

Preliminary Results of Recent Studies of Belukhas in Alaskan Waters

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ABSTRACT

Belukha whales are an important food resource to residents of coastal Alaska, in an area extending from Bristol Bay to the eastern Beaufort Sea. Recent annual harvests in Alaska average about 185 belukhas per year. Unretrieved loss varies depending on hunting conditions. The total annual kill (retrieved harvest plus whales killed and lost) was estimated to approximate 264 to 319 whales. Sex ratio of harvested whales approximates 1:1. The proportion of older whales in the harvest suggests a relatively low level of exploitation. Sexual maturity in females, as indicated by first pregnancy, occurred in four- and five-year olds. The breeding cycle was found to be mainly triennial. Gestation was estimated to be 14.5 months. Timing of events in the reproductive cycle as well as fetal growth of belukhas from Alaskan waters were similar to those reported from other areas. Belukhas utilized a large variety of food items. However, during the open water seasons, they depended on relatively few sequentially abundant and highly available prey species.

INTRODUCTION

This preliminary report concerns belukha whales (*Delphinapterus leucas*) of the Bering and Chukchi Seas. A second, small, currently unexploited stock, usually referred to as the Cook Inlet population, also exists but is not discussed here.

Belukhas have been and remain an important component of the marine mammal resource base available to coastal dwelling peoples of western and northern Alaska. These small whales are available to subsistence hunters at different sites usually starting in spring when some move north through the lead systems of the Bering and Chukchi Seas, and during the months of open water when they occur in the nearshore coastal zone from Bristol Bay to the Beaufort Sea. Archaeological evidence indicates that they were taken by prehistoric subsistence hunters along the western and northern mainland as well as at Nunivak, St. Lawrence, King, and the Diomed Islands (e.g. Nelson and True, 1887; Nelson, 1899; Geist and Rainey, 1936; Giddings, 1951, 1977; Spencer, 1959; Hughes, 1960; Kowta, 1963; Nowak, 1970; McGhee, 1974; Bockstoce, 1979).

Belukhas continue to occur in all regions of their former range in western and northern Alaska. They remained an important subsistence resource over a broad geographical area until relatively recently (e.g. Nelson, 1899; Spencer, 1959; Van Stone, 1962, 1967; Milan, 1964; Foote and Williamson, 1966; Klinkhart, 1966; Ray, 1966, 1975; Saario and Kessel, 1966; Nelson, 1969). In some regions they are now taken whenever and wherever opportunity permits, but contemporary settlement patterns, seasonal activity patterns, wage earning employment, availability of alternative resources, hunting technology, and dietary preferences have drastically changed at many locations. These changes have had a major impact on subsistence hunting activities and on the number, harvest distribution and species composition of marine mammals, including belukhas, presently harvested.

This report presents information on aspects of the biology of belukhas, hunting practices and the magnitude of recent harvests. A more complete report is being prepared. We have not had the benefit of an adequately funded, broad-scale study. The information available to

us has been obtained from published and unpublished records, continuing personal contact and interviews with hunters in villages from Bristol Bay to Barter Island, opportunistic field work associated with other marine mammal studies (continuing since 1962), and information provided by area and research biologists of the Alaska Department of Fish and Game, and other interested scientists. The compilation of data, analysis of specimen material, and preparation of a detailed report about belukhas in Alaska (in preparation) have largely been a volunteer effort. As such, its completion is subject to the competing demands of funded projects.

BACKGROUND

Belukhas were a resource well suited to exploitation by the aboriginal subsistence hunters of western and northern Alaska. They provided relatively large amounts of meat, edible skin (muktaag or maktaag), oil, and byproducts important for local use and barter. The return per unit of effort at favourable hunting locations was apparently quite high. Traditional methods of capture involved harpooning, spearing, and netting. Whales were struck under a variety of circumstances. Some were opportunistically struck as they migrated through nearshore lead systems on their northward spring migration during March through June. Most were taken during the open water season when they move close to shore and enter the river mouths, bays, and lagoons. Under these conditions a variety of hunting methods using kayak-like craft were employed.

Residents of coastal villages have related that at some locations belukhas were permitted to enter confined bodies of water and harpooned or lanced as they returned seaward past strategically positioned kayakers. Often, organized drives were made in which many hunters attempted to herd whales into gently sloping shallow areas where they could be easily followed and struck. At other locations a line of kayakers would attempt to slowly drive whales to other hunters waiting on high banks or in kayaks. Harpooned whales were often killed with spears.

All accounts of belukha drives or herding techniques conveyed to us, involved two important components: a high degree of organization in the line of drivers and the maximum silence until whales reached a location suitable

for killing. If killing occurred in shallow water the hunters commenced to make as much noise as possible. This and the sounds produced by the whales themselves apparently resulted in confusion and disorientation among the whales, permitting more of them to be taken. Frequently, the younger gray colored whales would strand themselves. In deep waters, such as the entrance to bays or rivers, hunters waited as quietly as possible for whales to surface nearby. When a whale was struck the hunter pursued it seaward, guided by the line and float attached to the implanted harpoon. Another kayaker moved into position to attempt a strike.

Belukha nets were commonly used along the coast where these whales travelled, mainly south of Cape Lisburne. They were usually set at capes and other projections of land where relatively deep water extended to the coast. Most commonly nets were set perpendicular to the beach with one end fixed to the shore. Occasionally, if whales were known to be in the area, a kayaker would try to turn them toward shore and into the net, more recently with the aid of rifle fire. Usually, the nets (of about 12-inch mesh and formerly made of seal and walrus skin line) were unattended except for periodic checking. In some locations, such as Kotzebue Sound, nets were set away from shore, while in others they were set near the mouths of rivers. Netting was a productive method of catching belukhas and was often used because the people involved could also devote their efforts to other pursuits while waiting for a whale to be caught.

Informants who had heard about or engaged in belukha netting indicated that during summer there was no consistent directional movement of whales along the coast, except those associated with changing stages of tide. They moved back and forth, usually between rivers or bays, and entered nets from either side. In Alaska, netting of belukhas was largely discontinued by the 1940's. In Norton Sound the last successful effort employing a net specifically constructed to catch belukhas was at Cape Nome. In August 1967, Mr Jerone Trigg of Nome took several belukhas there using a net. In the Kotzebue Sound area a few people continue to use belukha nets with some success. Storm borne debris, particularly driftwood, is a continuing problem to belukha netters, and in some years storms precluded any effort to maintain a functional net.

Although netting is no longer widely practised, a knowledge of the technique remains, but it is rapidly disappearing. A few belukhas, estimated at less than 10 per year, are taken incidentally by salmon fishermen, mainly using 6-inch or larger mesh salmon nets used during June, to catch the large king salmon (*Oncorhynchus tshawytscha*). Fishermen are of the opinion that belukhas can detect and avoid smaller mesh nets used for other species of salmon. Most belukhas taken in salmon nets are consumed locally. We have included them in our records of harvest.

Contemporary hunting practices are a direct extension of traditional methods but employ modern implements including rifles and outboard powered small boats with outboard motors. The following description of belukha hunting in northern Kotzebue Sound by people from Noatak and Kotzebue in summer 1960 was prepared by Foote and Cooke (unpublished) and was included in Foote and Williamson (1966, pp. 1082-1084). It is a graphic and informative description of contemporary hunting methods.

*Beluga, White Whale, or Seshok: Local information on the movement of beluga is that they migrate northward in spring,

following the retreating edge of the ice pack. Large numbers pass through the strait between Kotzebue Sound and Hotham Inlet (called locally Kobuk Lake) to feed in the shallow, warm waters near the river deltas. It is known that the beluga follow the coast of Alaska at least as far north as Point Lay, but of their movements in the Chukchi Sea or the Arctic Ocean there is no informed opinion. They travel in gangs as large as 80 or 100, but are more often found, at least within the sound and inlet, in groups of 30 to 50.

It is believed that a second wave of migrating whales appears in the area some time in early July. These beluga are said to be larger than the ones that first appear. However this may be, none of the beluga shot in 1960 were claimed to be part of such a second wave.

Hunters see the beluga as they surface to breathe in a series of forward-rolling plunges. The young whales are slate colored, whitening to a dull ivory as they mature.

Primitively the beluga were herded by a group of kayakers into very shallow water and there harpooned and speared. A great killing could be made so long as the whales were kept in shallow water, for they could not then submerge enough to swim rapidly. This practice was abandoned when the Eskimos began to use power-driven boats, but the excitement of the old method of hunting is part of the conversation of all Eskimos past middle age. They say that before motors became common in Kotzebue Sound the beluga used to come very close to shore and enter the lagoon behind Sheshalik spit (Imaruruk) and that, in general, they were easier to hunt.

Today the beluga is shyer and is therefore more actively pursued. One method of hunting is to anchor the boat in the Strait between Kotzebue and Sheshalik and to keep watch for gangs of whales entering or leaving Hotham Inlet. Hunters attempt to herd the whales into water no more than 10 feet deep before they begin to fire. The second method is to cruise about looking for whales. Although the latter method improves the chances of seeing a gam, the gas consumption is higher and the whales are made uneasy by the sound of the motor. When the hunters wait quietly the whales may surface so close that they can almost be speared.

A white whale can remain under water for more than 20 minutes according to native report, but less long while being chased. It is often possible to track a submerged whale by its wake, a regularly spaced series of boils made by the powerful vertical sweep of the tail. While being chased, the whale zig-zags and doubles back, often passing under the boat. So long as the whale runs forward, the hunter can usually follow it, but when it doubles back he frequently loses it in the time it takes to turn the boat.

Whenever the whale surfaces within shooting range, the hunter fires at it if he is quick enough. The preferred target is the highest spot on the back—or slightly in front of it—that shows as the whale rolls forward to resubmerge. This shot offers a chance of hitting the brain or breaking the spine, whereas a shot farther forward is likely to be only a flesh wound. The whale usually makes at least two rolls before submerging. The hunter may hold his fire until the second roll, when he will have a better aim. The first few shots seldom kill a whale: a chase may last for 2 hours or more, although a half hour is more nearly average. When a whale is so badly wounded that the boat can overtake it while it is at or near the surface, it is harpooned as forcefully as possible. If more than one party of hunters is shooting at a whale, the first to get a harpoon into it firmly may claim possession. In shallow water the whale may be harpooned before it is shot. If the harpoon does not pierce the blubber and enter the meat, it is not likely to hold, for the skin and blubber are soft. The head—usually detachable—of the harpoon is tied with a length of rope to a 5-gallon gas tin. The whale, tired by this buoyant drag as well as by wounds, usually dies, although it may need shooting once or twice more. A dead whale always sinks in summer; if it drags the harpoon's buoy under water, a second tin is left to mark the spot. The hunt continues as long as whales are in sight and the supply of floats and the gasoline last.

The Eskimos use rifles ranging in caliber from .222 to .30-30. One or two men stand in the bow with their rifles ready just under the deck. Other hunters sit amidships. During a chase the rifles are readied and aimed in the general area in which the whale is expected to surface. The man who runs the motor seldom shoots. Nearly every hunter has a pair of binoculars, some hardly more than toys, others worth \$50 or more. The harpoon and spear handles are made of local spruce, smoothly tapered. The blades, usually of brass, are handmade, following primitive design.

When the hunters decide to go home, they rope the dead whales along the side of the boat. Speared whales are pulled up by the buoy rope. Sunken whales that are unattached to a buoy are retrieved with a grappling hook thrown out on a long cord. If a heavy swell or overloading makes the boat begin to ship water, a whale may be let out on a 20- to 30-foot rope to be towed. As the whale is being tied to

the boat, the hunters hack off a large slice of the tail fluke or one of the side flippers and eat slices of it for lunch. When the whales have been brought to shore, a team is rounded up to pull them onto the beach, where they are butchered.

The women pay special attention to keeping the dogs quiet while the men are hunting beluga. Because the dogs are especially restless and vocal on days of fine weather, the task is not easy. It is thought that the whales may be frightened away by the sound of howling carrying over the water, but it appears not to matter that the men waiting in the boats talk and laugh all the while in ordinary tones.

The three largest whales measured for a competition in Kotzebue's Fourth of July celebration were, respectively, 15'4", 15'1½" and 15'1". The second and third longest whales were shot by Nuatak men, the longest by a Kotzebue Eskimo. Most of the whales taken were about 10 feet long and weighed an estimated average of 1,000 lbs. A beluga 15 feet long might weigh 2,000 lbs or more. I counted 41 beluga killed last summer. There were another half dozen or more brought in during my absences. The total is about 50.²

The organized, large-scale, annual, summer whale hunt at Sheshalik (Inupiat Eskimo word meaning a place where belukha are found) in northeastern Kotzebue Sound continued until about 1965 when a commercial salmon fishery developed. Apparently whales no longer congregate as long or as abundantly in the former hunting area, although they still pass through it. They are now reportedly more difficult to drive. Nevertheless, a few are taken every year. The local people attribute this change primarily to fishing activity involving continuous operations of many outboard powered small boats, and to aircraft traffic.

Summer belukha hunting involving organized drives continues in south eastern Kotzebue Sound, particularly Eschscholtz Bay, where usually more than half of the annual Alaska harvest is taken. There is no intensive salmon fishery in that part of the Sound, although a herring fishery may develop. Based on their understanding of belukha behavior, people of this area are concerned about a reduction in, or termination of whale hunting if that fishery develops. The situation in Kotzebue Sound is not unique, having occurred in the recent past in several areas farther south, along the Bering Sea coast.

Belukhas are still abundant and available to the people of Bristol Bay throughout the open water season. However, they are no longer hunted appreciably except in cases of need such as failure of a fishery. The local people are now heavily involved in commercial fishing. Their fishing boats are not well suited to belukha hunting and the whales are reportedly more difficult to capture. In Kuskokwim Bay, the various mouths of the Yukon River, and Norton Sound, belukha hunting has undergone a somewhat similar change (though not to the same extent) because of the shift in interest of local people during the herring and salmon fishing seasons (which occurs during the former peak of whale hunting activity), reduction in the number of men available to conduct the organized whale drives at the opportune times and, correspondingly, the greater difficulty in manoeuvring whales into the shallow-water killing areas. Intensive belukha hunting during summer occurred until recently in Bristol Bay, Kuskokwim Bay, the several mouths of the Yukon River, eastern Norton Sound and northern Kotzebue Sound.

Although belukhas are no longer pursued in a regular manner in Bristol Bay, Kuskokwim Bay, the Yukon River Delta, or eastern Norton Sound in summer, they are actively hunted in southern Kotzebue Sound and in the vicinity of Kasegaluk Lagoon. Belukhas are also taken by bowhead whaling crews that camp along the nearshore lead of the Chuckchi Sea during April to June. Such taking occurs near the villages of Wales, Kivalina, Point Hope,

Wainwright, and Barrow. Hunters from Point Hope usually account for the largest numbers of belukhas taken in this manner, occasionally up to 50 in years of poor hunting for bowheads. Opportunistic hunting during the open water season may occur on a very irregular basis at any location, particularly in Hooper, Tooksook and Norton Bays, and near the settlements of Kaktovik, Kivalina, Wales, Wainwright and Tuntutuliak.

On the basis of information available to us, we estimate that the overall contemporary belukha hunting and netting effort in western and northern Alaska has decreased as much as 50 to 70 per cent below that expended during the early and mid parts of this century.

METHODS

The magnitude of belukha harvests during the 1960's was determined by biologists present at major hunting sites, by reports from interested persons, and by interviews of village residents. In the 1960's a bounty was paid on seals. In the course of dispersing the bounty there was frequent opportunity for biologists of the Alaska Department of Fish and Game (ADF&G) to talk with hunters from almost all coastal villages and thereby obtain harvest data about many different animals including belukhas.

From 1968 to 1973 a specific effort was made by the ADF&G to determine the magnitude of annual belukha harvests. This task was somewhat easier because intensive hunting occurred at fewer sites and more biologists were permanently stationed in coastal areas. From 1977 to 1979 the same procedures were employed with the addition of a field program that included interviews in villages where hunters had succeeded in taking whales during the year, and specimen collection efforts during appropriate hunting periods at the more predictably successful sites of Eschscholtz Bay, Point Hope, Point Lay and Wainwright.

Harvested belukhas were measured and specimens including reproductive tracts (including a fetus if present), stomachs, and jaws were collected. Teeth were sectioned longitudinally and the number of dentine layers determined. Ovaries were weighed, measured, and sectioned (1–2 mm) by hand. The number, size, and condition of corpora lutea and corpora albicantia were noted. Testes were weighed and measured and their volume determined by water displacement. Food remains in stomachs were identified by ADF&G biologists L. Lowry, G. Seamann, and R. Tremaine.

Additional efforts such as coastal surveys, behavioral observations, and characterization of estuarine systems utilized by belukhas were also undertaken but are beyond the scope of this preliminary report.

RESULTS

1. Distribution

Based on various sources of information available to us, we have compiled a series of distribution maps, for each 2-month period of the year (beginning in January), for two time periods—pre- and post-1960. The areas include the Bering and Chuckchi Seas, the Beaufort Sea to eastern Mackenzie Bay, and the eastern part of the East Siberian Sea. With one exception, the pre- and post-1960 distributions are similar. The exception was a pre-1960 report of belukhas in the vicinity of the Commander Islands (Tomilin, 1957; Kleinenberg *et al.*, 1964). No recent sightings in this vicinity are known to us.

We anticipate that the volume of information about the seasonal distribution of belukhas will grow rapidly as the result of intensified research including that on the bowhead whale (*Balaena mysticetus*) and that related to petroleum exploration and development on the outer continental shelf. The major sources of recent information include personal communication from L. Barton, H. Braham, T. Dohl, F. Fay, G. Fedoseev, C. Fiscuss, S. Fried, B. Kelly, C. Ray, as well as published accounts by Johnson *et al.* (1966), Childs (1969), Kenyon (1972), Sergeant and Hoek (1974), Braham and Krogman (1977), Fraker (1978), Fraker *et al.* (1978 and 1979), Harrison and Hall (1978), Johnson (1979), and Braham *et al.* (in preparation).

Survey efforts or casual sightings in January and February have been infrequent. Belukhas were recorded in Bristol Bay, Karaginski Bay, and at various locations in the eastern Bering Sea. A few were recorded in the southern Chukchi Sea. Belukhas were sighted from headlands of western St. Lawrence Island, Nelson Island, Nunivak Island, Cape Prince of Wales, Hooper Bay and northern Bristol Bay.

Records in March and April are more numerous and also suggestive of midwinter distribution. Sightings were widely dispersed throughout the ice-covered regions of the Bering Sea, in Karaginski Bay, and in Bristol Bay (including the major rivers as they become ice free). The greatest number of sightings were in the western Bering Sea from the ice edge to Bering Strait. Sightings in the Chukchi Sea were mainly near the coast extending to the vicinity of Cape Schmidt on the Siberian side and Point Barrow on the Alaskan side.

In May and June belukhas were still reported throughout the northern Bering Sea. There were fewer pelagic sightings than in March and April and the majority of sightings were relatively near shore. On the Siberian coast these were in Karaginski Bay and along the coast from Cape Navarin to East Cape. In Alaskan waters belukhas occurred from south eastern Bristol Bay to Bering Strait, with the greatest number of sightings in Bristol Bay and Norton Sound. Clearly, a large segment of the population had moved northward into the Chukchi Sea and western Beaufort Sea by late June. Most sightings were on the Alaskan side and extended from Kotzebue Sound well into the Beaufort Sea northeast of Point Barrow. A few sightings occurred near the Siberian coast as far west as Cape Shelagsky (East Siberian Sea).

In July and August most sightings were relatively near shore or close to shore. On the Siberian side belukhas appeared to be rare in Karaginski Bay and common in coastal areas of the Gulf of Anadyr, western Bering Strait and along the northern coast of the Chukchi Peninsula to the vicinity of Long Strait. A few sightings were from the East Siberian Sea. The distribution on the Alaskan side was continuous from Bristol Bay to the western Beaufort Sea and from Barter Island into Canadian waters of the eastern Beaufort Sea. The largest number of sightings at this time of year also involved some of the largest groups of belukhas. These occurred in Bristol Bay, Kotzebue Sound, between Cape Lisburne and Point Barrow (mainly near Icy Cape and, in late August, north of Barrow) and in Canadian waters of the eastern Beaufort Sea. Several small groups of whales were seen along the margin of the pack ice from Barrow to Barter Island.

The pattern of distribution changed dramatically in September and October. Fewer belukhas were observed in the coastal zone although the distribution of these

sightings was similar to those in July and August. Exceptions are in the East Siberian Sea and the north side of the Chukchi Peninsula, where whale distribution shifted seaward and to the east, and the eastern Beaufort Sea, where the distribution shifted westward and mostly seaward. Most sightings in September and October were from the Chukchi Sea between Wrangell Island and northeast of Point Barrow (relatively close to the ice). Some sightings were also made southward, in open water, to Bering Strait. Very large aggregations of belukhas (one in excess of several thousand, T. Dohl and C. Ray, personal communication) were occasionally seen at this time of year, mostly in the Chukchi and Beaufort Seas.

In November and December most sightings were in the Bering Sea with a few in the Chukchi Sea from Point Hope southward. Most sightings were by coastal hunters and commercial airline pilots. Survey efforts have been minimal during these months.

In summary, the general pattern of seasonal distributions and movements of belukhas are similar to those suggested by Fay (1978). They winter mainly in the drifting ice of the Bering Sea. As the ice recedes in spring, a large segment of the population moves northward, some extending into the East Siberian Sea in the west, the eastern Beaufort Sea (and Amundsen Gulf) in the east, and along the summer ice fringe. Most of the belukhas appear to enter the coastal zone during midsummer, with a range extending from about 57°N to 72° or 73°N (up to 75°N in years of minimal ice). They leave the coastal zone in late summer to late fall, depending on latitude. Those in the northern part of their range move southward ahead of and with the advancing ice pack, passing through Bering Strait and again entering the Bering Sea. Those that summered in the Bering Sea move seaward. Essentially the entire population resides in the drifting pack during winter.

2. Magnitude of Recent Harvests in Alaska

Brooks (1954b) estimated that during the early 1950's Native Alaskans utilized at least 200,000 pounds of belukha meat and muktaag annually. This was used as food for humans and sled dogs. Lensink (1961) estimated that the annual harvest in Alaska during the late 1950's was approximately 400 to 500 whales. By the mid-1960's the harvest had declined to between 150 to 300 per year (Burns, unpublished). It is noteworthy that dog teams (except those used for racing) had largely been replaced by motorized 'snow-travellers' by 1964.

Alaska Department of Fish and Game records of annual belukha harvests at all locations from Bristol Bay to Barter Island between 1968 and 1973 are: 1968, 150; 1969, 170; 1970, 200; 1971, 250; 1972, 180; and 1973, 150. The average annual harvest during that 6-year period was 183. No efforts were made to determine the sex and age composition of harvested whales during this period.

During 1977 to 1979 a more concerted effort was made to determine the sex composition as well as the magnitude of annual harvests. Harvest levels in those 3 years were: 1977, 247; 1978, 177; and 1979, 138. The geographical distribution and composition of those harvests are presented in Table 1. The average annual harvest of 187 whales for these 3 years is similar to that for the years 1968 to 1973 ($\bar{x} = 183$). The 1979 harvest at Elephant Point (Eschscholtz Bay) was five belukhas, well below the average of about 80 per year. Whales were present near this hunting area, but attempts to drive them into the bay

Table 1

The geographical distribution and composition of belukha harvests in Alaska in 1977 to 1979.

Location Village or Area	Number of males			Number of females			Sex unknown			Totals		
	1977	1978	1979	1977	1978	1979	1977	1978	1979	1977	1978	1979
Bristol Bay	—	—	—	—	—	—	5	2	3	5	2	3
Quinhagak	—	—	—	—	1	—	—	1	—	0	2	0
Tanunak	—	—	—	—	—	—	—	1	—	0	2	0
Hooper Bay	—	—	—	—	—	—	30	—	23	30	0	23
Toksook Bay	—	—	—	—	—	—	—	12	—	0	12	0
Stebbins St. Michael	—	—	—	—	—	—	3	2	23	3	2	23
Koyuk	—	—	—	—	—	—	7	7	10	7	7	10
Elim	3	—	—	—	—	—	—	2	—	3	2	0
Shaktolik	—	—	—	—	—	—	5	5	6	5	5	6
Nome	—	—	—	—	—	—	—	—	1	0	0	1
Gambell	—	—	—	—	—	—	—	1	1	0	1	1
Savoonga	—	—	—	—	—	—	2	—	—	2	0	0
Wales	—	—	1	—	—	1	4	2	1	4	2	3
Diomede	—	—	—	—	—	1	—	3	1	0	3	2
Eschscholtz Bay	—	36	2	—	39	1	105	15	2	105	90	5
Kotzebue	—	—	—	—	—	—	3	5	2	3	5	2
Kivalina	—	—	—	—	—	—	15	8	5	15	8	5
Point Hope	19	11	5	22	5	1	12	—	5	53	16	11
Point Lay	—	8	—	—	4	—	8	1	3	8	13	3
Wainwright	—	—	19	—	—	14	2	2	4	2	2	37
Barrow	1	—	1	—	—	—	1	4	2	2	4	3
Totals	23	55	28	22	49	18	202	73	92	247	177	138

were unsuccessful (Seaman, field notes). Poor hunting at Elephant Point is reflected in the low harvest for 1979.

3. Hunting Loss and Estimated Total Kill

Methods currently employed for hunting belukhas involve a higher degree of loss than when nets, harpoons, and lances were used.

Estimates of the contemporary annual total kills (retrieved harvest plus whales killed but lost) are presently tenuous at best. Intensive (and very expensive) efforts in several different hunting areas would have to be made to accurately estimate the variable magnitude of hunting loss. Information available to us, as well as personal observation of hunts, indicates that when belukhas are killed in deep water (as in spring when seal hunters and bowhead whalers take them), the unretrieved loss equals or exceeds the retrieved harvest. In the open water season, when they are hunted in shallow coastal waters, loss approximates one in five or less (20%).

One-fourth to one-third of an annual retrieved harvest will be taken in deep water and two-thirds to three-fourths in shallow water. Assuming an annual harvest of 185 belukhas, a crude estimate of the average annual total kill in Alaskan waters can be derived as follows:

1. average annual harvest = 185;
2. one-fourth to one-third are taken in deep water, with losses of 60% = 115 to 152;
3. two-thirds to three-fourths are taken in shallow water, with losses of 20% = 149 to 167;
4. average annual total kill in Alaskan waters probably approximates 264 to 319 belukhas.

This level of exploitation appears significantly less than that sustained in former times.

4. Sex Composition of the Harvests

Although sample size is insufficient to demonstrate, with any acceptable degree of confidence, the sex ratio which actually prevails in the population, all indications are that

it approximates 1:1. This is suggested by observed ratios of males to females in our 1977 to 1979 samples, as follow: (1) fetuses for which sex could be determined, 1.1:1 ($n = 15$); (2) harvested whales examined in Eschscholtz Bay during 1978 and 1979, 0.95:1 ($n = 78$); and (3) all harvested whales for which sex was determined 1.2:1 ($n = 195$).

5. Age Structure of Harvested Whales

The age composition of whales taken in 1977, 1978 and 1979 is shown in Fig. 1. Based on the assumption that two growth layers are deposited in the teeth each year, and making no allowances for loss of layers from tooth wear, the estimated age of the oldest animal examined by us was 32 years. Ages of belukhas harvested in Alaska have not yet been compared to those from other exploited populations. In general, however, the relatively old-age structure of the harvest in Alaska indicates that the stock of whales in Alaska is presently being exploited at a low level.

6. Reproduction

The reproductive cycle of belukhas in Alaskan waters is similar to that reported for eastern Canada (Sergeant, 1962; 1973; Brodie, 1971). Peak of breeding activity in our samples, based on the time of maximum size of testes in adult males, the greatest prevalence of sperm in tubules of the epididymides, or the presence of incompletely formed corpora lutea in females, is in mid-April-early May. Small embryos, 0.5 to 8 cm long, were obtained mainly in mid-June but occurred from mid-June to mid-July. In Alaskan waters births occurred mainly in July although apparently some occurred from mid-May to the first part of September. The gestation period was estimated to be about 14.5 months, as reported by Brodie (1971). First pregnancies occur at 4 or 5 years of age. Four of seven females confirmed pregnant for the first time were 4 years old and the other three were 5 years old.

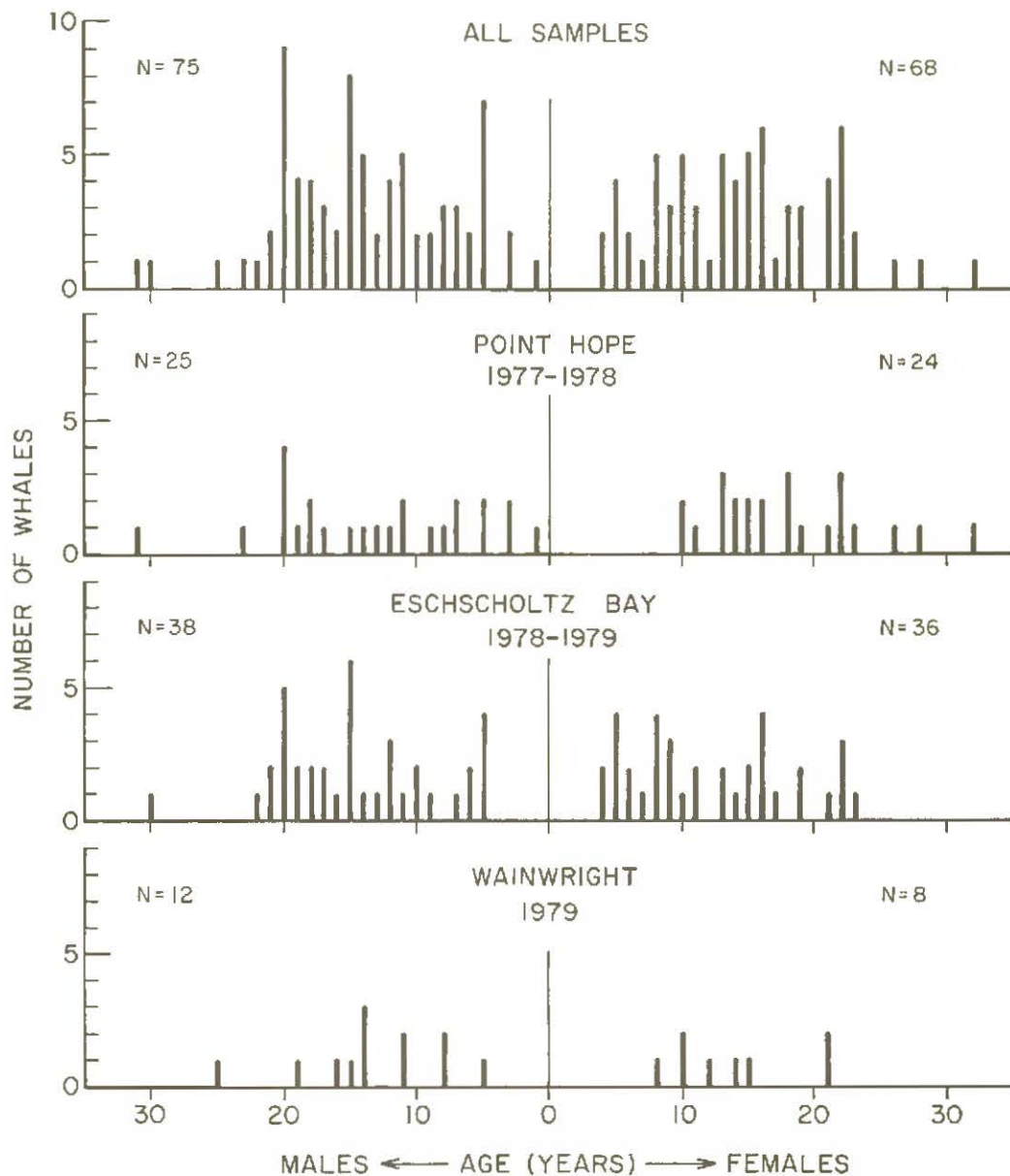


Fig. 1. Age and sex composition of belukhas taken from 1977 to 1979 in western Alaska. Ages were based on the number of tooth layers divided by 2.

The incidence of pregnancy in sexually mature females in our samples indicates a mainly triennial breeding cycle. In some instances pregnancies occur less frequently, and in others biennial breeding is suggested. Of 71 sexually mature females examined by us (those containing at least one corpus albicans or corpus luteum), 19 (27%) contained a near-term fetus and 21 (30%) contained neither an active corpus luteum nor a fetus though they did contain one or more corpora albicantia from previous ovulations. The remaining 31 included 18 (25%) which supported a small fetus and 13 (19%) with an active recently formed corpus luteum but no obvious fetus. Some of the latter were doubtless pregnant but were taken prior to the presence of an identifiable fetus (i.e. in late April to mid-June), while others may have ovulated but not become pregnant. Thus, approximately one-third of the mature females were about to calve, one-third had recently become pregnant, and the remainder had not bred during the year of collection. Brodie (1971) also reported a 36-month breeding cycle for belukhas in eastern Canada.

A fetal growth curve, constructed on the basis of more

than 225 records from all sources available to us (Degerbol and Nielsen, 1930; Vladykov, 1944; Douglas, 1951; Doan and Douglas, 1953; Tomilin, 1957; Kleinenberg *et al.*, 1964; Brodie, 1971; Sergeant, 1973; present study) indicated a similar growth rate and similar times for breeding and calving in waters near Greenland, eastern Canada, the Soviet Union and Alaska.

7. Food Habits

Kleinenberg *et al.* (1964) reported that the diet of belukhas is quite varied and includes more than 100 different organisms. Studies in Alaska indicate that relatively few species comprise the bulk of the diet and that these vary with season and location. Brooks (1954a, b, 1955, 1956, 1957) and observations of local residents indicate that in Bristol Bay during the open water season belukhas utilized a succession of important prey items as each became abundant and available in the coastal zone, estuaries, and rivers. These included eulachon (*Thaleichthys pacificus*) in late April-early May, coastal spawning herring (*Clupea pallasii*), and capelin (*Mallotus villosus*) in May and early

June (and to a lesser extent throughout summer), various species of salmon, first when the smolt are migrating seaward and concentrated in lower reaches of river systems and then when the adults are returning to spawn. Red or sockeye salmon (*Oncorhynchus nerka*) are particularly important in Bristol Bay, but other salmonids are taken as available. Late summer-early autumn runs of rainbow smelt (*Osmerus mordax dentex*) occur after the major salmon runs and are eaten by belukhas. Other items eaten in Bristol Bay were found to include flounders, sole, sculpin, blennies, lamprey, shrimps, and mussels (Brooks, 1956; Klinkhart, 1966).

Seaman and Lowry (in preparation), who examined the contents of 85 stomachs, conducted the most detailed belukha food habits studies in the northeastern Bering and Chukchi Seas. Their results reflected the same general pattern of utilization of seasonally abundant prey in the coastal zone. Belukhas taken during spring migration in the Chukchi Sea had eaten arctic cod (*Boreogadus saida*), shrimps, and octopus. During late spring and summer, in the coastal zone, important prey included saffron cod (*Eleginus gracilis*), sculpins, herring, smelt, capelin, salmon, char (*Salvelinus malma*), shrimps, and octopus. In Norton Sound and southeastern Kotzebue Sound saffron cod were the primary prey. It was presumed that overall, arctic cod are the most important prey in more northerly regions. In all regions a diversity of less important foods was reported (Seaman and Lowry, in preparation).

Use of the Alaskan coastal zone by belukhas in the open water seasons appears to be for feeding on sequentially abundant and highly available prey and for obtaining the thermal advantage of relatively warm water during the calving season, as suggested by Sergeant (1973). The latter may be of greater significance in the northern Chukchi and Beaufort Seas. Belukhas enter the bays and rivers of Bristol Bay as early as ice conditions permit, which may be in late March or early April. They frequent these areas until late summer.

Our impression is that during the open water season, movement and aggregation patterns of belukhas in the Bering Sea (including Bristol Bay and Norton Sound) are related mainly to availability of prey. Water temperatures in the coastal zone of the Bering Sea are significantly warmer, over a much broader area, than in areas farther north. In the Chukchi and Beaufort Seas belukhas aggregate in significantly larger numbers at relatively few favorable (warm water) locations. Availability of prey may be a less important factor in more northerly regions.

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