SC/68C/ASW/03Rev1

Sub-committees/working group name: ASW

FIELD REPORT OF THE 2019 ICE-BASED BOWHEAD SURVEY OFF POINT BARROW, ALASKA

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[1]North Slope Borough, Department of Wildlife Management, PO Box 69, Utqiaġvik (Barrow), Alaska 99723
[2]Applied Physics Lab, University of Washington, 1013 NE 40th St, Seattle WA 98105
[3]University of Alaska Fairbanks, Seward Marine Center, PO Box 730, Seward, AK 99664
[4]Givens Statistical Solutions, LLC, 4913 Hinsdale Drive, Fort Collins, CO 80526
[5]DeLongView Enterprises, PO Box 85044, Fairbanks, AK 99708

ABSTRACT

The 2019 bowhead whale ice-based abundance survey was conducted near Point Barrow, Alaska, from 16 March to 23 May. A total of 2,409 "New" (primary sighting), which includes 34 calves, and 353 "Conditional" whales (50% chance of being "New" sighting) were counted in 657 hours of watch. While every effort was made to conduct the survey in a manner consistent with past surveys, several factors compromised visual detection in 2019. Leads were closed during the beginning of the migration; however, once they opened, the leads grew much wider than in most past surveys. An unusual shorefast ice event in which a large portion of ice broke off close to shore between Point Franklin and Utqiaġvik likely caused whales to migrate farther from the lead edge than usual. The Point Barrow area was designated as a power-boat hunting area; nevertheless, due to the ice conditions, it was also the best location for the observation perch. The motorized skiffs appeared to have a substantial effect on whale behavior, distribution, and the number of whales observed in 2019. Other locations farther south were not suitable for counting bowheads because an ice attachment (*iiguaq)* blocked the view of the lead and made these locations unusable. The primary perch was set in relatively shallow water which is associated with a lower proportion of whales within 4 km of the ice edge (termed P_4) than perches in deeper water, examples include the 1993, 2001, and 2011 seasons. Five ice floes became grounded in the lead partially obstructing the viewing area at the primary perch in the north. The 2019 survey was visual-only and, unlike previous surveys, did not include an acoustic array to locate whale positions. Two acoustic recording units, however, were deployed on 24 and 31 March to acoustically document the season (i.e., call rates, call types, whale song, etc). Unfortunately, neither could be retrieved post-season. Since an acoustic array was not deployed, a P_4 estimate specifically for the 2019 could not be computed. Instead, a weighted average of past P_4 statistics was used to correct the estimated number of whales within 4 km of the lead edge (N_4). Despite these limitations, sufficient visual effort occurred during periods with open leads, and sufficient numbers of whales were seen to allow calculation of an abundance estimate. Givens et al. (2020) calculated an abundance estimate of 12,505 whales (CV 0.228) for the 2019 season. In a subsequent paper, Givens et al. (2021) estimated a correction factor for boat disturbance that increased the initial abundance estimate by about 12%, yielding a corrected abundance of 14,025 (CV=0.228).

INTRODUCTION

Understanding the size and trends of populations is vitally important for making informed management decisions about sustainable harvests, including for bowhead whales (*Balaena mysticetus*). Bowheads have been counted from the ice edge near Utqiaġvik (formerly Barrow), Alaska, since the 1970s. Counts were conducted annually through the late 1980s, but as the estimates became more accurate and suggested a relatively large growing population, the surveys became less frequent. In some cases, field work was unsuccessful, primarily because of challenges associated with counting whales from the sea ice, but also because of the vagaries of weather. Currently, we count whales about every 7 to 8 years in order to achieve a new estimate within the 10-year time period, as requested by the International Whaling Commission's Scientific Committee (SC), which agreed that a population update was needed every ~10 years.

Since 1978, the majority of the population surveys have been conducted from the edge of the sea ice (George et al. 2013); however, three abundance estimates have been computed based on aerial photo-identification surveys using mark-recapture methods: 1985-1986 (da Silva et al., 2000), 2003-2004 (Koski et al. 2010), and 2011 (Givens et al. 2017, 2018). Ice-based methods have typically been preferred due to the greater precision and narrower confidence limits relative to the photo-identification approach. The previous population estimate for the Bering-Chukchi-Beaufort (BCB) seas stock of bowhead whales occurred in 2011. That ice-based effort resulted in an estimate of 16,820 whales (95% CI: of 15,176 – 18,643) (Givens et al. 2016). Both methods typically require three to five years to obtain a final estimate, from initiation of fieldwork to data processing, analysis and publication. Spring 2019 was our last opportunity to conduct an ice-based survey in order to ensure an estimate was completed by 2021 as specified in the IWC Aboriginal Whaling Scheme.

METHODS

Visual Survey Field Methods

We made every attempt to conduct the 2019 survey in a manner consistent with past seasons such as perch location, timing, survey methods, etc. This included an intensive three-day training session at the start of the survey, which focused on observation techniques, data collection, and safety. Several observers had worked on at least four previous bowhead surveys (see footnote[1]). Details of survey methods have been described in earlier publications (Clark *et al*., 1986; Krogman *et al*., 1989; Zeh *et al*., 1993; George *et al*., 1995). In 2019, as in other surveys, visual counts were made from perches situated on top of an ice ridge located on the shorefast ice as near to edge of the shear zone, or lead, as possible (Fig. 1). It is safer and preferable, but not always possible, to establish perches on grounded pressure ridges. In 2019, two perches were used: Clifford Perch, about 4 km west of Naval Arctic Research Laboratory facilities (NARL), and Roxy Perch, 5 km northwest of Point Barrow (Fig. 1),

[1] Observer experience. Number of prior surveys in parenthesis if more than 1. Alphabetically: Ryan Adam, Baxter Akootchook (2), Perry Anashugak (15), Bob Brouillette, Ross Burgener (2), Lindsay Cameron, Geoff Carroll (22), John Citta (3), Stacey Davis, Leandra de Sousa, Alicia Flores, Hannah Foss, Nick Gales, Tiff Gales, Andrew George, Craig George (20), Geof Givens (2), Cyd Hanns (4), Bill Hess, Tyson Kade, Nicole Kanayurak, Olive Kanayurak, Darren Kayotuk, Madison Kosma, Doreen Leavitt, Frances Olemaun, Brian Person (2), Leslie Pierce (2), Kimberly Pikok, Dave Ramey (16), Ethan Roth (2), Robert Scott, Todd Sformo (2), Heidi Sinclair, Kate Stafford (3), Raphaela Stimmelmayr, Robert Suydam (9), Peter Thomas, Andrew Vanderjack, Andrew Von Duyke, Michael Wald (6), and Laura Weingartner.

although the latter perch was used almost exclusively due to the ice blockage. However, Roxy perch was on more stable ice and closer to the lead. During a typical observation period, one observer operated a theodolite (used for obtaining positions of whales at the surface), a second observer scanned the area for whales, using binoculars, and another recorded the data, although all watched for whales. During busy times, a fourth observer would help with data recording and scanning for whales. Three-hour watches were used in 2019 rather than the typical 4-hour watches used in the past (although 3-hour watches are not unprecedented). Observers worked two 3-hr shifts per day over a six-day workweek. The shifts overlapped by two hours so that there was always one rested observer and at least one observer acquainted with recent whale positions and lead conditions. A 24-hour watch was maintained by at least two but usually three observers as daylight and other conditions allowed.

One critical aspect of data collection involves linking sightings of the same whales (or groups of whales). Observers used nautical-type plotting sheets and calculators to link whale sightings and evaluate whether a sighting was a "New" whale (i.e., a whale not previously seen during the season), a re-sighting, referred to as a "Duplicate", or a possible re-sighting (i.e., conditional whale, see below). Plotting sheets were used in the earliest survey years and then again in more recent surveys (1993, 2001, 2011) to facilitate linking sightings. Calculators have also been used since 1980 to calculate whale swim speeds and movement angles of whales, which also improves the ability to link sightings (George *et al.*, 1995, 2001). Codes were assigned to linked whales depending on the observers' confidence that the sighted whale(s) had been seen before. Duplicate sightings were assigned the codes of X, Y or Z if observers were 100%, 90% or 50-90% confident, respectively, that the whale(s) had been previously seen (Table 1). An R (roll series) sighting is essentially a subset of an X sighting, applied when whales were sighted more than once in a single surfacing sequence. Whales that could not be assigned with certainty as New or Duplicate were recorded as 'Conditional' (50% chance of being seen previously and count as 0.5-whale in the seasonal tally). This linking process is done to reduce the possibility of double counting a whale.

Acoustic Surveys

While visual methods were similar with past surveys, a notable difference in the 2019 study design was that an acoustic array for locating bowhead calls was not deployed (Givens et al. 2016). Two AURALs (underwater hydrophones and recorders) were deployed in the Chukchi Sea at locations west of NARL (Fig. 1). One was at the terminus of Trail 2 (71° 20.972' N, 156° 41.622' W) and a second 3 nm west of Trail 4 at (71° 23.219' N, 156° 44.840' W). Also, approximately 6 hours of acoustic recordings were made per day at the perch by deploying an acoustic recorder ('SoundTrap') during K. Stafford's watch hours.

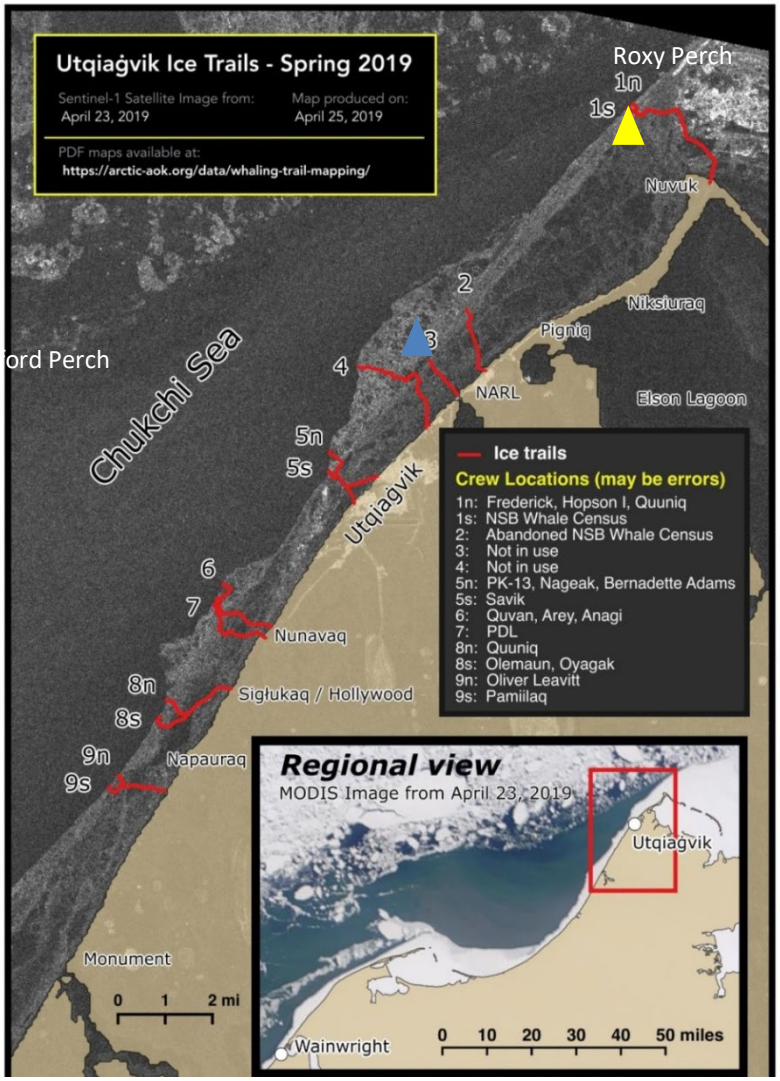

Figure 1. Map of the 2019 shorefast ice off Utqiaġvik, Alaska, showing the positions of whaling crews and perches. Map produced by Matt Druckenmiller, NSICD, Boulder, CO. Essentially all survey observations were made at Roxy Perch on the northernmost trail in the figure. Blue triangle = Clifford Perch; yellow triangle = Roxy Perch.

RESULTS AND DISCUSSION

Visual Survey Results

The 2019 survey started with brief watches on 16, 17, and 23 March (Fig. 2, Table 2) west of NARL (Clifford Perch). However, leads closed in late March and attached seaward of Clifford Perch forcing us to abandon that perch. Bowhead calls were detected acoustically on the SoundTrap on 7 April in closed leads. Leads finally reopened on 14 April at Roxy Perch when the first whale was seen which was several days later than the 2011 survey. Sufficient visual effort occurred during periods of open leads that allowed an abundance estimate to be calculated (Givens *et al*. 2016). A total of 2,409 New (including 34 Calves) and 353 Conditional whales were observed in 657 hours of watch during the 2019 season (Fig. 2; Table 1). Givens et al. (2020) provide an abundance estimate for the 2019 season of 12,505 whales (CV 0.228). The analysis includes corrections for missed watch, the proportion of whales beyond observer vision (P_4), and other factors such as 'group size'. However, Givens et al. (2021) estimated an additional correction factor for boat disturbance that increased the initial abundance estimate by about 12%, yielding a corrected abundance of 14,025 (CV=0.228). That estimate is being reviewed by the SC in 2021.

Over the past 40 years, our experience conducting ice-based surveys has been that the surveys either entirely "fail" due to weather and sea ice conditions (e.g., 1979, 1984, 1992, 1999, 2000, 2009, 2010) or are quite successful (e.g., 1978, 1982, 1993, 2001, 2011) with sampling occurring across most of the migration period. In a comparative sense, the 2019 season fell between these extremes. Factors affecting the count were many and included closed leads during the first two weeks of the survey (1-14 April), relocating the perch from west of NARL to northwest of Point Barrow, huge shore leads 50+ miles in width, extensive trail building, exceptionally long commutes for watches, significant interference from powerboats, and ice floes in the lead. In the 1980s, the ice provided a sturdy platform into the first weeks of June, but that has not been the case in recent years as the sea ice has become thinner and less stable due to climate change.

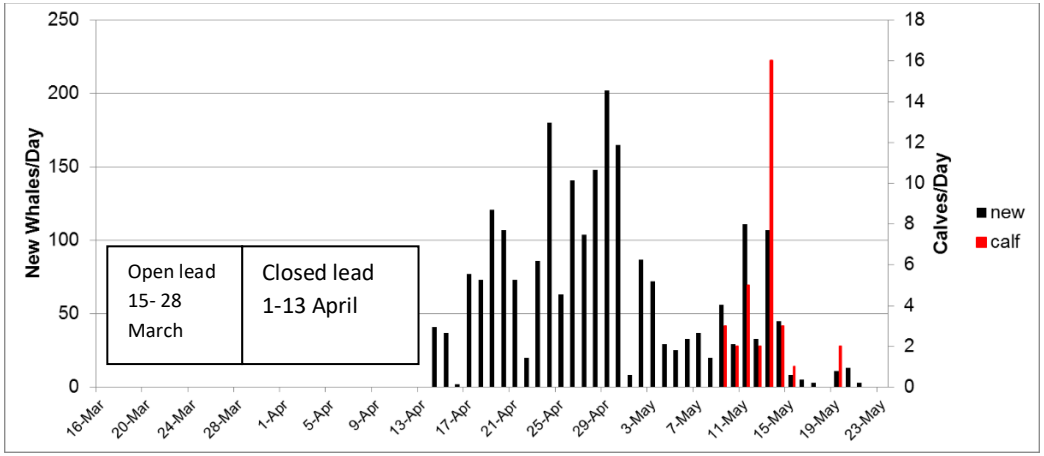

Figure 2. Numbers of new whales and calves seen per day during the 2019 season.

Number of Calves Seen

Of the 2,409 primary sightings, 34 (1.4%) were calves which is near to the long-term average (1.5%). Calf production is highly variable among seasons (Clarke et al., 2018), so an average is not a very meaningful statistic in this case. For instance, in 2019 observers logged more calves in a single day (13 May) than in the *entire* 2011 season in which 3,379 new whales were counted which is a comparatively low calf count based on long term survey records. In 2001, a total of 121 (3.7% of total count) calves were seen, which is the highest in any season (Table 2) (George et al. 2004). Historically, mature females and the vast majority of mother-calf pairs pass Pt. Barrow in mid to late May the final phase of the migration (George et al., 2004). Our 2019 survey effectively ended on 20 May when the northern perch was abandoned for safety reasons (the brief watch at Clifford Perch 21-23 May was not used in the abundance estimate (Table 1; Givens et al, 2020). Therefore, it is quite likely that many more mother-calf pairs migrated past Point Barrow in the final week of May and early June and were missed in the survey. We also note that the 2019 NMFS aerial summer survey in the Beaufort Sea recorded a near-record high percentage of calves further suggesting that 2019 was a high calf-production year (Stimmelmayr et al., 2020).

> Hunter Observation - Billy Adams statement (15 May) regarding calves:
> *"I was out in a boat for 13 hours yesterday looking for ingutuq[2], but did not come across any that size. Throughout the day almost every boat that were out which may have been 6-8 boats encountered cow and calves! We were all scattered from*

[2] Iñupiat: fat yearling whale, whale 25-29.9 feet (7.6-9.1 m) in length

the tuvaq[3] *and out to 14 miles offshore. At least every 2 hours there was cow and calf pair reported by whalers. I don't know if I remember seeing that many cow and calves. Most of the whales were on the pack ice side which was about 14 miles out where Arey crew harvested their 40-45 footer in my estimation at that momentous moment. I did not carry my camera on this day, probably could have been very useful for Craig and others*."

Survey Chronology

A chronology of the 2019 season is reported in tabular form. Here, important events during 2019 survey are listed below by date.

Nov 2018	Observation crew selection and long-lead preparations began (food and equipment ordering, theodolite repair, etc.)
19 Feb 2019	Began skidoo and sled repair and refurbishing; experienced crew arrives for survey preparations
1 Mar	Ice-recon flight with NSB Search and Rescue
2 Mar	First trail building began NNW of Nuvuk (i.e., Point Barrow) to a possible perch location (Roxy)
3 Mar	Trail building starts to Clifford perch ~1.5 west of NARL along the 60 ft bathymetry line.
15 Mar	Completed trail to Clifford Perch
16 Mar	First watch at Clifford
17 Mar	Watch at Clifford with near perfect visibility and lead conditions; no whales seen
18-20 Mar	Strong west winds close leads
23 Mar	Wind changes to ENE; Short watch; 90% open water; no whales
24 Mar	Big section of shorefast ice breaks off from Pt. Franklin to Monument (south of Utqiaġvik). First deployment of AURAL device in the Chukchi Sea
27-31 Mar	Strong SW wind, closed leads, ice attaches in front of Clifford
27-29 Mar	Training days; lead is full of heavy ice, slowly moving north
31 Mar	Second deployment of AURAL device in the Chukchi Sea
3-6 Apr	Intermittent watches at Clifford during closed leads
7 Apr	First bowheads detected acoustically
8 Apr	Ice *iiguaq*[4] remains attached at Clifford; recorded more bowhead calls
9 Apr	Lead closed but east wind increasing; crew completing trail and perch north of the Point (Roxy)

[3] Iñupiat: ice edge nearest the shore
[4] Iñupiat: shorefast ice attachment

10-13 Apr	East wind opens leads along coast (but not at Clifford)
14 Apr	Lead opens at Roxy (not Clifford); first whales counted!; powerboating starts 200 m from perch
22-23 Apr	Difficult counting conditions—high winds, flurries, white caps; fixed windbreak damaged by high winds
24 Apr	Polar Bears are a continual distraction; warning shots to deflect bears are fired from perch
26-29 Apr	Strong south wind closes leads; so called 'barrier islands' ice-floes grounded just west of Roxy Perch (Fig. 6)
30 Apr	Very wide lead (> 50 miles wide west of Utqiaġvik)
1 May	Crew built up perch to 7.01 meters in height during a fog watch
2 May	First 24 hr watch; windy, foggy, dark, hard to see whales in the early AM
7 May	Powerboating opens for entire coast because whales were farther offshore than normal.
8 May	First lead-width measurement (3181 m) possible since 30 Apr; i.e., Lead Condition 3
9 May	First cow/calf pair observed; numerous polar bears near perch
10 May	Large piece of ice broke off the front of Roxy; large crack near Nuvuk (i.e., Point Barrow); 4 bears by perch
16 May	East winds picked up; many waves chipping off ice edge; observers felt a crack under perch; "barrier islands" 2 and 5 moving south; watch shut down; an observer is uncomfortable with the ice conditions and quits
17 May	Watch on and off at Roxy due to high winds (up to 30 mph); many whitecaps; poor viewing; Clifford Perch has finally opened up
17-18 May	NE wind storm, results in break in watch; evaluating perches, continuing watches at Roxy
19 May	New cracks forming at Roxy; only 1 "Barrier Island" left
20 May	Last watches at Roxy, sections of the edge still falling off, lead had a lot of ice and intermittent light snow during the day made watches difficult; some very large whales seen
21 May	Re-starting watch at Clifford; a few distant very large whales counted; breaking down Roxy perch and Camp
22 May	7 hr watch at Clifford, no whales
23 May	Short watch, no whales
24 May	SW wind storm takes out Clifford perch; End of Season

Acoustic Array

An acoustic array was *not* deployed during the 2019 survey. This approach was reviewed earlier by the IWC SC at their 2018 meeting and deemed acceptable (see: IWC SC Report, 2018). The SC recognized that this would increase the CV of the estimate but would meet the guidelines for surveys. While a full array was not deployed, two AURAL acoustic recorders were deployed. One was on 24 March 2019 at 71° 20.972' N, 156° 41.622' W. The second deployment was on 31 March, 2019 at 71° 23.219' N, 156° 44.840' W. Also, many hours of acoustic recordings were

made with an acoustic recorder (Sound Trap) that was deployed at Roxy Perch during watch hours (Table 3). Bowhead calls were detected acoustically with the SoundTrap on 7 April and again on 8 April. They were not heard earlier in the spring when the SoundTrap was deployed in March. Unfortunately, an effort to retrieve the AURAL recorders during the summer was unsuccessful. One unit was located but it had become buried under a grounded pressure ridge during the spring and was likely disabled. The other unit failed for some reason and was never detected.

The P_4 statistic, the percentage of calling whales within 4 km of the ice edge, is computed with acoustic data. It is assumed to be representative of the distribution of all migrating whales – and not just vocalizing whales. Zeh and Punt (2005) computed a mean P_4 estimate of 0.67 for all years with sufficient data. Values range from a low of 0.405 in 1986 to a remarkably high value of 0.933 for 1993, which is the highest of any census. Obviously, a P_4 estimate cannot be made for 2019 since there was no acoustic array or aerial surveys. Givens et al. (2020) used P_4 estimates and perch positions from past seasons to compute a P_4 value of 0.5713 to be applied to the 2019 season.

Factors Affecting the Survey and Visual Detection

Closed Lead/Missed Watch

Leads were open along the entire Chukchi Sea coast, and Clifford Perch was open through most of March, however it was blocked by an *iiguaq* (Inupiat term for an attachment of shorefast ice) from ~ 27 March through 21 May. The *iiguag* (~ 2 km wide) attached to the shorefast ice in an area extending from roughly Utqiaġvik to just north of NARL (Fig. 1). Leads in the ice began opening on 13 April at all locations except for the *iiguaq* at Clifford Perch, which rendered that perch useless for nearly all the 2019 survey. A new perch—Roxy—was quickly built and watches commenced there on 14 April.

Lead Width

Following the period of closed leads (27 March to ~13 April), the shore lead opened under strong and persistent NE winds and became increasingly wider (Fig. 3) as the season progressed. It is unusual, or possibly unprecedented, for leads to increase to nearly 100 km in width by early May.

> Hunter Observation - Gordon Brower statement:
> *"Looking at the ice maps during the spring hunt, the lead was open far out early on, [and] whales had a huge area of movement. I did not see the type of movements that we all expect. The period where we get sleepless days due to whales migrating right along the shorefast ice, didn't happen, although some did get close. There were some along the edge but not the hundreds day in and day out. The Nuvuk[5] area being closer [to the ice] and the bottle neck always up North where they have to come close, is merely due to the ice and the abundance of ice and the relatively modest open lead there. The [whales] had no choice but to concentrate to move through that area. I can't say that about the [area] west of Barrow where a massive open lead up to 50+ miles existed throughout the season. A couple times the massive ice movement occurred, as predicted, that would make it advantageous for those whaling west or down south from Barrow. Primarily,*

[5] Iñupiat: Point Barrow

that the huge pan ice was 5 miles wide and about 10 miles long, could funnel migrating whales along the 10-mile area of that [shorefast] ice, as it [the ice floe] was long east to west. This was important as it facilitated chase as we moved into outboard [season]. The ice has a lot to do with movements. I suspect this was the case where we did not see the concentration [of whales] right at the shorefast ice."

Shorefast Ice Configuration

Another unusual aspect was the configuration of the shorefast ice. The shorefast ice broke very close to shore from the Wiley Post Monument (also known as Ualakpa to the south of Utqiaġvik) to Point Franklin. Senior hunters at Barrow agreed that this caused the whales to swim straight from Pt. Franklin to Pt. Barrow, and were therefore located farther offshore of the shorefast ice than in a typical year near Utqiaġvik where many crews hunt (Fig. 1; Figs. 4a,b).

Hunter Observation - Eugene Brower statement:

"[With regard to] the migration route from Franklin Point, the whales go straight toward Nuvuk when the shore ice from Franklin Point breaks off towards the land. The shorefast ice is only 1/4 to 1/2 mile out [from Peard Bay] then it kind of goes out from NARL to Nuvuk. Also, when we have big open water [leads], 10 to 30 miles out, the whalers that are whaling southwest of Barrow will see a blow once in a while but nothing close to the shore ice."

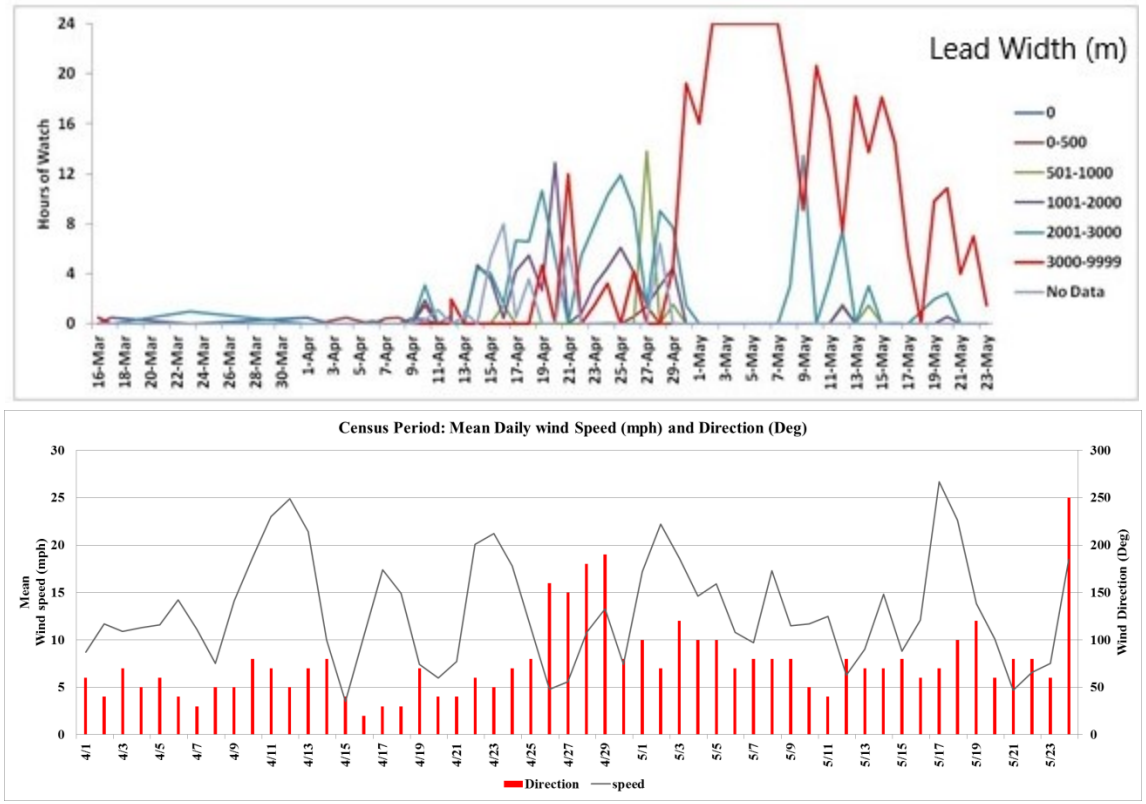

Figure 3. Top Panel. Hours of watch and lead width (meters) vs date through the survey period. Note the high frequency of very wide leads (> 3000 m) as viewed from the perch after 29 April. Bottom panel. Wind speed and direction during the survey period.

Fig. 4A **13 May 2011**

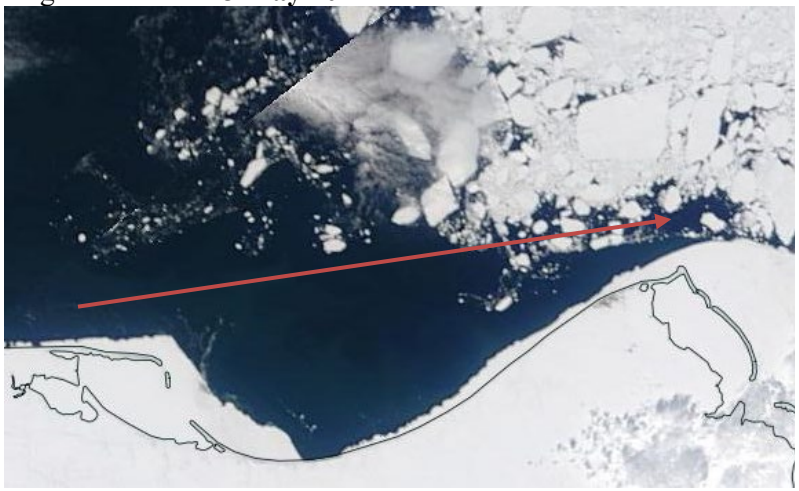

Fig. 4B **13 May 2019**

Figure 4A and 4B. Satellite images of the region near Point Barrow in 2011 and 2019 illustrating differences in shorefast ice morphology and proximity of the "pack ice." **Fig. 4A**. Image from 13 May 2011 showing the sea ice configuration southwest of Barrow. Note the narrower lead in 2011 that probably funneled whales along the shorefast ice. **Fig. 4B**. Image from 13 May 2019 of the sea ice in the Barrow region. Note that the shorefast ice broken off to the shore southwest of Utqiaġvik (Barrow). Also note the extremely wide leads west of Utqiaġvik. Red arrows indicate the possible whale migratory path.

Powerboat effects on Whale Distribution

A substantial effect that likely resulted in a downward bias of whale observations in 2019 was the use of powerboats in the proximity of the perch and later to the SW of the perch location. Observers noted a downturn in the whale count in the hours after powerboats launched, which is consistent with observations from past seasons and comments we have received from elders and senior whaling captains. Boat launches and their effect was intermittent but occurred throughout the entire season (Appendix 1; Fig. 5). When the lead opened on 14 April, powerboat hunting started immediately. Then on 7 May, the Barrow Whaling Captains Association (BWCA) opened the entire coast to powerboat hunting because so few whales had been seen near the ice-edge. Boating appeared to further disturb the whales which then migrated even farther offshore. It is well established in the literature that bowheads are sensitive to noise from boats (Richardson et al., 1995). Indigenous hunters have known for centuries that noise disturbs migrating bowhead whales. Ethnographic studies at Utqiaġvik in 1881 described local practices to reduce noise disturbance during bowhead hunting:

> "During this period, and while the whaling is going on, no pounding must be done in the village [several miles away], and it is not allowed even to rap with the knuckles on wood for fear of frightening away the whales" (Murdoch, 1892).

Carroll and Smithhisler (1980) described bowhead reactions to powered whaling skiffs (used to retrieve whales) on the migration at Utqiaġvik:

> "When bowheads are pursued by Eskimo whalers their usual reaction is docile escape. When they perceive something as threatening, bowheads quickly dive and do not resurface in the immediate area."

Bockstoce (1986) described the Yankee whaleman's observations on noise disturbance:

> "Silence was important. A bowheads hearing is very good. The dull rattle of oars in the muffled oarlocks was usually enough to 'gally' the whale and drive it under."

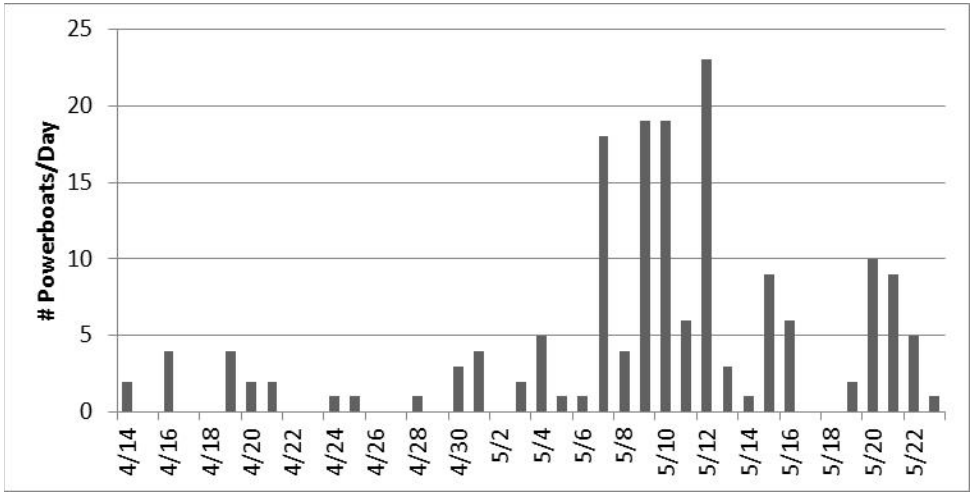

Figure 5. Numbers of powerboats cruising in the lead by date. Beginning on 7 May, all areas of the coast were opened to powerboating. Source: Barrow Volunteer Search and Rescue.

Perch Height

The height of the primary perch (Roxy, 6.2 m) used in the 2019 survey was one of the shortest perches in the last 40 years (Givens et al, 2020) and about half the height of the successful 2011 season (~12 m). Whales can be easier to detect from higher perches and can be seen at greater distances. Thus, lower perch height could lead to reduced detection probabilities of sighted whales.

Lead Condition vs Whale Distribution

On 30 April, the lead widened to Condition 4 (wide open) and remained that way for eight days, including through all the 24-hour watches in 2019. Although there were intermittent periods of Lead Condition 3 (i.e., well-defined lead or series of polynyas), most watches were conducted under Lead Condition 4. The impression of the observers was that the wide leads affected whale distribution. That is, when lead conditions were scored as "wide open" (i.e., Lead Condition 4), the observers saw fewer whales than in Lead Condition 3. Also the observed distance to the whales increased. While the impression was that the mean sighting distance in 2019 was greater than past years with fewer whales near the perch, in reality that was not the case. The mean distance was ~1,900 m in 2019 which is similar to the mean sighting distance in 2011 at about ~2,000 m. This is somewhat perplexing, and it could be that the lower perch gave observers the *impression* that whales were further offshore and close to the horizon when in fact, they were not.

Whales were farther offshore for whaling crews at trail locations #4 through #9 (Fig. 1). This is reinforced by the fact that the whaling crews using skin boats to the SW of Nuvuk (i.e., Point Barrow) did not strike a single whale in spring 2019 and all 9 whales were harvested using powered skiffs far offshore from the lead edge. This suggests that whales tended to migrate further offshore of Utqiaġvik in 2019 than in past seasons. In strong contrast, in 2018 the shorefast ice sheet was much wider extending out over deep water. Hence, the whales migrated along the lead edge and vast majority of whales were taken using skin boats in 2018 close to the edge.

> *Hunter Observation* - Quuniq Donovan:
> *Whales were far offshore and not near the lead-edge in spring 2019. That's why we moved to Nuvuk where powerboating was allowed. Briefly there was a huge ice floe in the lead that funneled whales towards the tuvaaq* [shorefast ice]. *We saw lots of whales then chased some with the skin boat. The ice hit the point near Nunavaaq (SW of Utqiaġvik) and knocked it off. Then the lead opened wide, and few whales were seen. All the whales at Utqiaġvik were taken by powerboats in spring 2019.*

> *Hunter Observation* - Billy Adams:
> *We departed on April 14, 2019 out near Nunavaaq and set up camp near the ice edge. Maybe 5 whales came close but 3 were too large in the first few days after that many whales traveling in large groups farther out. We went to Nuvuk after the whalers who locked the trail down landed whales and landed a small ingutuq* [a yearling whale] *using a powerboat. Saw many many small whales pass when it was glass water but whales were way out in the distance. Maybe more small whales could have been taken if powerboat season started April 25th as elder Wesley Aiken observed the shore ice to be too near to the shore. The open lead was too close to shore was the main reason whales were traveling farther out.*

Grounded Ice floes in Lead

During strong south winds between 26-29 April, five ice floes grounded ≤500 m seaward ("in front") of the perch which significantly obstructed the viewing area (Fig. 6) particularly offshore. In total, these grounded ice floes partially obscured about 53°of the roughly 180° observer-view of the lead.

Figure 6. Panorama from Roxy Perch showing the grounded ice floes in the lead which reduced visibility in significant portions of the lead.

Perch in Shallow Water

The water depth by Roxy Perch was measured at 15.2 m. This relatively shallow water may have led to fewer whales being counted than in some past seasons where perches were set in deeper water. To test this, we compiled data for all years with P_4 estimates. Perches set in shallow water, as in 2019, tended to have lower P_4 values than perches in deeper water (e.g., 1993, 2001, 2011) (Table 4). However, analysis by Givens et al. (2020) indicated that indeed position relative to Point Barrow has a significant effect on P_4 with higher values occurring south of Point Barrow.

Summary on 2019 Survey Conditions

Several factors likely caused a downward bias in the number of whales counted in the 2019 survey. Leads were closed during the first two weeks of April when the migration was likely underway based on acoustic recordings. For comparison, the first whales were seen on 14 April in 2019 vs. 9 April in 2011, and 30 March in 2010. The 2019 primary perch (Roxy) was not nearly as high as in other successful ice-based surveys. As noted earlier, Roxy Perch used at the start of the 2019 survey was roughly half the height of the perch used in the very successful 2011 survey. The crew had to commute nearly 2 hours per day to the perch which caused some observer-fatigue and significantly lengthened the workday. Polar bears

were unusually common during the 2019 field season and at times posed a safety risk and significant distraction particularly during watches with only two observers on the perch.

On the other hand, consistent east winds held the nearshore leads open for most of the season, which is very unusual compared with past seasons (Fig. 3). Also, the 2019 survey was not compromised by long periods of heavy fog with "Unacceptable" visibility which was common in 2011. As noted earlier, despite these limitations and the unusual ice conditions, observers gathered sufficient data to calculate bowhead abundance estimate for the 2019 season (Givens et al., 2020; 2021).

The question of whether an ice-based census is possible in the future has been a topic of interest in recent years. In our opinion the answer is likely "yes" for the near future with the understanding that the success rate of ice-based survey has been considerably less than 50% since it stated in 1978. A reason the ice-based survey may still be viable is that the migration passes Pt. Barrow about 2 to 3 weeks earlier than it did decades ago; hence, the ice is still fairly solid during a major portion of the migration. In 2019, although the shorefast ice broke off at the beach SW of Utqiaġvik and ice thickness was thin in many areas, terminal pressure ridges were grounded along much of the shorefast ice edge from Utqiaġvik to Point Barrow making it relatively safe. However, by the third week in May, the ice had become unsuitable for travel which is much earlier than in the 1970s and 1980s when it was possible to maintain the survey into June. Therefore, while ice-based surveys are still possible, other methods such as aerial line-transect surveys, photo-recapture or even analyzing high-resolution satellite imagery (Cubaynes et al., 2019 and 2020) may prove to be safer and more effective in the future and should be investigated.

ACKNOWLEDGEMENTS

We gratefully acknowledge the many researchers who conducted the 2019 ice-based surveys under very tough field conditions. Many of these technicians had worked on previous surveys as noted earlier. These include (alphabetically): Ryan Adam, Baxter Akootchook, Perry Anashugak, Bob Brouillette, Ross Burgener, Lindsay Cameron, Geoff Carroll, Stacey Davis, Alicia Flores, Hannah Foss, Nick Gales, Tiff Gales, Andrew George, Cyd Hanns (4), Bill Hess, Tyson Kade, Nicole Kanayurak, Olive Kanayurak, Darren Kayotuk, Madison Kosma, Doreen Leavitt, Frances Olemaun, Leslie Pierce, Kimberly Pikok, Dave Ramey, Robert Scott, Heidi Sinclair, Peter Thomas, Andrew Vanderjack, Michael Wald, and Laura Weingartner.

We thank the Whaling Captains Association at Barrow and the Alaska Eskimo Whaling Commission for allowing us to conduct these studies near their village during the whaling season–which can interfere with their activities. In particular, we thank the crews of Fredrick Brower, Hopson 1, and Quunik for allowing us to share their trail as the survey would have failed without their assistance.

We acknowledge the use of imagery from the NASA Worldview application (https://worldview.earthdata.nasa.gov/), part of the NASA Earth Observing System Data and Information System (EOSDIS).

Finally, we thank the North Slope Borough and the Alaska Eskimo Whaling Commission (with co-management funding from NOAA, NA16NMF4390120) for providing the financial support (~$400,000 and ~$100,000, respectively) for conducting surveys.

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Table 1. Number of sightings by date and perch for the 2019 survey. Column headings are as follows: Date = date sighting observed, Perch = perch name; New = primary sighting; C = conditional sighting,50% chance duplicate, R= Roll series duplicate; X = 100% confident duplicate, Y = 90% confident duplicate, Z = <90% confident duplicate, Calf = new calf sighting, New+Cond+Calf = total sightings, including conditional sightings weighted at 0.5, DecHr = decimal hours; Corr.Count = Number of New+Conditional+Calf corrected to 24 hr. watch.

Date	Perch	New	Cond.	R	X	Y	Z	calf	New+Cond+ Calf	DecHr	Corr. Count
16-Mar	Clifford	0	0	0	0	0	0	0	0	0.5	0
17-Mar	Clifford	0	0	0	0	0	0	0	0	0.5	0
23-Mar	Clifford	0	0	0	0	0	0	0	0	1.0	0
1-Apr	Clifford	0	0	0	0	0	0	0	0	0.5	0
2-Apr	Clifford	0	0	0	0	0	0	0	0	0.3	0
3-Apr	Clifford	0	0	0	0	0	0	0	0	0.3	0
4-Apr	Clifford	0	0	0	0	0	0	0	0	0.5	0
5-Apr	Clifford	0	0	0	0	0	0	0	0	0.3	0
6-Apr	Clifford	0	0	0	0	0	0	0	0	0.3	0
7-Apr	Clifford	0	0	0	0	0	0	0	0	0.4	0
8-Apr	Clifford	0	0	0	0	0	0	0	0	0.5	0
9-Apr	Clifford	0	0	0	0	0	0	0	0	0.4	0
10-Apr	Clifford	0	0	0	0	0	0	0	0	7.0	0
11-Apr	Clifford	0	0	0	0	0	0	0	0	1.1	0
12-Apr	Clifford	0	0	0	0	0	0	0	0	0.6	0
12-Apr	Roxy	0	0	0	0	0	0	0	0	2.0	0
13-Apr	Clifford	0	0	0	0	0	0	0	0	0.6	0
13-Apr	Roxy	0	0	0	0	0	0	0	0	1.0	0
14-Apr	Roxy	41	6	0		1	5	0	44	9.1	116
15-Apr	Roxy	37	4	0	3	4	1	0	39	13.0	72
16-Apr	Roxy	2	0	0	0	0	0	0	2	11.5	4
17-Apr	Roxy	77	7	0	6	7	5	0	80.5	11.4	170
18-Apr	Roxy	73	7	0	4	8	10	0	76.5	15.6	118
19-Apr	Roxy	121	24	1	1	11	10	0	133	18.0	177
20-Apr	Roxy	107	17	0		9	13	0	115.5	18.2	153
21-Apr	Roxy	73	16	0	4	13	2	0	81	18.2	107
22-Apr	Roxy	20	0	1	0	2	0	0	20	6.3	76
23-Apr	Roxy	86	20	1	2	8	2	0	96	12.5	184
24-Apr	Roxy	180	39	0	0	18	12	0	199.5	18.1	265
25-Apr	Roxy	63	8	1	0	9		0	67	18.0	89
26-Apr	Roxy	141	17	1	0	29	35	0	149.5	18.08	198

27-Apr	Roxy	104	12	1	0	16	3	0	110	18.08	146
28-Apr	Roxy	148	38	3	0	8	15	0	167	18.45	217
29-Apr	Roxy	202	39	0	0	36	21	0	221.5	18	291
30-Apr	Roxy	165	34	0	0	17	6	0	182	21	211
1-May	Roxy	8	0	0	0	0	0	0	8	16	12
2-May	Roxy	87	9	1	0	7	3	0	91.5	24	92
3-May	Roxy	72	5	6	0	4	2	0	74.5	24	74.5
4-May	Roxy	29	1	0	0	1	1	0	29.5	24	29.5
5-May	Roxy	25	2	2	0	1	0	0	26	24	26
6-May	Roxy	33	3	0	0	0	0	0	34.5	24	35
7-May	Roxy	37	1	0	0	0	0	0	37.5	24	38
8-May	Roxy	20	1	0	0	0	0	0	20.5	21	23
9-May	Roxy	56	5	0	0	3	0	3	61.5	23	62
10-May	Roxy	29	2	0	0	2	0	2	32	21	35
11-May	Roxy	111	18	0	2	5	2	5	125	19.8	146
12-May	Roxy	33	3	0	2	1	1	2	36.5	17.8	47
13-May	Roxy	107	11	2	2	18	1	16	128.5	18.2	148
14-May	Roxy	45	3	0	0	3	0	3	49.5	18	61
15-May	Roxy	8	0	0	0	0	0	1	9	18	11
16-May	Roxy	5	1	0	0	1	0	0	5.5	15	9
17-May	Roxy	3	0	0	0	0	0	0	3	6	13
18-May	Roxy	0	0	0	0	0	0	0	0	1	0
19-May	Roxy	11	0	0	0	0	1	2	13	12	22
20-May	Roxy	13	0	0	0	0	2	0	13	14	22
21-May	Clifford	3	0	0	0	0	0	0	3	4	18
22-May	Clifford	0	0	0	0	0	0	0	0	7	0
23-May	Clifford	0	0	0	0	0	0	0	0	2	0
	TOTALS	2375	353	20	26	242	153	34	2586	657	3517

Table 2. Effort, sighting conditions, and whales counted (excluding duplicate and conditional sightings) during years when the ice-based spring surveys or other shore-based counts were conducted.

Year	Beginning Date[1]	Ending Date[1]	Date of First Sighting	Total Watch effort (hrs)[2]	% Watch at FA-EX visibility (hrs)[3]	Number of whales seen[4]	Number of Calves[4]
1962	12 Apr	25 May[5]	12 Apr	--	--	177	3
1976	25 Apr	2 June	25 Apr	392	--	357	--
1977	19 Apr	3 June	20 Apr	395	--	327	4
1977	18 Apr	28 May[5]	--	546	--	185	--
1977	5 May	17 May[6]	--	--	--	49	--
1978	2 Apr	7 June[6]	14 Apr	691	--	280	--
1978	15 Apr	5 June	20 Apr	1,011	70	1,749	30
1979[7]	17 Apr	24 May	18 Apr	430	40	336	10
1980	17 Apr	4 June	21 May	881	93	1,392	4
1981	14 Apr	2 June	14 Apr	967	54	1,091	21
1982	17 Apr	4 June	26 Apr	935	56	2,174	51
1983	11 Apr	26 May	16 Apr	900	48	1,318	14
1984[7]	12 Apr	26 May	19 Apr	654	37	699	11
1985	7 Apr	9 June	21 Apr	1,030	49	1,294	12
1986	16 Apr	2 June	17 Apr	996	57	1,876	59
1987	2 May	30 May	2 May	448	59	1,376	7
1988	17 Apr	10 June	17 Apr	1,052	74	2,089	17
1992[7]	10 April	23 May	18 Apr	339	31	291	2
1993	10 April	4 June	17 Apr	1,067	74	3,383	66
1999[7]	25 April	19 May	--	300	--	406	--
2000[7]	7 April	12 May	13 Apr	473	--	1,606	1
2001	5 April	7 June	15 Apr	1,130[8]	46	3,295	121
2010	31-Mar	28 May	31 Mar	399[9]	40	1,332	12
2011	4 Apr	5-June	9-Apr	859 [10]	52[11]	3,379	10
2019	Mid-March	23 May[12]	14-Apr	657	85	2,409	34

Double dashes (--) denote unavailable data.

[1] The beginning and ending dates of the survey are the dates of the first and last watches respectively. Unwatched periods occur between these dates. Only visual, not acoustic, monitoring and counts are included.

[2] Total watch effort includes all watched periods, regardless of visibility, at the primary perch, South Perch, except for 1984. In 1984, watch was sometimes being conducted at two locations simultaneously although it was not possible to follow the standard North and South Perch procedures because of environmental conditions. All watch hours at all perches are included in the 1984 total, disregarding the fact that some of them overlap. No abundance estimate was possible.

[3] Indicates the amount of data on which visual survey estimates for the season could be based. It is the time between the first and last bowhead sightings of the season during which watch was being conducted under FA-EX visibility conditions. Periods of no watch due to unacceptable conditions are added to the denominator (total watch possible).
[4] Numbers of whales and calves include those designated as new whales at South Perch and those designated as missed at North Perch during seasons when both perches operated. For 1984, new whales seen at all perches are included. (Note: see Methods for definitions of 'new' and 'conditional' whale sighting.)
[5] Counts made at Point Hope in 1962 (Foote, 1964) and 1977 (Braham *et al.,* 1984).
[6] Counts made at Cape Lisburne (Rugh and Cubbage, 1980).
[7] Data insufficient to compute estimate.
[8] Includes ~40 hr of watch scored as 'unacceptable' visibility.
[9.] Includes 17 days with closed leads; 16 hour watches conducted in 2010
[10.] Effort for South perch; N perch effort was 182 hrs.
[11.] Rough estimate based on useable "effort" in Givens *et al*. (2013)
12. Three brief watches were made in March. The count effectively ended on 20 May as the data for 21-23 May were not used in the estimate.

Table 3. Hydrophone Acoustic Surveillance log.

Hydrophone Surveillance: Dipping Phone (D) and Soundtrap (S)			
Date	**time**	**Instrument: D or S**	**Comment**
21-Mar	4 min	D	test
22-Mar	30 min	S	Low quality recording
7-Apr	10 min	S	ice noise, faint bowhead, bearded seal. First detection of bowhead.
8-Apr	3 h	S	distant bowhead, bearded seal
9-Apr	26 min	S	nothing much - S may have been on the bottom?
11-Apr	1 h	S	Bearded seals, ice noise - no obvious bowheads
13-Apr	10 min	D	
13-Apr	23 min	S	Faint bowhead upsweeps and distant song - ice noise, bearded seals
15-Apr	23 min	D	wonderful loud clear bowhead songs, under ice cover, no water movement
15-Apr	44 min	S	Belugas, bowhead simple calls, bowhead song
16-Apr	16 min	D	songs, ice noise, beluga
16-Apr	30 min	S	Bearded seals, belugas, simple bowhead sounds, song, high background noise levels
19-Apr	3.5 h	S	Relatively few sounds despite numerous whales in lead. Pretty open water
21-Apr	30 min	D	Good loud bowhead song but a lot of wave noise - very windy and wavy

22-Apr	3 h	S	Lots of wave noise, good songs, calls, not as much as expected given many migrating, fair bit of ice in lead
23-Apr	2.3 h	S	Lots of wave noise, bearded seals, bowheads - faint song and upsweeps
24-Apr	9 h	S	Lots of wave noise, bearded seals, song
25-Apr	5.25	S	Lots of wave noise, bearded seals, song
26-Apr	9 h	S	Very calm conditions lots of lingering bowheads and distant belugas. Good songs, social sounds, gunshots, lots of bearded seals
27-Apr	3 h	S	Calm, lead condition 2, lots of ice so hard to get S in and out. Ice noise and singing and calling bowheads. Nothing very loud
27-Apr	30 min	D	Belugas and faint bowheads
28-Apr	8 h	S	Low wind and ice choked lead then some open water. Whales moving quickly north with the current, lots of belugas. Faint and good bowhead song and lots of simple calls
29-Apr	7.7 h	S	Good sound to noise ratio (SNR), loud bearded seal, bowhead song and calls, beluga
30-Apr	8.25 h	S	Good SNR, loud bearded seal, bowhead song and calls, beluga, lots of overlapping animals and species
1-May	7.75 h	S	Some background wave and ice noise, consistent bearded seals and bowheads but nothing really loud
2-May	4.5 H	s	Lots of wave noise, bearded seals, bowhead calls and song, not a good recording
3-May	0		No deployment
4-May	7.5 H	S	Calm day but still wave noise under the ice, boats in water, 6 bomb, bearded seals, belugas, bowhead FM calls including 'growls', song (but often too much water and boat noise), belugas, only distant whales seen
5-May	7.5 H	S	Small boats in water, bearded seals, wave noise, belugas, LF bowhead FM calls, simple song
6-May	1 H	S	Lots of ice and wave noise, in the background you can hear bearded seals and some bowhead - possibly song
7-May	7.5 H	S	Odd strumming in recordings. Bearded seals, lots of belugas and bowhead calls, no song
8-May	0		Water too rough for decent recording

9-May	7.5 H	S	Bearded seals, nearby belugas, lots of small boats in water, some low frequency bowhead signals
10-May	0		No deployment
11-May	7.75	S	Horrible wave noise, bearded seals, loud beluga, bowhead, wave noise reduced towards end of recording
12-May	7.4 H	S	Loud bearded seals, loud beluga, nice recording quality, bowhead FM, faint bowhead song
13-May	7.25	S	Loud song, bearded seals, calm at first so good recording
14-May	0		Water too rough for decent recording
15-May	0		No deployment
16-May	6 H	S	Loud bearded seals, loud beluga, some ice noise, loud bowhead song
17-May	0		Too rough for deployment
18-May	0		Too rough for deployment
19-May	1 H	S	Waves and “iffy” ice - noisy recording. Only heard bearded seals

Table 4. Proportions of whales within viewing range (P_4) vs water depth and distance from Point Barrow for previous surveys with acoustic data (P_4 data from Zeh and Punt, 2005).

Year	Perch	P_4 (acoustic)	SE	Weighted Average P_4 vis-aerial	SE	Dist. North PTB	Depth (m)	Comment
1982	South	0.567	0.191			1.19	18	North of Point
1985	Perilous, Flounder, Slipper	0.500	0.131	0.479	0.093	-0.76	31	Punt and Zeh give P_4 average for 3 perches. Perches had different depths, some were N some S of PTB; most effort at Slippery & Perilous, south of PTB. Unweighted
1986	Polar	0.515	0.080	0.405	0.065	2.79	15.2	Farthest north perch used for census, one of the shallowest too
1988	Tookalook III	0.740	0.062			0.31	18.3	main perch
1993	Carolyn, Spamalot	0.933	0.014			-2.66	38.1	Excellent data; highest raw count ever. Very high P_4. two perches Carolyn & Spamalot, most effort at Carolyn; Spamalot was N of PTB
2001	Natchiq, Pucker Factor	0.862	0.044			1.84	53.3	west of NARL
2011	Judy	0.62				-2.03	36.6	One perch used; high count
2019	Roxy					1.29	15.2	

Appendix 1. Data on outboard boating (dates and times) obtained from Barrow Volunteer Search and Rescue, Utqiaġvik, AK.

Event	**Crew**	**Month**	**Day**	**Launch time**	**Return Time**	**Time at Sea**	**Dist. To Perch (m)**
1	23	4	14	14:00:00	20:40:00	6.67	200
2	10	4	14	17:40:00	21:50:00	4.17	200
3	10	4	16	14:43:00	21:12:00	6.48	200
4	5	4	16	15:40:00	21:12:00	5.53	200
5	23	4	16	17:45:00	21:35:00	3.83	200
6	24	4	16	19:36:00	21:10:00	1.57	200
7	10	4	19	13:47:00	22:35:00	8.80	200
8	5	4	19	15:06:00	22:35:00	7.48	200
9	23	4	19	16:39:00	22:35:00	5.93	200
10	24	4	19	19:42:00	22:35:00	2.88	200
11	5	4	20	11:15:00	20:17:00	9.03	200
12	10	4	20	11:43:00	20:16:00	8.55	200
13	5	4	21	9:58:00	17:30:00	7.53	200
14	10	4	21	10:57:00	17:30:00	6.55	200
15	10	4	24	23:19:00	23:59:59	0.68	200
16	10	4	25	0:00:00	4:28:00	4.47	200
17	25	4	28	16:39:00	19:15:00	2.60	22,000
18	10	4	30	21:24:00	23:59:59	2.60	200
19	5	4	30	21:34:00	23:59:59	2.43	200
20	23	4	30	23:20:00	23:59:59	0.67	200
21	5	5	1	0:00:00	3:40:00	3.67	200
22	10	5	1	0:00:00	3:41:00	3.68	200
23	23	5	1	0:00:00	2:52:00	2.87	200
24	5	5	1	16:41:00	20:31:00	3.83	200
25	10	5	1	16:46:00	18:38:00	1.87	200
26	23	5	1	16:55:00	18:38:00	1.72	200
27	24	5	1	17:18:00	18:38:00	1.33	200

28	16	5	3	10:46:00	19:42:00	8.93	28,500
29	4	5	3	22:34:00	23:59:59	1.43	200
30	4	5	4	0:00:00	0:20:00	0.33	200
31	4	5	4	10:55:00	22:35:00	11.67	200
32	23	5	4	11:21:00	22:35:00	11.23	200
33	2	5	4	15:47:00	22:35:00	6.80	22,000
34	24	5	4	16:15:00	22:35:00	6.33	200
35	19	5	4	21:32:00	23:59:59	2.47	28,500
36	19	5	5	0:00:00	1:54:00	1.90	28,500
37	17	5	6	0:00:00	6:42:00	6.70	15,500
38	16	5	7	7:52:00	17:02:00	9.17	28,500
39	2	5	7	8:24:00	17:02:00	8.63	22,000
40	1	5	7	11:00:00	16:22:00	5.37	15,500
41	21	5	7	11:04:00	18:15:00	7.18	15,500
42	11	5	7	11:05:00	18:57:00	7.87	15,500
43	8	5	7	11:14:00	16:44:00	5.50	22,000
44	25	5	7	11:39:00	23:59:59	12.35	22,000
45	27	5	7	11:43:00	14:30:00	2.78	15,500
46	17	5	7	12:32:00	16:44:00	4.20	15,500
47	12	5	7	12:34:00	17:58:00	5.40	28,500
48	15	5	7	13:16:00	19:42:00	6.43	24,600
49	6	5	7	14:26:00	20:53:00	6.45	15,500
50	14	5	7	14:36:00	19:45:00	5.15	24,600
51	13	5	7	15:04:00	18:06:00	3.03	28,500
52	27	5	7	15:52:00	16:44:00	0.87	15,500
53	9	5	7	16:08:00	16:58:00	0.83	15,500
54	3	5	7	16:20:00	20:02:00	3.70	15,500
55	29	5	7	16:28:00	19:55:00	3.45	28,500
56	16	5	7	18:02:00	19:15:00	1.22	28,500
57	27	5	7	18:22:00	23:59:59	5.63	15,500

58	2	5	7	18:28:00	22:28:00	4.00	22,000
59	1	5	7	18:36:00	21:31:00	2.92	15,500
60	11	5	7	19:41:00	21:25:00	1.73	15,500
61	8	5	7	20:08:00	23:59:59	3.87	22,000
62	21	5	7	20:19:00	22:22:00	2.05	15,500
63	19	5	7	23:18:00	23:59:59	0.70	28,500
64	14	5	7	23:28:00	23:59:59	0.53	24,600
65	14	5	8	0:00:00	1:35:00	1.58	24,600
66	19	5	8	0:00:00	1:35:00	1.58	28,500
67	27	5	8	0:21:00	2:22:00	2.02	15,500
68	14	5	8	2:07:00	3:54:00	1.78	24,600
69	15	5	8	2:08:00	3:58:00	1.83	24,600
70	27	5	8	5:21:00	7:00:00	1.65	15,500
71	18	5	9	0:00:00	2:07:00	2.12	15,500
72	27	5	9	7:00:00	14:09:00	7.15	15,500
73	9	5	9	11:27:00	16:15:00	4.80	15,500
74	6	5	9	11:33:00	23:59:59	12.45	15,500
75	1	5	9	12:00:00	23:59:59	12.00	15,500
76	18	5	9	14:33:00	23:59:59	9.45	15,500
77	11	5	9	14:49:00	23:26:00	8.62	15,500
78	2	5	9	14:50:00	20:21:00	5.52	22,000
79	26	5	9	15:33:00	20:07:00	4.57	15,500
80	8	5	9	15:40:00	19:44:00	4.07	22,000
81	12	5	9	15:47:00	23:59:59	8.22	28,500
82	14	5	9	15:55:00	18:06:00	2.18	24,600
83	27	5	9	15:55:00	23:12:00	7.28	15,500
84	16	5	9	16:05:00	23:59:59	7.92	28,500
85	9	5	9	18:34:00	21:07:00	2.55	15,500
86	21	5	9	20:49:00	23:59:59	3.18	15,500
87	3	5	9	20:51:00	23:59:59	3.15	15,500

88	15	5	9	20:55:00	23:59:59	3.08	24,600
89	19	5	9	21:10:00	23:59:59	2.83	28,500
90	20	5	9	21:12:00	23:59:59	2.80	28,500
91	25	5	9	21:15:00	23:59:59	2.75	22,000
92	8	5	9	21:21:00	23:59:59	2.65	22,000
93	2	5	9	22:22:00	23:59:59	1.63	22,000
94	29	5	9	22:27:00	23:59:59	1.55	28,500
95	9	5	9	23:06:00	23:59:59	0.90	15,500
96	27	5	9	23:12:00	23:59:59	0.80	15,500
97	2	5	10	0:00:00	3:11:00	3.18	22,000
98	3	5	10	0:00:00	7:00:00	7.00	15,500
99	6	5	10	0:00:00	1:15:00	1.25	15,500
100	8	5	10	0:00:00	0:55:00	0.92	22,000
101	9	5	10	0:00:00	0:40:00	0.67	15,500
102	12	5	10	0:00:00	11:00:00	11.00	28,500
103	15	5	10	0:00:00	0:44:00	0.73	24,600
104	16	5	10	0:00:00	3:17:00	3.28	28,500
105	19	5	10	0:00:00	7:42:00	7.70	28,500
106	20	5	10	0:00:00	3:30:00	3.50	28,500
107	21	5	10	0:00:00	2:18:00	2.30	15,500
108	25	5	10	0:00:00	2:20:00	2.33	22,000
109	27	5	10	0:00:00	1:55:00	1.92	15,500
110	29	5	10	0:00:00	3:58:00	3.97	28,500
111	11	5	10	0:30:00	6:14:00	5.73	15,500
112	1	5	10	1:13:00	3:40:00	2.45	15,500
113	9	5	10	1:54:00	2:56:00	1.03	15,500
114	6	5	10	2:17:00	6:10:00	3.88	15,500
115	14	5	10	3:19:00	13:45:00	10.43	24,600
116	2	5	10	4:22:00	6:32:00	2.17	22,000
117	27	5	10	10:45:00	17:27:00	6.70	15,500

118	9	5	10	10:49:00	18:58:00	8.15	15,500
119	26	5	10	11:39:00	15:49:00	4.17	15,500
120	3	5	10	11:41:00	23:59:59	12.32	15,500
121	1	5	10	11:54:00	15:08:00	3.23	15,500
122	25	5	10	12:48:00	17:00:00	4.20	22,000
123	21	5	10	13:30:00	16:23:00	2.88	15,500
124	11	5	10	15:00:00	18:21:00	3.35	15,500
125	15	5	10	15:45:00	17:32:00	1.78	24,600
126	23	5	10	16:00:00	17:55:00	1.92	24,600
127	6	5	10	18:15:00	19:35:00	1.33	15,500
128	27	5	11	15:00:00	16:14:00	1.23	15,500
129	2	5	11	21:34:00	23:59:59	2.43	22,000
130	8	5	11	21:58:00	23:59:59	2.03	22,000
131	14	5	11	22:26:00	23:59:59	1.57	24,600
132	18	5	11	22:41:00	23:59:59	1.32	15,500
133	23	5	11	23:05:00	23:59:59	0.92	24,600
134	2	5	12	0:00:00	4:33:00	4.55	22,000
135	8	5	12	0:00:00	1:26:00	1.43	22,000
136	14	5	12	0:00:00	6:16:00	6.27	24,600
137	18	5	12	0:00:00	12:52:00	12.87	15,500
138	23	5	12	0:00:00	4:42:00	4.70	24,600
139	13	5	12	0:03:00	4:20:00	4.28	28,500
140	11	5	12	0:25:00	10:07:00	9.70	15,500
141	6	5	12	1:14:00	7:28:00	6.23	15,500
142	3	5	12	1:32:00	4:36:00	3.07	15,500
143	19	5	12	1:45:00	12:15:00	10.50	28,500
144	8	5	12	2:55:00	5:21:00	2.43	22,000
145	1	5	12	3:17:00	8:47:00	5.50	15,500
146	21	5	12	3:51:00	6:00:00	2.15	15,500
147	14	5	12	8:45:00	12:47:00	4.03	24,600

148	6	5	12	8:55:00	11:10:00	2.25	15,500
149	27	5	12	9:10:00	23:59:59	14.83	15,500
150	1	5	12	9:40:00	12:33:00	2.88	15,500
151	8	5	12	10:01:00	23:34:00	13.55	22,500
152	29	5	12	10:17:00	16:20:00	6.05	28,500
153	2	5	12	10:55:00	23:50:00	12.92	22,000
154	16	5	12	10:55:00	23:59:59	13.08	28,500
155	13	5	12	10:57:00	16:20:00	5.38	28,500
156	21	5	12	11:00:00	14:40:00	3.67	15,500
157	25	5	12	11:02:00	23:59:59	12.97	22,000
158	26	5	12	11:19:00	18:45:00	7.43	15,500
159	11	5	12	12:23:00	22:50:00	10.45	15,500
160	1	5	12	13:23:00	23:30:00	10.12	15,500
161	6	5	12	14:34:00	22:51:00	8.28	15,500
162	3	5	12	15:00:00	22:54:00	7.90	15,500
163	12	5	12	15:00:00	23:09:00	8.15	28,500
164	28	5	12	15:20:00	23:59:59	8.67	22,000
165	9	5	12	16:14:00	23:04:00	6.83	15,500
166	21	5	12	16:35:00	20:38:00	4.05	15,500
167	18	5	12	17:06:00	23:52:00	6.77	15000
168	20	5	12	17:41:00	23:59:59	6.32	28,500
169	19	5	12	17:42:00	23:59:59	6.30	28,500
170	29	5	12	17:49:00	23:09:00	5.33	28,500
171	13	5	12	17:53:00	23:59:59	6.12	28,500
172	15	5	12	18:29:00	21:11:00	2.70	24,600
173	22	5	12	18:50:00	23:31:00	4.68	22,000
174	13	5	13	0:00:00	8:09:00	8.15	28,500
175	25	5	13	0:01:00	9:00:00	8.98	22,000
176	14	5	13	2:33:00	8:09:00	5.60	24,600
177	27	5	14	21:55:00	23:59:59	2.08	15,500

178	27	5	15	0:00:00	4:00:00	4.00	15,500
179	27	5	15	4:58:00	13:34:00	8.60	15,500
180	16	5	15	8:40:00	21:55:00	13.25	28,500
181	1	5	15	9:57:00	23:36:00	13.65	15,500
182	21	5	15	10:30:00	21:34:00	11.07	15,500
183	2	5	15	13:02:00	22:40:00	9.63	22,000
184	15	5	15	14:05:00	19:22:00	5.28	24,600
185	14	5	15	14:07:00	23:59:59	9.88	24,600
186	6	5	15	16:49:00	21:02:00	4.22	15,500
187	27	5	15	18:13:00	23:24:00	5.18	15,500
188	12	5	15	18:35:00	21:13:00	2.63	28,500
189	15	5	15	22:16:00	23:59:59	1.73	24,600
190	12	5	15	23:27:00	23:59:59	0.55	28,500
191	12	5	16	0:00:00	10:13:00	10.22	28,500
192	14	5	16	0:00:00	1:01:00	1.02	24,600
193	15	5	16	0:00:00	2:05:00	2.08	24,600
194	6	5	16	1:49:00	14:55:00	13.10	15,500
195	27	5	16	2:33:00	14:55:00	12.37	15,500
196	21	5	16	8:55:00	23:59:59	15.08	15,500
197	14	5	16	11:30:00	12:12:00	0.70	24,600
198	15	5	16	11:38:00	15:13:00	3.58	24,600
199	18	5	19	19:46:00	23:59:59	4.23	15,500
200	1	5	19	21:13:00	23:59:59	2.78	15,500
201	1	5	20	0:00:00	2:30:00	2.50	15,500
202	18	5	20	0:00:00	3:04:00	3.07	15,500
203	14	5	20	8:05:00	15:35:00	7.50	24,600
204	29	5	20	8:30:00	14:54:00	6.40	28,500
205	18	5	20	8:36:00	16:08:00	7.53	15,500
206	27	5	20	13:23:00	23:59:59	10.62	15,500
207	26	5	20	14:44:00	17:56:00	3.20	15,500

208	1	5	20	15:06:00	18:00:00	2.90	15,500
209	15	5	20	15:13:00	20:02:00	4.82	24,600
210	14	5	20	16:57:00	20:02:00	3.08	24,600
211	12	5	20	20:02:00	23:10:00	3.13	28,500
212	16	5	20	21:31:00	23:59:59	2.48	28,500
213	29	5	20	21:39:00	23:59:59	2.35	28,500
214	7	5	20	21:57:00	23:59:59	2.05	15,500
215	15	5	20	22:08:00	23:59:59	1.87	24,600
216	18	5	20	23:01:00	23:59:59	0.98	15,500
217	7	5	21	0:00:00	3:50:00	3.83	15,500
218	7	5	21	0:00:00	19:03:00	19.05	15,500
219	15	5	21	0:00:00	0:59:00	0.98	24,600
220	16	5	21	0:00:00	5:34:00	5.57	28,500
221	18	5	21	0:00:00	4:02:00	4.03	15,500
222	18	5	21	0:00:00	21:30:00	21.50	15,500
223	29	5	21	0:00:00	0:55:00	0.92	28,500
224	26	5	21	9:19:00	15:37:00	6.30	15,500
225	15	5	21	11:08:00	11:40:00	0.53	24,600
226	29	5	21	11:45:00	16:49:00	5.07	28,500
227	14	5	21	12:45:00	17:03:00	4.30	24,600
228	15	5	21	12:45:00	16:49:00	4.07	24,600
229	16	5	21	13:23:00	23:59:59	10.62	28,500
230	1	5	21	16:49:00	23:04:00	6.25	15,500
231	12	5	21	18:15:00	21:54:00	3.65	28,500
232	7	5	21	21:04:00	23:59:59	2.93	15,500
233	29	5	21	22:03:00	23:59:59	1.95	28,500
234	29	5	22	0:00:00	5:01:00	5.02	28,500
235	26	5	22	10:25:00	18:40:00	8.25	15,500
236	12	5	22	11:02:00	18:42:00	7.67	28,500
237	18	5	22	11:03:00	19:47:00	8.73	15,500

238	1	5	22	14:55:00	20:34:00	5.65	15,500
239	16	5	23	0:05:00	4:40:00	4.58	28,500
240	1	5	24	13:50:00	23:59:59	10.17	15,500