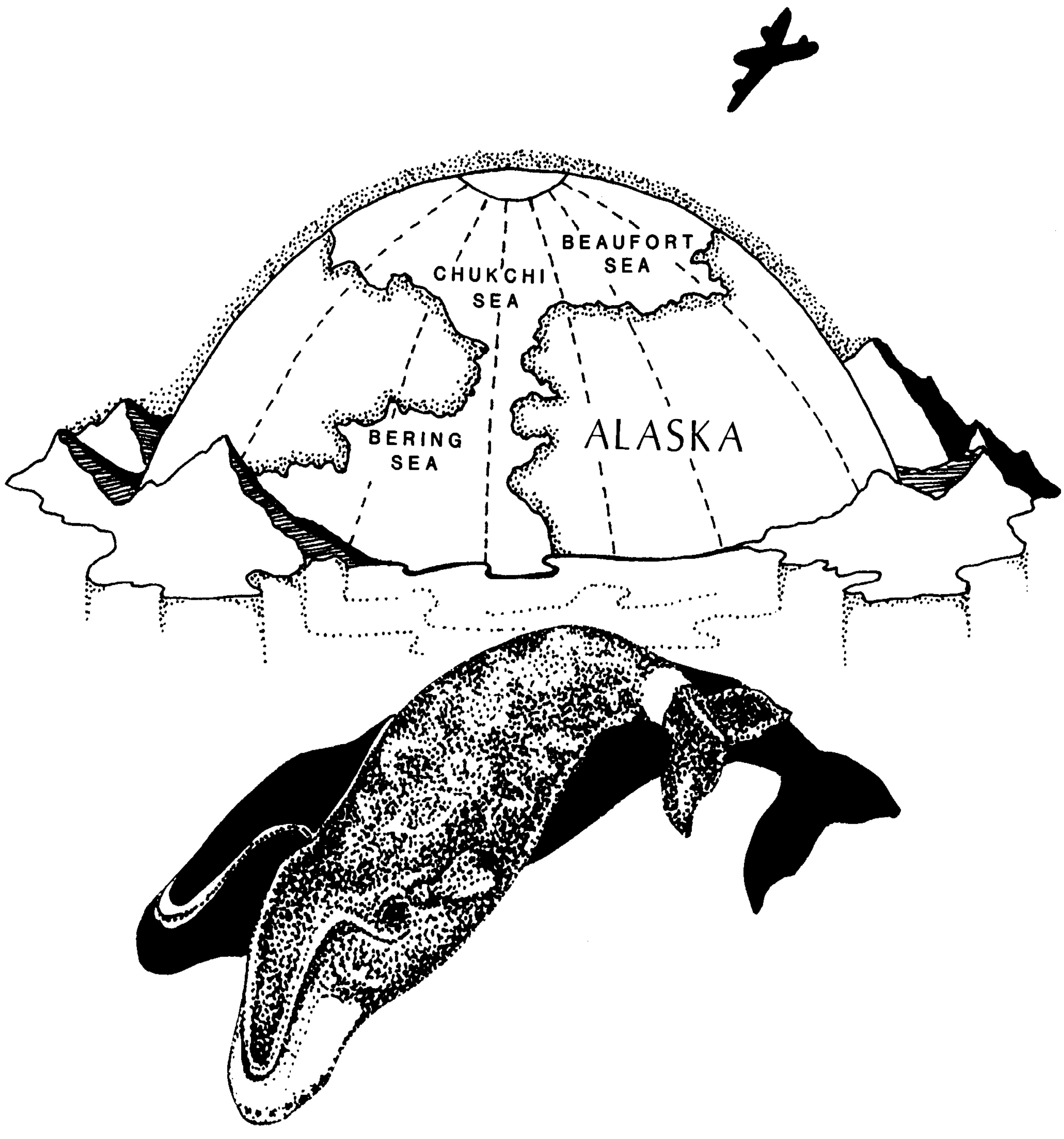
# Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2005

OCS Study
MMS 2008-023




U.S. Department of the Interior
Minerals Management Service
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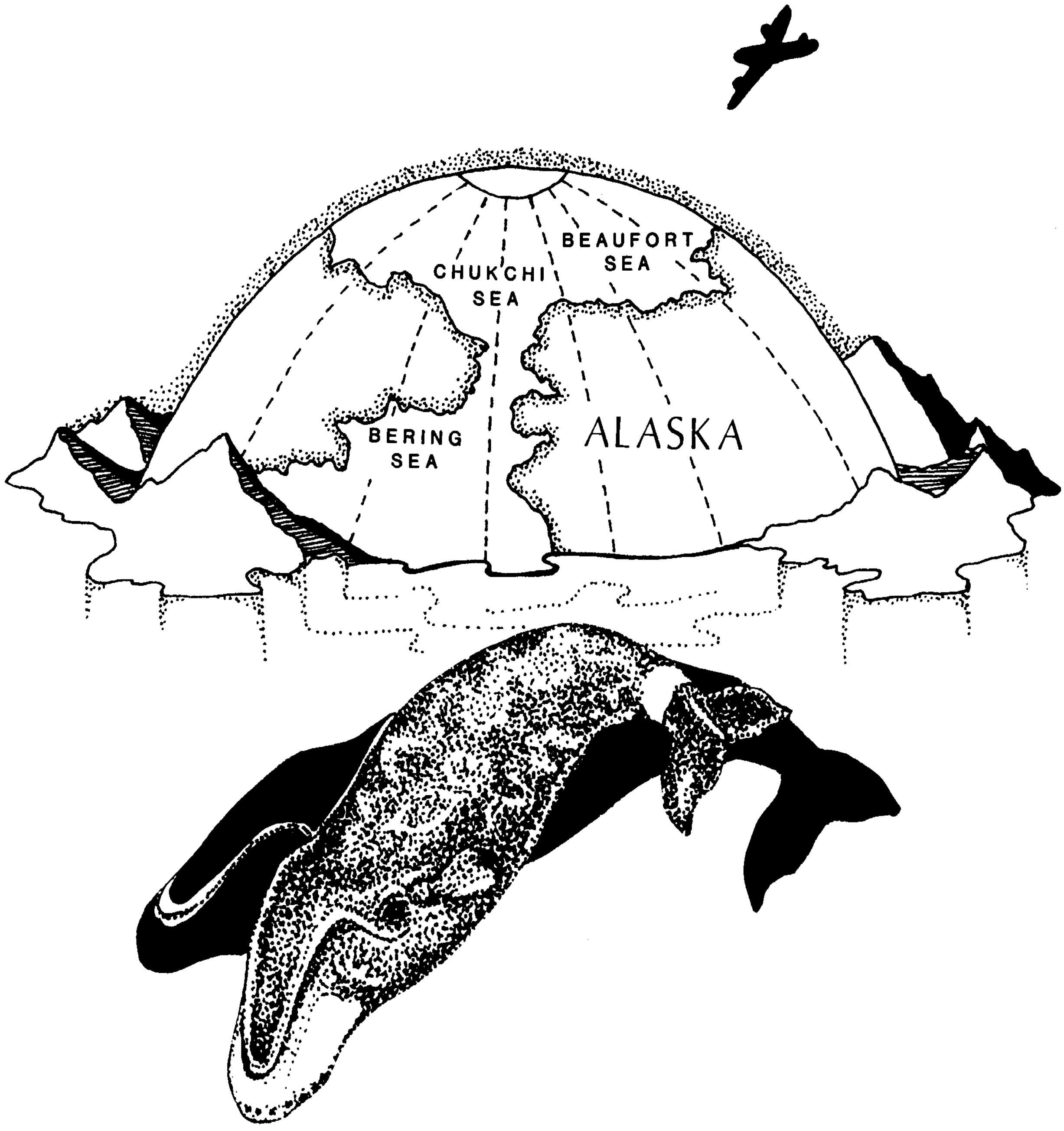


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# ABSTRACT

This report describes field activities and data analyses for aerial surveys of bowhead whales conducted during Fall 2005 (3 September – 20 October) in the Beaufort Sea, between 140°W. and 156°W. longitudes south of 72°N. latitude.

During September and October 2005, general ice cover was relatively light. A total of 26 survey flights were made. There were 81 sightings for a total of 139 bowhead whales counted. Additionally, 521 beluga whales, 14 bearded seals, 1,126 ringed seals, and 53 polar bears were observed during 81.2 hours of survey effort that included 40.8 hours in flight time on randomized transects.

Median distances from locations of sightings of bowhead whales to a normalized shoreline in 2005 were 28.1 km (range = 3.0–44.8 km) in the East Region (140 - 148° W), and 39.8 km (range = 5.2–73.6 km) in the West Region (148 - 156° W) . Median depths at sightings were 42.0 m (range = 12.0–57.0 m) in the East Region, and 33.0 m (range = 10.0–285.0 m) in the West Region. Compared to other light-ice years, sightings were significantly farther from shore and in deeper water in the West Region, but not significantly different in the East Region.

In 2005, MMS staff completed two journal articles (published in 2006) from aerial survey data that separately analyzed relationships between sea ice in the Beaufort Sea and offshore sighting occurrences for both bowhead whales and swimming polar bears.

## ACKNOWLEDGMENTS

This annual report follows a format established by Steve Treacy during his tenure as Bowhead Whale Aerial Survey Project (BWASP) Research Manager and much of the introductory and descriptive narrative has been modified from his earlier reports. We sincerely thank Steve for all the thought and effort he contributed to the creation and maintenance of BWASP during this stewardship.

The study benefited from the extensive efforts of MMS staff who played various roles on the survey team or assisted with technical, administrative or logistical aspects of the study (Cleve Cowles, Charles Monnett, Jeffrey Gleason, Fred King, Jim Lima, Tom Murrell, Kris Nuttall, Lisa Rotterman, Theresa Schloesser, Caryn Smith, Ruthie Way and Dee Williams). Mike Hay, MMS contractor working with Resource Data Incorporate, provided much needed assistance with data analysis, mapping and report preparation.

The Department of the Interior, National Business Center, Aviation Management (formerly Office of Aviation Safety) were extremely helpful, making all aircraft arrangements, including administering the contract with ERA Aviation (Alf Aanensen, Carol Peterson, Joe Bussard, Anita Roberts, Bud Walters) and monitoring satellite tracking of survey flights (Jan Bennett, Lark Wuerth). Rick Andreson, Don Fry, Tommy McWilliams, and Roger Warren (ERA Aviation) piloted the Twin Otter in 2005. Amber Babcock (ERA Aviation) provided much appreciated help with equipment and logistics.

We appreciate review comments on this and/or previous project reports by the National Marine Fisheries Service (NMFS), the State of Alaska, the North Slope Borough (NSB), the Indigenous People's Council for Marine Mammals, the National Ice Center, and Dr. Steven Swartz, formerly with the Marine Mammal Commission.

The project acknowledges the National Ice Center for providing draft sea-ice-severity rankings and sea-ice concentrations in ARC/INFO format at www.natice.noaa.gov. Ann Treacy contributed the cover illustration.

## TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

**Table Number** | **Title** | **Page**

# I. INTRODUCTION

In 1953, the Outer Continental Shelf Lands Act (OCSLA) (43 USC 1331-1356) charged the Secretary of the Interior with the responsibility for administering minerals exploration and development of the OCS. The Act empowered the Secretary to formulate regulations so that its provisions might 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) as the administrative agency responsible for leasing submerged Federal lands and the Conservation Division of the U.S. Geological Survey for classification and evaluation of submerged Federal lands and regulation of exploration and production. In 1982, the Minerals Management Service (MMS) assumed these responsibilities.

To provide information used in environmental impact statements and environmental assessments under the National Environmental Policy Act of 1969 (42 USC 4321-4347), and to support protection of marine mammals under the Marine Mammal Protection Act of 1972 (16 USC 1361-1407) and the Endangered Species Act (ESA) of 1973 (16 USC 1531-1543), BLM funded numerous studies involving acquisition and analysis of marine mammal and other environmental data.

In June 1978, BLM entered into an ESA Section 7 consultation with National Marine Fisheries Service (NMFS). The purpose of the consultation was to determine whether the proposed Beaufort Sea Oil and Gas Lease Sale may jeopardize the continued existence or adversely modify the critical habitat of endangered bowhead (*Balaena mysticetus*) and gray (*Eschrichtius robustus*) whales. The NMFS determined that insufficient information existed to conclude whether the proposed Beaufort Sea sale was or was not likely to jeopardize the continued existence of bowhead and gray whales. In August 1978, NMFS recommended studies to 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, 1988) and monitoring of bowhead whale presence during periods when geophysical exploration and drilling are occurring.

Following several years when drilling was limited to the period 1 November through 31 March (USDOI, MMS, 1979), a variable 2-month seasonal-drilling restriction on fall exploratory activity in the joint Federal/State Beaufort Sea sale area was implemented. The period of restriction would vary depending on bowhead whale presence, and "this determination would require development of a monitoring program..." (USDOI, MMS, 1982). Subsequently, MMS (Alaska OCS Region) adopted an endangered whale-monitoring plan that required aerial surveys. The Diapir Field Sale 87 Notice of Sale (NOS) (1984) states 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) did not include a seasonal drilling restriction but the NOS for each contained an Information to Lessees clause that "MMS intends to continue its area wide endangered whale monitoring program in the Beaufort Sea during exploration activities" (USDOI, MMS, 1988, 1991, 1996, 1998). Information gathered by the BWASP is used to help determine the extent, if any, of adverse effects on the species.

From 1979 to 1987, the MMS (formerly BLM) funded annual monitoring of endangered whales in arctic waters under Interagency Agreements with the Naval Ocean Systems Center and through subcontracts to SEACO, Inc. On 15 April 1987, a proposal for MMS scientists to conduct aerial surveys of endangered whales was approved by the Associate Director for Offshore Minerals Management. The MMS uses agency personnel to perform fieldwork and reporting activities for the Beaufort Sea on an annual basis.

The goals of the ongoing project are to:

1. Define the annual fall migration of bowhead whales, significant inter-year differences, and long-term trends in the distance from shore and water depth at which whales migrate;

2. Monitor temporal and spatial trends in the distribution, relative abundance, habitat, and behaviors (especially feeding) of endangered whales in arctic waters;

3. Provide real-time data to MMS and NMFS on the general progress of the fall migration of bowhead whales across the Alaskan Beaufort Sea, for use in protection of this Endangered Species;

4. Provide an objective wide-area context for management interpretation of the overall fall migration of bowhead whales and site-specific study results;

5. Record and map beluga whale distribution and incidental sightings of other marine mammals; and

6. Determine seasonal distribution of endangered whales in planning areas of interest to MMS.

## II. METHODS AND MATERIALS

### A. Study Area

The annual survey program has been based on a design of random field transects within established geographic blocks overlapping or near Chukchi and Beaufort Sea sale areas offshore of Alaska. The present study included Beaufort Sea Survey Blocks 1 through 12 (Figure 1) between 140°W. and 157°W. longitude south of 72°N. latitude.

A large-scale Beaufort Gyre moves waters clockwise from the Canadian Basin westward in the deeper offshore regions. Nearshore surface currents tend to follow local wind patterns and bathymetry, moving from the east in winter, with an onshore component, and to the west in summer, with an offshore component (Brower et al., 1988). There is recent evidence for the existence of two regimes or climate states for arctic atmospheric-ice-ocean circulation. 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 for 5-7 years (Proshutinsky and Johnson, 1997; Johnson et al., 1999).

In the Beaufort Sea, landfast ice forms during the fall and may eventually extend up to 50 kilometers (km) offshore by the end of winter (Norton and Weller, 1984). The pack ice, which includes multiyear ice averaging 4 meters (m) in thickness, with pressure ridges up to 50 m thick (Norton and Weller, 1984), becomes contiguous with the new and fast ice in late fall—effectively closing off the migration corridor to westbound bowhead whales. From early November to mid-May, the Beaufort Sea normally remains almost totally covered by ice considered too thick for whales to penetrate. In mid-May, a recurring flaw lead can form 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 summer ice pack has been shrinking, setting records for new minimums in several years including 2005. The open water season has lengthened and the southern edge of the ice pack has been further from Alaskan shorelines.

Local weather patterns affect the frequency and effectiveness of all marine aerial surveys. The present study area is in the arctic climate zone, with mean temperatures at the Alaskan Beaufort Sea coast communities of Barrow, Lonely, Oliktok, and Barter Island from -0.9°C to -0.1°C during September and from -9.7°C to -8.5°C during October. Precipitation in these communities occurred an average of 10 to 34 percent of the time during September (snow with some rain) and 13 to 43 percent during October (almost all snow), with the heaviest precipitation at Barrow and Barter Island during both months. Fog (without precipitation) reduces visibility approximately 11 to 19 percent of the time during September and 6 to 8 percent of the time during October. Mean wind speed in the same communities is from 5 to 6 m per second during September and 5 to 7 m per second during October (Brower et al., 1988).

Sea state is another environmental factor affecting visibility during aerial surveys. Surface waters in the Beaufort Sea 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 survey.

## B. Equipment

The Project aircraft was a de Havilland Twin Otter Series 300 equipped for arctic operation and aerial surveys of endangered whales. The Department of the Interior, Office of Aircraft Services, provided administrative support in managing the aircraft contract, approving the aircrew and aircraft, and tracking the position of the survey aircraft. Onboard equipment, data collection, and post-field analyses replicated equipment and standard procedures developed and used in past years (1979-2004). These methodologies are described in detail elsewhere (Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002a, 2002b; Monnett and Treacy, 2005)

The aircraft was equipped with two medium-size bubble windows behind the cabin bulkhead and two larger bubble windows forward of the aft-bulkhead that afforded complete trackline viewing. The pilot and copilot seats provided good forward and side viewing. Each observer was issued a hand-held clinometer (Suunto) for measuring the angle of inclination to the sighting location of endangered whales. Observers and pilots were linked to common communication systems, and commentary could be recorded. The aircraft's maximum time aloft under normal survey load was extended to approximately 7 hours (hr) through the use of a supplemental onboard fuel tank.

A portable IBM Think Pad laptop computing system is used aboard the aircraft to store and analyze flight and observational data. The computer system is connected to a local Garmin III Global Positioning System (GPS) with external aircraft antenna. Latitude, longitude, and flight altitude from the GPS are transmitted to the computer through a standard serial connection. An on-board printer provides hard-copy backup of data as it is collected. A custom moving-map program developed by MMS project personnel in Visual Basic permits surveyors to view the aircraft’s track-line in real time.

Onboard safety equipment included an impact-triggered emergency locator transmitter installed in the aircraft, a 6-person Switlik Search and Rescue Life Raft equipped with a portable Personal Locator Beacon and desalination pump, a portable ICOM A3 Sport aircraft-band transceiver, an emergency Magellan 3000 GPS, White dry suits, and emergency flight helmets.

The Department of Interior, National Business Center, Aviation Management “Automated Flight Following” (AFF) system was used by Anchorage-based Aviation Management personnel for “satellite-tracking” the project aircraft over the Alaskan Beaufort Sea. Aviation Management obtained current flight information in the form of maps for visual tracking of the survey aircraft. As a backup, an Iridium phone system was used when needed for communicating aircraft position to Aviation Management. In addition to these flight-following systems, the onboard transponder was set at a discrete identification code for radar tracking by air-traffic-control personnel.

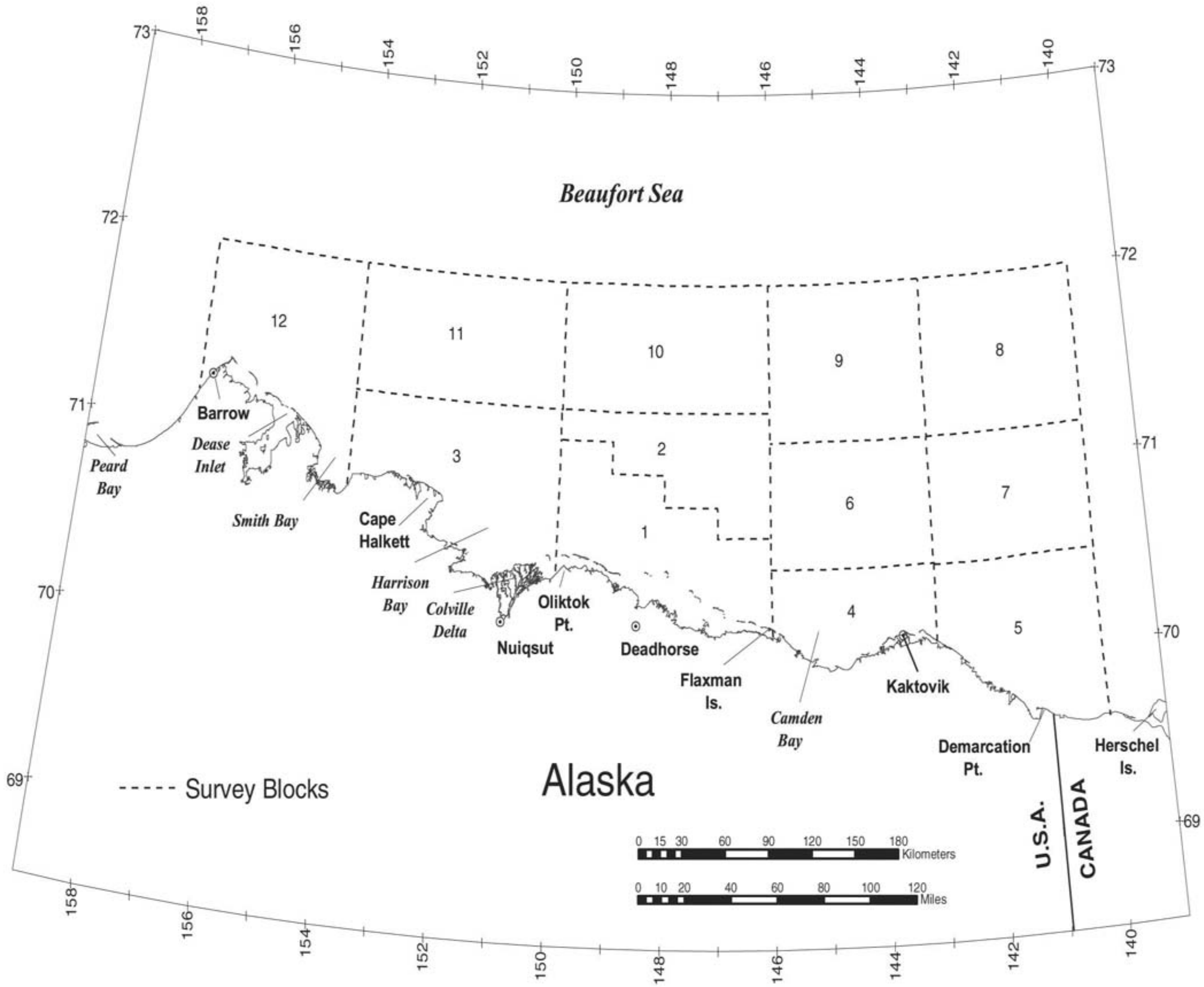


Figure 1 – Study Area Showing Survey Blocks

### C. Aerial-Survey Design

Aerial surveys were based out of Deadhorse, Alaska, from 1 September through 20 October 2005. Field schedules were designed to monitor the progress of fall bowhead migrations across the Alaskan Beaufort Sea. All bowhead whale observations were recorded, along with incidental sightings of other marine mammals.

Daily flight patterns were based on sets of unique transect grids computer-generated for each survey block. 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 then connected by a straight line to a similarly selected endpoint along the southern edge of that same section. This procedure was followed for all sections of that survey block. These transect legs were then connected alternately at their northernmost or southernmost ends to produce one continuous flight grid within each survey block. The use of random-transect grids is a requirement for subsequent analyses of the bowhead migration corridor based on line-transect theory (Cochran, 1963).

The selection of the survey blocks to be flown on a given day was nonrandom, based primarily on criteria such as reported or observed weather conditions over the study area. Weather permitting, the project attempted to distribute effort fairly evenly east-to-west across the entire study area. It also used a semimonthly flight-hour goal for each survey block allocated proportionately for survey blocks east of 154°W. longitude and semimonthly time periods based on relative abundance of bowhead whales as determined from earlier fall migrations (1979-1986). Such allocations, detailed in our Project Management Plan (USDOI, MMS, 2005), greatly favor survey coverage in inshore Survey Blocks 1 through 7 and 11 (Figure 1), since bowheads were rarely sighted north of these blocks in previous surveys. The purpose of these survey-effort allocations was to increase the sample size (n) of whale sightings within the primary migration corridor, thus increasing the power of statistical analysis within these inshore blocks. Only data from random-transect legs were used to analyze the migration axis, using a line-transect model.

### D. Survey-Flight Procedures

During a typical flight, a “search” leg was flown to the target survey block, beginning a series of random-“transect” legs (above) in survey blocks joined together by “connect” legs, followed by a search leg back to Deadhorse. Surveys generally were flown at a target altitude of 458 m. Weather permitting, this altitude was maintained in order to maximize visibility and to minimize potential disturbance to marine mammals. Flights were normally aborted when cloud ceilings were consistently less than 305 m or the wind force was consistently estimated to be above Beaufort 4.

Port observers included a Primary Observer, whose field of vision through a bubble window included the trackline directly below the aircraft to the horizon, the Pilot, and an occasional secondary observer-visitor, stationed aft at a flat window. Starboard observers included a Data Recorder-Observer, whose field of vision through a bubble window was particularly focused on guarding the trackline, as well as a Team Leader and a second Pilot, who were alternately stationed at an aft bubble window and the copilot’s seat. A clinometer was used to measure the angle of inclination to each sighting of endangered whales when the initial sighting location was abeam of the aircraft.

When bowheads were encountered while surveying a transect line, the aircraft sometimes diverted from transect for brief (<10-minute) periods and circled the whales to observe behavior, obtain better estimates of their numbers, and determine whether calves were present. Any new sightings of whales made while circling were not counted as “on transect.” Likewise, sightings made while en route to transect grids were counted as “on search”.

## E. Data Entry

A customized computer data-entry form developed by MMS project personnel was used to record all data in database format (Access 97). A multi-columnar data table permitted several entries of sighting and position-update data to be logged and edited simultaneously. The data-entry form is menu-driven, facilitating entry of a complete data sequence for sightings of whales. These data included date, time, latitude, longitude, altitude, aircraft heading, reason for entry, species, total number, observer, swim direction (magnetic), clinometer angle, calf number, behavior, sighting cue, predominant size, habitat, swim speed, repeat sighting, and response to aircraft. Reduced data sequences were used when recording other marine mammals. Position-update data on sky conditions, visual impediments, visibility left and right, percent ice coverage, ice type, and wind force were entered at sightings, turning points, when changes in environmental conditions were observed, and otherwise within 10-minute intervals. Entries were simultaneously printed out in hard copy.

The behavior, swim speed, and swim direction for observed whales represent what the pod as a whole was doing at the time it was first sighted. Behaviors were entered into one of 15 categories as noted on previous surveys. These categories—breaching, cow-calf association, diving, feeding, flipper-slapping, log-playing, mating, milling, resting, rolling, spy-hopping, swimming, tail-slapping, thrashing, and underwater-blowing—are defined in Table 1. 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). Likewise, whale size was estimated relatively as calf (length less than half of accompanying adult), immature, adult, or large adult. Swim direction was initially recorded in magnetic degrees, using the aircraft's compass.

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, 1956). Average ice cover over a 1-2 km lateral distance from the aircraft was estimated as a single percentage, regardless of ice type.

## F. General Data Analyses

Preliminary field data analysis was performed by a computer program—developed by MMS project personnel—that provided daily summations of marine mammals observed, plus calculation of time and distance on transect legs, connect legs, and general search portions of the flight. This analysis program provided options for editing the data file, calculating summary values, and printing various flight synopses.

Tables showing the number of survey hours flown for individual days, half-months, months, or survey blocks were subject to decimal-rounding errors and may or may not add up to the grand total shown for the entire field season. For greatest accuracy and consistency, the total survey hours shown in tables was calculated separately from the cumulative total minutes flown over the entire field season.

The water depth at each bowhead sighting in the 1982-2005 database was derived from the International Bathymetric Chart of the Arctic Ocean (IBCAO) containing grid cells 2.5 km square (website http://www.ngdc.noaa.gov/mgg/bathymetry/arctic/arctic.html. Selected isobaths (10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 100 m, 500 m, 1,000 m, 1,500 m, 2,000 m, 2,500 m, 3,000 m, and 3,500 m), also derived from IBCAO data, were included in Figure for visual reference.

The maps in this report were prepared with application software (ArcGIS) based on Universal Transverse Mercator Zone 6 (central meridian =147°W. longitude, reference latitude 0.00000, false easting

500000.00000, false northing 0.00000, spheroid = GRS 80, scale factor = 0.99960). The natural coastline was adopted from the State of Alaska, Department of Natural Resources.

Sea-ice concentrations were derived from the Beaufort Sea Ice Analysis provided by the National Ice Center in Suitland, Maryland. The Beaufort Sea Ice Analysis shows average ice concentrations over the prior 2- to 3-day period based on visual, infrared, and synthetic-aperture-radar satellite imagery combined with reconnaissance, ship, and shore observations, including sea-ice observations made by the project. Polygons of ice concentrations in the Beaufort Sea bracketing the field seasons were downloaded from the National Ice Center Internet web site for the western Arctic (http://www.natice. noaa.gov) and imported into ArcView. Total sea-ice concentrations, regardless of ice type, were edited from these polygons and specially coded to distinguish 0-percent, 1- to 9-percent, 10- to 19-percent, 20- to 29-percent, 30- to 39-percent, 40- to 49-percent, 50- to 59-percent, 60- to 69-percent, 70- to 79-percent, 80- to 89-percent, 90- to 99-percent, or 100-percent ice cover.

Survey effort and observed bowhead distribution were plotted semimonthly over the Beaufort Sea study area. Overall fall sightings of beluga whales, as well as incidental sightings of other marine mammals, were depicted on separate maps.

Whale sightings were shown on distribution maps and entered into relative-abundance analyses, regardless of the type of survey leg (transect, search, or connect) being conducted or the prevailing environmental conditions (sea state, ice cover, etc.) when the sightings were made. As with previous reports in this series (Treacy, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 2000, 2001, 2002a, 2002b; Monnett and Treacy, 2005), 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.

**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 general 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 about in association with a floating log. |
| Mating | Ventral-ventral orienting 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 pushes. |
| 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. |

## G. Analysis of the Bowhead Whale Migration Corridor

The corridor used by bowhead whales during their fall migration was estimated in relation to mean distance from shore to whales sighted on randomized transects. The analyses presented here were completed using *Statistica*™ StatSoft, Version 5.1 and ArcGIS. During 2005 a new minimum extent of summer ice coverage was established and this tendency was particularly well established in the Alaskan Beaufort Sea (MMS, unpublished data). During years of light ice coverage, bowheads tend to be found closer to shore than in years of moderate or heavy ice coverage (Treacy, et.al, 2005). Therefore, the mean distance from shore for bowhead sightings in 2005 was compared with combined data from previous years having "light ice coverage" (ie. 1982, 1986, 1987, 1989, 1990 and 1993-2004) using the nonparametric Mann-Witney *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. When assumptions of the *t*-test are seriously violated, as in this case where variances and sample sizes are not equal, the Mann-Whitney test may be much more powerful (Hodges and Liehman, 1956; Zar, 1984). The present analysis provides biological information needed to test the following null hypotheses recommended by an initial planning workshop:

Ho1: The axis of the fall migration of bowhead whales will not be altered during periods of increased OCS oil and gas development activities in the Alaska Beaufort Sea.
Ho2: Changes in bowhead migration patterns are not related to OCS oil and gas development activity.

To define the migration axis, a separate file was created for bowhead whale sightings made while on random transects, regardless of distance from the transect line. Distance from shore and water depth at bowhead whale sightings made during random transect aerial surveys in the Alaskan Beaufort Sea were analyzed for two regions (Figure 2), the boundaries of which correspond roughly to oceanographic patterns and the offshore-extent of sampling.

Oceanographic patterns common to waters offshore 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.). Therefore, the delineation between West-East regions for this analysis occurs at 148°W., based upon association with general patterns for these water masses.

The northern extent of each region is based upon survey effort. For example, the East Region extends from 140°W. to 148°W. and from the shore north 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 boundaries of survey blocks 6, 7 and 2 (Figure 1): blocks with sufficient survey effort to support analyses (Treacy, 1997). The West Region extends from 148°W. to 156°W. and from the shore north 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 eastern boundary (140°W.) is simply the easternmost longitude of the survey blocks. The western cutoff at 156°W. limits the analysis to bowheads seen in the Alaskan Beaufort Sea and avoids the influence of Barrow Canyon on bowhead depth distribution.

The shoreline used for this analysis was 'normalized' from the actual Beaufort Sea shoreline to provide a standardization of distance-from-shore measures regardless of the mapping software being used to depict the distribution data. The 'normalized' shoreline was derived by connecting, with straight lines, eleven points at various shoreline or barrier islands locations across Alaska's North Slope between 156°W. and 140°W (Figure 2). The points used to 'normalize' the shoreline are as follows:

71.317°N., 156.000°W.
70.883°N., 153.900°W.

70.917°N., 153.115°W.
70.817°N., 152.200°W.
70.430°N., 151.000°W.
70.550°N., 150.167°W.
70.450°N., 147.950°W.
69.967°N., 144.700°W.
70.150°N., 143.250°W.
69.650°N., 141.000°W.
69.617°N., 140.000°W.

### H. Sighting-Rate and Relative-Occurrence Maps

Maps of raw sighting points can give a misleading visual impression when survey effort is unequal. Because survey effort was unequal across our study area, due primarily to environmental conditions, a graphic method that adjusts for discontinuities in effort was desired. First, a grid matrix was superimposed across the study area using a Geographic Information System (ArcGIS). The matrix, consisting of approximately equilateral grid cells sized 5’ latitude by 15’ longitude, was considered appropriate to the data, simple to query, and visually easy to interpret. Bowhead sighting rates were calculated as the number of sightings per unit effort (SPUE) for each grid cell (5’ latitude by 15’ longitude) while on northerly-southerly transect. The index of relative occurrence of particular behaviors was calculated as the number of individual whales per unit effort (WPUE). The unit of effort for sighting-rate and relative occurrence maps was the number of kilometers (km) flown. Calculated rates were color-coded for quick visual comparison.

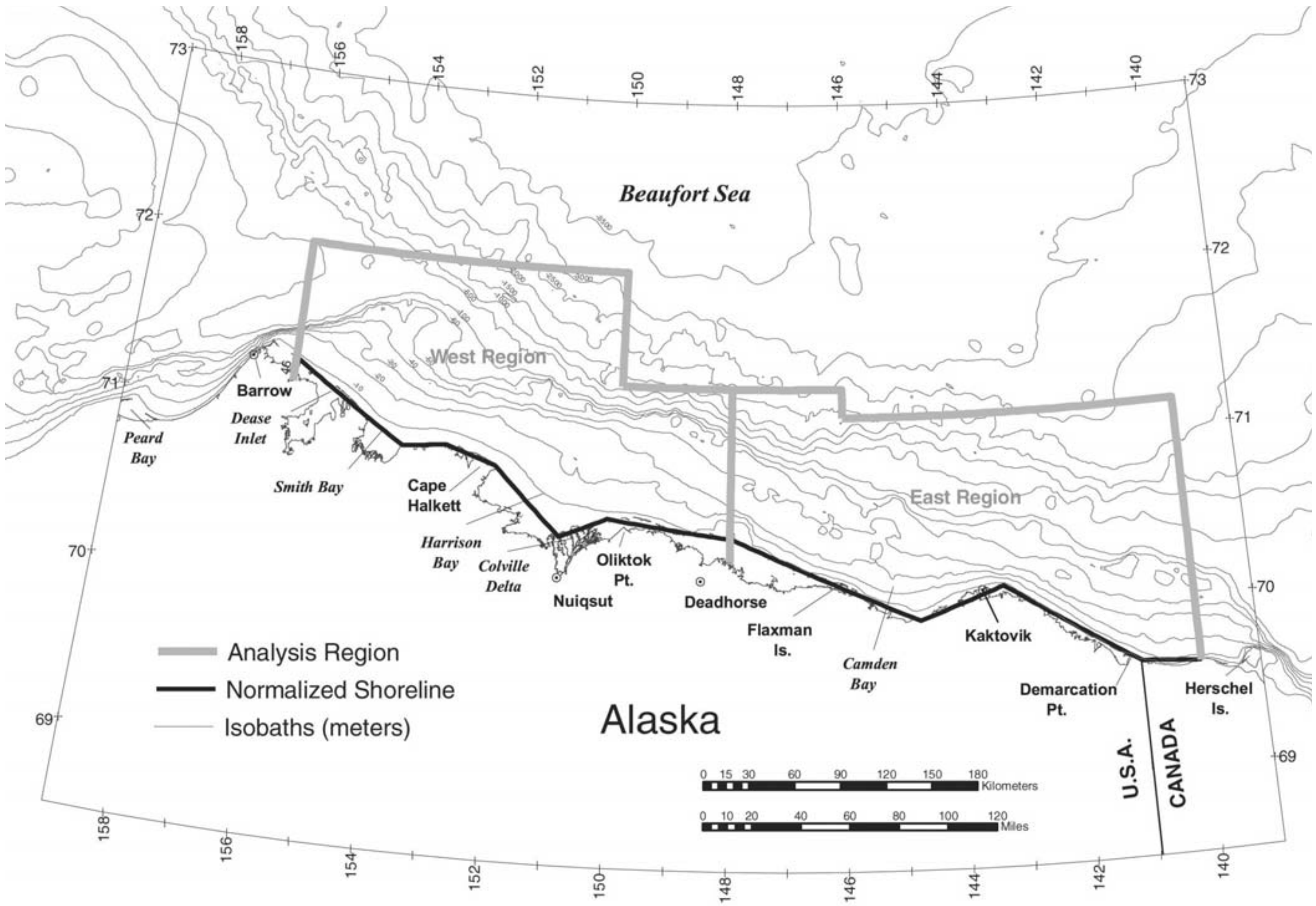


Figure 2 – East and West Regions Showing a Normalized Shoreline and Selected IBCAO Isobaths

# III. RESULTS

## A. Environmental Conditions

Sea-ice coverage in the Alaskan Beaufort Sea (Appendix A) was light overall during the survey period in 2005 (USDOC, NOAA, 2006). By 5 September most of the study area was either ice-free or less than 10% ice. Subsequently, the study area was nearly ice-free after September 23 and through at least 7 October. By 21 October, heavier offshore ice was closer to shore in only the most eastern blocks. By that date, lighter, but variable concentrations of shore-fast ice had formed along the coastline between Barrow and Canada. Ice percentages and sea states at each sighting of endangered whales are shown in Appendix B. See also Appendix C for sea states along flight lines of individual surveys.

## B. Survey Effort

The fall field season was from 3 September 2005 through 20 October 2005. There were 26 flights, of which 14 were in September and 12 were in October. Daily totals of kilometers and hours flown per survey flight during this period are shown in Table 2. A total of 17,976 km of surveys were flown in 81.2 hrs in the study area at an average speed of 221.4 km/hr. The average survey flight was 691.4 km, with over-ocean flight distances ranging from 51 km to 1,444 km. A total of 8,939 km of random-transect lines were flown in 40.8 hrs at an average transect speed of 219.1 km/hr. These random transects constituted 49.7% of the total kms flown and 50.2% of the total flight hours. Survey-flight lines are summarized by semimonthly period in Figures 3 through Figure 6. Flight lines are shown for individual flights in Appendix C.

**Table 2**
**Aerial-Survey Effort in the Beaufort Sea, 3 September-20 October 2005, by Survey Flight**

| Day | Flight No | Transect (km) | Connect (km) | Search (km) | Total (km) | Transect (hr) | Total (hr) |
|---|---|---|---|---|---|---|---|
| 3 Sep | 1 | 482 | 59 | 197 | 737 | 2.10 | 3.12 |
| 4 Sep | 2 | 914 | 59 | 121 | 1,094 | 4.17 | 4.98 |
| 5 Sep | 3 | 804 | 100 | 540 | 1,444 | 3.58 | 6.28 |
| 6 Sep | 4 | 170 | 21 | 132 | 322 | 0.77 | 1.62 |
| 8 Sep | 5 | 0 | 0 | 188 | 188 | 0.00 | 0.75 |
| 8 Sep | 6 | 517 | 113 | 460 | 1,090 | 2.40 | 5.47 |
| 13 Sep | 7 | 543 | 174 | 472 | 1,189 | 2.45 | 5.13 |
| 14 Sep | 8 | 501 | 109 | 343 | 952 | 2.28 | 4.15 |
| 14 Sep | 9 | 503 | 58 | 7 | 568 | 2.27 | 2.72 |
| 19 Sep | 10 | 0 | 0 | 292 | 292 | 0.00 | 1.20 |
| 20 Sep | 11 | 202 | 52 | 581 | 835 | 0.93 | 3.87 |
| 25 Sep | 12 | 0 | 0 | 343 | 343 | 0.00 | 1.48 |
| 26 Sep | 13 | 110 | 25 | 207 | 341 | 0.50 | 1.58 |
| 30 Sep | 14 | 280 | 113 | 393 | 785 | 1.37 | 3.42 |
| 2 Oct | 15 | 0 | 0 | 92 | 92 | 0.00 | 0.37 |
| 4 Oct | 16 | 701 | 122 | 211 | 1,035 | 3.18 | 4.58 |
| 6 Oct | 17 | 16 | 0 | 36 | 51 | 0.07 | 0.23 |
| 8 Oct | 18 | 0 | 0 | 240 | 240 | 0.00 | 0.93 |
| 9 Oct | 19 | 55 | 0 | 609 | 663 | 0.27 | 2.72 |
| 13 Oct | 20 | 369 | 72 | 38 | 480 | 1.68 | 2.23 |
| 13 Oct | 21 | 514 | 123 | 147 | 783 | 2.33 | 3.47 |
| 14 Oct | 22 | 586 | 86 | 370 | 1,041 | 2.70 | 4.53 |
| 15 Oct | 23 | 273 | 85 | 192 | 551 | 1.28 | 2.65 |
| 17 Oct | 24 | 452 | 123 | 222 | 796 | 2.10 | 3.57 |
| 19 Oct | 25 | 947 | 86 | 394 | 1,427 | 4.37 | 7.23 |
| 20 Oct | 26 | 0 | 0 | 637 | 637 | 0.00 | 2.90 |
| Semimonthly Effort Summary | | | | | | | |
| 3-15 Sep | | 4,434 | 693 | 2,460 | 7,584 | 20.02 | 34.22 |
| 16-30 Sep | | 592 | 190 | 1,816 | 2,596 | 2.80 | 11.55 |
| 1-15 Oct | | 2,514 | 488 | 1,935 | 4,936 | 11.43 | 21.71 |
| 16-20 Oct | | 1,399 | 209 | 1,253 | 2,860 | 6.47 | 13.7 |
| TOTAL | | 8,939 | 1,580 | 7,464 | 17,976 | 40.72 | 81.18 |

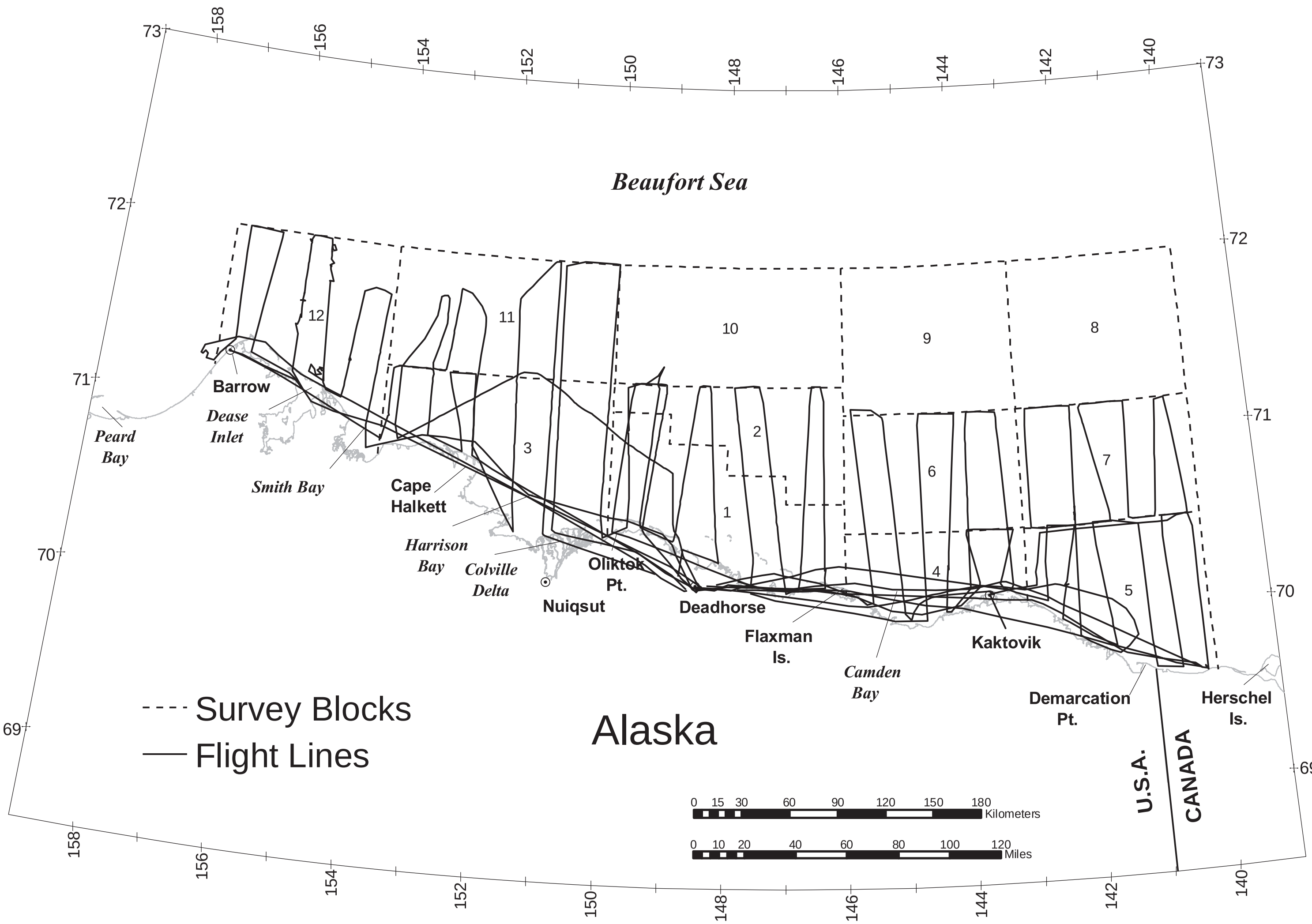


Figure 3 – Combined Flight Tracks, 3 - 15 September 2005

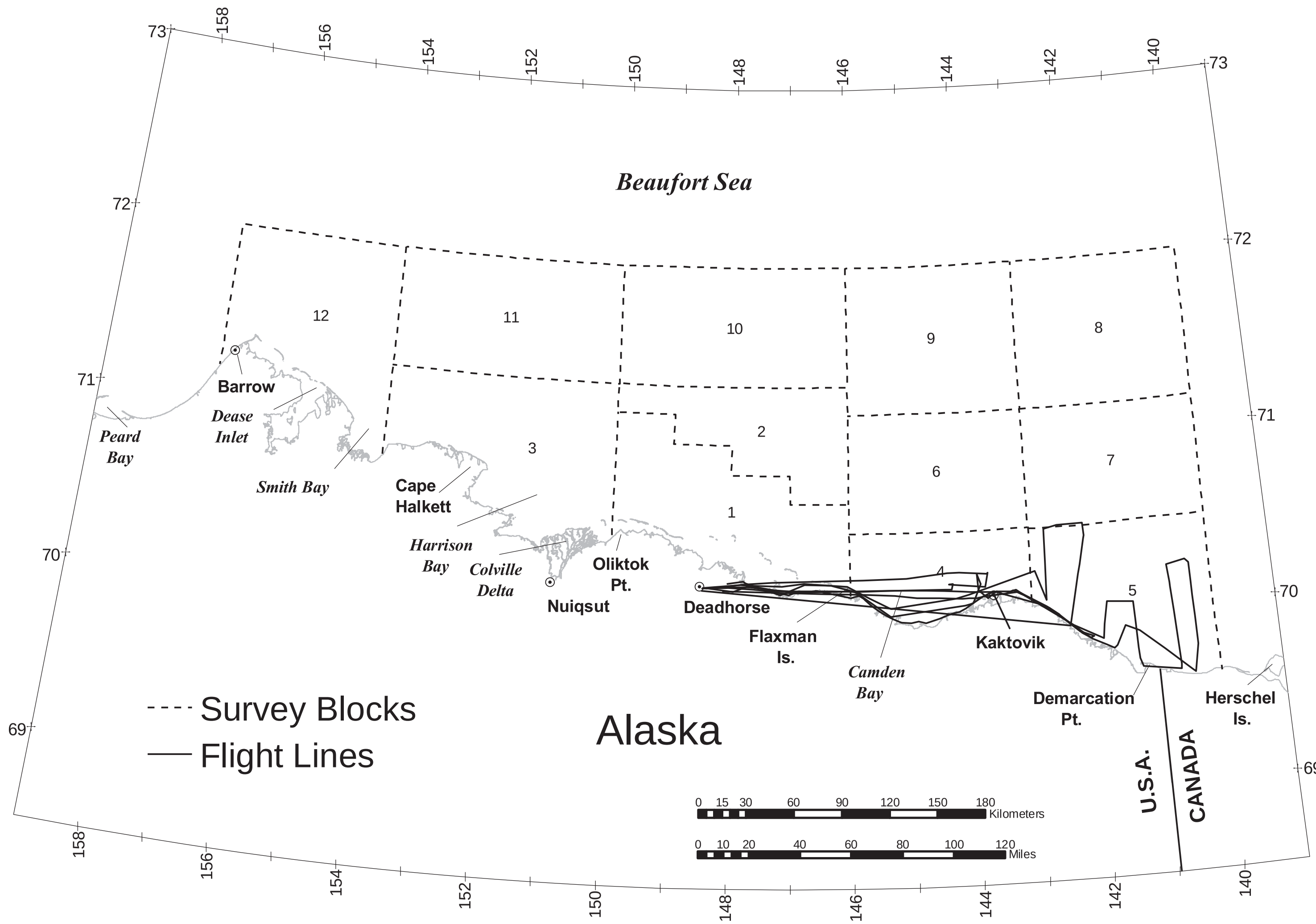


Figure 4 – Combined Flight Tracks, 16 - 30 September 2005

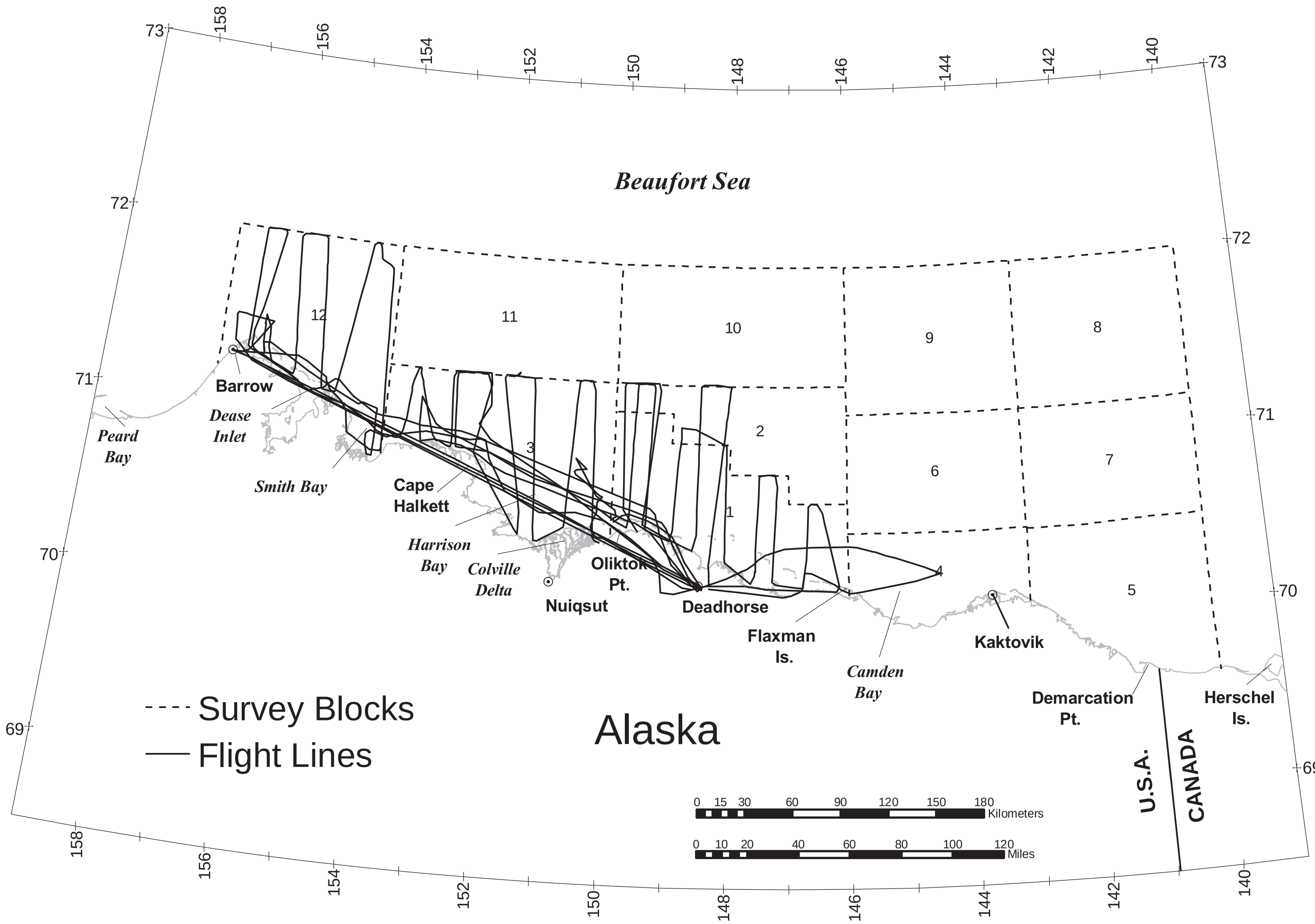


Figure 5 – Combined Flight Tracks, 1 - 15 October 2005

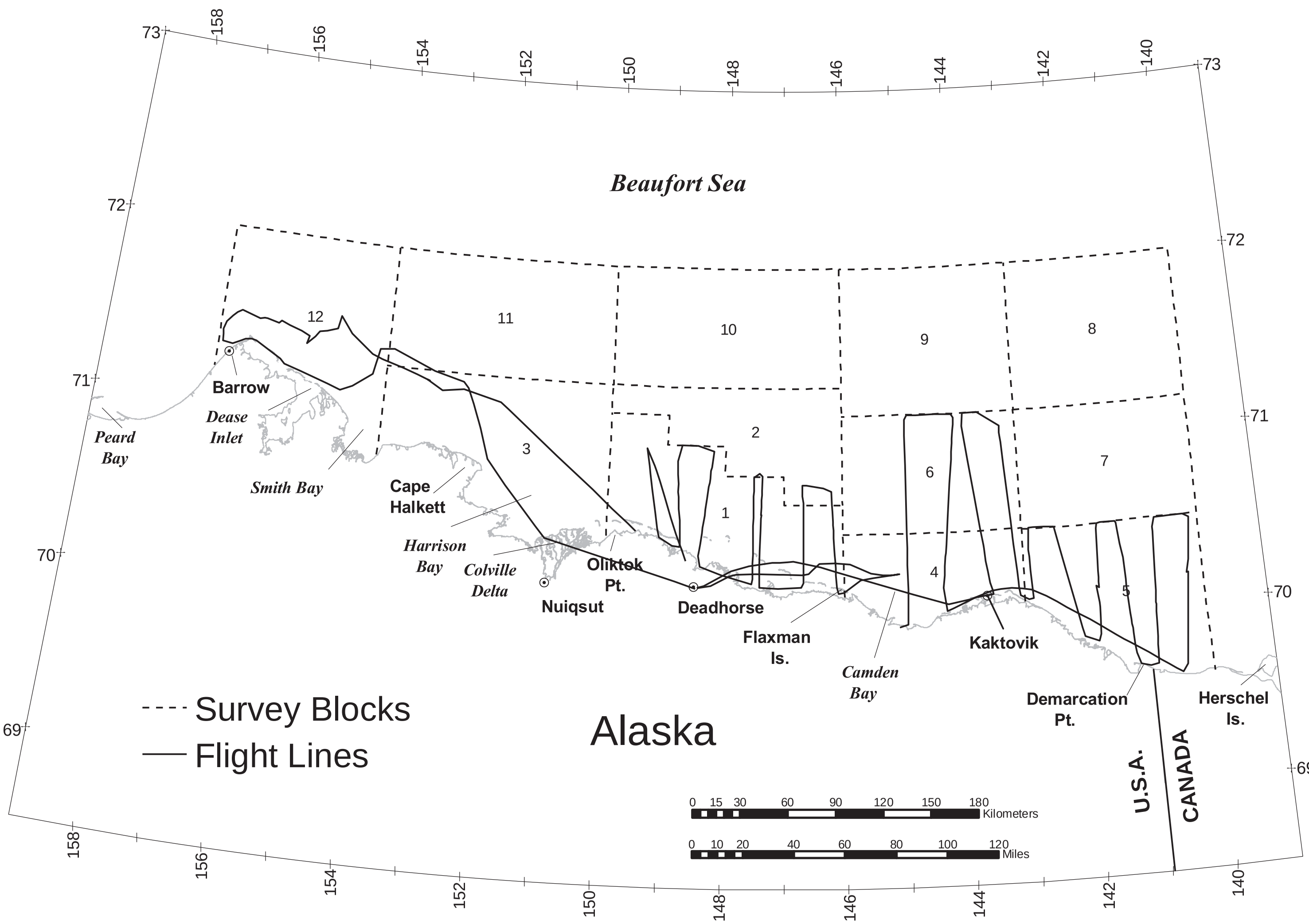


Figure 6 – Combined Flight Tracks, 16 - 20 October 2005

**Table 3**
**Summary of Marine Mammal Sightings, 3 September-20 October 2005, by Survey Flight**
**(number of sightings/number of animals)**

| Day | Flight No | Bowhead Whale | Gray Whale | Beluga Whale | Unident. Cetacean | Bearded Seal | Ringed Seal | Pacific Walrus | Unident. Pinniped | Polar Bear (PB) | PB Tracks (no bear) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 Sep | 1 | 2/3 | 0 | 16/34 | 0 | 0 | 14/144 | 0 | 0 | 0 | 0 |
| 4 Sep | 2 | 3/3 | 0 | 5/11 | 0 | 1/1 | 7/19 | 0 | 0 | 0 | 0 |
| 5 Sep | 3 | 1/1 | 0 | 34/112 | 1/1 | 0 | 2/26 | 0 | 0 | 2/2 | 0 |
| 6 Sep | 4 | 1/1 | 5/5 | 2/2 | 1/1 | 0 | 1/3 | 0 | 0 | 0 | 0 |
| 8 Sep | 5 | 2/2 | 0 | 3/7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 Sep | 6 | 20/49 | 0 | 13/51 | 0 | 3/3 | 74/150 | 16/61 | 2/2 | 0 | 0 |
| 13 Sep | 7 | 17/26 | 0 | 0 | 0 | 1/1 | 2/7 | 0 | 0 | 2/3 | 0 |
| 14 Sep | 8 | 3/4 | 0 | 15/51 | 0 | 4/6 | 105/234 | 0 | 0 | 0 | 0 |
| 14 Sep | 9 | 4/14 | 0 | 12/51 | 0 | 2/3 | 70/535 | 0 | 0 | 0 | 0 |
| 19 Sep | 10 | 1/1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 Sep | 11 | 1/1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3/28 | 0 |
| 25 Sep | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4/19 | 0 |
| 26 Sep | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 Sep | 14 | 7/10 | 0 | 3/4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 Oct | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 Oct | 16 | 2/3 | 0 | 4/63 | 1/2 | 0 | 1/2 | 0 | 1/1 | 0 | 0 |
| 6 Oct | 17 | 1/1 | 0 | 4/5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 Oct | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 Oct | 19 | 5/5 | 0 | 1/1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 Oct | 20 | 2/2 | 0 | 1/2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 Oct | 21 | 2/5 | 0 | 0 | 1/1 | 0 | 1/1 | 0 | 0 | 0 | 0 |
| 14 Oct | 22 | 2/3 | 0 | 5/50 | 0 | 0 | 2/2 | 0 | 0 | 0 | 0 |
| 15 Oct | 23 | 1/1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 Oct | 24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 Oct | 25 | 0 | 0 | 3/3 | 0 | 0 | 1/1 | 0 | 0 | 0 | 0 |
| 20 Oct | 26 | 4/4 | 0 | 5/74 | 0 | 0 | 2/2 | 0 | 0 | 1/1 | 0 |
| Total Semimonthly Sightings | | | | | | | | | | | |
| 3-15 Sep | | 53/103 | 5/5 | 100/319 | 2/2 | 11/14 | 275/1118 | 16/61 | 2/2 | 4/5 | 0 |
| 16-30 Sep | | 9/12 | 0 | 3/4 | 0 | 0 | 0 | 0 | 0 | 7/47 | 0 |
| 1-15 Oct | | 15/20 | 0 | 15/121 | 2/3 | 0 | 4/5 | 0 | 1/1 | 0 | 0 |
| 16-20 Oct | | 4/4 | 0 | 8/77 | 0 | 0 | 3/3 | 0 | 0 | 1/1 | 0 |
| TOTAL | | 81/139 | 5/5 | 126/521 | 4/5 | 11/14 | 282/1126 | 16/61 | 3/3 | 12/53 | 0 |

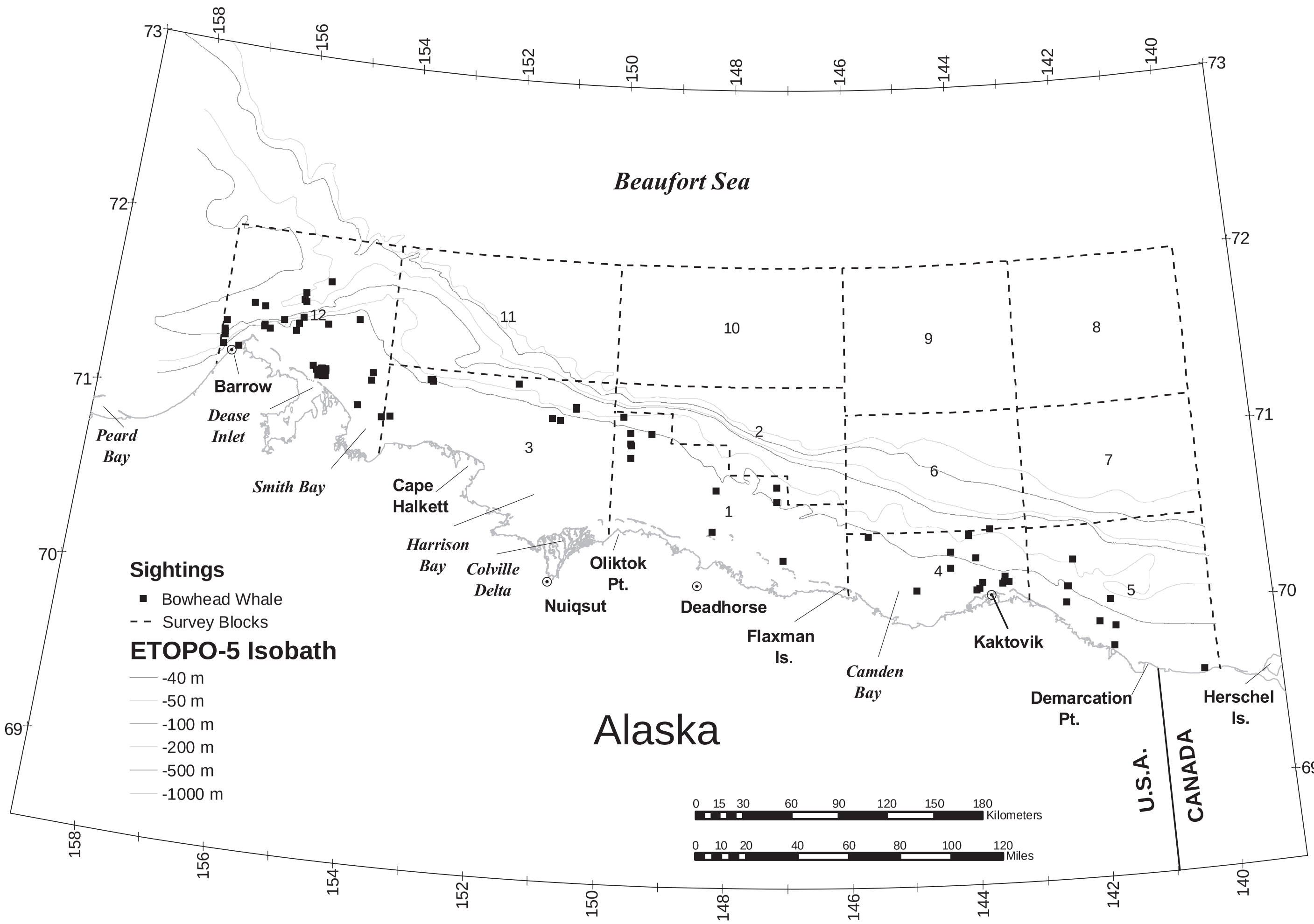


Figure 7 – Map of Bowhead Whale Sightings, Fall 2005

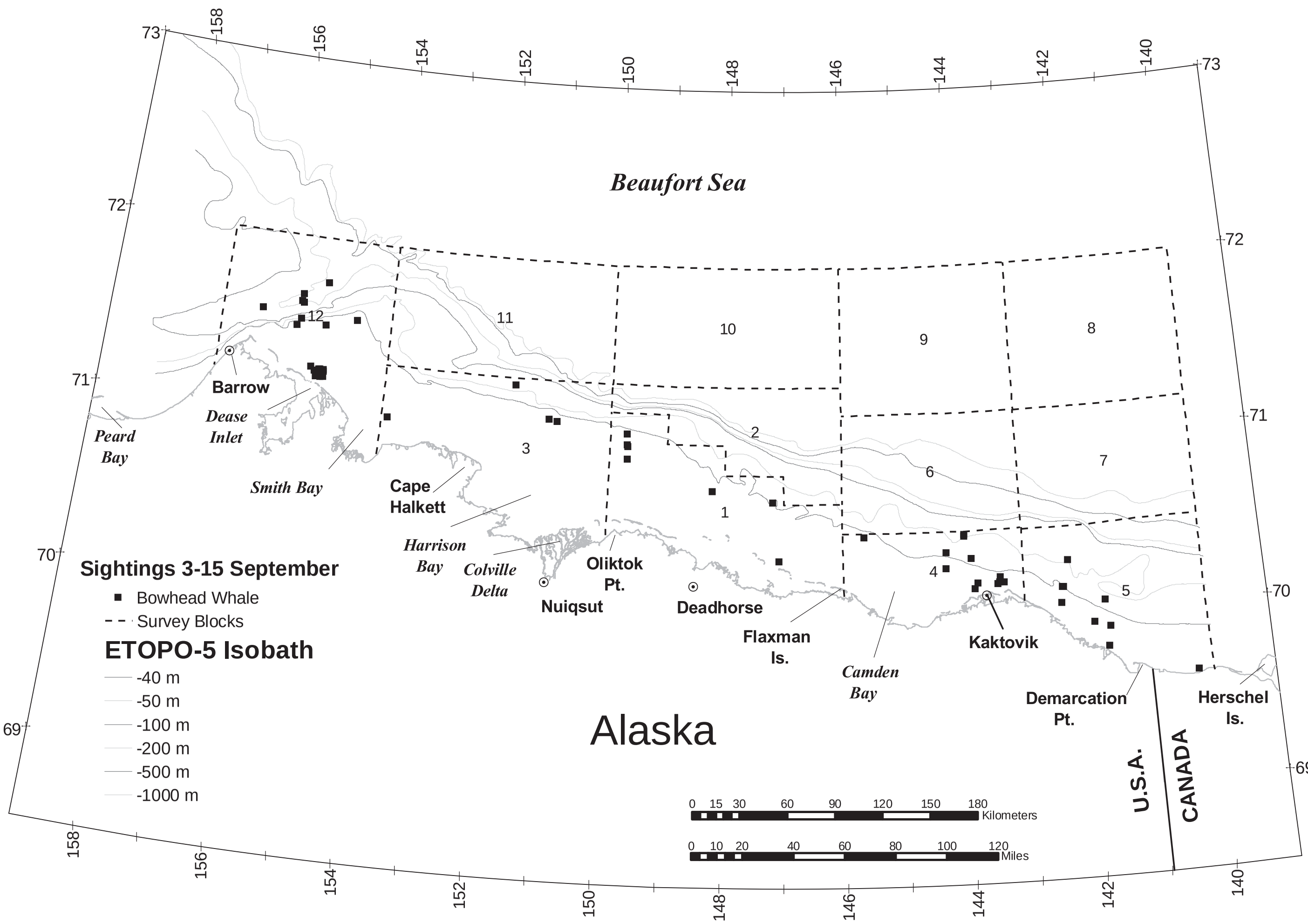


Figure 8 – Map of Bowhead Whale Sightings, 3-15 September 2005

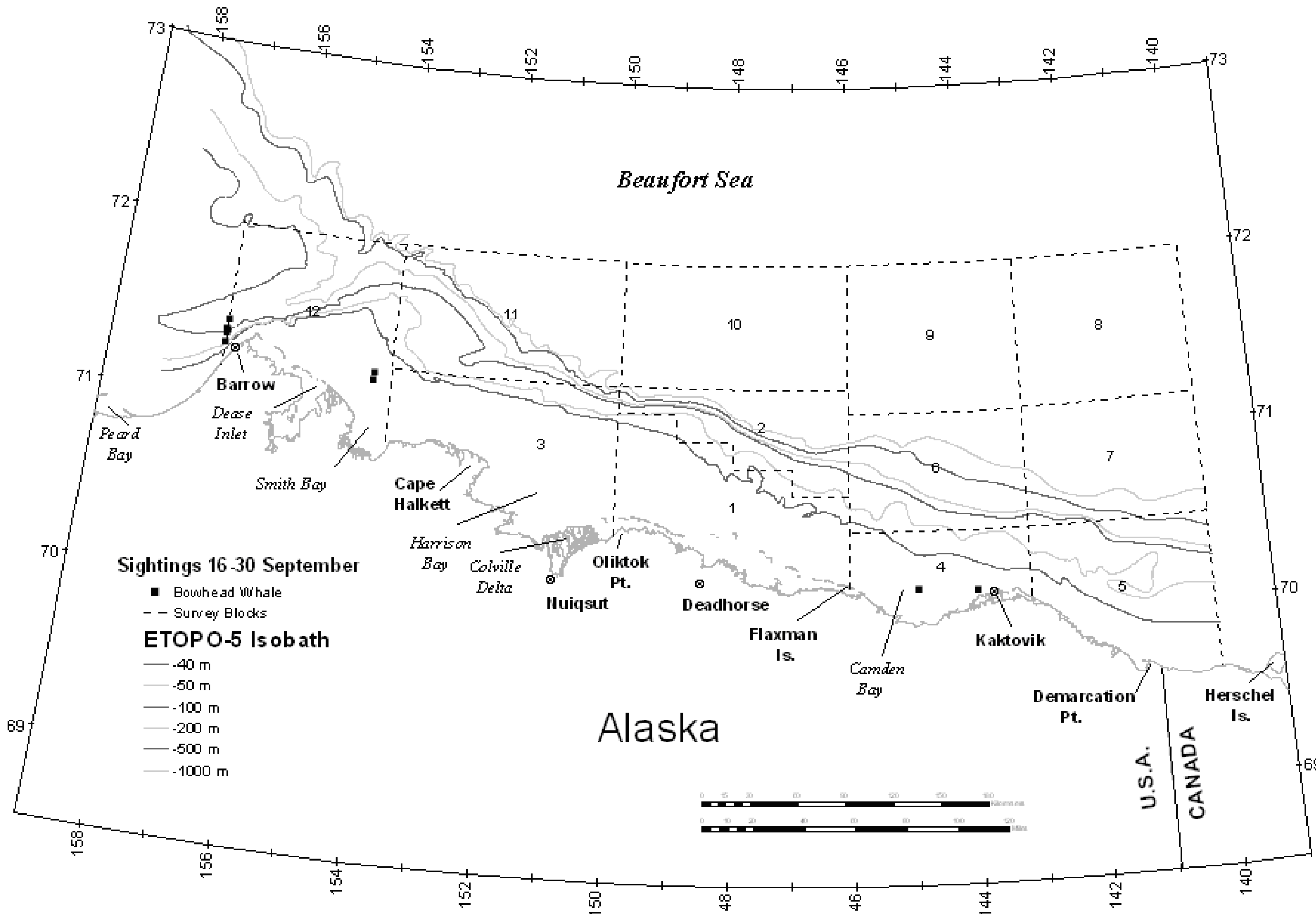


Figure 9 – Map of Bowhead Whale Sightings, 16-30 September 2005

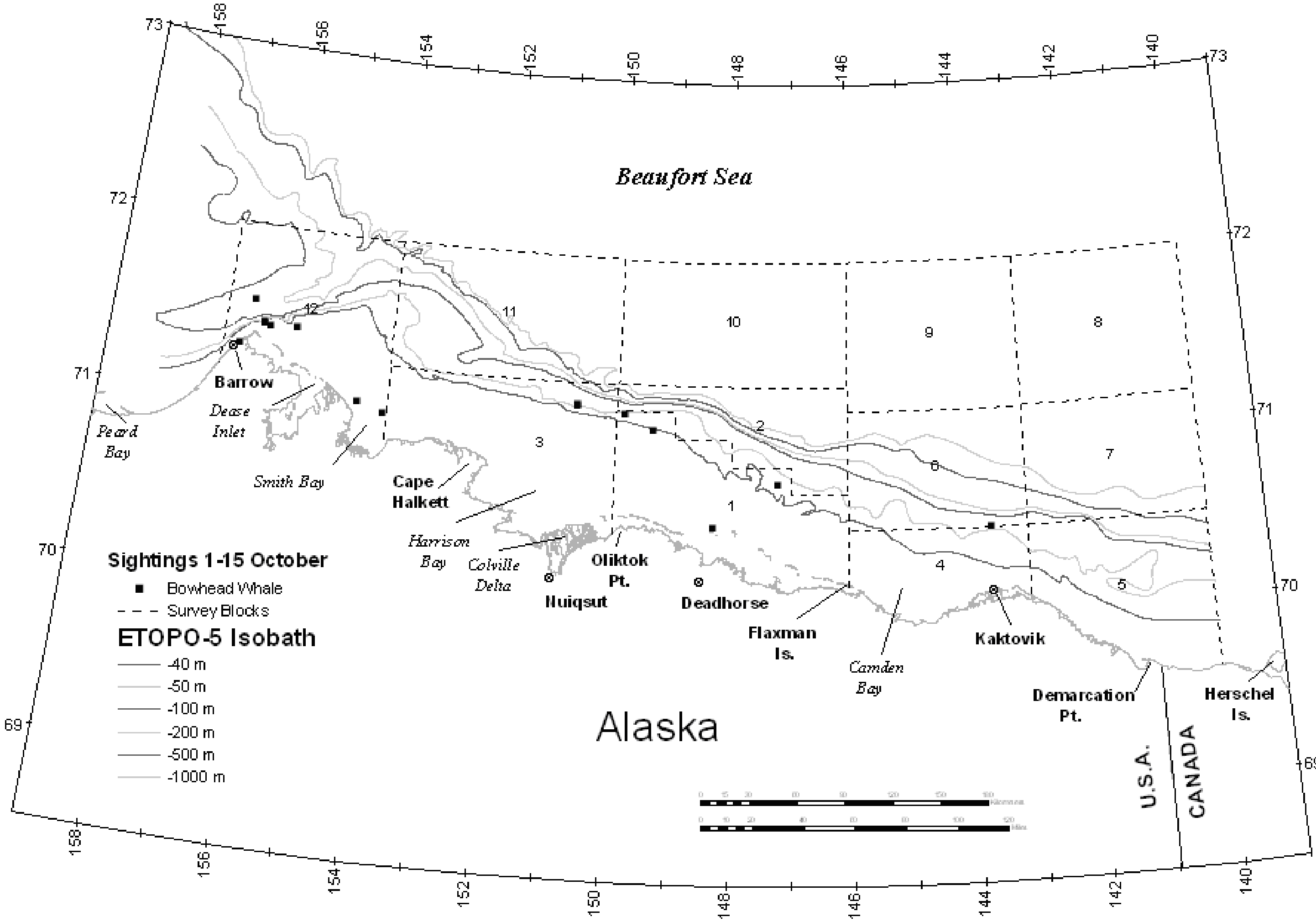


Figure 10 – Map of Bowhead Whale Sightings, 1-15 October 2005

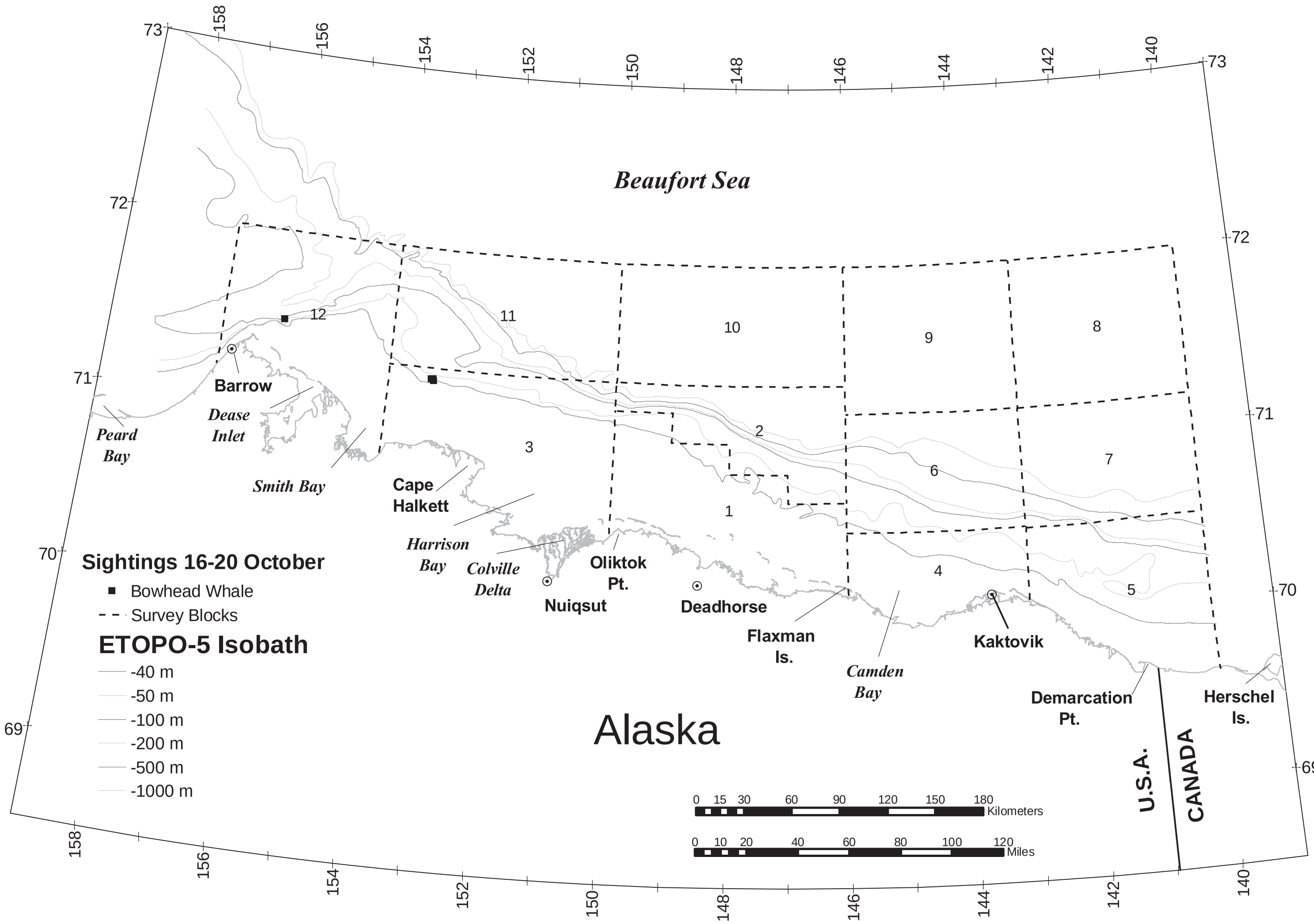


Figure 11 – Map of Bowhead Whale Sightings. 16-20 October 2005

## C. Bowhead Whale *(Balaena mysticetus)* Observations

### 1. Sighting Summary

Eighty-one sightings were made for a total of 139 bowhead whales observed during Fall-2005 surveys in the study area (Table 3). Relatively widespread survey coverage between 140°W. and 158°W. longitudes showed bowhead whales distributed throughout the survey area (Figure 7). Five of the 139 whales were identified as calves (Appendix B-2005), resulting in a seasonal calf ratio (number calves/total whales) of 0.037. Locations of observations of bowhead whales are shown by semi-monthly period in Figures 8-11. Bowhead whale sightings and associated sea states are shown for individual flights in Appendix C.

### 2. Sighting Rates

In Fall 2005, bowheads were seen from Barrow to Canada. On September 8th, 21 whales were seen milling or feeding within approximately 10 km of the barrier islands north of Dease Inlet. A second concentration of 23 whales was seen swimming and feeding approximately 50 km northwest of Barrow. On September 14th a group of 10 whales, including one calf, was seen feeding 50-60 km north of Oliktok Pt. (Appendix B). Counts of individual bowhead whales are summarized by 5km blocks in Figure 12.

### 3. Habitat Associations

In addition to general ice coverage for arctic waters during 2005 (Appendix A), the percentage of ice cover visible from the aircraft at each bowhead sighting (Appendix B) was summarized. Of the 139 bowheads counted over the field season, 121 whales (87%) were sighted in open water, 7 (5%) whales were observed in 1-5% sea ice, 2 (1.5%) were counted in 6-10%, 2 were in 11-20% (1.5%), 5 were in 21-79% (4%), and 2 (1.5%) were in 80-100% sea ice coverage (Table 4).

**Table 4**
**Semimonthly Summary of Bowhead Whales Observed,**
**By Percent Ice Cover Present at Sighting Location, Fall 2005**

| % Ice Cover | 3-15 Sep | 16-30 Sep | 1-15 Sep | 16-20 Oct | Total |
|---|---|---|---|---|---|
| 0 | 96(93%) | 12(1%) | 13(65%) | 0(0%) | 121(87%) |
| 1-5 | 4(3%) | 0(0%) | 0(0%) | 3(0.75%) | 7(5%) |
| 6-10 | 2(2%) | 0(0%) | 0(0%) | 0(0%) | 2(1%) |
| 11-20 | 0(0%) | 0(0%) | 2(10%) | 0(0%) | 2(1%) |
| 31-40 | 0(0%) | 0(0%) | 1(5%) | 1(0.25%) | 2(1%) |
| 41-50 | 1(1%) | 0(0%) | 1(5%) | 0(0%) | 2(1%) |
| 51-60 | 0(0%) | 0(0%) | 1(5%) | 0(0%) | 1(1%) |
| 81-90 | 0(0%) | 0(0%) | 1(5%) | 0(0%) | 1(1%) |
| 91-100 | 0(0%) | 0(0%) | 1(5%) | 0(0%) | 1(1%) |
| TOTAL | 103(100%) | 12(1%) | 20(100%) | 4(1%) | 139(100%) |

**Table 5**
**Semimonthly Summary of Bowhead Whales Observed, by Behavioral Category, Fall 2005**
number of animals (percentage of total animals)

| Behavior | 3-15 Sep | 16-30 Sep | 1-15 Oct | 16-20 Oct | Total |
|---|---|---|---|---|---|
| Breach | 1 (1%) | 0 (0%) | 0 (0%) | 0 (0%) | 1 (1%) |
| Dive | 1 (1%) | 0 (0%) | 1 (5%) | 0 (0%) | 2 (1%) |
| Feed | 40 (39%) | 0 (0%) | 1 (5%) | 0 (0%) | 41 (29%) |
| Log Play | 2 (2%) | 0 (0%) | 0 (0%) | 0 (0%) | 2 (1%) |
| Mill | 7 (7%) | 0 (0%) | 0 (0%) | 0 (0%) | 7 (5%) |
| Rest | 2 (2%) | 0 (0%) | 1 (5%) | 1 (25%) | 4 (3%) |
| Swim | 50 (49%) | 12 (100%) | 17 (85%) | 3 (75%) | 82 (59%) |
| TOTAL | 103 (100%) | 12 (100%) | 20 (100%) | 4 (100%) | 139 (100%) |

### 4. Behaviors

Behaviors of the 139 bowhead whales observed during Fall 2005, are summarized in Table 5. Most whales (59%) were swimming when observed. Forty-one whales (29%) were seen feeding. Locations of these observations, and others including milling whales, are shown on Figure 13.

Feeding was most commonly observed in Block 12 between Smith Bay and Barrow. Behaviors are defined in Table 1.

Flight observers watched for sudden overt changes (e.g., an abrupt dive, course diversion, or cessation of behavior ongoing) in whale behavior. No bowheads were observed for which responses to the survey aircraft were noted.

### 5. Distance from Shore

Distances from shore of Fall-2005 bowhead whale sightings made on transect were measured using ArcGIS as the distance due north of a normalized shoreline. Median distances from locations of sightings of bowhead whales to a normalized shoreline in 2005 were 28.1 km (range = 3.0–44.8 km) in the East Region, and 39.8 km (range = 5.2–73.6 km) in the West Region (Figure 14, Table 6).

### 6. Depth at Sightings

Median depths at sightings were 42.0 m (range = 12.0–57.0 m) in the East Region, and 33.0 m (range = 10.0–285.0 m) in the West Region (Table 7).

**Table 6**
**Central-Tendency Statistics for Distance from Shore (in kilometers) to Random Sightings of Bowhead Whales (September-October), by Year and Region, 1982-2005**

| Year | Region | trSI[1] | Median | 25th-75th Quartile Range | Mean | SD[2] | CI[3] | Range |
|---|---|---|---|---|---|---|---|---|
| 1982 | East | 28 | 36.9 | 31.5-43.2 | 38.2 | 8.5 | 34.9-41.5 | 26.0-56.6 |
| | West | 26 | 41.7 | 37.7-48.9 | 43.7 | 16.7 | 36.9-50.4 | 14.6-86.3 |
| 1983 | East | 14 | 89.5 | 82.0-98.9 | 89.7 | 15.7 | 80.7-98.8 | 59.6-121.2 |
| | West | 15 | 53.3 | 42.3-86.6 | 62.2 | 26.3 | 47.6-76.7 | 27.5-125.3 |
| 1984 | East | 23 | 36.6 | 25.6-56.5 | 39.7 | 23.9 | 29.3-50.0 | 1.9-103.4 |
| | West | 36 | 46.2 | 36.8-60.3 | 45.7 | 19.2 | 39.2-52.2 | 8.9-85.2 |
| 1985 | East | 10 | 29.5 | 23.7-40.5 | 31.8 | 16.0 | 20.4-43.3 | 1.9-61.4 |
| | West | 7 | 50.3 | 25.9-86.3 | 53.8 | 29.2 | 26.8-80.8 | 15.4-88.9 |
| 1986 | East | 30 | 27.5 | 16.7-39.8 | 27.8 | 16.7 | 21.5-34.0 | 1.0-58.1 |
| | West | 19 | 38.8 | 24.7-52.4 | 39.9 | 22.8 | 28.9-50.9 | 3.7-81.7 |
| 1987 | East | 30 | 33.5 | 18.5-50.1 | 37.0 | 20.7 | 29.3-44.7 | 6.9-86.1 |
| | West | 8 | 29.2 | 16.7-51.2 | 32.7 | 20.2 | 15.9-49.6 | 7.4-60.3 |
| 1988 | East | 6 | 29.5 | 24.4-33.9 | 33.4 | 23.5 | 8.8-58.0 | 6.4-76.8 |
| | West | 8 | 64.5 | 59.1-71.4 | 65.9 | 11.2 | 56.6-75.3 | 50.7-86.8 |
| 1989 | East | 6 | 55.8 | 49.3-89.4 | 63.4 | 23.4 | 38.8-87.9 | 36.1-94.0 |
| | West | 17 | 35.4 | 15.6-45.8 | 32.8 | 19.4 | 22.8-42.8 | 7.5-74.5 |
| 1990 | East | 93 | 33.8 | 25.4-43.0 | 34.5 | 13.8 | 31.7-37.4 | 8.1-78.6 |
| | West | 6 | 35.8 | 32.3-48.2 | 42.5 | 18.5 | 23.1-61.9 | 25.9-77.3 |
| 1991 | East | 15 | 56.0 | 38.8-76.7 | 56.7 | 22.0 | 44.6-68.9 | 22.0-85.6 |
| | West | 6 | 46.0 | 34.1-72.3 | 51.5 | 18.8 | 31.7-71.2 | 33.6-76.8 |
| 1992 | East | 12 | 38.2 | 34.3-51.6 | 42.5 | 10.9 | 35.6-49.4 | 28.5-60.5 |
| | West | 13 | 61.1 | 45.1-74.3 | 59.3 | 17.2 | 48.9-69.7 | 29.9-82.2 |
| 1993 | East | 55 | 30.3 | 21.2-40.4 | 31.9 | 17.0 | 27.3-36.5 | 6.4-88.4 |
| | West | 35 | 25.1 | 20.4-38.6 | 29.9 | 12.7 | 25.6-34.3 | 11.8-62.7 |
| 1994 | East | 32 | 29.4 | 22.4-56.2 | 37.2 | 18.7 | 30.4-44.0 | 13.9-77.7 |
| | West | 3 | 23.3 | [4] | 24.8 | 11.5 | [4] | 14.1-36.9 |

| Year | Region | trSI[1] | Median | 25th-75th Quartile Range | Mean | SD[2] | CI[3] | Range |
|---|---|---|---|---|---|---|---|---|
| 1995 | East | 94 | 30.2 | 23.6-41.6 | 33.1 | 16.4 | 29.7-36.5 | 3.7-99.5 |
| | West | 44 | 36.5 | 25.3-51.7 | 42.9 | 26.5 | 34.8-50.9 | 7.6-118.7 |
| 1996 | East | 13 | 29.4 | 21.0-34.6 | 29.1 | 11.4 | 22.2-36.0 | 15.3-57.6 |
| | West | 15 | 40.6 | 23.6-55.1 | 40.8 | 14.8 | 32.6-49.1 | 21.4-64.1 |
| 1997 | East | 35 | 10.2 | 5.9-20.4 | 15.1 | 11.9 | 11.0-19.1 | 3.4-44.9 |
| | West | 145 | 27.4 | 20.0-36.3 | 29.2 | 13.0 | 27.1-31.3 | 1.0-66.0 |
| 1998 | East | 103 | 22.2 | 13.6-31.3 | 23.8 | 13.0 | 21.3-26.3 | 4.0-73.8 |
| | West | 113 | 20.9 | 14.7-32.5 | 26.3 | 18.6 | 22.8-29.8 | 1.1-124.0 |
| 1999 | East | 68 | 40.2 | 28.5-49.7 | 39.5 | 13.5 | 36.3-42.8 | -0.1[5]-65.8 |
| | West | 68 | 36.1 | 27.0-52.1 | 39.3 | 17.5 | 35.1-43.6 | 9.2-75.6 |
| 2000 | East | 26 | 39.3 | 28.7-52.1 | 43.5 | 22.7 | 34.3-52.7 | 13.9-108.8 |
| | West | 19 | 11.0 | 4.7-25.3 | 17.7 | 19.2 | 8.5-27.0 | 0.02-80.8 |
| 2001 | East | 16 | 33.9 | 22.7-39.5 | 31.5 | 10.8 | 25.7-37.2 | 13.5-49.8 |
| | West | 2 | 42.4 | [4] | 42.4 | 43.2 | [4] | 11.8-73.0 |
| 2002 | East | 16 | 14.8 | 6.5-25.0 | 19.0 | 16.6 | 10.2-27.2 | 2.4-60.9 |
| | West | 23 | 33.9 | 18.0-151.6 | 35.6 | 12.3 | 30.3-40.9 | 2.4-60.9 |
| 2003 | East | 33 | 34.7 | 14.1-44.0 | 29.8 | 17.3 | 23.6-35.9 | 3.9-64.7 |
| | West | 41 | 30.5 | 18.1-40.2 | 32.4 | 18.4 | 26.6-38.2 | 6.9-86.0 |
| 2004 | East | 67 | 21.5 | 16.7-29.5 | 24.2 | 11.6 | 21.3-27.0 | 1.6-72.6 |
| | West | 60 | 23.1 | 19.1-27.5 | 23.5 | 10.4 | 20.8-26.2 | 0.7-66.1 |
| 2005 | East | 19 | 28.1 | 12.2-38.9 | 26.4 | 14.2 | 19.6-33.2 | 3.0-44.8 |
| | West | 27 | 39.8 | 23.3-57.8 | 38.3 | 20.4 | 31.8-47.9 | 5.2-73.6 |
| Cumulative | East | 746 | 27.0 | 17.4-38.1 | 29.1 | 16.4 | 27.9-30.2 | 0.8-138.0 |
| (1982-2005) | West | 644 | 26.2 | 17.8-38.1 | 29.4 | 17.0 | 28.1-30.7 | 0.1-120.1 |

[1] trSI = number of transect sightings.
[2] SD = standard deviation.
[3] CI ≥ 95-percent confidence interval (positive values).
[4] Insufficient sample size.
[5] Negative value is for one transect sighting between the actual and normalized coastline.

**Table 7**
**Central-Tendency Statistics for Water Depth (in meters) at Random Sightings of Bowhead Whales (September-October), by Year and Region, 1982-2005**

| Year | Region | trSI [1] | Median | 25th-75th Quartile Range | Mean | SD [2] | CI [3] | Range |
|---|---|---|---|---|---|---|---|---|
| 1982 | East | 28 | 42 | 39-49 | 44 | 6 | 41-46 | 35-57 |
| | West | 26 | 30 | 23-37 | 94 | 211 | 9-179 | 14-1042 |
| 1983 | East | 14 | 804 | 263-1779 | 916 | 719 | 501-1331 | 65-1953 |
| | West | 15 | 68 | 34-209 | 313 | 598 | 18-644 | 21-2166 |
| 1984 | East | 23 | 44 | 35-54 | 77 | 105 | 32-122 | 18-508 |
| | West | 36 | 40 | 32-56 | 48 | 33 | 37-59 | 13-189 |
| 1985 | East | 10 | 38 | 35-41 | 38 | 7 | 32-43 | 23-51 |
| | West | 7 | 36 | 24-148 | 193 | 349 | 129-516 | 16-975 |
| 1986 | East | 30 | 41 | 24-50 | 38 | 18 | 31-45 | 7-92 |
| | West | 19 | 28 | 19-75 | 78 | 117 | 21-135 | 10-490 |
| 1987 | East | 30 | 40 | 33-54 | 56 | 48 | 38-74 | 15-223 |
| | West | 8 | 25 | 13-32 | 23 | 10 | 14-31 | 8-32 |
| 1988 | East | 6 | 49 | 39-50 | 92 | 124 | 37-222 | 23-343 |
| | West | 8 | 49 | 47-53 | 50 | 6.9 | 45-56 | 41-64 |
| 1989 | East | 6 | 61 | 51-448 | 196 | 220 | 35-427 | 47-509 |
| | West | 17 | 20 | 11-24 | 19 | 8 | 15-23 | 6-34 |
| 1990 | East | 93 | 42 | 36-50 | 48 | 33 | 41-55 | 20-285 |
| | West | 6 | 32 | 23-39 | 33 | 11 | 21-45 | 20-51 |
| 1991 | East | 15 | 55 | 50-191 | 122 | 108 | 62-1821 | 35-387 |
| | West | 6 | 42 | 36-205 | 97 | 94 | 2-196 | 26-230 |
| 1992 | East | 12 | 54 | 47-56 | 52 | 6 | 48-55 | 41-59 |
| | West | 13 | 51 | 44-54 | 54 | 28 | 37-71 | 14-121 |
| 1993 | East | 55 | 41 | 34-50 | 58 | 97 | 32-85 | 11-717 |
| | West | 35 | 20 | 16-25 | 23 | 9 | 10-26 | 11-49 |
| 1994 | East | 32 | 47 | 39-53 | 80 | 176 | 17-143 | 31-1038 |

| Year | Region | trSI [1] | Median | 25th-75th Quartile Range | Mean | SD [2] | CI [3] | Range |
|---|---|---|---|---|---|---|---|---|
| | West | 3 | 12 | [4] | 21 | 17 | [4] | 12-41 |
| 1995 | East | 94 | 41 | 36-50 | 53 | 69 | 38-67 | 15-628 |
| | West | 44 | 30 | 26-39 | 107 | 260 | 28-186 | 6-1233 |
| 1996 | East | 13 | 39 | 33-46 | 38 | 9 | 32-43 | 15-49 |
| | West | 15 | 34 | 24-44 | 37 | 17 | 28-47 | 19-83 |
| 1997 | East | 35 | 22 | 13-32 | 24 | 12 | 20-28 | 11-50 |
| | West | 145 | 20 | 16-27 | 25 | 21 | 22-29 | 5-189 |
| 1998 | East | 103 | 32 | 26-40 | 34 | 12 | 32-37 | 7-83 |
| | West | 113 | 15 | 12-22 | 38 | 171 | 6-70 | 5-1814 |
| 1999 | East | 68 | 50 | 40-55 | 51 | 21 | 46-56 | 8-171 |
| | West | 68 | 31 | 21-42 | 43 | 43 | 32-53 | 11-210 |
| 2000 | East | 26 | 41 | 36-57 | 82 | 122 | 32-131 | 28-109 |
| | West | 19 | 11 | 7-20 | 32 | 82 | 8-71 | 4-367 |
| 2001 | East | 16 | 46 | 38-50 | 43 | 9 | 38-48 | 27-53 |
| | West | 2 | 29 | [4] | 29 | 26 | [4] | 10-47 |
| 2002 | East | 16 | 28 | 23-37 | 28 | 13 | 21-35 | 0-50 |
| | West | 23 | 24 | 19-31 | 27 | 12 | 23-32 | 11-61 |
| 2003 | East | 33 | 40 | 30-23 | 39 | 17 | 33-45 | 12-92 |
| | West | 41 | 23 | 19-42 | 58 | 74 | 38-82 | 8-291 |
| 2004 | East | 67 | 39 | 29-45 | 43 | 48 | 31-55 | 6-423 |
| | West | 60 | 20 | 16-34 | 31 | 36 | 22-40 | 4-211 |
| 2005 | East | 19 | 42 | 33-49 | 39 | 12 | 33-45 | 12-57 |
| | West | 27 | 33 | 24-51 | 59 | 8 | 31-88 | 10-285 |
| Cumulative | East | 746 | 40 | 32-50 | 56 | 157 | 45-67 | 0-2811 |
| (1982-2005) | West | 644 | 21 | 16-32 | 42 | 115 | 33-51 | 4-1815 |

[1] trSI = number of transect sightings.
[2] SD = standard deviation.
[3] CI ≥ 95-percent confidence interval (positive values).
[4] Insufficient sample size.

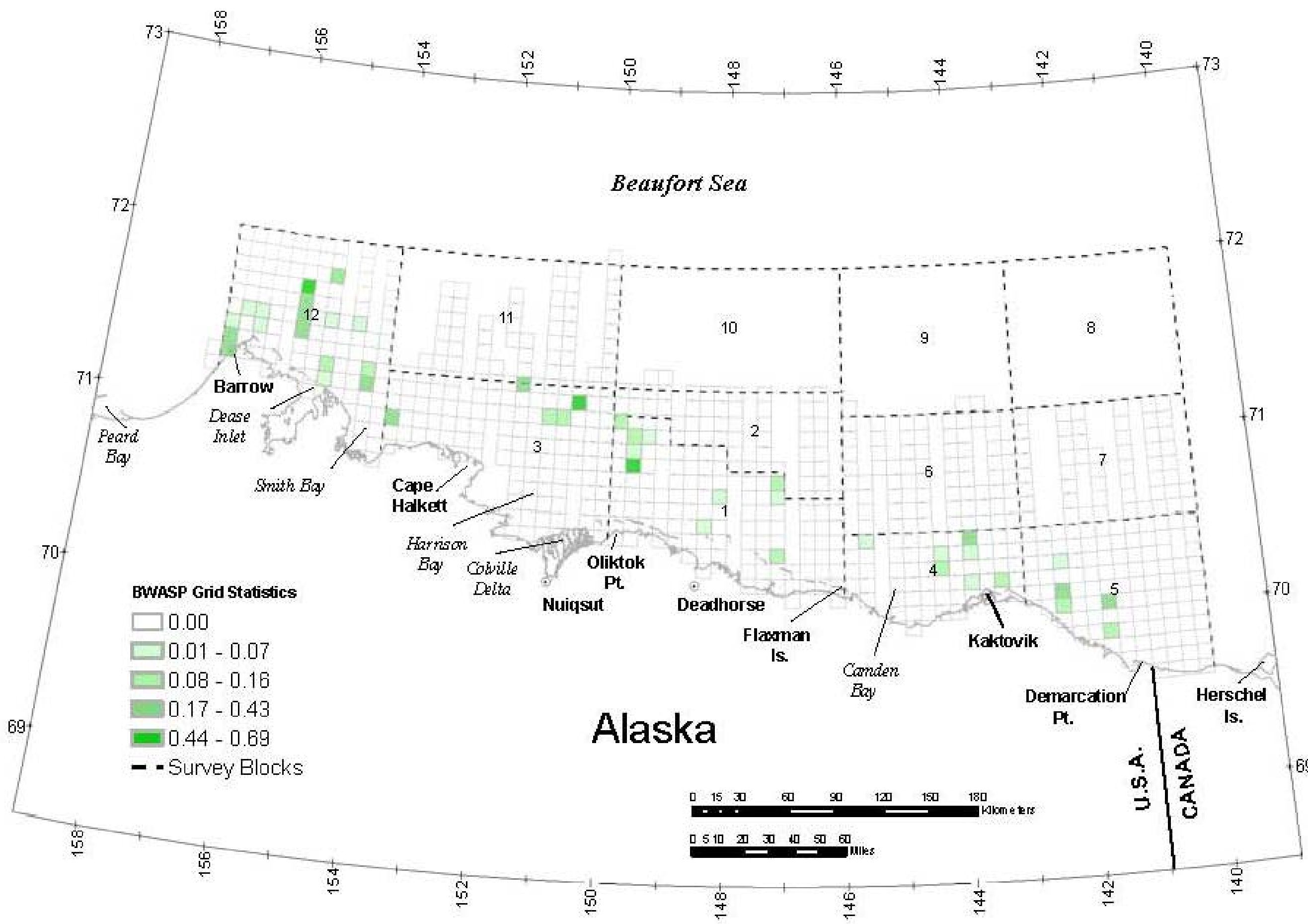


Figure 12 – Count Rates of Bowhead Whales on Transect, Fall 2005 (Bowhead Whales/km surveyed)

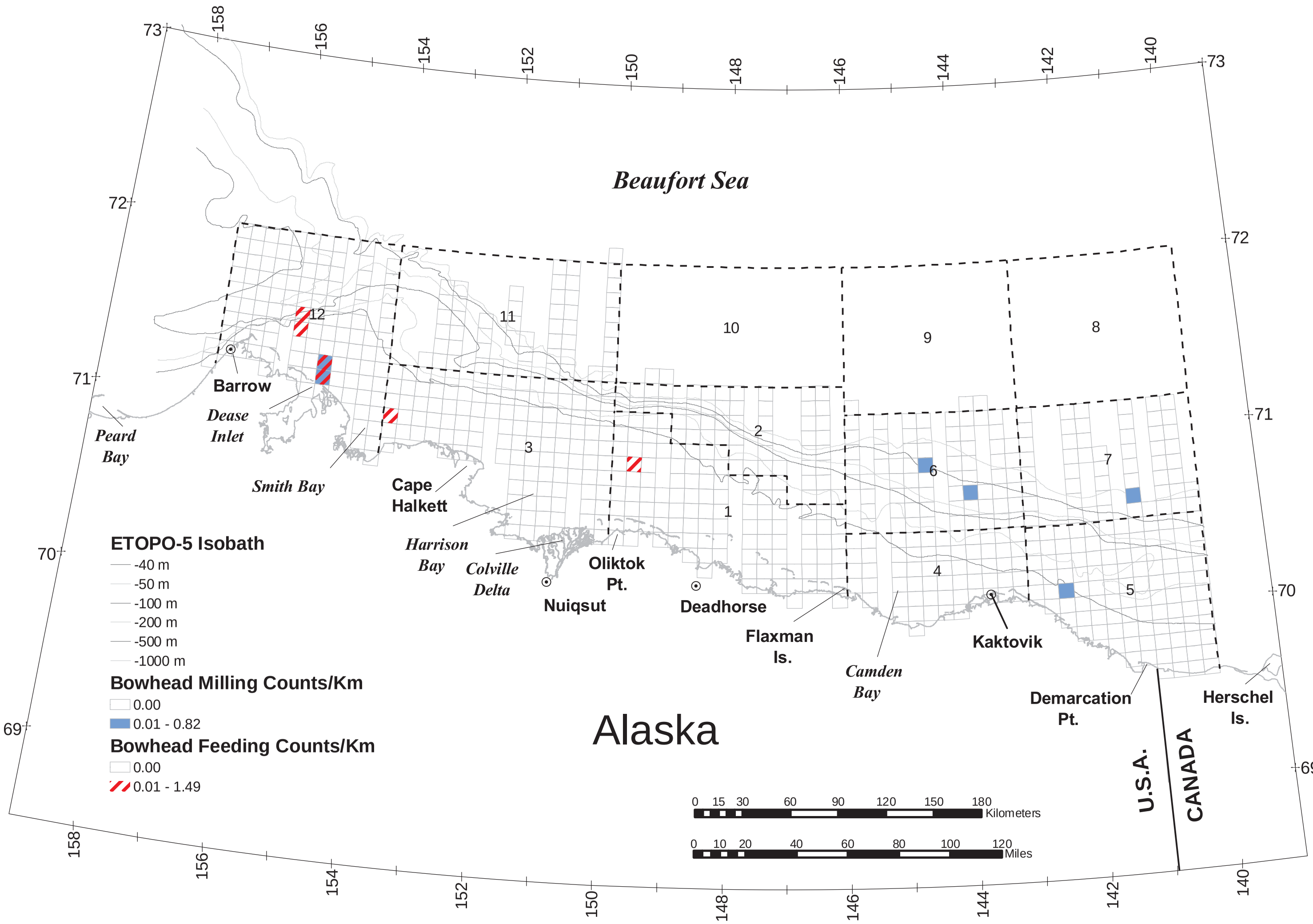


Figure 13 – Fall 2005 Counts of Feeding (purple) and Milling (cyan) Bowhead Whales Per Unit Effort (km) – on Transect

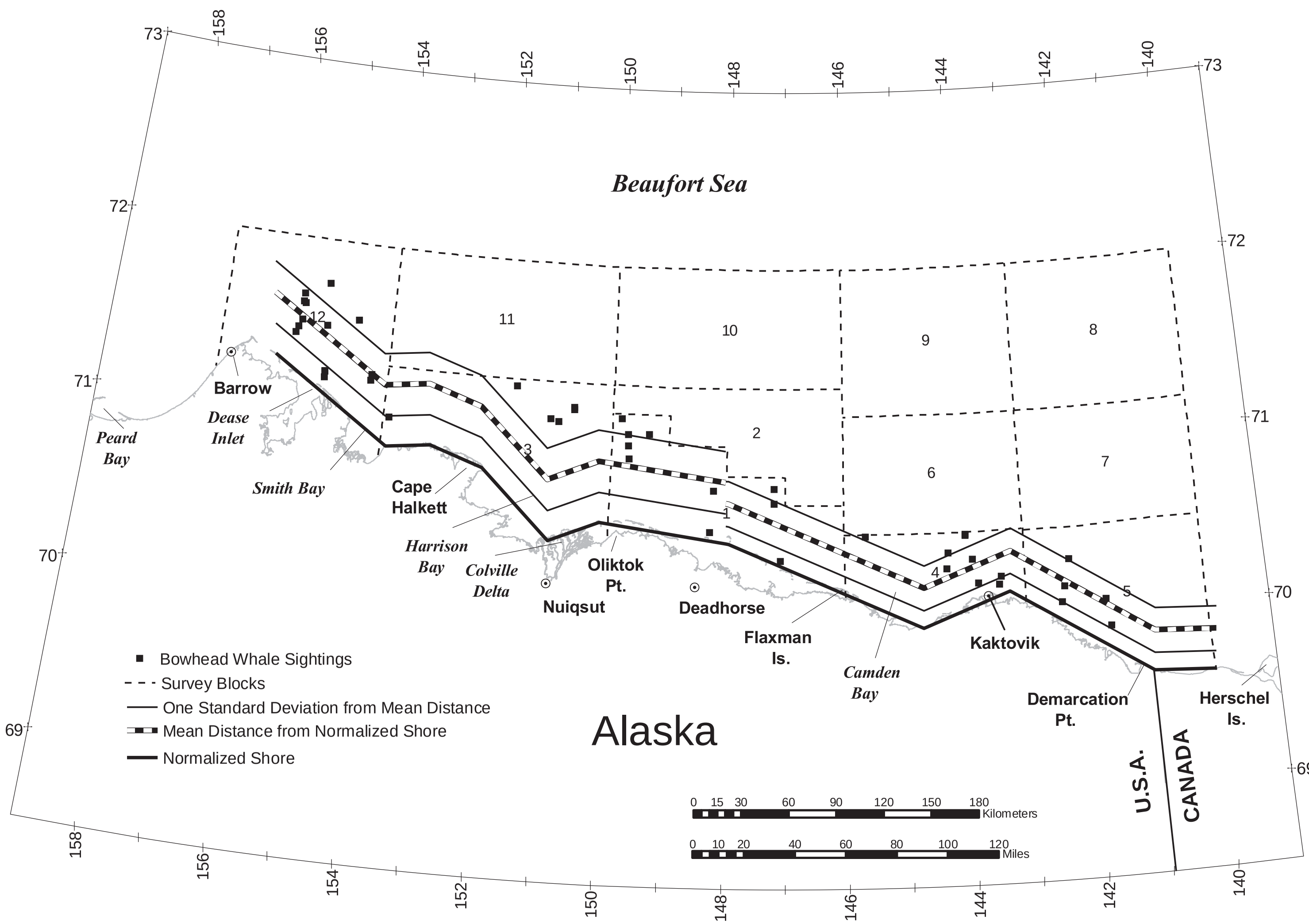


Figure 14 – Bowhead Whale Sightings on Transect Fall 2005, Showing Mean Distance from a Normalized Shoreline

## D. DISTRIBUTION OF MIGRATING BOWHEAD WHALES RELATIVE TO SHORE, 2005

In order to evaluate whether significant displacements had occurred in the bowhead whale migratory corridor during 2005, estimates of mean distance of sightings from a normalized shoreline were compared with comparable data from previous years having “light ice coverage” (i.e., 1982, 1986, 1987, 1989, 1990 and 1993-2004). The median distance from shore during previous “light ice coverage” for bowhead whales was 27.0 km in the East Region, and 26.2 km in the West Region; the median water depth at sightings was 40.0 m in the East Region and 21.0 m in the Western Region.

During 2005, bowhead whales in the Eastern Region were not significantly closer to shore than in previous “light ice coverage” years (28.1 km versus 27.0 km; $Z = 0.37$, $p > 0.70$). Locations of bowheads sighted in the Western Region were significantly further offshore (39.8 km versus 26.2 km; $Z = 2.77$, $p < 0.006$).

Water depth at bowhead whale sightings during 2005 showed the same trends: Eastern Region (42.0 m versus 40.0 m; $Z = 0.04$, $p > 0.96$); Western Region (33.0 m versus 21.0 m; $Z = 3.08$, $p < 0.003$).

An analysis of the relationship between relative sea ice severity and the distribution of sightings of bowhead whales relative to shore using data from 1982-2000 was published by Treacy et al. (2006). These authors concluded that bowhead whales occurred farther offshore during years having relatively heavy ice conditions than in years of light to moderate ice conditions.

## E. OTHER MARINE MAMMAL OBSERVATIONS

Observations of beluga whales, bearded seals, ringed seals, walrus, and polar bears are plotted in Appendix D.

A paper was published by Monnett and Gleason in “Polar Biology” during 2006 entitled: “Observations of mortality associated with extended open-water swimming by polar bears in the Alaskan Beaufort Sea”. During surveys in September, an unusual number of bears were seen swimming offshore and observations of floating carcasses were made in the same vicinity following an intervening storm. The authors posited that mortalities due to offshore swimming during late-ice (or mild ice) years may be an important and previously unaccounted for source of mortality that could increase in the future if the recent trend of regression of pack ice and longer open water periods continues.

## IV. DISCUSSION

### A. Conclusions

Compared to other light-ice years, bowhead whale sightings were significantly farther from shore and in deeper water in the West Region, but not significantly different in the East Region.

Conclusions about the effect of sea ice concentration on the bowhead migration and observations of feeding behavior during the Fall migration have been previously discussed in reports of this series (e.g., Treacy 2000, 2002a, and 2002b) and by Treacy, et al. 2006.

### B. Management Use of Real-Time Field Information

The MMS authorizes various types of oil and gas exploration activities on the OCS. These actions include: geophysical permits for open-water exploration seismic surveys using airgun arrays; geological permits for exploration geological studies; authorizations for ancillary activities including site-clearance shallow-penetration seismic surveys and geotechnical sampling; and permits to drill exploration and delineation wells. The MMS is also responsible for reviewing and authorizing development and production activities including platform and pipeline construction, permits to drill development wells, production operations, platform decommissioning, and lease abandonment. MMS authorizations of OCS activities typically include requirements for mitigation and monitoring.

During 2005, there were no winter or summer seismic programs in Federal waters in the Beaufort Sea. In general, to prevent potential operational effects on subsistence whaling, any geophysical-vessel explorations permitted during the fall follow stringent restrictions—including a provision to stop seismic operations when whales are visible from the vessel—as the bowhead whale migration progresses through the area of operations. For any explorations that occur during the fall, daily summaries of survey information are transferred from the field to Anchorage for use by MMS Resource Evaluation and by NMFS in implementing area-wide permit restrictions on high-energy seismic operations during the whale migration.

Development drilling occurred at Northstar throughout 2002-2005. Development drilling is not allowed to penetrate into the Northstar reservoir except when there is solid ice around Northstar Island. During the open-water and broken ice periods, development drilling is completed to the intermediate casing point and the wells are re-entered and drilling completed to the production interval once solid ice develops. In late October 2001, production commenced from the Northstar Project. Production reached the facility capacity in early 2002. Development drilling is continuing at Northstar with the same restriction addressed above. In general, during any fall drilling operations, daily summaries of field information from this survey, and other arctic surveys being conducted concurrently, are transferred by the MMS Team Leader to MMS Field Operations in Anchorage. The MMS and NMFS review daily reports to determine the distribution patterns of bowheads in the vicinity of oil-and-gas-industry activities and the timing of the bowhead whale migration, especially the "end of the migration" past any drill sites.

Real-time field information can be used by MMS and NMFS for management purposes. The sighting data are typically used by area management groups to monitor the progress of the overall fall migration of bowhead whales across the Alaskan Beaufort Sea and to determine the position of their overall migratory corridor relative to shore. The data are also provided to other MMS studies and to industry-sponsored site-specific studies investigating the potential effects of industry activity on marine mammals. Project ice and weather data were also transmitted daily to the National/Naval Ice Center and National Weather Service for use in ground-truthing satellite imagery.

### C. Management Use of Interannual Monitoring

The MMS bowhead whale monitoring began in 1979 and has continued every year up to the present. While some aspects of this study have been updated from time to time, the data recorded have remained remarkably parallel (especially data from 1982-2005), thus permitting many one-to-one comparisons between years. Such continuous, long-term, wide-area, aerial monitoring of a large whale migration is indeed unique.

In addition to the use of real-time information by both MMS and NMFS when documenting the progress of endangered bowhead whales past offshore drilling and seismic exploration operations, the project has been helpful to managers in other ways. Some notable examples are:

- providing raw data to all parties (MMS, Western Geophysical, NMFS, ARCO Alaska, Inc., and Alaska Eskimo Whaling Commission (AEWC)) at an Oil/Whalers Agreement Post Season Meeting on 18 December 1990 to determine whether the Fall 1990 bowhead migration had been temporarily blocked due to seismic exploration activities;
- providing all parties with annual reports from which data were subsequently cited in a declaration to a lawsuit in 1993 (AEWC et al. vs. Dr. Nancy Foster et al., Civil Action No. 93-1629 HHG) on the effects of Kuvlum drilling and seismic exploration operations on the bowhead migration corridor;
- providing upstream, offshore, and downstream sighting-and-effort data in order to enhance sample sizes of many site-specific studies looking at the potential effects of oil-industry activity on bowhead whale migrations;
- documenting geographic areas, especially migration corridors and feeding areas, used annually by bowhead whales. Such data from previous surveys continue to be used by MMS in writing Environmental Impact Statements and Environmental Assessments and in interpreting the results of site-specific studies;
- performing an analysis of the distances from shore to bowhead sightings relative to general sea ice severity.

The NMFS Administrator, Alaska Region, (letter dated 22 December 1998) commended MMS information support to NMFS: "The BWASP has provided a critical element in our ability to evaluate the effects of development in the Beaufort Sea on the bowhead whale. Additionally, the Minerals Management Service has demonstrated the flexibility and willingness to allow this program to compliment and extend project-specific monitoring required for authorizations under the Marine Mammal Protection Act (Incidental Harassment Authorizations). The combined information of these efforts has greatly extended our knowledge and facilitated conflict avoidance agreements. These agreements have allowed oil and gas activities to go forward while minimizing interference with traditional Native subsistence hunting. We have found BWASP statistical analysis and data presentation to be very useful in assessing potential impacts within the Beaufort Sea."

### D. Field Coordination and Other Information Support

During the field seasons, we coordinated with AEWC, Barrow, Alaska; Whalers Communication Center, Deadhorse, Alaska; NMFS, Anchorage, Alaska; and NSB, Department of Wildlife Management, Barrow, Alaska.

Selected BWASP information-support activities during calendar years 2005 included:

- Reviewed charter of MMS sponsored Alternative Management Control Review (AMCR) of BWASP to be completed during 2006;
- providing data to and coordinating with scientists and subsistence whalers in support of the National Science Foundation study "Study of Northern Alaska Coastal Systems" (SNACS), Carin Asjian Principle Investigator, of Woods Hole Oceanographic Institute;
- providing data to and coordinating with scientists at LGL Inc. (contact T. Elliott) in support of the Shell Oil Incorporated operations in the Beaufort and Chukchi Sea;
- providing data to K Herrmann., EDW Geomatics Department, (working with Shell Oil Co.) for use in developing computer analytical systems;

- participating in annual interagency evaluations (with NMFS, NSB, AEWC) on BP Exploration (Alaska)'s site-specific planned and reported monitoring of marine mammals near seismic and Northstar pre-production operations;
- providing a PDF versions of the reports "Aerial Surveys of Endangered Whales in the Beaufort Sea, Fall 2002-2004" to Environmental Studies Program Information System (http://mmspub.mms.gov:81/espis);
- providing requested maps of bowhead whale distribution to various MMS EIS writers.

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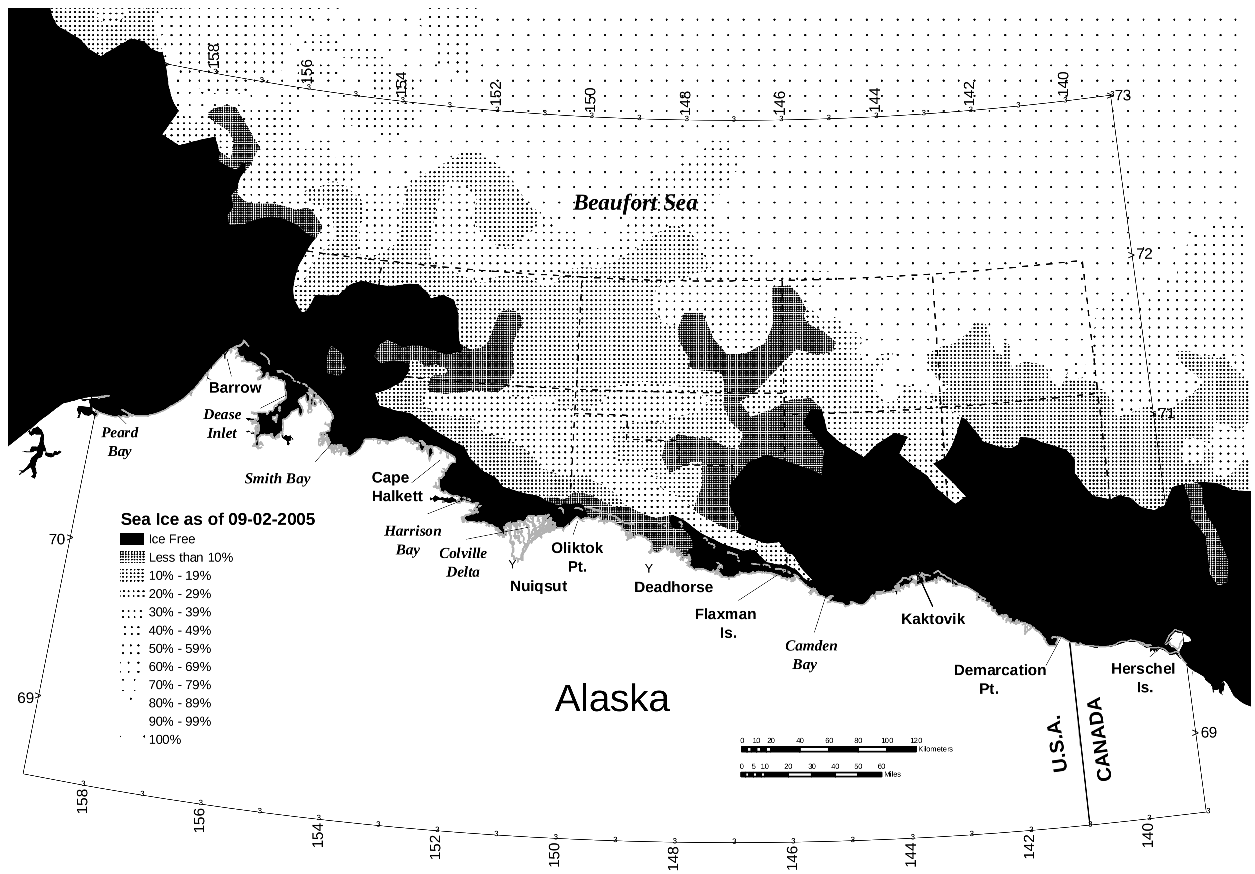
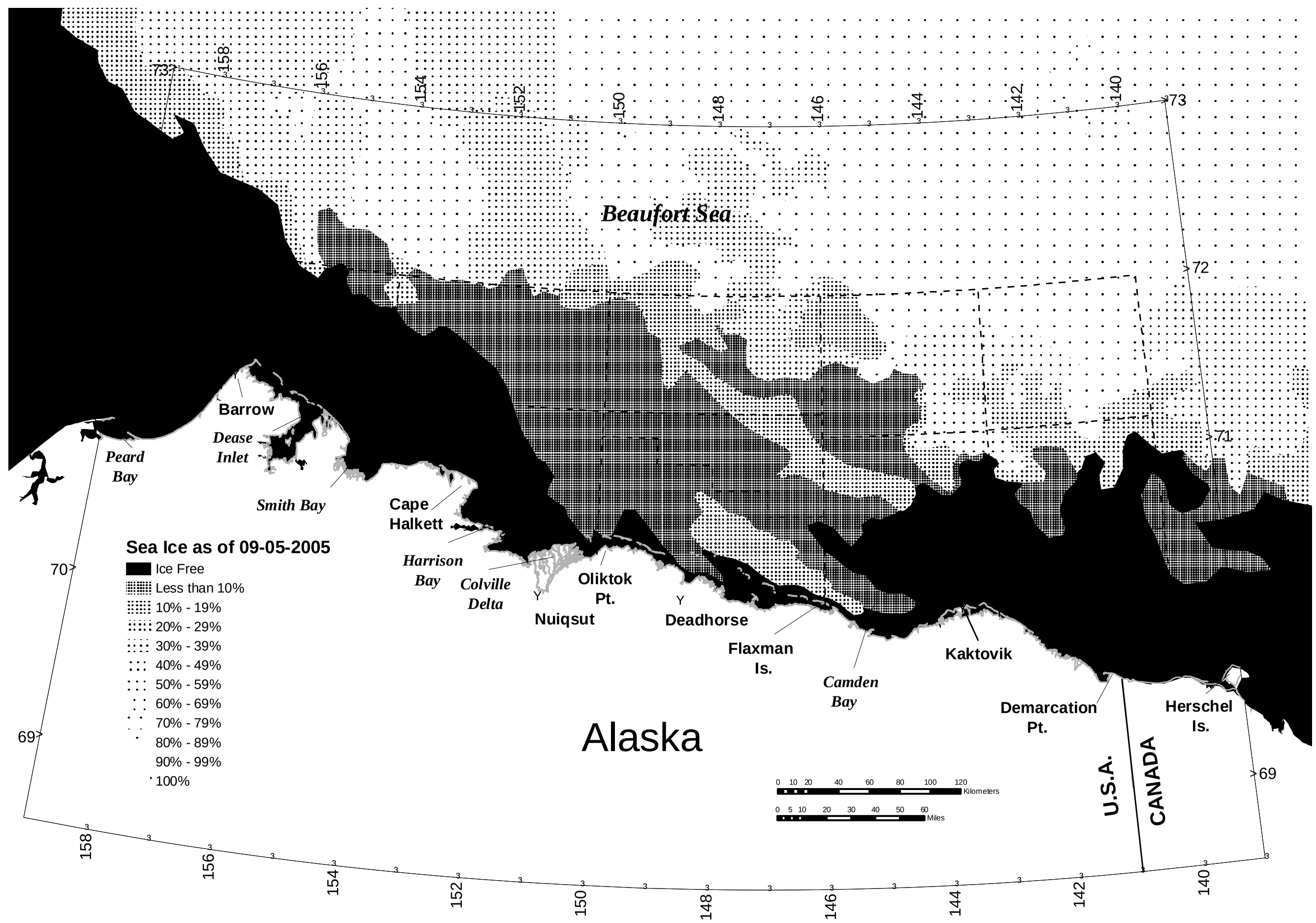
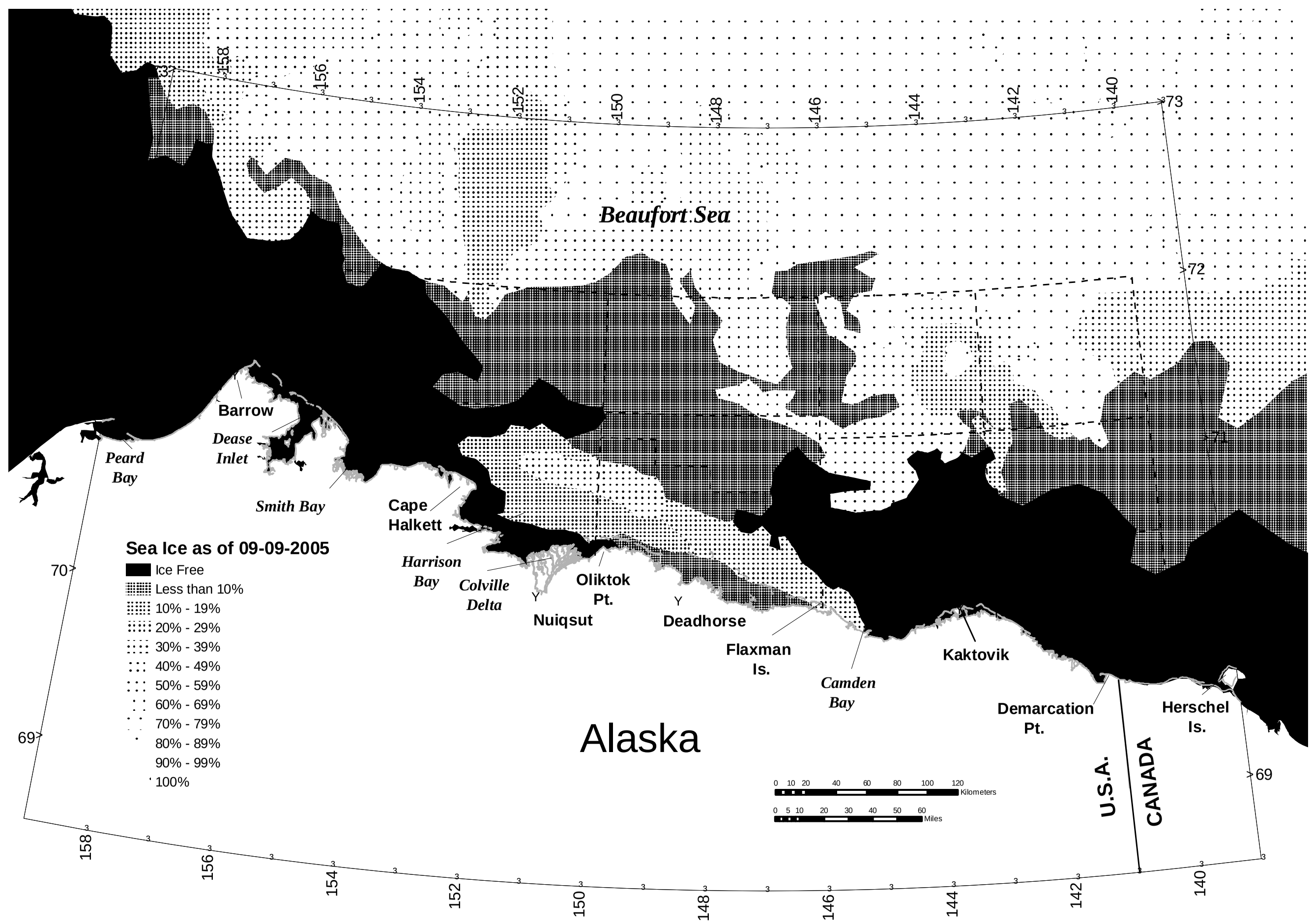
## APPENDIX A: ICE-CONCENTRATION MAPS – ALASKAN BEAUFORT SEA



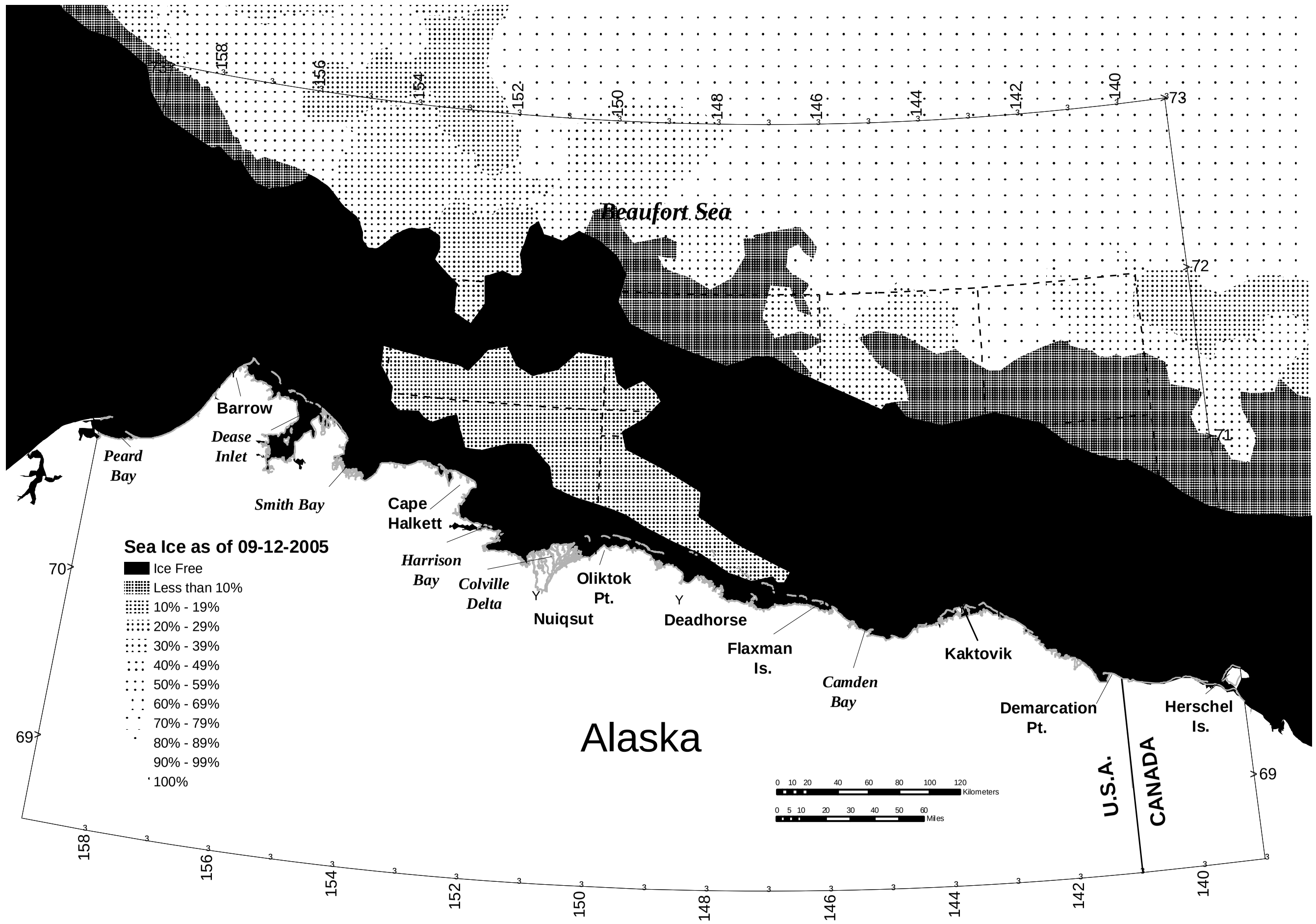

Map of Ice Concentrations in the Alaskan Beaufort Sea, 2 September 2005



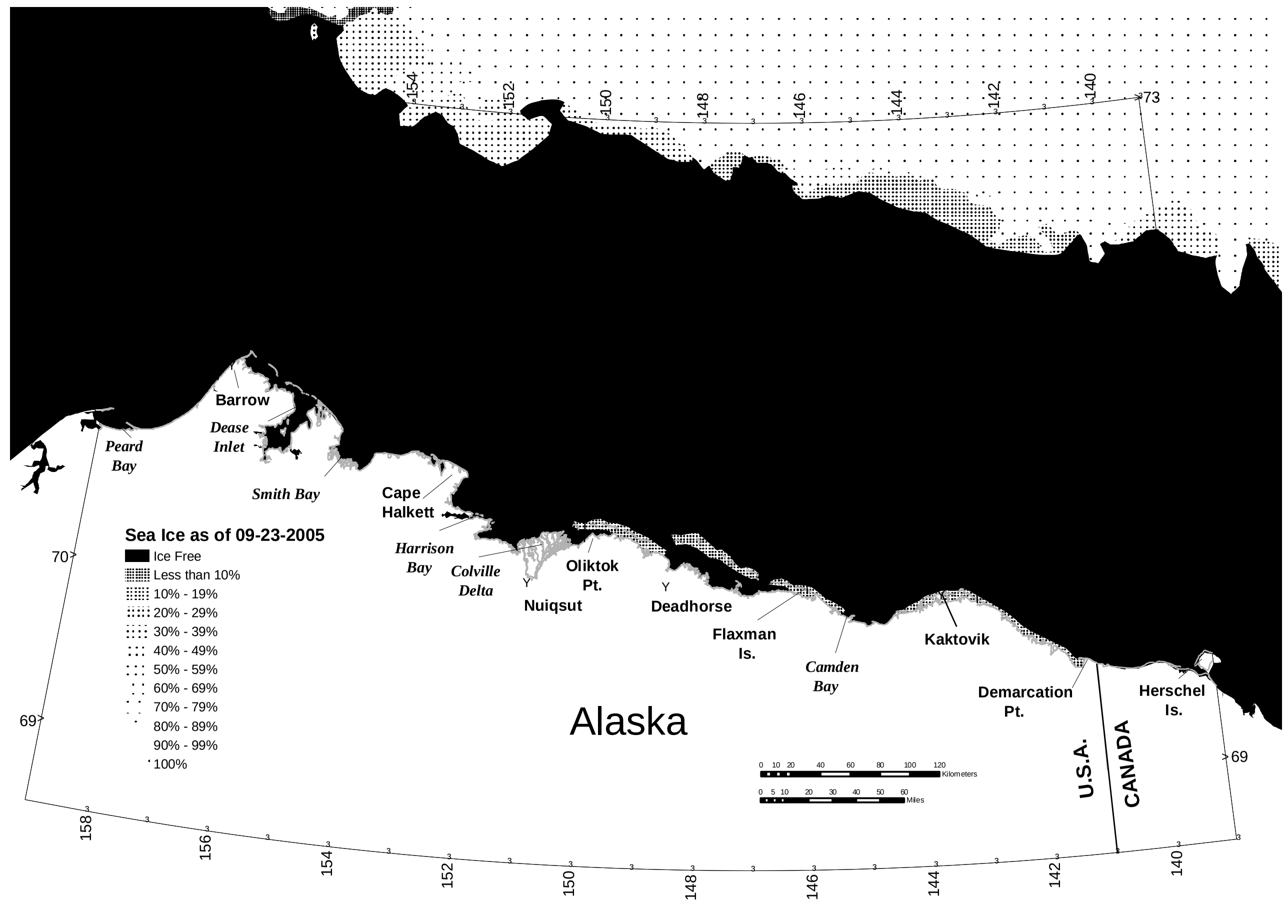

Map of Ice Concentrations in the Alaskan Beaufort Sea, 5 September 2005



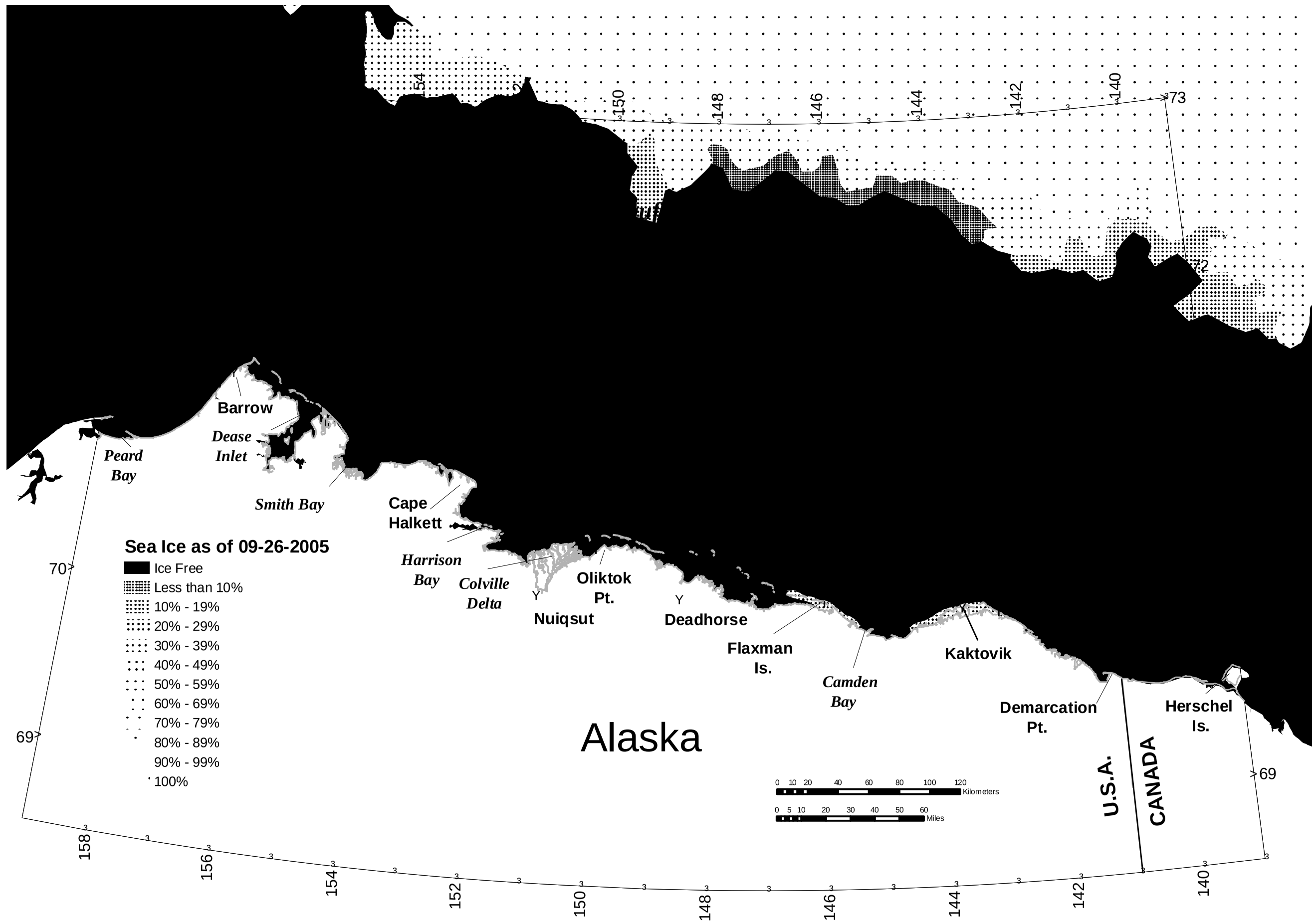

Map of Ice Concentrations in the Alaskan Beaufort Sea, 9 September 2005



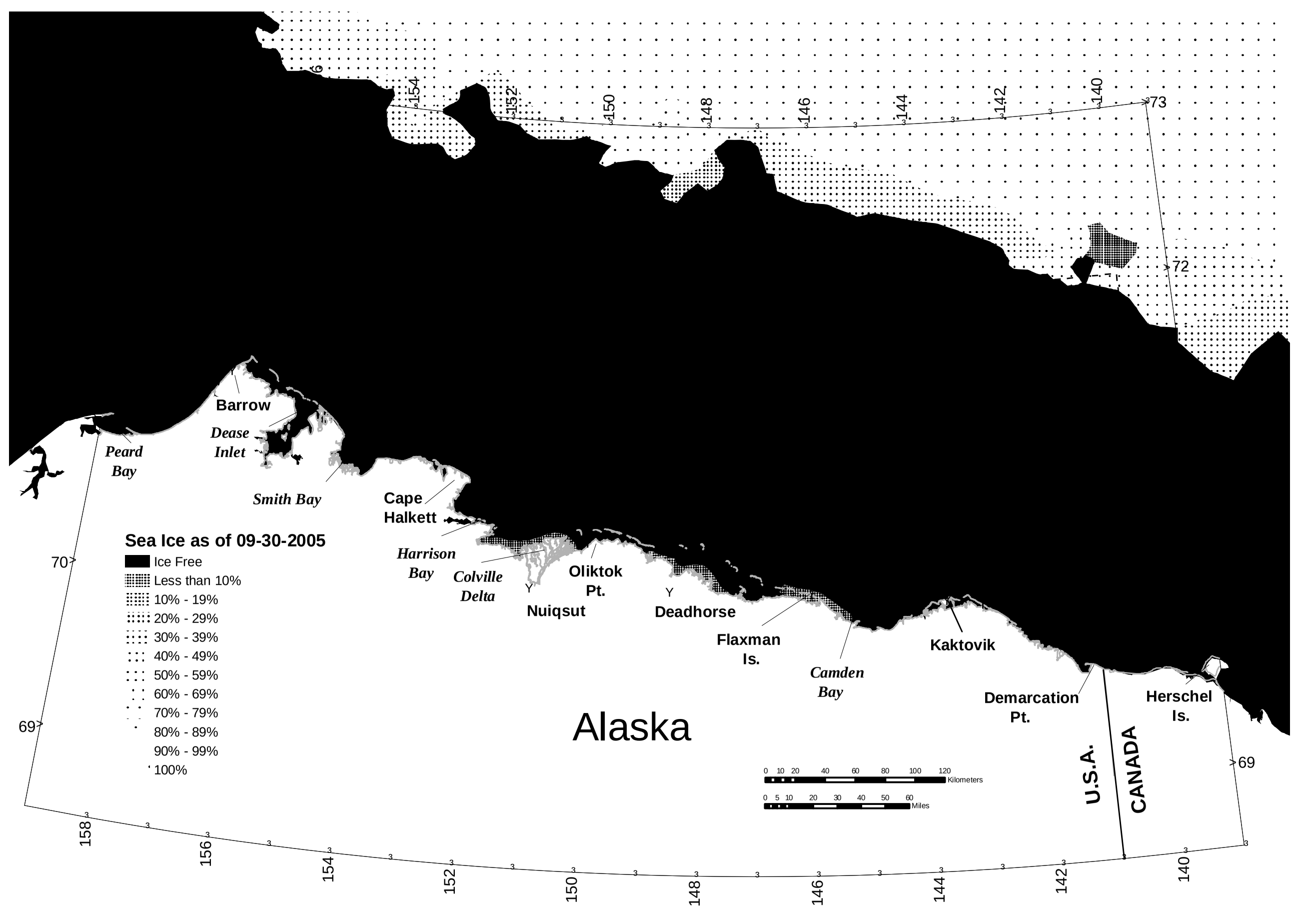

Map of Ice Concentrations in the Alaskan Beaufort Sea, 12 September 2005



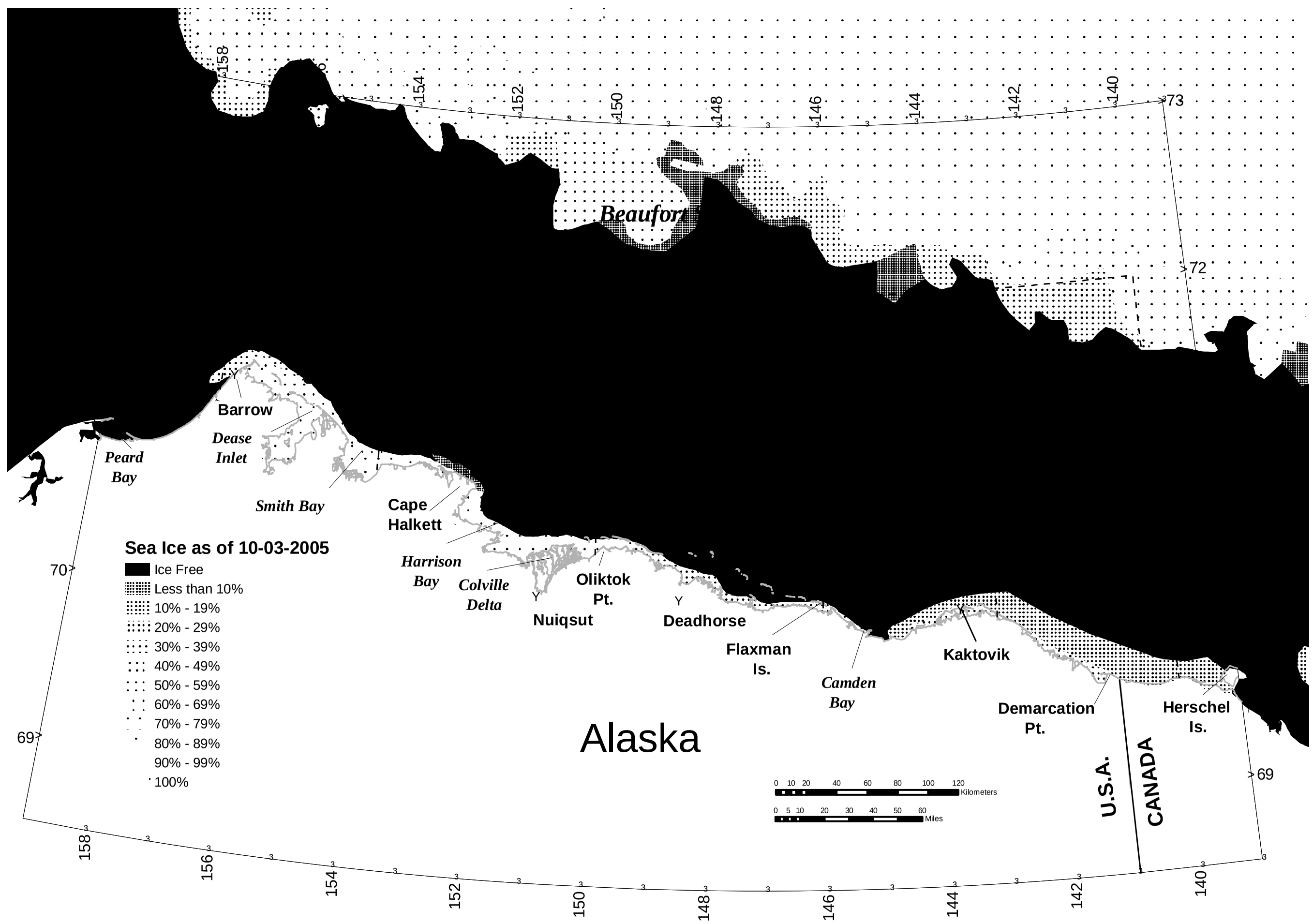

Map of Ice Concentrations in the Alaskan Beaufort Sea, 23 September 2005



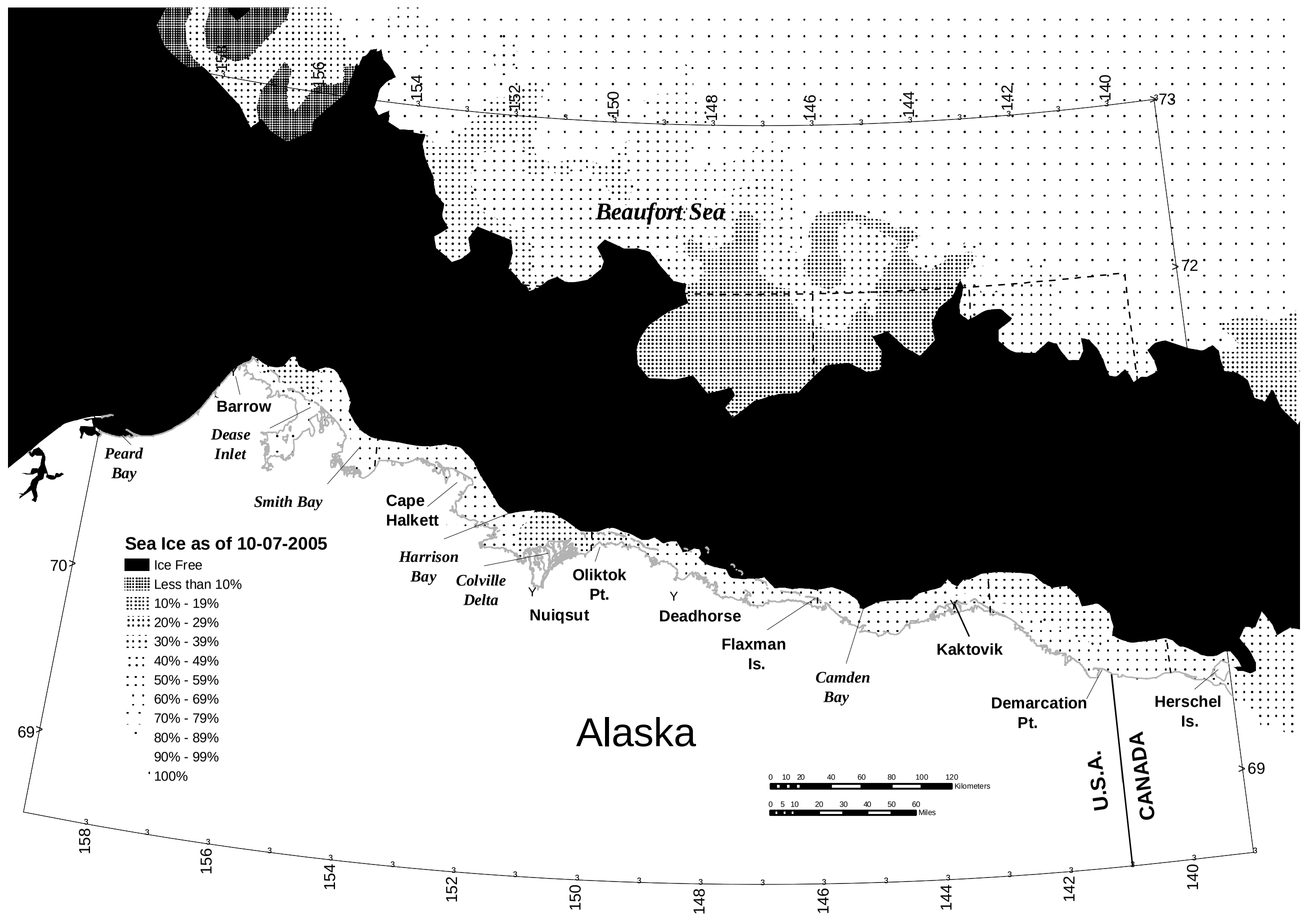

Map of Ice Concentrations in the Alaskan Beaufort Sea, 26 September 2005



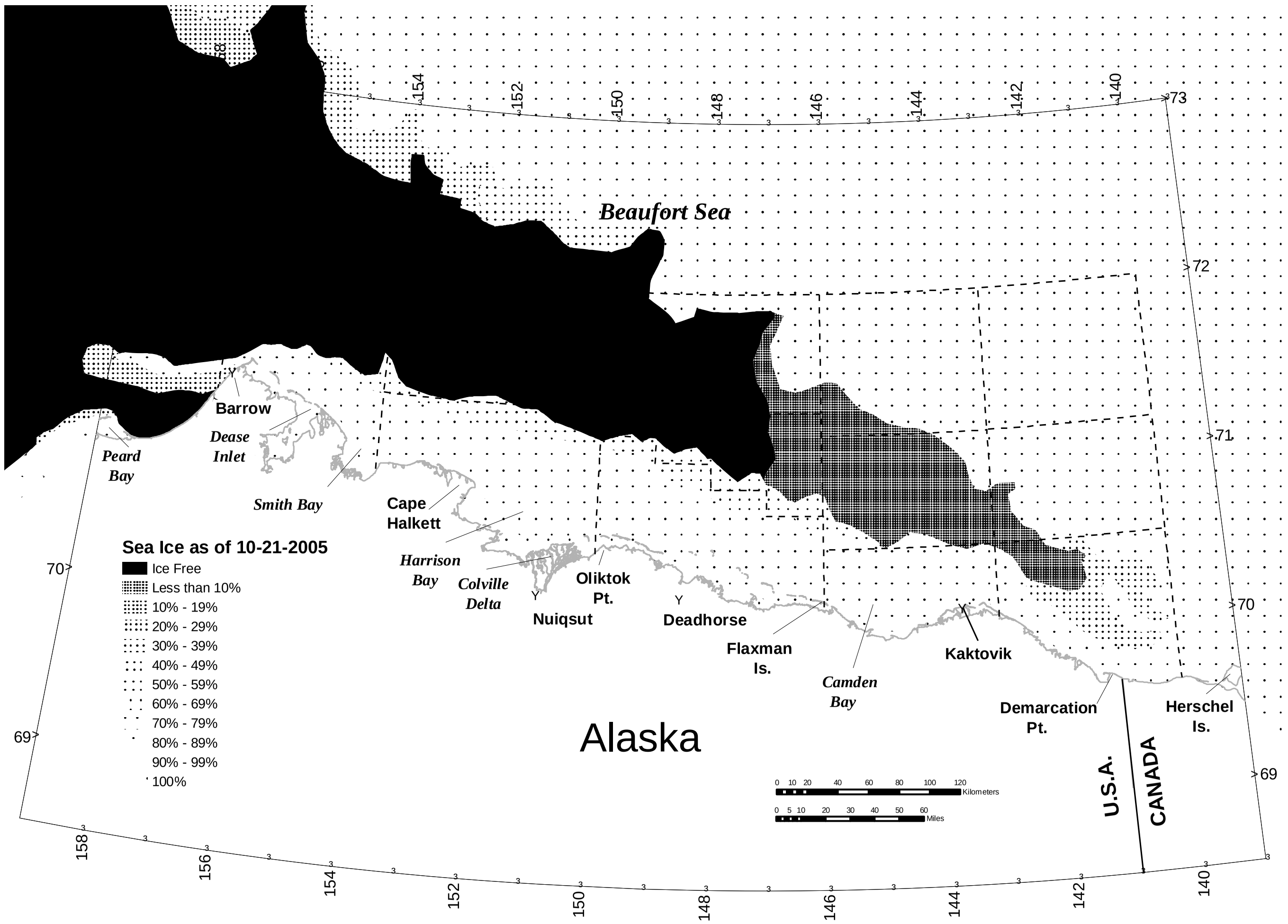

Map of Ice Concentrations in the Alaskan Beaufort Sea, 30 September 2005




Map of Ice Concentrations in the Alaskan Beaufort Sea, 3 October 2005




Map of Ice Concentrations in the Alaskan Beaufort Sea, 7 October 2005




Map of Ice Concentrations in the Alaskan Beaufort Sea, 21 October 2005

## APPENDIX B: FALL 2005 BOWHEAD WHALE SIGHTING DATA

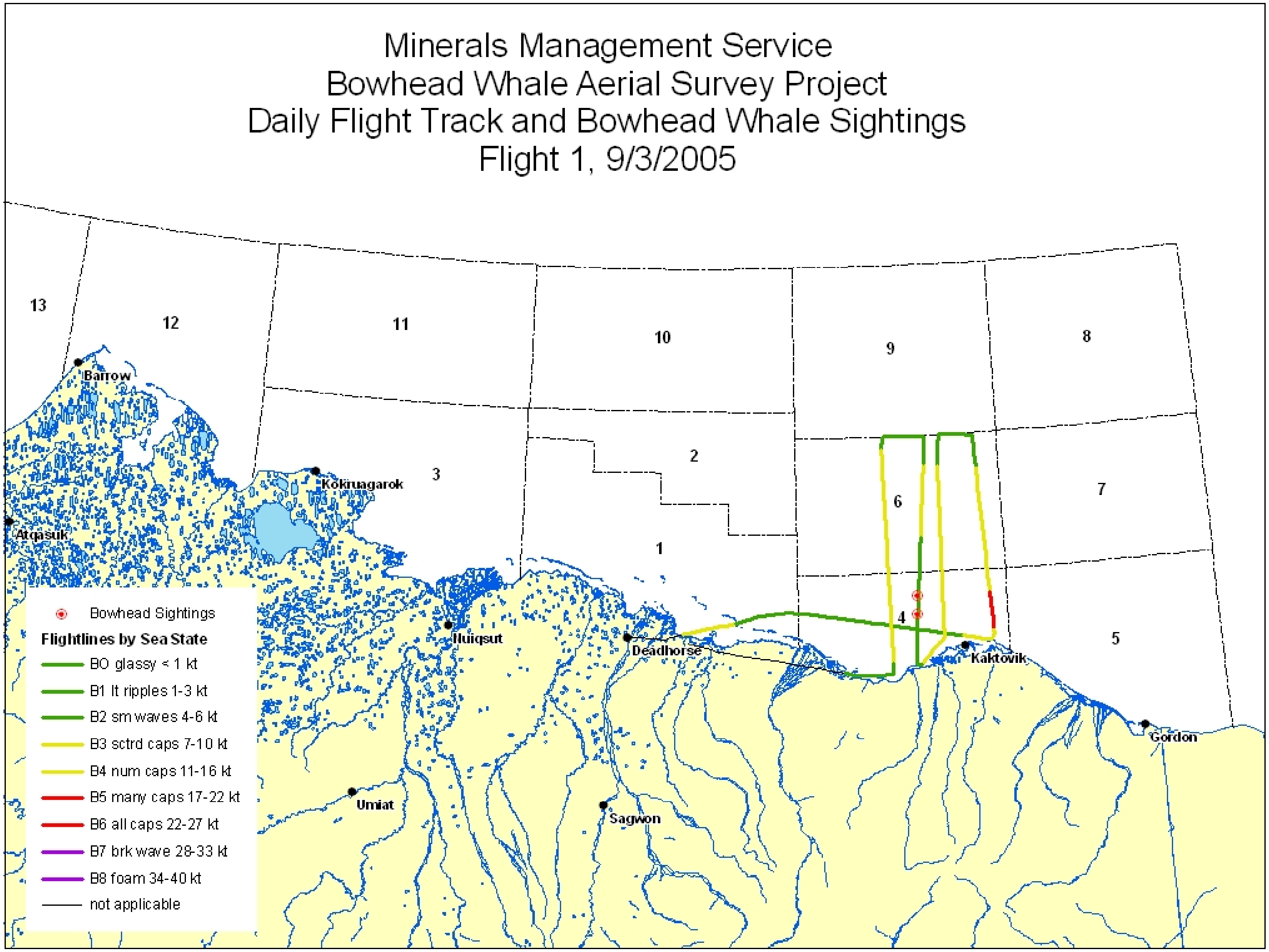
## Selected Sighting Data for Bowhead Whales Observed, Fall 2005

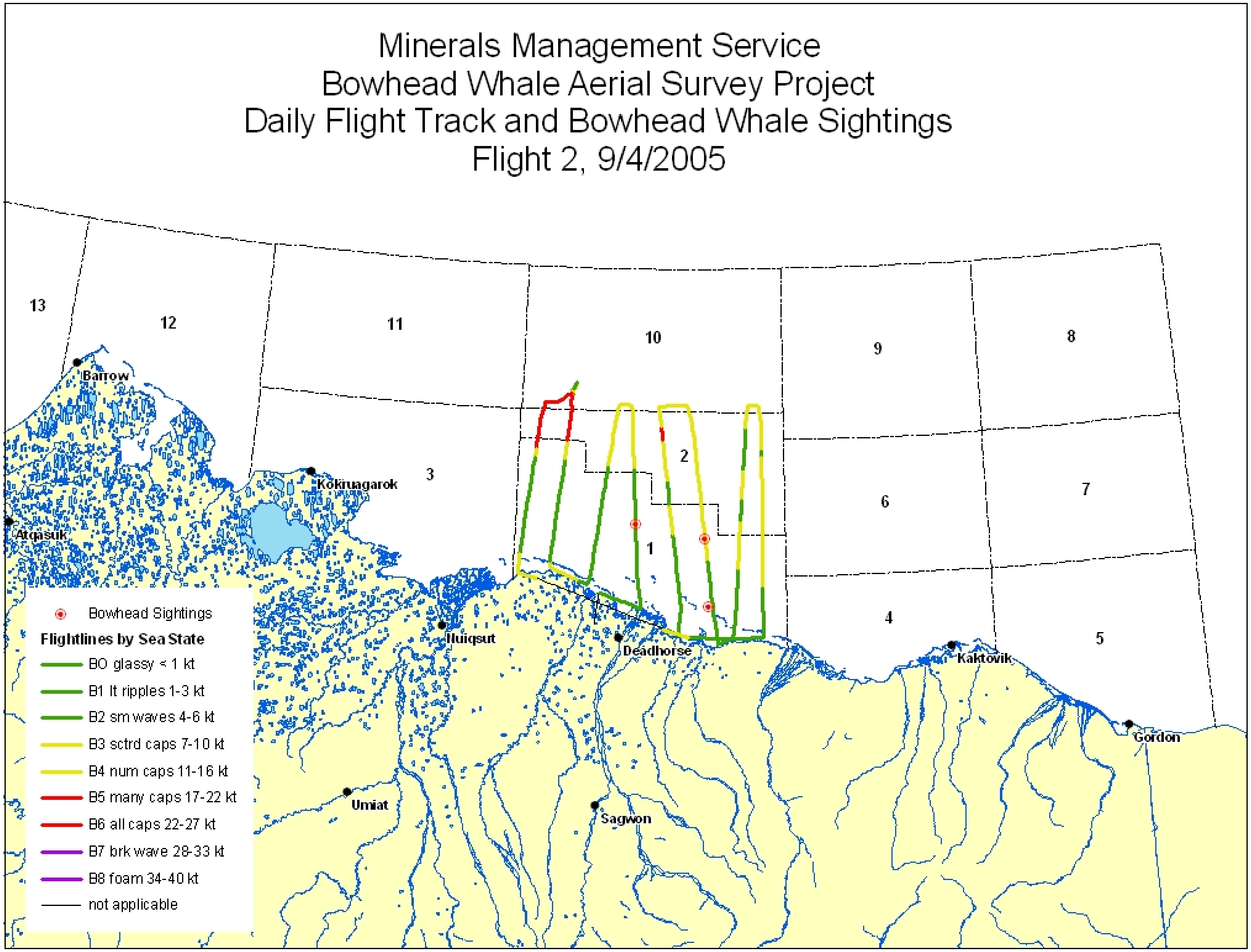
| Flight No. | Day | Total Whales | No of Calves | Latitude | Longitude | Behavior | Compass Heading | Ice (%) | Wind Force |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 Sep | 2 | 1 | 70º17.7' | 144º17.6' | swim | 250º | 0 | 1 |
| 1 | 3 Sep | 1 | 0 | 70º23.0' | 144º16.3' | dive | 180º | 0 | 1 |
| 2 | 4 Sep | 1 | 0 | 70º45.0' | 148º13.9' | swim | 240º | 10 | 1 |
| 2 | 4 Sep | 1 | 0 | 70º40.8' | 147º11.6' | swim | 10º | 1 | 3 |
| 2 | 4 Sep | 1 | 0 | 70º21.3' | 147º04.9' | breach | 155º | 50 | 2 |
| 3 | 5 Sep | 1 | 0 | 70º29.2' | 145º39.3' | swim | 290º | 0 | 3 |
| 4 | 6 Sep | 1 | 0 | 71º34.2' | 156º19.2' | rest | 260º | 0 | 3 |
| 5 | 8 Sep | 1 | 0 | 69º48.1' | 141º40.7' | swim | 180º | 0 | 3 |
| 5 | 8 Sep | 1 | 0 | 69º37.8' | 140º16.2' | swim | 270º | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º34.1' | 154º37.3' | swim | 250º | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º15.6' | 155º07.1' | feed | [1] | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º16.1' | 155º11.6' | feed | [1] | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º14.9' | 155º08.9' | swim | [1] | 0 | 3 |
| 6 | 8 Sep | 5 | 0 | 71º15.8' | 155º10.3' | feed | [1] | 0 | 3 |
| 6 | 8 Sep | 4 | 0 | 71º15.0' | 155º13.3' | feed | [1] | 0 | 3 |
| 6 | 8 Sep | 3 | 0 | 71º13.8' | 155º09.0' | feed | [1] | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º13.2' | 155º14.7' | feed | [1] | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º15.2' | 155º16.7' | feed | [1] | 0 | 3 |
| 6 | 8 Sep | 2 | 0 | 71º16.5' | 155º20.6' | mill | [1] | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º13.4' | 155º06.5' | mill | [1] | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º15.4' | 155º07.0' | mill | 250º | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º30.8' | 155º10.2' | swim | 100º | 0 | 3 |
| 6 | 8 Sep | 1 | 0 | 71º45.1' | 155º12.8' | rest | 120º | 0 | 3 |
| 6 | 8 Sep | 7 | 0 | 71º40.6' | 155º38.3' | swim | 60º | 0 | 2 |
| 6 | 8 Sep | 2 | 0 | 71º38.0' | 155º38.7' | swim | 330º | 0 | 2 |
| 6 | 8 Sep | 2 | 0 | 71º37.6' | 155º36.4' | swim | [1] | 0 | 2 |
| 6 | 8 Sep | 6 | 0 | 71º31.9' | 155º37.7' | feed | 230º | 0 | 2 |
| 6 | 8 Sep | 6 | 0 | 71º29.4' | 155º41.0' | feed | [1] | 0 | 2 |
| 6 | 8 Sep | 2 | 0 | 71º02.6' | 153º54.4' | feed | 100º | 0 | 2 |
| 7 | 13 Sep | 1 | 0 | 70º10.5' | 143º49.6' | swim | 230º | 0 | 3 |
| 7 | 13 Sep | 1 | 0 | 70º12.1' | 143º24.3' | swim | 240º | 0 | 3 |
| 7 | 13 Sep | 1 | 0 | 70º12.0' | 143º20.3' | swim | 240º | 0 | 3 |
| 7 | 13 Sep | 1 | 0 | 69º56.9' | 141º53.0' | swim | 180º | 0 | 2 |
| 7 | 13 Sep | 2 | 0 | 70º04.1' | 141º41.2' | swim | 250º | 0 | 3 |
| 7 | 13 Sep | 1 | 0 | 69º54.9' | 141º37.8' | swim | 250º | 0 | 3 |
| 7 | 13 Sep | 2 | 0 | 70º04.2' | 142º24.5' | swim | 280º | 0 | 2 |
| 7 | 13 Sep | 1 | 0 | 70º09.4' | 142º21.0' | swim | 80º | 0 | 3 |
| 7 | 13 Sep | 3 | 1 | 70º09.4' | 142º21.0' | mill | [1] | 0 | 3 |
| 7 | 13 Sep | 1 | 0 | 70º09.4' | 142º22.3' | swim | 300º | 0 | 3 |
| 7 | 13 Sep | 1 | 0 | 70º18.5' | 142º15.1' | swim | 70º | 0 | 3 |

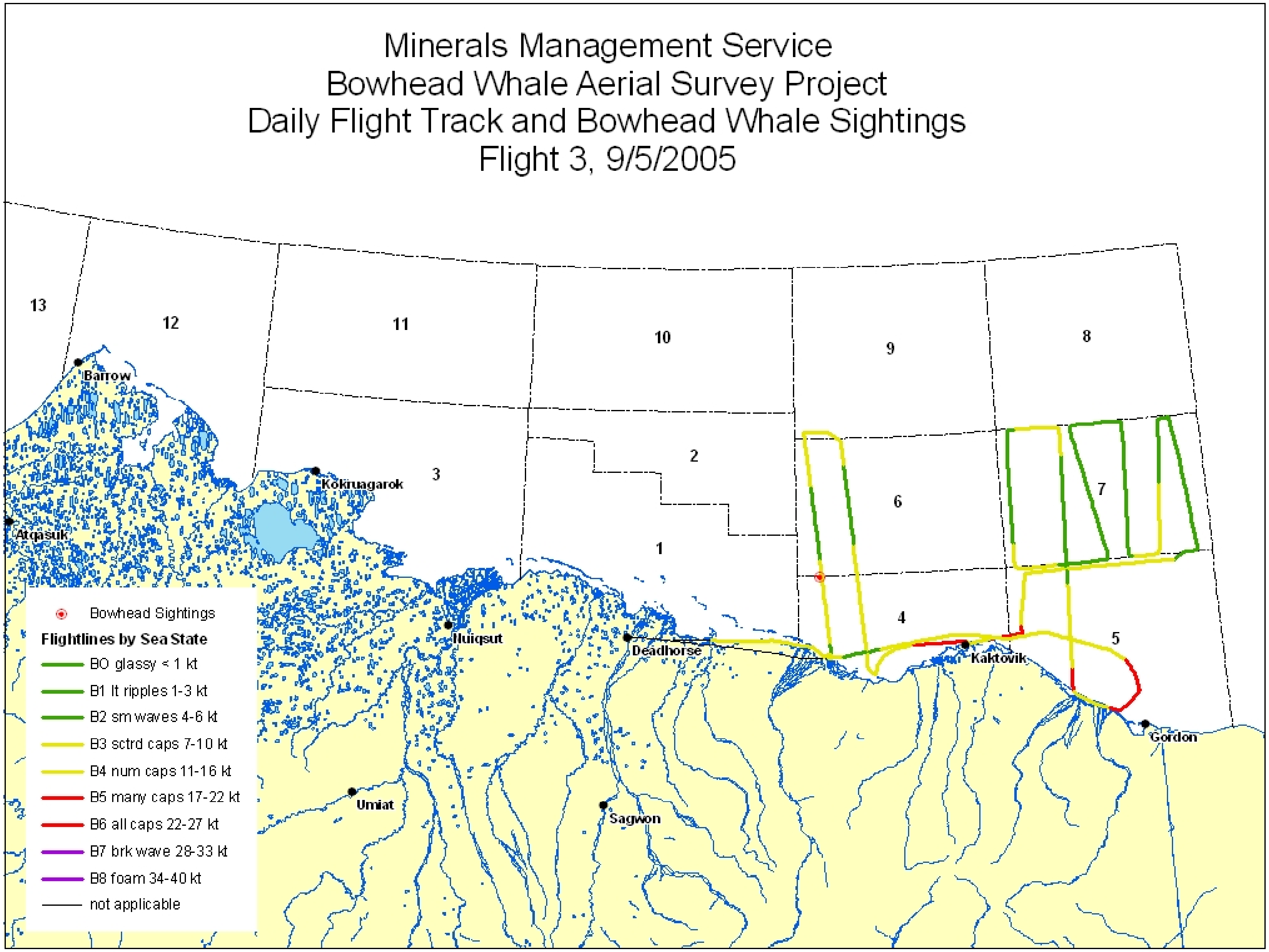
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7 | 13 Sep | 2 | 1 | 70º11.5' | 143º26.1' | swim | 240º | 0 | 2 |
| **Flight No.** | **Day** | **Total Whales** | **No of Calves** | **Latitude** | **Longitude** | **Behavior** | **Compass Heading** | **Ice (%)** | **Wind Force** |
| 7 | 13 Sep | 1 | 0 | 70º14.3' | 143º23.6' | swim | 230º | 0 | 3 |
| 7 | 13 Sep | 3 | 0 | 70º29.2' | 143º57.8' | swim | 250º | 0 | 3 |
| 7 | 13 Sep | 3 | 0 | 70º28.6' | 143º57.9' | swim | 350º | 0 | 3 |
| 7 | 13 Sep | 1 | 0 | 70º20.4' | 143º52.0' | swim | 240º | 0 | 3 |
| 7 | 13 Sep | 1 | 0 | 70º12.4' | 143º46.7' | swim | 240º | 0 | 2 |
| 8 | 14 Sep | 1 | 0 | 70º59.2' | 149º42.5' | swim | 230º | 0 | 2 |
| 8 | 14 Sep | 2 | 0 | 71º17.4' | 151º43.3' | log play | [1] | 1 | 1 |
| 8 | 14 Sep | 1 | 0 | 71º07.1' | 151º05.6' | swim | 260º | 10 | 2 |
| 9 | 14 Sep | 1 | 0 | 71º06.3' | 150º57.3' | swim | 135º | 5 | 1 |
| 9 | 14 Sep | 10 | 1 | 70º54.9' | 149º42.3' | feed | [1] | 0 | 1 |
| 9 | 14 Sep | 1 | 0 | 70º59.4' | 149º43.1' | swim | 150º | 0 | 1 |
| 9 | 14 Sep | 2 | 0 | 71º03.1' | 149º43.6' | swim | 210º | 0 | 2 |
| 10 | 19 Sep | 1 | 0 | 70º10.6' | 144º51.7' | swim | 10º | 0 | 6 |
| 11 | 20 Sep | 1 | 0 | 70º09.8' | 143º52.5' | swim | 250º | 0 | 4 |
| 14 | 30 Sep | 2 | 0 | 71º14.3' | 154º17.4' | swim | 70º | 0 | 6 |
| 14 | 30 Sep | 1 | 0 | 71º16.3' | 154º17.3' | swim | 250º | 0 | 6 |
| 14 | 30 Sep | 1 | 0 | 71º27.1' | 156º57.6' | swim | 300º | 0 | 5 |
| 14 | 30 Sep | 2 | 1 | 71º24.0' | 156º57.6' | swim | 210º | 0 | 5 |
| 14 | 30 Sep | 1 | 0 | 71º23.4' | 156º57.5' | swim | 210º | 0 | 5 |
| 14 | 30 Sep | 2 | 0 | 71º22.3' | 156º57.2' | swim | 240º | 0 | 5 |
| 14 | 30 Sep | 1 | 0 | 71º19.3' | 156º57.3' | swim | 330º | 0 | 5 |
| 16 | 4 Oct | 1 | 0 | 71º34.2' | 156º31.2' | swim | 340º | 0 | 3 |
| 16 | 4 Oct | 2 | 0 | 71º27.4' | 155º42.9' | swim | 360º | 0 | 1 |
| 17 | 6 Oct | 1 | 0 | 71º19.6' | 156º40.9' | feed | 300º | 0 | 2 |
| 19 | 9 Oct | 1 | 0 | 71º05.3' | 154º29.7' | swim | 180º | 90 | 2 |
| 19 | 9 Oct | 1 | 0 | 71º27.3' | 156º16.8' | swim | 180º | 20 | 5 |
| 19 | 9 Oct | 1 | 0 | 71º27.8' | 156º16.9' | swim | 180º | 20 | 5 |
| 19 | 9 Oct | 1 | 0 | 71º26.9' | 156º11.1' | swim | 360º | 60 | 3 |
| 19 | 9 Oct | 1 | 0 | 71º02.3' | 154º03.3' | swim | 90º | 40 | 5 |
| 20 | 13 Oct | 1 | 0 | 71º08.5' | 149º51.1' | swim | 240º | 0 | 2 |
| 20 | 13 Oct | 1 | 0 | 70º30.8' | 148º17.1' | rest | 210º | 100 | 1 |
| 21 | 13 Oct | 4 | 0 | 71º10.7' | 150º41.5' | swim | 260º | 0 | 2 |
| 21 | 13 Oct | 1 | 0 | 71º11.4' | 150º41.6' | dive | [1] | 0 | 2 |
| 22 | 14 Oct | 1 | 0 | 71º03.4' | 149º22.1' | swim | 300º | 0 | 2 |
| 22 | 14 Oct | 2 | 0 | 70º45.7' | 147º11.8' | swim | 270º | 0 | 2 |
| 23 | 15 Oct | 1 | 0 | 70º30.3' | 143º36.1' | swim | 240º | 50 | 1 |
| 26 | 20 Oct | 1 | 0 | 71º30.2' | 155º57.5' | swim | 270º | 40 | 4 |
| 26 | 20 Oct | 1 | 0 | 71º16.3' | 153º13.9' | swim | 270º | 5 | 1 |
| 26 | 20 Oct | 1 | 0 | 71º16.7' | 153º16.1' | swim | 280º | 5 | 1 |
| 26 | 20 Oct | 1 | 0 | 71º16.1' | 153º13.6' | rest | 240º | 5 | 1 |

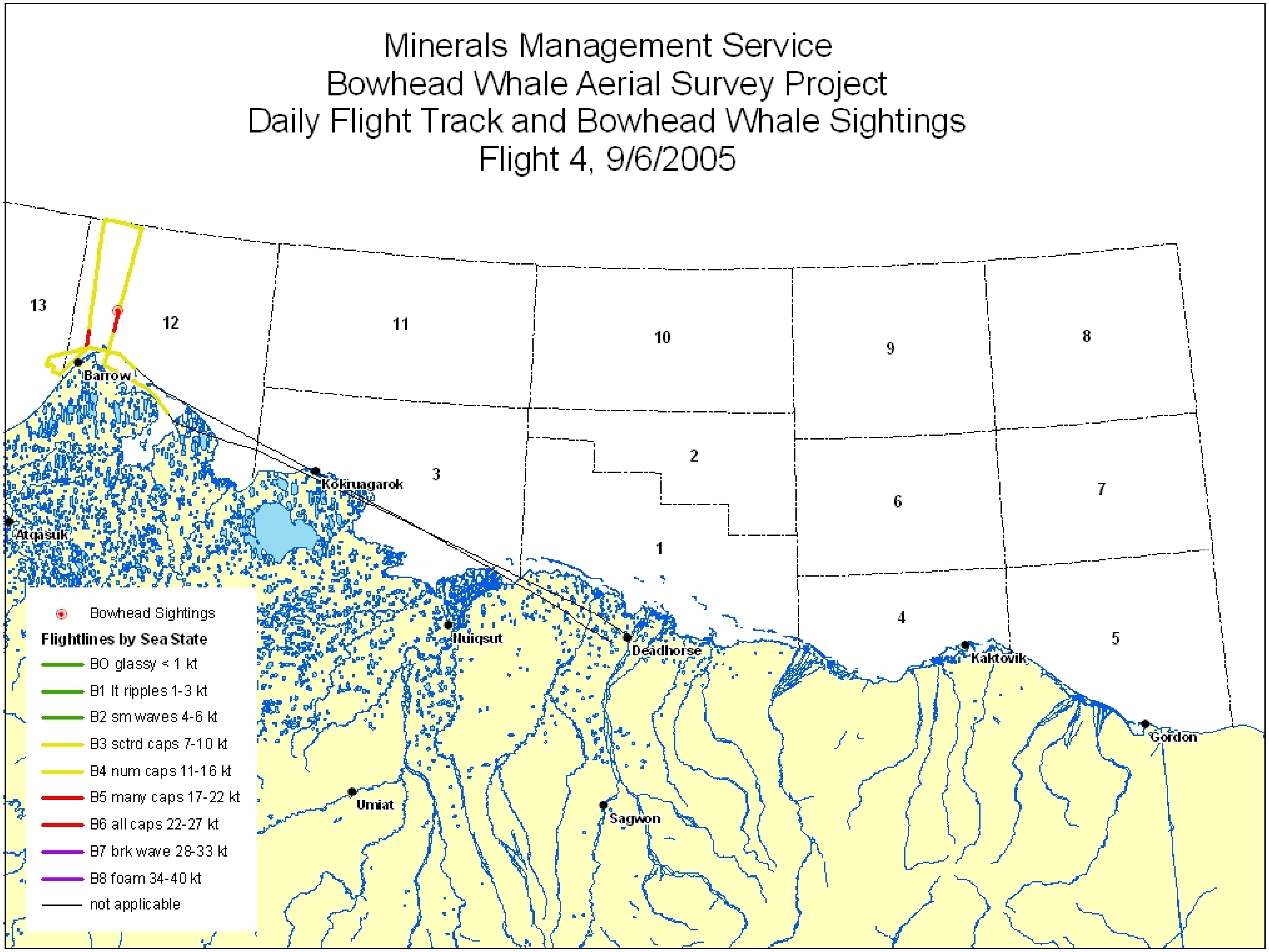
[1] Compass heading not reported.

## APPENDIX C: FALL 2005 DAILY FLIGHT SUMMARIES

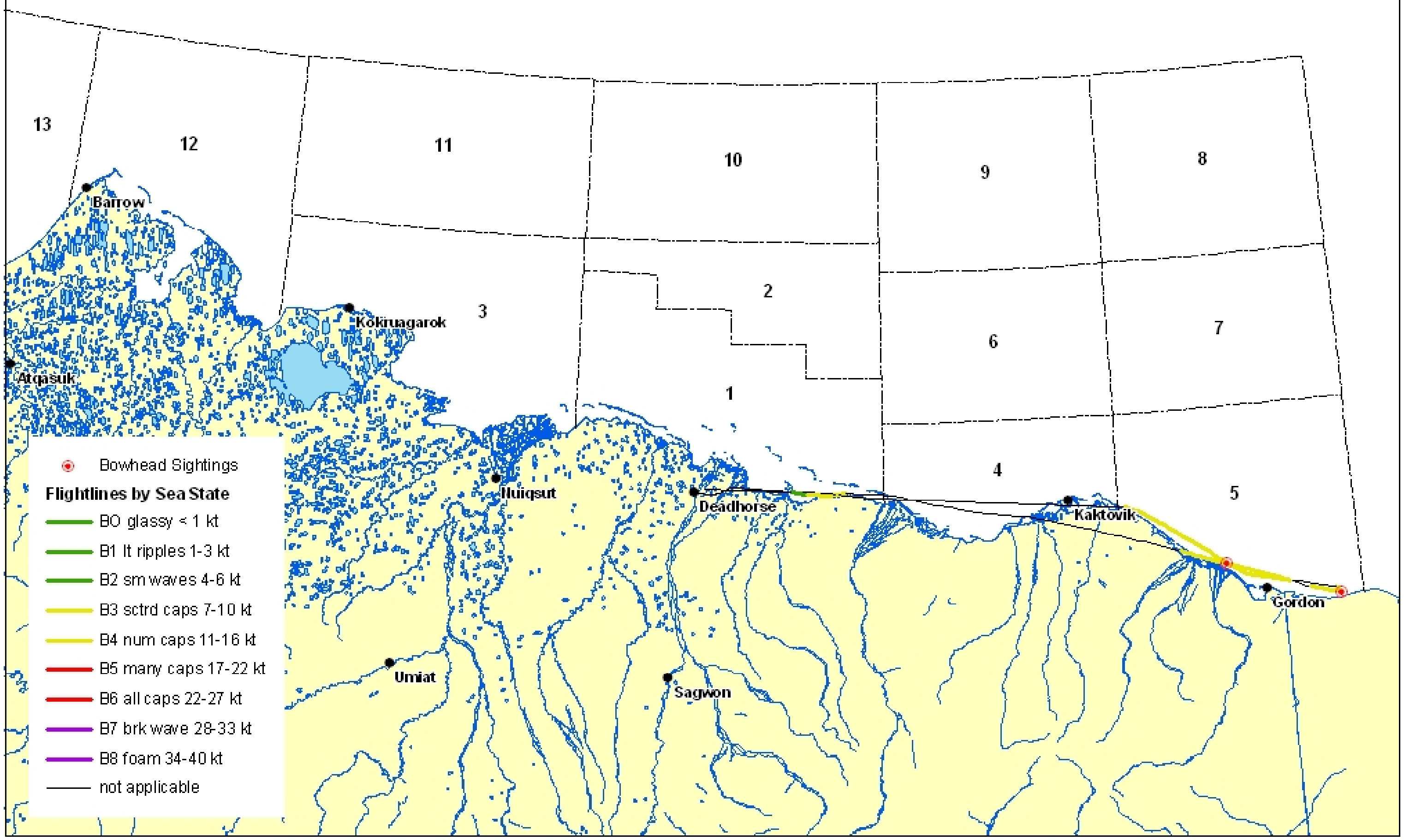

Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 1, 9/3/2005
13
12
11
10
9
8
3
2
6
7
1
4
5
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable

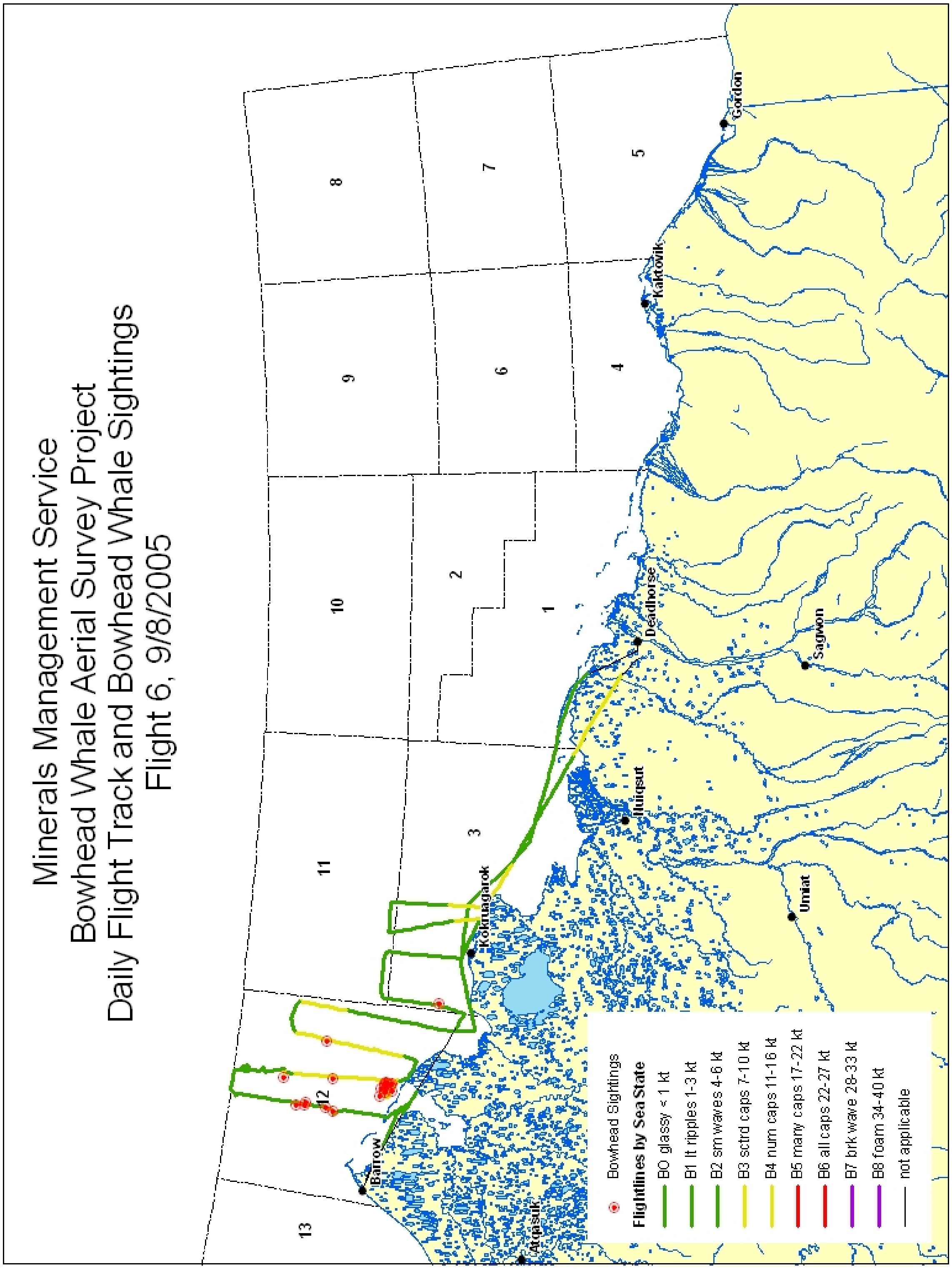

Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 2, 9/4/2005
13
12
11
10
9
8
3
2
1
6
7
4
5
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 3, 9/5/2005
13
12
11
10
9
8
3
2
1
6
7
4
5
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable

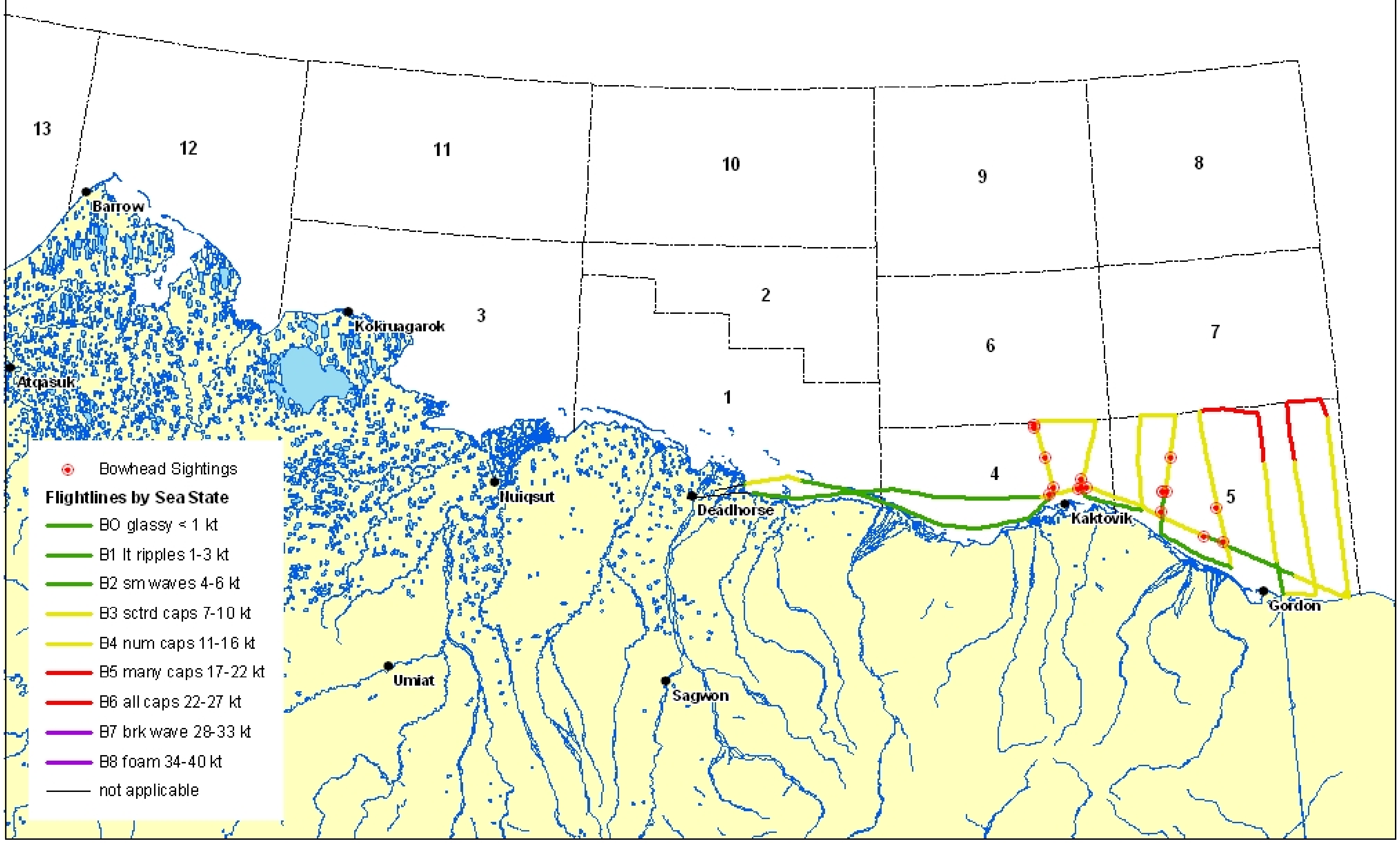

Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 4, 9/6/2005
13
12
11
10
9
8
3
2
6
7
1
4
5
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable

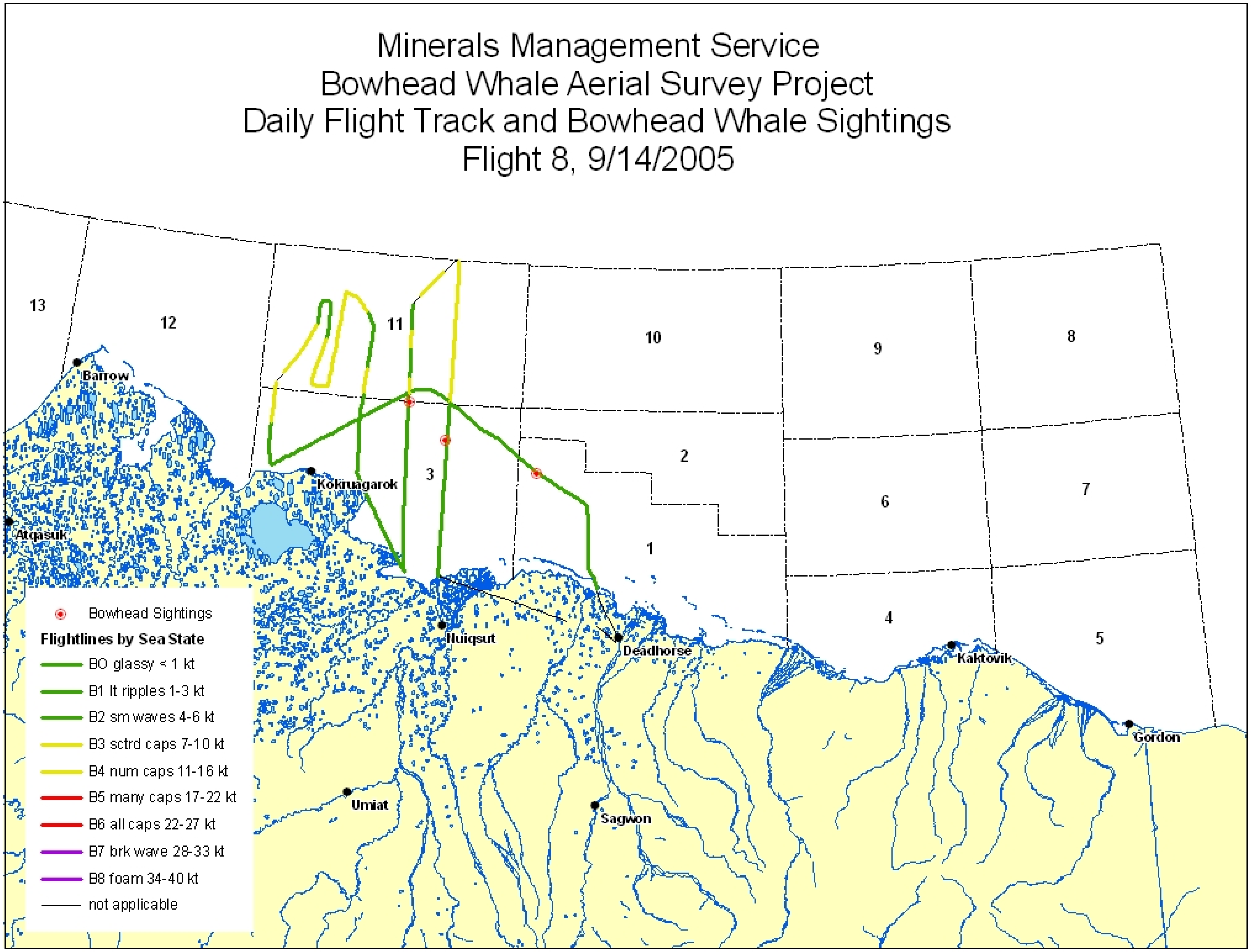
Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 5, 9/8/2005




Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 6, 9/8/2005
1
2
3
4
5
6
7
8
9
10
11
12
13
Gordon
Kaktovik
Deadhorse
Sagwon
Nuiqsut
Umiat
Kokruagarok
Barrow
Atqasuk
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable

Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 7, 9/13/2005




Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 8, 9/14/2005
13
12
11
10
9
8
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2
6
7
1
4
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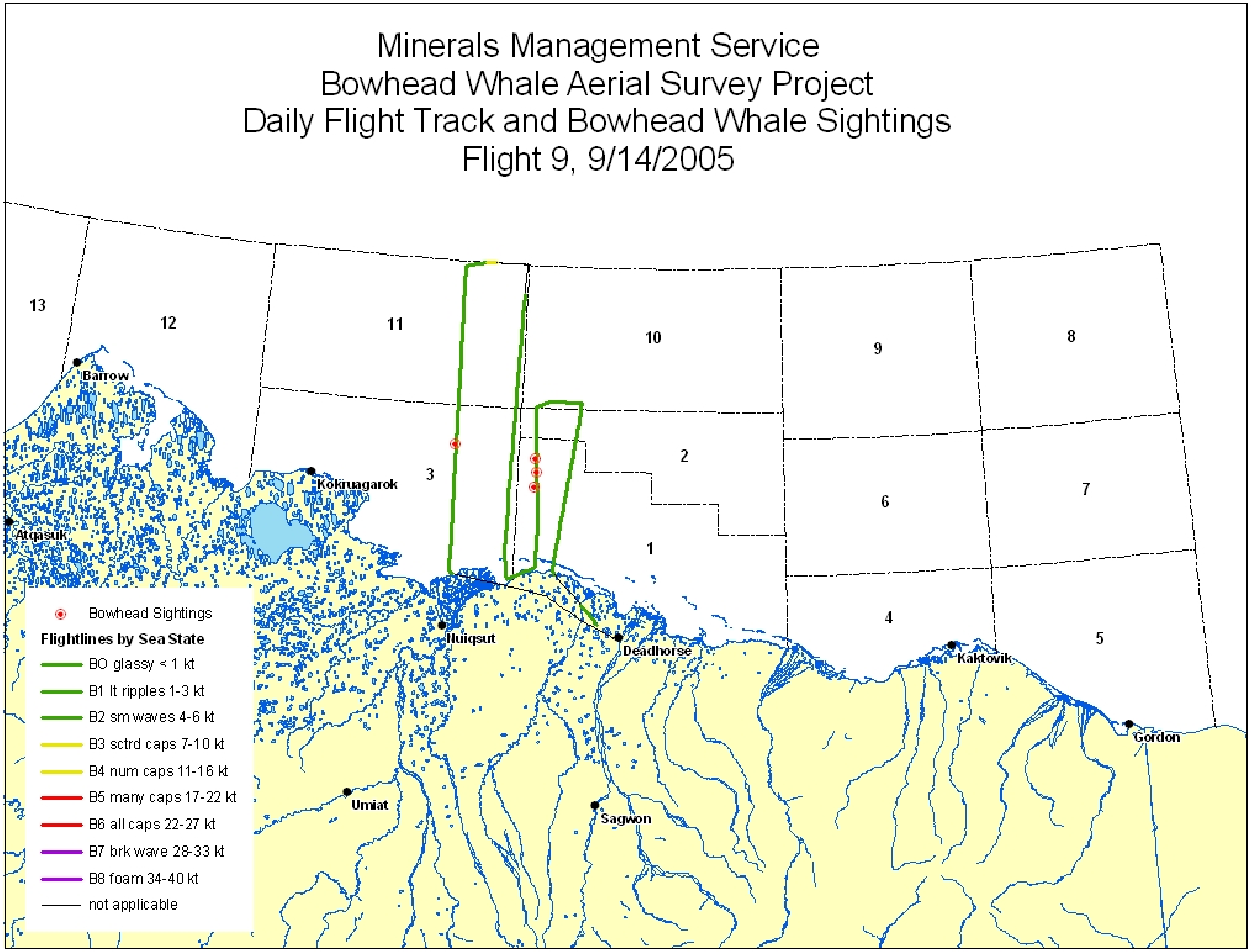
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 9, 9/14/2005
13
12
11
10
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7
1
4
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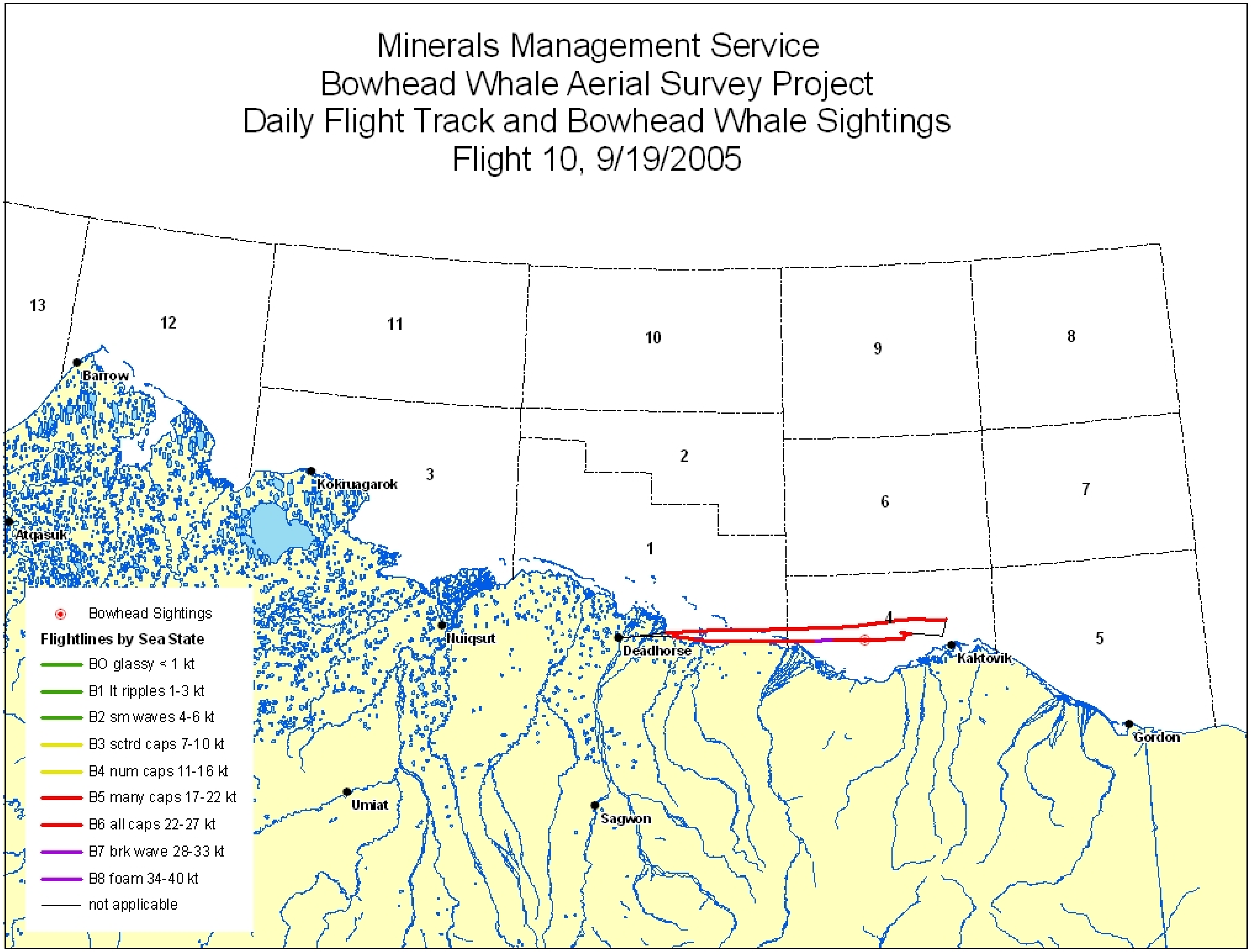
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 10, 9/19/2005
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12
11
10
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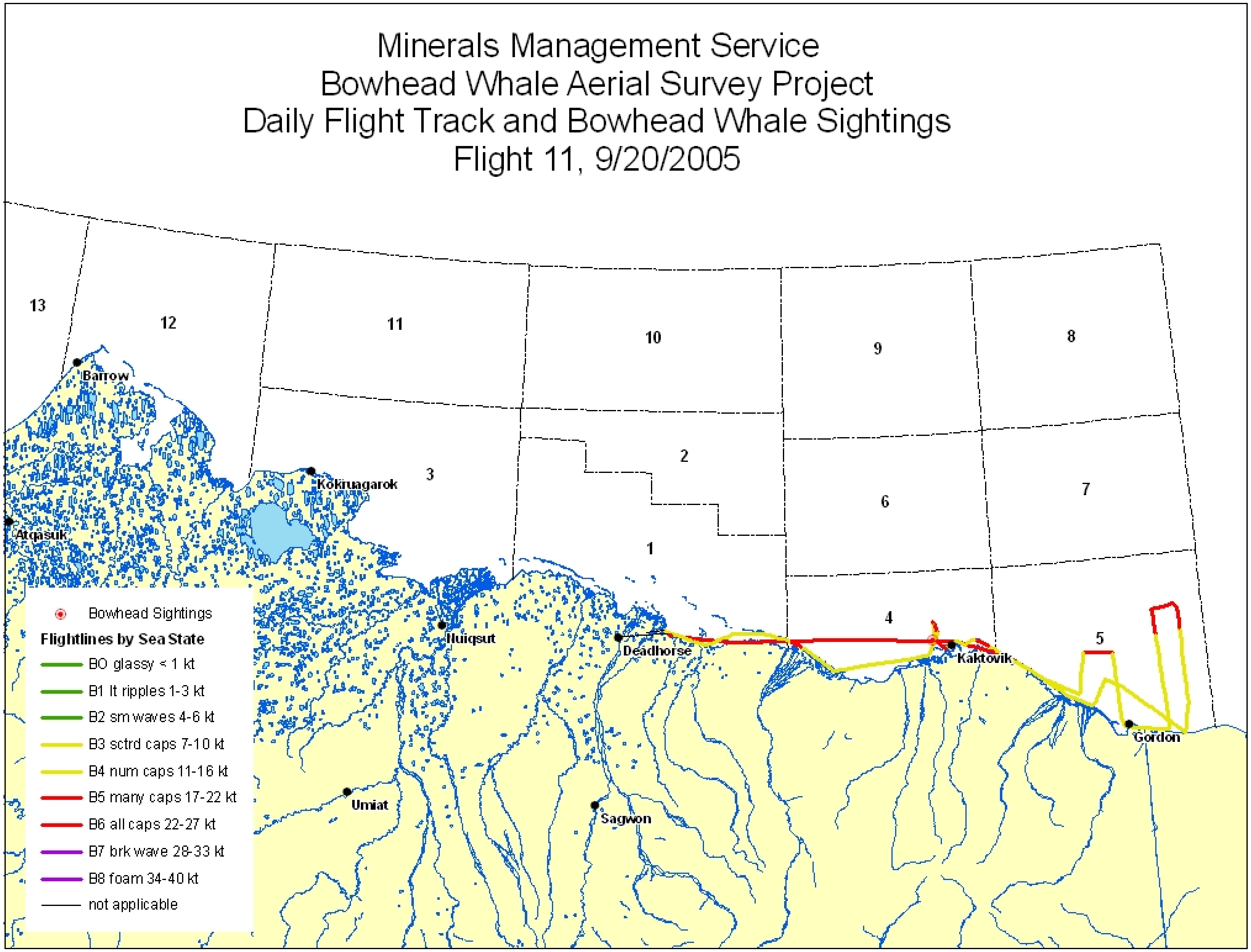
2
6
7
1
4
5
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 11, 9/20/2005
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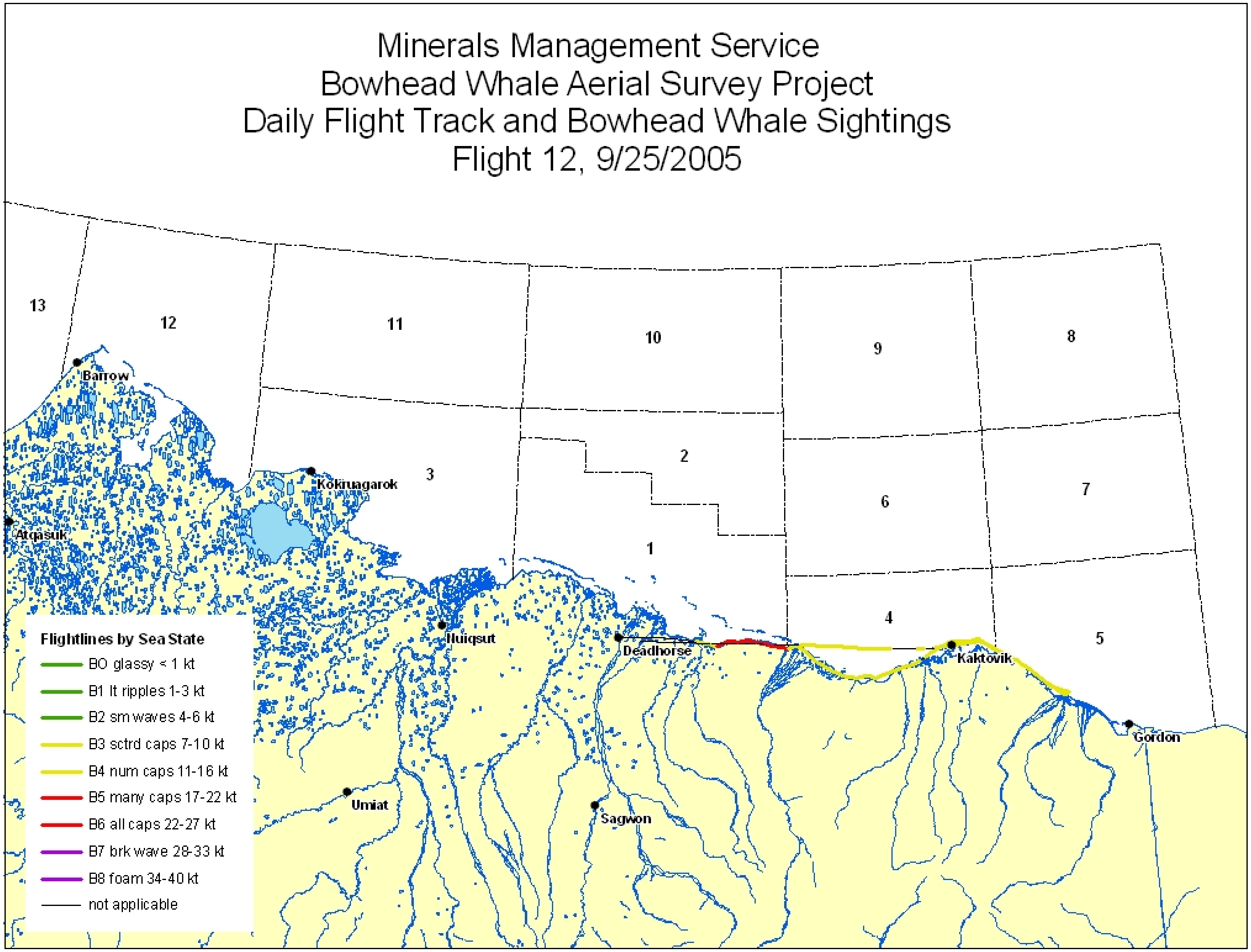
12
11
10
9
8
3
2
6
7
1
4
5
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable



Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 12, 9/25/2005
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12
11
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7
1
4
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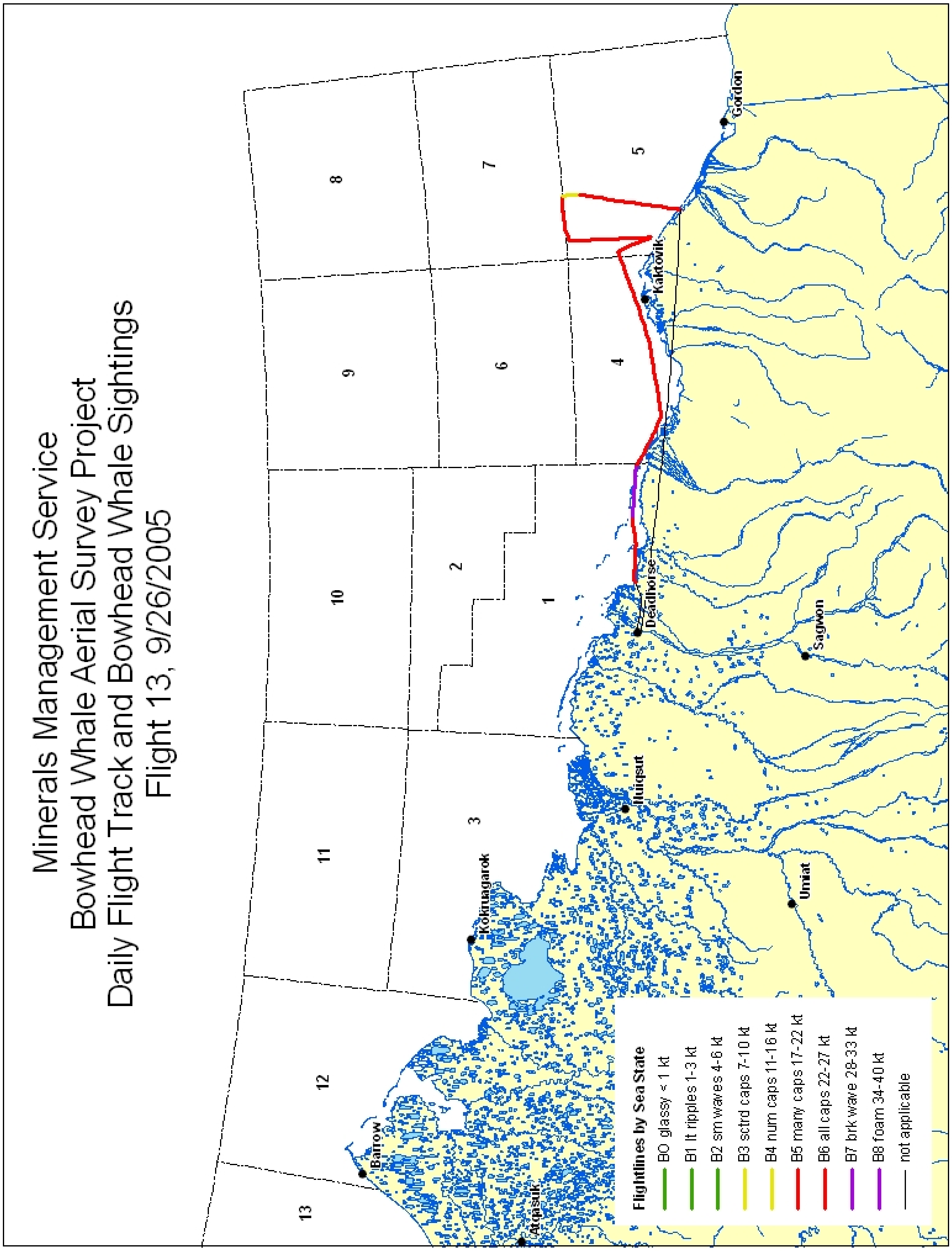
Barrow
Kokruagarok
Atqasuk
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 13, 9/26/2005
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Umiat
Sagwon
Kaktovik
Gordon
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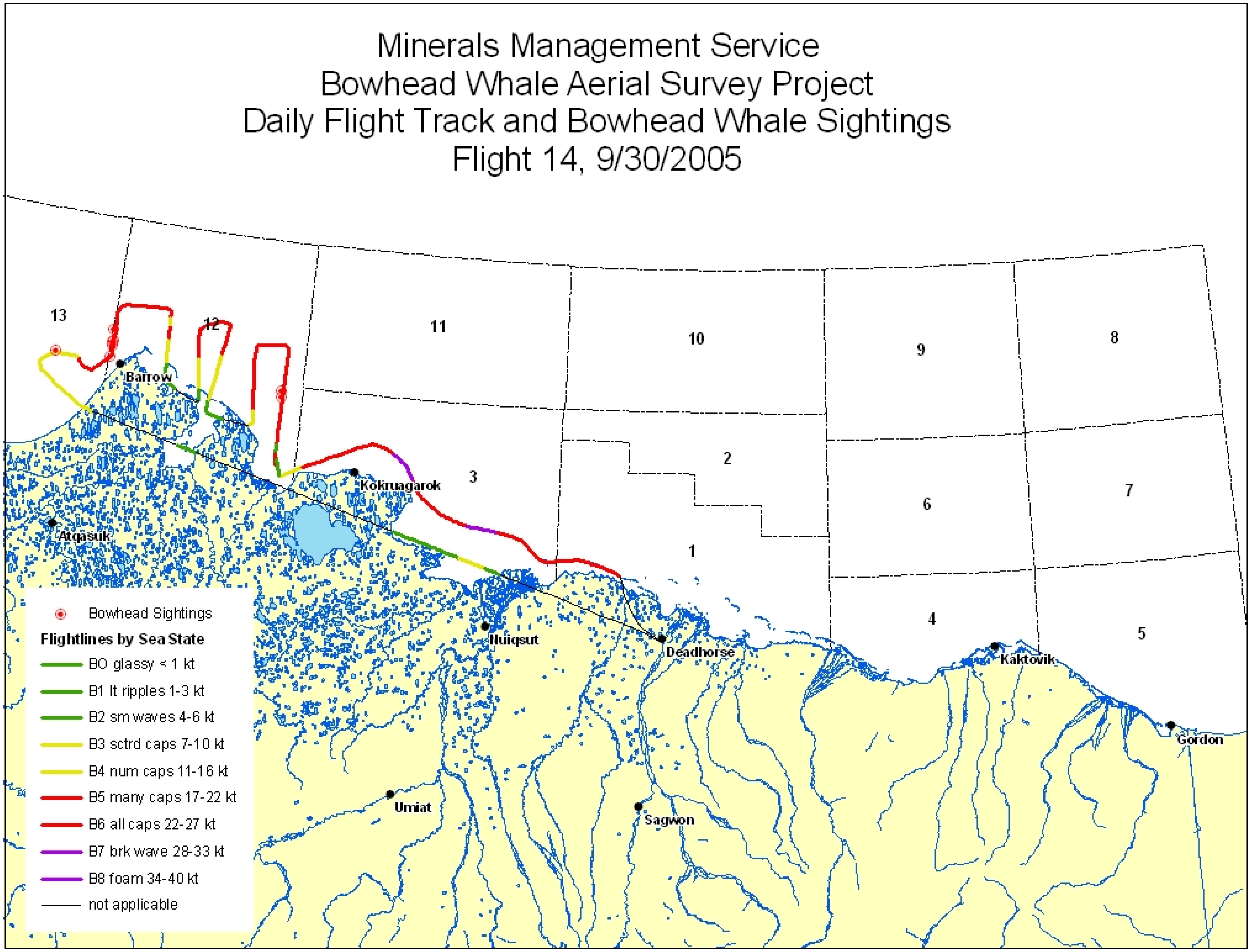

Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 14, 9/30/2005
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12
11
10
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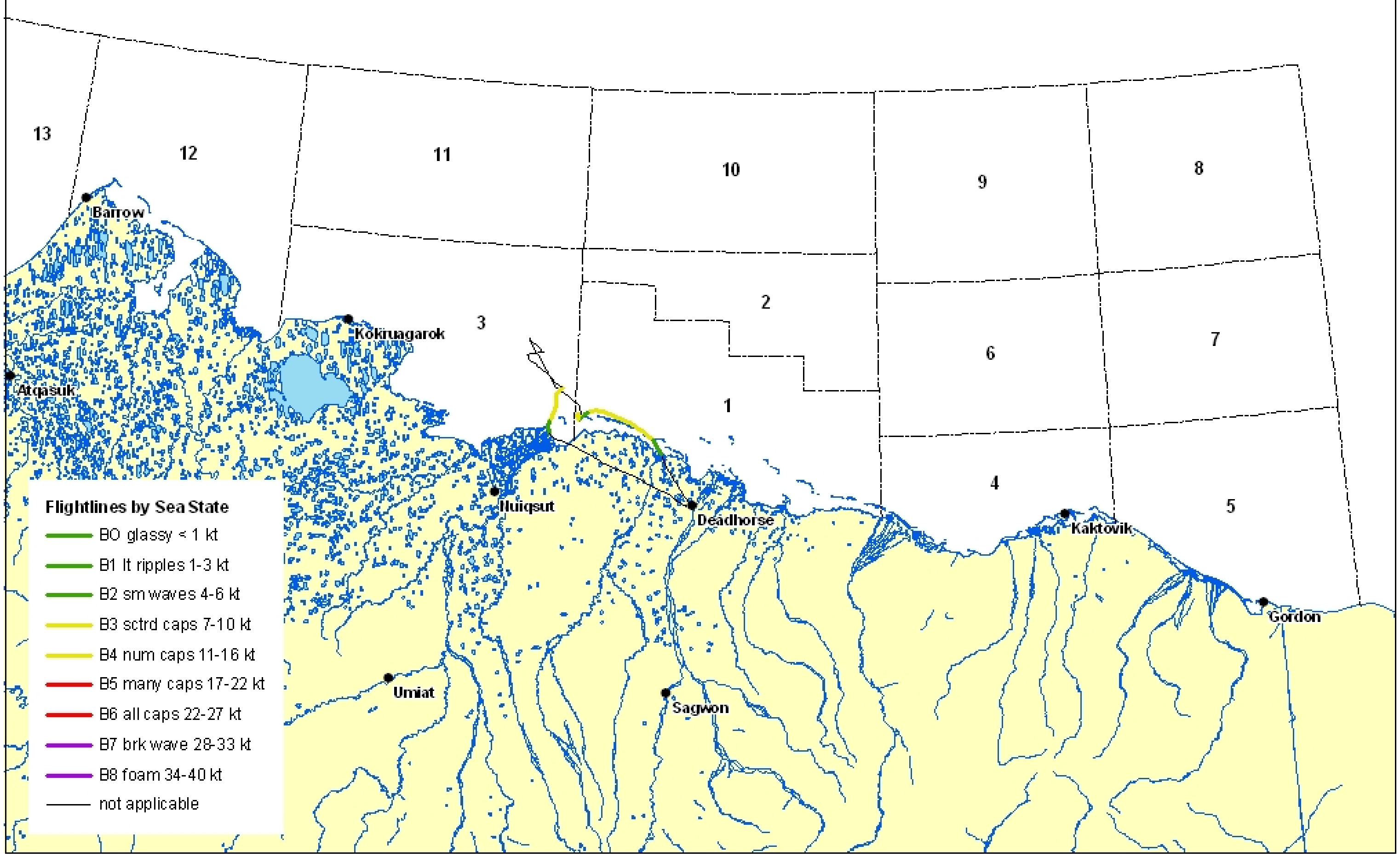
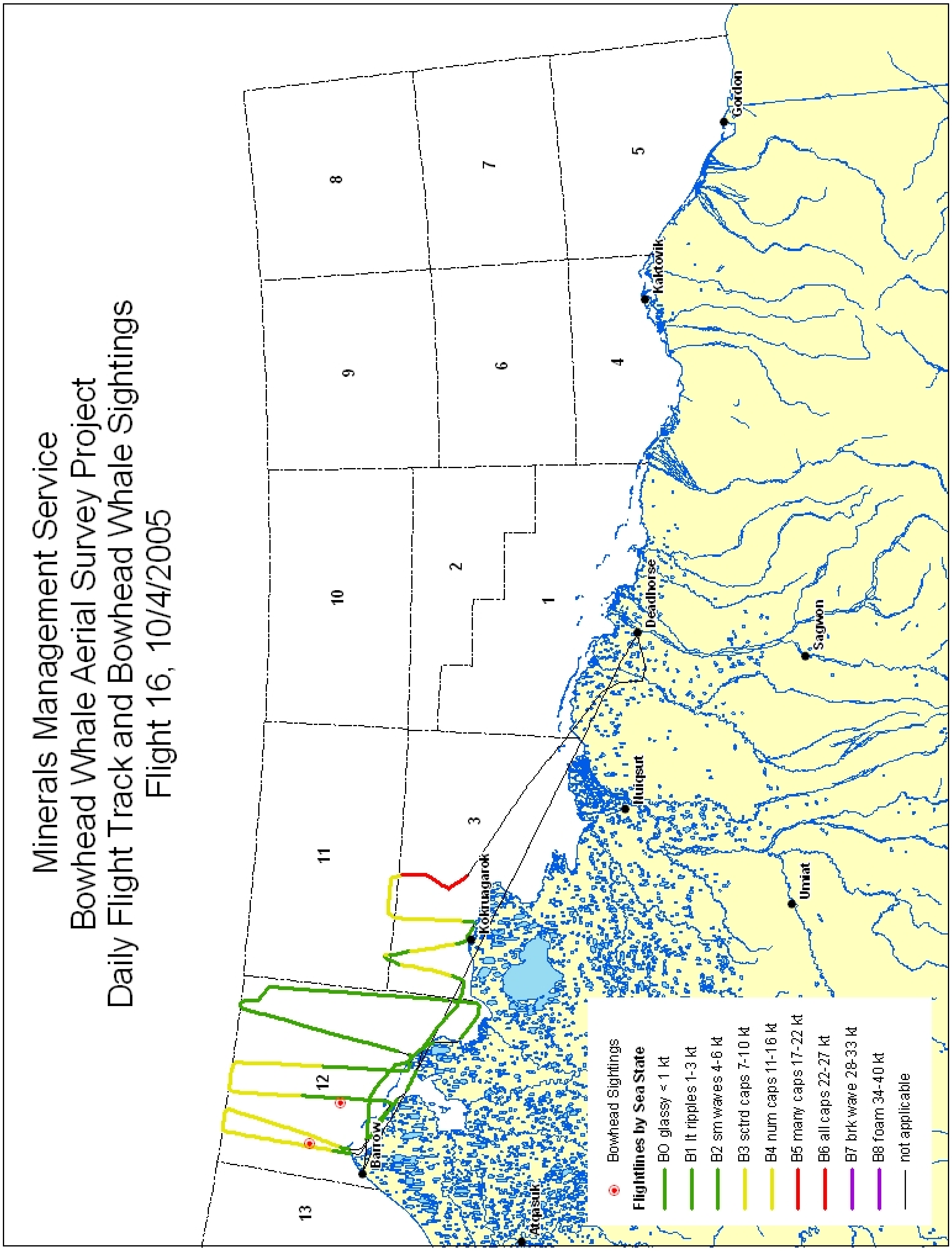
2
1
6
7
4
5
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable

Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 15, 10/2/2005




Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 16, 10/4/2005
13
12
11
10
9
8
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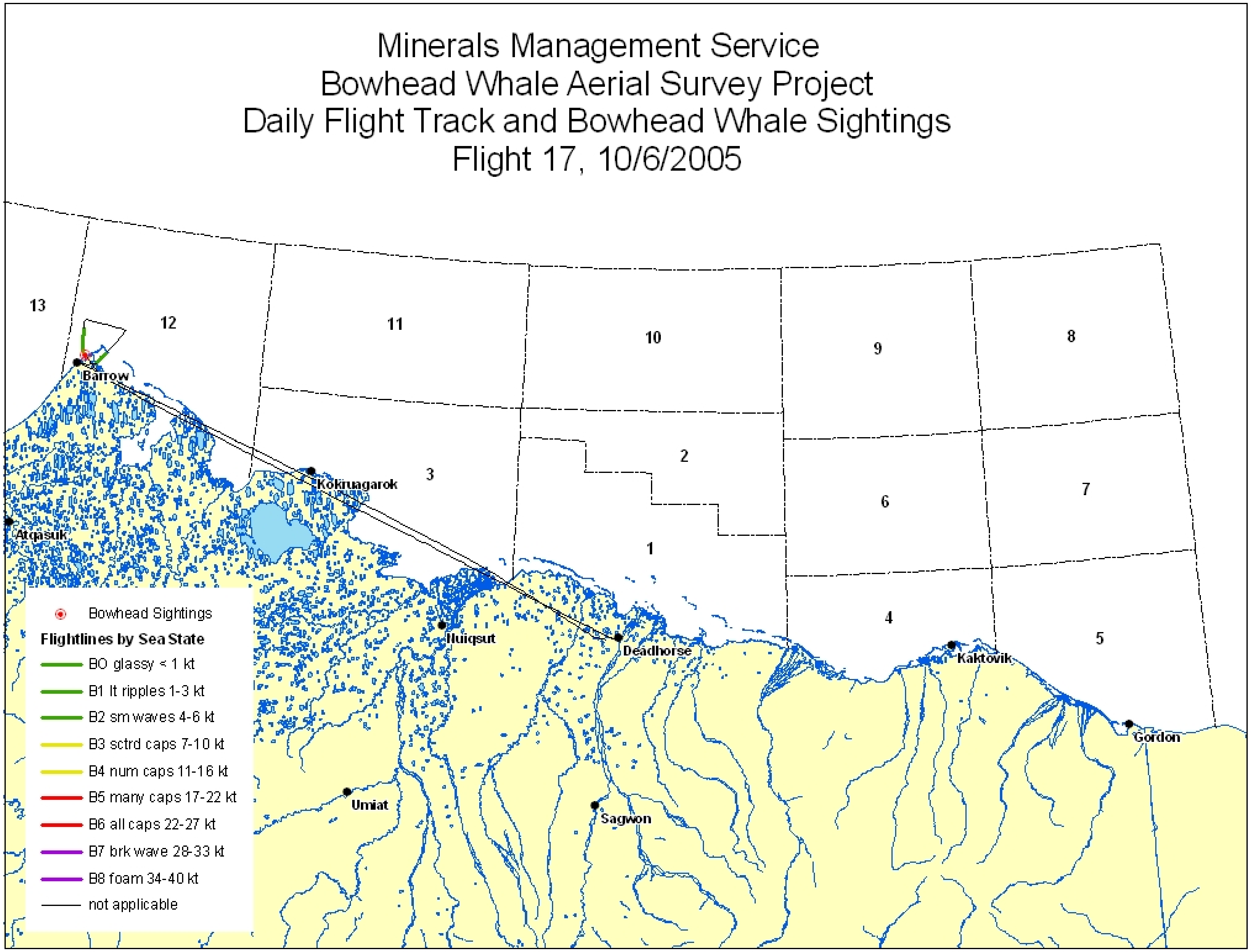
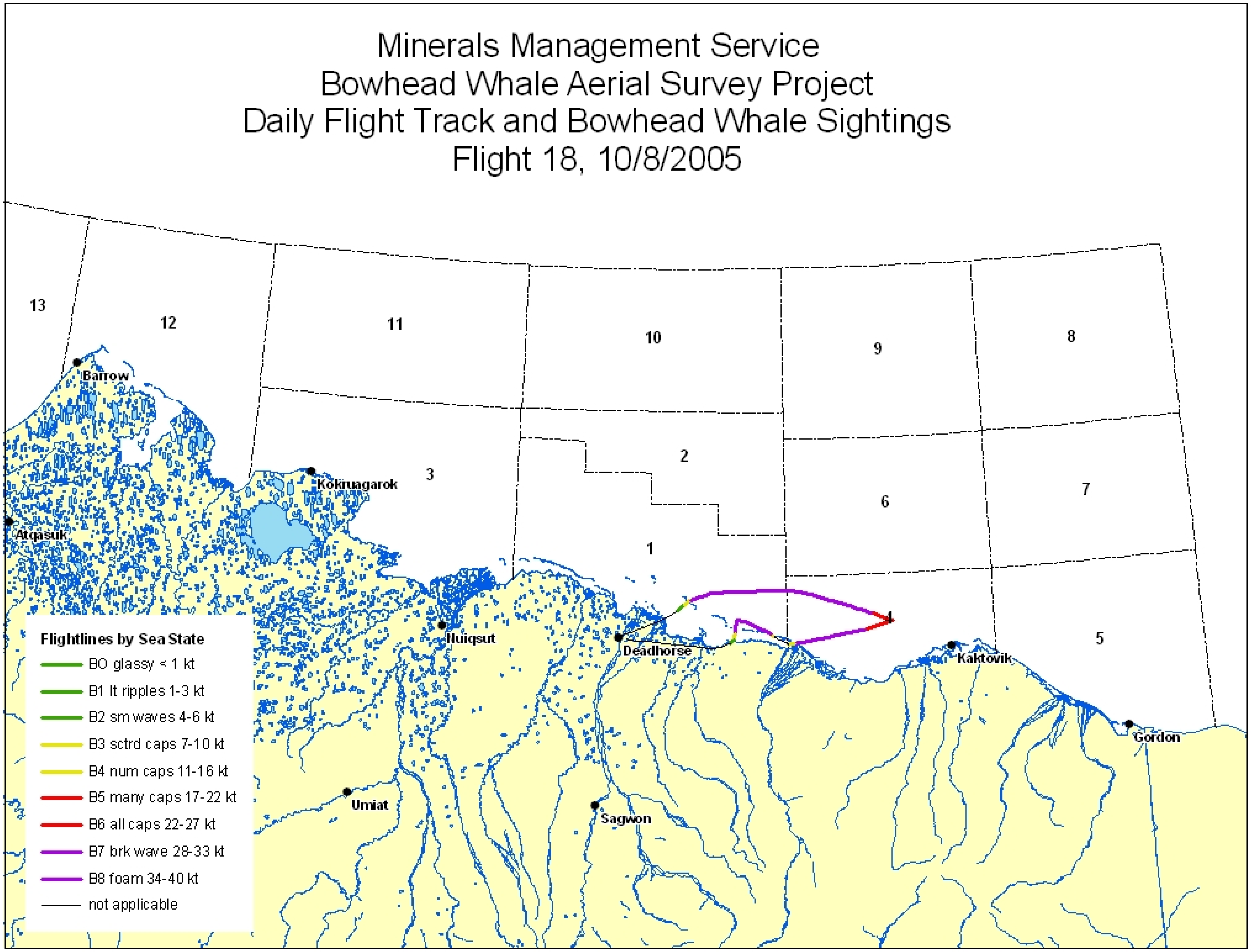
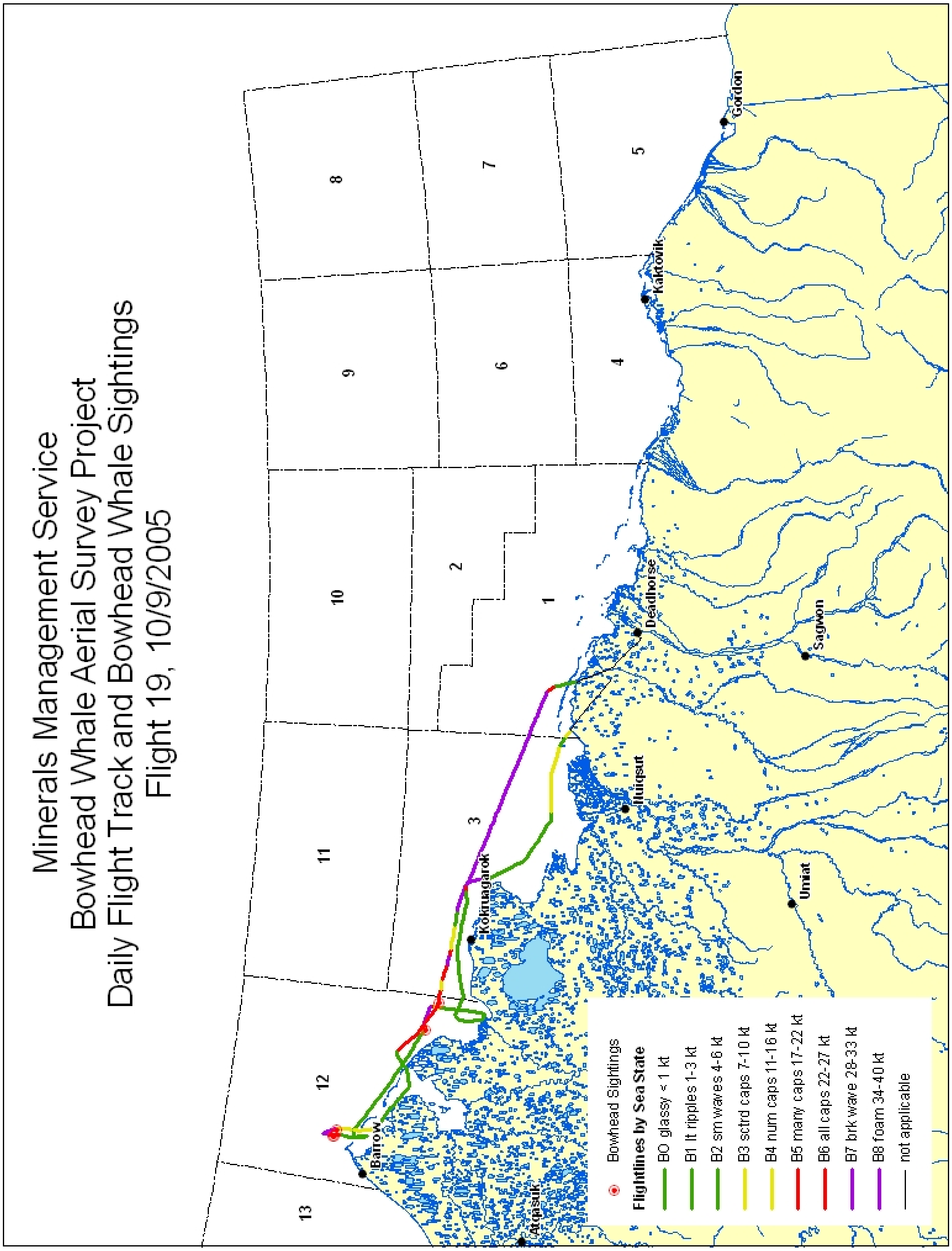
6
5
4
3
2
1
Atqasuk
Barrow
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Sagwon
Umiat
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 17, 10/6/2005
13
12
11
10
9
8
3
2
6
7
1
4
5
Barrow
Kokruagarok
Atqasuk
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 18, 10/8/2005
13
12
11
10
9
8
3
2
6
7
1
5
Barrow
Kokruagarok
Atqasuk
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 19, 10/9/2005
13
12
11
10
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6
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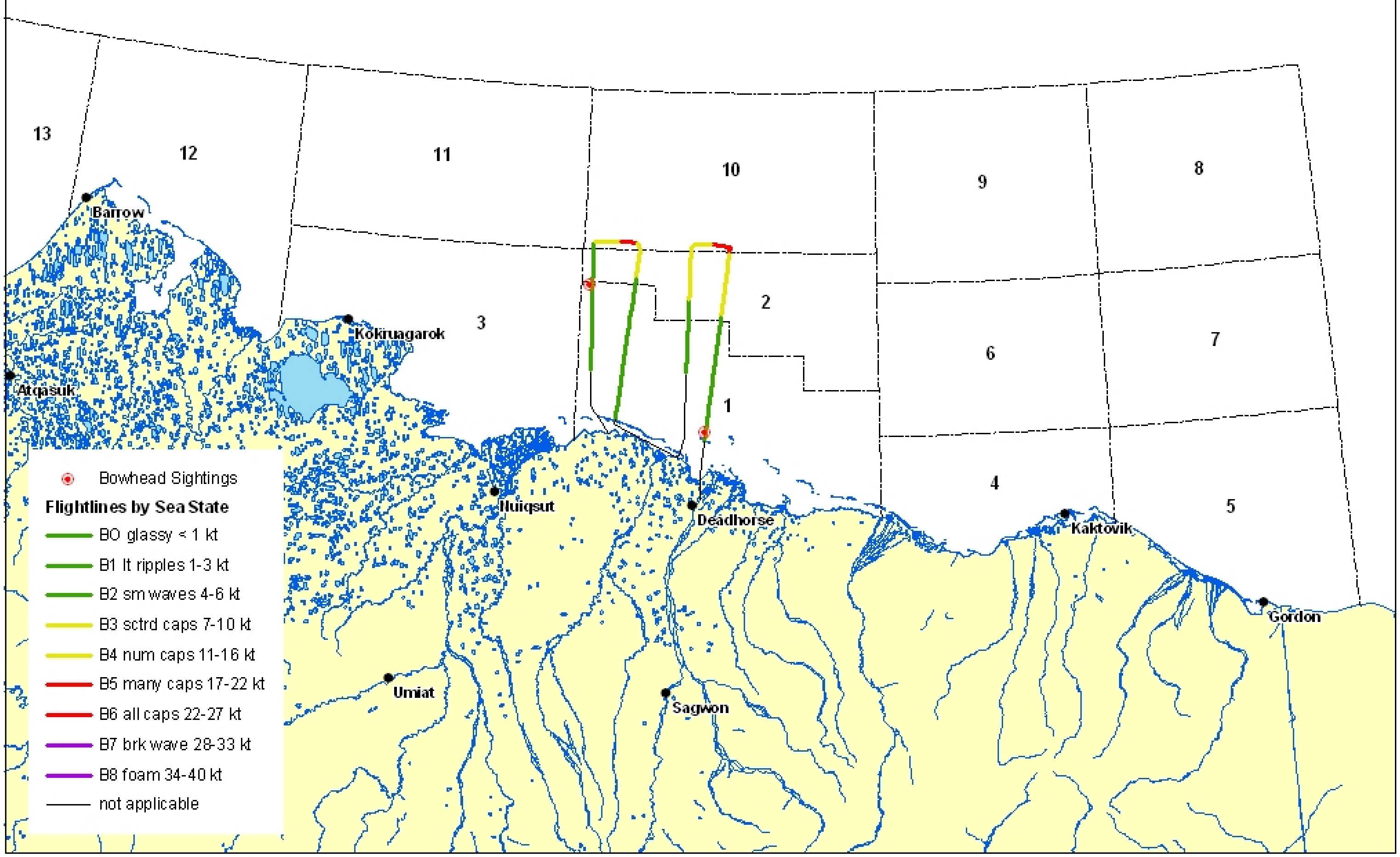
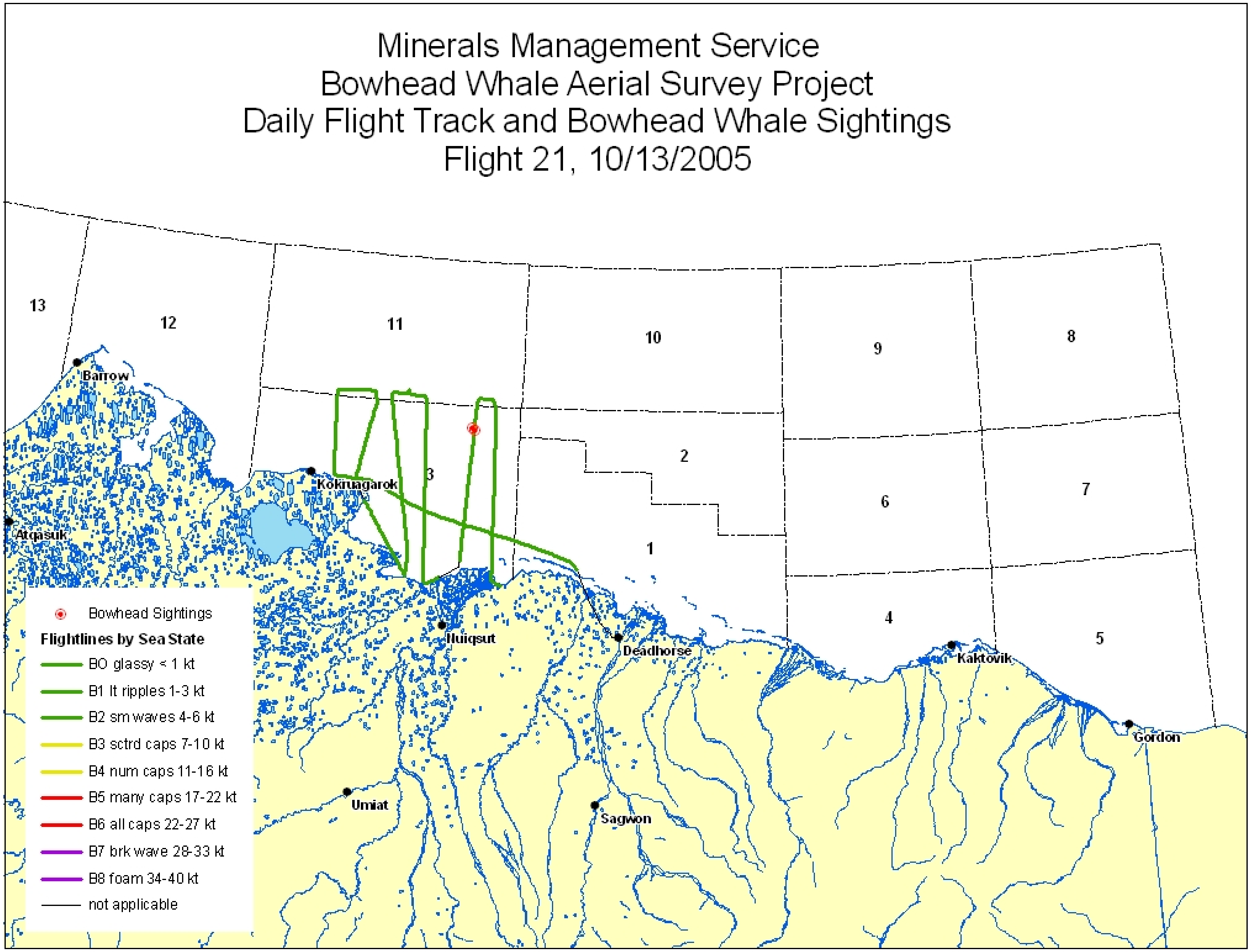
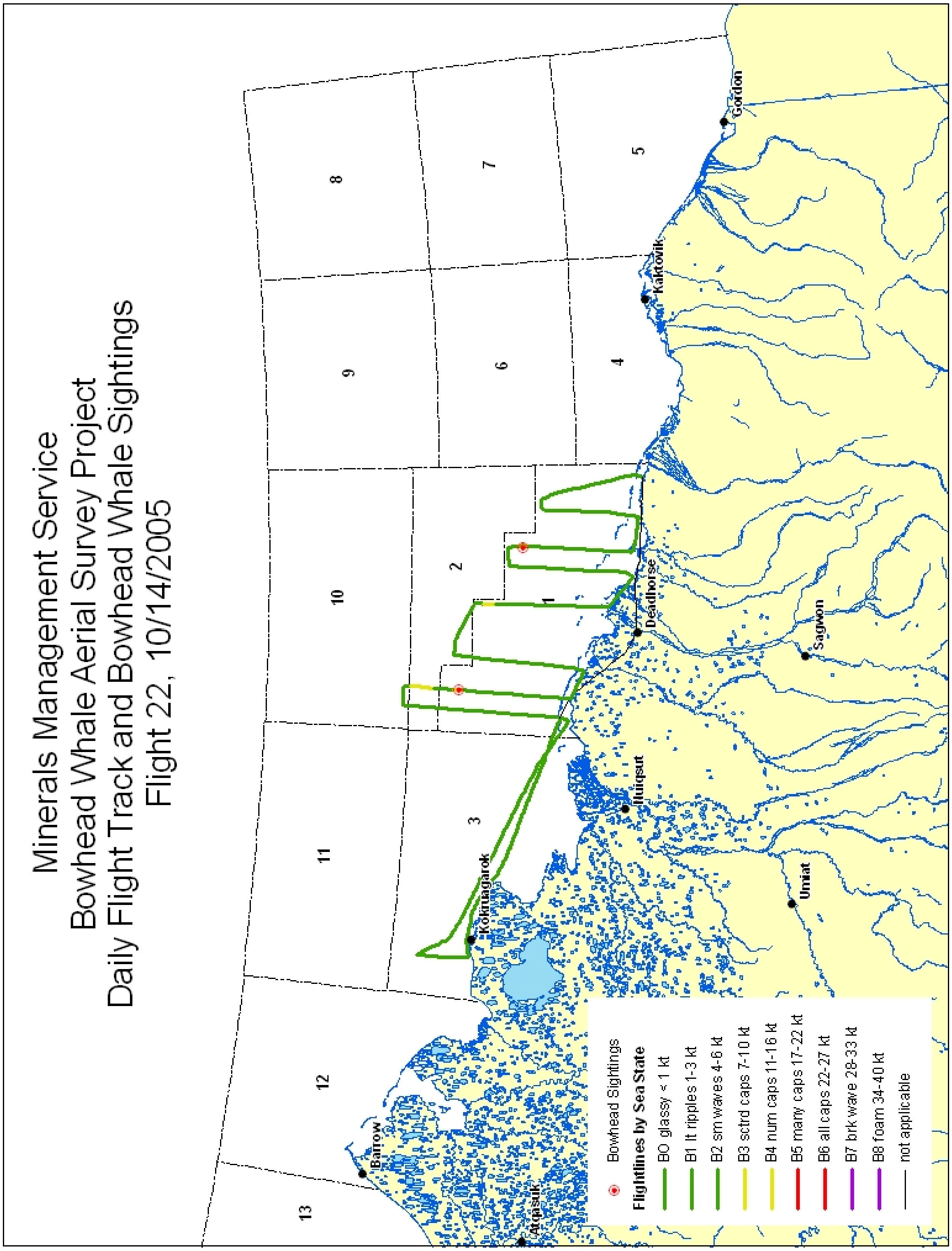
4
3
2
1
Atqasuk
Barrow
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Sagwon
Umiat
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable

Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 20, 10/13/2005




Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 21, 10/13/2005
13
12
11
10
9
8
2
6
7
3
1
4
5
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 22, 10/14/2005
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Sagwon
Umiat
Kaktovik
Gordon
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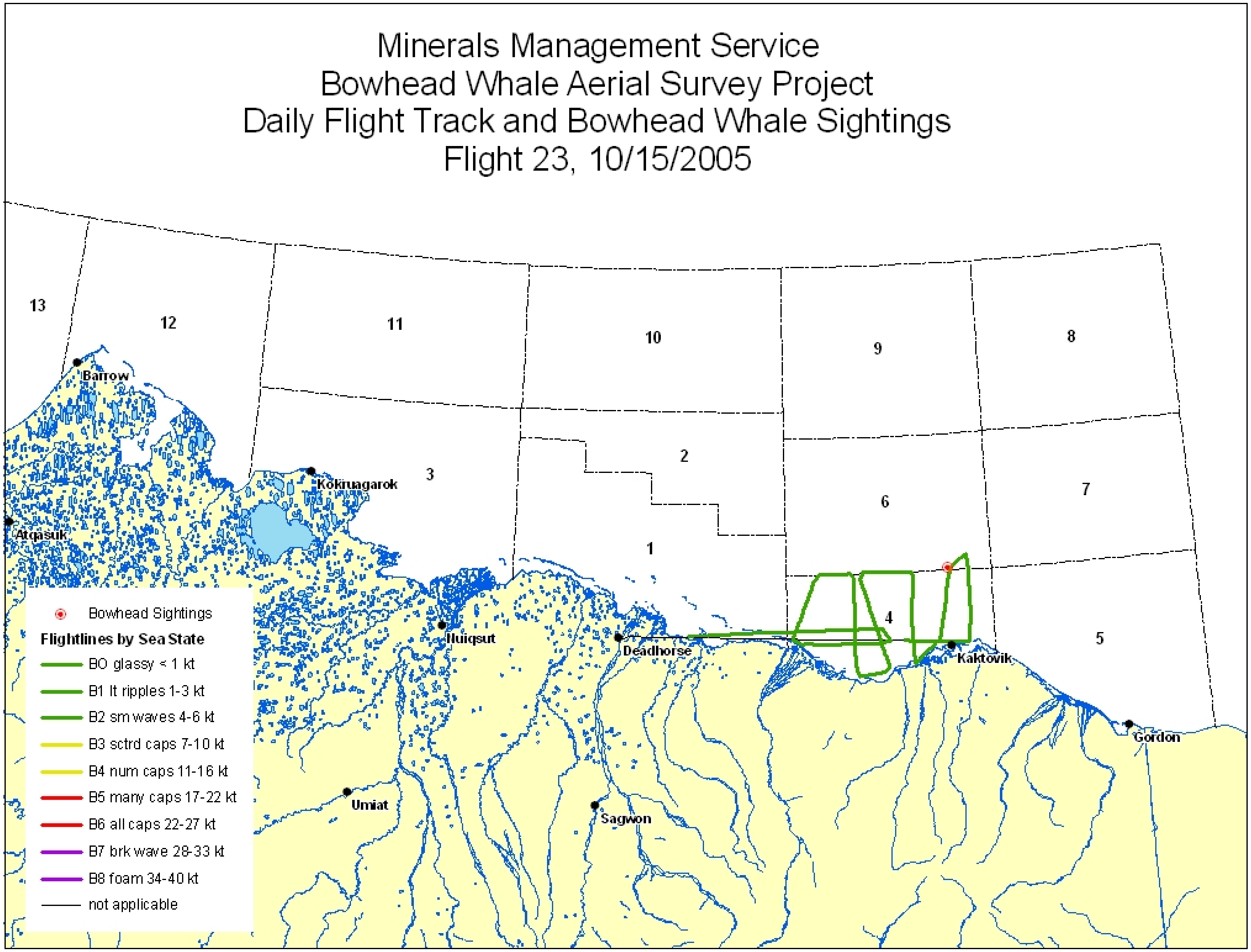
Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 23, 10/15/2005
13
12
11
10
9
8
3
2
6
7
1
4
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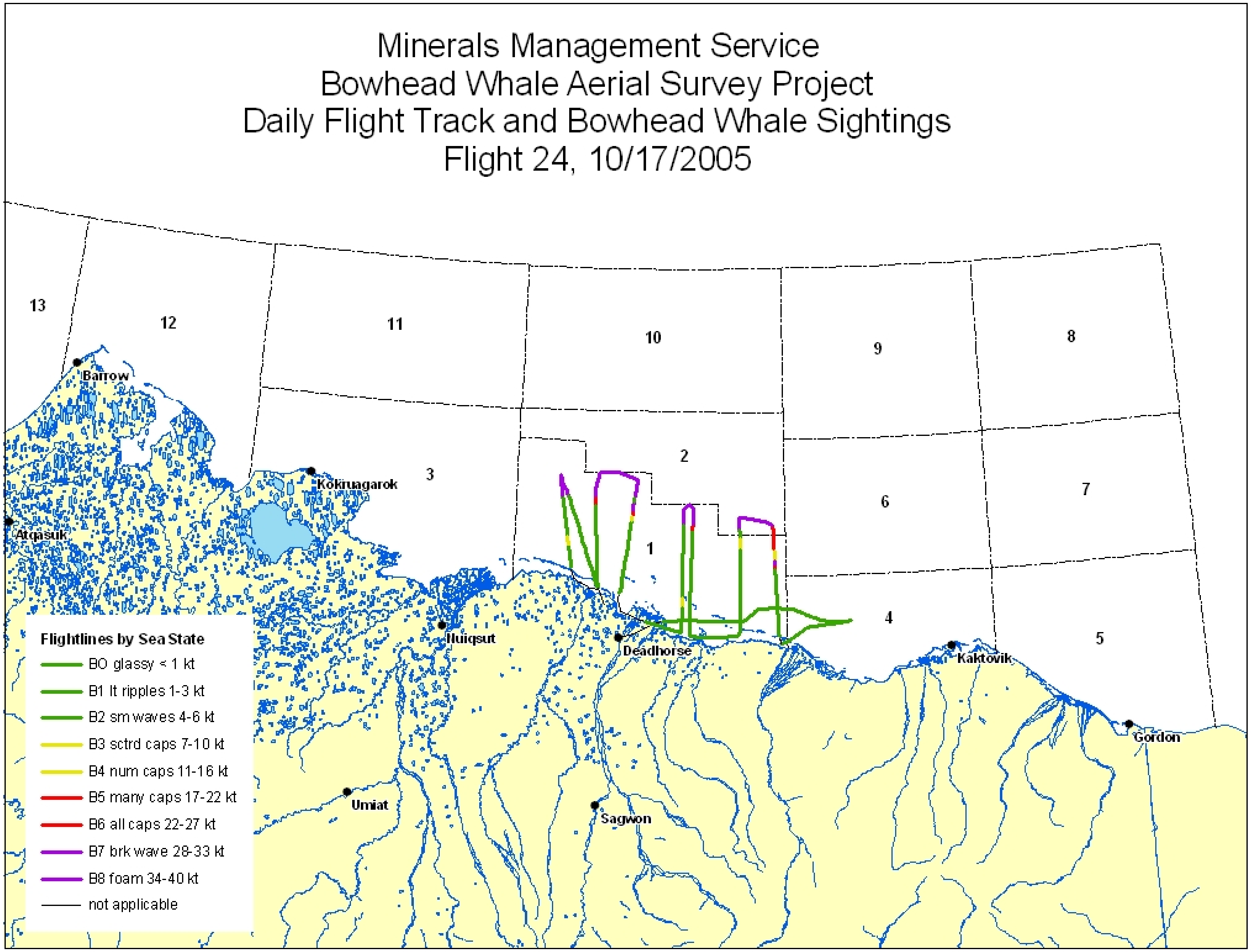
Barrow
Atqasuk
Kokruagarok
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable


Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 24, 10/17/2005
13
12
11
10
9
8
3
2
6
7
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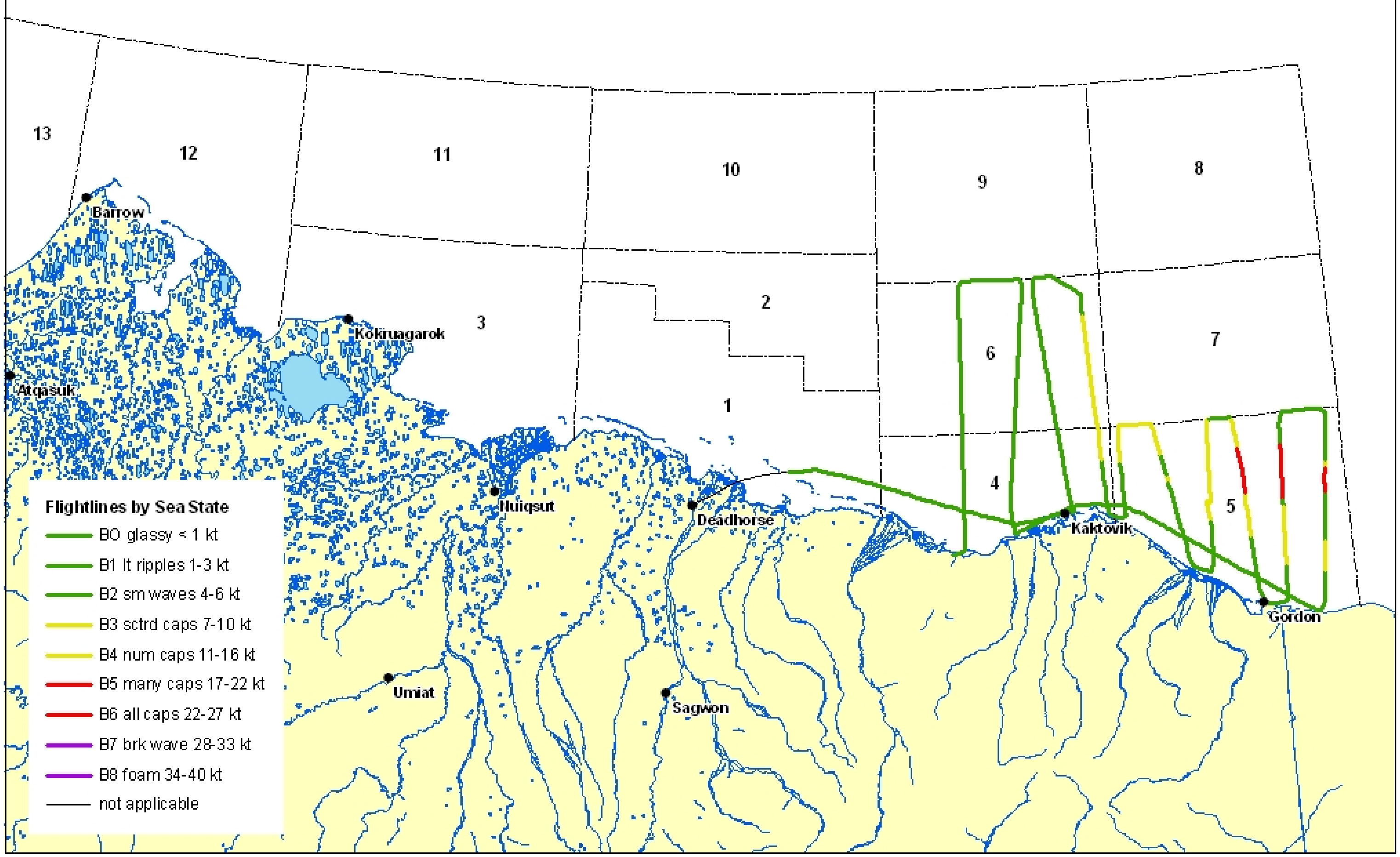
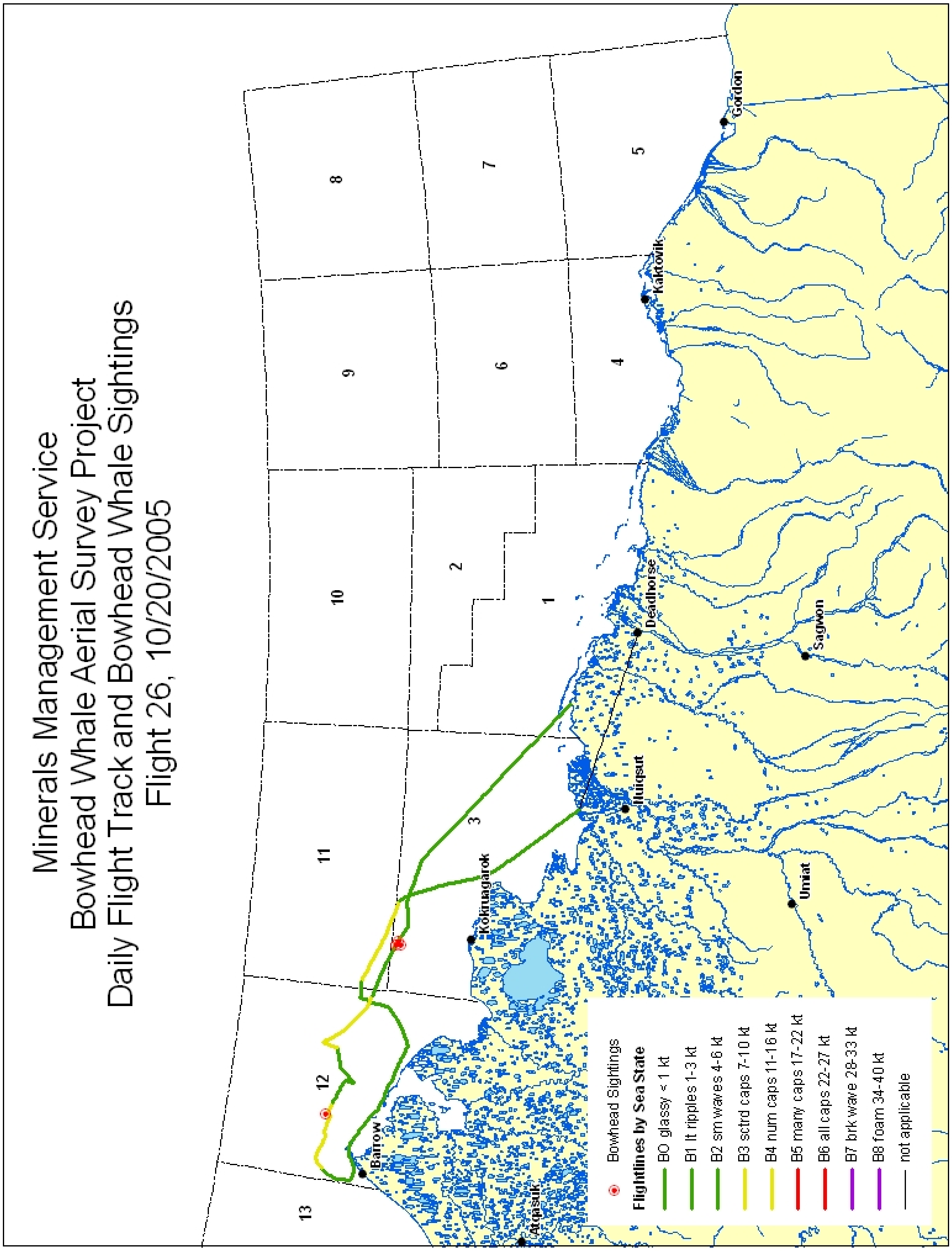
4
5
Barrow
Kokruagarok
Atqasuk
Nuiqsut
Deadhorse
Kaktovik
Gordon
Umiat
Sagwon
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable

Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 25, 10/19/2005




Minerals Management Service
Bowhead Whale Aerial Survey Project
Daily Flight Track and Bowhead Whale Sightings
Flight 26, 10/20/2005
13
12
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4
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2
1
Atqasuk
Barrow
Kokruagarok
Nuiqsut
Deadhorse
Sagwon
Umiat
Kaktovik
Gordon
Bowhead Sightings
Flightlines by Sea State
B0 glassy < 1 kt
B1 lt ripples 1-3 kt
B2 sm waves 4-6 kt
B3 sctrd caps 7-10 kt
B4 num caps 11-16 kt
B5 many caps 17-22 kt
B6 all caps 22-27 kt
B7 brk wave 28-33 kt
B8 foam 34-40 kt
not applicable

## APPENDIX D: FALL 2005 SIGHTING MAPS – OTHER MARINE MAMMALS

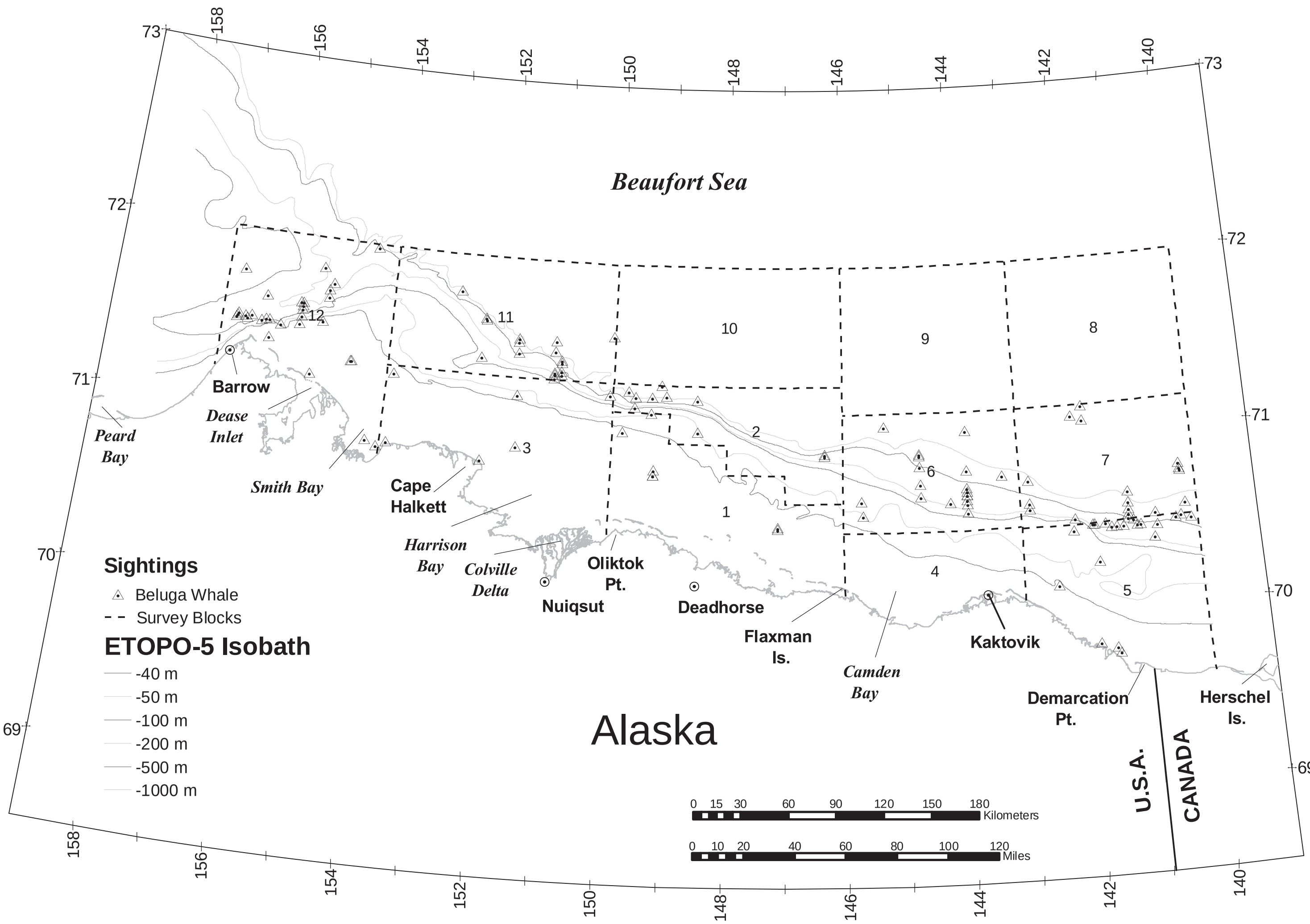


Figure 15 – Map of Beluga Whale Sightings, Fall 2005

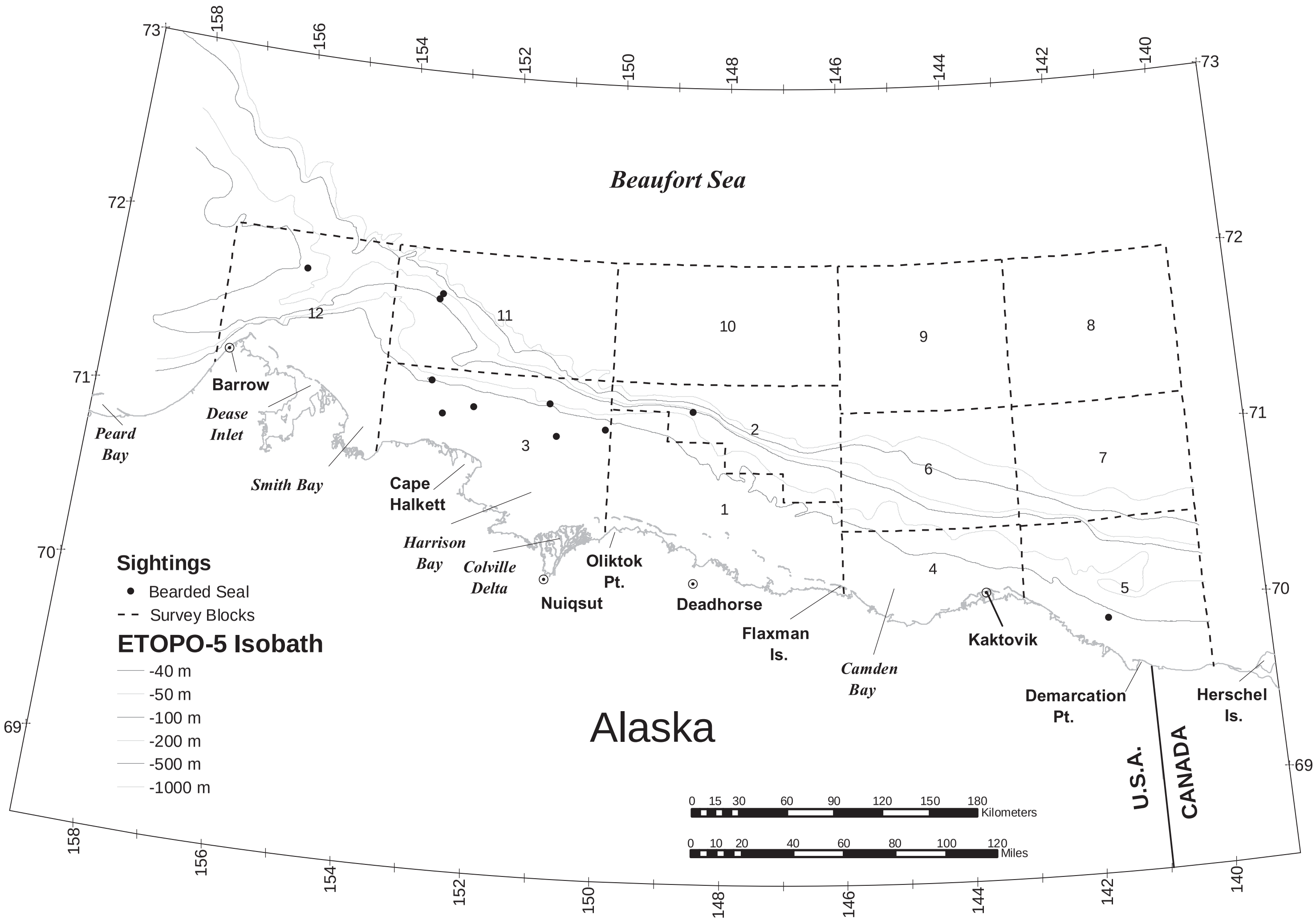


Figure 16 – Map of Bearded Seal Sightings, Fall 2005

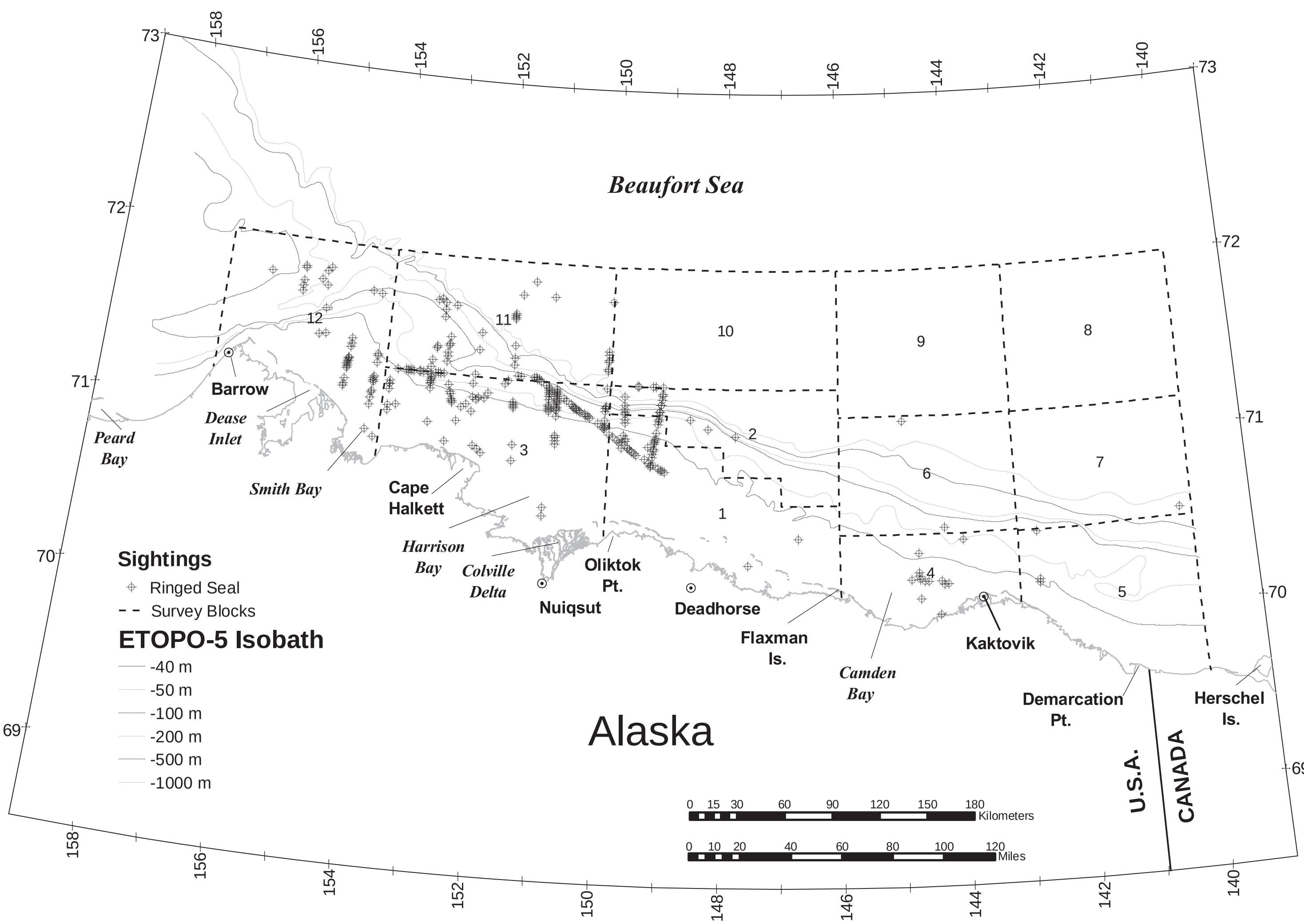


Figure 17 – Map of Ringed Seal Sightings, Fall 2005

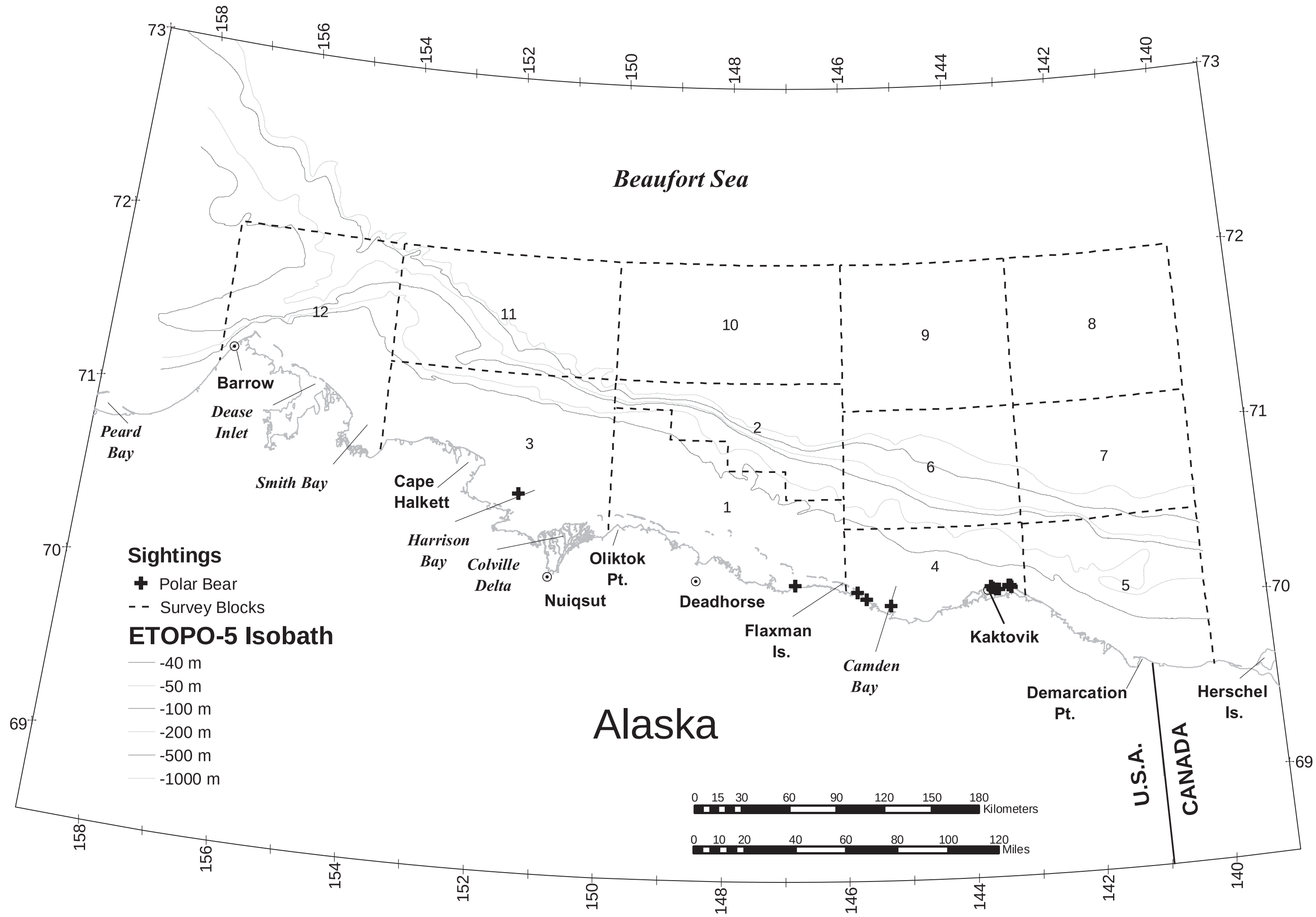


Figure 18 – Map of Polar Bear Sightings, Fall 2005

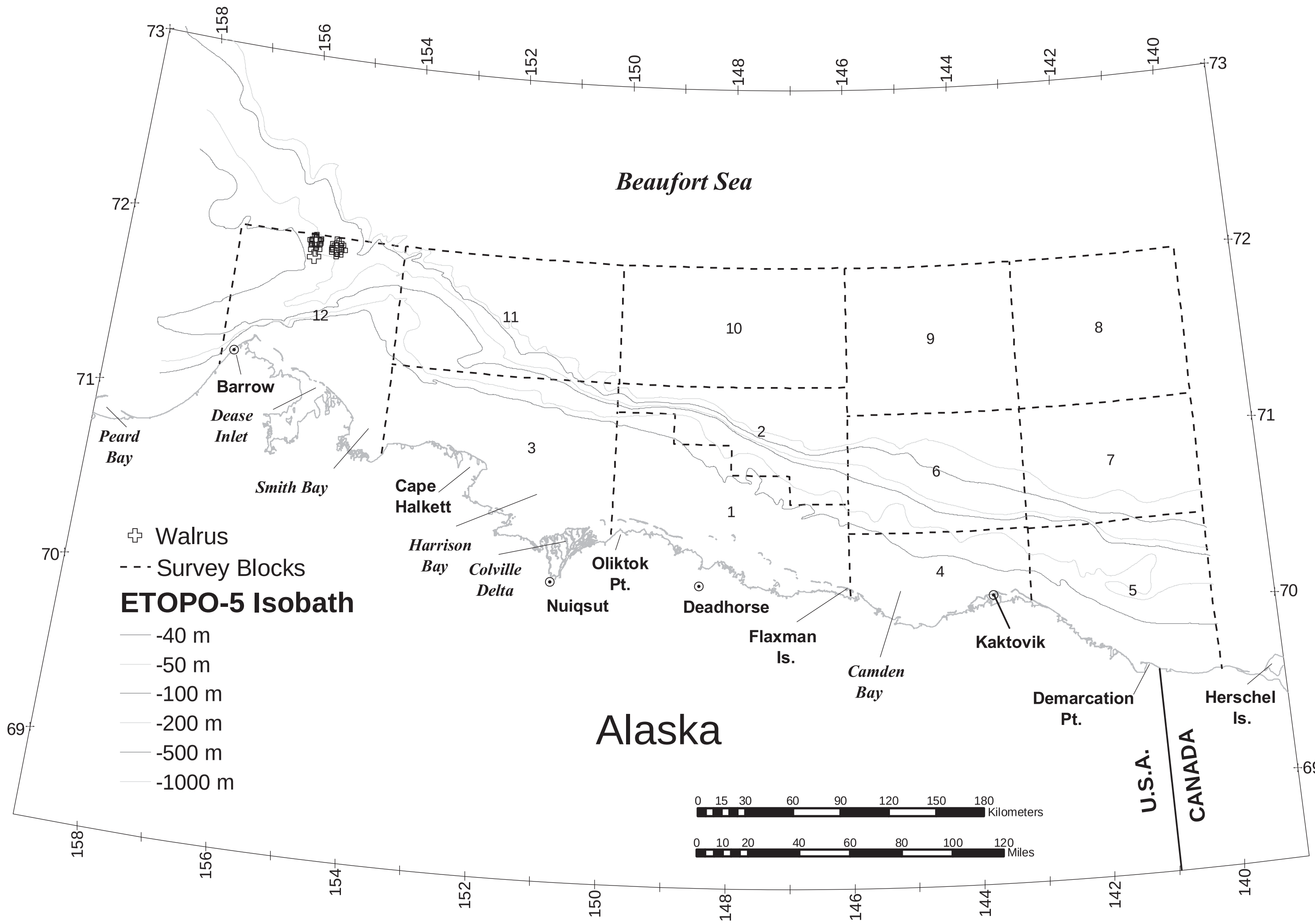


Figure 19 – Map of Walrus Sightings, Fall 2005

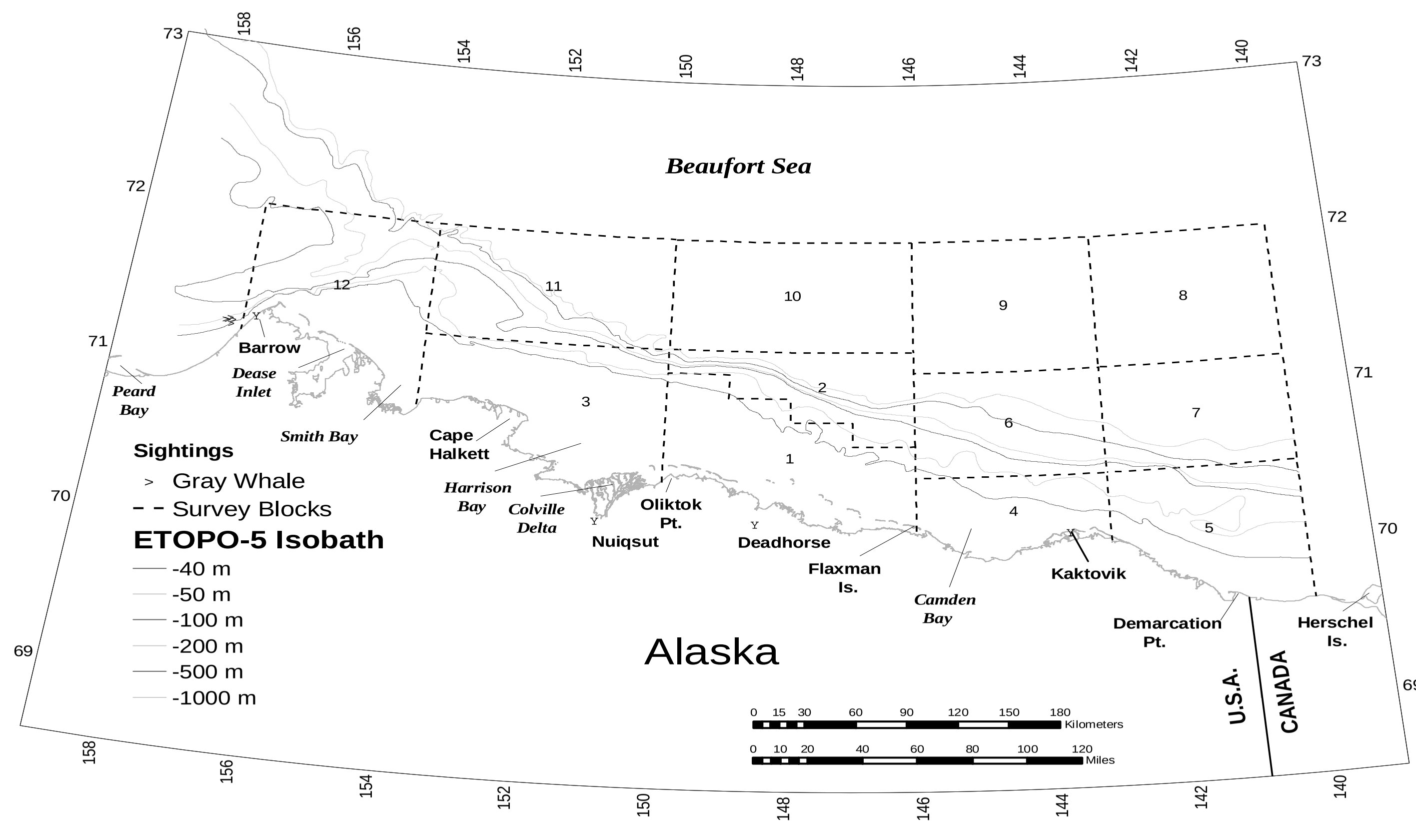


Figure 20 – Map of Gray Whale Sightings, Fall 2005

## APPENDIX E:  GLOSSARY OF ABBREVIATIONS, ACRONYMS, AND INITIALISMS

## GLOSSARY OF ABBREVIATIONS, ACRONYMS, AND INITIALISMS

| | |
|---|---|
| AEWC | Alaska Eskimo Whaling Commission |
| ANOVA | analysis of variance |
| BLM | Bureau of Land Management |
| BWASP | Bowhead Whale Aerial Survey Project |
| CI | confidence interval |
| e.g. | for example |
| ESA | Endangered Species Act |
| FR | Federal Register |
| GPS | Global Positioning System |
| hr | hour |
| HSD | "honestly significant difference" (Tukey statistical test) |
| i.e. | that is |
| k | number of samples |
| km | kilometer |
| m | meter |
| MMS | Minerals Management Service |
| n | sample size |
| nm | nautical mile |
| NMFS | National Marine Fisheries Service |
| NOAA | National Oceanic and Atmospheric Administration |
| NOS | Notice of Sale |
| NSB | North Slope Borough |
| OAS | Office of Aircraft Services |
| OCS | Outer Continental Shelf |
| OCSLA | Outer Continental Shelf Lands Act |
| p | probability |
| 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 |
| WPUE | whales per unit effort (index of relative abundance or occurrence) |

## The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

## The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Royalty Management Program** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.