

Observations of Beachcast Bowhead Whales (*Balaena mysticetus*) in the Southeastern Beaufort Sea and Amundsen Gulf, 1987–2016

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Each spring, most Bowhead Whales (*Balaena mysticetus*) of the Bering-Chukchi-Beaufort (BCB) population migrate to the Canadian Beaufort Sea and Amundsen Gulf for summer feeding. Occasionally, Inuvialuit hunters and others observe beachcast (stranded) or adrift Bowhead Whale carcasses. From 1987 to 2016, 26 such occurrences were recorded. Most (65%) were found by Inuvialuit hunters travelling on the land, with the majority (54%) reported during 2000–2006. Bowhead Whale carcasses were found widely distributed throughout the region, with twice as many in Amundsen Gulf (65%) compared with the southeastern Beaufort Sea (35%). It was possible to measure or estimate standard length for 17 of 26 specimens, and all were either provisional ‘subadults’ (7–9.5 m; $n = 10$; 59%) or provisional ‘mature adults’ (13–16 m; $n = 7$; 41%). The cause(s) of mortality was not determined for any of the specimens. Whales in the ‘subadult’ group were likely 1–4 years old, while the ‘mature adult’ group were likely mostly mature animals (~25 y), including some potentially very old (>100 y). There was evidence or direct observation of Polar Bears (*Ursus maritimus*) and/or Grizzly Bears (*U. arctos*) scavenging at 60% of the carcasses for which presence or absence of bears or bear sign (scats and/or tracks) was reported. It is important to continue to record incidental observations of beachcast Bowhead Whales, as this may enable stranding rates to be evaluated.

Key Words: *Balaena mysticetus*; Bowhead Whale; beachcast; stranding; Beaufort Sea; Amundsen Gulf

Introduction

Each spring, most Bowhead Whales (*Balaena mysticetus*) of the Bering-Chukchi-Beaufort (BCB) population migrate to the Canadian portion of the Beaufort Sea and the Amundsen Gulf to feed during the summer (Richardson *et al.* 1987; Moore and Reeves 1993; Harwood *et al.* 2010, 2017). They aggregate and forage there during August and September, with most starting their return westward to the Bering Sea wintering areas by mid to late September (Citta *et al.* 2015; ADFG 2017; Harwood *et al.* 2017).

The BCB population is listed as Special Concern under Canada’s *Species at Risk Act* (SARA Registry 2017) and endangered under the US *Endangered Species Act* (NOAA 2016). Bowhead Whales have a slow growth rate, a low reproductive rate, a late age of sexual maturity (~25 y; Rosa *et al.* 2013), and are extremely long-lived (oldest on record is a 14.6 m male, 211 y; George *et al.* 1999; Lubetkin *et al.* 2012). Based on the spring 2011 census at Point Barrow, Alaska, the most recent estimate of population size for the BCB population was 16 820 whales (95% CI = 15 176–18 643; Givens *et al.* 2016), representing an increase over the last decade. Clarke *et al.* (2013, 2014) reported that calf sighting rates increased during this same period, and

George *et al.* (2015) detected increases in the body condition of whales from 1989–2011, statistically so in subadults. Although future trajectories for population size and body condition are not known (George *et al.* 2015), a suite of indicators are presently showing positive or stable trends (George *et al.* 2017).

In the western Canadian Arctic, local Inuvialuit hunters, fishers, pilots, researchers, and park staff have observed and reported beachcast or drifting Bowhead Whale carcasses during recent decades. The co-management framework which is now in place with the implementation of the Inuvialuit Final Agreement (IFA; INAC 1986) has fostered and enhanced reporting of unusual occurrences of wildlife in the Inuvialuit Settlement Region (ISR), including beachcast Bowhead Whale carcasses. Our objective was to summarize the location and timing of beachcast Bowhead Whale reports in the western Canadian Arctic, by reviewing available stranding records for 1987 to 2016. Where feasible, our secondary objective was to examine the relative size of beachcast specimens, and examine the records for possible reason(s) for the mortalities. We also note observations of Grizzly Bear (*Ursus arctos*) and Polar Bear (*U. maritimus*) scavenging at beachcast Bowhead Whale carcasses.

Methods

People travelling in coastal areas of the Inuvialuit Settlement Region (i.e., subsistence hunters and fishers, and scientific, enforcement, aviation, and park staff) have made opportunistic observations of beachcast or drifting Bowhead Whale carcasses and reported these to Fisheries and Oceans Canada (DFO). Coastal areas of the ISR used by Inuvialuit harvesters for hunting and travel are extensive and include most coastlines (Figure 1). We do not have empirical records of the number of trips or hours of search effort that were involved in the discovery of the carcasses.

DFO has maintained a database of these incidental observations, including the reported locations, date and source of first observation or report, state of the carcass, and associated notes and photographs. Where practical and when resources and personnel were available, site visits were done to obtain additional photographs and length measurements (standard length, tip of rostrum to notch in tail), and in a few cases, to collect tissue samples and measure blubber thickness. The geographic locations of the carcasses were recorded with global positioning systems (GPS), or reported according to local landmarks and official or local geographic names. Locations where beachcast whales were initially observed were mapped using ArcGIS (Figure 2).

Skin tissue samples were collected from seven carcasses to molecularly determine gender (Table 1). These were preserved either in a salt-saturated 20% dimethyl sulphoxide (DMSO) solution (Seutin *et al.* 1991), or frozen as soon as possible after collection. These tissues were transferred to fresh salt/DMSO solution in the lab and archived at -20°C to -80°C . Total cellular DNA extractions were performed using DNeasy blood and tissue kit spin columns (Qiagen Hilden, Germany). A polymerase chain reaction (PCR) based method was used for molecular determination of gender following methods described by Rosel (2003) and Shaw *et al.* (2003). For most of the tissues, these different methods were used in tandem to verify gender assignment.

Results

From 1987 to 2016, 23 beachcast and three drifting Bowhead Whale carcasses were found opportunistically in the western Canadian Arctic and reported to DFO (Figure 2; Table 1). Most were discovered by Inuvialuit harvesters travelling on the land (65%), with the rest reported by others (e.g., pilots, researchers, government staff). Nearly half (47%) of the observations recorded during the 30-year period were from 2000 to 2006 (Table 1). Half of the years (15 of 30) had no occurrences, and the other years had 1–4 observations of beachcast Bowhead Whales per year.

Carcasses were reported from widely distributed locations (Figure 2), in both the southeastern Beaufort Sea (35%) and Amundsen Gulf (65%). The carcasses were clustered in several recurring locations, including Franklin Bay ($n = 4$), Darnley Bay including Pearce

Point ($n = 4$), along the Yukon coast ($n = 5$), off the southwest coast of Banks Island ($n = 5$), and in Prince Albert Sound ($n = 3$).

Carcasses were generally inaccessible for complete necropsy, due to their remote location, positioning on shore (e.g., portion sunk, buried), prevailing weather conditions, and/or the presence of bears; only one carcass was necropsied by a veterinary pathologist (Figure 3). Carcasses ranged from bone piles (Figure 3) to relatively intact carcasses (Figure 4). It was however possible to estimate or measure standard length of 17 (65%) of the carcasses, measure dorsal blubber thickness (25–30 cm) in three, and determine gender for two using molecular methods (Table 1).

The estimated whale lengths were all in one of two distinct size groupings, referred to here as provisional ‘subadults’ (7.0–9.5 m; $n = 10$; 59%) and provisional ‘mature adults’ (13–16 m; $n = 7$; 41%; Table 1) based on suggestions by George *et al.* (2011). No ‘mature adults’ were found west of Cape Bathurst, and mainly ‘subadults’ were found east of Cape Bathurst (Figure 2; Table 1). cursory external examination of some carcasses and in some cases archived photos did not yield clues as to the cause of death in any of the specimens. None of the carcasses had any external or obvious indications of predation by Killer Whales (*Orcinus orca*; George *et al.* 2004), or human interactions, such as ship-strike related trauma, or harpoons, floats, or attached ropes that would suggest the whale was struck-and-lost during subsistence hunting.

Of the 15 reports with notes about the presence/absence of bears, nine carcasses had one or more bears, or evidence of scavenging (scats and/or tracks) by Polar Bears and/or Grizzly Bears (Table 1). One carcass on the Yukon coast (no. 2; Table 1) had both bear species feeding on the carcass at the same time. A female Polar Bear with three cubs and three male Polar Bears were simultaneously feeding on a carcass (no. 8; Table 1) in southeastern Franklin Bay. At a relatively ‘fresh’ carcass on the western shores of Franklin Bay in 2000 (no. 7; Table 1), there were ten Grizzly Bears observed feeding at the carcass, and another six fled when the helicopter arrived and were sighted within 2–3 km in the nearby hills. A large male Grizzly Bear was observed at the Bowhead Whale carcass in Franklin Bay in August 2015 (Figure 4).

Discussion

Since 1987, there have been 26 opportunistic reports of beachcast or drifting bowhead carcasses in the western Canadian Arctic, 65% of these reported by Inuvialuit harvesters. The carcasses were widely distributed along the mainland coast and the southwest shores of Banks and Victoria islands in the Inuvialuit Settlement Region, with twice as many found on the shores of Amundsen Gulf (65%; all mature adults) compared with the southeastern Beaufort Sea (35%, mainly subadults). Polar Bears and/or Grizzly Bears were observed

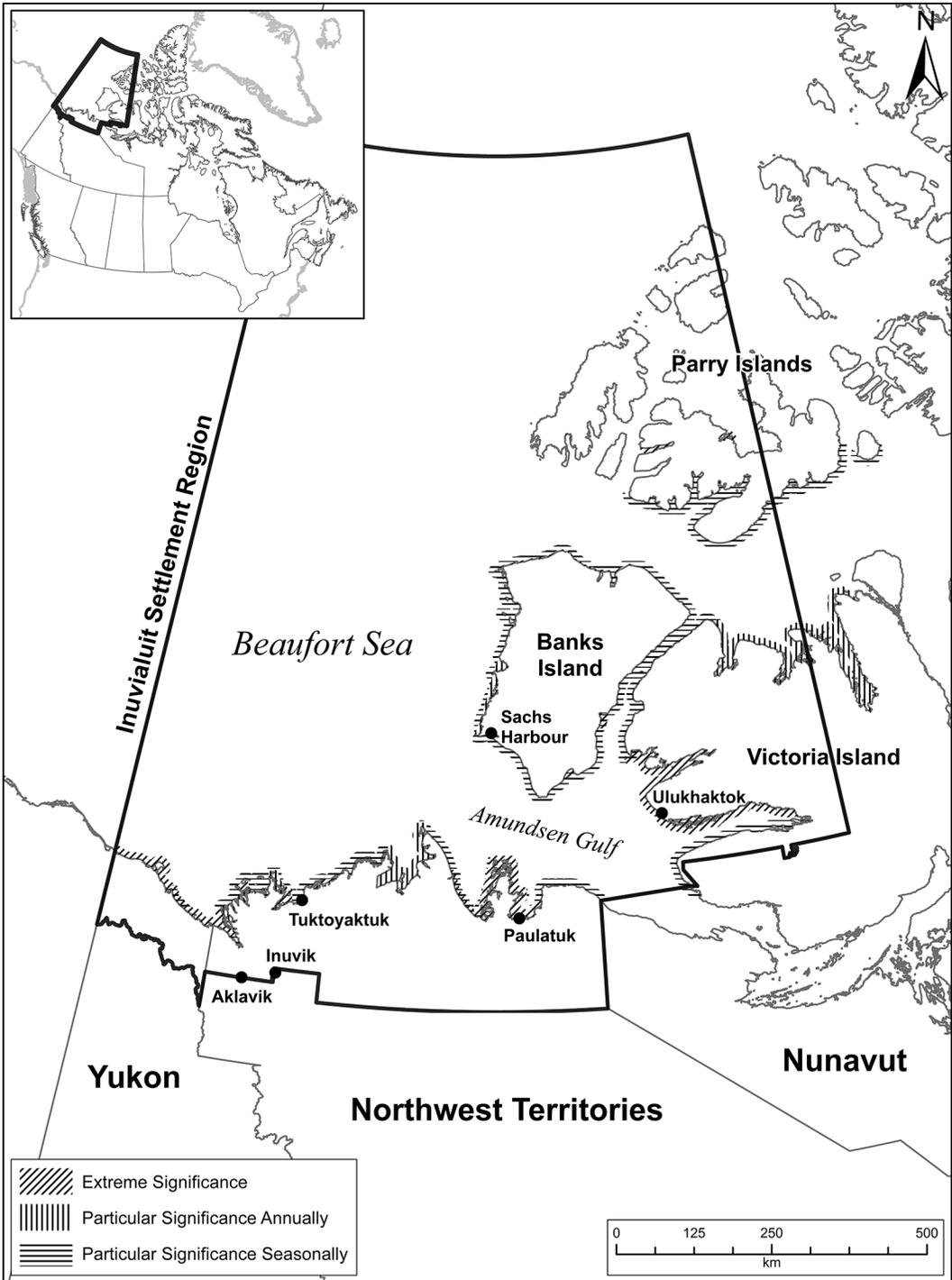


FIGURE 1. Coastlines in the Inuvialuit Settlement Region (ISR; polygon) self-identified by harvesters as having extreme or particular significance to ISR hunters. We infer these to include hunting and travelling routes that are regularly used (adapted from Community of Aklavik *et al.* 2008; Community of Inuvik *et al.* 2008; Community of Paulatuk *et al.* 2008; Community of Sachs Harbour *et al.* 2008; Community of Tuktoyaktuk *et al.* 2008; Community of Ulukhaktok *et al.* 2008).

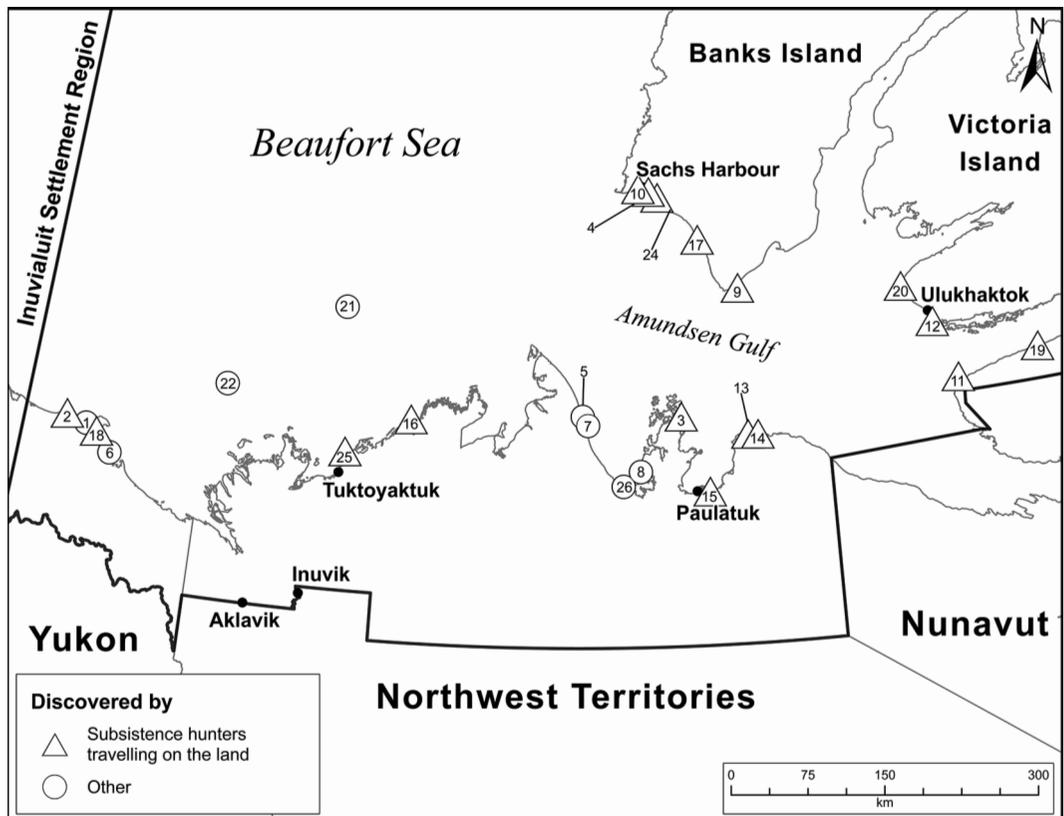


FIGURE 2. Location of beachcast and drifting Bowhead Whale (*Balaena mysticetus*) carcasses discovered in the western Canadian Arctic by hunters and others, 1987–2016 (whale number corresponds to Table 1).

at, or inferred to have been scavenging at, 60% of the carcasses. It was not possible to determine the cause(s) of mortality in any of the specimens.

Hunters from the ISR that found these carcasses have self-identified the lands and waters where cultural and renewable resources are of extreme significance and sensitivity (Figure 1), and we infer these to be the most intensely ‘searched’ coastlines during hunting and other traditional travel-based activities. Hunter reports of beachcast animals, ‘accidental’ wildlife sightings, predation accounts, and information on animal behaviour are some of the best examples of “local ecological knowledge” (Noongwook *et al.* 2007). Additionally, the onshore locations where the carcasses are discovered likely reflect, at least in part, a combination of prevailing winds, currents, and bathymetry that tends to concentrate the carcasses and wash them ashore (Figure 2). Similarly, flight routes used by light commercial aircraft are generally established and consistent, as are the locations where park staff work (airstrips and parks), although deviations from typical routes due to weather, altitude, or destination cannot be discounted.

Despite the limitations and biases associated with the data from beachcast whales, including an inability to quantify search effort, the database is unique in that it provides a long-term record of occurrences.

Our efforts to determine the cause of mortality and establish baseline health parameters were hindered by our inability to access fresh carcasses in a timely manner. None of the carcasses had any obvious evidence of predation or ship strike-related wounds, although most were in an advanced state of decomposition. Length measurements were subject to error due to decomposition, scavenging, access, and positioning of the carcass. Evidence of freeze and thaw cycles in successive winter seasons (Table 1) further confounds the comparison of inter-annual data. The blubber thickness measured on the three specimens was consistent with that for healthy landed bowheads (George 2009), although blubber thickness may not be the best indicator of nutritional state. A more recent study indicates adipocyte size and fibre density may be more informative indicators of body condition (Ball *et al.* 2015).

TABLE 1. Beachcast and adrift Bowhead Whale (*Balaena mysticetus*) carcasses observed in the southeast Beaufort Sea and Amundsen Gulf, from 1987 to 2016, as recorded by, or reported to, Fisheries and Oceans Canada (no data = -).

Whale #	Carcass first observed		On-site inspection of carcass by technical staff	Estimated length (m)*	Size class†	Discovered and/or reported to DFO by	Sex	Blubber thickness (cm)	No. bears † observed or evidence of bears, scavenging (scats and/or tracks) at carcass
	Year	Month							
1	1987	9	yes	9§	subadult	DFO staff	-	-	-
2	1991	-	no	-	-	Aklavik Hunter	-	-	3 (GB) + 1 (PB)
3	1989	7	no	7	subadult	Paulatuk Hunter	-	-	-
4	1993	8	no	13-14	mature adult	Sachs Harbour HTC/hunters	-	-	-
5	1995	4	yes	16§	mature adult	pilot report	-	-	scavenged
6	1996	8	yes	9	subadult	parks crew	male	-	-
7	2000	9	yes	8.9	subadult	pilot report	-	25-30	-
8	2000	9	yes	14	mature adult	unknown	-	-	10 (GB) 7 (PB)¶
9	2003	4	no	-	-	Sachs Harbour hunters	-	-	-
10	2003	7	yes	14	mature adult	parks crew	female	30	no
11	2003	8	yes	14	mature adult	Ulukhaktok hunters	-	-	scavenged
12	2003	9	no	-	-	Ulukhaktok hunters	-	-	no
13	2004	8	no	14	mature adult	Paulatuk hunters	-	-	4 (GB)
14	2004	8	no	9.5§	subadult	Paulatuk hunters	-	-	-
15	2004	8	yes	14	mature adult	Paulatuk hunters	-	30	no
16¶	2004	12	yes	8	subadult	Paulatuk hunters	-	-	scavenged
17	2005	7	yes	8.2§	subadult	Tuktoyaktuk hunters/wildlife officers	-	-	-
18	2005	-	no	-	-	Sachs Harbour hunters	-	-	-
19	2006	8	no	-	-	Tuktoyaktuk hunters	-	-	-
20	2006	-	no	-§	-	Ulukhaktok hunters	-	-	-
21	2009	10	no	8	subadult	Ulukhaktok hunters	-	-	no
22	2009	10	no	-	-	Coast Guard ship	-	-	no
23	2010	8	no	9	subadult	Coast Guard ship	-	-	-
24	2014	8	no	-§	-	parks crew	-	-	scavenged
25	2015	8	yes	9.2	subadult	Sachs Harbour hunters	-	-	no
26	2015	9	no	-	-	Tuktoyaktuk hunters	-	-	1 (GB)
						canoeists reported to Paulatuk HTC	-	-	-

*Not possible or practical to estimate measurement error.

†Provisional subadult = 7-9.5 m; provisional mature adult = >13 m.

‡GB = Grizzly Bear (*Ursus arctos*); PB = Polar Bear (*Ursus maritimus*).

§State of decomposition suggested whale was beachcast in previous year(s).

¶Female Polar Bear, three cubs, and three male Polar Bears feeding.

**Whale was accessible and necropsied by a veterinary pathologist on 15 July 2005 (Figure 3), > 8 months after stranding. The carcass was in an advanced stage of decomposition.

In cases where fresh carcasses are examined, such as is possible with Alaskan subsistence harvests, very few Bowhead Whales are found with any pathology (George *et al.* 1999), and blubber thickness and body condition of subadults have been showing a positive trend over the past 20 years (George *et al.* 2015). Bowheads have a long evolutionary history and are considered to possess protective molecular adaptations relevant to age-related diseases (Keane *et al.* 2015). Although the only

known natural cause of death in a stranded Bowhead Whale was attributed to intestinal volvulus (Heidel and Albert 1994), recent detection of harmful algal (HABs) toxins in harvested and stranded marine mammals in Alaska in 2014 suggest this could be a potential contributing factor to future whale morbidity and loss (Lefebvre *et al.* 2016). As well, detection of an exotic pathogen, phocine distemper virus in Alaskan Sea Otters (*Enhydra lutris*), suggests a possible route of intro-



FIGURE 3. Veterinary pathologist, assisted by technical staff from Fisheries and Oceans Canada and the community of Tuktoyaktuk, Northwest Territories, conducting a necropsy of a highly decomposed 'subadult' beachcast Bowhead Whale (*Balaena mysticetus*) carcass, Atkinson Point, Northwest Territories, Canada (no. 16, Figure 2). Photo: E. Linn.



FIGURE 4. Bowhead Whale (*Balaena mysticetus*) 'adult' carcass at Franklin Bay with Grizzly Bear (*Ursus arctos*) scavenging (no. 26, Figure 2). Photo: B. Orkin.

duction via the Northwest Passage (Goldstein *et al.* 2009). Exposure of Bowhead Whales to other novel pathogens may also be a consideration.

Another possible explanation for death would be natural mortality. Despite the above mentioned limitations in measuring carcasses, given the 4 m separation in length between our 'subadult' and 'adult' age classes, it is unlikely that we would have assigned specimens to the wrong group. George *et al.* (2015) suspect that Bowhead Whales are most vulnerable to environmental vagaries when standard length is 8–10 m, and this matches with our 'subadult' group. Mortalities in this category may reflect early life stage events that coincide with a time of weight loss and growth of baleen racks (George *et al.* 2016). Our provisional 'adult' group most likely consisted of sexually mature whales, some potentially very old, although recently or nearly matured whales may have also been included (Koski *et al.* 1988, 1993). Mortality in our 'adult' group likely includes senescent mortality, but to an unknown extent.

Stable and positive trends observed in this population in recent years (see George *et al.* 2017) may be linked with enhanced production of the bowhead's planktonic prey, associated with the changing climate (Moore

et al. 2014; Arrigo and van Dijken 2015; George *et al.* 2015; Moore and Stabeno 2015; Wood *et al.* 2015). It could also include an increase in whale abundance since the cessation of commercial whaling in the early 1900s (McGhee 1988); population size has shown a strong recovery and has now approached pre-contact estimates of population size (Woodby and Botkin 1993; Brandon and Wade 2006).

Finally, based on the absence of observed harpoons, floats or ropes, or other signs of prior strikes, there was no indication of beachcast Bowhead Whales having been struck-but-lost by harvesters, as reported in Alaska (NOAA 2017a). The only recent subsistence harvests of Bowhead Whales in the western Canadian Arctic were in 1991 (Freeman *et al.* 1992) and 1994 (Harwood and Smith 2002). Prior to the 1991 harvest, the last recorded landed bowhead in this region was in 1925 (McGhee 1988). The reasons for the concentration of reported mortalities in the mid-early 2000s are not known, but for the reasons above, we do not attribute these to be hunting losses by Canadian hunters.

The geographic separation of carcasses, with 'subadults' in the Beaufort Sea and 'adults' in Amundsen Gulf, matches the segregation of subadults and adults

that has been observed during photogrammetric, telemetry, and aerial survey studies conducted in these same areas (Cubbage and Calambokidis 1987; Koski *et al.* 1988; Koski and Miller 2009; Harwood *et al.* 2010, 2017). In all of these cases, subadults occurred mainly in waters over the continental shelf in the Beaufort Sea, while mature animals used more distant habitats and deeper waters, particularly Amundsen Gulf (Koski and Miller 2009; Harwood *et al.* 2017). This may explain the propensity for beachcast specimens in the two age groups to be separated geographically.

The prevalence of bears and bear sign at the beachcast carcasses was also notable. There is growing evidence that subsistence-harvested Bowhead Whale carcasses (bone piles left after subsistence hunts in Alaska) are becoming increasingly important in the diet of Polar Bears, particularly because more bears are spending more time close to shore (Miller *et al.* 2015; Rogers *et al.* 2015). Although the extent of scavenging at Bowhead Whale bone piles varied among years, there are indications that the contribution of Bowhead Whale to the diet of Polar Bears is increasing (Bentzen *et al.* 2007; Herreman and Peacock 2013; Rogers *et al.* 2015).

Emerging and dramatic environmental change in the Arctic marine ecosystem (e.g., Moore and Stabeno 2015), coupled with anticipated increases in shipping traffic in the Arctic (Halliday *et al.* 2017), prompted us to compile the historical stranding records for the Canadian portion of the BCB Bowhead range. In the Alaskan portion of their range, which includes the western Beaufort Sea, Chukchi Sea, and Bering Sea, beachcast Bowhead Whales are similarly recorded through the Alaska Marine Mammal Stranding Network (NOAA 2017a). Together, these datasets are the most practical means to document occurrences, and may inform managers when considering trends in spatial and temporal stranding records, and often is the only metric available to assess marine mammal mortality events (NOAA 2017b). We urge keeping the database as standard and current as possible.

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