

Subsistence harvest of beluga or white whales (*Delphinapterus leucas*) in northern and western Alaska, 1987–2006

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ABSTRACT

Four stocks of beluga or white whales (*Delphinapterus leucas*) are hunted by Alaska Natives in northern and western Alaska. These are the Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea and Bristol Bay stocks. Since 1987, the Alaska Beluga Whale Committee has monitored the subsistence harvests of belugas from these stocks. During this 20 year period, the total landed harvest for the four stocks combined (adjusted for years with missing data) ranged from 208 in 1995 to 494 in 1988, with a 20 year average of 323 per year. For individual stocks the average annual landed harvests for 1987–2006 were: Beaufort Sea – 41; Chukchi Sea – 62; eastern Bering Sea – 191; and Bristol Bay – 20. There was no significant long-term trend ($p > 0.05$) in the rate of harvesting for any stock from 1987–2006. Average landed harvests relative to estimated stock size were: 0.1% for the Beaufort Sea (0.4% including belugas harvested from the Beaufort Sea stock by Canadian hunters); 1.7% for the eastern Chukchi Sea; 1.1% for the eastern Bering Sea; and 1.1% for Bristol Bay. The success of beluga harvest monitoring in Alaska is due to the cooperation of beluga hunters from more than 40 small coastal communities who report their harvests to the Alaska Beluga Whale Committee (ABWC). Through the ABWC, beluga hunters have been able to formalise their role in managing their subsistence resources.

KEY WORDS: BELUGA WHALE; WHITE WHALE; WHALING – ABORIGINAL; MANAGEMENT; ARCTIC

INTRODUCTION

Beluga whales (*Delphinapterus leucas*)¹ are an important subsistence resource for coastal residents of Alaska. They appear seasonally near villages and hunting camps from Cook Inlet to the Beaufort Sea where they are hunted with rifles and harpoons, or are caught in nets. Meat and muktuk (or maktaaq, i.e. skin and blubber) are consumed locally, or are shared with friends and relatives in other communities.

Belugas in Alaska are found in five summering concentrations, namely Cook Inlet, Bristol Bay, eastern Bering Sea (Norton Sound/Yukon Delta), eastern Chukchi Sea (Kotzebue Sound and Kasegaluk Lagoon), and the eastern Beaufort Sea. These concentrations have been considered as provisional management stocks for the last 20 years and previous harvests have been evaluated in terms of their impact on these provisional stocks (Frost and Lowry, 1991; Frost and Suydam, 1995; Lowry *et al.*, 1989; Seaman *et al.*, 1988). Recent analysis of mitochondrial DNA has supported treatment of these summering concentrations as separate management stocks (Angliss and Lodge, 2002; O’Corry-Crowe *et al.*, 2002; O’Corry-Crowe *et al.*, 1997). Belugas are also sometimes present and harvested in Kuskokwim Bay, although Kuskokwim Bay belugas have not been assigned to a provisional stock.

Prior to 1988, information on the harvest of belugas in Alaska was obtained primarily by personnel of the Alaska Department of Fish and Game (ADF&G) on an opportunistic basis. Harvest data have previously been published for 1977–1979 (Seaman and Burns, 1981), 1980–1983 (Burns and Seaman, 1988), and 1984–1986 (Lowry *et al.*, 1989). In 1988, the Alaska Beluga Whale Committee (ABWC) was formed, with goals of collecting harvest data and biological

samples and identifying and conducting research needed for beluga whale conservation and management (Adams *et al.*, 1993). At that time, the ABWC began to compile and report harvest data on a more complete and regular basis than had been done in the past (Frost, 1999; Frost and Suydam, 1995).

In this paper, we present harvest data collected by the ABWC for the 20 year period from 1987–2006 for the four management stocks in western and northern Alaska and for animals harvested in the Kuskokwim delta. Data are not included from Canadian hunters in the Mackenzie River estuary, they are reported in Harwood *et al.* (2002). Data for Cook Inlet, where hunters and hunting communities do not belong to the ABWC, are not included.

METHODS

Harvest data were obtained from a variety of sources, as follows.

The ABWC held annual meetings in the autumn of each year from 1988–2006, after beluga hunting had ended for the year. At those meetings, hunter representatives reported on the harvest for each village or region. In addition, at least twice each year harvest questionnaires were mailed to village or regional government offices and to several hunters in most beluga hunting villages. Those hunters were individuals who had assisted the ABWC with harvest information in the past. The questionnaires asked for the number of belugas landed and struck and lost by season, as well as for other information about the location and type of hunt.

In the Norton Sound region, the Elim-Shaktoolik-Koyuk Marine Mammal Commission, with some financial support from the ABWC, hired monitors to collect harvest data for these three villages, and also to collect certain measurements

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¹ While not the official IWC common name for this species, ‘beluga’ is the name used in Alaska.

and samples for the ABWC. At some locations in northern Alaska (Point Lay), the entire beluga whale harvest was observed and sampled by harvest monitors working for the North Slope Borough Department of Wildlife Management in cooperation with local residents. The collection of Bristol Bay harvest data was coordinated by the ADF&G Division of Subsistence, in cooperation with the Bristol Bay Marine Mammal Council and Bristol Bay Native Association. Information from each of these sources about the number of landed belugas was considered reliable.

In addition, information about harvest was obtained through interviews with local residents and from ADF&G and other biologists working along the coast. Numbers obtained through these means were sometimes estimates rather than exact counts, or may not have included all hunters or the entire hunting season. Sometimes we received a minimum estimate of the number taken but other sources indicated that additional whales may have been harvested. In such cases, we used the highest estimate for the reported harvest. Whenever possible, harvest numbers were corroborated by contacting multiple sources for each harvest location.

Struck and lost rates were calculated only when data were reported for both harvested and struck and lost animals for a given year at a particular site. When either the harvest or the number struck and lost was missing or estimated, the struck and lost data were not used in the calculations.

We partitioned harvest data among the four management stocks, based on our knowledge of the seasonal distribution and movements of belugas as well as on genetics information. Harvests south of Bering Strait occurred while belugas were in seasonal concentration areas, and thus were easily ascribed to a particular stock. In Bering Strait and along the Chukchi Sea coast, harvest was assigned to a particular stock based on both where and when it occurred. The Beaufort Sea stock travels through open leads in the sea ice along the coast in spring (March–May) on its way to the eastern Beaufort Sea, and belugas harvested during this period were presumed to belong to the Beaufort Sea stock. This assumption was verified by genetics analyses of whales take at Point Hope, where the majority of such hunting occurs (O’Corry-Crowe *et al.*, 2002; 1997). Western Alaska villages whose spring harvests were attributed to the Beaufort Sea stock included Diomedea, Kivalina, and Point Hope. Belugas taken in the Beaufort Sea at Barrow and Kaktovik during summer or moving westward in the fall were also attributed to the Beaufort Sea stock.

During and after breakup of the sea ice (June to mid-August), belugas appear along the Chukchi Sea coast between Kotzebue Sound and Wainwright (Frost and Lowry, 1991; Seaman *et al.*, 1988). All summer harvests in this region were assigned to the eastern Chukchi Sea stock. Villages/towns included in this region were Buckland, Deering, Kotzebue, Noatak, Kivalina, Point Hope, Point Lay, and Wainwright. Mitochondrial DNA analysis suggests that belugas harvested in Kotzebue Sound may differ genetically from other eastern Chukchi Sea belugas (G. O’Corry-Crowe, pers. comm.). However, for the current analysis, we have assumed that Kotzebue animals are part of the eastern Chukchi Sea stock.

For some locations in some years, particularly in the ABWC’s early years, no harvest data were available. Since

a compilation of harvest data without these sites would underestimate the total harvest, we calculated an ‘adjusted harvest’ to use in evaluating landed harvest relative to stock size and harvest trend. For all missing data points, we assigned a value equal to the average value for that site for all years for which data were available. Thus, if data were missing for 4 of 20 years at a particular site, the assigned value would be the average of the 16 years with data. The adjusted harvests were used to estimate the percent of a stock that was harvested.

We used a linear model and data adjusted for missing values to examine trend in harvest over the 20 year period. We used standard diagnostics to ensure that errors were normally and identically distributed (e.g., normal probability plots, model specification tests) and that there was no autocorrelation in the data (i.e. Durban-Watson tests). Landed harvest as a proportion of estimated stock size was evaluated by comparing adjusted harvests, by stock, to the best available population estimate for that stock.

RESULTS

Reported landed harvests

Landed harvest data for 1987–2006 were obtained from more than 40 communities from along the Bering, Chukchi and Beaufort Sea coasts of Alaska (Fig. 1). The reported annual landed harvest of belugas (Table 1) averaged 275 (SE = 17.9) and was lowest in 1995 (101) and highest in 1988 (418).

Seven communities harvested animals from the Beaufort Sea stock (Table 1), with an average annual harvest of 39 belugas landed (range 4–85 SE = 4.7). Belugas from the eastern Chukchi Sea stock were harvested by six villages, with an average annual harvest of 62 (range 2–116, SE = 6.4). Fifteen or more communities hunted from the eastern Bering Sea stock, with an annual harvest of 152 (range 31–281, SE = 14.6). Eleven communities hunted from the Bristol Bay stock, with annual harvests averaging 17 (range 6–35, SE = 1.7). Harvest reports were intermittent for the Kuskokwim delta region, but it is clear from the data we received and from discussions with local hunters that few belugas were seen or taken in most years. The average annual harvest over 20 years was 5 (range 0–27. SE = 1.6).

Only four villages reported average annual harvests of 20 or more belugas and 30 villages harvested five or fewer belugas per year. The average annual harvests were dominated by a single village for the Beaufort Sea (Alaska only, Point Hope, 79%) and the eastern Chukchi Sea (Point Lay, 60%) stocks. The harvest was spread more evenly among villages for the eastern Bering Sea and Bristol Bay stocks.

Harvest reporting improved over the 20 year period 1987–2006. For the four management stocks combined (not including the Kuskokwim where data were intermittent), reporting improved from 75% of villages reporting during 1987–1996 to 90% during 1997–2006. Improvement was greatest for the eastern Bering Sea and Bristol Bay stocks (about 70% of villages reporting during the first 10 years and 90% in more recent years). Reporting rates were high over the entire 20 year period for the Beaufort Sea (80%–87%) and eastern Chukchi Sea (93%–97%) stocks. A comparison of reported harvest totals to totals adjusted for missing data suggests that the actual harvest was probably about 20%

Table 1

Reported landed harvest of beluga whales from western and northern Alaska, 1987–2006. Data provided by the Alaska Beluga Whale Committee. nd = no data.

Location	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	\bar{x}
Beaufort Sea stock																					
Barrow	0	0	1	0	1	0	2	5	0	2	8	1	1	1	1	1	2	1	7	1	2
Diomede	10	3	6	5	3	2	1	0	nd	0	1	4	0	6	0	0	4	0	0	4	3
Kaktovik	0	0	0	10	0	0	0	0	1	0	2	0	0	0	0	0	3	1	0	0	1
Kivalina	nd	5	0	0	0	10	3	3	3	7	0	0	1	43	0	0	0	1	2	0	4
Nuiqsut	nd	nd	nd	nd	nd	nd	nd	nd	0	0	0	1	0	nd	0	0	0	0	0	0	0
Point Hope	40	59	17	16	39	15	79	53	nd	15	32	52	33	16	24	23	34	29	11	0	31
Wales	0	0	2	3	nd	1	nd	1	nd	nd	nd	1	nd	nd	nd	0	nd	nd	nd	nd	1
TOTAL	50	67	26	34	43	28	85	62	4	24	43	59	35	66	25	24	43	32	20	5	39
Eastern Chukchi Sea stock																					
Buckland	7	17	0	31	0	4	0	0	1	5	1	1	0	1	18	2	0	0	0	0	4
Deering	0	0	0	nd	nd	nd	0	0	0	2	0	0	nd	0	nd	0	0	0	0	0	0
Kivalina	0	1	0	1	1	0	0	0	0	0	1	0	0	1	0	3	0	0	0	0	0
Kotz/Noatak	2	8	37	6	11	5	6	7	4	68	7	4	2	0	9	4	0	1	1	2	9
Point Lay	22	40	16	62	35	24	77	56	31	41	3	48	47	0	34	47	36	53	41	29	37
Wainwright	47	3	0	0	5	20	0	0	0	0	4	38	3	0	23	37	38	0	1	0	11
TOTAL	78	69	53	100	52	53	83	63	36	116	16	91	52	2	84	93	74	54	43	31	62
Eastern Bering Sea stock																					
Alakanuk	nd	nd	nd	14	nd	10	nd	10	nd	nd	7	14	nd	9	13	nd	nd	32	37	15	16
Elim	nd	27	22	8	14	2	16	5	10	27	21	13	9	30	20	13	9	22	17	11	16
Emmonak	3	nd	1	nd	nd	12	15	20	nd	nd	20	20	8	30	30	40	30	nd	40	30	21
Golovin	nd	5	13	0	0	1	2	1	0	0	1	4	0	0	2	0	0	0	0	5	2
Hooper Bay	nd	5	nd	nd	10	nd	nd	40	5	35	17	6	6	39	69	46	8	3	29	33	23
Kotlik	nd	nd	nd	1	nd	9	40	15	5	2	8	4	13	11	6	12	nd	nd	13	12	11
Koyuk	15	54	30	45	55	3	20	8	0	8	6	6	4	0	13	17	3	9	5	3	15
Nome/Brevg	0	0	0	0	0	nd	nd	1	0	1	0	0	0	2	nd	nd	0	nd	3	2	1
Nunam Iqua	nd	nd	nd	25	nd	11	nd	nd	nd	nd	2	1	nd	3	12	13	10	7	9	2	9
St. Michael	nd	50	25	22	5	5	17	1	5	14	8	16	13	8	21	13	2	3	6	5	13
Scammon	nd	nd	nd	7	15	5	nd	nd	nd	6	3	13	9	12	12	nd	11	11	6	7	9
Shaktoolik	nd	30	15	12	17	5	12	9	10	4	17	16	13	nd	40	12	10	26	13	14	15
Stebbins	10	30	22	20	46	7	12	6	12	6	20	17	16	15	18	21	20	8	9	9	16
Unalakleet	nd	35	14	12	17	3	2	nd	8	3	5	14	20	29	21	38	5	4	4	10	14
White Mt.	nd	1	1	0	0	0	0	nd	0	0	1	0	2	0	6	4	4	7	5	4	2
Other	3	6	12	2	10	6	nd	nd	nd	nd	7	nd	1	nd	nd	5	nd	0	53	1	9
TOTAL	31	243	155	168	189	79	136	116	55	106	143	144	114	188	281	234	112	132	249	163	152
Kuskokwim																					
Eek	nd	3	4	0	7	7	nd	2	nd	nd	nd	nd	nd	0	0	0	0	0	0	nd	2
Goodnews	nd	1	nd	0	0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0	nd	nd	nd	0
Newtok	nd	nd	nd	nd	nd	nd	0	nd	nd	nd	0	nd	nd	0	0	1	0	0	nd	nd	0
Quinhagak	nd	5	4	nd	15	8	nd	4	nd	0	0	nd	4	0	0	0	0	0	0	0	3
Toksook	0	0	0	0	0	nd	nd	nd	nd	2	0	0	0	0	0	3	0	0	nd	8	1
Tuntatuliak	nd	1	3	nd	nd	nd	nd	0	nd	nd	nd	nd	nd	nd	nd	nd	0	nd	nd	nd	0
Other	5	3	2	nd	5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	2	1	3
TOTAL	5	13	13	0	27	15	0	6	0	2	0	0	4	0	0	4	0	0	2	9	5
Bristol Bay Stock																					
Aleknagek	nd	nd	1	nd	nd	nd	3	1	1	1	0	0	2	1	2	2	0	2	3	1	1
Clark's Point	1	nd	1	4	nd	nd	4	3	0	3	2	2	2	3	4	4	0	0	nd	0	2
Dillingham	2	3	nd	nd	nd	nd	3	5	1	8	4	1	3	5	8	1	8	4	7	4	4
Egegik	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0
Igiugig	nd	nd	nd	nd	nd	3	3	1	1	0	0	0	0	1	nd	0	0	3	0	2	1
Iliamna	nd	nd	nd	nd	3	3	0	1	1	0	0	0	0	0	2	0	0	0	0	2	1
Levelock	3	23	6	10	10	5	9	2	1	4	2	0	3	7	2	1	0	0	2	2	5
Manokotak	3	nd	nd	6	6	nd	11	4	1	2	2	2	2	3	4	1	10	4	3	5	4
Naknek	nd	nd	nd	nd	nd	1	2	0	0	0	1	1	1	1	nd	nd	nd	1	1	4	1
Newhalen	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	1	nd	nd	nd	0	3	0	1
Non-local	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	2	2	2	2	nd	2
Togiak	nd	0	0	0	0	0	0	0	0	0	0	0	0	2	1	nd	0	0	0	0	0
TOTAL	9	26	8	20	19	12	35	17	6	18	11	6	13	24	25	11	21	16	21	20	17
All stocks	173	418	255	322	330	187	339	264	101	266	213	300	218	280	415	366	250	234	335	228	275

higher than reported during 1987–1996, and about 7% higher during 1997–2006. The difference was greatest for stocks with the most missing data. Reported harvests were probably about 30% underestimated for the eastern Bering Sea stock and 25% for the Bristol Bay stock during 1987–1996, but less than 10% underestimated for both during 1997–2006.

Harvest trends and harvest relative to population size

There was no statistically significant long-term trend ($p>0.05$) in the rate of harvesting for the Beaufort Sea,

eastern Chukchi Sea, eastern Bering Sea and Bristol Bay beluga stocks from 1987–2006 (Table 2; Fig. 2). For each stock, residuals from the linear models used to estimate trend were normally distributed, homoscedastic, and devoid of serial autocorrelation ($p>0.05$), indicating that linear models were appropriate for examining trends.

Average annual landed harvests of Alaskan beluga stocks during 1987–2006 ranged from 0.1% to 1.7% of estimated stock size (Table 2). The Alaskan harvest of the Beaufort Sea stock was <0.2% of the estimated stock size. The average

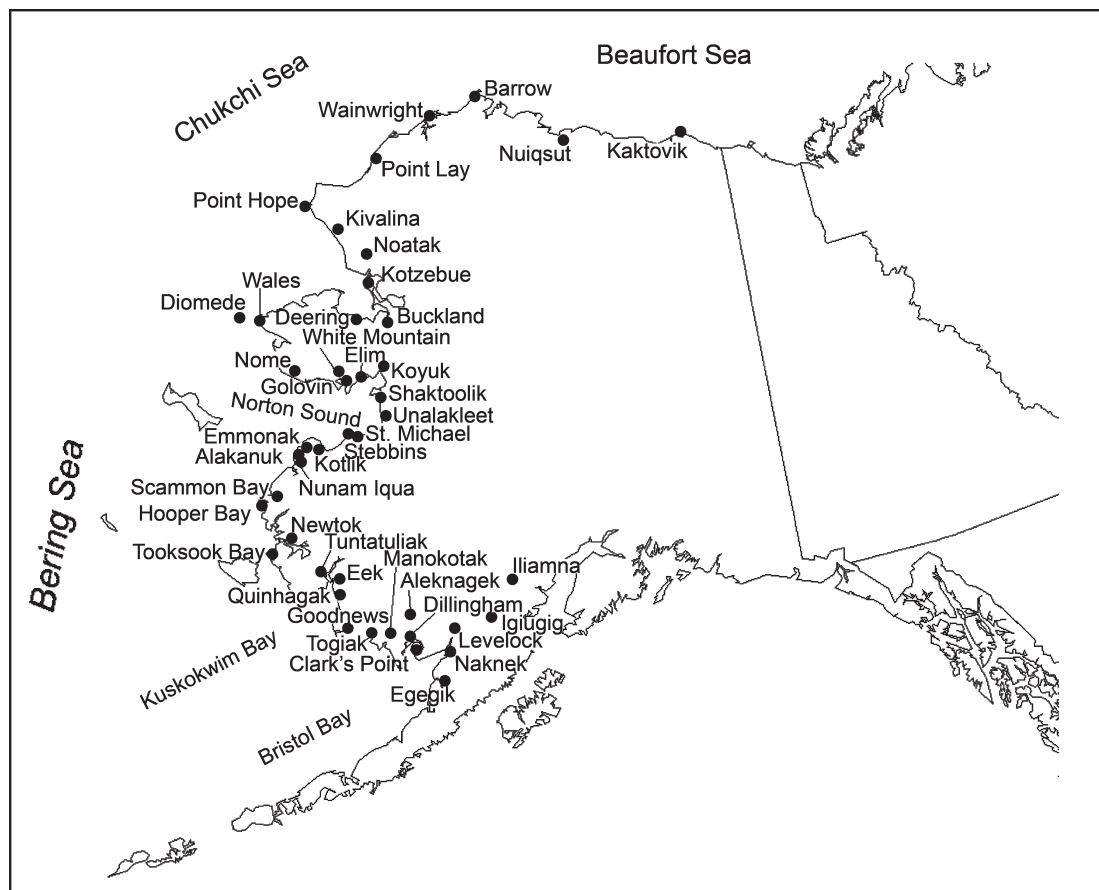


Fig. 1. Map of Alaska showing communities where beluga harvest data were collected.

adjusted harvest for the eastern Bering Sea and Bristol Bay stocks was 1.1% of estimated stock size and never exceeded 1.9% in any year. Annual harvest for the eastern Chukchi Sea stock averaged 1.7%, although in a few years it was as high as 3.1%.

Struck and lost

Struck and lost information was not reported for all sites and years. Information was poorly reported in most years for most communities hunting from the Beaufort Sea and eastern Bering Sea stocks so we do not report it. Data for the eastern Chukchi Sea and Bristol Bay stocks are summarised below for 1997–2006 only since data before then were sporadic.

Struck and lost information was available 83% of the time for the six villages harvesting from the eastern Chukchi Sea stock, with an average struck and lost rate for 1997–2006 of

7%. Sixty percent of the eastern Chukchi Sea harvest occurred at Point Lay, where the hunt usually occurs in very shallow water (<2m) near town. Starting in 1996 Point Lay hunters established guidelines that encouraged hunters to harpoon every beluga before it was shot. Their struck and lost rate since 1996 has been less than 2%. Struck and lost information was available for Bristol Bay villages 63% of the time. The average struck and lost rate for the 11 Bristol Bay villages was 9%.

DISCUSSION

Landed harvest as a proportion of estimated stock size

A marine mammal population is thought to be able to reach or maintain its optimum sustainable population if human-induced mortalities are kept below one half of the maximum net productivity rate. Two percent has been considered a

Table 2

Raw and adjusted annual harvest (average, range) for four Alaska stocks of beluga whales relative to stock size during 1987–2006. Stock identity and abundance are unknown for Kuskokwim belugas. Data were provided by the Alaska Beluga Whale Committee.

	Stock estimate	Raw landed (range)	Reported % of stock	Adjusted (range)	Adjusted % of stock
Beaufort ^a	39,258 ^{b,c}	39 (4–85)	0.10 (0.01–0.22)	41 (6–86)	0.11 (0.02–0.22)
E. Chukchi	3,710 ^{b,d}	62 (2–116)	1.68 (0.05–3.13)	62 (2–116)	1.68 (0.05–3.13)
E. Bering	18,142 ^b	152 (31–281)	0.84 (0.17–1.55)	191 (103–309)	1.05 (0.57–1.70)
Kuskokwim	?	5 (0–27)		8 (1–27)	
Bristol Bay	1,888 ^{b,e}	17 (6–35)	0.90 (0.32–1.85)	20 (6–36)	1.08 (0.32–1.85)
TOTAL		275 (101–418)		323 (208–494)	

^aDoes not include harvests by Canadian hunters when this stock is in the Mackenzie River estuary; ^bAngliss and Lodge (2002); ^cHarwood *et al.* (1996); ^dLowry *et al.* (1999); ^eFrost *et al.* (2002).

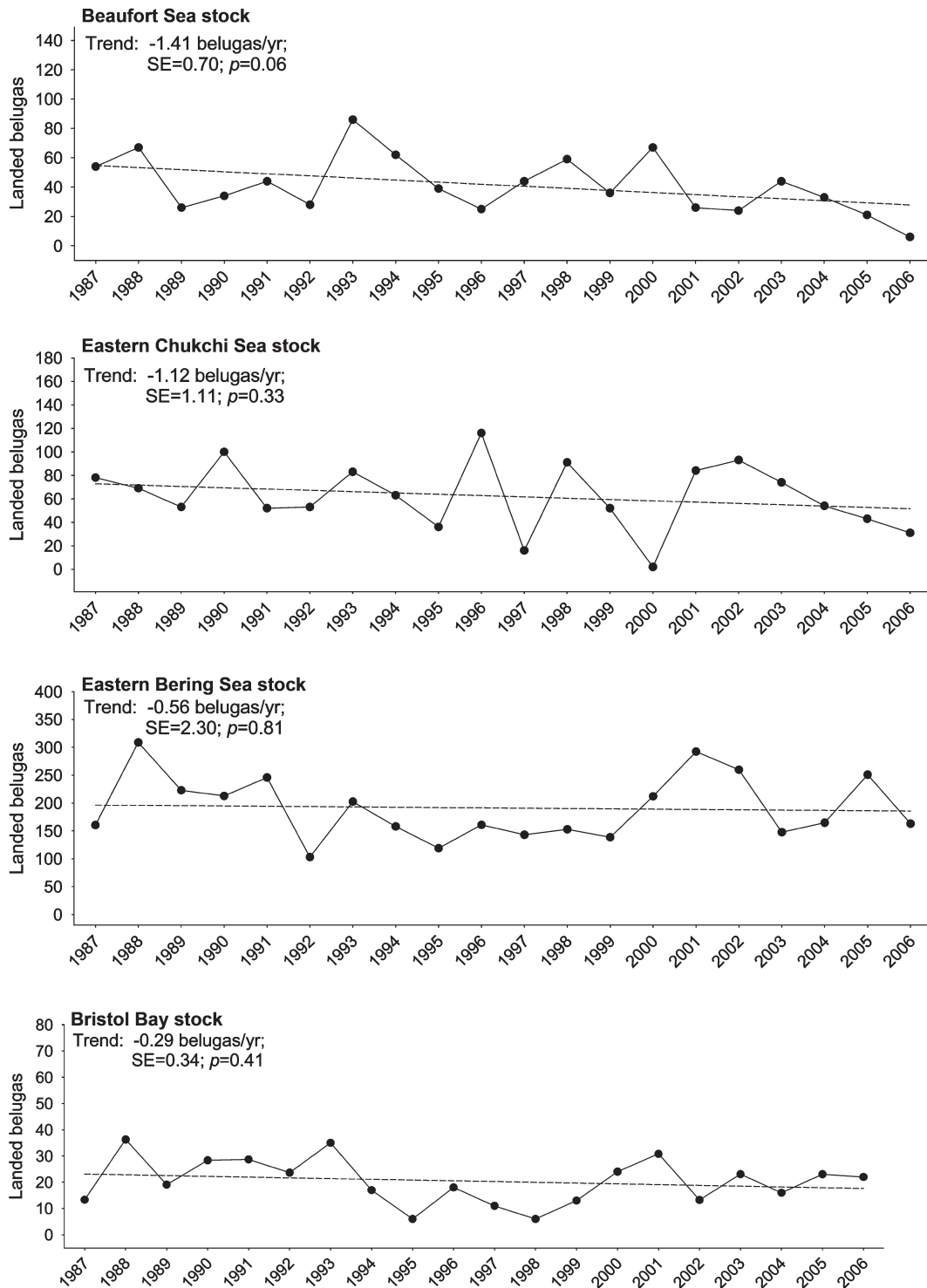


Fig. 2. Adjusted annual harvests from four stocks of beluga whales in northern and western Alaska, 1987–2006. Data are from the Alaska Beluga Whale Committee.

reasonable estimate for cetaceans such as belugas (Wade, 1998) although it has been suggested that removal rates of >1% can be problematic for some small cetaceans (Reeves and Brownell, 2009). However, even 2% for belugas may be conservative in some situations. Lowry *et al.* (2008) reported an estimated rate of increase for beluga whales of 4.8%/year (95% CI = 2.1%–7.5%) in Bristol Bay, Alaska during 1993–2005 (a 65% population increase overall). The increase was concurrent with landed harvests of 1%–2% per year, as well as some fishing related mortality and predation by killer whales. All of the long-term average landed harvests for the

Beaufort Sea, eastern Chukchi Sea, eastern Bering Sea and Bristol Bay beluga stocks are <2% of the estimated stock size.

There is large annual variation in the harvest from each management stock, due to a combination of factors including accessibility of belugas, weather, sea ice conditions and activities of the hunters. Thus, annual harvests from a particular stock can range from a few percent to almost double the long-term average. For this reason, the ABWC recommended to NOAA in 1996 that harvests be averaged over moving five year periods when assessing harvest

sustainability. During 1987–2006, the average landed beluga harvest did not exceed 1.9% of the estimated stock size during any five year period for any stock, and was usually much less.

Harvest data reported here for the Beaufort Sea stock (Table 1) do not include harvests by Canadian beluga hunters in the Mackenzie River estuary where average landed harvest for 1990–1999 was 111 plus a loss rate of 11.3% (Harwood *et al.*, 2002). When Canadian and Alaskan average harvests were combined, the total landed harvest represents an estimated 0.4% of the Beaufort Sea stock.

Annual landed harvest for the eastern Chukchi Sea stock averaged 1.7% over 20 years, although in a few years it was as high as 3.1%. We do not consider these occasional higher harvests to be of concern since five year average harvests as well as the long-term harvest were always <2%. Furthermore, the population size used in the calculations for this stock was likely an underestimate. During 1998, five belugas were satellite tagged in the eastern Chukchi Sea. When aerial surveys were conducted 5–9 days after tagging, only one of the tagged belugas was located in the area counted (Lowry *et al.*, 1999; Suydam *et al.*, 2001).

Struck and lost

Hunters are often reluctant to provide information about the number of animals that are struck and lost during hunting. Recently however there has been increased awareness of this issue. Senior hunters are encouraging young and new hunters to be careful how and where they hunt so as to minimise hunting-related loss. Communities are discussing hunter guidelines that would encourage hunting in shallow water where belugas are more easily retrieved. The overall ABWC Management Plan, as well as regional management plans for Bristol Bay and northeastern Norton Sound include provisions encouraging the reduction of struck and lost rates (Adams *et al.*, 1993; ABWC unpublished).

The struck and lost information we did obtain for 1997–2006 suggests that the number of belugas struck and lost is not problematic relative to estimated stock size for the Bristol Bay and eastern Chukchi Sea stocks. The reported struck and lost rate for Bristol Bay was 9%. Whether or not the reported rates for the Bristol Bay stock were underestimated, the harvest there was clearly sustainable since the population increased by 65% over the period during which the harvest data were collected.

The overall reported struck and lost rate for the eastern Chukchi Sea stock was 7%, and it was an even lower 2% at Point Lay. Information for Point Lay was considered accurate since biologists usually observed the hunt, research aircraft often flew over the lagoon on days following the harvest and could observe any lost carcasses, and research boats transited the area during and following the harvest. The very shallow water in the hunt area, the drive nature of the hunt, and hunting practices requiring that each beluga be harpooned before it was shot all probably contributed to the very low struck and lost rate. Although researchers were not present at other Chukchi Sea villages during the harvest, hunting conditions and methods were similar in several, suggesting that low reported struck and lost rates were reasonable.

There are no reliable struck and lost data for the Alaskan

harvests of the Beaufort Sea stock. However, the landed harvest for Alaska and Canada combined is less than 0.4% of a population exceeding 39,000. Similarly, the eastern Bering Sea stock landed harvest is about 1% of a population exceeding 18,000.

Data quality and the ABWC

The ABWC has collected harvest data since 1987 (Frost, 1999; Frost and Suydam, 1995). Data for this 20 year period are generally more complete and include many more villages than data available prior to 1987 (Burns and Seaman, 1988; Lowry *et al.*, 1989; Seaman and Burns, 1981). Since 1987, the ABWC has seen consistent improvements in the quality of the harvest data. Harvest reports have been obtained from about 45 communities since 2000, compared to 21 in 1987. On average, data were missing for 25% of the communities during the ABWC's first 10 years (1987–1996) and only 9% since then.

In the early years, many harvest reports were of an approximate number or range of belugas taken. It was sometimes unclear whether the reported harvest represented both spring and fall hunts or only the most recent harvest. Rarely was it known whether the belugas were taken by net or by shooting, which can be an important factor when estimating the number of animals lost. At present, for most villages data are reported separately for spring, summer and fall harvests, and for belugas taken by net and by shooting. Comments frequently accompany the data about unusual occurrences, beluga diet, or general abundance.

Coverage has been adequate for all communities hunting from both the Beaufort (79% of communities reporting 1987–1996 and 87% 1997–2006) and eastern Chukchi sea stocks (93% of communities reporting 1987–1996 and 97% 1997–2006). This is in large part because of the North Slope Borough Department of Wildlife Management's regular involvement in harvest monitoring in their region, dedicated village harvest monitors, and because ADF&G biologists have a long-term history of working with beluga hunters there.

The quality and regularity of harvest data for the eastern Bering Sea stock has improved since the initial formation of the ABWC. During the first 10 years that the ABWC collected harvest data (1987–1996), there were no harvest reports for an average of 31% (13%–73%) of the eastern Bering Sea communities in any one year. During the subsequent 10 year period (1997–2006), data were missing on average from only 11% (0%–19%) of the communities in any year. Few Yukon delta villages reported harvests initially, but reporting has improved markedly since then with the addition of more village representatives at ABWC meetings.

Harvest reports have been intermittent for Kuskokwim villages. In part, this reflects the intermittent occurrence of belugas in the area and consequently the infrequent hunting of belugas. According to local residents, belugas were common in Kuskokwim Bay and the lower Kuskokwim River in the early 1900s, but stopped using the area regularly in the 1940s (Frost and Lowry, 1991). During April–August 1988, frequent sightings of up to several hundred belugas were made in Kuskokwim Bay for the first time in many years (Frost and Lowry, 1991). We also received reports of harvests by several communities that year (Table 1). Since

then, there have been infrequent reports of both sightings and harvests. Many Kuskokwim villages have responded to ABWC questionnaires saying that belugas are rarely seen and seldom, if ever, hunted. Therefore, less effort has been devoted to obtaining harvest information from this region.

ADF&G's Division of Subsistence, in cooperation with the Bristol Bay Marine Mammal Council, began to monitor the beluga harvest in Bristol Bay in 1994. Since then, there has been nearly complete reporting for all villages in all years. From 1987–1996, 70% of all villages reported harvest data. Since 1996, 93% have reported.

The existence of the ABWC and its agreement with NOAA for the cooperative management of the beluga subsistence hunt has enhanced the amount and quality of harvest data collected since 1988. In addition, the ABWC has raised awareness of the need for better abundance estimates, genetics studies and biological information about belugas to ensure data for management of sustainable harvests. Through the ABWC, beluga hunters have been able to formalise their role as partners in managing their subsistence resources. They have become active participants in recommending and conducting research needed for effective management.

Future work

Estimates of stock size are required for any evaluation of the impact of harvest on population status. Currently, adequate estimates exist for the Bristol Bay, eastern Bering Sea and Beaufort Sea stocks. However, there is no adequate estimate for the eastern Chukchi Sea stock. The existing estimate of about 3,700 is thought to be quite low. To address this deficiency, the ABWC convened a workshop in March 2010 to develop a detailed design for a future Chukchi Sea assessment effort to begin in 2011.

The ABWC continues to stress the importance of obtaining accurate and complete harvest data, including the number of belugas struck and lost.

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