OCS Study
BOEM 2012-009

Distribution and Relative Abundance of Marine Mammals in the Alaskan Chukchi and Beaufort Seas, 2011

Annual Report

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Funding Agency:
Bureau of Ocean Energy Management (BOEM)
Alaska OCS Region
3801 Centerpoint Drive, Suite 500, Anchorage, AK 99503
Contract No. M11PG00033
March 2012

Cover Photo Credit:
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Belugas
Elson Lagoon, Alaska
July 2010
NMFS Permit No. 782-1719

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Distribution and Relative Abundance of Marine Mammals in the Alaskan Chukchi and Beaufort Seas, 2011

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This study was funded by the U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM), Alaska Outer Continental Shelf Region, Anchorage, Alaska, through an Interagency Agreement between BOEM and the National Marine Mammal Laboratory (M11PG00033), as part of the BOEM
Alaska Environmental Studies Program.

BOEM
Bureau of Ocean Energy Management

March 2012

REPORT AVAILABILITY

This document is available to the public through:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161
FAX: (703) 605 6900
www.ntis.gov

CITATION

May be cited as: Clarke, J.T., C.L. Christman, A.A. Brower, and M.C. 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/AKC3, Seattle, WA 98115-6349.

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ABSTRACT

This report describes field activities and data analyses for the Aerial Surveys of Arctic Marine Mammals (ASAMM) project conducted during summer and fall 2011 (17 June – 24 October). Surveys were based in Barrow and Deadhorse, Alaska, and targeted the northeastern Chukchi and Alaskan Beaufort Seas, between 68°N and 72°N, 140°W and 169°W.

Sea ice cover in 2011 was extremely light. From mid-June through early July, pack ice remained only in the northernmost regions of the study area; shorefast ice was present along the Alaskan coastline from Point Barrow to Point Lay and between Point Hope and Cape Lisburne. By mid-July, sea ice remained only in the northeasternmost parts of the Chukchi Sea study area. Sea ice cover in the Alaskan Beaufort Sea was light by mid-July, with the exception of sea ice that remained between Deadhorse and Point Barrow. By 22 August, when ASAMM surveys were being regularly conducted in both the northeastern Chukchi and the Alaskan Beaufort Sea, the ASAMM study area was completely free of any ice cover, and remained ice free until mid-October when new ice started to form in bays and lagoons. The absence of sea ice in most of the study area during the field season negatively impacted overall survey effort on several days, due to the combination of persistent ground fog and/or high sea states that frequently result from strong winds and no ice.

A total of 97 survey flights were conducted, and survey effort far surpassed previous annual efforts. Total flight time was 394 hours, which included 189 hours of transect survey effort. Over 100,000 km were flown, with 40,006 km of effort on transect.

There were 87 sightings of 112 bowhead whales (*Balaena mysticetus*), 234 sightings of 330 gray whales (*Eschrichtius robustus*), 5 sightings of 6 minke whales (*Balaenoptera acutorostrata*), 299 sightings of 1,508 belugas (*Delphinapterus leucas*), 819 sightings of 111,915 walruses (*Odobenus rosmarus*), including known repeat sightings of a walrus haulout at Point Lay, Alaska, 78 sightings of 82 bearded seals (*Erignathus barbatus*), 7 sightings of 8 ringed seals (*Pusa hispida*), 1,066 sightings of 1,613 unidentified pinnipeds, and 21 sightings of 52 polar bears (*Ursus maritimus*) observed during all (transect, search and circling) survey modes.

Bowhead whales were seen in all months of the study period, predominantly in the Alaskan Beaufort Sea in September and October. Sighting rates (number of whales per km surveyed) of bowhead whales on transect were relatively low compared to previous years, possibly due to an unusually late migration across the Beaufort Sea. Sighting rate per depth zone between 140°W and 154°W was highest in the ≤20 m depth zone. Few bowhead whales were seen in the northeastern Chukchi Sea and, unlike previous years, no feeding aggregations were noted northeast of Point Barrow (154°W to 157°W). Compared to previous years with light sea ice cover (i.e., 1982, 1986, 1987, 1989, 1990, 1993-2010), bowhead whale sightings in the Alaskan Beaufort Sea in 2011 were significantly closer to shore and in shallower water in the East Region (140°W-148°W); no significant difference was noted in distance from shore or water depth at sighting locations in the West Region (148°W-156°W). Four bowhead whale calves were seen in 2011.

Gray whales were seen in all months of the study period in the northeastern Chukchi Sea, but none were seen in the Beaufort Sea. Similar to previous years, locations where gray whale aggregations were observed continued to be near the Alaska coastline between Point Barrow and Point Franklin. Scattered sightings were observed offshore (>100 km) and very nearshore (<5 km) between Cape Lisburne and Point Hope. Similar to 2008-2010, gray whales were not seen on Hanna Shoal (~72°N, 162°W), but sightings were farther offshore between Point Franklin and Icy Cape than were observed in 2008-2010. Sighting rate per depth zone was highest in the 51-200 m depth zone, a trend noted since surveys in the Chukchi Sea recommenced in 2008; the highest sighting rate per month was in July, which is earlier than the peak in 2008-2010. Most gray whales (62%) were feeding. Eighteen gray whale calves were seen, although some calf sightings may have been repeat sightings.

Additional noteworthy results from the 2011 ASAMM field effort included:

- Ground-truthing the location of a satellite-tagged bowhead whale during an exploratory survey of the central Alaskan Beaufort Sea on 14 July. Sixteen bowhead whales, including two potential repeats, were found in the immediate vicinity of the tagged whale's location, with two additional bowhead whales sighted farther east. Some of these whales were possibly feeding, as evident by mud on their heads.
- Documentation of a walrus haulout near Point Lay, from mid-August to early October. Unlike the walrus haulout documented near Point Lay in 2010, the 2011 haulout was observed earlier and for a longer period of time. Group size estimates of the haulout throughout the field season ranged from 1,000 to 20,000 walruses.
- Minke whales (five sightings of six whales in addition to "probable" minke whale sightings) in the northeastern Chukchi Sea, including what is likely the farthest north confirmed minke whale sighting recorded in the Chukchi Sea.
- Observed beluga distribution in the Alaskan Beaufort Sea was similar to that prior to 2007 (2007-2010 beluga distribution was hard to determine due to paucity of sightings). Distribution in the northeastern Chukchi Sea, including the Chukchi Sea Planning Area, was fairly widespread. Large groups of belugas were seen in late June and early July nearshore south of Point Lay.

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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 for 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), Department of the Interior (DOI) as the administrative agency responsible for leasing submerged federal lands, and the Conservation Division of the U.S. Geological Survey (USGS) for classification and evaluation of submerged federal lands and regulation of exploration and production. In 1982, the U.S. Minerals Management Service (MMS) assumed these responsibilities.

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 Marine Mammal Protection Act (MMPA) of 1972 (16 USC 1361-1407) and the Endangered Species Act (ESA) of 1973 (16 USC 1531-1543), the BLM (and, later, MMS) funded numerous studies involving acquisition and analysis of marine mammal and other environmental data.

In June 1978, the BLM entered into an Endangered Species Act Section 7 consultation with the National Marine Fisheries Service (NMFS). 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 whales (*Eschrichtius robustus*). 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 ARBO and the current ARBO issued by NMFS in 2008 for leasing and exploration in the U. S. Beaufort and Chukchi Seas, Alaska, and authorizations of small takes under the Marine Mammal Protection Act recommended the following conservation recommendations:

> MMS [now BOEM] 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 program should be expanded to include Block 13. MMS (now BOEM) 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 [now BOEM] 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.

Following several years when drilling was limited to the period 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. The MMS (Alaska OCS Region) adopted an endangered whale monitoring plan that required aerial surveys. 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 (Sales 97, 124, 144, 170, 186, 195, and 202) and Lease Sale 193 in the Chukchi Sea 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, and 1998). 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 MMS (formerly the BLM) funded annual monitoring of endangered whales via aerial surveys (referred to as the Bowhead Whale Aerial Survey Project, BWASP) 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 Alaskan Beaufort Sea on an annual basis from 1987 to 2006 (Treacy 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2002a, 2002b; Monnett and Treacy 2005; and USDOI, MMS 2008). In 2007, an Interagency Agreement between the MMS (U.S. Department of the Interior) and NMFS (specifically, the National Marine Mammal Laboratory [NMML], Alaska Fisheries Science Center) was established to authorize NMML 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 by the MMS (now BOEM) (Clarke et al. 2011a, 2011b, 2011c).

The Chukchi Offshore Monitoring in Drilling Area (COMIDA) aerial survey component was initiated in 2008, via an Interagency Agreement between the MMS and NMML. These surveys were a continuation of aerial surveys that were conducted by MMS-sponsored contractors from 1982-1991 (Ljungblad et al. 1987; Moore and Clarke 1992) and used similar methodology. The

goal of the COMIDA surveys was to investigate the distribution and relative abundance of marine mammals in the Chukchi Sea Planning Area (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, latitude 68°N to 72°N and longitude 157°W to 169°W, and overlaid Lease Sale 193 (offered in February 2008).

In 2011, an Interagency Agreement between the BOEM and NMML 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 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 Alaskan Beaufort and northeastern Chukchi Seas. 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, 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, BOEM) as directed by BOEM's Representative.

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METHODS AND MATERIALS

Study Area

The study area encompasses the Alaskan Beaufort and northeastern Chukchi Seas (Figure 1). Survey blocks overlay Beaufort and Chukchi Sea oil and gas lease sale areas offshore of Alaska. The present study includes survey blocks 1 through 22 between 140°W and 169°W, and between 68°N and 72°N, and encompasses approximately 230,000 km^2. Survey blocks 1 through 12 (140°W to 157°W) comprise the Alaskan Beaufort Sea study area, while survey blocks 13 through 22 (157°W to 169°W) comprise the northeastern Chukchi Sea study area.

The 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. 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 (ACW) and Bering Shelf Water (BSW), are found in the northeastern Chukchi Sea. Current flow is often opposite that of predominant winds. In the Beaufort Sea, a large-scale Beaufort Gyre moves waters clockwise from the Canadian Basin, westward in the deeper offshore regions. Seaward of the gyre is the eastward-flowing Beaufort Undercurrent, which flows subsurface in areas where bathymetry is 51 to 2,000 m (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, depending on prevailing winds. Based on analysis of modeled sea level and ice motion, wind-driven motion in the Arctic was 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).

In the Beaufort Sea, 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 includes multiyear ice averaging 4 m in thickness with pressure ridges up to 50 m thick (Norton and Weller 1984), becomes contiguous with the new and shorefast ice in late fall. From early 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 fast 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 minimums in several years, including 2007-2011 (National Snow and Ice Data Center 2007, 2008, 2009, 2010, 2011). Arctic summer sea ice extent continued to decline in 2011, reaching its lowest extent since 2007 (National Snow and Ice Data Center 2011). The open water season has lengthened and the southern edge of the ice pack has been farther from Alaskan coastlines. 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 effectiveness of all marine aerial surveys. The ASAMM study area is in the Arctic climate zone, with mean temperatures at Alaskan Beaufort Sea coastal locations ranging from -0.9°C to -0.1°C during September and from -9.7°C to -8.5°C

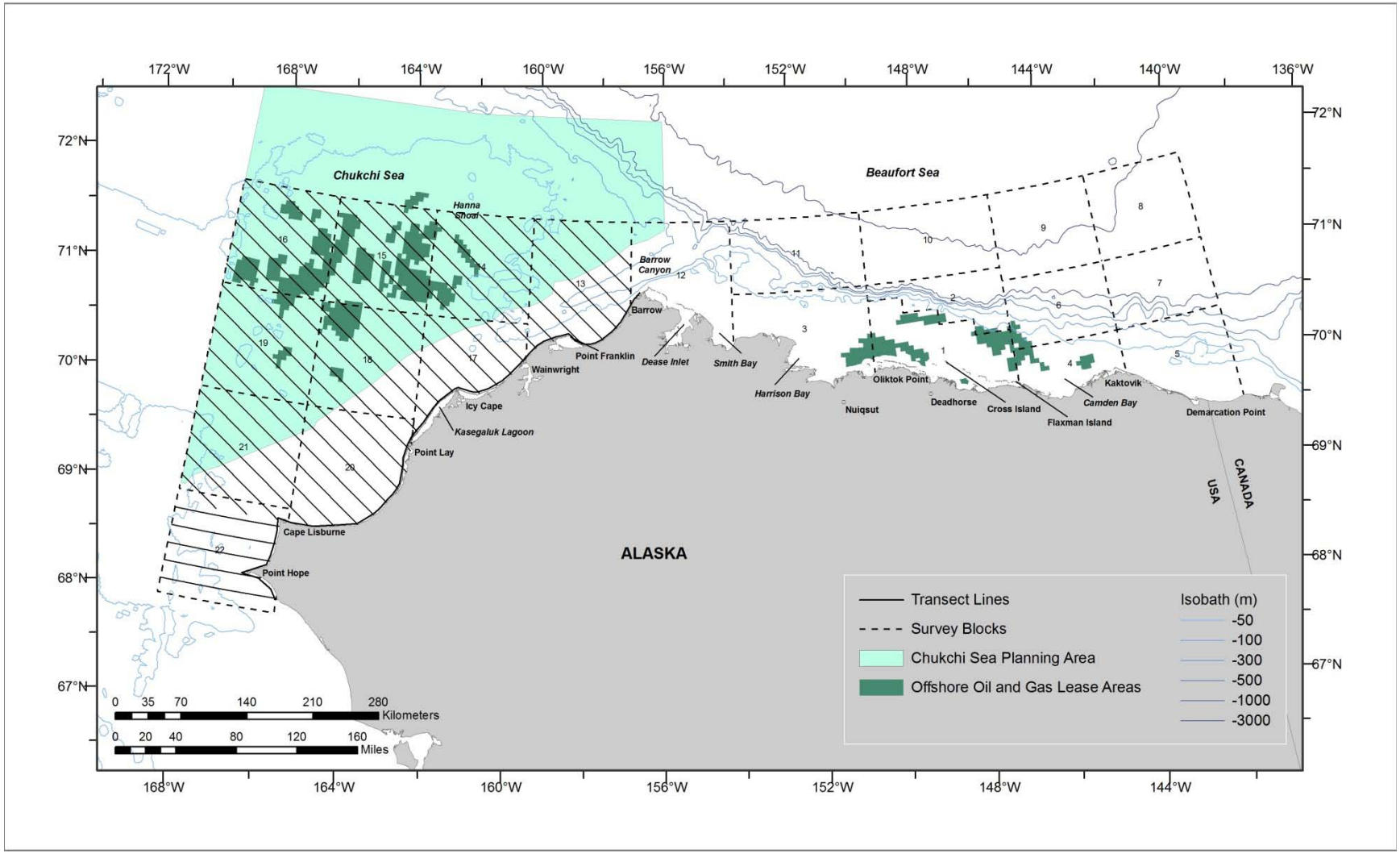


Figure 1. Study area showing survey blocks, Chukchi Sea transect lines, Chukchi Sea Planning Area (CSPA), lease areas, and isobaths. Transect lines in the Beaufort Sea are generated daily and, therefore, not shown.

during October (Brower et al. 1988). Mean temperatures measured at Barrow, Alaska, since 1972 have increased by 2.9°C , likely due to circulation changes (increased warm air advection from southern latitudes) or increased infrared back-radiation due to increased cloudiness, water vapor or CO_2 (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 to 6 m/s during September and 5 to 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 increases thermal instability (Wendler et al. 2009). Wind direction is predominantly easterly, driving the Beaufort Gyre, but winds occasionally reverse and shift to being westerly. The occurrence of storms during which at least one hourly reading of wind speed was > 15 m/s (approximately Beaufort wind force 7) has also increased since 1972 (Wendler et al. 2009). Highest annual mean wind speeds at Barrow were recorded since the early 1990s; the mean annual wind speed in 2006 was approximately 5.2 m/s (Figure 3 in Wendler et al. 2009).

Sea state also affects visibility during aerial surveys. Surface waters in the Beaufort and Chukchi Seas are driven primarily by wind. Ocean waves are generally from northerly or easterly directions during September and October. Prior to 1997, significant wave heights were reduced by a factor of 4 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.

Equipment

Surveys were primarily flown in Aero Commander 690A twin turbine aircraft, provided by Clearwater Air, Inc. A few surveys in the Alaskan Beaufort Sea were also flown in a de Havilland Twin Otter Series 300 equipped for Arctic operation and aerial surveys of whales, provided by the U.S. DOC NOAA, Aircraft Operations Center (AOC). All aircraft were equipped with bubble windows that afforded observers a complete view of the trackline. The pilot and copilot seats provided good forward and side viewing. Each observer was issued a hand-held clinometer for measuring the angle of inclination to sighting locations. Observers and pilots were linked with a common communication system. The maximum time aloft in the Aero Commander was approximately 5.5 hours, while the maximum time aloft in the Twin Otter under normal survey load was approximately 4 hours.

A laptop computing system was used aboard each aircraft to 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 flight altitude from the GPS were transmitted to the computer through a standard serial connection. Data were backed up to an onboard external hard drive. A custom mapping program permitted the data recorder to view sightings and the aircraft's trackline in real time.

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, a portable personal locator beacon, portable marine and aviation band transceivers, and orange 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.

The DOI, National Business Center, Aviation Management Division "Automated Flight Following" (AFF) system was used by Anchorage-based Aviation Management Division personnel for "satellite-tracking" project aircraft. Aviation Management obtained current flight information in the form of maps for real-time visual tracking of survey aircraft. Iridium satellite phones were used to communicate aircraft position to Aviation Management each hour. In addition to these flight-following systems, onboard transponders were set at discrete identification codes for radar tracking by air-traffic-control personnel.

Methodologies, equipment and standard procedures have been developed and refined over the duration of the ASAMM project and precursor studies (1979-2011). 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).

Aerial Survey Design

Aerial surveys were based out of Barrow, Alaska, to target the northeastern Chukchi Sea study area, and out of Deadhorse, Alaska, to target the Alaskan Beaufort Sea study area. The field schedule was designed to maximize survey effort during the open water time period in the northeastern Chukchi Sea and monitor the progress of the fall bowhead whale migration across the Alaskan Beaufort Sea. All marine mammal sightings were recorded.

Survey design differed between the two study areas. In the northeastern Chukchi Sea (157°W to 169°W), 32 numbered transects (Figure 1) were generated once at the beginning of the season and then flown for the duration of the field season. Transects were perpendicular to the coastline and spaced 19 km apart. The survey design also included a coastal transect located 1 km offshore between Point Barrow and Point Hope, Alaska. The perpendicular transects crossed major bathymetric features, such as Barrow Canyon and Hanna Shoal, and bowhead whale and beluga migration paths. The coastal transect allowed better documentation of nearshore habitat, including pinniped haulouts along the coastline. In the Beaufort Sea (140°W to 157°W), daily flight patterns were based on sets of unique transect grids, 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). Transect grids were derived by dividing each survey block into sections 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 similarly 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 grid within each

survey block. Transect grids changed each time a survey block was surveyed, so that unique 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 previous surveys. The purpose of these survey-effort allocations was to increase the sample size of whale sightings within the primary migration corridor, thus increasing the power of statistical analyses within these inshore blocks.

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 and avoidance of recently surveyed areas. Weather permitting, the project attempted to distribute effort fairly evenly across the entire study area, with the exception of the northeasternmost Beaufort Sea survey blocks (blocks 8, 9, and 10).

Survey Flight Procedures

During a typical flight, a search or deadhead leg was flown to the targeted survey block or transect line, whereby a series of transect lines were flown, followed by a search or deadhead leg back to the base of operations. Transects were joined together by short search legs. Circling was initiated to further investigate cetacean sightings, as described below. Surveys were generally flown at a target altitude of 365 m in the northeastern Chukchi Sea and 458 m in the Beaufort Sea, but could be flown as low as 305 m in either area. Weather permitting, higher altitudes were maintained to maximize visibility and minimize potential disturbance to marine mammals. When cloud ceilings were less than 305 m or the wind force was above Beaufort 5, survey flights were redirected to survey blocks or transects with better conditions. Survey flights were aborted when conditions consistently did not meet minimum altitude (305 m) or wind force (Beaufort 5) requirements. Survey speed was generally 204 km/h.

Primary observers were stationed on either 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. A clinometer was used to measure the angle of inclination to each sighting when the aircraft was abeam of the initial sighting location. Sightings from only primary observers were recorded as on transect; sightings by the data recorder, pilots, or occasional fourth observer were recorded as on search.

When cetaceans were encountered, the aircraft sometimes diverted from the trackline for brief (< 10 minute) periods and circled the whales to verify species, observe behavior, obtain better estimates of group size, and determine whether calves were present. Any new sightings of whales made while circling were recorded as on circling. Sightings made off transect and not while circling were recorded as on search.

Survey effort over land or in areas with zero visibility was designated as deadhead and not incorporated into further analyses.

Data Entry

Customized, menu-driven data entry software was used to record all data in database format (Microsoft Access). Location data (date, 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 flight type (transect, search, circling or deadhead), when environmental conditions changed, or otherwise at intervals of 5 minutes (in time). The complete suite of data was recorded for cetacean sightings, including location data, environmental conditions, survey mode, species, total number (as well as low, high, and best estimate of group size), observer, swim direction (true), clinometer angle, number of calves, behavior, sighting cue, group classification, habitat, swim speed, whether it was a repeat sighting, and response to aircraft. Reduced data subsets were often used when recording other marine mammals. Position data only (date, time, latitude, longitude, and altitude) were automatically recorded every 30 seconds (in time) to provide a detailed record of the flight track.

The behavior, swim speed, and swim direction of observed whales represent what the pod as a whole was doing at the time it was first sighted. Behaviors were entered into 1 of 15 categories, as noted during previous surveys (Table 1). The default behavior was "swimming", entered whenever an alternate behavior was not observed. Swimming speed was subjectively estimated by observing the time it took a whale to swim one body length. An observed swimming rate of one body length per minute corresponded to an estimated speed of 1 km/hr, one body length per 30 seconds was estimated at 2 km/hr, and so on. Swimming speed was recorded by relative category (i.e., still, 0 km/hr; slow, 0-2 km/hr; medium, 2-4 km/hr; or fast, > 4 km/hr). Group composition categories included single, pair, and group of mixed sizes, and were designed to provide additional information on group dynamics. Swim direction was recorded relative to the aircraft's heading, and then converted to actual swim direction via a module incorporated into the data collection software.

Wind force was recorded according to the Beaufort scale outlined in *Piloting, Seamanship, and Small Boat Handling* (Chapman 1971). 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.

General Data Analyses

Preliminary data analysis was performed in the field by a customized computer program that provided daily summations of marine mammals observed, in addition to calculation of time and distance on transect, search, circling, and deadhead portions of the flight. The program provided options for editing the data file, calculating summary statistics on sightings and effort, 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.

Table 1. Operational definitions of observed whale behaviors.

Behavior	Definition
Breaching	Whale(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.
Cow-Calf	Calf nursing; cow-calf pairs swimming within 20 m of each other.
Diving	Whale(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	Whale(s) diving repeatedly in a fixed area, sometimes with mud streaming from the mouth and/or defecation observed upon surfacing. Feeding behavior is further defined as synchronous diving and surfacing or echelon-formations at the surface with swaths of clearer water behind the whale(s), or as surface swimming with mouth agape.
Flipper-Slapping	Whale(s) floating on side, striking the water surface with pectoral flipper one or many times; usually seen within groups or when the slapping whale is touching another whale.
Log-Playing	Whale(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	Whales moving slowly at the surface in close proximity (within 100 m) to other whales, often with varying headings. Also one whale slowly changing its heading.
Resting	Whale(s) floating at the surface with head, or head and back exposed, showing no movement; more commonly observed in heavy ice conditions than in open water.
Rolling	Whale(s) rotating on the longitudinal axis, sometimes associated with mating.

Spy-Hopping	Whale(s) extending head vertically out of the water such that up to one-third of the body, including the eye, is above the surface.
Swimming	Whale(s) proceeding forward through the water propelled by tail.
Tail-Slapping	Whale(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	Whale(s) exhibiting rapid flexure or gyration in the water.
Underwater-Blowing	Whale(s) exhaling while submerged, thus creating a visible bubble.

Data from the Alaskan Beaufort Sea and northeastern Chukchi Sea study areas were combined into one large dataset, and were parsed into smaller subsets for various analyses, including sighting rates, relative occurrence, swimming direction, and migration corridor.

Maps were prepared with application software (ESRI ArcGIS 9.3.1) 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.

Survey effort and observed bowhead whale and gray whale distributions were plotted semimonthly over the study area. Beluga and walrus distributions were plotted monthly, and minke whale, pinniped and polar bear distributions were plotted seasonally. Common and scientific names used for marine mammals in this report are taken from Rice (1998).

All sightings were shown on distribution maps regardless of survey mode (e.g., transect, search, or circling) being conducted 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. 2011a, 2011b, 2011c), same-day repeat sightings or sightings of dead marine mammals were not included in summary analyses or maps. Where tables and figures exclude certain data, such exclusions are indicated in the captions.

The water depth at each bowhead whale sighting in the ASAMM database was derived from the International Bathymetric Chart of the Arctic Ocean (IBCAO; http://www.ngdc.noaa.gov/mgg/bathymetry/arctic/arctic.html), which had a spatial resolution of 2 km squared; the spatial resolution after geoprocessing was 2.037 km squared. 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 (DFS) measurements regardless of the mapping software being used to depict the distribution data. The normalized shoreline was re-defined in

2011 to better approximate the actual coastline of Alaska from 140°W (in the easternmost part of the ASAMM study area) to 68°N (in the southernmost part of the study area), to improve approximation of bays and barrier islands. The projection used for the normalized shoreline was North American Equidistant Conic, appropriate for distance measurements, with custom projection parameters (central meridian=-154.5, latitude of origin=70.5, standard parallels=60.5, 80.5). This differs from the normalized shoreline and DFS calculations used previously (e.g., Clarke et al. 2011a, 2011b, 2011c). To ensure that all DFS values in the historical ASAMM database were normalized to the same coastline, all DFS values were recalculated using the new normalized shoreline. DFS was calculated for all sightings north of 68°N and west of 140°W, and was determined by measuring the distance between the location of each sighting and the closest point along the normalized shoreline. Sightings that fell outside of these bounds were not assigned a DFS value. DFS was generated from the actual position of the whale when possible, otherwise the aircraft position was used.

Mean vector headings and circular standard deviations for headings of swimming cetaceans were determined using Oriana statistical software (Rayleigh Test, KCS, 2008) for two subareas (Beaufort Sea subarea 140°W-154°W; Chukchi subarea 154°W-169°W). The 154°W demarcation between subareas for swim direction most closely approximates the natural break between the Beaufort and Chukchi basins.

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 web sites 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, Deadhorse, Barter Island, Kuparak, Alpine, and the weather station at West Dock) and for the broader Chukchi and Beaufort Sea regions.

Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov), where it is available as charts or shapefiles. Sea ice analyses were performed by the National Ice Center two days per week, using data from several sources including ENVISAT Imagery and 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.

Analysis of the Bowhead Whale Migration Corridor in the Beaufort Sea

Two analyses of the bowhead whale migration corridor across the Alaskan Beaufort Sea were undertaken. One analysis was identical to that conducted for previous BWASP annual reports, in which the bowhead whale migration corridor was examined using the mean and median distance from shore of, and the median depth at, whales sighted on transects (Houghton et al. 1984). 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 Liehman 1956, Zar 1984). Statistical tests were undertaken using *Statistica*^{TM} StatSoft, Version 10.0 and ArcGIS, Version 9.3.2. Median distance from shore and depths for bowhead whale sightings in 2011, a year with light sea ice cover, were compared with analogous values for combined data from previous years having light sea ice cover (i.e., 1982, 1986, 1987, 1989, 1990, 1993-2010).

All bowhead whale sightings made while on transect, regardless of distance from the transect line, were included in this analysis. Neither group size nor survey effort (km) was taken into account. Distance from shore and water depth at bowhead whale sightings were analyzed for two regions (Figure 2), 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 (1997). In brief, cold saline Bering Sea Water and warm fresh Alaskan Coastal Water enter the Alaskan 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 Sea Water has been traced at least as far east as Barter Island (~143°W), but the Alaskan Coastal Water mixes with ambient surface waters as it moves eastward and is not clearly identifiable east of Prudhoe Bay (~147°-148°W).

The northern extent of each region is based upon survey effort. The East Region extends from 140°W to 148°W and northward from the shore to 71°10'N, except between 146°W and 148°W where the region extends to 71°20'N. 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°20'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 eastern boundary (140°W) is the easternmost longitude of the survey blocks. The western cutoff at 156°W limits the analysis to bowhead whales seen in the Alaskan Beaufort Sea and minimizes the influence of Barrow Canyon on bowhead whale depth distribution.

Two subsets of data from 2011 were analyzed and are described below:

- All bowhead whale sightings on transect, regardless of behavior recorded. The analysis of this subset assumed that *all* bowhead whales in the Alaskan Beaufort Sea were migrating from the Canadian Beaufort Sea, where most bowhead whales are assumed to spend summer months, through the Alaskan Beaufort Sea en route to wintering areas in the Bering Sea. Under this assumption, any feeding, milling, or resting behavior observed was considered temporary, and all whales were considered “migratory”.

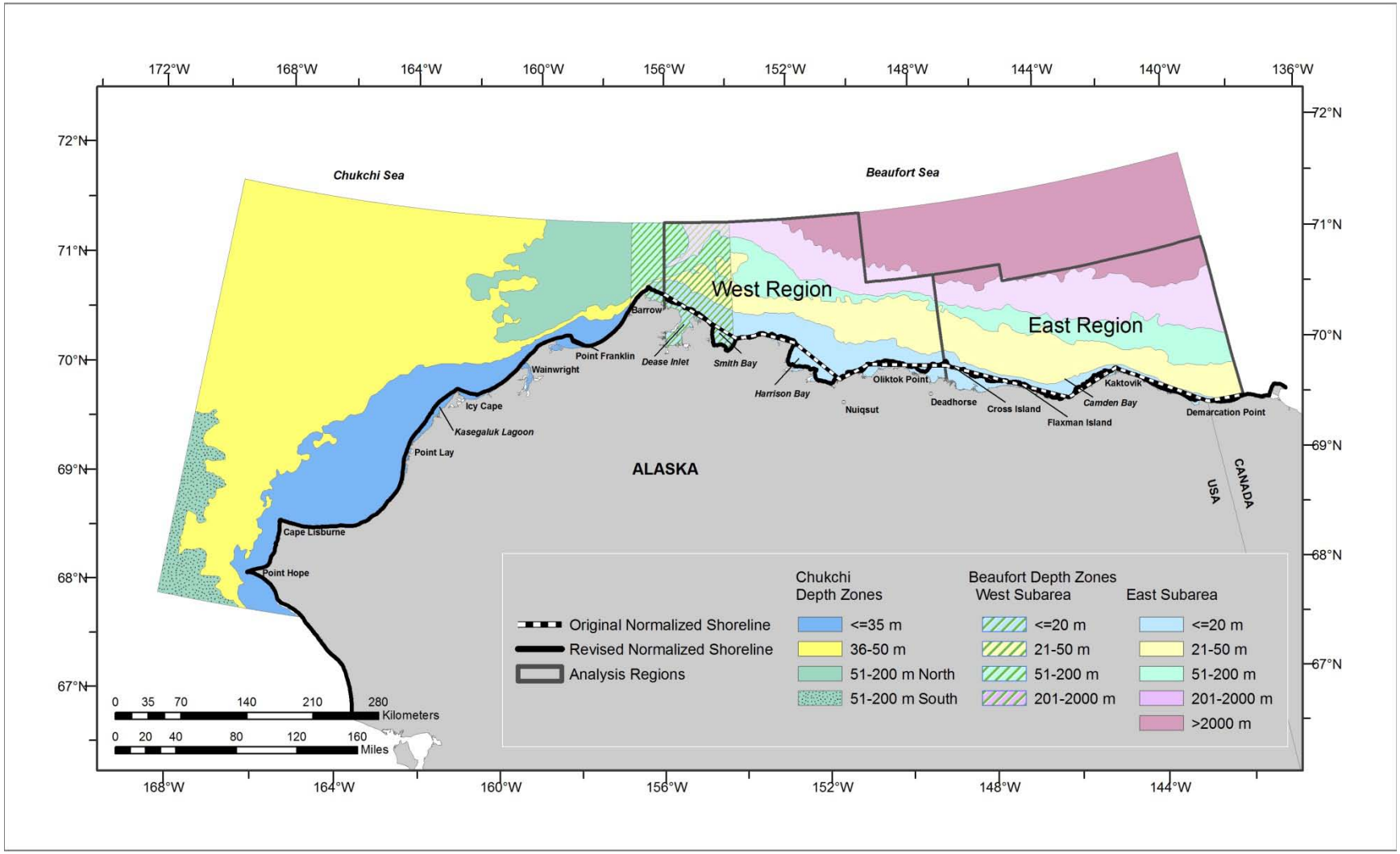


Figure 2. East and West Regions and 2011 normalized shoreline used in bowhead whale migration corridor analysis (previous normalized shoreline is also shown for comparison), and depth zones used for sighting rate analyses.

- All bowhead whale sightings on transect, *excluding* whales that were observed feeding, milling, or resting. These behaviors might be considered "non-migratory" and may influence, at least temporarily, the migratory path.

One caveat to this analysis is that analyzing the bowhead whale migration corridor 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 be more sightings in areas with greater transect effort and fewer sightings in areas with less transect effort, even if the density of individuals in the two areas is the same.

The second method for investigating the central tendency of the fall bowhead whale distribution in the Alaskan Beaufort Sea in 2011 involved a three step process: 1) constructing spatial models of bowhead whale encounter rate based on bowhead whale sightings from 2011; 2) applying the spatial encounter rate 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 2011. As in the central tendency analysis described above, this analysis was based on all transect bowhead whale sightings from September and October, 2011, excluding repeat and dead sightings, and did not account for availability or perception bias. Estimates of median distance from shore were calculated for the East and West Regions individually, and for the entire region from 140°W to 156°W. The analysis was conducted in R version 2.14.1 (R Development Core Team 2011) using packages *sp* (Pebesma and Bivand 2005; Bivand et al. 2008), *maptools* (Lewin-Koh et al. 2011), *raster* (Hijmans and van Etten 2012), *rgeos* (Bivand and Rundel 2011), *rgdal* (Keitt et al. 2011), and *mgcv* (Wood 2006).

To begin, the Alaskan Beaufort Sea study area was partitioned into a 5 km x 5 km grid, which 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 = 60.5^{o}; second standard parallel = 80.5^{o}; latitude of origin = 70.5^{o}; central meridian = -154.5^{o}; 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 (see **General Data Analysis**). Bowhead whale encounter rate (number of whales per km of transect surveyed) was modeled as a generalized additive model (GAM), parameterized by a Tweedie distribution having a power of 1.5 and a natural logarithmic link function (Tweedie 1984; Dunn and Smith 2005). Quasi-Poisson and negative binomial models were also considered, but examination of model residuals (Ver Hoef and Boveng 2007) suggested that the Tweedie distribution provided a better fit to the data. The model formula can be represented as

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

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*

te( ) : tensor product smooth function of location covariates used to describe bowhead whale encounter rate; 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 study area. 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, and then the associated 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.

Sighting Rate and Relative Occurrence Analyses

Sighting rates quantify relative occurrence while accounting for heterogeneity in survey effort and sighting group size across the study area. Sighting rates were derived for three different spatial scales. Estimated transect effort (km) per survey block was calculated to determine monthly and annual sighting rates (number of whales per unit effort, WPUE) for bowhead whales. 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 this sighting rate analysis. Estimated transect effort (km) per depth zone was calculated to determine monthly and annual sighting rates (WPUE) for bowhead whales, gray whales and belugas. Depth zone analysis ($\leq$ 20 m, 21-50 m, 51-200 m, and 201-2,000 m) was computed for two subareas in the Alaskan Beaufort Sea study area. One subarea spanned from 154°W to 157°W, and included Barrow Canyon and its surrounding area, which has noticeably different bathymetry than the rest of the Beaufort study area (Figure 1). The other subarea for the Alaskan Beaufort Sea depth zone analysis spanned 140°W to 154°W, an area incorporating a well-defined continental shelf and slope. Depth zone analysis in the northeastern 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 segments because they were separated by a large expanse of shallower depths (Figure 2). Sighting rates for survey blocks and depth zones used an Equidistant Conic projection (False_Easting: 0.0; False_Northing: 0.0; Central_Meridian: -154.5^{o}; Standard_Parallel_1: 60.5^{o}; Standard_Parallel_2: 80.5^{o}; Latitude_Of_Origin: 70.5^{o}; Linear Unit: Meter (1.0)). An additional sighting rate analysis was conducted at a finer-scale (5' latitude by 15' longitude), using a grid matrix consisting of approximately equilateral grid cells (roughly 5 km x 5 km) superimposed across the study area. Bowhead whale, gray whale and beluga sighting rates on this finer scale were calculated as the number of transect sightings per unit transect effort (SPUE) for each grid cell. An index of relative occurrence of bowhead whale and gray whale feeding and milling behaviors, quantified as SPUE, was also calculated for the finer scale grid. The finer-scale grid analysis included transect effort within barrier islands and north of 72°N. Sighting rates were not corrected for availability or perception bias (Buckland 2001).

RESULTS

Environmental Conditions

In 2011, sea ice cover in the area surveyed was generally light. When surveys commenced in the northeastern Chukchi Sea in mid-June, sea ice remained in the northernmost portions of the study area and shorefast ice was present from Point Barrow to Point Lay and between Point Hope and Cape Lisburne (Figure A-1). By mid-July, shorefast ice in the Chukchi Sea was no longer present and sea ice remained in only the northeasternmost parts of the Chukchi Sea study area. Sea Ice cover in the Alaskan Beaufort Sea by mid-July was light except for the area between Deadhorse and Point Barrow (Figure A-3). By 22 August, when surveys were regularly being conducted in both the northeastern Chukchi and the Alaskan Beaufort Seas, the ASAMM study area was completely free of sea ice cover (Figure A-6), and remained ice-free until mid-October when new ice started to form in bays and lagoons (Figure A-10).

Arctic sea ice extent was at seasonal minimum on 9 September 2011. Sea ice fell to the second-lowest extent since satellite records were first recorded in 1979. Only 2007 had a lower sea ice extent (NSIDC 2011). To examine interannual variability in bowhead whale and other marine mammal distributions and relative abundance, 2011 data were compared to data from previous years with light sea ice cover.

Survey Effort

The ASAMM field season commenced 16 June 2011 and ended 26 October 2011; flights were conducted from 17 June to 24 October (Table 2). Surveys were conducted from one aircraft based in Barrow from 17 June to 18 August primarily targeting the northeastern Chukchi Sea. Surveys were conducted from two aircraft, one based in Barrow and one based in Deadhorse, from 19 August to 24 October targeting the northeastern Chukchi and Alaskan Beaufort Seas, respectively. There were 97 survey flights, of which 9 were in June, 16 in July, 21 in August, 35 in September, and 16 in October. Flights originating on the survey aircraft based in Barrow were numbered sequentially starting with 201; flights originating on the survey aircraft based in Deadhorse were numbered sequentially starting with 1. On 18 days, two flights were completed by the same survey team to take advantage of favorable survey conditions. Surveys were conducted on 48% of the days in the field season (97 out of 203 possible days), while weather prevented surveys on 44% of the days. Days on which surveys were not possible due to mechanical issues, transits to or from Anchorage, or other factors that rendered the survey aircraft unavailable accounted for only 8% of the days in the field season.

Over 100,000 km were flown during 394.4 hours (Figure 3). A total of 40,006 km of effort on transect was flown during 189 hours (Figure 4). Transect effort constituted 40% of the total kilometers flown and 48% of the total flight hours. Forty-seven percent of total survey effort was on deadhead (non-usable flight time), flown during transits to and from transects when the observers were not actively searching for marine mammals. Deadhead was also recorded during

Table 2. Aerial survey flight effort, 17 June-24 October, 2011, by survey flight. Semimonthly totals may not exactly match the sum for the time period due to rounding error.

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)	Total (km)	Transect (hr)	Total (hr)
17 Jun	201	588	13	189	103	893	2.9	4.3
18 Jun	202	407	0	208	359	974	2.0	3.9
19 Jun	203	1,125	38	127	1,161	2,451	5.4	9.7
21 Jun	204	461	0	113	233	807	2.2	3.4
22 Jun	205	0	16	92	210	317	0.0	1.0
25 Jun	206	507	12	142	492	1,153	2.5	4.6
26 Jun	207	561	0	187	1,354	2,102	2.5	7.1
27 Jun	208	508	30	202	111	850	2.5	3.8
28 Jun	209	0	0	171	379	550	0.0	2.1
2 Jul	210	235	18	132	77	462	1.2	2.2
3 Jul	211	170	27	95	131	422	0.9	1.7
6 Jul	212	350	0	122	195	668	1.7	2.9
7 Jul	213	287	18	96	219	621	1.3	2.6
8 Jul	214	525	51	83	1,415	2,074	2.5	7.1
10 Jul	215	203	22	115	14	354	1.1	1.7
11 Jul	216	193	0	97	16	306	1.0	1.5
14 Jul	217	0	121	588	809	1,518	0.0	5.5
16 Jul	218	69	24	4	437	534	0.3	1.7
17 Jul	219	598	72	177	366	1,213	2.9	5.2
18 Jul	220	469	85	61	677	1,292	2.3	4.9
20 Jul	221	253	51	124	105	533	1.3	2.5
23 Jul	222	88	26	11	253	379	0.4	1.5
26 Jul	223	242	0	53	557	852	1.1	3.1
30 Jul	224	281	0	83	590	954	1.4	3.7
31 Jul	225	1,078	28	218	722	2,047	4.9	8.6
1 Aug	226	501	6	166	671	1,345	2.3	5.0
2 Aug	227	1,113	44	205	762	2,123	5.3	8.9
6 Aug	228	664	26	5	507	1,202	3.3	4.8
7 Aug	229	399	36	163	507	1,105	2.1	4.4
8 Aug	230	448	28	0	576	1,053	2.2	3.9
12 Aug	231	273	0	7	307	587	1.2	2.2
15 Aug	232	365	0	27	364	756	1.7	3.2
16 Aug	233	485	0	142	1,062	1,689	2.3	6.1
17 Aug	234	602	31	120	323	1,076	2.9	4.7
19 Aug	235	280	0	10	539	828	1.4	2.9
20 Aug	1	349	47	140	173	710	1.8	3.5

Day	Flight No.	Transect (km)	Circling (km)	Search (km)	Deadhead (km)		Transect (hr)	Total (hr)
22 Aug	2	184	0	291	310		1.0	3.5
22 Aug	236			0	626		0.0	1.9
24 Aug	3	190	0	83	456		1.0	3.2
24 Aug	237		19	11	1,1		3.7	7.6
26 Aug	4		0	44	615		0.0	2.6
26 Aug	238	683	73	179	559		3.2	6.1
27 Aug	239	684	14	115			3.1	6.0
28 Aug	240		0	1	72		0.8	2.8
30 Aug	5		0	613	10		0.9	3.6
31 Aug	6	258	27		352		1.3	3.5
1 Sep	7	570	31	1	56		2.6	5.0
2 Sep		0	0	0	57		0.0	1.8
2 Sep		1,245	80	292	261		5.8	8.5
3 Sep		332	0	109	789		1.6	4.2
5 Sep		504					2.2	4.5
	243	439			846		2.2	5.3
		652	0		190		2.9	3.9
	244	672		101			3.3	5.0
	11	529	30	2		1,123	2.5	4.5
	12		0	161		1,021	1.3	3.7
			0	126		1,076	2.3	4.3
		704	8	133		1,023	3.2	4.4
	246	267	0	116		790	1.3	3.2
10 Sep	14	72	0	17	6	746	0.3	2.5
10 Sep	247	0	0	0	427	427	0.0	1.4
12 Sep	15	977	22	101		2,06	4.4	7.8
12 Sep	248	975	94	272		1,76	4.7	7.9
13 Sep	16	734	35	134	411	1,314	3.3	5.2
13 Sep	249	939	127	240	619	1,925		8.2
14 Sep	250	518	88	7	611	1,223	2.2	4.5
17 Sep	251	0		0		455	0.0	1.3
19 Sep	17	0	0	0	916	916	0.0	4.0
22 Sep	252	282	0	2	400	683	1.1	2.6
23 Sep	18		0	114		1,23	2.1	4.9
23 Sep	253	217	38	171				4.6
24 Sep	19	493	31	162	310	997	2.4	4.4
24 Sep	254	56	0	195		266	0.3	1.2
25 Sep	255	368	0	190		1,314	1.7	4.8
27 Sep	20	297	0	172	514	983	1.4	3.6

Day	Flight No.	Transect (km)	Cir (	Search (km)	Deadhead (km)	T (	Transect (hr)	l
28 Sep	21	1,263		161		1	5.9	
28 Sep	256	1,137	1	7	581	2	5.4	
29 Sep	22	219			709		1.1	
29 Sep		762			1		3.7	
30 Sep		542		10	6	17	2.5	
30 Sep					4	1	3.2	
1 Oct	24					0	2.9	
1 Oct	259	393	30	124	589	1,137	2.0	
2 Oct	25	430	33	89		4	2.0	
2	260	427	0	174		750	1.9	
3	261	313	9	121		482	1.5	
4	26	0	0	36	5	592	0.0	
5 Oct	27	0	13	8		703	0.0	
5 Oct	262	538	0	69	408	1,015	2.4	
6	263	4	24	1	7	884	2.1	
1	28	4	0	26	342	410	0.2	
11 Oct	29	327	21	93	427	868	1.5	
11 Oct	264	630	17	138	78	863	3.0	
17 Oct	265	203	0	1	439	643	1.0	
21 Oct	30	0	0	0	359	359	0.0	1.1
21 Oct	266	44	0	0	337	382	0.2	1.2
24 Oct	31	157	0	15	324	497	0.7	1.9
Semimonthly Effort Summary								
17-30 Jun		**4,157**	**109**	**1,431**	**4,402**	**10,097**	**19.9**	**39.9**
1-15 Jul		**1,963**	**257**	**1,328**	**2,876**	**6,425**	**9.7**	**25.1**
16-31 Jul		**3,078**	**286**	**731**	**3,707**	**7,804**	**14.6**	**31.0**
1-15 Aug		**3,763**	**140**	**573**	**3,694**	**8,171**	**18.1**	**32.3**
16-31 Aug		**4,874**	**211**	**2,057**	**7,703**	**14,842**	**23.3**	**57.8**
1-15 Sep		**10,885**	**579**	**2,414**	**10,164**	**24,041**	**50.3**	**95.5**
16-30 Sep		**6,720**	**393**	**1,808**	**7,938**	**16,861**	**31.8**	**67.9**
1-15 Oct		**4,162**	**179**	**1,035**	**4,682**	**10,058**	**19.4**	**38.4**
16-24 Oct		**404**	**0**	**16**	**1,459**	**1,881**	**1.9**	**6.5**
TOTAL		**40,006**	**2,154**	**11,393**	**46,625**	**100,180**	**189.0**	**394.4**

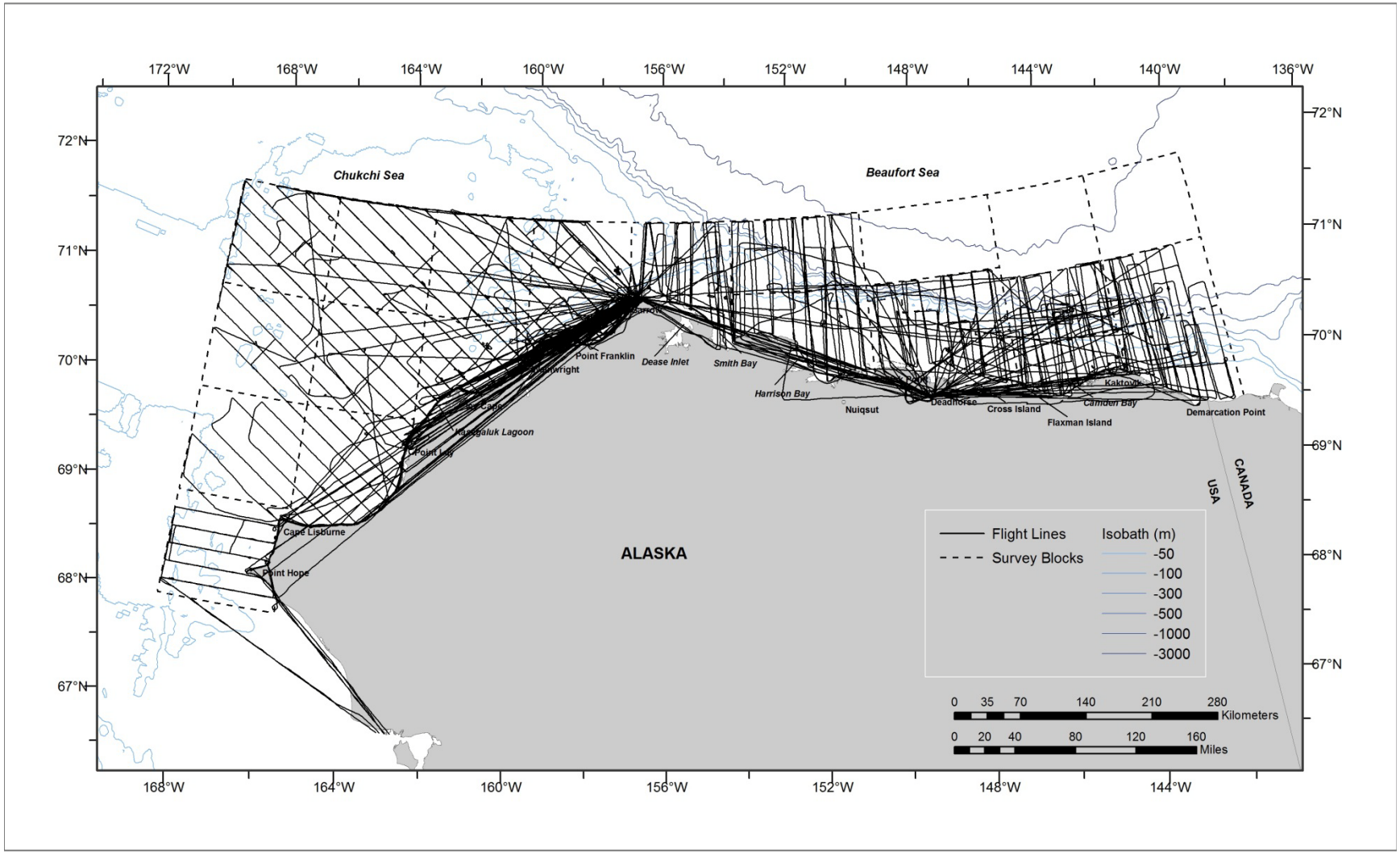


Figure 3. Combined flight tracks, all flight types (transect, search, circling and deadhead), 2011.

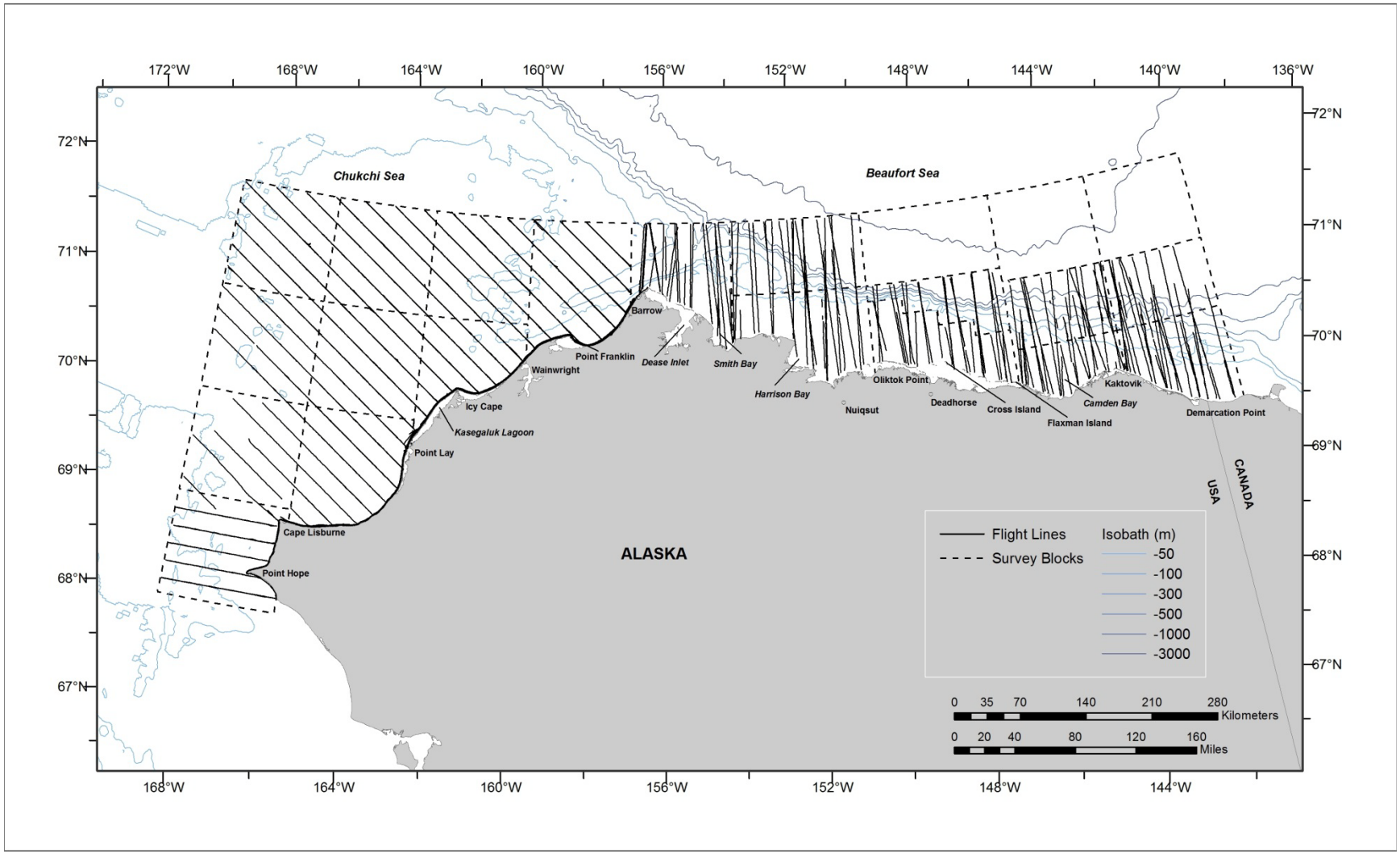


Figure 4. Combined flight tracks, transect effort only, 2011.

several flights when local weather conditions were not conducive to collecting data; eight flights were entirely or almost entirely on deadhead due to prevailing poor weather conditions. The average survey flight covered 1,033 km, ranging from 266 to 2,451 km.

Survey effort (transect, search, and circling effort) is summarized bimonthly in Figure 5. Coverage from mid-June through mid-August was focused on the northeastern Chukchi Sea, with one flight conducted in mid-July in the central Alaskan Beaufort Sea. Transects near active Chukchi Sea lease areas were targeted more often than areas absent active lease areas (e.g., survey blocks 20-22). From mid-August through the end of October, survey coverage was balanced between the Chukchi Sea and the Alaskan Beaufort Sea. Survey coverage was lowest in October when, despite the presence of two aircraft, less than 50 hours were flown due to persistently poor survey conditions. The last survey in the northeastern Chukchi Sea was conducted on 21 October; the survey team remained in Barrow until 25 October but weather precluded further survey attempts. The last survey in the Alaskan Beaufort Sea was conducted on 24 October; the survey team remained in Deadhorse until 26 October but weather precluded further survey attempts. Survey coverage was greatest in survey blocks 13, 17, and 20 in the Chukchi Sea and survey blocks 12 and 5 in the Beaufort Sea. Surveys in blocks 8, 9, and 10 were not attempted in 2011 because conditions were not favorable for surveying offshore (e.g., strong winds and low visibility). Flight lines, associated sea states, and sightings on individual flights are shown in Appendix B.

There were two extended periods of time in 2011 when few surveys were possible due to poor weather. The first occurred 14-22 September, when strong winds kept both survey teams largely grounded. A few survey flights were attempted during this time but the flights were mostly unsuccessful due to poor survey conditions. The second time period occurred 7-26 October, when strong winds, fog, blowing snow and low cloud ceilings prevailed. Good survey effort was possible on only one day during that time period, 11 October; other survey flights in October were unsuccessful due to poor survey conditions. Both of these unsurveyable weather periods occurred during the time period corresponding to the peak westward bowhead whale migration in previous years, and likely negatively impacted data collection relevant to determining migration timing and route.

The absence of sea ice in most of the study area during the 2011 field season negatively impacted overall survey effort more than 50% of the time, due to the high sea states that resulted from strong winds and no ice to interrupt the fetch. Surveys were not attempted on 60 days (out of 203 possible survey days) due at least in part to the presence of strong winds, although other weather factors such as low cloud ceilings, fog and poor visibility may have also been present. Furthermore, on 44 out of 97 flights, high sea states forced transects to be truncated, surveys to be redirected to areas where sea states were lower, or surveys to be terminated altogether.

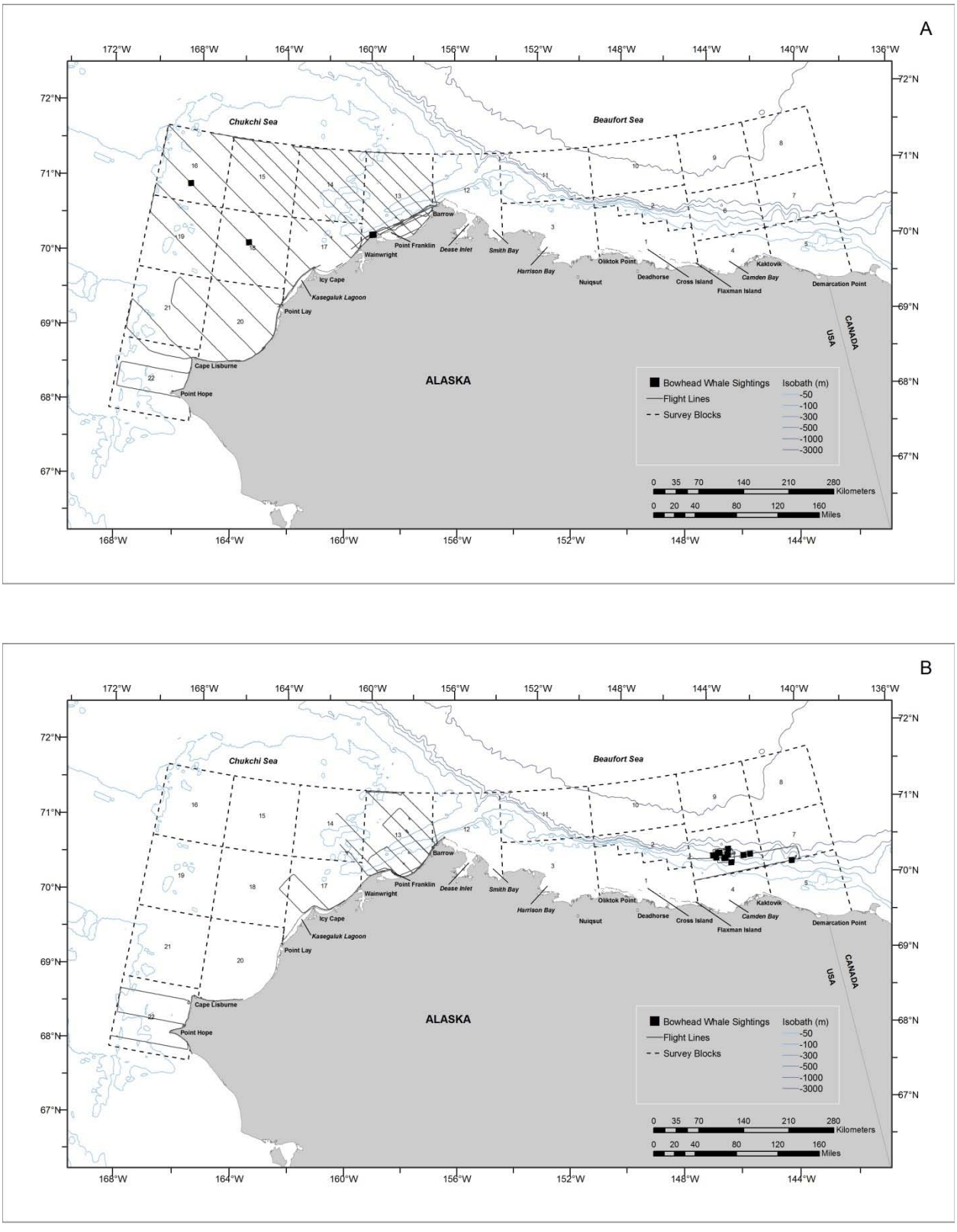
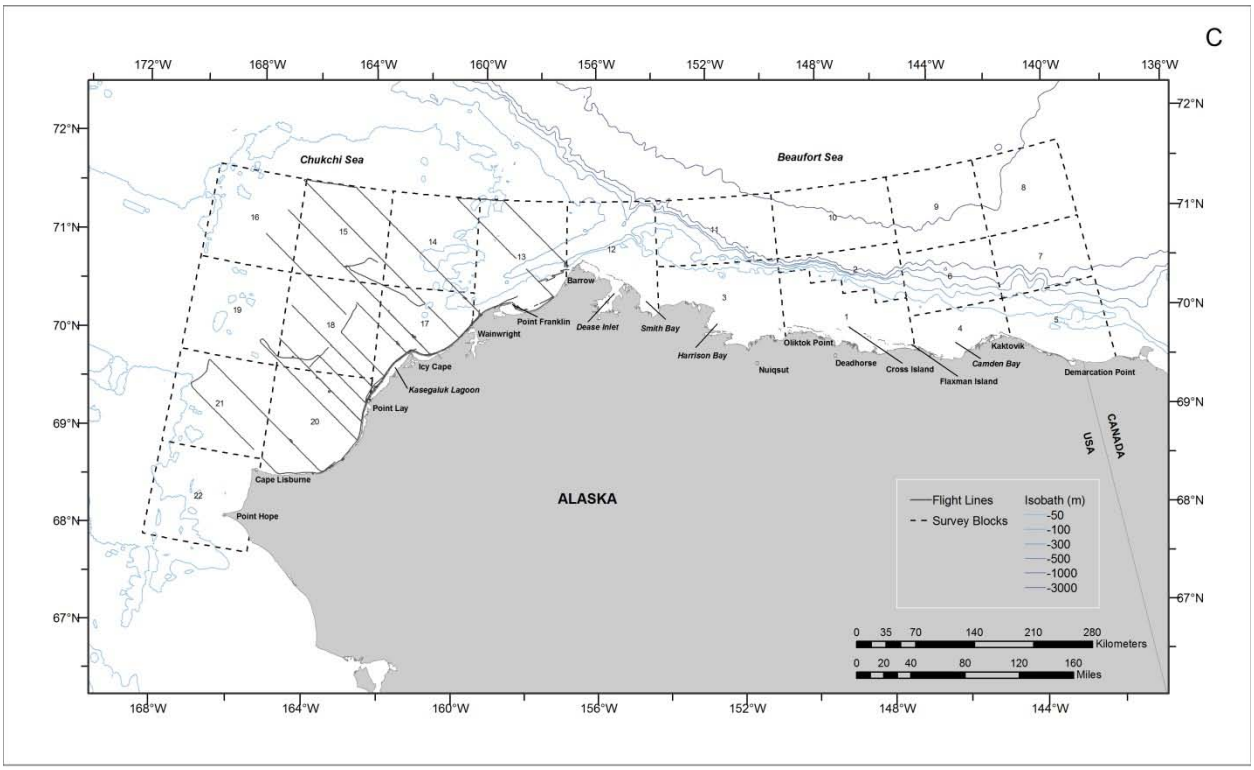


Figure 5. Bimonthly bowhead whale sightings, with transect, search and circling survey effort, 2011. Deadhead flight tracks are not shown. A: 17-30 June; B: 1-15 July.



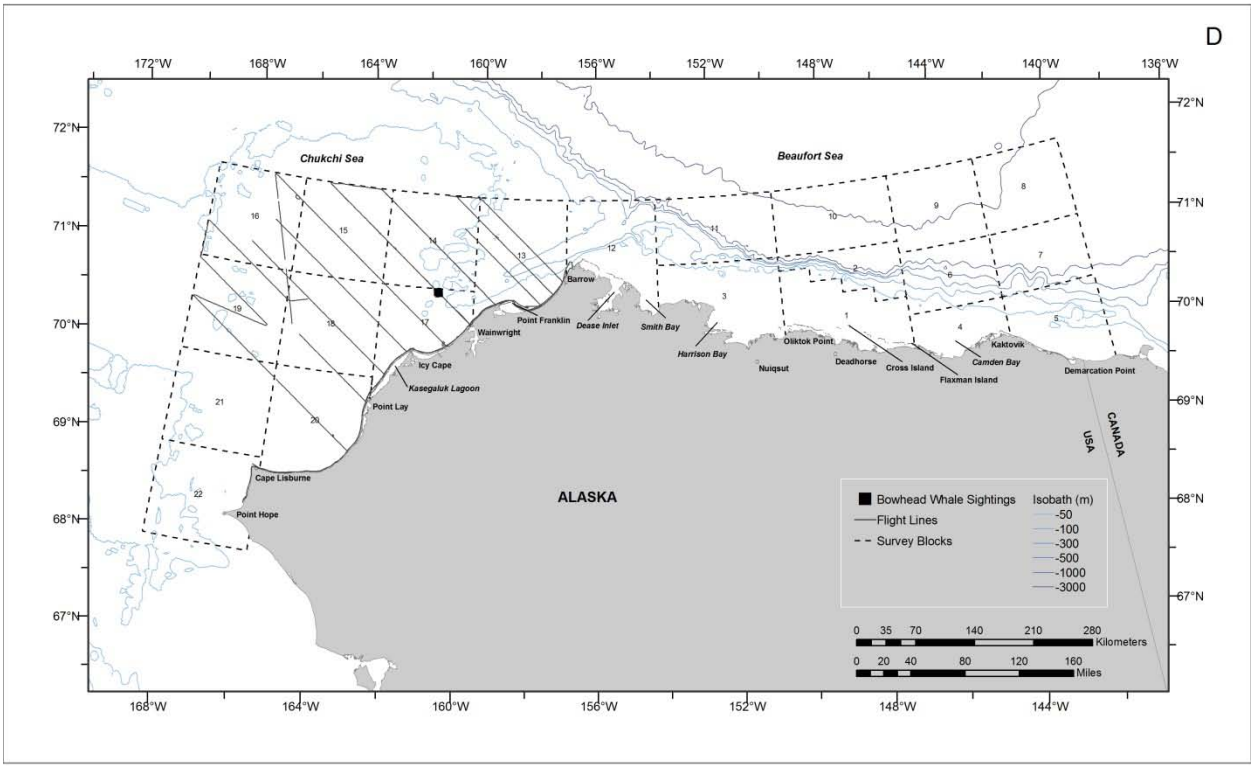
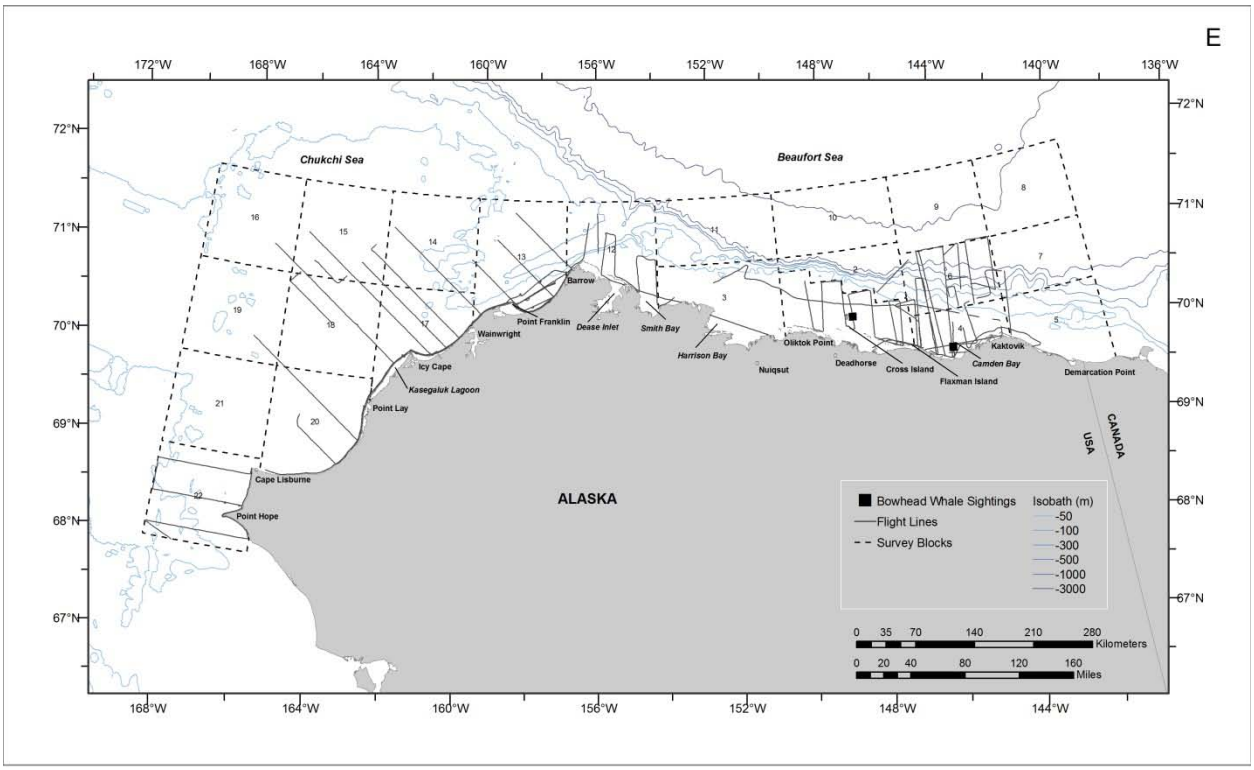


Figure 5 (cont). Bimonthly bowhead whale sightings, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown. C: 16-31 July; D: 1-15 August.



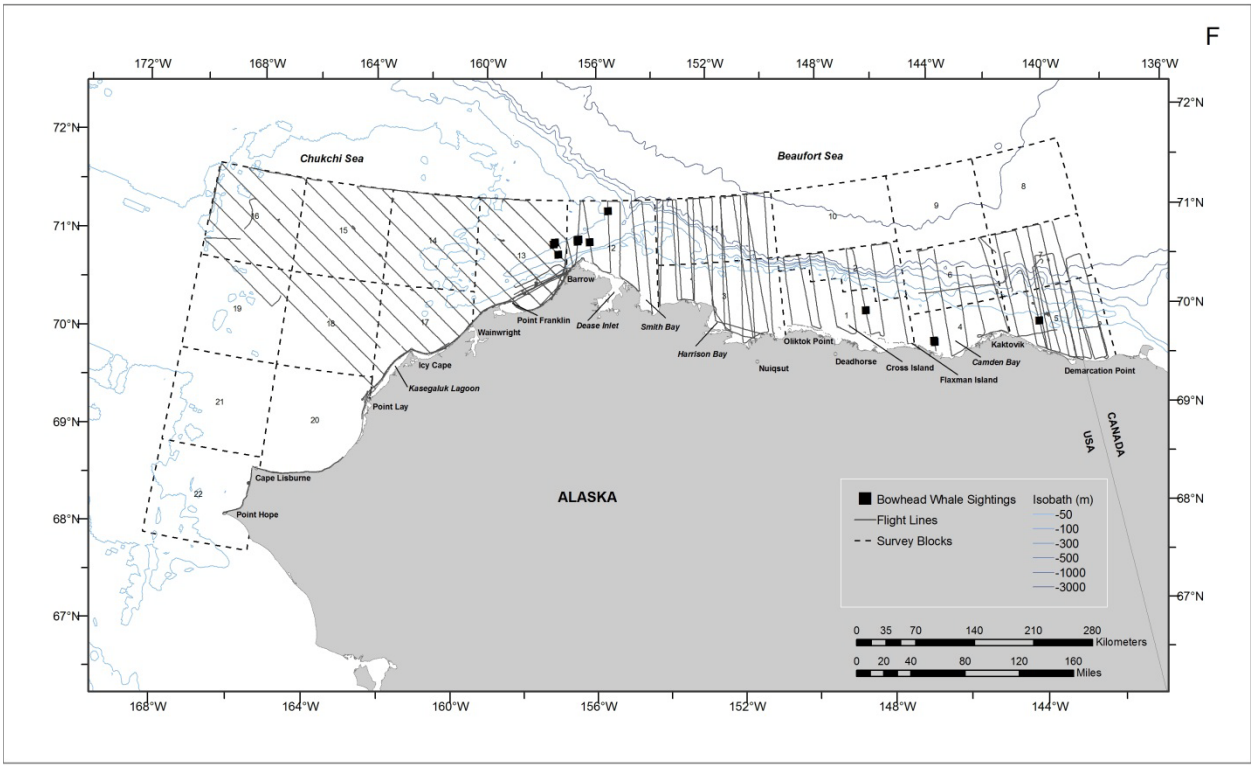
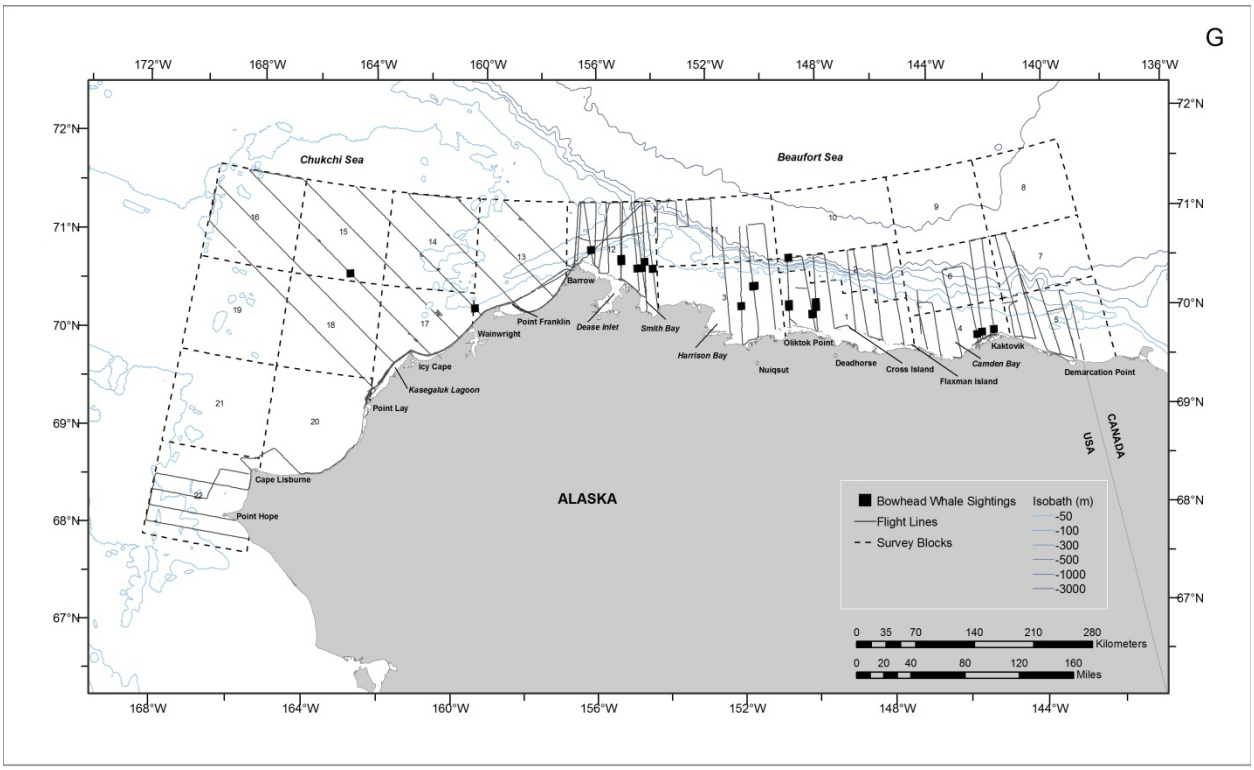


Figure 5 (cont). Bimonthly bowhead whale sightings, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown. E: 16-31 August; F: 1-15 September.



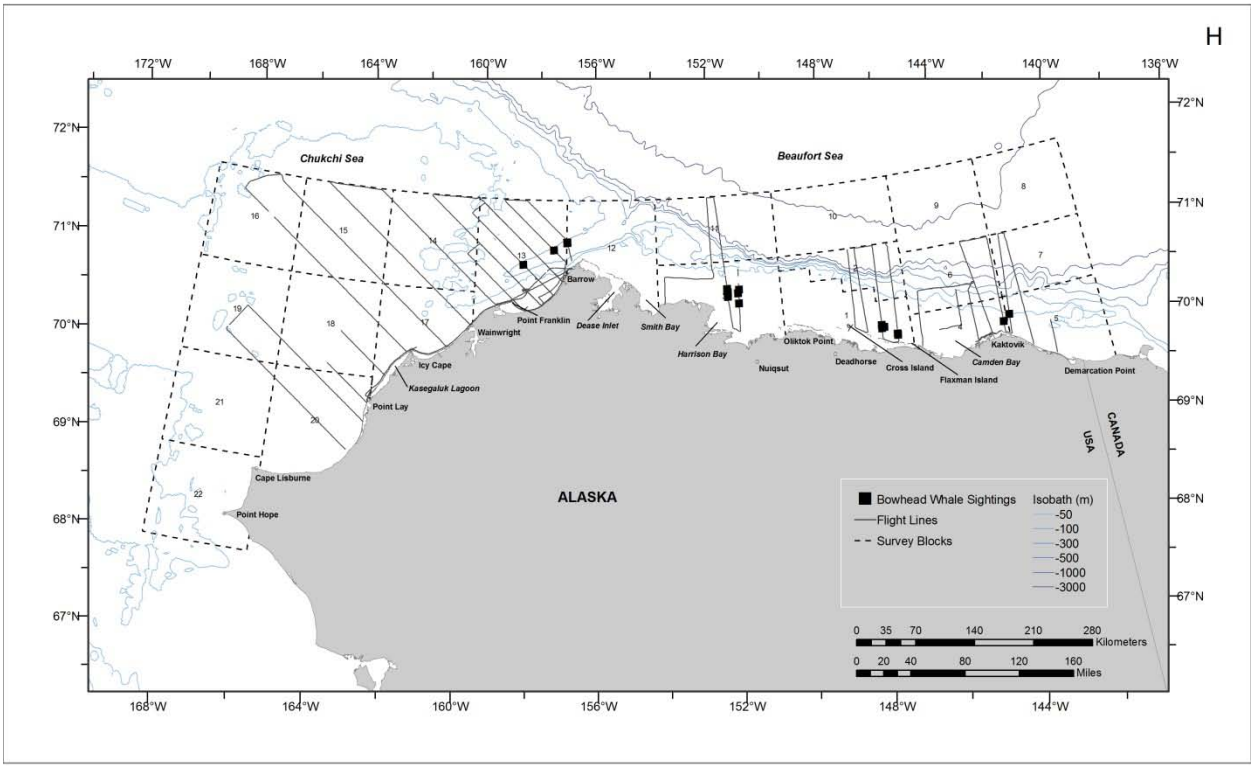


Figure 5 (cont). Bimonthly bowhead whale sightings, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown. G: 16-30 September; H: 1-15 October.

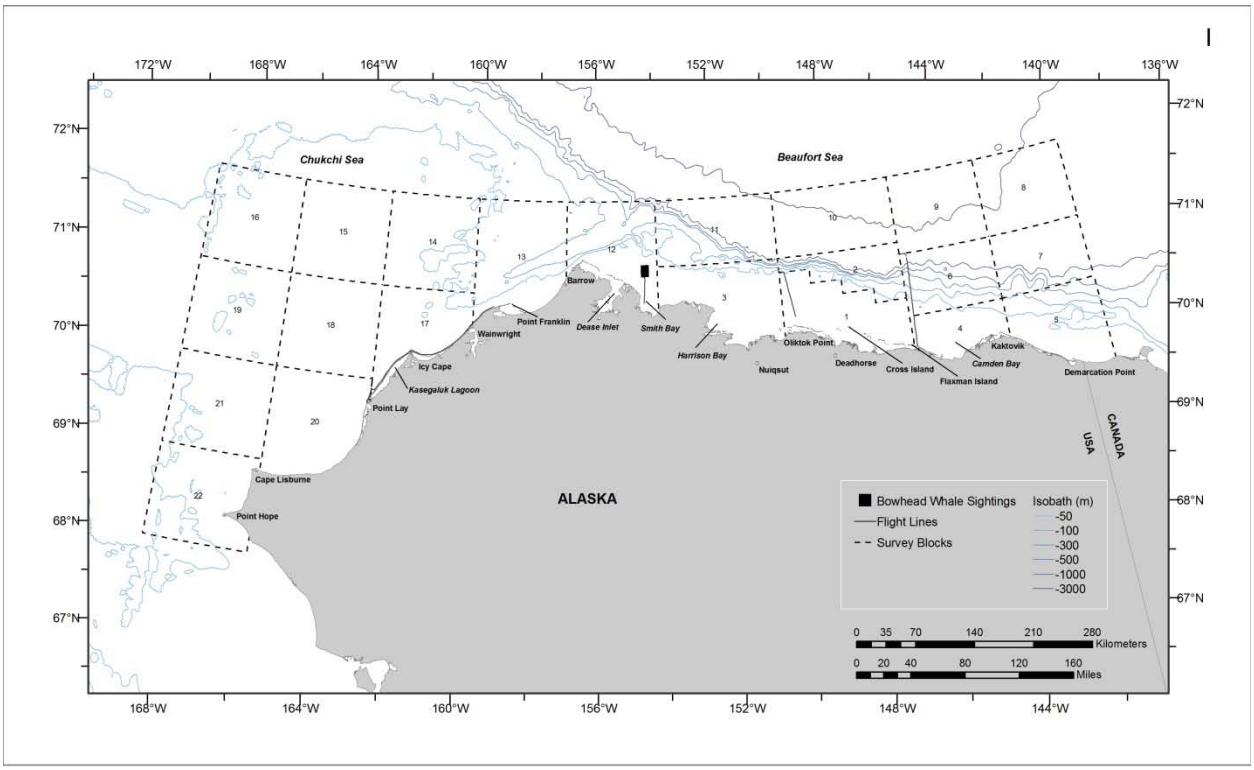


Figure 5 (cont). Bimonthly bowhead whale sightings, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown. I: 16-24 October.

Cetaceans

Bowhead Whales

BOWHEAD WHALE SIGHTING SUMMARY

During 2011 surveys, 87 sightings of 112 bowhead whales (*Balaena mysticetus*) were observed during transect, search and circling survey modes in the study area (Table 3). This is far fewer than the number of bowhead whales normally observed on these surveys during the fall migration (e.g., Clarke et al. 2011a) and is likely due, at least in part, to the unacceptable survey conditions (strong winds, poor visibility, low cloud ceilings) that prevailed in late September and most of October. The low numbers of sightings may also be due to what might have been an abnormally late migration through the Alaskan Beaufort Sea, as evidenced by the late arrival (end of October) of relatively large groups of whales near Barrow. Bowhead whales were seen in every month except July in the northeastern Chukchi Sea, and from July through October in the Alaskan Beaufort Sea (surveys were not conducted in the Beaufort Sea in June) (Figure 6).

There were few bowhead whale sightings in the Chukchi Sea in 2011, despite excellent survey effort particularly in August and September. Sightings in the Chukchi Sea were both nearshore

Table 3. Summary of marine mammal sightings (number of sightings/number of individuals) during all survey modes (transect, search and circling), 17 June-24 October, 2011, by survey flight and semimonthly time periods. Excludes dead and repeat sightings.

Day	Flight No	Bowhead Whale	Gray Whale	Beluga	Minke Whale	Unidentified Cetacean	Bearded Seal	Ringed Seal	Walrus	Unidentified Pinniped*	Polar Bear
17 Jun	201	0	2/3	2/11	0	1/1	4/5	0	16/119	8/8	0
18 Jun	202	0	9/15	3/3	0	1/1	0	0	18/45	13/23	0
19 Jun	203	2/3	1/1	5/29	0	0	6/6	0	77/418	87/96	1/1
21 Jun	204	0	0	2/3	0	0	0	0	17/260	0/0	0
22 Jun	205	0	6/8	0	0	3/5	0	0	3/381	0/0	0
25 Jun	206	0	9/11	8/562	0	0	3/3	0	17/172	21/25	0
26 Jun	207	0	2/2	0	0	0	0	0	0	1/1	0
27 Jun	208	3/4	19/25	0	0	0	2/2	0	32/1331	10/10	0
28 Jun	209	0	3/4	0	0	0	0	0	14/431	0/0	0
2 Jul	210	0	4/7	6/17	0	0	1/1	0	0	1/1	0
3 Jul	211	0	8/17	6/12	0	1/1	1/1	0	1/10	0/0	0
6 Jul	212	0	0	0	0	0	0	0	1/1	1/1	0
7 Jul	213	0	7/8	0	0	0	2/2	0	17/257	1/1	0
8 Jul	214	0	8/12	1/1	0	0	2/2	0	0	15/16	0
10 Jul	215	0	3/4	0	0	0	2/2	0	0	0/0	0
11 Jul	216	0	4/4	0	0	0	0	0	1/50	0/0	0
14 Jul	217	15/18	0	25/34	0	1/1	0	0	0	0/0	0
16 Jul	218	0	1/1	0	0	0	0	0	3/3	1/1	0
17 Jul	219	0	6/11	9/19	1/1	1/1	16/17	0	3/6	61/181	0
18 Jul	220	0	3/4	3/182	2/3	0	3/3	0	2/6	23/27	0
20 Jul	221	0	22/38	0	0	1/1	2/2	0	33/56	7/7	0
23 Jul	222	0	2/5	3/104	0	0	0	0	0	0/0	0
26 Jul	223	0	0	2/13	0	0	0	0	1/1	1/1	0
30 Jul	224	0	0	0	0	0	0	0	0	0/0	0
31 Jul	225	0	5/6	5/15	0	1/2	1/1	0	7/11	8/8	0
1 Aug	226	0	0	0	0	0	0	0	2/2	3/3	0
2 Aug	227	2/2	10/13	0	1/1	0	0	0	63/418	27/33	0

Day	Flight No	Bowhead Whale	Gray Whale	Beluga	Minke Whale	Unidentified Cetacean	Bearded Seal	Ringed Seal	Walrus	Unidentified Pinniped*	Polar Bear
6 Aug	228	0	9/12	4/5	0	0	0	0	45/115	12/13	0
7 Aug	229	0	3/3	1/2	0	0	1/1	1/1	7/32	21/22	0
8 Aug	230	0	0	1/1	0	2/3	0	0	112/731	1/1	0
12 Aug	231	0	0	1/1	0	0	0	0	1/1	0/0	0
15 Aug	232	0	0	1/1	0	0	0	0	16/27	0/0	0
16 Aug	233	0	0	7/34	0	0	0	0	0	0/0	0
17 Aug	234	0	0	1/1	0	1/1	0	0	9/8,014	4/4	0
19 Aug	235	0	0	0	0	0	0	0	17/10,052	1/1	0
20 Aug	1	1/1	0	0	0	0	0	0	0	2/3	1/7
22 Aug	2	0	0	2/4	0	0	0	0	0	6/7	0
22 Aug	236	0	0	0	0	0	0	0	0	0/0	0
24 Aug	3	0	0	7/31	0	0	0	0	0	0/0	0
24 Aug	237	0	1/1	1/1	0	0	0	0	7/10,511	7/7	0
26 Aug	4	0	0	0	0	0	0	0	0	0/0	0
26 Aug	238	0	11/13	5/5	0	3/3	1/1	5/6	32/20,106	24/37	0
27 Aug	239	0	8/9	0	0	1/1	2/2	0	32/100	36/48	0
28 Aug	240	0	0	0	0	0	0	0	3/4	0/0	0
30 Aug	5	0	0	2/4	0	0	0	0	0	0/0	0
31 Aug	6	2/3	0	0	0	0	0	0	0	4/5	0
1 Sep	7	0	0	1/2	0	1/1	0	0	0	0/0	0
2 Sep	8	0	0	0	0	0	0	0	0	0/0	0
2 Sep	241	0	6/12	1/1	1/1	0	5/5	0	19/25	60/67	0
3 Sep	242	0	0	0	0	0	0	0	0	0/0	0
5 Sep	9	0	0	9/10	0	0	0	0	0	6/7	2/2
5 Sep	243	0	10/12	0	0	0	0	0	6/5,305	8/8	0
6 Sep	10	0	0	1/1	0	0	0	0	0	2/2	0
6 Sep	244	5/6	4/5	25/85	0	0	1/1	0	0	5/6	0
7 Sep	11	2/2	0	6/14	0	0	0	0	0	52/106	1/1
8 Sep	12	0	0	7/7	0	0	0	0	0	35/58	0
8 Sep	245	0	0	0	0	0	0	0	6/10	2/3	0
9 Sep	13	1/1	0	12/67	0	0	2/2	0	0	63/115	0
9 Sep	246	1/1	6/7	0	0	0	0	0	0	0/0	0
10 Sep	14	0	0	0	0	0	0	0	0	0/0	0

Day	Flight No	Bowhead Whale	Gray Whale	Beluga	Minke Whale	Unidentified Cetacean	Bearded Seal	Ringed Seal	Walrus	Unidentified Pinniped*	Polar Bear
10 Sep	247	0	0	0	0	0	0	0	0	0/0	0
12 Sep	15	1/1	0	27/50	0	0	3/3	1/1	0	94/125	0
12 Sep	248	0	14/19	0	0	0	1/1	0	59/140	35/35	0
13 Sep	16	0	0	12/18	0	0	4/5	0	0	76/175	0
13 Sep	249	2/2	7/8	0	0	0	0	0	22/24	14/14	0
14 Sep	250	0	0	0	0	1/1	0	0	36/18,191	0/0	0
17 Sep	251	0	0	0	0	0	0	0	0	0/0	0
19 Sep	17	0	0	0	0	0	0	0	0	0/0	0
22 Sep	252	0	0	0	0	0	0	0	0	0/0	0
23 Sep	18	0	0	5/6	0	0	0	0	0	0/0	0
23 Sep	253	0	1/1	0	0	0	0	0	1/12,000	0/0	0
24 Sep	19	3/3	0	4/14	0	0	1/1	0	0	0/0	6/11
24 Sep	254	0	0	3/6	0	0	0	0	0	0/0	0
25 Sep	255	0	0	1/4	0	0	0	0	2/8,002	2/3	0
27 Sep	20	0	0	0	0	0	0	0	0	0/0	3/9
28 Sep	21	14/25	0	11/15	0	0	7/7	0	0	32/58	3/5
28 Sep	256	2/2	3/5	10/15	0	0	0	0	10/41	23/23	0
29 Sep	22	0	0	24/56	0	0	0	0	0	4/11	0
29 Sep	257	1/1	3/8	5/12	0	0	4/5	0	11/20	24/40	0
30 Sep	23	6/6	0	4/6	0	0	1/1	0	0	6/6	0
30 Sep	258	0	0	0	0	0	0	0	14/13,108	3/4	0
1 Oct	24	2/4	0	3/3	0	0	0	0	0	4/4	1/3
1 Oct	259	0	4/4	0	0	0	0	0	4/34	1/1	0
2 Oct	25	5/8	0	6/8	0	0	0	0	0	16/21	0
2 Oct	260	0	5/6	2/2	0	0	0	0	8/16	7/9	0
3 Oct	261	0	1/1	3/7	0	0	0	0	0	1/1	0
4 Oct	26	0	0	0	0	0	0	0	0	0/0	2/5
5 Oct	27	0	0	0	0	0	0	0	0	0/0	1/8
5 Oct	262	0	0	0	0	0	0	0	0	19/26	0
6 Oct	263	0	0	1/1	0	0	0	0	6/1,318	16/19	0
10 Oct	28	0	0	0	0	0	0	0	0	0/0	0
11 Oct	29	9/10	0	2/2	0	0	0	0	0	0/0	0
11 Oct	264	5/6	4/5	0	0	0	0	0	0	8/9	0

Day	Flight No	Bowhead Whale	Gray Whale	Beluga	Minke Whale	Unidentified Cetacean	Bearded Seal	Ringed Seal	Walrus	Unidentified Pinniped*	Polar Bear
17 Oct	265	0	0	1/1	0	0	0	0	6/10	41/66	0
21 Oct	30	0	0	0	0	0	0	0	0	0/0	0
21 Oct	266	3/3	0	0	0	0	0	0	0	0/0	0
24 Oct	31	0	0	0	0	0	0	0	0	0/0	0
					Semimonthly Sighting Summary						
17-30 Jun		**5/7**	**51/69**	**20/608**	**0**	**5/7**	**15/16**	**0**	**194/3,157**	**140/163**	**1/1**
1-15 Jul		**15/18**	**34/52**	**38/64**	**0**	**2/2**	**8/8**	**0**	**20/318**	**18/19**	**0**
16-31 Jul		**0**	**39/65**	**22/333**	**3/4**	**3/4**	**22/23**	**0**	**49/83**	**101/225**	**0**
1-15 Aug		**2/2**	**22/28**	**8/10**	**1/1**	**2/3**	**1/1**	**1/1**	**246/1,326**	**64/72**	**0**
16-31 Aug		**3/4**	**20/23**	**25/80**	**0**	**5/5**	**3/3**	**5/6**	**100/48,787**	**84/112**	**1/7**
1-15 Sep		**12/13**	**47/63**	**101/255**	**1/1**	**2/2**	**16/17**	**1/1**	**148/23,695**	**452/721**	**3/3**
16-30 Sep		**26/37**	**7/14**	**67/134**	**0**	**0**	**13/14**	**0**	**38/33,171**	**94/145**	**12/25**
1-15 Oct		**21/28**	**14/16**	**17/23**	**0**	**0**	**0**	**0**	**18/1,368**	**72/90**	**4/16**
16-24 Oct		**3/3**	**0**	**1/1**	**0**	**0**	**0**	**0**	**6/10**	**41/66**	**0**
TOTAL		**87/112**	**234/330**	**299/1,508**	**5/6**	**19/23**	**78/82**	**7/8**	**819/111,915**	**1,066/1,613**	**21/52**

* Unidentified Pinniped also includes sightings designated as Small Unidentified Pinniped

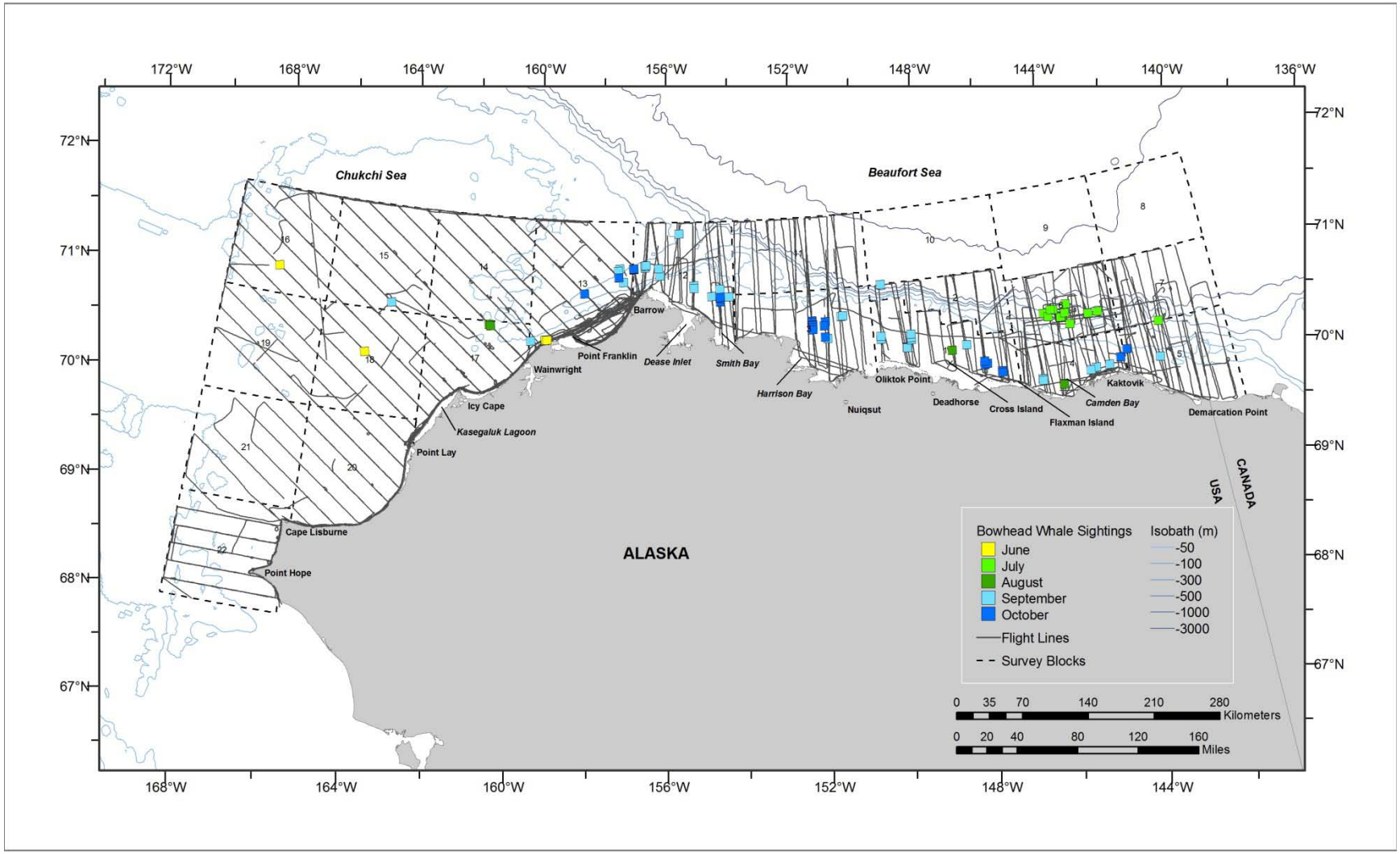


Figure 6. Bowhead whale sightings plotted by month, with transect, search and circling effort, 2011. Deadhead flights tracks are not shown.

near Barrow Canyon and Point Franklin, Alaska, and offshore near lease areas in blocks 15, 16, and 18 (Figures 5A and 5G). The distribution of bowhead whales in fall in the Alaskan Beaufort Sea was predominantly nearshore. Surveys were conducted in the central Alaskan Beaufort Sea in late August for the first time since 2002, but relatively few bowhead whales were seen nearshore and, unlike August 1982-1986 (Ljungblad et al. 1987), no bowhead whales were seen offshore (Figure 5E). From September to October, bowhead whales were not seen in offshore blocks 6, 7, and 11, and only one sighting occurred in block 2, despite surveys conducted there in good weather (Appendix B). The greatest number of whales was seen in block 1. Unlike some previous years, in particular 2009, no large groups of bowhead whales were observed in block 12, despite survey effort there in late September and early October. Out of the 112 bowhead whales sighted, 4 were identified as calves, all of which were observed in the Beaufort Sea (Appendix B, Flights 6, 21 and 24). The resulting seasonal calf ratio (number of calves/number of total whales) was 0.036, which is similar to calf ratios observed during these surveys in recent years (0.022 to 0.058; 2006-2010; Clarke et al., 2011 a, b, c).

Central Alaskan Beaufort Sea Sightings, July

Bowhead whales were seen in the Alaskan Beaufort Sea in mid-July 2011 during an opportunistic survey conducted based on data received from one satellite tagged bowhead whale. In late June 2011, Argos satellite data from a bowhead whale tagged in summer 2010 near Tuktoyaktuk, Canada (available from J. Citta, Alaska Department of Fish and Game [ADFG], Fairbanks, Alaska), indicated that the whale had left the Canadian Beaufort and was heading west into the Alaskan Beaufort Sea. This whale remained in the central Alaskan Beaufort Sea, north of Camden Bay near 71°N, 144°W, for approximately four weeks before heading back towards the Canadian Beaufort. On 14 July, the ASAMM aerial survey team flew east to the latest location of the tagged bowhead whale, as received by the Argos system earlier that day and provided by J. Citta of the ADFG (pers. comm. to Janet Clarke, 14 July 2011). A total of 18 bowhead whales were seen, including 14 whales (2 of which were potential repeat sightings) that were sighted in the immediate vicinity of the tagged whale location (approximately 70.7°N, 144.5°W) (Figure 7). It is unknown if the tagged whale was one of the whales observed; aircraft altitude (~457 m) and prevailing sea states (Beaufort 4-6) were not conducive to observing a satellite tag. Behaviors of the whales in the vicinity of the tagged whale location included milling (3 whales), resting (2 whales), diving (2 whales), displaying (body slap, 1 whale) and swimming (6 whales). One of the milling whales observed had mud on its head, suggesting that it had recently been feeding at the bottom. One of the whales that was initially seen diving returned to the surface and breached. The swimming whales were heading 100°T to 329°T but did not exhibit directed travel. Four bowhead whales were also seen farther east, resting and swimming.

Bowhead whales have previously been documented in the central Alaskan Beaufort Sea during June and July (Ljungblad et al. 1986; Quakenbush et al. 2010; Funk et al. 2010), but surveys in the area are rarely undertaken during the summer months. The sightings in July 2011 were significant in that they ground-truthed results available from a single satellite tagged animal (in this case, 1 tagged bowhead whale actually represented at least 14 bowhead whales) and further illustrated that the entire Bering-Chukchi-Beaufort bowhead whale stock does not remain in the Canadian Beaufort throughout summer. The central Alaskan Beaufort Sea may be important habitat for summering bowhead whales.

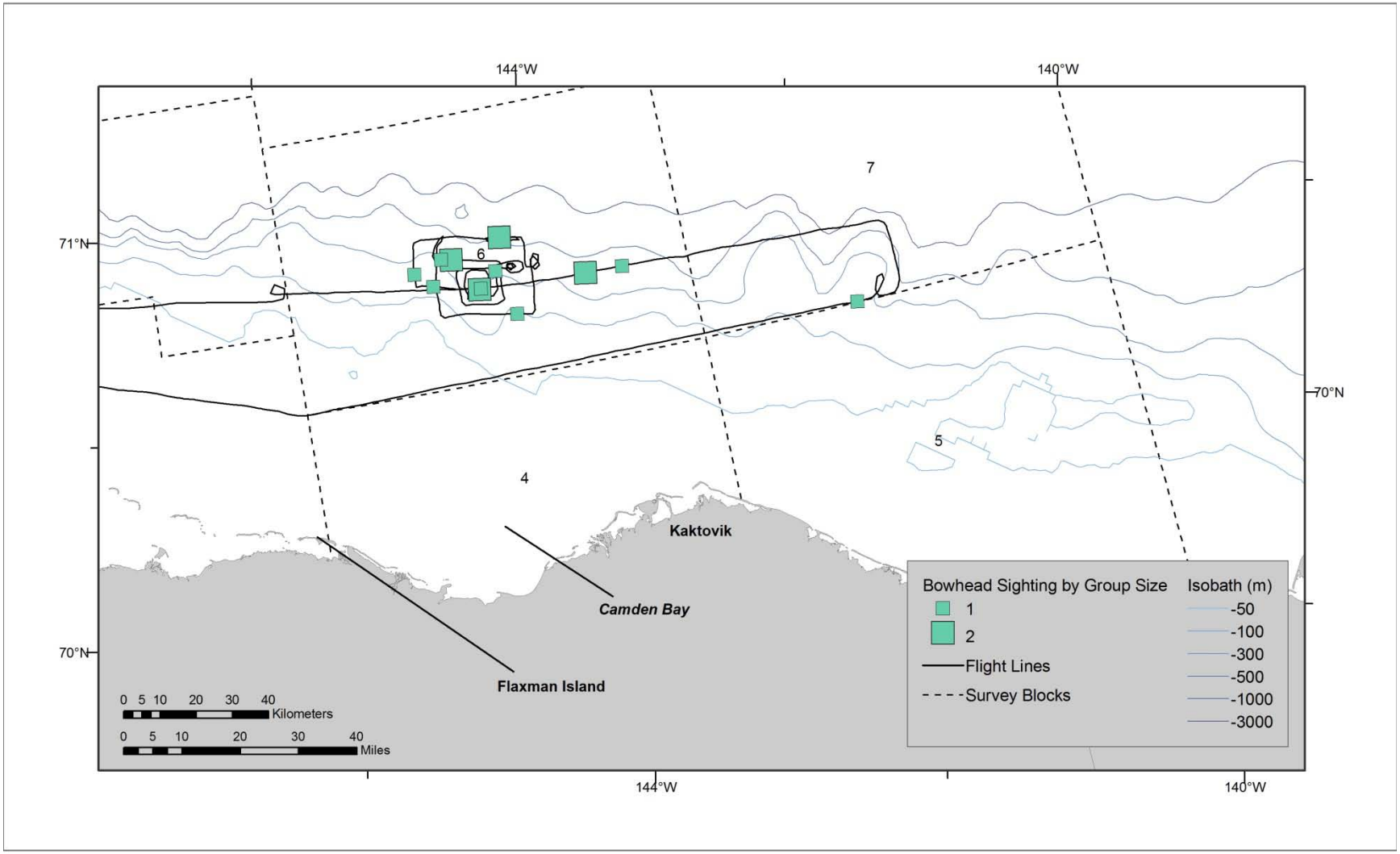


Figure 7. Bowhead whale sightings and flight track, Alaskan Beaufort Sea, 14 July 2011.

BOWHEAD WHALE SIGHTING RATES

In summer and fall 2011, bowhead whales were seen from 142°W to 168°W. There were 57 bowhead whale sightings on transect, ranging from 1 whale per sighting (n = 45) to 6 whales per sighting (n = 1). The highest number of sightings on transect was in block 1 (16 sightings), followed by block 12 (13 sightings). The largest group of bowhead whales on transect (6 animals) was observed on 28 September, north of Harrison Bay in block 3. The highest fine-scale sighting rate (number of transect sightings/transect km surveyed in 5 km^2 grid cells) was north of Harrison Bay (in block 3); areas north of Kaktovik (in block 4), in the central Alaskan Beaufort Sea (in block 1), and between Smith Bay and Point Barrow (in block 12) also had high sighting rates (Figure 8).

The highest sighting rates per survey block were in block 1 (0.017 WPUE), block 3 (0.010 WPUE) and block 4 (0.008 WPUE), with an overall sighting rate of 0.002 WPUE (Table 4). Combined sighting rate for the Alaskan Beaufort Sea only was 0.002 WPUE, which is far lower than that observed annually since 2006 (Clarke et al. 2011a, 2011b, 2011c). Survey block sighting rate analyses for previous years with light sea ice cover in the 1980s and 1990s (e.g., Ljungblad et al. 1987; Treacy 1988, 1990, 1991, 1994, 1995, 1996, 1997, 1998) analyzed total number of bowhead whales/survey hour flown, and did not remove unsurveyable time periods (due to lack of suitable visibility) or time spent surveying inside the barrier islands and north of 72°N. Nonetheless, the pattern of highest sighting rates per year is similar across all years. Highest sighting rates were generally in coastal survey blocks (1, 3, 4, 5, and 12), and were usually correlated with large groups of bowhead whales in feeding or milling aggregations (Clarke et al. 2011c).

The highest bowhead whale sighting rate per depth zone in the central-eastern (140°-154°W) Alaskan Beaufort Sea region was in the ≤20 m depth zone (0.012 WPUE) (Table 5). The highest bowhead whale sighting rate per depth zone in the western (154°-157°W) Alaskan Beaufort Sea region was in the 21-50 m depth zone (0.014 WPUE). This differs from sighting rates calculated for 2009 and 2010 when the highest sighting rate in this area was in the ≤20 m depth zone, due in part to the lack of feeding whales observed in the western Alaskan Beaufort Sea. Sighting rates in the northeastern Chukchi Sea subarea were 0.001 WPUE in both the 36-50 m and 51-200 m North depth zones; bowhead whales were not observed in depths ≤35 m nor in the deeper waters (51-200 m) of the southern Chukchi Sea.

Monthly sighting rates in the Alaskan Beaufort Sea in September 2011 were lower than combined sighting rates for September 1982-2010 (Figure 9) for all survey blocks except block 1, perhaps due to the unusually late migration. Sighting rates in the Alaskan Beaufort Sea in October 2011 were higher than combined sighting rates for October 1982-2010, due to the relatively high number of bowhead whales observed during relatively few transect kilometers flown.

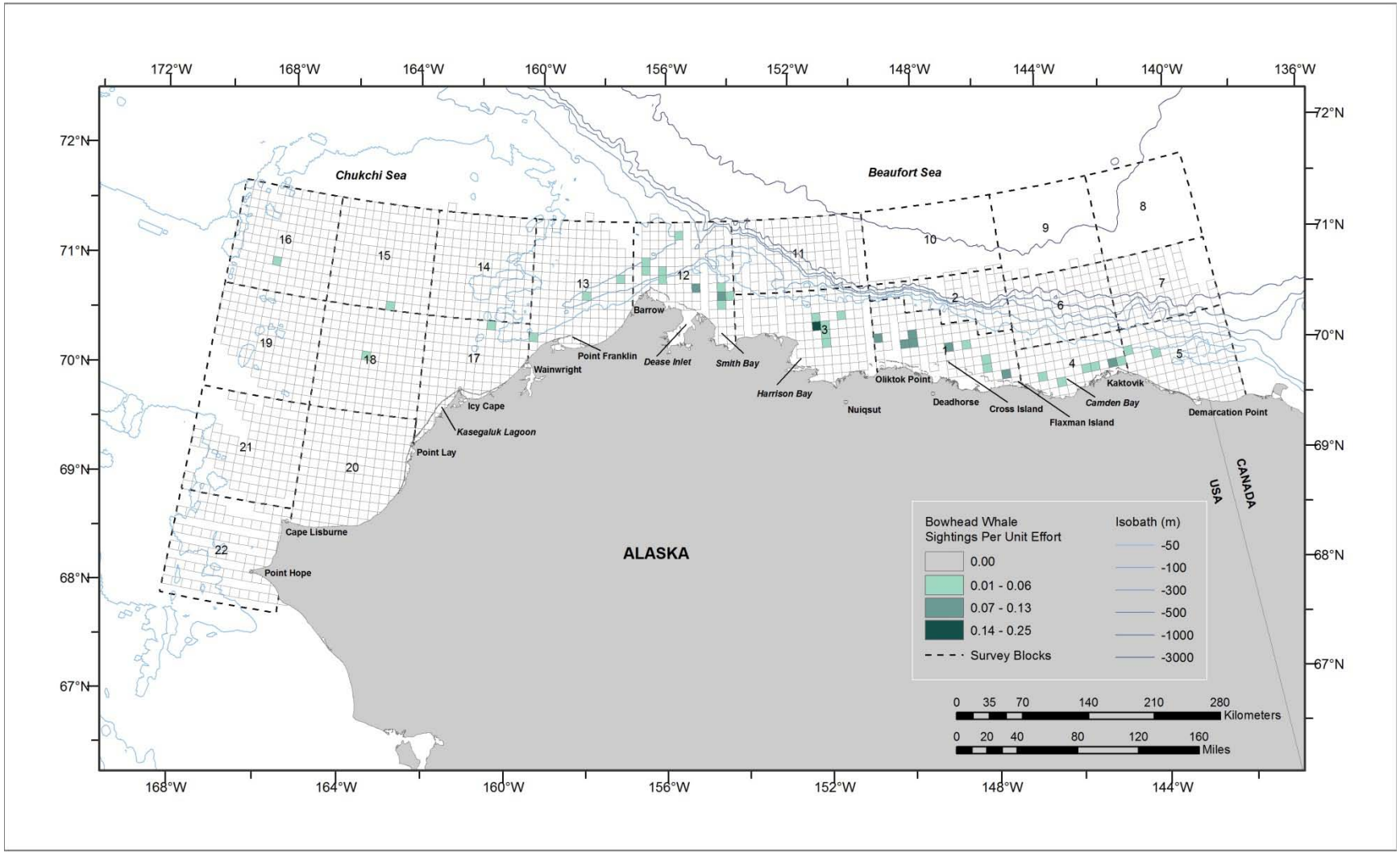


Figure 8. Sighting rates of bowhead whales, 2011 (bowhead whale sightings on transect/km of transect surveyed). Transect survey effort was not conducted in areas without grid cells.

Table 4. Transect (Tr) effort (km), bowhead whale transect sightings and bowhead whale sighting rate (WPUE = bowhead whales per transect km surveyed) per survey block per month, 2011. NA – surveys were not conducted.

BLOCK	JUN Tr km	Tr Sightings	Tr Whales	WPUE	JUL Tr km	Tr Sightings	Tr Whales	WPUE	AUG Tr km	Tr Sightings	Tr Whales	WPUE
1	0	NA	NA	NA	0	NA	NA	NA	346	1	1	0.0029
2	0	NA	NA	NA	0	NA	NA	NA	2	0	0	0.0000
3	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
4	0	NA	NA	NA	0	NA	NA	NA	425	1	2	0.0047
5	0	NA	NA	NA	0	NA	NA	NA	44	0	0	0.0000
6	0	NA	NA	NA	0	NA	NA	NA	557	0	0	0.0000
7	0	NA	NA	NA	0	NA	NA	NA	30	0	0	0.0000
8	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
9	0	NA	NA	NA	0	NA	NA	NA	2	0	0	0.0000
10	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
11	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
12	0	NA	NA	NA	0	NA	NA	NA	275	0	0	0.0000
13	695	0	0	0.0000	1,474	0	0	0.0000	1,363	0	0	0.0000
14	590	0	0	0.0000	277	0	0	0.0000	630	0	0	0.0000
15	497	0	0	0.0000	311	0	0	0.0000	528	0	0	0.0000
16	315	1	1	0.0032	67	0	0	0.0000	226	0	0	0.0000
17	345	0	0	0.0000	927	0	0	0.0000	1,663	2	2	0.0012
18	317	1	2	0.0063	453	0	0	0.0000	520	0	0	0.0000
19	249	0	0	0.0000	31	0	0	0.0000	330	0	0	0.0000
20	530	0	0	0.0000	793	0	0	0.0000	1,075	0	0	0.0000
21	251	0	0	0.0000	196	0	0	0.0000	26	0	0	0.0000
22	333	0	0	0.0000	450	0	0	0.0000	503	0	0	0.0000
Total	**4,121**	**2**	**3**	**0.0007**	**4,979**	**0**	**0**	**0.0000**	**8,545**	**4**	**5**	**0.0006**

BLOCK	SEP Tr km	Tr Sightings	Tr Whales	WPUE	OCT Tr km	Tr Sightings	Tr Whales	WPUE	TOTAL Tr km*	Tr Sightings	Tr Whales	WPUE
1	903	11	17	0.0188	227	4	7	0.0309	1,476	16	25	0.0169
2	650	0	0	0.0000	235	0	0	0.0000	888	0	0	0.0000
3	1,403	2	7	0.0050	185	8	9	0.0487	1,588	10	16	0.0101
4	527	5	5	0.0095	219	1	2	0.0091	1,171	7	9	0.0077
5	1,511	1	1	0.0007	124	1	2	0.0161	1,680	2	3	0.0018
6	539	0	0	0.0000	277	0	0	0.0000	1,373	0	0	0.0000
7	775	0	0	0.0000	146	0	0	0.0000	951	0	0	0.0000
8	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
9	0	NA	NA	NA	0	0	0	0.0000	2	0	0	0.0000
10	0	NA	NA	NA	0	NA	NA	NA	0	NA	NA	NA
11	1,400	0	0	0.0000	145	0	0	0.0000	1,545	0	0	0.0000
12	1,676	10	11	0.0066	56	3	3	0.0537	2,006	13	14	0.0070
13	2,089	2	2	0.0010	1,042	2	3	0.0029	6,662	4	5	0.0008
14	990	0	0	0.0000	318	0	0	0.0000	2,804	0	0	0.0000
15	923	1	1	0.0011	309	0	0	0.0000	2,567	1	1	0.0004
16	956	0	0	0.0000	109	0	0	0.0000	1,672	1	1	0.0006
17	1,290	0	0	0.0000	536	0	0	0.0000	4,762	2	2	0.0004
18	768	0	0	0.0000	197	0	0	0.0000	2,254	1	2	0.0009
19	208	0	0	0.0000	107	0	0	0.0000	924	0	0	0.0000
20	354	0	0	0.0000	284	0	0	0.0000	3,036	0	0	0.0000
21	0	NA	NA	NA	27	0	0	0.0000	500	0	0	0.0000
22	541	0	0	0.0000	0	NA	NA	NA	1,827	0	0	0.0000
Total	**17,502**	**32**	**44**	**0.0025**	**4,541**	**19**	**26**	**0.0057**	**40,682**	**57**	**78**	**0.0019**

* Total transect effort (Tr km) differs from values in Tables 2 and 5 because effort between barrier islands and the mainland was not included in the sighting rate per survey block analysis.

Table 5. Transect (Tr) effort (km), bowhead whale transect sightings and bowhead whale sighting rate (WPUE = bowhead whales per transect km surveyed) per depth zone per month, 2011. NA – surveys were not conducted.

	JUN Tr km	Tr Sightings	Tr Whales	WPUE	JUL Tr km	Tr Sightings	Tr Whales	WPUE	AUG Tr km	Tr Sightings	Tr Whales	WPUE
157W-169W												
0-35 m	950	0	0	0.0000	2,412	0	0	0.0000	3,339	0	0	0.0000
36-50 m	2,327	2	3	0.0013	1,562	0	0	0.0000	2,647	2	2	0.0008
51-200 m N	680	0	0	0.0000	865	0	0	0.0000	703	0	0	0.0000
51-200 m S	116	0	0	0.0000	98	0	0	0.0000	100	0	0	0.0000
154W-157W												
0-20 m	0	NA	NA	NA	0	NA	NA	NA	99	0	0	0.0000
21-50 m	0	NA	NA	NA	0	NA	NA	NA	70	0	0	0.0000
51-200 m	0	NA	NA	NA	0	NA	NA	NA	101	0	0	0.0000
201-2,000 m	0	NA	NA	NA	0	NA	NA	NA	5	0	0	0.0000
140W-154W												
0-20 m	0	NA	NA	NA	0	NA	NA	NA	164	1	2	0.0122
21-50 m	0	NA	NA	NA	0	NA	NA	NA	711	1	1	0.0014
51-200 m	0	NA	NA	NA	0	NA	NA	NA	173	0	0	0.0000
201-2,000 m	0	NA	NA	NA	0	NA	NA	NA	331	0	0	0.0000
>2,000 m	0	NA	NA	NA	0	NA	NA	NA	28	0	0	0.0000
TOTAL	**4,073**	**2**	**3**	**0.0007**	**4,937**	**0**	**0**	**0.0000**	**8,470**	**4**	**5**	**0.0006**

	SEP Tr km	Tr Sightings	Tr Whales	WPUE	OCT Tr km	Tr Sightings	Tr Whales	WPUE	TOTAL Tr km*	Tr Sightings	Tr Whales	WPUE
157W-169W												
0-35 m	2,403	0	0	0.0000	992	0	0	0.0000	10,096	0	0	0.0000
36-50 m	4,188	2	2	0.0005	1,172	0	0	0.0000	11,895	6	7	0.0006
51-200 m N	1,327	1	1	0.0008	760	2	3		4,335	3	4	0.0009
51-200 m S	120	0	0	0.0000	0	NA	NA	NA	435	0	0	0.0000
154W-157W												
0-20 m	354	2	2	0.0056	33	0	0	0.0000	487	2	2	0.0041
21-50 m	351	3	3	0.0085	23	3	3	0.1333	444	6	6	0.0135
51-200 m	797	5	6	0.0075	0	NA	NA	NA	898	5	6	0.0067
201-2,000 m	173	0	0	0.0000	0	NA	NA	NA	178	0	0	0.0000
140W-154W												
0-20 m	1,014	6	6	0.0059	197	7	8	0.0406	1,375	14	16	0.0116
21-50 m	2,589	13	24	0.0093	531	7	12	0.0226	3,831	21	37	0.0097
51-200 m	1,601	0	0	0.0000	304	0	0	0.0000	2,077	0	0	0.0000
201-2,000 m	1,966	0	0	0.0000	434	0	0	0.0000	2,731	0	0	0.0000
>2,000 m	537	0	0	0.0000	93	0	0	0.0000	658	0	0	0.0000
TOTAL	**17,421**	**32**	**44**	**0.0025**	**4,538**	**19**	**26**	**0.0057**	**39,438**	**57**	**78**	**0.0020**

* Total transect effort (Tr km) differs from values in Tables 2 and 4 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis.

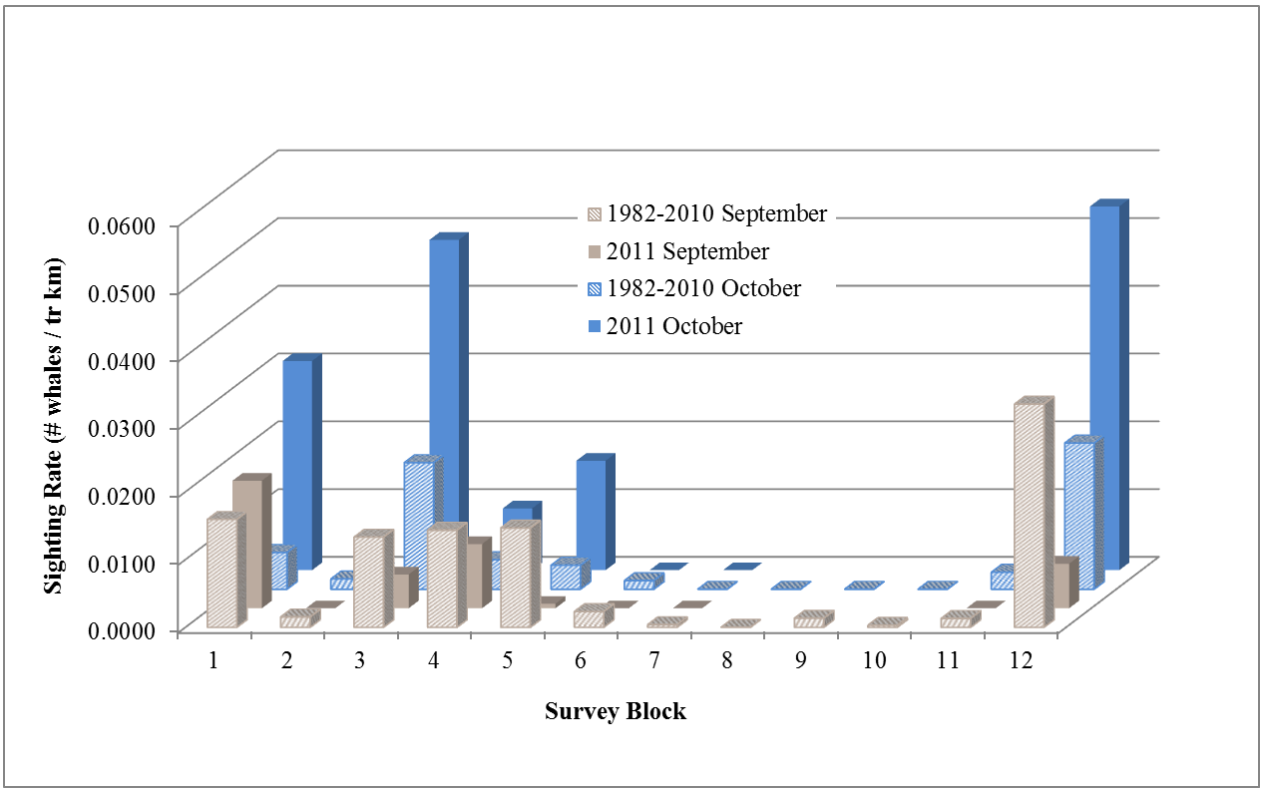


Figure 9. September and October sighting rates (# whales per transect km) of bowhead whales on transect in the Alaskan Beaufort Sea per survey block, 1982-2010 and 2011.

BOWHEAD WHALE HABITAT ASSOCIATIONS

Biweekly sea ice cover maps for the Alaskan Beaufort Sea during 2011 are included in Appendix A. Most bowhead whales (96%, n = 108) were observed in 0% sea ice cover (Table 6). Four bowhead whales (4%) were sighted in 40% sea ice cover, all in late June in the northeastern Chukchi Sea.

BOWHEAD WHALE BEHAVIORS

Behaviors of 112 bowhead whales observed during all survey modes (i.e., transect, search and circling) in 2011 are summarized in Table 7. The behavior most often recorded (53%) was swimming. Milling was recorded for 7 whales (6%) and resting was recorded for 37 whales (33%). One whale was recorded displaying with a body slap. Feeding was not observed for any bowhead whale in 2011, although mud plumes were noted near one resting bowhead whale and mud was noted on the rostrum of another resting whale. Sighting rates of milling whales observed on transect are shown in Figure 10. Four bowhead whales were seen near Point Franklin on 27 June in the same area where whales were seen feeding in June and July 2009 (Clarke et al. 2011d), but there was no indication that feeding was occurring in 2011.

Table 6. Monthly 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, 2011. Excludes dead and repeat sightings.

Percent Sea Ice Cover	17-30 Jun	1-15 Jul	1-15 Aug	16-31 Aug	1-15 Sep	16-30 Sep	1-15 Oct	16-24 Oct	Total
0	2/3	15/18	2/2	3/4	12/13	26/37	21/28	3/3	84/108 (96%)
31-40	3/4	0	0	0	0	0	0	0	3/4 (4%)
TOTAL	5/7	15/18	2/2	3/4	12/13	26/37	21/28	3/3	87/112

Table 7. Monthly summary of bowhead whales (number of sightings/number of individuals) observed during all survey modes (transect, search and circling), by behavioral category, 2011. Excludes dead and repeat sightings.

Behavior	17-30 Jun	1-15 Jul	1-15 Aug	16-31 Aug	1-15 Sep	16-30 Sep	1-15 Oct	16-24 Oct	Total
Dive	0	1/2	0	0	2/2	1/1	0	0	4/5 (4%)
Mill	2/4	2/3	0	0	0	0	0	0	4/7 (6%)
Other	0	1/1	0	0	0	0	0	0	1/1 (1%)
Rest	2/2	3/4	1/1	1/1	2/3	6/17	3/7	2/2	20/37 (33%)
Swim	1/1	8/8	1/1	2/3	8/8	16/16	18/21	1/1	55/59 (53%)
Unknown	0	0	0	0	0	3/3	0	0	3/3 (3%)
TOTAL	5/7	15/18	2/2	3/4	12/13	26/37	21/28	3/3	87/112

Other = “body slap but not full breach”

Furthermore, this area was surveyed frequently in 2011 both during transits and coastal transects, and bowhead whales were not observed there again.

In the Alaskan Beaufort Sea in September and October, swimming direction was significantly clustered around a mean vector of 305°T (n = 25 observations, Rayleigh Z = 6.565, p = 0.001). Swim direction was not clustered around any mean vector in the Chukchi Sea in September and October (n = 13 observations, Rayleigh Z = 0.483, p = 0.626). There were too few observations to test for mean swimming direction during other time periods.

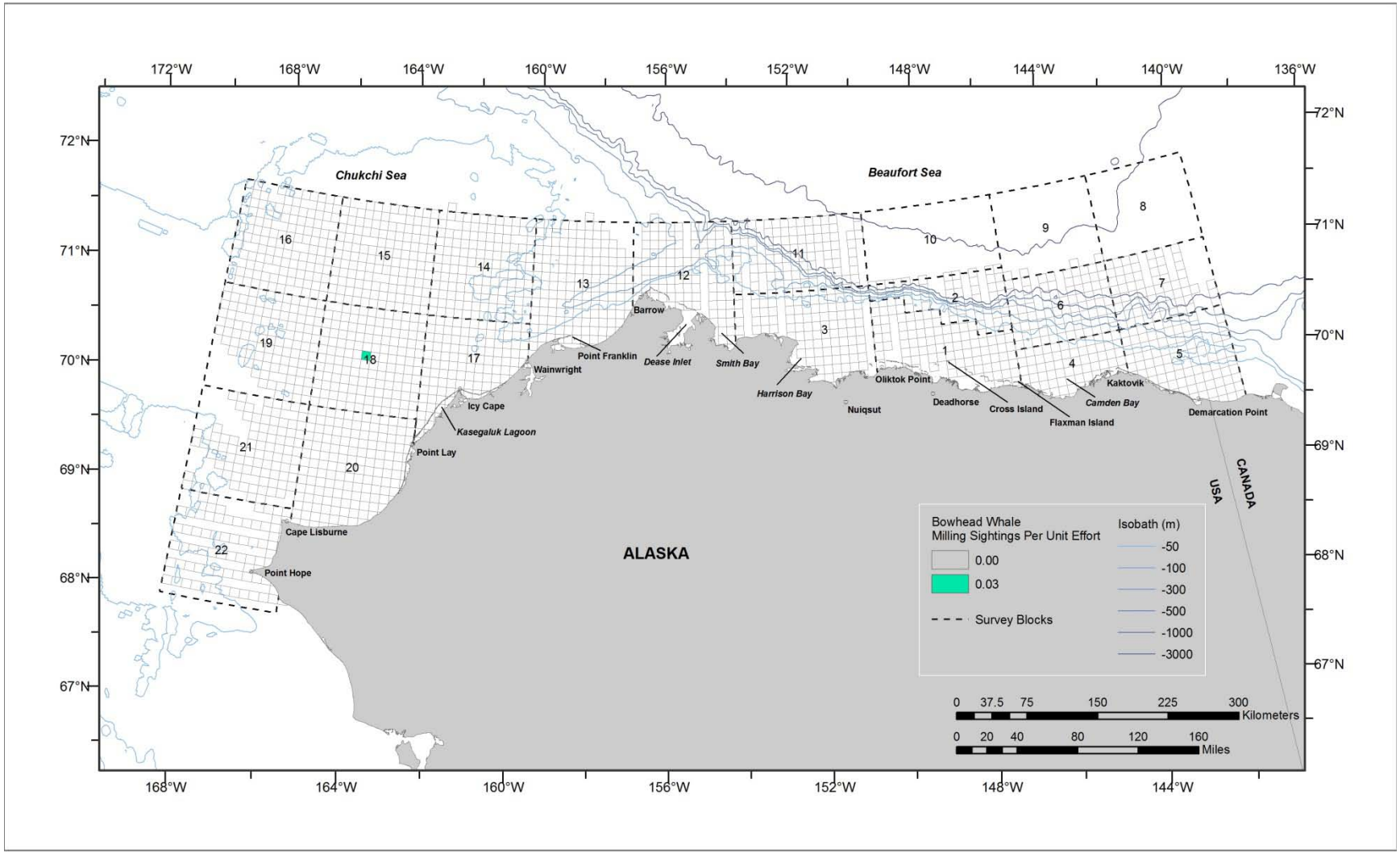


Figure 10. Sighting rates of milling bowhead whales, 2011 (bowhead whale sightings on transect/km of transect surveyed). Transect survey effort was not conducted in areas without grid cells. Feeding was not observed in 2011.

Marine mammal observers and flight crew watched for sudden overt changes (e.g., an abrupt dive, course diversion, or cessation of initial observed behavior) in whale behavior that may indicate a response to the survey aircraft. Based on these criteria, two bowhead whales (2% of all bowhead whales sighted) appeared to respond to the survey aircraft.

Western Alaskan Beaufort Bowhead Whale Feeding Area

Large groups of bowhead whales have been regularly observed in block 12 (154°W to 157°W) in recent years. This area is a well-documented bowhead whale feeding ground (Moore and Reeves 1993; Mocklin et al. 2009) and the site of the BOEM-sponsored Bowhead Whale Feeding Ecology Study (BOWFEST, 2007-2011). Preliminary results from BOWFEST indicate that krill are advected onto the Beaufort Sea shelf from the Beaufort Sea slope during sustained winds from the east or southeast, or possibly from Barrow Canyon during sustained winds from the north or northeast. This causes the wind-driven, northwestward-flowing shelf current to carry the krill toward Barrow (Ashjian et al. 2010). When winds weaken or change to blow from the south, the northeastward-flowing Alaska Coastal Current moves adjacent to the southern edge of Barrow Canyon, thereby blocking the off-shelf movement of krill. This phenomenon results in the aggregation of krill at the western end of the Beaufort shelf near Barrow. The oceanographic response to the sequence of upwelling-favorable winds followed by weak or southerly winds produces conditions conducive to energetically efficient feeding by bowhead whales. Bowhead whale sightings in block 12 in 2009 appeared to be consistent with the predicted mechanism (Clarke et al. 2011c), but were not observed in 2010 (Clarke et al. 2011a).

In 2011, surveys were conducted in block 12 on seven occasions during ASAMM, and bowhead whales were seen during five flights (Figure 11). Whales were not seen during flights on 30 August (Beaufort 2-4, <1-10 km visibility) or 24 September (Beaufort 3-6, 0-5 km visibility). On 6 September, six bowhead whales were seen near Barrow Canyon during good survey conditions (Beaufort 2-4, <1-3 km visibility). On 28 September, one bowhead whale was observed north of Smith Bay during excellent survey conditions (Beaufort 2-5, 5-10 km visibility). On 30 September, six bowhead whales were observed during excellent survey conditions, scattered from Smith Bay to north of Point Barrow. On 11 October, one bowhead whale was observed at the westernmost edge of block 12 during a transect survey of block 13. On 21 October, three bowhead whales were observed under marginal survey conditions; effort consisted of only one partial transect because low cloud ceilings, snow and high sea states prevented surveying additional areas. There were no observations of bowhead whale feeding behavior during any of these flights.

Information on wind speed, wind direction, and other environmental variables, were collected three times per day for Barrow from the National Weather Service, Alaska Aviation Weather Unit web site (http://aawu.arh.noaa.gov/), and plotted for several days preceding ASAMM bowhead whale sighting events in block 12 (Figure 12). Winds were fairly light through the first half of September, but the latter half of September and much of October were characterized by frequent strong winds (>15 kts). However, winds were fairly light for most of the period 27 September to 11 October. Based on past years (e.g., 2009), these conditions were when large groups of feeding bowhead whales would be expected, yet none were seen during ASAMM surveys in 2011.

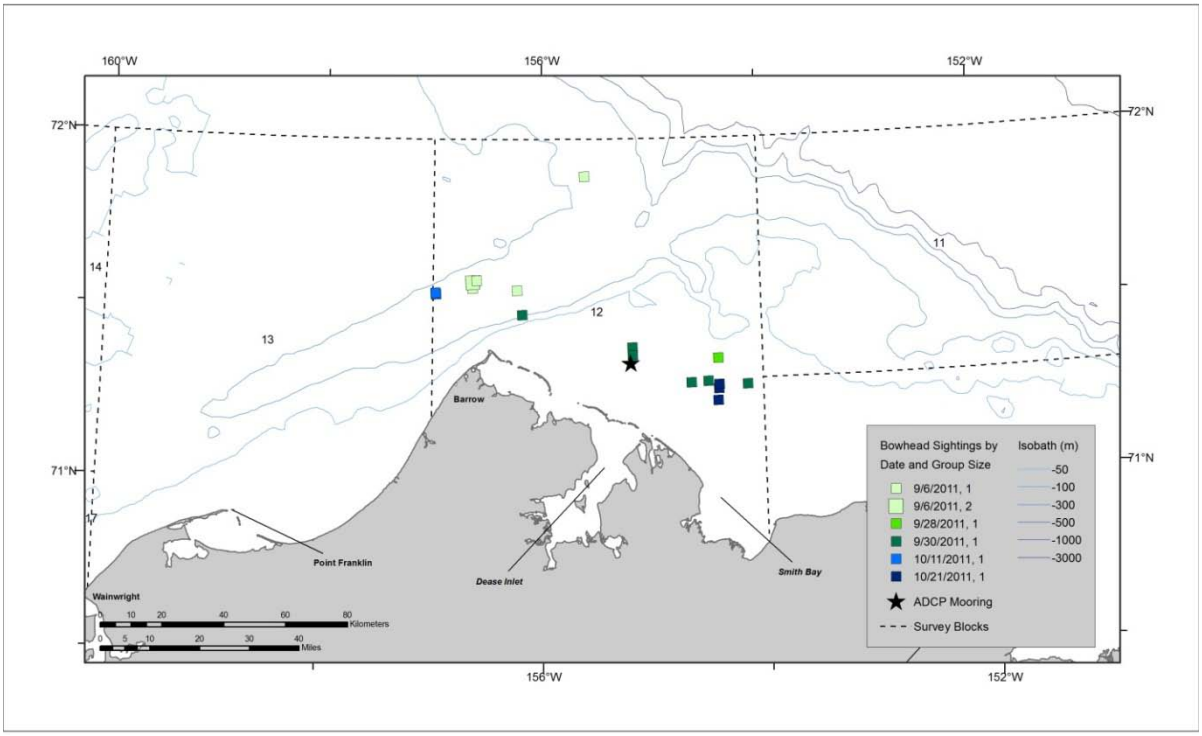


Figure 11. Bowhead whale sightings in survey block 12, all survey modes (transect, search, and circling), 2011. ADCP – Acoustic Doppler Current Profiler.

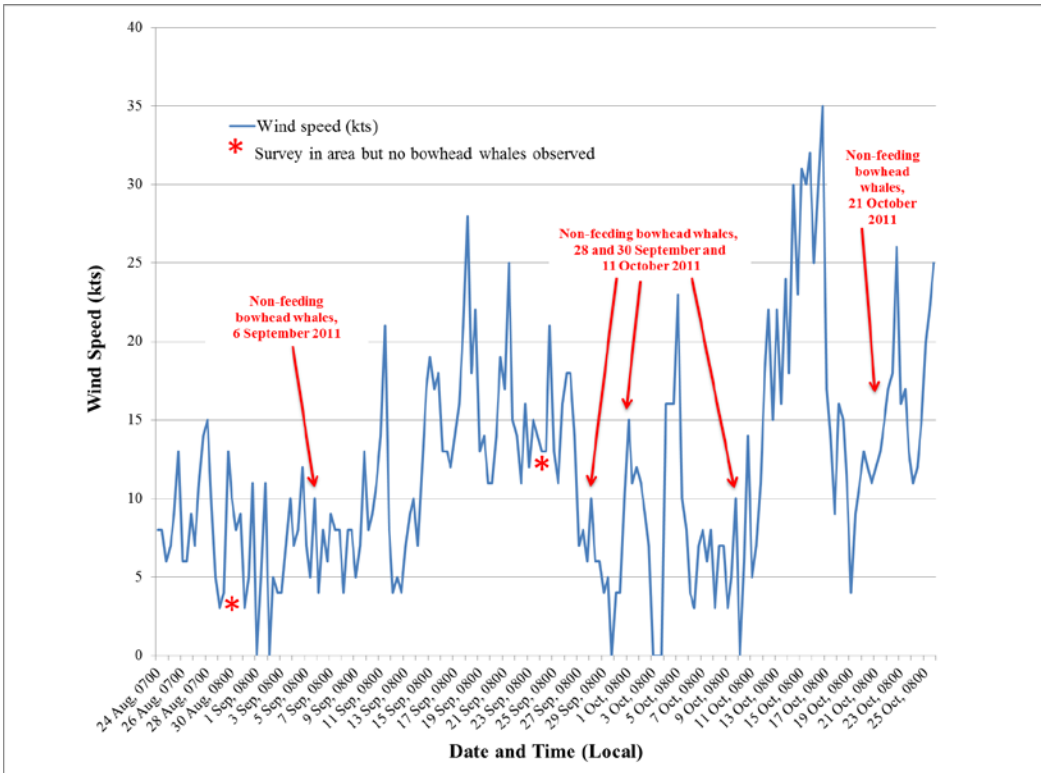


Figure 12. Wind speeds measured at Barrow, Alaska, late August to late October, 2011.

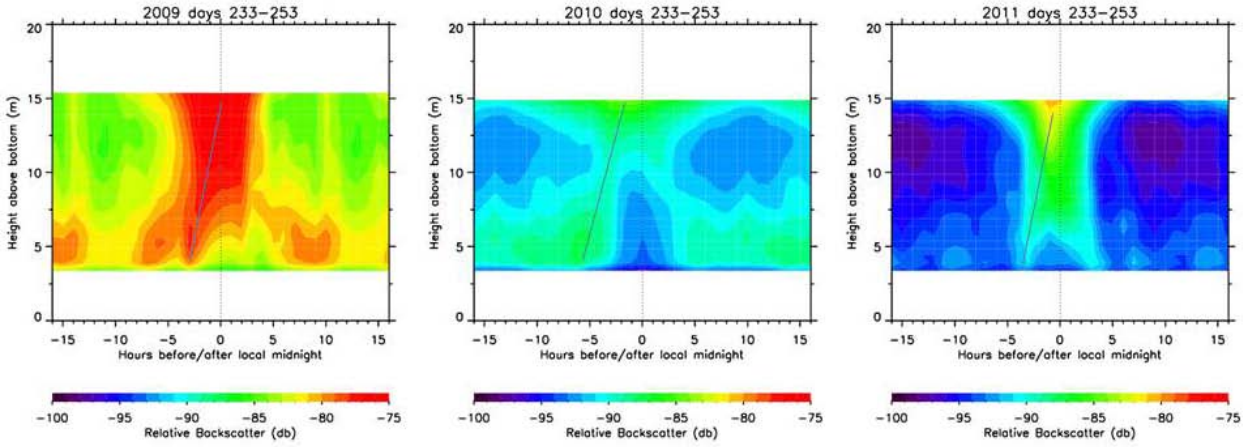


Figure 13. Time-averaged, Acoustic Doppler Current Profiler (ADCP) measured backscatter at a Beaufort Shelf mooring site east of Point Barrow from 20 August-15 September, 2009, 2010 and 2011. The mooring site is shown on Figure 11. Greater backscatter (inferred greater zooplankton abundance) is indicated by red coloration. Provided by S. Okkonen, University of Alaska, Fairbanks.

Bowhead whale groups were observed foraging in shelf waters near Barrow by ASAMM aerial observers and North Slope Borough (NSB) boat-based observers on multiple days in September and October 2009 and 2010, but none were observed in September or early October 2011 (C. George, NSB, pers. comm. to Janet Clarke, 10 October 2011). Bowhead whales were seen near Barrow in late October 2011, although animals harvested during the fall 2011 subsistence hunt had very few krill in their stomachs. Bowhead whale feeding aggregations may not have been detected east of Point Barrow because bowhead whale prey was not present, the 2011 migration was late through this region, or both. Recent (2009-2011) acoustic measurements acquired by an oceanographic mooring deployed on the western Beaufort Shelf indicated that the numbers of krill arriving on the shelf in late summer were highest in 2009 and lowest in 2011 (Figure 13) (S. Okkonen, University of Alaska Fairbanks, pers. comm. to Janet Clarke, 9 January 2011).

BOWHEAD WHALE CENTRAL TENDENCY – ANALYSIS 1

Summary statistics for bowhead whale data from 1982-2011 are shown in Table 8. All values in this table were recalculated in 2011 to ensure an accurate representation of the current ASAMM database, which has undergone an extensive quality review as part of enhanced database management (see http://www.afsc.noaa.gov/nmml/software/bwasp-comida.php for more details). In addition to the updated DFS values calculated from a more detailed normalized shoreline, depth summary statistics and, in rare cases, sample sizes also changed.

Table 8. Central Tendency statistics for distance from shore (km) and depth (m) at bowhead whale transect sightings (September-October), by year and region in the Alaskan Beaufort Sea, 1982-2011. TrSi = transect sightings

			DEPTH (M)				DISTANCE FROM SHORE (KM)			
Year	Region	TrSi	Median	Mean	SD	Min-Max	Median	Mean	SD	Min-Max
1982	East	29	41	44	6.24	35-58	32.5	34.0	7.43	21-50
	West	27	30	96	228.74	14-1,173	37.7	39.3	15.32	12-83
1983	East	14	1,020	960	759.40	59-2,108	80.9	79.6	15.44	50-109
	West	15	120	317	614.79	21-2,265	44.7	53.3	23.39	24-113
1984	East	23	43	70	100.67	14-517	33.6	35.1	20.61	3-91
	West	36	47	53	36.07	13-190	39.3	39.4	16.72	9-72
1985	East	10	37	37	7.70	20-50	28.9	29.2	13.88	5-54
	West	7	36	220	399.58	16-1,114	45.2	49.8	27.54	14-84
1986	East	30	42	38	16.85	8-81	23.8	24.2	15.22	1-54
	West	19	36	86	124.83	8-512	32.7	34.4	20.87	2-79
1987	East	34	38	54	47.73	17-276	30.7	32.2	17.55	7-75
	West	8	26	23	9.68	9-34	25.0	24.9	14.60	5-43
1988	East	6	49	66	59.74	23-186	26.3	29.4	18.98	8-65
	West	8	50	51	7.11	42-65	53.5	54.5	5.92	46-64
1989	East	6	66	196	215.40	48-499	48.7	56.9	24.65	29-89
	West	17	20	21	12.29	7-58	29.4	26.0	14.76	4-60
1990	East	93	42	47	26.90	22-260	29.5	29.7	12.59	8-78
	West	6	33	33	11.62	20-50	30.8	34.2	11.69	24-54
1991	East	15	55	115	96.60	35-336	51.2	51.2	18.66	22-78
	West	6	51	126	142.74	29-383	40.4	47.1	19.30	30-73
1992	East	12	53	52	7.45	40-62	35.5	38.3	11.77	24-61
	West	13	52	56	25.61	15-106	54.1	50.6	13.94	22-71
1993	East	55	42	56	80.94	11-610	25.5	26.9	14.92	5-77
	West	35	20	24	9.34	12-49	24.3	26.6	11.96	11-61

			DEPTH (M)				DISTANCE FROM SHORE (KM)			
Year	Region	TrSi	Median	Mean	SD	Min-Max	Median	Mean	SD	Min-Max
1994	East	32	46	83	199.56	30-1,174	29.9	36.0	17.90	14-70
	West	3	13	22	15.89	12-40	19.2	21.3	11.67	11-34
1995	East	94	42	51	62.10	13-604	26.6	28.8	14.92	3-97
	West	44	32	107	260.14	6-1,308	33.0	39.1	23.44	10-102
1996	East	13	39	38	9.55	14-49	24.2	24.7	10.17	11-48
	West	15	35	38	19.92	19-95	38.4	37.4	14.72	18-62
1997	East	35	21	25	11.64	11-49	8.0	12.5	10.30	2-36
	West	145	20	29	28.69	5-187	22.7	24.6	10.63	7-55
1998	East	104	32	35	11.71	13-82	18.2	21.2	12.85	2-66
	West	113	16	40	188.09	7-2,001	17.9	23.1	17.22	3-118
1999	East	70	50	50	16.02	7-106	34.5	33.7	12.20	4-57
	West	68	31	43	41.81	10-211	30.9	34.2	15.82	6-73
2000	East	26	42	82	126.23	28-593	34.0	36.9	20.11	12-95
	West	19	11	22	37.36	5-173	9.7	15.3	17.00	1-73
2001	East	16	46	44	8.35	28-53	32.7	29.4	10.31	12-42
	West	2	42	42	43.84	11-73	39.6	39.6	43.50	9-70
2002	East	16	30	29	12.68	3-49	13.8	17.9	16.40	0-58
	West	23	25	30	19.55	11-88	30.3	32.6	12.35	9-56
2003	East	33	40	39	17.25	12-99	33.7	27.9	16.89	3-62
	West	41	24	61	77.48	10-310	28.3	31.0	17.80	2-84
2004	East	68	39	42	37.81	7-337	21.6	23.3	11.61	5-71
	West	59	21	33	34.33	5-206	22.4	23.0	9.86	5-65
2005	East	19	41	40	12.41	13-61	23.6	24.4	12.64	5-40
	West	27	33	63	70.30	8-260	37.5	37.3	19.26	3-68
2006	East	44	45	208	476.60	9-1,966	30.3	36.9	21.21	2-89
	West	46	35	43	33.59	4-175	37.0	35.2	18.64	1-67
2007	East	49	34	43	48.77	17-362	21.3	23.0	13.27	5-69
	West	6	23	24	8.57	13-36	24.0	25.2	6.16	18-33

			DEPTH (M)				DISTANCE FROM SHORE (KM)			
Year	Region	TrSi	Median	Mean	SD	Min-Max	Median	Mean	SD	Min-Max
2008	East	25	32	32	5.89	20-43	23.3	20.7	9.39	7-36
	West	37	17	20	7.06	7-40	19.8	22.2	12.69	4-55
2009	East	9	21	29	19.38	11-55	6.3	19.9	22.45	3-58
	West	42	17	30	43.62	8-239	16.7	21.7	16.13	4-81
2010	East	43	30	30	11.13	13-49	11.9	14.2	7.73	3-29
	West	25	20	32	34.22	10-189	20.6	26.3	14.81	3-76
2011	East	13	27	31	8.55	22-50	10.9	13.6	6.57	7-27
	West	29	20	26	22.65	15-141	26.0	27.2	10.37	16-64

Depth at Sighting

Mean depth at sightings of *all* bowhead whales on transect was 31 m (SD = 8.6, range 22-50 m) in the East Region, and 26 m (SD = 22.7, range 15-141 m) in the West Region (Table 8). Mean depth of "migrating" bowhead whales on transect was 32 m (SD = 9.4, range 22-50 m) in the East Region and 25 m (SD = 26.1, range 15-141 m) in the West Region. A Mann-Whitney *U*-test of significant difference of medians indicated no difference between median depths of all sightings versus only those sightings considered "migrating" in the East (Z = -0.186, P = 0.8524) and West (Z = 1.084, P = 0.2783) Regions.

Distance from Shore

Mean distance of locations of *all* bowhead whale transect sightings to the normalized shoreline between 140°W and 156°W in 2011 was 13.6 km (SD = 6.6) in the East Region, and 27.2 km (SD = 10.4) in the West Region (Table 8). Mean distance of locations of "migrating" bowhead whale transect sightings (i.e., excluding sightings of feeding, milling, or resting whales) was 14.6 km (SD = 7.3) in the East Region, and 25.9 km (SD = 10.1) in the West Region. A Mann-Whitney *U*-test of significant difference between medians indicated no difference between median distances of all sightings versus only those sightings considered "migrating" in the East (Z = -0.217, P = 0.8282) or West (Z = 0.618, P = 0.5365) Regions.

Based on the lack of significant difference between all bowhead whale sightings in 2011 and sightings limited to whales considered "migrating," additional analyses of the bowhead whale migration corridor incorporated all sightings and were not limited to only those animals considered actively "migrating".

Distribution of Bowhead Whales, 2011, Relative to Bowhead Whale Distribution in Previous Years with Light Sea Ice Cover

Bowhead distribution in 2011 did not appear to differ noticeably from the distribution observed in previous years having light sea ice cover (i.e., 1982, 1986, 1987, 1989, 1990, 1993-2010) (Figure 14). With the exception of one sighting in block 16, bowhead whale transect sightings in 2011 overlay those from 1982-2010.

To evaluate whether significant displacements occurred in the Alaskan Beaufort Sea bowhead whale migration corridor during 2011, estimates of median depth at sighting and distance of sightings from the normalized shoreline were compared with pooled data from previous years having light sea ice cover. During previous years with light sea ice cover, median water depth at bowhead whale sightings on transect was 40 m in the East Region and 22 m in the West Region; the median distance from shore was 25.2 km in the East Region and 24.6 km in the West Region.

In 2011, bowhead whales sighted on transect in the East Region were in significantly shallower water (27 m vs. 40 m, Z = 2.869, P = 0.0041) and significantly closer to shore (10.9 km vs. 25.2 km, Z = 3.524, P = 0.0004) than in previous years with light sea ice cover.

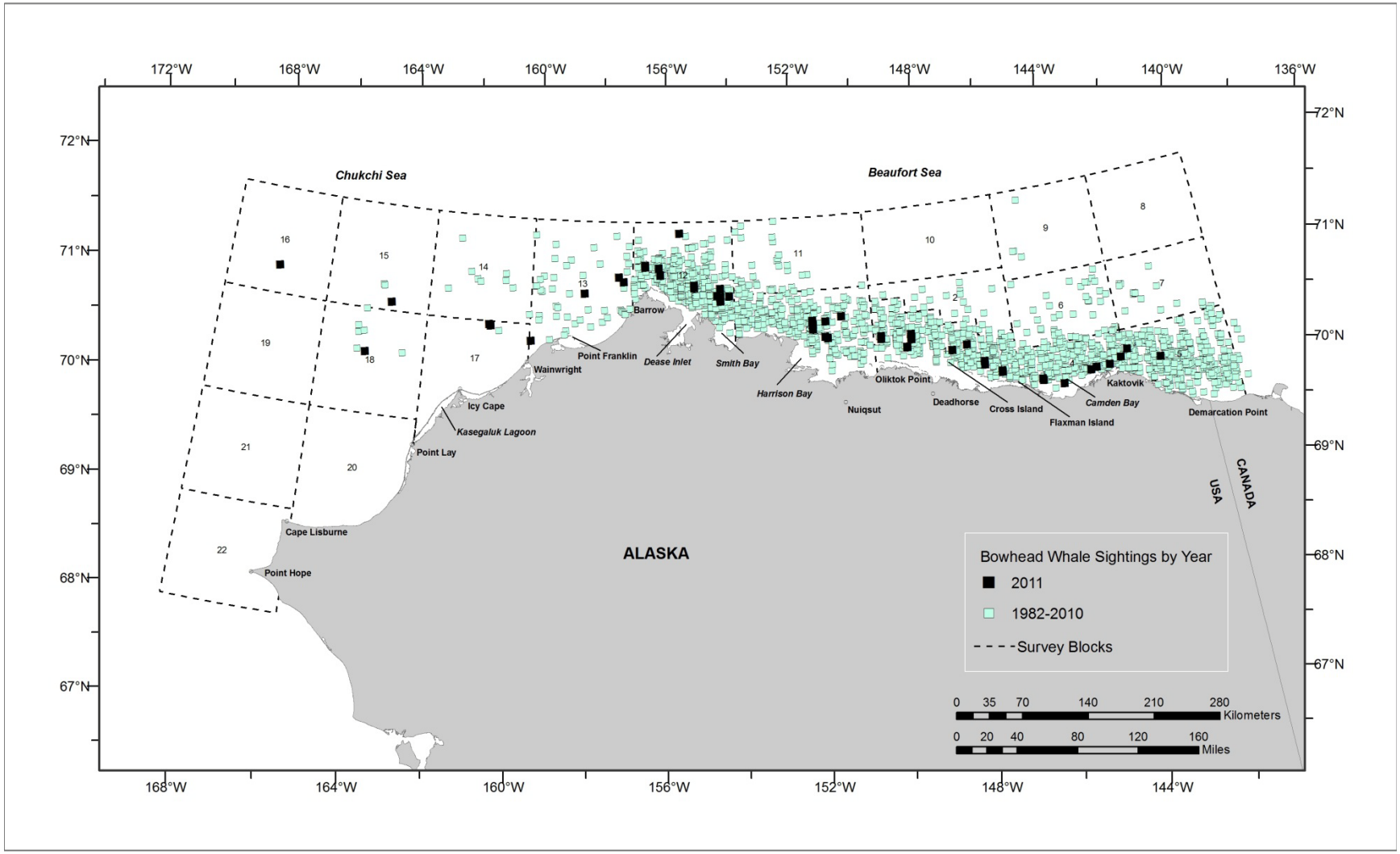


Figure 14. Bowhead whale sightings on transect in years with light sea ice cover: 1982, 1986, 1987, 1989, 1990, 1993-2010, and 2011.

In the West Region, there was no significant difference in distance from shore of bowhead whale sightings between 2011 (26.0 km) and previous years with light sea ice cover (24.6 km), nor was there any significant difference in depth at bowhead whale sightings between 2011 (20 m) and previous years with light sea ice cover (22 m).

BOWHEAD WHALE CENTRAL TENDENCY – ANALYSIS 2

Encounter rate predictions resulting from the spatial model (encounter rate GAM) applied to the 2011 survey data for the Alaskan Beaufort Sea were plotted in Figure 15. The highest predicted encounter rates were located off of Harrison and Camden Bays. The cumulative distributions for distance from shore of individual bowhead whales in the East and West Regions, and in both Regions combined, are shown in Figure 16; the corresponding estimated median distance from shore values are 14.5 km, 32.8 km, and 29.1 km, respectively.

The estimated median statistics derived using the spatial model were between 3.6-6.8 km larger (farther offshore) than the median statistics associated with the bowhead whale sightings that were unadjusted for transect effort or group size (summarized in BOWHEAD WHALE CENTRAL TENDENCY – ANALYSIS 1). Three factors likely contributed to these differences. First, the spatial model had a 5-km resolution; therefore, the model could not identify differences in distance from shore that are smaller than 5 km. Second, the group sizes of the bowhead whale transect sightings ranged from 1 to 6 individuals in the West Region and from 1 to 4 individuals in the East Region, with the two highest group sizes (five and six individuals) located further than 20 km from shore in the West Region. The spatial model effectively placed more weight on sightings with larger group sizes, resulting in a larger median distance from shore. Finally, due to logistical and weather constraints, there was greater survey effort in the nearshore areas of the Alaskan Beaufort Sea study area compared to the offshore areas (Figure 4; Table 4). Because the spatial model weighted the observed number of individuals by the inverse of the survey effort in the associated grid cell, each sighting in a grid cell having relatively little survey effort counted for more in the model-derived median statistics.

Gray Whales

GRAY WHALE SIGHTING SUMMARY

During 2011 surveys, 234 sightings of 330 gray whales (*Eschrichtius robustus*) were observed during all survey modes (transect, search and circling) in the study area (Table 3). Gray whales were seen in every month surveyed in the northeastern Chukchi Sea (Figure 17); they were not seen east of Point Barrow despite extensive survey effort in that area from mid-August through the end of October. In all months, gray whales were seen primarily nearshore (<50 km) between Point Barrow and Point Franklin, and up to 100 km offshore between Point Franklin and Point Lay. There were scattered sightings offshore (>100 km) and nearshore between Cape Lisburne and Point Hope. There appeared to be some preference for areas further offshore between Point Franklin and Icy Cape in late summer and early fall, but gray whales were not seen near Hanna

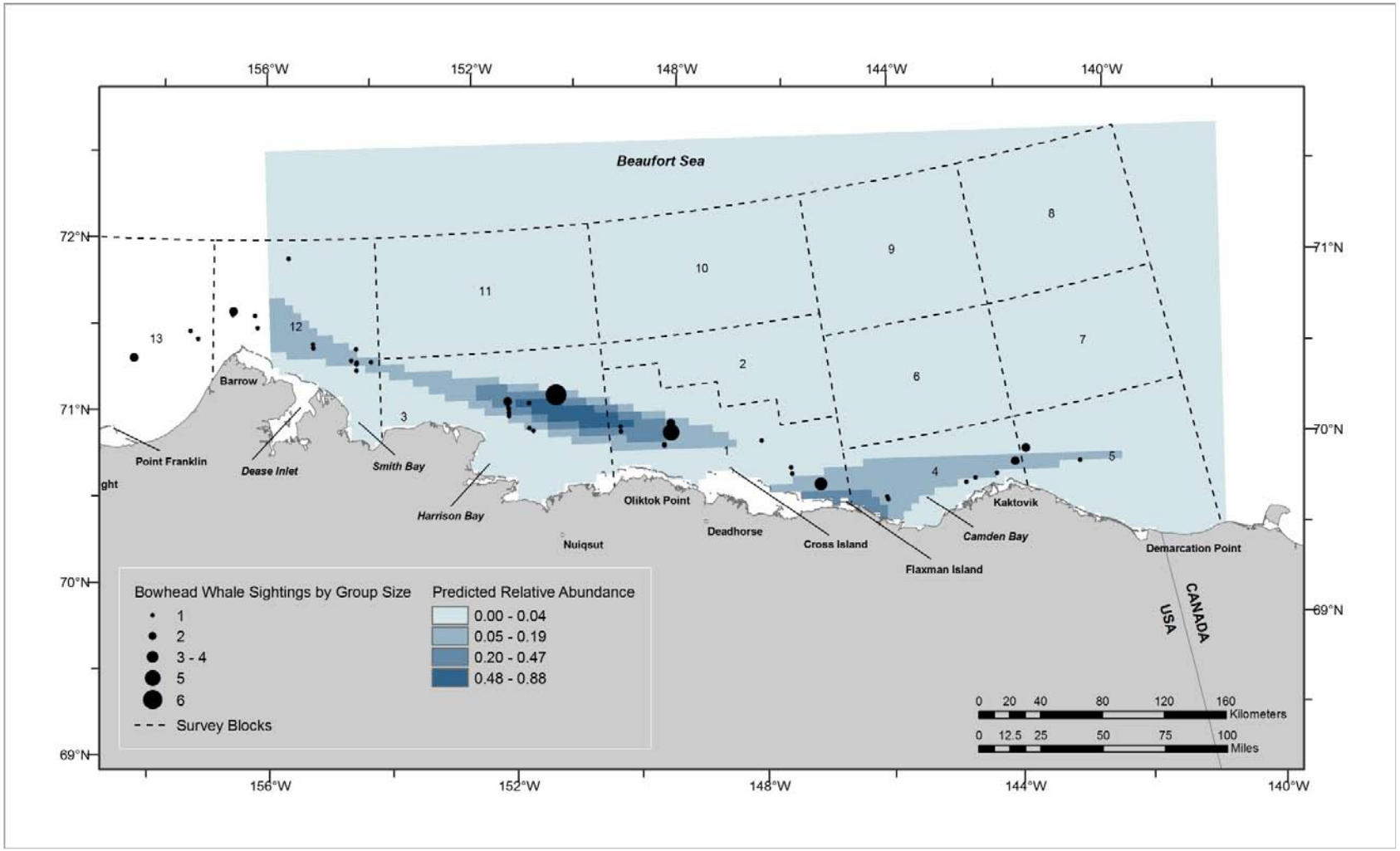


Figure 15. Observed 2011 bowhead whale transect sightings by group size and predicted relative abundance of bowhead whales in the Alaskan Beaufort Sea, based on the spatial encounter rate model that accounted for effort by assuming a uniform 5 km of transect effort in every cell. Predictions are not corrected for perception or availability bias.

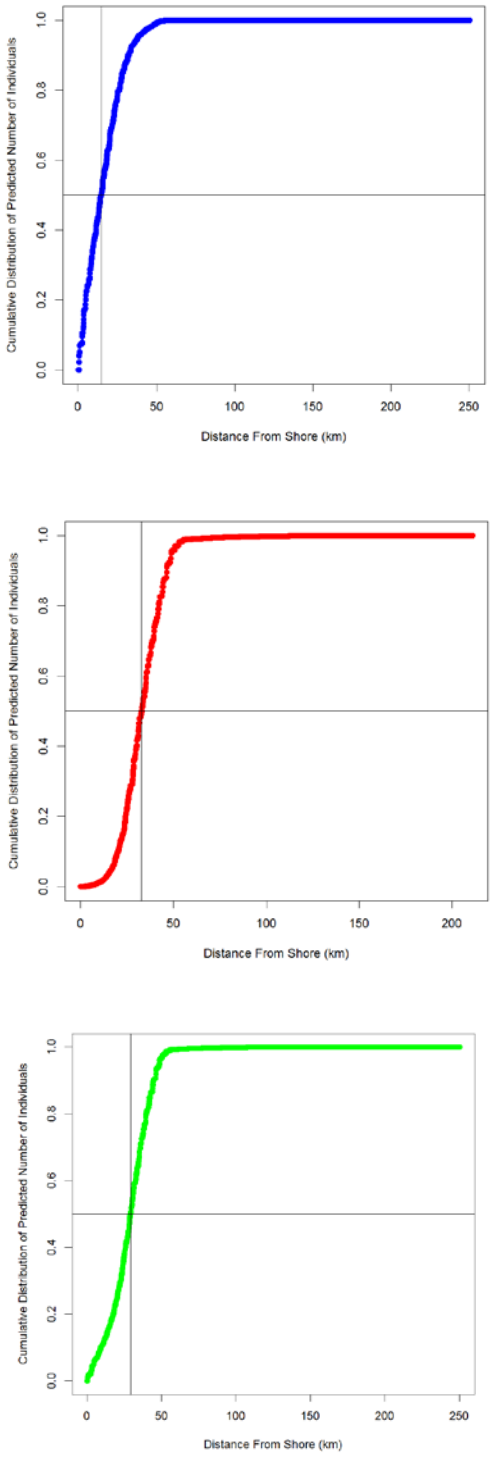


Figure 16. Cumulative distribution of predicted number of bowhead whales in each 5 x 5 km grid cell in the East (top), West (middle) and combined (bottom) Region of the Alaskan Beaufort Sea study area, based on the spatial model (encounter rate GAM). The gray horizontal line corresponds to the 50th percentile (median) of the distribution; the gray vertical line denotes the associated distance from shore value.

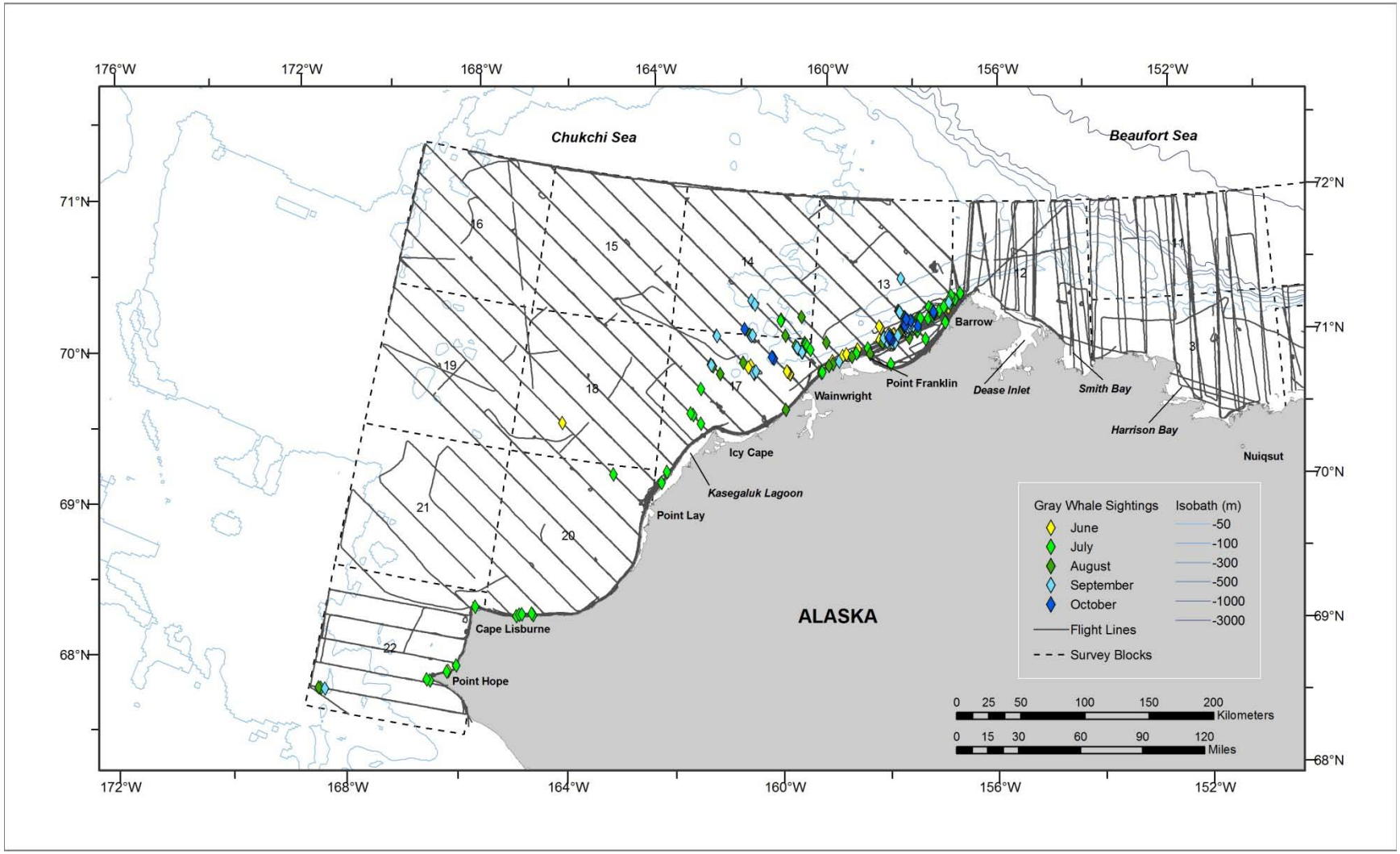


Figure 17. Gray whale sightings plotted by month, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown.

Shoal and few were seen offshore west of Point Hope. Locations of gray whale sightings are shown in semimonthly periods in Figure 18.

Gray whale distribution in 2011 was generally similar to that documented in previous years with light sea ice cover, with a few exceptions (Figure 19).

- Gray whales continued to be absent from Hanna Shoal in all months in 2011, as has been documented since 2008 (Clarke et al. 2011d). Gray whales were frequently observed feeding near Hanna Shoal in the 1980s and early 1990s (Moore 2000).
- Gray whales were observed very close to shore from east of Cape Lisburne to just south of Point Hope, particularly in June and July 2011. While gray whales were often seen in this area in the 1980s and early 1990s (Moore 2000), they were not observed there in 2008-2010 (Clarke et al. 2011d).
- Very few gray whales were seen offshore west of Point Hope in 2011, which differs from earlier years when gray whales were seen in that area nearly every month surveys were conducted.
- Gray whales were observed 50-100 km offshore between Point Franklin and Icy Cape (southeast corner of block 14 and northeasternmost area of block 17) in 2011 in an area where few gray whales have been seen in previous years (Moore 2000; Clarke et al. 2011d).

GRAY WHALE SIGHTING RATES

In summer and fall 2011, gray whales were seen from 68°N to 71.5°N and 156.5°W to 169°W. There were 131 gray whale sightings on transect, ranging from 1 whale per sighting (n = 92) to 5 whales per sighting (n = 2). The greatest number of sightings on transect was in Block 13 with 68 sightings, followed by block 17 with 41 sightings. The highest sighting rates per survey block were in block 13 (0.014 WPUE) and block 17 (0.012 WPUE) (Table 9). The highest monthly sighting rate was in July (0.012 WPUE) and the lowest was in October (0.003 WPUE).

The highest sighting rate per depth zone was in the 51-200 m North zone (0.012 WPUE) followed by the 51-200 m South zone (0.009 WPUE) (Table 10).

Areas of highest fine-scale sighting rates (number of transect sightings/transect km surveyed in 5 km grid cells) were west of Barrow, between Barrow and Point Franklin (in block 13), northwest of Wainwright (in block 17) and northwest of Point Lay (in block 18) (Figure 20).

Overall, the 2011 gray whale sighting rate of 0.0067 gray whales on transect/transect km flown was higher than that calculated for 1982-1991 (0.0052 WPUE) and 2008-2010 (0.0052 WPUE). Peak sighting rate per month was earlier in 2011 (July) than in previous years (Figure 21), dropping off substantially in August, September and October. Sighting rate per depth zone continued to be highest in the 51-200 m zones in both the northern and southern parts of the Chukchi Sea study area, a trend noted since aerial surveys recommenced in the northeastern Chukchi Sea in 2008 (Clarke et al. 2011d). The highest sighting rate per depth zone in 1982-1991 was in the deepest depth zone, 51-200 m, in the southern area, offshore of Point Hope, but highest in the shallowest depth zone (≤35 m) in the northern part of the study area.

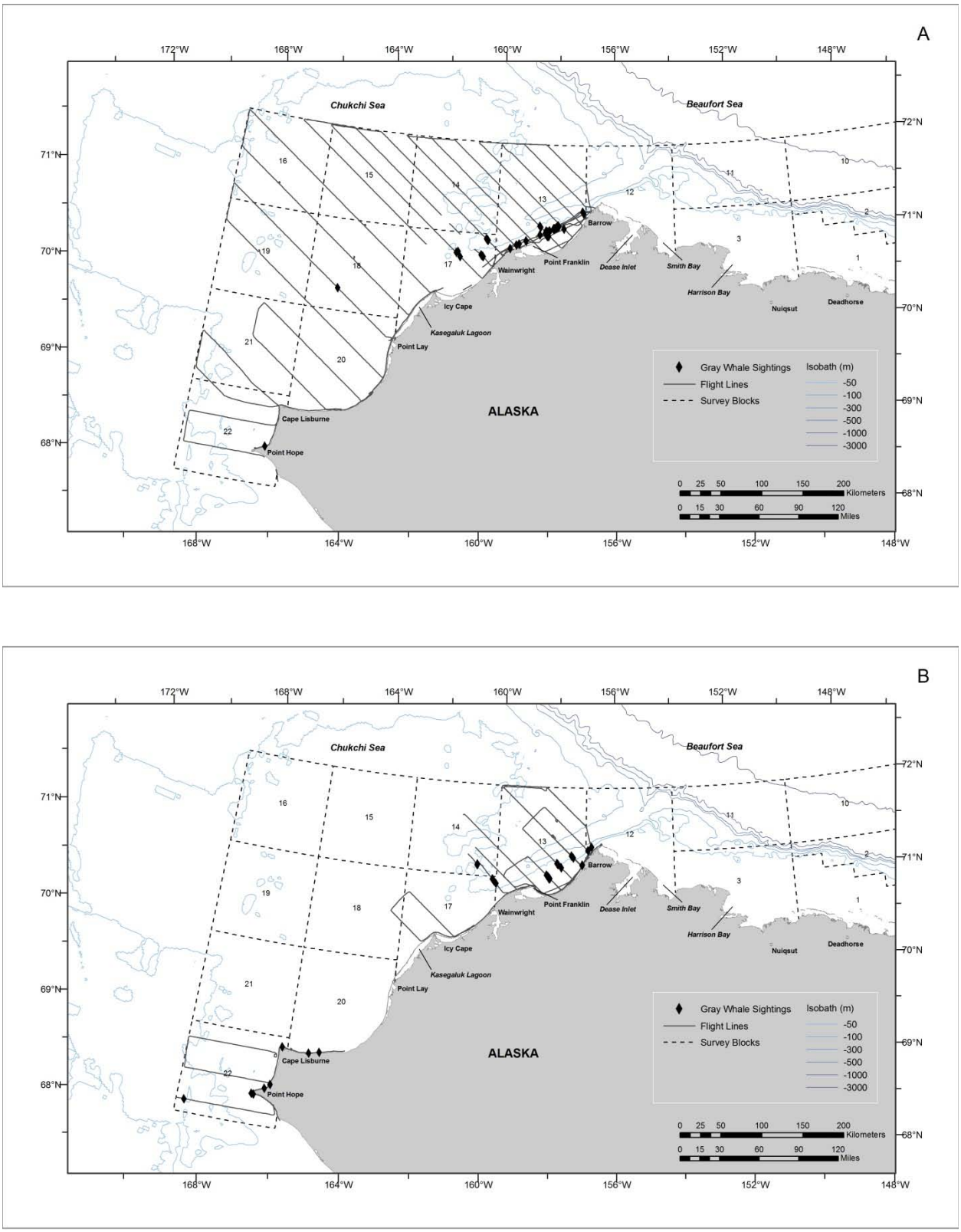


Figure 18. Bimonthly gray whale sightings, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown. A: 17-30 June; B: 1-15 July.

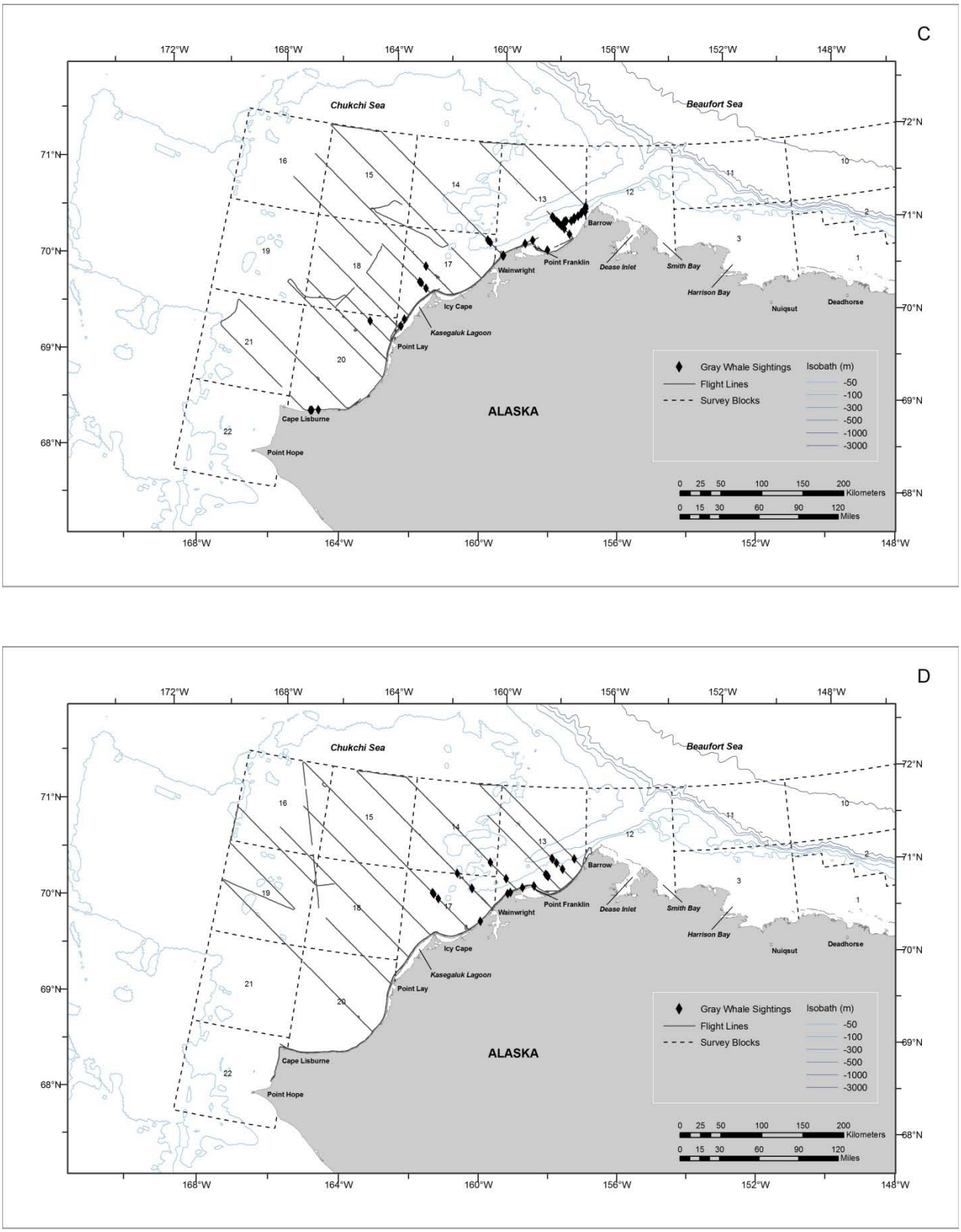
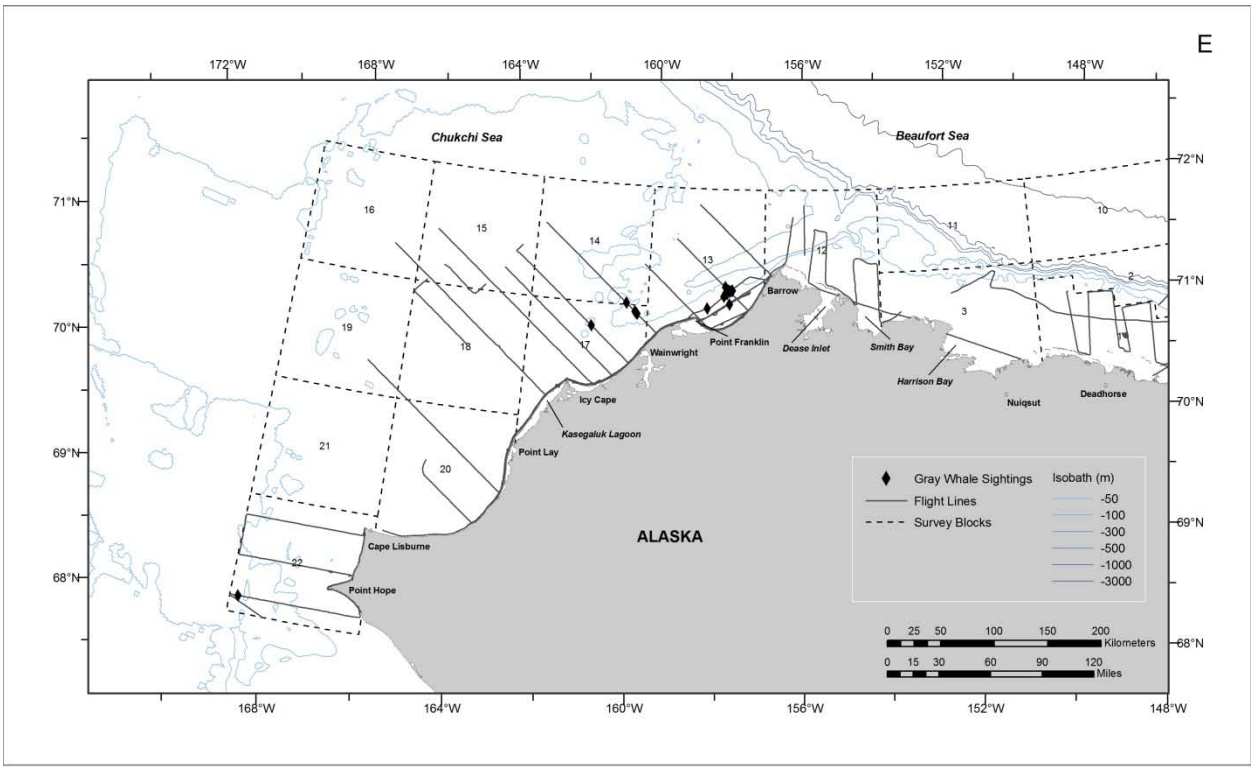


Figure 18 (cont). Bimonthly gray whale sightings, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown. C: 16-31 July; D: 1-15 August.



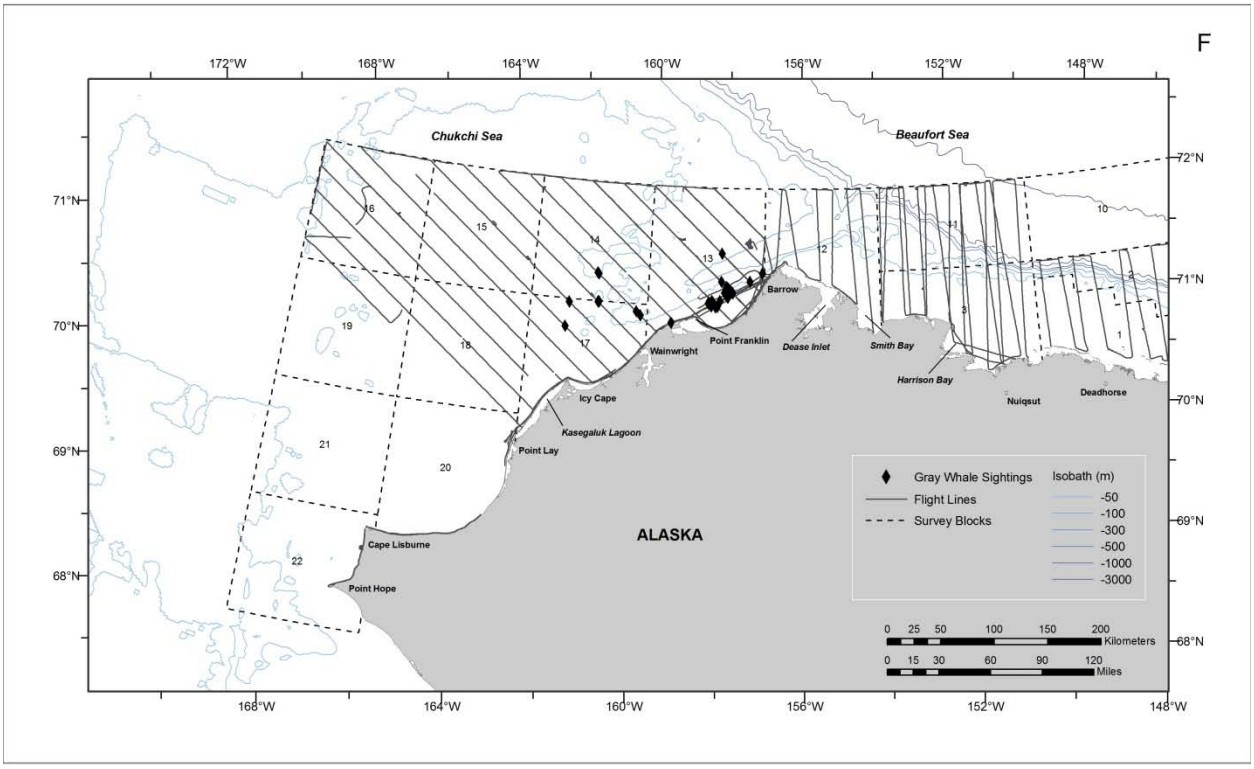
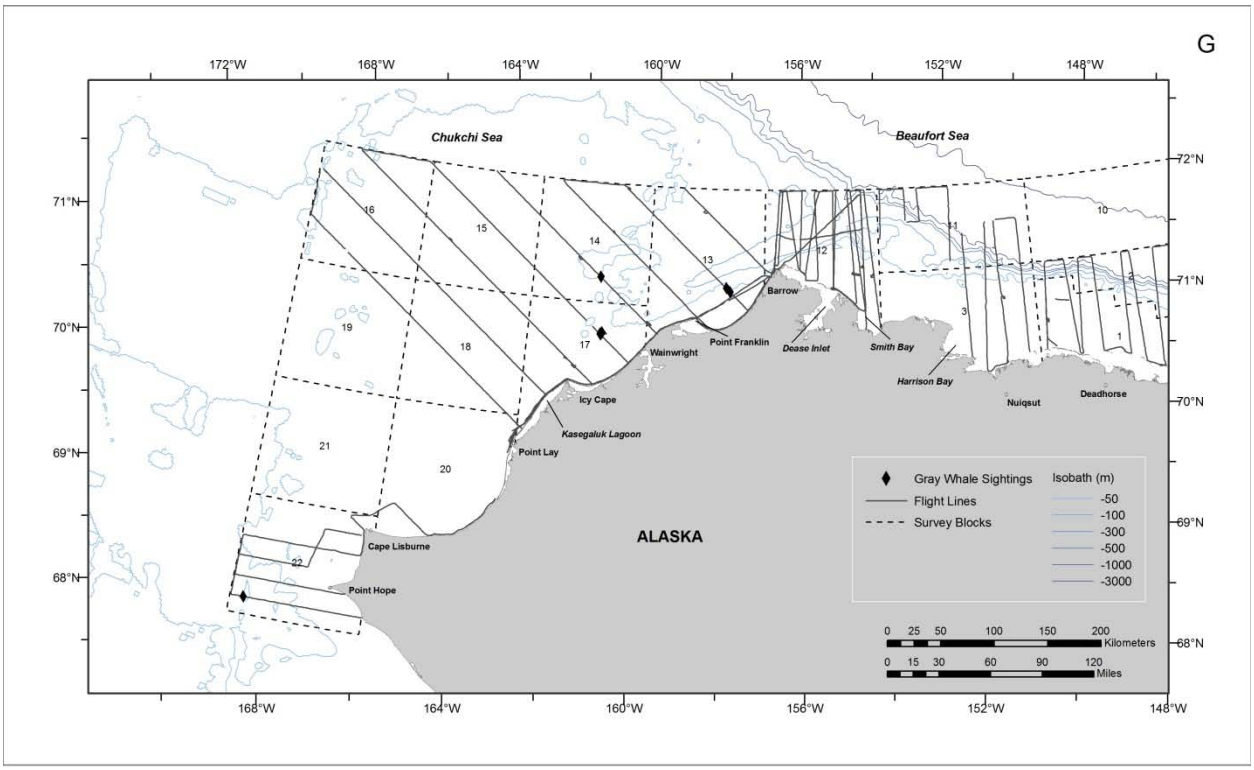


Figure 18 (cont). Bimonthly gray whale sightings, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown. E: 16-31 August; F: 1-15 September.



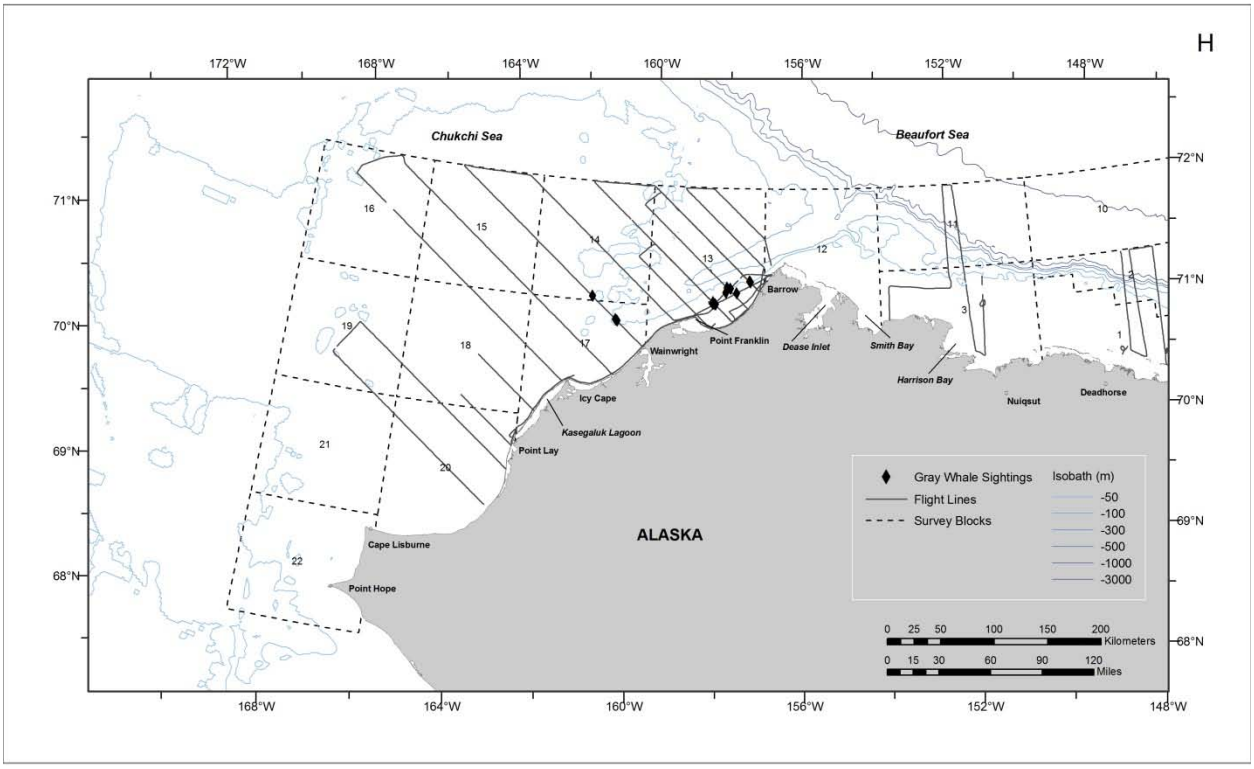


Figure 18 (cont). Bimonthly gray whale sightings, with transect, search and circling effort, 2011. Deadhead flight tracks are not shown. G: 16-30 September; H: 1-15 October.

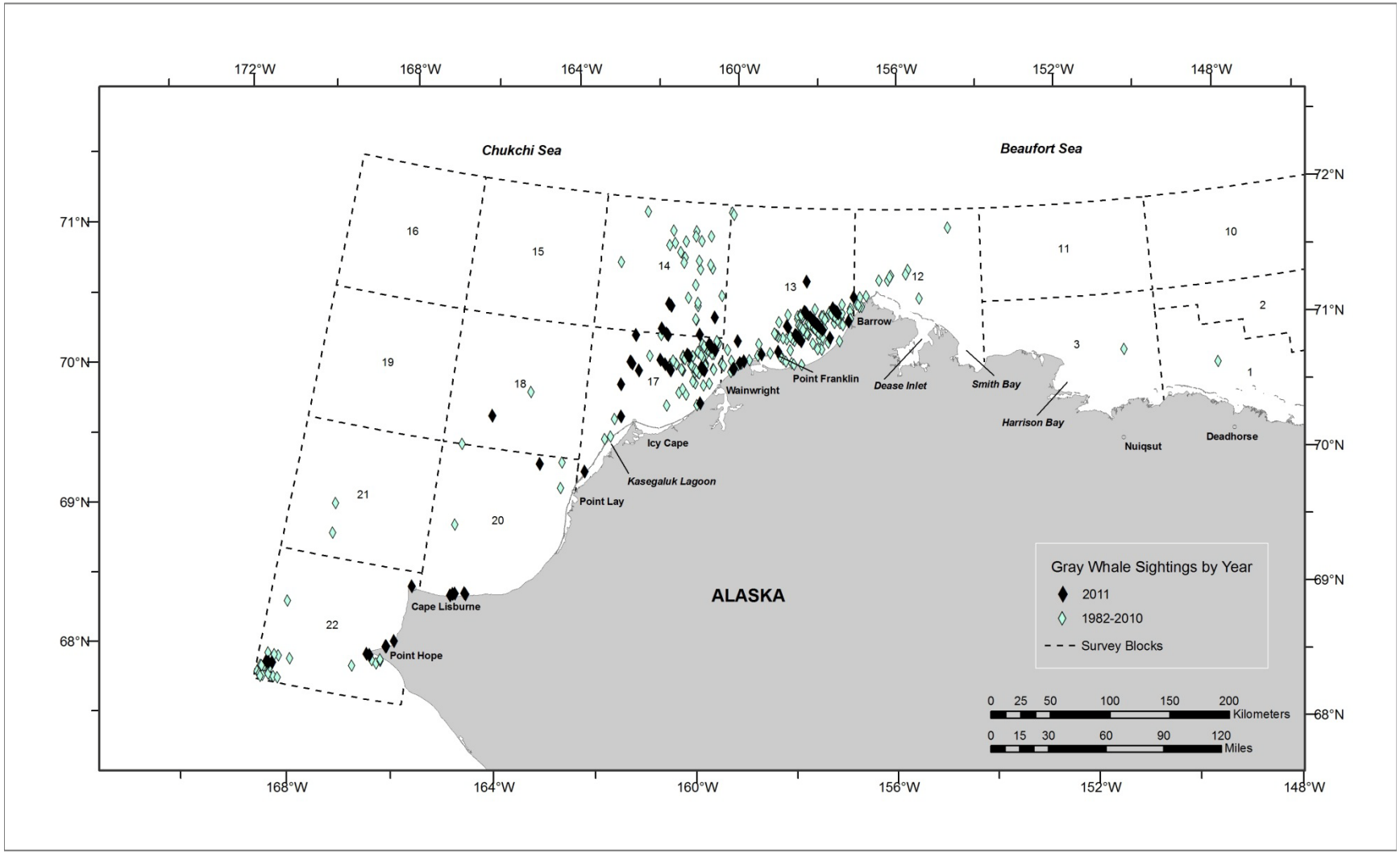


Figure 19. Gray whale sightings on transect in years with light sea ice cover: 1982, 1986, 1987, 1989, 1990, 1993-2010, and 2011. Surveys were not conducted in the northeastern Chukchi Sea from 1992-2007.

Table 9. Transect (Tr) effort (km), gray whale transect sightings and gray whale sighting rate (WPUE = gray whales per transect km surveyed) per survey block per month, 2011. NA – surveys were not conducted.

BLOCK	JUN Tr km	Tr Sightings	Tr Whales	WPUE	JUL Tr km	Tr Sightings	Tr Whales	WPUE	AUG Tr km	Tr Sightings	Tr Whales	WPUE
13	695	2	3	0.0043	1,474	23	34	0.0231	1,363	18	21	0.0154
14	590	0	0	0.0000	277	0	0	0.0000	630	3	5	0.0079
15	497	0	0	0.0000	311	0	0	0.0000	528	0	0	0.0000
16	315	0	0	0.0000	67	0	0	0.0000	226	0	0	0.0000
17	345	12	19	0.0550	927	6	9	0.0097	1,663	12	14	0.0084
18	317	1	1	0.0032	453	0	0	0.0000	520	0	0	0.0000
19	249	0	0	0.0000	31	0	0	0.0000	330	0	0	0.0000
20	530	0	0	0.0000	793	6	7	0.0088	1,075	0	0	0.0000
21	251	0	0	0.0000	196	0	0	0.0000	26	0	0	0.0000
22	333	1	1	0.0030	450	6	10	0.0222	503	1	1	0.0020
Total	**4,121**	**16**	**24**	**0.0058**	**4,979**	**41**	**60**	**0.0121**	**6,864**	**34**	**41**	**0.0060**

BLOCK	SEP Tr km	Tr Sightings	Tr Whales	WPUE	OCT Tr km	Tr Sightings	Tr Whales	WPUE	TOTAL Tr km*	Tr Sightings	Tr Whales	WPUE
13	2,089	20	27	0.0129	1,042	5	6	0.0058	6,662	68	91	0.0137
14	990	2	3	0.0030	318	1	2	0.0063	2,804	6	10	0.0036
15	923	0	0	0.0000	309	0	0	0.0000	2,567	0	0	0.0000
16	956	0	0	0.0000	109	0	0	0.0000	1,672	0	0	0.0000
17	1,290	9	14	0.0109	536	2	2	0.0037	4,762	41	58	0.0122
18	768	0	0	0.0000	197	0	0	0.0000	2,254	1	1	0.0004
19	208	0	0	0.0000	107	0	0	0.0000	924	0	0	0.0000
20	354	0	0	0.0000	284	0	0	0.0000	3,036	6	7	0.0023
21	0	NA	NA	NA	27	0	0	0.0000	500	0	0	0.0000
22	541	1	1	0.0018	0	NA	NA	NA	1,827	9	13	0.0071
Total	**8,117**	**32**	**45**	**0.0055**	**2,927**	**8**	**10**	**0.0034**	**27,008**	**131**	**180**	**0.0067**

* Total transect effort (Tr km) differs from values in Tables 2 and 10 because effort between barrier islands and the mainland was not included in the sighting rate per survey block analysis.

Table 10. Transect (Tr) effort (km), gray whale transect sightings and gray whale sighting rate (WPUE = gray whales per transect km surveyed) per depth zone per month, 2011. NA – surveys were not conducted.

	JUN Tr km	Tr Sightings	Tr Whales	WPUE	JUL Tr km	Tr Sightings	Tr Whales	WPUE	AUG Tr km	Tr Sightings	Tr Whales	WPUE
157W-169W												
0-35 m	950	1	1	0.0011	2,412	22	33	0.0137	3,339	10	13	0.0039
36-50 m	2,327	8	14	0.0060	1,562	10	13	0.0083	2,647	11	12	0.0045
51-200 m N	680	7	9	0.0132	865	8	12	0.0139	703	12	15	0.0213
51-200 m S	116	0	0	0.0000	98	1	2	0.0203	100	1	1	0.0100
TOTAL	**4,073**	**16**	**24**	**0.0059**	**4,937**	**41**	**60**	**0.0122**	**6,789**	**34**	**41**	**0.0060**

	SEP Tr km	Tr Sightings	Tr Whales	WPUE	OCT Tr km	Tr Sightings	Tr Whales	WPUE	TOTAL Tr km	Tr Sightings	Tr Whales	WPUE
157W-169W												
0-35 m	2,403	2	6	0.0025	992	1	1	0.0010	10,096	36	54	0.0053
36-50 m	4,188	21	28	0.0067	1,172	2	4	0.0034	11,895	52	71	0.0060
51-200 m N	1,327	8	10	0.0075	760	5	5	0.0066	4,335	40	51	0.0118
51-200 m S	120	1	1	0.0083	0	NA	NA	NA	435	3	4	0.0092
TOTAL	**8,038**	**32**	**45**	**0.0056**	**2,924**	**8**	**10**	**0.0034**	**26,761**	**131**	**180**	**0.0067**

* Total transect effort (Tr km) differs from values in Tables 2 and 9 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis.

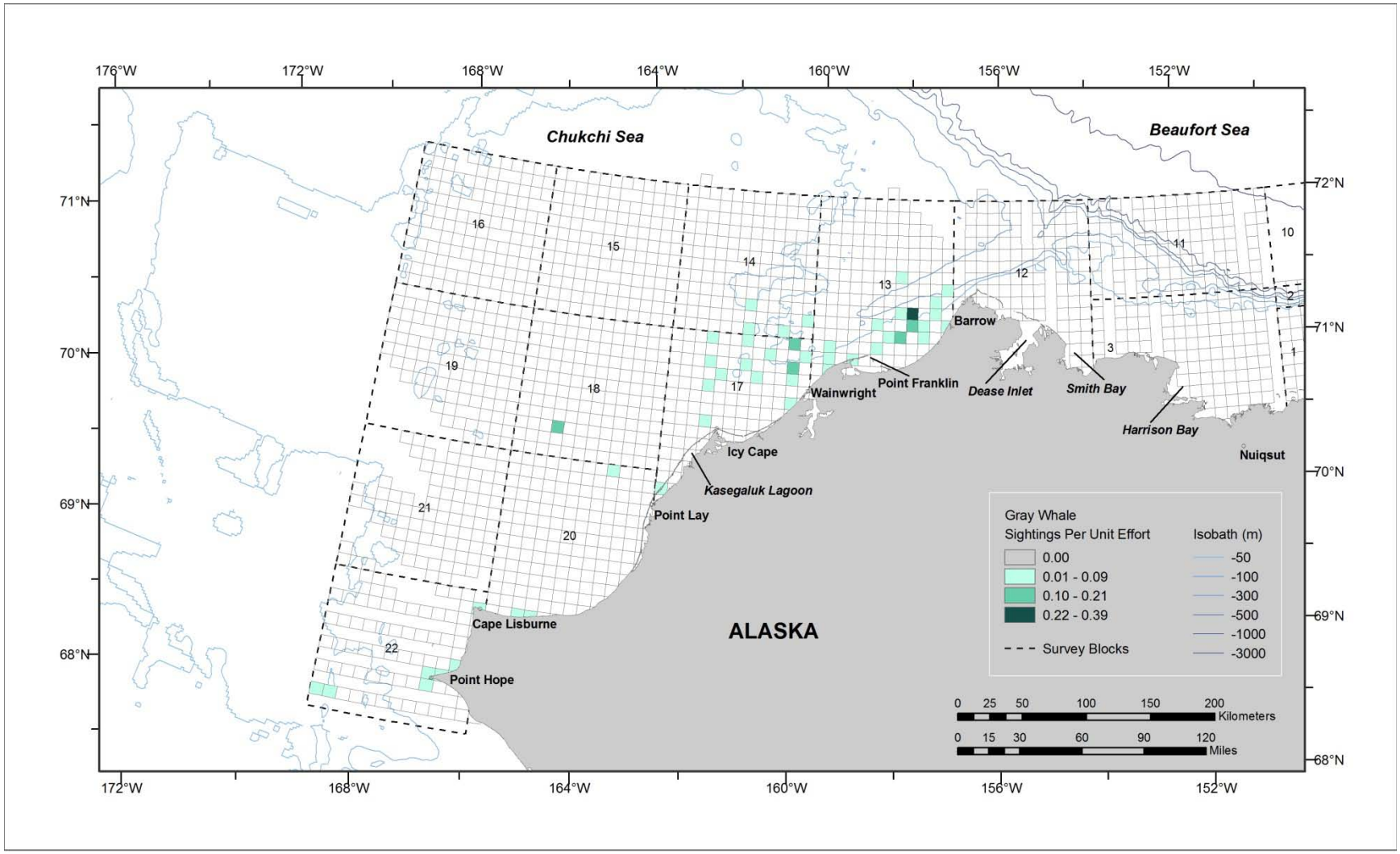


Figure 20. Sighting rates of gray whales, 2011 (gray whale sightings on transect/km of transect surveyed). Transect survey effort was not conducted in areas without grid cells.

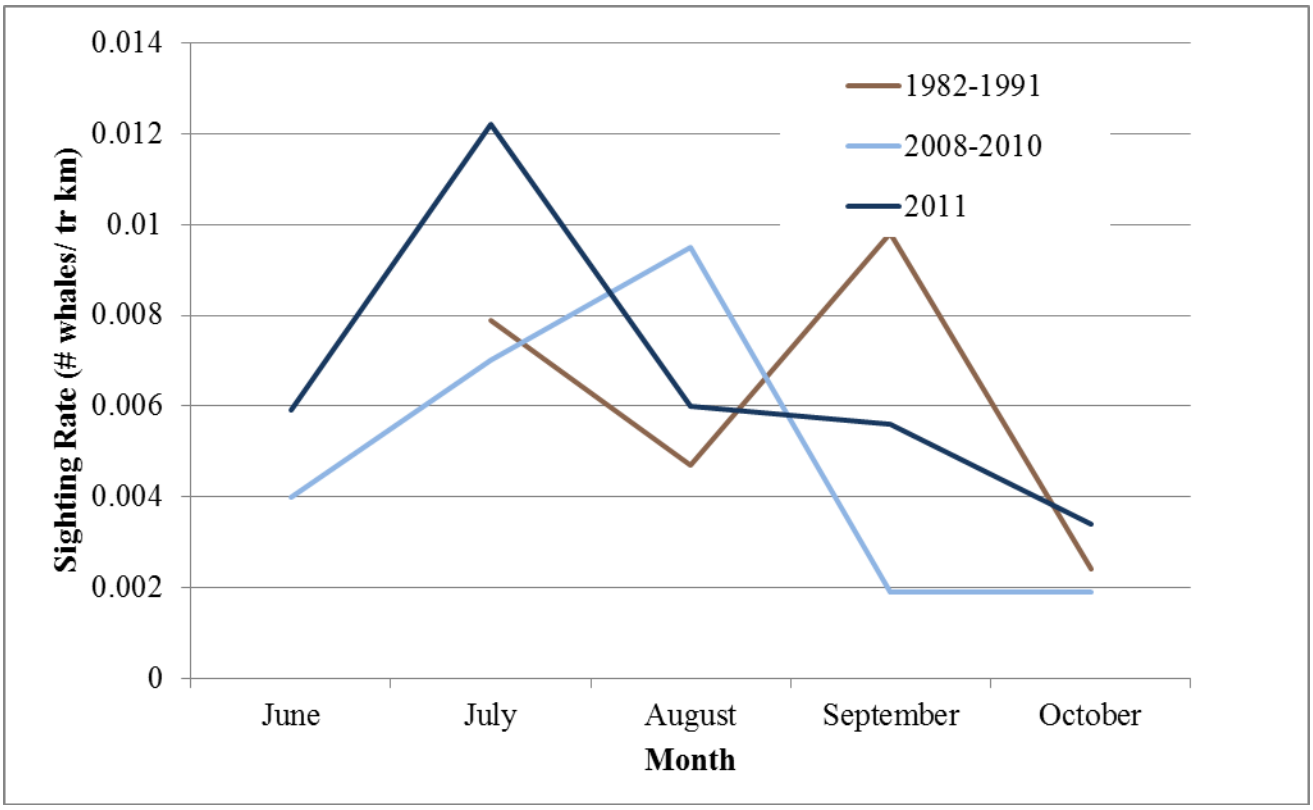


Figure 21. Monthly sighting rates (# whales per transect km) of gray whales on transect in the northeastern Chukchi Sea, 1982-1991, 2008-2010, and 2011.

Gray Whale Habitat Associations

Most gray whales (78%) were observed in 0% sea ice cover. Gray whales were observed in areas with sea ice cover in June (1-70% sea ice cover) and early July (1-10% sea ice cover), which were the only times ice was present in the area. Feeding behavior and calves were both observed in areas of 70% sea ice cover. Sea ice cover does not appear to be an impediment to gray whale occurrence.

Gray Whale Behaviors

Behaviors of 330 gray whales observed during all survey modes (transect, search and circling) in 2011 are summarized in Table 11. The behaviors most often recorded were feeding (62%) and swimming (26%). Milling was recorded for 8 whales (3%) and resting was recorded for 24 whales (7%). Fine scale sighting rates of feeding and milling gray whales observed on transect are shown in Figure 22.

Eighteen gray whale calves were seen in 2011 (Figure 23); the seasonal calf ratio (number of calves/number of total whales) was 0.055 which is higher than calf ratios in recent years (2008 = 0.005; 2009 = 0.026; 2010 = 0.000). Gray whale calf occurrence in the Alaskan Chukchi Sea is

Table 11. Monthly summary of gray whales (number of sightings/number of individuals) observed during all survey modes (transect, search and circling), by behavioral category, 2011. Excludes dead and repeat sightings.

Behavior	17-30 Jun	1-15 Jul	16-31 Jul	1-15 Aug	16-31 Aug	1-15 Sep	16-30 Sep	1-15 Oct	Total
Dive	1/1	0	0	0	0	2/2	0	0	3/3 (1%)
Feed	34/46	23/35	17/26	14/15	18/21	33/45	4/8	7/8	150/204 (62%)
Mill	4/4	1/1	1/1	1/2	0	0	0	0	7/8 (3%)
Rest	2/3	2/4	5/12	1/2	1/1	2/2	0	0	13/24 (7%)
Swim	10/15	8/12	16/26	6/9	1/1	10/14	2/2	7/8	60/87 (26%)
Not recorded	0	0	0	0	0	0	1/4	0	1/4 (1%)
TOTAL	51/69	34/52	39/65	22/28	20/23	47/63	7/14	14/16	234/330

inconsistent between years. In the 14 years that aerial surveys have been conducted with some regularity (1982-1991, 2008-2011), gray whale calves have been seen in only 9 of those years and more than one gray whale calf per year has been documented in only 4 of the fourteen years (Clarke et al. 1989; Clarke et al. 2011d). No gray whale calves were seen in 2010 despite similar effort to 2011. Calf distribution overlapped that of adult gray whales both temporally and spatially in 2011. Most calves were within 25 km of shore, but five calves were slightly farther offshore. One calf was observed in the westernmost part of block 22, where gray whales have been regularly sighted in previous years. Five calves were observed in June, eight calves in July, four calves in August and one calf in September. On two occasions (8 July and 2 August), 3 calves were seen during a single survey flight. Some calves may have been sighted on more than one day.

Gray whale swim direction was not significantly clustered about any mean heading for either summer (June-August) or fall (September-October) time periods. Most gray whales observed during ASAMM are at the far northern extent of the species' range so a lack of directed migratory movement is not surprising.

One gray whale, representing <1% of all gray whales sighted, appeared to respond to the survey aircraft.

Minke Whales

There were five sightings of six minke whales (*Balaenoptera acutorostrata*) in 2011, and four sightings of five unidentified cetaceans that were probable or possible minke whales (Figure 24). Four minke whales were seen in July, three east of Cape Lisburne and one offshore in block 18. One minke whale was seen in August, east of Point Franklin and very close to shore. One minke whale was seen in September at 71.89°N, 163°W; this is thought to be the farthest north documented minke whale in the northeastern Chukchi Sea. Four unidentified cetaceans that

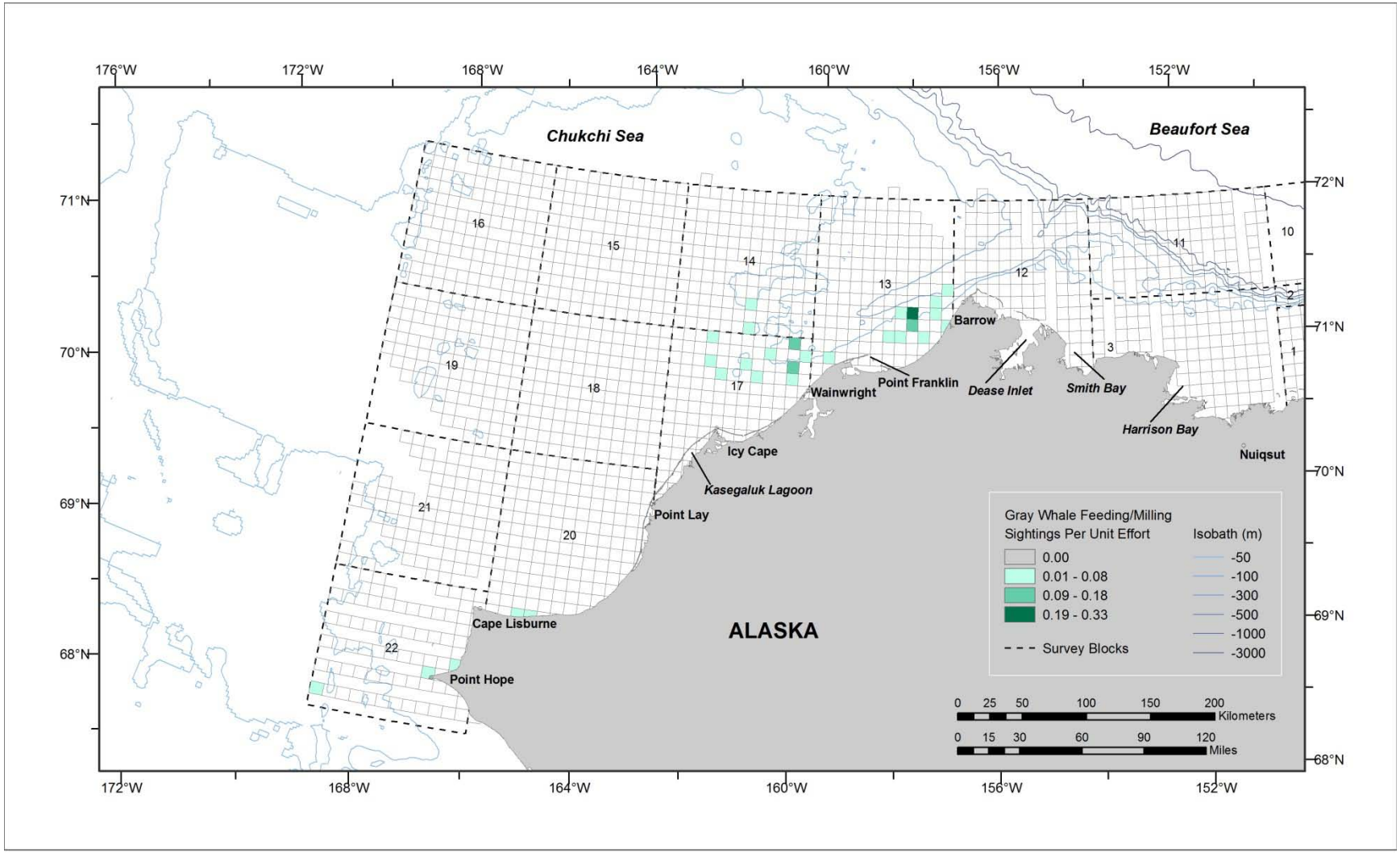


Figure 22. Sighting rates of feeding and milling gray whales, 2011 (gray whale sightings on transect/km of transect surveyed). Transect survey effort was not conducted in areas without grid cells.

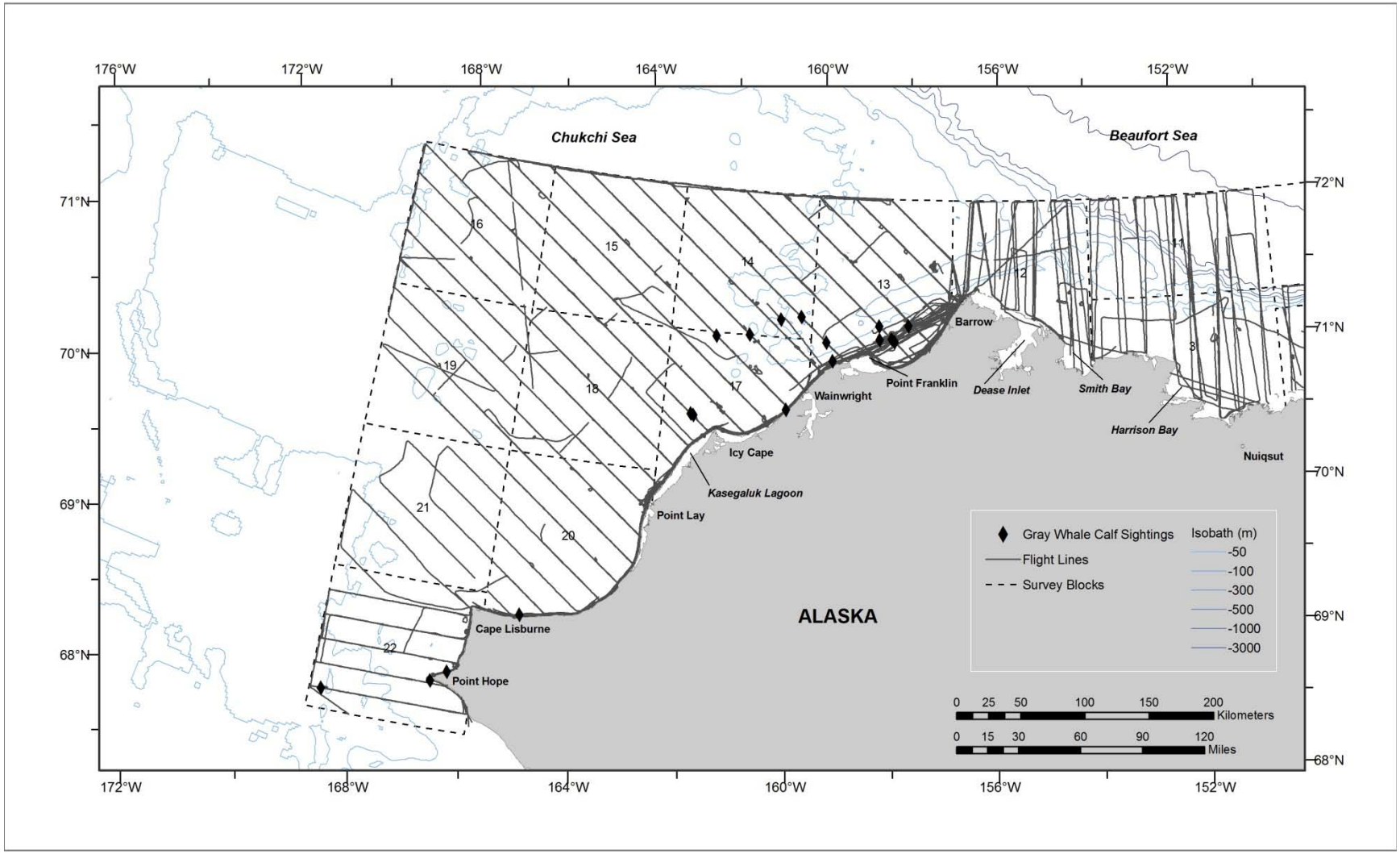


Figure 23. Gray whale calves, with transect, search, and circling effort, 2011. Deadhead flight tracks are not shown.

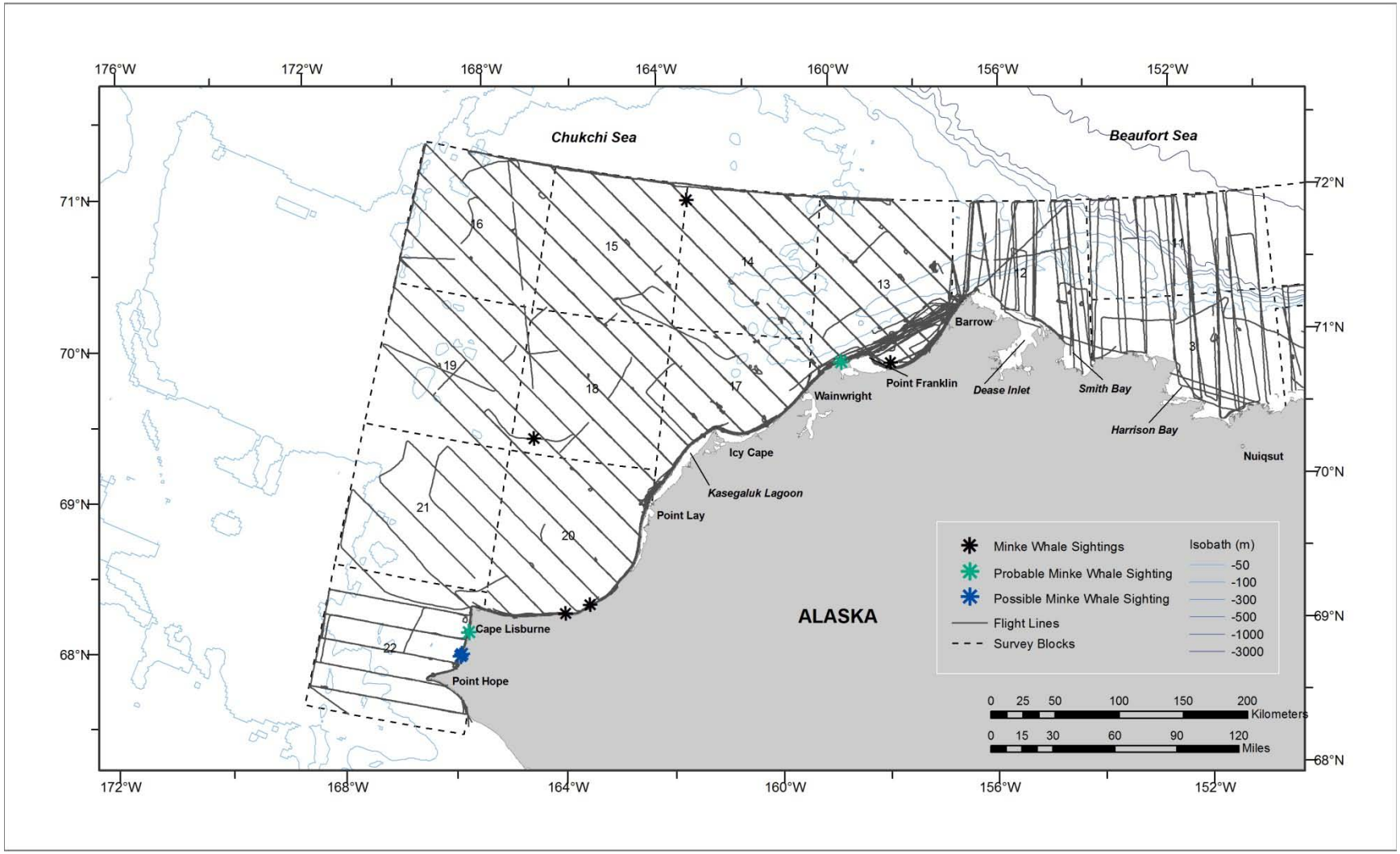


Figure 24. Minke whale sightings, with transect, search, and circling effort, 2011. Unidentified cetacean sightings identified as probable or possible minke whales are also shown. Deadhead flight tracks are not shown.

were probable/possible minke whales were sighted in August and September between Cape Lisburne and Point Hope. The other unidentified cetacean that was a probable minke whale was sighted in August just west of Point Franklin, and could potentially be a resighting of the confirmed minke whale sighting east of Point Franklin in early August. All confirmed/possible minke whales sighted were rather elusive, did not stay at the surface very long, and/or did not have conspicuous blows. None of the confirmed/possible/probable minke whales were in the vicinity of other cetaceans. None of the confirmed/possible/probable minke whales appeared to respond to the survey aircraft.

Minke whales were not previously sighted in the northeastern Chukchi Sea study area during aerial surveys conducted in 1982-1991 (Moore and Clarke 1992), 2008-2010 (Clarke et al. 2011d) or 2006-2010 (Thomas et al. 2011). They were also not sighted during the 2009 Joint Russian-American Long-term Census of the Arctic (RUSALCA; Anonymous 2009) or the 2010 and 2011 Chukchi Acoustic, Oceanographic and Zooplankton (CHAOZ; B. Rone, NMML-AFSC, pers. comm. to Janet Clarke, 14 November 2011) cruises. However, sightings of minke whales are becoming increasingly frequent in the eastern Chukchi Sea, especially south of Point Lay. Dave Roseneau, of the U.S. Fish and Wildlife Service (USFWS), reported seeing 1to 3 minke whales per year near Cape Lisburne from 1995-2009 (pers. comm. to Jeffrey Denton, BOEM, 15 October 2010). Brueggeman (2010) reported two minke whales in the CSPA in summer 2009, near 71°N. Marine mammal observers on seismic and other ships in the Chukchi Sea reported observations of 59 minke whales during summer 2006-2010, although locations of sightings were not provided (Hartin et al. 2011). One minke whale was sighted in early September during vessel surveys conducted within the CSPA in 2011 (L. Aerts, LAMA Ecological, pers. comm. to Janet Clarke, 15 November 2011; D. Ireland, LGL Alaska Research Associates, Inc., pers. comm. to Janet Clarke, 16 November 2011).

Unidentified Cetaceans and Unidentified Marine Mammals

There were 19 sightings of 23 unidentified cetaceans in 2011 (Figure 25). Sightings were recorded as unidentified whenever 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, or glare, prevented circling to relocate the initial sighting. Twenty-one of the unidentified cetaceans were in the northeastern Chukchi Sea, and two unidentified cetaceans were in the Alaskan Beaufort Sea. Five of the unidentified cetaceans were probable or possible minke whales, based on the initial brief observation of relative size and coloration. Three of the unidentified cetaceans were probable gray whales, including one calf, based on their close proximity to other gray whales, relative size, and the presence of well-defined mud plumes. The remaining 15 unidentified cetaceans were not seen clearly enough to identify to species with any probability.

There were also 6 sightings of 14 unidentified marine mammals. One of these sightings was either a beluga or swimming polar bear, sighted near a barrier island east of Cross Island. Circling was not initiated to prevent any potential negative impacts if the sighting were a swimming polar bear, in accordance with survey protocol. The other five sightings, including

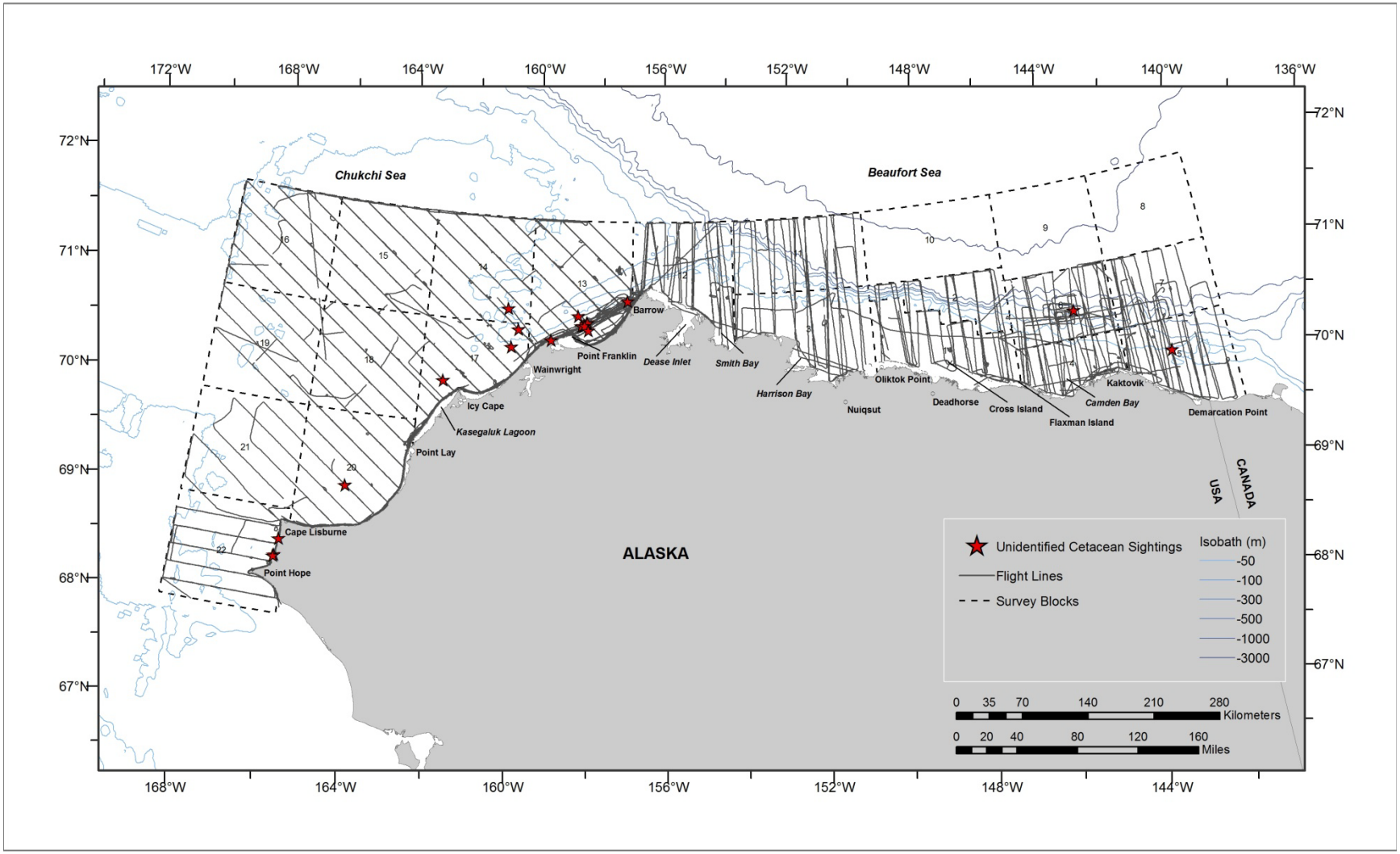


Figure 25. Unidentified cetacean sightings, with transect, search, and circling effort, 2011. Deadhead flight tracks are not shown.

two sightings of 5 animals each, were not seen closely enough to identify to species with any probability.

Belugas

Beluga Sighting Summary

During the 2011 surveys, 299 sightings of 1,508 belugas (*Delphinapterus leucas*) were observed during all survey modes (transect, search and circling) in the study area (Table 3). Beluga sightings in the Chukchi Sea were scattered both offshore and relatively nearshore in June, September and October; were consistently closer to shore (within ~100 km) in July; they were almost exclusively along the northwestern Alaskan coast in August (Figure 26). In the Alaskan Beaufort Sea, belugas were seen along the continental slope in all months surveyed (July through October), with scattered sightings nearshore. Belugas were also seen near Barrow Canyon from July through October.

Beluga distribution in 2011 was generally similar to that documented in previous years, particularly in the Alaskan Beaufort Sea (Figure 27). In the northeastern Chukchi Sea, there were very few belugas sighted from 1982-1991 and 2008-2010, particularly in the summer months (Moore et al. 2000; Clarke et al. 2011d). Conversely, in 2011, belugas were distributed throughout the Chukchi Sea study area in all months, and large groups (>150 whales) were seen on multiple occasions near the coast south of Point Lay in June and mid-July. There were more sightings in 2011 (299) than in 2008-2010 combined (153) in the ASAMM study area.

Aerial survey effort conducted north of the current ASAMM study area from 1989-1991 (Moore and Clarke, 1992) and results from beluga satellite tagging efforts (Suydam et al. 2001) indicated that belugas regularly traversed the northeastern Chukchi and Alaskan Beaufort Seas much farther north than the current ASAMM study area. It is therefore likely that ASAMM effort does not document the full extent of beluga occurrence and habitat use. However, distribution patterns south of 72°N have remained remarkably similar over the past 30 years, particularly in the Alaskan Beaufort Sea. In the northeastern Chukchi Sea, data collected in 2011 added considerably to the existing understanding of beluga distribution, particularly during summer months. The large groups of belugas seen south of Point Lay in late June and early July 2011 were not seen in 2008-2010, and were reminiscent of large beluga groups seen during surveys conducted in the late 1970s through the early 1990s (Frost et al. 1993; Frost and Lowry 1990), although group sizes were smaller in 2011.

Beluga Sighting Rates

In summer and fall 2011, belugas were seen from 68.3°N to 72°N between 140.8°W and 169°W. There were 214 beluga sightings on transect, ranging from 1 beluga per sighting (n = 141) to 180 belugas per sighting (n = 1). The highest number of sightings on transect per survey block was in block 11 (37 sightings), followed by blocks 2 and 12 (28 sightings each). The highest beluga

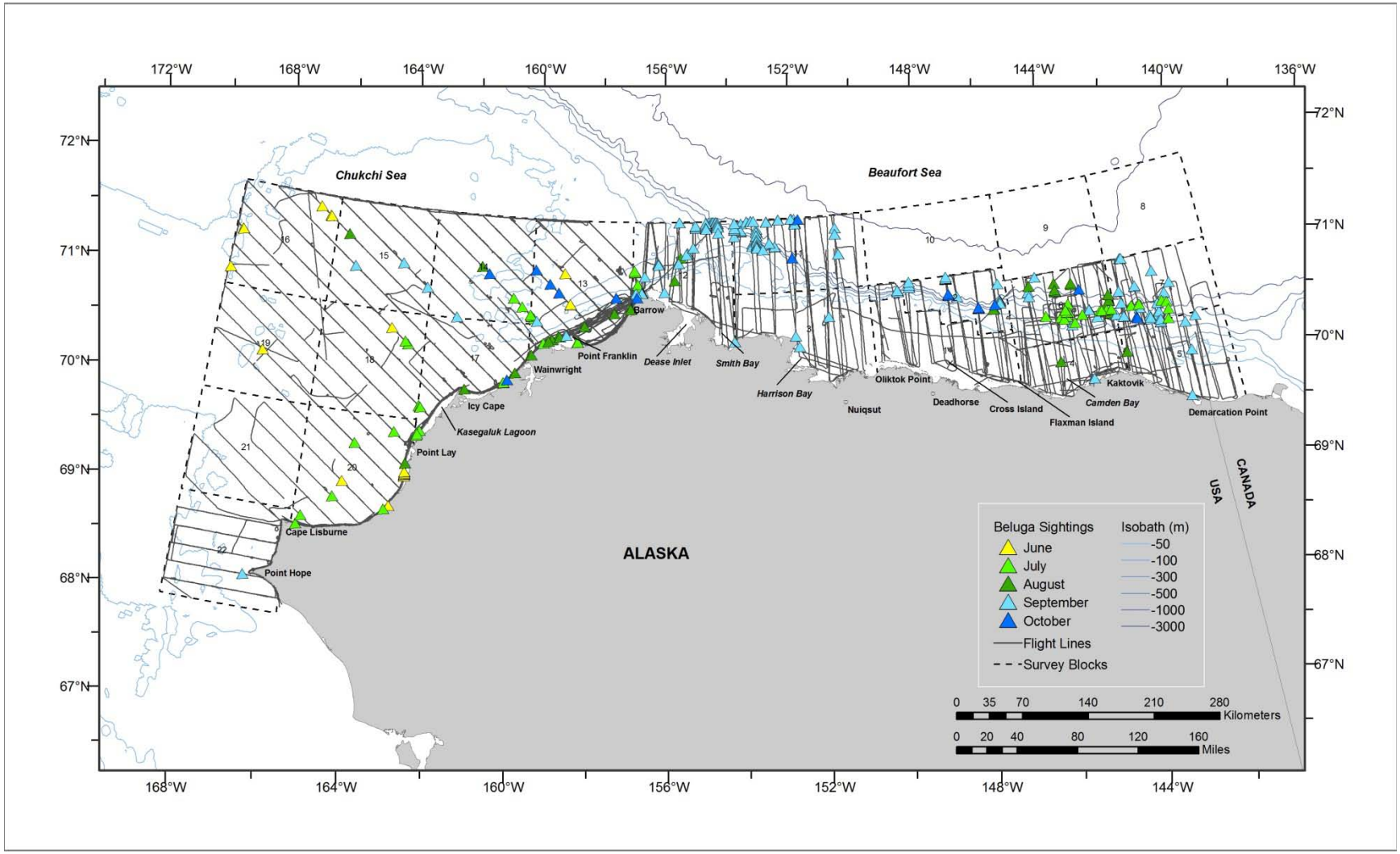


Figure 26. Beluga sightings plotted by month, with transect, search, and circling effort, 2011. Deadhead flight tracks are not shown.

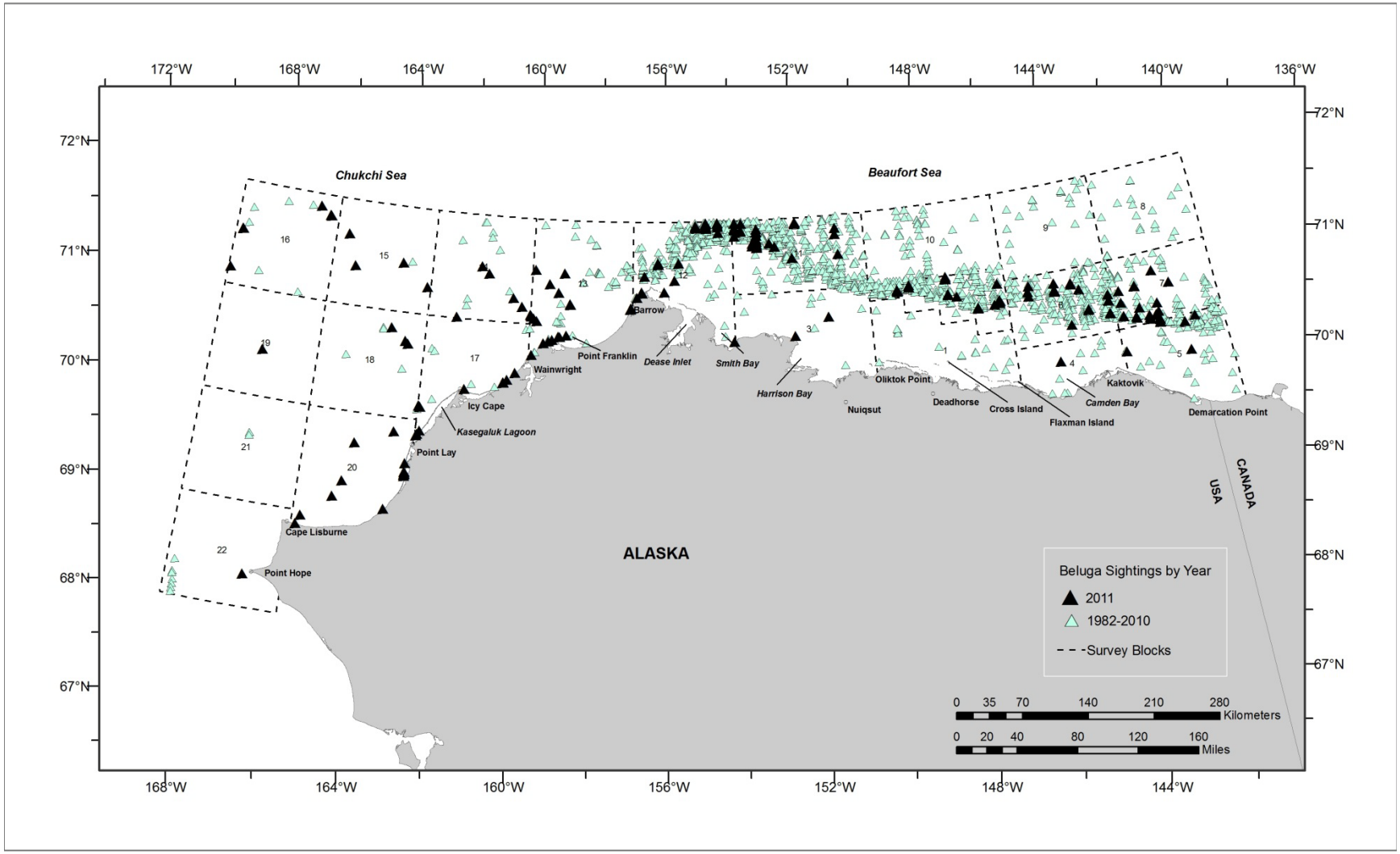


Figure 27. Beluga sightings on transect in years with light sea ice cover: 1982, 1986, 1987, 1989, 1990, 1993-2010, and 2011.

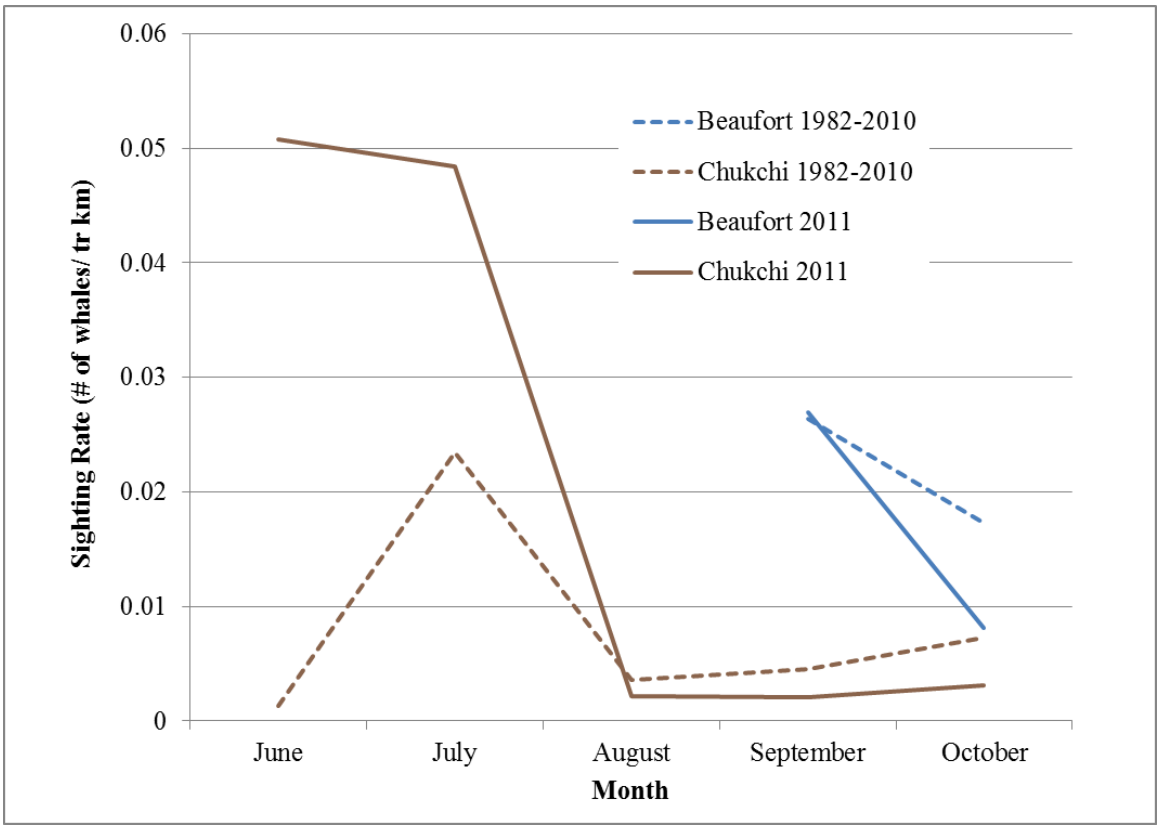


Figure 28. Monthly sighting rates (# whales per transect kilometer) of belugas on transect in the Alaskan Beaufort and northeastern Chukchi Seas, 1982-2010 and 2011.

sighting rate in 2011 occurred during summer (June and July), declined sharply in August and remained low in fall (September and October) (Figure 28). Areas of highest fine-scale sighting rates (number of transect sightings/transect km surveyed in 5 km grid cells) were along the slope in the Alaskan Beaufort Sea (in blocks 2, 11, and 12) (Figure 29). In the northeastern Chukchi Sea, there were no particular areas of highest sighting rates due to the scattered sightings throughout the study area.

In 2011, beluga sighting rate per depth zone was highest in the 201-2000 m depth zone near Barrow Canyon and in the >2000 m depth zone in the Alaskan Beaufort Sea (Table 12). In the northeastern Chukchi Sea, beluga sighting rate per depth zone was highest in the ≤35 m depth zone. Sighting rates in 2011 followed similar trends to those documented previously in the same areas.

BELUGA HABITAT ASSOCIATIONS

Most belugas (97%) were observed in 0% sea ice cover. Belugas were observed in association with sea ice cover (1-50% sea ice cover) in June through mid-July, the only time ice was present in the study area.

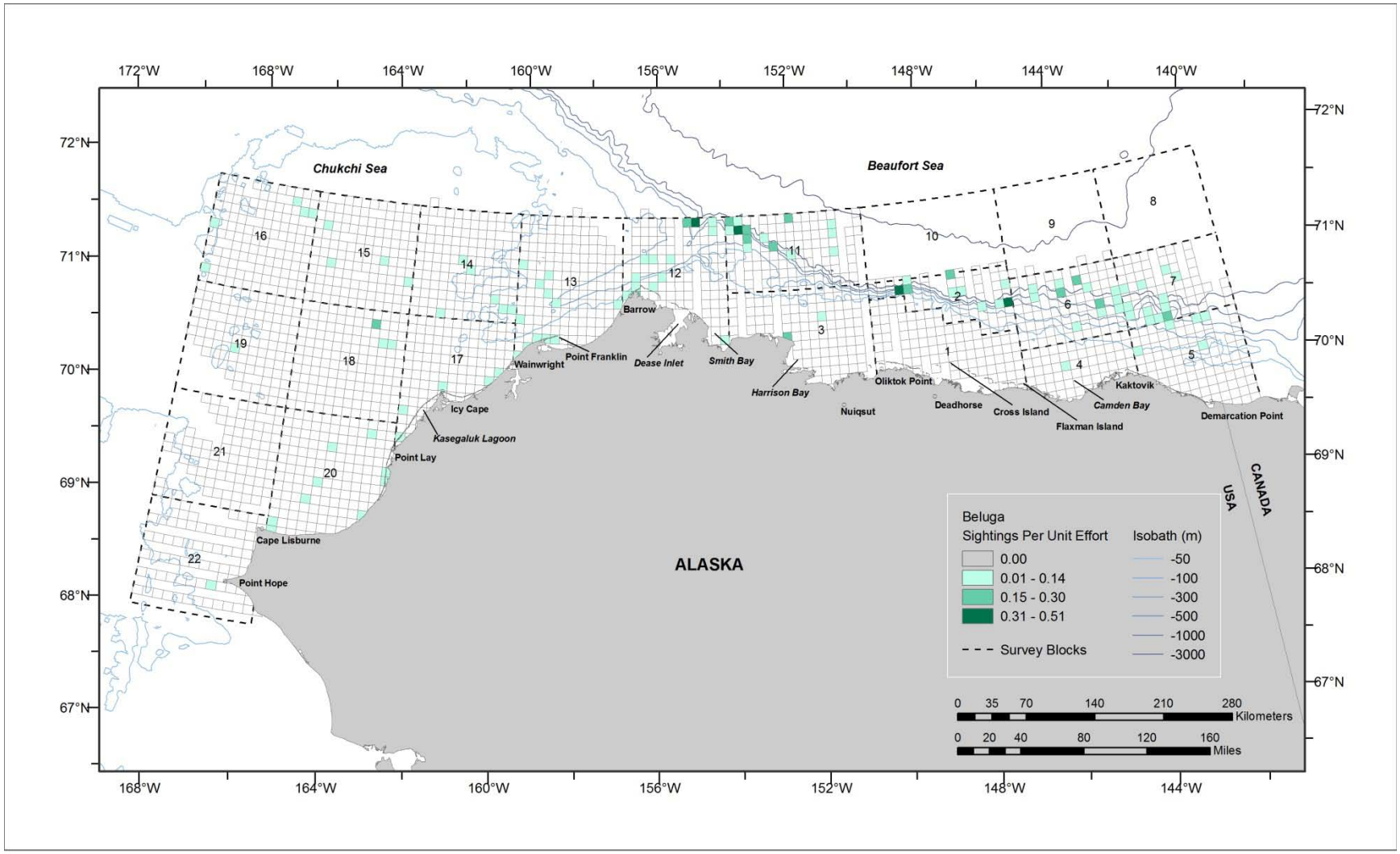


Figure 29. Sighting rates of belugas, 2011 (beluga sightings on transect/km of transect surveyed). Transect survey effort was not conducted in areas without grid cells.

Table 12. Transect (Tr) effort (km), beluga transect sightings and beluga sighting rate (WPUE = belugas per transect km surveyed) per depth zone per month, 2011. NA – surveys were not conducted.

	JUN Tr km	Tr Sightings	Tr Belugas	WPUE	JUL Tr km	Tr Sightings	Tr Belugas	WPUE	AUG Tr km	Tr Sightings	Tr Belugas	WPUE
157W-169W												
0-35 m	950	7	162	0.1706	2412	17	225	0.0933	3339	11	12	0.0036
36-50 m	2327	6	6	0.0026	1562	2	2	0.0013	2647	2	3	0.0011
51-200 m N	680	5	39	0.0574	865	6	12	0.0139	703	0	0	0.0000
51-200 m S	116	0	0	0.0000	98	0	0	0.0000	100	0	0	0.0000
154W-157W												
0-20 m	0	NA	NA	NA	0	NA	NA	NA	99	1	1	0.0101
21-50 m	0	NA	NA	NA	0	NA	NA	NA	70	0	0	0.0000
51-200 m	0	NA	NA	NA	0	NA	NA	NA	101	0	0	0.0000
201-2,000 m	0	NA	NA	NA	0	NA	NA	NA	5	0	0	0.0000
140W-154W												
0-20 m	0	NA	NA	NA	0	NA	NA	NA	164	0	0	0.0000
21-50 m	0	NA	NA	NA	0	NA	NA	NA	711	2	3	0.0042
51-200 m	0	NA	NA	NA	0	NA	NA	NA	173	0	0	0.0000
201-2,000 m	0	NA	NA	NA	0	NA	NA	NA	331	12	62	0.1872
>2,000 m	0	NA	NA	NA	0	NA	NA	NA	28	0	0	0.0000
TOTAL	**4,073**	**18**	**207**	**0.0508**	**4,937**	**25**	**239**	**0.0484**	**8,470**	**28**	**81**	**0.0096**

	SEP Tr km	Tr Sightings	Tr Belugas	WPUE	OCT Tr km	Tr Sightings	Tr Belugas	WPUE	TOTAL Tr km*	Tr Sightings	Tr Belugas	WPUE
157W-169W												
0-35 m	2,403	2	10	0.0042	992	1	1	0.0010	10,096	38	410	0.0406
36-50 m	4,188	4	6	0.0014	1,172	1	1	0.0009	11,895	15	18	0.0015
51-200 m N	1,327	1	1	0.0008	760	3	7	0.0092	4,335	15	59	0.0136
51-200 m S	120	0	0	0.0000	0	NA	NA	NA	435	0	0	0.0000
154W-157W												
0-20 m	354	2	2	0.0056	33	0	0	0.0000	487	3	3	0.0062
21-50 m	351	3	7	0.0199	23	1	1	0.0444	444	4	8	0.0180
51-200 m	797	5	5	0.0063	0	NA	NA	NA	898	5	5	0.0056
201-2,000 m	173	16	39	0.2253	0	NA	NA	NA	178	16	39	0.2190
140W-154W												
0-20 m	1,014	1	2	0.0020	197	0	0	0.0000	1,375	1	2	0.0015
21-50 m	2,589	2	2	0.0008	531	0	0	0.0000	3,831	4	5	0.0013
51-200 m	1,601	10	16	0.0100	304	3	4	0.0132	2,077	13	20	0.0096
201-2,000 m	1,966	67	110	0.0560	434	7	8	0.0184	2,731	86	180	0.0659
>2,000 m	537	14	69	0.1284	93	0	0	0.0000	658	14	69	0.1049
TOTAL	**17,421**	**127**	**269**	**0.0154**	**4,538**	**16**	**22**	**0.0048**	**39,438**	**214**	**818**	**0.0207**

* Total transect effort (Tr km) differs from values in Table 2 because effort between barrier islands and the mainland was included in the sighting rate per depth zone analysis.

Table 13. Monthly summary of belugas (number of sightings/number of individuals) observed during all survey modes (transect, search and circling), by behavioral category, 2011. Excludes dead and repeat sightings.

Behavior	17-30 Jun	1-15 Jul	16-31 Jul	1-15 Aug	16-31 Aug	1-15 Sep	16-30 Sep	1-15 Oct	16-24 Oct	Total
Dive	0	1/1	0	0	0	2/2	0	0	0	3/3 (<1%)
Feed	1/400	0	0	0	0	0	0	0	0	1/400 (26%)
Mill	2/151	1/4	5/197	0	0	0	0	1/5	0	9/357 (24%)
Rest	0	10/16	1/1	1/1	4/14	38/104	19/50	5/5	1/1	79/192 (13%)
Roll	0	0	0	1/2	0	0	0	0	0	1/2 (<1%)
Swim	17/57	26/43	16/135	6/7	21/66	61/149	48/84	11/13	0	206/554 (37%)
TOTAL	20/608	38/64	22/333	8/10	25/80	101/255	67/134	17/23	1/1	299/1,508

BELUGA BEHAVIORS

Behaviors of belugas observed during all survey modes (transect, search and circling) in 2011 are summarized in Table 13. The behavior most often recorded was swimming (37%). Milling was recorded for 357 belugas (24%), including 1 group of 150 belugas in which feeding was also noted. One group of 400 belugas, observed on 25 June south of Point Lay, was feeding.

Swim direction was evaluated for all "swimming" 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 the summer months (June-August) was 107°T but headings were not significantly clustered ($Z = 1.29$, $P = 0.277$). In fall months in the northeastern Chukchi Sea, the mean vector swim direction was 64°T and also not significantly clustered ($Z = 2.33$, $P = 0.097$). Swim direction was also not clustered around a mean heading for belugas in the Alaskan Beaufort Sea (140°W-154°W; mean vector = 325°T, $Z = 0.389$, $P = 0.677$).

There were 29 sightings of 155 beluga calves, including 13 cow-calf pairs, observed during all survey modes (transect, search and circling). Beluga calves were scattered throughout the Beaufort and Chukchi Seas (Figure 30), although none were seen in the offshore survey blocks of the Chukchi Sea. Calves were seen throughout summer and fall, although none were seen during October. Beluga calves are likely underrepresented in the dataset because of their small size and the infrequency of circling over beluga sightings.

One beluga (<1% of all belugas sighted) appeared to respond to the survey aircraft.

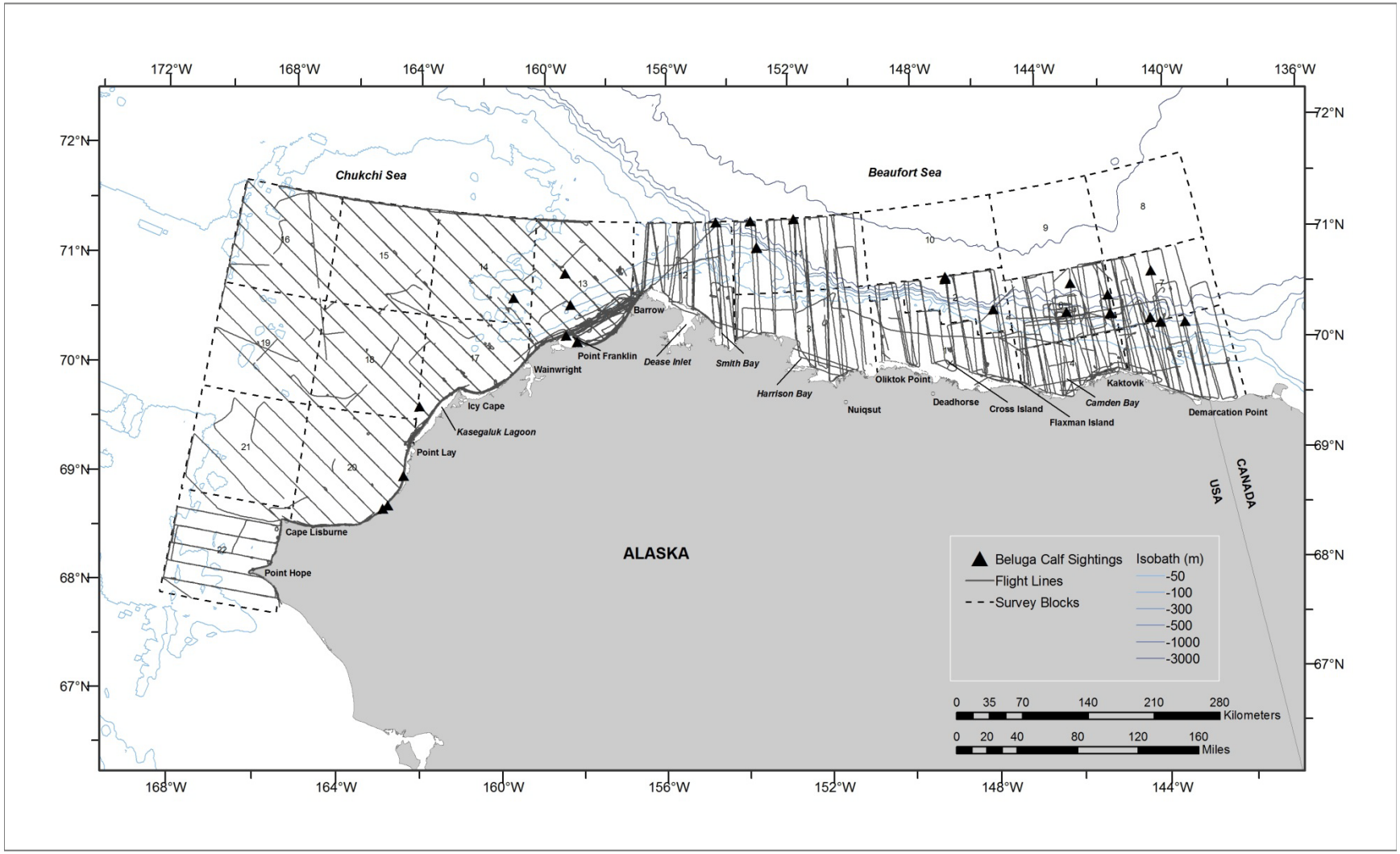


Figure 30. Beluga calves, with transect, search, and circling effort, 2011. Deadhead flight tracks are not shown.

Pinnipeds

Walruses

Pacific walruses (*Odobenus rosmarus divergens*) were observed throughout the northeastern Chukchi Sea, with distributions varying across months. No walruses were observed in the Alaskan Beaufort Sea. Walruses were observed in all months of the study period (Figure 31). Excluding dead walruses and walruses that were known to be duplicate sightings within the same day, there were 819 sightings of 111,915 walruses (Table 14). These totals are artificially high as they include resightings of a walrus haulout near Point Lay. When only the highest group size estimate of the haulout (2 sightings of 20,000 walruses) is taken into account and resightings of the haulout are excluded, there were 808 sightings of 26,415 walruses.

In June and July, when sea and shorefast ice were still present in the study area, walruses were either hauled out on ice or swimming in open water; group sizes ranged from single animals to 600, with larger groups hauled out on ice. In early August, when sea ice had receded north and the study area was virtually ice-free (Appendix A), walruses were observed only in open water and were starting to congregate nearshore. On 17 August, the first aggregation of walruses to haul out on the Alaskan coastline during the 2011 field season was observed (Figure 32). Walruses observed offshore in August and September appeared to show a preference for Hanna Shoal (~72°N, 162°W), presumably using this area as a feeding ground.

The walrus haulout was located approximately 6 km northeast of Point Lay, Alaska, relatively close to where walrus haulouts were documented during 2010 aerial surveys (Clarke et al. 2011d). The aggregation was documented on nine subsequent surveys between mid-August and early October. Group size estimates of the haulout throughout the season ranged from 1,000 to 20,000 individuals (Table 14). The haulout was documented on every survey near Point Lay until it was last observed on 6 October. Additional survey effort near Point Lay was conducted in mid-October (17 October), and no haulouts were observed. Walrus aggregations on land were observed earlier and for a longer period of time in 2011 compared to those observed in 2009 and 2010 (Clarke et al. 2011d).

There were 223 walruses (representing <1% of the total walruses sighted) that appeared to respond to the survey aircraft.

Other Pinnipeds

Bearded seals, *Erignathus barbatus*, (78 sightings of 82 seals) were distributed across the Alaskan Beaufort and northeastern Chukchi Seas (Figure 33). Five bearded seals were observed hauled out on sea ice in mid-June; all other bearded seals were observed in open water.

Eight seals were identified as ringed seals (*Pusa hispida*), but most other pinnipeds were not identifiable to species, and were recorded as unidentified pinnipeds (74 sightings of 82 seals) or small unidentified pinnipeds (992 sightings of 1,531 seals) (Figure 34). The unidentified

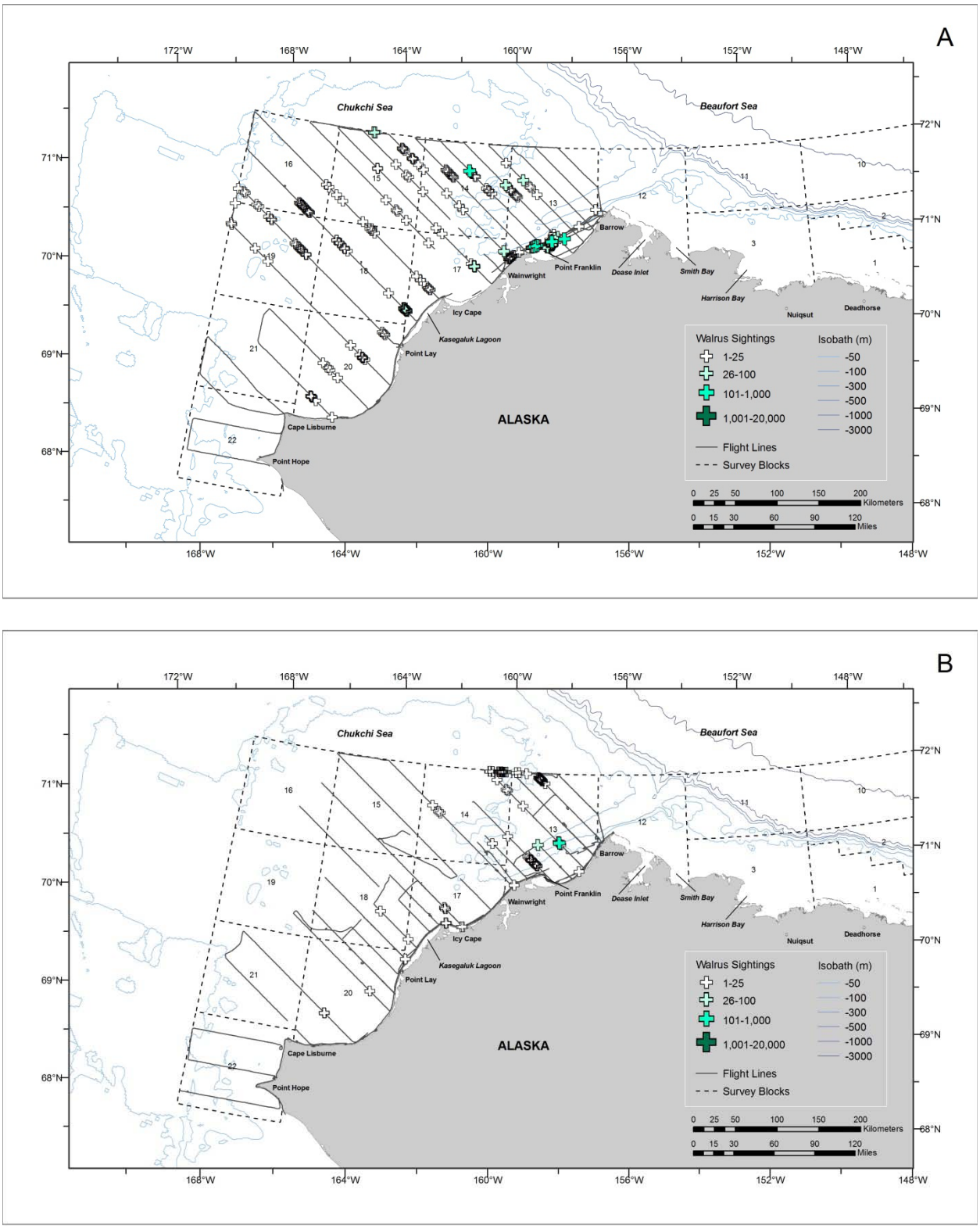


Figure 31. Walrus sightings plotted by month, with transect, search, and circling effort, 2011. Deadhead flight tracks are not shown. A: June; B: July.

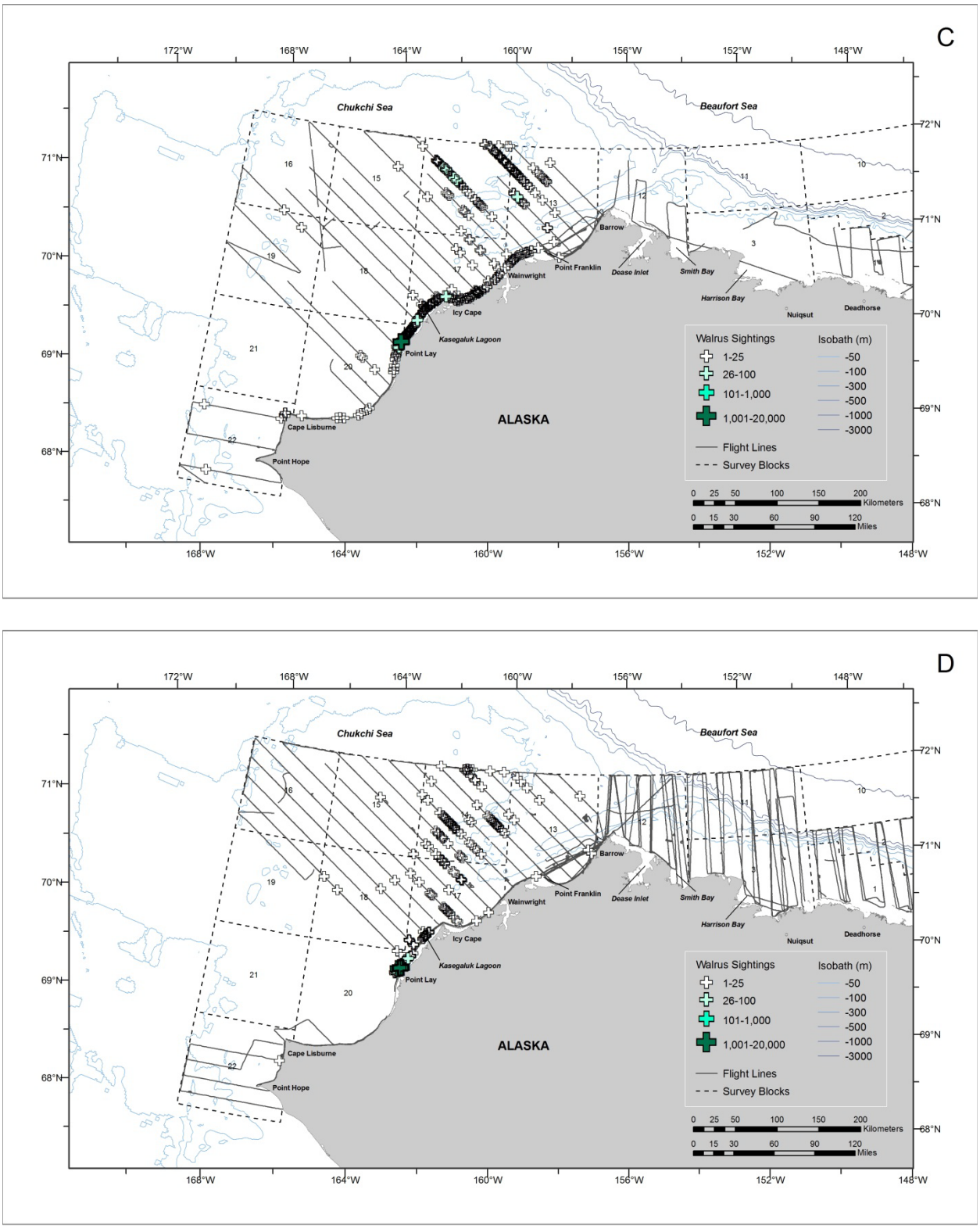


Figure 31 (cont). Walrus sightings plotted by month, with transect, search, and circling effort, 2011. C: August; D: September.

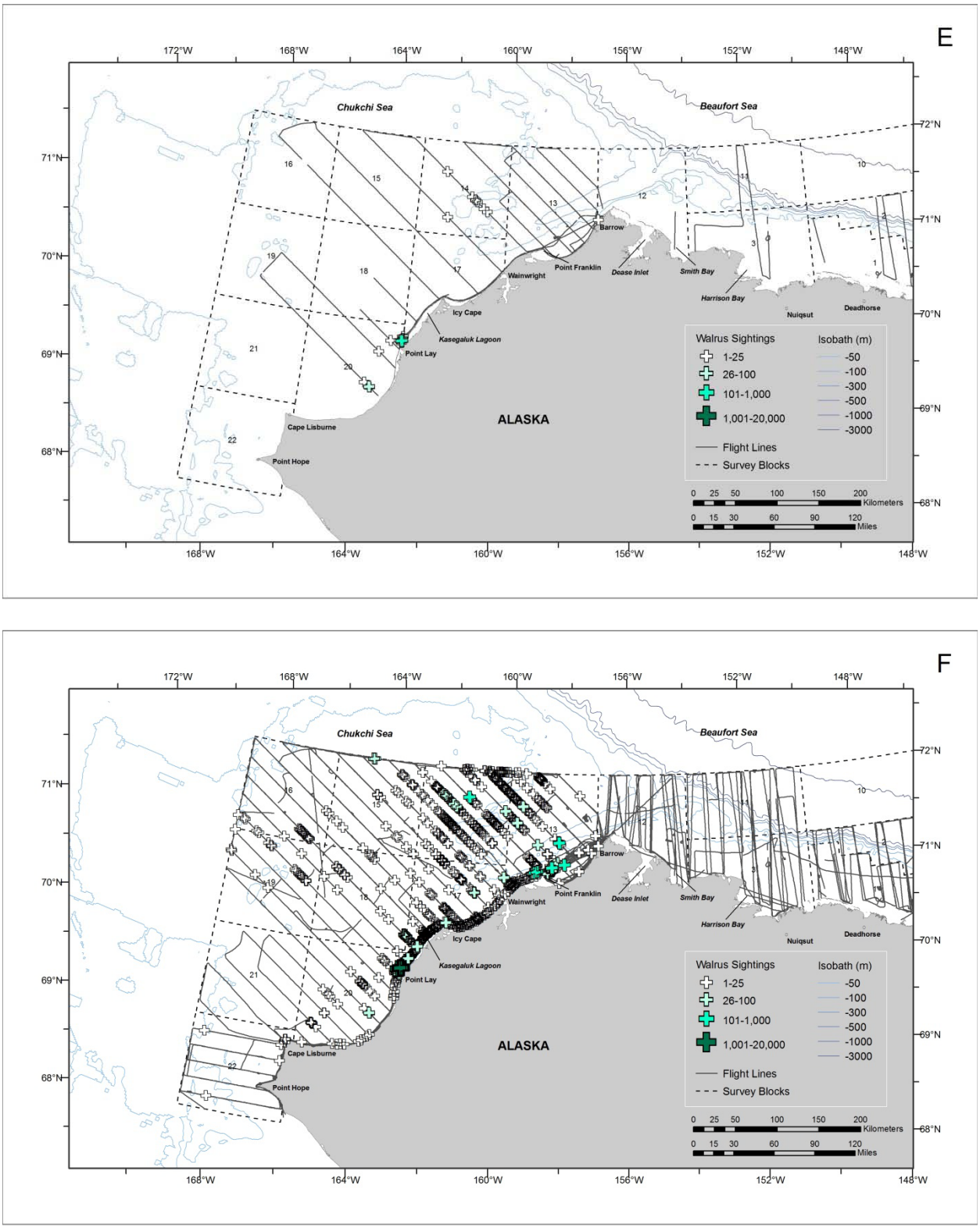


Figure 31 (cont). Walrus sightings plotted by month, with transect, search, and circling effort, 2011. E: October; F: All months.

Figure 32. Walrus haulout near Point Lay, Alaska, 19 August 2011. Photo by Rebecca Shea, (NOAA/AFSC/NMML) under U.S. Fish and Wildlife Permit No. MA212570.

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 aircraft (>305 m). "Unidentified pinnipeds" likely included sightings of ringed and spotted (*Phoca largha*) seals in addition to bearded seals and 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 Alaskan Beaufort Sea (Boveng et al. 2009; Angliss and Allen 2009; Lowry et al. 1998); 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 Janet Clarke, 8 December 2009). Pinnipeds were seen both on the continental shelf and in deeper areas of the continental slope.

Table 14. Summary of walrus sightings observed during all survey modes (transect, search and circling), 2011.

	No. Sightings	No. Individuals
Dead*	17	19
Highest estimate of Point Lay haulout**	2	20,000
Total, including all sightings	837	123,934
Total, excluding dead & repeat sightings	819	111,915
Total, excluding dead, repeat, and additional Point Lay haulout sightings***	808	26,415

*Likely includes duplicates sightings of carcasses sighted on different survey dates.

**Highest group size estimate was observed on 8/26/2011.

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

Polar Bears

There were 21 sightings of 52 polar bears, with all but 1 bear sighted in the Beaufort Sea (Figure 35). The only Chukchi Sea polar bear sighting occurred on 19 June. The bear was swimming northward in open water approximately 65 km northwest of Icy Cape. Shorefast ice and some broken floe ice was still present; pack ice, however, was much farther offshore (~110 km) than the bear. This was the only polar bear in 2011 sighted offshore in either the Chukchi or Beaufort Seas. No polar bears were sighted along the Alaskan coastline in the northeastern Chukchi Sea, despite coastal transects and transits in that area.

All polar bears sighted in the Beaufort Sea were nearshore or onshore between Smith Bay and Kaktovik, Alaska (Figure 35). The Beaufort Sea survey design is not optimized for surveying polar bears; polar bear sightings in the Beaufort Sea are incidental to other marine mammal sightings. A coastal transect is not part of the Beaufort Sea survey protocol, and transits to and from survey blocks were often on deadhead or over land. Therefore, the opportunity to find bears along the coastline, where they would most likely be seen when the ice edge is beyond the confines of the study area, is low. Single bears were seen at the edge of Smith Bay, near Harrison Bay, and west of Kaktovik in Camden Bay. The remaining polar bears were seen at two locations, Cross Island and near Kaktovik; these locations attract polar bears because bowhead whale carcasses from fall subsistence hunts are hauled there by villagers from Nuiqsut, Alaska (at Cross Island), and Kaktovik, and are a source of food for polar bears. Bears were seen

on Cross Island on 3 days: 7 bears on 20 August, 5 bears on 28 September, and 8 bears on 5 October. Bears were seen near Kaktovik on 4 days: 11 bears on 24 September, 9 bears on 27 September, 3 bears on 1 October, and 5 bears on 4 October. Some of these bears may have been repeat sightings.

Most of the polar bears (67%, n=35) were onshore, with the remaining bears (33%, n=17) sighted swimming in the water; no polar bears were sighted on ice and there was no sea ice present near any of the sightings. One polar bear (the Chukchi Sea sighting) was swimming far offshore; all other bears in the water were swimming very close to shore or in the surf zone. Polar bears on land were observed feeding, walking, standing, sitting, or lying on the ground. There were four sightings of six polar bear cubs in 2011; two of those sightings were of a mother and two cubs, the other two sightings were of a mother and one cub.

None of the polar bears sighted in 2011 appeared to respond to the survey aircraft.

The number of polar bears sighted in 2011 was similar to 2009 and 2010 (Clarke et al. 2011a, 2011c, 2011d), despite considerably greater survey effort in 2011. Polar bear sightings in 2008 were much higher than 2011, with 14 bears in the Chukchi Sea (Clarke et al. 2011d) and 107 bears in the Beaufort Sea (Clarke et al. 2011b). Sea ice remained in some of the study area in 2008, which may have influenced the distribution of polar bears.

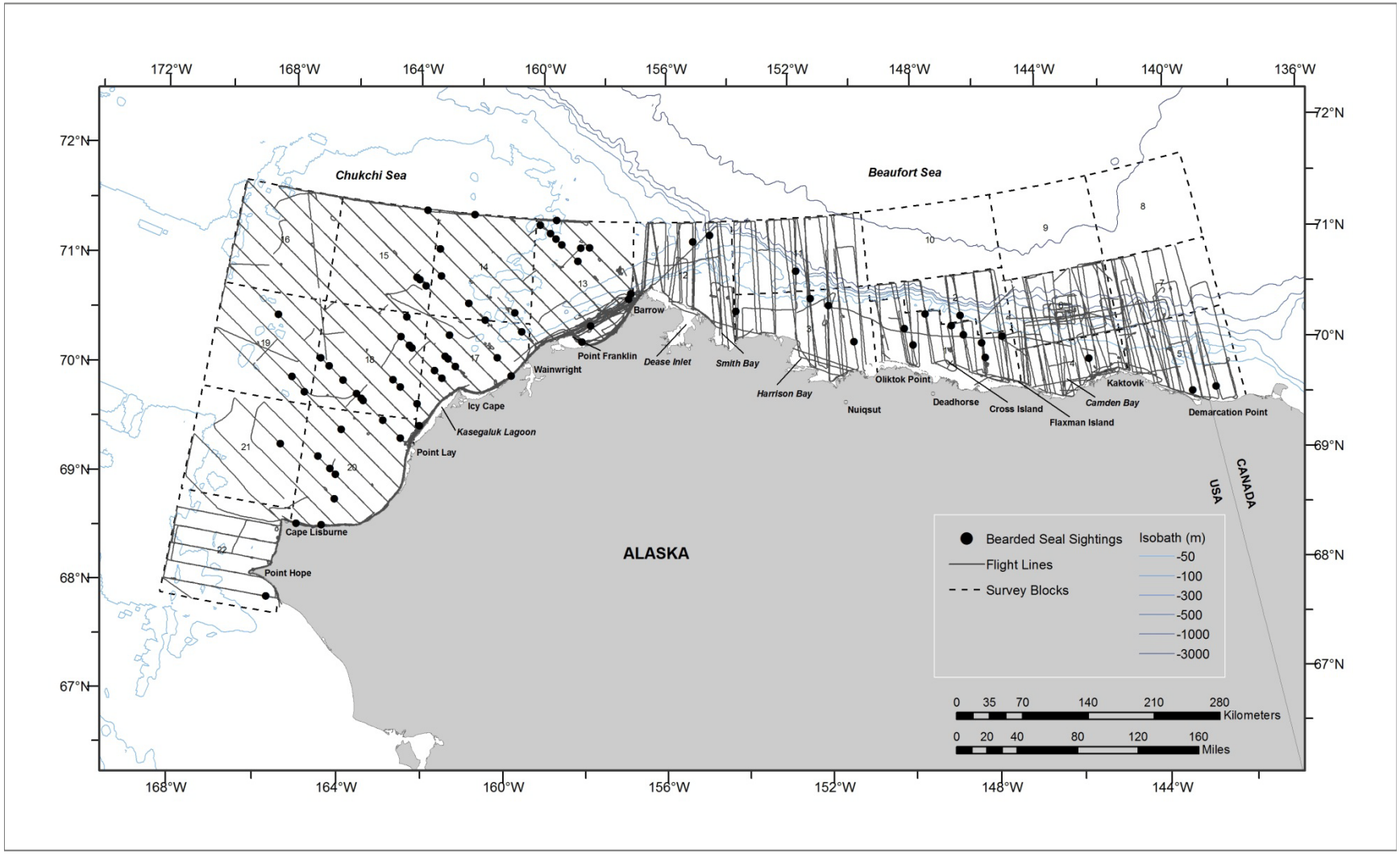


Figure 33. Bearded seal sightings, with transect, search, and circling effort, 2011. Deadhead flight tracks are not shown.

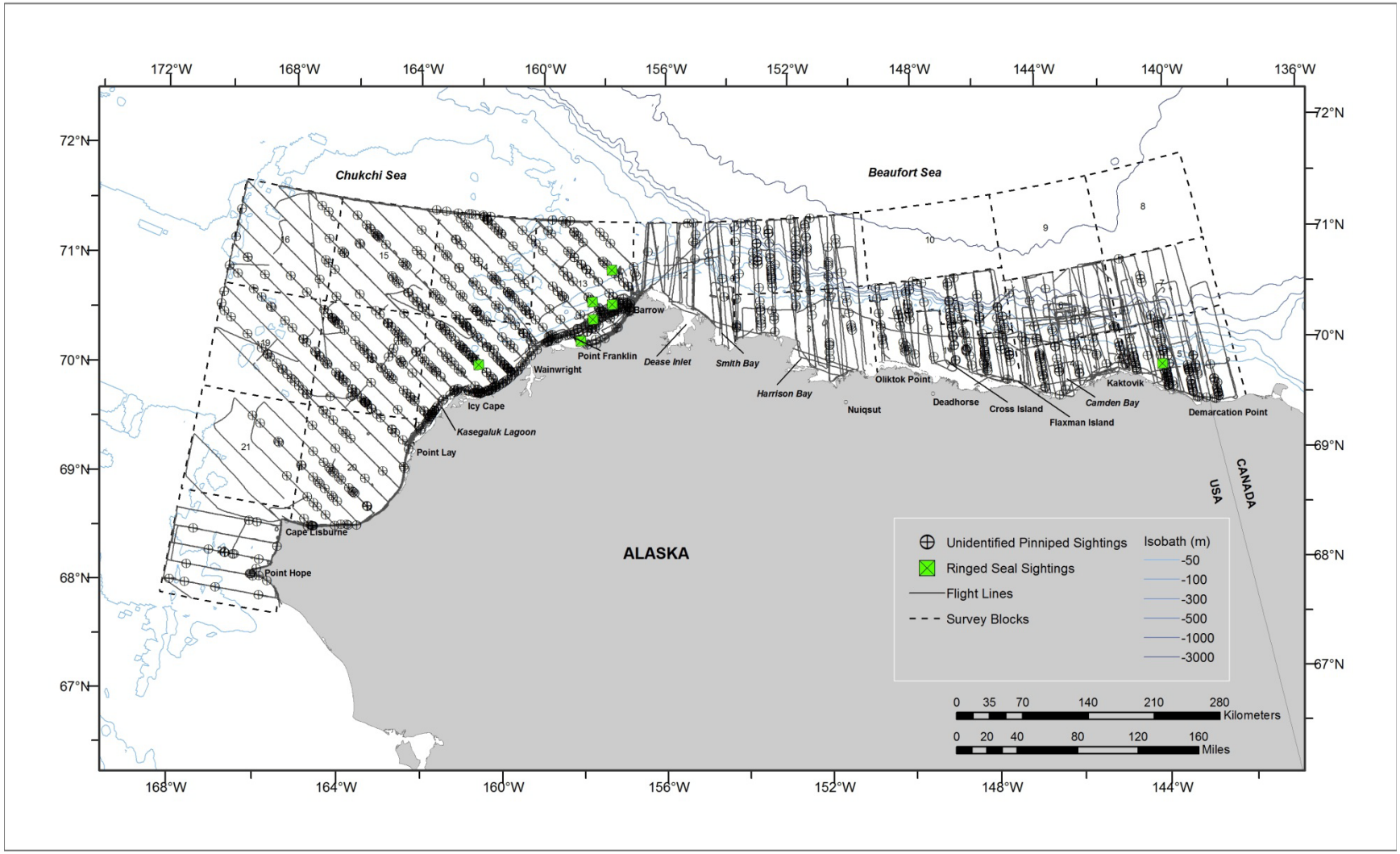


Figure 34. Ringed seal and unidentified pinniped sightings (including small unidentified pinniped sightings), with transect, search, and circling effort, 2011. Deadhead flight tracks are not shown.

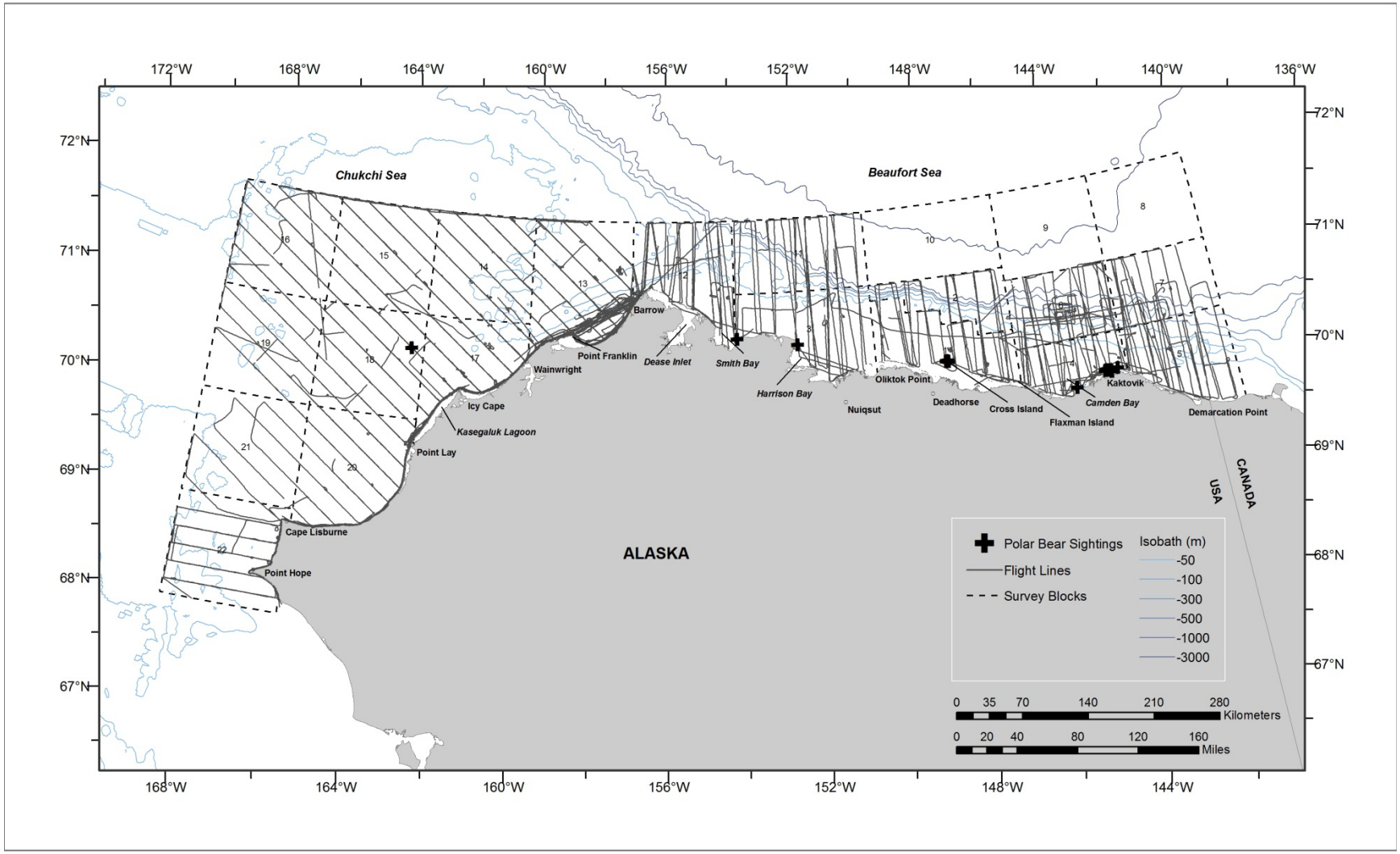


Figure 35. Polar bear sightings, with transect, search, and circling effort, 2011. Deadhead flight tracks are not shown.

Dead Marine Mammals

There were 23 sightings of 25 dead marine mammals in 2011 (Table 15), although it is possible that some sightings were repeats of earlier observations. The majority of dead animals were walruses (17 sightings of 19 animals). Two carcasses were cetaceans, one identified as a gray whale and the other too decomposed to determine species. The other carcasses were pinnipeds, species undetermined. Thirteen of the carcasses were observed on land and 12 were seen in the water. All dead marine mammals were in the northeastern Chukchi Sea. Level A stranding forms were completed by field teams and forwarded to personnel at the NSB Department of Wildlife Management (all sightings), NMFS (cetaceans and ice seals) and USFWS (walruses).

Table 15. Summary of dead marine mammal sightings, all survey modes (transect, search and circling), 2011.

Flight No.	Date	Latitude °N	Longitude °W	Species	Group Size	Habitat
203	6/19/2011	70.491	167.769	gray whale	1	open water
207	6/26/2011	69.496	168.795	walrus	1	open water
214	7/8/2011	68.485	167.622	walrus	1	open water
221	7/20/2011	70.844	158.328	walrus	1	open water
226	8/1/2011	69.328	163.995	walrus	1	open water
234	8/17/2011	70.313	161.742	walrus	1	on land
234	8/17/2011	70.318	161.200	unid. pinniped	1	on land
234	8/17/2011	70.888	159.070	unid. pinniped	1	on land
237	8/24/2011	68.483	166.863	walrus	1	open water
237	8/24/2011	68.468	166.423	walrus	1	open water
237	8/24/2011	68.444	166.330	unid.cetacean	1	on land
237	8/24/2011	68.435	166.391	walrus	1	open water
237	8/24/2011	68.725	166.229	walrus	1	open water
238	8/26/2011	69.482	163.168	walrus	1	open water
238	8/26/2011	70.938	157.567	sm. unid. marine mammal	1	on land
238	8/26/2011	71.067	157.245	walrus	1	on land
239	8/27/2011	70.269	162.131	walrus	1	open water
241	9/2/2011	70.855	159.378	walrus	1	on land
241	9/2/2011	70.968	157.482	walrus	1	on land
241	9/2/2011	71.060	157.260	walrus	1	on land
243	9/5/2011	70.809	159.639	walrus	1	on land
250	9/14/2011	68.368	166.757	walrus	3	on land
256	9/28/2011	71.957	160.693	unid. pinniped	1	open water

"unid." – unidentified; "sm." – small

Accomplishments

Data from ASAMM 2011 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 NMML project website: http://www.afsc.noaa.gov/nmml/cetacean/bwasp/index.php.
- Ice data, including photos of representative sea ice cover, were sent to the National Ice Center to assist with ground-truthing satellite ice data.
- Biweekly effort and sighting summary figures were sent to BOEM, NMML and NSB to provide an overview of data collected.
- Biweekly walrus sighting figures of distribution and group size were sent to researchers at BOEM, USFWS, USGS and ADFG.
- Information on the coastal walrus haulout was shared with BOEM, USFWS, USGS, ADFG, NSB and industry vessels operating in the area.
- Biweekly polar bear sighting figures were sent to BOEM, USFWS, USGS and ADFG.
- All Level A stranding forms were sent to NMFS-AFSC and NSB (cetaceans and ice seals) and USFWS (walruses) – total of 25 forms.

ASAMM provided locations and photographs of beached oceanographic buoys to industry representatives to allow equipment to be retrieved.

ASAMM participated in walrus reconnaissance surveys in late July to assist with USGS satellite tagging efforts.

Additionally, ASAMM provided subsets of the 1982-2010 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, NMFS Northwest Fisheries Science Center, USFWS, University of Alaska Fairbanks, Conoco Phillips, Dutch World Wildlife Fund, University of Texas, NSB, and the U.S. Coast Guard.

Results from the 2011 ASAMM field season were presented by NMML personnel at several venues, including:

Brower, A., C. Christman, M. Ferguson, J. Clarke, S. Grassia, R. Shea, B. Rone and A. Kennedy. 2012. Eastern North Pacific gray whales and minke whales from aerial surveys in the Alaskan Arctic, Summer and Fall 2011. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, 16-20 January.

Christman, C., A. Brower, J. Clarke, M. Ferguson, S. Grassia, A. Kennedy, B. Rone, and R. Shea. 2012. Aerial observations of Pacific walruses (*Odobenus rosmarus divergens*) in the northeastern Chukchi Sea, Summer and Fall, 2011. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, 16-20 January.

Christman, C.L., M.C. Ferguson, J.T. Clarke, and A. A. Brower. 2012. Marine mammal aerial surveys in the Chukchi Sea. Presentation: Workshop on Assessing Pacific Walrus Population Attributes from Coastal Haul-Outs, Anchorage, AK, March 2012.

Clarke, J., M. Ferguson, C. Christman, A. Brower, S. Grassia, R. Shea, B. Rone and A. Kennedy. 2012. Distribution and relative abundance of belugas (*Delphinapterus leucas)* in the Alaskan Arctic, Summer and Fall, 2011. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, 16-20 January.

Ferguson, M., J. Clarke, A. Brower, C. Christman, S. Grassia, A. Kennedy, B. Rone and R. Shea. 2012. Bowhead whale (*Balaena mysticetus*) distribution and relative abundance in the Alaskan Arctic, Summer and Autumn, 2011. Poster presented at the Alaska Marine Science Symposium, Anchorage, AK, 16-20 January.

Lemons, P. and C. Christman. 2012. Pacific Walrus (*Odobenus rosmarus divergens*) Abundance and Use of the Northeast Chukchi Sea Based on COMIDA Aerial Surveys. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2012.

A complete listing of publications, posters and verbal presentations from the ASAMM project (and its precursors BWASP and COMIDA) from 2008-2012 is included in Appendix D.

DISCUSSION

Conclusions

Sea ice conditions in 2011 were very light, similar to conditions observed from 2007-2010, with little to no ice in most of the study area during the field season. 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 2011 leading to long expanses of time when little survey effort could be completed, particularly in October. Regardless, observed bowhead whale distribution in the Alaskan Beaufort Sea was similar to previous years with light sea ice cover (Figure 14). Bowhead whale sightings were significantly closer to shore and in shallower water in the East Region of the Alaskan Beaufort Sea in 2011 compared to previous years with light sea ice cover. While the trend for increased bowhead whale sightings near the coast may be related to higher concentrations of bowhead whale prey near the coastline, none of the whales in the East Region were observed feeding. Survey coverage in the offshore areas was relatively good, so differences in survey effort cannot explain the relative lack of observations offshore.

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 2011 (National Snow and Ice Data Center 2007, 2011). The 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), and these changes have likely impacted or will impact most marine mammal species (Kovacs et al. 2011). Comparisons in marine mammal distribution over time periods spanning three decades (1982-2010) should be interpreted with caution because different ecological mechanisms could have been acting at different time periods within the duration of the study.

Marine mammal data collected during the 2011 ASAMM field effort is vital in contributing to the overall understanding of marine mammal ecosystems in the northeastern Chukchi and Alaskan Beaufort Seas. In addition to continuing to document bowhead and gray whale distribution, relative abundance and habitat during summer and fall, important information was also obtained during ASAMM 2011 relating to unique situations and other species.

The location of a satellite-tagged bowhead whale in the central Alaskan Beaufort Sea was investigated during an exploratory survey in mid-July. Several bowhead whales were found in the immediate vicinity of the tagged whale location, north of Camden Bay. Some of the whales were possibly feeding, as evident by mud on the head, and none of the whales were actively migrating east, unlike bowhead whales previously documented in this area. The July sightings were significant in ground-truthing data available from a single satellite-tagged animal (in this case, 1 tagged whale actually represented at least 14 bowhead whales) and providing additional evidence that the entire Bering-Chukchi-Beaufort bowhead whale population does not remain in the Canadian Beaufort Sea throughout the summer. The presence of bowhead whales in the

central Alaskan Beaufort Sea in summer may be significant in future planning of offshore oil and gas exploration and production activities.

The coastal walrus haulout near Point Lay formed in mid-August and remained through early October. Group size was dynamic over the life of the haulout, but was estimated as at least 20,000 walruses on a few occasions. ASAMM and biologists from USFWS and USGS will continue to collaborate to document the timing, location, and size of future walrus haulouts that may form along the Alaskan coastline, and investigate other aspects of walrus ecology.

Minke whales were repeatedly seen in and near the CSPA. Two sightings were noteworthy: 1) one minke whale was sighted very close to the coastline east of Point Franklin, and 2) one minke whale was sighted approximately 180 km northwest of Wainwright, which is likely the farthest north that a verified minke whale sighting has occurred in the northeastern Chukchi Sea. These sightings reinforce the possibility of species expanding their range in the Arctic, and serve as reminders that every cetacean sighting needs to be positively verified to species.

Finally, after four years (2007-2010) of low numbers of beluga sightings, the observed beluga distribution in the Alaskan Beaufort Sea was similar to that observed prior to 2007. Distribution in the northeastern Chukchi Sea was fairly widespread, including in the CSPA. Large groups of belugas were seen in late June and early July nearshore south of Point Lay.

Management Use of Real-Time Field Information

BOEM issues various permits to industry for gas and oil exploration, including vessel geophysical permits for on-water exploration using an array of deep-seismic airguns; vessel geological-geophysical permits for shallow-seismic exploration using airguns; on-ice geophysical permits using VIBROSEIS technology; both vessel and on-ice geological permits for obtaining core samples; and permits to drill for gas and oil. ASAMM aerial survey data were made available to representatives of oil companies, the North Slope Borough Department of Wildlife Management, and the general public on a near real-time basis to encourage data transfer and enhance management via a web site maintained by NMML, (http://www.afsc.noaa.gov/nmml/cetacean/bwasp/index.php).

Management Use of Interannual Monitoring

This BOEM 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 1982-2011), 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., Manly et al. 2007, Schick and Urban 2000, Givens et al. 2010; Okkonen et al., 2011).

ACKNOWLEDGMENTS

This study was funded by the U.S. Department of the Interior, Bureau of Ocean Energy Management (BOEM, formerly MMS), Alaska Outer Continental Shelf Region, Anchorage, Alaska, through Interagency Agreement No. M11PG00033, as part of the Alaska Environmental Studies Program. We particularly appreciate the support, guidance, and encouragement of Charles Monnett and Jeffrey Denton.

Numerous NMML personnel provided support to the survey team or assisted with technical, administrative, or logistical aspects of the study. Robyn Angliss, Stefan Ball, Phil Clapham, Kim Shelden, and Joann Wejak provided logistical and program support. Observers included Corey Accardo, Mike Borden, Amelia Brower, Cynthia Christman, Janet Clarke, Jessica Crance, Megan Ferguson, Stephanie Grassia, Suzie Hanlan, Brendan Hurley, Amy Kennedy, Brenda Rone, Rebecca Shea, and Jessica Thompson. Mike Hay of XeraGIS provided much needed assistance with the data collection program, data analysis, and report preparation.

The Aero Commander aircraft were provided by Clearwater Air, Inc. of Nikiski, Alaska, via Intraagency Agreement No. M11PG00032 with the Department of the Interior, Aviation Management Division. Surveys were enthusiastically and safely flown by Stan Churches, Andy Harcombe, Eric Seller, Baine Thorn, and Jake Turner; Chad Russell provided mechanical support.

The Twin Otter aircraft was provided by the NOAA Aircraft Operations Center (AOC), Tampa, Florida, via Interagency Agreement No. M07RG13263 between BOEM and NOAA AOC. Kristie Twining and the AOC Programs Office were instrumental in assisting with aircraft arrangements and preparations. Surveys were capably and safely flown by Robert Mitchell and Michael (Sandor) Silagi; on-site aircraft mechanical support was provided by Rob Miletic.

Bald Mountain provided a hangar at the Deadhorse airport.

Real-time monitoring via satellite tracking of survey flights was provided by Jan Bennett and Lark Wuerth of the Department of the Interior, National Business Center, Aviation Management Division.

Phil Clapham and Julie Mocklin (NMML) reviewed the report. The NMFS Alaska Fisheries Science Center (AFSC) Publications Unit assisted with preparing this report for publication.

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APPENDIX A: 2011 ICE CONCENTRATION MAPS

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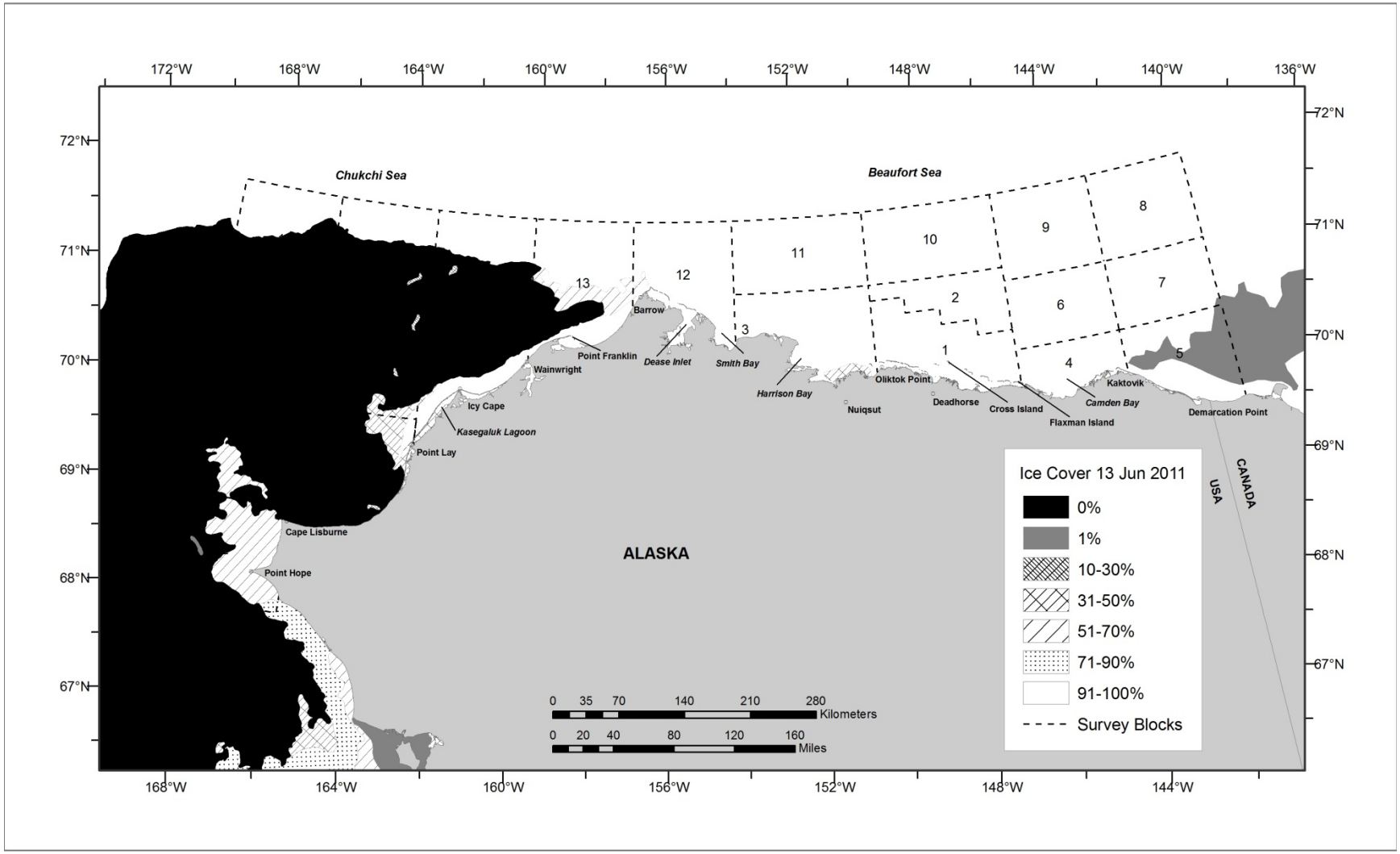

Figure A-1. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 13 June 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

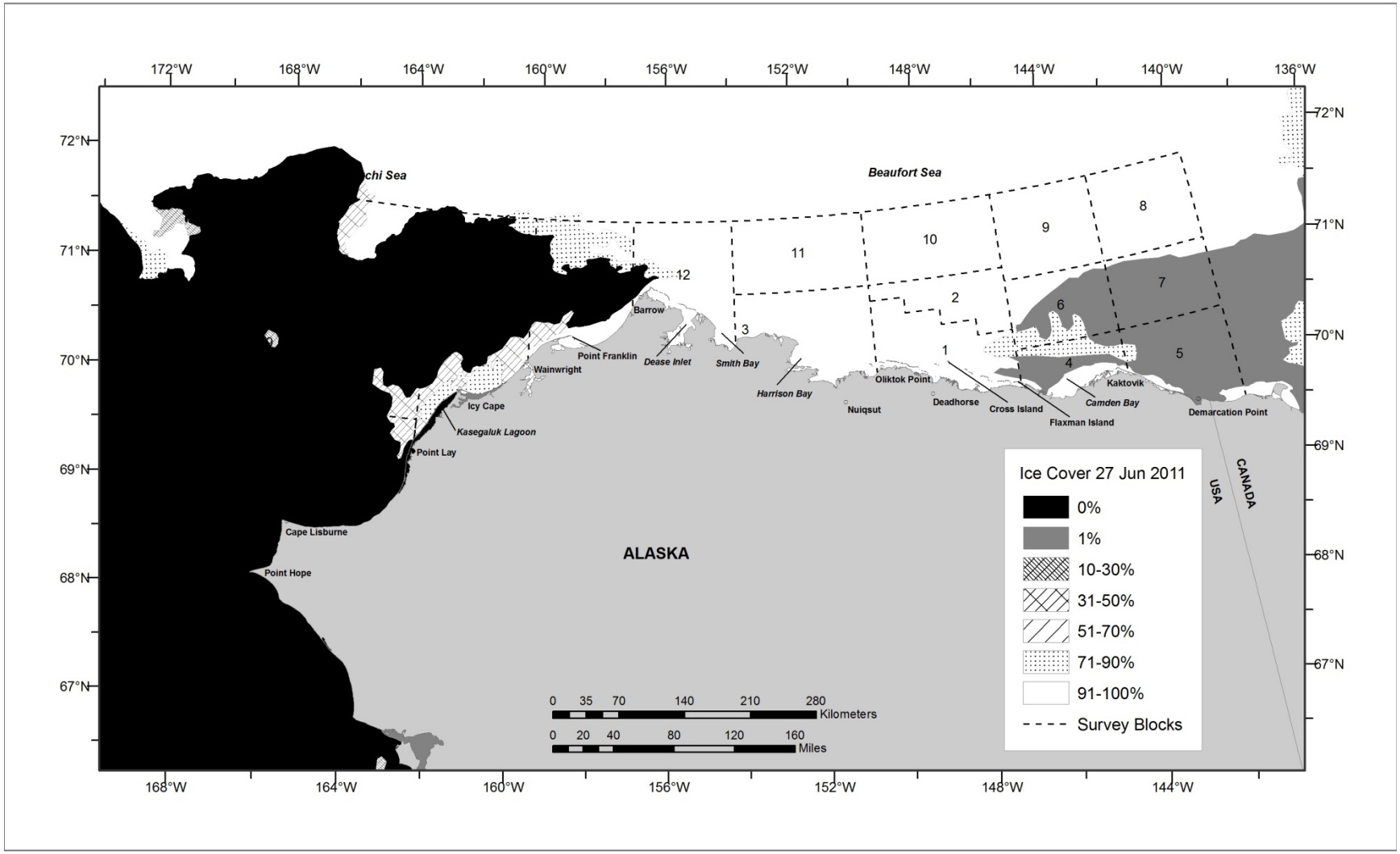

Figure A-2. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 27 June 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

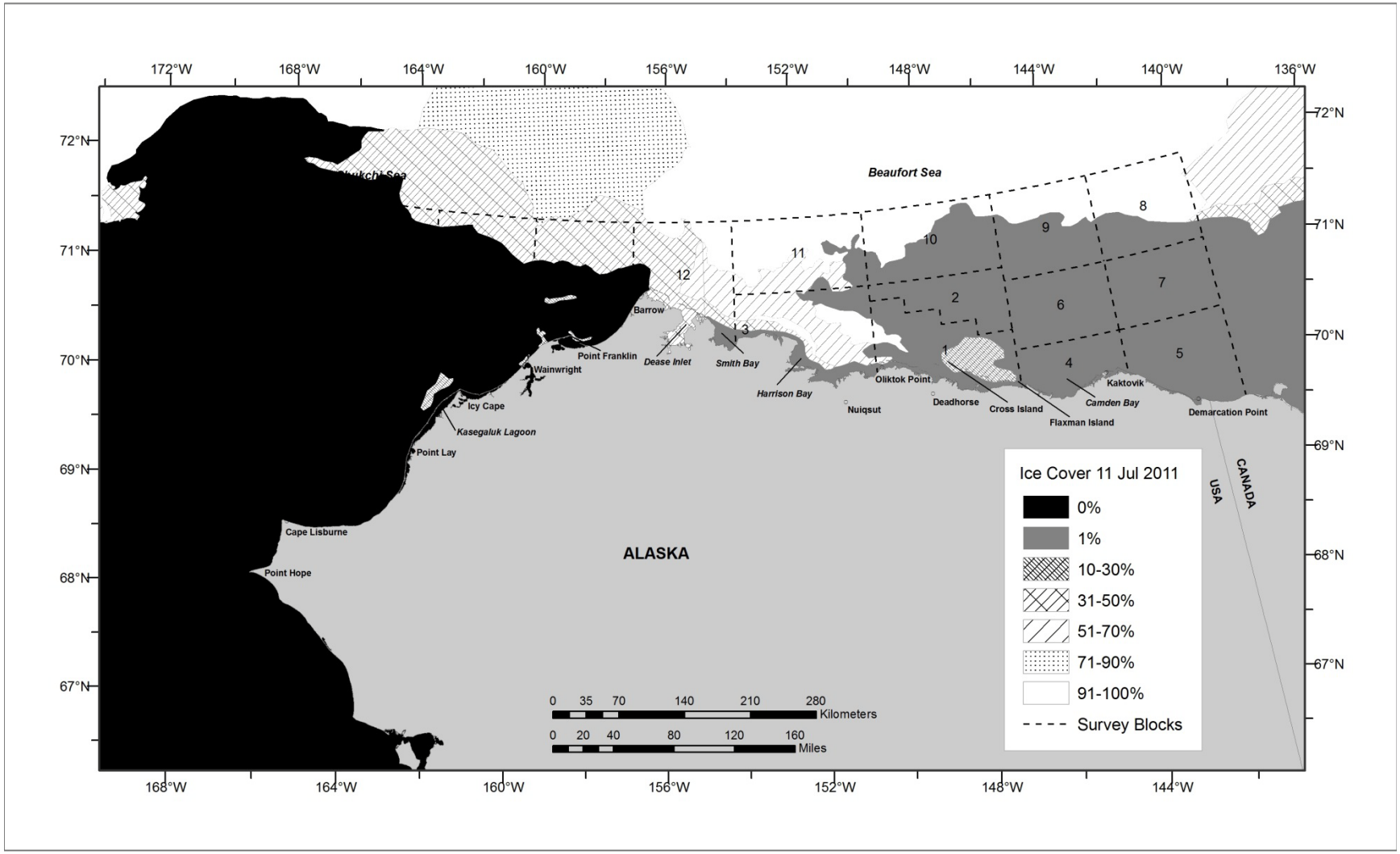

Figure A-3. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 11 July 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

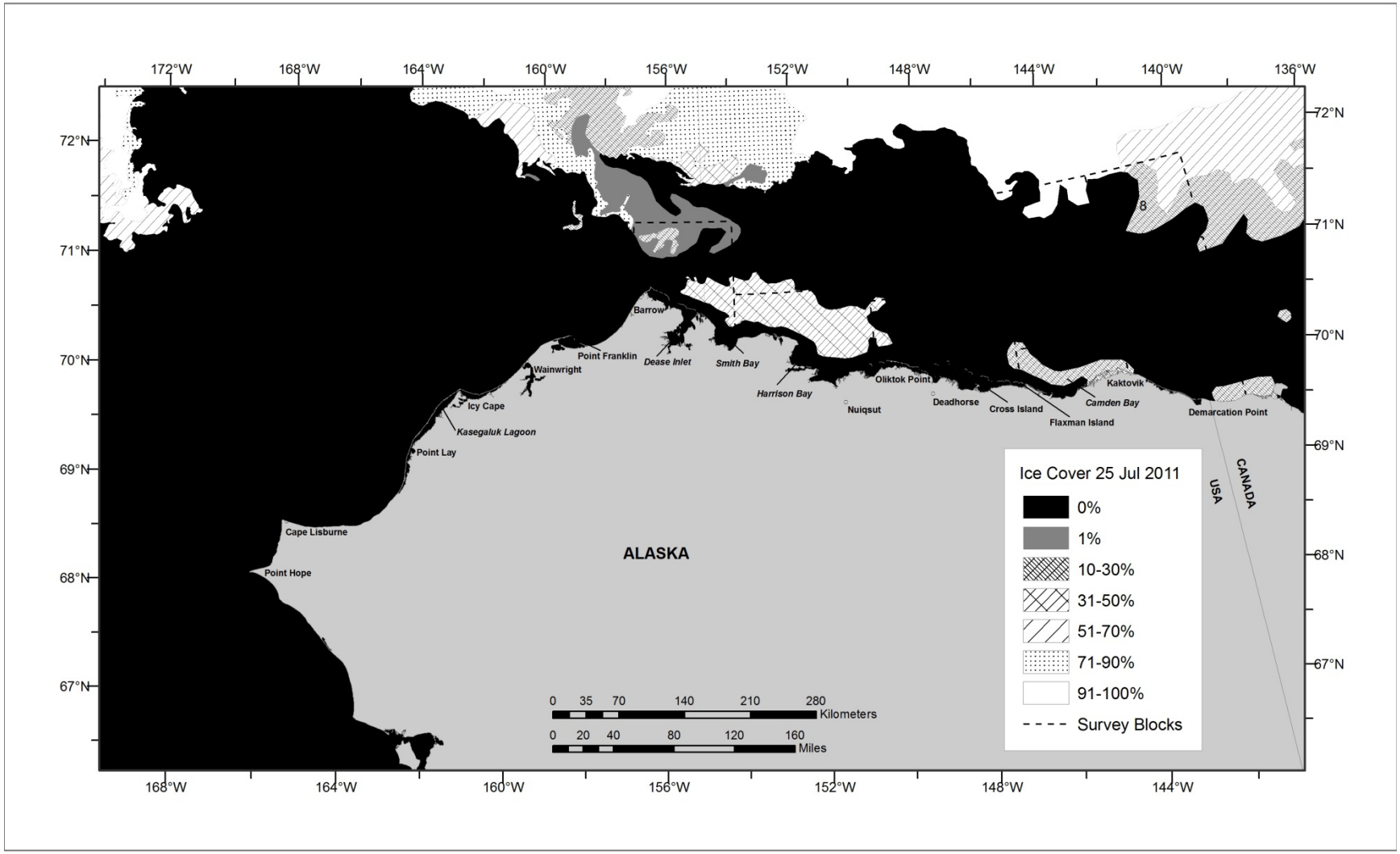

Figure A-4. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 25 July 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

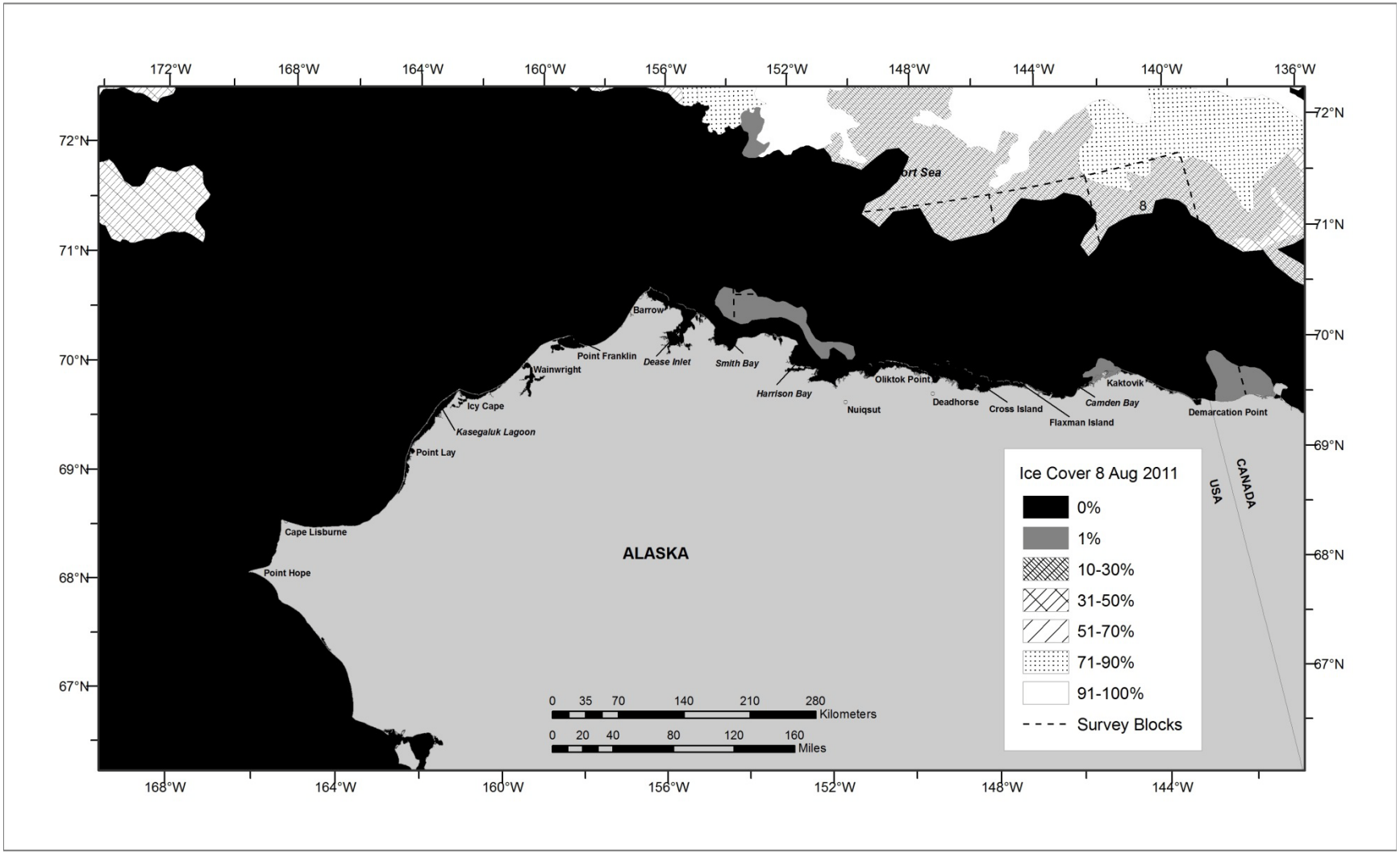

Figure A-5. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 8 August 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

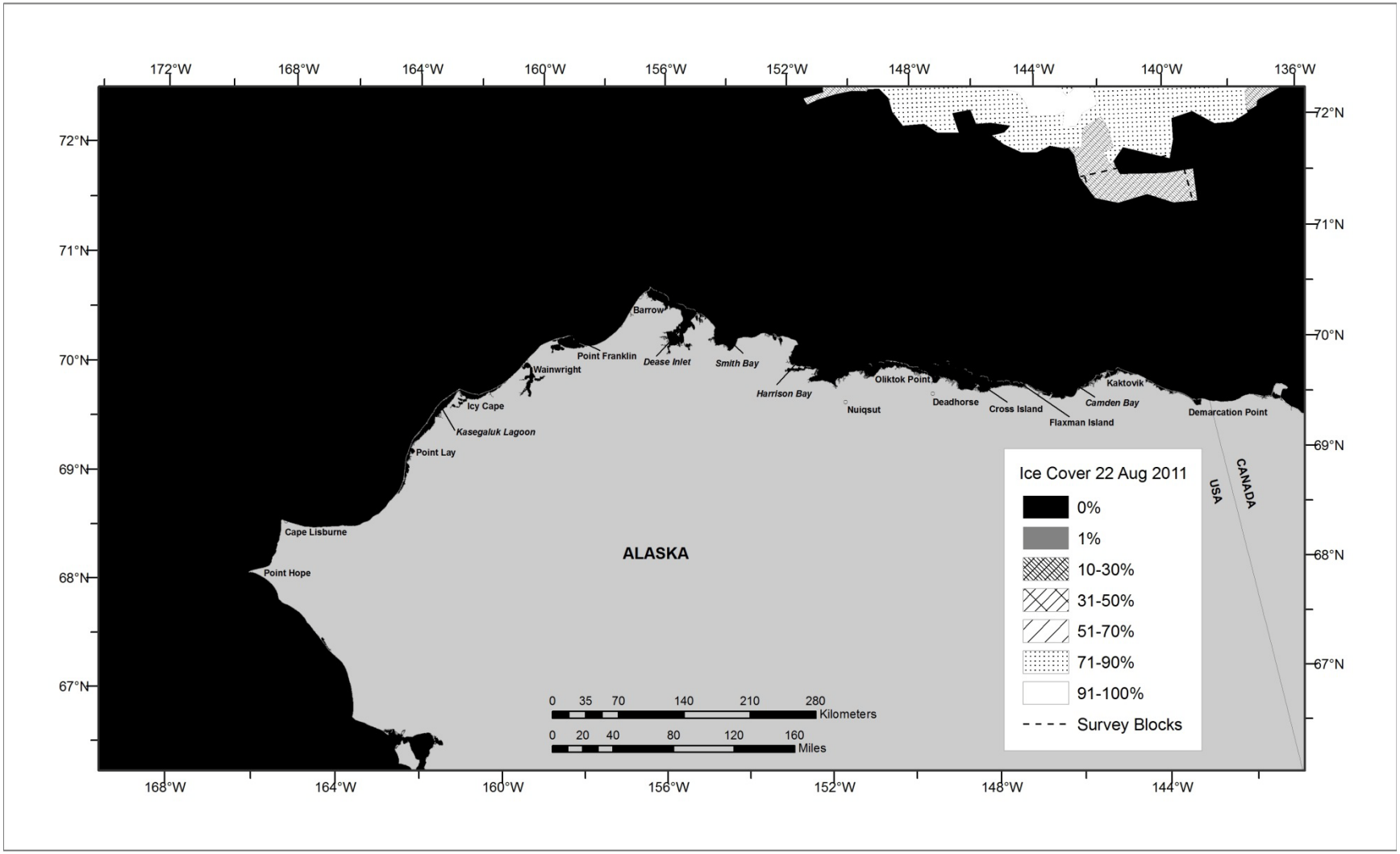

Figure A-6. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 22 August 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

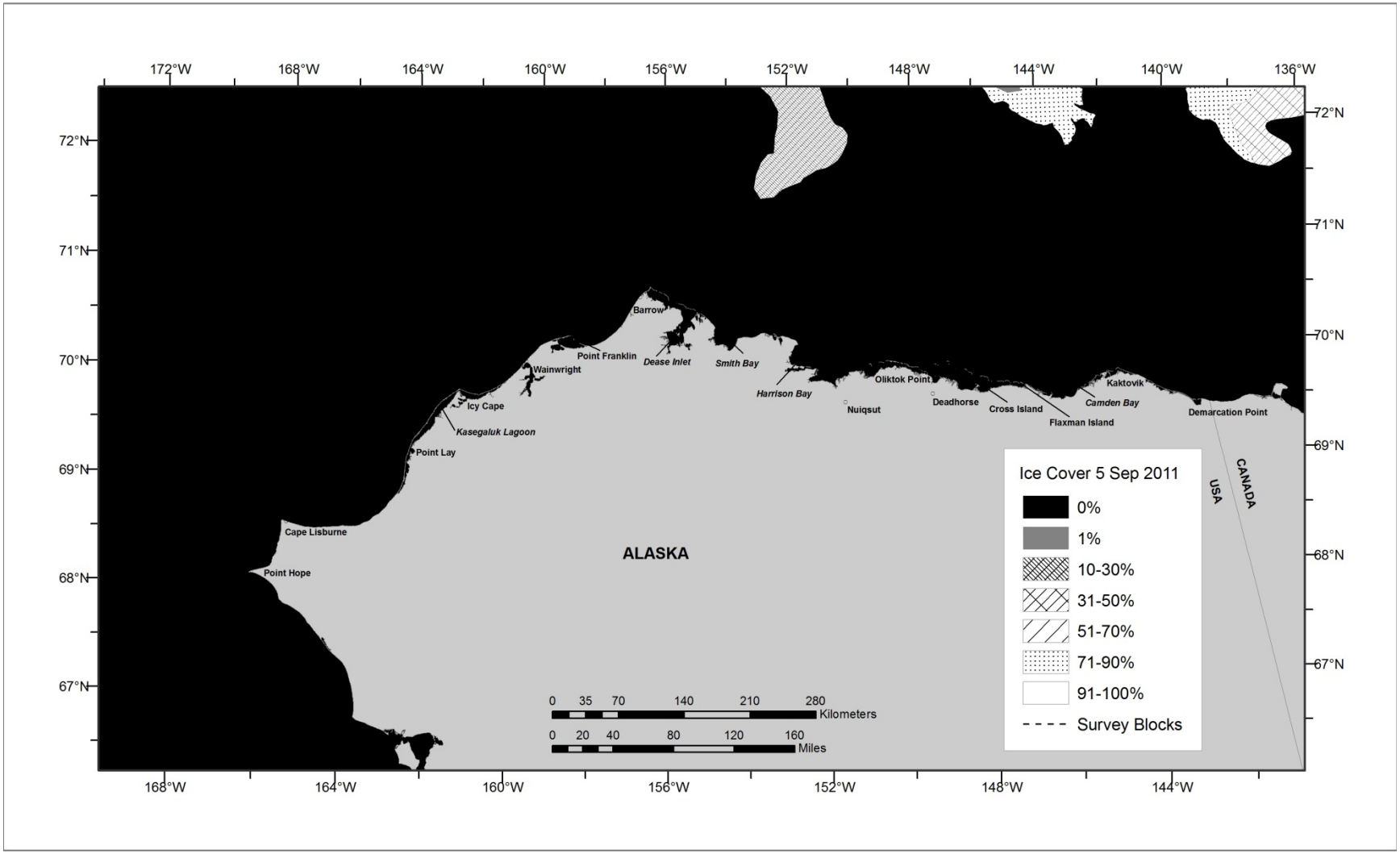

Figure A-7. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 5 September 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

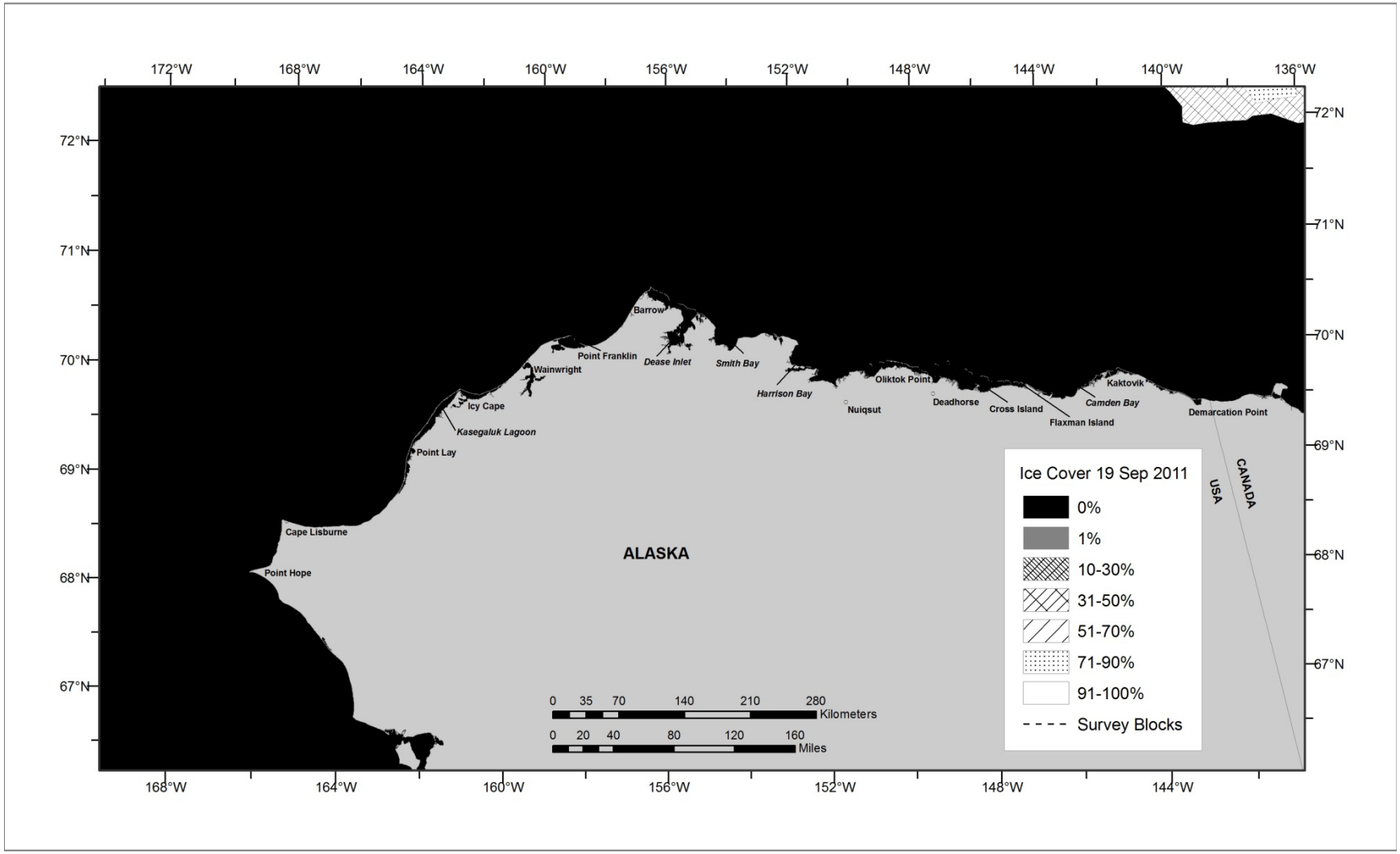

Figure A-8. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 19 September 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

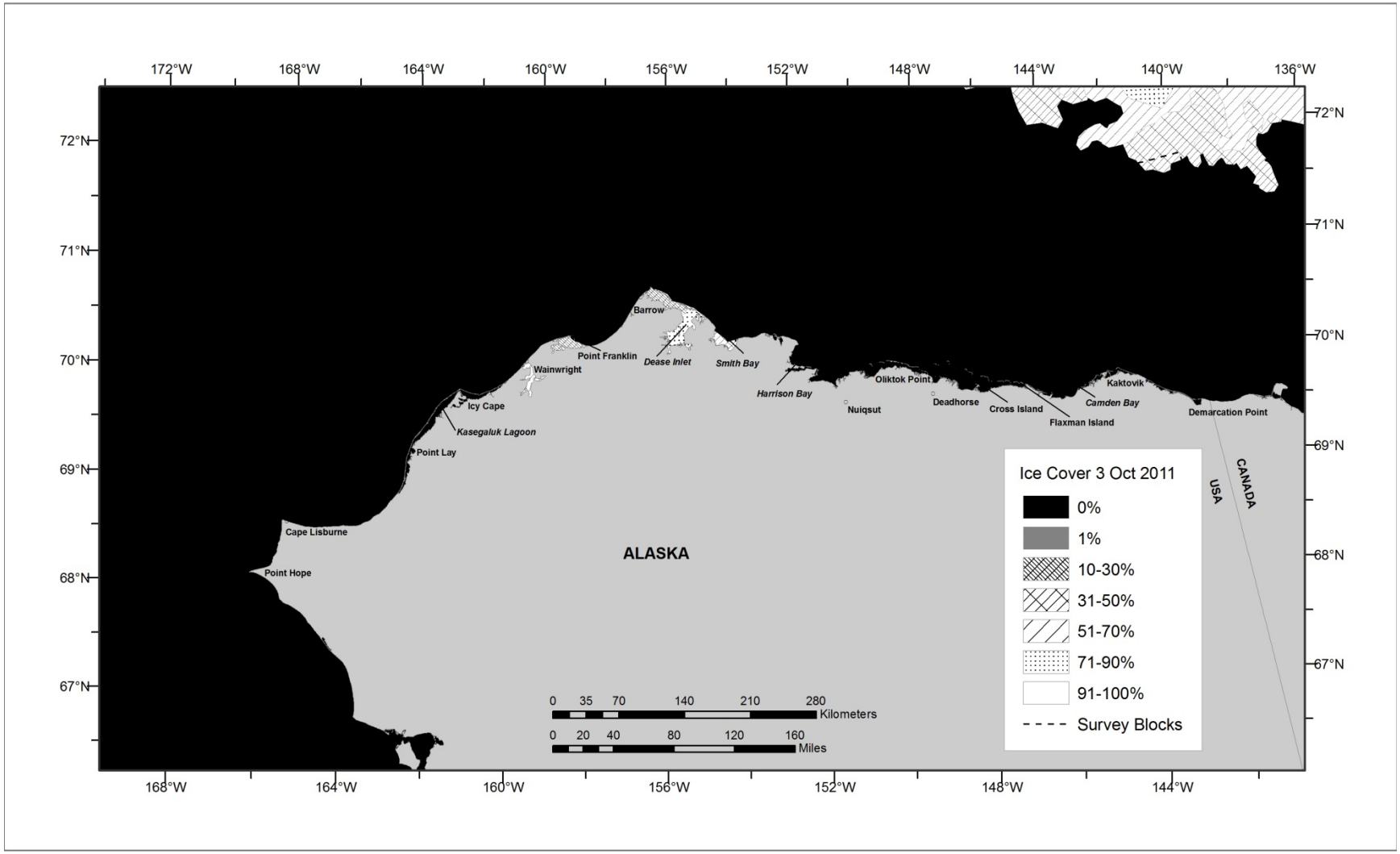

Figure A-9. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 3 October 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

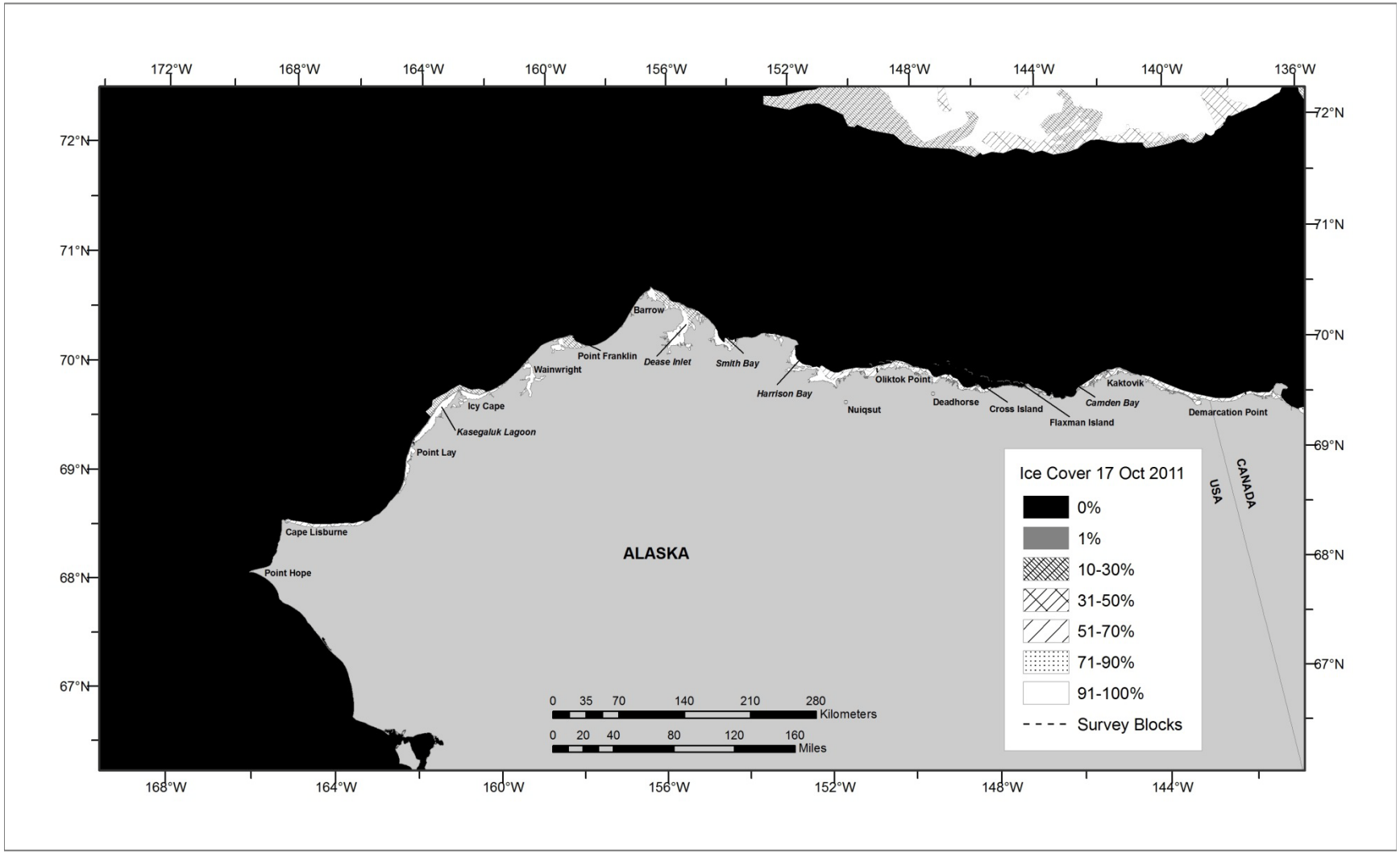

Figure A-10. Ice concentrations in the northeastern Chukchi and Alaskan Beaufort Seas, 17 October 2011. Sea ice information was obtained from the National Ice Center (http://www.natice.noaa.gov).

APPENDIX B: 2011 DAILY FLIGHT SUMMARIES

17 June 2011, Flight 201

Flight was a survey of Transects 1, 3, 5 and 7. Survey conditions were very good, with clear to partly cloudy skies, sea state Beaufort 0-3, and visibility 5-10 km. Ice cover ranged from 0-100%. The offshore ice edge (>95% broken floe) was near 71.5°N in block 13 and farther north in block 14. There was shorefast ice between Barrow and Point Franklin, with very little shorefast ice remaining south of Point Franklin. Three gray whales, including a cow-calf pair, belugas, and an unidentified cetacean were seen northeast of Point Franklin. Walruses that were swimming mostly near the broken ice edge, bearded seals, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
201	6/17/2011 16:38	71.105	158.525	gray whale	swim	1	0	13
201	6/17/2011 16:40	71.114	158.555	gray whale	swim	2	1	13
201	6/17/2011 16:41	71.100	158.579	unidentified cetacean	.	1	0	13
201	6/17/2011 16:47	71.201	158.839	beluga	swim	10	3	13
201	6/17/2011 16:48	71.206	158.855	beluga	swim	1	0	13

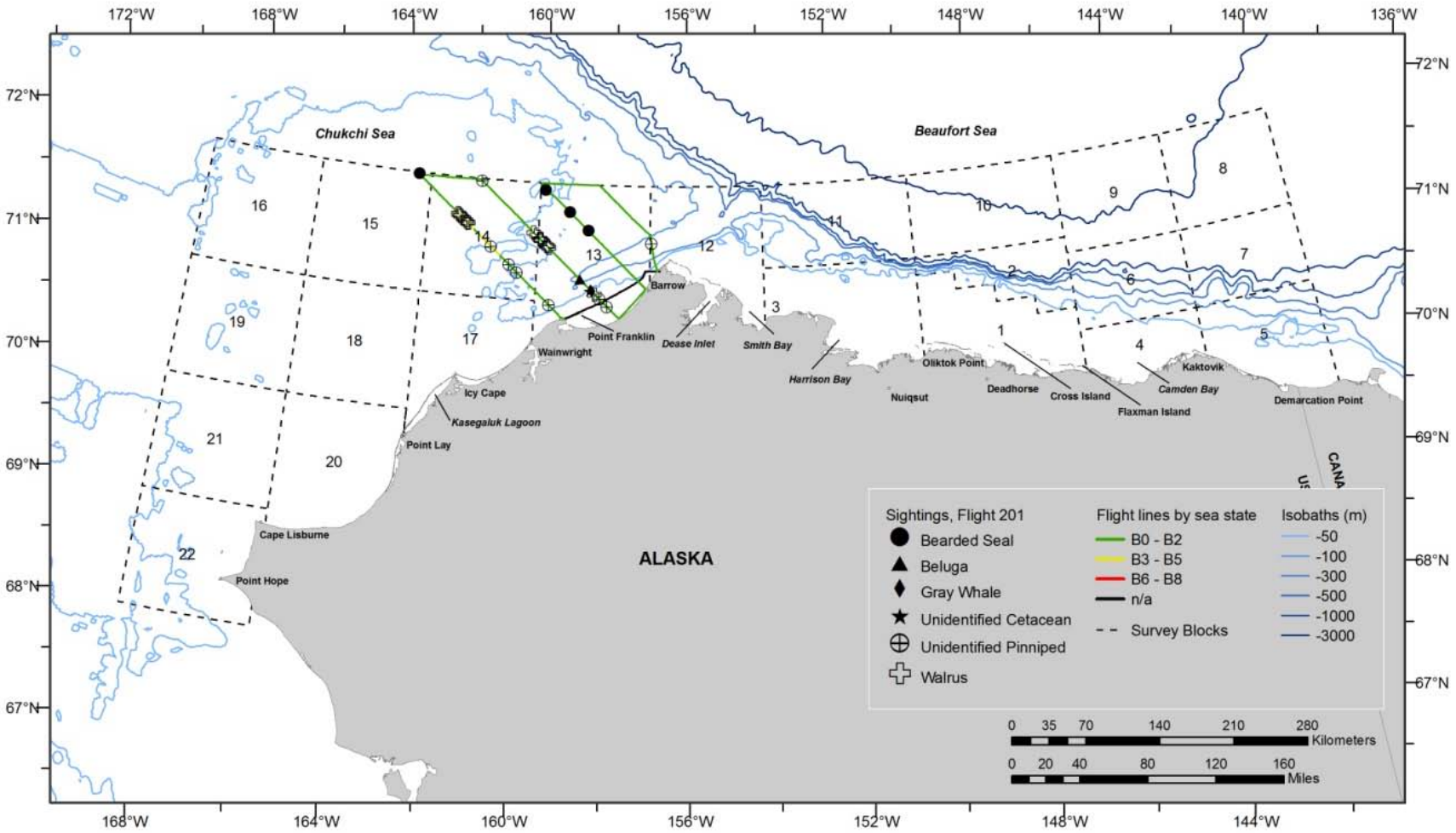

Figure B-1. Flight 201 survey track, depicted by sea state, and all sightings.

18 June 2011, Flight 202

Flight was a survey of Transects 9 and 11 and a search survey from Barrow to Wainwright. Survey conditions were fair, with clear to overcast skies, but fog prevalent over much of the survey area. Sea state was Beaufort 0-3, and visibility 0-10 km. Ice cover ranged from 0-100% and included broken floe and shorefast ice. The offshore ice edge was near 71.9° N in block 15. Fifteen gray whales, including one cow-calf pair, were seen between Barrow and Point Franklin and off of Wainwright. An unidentified cetacean was also seen near the gray whales off of Wainwright. Belugas were seen in block 16 and walruses were seen mostly swimming near the ice edge; an unidentified pinniped and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
202	6/18/2011 11:05	70.749	160.397	gray whale	feed	1	0	17
202	6/18/2011 11:05	70.751	160.406	gray whale	feed	5	0	17
202	6/18/2011 11:06	70.761	160.444	gray whale	swim	2	0	17
202	6/18/2011 11:06	70.767	160.468	gray whale	feed	1	0	17
202	6/18/2011 11:06	70.772	160.493	unidentified cetacean	swim	1	0	17
202	6/18/2011 12:31	71.887	166.586	beluga	swim	1	0	16
202	6/18/2011 12:35	71.817	166.267	beluga	swim	1	0	16
202	6/18/2011 12:35	71.811	166.241	beluga	swim	1	0	16
202	6/18/2011 14:08	71.019	158.539	gray whale	swim	2	1	13
202	6/18/2011 14:09	71.044	158.362	gray whale	swim	1	0	13
202	6/18/2011 14:09	71.054	158.293	gray whale	feed	1	0	13
202	6/18/2011 14:10	71.065	158.218	gray whale	feed	1	0	13
202	6/18/2011 14:22	71.257	157.075	gray whale	swim	1	0	13

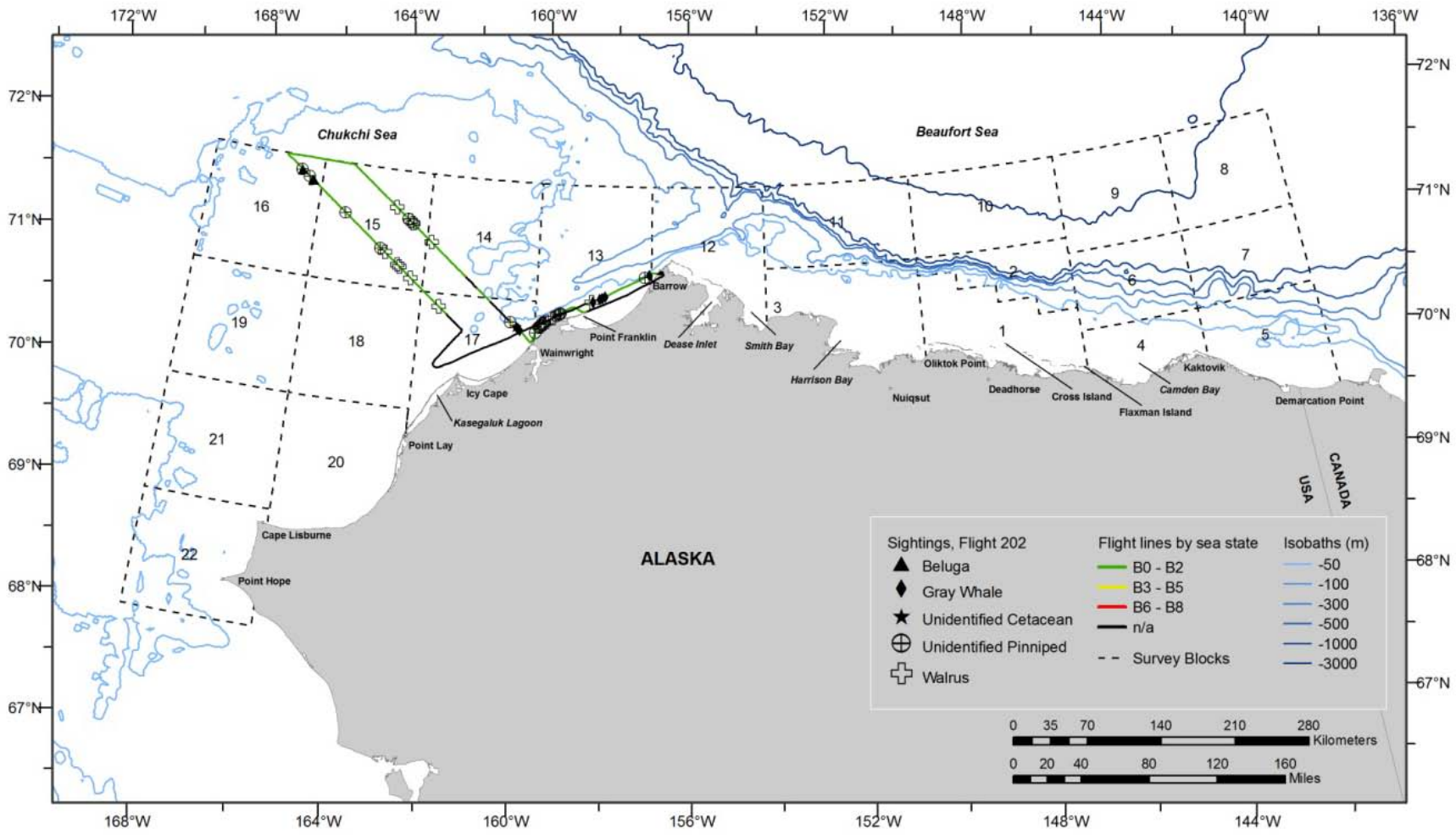

Figure B-2. Flight 202 survey track, depicted by sea state, and all sightings.

19 June 2011, Flight 203

Flight was a survey of Transects 13, 15, 17 and 19. Survey conditions were very good, with clear to partly cloudy skies, sea state Beaufort 0-3, and visibility 3-10 km. Ice cover ranged from 0-90% and included broken floe and shorefast ice. The offshore ice edge was near 71.7° N in block 15. Two bowhead whales were sighted offshore in blocks 16 and 18. One gray whale was seen offshore in block 18 and a dead gray whale was seen offshore in block 19. Belugas were sighted offshore along all four transects. Several groups of walruses were sighted hauled out on ice floes. Bearded seals, unidentified pinnipeds, and a swimming polar bear were also sighted. The polar bear was approximately 65 km from the nearest land and heading north.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
203	6/19/2011 11:00	70.841	163.995	beluga	swim	1	0	18
203	6/19/2011 12:20	71.540	168.805	beluga	swim	1	0	16
203	6/19/2011 12:20	71.538	168.798	beluga	swim	25	0	16
203	6/19/2011 12:39	71.262	167.517	bowhead whale	swim	1	0	16
203	6/19/2011 13:21	70.583	164.672	bowhead whale	mill	2	0	18
203	6/19/2011 17:22	70.243	165.016	gray whale	swim	1	0	18
203	6/19/2011 18:17	71.162	168.940	beluga	swim	1	0	16
203	6/19/2011 18:47	70.491	167.769	gray whale	dead	1	0	19
203	6/19/2011 18:52	70.446	167.569	beluga	swim	1	0	19

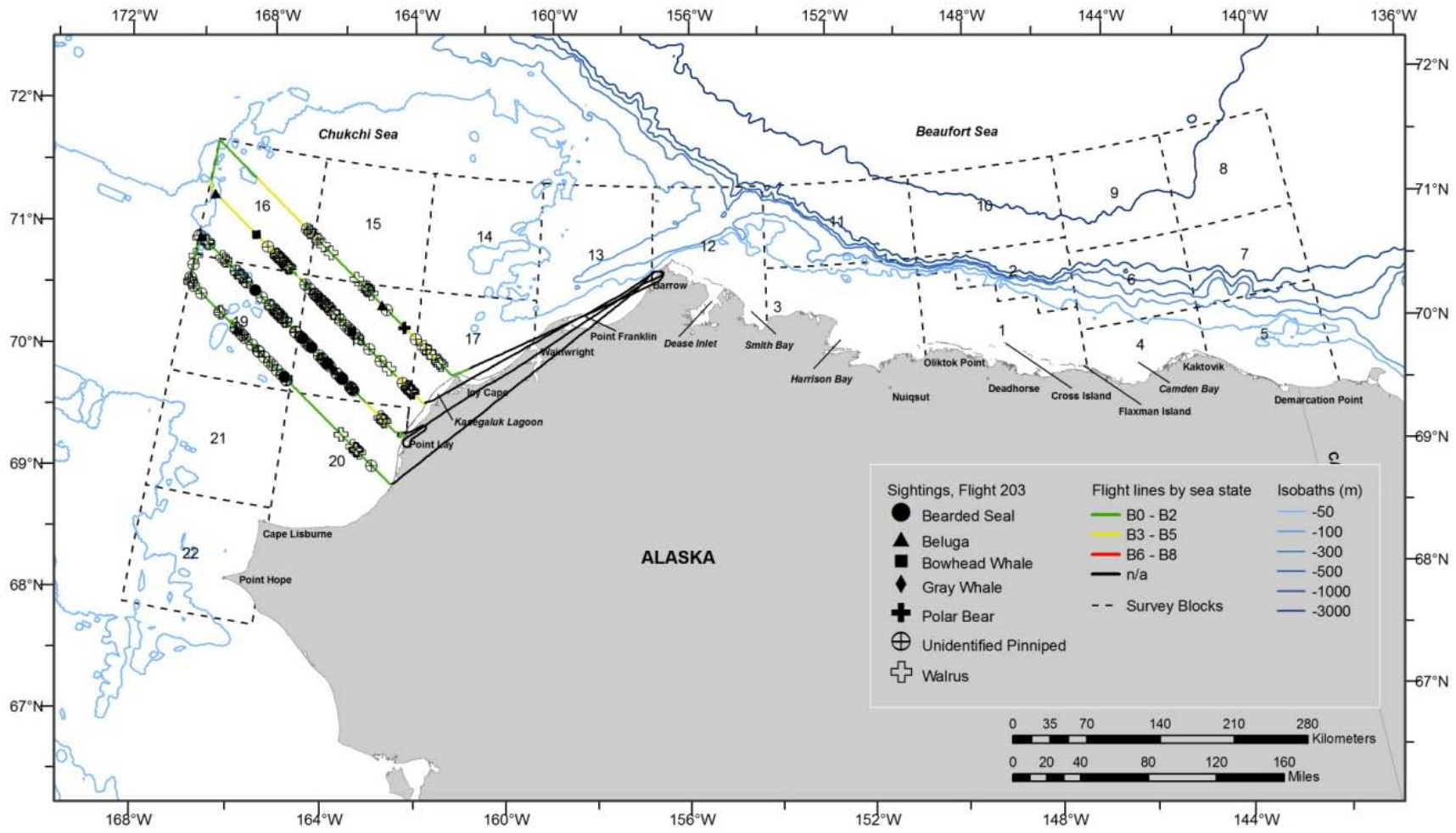

Figure B-3. Flight 203 survey track, depicted by sea state, and all sightings.

21 June 2011, Flight 204

Flight was a survey of Transects 2, 4 and 6. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 0-6, and visibility 5-10 km. High sea states of Beaufort 6 in open water areas precluded surveying other transects. Ice cover ranged from 0-100% and included broken floe and shorefast ice. The offshore ice edge was near 71.5° N in block 13. One beluga was sighted nearshore northeast of Barrow, and two belugas were sighted offshore in block 13; walruses were also sighted, including groups hauled out on ice.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
204	6/21/2011 10:37	71.333	156.793	beluga	swim	1	0	12
204	6/21/2011 11:50	71.494	159.050	beluga	swim	2	1	13

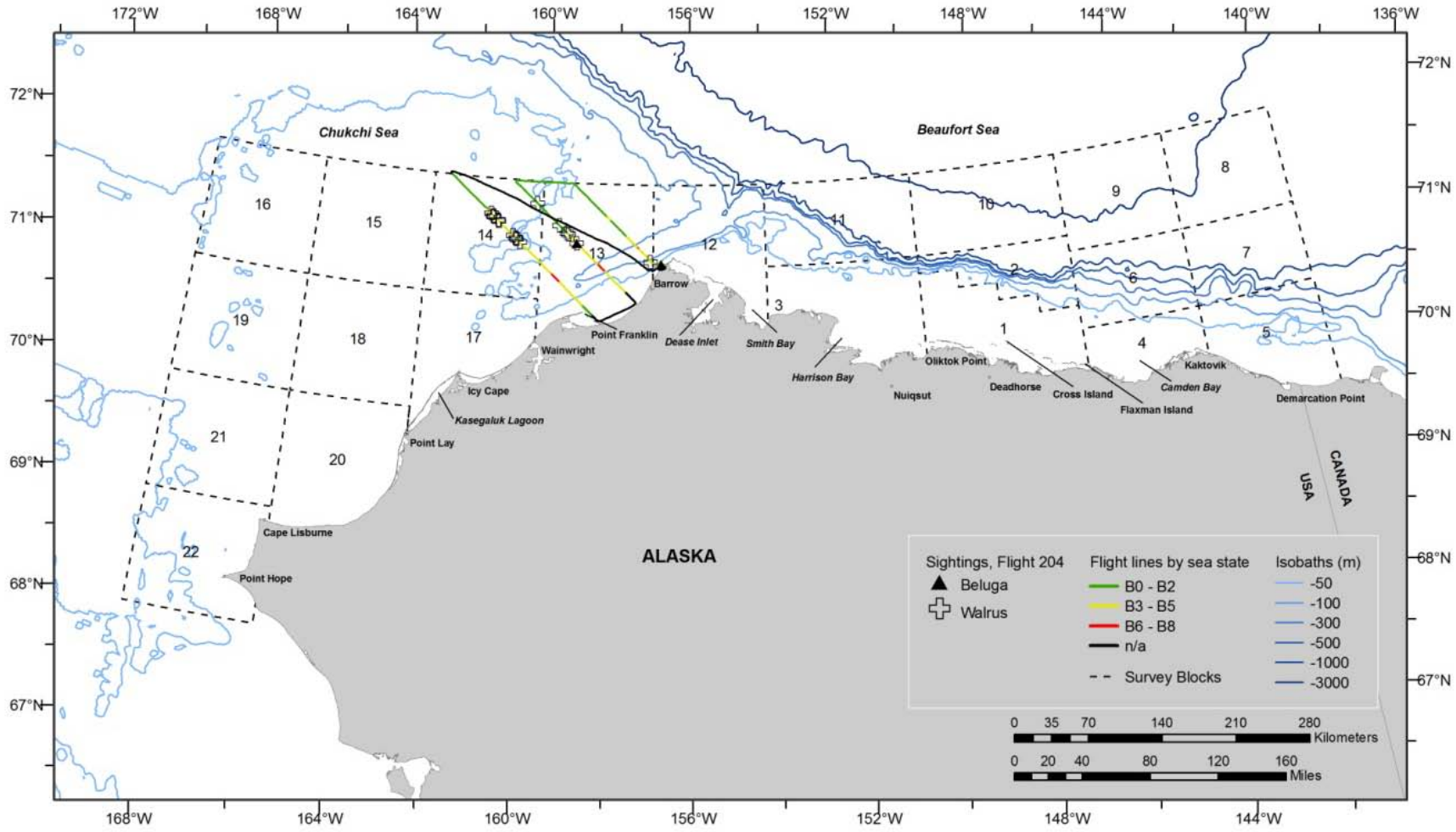

Figure B-4. Flight 204 survey track, depicted by sea state, and all sightings.

22 June 2011, Flight 205

Flight was a search survey in an attempt to find an area suitable to complete transect lines in block 13. Survey conditions were poor, with clear skies but widespread fog offshore, sea state Beaufort 1-4, and visibility 0-10 km. Offshore fog precluded surveying transect lines. Ice cover ranged from 30-100% shorefast ice. Gray whales and unidentified cetaceans were sighted between Barrow and Point Franklin. Walruses were also sighted, mostly on the shorefast ice near the gray whale sightings.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
205	6/22/2011 15:58	71.088	157.742	gray whale	feed	1	0	13
205	6/22/2011 16:02	71.003	158.250	gray whale	feed	1	0	13
205	6/22/2011 16:03	71.027	158.326	unidentified cetacean	swim	1	0	13
205	6/22/2011 16:03	71.035	158.310	unidentified cetacean	swim	3	0	13
205	6/22/2011 16:03	71.045	158.264	gray whale	feed	1	0	13
205	6/22/2011 16:04	71.027	158.283	gray whale	feed	2	1	13
205	6/22/2011 16:04	71.025	158.305	gray whale	feed	1	0	13
205	6/22/2011 16:05	71.022	158.330	gray whale	feed	2	0	13
205	6/22/2011 16:05	71.008	158.424	unidentified cetacean	feed	1	0	13

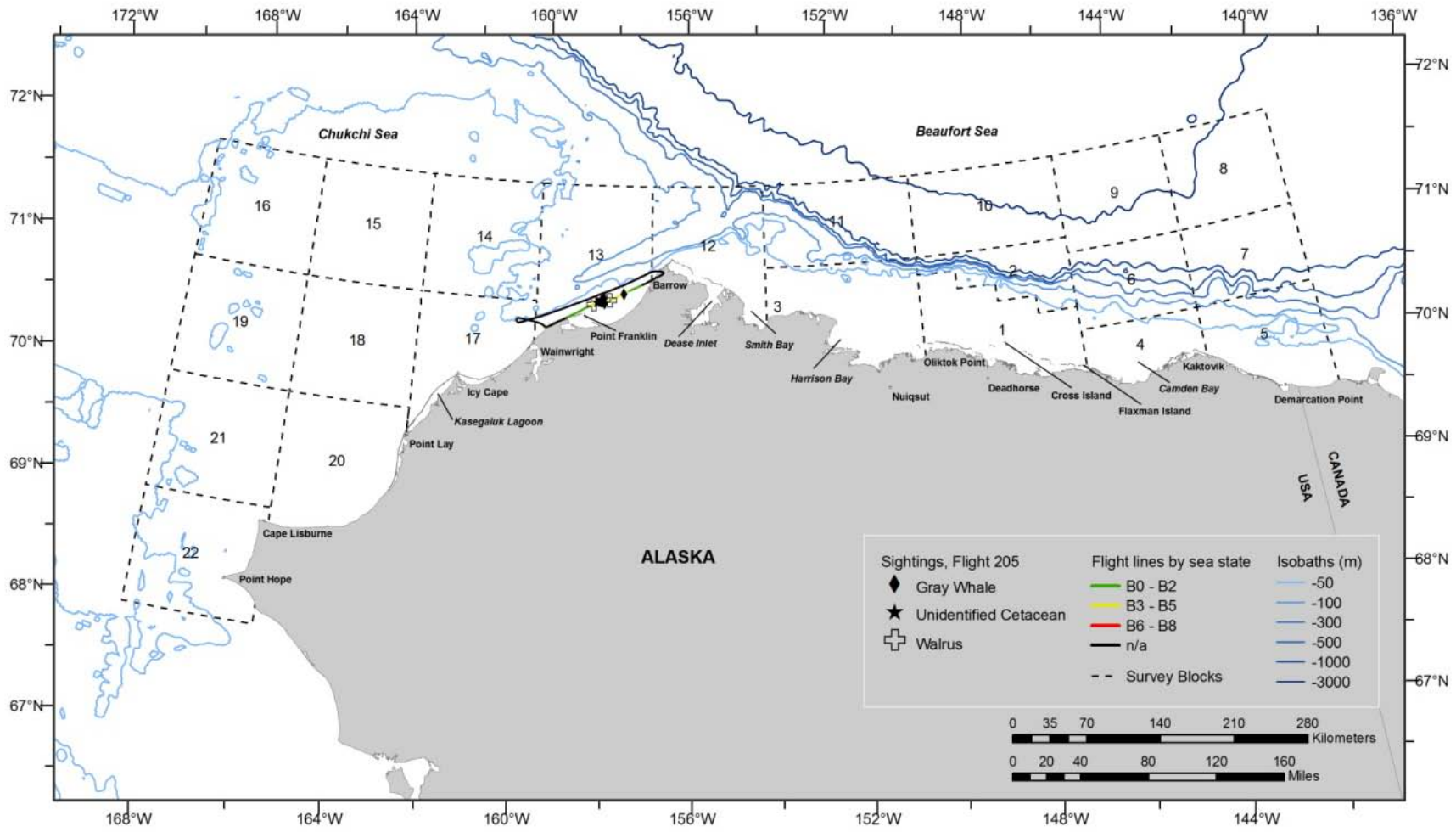

Figure B-5. Flight 205 survey track, depicted by sea state, and all sightings.

25 June 2011, Flight 206

Flight was a survey of Transects 21 and 23, a Coastal Transect from south of Point Lay north to Icy Cape, and a search survey from Barrow to Point Franklin. Survey conditions were fair, with clear skies, sea state Beaufort 0-6, and visibility 1-10 km. High sea states precluded complete coverage of transect lines. Ice cover ranged from 0-100% and included broken floe and shorefast ice. Gray whales were seen between Point Franklin and Barrow, and large groups of belugas were seen south of Point Lay, feeding and milling very close to shore. Walruses, including groups hauled out on ice, and unidentified pinnipeds were sighted throughout the area surveyed.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
206	6/25/2011 11:53	69.157	163.497	beluga	feed	400	75	20
206	6/25/2011 12:15	69.336	164.824	beluga	swim	1	0	20
206	6/25/2011 14:00	69.134	163.573	beluga	feed	350	50	20
206	6/25/2011 14:12	69.455	163.175	beluga	mill	150	15	20
206	6/25/2011 14:13	69.468	163.175	beluga	swim	1	0	20
206	6/25/2011 14:13	69.472	163.175	beluga	swim	6	0	20
206	6/25/2011 14:13	69.478	163.175	beluga	swim	1	0	20
206	6/25/2011 14:13	69.491	163.174	beluga	swim	2	0	20
206	6/25/2011 14:14	69.494	163.174	beluga	mill	1	0	20
206	6/25/2011 15:12	71.061	158.240	gray whale	feed	1	0	13
206	6/25/2011 15:14	71.086	158.093	gray whale	mill	1	0	13
206	6/25/2011 15:14	71.089	158.074	gray whale	mill	1	0	13
206	6/25/2011 15:14	71.089	158.071	gray whale	mill	1	0	13
206	6/25/2011 15:14	71.091	158.055	gray whale	feed	1	0	13
206	6/25/2011 15:15	71.099	158.004	gray whale	feed	1	0	13
206	6/25/2011 15:15	71.100	157.998	gray whale	feed	1	0	13
206	6/25/2011 15:16	71.107	157.953	gray whale	feed	1	0	13

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
206	6/25/2011 15:16	71.112	157.916	gray whale	feed	3	0	13

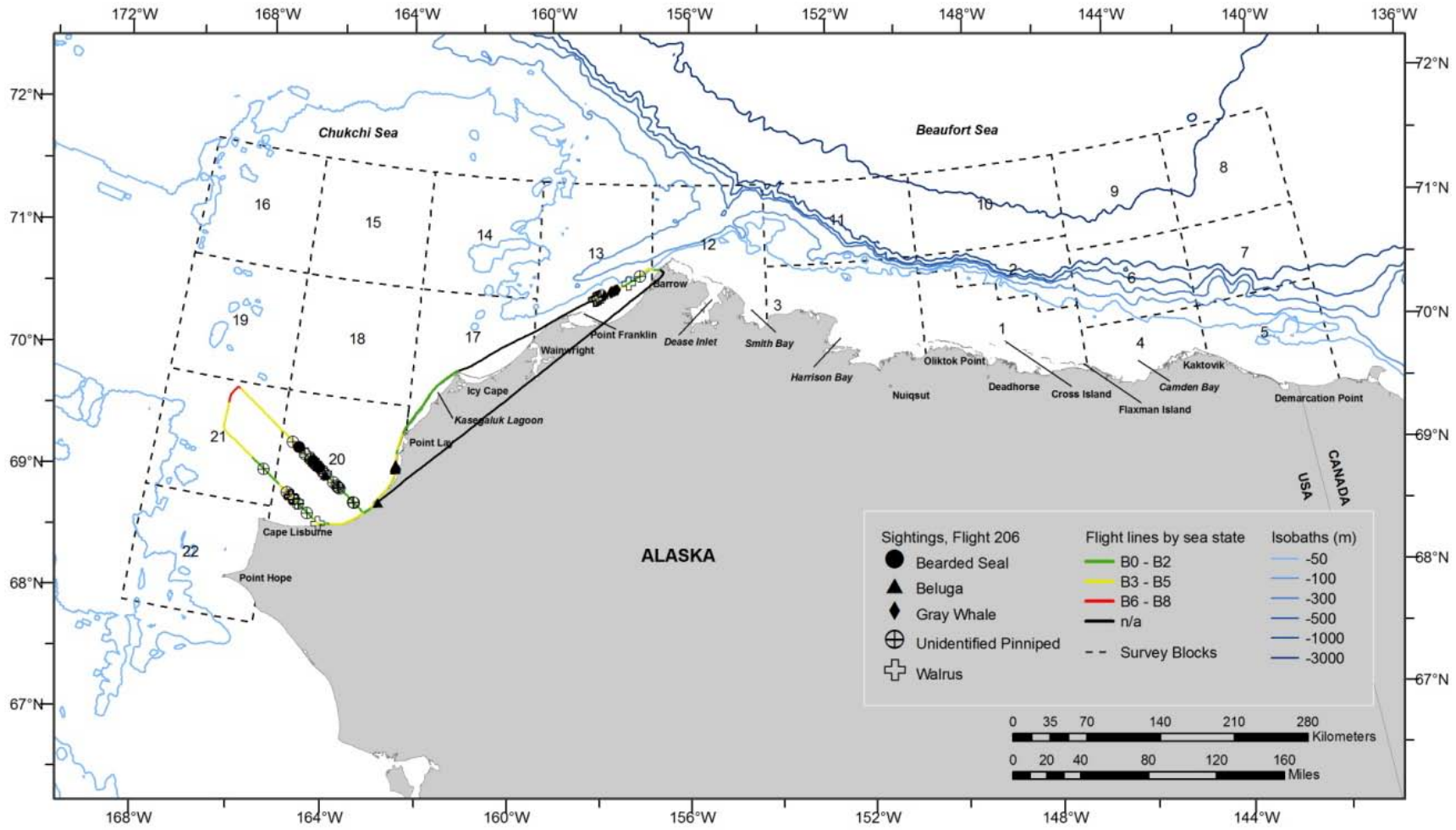

Figure B-6. Flight 206 survey track, depicted by sea state, and all sightings.

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26 June 2011, Flight 207

Flight was a survey of Transects 25, 27, 29 and 31, a partial Transect 8, and a Coastal Transect from Point Hope to south of Point Lay. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-6, and visibility 3-10 km. High sea states precluded complete coverage of Transect 8. Ice cover ranged from 0-100% and included broken floe and shorefast ice. One gray whale was seen offshore off of Wainwright, and another was seen near Point Hope. A dead walrus was sighted offshore of Cape Lisburne, and a small unidentified pinniped was sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
207	6/26/2011 9:50	70.947	160.324	gray whale	feed	1	0	17
207	6/26/2011 14:10	68.417	166.486	gray whale	mill	1	0	22

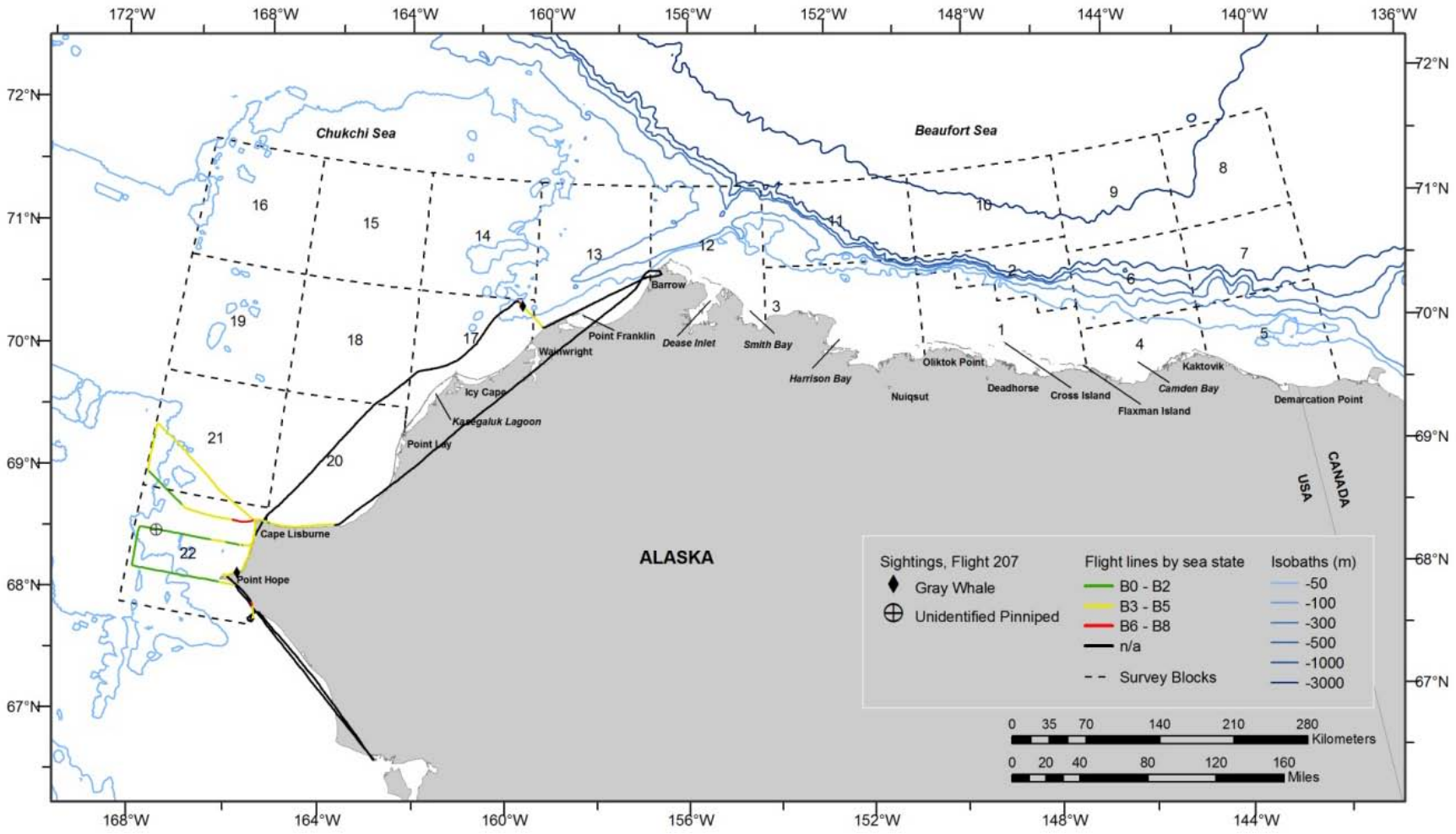

Figure B-7. Flight 207 survey track, depicted by sea state, and all sightings.

27 June 2011, Flight 208

Flight was a survey of Transects 8 and 10, a Coastal Transect from south of Wainwright to Point Franklin, and search effort from Point Franklin to Barrow. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 0-4, and visibility 1-10 km, with patches of fog over the offshore ice. Ice cover ranged from 0-95% and included broken floe and shorefast ice. The offshore ice edge was near 71.8° N in block 15. Bowhead whales were seen near Point Franklin next to the shorefast ice. Gray whales were sighted between Barrow and Point Franklin and offshore of Wainwright. Thirteen hundred walruses were sighted, most of which were hauled out on ice; bearded seals and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
208	6/27/2011 10:23	70.930	160.268	gray whale	feed	2	0	17
208	6/27/2011 10:23	70.931	160.272	gray whale	feed	1	0	17
208	6/27/2011 10:23	70.939	160.300	gray whale	feed	1	0	17
208	6/27/2011 10:23	70.940	160.306	gray whale	feed	1	0	17
208	6/27/2011 10:23	70.941	160.310	gray whale	feed	1	0	17
208	6/27/2011 12:37	70.774	161.293	gray whale	feed	2	0	17
208	6/27/2011 12:39	70.787	161.241	gray whale	swim	2	0	17
208	6/27/2011 12:41	70.733	161.154	gray whale	feed	1	0	17
208	6/27/2011 13:06	70.853	159.526	bowhead whale	mill	2	0	13
208	6/27/2011 13:06	70.852	159.478	bowhead whale	rest	1	0	13
208	6/27/2011 13:09	70.849	159.529	bowhead whale	rest	1	0	13
208	6/27/2011 13:09	70.856	159.514	gray whale	swim	2	1	13
208	6/27/2011 13:11	70.896	159.311	gray whale	rest	2	0	13
208	6/27/2011 13:12	70.911	159.228	gray whale	swim	1	0	13
208	6/27/2011 13:23	71.049	158.282	gray whale	feed	1	0	13
208	6/27/2011 13:25	71.064	158.332	gray whale	dive	1	0	13

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
208	6/27/2011 13:28	71.089	158.082	gray whale	feed	1	0	13
208	6/27/2011 13:29	71.097	158.013	gray whale	feed	1	0	13
208	6/27/2011 13:30	71.113	157.966	gray whale	feed	1	0	13
208	6/27/2011 13:30	71.120	157.942	gray whale	rest	1	0	13
208	6/27/2011 13:30	71.124	157.929	gray whale	feed	2	1	13
208	6/27/2011 13:39	71.281	157.117	gray whale	feed	1	0	13

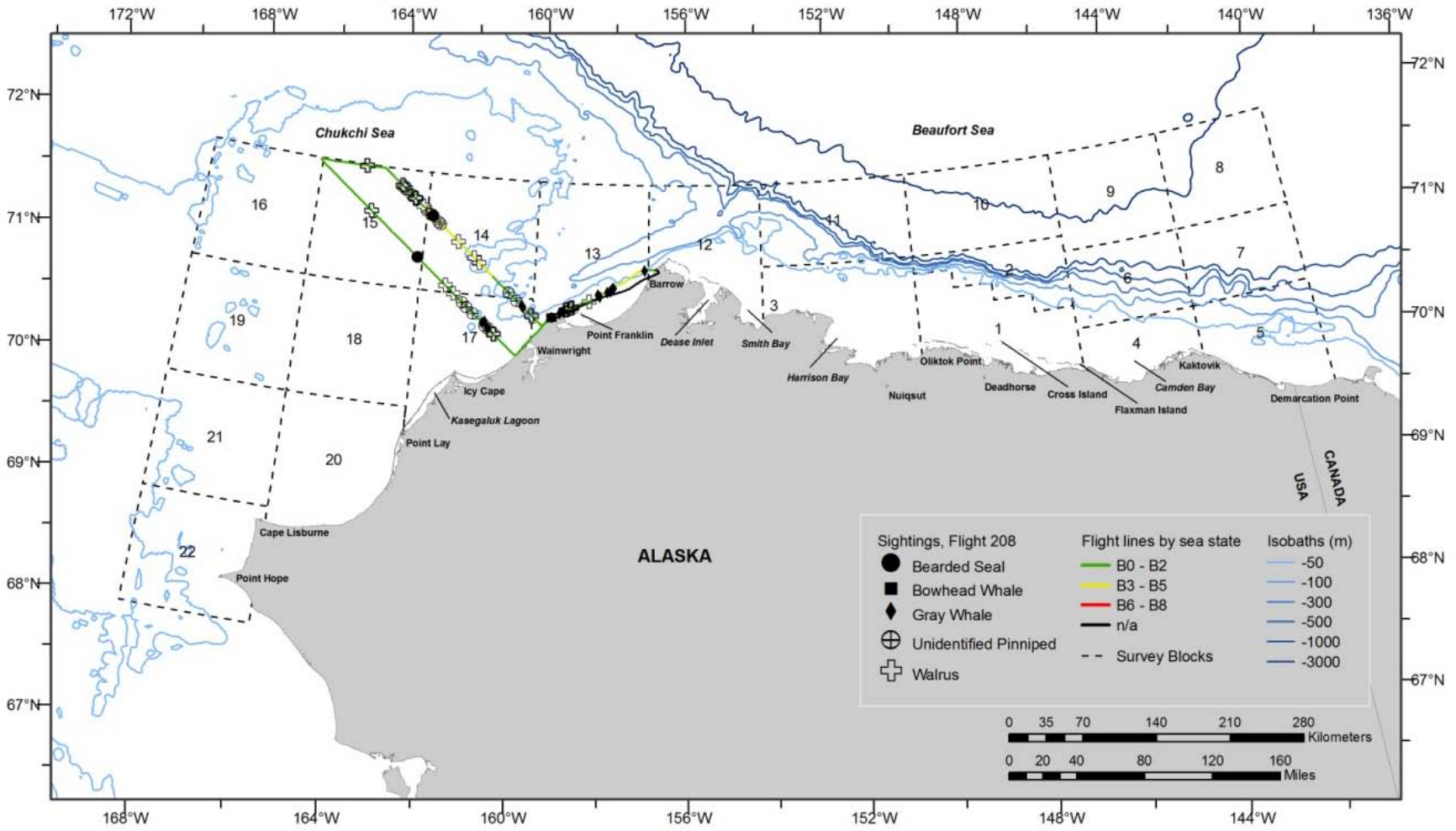

Figure B-8. Flight 208 survey track, depicted by sea state, and all sightings.

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28 June 2011, Flight 209

Flight was search effort from south of Wainwright to Barrow. Survey conditions were poor, with partly cloudy skies, sea state Beaufort 1-6, and visibility from <1-10 km, with widespread fog from Wainwright to the south. Ice cover ranged from 20-70% and included broken floe and shorefast ice. The shorefast ice from Point Franklin to Barrow was beginning to break free of land. Gray whales were sighted between Point Franklin and Barrow, and small groups of walruses were hauled out on what remained of the shorefast ice east of Pt. Franklin.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
209	6/28/2011 10:32	70.945	159.006	gray whale	feed	2	0	13
209	6/28/2011 10:32	70.947	158.996	gray whale	feed	1	0	13
209	6/28/2011 10:46	71.004	158.299	gray whale	feed	1	0	13

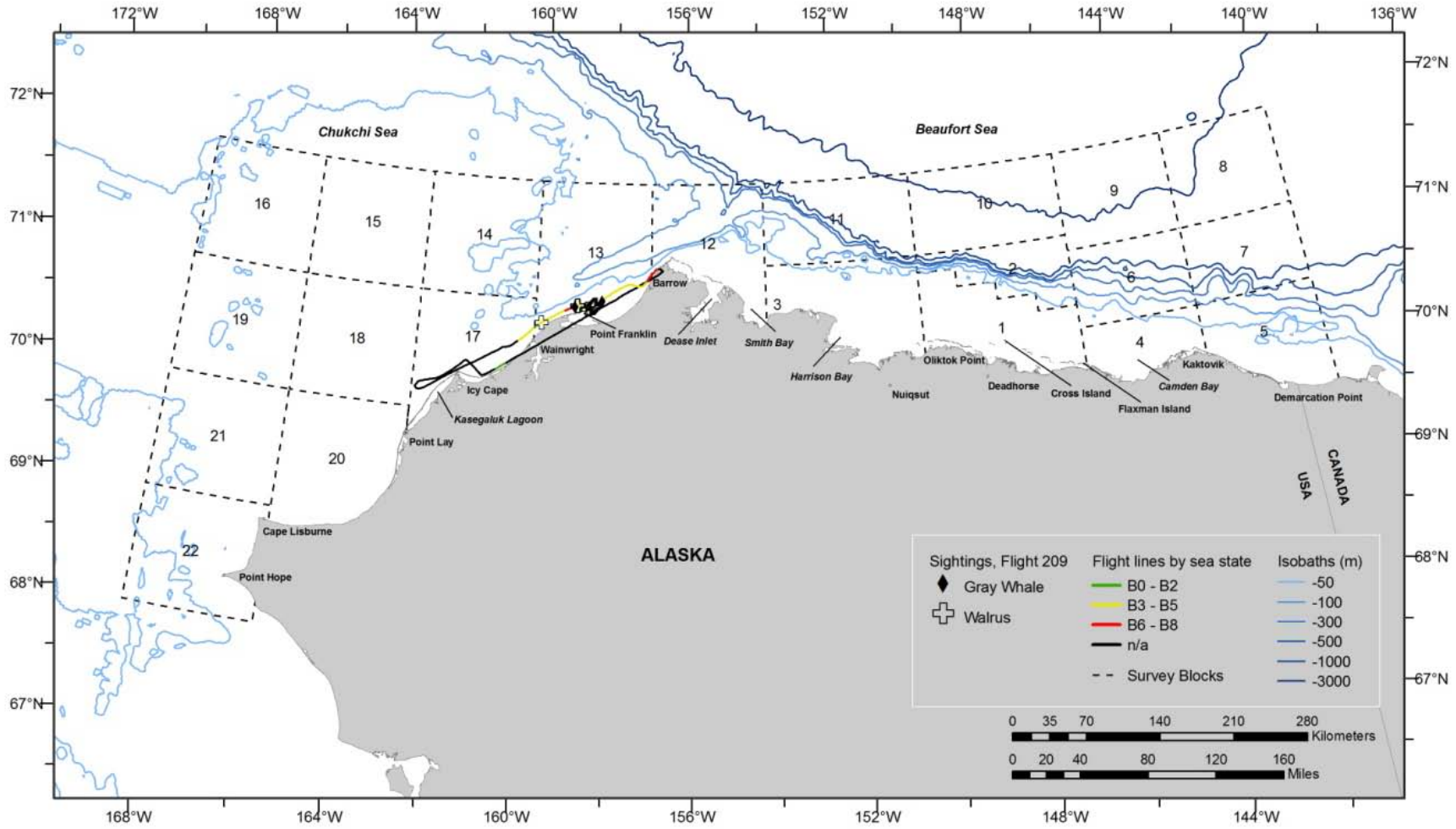

Figure B-9. Flight 209 survey track, depicted by sea state, and all sightings.

2 July 2011, Flight 210

Flight was a survey of Transects 1 and 3, and a partial Transect 5. Survey conditions were poor, with partly cloudy to overcast skies, sea state Beaufort 1-6, and visibility 1-10 km, with areas of low clouds. High sea states precluded complete coverage of Transect 5. Ice cover ranged from 5-90% and consisted of broken floe ice. Gray whales were sighted between Point Franklin and Barrow, including one cow-calf pair. Belugas were sighted north of Barrow, and a bearded seal and a small unidentified pinniped were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
210	7/2/2011 10:37	71.390	156.849	beluga	swim	1	0	12
210	7/2/2011 10:38	71.406	156.867	beluga	swim	1	0	12
210	7/2/2011 10:41	71.521	156.954	beluga	swim	2	0	12
210	7/2/2011 10:41	71.523	156.956	beluga	swim	5	0	12
210	7/2/2011 10:41	71.526	156.958	beluga	swim	6	0	12
210	7/2/2011 10:42	71.538	156.966	beluga	swim	2	0	12
210	7/2/2011 12:17	71.007	158.214	gray whale	feed	1	0	13
210	7/2/2011 12:17	71.008	158.217	gray whale	swim	2	1	13
210	7/2/2011 12:19	71.003	158.232	gray whale	feed	2	0	13
210	7/2/2011 12:24	71.030	158.280	gray whale	swim	2	0	13

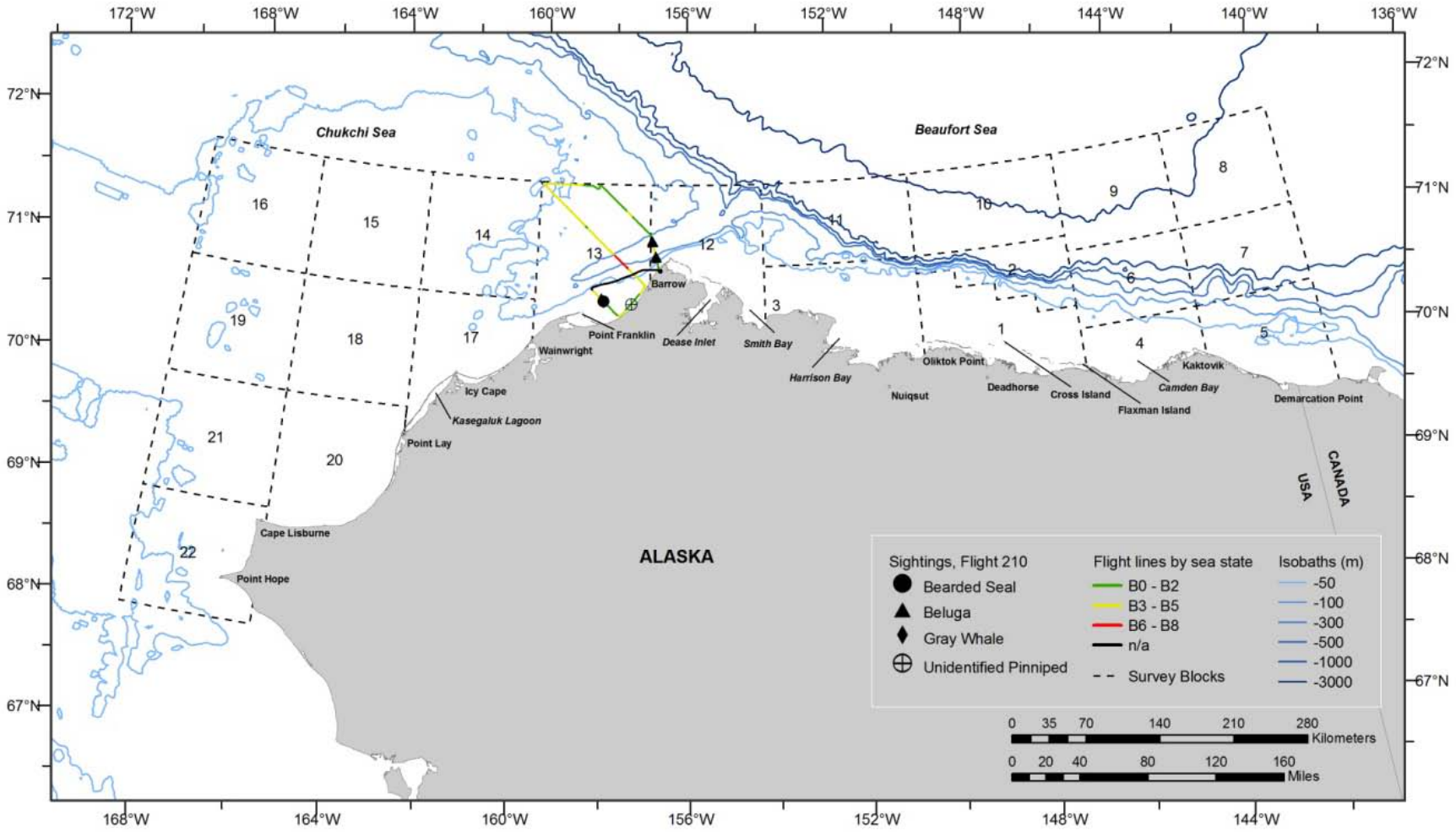

Figure B-10. Flight 210 survey track, depicted by sea state, and all sightings.

3 July 2011, Flight 211

Flight was a survey of partial Transect 7, and a Coastal Transect from Point Franklin to south of Barrow. Survey conditions were poor, with partly cloudy skies, sea state Beaufort 2-6, and visibility <1-10 km. Areas of low clouds and fog precluded complete coverage of Transect 7. Ice cover ranged from 0-50% broken floe ice. Gray whales, including a cow-calf pair, an unidentified cetacean, and belugas were sighted offshore of Point Franklin. Walruses hauled out on ice and a bearded seal were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
211	7/3/2011 15:54	71.054	159.909	beluga	swim	1	0	13
211	7/3/2011 15:55	71.073	159.971	beluga	swim	1	0	13
211	7/3/2011 15:55	71.077	159.986	beluga	swim	2	0	13
211	7/3/2011 15:56	71.084	160.008	beluga	swim	5	0	14
211	7/3/2011 15:59	71.158	160.267	beluga	swim	1	0	14
211	7/3/2011 16:03	71.235	160.535	beluga	rest	2	1	14
211	7/3/2011 16:12	71.123	160.669	gray whale	feed	7	1	14
211	7/3/2011 16:12	71.122	160.666	gray whale	feed	1	0	14
211	7/3/2011 16:14	71.117	160.680	gray whale	feed	1	0	14
211	7/3/2011 16:14	71.135	160.644	unidentified cetacean	swim	1	0	14
211	7/3/2011 16:23	70.973	160.134	gray whale	feed	1	0	17
211	7/3/2011 16:23	70.966	160.117	gray whale	feed	1	0	17
211	7/3/2011 16:23	70.962	160.107	gray whale	feed	4	0	17
211	7/3/2011 16:24	70.951	160.074	gray whale	feed	1	0	17
211	7/3/2011 16:24	70.926	160.005	gray whale	swim	1	0	17

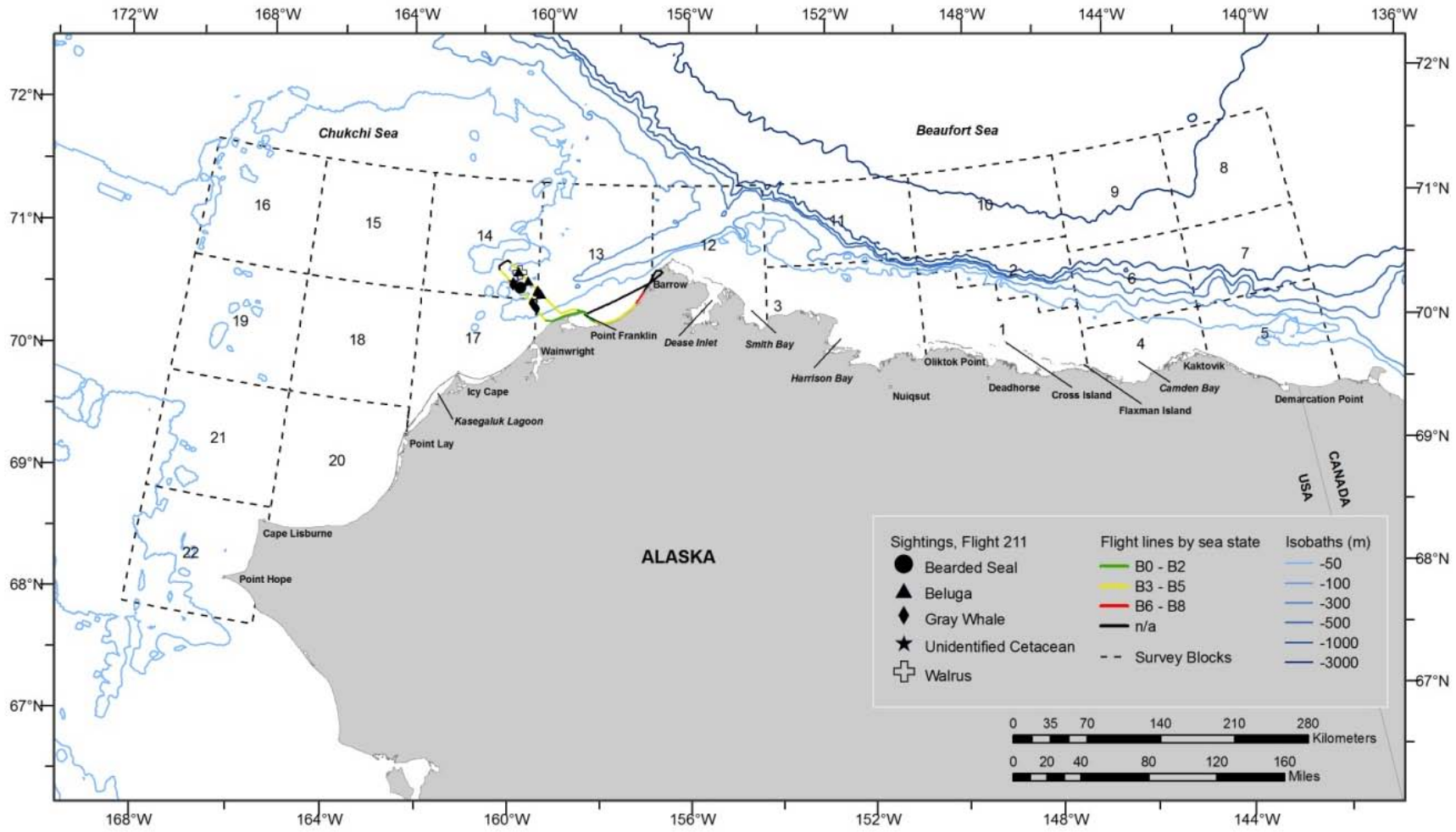

Figure B-11. Flight 211 survey track, depicted by sea state, and all sightings.

6 July 2011, Flight 212

Flight was a survey of partial Transect 12, and a Coastal Transect from south of Icy Cape to Barrow. Survey conditions were poor, with clear to partly cloudy skies, sea state Beaufort 2-6, and visibility 0-10 km, with an area of fog west of Point Barrow. High sea states precluded complete coverage of Transect 12. Ice cover ranged from 0-50% broken floe ice. Sightings included a walrus and a small unidentified pinniped.

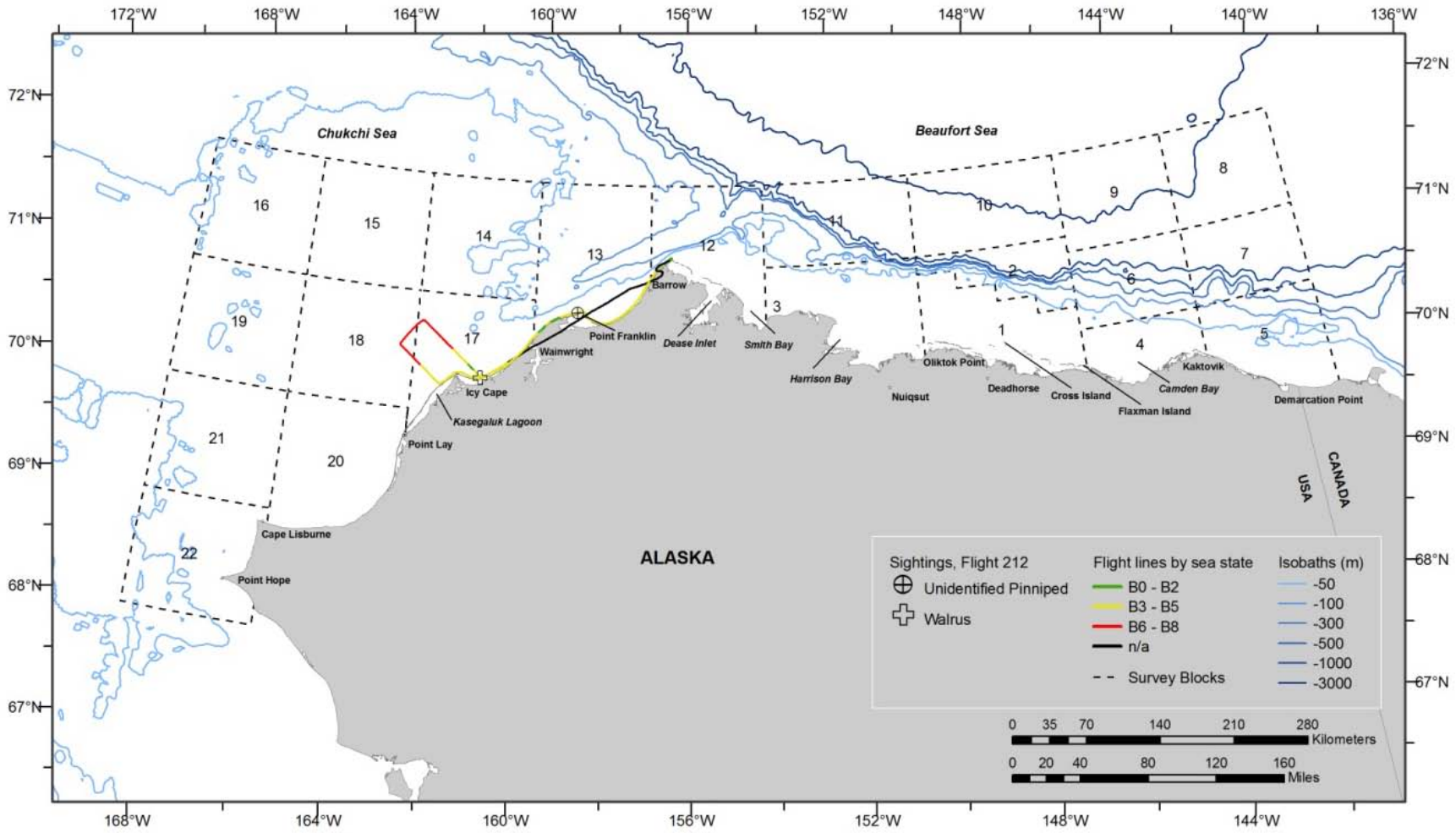

Figure B-12. Flight 212 survey track, depicted by sea state, and all sightings.

7 July 2011, Flight 213

Flight was a survey of partial Transects 2, 4 and 6. Survey conditions were poor, with partly cloudy skies, sea state Beaufort 2-6, and visibility <1-10 km. Offshore fog precluded complete coverage of transect lines. Ice cover ranged from 0-50% broken floe ice. Gray whales were sighted between Point Franklin and Barrow. Walruses, mostly hauled out on ice, bearded seals, and an unidentified pinniped were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
213	7/7/2011 11:05	71.318	156.935	gray whale	swim	1	0	13
213	7/7/2011 11:59	71.172	157.978	gray whale	feed	1	0	13
213	7/7/2011 11:59	71.164	157.954	gray whale	feed	1	0	13
213	7/7/2011 11:59	71.164	157.953	gray whale	feed	2	0	13
213	7/7/2011 12:02	71.161	157.946	gray whale	feed	1	0	13
213	7/7/2011 12:04	71.129	157.839	gray whale	swim	1	0	13
213	7/7/2011 12:04	71.128	157.837	gray whale	feed	1	0	13

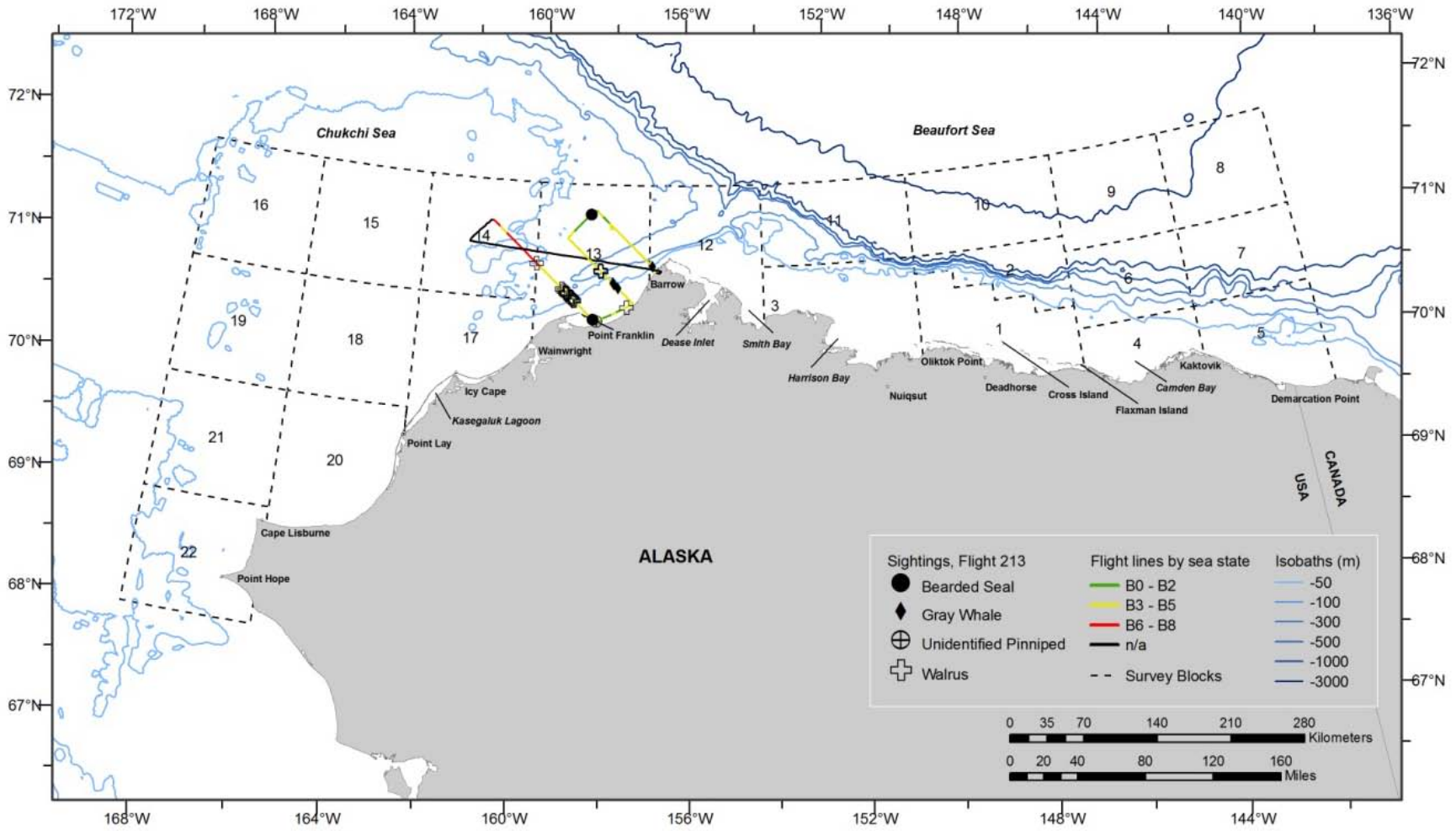

Figure B-13. Flight 213 survey track, depicted by sea state, and all sightings.

8 July 2011, Flight 214

Flight was a survey of Transects 28, 30 and 32 and a Coastal Transect from south of Point Hope to east of Cape Lisburne. Survey conditions were good, with partly cloudy skies, sea state Beaufort 2-6, and visibility 5-10 km. Ice cover ranged from 0-50% broken floe ice. Gray whales were sighted both nearshore and offshore of Point Hope, and nearshore at Cape Lisburne. One beluga was seen. Bearded seals and small unidentified pinnipeds were also sighted, and a dead walrus was sighted offshore northwest of Point Hope. One musk ox was sighted on the cliffs east of Cape Lisburne.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
214	7/8/2011 12:46	68.140	168.772	gray whale	rest	2	1	22
214	7/8/2011 15:36	68.331	166.794	gray whale	rest	2	1	22
214	7/8/2011 15:36	68.335	166.857	gray whale	feed	1	0	22
214	7/8/2011 15:41	68.412	166.505	gray whale	swim	2	1	22
214	7/8/2011 15:44	68.464	166.351	gray whale	swim	1	0	22
214	7/8/2011 16:03	68.889	166.172	gray whale	swim	2	0	22
214	7/8/2011 16:08	68.871	165.883	beluga	dive	1	0	20
214	7/8/2011 16:17	68.868	165.358	gray whale	mill	1	0	20
214	7/8/2011 16:26	68.892	165.045	gray whale	feed	1	0	20

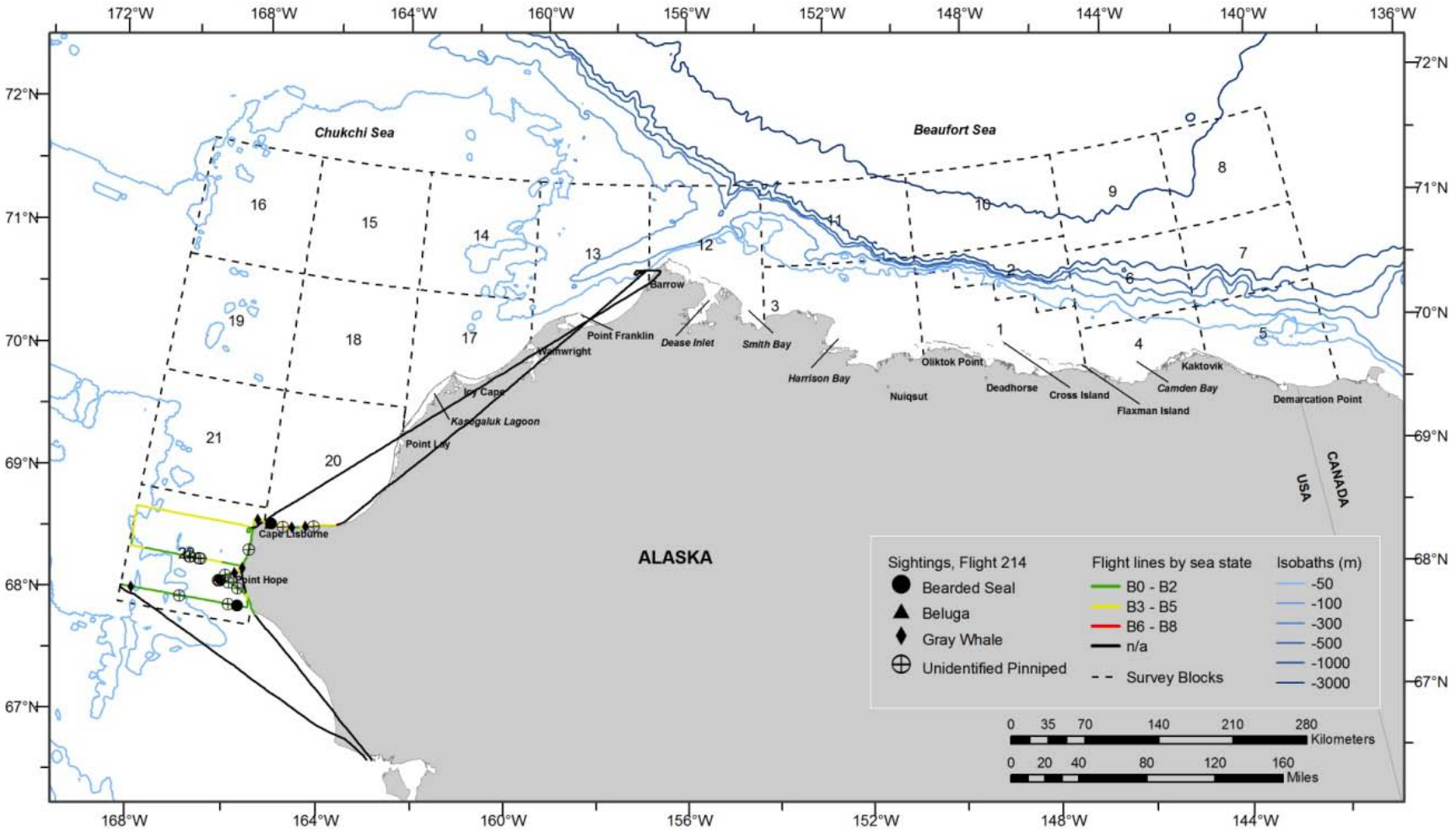

Figure B-14. Flight 214 survey track, depicted by sea state, and all sightings.

10 July 2011, Flight 215

Flight was a survey of Transects 1 and 3. Survey conditions were fair, with clear skies, sea state Beaufort 2-6, and visibility 5-10 km. Ice cover ranged from 0-70% broken floe ice. Gray whales were sighted off of Barrow, and bearded seals were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
215	7/10/2011 11:27	71.358	156.820	gray whale	feed	2	0	12
215	7/10/2011 12:53	71.258	157.494	gray whale	feed	1	0	13
215	7/10/2011 12:54	71.238	157.435	gray whale	feed	1	0	13

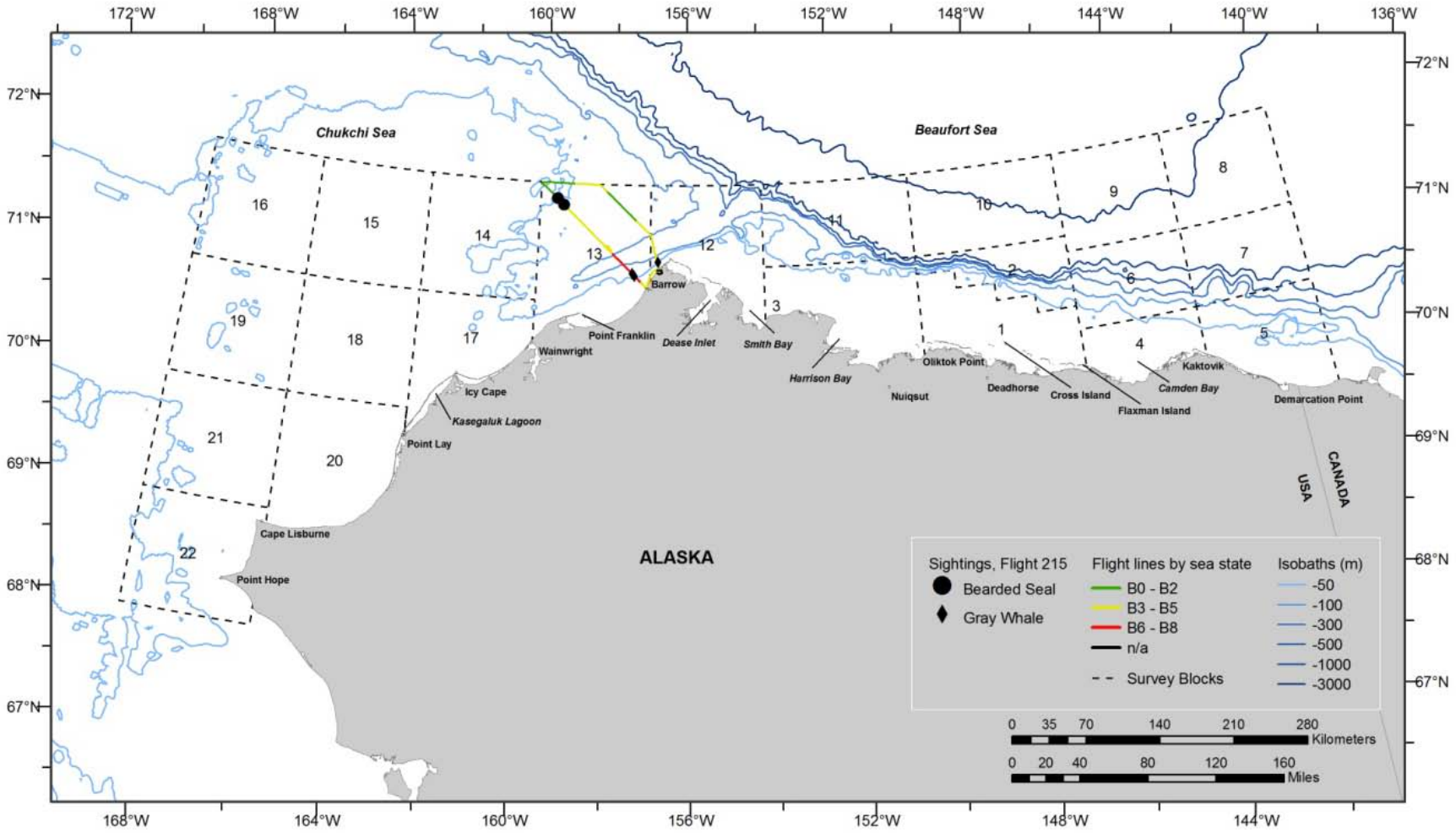

Figure B-15. Flight 215 survey track, depicted by sea state, and all sightings.

11 July 2011, Flight 216

Flight was a survey of partial Transects 5 and 7, and a Coastal Transect from just south of Point Franklin to Barrow. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 3-7, and visibility 0-10 km. High sea states and fog precluded complete coverage of transect lines. Ice cover ranged from 0-90% broken floe ice; most of the area surveyed was ice free. Gray whales were sighted between Point Franklin and Barrow, and walruses hauled out on ice were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
216	7/11/2011 12:16	71.155	157.132	gray whale	feed	1	0	13
216	7/11/2011 12:32	71.025	158.267	gray whale	feed	1	0	13
216	7/11/2011 12:32	71.043	158.325	gray whale	feed	1	0	13
216	7/11/2011 13:33	71.162	157.125	gray whale	feed	1	0	13

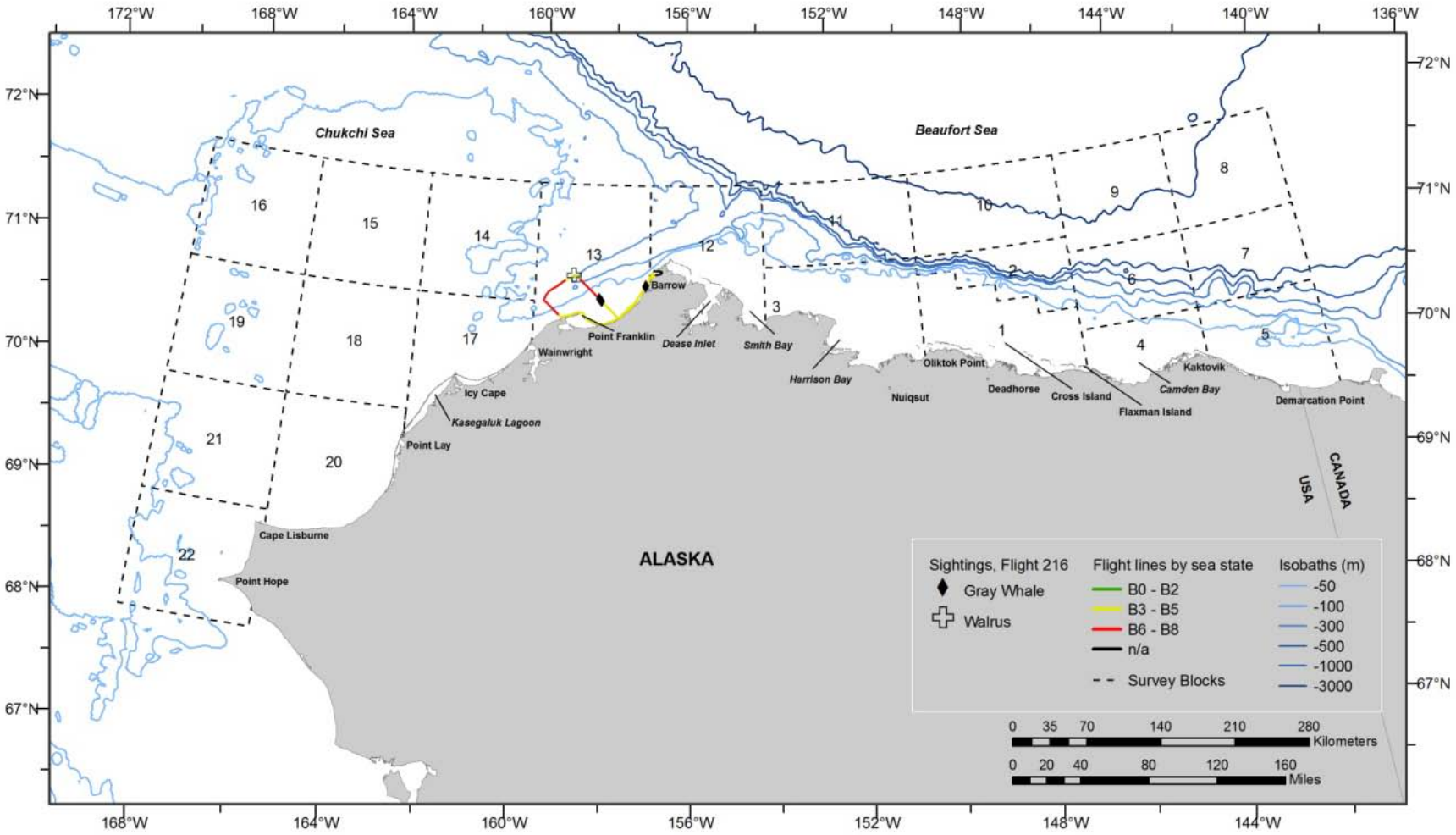

Figure B-16. Flight 216 survey track, depicted by sea state, and all sightings.

14 July 2011, Flight 217

Flight was an exploratory search survey north of Camden Bay to investigate the area near the last known position of a satellite tagged bowhead whale. An expanding box was flown around position 70°44'N 144°36'W, followed by a search survey east to 141°30'W, south to 70°30'N, and west to 146°W. Survey conditions were good, with partly cloudy skies, sea state Beaufort 4-6, and visibility 5-10 km. Ice cover ranged from 0-1% broken floe ice; most of the survey area was ice free. Sightings included bowhead whales, the majority of which were within the expanding survey box (block 6); one bowhead whale was seen on the northern edge of block 5. Belugas and an unidentified cetacean were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
217	7/14/2011 10:54	70.731	144.576	bowhead whale	mill	2	0	6
217	7/14/2011 11:01	70.732	144.564	bowhead whale	swim	1	0	6
217	7/14/2011 11:09	70.707	144.489	beluga	swim	1	0	6
217	7/14/2011 11:11	70.767	144.430	bowhead whale	swim	1	0	6
217	7/14/2011 11:18	70.763	144.317	beluga	swim	1	0	6
217	7/14/2011 11:21	70.771	144.372	beluga	swim	2	1	6
217	7/14/2011 11:34	70.790	144.403	beluga	swim	1	0	6
217	7/14/2011 11:37	70.816	144.742	bowhead whale	rest	2	0	6
217	7/14/2011 11:38	70.821	144.815	bowhead whale	other	1	0	6
217	7/14/2011 11:55	70.653	144.331	bowhead whale	swim	1	0	6
217	7/14/2011 11:57	70.656	144.194	beluga	swim	1	0	6
217	7/14/2011 12:01	70.772	144.159	unidentified cetacean	dive	1	0	6
217	7/14/2011 12:11	70.848	144.354	bowhead whale	dive	2	0	6
217	7/14/2011 12:14	70.844	144.298	beluga	swim	1	0	6
217	7/14/2011 12:29	70.797	145.033	bowhead whale	swim	1	0	6
217	7/14/2011 12:30	70.765	144.987	beluga	swim	1	0	6

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
217	7/14/2011 12:31	70.758	144.911	bowhead whale	swim	1	0	6
217	7/14/2011 12:36	70.733	144.564	beluga	swim	1	0	6
217	7/14/2011 12:36	70.732	144.546	bowhead whale	swim	1	0	6
217	7/14/2011 12:36	70.732	144.543	bowhead whale	mill	1	0	6
217	7/14/2011 12:38	70.728	144.387	beluga	rest	1	0	6
217	7/14/2011 12:43	70.718	143.946	beluga	rest	3	0	6
217	7/14/2011 12:45	70.720	143.774	bowhead whale	swim	1	0	6
217	7/14/2011 12:45	70.720	143.774	bowhead whale	rest	1	0	6
217	7/14/2011 12:49	70.717	143.494	bowhead whale	swim	1	0	6
217	7/14/2011 12:49	70.716	143.434	beluga	swim	1	0	6
217	7/14/2011 12:50	70.715	143.381	beluga	swim	1	0	6
217	7/14/2011 12:51	70.715	143.328	beluga	rest	1	0	6
217	7/14/2011 12:51	70.715	143.328	beluga	rest	1	0	6
217	7/14/2011 12:51	70.715	143.302	beluga	swim	1	0	6
217	7/14/2011 12:51	70.715	143.263	beluga	swim	1	0	6
217	7/14/2011 12:52	70.714	143.240	beluga	swim	1	0	6
217	7/14/2011 12:52	70.714	143.240	beluga	rest	2	0	6
217	7/14/2011 12:53	70.710	143.099	beluga	rest	1	0	6
217	7/14/2011 13:00	70.702	142.510	beluga	rest	1	0	7
217	7/14/2011 13:02	70.698	142.286	beluga	swim	1	0	7
217	7/14/2011 13:10	70.687	141.626	beluga	rest	1	0	7
217	7/14/2011 13:12	70.664	141.503	beluga	swim	1	0	7
217	7/14/2011 13:14	70.593	141.499	beluga	rest	3	0	7
217	7/14/2011 13:17	70.504	141.556	beluga	mill	4	0	7
217	7/14/2011 13:23	70.503	141.846	bowhead whale	rest	1	0	5

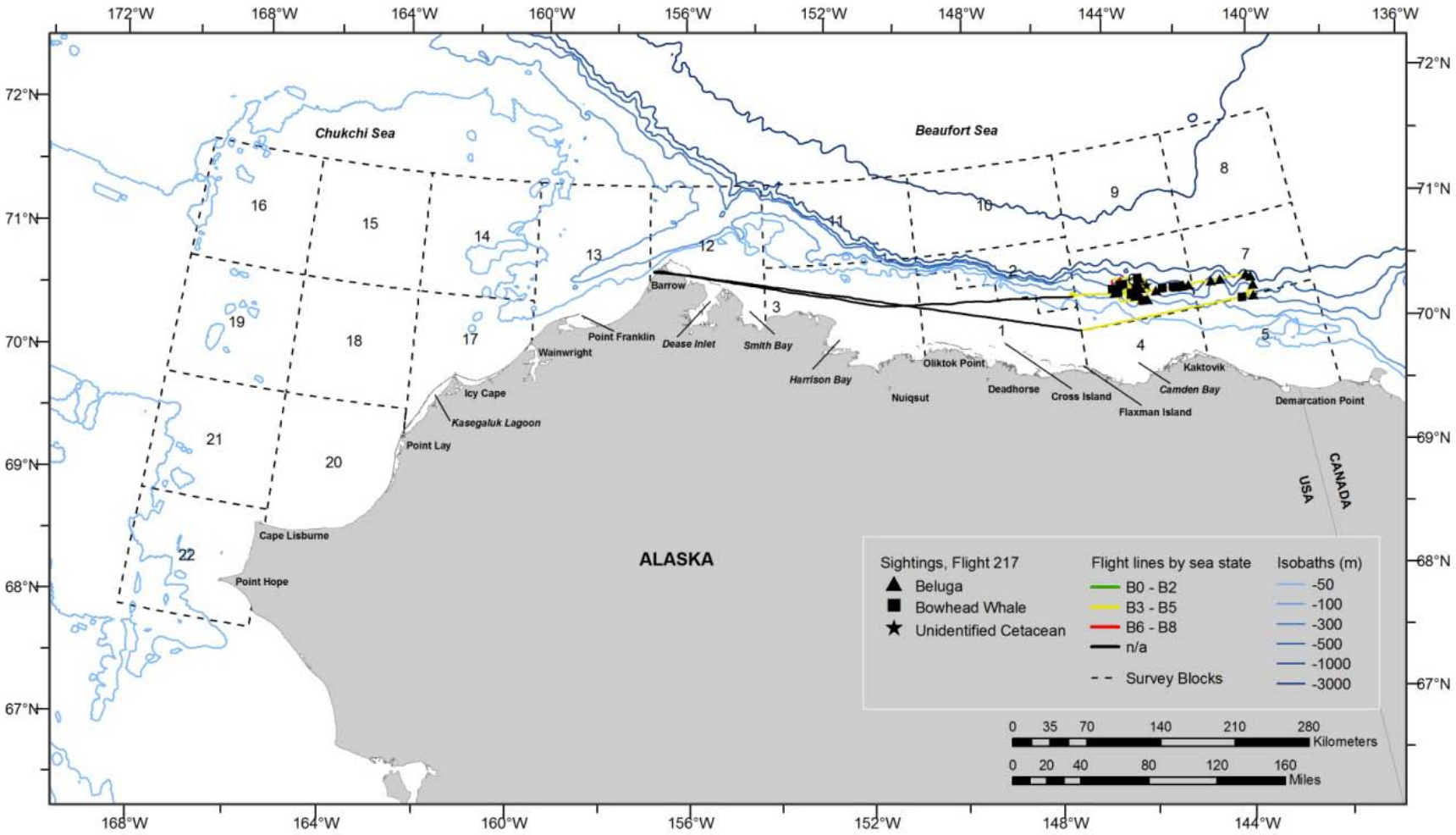

Figure B-17. Flight 217 survey track, depicted by sea state, and all sightings.

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16 July 2011, Flight 218

Flight was a survey of partial Transect 12. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 4-6, and visibility 1-5 km, with widespread fog south of Point Franklin and in the survey area. High sea states and fog precluded complete coverage of Transect 12. Ice cover ranged from 0-1% broken floe ice; most of the area surveyed was ice free. One gray whale was sighted offshore of Icy Cape; walruses and an unidentified pinniped were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
218	7/16/2011 14:47	70.595	162.248	gray whale	swim	1	0	17

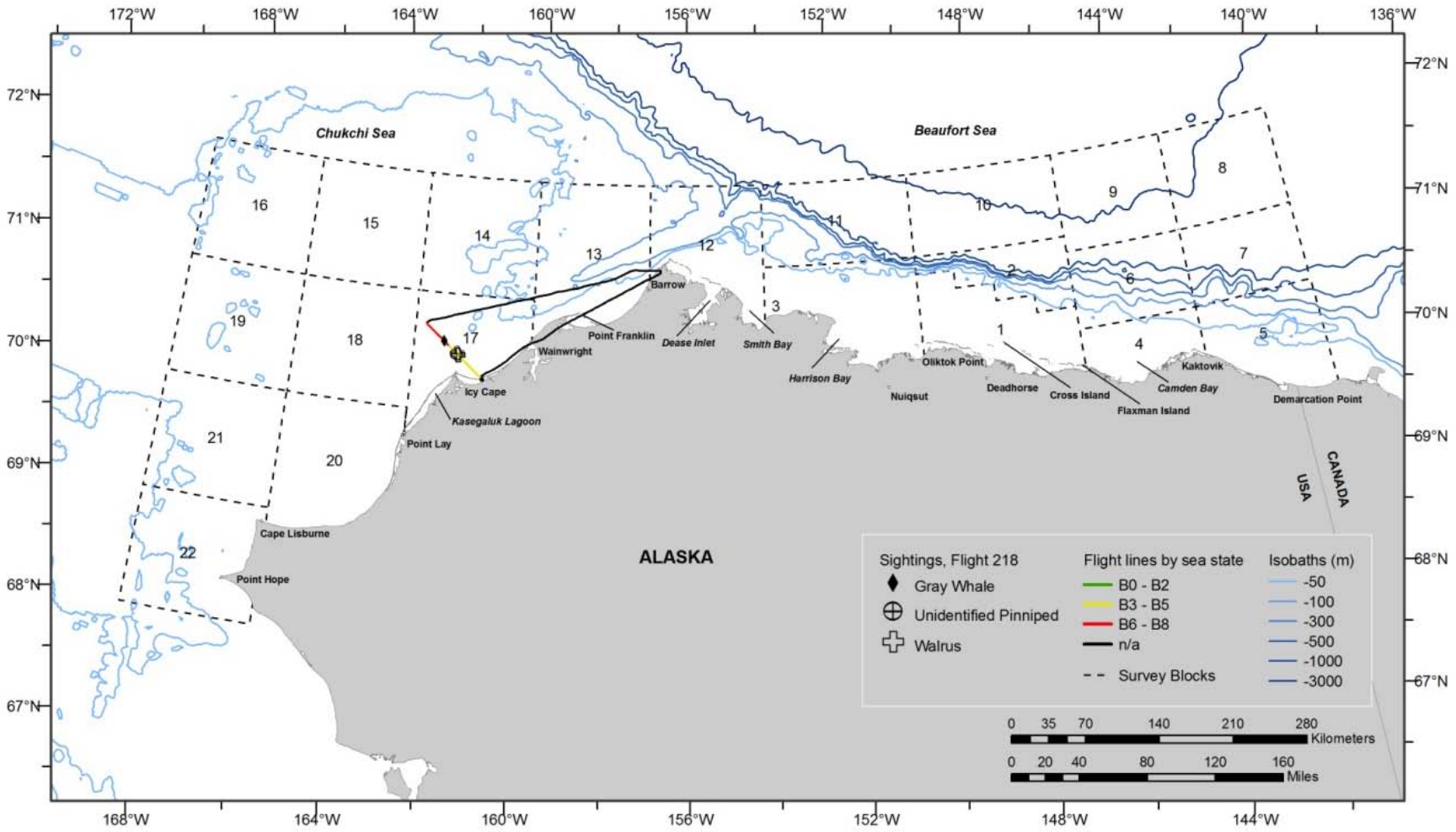

Figure B-18. Flight 218 survey track, depicted by sea state, and all sightings.

17 July 2011, Flight 219

Flight was a survey of partial Transects 13, 15, 17 and 19, and a Coastal Transect from just south of Point Lay to Wainwright. Survey conditions were fair, with clear to partly cloudy skies, sea state Beaufort 1-5, and visibility 1-10 km. Widespread fog located approximately 40 miles offshore precluded complete coverage of transect lines. Ice cover ranged from 0-2% broken floe ice; most of the area surveyed was ice free. Gray whales, including two cow-calf pairs, and an unidentified cetacean were seen off of Point Lay and Icy Cape; one minke whale was seen offshore of Point Lay, and belugas were seen offshore of Point Lay and Icy Cape. Walruses, bearded seals, and unidentified pinnipeds were also seen.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
219	7/17/2011 15:31	70.354	162.177	gray whale	swim	2	0	17
219	7/17/2011 15:34	70.401	162.348	unidentified cetacean	swim	1	0	17
219	7/17/2011 15:40	70.411	162.347	gray whale	rest	2	1	17
219	7/17/2011 15:42	70.418	162.402	gray whale	swim	2	1	17
219	7/17/2011 15:58	70.707	163.478	beluga	swim	1	0	18
219	7/17/2011 15:59	70.730	163.565	beluga	swim	1	0	18
219	7/17/2011 16:32	70.135	162.979	beluga	swim	2	0	17
219	7/17/2011 16:32	70.134	162.977	beluga	swim	8	0	17
219	7/17/2011 16:32	70.127	162.951	beluga	mill	2	1	17
219	7/17/2011 16:33	70.123	162.937	beluga	mill	2	0	17
219	7/17/2011 16:39	69.996	162.765	gray whale	swim	2	0	17
219	7/17/2011 16:54	69.864	163.582	beluga	swim	1	0	20
219	7/17/2011 16:58	69.935	163.843	gray whale	rest	1	0	20
219	7/17/2011 17:21	70.109	165.557	minke whale	swim	1	0	18
219	7/17/2011 18:13	69.712	164.622	beluga	swim	1	0	20

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
219	7/17/2011 18:50	69.898	162.887	beluga	mill	1	0	17
219	7/17/2011 18:51	69.915	162.854	gray whale	swim	2	0	17

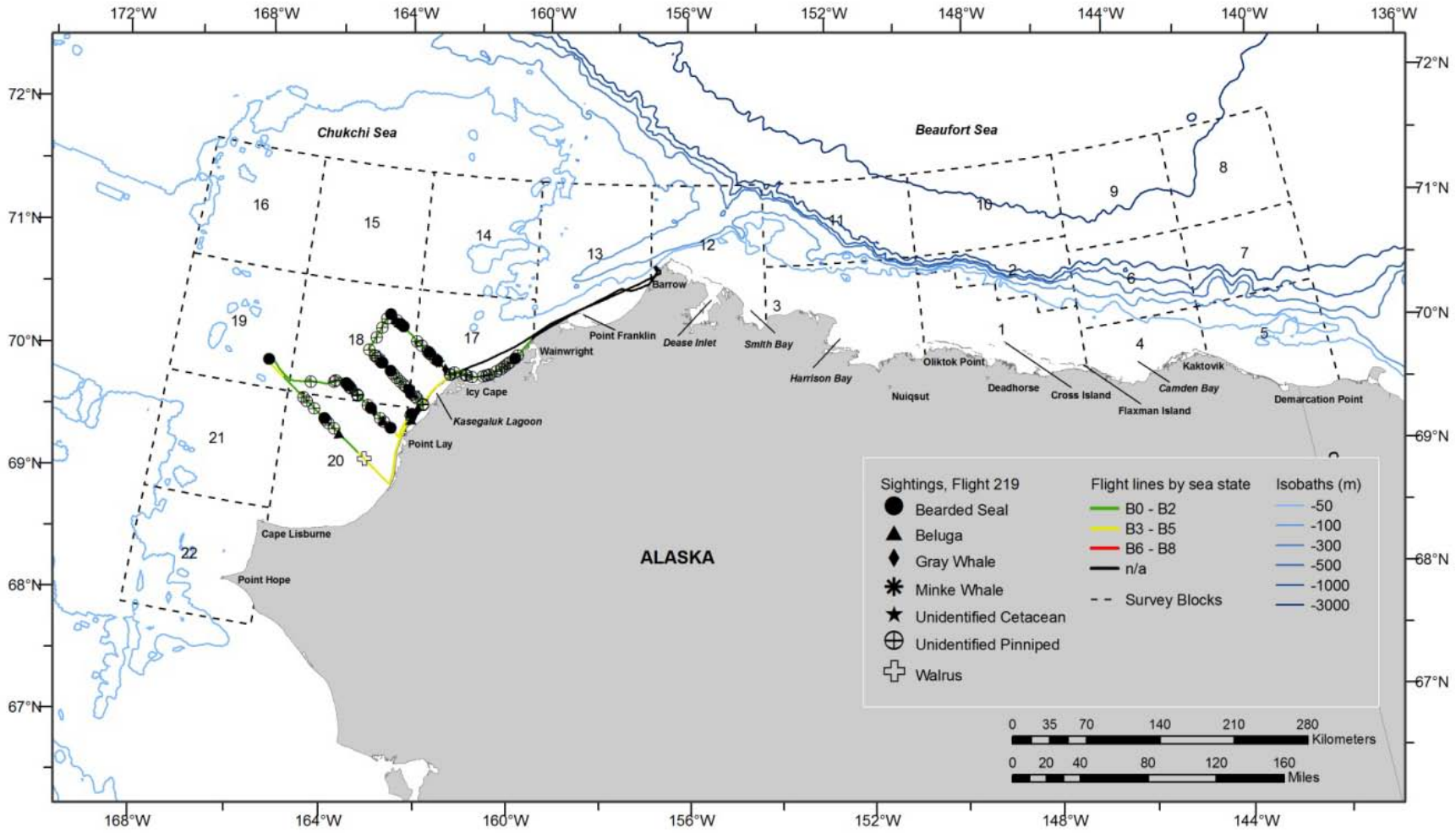

Figure B-19. Flight 219 survey track, depicted by sea state, and all sightings.

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18 July 2011, Flight 220

Flight was a survey of Transects 22 and 24, and a Coastal Transect from Cape Lisburne to Point Lay. Survey conditions were fair, with clear to partly cloudy skies, sea state Beaufort 1-5, and visibility 0-10 km. Widespread fog on the offshore ends of the transect lines and south of Cape Lisburne precluded complete coverage of transect lines. The area surveyed was ice free. Gray whales, including a cow-calf pair, three minke whales, and a group of 180 belugas were sighted along the coastal transect in Ledyard Bay; two belugas were also sighted offshore. Walruses, bearded seals, and unidentified pinnipeds were also seen, plus two brown bears on shore.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
220	7/18/2011 12:37	69.018	163.989	minke whale	mill	2	0	20
220	7/18/2011 13:09	69.179	165.020	beluga	rest	1	0	20
220	7/18/2011 14:47	68.956	165.788	beluga	swim	1	0	20
220	7/18/2011 14:53	68.880	165.311	gray whale	feed	2	1	20
220	7/18/2011 14:54	68.886	165.263	gray whale	feed	1	0	20
220	7/18/2011 14:56	68.900	165.074	gray whale	swim	1	0	20
220	7/18/2011 15:04	68.935	164.436	minke whale	swim	1	0	20
220	7/18/2011 15:19	69.121	163.630	beluga	mill	180	20	20

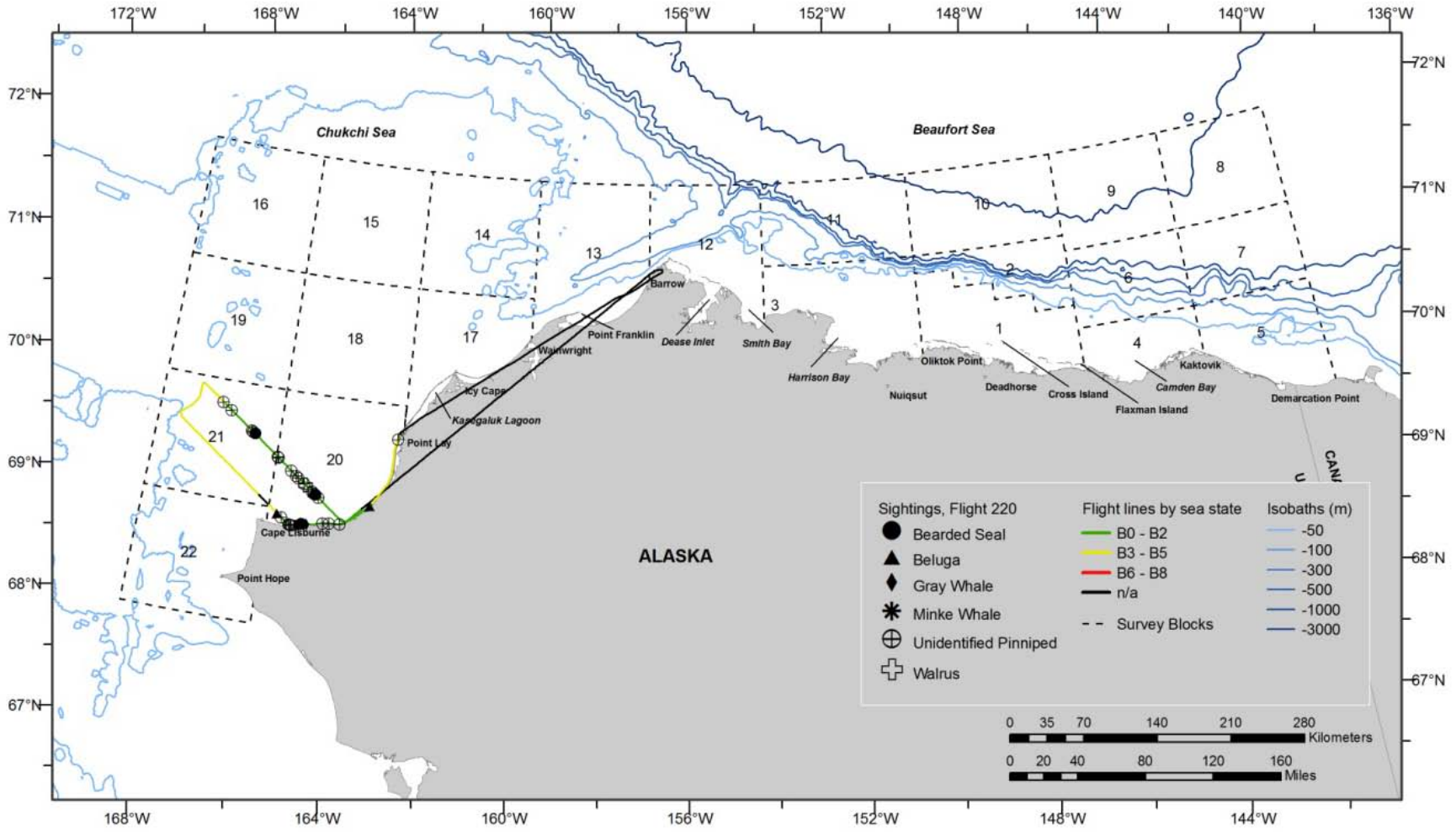

Figure B-20. Flight 220 survey track, depicted by sea state, and all sightings.

20 July 2011, Flight 221

Flight was a survey of Transects 2 and 4. Survey conditions were fair, with overcast skies, sea state Beaufort 2-3, and visibility 0-10 km. Scattered rain showers throughout the survey area precluded survey effort to the south. Ice coverage ranged from no ice to 1% broken floe ice; most of the survey area was ice free. Gray whales, an unidentified cetacean, walruses, bearded seals, and unidentified pinnipeds were sighted between Point Franklin and Barrow.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
221	7/20/2011 12:18	71.319	157.009	gray whale	feed	1	0	13
221	7/20/2011 12:20	71.344	157.014	gray whale	feed	3	0	13
221	7/20/2011 12:22	71.313	157.059	gray whale	feed	1	0	13
221	7/20/2011 13:49	71.221	158.136	gray whale	feed	2	0	13
221	7/20/2011 13:50	71.212	158.106	gray whale	feed	2	0	13
221	7/20/2011 13:50	71.209	158.100	gray whale	swim	1	0	13
221	7/20/2011 13:52	71.172	157.980	gray whale	feed	1	0	13
221	7/20/2011 13:53	71.152	157.915	gray whale	feed	1	0	13
221	7/20/2011 13:54	71.128	157.836	gray whale	feed	2	0	13
221	7/20/2011 13:56	71.094	157.729	gray whale	swim	2	0	13
221	7/20/2011 13:58	71.037	157.549	gray whale	feed	1	0	13
221	7/20/2011 14:12	70.856	158.274	gray whale	swim	1	0	13
221	7/20/2011 14:30	71.171	157.734	gray whale	rest	2	0	13
221	7/20/2011 14:30	71.178	157.690	gray whale	rest	3	0	13
221	7/20/2011 14:30	71.180	157.670	gray whale	swim	1	0	13
221	7/20/2011 14:33	71.181	157.503	gray whale	feed	1	0	13
221	7/20/2011 14:34	71.198	157.403	gray whale	swim	6	0	13
221	7/20/2011 14:35	71.217	157.396	gray whale	swim	1	0	13

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
221	7/20/2011 14:38	71.235	157.276	gray whale	feed	1	0	13
221	7/20/2011 14:39	71.249	157.146	unidentified cetacean	.	1	0	13
221	7/20/2011 14:41	71.273	157.158	gray whale	feed	2	0	13
221	7/20/2011 14:42	71.264	157.172	gray whale	swim	1	0	13
221	7/20/2011 14:43	71.284	157.035	gray whale	feed	2	0	13

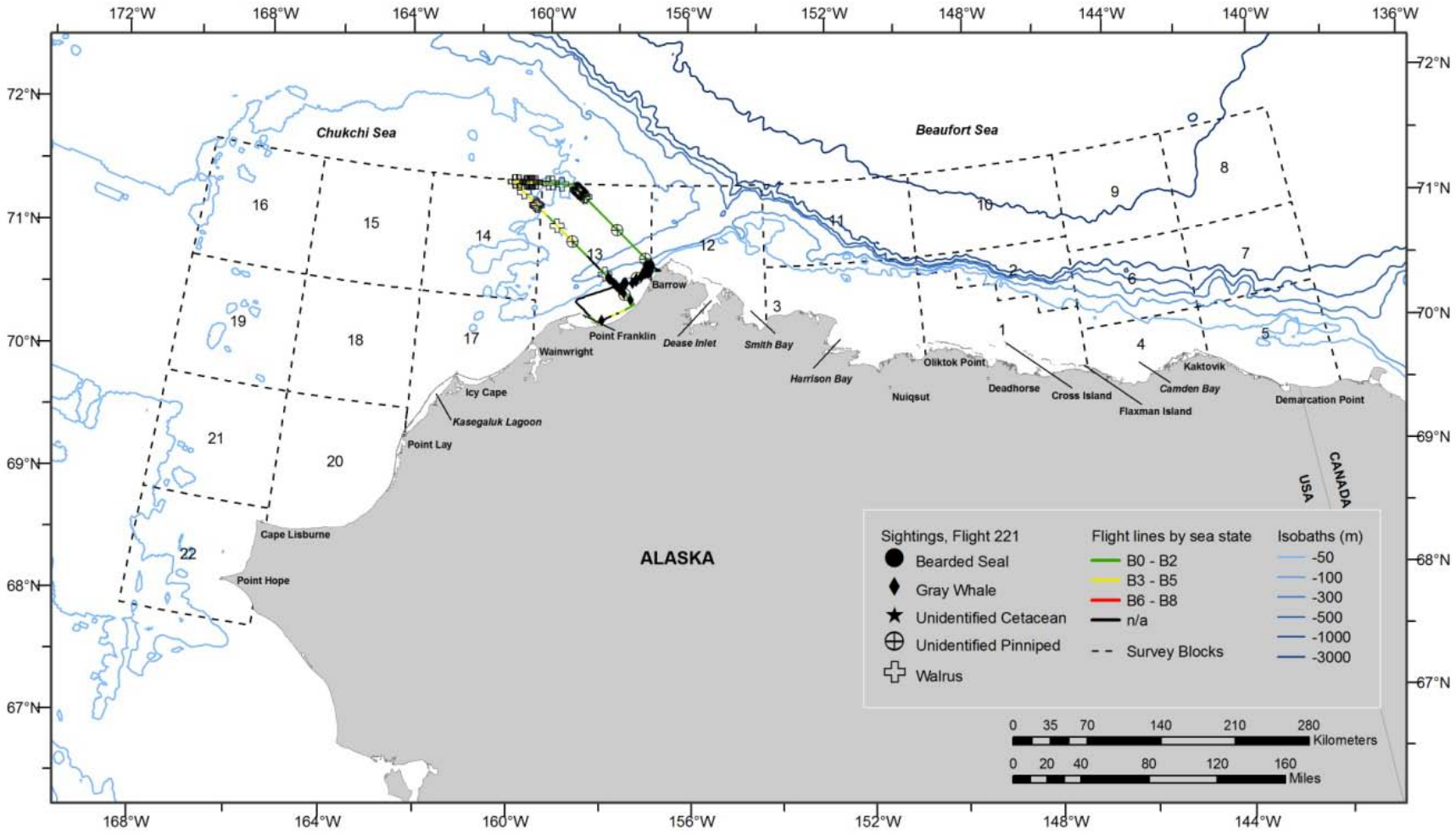

Figure B-21. Flight 221 survey track, depicted by sea state, and all sightings.

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23 July 2011, Flight 222

Flight was a Coastal Transect from Wainwright to south of Barrow. Survey conditions were poor, with partly cloudy to overcast skies, sea state Beaufort 2-3, and visibility 0-5 km. Widespread fog throughout the survey area precluded survey effort offshore. Ice coverage ranged from no ice to 1% broken floe ice; most of the survey area was ice free. Gray whales were sighted northeast of Wainwright and belugas were sighted near Point Franklin.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
222	7/23/2011 10:00	70.771	159.743	gray whale	rest	4	0	13
222	7/23/2011 10:00	70.776	159.723	gray whale	swim	1	0	13
222	7/23/2011 10:20	70.850	158.603	beluga	swim	80	8	13
222	7/23/2011 10:20	70.849	158.600	beluga	swim	18	3	13
222	7/23/2011 10:20	70.849	158.592	beluga	swim	6	0	13

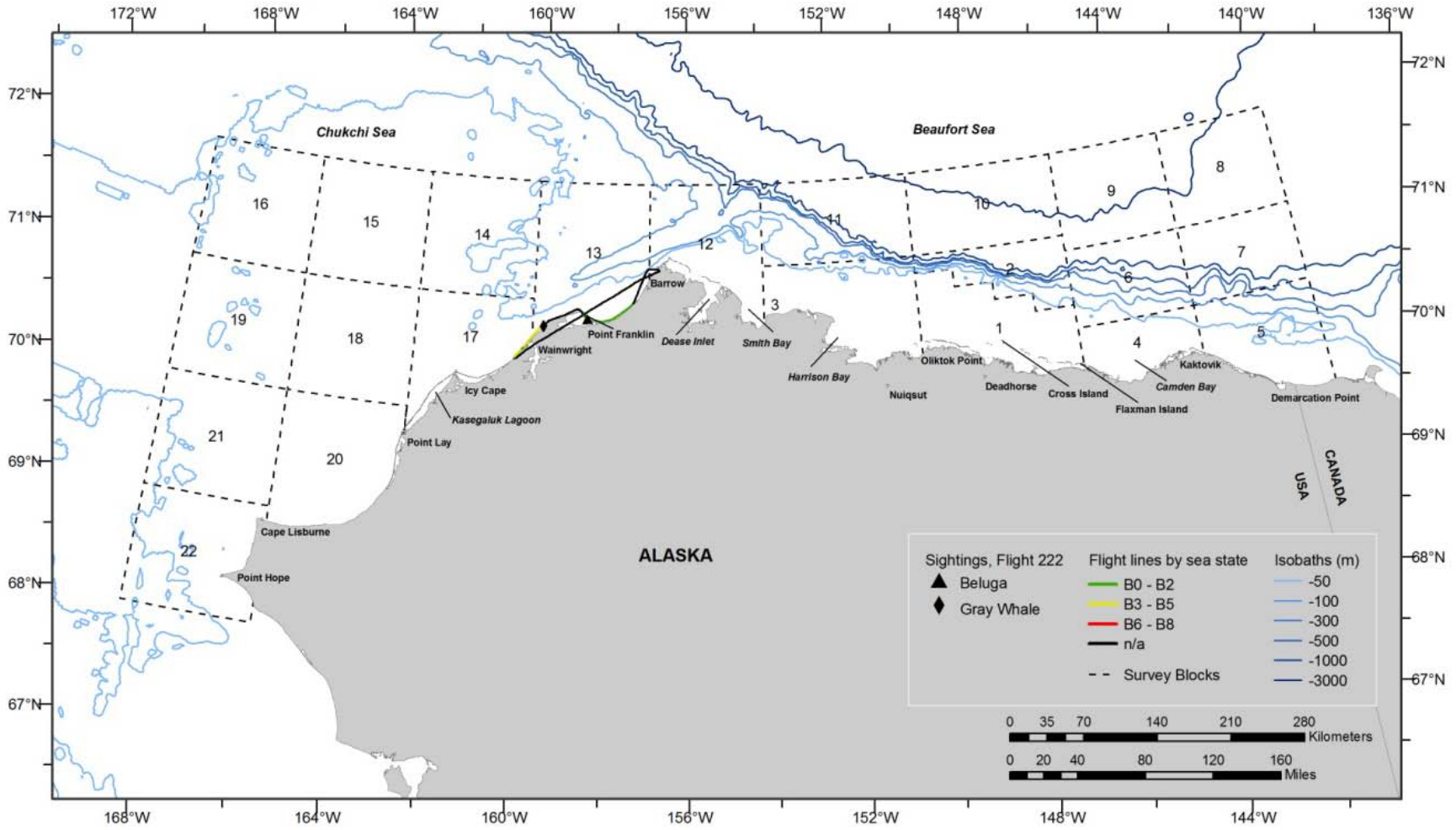

Figure B-22. Flight 222 survey track, depicted by sea state, and all sightings.

26 July 2011, Flight 223

Flight was a survey of partial Transects 16 and 18, and a Coastal Transect from north of Point Lay to Icy Cape. Survey conditions were poor, with partly cloudy to overcast skies, sea state Beaufort 2-6, and visibility 0-10 km. Low ceilings and fog on the offshore ends of the transects precluded survey effort offshore. There was no ice present within the survey area. Belugas were sighted northeast of Point Lay; a walrus and an unidentified pinniped were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
223	7/26/2011 16:52	69.850	162.971	beluga	mill	12	0	17
223	7/26/2011 16:52	69.863	162.947	beluga	swim	1	0	17

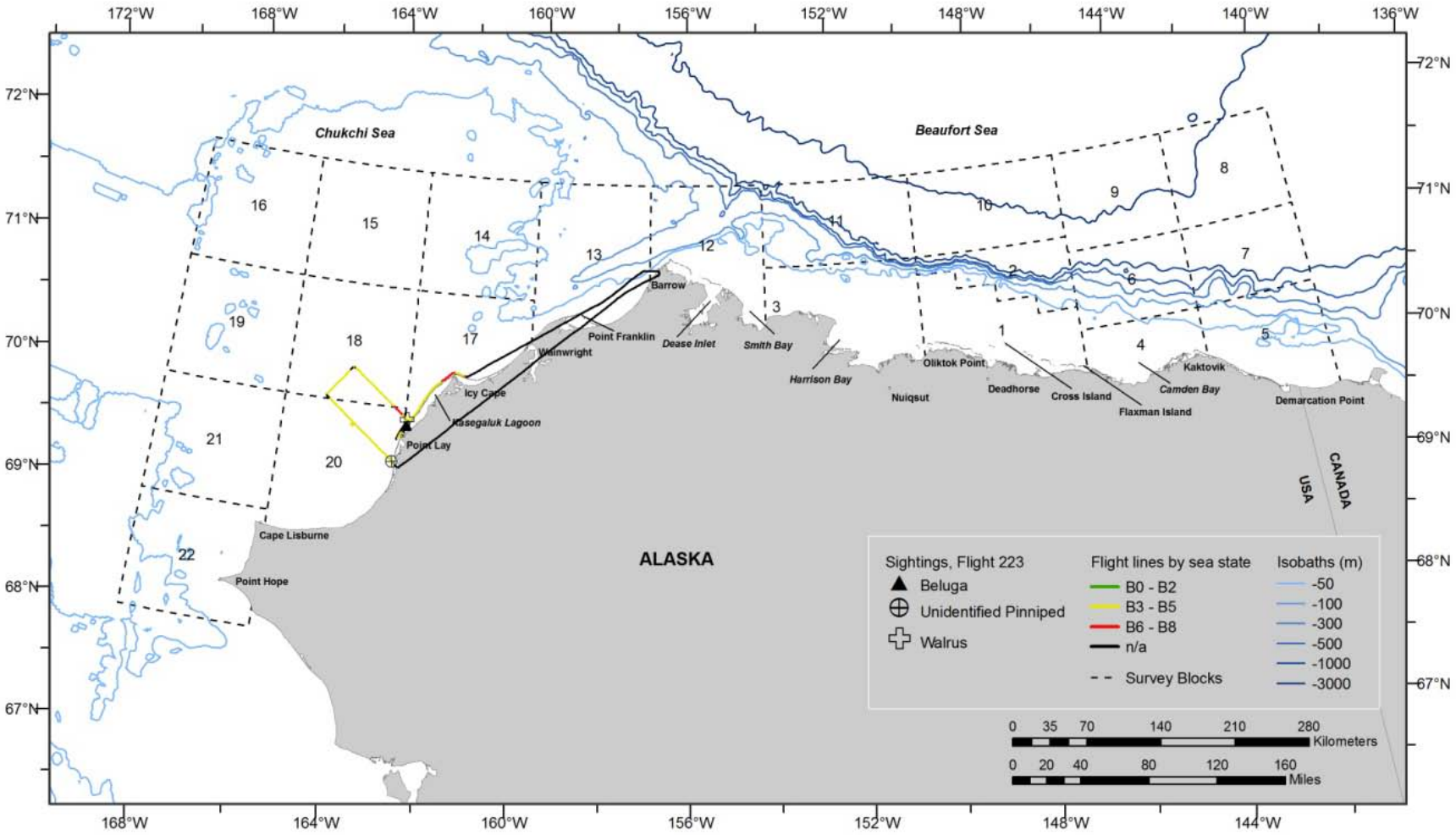

Figure B-23. Flight 223 survey track, depicted by sea state, and all sightings.

30 July 2011, Flight 224

Flight was a survey of partial Transects 10, 12 and 14. Survey conditions were poor, with partly cloudy to overcast skies, sea state Beaufort 5-6, and visibility 0-10 km. Low ceilings and fog were present throughout the survey area and precluded complete coverage of transect lines. There was no ice present within the survey area. There were no sightings.

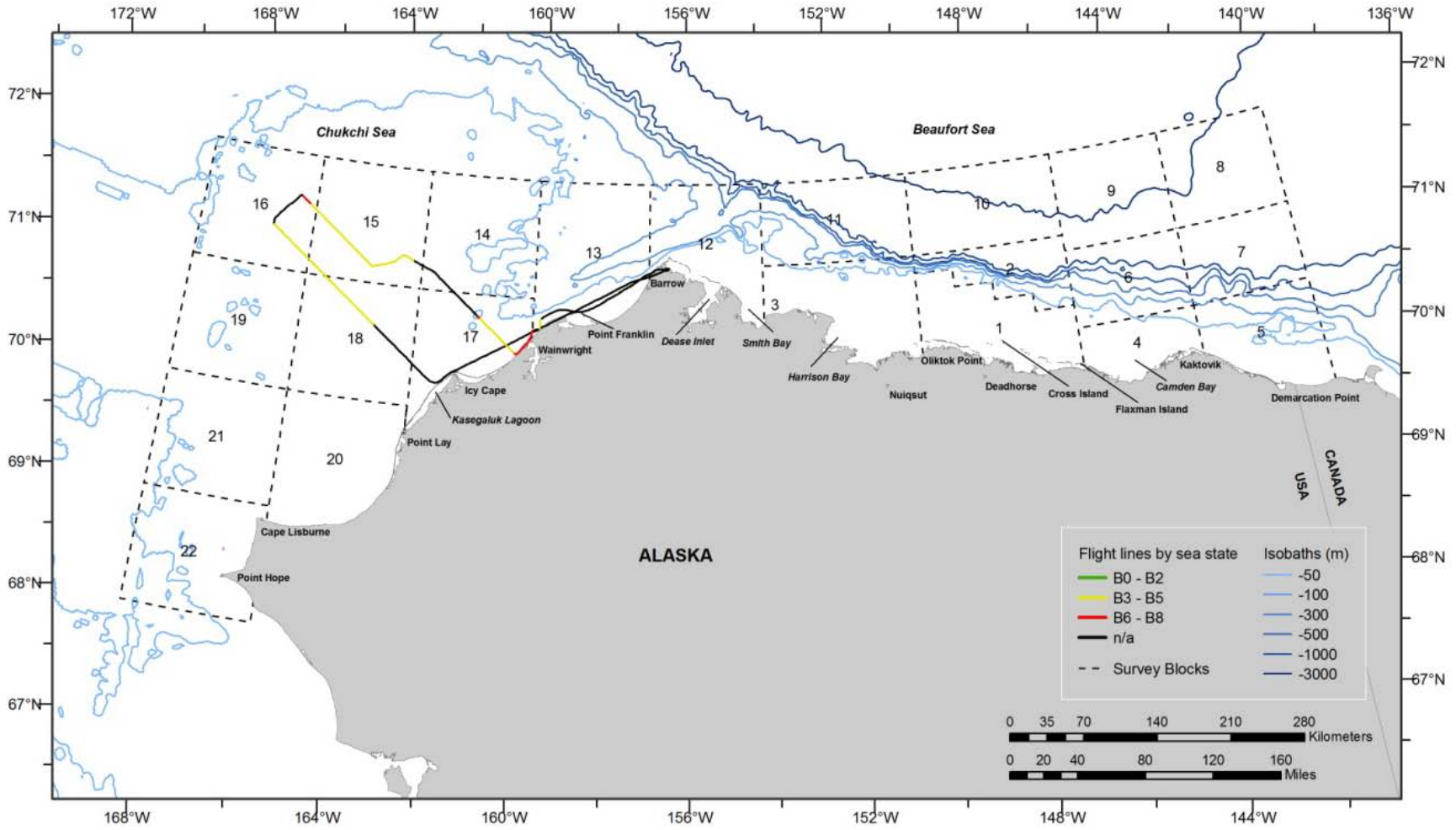

Figure B-24. Flight 224 survey track, depicted by sea state.

31 July 2011, Flight 225

Flight was a survey of Transect 8, partial Transects 10, 12, 16 and 18, and a Coastal Transect from approximately 15 miles south of Point Lay to Point Franklin. Survey conditions were good, with partly cloudy to overcast skies, sea state Beaufort 2-4, and visibility 0-10 km. Low ceilings precluded complete coverage of transect lines. There was no ice present within the survey area. Gray whales and belugas were seen near Point Franklin; gray whales and unidentified cetaceans were sighted offshore of Wainwright; belugas were seen nearshore south of Wainwright. Walruses, bearded seals, and unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
225	7/31/2011 9:56	70.957	158.775	gray whale	swim	1	0	13
225	7/31/2011 9:58	70.918	159.021	gray whale	feed	1	0	13
225	7/31/2011 9:59	70.891	159.153	beluga	swim	3	0	13
225	7/31/2011 10:09	70.909	160.191	gray whale	mill	1	0	17
225	7/31/2011 10:11	70.932	160.265	gray whale	feed	2	0	17
225	7/31/2011 10:11	70.935	160.276	gray whale	swim	1	0	17
225	7/31/2011 10:11	70.944	160.309	unidentified cetacean	swim	2	1	17
225	7/31/2011 13:39	70.422	160.675	beluga	swim	4	0	17
225	7/31/2011 13:39	70.423	160.673	beluga	swim	2	0	17
225	7/31/2011 13:39	70.426	160.660	beluga	swim	3	0	17
225	7/31/2011 13:54	70.823	159.588	beluga	swim	3	0	13

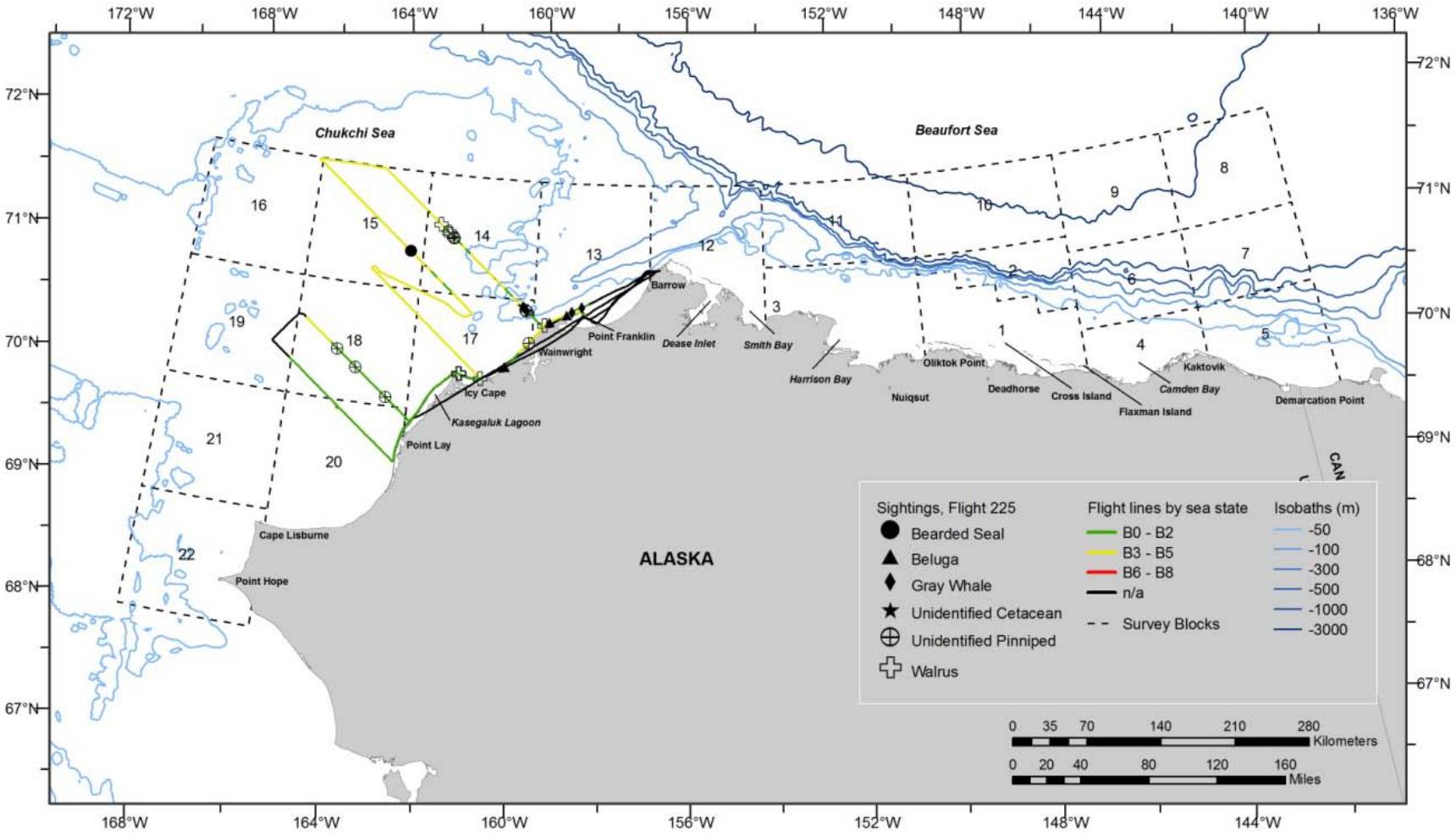

Figure B-25. Flight 225 survey track, depicted by sea state, and all sightings.

1 August 2011, Flight 226

Flight was a survey of Transect 20 and partial Transects 16 and 18. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-4, and visibility 0-10 km. There was no ice present within the survey area. Walruses, including one dead walrus, and small unidentified pinnipeds were sighted.

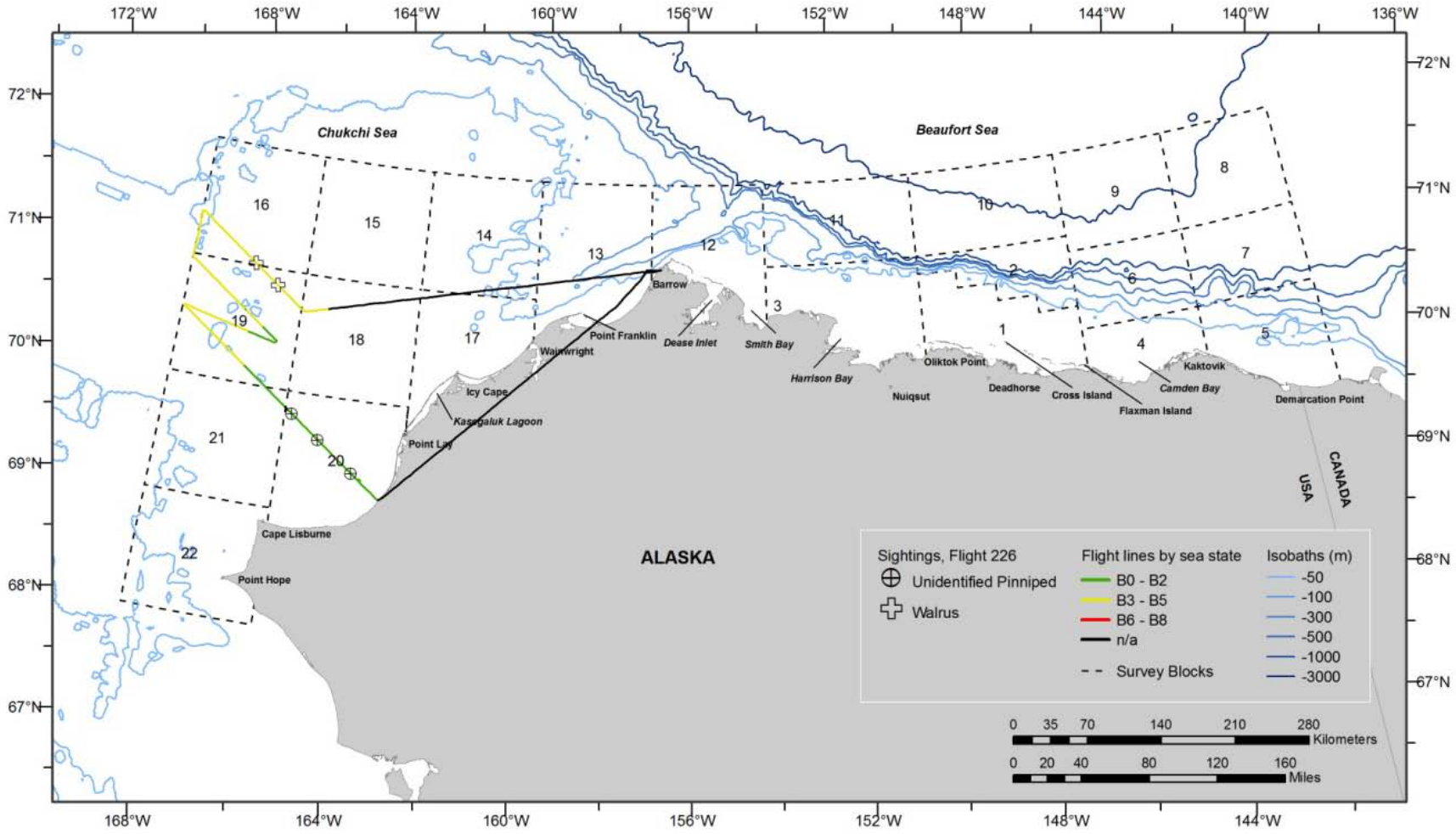

Figure B-26. Flight 226 survey track, depicted by sea state, and all sightings.

2 August 2011, Flight 227

Flight was a survey of Transects 3, 5, 7, 9, 13, and 15. Survey conditions were good, with partly cloudy to overcast skies, sea state Beaufort 2-5, and visibility 0-10 km. Low ceilings and precipitation prevented complete coverage of Transects 13 and 15. There was no ice present within the survey area. Two bowhead whales and several gray whales, including 3 cow-calf pairs, were seen offshore of Wainwright, and gray whales and one minke whale were seen between Point Franklin and Barrow. Walruses, unidentified pinnipeds, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
227	8/2/2011 9:01	71.230	157.400	gray whale	feed	1	0	13
227	8/2/2011 10:34	71.052	158.355	gray whale	feed	1	0	13
227	8/2/2011 10:35	71.040	158.312	gray whale	feed	1	0	13
227	8/2/2011 10:35	71.032	158.278	gray whale	feed	1	0	13
227	8/2/2011 10:35	71.029	158.270	gray whale	feed	1	0	13
227	8/2/2011 10:47	70.868	158.297	minke whale	swim	1	0	13
227	8/2/2011 11:10	70.986	159.669	gray whale	swim	2	1	13
227	8/2/2011 11:18	71.151	160.240	gray whale	rest	2	1	14
227	8/2/2011 13:10	71.004	161.316	gray whale	feed	2	1	14
227	8/2/2011 13:12	70.968	161.187	bowhead	rest	1	0	17
227	8/2/2011 13:15	70.954	161.140	bowhead	swim	1	0	17
227	8/2/2011 13:21	70.857	160.795	gray whale	swim	1	0	17
227	8/2/2011 13:22	70.853	160.783	gray whale	feed	1	0	17

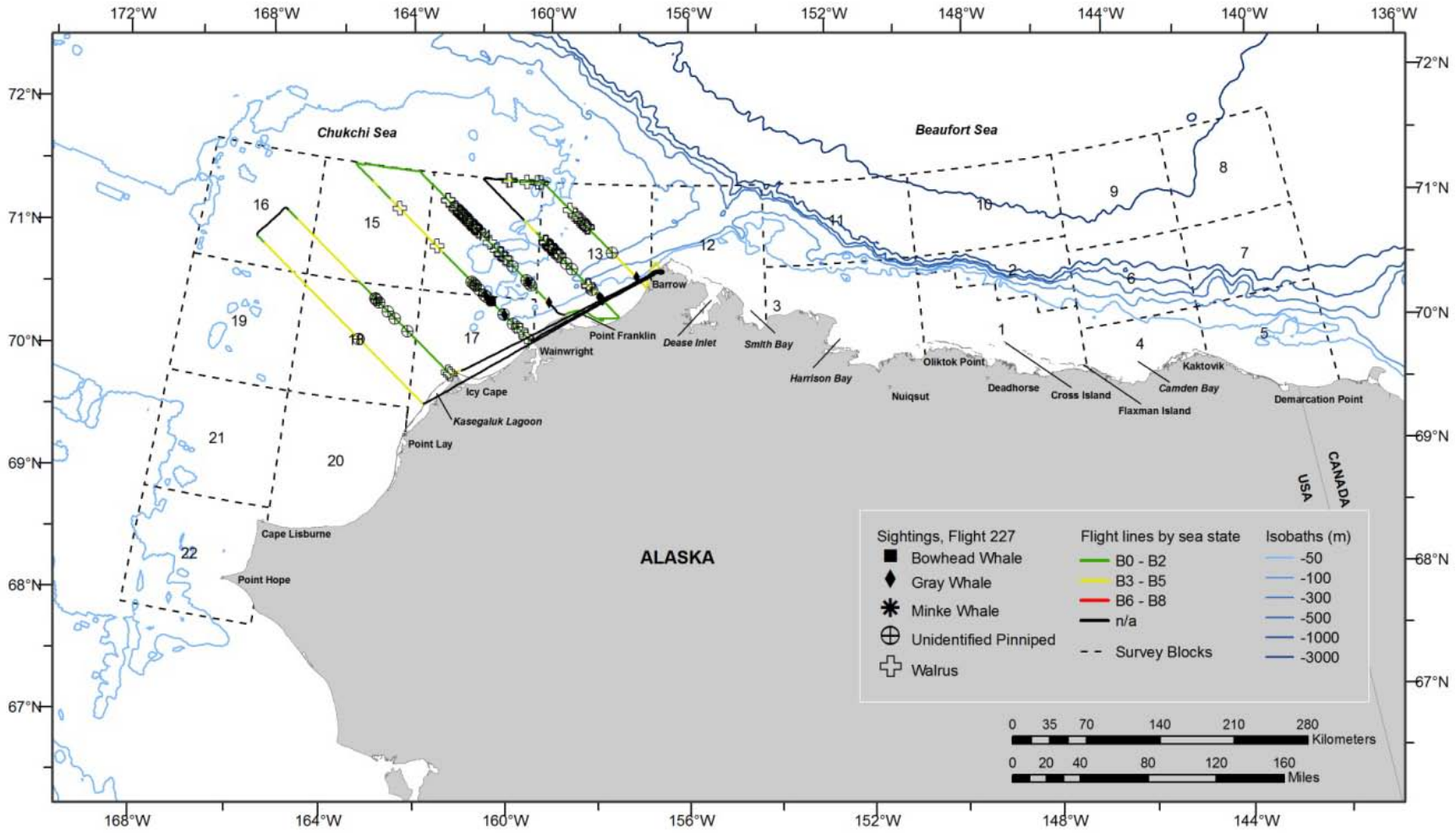

Figure B-27. Flight 227 survey track, depicted by sea state, and all sightings.

6 August 2011, Flight 228

Flight was a survey of Transect 4, and a Coastal Transect from Barrow to Cape Lisburne. Survey conditions were fair, with clear to overcast skies with some precipitation, sea state Beaufort 2-6, and visibility 2-10 km. There was no ice present within the survey area. Gray whales, including one cow-calf pair, were sighted from Barrow to just south of Wainwright. Belugas were sighted just south of Barrow and Point Lay.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
228	8/6/2011 14:18	71.182	157.056	beluga	swim	2	0	13
228	8/6/2011 14:18	71.177	157.065	beluga	swim	1	0	13
228	8/6/2011 14:18	71.171	157.077	beluga	rest	1	0	13
228	8/6/2011 14:43	70.921	158.729	gray whale	swim	1	0	13
228	8/6/2011 14:47	70.896	159.111	gray whale	swim	1	0	13
228	8/6/2011 14:53	70.838	159.505	gray whale	mill	2	0	13
228	8/6/2011 14:54	70.822	159.593	gray whale	swim	2	0	13
228	8/6/2011 15:08	70.501	160.437	gray whale	swim	2	1	17
228	8/6/2011 16:00	69.577	163.181	beluga	swim	1	0	20
228	8/6/2011 18:43	71.227	158.155	gray whale	feed	1	0	13
228	8/6/2011 18:43	71.221	158.139	gray whale	feed	1	0	13
228	8/6/2011 18:45	71.179	157.999	gray whale	feed	1	0	13
228	8/6/2011 18:48	71.114	157.793	gray whale	feed	1	0	13

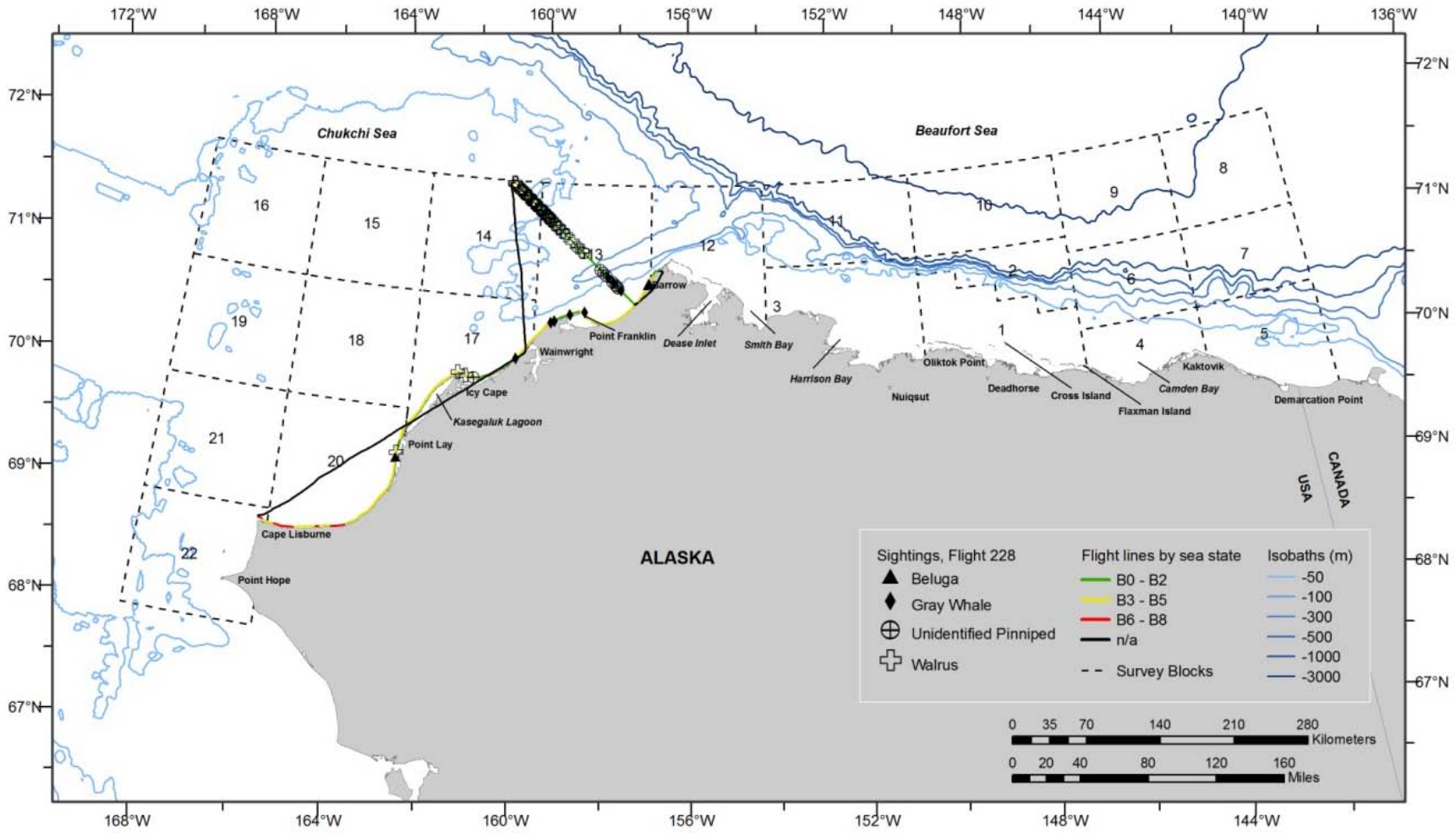

Figure B-28. Flight 228 survey track, depicted by sea state, and all sightings.

7 August 2011, Flight 229

Flight was a survey of Transect 11 and a partial Transect 17. Survey conditions were fair, with partly cloudy to overcast skies and precipitation, sea state Beaufort 2-6, and visibility 2-10 km. Low ceilings prevented completion of Transect 17. There was no ice present within the survey area. Gray whales were seen offshore north of Icy Cape and belugas were seen far offshore in block 15. One small unidentified marine mammal, possibly a minke whale, was sighted nearshore south of Wainwright. Walruses, a ringed seal, a bearded seal, unidentified pinnipeds, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
229	8/7/2011 11:35	71.668	165.619	beluga	roll	2	0	15
229	8/7/2011 12:27	70.771	162.087	gray whale	feed	1	0	17
229	8/7/2011 12:27	70.759	162.041	gray whale	feed	1	0	17
229	8/7/2011 12:30	70.711	161.871	gray whale	feed	1	0	17
229	8/7/2011 12:45	70.422	160.849	small unidentified marine mammal	.	1	0	17

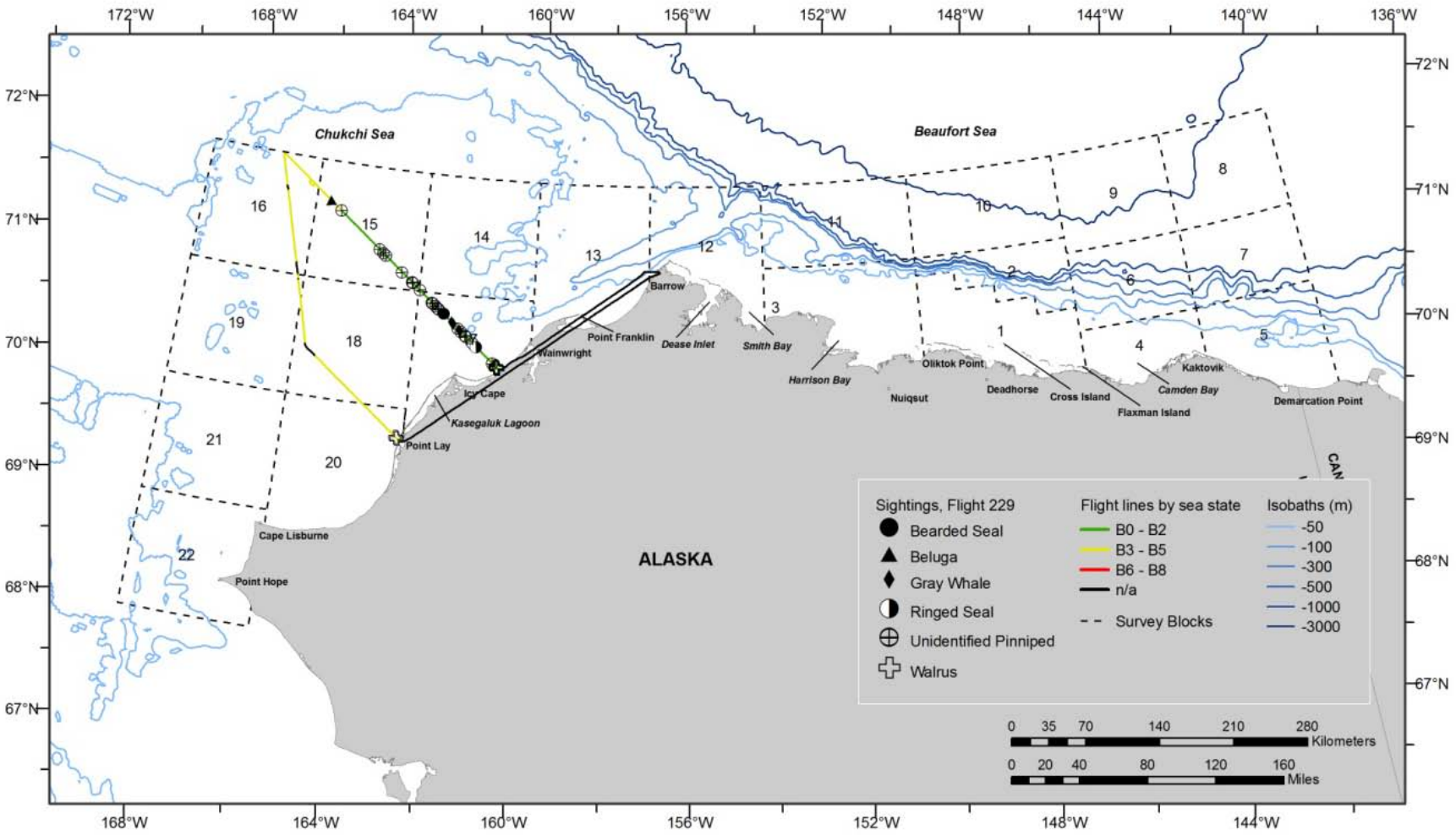

Figure B-29. Flight 229 survey track, depicted by sea state, and all sightings.

8 August 2011, Flight 230

Flight was a Coastal Transect from Point Franklin to south of Cape Lisburne. Survey conditions were fair, with partly cloudy to overcast skies with precipitation and low ceilings, sea state Beaufort 2-3, and visibility 1-10 km. There was no ice present within the survey area. One beluga was seen near Icy Cape and unidentified cetaceans were seen north of Point Hope. Walruses and small unidentified pinnipeds were also sighted. No walruses were observed hauled out on land.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
230	8/8/2011 12:05	70.334	161.752	beluga	swim	1	0	17
230	8/8/2011 13:36	68.549	166.284	unidentified cetacean	unknown	1	0	22
230	8/8/2011 13:45	68.537	166.303	unidentified cetacean	unknown	2	0	22

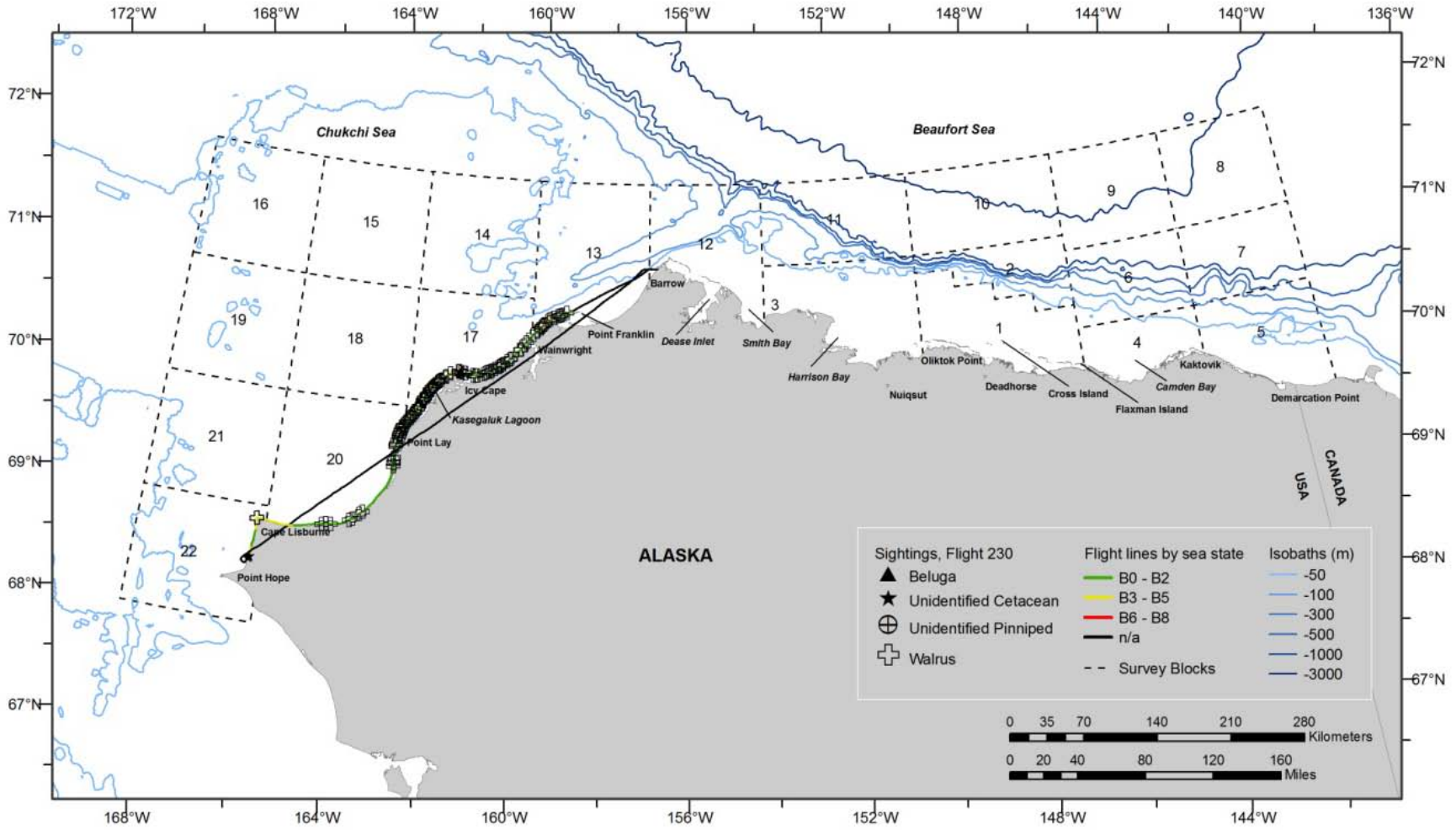

Figure B-30. Flight 230 survey track, depicted by sea state, and all sightings.

12 August 2011, Flight 231

Flight was a Coastal Transect from Barrow to approximately 20 miles northeast of Point Lay. Survey conditions were fair, with partly cloudy to overcast skies and precipitation, sea state Beaufort 2-5, and visibility 0-10 km. Low ceilings prevented completion of the Coastal Transect. There was no ice present within the area surveyed. One beluga was sighted near Point Franklin, and a walrus was also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
231	8/12/2011 17:08	70.892	159.163	beluga	swim	1	0	13

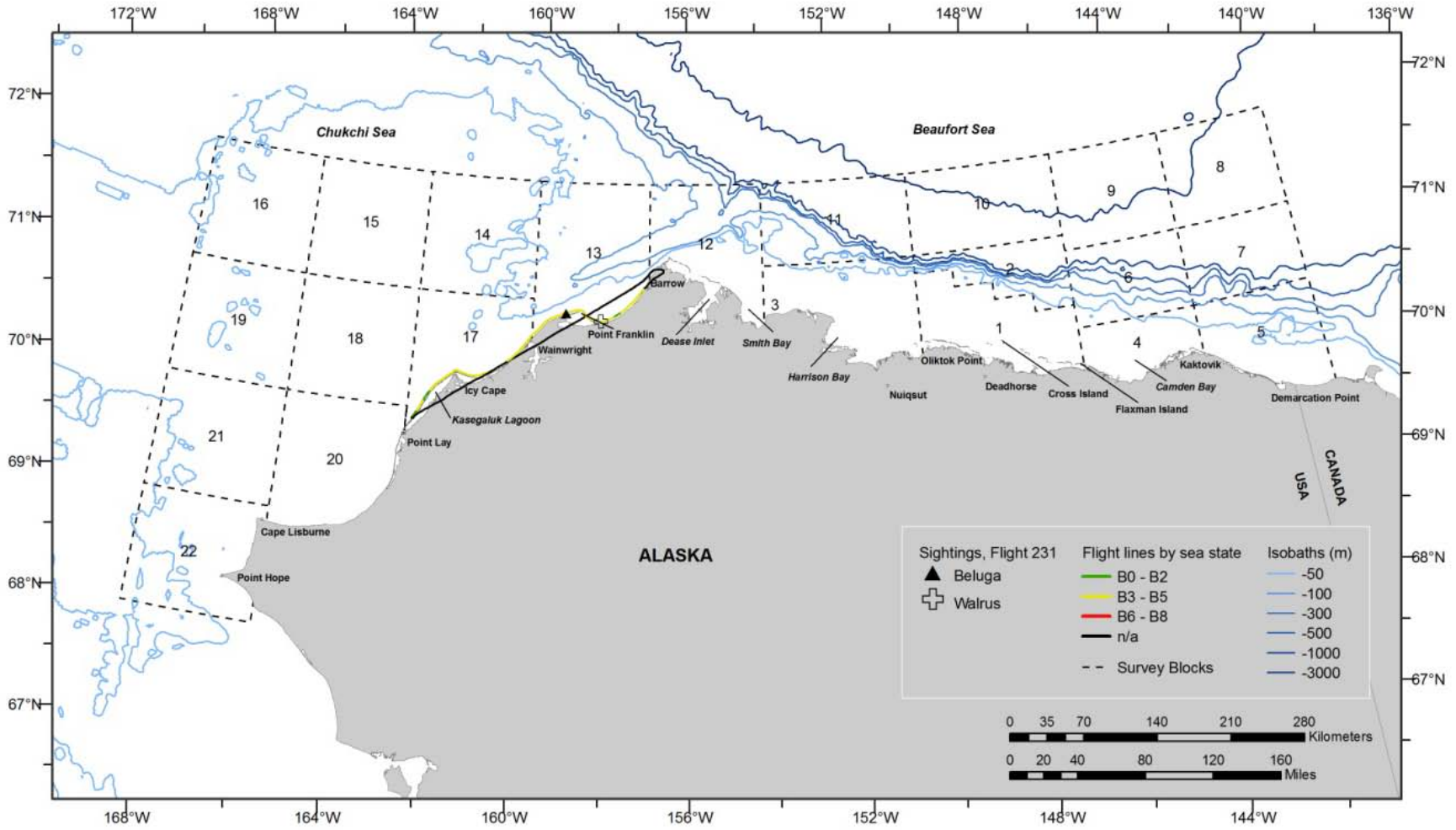

Figure B-31. Flight 231 survey track, depicted by sea state, and all sightings.

15 August 2011, Flight 232

Flight was a survey of Transects 7 and 9. Survey conditions were fair, with partly cloudy to overcast skies and precipitation, sea state Beaufort 4-5, and visibility 0-10 km. Low ceilings prevented completion of Transect 9. There was no ice present within the area surveyed. One beluga and walruses were sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
232	8/15/2011 15:55	71.512	161.535	beluga	swim	1	0	14

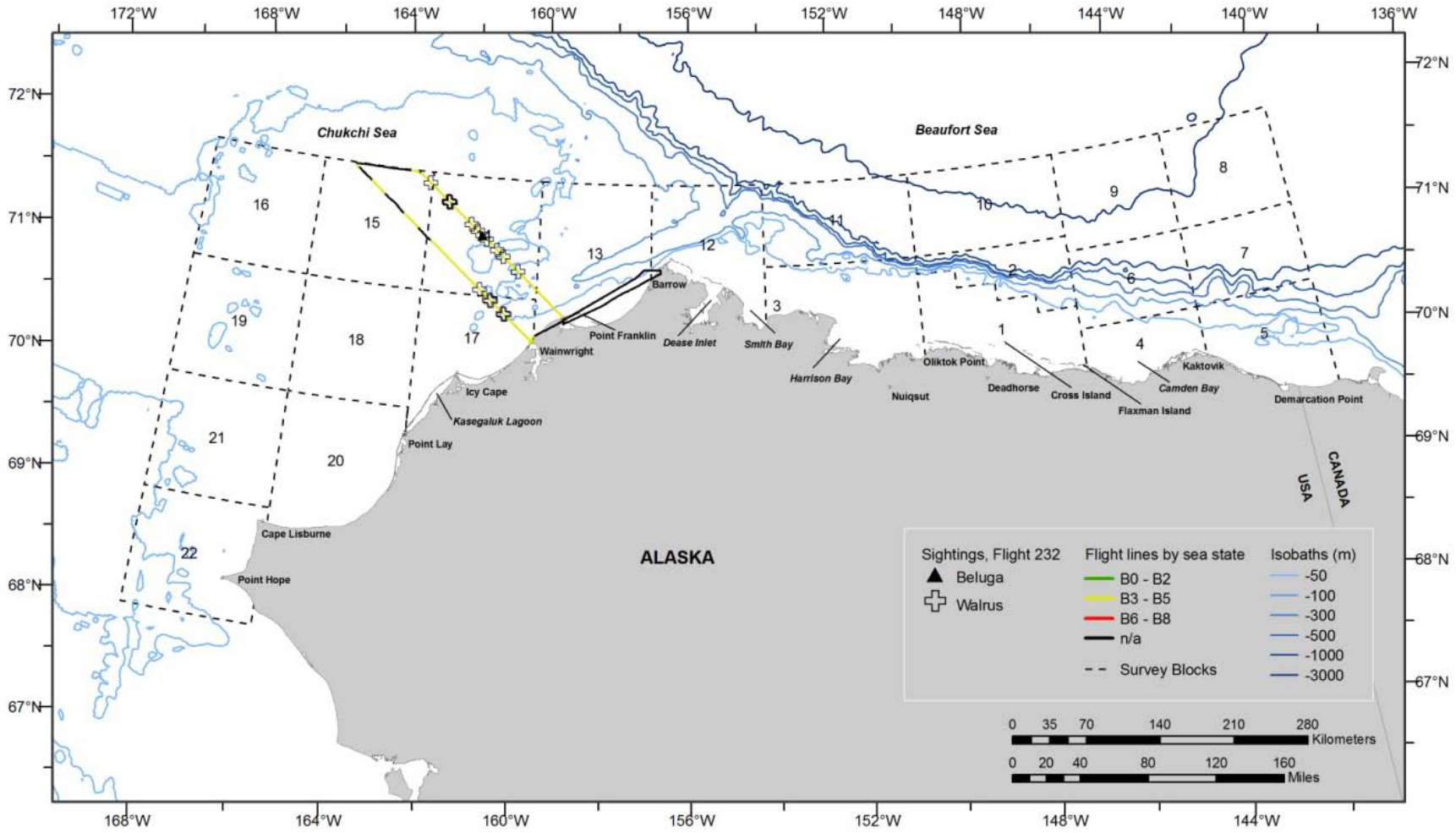

Figure B-32. Flight 232 survey track, depicted by sea state, and all sightings.

16 August 2011, Flight 233

Flight was a transect survey of portions of blocks 4, 5, 6 and 7. Survey conditions were fair, with partly cloudy to overcast skies and precipitation, sea state Beaufort 2-6, and visibility 0-10 km. Low ceilings and high sea states prevented completion of transects. Ice coverage ranged from 1-2% broken floe ice nearshore and west of Kaktovik; most of the survey area was ice free. Belugas were sighted in blocks 4, 5 and 6.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
233	8/16/2011 13:37	70.285	142.916	beluga	swim	1	0	5
233	8/16/2011 14:45	70.317	144.799	beluga	swim	2	0	4
233	8/16/2011 15:08	70.980	144.604	beluga	swim	1	0	6
233	8/16/2011 15:08	70.988	144.602	beluga	swim	13	0	6
233	8/16/2011 15:08	70.998	144.599	beluga	swim	6	0	6
233	8/16/2011 15:11	71.061	144.582	beluga	swim	4	0	6
233	8/16/2011 15:23	71.077	145.331	beluga	swim	7	0	6

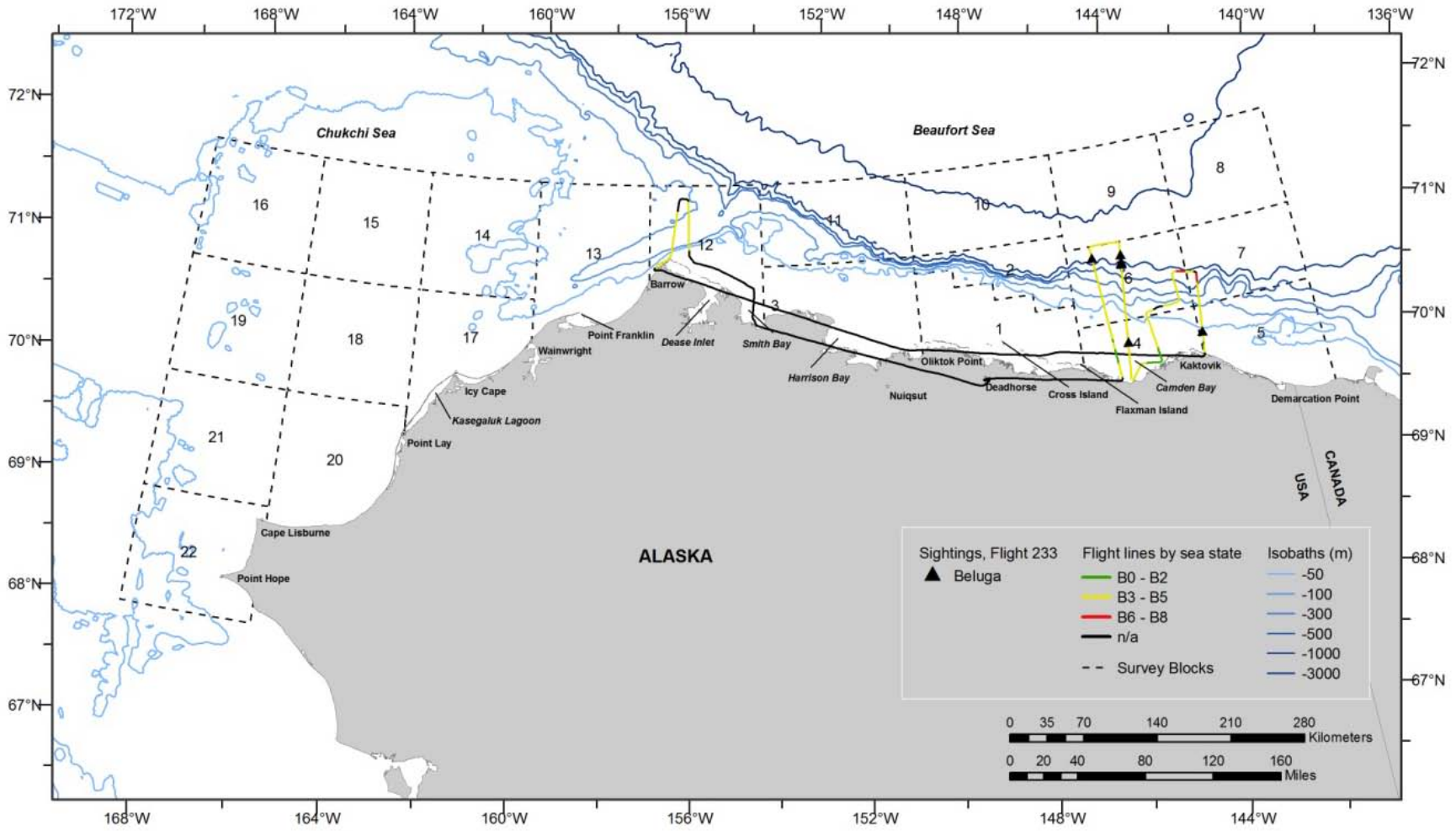

Figure B-33. Flight 233 survey track, depicted by sea state, and all sightings.

17 August 2011, Flight 234

Flight was a survey of partial Transects 11, 13 and 15. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-6, and visibility 0-10 km. Low ceilings prevented completion of transects offshore and high sea states prevented completion of transects nearshore. There was no ice present within the area surveyed. One beluga was sighted between Barrow and Point Franklin, and an unidentified cetacean that was a probable minke whale was sighted near Point Franklin. Approximately 8,000 walruses were observed hauled out on land slightly north of Point Lay. Unidentified pinnipeds and small unidentified pinnipeds were also sighted, and one brown bear was sighted on shore.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
234	8/17/2011 15:36	71.131	157.544	beluga	rest	1	0	13
234	8/17/2011 19:28	70.857	159.345	unidentified cetacean	unknown	1	0	13

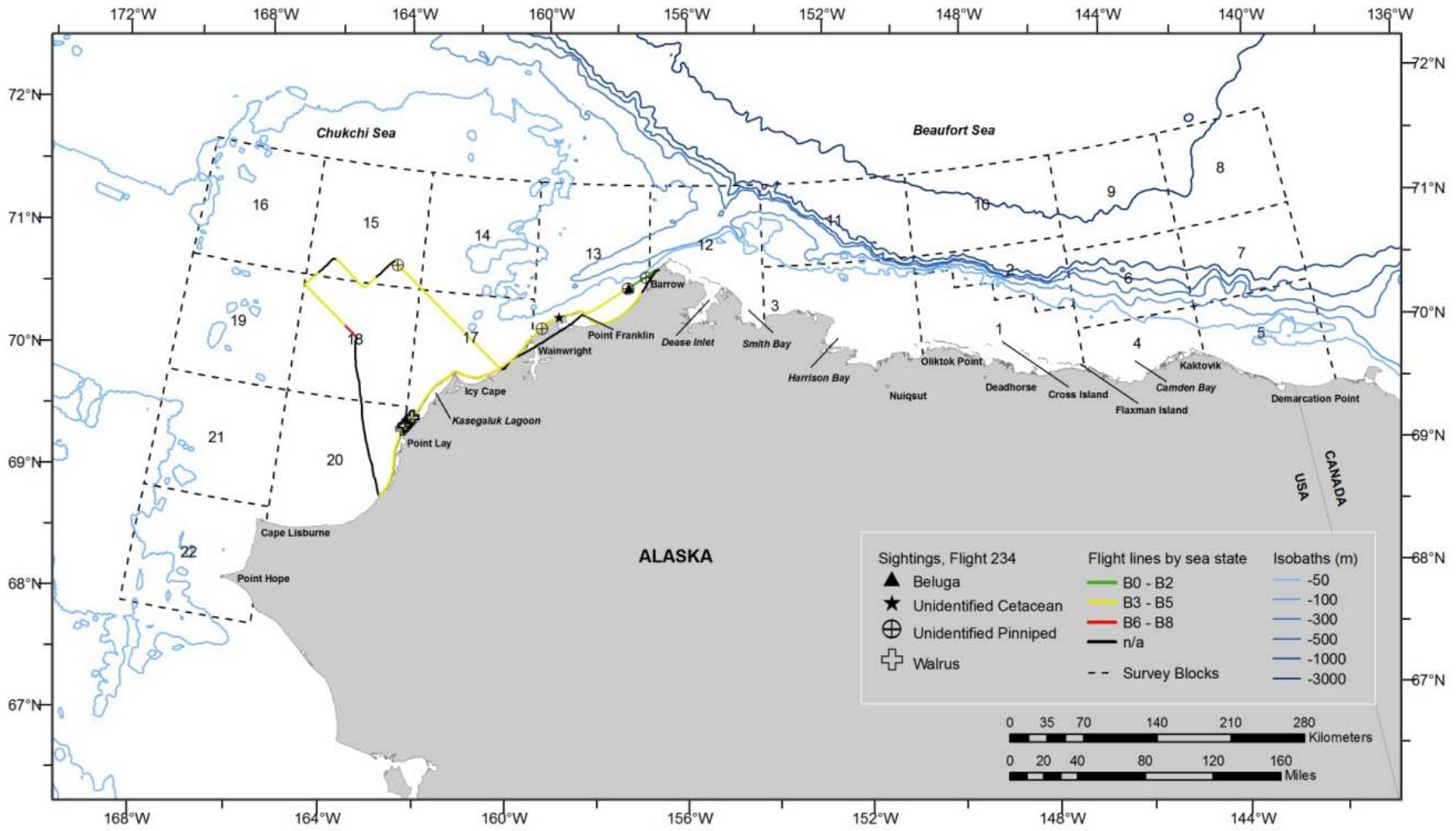

Figure B-34. Flight 234 survey track, depicted by sea state, and all sightings.

19 August 2011, Flight 235

Flight was a Coastal Transect from Point Lay to 30 miles south of Barrow. Survey conditions were fair, with clear to partly cloudy skies, sea state Beaufort 3-5, and visibility 0-10 km. Low ceilings prevented completion of transects offshore and high sea states prevented completion of transects nearshore. There was no ice present within the area surveyed. Approximately 10,000 walruses were observed hauled out on land slightly north of Point Lay in the same location as the haulout sighted on Flight 234. One unidentified pinniped was also sighted.

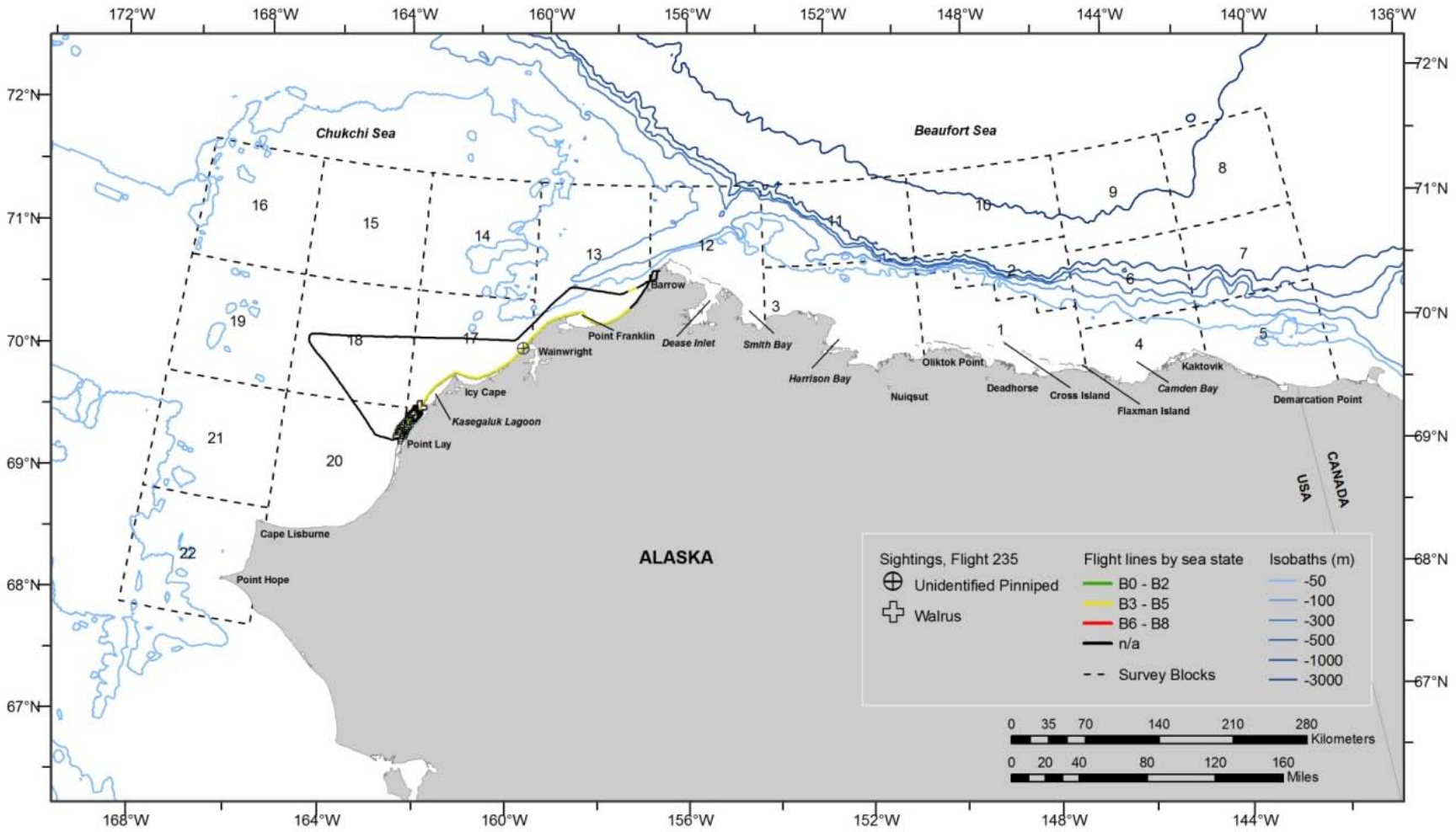

Figure B-35. Flight 235 survey track, depicted by sea state, and all sightings.

20 August 2011, Flight 1

Flight was a transect survey of portions of block 1. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 2-6, and visibility 2-10 km. High sea states precluded survey effort offshore and in the remainder of block 1. No ice was present in the area surveyed. One bowhead whale was seen northeast of Cross Island. Small unidentified pinnipeds were also seen, and seven polar bears were seen on Cross Island.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
1	8/20/2011 16:12	70.590	147.791	bowhead whale	swim	1	0	1

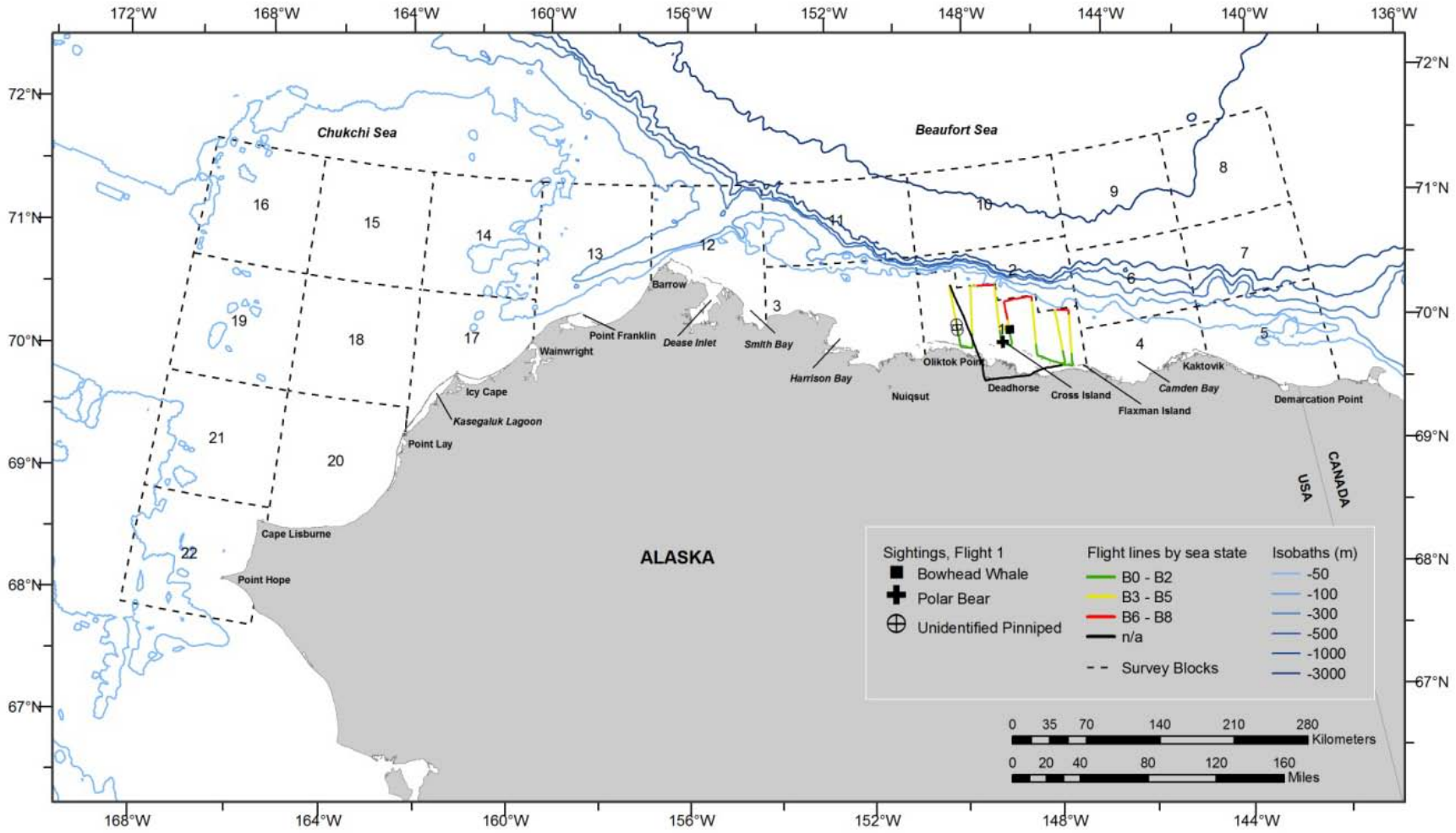

Figure B-36. Flight 1 survey track, depicted by sea state, and all sightings.

22 August 2011, Flight 236

Flight was a deadhead survey in an attempt to find an area suitable for transects in the western Beaufort Sea. Survey conditions were poor, and low ceilings and fog prevented any survey attempt.

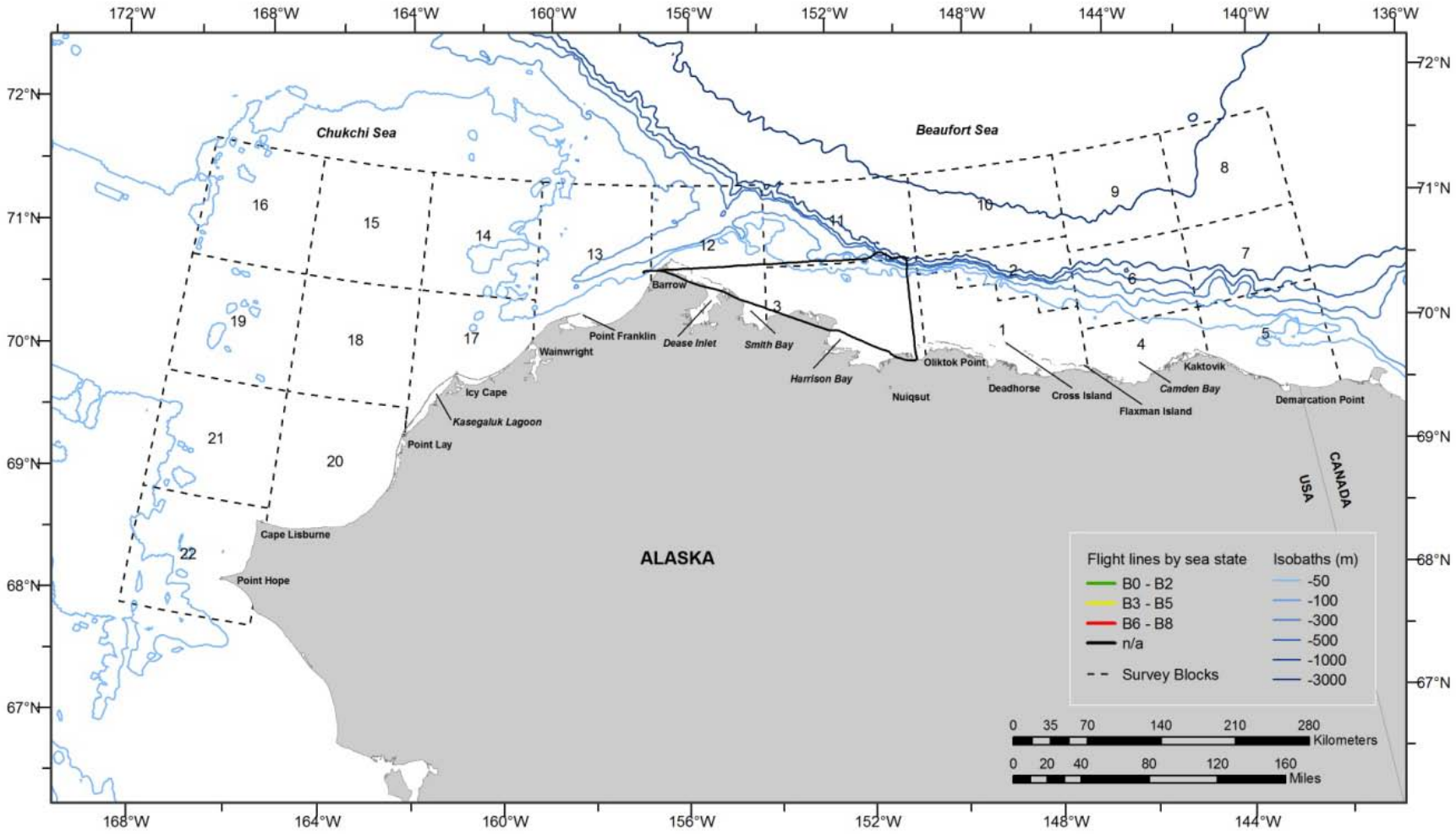

Figure B-37. Flight 236 survey track, depicted by sea state.

22 August 2011, Flight 2

Flight was a transect survey of portions of blocks 4 and 6. Survey conditions were fair, with clear skies, sea state Beaufort 2-3, and visibility 0-10 km. Widespread fog precluded survey effort throughout much of blocks 4 and 6. Most of the area surveyed was ice free; however, 1% broken ice floe was scattered near Kaktovik. Belugas were seen in block 2, and small unidentified pinnipeds were also seen.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
2	8/22/2011 18:24	70.925	146.434	beluga	swim	1	0	2
2	8/22/2011 18:25	70.920	146.454	beluga	swim	3	1	2

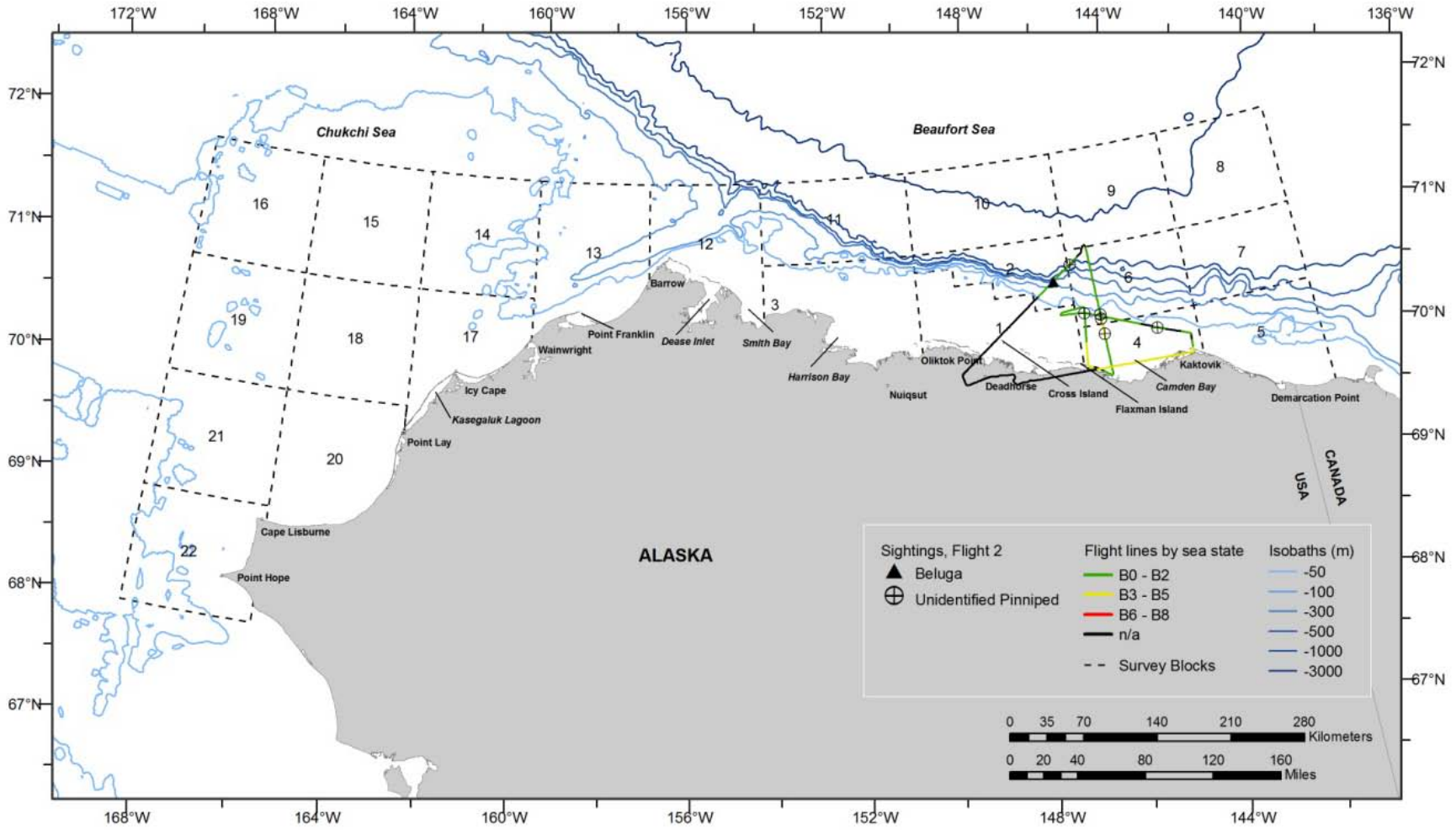

Figure B-38. Flight 2 survey track, depicted by sea state, and all sightings.

24 August 2011, Flight 237

Flight was a survey of Transects 28, 30, and 32 and a Coastal Transect from approximately 15 miles south of Point Hope to Wainwright. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-5, and visibility 0-10 km. Low ceilings and fog prevented completion of the Coastal Transect. There was no ice present within the area surveyed. One gray whale was sighted offshore of Point Hope, one beluga was sighted south of Wainwright, and a dead unidentified cetacean was sighted north of Point Hope. Walruses (including four dead walruses), an unidentified pinniped, and small unidentified pinnipeds were also sighted. A few caribou and a brown bear were sighted on shore. Approximately 10,500 walruses were observed hauled out on land slightly north of Point Lay.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
237	8/24/2011 12:51	68.444	166.330	unidentified cetacean	dead	1	0	0
237	8/24/2011 13:32	68.140	168.817	gray whale	feed	1	0	22
237	8/24/2011 18:06	70.524	160.356	beluga	swim	1	0	17

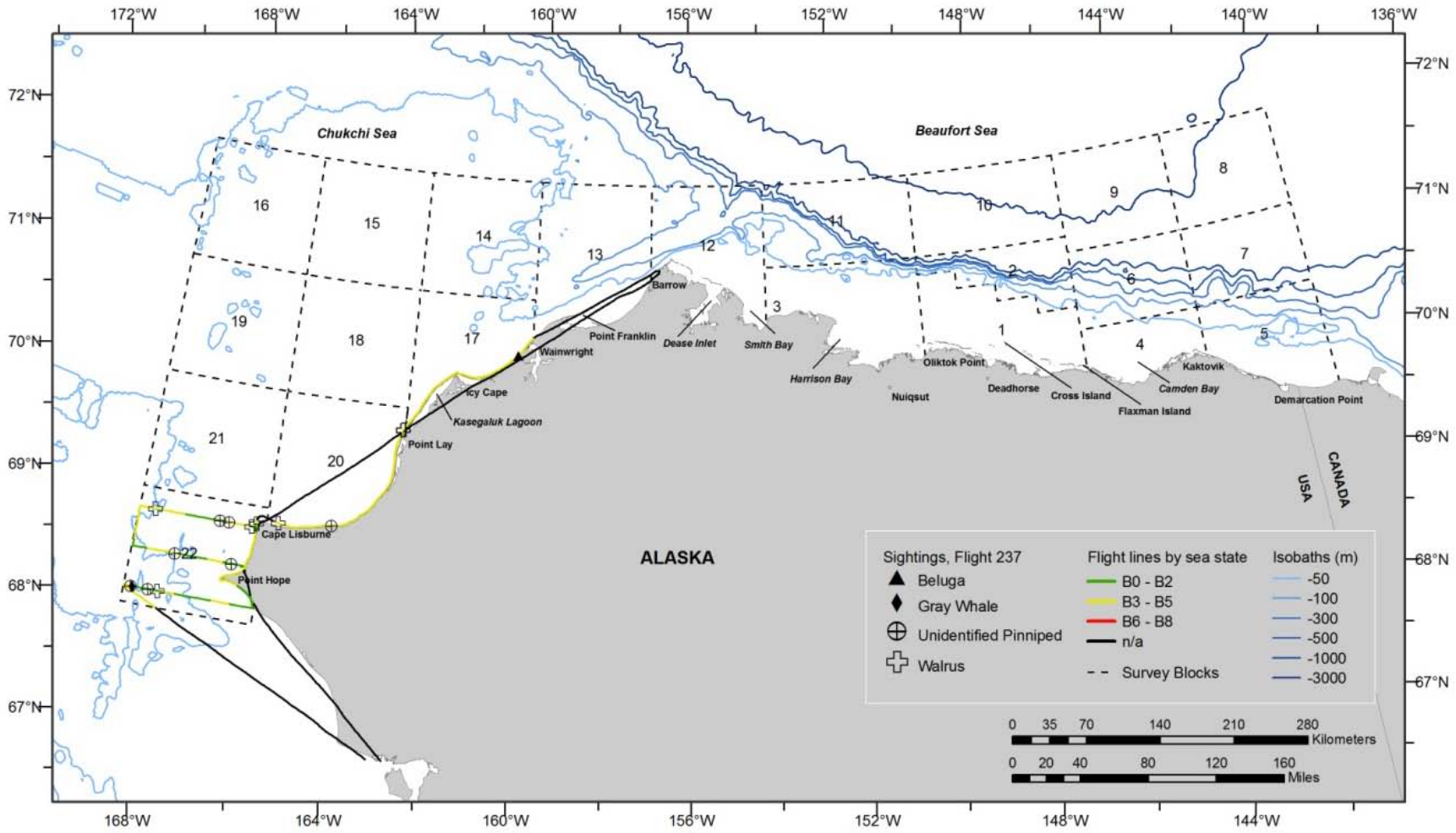

Figure B-39. Flight 237 survey track, depicted by sea state, and all sightings.

24 August 2011, Flight 3

Flight was a transect survey of portions of block 6. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 2-5, and visibility 0-10 km. Low ceilings precluded survey effort in the western half of block 6 and in the surrounding survey areas. No ice was present in the area surveyed. Belugas were seen in block 6.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
3	8/24/2011 16:33	70.672	143.140	beluga	rest	2	1	6
3	8/24/2011 16:33	70.678	143.139	beluga	swim	14	2	6
3	8/24/2011 16:37	70.793	143.117	beluga	swim	1	0	6
3	8/24/2011 16:37	70.797	143.116	beluga	swim	1	0	6
3	8/24/2011 16:39	70.853	143.105	beluga	swim	2	1	6
3	8/24/2011 17:41	71.017	144.105	beluga	rest	6	0	6
3	8/24/2011 17:42	71.033	144.099	beluga	rest	5	1	6

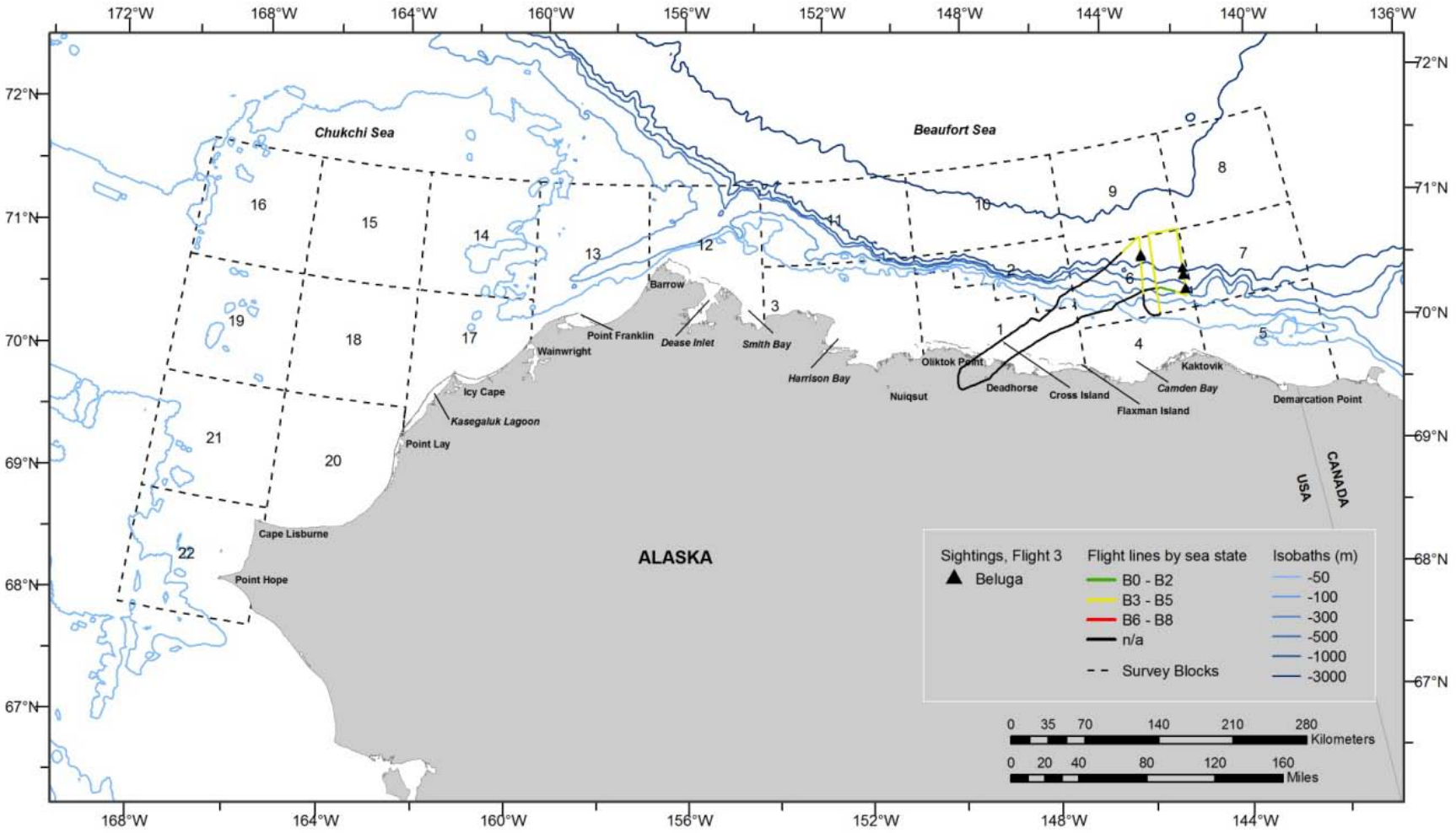

Figure B-40. Flight 3 survey track, depicted by sea state, and all sightings.

26 August 2011, Flight 238

Flight was a survey of partial Transects 2, 4, 6 and 21, and a Coastal Transect from approximately 60 miles south of Point Hope to Barrow. Survey conditions were fair, with partly cloudy skies and precipitation, sea state Beaufort 2-3, and visibility 0-10 km. Low ceilings prevented completion of transects. There was no ice present within the area surveyed. Gray whales and unidentified cetaceans were sighted from Barrow to Point Franklin, belugas were sighted from Point Franklin to Wainwright, and an unidentified cetacean was sighted east of Cape Lisburne. Walruses (including two dead walruses), a bearded seal, ringed seals, unidentified pinnipeds, small unidentified pinnipeds, and a dead unidentified small marine mammal were also sighted. Approximately 20,000 walruses were observed hauled out on land slightly north of Point Lay.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
238	8/26/2011 12:04	71.150	157.897	gray whale	feed	1	0	13
238	8/26/2011 12:06	71.156	157.840	gray whale	feed	1	0	13
238	8/26/2011 12:06	71.156	157.844	gray whale	feed	1	0	13
238	8/26/2011 12:06	71.147	157.905	gray whale	feed	1	0	13
238	8/26/2011 12:07	71.128	157.979	gray whale	feed	1	0	13
238	8/26/2011 12:08	71.107	158.050	gray whale	feed	1	0	13
238	8/26/2011 12:13	71.005	158.391	unidentified cetacean	unknown	1	0	13
238	8/26/2011 12:13	71.000	158.409	beluga	swim	1	0	13
238	8/26/2011 12:15	71.003	158.475	gray whale	feed	3	0	13
238	8/26/2011 12:18	71.007	158.474	unidentified cetacean	unknown	1	0	13
238	8/26/2011 13:35	69.301	164.694	unidentified cetacean	breach	1	0	20
238	8/26/2011 14:54	70.704	159.918	beluga	swim	1	0	13
238	8/26/2011 15:01	70.844	159.445	beluga	swim	1	0	13
238	8/26/2011 15:02	70.858	159.339	beluga	swim	1	0	13
238	8/26/2011 15:04	70.889	159.119	beluga	swim	1	0	13

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
238	8/26/2011 15:23	70.938	157.567	small unidentified marine mammal	dead	1	0	0
238	8/26/2011 17:52	71.185	158.020	gray whale	feed	1	0	13
238	8/26/2011 17:52	71.182	158.011	gray whale	feed	1	0	13
238	8/26/2011 17:53	71.157	157.931	gray whale	feed	1	0	13
238	8/26/2011 17:53	71.156	157.929	gray whale	feed	1	0	13

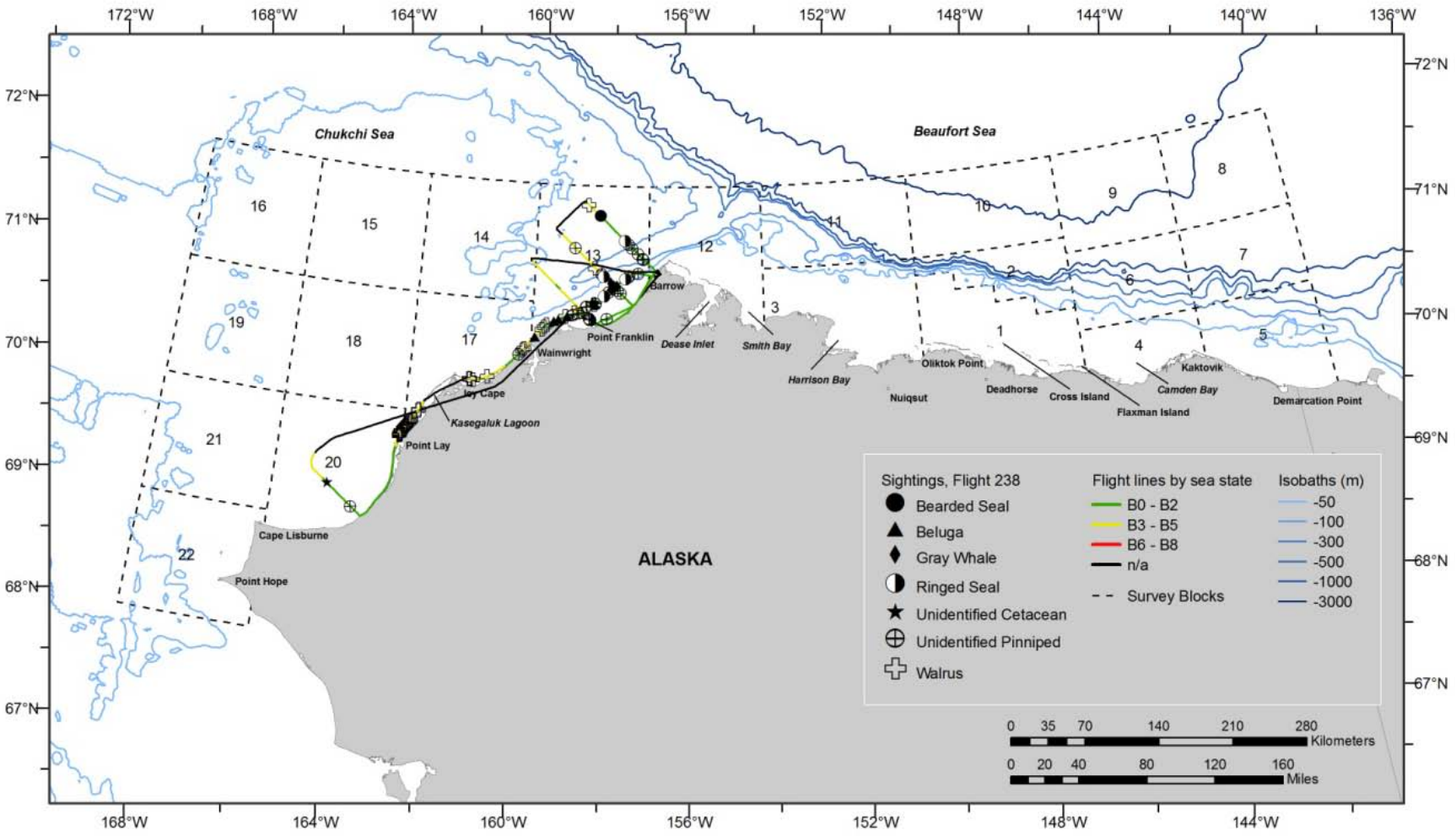

Figure B-41. Flight 238 survey track, depicted by sea state, and all sightings.

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26 August 2011, Flight 4

Flight was a search survey in an attempt to find an area suitable for transects in blocks 4, 5, 6 and 7. Survey conditions were poor, with clear skies, sea state Beaufort 5, and visibility 0-3 km. Widespread low ceilings and fog precluded survey effort. No ice was present in the area surveyed. There were no sightings.

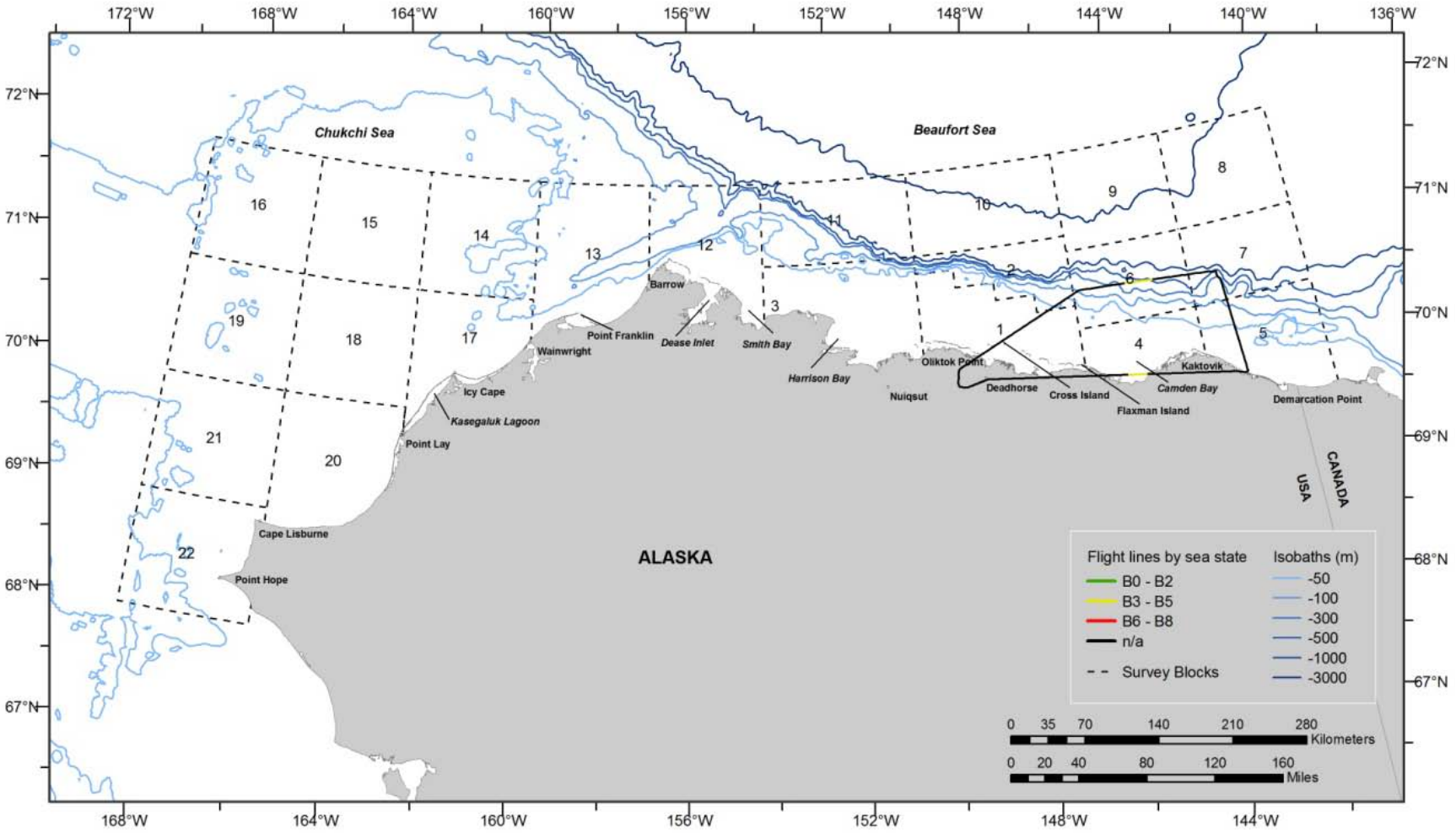

Figure B-42. Flight 4 survey track, depicted by sea state.

27 August 2011, Flight 239

Flight was a survey of partial Transects 8, 10, 12 and 14, Coastal Transect near Icy Cape, and search effort between Barrow and Point Franklin. Survey conditions were fair, with partly cloudy to overcast skies and fog and precipitation, sea state Beaufort 2-5, and visibility 0-10 km. Low ceilings prevented completion of transects. There was no ice present within the area surveyed. Gray whales and an unidentified cetacean were sighted between Barrow and Point Franklin and offshore of Wainwright. Walruses (including one dead walrus), bearded seals, unidentified pinnipeds, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
239	8/27/2011 10:13	70.929	160.263	gray whale	feed	1	0	17
239	8/27/2011 10:13	70.934	160.279	gray whale	feed	1	0	17
239	8/27/2011 10:14	70.943	160.309	gray whale	feed	1	0	17
239	8/27/2011 10:14	70.946	160.320	gray whale	feed	2	0	17
239	8/27/2011 10:14	70.946	160.320	gray whale	swim	1	0	17
239	8/27/2011 10:17	71.016	160.555	gray whale	rest	1	0	14
239	8/27/2011 11:22	70.805	161.410	gray whale	feed	1	0	17
239	8/27/2011 14:43	71.042	157.906	gray whale	feed	1	0	13
239	8/27/2011 14:47	70.965	158.282	unidentified cetacean	unknown	1	0	13

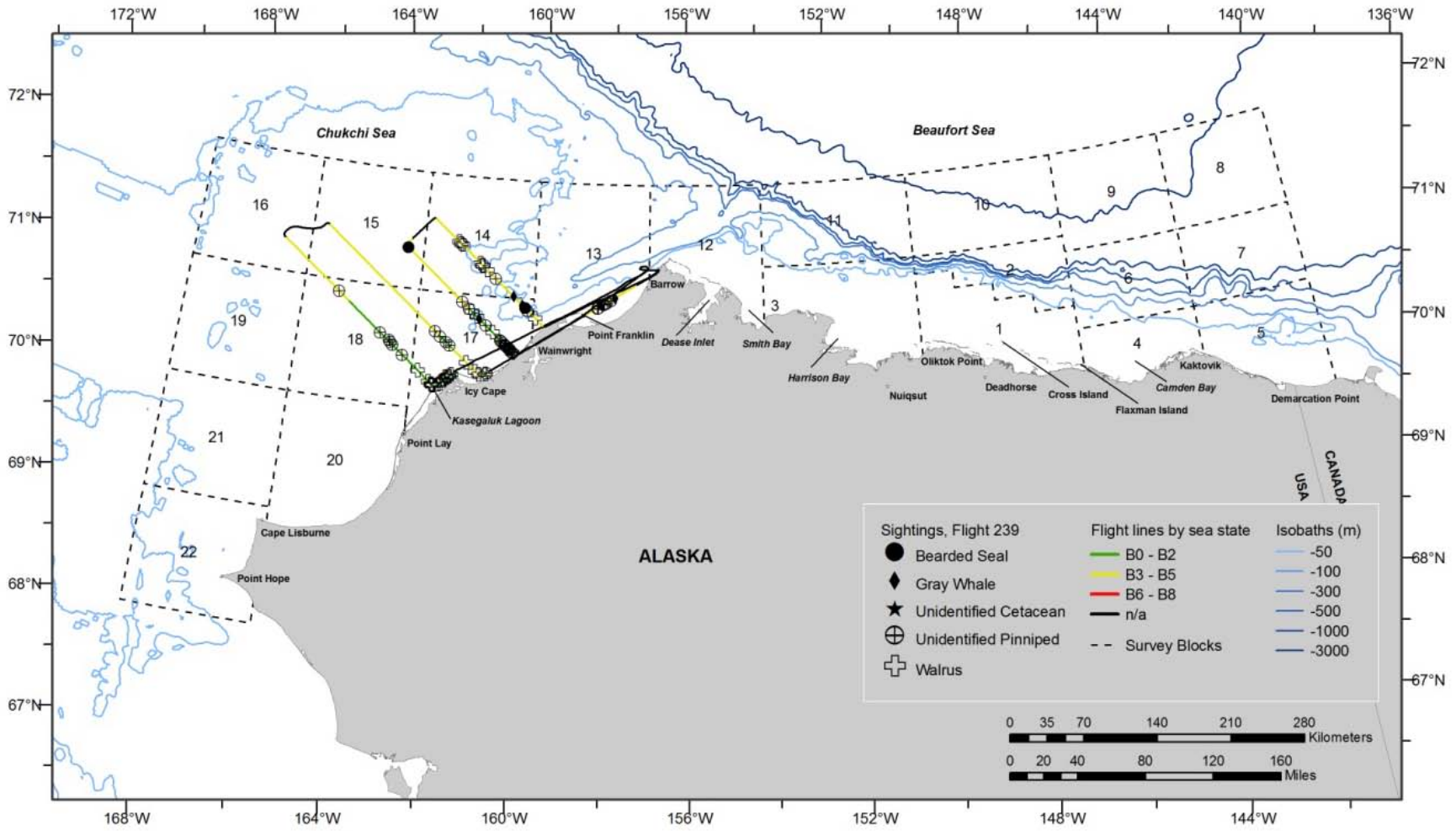

Figure B-43. Flight 239 survey track, depicted by sea state, and all sightings.

28 August 2011, Flight 240

Flight was a survey of partial Transect 19. Survey conditions were poor, with partly cloudy to overcast skies and fog and precipitation, sea state Beaufort 3-5, and visibility 0-10 km. Low ceilings prevented completion of transects. There was no ice present within the area surveyed. Walruses were sighted south of Point Lay.

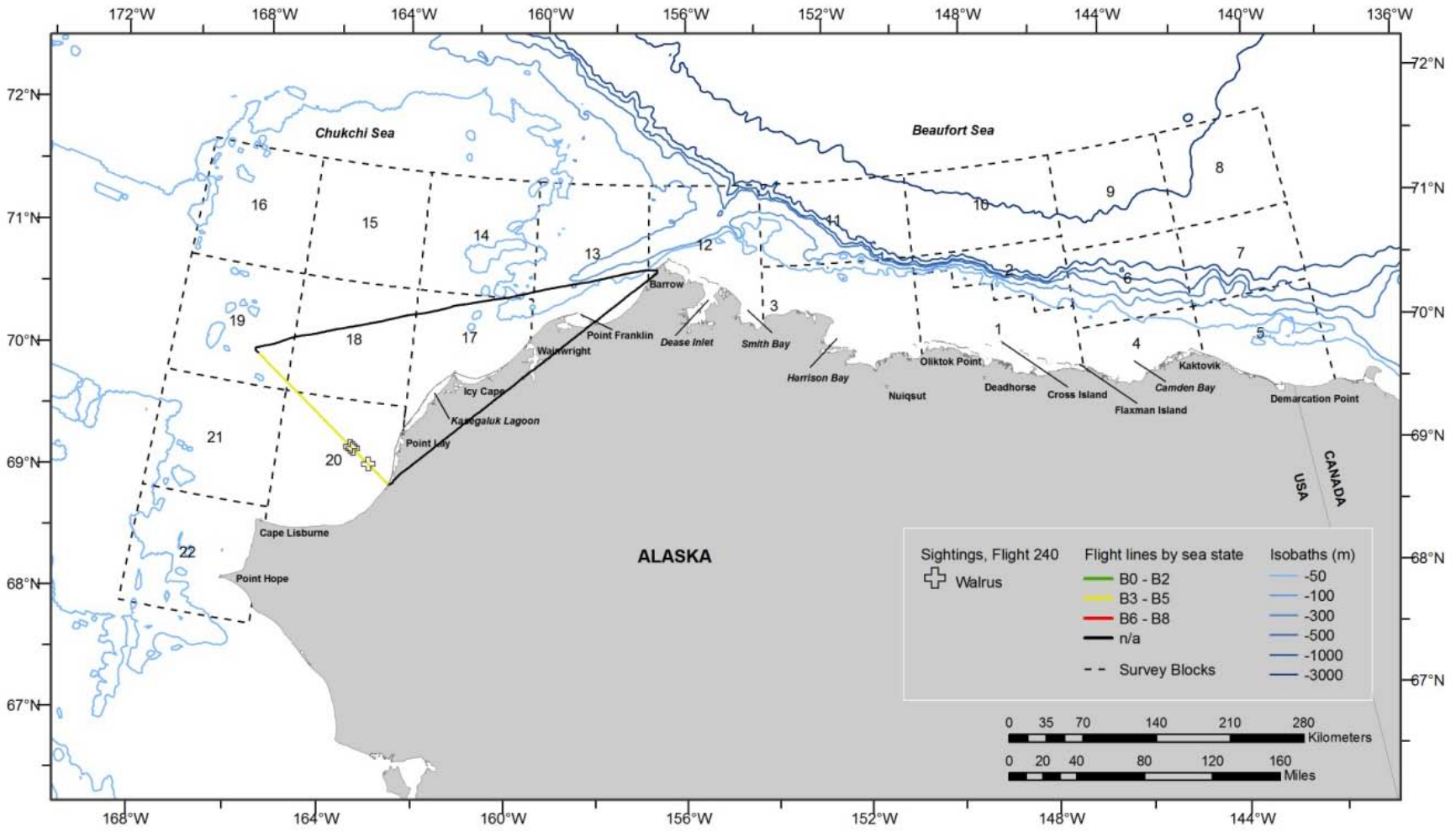

Figure B-44. Flight 240 survey track, depicted by sea state, and all sightings.

30 August 2011, Flight 5

Flight was a transect survey of portions of blocks 4 and 12. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 2-7, and visibility 0-10 km. Transect effort was precluded in block 4 by high sea states, and offshore in block 12 by low ceilings. No ice was present in the area surveyed. Belugas were sighted in block 12.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
5	8/30/2011 18:03	71.661	155.567	beluga	swim	3	0	12
5	8/30/2011 18:12	71.446	155.771	beluga	swim	1	0	12

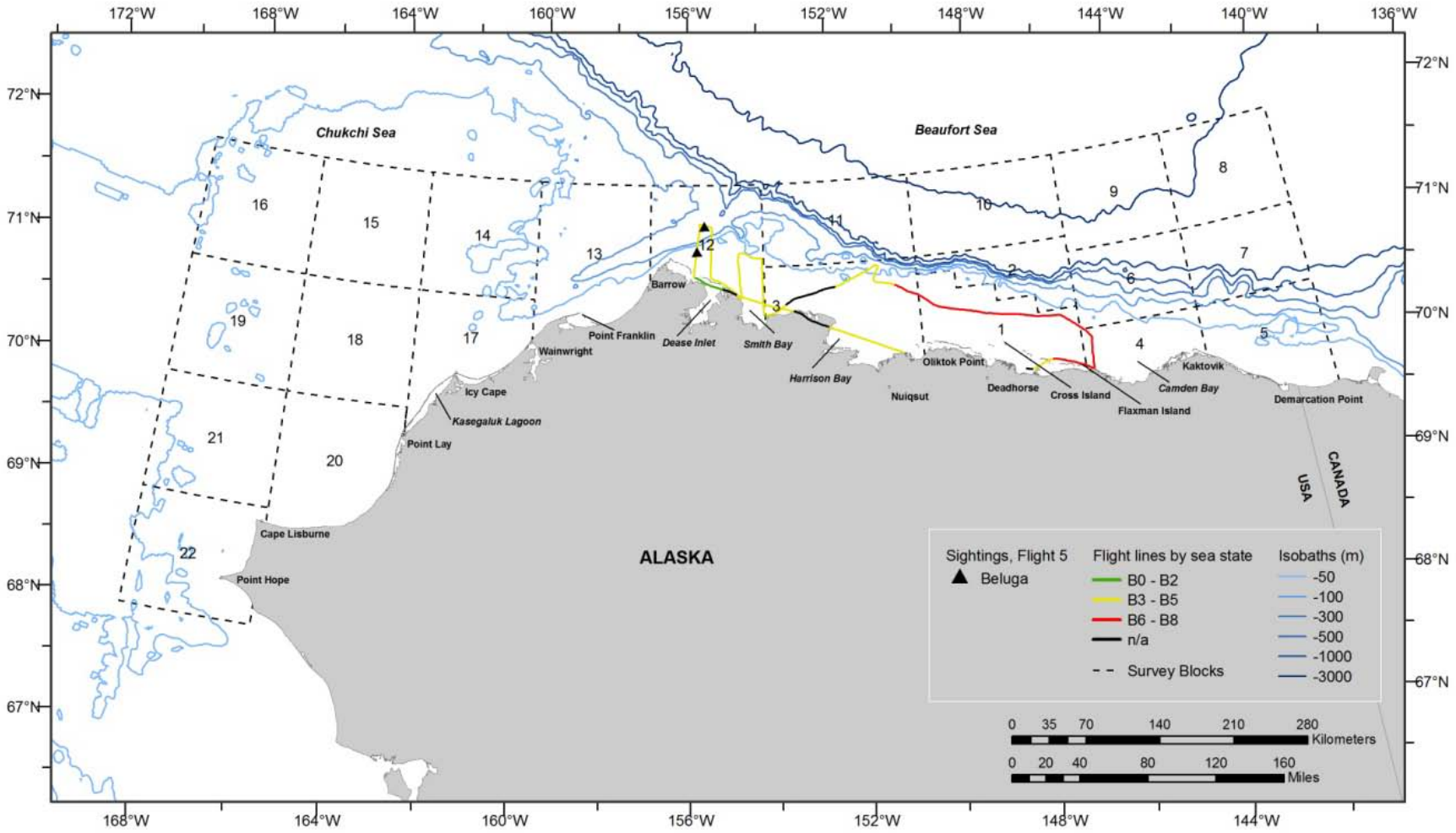

Figure B-45. Flight 5 survey track, depicted by sea state, and all sightings.

31 August 2011, Flight 6

Flight was a transect survey of portions of blocks 4 and 6. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 2-7, and visibility 0-10 km. Transect effort was precluded in blocks 4 and 6 by low ceilings, and in block 6 by high sea states. No ice was present in the area surveyed. Three bowhead whales, including a cow-calf pair, were seen in Camden Bay, and small unidentified pinnipeds were sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
6	8/31/2011 12:20	70.104	144.807	bowhead whale	swim	2	1	4
6	8/31/2011 12:28	70.099	144.818	bowhead whale	rest	1	0	4

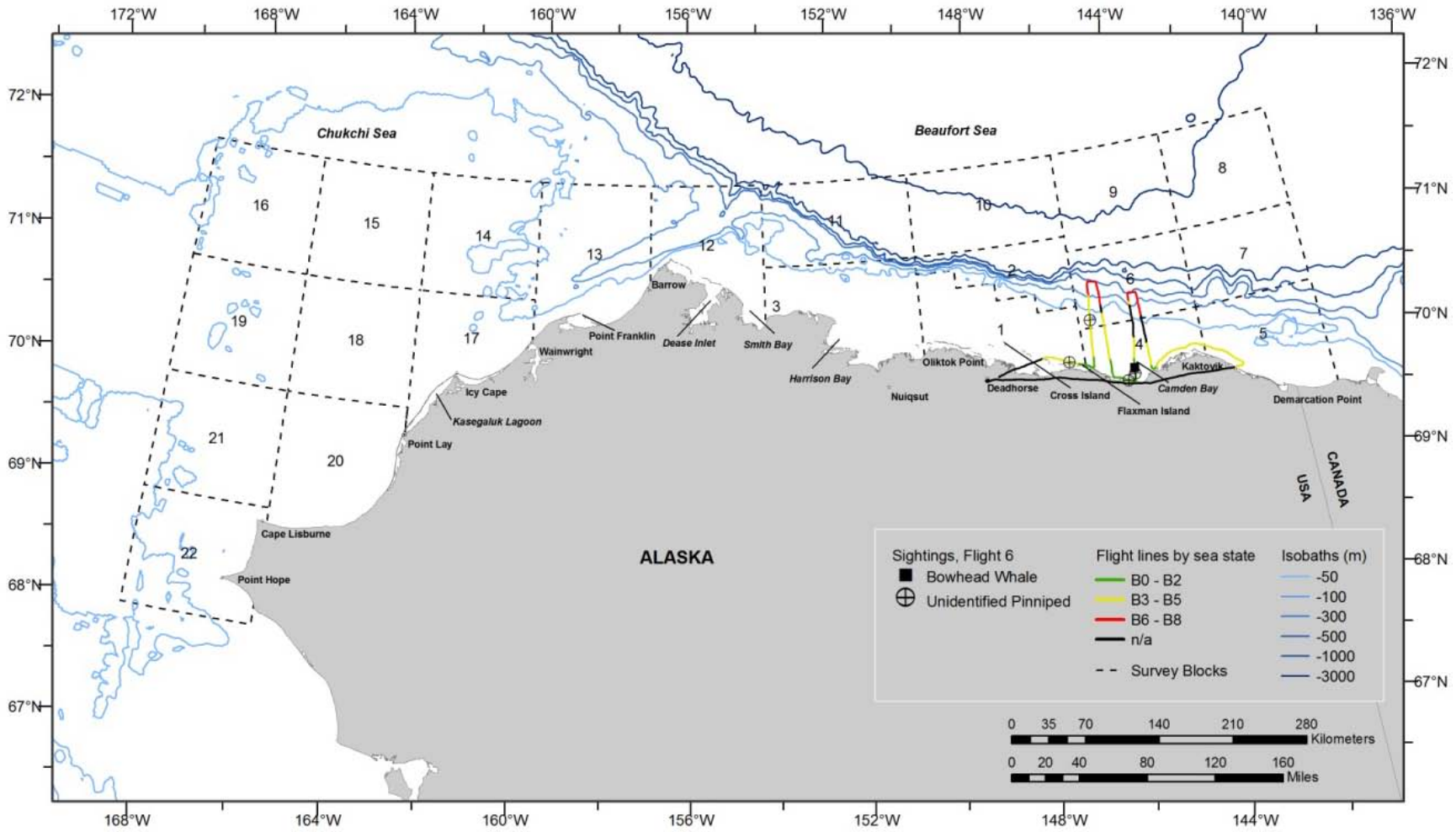

Figure B-46. Flight 6 survey track, depicted by sea state, and all sightings.

1 September 2011, Flight 7

Flight was a transect survey of portions of blocks 5 and 7. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 3-5, and visibility 0-10 km. Transect effort was truncated in block 7 by low ceilings. There was 1% broken floe ice scattered along the shore in block 5. A beluga cow-calf pair and an unidentified cetacean were seen in block 5.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
7	9/1/2011 16:54	70.438	141.125	beluga	swim	2	1	5
7	9/1/2011 17:33	70.206	141.668	unidentified cetacean	swim	1	0	5

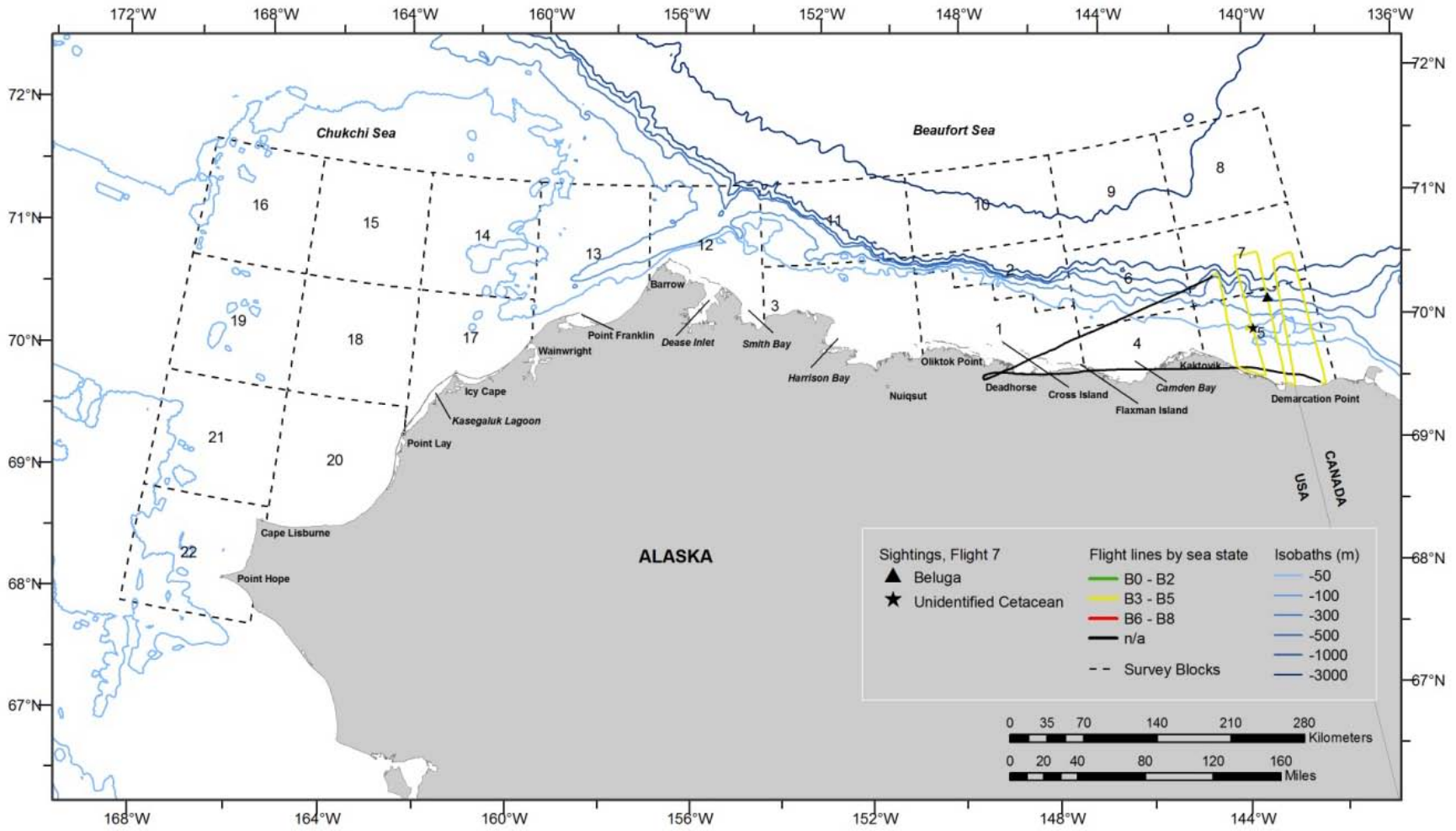

Figure B-47. Flight 7 survey track, depicted by sea state, and all sightings.

2 September 2011, Flight 241

Flight was a survey of Transects 1, 3, 5, 7, 9, and 11, and a Coastal Transect from approximately 30 miles south of Wainwright to Barrow. Survey conditions were good, with partly cloudy to overcast skies and fog and precipitation, sea state Beaufort 1-5, and visibility 0-10 km. Low ceilings prevented completion of some transects. There was no ice present within the area surveyed. Gray whales were sighted offshore from Barrow to Wainwright, one minke was sighted offshore in block 14, a beluga was sighted offshore of Point Franklin, and a small unidentified marine mammal was sighted offshore of Wainwright. Walruses (including three dead walruses), bearded seals, and unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
241	9/2/2011 11:08	71.002	158.262	gray whale	feed	1	0	13
241	9/2/2011 11:41	70.995	161.285	gray whale	swim	2	0	17
241	9/2/2011 11:42	70.999	161.259	gray whale	swim	2	0	17
241	9/2/2011 11:44	71.040	161.444	small unidentified marine mammal	unknown	1	0	14
241	9/2/2011 13:52	70.767	162.068	gray whale	feed	1	0	17
241	9/2/2011 17:23	71.452	158.126	gray whale	swim	1	0	13
241	9/2/2011 17:52	71.008	158.209	gray whale	feed	5	0	13
241	9/2/2011 18:58	71.893	163.000	minke whale	swim	1	0	14
241	9/2/2011 19:46	71.029	159.818	beluga	rest	1	0	13

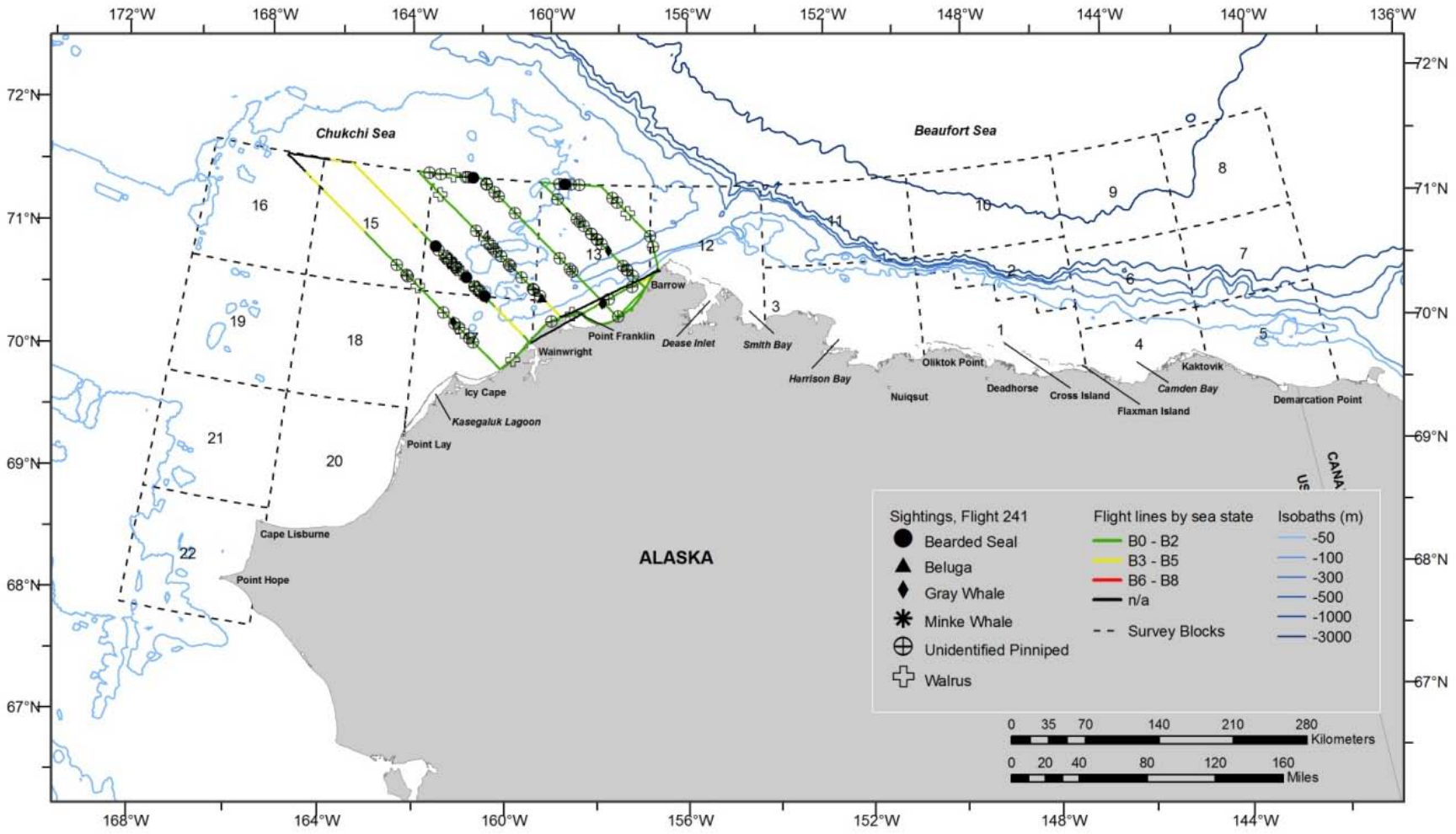

Figure B-48. Flight 241 survey track, depicted by sea state, and all sightings.

2 September 2011, Flight 8

Flight was a deadhead survey in an attempt to find an area suitable for transects. Survey conditions were very poor, with partly cloudy to overcast skies, the sea state was not visible, and visibility was 0 km. There were no sightings.

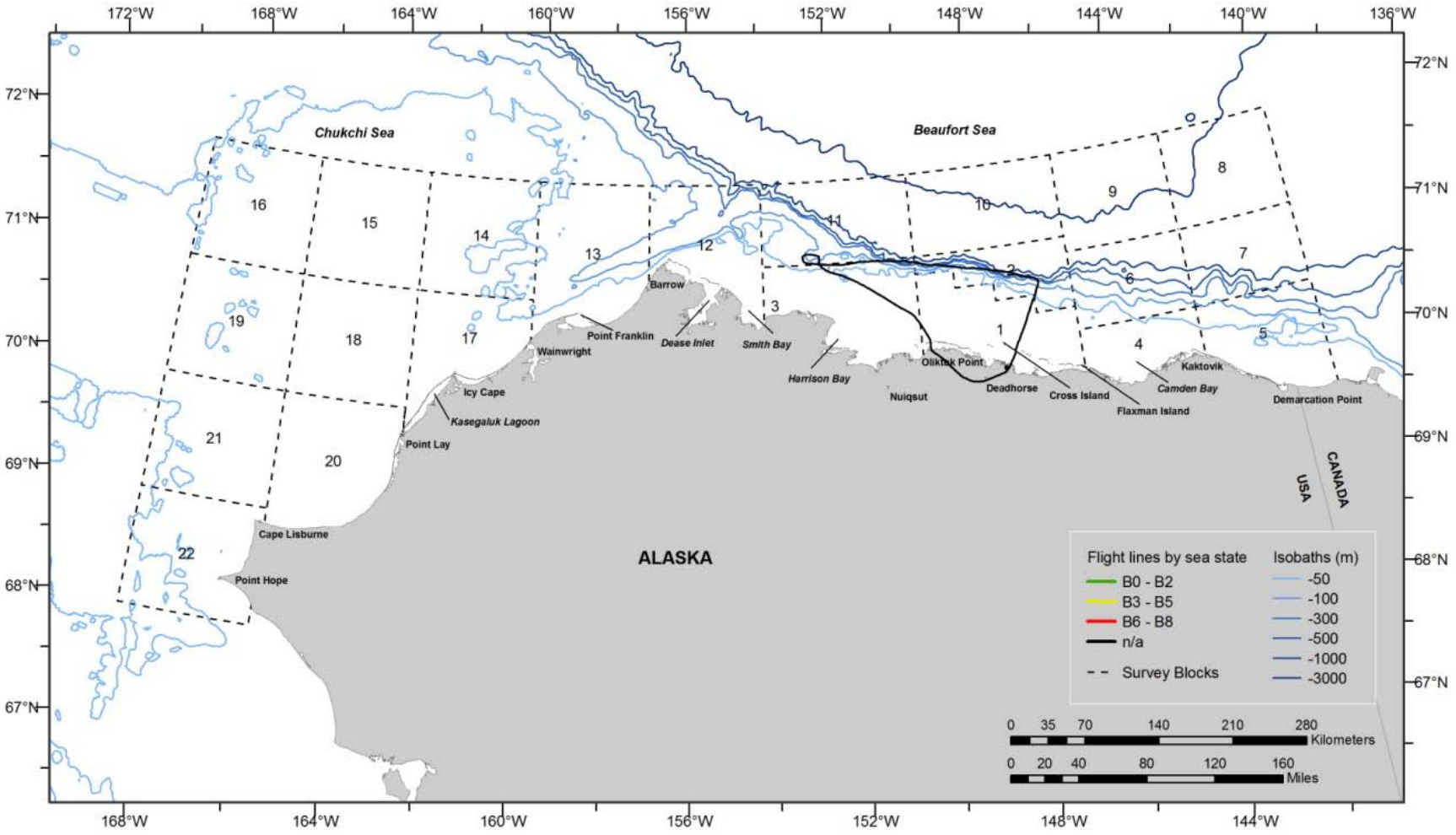

Figure B-49. Flight 8 survey track, depicted by sea state.

3 September 2011, Flight 242

Flight was a survey of partial Transects 13, 15 and 17. Survey conditions were poor, with partly cloudy to overcast skies and precipitation, sea state Beaufort 3-5, and visibility 0-10 km. Low ceilings prevented completion of transects. There was no ice present within the area surveyed. There were no sightings.

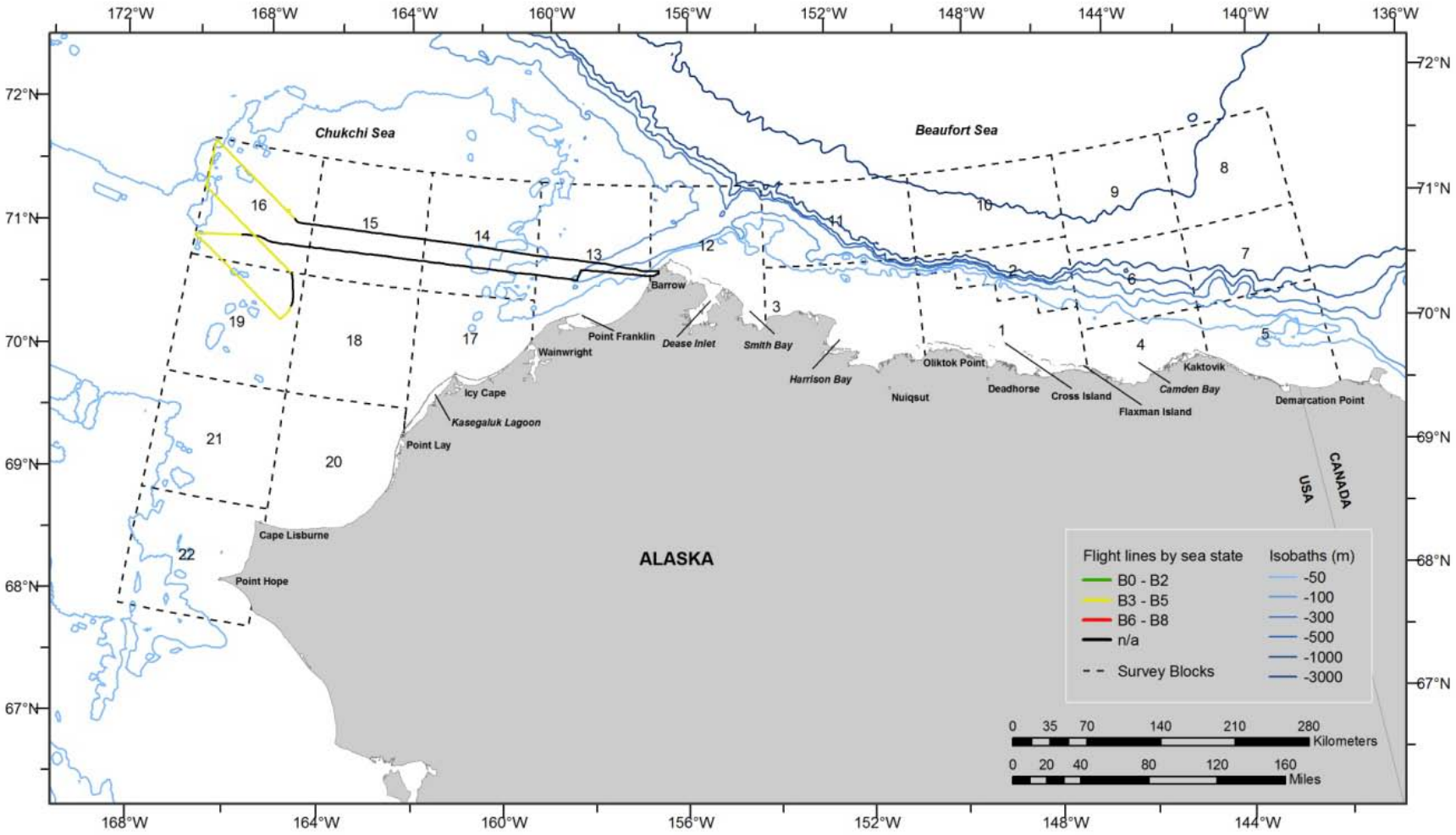

Figure B-50. Flight 242 survey track, depicted by sea state.

5 September 2011, Flight 243

Flight was a survey of partial Transect 4, Coastal Transect from Point Lay to Barrow, and search effort from Barrow to Point Franklin. Survey conditions were fair, with partly cloudy to overcast skies and precipitation, sea state Beaufort 1-7, and visibility 0-10 km. High sea states prevented completion of transects in the southern part of the study area, while low ceilings prevented survey effort in the northern part of the study area. There was no ice present within the area surveyed. Gray whales were sighted between Barrow and Point Franklin. Walruses (including a dead walrus), small unidentified pinnipeds, and one brown bear were also sighted. Approximately 5,000 walruses were observed hauled out on land slightly north of Point Lay with approximately 300 walruses in the water slightly south of the haulout.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
243	9/5/2011 14:58	71.091	157.942	gray whale	feed	2	0	13
243	9/5/2011 15:03	71.124	158.038	gray whale	feed	1	0	13
243	9/5/2011 15:04	71.112	157.994	gray whale	swim	2	0	13
243	9/5/2011 15:05	71.126	158.012	gray whale	rest	1	0	13
243	9/5/2011 15:00	71.111	157.943	gray whale	rest	1	0	13
243	9/5/2011 15:56	71.125	157.823	gray whale	dive	1	0	13
243	9/5/2011 16:01	71.173	157.993	gray whale	feed	1	0	13
243	9/5/2011 15:58	71.162	157.946	gray whale	feed	1	0	13
243	9/5/2011 15:58	71.165	157.955	gray whale	dive	1	0	13
243	9/5/2011 15:58	71.167	157.964	gray whale	swim	1	0	13

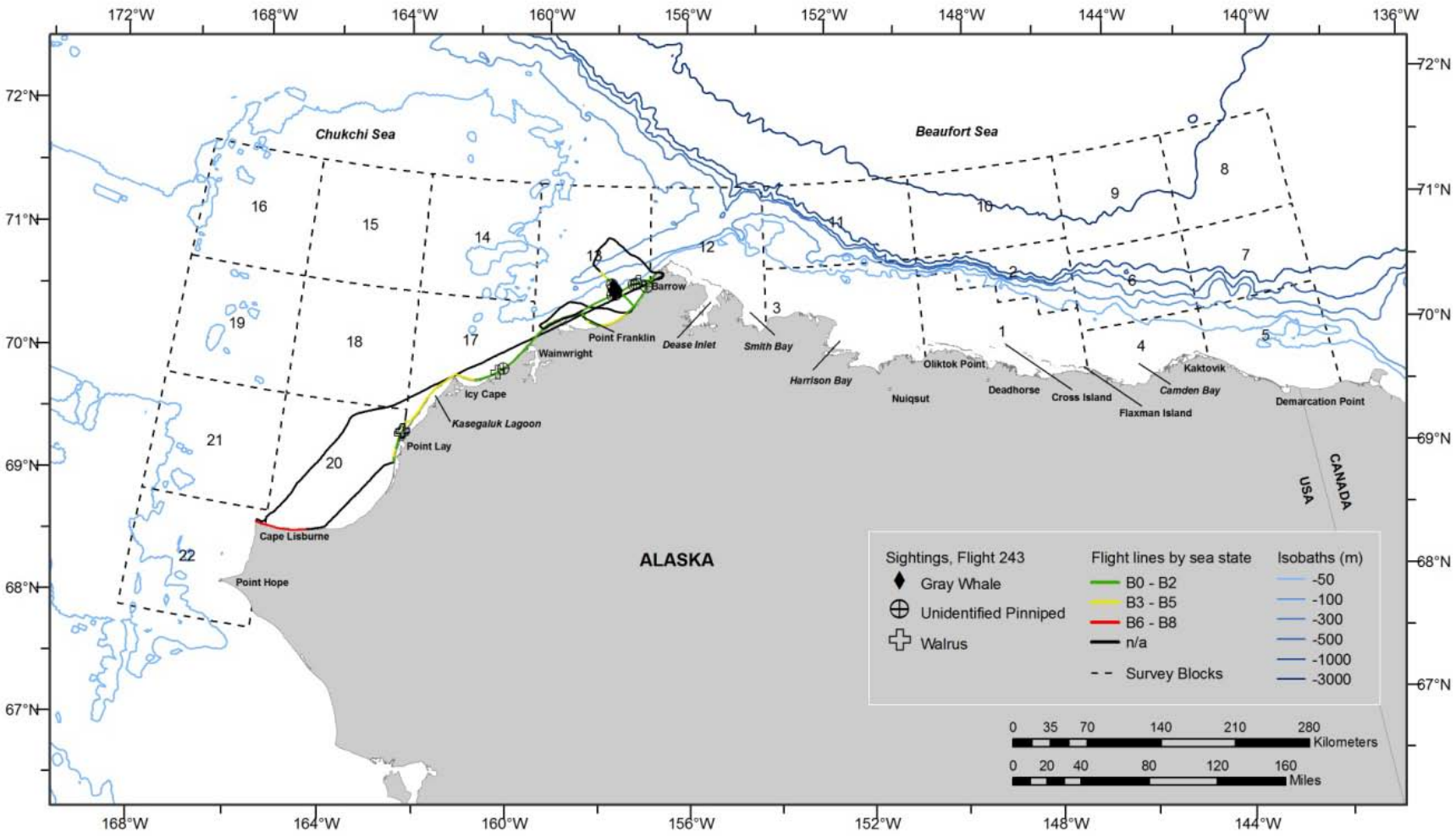

Figure B-51. Flight 243 survey track, depicted by sea state, and all sightings.

5 September 2011, Flight 9

Flight was a transect survey of portions of blocks 3 and 11. Survey conditions were good, with partly cloudy to overcast skies, sea state Beaufort 3-4, and visibility <1-10 km. The area surveyed was ice free. Belugas were seen offshore scattered across the northern part of block 11, two polar bears were seen on barrier islands, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
9	9/5/2011 15:54	71.897	153.742	beluga	swim	2	0	11
9	9/5/2011 15:54	71.900	153.741	beluga	swim	1	0	11
9	9/5/2011 15:55	71.907	153.739	beluga	swim	1	0	11
9	9/5/2011 15:57	71.975	153.720	beluga	swim	1	0	11
9	9/5/2011 16:06	71.780	153.389	beluga	rest	1	0	11
9	9/5/2011 16:07	71.760	153.390	beluga	rest	1	0	11
9	9/5/2011 16:07	71.757	153.390	beluga	rest	1	0	11
9	9/5/2011 17:04	71.738	152.714	beluga	swim	1	0	11
9	9/5/2011 17:04	71.743	152.715	beluga	swim	1	0	11

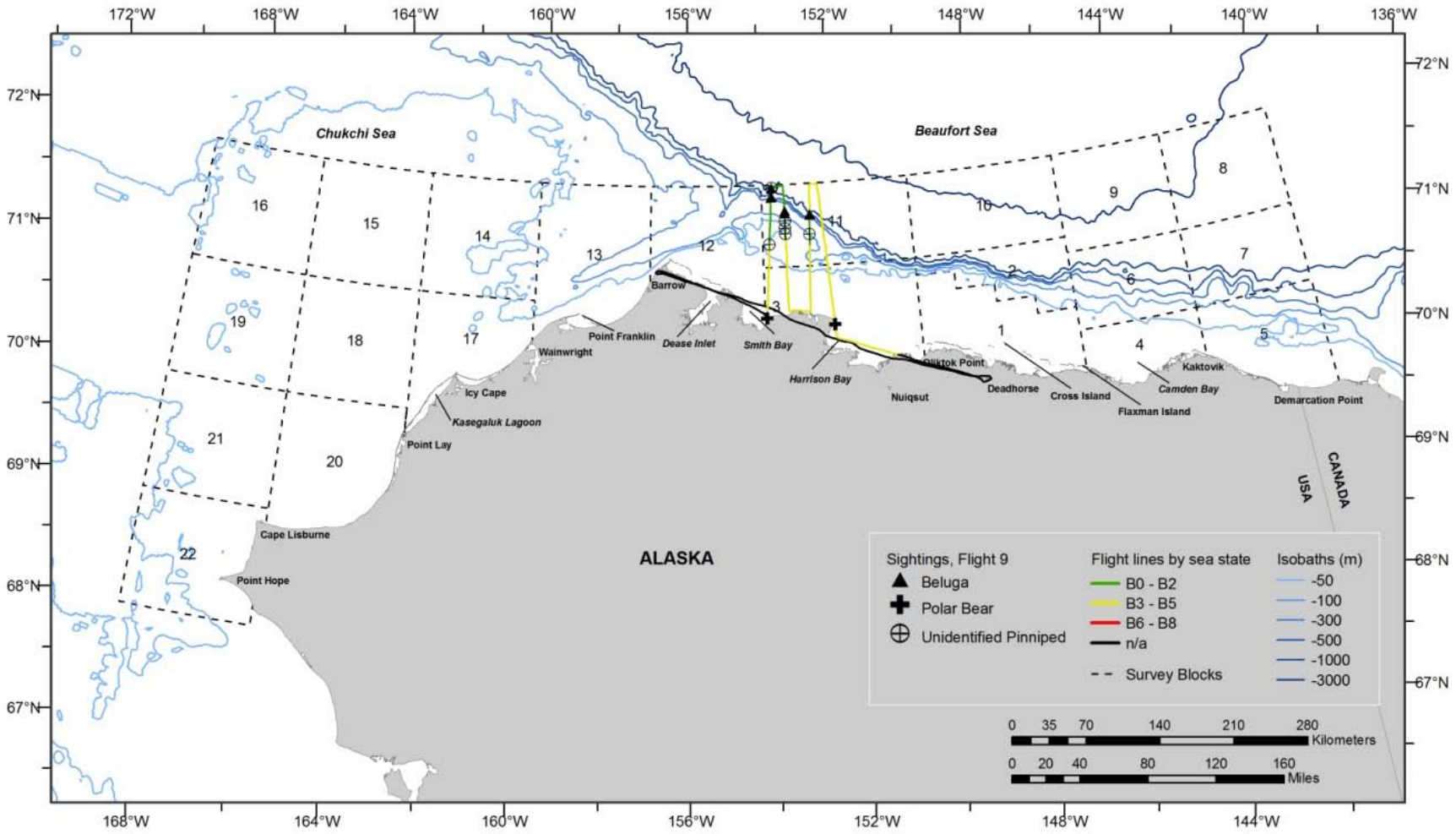

Figure B-52. Flight 9 survey track, depicted by sea state, and all sightings.

6 September 2011, Flight 244

Flight was a transect survey of block 12, and a survey of partial Transects 2 and 4. Survey conditions were fair, with partly cloudy to overcast skies with low ceilings and precipitation, sea state Beaufort 2-6, and visibility 0-10 km. High seas states prevented completion of transects in the Chukchi Sea. There was no ice present within the area surveyed. Bowhead whales and belugas were sighted offshore in block 12, and gray whales were sighted nearshore between Barrow and Point Franklin. Bearded seals, unidentified pinnipeds, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
244	9/6/2011 9:40	71.483	156.656	beluga	rest	1	0	12
244	9/6/2011 9:43	71.568	156.641	bowhead whale	swim	1	0	12
244	9/6/2011 9:43	71.586	156.636	bowhead whale	rest	2	0	12
244	9/6/2011 9:44	71.591	156.605	bowhead whale	swim	1	0	12
244	9/6/2011 10:12	71.613	156.257	beluga	rest	1	0	12
244	9/6/2011 10:12	71.605	156.252	beluga	rest	1	0	12
244	9/6/2011 10:13	71.595	156.246	beluga	swim	1	0	12
244	9/6/2011 10:14	71.562	156.234	bowhead whale	swim	1	0	12
244	9/6/2011 10:50	71.892	155.609	bowhead whale	swim	1	0	12
244	9/6/2011 10:54	71.998	155.608	beluga	rest	6	0	12
244	9/6/2011 10:54	71.998	155.601	beluga	swim	1	0	12
244	9/6/2011 12:01	71.944	154.797	beluga	rest	1	0	12
244	9/6/2011 12:01	71.949	154.798	beluga	rest	1	0	12
244	9/6/2011 12:01	71.951	154.799	beluga	rest	7	0	12
244	9/6/2011 12:02	71.962	154.801	beluga	dive	1	0	12
244	9/6/2011 12:02	71.978	154.804	beluga	rest	2	0	12

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
244	9/6/2011 12:03	71.994	154.788	beluga	rest	2	0	12
244	9/6/2011 12:04	71.995	154.712	beluga	rest	3	0	12
244	9/6/2011 12:04	71.994	154.636	beluga	swim	1	0	12
244	9/6/2011 12:04	71.994	154.633	beluga	dive	1	0	12
244	9/6/2011 12:05	71.995	154.613	beluga	rest	3	0	12
244	9/6/2011 12:05	71.995	154.593	beluga	rest	1	0	12
244	9/6/2011 12:05	71.995	154.557	beluga	rest	3	0	12
244	9/6/2011 12:06	71.995	154.507	beluga	rest	1	0	12
244	9/6/2011 12:06	71.995	154.484	beluga	rest	28	3	12
244	9/6/2011 12:07	71.985	154.443	beluga	swim	7	0	12
244	9/6/2011 12:07	71.984	154.443	beluga	rest	7	0	12
244	9/6/2011 12:07	71.966	154.439	beluga	swim	3	0	12
244	9/6/2011 12:08	71.951	154.433	beluga	swim	1	0	12
244	9/6/2011 12:09	71.895	154.423	beluga	rest	1	0	12
244	9/6/2011 13:21	71.132	157.853	gray whale	feed	2	0	13
244	9/6/2011 13:22	71.154	157.921	gray whale	feed	1	0	13
244	9/6/2011 13:22	71.158	157.933	gray whale	feed	1	0	13
244	9/6/2011 13:23	71.162	157.948	gray whale	feed	1	0	13

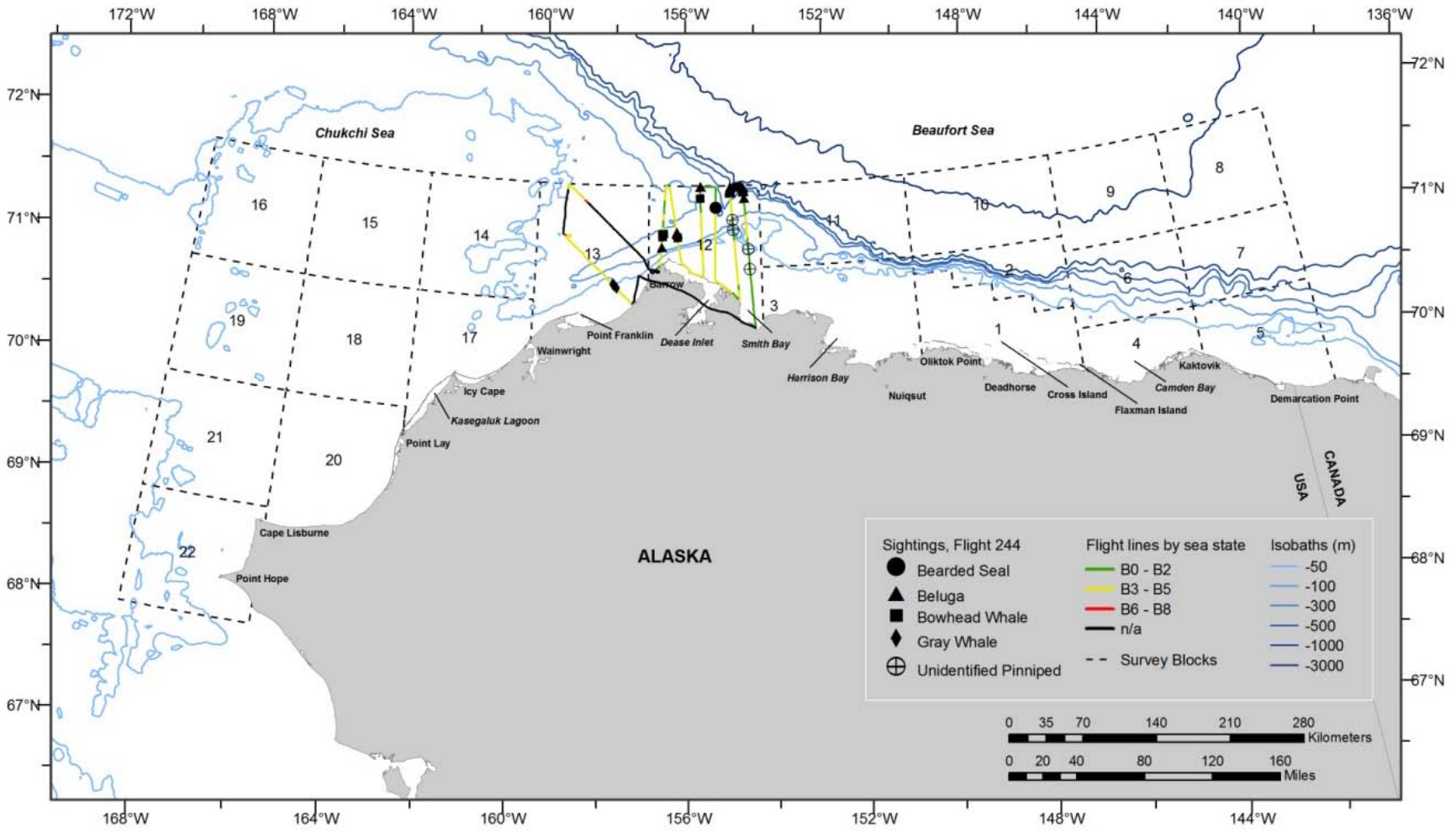

Figure B-53. Flight 244 survey track, depicted by sea state, and all sightings.

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6 September 2011, Flight 10

Flight was a transect survey of the eastern half of blocks 3 and 11. Survey conditions were good, with partly cloudy to overcast skies, sea state Beaufort 2-6, and visibility 0-10 km. The area surveyed was ice free. One beluga was sighted offshore in block 11, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
10	9/6/2011 16:46	71.875	150.855	beluga	swim	1	0	11

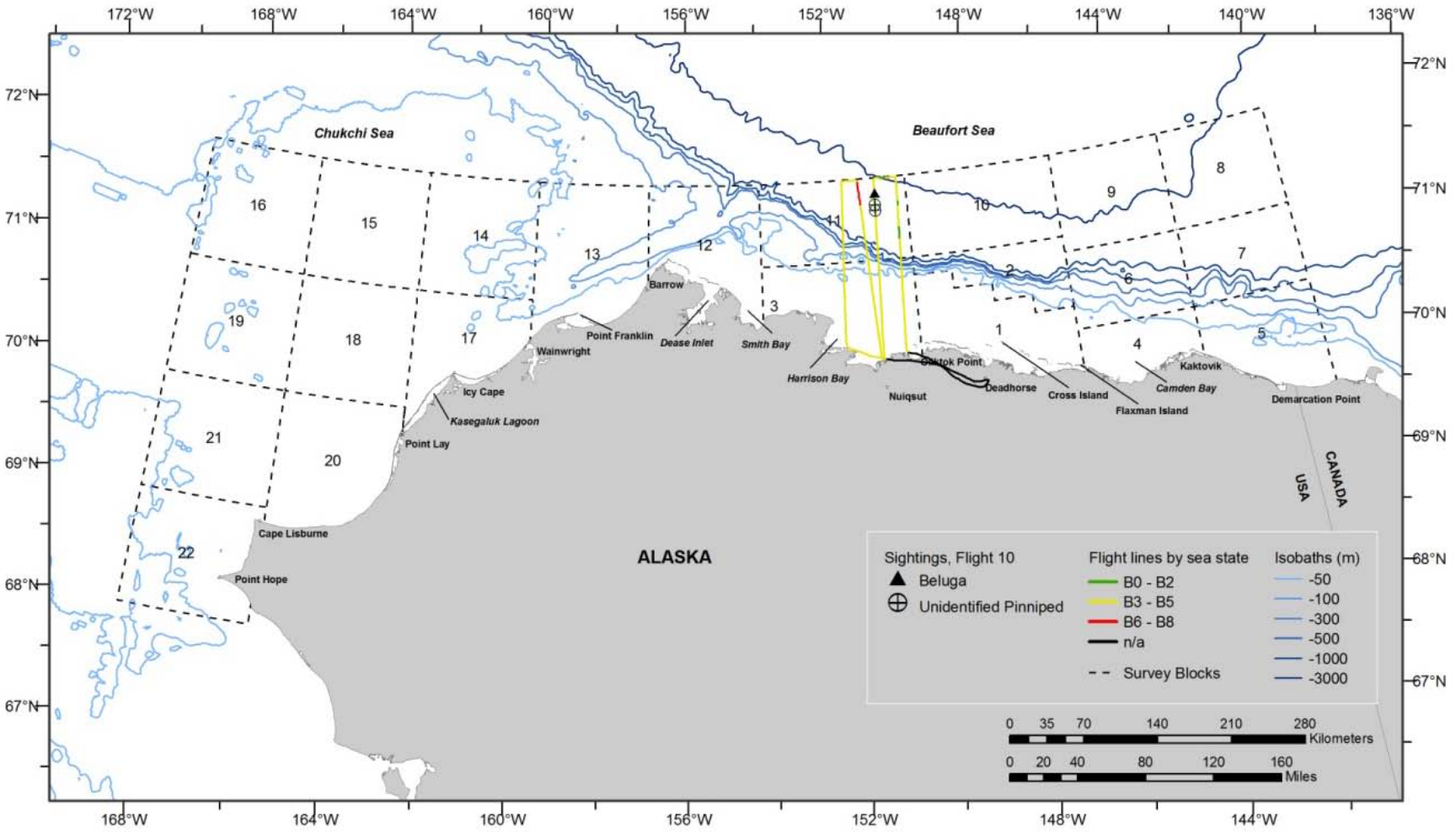

Figure B-54. Flight 10 survey track, depicted by sea state, and all sightings.

7 September 2011, Flight 11

Flight was a transect survey of portions of blocks 4, 6 and 7. Survey conditions were good, with partly cloudy to overcast skies, sea state Beaufort 2, and visibility 0-10 km. Transect effort was truncated in blocks 6 and 7 by low ceilings. The area surveyed was ice free. Two bowhead whales were sighted in Camden Bay, belugas were scattered across block 6, small unidentified pinnipeds were seen throughout the survey area, and one polar bear was observed swimming a few kilometers offshore in Camden Bay.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
11	9/7/2011 15:45	70.667	143.533	beluga	swim	1	0	6
11	9/7/2011 15:48	70.649	142.990	beluga	swim	3	0	7
11	9/7/2011 17:29	70.639	144.294	beluga	swim	1	0	6
11	9/7/2011 18:33	71.153	145.111	beluga	swim	6	0	6
11	9/7/2011 18:39	71.023	145.381	beluga	swim	2	0	6
11	9/7/2011 18:40	70.979	145.376	beluga	swim	1	0	6
11	9/7/2011 19:06	70.187	145.379	bowhead whale	swim	1	0	4
11	9/7/2011 19:09	70.173	145.368	bowhead whale	rest	1	0	4

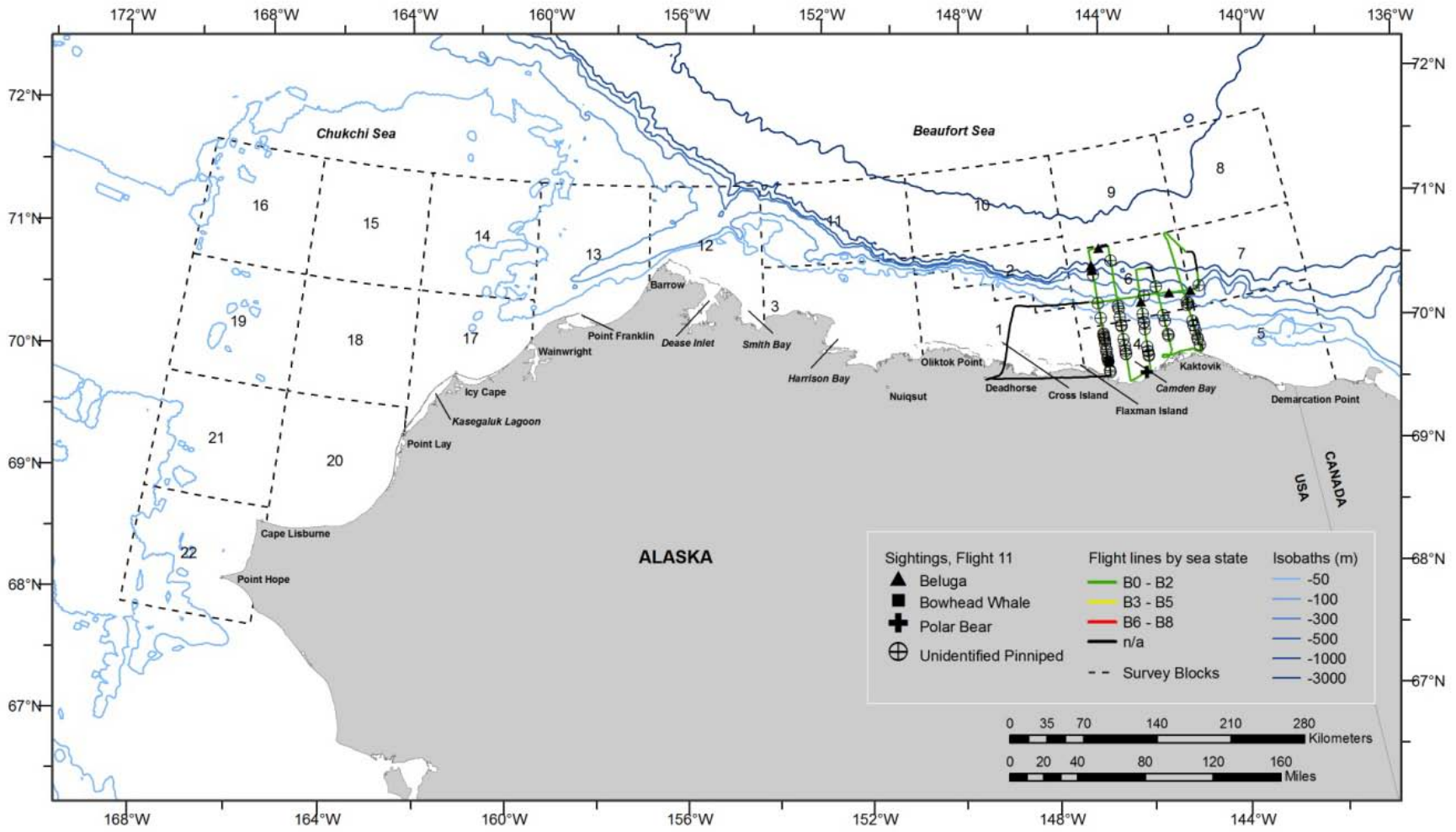

Figure B-55. Flight 11 survey track, depicted by sea state, and all sightings.

8 September 2011, Flight 245

Flight was a survey of Transects 13 and 15. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-4, and visibility 0-10 km. Precipitation and low ceilings prevented completion of transects. There was no ice present within the area surveyed. Sightings included walruses and unidentified pinnipeds.

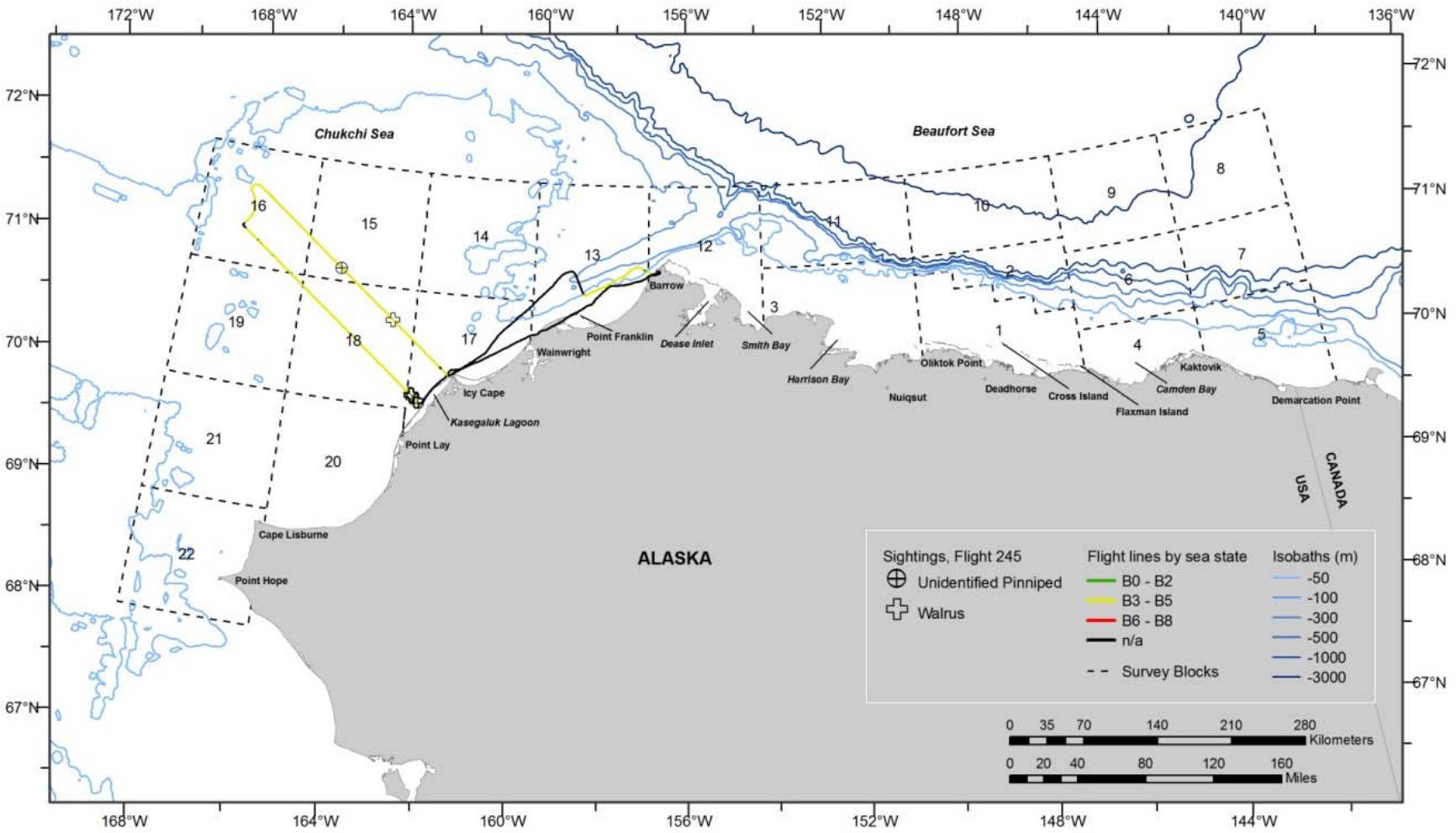

Figure B-56. Flight 245 survey track, depicted by sea state, and all sightings.

8 September 2011, Flight 12

Flight was a transect survey of portions of blocks 1, 5 and 7. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-4, and visibility 0-10 km. Transect effort was curtailed in block 1 due to snow, and in blocks 5 and 7 due to fog and low ceilings. The area surveyed was ice free. Belugas were sighted in blocks 5 and 7, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
12	9/8/2011 14:43	70.754	141.515	beluga	swim	1	0	7
12	9/8/2011 14:53	70.565	141.873	beluga	swim	1	0	7
12	9/8/2011 14:53	70.563	141.874	beluga	rest	1	0	7
12	9/8/2011 14:53	70.559	141.875	beluga	rest	1	0	7
12	9/8/2011 14:53	70.558	141.875	beluga	rest	1	0	7
12	9/8/2011 14:53	70.557	141.875	beluga	swim	1	0	7
12	9/8/2011 15:39	70.167	141.136	beluga	swim	1	0	5

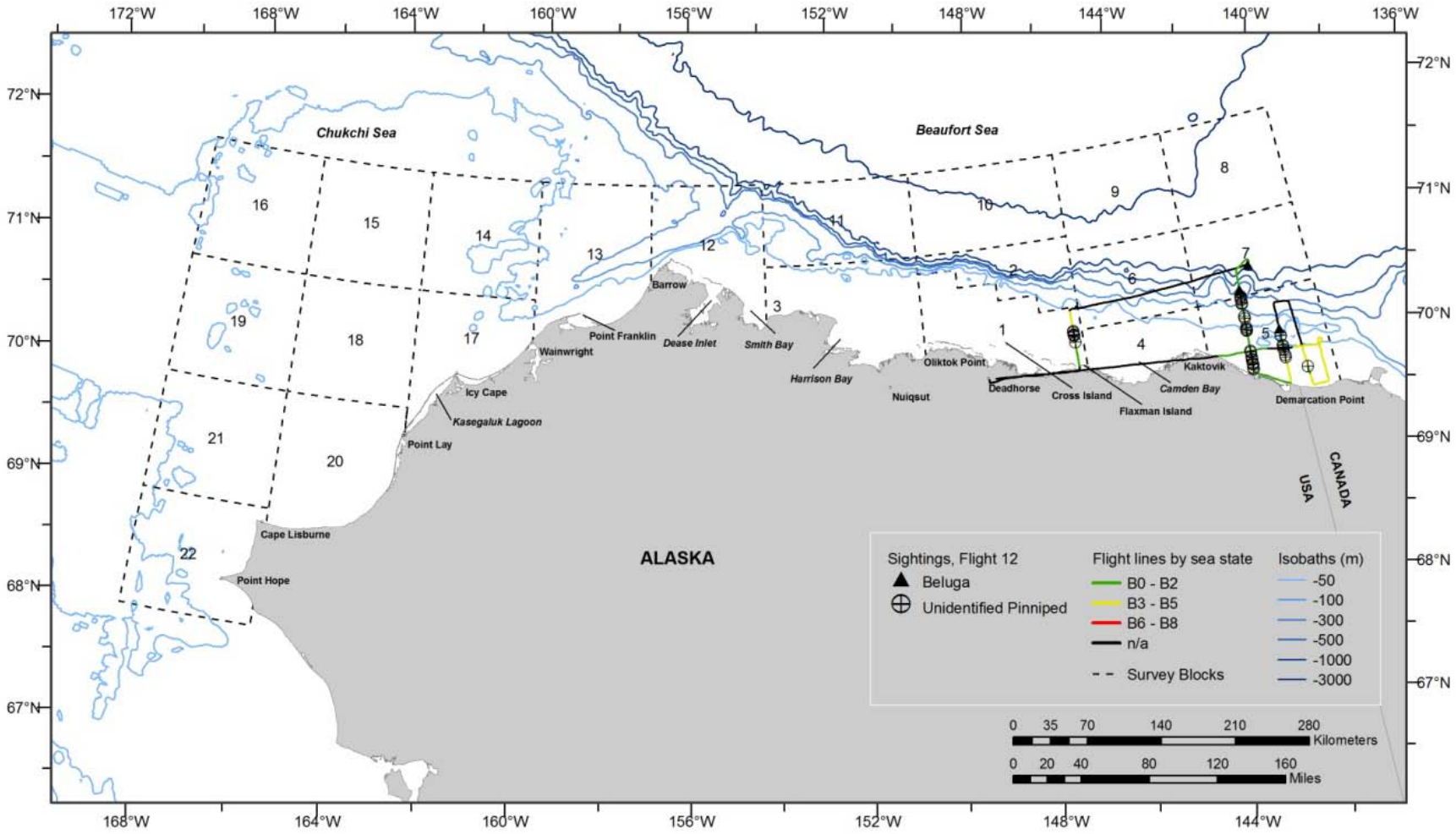

Figure B-57. Flight 12 survey track, depicted by sea state, and all sightings.

9 September 2011, Flight 246

Flight was a survey of Transects 2 and 4 and a partial Transect 10. Survey conditions were fair, with partly cloudy to overcast skies with low ceilings and precipitation, sea state Beaufort 2-6, and visibility <1-10 km. High sea states prevented completion of Transect 10. There was no ice present within the area surveyed. One bowhead whale was seen northwest of Barrow, and gray whales were seen between Barrow and Point Franklin.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
246	9/9/2011 13:37	71.217	158.125	gray whale	feed	1	0	13
246	9/9/2011 13:39	71.176	157.990	gray whale	feed	2	0	13
246	9/9/2011 13:40	71.152	157.912	gray whale	swim	1	0	13
246	9/9/2011 13:41	71.141	157.879	gray whale	feed	1	0	13
246	9/9/2011 13:41	71.132	157.849	gray whale	feed	1	0	13
246	9/9/2011 13:42	71.126	157.828	gray whale	feed	1	0	13
246	9/9/2011 14:03	71.427	157.278	bowhead whale	swim	1	0	13

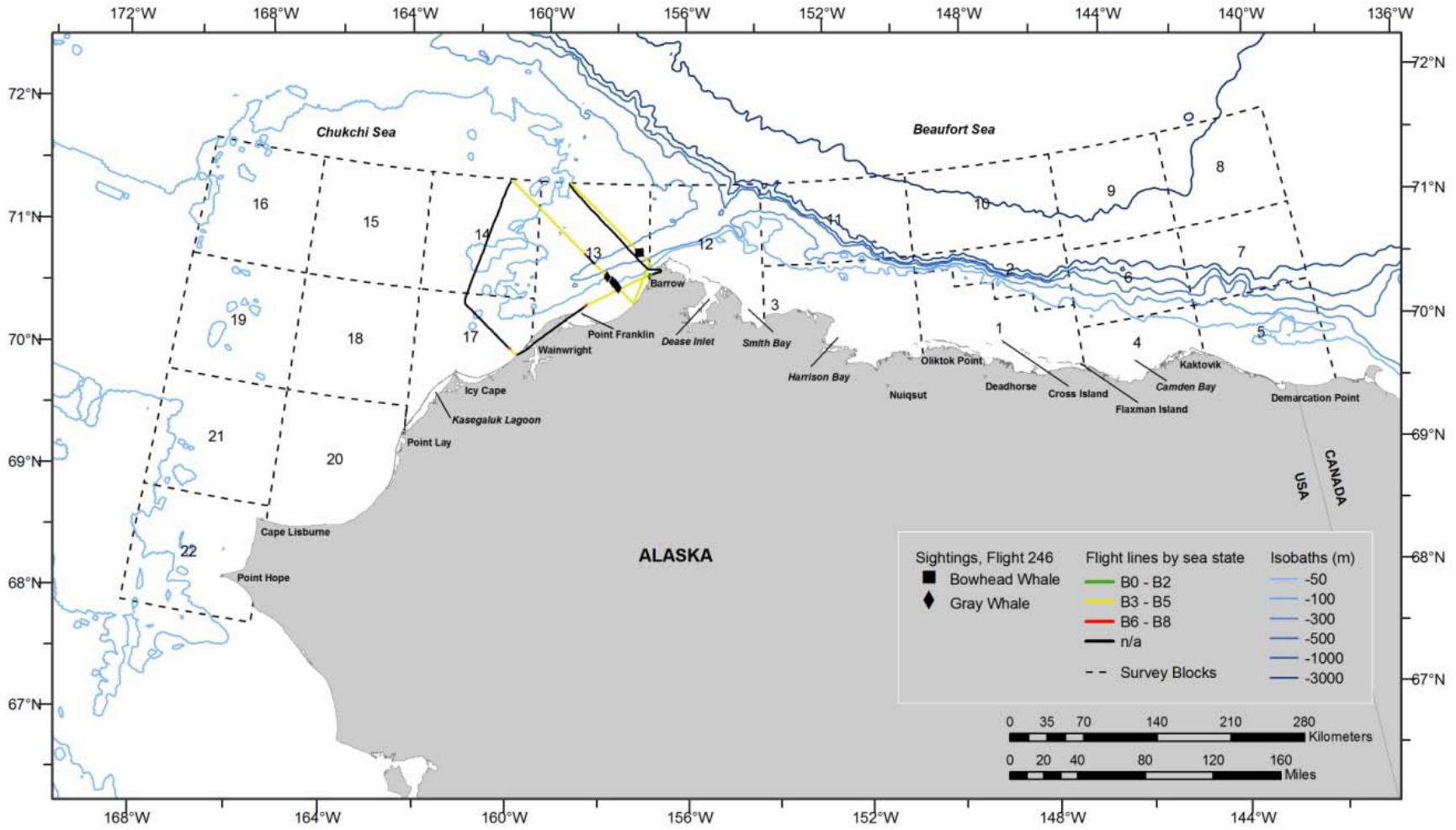

Figure B-58. Flight 246 survey track, depicted by sea state, and all sightings.

9 September 2011, Flight 13

Flight was a transect survey of portions of blocks 1 and 2. Survey conditions were good, with partly cloudy to overcast skies and snow and low ceilings, sea state Beaufort 2-3, and visibility 0-10 km. The area surveyed was ice free. One bowhead whale was sighted offshore in block 1, belugas were sighted offshore in block 2, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
13	9/9/2011 13:22	71.268	147.712	beluga	swim	1	0	2
13	9/9/2011 13:22	71.270	147.712	beluga	swim	2	1	2
13	9/9/2011 13:22	71.274	147.712	beluga	swim	1	0	2
13	9/9/2011 13:22	71.279	147.712	beluga	swim	35	1	2
13	9/9/2011 13:22	71.291	147.711	beluga	swim	15	3	2
13	9/9/2011 13:30	71.092	147.448	beluga	swim	1	0	2
13	9/9/2011 13:44	70.624	147.361	bowhead whale	dive	1	0	1
13	9/9/2011 14:39	71.151	146.225	beluga	rest	1	0	2
13	9/9/2011 14:44	70.997	146.224	beluga	swim	1	0	2
13	9/9/2011 14:44	70.994	146.225	beluga	swim	1	0	2
13	9/9/2011 14:44	70.990	146.226	beluga	swim	2	0	2
13	9/9/2011 14:45	70.979	146.228	beluga	swim	1	0	2
13	9/9/2011 14:45	70.967	146.228	beluga	swim	6	0	2

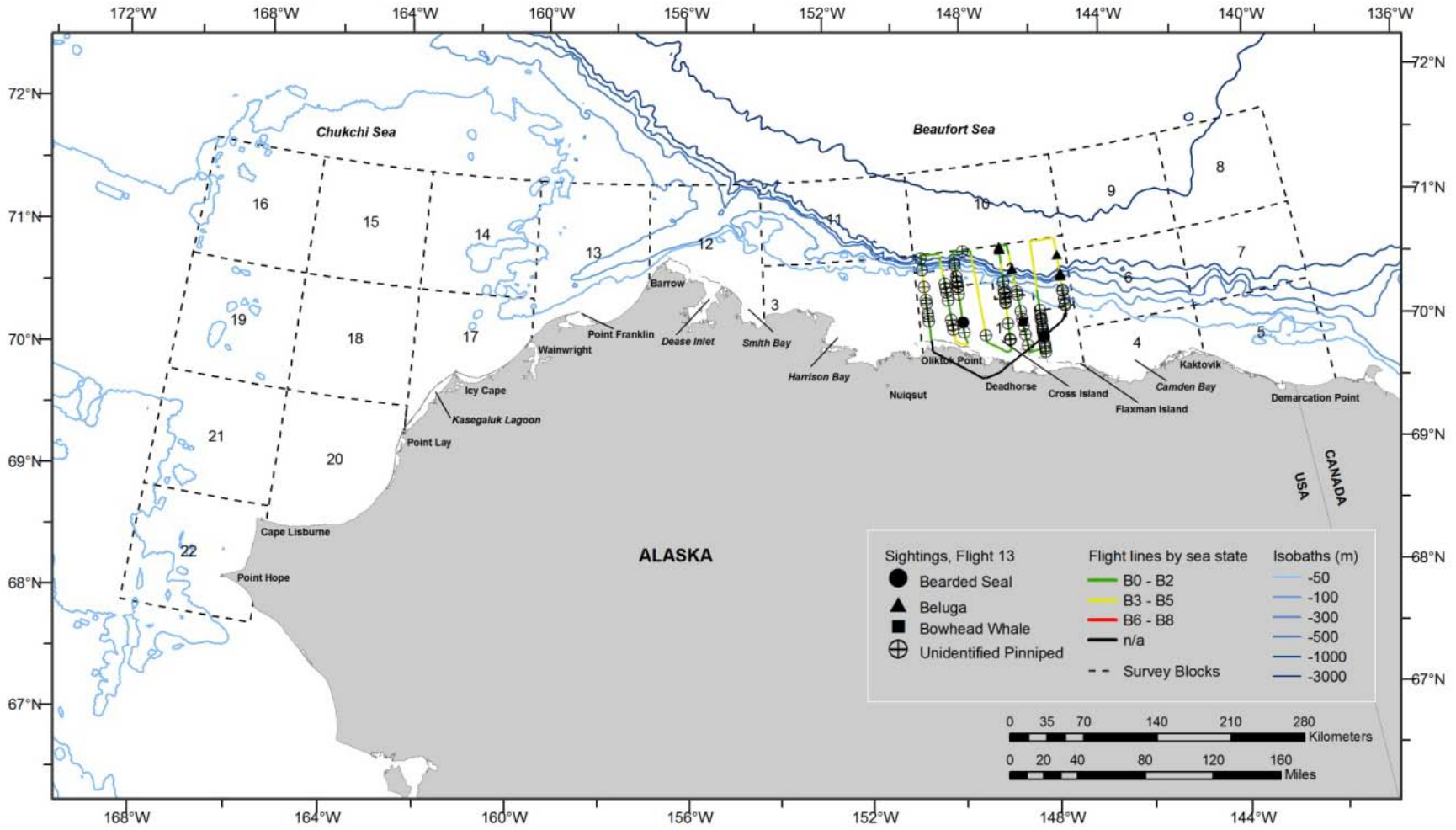

Figure B-59. Flight 13 survey track, depicted by sea state, and all sightings.

10 September 2011, Flight 247

Flight was an attempt to survey in the western Beaufort. Poor weather conditions, including high sea states (Beaufort 7) and low ceilings, prevented any survey effort.

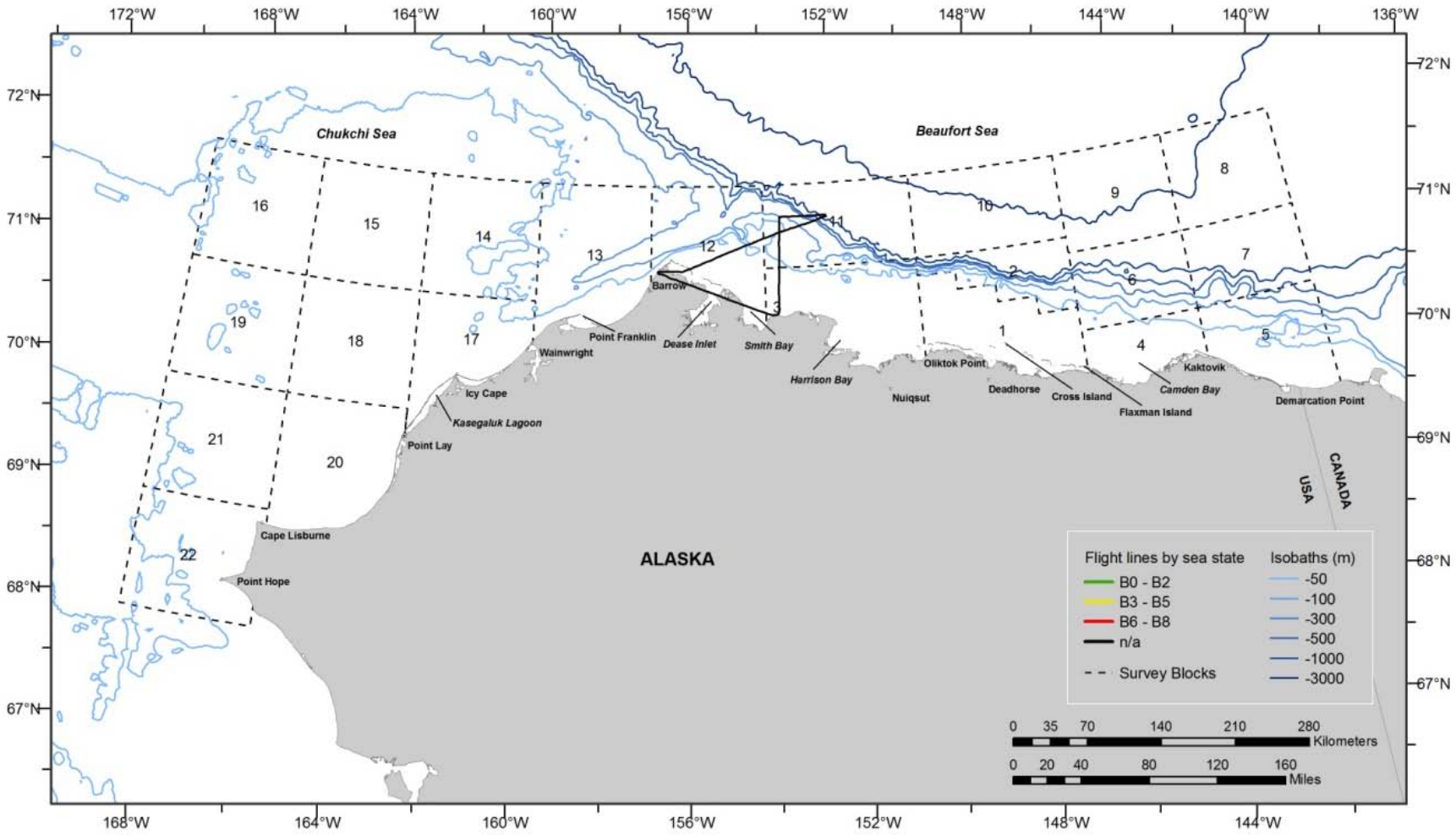

Figure B-60. Flight 247 survey track, depicted by sea state.

10 September 2011, Flight 14

Flight was a transect survey of portions of blocks 5 and 7. Survey conditions were poor, with partly cloudy to overcast skies and low ceilings in most of the survey area, sea state Beaufort 5-6, and visibility 0-10 km. The area surveyed was ice free. There were no sightings.

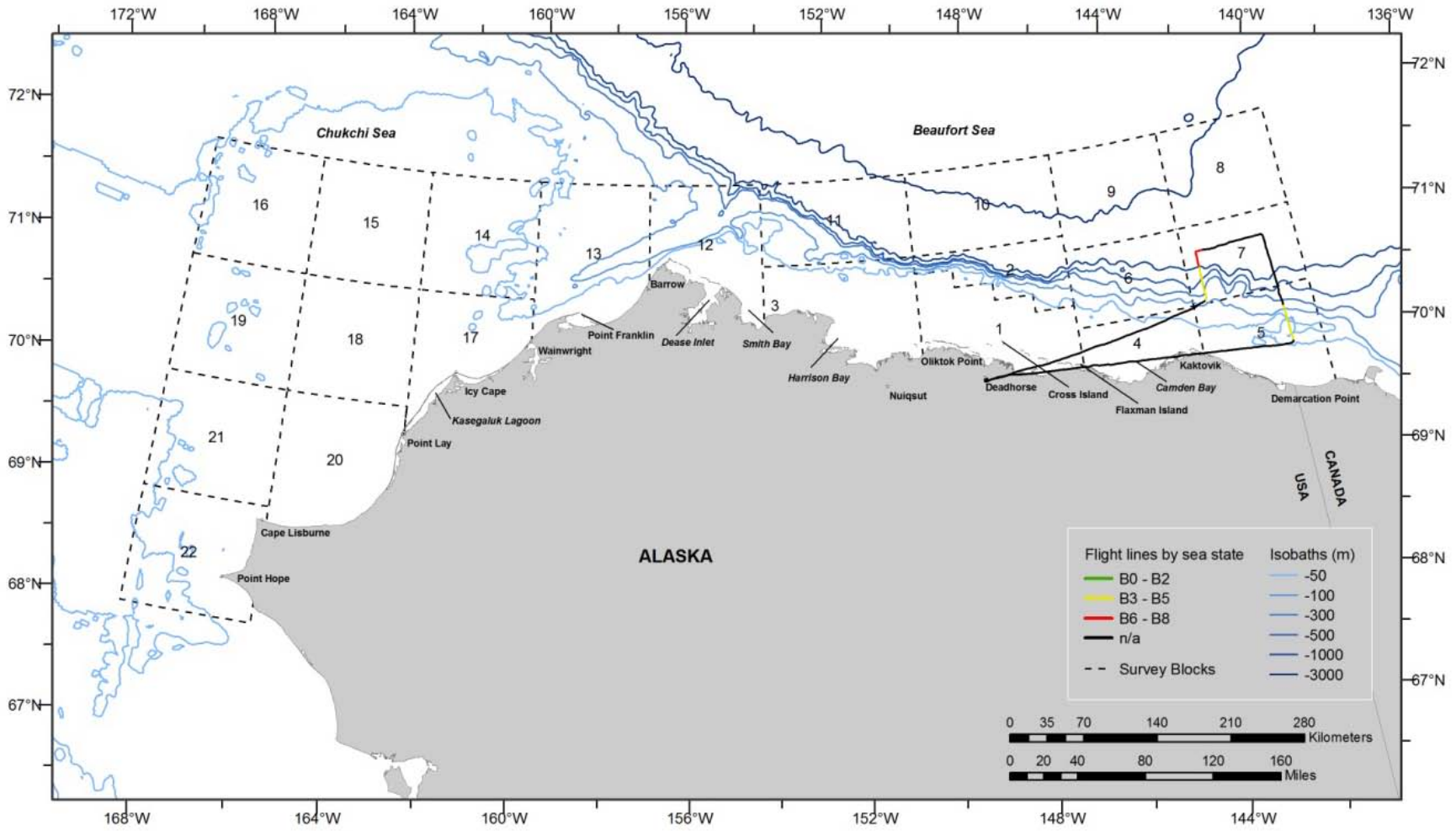

Figure B-61. Flight 14 survey track, depicted by sea state.

12 September 2011, Flight 248

Flight was a survey of Transects 6, 8, 10 and 12. Survey conditions were good, with clear to overcast skies, sea state Beaufort 1-5, and visibility 5-10 km. No sea ice was present within the area surveyed. Gray whales were seen offshore south of Hanna Shoal (block 14), offshore of Wainwright, and between Barrow and Point Franklin. Walruses, a bearded seal, and unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
248	9/12/2011 10:00	71.089	157.959	gray whale	feed	1	0	13
248	9/12/2011 10:02	71.111	157.981	gray whale	feed	1	0	13
248	9/12/2011 10:02	71.121	157.962	gray whale	feed	1	0	13
248	9/12/2011 10:02	71.118	157.941	gray whale	feed	1	0	13
248	9/12/2011 10:06	71.055	158.145	gray whale	feed	1	0	13
248	9/12/2011 10:09	71.009	158.370	gray whale	swim	2	0	13
248	9/12/2011 10:29	70.858	159.379	gray whale	feed	1	0	13
248	9/12/2011 10:39	70.905	160.174	gray whale	feed	1	0	17
248	9/12/2011 10:39	70.907	160.181	gray whale	feed	1	0	17
248	9/12/2011 10:40	70.935	160.283	gray whale	feed	2	0	17
248	9/12/2011 10:55	71.230	161.322	gray whale	swim	1	0	14
248	9/12/2011 10:56	71.238	161.341	gray whale	feed	3	0	14
248	9/12/2011 17:57	70.974	162.019	gray whale	feed	2	1	17
248	9/12/2011 17:57	70.972	162.015	gray whale	swim	1	0	17

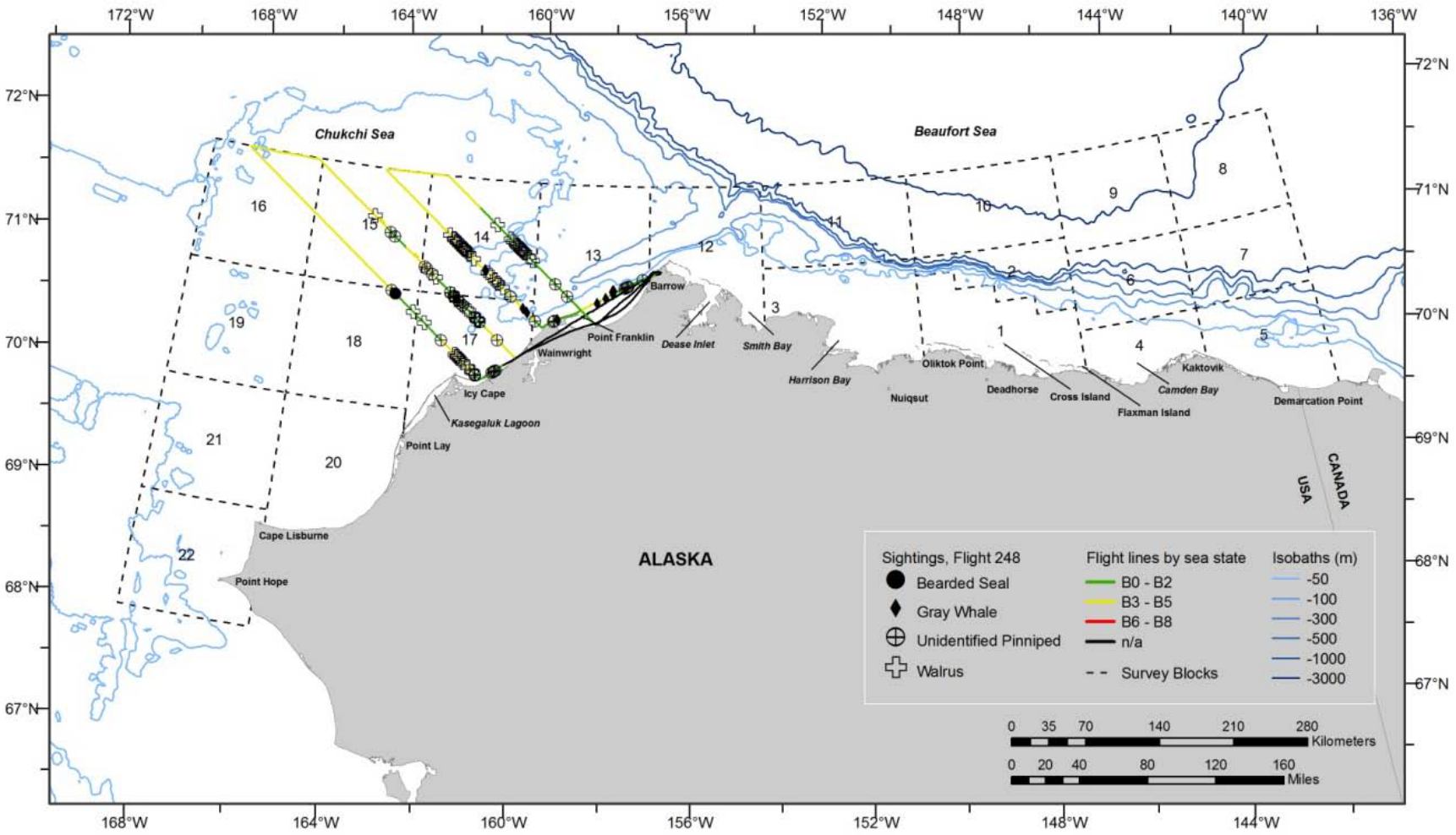

Figure B-62. Flight 248 survey track, depicted by sea state, and all sightings.

12 September 2011, Flight 15

Flight was a transect survey of portions of blocks 3, 5, 7 and 11. Survey conditions were good, with clear to overcast skies. Sea state in blocks 5 and 7 was Beaufort 1-5; sea state in blocks 3 and 11 was Beaufort 1-2. Visibility in both areas surveyed was 5-10 km. The area surveyed was ice free. One bowhead whale was sighted in block 5, belugas were sighted offshore in blocks 5, 7 and 11, and bearded seals, a ringed seal, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
15	9/12/2011 10:51	70.618	142.788	beluga	swim	1	0	7
15	9/12/2011 10:51	70.619	142.789	beluga	swim	2	0	7
15	9/12/2011 10:55	70.749	142.780	beluga	swim	1	0	7
15	9/12/2011 10:58	70.861	142.786	beluga	swim	1	0	7
15	9/12/2011 11:09	71.162	142.565	beluga	swim	2	0	7
15	9/12/2011 11:09	71.162	142.545	beluga	swim	1	0	7
15	9/12/2011 11:10	71.162	142.512	beluga	swim	7	0	7
15	9/12/2011 11:33	70.575	142.056	beluga	swim	1	0	7
15	9/12/2011 11:33	70.552	142.052	beluga	rest	2	1	7
15	9/12/2011 11:34	70.533	142.056	beluga	rest	1	0	7
15	9/12/2011 11:34	70.533	142.056	beluga	rest	1	0	7
15	9/12/2011 11:48	70.168	142.028	bowhead whale	dive	1	0	5
15	9/12/2011 12:19	70.486	141.796	beluga	swim	2	1	5
15	9/12/2011 12:19	70.492	141.795	beluga	swim	2	1	5
15	9/12/2011 12:20	70.518	141.792	beluga	rest	3	0	7
15	9/12/2011 12:20	70.521	141.792	beluga	rest	2	0	7
15	9/12/2011 12:22	70.590	141.781	beluga	swim	1	0	7
15	9/12/2011 12:24	70.673	141.770	beluga	swim	1	0	7

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
15	9/12/2011 12:33	70.982	141.727	beluga	rest	5	2	7
15	9/12/2011 12:52	70.840	141.304	beluga	rest	1	0	7
15	9/12/2011 12:54	70.762	141.307	unidentified cetacean	.	1	0	7
15	9/12/2011 14:04	70.473	140.799	beluga	rest	1	0	5
15	9/12/2011 17:12	71.856	153.932	beluga	swim	1	0	11
15	9/12/2011 17:25	71.913	153.262	beluga	swim	1	0	11
15	9/12/2011 17:25	71.891	153.264	beluga	swim	1	0	11
15	9/12/2011 17:26	71.887	153.265	beluga	swim	1	0	11
15	9/12/2011 17:27	71.854	153.267	beluga	rest	3	0	11
15	9/12/2011 17:27	71.851	153.267	beluga	rest	4	0	11
15	9/12/2011 17:28	71.813	153.268	beluga	swim	1	0	11

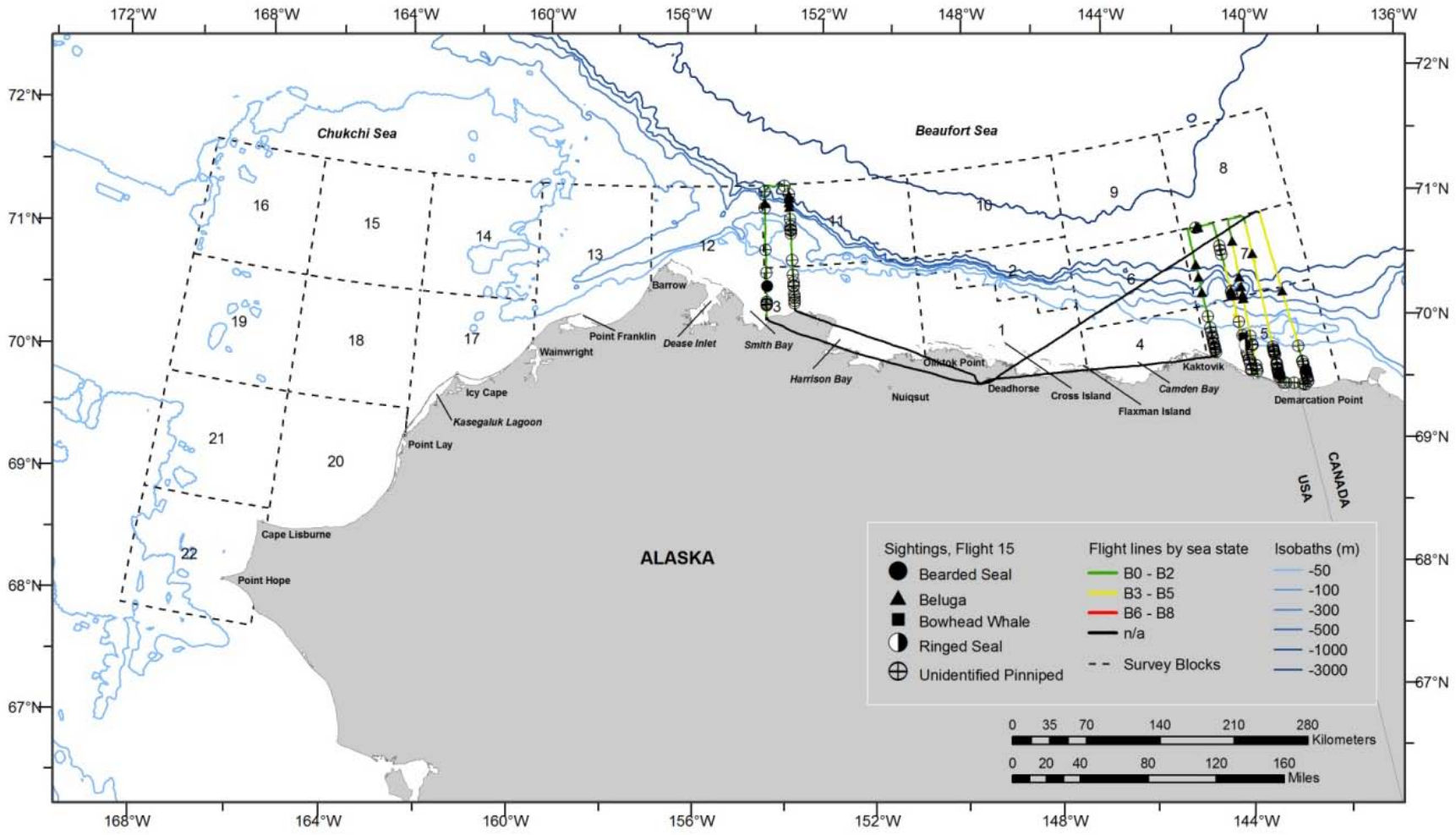

Figure B-63. Flight 15 survey track, depicted by sea state, and all sightings.

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13 September 2011, Flight 249

Flight was a survey of Transects 1, 3, 5, 14 and 16, and search effort from Barrow to Point Franklin. Survey conditions were good, with clear to partly cloudy skies, sea state Beaufort 2-6, and visibility 0-10 km. Low ceilings precluded complete coverage of Transect 14. No sea ice was present within the area surveyed. Two bowhead whales were seen northwest of Barrow, and gray whales were seen between Barrow and Point Franklin. Walruses and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
249	9/13/2011 13:53	71.041	158.436	gray whale	feed	2	0	13
249	9/13/2011 13:54	71.034	158.451	gray whale	feed	1	0	13
249	9/13/2011 13:55	71.054	158.361	gray whale	feed	1	0	13
249	9/13/2011 14:01	71.122	157.897	gray whale	feed	1	0	13
249	9/13/2011 15:47	71.044	158.323	gray whale	swim	1	0	13
249	9/13/2011 17:26	71.224	157.387	gray whale	feed	1	0	13
249	9/13/2011 17:35	71.293	157.062	gray whale	feed	1	0	13
249	9/13/2011 18:18	71.535	157.436	bowhead whale	swim	1	0	13
249	9/13/2011 18:25	71.555	157.403	bowhead whale	swim	1	0	13

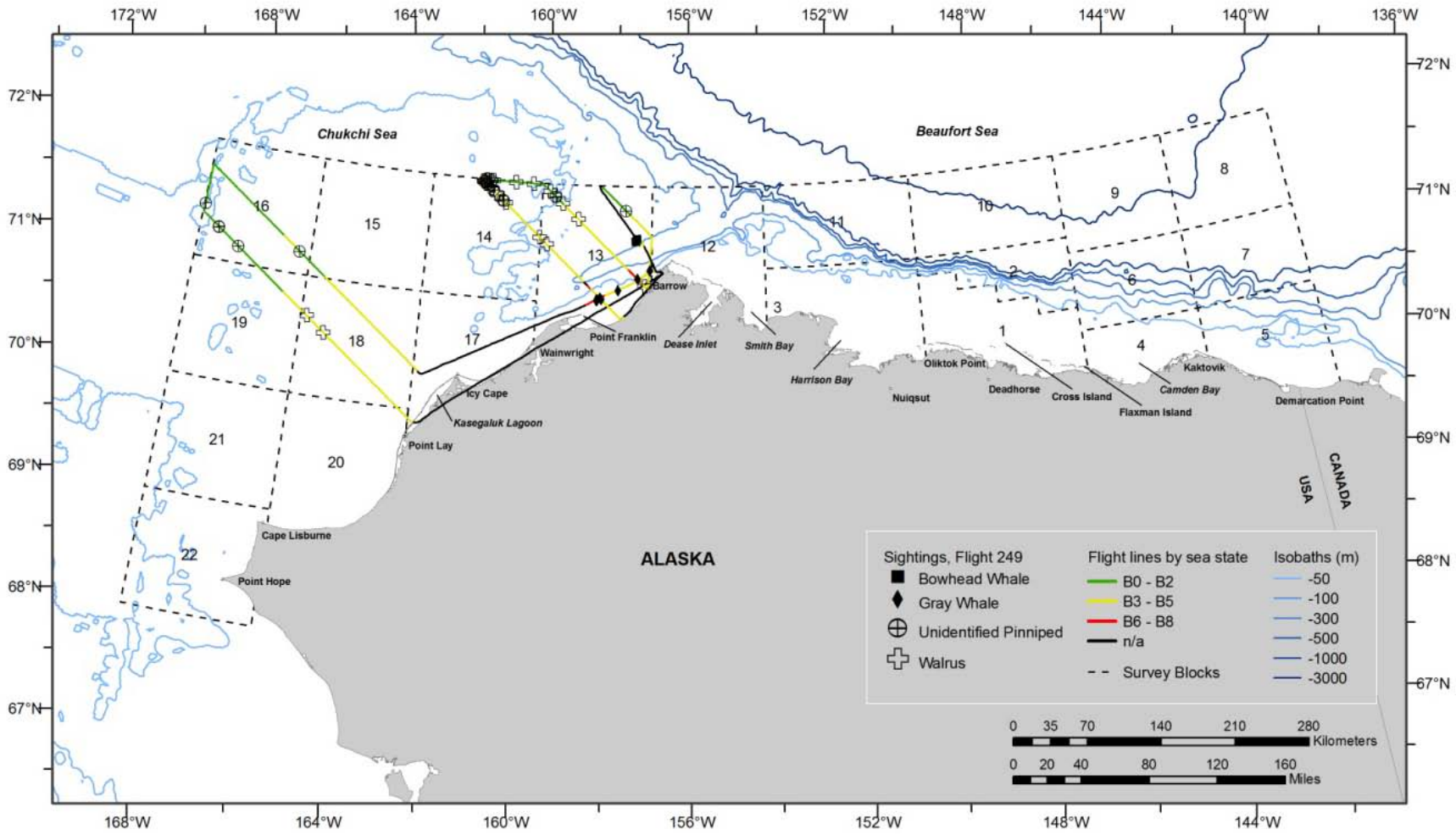

Figure B-64. Flight 249 survey track, depicted by sea state, and all sightings.

13 September 2011, Flight 16

Flight was a transect survey of portions of blocks 3 and 11. Survey conditions were good, with clear to partly cloudy skies, sea state Beaufort 2-3, and visibility 5-10 km. The area surveyed was ice free. Belugas were sighted nearshore in block 3, and offshore in blocks 3 and 11. Bearded seals and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
16	9/13/2011 13:42	71.775	152.879	beluga	rest	1	0	11
16	9/13/2011 13:50	71.981	152.941	beluga	rest	1	0	11
16	9/13/2011 13:50	71.978	152.940	beluga	rest	2	0	11
16	9/13/2011 13:57	71.993	152.579	beluga	swim	3	0	11
16	9/13/2011 13:57	71.993	152.566	beluga	swim	1	0	11
16	9/13/2011 14:36	70.878	152.254	beluga	swim	2	0	3
16	9/13/2011 14:39	70.777	152.157	beluga	swim	3	0	3
16	9/13/2011 16:09	71.039	151.251	beluga	swim	1	0	3
16	9/13/2011 17:12	71.628	150.818	beluga	swim	1	0	11
16	9/13/2011 17:12	71.629	150.818	beluga	swim	1	0	11
16	9/13/2011 17:18	71.817	150.873	beluga	swim	1	0	11
16	9/13/2011 17:18	71.819	150.874	beluga	swim	1	0	11

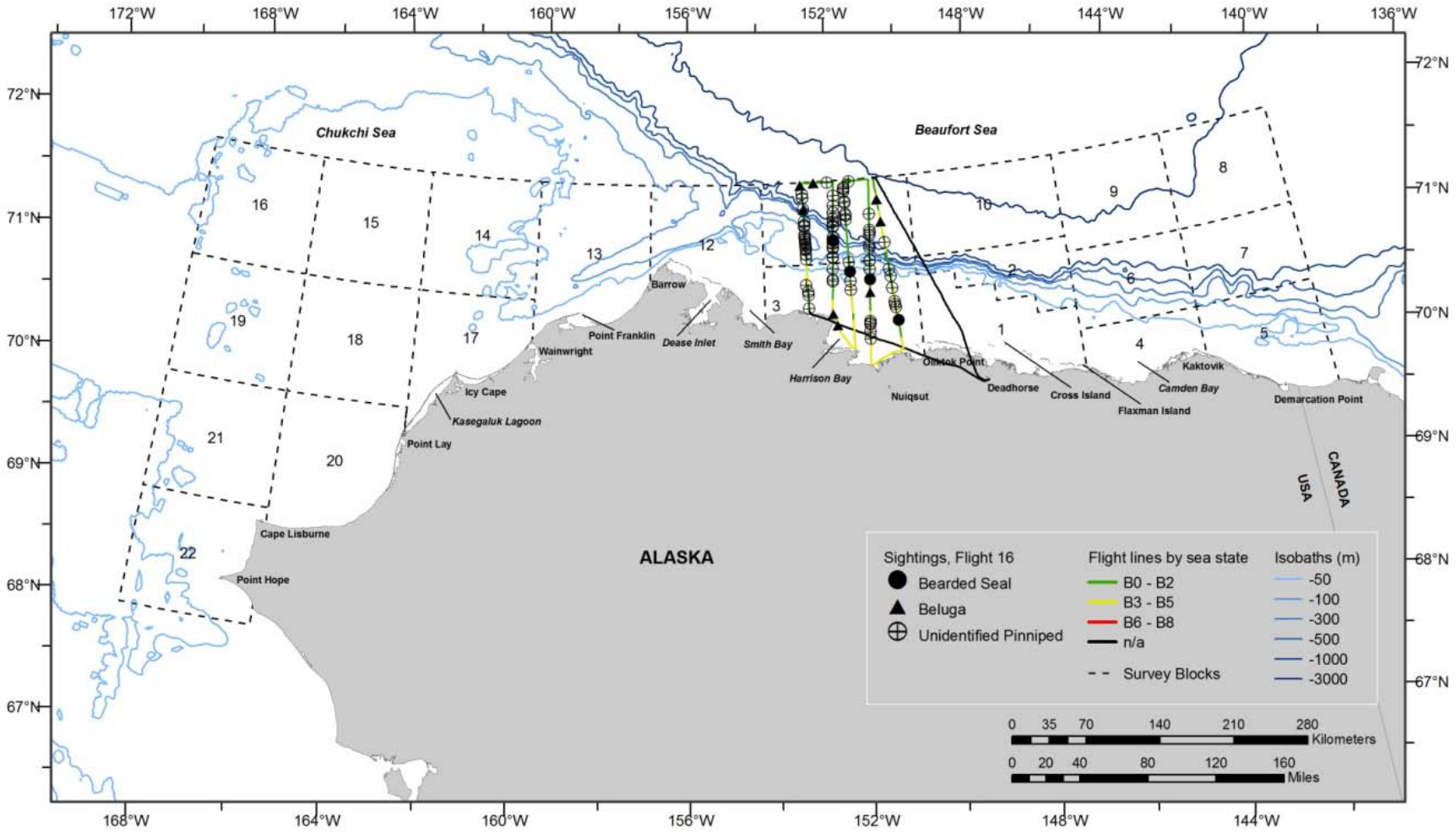

Figure B-65. Flight 16 survey track, depicted by sea state, and all sightings.

14 September 2011, Flight 250

Flight was a Coastal Transect from Point Barrow to Point Hope. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-7, and visibility 0-10 km. No sea ice was present within the area surveyed. One unidentified cetacean, a probable minke whale, was sighted south of Cape Lisburne. Walruses, including three dead walruses, were also seen, and 28 Dall sheep were sighted on the cliffs south of Cape Lisburne. Approximately 18,000 walruses were observed hauled out on land slightly north of Pt. Lay, in two groups of 15,000 and 3,000.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
250	9/14/2011 12:36	68.708	166.223	unidentified cetacean	swim	1	0	22

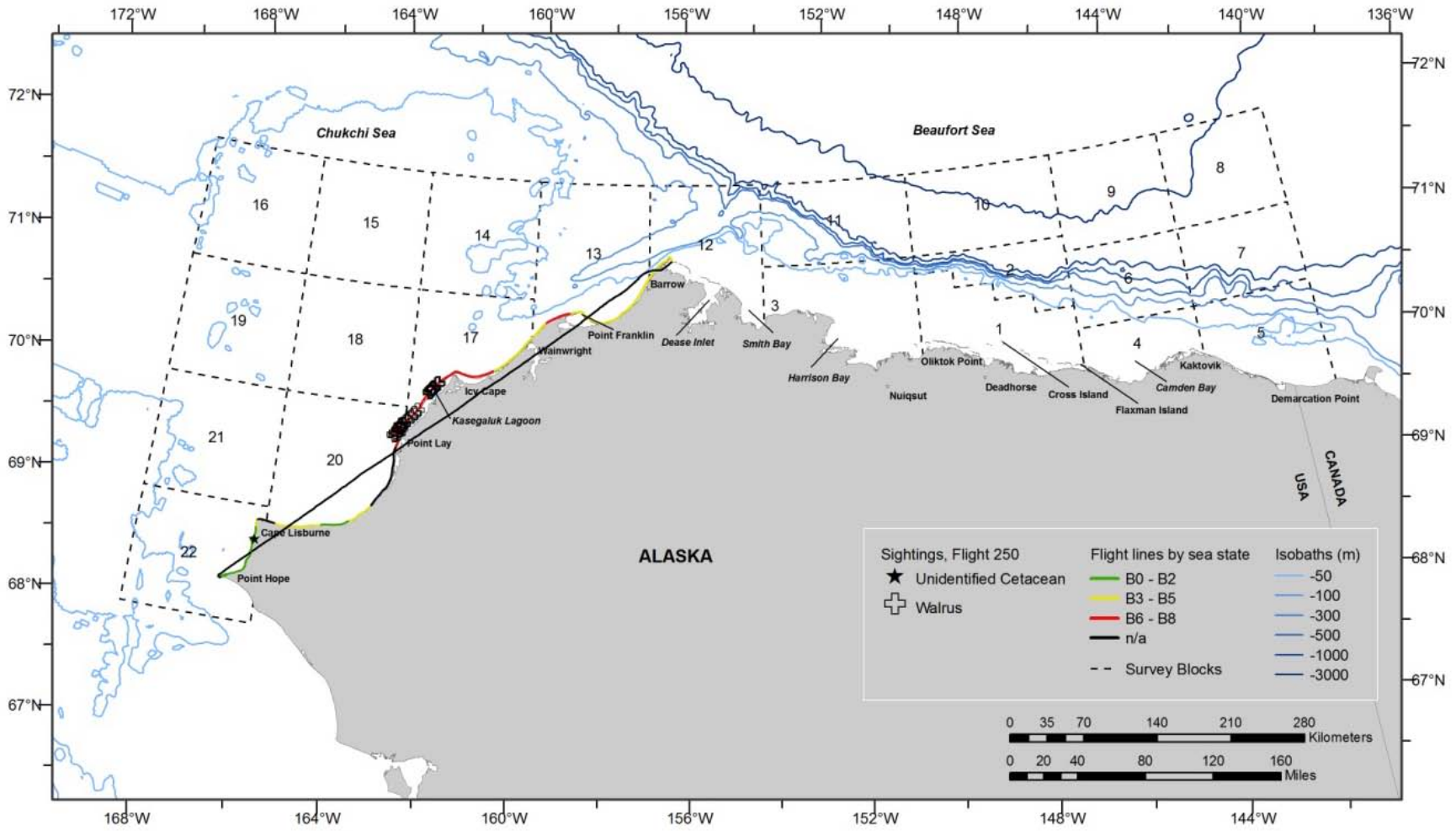

Figure B-66. Flight 250 survey track, depicted by sea state, and all sightings.

17 September 2011, Flight 251

Flight was a deadhead survey in an attempt to find an area suitable for surveying transects. Survey conditions were poor; low ceilings, widespread snow showers, and high sea states prevented any survey attempt.

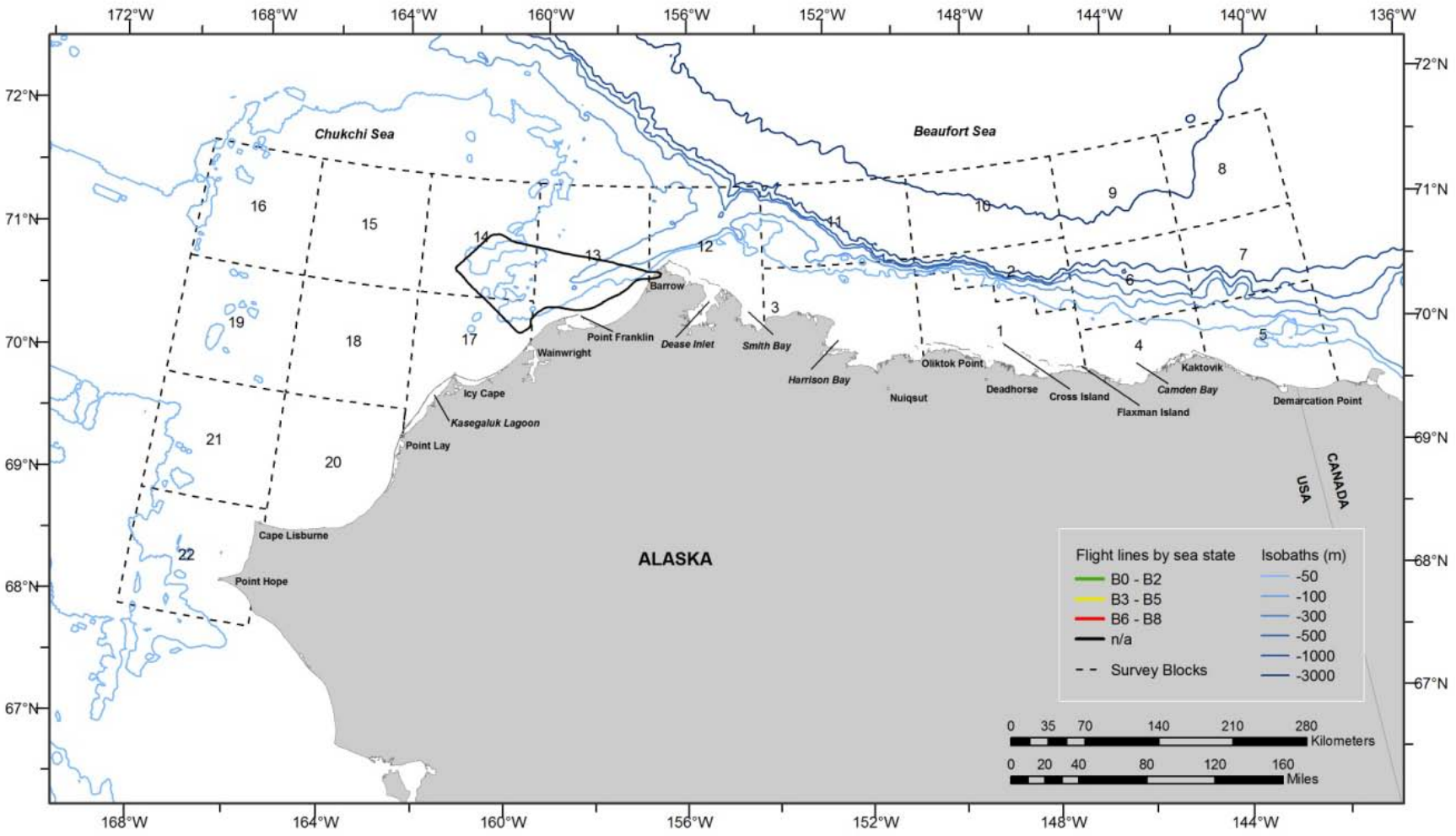

Figure B-67. Flight 251 survey track, depicted by sea state.

19 September 2011, Flight 17

Flight was a deadhead survey in an attempt to find an area suitable for transects. Survey conditions were very poor, with low ceilings covering the entire survey area. The sea state was not visible, and visibility was 0 km. There were no sightings.

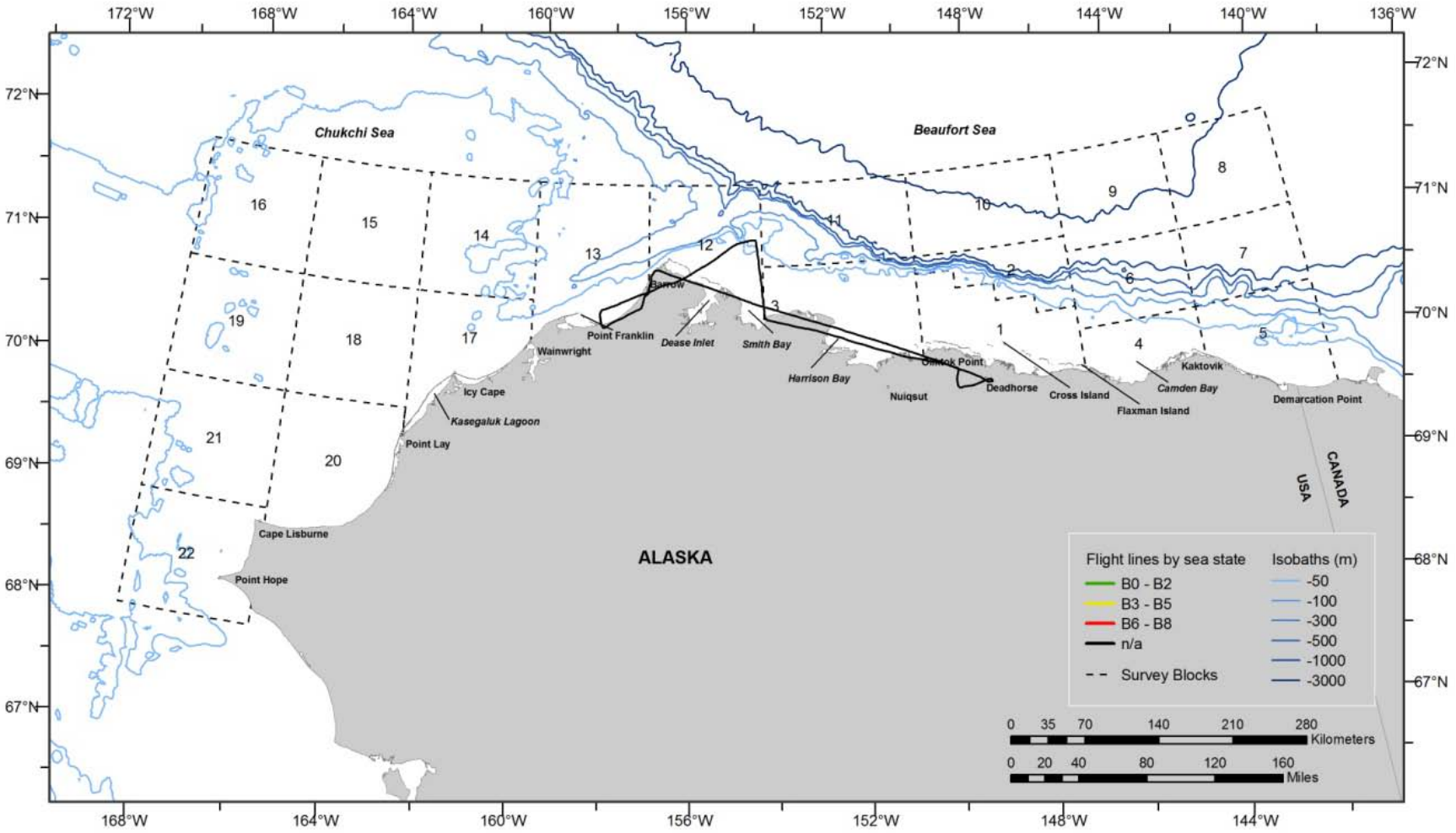

Figure B-68. Flight 17 survey track, depicted by sea state.

22 September 2011, Flight 252

Flight was a Coastal Transect from Barrow to north of Point Lay. Survey conditions were poor, with mostly overcast skies, sea state Beaufort 3-7, and visibility 0-10 km. High sea states and low ceilings limited the survey effort and prevented reconnaissance of the walrus haulout location near Point Lay. No sea ice was present within the area surveyed. There were no sightings.

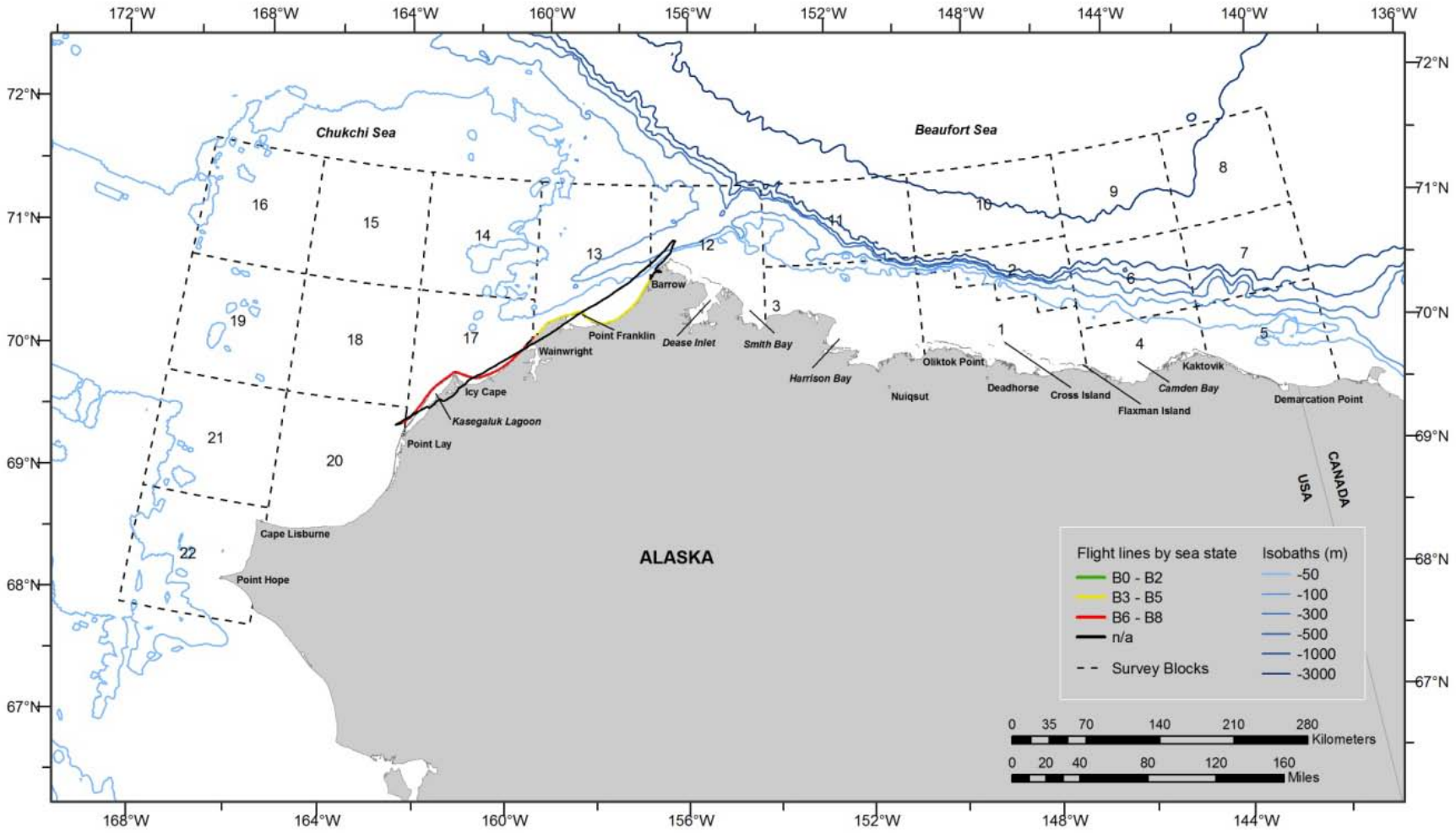

Figure B-69. Flight 252 survey track, depicted by sea state.

23 September 2011, Flight 253

Flight was a survey of Transect 32, partial Transects 28 and 30, and a search survey between Icy Cape and Point Lay to relocate the walrus haulout. Survey conditions were fair, with mostly overcast skies, sea state Beaufort 2-7, and visibility 1-10 km. High sea states prevented complete coverage of Transects 28 and 30. No sea ice was present within the area surveyed. One gray whale was sighted far offshore west of Point Hope. Approximately 15,000 walruses were hauled out north of Point Lay.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
253	9/23/2011 17:01	68.141	168.698	gray whale	swim	1	0	22

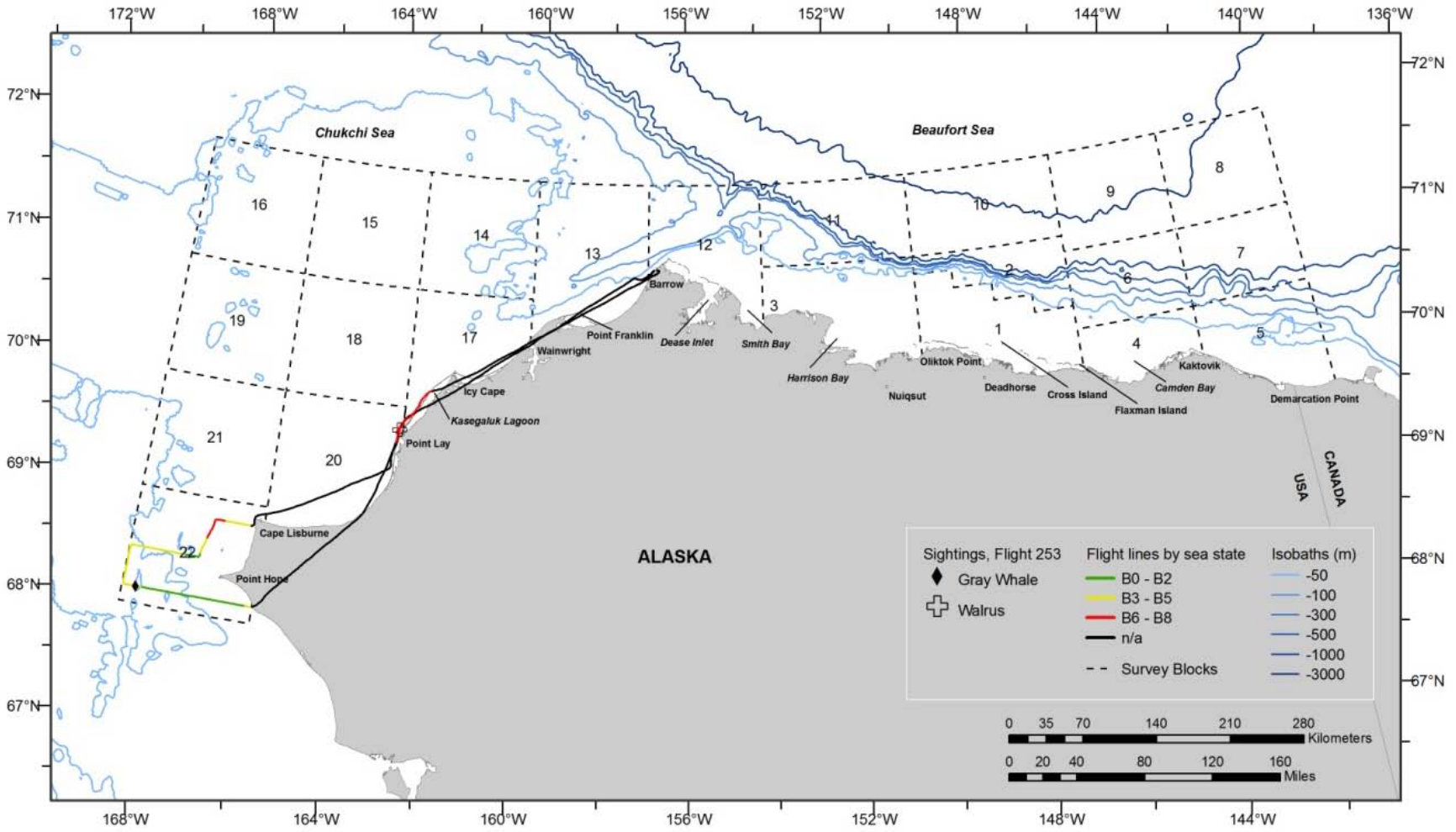

Figure B-70. Flight 253 survey track, depicted by sea state, and all sightings.

23 September 2011, Flight 18

Flight was a transect survey of portions of blocks 1, 5 and 7. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-7, and visibility 0-10 km. Transect effort was curtailed in block 1 due to high sea states and low ceilings, and in blocks 5 and 7 due to low ceilings. The area surveyed was ice free. Belugas were sighted nearshore in block 5 and offshore in block 7.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
18	9/23/2011 12:42	70.666	142.296	beluga	swim	2	0	7
18	9/23/2011 12:50	70.873	142.307	beluga	swim	1	0	7
18	9/23/2011 12:50	70.878	142.308	beluga	swim	1	0	7
18	9/23/2011 13:14	70.513	141.780	beluga	swim	1	0	7
18	9/23/2011 13:40	69.745	141.422	beluga	swim	1	0	5

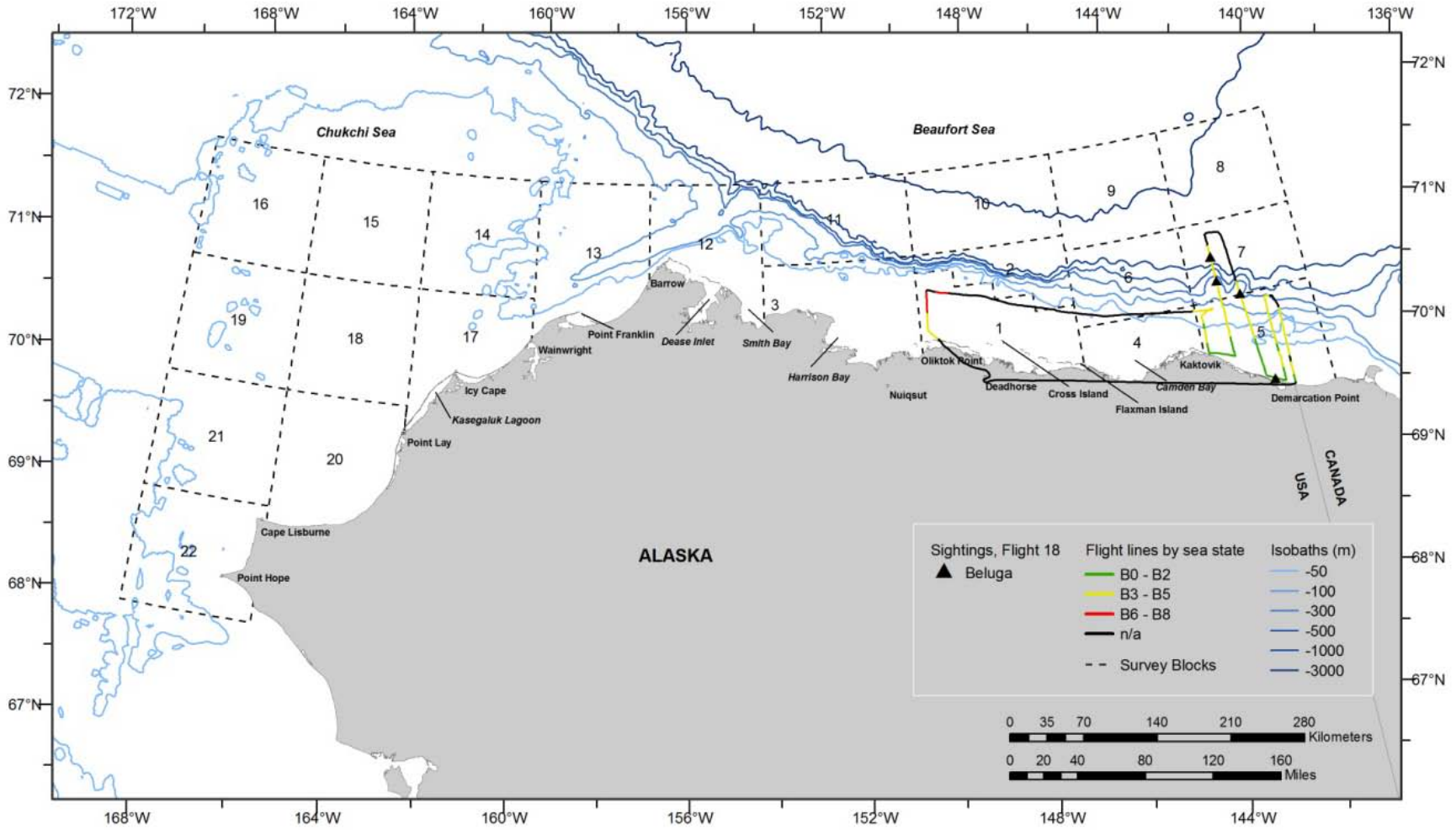

Figure B-71. Flight 18 survey track, depicted by sea state, and all sightings.

24 September 2011, Flight 254

Flight was a transect survey of portions of block 12. Survey conditions were poor, with overcast skies, sea state Beaufort 3-6, and visibility 0-5 km. High sea states and snow showers prevented complete coverage of transects. No sea ice was present within the area surveyed. Belugas were sighted offshore in block 12.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
254	9/24/2011 15:01	71.706	155.365	beluga	swim	2	0	12
254	9/24/2011 15:01	71.702	155.379	beluga	swim	3	0	12
254	9/24/2011 15:02	71.692	155.407	beluga	swim	1	0	12

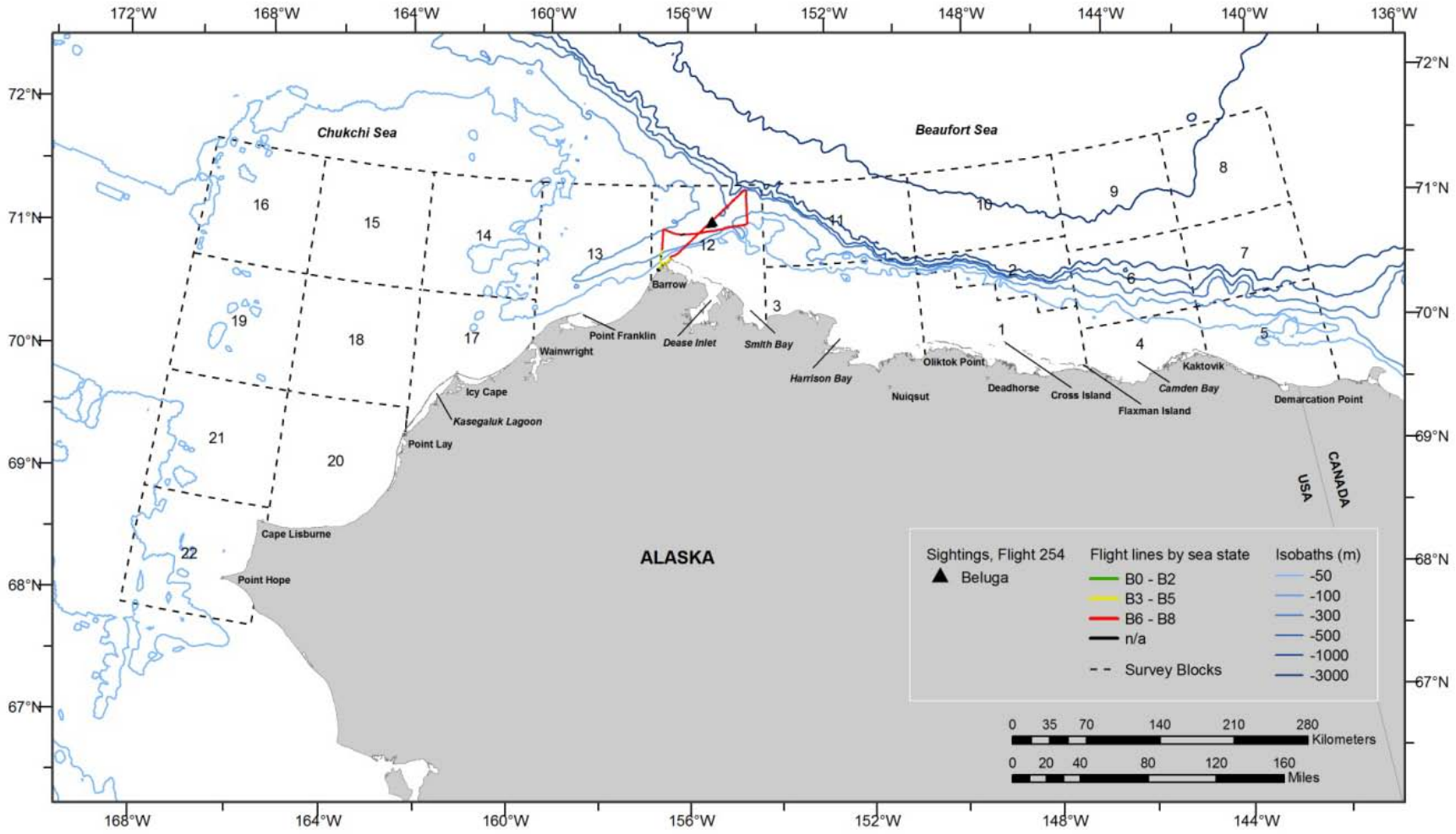

Figure B-72. Flight 254 survey track, depicted by sea state, and all sightings.

24 September 2011, Flight 19

Flight was a transect survey of portions of blocks 4 and 6. Survey conditions were fair, with overcast skies, sea state Beaufort 3-7, and visibility <1-10 km. Transect effort was curtailed in block 6 due to high sea states. The area surveyed was ice free. Three bowhead whales were sighted nearshore in block 4. Belugas were sighted nearshore in block 4 and offshore in block 6, 11 polar bears were sighted near Kaktovik, and a bearded seal was sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
19	9/24/2011 11:44	70.201	143.461	bowhead whale	unknown	1	0	4
19	9/24/2011 12:42	70.756	143.729	beluga	swim	1	0	6
19	9/24/2011 12:42	70.751	143.730	beluga	swim	2	0	6
19	9/24/2011 12:42	70.749	143.731	beluga	swim	2	0	6
19	9/24/2011 13:00	70.200	143.840	bowhead whale	swim	1	0	4
19	9/24/2011 13:07	70.102	143.959	beluga	rest	9	0	4
19	9/24/2011 13:11	70.185	144.007	bowhead whale	swim	1	0	4

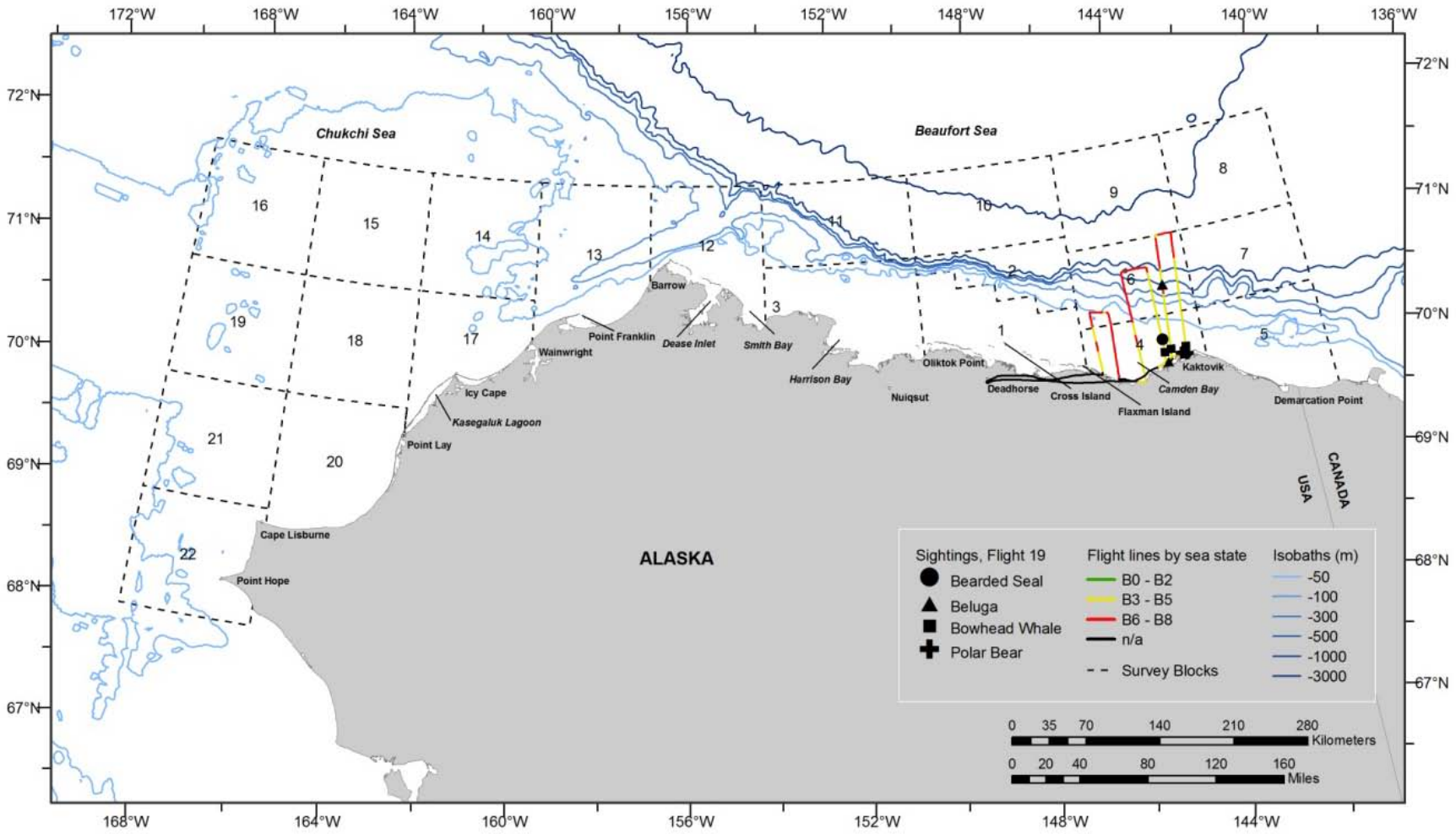

Figure B-73. Flight 19 survey track, depicted by sea state, and all sightings.

25 September 2011, Flight 255

Flight was a survey of Transects 29 and 31, partial Transects 23 and 25, Coastal Transect from south of Cape Lisburne to Point Lay, and search effort between Barrow and Point Franklin and near Point Lay to relocate the walrus haulout. Survey conditions were poor, with clear to overcast skies, sea state Beaufort 1-8, and visibility <1-10 km. High sea states limited survey effort. No sea ice was present within the area surveyed. Belugas were sighted off of Point Hope, and walruses and unidentified pinnipeds were also sighted. Approximately 8,000 walruses were hauled out north of Point Lay; the haulout was split into two aggregations in close proximity to one another.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
255	9/25/2011 11:29	68.315	167.024	beluga	rest	4	0	22

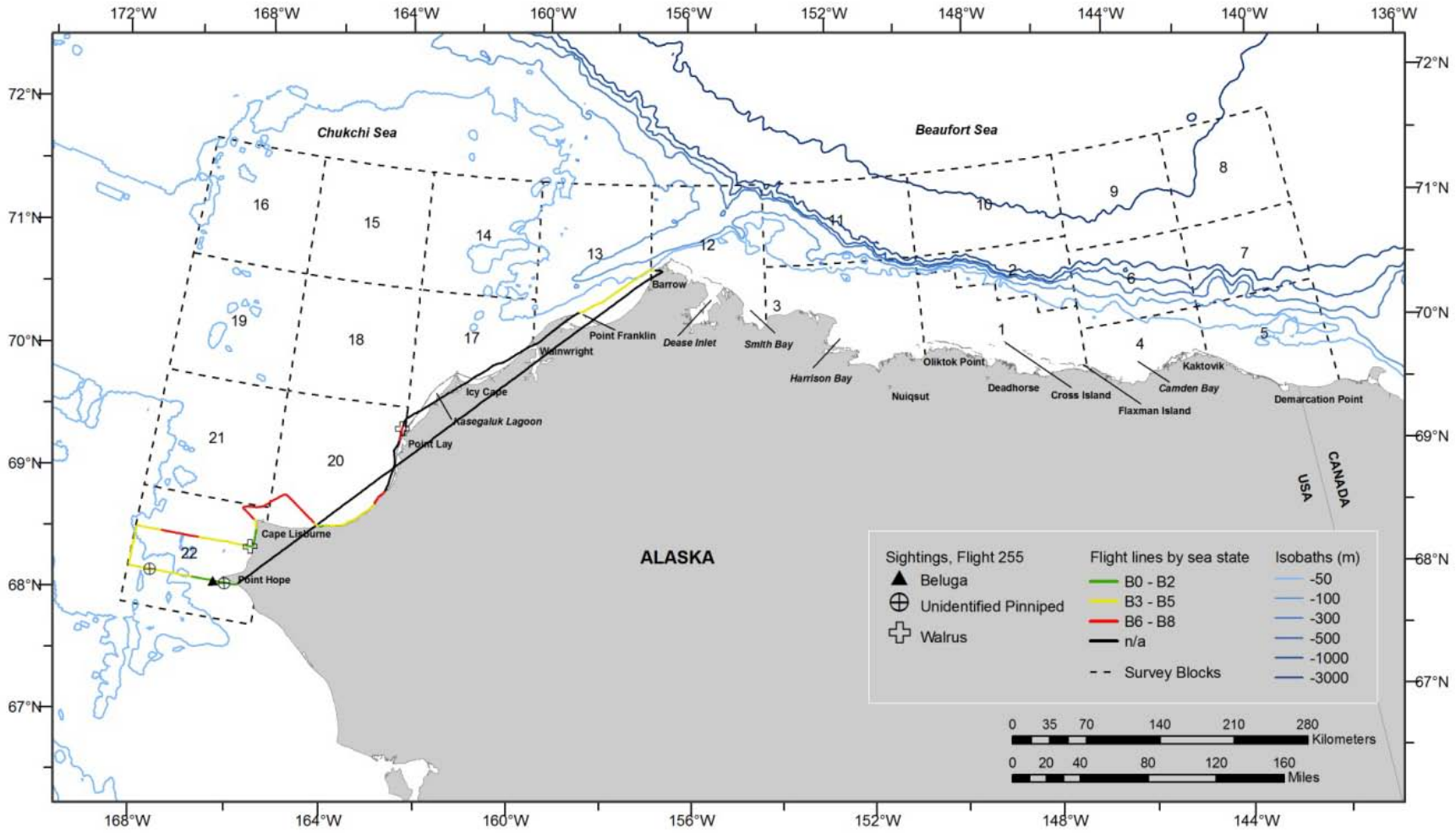

Figure B-74. Flight 255 survey track, depicted by sea state, and all sightings.

27 September 2011, Flight 20

Flight was a transect survey of portions of blocks 5 and 7. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 3-6, and visibility 0-10 km. Transect effort was curtailed in blocks 5 and 7 due to high sea states. The area surveyed was ice free. Nine polar bears were sighted near Kaktovik.

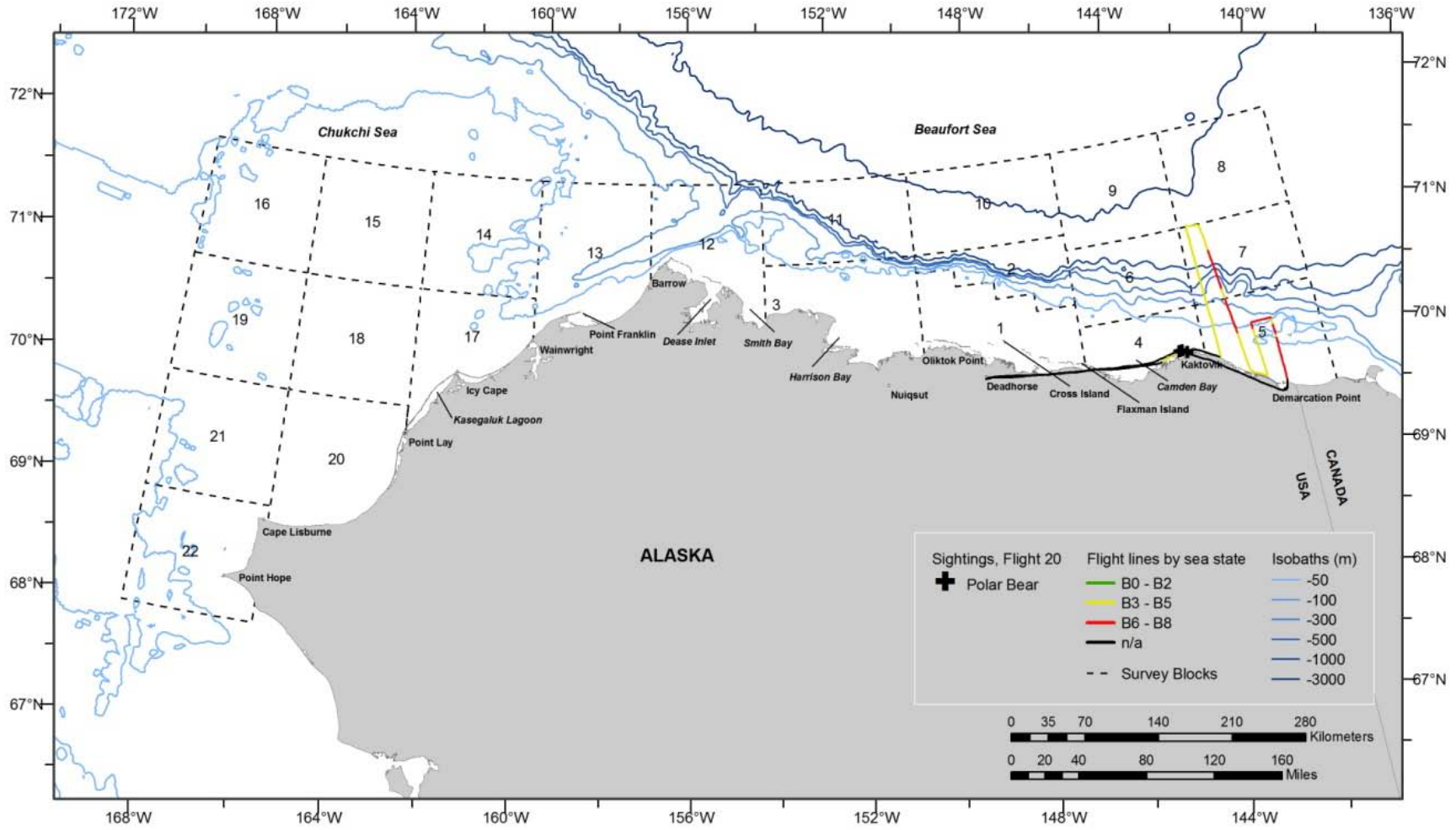

Figure B-75. Flight 20 survey track, depicted by sea state, and all sightings.

28 September 2011, Flight 256

Flight was a transect survey of block 12 and Transects 2, 4, 6 and 8. Survey conditions were good, with partly cloudy to overcast skies, sea state Beaufort 2-5, and visibility <1-10 km. No sea ice was present within the area surveyed. One bowhead whale was sighted in block 12 and one bowhead whale was sighted northeast of Wainwright. Gray whales were sighted between Barrow and Point Franklin and offshore in block 14. Belugas were sighted in block 12. Walruses and unidentified pinnipeds, including a dead unidentified pinniped that was a probable walrus, were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
256	9/28/2011 10:32	71.360	154.407	bowhead whale	swim	1	0	12
256	9/28/2011 11:09	71.986	154.799	beluga	swim	1	0	12
256	9/28/2011 11:10	71.944	154.796	beluga	swim	1	0	12
256	9/28/2011 11:10	71.935	154.793	beluga	swim	1	0	12
256	9/28/2011 12:07	71.758	155.190	beluga	rest	1	0	12
256	9/28/2011 12:30	71.609	155.639	beluga	rest	1	0	12
256	9/28/2011 12:48	71.335	156.069	beluga	rest	1	0	12
256	9/28/2011 13:35	71.336	156.740	beluga	swim	5	0	12
256	9/28/2011 13:36	71.327	156.740	beluga	swim	1	0	12
256	9/28/2011 13:36	71.326	156.740	beluga	swim	1	0	12
256	9/28/2011 13:38	71.326	156.922	beluga	swim	2	0	12
256	9/28/2011 16:01	71.146	157.898	gray whale	feed	2	0	13
256	9/28/2011 16:02	71.176	157.988	gray whale	feed	1	0	13
256	9/28/2011 18:16	70.837	159.947	bowhead whale	swim	1	0	13
256	9/28/2011 18:45	71.214	161.262	gray whale	feed	2	0	14

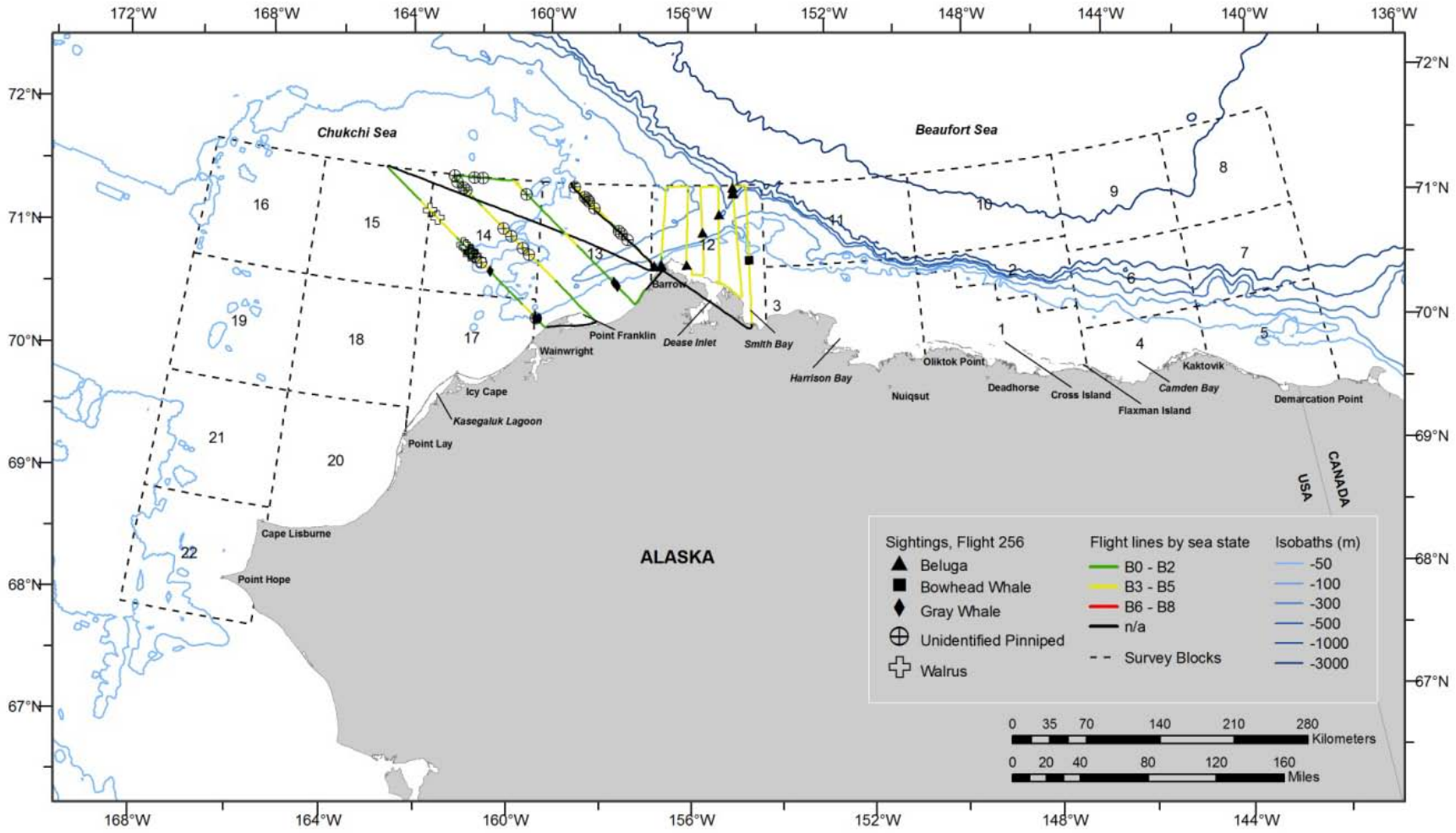

Figure B-76. Flight 256 survey track, depicted by sea state, and all sightings.

28 September 2011, Flight 21

Flight was a transect survey of blocks 1 and 2, with partial coverage of blocks 3 and 11. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 2-4, and visibility 0-10 km. Low ceilings impeded survey effort in block 11. The area surveyed was ice free. Twenty-five bowhead whales, including two calves, were sighted in blocks 1, 2 and 3, and belugas were sighted offshore in block 2. A small unidentified marine mammal, which was either a beluga or polar bear that dove soon after sighting, was sighted near a barrier island. Unidentified pinnipeds and small unidentified pinnipeds were also sighted, and five polar bears were near Cross Island.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
21	9/28/2011 9:49	70.779	149.786	bowhead whale	swim	1	0	1
21	9/28/2011 9:50	70.807	149.782	bowhead whale	swim	1	0	1
21	9/28/2011 10:12	71.296	149.637	bowhead whale	unknown	1	0	2
21	9/28/2011 10:19	71.226	149.170	beluga	swim	1	0	2
21	9/28/2011 10:19	71.224	149.169	beluga	swim	1	0	2
21	9/28/2011 10:19	71.216	149.168	beluga	swim	1	0	2
21	9/28/2011 10:19	71.208	149.167	beluga	swim	5	0	2
21	9/28/2011 10:36	70.678	149.058	bowhead whale	swim	1	0	1
21	9/28/2011 10:36	70.675	149.058	bowhead whale	swim	1	0	1
21	9/28/2011 10:36	70.673	149.058	bowhead whale	swim	1	0	1
21	9/28/2011 10:36	70.671	149.058	bowhead whale	swim	1	0	1
21	9/28/2011 10:50	70.741	148.916	bowhead whale	rest	1	0	1
21	9/28/2011 10:50	70.742	148.915	bowhead whale	rest	5	0	1
21	9/28/2011 10:51	70.761	148.911	bowhead whale	rest	2	1	1
21	9/28/2011 10:52	70.794	148.905	bowhead whale	rest	2	0	1
21	9/28/2011 11:05	71.237	148.815	beluga	rest	1	0	2

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
21	9/28/2011 11:05	71.238	148.815	beluga	rest	1	0	2
21	9/28/2011 11:05	71.238	148.815	beluga	rest	1	0	2
21	9/28/2011 11:05	71.238	148.815	beluga	rest	1	0	2
21	9/28/2011 11:06	71.259	148.815	beluga	rest	1	0	2
21	9/28/2011 11:07	71.290	148.807	beluga	rest	1	0	2
21	9/28/2011 12:07	71.116	147.697	beluga	rest	1	0	2
21	9/28/2011 12:45	70.395	147.398	small unidentified marine mammal	swim	1	0	1
21	9/28/2011 17:15	70.832	151.318	bowhead whale	swim	1	0	3
21	9/28/2011 17:53	71.030	150.881	bowhead whale	rest	6	1	3
21	9/28/2011 17:55	71.033	150.835	bowhead whale	swim	1	0	3

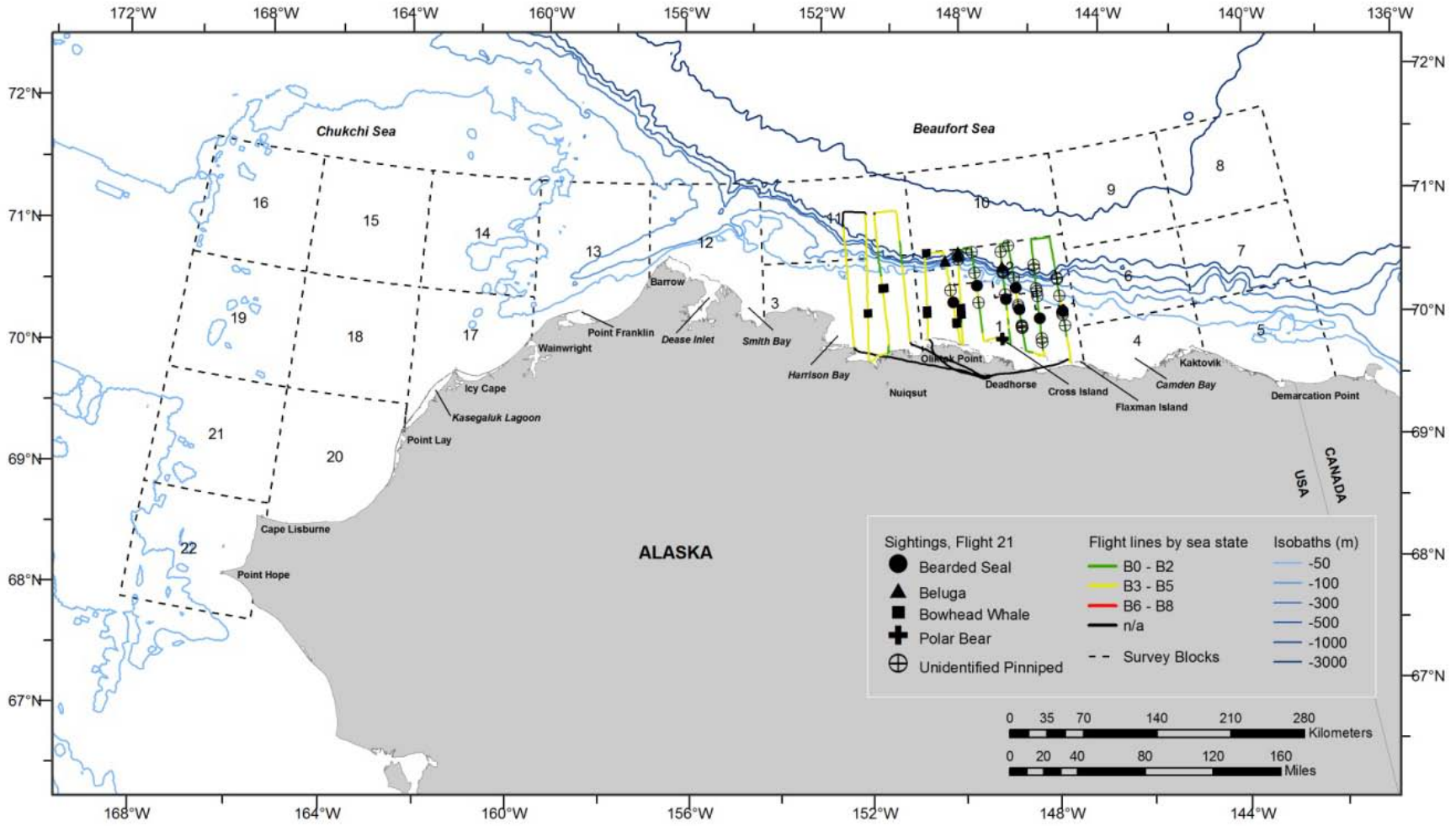

Figure B-77. Flight 21 survey track, depicted by sea state, and all sightings.

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29 September 2011, Flight 257

Flight was a survey of Transects 10 and 12, and a Coastal Transect from north of Icy Cape to Barrow. Survey conditions were good, with partly cloudy to overcast skies and scattered snow showers, sea state Beaufort 1-4, and visibility 0-10 km. No sea ice was present within the area surveyed. One bowhead whale was sighted offshore in block 15, and gray whales were sighted offshore of Wainwright. Belugas were sighted offshore in block 15 and nearshore at Point Franklin. Unidentified marine mammals were sighted offshore of Wainwright. Walruses, bearded seals, and unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
257	9/29/2011 12:33	70.733	161.154	gray whale	swim	1	0	17
257	9/29/2011 12:33	70.738	161.172	gray whale	feed	3	0	17
257	9/29/2011 12:36	70.751	161.124	gray whale	.	4	0	17
257	9/29/2011 12:55	71.013	162.157	beluga	rest	1	0	14
257	9/29/2011 13:07	71.261	163.097	beluga	swim	2	0	15
257	9/29/2011 13:18	71.465	163.893	beluga	swim	2	0	15
257	9/29/2011 14:39	71.381	165.305	beluga	rest	1	0	15
257	9/29/2011 14:58	71.081	164.089	bowhead whale	rest	1	0	15
257	9/29/2011 15:26	70.540	162.052	unidentified marine mammal	unknown	5	0	17
257	9/29/2011 15:35	70.454	161.740	unidentified marine mammal	swim	5	0	17
257	9/29/2011 15:43	70.447	161.724	unidentified marine mammal	.	1	0	17
257	9/29/2011 16:28	70.907	158.933	beluga	swim	6	2	13

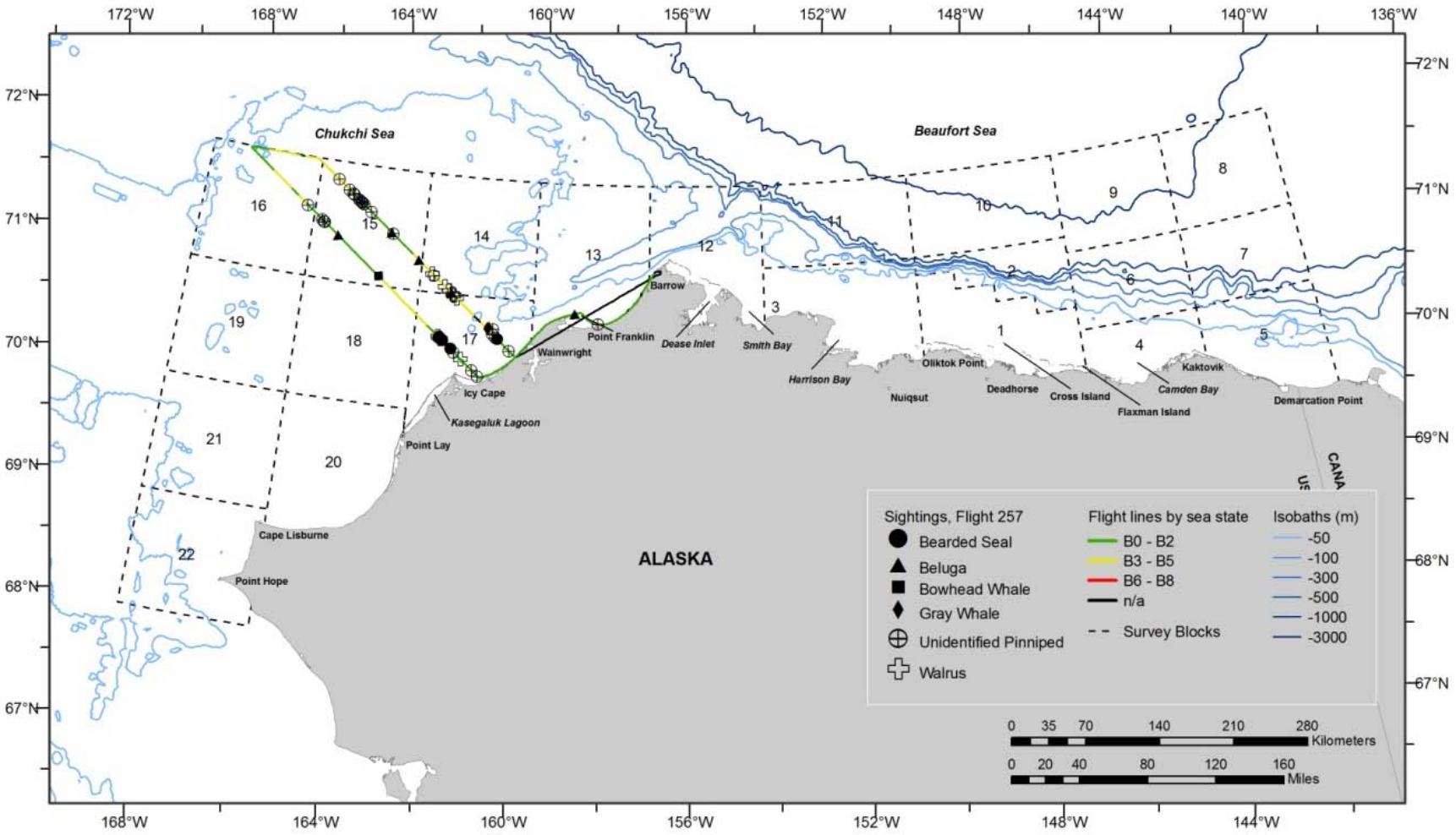

Figure B-78. Flight 257 survey track, depicted by sea state, and all sightings.

29 September 2011, Flight 22

Flight was a transect survey of portions of blocks 3, 4, 6 and 11. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 3-6, and visibility 0-10 km. Low ceilings and high sea states impeded survey effort in blocks 3, 4, 6 and 11. The area surveyed was ice free. Fifty-six belugas were sighted offshore in block 11, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
22	9/29/2011 10:58	71.916	153.924	beluga	rest	3	0	11
22	9/29/2011 10:58	71.917	153.924	beluga	rest	15	0	11
22	9/29/2011 10:58	71.921	153.923	beluga	rest	1	0	11
22	9/29/2011 10:59	71.935	153.922	beluga	rest	2	0	11
22	9/29/2011 11:00	71.980	153.922	beluga	swim	1	0	11
22	9/29/2011 11:05	71.993	153.553	beluga	swim	1	0	11
22	9/29/2011 11:06	71.994	153.426	beluga	swim	1	0	11
22	9/29/2011 11:06	71.993	153.408	beluga	swim	5	2	11
22	9/29/2011 11:06	71.993	153.408	beluga	swim	1	0	11
22	9/29/2011 11:07	71.992	153.335	beluga	swim	1	0	11
22	9/29/2011 11:14	71.796	153.264	beluga	swim	1	0	11
22	9/29/2011 11:15	71.768	153.263	beluga	swim	1	0	11
22	9/29/2011 11:16	71.753	153.264	beluga	swim	1	0	11
22	9/29/2011 11:16	71.743	153.267	beluga	rest	4	1	11
22	9/29/2011 11:16	71.738	153.267	beluga	swim	2	1	11
22	9/29/2011 11:19	71.716	153.082	beluga	swim	1	0	11
22	9/29/2011 11:38	71.991	152.185	beluga	swim	4	0	11
22	9/29/2011 11:38	71.991	152.172	beluga	swim	2	0	11

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
22	9/29/2011 11:38	71.991	152.165	beluga	swim	1	0	11
22	9/29/2011 11:39	71.989	152.092	beluga	swim	2	1	11
22	9/29/2011 11:40	71.959	152.071	beluga	swim	1	0	11
22	9/29/2011 11:41	71.951	152.072	beluga	swim	3	0	11
22	9/29/2011 11:41	71.945	152.073	beluga	swim	1	0	11
22	9/29/2011 11:41	71.944	152.073	beluga	swim	1	0	11

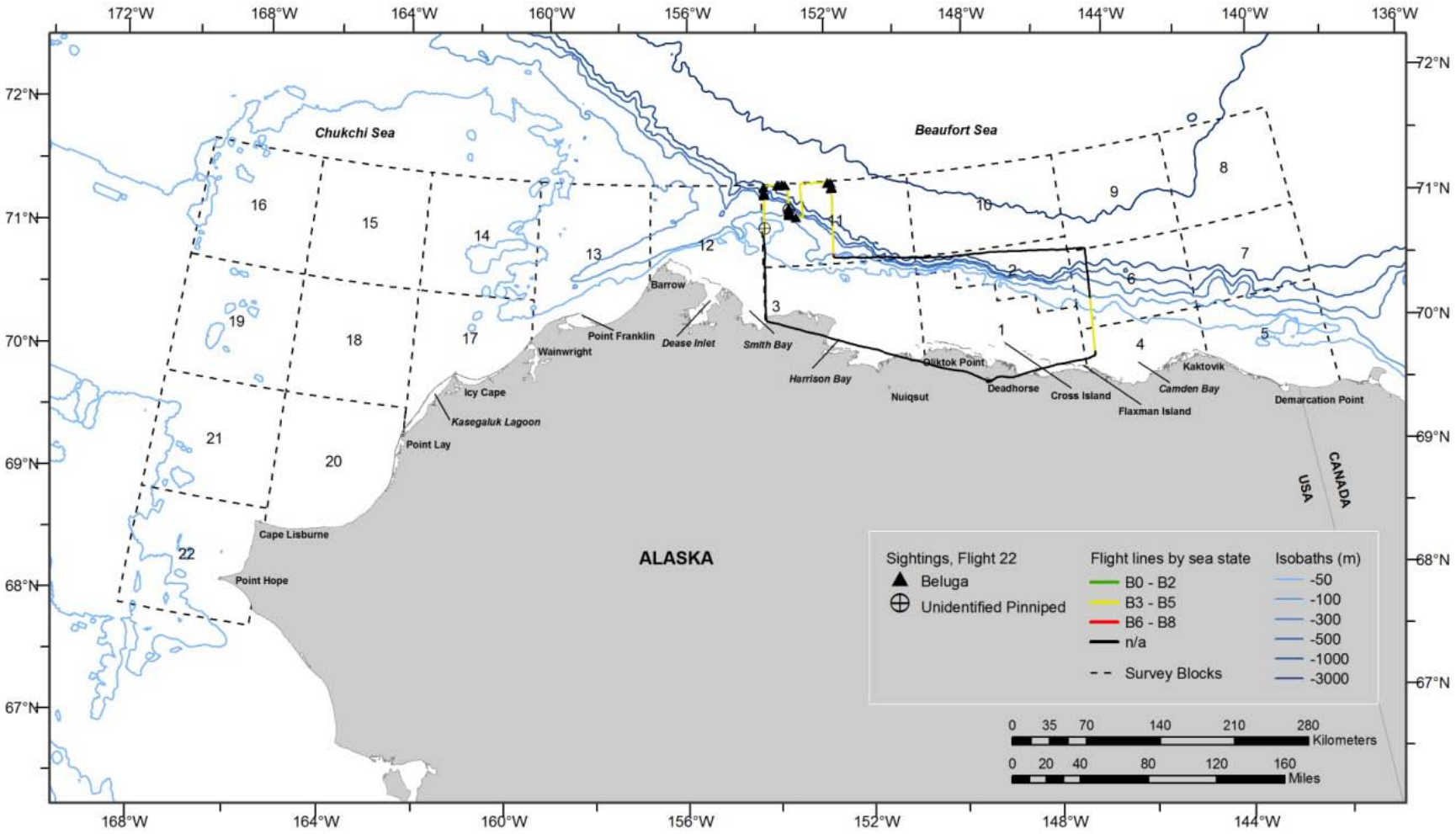

Figure B-79. Flight 22 survey track, depicted by sea state, and all sightings.

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30 September 2011, Flight 258

Flight was a survey of Transects 14 and 16, Coastal Transect from Point Lay to north of Icy Cape, and search effort between Barrow and Point Franklin. Survey conditions were good, with partly cloudy to overcast skies and scattered snow showers, sea state Beaufort 2-6, and visibility 0-10 km. No sea ice was present within the area surveyed. Walruses and unidentified pinnipeds were sighted. Approximately 13,000 walruses were hauled out northeast of Point Lay.

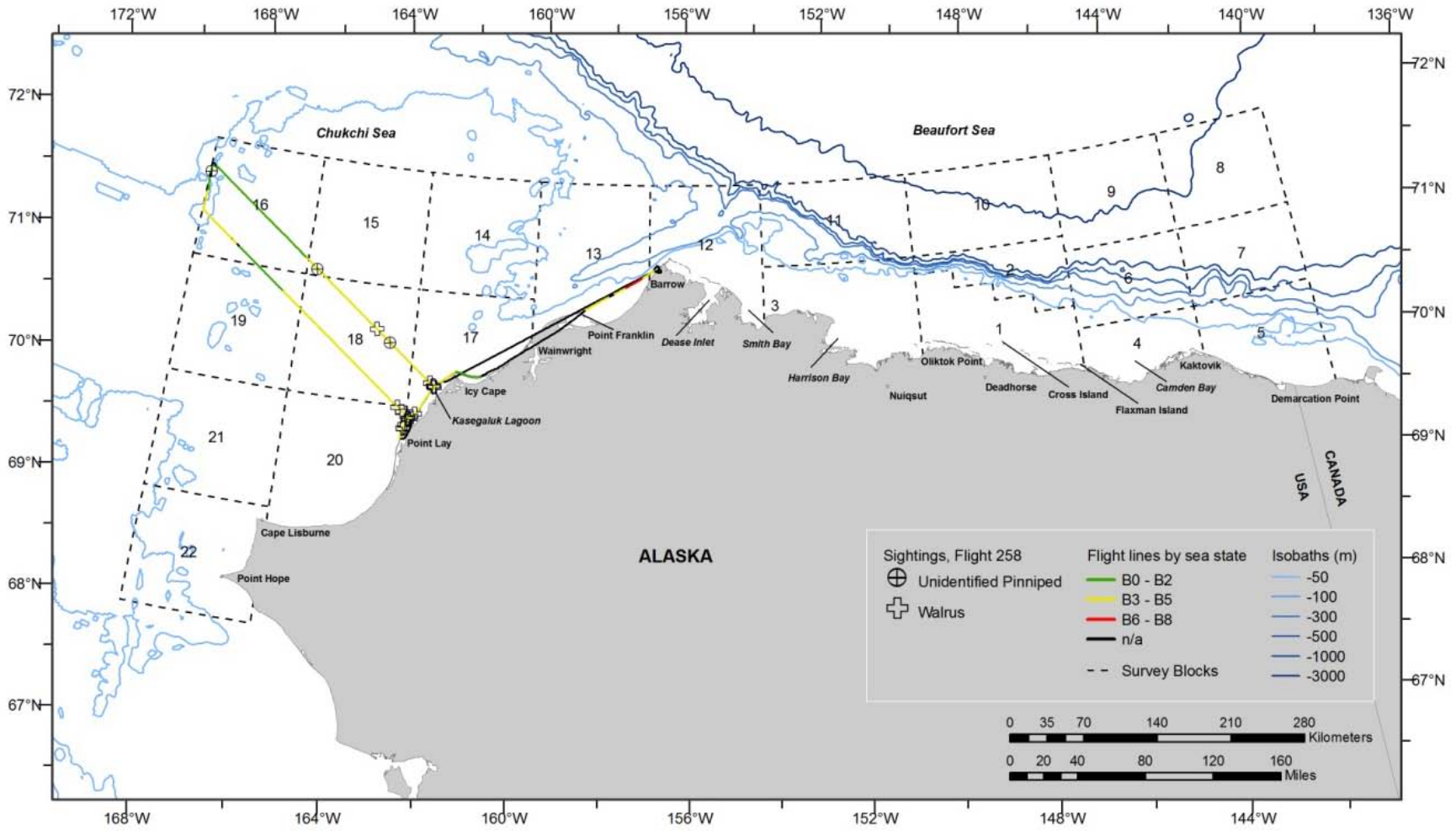

Figure B-80. Flight 258 survey track, depicted by sea state, and all sightings.

30 September 2011, Flight 23

Flight was a transect survey of block 12. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 2-6, and visibility 0 to unlimited. The area surveyed was ice free. Six bowhead whales were seen scattered near the 20 m contour, and a few belugas were seen near the north end of the block, along with one beluga sighted at the mouth of Smith Bay. One bearded seal and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
23	9/30/2011 14:56	70.853	154.028	beluga	swim	1	0	12
23	9/30/2011 15:10	71.283	154.145	bowhead whale	unknown	1	0	12
23	9/30/2011 16:03	71.294	154.499	bowhead whale	swim	1	0	12
23	9/30/2011 16:05	71.290	154.653	bowhead whale	swim	1	0	12
23	9/30/2011 16:35	71.372	155.180	bowhead whale	dive	1	0	12
23	9/30/2011 16:36	71.395	155.182	bowhead whale	swim	1	0	12
23	9/30/2011 16:52	71.944	155.109	beluga	swim	1	0	12
23	9/30/2011 16:52	71.957	155.110	beluga	swim	1	0	12
23	9/30/2011 16:52	71.964	155.109	beluga	swim	3	0	12
23	9/30/2011 17:27	71.491	156.187	bowhead whale	swim	1	0	12

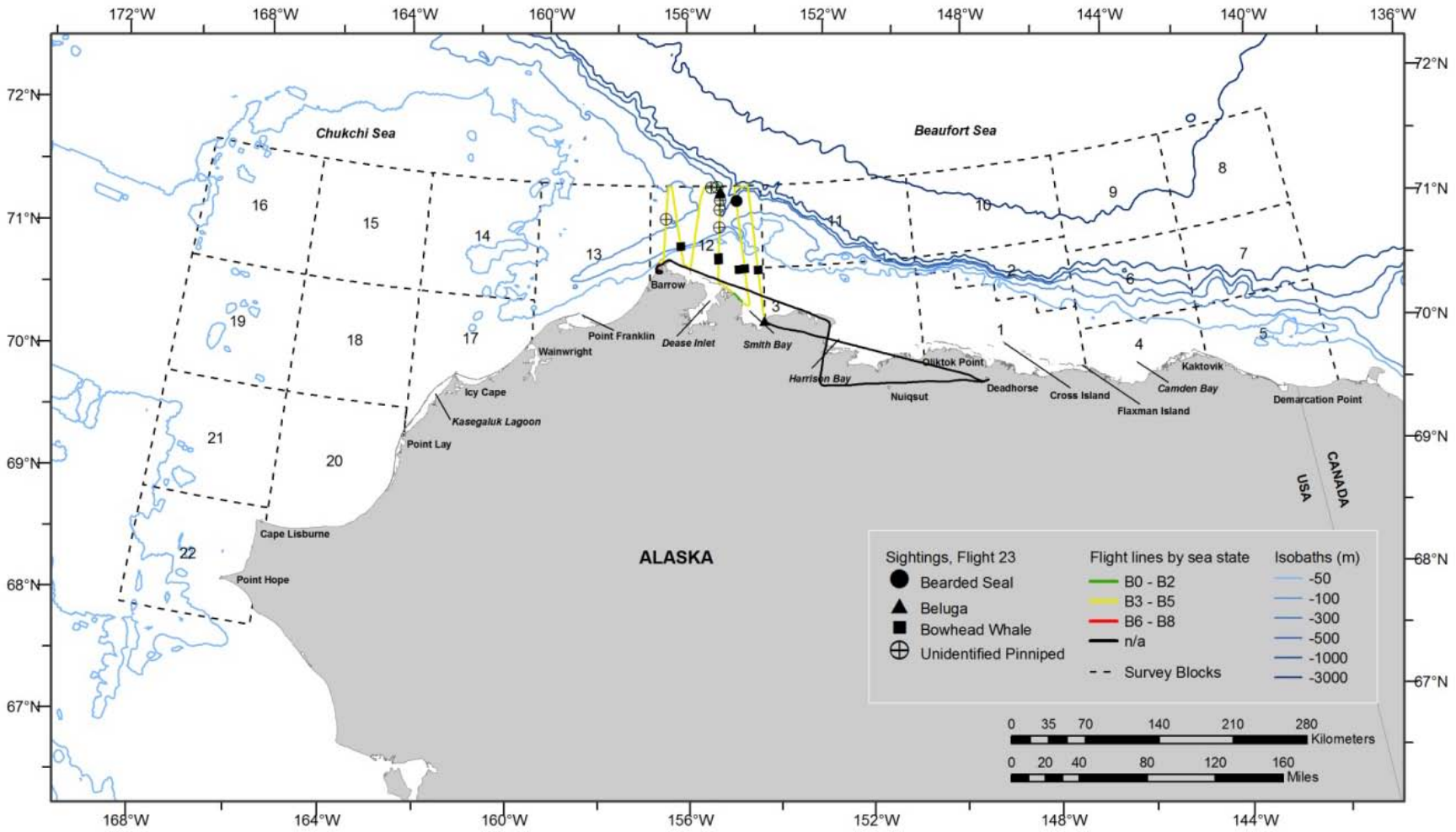

Figure B-81. Flight 23 survey track, depicted by sea state, and all sightings.

1 October 2011, Flight 259

Flight was a survey of Transects 18 and 20, and search effort between Barrow and Point Franklin. Survey conditions were fair, with partly cloudy to overcast skies and scattered snow showers, sea state Beaufort 2-6, and visibility 0-10 km. High sea states impeded completion of transects 18 and 20. No sea ice was present within the area surveyed. Gray whales were sighted between Barrow and Point Franklin. Walruses and an unidentified pinniped were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
259	10/1/2011 14:26	71.02834	158.2623	gray whale	feed	1	0	13
259	10/1/2011 14:35	71.0338	158.3416	gray whale	feed	1	0	13
259	10/1/2011 14:36	71.03225	158.3067	gray whale	swim	1	0	13
259	10/1/2011 14:42	71.1241	157.7255	gray whale	swim	1	0	13

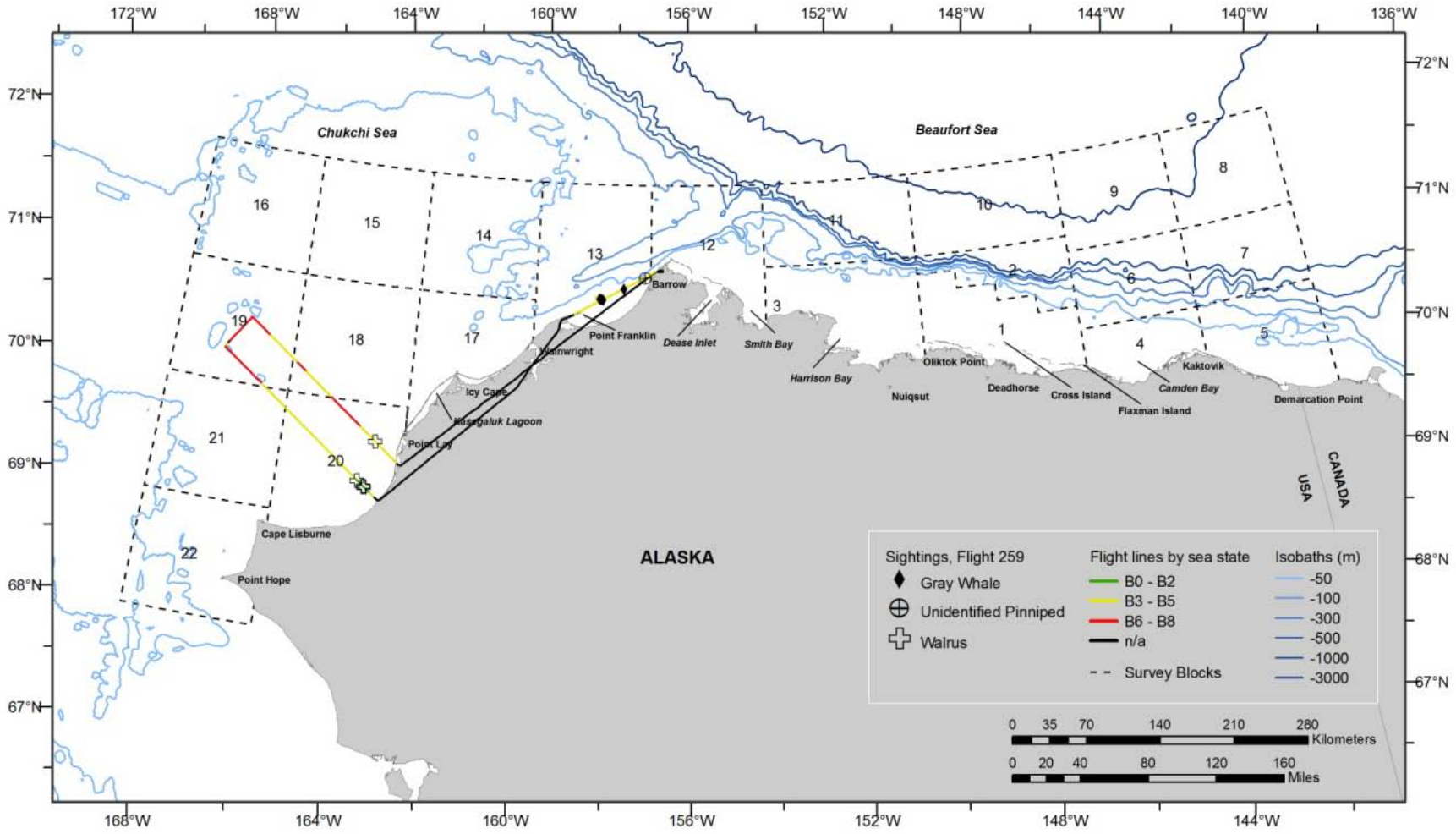

Figure B-82. Flight 259 survey track, depicted by sea state, and all sightings.

1 October 2011, Flight 24

Flight was a transect survey of portions of blocks 4, 5, 6 and 7. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 2-6, and visibility 0-10 km. Low ceilings impeded survey effort in blocks 4 and 6. The area surveyed was ice free. Four bowhead whales, including a cow-calf pair, were seen northeast of Kaktovik. Belugas were sighted offshore; small unidentified pinnipeds were sighted, and a polar bear sow and two cubs were sighted onshore near Kaktovik.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
24	10/1/2011 12:25	70.957	143.898	beluga	rest	1	0	6
24	10/1/2011 13:10	70.245	143.119	bowhead whale	swim	2	0	4
24	10/1/2011 13:27	70.307	142.896	bowhead whale	swim	2	1	5
24	10/1/2011 14:22	70.591	142.428	beluga	swim	1	0	7
24	10/1/2011 14:23	70.575	142.425	beluga	swim	1	0	7

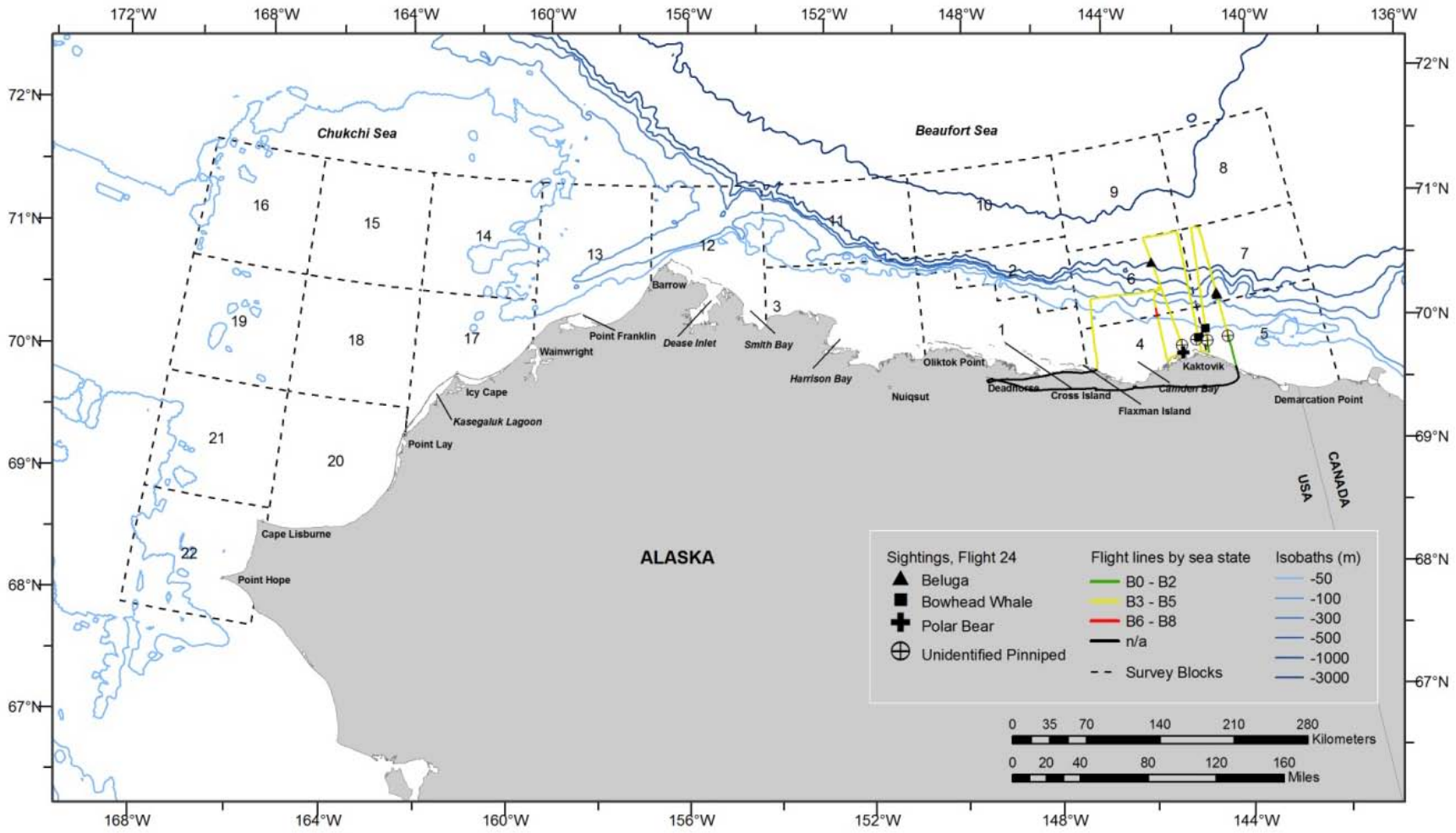

Figure B-83. Flight 24 survey track, depicted by sea state, and all sightings.

2 October 2011, Flight 260

Flight was a survey of Transects 7 and 9, and search effort between Barrow and Point Franklin. Survey conditions were fair, with partly cloudy to overcast skies and scattered snow showers, sea state Beaufort 2-4, and visibility 0-10 km. No sea ice was present within the area surveyed. Gray whales were sighted between Barrow and Point Franklin and offshore in blocks 14 and 17. Belugas, walruses and unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
260	10/2/2011 12:44	70.848	160.763	gray whale	feed	1	0	17
260	10/2/2011 12:45	70.859	160.804	gray whale	feed	1	0	17
260	10/2/2011 12:53	71.039	161.440	gray whale	swim	2	0	14
260	10/2/2011 14:22	71.448	161.303	beluga	rest	1	0	14
260	10/2/2011 15:03	71.128	158.002	gray whale	swim	1	0	13
260	10/2/2011 15:04	71.163	157.884	gray whale	swim	1	0	13
260	10/2/2011 15:09	71.281	157.503	beluga	swim	1	0	13

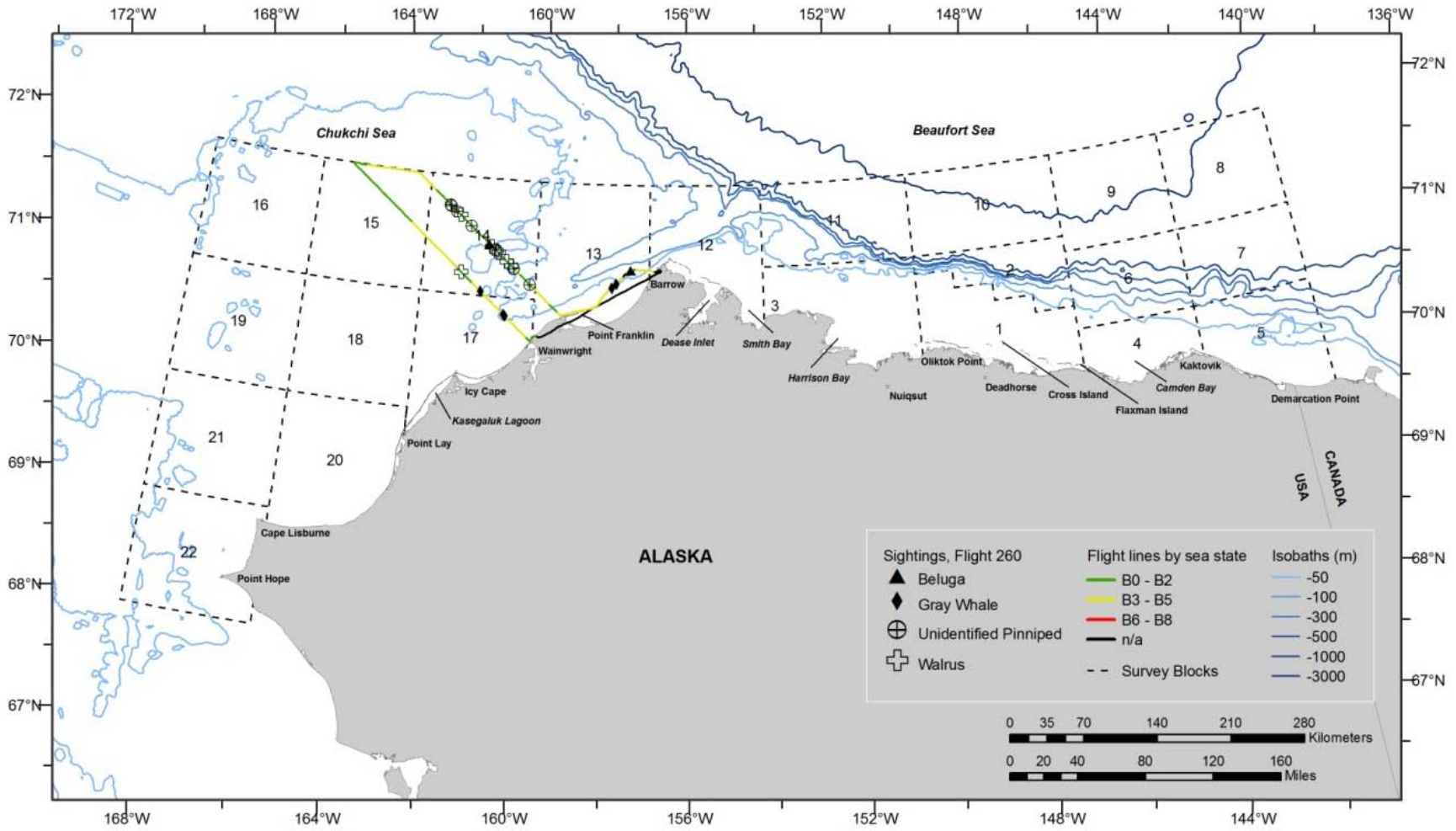

Figure B-84. Flight 260 survey track, depicted by sea state, and all sightings.

2 October 2011, Flight 25

Flight was a transect survey of portions of blocks 1, 2 and 5. Survey conditions were fair, with partly cloudy skies, sea state Beaufort 2-6, and visibility 0-10 km. Low ceilings and high sea states impeded survey effort in block 5. The area surveyed was ice free. Eight bowhead whales were sighted in block 1, belugas were sighted offshore in block 2, and small unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
25	10/2/2011 12:26	70.959	146.386	beluga	swim	2	0	2
25	10/2/2011 12:47	70.326	146.463	bowhead whale	rest	4	0	1
25	10/2/2011 12:47	70.315	146.461	bowhead whale	rest	1	0	1
25	10/2/2011 12:58	70.408	146.925	bowhead whale	swim	1	0	1
25	10/2/2011 12:59	70.418	146.851	bowhead whale	swim	1	0	1
25	10/2/2011 13:09	70.445	146.927	bowhead whale	swim	1	0	1
25	10/2/2011 13:23	70.948	146.877	beluga	swim	2	0	2
25	10/2/2011 13:23	70.955	146.875	beluga	swim	1	0	2
25	10/2/2011 13:23	70.957	146.875	beluga	swim	1	0	2
25	10/2/2011 14:32	71.115	147.691	beluga	swim	1	0	2
25	10/2/2011 14:32	71.128	147.689	beluga	swim	1	0	2

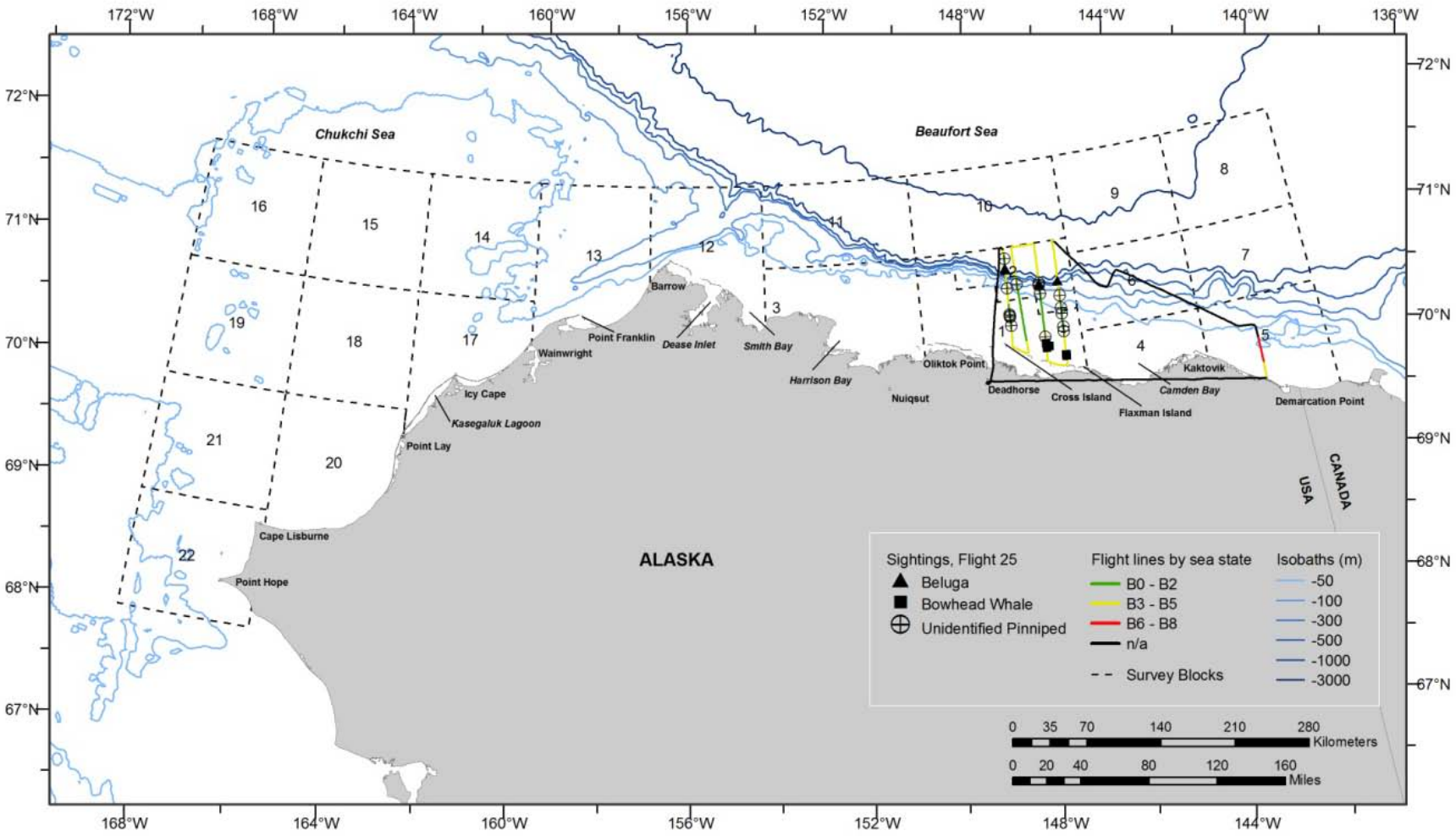

Figure B-85. Flight 25 survey track, depicted by sea state, and all sightings.

3 October 2011, Flight 261

Flight was a survey of Transects 3 and 5. Survey conditions were fair, with partly cloudy to overcast skies and scattered snow showers, sea state Beaufort 3-6, and visibility 0-10 km. No sea ice was present within the area surveyed. One gray whale was sighted between Barrow and Point Franklin, belugas were sighted in block 13, and an unidentified pinniped was also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
261	10/3/2011 10:23	71.044	158.328	gray whale	feed	1	0	13
261	10/3/2011 10:38	71.307	159.203	beluga	mill	5	0	13
261	10/3/2011 10:41	71.387	159.476	beluga	swim	1	0	13
261	10/3/2011 10:47	71.514	159.917	beluga	rest	1	0	13

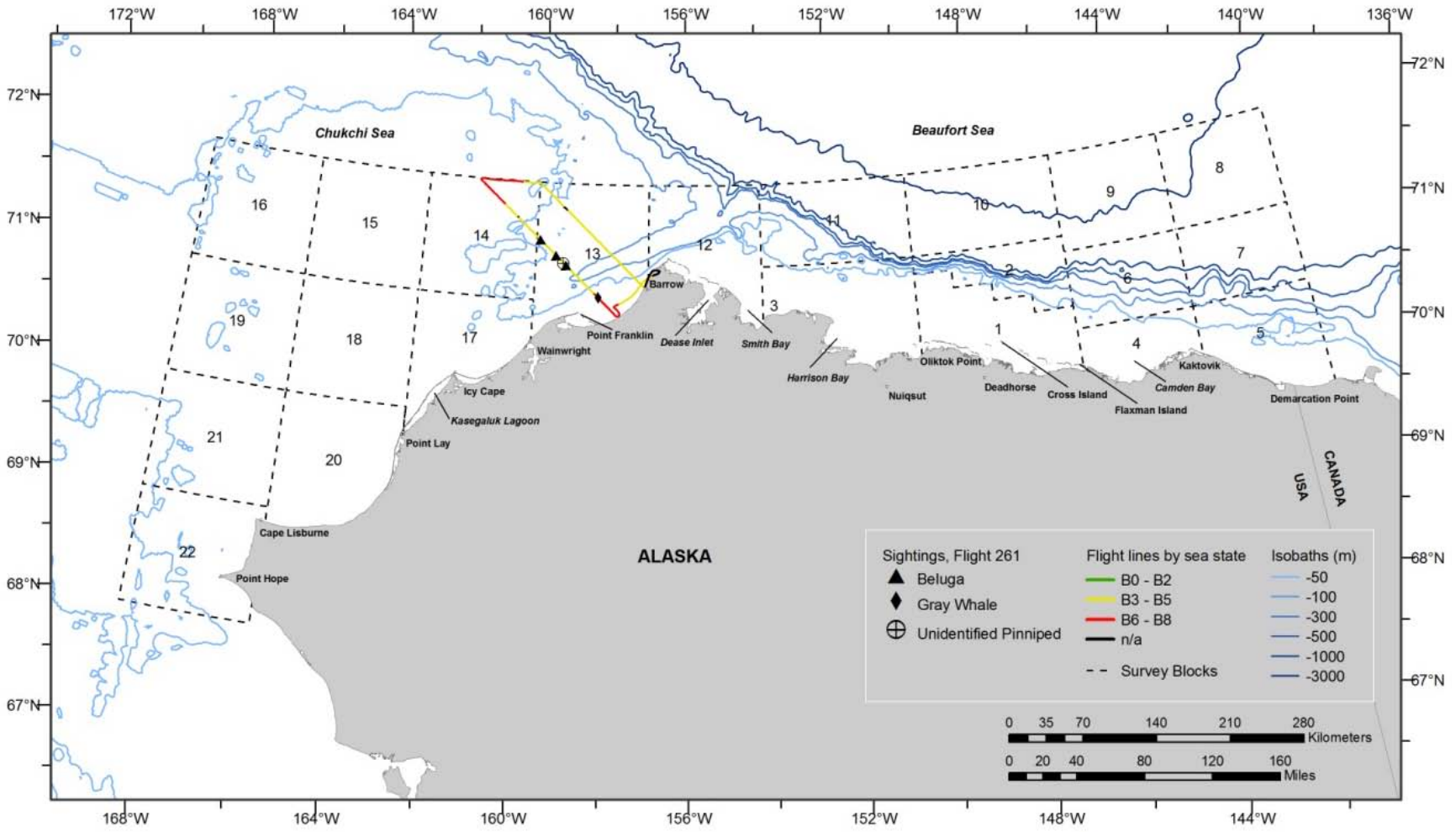

Figure B-86. Flight 261 survey track, depicted by sea state, and all sightings.

4 October 2011, Flight 26

Flight was a search and deadhead survey of blocks 4 and 5 in an attempt to find an area suitable for transects. Survey conditions were very poor, with low ceilings and high sea states. While on search effort, the sea state was a Beaufort 3 to 5, and visibility ranged from 2 to 10 km. The area surveyed was ice free. Five polar bears were sighted near Kaktovik.

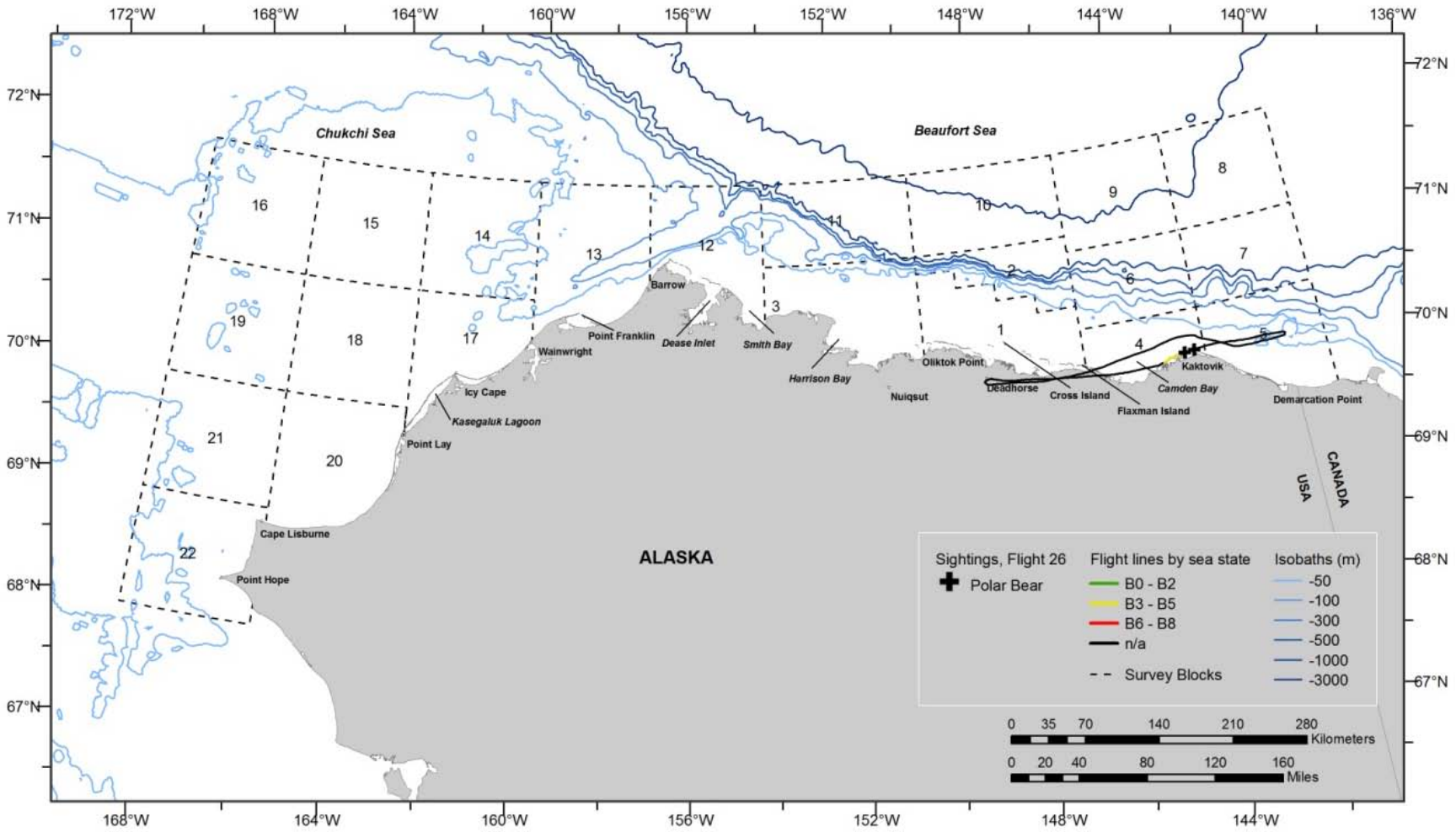

Figure B-87. Flight 26 survey track, depicted by sea state, and all sightings.

5 October 2011, Flight 262

Flight was a survey of Transects 11 and 13. Survey conditions were fair, with partly cloudy skies and scattered snow showers, sea state Beaufort 1-6, and visibility 0-10 km. No sea ice was present within the area surveyed. Unidentified pinnipeds were sighted.

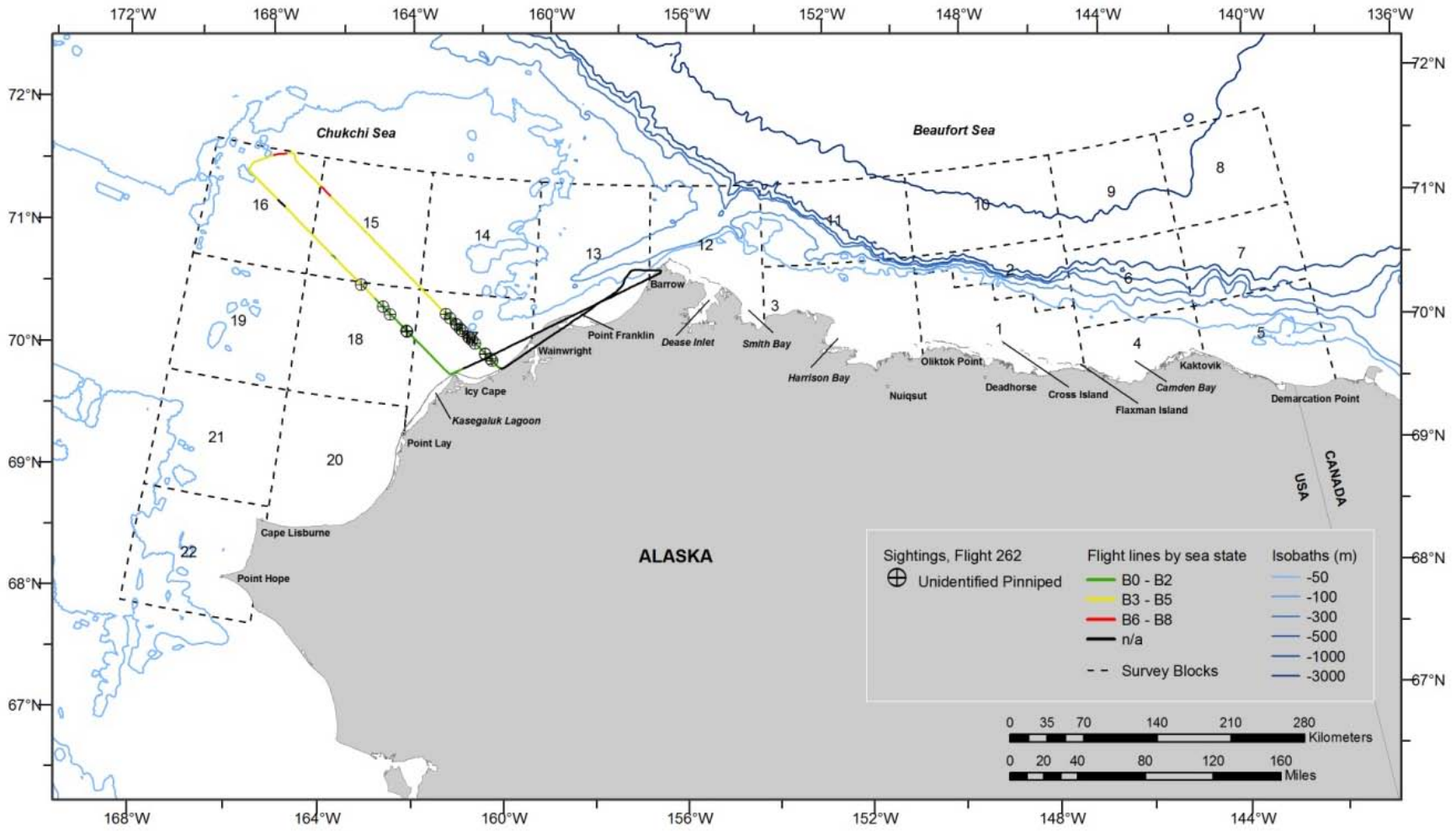

Figure B-88. Flight 262 survey track, depicted by sea state, and all sightings.

5 October 2011, Flight 27

Flight was a search and deadhead survey of blocks 1, 2, 3 and 11 in an attempt to find an area suitable for transects. Survey conditions were very poor, with low ceilings. During very brief search effort near Cross Island, sea state was a Beaufort 2, and visibility ranged from <1 to 3 km. The area surveyed was ice free. Eight polar bears were sighted on or near Cross Island.

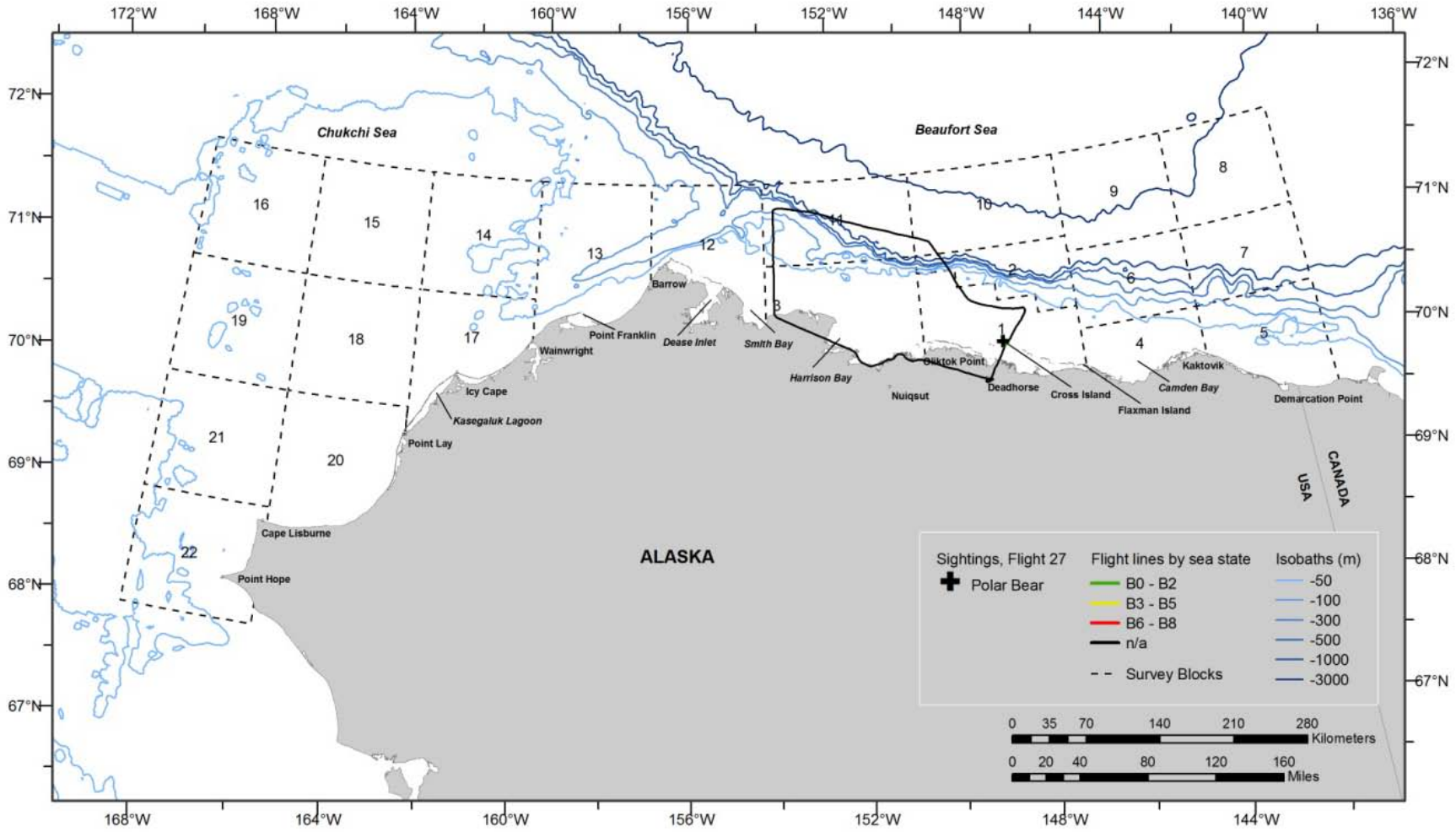

Figure B-89. Flight 27 survey track, depicted by sea state, and all sightings.

6 October 2011, Flight 263

Flight was a survey of partial Transects 15 and 17, and a Coastal Transect from Point Lay to Barrow. Survey conditions were fair, with partly cloudy to overcast skies and scattered snow showers, sea state Beaufort 2-4, and visibility <1-10 km. Ice cover ranged from 1-5% and consisted of grease/new sea ice nearshore. One beluga was sighted just off of Barrow, and walruses and unidentified pinnipeds were also sighted. Approximately 1,000 walruses were hauled out northeast of Point Lay, slightly north of the haulout location observed on 30 September.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
263	10/6/2011 15:21	71.284	156.886	beluga	swim	1	0	12

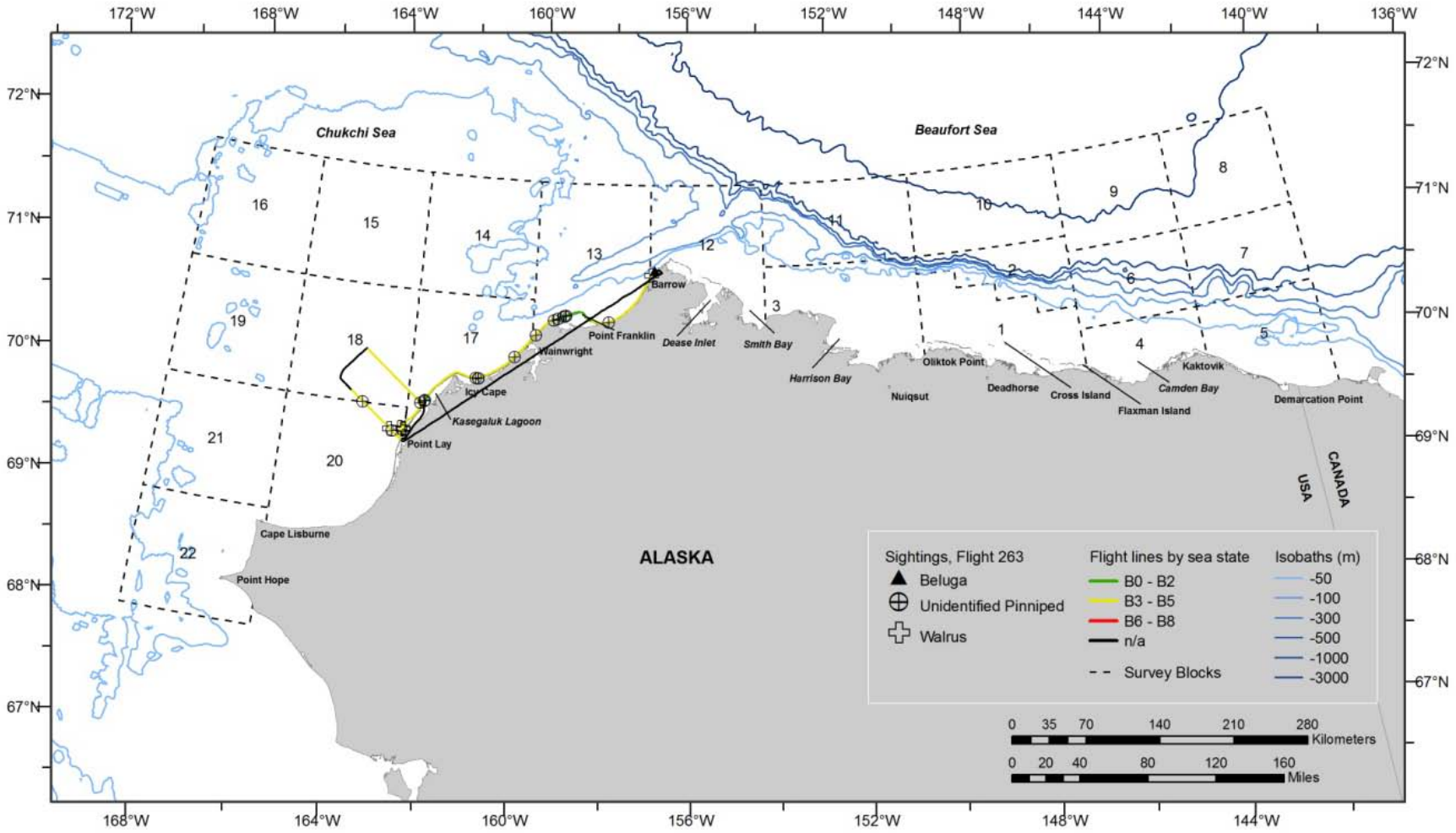

Figure B-90. Flight 263 survey track, depicted by sea state, and all sightings.

10 October 2011, Flight 28

Flight was a transect survey of portions of blocks 4 and 6. Survey conditions were fair, with overcast skies, sea state Beaufort 2-5, and visibility 0-5 km. Low ceilings, frequent snow showers, and high sea states impeded survey effort in blocks 4 and 6. The area surveyed was ice free. There were no sightings.

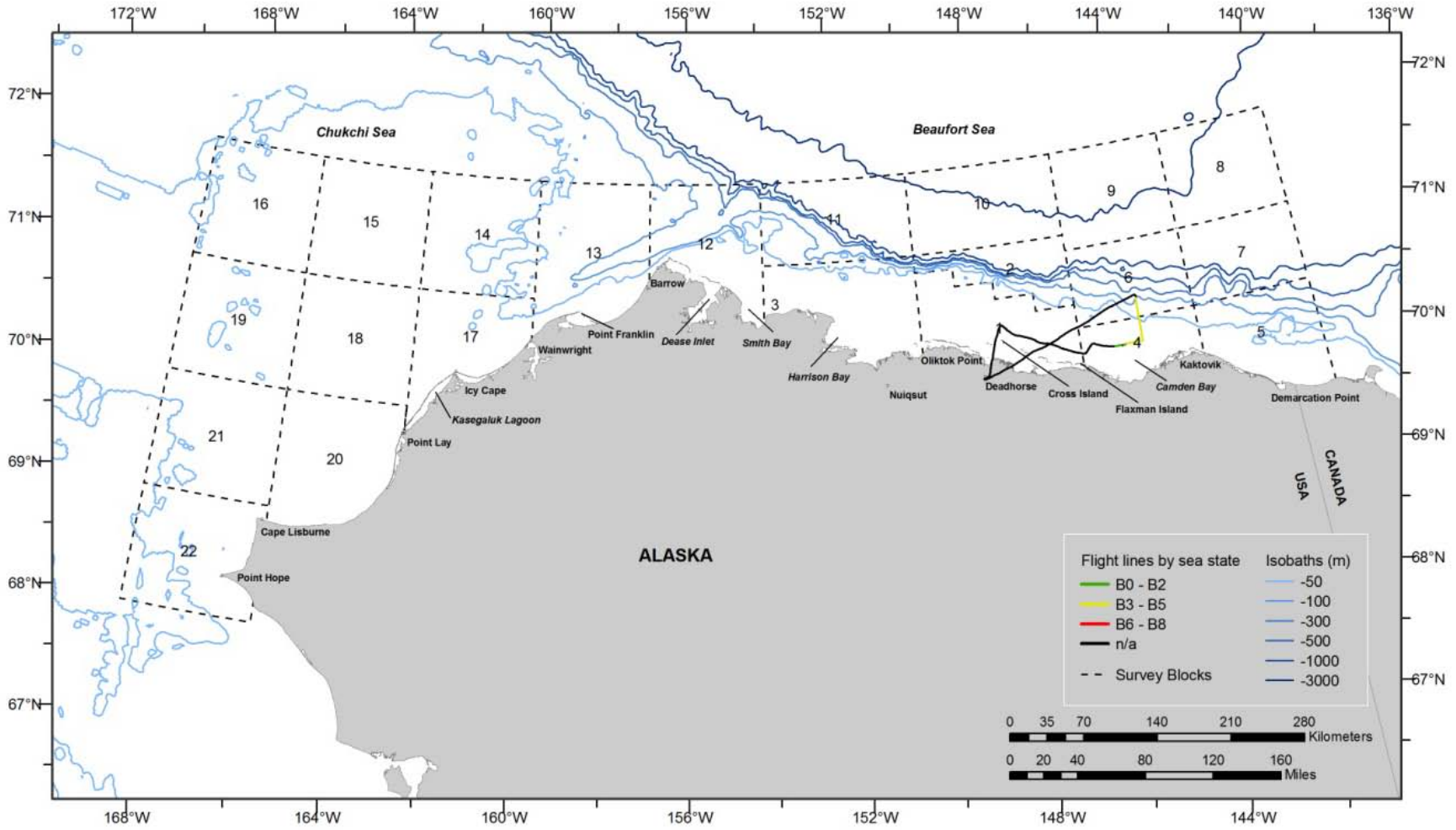

Figure B-91. Flight 28 survey track, depicted by sea state.

11 October 2011, Flight 264

Flight was a survey of Transects 1, 2, 3 and 4, and partial Transects 5 and 6. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 2-6, and visibility 2-10 km. High sea states prevented completion of Transects 3, 4, 5 and 6. No sea ice was present within the area surveyed. Bowhead whales were seen in block 13; gray whales were seen between Barrow and Point Franklin. Unidentified pinnipeds were also sighted.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
264	10/11/2011 11:43	71.551	156.977	bowhead whale	swim	1	0	12
264	10/11/2011 11:43	71.552	156.978	bowhead whale	swim	1	0	12
264	10/11/2011 11:43	71.555	156.981	bowhead whale	swim	1	0	12
264	10/11/2011 12:36	71.471	157.421	bowhead whale	swim	1	0	13
264	10/11/2011 12:52	71.221	157.373	gray whale	swim	1	0	13
264	10/11/2011 12:52	71.222	157.376	gray whale	feed	1	0	13
264	10/11/2011 12:53	71.227	157.393	gray whale	swim	1	0	13
264	10/11/2011 13:55	71.309	158.430	bowhead whale	rest	2	0	13
264	10/11/2011 14:04	71.171	157.976	gray whale	feed	2	0	13

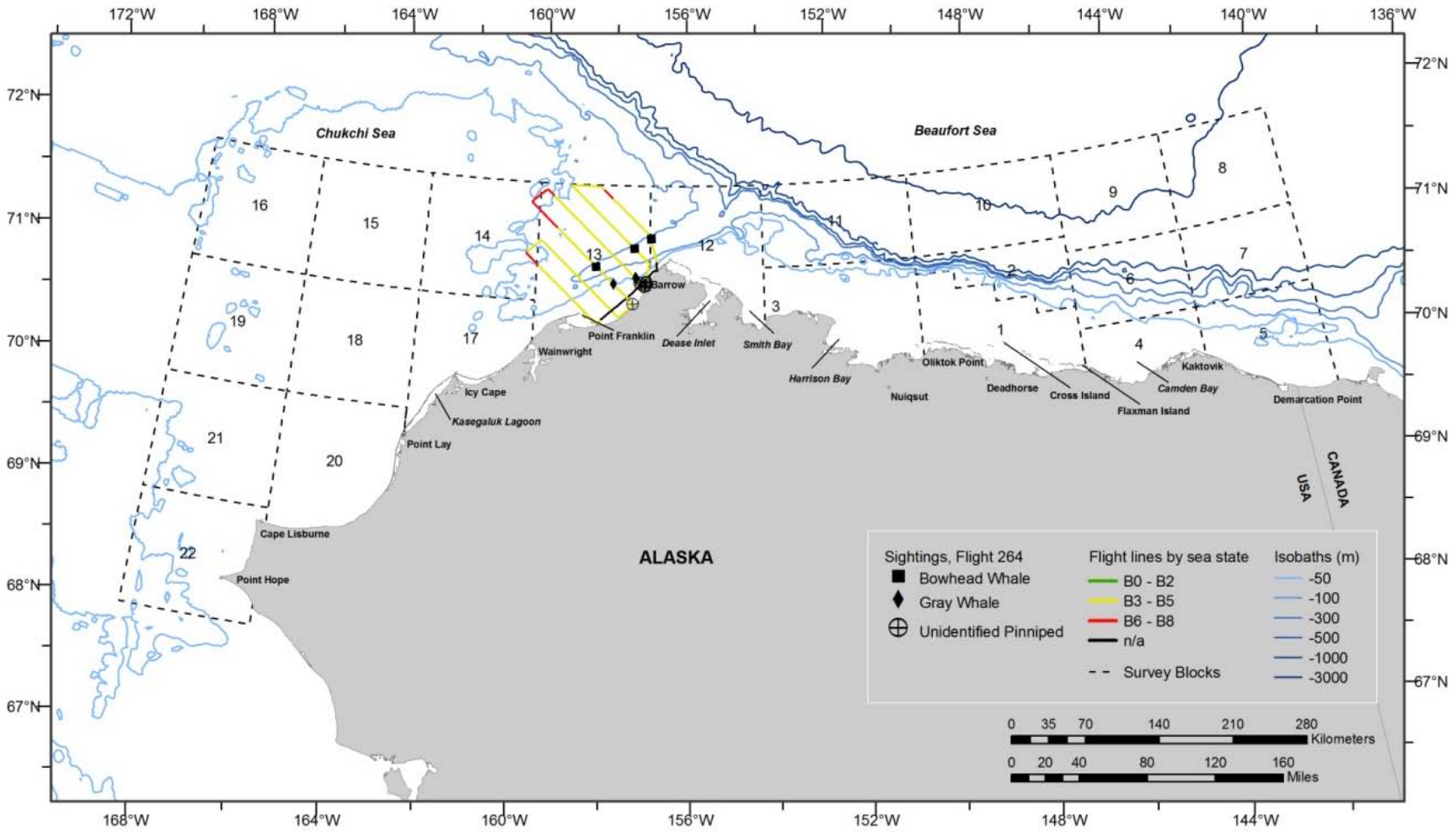

Figure B-92. Flight 264 survey track, depicted by sea state, and all sightings.

11 October 2011, Flight 29

Flight was a transect survey of portions of blocks 3 and 11. Survey conditions were fair, with partly cloudy to overcast skies, sea state Beaufort 3-7, and visibility 0-10 km. Low ceilings, frequent snow showers, and high sea states impeded survey effort in blocks 3 and 11. The area surveyed was ice free. Ten bowhead whales were sighted in block 3, northeast of Cape Halkett, and belugas were sighted offshore in block 11.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
29	10/11/2011 16:07	71.623	152.211	beluga	rest	1	0	11
29	10/11/2011 16:21	71.986	151.966	beluga	rest	1	0	11
29	10/11/2011 16:50	71.012	151.740	bowhead whale	swim	2	0	3
29	10/11/2011 16:51	70.995	151.737	bowhead whale	swim	1	0	3
29	10/11/2011 16:51	70.973	151.725	bowhead whale	swim	1	0	3
29	10/11/2011 16:52	70.970	151.726	bowhead whale	swim	1	0	3
29	10/11/2011 16:52	70.947	151.727	bowhead whale	swim	1	0	3
29	10/11/2011 16:53	70.928	151.729	bowhead whale	swim	1	0	3
29	10/11/2011 17:16	70.847	151.386	bowhead whale	swim	1	0	3
29	10/11/2011 17:20	70.993	151.356	bowhead whale	swim	1	0	3
29	10/11/2011 17:23	70.958	151.392	bowhead whale	swim	1	0	3

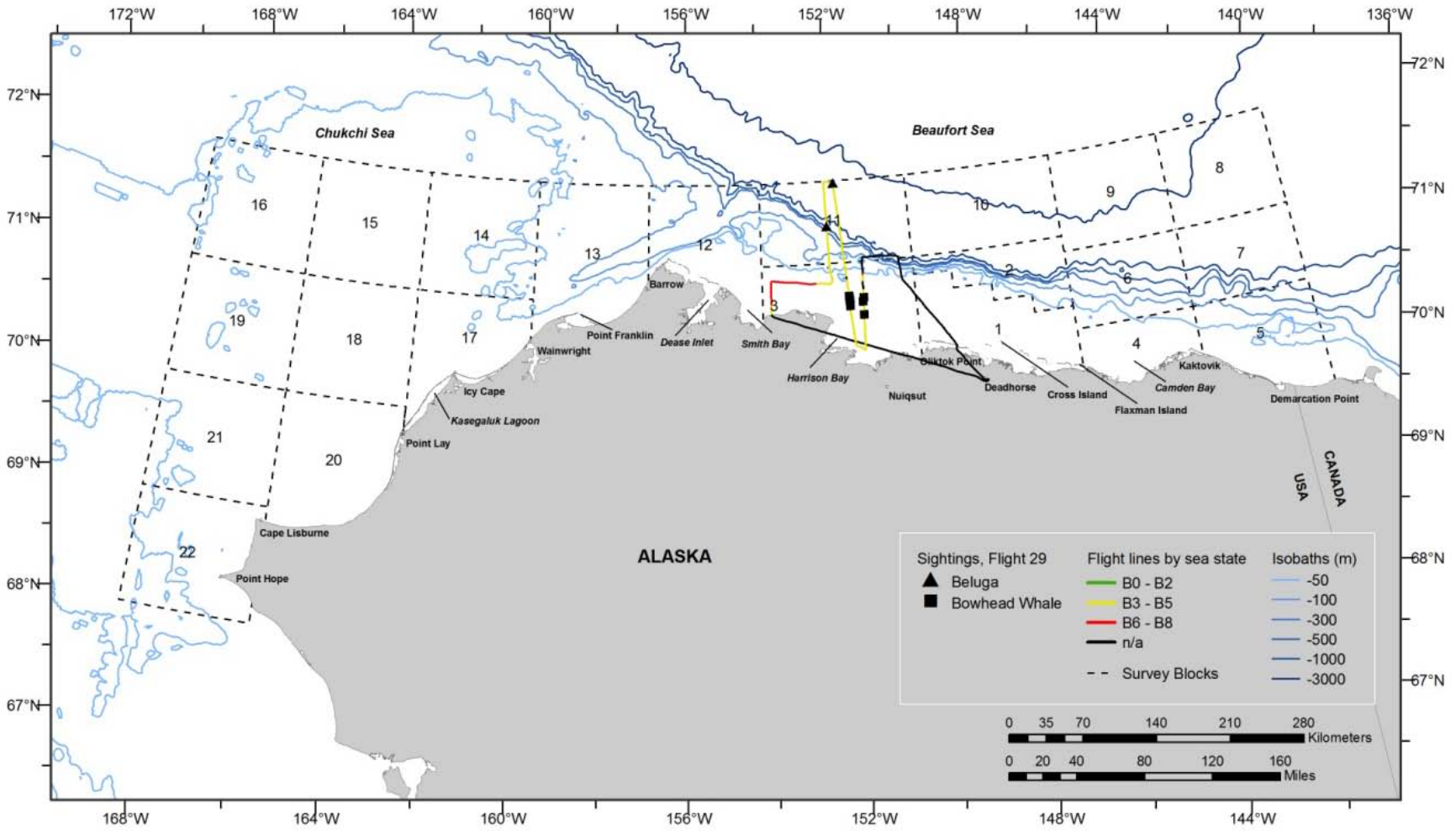

Figure B-93. Flight 29 survey track, depicted by sea state, and all sightings.

17 October 2011, Flight 265

Flight was a Coastal Transect from Point Lay to 25 km northeast of Wainwright. Survey conditions were poor, with partly cloudy skies, sea state Beaufort 1-4, and visibility <1-10 km. Fog and low ceilings prevented completion of the Coastal Transect from 25 km northeast of Wainwright to Barrow. Ice cover ranged from 0-90% and consisted of grease, new, and frazil ice nearshore. One beluga was sighted south of Wainwright, and walruses and unidentified pinnipeds were also sighted. No walruses were observed onshore at the site of the previous haulout near Pt. Lay or anywhere along the coast.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
265	10/17/2011 15:15	70.453	160.566	beluga	rest	1	0	17

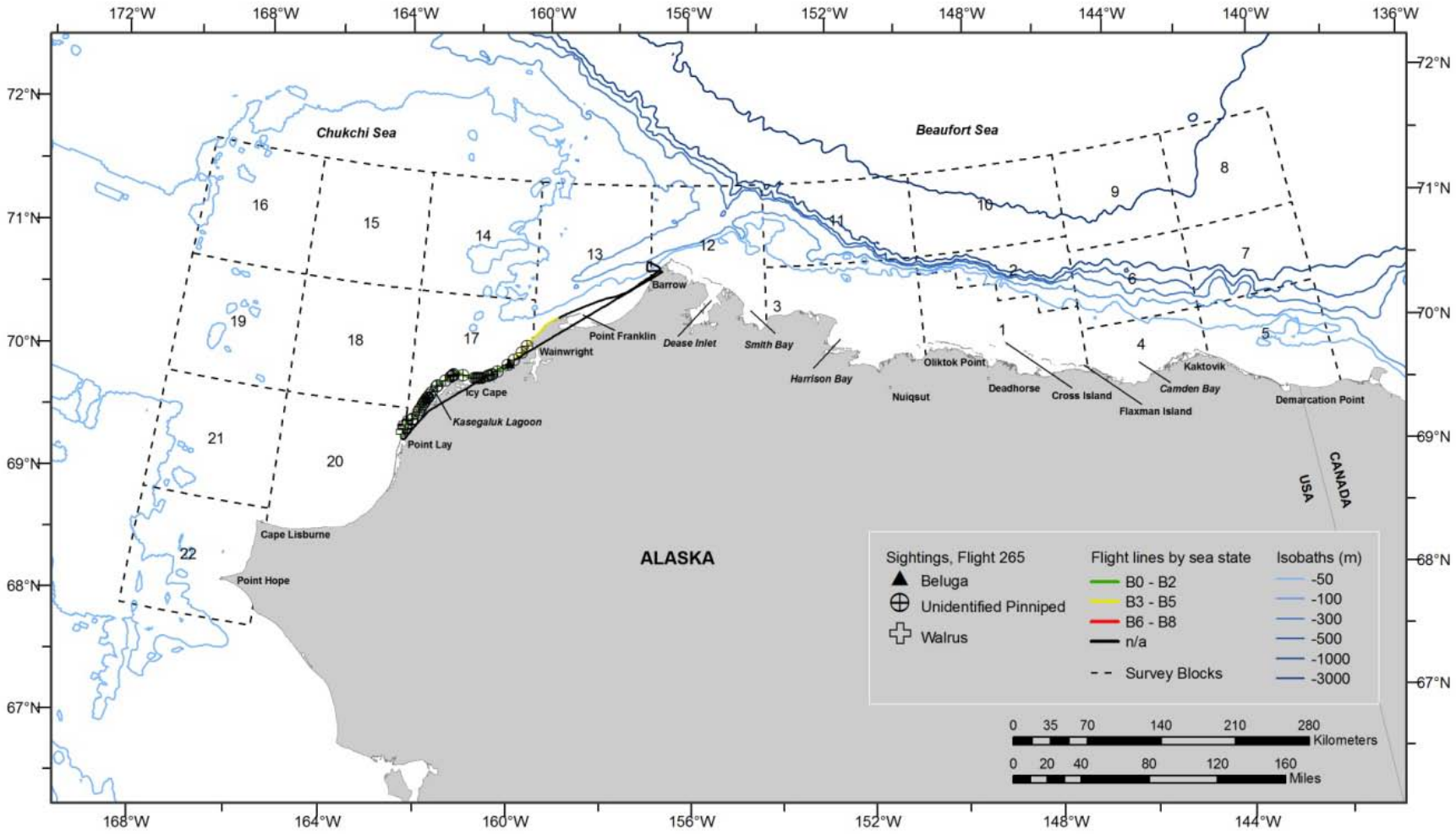

Figure B-94. Flight 265 survey track, depicted by sea state, and all sightings.

21 October 2011, Flight 266

Flight was a transect survey of portions of block 12. Survey conditions were poor, with overcast skies, sea state Beaufort 1-4, and visibility <1-10 km. Fog, low ceilings, snow showers, and high sea states prevented completion of the transect lines. Ice cover ranged from 0-90% and consisted of grease/new ice nearshore. Three bowhead whales were sighted in block 12.

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

Flight No.	Date and Time	Latitude °N	Longitude °W	Species	Behavior	Total No.	Calf No.	Block
266	10/21/2011 12:16	71.236	154.414	bowhead whale	swim	1	0	12
266	10/21/2011 12:17	71.272	154.407	bowhead whale	rest	1	0	12
266	10/21/2011 12:17	71.283	154.401	bowhead whale	rest	1	0	12

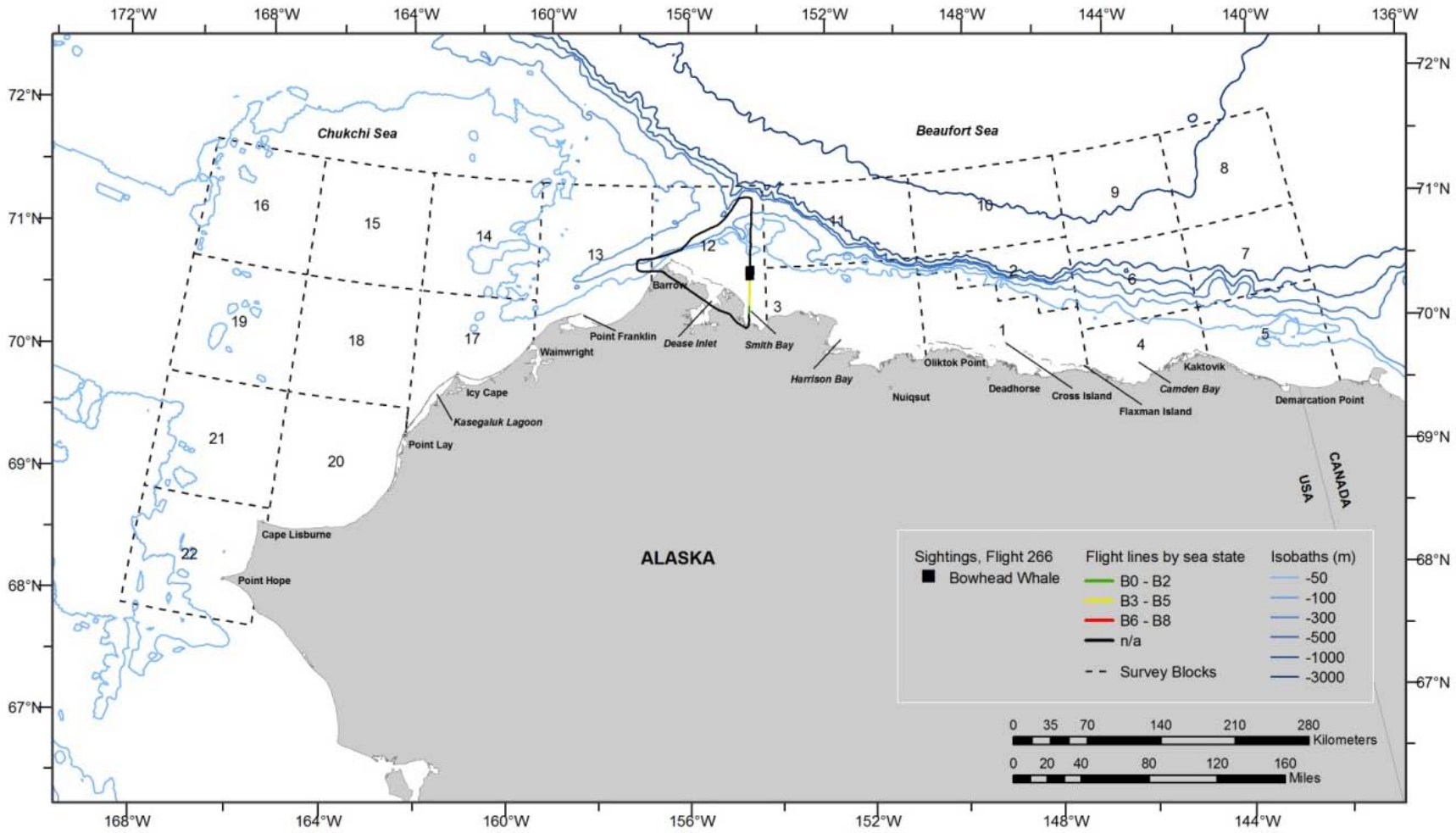

Figure B-95. Flight 266 survey track, depicted by sea state, and all sightings.

21 October 2011, Flight 30

Flight was a deadhead survey in an attempt to find an area suitable for transects. Survey conditions were very poor, with widespread ground fog preventing survey effort. The sea state, visible between patches of fog, was a Beaufort 6-7. There were no sightings.

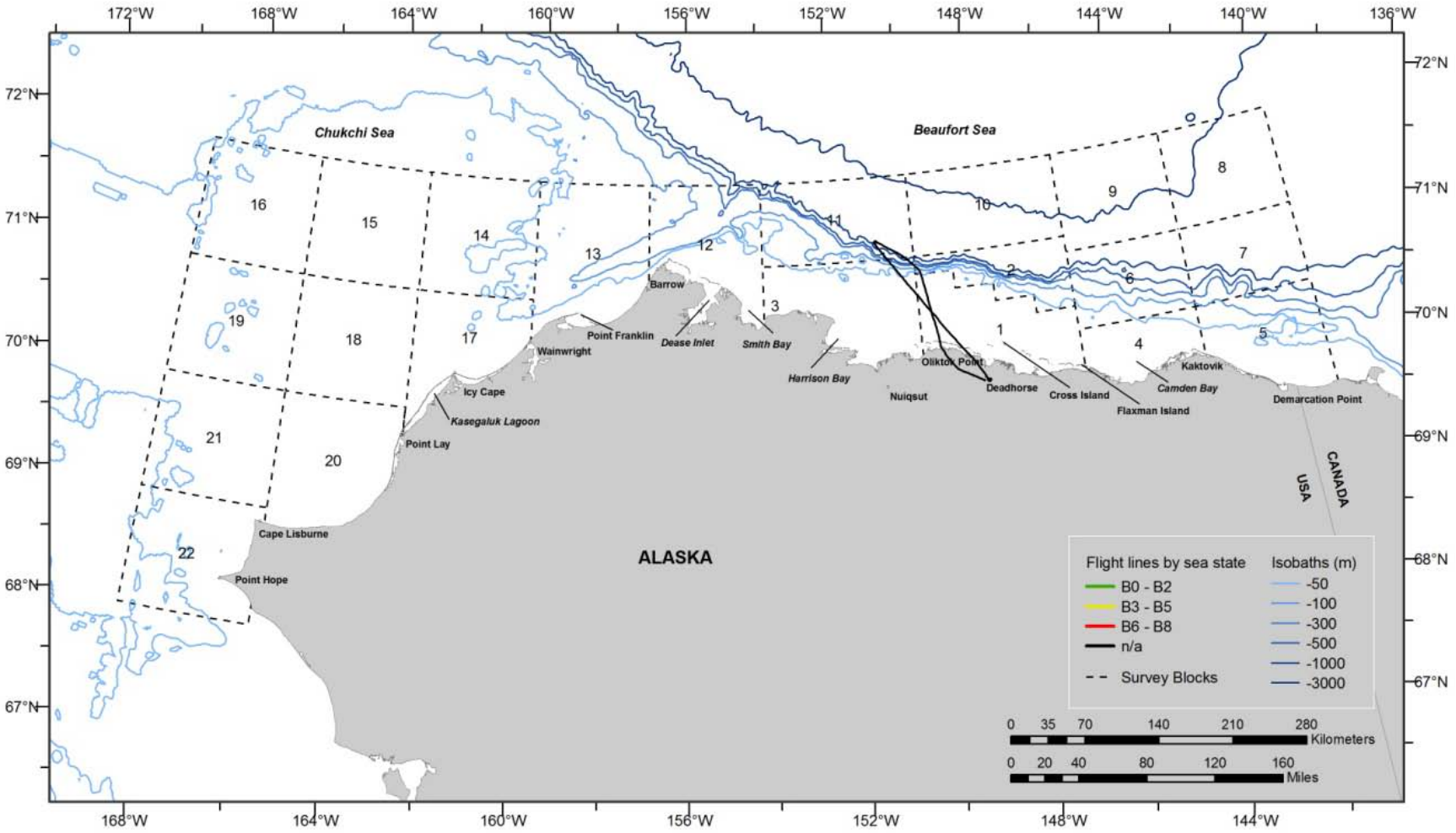

Figure B-96. Flight 30 survey track, depicted by sea state.

24 October 2011, Flight 31

Flight was a transect survey of portions of blocks 1, 4 and 6. Survey conditions were poor, with overcast skies and snow showers, sea state Beaufort 3-7, and visibility 0-10 km. High sea states prevented further transect effort. Sea ice in the area surveyed ranged from 0% offshore to 70-100% grease/new ice near Flaxman Island. There were no sightings.

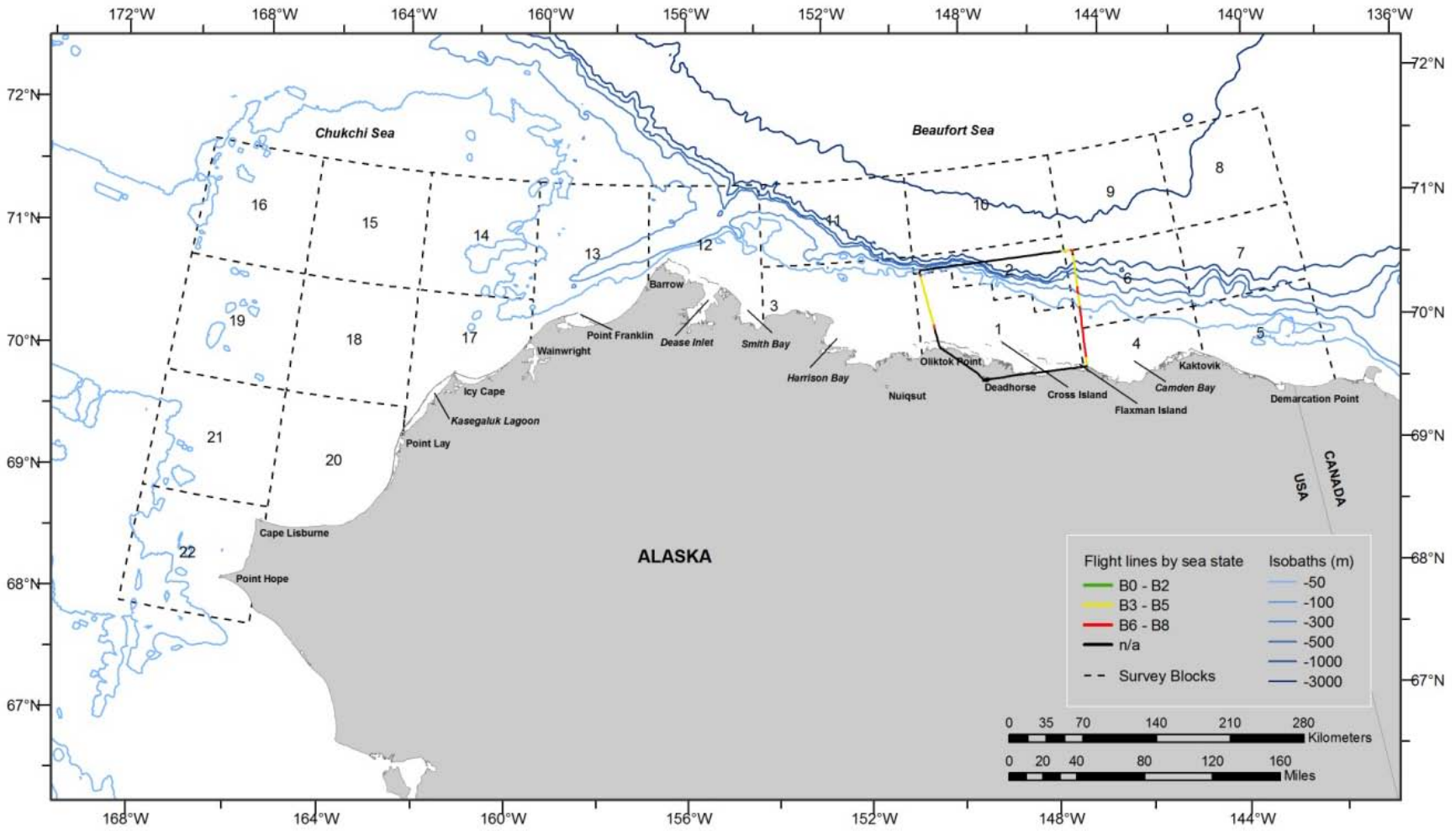

Figure B-97. Flight 31 survey track, depicted by sea state.

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APPENDIX C: GLOSSARY OF ABBREVIATIONS and ACRONYMS

ADFG	Alaska Department of Fish and Game
AFSC	Alaska Fisheries Science Center
ASAMM	Aerial Surveys of Arctic Marine Mammals
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement
BWASP	Bowhead Whale Aerial Survey Project
CI	confidence interval
CSPA	Chukchi Sea Planning Area
e.g.	for example
ENVISAT	Environmental Satellite
ESA	Endangered Species Act
FR	Federal Register
GPS	Global Positioning System
hr	hour
i.e.	that is
IBCAO	International Bathymetric Chart of the Arctic Ocean
km	kilometer
m	meter
Max	maximum
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
Min	minimum
MODIS	Moderate Resolution Imaging Spectroradiometer
n	sample size
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
NMML	National Marine Mammal Laboratory
nm	nautical mile
NSB	North Slope Borough
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
P	probability
s	second
SAIC	Science Applications International Corporation
SD	standard deviation
SPUE	sightings per unit effort (sighting rate)
TrSi	transect sightings
USC	U.S. Code
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)

APPENDIX D: PUBLICATIONS, POSTERS AND PRESENTATIONS FROM ASAMM, 2008-2012

2008

Clarke, J.T., L. Morse and D. Rugh. 2008. Marine Mammal Occurrence in the Northeastern Chukchi Sea, Alaska – Comparison of Data from Autumn 1989-91 and Autumn 2008. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2009.

Clarke, J.T., L. Morse and D. Rugh. 2008. Marine Mammal Occurrence in the Northeastern Chukchi Sea, Alaska – Comparison of Data from Autumn 1989-91 and Autumn 2008. Poster: American Cetacean Society 11th International Conference, Monterey, CA, November 2008.

Clarke, J.T. 2008. Monitoring the Distribution of Arctic Whales. Presentation: 11th MMS Information Transfer Meeting, Anchorage, AK, October 2008.

Clarke, J.T. 2008. COMIDA Distribution and Abundance of Marine Mammals, Aerial Surveys. Presentation: 11th MMS Information Transfer Meeting, Anchorage, AK, October 2008.

Morse, L. and J. Clarke. 2008. Swimming polar bears in the Alaskan Chukchi Sea – the REAL story. Poster: American Cetacean Society 11th International Conference, Monterey, CA, November 2008.

Morse, L., J. Clarke and D. Rugh. 2008. Marine mammal occurrence in the northeastern Chukchi Sea, Alaska – summer 2008. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2009.

2009

Clarke, J.T. 2009. Bowhead whale aerial survey project (BWASP), 2008. Report: Prepared for NMML-NMFS and MMS-Alaska. 15 pp.

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

Clarke, J.T. 2009. COMIDA and BWASP, Aerial Surveys Conducted by NMML. Presentation: Arctic Seismic Open Water Meeting, Anchorage, AK, April 2009. Similar presentation at BOWFEST workshop, Anchorage, AK, January, 2009.

Ferguson, M.C., R.P. Angliss, D.J. Rugh, J. Mocklin, and L. Vate Brattström. 2009. Comparison of UASs and manned aircraft for surveying bowhead whale distribution and density. Presentation: workshop *Using Unmanned Aircraft Systems to Study Marine Mammals and Other Wildlife Species*, Quebec City, Canada, October, 2009.

2010

Christman, C., M. Ferguson, G. Friedrichsen, B. Rone and J. Clarke. 2010. Pacific Walrus Sightings Documented by Aerial Surveys of the Northeastern Chukchi Sea in 2009. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2010.

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

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

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. Report: Prepared by the National Marine Mammal Laboratory (NMFS) for U.S. Fish and Wildlife Service. 11 pp.

Clarke, J., C. Christman, M. Ferguson and L. Morse. 2010. Bowhead Whale Aerial Survey Project (BWASP) Status Update in 2009. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2010.

Clarke, J.T., M. Ferguson, L. Morse, G. Friedrichsen, B. Rone and C. Christman. 2010. Aerial Survey for Marine Mammals in the Northeastern Chukchi Sea: 2009. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2010.

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

Ferguson, M.C. and R.P. Angliss. Efficiency of Unmanned Aircraft Systems (UAS) relative to manned aircraft for surveying bowhead whale distribution and density in the Arctic. Poster: in Alaska Marine Science Symposium, Anchorage, AK, January 2010.

Ferguson, M. and J. Clarke. 2010. COMIDA and BWASP aerial surveys conducted by NMML, 2009. Presentation: Arctic Seismic Open Water Meeting, Anchorage, AK, May 2010. Similar presentation at BOWFEST workshop, Anchorage, AK, January, 2010.

2011

Brower, A., J. Clarke, M. Ferguson, C. Christman and S. Grassia. 2011. Eastern North Pacific gray whale distribution and habitat use in the Chukchi Sea from aerial surveys: 1982-1991, 2008-2010. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2011.

Brower, A., J. Clarke, M. Ferguson, C. Christman and S. Grassia. 2011. Eastern North Pacific gray whale distribution and habitat use in the Chukchi Sea from aerial surveys: 1982-1991, 2008-2010. Poster: Society for Marine Mammalogy 19th Biennial Conference on the Biology of Marine Mammals, Tampa, FL, November/December 2011.

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. Report: Prepared by the National Marine Mammal Laboratory (NMFS) for U.S. Fish and Wildlife Service. 12 pp.

Christman, C., A. Brower, J. Clarke, M. Ferguson and S. Grassia. 2011. Pacific walrus sightings documented by COMIDA aerial surveys of the Northeastern Chukchi Sea in 2010. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2011.

Clarke, J.T., C.L. Christman, A.A. Brower, M.C. Ferguson and S.L. Grassia. 2011. Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2010. Report: Prepared by the National Marine Mammal Laboratory (NMFS) for the BOEMRE, OCS Study BOEMRE 2011-35.

Clarke, J., C. Christman, M. Ferguson and S. Grassia. 2011. Aerial surveys of endangered whales in the Beaufort Sea, Fall 2006-2008. Report: Prepared by the National Marine Mammal Laboratory (NMFS) for the BOEMRE, OCS Study BOEMRE 2010-42. 240 pp.

Clarke, J.T., C.L. Christman, S.L. Grassia, A.A. Brower, and M.C. Ferguson. 2011. Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2009. Report: Prepared by the National Marine Mammal Laboratory (NMFS) for the BOEMRE, OCS Study BOEMRE 2010-40.

Clarke, J.T., M.C. Ferguson, C.L Christman, S.L. Grassia, A.A. Brower, and L.J. Morse. 2011. Chukchi Offshore Monitoring in Drilling Area (COMIDA) Distribution and Relative Abundance of Marine Mammals: Aerial Surveys. Report: Prepared by the National Marine Mammal Laboratory (NMFS) for the BOEMRE, OCS Study BOEMRE 2011-06. 296 pp.

Ferguson, M., J. Clarke, C. Christman, S. Grassia and A. Brower. 2011. A tale of two seas: lessons from multi-decadal aerial surveys for cetaceans in the Beaufort and Chukchi seas. Presentation: Alaska Marine Science Symposium, Anchorage, AK, January 2011.

Grassia, S., J. Clarke, M. Ferguson, C. Christman and A. Brower. 2011. Distribution, relative abundance and behaviors of bowhead whales in the Alaskan Beaufort and Northeastern Chukchi seas – Autumn 2007-2010. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2011.

Lemons, P. and C. Christman. 2011. Pacific Walrus (*Odobenus rosmarus divergens*) Abundance and Use of the Northeast Chukchi Sea Based on COMIDA Aerial Surveys. Poster: Society for Marine Mammalogy 19th Biennial Conference on the Biology of Marine Mammals, Tampa, FL, November/December 2011.

Okkonen, S.P., C.J. Ashjian, R.G. Campbell, J.T. Clarke, S.E. Moore and K.D. Taylor. 2011. Satellite observations of circulation features associated with a bowhead whale feeding 'hotspot' near Barrow, Alaska. Remote Sensing of Environment 115: 2168-2174.

2012

Brower, A., C. Christman, M. Ferguson, J. Clarke, S. Grassia, R. Shea, B. Rone, and A. Kennedy. 2012. Eastern North Pacific Gray Whales and Minke Whales from Aerial Surveys in the Alaskan Arctic, Summer and Fall 2011. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2012.

Brower, A.A, M.C. Ferguson and J.T. Clarke. *In prep*. Gray whale distribution in the northeastern Chukchi Sea, 2008-2010, with comparison to historical data.

Christman, C.L., J.J. Citta, L.T. Quakenbush, J.T. Clarke, B.K. Rone, R.A. Shea, M.C. Ferguson, and M.P. Heide-Jorgensen. *In prep*. Summer presence of bowhead whales (*Balaena mysticetus*) in the Alaskan Beaufort Sea: Using aerial surveys and satellite telemetry as complementary tools.

Christman, C.L., M.C. Ferguson, J.T. Clarke, and A. A. Brower. 2012. Marine mammal aerial surveys in the Chukchi Sea. Presentation: Workshop on Assessing Pacific Walrus Population Attributes from Coastal Haul-Outs, Anchorage, AK, March 2012.

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. Report: Prepared by the National Marine Mammal Laboratory (NMFS) for U.S. Fish and Wildlife Service. 16 pp.

Christman, C., A. Brower, J. Clarke, M. Ferguson, S. Grassia, A. Kennedy, B. Rone, and R. Shea. 2012. Aerial Observations of Pacific Walruses (*Odobenus rosmarus divergens*) in the Northeastern Chukchi Sea, Summer and Fall 2011. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2012.

Clarke, J. T. and M.C. Ferguson. *In prep*. Distribution and sighting rates of large whales in the northeastern Chukchi Sea before (1982-1991) and after (2008-2010) a 17-year gap.

Clarke, J., M. Ferguson, C. Christman, A. Brower, S. Grassia, R. Shea, B. Rone, and A. Kennedy. 2012. Distribution and Relative Abundance of Belugas (*Delphinapterus leucas*) in the Alaskan Arctic, Summer and Fall 2011. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2012.

Ferguson, M.C. and J.T. Clarke. *In prep*. Detecting spatial variability in the autumn migration of the Bering-Chukchi-Beaufort stock of bowhead whales across the Alaskan Beaufort Sea.

Ferguson, M.C. and J.T. Clarke. *In prep*. Distribution and relative density of bowhead whales and belugas in the Alaskan Beaufort Sea: similarities and differences between 1982-2006 and 2007-2010.

Ferguson, Megan C. *In press*. Quantifying spatial characteristics of the Bowhead Whale Aerial Survey Project (BWASP) survey design. *Journal of Cetacean Research and Management*.

Ferguson, M., J. Clarke, A. Brower, C. Christman, S. Grassia, A. Kennedy, B. Rone, and R. Shea. 2012. Bowhead Whale (*Balaena mysticetus*) Distribution and Relative Abundance in the Alaskan Arctic, Summer and Autumn 2011. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2012.

Lemons, P. and C. Christman. 2012. Pacific Walrus (*Odobenus rosmarus divergens*) Abundance and Use of the Northeast Chukchi Sea Based on COMIDA Aerial Surveys. Poster: Alaska Marine Science Symposium, Anchorage, AK, January 2012.

Okkonen, S.A., K.M. Stafford and J.T. Clarke. *In prep*. Correlation of a strong Alaska Coastal Current with the occurrence of belugas whales (*Delphinapterus leucas*) near Barrow, Alaska.

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The U.S. Department of the Interior protects America’s natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.