Subsistence harvest of bowhead whales (*Balaena mysticetus*) by Alaskan Natives during 2018

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ABSTRACT

In 2018, 68 bowhead whales (*Balaena mysticetus*) were struck during the Alaskan subsistence hunt resulting in 47 animals landed. The total number of whales struck and the number landed in 2018 was higher than the averages for the previous 10 years (2008-2017: mean struck = 55.3; *SD* = 9.8 and mean landed = 42.6; *SD* = 7.2; respectively). The efficiency (# landed / # struck) of the hunt (69%) was lower than the average over the past 10 years (mean of efficiency = 77.4%; *SD* = 6.6%). Total mortality was estimated at 64 animals after the fate of the struck and lost whales was considered. Spring hunts are logistically more difficult than autumn hunts because of challenging and dynamic environmental conditions, difficulty in accessing open water, and changing sea ice thickness and dynamics. The hunting efficiency during spring is usually lower than autumn, which was the case in 2018. In 2018, the efficiency of the spring hunt (51%) was lower than the previous 10 years (2008-2017; mean efficiency = 69%) and lower than the 2018 autumn hunt (100%). Twenty-one whales were struck and lost in 2018, including one in the northern Bering Sea during the winter. Of the other 20 whales, six were lost under the sea ice, five whales died and sank, three were harvested but had to be cut loose during towing because of unsafe conditions, five whales were lost because of equipment malfunction, and no explanation was given for why one whale was struck and lost. No whales were struck and lost during the autumn hunt. Of the harvested whales, 23 were females and 24 were males. Based on total length (>13.7 m in length), seven of the females were presumed mature. Three of the mature females were closely examined. Of those, two were pregnant, one with a term fetus (4.2m long), one with a small fetus (4.5cm long), and one female was lactating. In 2018, we collected genetic samples from 35 harvested and 9 satellite tagged and biopsied whales.

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

INTRODUCTION

The subsistence harvest of bowhead whales (*Balaena mysticetus*) provides 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), comprised of 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 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 2018 under a six-year block quota that began in 2013 (IWC, 2013).

The subsistence hunt typically occurs during spring and autumn as 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 are affected by environmental conditions (e.g., wind speed and direction, fog, and temperature), stability of shorefast ice, and sea ice concentration, type, and dynamics. The success of each hunt is greatly affected by many factors, including those mentioned above, and shows considerable annual and regional variation.

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 and struck and lost whales (Albert, 1988). In 2018, the NSB gathered detailed information and tissue samples on whales landed at Utqiaġvik (formerly Barrow), and with the assistance from the Alaska Sea Grant, we also collected detailed information and tissue samples from most of the whales landed at Kaktovik, Gambell, and Savoonga. The objectives of this paper are to document: (1) the number, location (village), and dates of landed and struck and lost bowhead whales during 2018 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, and (5) relevant additional environmental observations on hunting conditions.

METHODS

Data on sex, standard length, harvest and landed dates, as well as the fate of struck and lost whales for all whaling villages were obtained from the AEWC. Biologists recorded similar information for the whales taken at Utqiaġvik, Gambell, Kaktovik, and Savoonga during 2018. Biologists also collected tissue samples, detailed morphometric data, and documented evidence from scarring of previous non-lethal human interactions (i.e., ship strikes or line entanglements) and killer whale attacks.

We estimated the approximate animal age and reproductive status based on several published criteria. Historically, we used 14.2 m as the best estimate of length at sexual maturity for females (Tarpley and Hillmann, 1999). Updated information was available in 2004, which provided an estimate of 13.4m; however, females shorter than that have been pregnant, and females greater in length have been immature (George *et al*., 2004). For example, a 12.6 m female landed at Utqiaġvik in spring 2016 was pregnant and the longest immature female that we have examined was 14.4 m (George *et al.*, 2004; NSB unpublished data). Based on a new analysis, females with a total body length greater than 13.7 m were considered to be sexually mature (George et al. 2018). 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 2018, 68 whales were struck, and of those, 47 were landed during the Alaskan subsistence hunt. The total number of whales struck and the number landed in 2018 was higher than the averages for the previous 10 years (2008-2017: mean struck = 55.3; *SD* = 9.8 and mean landed = 42.6; *SD* = 7.2; respectively). One whale was struck and lost and one landed during the winter. Twenty-one bowheads were landed and 20 were struck and lost during the spring (Tables 1 and 2). Twenty-five whales were struck and landed by three villages during the autumn (Utqiaġvik, Kaktovik, and Nuiqsut; Table 1).

Winter Hunting Conditions

The timing, extent, and quality of sea ice formation and presence in the northern Bering Sea has changed dramatically in the past 30 years or so (Stroeve et al. 2014). Sea ice now forms later in the autumn, there is less sea ice coverage, and it is of thinner, weaker quality (Jones 2013). In the late 1990s, Savoonga and Gambell responded to the reduced sea ice by hunting more regularly for bowheads in winter (Suydam and George, 2012; Noongwook *et al.*, 2007). In 2018, Savoonga struck and lost a whale on 20 January and Gambell landed a whale on 11 February.

Spring Hunting Conditions
Hunting conditions during much of spring 2018 were especially challenging in the northern Bering Sea because of unprecedented open water conditions and prolonged windy conditions. Conditions were better in the Chukchi Sea. The villages that are typically successful in the spring were able to land whales in 2018.

Gambell and Savoonga, on Saint Lawrence Island in the northern Bering Sea, landed two and one whales, respectively, during spring in early April. The environmental conditions were atypical primarily because of the unprecedented open water conditions. Regardless of the environmental and logistical challenges associated with less ice, the 2018 harvests for Gambell and Savoonga were similar to the past several years when there was also diminished sea ice. About five to 10 years ago Gambell and Savoonga were landing about six to 10 whales per year (Suydam and George, 2018). Sea ice, weather conditions, and logistical constraints prevented hunters from striking a whale at Little Diomede, Wales, and Kivalina.

Point Hope had a successful spring hunting season landing seven whales between mid-April and mid-May. Point Lay was able to strike one whale but had to abandon it while towing because of dangerous environmental conditions, including strengthening winds and river breakup making access back to the village treacherous. Wainwright landed three whales during late April through mid-May. Hunting conditions for Point Hope and Wainwright were generally good during the spring.

Utqiaġvik landed eight whales from 25 April to 7 May 2018. Many whales were seen in early April, which is becoming more typical in recent years. Previously whales were not seen until ~mid-April. Jumbled ice attached to the shorefast ice (i.e., *iiguaq*) made getting to the open water more difficult. There was also a considerable amount of small ice floes and slush ice in the lead until late April. The first whale was landed on 25 April. By mid-May few whales were being seen and the shorefast ice was beginning to melt. Many crews had pulled off the ice although a few continued to hunt until late May or early June.

Autumn Hunting Conditions
At Kaktovik, sea ice was present throughout the harvest season, air temperatures remained cool, and there were several days of heavy rains. By 21 September, slush ice was forming in the lagoon. Nuiqsut landed three whales at Cross Island during the first two weeks of September.

At Utqiaġvik, 19 bowheads were landed from 7 to 23 October. The whale hunt opened on 6 October but due to bad weather on that day, primarily high winds, the first whale was not landed until 7 October. There were other days of high winds that also made hunting dangerous. On one of those days, two hunters, including a Captain, died in an accident while towing a whale in rough seas.

As mentioned above, hunting conditions in the northern Bering Sea have been increasingly challenging, in large part because of the diminishing sea ice and unprecedented time periods of open water. The diminished amount of sea ice and rapid breakup during spring reduces access to bowheads and walruses by hunters. Both of those species are important subsistence resources for the communities in the northern Bering. Thus, in order to meet the nutritional and cultural needs of their community, a 7.3m long, male gray whale was landed by Gambell. The take of this whale will be reported by the U.S. and the AEWC as an infraction to the IWC.

Struck and Lost and Hunting Efficiency
Of the 21 whales struck and lost in 2018, two whales had an excellent chance of survival, two whales had a fair chance of survival, four had a poor chance of survival, 11 died, and the fate was unknown for two whales. The estimates of survival are primarily based on the Captain's assessment and our assessment of the Captain's description of the circumstances of the struck and lost whale (Table 2 and 3). Based on the number of landed whales and the assessment of survival, the total hunting mortality for 2018 was 64 whales (i.e., 47 landed, plus 17 whales that were struck and lost, which died [n=11] or had a poor chance of survival [n=4], plus the two whales with unknown fates; see criteria in Suydam *et al.*, 1995).

The overall efficiency of the hunt (#landed/#struck) in 2018 was 69%, which is lower than the average efficiency over the past 10 years (2008-2017: mean of efficiency = 77%; *SD* = 6.6%). Since the mid-

1970s, the efficiency of the harvest increased steadily until about the mid-1990s when it stabilized around 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 and 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 variable environmental conditions (George *et al.*, 2003). As such, efficiency varies between seasons and among years. The efficiency of the spring harvest is on average lower than the autumn harvest due to more demanding ice and weather conditions. Additionally, during spring whaling, some struck whales are able to escape pursuit by swimming under the sea ice. That was in part the case in 2018. The efficiency of the spring hunt was 51% and the autumn hunt was 100%. Twenty-one whales were struck and lost in 2018, including one at Savoonga during the winter, which was lost under the sea ice. Of the other 20 whales struck and lost in the spring, six were lost under the sea ice, five whales died and sank, three were harvested but had to be cut loose during towing because of unsafe conditions, five whales were lost because of equipment malfunction, and no explanation was given for why another whale was struck and lost.

No whales were struck and lost during the autumn hunt. Autumn hunts typically occur in more open water conditions with sea ice less of an influence on success. However, high wind speeds with the larger fetch of the open water period can limit and make hunting opportunities extremely difficult in the autumn (George *et al.*, 2003). As climate change causes a larger and longer open water period, 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, which possibly offsets inclement weather that typically results in poor hunting conditions and success. Hunters at Utqiaġvik in particular have responded to the changing hunting conditions by purchasing larger boats (~8-9 m long) capable of handling larger seas.

Sex and Maturity

Twenty-four (51%) of the landed whales were males. The longest male was 17.5 m and the shortest was 8.0 m. Based on a length of >13 m (O'Hara *et al*., 2002), four males were presumably sexually mature (see Table 1).

Twenty-three (49%) of the landed whales were females. The longest female was 16.1 m and the shortest was 7.1 m. Based on a length >13.7 m (George *et al*., 2018), seven of the females were sexually mature. Three of those were closely examined for pregnancy. Two were pregnant, one with a term fetus (4.2m long), one with a small fetus (4.5cm), and one female was lactating. The percent pregnant of harvested mature females during 2018 was higher (67%) than the long-term average of 33% (George *et al.*, 2004; George *et al.*, 2011), although the sample size was small. At the 2018 bowhead Implementation Review, we reported an updated pregnancy rate for 1976-2016 to be 32% (95% CI: 21% to 55%) with the possibility that the pregnancy rate has increased over that period (George et al., 2018).

High variation in annual bowhead calf production is well established (Koski *et al.*, 2008; Clarke *et al.*, 2014). However, bowheads had high pregnancy rates in 2015 (Suydam *et al.*, 2016), 2016 (Suydam *et al.*, 2017) and again in 2017 (Suydam et al. 2018). Aerial surveys in the summer and autumn (Aerial Surveys for Arctic Marine Mammals, conducted by the U.S. National Marine Fisheries Service with funding from the U.S. Bureau of Ocean Energy Management) in the Alaskan Beaufort Sea provide information about calf production. During 2016, the surveys documented 104 bowhead calves (J. Clarke, *personal communication*) and during 2017, 155 bowhead calves were observed, a record high number. These numbers were not corrected for bowhead habitat not surveyed, thus there were likely many more calves present but not observed (Clarke *et al.*, 2018). We do not have a recent estimate of pregnancy rate for the entire population but based on data from harvested whales and aerial surveys the BCB bowheads had a very strong period of reproduction from 2015 to 2018.

2013-2018 Block Quota
The IWC quota for bowheads from the Bering-Chukchi-Beaufort seas stock from 2013 to 2018 states that "…the number of bowhead whales landed shall not exceed 336. For each of these years the number of bowhead whales struck shall not exceed 67, except that any unused portion of the strike quota from any year…shall be carried forward and added to the strike quotas of any subsequent year, provided that no more than 15 strikes shall be added to the strike quota for any one year." (*emphasis added*; IWC 2013). From 2013 to 2018, 342 strikes were used in Alaska resulting in 266 whales landed. In Chukotka, Russian Federation, four bowheads were struck and landed between 2013 and 2017 (IWC 2019). Information will be presented at the 2019 Scientific Committee meeting about any additional bowheads that might have been struck in Chukotka in 2018. Thus, at least 346 strikes were used (from a total possible 402 strikes [67 strikes x 6 years]) between 2013 and 2018 resulting in at least 270 whales landed.

Genetic Sampling
Genetic tissue samples were collected from whales landed in 2018. These include 35 samples from harvested whales (26 from Barrow, 3 from Gambell, 1 from Savoonga, 1 from Kaktovik, and 4 from Wainwright, including tissue from a fetus of a pregnant female) and samples from 9 satellite tagged bowheads. Analyses of these 44 samples are presently being conducted. These include sequencing 3 mitochondrial DNA genes and analyzing a panel of single nucleotide polymorphisms (SNPs). Standard population genetic analyses continue to be conducted on these databases, including Fst, Analysis of Molecular Variance (AMOVA), population structure analyses, and diversity estimates. The most recent population genetic results were reported to the IWC Scientific Committee as part of the bowhead implementation review in 2018 (Baird et al. 2018). We will continue to regularly update the SC regarding our genetic findings, as they have historically been, and will continue to be useful for making recommendations about bowhead management.

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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 2018 subsistence hunt.

Village	Whale ID#	Date Landed	Length (m)	Sex
Utqiaġvik	18B1	25 Apr	8.9	F
(formerly Barrow)	18B2	26 Apr	9.1	F
	18B3	26 Apr	9.1	M
	18B4	27 Apr[1]	9.9	M
	18B5	27 Apr	8.9	M
	18B6	27 Apr	8.0	M
	18B7	7 May	8.6	M
	18B8	7 May	8.4	M
	18B9	7 Oct	8.6	M
	18B10	7 Oct	8.9	F
	18B11	7 Oct	9.2	M
	18B12	9 Oct	9.3	F
	18B13	9 Oct	10.9	F
	18B14	19 Oct	8.2	F
	18B15	19 Oct	9.1	F
	18B16	19 Oct	8.1	M
	18B17	19 Oct	9.4	M
	18B18	20 Oct	8.4	F
	18B19	20 Oct	7.1	F
	18B20	20 Oct	8.3	M
	18B21	21 Oct	8.3	F
	18B22	22 Oct	8.6	M
	18B23	22 Oct	10.2	M
	18B24	23 Oct	8.1	M
	18B25	23 Oct	7.7	F
	18B26	23 Oct	8.5	F
	18B27	23 Oct	16.1[2]	F
Gambell	18G1	11 Feb	17.5	M
	18G2	1 Apr	13.6	M
	18G3	7 Apr	14.6[3]	F[3]
Kaktovik	18KK1	6 Sep	14.0	M
	18KK2	8 Sep	9.3	M
	18KK3	21 Sep	9.9	M
Nuiqsut	18N1	2 Sep	8.0	M
	18N2	8 Sep	9.9	F
	18N3	13 Sep	11.3	M
Point Hope	18H1	14 Apr	15.4	M
	18H2	21 Apr	12.0	M
	18H3	22 Apr	9.1	M
	18H4	22 Apr	9.0	F
	18H5	22 Apr	8.2	F
	18H6	15 May	14.7	F
	18H7	16 May	15.7	F
Savoonga	18S1	10 Apr[4]	15.2	F
Wainwright	18WW1	26 Apr	9.0	F
	18WW2	2 May[5]	14.9	F[6]
	18WW3	17 May	15.7	F

[1] Struck on 26 April and landed on 27 April.
[2] Lactating
[3] Pregnant with 4.5cm long fetus.
[4] Struck on 7 April and landed on 10 April.
[5] Struck on 1 May and landed on 2 May.
[6] Pregnant with male fetus 4.2 m in length.

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 2018. Data provided by the Alaska Eskimo Whaling Commission.

Village	Date	Season	Estimated Survival
Utqiaġvik	23 Apr	Spring	Died
	26 Apr	Spring	Died
	26 Apr	Spring	Unknown
	2 May	Spring	Fair
	2 May	Spring	Unknown
	4 May	Spring	Died
	4 May	Spring	Died
	7 May	Spring	Poor
	9 May	Spring	Poor
	9 May	Spring	Died
	18 May	Spring	Fair
Point Hope	14 Apr	Spring	Died
	14 Apr	Spring	Died
	14 Apr	Spring	Unknown
	19 Apr	Spring	Poor
	19 Apr	Spring	Poor
	6 May	Spring	Died
	10 May	Spring	Died
Point Lay	14 May	Spring	Died
Savoonga	20 Jan	Winter	Excellent
Wainwright	25 Apr	Spring	Died

Table 3. Summary of the number of landed bowhead whales and the Captains' estimate of survival (or our assessment based on the Captain's description) for whales struck and lost during 2018. Data provided by the Alaska Eskimo Whaling Commission.

Village	Landed	Struck & Lost	Total Struck	Estimated Survival[1]
Utqiaġvik	27	11	39	1E; 2F; 2P; 5D; 1U
Gambell	3	-	3	-
Kaktovik	3	-	3	-
Nuiqsut	3	-	3	-
Point Hope	7	7	14	2P; 4D; 1U
Point Lay	-	1	1	1D
Savoonga	1	1	2	1E
Wainwright	3	1	4	1D
Totals	47	21	68	2E; 2F; 4P; 11D; 2U

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