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Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Natives during 2020 and updates on genetics and health studies

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ABSTRACT

In 2020, 69 bowhead whales (*Balaena mysticetus*) were struck during the Alaskan subsistence hunt resulting in 54 animals landed. The total number of whales struck and the number landed in 2020 was higher than the averages for the previous 10 years (2010-2019: mean struck = 56.9, *SD* = 10.7 and mean landed = 43.4, *SD* = 7.3; respectively). The efficiency (# landed / # struck) of the hunt (78%) in 2020 was similar to the average over the past 10 years (mean of efficiency = 77%; *SD* = 7%). Spring hunts are logistically more difficult than autumn hunts because of difficulty in accessing open water, and changing sea ice thickness and dynamics. The hunting efficiency during spring is usually lower than in autumn, which was the case during 2020. In 2020, the efficiency of the spring hunt (73%) was slightly higher than the previous 10 year average (2010-2019; mean spring efficiency = 68%) but lower than the 2020 autumn hunt (92%). The efficiency of the autumn hunt over the past ten years (2010-2019) was 93% (SD = 9%). Fifteen whales were struck and lost in 2020. Of those 15 whales, eight were lost due to equipment malfunction (i.e., float pulled off whale), three whales were lost when they swam under the ice, three whales sank, and one whale could not be found. Of the harvested whales, 22 were females and 32 were males. Based on total length (≥13.7 m in length), seven of the females were presumed mature. One captain reported a whale to be pregnant with a fetus estimated at 1.8-2.1 m long, while another captain reported a whale to be pregnant with a female fetus 4.4 m long. None of those whales were closely examined by biologists for pregnancy primarily because monitoring was suspended in response to the Covid-19 pandemic.

KEYWORDS: ARCTIC; *BALAENA MYSTICETUS*; BOWHEAD WHALE; STATISTICS; WHALING-ABORIGINAL

INTRODUCTION

The subsistence harvest of bowhead whales (*Balaena mysticetus*) helps meet important nutritional and cultural needs for many Native communities in northern and western Alaska (United States) and eastern Chukotka (Russian Federation). The Alaska Eskimo Whaling Commission (AEWC), representing 11 communities, locally manages the Alaskan harvest through an agreement with the U.S. National Oceanic and Atmospheric Administration (NOAA). The level of allowable harvest is determined under a quota system in compliance with the International Whaling Commission (IWC, 1980; Gambell, 1982). The harvest quota is based on the nutritional and cultural needs of Alaskan Natives as well as on estimates of the size and growth of the Bering-Chukchi-Beaufort seas stock of bowhead whales (Donovan, 1982; Braund, 1992). Whales were harvested in 2020 under a seven-year block quota that began in 2019 (IWC, 2018).

The subsistence hunts typically occur during spring and autumn when bowhead whales migrate between the Bering and Beaufort seas. Hunters on Saint Lawrence Island, in the northern Bering Sea, may harvest whales during the winter (e.g., December to February) as well. Bowhead harvests show considerable annual and regional variation, and the success of each hunt is greatly affected by many factors, including: environmental conditions (e.g., wind speed and direction, wave size, fog, and temperature), stability of shorefast ice, sea ice concentration, type, and movements, and other factors.

Since 1981, the North Slope Borough Department of Wildlife Management (NSB DWM) has gathered basic data on landed whales in several communities and assists the AEWC with compilation of statistics on landed as well as struck and lost whales (Albert, 1988). During 2020, the NSB DWM gathered detailed information and tissue samples on a subset of the whales landed at Utqiaġvik (formerly Barrow). The objectives of this paper are to document: (1) the number, location (village), and dates of landed and struck and lost bowhead whales during 2020 in Alaska, (2) the estimated fate of struck and lost bowhead whales, (3) basic morphometric data and the sex composition of the harvest, (4) hunting efficiency, (5) health and genetic data, and (6) relevant additional environmental observations on hunting conditions.

METHODS

Data on sex, standard length, harvest date, and landed date, as well as the fate of struck and lost whales for all whaling villages were obtained from the AEWC. Biologists were not able to measure and sample all whales landed in Utqiaġvik or other villages in 2020 because of precautionary NSB safety protocols to ensure safety during the COVID-19 pandemic. NSB DWM staff were able to collect tissue samples, detail morphometric data, and document evidence from scarring of previous non-lethal human interactions (i.e., ship strikes or line entanglements) and killer whale attacks, for some whales landed in the spring and all fall whales at Utqiaġvik.

We estimated sexual maturity based on several published criteria. Historically, several estimates of average length at sexual maturity in females were used; this has changed as more data were collected. Initially 14.2 m was used (Tarpley and Hillmann, 1999), then 13.4 m (George *et al.*, 2004), and most recently 13.7 m (George *et al.*, 2018). This latter estimate of average length at sexual maturity is based on pregnancy rate data through 2016. For this paper, we use 13.7 m as the length of sexual maturity for females. Males with a total body length greater than 13 m are considered to be sexually mature (O'Hara *et al*., 2002).

RESULTS AND DISCUSSION

During the 2020 Alaskan subsistence hunt, of the 69 whales that were struck, 54 (78%) were landed. The total number of whales struck and the number landed in 2020 was higher than the averages for the previous 10 years (2010-2019: mean struck = 56.9, *SD* = 10.7 and mean landed = 43.4, *SD* = 7.3; respectively). During spring 2020, 30 bowheads were landed and 11 were struck and lost (Tables 1 and 2). During the fall harvest, 22 whales were struck and landed by three villages (Utqiaġvik, Kaktovik, and Nuiqsut) and two were struck and lost in Utqiaġvik. Gambell and Savoonga landed one and two whales, respectively, during December and each reported one struck and lost whale during that same time period (Tables 1 and 2).

Spring Hunting Conditions

Hunting conditions during much of spring 2020 were especially challenging in the northern Bering Sea because of another year with an early northward retreat of sea ice, as well as considerable open water with prolonged windy conditions.

At Saint Lawrence Island, hunters from Gambell landed one whale on 27 April and hunters at Savoonga landed one whale on 28 April. Typically, the combined harvest for both Gambell and Savoonga during 2010-2015 was about 6 to 10 whales (Suydam and George, 2018).

Farther north in the Chukchi Sea, conditions were conducive for whaling, with captains in most villages reporting good ice conditions and calm winds. Point Hope landed 12 whales between late-April and early-May. Wainwright landed three whales in May. Utqiaġvik landed 13 whales from 30 April to 23 May 2020.

Autumn Hunting Conditions
There are three villages that typically hunt bowheads in the Beaufort Sea during the autumn: Kaktovik, Nuiqsut and Utqiaġvik. The 2020 season offered good weather conditions and whales close to shore, especially in the western Beaufort. This contrasts with 2019 when bowheads were distributed farther offshore, resulting in an unusually unproductive fall hunting season for Utqiaġvik during which only one whale was harvested (Suydam et al. 2020).

At Kaktovik, three whales were landed between late August and mid-September. Nuiqsut landed three whales at Cross Island from 5 to 8 September. At Utqiaġvik, 15 whales were landed between 25 August and 12 October. The harvest on 25 August was one of the three earliest documented autumn harvest dates at Utqiaġvik. The other August harvests occurred in 1992 and 1976. In autumn 2020, the Barrow Whaling Captains Association (BWCA) decided to begin the hunt on 25 August, which is about three weeks earlier than usual. This early start date was a response to the very unsuccessful season that occurred in fall 2019 when only one whale was landed (Suydam et al. 2020).

Winter Hunting Conditions
On Saint Lawrence Island, the villages of Gambell and Savoonga landed one and two whales, respectively, in late December 2020. Typically, these two villages hunt during the spring but since about 2000, they have been hunting more frequently during the late fall and early winter because environmental conditions during the spring are increasingly variable (Noongwook et al. 2007; Suydam and George 2021).

Struck and Lost and Hunting Efficiency
Of the 15 whales struck and lost in 2020, 11 occurred in the spring, two during the fall and two during the winter. Eight of the 15 whales were lost due to equipment malfunction (e.g., float pulled off whale), three whales were lost when they swam under the ice, three whales sank, and one whale could not be found. The estimates of survival included: one had an excellent chance of survival, one had a fair chance of survival, five had a poor chance of survival and eight died. Those estimates of survival are primarily based on the assessment of the Captains or their crews (Table 2 and 3).

The overall efficiency (# landed / # struck) of the hunt (78%) was similar to the average over the past 10 years (mean of efficiency = 77%; *SD* = 7%). Since the mid-1970s, efficiency of the hunt increased steadily until the mid-1990s, when it stabilized at about 75 to 80%. That increase was due to many factors, including enhanced communication (i.e., improved marine radio capabilities) among hunting crews, education/training of younger hunters, and improved weaponry (Suydam & George, 2012). However, efficiency can vary substantially from year to year, primarily due to environmental conditions. For example, 2010 had a relatively low efficiency of 63% (Suydam *et al.*, 2011), while 1999 had a high efficiency of 89% (George *et al.*, 2000).

The success of the spring hunt is quite sensitive to the highly variable environmental conditions (George *et al.*, 2003). As such, hunting efficiency varies between seasons and among years. Spring hunts are logistically more difficult than autumn hunts because of difficulty in accessing open water (often in hand-paddled skin boats), and changing sea ice thickness and dynamics. The hunting efficiency during spring is usually lower than autumn, which was the case during 2020. In 2020, the efficiency of the spring hunt (73%) was slightly higher than the previous 10 year average (2010-2019; mean spring efficiency = 68%) but lower than the 2020 autumn hunt (92%). The efficiency of the autumn hunt over the past ten years (2010-2019) was 93% (SD = 9%). Autumn hunts typically occur in more open water conditions, at which time sea ice is less of an influence on hunting success. However, high wind speeds with the larger fetch of the open water period during the autumn can generate large waves limiting hunting opportunities and making boating conditions extremely difficult (George *et al.*, 2003). As climate change causes a longer period and larger area of open water, the corresponding increased fetch contributes to larger swells that persist even after strong winds abate. The overall hunting period has increased in recent years due to sea ice reduction and retreat, in an effort to compensate for inclement weather that typically results in poor hunting conditions and harvest.

Sex and Maturity
Thirty-two (59%) of the 54 landed whales were males. The longest male measured 15.3 m and the smallest was 7.2 m. Based on a length of $\geq$13 m (O'Hara *et al.*, 2002), 11 males were presumably sexually mature (see Table 1).

Twenty-two (41%) of the 54 landed whales were females. The longest female measured 18.3 m; however, this is an estimated length. The shortest female measured 7.5 m. Based on pregnancy and a length ≥13.7 m (George *et al*., 2018), seven of the females were sexually mature. One Nuiqsut captain reported that a landed whale was pregnant with a fetus estimated to be 1.8-2.1 m long. A captain in Wainwright reported another whale (13.2m long) to be pregnant with a female fetus 4.4 m long. Due to concerns and resulting safety protocols related to COVID-19, none of the other mature females were closely examined by biologists for pregnancy

Update on Health Studies
Spring whales were not examined by NSB DWM staff as spring harvest monitoring was suspended due to Covid-19 pandemic concerns. A number of unusual findings (abnormal; pathological) were observed in subsistence harvested bowhead whales during fall 2020. During the fall harvest these findings included: (1) penetrating injury that may have been from the prior deployment of a satellite tag; (2) inflamed large intestines (colonitis) and upper urinary tract (ureters); (3) small benign hepatic fatty tumors (hepatic lipoma); (4) anatomical variation of the liver, spleen, adrenal glands, and testes; and (5) epidermal inclusion cyst (skin invagination). With the exception of hepatic lipomas and inflamed ureters which were observed in two whales each, all other reported lesions were observed in individual whales only. Parasitic kidney infection of *Crassicauda spp.* was present in all fall-harvested bowhead whales at Utqiaġvik. An adult *Anisakis sp.* (roundworm) was detected in the stomach of one whale. A single cyamid was detected on the skin of another individual.

The observed disease conditions and/or parasitic infections that were documented are not novel and have been reported in bowhead whales previously (see Stimmelmayr *et al.* 2021). The penetrating injury was of interest as there is no evidence that any of the 64 bowheads that have been tagged in the past ~15 years (Quakenbush *et al.* 2018) have yet been harvested. Genetic samples from the tagged whales and the harvested whale were collected and results from single nucleotide polymorphisms (SNP) analysis for possible genetic matching to tagged whales remain pending. As in previous years, scars from rope entanglement (n=4) and killer whale predation attempts (n=1) were documented in landed whales. Long term documentation of scarring on landed bowhead whales has indicated an increase in healed injuries caused by killer whale predation attempts (George *et al.* 2017), but not an increase in scarring associated with line entanglement. Corroborating evidence comes from aerial surveys which indicate that killer whales increasingly prey on bowhead whales in small numbers in the Beaufort Sea (Willoughby *et al.* 2020). Lastly, an unusual proliferative skin condition was observed on a live bowhead whale calf deemed sick by Kaktovik whalers (Kaktovik Whalers Association pers. communication). After initial sightings, the whale could not be relocated and further investigation was not possible.

Update on Genetics Studies
An update on bowhead genetics studies was last provided to the IWC in 2018 (Baird et al. 2018). Additional samples from whales landed in the years since have subsequently been collected for genetic analysis. Analyses of these samples, as well as prior unanalyzed samples, are presently being conducted. Our methods include sequencing 3 mitochondrial DNA (mtDNA) genes (cytochrome-b [cyt-b], NADH dehydrogenase subunit I [ND1], and the hypervariable region 1 of the control region [HVR1]) and analyzing a panel of SNPs. In sum, the SNP database contains data from 608 whales. The mtDNA database contains sequences from 682 whales for cyt-b, 614 for ND1, and 890 for HVR1. MtDNA sequences have been completed for 541 samples for all 3 genes; mtDNA sequences and SNP genotypes have been completed for 422 samples. Standard population genetic analyses continue to be conducted on these data, including Fst (fixation index for measuring population differentiation), AMOVA (Analysis of Molecular Variance), population structure analyses, and diversity estimates. Regular updates to the Scientific Committee (SC) regarding genetic findings will be provided, as these results are important for the management of bowhead whales.

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Table 1. Village, whale identification number, dates landed, standard length (meters) and sex of bowhead whales landed by Alaskan Eskimos during the 2020 subsistence hunt.

Village	Whale ID#	Date Landed	Length (m)	Sex
Utqiaġvik	20B1	30 Apr	8.6	F
(formerly Barrow)	20B2	30 Apr	8.6	M
	20B3	30 Apr	8.5	M
	20B4	1 May	7.9	M
	20B5	2 May	8.4	F
	20B6	2 May	9.3	M
	20B7	3 May	8.6	M
	20B8	4 May[1]	8.8	F
	20B9	4 May	8.4	F
	20B10	9 May[2]	8.6	F
	20B11	9 May	8.8	M
	20B12	10 May	14.4	F
	20B13	23 May	15.0	M
	20B14	25 Aug	11.0	M
	20B15	25 Aug	12.0[3]	M
	20B16	28 Aug	10.6	F
	20B17	29 Aug[4]	11.9	F
	20B18	30 Aug	13.7	M
	20B19	4 Sep	12.8	M
	20B20	4 Sep	12.8	M
	20B21	4 Sep	13.0	M
	20B22	5 Sep	9.9	M
	20B23	8 Sep	10.0	M
	20B24	8 Sep	10.7	F
	20B25	17 Sep[5]	11.9	M
	20B26	17 Sep	13.4	M
	20B27	11 Oct	9.5	M
	20B28	12 Oct	9.8	M
Gambell	20G1	27 Apr	13.7	F
	20G2	24 Dec	14.9	M
Savoonga	20S1	28 Apr[6]	17.4	F
	20S2	23 Dec	15.8	F
	20S3	30 Dec	14.2	M
Kaktovik	20KK1	25 Aug	7.2	M
	20KK2	6 Sep	16.0	M
	20KK3	17 Sep	8.8	F
Nuiqsut	20N1	5 Sep	15.3	M
	20N2	6 Sep	10.5	M
	20N3	8 Sep	14.0	F[7]
Point Hope	20H1	22 Apr	9.7	F
	20H2	23 Apr	10.6	M
	20H3	24 Apr	7.5	F
	20H4	24 Apr	10.6	M
	20H5	24 Apr	12.8	M
	20H6	26 Apr	8.5	F
	20H7	26 Apr	8.6	F
	20H8	27 Apr	8.1	F
	20H9	29 Apr	13.0	M
	20H10	29 Apr	13.8	M
	20H11	1 May	9.1	M
	20H12	6 May	18.3	F

Wainwright	20WW1	5 May	13.7	M
	20WW2	8 May	12.3	F
	20WW3	26 May[8]	13.2	F[9]

[1]Struck on 3 May and landed on 4 May
[2]Struck on 5 May and landed on 9 May
[3]Estimated length
[4]Struck on 28 August and landed on 29 August
[5]Struck on 16 September and landed on 17 September
[6]Struck on 27 April and landed on 28 April
[7]Pregnant with fetus 1.8-2.1 m long
[8]Struck on 25 May and landed on 26 May
[9]Pregnant with female fetus 4.4 m long

Table 2. Locations, dates, season, and Captains' estimate of survival or our assessment based on the Captain's description, for whales struck and lost during 2020. Data provided by the Alaska Eskimo Whaling Commission.

Village	Date	Season	Estimated Survival
Utqiaġvik	2 May	Spring	Died
	3 May	Spring	Fair
	6 May	Spring	Died
	9 May	Spring	Died
	28 Aug	Fall	Excellent
	31 Aug	Fall	Died
Gambell	23 Dec	Winter	Poor
Savoonga	30 Dec	Winter	Died
Point Hope	23 Apr	Spring	Poor
	23 Apr	Spring	Died
	24 Apr	Spring	Poor
	29 Apr	Spring	Poor
	3 May	Spring	Poor
Wainwright	5 May	Spring	Died
	17 May	Spring	Died

Table 3. Summary of the number of landed bowhead whales and the Captains' estimate of survival for whales struck and lost during 2020. Data provided by the Alaska Eskimo Whaling Commission.

Village	Landed	Struck & Lost	Total Struck	Estimated Survival[1]
Utqiaġvik	28	6	34	1E; 1F; 4D
Gambell	2	1	3	1P
Kaktovik	3	-	3	-
Nuiqsut	3	-	3	-
Point Hope	12	5	17	4P; 1D
Point Lay	-	-	-	-
Savoonga	3	1	4	1D
Wainwright	3	2	5	2D
Totals	54	15	69	1E; 1F; 5P; 8D

[1] E=excellent, F=fair, P=poor, D=died, U=unknown.