NOAA Technical Memorandum NMFS-AFSC-439

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U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
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Distribution and Relative Abundance of Bowhead Whales and Other Marine Mammals in the Western Beaufort Sea, 2020

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ABSTRACT

Aerial line-transect surveys for bowhead whales (*Balaena mysticetus*) and other marine mammals were conducted in the western Beaufort and eastern Chukchi seas from 17 September to 15 October 2020. The primary survey area ranged from Utqiaġvik to Prudhoe Bay, Alaska (157°-148°W, shore to 72°N). Surveys were conducted on a total of 14 days, mostly in the primary survey area due to survey priorities, weather, and logistical limitations. Outside of the primary survey area, surveys were conducted in the Chukchi Sea on two days, including one survey leg near Point Hope. A total of 293 sightings of 770 bowhead whales were documented during the surveys. The 2020 bowhead whale sightings were unusual as whales were sighted in very dense feeding aggregations close to shore from Point Barrow to Oliktok Point in the western Beaufort Sea. They were significantly closer to shore and in shallower water compared to sightings from previous years when similar surveys were conducted. By some metrics, these are the densest bowhead whale aggregations documented in the history of line-transect aerial surveys in the study area, which were conducted annually from 1979 to 2019. Bowhead whales observed during the survey were likely feeding on krill. Favorable winds in autumn 2020 provided the upwelling conditions needed for concentrating krill on the continental shelf near Utqiaġvik, evidenced by a large mass of krill that washed up on the beach near Utqiaġvik in September 2020. Bowhead whales were also sighted in high density near Harrison Bay, where bowhead whales are not typically sighted. The high densities of feeding bowhead whales in October 2020 are also unusual; although bowhead whales are typically present in the study area in October, they are not usually sighted in such high densities.

One of the motivations for flying surveys in 2020 was because the bowhead whale migration across the western Beaufort Sea in autumn 2019 was unlike any on record. In autumn 2019, bowhead whales were mostly absent, and the few that were documented were farther from shore and in deeper water than in previous years with light sea ice cover. Bowhead distribution in 2019 and 2020 represent opposite extremes. Arctic ecosystems that bowhead whales depend upon are rapidly changing due to the warming climate. Lessons learned from the past, particularly about spatiotemporal variability in bowhead whale density and habitat use, likely need to be revised to accurately reflect the present and future ecosystems. Climate-related changes have profound effects throughout ecosystems and high variability in the distribution of bowheads may have substantial impacts to Alaskan coastal communities who rely on bowhead whales for subsistence.

Aerial survey results from 2019 and 2020, two sequential years in which the autumn bowhead whale migration across the western Beaufort Sea were contrasting and unexpected, provide strong justification for annual monitoring of the bowhead whale autumn migration in order to better understand the future availability of bowhead whales to subsistence hunters and to provide data for sound decision-making by resource managers to minimize or mitigate the effects of human activities on this endangered marine mammal.

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INTRODUCTION

In 2019, the bowhead whale autumn migration across the western Beaufort Sea (140°-157°W, shore to 72°N) was unexpected and unlike any on record. Subsistence hunters from Kaktovik and Nuiqsut, Alaska, (in the eastern and central Alaskan Beaufort Sea, respectively) had to travel farther north than usual to find whales. The bowhead whales were largely absent near Utqiaġvik, Alaska, from September to November, resulting in only one harvested whale, which was taken very late in the whaling season, in mid-November. More typically, whales in Utqiaġvik are harvested from mid-September through mid-October.

These observations from hunters were reflected in observations from the Aerial Surveys of Arctic Marine Mammals (ASAMM) survey flights in autumn 2019, which covered the broader extent of the western Beaufort Sea shelf, slope, and basin. From 1979 to 2019, ASAMM line-transect aerial surveys (and predecessors; Clarke et al. 2020) were conducted in the Alaskan Arctic to study spatial and temporal patterns in the density, habitat, and behavior of marine mammals, many of which are hunted for subsistence by Alaska Natives. The ASAMM project was funded under an InterAgency agreement between the Bureau of Ocean Energy Management (BOEM) and National Oceanic and Atmospheric Administration's (NOAA) Alaska Fisheries Science Center (AFSC), and co-managed by BOEM and AFSC. The ASAMM survey design and protocols focused on bowhead whales, but the project collected information on all marine mammal species observed. In 2019, ASAMM found that bowhead whales were mostly absent from the nearshore Beaufort Sea during September and October, and whales that were sighted were farther offshore and in deeper water than previous survey years with similarly light sea ice cover (Clarke et al. 2020). No bowhead whales were detected by ASAMM during autumn 2019 in the eastern Chukchi Sea (67°-72°N, 157°-169°W), also unprecedented compared to previous years during which aerial surveys were conducted in the Chukchi Sea (1982-1991; 2008-2018) (Clarke et al. 2020).

The distribution of bowhead whales in autumn 2019, as observed by both subsistence hunters and ASAMM surveys in the western Beaufort and eastern Chukchi seas, was likely because: 1) the migration was farther north than normal, outside the normal ASAMM study area, and therefore fewer whales were present during aerial surveys; 2) the migration was delayed, with the whales remaining in the eastern Beaufort Sea longer and later in the year; 3) processes needed to aggregate bowhead whale prey on the shelf east of Point Barrow were poor in 2019, due to unfavorable wind conditions; or 4) a combination of these and other factors. The underlying causes for this anomalous migration are not completely known.

The Pacific Arctic is a region with dynamic ecosystems that are undergoing unpredictable and rapid changes. During 2019, in addition to record low summer and winter sea ice extents in the Arctic (National Snow and Ice Data Center 2019), other extreme environmental variables were recorded, including warmer surface air and sea surface temperatures, lower snow cover, thawing permafrost, and decreased sea ice thickness (Richter-Menge et al. 2019), which undoubtedly affected primary and secondary productivity, transport of water and krill from the Bering Sea, and freshwater runoff (e.g., Ashjian et al. 2021, Grebmeier et al. 2018, Huntington et al. 2020). Very few bowhead whale aggregations, an indication of potential feeding, were observed in the western Beaufort Sea, and feeding behavior was conspicuously absent (Clarke et al. 2020), suggesting that krill and other bowhead whale prey were mostly absent or present in only very low densities in the western Beaufort Sea. The presence of killer whales in the vicinity of Point Barrow may also have influenced the distribution of bowhead whales (Willoughby et al. 2020a). Additionally, underwater sound may also affect bowhead whale behavior, and it may come from a variety of industrial, commercial, and natural sources (e.g., vessel traffic, seismic surveys and mapping, sound used to guide autonomous scientific instruments, and noise from increased wave action resulting from loss of sea ice and the associated increase in storm frequency and intensity, etc.) (Blackwell and Thode 2021, Robertson et al. 2015, Würsig and Koski 2021).

The anomalous autumn 2019 migration resulted in substantial negative impacts to the subsistence communities of northern Alaska, whose spiritual, cultural, and nutritional needs are tied to subsistence hunting, especially bowhead whale hunting (Braund et al. 2018, Suydam et al. 2021). Impacts to these communities included increased safety risks to each whaling crew due to the greater distances traveled searching for whales, particularly later in autumn when weather becomes more unpredictable and often more dangerous (i.e., stronger wind and higher sea state). The higher fuel costs associated with searching for whales farther from the villages and for greater periods of time increased financial burdens. Furthermore, hunting through November limited opportunities and resources to pursue other critical subsistence hunting activities. Finally, the reduction in harvested bowhead whales in Utqiaġvik meant the very real potential of food shortages, as the community had to increase reliance either on other subsistence foods or on non-subsistence foods, which are expensive, difficult to obtain, and generally not as nutritious as traditional foods.

In 2019, the ASAMM project completed its last year of federally funded field work. Neither BOEM nor NOAA allocated funding for cetacean aerial or vessel-based line-transect surveys in the Arctic in 2020. At the conclusion of 2019, it was unknown whether the bowhead whale migration during autumn 2019 was an exception and unlikely to happen again, a new extreme that may be repeated with some frequency, or a new normal (Huntington et al. 2020). In light of these two events, the North Slope Borough (NSB), NOAA, and BOEM hosted an Arctic Cetacean Listening Session in January 2020 in Utqiaġvik, Alaska, to gather input from co-management partners, NSB residents, and stakeholders to help develop and focus the next generation of research initiatives that will build on the strong foundation that ASAMM established. Participants at this meeting included NSB Mayor Harry Brower, Jr., NSB Department of Wildlife Management, Alaska Eskimo Whaling Commission (AEWC), Alaska Beluga Whale Committee, Iñupiat Community of the Arctic Slope, Barrow Whaling Captains' Association (BWCA), Marine Mammal Commission, U.S. Coast Guard, and Alaska Ecological Research (under contract with Hilcorp). Recognizing the importance of cetaceans to Alaska Native coastal communities in the Arctic, the purpose of the Listening Session was to provide co-management partners with an opportunity to identify information needed to promote healthy Arctic cetacean populations and to sustainably manage cetacean subsistence harvests.

The Listening Session concluded that data should continue to be collected that are needed to assess marine mammal population size and trends, distribution, migration, and diet. Flying aerial surveys during autumn 2020 would help to meet the goal of monitoring the bowhead whale migration. Furthermore, survey methods should be consistent with the existing 41-year ASAMM time series to facilitate comparison with past years, including analysis of variability and trends. The 2020 aerial survey objectives were as follows:

i. Conduct line-transect aerial surveys in the western Beaufort Sea to collect data on bowhead whale density, distribution, activities, and calves using survey methods consistent with the existing 41-year ASAMM time series.
ii. Analyze the autumn 2020 aerial survey data with the ASAMM historical database to investigate spatial and temporal patterns, variability, and trends in bowhead whale density and habitat use in the western Alaskan Beaufort Sea, including comparison with data collected in 2019.

METHODS

Study Area

In 2020, the Beaufort Sea study area covered the western Beaufort Sea, from 140°W to 157°W and the coastline to 72°N (Fig. 1). The Chukchi Sea study area consisted of the eastern Chukchi Sea, from 157°W to 169°W and 67°N to 72°N (Fig. 1). The western Alaskan Beaufort Sea, from Utqaiġvik to Prudhoe Bay, was the highest priority region to survey. Transect lines near Utqaiġvik and Deadhorse (airports with aviation fuel available) could optionally be extended up to 74ºN if there were indications that bowhead whales might be traveling farther north than usual. The eastern Alaskan Beaufort Sea, from Prudhoe Bay to the U.S.-Canada border, was of secondary importance. However, this area could have risen in priority if bowhead whales were absent in the western Alaskan Beaufort Sea and there was reason to believe there may be many whales still migrating from the Canadian Beaufort Sea. The northeastern Chukchi Sea, from Utqaiġvik to Wainwright, comprised the third highest priority area. The rest of the Chukchi Sea was the lowest priority for documenting the bowhead whale migration, but it was of importance for documenting the presence of other species, such as gray, humpback, fin, minke, and killer whales.

The northern Chukchi Sea is largely ice-covered from early winter through early spring, although dramatic environmental changes have reduced modern sea ice extent from historical levels (Wood et al. 2015). In spring, open water leads begin to develop as ambient temperatures increase and warmer water flows northward from the Pacific Ocean through the Bering Sea and Bering Strait. The most nutrient-rich waters flow in the Siberian Coastal Current, west of the ASAMM study area. Two less productive water masses, the Alaska Coastal Water and Bering Shelf/Anadyr Water, are found in the eastern Chukchi Sea (Fig. 2). Current flow may be with or against the wind direction. In the Beaufort Sea, the Beaufort Gyre moves surface waters clockwise in the offshore regions. Underlying the gyre is the predominantly eastward-flowing Beaufort Undercurrent, which flows subsurface in areas where the seafloor is 51-2,000 m deep and undergoes frequent current reversals (Aagaard 1984; Carmack and MacDonald 2002). In the nearshore shallow waters of the Beaufort inner shelf (≤ 50 m depth), currents tend to follow local wind patterns during periods of open water.

Line-Transect Aerial Surveys

Line-transect aerial surveys were designed to be flown in the western Beaufort and eastern Chukchi seas (Fig. 1; total area 242,000 km^2). Systematic transects were placed 18 km apart, based on a grid with a randomly selected start point. Transects were oriented perpendicular to the coastline, to cut across isobaths, from shore to the Beaufort Sea basin (> 2,000 m), extending a maximum of 181 km offshore. A coastal transect was designed to be flown one km offshore between Demarcation Bay in the western Beaufort Sea and Point Hope in the eastern Chukchi Sea. The survey team was based in Utqiaġvik, Alaska, to be located near the primary study area.

Surveys were conducted in a Turbo Commander aircraft provided by Clearwater Air, Inc. Surveys were flown at 305-460 m (1,000-1,500 ft) above ground level, 213 km/hour (115 knots/hour) survey speed. The aircraft had bubble windows for the left- and right-side primary observers, allowing unobstructed views from the horizon to directly beneath the aircraft.

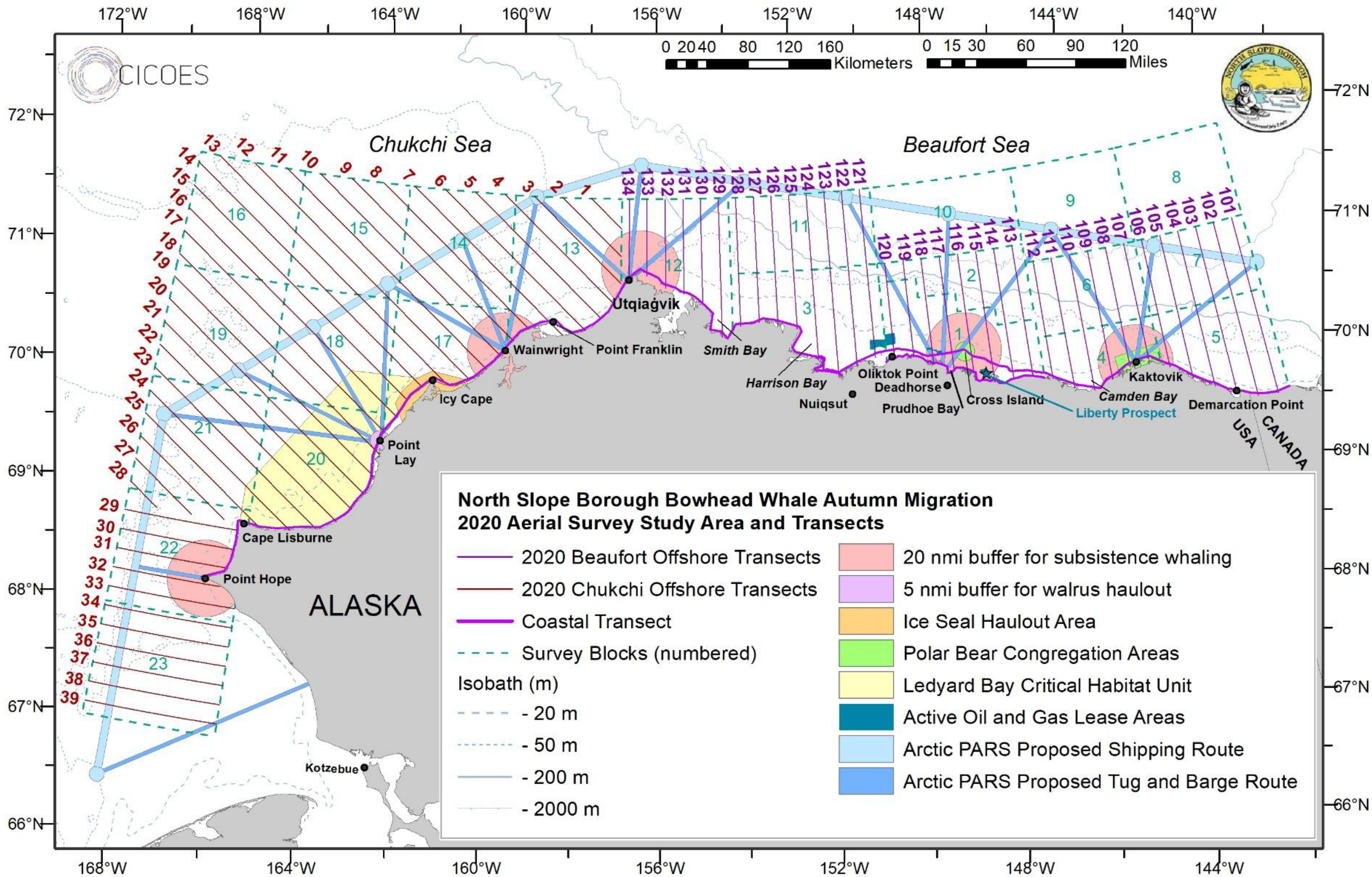

Figure 1. -- Study area and transects for the North Slope Borough Bowhead Whale Autumn Migration 2020 Aerial Survey. The western Alaskan Beaufort Sea, between Utqiaġvik and Prudhoe Bay, was the highest priority area. The eastern Alaskan Beaufort Sea, from Prudhoe Bay to the U.S.-Canada border, was the second highest priority area. The northeastern Chukchi Sea, from Utqiaġvik to Wainwright, was the third highest priority area. The rest of the Chukchi Sea was the lowest priority area.

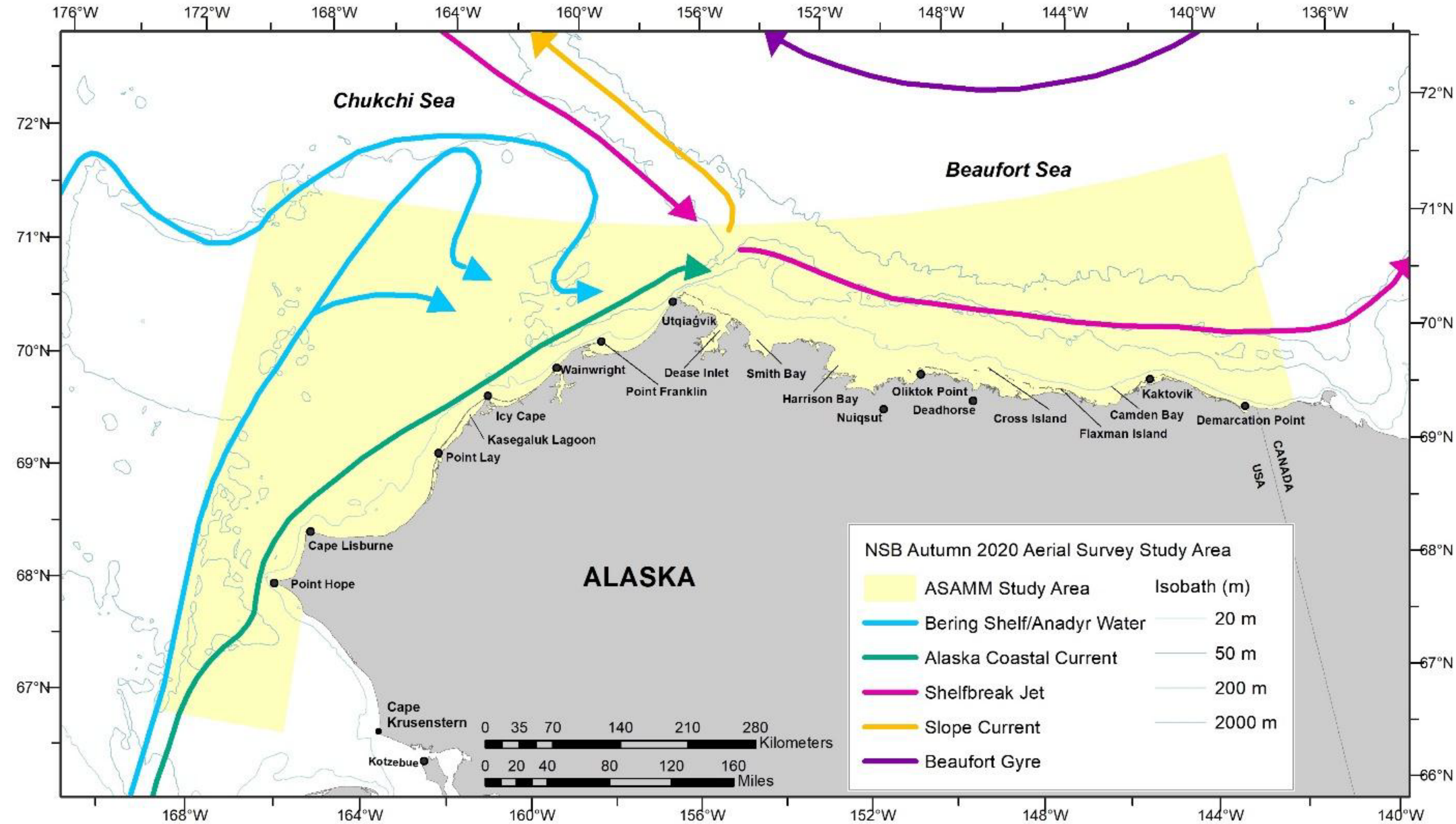

Figure 2. -- Oceanographic features in the eastern Chukchi and western Beaufort seas. Adapted from Corlett and Pickart (2017).

The survey team was comprised of two primary observers and one dedicated data recorder who served as the team leader. The primary observers and data recorder were experienced field biologists and had served as observers and team leaders on the former ASAMM project (ASAMM experience ranged from 6 to 12 years, averaging 10 years), ensuring consistency in data collection between projects. The data recorder and pilots served as secondary observers.

The data recorder input sighting data into a laptop computer that was connected to a GPS and running specialized, menu-driven ASAMM Survey software. Time and position data (latitude, longitude, altitude) were automatically recorded every 30 seconds (in time) or whenever a manual data entry was recorded. Environmental and viewing conditions, including integer-valued Beaufort Sea State, visibility range perpendicular to the aircraft on each side of the plane (< 1 km, 1-2 km, 2-3 km, 3-5 km, 5-10 km, or unlimited), sky conditions (clear, partly cloudy, overcast), integer-valued sea ice percent on each side of the plane, and impediments to visibility (glare, fog, haze, precipitation, ice on the window, low ceiling) on each side of the plane were recorded every 5 minutes (in time) or whenever conditions changed. Primary observers scanned with the naked eye, using binoculars only to check potential targets or to get a magnified view on a confirmed target. Declination angles from the horizon to each sighting were measured using handheld Suunto clinometers when the sighting was abeam. One "sighting" was defined as all animals of the same species within 5 body lengths of each other. Once the clinometer angle was recorded, most sightings of large cetaceans (i.e., anything larger than a beluga, *Delphinapterus leucas*) were circled to determine a final group size estimate, confirm species identification, look for calves, and to determine behavior. Both initial and final group size estimates were recorded in the database; if group size could not be determined with certainty, high and low estimates could also be recorded. Calves initially detected from the trackline were distinguished in the database from calves that were only detected during circling. Circling did not commence in special circumstances, such as restrictions due to weather, fuel level, time of day, or pilot duty hours, or being in the vicinity of sensitive wildlife habitat or subsistence hunting activities. A custom mapping component of the survey software permitted the data recorder to view sightings relative to the aircraft's trackline in real time, which minimized chances of duplicate sightings being recorded during circling. Sightings that could not be positively identified to species were recorded at the taxonomic level to which they could be identified (e.g., unidentified cetacean). Behaviors were entered as one of several categories (Table 1), although additional details about behaviors could be included in notes. The observers watched for any abrupt and unexpected changes in the animals' initially observed behavior due to the presence of the aircraft; observed responses were recorded in the database, along with the number of animals that responded.

Six survey modes were used for data collection (Table 2): transect, circling from transect, Cetacean Aggregation Protocols (CAPs), CAPs circling, search, and circling from search. During all six of these survey modes, observers were actively surveying and all sighting and effort data were recorded. Transect effort refers to systematic survey effort along a prescribed transect line. Search refers to non-systematic survey effort during transit or between transects. Circling from search or transect occurred when the aircraft diverted from flat and level flight to circle a localized area to investigate a sighting or potential sightings. Standard line-transect survey protocols were followed until encounter rates of large cetaceans exceeded the observers' ability to accurately record location and clinometer angle to each sighting.

Table 1. -- Definitions of observed marine mammal behaviors.

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

Underwater Blow	Animal(s) exhaling under water, creating a visible bubble.
Unknown	Behavior not able to be determined, usually due to the sighting occurring at some distance from the aircraft location.
Walk/Run	Animal(s) moving on ground or ice at slow or normal pace (walking) or more rapid pace (running).

Table 2. -- Survey mode definitions.

Survey mode	**Definition**
Transect	Systematic survey effort (non-CAPs) along a prescribed line; sightings not limited to any distance from the trackline; on effort.
Circling from transect	Directed effort searching a small, localized area after diverting from transect; sightings limited to area inside the circle; off effort.
Search	Non-systematic survey effort during transit or between transects; off effort.
Circling from search	Directed effort searching a small, localized area after diverting from search; off effort.
Cetacean Aggregation Protocols (CAPs) - passing	Systematic survey effort along a prescribed transect in an area of high density large cetaceans; sightings limited to within 3 km of the trackline; on effort; immediately followed by CAPs circling.
CAPs circling	Directed effort searching the area out to 3 km from the trackline immediately after completing CAPs passing; excludes any areas surveyed in CAPs strip mode; off effort.
Deadhead	High-speed, high-altitude transits to and from transects, and areas over land or without any downward visibility; off effort.

In areas with extremely high densities of large cetaceans, CAPs was used, wherein the survey team flew through the high-density patch in passing mode (without circling) to collect accurate encounter rate data, and then flew back through the patch in closing (CAPs circling) mode to collect information on group size, number of calves, and behavior (Appendix A). Determining species, group size, calf presence, and behavior during CAPs passing is difficult because of the high density of sightings and because all sightings detected within 3 km of the trackline are recorded. Statistics for CAPs passing mode that are inferred from CAPs circling data (e.g., group size, number of calves, and feeding or milling behavior) are referred to as CAPs-adjusted statistics. Additional detail about the integration of CAPs data is included in Appendix A. Transect and CAPs passing survey modes are considered on effort; search, circling from transect or from search, and CAPs circling are considered off effort. Deadhead mode was recorded during transits over land, transits at high speeds or high altitudes, or when weather impeded visibility to the extent that the observers could not collect data.

Generally, when cloud ceilings were consistently less than ~335 m or the wind force was above Beaufort 5, survey flights were redirected to survey blocks or transects with better conditions. Survey flights were aborted when conditions consistently did not meet minimum altitude (305 m), visibility, or wind force (Beaufort 5) requirements.

The surveys in 2020 followed the same protocols as were implemented during the ASAMM surveys in 2019; more detailed methods can be found in Clarke et al. (2020).

Altitude and Lateral Adjustments to Avoid Subsistence Hunting and Sensitive Wildlife

The surveys followed the same, or more conservative, protocols used successfully by the previous ASAMM surveys to avoid interfering with subsistence hunting activities and sensitive areas for wildlife (Clarke et al. 2020).

Whenever small boats were seen, the survey aircraft avoided the boats by 9 km (5 nmi) to avoid potential interference with subsistence activities. Most subsistence activity occurs fairly close to shore and within nearshore lagoons, although whalers can be found farther than 64 km (40 mi) offshore. When bowhead whaling was active, a minimum altitude of 458 m (1,500 ft) was maintained within 37 km (20 nmi) of Point Barrow, Cross Island, Kaktovik, and Wainwright, regardless of whether small boats had been sighted in the vicinity that day. If the minimum altitude of 458 m (1,500 ft) could not be maintained, survey effort was truncated to avoid a 37-km (20 nmi) radius around each whaling area, regardless of whether small boats had been sighted in the vicinity that day (Fig. 1).

The survey aircraft did not directly overfly any walrus or seal haulouts on land or on ice. The U.S. Fish and Wildlife Service requested that the survey team remain at least 9 km (5 nmi) offshore of walruses hauled out on land to ensure there was no disturbance to the haulout. In early September 2020, one large walrus haulout numbering approximately 20,000 animals was observed near Point Lay, and a smaller haulout was located approximately 40 km (22 nmi) north of Point Lay (J. Snyder, USFWS Biologist, pers. commun., September 2020). The survey team planned to notify the Point Lay Council by email prior to survey flights in the vicinity of Point Lay whenever walruses were hauled out near Point Lay.

If a coastal transect was conducted near the Icy Cape area (transects 11-16), where smaller haulouts of spotted seals are often encountered, protocol was to increase survey altitude to at least 610 m (2,000 ft) when ceilings allowed and increase lateral distance to 1.9 km (1 nmi) offshore to avoid disturbing seals. If ceilings did not allow for increased altitude near Icy Cape, the survey aircraft would divert farther offshore, to 3.7 km (2 nmi).

Critical habitat for Spectacled Eiders is located in Ledyard Bay. To minimize disturbance to Spectacled Eiders, the survey aircraft was not allowed to fly below 305 m (1,000 ft) in Ledyard Bay. To minimize potential disturbances, it was planned that each transect line in Ledyard Bay would be flown only once over the course of the survey period, and the aircraft would avoid extensive circling in the area.

To minimize disturbance to polar bears, the survey aircraft did not directly fly over Barter Island and Cross Island, locations where polar bears are known to congregate near bowhead whale bone piles.

Circling near polar bear habitat was limited to 15 minutes and greater than 152 m (500 ft) altitude. Particular caution would have been used near Cross Island and Kaktovik/Barter Island if the survey aircraft flew in those areas and needed to circle whale sightings. The survey aircraft never circled swimming polar bears. Lastly, the aircraft maintained at least 458 m (1,500 ft) altitude within 0.9 km (0.5 nmi) of polar bears when the aircraft was transiting (i.e., on deadhead) known polar bear areas.

In addition to the items above, higher or lower altitudes were acceptable, as noted below.

- Less than 305 m (1,000 ft), with a minimum of 152 m (500 ft) for brief periods of time (< 10 min) to photograph large whales or carcasses, or to determine group size and calf presence. Extended time at less than 305 m (1,000 ft) should not occur if whales appear to be responding to the aircraft. No circling lower than 458 m (1,500 ft) may occur in areas where walruses have recently been sighted.
- In areas where walruses likely occur in the water or on sea ice, less than 305 m (1,000 ft) should not be maintained for greater than 10 minutes, except for safety reasons.
- Greater than 458 m (1,500 ft) within 0.9 km (0.5 mi) over walruses hauled out on ice. Walruses will react differently depending on behavioral state, but in general seem to respond to abrupt changes by the aircraft (e.g., turning, change in pitch) more than if the aircraft continues in a straight line. Walruses on ice have responded to the aircraft at 366 m (1,200 ft), so pilots should increase altitude to greater than 458 m (1,500 ft) prior to overflights if the pilots or observers detect walruses in advance.
- 305-458 m (1,000-1,500 ft) to avoid localized weather such as low clouds or precipitation.
- Higher altitudes (e.g., greater than 1,219 m; 4,000 ft) may be flown during deadheads.
- Altitude may also need to be adjusted for aircraft deconfliction with manned or unmanned aircraft.

Safety

The survey team followed strict safety protocols specific to COVID-19 and flight operations. The complete safety protocols are detailed in Appendices B and C, respectively. Below, we summarize the main points from each protocol.

Covid-19 Safety Protocols

The health and safety of Utqiaġvik residents and survey personnel were of utmost importance during the survey period. Strict measures were implemented to ensure that survey scientists and pilots who arrived in Utqiaġvik were COVID-19 negative and remained free of the virus for the duration of their stay. The central pillar of the COVID-19 safety protocols was establishment and maintenance of a 'bubble' of survey personnel who used an 8-day shelter-in-place with a negative COVID-19 test on day 5 to enter the bubble. Stringent practices of wearing face masks, social distancing, and severely limiting external contacts were used to maintain the integrity and safety of the bubble, and to prevent the potential spread of the virus. Necessary activities within the bubble wherein social distancing could not be maintained, such as flying in the survey aircraft, were limited to bubble members. Masks and either goggles or face shields were worn by the scientists during travel on Alaska Airlines to Utqiaġvik. Personnel employed frequent hand washing/sanitizing. For complete details of the team's COVID-19 safety measures, see Appendix B.

Aerial Survey Safety Protocols

Aviation safety protocols were based on training, emergency preparedness, real-time flight following, reporting, and a safety culture that considered safety to be a lifestyle as opposed to a set of rules, as detailed in Appendix C. Every survey flight was satellite-tracked in real-time by the Automated Flight Following (AFF) system via SpiderTracks and followed strict communication and tracking protocols (Fig. 3). Aviation dispatchers from the Alaska Fire Service, Bureau of Land Management (BLM), provided real-time flight following assistance to the project.

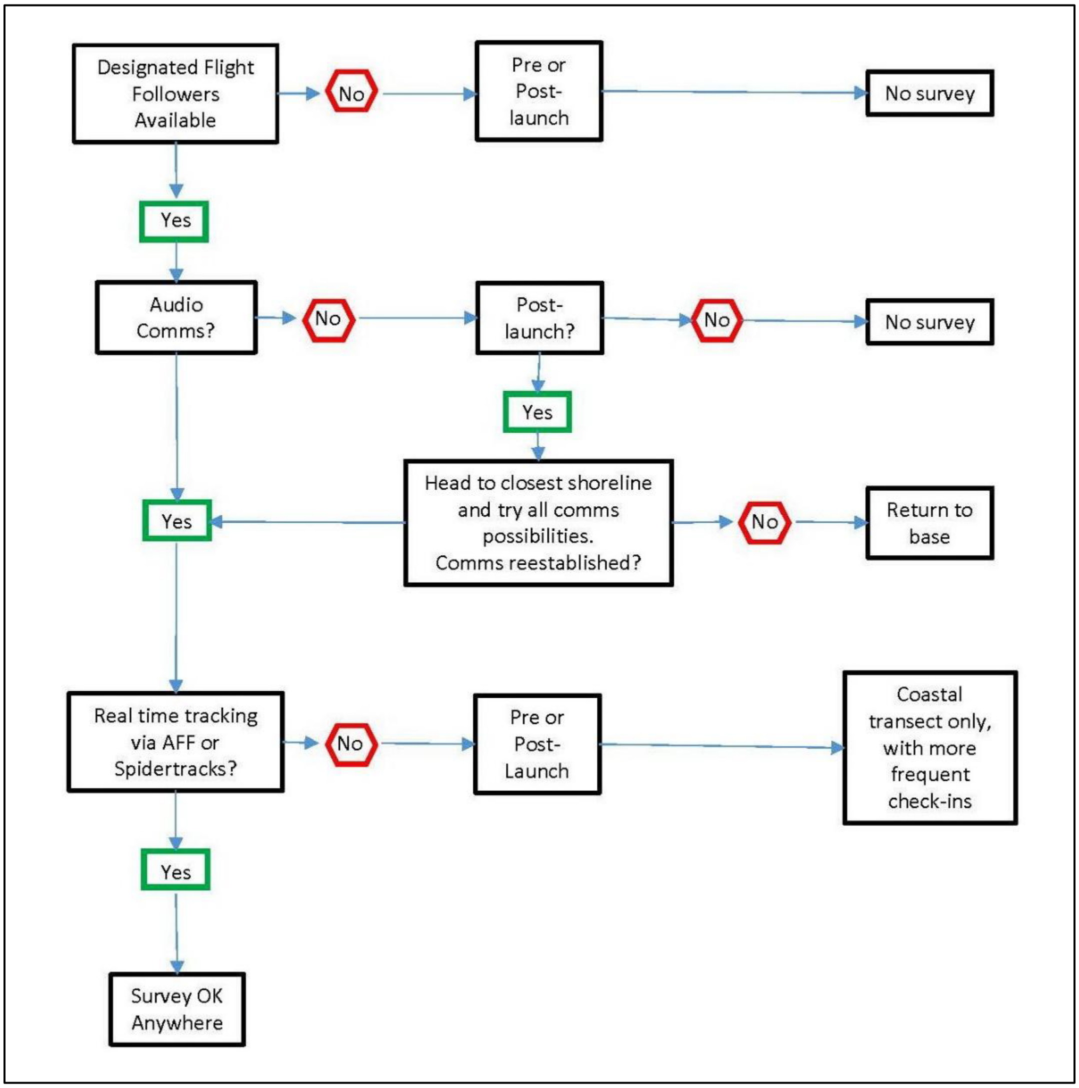

Figure 3. -- Flow chart used to determine whether a survey flight could be initiated or an existing flight plan should change, pending available communication and flight tracking capabilities.

Analytical Methods

Sighting Rate and Relative Abundance Analyses

Sighting rates (number of whales or walruses per unit [km] effort [WPUE]) quantify relative abundance by accounting for heterogeneity in survey effort and group size across the study area. Sighting rates are derived for three spatial scales, each limited to on-effort sightings by primary observers. Sighting rates are not corrected for availability or perception bias (Buckland 2001), but it makes sighting results more easily comparable across years.

Sighting rate is calculated for fine-scale areas using a grid consisting of approximately equilateral cells (5 minutes latitude by 15 minutes longitude, roughly 5 km by 5 km) superimposed across the study area. Sighting rates were calculated for bowhead whales, gray whales, belugas, and walruses. Sighting rates were not calculated for seals or polar bears because they were not priorities for these surveys, and seals are small and difficult to detect and identify to species from the survey altitude.

To calculate sighting rates for bowhead whales, gray whales, and belugas within each survey block in the study area, the number of on-effort whales is divided by effort (kilometers flown on transect and CAPs passing). Although survey blocks are arbitrary geographic areas, they provide a basis for inter-annual comparisons in the eastern Chukchi and western Beaufort seas. Effort over land, between barrier islands and the mainland, and north of the study area is not included in the survey block sighting rate analysis in order to facilitate comparisons with previous years.

To calculate sighting rates per depth zone for bowhead whales, gray whales, and belugas, the number of on-effort whales is divided by effort (kilometers flown on transect and CAPs passing) per depth zone in the study areas. Depth zones are defined based on depth data in the International Bathymetric Chart of the Arctic Ocean Version 2.23 (Jakobsson et al. 2008), which has a pixel resolution of 2 km. Depth zone analysis in the western Beaufort Sea is computed for two subareas (Fig. 4). The East and West subareas in the western Beaufort Sea are identical to previous analyses (e.g., Clarke et al. 2020). The West subarea spans 154°-157°W and includes Barrow Canyon and its surrounding area, which has noticeably different bathymetry than the rest of the western Beaufort Sea survey area. The East subarea spans 140°-154°W, an area that incorporates a well-defined continental shelf and slope. Depth zone analysis in the eastern Chukchi Sea uses slightly different depth zones to better reflect the bathymetric features of the area (≤35 m, 36-50 m, and 51-200 m); the 0-35 m and 51-200 m depth zones may be divided into North and South regions because they are separated by large expanses of intermediate (36-50 m) depths (Fig. 4). Projections used for sighting rate analyses for survey blocks and depth zones are included in Appendix D. Depth zone sighting rate analysis includes effort between barrier islands and the mainland. Sightings per depth zone are based on geographic placement of sightings within depth strata, not on the depth associated with each individual sighting in the survey database.

Sighting rates calculated for each of the three spatial scales described above for large cetaceans use effort on transect and CAPs passing, in combination with transect and CAPs-adjusted sightings from primary observers. This differs from large cetacean sighting rate analyses for ASAMM prior to 2018, when sighting rate analyses used transect effort only. In 2014-2017, large cetacean sighting rate analyses incorporated sightings and effort on transect combined with sightings and effort during

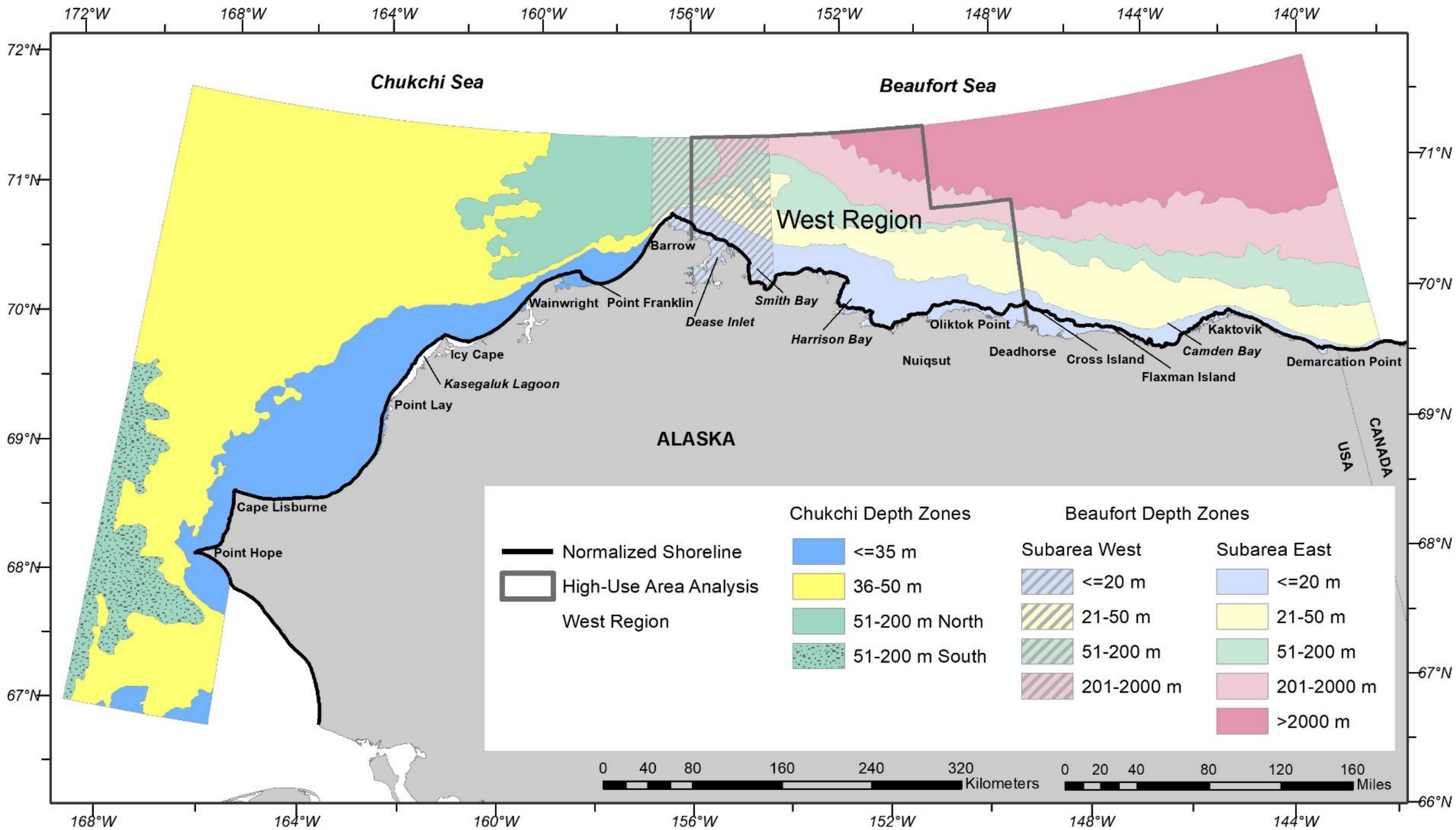

Figure 4. --West region and normalized shoreline used in bowhead whale high-use area (HUA) analysis, and depth zone subareas used for sighting rate analyses.

circling from transect. That metric is no longer used, as sightings and effort during circling from transect are considered off effort.

Beluga sighting rates calculated for each of the three spatial scales described above use effort on transect and sightings from primary observers on transect because belugas sighted during CAPs are recorded only in notes, not as individual sightings.

Fine-scale sighting rates for walruses use effort on transect and sightings from primary observers on transect, similar to belugas.

Indices of relative abundance of bowhead whale and gray whale feeding and milling behaviors, quantified as WPUE, are calculated for the fine-scale grid using effort on transect and CAPs passing, in combination with transect and CAPs-adjusted sightings from primary observers.

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

The majority of the bowhead whales observed in the Beaufort Sea in summer and autumn migrate through the Chukchi Sea to return to wintering areas in the Bering Sea. It was previously thought that most bowhead whales summered in the eastern Beaufort Sea, then actively migrated westward through the western Beaufort Sea in autumn (Moore and Reeves 1993). Previous central tendency analyses (e.g., Treacy 2002a; Monnett and Treacy 2005; Clarke et al. 2011a, 2012) defined bowhead whale observations to be in “migratory corridors.” However, results of satellite telemetry studies have shown that some bowhead whales will move back and forth across the Beaufort Sea during summer (Olnes et al. 2020). Furthermore, large dynamic groups of bowhead whales have been documented feeding in the western Beaufort Sea as early as July and continuing into October (e.g., Clarke et al. 2015, 2017b; Ferguson et al. 2020). There is no reliable way, via data collected during line-transect aerial surveys, to differentiate between whales that are actively undergoing a focused, unidirectional, westward autumn migration and whales that are crisscrossing the western Beaufort Sea prior to undergoing directed migration.

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

Bowhead whale HUAs were analyzed for the West region (148°-156°W) of the western Beaufort Sea (Fig. 4), the boundary of which corresponds roughly to oceanographic patterns and the offshore extent of sampling. Oceanographic patterns common to waters off northern Alaska are reviewed in Moore and DeMaster (1998). In brief, cold saline Bering Shelf Water and warm, fresh Alaska Coastal Water enter the western Beaufort Sea through Barrow Canyon. Both water masses are identifiable on the outer shelf (seaward of 50 m) as the eastward flowing Beaufort Undercurrent (Aagaard 1984). Bering Shelf Water has been traced in the Beaufort Sea at least as far east as Barter Island (~143°W), but the Alaska Coastal Water mixes with ambient surface waters as it moves eastward and is not clearly identifiable east of Prudhoe Bay (~147°-148°W).

The northern extent of the West region is based upon historical ASAMM survey effort. The West region extends from 148°W to 156°W and northward from shore to 72°N, except between 148°W and 150°W where the region extends to 71.333°N due to the layout of block 2. The northern boundary for this region corresponds with the boundaries of blocks 2, 11, and 12 (Fig. 4). The western cutoff at 156°W limits the analysis to bowhead whales seen in the western Beaufort Sea. Analyses were not conducted for the Chukchi Sea or east of the West region because few bowheads were sighted there in 2020.

Central tendency analyses are used to compare HUAs from 15 September to 15 October between 2020 and prior years. Two analyses of bowhead whale HUAs in the western Beaufort Sea were undertaken, as detailed below.

Bowhead Whale Central Tendency – Analysis 1

Non-parametric statistical tests, via the non-parametric Mann-Whitney *U*-test, were used to examine differences in median depth and distance from shore. Treacy (1998) found that median and mean bowhead whale distance from shore values were only slightly different. The non-parametric test is used for these data because distributions generally do not fit assumptions necessary to use the two-sample *t*-test. The variances are not equal between time periods for both depth and distance from shore; in addition, the depth data are considerably skewed and the distance-from-shore data are slightly skewed, so neither distribution strictly meets the assumption of normality. When assumptions of the *t*-test are seriously violated, the Mann-Whitney *U*-test may be more powerful than the two-sample *t*-test (Hodges and Lehmann 1956; Zar 1984). Statistical tests were undertaken using Real Statistics Using Excel Resource Pack (Zaiontz 2020).

Bowhead whale HUAs were examined using the median water depth, and mean and median distance from shore, by transect and CAPs-adjusted sightings (Houghton et al. 1984) from 15 September to 15 October 2020. Median distance from shore and depths at bowhead whale sightings in 2020, a year with light sea ice cover (National Snow and Ice Data Center 2020a) in autumn, were compared with analogous values from 15 September to 15 October of previous years having light sea ice cover (i.e., 1989, 1990, 1993-2019; Treacy 1990, 1991, 1994, 1995, 1996, 1997, 1998, 2000, 2002a, 2002b; Monnett and Treacy 2005; USDOI MMS 2008; Clarke et al. 2011a, 2011b, 2012, 2013, 2014, 2015, 2017a, b, 2018, 2019).

All transect and CAPs-adjusted bowhead whale sightings by primary observers, regardless of distance from the transect line, are included in the non-parametric central tendency analyses. Neither group size nor survey effort (km) is considered.

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

Bowhead Whale Central Tendency – Analysis 2

The second method for investigating the central tendency of the autumn bowhead whale distribution in the western Alaskan Beaufort Sea in 2020 involved a three-step process: 1) constructing spatial models of bowhead whale relative abundance (encounter rate) based on bowhead whale sightings from 2020; 2) applying the spatial relative abundance model to predict the expected number of bowhead whales in every cell of a grid overlying the study area; and 3) using the predicted number of bowhead whales in each cell to compute the median distance from shore of the whales sighted in 2020. This analysis was based on transect and CAPs-adjusted bowhead whale sightings made by primary observers from 15 September to 15 October 2020. This analysis did not account for availability or perception bias. Estimates of median distance from shore were calculated only for the West region due to lack of survey effort in the East region. The analysis was conducted in R version 4.0.3 (R Core Team 2020) using packages *sp* (Pebesma and Bivand 2005; Bivand et al. 2013), *maptools* (Bivand and Lewin-Koh 2020), *raster* (Hijmans 2020), *rgeos* (Bivand and Rundel 2020), *rgdal* (Bivand et al. 2020), and *mgcv* (Wood 2017).

To begin, the western Beaufort Sea survey area was partitioned into a 5-km by 5-km grid. This grid resolution was chosen as a compromise between having adequate survey effort and sightings in each cell to construct models, versus maximizing the resolution of the distance-from-shore data. All geospatial data were projected into an Equidistant Conic projection (false easting: 0.0; false northing: 0.0; central meridian: -148.0°; latitude of origin: 70.75°; standard parallels: 69.9°, 71.6°; linear unit: meter [1.0]). Data extracted for each cell included the total number of whales sighted, the projected x- and y-coordinates of the midpoint of each cell, and the shortest distance from that midpoint to the normalized shoreline. Bowhead whale relative abundance was modeled as a generalized additive model, parameterized by a Tweedie (Tweedie 1984; Dunn and Smith 2005) distribution with a natural logarithmic link function. Negative binomial models were also considered, but examination of model residuals (Ver Hoef and Boveng 2007) suggests that the Tweedie distribution provided a better fit to the data. The model formula is represented as

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

where

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

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

a: intercept;

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

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

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

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

The median distance from shore of the autumn distribution of bowhead whales in 2020 was estimated using the spatial model to predict the number of individuals likely to be observed in each cell after a uniform amount of effort (a constant L_i L_i for all *i*) was covered throughout the portion of the study area contained within the West region. The magnitude of L_i L_i used in the predictions does not affect the resulting median statistic as long as L_i L_i is constant across all cells, thereby eliminating apparent variability in bowhead whale distribution due only to spatial heterogeneity in survey effort. The predicted number of individuals per cell is cumulated, beginning with the cell closest to the normalized shoreline and ending with the farthest. The median distance from shore was calculated as the distance corresponding to the midpoint of the cell for which one-half of the total predicted number of individuals are assigned to cells located closer to shore and one-half assigned to cells located farther from shore.

The median is also referred to as the 50th percentile or quantile. An additional analysis that was undertaken defined the location of bowhead whale HUAs in 2020 based on the locations of the 30th, 40th, 50th, 60th, and 70th percentiles of predicted bowhead whale relative abundance for each column of 5-km × 5-km cells in the West region. For example, in this analysis the location of the 30th percentile in a specific column of cells refers to the location where 30% of the predicted number of bowhead whales would be closer to shore and 70% would be farther offshore. Due to the granularity of the spatial grid used for this analysis, adjacent percentiles may overlap in a single cell in locations where the predicted distribution of bowhead whales changes rapidly with distance from shore. The midpoints of all cells corresponding to the 30th percentile are connected across the entire region to define a linear boundary across the western Beaufort Sea corresponding to the 30th percentile of bowhead whale HUAs, and similarly for the 40th, 50th, 60th, and 70th percentiles.

Multiyear Analyses

To expand the usefulness of data collected in 2020, several multiyear analyses that use many stats were also conducted. Temporal and spatial parameters for each multiyear analysis are specifically chosen to maximize the amount of relevant information contained in the ASAMM dataset used to address the objectives of the analysis. These parameters vary substantially across multiyear analyses due to annual differences in when and where surveys were conducted. For example, multiyear analyses for the western Beaufort Sea from mid-September to mid-October justifiably can, in some situations (e.g., sightings in Harrison Bay), incorporate data from 1982 through 2020. Multiyear analyses for the northeastern Chukchi Sea included data collected from mid-September to mid-October 2009-2020 because survey effort was mostly equivalent during those time periods. Other applications require sightings from primary observers only and, therefore, incorporate data from only 1989 through 2020, which is when details related to primary observers were recorded in the dataset.

RESULTS

Environmental Conditions

In 2020, sea ice cover in the survey area was very light. Minimal broken floe sea ice was observed at the ends of transect lines 129 and 130 (Fig. 1) on 6 October. On 12 October, broken floe and new sea ice was observed at the ends of transect lines 109, 110, 113, and 114 (Fig. 1). New ice started to form in lagoons and other shallow water areas in mid-October. Arctic sea ice extent reached the seasonal minimum on 15 September 2020. Average Arctic sea ice extent for September 2020 was second lowest since satellite data were first recorded in 1979, behind only September 2012 (National Snow and Ice Data Center 2020b). Average Arctic sea ice extent for October 2020 was the lowest in the satellite data record (National Snow and Ice Data Center 2020c). To examine interannual variability in bowhead whale and other marine mammal distributions and relative abundance, 2020 data were compared to data from previous years with light sea ice cover (1982, 1986-87, 1989-90, 1993-2019).

Survey Effort

The field season commenced 15 September 2020 and ended 16 October 2020; survey flights were conducted from 17 September to 15 October (Table 3). There were 14 survey days, comprising 6 in September and 8 in October. On seven occasions, multiple flights in one day were flown to take advantage of favorable survey conditions or to extend the search for areas with weather suitable for conducting surveys, which required a refuel in Deadhorse or Kotzebue. For simplicity, "survey flight" and "survey day" are used interchangeably in this report; that is, a single unique flight number was assigned to each day that the team surveyed, regardless of whether only one or multiple flights were flown. A short section of coastal transect was flown near Cape Krusenstern to take advantage of good visibility during transit to refuel in Kotzebue. Surveys were conducted on 45% of days during the field season (14 out of 31 days). Surveys were not conducted on 55% of days (17 out of 31 days) due to weather (16 days) or both weather and waiting for COVID-19 test results at the beginning of the field season (1 day).

Survey effort was summarized by hours (hr) or kilometers (km) flown in different survey modes. Over 14,000 km were flown during 56.6 hours total effort (Fig. 5). A total of 4,680 km were flown on effort (transect and CAPs passing) during 21.9 hours (Fig. 6). Kilometers on effort constituted 33% of the total distance flown, corresponding to 39% of the total flight hours. Fifty-eight percent of total survey kilometers were flown on deadhead. No flights were flown entirely on deadhead, which has happened in previous years due to poor weather conditions. The average survey distance flown per day was 1,024 km, ranging from 255 km to 1,770 km. The longer distances required 2-3 flights per survey.

Direct avoidance of possible subsistence activities, specifically the autumn bowhead whale hunt near Utqiaġvik, occurred on one day in 2020. On 20 September, transects were not flown when within a 37-km (20 nmi) radius of Utqiaġvik to avoid potential interference with subsistence whaling because the cloud ceilings were lower than 457 m (1,500 ft).

Aerial surveys supporting sea ice and marginal ice zone research were conducted in the western Beaufort Sea by researchers using a NOAA Twin Otter. Communications between researchers allowed for airspace deconfliction and uninterrupted survey effort.

Table 3. -- Aerial survey flight effort in chronological order, 17 September – 15 October 2020, by survey day. On-effort includes distance (km) and time (hr) during transect and CAPs passing survey modes. Off-effort includes distance during search, circling from search, circling from transect, and CAPs circling survey modes.

Day	Flight No.	On-Effort (km)	Off-Effort (km)	Deadhead (km)	Total (km)	On-Effort (hr)	Total (hr)
17 Sep	1	571	123	286	979	2.7	4.6
20 Sep	2	519	15	327	861	2.4	3.5
22 Sep	3	90	22	778	890	0.4	2.8
23 Sep	4	848	149	716	1,713	4.0	7.4
25 Sep	5	29	0	248	278	0.1	1.1
28 Sep	6	311	95	209	616	1.5	2.9
4 Oct	7	151	37	66	255	0.7	1.1
6 Oct	8	449	136	619	1,204	2.1	5.0
7 Oct	9	115	2	984	1,101	0.6	3.7
10 Oct	10	76	194	1,343	1,613	0.4	5.1
12 Oct	11	501	40	1,228	1,770	2.3	6.4
13 Oct	12	247	56	905	1,209	1.1	4.5
14 Oct	13	454	98	376	928	2.1	4.0
15 Oct	14	319	324	274	916	1.5	4.5
Total		**4,680**	**1,291**	**8,359**	**14,333**	**21.9**	**56.6**

Survey coverage in the study area was greatest in block 12 in the Beaufort Sea (Fig. 7) because it is located within the primary study area and is closest to the base airport at Utqiaġvik. When weather conditions were marginal, the survey team remained relatively close to base in case weather conditions started to rapidly worsen. When conditions quickly deteriorated, survey effort was immediately aborted so that the team could return safely to base. When comparing survey results from 2020 with previous ASAMM surveys, it is important to remember that *in 2020 no surveys were flown in the easternmost portion of the study area, from Kaktovik to the U.S.-Canada border, or in the majority of the Chukchi Sea* (Fig. 5) due to survey priorities, limited funding, weather, and logistical limitations. Flight lines, associated sea states, and sightings on individual flights are shown in Appendix E.

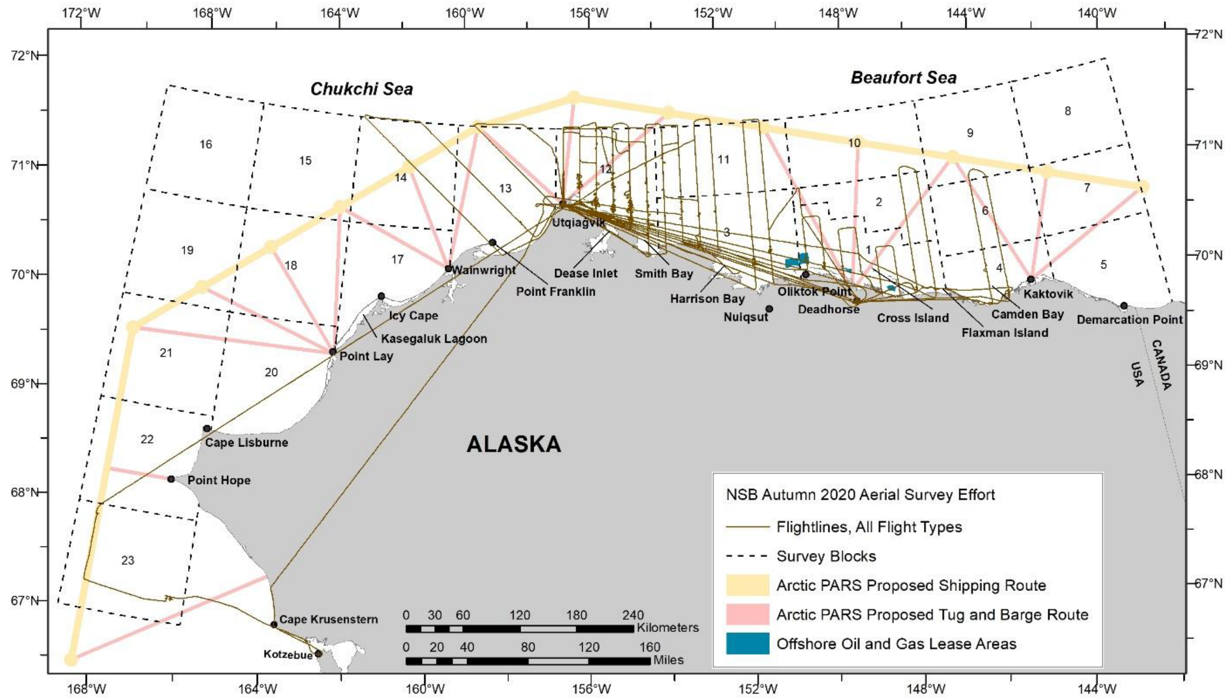

Figure 5. --Combined flight tracks, all survey modes (transect, CAPs, search, circling, and deadhead), 17 September – 15 October 2020.

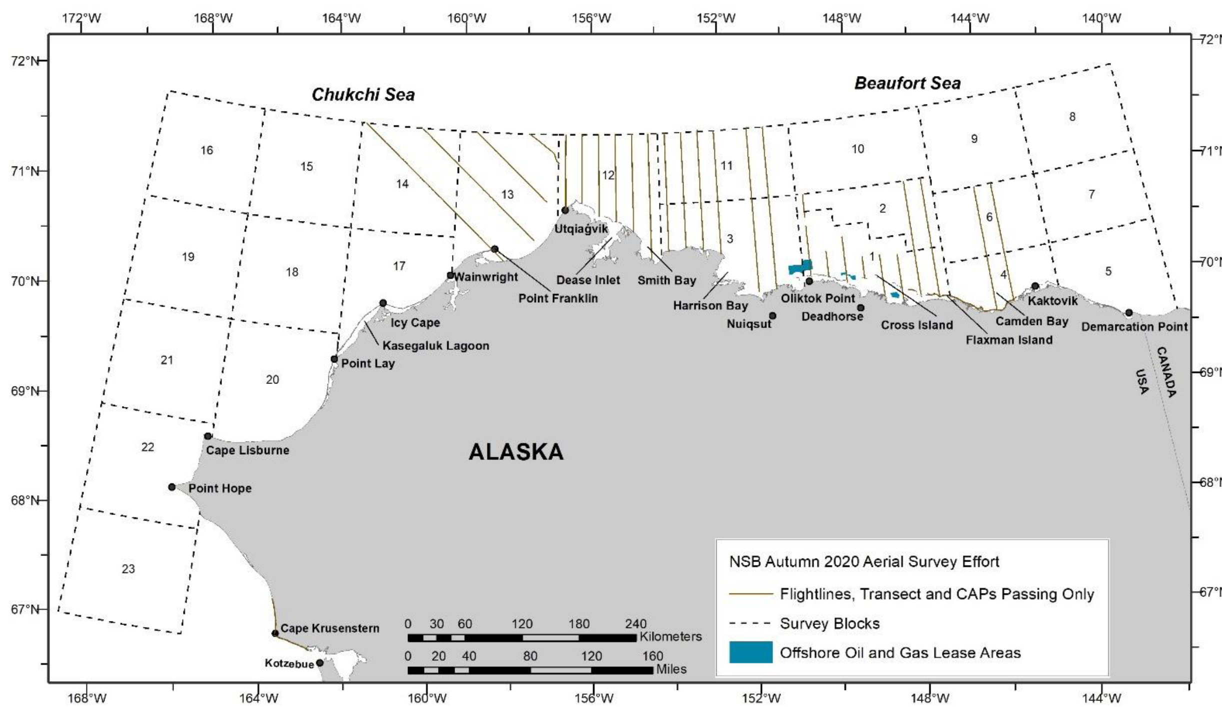

Figure 6. -- Combined on-effort flight tracks, transect and CAPs passing effort only, 17 September – 15 October 2020. Some lines were flown on multiple days.

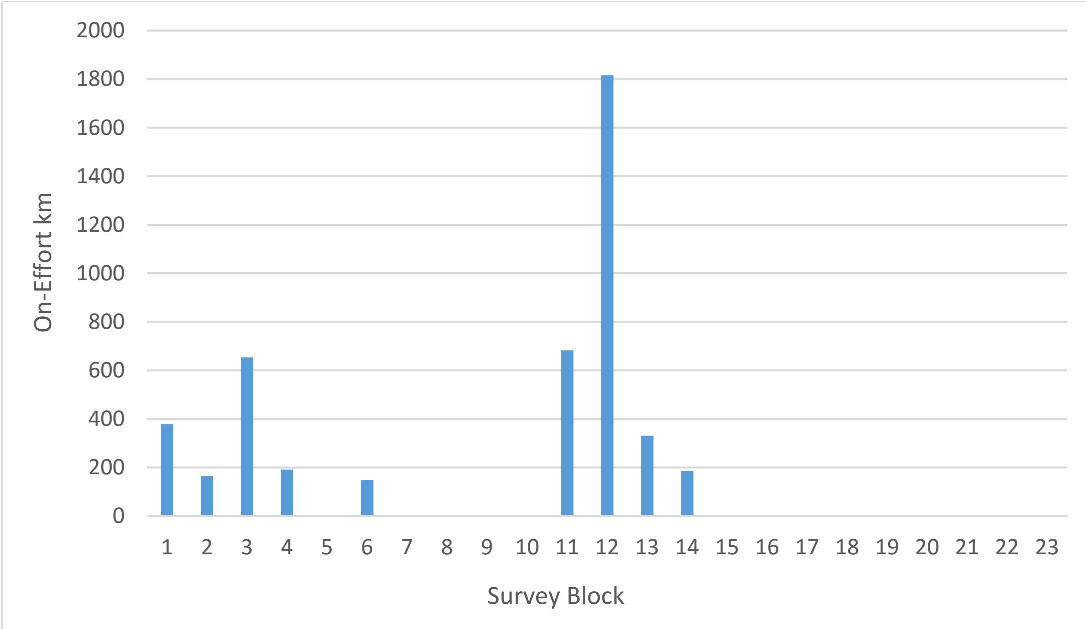

Figure 7. -- Kilometers flown on effort (transect and CAPs passing) per survey block, 17 September – 15 October 2020. The total for block 1 includes 25 km flown inshore of the barrier islands.

Cetaceans

Bowhead Whales

Bowhead Whale Sighting Summary

During the 2020 field season, 293 sightings of 770 bowhead whales (*Balaena mysticetus*) from the Western Arctic (also known as the Bering-Chukchi-Beaufort Seas) stock were observed during all survey modes (transect, CAPs, search, and circling) (Table 4; Fig. 8).

Observed bowhead whale distribution extended across the western Beaufort Sea from 144°W to 157°W. Sightings were primarily over the inner continental shelf (≤ 50 m), with a small number of whales (17 whales) sighted over the outer continental shelf (51-200 m). The majority of bowhead whales (85%, 653 whales) were sighted in survey block 12 (154°-157°W). Minimal survey effort was conducted in the eastern Chukchi Sea, and no bowheads were sighted there.

Bowhead Whale Sighting Rates

There were 209 sightings of 589 bowhead whales on effort (transect and CAPs-adjusted) by primary observers, ranging from one whale per sighting (114 sightings) to 39 whales per sighting (1 sighting). Eighty-four percent (492 whales) of all bowhead whales on effort were seen in survey block 12 (154°-157°W). Highest fine-scale sighting rates (WPUE, 5-km grid) were distributed from Point Barrow to Dease Inlet, in Harrison Bay, and east of Oliktok Point (Fig. 9). The highest sighting rate per survey block occurred in block 12 (0.2711 WPUE), followed by block 1 (0.1527 WPUE) (Table 5, Fig. 10). Sighting rates in both the western and central-eastern Beaufort Sea subareas were highest in the 0-20 m depth zone (0.8653 WPUE and 0.1102 WPUE, respectively) (Table 6, Fig. 11).

Table 4. -- Summary of cetacean sightings (number of sightings/number of individuals) during transect, CAPs, search, and circling survey modes, in chronological order, 17 September – 15 October 2020, by survey day. Excludes dead and repeat sightings.

Day	Flight No.	Bowhead whale	Gray whale	Humpback whale	Fin whale	Beluga	Harbor porpoise	Unidentified cetacean
17 Sep	1	29/104	1/1	0	0	18/74	0	0
20 Sep	2	0	4/8	0	0	0	0	0
22 Sep	3	1/5	0	0	0	4/5	0	0
23 Sep	4	26/42	0	0	0	43/139	0	1/1
25 Sep	5	0	0	0	0	0	0	0
28 Sep	6	60/73	0	0	0	5/12	0	1/1
4 Oct	7	0	0	0	0	6/6	0	0
6 Oct	8	85/149	0	0	0	39/54	0	0
7 Oct	9	0	0	0	0	0	0	0
10 Oct	10	0	1/1	2/4	5/6	0	1/2	0
12 Oct	11	4/8	0	0	0	0	0	0
13 Oct	12	14/45	0	0	0	0	0	0
14 Oct	13	19/27	0	0	0	2/3	0	1/1
15 Oct	14	55/317	0	0	0	38/91	0	0
TOTAL		**293/770**	**6/10**	**2/4**	**5/6**	**155/384**	**1/2**	**3/3**

Bowhead Whale Behaviors

Bowhead whale behaviors observed during all survey modes (i.e., transect, CAPs, search, and circling) and by primary and secondary observers in 2020 are summarized in Table 7. The behavior most often recorded was feeding (64%), followed by swimming (21%). Feeding behavior was likely underreported due to the difficulty of identifying this behavior for animals feeding on benthic or mid-water prey; milling was recorded in situations where obvious evidence of feeding was not directly observed but was suspected. Behavior was recorded as unknown for 72 whales, likely because the sightings were too brief or far away to determine a behavior. No bowhead whales appeared to respond to the survey aircraft.

Bowhead whale feeding behavior, which includes sightings reported as milling, was observed in 115 sightings of 505 whales from 146.7°W to 156.4°W (Fig. 12). The majority of feeding and milling whales (90%, 454 whales) were sighted from 154°W to 157°W, in survey block 12. Some of these feeding and milling whales were sighted in very dense aggregations of feeding whales, arguably the densest aggregations ever recorded in 41 years of comparable surveys dating back to 1979.

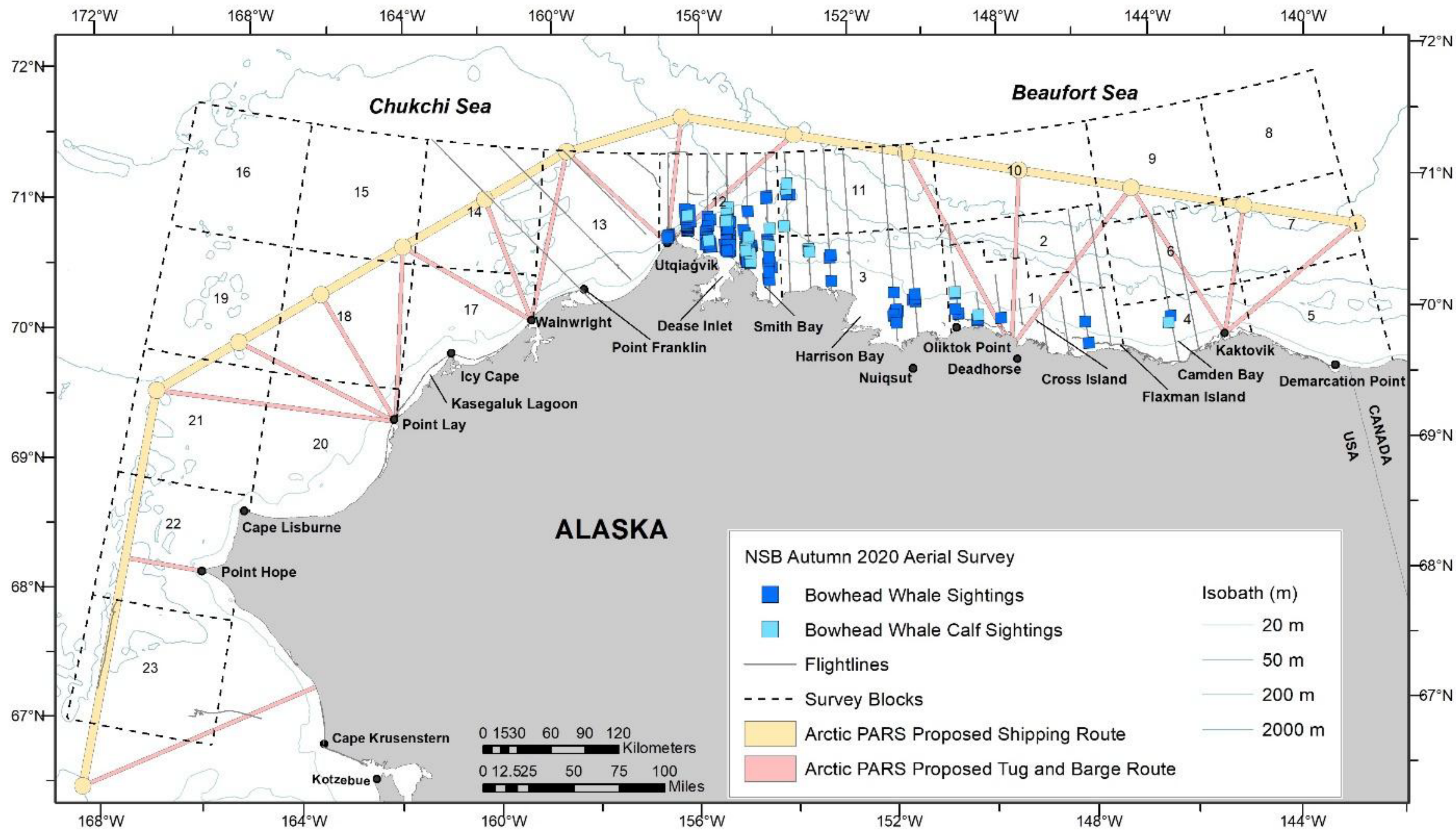

Figure 8. -- Bowhead whale and bowhead whale calf sightings, all survey modes, with transect, CAPs, search, and circling effort, 17 September – 15 October 2020. Deadhead flight tracks are not shown.

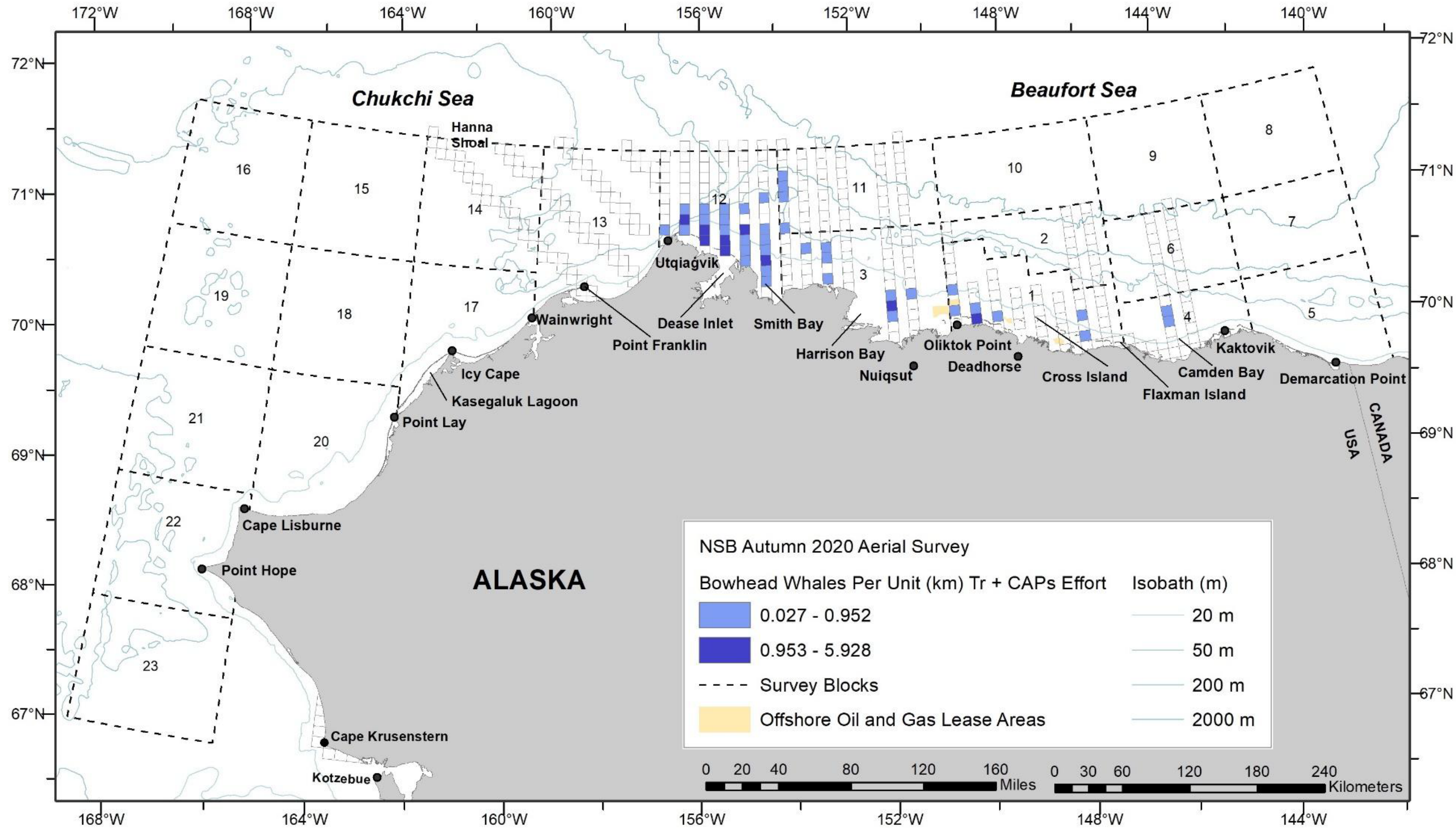

Figure 9. -- Bowhead whale on-effort sighting rates (WPUE; sightings from primary observers only). Empty cells indicate sighting rates of zero. Transect (Tr) and CAPs survey effort were not conducted in areas without cell outlines.

Table 5. -- On-effort (transect and CAPs passing) kilometers (km), number of bowhead whale on-effort sightings (primary observers only), and bowhead whale sighting rate (WPUE = bowhead whales per km surveyed) per survey block, 17 September – 15 October 2020. NA – surveys were not conducted. The total for block 1 includes 25 km flown inshore of the barrier islands. Minor discrepancies within the table are due to rounding errors.

BLOCK	km	Sightings	Bowhead whales	WPUE
1	379	14	54	0.1425
2	164	0	0	0.0000
3	654	20	32	0.0491
4	191	2	4	0.0209
5	0	0	0	NA
6	148	0	0	0.0000
7	0	0	0	NA
8	0	0	0	NA
9	0	0	0	NA
10	0	0	0	NA
11	682	6	7	0.0103
12	1,816	167	492	0.2711
Total	**4,034**	**209**	**589**	**0.1461**

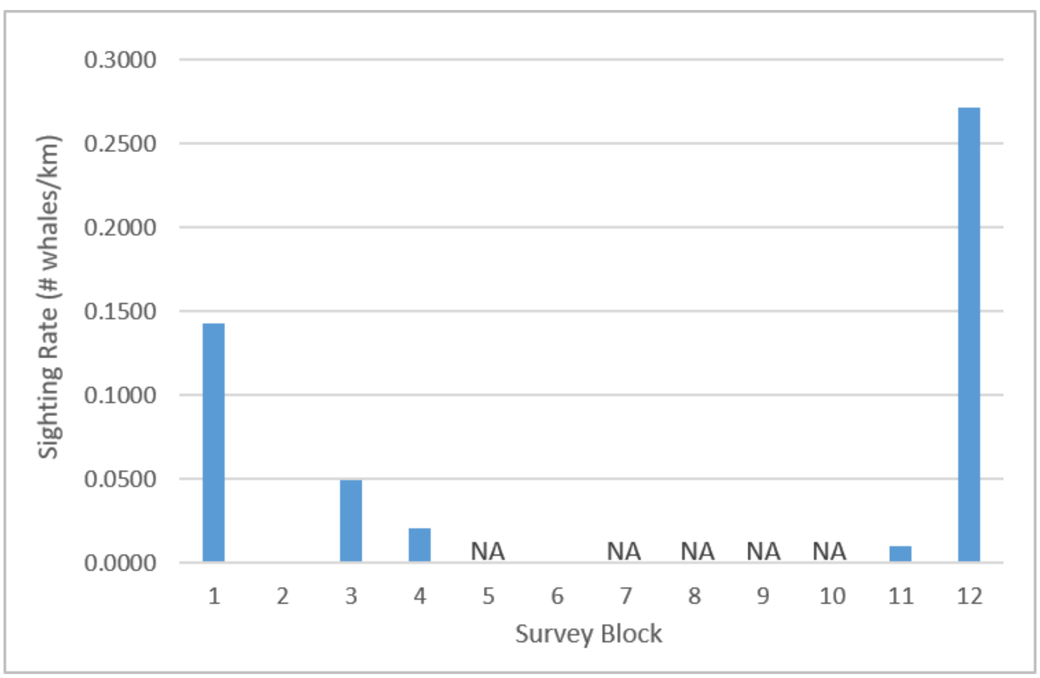

Figure 10. -- Bowhead whale on-effort sighting rates (WPUE; sightings from primary observers only) per survey block, 17 September – 15 October 2020. NA – surveys were not conducted. Sighting rates of zero were removed from Block 6 from the graph for clarity.

Table 6. -- On-effort (transect and CAPs passing) kilometers (km), number of bowhead whale on effort sightings (primary observers only), and bowhead whale sighting rate (WPUE = bowhead whales per km surveyed) per depth zone, 17 September – 15 October 2020. Minor discrepancies within the table are due to rounding errors.

DEPTH ZONE	km	Sightings	Bowhead whales	WPUE
154°W-157°W				
0-20 m	413	106	357	0.8653
21-50 m	345	51	119	0.3448
51-200 m	866	10	16	0.0185
201-2,000 m	191	0	0	0.0000
140°W-154°W				
0-20 m	645	24	71	0.1102
21-50 m	583	15	22	0.0377
51-200 m	480	3	4	0.0083
201-2,000 m	378	0	0	0.0000
>2,000 m	130	0	0	0.0000
TOTAL	4,032	209	589	0.1462

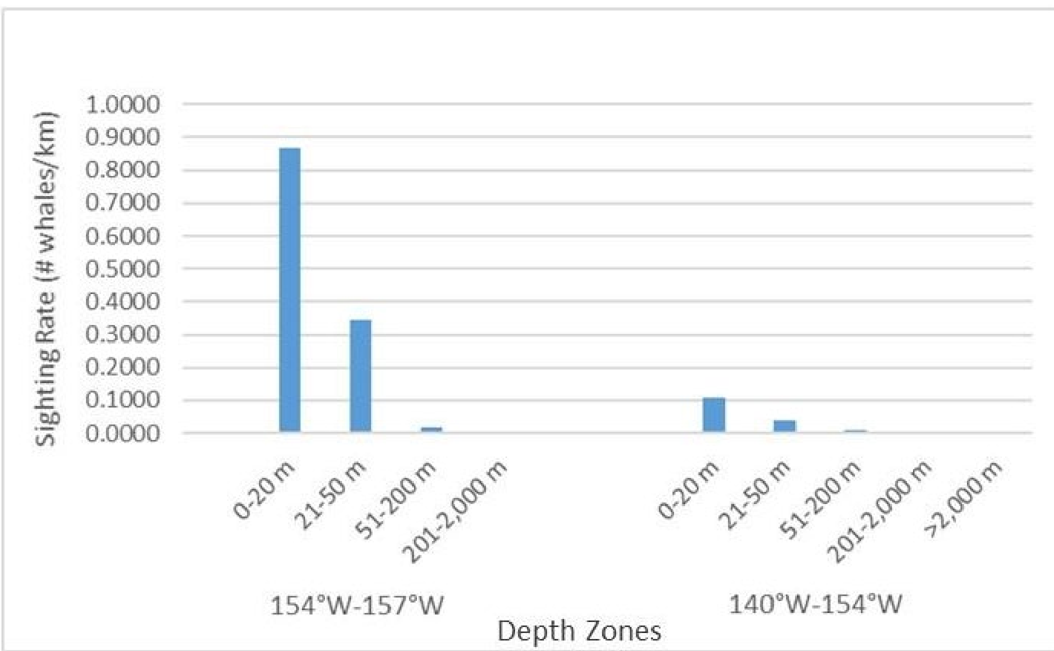

Figure 11. -- Bowhead whale on-effort monthly sighting rates (WPUE; sightings from primary observers only) per depth zone, 17 September – 15 October 2020. NA – surveys were not conducted. Sighting rates of zero were removed from depth zones 201-2,000 m and >2,000 m of the graph for clarity.

Table 7. -- Bowhead whales (number of sightings/number of individuals) observed during transect, CAPs, search, and circling survey modes, by behavioral category, 17 September – 15 October 2020. Excludes dead and same-day repeat sightings.

Behavior	**Whales**
Breach	1/1
Dive	9/9
Feed	109/491
Flipper Slap	1/1
Mill	6/14
Rest	18/21
Swim	112/161
Unknown	37/72
TOTAL	**293/770**

Cetacean Aggregation Protocols effort is used when densities of bowhead whales become so high that the data recorder needs to be able to enter data more rapidly than the standard, comprehensive data entry protocols allow. During CAPs passing effort, behavior is not routinely recorded; however, behavior is recorded during CAPs circling effort and is used to infer the proportion of CAPs passing whales that were feeding and milling. In most of the CAPs sessions from 2020, it is reasonable to assume that even though not all whales could definitively be determined to be feeding, all whales in the area were there to feed because there were so many whales in such a small area. For this reason, the non-feeding and non-milling CAPs whales are plotted on the feeding and milling maps in Figures 12 and 15 to give a better visual representation of the densities of whales likely feeding in the area.

Feeding and milling bowhead whales were sighted in very shallow water and very close to shore in 2020. Water depths at sightings of feeding and milling whales ranged from 5 m to 26 m, and distance from shore ranged from 0.6 km to 30 km. Fine-scale sighting rates (WPUE, 5-km grid) for feeding and milling bowhead whales are shown in Figure 13. Highest fine-scale sighting rates (WPUE, 5-km grid) were located between Utqiaġvik and Smith Bay, and east of Oliktok Point.

The area between roughly Cape Halkett and Point Barrow (~152.5°-157°W) encompasses a well-documented bowhead whale feeding area (Moore and Reeves 1993; Mocklin et al. 2011; Shelden et al. 2017) that has been linked to upwelling-favorable winds, followed by decreased winds, and the formation of a "krill trap", which aggregates and traps krill on the continental shelf between water masses (Ashjian et al. 2010). In 2020, surveys were conducted in this area on eight days; bowhead whales were observed on five of the days that surveys were conducted, and were documented feeding and milling on four of those days (Fig. 14). On some of the days that this area was flown and no bowhead whales were sighted, survey effort was limited due to poor weather. To limit data biases, surveys were not preferentially conducted on days with a higher likelihood of seeing bowhead whales; for example, based on recent wind conditions that are favorable to aggregate bowhead whale prey.

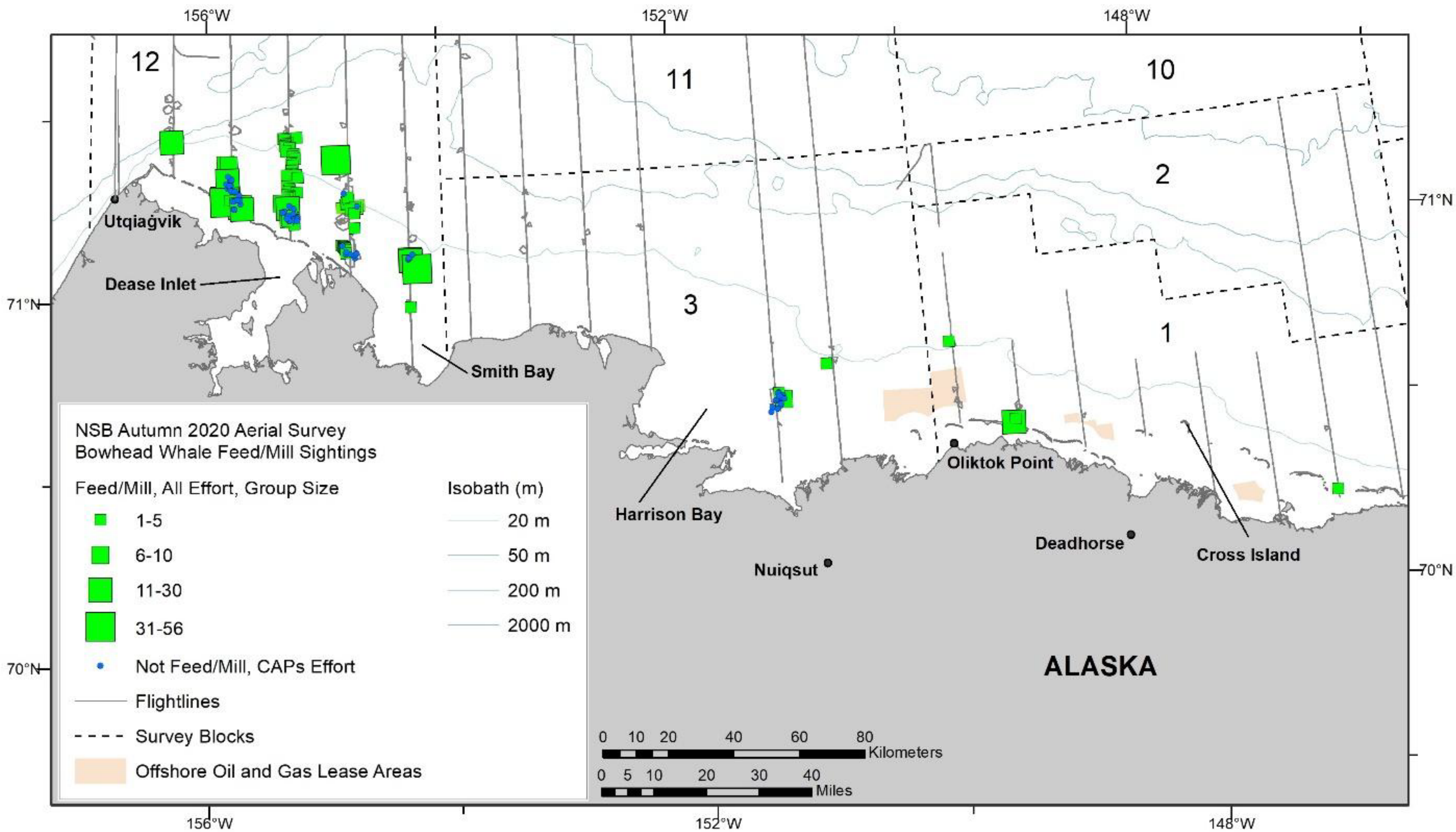

Figure 12. -- Bowhead whale feeding and milling sightings during transect, CAPs, search, and circling survey modes, 17 September – 15 October 2020. Non-feeding and non-milling sightings on CAPs and circling from CAPs that were associated with CAPs sessions in which feeding or milling whales were sighted are also included because these whales were likely also feeding.

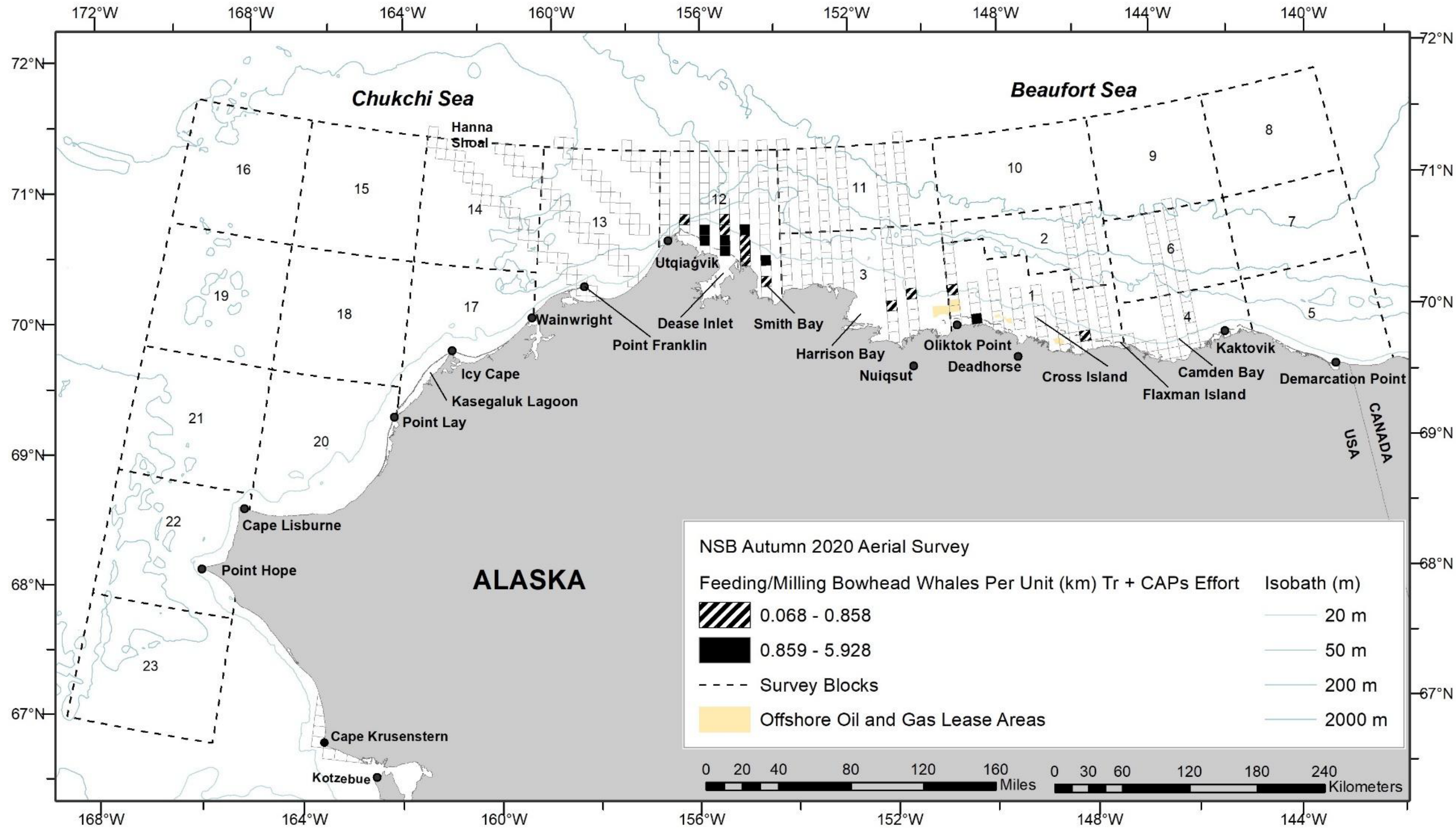

Figure 13. -- Bowhead whale on-effort feeding and milling sighting rates (WPUE; sightings from primary observers only), 17 September – 15 October 2020. Empty cells indicate sighting rates of zero. Transect (Tr) and CAPs survey effort were not conducted in areas without cell outlines.

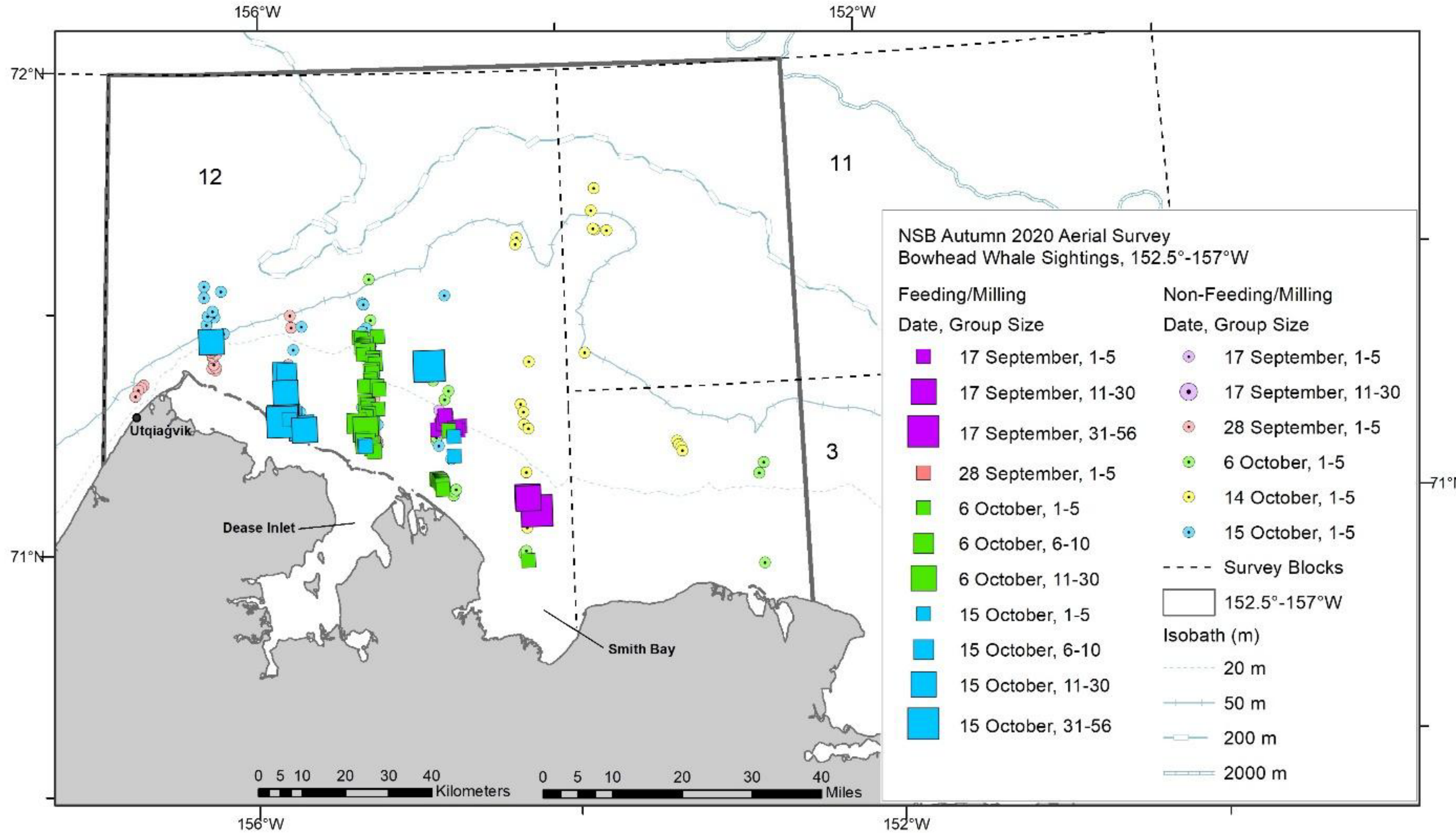

Figure 14. -- Bowhead whale sightings by date and group size, 152.5°-157°W, observed during transect, CAPs, search, and circling survey modes, 17 September – 15 October 2020. "Non-Feeding/Milling" means that the whales were not recorded as engaging in feeding or milling behavior during the period of time in which they were observed.

This area did have the highest amount of survey effort because, not only was it the highest priority survey area, but weather often precluded surveying in other areas. Bowhead whales were sighted in dense aggregations in this area: 670 bowhead whales were observed between Cape Halkett and Point Barrow, and 68% (454 whales) of them were recorded as feeding or milling.

Bowhead whales were also sighted in a dense aggregation at the mouth of Harrison Bay on 23 September 2020 (Fig. 15). This aggregation was unusual because bowhead whales were not typically sighted in Harrison Bay during previous ASAMM surveys. Forty-two bowhead whales were sighted, 11 of which were documented as feeding. Although the majority of the animals were documented as swimming, diving, resting, or "unknown" behavior, it is presumed that because these whales were in a dense aggregation, they were in this area to feed.

Bowhead Whale Calves

Of the 770 bowhead whales sighted, 24 were identified as calves (Fig. 8). Similar to previous ASAMM surveys (e.g., Clarke et al. 2020), most calves (20 calves, 83%) were sighted after circling was initiated and likely would not have been observed if circling had not commenced. All calves were sighted in October, distributed from 144.8°W to 156.3°W. Calves were observed with adult bowhead whales that were swimming and milling. Calves may not have been sighted in feeding aggregations due to their small size, the overall number of whales in the vicinity, and the opaque, muddy water that was common where bowhead whales were feeding in 2020 due to the sediment being stirred up by their feeding activities. Three calves were sighted without a closely associated adult, although in two of those cases, adult whales were in the general vicinity. Lone calves were observed resting, swimming, and one was flipper and tail slapping. The calf ratio (number of calves sighted on effort by primary or secondary observers/number of total whales on effort) was 0.037.

Bowhead Whale Central Tendency – Analysis 1

Bowhead whale distribution in the western Beaufort Sea in 2020, based on transect and CAPs sightings by primary and secondary observers, shared similarities with the distribution of on-effort sightings observed during 15 September – 15 October in previous years having light sea ice cover (i.e., 1982, 1986, 1987, 1989, 1990, 1993-2019). Sightings in 2020 stood out, however, due to their proximity to shore (Fig. 16).

Summary statistics for bowhead whale data from the western Beaufort Sea West region from 15 September to 15 October 1989-2020 are presented in Table 8. Summary statistics are from sightings made by primary observers only. Limiting sightings for this analysis to only primary observers results in the exclusion of >500 sightings across all years but provides tighter data constraints resulting in a more robust analysis. In the West region, mean depth at bowhead whale sightings made on effort by primary observers in 2020 was 18 m (SD = 11.1 m, range 5-77 m) and median depth was 16 m (Table 8). Mean and median distances to the normalized shoreline were 18.4 km (SD = 14.5 km, range 1-81 km) and 16.1 km, respectively (Table 8).

To evaluate whether significant displacements occurred in western Beaufort Sea bowhead whale HUAs during 15 September - 15 October 2020 compared to previous years with light sea ice cover, estimates of median depth and distance from shore were compared with pooled data from previous years. From 15 September to 15 October 2020 in the West region, bowhead whale sightings were in

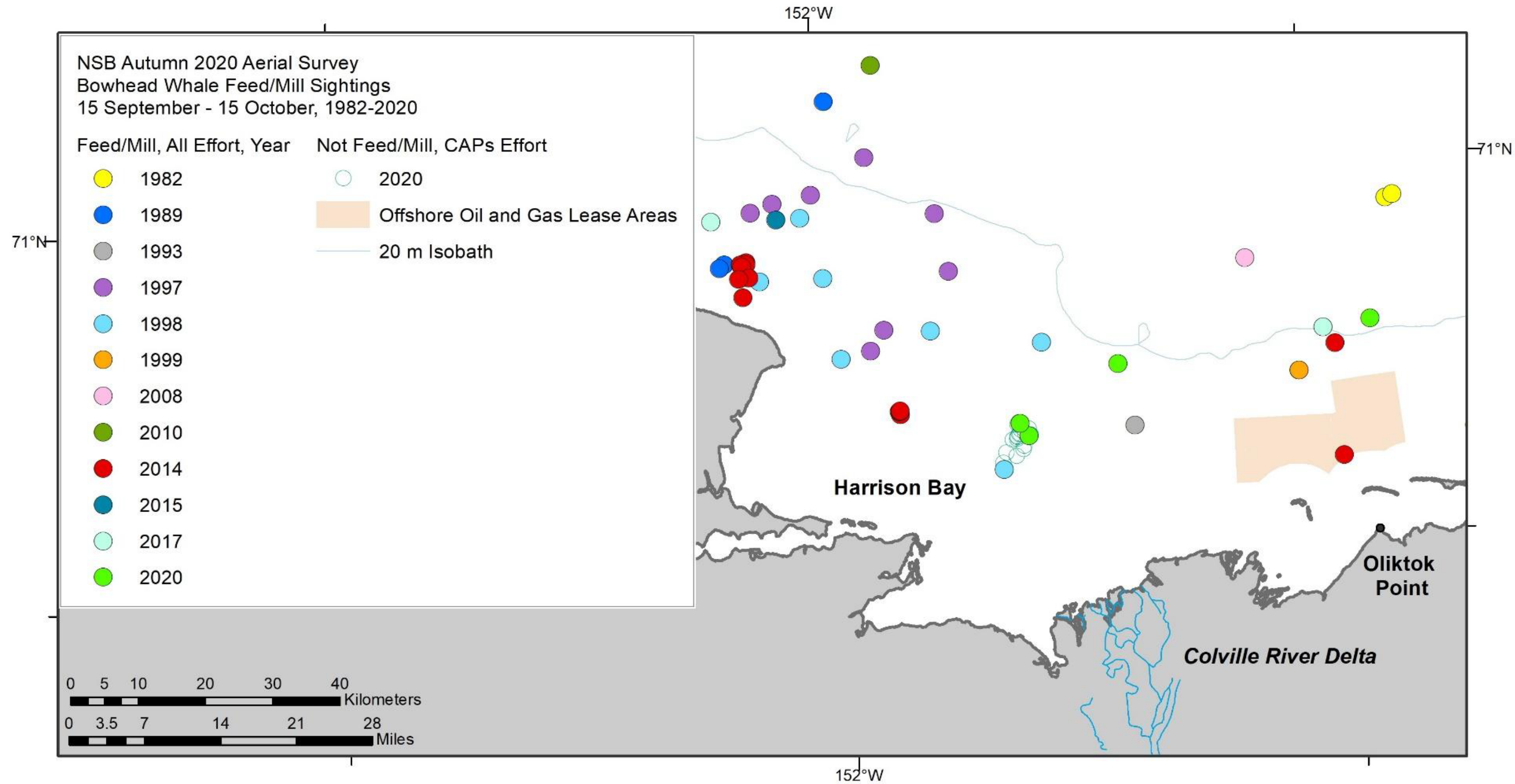

Figure 15. -- Bowhead whale feeding and milling sightings in Harrison Bay, observed during transect, CAPs, search, and circling survey modes, by year, 15 September – 15 October 1982-2020. Bowhead whales sighted on CAPs and circling from CAPs between 17 September and 15 October 2020 that were not recorded as feeding or milling but were associated with CAPs sessions in which feeding or milling whales were sighted are included because these whales were likely also feeding.

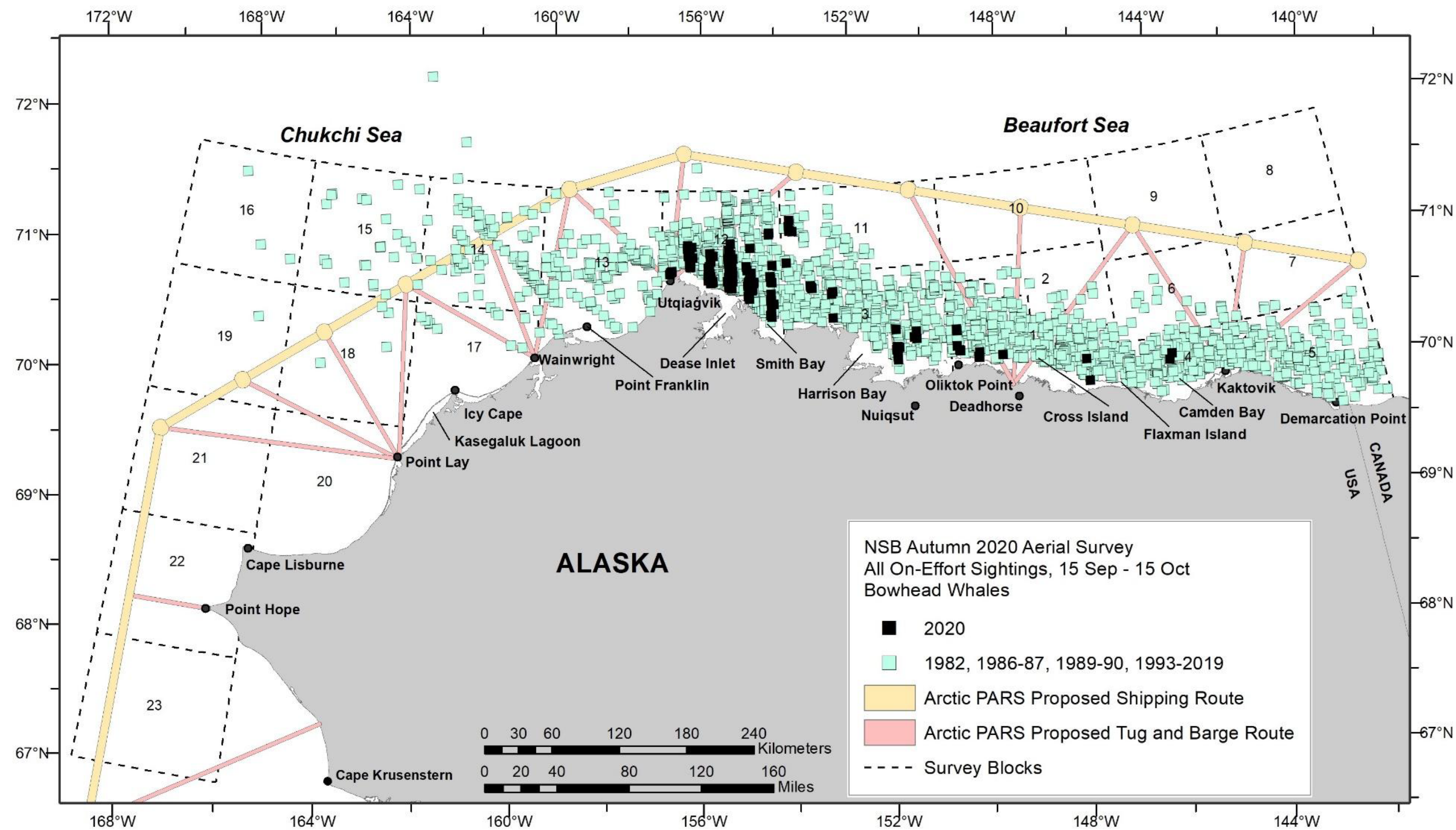

Figure 16. -- Bowhead whale sightings 15 September – 15 October, in years with light sea ice cover: 1982, 1986-1987, 1989-1990, 1993-2018, 2019, and 2020. Includes all on-effort sightings from primary and secondary observers.

Table 8. -- Central tendency statistics for depth (m) and distance from shore (km) at bowhead whale transect sightings between 15 September and 15 October in the western Beaufort Sea West region, by year, 1989-2020. OE-Si = number of on-effort sightings made by primary observers.

		Depth				Distance from shore			
Year	**OE-Si**	**Median**	**Mean**	**SD**	**Min-Max**	**Median**	**Mean**	**SD**	**Min-Max**
1989	5	19	16	7.0	7-24	25.3	20.6	14.5	4-35
1990	5	27	29	8.9	20-39	27.4	30.2	7.2	24-41
1991	1	383	383	-	-	72.8	72.8	-	-
1992	6	57	66	20.4	52-106	53.1	52.5	6.7	43-63
1993	18	20	23	10.0	12-49	24.5	26.6	13.2	11-61
1994	2	13	13	0.7	12-13	15.0	15.0	6.0	11-19
1995	6	50	258	514.6	35-1308	50.3	56.2	23.5	32-102
1996	3	35	35	2.5	32-37	38.4	38.1	1.3	37-39
1997	54	19	25	19.0	5-100	21.5	24.2	10.8	7-52
1998	49	17	62	283.1	7-2001	17.7	24.7	19.7	3-118
1999	15	15	17	5.7	10-35	16.1	16.1	5.5	6-31
2000	9	19	33	53.1	5-173	23.1	23.6	21.4	3-73
2001	0	-	-	-	-	-	-	-	-
2002	10	25	36	27.5	11-88	31.2	31.9	11.8	9-48
2003	29	20	50	67.3	12-310	27.2	28.9	15.7	2-72
2004	31	22	24	11.2	5-51	23.3	22.1	8.6	5-42
2005	1	22	22	-	-	17.8	17.8	-	-
2006	11	33	44	33.2	17-141	38.6	41.3	12.3	23-63
2007	6	23	24	8.6	13-36	24.0	25.2	6.2	18-33
2008	28	16	17	6.0	7-40	16.7	16.7	7.5	4-37
2009	37	17	31	46.4	8-239	15.7	20.3	16.4	4-81
2010	18	19	31	40.5	10-189	18.1	23.5	16.5	3-76
2011	24	20	21	4.9	15-31	25.4	25.6	8.1	16-56
2012	43	27	58	106.6	15-648	26.7	37.1	20.7	11-76
2013	22	29	87	87.6	6-258	22.1	40.3	31.1	3-87
2014	67	17	38	53.7	5-220	20.2	28.9	24.4	2-84
2015	85	15	17	8.8	6-52	15.1	18.6	12.2	4-69
2016	74	50	67	55.9	11-227	51.9	51.9	18.3	11-90
2017	48	15	20	32.6	7-239	14.0	15.2	7.1	5-43
2018	129	120	120	93.4	3-341	51.3	47.8	22.6	2-88
2019	16	50	94	118.0	25-503	56.9	59.2	15.2	37-91
2020	179	16	18	11.1	5-77	16.1	18.4	14.5	1-81

significantly shallower water (median depth 16 m vs. 21 m, Z = 7.748, P = < 0.0001) and closer to shore (median distance from shore 16.1 km vs. 24.5 km, Z = 8.076, P = < 0.0001) than in previous years with light sea ice cover.

Bowhead Whale Central Tendency – Analysis 2

The 2020 spatial relative abundance model for autumn (15 September – 15 October) incorporated 179 bowhead whale sightings of 532 total individuals in the West region (Fig. 17). The model predicted that the area inshore of the 20-m isobath between Utqiaġvik and Smith Bay had the highest relative abundance of bowhead whales in autumn 2020 (Figs. 17 and 18). The area inshore of the 20-m isobath between Oliktok Point and Prudhoe Bay had the second highest predicted relative abundances.

The estimated median distance-from-shore in the West region for autumn 2020 that was derived using the spatial model was 9.7 km (Table 9). The model-derived results were 6.4 km closer to shore in the West region compared to the results from the analysis of bowhead whale sightings that were unadjusted for transect effort or group size (median value of 16.1 km; Table 8).

Table 9. -- Percentiles of bowhead whale predicted distribution (km) from the spatial model for the western Beaufort Sea West region.

Percentile	**Distances (km)**
30th	5.3
40th	7.7
50th	9.7
60th	12.4
70th	15.9

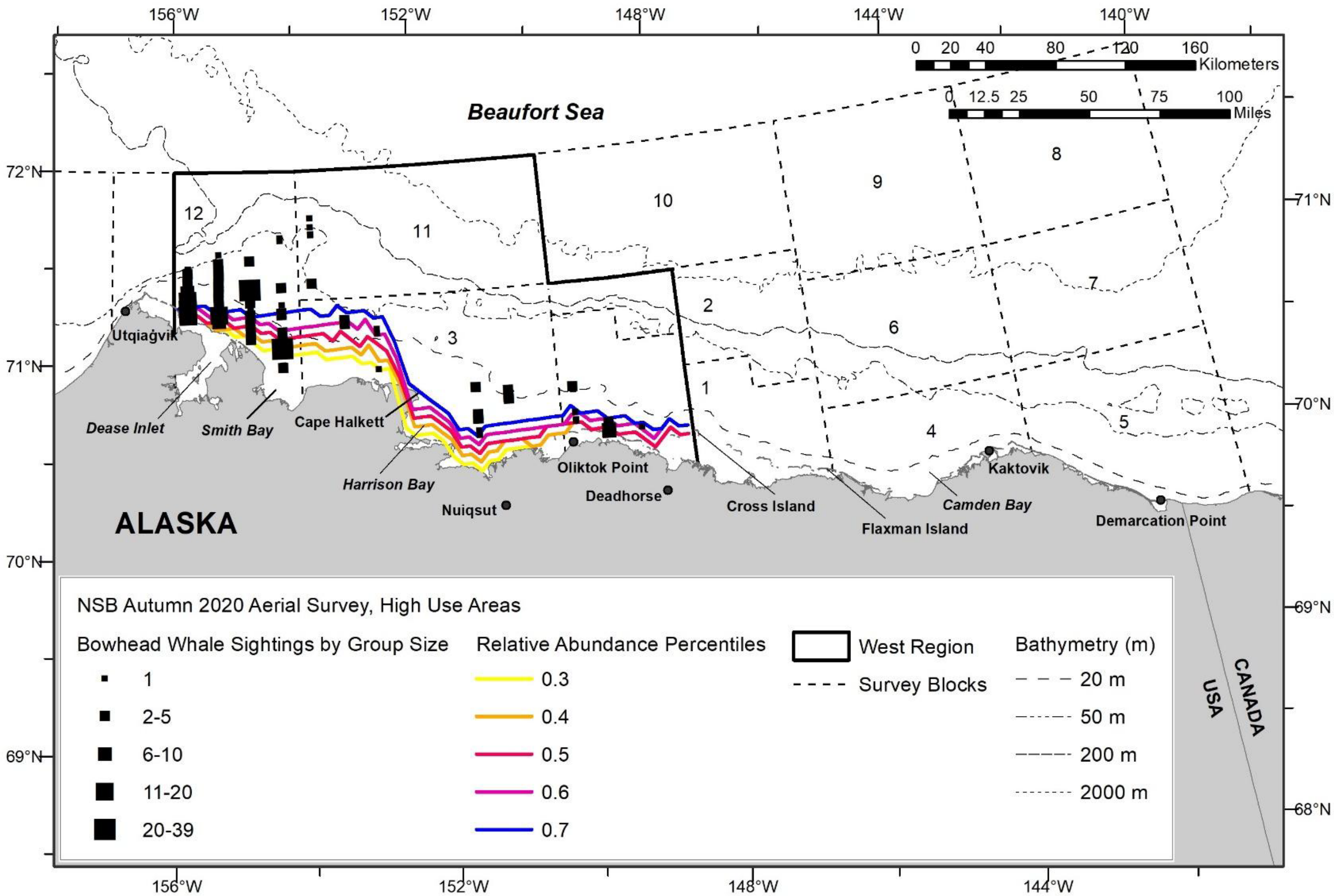

Figure 17. -- Autumn (17 September – 15 October) 2020 bowhead whale transect and CAPs passing sightings (primary observers only) by group size. The bowhead whale high-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

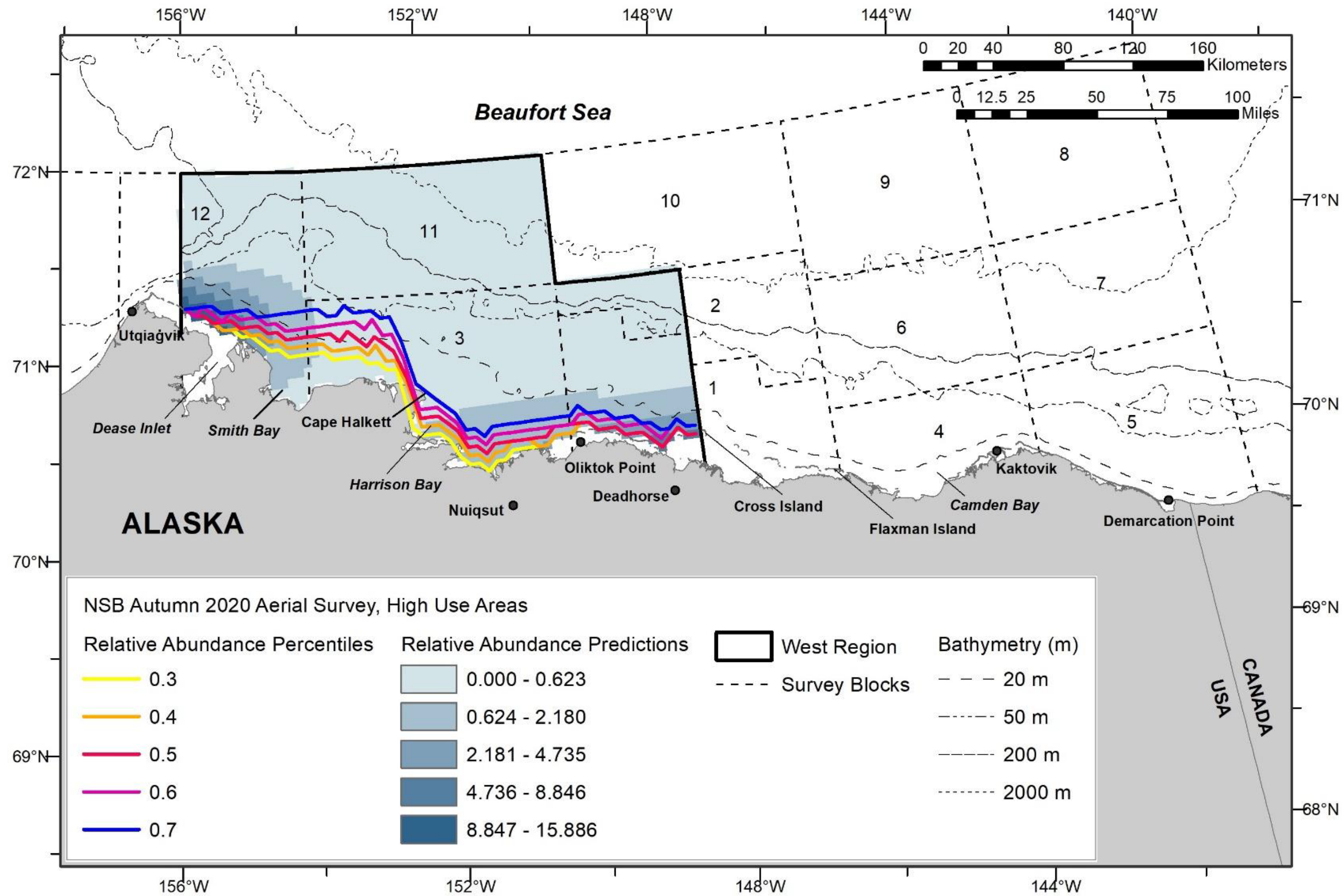

Figure 18. -- Autumn (17 September – 15 October) 2020 bowhead whale relative abundance predictions. The bowhead whale high-use area is represented by distribution percentiles (30th, 40th, 50th, 60th, and 70th), which represent the offshore extent of 30%, 40%, 50%, 60%, and 70% of the predicted number of bowhead whales from the spatial model.

Gray Whales

Gray Whale Sighting and Behavior Summary

Six sightings of 10 gray whales (*Eschrichtius robustus*) were observed during all survey modes (transect, CAPs, search, and circling) (Table 4, Fig. 19). One gray whale was sighted resting 21.2 km from shore in water 38 m deep between Point Barrow and Dease Inlet. This gray whale was not near the dense feeding aggregations of bowhead whales sighted during the same flight between Dease Inlet and Smith Bay. Gray whales were sighted feeding (five whales), resting (three whales), and swimming (one whale) from 18 to 26 km from shore in water 32-41 m deep between Utqiaġvik and Point Franklin (Table 10). One gray whale was sighted swimming in water 55 m deep, 84.1 km from shore southwest of Point Hope. The area where this whale was sighted is a known gray whale and benthic hotspot (Grebmeier et al. 2015; Kuletz et al. 2015); however, on the day the area was surveyed, the weather was uncooperative, with widespread fog precluding transect effort. No gray whales appeared to respond to the survey aircraft. No gray whale calves were seen.

Table 10. Gray whales (number of sightings/number of individuals) observed during transect, CAPs, search, and circling survey modes, by behavioral category, 17 September – 15 October 2020.

Behavior	**Whales**
Feed	2/5
Rest	2/3
Swim	2/2
TOTAL	**6/10**

Gray Whale Sighting Rates

There were five sightings of nine gray whales on effort by primary observers from 155.8°W to 158°W; fine-scale sighting rates are shown in Figure 20. On-effort gray whales were sighted in blocks 12 and 13 (Table 11, Fig. 21), with a higher sighting rate in block 13 (0.0242 WPUE) than block 12 (0.0006 WPUE). Gray whale sighting rates by depth zone were highest in the 36-50 m depth zone (0.0418 WPUE) followed by the 0-35 m depth zone (0.0255 WPUE), both in the northeastern Chukchi Sea, and finally the 51-200 m depth zone (0.0012 WPUE) in the western Beaufort Sea subarea (Table 12, Fig. 22). Gray whale distribution in 2020 using on-effort sightings overlapped the distribution of on-effort sightings observed in previous years having light sea ice cover (Fig. 23); however, the area between Utqiaġvik and Point Franklin had few gray whale sightings in 2016-2019. Fine-scale sighting rates of feeding and milling gray whales located between Utqiaġvik and Point Franklin are shown in Figure 24.

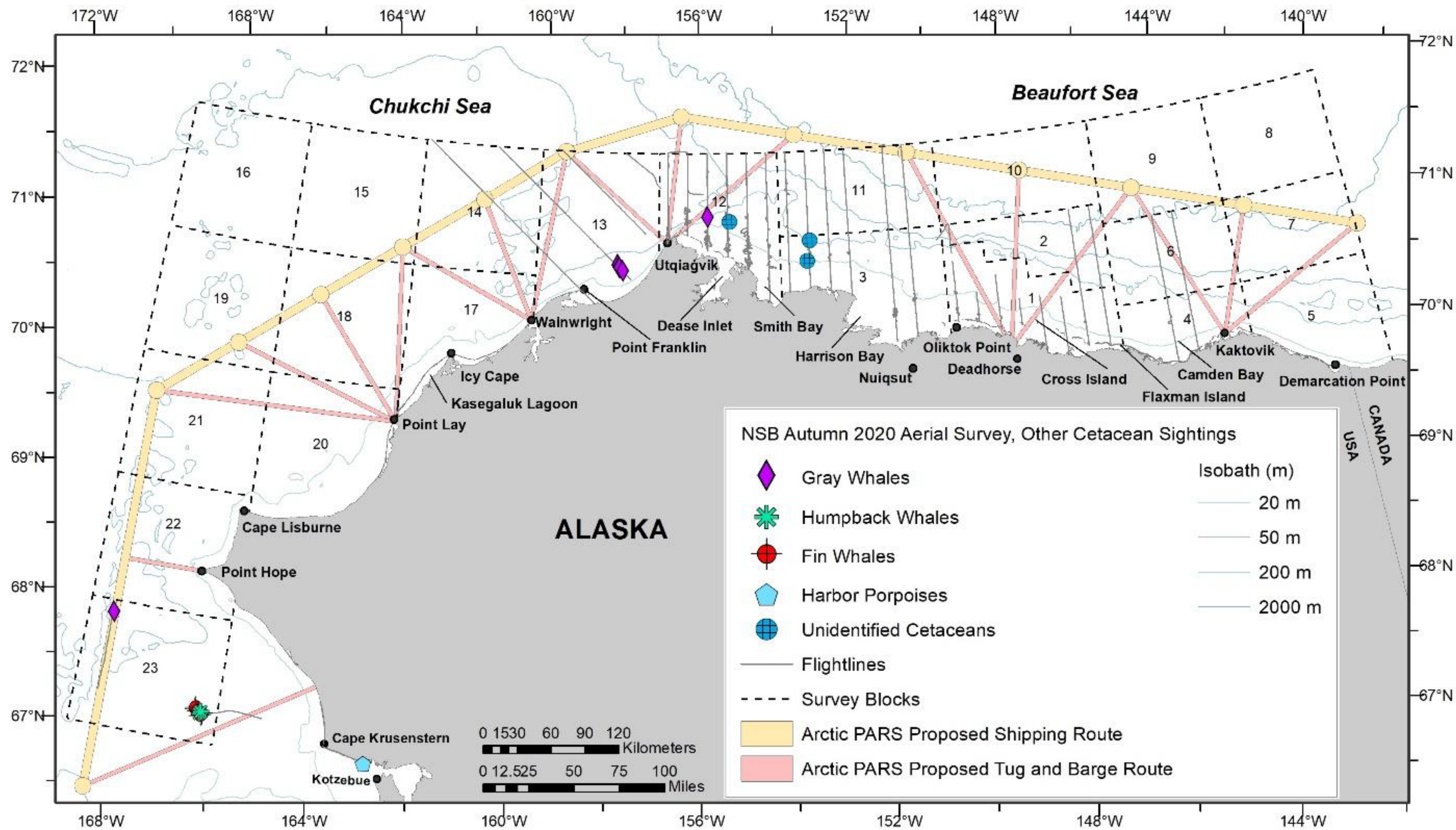

Figure 19. -- Gray, humpback, and fin whale; harbor porpoise; and unidentified cetacean sightings, all survey modes, with transect, CAPs, search, and circling effort, 17 September – 15 October 2020. Deadhead flight tracks are not shown.

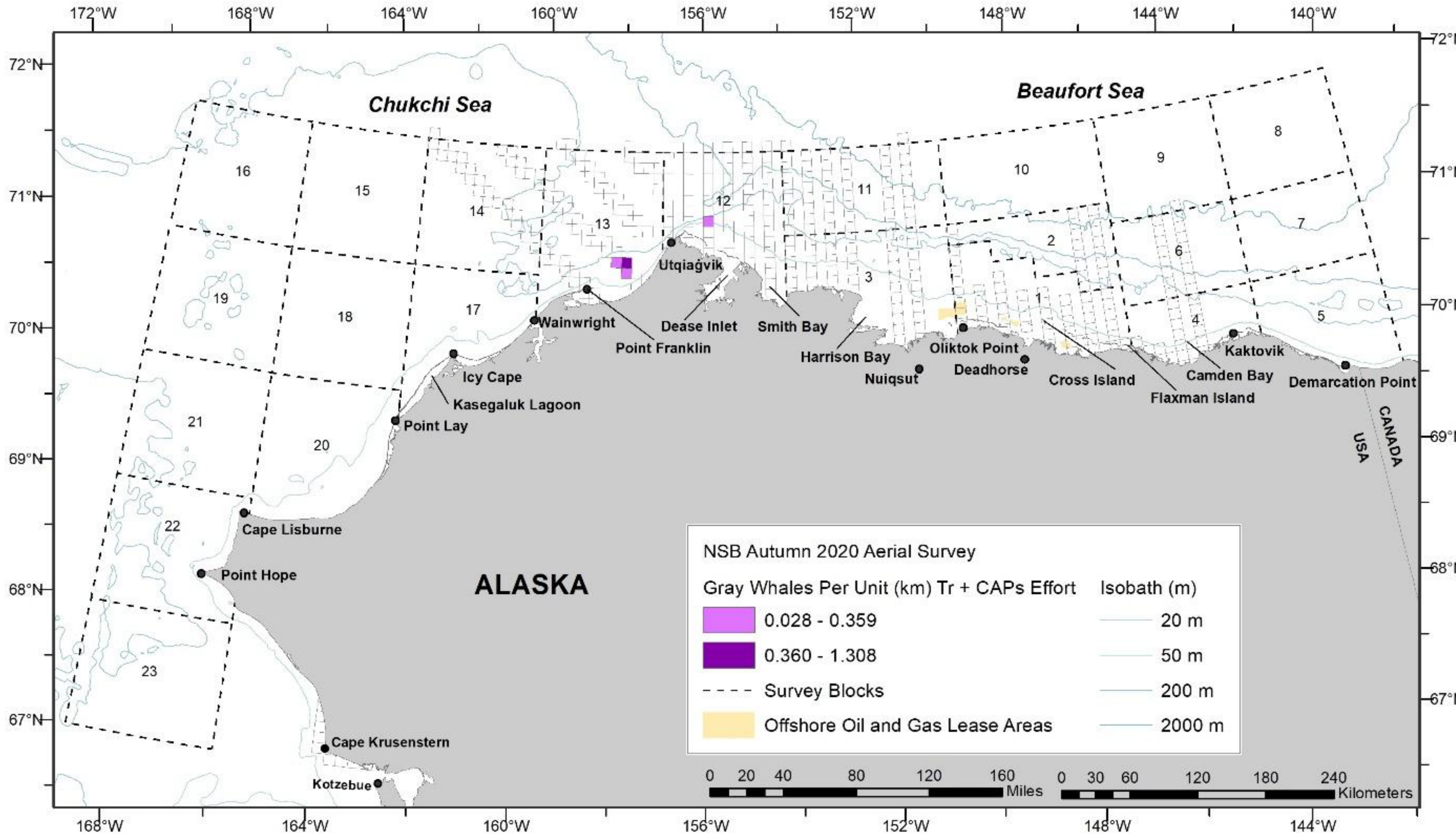

Figure 20. -- Gray whale on-effort sighting rates (WPUE; sightings from primary observers only) in the study area, 17 September – 15 October 2020. Empty cells indicate sighting rates of zero. Transect (Tr) and CAPs survey effort was not conducted in areas without cell outlines.

Table 11. -- On-effort (transect and CAPs passing) kilometers (km), number of gray whale on-effort sightings (primary observers only), and gray whale sighting rate (WPUE = gray whales per km surveyed) per survey block, 17 September – 15 October 2020. NA – surveys were not conducted; surveys were also not conducted in survey blocks 15-23. The total for block 1 includes 25 km flown inshore of the barrier islands. Minor discrepancies within the table are due to rounding error.

BLOCK	km	Sightings	Whales	WPUE
1	379	0	0	0.0000
2	164	0	0	0.0000
3	654	0	0	0.0000
4	191	0	0	0.0000
5	0	0	0	NA
6	148	0	0	0.0000
7	0	0	0	NA
8	0	0	0	NA
9	0	0	0	NA
10	0	0	0	NA
11	682	0	0	0.0000
12	1,816	1	1	0.0006
13	331	4	8	0.0242
14	185	0	0	0.0000
Total	**4,551**	**5**	**9**	**0.0020**

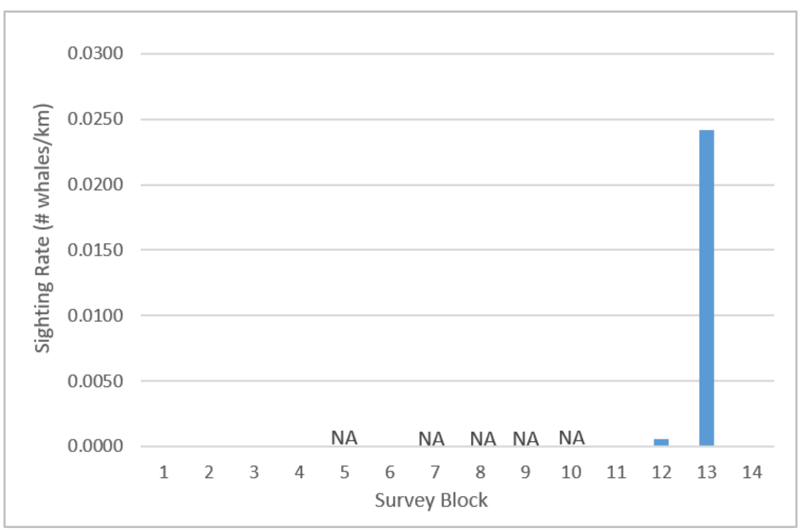

Figure 21. -- Gray whale on-effort sighting rates (WPUE; sightings from primary observers only) per survey block in the study area, 17 September – 15 October 2020. NA – surveys were not conducted. Sighting rates of zero were removed from blocks 1, 2, 3, 4, 6, 11, and 14 of the graph for clarity. Neither transect nor CAPs passing effort was flown in survey blocks 15-23.

Table 12. -- On-effort (transect and CAPs passing) kilometers (km), number of gray whale on-effort sightings (primary observers only), and gray whale sighting rate (WPUE = gray whales per km surveyed) per depth zone, 17 September – 15 October 2020. NA – surveys were not conducted. Minor discrepancies within the table are due to rounding error.

DEPTH ZONE	km	Sightings	Whales	WPUE
157°W-169°W				
0-35 m	39	1	1	0.0255
36-50 m	168	3	7	0.0418
51-200 m N	310	0	0	0.0000
51-200 m S	0	0	0	NA
154°W-157°W				
0-20 m	413	0	0	0.0000
21-50 m	345	0	0	0.0000
51-200 m	866	1	1	0.0012
201-2,000 m	191	0	0	0.0000
TOTAL	**4,548**	**5**	**9**	**0.0020**

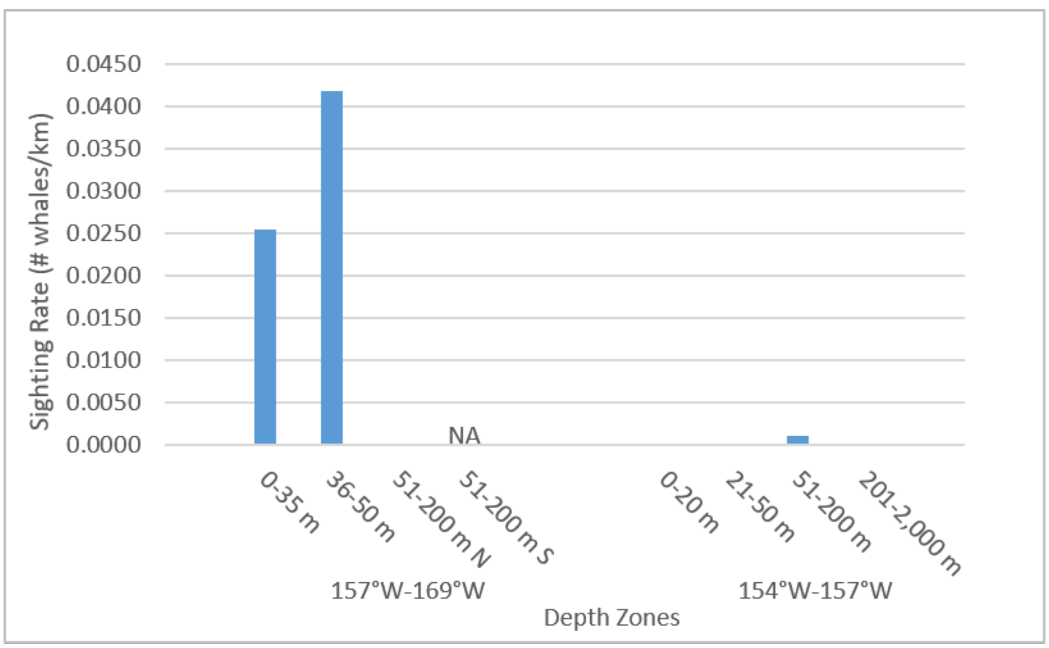

Figure 22. -- Gray whale on-effort sighting rates (WPUE; sightings from primary observers only) per depth zone in the eastern Chukchi and western Alaskan Beaufort seas, 17 September – 15 October 2020. NA – surveys were not conducted. Sighting rates of zero were removed from depth zones 51-200 m N, 0-20 m, 21-50 m, and 201-2,000 m of the graph for clarity.

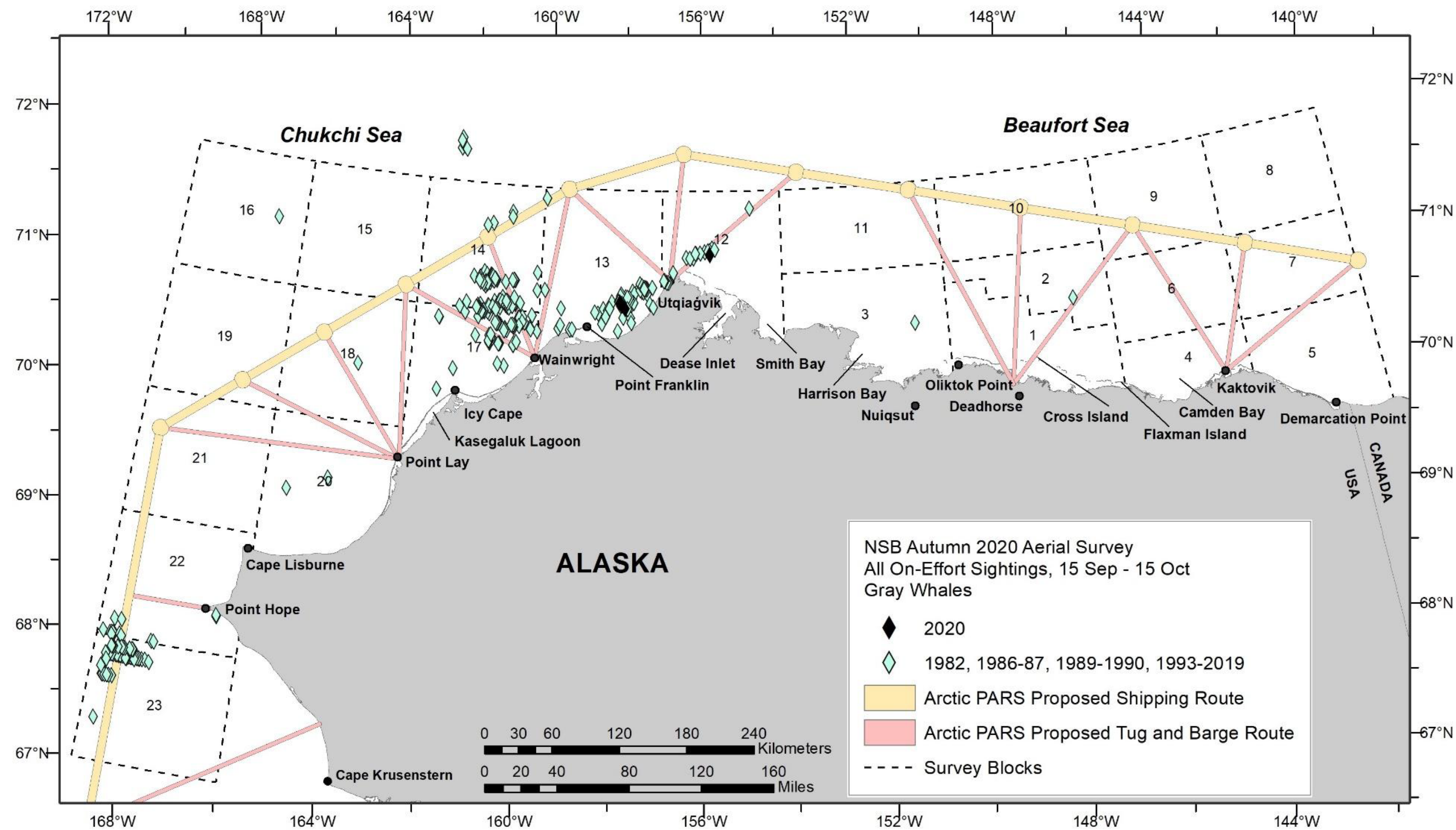

Figure 23. -- Gray whale sightings 15 September – 15 October, in years with light sea ice cover: 1982, 1986-1987, 1989-1990, 1993-2018, 2019, and 2020. Includes all on-effort sightings from primary and secondary observers.

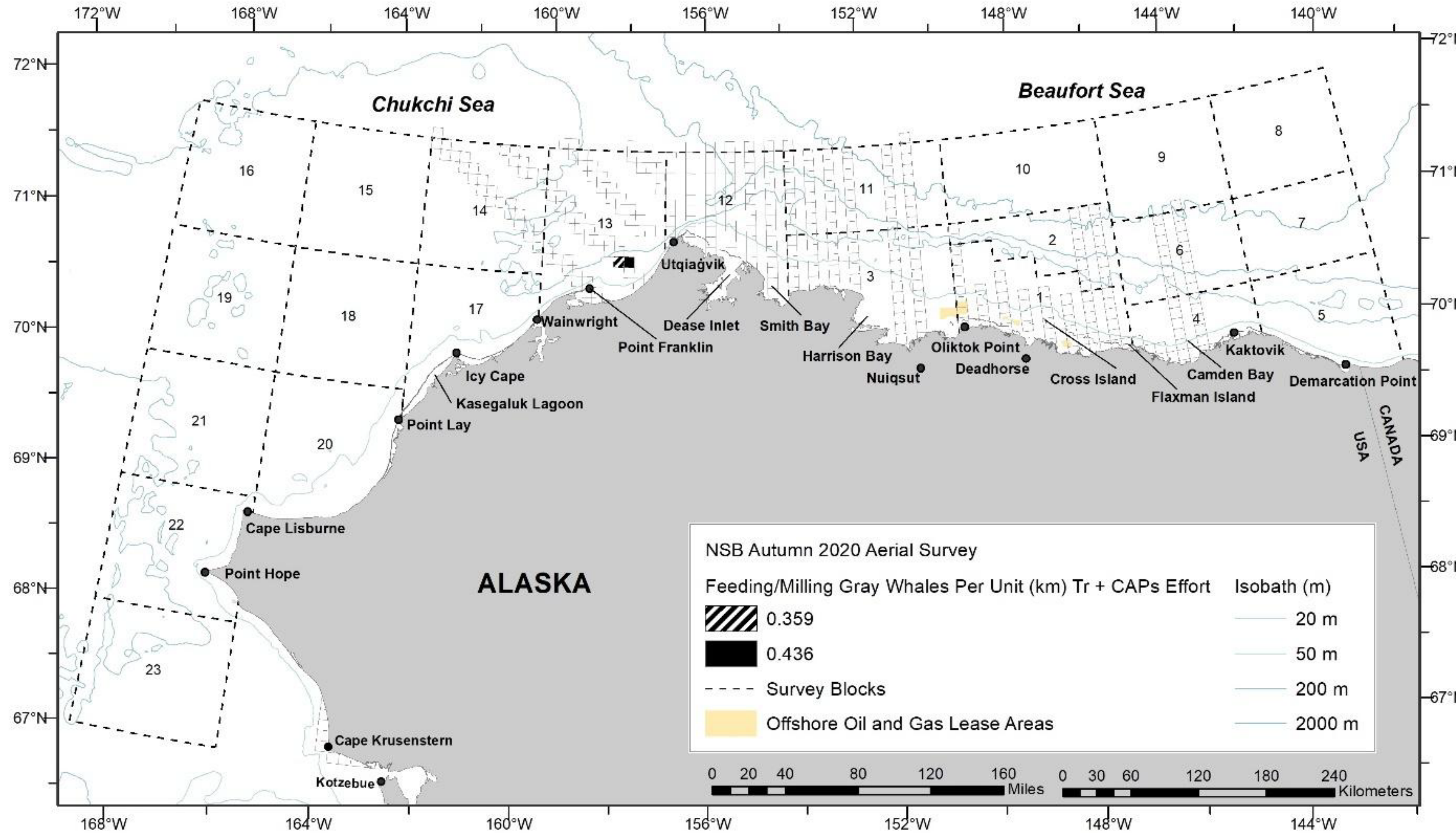

Figure 24. -- Gray whale on-effort seasonal feeding and milling sighting rates (WPUE; sightings from primary observers only), 17 September – 15 October 2020. Empty cells indicate sighting rates of zero. Transect (Tr) and CAPs survey effort was not conducted in areas without cell outlines.

Humpback and Fin Whales

There were two sightings of four humpback whales (*Megaptera novaeangliae*), and five sightings of six fin whales (*Balaenoptera physalus*) observed during all survey modes (transect, CAPs, search, and circling). All were sighted approximately 95 km offshore in the south-central Chukchi Sea in water 35-38 m deep, south of Point Hope, during one flight in survey block 23 (Table 4, Fig. 19). Unexpected widespread fog and low cloud ceilings precluded systematic survey effort in block 23 during this flight. However, survey conditions were clear in one small area of block 23. Swimming behavior was documented for all whales, although it was suspected that the whales were feeding in the area because this is an area where dense feeding aggregations have been sighted in recent years (2014-2019, Clarke et al. 2020). No humpback or fin whales appeared to respond to the survey aircraft. No humpback or fin whale calves were seen.

Belugas

Beluga Sighting Summary

There were 155 sightings of 384 belugas (*Delphinapterus leucas*) observed during all survey modes (transect, CAPs, search, and circling) (Table 4, Fig. 25). Beluga stock affiliation is impossible to determine from aerial surveys, and sightings likely included belugas from the Eastern Chukchi Sea (ECS) and Beaufort Sea (BS) stocks (Hauser et al. 2014). All belugas were sighted in the western Beaufort Sea, predominantly in Barrow Canyon and along the continental slope. Beluga distribution in 2020 was similar to previous years with light sea ice cover in autumn in the western Beaufort Sea (Fig. 26).

Beluga Sighting Rates

Belugas were seen on effort from 71.1°N to 72.0°N between 149.7°W and 156.8°W. There were 154 sightings of 379 belugas on transect by primary observers, ranging from one beluga per sighting (96 sightings) to 33 belugas per sighting (1 sighting). Some of the larger beluga groups were pooled counts due to rapid sighting rates. The area with the highest fine-scale sighting rates was offshore in Barrow Canyon (Fig. 27). Sighting rates by survey block were highest in blocks 11 (0.1788 WPUE) and block 12 (0.1287 WPUE) (Table 13, Fig. 28). Sighting rates by depth zone were highest in the 201-2,000 m depth zone in both the western and central-eastern Beaufort Sea subareas (Table 14, Fig. 29).

Beluga Behaviors and Calves

Beluga behaviors observed during transect, search, and circling survey modes are summarized in Table 15. The behavior most often recorded was swimming (96%). No belugas appeared to respond to the survey aircraft. There were 23 sightings of 34 beluga calves during transect, search, and circling survey modes (Fig. 25). Animals identified as calves likely included belugas up to a few years old. Calves nurse for up to two years but may remain with their mothers after weaning (Suydam 2009), often forming triads when a new calf is born. Color is not necessarily a good indication of age because beluga calves lighten progressively over time, changing from charcoal gray at birth to blue-gray then light gray before becoming completely white by 7-9 years of age. Calf sightings extended

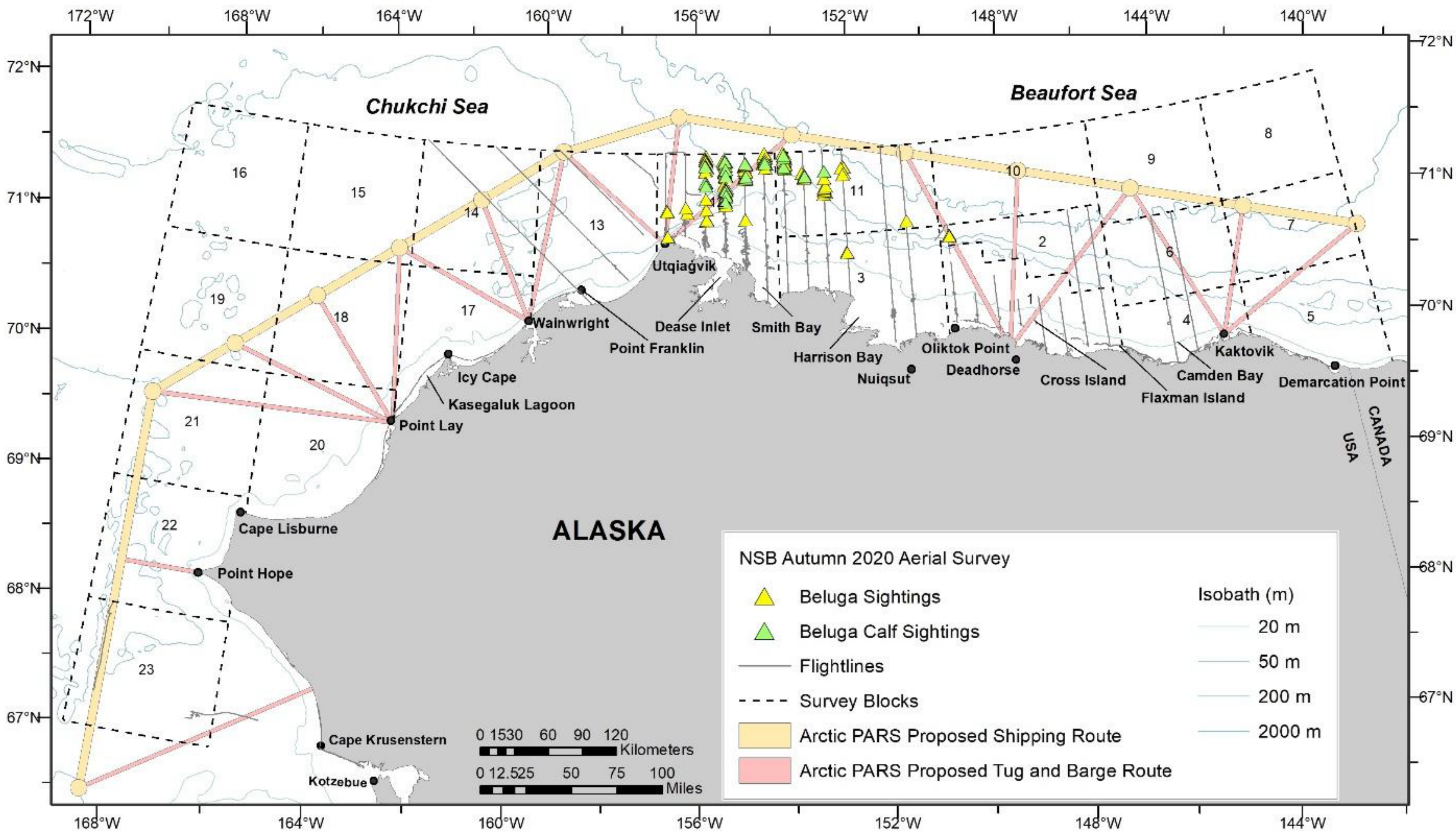

Figure 25. --Beluga and beluga calf sightings, all survey modes, with transect, CAPs, search, and circling effort, 17 September – 15 October 2020. Deadhead flight tracks are not shown.

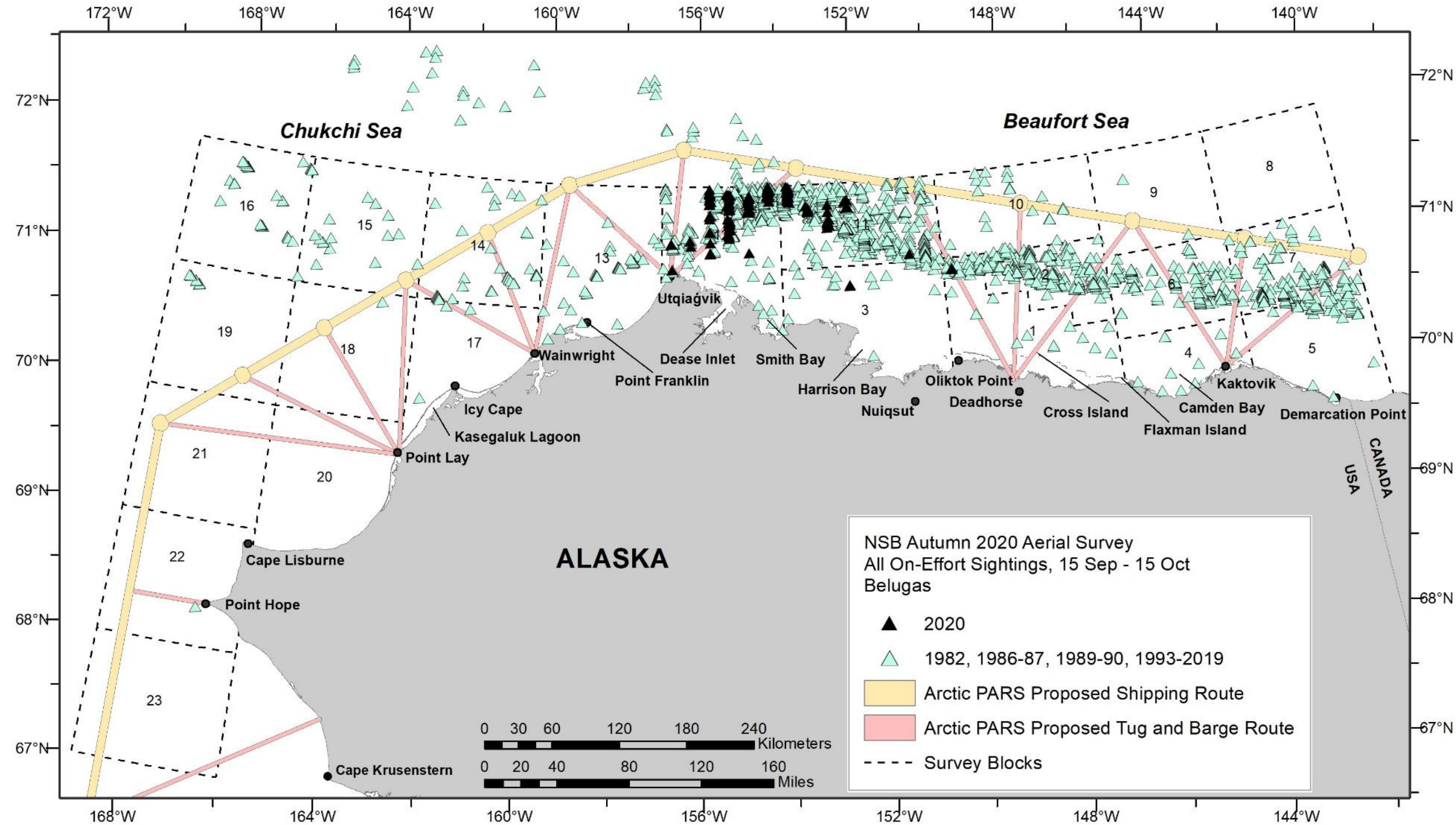

Figure 26. -- Beluga sightings 15 September – 15 October, in years with light sea ice cover: 1982, 1986-1987, 1989-1990, 1993-2018, 2019, and 2020. Includes all on-effort sightings from primary and secondary observers.

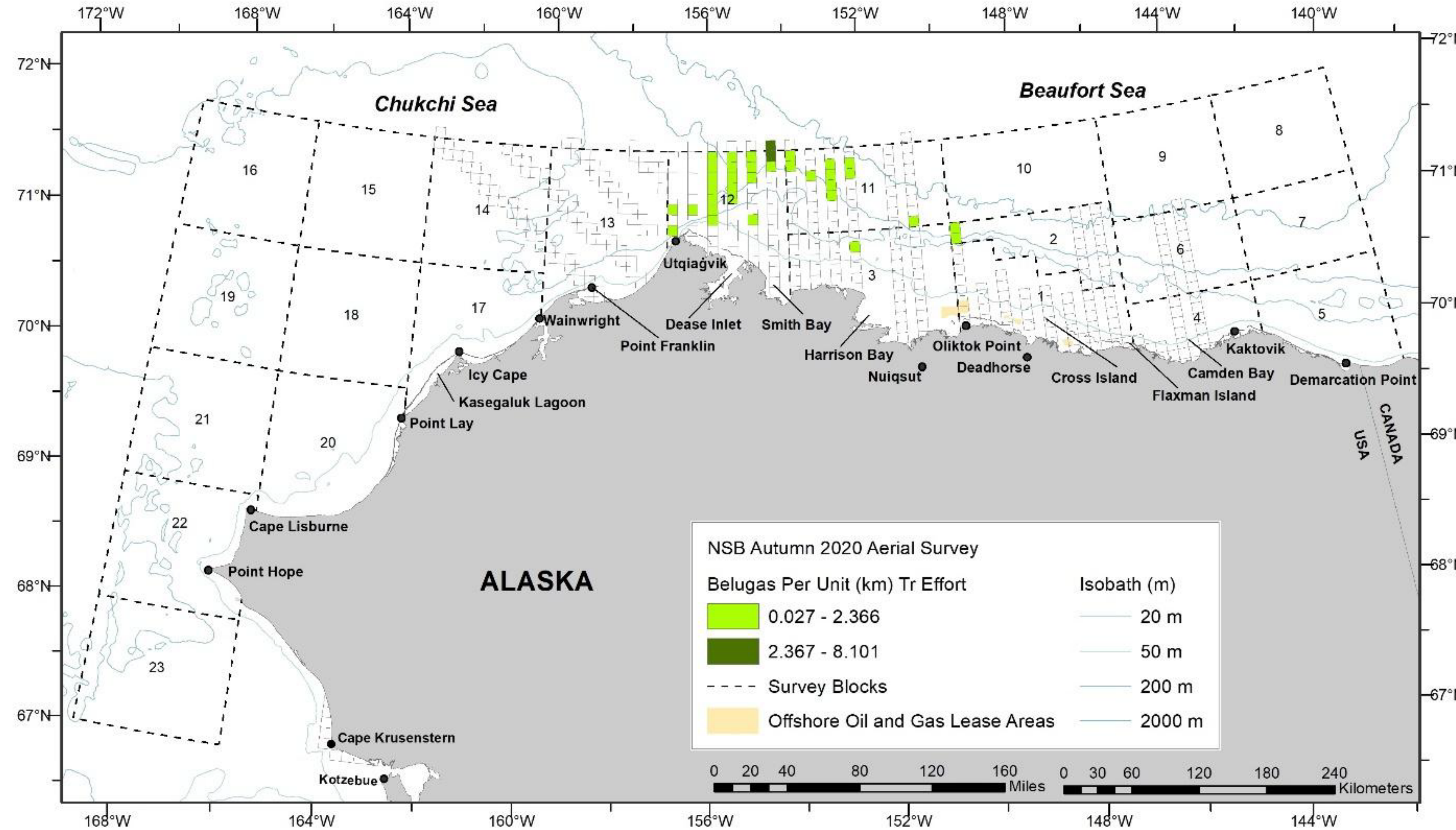

Figure 27. -- Beluga on-effort sighting rates (WPUE; sightings from primary observers only) 17 September – 15 October 2020. Empty cells indicate sighting rates of zero. Transect (Tr) survey effort was not conducted in areas without cell outlines.

Table 13. -- On-effort (transect) kilometers (km), number of beluga transect sightings (primary observers only), and beluga sighting rate (WPUE = belugas per transect km surveyed) per survey block, 17 September – 15 October 2020. NA – surveys were not conducted. The total for block 1 includes 25 km flown inshore of the barrier islands. Minor discrepancies within the table are due to rounding error.

BLOCK	km	Sightings	Whales	WPUE
1	374	0	0	0.0000
2	164	4	5	0.0304
3	648	2	22	0.0339
4	191	0	0	0.0000
5	0	0	0	NA
6	148	0	0	0.0000
7	0	0	0	NA
8	0	0	0	NA
9	0	0	0	NA
10	0	0	0	NA
11	682	45	122	0.1788
12	1,780	102	229	0.1287
Total	**3,988**	**153**	**378**	**0.0948**

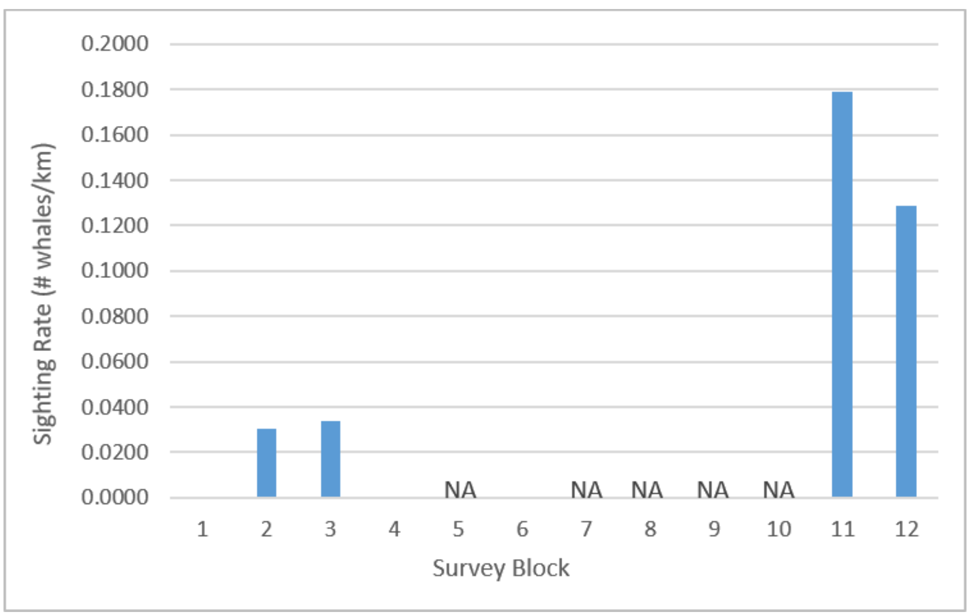

Figure 28. -- Beluga on-effort sighting rates (WPUE; sightings from primary observers only) per block, 17 September – 15 October 2020. NA – surveys were not conducted. Sighting rates of zero were removed from blocks 1, 4, and 6 of the graph for clarity.

Table 14. -- On-effort (transect) kilometers (km), number of beluga transect sightings (primary observers only), and beluga sighting rate (WPUE = belugas per transect km surveyed) per depth zone, 17 September – 15 October 2020. Minor discrepancies within the table are due to rounding error.

DEPTH ZONE	km	Sightings	Whales	WPUE
154°W-157°W				
0-20 m	377	0	0	0.0000
21-50 m	345	6	6	0.0174
51-200 m	866	40	56	0.0647
201-2,000 m	191	56	167	0.8726
140°W-154°W				
0-20 m	635	0	0	0.0000
21-50 m	583	2	22	0.0377
51-200 m	480	7	12	0.0250
201-2,000 m	378	42	115	0.3038
>2,000 m	130	0	0	0.0000
TOTAL	**3,985**	**153**	**378**	**0.0948**

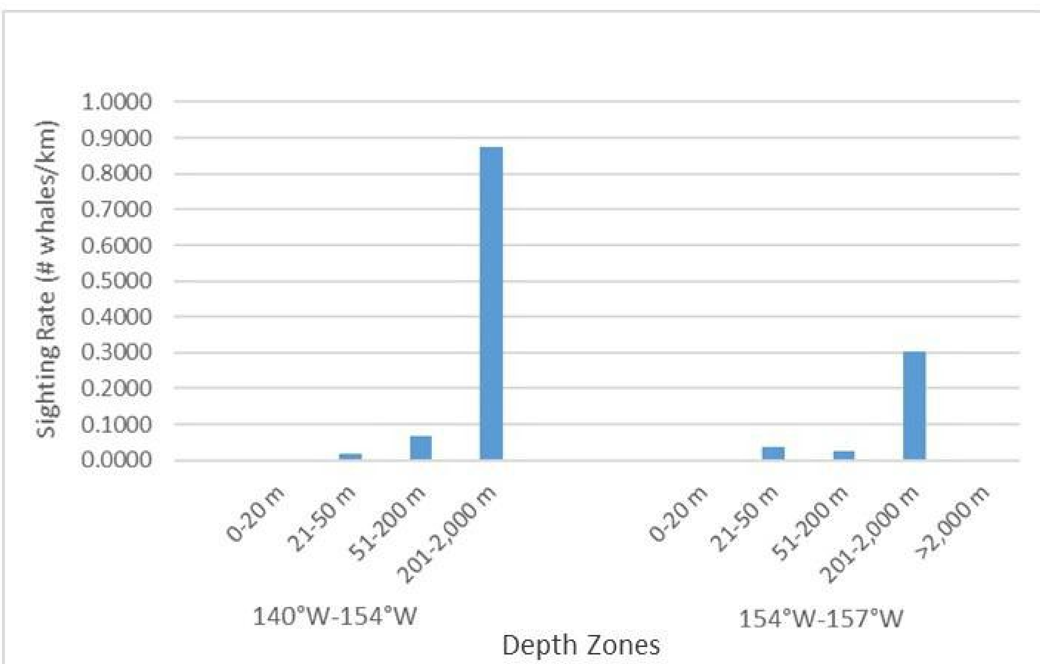

Figure 29. -- Beluga on-effort sighting rates (WPUE; sightings from primary observers only) per depth zone, 17 September – 15 October 2020. NA – surveys were not conducted. Sighting rates of zero were removed from depth zones 0-20 m and > 2,000 m of the graph for clarity.

from 152.8°W to 155.8°W, primarily in Barrow Canyon. Beluga calves may be underrepresented in the dataset because of their small size and the infrequency of circling over beluga sightings.

Table 15. -- Belugas (number of sightings/number of individuals) observed during transect, search, and circling survey modes, by behavioral category, 17 September – 15 October 2020. Excludes dead and same-day repeat sightings.

Behavior	Belugas
Mill	2/9
Rest	7/8
Swim	146/367
TOTAL	155/384

Harbor Porpoise

One sighting of two swimming harbor porpoises (*Phocoena phocoena*) was documented less than 1 km from shore near Kotzebue (Table 4, Fig. 19). The porpoises did not appear to react to the survey aircraft.

Unidentified Cetaceans

Sightings were recorded as unidentified when a positive species identification was not possible. This usually occurred when an animal dived and could not be resighted, when the sighting was greater than 3 km from the trackline, or when environmental conditions such as fog, low cloud ceilings, glare, or sea state hindered efforts to relocate the initial sighting. There were three sightings of single unidentified cetaceans observed during all survey modes (transect, CAPs, search, and circling) (Table 4, Fig. 19). One unidentified cetacean was sighted 28.2 km offshore from Dease Inlet near bowhead whales, one unidentified cetacean was sighted 41 km offshore to the northeast of Smith Bay without any other whales nearby, and one unidentified cetacean was sighted 23.3 km offshore to the northeast of Smith Bay, with bowhead whales sighted to the north of it. None of the unidentified cetaceans appeared to respond to the survey aircraft.

Pinnipeds

Walruses

There were 20 sightings of 30 Pacific walruses (*Odobenus rosmarus divergens*) observed during transect, search and circling survey modes (Table 16, Fig. 30). Walruses were sighted on two days. On 17 September, three walruses were sighted in the western Beaufort Sea at 155.8°W and 156.3°W in survey block 12. On 20 September, 27 walruses were sighted in the eastern Chukchi Sea from 160.1°W to 162.6°W in survey block 14, which is on the south side of the walrus feeding grounds on Hanna Shoal. Besides the flight on 20 September, no other surveys were flown in the northeastern Chukchi Sea, including near Point Lay where walruses were reported to have hauled out from late July to September 2020. All walruses were sighted in open water, swimming or resting. All walruses were sighted on transect by primary observers. The highest fine-scale transect sighting rate of walruses was observed at 162.5°W, on the southwestern side of Hanna Shoal (Fig. 31). No walruses appeared to react to the survey aircraft.

Table 16. -- Summary of pinniped and polar bear sightings (number of sightings/number of individuals) during transect, search, and circling survey modes, in chronological order, 17 September – 15 October 2020, by survey day. Excludes dead and repeat sightings.

Day	Flight No.	Walrus	Bearded seal	Unidentified pinniped*	Polar bear
17 Sep	1	2/3	7/7	60/237	0
20 Sep	2	18/27	2/2	5/6	0
22 Sep	3	0	0	0	0
23 Sep	4	0	0	19/44	0
25 Sep	5	0	0	0	0
28 Sep	6	0	0	0	0
4 Oct	7	0	0	0	0
6 Oct	8	0	0	5/5	0
7 Oct	9	0	0	0	1/2
10 Oct	10	0	0	0	0
12 Oct	11	0	0	0	0
13 Oct	12	0	0	0	0
14 Oct	13	0	0	0	0
15 Oct	14	0	0	0	0
TOTAL		20/30	9/9	89/292	1/2

* Includes sightings designated as 'unidentified pinniped' and 'small unidentified pinniped'

Other Pinnipeds

Bearded seals (*Erignathus barbatus,* 9 sightings of 9 bearded seals) were sighted on transect, search, and circling modes (Table 16, Fig. 30). The bearded seals were distributed from 155.7°W to 161.9°W and were resting in open water. No bearded seals appeared to react to the survey aircraft. Other pinnipeds not identifiable to species were recorded as either unidentified pinnipeds (2 sightings of 2 unidentified pinnipeds) or small unidentified pinnipeds (87 sightings of 290 small unidentified pinnipeds) (Table 16, Fig. 30). Unidentified pinnipeds likely included sightings of ringed (*Pusa hispida*), spotted (*Phoca largha*), ribbon (*Histriophoca fasciata*), and bearded seals, in addition to small walruses. Small unidentified pinnipeds included sightings of small pinnipeds (ringed and spotted seals and possibly juvenile bearded seals) only. Unidentified pinniped distribution ranged from 150.7°W to 160°W. All unidentified pinnipeds were sighted in open water; behaviors included diving, feeding, milling, resting, and swimming. Some of the pinnipeds were sighted in large groups up to 50 individuals; these seals were documented as milling or feeding based on the localized diving behavior and association with diving birds at the surface. One small unidentified pinniped originally documented as resting appeared to react to the survey aircraft by diving.

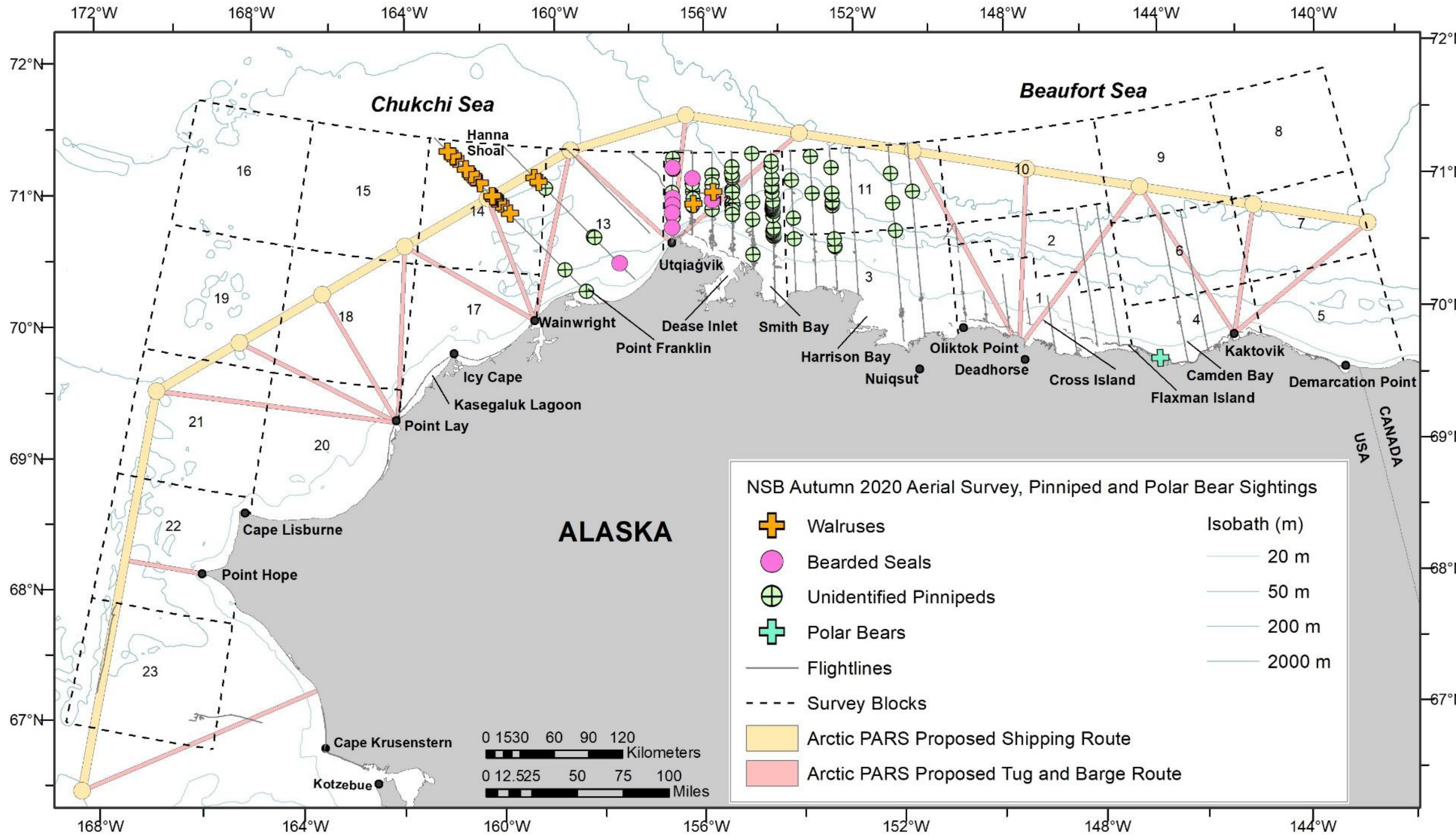

Figure 30. -- Walrus, bearded seal, unidentified pinniped, and polar bear sightings, all survey modes, with transect, CAPs, search, and circling effort, 17 September – 15 October 2020. Deadhead flight tracks are not shown.

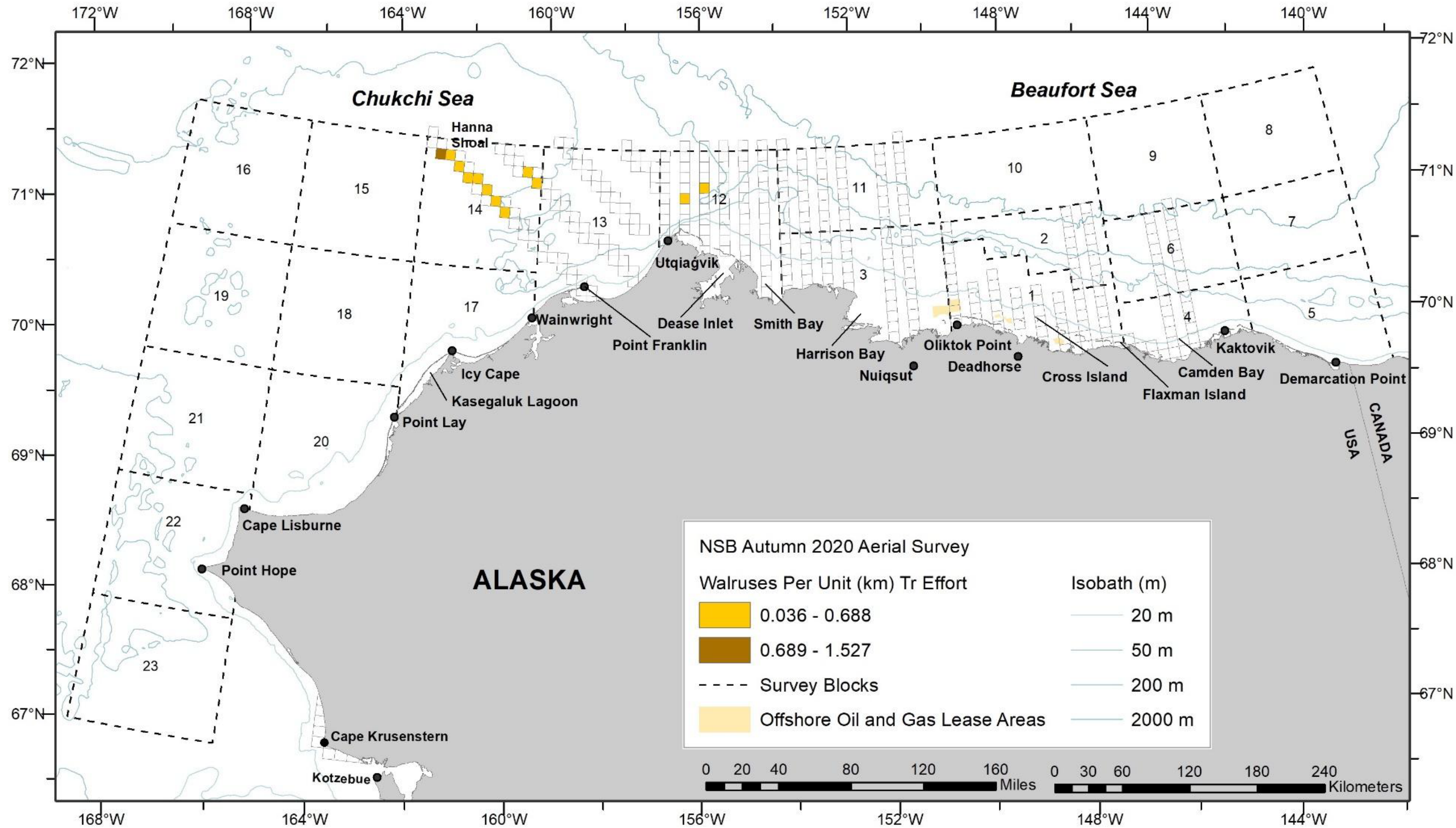

Figure 31. -- Walrus on-effort sighting rates (WPUE; transect sightings from primary observers only), 17 September – 15 October 2020. Empty cells indicate sighting rates of zero. Transect (Tr) survey effort was not conducted in areas without cell outlines.

Polar Bears

There was one sighting of two polar bears (*Ursus maritimus*), consisting of one adult and one cub or yearling (Table 16, Fig. 30). The bears were feeding on an unidentified cetacean carcass on a barrier island in Camden Bay. The bears did not appear to react to the survey aircraft. Cross Island and the waters off Kaktovik were not surveyed in 2020. These are areas where polar bears typically congregate in the autumn due to the presence of bowhead whale carcasses hauled there by subsistence whalers.

Dead Marine Mammals

Two dead marine mammals were sighted. On 17 September, one bowhead whale carcass was sighted 5 km to the east of Point Barrow. After consulting experts at the NSB, it was concluded this sighting was a piece of bowhead whale tongue, likely from the autumn subsistence hunt (C. George and R. Suydam, North Slope Borough Department of Wildlife Management, pers comm. to A. Brower, 18 September 2020). On 10 October, one unidentified cetacean carcass was sighted on a barrier island in Camden Bay. Due to the presence of an adult polar bear and a cub or yearling that were feeding on the carcass, the aircraft did not circle the carcass or attempt to photograph it. The carcass appeared to be in a state of advanced decomposition.

Debris

On 17 September, there were five sightings of debris that were mistaken as potential marine mammal carcasses. As in previous ASAMM surveys, debris data were not typically recorded, but these pieces were light in color (similar to a carcass that is sloughing skin) and were similar in size to pinnipeds or small cetaceans. The debris was sighted in survey block 12 from 40 to 80 km to the northeast of Point Barrow.

Accomplishments and Community Engagement

Data from 2020 were shared throughout the field season with NSB residents, researchers, and interested parties within other agencies:

- Daily reports of flight and sighting information and biweekly effort and sighting summary figures were sent to NSB, AEWC, BWCA, BOEM, NOAA, University of Washington (UW), Woods Hole Oceanographic Institution, Marine Mammal Commission, and the University of Alaska.
- All Level A stranding forms (two total forms) were sent to the relevant agencies for cetacean strandings: NMFS, NSB, and the Alaska Marine Advisory Program.
- Gray whale sighting data were shared with the NOAA Gray Whale Unusual Mortality Event Task Force.

Community engagement in 2020 included:

- Daily communications with AEWC and BWCA to ensure that aerial survey activities would not interfere with subsistence whaling activities.
- Communicating with the NSB Search and Rescue to familiarize them with our project.

There was public interest in the 2020 field season due to the unusual bowhead whale autumn migration in 2019 and the high numbers of whales sighted in 2020. Media articles included:

- Bauman, M. "North Slope Borough, NOAA, UW collaborate on whale study." The Cordova Times. 14 November 2020. https://www.thecordovatimes.com/2020/11/14/north-slope-borough-noaa-uw-collaborate-on-whale-study/
- NOAA Fisheries. "North Slope Borough, NOAA, University of Washington and Cooperative Institute for Climate Ocean and Ecosystem Studies scientists collaborate to monitor whales in 2020 in northern Alaska." NOAA Fisheries. 9 November 2020. https://www.fisheries.noaa.gov/feature-story/north-slope-borough-noaa-university-washington-and-cooperative-institute-climate-ocean
- Rozell, N. "Bowhead whales: A recent success story." SitNews Stories in the News. 31 January 2020. http://www.sitnews.us/0121News/013121/013121_ak_science.html

DISCUSSION

In autumn 2020, bowhead whales were sighted in dense feeding aggregations close to shore from Point Barrow to Oliktok Point in the western Beaufort Sea. Bowhead whales were significantly closer to shore and in shallower water than previous years with similar surveys. By some metrics, these are the densest bowhead whale aggregations documented in the history of the ASAMM project, dating back to 1979. Specifically, during the last flight on 15 October 2020, the survey team recorded 317 bowhead whales in 3.3 hours of transect effort. The closest comparison in the historical database occurred on 26 August 2016, when one survey team conducted two flights between Smith Bay and Harrison Bay; during 6 transect hours, they recorded 498 bowhead whales (Clarke et al. 2017b). Discussion comparing conditions and sightings between 2019 and 2020 are found below.

The area east of Point Barrow is a well-documented bowhead whale feeding area in years when upwelling winds create conditions conducive to aggregating krill that have been advected north from the Bering Sea (Ashjian et al. 2010). The formation of a "krill trap" in this area often leads to increased bowhead whale sighting rates due to the presence of large feeding aggregations of bowhead whales (Clarke et al. 2017a, Okkonen et al. 2011). This area has been identified as a bowhead whale core-use area in autumn based on satellite tag data collected from 2006 to 2015 (Citta et al. 2018, Olnes et al. 2020) and a summer and autumn bowhead whale hotspot based on aerial survey data collected from 2007 to 2012 (Kuletz et al. 2015).

Autumn 2020 provided physical conditions favorable for the formation of a krill trap, including repetitive occurrences of upwelling-favorable winds and inferred upwelling of krill onto the continental shelf, followed by relaxed winds to trap the krill onto the shelf (S. Okkonen, University of Alaska Fairbanks, Oceanographer, pers. comm. to M. Ferguson, 8 September 2020; Fig. 32). On 2 September 2020, an unusually large mass of krill washed up on the beach in North Salt Lagoon, near Utqiaġvik (C. George, retired NSB-DWM Biologist, pers. commun., September 2020). The high densities of feeding bowhead whales in the krill trap area in 2020 were undoubtedly feeding on krill. This is in contrast to autumn 2019, when winds were not conducive to the upwelling of krill (Fig. 32). Based on the ASAMM historical database, the year most similar to the feeding aggregations documented in the krill trap area in 2020 was 2015, when 115 feeding bowhead whales were sighted up to 15 miles offshore in early October during active krill trap conditions (Clarke et al. 2017a).

Bowhead whales are not typically sighted in Harrison Bay, making the aggregation of bowhead whales sighted on 23 September at the mouth of Harrison Bay unusual and noteworthy (Fig. 15). Mechanisms leading to bowhead whale foraging aggregations near Harrison Bay may include freshwater river discharge, upwelling-favorable winds, and a resultant frontal system that can aggregate bowhead whale prey. On 23 September 2020, the Colville River discharge was approximately three and a half times the median historical discharge on the same date (S. Okkonen, University of Alaska Fairbanks, Oceanographer, pers. commun., September 2020; Fig. 33). Similar conditions were in effect near Harrison Bay in late August 2016, when freshwater river discharge from the Colville River was eight times greater than the 13-year mean for that time period (S. Okkonen, University of Alaska Fairbanks, Oceanographer, pers. commun., October 2016), producing a large oceanographic front offshore (visible in satellite imagery), and resulting in the large

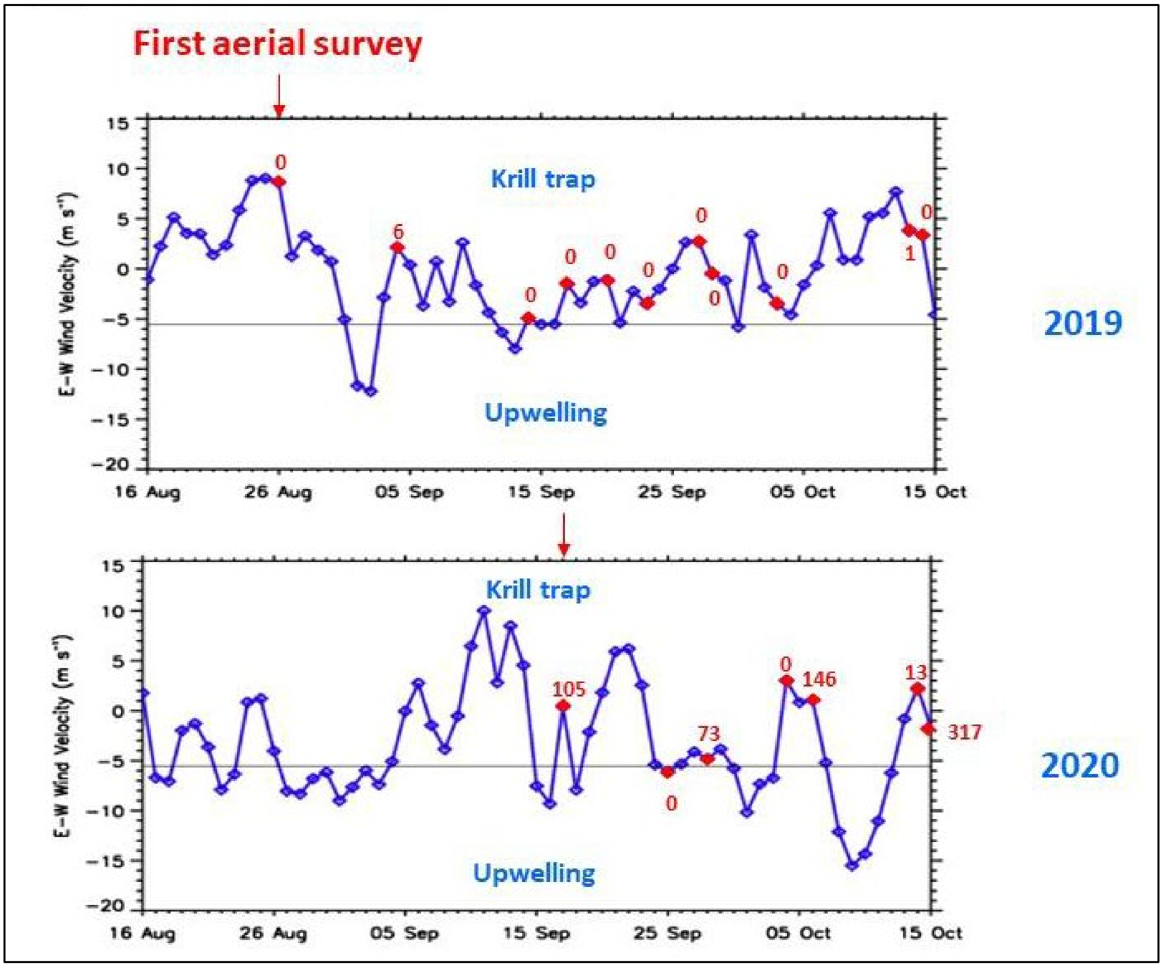

Figure 32. --Wind speed in the krill trap area (152.5°-157.5°W, 70°-72.5°N) by date, 16 August – 15 October, 2019 and 2020, denoted by the blue lines. The dates aerial surveys were flown are denoted by the red numbers, which indicate the numbers of bowhead whales sighted during the flight. The first aerial survey of the season is indicated by a red arrow above each figure. The gray horizontal line indicates the upwelling wind speed threshold (-6 m/sec). Winds below the gray line promote upwelling of krill; winds above the gray line promote retention and aggregation of krill. (Figure provided by S. Okkonen.)

feeding aggregation mentioned above. Furthermore, winds recorded at West Dock near Prudhoe Bay in late August 2016 were also upwelling-favorable (Unpubl. data, Marine Mammal Laboratory, Alaska Fisheries Science Center, NMFS, NOAA). In the central Alaskan Beaufort Sea, similar conditions were observed in September 2014 (Okkonen et al. 2017) when high numbers of feeding bowhead whales were observed near shore between 144°W and 150°W.

Based on the ASAMM historical database, large aggregations of feeding bowhead whales in the western Beaufort Sea in October are unusual. From 1982 to 2019, there were only a few sightings of

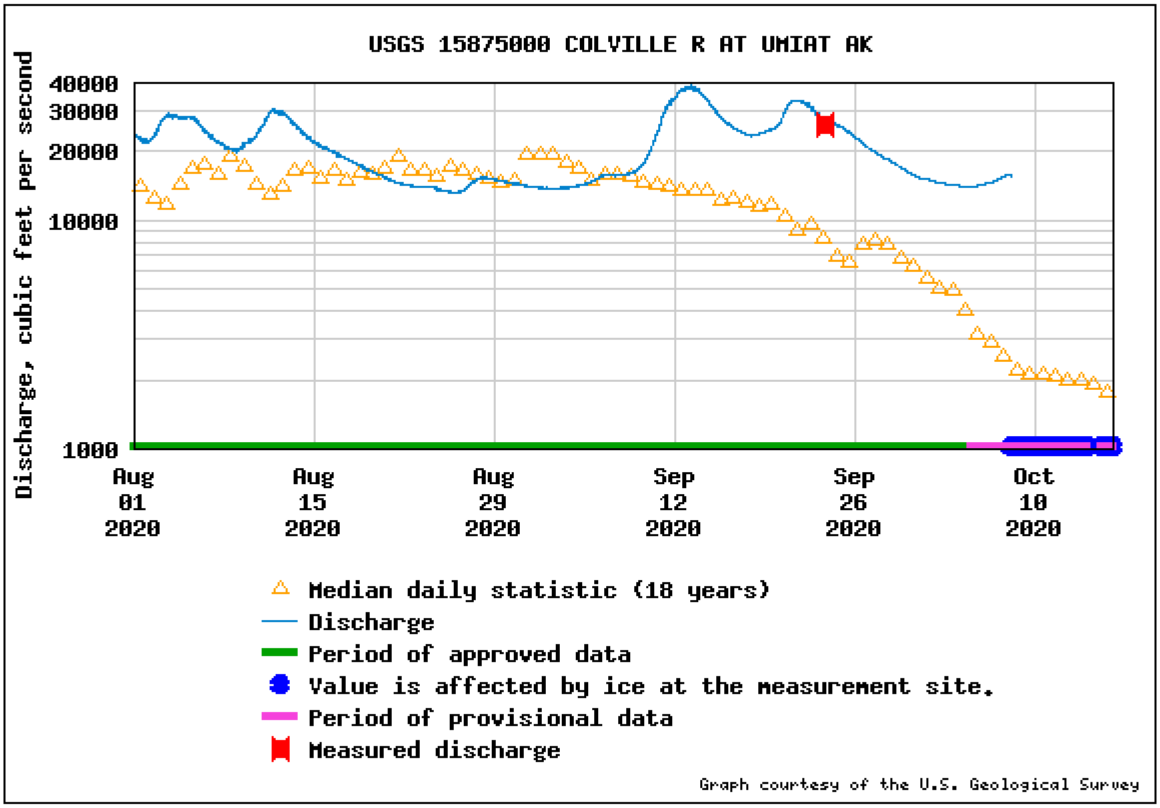

Figure 33. -- Colville River discharge at Umiat, Alaska, 1 August – 15 October 2020. Data available from: https://waterdata.usgs.gov/ak/nwis/current/?type=flow.

small groups of feeding and milling bowhead whales sighted on effort in October in each year; feeding and milling bowhead whales made up 32% of all bowhead whales sighted. Large aggregations (≥ 20 whales) of feeding and milling bowhead whales were sighted on effort in only five years: 1997, 1999, 2009, 2015, and 2017. Of those five years, the highest number of feeding and milling bowhead whales on effort (104 whales) was in 1997, compared to 319 feeding and milling bowhead whales sighted on effort in 2020, which comprised 70% of all on-effort bowhead whales sighted in 2020. The majority of on-effort feeding and milling bowhead whales sighted from 1982 to 2019 were sighted in the krill trap area (152.5°-157°W) (65% of whales) and in early to mid-October (71% of whales). However, it should be noted that survey effort in the western Beaufort Sea in the latter half of October in many years was often compromised due to inclement weather and the lack of a dedicated Deadhorse-based aircraft after 10 October.

The bowhead whale migration in autumn 2020 was the opposite extreme from 2019 (Fig. 34). In 2019, the migration was unprecedented, based on the collection of information within Indigenous knowledge and scientific ecological research. In September and October 2019, bowhead whales were sparse along the inner continental shelf, particularly near Utqiaġvik, Alaska, and whales that were sighted were farther offshore and in deeper water than previous survey years with similarly light sea ice cover (Clarke et al. 2020). The underlying causes for the 2019 anomalous migration are unknown, although the lack of upwelling winds (Fig. 32) was likely a contributing factor.

Sea surface temperatures (SST) in the Pacific Arctic provide another contrast between 2019 and 2020. In 2019, SST in the Pacific Arctic were very warm compared to previous years (Richter-Menge et al. 2019) and compared to 2020 (Unpubl. data, Earth System Research Laboratories, NOAA; Fig. 35). The SST increase, in combination with other environmental variables such as record low sea ice extent in the Alaskan Arctic, warmer surface air, lower snow cover, thawing permafrost, and decreased sea ice thickness (Richter-Menge et al. 2019), may have affected primary and secondary productivity, transport from the Bering Sea, and freshwater runoff. These things would undoubtedly affect bowhead whale prey, including krill that are transported from the Bering Sea in the Bering Sea Anadyr water (Ashjian et al. 2010). Alternatively, or in combination, warm water temperatures could potentially result in thermal stress to bowhead whales (Chambault et al. 2018), and the whales might change their migration paths to remain in cooler waters.

The presence of killer whales in the vicinity of Point Barrow also may have influenced the distribution of bowhead whales in autumn 2019 (Clarke et al. 2020, Willoughby et al. 2020a) and 2020. In 2019, the presence of killer whales may have contributed to the cumulative effects from other possible influences (e.g., the absence of "krill trap" conditions, etc.). Bowhead whales have been documented avoiding killer whales in the Canadian Arctic, over distances of 10s to 100 km, and killer whale presence can affect bowhead whale behavior for weeks (Breed et al. 2021, Matthews et al. 2020). In 2019, ASAMM documented 15 killer whales in late August and mid-September from 158°W to 159.2°W (Clarke et al. 2020), and bowhead whales were scarce in September and October in the eastern Chukchi and western Beaufort seas. In the western Beaufort Sea in 2019, eight bowhead whale carcasses were documented, the same number as the previous 10 years combined (2009–2018) (Willoughby et al. 2020b). The cause of death for five of the western Beaufort Sea carcasses in 2019 were classified as killer whale predation, compared to three from 2009 to 2018 (Willoughby et al. 2020b; Willoughby et al. in review). The cause of death was not determined for the other three carcasses in 2019 (Willoughby et al. in review). In 2020, no killer whales were sighted, and bowhead whales were sighted in high densities. The lack of killer whale sightings during the 2020 aerial surveys must be put in perspective: in previous years, all ASAMM killer whale sightings were in the northeastern Chukchi Sea in the months of August and September (Clarke et al. 2020, Willoughby et al. 2020a); in 2020, there was minimal survey effort in the Chukchi Sea, thereby reducing the opportunity to detect killer whales.

The bowhead whale calf ratio (number of calves on effort/number of total whales on effort) from 15 September to 15 October in 2020 (0.037) was similar to bowhead whale calf ratios in many previous years (Fig. 36). Annual calf ratios for 15 September – 15 October 1982-2019 were similar to calf ratios spanning all of September and October (Clarke et al. 2020). Calf ratios were highest in 2001 (0.333) and 2019. The calf ratio from 15 September – 15 October 2001 was particularly high because only three bowhead whales, including one calf, were sighted. However in early September 2001, 20 bowhead whales, including one calf, were sighted and the 1 September – 30 October 2001 calf ratio (0.087) is similar to other years with high calf ratios, but not as extraordinarily high as when limiting the data to only 15 September – 15 October.

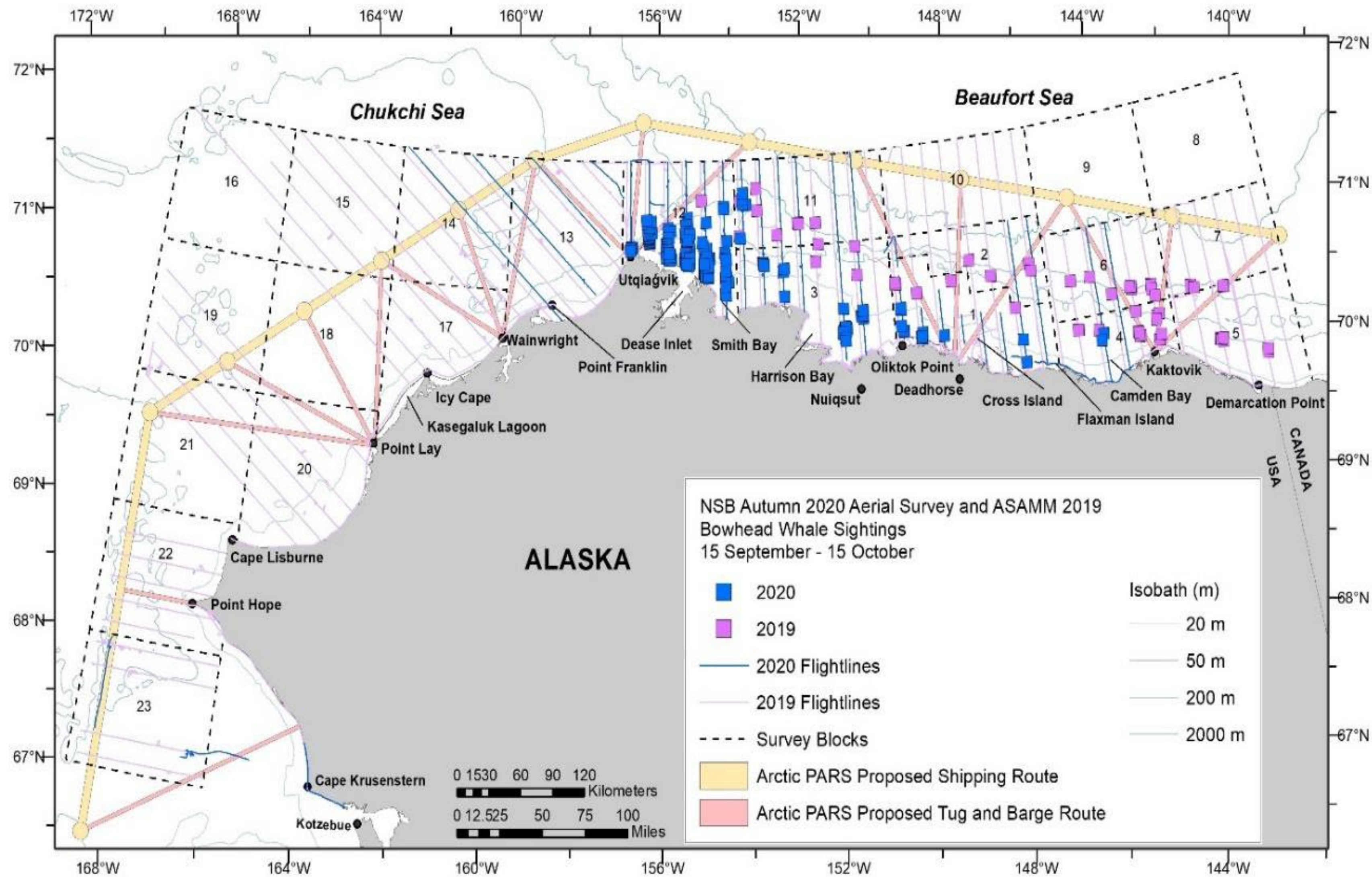

Figure 34. -- Bowhead whale sightings, 17 September – 15 October 2020, and ASAMM bowhead whale sightings, 15 September – 15 October 2019, all survey modes (transect, CAPs, search, and circling effort). Deadhead flight tracks are not shown.

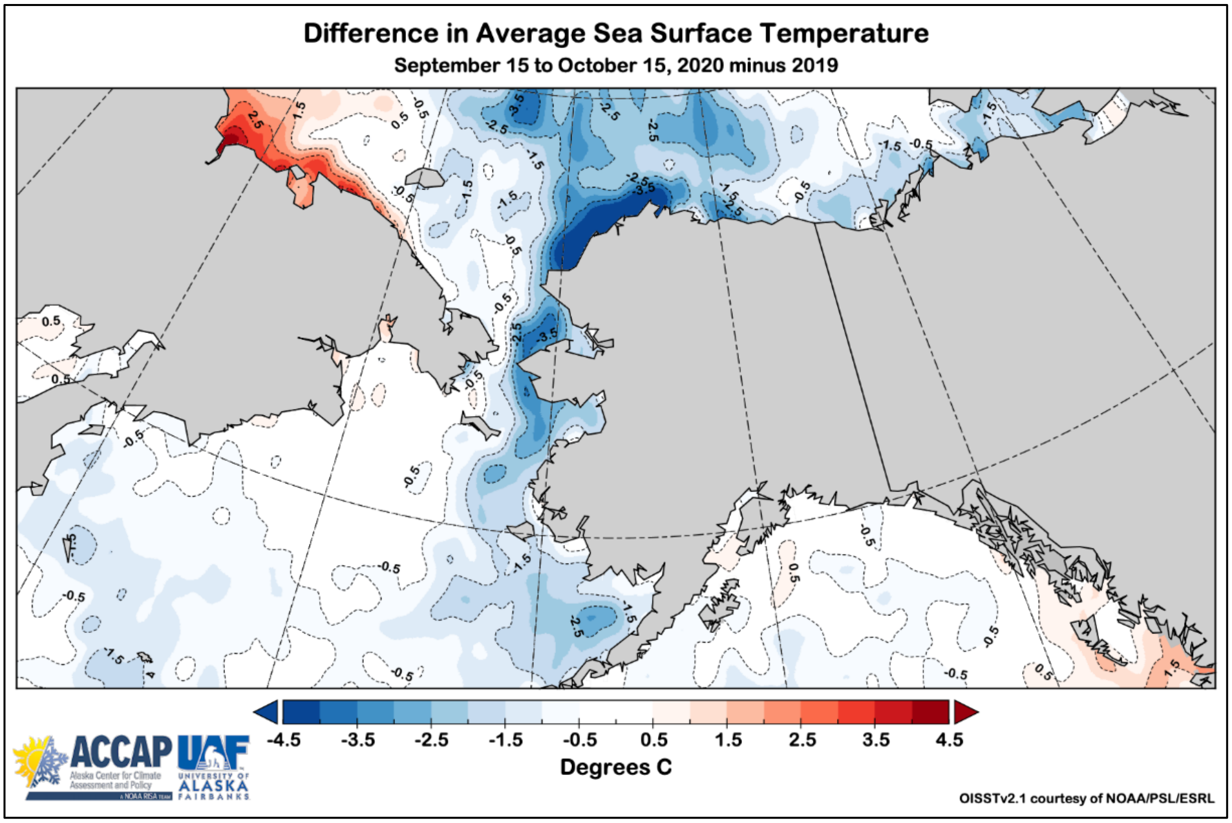

Figure 35. -- Difference in average sea surface temperature (°Celsius) between 27 September – 3 October 2020 and 27 September – 3 October 2019. Negative values (and blue colors) correspond to cooler SSTs in 2020 and warmer SSTs in 2019. Data from NOAA Earth System Research Laboratories; figure courtesy of Alaska Center for Climate Assessment and Policy, International Arctic Research Center, University of Fairbanks.

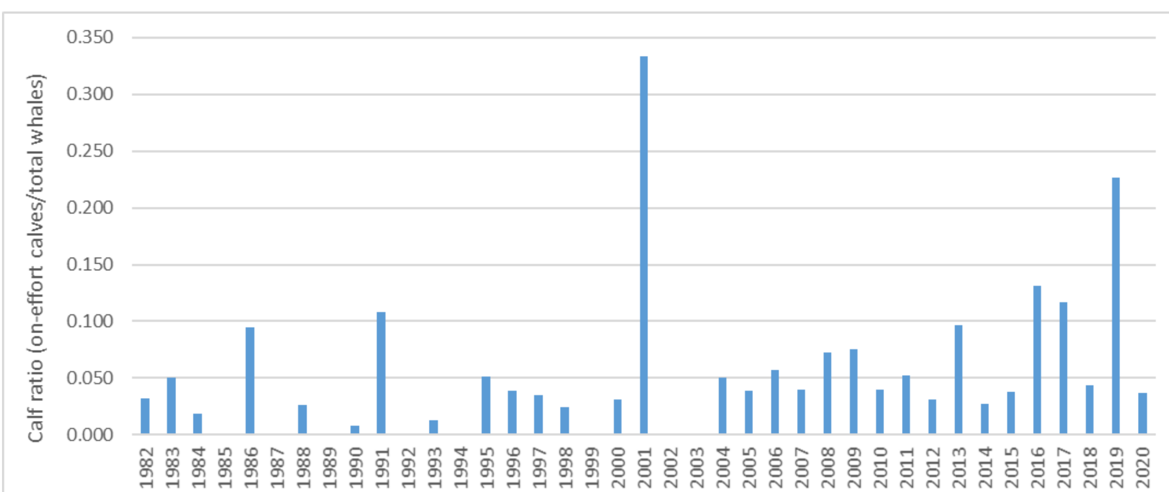

Figure 36. -- Bowhead whale annual calf ratios (number of bowhead whale calves on effort per number of total bowhead whales on effort, primary and secondary observers included), 15 September – 15 October.

Eight of the 10 gray whales sighted in 2020 were located in the nearshore area between Utqiaġvik and Point Franklin, which is an area where gray whales have not been sighted in high densities in recent years. Five of those whales were associated with mud plumes, indicative of benthic feeding. The nearshore area between Utqiaġvik and Point Franklin had high amphipod (gray whale prey) abundance when benthic sampling was conducted in 2009-2012 (Brower et al. 2017), and was a hotspot for gray whale foraging until 2016 (Fig. 37). From 2016 to 2019, the area had few gray whale sightings and there was an increase in gray whale sightings farther west and offshore in survey blocks 14 and 17 (Clarke et al. 2020) (Fig. 37). In 2020, survey coverage did not include the sections of survey blocks 14 and 17 where the highest densities of gray whales were typically sighted in the northeastern Chukchi Sea during ASAMM surveys since 2016.

Management Use of Interannual Monitoring

The data collected during the North Slope Borough 2020 Autumn Bowhead Whale Aerial Survey have been archived in the ASAMM historical database. These data are invaluable for addressing near real-time management concerns and assisting future planning. Under the requirements of several federal regulations, including the Endangered Species Act, National Environmental Policy Act, and Marine Mammal Protection Act, estimates of animal density and abundance are essential in permitting, monitoring, minimizing, and mitigating the impacts of anthropogenic activities (i.e., offshore energy, military, shipping, and recreational activities) on marine mammals. The observations from aerial surveys conducted in the Chukchi and Beaufort seas during summer and autumn 2019 and 2020 show us how much we have learned through consistent long-term ecosystem monitoring, and what surprising and unpredictable extremes the future may hold.

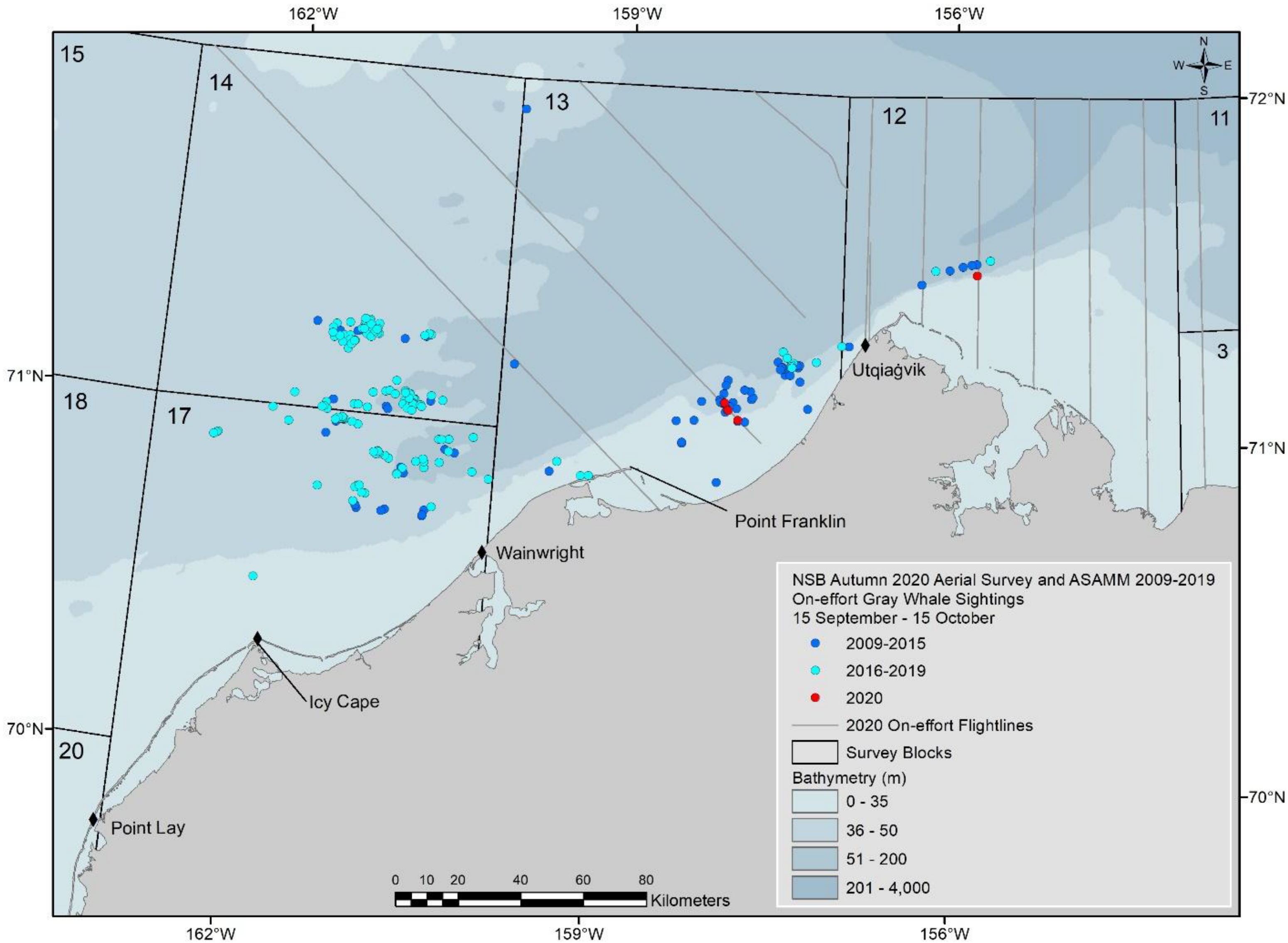

Figure 37. -- Gray whale on-effort sightings and survey effort, 17 September – 15 October 2020, and ASAMM on-effort gray whale sightings, 15 September – 15 October 2009-2019. Deadhead flight tracks are not shown.

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The 2020 field season required extra safety precautions due to the COVID-19 pandemic. We thank the people and organizations above for helping compile, revise, and approve our safety plans.

Mike Hay of XeraGIS provided timely assistance with the data collection program, data analysis, and report preparation.

The Turbo Commander aircraft, pilots, and mechanical support were provided by Clearwater Air, Inc., of Soldotna, Alaska, via contract between NSB and Clearwater Air, Inc. The 2020 aerial surveys posed considerable logistical challenges due to COVID-19, and Clearwater Air rose to the challenge. The surveys would not be possible without the enthusiastic support of Andy Harcombe. We were especially grateful to fly with Jacob Creglow, Robert McPhie, and Kaden Vacendak. Mary Pratt provided administrative support.

Real-time monitoring via satellite tracking of all survey flights was provided by U.S. Department of Interior, Bureau of Land Management (BLM), Alaska Interagency Coordination Center, South Zone Dispatch. We especially thank Jerrid Palmatier for coordinating BLM flight followers.

Arctic research necessarily relies on cooperation and timely sharing of information to ensure safe and successful operations. We appreciate the cooperation of the agencies, individuals, and entities who assisted or coordinated with the team in 2020, including Craig George and Raphaela Stimmelmayr (NSB Department of Wildlife Management), Alaska Eskimo Whaling Commission, Barrow Whaling Captains' Association, Alaska Beluga Whale Committee, Iñupiat Community of the Arctic Slope, U.S. Fish and Wildlife Service, and King Eider Inn.

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APPENDIX A: CETACEAN AGGREGATION PROTOCOL (CAPS)

Version 22, 15 September 2020

BACKGROUND

During all ASAMM surveys, when surveying aggregations of large cetaceans (bowhead, gray, humpback, fin, and minke whales), data collection on those large cetacean species should take precedence over any other species. Data should not be recorded on pinniped or small cetacean sightings so that the ability to record accurate and complete data for targeted cetacean species is not compromised.

Temporary marks indicating distances of 1 km (0.5 nmi) and 3 km (1.6 nmi) from the transect should be made on each bubble window for each observer at the beginning of every flight (Appendix Table A1). Observers should check the accuracy of the 1-km and 3-km marks with their clinometer a few times over the course of a flight, in case the observer's posture in the window changes substantially and affects the location of these marks.

Appendix Table A1. -- Clinometer angles (°) associated with CAPs distances at survey altitudes 1,000 ft, 1,300 ft, and 1,500 ft.

Altitude (ft)	3 km	1 km
1,000	5.8°	17°
1,300	7.5°	21.7°
1,500	8.7°	24.5°

The definition of a "sighting" is all whales within 5 body lengths of each other. For example, a sighting could comprise a single whale, one cow-calf pair swimming closely together, or several whales located within 5 body lengths of each other. A patch of tens of whales causing a broad disturbance on the surface of the water should be counted as a single sighting only if all whales are within 5 body lengths of their nearest neighbor. Whales separated from neighbors by greater than 5 body lengths should be recorded as separate sightings. The final group size estimate for a sighting can be updated to incorporate additional animals associated with (e.g., within 5 body lengths of) the initial detection. Any whale sighted during circling that was not in close proximity to the originally detected sighting will be considered a separate sighting on circling.

An aggregation is a high-density patch of cetaceans. An aggregation may span several transects (Appendix Fig. A1).

DATA COLLECTION

Low Sighting Density

When a sighting is detected in an area of low sighting density, the clinometer and an initial estimate of group size should be recorded when the aircraft is on the transect and the sighting is abeam. The aircraft should circle the sighting, as weather and fuel allow, to confirm species identification, obtain a final estimate of group size, determine whether calves are present, and record any other relevant sighting data. Circling should only occur over areas that have already been surveyed on effort (i.e., passed abeam). ***The observer on the opposite side of the aircraft from the original transect sighting should avoid scanning for new animals on the outside of the circle while circling.***

Sightings during circling-from-transect will inevitably occur. Guidelines for entering s(ighting) on circling:

- Sighting on circling are low priority and should not compromise the team's ability to accurately record s on transect. For example, it might be a good idea to not enter s on circling detected immediately prior to a resume transect in an area of moderately-high to high density because that might tie up the data recorder and affect the ability to record upcoming s on transect.
- Do not enter any s on circling that are located on fresh transect and have a chance of being sighted from transect.
- Sighting on circling located inside the circle can be recorded.
- Sighting on circling located far from the transect (e.g., > 3 km) are the lowest of the low priority.

High Sighting Density

Cetacean Aggregation Protocols will be triggered when the density of large cetacean sightings on transect exceeds the observers' ability to mark, ***record an accurate clinometer for***, and circle every sighting (Appendix Fig. A2). Also consider entering CAPs mode if you detect several s on circling-from-transect within a short period of time. There may be circumstances when the pilots detect extremely dense aggregations of large cetaceans prior to detection by observers; in those situations, the pilots will communicate this information to the team leader to assist with decisions concerning if and when CAPs should be initiated.

There are two strategies for dealing with high-density aggregations of large cetaceans, CAPs passing and CAPs strip. Cetacean Aggregation Protocols passing is implemented in areas where large cetacean sighting densities are dispersed enough that the observers are able to mark individual sightings and accurately collect sighting data within 3 km of the trackline. Cetacean Aggregation Protocols strip is initiated when large cetacean sighting density becomes so high that it is impossible to record groups of whales within 5 body lengths of each other as individual sighting events. Cetacean Aggregation Protocols strip is limited to sightings within 1 km of the track.

CAPs passing

During CAPs passing, the first step is to continue to fly directly on the transect without circling (i.e., survey in "passing mode"), and record data for large cetacean sightings located within 3 km of the transect. Only primary observers should call out sightings.

CAPs circling

When the aircraft reaches the point where large cetacean density has obviously diminished to background levels, CAPs circling will commence. During CAPs circling, the full suite of ASAMM sighting data should be recorded for each cetacean sighting that is located less than or equal to 3 km of the transect covered during CAPs passing mode. It might be most effective for the aircraft to travel approximately 1.5 km from the trackline while scanning for sightings during CAPs circling so that each observer is responsible for scanning the same perpendicular distance from the aircraft. While circling during CAPs, do not record data for cetaceans located greater than 3 km from the transect. Sightings recorded during CAPs circling do not need to match sightings during CAPs passing mode. We do not expect or need to obtain a direct match because sightings in passing mode are used to estimate encounter rate, while sightings on circling are used to infer average group size, number of calves present, and species identification. During CAPs circling, it is acceptable to circle a fresh mud plume until a cetacean surfaces in order to record the sighting as s on CAPs circling. Note that if CAPs strip is initiated in association with a CAPs segment, circling should not be conducted in the area flown in CAPs strip mode.

When both sides of the transect have been surveyed under CAPs circling out to a maximum of 3 km from the transect (with the exception of CAPs strip segments), the survey team will do one of the following: a) return to the point on the transect downstream of the aggregation where only unsurveyed transect lies ahead and proceed to survey using standard ASAMM protocols; b) deadhead (e.g., if weather, fuel, or other logistical constraints require returning to base); or c) repeat CAPs passing survey mode in the current CAPs segment. Option "c" would be initiated if, based on CAPs circling sightings, the team has reason to believe that during the initial CAPs passing effort the whales were diving synchronously and many whales were underwater, and conditions (fuel, weather, etc.) allow. The subsequent effort should include, at a minimum, CAPs passing over the same section of transect as flown initially, and preferably would include a second CAPs circling session (although that is not a necessity). Sighting data should not be entered as "repeat" on the second pass. The data recorder should include notes either in the database or in the log book describing the events and decision-making, so that project management will be able to determine the best way to incorporate the data[1].

If the aggregation extends farther than the initial CAPs segment, a new CAPs session can be started.

CAPs strip

If, during transect or CAPs passing mode, the large cetacean sighting density becomes so high that it is impossible to record groups of whales within 5 body lengths of each other as individual sighting events, the survey mode will become a strip transect, "CAPs strip", in which it is assumed that every large cetacean at the surface in the field of view within a certain distance of the transect is detected and recorded. To meet this strict assumption of 100% detectability of surfaced cetaceans, observers should include animals located only within 1 km of the transect. Observers may pool sightings into single sighting events for each side of the aircraft (Appendix Fig. A3). Because strip-transect methods assume that 100% of surfaced cetaceans will be detected and counted in passing mode, the area covered during CAPs strip will not be included in subsequent circling effort (Appendix Fig. A2). When the sighting density within the aggregation thins to a level at which it is possible to resume collecting data for individual sightings (groups), resurvey the CAPs strip two more times. After the third CAPs strip

[1] Options for incorporating the data from multiple CAPs passing trials into the database include: 1) change one CAPs passing trial to "deadhead"; 2) change the entries associated with one CAPs passing trial to saved = 0; or 3) keep both CAPs passing trials in the database, saved = 1. The advantages to the second and third options are that the entry, sighting, environmental, flight type, and enttag data from both CAPs passing trials are easily accessible if they are found to be useful in future analyses. The additional advantage of the third option is that it maintains the aircraft position data, which are useful for plotting flight tracks and computing effort.

transect, resume collecting sighting-specific CAPs passing mode sighting data. Sightings should be pooled only during CAPs strip mode, never during CAPs passing or CAPs circling modes.

ADDITIONAL CONSIDERATIONS

Cetacean Aggregation Protocols sessions should always include, at a minimum, CAPs passing and CAPs circling. If conditions (weather, fuel, etc.) will not support CAPs circling, CAPs should not be initiated because the resulting data would be incomplete. There is no time limit for collecting data during CAPs, assuming weather and fuel allow. There is no limit to the "length" along the transect of a CAPs segment; however, CAPs circling should never extend beyond the bounds of the initial CAPs segment (gray areas in Appendix Fig. A2). Continue to enter environmental updates as time allows during CAPs, CAPs strip, and CAPs circling survey modes.

Cetacean Aggregation Protocols will not be used during search effort. Do not survey in search mode between transects in areas with known moderately high to high densities of large whales (e.g., western edge of block 23) because searching between transects in those areas has a relatively high chance of taking s on transect away from the next transect. If you find yourself surprised by moderately high to high densities of large whales during a search between transects, enter the original s on search, mop up the relevant s on circling-search, then resume and switch to deadhead mode as quickly as possible. Deadhead for the remainder of the transit between transects.

In situations where large whale density slowly increases on transect and the team determines that the density is enough to initiate CAPs, it is possible to backtrack along a transect to return to a logical trigger point to implement CAPs. In that situation, all of the original effort and sightings on transect located perpendicular to the CAPs segment should be identified and changed to deadhead events (see example in Appendix Fig. A4). The data recorder can make a note saying where transect effort should end and deadhead effort should begin so that the data editor can make the necessary edits during post-flight processing. During final data editing, be sure that there is a note near the beginning of the deadhead section that reads, "backtracking to begin CAPs". It is unusual for ASAMM to have deadhead effort in the middle of bowhead aggregations, so this note should help explain the situation to data users.

Cetacean Aggregation Protocols should not be initiated if visibility is less than 1-2 km on either side of the aircraft, or the aircraft is frequently passing through cloud layers that obscure visibility. Cetacean Aggregation Protocols can be initiated when visibility is 2-3 km, but the limited visibility should be noted. Cetacean Aggregation Protocols can be initiated during the coastal transect. Because sightings are limited to 1 km on the shoreward side of the coastal transect, conduct all CAPs sessions during coastal transect effort as CAPs strip, recording sightings only out to 1 km, replicating the strip three times, and do not circle sightings.

Cetacean Aggregation Protocols should not be initiated in areas where walruses are hauled out on ice or along the coast. Care should be taken when initiating CAPs near known areas of polar bear aggregations (i.e., near Barter and Cross islands). Cetacean Aggregation Protocols can be initiated in those areas but circling needs to be limited to 15 minutes.

The following “shades of gray” should also be considered when deciding whether to begin CAPs:

- An s on transect at approximately clino 7.5° or farther when the aircraft altitude is 1,300 ft is on the edge of the CAPs 3-km strip. In an area of moderately-high large cetacean density, diverting to circle distant sightings will likely result in s on circling, which may or may not have been detectable from the transect.
- In areas with multiple species of large cetaceans (e.g., southern Chukchi Sea), CAPs passing will likely result in many unidentified cetacean sightings. The team leader needs to make a judgment call regarding whether the inability to positively identify sightings to species is outweighed by the advantages of getting accurate encounter rates during CAPs passing or strip modes, supplemented by group size, calf numbers, and species identification info from CAPs circling modes.
- If the team refrains from calling sightings located on fresh transect during circling-from-transect, those sightings may be detected from the trackline after resuming transect mode. This discipline helps justify staying in transect mode rather than entering CAPs mode.

Due to the subjective nature of the CAPs decision-making process, it is quite possible that CAPs may be initiated prematurely or in an area that can be adequately surveyed in transect mode. When in “CAPs fail” (i.e., after starting CAPs, but realizing there are not many whales in the area), return to specific s on CAPs passing locations during CAPs circling to increase your chances of finding animals. Depending on the time passed since marking the s on CAPs passing, the separation of sightings, and other factors, it might be possible to gather additional info for the s on CAPs passing sighting during CAPs circling. If there is confidence that an s on CAPs passing was resighted during CAPs circling, enter the resight as an s on CAPs circling and, post-flight, make a note in the s on CAPs passing stating what s on CAPs circling it corresponds to. If a sighting is found during CAPs circling in the general vicinity of an s on CAPs passing, but there is not very high confidence that the exact same sighting was relocated during CAPs circling, enter it as an s on CAPs circling; no additional notation needed.

There is interest in beluga presence in the eastern Beaufort Sea and Amundsen Gulf and a value in knowing whether a lack of beluga sightings recorded during CAPs was due to there being zero sightings of belugas during CAPs or if it was due to the team not recording belugas that were sighted during CAPs. Therefore, at the end of CAPs circling and right before the start transect or deadhead, make an environmental update to record presence or absence of belugas during the CAPs session. In the notes for the environmental update, state either "zero belugas sighted during CAPs session" or "~X # of belugas sighted during CAPs session”, and note the approximate number of belugas (keep it simple, e.g., < 5, 5-25, > 25, > 100, etc.).

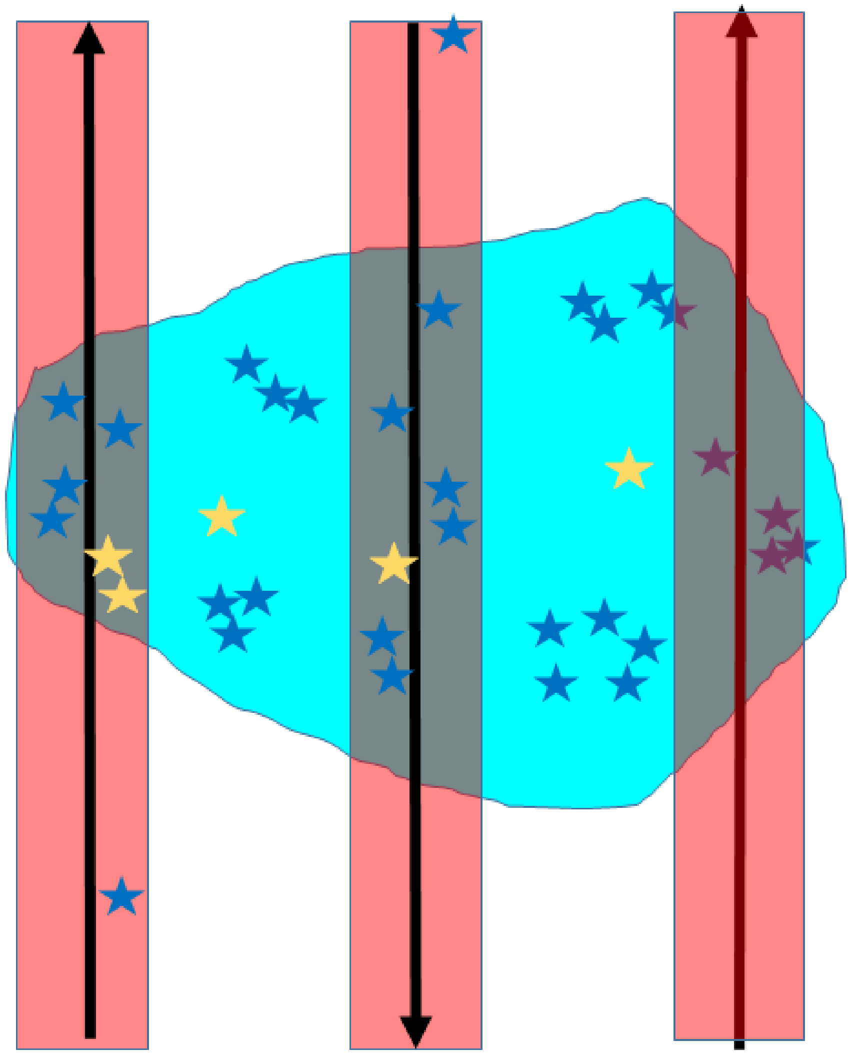
Specific Data Collection Steps

Steps shown in Figure A5. FltType and EntTag are provided in ( ) for data editing assistance, and are entered automatically into the database.

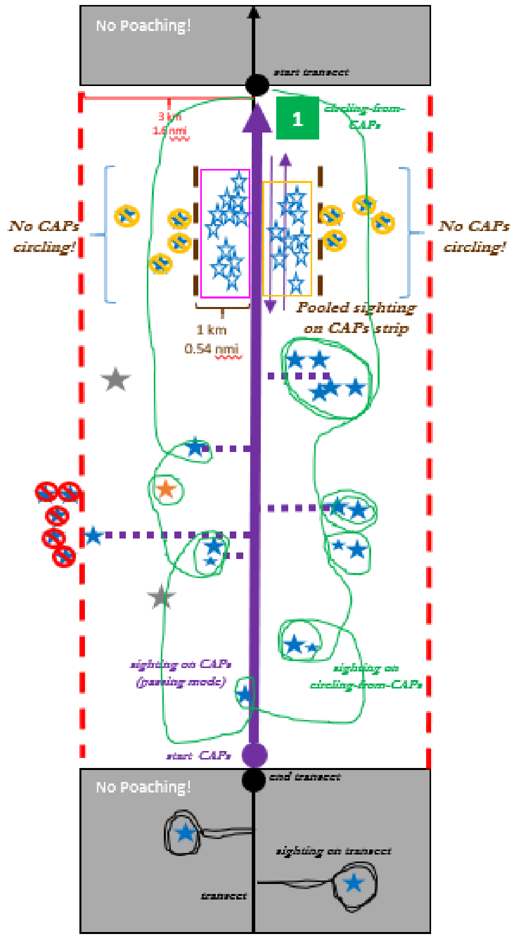
In the ASAMM database, habitat auto-populates to open water during CAPs passing and CAPs strip. If CAPs takes place in sea ice, make a note in the notes field of the data or the green book to update Habitat, Icetype, Icepercent_l, and Icepercent_r. The percentages can be a general estimate for the CAPs area.

1. When CAPs protocol is triggered, select **end transect** (4, 1).
2. Select **CAPs** (7, 1). The flight track will change to a different color, which will be useful once CAPs circling commences. Make sure the 3-km layer is visible on the map. Continue along "fresh" transect in passing mode.
3. Limit sightings during CAPs passing, circling, and strip to large cetaceans (i.e., do not record belugas, killer whales, pinnipeds, polar bears, etc.).
4. When a large cetacean sighting is made, select **sighting on CAPs** (7, 3), and enter abbreviated sighting information, including observer, species, clino, group size, calf number, NoReacted (number reacted – leave blank if no reaction), and behavior. Species identification will trickle down to subsequent sighting events and can be manually changed. Behavior will not trickle down; it is o.k. to leave the behavior field empty during CAPs, but record it, if possible.
    a. Environmental updates (7, 2) should be entered as needed during CAPs.
    b. Do not include any sightings that are greater than 3 km (1.6 nmi) from the trackline.
    c. Record unique species separately.
    d. Do not pool sightings.
5. If large cetacean density is extraordinarily high, necessitating the need to pool sightings, select **CAPs strip** (11, 1) and continue along the transect in passing mode. The flight track will change to a different color.
    a. During CAPs strip, observers on each side of the aircraft should keep a running tally of large cetaceans within 1 km (0.54 nmi) of the transect. Select the **CAPs left** or **right sighting** (11, 3) button, and enter abbreviated sighting information, including observer, species, clino, group size, calf number, NoReacted (number reacted – leave blank if no reaction), and behavior. The clino should reflect the center of the group. Record unique species separately. Data should be entered separately for each side of the aircraft. Several pooled and unpooled sightings may be entered during CAPs strip. It will be assumed that all CAPs strip sightings (11, 3) are pooled, regardless of the number of sightings per record.
    b. Do not include any sightings beyond the 1-km strip, because the survey is in strip-transect mode.
    c. When the extremely dense area of sightings has been surveyed once, enter **CAPs circling** (9, 1), and make a U-turn to get back to where CAPs strip effort was ended. Enter **CAPs strip** (11, 1) and fly the exact area just covered in CAPs strip along the same transect but in the opposite direction. Update environmental conditions (11, 2) at the start of the second pass. Record all CAPs strip sightings (11, 3) in the same manner as 4a above.
    d. At the point where the CAPs strip protocol started in 4a above, enter **CAPs circling** (9, 1), make another U-turn to get back to where CAPs strip effort should begin, enter **CAPs strip** (11, 1) and fly the exact area for the third time. Update environmental conditions (11, 2) at the start of the third pass, and record data from that pass in the same manner as 4a above.
    e. Environmental updates (11, 2) can be entered whenever survey conditions change.
6. After the third CAPs strip pass through the extremely high density area, if the aggregation continues and more CAPs passing effort is needed, select **CAPs** (7, 1), and continue on the transect through unsurveyed waters collecting CAPs passing data.

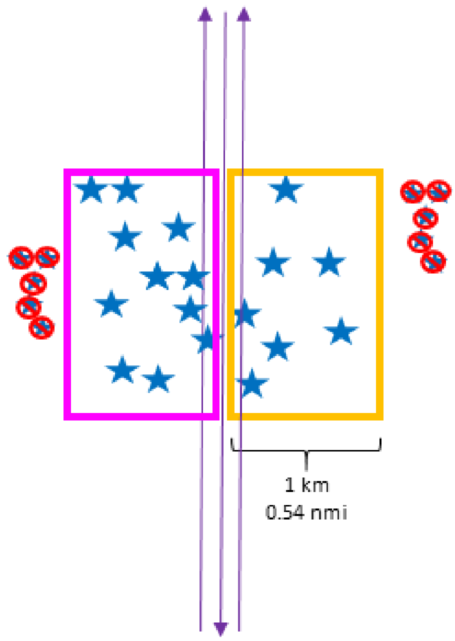
7. When CAPs passing or strip protocol are no longer necessary because large cetacean sightings have returned to normal manageable levels, commence **CAPs circling** (9, 1), and start recording detailed sighting data. If the normal manageable levels follows CAPs passing effort, go directly into CAPs circling. The area in which circling occurs should include 3 km off either side of the transect, back to where the CAPs passing session began. Circling may start on either side of the transect, and it is okay to cross the transect to obtain data for sightings on circling.
    a. Areas surveyed in CAPs strip mode <u>should not</u> be included in CAPs circling. If CAPs passing effort was conducted, and then CAPs strip effort was conducted, the plane will need to backtrack across the CAPs strip effort to get to the area where CAPs passing effort was conducted and where CAPs circling effort needs to be conducted. Enter CAPs circling (9, 1) immediately after CAPs strip effort and use CAPs circling effort while backtracking to get to the area where circling should occur.
8. **Sightings on CAPs circling** (9, 3) should be recorded as closely as possible to the actual sighting location. Record the full suite of ASAMM sighting data (species, minimum/maximum/final group size, number of calves, calf detection certainty, reactions, behavior) for each cetacean sighting that is located within 3 km of the transect covered during CAPs passing mode. Only large cetaceans should be recorded; do not record small cetaceans or non-cetaceans.
    a. Sightings will be attributed to whoever (right or left observer, data recorder, 4th observer, or pilot) made the sighting.
    b. Sightings do not have to "match" those from the initial CAPs passing mode.
    c. Sightings should not be lumped together during CAPs circling - no pooling! If density of cetaceans is such that all individual sightings cannot be recorded, record a random sample of sightings without biasing towards "large" or "small" groups.
    d. Enter sightings of individual species separately.
    e. Continue to enter environmental updates (9, 2), as needed.
9. When the entire CAPs area (sans any CAPs strip area) has been circled to obtain detailed cetacean sighting information and the CAPs session is finished, make an environmental update to record presence/absence of belugas during the CAPs session; in the notes, state either "zero belugas sighted during CAPs session" or "~X # of belugas sighted during CAPs session", and note the approximate number of belugas (keep it simple, e.g., < 5, 5-25, > 25, > 100, etc.). Then do one of the following: a) return to the point on the transect downstream of the aggregation where only unsurveyed transect lies ahead, **start transect** (2,1), and proceed to survey using standard ASAMM protocols; b) **deadhead** (1,1) (e.g., if weather, fuel, or other logistical constraints require returning to base); or c) repeat **CAPs passing** (7,1) survey mode in the current CAPs segment if the team suspects that the whales are diving synchronously and many whales were underwater during the initial CAPs passing effort. If time and conditions allow, consider repeating **CAPs circling** (9, 1) also. If option "c" is chosen, keep data from both CAPs attempts: do not change the data from either of the CAPs attempts to saved = 0 during post-flight data editing, but include notes in the database or log book detailing what was done, and why.



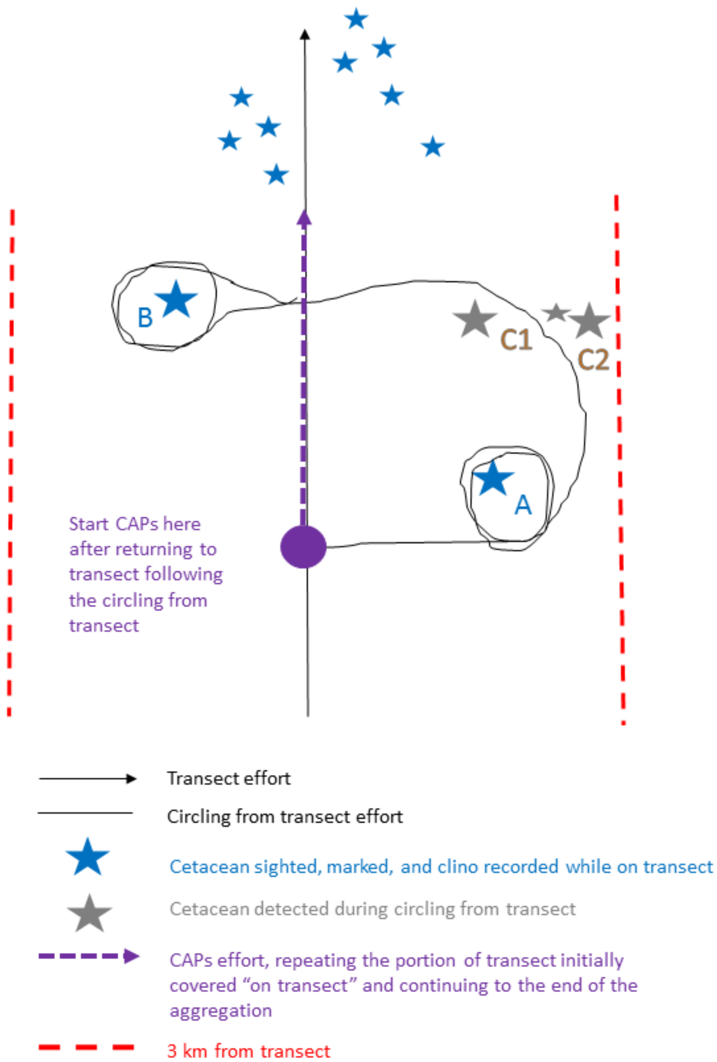
Appendix Figure A1. -- A cetacean sighting comprises all whales within 5 body lengths of each other. The final group size estimate for a sighting can be updated to incorporate additional animals detected near the initial detection (e.g., within ~ 5 body lengths of the cetaceans that were initially sighted). An aggregation comprises all cetaceans in a high-density patch of cetaceans, including those beyond 3 km from a transect, depicted within the turquoise blob. An aggregation may span more than one transect. The survey and analytical methods allow for whales in an aggregation to go undetected. Black arrows: transects. Salmon shading: 3-km strip on each side of a transect. Stars: individual whales, with different colors used to depict different species.



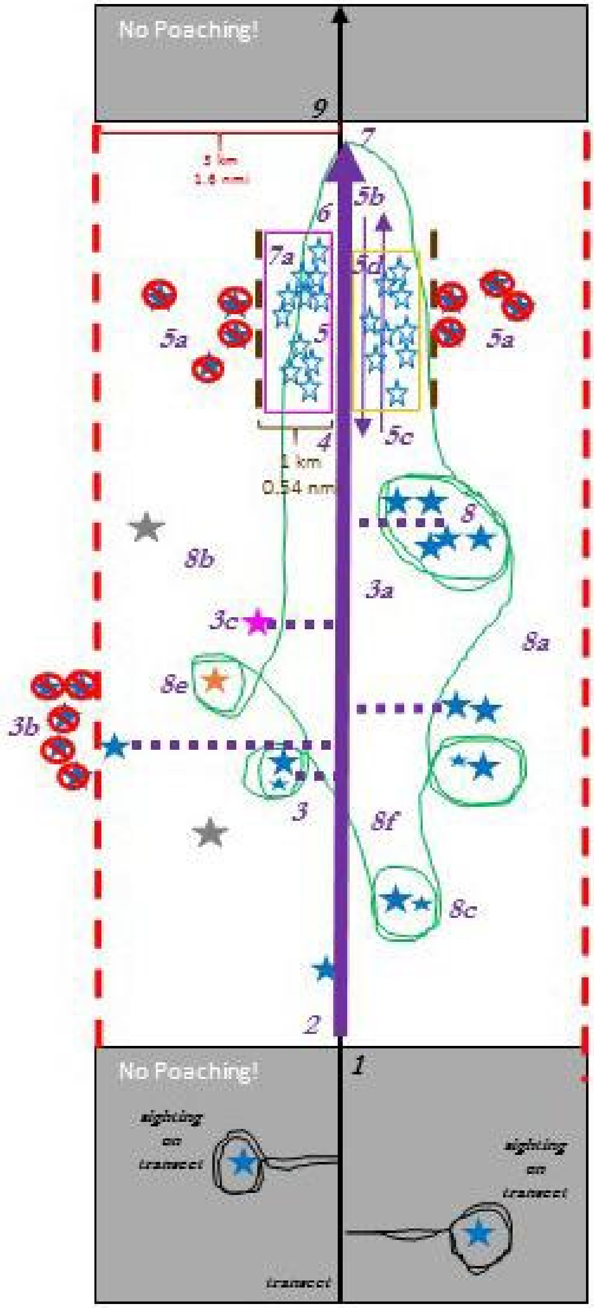
Appendix Figure A2. -- Black: transect and circling-from-transect, surveyed using standard ASAMM protocols, from bottom to top of figure. Purple: CAPs passing mode effort (solid line) and perpendicular distances to sightings (dotted lines). Magenta and yellow boxes: CAPs strip effort in extremely high-density area, only 1 km wide. Green "1": commence CAPs circling. Green line: CAPs circling effort; no circling along CAPs strip section. Red dashed line is 3 km (1.6 nmi) from transect. Red circle-and-slash symbols: do not count these cetaceans at any time during CAPs passing or CAPs circling because they are greater than 3 km from transect. Orange circle-and-slash symbols: do not count these cetaceans during CAPs strip or CAPs circling because they are greater than 1 km from transect. Solid blue and orange stars: cetaceans detected during either CAPs passing or CAPs circling mode; species denoted by color, and calves denoted by small stars. Open blue stars: cetaceans detected during CAPs strip. Some cetacean sightings will be detected only during CAPs passing mode, some will be detected only during CAPs circling mode, and some will never be detected (gray stars). While in CAPs passing or CAPs circling mode, do not record sightings that are located before start CAPs or after the initial divert to circling during CAPs (green "1"); these off-limit areas are shaded gray.



Appendix Figure A3. -- Schematic of CAPs strip mode. During CAPs passing mode, if sighting density precludes the ability to enter a new sighting record for each sighting, survey the high-density area using strip-transect methods. Make three passes through the area (depicted by adjacent purple arrows but actually flown along the exact same path), without circling. It is okay to pool sightings located on one side of the aircraft into a single sighting record for that side. It is okay to record multiple pooled sighting events per side per pass. For each sighting record, enter group size, number of calves, species, behavior, NoReacted (number reacted – leave blank if no reaction), and clinometer corresponding to the center of the pooled sightings. Focus only on the animals located within 1 km of the transect; do not include cetaceans farther than 1 km from the transect in the group size estimate for a pooled sighting. The area in which pooled sightings are recorded should <u>not</u> be included in the area subsequently circled during CAPs circling.



Appendix Figure A4. -- Schematic illustrating "backtracking" to start CAPs. Cetaceans A and B were detected from the transect at approximately the same time. Cetacean A was marked with a clinometer; the aircraft continued on the transect to mark and record the clinometer for B before diverting to circle from transect. The aircraft circled B first, then crossed the transect to circle A. While flying towards A, cetacean sightings C1 and C2 were detected for the first time, and the team realized they were entering a high-density patch of cetaceans. Because C1 and C2 were not detected (or marked) from the transect and are not within 5 body lengths of A or B, they cannot be combined with the group size estimates for the transect sightings and should not be recorded. Upon returning to the transect at the point perpendicular to sighting A, end the transect and start a CAPs session. Continue surveying the aggregation using standard CAPs protocols (not shown in diagram; refer to Appendix Figs. A2 and A3). Note that all of the original effort and sightings on transect located perpendicular to the CAPs segment should be identified and changed to deadhead events.



Appendix Figure A5. -- CAPs protocol with data collection steps.

Data Integration

Here, we summarize how CAPs data are incorporated into analyses.

Survey effort on CAPs passing and CAPs strip is equivalent to transect effort and is included in total on-effort kilometers for sighting rate and high-use-area (HUA) analyses. Survey effort on CAPs circling is considered off-effort.

Sightings made during CAPs passing may be identified to species, but sightings may need to be recorded as unidentified cetaceans, particularly sightings that are farther from the trackline and in areas where multiple large cetacean species are expected to occur (e.g., southcentral Chukchi Sea and near Point Barrow).

We use many stats to incorporate sightings from CAPs into sighting rate and HUA analyses:

1. Species Identification: Species Identification for sightings identified to species during CAPs passing are unchanged. For each CAPs session, sightings entered as unidentified cetaceans during CAPs passing are adjusted based on the proportion of sightings positively identified to each large whale species during CAPs circling. The resulting adjusted number of CAPs passing sightings assigned to each species might not be an integer value; that is, the CAPs-adjusted number of sightings might be a real number, with non-zero digits to the right of the decimal place.
2. For each CAPs session, average group size and average number of calves per CAPs passing sighting are updated based on CAPs circling statistics.
    a. Average group size and average number of calves are computed for each positively identified species. These statistics are computed separately for CAPs passing and CAPs circling.
    b. The CAPs-adjusted average group size corresponds to the average group size from either CAPs passing or CAPs circling, whichever is largest.
    c. Similarly, the CAPs-adjusted average number of calves per sighting corresponds to the average from either CAPs passing or CAPs circling, whichever is largest.
    d. The total CAPs-adjusted number of sightings, whales, and calves used in sighting rate and HUA analyses result from summing sightings, whales, and calves identified to species during CAPs passing with sightings, whales, and calves assigned proportionally to species based on CAPs circling statistics.
3. Behavior is left unchanged for CAPs passing sightings with behaviors recorded in the original survey data. For CAPs passing sightings lacking behavior in the original survey data, behavior is adjusted for each species according to the proportion of sightings during CAPs circling that were recorded as feeding/milling. Only two behavior states are possible for CAPs-adjusted data: feeding/milling or not feeding/milling.

APPENDIX B: COVID-19 PROTOCOLS

University of Washington Fieldwork Health and Safety Plan (COVID Return: Phases 1-2), 11 September 2020

September 4, 2020
RE: North Slope Borough Aerial Survey - MML Whales

To Ivonne Ortiz:

The University of Washington has designated the Aerial surveys of the bowhead whale fall migration in the Western Beaufort Sea, based out of Utqiaġvik, Alaska as an essential function for the period of September 7 – October 16, 2020. This fieldwork is authorized by Clearwater Air and the North Slope Borough. This designation and authorization allows this critical research to go forward under the Washington State Governor's "Safe Start Reopening Plan".

This is a collaborative project between the North Slope Borough, the University of Washington, and the NOAA Marine Mammal Laboratory and is funded by the North Slope Borough of Alaska. The goals of the survey are to understand the distribution of bowhead whales near Utqiaġvik, Alaska. This is of particular concern to the local Alaska Native community because bowhead whales were unusually rare near Utqiaġvik in 2019 due to warmer oceanographic conditions. The Alaska Eskimo Whaling Commission (AEWC) passed a motion of support for this survey at their 2020 summer meeting and highlighted that, "It is essential that data continue to be collected on bowhead whales in the Beaufort Sea because of the rapidly changing conditions in the Arctic, the increasing human activities in the Arctic, the importance of bowheads for the villages of the AEWC, and ongoing pressure from the International Whaling Commission."

An approved COVID Health and Safety Plan for this fieldwork is on file in the CICOES Unit Folder and will be provided upon request.

Names of employee(s) providing critical in-person services in support of this activity include:
Amelia Brower and Amy Willoughby, staff with the University of Washington's Cooperative Institute for Climate, Ocean, and Ecosystem Studies [CICOES] and NOAA-NMFS-AFSC-MML.

If you have any questions, please feel free to contact me at jhorne@uw.edu.
Sincerely,

John Horne
CICOES Executive Director

Cc: Amelia Brower
Amy Willoughby

Unit	CICOES		
Plan Created for	North Slope Borough Aerial Survey - MML Whales	**Date of revision:**	08/16/2020
PI/Supervisor	Ivonne Ortiz, ivonne.ortiz@noaa.gov		
Field Team Leader/ Chief Scientist	Megan Ferguson, NOAA Federal employee, megan.ferguson@noaa.gov		
Activity Description	Aerial surveys of bowhead whale fall migration		

Field Site Location(s)	Western Beaufort Sea, based out of Utqiaġvik, Alaska
Date(s) of Fieldwork	September 7 – October 16, 2020, first potential survey date: September 15

Approved by:	*JOHN HORNE see first page approval letter*	*09/04/2020*

CICOES Field Operations Emergency* Notification Plan

ENTER YOUR NAME HERE Program

*Emergency: Any accident, injury, illness, or other incident that seriously threatens the health or safety of a field researcher/tech or otherwise requires that the individual be transported to shore or removed from his/her temporary duty work assignment.

Group 1

MUST PROVIDE INFORMATION FROM FORM ON BACK TO GROUP 2 CONTACTS

First notification of an emergency typically reported by a member of this group

Dedicated Flight Follower at the Bureau of Land Management, Dept. of Interior

(907) 267-1360

blm_ak_adc_dispatch@blm.gov

↓

Group 2

MUST COMPLETE INFORMATION FORM ON BACK

First person (1.) to notify Horne and Marquist by phone with a follow-up email.

2. CICOES Executive Director
John Horne
jhorne@uw.edu
Notify Ortiz

1. NOAA Emergency Contact
Robyn Angliss
Robyn.Angliss@noaa.gov

Notify Horne and Marquist

CICOES Associate Director
Ivonne Ortiz
ivonne.ortiz@noaa.gov

2. CICOES Safety Manager
Collen Marquist
marquist@uw.edu
Notify Group 3

OARS Reporting
Collen Marquist

https://www.uwb.edu/safety/
Emergency-preparedness/oars

↓

Group 3

Notified by CICOES Safety Manager

Stephanie Harrington, COE Assoc Dean	stephah@uw.edu
Fred Averick, Asst Director	faverick@uw.edu
Abby Zorn, CICOES HR Manager	azorn@uw.edu

Information Required for Emergency Report Communication

Name/Position of person reporting the emergency:

Group 1 reporter: ____________________

Group 2 reporter: ____________________

Location and contact information of person reporting the emergency: ____________________

WHO?
Name of person involved: ____________________

WHEN?
Date and time of the incident: ____________________

WHERE?
Where did the incident occur?

WHAT?
Sequential facts describing what happened: ____________________

HOW?
How is emergency response taking place? ____________________

Further action to be taken: ____________________

FAMILY TO CONTACT?
Injured party's Emergency Contact information: ____________________

UW Fieldwork Health and Safety Plan (COVID Return: Phases 1-2)

Site Information	
Location(s)	*Describe the location(s) of the fieldwork and housing, if different. Attach a work and route plan including address and/or geographic coordinates (i.e., latitude/longitude), as appropriate.* Aerial surveys will take place over the western Beaufort Sea and possibly the eastern Chukchi Sea. Base of operations will be Utqiaġvik, Alaska. Survey team will consist of 2 pilots and 3 scientific crew. Survey team will stay at the King Eider Inn and each crew member will have their own room with bathroom and kitchenette. Please see Appendix_1a_COVID-19 Approval Memo Template_NSB_2020Autumn_Survey_v2 and Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx for more information.
Site Information	*Briefly describe physical conditions of vessel or plane (e.g., expected weather).* The village of Utqiagvik is a small, mostly native Iñupiat community along the Arctic coast. The village has all the necessary infrastructure: aircraft fuel, hotel, hospital, grocery store, etc. The survey aircraft is a small twin engine turbo prop aircraft with seating for 5 people. Surveys will take place only in good weather conditions when it is safe to launch and land the survey aircraft. If inclement, unsafe weather is encountered during flight, an alternate flight path will be taken. The NOAA pilot is responsible for filing a flight plan and has the authority to alter or abort a flight due to weather conditions. Please see Appendix_1a_COVID-19 Approval Memo Template_NSB_2020Autumn_Survey_v2 andAppendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx for more information.
Travel to Site	*How will participants get to the field site? Note any dangerous conditions.* *Please indicate how participants will travel to/from the field in a way that minimizes the spread of COVID-19.* The scientists will travel via Alaska Airlines to Utqiaġvik, AK. The pilots, who are Alaska residents, will travel from Anchorage to Utqiaġvik via the survey aircraft. Please see Appendix_2_NMFS COVID-19 Exposure Assessment Tool v.5(061720)_NSB Survey_v7.xlsx andAppendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx for more information including all COVID-19 precautions.
Site Ownership	*What agency, organization, or individual controls access to your vessel(s) or plane(s)?* Name: Clearwater Air, Inc Address: 1100 Merrill Field Dr, Anchorage, AK 99501 Email: andrew.harcombe@clearwaterair.com

Site Access	*Are there any particular restrictions or challenges to accessing the point of departure or taking flight? Make special note if isolated or remote.* *Please make sure to obtain written confirmation from the property owner or responsible agency if the vessel(s) or plane(s) are not accessible by the public during research. In addition, once your fieldwork has been approved, you should receive an authorization letter on university letterhead. Make sure all members of the field team have a copy of this authorization letter and it can be made available upon request.* Is/are the vessel(s) or plane(s) used by the public, or do you have written confirmation of your ability to access the vessel or plane? ☐Open to the public ☐Written confirmation of access ☒ N/A Are there access restrictions related to COVID-19 mitigation measures that exceed those of the University of Washington? ☐Yes ☒ No If yes, have you integrated these measures into this COVID EH&S plan? ☐Yes ☒ No The survey aircraft is owned by a private company, Clearwater Air, and will be contracted by the North Slope Borough specifically for these surveys. Once the survey plane is in Utqiaġvik, only the survey crew (2 pilots; and 3 scientists: Amy Willoughby and Amelia Brower, CICOES; Megan Ferguson, NOAA Federal employee) will have access to the aircraft. The entry point for the survey crew access the airstrip and aircraft is a short walk across the street from the hotel where the crew will be staying to a gated fence, for which the crew will have the access code. This entry point to the airstrip requires no interaction or contact with airport personnel.
Environmental Hazards	*Describe any dangerous wildlife, insects or endemic diseases, etc. that participants may encounter. Note intended mitigation measures and discuss prior to trip.* Polar bears are rare visitors to town, and the North Slope Borough Dept. of Wildlife Management uses scare tactics to chase bears out of town as soon as a bear is reported. All survey crew are versed in bear avoidance strategies and are aware of their surroundings while walking. Bear noise deterrents are available for use. People in town leave their cars unlocked so anyone needing shelter will have it.
International	☐Register your travel with the UW International Travel Registry for location-specific travel alerts and emergency/travel assistance contacts. In addition, encourage all members of your field team to register themselves with the U.S. Department of State Smart Traveler Enrollment Program. ☐Review the UW Office of Global Support guidance on import/export controls, transportation of specialized equipment, and data security must be considered. All official travel outside the U.S. by UW employees is restricted during Phase 1. Staff researchers may apply for an exceptional waiver to the current official travel restrictions if their travel is endorsed as essential by their Dean/s and the UW Office of Research. Check the U.S. State Department travel site for current travel alerts and to look up the security rating. Contact the UW Global Travel Security Manager at travelemergency@uw.edu or 206-616-7927 for international travel consultations. NA

Security	*Personal safety risks and conduct expectations during both work and free time should be considered and discussed in advance (e.g., alcohol or drug use, leaving the group, situational awareness, sexual harassment, and local crime/security concerns). Review expectations and set the tone for a safe, successful trip. In addition, describe any current travel alerts or restrictions. Note intended mitigation measures; discuss with field team prior to trip.* The science crew has been working together and conducting surveys out of Utqiaġvik for 6-12 years and are familiar with the culture and safety of the village. Expectations of personnel conduct are documented in the ASAMM Observer Manual (the 44 MB doc can be made available upon request). A mandatory pre-survey virtual training for all survey members will occur prior to the scientists' departure for Utqiaġvik, and will cover any new information, including COVID-19 safety procedures and survey protocols. Protocols will be documented as an appendix to the ASAMM observer manual. Any changes that occur during the field season will be communicated among survey team members and documented in a revised version of the ASAMM observer manual.
No Go Criteria	*What are the possible conditions under which approach to - or activities at - the site should be stopped or canceled? e.g. heavy rains, electrical storms, snow, temperatures > 100 degrees, within 2 hours of high tide, wave heights over 1 meter, field team readiness, etc.* The science team will travel via Alaska Airlines to Utqiaġvik, AK on the scheduled day of departure. If inclement weather prevents travel from Seattle, then travel will proceed on any following day when the weather clears. If inclement weather delays the team in Anchorage or Fairbanks, the team will try and wait at the airport until the next available flight; however, if the next available flight isn't until the next day, the team may need to seek out lodging in town. All precautions will be taken to find lodging that is following strict cleaning and sanitizing protocols to reduce the chance of being exposed to COVID-19. The survey aircraft does not launch when weather conditions at the airport are below minimum visibility standards set by the airport, or when conditions are predicted to be below minimums while the aircraft is out surveying. An alternate airport landing is required in case airport conditions at the base of operations are not conducive to landing, and enough fuel is always reserved in order to divert to the alternate airport. Cloud ceilings need to be a minimum of 1100 ft in the survey area to conduct surveys at an altitude of 1,000 ft. In the event of an emergency landing and potential overnight in Deadhorse, the team will take all precautions to find lodging that is following strict cleaning and sanitizing protocols to reduce the chance of being exposed to COVID-19. ☒*During COVID-19 Phase 1, the [LINK: Returning to Research Involving Fieldwork Decision Tree] must be completed. If the questions in the Decision Tree cannot be answered Yes or N/A at any point during the project, the fieldwork may not proceed.* UW is now in Phase 2. The Phase 2 Decision Tree (attached as Appendix A) was consulted, and Yes can be answered for all questions: 1b, 1d, and 2-4 a-d. A confirmed or suspected case of COVID-19 by any personnel involved in the survey would stop or cancel operations.
Expected Weather	*Note extreme conditions that could impact the trip or require additional planning, (e.g. high heat, wind, rain, snow, approaching storm).* The survey aircraft will not launch in extreme weather conditions as mentioned above.
Drinking Water Availability	☒ Plumbed water available ☐Water cooler with ice provided ☐Bottled water provided ☐Natural source and treatment methods (e.g. filtration, boiling, chemical disinfection):
Additional Considerations	

Insurance	**Equipment Insurance:** All equipment is owned by the federal government or Clearwater Air, Inc, and covered by their insurance. **Travel Insurance:** All team members have personal medical insurance and will purchase supplemental travel insurance to cover extra medical costs (e.g., medevac) if deemed necessary.

Emergency Services and Contact Information			
Local Contact	Robert Suydam, Robert.Suydam@north-slope.org	**University Contact** Not on trip. Will have a copy of this plan.	Ivonne Ortiz, ivonne.ortiz@noaa.gov Collen Marquist, marquist@uw.edu **Frequency of check ins:** Team will check in with Collen Marquist and Ivonne Ortiz via email once per week.
Lodging Location	King Eider Inn, 1752 Ahkovak St, Utqiaġvik, AK 99723, 907-852-4700		
Local Emergency Number	911		
Emergency Medical Services	Samuel Simmonds Memorial Hospital, 7000 Uula St, Utqiaġvik, AK 99723, 907-852-4611 SSMH is a certified Level IV Trauma Center https://arcticslope.org/ssmh-now-certified-as-level-iv-trauma-center/#:~:text=Julie%20Rabeau%2C%20Trauma%20Program%20Manager,a%20Level%20IV%20Trauma%20Center.		
Nearest Emergency Department	*Evacuation plan and transportation options to the nearest Emergency Department; include estimated transport time, contact information and driving directions from the site to the nearest provider of emergency medical care. Attach map with specific directions.* Samuel Simmonds Memorial Hospital, 7000 Uula St, Utqiaġvik, AK 99723, 907-852-4611 Appendix 3 is a map of the route from King Eider Inn to hospital. The Marine Mammal Laboratory and Clearwater Air will have vehicles in Utqiaġvik that can be used for transport.		
Cell Phone Coverage	**Primary Number:** Amelia Brower, Amy Willoughby **Coverage:** spotty **Nearest location with reliable coverage:** The best phone number to reach us is the landline at the King Eider Inn: 907-852-4700, and ask to be transferred to one of our rooms.		
Satellite phone/other device	**Device carried?** ☒yes ☐no **Type/number:** Iridium 9555, phone number: 8816 2244 0629 **Location/access:** This satellite phone is carried in the aircraft emergency ditching bag and will only be turned on in an emergency ditching scenario. This phone number will also be shared with Clearwater Air, Robyn Angliss (NOAA AFSC MML CAEP Program Lead).		

Nearby Facilities	*What facilities are available at or near the site: restrooms, water, gas, public phone, store? If none, where are the nearest services along the route?* During Phase 1, in order to minimize the risk of spreading COVID-19 to or from the field team, visits to nearby facilities should be minimized and done only to support field operations. Members of the field team who visit facilities away from the field site(s) or otherwise interact with individuals outside of the field team must: ● Maintain social distancing of at least 6 feet at all times; ● Wear appropriate PPE (e.g., disposable gloves, masks, goggles); and ● Wash or sanitize their hands thoroughly prior to and after each visit. UW is now in Phase 2. The survey crew will have all necessary facilities in their hotel rooms. Please see Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx for more details.
Side Trips	*Are side trips planned or allowed during free time? Before or after the planned activities? Are there restrictions, specific rules, or expected code of conduct?* During Phase 1, in order to minimize the risk of spreading COVID-19 to or from the field team, there should be NO recreational side trips away from a field site. The response above should be "None". UW is now in Phase 2. Please see Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx for details on sheltering in place while in the field.

Participant Information	
Field Team/ Participants	Primary Field Team Leader: Megan Ferguson, NOAA Federal employee Secondary Field Team Leader: Amelia Brower, CICOES ☒ Field Team/Participant list is attached and includes training documentation See Appendix 4_Science_field_team_participant_list_and_training_documentation.doc Amelia Brower CICOES, UW Amy Willoughby, CICOES, UW Megan Ferguson, AFSC, NOAA ☐Other attachment The field team should be reduced to the minimum number necessary to safely carry out the work. Field team consists of 5 people (2 pilots, 3 scientists), which is the minimum number necessary to conduct these aerial surveys.
Physical Demands	*List any physical demands required for this trip and training/certification provided. (e.g. diving, swimming, flying, heights, confined or restricted spaces, etc.* Surveys take place inside a small airplane cabin and time aloft can be up to 6 hours. Each member of the science crew has at least 6 years of experience conducting these surveys and all crew are very comfortable in this environment.
Mental Demands	*List any unique mental demands required for this trip, e.g. long travel days, high stress environments, different cultural norms, etc.* Surveys take place inside a small airplane cabin while flying offshore over the Arctic Ocean. Ample and sufficient emergency gear are brought on board, and each member of the science crew has at least 6 years of experience conducting these surveys and are very comfortable in this environment.

Lone Worker	Is anyone working alone? ☐Yes ☒ No *If yes, describe a communications plan with strict check-in procedures (daily at a minimum) and actions to be taken in the event of a failure to establish contact when expected. If cell coverage is unreliable, a satellite communication device and/or personal locator beacon must be carried.*
First Aid Training	UW policy (APS 10.5) requires that all academic and/or research field teams must include at least one person with valid first aid certification. The level of first aid training required will depend on the type of activity the team is pursuing; the location; and the availability, response time, and means of communication by and with emergency response units. *List team members trained in first aid, type of training received (e.g., First Aid, CPR, Wilderness First Aid), and date of certification. Attach copies of first aid certifications to this plan.* Appendix 4a_Amelia Brower – Wilderness First Aid & CPR Training, valid through April 2021 Appendix 4b_Amy Willoughby – First Aid Training & CPR, valid through August 2022 Megan Ferguson – First Aid Training & CPR, valid through July 2022
Packing List	☒ Attach a copy of the packing list for COVID prevention for your field team/participants, including information on who is responsible for providing specific supplies and/or PPE as applicable. See Appendix 5 Packing list for COVID prevention.doc
Immunizations or Required Medical Evaluation	For travel-related immunizations or medical advice, contact UW Travel Medicine 6-8 weeks in advance of departure. Consultations include country-by-country analysis of project itinerary and anticipated activities. *List required immunizations/prophylaxis or required medical evaluation, if applicable.* NA
Participant Emergency Contact Information	While the University cannot require field participants to provide current emergency contact information and proof of medical insurance, PIs are encouraged to request this information from all field trip participants so that they have the information on hand to give to medical providers if the field team participants are not able to do so themselves. This information should be: 1) treated as confidential (i.e., locked, limited access and distribution); 2) accessed and shared only with health providers during an emergency; and 3) shredded immediately upon completion of the trip. ☐ Check box if optional Emergency Contact Information/Medical Information Forms have been collected. *If yes, describe security measures to be taken to ensure information is kept confidential and available to be used by medical personnel in the event of an emergency.* Emergency contact information will be shared with project lead, Megan Ferguson, who will keep information confidential. CICOES employees' Workday emergency contact information is up to date.

Attestations of Health	Fieldwork involving local travel to field site from home ● Participants should follow the same protocols for daily attestations of health as UW researchers going into a UW facility (i.e., daily attestations of well-being through Workday or other communications with a supervisor if Workday is not an option) ● Personnel who feel ill may not participate in fieldwork and should notify their supervisor that they are unable to do so. In addition, if a member of their household develops symptoms of illness they must stay home and self-quarantine according to current CDC recommendations. Fieldwork involving travel to a remote field site for longer than one day ● Members of the field team who exhibit any symptoms of illness within 96 hours prior to departure MUST stay home. ● Field team leaders should request attestations (See Appendix XXX) immediately prior to departure before allowing field team members to participate. ● Field Team leaders should incorporate daily in-person health check-ins. If internet is available at hotel, then UW workday attestations should be filled out each day. If not available, then a form with a signature, witness, and date will be used for the daily attestation. The COVID-19 Symptom Attestation Prior to Departure for Fieldwork Involving Overnight Travel.docx will be emailed immediately prior to departure. Daily Workday Attestations will take place. Please see Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx and Appendix_2_NMFS COVID-19 Exposure Assessment Tool v.5(061720)_NSB Survey_v7.xlsx for covid-19 testing, symptoms of illness, and daily health check plans.
Use of Virus Testing	Fieldwork involving travel to a remote field site for longer than one day ● Participants and members of their household should self-isolate for at least 14 days prior to departure. ● If virus testing is available and approved for use by EH&S, this guidance may be modified at the approval of a health-care professional and the testing protocols. The survey crew will follow guidelines and requirements set by the NOAA Office of Marine and Aviation Operations, the state of Alaska, and the North Slope Borough. Scientists will shelter in place four days prior (OMAO guidelines) to being tested on the 5th day for COVID-19 within 72 hrs of traveling to Utqiaġvik (State of Alaska requirements https://covid19.alaska.gov/travelers/). Upon arrival in Utqiaġvik, scientists will shelter in place for 4 days, will be tested for COVID-19 via drive thru at the local hospital on day 5 after arrival (OMAO guidelines), and will continue to shelter in place until receiving a negative test result. Per the state of Alaska requirements, scientists will be tested again for COVID-19 between 7-14 days after arrival in Utqiaġvik. See Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9 and Appendix_1a_COVID-19 Approval Memo Template_NSB_2020Autumn_Survey_v2 for more information.
Activities, Equipment, and Supplies	
Research Activities	*Briefly describe the goal of your field operations, e.g. collection of samples, observation of animals/environment, equipment repair and maintenance, drones, etc.* Aerial surveys will be conducted in the western Beaufort Sea to sight and document location, group size, habitat, and activities of bowhead whales and all other marine mammals detected. Please see Appendix_1a_COVID-19 Approval Memo Template_NSB_2020Autumn_Survey_v2 for more information.

Field Transportation	*What vehicles will be used during field operations? e.g. chartered boat, car, truck with trailer, chartered plane or helicopter, etc.* Clearwater Air Turbo Commander aircraft NOAA truck Clearwater Air vehicle *Who is authorized to operate/use each vehicle?* Clearwater Air, Inc. is authorized to operate the aircraft and the Clearwater Air vehicle. NOAA and CICOES employees are authorized to occupy the aircraft and Clearwater Air vehicle. NOAA and CICOES employees are authorized to operate the NOAA truck. NOAA, CICOES, and Clearwater employees are authorized to occupy the truck. The driver is responsible for wiping down common touch areas and keys. Masks will be worn when more than one person is in a vehicle ***Briefly describe additional transportation logistics that have been added in response to COVID-19. Vehicles should be single-occupancy to the extent possible and PPE/masks and goggles should be used when they aren't.*** Please see Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx and Appendix_2_NMFS COVID-19 Exposure Assessment Tool v.5(061720)_NSB Survey_v7.xlsx for detailed commercial airline and survey plane protocols. To summarize, during transit between Seattle and Utqiaġivk, personnel will wear a face mask and goggles or a face shield, will frequently wash hands or use hand sanitizer, and will maintain at least 6 feet distance from others whenever possible. While on the Alaska Airlines aircraft, personnel will wear a face mask and goggles or a face shield, and will frequently sanitize surfaces around their seating area. No one outside the survey team will be allowed in the NOAA truck, the Clearwater Air vehicle, or the survey aircraft. Before entering the NOAA truck and Clearwater Air vehicle at the beginning of a drive, all surfaces will be wiped down. Before the start of each survey flight, one survey team member will be assigned to wipe down all surfaces on the survey aircraft.
Research Tools	*Briefly describe tools or equipment that will be used to access the research site or during research activities, and training to use or operate tools.* ● Field crew members should be assigned individual field equipment (e.g., GPS units, binoculars, laptops, clipboard, and other miscellaneous field gear) for the duration of the field season to the extent possible. ● Prior to use, field equipment should be cleaned with a disinfecting cleaner (no less than 70% isopropyl alcohol). Equipment should be sanitized again before it is returned at the end of the field season. ● If at any time there is a need to share equipment, crew members should wipe down the equipment first with disinfecting cleaner (no less than 70% isopropyl alcohol) and thoroughly wash their hands afterward. *Briefly describe additional tool/equipment logistics added in response to COVID-19.* Additional precautions in response to COVID-19 include: assigning crew members individual field equipment for the duration of the field season, frequently sanitizing high-touch areas, and frequent hand washing.
Other Research Hazards	*Describe other potential research-associated hazards that involve non-research crews and operators that handle shipped research materials, use common climbing equipment and rigging, share confined spaces, and assist with equipment delivery, placement, recovery, etc.* See Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx for protocols (e.g., only survey crew will be allowed in the survey aircraft, all equipment will arrive to Utqiaġvik with survey personnel or on the survey aircraft, etc.)

Personal Protective Equipment	Required: *If PPE is expected to be provided by the participant, it should be included in the attached packing list.* Additional recommended items: gloves, long pants, hats. Keeping a distance (at least 6 feet) from other people is our best protection against COVID-19; however, wearing a mask and goggles can add another layer of protection, especially if you must be inside with others. Masks can help protect others by containing respiratory droplets when the mask wearer coughs, sneezes or speaks. Face coverings must not interfere with other PPE (e.g., eye shields), required for safety and must be compatible with all safety requirements. An entry point for the virus is through the eyes so any eye protection, especially in confined spaces including commercial travel, is recommended. Individual PPE should be assigned to each member of the field team. *Describe when/how PPE is to be stored, used, cleaned, and disposed of as well as training on appropriate PPE use that will be done prior to use.* Please see Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx and Appendix_2_NMFS COVID-19 Exposure Assessment Tool v.5(061720)_NSB Survey_v7.xlsx for detailed use of PPE. To summarize, personnel will maintain at least 6 feet distance from other people whenever possible, wear face masks when there is any chance of coming within 6 feet of other people, wear goggles or a face shield while on the Alaska Airlines aircraft, and frequently wash hands with soap and water (when available) or use hand sanitizer. ☒ Attach a copy of the list of PPE required to safely implement your field work that will be provided by the PI/Supervisor. Goggles and disposable gloves should be included on this list. As adequate supplies become available, surgical, N95 and KN95 may be used. KN95 masks can be an alternative than cloth masks. PPE should be purchased in advance to confirm availability prior to departure and the location of supplies should be announced to all team members. See Appendix_5_Packing_list_for_COVID_prevention.doc
	Briefly describe the supplies needed to support the fieldwork, both for research and support functions (e.g., food, water, toilet paper). Indicate what will be brought from the point of departure and what will be acquired in the field. • Cleaning wipes, hand sanitizer and soap should be provided by the PI/Supervisor. • Review the EH&S Cleaning and Disinfection Resources to help select appropriate disinfection products, including the use of EPA-registered disinfectants, and the manufacturer's instructions for safe and effective use of all cleaning and disinfection products. Contact EH&S at ehsdept@uw.edu or 206-543-7262 with questions about cleaning and disinfection procedures. • Note that disinfectant wipes solution is an alkyl quaternary ammonium compound which cannot be made at home despite U-tube videos on the subject. Please see Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx and Appendix_2_NMFS COVID-19 Exposure Assessment Tool v.5(061720)_NSB Survey_v7.xlsx for necessities and use of cleaning equipment. ☒ Attach a copy of a list of COVID-19-related cleaning/disinfecting supplies required to safely implement your field work. These products should be purchased in advance to confirm availability and the location of supplies should be announced to all team members. Please see Appendix_5_Packing list for COVID prevention.docx.
First Aid Supplies	An emergency first aid kit should be available to the entire field team at all times. Location and description of group medical/first aid kit(s): *Who is carrying it, where is it stored? Brief description of contents.*

	The first aid kit is located in the emergency ditch bag and is carried on the plane. The kit contains gauze, bandages, bandage tape, pain medications, motion sickness medication, SAM splint, syringe, and super glue. If a field team member requires urgent medical attention, emergency services should be called immediately. For COVID-19 daily monitoring, first aid kits must include non-contact thermometers and/or personal thermometers and pulse oximeters that can be sanitized between uses. If a member of the field team requires immediate first aid that cannot be self-administered, another crew member may assist. All members of the field team involved in the emergency response (including the injured party) will sanitize their hands prior to and after care and wear personal protective equipment (e.g., gloves, face masks, goggles). Each team member will have a personal thermometer that will be used to take their temperature at the beginning of each day.
Cleaning and Sanitizing Procedures	*Briefly describe the cleaning and sanitizing procedures and responsibilities for all members of the field team. Description should include expectations regarding equipment, common spaces, food preparation/clean-up/storage, and actions that should be taken to mitigate spread of illness.* ● In alignment with public health recommendations, field teams should undertake enhanced cleaning and disinfection procedures. Increase the frequency of cleaning and disinfecting, focusing on high-touch surfaces in common areas, restrooms, etc. Increased frequency of cleaning and disinfecting with attention to these areas helps remove bacteria and viruses, including the novel coronavirus. Identify all high touch surfaces in communal spaces and disinfect them before and after use, and daily at a minimum. ● Schedule any communal use equipment such that appropriate cleaning can take place before and after use. ● Participants should be able to wash their hands often with soap and water, for at least 20 seconds, or use hand sanitizer that contains at least 70% alcohol if soap and water are not available. See Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx and Appendix_2_NMFS COVID-19 Exposure Assessment Tool v.5(061720)_NSB Survey_v7.xlsx for detailed cleaning protocols. To summarize, personnel will wipe down their hotel room upon arrival. Housekeeping will enter hotel rooms only once a week to change linens, clean kitchenettes, and resupply. Personnel will wipe down their hotel room after each weekly cleaning. Personnel will wipe down seating areas in airport waiting areas, on Alaska Airlines jets, in field vehicles, and in the survey aircraft. Personnel will comply with recommendations for frequent hand washing with soap and water, when available, and use of hand sanitizer when hand-washing facilities are not available.

Food and Meals	*Briefly describe how food and beverages will be made available to the field team (including preparation, distribution, and procurement). Indicate what will be brought from the point of departure and what will be acquired in the field.* Fieldwork involving daily travel to field site from home ● Individuals who travel daily to a field site should pack their food/water each day. Provisions should not be shared with other crew members. Fieldwork involving travel to a remote field site for longer than one day ● Where practicable, establish social distancing policies and procedures around meals. ○ Adjust mealtimes to facilitate social distancing while eating. ○ Shift food service operations away from self-service. ○ Participants should wash or sanitize hands before and after meals. Survey team will bring food with them for the first week or two from Seattle by packing coolers and dried goods in their luggage and then will make quick trips to the grocery store for food supplies. Each team member will have their own hotel room with kitchenette to prepare their own food and to dine. Please see Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx for more information.

Campus Contacts	
Primary Department Contacts	*Unit chair/director:* John Horne, CICOES Director, jhorne@uw.edu *Unit Administrator,* Fred Averick, faverick@uw.edu *Other Designated Point of Contact?* Robyn Angliss, CAEP Program Leader These individuals should have access to a copy of your final project Health and Safety Plan.
Environmental Health and Safety (EH&S)	206-543-7262, ehsdept@uw.edu
Report Injuries and Accidents	Report any work-related injury or illness to your supervisor as soon as possible. After reporting the incident to your supervisor, submit a report of the incident within 24 hours to EH&S via the UW's Online Accident Reporting System (OARS). **Call EH&S immediately at 206-543-7262 if the incident involves any of the following:** ● In-patient hospitalization ● Recombinant/synthetic DNA exposure or spill ● Fatality EH&S must immediately report any employee in-patient hospitalization or fatality to Washington State Department of Labor & Industries (L&I). Do not move any equipment involved in the incident until EH&S receives clearance from L&I. **Outside of EH&S business hours (8:00 a.m. to 5:00 p.m., Monday to Friday), call the UW Police Department (UWPD) at 206-685-UWPD (8973). UWPD will notify an EH&S on-call staff member.**
Reporting Cases of COVID-19	If a member of the field team shows any symptoms of COVID-19 infection, they should be isolated from all other members of the field team and contact local health providers. If a health-care provider has confirmed or suspects that a UW-affiliated member of the field team has COVID-19, the individual should notify the field team and UW EH&S Employee Health Center at covidehc@uw.edu or 206-685-1026 for tracking and contract tracing.

First Aid Reference – COVID-19 Signs & Symptoms Relevant to Conditions of Proposed Fieldwork

<table>
<tr><th>Signs & Symptoms</th><th>Treatment</th><th>Response Action:</th></tr>
<tr><td>COVID-19
People with COVID-19 have had a wide range of symptoms reported – ranging from mild symptoms to severe illness.

Symptoms may appear 2-14 days after exposure to the virus and may include:
● Cough
● Shortness of breath or difficulty breathing
● Fever
● Chills
● Muscle pain
● Sore throat
● New loss of taste or smell

The UW Coronavirus website and CDC are resources for current lists of COVID-19 symptoms.</td><td>If members of the field team begin experiencing symptoms while in the field, they should avoid all contact with other members of the field team. Describe specific isolation plans for individuals who exhibit mild symptoms of COVID-19 and evacuation plans for individuals exhibit symptoms of concern or must otherwise leave the field site.

Additional UW guidance on health, wellness, and prevention FAQs can be found on the UW COVID-19 webpage: https://www.washington.edu/coronavirus/

Please see COVID-19 RTOW Checklist v.3(06.09.20)_Ferguson_Brower_Willoughby_v7.xlsx for information on possible COVID exposure or symptoms protocols.</td><td>When to Seek Emergency Medical Attention

Look for emergency warning signs* for COVID-19. If someone is showing any of these signs, seek emergency medical care immediately:
● Trouble breathing
● Persistent pain or pressure in the chest
● New confusion
● Inability to wake or stay awake
● Bluish lips or face

*This list is not all possible symptoms. Please call a medical provider for any other symptoms that are severe or concerning to you.

Members of the field team who develop a suspected or confirmed case of COVID-19 should report it to UW EH&S Employee Health (206-685-1026 or emphlth@uw.edu) for public health follow up.</td></tr>
</table>

Signature of PI/Supervisor:

I acknowledge this COVID-19 health and safety plan has been prepared for fieldwork under my supervision.

Name	Signature	Date	Phone Number
Ivonne Ortiz			

Field Team/Participant Roster - Training Documentation

I understand that this Project COVID-19 Health & Safety Plan is intended to document COVID-19 hazard assessments, communication plans, emergency procedures, and training requirements for the proposed fieldwork. This plan identifies precautions and actions to be taken to address and mitigate those hazards, to significantly mitigate the risk of COVID-19 exposure and transmission, but is not a substitute for self-isolation for individuals who may have concerns about their health or that of others. I verify that I have read this COVID-19 Fieldwork Prevention Plan, understand its contents, am voluntarily participating in the fieldwork, and agree to comply with its requirements.

Name/Contact Information	Signature	Date	Training Completed[1]
Amelia Brower amelia.brower@noaa.gov		8/6/2020	Wilderness First Aid – Apr 2019 CPR – Apr 2019 Aircraft Ditch & Helicopter Emergency Egress Device Training – Feb 2020 Cold Water Survival – Jun 2010
Amy Willoughby amy.willoughby@noaa.gov		8/19/2020	First Aid – will be completed prior to field season CPR – will be completed prior to field season Aircraft Ditch & Helicopter Emergency Egress Device Training – Feb 2020 Cold Water Survival - 2014
Megan Ferguson NOAA Federal employee megan.ferguson@noaa.gov			First Aid – July 2020 CPR – July 2020 Aircraft Ditch & Helicopter Emergency Egress Device Training – May 2018 Cold Water Survival – taken at NOAA

[1] All research field teams must include at least one individual with valid first aid certification.

UW Fieldwork Health and Safety Plan (COVID Return: Phases 1-2)

Appendices

1) Work and Route Plan
   Appendix_1a_COVID-19 Approval Memo Template_NSB_2020Autumn_Survey_v2 .doc

2) Map with specific directions to closest Emergency Department
   Appendix 3 Map from King Eider Inn to Utqiaġvik hospital.doc

3) Participant packing list
   Appendix_4_Science Field Team participant list and training documentation.doc

4) First Aid Training Certification(s)
   Appendix 4a_Amelia_.Brower_Wilderness_FirstAid_Certificate_validthrough_04-2021.doc
   Appendix_4b_Amy_Willoughby_FirstAid_CPR_AED_Certificate_validthrough_08-2022.pdf

5) List of PPE provided by PI/ Supervisor
   Appendix 5_Packing list for COVID prevention.doc”

6) Supplemental COVID-19 supply list (e.g., hand sanitizer, soap, disinfecting products)
   Appendix 5_Packing list for COVID prevention.doc

7) Supplemental Safety Plans, as applicable (e.g., small boats, diving)
   Appendix_1b_COVID-19 RTOW Checklist v.3(06.09.20)_CAEP_v9.xlsx
   Appendix_2_NMFS COVID-19 Exposure Assessment Tool v.5(061720)_NSB Survey_v7 .xlsx

8) COVID-19 Symptom Attestation Prior to Departure for Fieldwork Involving Overnight Travel
   See following page.

Appendix 8. COVID-19 Symptom Attestation Prior to Departure for Fieldwork Involving Overnight Travel

The following text should be sent by email to a field team leader by all members of the field team immediately prior to departure for fieldwork involving overnight travel. Daily attestations in Workday should be made for fieldwork that is conducted by daily travel to the site from the participants' homes. Members of the field team who do not submit attestations are not allowed to participate in fieldwork.

In the last 96 hours, have you experienced any of the following symptoms:

- A new **fever** (100.4 F or higher) or a sense of having a fever?
- A new **cough** that you cannot attribute to another health condition?
- New **shortness of breath** that you cannot attribute to another health condition?
- A new **sore throat** that you cannot attribute to another health condition?
- New **muscle aches** that you cannot attribute to another health condition or that may have been caused by a specific activity, such as physical exercise?
- New **respiratory symptoms**, such as sore throat, runny nose/nasal congestion or sneezing, that you cannot attribute to another health condition?
- New **chills or repeated shaking with chills** that you cannot attribute to another health condition?
- New **loss of taste or smell** that you cannot attribute to another health condition?

If you are sick or have one or more of the above symptoms:

- You must stay home and cannot participate in the fieldwork until at least 72 hours after the time when your symptoms improve and your fever goes down without the use of fever-reducing medication.
- Follow your department's procedure for calling out sick or requesting to work from home.
- Contact your health care provider for medical guidance.
- Follow the guidance on the FAQ What do I do if I feel sick? at the UWs Novel coronavirus & COVID-19 facts & resources webpage.

By sending this email, I attest that

I have read the above statement YES

and

I attest that I do not have any of the above symptoms. YES

and

I have not knowingly been in contact with COVID-19 cases or high-risk regions for at least 14 days. YES

Signed,

Amelia Brower
Research Scientist, CICOES

Amy Willoughby,
Research Scientist, CICOES

COVID-19 Return to Work Checklist v.3(06.09.20)_CAEP_v10

FMC: Alaska Fisheries Science Center							
Completed By:			**Date Completed:**				
Approved By:			**Date Approved:**				
COVID-19 Return to On-Site Work (RTOW) Checklist			*Version 3 (6/09/20)*				
While many of Fisheries missions and supporting activities can continue with no or limited mission impact under these conditions, many cannot. Fisheries must have a deliberate approach to resuming and optimizing all missions that considers mission risks and impacts and the risk to Fisheries staff. Each FMC must complete the following check list prior to transitioning activities and personnel on-site.			Need for Gating Period	Need for Phase 1	Need for Phase 2	Need for Phase 3	
GENERAL PREPAREDNESS	**Y/N/NA**	**Comments**					
Have you assessed which missions need to return to on-site work using the Reintegration Mission Analysis Flowchart?	Yes	This work cannot be done remotely and alternate technology is not available. Not conducting this work will result in the loss of crucial information needed for managing the Western Arctic bowhead whale, which is an endangered marine mammal stock that is part of an important aboriginal subsistence hunt.	x	x	x	x	
Do employees have the appropriate equipment/tools and work assignments to telework full time?	Yes	As mentioned above, the aerial surveys cannot be conducted remotely. However, there will be down time in the field due to shelter-in-place/COVID-19 testing and bad weather days. Employees do have the appropriate equipment and tools to telework from Utqiaġvik during that down time.	x	x	x	x	
Have you established entering sites policies and protocols such as prior approval, hand washing/sanitizing prior to or immediately after entering site, face mask requirements, etc.?	Yes	The survey team (3 scientists and 2 pilots) will follow strict health and sanitation policies.	x	x	x		
Is your site able to implement NOAA guidances?	Yes	Scientists and pilots will ensure they follow NOAA guidance.	x	x	x	x	
Are you communicating regularly with your employees on status of worksites and missions?	Yes	Prior to the field season, we regularly communicate developments among all members of the survey team via telephone or email. During the field season, communication will continue via either in-person communication, telephone, or email.	x	x	x	x	
FACILITY PREPAREDNESS							
Access Control							
Does your facility(s) have an access control Plan?	Yes	Clearwater Air survey aircraft pilots are residents of the State of Alaska. Clearwater pilots will depart for Utqiaġvik only after receiving a negative COVID-19 test result; pilots will shelter-in-place (see definition) from 5 days prior to testing (OMAO guidelines) until departing Anchorage for Utqiaġvik. Pilots will avoid commercial travel by traveling to Utqiaġvik onboard the survey aircraft. If required by the North Slope Borough, after arriving in Utqiaġvik, pilots will be tested for COVID-19 and will shelter-in-place until receiving a negative test result. Scientists will shelter-in-place 5 days prior (1 day more than OMAO guidelines) to being tested for COVID-19 which will occur within 72 hrs. of traveling to Utqiaġvik (State of Alaska requirements https://covid19.alaska.gov/travelers/). Upon arrival in Utqiaġvik, scientists will shelter-in-place for 5 days, will be tested for COVID-19 on day 5 after arrival (OMAO guidelines), and will continue to shelter in place until receiving a negative test result. Per the state of Alaska requirements, scientists will be tested again for COVID-19 between 7-14 days after arrival in Utqiaġvik.	x	x	x		

If a leased space, have you gathered information from facility owners regarding plans to control building access, and clean and disinfect the workplace?	Yes	King Eider Inn - The King Eider Inn is a small hotel with approx. 20 rooms. They have increased cleaning and disinfecting of common areas, limited the number of occupied rooms, performed extra cleaning of rooms, ensured that rooms remain empty for at least 3 days between occupation, and made available in the lobby hand sanitizer and face masks. As in previous years, housekeeping will access private guest rooms only once a week to change linens and conduct other weekly cleaning of the bathrooms and kitchenettes. Survey aircraft - Each survey team member will be assigned a headset and other necessary survey gear (e.g., PPE, clinometers, notebooks, pens) for the duration of the survey season. Survey members will sanitize surfaces using disinfecting wipes at least three times per day, including before and after each flight or whenever survey members change positions in flight. Colville - Site policies and protocols are in place. Access is restricted to employees of Colville and paying customers. All visitors must have and wear their own face masks. Colville employees are required to wear face masks. Hand sanitizer, hand washing sink, soap, and single person bathrooms are available. Visitors must have and wear their own masks.	X	X	X	
Are you restricting or prohibiting non-essential visitors?	Yes	Scientists and pilots will not have visitors to the inn or survey aircraft.	X	X	X	
Do you have a process for determining and approving essential employees and visitors?	Yes	There will be no visitors. The essential employees comprise the two pilots required to fly the aircraft and the three scientists required to collect data. The survey team cannot fully function with fewer people onboard the aircraft for a survey flight.	X	X	X	
Do you have a plan for handling mail and deliveries?	NA	No deliveries are needed. Scientists will travel with their own gear/equipment. Survey equipment will arrive on the survey aircraft.	X	X	X	
Have critical buildings that need on-site operations been identified and appropriate plans set in place?	Yes	Scientists and pilots will access only the inn where they are lodging and Colville aviation fuel station to use the bathroom facility on occasions when refueling is necessary in Deadhorse, Alaska. Appropriate COVID-19 health and safety plans have been set in place and will be clearly explained to all survey members during pre-season and in-season training and debriefs, as discussed further below. All team members will maintain flexibility to implement any necessary changes to COVID-19 health and safety plans that might arise during the field operations.	X	X	X	
Physical Distancing						
Have you established physical distancing measures within the facility(s)?	Yes	Each survey team member will have their own room at the inn. Survey team members have multiple years of experience conducting aerial surveys with each other from the field site, allowing for morning meetings to take place remotely (i.e., via telephone or email) from their individual rooms. During survey, space on the aircraft does not allow for social distancing; however, the survey team will constitute a bubble. At all times, the survey team will follow CDC guidelines for wearing face masks and maintaining appropriate physical distance from individuals who are not on the survey team.	X	X	X	X
Have you considered reconfiguring/restricting spaces to facilitate physical distancing?	No	The seating and observing windows cannot be reconfigured on the Aero Commander aircraft. Survey team members will minimize time spent in common areas at the inn, restricting time in those areas to only transiting between their private rooms and outside the inn.		X	X	
Have you closed all breakrooms, kitchen spaces, conference rooms, and teaming areas?	Yes	At the inn, each survey team member will have their own private room with kitchenette, bathroom facilities, and workspace. Team meetings will no longer take place in person in the common area of the inn, but instead will be held via phone calls while survey team members are in their private rooms. Survey team members will minimize time spent in common areas at the inn, restricting time in those areas to only transiting between their private rooms and outside the inn.	X	X	X	
Have you determined how to use stairwells, elevators, restrooms, and other physically compact spaces? (i.e. limiting use of elevators to allow for physical distancing or making stairwells one directional)	Yes	At the inn, survey team members will transit between the first and second floors via the inn's infrequently-traveled side stairwell while wearing masks to minimize risk of exposure from, and encounters with, other guests. (There is no elevator at the inn.) The only opportunity to use a public restroom will be at Colville aviation fuel station, which has two single-occupancy, completely enclosed restrooms. Survey members will not eat at restaurants; instead, they will cook in their private kitchenettes at the inn.		X	X	X
Have staggered employee schedules and/or seating to promote physical distancing?	Yes	Scientists and pilots will be together only when in the survey aircraft. Meetings will not be held in person. Furthermore, the survey team will constitute a bubble.			X	

Have you placed Plexiglas or other barriers to limit contact in areas such as guard stations, receptionist areas, customer service greeting areas, etc?	NA		X	X	X	
Have you reassessed the flow patterns throughout the building to allow for reduced contact and discourage congregation?	Yes	When returning to or leaving the inn, scientists and pilots will have access to a separate entrance/exit to avoid the main lobby if it's occupied and social distancing is not possible. Survey team members will transit between the first and second floors via the inn's infrequently-traveled side stairwell while wearing masks to minimize risk of exposure from, and encounters with, other guests.			X	
Do you have proper signage and floor markings in place?	NA		X		X	X
Sanitation and Cleaning						
Are handwashing stations with soap and water or hand sanitizer available in common areas?	Yes	King Eider Inn - Hand sanitizer and masks are available in the lobby. For hand washing, scientists and pilots will use facilities in their private rooms. Survey aircraft - Hand wipes and hand sanitizer will be available. Colville - Colville empoyees are required to wear face masks. Hand sanitizer, hand washing sink, soap, and single person bathrooms are available. Visitors must have and wear their own masks.	X	X	X	X
Have you consult with your janitorial contractor about the level of cleaning that may be needed in your facility? If the building has been empty, normal cleaning and sanitizing may be all that is needed. If the building has been occupied or partially occupied, more thorough cleaning and disinfection may be desirable.	Yes	King Eider Inn - The King Eider Inn is a small hotel with approx. 20 rooms. They have increased cleaning and disinfecting of common areas, limited the number of occupied rooms, performed extra cleaning of rooms, ensured that rooms remain empty for at least 3 days between occupation, and made available in the lobby hand sanitizer and face masks. As in previous years, housekeeping will access private guest rooms only once a week to change linens and conduct other weekly cleaning of the bathrooms and kitchenettes. Survey aircraft - Clearwater Air will completely disinfect all surfaces in the survey aircraft according to EPA guidelines prior to its arrival in Utqiaġvik for the start of the field work.	X	X		
Are cleaning protocols in place that comply with CDC and EPA guidance to clean high touch common areas? (e.g. 3x per day)	Yes	King Eider Inn - Following CDC and EPA guidance. Survey aircraft - Each survey team member will be assigned a headset and other necessary survey gear (e.g., PPE, clinometers, notebooks, pens) for the duration of the survey season. Survey members will sanitize surfaces using disinfecting wipes at least three times per day, including before and after each flight or whenever survey members change positions in flight. Colville - Following CDC and EPA guidance.	X	X	X	X
Do you have protocols in place that comply with CDC and EPA guidance to clean contaminated spaces?	Yes	King Eider Inn - CDC and EPA guidance will be followed. They are waiting 3 days before following CDC and EPA guidance and then allowing the room to sit for another 3 days following cleaning and disinfecting of contaminated rooms. They also have UV lights that would be utilized. Survey aircraft - CDC guidance will be followed as outlined on their webpage for Cleaning and Disinfecting Your Facility, which includes all surface types: https://www.cdc.gov/coronavirus/2019-ncov/community/disinfecting-building-facility.html. EPA: "First, clean the surface or object with soap and water. Then, disinfect using an EPA-approved disinfectant external icon. If an EPA-approved disinfectant is unavailable, you can use 1/3 cup of bleach added to 1 gallon of water, or 70% alcohol solutions to disinfect. Do not mix bleach or other cleaning and disinfection products together. Bleach solutions will be effective for disinfection up to 24 hours. Find additional information at CDC's website on Cleaning and Disinfecting Your Facility." Also available is a 6 Step Process which we have downloaded as a PDF https://www.epa.gov/sites/production/files/2020-04/documents/disinfectants-onepager.pdf. Colville - CDC and EPA guidance will be followed.	X	X	X	X

Do you have plan in place to close off any areas used for prolonged periods of time by the sick person? It is recommended by CDC to wait 24 hours before cleaning and disinfecting.	Yes	In the event someone gets sick with suspected COVID-19 or if a survey team member is notified via contact tracing of possible exposure, the surveys will stop, all members of the survey team will quarantine in their rooms and will follow local, state, and CDC guidance for determining when it is safe to be around others again (https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/end-home-isolation.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fprevent-getting-sick%2Fwhen-its-safe.html). Medical attention will be sought if symptoms become severe.	x	x	x	
Will personnel be responsible for cleaning their work areas?	Yes	King Eider Inn - All survey personnel will thoroughly sanitize surfaces in their private rooms at the inn upon arrival in Utqiaġvik. Survey aircraft - Clearwater Air will completely disinfect all surfaces in the survey aircraft according to EPA guidelines prior to its arrival in Utqiaġvik for the start of the field work. Survey members will sanitize surfaces using disinfecting wipes at least three times per day, including before and after each flight or whenever survey members change positions in flight.		X	X	X
Do you have nitrile gloves and EPA approved cleaning supplies available for personnel to use?	Yes	Scientists will travel with nitrile gloves and EPA-approved disinfectant wipes and hand sanitizer while in transit between Seattle and Utqiaġvik. A supply of nitrile gloves, EPA-approved disinfectant wipes, and hand sanitizer will be stored in survey team members' rooms at the inn. The survey plane will also carry nitrile gloves and EPA-approved disinfectant wipes and hand sanitizer.		X	X	X
Do you have proper signage to promote hand hygiene and cleaning in place?	NA		X	X	X	
Ventilation and Equipment						
Have you replaced all filters in the Facility HVAC system?	Yes	King Eider Inn has replaced their entire HVAC system (in 2020) and has replaced all filters. Colville has replaced all filters in their HVAC system.			X	
Have you considered general ventilation adjustments, such as increasing ventilation and increasing amount of outdoor air used by the HVAC system, opening windows and doors, or other methods e.g. fans?	Yes	King Eider Inn rooms have opening windows; fans are available upon request.			X	
Has idle equipment been properly stored or are there plans to provide proper maintenance to idle equipment?	NA		X	X		
Does critical infrastructure such as data centers and networks have proper facility services and maintenance in place?	NA		X	X		
MISSION ACTIVITY and EMPLOYEE READINESS						
Have you completed a COVID-19 Exposure Potential Assessment for each mission/activity?	Yes	See accompanying spreadsheet with detailed responses and protocols.	X	X	X	
Have you implemented engineering and administration mitigation strategies to reduce potential exposure for each activity to the maximum extent possible?	Yes	Scientists will be flying to Utqiaġvik on Alaska Airlines, with a short layover in Anchorage. Sea-Tac and Anchorage airports have implemented protocols to maintain the health, safety, and well-being of their employees, travelers, and community members. Alaska Airlines has taken preventative measures to reduce the spread of COVID-19 with their "Next-Level Care", including limiting the number of travelers per flight. The State of Alaska has travel restrictions in place that apply to all non-resident travelers, including requiring a negative test result or pending results from a test taken within 72 hours prior to arrival in Alaska. Risk of exposure while conducting the aerial survey is low, given the COVID-19 shelter-in-place and testing protocols detailed above. Furthermore, the survey team will comprise a "bubble" and will follow CDC recommendations regarding face masks, hygiene, and physical distancing. The King Eider Inn is a small inn (approx. 20 rooms) operating at a reduced capacity. Scientists and pilots will be able to wear PPE while swiftly navigating between the inn's main entrance or alternate side entrance and their private rooms. Survey members will keep a log of contacts to aid in contact tracing should someone fall ill or be notified of possible exposure by contact tracing.	X	X	X	

Have you determined what COVID-19 PPE is needed based on specific job tasks?	Yes	PPE (masks, face shields or goggles, gloves) will be provided.	X	X	X			
Have you provided and trained personnel on required PPE?	Yes	Training on COVID-19 safety procedures and survey protocols will be mandatory for all survey members and will occur prior to travel. Additional safety briefings will be held during the field season if recommended procedures or protocols change.	X	X	X			
Do you have guidance in place for vehicle travel, minimize number of occupants in the vehicle is highly recommended?	Yes	While traveling on Alaska Airlines and through airports, all possible safety precautions will be followed, e.g., wearing face masks/shields/goggles, frequent hand washing and sanitizing, sanitizing surfaces near seating areas, and practicing social distancing to the maximum extent possible.	X	X	X			
COMMUNCIATION								
Do you have a communication and training plan in place for keeping personnel, tenants, etc. informed of new processes, policies, etc.?	Yes	A mandatory pre-survey virtual training for all survey members will occur prior to the scientists' departure for Utqiaġvik. The training will cover COVID-19 safety procedures and survey protocols. Protocols will be documented as an appendix to the ASAMM observer manual. Any changes that occur during the field season will be communicated among survey team members and documented in a revised version of the ASAMM observer manual.	X	X	X	X		
Is there an established training session(s) to teach employees about the new policies, procedures, etc.?	Yes	Once all survey team members have received their ultimate negative COVID-19 test results in Utqiaġvik, a one-time mandatory in-person safety training session will be held at the survey aircraft. This training session will cover COVID-19 safety protocols and aircraft safety and emergency protocols.	X	X	X	X		
MEDICAL PREPAREDNESS								
Have you established screening protocols?	Yes	Scientists will be tested for COVID-19 on the day that corresponds to 5 days after sheltering-in-place (1 day more than OMAO guidelines) and within 72 hrs. prior to traveling to Alaska (State of Alaska regulations). Scientists will be tested for COVID-19 again 5 days (1 day more than OMAO guidelines) after arriving to Utqiaġvik, and again 7-14 days after arriving in Utqiaġvik (State of Alaska regulations). In Utqiaġvik, COVID-19 testing is available as a drive-through service by the hospital and also at the airport. Upon arrival in Utqiaġvik, scientists will shelter-in-place until they receive their ultimate COVID-19 test results. Survey aircraft pilots are residents of the State of Alaska. Prior to flying to Utqiaġvik, pilots will be tested for COVID-19 after 5 days of sheltering in place; pilots will continue to shelter-in-place from the time of testing until departing Anchorage for Utqiaġvik. Pilots will fly to Utqiaġvik only after receiving a negative test result. Pilots will avoid commercial travel by traveling to Utqiaġvik onboard the survey aircraft. If required by the North Slope Borough, after arriving to Utqiaġvik, pilots will be tested for COVID-19 and will shelter-in-place until receiving a negative test result. Scientists and pilots will take their temperatures and complete an online COVID-19 self-evaluation screening each morning.	X	X	X	X		
If there are multiple tenants in the building, have you determined who is leading and coordinating this effort?	Yes	Megan Ferguson (NOAA/AFSC, Research Fisheries Biologist) and the Clearwater Air Pilot in Command are responsible for all logistical coordination of the survey and aircraft.	X	X	X	X		
If you have security, have you coordinated and modified security procedures as necessary to implement your screening protocols?	NA		X	X	X	X		
Do you have a plan in place for contact tracing when an employee is suspected or confirmed to have COVID-19?	Yes	Survey members will keep a log of contacts to aid in contact tracing should someone fall ill or be notified of possible exposure by contact tracing.	X	x	x	X		
Have you encouraged sick workers to stay home?	Yes	A worker will not leave for the field if they are feeling sick. Once in the field, if a worker begins feeling sick, they will quarantine in their hotel room.	X	X	X	X		

Are supervisors' aware of reporting protocols for symptomatic personnel? (NOAA - SECO reporting tool)	Yes	Robyn Angliss (NOAA/AFSC/CAEP Program Leader) and Megan Ferguson (NOAA/AFSC, Research Fisheries Biologist) are aware of the Employee Reporting of Coronavirus (COVID-19) Illness or Potential Exposure form, which is to be filled out and submitted by affected Employee (or their supervisor, if the employee is unable to submit). Robyn and Megan have the COVID-19 Notification Process Checklist, which can also be accessed at https://sites.google.com/a/noaa.gov/afsc-home/home/covid-19 (see COVID Resources>NOAA checklist for Covid-19 reports) or at https://drive.google.com/file/d/1MM_nJ1Rw7ISaYGXMFyH3b-0-guQVpvDT/view. The link for the reporting tool is within the notification checklist and can be accessed directly at https://docs.google.com/a/noaa.gov/forms/d/e/1FAIpQLSet4_rylOnUb2Q6isEROIvpkQI1EZtwLb7RuDzQyaGctz2dsQ/viewform	x	x	x	x		
Are supervisors' aware of the COVID-19 Notification Process Checklist?	Yes	Robyn Angliss (NOAA/AFSC/CAEP Program Leader) and Megan Ferguson (NOAA/AFSC, Research Fisheries Biologist) have a copy of the Checklist, Potential Case of COVID-19 (maintain employee confidentiality at all times) form updated on March 19 2020.	x	x	x	x		
Do you have a plan in place to separate those who become ill while on-site?	Yes	In the event someone gets sick with suspected COVID-19 or if a survey team member is notified via contact tracing of possible exposure, the surveys will stop, all members of the survey team will quarantine in their rooms and will follow local, state, and CDC guidance for determining when it is safe to be around others again (https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/end-home-isolation.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fprevent-getting-sick%2Fwhen-its-safe.html). Medical attention will be sought if symptoms become severe. The hospital in Utqiaġvik has an emergency room with a Level IV Trauma Center which is open 24/7 for evaluation, care, and advanced trauma life support.	x	x	x	x		
Do you have an emergency contact list and protocols in place for personnel?	Yes	An emergency contact list for all survey participants will be shared among the survey team. In the event anyone contracts COVID-19, emergency contacts will be notified. Information shared will be voluntary and scientists will defer to Robyn Angliss for the Notification Process Checklist to ensure that confidentiality is maintained.	x	x	x	x		

NMFS COVID-19 Exposure Assessment Tool v.5(061720)_NSB Survey_v8

FACILITY:	DEPARTMENT:	ACTIVITY NAME:	ANALYSIS BY:	
Alaska Fisheries Science Center, King Eider Inn, and Clearwater Air Inc. aircraft	AFSC/Marine Mammal Laboratory	North Slope Borough Aerial Surveys of Bowhead Whale Fall Migration	<Name(s)>	
			DATE OF ANALYSIS: <date>	
			Approved By: <Name>	
			DATE OF APPROVAL: <date>	

GENERAL NOTES:

The proposed activity includes preparation for, and participation in, the North Slope Borough Aerial Surveys of Bowhead Whale Fall Migration. Scientists will have to prepare equipment at the Marine Mammal Laboratory (can be done by themselves), travel to and from Utqiaġvik, Alaska (this will include flying on Alaska Airlines, a brief airport layover, and overnight stays at an inn while operating from Utqiaġvik), safety briefing at the survey aircraft, and daily surveys (weather permitting) onboard the Clearwater Air Inc. survey aircraft. During surveys, scientists will be responsible for collecting environmental and sighting data on all marine mammals encountered. Note: Encounters during travels are treated as those situations where the scientists directly interact with people.

COVID-19 EXPOSURE ASSESSMENT:

Task	Step Description	Number of people encountered	Duration of the encounter(s)	Proximity to people encountered	Environment of the encounter(s)	Exposure Risk	Mitigation Actions	Comments
1	Prepare field equipment/gear (e.g., test field laptops, pull field equipment [PPE and field gear], and pack gear)	0 - 2	<5 Minutes	far (> 12 FT)	B: Large or well ventilated room	Low	Controlled entry to facility. Wash hands upon arriving to the facility. Maintain social distancing. Face covering to be worn the entire time -- starting and end at car in parking lot. Field equipment/gear is then brought home with the scientist.	
2	Carpool between home and SeaTac airport	0 - 2	<5 Minutes	far (> 12 FT)	C: Enclosed space; OR limited/poor ventilation	Medium	Scientists will carpool from their homes in the Seattle metropolitan airport to SeaTac airport at the start of the trip, and again upon returning home at the end of the trip. Car windows will be opened for ventilation.	Scientists will not use shared-ride services or public transportation (e.g., light rail, buses, shuttles). The only exception is that it may be necessary to take the SeaTac airport underground train between the main terminal and gates located in a satellite terminal. However, scientists will be wearing face masks and either face shields or goggles for the duration of their transit through the airport.
3	Time at duty station airport (SEA) before flight to Utqiaġvik	0 - 2	<5 Minutes	moderate (6 - 12 FT)	B: Large or well ventilated room	Low	Wash hands (or use hand sanitizer, if restroom is not immediately available) upon arrival and frequently throughout the duration of the airport stay. Face covering to be worn at all times. Maintain social distancing. Clean surfaces around seating areas with disinfecting wipes.	1. From Alaska Airlines on limiting contact: More convenience—less contact! With the Alaska app, you can make sure your trip is as smooth and contactless as possible by using it to check in for your flight, generate a mobile boarding pass and more. Effective June 30, 2020, as part of your flight check-in process, you will be asked to complete a health agreement. For your safety and for the safety of others around you, the agreement simply confirms you have not exhibited COVID-19 symptoms in the past 72 hours, have not been in close proximity to someone who has tested positive and will bring and wear a face covering in the airport and on board. 2. From Alaska Airlines on cleaning of check-in lobby and gates: At the airport we've instituted a workstation cleaning program for the check-in lobby counters and gate counters where the surfaces are wiped down with a disinfectant at a frequent cadence. We're working closely with airport janitorial services to ensure the highest level of cleanliness. Please let an agent know if you see something that doesn't meet this standard. 3. Alaska Airlines has floor decals and signage through out their areas to remind people to stay 6 feet apart. 4. Alaska Airlines at the gate: To better allow for personal distancing, boarding procedures have been updated so guests board by row numbers in smaller groups from the back to the front.

4	Fly from duty station airport (SEA) to Utqiagvik, Alaska, with 2-hour layover in Ted Stevens International Airport in Anchorage, Alaska.	3 - 6	>30 Minutes	close (<6 FT)	B: Large or well ventilated room	Very High	Once onboard aircraft, sanitize seating area, seat belt buckles, and tray table. Wash and/or sanitize hands frequently throughout the duration of the flight. Pending seat availability, sit in a window seat to maximize the distance between the scientist and the aisle. Face covering and eye shield/goggles to be worn at all times unless actively eating or drinking. Limit physical contact with people/objects as much as possible. From Alaska Airlines on onboard seating: Through September 30, 2020, we're limiting the number of guests on our flights and blocking seats.	1. From the State Of Alaska on travel restrictions: Starting on August 11 all non-residents must arrive with a negative or pending COVID-19 PCR test result taken within 72 hours of departure. (This means that a percentage of passengers will also have tested negative for COVID-19 within the prior 72 hrs, thus reducing risk of exposure at the gate and onboard.) 2. From Alaska Airlines on cleaning onboard: We've developed and validated enhanced aircraft cleaning procedures with the University of Washington Medical Directors, specializing in Infectious Diseases. Onboard we're using electrostatic disinfectant sprayers, which emit a safe, high-grade EPA cleaning solution that sanitize surfaces (overhead bins, armrests, tray tables, seatbelts, lavatories, etc.). Between flights, a dedicated cleaning crew covers the most critical areas using a high-grade EPA disinfectant. The crew also cleans pilot/flight attendant spaces to keep you and our employees safe. Once complete, our procedures are thoroughly audited by the crew lead, who signs and validates a cleaning certificate. Please note: If you wipe the leather seat with your own cleaning wipe, the blue leather dye color may come off. This doesn't mean it's dirty, it's the active ingredient that is causing the color to come off on the wipe. We're using ATP (adenosine triphosphate) testing, where verification is conducted throughout the cabin to ensure the cleanliness level matches a sanitized environment like a hospital operating room. 3. From Alaska Airlines on air ventilation: Alaska Airlines has one of the newest fleets in the country, which ensures our aircraft have the latest filtration technology in use. Our aircraft are equipped with systems that contain two HEPA (high efficiency particulate air) filters—the same kind found in hospital operating rooms. The HEPA filters are 99.9% effective or greater in removing particulate contaminants, including viruses like COVID-19, and bacteria and fungi from recirculated air. The air flows from the ceiling to the floor and creates completely new air in the cabin 20-30 times an hour (every 2 to 3 minutes). If you want more filtered air, simply open the vent above you. That air is filtered for your seat only.
5	Check into King Eider Inn	0 - 2	<5 Minutes	moderate (6 - 12 FT)	B: Large or well ventilated room	Low	Face covering will be worn at check-in and hands will be washed upon access to room. Survey team member will disinfect all surfaces of room using project-supplied disinfectant.	Scientists have stayed at the King Eider Inn in past years and can arrange for near contactless check-in and check-out.
6	Safety briefing at survey airplane (outside aircraft)	3 - 6	5-30 Minutes	moderate (6 - 12 FT)	A: Outdoors	Medium	Face covering will be worn and social distancing maintained.	This one-time mandatory safety briefing will occur only among survey team members and only after all members of the survey team have received their ultimate negative test result indicating they are COVID-19-free in Utqiagvik. At this point, the survey team will comprise a "bubble".
7	Safety briefing at survey airplane (inside aircraft)	0 - 2	<5 Minutes	close (<6 FT)	C: Enclosed space; OR limited/poor ventilation	Medium	Face covering will be worn and social distancing to maximum extent possible.	This one-time mandatory safety briefing will occur only among survey team members and only after all members of the survey team have received their ultimate negative test result indicating they are COVID-19-free in Utqiagvik. At this point, the survey team will comprise a "bubble".
8	Daily (weather permitting) survey flights	3 - 6	>30 Minutes	close (<6 FT)	C: Enclosed space; OR limited/poor ventilation	Very High	Each morning, scientists and pilots will complete a NOAA/OMAO COVID-19 Isolation Surveillance Form and take their temperatures; they will self-report any COVID-19 related symptoms. Scientists and pilots will wear face masks while transiting between their hotel rooms and the aircraft. Surfaces will be disinfected at least three times per flight, including whenever survey members change position and at the beginning and end of each flight. Scientists and pilots will be the only people allowed onboard the survey aircraft. Aircraft air vents that blow outside air into the cabin will remain open at all times.	Wearing face masks during survey would considerably interfere with effective communication of sighting data and in-flight logistics over headset radios. However, the survey team will comprise a "bubble", so there will be minimal chances for transmitting COVID-19 among members of the survey team. Survey team members will also maintain a log of interactions with people outside of the survey team, to assist in contact tracing measures in the event someone were to become ill.
9	Refueling at Colville aviation fuel center as needed	0 - 2	<5 Minutes	moderate (6 - 12 FT)	B: Large or well ventilated room	Low	Face covering, hand washing, and social distancing to maximum extent possible.	
10	Infrequent trip to grocery store	0 - 2	<5 Minutes	moderate (6 - 12 FT)	B: Large or well ventilated room	Low	Face covering, hand sanitizing, and social distancing to maximum extent possible.	Each team member will have a private kitchenette room. Personnel will bring coolers of food and non-perishables with them to Utqiagvik to last through the initial sheltering-in-place; non-perishables can continue to be used throughout the field trip. No team member will eat at any restaurants; however, some restaurants offer delivery or take-out services and those will be acceptable as long as team members follow social distancing, personal hygiene, and face covering protocols. We expect to need to go to the grocery store only infrequently.
11	Time at Utqiagvik airport before return flight to duty station airport	0 - 2	<5 Minutes	moderate (6 - 12 FT)	B: Large or well ventilated room	Low	Wash hands after check-in and wait outside until boarding begins (note that security check does not occur until you are physically boarding the aircraft). Face covering to be worn at all times. Maintain social distancing, when possible.	1. Scientists will walk to airport from the inn. 2. From Alaska Airlines on limiting contact: More convenience—less contact! With the Alaska app, you can make sure your trip is as smooth and contactless as possible by using it to check in for your flight, generate a mobile boarding pass and more. Effective June 30, 2020, as part of your flight check-in process, you will be asked to complete a health agreement. For your safety and for the safety of others around you, the agreement simply confirms you have not exhibited COVID-19 symptoms in the past 72 hours, have not been in close proximity to someone who has tested positive and will bring and wear a face covering in the airport and on board. 3. From Alaska Airlines on cleaning of check in lobby and gates: At the airport we've instituted a workstation cleaning program for the check-in lobby counters and gate counters where the surfaces are wiped down with a disinfectant at a frequent cadence. We're working closely with airport janitorial services to ensure the highest level of cleanliness. Please let an agent know if you see something that doesn't meet this standard. 4. Alaska Airlines has floor decals and signage through out their areas to remind people to stay 6 feet apart. 5. Alaska Airlines at the gate: To better allow for personal distancing, boarding procedures have been updated so guests board by row numbers in smaller groups from the back to the front.

12	Fly from Utqiaġvik to duty station airport with 2.5-hour layover in Fairbanks, Alaska.	3 - 6	>30 Minutes	close (< 6 FT)	B: Large or well ventilated room	Very High	Once onboard, sanitize seating area, seat belt buckles, and tray table. Wash and/or sanitize hands frequently throughout the duration of the flight. Pending seat availability, sit in a window seat to maximize the distance between the scientist and the aisle. Face covering and eye shield/goggles to be worn at all times unless actively eating or drinking. Limit physical contact with people/objects as much as possible.	1. From Alaska Airlines on **cleaning onboard**: We've developed and validated enhanced aircraft cleaning procedures with the University of Washington Medical Directors, specializing in Infectious Diseases. Onboard we're using electrostatic disinfectant sprayers, which emit a safe, high-grade EPA cleaning solution that sanitize surfaces (overhead bins, arm rests, tray tables, seatbelts, lavatories, etc.). Between flights, a dedicated cleaning crew covers the most critical areas using a high-grade EPA disinfectant. The crew also cleans pilot/flight attendant spaces to keep you and our employees safe. Once complete, our procedures are thoroughly audited by the crew lead, who signs and validates a cleaning certificate. Please note: If you wipe the leather seat with your own cleaning wipe, the blue leather dye color may come off. This doesn't mean it's dirty, it's the active ingredient that is causing the color to come off on the wipe. We're using ATP (adenosine triphosphate) testing, where verification is conducted throughout the cabin to ensure the cleanliness level matches a sanitized environment like a hospital operating room. 2. From Alaska Airlines on **air ventilation**: Alaska Airlines has one of the newest fleets in the country, which ensures our aircraft have the latest filtration technology in use. Our aircraft are equipped with systems that contain two HEPA "This indicates a link to an external site that may not follow the same accessibility or privacy policies as Alaska Airlines. By selecting a partner link you agree to share your data with these sites." (high efficiency particulate air) filters—the same kind found in hospital operating rooms. The HEPA filters are 99.9% effective or greater in removing particulate contaminants, including viruses like COVID-19, and bacteria and fungi from recirculated air. The air flows from the ceiling to the floor and creates completely new air in the cabin 20 - 30 times an hour (every 2 to 3 minutes). If you want more filtered air, simply open the vent above you. That air is filtered for your seat only.
13						#N/A		

APPENDIX C: SAFETY AND LOGISTICS PLAN, 2020

25 August 2020

The North Slope Borough Aerial Surveys of the Bowhead Whale Fall Migration project is co-managed and conducted by the North Slope Borough (NSB) and University of Washington, and funded by NSB. The primary study area covers the western Beaufort Sea, from 140° to 157°W and the coastline to 72°N (Appendix Fig. C1). A secondary study area consists of the eastern Chukchi Sea, from 157° to 169°W and 67° to 72°N. The 2020 field season will begin on 7 September while the survey team shelters in place in Utqiaġvik, Alaska. Surveys will begin on 15 September, are weather-dependent, and will run until 15 October. This safety plan provides information about emergency support services, aviation safety protocols, firearms protocols, and protocols for mitigating risks to project personnel posed by wildlife encounters on the ground.

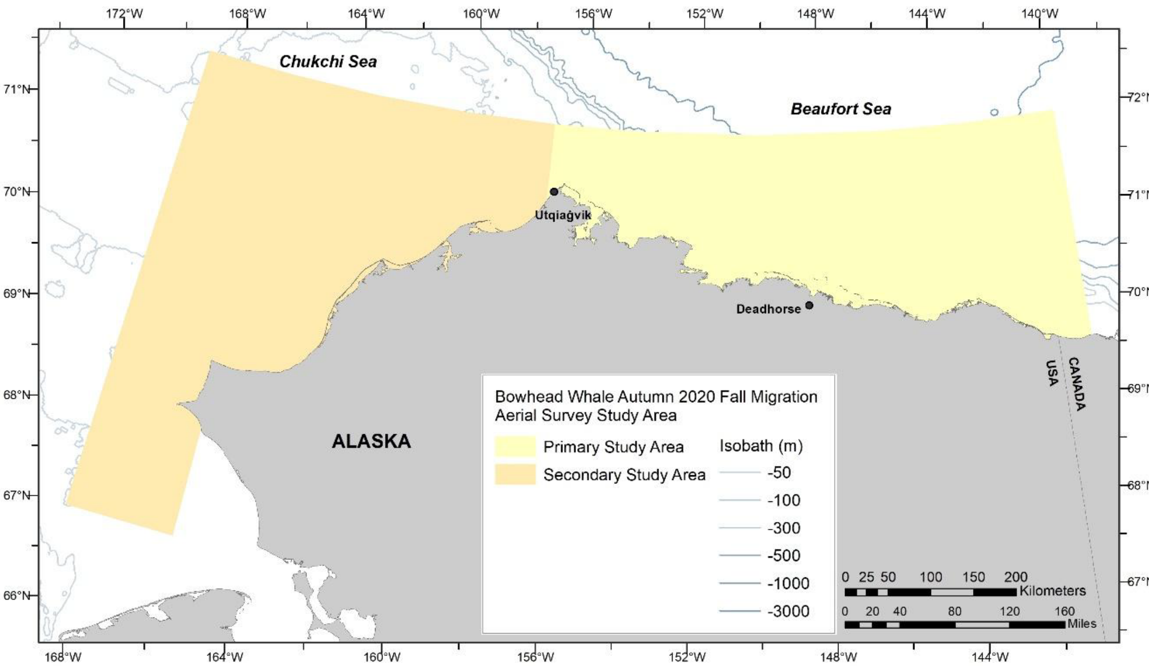
EMERGENCY SUPPORT SERVICES AT THE BASE OF OPERATIONS

The project will operate from its base in Utqiaġvik, located on the North Slope of Alaska (Appendix Fig. C1). Lodging in Utqiaġvik will be provided by the King Eider Inn. One Turbo Commander, operated by Clearwater Air, Inc., will be stationed at the base, and will be available to the project under an exclusive use contract for the duration of the field season. A refueling and emergency alternate landing site is Deadhorse, also located on the North Slope of Alaska.

Primary emergency support services in Utqiaġvik include 9-1-1, the Samuel Simmonds Memorial Hospital, and the North Slope Borough Search and Rescue (NSB SAR) Department. The hospital is an outpatient unit providing emergency clinic and urgent care, including a Level IV Trauma Center with 45 beds and 17 ventilators, among other things. It is open for emergencies 24 hours a day and accepts non-emergency walk-ins until 1630 Alaska Standard Time. It is located at 7000 Uula St., and the phone number is 907-852-4611.

The NSB SAR crew are well-trained and have well-maintained equipment to provide a rapid response. They are available around the clock at 907-852-0401 and 907-852-2822. At the beginning of the field season, the survey team will make contact with the NSB SAR to let them know of our presence and activities, including our aircraft type, call sign, emergency frequencies, contact phone numbers, and map of the study area and survey blocks. This contact has a dual purpose: to introduce our project in the event that we should need assistance and to let NSB SAR know that our aircraft and crew could be available for coordination and assistance should the occasion arise for a SAR effort while we are based in Utqiaġvik.

Medical assistance and emergencies in Deadhorse will be handled by a medical clinic operated by British Petroleum. The clinic is referred to as the "MCC" (main construction camp). MCC can facilitate MedEvac air transfers, triage trauma, and provide a spectrum of acute care, emergency medicine, and first aid. The clinic is open and staffed around the clock, 365 days a year; they are located on oilfield lease land, and their phone number is 907 659 5239. Access to the facility is via the Central Check Point gate, beyond which oil field security will provide an escort to MCC. Deadhorse is also served by the North Slope Borough Police, who can be reached by calling 9-1-1.



Appendix Figure C1. -- Study area, 2020.

Both Utqiaġvik and Deadhorse are served by commercial jets at least once daily, weather permitting. It is also possible that the survey aircraft could be used for an emergency medevac to Anchorage. There are two main hospitals in the Anchorage area, both of which provide emergency services 24 hours a day:

Alaska Regional Hospital
2801 DeBarr Road
Anchorage, AK 99508
907 276 1131

Providence Alaska Medical Center
3200 Providence Drive
Anchorage, AK 99508
907 562 2211

AVIATION SAFETY PROTOCOLS

The aircraft used during the 2020 season will include Turbo Commander (twin turbine, high fixed-wing) aircraft. The Commanders were used by the survey team during previous aerial survey field seasons flown with the same protocols. The aviation safety protocols are based on training, emergency preparedness, flight following, and reporting, as detailed below.

Training

Each person flying on the surveys must have a combination of annual, periodic, and one-time trainings. The field team will be thoroughly briefed on aircraft operations and COVID-19 protocols, will have practiced donning the Ice Commander Immersion Suits, and will participate in aircraft egress drills. The egress drills will allow each team member the opportunity to practice preparing for and surviving an in-air emergency so that everyone onboard the aircraft knows precisely what their responsibilities are in an emergency situation. These trainings will review emergency materials, including use of GPS units, satellite phones, personal locator beacons (PLB), and aircraft and marine band handheld radios.

The Clearwater Air Pilots in Command (PIC) have an average of over 8,500 hours flying experience and considerable experience flying small aircraft in arctic Alaska. All PICs also conduct a comprehensive Flight Risk Assessment (Appendix Fig. C2) as part of survey planning, which incorporates inputs about crew, environment, operations, and aircraft, and allows for inputs from aircraft management.

These NSB surveys will follow NOAA's aviation safety policy, which is available online: (https://sites.google.com/a/noaa.gov/omao-intranet-dev/operations/hq/safety/aviation-safety/safety-training). Annual training for personnel participating in NOAA aerial surveys includes reviewing three of NOAA's aviation safety modules: 1) NOAA Aviation Policy and Procedures; 2) Basic Aviation Safety and Survival; and 3) Aviation Health. In addition, NOAA requires all personnel participating in aerial surveys to complete a water ditching, safety, and survival course once every 5 years; AFSC policy is more stringent, requiring this training once every 3 years due to the remote and harsh environments that our field teams operate in. This survey follows AFSC's guidelines for ditching certification. Aerial survey personnel may optionally be trained in the use of helicopter emergency egress devices. Aerial survey personnel must be current in first aid and Cardiopulmonary Resuscitation training. Finally, all aerial survey personnel who conduct NOAA operations in cold environments must have training in aviation safety and cold weather survival.

Under NOAA policy, one-time flights are possible for non-egress-trained guests and must be pre-approved by Project Management, a NMFS Aviation Safety Officer, and Clearwater Air. Individuals requesting to participate in a survey must have a mission-applicable reason (e.g., representatives from the NSB, BOEM, NMFS, Alaska Department of Fish and Game, U.S. Geological Survey). Survey flights will not be altered to suit the needs of guests (e.g., flying to specific areas for sightseeing), and all guests must be made aware that the flight may last in excess of five hours.

Emergency Preparedness

Emergency preparedness for survey flights will be achieved by wearing appropriate clothing, maintaining and having access to necessary emergency gear, being knowledgeable about aviation safety risks, feeling comfortable voicing safety concerns, and having reliable protocols in place that will be followed in the event of an emergency.

During surveys, all personnel onboard the aircraft will wear either flight or dry suits and be outfitted with Switliks or other personal floatation devices containing emergency equipment. Onboard safety equipment will include an impact-triggered emergency locator transmitter (ELT) installed in the aircraft, an 8-person search and rescue life raft equipped with an emergency survival kit, PLB, portable marine and aviation band transceivers, satellite telephone, flares, immersion suits, battery fire containment bag, and helicopter emergency egress breathing devices. The emergency satellite telephone and radios will be charged and tested at the beginning of each month during the field season. All safety gear will be maintained and inspected according to the manufacturer's instructions.

Risk Assessment Template.xlsx

Clearwater Air **Multi-Engine IFR**

Flight Risk Assessment

PIC: **SIC:** **Aircraft:** **Date:**

For single pilot operations use score in parenthesis.

Crew			Total
≤ 10 Hrs in last 30 days	1(3)	1	1
≤ 2000 hrs TT		1	0
≤ 200 hrs in type	2(4)	1	0
Fatigue (Less than 8 hours of sleep)	2(4)	1	0
Divorce / Separation / Death	2(4)	1	0
Illness requiring medication	2(4)	1	0
Crew Total			1

Aircraft		
Inoperative Instruments (MEL)	1	0
Max Gross T/O Weight	2	2
Aircraft Hangared	-2	0
Preflight deicing required	2	2
Weight and Balance Completed	-1	-1
Aircraft Total		3

Environment		
Departure: Vis ≤3 Miles	3	3
Departure: Vis 3-5 Miles	1	0
Icing Conditions Forecast	2	2
Ice on Runway	2	0
Arrival:Precision Approach Available	-2	-2
Fog in Forecast	3	3
Wind ≥ 20 knots	2	2
Arrival Forecast: ≤ Special VFR	4	0
Arrival: Vis ≤ 3 miles	2	0
Arrival Forecast: Night	2	0
Alternate Forecast: Wx ≤ 5mile vis	4	4
Enviroment Total*		12

***If Enviroment total score is ≥15 weather observer must be used.**

Grand Total	**27**
Go	≤23
Manager Approval	23-34
NO GO	>34

PIC Initials: ______________________

Operations		
2nd Survey Flt of the day (≥5.5 Hrs)	3	0
Late departure (after 5pm)	2	0
Reposition Flight	1	0
Max Endurance Survey Flight	3	3
Survey Altitude ≤ 500 ft	4	0
Offshore ≥ 50 miles	3	3
Circling on Target required	2	2
Near/Over Mountainous Terrain	2	0
New Survey Type	1	0
Slow Flight Required ≤ 115kts	3	3
Remote Fueling	2	0
Operations Total		11

Figure C2. Sample pre-flight Risk Assessment completed prior to every survey flight.

Safety is everyone's responsibility. Aerial survey team members are encouraged to ask questions or voice concerns if they notice any potential safety hazards. Any team member has the right to "call" (i.e., abort) a flight based on questionable weather conditions or other safety considerations.

Every survey flight will be satellite-tracked in real-time by the Automated Flight Following (AFF) system via SpiderTracks (Clearwater Air). AFF is software that automatically tracks the location and velocity of specially equipped aircraft, providing this information in near-real-time to dispatchers, aviation managers, and other authorized users. The equipment includes geolocation and data communication devices that use satellite-based technology. As in 2013-2019, the aviation dispatchers from the Alaska Fire Service, Bureau of Land Management, will provide real-time flight following assistance to the project.

AVIATION SAFETY REPORTING

Clearwater has implemented an online Safety Management System for reporting any safety, security, quality, compliance, or environmental concerns that may arise during the season, which is accessible via a link on the Safety tab on Clearwater's webpage (www.clearwaterair.com). Clearwater management encourages ASAMM personnel to utilize this tool to address any aviation safety concerns. The link for reporting concerns can be found at http://clearwatersms.com/MySafety/PublicIssueReporting.aspx.

Survey personnel have been instructed that, in the event of an incident, hazard, maintenance, or airspace issue, Project Management should be informed immediately.

During a survey flight, if a safety orange object (e.g., life vest, raft, streamer) is sighted or if people are sighted and there is suspicion that they might be in distress (e.g., in the middle of nowhere, waving their arms; smoke signals), survey personnel are instructed to take the following steps:

1. Make a comment in the data to note the position and time of sighting, and include a brief description of what was seen. The pilots will also mark the position on their GPS and, if it is clear that it is an emergency, they will report the sighting to Flight Service.
2. Circle to try to get more information about whether it likely represents a genuine emergency. Descend to a lower altitude and take photographs to get a better look at the scene, if necessary.
3. If it is an emergency and people are in distress:
    a. Contact local Search and Rescue, who have an established protocol for dealing with these situations.
    b. If the survey aircraft has enough fuel to continue circling, do so. For as long as safety will allow, stay in visual contact with the people in order to update rescuers on the location and status of the emergency.
    c. Try to make contact via marine band radio.
4. DO NOT take any measures that would jeopardize the safety of the survey team.

FIREARMS

The survey project does not provide firearms and no personal observer firearms are allowed on the survey aircraft. Clearwater Air pilots may use their discretion regarding whether they bring personal firearms onto the plane. Some of the lodging facilities allow firearms but with special considerations or restrictions. Pilots will inquire prior to the field season as to firearms rules.

GROUND SAFETY AND BEAR AWARENESS

The North Slope is home to two bear species, polar bears and brown bears. Awareness of their presence and behavior is important for personal safety. The survey team has bear deterrent devices for carrying during survey flights or when on the ground. Devices include bear bangers and air horns. Situational awareness is the best form of defense. Field personnel has access to a Bear Awareness and Defense Training Manual on the survey laptops.

In Utqiaġvik, polar bear sightings are common along the beach and, on occasion, in town. While walking around town it is important to remain aware of surroundings and places to take cover, including flagging down anyone in a vehicle. The King Eider Inn managers usually hear the latest on if/where bears are present. If survey personnel think a bear has gone undocumented, they will report it to the local law enforcement authorities.

Brown bears are year-round residents in Deadhorse, and are frequently seen. Walking around Deadhorse is frowned upon, due to the bear presence, industrial activity, and truck traffic in the area. Polar bears are rarely sighted in Deadhorse, are far less habituated to human activity, and may be far more aggressive than resident brown bears. If survey personnel observe any bears anywhere in Deadhorse, they will immediately report the sighting to local law enforcement authorities.

CONTACT INFORMATION

Project Management maintains an updated list of emergency contact information for the team members participating in the surveys. Additional emergency contact information is provided in the master contact list, which is distributed to survey personnel.

APPENDIX D: GIS PROJECTIONS

FOR CALCULATING DISTANCE FROM SHORE VALUES IN THE ACCESS DATABASE

For the Chukchi: "Central_Meridian", -163.0

PROJCS["Chukchi Equidistant Conic",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Equidistant_Conic"],PARAMETER["False_Easting",0.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-163.0],PARAMETER["Standard_Parallel_1",68.5],PARAMETER["Standard_Parallel_2",71.5],PARAMETER["Latitude_Of_Origin",70.0],UNIT["Meter",1.0]]

For the Beaufort: "Central_Meridian", -148.0

PROJCS["Beaufort Equidistant Conic",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Equidistant_Conic"],PARAMETER["False_Easting",0.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-148.0],PARAMETER["Standard_Parallel_1",70.5],PARAMETER["Standard_Parallel_2",71.5],PARAMETER["Latitude_Of_Origin",71.0],UNIT["Meter",1.0]]

FOR CALCULATING DISTANCE FROM SHORE VALUES IN THE BOWHEAD WHALE CENTRAL TENDENCY – ANALYSIS 2

All geospatial data are projected into an Equidistant Conic projection (false easting: 0.0; false northing: 0.0; central meridian: -148.0°; latitude of origin: 70.75°; standard parallels: 69.9°, 71.6°; linear unit: meter [1.0]).

DATA FRAMES IN THE ANNUAL MAPS

Because this is just for cartographic purposes, Universal Transverse Mercator (UTM) is retained and has been used since 2007.
NAD_1983_UTM_Zone_5N
Authority: Custom
Projection: Transverse_Mercator
False_Easting: 500000.0
False_Northing: 0.0
Central_Meridian: -154.0
Scale_Factor: 0.9996
Latitude_Of_Origin: 70.0
Linear Unit: Meter (1.0)
Geographic Coordinate System: GCS_North_American_1983
Angular Unit: Degree (0.0174532925199433)

Prime Meridian: Greenwich (0.0)
Datum: D_North_American_1983
Spheroid: GRS_1980
Semimajor Axis: 6378137.0
Semiminor Axis: 6356752.314140356
Inverse Flattening: 298.257222101

FLIGHTLINES_19.GDB\FLTLN_BYGRID_ASAED:

Flightlines are in a single feature class so have to be one projection. Therefore this equidistant conic covers the Chukchi Sea to Beaufort Sea.

PROJCS["Beaufort-Chukchi Equidistant Conic",GEOGCS["GCS_North_American_1983",DATUM["D_North_American_1983",SPHEROID["GRS_1980",6378137.0,298.257222101]],PRIMEM["Greenwich",0.0],UNIT["Degree",0.0174532925199433]],PROJECTION["Equidistant_Conic"],PARAMETER["False_Easting",0.0],PARAMETER["False_Northing",0.0],PARAMETER["Central_Meridian",-155.0],PARAMETER["Standard_Parallel_1",69.0],PARAMETER["Standard_Parallel_2",71.0],PARAMETER["Latitude_Of_Origin",70.0],UNIT["Meter",1.0]]

MISCELLANEOUS OTHER PROJECTION INFO

When getting actual locations of sightings (XofWhale, YofWhale) the plane’s location is projected to the UTM zone that it falls within before calculating direction and distance to actual location. The projection of the new location point is removed before writing the coordinates to the table.

APPENDIX E: 2020 DAILY FLIGHT SUMMARIES

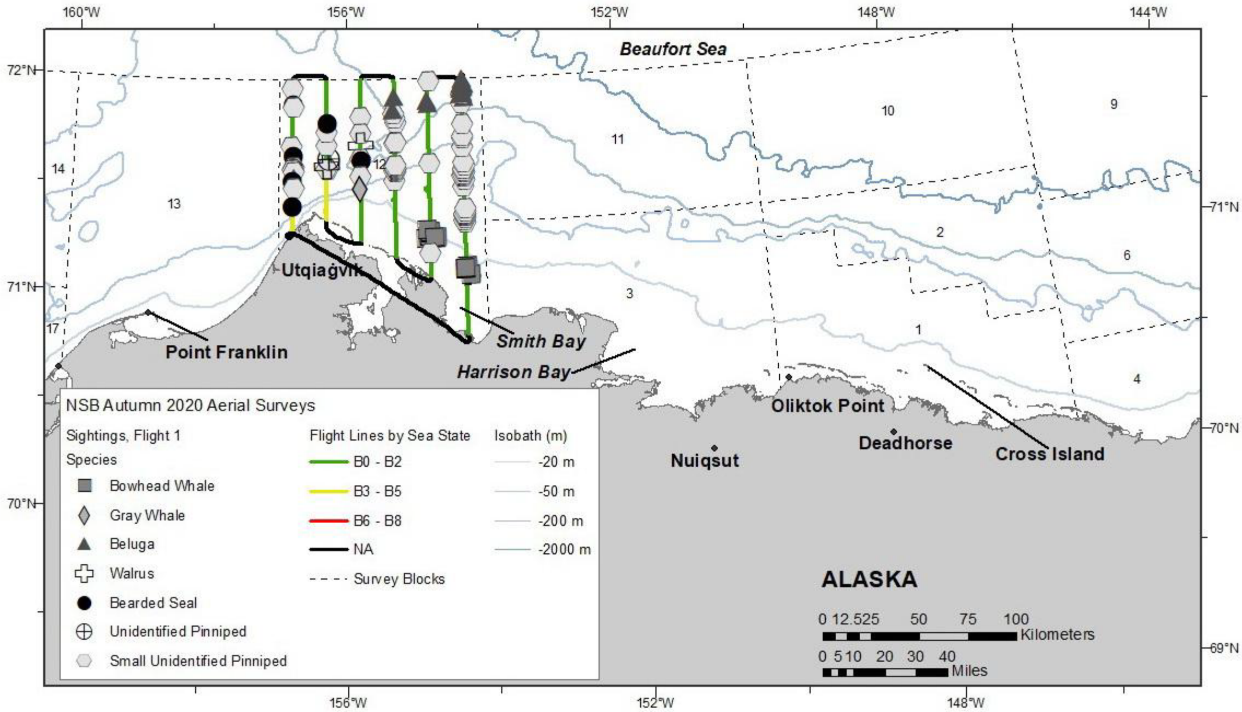
17 September 2020, Flight 1

Flight was a complete survey of transects 129, 130, 131, 132, 133, and 134. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility, with fog, glare, and low ceilings, and Beaufort 1-3 sea states. There was no sea ice in the area surveyed. Sightings included bowhead whales (including one carcass), one gray whale, belugas (including six calves), walruses, bearded seals, one unidentified pinniped, and small unidentified pinnipeds. The bowhead whale carcass was located approximately 5 km east of Point Barrow, Alaska.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
1	9/17/2020 10:44	71.088	154.225	bowhead whale	feed	39	0	12
1	9/17/2020 10:50	71.116	154.303	bowhead whale	.	1	0	12
1	9/17/2020 10:50	71.119	154.298	bowhead whale	.	2	0	12
1	9/17/2020 10:50	71.121	154.287	bowhead whale	.	13	0	12
1	9/17/2020 10:50	71.122	154.299	bowhead whale	.	1	0	12
1	9/17/2020 10:52	71.129	154.266	bowhead whale	swim	1	0	12
1	9/17/2020 10:53	71.117	154.286	bowhead whale	feed	12	0	12
1	9/17/2020 10:53	71.120	154.295	bowhead whale	feed	1	0	12
1	9/17/2020 10:53	71.122	154.278	bowhead whale	feed	1	0	12
1	9/17/2020 10:53	71.117	154.290	bowhead whale	feed	1	0	12
1	9/17/2020 10:53	71.117	154.298	bowhead whale	feed	1	0	12
1	9/17/2020 10:56	71.114	154.280	bowhead whale	feed	12	0	12
1	9/17/2020 11:28	71.914	154.254	beluga	swim	3	0	12
1	9/17/2020 11:28	71.931	154.298	beluga	swim	1	0	12
1	9/17/2020 11:29	71.934	154.299	beluga	swim	13	0	12
1	9/17/2020 11:29	71.934	154.274	beluga	swim	33	6	12
1	9/17/2020 11:29	71.956	154.302	beluga	swim	2	0	12
1	9/17/2020 11:29	71.963	154.302	beluga	swim	5	0	12
1	9/17/2020 11:29	71.963	154.260	beluga	swim	2	0	12
1	9/17/2020 11:30	71.970	154.274	beluga	swim	2	0	12
1	9/17/2020 11:30	71.978	154.258	beluga	swim	3	0	12
1	9/17/2020 11:30	71.979	154.289	beluga	rest	1	0	12
1	9/17/2020 11:30	71.981	154.304	beluga	swim	2	0	12
1	9/17/2020 11:31	72.000	154.286	beluga	swim	1	0	0
1	9/17/2020 11:40	71.907	154.807	beluga	swim	1	0	12
1	9/17/2020 11:40	71.891	154.803	beluga	swim	1	0	12
1	9/17/2020 12:13	71.290	154.804	bowhead whale	feed	1	0	12
1	9/17/2020 12:13	71.281	154.807	bowhead whale	feed	1	0	12
1	9/17/2020 12:13	71.278	154.810	bowhead whale	feed	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
1	9/17/2020 12:13	71.274	154.813	bowhead whale	feed	1	0	12
1	9/17/2020 12:13	71.273	154.815	bowhead whale	feed	1	0	12
1	9/17/2020 12:13	71.271	154.824	bowhead whale	feed	1	0	12
1	9/17/2020 12:13	71.268	154.705	bowhead whale	feed	1	0	12
1	9/17/2020 12:13	71.262	154.851	bowhead whale	feed	1	0	12
1	9/17/2020 12:14	71.259	154.721	bowhead whale	feed	1	0	12
1	9/17/2020 12:17	71.273	154.817	bowhead whale	feed	1	0	12
1	9/17/2020 12:17	71.277	154.810	bowhead whale	feed	1	0	12
1	9/17/2020 12:18	71.274	154.813	bowhead whale	feed	1	0	12
1	9/17/2020 12:19	71.286	154.796	bowhead whale	feed	1	0	12
1	9/17/2020 12:19	71.291	154.802	bowhead whale	feed	1	0	12
1	9/17/2020 12:20	71.301	154.835	bowhead whale	rest	1	0	12
1	9/17/2020 12:25	71.264	154.738	bowhead whale	feed	3	0	12
1	9/17/2020 12:25	71.266	154.727	bowhead whale	rest	1	0	12
1	9/17/2020 13:06	71.863	155.323	beluga	rest	1	0	12
1	9/17/2020 13:08	71.925	155.305	beluga	swim	1	0	12
1	9/17/2020 13:35	71.495	155.803	gray whale	rest	1	0	12
1	9/17/2020 13:50	71.397	156.312	bowhead whale	dead	1	0	12
1	9/17/2020 14:31	71.550	156.766	beluga	swim	1	0	12
1	9/17/2020 14:32	71.543	156.762	beluga	swim	1	0	12



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

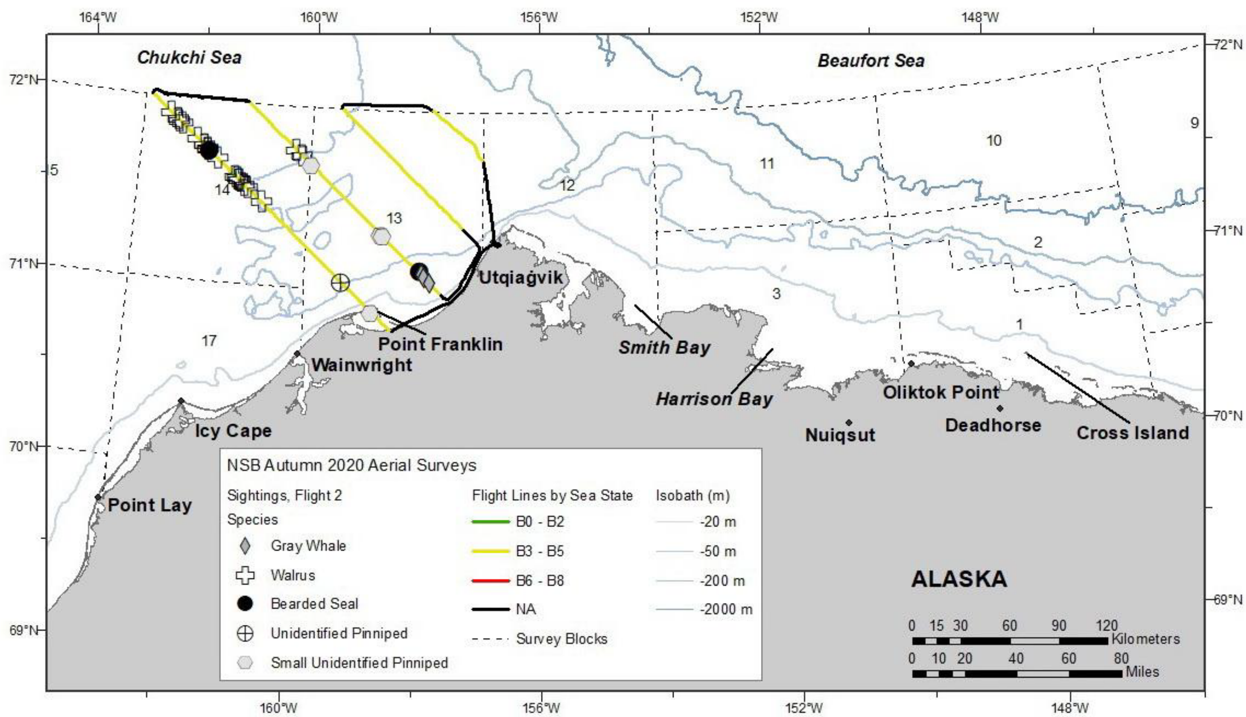
Two bowhead whales skim feeding at the water's surface, one on its side, the other showing only its rostrum, sighted in a feeding aggregation approximately 15 km north of the mouth of Smith Bay, Alaska, on Flight 1, 17 September 2020.

20 September 2020, Flight 2

Flight was a complete survey of transects 1, 5, and 7 and a partial survey of transect 3. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility, with ice on the window, low ceilings, and precipitation, and Beaufort 3-4 sea states. There was no sea ice in the area surveyed. Sightings included gray whales, walruses, bearded seals, one unidentified pinniped, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude °N	Longitude °W	Species	Behavior	Group Size	Calf No.	Block
2	9/20/2020 12:26	71.110	158.016	gray whale	feed	4	0	13
2	9/20/2020 12:29	71.090	157.986	gray whale	rest	2	0	13
2	9/20/2020 12:30	71.088	157.979	gray whale	feed	1	0	13
2	9/20/2020 12:33	71.061	157.892	gray whale	swim	1	0	13



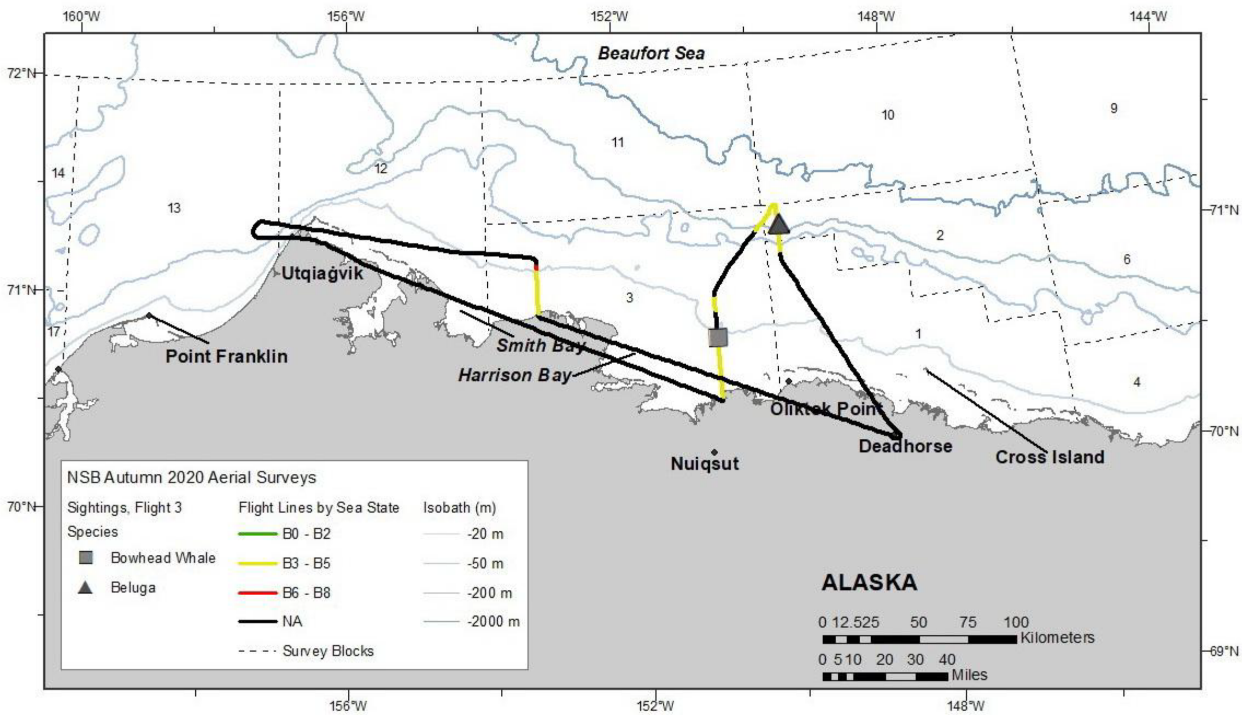
Appendix Figure E-2. -- Flight 2 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

22 September 2020, Flight 3

Flight was a partial survey of transects 120, 122, and 127. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility, with low ceilings and precipitation, and Beaufort 3-6 sea states. There was no sea ice in the area surveyed. Sightings included bowhead whales and belugas.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
3	9/22/2020 14:01	70.746	150.792	bowhead whale	swim	5	0	3
3	9/22/2020 14:21	71.252	149.780	beluga	swim	1	0	2
3	9/22/2020 14:21	71.245	149.780	beluga	swim	1	0	2
3	9/22/2020 14:21	71.245	149.793	beluga	swim	1	0	2
3	9/22/2020 14:21	71.241	149.775	beluga	swim	2	0	2



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

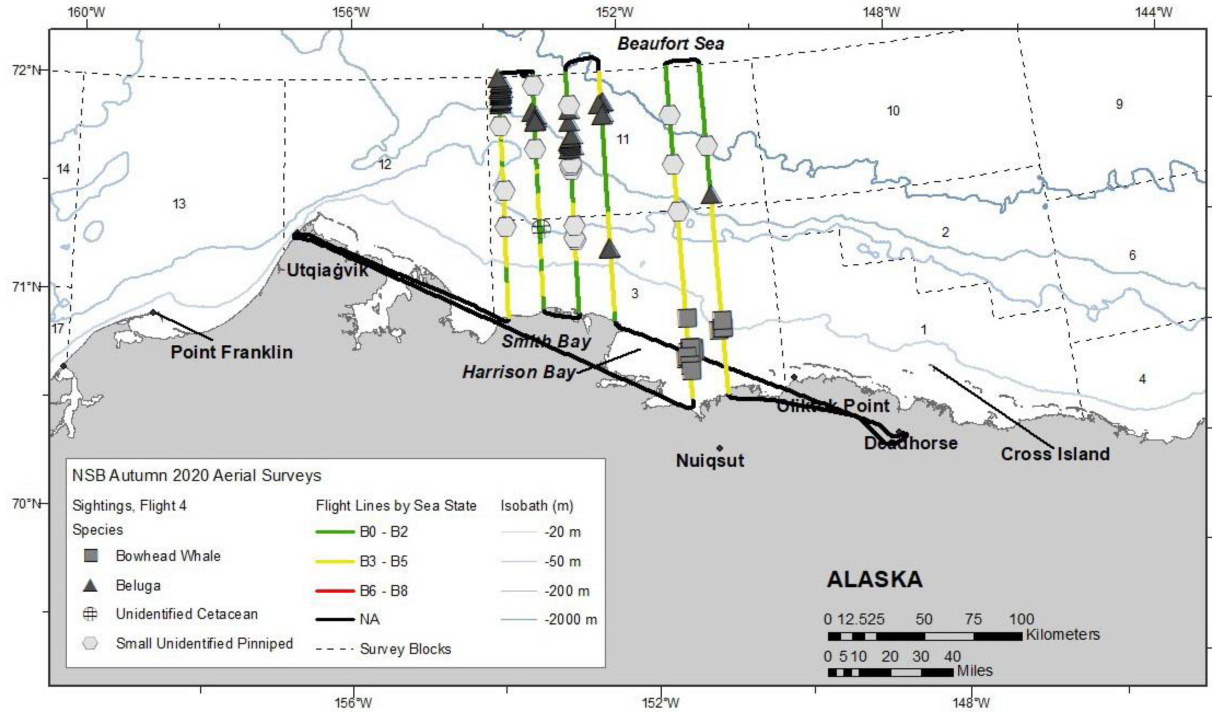
23 September 2020, Flight 4

Flight was a complete survey of transects 122, 123, 125, 126, 127, and 128. Survey conditions included partly cloudy to overcast skies, 0 km to unlimited visibility, with glare, ice on the window, and precipitation, and Beaufort 2-5 sea states. There was no sea ice in the area surveyed. Sightings included bowhead whales, belugas (including 10 calves), one unidentified cetacean, and small unidentified pinnipeds.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
4	9/23/2020 10:02	71.877	153.801	beluga	swim	2	1	11
4	9/23/2020 10:02	71.886	153.797	beluga	swim	7	2	11
4	9/23/2020 10:02	71.889	153.802	beluga	swim	2	0	11
4	9/23/2020 10:02	71.894	153.790	beluga	swim	15	0	11
4	9/23/2020 10:02	71.897	153.789	beluga	swim	1	0	11
4	9/23/2020 10:03	71.914	153.806	beluga	swim	1	0	11
4	9/23/2020 10:03	71.916	153.795	beluga	swim	1	0	11
4	9/23/2020 10:03	71.923	153.790	beluga	swim	4	0	11
4	9/23/2020 10:03	71.928	153.791	beluga	swim	6	0	11
4	9/23/2020 10:04	71.933	153.778	beluga	swim	1	0	11
4	9/23/2020 10:04	71.935	153.790	beluga	swim	1	0	11
4	9/23/2020 10:04	71.947	153.758	beluga	swim	1	0	11
4	9/23/2020 10:04	71.948	153.812	beluga	mill	7	0	11
4	9/23/2020 10:04	71.956	153.796	beluga	swim	2	1	11
4	9/23/2020 10:05	71.966	153.772	beluga	swim	1	0	11
4	9/23/2020 10:05	71.972	153.775	beluga	rest	1	0	11
4	9/23/2020 10:05	71.978	153.799	beluga	rest	2	1	11
4	9/23/2020 10:05	71.987	153.773	beluga	swim	1	0	11
4	9/23/2020 10:06	71.996	153.822	beluga	swim	9	0	11
4	9/23/2020 10:18	71.831	153.347	beluga	swim	2	0	11
4	9/23/2020 10:18	71.815	153.283	beluga	swim	1	0	11
4	9/23/2020 10:19	71.802	153.280	beluga	swim	18	4	11
4	9/23/2020 10:19	71.794	153.294	beluga	swim	1	0	11
4	9/23/2020 10:19	71.790	153.291	beluga	swim	5	0	11
4	9/23/2020 10:19	71.786	153.293	beluga	swim	1	0	11
4	9/23/2020 10:34	71.289	153.280	unid cetacean	swim	1	0	3
4	9/23/2020 11:22	71.650	152.822	beluga	swim	1	0	11
4	9/23/2020 11:22	71.668	152.758	beluga	swim	1	0	11
4	9/23/2020 11:23	71.676	152.800	beluga	swim	1	0	11
4	9/23/2020 11:23	71.689	152.809	beluga	swim	1	0	11
4	9/23/2020 11:23	71.697	152.792	beluga	swim	1	0	11
4	9/23/2020 11:23	71.702	152.797	beluga	swim	1	0	11

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
4	9/23/2020 11:24	71.705	152.802	beluga	swim	1	0	11
4	9/23/2020 11:24	71.716	152.760	beluga	swim	2	0	11
4	9/23/2020 11:26	71.778	152.791	beluga	swim	1	0	11
4	9/23/2020 11:28	71.834	152.784	beluga	swim	2	1	11
4	9/23/2020 11:43	71.863	152.301	beluga	swim	3	0	11
4	9/23/2020 11:43	71.859	152.276	beluga	swim	1	0	11
4	9/23/2020 11:43	71.852	152.350	beluga	swim	1	0	11
4	9/23/2020 11:45	71.810	152.282	beluga	swim	5	0	11
4	9/23/2020 11:45	71.800	152.313	beluga	swim	1	0	11
4	9/23/2020 12:04	71.184	152.326	beluga	swim	20	0	3
4	9/23/2020 12:04	71.179	152.323	beluga	swim	2	0	3
4	9/23/2020 14:28	70.762	150.847	bowhead whale	feed	2	0	3
4	9/23/2020 14:31	70.771	150.795	bowhead whale	swim	3	0	3
4	9/23/2020 14:35	70.769	150.786	bowhead whale	swim	1	0	3
4	9/23/2020 14:56	70.806	150.786	bowhead whale	swim	2	0	3
4	9/23/2020 15:17	71.395	150.796	beluga	rest	1	0	11
4	9/23/2020 16:18	70.832	151.284	bowhead whale	rest	2	0	3
4	9/23/2020 16:27	70.695	151.266	bowhead whale	.	2	0	3
4	9/23/2020 16:27	70.693	151.271	bowhead whale	.	1	0	3
4	9/23/2020 16:28	70.686	151.228	bowhead whale	.	2	0	3
4	9/23/2020 16:28	70.679	151.268	bowhead whale	.	2	0	3
4	9/23/2020 16:28	70.676	151.275	bowhead whale	.	1	0	3
4	9/23/2020 16:28	70.673	151.277	bowhead whale	.	2	0	3
4	9/23/2020 16:28	70.673	151.294	bowhead whale	.	1	0	3
4	9/23/2020 16:30	70.659	151.256	bowhead whale	rest	1	0	3
4	9/23/2020 16:30	70.651	151.285	bowhead whale	swim	1	0	3
4	9/23/2020 16:31	70.676	151.276	bowhead whale	dive	1	0	3
4	9/23/2020 16:32	70.680	151.263	bowhead whale	dive	1	0	3
4	9/23/2020 16:32	70.680	151.243	bowhead whale	dive	1	0	3
4	9/23/2020 16:32	70.676	151.228	bowhead whale	feed	6	0	3
4	9/23/2020 16:33	70.677	151.220	bowhead whale	swim	1	0	3
4	9/23/2020 16:34	70.685	151.259	bowhead whale	swim	1	0	3
4	9/23/2020 16:34	70.663	151.251	bowhead whale	swim	1	0	3
4	9/23/2020 16:36	70.694	151.260	bowhead whale	feed	3	0	3
4	9/23/2020 16:43	70.643	151.340	bowhead whale	rest	1	0	3
4	9/23/2020 16:44	70.656	151.324	bowhead whale	swim	1	0	3
4	9/23/2020 16:46	70.611	151.284	bowhead whale	dive	1	0	3
4	9/23/2020 16:48	70.589	151.278	bowhead whale	dive	1	0	3

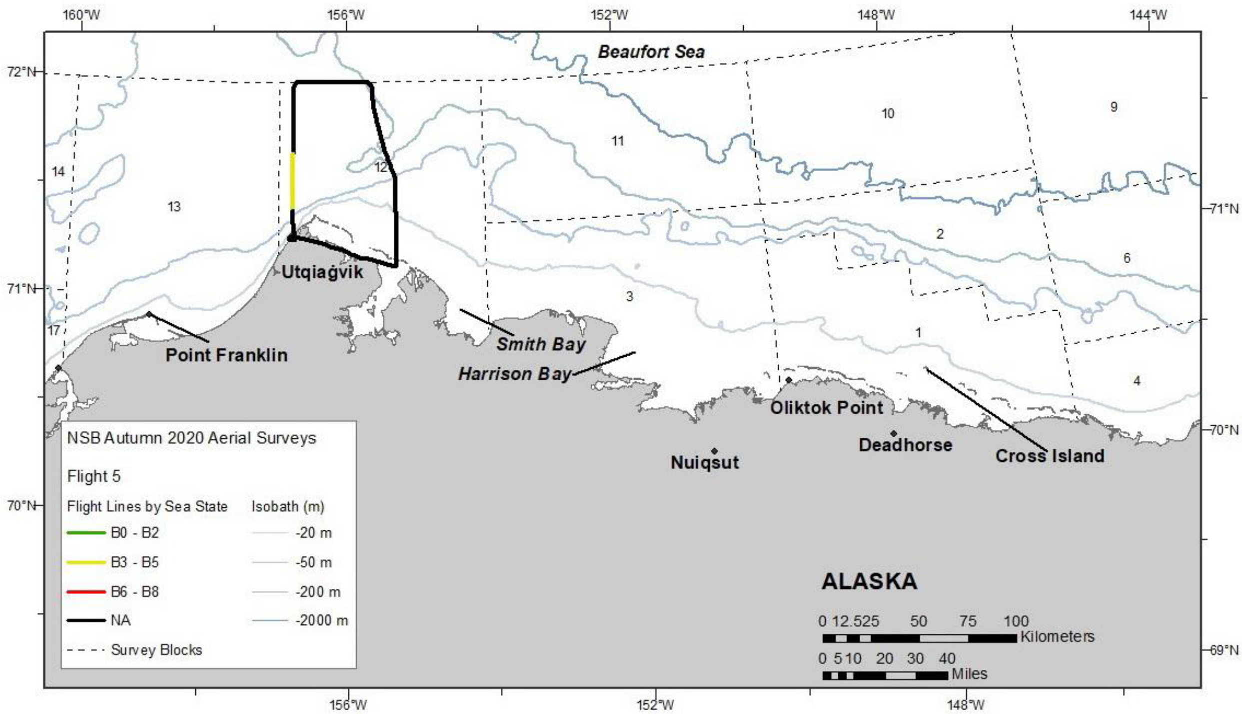


Appendix Figure E-4. -- Flight 4 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

A bowhead whale with distinctive scarring on its rostrum. This whale was sighted with two other bowheads, approximately 50 km north of the Colville River Delta, on Flight 4, 23 September 2020.

25 September 2020, Flight 5

Flight was a partial survey of transect 134. Survey conditions included overcast skies, <1-10 km visibility, with glare, ice on the window, and precipitation, and Beaufort 4-5 sea states. There was no sea ice in the area surveyed. There were no marine mammal sightings.



Appendix Figure E-5. -- Flight 5 survey track, depicted by sea state.

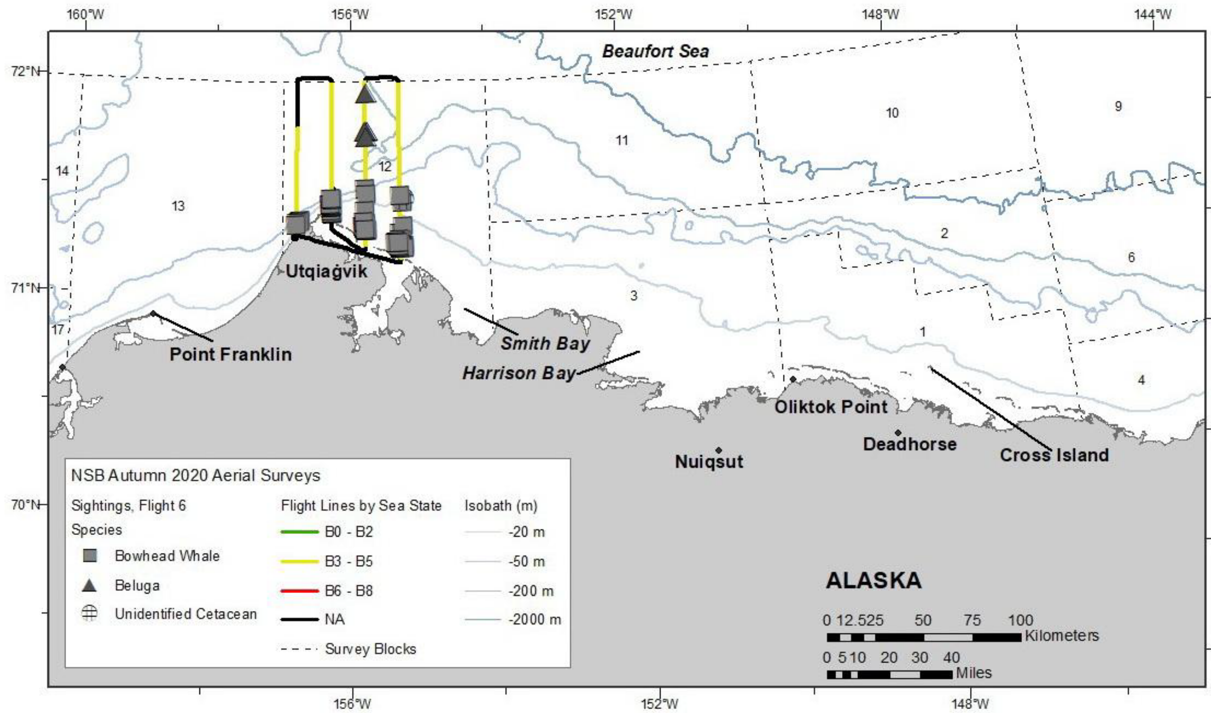
28 September 2020, Flight 6

Flight was a complete survey of transects 131, 132, and 133 and a partial survey of transect 134. Survey conditions included overcast skies, 0-10 km visibility, with ice on the window and precipitation, and Beaufort 3-5 sea states. There was no sea ice in the area surveyed. Sightings included bowhead whales, belugas (including three calves), and one unidentified cetacean.

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

Flight No.	Date/Time (AK Local)	Latitude °N	Longitude °W	Species	Behavior	Group Size	Calf No.	Block
6	9/28/2020 11:23	71.228	155.307	bowhead whale	swim	1	0	12
6	9/28/2020 11:24	71.237	155.300	bowhead whale	.	2	0	12
6	9/28/2020 11:24	71.242	155.282	bowhead whale	.	1	0	12
6	9/28/2020 11:24	71.245	155.309	bowhead whale	.	1	0	12
6	9/28/2020 11:24	71.247	155.271	bowhead whale	.	2	0	12
6	9/28/2020 11:24	71.263	155.267	bowhead whale	.	1	0	12
6	9/28/2020 11:25	71.270	155.306	bowhead whale	.	1	0	12
6	9/28/2020 11:27	71.245	155.268	bowhead whale	mill	2	0	12
6	9/28/2020 11:28	71.235	155.249	bowhead whale	rest	1	0	12
6	9/28/2020 11:28	71.240	155.238	bowhead whale	rest	1	0	12
6	9/28/2020 11:29	71.236	155.245	bowhead whale	rest	1	0	12
6	9/28/2020 11:29	71.235	155.267	bowhead whale	dive	1	0	12
6	9/28/2020 11:31	71.233	155.236	bowhead whale	swim	1	0	12
6	9/28/2020 11:31	71.230	155.265	bowhead whale	swim	1	0	12
6	9/28/2020 11:31	71.230	155.241	bowhead whale	dive	1	0	12
6	9/28/2020 11:33	71.231	155.302	bowhead whale	swim	1	0	12
6	9/28/2020 11:34	71.236	155.327	bowhead whale	swim	1	0	12
6	9/28/2020 11:37	71.256	155.348	bowhead whale	swim	1	0	12
6	9/28/2020 11:37	71.252	155.361	bowhead whale	swim	2	0	12
6	9/28/2020 11:38	71.253	155.323	bowhead whale	mill	3	0	12
6	9/28/2020 11:40	71.301	155.298	bowhead whale	swim	1	0	12
6	9/28/2020 11:42	71.328	155.256	bowhead whale	swim	1	0	12
6	9/28/2020 11:47	71.442	155.266	bowhead whale	rest	1	0	12
6	9/28/2020 11:49	71.460	155.260	unid cetacean	dive	1	0	12
6	9/28/2020 11:50	71.469	155.298	bowhead whale	rest	1	0	12
6	9/28/2020 12:14	71.951	155.790	beluga	swim	5	0	12
6	9/28/2020 12:20	71.773	155.785	beluga	swim	1	0	12
6	9/28/2020 12:20	71.774	155.782	beluga	swim	2	1	12
6	9/28/2020 12:20	71.770	155.806	beluga	swim	2	1	12
6	9/28/2020 12:20	71.748	155.789	beluga	swim	2	1	12
6	9/28/2020 12:28	71.502	155.797	bowhead whale	swim	1	0	12
6	9/28/2020 12:30	71.477	155.790	bowhead whale	swim	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
6	9/28/2020 12:33	71.400	155.809	bowhead whale	swim	1	0	12
6	9/28/2020 12:41	71.342	155.805	bowhead whale	.	3	0	12
6	9/28/2020 12:41	71.339	155.800	bowhead whale	.	1	0	12
6	9/28/2020 12:42	71.327	155.828	bowhead whale	.	1	0	12
6	9/28/2020 12:42	71.324	155.805	bowhead whale	.	1	0	12
6	9/28/2020 12:42	71.312	155.780	bowhead whale	.	1	0	12
6	9/28/2020 12:42	71.309	155.769	bowhead whale	.	1	0	12
6	9/28/2020 12:45	71.320	155.829	bowhead whale	swim	1	0	12
6	9/28/2020 12:46	71.324	155.817	bowhead whale	swim	1	0	12
6	9/28/2020 12:47	71.329	155.808	bowhead whale	swim	1	0	12
6	9/28/2020 12:47	71.329	155.802	bowhead whale	swim	2	0	12
6	9/28/2020 12:48	71.333	155.840	bowhead whale	swim	1	0	12
6	9/28/2020 12:48	71.327	155.817	bowhead whale	swim	1	0	12
6	9/28/2020 12:50	71.346	155.803	bowhead whale	swim	1	0	12
6	9/28/2020 12:50	71.343	155.794	bowhead whale	swim	1	0	12
6	9/28/2020 12:51	71.353	155.828	bowhead whale	swim	1	0	12
6	9/28/2020 12:53	71.311	155.794	bowhead whale	swim	1	0	12
6	9/28/2020 12:53	71.313	155.800	bowhead whale	swim	1	0	12
6	9/28/2020 13:04	71.389	156.281	bowhead whale	swim	1	0	12
6	9/28/2020 13:04	71.393	156.302	bowhead whale	swim	1	0	12
6	9/28/2020 13:04	71.395	156.278	bowhead whale	.	2	0	12
6	9/28/2020 13:04	71.401	156.292	bowhead whale	.	2	0	12
6	9/28/2020 13:05	71.415	156.299	bowhead whale	.	2	0	12
6	9/28/2020 13:05	71.419	156.300	bowhead whale	.	1	0	12
6	9/28/2020 13:05	71.423	156.279	bowhead whale	swim	1	0	12
6	9/28/2020 13:05	71.427	156.312	bowhead whale	.	1	0	12
6	9/28/2020 13:05	71.430	156.299	bowhead whale	.	1	0	12
6	9/28/2020 13:05	71.433	156.306	bowhead whale	swim	1	0	12
6	9/28/2020 13:06	71.455	156.286	bowhead whale	swim	1	0	12
6	9/28/2020 13:06	71.456	156.290	bowhead whale	.	1	0	12
6	9/28/2020 13:52	71.357	156.746	bowhead whale	swim	1	0	12
6	9/28/2020 13:52	71.352	156.762	bowhead whale	swim	2	0	12
6	9/28/2020 13:52	71.347	156.781	bowhead whale	swim	1	0	12
6	9/28/2020 13:53	71.334	156.798	bowhead whale	swim	1	0	12



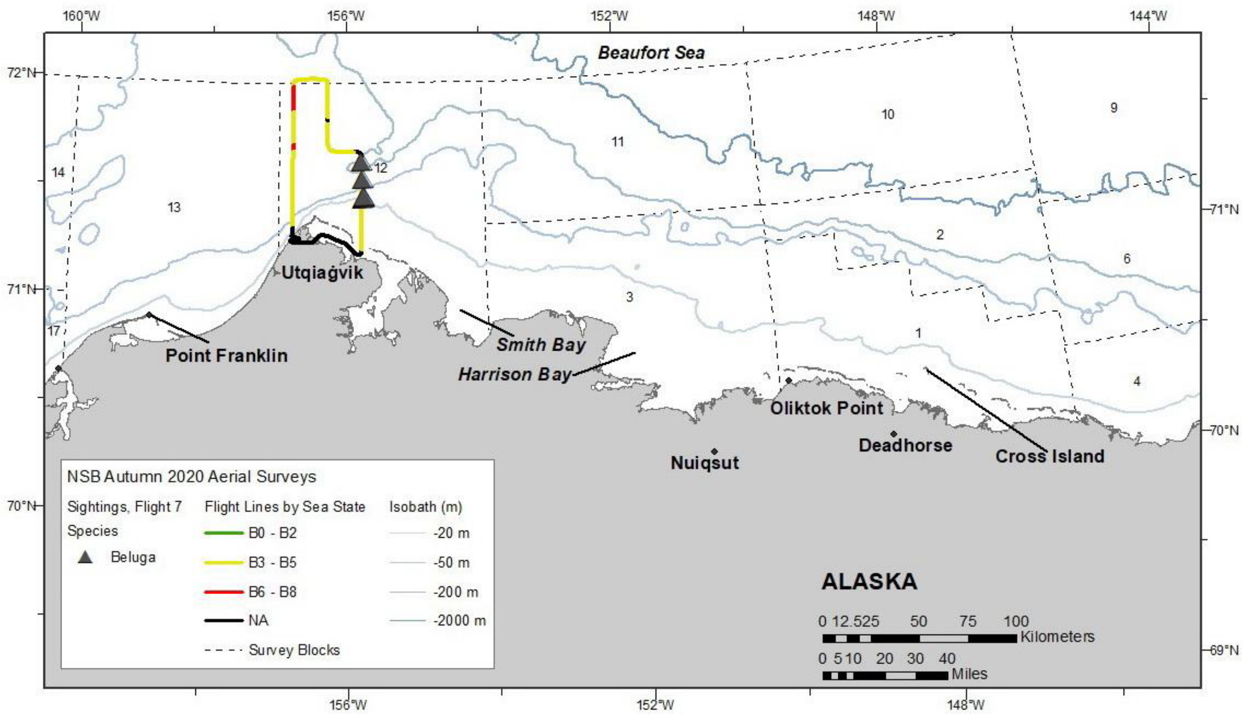
Appendix Figure E-6. -- Flight 6 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

4 October 2020, Flight 7

Flight was a complete survey of transect of 134 and a partial survey of transects 132 and 133. Survey conditions included partly cloudy to overcast skies, 0-10 km visibility, with glare, low ceilings, and precipitation, and Beaufort 3-6 sea states. There was no sea ice in the area surveyed. Sightings included belugas.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
7	10/4/2020 15:42	71.469	155.791	beluga	swim	1	0	12
7	10/4/2020 15:42	71.472	155.778	beluga	swim	1	0	12
7	10/4/2020 15:42	71.474	155.776	beluga	swim	1	0	12
7	10/4/2020 15:42	71.479	155.774	beluga	swim	1	0	12
7	10/4/2020 15:44	71.557	155.779	beluga	swim	1	0	12
7	10/4/2020 15:47	71.642	155.794	beluga	swim	1	0	12



Appendix Fig. E7. -- Flight 7 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

6 October 2020, Flight 8

Flight was a complete survey of transects 129, 130, and 131 and a partial survey of transects 126 and 128. Survey conditions included partly cloudy to overcast skies, 5 km to unlimited visibility, with glare, ice on the window, and precipitation, and Beaufort 2-7 sea states. Sea ice was 0-3% broken floe in the area surveyed. Sightings included bowhead whales (including five calves), belugas (including eight calves), and small unidentified pinnipeds.

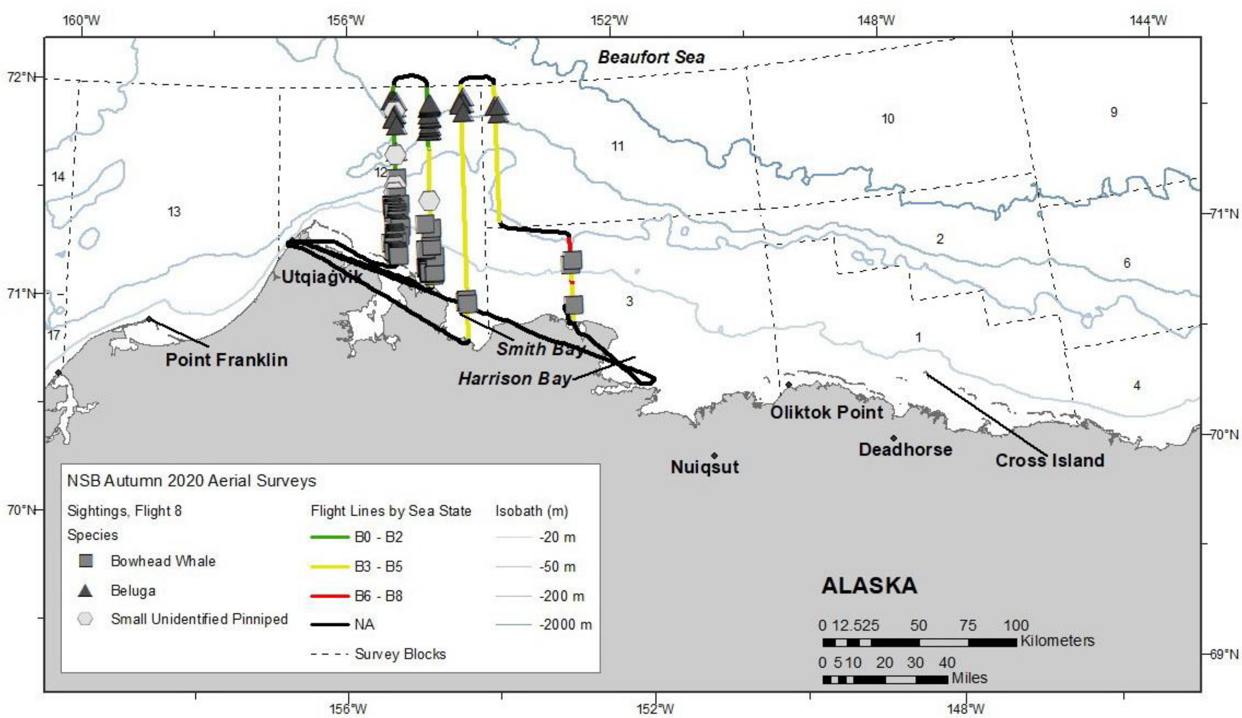
Cetacean sightings only (transect, CAPs, circling, and search effort):

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
8	10/6/2020 10:26	70.959	152.788	bowhead whale	swim	1	0	3
8	10/6/2020 10:32	71.146	152.794	bowhead whale	swim	1	0	3
8	10/6/2020 10:36	71.168	152.760	bowhead whale	swim	1	0	3
8	10/6/2020 11:08	71.868	153.767	beluga	swim	1	0	11
8	10/6/2020 11:09	71.902	153.798	beluga	swim	1	0	11
8	10/6/2020 11:10	71.902	153.758	beluga	swim	1	0	11
8	10/6/2020 11:20	71.952	154.272	beluga	swim	1	0	12
8	10/6/2020 11:21	71.926	154.325	beluga	swim	1	0	12
8	10/6/2020 11:21	71.919	154.277	beluga	swim	2	1	12
8	10/6/2020 11:22	71.913	154.318	beluga	swim	1	0	12
8	10/6/2020 11:23	71.880	154.276	beluga	swim	1	0	12
8	10/6/2020 11:48	71.001	154.311	bowhead whale	swim	1	0	12
8	10/6/2020 11:48	70.999	154.314	bowhead whale	swim	1	0	12
8	10/6/2020 11:49	71.005	154.302	bowhead whale	swim	1	0	12
8	10/6/2020 11:49	70.986	154.292	bowhead whale	feed	3	0	12
8	10/6/2020 13:39	71.135	154.829	bowhead whale	.	1	0	12
8	10/6/2020 13:40	71.158	154.856	bowhead whale	.	2	0	12
8	10/6/2020 13:43	71.135	154.796	bowhead whale	swim	1	0	12
8	10/6/2020 13:43	71.141	154.827	bowhead whale	rest	1	0	12
8	10/6/2020 13:45	71.160	154.863	bowhead whale	feed	1	0	12
8	10/6/2020 13:45	71.159	154.857	bowhead whale	feed	1	0	12
8	10/6/2020 13:45	71.158	154.849	bowhead whale	feed	1	0	12
8	10/6/2020 13:45	71.157	154.846	bowhead whale	feed	1	0	12
8	10/6/2020 13:45	71.155	154.843	bowhead whale	feed	3	0	12
8	10/6/2020 13:45	71.154	154.840	bowhead whale	feed	1	0	12
8	10/6/2020 13:45	71.153	154.837	bowhead whale	feed	1	0	12
8	10/6/2020 13:45	71.151	154.834	bowhead whale	feed	1	0	12
8	10/6/2020 13:45	71.150	154.832	bowhead whale	feed	1	0	12
8	10/6/2020 13:45	71.148	154.829	bowhead whale	feed	1	0	12
8	10/6/2020 13:46	71.147	154.827	bowhead whale	feed	1	0	12
8	10/6/2020 13:48	71.138	154.826	bowhead whale	feed	1	0	12
8	10/6/2020 13:52	71.124	154.754	bowhead whale	swim	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
8	10/6/2020 13:52	71.132	154.753	bowhead whale	swim	1	0	12
8	10/6/2020 13:53	71.137	154.738	bowhead whale	swim	2	1	12
8	10/6/2020 13:58	71.209	154.739	bowhead whale	swim	1	0	12
8	10/6/2020 14:01	71.239	154.859	bowhead whale	swim	1	0	12
8	10/6/2020 14:02	71.245	154.857	bowhead whale	swim	2	1	12
8	10/6/2020 14:05	71.260	154.780	bowhead whale	mill	2	0	12
8	10/6/2020 14:05	71.261	154.790	bowhead whale	swim	1	0	12
8	10/6/2020 14:08	71.324	154.799	bowhead whale	swim	2	1	12
8	10/6/2020 14:11	71.341	154.774	bowhead whale	swim	2	1	12
8	10/6/2020 14:13	71.364	154.870	bowhead whale	swim	2	0	12
8	10/6/2020 14:32	71.796	154.777	beluga	swim	1	0	12
8	10/6/2020 14:32	71.796	154.831	beluga	swim	1	0	12
8	10/6/2020 14:32	71.800	154.777	beluga	swim	6	2	12
8	10/6/2020 14:32	71.800	154.808	beluga	swim	1	0	12
8	10/6/2020 14:33	71.813	154.794	beluga	swim	2	1	12
8	10/6/2020 14:33	71.817	154.770	beluga	swim	2	1	12
8	10/6/2020 14:33	71.826	154.796	beluga	swim	2	0	12
8	10/6/2020 14:34	71.852	154.780	beluga	swim	1	0	12
8	10/6/2020 14:34	71.855	154.771	beluga	swim	1	0	12
8	10/6/2020 14:34	71.857	154.770	beluga	swim	1	0	12
8	10/6/2020 14:35	71.873	154.800	beluga	swim	1	0	12
8	10/6/2020 14:36	71.905	154.796	beluga	swim	1	0	12
8	10/6/2020 14:36	71.907	154.781	beluga	swim	1	0	12
8	10/6/2020 14:36	71.909	154.786	beluga	swim	1	0	12
8	10/6/2020 14:36	71.909	154.790	beluga	swim	1	0	12
8	10/6/2020 14:36	71.912	154.776	beluga	swim	1	0	12
8	10/6/2020 14:36	71.914	154.777	beluga	swim	1	0	12
8	10/6/2020 14:36	71.921	154.770	beluga	swim	1	0	12
8	10/6/2020 14:36	71.923	154.786	beluga	mill	2	1	12
8	10/6/2020 14:45	71.943	155.356	beluga	swim	1	0	12
8	10/6/2020 14:45	71.941	155.312	beluga	swim	1	0	12
8	10/6/2020 14:46	71.938	155.298	beluga	swim	2	1	12
8	10/6/2020 14:46	71.936	155.263	beluga	swim	1	0	12
8	10/6/2020 14:46	71.933	155.283	beluga	swim	1	0	12
8	10/6/2020 14:47	71.906	155.289	beluga	swim	1	0	12
8	10/6/2020 14:48	71.874	155.282	beluga	swim	3	1	12
8	10/6/2020 14:48	71.872	155.305	beluga	swim	1	0	12
8	10/6/2020 14:48	71.859	155.316	beluga	swim	1	0	12
8	10/6/2020 14:48	71.857	155.317	beluga	swim	1	0	12
8	10/6/2020 14:49	71.825	155.281	beluga	swim	1	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
8	10/6/2020 14:53	71.704	155.280	beluga	swim	3	0	12
8	10/6/2020 14:57	71.575	155.277	bowhead whale	rest	1	1	12
8	10/6/2020 15:05	71.490	155.272	bowhead whale	swim	2	0	12
8	10/6/2020 15:07	71.458	155.229	bowhead whale	feed	2	0	12
8	10/6/2020 15:07	71.456	155.347	bowhead whale	feed	1	0	12
8	10/6/2020 15:07	71.452	155.334	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.443	155.303	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.440	155.319	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.438	155.320	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.437	155.326	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.434	155.333	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.432	155.324	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.430	155.286	bowhead whale	feed	3	0	12
8	10/6/2020 15:08	71.429	155.289	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.429	155.290	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.420	155.322	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.413	155.249	bowhead whale	feed	1	0	12
8	10/6/2020 15:08	71.413	155.260	bowhead whale	feed	2	0	12
8	10/6/2020 15:09	71.406	155.265	bowhead whale	feed	1	0	12
8	10/6/2020 15:09	71.407	155.265	bowhead whale	feed	1	0	12
8	10/6/2020 15:09	71.401	155.246	bowhead whale	feed	2	0	12
8	10/6/2020 15:09	71.390	155.266	bowhead whale	feed	1	0	12
8	10/6/2020 15:09	71.386	155.278	bowhead whale	feed	1	0	12
8	10/6/2020 15:09	71.382	155.268	bowhead whale	feed	4	0	12
8	10/6/2020 15:10	71.369	155.280	bowhead whale	feed	1	0	12
8	10/6/2020 15:10	71.367	155.277	bowhead whale	feed	1	0	12
8	10/6/2020 15:10	71.358	155.273	bowhead whale	feed	1	0	12
8	10/6/2020 15:10	71.355	155.318	bowhead whale	feed	1	0	12
8	10/6/2020 15:10	71.355	155.237	bowhead whale	feed	2	0	12
8	10/6/2020 15:10	71.348	155.225	bowhead whale	feed	3	0	12
8	10/6/2020 15:11	71.324	155.317	bowhead whale	feed	1	0	12
8	10/6/2020 15:11	71.318	155.299	bowhead whale	feed	1	0	12
8	10/6/2020 15:11	71.315	155.294	bowhead whale	feed	1	0	12
8	10/6/2020 15:12	71.310	155.298	bowhead whale	feed	1	0	12
8	10/6/2020 15:12	71.307	155.233	bowhead whale	feed	2	0	12
8	10/6/2020 15:12	71.302	155.315	bowhead whale	feed	1	0	12
8	10/6/2020 15:12	71.298	155.293	bowhead whale	feed	1	0	12
8	10/6/2020 15:12	71.295	155.294	bowhead whale	feed	2	0	12
8	10/6/2020 15:12	71.292	155.309	bowhead whale	feed	3	0	12
8	10/6/2020 15:12	71.278	155.368	bowhead whale	feed	10	0	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
8	10/6/2020 15:13	71.276	155.268	bowhead whale	feed	1	0	12
8	10/6/2020 15:13	71.273	155.318	bowhead whale	feed	5	0	12
8	10/6/2020 15:13	71.268	155.314	bowhead whale	feed	1	0	12
8	10/6/2020 15:13	71.265	155.315	bowhead whale	feed	12	0	12
8	10/6/2020 15:13	71.245	155.337	bowhead whale	feed	1	0	12
8	10/6/2020 15:14	71.237	155.268	bowhead whale	feed	2	0	12
8	10/6/2020 15:14	71.236	155.314	bowhead whale	feed	10	0	12
8	10/6/2020 15:14	71.234	155.275	bowhead whale	feed	2	0	12
8	10/6/2020 15:14	71.232	155.277	bowhead whale	feed	2	0	12
8	10/6/2020 15:14	71.225	155.282	bowhead whale	feed	2	0	12
8	10/6/2020 15:14	71.221	155.257	bowhead whale	feed	1	0	12
8	10/6/2020 15:14	71.219	155.264	bowhead whale	feed	1	0	12



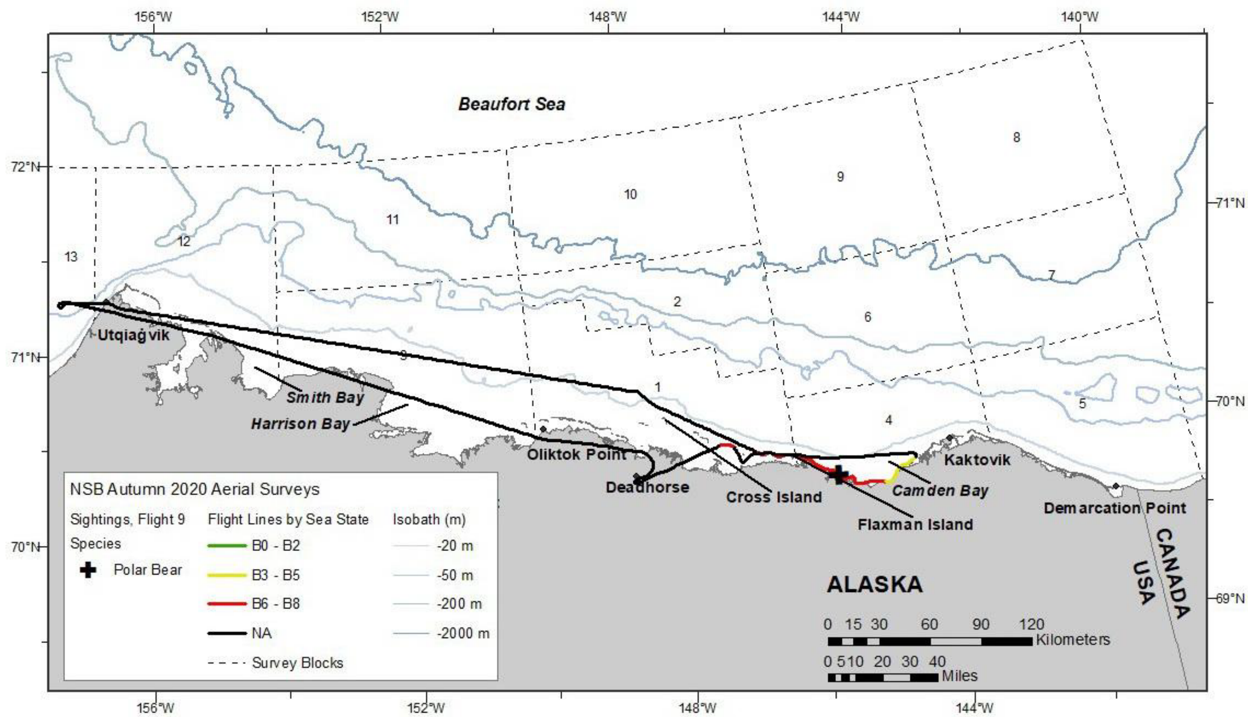
Appendix Figure E-8. --Flight 8 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

7 October 2020, Flight 9

Flight was a partial coastal transect from 30 km west of Point Thomson to 15 km west of Kaktovik. Survey conditions included partly cloudy to overcast skies, 0-5 km visibility, with low ceilings, and Beaufort 4-7 sea states. There was no sea ice in the area surveyed. Sightings included one unidentified cetacean carcass and polar bears. The unidentified cetacean carcass was located approximately 35 km west of Kaktovik, Alaska.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
9	10/7/2020 12:15	70.054	145.413	unid cetacean	dead	1	0	4



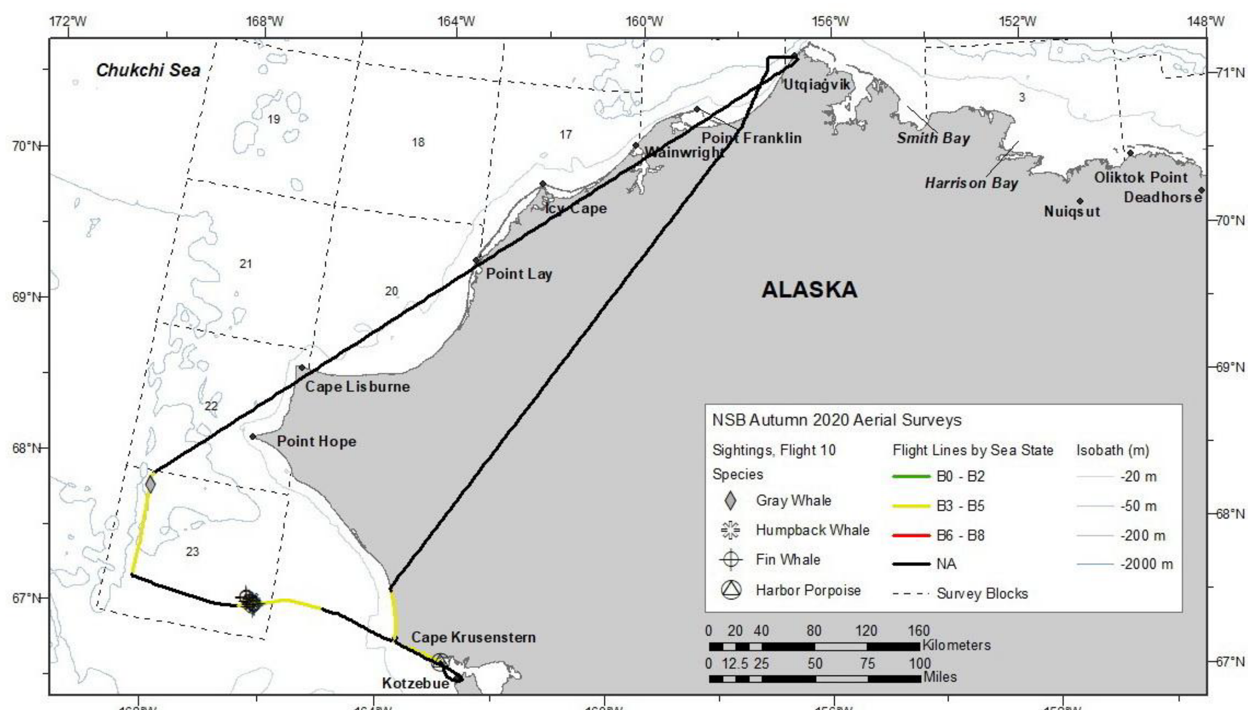
Appendix Figure E-9. --Flight 9 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

10 October 2020, Flight 10

Flight was a partial coastal transect located approximately 50 km on either side of Cape Krusenstern and search effort in and near survey block 23. Survey conditions included clear to partly cloudy skies, 2 km to unlimited visibility, with glare and low ceilings, and Beaufort 2-6 sea states. There was no sea ice in the area surveyed. Sightings included one gray whale, humpback whales, fin whales, and harbor porpoises.

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

Flight No.	Date/Time (AK Local)	Latitude °N	Longitude °W	Species	Behavior	Group Size	Calf No.	Block
10	10/10/2020 12:28	67.904	168.496	gray whale	swim	1	0	23
10	10/10/2020 13:07	67.264	166.464	fin whale	swim	1	0	23
10	10/10/2020 13:07	67.274	166.459	fin whale	swim	1	0	23
10	10/10/2020 13:10	67.248	166.403	fin whale	swim	1	0	23
10	10/10/2020 13:14	67.227	166.320	fin whale	swim	2	0	23
10	10/10/2020 13:15	67.233	166.313	fin whale	swim	1	0	23
10	10/10/2020 13:18	67.231	166.365	humpback whale	swim	3	0	23
10	10/10/2020 13:20	67.247	166.344	humpback whale	swim	1	0	23
10	10/10/2020 13:59	67.004	162.923	harbor porpoise	swim	2	0	0



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

Three humpback whales sighted swimming together, approximately 150 km northwest of Kotzebue, Alaska, on Flight 10, 10 October 2020.

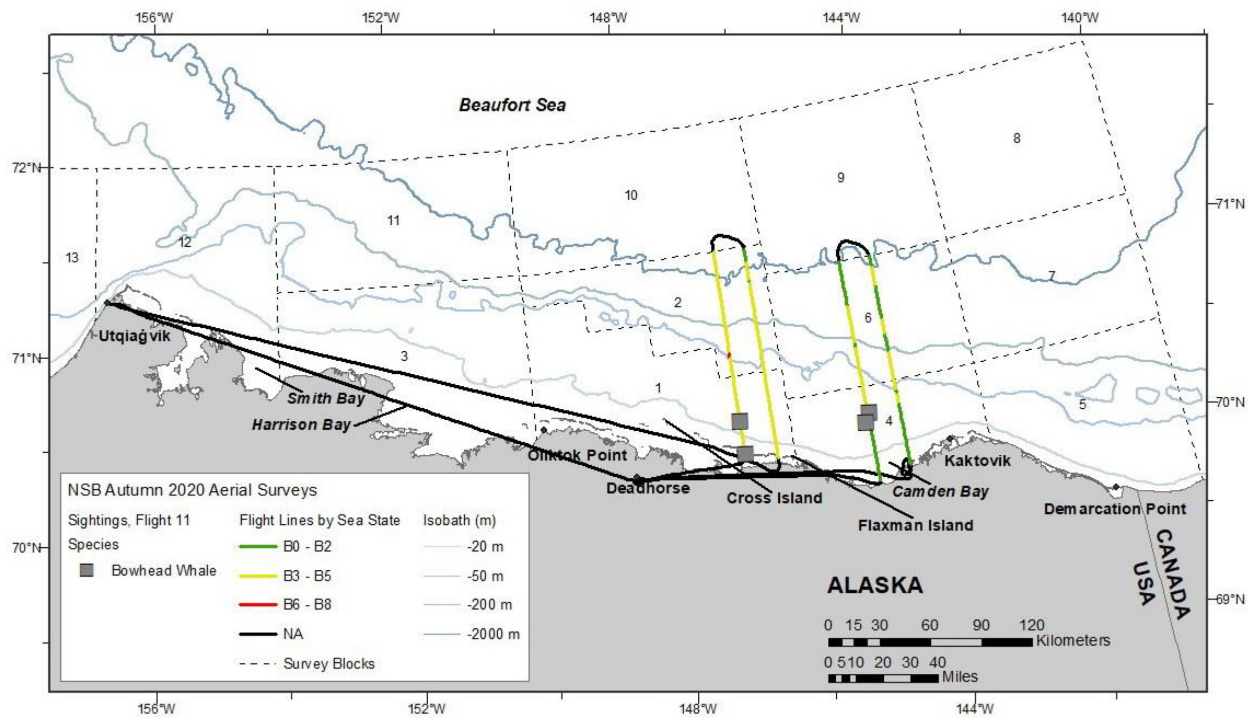
Three humpback whales sighted swimming together, approximately 150 km northwest of Kotzebue, Alaska, on Flight 10, 10 October 2020.

12 October 2020, Flight 11

Flight was a complete survey of transects 109, 110, 113, and 114. Survey conditions included partly cloudy to overcast skies, less than 1 km to unlimited visibility, with low ceilings and precipitation, and Beaufort 1-6 sea states. Sea ice was 0-95% grease/new ice and broken floe in the area surveyed. Sightings included bowhead whales (including one calf).

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

Flight No.	Date/Time (AK Local)	Latitude °N	Longitude °W	Species	Behavior	Group Size	Calf No.	Block
11	10/12/2020 12:51	70.422	146.809	bowhead whale	swim	1	0	1
11	10/12/2020 12:59	70.251	146.799	bowhead whale	feed	3	0	1
11	10/12/2020 16:19	70.350	144.789	bowhead whale	swim	1	0	4
11	10/12/2020 16:22	70.304	144.860	bowhead whale	swim	3	1	4



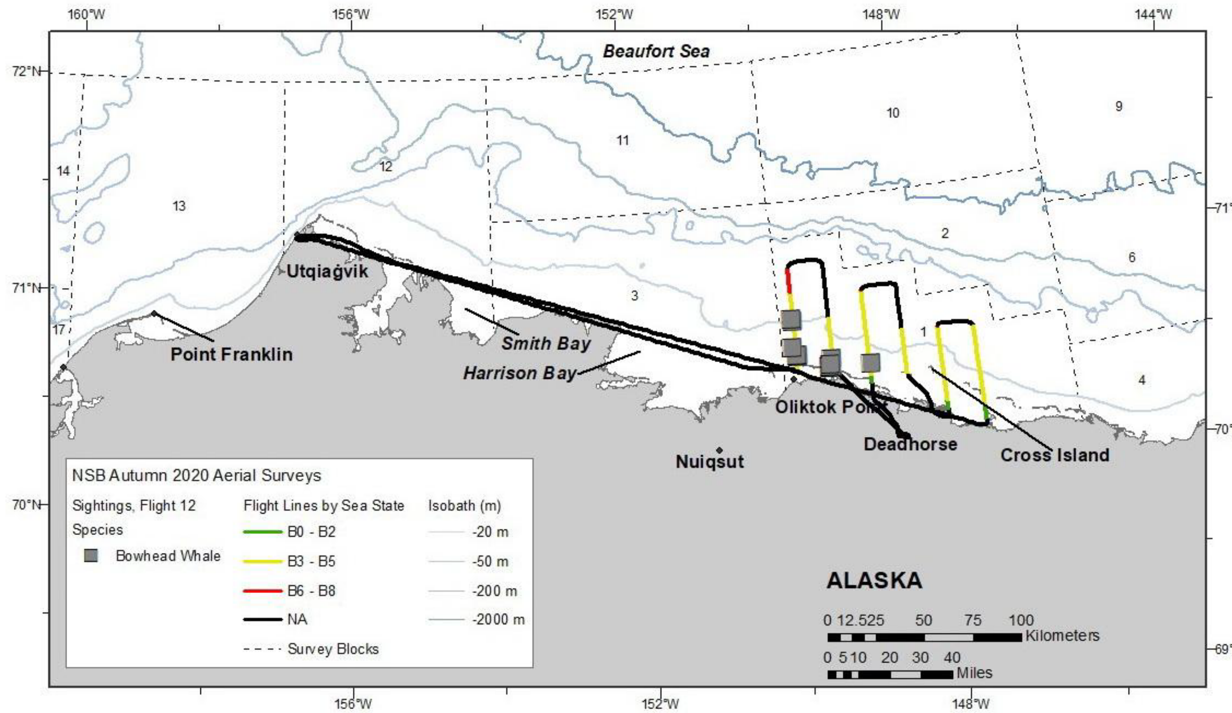
Appendix Figure E-11. -- Flight 11 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

13 October 2020, Flight 12

Flight was a partial survey of transects 115, 116, 117, 118, 119, and 120. Survey conditions included partly cloudy to overcast skies, unlimited visibility, with glare, and Beaufort 0-6 sea states. Sea ice was 0-95% grease/new ice in the area surveyed. Sightings included bowhead whales (including two calves).

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

Flight No.	Date/Time (AK Local)	Latitude °N	Longitude °W	Species	Behavior	Group Size	Calf No.	Block
12	10/13/2020 10:28	70.614	149.774	bowhead whale	swim	1	0	1
12	10/13/2020 10:28	70.617	149.776	bowhead whale	swim	1	0	1
12	10/13/2020 10:28	70.621	149.793	bowhead whale	rest	1	0	1
12	10/13/2020 10:33	70.657	149.841	bowhead whale	swim	1	0	1
12	10/13/2020 10:39	70.777	149.813	bowhead whale	rest	1	0	1
12	10/13/2020 10:40	70.790	149.814	bowhead whale	mill	2	1	1
12	10/13/2020 11:09	70.589	149.316	bowhead whale	swim	2	1	1
12	10/13/2020 11:21	70.555	149.342	bowhead whale	feed	1	0	1
12	10/13/2020 11:21	70.553	149.346	bowhead whale	feed	1	0	1
12	10/13/2020 11:21	70.550	149.347	bowhead whale	feed	10	0	1
12	10/13/2020 11:21	70.546	149.332	bowhead whale	feed	3	0	1
12	10/13/2020 11:22	70.553	149.351	bowhead whale	feed	15	0	1
12	10/13/2020 11:24	70.560	149.334	bowhead whale	feed	5	0	1
12	10/13/2020 12:36	70.546	148.772	bowhead whale	swim	1	0	1



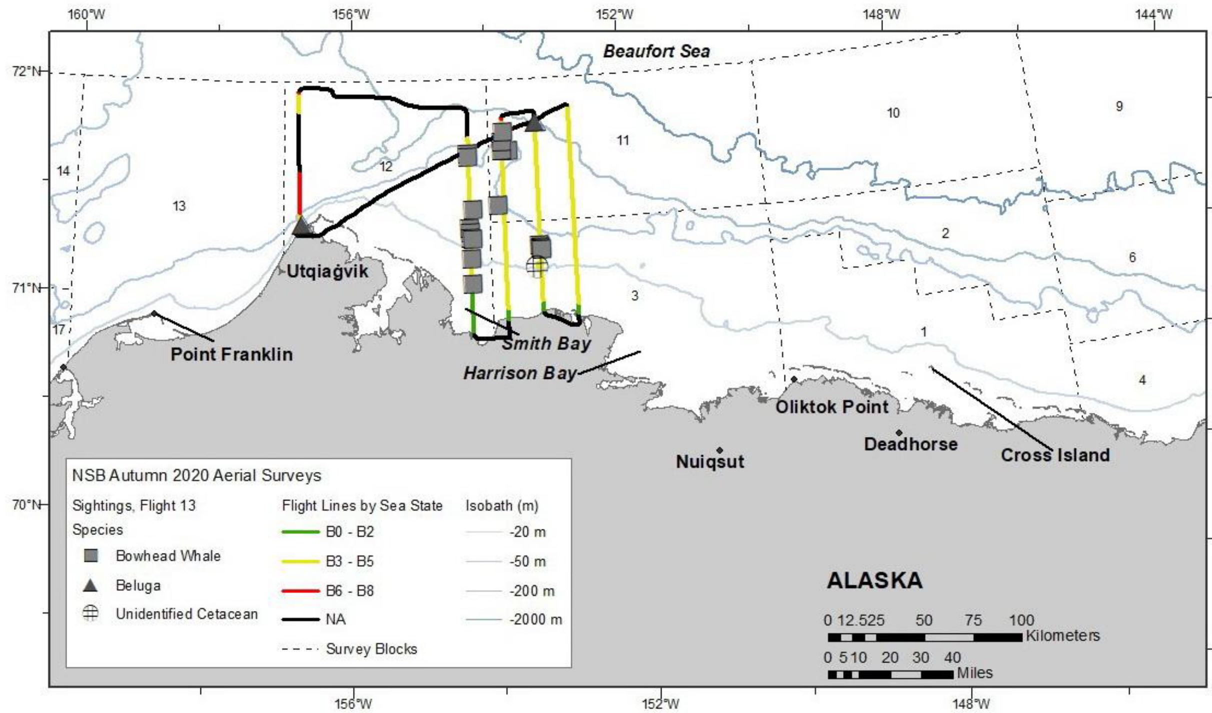
Appendix Figure E-12. -- Flight 12 survey track, depicted by sea state, and all marine mammal sightings, excluding carcasses.

14 October 2020, Flight 13

Flight was a partial survey of transects 126, 127, 128, 129, and 134. Survey conditions included partly cloudy to overcast skies, 2 km to unlimited visibility, with glare and precipitation, and Beaufort 0-6 sea states. Sea ice was 0-99% grease/new ice in the area surveyed. Sightings included bowhead whales (including nine calves), belugas, and one unidentified cetacean.

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

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
13	10/14/2020 14:12	71.342	156.739	beluga	swim	1	0	12
13	10/14/2020 14:52	71.655	154.300	bowhead whale	swim	1	0	12
13	10/14/2020 14:55	71.641	154.311	bowhead whale	swim	1	0	12
13	10/14/2020 15:04	71.397	154.245	bowhead whale	swim	2	1	12
13	10/14/2020 15:08	71.310	154.308	bowhead whale	swim	1	0	12
13	10/14/2020 15:10	71.293	154.290	bowhead whale	swim	1	0	12
13	10/14/2020 15:11	71.268	154.291	bowhead whale	swim	2	1	12
13	10/14/2020 15:15	71.259	154.263	bowhead whale	swim	2	1	12
13	10/14/2020 15:21	71.168	154.285	bowhead whale	swim	2	0	12
13	10/14/2020 15:29	71.054	154.291	bowhead whale	swim	1	0	12
13	10/14/2020 15:59	71.412	153.883	bowhead whale	swim	2	1	11
13	10/14/2020 16:09	71.663	153.708	bowhead whale	swim	1	0	11
13	10/14/2020 16:09	71.666	153.785	bowhead whale	swim	1	0	11
13	10/14/2020 16:09	71.668	153.794	bowhead whale	dive	1	0	11
13	10/14/2020 16:12	71.706	153.803	bowhead whale	swim	1	1	11
13	10/14/2020 16:17	71.752	153.779	bowhead whale	flipper slap	1	1	11
13	10/14/2020 16:27	71.796	153.300	beluga	swim	2	0	11
13	10/14/2020 16:45	71.221	153.308	bowhead whale	swim	2	1	3
13	10/14/2020 16:47	71.214	153.299	bowhead whale	swim	1	0	3
13	10/14/2020 16:47	71.208	153.286	bowhead whale	swim	2	1	3
13	10/14/2020 16:47	71.200	153.279	bowhead whale	swim	2	1	3
13	10/14/2020 16:52	71.127	153.361	unid cetacean	swim	1	0	3



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

15 October 2020, Flight 14

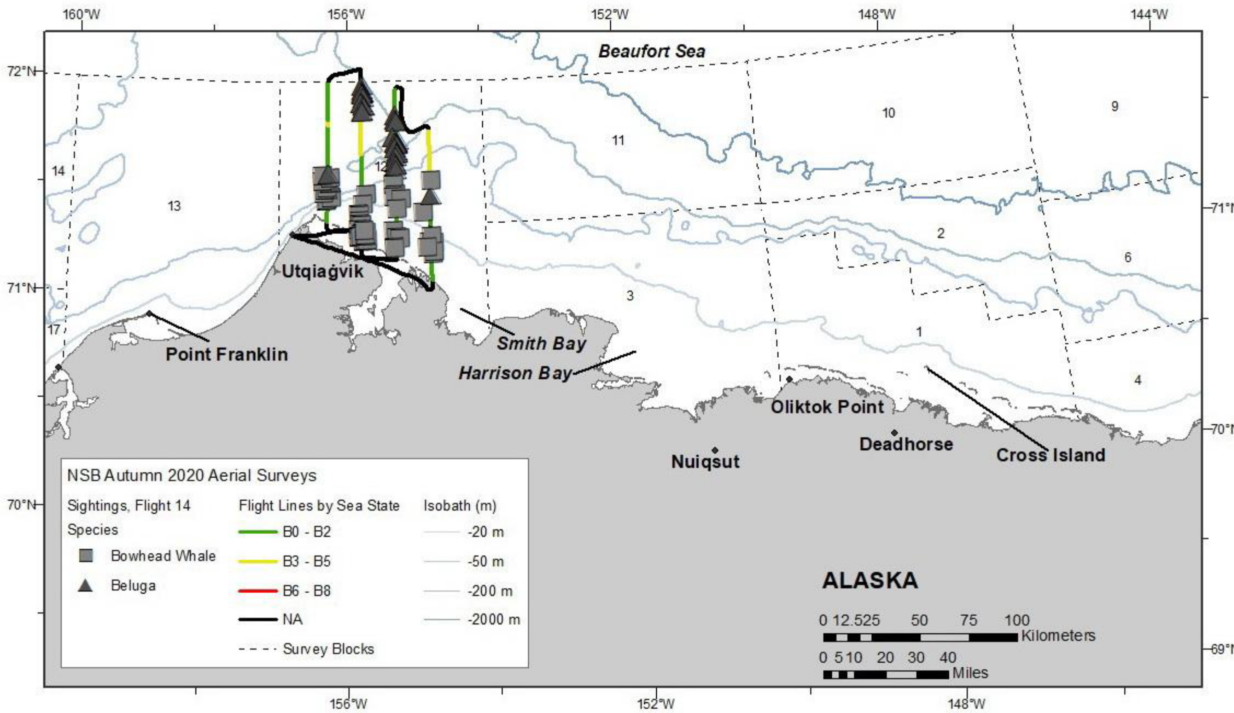
Flight was a complete survey of transects 132 and 133 and a partial survey of transects 130 and 131. Survey conditions included partly cloudy to overcast skies, less than 1 km to unlimited visibility, with glare, ice on the window, low ceilings, and precipitation, and Beaufort 1-5 sea states. Sea ice was 0-90% grease/new ice in the area surveyed. Sightings included bowhead whales (including seven calves) and belugas (including seven calves).

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

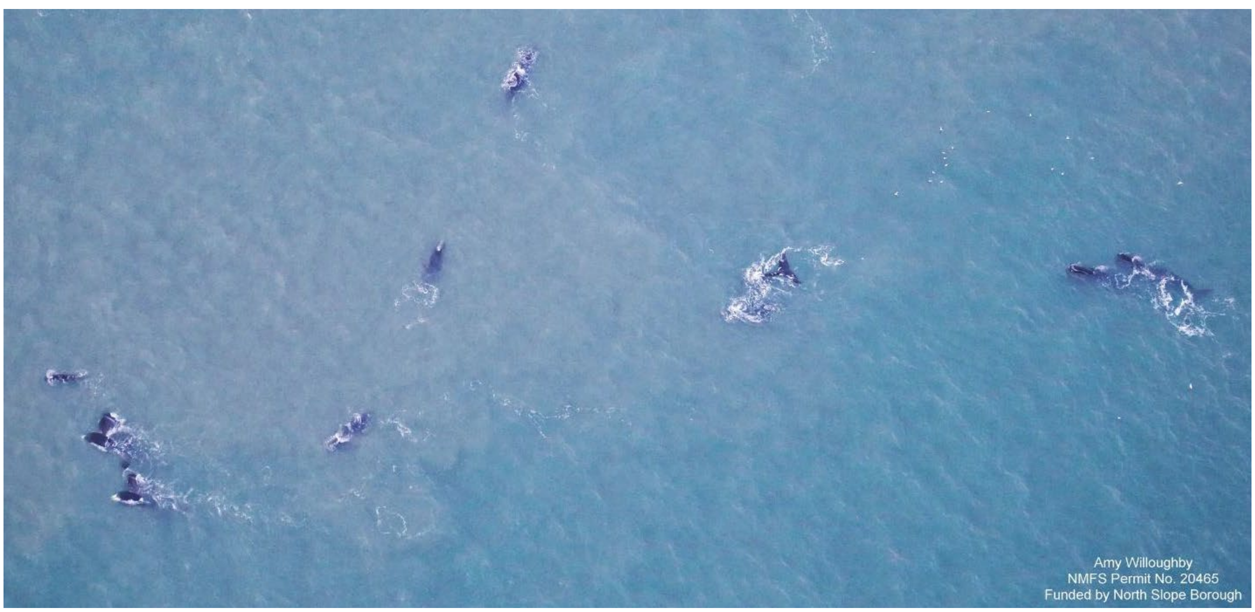
Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	10/15/2020 9:55	71.200	154.764	bowhead whale	swim	1	0	12
14	10/15/2020 9:57	71.206	154.750	bowhead whale	mill	3	1	12
14	10/15/2020 9:59	71.228	154.843	bowhead whale	swim	4	1	12
14	10/15/2020 10:30	71.247	154.748	bowhead whale	mill	2	0	12
14	10/15/2020 10:30	71.254	154.815	bowhead whale	swim	1	0	12
14	10/15/2020 10:36	71.282	154.782	bowhead whale	swim	1	0	12
14	10/15/2020 10:39	71.393	154.893	bowhead whale	feed	31	0	12
14	10/15/2020 10:49	71.473	154.807	beluga	swim	1	0	12
14	10/15/2020 10:51	71.539	154.786	bowhead whale	rest	2	0	12
14	10/15/2020 11:10	71.846	155.299	beluga	swim	1	0	12
14	10/15/2020 11:11	71.827	155.281	beluga	swim	2	1	12
14	10/15/2020 11:11	71.824	155.302	beluga	swim	5	0	12
14	10/15/2020 11:11	71.822	155.287	beluga	swim	1	0	12
14	10/15/2020 11:11	71.816	155.285	beluga	swim	1	0	12
14	10/15/2020 11:14	71.747	155.337	beluga	swim	1	0	12
14	10/15/2020 11:14	71.727	155.272	beluga	swim	1	0	12
14	10/15/2020 11:14	71.722	155.307	beluga	swim	1	0	12
14	10/15/2020 11:14	71.721	155.310	beluga	swim	1	0	12
14	10/15/2020 11:14	71.717	155.279	beluga	swim	2	0	12
14	10/15/2020 11:15	71.715	155.284	beluga	swim	3	0	12
14	10/15/2020 11:15	71.713	155.291	beluga	swim	14	0	12
14	10/15/2020 11:15	71.709	155.279	beluga	swim	10	1	12
14	10/15/2020 11:15	71.695	155.308	beluga	swim	12	2	12
14	10/15/2020 11:16	71.679	155.286	beluga	swim	3	0	12
14	10/15/2020 11:16	71.671	155.286	beluga	swim	2	0	12
14	10/15/2020 11:16	71.667	155.285	beluga	swim	2	1	12
14	10/15/2020 11:16	71.655	155.300	beluga	swim	1	0	12
14	10/15/2020 11:17	71.630	155.315	beluga	swim	2	0	12
14	10/15/2020 11:18	71.617	155.306	beluga	swim	1	1	12
14	10/15/2020 11:18	71.611	155.304	beluga	swim	3	0	12
14	10/15/2020 11:18	71.592	155.299	beluga	swim	1	0	12
14	10/15/2020 11:20	71.527	155.322	bowhead whale	swim	2	1	12

Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	10/15/2020 11:20	71.524	155.316	bowhead whale	swim	2	0	12
14	10/15/2020 11:25	71.475	155.298	bowhead whale	swim	2	1	12
14	10/15/2020 11:27	71.467	155.327	bowhead whale	swim	2	1	12
14	10/15/2020 11:29	71.455	155.221	bowhead whale	swim	1	0	12
14	10/15/2020 11:33	71.410	155.283	bowhead whale	swim	4	0	12
14	10/15/2020 11:41	71.310	155.333	bowhead whale	dive	1	0	12
14	10/15/2020 11:42	71.279	155.295	bowhead whale	swim	1	0	12
14	10/15/2020 11:42	71.274	155.232	bowhead whale	swim	2	0	12
14	10/15/2020 11:45	71.233	155.324	bowhead whale	feed	5	0	12
14	10/15/2020 11:45	71.230	155.316	bowhead whale	feed	3	0	12
14	10/15/2020 12:10	71.448	156.310	bowhead whale	feed	12	0	12
14	10/15/2020 12:10	71.453	156.303	bowhead whale	swim	3	0	12
14	10/15/2020 12:19	71.465	156.226	bowhead whale	swim	1	0	12
14	10/15/2020 12:23	71.482	156.340	bowhead whale	swim	1	0	12
14	10/15/2020 12:27	71.499	156.289	bowhead whale	swim	1	0	12
14	10/15/2020 12:27	71.500	156.333	bowhead whale	swim	3	0	12
14	10/15/2020 12:27	71.511	156.299	bowhead whale	swim	2	1	12
14	10/15/2020 12:30	71.533	156.265	beluga	swim	1	0	12
14	10/15/2020 12:30	71.540	156.358	bowhead whale	swim	3	0	12
14	10/15/2020 12:34	71.552	156.247	bowhead whale	breach	1	0	12
14	10/15/2020 12:37	71.562	156.357	bowhead whale	swim	2	0	12
14	10/15/2020 12:41	71.574	156.294	beluga	swim	1	0	12
14	10/15/2020 13:01	71.984	155.785	beluga	swim	1	0	12
14	10/15/2020 13:02	71.962	155.793	beluga	rest	1	0	12
14	10/15/2020 13:02	71.954	155.799	beluga	swim	1	0	12
14	10/15/2020 13:02	71.949	155.777	beluga	swim	2	0	12
14	10/15/2020 13:03	71.947	155.791	beluga	swim	3	0	12
14	10/15/2020 13:03	71.945	155.785	beluga	swim	2	0	12
14	10/15/2020 13:03	71.927	155.775	beluga	swim	1	0	12
14	10/15/2020 13:04	71.904	155.786	beluga	swim	1	0	12
14	10/15/2020 13:04	71.903	155.802	beluga	swim	2	1	12
14	10/15/2020 13:04	71.896	155.773	beluga	swim	1	0	12
14	10/15/2020 13:04	71.887	155.761	beluga	swim	1	0	12
14	10/15/2020 13:05	71.870	155.791	beluga	rest	1	0	12
14	10/15/2020 13:05	71.862	155.801	beluga	swim	1	0	12
14	10/15/2020 13:17	71.479	155.721	bowhead whale	swim	2	0	12
14	10/15/2020 13:22	71.431	155.777	bowhead whale	rest	2	0	12
14	10/15/2020 13:25	71.386	155.845	bowhead whale	feed	10	0	12
14	10/15/2020 13:25	71.383	155.817	bowhead whale	feed	6	0	12
14	10/15/2020 13:31	71.358	155.824	bowhead whale	swim	1	0	12

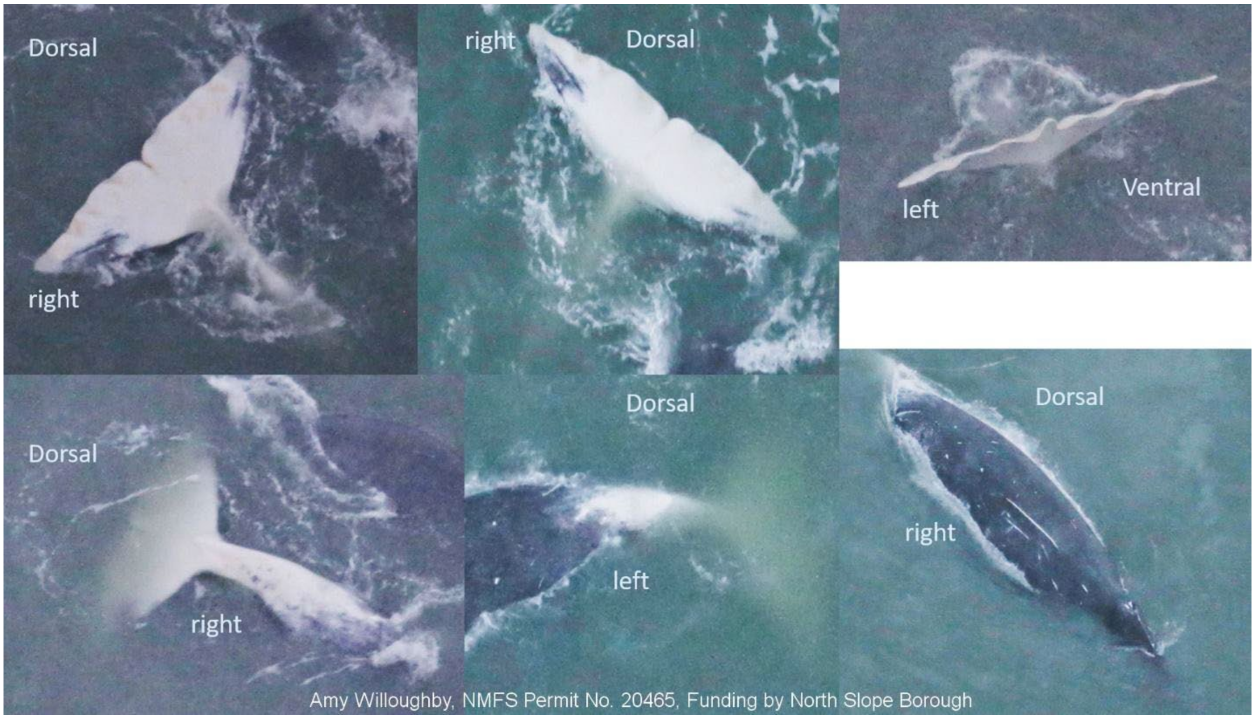
Flight No.	Date/Time (AK Local)	Latitude ºN	Longitude ºW	Species	Behavior	Group Size	Calf No.	Block
14	10/15/2020 13:31	71.342	155.830	bowhead whale	feed	17	0	12
14	10/15/2020 13:35	71.335	155.787	bowhead whale	rest	1	0	12
14	10/15/2020 13:35	71.316	155.786	bowhead whale	rest	1	0	12
14	10/15/2020 13:35	71.314	155.844	bowhead whale	swim	1	0	12
14	10/15/2020 13:45	71.301	155.771	bowhead whale	feed	1	0	12
14	10/15/2020 13:45	71.296	155.788	bowhead whale	feed	1	0	12
14	10/15/2020 13:46	71.287	155.765	bowhead whale	.	1	0	12
14	10/15/2020 13:46	71.285	155.841	bowhead whale	feed	40	0	12
14	10/15/2020 13:46	71.284	155.784	bowhead whale	.	1	0	12
14	10/15/2020 13:46	71.276	155.721	bowhead whale	.	3	0	12
14	10/15/2020 13:46	71.270	155.727	bowhead whale	feed	25	0	12
14	10/15/2020 13:46	71.264	155.778	bowhead whale	.	5	0	12
14	10/15/2020 13:46	71.262	155.772	bowhead whale	.	5	0	12
14	10/15/2020 13:49	71.282	155.847	bowhead whale	feed	56	0	12
14	10/15/2020 13:50	71.288	155.807	bowhead whale	feed	1	0	12
14	10/15/2020 13:51	71.267	155.741	bowhead whale	feed	2	0	12
14	10/15/2020 13:51	71.265	155.708	bowhead whale	feed	30	0	12
14	10/15/2020 13:54	71.302	155.733	bowhead whale	swim	1	0	12
14	10/15/2020 13:54	71.287	155.724	bowhead whale	swim	2	0	12
14	10/15/2020 13:54	71.288	155.748	bowhead whale	swim	1	0	12
14	10/15/2020 13:56	71.312	155.765	bowhead whale	swim	2	1	12



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



A group of 31 bowhead whales was observed feeding approximately 60 km east of Point Barrow, Alaska, on Flight 14, 15 October 2020.



A female bowhead whale with a remarkably white posterior was sighted with her calf (the calf's back is visible in the bottom left image), approximately 60 km southeast of Point Barrow, Alaska, on Flight 14, on 15 October 2020. This collection of images shows the extent of the light pigmentation. Here the whitening appears to extend from the flukes into the lower lumbar of this whale. Loss of pigmentation on the peduncle and flukes are an indication of advanced age (George et al. 2020). The image on the bottom right also displays scarring that could aid in matching her to previous and future sightings.

APPENDIX F: ABBREVIATIONS AND ACRONYMS

AEWC	Alaska Eskimo Whaling Commission
AFF	Automated Flight Following
AFSC	Alaska Fisheries Science Center
ASAMM	Aerial Surveys of Arctic Marine Mammals
BLM	Bureau of Land Management
BOEM	Bureau of Ocean Energy Management
BS	Beaufort Sea (specific to beluga population)
BWCA	Barrow Whaling Captains' Association
CAPs	Cetacean Aggregation Protocols
CICOES	Cooperative Institute for Climate, Ocean, and Ecosystem Studies
ECS	Eastern Chukchi Sea (specific to beluga population)
e.g.	for example
ELT	emergency locator transmitter
etc.	et cetera
ft	feet
GPS	Global Positioning System
hr	hour
HUA	high-use area
i.e.	that is
km	kilometer
m	meter
MCC	Main Construction Camp
mi	mile
min	minute
nmi	nautical mile
No.	number
NSB	North Slope Borough
NSB SAR	North Slope Borough Search and Rescue
NOAA	National Oceanic and Atmospheric Administration
OE-Si	On Effort sighting(s)
P	probability
PIC	pilot in command
PLB	personal locator beacon
SD	standard deviation
sec	second
SST	sea surface temperatures
Tr	transect
UTM	Universal Transverse Mercator
UW	University of Washington
WPUE	whales or walruses per unit effort (index of relative abundance or occurrence)
Z	standard normal variable

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