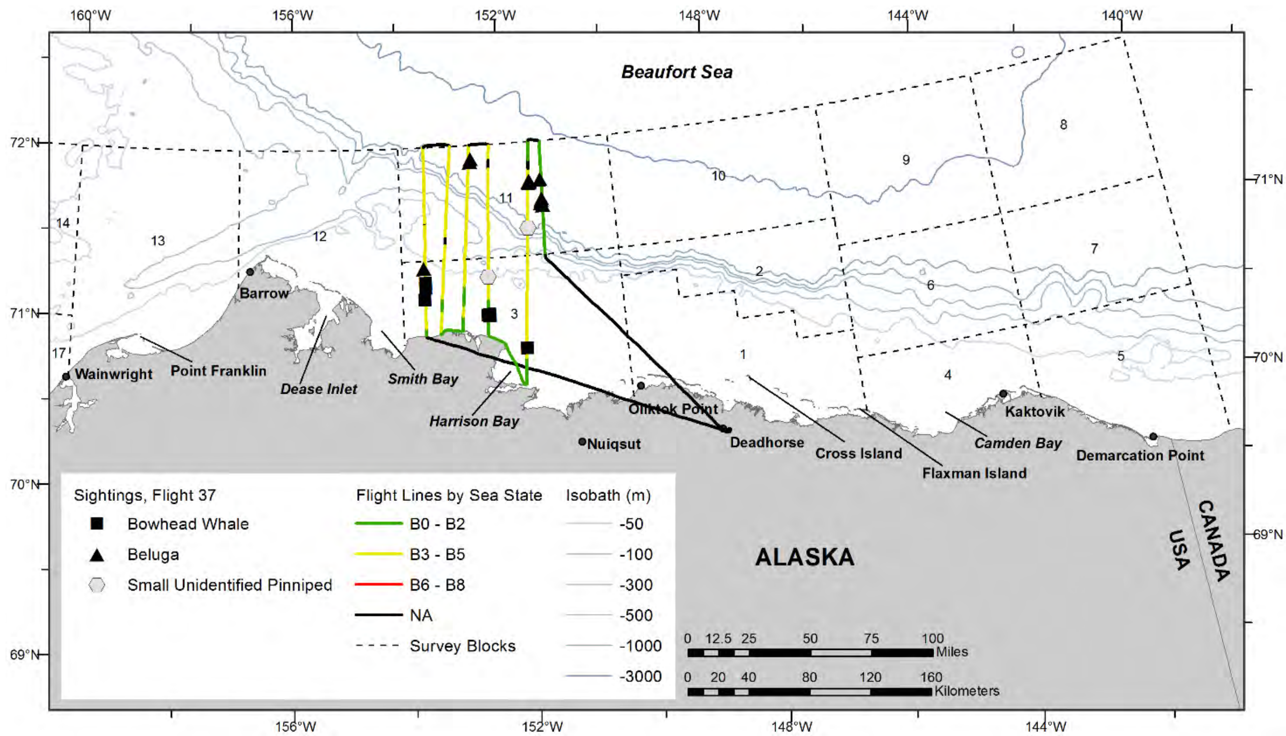

Figure B-80. ASAMM Flight 37 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale cow-calf pair sighted in the western Alaskan Beaufort Sea, approximately 100 km southeast of Barrow, Alaska, during ASAMM Flight 37, 26 September 2015. The lighter gray calf is to the right of the cow's flukes.

Bowhead whale cow and belly-up rolling calf sighted in the western Alaskan Beaufort Sea, approximately 100 km southeast of Barrow, Alaska, during ASAMM Flight 37, 26 September 2015. The flukes of the cow can be seen to the left of the calf.

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27 September 2015, Flight 244

Flight was a complete survey of transects 1, 5, 7, 9, and 11, and a partial survey of transect 3. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including one carcass), gray whales, one unidentified cetacean carcass, 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
244	9/27/15 12:28	71.232	161.454	gray whale	feed	1	0	14
244	9/27/15 12:31	71.253	161.530	gray whale	feed	1	0	14
244	9/27/15 12:34	71.231	161.489	gray whale	swim	1	0	14
244	9/27/15 12:50	70.921	160.436	gray whale	feed	1	0	17
244	9/27/15 12:52	70.913	160.352	gray whale	feed	2	0	17
244	9/27/15 12:52	70.897	160.359	gray whale	feed	1	0	17
244	9/27/15 13:26	71.333	157.123	unid cetacean	dead	1	0	13
244	9/27/15 13:32	71.476	157.595	bowhead whale	feed	1	0	13
244	9/27/15 13:33	71.500	157.597	bowhead whale	unknown	1	0	13
244	9/27/15 13:33	71.492	157.690	bowhead whale	swim	1	0	13
244	9/27/15 13:35	71.522	157.812	bowhead whale	rest	1	0	13
244	9/27/15 17:27	71.415	159.031	bowhead whale	dead	1	0	13
244	9/27/15 17:32	71.360	158.789	bowhead whale	rest	1	0	13

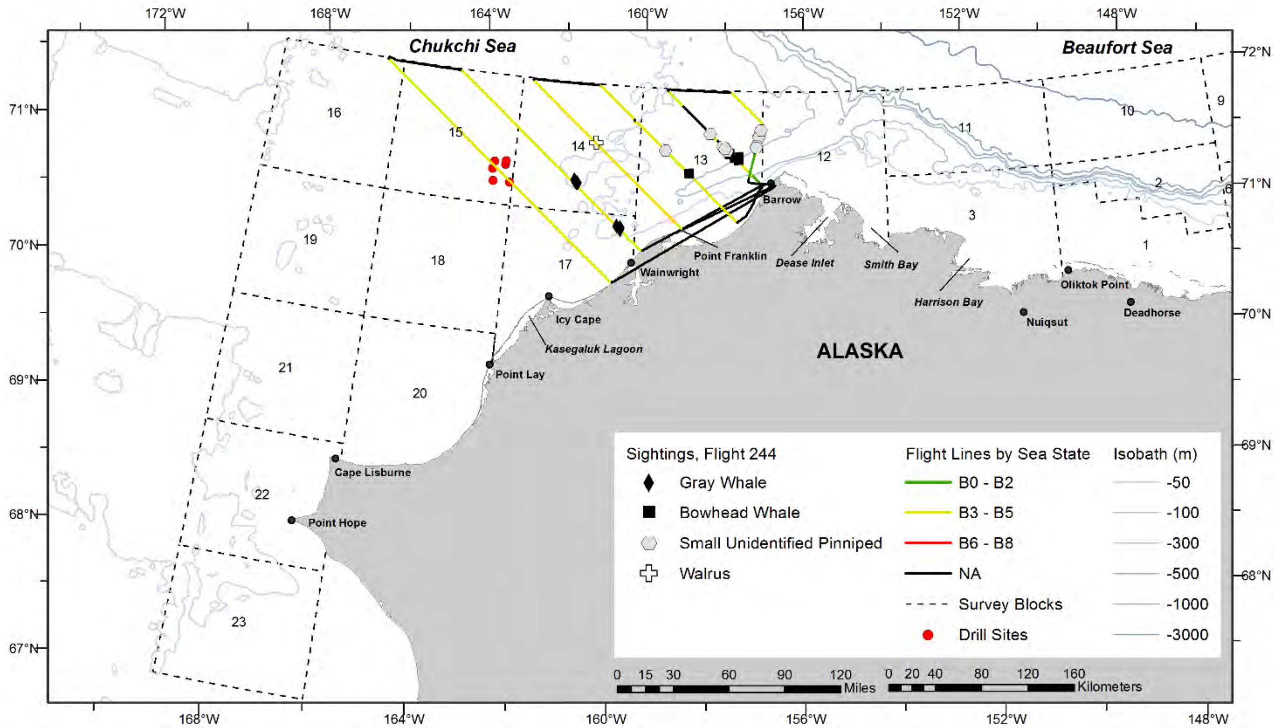


Figure B-81. ASAMM Flight 244 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

27 September 2015, Flight 38

Flight was a survey of block 12. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with haze, low ceilings, and precipitation), and Beaufort 2-3 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales, belugas (including four calves), unidentified cetaceans, one walrus, 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
38	9/27/15 12:38	71.373	156.780	unid cetacean	unknown	2	0	12
38	9/27/15 13:53	71.946	155.082	beluga	swim	1	0	12
38	9/27/15 13:53	71.944	155.087	beluga	swim	1	0	12
38	9/27/15 13:53	71.940	155.084	beluga	swim	1	0	12
38	9/27/15 13:53	71.934	155.088	beluga	swim	1	0	12
38	9/27/15 13:53	71.934	155.087	beluga	swim	1	0	12
38	9/27/15 13:53	71.932	155.088	beluga	mill	10	2	12
38	9/27/15 13:53	71.931	155.090	beluga	swim	4	0	12
38	9/27/15 13:54	71.897	155.088	beluga	swim	2	0	12
38	9/27/15 13:55	71.887	155.072	beluga	swim	1	0	12
38	9/27/15 13:55	71.870	155.097	beluga	swim	1	0	12
38	9/27/15 13:57	71.824	155.084	beluga	rest	1	0	12
38	9/27/15 13:57	71.823	155.107	beluga	swim	3	0	12
38	9/27/15 13:57	71.815	155.099	beluga	rest	4	0	12
38	9/27/15 14:01	71.815	155.164	beluga	swim	48	0	12
38	9/27/15 14:04	71.798	155.106	beluga	swim	1	0	12
38	9/27/15 14:05	71.791	155.092	beluga	mill	2	1	12
38	9/27/15 14:23	71.233	155.133	bowhead whale	feed	1	0	12
38	9/27/15 14:23	71.233	155.073	bowhead whale	feed	1	0	12
38	9/27/15 14:23	71.228	155.158	bowhead whale	feed	2	0	12
38	9/27/15 14:23	71.227	155.149	bowhead whale	feed	1	0	12
38	9/27/15 14:23	71.227	155.135	bowhead whale	feed	1	0	12
38	9/27/15 14:25	71.229	155.191	bowhead whale	feed	2	0	12
38	9/27/15 14:25	71.233	155.191	bowhead whale	swim	1	0	12
38	9/27/15 14:25	71.238	155.157	bowhead whale	feed	1	0	12
38	9/27/15 14:26	71.230	155.151	bowhead whale	feed	1	0	12
38	9/27/15 14:27	71.230	155.109	bowhead whale	swim	1	0	12
38	9/27/15 14:28	71.245	155.119	bowhead whale	swim	1	0	12
38	9/27/15 14:28	71.247	155.124	bowhead whale	feed	1	0	12
38	9/27/15 14:29	71.221	155.082	bowhead whale	feed	2	0	12
38	9/27/15 14:29	71.224	155.078	bowhead whale	feed	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
38	9/27/15 14:34	71.216	155.247	bowhead whale	swim	1	0	12
38	9/27/15 14:34	71.215	155.249	bowhead whale	swim	1	0	12
38	9/27/15 14:34	71.210	155.259	bowhead whale	swim	1	0	12
38	9/27/15 14:35	71.223	155.247	bowhead whale	swim	1	0	12
38	9/27/15 14:36	71.221	155.207	bowhead whale	feed	2	0	12
38	9/27/15 14:37	71.226	155.222	bowhead whale	feed	3	0	12
38	9/27/15 14:38	71.224	155.198	bowhead whale	mill	3	0	12
38	9/27/15 14:38	71.232	155.184	bowhead whale	feed	3	0	12
38	9/27/15 14:39	71.245	155.223	bowhead whale	feed	1	0	12
38	9/27/15 14:40	71.199	155.149	bowhead whale	feed	1	0	12
38	9/27/15 14:41	71.190	155.149	bowhead whale	swim	1	0	12
38	9/27/15 14:42	71.164	155.028	bowhead whale	swim	1	0	12
38	9/27/15 14:42	71.165	155.017	bowhead whale	swim	1	0	12
38	9/27/15 14:43	71.165	154.980	bowhead whale	feed	18	0	12
38	9/27/15 14:43	71.155	154.983	bowhead whale	mill	2	0	12
38	9/27/15 14:43	71.165	154.953	bowhead whale	swim	1	0	12
38	9/27/15 14:43	71.143	154.978	bowhead whale	feed	1	0	12
38	9/27/15 14:53	71.145	154.982	bowhead whale	feed	9	0	12
38	9/27/15 14:53	71.156	154.983	bowhead whale	feed	1	0	12
38	9/27/15 14:55	71.131	154.866	bowhead whale	feed	2	0	12
38	9/27/15 14:55	71.128	154.854	bowhead whale	feed	4	0	12
38	9/27/15 14:58	71.120	154.810	bowhead whale	feed	1	0	12
38	9/27/15 14:58	71.115	154.820	bowhead whale	feed	1	0	12
38	9/27/15 14:58	71.115	154.831	bowhead whale	feed	1	0	12
38	9/27/15 14:59	71.116	154.793	bowhead whale	feed	2	0	12
38	9/27/15 14:59	71.116	154.761	beluga	swim	1	0	12
38	9/27/15 14:59	71.117	154.759	beluga	swim	2	0	12
38	9/27/15 14:59	71.119	154.756	bowhead whale	feed	1	0	12
38	9/27/15 15:00	71.125	154.761	bowhead whale	feed	1	0	12
38	9/27/15 15:01	71.126	154.759	bowhead whale	feed	1	0	12
38	9/27/15 15:07	71.060	154.506	bowhead whale	feed	40	0	12
38	9/27/15 15:11	71.080	154.494	bowhead whale	feed	4	0	12
38	9/27/15 15:11	71.090	154.494	bowhead whale	feed	18	0	12
38	9/27/15 15:12	71.098	154.505	bowhead whale	feed	6	0	12
38	9/27/15 15:12	71.096	154.520	bowhead whale	feed	2	0	12
38	9/27/15 15:12	71.090	154.497	bowhead whale	feed	3	0	12
38	9/27/15 15:14	71.109	154.634	bowhead whale	feed	20	0	12
38	9/27/15 15:22	71.308	154.711	bowhead whale	feed	2	0	12
38	9/27/15 15:34	71.654	154.638	bowhead whale	swim	1	0	12
38	9/27/15 15:37	71.720	154.633	beluga	swim	2	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
38	9/27/15 15:43	71.921	154.663	beluga	swim	1	0	12
38	9/27/15 15:45	71.983	154.675	beluga	swim	3	1	12
38	9/27/15 15:45	71.998	154.693	beluga	rest	2	0	12
38	9/27/15 15:49	71.961	154.486	beluga	swim	1	0	12
38	9/27/15 15:49	71.962	154.473	beluga	swim	3	0	12
38	9/27/15 15:52	71.886	154.422	beluga	rest	1	0	12
38	9/27/15 15:52	71.876	154.467	beluga	rest	1	0	12
38	9/27/15 15:55	71.786	154.466	beluga	swim	1	0	12
38	9/27/15 15:55	71.780	154.491	beluga	swim	1	0	12
38	9/27/15 15:55	71.773	154.490	beluga	swim	1	0	12
38	9/27/15 15:55	71.773	154.450	beluga	swim	1	0	12
38	9/27/15 15:55	71.765	154.494	beluga	swim	1	0	12
38	9/27/15 15:56	71.736	154.478	beluga	swim	1	0	12
38	9/27/15 15:56	71.736	154.469	beluga	swim	2	0	12
38	9/27/15 15:56	71.730	154.473	beluga	swim	2	0	12
38	9/27/15 16:05	71.440	154.457	bowhead whale	swim	1	0	12
38	9/27/15 16:09	71.289	154.372	unid cetacean	swim	1	0	12
38	9/27/15 16:10	71.249	154.460	bowhead whale	mill	2	0	12
38	9/27/15 16:15	71.097	154.502	bowhead whale	feed	2	0	12
38	9/27/15 16:15	71.088	154.458	bowhead whale	feed	3	0	12
38	9/27/15 16:16	71.051	154.458	bowhead whale	dive	1	0	12
38	9/27/15 16:17	71.036	154.525	bowhead whale	swim	1	0	12
38	9/27/15 16:18	70.988	154.494	beluga	swim	1	0	12

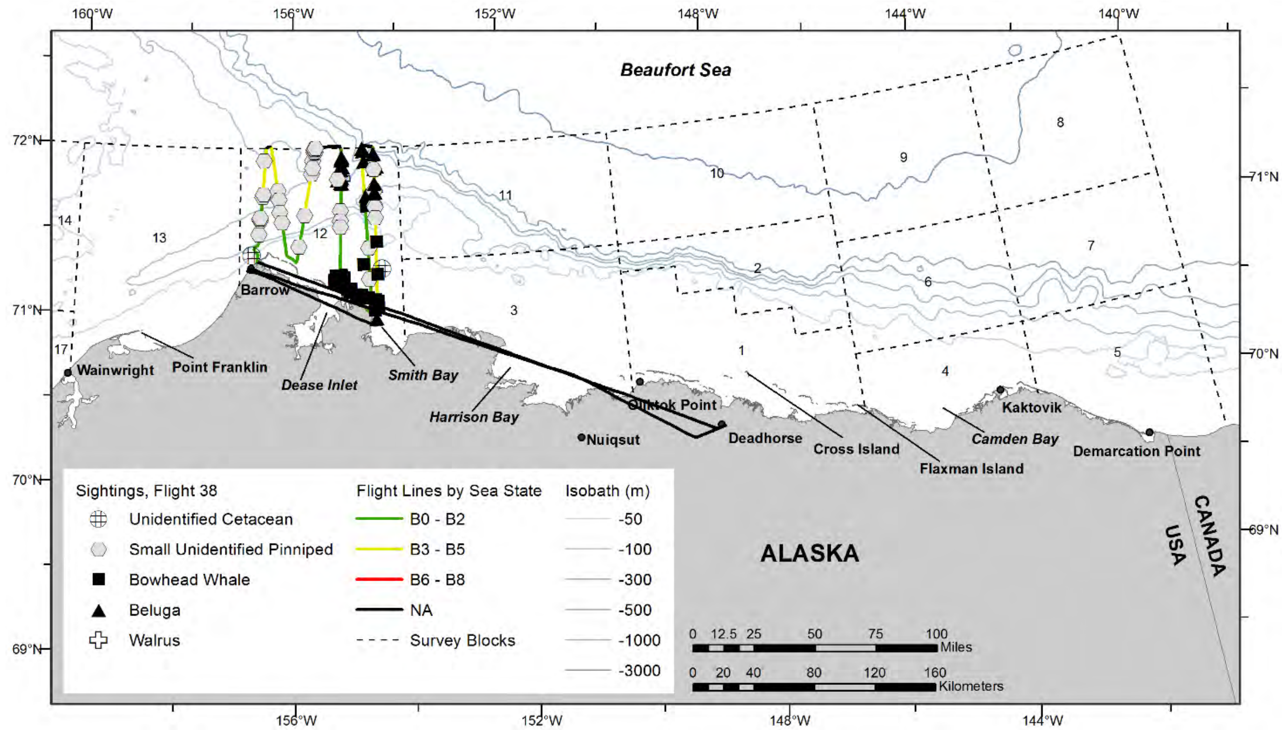


Figure B-82. ASAMM Flight 38 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whales sighted skim feeding in the western Alaskan Beaufort Sea, approximately 60 km southeast of Point Barrow, Alaska, during ASAMM Flight 38, 27 September 2015. These whales were a part of a larger group of 18 bowhead whales.

Bowhead whale feeding aggregation sighted in the western Alaskan Beaufort Sea, approximately 75 km southeast of Point Barrow, Alaska, during ASAMM Flight 38, 27 September 2015. These whales were a part of a larger group of approximately 40 feeding bowhead whales.

Two bowhead whales sighted feeding in the western Alaskan Beaufort Sea, approximately 75 km southeast of Point Barrow, Alaska, during ASAMM Flight 38, 27 September 2015. These whales were a part of a larger group of approximately 40 feeding bowhead whales. Only the upper rostrum, gum line, and baleen are visible on the whale skim feeding in the upper middle portion of the image. The second whale is side feeding, with white chin spots, right lower lip, right baleen rack, and rostrum visible.

28 September 2015, Flight 245

Flight was a complete survey of transects 6, 8, 13, and 15. 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. There was no sea ice observed in the area surveyed. Sightings included one bowhead whale carcass, walruses, and one breaded 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
245	9/28/15 17:36	71.444	159.198	bowhead whale	dead	1	0	13

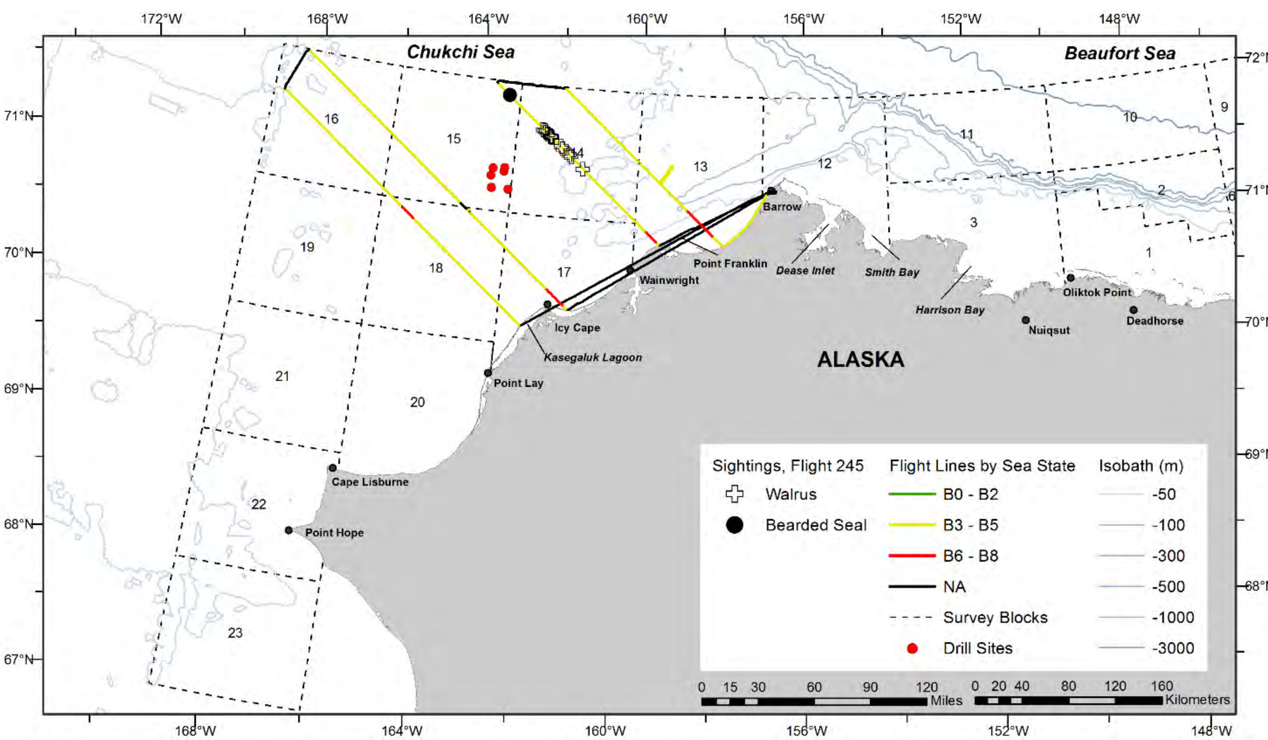


Figure B-83. ASAMM Flight 245 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

29 September 2015, Flight 39

Flight was a survey of portions of blocks 4, 5, 6, and 7, and a coastal search survey from Camden Bay to 65 km east of Deadhorse. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with fog, glare, haze, low ceilings, and precipitation), and Beaufort 1-5 sea states. Sea ice cover was 0-85% new and broken floe ice in the area surveyed. Sightings included one bowhead whale and one beluga.

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	9/29/15 11:18	70.213	142.959	bowhead whale	swim	1	0	5
39	9/29/15 11:27	70.220	143.321	beluga	swim	1	0	4

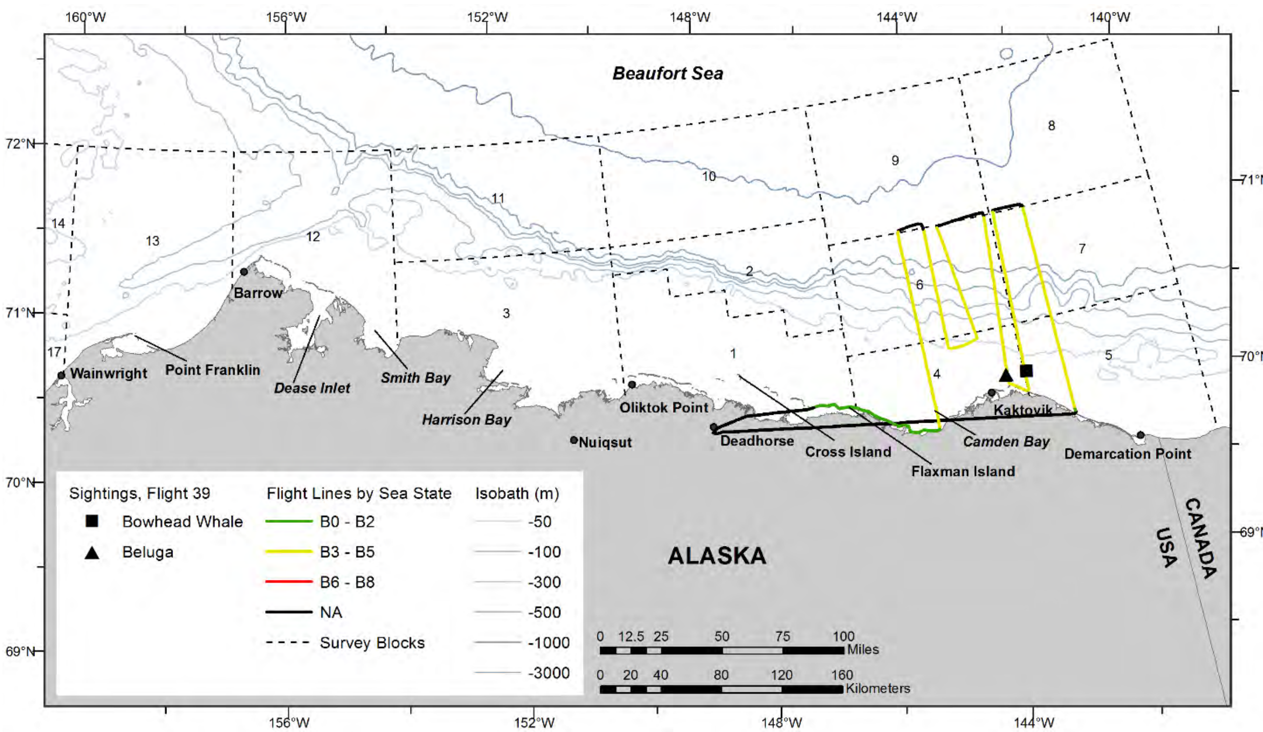


Figure B-84. ASAMM Flight 39 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

30 September 2015, Flight 40

Flight was a survey of portions of blocks 1 and 11. Survey conditions included partly cloudy skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 3-6 sea states. Sea ice cover was 0-65% new and broken floe 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
40	9/30/15 14:17	71.725	150.829	beluga	rest	1	0	11
40	9/30/15 14:18	71.730	150.817	beluga	swim	2	0	11
40	9/30/15 14:18	71.734	150.807	beluga	swim	3	0	11
40	9/30/15 14:18	71.734	150.806	beluga	swim	6	0	11
40	9/30/15 14:23	71.917	150.826	beluga	swim	2	0	11
40	9/30/15 14:24	71.921	150.819	beluga	swim	2	0	11
40	9/30/15 14:24	71.923	150.837	beluga	swim	1	0	11
40	9/30/15 14:24	71.925	150.840	beluga	swim	1	0	11
40	9/30/15 14:25	71.967	150.825	beluga	swim	1	0	11

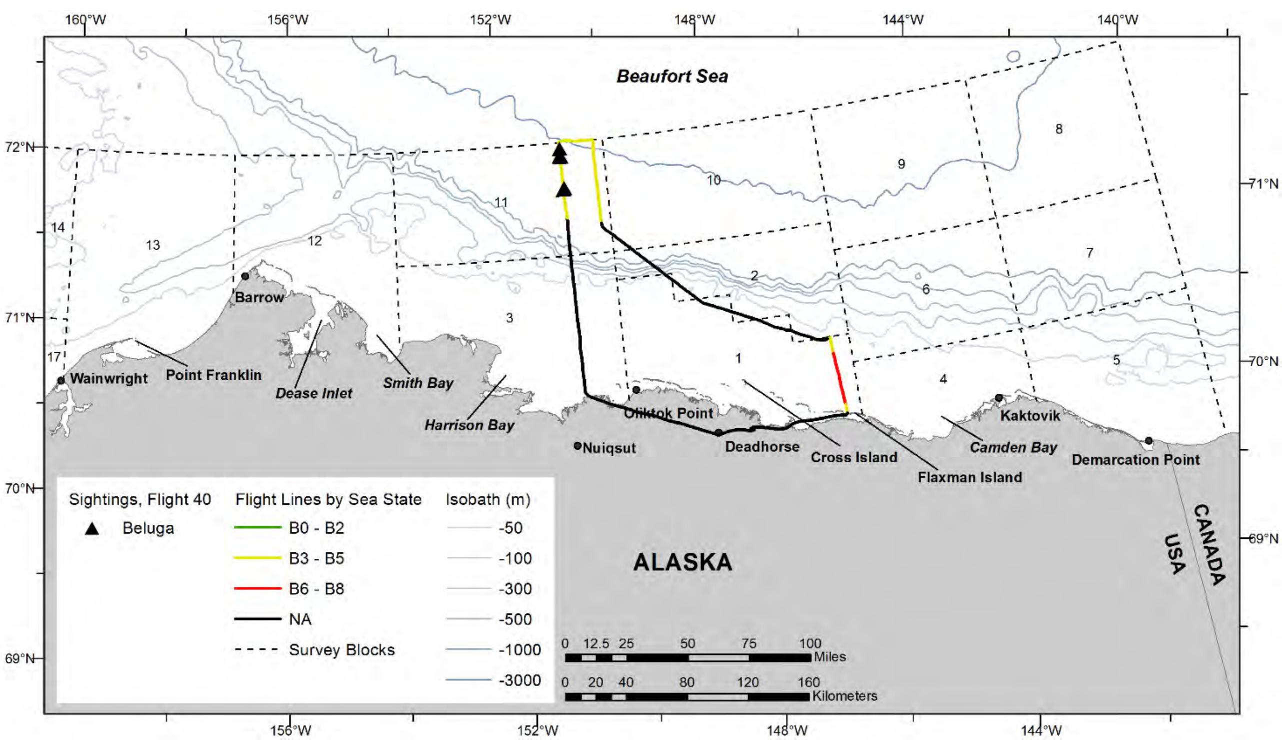


Figure B-85. ASAMM Flight 40 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

2 October 2015, Flight 41

Flight was a survey of blocks 1 and 2, and portions of blocks 3, 4, 6, and 11. Survey conditions included partly cloudy to overcast skies, 1 km to unlimited visibility (with glare, haze, and precipitation), and Beaufort 1-3 sea states. Sea ice cover was 0-90% grease/new and broken floe ice in the area surveyed. Sightings included bowhead whales (including two calves), belugas (including two calves), one unidentified cetacean, one unidentified pinniped, small unidentified pinnipeds, and polar bears (including 6 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
41	10/2/15 9:45	70.814	150.825	bowhead whale	rest	1	0	3
41	10/2/15 9:46	70.818	150.833	bowhead whale	rest	2	1	3
41	10/2/15 9:46	70.812	150.835	bowhead whale	rest	1	0	3
41	10/2/15 9:46	70.811	150.817	bowhead whale	mill	2	0	3
41	10/2/15 9:47	70.798	150.802	bowhead whale	rest	1	0	3
41	10/2/15 9:48	70.792	150.839	bowhead whale	rest	1	0	3
41	10/2/15 9:48	70.803	150.831	bowhead whale	mill	2	0	3
41	10/2/15 9:51	70.821	150.836	bowhead whale	feed	1	0	3
41	10/2/15 9:54	70.833	150.836	bowhead whale	rest	1	0	3
41	10/2/15 9:56	70.816	150.812	bowhead whale	rest	1	0	3
41	10/2/15 9:56	70.821	150.838	bowhead whale	mill	2	1	3
41	10/2/15 9:58	70.821	150.742	bowhead whale	rest	1	0	3
41	10/2/15 9:59	70.825	150.728	bowhead whale	rest	1	0	3
41	10/2/15 9:59	70.821	150.751	bowhead whale	rest	1	0	3
41	10/2/15 10:01	70.845	150.776	bowhead whale	swim	1	0	3
41	10/2/15 10:17	71.337	150.785	beluga	rest	1	0	11
41	10/2/15 10:18	71.353	150.766	beluga	swim	1	0	11
41	10/2/15 10:18	71.366	150.788	beluga	rest	1	0	11
41	10/2/15 10:20	71.417	150.836	beluga	swim	16	0	11
41	10/2/15 11:39	71.223	149.081	beluga	swim	1	0	2
41	10/2/15 11:39	71.222	149.040	beluga	swim	53	0	2
41	10/2/15 11:39	71.220	149.068	beluga	swim	1	0	2
41	10/2/15 13:29	71.056	147.751	beluga	swim	2	1	2
41	10/2/15 13:46	71.121	147.462	beluga	rest	2	1	2
41	10/2/15 13:47	71.085	147.468	beluga	rest	1	0	2
41	10/2/15 14:03	70.571	147.379	unid cetacean	feed	1	0	1
41	10/2/15 16:18	71.145	146.448	beluga	swim	1	0	2
41	10/2/15 16:23	70.968	146.427	beluga	swim	1	0	2
41	10/2/15 16:23	70.963	146.424	beluga	swim	1	0	2
41	10/2/15 16:24	70.950	146.390	beluga	swim	4	0	2

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
41	10/2/15 16:24	70.945	146.405	beluga	swim	5	0	2
41	10/2/15 17:23	70.992	145.724	beluga	rest	1	0	6
41	10/2/15 17:24	71.023	145.717	beluga	rest	1	0	6
41	10/2/15 17:25	71.058	145.760	beluga	swim	1	0	6

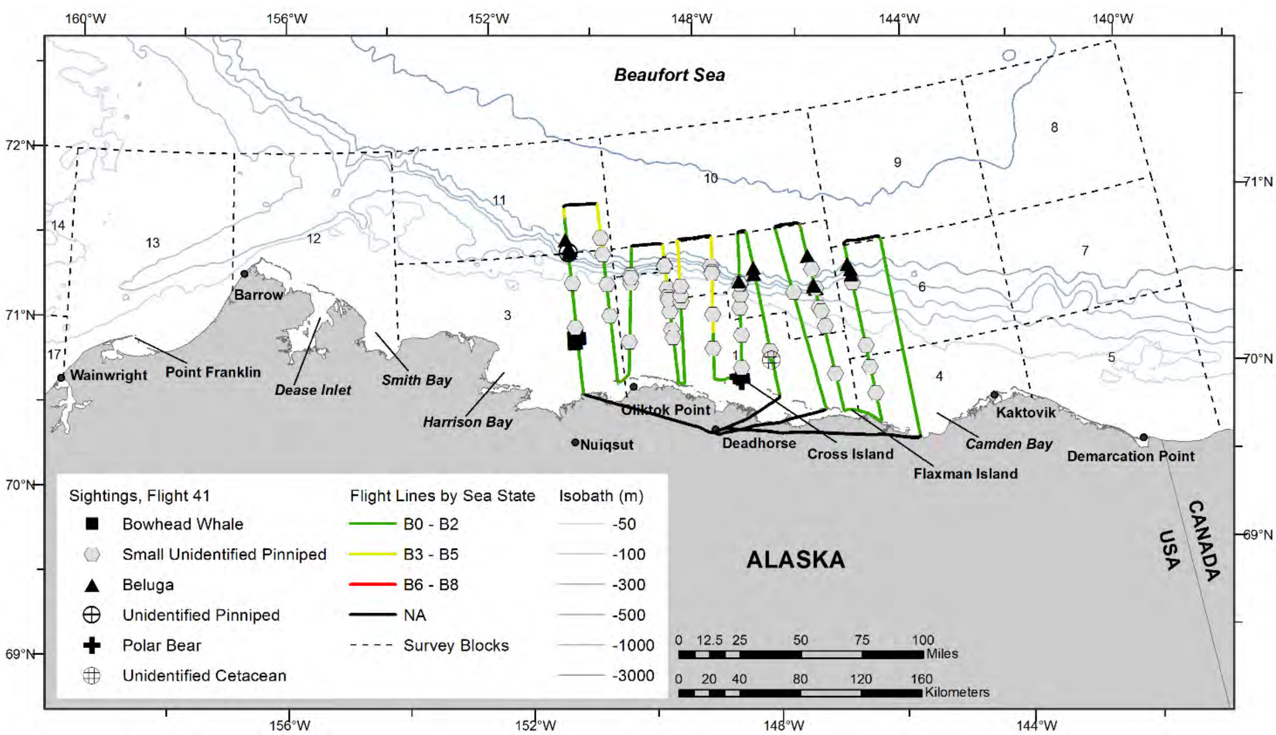
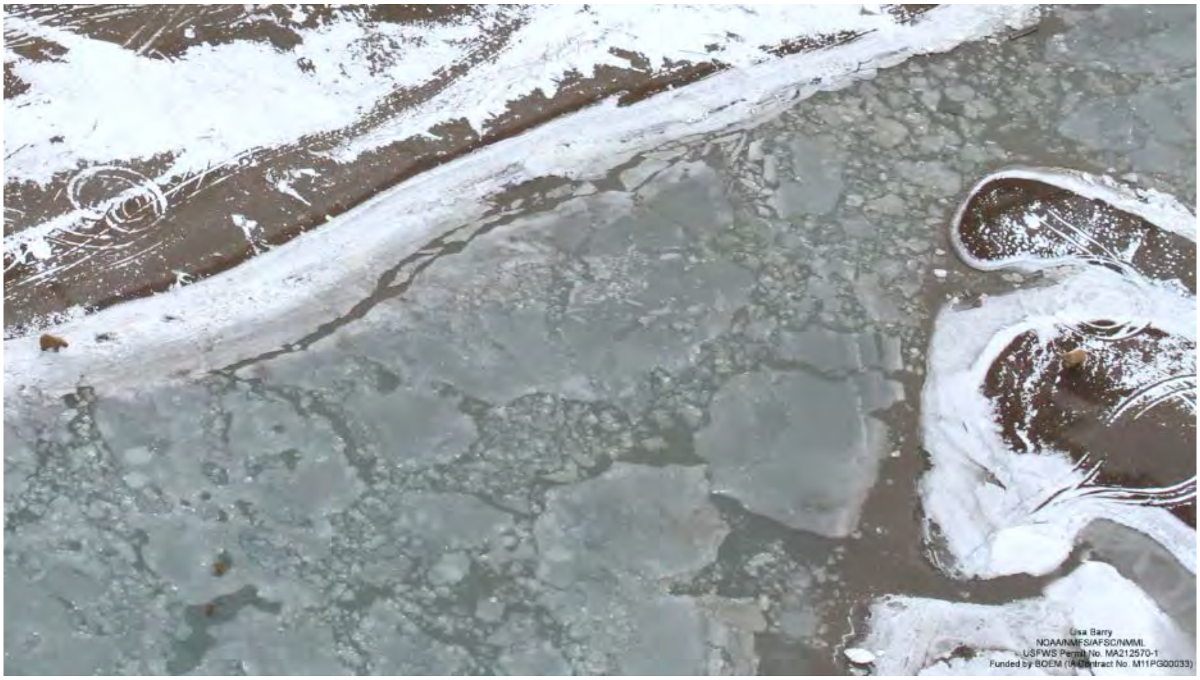


Figure B-86. ASAMM Flight 41 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale flexing just prior to a dive, sighted north of Harrison Bay in the western Alaskan Beaufort Sea, during ASAMM Flight 41, 2 October 2015.

Bowhead whale with mud visible on its head, sighted north of Harrison Bay in the western Alaskan Beaufort Sea, during ASAMM Flight 41, 2 October 2015.



Polar bears sighted in and around one of the quickly freezing lagoons on Cross Island, northeast of Deadhorse, Alaska, during ASAMM Flight 41, 2 October 2015.

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3 October 2015, Flight 246

Flight was a partial survey of transects 16 and 18 and search effort from Point Franklin to southwest of Barrow. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 3-6 sea states. There was no sea ice observed in the area surveyed. Sightings included gray whales.

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	10/3/15 16:54	71.014	158.161	gray whale	rest	1	0	13
246	10/3/15 16:58	71.020	158.096	gray whale	feed	1	0	13
246	10/3/15 16:59	71.017	158.099	gray whale	feed	1	0	13
246	10/3/15 16:59	71.024	158.101	gray whale	feed	1	0	13
246	10/3/15 17:00	71.034	158.090	gray whale	feed	1	0	13

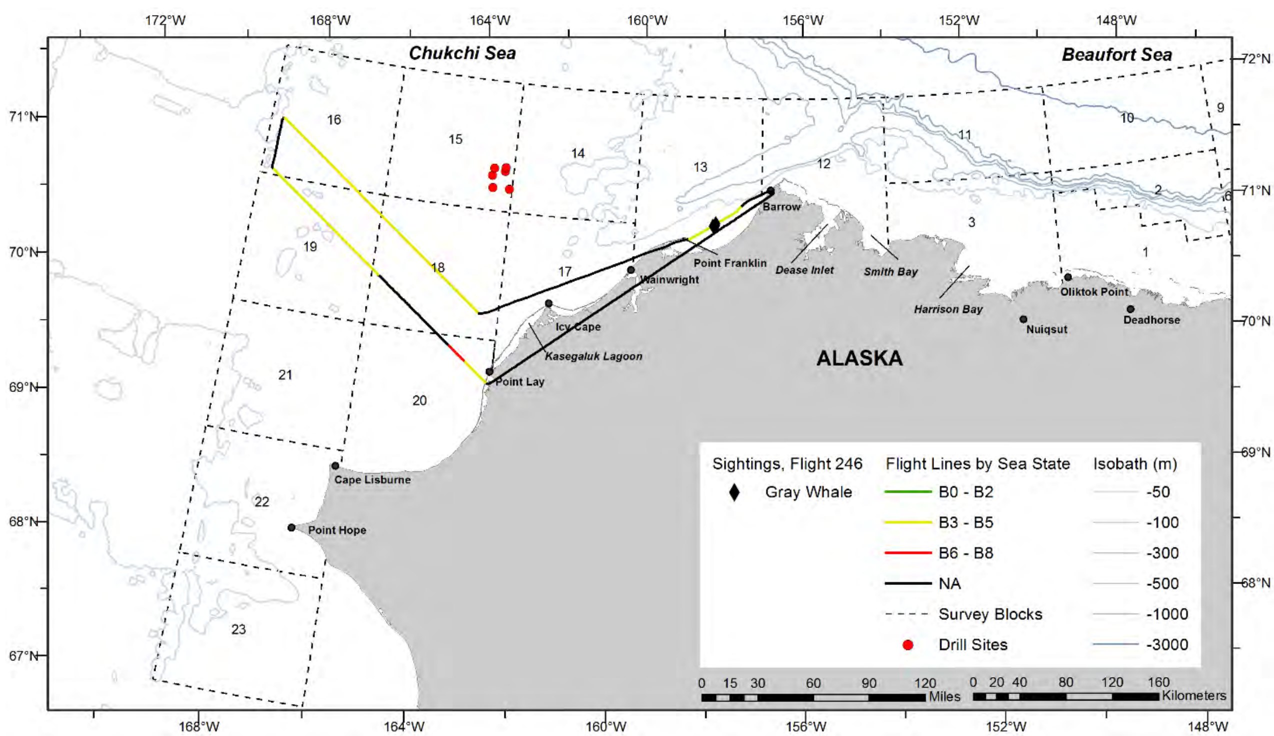


Figure B-87. ASAMM Flight 246 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

3 October 2015, Flight 42

Flight was a survey of portions of blocks 5 and 7. Survey conditions included partly cloudy to overcast skies, 1 km to unlimited visibility (with glare, haze, low ceilings, and precipitation), and Beaufort 1-2 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including one calf), belugas (including nine calves), 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
42	10/3/15 10:44	70.316	140.426	beluga	swim	5	2	5
42	10/3/15 10:44	70.320	140.435	beluga	swim	1	0	5
42	10/3/15 10:44	70.323	140.430	beluga	swim	1	0	5
42	10/3/15 10:44	70.323	140.421	beluga	swim	3	0	5
42	10/3/15 10:45	70.328	140.419	beluga	swim	2	0	5
42	10/3/15 10:45	70.338	140.438	beluga	swim	1	0	5
42	10/3/15 10:45	70.349	140.455	beluga	swim	3	1	5
42	10/3/15 10:46	70.364	140.405	beluga	swim	2	0	5
42	10/3/15 10:47	70.392	140.440	beluga	swim	1	0	5
42	10/3/15 10:47	70.394	140.462	beluga	swim	1	0	5
42	10/3/15 10:49	70.455	140.460	beluga	swim	1	0	5
42	10/3/15 10:49	70.467	140.404	beluga	swim	1	0	5
42	10/3/15 10:52	70.569	140.462	beluga	swim	1	0	7
42	10/3/15 10:52	70.572	140.476	beluga	swim	1	0	7
42	10/3/15 10:52	70.578	140.443	beluga	swim	1	0	7
42	10/3/15 10:53	70.583	140.463	beluga	swim	1	0	7
42	10/3/15 10:53	70.606	140.416	beluga	swim	2	1	7
42	10/3/15 11:38	70.462	140.825	beluga	swim	1	0	5
42	10/3/15 11:41	70.367	140.850	beluga	swim	1	0	5
42	10/3/15 12:14	69.892	141.291	bowhead whale	rest	2	1	5
42	10/3/15 12:35	70.413	141.192	beluga	swim	1	0	5
42	10/3/15 12:35	70.428	141.181	beluga	swim	1	0	5
42	10/3/15 12:35	70.431	141.207	beluga	swim	1	0	5
42	10/3/15 12:35	70.435	141.195	beluga	swim	1	0	5
42	10/3/15 12:35	70.436	141.203	beluga	swim	11	0	5
42	10/3/15 12:36	70.450	141.237	beluga	swim	1	0	5
42	10/3/15 12:37	70.497	141.202	beluga	swim	1	0	5
42	10/3/15 13:23	70.484	141.655	beluga	swim	10	1	5
42	10/3/15 13:23	70.479	141.656	beluga	swim	6	2	5
42	10/3/15 13:24	70.463	141.651	beluga	swim	6	2	5

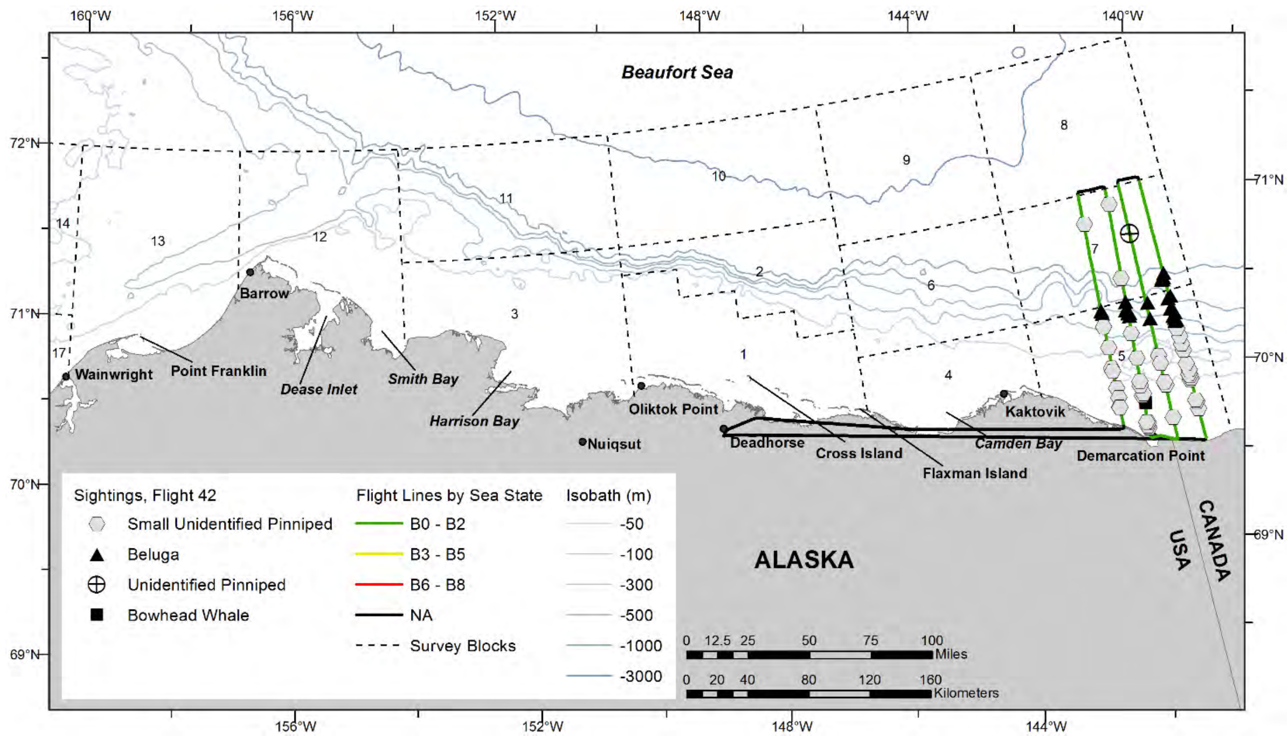
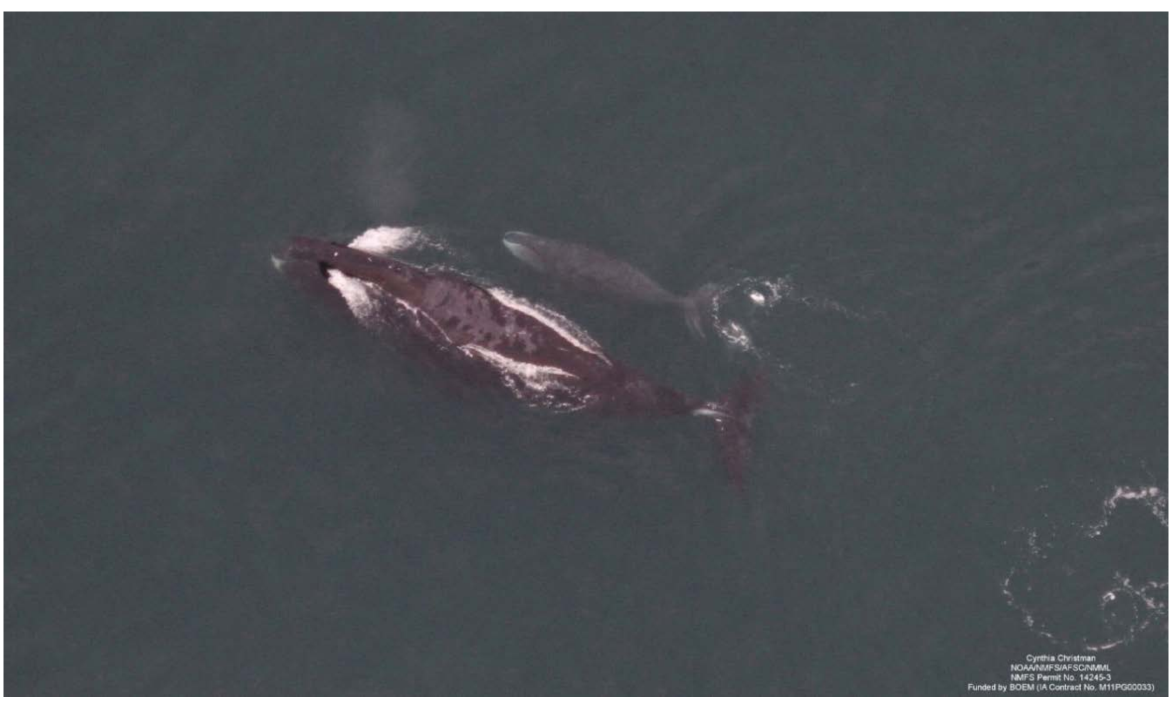


Figure B-88. ASAMM Flight 42 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.



Bowhead whale cow-calf pair sighted resting in the eastern Alaskan Beaufort Sea, approximately 90 km southeast of Kaktovik, Alaska, during ASAMM Flight 42, 3 October 2015.

Team Beaufort after a successful aerial survey of the western Alaskan Beaufort Sea, during ASAMM Flight 42, 3 October 2015.
L to R: Corey Accardo, Jake Turner, Greg Pfeifer, Cynthia Christman, and Lisa Barry.

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4 October 2015, Flight 247

Flight was a complete survey of transects 1, 2, 3, 5, and 7. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included bowhead whales (including one carcass), 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
247	10/4/15 10:23	71.151	159.646	bowhead whale	rest	1	0	13
247	10/4/15 10:27	71.166	159.649	bowhead whale	dive	2	0	13
247	10/4/15 10:48	71.601	161.288	bowhead whale	dive	1	0	14
247	10/4/15 12:02	71.281	158.512	bowhead whale	dead	1	0	13
247	10/4/15 12:41	71.422	157.475	beluga	rest	1	0	13
247	10/4/15 12:53	71.710	158.392	beluga	swim	1	0	13
247	10/4/15 13:18	71.884	158.244	bowhead whale	swim	1	0	13
247	10/4/15 13:50	71.592	157.006	bowhead whale	swim	1	0	13
247	10/4/15 13:50	71.593	157.019	bowhead whale	swim	1	0	13
247	10/4/15 13:50	71.598	157.006	bowhead whale	swim	1	0	13
247	10/4/15 13:51	71.609	157.018	bowhead whale	swim	1	0	13
247	10/4/15 13:51	71.612	156.929	bowhead whale	rest	2	0	12
247	10/4/15 13:52	71.608	156.938	bowhead whale	dive	1	0	12
247	10/4/15 13:55	71.599	156.923	bowhead whale	dive	1	0	12
247	10/4/15 13:55	71.610	156.916	bowhead whale	rest	1	0	12
247	10/4/15 13:56	71.626	156.875	bowhead whale	rest	1	0	12
247	10/4/15 13:56	71.626	156.868	bowhead whale	rest	1	0	12
247	10/4/15 13:56	71.625	156.855	bowhead whale	rest	1	0	12
247	10/4/15 13:57	71.628	156.860	bowhead whale	swim	1	0	12

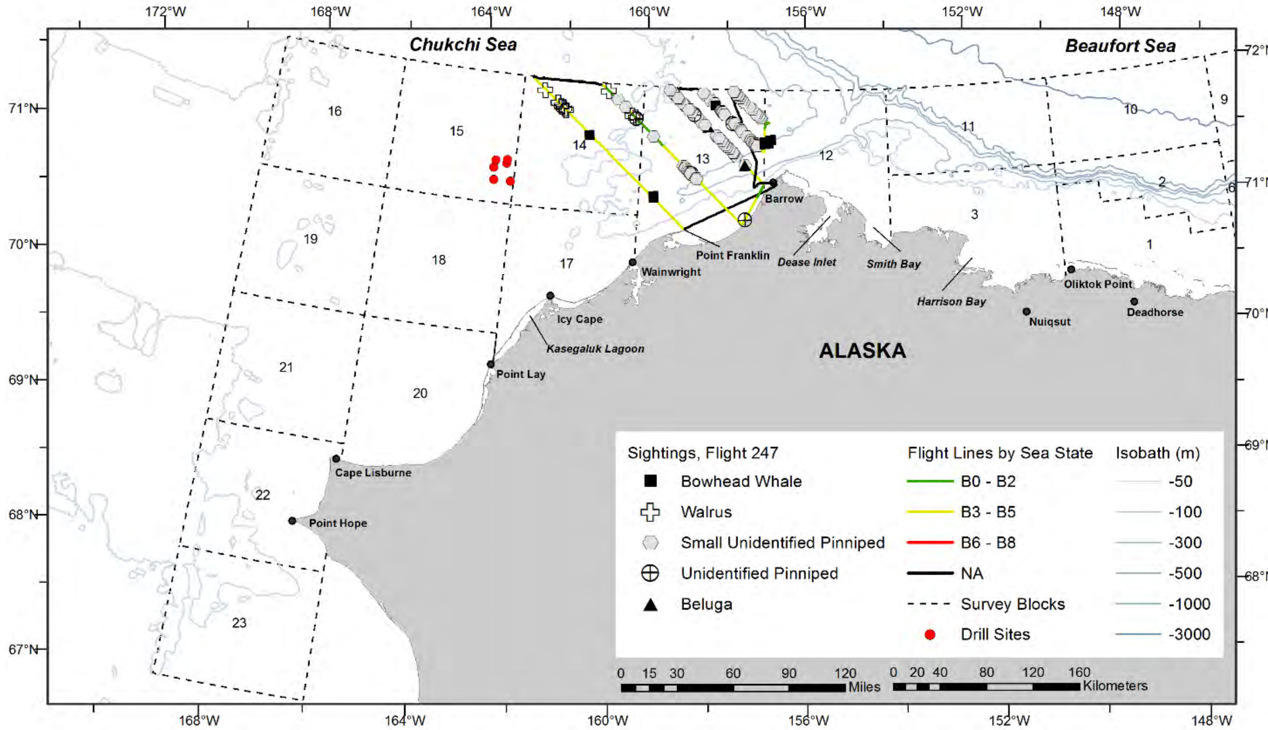

Figure B-89. ASAMM Flight 247 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

4 October 2015, Flight 43

Flight was a survey of block 12 and portions of blocks 3 and 11. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 1-4 sea states. Sea ice cover was 0-85% new/grease ice in the area surveyed. Sightings included bowhead whales (including 8 calves and 2 carcasses, one of which was a calf carcass), belugas (including 31 calves), one unidentified cetacean carcass, one walrus, unidentified pinnipeds, 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
43	10/4/15 10:19	71.024	154.219	bowhead whale	rest	1	0	12
43	10/4/15 10:19	71.026	154.236	bowhead whale	mill	2	1	12
43	10/4/15 10:19	71.034	154.236	bowhead whale	rest	1	0	12
43	10/4/15 10:21	71.026	154.201	bowhead whale	rest	1	0	12
43	10/4/15 10:25	71.038	154.288	bowhead whale	rest	1	0	12
43	10/4/15 10:26	71.076	154.312	bowhead whale	feed	6	0	12
43	10/4/15 10:30	71.135	154.194	bowhead whale	mill	2	0	12
43	10/4/15 10:31	71.128	154.232	bowhead whale	mill	2	1	12
43	10/4/15 10:37	71.225	154.300	bowhead whale	swim	1	0	12
43	10/4/15 10:59	71.922	154.317	beluga	swim	1	0	12
43	10/4/15 10:59	71.926	154.338	beluga	swim	2	1	12
43	10/4/15 10:59	71.931	154.341	beluga	swim	9	0	12
43	10/4/15 10:59	71.931	154.350	beluga	swim	5	3	12
43	10/4/15 11:06	71.969	154.704	beluga	swim	7	1	12
43	10/4/15 11:06	71.963	154.695	beluga	swim	13	4	12
43	10/4/15 11:07	71.929	154.741	beluga	mill	2	0	12
43	10/4/15 11:08	71.891	154.696	beluga	swim	2	1	12
43	10/4/15 11:08	71.888	154.741	beluga	swim	1	0	12
43	10/4/15 11:26	71.314	154.826	bowhead whale	feed	2	0	12
43	10/4/15 11:26	71.300	154.812	bowhead whale	feed	20	0	12
43	10/4/15 11:27	71.285	154.739	bowhead whale	swim	1	0	12
43	10/4/15 11:28	71.288	154.806	bowhead whale	feed	1	0	12
43	10/4/15 11:28	71.289	154.810	beluga	rest	1	0	12
43	10/4/15 11:28	71.290	154.817	bowhead whale	tail slap	1	0	12
43	10/4/15 11:28	71.293	154.832	bowhead whale	feed	2	0	12
43	10/4/15 11:32	71.350	154.824	bowhead whale	mill	2	0	12
43	10/4/15 11:32	71.360	154.839	bowhead whale	feed	2	0	12
43	10/4/15 11:33	71.324	154.859	bowhead whale	feed	1	0	12
43	10/4/15 11:33	71.322	154.859	bowhead whale	feed	3	0	12
43	10/4/15 11:34	71.318	154.859	bowhead whale	feed	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
43	10/4/15 11:34	71.317	154.859	bowhead whale	breach	1	0	12
43	10/4/15 11:43	71.233	154.675	bowhead whale	tail slap	2	0	12
43	10/4/15 11:45	71.221	154.712	bowhead whale	rest	1	0	12
43	10/4/15 11:45	71.214	154.674	bowhead whale	rest	1	0	12
43	10/4/15 11:46	71.225	154.732	bowhead whale	mill	2	1	12
43	10/4/15 11:51	71.189	154.708	bowhead whale	rest	1	0	12
43	10/4/15 11:59	71.150	155.012	bowhead whale	feed	3	0	12
43	10/4/15 12:00	71.158	155.060	bowhead whale	feed	1	0	12
43	10/4/15 12:00	71.160	155.078	bowhead whale	feed	1	0	12
43	10/4/15 12:02	71.162	155.099	bowhead whale	feed	1	0	12
43	10/4/15 12:02	71.174	155.128	bowhead whale	feed	1	0	12
43	10/4/15 12:03	71.177	155.154	bowhead whale	feed	5	0	12
43	10/4/15 12:03	71.180	155.170	bowhead whale	feed	2	0	12
43	10/4/15 12:04	71.190	155.281	bowhead whale	feed	1	0	12
43	10/4/15 12:04	71.193	155.300	bowhead whale	feed	1	0	12
43	10/4/15 12:11	71.388	155.454	bowhead whale	dead	1	0	12
43	10/4/15 12:17	71.453	155.280	bowhead whale	mill	2	0	12
43	10/4/15 12:17	71.458	155.284	bowhead whale	mill	2	0	12
43	10/4/15 12:17	71.462	155.292	bowhead whale	rest	1	0	12
43	10/4/15 12:17	71.469	155.290	bowhead whale	rest	1	0	12
43	10/4/15 12:18	71.478	155.287	bowhead whale	mill	2	0	12
43	10/4/15 12:18	71.483	155.288	bowhead whale	mill	6	0	12
43	10/4/15 12:18	71.489	155.308	bowhead whale	log play	2	0	12
43	10/4/15 12:23	71.455	155.252	bowhead whale	feed	1	0	12
43	10/4/15 12:23	71.442	155.258	bowhead whale	rest	1	0	12
43	10/4/15 12:40	71.961	155.142	beluga	swim	1	0	12
43	10/4/15 13:02	71.481	155.735	bowhead whale	swim	1	0	12
43	10/4/15 13:03	71.456	155.662	bowhead whale	swim	1	0	12
43	10/4/15 13:03	71.450	155.696	bowhead whale	mill	3	0	12
43	10/4/15 13:04	71.436	155.630	bowhead whale	rest	1	0	12
43	10/4/15 13:06	71.383	155.674	bowhead whale	rest	1	0	12
43	10/4/15 13:24	71.500	156.322	bowhead whale	swim	1	0	12
43	10/4/15 13:27	71.589	156.406	bowhead whale	dive	1	0	12
43	10/4/15 13:27	71.596	156.360	bowhead whale	dive	1	0	12
43	10/4/15 13:28	71.615	156.453	bowhead whale	swim	1	0	12
43	10/4/15 13:29	71.644	156.463	bowhead whale	swim	2	0	12
43	10/4/15 13:30	71.658	156.422	bowhead whale	swim	1	0	12
43	10/4/15 13:30	71.642	156.476	bowhead whale	swim	1	0	12
43	10/4/15 13:30	71.642	156.476	bowhead whale	swim	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
43	10/4/15 13:30	71.642	156.476	bowhead whale	swim	1	0	12
43	10/4/15 13:49	71.988	156.933	beluga	swim	9	0	12
43	10/4/15 13:49	71.988	156.933	beluga	swim	4	0	12
43	10/4/15 13:49	71.986	156.922	beluga	swim	1	0	12
43	10/4/15 13:50	71.975	156.937	beluga	swim	5	0	12
43	10/4/15 13:51	71.939	156.937	beluga	swim	8	2	12
43	10/4/15 13:52	71.912	156.932	beluga	swim	2	1	12
43	10/4/15 13:52	71.907	156.925	beluga	swim	1	0	12
43	10/4/15 14:01	71.612	156.918	bowhead whale	mill	2	0	12
43	10/4/15 14:01	71.602	156.959	bowhead whale	rest	1	0	12
43	10/4/15 14:03	71.606	156.920	bowhead whale	mill	2	1	12
43	10/4/15 14:04	71.609	156.967	bowhead whale	swim	1	0	12
43	10/4/15 14:04	71.599	157.008	bowhead whale	rest	1	0	13
43	10/4/15 14:05	71.596	157.029	bowhead whale	mill	7	1	13
43	10/4/15 14:05	71.593	157.036	bowhead whale	rest	1	0	13
43	10/4/15 14:07	71.614	157.057	bowhead whale	rest	1	0	13
43	10/4/15 14:07	71.617	157.046	bowhead whale	rest	1	0	13
43	10/4/15 16:09	70.984	153.630	bowhead whale	swim	1	0	3
43	10/4/15 16:10	70.973	153.611	bowhead whale	feed	1	0	3
43	10/4/15 16:11	70.974	153.660	bowhead whale	rest	1	0	3
43	10/4/15 16:12	70.989	153.659	bowhead whale	rest	1	0	3
43	10/4/15 16:14	71.059	153.651	bowhead whale	feed	2	0	3
43	10/4/15 16:14	71.061	153.681	bowhead whale	swim	1	0	3
43	10/4/15 16:17	71.069	153.627	bowhead whale	feed	1	0	3
43	10/4/15 16:17	71.071	153.639	bowhead whale	rest	1	0	3
43	10/4/15 16:19	71.088	153.594	bowhead whale	feed	4	1	3
43	10/4/15 16:26	71.124	153.639	bowhead whale	feed	3	1	3
43	10/4/15 16:36	71.331	153.749	bowhead whale	dead	1	1	3
43	10/4/15 16:48	71.601	153.820	unid cetacean	dead	1	0	11
43	10/4/15 16:56	71.784	153.889	beluga	swim	10	0	11
43	10/4/15 16:56	71.791	153.890	beluga	swim	4	0	11
43	10/4/15 16:57	71.806	153.916	beluga	swim	23	3	11
43	10/4/15 16:57	71.832	153.905	beluga	swim	1	0	11
43	10/4/15 16:58	71.840	153.939	beluga	swim	2	0	11
43	10/4/15 16:58	71.847	153.890	beluga	swim	1	0	11
43	10/4/15 16:58	71.848	153.906	beluga	swim	1	0	11
43	10/4/15 16:58	71.860	153.910	beluga	swim	9	1	11
43	10/4/15 16:59	71.868	153.912	beluga	swim	8	2	11
43	10/4/15 16:59	71.889	153.929	beluga	swim	1	0	11

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
43	10/4/15 16:59	71.896	153.922	beluga	swim	19	2	11
43	10/4/15 16:59	71.896	153.920	beluga	swim	1	0	11
43	10/4/15 17:00	71.903	153.924	beluga	swim	12	2	11
43	10/4/15 17:00	71.918	153.928	beluga	swim	9	2	11
43	10/4/15 17:02	71.977	153.984	beluga	swim	8	0	11
43	10/4/15 17:13	71.871	153.072	beluga	swim	1	0	11
43	10/4/15 17:15	71.813	153.082	beluga	swim	1	0	11
43	10/4/15 17:15	71.809	153.141	beluga	swim	1	0	11
43	10/4/15 17:15	71.790	153.097	beluga	swim	1	0	11
43	10/4/15 17:15	71.789	153.095	beluga	swim	1	0	11
43	10/4/15 17:16	71.761	153.128	beluga	swim	1	0	11
43	10/4/15 17:17	71.749	153.107	beluga	swim	2	1	11
43	10/4/15 17:17	71.745	153.089	beluga	mill	2	0	11
43	10/4/15 17:17	71.745	153.099	beluga	swim	4	0	11
43	10/4/15 17:17	71.736	153.076	beluga	swim	2	0	11
43	10/4/15 17:17	71.731	153.102	beluga	swim	12	2	11
43	10/4/15 17:18	71.708	153.133	beluga	swim	1	0	11
43	10/4/15 17:34	71.192	153.218	bowhead whale	feed	2	0	3
43	10/4/15 17:41	71.088	153.197	bowhead whale	dive	1	0	3
43	10/4/15 17:45	70.970	153.242	bowhead whale	feed	1	0	3
43	10/4/15 17:45	70.966	153.247	bowhead whale	feed	4	0	3
43	10/4/15 17:45	70.957	153.196	bowhead whale	feed	3	0	3
43	10/4/15 17:45	70.955	153.227	bowhead whale	feed	1	0	3
43	10/4/15 17:47	70.961	153.223	bowhead whale	feed	1	0	3
43	10/4/15 17:59	71.024	152.727	bowhead whale	dive	1	0	3
43	10/4/15 18:04	71.189	152.765	beluga	swim	1	0	3
43	10/4/15 18:04	71.194	152.721	beluga	swim	13	3	3
43	10/4/15 18:06	71.256	152.681	beluga	swim	1	0	3
43	10/4/15 18:26	70.989	152.188	bowhead whale	feed	1	0	3
43	10/4/15 18:27	70.948	152.177	bowhead whale	swim	1	0	3
43	10/4/15 18:27	70.945	152.207	bowhead whale	rest	1	0	3

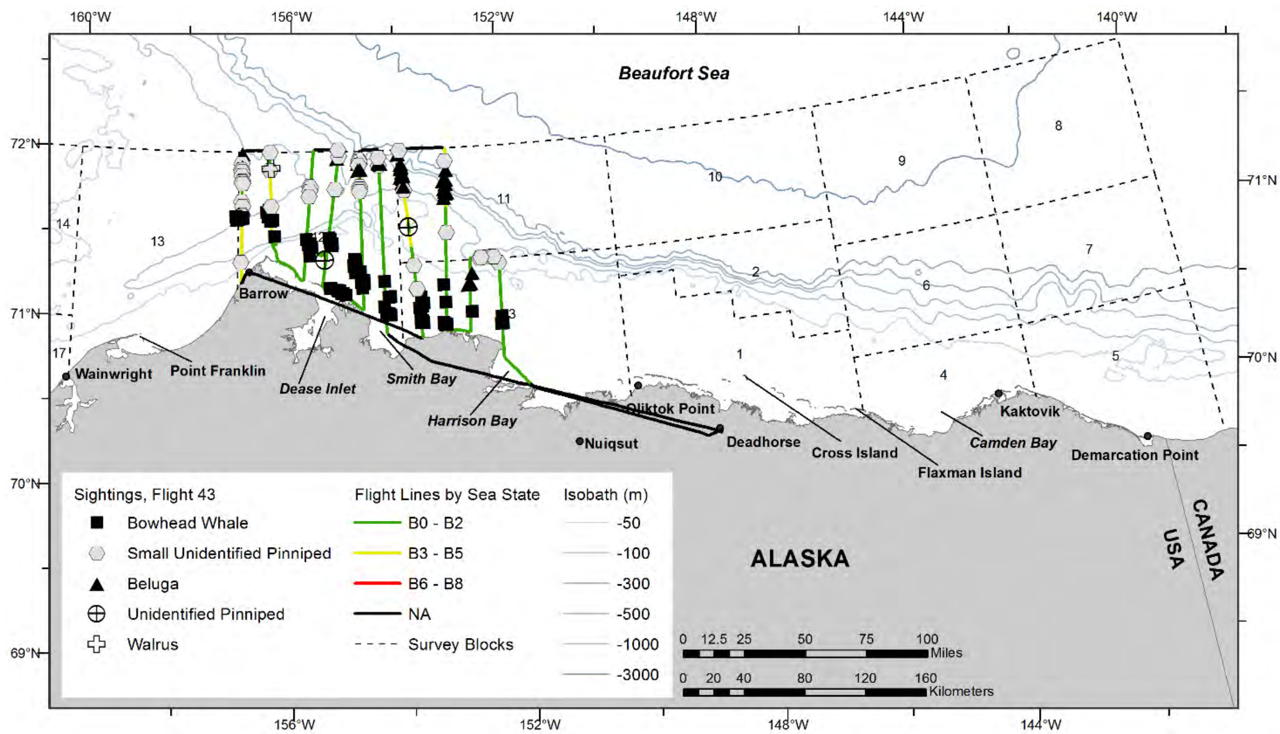

Figure B-90. ASAMM Flight 43 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

Bowhead whale sighted breaching in the western Alaskan Beaufort Sea, approximately 60 km east of Barrow, during ASAMM Flight 43, 4 October 2015.

Bowhead whale feeding aggregation sighted in the western Alaskan Beaufort Sea, approximately 60 km east-southeast of Barrow, Alaska, during ASAMM Flight 43, 4 October 2015.

6 October 2015, Flight 44

Flight was a survey of portions of blocks 4, 5, 6, and 7. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 1-5 sea states. Sea ice cover was 0-20% new and broken floe ice in the area surveyed. Sightings included one bowhead whale, 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
44	10/6/15 11:27	70.572	142.260	beluga	swim	2	0	7
44	10/6/15 11:27	70.583	142.259	beluga	swim	1	0	7
44	10/6/15 11:28	70.619	142.236	beluga	dive	1	0	7
44	10/6/15 11:51	71.037	142.669	beluga	swim	3	0	7
44	10/6/15 12:41	70.671	143.099	beluga	swim	1	0	6
44	10/6/15 12:42	70.682	143.110	beluga	swim	1	0	6
44	10/6/15 14:39	70.413	144.834	bowhead whale	swim	1	0	4

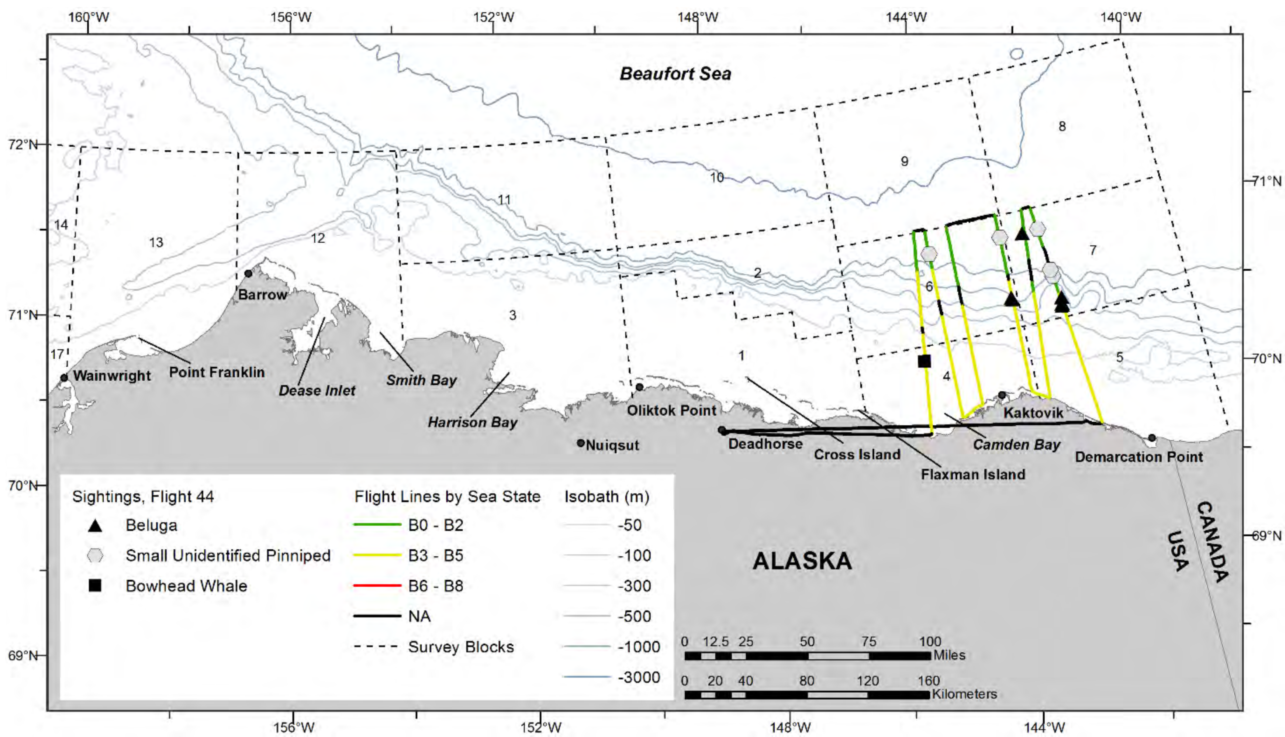

Figure B-91. ASAMM Flight 44 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

8 October 2015, Flight 45

Flight was a survey of portions of block 12. Survey conditions included overcast skies, <1-10 km visibility (with low ceilings), and Beaufort 2-5 sea states. Sea ice cover was 0-10% new and grease ice in the area surveyed. Sightings included bowhead whales.

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
45	10/8/15 11:22	71.257	154.756	bowhead whale	rest	1	0	12
45	10/8/15 11:38	71.294	155.505	bowhead whale	rest	1	0	12
45	10/8/15 11:53	71.352	155.892	bowhead whale	dive	1	0	12
45	10/8/15 11:58	71.345	156.167	bowhead whale	rest	1	0	12

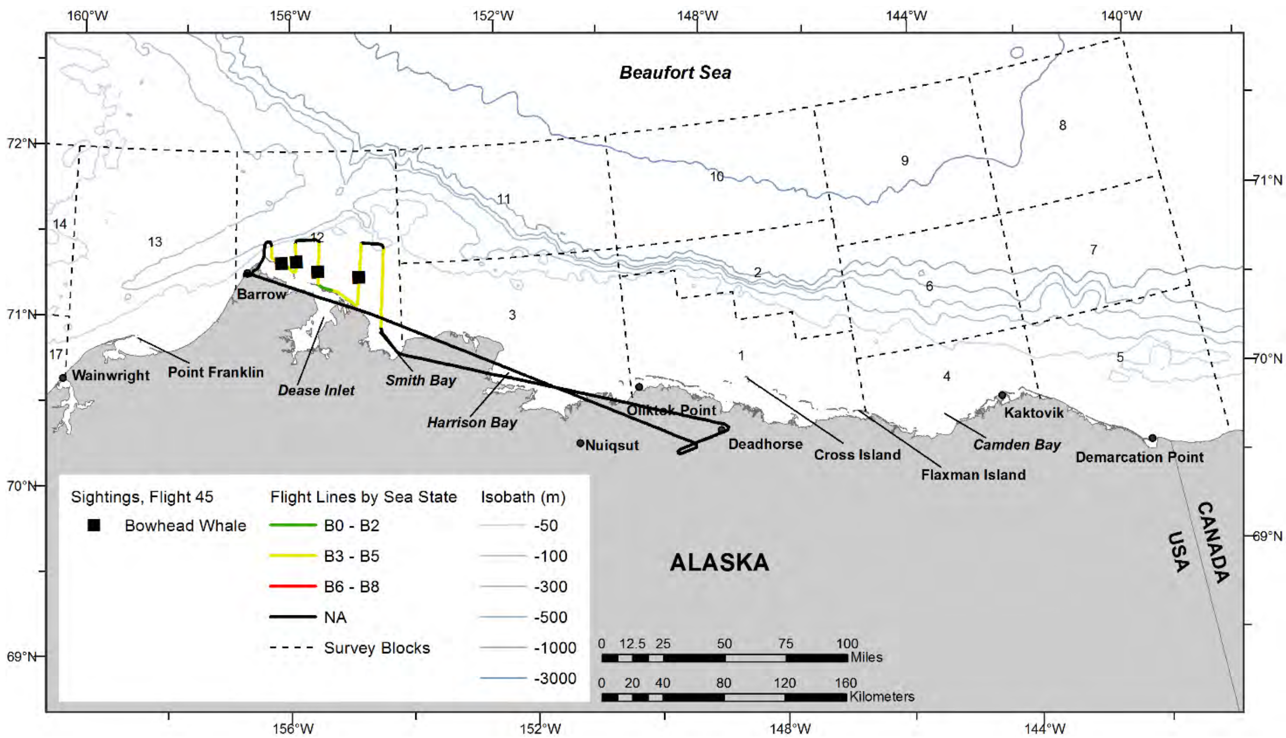

Figure B-92. ASAMM Flight 45 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

10 October 2015, Flight 248

Flight was a complete survey of transects 34, 35, and 36, and a partial survey of transects 37, 38, and 39. Survey conditions included partly cloudy to overcast skies, unlimited visibility (with glare), and Beaufort 2-6 sea states. There was no sea ice observed in the area surveyed. Sightings included gray whales (including two calves), humpback whales, fin whales, and unidentified cetaceans.

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	10/10/15 11:49	67.801	168.726	gray whale	swim	3	1	23
248	10/10/15 11:50	67.796	168.713	gray whale	swim	5	0	23
248	10/10/15 11:51	67.795	168.710	gray whale	swim	3	1	23
248	10/10/15 14:04	67.282	168.596	fin whale	swim	2	0	23
248	10/10/15 14:12	67.106	168.736	unid cetacean	swim	1	0	23
248	10/10/15 14:13	67.098	168.698	humpback whale	feed	2	0	23
248	10/10/15 14:15	67.095	168.690	humpback whale	swim	2	0	23
248	10/10/15 14:19	67.099	168.720	humpback whale	swim	3	0	23
248	10/10/15 14:21	67.091	168.702	humpback whale	swim	3	0	23
248	10/10/15 14:21	67.101	168.656	humpback whale	swim	1	0	23
248	10/10/15 14:24	67.140	168.482	unid cetacean	swim	1	0	23

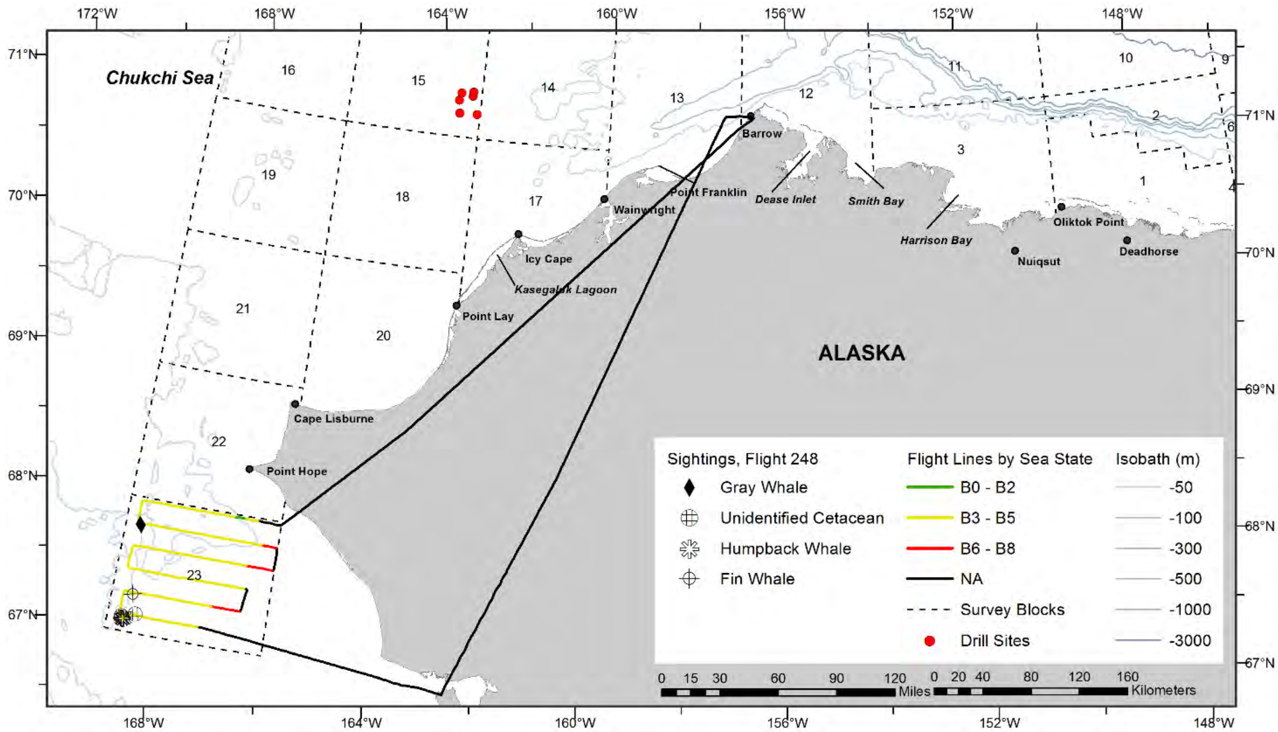

Figure B-93. ASAMM Flight 248 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

12 October 2015, Flight 249

Flight was a partial survey of transects 10 and 12 and the coastal transect from southwest of Wainwright to Point Franklin. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility (with glare, haze, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. Sea ice cover was 0-10% new and broken floe ice in the area surveyed. Sightings included bowhead whales, gray whales, belugas (including one calf), unidentified cetaceans, 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
249	10/12/15 13:42	70.725	160.586	gray whale	unknown	1	0	17
249	10/12/15 13:42	70.729	160.582	gray whale	feed	1	0	17
249	10/12/15 13:53	70.873	161.016	unid cetacean	swim	3	0	17
249	10/12/15 13:54	70.874	160.996	gray whale	swim	1	0	17
249	10/12/15 13:57	70.876	160.963	gray whale	feed	3	0	17
249	10/12/15 13:59	70.889	160.915	gray whale	feed	2	0	17
249	10/12/15 14:01	70.878	160.987	gray whale	swim	1	0	17
249	10/12/15 14:02	70.894	161.011	gray whale	swim	1	0	17
249	10/12/15 14:03	70.900	161.018	gray whale	feed	1	0	17
249	10/12/15 14:04	70.898	161.073	gray whale	feed	1	0	17
249	10/12/15 14:08	70.972	161.407	gray whale	dive	1	0	17
249	10/12/15 14:48	71.237	164.129	beluga	swim	3	1	15
249	10/12/15 15:09	70.801	162.427	bowhead whale	dive	1	0	17
249	10/12/15 15:50	70.808	159.646	unid cetacean	dive	1	0	13
249	10/12/15 15:53	70.819	159.695	gray whale	swim	1	0	13
249	10/12/15 15:53	70.827	159.676	gray whale	swim	1	0	13
249	10/12/15 15:53	70.827	159.672	gray whale	swim	1	0	13
249	10/12/15 15:54	70.817	159.683	bowhead whale	swim	1	0	13
249	10/12/15 15:54	70.822	159.725	bowhead whale	swim	1	0	13
249	10/12/15 15:55	70.817	159.714	bowhead whale	swim	1	0	13
249	10/12/15 15:56	70.813	159.773	bowhead whale	swim	1	0	13
249	10/12/15 15:57	70.807	159.740	gray whale	swim	2	0	13
249	10/12/15 16:06	70.927	158.814	bowhead whale	dive	3	0	13
249	10/12/15 16:10	70.921	158.905	bowhead whale	dive	1	0	13

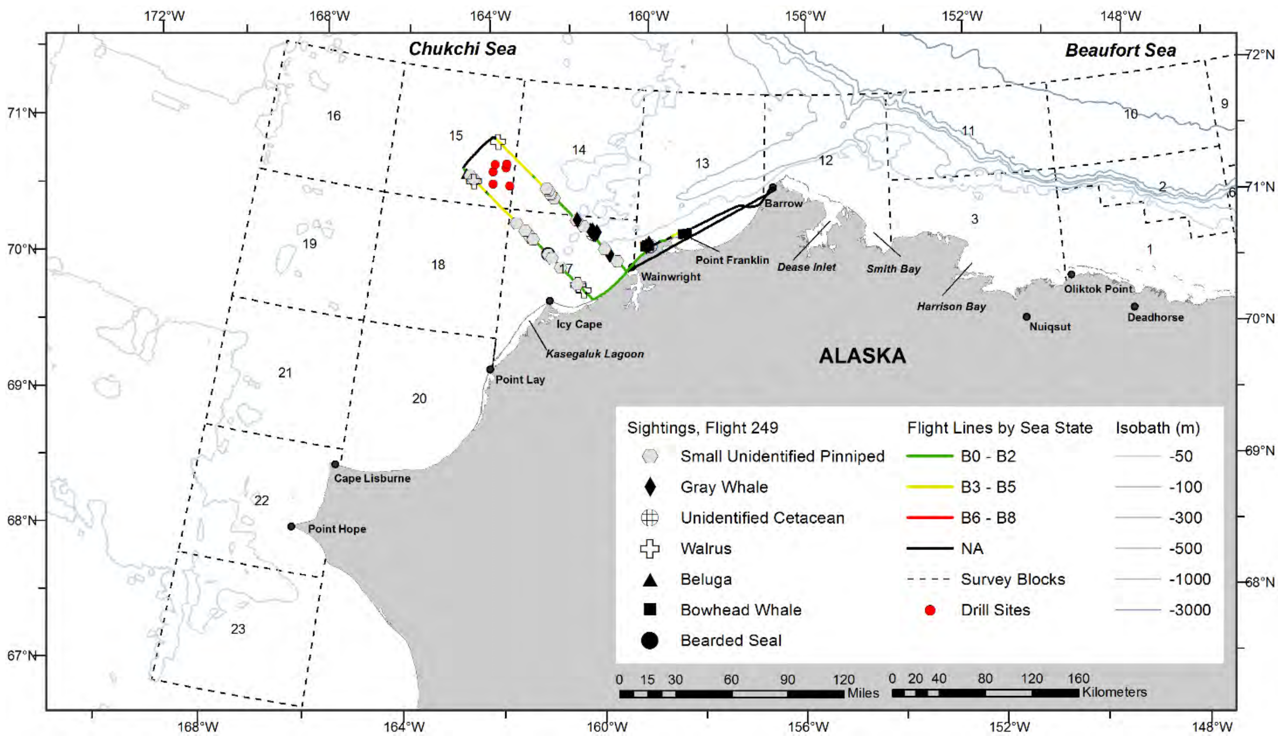

Figure B-94. ASAMM Flight 249 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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13 October 2015, Flight 250

Flight was a partial survey of transects 4 and 8. Survey conditions included overcast skies, 0-2 km visibility (with low ceilings and precipitation), and Beaufort 0-3 sea states. Sea ice cover was 0-100% grease/new ice in the area surveyed. Sightings included bowhead whales (including 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
250	10/13/2015 12:00	70.908	159.645	bowhead whale	swim	2	1	13

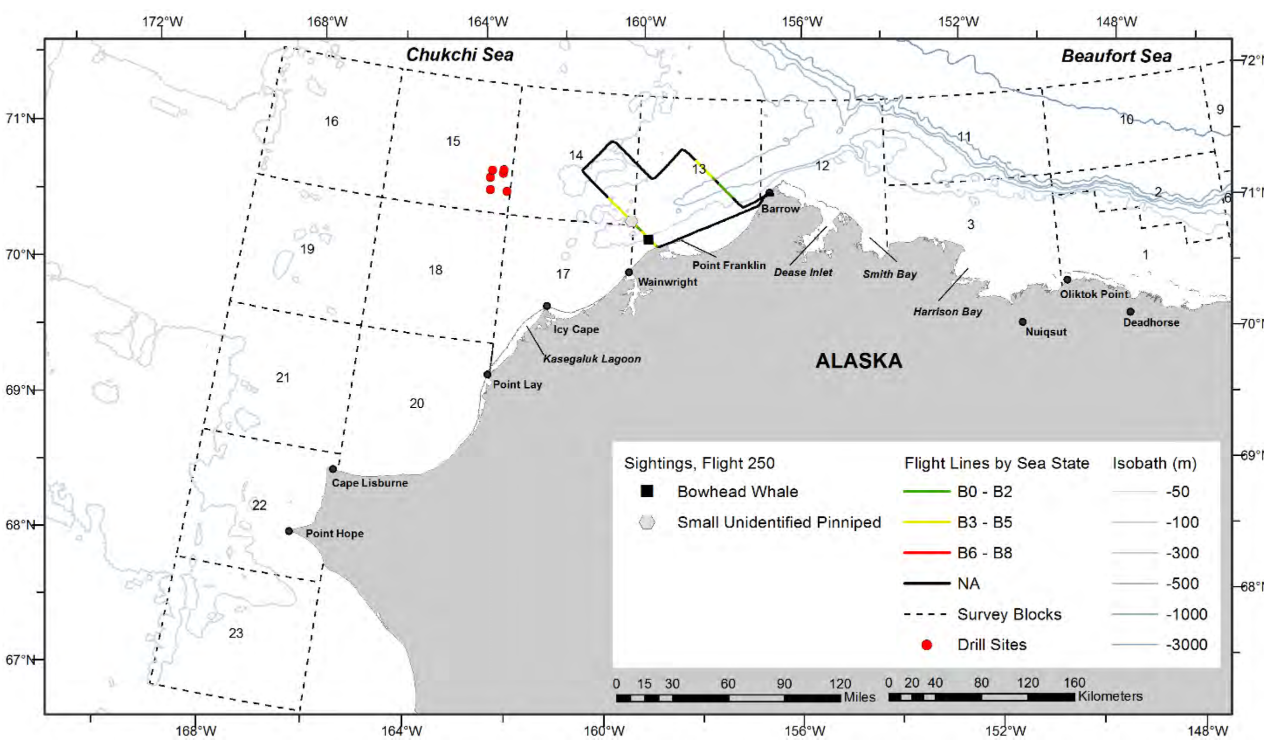

Figure B-95. ASAMM Flight 250 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

14 October 2015, Flight 251

Flight was a complete survey of transects 4, 6, 13, and 15. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. Sea ice cover was 0-30% grease/new ice in the area surveyed. Sightings included bowhead whales (including one calf), one gray whale, belugas (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
251	10/14/15 11:37	71.042	165.974	beluga	swim	1	0	15
251	10/14/15 16:01	70.900	158.064	bowhead whale	swim	1	0	13
251	10/14/15 16:01	70.901	158.068	beluga	swim	1	0	13
251	10/14/15 16:02	70.910	158.116	bowhead whale	swim	1	0	13
251	10/14/15 16:05	70.915	158.112	bowhead whale	swim	1	0	13
251	10/14/15 16:10	70.991	158.374	gray whale	swim	1	0	13
251	10/14/15 16:10	70.998	158.397	bowhead whale	swim	1	0	13
251	10/14/15 16:15	71.101	158.727	bowhead whale	swim	1	0	13
251	10/14/15 16:15	71.105	158.746	bowhead whale	rest	1	0	13
251	10/14/15 16:41	71.584	160.396	bowhead whale	swim	1	0	14
251	10/14/15 16:41	71.589	160.414	bowhead whale	rest	1	0	14
251	10/14/15 16:42	71.591	160.415	beluga	swim	2	1	14
251	10/14/15 16:42	71.599	160.434	beluga	swim	2	0	14
251	10/14/15 16:47	71.600	160.521	bowhead whale	swim	2	1	14

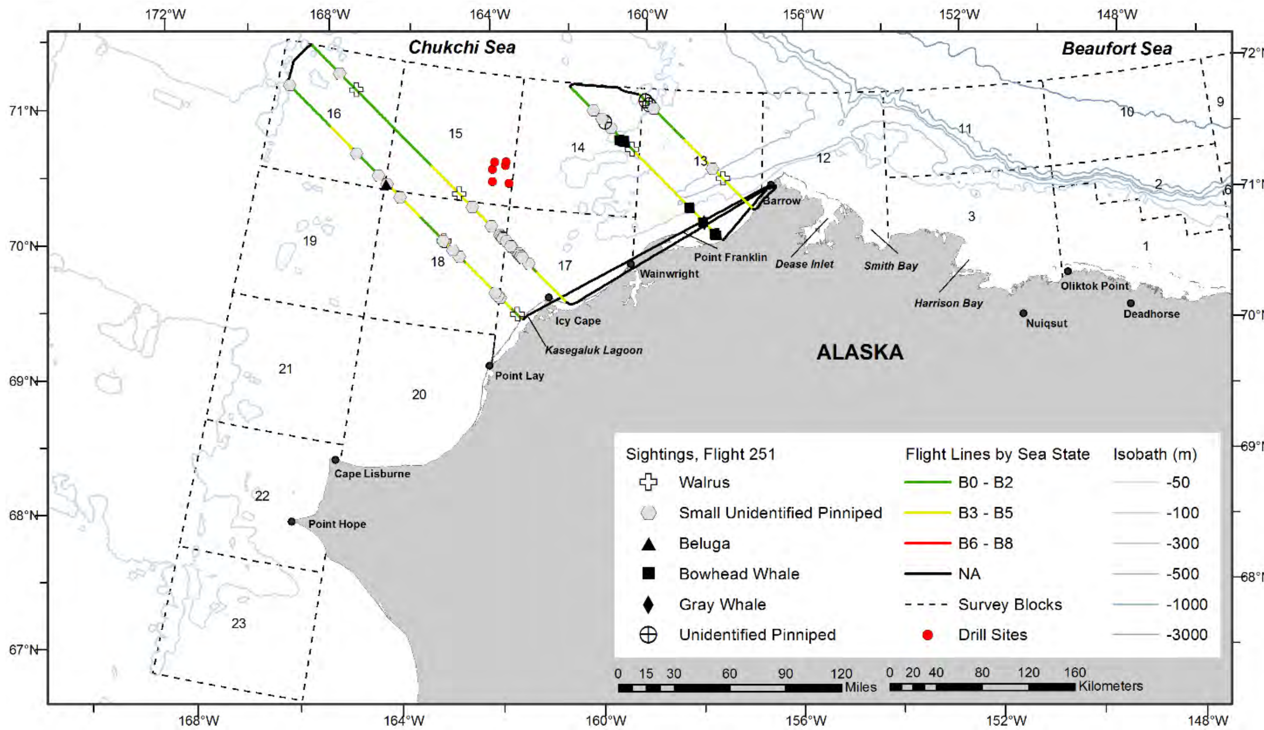

Figure B-96. ASAMM Flight 251 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

15 October 2015, Flight 252

Flight was a complete survey of transects 29, 30, 31, 32, and 33. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included one bowhead whale, one humpback whale, 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
252	10/15/2015 12:16	68.662	168.772	bowhead whale	swim	1	0	22
252	10/15/2015 13:26	68.324	168.613	humpback whale	swim	1	0	22

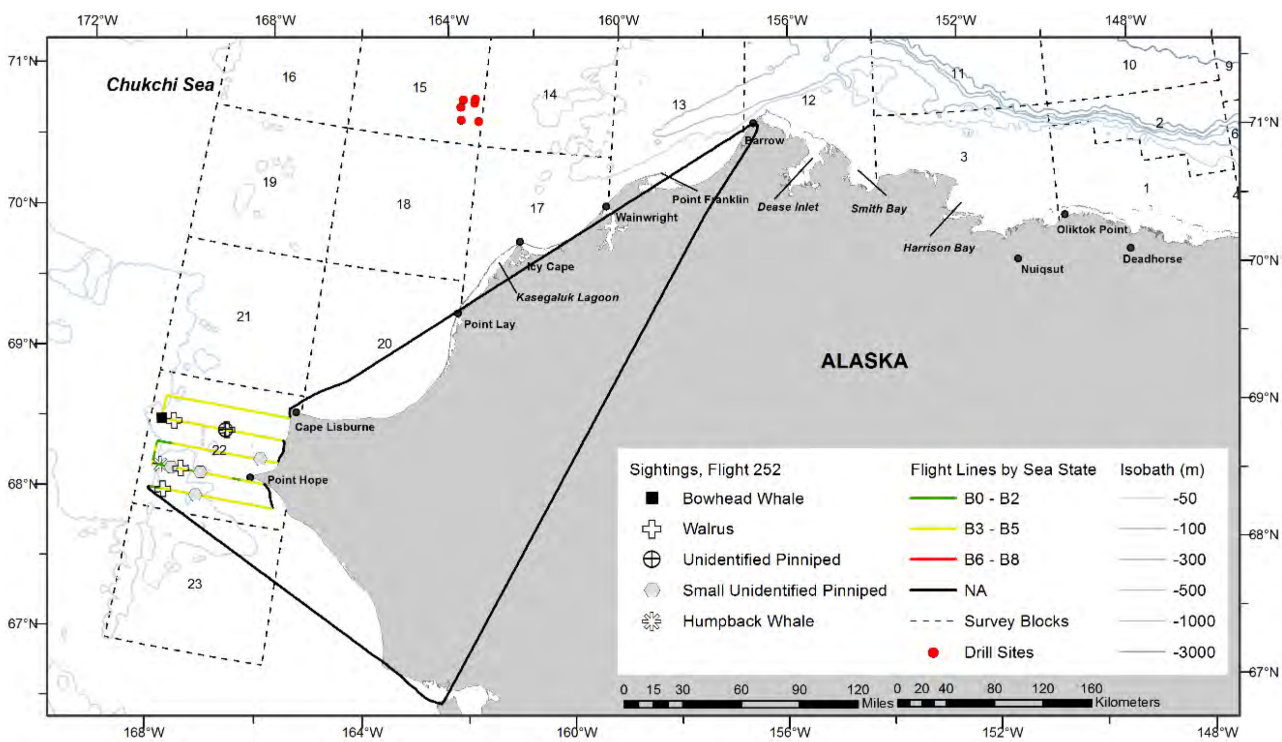

Figure B-97. ASAMM Flight 252 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

16 October 2015, Flight 253

Flight was a complete survey of transects 17 and 19, and the coastal transect from Point Lay to Point Barrow. Survey conditions included clear to overcast skies, <1 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort1-6 sea states. Sea ice cover was 0-90% new/grease and broken floe ice in the area surveyed. Sightings included walruses, unidentified pinnipeds, and small unidentified pinnipeds.

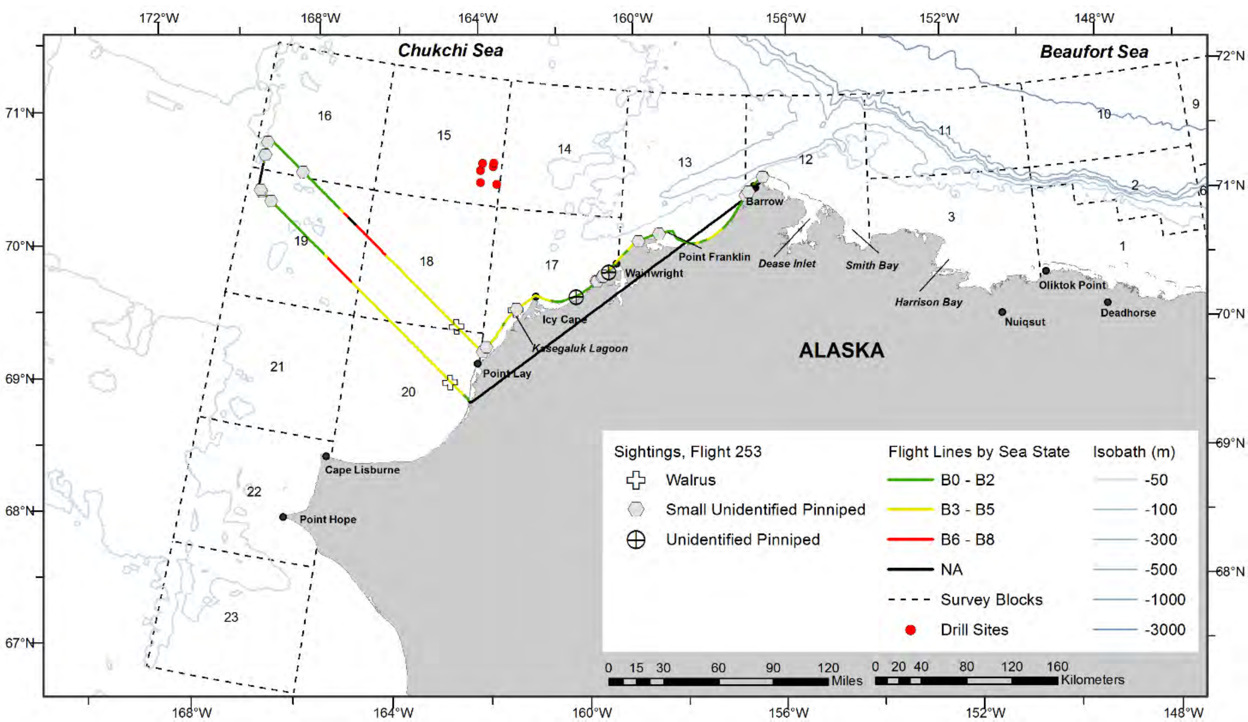

Figure B-98. ASAMM Flight 253 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

19 October 2015, Flight 254

Flight was a partial survey of block 12. Survey conditions included partly cloudy to overcast skies, <1-10 km visibility (with glare, iced windows, and low ceilings), and Beaufort 0-5 sea states. Sea ice cover was 0-100% new/grease and broken floe ice in the area surveyed. Sightings included one small unidentified pinniped.

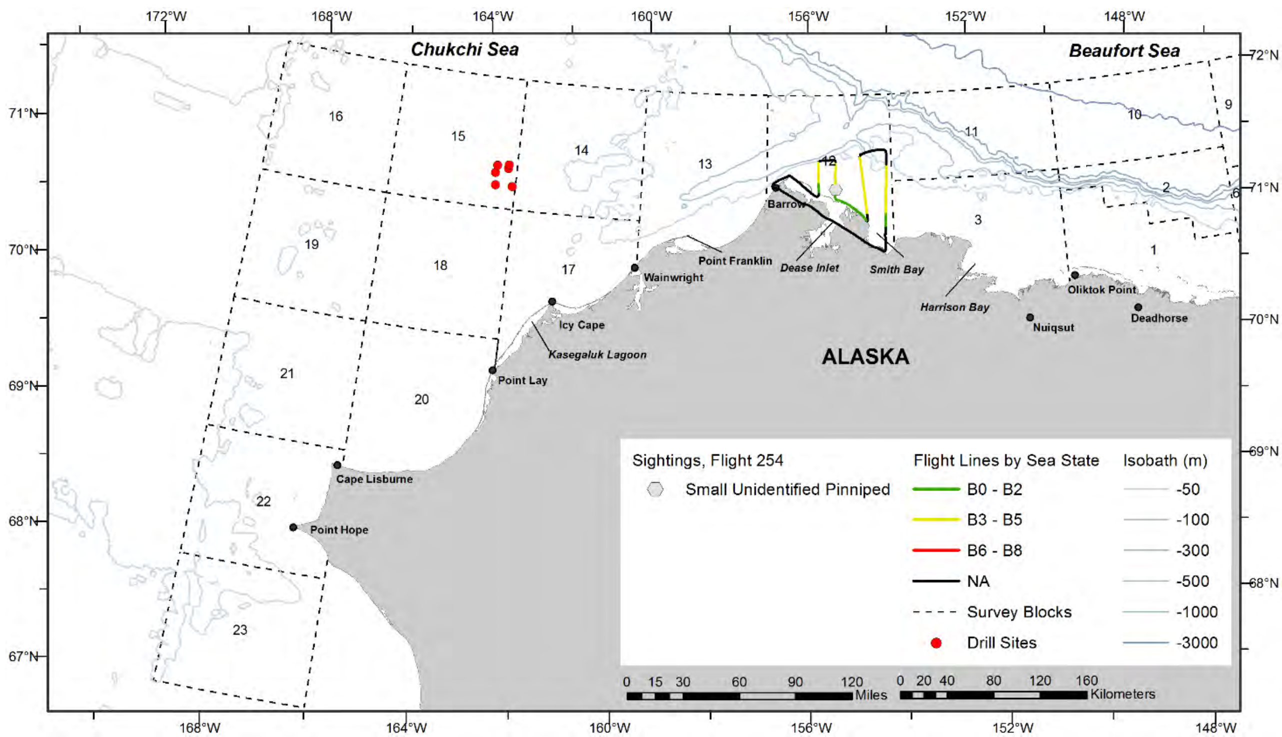

Figure B-99. ASAMM Flight 254 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

24 October 2015, Flight 255

Flight was complete survey of transects 32, 33, and 34, and a partial survey of transects 35, 36, and 37. Survey conditions included partly cloudy to overcast skies, <1 km to unlimited visibility (with glare, iced windows, low ceilings, and precipitation), and Beaufort 2-5 sea states. There was no sea ice observed in the area surveyed. Sightings included fin whales, one beluga, one unidentified cetacean, 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
255	10/24/15 13:23	67.979	168.232	unid cetacean	breach	1	0	23
255	10/24/15 13:55	67.982	166.917	fin whale	swim	1	0	23
255	10/24/15 13:59	67.975	166.859	fin whale	swim	1	0	23
255	10/24/15 14:05	67.984	166.372	beluga	rest	1	0	23

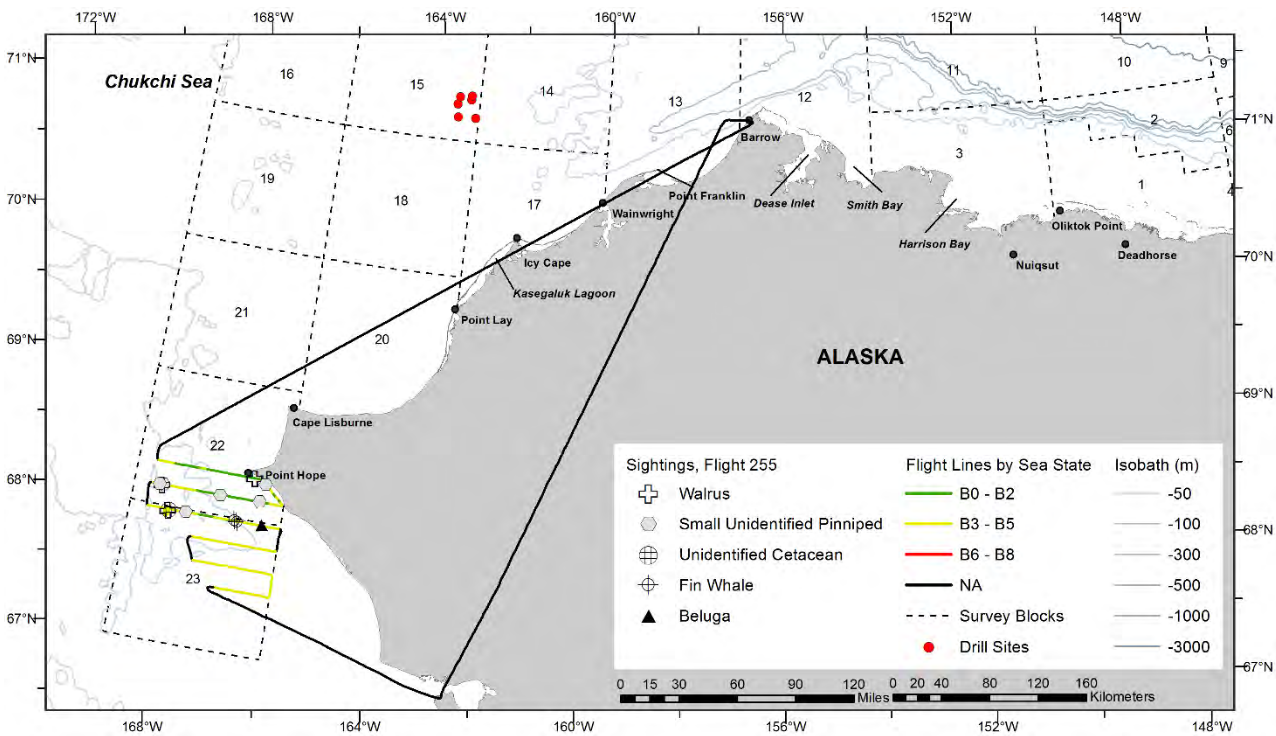

Figure B-100. ASAMM Flight 255 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

26 October 2015, Flight 256

Flight was a survey of portions of block 12. Survey conditions included overcast skies, <1-10 km visibility (with fog, low ceilings, and precipitation), and Beaufort 0-3 sea states. Sea ice cover was 0-100% grease/new ice and broken floe ice in the area surveyed. Sightings included one bowhead whale, belugas (including one calf), 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
256	10/26/15 14:25	71.860	154.879	beluga	swim	1	0	12
256	10/26/15 14:26	71.847	154.883	beluga	swim	1	0	12
256	10/26/15 14:26	71.831	154.894	beluga	mill	3	1	12
256	10/26/15 14:29	71.747	154.904	beluga	swim	1	0	12
256	10/26/15 15:05	71.717	155.183	beluga	swim	1	0	12
256	10/26/15 15:05	71.718	155.186	beluga	swim	1	0	12
256	10/26/15 15:05	71.740	155.189	beluga	swim	1	0	12
256	10/26/15 15:06	71.752	155.198	beluga	swim	1	0	12
256	10/26/15 15:06	71.768	155.185	beluga	swim	1	0	12
256	10/26/15 15:06	71.768	155.173	beluga	swim	1	0	12
256	10/26/15 15:10	71.883	155.159	beluga	swim	1	0	12
256	10/26/15 15:10	71.887	155.159	beluga	swim	1	0	12
256	10/26/15 15:10	71.891	155.162	beluga	swim	1	0	12
256	10/26/15 15:44	71.511	156.131	beluga	swim	1	0	12
256	10/26/15 15:44	71.515	156.121	beluga	swim	1	0	12
256	10/26/15 15:44	71.522	156.101	beluga	swim	1	0	12
256	10/26/15 16:14	71.631	156.723	bowhead whale	swim	1	0	12

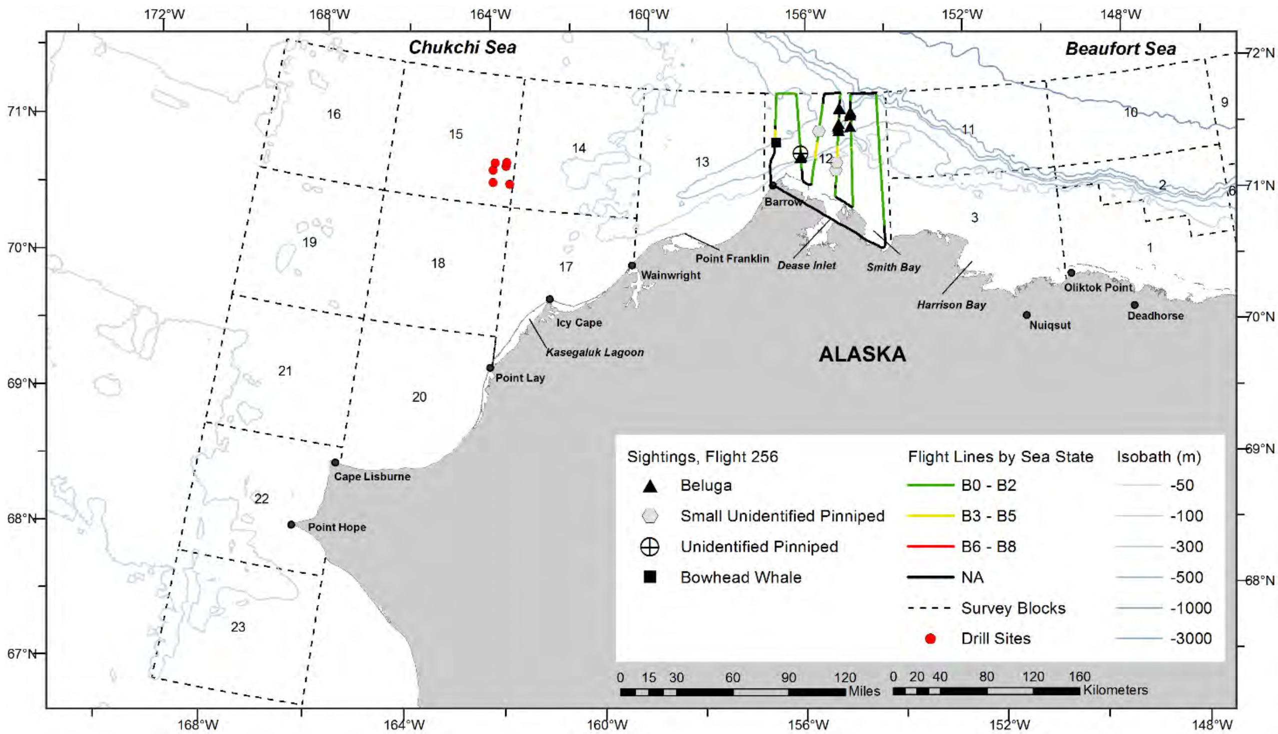

Figure B-101. ASAMM Flight 256 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

27 October 2015, Flight 257

Flight was complete survey of transects 9 and 11, and the coastal transect from Barrow to Wainwright. Survey conditions included partly cloudy to overcast skies, 1 km to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 1-5 sea states. Sea ice cover was 0-90% grease/new ice in the area surveyed. Sightings included bowhead whales (including three carcasses), gray whales, one walrus, 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
257	10/27/15 13:15	70.992	162.354	bowhead whale	dead	1	0	17
257	10/27/15 13:42	71.460	164.172	bowhead whale	dead	1	0	15
257	10/27/15 14:24	72.017	165.377	bowhead whale	dead	1	0	0
257	10/27/15 15:01	71.493	162.559	bowhead whale	swim	1	0	14
257	10/27/15 15:15	71.226	161.494	gray whale	swim	1	0	14
257	10/27/15 15:16	71.213	161.507	gray whale	swim	1	0	14
257	10/27/15 15:16	71.210	161.488	gray whale	feed	1	0	14
257	10/27/15 15:30	70.921	160.459	gray whale	swim	2	0	17

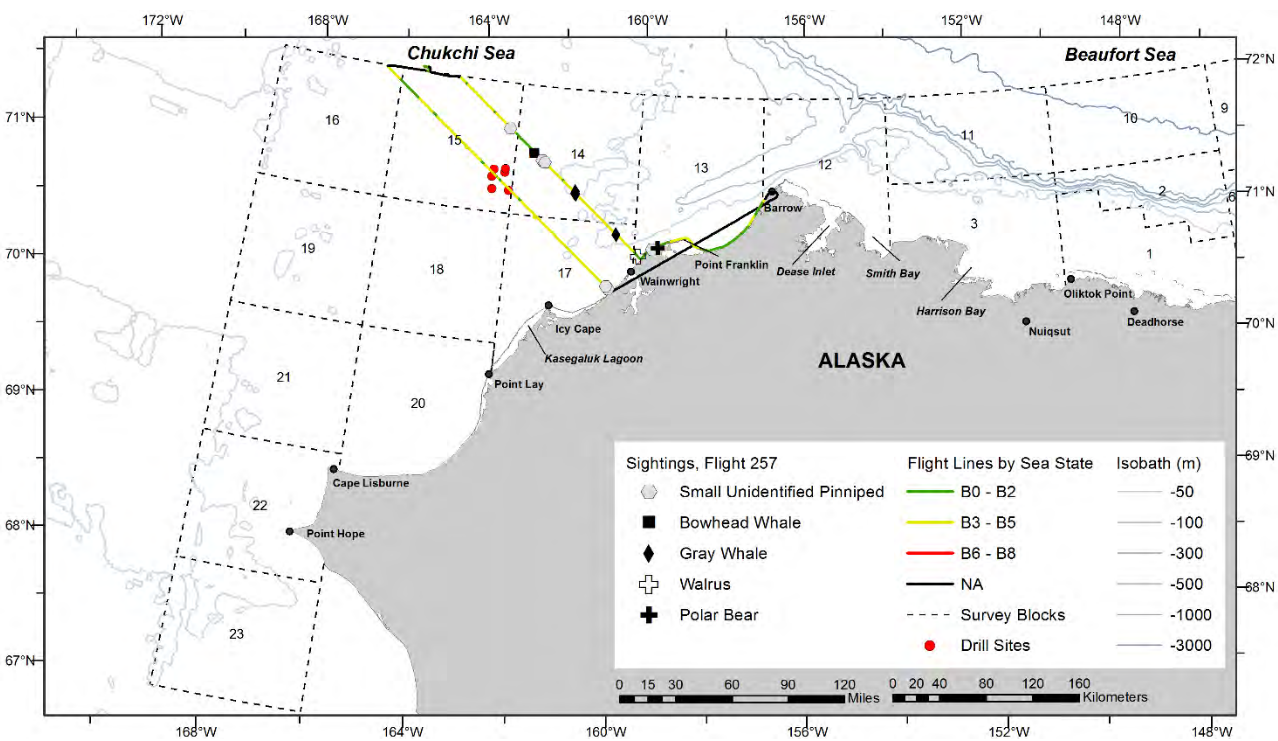

Figure B-102. ASAMM Flight 257 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

28 October 2015, Flight 258

Flight was complete survey of transect 1, a partial survey of transect 2, and portions of blocks 3 and 11. Survey conditions included clear to overcast skies, <1-10 km visibility (with glare, low ceilings, and precipitation), and Beaufort 0-3 sea states. Sea ice cover was 0-100% new/broken floe ice and pack ice in the area surveyed. Sightings included 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
258	10/28/2015 14:44	71.585	152.339	beluga	swim	1	0	11
258	10/28/2015 14:44	71.598	152.314	beluga	swim	1	0	11

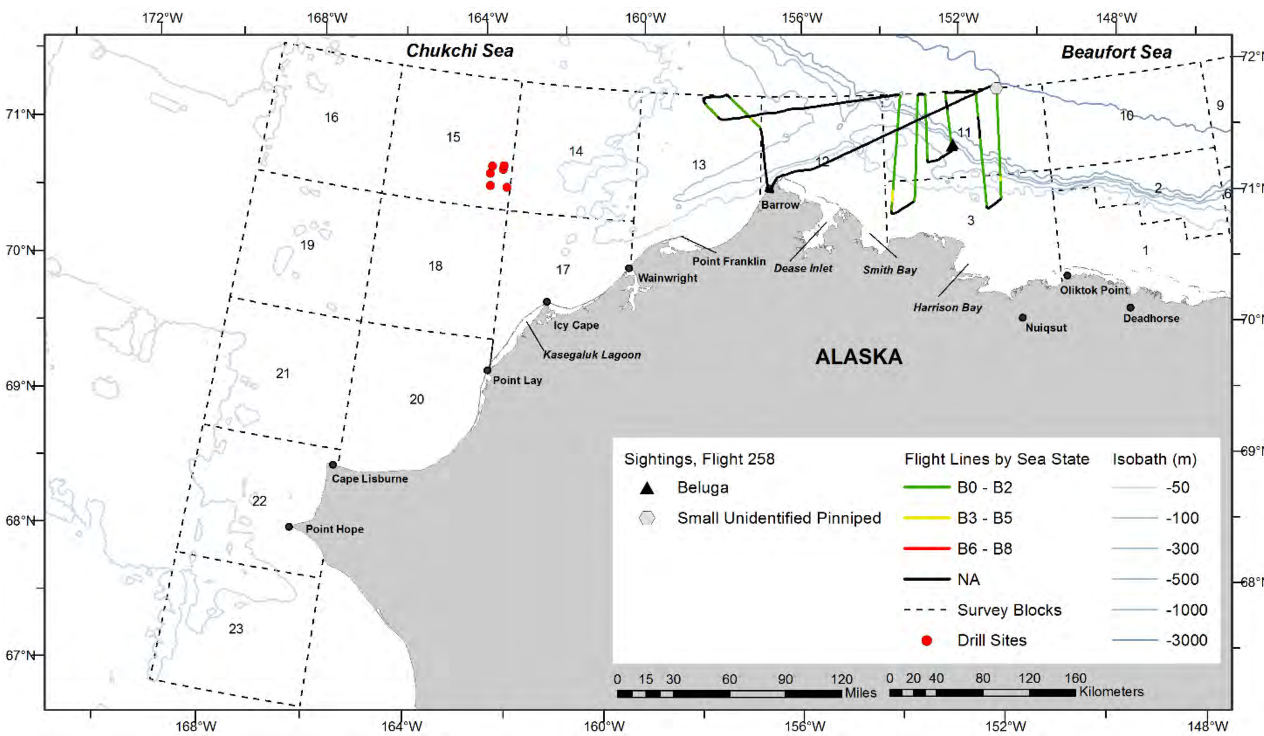

Figure B-103. ASAMM Flight 258 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

29 October 2015, Flight 259

Flight was complete survey of transects 14 and 16, and the coastal transect near Icy Cape. Survey conditions included partly cloudy to overcast skies, <1 to unlimited visibility (with glare, low ceilings, and precipitation), and Beaufort 0-4 sea states. Sea ice cover was 0-98% grease/new ice in the area surveyed. Sightings included walruses and small unidentified pinnipeds.

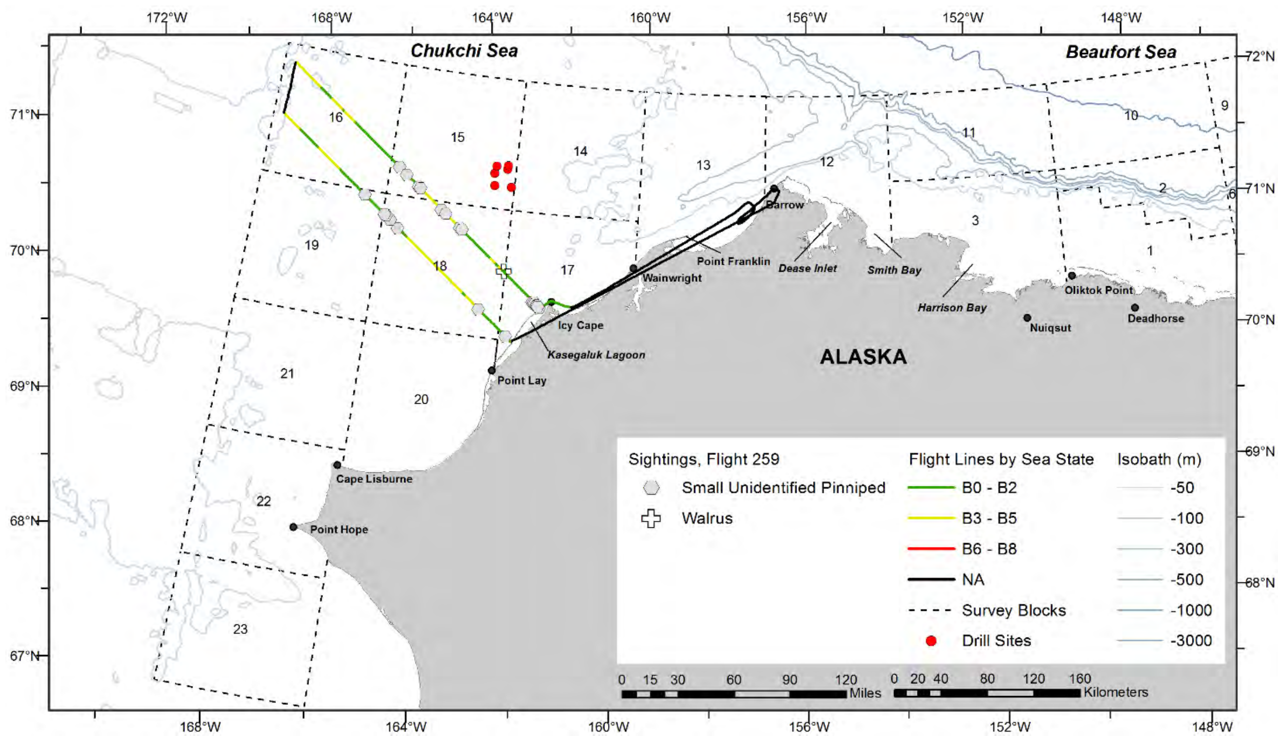

Figure B-104. ASAMM Flight 259 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

30 October 2015, Flight 260

Flight was partial survey of transects 5, 6, 7, and 8. Survey conditions included overcast skies, <1-10 km visibility (with low ceilings and precipitation), and Beaufort 0-6 sea states. Sea ice cover was 0-98% grease/new and broken floe ice in the area surveyed. Sightings included one bowhead whale, one bearded seal, 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
260	10/30/15 12:30	71.299	160.971	bowhead whale	swim	1	0	14

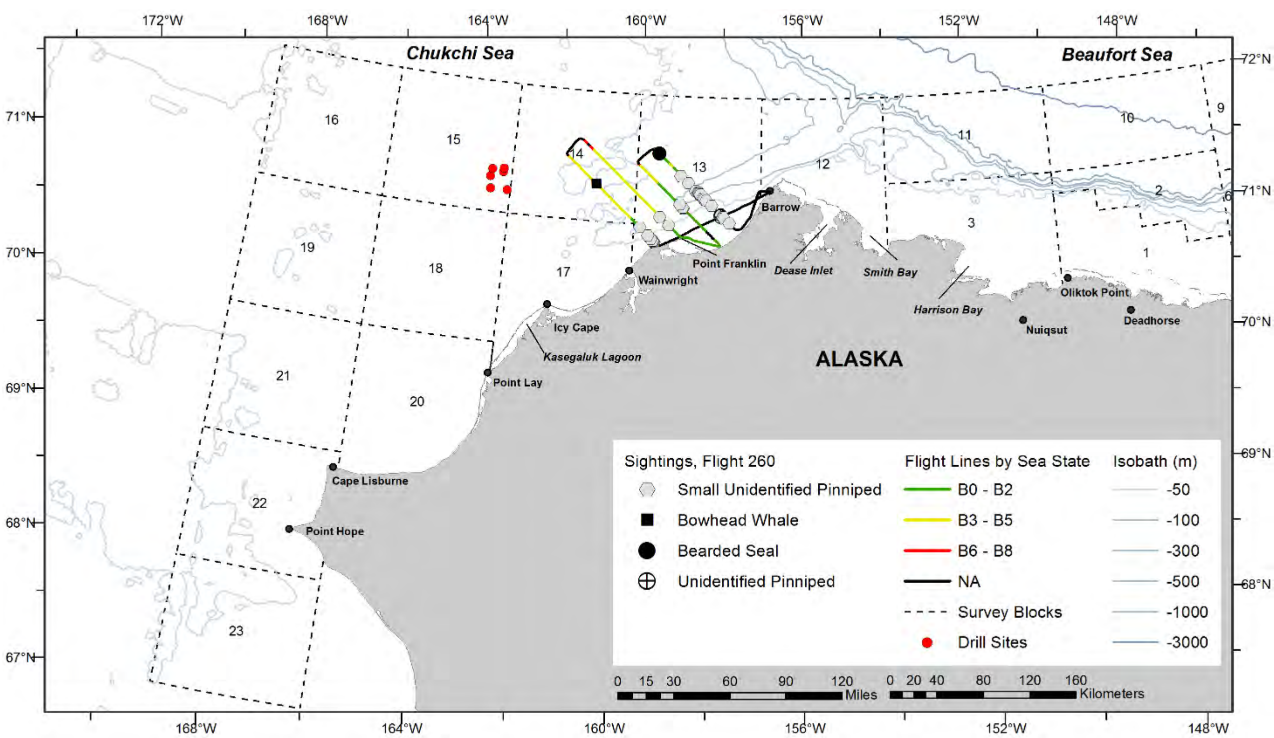

Figure B-105. ASAMM Flight 260 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

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APPENDIX C: PUBLICATIONS, POSTERS, PRESENTATIONS, and MEDIA OUTREACH FROM ASAMM 2015-2016

LIST OF PUBLICATIONS, POSTERS AND PRESENTATIONS

2015

Brower, A., J. Clarke, and M. Ferguson. 2015. Gray Whale Occurrence in the Beaufort Sea. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2015.

Brower A., J. Clarke, M. Ferguson, A. Willoughby. 2015. Gray whale foraging habits in the Alaskan Arctic, summer and fall 2009-2014. Poster: The Society for Marine Mammal Symposium, San Francisco, CA, December 2015.

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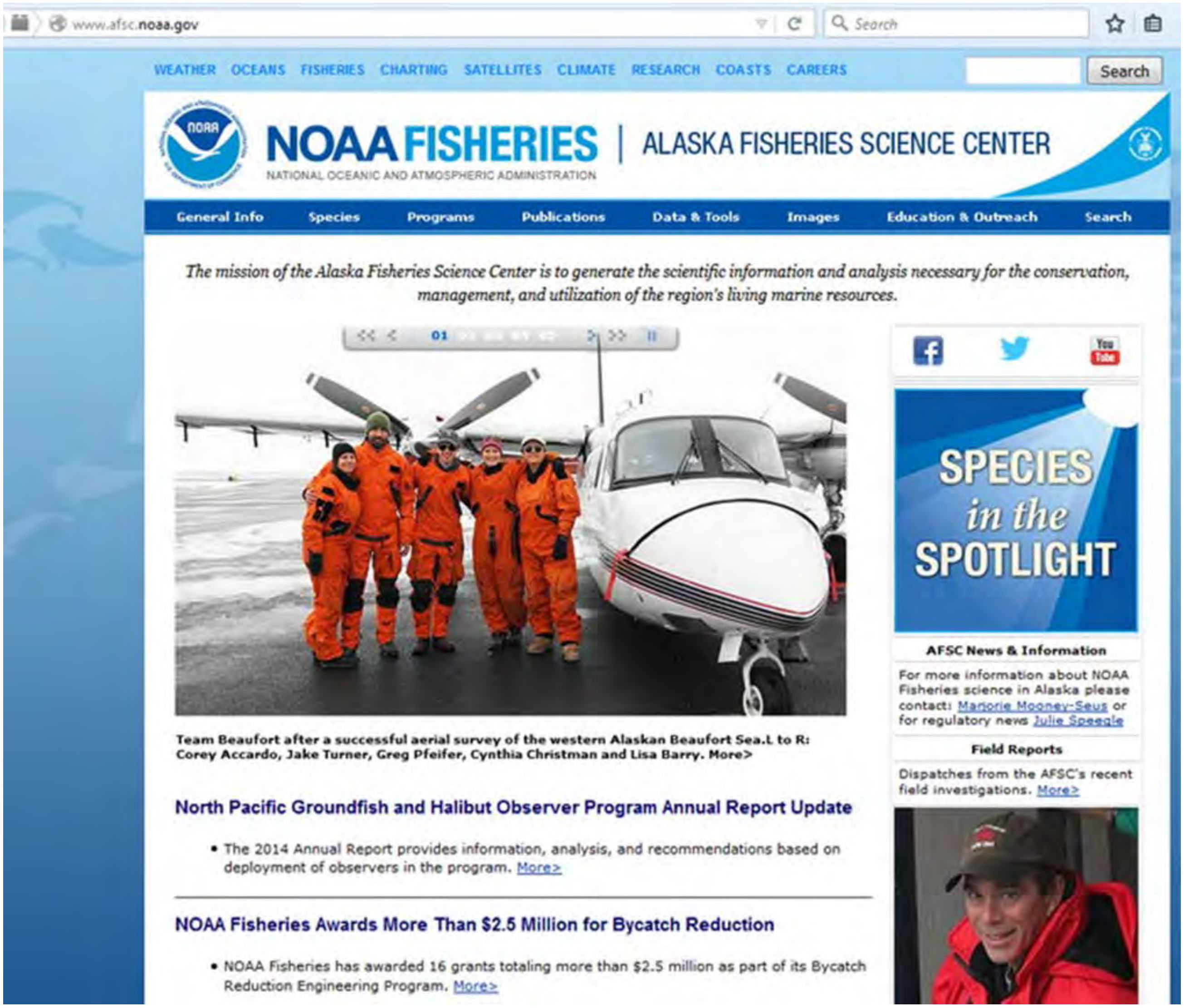
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Arctic (/term/arctic)

Estimated 35,000 walrus come ashore in Northwest Alaska

Dan Joling | Associated Press | September 10, 2015

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http://www.adn.com/article/20150910/estimated-35000-walrus-come-ashore-northwest-alaska

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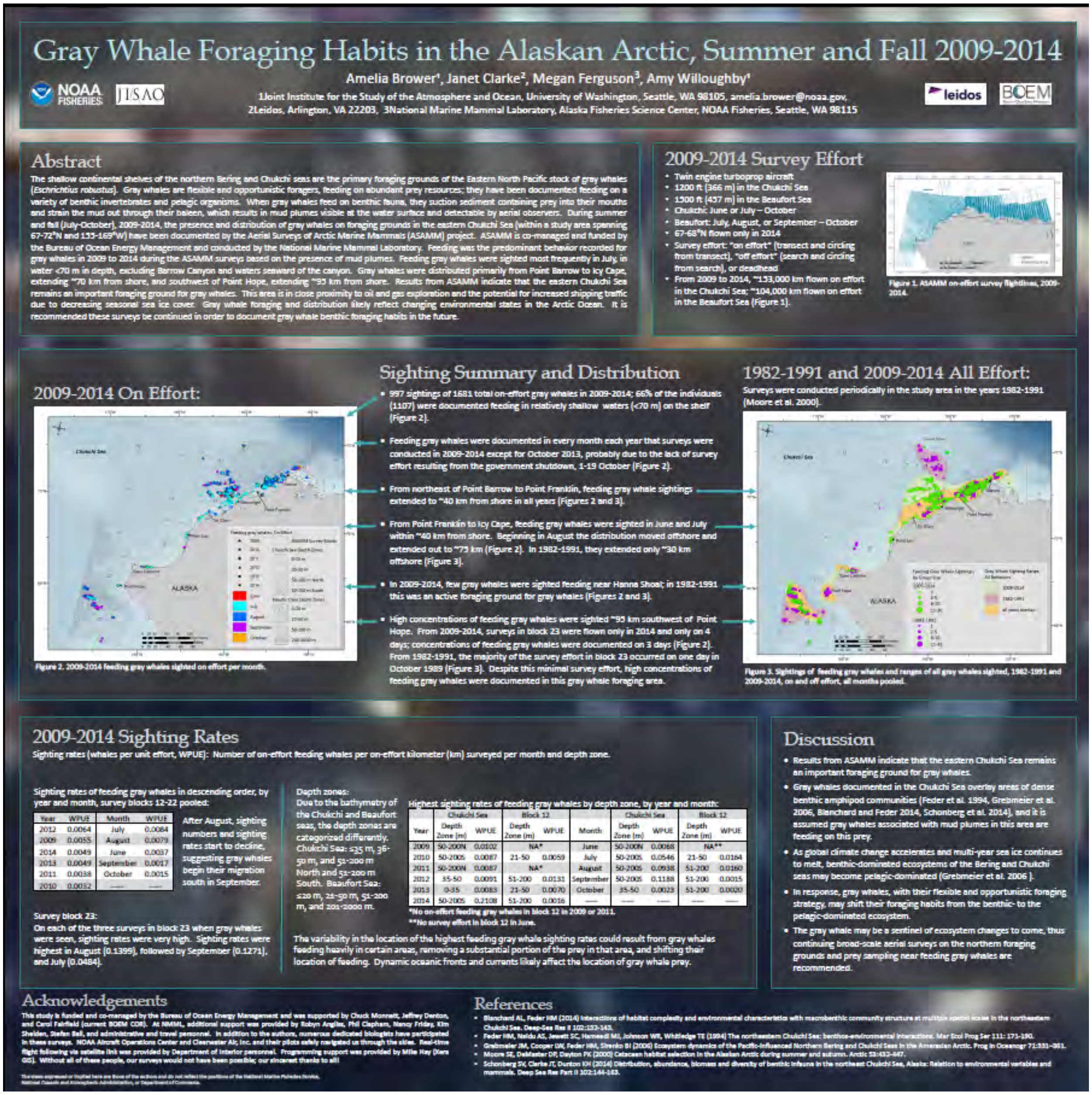

Gray Whale Foraging Occurrence in the Northeastern Chukchi Sea, Summer and Fall 2015

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Janet Clarke– Leidos **Megan Ferguson** – Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA

Overview

Foraging gray whales (*Eschrichtius robustus*) were documented in the northeastern Chukchi Sea in summer and fall 2015 by the Aerial Surveys of Arctic Marine Mammals (ASAMM) project. ASAMM line transect surveys, conducted by the Marine Mammal Laboratory and funded and co-managed by the Bureau of Ocean Energy Management, were conducted in the eastern Chukchi Sea, 67°-72°N and 155°-169°W, from July through October 2009-2015. The northeastern Chukchi Sea is an important foraging and weaning ground for gray whales. They typically begin to arrive in the northeastern Chukchi Sea in June and July, feed heavily in July and August, and migrate south in September and October. Feeding gray whales accounted for 58% of the total gray whales sighted on effort in 2015, similar to 2009-2014 (50-76% of total gray whales sighted on effort per year). Feeding gray whale sighting rate (SR, number of whales on effort per km flown) in summer 2015 was higher than summer SRs in 2009-2014, but fall 2015 SR was lower than the mean fall SR from 2009-2014. Gray whales were sighted foraging predominantly between Point Barrow and Icy Cape, similar to 2009-2014. However, compared to previous years, gray whales in 2015 were sighted farther offshore in July, were not sighted as far offshore between Point Franklin and Icy Cape, and were not sighted east of 157.8°W.

Methods & Survey Effort

- Line transect aerial surveys
- Twin engine turboprop aircraft
- 2 July – 30 October 2015
- 1200 ft (366 m) in the Chukchi Sea
- 1500 ft (457 m) in the Beaufort Sea
- Survey effort: "on-effort" (transect and circling from transect), "off-effort" (search and circling from search), or deadhead
- ~34,300 km flown on effort in survey blocks 12-22 in 2015 (Figure 1).

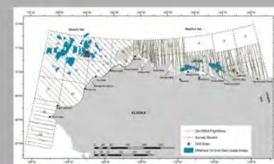

Figure 1. ASAMM on-effort survey flightlines, 2015.

Feeding Gray Whale Sighting Rates

Survey Blocks 12-22

- Sighting Rate (SR): Number of on-effort feeding whales per on-effort kilometer surveyed (whales per unit effort, WPUE).
- 2015 had the highest summer SR (WPUE = 0.0120) (Figure 2), despite poor weather that reduced survey effort in July.
- Fall 2015 SR (WPUE = 0.0013) was lower than the Fall SR in some previous years (Figure 2) and lower than the mean SR from 2009-2014 (mean WPUE = 0.0016), possibly due to differing survey protocols during the Arctic Aerial Calibration Experiments, 26 Aug- 7 Sep which reduced survey effort in some areas where gray whales are sighted most frequently.
- The highest season total SR was in 2012 (WPUE = 0.0065) (Figure 2).
- High summer and low fall SRs of gray whales document the seasonal gray whale migration south out of the Chukchi Sea.

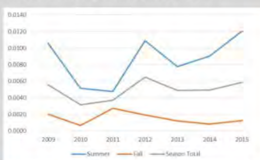

Figure 2. Foraging gray whale SRs, 2009-2015, summer (Jul-Aug), fall (Sep-Oct), and season total (Jul-Oct).

Survey Block 23

- Block 23 in the southcentral Chukchi Sea was flown only in 2014 and 2015. Foraging gray whale density in this area was very high in 2014, but there were few sightings in 2015 (Figure 3), possibly due to less survey effort.

Feeding Gray Whale Distribution

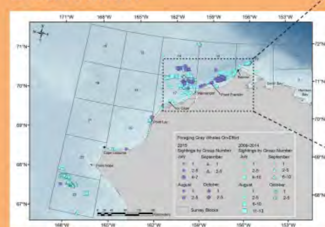

Figure 3. Foraging gray whale monthly sightings on effort in the eastern Chukchi Sea, 2015 and 2009-2014.

In 2015, foraging gray whales sighted on effort in all months were documented predominantly in water <55 m deep in these areas (Figure 3):

- Point Barrow to Point Franklin 10-30 km from shore
- NNW of Wainwright 25-40 km and 65-90 km from shore

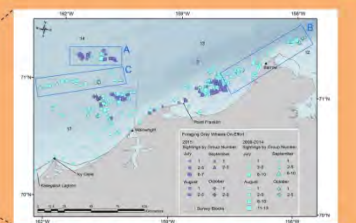

Figure 4. Area of high density of foraging gray whale sightings in the northeastern Chukchi Sea. On-effort, monthly sightings for 2015 and 2009-2014 are shown. Areas of differing distribution are shown in rectangle A (2015) and rectangles B and C (2009-2014).

How 2015 feeding gray whale sightings differed from 2009-2014 (Figure 4):

- Gray whales were consistently sighted offshore 65-90 km to the NNW of Wainwright from July to October 2015 (Figure 4, rectangle A). Gray whales were seldom seen in that area in July of previous years.
- In 2009-2014, gray whales were documented foraging east of 157.8°W (Figure 4, rectangle B), and beginning in August, foraging farther offshore between Point Franklin and Icy Cape up to ~70 km offshore (Figure 4, rectangle C); gray whales were seldom sighted foraging in these areas in 2015.

Acknowledgements: *This study is funded and co-managed by the Bureau of Ocean Energy Management and NOAA (IA No. M11PG00033) and was supported Carol Fairfield (BOEM COR). At MML, additional support was provided by Robyn Angliss, Stefan Ball, Phil Clapham, Nancy Friday, Kim Shelden, Janice Waite, and administrative personnel. At JISAO, support was provided by Amy Kennedy and administrative personnel. In addition to the authors, numerous dedicated biologists have participated in these surveys. Clearwater Air, Inc. pilots safely navigated us through the skies. Real-time flight following via satellite link was provided by Department of Interior personnel. Programming support was provided by Mike Hay (Xera GIS). Without all of these people, our surveys would not have been possible; our sincerest thanks to all!*

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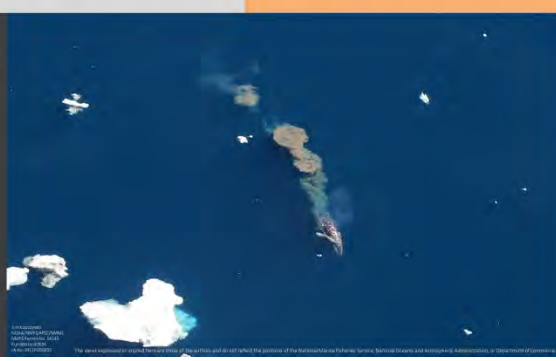

Discussion

- The differences in distribution and relative abundance from 2015 and previous years could be due to changes in prey distribution resulting from changing hydrographic conditions and oceanic productivity or from intense feeding by gray whales.
- Gray whales documented in the Chukchi Sea overlay areas of dense benthic amphipod communities (Blanchard and Feder 2014, Schonberg et al. 2014), and it is assumed that gray whales associated with mud plumes in this area are feeding on this prey.
- As global climate change accelerates and multi-year sea ice continues to melt, benthic-dominated ecosystems of the Bering and Chukchi seas may become pelagic-dominated (Grebmeier et al. 2006).
- Gray whales have a flexible and opportunistic foraging strategy and may shift their foraging habits from the benthic- to the pelagic-dominated ecosystem.
- The spatial, temporal, and interannual changes in gray whale foraging distribution and relative abundance highlight the need for continued broad-scale aerial surveys each summer and fall.

Occurrence of Humpback, Fin, and Minke Whales in the Eastern Chukchi Sea, 2008-2015: Population Recovery, Response to Climate Change, or Greater Effort?

BOEM

NOAA FISHERIES

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Amelia Brower, Amy Willoughby, and Christy Sims – Joint Institute for the Study of the Atmosphere and the Ocean

Abstract

Sightings of humpback (*Megaptera novaeangliae*), fin (*Balaenoptera physalus*) and minke (*Balaenoptera acutorostrata*) whales were made during the Aerial Surveys of Arctic Marine Mammals (ASAMM) project, funded by BOEM and co-managed by BOEM and NOAA. Surveys were conducted in the eastern Chukchi Sea (67°-72°N, 157°-169°W) from July through October, 2008-2015, in a study area that encompassed offshore oil and gas leases in the Chukchi Sea Planning Area and shipping lanes in the southern Chukchi Sea. Approximately 186,000 km on effort was flown to document relative abundance, spatial and temporal distribution, and behavior of marine mammals. Fin whales (41 sightings of 67 whales) had the most limited distribution, from 67°N to 69.5°N, and were seen primarily in August and September. Humpback whales (55 sightings of 97 whales) were distributed from 66.9°N to 71.2°N, and were seen primarily in September. Minke whales (24 sightings of 27 whales) had the most extensive distribution, from 67.1°N to 71.9°N, and were seen from July through September. Fin, humpback, and minke whales were often seen in close association with other cetacean species, including gray whales. Behaviors observed included diving, feeding, milling, resting, rolling, swimming, and tail slapping. Fin whale calves (2) were seen in 2012; humpback whale calves were seen in 2014 (1) and 2015 (1). Fin, humpback and minke whales are known to have occurred historically in the Pacific Arctic, particularly near the Chukotka Peninsula, and recent visual and acoustic detections suggest that use of this area may be increasing. During aerial surveys conducted from 1979-1991 in this same area, there was 1 sighting of 3 fin whales; however, survey effort was sporadic among years, and most survey effort occurred in October. Increased occurrence may be due to each population's abundance and range recovering from commercial whaling that occurred as recently as the 1970s, but may also reflect an increase in marine mammal research in the area or responses to ongoing climate change. (Abstract has been updated to reflect sightings from October 2015.)

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Acknowledgements: This study was funded and co-managed by the Bureau of Ocean Energy Management (IA Nos. M11PG00033 and M08PG20023), 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, Nancy Friday, Kim Shelden, Janice Waite, and administrative and travel personnel. Aerial surveys were safely and expertly flown by NOAA Aircraft Operations Center, Commander Northwest, and Clearwater Air. 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.

leidos ASAMM JISAO

Methods

- Eastern Chukchi Sea study area, 67°-72°N, 157°-169°W (Figure 1)
- Line transect aerial surveys
- Twin turboprop, high wing aircraft
- 1200 ft (366 m) survey altitude
- Fly every day, weather permitting, 2 July through 30 October
- Two primary marine mammal observers, one data recorder
- Survey modes include on-effort (transect and circling from transect) and off-effort (search and circling from search)
- Circle on most cetacean sightings to get positive species ID, determine group size, and look for calves

Results

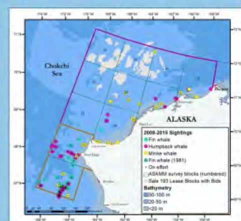

Figure 1. Eastern Chukchi Sea study area with fin, humpback, and minke whale sightings, July-October 2008-2015, and one fin whale sighting, July 1981. All sightings are plotted, regardless of survey mode; on-effort sightings by primary observers are designated with a star. Each sighting may be of one or more whales. The northeastern Chukchi Sea subarea is outlined in magenta; the southcentral Chukchi Sea subarea is outlined in umber.

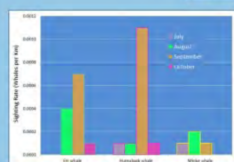

Figure 2. Fin, humpback, and minke whale sighting rates per month, eastern Chukchi Sea, 2008-2015. Sighting rate, using sightings by primary observers collected only during on-effort surveys, provides an estimate of relative abundance.

Figure 3. Fin, humpback, and minke whale sighting rates for the northeastern Chukchi Sea and southcentral Chukchi Sea subareas, July-October combined, 2008-2015. Sighting rate, using sightings by primary observers collected only during on-effort surveys, provides an estimate of relative abundance.

Summary, 2008-2015

Table 1. Summary of key results based on all sightings, regardless of survey mode (except as noted). Maximum values ***bolded and italicized***.

	Fin whale	Humpback whale	Minke whale
Eastern Chukchi Sea			
Months of occurrence	***July to October***[1]	***July to October***[1]	July to September[1]
Relative abundance [4]	0.0003 [2]	***0.0005*** [2]	0.0001 [2]
Distribution	67°N to 69.5°N[1]	66.9°N to 71.2°N[1]	***67.1°N to 71.9°N***[1]
Depth range	28 to 52 m	7 to 61 m	3 to 60 m
Distance from shore range	24 to 140 km	1 to 145 km	<1 to 170 km
Northeastern Chukchi Subarea			
Months of occurrence	July to August[1]	July to August[1]	***July to September***[1]
Relative abundance [4]	0 [3]	<0.0001 [3]	***0.0001*** [3]
Depth range	28 to 33 m	7 to 55 m	3 to 60 m
Distance from shore range	42 to 75 km	1 to 89 km	<1 to 170 km
Southcentral Chukchi Sea Subarea			
Months of occurrence	***July to October***[1]	August to October[1]	August to September[1]
Relative abundance [4]	0.0043 [3]	***0.0054*** [3]	0.0004 [3]
Depth range	33 to 52 m	15 to 61 m	24 to 38 m
Distance from shore range	24 to 140 km	4 to 145 km	8 to 114 km

[1] Figure 1; [2] Figure 2; [3] Figure 3; [4] based on sightings by primary observers during on-effort surveys

Humpback whale, September 2014; photo by Leah Crowe, NMFS Permit No. 14245

Comparison with ASAMM 1979-1991

- Sightings limited to 1 sighting of 3 fin whales (July 1981) (Figure 1)
- Survey effort was orders of magnitude less except in October (Figure 4)

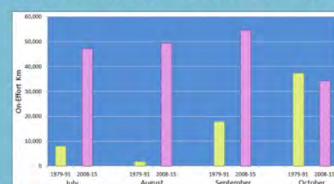

Figure 4. Summary of ASAMM effort in the eastern Chukchi Sea, 1979-1991 and 2008-2015. Effort from 1992 to 2007 was negligible.

Discussion

- Fin, humpback, and minke whales occur in the northern Bering Sea (Moore et al., 2002) and there is ample evidence of historical occurrence in the western Chukchi Sea, but there are relatively few records for the eastern Chukchi Sea (summarized in Clarke et al., 2014).
- Increasingly common occurrence of these large whales in the eastern Chukchi Sea in recent years (2008-present) has been documented by this study and corroborated by concurrent visual and acoustic studies (e.g., CSESP, ARCWEST, CHAOZ, Shell).
- Populations may be recovering from illegal commercial whaling that occurred in the North Pacific as recently as the 1970s (Ivashchenko et al., 2013).
- Distribution of these large whales may also be related to water masses that collectively produce sharp temperature and salinity gradients (Eisner et al., 2013), which can aggregate zooplankton, fishes that feed on zooplankton, and large whales that feed on fishes. Variations in water mass incursion, combined with earlier and greater loss of summer sea ice and other effects of climate change, may be enhancing the ability of large whales to expand further into the Chukchi Sea .
- Finally, the potential effect of increased survey effort cannot be ignored. Most fin, humpback, and minke whales were seen (and sighting rates were highest) in August and September 2008-2015. Survey effort during August and September 1979-1991 was not extensive, particularly in August (Figure 4). Survey effort in October 1979-1991 actually exceeded that for October 2008-2015. However, October 2008-2015 had the lowest sighting rates, indicating that fin, humpback, and minke whales may be migrating south from the Chukchi Sea by that time. It is possible that large whales were present in the eastern Chukchi Sea, particularly the southcentral subarea, in 1979 to 1991 but not detected due to infrequent survey effort during the months they would most likely have occurred.

Relationships between high river discharge, upwelling events, and bowhead whale (*Balaena mysticetus*) occurrence in the central Alaskan Beaufort Sea HE44C-1530

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Introduction

Aerial surveys of bowhead whales have been conducted in September in the central Alaskan Beaufort Sea (144°W-150°W) for several decades. These surveys, co-managed by BOEM and NOAA, have documented bowhead whale distribution that is almost exclusively on the continental shelf, generally from <1 to 70 km from shore. Most whales observed in September are actively migrating and swimming in a westerly direction, with feeding behavior occasionally observed. In September 2014, several hundred bowhead whales were observed feeding on several occasions within a few kilometers of local barrier islands. This is an unusual situation that has been observed in September in only one other year (1997). To investigate local conditions that might be conducive to increased bowhead whale occurrence, freshwater discharge data from the Sagavanirktok and Kuparuk rivers, surface wind data, and suspended sediment data obtained from MODIS satellite imagery were analyzed and compared to bowhead whale observations for September 1989-2014. Results indicate that anomalously high freshwater river discharge coupled with prior upwelling events, based on surface winds >5.4 m s^{-1}, may combine to promote the aggregation of bowhead whale prey on the shallow shelf. When these two conditions were met, whales were sighted more frequently, were more likely to be in groups of ≥2 animals, and were closer to shore. Conversely, when either of the two conditions was not met, whales were sighted less frequently, were more likely to be single animals, and were farther from shore. These results underscore annual variation during the bowhead whale fall migration and the physical oceanographic processes that may be related to whale distribution and behavior.

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The usual distribution of the Bering-Chukchi-Beaufort stock of bowhead whales in September in the central Alaskan Beaufort Sea lies on the inner continental shelf within the 50-m contour.

It was a different story in September 1997 and 2014.

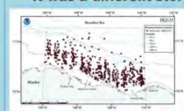


Figure 1. Locations of all bowhead whales observed by ASAMM within the study area (enclosed by the dotted line) in September 1989-2014. Data available from http://www.afsc.noaa.gov/NMML/cetacean/bwasp/

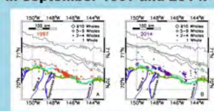
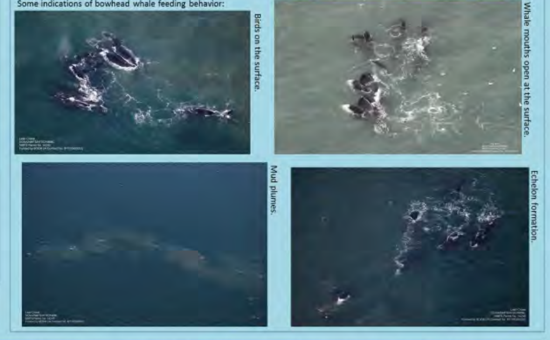


Figure 2. In September 1997 (A) and 2014 (B), bowhead whales were observed decidedly closer to shore, with the majority seen feeding. Survey effort in 1997 and 2014 was not significantly different compared to other years. The light blue line shows the location of the reference coastline associated with the barrier island system.

Some indications of bowhead whale feeding behavior:



What was going on?

Variable 1. High River Discharge

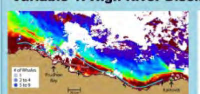


Figure 3. MODIS Aqua false-color image acquired 22 September 2014 showing reddish-brown sediment-laden waters of riverine origin inshore of blue marine waters. White areas are cloud covered. Blue dots indicate numbers and locations of bowhead whales observed during the 22 September aerial survey. Image acquired from the NASA Ocean Biology Distributed Active Archive Center for MODIS data access.

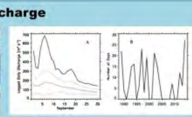


Figure 4. (A) Daily mean (dotted line) and daily maximum (dark solid line) composite river discharges for the 1989-2014 period and (B) number of days in September of each year in which the daily river discharges exceeded 153 m^3 s^{-1}, which is used as the threshold for categorizing high and low river discharges. Light gray lines are ± 1 SD. River discharge data from the Sagavanirktok and Kuparuk river watersheds; obtained from USGS (http://waterdata.usgs.gov/ak/nwis/current/?type=flow)

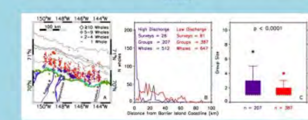


Figure 5. (A) Whale group locations associated with high river discharge (purple diamonds) and low river discharge (red diamonds) conditions, September 1989-2014. The light blue line shows the location of the reference coastline associated with the barrier island system. (B) Frequency distributions of whale distances from the coast for high river discharge conditions (purple line) and low river discharge conditions (red line). Annotation indicates the numbers of aerial surveys during which whales were observed, the numbers of recorded groupss, and the aggregate numbers of whales observed. (C) Box plots of whale group sizes for high river discharge (purple) and low river discharge (red) conditions. Dotted lines are median values, box boundaries are the 25th and 75th percentiles, whiskers are the 90th percentiles, and dots are 95th percentiles. The 5th, 10th, 25th, and 50th percentiles all correspond to one animal. Percentiles computed according to nearest rank method.

Variable 2. Prior (within 5 days) Upwelling Favorable Winds (> 5.4 m s^{-1})

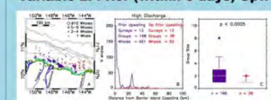


Figure 6. (A) Whale group locations associated with high river discharge and prior upwelling (purple diamonds), and high river discharge with no prior upwelling (red diamonds) conditions, September 1989-2014. (B) Frequency distributions of whale distances from the coast for high river discharge conditions preceded by an upwelling event (purple line) and not preceded by an upwelling event (red line). (C) Box plots of whale group sizes for high river discharge with prior upwelling (purple) and high river discharge with no prior upwelling (red) conditions. Explanations same as for Figure 5.

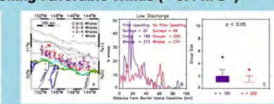


Figure 7. (A) Whale group locations associated with low river discharge and prior upwelling (purple diamonds), and low river discharge with no prior upwelling (red diamonds) conditions, September 1989-2014. (B) Frequency distributions of the whale distances from the coast for low river discharge conditions preceded by an upwelling event (purple line) and not preceded by an upwelling event (red line). (C) Box plots of whale group sizes for low river discharge with prior upwelling (purple) and low river discharge with no prior upwelling (red) conditions. Explanations same as for Figure 5.

Plausible Relationships

River Discharge	Prior Upwelling Winds: Yes	Prior Upwelling Winds: No
High	Bowhead whales nearest to shore, larger group sizes	Bowhead whales distributed on shelf, smaller group sizes
Low	Bowhead whales distributed on shelf, smaller group sizes	Bowhead whales distributed on shelf, smaller group sizes

Conclusions

When high river discharges occur up to 5 days after upwelling favorable winds, conditions appear ideal for zooplankton aggregations to occur in nearshore areas of the central Alaskan Beaufort Sea. Under these conditions, bowhead whales are closer to shore, found in larger groups, and foraging.

Caveats

Circumstantial evidence only - no direct evidence for upwelling and zooplankton in 1997 or 2014 (or other years). Additional oceanographic processes may be involved.

Observations of Bowhead Whale Foraging Near Barrow, Alaska, in 2015 Support the Krill Trap Model

Megan Ferguson – Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, megan.ferguson@noaa.gov
Stephen Okkonen – University of Alaska Fairbanks **Janet Clarke** – Leidos **Amy Willoughby & Amelia Brower** – Joint Institute for the Study of the Atmosphere and Ocean
Carin Ashjian – Woods Hole Oceanographic Institution **Craig George** – North Slope Borough Department of Wildlife Management

Abstract

The density, behavior, and group size distribution of bowhead whales over Barrow Canyon and the Beaufort Sea shelf near Barrow, AK, during late summer and fall exhibit interannual variability that may be partially explained by the presence of dense patches of euphausiids (krill) and copepod prey. The "krill trap" model theorizes that moderate to strong easterly winds cause upwelling that advects prey onto the shelf, which then become aggregated ("trapped") when wind speed decreases or direction changes to westerly or southwesterly. Furthermore, the model predicts that during upwelling periods bowhead whales will be found in smaller groups, often in Barrow Canyon, whereas during krill trap active periods bowhead whales will be found in larger groups over the shelf. Between 26 August and 4 October 2015, the Aerial Surveys of Arctic Marine Mammals (ASAMM) project (funded and co-managed by BOEM, conducted by NOAA) found historically high densities of feeding bowhead whales on the shelf south of 72° N, between Pt. Barrow and Cape Halkett (152°-157° W). During this period, ASAMM conducted 8 surveys totaling over 40 hrs and observed 672 total bowhead whales, 454 of which were either feeding or milling. The ratio of feeding/milling to total bowhead whales in 2015 (0.676) was second only to 2009 (0.732) in a time series of annual surveys beginning in 1989. Seven ASAMM surveys were conducted on 6 of 8 krill trap active periods in 2015; feeding/milling bowhead whales were observed on 5 of those surveys. During the active krill trap phase, the observed mean and maximum bowhead whale group sizes were larger than at other times. A single survey was conducted during the upwelling phase and moderate numbers of bowhead whales were observed, none of which were feeding/milling. Comparison of bowhead whale group sizes on krill trap active days with data from surveys conducted 5 days prior showed that krill trap group sizes were larger, implying that the bowhead whale congregation response was rapid. All of the fall bowhead whales harvested near Barrow in 2015 had been feeding on euphausiids. ASAMM bowhead whale observations in 2015 support the krill trap model.

References

[1]Ashjian, C.J., S.R. Braund, R.G. Campbell, J.C. George, J. Kruse, W. Maslowski, S.E. Moore, C.R. Nicolson, S.R. Okkonen, B.F. Sherr, E.B. Sherr, and Y.H. Spitz. 2010. Climate variability, oceanography, bowhead whale distribution, and Iñupiat subsistence whaling near Barrow, Alaska. Arctic 63(2): 179-194.

Acknowledgments

This study is funded and co-managed by the Bureau of Ocean Energy Management (IA No. M11PG00033), where we appreciate the support of Carol Fairfield and Dee Williams. At NMML, additional support was provided by Robyn Angliss, Phil Clapham, Stefan Ball, Nancy Friday, Kim Shelden, Janice Waite, and administrative and travel personnel. Thank you to the hard-working and talented marine mammal observers and pilots who spent their summer and fall flying over the Arctic. Real-time monitoring via satellite tracking of survey flights was provided by USDOI, Bureau of Land Management, Anchorage Interagency Dispatch Center. We also appreciate the analytical and programming expertise of Mike Hay (XeraGIS), who always responds instantaneously to questions from our field teams. Thank you to AFSC Graphics for assisting with the poster design.

Krill Trap Model

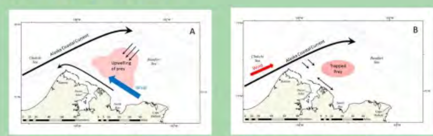


Figure 1. The "krill trap" model[1] theorizes that moderate to strong easterly winds cause upwelling that advects prey onto the shelf (A), which then become aggregated ("trapped") when wind speed decreases or direction changes to westerly or southwesterly (B). Black arrows show schematized currents. The model predicts that during upwelling periods bowhead whales will be found in smaller groups, often in Barrow Canyon, whereas during krill trap active periods bowhead whales will be found in larger groups over the shelf.

Methods

- Line-transect aerial surveys for marine mammals were conducted by observers in high-wing twin engine turboprop aircraft
- Focal study area: 152° to 157° W, from the coast to 72° N (Figure 2)
- Focal survey dates in 2015: August 26; September 1, 7, 16*, 21, 26, 27; October 4 (Table 2). *Survey conducted during upwelling period.
- Survey effort and sightings were recorded as one of four flight types: deadhead, circling, search, or transect
- Similar survey protocols were used from 1989 to 2015

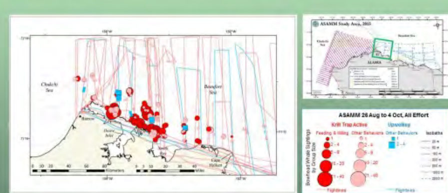


Figure 2. ASAMM Bowhead whale sightings (including circling, search, and transect) and survey effort (including deadhead, circling, search, and transect) in the focal study area near Barrow, Alaska, during krill trap active and upwelling periods, 26 August to 4 October 2015.

Conclusions

1) The ratio of feeding & milling bowhead whales in 2015 was second only to 2009 in records dating back to 1989
2) During krill trap active periods, the observed mean and maximum bowhead whale group sizes were larger than at other times
3) Comparison of bowhead whale group sizes on krill trap active days with data from surveys conducted 5 days prior showed that krill trap group sizes were larger, implying that the bowhead whale congregation response was rapid
4) ASAMM bowhead whale observations in 2015 support the krill trap model

Winds and Whales

- In 2015, the total number of bowhead whales and the number of feeding and milling bowhead whales were high, resulting in the second-highest feeding ratio (# feeding and milling whales / total # whales) since 1989 (Table 1).

Table 1. Number of feeding or milling and total bowhead whales observed during all flight types, by month, near Barrow during ASAMM surveys, 1989-2015. Feeding ratios were calculated as the number of feeding or milling bowhead whales divided by total bowhead whales. Black cells identify periods with no survey effort.

	JUL			AUG			SEP			OCT			TOTAL		
Year	Feed & Mill	Total	Feeding Ratio	Feed & Mill	Total	Feeding Ratio	Feed & Mill	Total	Feeding Ratio	Feed & Mill	Total	Feeding Ratio	Feed & Mill	Total	Feeding Ratio
1989							0	0	NaN	3	9	0.333	3	9	0.333
1990							0	0	NaN	3	32	0.094	3	32	0.094
1991							0	0	NaN	0	1	0.000	0	1	0.000
1992							0	1	0.000	37	77	0.481	37	78	0.474
1993							0	9	0.000	6	32	0.188	6	41	0.146
1994							0	6	0.000	0	2	0.000	0	8	0.000
1995							0	1	0.000	0	8	0.000	0	9	0.000
1996							6	18	0.333	0	0	NaN	6	18	0.333
1997							55	105	0.524	127	204	0.623	182	309	0.589
1998							243	385	0.631	9	55	0.164	252	440	0.573
1999							3	24	0.125	57	109	0.523	60	133	0.451
2000							38	57	0.667	0	7	0.000	38	64	0.594
2001							0	2	0.000	0	0	NaN	0	2	0.000
2002				1	1	1.000	0	1	0.000	3	13	0.231	4	15	0.267
2003							0	12	0.000	0	1	0.000	0	13	0.000
2004							138	200	0.690	0	23	0.000	138	223	0.619
2005							28	37	0.757	1	8	0.125	29	45	0.644
2006							37	75	0.493	6	17	0.353	43	92	0.467
2007							0	0	NaN	12	20	0.600	12	20	0.600
2008				0	0	NaN	15	89	0.169	23	64	0.359	38	153	0.248
2009	0	0	NaN	0	0	NaN	2	11	0.182	266	355	0.749	268	366	0.732
2010	0	0	NaN	0	0	NaN	22	34	0.647	0	13	0.000	22	47	0.468
2011	0	0	NaN	0	0	NaN	0	13	0.000	0	6	0.000	0	19	0.000
2012	0	8	0.000	24	37	0.649	1	29	0.034	20	91	0.220	45	165	0.273
2013	0	0	NaN	24	45	0.533	54	105	0.514	0	35	0.000	78	185	0.422
2014	0	14	0.000	0	8	0.000	69	129	0.535	40	78	0.513	109	229	0.476
2015	0	0	NaN	24	48	0.500	322	461	0.698	108	163	0.663	454	672	0.676

- In 2015, feeding and milling bowhead whales were observed only during krill trap active periods (Figures 2 and 3, Table 2).

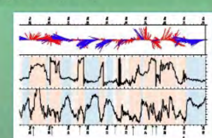


Figure 3. Wind speed and direction near Barrow from 20 August to 9 October, 2015. Upwelling periods, when easterly winds are stronger than 5.4 m/s, are shown as blue stripes. Red stripes depict krill trap active periods, which occur under westerly winds or when winds are weak from any direction. ↑Feeding bowhead whales sighted during survey. ↑ No feeding bowhead whales sighted during survey

Table 2. Summary of ASAMM survey flights and bowhead whales observed in the focal area between 26 August and 4 October 2015. Red = krill trap active period. Blue = upwelling period.

		Number of Bowhead Whales Observed			
Date	Flight Time (hours) in Focal Area	Total	Calves	Mill	Feed
8/26/2015	3.23	32	1	0	23
9/1/2015	1.33	57	2	0	9
9/7/2015	2.23	8	0	0	0
9/16/2015	6.62	46	3	0	0
9/21/2015	4.28	187	6	0	136
9/26/2015	2.55	10	1	0	0
9/27/2015	3.18	187	0	18	165
10/4/2015	6.93	164	8	36	79

- During krill trap active periods, the observed mean (2.43 whales) and maximum (40 whales) group sizes were larger than during the upwelling period (mean = 1.23 whales, maximum = 4 whales) (Figures 2 and 4).

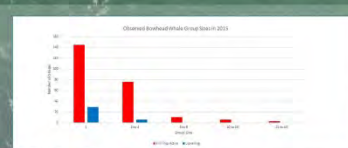


Figure 4. Histogram of observed bowhead whale group sizes in the focal area in 2015, all flight types, during krill trap active and upwelling periods.

Gray Whale Calf Occurrence in the Chukchi Sea, Summer and Fall 2015

Amy Willoughby[1], Amelia Brower[1], Janet Clarke[2], Megan Ferguson[3]

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OVERVIEW

Eighty-three Eastern North Pacific gray whale (*Eschrichtius robustus*) calves were observed during systematic line transect aerial surveys conducted from July to October 2015 in the northeastern Chukchi Sea (67°-72°N, 169°-154°W). These surveys, part of the Aerial Surveys of Arctic Marine Mammals (ASAMM) project, funded by BOEM and co-managed by BOEM and NOAA, have been conducted from July to October since 2009 to document the relative abundance and distribution of marine mammals in the Chukchi Sea Planning Area. The Chukchi Sea is recognized as the northernmost extent of the gray whale's seasonal migration, and serves as important foraging and weaning grounds during summer and fall. Recent survey seasons have recorded an increase in gray whale calf occurrences. The gray whale calf ratio for 2015 (0.18; 83 calves, 465 total gray whales) was the second highest since 2009. Calf sighting rates (number of calves on effort per km flown) have also been high, particularly since 2012. Calf distribution in 2015 was similar to previous years, with the greatest number of sightings occurring nearshore along the Alaskan coast from Point Lay to Barrow, although >45% of gray whale calves sighted in 2015 were 25 to 85 km offshore NNW of Wainwright.

METHODS AND SURVEY EFFORT

- Line transect aerial surveys
- 2 July to 30 October 2015
- Twin engine turboprop aircraft with bubble windows
- Target altitude 366 m (1200 ft.)
- Two marine mammal observers, one data recorder
- Chukchi Sea blocks 13-22, 23, and Beaufort Sea block 12. Block 23 was not surveyed prior to 2014 (Figure 1).
- Survey Effort: "on effort" (transect and circling from transect, Tr+TrC), "off effort" (search and circling from search), or deadhead
- ~ 36,300 km flown on and off effort within blocks 12-23 (Figure 1)

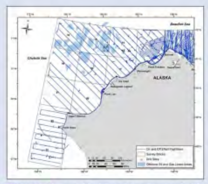

Figure 1. 2015 flightlines flown on and off effort, survey blocks 12-23.

CALF DISTRIBUTION

- In 2015, calves were distributed nearshore from Point Lay to Barrow in water <50 m deep, similar to previous years (Figure 2).
- >45% of gray whale calves were sighted 25 to 85 km NNW of Wainwright (Figure 2)
- In 2015, 20 calves were sighted in block 14 (Figure 3), compared to a single calf in 2012 and 2014, and two in 2013.
- Gray whale calf sightings overlap with non-calf sightings both spatially and temporally; the offshore calf sightings were associated with other gray whales recorded as feeding.

Figure 2. 2015 on- and off-effort calf sightings relative to shore.

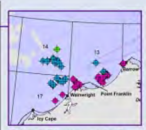

Figure 3. 2015 on- and off-effort calf sightings in block 14.

CALF RATIO PER YEAR

- Calf Ratio: Number of gray whale calves divided by the number of gray whales
- Includes sightings made on and off effort
- In 2015, the calf ratio of blocks 12-22 was the same as 2014 but lower than 2013 (Table 1).
- Including block 23, the calf ratio for 2015 was considerably higher than 2014.

Table 1. Gray whale calf ratios, on and off effort, July to October pooled, per year.

Calf Ratio: Gray Whale Calves / Total Whales				
Year	Survey Blocks	Whales	Calves	Calf Ratio
2009	12-22	366	10	0.03
2010	12-22	283	0	0.00
2011	12-22	261	13	0.05
2012	12-22	558	67	0.12
2013	12-22	281	57	0.20
2014	12-22	541	99	0.18
2015	12-22	425	77	0.18
2014	12-23	868	109	0.13
2015	12-23	465	83	0.18

CALF SIGHTING RATES PER YEAR

- Calf Sighting Rate: Number of gray whale calves per unit effort (CPUE), computed as gray whale calves (n) divided by the number of kilometers flown on effort (Tr+TrC km)
- In 2015, the gray whale calf sighting rate for blocks 12-22 and blocks 12-23, was almost equal to 2014 despite seeing fewer gray whales (Tables 1 and 2).
- The sighting rates for 2014 and 2015 were higher than any previous year (2009-2013).

Table 2. Sighting rates of gray whale calves, on effort, summer and fall, per year.

Calf Sighting Rate		Summer (July-Aug)			Fall (Sep-Oct)			Total		
Year	Survey Blocks	Tr+TrC km	n	CPUE	Tr+TrC km	n	CPUE	Tr+TrC km	n	CPUE
2009	12-22	9152	5	0.0005	12771	0	0.0000	21924	5	0.0002
2010	12-22	11785	0	0.0000	9206	0	0.0000	20992	0	0.0000
2011	12-22	12580	11	0.0009	13384	1	0.0001	25965	12	0.0005
2012	12-22	18781	53	0.0028	18136	0	0.0000	36917	53	0.0014
2013	12-22	16027	45	0.0028	12376	1	0.0001	28403	46	0.0016
2014	12-22	14211	60	0.0042	14174	1	0.0001	28385	61	0.0021
2015	12-22	14725	68	0.0046	19588	1	0.0001	34314	69	0.0020
2014	12-23	15518	69	0.0044	15432	2	0.0001	30950	71	0.0023
2015	12-23	15693	71	0.0045	20573	3	0.0001	36266	74	0.0020

DISCUSSION

While survey effort varies annually and repeat calf sightings are possible, our gray whale calf occurrence findings are consistent with the NMFS Southwest Fisheries Science Center's (SWFSC) counts of cow-calf pairs documented during their northward spring migration off the California coast (Figure 4; see the SWFSC's Gray Whale Studies – Calf Production website at: https://swfsc.noaa.gov/textblock.aspx?Division=PRD&ParentMenuId=211&id=16464).

- Increases in calf occurrence could be due to favorable foraging conditions from 2011 to 2014, resulting in higher reproductive success.
- More gray whale cow-calf pairs may be migrating to the northeastern Chukchi Sea if there is reduced resource productivity in other cow-calf pair habitat or increased inter- or intraspecific competition on favored foraging grounds.
- Future monitoring will be required to determine whether these high gray whale calf occurrence rates recorded in 2012 to 2015 are sustained.

Figure 4. Timeline of ASAMM's annual gray whale calf counts in the Chukchi Sea study area and SWFSC's northbound cow-calf pair counts off California, 2009-2015.

Acknowledgments

The ASAMM project was funded and co-managed by the Bureau of Ocean Energy Management and NOAA (IA No. M11PG00033), and supported by Carol Fairfield (current BOEM COR). At NMML, support was provided by Robyn Angliss, Stefan Ball, Phil Clapham, Mary Foote, Nancy Friday, Kim Shelden, Janice Waite, and Dave Withrow. At the Joint Institute for the Study of the Atmosphere and Ocean, additional support was provided by Amy Kennedy and the administrative and travel personnel. Additional gratitude to the hard working and passionate field biologists who collect these data, to Clearwater Air, Inc. pilots for safely navigating the extreme arctic airways, the vigilant flight followers with the Bureau of Land Management (DOI), and Mike Hay (Xera GIS), for providing our programming support.

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APPENDIX D: 2015 ARCTIC ACES – ASAMM COMMUNICATIONS PROTOCOL

Scan Eagle – ASAMM Survey Aircraft De-confliction Plan
8-29-2014

Planning, altitudes, and separation

- All team leads on the morning SIMOPS call
- All team leads present at the morning meeting
- SE1 will always fly upstream of 222ME in survey pattern
- 222ME will launch at least 30 minutes before launching SE1
- SE1 will transit the corridor at 400 ft
- 222ME will fly the survey at 1050 ft (GPS altitude)
- SE1 will fly survey at 1000 ft (GPS altitude); maximum allowable altitude is 2000 ft.
- SE1 will maintain at least 8 nmi separation at all times
- Primary air-to-air com is 122.8 Mhz; with sat phone as backup if VHF is not operational.
- 222ME has to monitor 121.5
- SE1 will make periodic ops normal calls on 122.8 (bottom and top of hour) and marine channel 16 VHF

Coms between 222ME and SE1

- 222ME shall call SE1 before engines start and establish coms via sat phone and relay 222ME transponder code.
- 222ME will call SE1 on 123.6 Mhz to announce overfly of NARL runway to ensure airspace is clear of all UAVs. If no positive coms, no overflight of runway, no entrance of study area.

SE1 coms

- 10 minutes prior to launch, SE1 calls Barrow Radio on 123.6 "UAV operations commencing in 10 minutes". This activates the flight plan.
- 10 minutes prior to launch, SE1 will call 222ME on the sat phone to announce plan to launch and will call the Clearwater operations phone. If no positive coms are established, the UAV will not launch.
- Once UAV airborne, call Barrow Traffic on 123.6 "SE1 airborne and proceeding via corridor to ________".
- SE1 calls 222ME on sat phone "SE1 entering the [east or west] study area". If SE1 can't establish sat phone coms with 222ME, call the Clearwater operations phone to establish coms. The Clearwater operations phone will be the third party who can relay information between parties. If no positive contact is established SE1 will not proceed into the same study area as 222ME. SE1 may proceed into an alternative study area.
- 222ME will attempt to call SE1 30 minutes after 222ME enters the survey area if 222ME hasn't heard from SE1.
- In the event that SE1 needs to deviate towards 222ME due to weather, SE1 will contact 222ME. Develop joint plan for remaining apart. If positive coms are not possible, then SE1 will remain at least 8 nmi away and upstream of 222ME.

Spatial separation

- A minimum of 8 nmi lateral separation will be maintained at all times between 222ME and SE1.
- Dahlgren will monitor the radar via WebAdapt at all times when SE1 is airborne to ensure that spatial separation is maintained between SE1 and 222ME (and any other aircraft that might be in the vicinity).

RTB contingencies – SE1 will RTB when:

- Lost command and control link
- Loss of WebAdapt for >15 minutes
- Signs of carb/structural icing
- SE1 will call 222ME to report EP

Lost link procedure:

- If SE1 Lost link occurs
- 2 minute timer on current route
- Lost link alarm - 2 minute timer on current route
- Turns to lost com route – direct to corridor at 1000 ft, descending to 400 ft

SATCOM

SE1 [redacted]
N222ME [redacted] Primary [redacted] Secondary
N690AX [redacted] Primary [redacted] Secondary
Dahlgren FA [redacted]
Dahlgren FA [redacted]
NOAA FA [redacted]

Landline and Cell Phones

Lorenz Eber Cell [redacted]
Jon Elliot Cell [redacted]
UAS Project Cell [redacted]
King Eider 907-852-4700 (request NOAA)
Clearwater operations phone [redacted]

** Sat phone to sat phone, just dial the number.
** From land lines or international cell phone to a sat phone, call 011 + the 12 digit sat phone number.
** From sat phone to land line, dial 001 + the 10 digit land line or cell phone number.

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APPENDIX E: 2015 SIGHTING RATE TABLES AND FIGURES

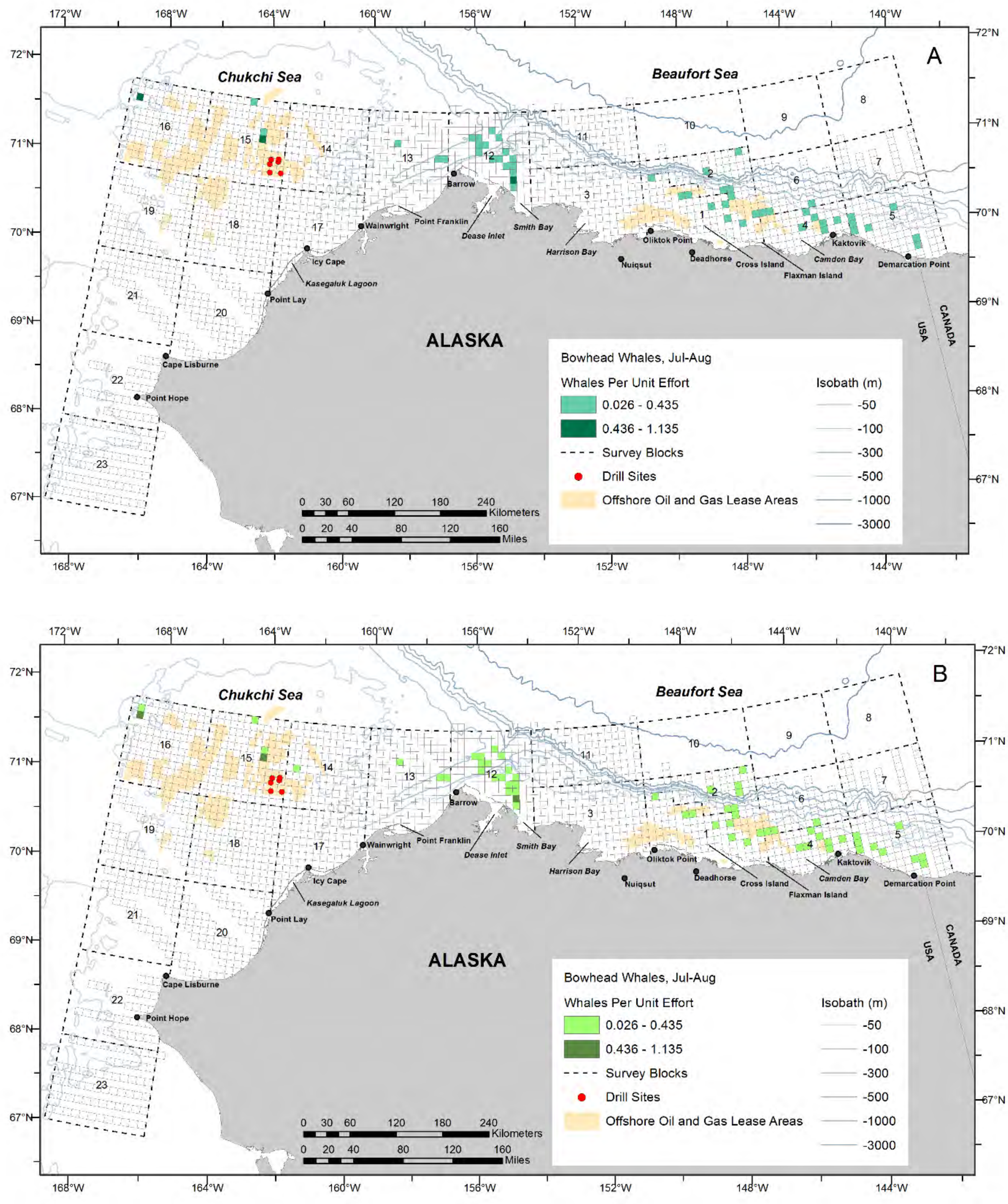


Figure E-1. ASAMM 2015 summer (July-August) bowhead whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

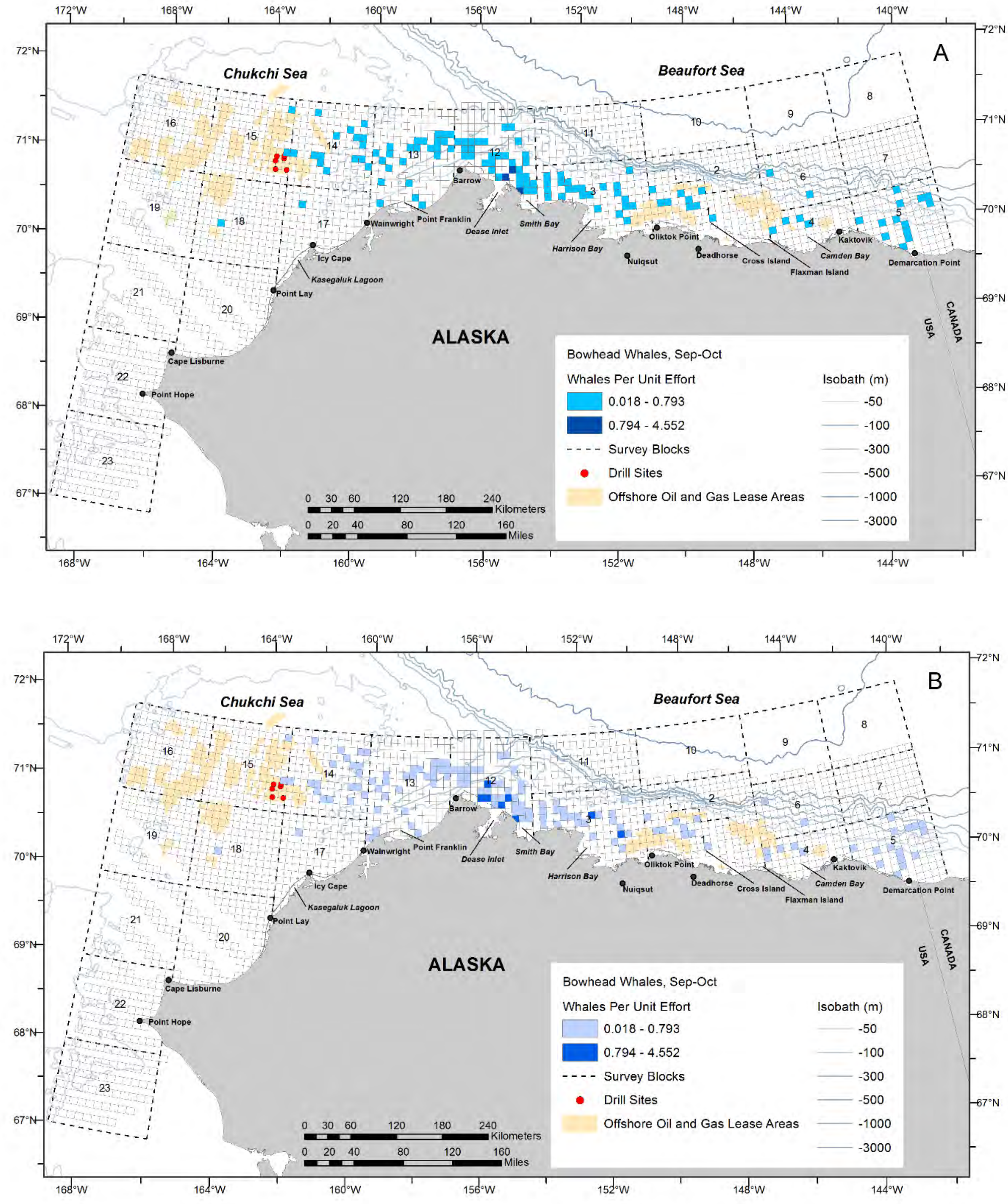


Figure E-2. ASAMM 2015 fall (September-October) bowhead whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

Table E-1. ASAMM 2015 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.

	JUL				AUG				SUMMER			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
1	422	0	0	0.0000	840	14	15	0.0179	1,262	14	15	0.0119
2	281	1	2	0.0071	548	4	5	0.0091	828	5	7	0.0084
3	633	0	0	0.0000	937	0	0	0.0000	1,570	0	0	0.0000
4	320	0	0	0.0000	684	7	8	0.0117	1,004	7	8	0.0080
5	0	0	0	NA	943	8	9	0.0095	943	8	9	0.0095
6	262	1	2	0.0076	472	2	2	0.0042	733	3	4	0.0055
7	0	0	0	NA	417	0	0	0.0000	417	0	0	0.0000
8	0	0	0	NA	0	0	0	NA	0	0	0	NA
9	0	0	0	NA	0	0	0	NA	0	0	0	NA
10	0	0	0	NA	13	0	0	0.0000	13	0	0	0.0000
11	583	0	0	0.0000	784	0	0	0.0000	1,367	0	0	0.0000
12	651	0	0	0.0000	1,098	20	43	0.0391	1,749	20	43	0.0246
13	1,156	0	0	0.0000	2,003	4	4	0.0020	3,159	4	4	0.0013
14	797	0	0	0.0000	1,055	0	0	0.0000	1,852	0	0	0.0000
15	466	0	0	0.0000	691	5	9	0.0130	1,158	5	9	0.0078
16	499	1	3	0.0060	148	0	0	0.0000	647	1	3	0.0046
17	639	0	0	0.0000	990	0	0	0.0000	1,629	0	0	0.0000
18	632	0	0	0.0000	299	0	0	0.0000	931	0	0	0.0000
19	330	0	0	0.0000	285	0	0	0.0000	615	0	0	0.0000
20	348	0	0	0.0000	488	0	0	0.0000	836	0	0	0.0000
21	85	0	0	0.0000	249	0	0	0.0000	334	0	0	0.0000
22	0	0	0	NA	320	0	0	0.0000	320	0	0	0.0000
23	0	0	0	NA	665	0	0	0.0000	665	0	0	0.0000
Total	**8,104**	**3**	**7**	**0.0009**	**13,930**	**64**	**95**	**0.0068**	**22,033**	**67**	**102**	**0.0046**

	SEP				OCT				FALL			
BLOCK	Tr Km	Tr Sightings	Tr Whales	WPUE	Tr Km	Tr Sightings	Tr Whales	WPUE	Tr Km	Tr Sightings	Tr Whales	WPUE
1	1,223	12	17	0.0139	440	0	0	0.0000	1,663	12	17	0.0102
2	975	0	0	0.0000	371	0	0	0.0000	1,346	0	0	0.0000
3	1,483	28	40	0.0270	466	16	26	0.0557	1,949	44	66	0.0339
4	702	3	3	0.0043	295	1	1	0.0034	997	4	4	0.0040
5	1,259	15	19	0.0151	485	1	2	0.0041	1,744	16	21	0.0120
6	1,574	2	2	0.0013	412	0	0	0.0000	1,986	2	2	0.0010
7	790	0	0	0.0000	418	0	0	0.0000	1,207	0	0	0.0000
8	2	0	0	0.0000	2	0	0	0.0000	4	0	0	0.0000
9	4	0	0	0.0000	1	0	0	0.0000	5	0	0	0.0000
10	2	0	0	0.0000	1	0	0	0.0000	3	0	0	0.0000
11	1,400	0	0	0.0000	607	0	0	0.0000	2,007	0	0	0.0000
12	2,322	45	116	0.0500	1,390	32	71	0.0511	3,712	77	187	0.0504
13	2,396	27	29	0.0121	1,324	6	7	0.0053	3,720	33	36	0.0097
14	1,163	17	23	0.0198	632	4	5	0.0079	1,795	21	28	0.0156
15	782	2	2	0.0026	416	0	0	0.0000	1,198	2	2	0.0017
16	631	0	0	0.0000	585	0	0	0.0000	1,216	0	0	0.0000
17	1,118	0	0	0.0000	669	1	1	0.0015	1,787	1	1	0.0006
18	793	1	2	0.0025	693	0	0	0.0000	1,487	1	2	0.0013
19	411	0	0	0.0000	327	0	0	0.0000	737	0	0	0.0000
20	772	0	0	0.0000	168	0	0	0.0000	940	0	0	0.0000
21	285	0	0	0.0000	0	0	0	NA	285	0	0	0.0000
22	367	0	0	0.0000	679	0	0	0.0000	1,046	0	0	0.0000
23	0	0	0	NA	858	0	0	0.0000	858	0	0	0.0000
Total	**20,453**	**152**	**253**	**0.0124**	**11,239**	**61**	**113**	**0.0101**	**31,692**	**213**	**366**	**0.0115**

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.

Table E-2. ASAMM 2015 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.

	JUL				**AUG**				**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	442	0	0	0.0000	859	15	17	0.0198	1,301	15	17	0.0131
2	331	3	4	0.0121	568	4	5	0.0088	899	7	9	0.0100
3	633	0	0	0.0000	937	0	0	0.0000	1,570	0	0	0.0000
4	320	0	0	0.0000	843	11	12	0.0142	1,163	11	12	0.0103
5	0	0	0	NA	1,120	15	19	0.0170	1,120	15	19	0.0170
6	293	1	2	0.0068	502	2	2	0.0040	795	3	4	0.0050
7	0	0	0	NA	417	0	0	0.0000	417	0	0	0.0000
8	0	0	0	NA	0	0	0	NA	0	0	0	NA
9	0	0	0	NA	0	0	0	NA	0	0	0	NA
10	0	0	0	NA	13	0	0	0.0000	13	0	0	0.0000
11	583	0	0	0.0000	784	0	0	0.0000	1,367	0	0	0.0000
12	663	0	0	0.0000	1,189	22	46	0.0387	1,852	22	46	0.0248
13	1,331	0	0	0.0000	2,292	4	4	0.0017	3,623	4	4	0.0011
14	956	1	1	0.0010	1,193	0	0	0.0000	2,149	1	1	0.0005
15	509	0	0	0.0000	728	5	9	0.0124	1,238	5	9	0.0073
16	534	2	4	0.0075	148	0	0	0.0000	682	2	4	0.0059
17	874	0	0	0.0000	1,074	0	0	0.0000	1,948	0	0	0.0000
18	704	0	0	0.0000	299	0	0	0.0000	1,004	0	0	0.0000
19	338	0	0	0.0000	285	0	0	0.0000	623	0	0	0.0000
20	387	0	0	0.0000	549	0	0	0.0000	937	0	0	0.0000
21	91	0	0	0.0000	257	0	0	0.0000	348	0	0	0.0000
22	0	0	0	NA	323	0	0	0.0000	323	0	0	0.0000
23	0	0	0	NA	968	0	0	0.0000	968	0	0	0.0000
Total	**8,990**	**7**	**11**	**0.0012**	**15,349**	**78**	**114**	**0.0074**	**24,338**	**85**	**125**	**0.0051**

	SEP				**OCT**				**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	1,350	13	19	0.0141	449	0	0	0.0000	1,798	13	19	0.0106
2	991	0	0	0.0000	377	0	0	0.0000	1,369	0	0	0.0000
3	1,685	46	77	0.0457	582	36	52	0.0894	2,267	82	129	0.0569
4	743	4	5	0.0067	299	1	1	0.0033	1,042	5	6	0.0058
5	1,390	17	21	0.0151	496	1	2	0.0040	1,886	18	23	0.0122
6	1,592	2	2	0.0013	412	0	0	0.0000	2,004	2	2	0.0010
7	798	0	0	0.0000	418	0	0	0.0000	1,216	0	0	0.0000
8	2	0	0	0.0000	2	0	0	0.0000	4	0	0	0.0000
9	4	0	0	0.0000	1	0	0	0.0000	5	0	0	0.0000
10	2	0	0	0.0000	1	0	0	0.0000	3	0	0	0.0000
11	1,400	0	0	0.0000	615	0	0	0.0000	2,015	0	0	0.0000
12	2,867	144	359	0.1252	1,574	57	106	0.0673	4,441	201	465	0.1047
13	2,705	41	51	0.0189	1,435	17	25	0.0174	4,141	58	76	0.0184
14	1,389	31	40	0.0288	670	4	5	0.0075	2,059	35	45	0.0219
15	826	2	2	0.0024	427	0	0	0.0000	1,254	2	2	0.0016
16	631	0	0	0.0000	595	0	0	0.0000	1,227	0	0	0.0000
17	1,167	0	0	0.0000	743	1	1	0.0013	1,911	1	1	0.0005
18	800	1	2	0.0025	698	0	0	0.0000	1,499	1	2	0.0013
19	411	0	0	0.0000	333	0	0	0.0000	744	0	0	0.0000
20	779	0	0	0.0000	168	0	0	0.0000	947	0	0	0.0000
21	285	0	0	0.0000	0	0	0	NA	285	0	0	0.0000
22	394	0	0	0.0000	688	0	0	0.0000	1,082	0	0	0.0000
23	0	0	0	NA	984	0	0	0.0000	984	0	0	0.0000
Total	**22,212**	**301**	**578**	**0.0260**	**11,970**	**117**	**192**	**0.0160**	**34,181**	**418**	**770**	**0.0225**

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.

Table E-3. ASAMM 2015 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.

	JUL				**AUG**				**SUMMER**			
	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	1,141	0	0	0.0000	2,017	0	0	0.0000	3,158	0	0	0.0000
36-50 m	2,764	1	3	0.0011	3,382	5	9	0.0027	6,146	6	12	0.0020
51-200 m North	1,048	0	0	0.0000	1,604	4	4	0.0025	2,652	4	4	0.0015
51-200 m South	0	0	0	NA	191	0	0	0.0000	191	0	0	0.0000
154°W-157°W												
0-20 m	159	0	0	0.0000	131	3	25	0.1912	290	3	25	0.0862
21-50 m	183	0	0	0.0000	259	8	8	0.0309	442	8	8	0.0181
51-200 m	266	0	0	0.0000	581	6	6	0.0103	847	6	6	0.0071
201-2,000 m	43	0	0	0.0000	128	3	4	0.0313	170	3	4	0.0235
140°W-154°W												
0-20 m	419	0	0	0.0000	732	2	2	0.0027	1,151	2	2	0.0017
21-50 m	963	0	0	0.0000	2,188	26	28	0.0128	3,152	26	28	0.0089
51-200 m	433	1	2	0.0046	1,181	6	8	0.0068	1,614	7	10	0.0062
201-2,000 m	506	1	2	0.0040	1,233	0	0	0.0000	1,739	1	2	0.0012
>2,000 m	177	0	0	0.0000	303	1	1	0.0033	480	1	1	0.0021
TOTAL	**8,103**	**3**	**7**	**0.0009**	**13,930**	**64**	**95**	**0.0068**	**22,033**	**67**	**102**	**0.0046**

	SEP				OCT				FALL			
	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	2,330	0	0	0.0000	1,371	3	3	0.0022	3,701	3	3	0.0008
36-50 m	4,190	17	21	0.0050	3,427	4	5	0.0015	7,617	21	26	0.0034
51-200 m North	2,127	30	35	0.0165	1,035	4	5	0.0048	3,161	34	40	0.0127
51-200 m South	70	0	0	0.0000	518	0	0	0.0000	588	0	0	0.0000
154°W-157°W												
0-20 m	360	30	98	0.2725	418	12	20	0.0479	777	42	118	0.1518
21-50 m	605	5	8	0.0132	347	12	41	0.1183	952	17	49	0.0515
51-200 m	1,144	8	8	0.0070	470	8	10	0.0213	1,614	16	18	0.0112
201-2,000 m	213	2	2	0.0094	156	0	0	0.0000	369	2	2	0.0054
140°W-154°W												
0-20 m	1,041	13	17	0.0163	343	11	18	0.0525	1,384	24	35	0.0253
21-50 m	2,992	37	52	0.0174	1,090	7	11	0.0101	4,082	44	63	0.0154
51-200 m	1,912	6	7	0.0037	726	0	0	0.0000	2,638	6	7	0.0027
201-2,000 m	2,651	4	5	0.0019	993	0	0	0.0000	3,644	4	5	0.0014
>2,000 m	824	0	0	0.0000	347	0	0	0.0000	1,170	0	0	0.0000
TOTAL	**20,459**	**152**	**253**	**0.0124**	**11,239**	**61**	**113**	**0.0101**	**31,698**	**213**	**366**	**0.0115**

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.

Table E-4. ASAMM 2015 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.

	JUL				**AUG**				**SUMMER**			
	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	1,424	0	0	0.0000	2,228	0	0	0.0000	3,652	0	0	0.0000
36-50 m	3,053	3	5	0.0016	3,909	5	9	0.0023	6,962	8	14	0.0020
51-200 m North	1,248	0	0	0.0000	1,774	4	4	0.0023	3,022	4	4	0.0013
51-200 m South	0	0	0	NA	206	0	0	0.0000	206	0	0	0.0000
154°W-157°W												
0-20 m	171	0	0	0.0000	181	4	26	0.1437	352	4	26	0.0739
21-50 m	183	0	0	0.0000	299	9	10	0.0335	482	9	10	0.0207
51-200 m	266	0	0	0.0000	581	6	6	0.0103	847	6	6	0.0071
201-2,000 m	43	0	0	0.0000	128	3	4	0.0313	170	3	4	0.0235
140°W-154°W												
0-20 m	419	0	0	0.0000	775	4	4	0.0052	1,194	4	4	0.0033
21-50 m	983	0	0	0.0000	2,476	36	42	0.0170	3,459	36	42	0.0121
51-200 m	465	1	2	0.0043	1,251	6	8	0.0064	1,716	7	10	0.0058
201-2,000 m	557	3	4	0.0072	1,233	0	0	0.0000	1,789	3	4	0.0022
>2,000 m	177	0	0	0.0000	308	1	1	0.0032	486	1	1	0.0021
TOTAL	**8,989**	**7**	**11**	**0.0012**	**15,349**	**78**	**114**	**0.0074**	**24,338**	**85**	**125**	**0.0051**

	SEP				OCT				FALL			
	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	2,491	0	0	0.0000	1,409	8	8	0.0057	3,900	8	8	0.0021
36-50 m	4,378	26	31	0.0071	3,600	4	5	0.0014	7,978	30	36	0.0045
51-200 m North	2,448	49	64	0.0261	1,126	10	18	0.0160	3,574	59	82	0.0229
51-200 m South	70	0	0	0.0000	609	0	0	0.0000	679	0	0	0.0000
154°W-157°W												
0-20 m	764	109	316	0.4137	514	21	32	0.0623	1,277	130	348	0.2724
21-50 m	688	23	30	0.0436	404	22	57	0.1412	1,091	45	87	0.0797
51-200 m	1,179	10	11	0.0093	501	14	17	0.0339	1,680	24	28	0.0167
201-2,000 m	236	2	2	0.0085	156	0	0	0.0000	392	2	2	0.0051
140°W-154°W												
0-20 m	1,225	24	39	0.0318	390	19	28	0.0718	1,615	43	67	0.0415
21-50 m	3,209	47	72	0.0224	1,189	19	27	0.0227	4,399	66	99	0.0225
51-200 m	1,998	7	8	0.0040	726	0	0	0.0000	2,724	7	8	0.0029
201-2,000 m	2,711	4	5	0.0018	1,000	0	0	0.0000	3,711	4	5	0.0013
>2,000 m	824	0	0	0.0000	347	0	0	0.0000	1,170	0	0	0.0000
TOTAL	**22,222**	**301**	**578**	**0.0260**	**11,970**	**117**	**192**	**0.0160**	**34,192**	**418**	**770**	**0.0225**

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.

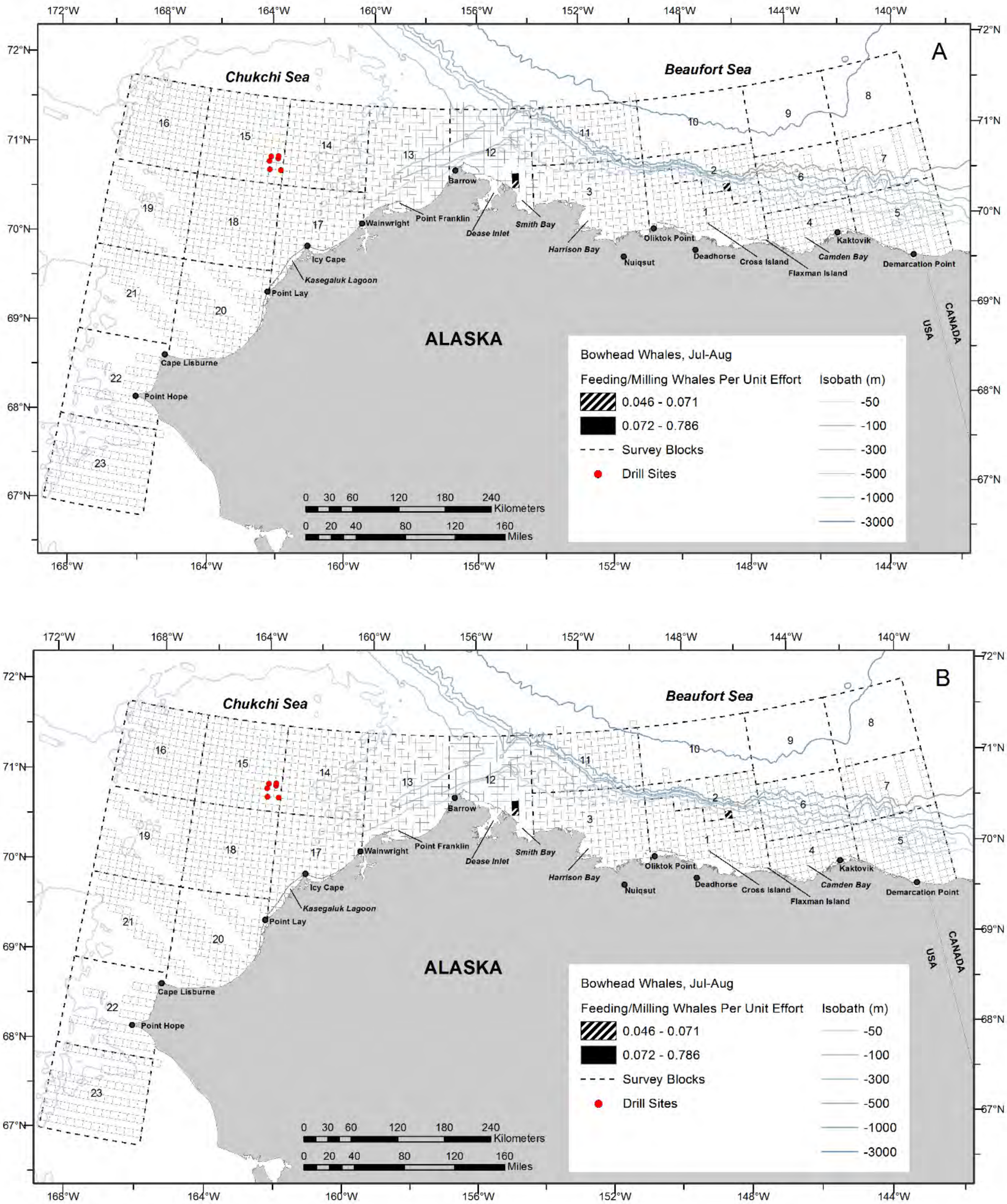
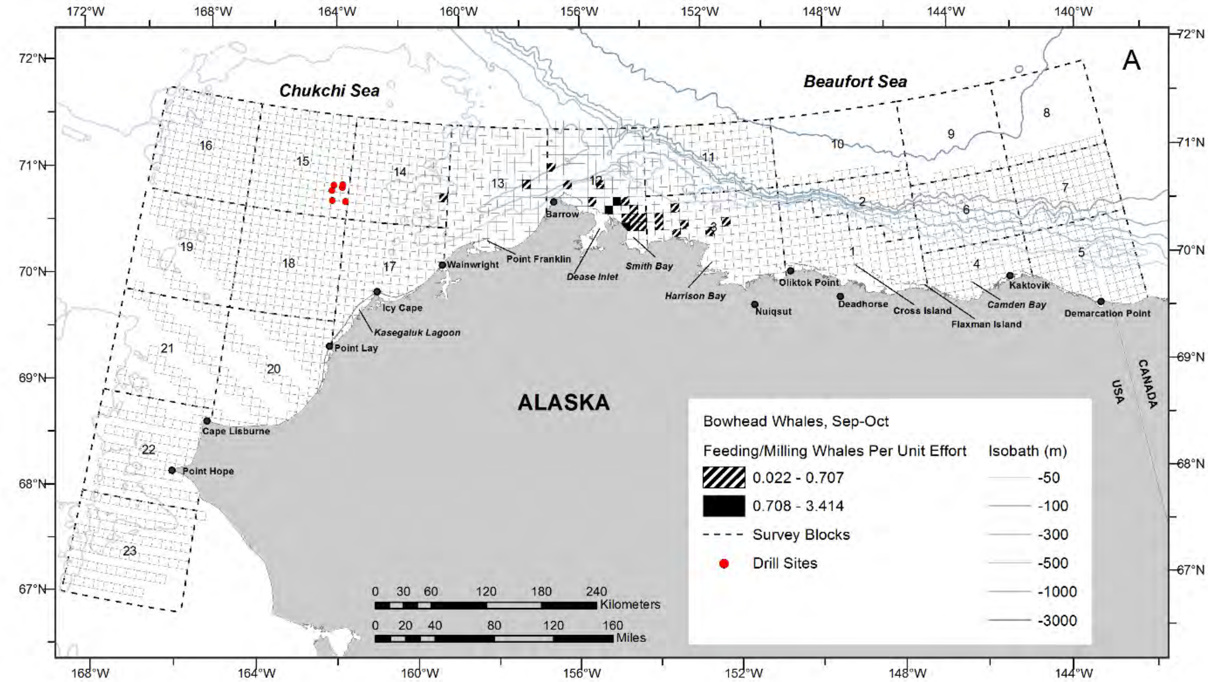


Figure E-3. ASAMM 2015 summer (July-August) feeding and milling bowhead whale sighting rates (WPUE; from primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.



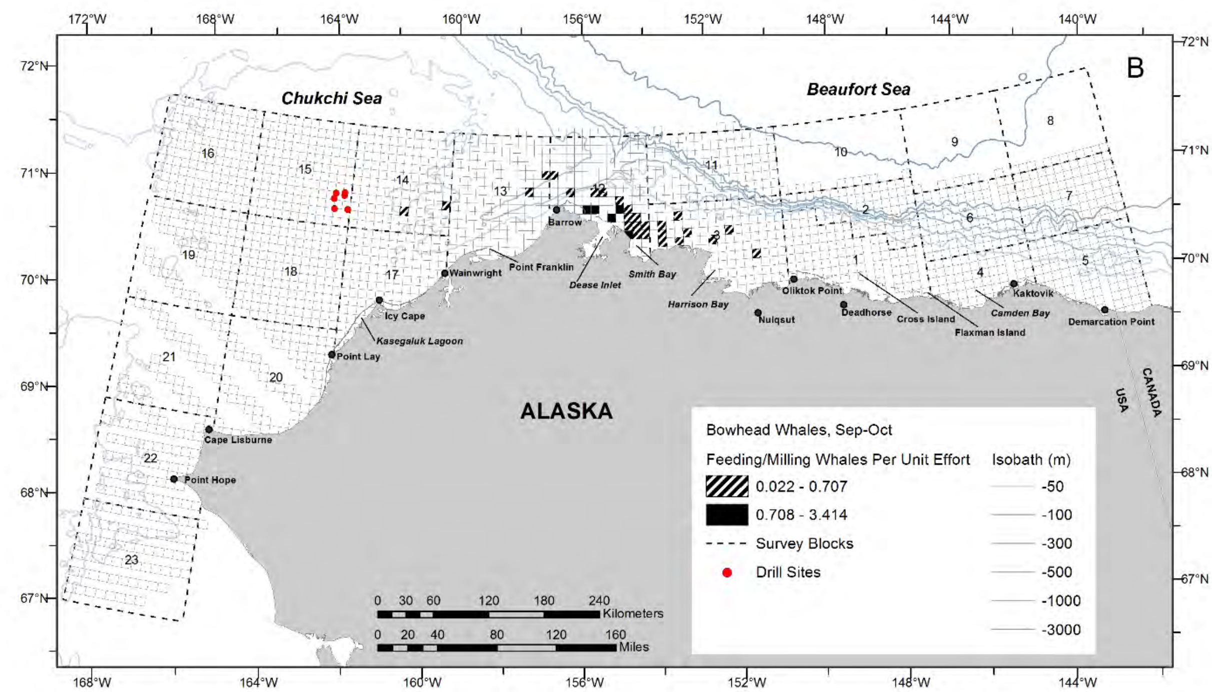


Figure E-4. ASAMM 2015 fall (September-October) feeding and milling bowhead whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

Table E-5. ASAMM 2015 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.

	JUL				AUG				SUMMER			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
12	651	0	0	0.0000	1,098	0	0	0.0000	1,749	0	0	0.0000
13	1,156	19	40	0.0346	2,003	24	39	0.0195	3,159	43	79	0.0250
14	797	10	26	0.0326	1,055	9	17	0.0161	1,852	19	43	0.0232
15	466	0	0	0.0000	691	0	0	0.0000	1,158	0	0	0.0000
16	499	0	0	0.0000	148	0	0	0.0000	647	0	0	0.0000
17	639	14	20	0.0313	990	4	7	0.0071	1,629	18	27	0.0166
18	632	1	1	0.0016	299	0	0	0.0000	931	1	1	0.0011
19	330	0	0	0.0000	285	0	0	0.0000	615	0	0	0.0000
20	348	2	9	0.0259	488	1	2	0.0041	836	3	11	0.0132
21	85	0	0	0.0000	249	0	0	0.0000	334	0	0	0.0000
22	0	0	0	NA	320	0	0	0.0000	320	0	0	0.0000
23	0	0	0	NA	665	4	9	0.0135	665	4	9	0.0135
Total	**5,604**	**46**	**96**	**0.0171**	**8,293**	**42**	**74**	**0.0089**	**13,896**	**88**	**170**	**0.0122**

	SEP				OCT				FALL			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
12	2,322	0	0	0.0000	1,390	0	0	0.0000	3,712	0	0	0.0000
13	2,396	5	9	0.0038	1,324	1	1	0.0008	3,720	6	10	0.0027
14	1,163	2	2	0.0017	632	3	3	0.0047	1,795	5	5	0.0028
15	782	0	0	0.0000	416	0	0	0.0000	1,198	0	0	0.0000
16	631	0	0	0.0000	585	0	0	0.0000	1,216	0	0	0.0000
17	1,118	3	4	0.0036	669	4	5	0.0075	1,787	7	9	0.0050
18	793	0	0	0.0000	693	0	0	0.0000	1,487	0	0	0.0000
19	411	0	0	0.0000	327	0	0	0.0000	737	0	0	0.0000
20	772	0	0	0.0000	168	0	0	0.0000	940	0	0	0.0000
21	285	0	0	0.0000	0	0	0	NA	285	0	0	0.0000
22	367	0	0	0.0000	679	0	0	0.0000	1,046	0	0	0.0000
23	0	0	0	NA	858	1	3	0.0035	858	1	3	0.0035
Total	**11,040**	**10**	**15**	**0.0014**	**7,740**	**9**	**12**	**0.0016**	**18,780**	**19**	**27**	**0.0014**

Total transect effort (Tr Km) may differ from values in Tables 2 and E-7 because effort between barrier islands and the mainland was not included in the sighting rate per survey block analysis.

Table E-6. ASAMM 2015 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.

	JUL				**AUG**				**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	663	0	0	0.0000	1,189	0	0	0.0000	1,852	0	0	0.0000
13	1,331	27	58	0.0436	2,292	54	92	0.0401	3,623	81	150	0.0414
14	956	17	35	0.0366	1,193	26	43	0.0360	2,149	43	78	0.0363
15	509	0	0	0.0000	728	0	0	0.0000	1,238	0	0	0.0000
16	534	0	0	0.0000	148	0	0	0.0000	682	0	0	0.0000
17	874	24	40	0.0458	1,074	11	16	0.0149	1,948	35	56	0.0287
18	704	1	1	0.0014	299	0	0	0.0000	1,004	1	1	0.0010
19	338	0	0	0.0000	285	0	0	0.0000	623	0	0	0.0000
20	387	2	9	0.0232	549	3	5	0.0091	937	5	14	0.0149
21	91	0	0	0.0000	257	0	0	0.0000	348	0	0	0.0000
22	0	0	0	NA	323	0	0	0.0000	323	0	0	0.0000
23	0	0	0	NA	968	9	25	0.0258	968	9	25	0.0258
Total	**6,387**	**71**	**143**	**0.0224**	**9,306**	**103**	**181**	**0.0195**	**15,693**	**174**	**324**	0.0206

BLOCK	SEP Tr+TrC Km	Tr+TrC Sightings	Tr+TrC Whales	WPUE	OCT Tr+TrC Km	Tr+TrC Sightings	Tr+TrC Whales	WPUE	FALL Tr+TrC Km	Tr+TrC Sightings	Tr+TrC Whales	WPUE
12	2,867	0	0	0.0000	1,574	0	0	0.0000	4,441	0	0	0.0000
13	2,705	5	9	0.0033	1,435	5	6	0.0042	4,141	10	15	0.0036
14	1,389	7	10	0.0072	670	3	3	0.0045	2,059	10	13	0.0063
15	826	0	0	0.0000	427	0	0	0.0000	1,254	0	0	0.0000
16	631	0	0	0.0000	595	0	0	0.0000	1,227	0	0	0.0000
17	1,167	4	5	0.0043	743	11	15	0.0202	1,911	15	20	0.0105
18	800	0	0	0.0000	698	0	0	0.0000	1,499	0	0	0.0000
19	411	0	0	0.0000	333	0	0	0.0000	744	0	0	0.0000
20	779	0	0	0.0000	168	0	0	0.0000	947	0	0	0.0000
21	285	0	0	0.0000	0	0	0	NA	285	0	0	0.0000
22	394	0	0	0.0000	688	0	0	0.0000	1,082	0	0	0.0000
23	0	0	0	NA	984	3	11	0.0112	984	3	11	0.0112
Total	**12,254**	**16**	**24**	**0.0020**	**8,318**	**22**	**35**	**0.0042**	**20,573**	**38**	**59**	**0.0029**

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.

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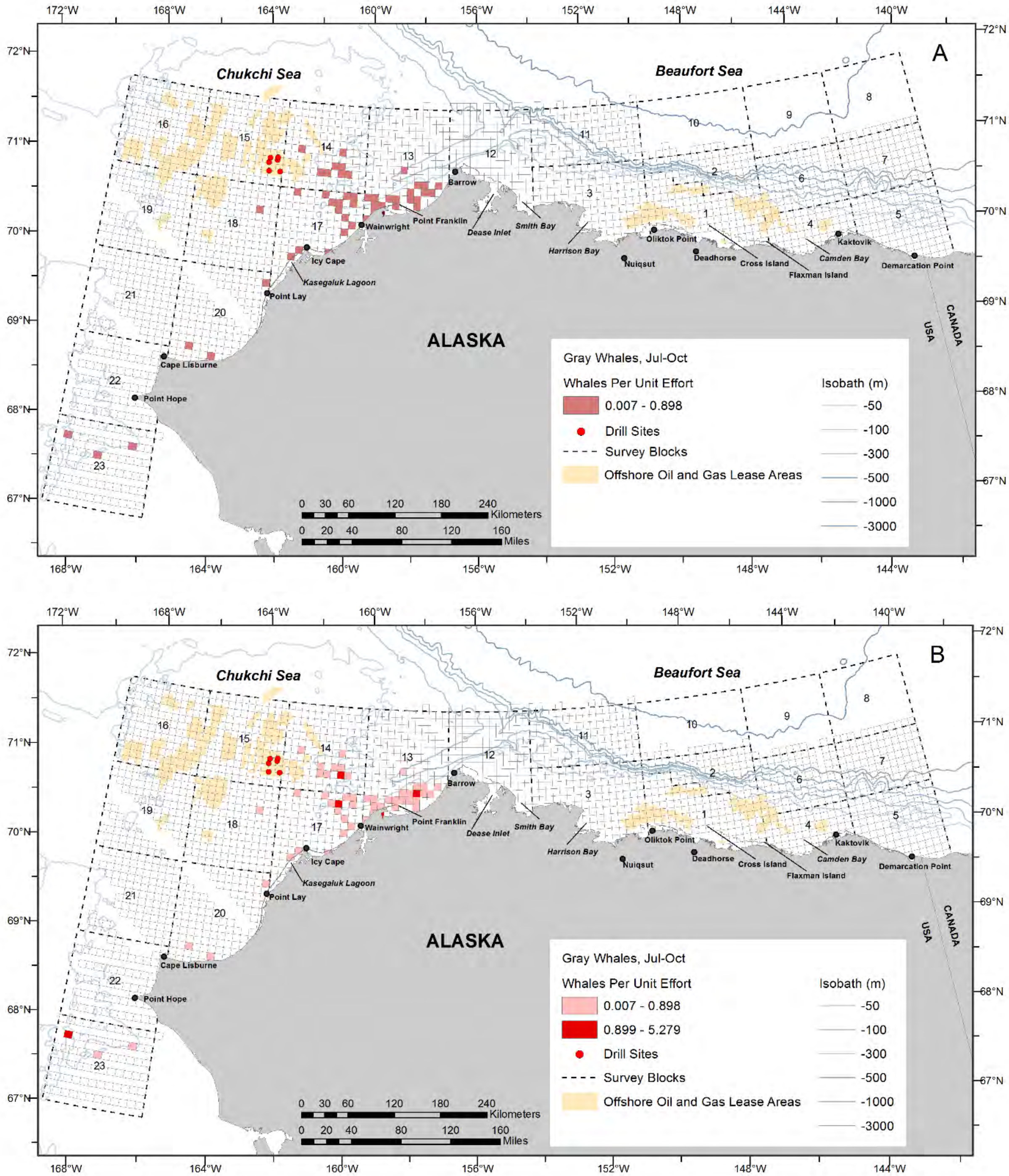

Figure E-5. ASAMM 2015 gray whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

Table E-7. ASAMM 2015 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.

	JUL				**AUG**				**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	1,141	21	49	0.0429	2,017	15	26	0.0129	3,158	36	75	0.0238
36-50 m	2,764	13	21	0.0076	3,382	13	25	0.0074	6,146	26	46	0.0075
51-200 m North	1,048	12	26	0.0248	1,604	12	20	0.0125	2,652	24	46	0.0173
51-200 m South	0	0	0	NA	191	2	3	0.0157	191	2	3	0.0157
154°W-157°W												
0-20 m	159	0	0	0.0000	131	0	0	0.0000	290	0	0	0.0000
21-50 m	183	0	0	0.0000	259	0	0	0.0000	442	0	0	0.0000
51-200 m	266	0	0	0.0000	581	0	0	0.0000	847	0	0	0.0000
201-2,000 m	43	0	0	0.0000	128	0	0	0.0000	170	0	0	0.0000
Total*	**5,604**	**46**	**96**	**0.0171**	**8,293**	**42**	**74**	**0.0089**	**13,896**	**88**	**170**	**0.0122**

	SEP				OCT				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	2,330	5	9	0.0039	1,371	1	1	0.0007	3,701	6	10	0.0027
36-50 m	4,190	1	1	0.0002	3,427	3	3	0.0009	7,617	4	4	0.0005
51-200 m North	2,127	4	5	0.0024	1,035	4	5	0.0048	3,161	8	10	0.0032
51-200 m South	70	0	0	0.0000	518	1	3	0.0058	588	1	3	0.0051
154°W-157°W												
0-20 m	360	0	0	0.0000	418	0	0	0.0000	777	0	0	0.0000
21-50 m	605	0	0	0.0000	347	0	0	0.0000	952	0	0	0.0000
51-200 m	1,144	0	0	0.0000	470	0	0	0.0000	1,614	0	0	0.0000
201-2,000 m	213	0	0	0.0000	156	0	0	0.0000	369	0	0	0.0000
Total*	**11,040**	**10**	**15**	**0.0014**	**7,740**	**9**	**12**	**0.0016**	**18,780**	**19**	**27**	**0.0014**

Total transect effort (Tr km) may differ from values in Tables 2 and E-5 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis.

Table E-8. ASAMM 2015 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.

	JUL				AUG				SUMMER			
	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	1,424	27	64	0.0449	2,228	37	68	0.0305	3,652	64	132	0.0361
36-50 m	3,053	20	33	0.0108	3,909	27	50	0.0128	6,962	47	83	0.0119
51-200 m North	1,248	24	46	0.0369	1,774	35	51	0.0287	3,022	59	97	0.0321
51-200 m South	0	0	0	NA	206	4	12	0.0584	206	4	12	0.0583
154°W-157°W												
0-20 m	171	0	0	0.0000	181	0	0	0.0000	352	0	0	0.0000
21-50 m	183	0	0	0.0000	299	0	0	0.0000	482	0	0	0.0000
51-200 m	266	0	0	0.0000	581	0	0	0.0000	847	0	0	0.0000
201-2,000 m	43	0	0	0.0000	128	0	0	0.0000	170	0	0	0.0000
Total*	**6,387**	**71**	**143**	**0.0224**	**9,306**	**103**	**181**	**0.0195**	**15,693**	**174**	**324**	**0.0206**

	SEP				OCT				FALL			
	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	2,491	5	9	0.0036	1,409	5	6	0.0043	3,900	10	15	0.0038
36-50 m	4,378	1	1	0.0002	3,600	10	13	0.0036	7,978	11	14	0.0018
51-200 m North	2,448	10	14	0.0057	1,126	4	5	0.0044	3,574	14	19	0.0053
51-200 m South	70	0	0	0.0000	609	3	11	0.0181	679	3	11	0.0162
154°W-157°W												
0-20 m	764	0	0	0.0000	514	0	0	0.0000	1,277	0	0	0.0000
21-50 m	688	0	0	0.0000	404	0	0	0.0000	1,091	0	0	0.0000
51-200 m	1,179	0	0	0.0000	501	0	0	0.0000	1,680	0	0	0.0000
201-2,000 m	236	0	0	0.0000	156	0	0	0.0000	392	0	0	0.0000
Total*	**12,254**	**16**	**24**	**0.0020**	**8,318**	**22**	**35**	**0.0042**	**20,573**	**38**	**59**	**0.0029**

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.

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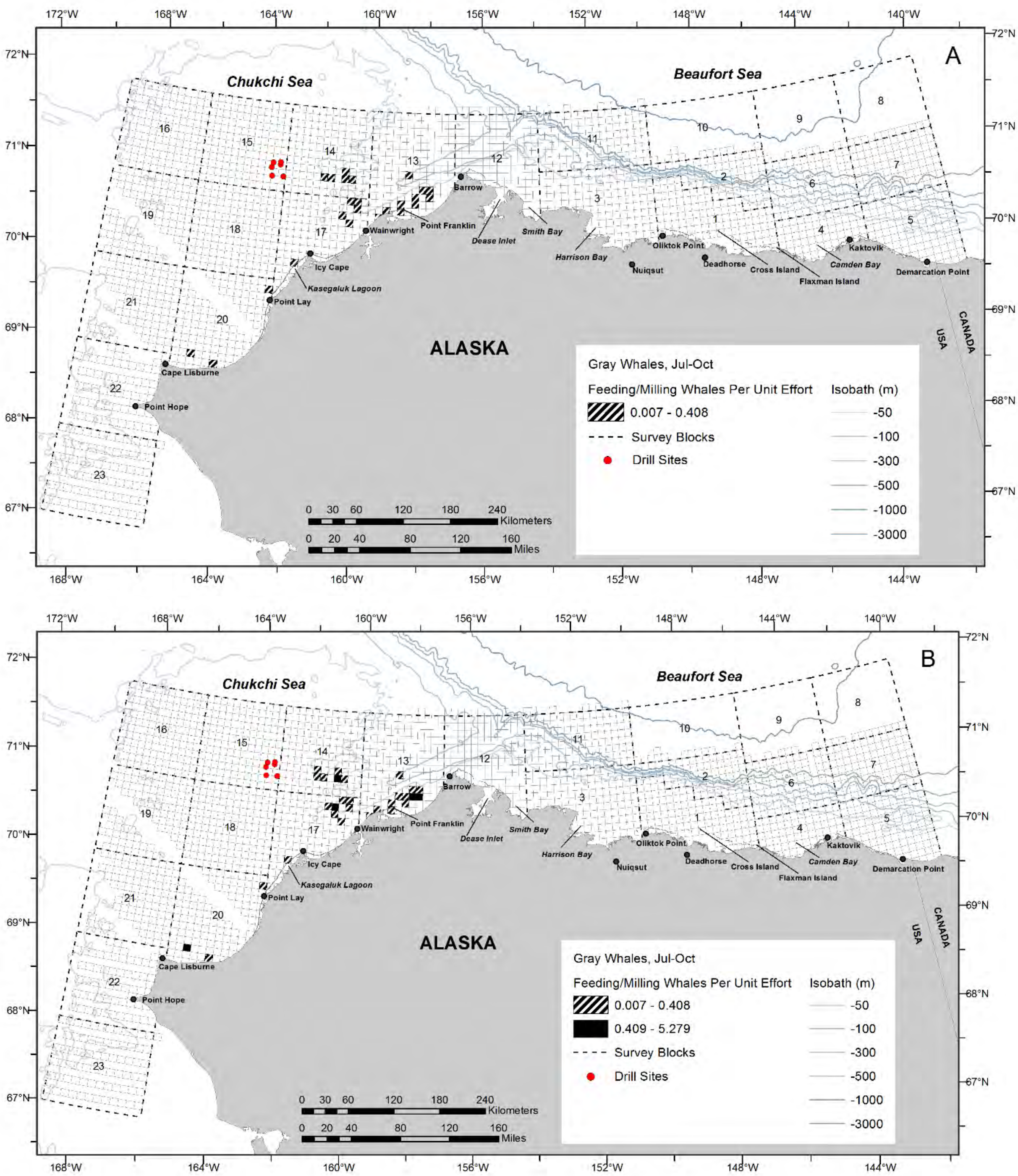

Figure E-6. ASAMM 2015 feeding and milling gray whale sighting rates (WPUE; primary observers only). A: transect (Tr); B: transect and circling from transect (Tr+TrC). Empty grid cells indicate sighting rates of zero. Transect survey effort was not conducted in areas without grid cells.

Table E-9. ASAMM 2015 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.

	JUL				AUG				SUMMER			
BLOCK	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**	**Tr Km**	**Tr Sightings**	**Tr Whales**	**WPUE**
1	422	1	1	0.0024	840	2	36	0.0429	1,262	3	37	0.0293
2	281	15	36	0.1281	548	55	83	0.1515	828	70	119	0.1436
3	633	2	2	0.0032	937	1	2	0.0021	1,570	3	4	0.0025
4	320	0	0	0.0000	684	4	6	0.0088	1,004	4	6	0.0060
5	0	0	0	NA	943	13	38	0.0403	943	13	38	0.0403
6	262	8	22	0.0841	472	26	54	0.1145	733	34	76	0.1037
7	0	0	0	NA	417	12	38	0.0912	417	12	38	0.0912
8	0	0	0	NA	0	0	0	NA	0	0	0	NA
9	0	0	0	NA	0	0	0	NA	0	0	0	NA
10	0	0	0	NA	13	2	4	0.3077	13	2	4	0.3077
11	583	20	31	0.0532	784	29	68	0.0867	1,367	49	99	0.0724
12	651	3	3	0.0046	1,098	17	50	0.0455	1,749	20	53	0.0303
13	1,156	1	1	0.0009	2,003	1	1	0.0005	3,159	2	2	0.0006
14	797	1	1	0.0013	1,055	1	1	0.0009	1,852	2	2	0.0011
15	466	2	2	0.0043	691	0	0	0.0000	1,158	2	2	0.0017
16	499	1	1	0.0020	148	0	0	0.0000	647	1	1	0.0015
17	639	6	255	0.3991	990	0	0	0.0000	1,629	6	255	0.1565
18	632	3	4	0.0063	299	0	0	0.0000	931	3	4	0.0043
19	330	0	0	0.0000	285	0	0	0.0000	615	0	0	0.0000
20	348	0	0	0.0000	488	0	0	0.0000	836	0	0	0.0000
21	85	0	0	0.0000	249	0	0	0.0000	334	0	0	0.0000
22	0	0	0	NA	320	1	1	0.0031	320	1	1	0.0031
23	0	0	0	NA	665	0	0	0.0000	665	0	0	0.0000
Total	**8,104**	**63**	**359**	**0.0443**	**13,930**	**164**	**382**	**0.0274**	**22,033**	**227**	**741**	**0.0336**

	SEP				OCT				FALL			
BLOCK	Tr Km	Tr Sightings	Tr Whales	WPUE	Tr Km	Tr Sightings	Tr Whales	WPUE	Tr Km	Tr Sightings	Tr Whales	WPUE
1	1,223	1	3	0.0025	440	0	0	0.0000	1,663	1	3	0.0018
2	975	31	57	0.0585	371	11	72	0.1941	1,346	42	129	0.0958
3	1,483	4	4	0.0027	466	3	15	0.0322	1,949	7	19	0.0097
4	702	1	1	0.0014	295	0	0	0.0000	997	1	1	0.0010
5	1,259	12	41	0.0326	485	24	63	0.1298	1,744	36	104	0.0596
6	1,574	19	29	0.0184	412	5	5	0.0121	1,986	24	34	0.0171
7	790	16	40	0.0507	418	9	13	0.0311	1,207	25	53	0.0439
8	2	0	0	0.0000	2	0	0	0.0000	4	0	0	0.0000
9	4	0	0	0.0000	1	0	0	0.0000	5	0	0	0.0000
10	2	0	0	0.0000	1	0	0	0.0000	3	0	0	0.0000
11	1,400	41	100	0.0714	607	33	159	0.2618	2,007	74	259	0.1290
12	2,322	49	107	0.0461	1,390	33	91	0.0655	3,712	82	198	0.0533
13	2,396	4	4	0.0017	1,324	3	3	0.0023	3,720	7	7	0.0019
14	1,163	1	2	0.0017	632	2	4	0.0063	1,795	3	6	0.0033
15	782	0	0	0.0000	416	2	4	0.0096	1,198	2	4	0.0033
16	631	0	0	0.0000	585	0	0	0.0000	1,216	0	0	0.0000
17	1,118	1	2	0.0018	669	0	0	0.0000	1,787	1	2	0.0011
18	793	0	0	0.0000	693	0	0	0.0000	1,487	0	0	0.0000
19	411	0	0	0.0000	327	0	0	0.0000	737	0	0	0.0000
20	772	0	0	0.0000	168	0	0	0.0000	940	0	0	0.0000
21	285	0	0	0.0000	0	0	0	NA	285	0	0	0.0000
22	367	0	0	0.0000	679	0	0	0.0000	1,046	0	0	0.0000
23	0	0	0	NA	858	1	1	0.0012	858	1	1	0.0012
Total	**20,453**	**180**	**390**	**0.0191**	**11,239**	**126**	**430**	**0.0383**	**31,692**	**306**	**820**	**0.0259**

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.

Table E-10. ASAMM 2015 transect (Tr) effort (km), beluga Tr sightings (primary observers only), and beluga 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.

	JUL				AUG				SUMMER			
	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	1,141	5	254	0.2226	2,017	2	2	0.0010	3,158	7	256	0.0811
36-50 m	2,764	8	9	0.0033	3,382	1	1	0.0003	6,146	9	10	0.0016
51-200 m North	1,048	1	1	0.0010	1,604	0	0	0.0000	2,652	1	1	0.0004
51-200 m South	0	0	0	NA	191	0	0	0.0000	191	0	0	0.0000
154°W-157°W												
0-20 m	159	0	0	0.0000	131	0	0	0.0000	290	0	0	0.0000
21-50 m	183	0	0	0.0000	259	2	7	0.0271	442	2	7	0.0158
51-200 m	266	0	0	0.0000	581	11	36	0.0619	847	11	36	0.0425
201-2,000 m	43	3	3	0.0698	128	4	7	0.0547	170	7	10	0.0587
140°W-154°W												
0-20 m	419	0	0	0.0000	732	3	12	0.0164	1,151	3	12	0.0104
21-50 m	963	2	2	0.0021	2,188	7	65	0.0297	3,152	9	67	0.0213
51-200 m	433	5	9	0.0208	1,181	15	27	0.0229	1,614	20	36	0.0223
201-2,000 m	506	36	77	0.1521	1,233	114	219	0.1777	1,739	150	296	0.1702
>2,000 m	177	3	4	0.0226	303	5	6	0.0198	480	8	10	0.0208
TOTAL	**8,103**	**63**	**359**	**0.0443**	**13,930**	**164**	**382**	**0.0274**	**22,033**	**227**	**741**	**0.0336**

	SEP				OCT				FALL			
	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	2,330	1	2	0.0009	1,371	2	2	0.0015	3,701	3	4	0.0011
36-50 m	4,190	1	2	0.0005	3,427	2	4	0.0012	7,617	3	6	0.0008
51-200 m North	2,127	4	4	0.0019	1,035	4	6	0.0058	3,161	8	10	0.0032
51-200 m South	70	0	0	0.0000	518	0	0	0.0000	588	0	0	0.0000
154°W-157°W												
0-20 m	360	2	2	0.0056	418	0	0	0.0000	777	2	2	0.0026
21-50 m	605	1	2	0.0033	347	0	0	0.0000	952	1	2	0.0021
51-200 m	1,144	18	26	0.0227	470	10	33	0.0702	1,614	28	59	0.0366
201-2,000 m	213	28	77	0.3615	156	23	58	0.3719	369	51	135	0.3655
140°W-154°W												
0-20 m	1,041	2	15	0.0144	343	0	0	0.0000	1,384	2	15	0.0108
21-50 m	2,992	3	5	0.0017	1,090	2	14	0.0128	4,082	5	19	0.0047
51-200 m	1,912	6	8	0.0042	726	15	68	0.0937	2,638	21	76	0.0288
201-2,000 m	2,651	98	214	0.0807	993	67	242	0.2437	3,644	165	456	0.1252
>2,000 m	824	16	33	0.0401	347	1	3	0.0087	1,170	17	36	0.0308
TOTAL	**20,459**	**180**	**390**	**0.0191**	**11,239**	**126**	**430**	**0.0383**	**31,698**	**306**	**820**	**0.0259**

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.

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APPENDIX F: ASAMM CONTRIBUTIONS TO THE SCIENTIFIC COMMUNITY, 2008-2015

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.
- 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.
- 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 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.

	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	
AOOS					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		
NGOs	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.

PUBLISHED PAPERS USING ASAMM/BWASP/COMIDA DATA (ALPHABETIZED):

Calambokidis, J., G. Steiger, C. Curtice, J. Harrison, M.C. Ferguson, E. Becker, M. DeAngelis, and S.M. Van Parijs. 2015. Biologically Important Areas for cetaceans within U.S. waters: West Coast region. *Aquatic Mammals* 41(1): 39-53.

Christman, C., J. Citta, L. Quakenbush, J. Clarke, B. Rone, R. Shea, M. Ferguson and M. Heide-Jørgensen. 2013. Presence and behavior of bowhead whales (*Balaena mysticetus*) in the Alaskan Beaufort Sea in July 2011. *Polar Biology* 36(12): 1851-1856. DOI 10.1007/s00300-013-1395-4.

Clarke, J., A. Kennedy, and M. Ferguson. 2016. Bowhead and gray whale distribution, relative abundance, and habitat selection in the northeastern Chukchi Sea, July-October 2009-2012. *Arctic* 69(4): 359-377.

Clarke, J.T., M.C. Ferguson, C. Curtice, and J. Harrison. 2015. Biologically Important Areas for cetaceans within the U.S. waters: Arctic region. *Aquatic Mammals* 41(1): 94-103.

Clarke, J., K. Stafford, S. Moore, B. Rone and J. Crance. 2014. Subarctic cetaceans in the southern Chukchi Sea: evidence of recovery or response to a changing ecosystem. *Oceanography* 24(4):46-59.

Edwards, E.F., C. Hall, T.J. Moore, C. Sheredy, and J.V. Redfern. 2015. Global distribution of fin whales *Balaenoptera physalus* in the post-whaling era (1980-2012). *Mammal Review* 45: 197-214.

Ferguson, M. 2012. Quantifying spatial characteristics of the Bowhead Whale Aerial Survey Project (BWASP) survey design. *Journal of Cetacean Research and Management* 12(1): 39-44.

Ferguson, M. and J. Clarke. 2013. Estimates of detection probability for BWASP bowhead whale, gray whale, and beluga sightings collected from Twin Otter and Aero Commander aircraft, 1989 to 2007 and 2008 to 2011. U.S. Department of Commerce, NOAA Tech. Memo. NMFS-AFSC-261. 52 p.

Ferguson, M.C., C. Curtice, and J. Harrison. 2015. Biologically Important Areas for cetaceans within U.S. waters: Gulf of Alaska region. *Aquatic Mammals* 41(1): 65-78.

Ferguson, M.C., C. Curtice, J. Harrison, and S.M. Van Parijs. 2015. Biologically Important Areas for marine mammals within U.S. waters: Overview and rationale. *Aquatic Mammals* 41(1):2-16.

Ferguson, M.C., J. Waite, C. Curtice, J.T. Clarke, and J. Harrison. 2015. Biologically Important Areas for cetaceans within U.S. waters: Aleutian Islands and Bering Sea region. *Aquatic Mammals* 41(1):79-93.

Givens, G.H., J.A. Hoeting, and L. Beri. 2009. Factors that influence aerial line transect detection of Bering-Chukchi-Beaufort Sea bowhead whales. *Journal of Cetacean Research and Management* 11(1): 9-16.

Grebmeier, J.M., B.A. Bluhm, L.W. Cooper, S. Danielson, K. Arrigo, A.L. Blanchard, J.T. Clarke, R.H. Day, K.E. Frey, R.R. Gradinger, M. Kedra, B. Konar, K.J. Kuletz, S.H. Lee, J.R. Lovvorn, B.L. Norcross, and S.R. Okkonen. 2015. Ecosystem characteristics and processes facilitating persistent macrobenthic biomass hotspots and associated benthivory in the Pacific Arctic. *Progress in Oceanography* 136: 92-114. doi:10.1016/j.pocean.2015.05.006

Kuletz, K.J., M.C. Ferguson, B. Hurley, A.E. Gall, E.A. Labunski, and T.C. Morgan. 2015. Seasonal spatial patterns in seabird and marine mammal distribution in the eastern Chukchi and western Beaufort seas: Identifying biologically important pelagic areas. *Progress in Oceanography* 136: 175-200. doi:10.1016/j.pocean.2015.05.012

Okkonen, S., C. Ashjian, R. Campbell, J. Clarke, S. Moore and K. Taylor. 2011. Satellite observations of circulation features associated with a bowhead whale feeding 'hotspot' near Barrow, Alaska. *Remote Sensing of Environment* 115: 2168-2174.

Schonberg, S., J. Clarke and K. Dunton. 2013. Distribution, abundance, biomass and diversity of benthic infauna in the northeast Chukchi Sea, Alaska: Relation to environmental variables and marine mammals. *Deep Sea Research Part II: Topical Studies in Oceanography* DOI 10.1016/j.dsr2.2013.11.004.

Stafford, K., S. Okkonen, and J. Clarke. 2013. Correlation of a strong Alaska Coastal Current with the presence of beluga whales (*Delphinapterus leucas)* near Barrow, Alaska. *Marine Ecology Progress Series* 474: 287-297.

ASAMM ANNUAL REPORTS, USFWS PERMIT REPORTS, INTERNATIONAL WHALING COMMISSION PAPERS, AND ALASKA FISHERIES SCIENCE CENTER QUARTERLY REPORTS (ALPHABETIZED):

Brower, A. 2013. Gray whale calf occurrence in the Alaskan Arctic, summer and fall 2013, with comparisons to previous years. Alaska Fisheries Science Center Quarterly Report Oct-Nov-Dec.

Brower, A., J. Clarke, M. Ferguson, C. Christman and C. Sims. 2012. Aerial surveys of Arctic marine mammals project: preliminary results from the 2012 field season. Alaska Fisheries Science Center Quarterly Report Jul-Aug-Sep.

Christman, C. and B. Rone. 2011. Annual report for activities conducted by the National Marine Mammal Laboratory under Federal Fish and Wildlife Permit MA212570-0 for calendar year 2010. Prepared by the National Marine Mammal Laboratory (NMFS) for U.S. Fish and Wildlife Service. 12 pp.

Christman, C. and B. Rone. 2012. Annual report for activities conducted by the National Marine Mammal Laboratory under Federal Fish and Wildlife Permit MA212570-0 in calendar year 2011. Prepared by the National Marine Mammal Laboratory (NMFS) for U.S. Fish and Wildlife Service. 16 pp.

Christman, C. and B. Rone. 2013. Annual report for activities conducted by the National Marine Mammal Laboratory under Federal Fish and Wildlife Permit MA212570-0 in calendar year 2012. Prepared by the National Marine Mammal Laboratory (NMFS) for U.S. Fish and Wildlife Service. 13 pp.

Christman, C. and B. Rone. 2013. Annual report for activities conducted by the National Marine Mammal Laboratory under Federal Fish and Wildlife Permit MA212570-0 in calendar year 2013. Prepared by the National Marine Mammal Laboratory (NMFS) for U.S. Fish and Wildlife Service. 10 pp.

Clarke, J. 2009. Chukchi Offshore Monitoring in Drilling Area, 2008. Prepared for NMML-NMFS and MMS-Alaska. 15 pp.

Clarke, J. 2010. Chukchi Offshore Monitoring in Drilling Area, 2009. Prepared for NMML-NMFS and MMS-Alaska. 26 pp.

Clarke, J. and M. Ferguson. 2010. Aerial surveys of large whales in the Northeastern Chukchi Sea, 2008-2009, with review of 1982-1991 data. SC/62/BRG13 presented at the International Whaling Commission Scientific Committee Meetings, Morocco, June 2010. 18 pp.

Clarke, J. and M. Ferguson. 2010. Aerial surveys for bowhead whales in the Alaskan Beaufort Sea: BWASP update 2000-2009 with comparisons to historical data. SC/62/BRG14 presented at the International Whaling Commission Scientific Committee Meetings, Morocco, June 2010. 11 pp.

Clarke, J. and B. Rone. 2010. Annual report for activities conducted by the National Marine Mammal Laboratory under Federal Fish and Wildlife Permit MA212570-0 For calendar year 2009. Prepared by the National Marine Mammal Laboratory (NMFS) for U.S. Fish and Wildlife Service. 11 pp.

Clarke, J., C. Christman, A.A. Brower, M.C. Ferguson and S.L. Grassia. 2011. Aerial Surveys of Endangered Whales in the Beaufort Sea, fall 2010. OCS Study BOEMRE 2011-035. Annual report, OCS Study BOEMRE 2011-035. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC, Seattle, WA 98115-6349. 119 pp.

Clarke, J., C. Christman, M. Ferguson and S. Grassia. 2011. Aerial surveys of endangered whales in the Beaufort Sea, fall 2006-2008. Final report, OCS Study BOEMRE 2011-042. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC, Seattle, WA 98115-6349. 240 pp.

Clarke, J., C. Christman, S. Grassia, A. Brower and M. Ferguson. 2011. Aerial surveys of endangered whales in the Beaufort Sea, fall 2009. Final report, OCS Study BOEMRE 2011-040. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC, Seattle, WA 98115-6349. 92 pp.

Clarke, J., M. Ferguson, C. Christman, S. Grassia, A. Brower and L. Morse. 2011. Chukchi Offshore Monitoring in Drilling Area (COMIDA) distribution and relative abundance of marine mammals: aerial surveys. Final report, OCS Study BOEMRE 2011-06. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC, Seattle, WA 98115-6349. 296 pp.

Clarke, J., C. Christman, A. Brower and M. Ferguson. 2012. Distribution and relative abundance of marine mammals in the Alaskan Chukchi and Beaufort Seas, 2011. Annual report, OCS Study BOEM 2012-009. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC, Seattle, WA 98115-6349. 344 pp.

Clarke, J., C. Christman, A. Brower, and M. Ferguson. 2013. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort Seas, 2012. Annual report, OCS Study BOEM 2013-00117. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC, Seattle, WA 98115-6349. 349 pp.

Clarke, J., A. Brower, C. Christman, and M. Ferguson. 2014. Distribution and relative abundance of marine mammals in the northeastern Chukchi and western Beaufort Seas, 2013. Annual report, OCS Study BOEM 2014-0018. National Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA, 7600 Sand Point Way NE, F/AKC, Seattle, WA 98115-6349. 330 pp.

Clarke, J., A. Brower, M. Ferguson, A. Kennedy, and A. Willoughby. 2015. Distribution and relative abundance of marine mammals in the eastern Chukchi and western Beaufort Seas, 2014. Annual report, OCS Study BOEM 2015-0040. 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, C. Sims. 2016. Occurrence of humpback, fin, and minke whale in the eastern Chukchi Sea, 2008-2015: population recovery, response to climate change, or increased effort? Alaska Fisheries Science Center Quarterly Report Jan-Feb-Mar 2016.

National Marine Mammal Laboratory. 2009. Annual Report for Permit No. 782-1719-09: 1 July 2008 – 30 June 2009. Submitted to the National Marine Fisheries Service Office of Protected Resources. 33 pp.

National Marine Mammal Laboratory. 2010. Annual Report for Permit No. 782-1719-09: 1 July 2009 – 30 June 2010. Submitted to the National Marine Fisheries Service Office of Protected Resources. 38 pp.

National Marine Mammal Laboratory. 2011. Annual Report for Permit No. 782-1719-09: 1 July 2010 to 24 April 2011. Submitted to the National Marine Fisheries Service Office of Protected Resources. 29 pp.

National Marine Mammal Laboratory. 2012. Annual Report for Permit No. 14245: 25 April 2011 to 30 April 2012. Submitted to the National Marine Fisheries Service Office of Protected Resources. 50 pp.

National Marine Mammal Laboratory. 2013. Annual Report for Permit No. 14245: 1 May 2012 to 30 April 2013. Submitted to the National Marine Fisheries Service Office of Protected Resources. 60 pp.
National Marine Mammal Laboratory. 2014. Annual Report for Permit No. 14245: 1 May 2013 to 30 April 2014. Submitted to the National Marine Fisheries Service Office of Protected Resources.
National Marine Mammal Laboratory. 2015. Annual Report for Permit No. 14245: 1 May 2014 to 30 April 2015. Submitted to the National Marine Fisheries Service Office of Protected Resources.

VENUES WHERE ASAMM RESULTS WERE PRESENTED (ALPHABETIZED):

Alaska Beluga Whale Committee Workshop, Anchorage, AK. 2012. Presentation.
Alaska Marine Science Symposium, Anchorage, AK. 2009-2015. Presentations (2), posters (34).
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).
North Slope Borough 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.
2nd DBO Data Workshop, Seattle, WA. 2014. Presentation.

TIMELINE OF ASAMM MARINE MAMMAL DATA REQUESTS (ALL GRANTED) AND USES (CHRONOLOGICAL):

Feb 2010: Conoco-Phillips requested ASAMM 2008 aerial survey data for use in an Environmental Impact Study.
Mar 2010: Greg Balogh (USFWS) requested an ASAMM 2009 Icy Cape walrus haulout photograph for use in a USFWS Landscape Conservation Cooperative planning document.
Apr 2010: Bill Lorand (SFSU GIS student) requested the ASAMM 2008-2009 walrus sighting data for use in a Coastal & Marine Applications GIS 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 Eastern Chukchi Sea 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 Pt. 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.

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.

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.

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.

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 GIS, and stored in a file geo-database.

Sea ice photos and data sent to NOAA, UAF, BOEM, USCG, USFWS and Shell throughout 2011-2013 ASAMM field seasons.

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.

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 Endangered Species Act.

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 Pt. Lay and coastal surveys between Pt. 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 Pt. 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: 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 (LIST TAKEN FROM IHAS ON NMFS OPR WEBSITE IN NOVEMBER 2015) (CHRONOLOGICAL):

Shell Exploration and Production: Application for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a proposed open water seismic program in the Chukchi and Beaufort Seas, Alaska, during 2007.

ASRC Energy Services: Revised request for Incidental Harassment Authorization for the non-lethal taking of whales and seals in conjunction with a proposed marine survey program in the Chukchi Sea, Alaska.

BP Exploration: Request for an Incidental Harassment Authorization pursuant to section 101(A)(5) of the Marine Mammal Protection Action 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.

PRESS RELEASES AND NEWS ARTICLES (ALPHABETICAL):

BOEM. 2013. Partnerships in Science: Research on the Alaska OCS. BOEM Ocean Science Vol. 10 (2). Apr-May-Jun. http://www.boem.gov/Ocean-Science-2013-Apr-May-Jun/
Dawicki, S. "NOAA Northeast Aerial Marine Mammal Team Flies Alaskan Skies." NOAA Fisheries. Oct 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. Aug 2, 2012.
Feidt, A. "Researchers Describe 'Jaw-Dropping' Whale Survey Near Point Hope." APRN Alaska Public Media. Nov. 26, 2012.
Heimbuch, H. "Chukchi Sea Whale Sightings Wow Researchers." The Arctic Sounder. Dec. 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. Sep 11, 2012.
Joling, D. 2012. "Large Groups of Orcas Sighted in Arctic Ocean off Alaska." Anchorage Daily News. Nov. 26, 2012.
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.
Speegle, J. 2013. "NOAA's Aerial Surveys of Arctic Marine Mammals: No One Flies Where These Scientists Fly." NOAA Fisheries Press Release. Aug 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. Sep 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 Pt. 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 Submitted (Alphabetical):

Brower, A., M. Ferguson, S. Schonberg, S. Jewett, and J. Clarke. *In press.* Gray whale distribution relative to benthic invertebrate biomass and abundance: northeastern Chukchi Sea, 2009-2012. *Deep-Sea Research II*.
Clarke, J.T., and M.C. Ferguson. Distribution, behavior, and habitat use of bowhead whales and belugas in the Alaskan Beaufort Sea, 2000-2014. *Paper in prep.*
Clarke et al. Bowhead whales in the western Beaufort Sea in summer. *Analysis in prep*.
Druckenmiller et al. Trends in sea ice cover and physical oceanographic conditions within Bowhead whale use areas in the Pacific Arctic. *Paper in prep*. *SOAR II submission.*
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 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.*

Okkonen, S., J. Clarke, and R. Potter. *In Press.* Relationship between high river discharge, upwelling events, and bowhead whale (*Balaena mysticetus*) occurrence in the central Alaskan Beaufort Sea. *Deep-Sea Research II.*

Pickart et al. Mechanisms for enhanced trophic productivity in Barrow Canyon, Chukchi Sea. *Paper in prep. SOAR II submission.*

Stafford, Ferguson, and others. Beluga whales in the Alaskan Beaufort Sea: a synthesis of available information on timing, distribution, habitat use, and environmental drivers. *In prep. SOAR II submission.*

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.