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ENVIRONMENT OF THE CAPE THOMPSON REGION, ALASKA

Norman J. Wilimovsky, Editor

Director, Institute of Fisheries
University of British Columbia
Vancouver, British Columbia

John N. Wolfe, Associate Editor

Chief, Environmental Sciences Branch
Division of Biology and Medicine
U. S. Atomic Energy Commission
Washington, D. C.

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Chapter 33

Marine Mammals

Murray L. Johnson, Clifford H. Fiscus, Burton T. Ostenson, and Myron L. Barbour

Marine mammals are used by the Eskimos for food and clothing and as a source of income. They are the most important item among natural resources. Data were secured on nine species, but only the ringed seal and bearded seal were taken in numbers. The ringed seal is present in abundance from November through June. Pups are born in late March. Mating, with an 86.7% pregnancy rate, occurs in April and May. Food is principally fish in the winter and invertebrates in the spring, and many species of both are used. The bearded seal is present in numbers only in June. Pups are born in late April and are completely molted. Food is principally invertebrates of many species. All marine mammals are migratory, and most of the animals used by the Eskimos are absent in the ice-free months.

The study of marine mammals was made primarily in the villages of Kivalina and Point Hope. The experience of local hunters was used in our study, and large numbers of animals were examined. In August and September of 1959, Murray Johnson and Mrs. Johnson spent 3 weeks in Kivalina and 1 week in Point Hope. The Johnsons interviewed local residents and examined the seas and beaches to learn the general pattern of occurrence and utilization of marine mammals in the Cape Thompson area. In April 1960 they spent 3 weeks in Point Hope and a few days in Kivalina investigating whaling and other hunting activities.

The need for full-time resident biologists was clearly established, and Ostenson and Barbour were assigned to Point Hope for the major hunting season, November 1960 through June 1961. Johnson made one visit to Point Hope in January 1961, when aerial census surveys were instituted. Dale Rice, cetacean specialist for the U. S. Fish and Wildlife Service, spent 3 weeks with Ostenson and Barbour in April 1961.

Biological specimens and data were obtained from more than 2200 marine mammals, most of which were secured at Point Hope during the winter and spring of 1960-1961. Some specimens were secured during the preliminary studies at Point Hope and Kivalina. Two species were obtained in numbers sufficient for

extensive study—the ringed seal (2028 specimens) and the bearded seal (208 specimens). Specimens and limited data were also obtained on the following: ribbon seal (7 specimens), fur seal (3 specimens), harbor seal (3 specimens), walrus (2 specimens), beluga (5 specimens), bowhead whale (3 specimens), and polar bear (3 specimens).

Working closely with the Marine Mammal Laboratory of the U. S. Fish and Wildlife Service in Seattle, we have analyzed our data to correlate field observations with final conclusions.

Historically, we find mention of marine mammals in most publications on arctic Alaska. These notations are scattered and fragmentary but are important in piecing together data on the occurrence of species. The reports of Scammon (1874), Nelson and True (1887), Bailey and Hendee (1926), Rainey (1945), and Bee and Hall (1956) have considerable general information concerning the marine mammals of northern Alaskan shores.

Authors of recent checklists of mammals who have brought together information on the general distribution and nomenclature of the marine species include Anderson (1946), Ellerman and Morrison-Scott (1951), Miller and Kellogg (1955), and Hall and Kelson (1959).

The biology and utilization of some Canadian eastern arctic species of seals have been investigated by personnel of the Fisheries Research Board of Canada, notably McLaren (1958a, b, and c and 1961). These reports are invaluable for comparative purposes.

Scheffer's (1958) review of the Pinnipedia is the best single volume regarding seals. Slijper's (1962) work contains much good general information about whales.

The Russians continue to publish results of their arctic research. Since these works involve areas closely related to our particular geographic region, they are of considerable interest. The most important of these are Naumov and Smirnov (1936), Ognev (1935), Nikulin (1940), Bobrinskii *et al.* (1944), and Tomilin (1957).

There has, however, been no previous organized study of the marine mammals of arctic Alaska. This report is the result of teamwork and is the product of many individuals.

The following list includes all species of marine mammals that have been reported from the northern Bering Sea and the Alaskan–Siberian Arctic Ocean. The habits and distribution of many of these species are poorly known; it is conceivable that individuals may at times occur in that part of the Arctic Ocean north of Bering Strait (Chukchi Sea).

The following is a list of species that may occur in the Chukchi Sea:

Species	Distribution
ORDER PINNIPEDIA	
Steller sea lion *Eumetopias jubata* (Schreber, 1776)	North Pacific, Bering Sea. Reported from Herschel I., Y. T. (McEwen, 1954—sight record.)
Northern fur seal* *Callorhinus ursinus* (Linnaeus, 1758)	North Pacific. Reported from Yukon and Northwest Territories (McEwen, 1954; Radvanyi, 1960).

*Species known to occur in the Chukchi Sea.

Walrus* *Odobenus rosmarus* (Linnaeus, 1758)	Circumpolar, arctic.
Harbor Seal, spotted seal* *Phoca vitulina* Linnaeus, 1758	Circumpolar, arctic, and temperate.
Ringed seal* *Pusa hispida* (Schreber, 1775)	Circumpolar, arctic.
Ribbon seal* *Histriophoca fasciata* (Zimmermann, 1783)	North Pacific, primarily Asian subarctic.
Bearded seal, ugruk* *Erignathus barbatus* (Erxleben, 1777)	Circumboreal, arctic.
ORDER CETACEA	
SUBORDER ODONTOCETI	
Baird's beaked whale *Berardius bairdii* Stejneger, 1883	Pacific, north to St. Matthew Island.
Bowdoin beaked whale *Mesoplodon bowdoini* Andrews, 1908	Pacific (Bering Sea).
Goose-beaked whale *Ziphius cavirostris* G. Cuvier, 1823	Circumboreal, eastern Bering Sea.
Sperm whale *Physeter catodon* Linnaeus, 1758	Pribilof Islands, south; worldwide.
White whale, beluga* *Delphinapterus leucas* (Pallas, 1776)	Circumboreal, arctic.
Narwhal* *Monodon monoceros* Linnaeus, 1758	Arctic, mainly Canadian. (Geist, Buckley, and Manville, 1960.)
Porpoise *Stenella styx* (Gray, 1846)	Circumboreal, subarctic (Bering Sea).
Right-whale porpoise *Lissodelphis borealis* (Peale, 1848)	Eastern North Pacific (Bering Sea).
Pacific killer whale* *Orcinus rectipinna* (Cope, 1869)	Eastern North Pacific into Arctic (Scammon, 1874).
Harbor porpoise* *Phocoena vomerina* Gill, 1865	Eastern North Pacific. Point Barrow (Miller and Kellogg, 1955).
SUBORDER MYSTICETI	
Gray whale* *Eschrichtius gibbosus* Erxleben, 1777	North Pacific into Arctic (Maher, 1960).
Common finback whale* *Balaenoptera physalus* (Linnaeus, 1758)	All oceans, mainly subarctic, Chukchi Sea (Tomilin, 1957).

*Species known to occur in the Chukchi Sea.

Sei whale* *Balaenoptera borealis* Lesson, 1828	All oceans, Chukchi Sea (Tomilin, 1957).
Little piked whale* *Balaenoptera acutorostrata* Lacepede, 1804	All oceans, Chukchi Sea (Scammon, 1874; Tomilin, 1957).
Blue whale *Sibbaldus musculus* (Linnaeus, 1758)	Circumboreal (Bering Sea).
Humpback whale* *Megaptera novaeangliae* (Bovowski, 1781)	Circumboreal, Chukchi Sea (Tomilin, 1957).
Pacific right whale *Eubalaena sieboldii* (Gray, 1864)	North Pacific (Cape Prince of Wales).
Bowhead whale* *Balaena mysticetus* Linnaeus, 1758	Circumboreal, arctic.
ORDER CARNIVORA	
Polar bear* *Thalarctos maritimus* (Phipps, 1774)	Circumboreal, polar.

*Species known to occur in the Chukchi Sea.

METHODS OF HUNTING

Seals

Summer hunting is minimal. A few harbor seals are obtained, usually in the river estuaries or off the point at Point Hope. These may be shot from the beach or from skin boats. A few young bearded seals may be secured in the estuaries. In late October there is usually a concentration of harbor seals near the outlet of the Kukpuk River, and these are used to a degree.

Major hunting, primarily for ringed seals and occasionally for bearded seals, is done during the ice season. Great anticipation attends the forming and coming in of the sea ice. At Point Hope this is usually in early November and is synchronous with the appearance of the ringed seals, usually along the north shore. At Kivalina good ice for hunting may not be present until January. Progressive ice formation with grounding of floes along the shore means progressively good hunting. The more ice on which the hunter may travel, the more area there is for hunting. Hunting is most likely to be productive at open leads but may also be done at the seal holes. The hunter may either move along the hunting area or may wait for moving seals to pass him. Dead seals will float in the winter months and may be retrieved by hooking or by using a skin boat or kayak. In 1961 the hunters first reported seals sinking in April. By June seals sank readily and had to be retrieved by weighted grappling hooks. There is no present usage of the old methods of harpooning and netting of pinnipeds in the Cape Thompson area.

In June and early July, as the ice is breaking up, hunting is done from the large umiaks, which are powered with outboard motors. At this time the great

catch of bearded seals is made, and "spring seals" (immature ringed seals) are secured in large numbers.

The rare ribbon seal and occasional walruses are secured either in the fall southward migration or, more often, in the northward migration in June. Walruses are obtained rarely during the winter.

It must be mentioned that our data regarding relative and seasonal abundance are biased because they are based on hunters' kills. These kills, in turn, are influenced by hunter preference of species and hunting locality and, more seriously, by limitations imposed on the hunter by the rigors of his environment. Hunting is impossible many days of the season.

Whales and Polar Bears

Bowhead whales are the only large whales hunted by the Eskimos in the Cape Thompson area. Point Hope has been a traditional whaling area since prehistoric times, and hunters come from other villages to participate. At the request of several experienced whalers in Kivalina, we helped equip one team in this village in 1960. The hunt was unsuccessful although valuable data were secured through this effort.

Twenty-four-hour camps ready to spring to action when a whale is sighted are set up on the ice. When launching their umiaks and paddling up to a blind area of a whale, hunters must be absolutely quiet. Bomb lances, or "darting guns," are thrown by hand when a boat grounds upon a whale. If the whale is "well struck," it may die almost immediately. The hunter attempts to insert the bomb near the occipital joint or along the vertebral column. A retention harpoon is attached to a long line and a seal-skin float to signal the position of a dead or wounded whale. Whale-hunting success is limited by many factors. Inclement weather may prevent the launching of boats even when whales are visible. The open leads may close for days at a time. The whales are not easily approached, and, even when struck, they are secured only about 25% of the time. At Point Hope in 1959, only one whale was secured; in 1960 four were secured, and in 1961, two.

The method of whaling has remained virtually the same for the past hundred years. Holmes (1857) cites the method as being commonly used by the English. It was also accepted at the time by American whalers. Scammon (1874) pictures the exact equipment we observed in Point Hope. Large shoulder guns, which fire bombs like those used in the darting gun and which date back almost as far, have been used little since a fatal accident in the early 1940's resulted from a gun explosion. Several injuries also resulted from the use of the shoulder guns.

Belugas or white whales are killed by rifle fire and then hooked and retrieved.

Although polar bears are much sought after, they are rare. They are shot whenever encountered and may be tracked over the snow.

UTILIZATION BY ESKIMOS

The marine mammals are very important to the Eskimos of the Cape Thompson area. They are used in many different ways, and nearly every part of each

animal is utilized. This is uniquely Arctic in character and has allowed the survival of the Eskimo race not only in prehistoric but also in modern times.

Skins

The bearded seal skin is a heavy, durable hide. It is used to make skin boats ranging in size from small one-skin boats up to eight-skin boats (umiaks), the largest. The skins are replaced every 3 to 5 years, and only a relatively small percentage of the skins obtained each year are used for these replacements. These skins are also used to make the soles of mukluks, which are universally of this skin, and rope and lines. All these objects are made from a dehaired hide that has been prepared by soaking in water and scraping. These skins are also used as a general utility cover to protect objects.

The ringed seal skin is thinner and more pliable than the bearded seal skin. It may be fashioned into wearing apparel with the hair left on, or it may be subjected to soaking and scraping followed by bleaching by the snow and sun. The result is an almost pure white skin that can be used in fancywork or clothing. "Seal pokes" are made by skinning the ringed seal through the mouth. The orifices are tied, and the skin is inflated for floats; or the skin is inverted and used for storage of oil and oil-preserved food.

The harbor, or spotted, seal skin is used with the hair left on for various articles of clothing. It is not usually sought by hunters although several men in Point Hope make a particular effort to secure it for personal use and sale.

The ribbon seal is not common enough to be of great importance in Point Hope. A few skins, for sale at $4.00 each at the native store for several years, were never sold. Individual fresh skins, however, sold for $25.00. The ribbon seal is so rare in Kivalina that it is unknown to several of the younger hunters.

Walruses are only sporadic in occurrence. Their hides are not used in this area for umiak covers as they are in some other Eskimo villages.

Polar bear skins are prime commercial items and are too valuable for the Eskimos to keep for personal use.

Seal Oil

Seal oil is self-rendering and is prepared by cutting the blubber into long strips and putting the strips into a seal poke or an ordinary barrel. The residual fibrous remnant from which the oil departs is considered edible. The oil may be used in cooking but is mostly used as a preservative for cooked or dried seal meat, for caribou meat, for dried fish, and for berries. Items immersed in seal oil can be kept as long as 4 or 5 years if stored in a permafrost deepfreeze or as long as a year if stored at room temperature. After about a year the oil begins to turn red but is still thought to be good. A note may be inserted here that several cases of botulism (Rabeau, 1959, Dolman, 1960), some fatal, have occurred in this general area (Kotzebue to Point Hope) from eating beluga skin preserved in seal oil. An experimental study in our laboratories by Frank Fiorino revealed no evidence that seal oil is a bacteriostatic or bacteriocidal agent to common bacteria.

Another important use for seal oil is heating. The very hot flame it generates is used to advantage by most of the villagers to burn pieces of driftwood in their stoves.

Food

Bearded and ringed seals are both standard foods in the Eskimo diet. They may be cooked or dried raw for preservation in seal pokes or cooked fresh or frozen for human and canine consumption. The harbor seal is usually prepared by the natives only for their dogs; walrus meat is also used for dog food.

Beluga and bowhead whales are used primarily as food. The skin, "muktuk," is a prime delicacy of the north, and the meat and all soft parts are used for either human or canine food.

Polar bear meat is considered very good by the Eskimos.

Income from Sale*

Whole ringed seals are sold to retail stores in Point Hope and Kivalina in limited quantities or in some cases to other villages, such as Noatak and Kotzebue. The price ranges from $6.00 to $8.50 a seal.

Ringed seal skins are sold to the stores at a price ranging from $2.00 to $4.00 for a well-prepared dried skin. Skins from unborn ringed seal are commonly obtained and are usually sold to the stores for $1.00 or $2.00 or are kept for use in making clothing. Harbor seal skins may sell for $8.00 to $12.00 a skin.

Polar bear skins had a great increase in value (from $10.00 to $20.00 a foot) during the time of this study. Polar bears are the most valuable animal obtained except for the bowhead whale.

Seal blubber is at times sold for $0.15 a pound, or $5.00 a 5-gal tin, an amount that can frequently be obtained from one fat animal. The meat of one seal, after skin and blubber are removed, may be sold for $1.50.

The prices mentioned are variable and may be different in each village.

A moderate amount of native handicraft is made with materials from marine mammals. Mukluks and parkas of seal skin are exported as are model kayaks and skin boats made of ringed seal skin. Walrus ivory, which sells at the native stores in the raw state for $3.00 a pound, is used in much of the Eskimo carving. At Point Hope baskets of baleen and face masks of whale bones are manufactured.

Generally, marine mammals are used primarily for food and clothing. Commercial uses are secondary but are quite valuable to the natives.

SEAL HARVEST AND CENSUS

Harvest

The harvest of ringed and bearded seals by the Eskimos began at the time of the formation of sea ice. The first ringed seal examined was taken Nov. 17, 1960. Ice 5 to 8 in. thick had formed and piled up along the shore north of Point Hope by that date. Winter sealing built up to a peak harvest of 532 ringed seals in February (Table 1) and tapered off to 146 in April. Spring sealing reached a climax in

*All prices are subject to great fluctuation; the stated prices refer only to the time of our field work. An Alaskan state bounty of $2.00 has been applied to all seals. There has been a phenomenal increase in the price of seal skins.

Table 1—NUMBERS OF SEALS TAKEN AT POINT HOPE NOVEMBER 1960 THROUGH JUNE 1961 BY HUNTING AREA AND MONTH*

Month	Hunting area†											
	I	II	III	IV	V	VI	VII	VIII	IX	X	Unknown	Total
November				58(3)	11	1						70(3)
December	3	11	10	60(1)	25	17		3	1	1	2	133(1)
January	14	37	39(1)	70	57(1)	26	13	26	10(1)	13	9	314(3)
February	1	11		34	329(2)	58(2)	27	29	20	3	24	536(4)
March	4		10(3)	38(1)	97(1)	68(1)	7	2(1)			6	232(7)
April	3(1)	6	2	21	86(8)	11	12(1)	6(1)		1	10(1)	158(12)
May		3	5	26	106(7)	13	17(1)	1		3	6	180(8)
June			1	18	260(84)	228(55)	2			3	268(26)	780(165)
Total	25(1)	68	67(4)	325(5)	971(103)	422(58)	78(2)	67(2)	31(1)	24	325(27)	2403(203)

*Figures in parentheses are numbers of bearded seals. Other figures are totals of ringed and bearded seals.

†Hunting areas are shown on Fig. 1.

June; 615 ringed seals and 165 bearded seals had been taken. Before June, April produced the most bearded seals although the number was still only 12. Virtually all animals taken by the villagers were weighed and measured by the biologists. However, the June totals include an estimated 241 ringed seals and 26 bearded seals that were harvested but not measured.

An interesting shift occurred in the area of the best sealing as the season advanced. In the first months of hunting, most seals were taken north of Point Hope (areas I to IV, Fig. 1), but by February most were taken at Point Hope and south toward Cape Thompson. By June very few were taken from the north side (only 19 out of 615); these few were almost all large adults.

Table 2—DISTRIBUTION BY SEX AND MATURITY OF SEALS TAKEN AT POINT HOPE NOVEMBER 1960 THROUGH JUNE 1961

Month	Ringed Seal				Bearded Seal			
	Adult		Immature		Adult		Immature	
	Male	Female	Male	Female	Male	Female	Male	Female
November	19	21	18	8			2	1
December	61	34	21	15			1	
January	177	89	24	12		1	1	1
February	179	112	129	102		1	2	1
March	59	21	78	71	1	1	1	4
April	36	10	51	41		3	4	4
May	37	13	64	53	3	1	3	1
June	28	30	163	144	30	50	26	30
Total	596	330	548	446	34	57	40	42

A combination of factors probably accounted for this seasonal shift of harvest from north to south of the village. The earlier formation of ice that could be used as a hunting platform on the north side would result in the first hunting success in that region. Also there is a southward migration of ringed seals in the fall as the ice forms. Such movement would tend to bring them close to the Point Hope peninsula as it juts out into the Chukchi Sea. Certainly in the spring there must be a definite movement of seals into the area since the harvest includes a much higher proportion of immature animals (Table 2) than the winter harvest shows.

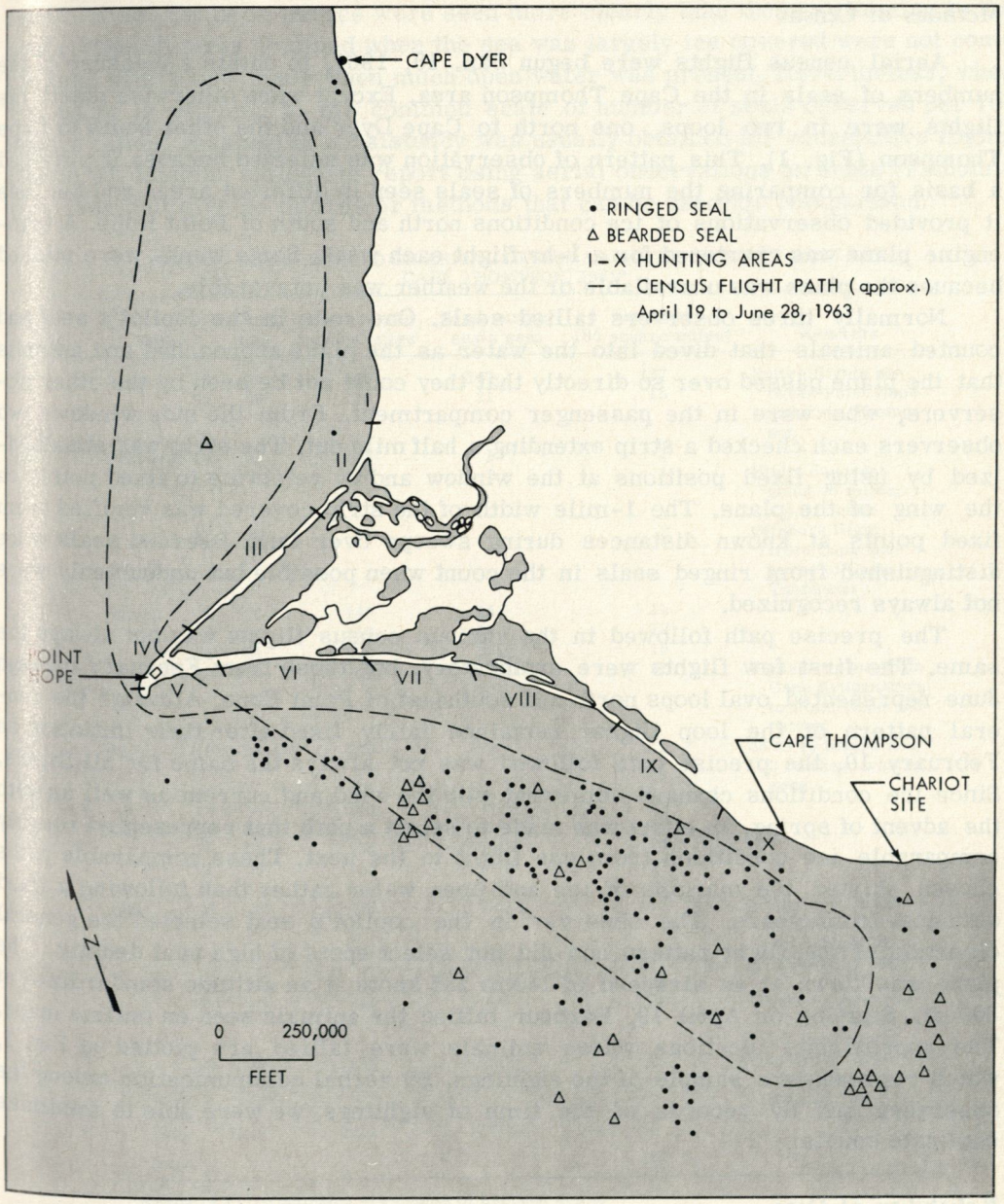

Fig. 1—Spring seal distribution and hunting area near Point Hope, Alaska.

The preponderance of males in the adult ringed seal sample is presumed to be due to greater activity and hence availability of the males to the hunters. The disparity in the sex ratio is not nearly so marked in the immature animals. By July virtually no more seals were taken. The impression given was that the ringed and bearded seals moved northwest and north and were gone from the Cape Thompson and Point Hope areas by early July.

Methods of Census

Aerial census flights were begun Jan. 18, 1961, to obtain a measure of the numbers of seals in the Cape Thompson area. Except when otherwise noted, the flights were in two loops, one north to Cape Dyer and the other south to Cape Thompson (Fig. 1). This pattern of observation was selected because it provided a basis for comparing the numbers of seals seen in different areas and because it provided observations of ice conditions north and south of Point Hope. A twin-engine plane was chartered for a 1-hr flight each week. Some weeks were missed because the plane was unavailable or the weather was unfavorable.

Normally three observers tallied seals. One rode in the copilot's seat and counted animals that dived into the water as the plane approached and animals that the plane passed over so directly that they could not be seen by the other observers, who were in the passenger compartment. From the side windows two observers each checked a strip extending a half mile out. The strip was standardized by using fixed positions at the window and by referring to fixed points on the wing of the plane. The 1-mile width of the strip covered was verified from fixed points at known distances during sweeps over land. Bearded seals were distinguished from ringed seals in the count when possible but undoubtedly were not always recognized.

The precise path followed in the various census flights was not always the same. The first few flights were exploratory, but those from February through June represented oval loops north and southeast of Point Hope. Although the general pattern of the loop flights remained fairly fixed after their initiation on February 10, the precise path followed was not always the same for all flights. Since ice conditions changed somewhat with the wind and current as well as with the advent of spring, an effort was made to select a path that represented roughly comparable ice conditions from one flight to the next. These comparable paths chosen skirted the margins of ice and open water rather than following a fixed distance from shore. The observer in the copilot's seat selected the general direction of the flight pattern and did not select spots of high seal density. The plane was flown at an airspeed of 130 to 135 knots at an altitude standardized at 300 ft. Starting on April 19, Barbour tallied the animals seen on outline maps. The approximate locations where animals were tallied are plotted on Fig. 1, which represents a sample of the sightings. By verbal communication among the observers and by records of the time of sightings, we were able to minimize duplicate counts.

Reliability of Data

Several factors doubtless affected the reliability of the data obtained. Observers may have differed as to visual capabilities even though all were experienced under arctic conditions. Differences in the altitude and speed of the plane probably caused errors in the calculated area covered. Chance variations in the availability of animals caused drastic differences in the numbers of animals sighted. For example, on March 29 at about 11:00 a. m., a pilot in a small plane flying north of Point Hope reported seeing more than 20 bearded seals and 6 ringed seals; the walrus survey crew flying a parallel route about 3 hr later

tallied none. Seals on the ice were seen more clearly than those swimming in the water. Thus figures obtained when the sea was largely ice covered were not comparable with those made when much open water was present. Nevertheless, when the count is reduced to the common scale of number of seals observed per 100 square miles, reasonable consistency was usually obtained for consecutive flights (Table 3). Russian biologists report using aerial observations on seals (Tikhomirov, 1961) but give no figures or methods that can be used for comparison.

Table 3—SEALS SIGHTED ON AERIAL CENSUS ADJACENT TO POINT HOPE AND CAPE THOMPSON, 1961*

Date		Time, min	Area covered, square miles	Total number seals seen	Seals per 100 square miles†	Remarks
January	18	58	145	343	237	Entire flights between Point Hope and Cape Thompson
	25	56	140	21	15	
February	10	58	145	1	1	
	15	76	190	2	1	Flight due west about 75 miles; 1 polar bear
	22	19	47	1	2	Offshore flight from Cape Lisburne to Cape Thompson
March	1	56	140	15	11	
	8	56	140	17	12	
	22	54	135	20(1)	15	
	30	180	407	44(1)	11	Zigzag course from Cape Krusenstern to Point Hope and return
April	19	66	165	4	2	35 to 40 beluga and 3 bowhead whales seen
	28	56	140	37(2)	26	
May	8	56	140	63(12)	45	
	15	54	135	54(3)	40	
	22	50	125	75(3)	60	
	31	46	115	37(2)	32	
June	9	22	55	62(12)	113	Flight over most productive area only; flight terminated by fog
	21	60	150	43(9)	29	
	27	32	64	23	36	Offshore observations to Cape Thompson only
	28	53	133	15(2)	11	One whale (bowhead?) and one walrus
Total		1108	2711	877(47)		
Mean					32	

*Numbers in parentheses are counts of bearded seals.
†Calculated to the nearest whole number.

Numbers of Seals Counted

The general pattern of seal sightings between April 19 and June 28 is shown on Fig. 1. This figure probably is a representative pattern of late-winter and spring seal distribution but is, of course, subject to the variables noted above. Most of the locations shown were noted by Barbour and were plotted from a time log and dead-reckoning plot of each flight. The spring concentration of seals ob-

served to the south of Point Hope is also reflected in the pattern of hunter success, as previously noted (Table 1). This preponderance of seals south of Point Hope was most noticeable after March. The scarcity of seal sightings over fast ice next to shore corresponds with information obtained on surface observations and from interviews with hunters. Seals rarely emerge on the fast ice but tend to gather adjacent to cracks and leads that occur where there is movement of the ice pack.

Bearded seals definitely recognized as such were plotted as distinct units. Concentrations of bearded seals shown off Jabbertown (area VI-VII, Fig. 1) and off the Chariot site may indicate favorable bottom-feeding conditions. That these two areas actually have concentrations of bearded seals is corroborated by the conviction among the Eskimo hunters that these are productive hunting areas for this mammal.

On 19 different flights totaling approximately 18 hr of flying time over potential seal habitat near Point Hope and Cape Thompson, 877 seals were seen on samples estimated to be 2711 square miles in total area (Table 3). This represents an average of 32 seals seen per 100 square miles of sea. Some counts varied widely from this average.

Our highest count of 237 animals per 100 square miles on January 18 apparently represented a midwinter concentration of basking seals, and, although this was our first census flight, conditions for observation may have been exceptionally favorable. The entire flight was south of Point Hope, where maximum numbers occurred throughout the season. By contrast, only a week later we had the January 25 density figure of 15 seals seen per 100 square miles, which is very close to results shown for flights in March.

The February flights were exploratory in nature and cannot strictly be compared with later flights. There is a high availability of seals during the month, as reflected in the high degree of hunter success (Table 1), but only a few were seen from the air (Table 3). On the February 10 census flight, only one seal was seen although 20 hunters brought in 51 seals on that day. During the 3 preceding days, 92 seals had been brought in. Despite this successful hunting activity, it is difficult to believe that this harvest of seals would have reduced the population so drastically that it was reflected in the aerial census figure.

The aerial census counts for March were quite uniform (11, 12, 15, 11) even though on the March 30 flight we were able to cover a more extensive area by using the equipment of the U. S. Fish and Wildlife Service walrus census crew. This flight is described in greater detail later.

Some of the spring flights showed wide fluctuations in counts. In April poor visibility and unavailability of a plane delayed our first flight until the 19th. At this time extensive leads were opening in the pack ice, and much open water was surveyed. The difficulty in identifying a swimming seal possibly was a factor in our low figure of 2 seals per 100 square miles (Table 3). The June 9 flight was terminated because of fog when only the most productive area toward Cape Thompson had been covered. This abnormally rich sample doubtless accounts for the unusually high density figure of 113 computed for this date. The remainder of the May and June flights produced counts that are roughly comparable (29 to 60) except that on June 28 the count dropped to 11. This coincided with a

marked drop in the numbers of seals taken by the hunters. Virtually no ringed or bearded seals were taken by the villagers after July 1.

The walrus survey party of the U. S. Fish and Wildlife Service cooperated with us in a marine mammal survey on March 29 and 30 as an extension of our census flights. The observations discussed here and Table 4 are based on a report written by Richard H. Manville and dated May 25, 1961. The survey party included the following personnel: Karl W. Kenyon and Richard H. Manville, biologists, and Don W. Hayne, biometrician. Ostenson and Barbour accompanied them for most of the flights.

Table 4— ESTIMATES (WITH STANDARD ERRORS) BASED ON SEALS OBSERVED DURING AERIAL SURVEY* OVER CHUKCHI SEA, MAR. 29 to 30, 1961

Miles from Cape Thompson	Area, square miles	Total number of seals	Seals per 100 square miles
0-40 (entire area within 20 miles of shore)	3,100	119 ± 53	4 ± 2
	1,900	119 ± 53	6 ± 3
40-80 (entire area within 20 miles of shore)	9,700	354 ± 102	4 ± 1
	2,400	354 ± 102	15 ± 4
80-120 (entire area within 20 miles of shore)	16,200	148 ± 90	1 ± 1
	2,700	148 ± 90	6 ± 3
Within 20 miles of path regularly flown by investigators at Point Hope	2,300	98 ± 51	4 ± 2

*Aerial survey covered about 1100 nautical miles.

The flight on March 29 started at Nome, headed across the Bering Sea past Big Diomede Island, and went across the Chukchi Sea to Point Hope. From there the flight proceeded north along the coast to Point Lay; then it moved over the Chukchi Sea west and south through Bering Strait to Nome. One walrus, six bearded seals, and five ringed seals were seen. The next day the flight began west of Shishmaref, proceeded to Cape Krusenstern and northwest by zigzag course to Point Hope, and then returned south to Kotzebue. The area from Cape Krusenstern to Point Hope and return was judged most representative of the Kivalina–Cape Thompson–Point Hope coastal area and was used as the basis of the figures in Table 3 for March 30. The census terminated over Kotzebue as the plane left the sea ice bound for Anchorage. On the second day of the census, 1 bearded seal and 62 ringed seals were tallied in the 1-mile strip covered by the observers. Estimates of populations within sectors at various distances from Cape Thompson are given in Table 4. The complete log of the two days of flying indicates that the most productive area was that adjacent to Cape Thompson between Cape Krusenstern and Point Hope although this is not shown in the sector analysis of the data of Table 4.

Summary of Flights

Our census flights indicate that almost all seals remain within a few miles of shore. The counts on different days in the same month appear to be somewhat comparable even though they are subject to wide variation. The surveys also indicate a considerable concentration of seals toward Cape Thompson in the spring of the year. When applied with caution, counts of seals by aerial census may be used as a rough index of numbers and distribution.

BIOLOGY OF THE RINGED SEAL

The biological data were derived primarily from seals secured by the hunters at Point Hope during the winter of 1960–1961. During the time that Ostenson and Barbour were resident biologists, a system was established whereby the Eskimos notified them when seals were brought in. The biologists then made rounds to each house, took desired measurements and observations, and collected specimens of skulls, teeth, claws, genitalia, stomachs, and other desired parts during the butchering. An adequate payment for this privilege produced completeness of reporting. The data therefore are derived from a total village catch for one season.

Weight

A monthly comparison of the weights of adult ringed seals (Table 5) shows a general increase in weight until midwinter and then a progressive drop through June. The adult males increased in average weight from 114.4 lb in November to

Table 5— COMPARISON OF WEIGHTS* OF ADULT RINGED SEALS, NOVEMBER 1960 to JUNE 1961

	Males			Pregnant females			Nonpregnant females		
	Mean	Number	Range	Mean	Number	Range	Mean	Number	Range
November	114.4 ± 13.7	16	90–150	112.7 ± 13.7	13	95–135	92.5 ± 2.5	2	90–95
December	123.3 ± 19.0	60	75–175	123.1 ± 16.8	24	95–170	110.0 ± 14.6	8	90–135
January	152.9 ± 20.6	174	110–220	139.9 ± 18.4	79	100–190	113.9 ± 21.2	14	85–170
February	143.2 ± 26.0	187	90–210	147.6 ± 21.6	94	100–200	122.7 ± 18.0	11	95–155
March	122.8 ± 21.1	61	85–180	148.5 ± 19.1	17	110–190	108.0 ± 16.3	5	85–135
April	116.1 ± 19.3	35	90–180	147.5 ± 22.5	2	125–170	107.5 ± 12.5	6	95–130
May	114.8 ± 19.9	41	90–160				108.1 ± 25.8	13	70–165
June	92.4 ± 12.0	19	75–120				101.0 ± 16.0	11	75–130

*Means with standard deviation in pounds.

152.9 lb in January; the average weight dropped to 143.2 in February and then to 122.8 in March. They continued a gradual decline in weight, with a decided drop to 92.4 lb in June. The nonpregnant females showed a similar pattern of change but without such marked extremes. Males were heavier than the females except in June. This heavier group of females in June may have no significance since only a small sample (11) of adult females was available. Pregnant females continue their increase in size until the pups are born, and then they decrease rapidly in weight. Pregnant females in March and April averaged about 148 lb, but all nonpregnant females in April and May (including several lactating females) averaged only 108 lb. As shown by the food-habits studies, the season of maximum weight follows the period of maximum feeding activity.

Measurements of blubber thickness (Table 6) indicate a seasonal change closely paralleling the pattern of body-weight change. This parallelism includes a later time of decrease in blubber thickness for the females in the spring (April). Blubber constitutes about half the body weight of a ringed seal in good condition. The weight of the blubber of two adults taken in March averaged 48% of the body weight. Muscle and bone constituted 37%; viscera, 10%; and the fresh skin, 5%. The blubber of an adult ringed seal taken in June was 34% of the body weight.

Table 6 — COMPARISON OF BLUBBER THICKNESS* (MIDSTERNUM) IN ADULT RINGED SEALS, NOVEMBER 1960 TO JUNE 1961

Month	Males			Females		
	Mean	Number	Range	Mean	Number	Range
November	55.9 ± 6.3	20	40–72	55.3 ± 7.7	18	40–77
December	53.5 ± 8.2	63	28–72	50.3 ± 6.7	38	36–64
January	56.8 ± 8.0	174	40–74	54.4 ± 7.8	95	37–72
February	55.5 ± 8.0	183	34–75	56.6 ± 8.2	112	35–72
March	48.7 ± 6.1	55	37–62	55.2 ± 6.6	23	40–66
April	44.3 ± 6.0	39	31–56	44.9 ± 11.1	12	25–70
May	38.3 ± 6.0	38	29–58	33.4 ± 10.6	14	19–50
June	32.3 ± 5.5	33	24–50	34.1 ± 6.4	32	21–48

*Means with standard deviation in millimeters.

Length

Standard lengths of ringed seals were measured from tip of nose to tip of tail. A steel tape was stretched over the animal parallel to the long axis of the body, and the measurement was recorded in millimeters. Since lengths may vary, depending on whether the head and neck are forcibly extended or not, seals were placed in comparable positions for measuring.

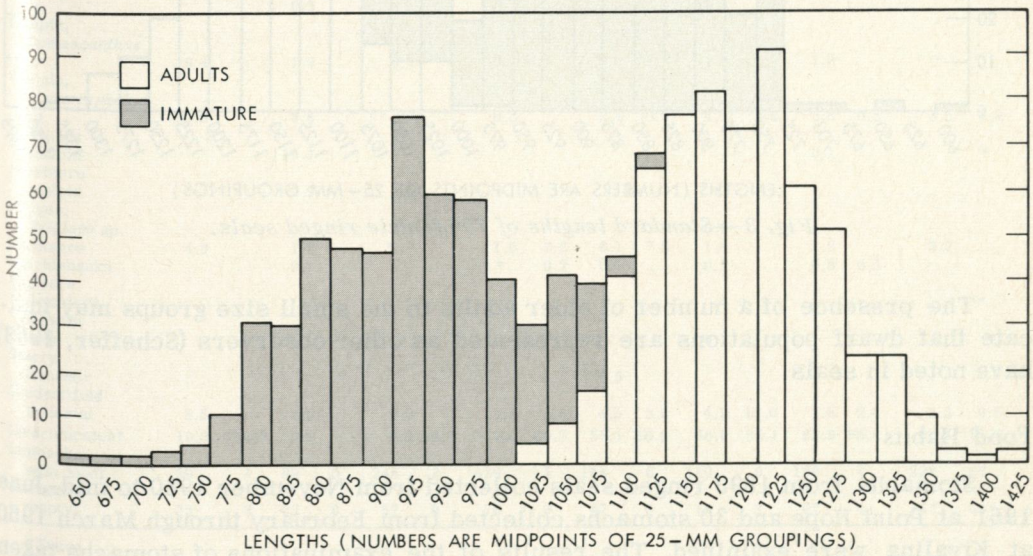

Fig. 2—Standard lengths of 1139 male ringed seals.

The lengths of 1139 male ringed seals (Fig. 2) ranged from 664 mm for a pup taken in June to 1433 mm for a large male taken in January. Lengths of 799 female ringed seals (Fig. 3) ranged from 602 mm for a pup taken in May to 1339 mm for a 15-year-old adult taken in June.

Pups measured less than 775 mm in length. Immature seals (i.e., those not yet in breeding condition) ranged to about 1100 mm. Adults were generally more than 1025 mm in length. Thus there was a zone of overlap in size between the immature and adult seals which would correspond roughly to the 5- to 7-year age

groups. The twin peaks shown in the graphs depicting the size distribution (Figs. 2 and 3) indicate relatively high populations in both immature and adult populations. Relatively fewer animals were represented in the transition group.

Males were longer than females in both the immature and adult groups. The peak of the sample of immature males was reached in the 925-mm group, and that of the females, in the 900-mm group. Also, there were twice as many females (20) as males (10) in the small immature 775-mm group. This larger size of the male was a little more evident in the adults. The peak of numbers came at the 1225-mm group for males as compared with the 1175-mm group for females. Relatively few females measured more than 1250 mm, but about a fourth of the adult males were larger than this.

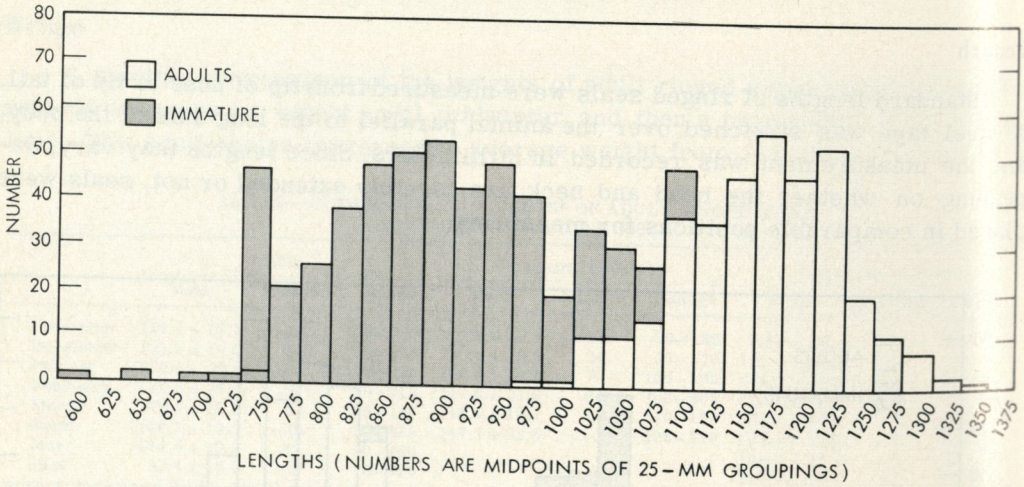

Fig. 3—Standard lengths of 799 female ringed seals.

The presence of a number of older adults in the small size groups may indicate that dwarf populations are represented as other observers (Scheffer, 1958) have noted in seals.

Food Habits

Stomachs from 1893 ringed seals collected from November 1960 to mid-June 1961 at Point Hope and 30 stomachs collected from February through March 1960 at Kivalina were examined. The results of the examinations of stomachs taken from seals at Point Hope are in Tables 7 and 8. Fishes and invertebrates found in stomachs of ringed and bearded seals are listed systematically in Tables 7 and 8. These data are combined to illustrate the differences in feeding habits between the two species. A list is included to show the taxonomic position of the food species and to give the scientific and common name when such is available.

The preserved stomach contents were washed into a sieve, and the excess fluid was allowed to drain off. The material was weighed, and the volume was measured by water displacement. The contents were then sorted by species where possible, and counts were made of each food item (actual number of larger species and estimated numbers of some of the smaller species). The percentage

of total volume of each food species in the stomach was calculated for the appropriate time span (Tables 7 and 8).

Identification to species was made whenever possible, but frequently the condition of the stomach contents did not permit this degree of accuracy. The frequency of occurrence and trace occurrence, the number of times dominant (50% or more), and the largest number of the particular food species counted in any one stomach were recorded and are on file at the University of Puget Sound.

Table 7 — PERCENTAGE OF TOTAL VOLUME OF FISHES FOUND IN STOMACHS OF RINGED SEALS (RS) AND BEARDED SEALS (BS), POINT HOPE, 1960–1961

	Month															
	November		December		January		February		March		April		May		June	
Species	RS	BS	RS	BS	RS	BS	RS	BS	RS	BS	RS	BS	RS	BS	RS	BS
Herring					*		*									
Salvelinus sp.															0.5	
Capelin					*						0.1					
Smelt											0.2					
Arctic cod	26.1	*	56.4		99.0	2.0	90.2	24.1	21.7		9.1		3.6		8.4	
Saffron cod	13.9		13.9		0.4		0.1		5.4		19.2		1.9		17.7	
Stickleback	0.2		*								0.3		*		0.1	
Sculpins, unspecified	2.8		*						0.3	*	2.9	*	0.8		0.2	*
Sculpin, *Artediellus* sp.			0.2				*				0.1					
Sculpin, *Gymnocanthus* sp.	0.4		1.9		0.1		0.1		0.8	1.9	1.0		1.2		*	
Sculpin, *Myoxocephalus* sp.	37.9		3.8				0.3		2.4	0.5	4.7	2.9	3.8	0.5	3.5	1.9
Fourhorn sculpin			10.7										0.1			*
Shorthorn sculpin			0.9													
Sculpin, *Triglops* sp.											0.1					
Sandlance	4.9		1.2		*		1.6	2.2	6.1	7.8	1.8		1.2		3.7	
Pricklebacks			0.1				*	0.2	0.1		0.1		0.5	0.5		
Righteye flounders									*							*
Yellowfin sole											0.1					
Starry flounder									0.6							
Unidentified material	3.5		1.3		0.3		0.7	4.8	4.5	3.2	4.2	12.0	1.6	2.4	3.3	6.5
Invertebrates†	10.3	100.0	9.6		0.2	98.0	7.0	68.7	58.1	86.6	56.0	85.1	83.9	96.6	62.5	91.6
Stomachs with food‡	30	1	99	0	248	2	439	4	168	6	119	9	100	4	229	87
Stomachs empty‡	33	2	23	0	57	0	76	0	47	0	16	3	67	4	142	42

*Trace
†Percent of total stomach contents that were invertebrates (from Table 8).
‡Also included in Table 8.

Throughout the collection area the ringed seal can probably reach the bottom. Depths of less than 10 fathoms can be found up to 2½ miles offshore in the Point Hope locality. In the vicinity of Cape Thompson, these depths extend out about 5 miles. Depths of 30 fathoms or more are found approximately 10 miles offshore in the Point Hope area. In the vicinity of Kivalina, depths of 20 fathoms or less are found up to 10 miles offshore. Open leads in the ice are irregularly present during the entire ice season; thus the seal may have a larger feeding range here than is possible in other parts of the Arctic. The shallow water in conjunction

with large open leads allows the seals to select from a wide variety of benthic, nektonic, and demersal food species.

The ringed seal apparently takes whatever food species are available. Few fish over 200 mm in length were found in the stomachs; the largest invertebrates present were shrimp *(Sclerocrangon boreas)* and crabs *(Hyas* sp.*)*. These findings may indicate a preference for the smaller species, but they are also the result of the greater abundance and availability of small fish. Ringed seals did not feed to any great degree on sedentary bottom dwellers as did bearded seals.

Table 8— PERCENTAGE OF TOTAL VOLUME OF INVERTEBRATES FOUND IN STOMACHS OF RINGED SEALS (RS) AND BEARDED SEALS (BS), POINT HOPE, 1960–1961

	Month															
	November		December		January		February		March		April		May		June	
Species*	RS	BS	RS	BS	RS	BS	RS	BS	RS	BS	RS	BS	RS	BS	RS	BS
Sponges																
Hydrozoa							†			1.1				†	3.0	6.4
Anthozoa												†		†		†
Sipunculida									0.1							
Priapulida												0.5				
Echiuroidea	2.0	4.8	0.4		0.1		0.1		0.9	†	0.5	0.5 †	4.5		0.4	0.7
Annelida							†						†		0.1	0.3
Crustacea, unspecified			0.3				0.3		1.3	1.3	1.1	1.6	1.4	18.3	4.7	1.5
Mysids	0.1		0.1		†		0.3		1.9	†	4.5		27.1	†	11.7	†
Cumacea							†								†	
Isopoda			0.7				†									1.1
Amphipoda	1.3		6.2		†		0.2		24.7	0.8	25.6	2.4	15.4		6.8	†
Euphausiacea	0.1						0.1		0.8		1.2		6.1		1.6	†
Decapoda, unspecified		20.0				8.3		5.3				8.2		22.6	1.6	2.7
Shrimp	6.8	60.0			0.1	85.2	6.0	51.8	27.4	24.5	23.0	51.7	29.4	26.8	28.2	12.6
Crabs, unspecified							†									0.6
Crabs, Brachyura		5.2				†	†	1.8	1.0	2.0		13.9		24.3	3.7	24.3
Crabs, Anomura		4.8				4.5	†	2.4	†	56.3	0.2	3.8	†		0.5	1.8
Sea spider													†			
Gastropoda								6.1				†		2.3	0.2	1.6
Tectibranchiata		5.2						1.3		0.6		1.8		2.3		0.2
Octopoda									†		†			†	†	
Clams												0.7			†	37.7
Echinodermata							†									
Tunicata					†									†	0.1	†
Milk													1.4			
Unidentified material‡	3.5		1.3		0.3		0.7	4.8	4.5	3.2	4.2	12.0	1.6	2.4	3.3	6.5
Fish§	86.2		89.1		99.5	2.0	92.3	26.5	38.6	10.2	39.7	2.9	13.1	1.0	34.1	1.9
Stomachs with food‡	30	1	99	0	248	2	439	4	168	6	119	9	100	4	229	87
Stomachs empty‡	33	2	23	0	57	0	76	0	47	0	16	3	67	4	142	42

*Common names are used when available.
†Trace.
‡Also included in Table 7.
§Percent of total stomach contents that were fish (from Table 7).

There appeared to be no significant differences in feeding habits between sexes. Feeding habits by year, class, or age group were not analyzed, nor was any attempt made to break down the food-habit studies to localities. Generally speaking, the food species found in stomachs of ringed seals from the Point Hope and Kivalina areas were similar. Both areas are much alike in regard to depth of water, but no information was available on water temperature, salinity, or currents.

Pebbles varying in size from 4 to 15 mm were found in stomachs of the ringed seal during all months of the study. Some of these undoubtedly were present in the stomachs of captured prey since most gadid stomachs contained some pebbles. Some might have been obtained accidentally in the pursuit of prey.

The contents of individual stomachs varied considerably. During December, January, and February, the arctic cod *(Boreogadus saida)* was frequently the only food species present. As many as 51 nearly complete cod were found in one stomach. Fragmentary and trace remains of 125 cod were found in another stomach. In the spring the gammarid amphipod *(Ampelisca* sp.) was frequently the only food species present, and as many as 1000 occurred in a single stomach. Commonly four to five species of shrimp occurred in one stomach. As an example of the variety of food, a well-filled stomach (310 cm^3) collected Apr. 21, 1961, contained: 7 small sand lance, 4 small sculpins (*Gymnocanthus* sp. and *Myoxocephalus* sp.), 1 saffron cod, 2 pricklebacks, 2 small (34 and 35 mm) yellowfin sole, 1 unidentified fish, 200 mysids, 100 amphipods, and 22 shrimp *(Pandalus* sp., *Pandalus goniurus, Argis* sp., and *Crangon dalli).*

Stomachs from seals taken in late spring often contained only one or two small fish (30 to 40 mm), a few mysids, or occasionally one or two shrimp. A single specimen of the shrimp *(Sclerocrangon boreas)* was sometimes the only food found in a stomach. These examples and the stomachs containing a large variety of food species are indicative of random feeding.

In stomachs containing food the average monthly volume was found to be:

Month	Volume of food, cm^3	Month	Volume of food, cm^3
November	75	March	96
December	116	April	88
January	264	May	72
February	149	June	35

The highest average volumes were obtained during the 3 months when cod was the predominant food species. The abrupt drop in volume in June may have been due in part to the inclusion of stomachs from young seals, which often contain relatively little food. Other factors involved in the decrease in volume are probably the approach of the molting (fasting) season and the migration northward.

The quantity and variety of the numerous food species changed during the months of the sampling, probably because of availability of food species although food preference could be a factor.

The major species in order of monthly importance were:

Month	Species	Remarks
November	Sculpins Arctic cod Saffron cod Shrimp	Approximately 90% of the volume of the stomach contents was fish
December	Arctic cod Sculpins Saffron cod Amphipods	More than 90% of the volume of the stomach contents was fish
January	Arctic cod	Represented 99% of the stomach contents

February	Arctic cod Shrimp	Arctic cod made up 90% of the volume of the stomach contents
March	Shrimp Amphipods Arctic cod Sand lance	Nearly 60% of the volume of the stomach contents was invertebrates
April (at Point Hope)	Shrimp Amphipods Saffron cod Arctic cod	Invertebrates made up 56% of the stomach contents
(at Kivalina)	Shrimp Crabs (Brachyura) Unidentified crustacea Sculpins	Invertebrates made up 87.2% of the stomach contents
May	Shrimp Mysids Amphipods Sculpins	Invertebrates made up 84% of the stomach contents
June	Shrimp Saffron cod Mysids Arctic cod	More than 62% of the volume of stomach contents was invertebrates; 56 different food species were identified from stomachs during this month

Fish formed a major part of the stomach contents from November through February, whereas invertebrates were dominant from March through June.

Seven food items were present during the entire collection period: Arctic cod was of major importance for November, December, January, February, and March. Saffron cod replaced the arctic cod in importance during April, May, and June. Although sand lance occurred in minor quantities at all times, it became an important food species in March. Echiuroids were of minor importance during most months but in May formed 4.5% of the total stomach volume. Most echiuroid remains were in such poor condition that specific identification was impossible; however, one echiuroid from the June collection was probably *Echiurus echiurus*. Mysids were of major importance in May and June. Mysids from two stomachs collected in June were tentatively identified as *Neomysis rayi*. Gammarid amphipods were of importance during the months of March, April, and May. One identified as *Ampelisca* sp. was a major food species in March and April. Shrimp (Carides) were of major importance in the collection from March through June. Eleven species from three families were identified. Members of the family Crangonidae were important food species in March, May, and June, and members of the family Pandalidae were important food species in April. Members of the family Hippolytidae were never found in important quantities.

A classification of fishes and invertebrates found in ringed and bearded seal stomachs is given here.

Classification of Fishes Found in Ringed and Bearded Seal Stomachs

Family Clupeidae—herring
Clupea harengus pallasi—Pacific herring
Family Salmonidae—trout, whitefish, grayling
Salvelinus sp.—trout, char

Family Osmeridae— smelt
Mallotus villosus— capelin
Osmerus dentex — arctic smelt
Family Gadidae
Boreogadus saida— arctic cod
Eleginus gracilis— saffron cod
Family Gasterosteidae
Pungitius pungitius— ninespine stickleback
Family Cottidae— sculpins
Artediellus sp.
Gymnocanthus sp.
Myoxocephalus sp.
Myoxocephalus quadricornis — fourhorn sculpin
Myoxocephalus scorpius — shorthorn sculpin
Triglops sp.
Family Ammodytidae
Ammodytes hexapterus— Pacific sand lance
Family Stichaeidae— prickleback
Stichaeus punctatus— Arctic shanny (identification uncertain)
Family Pleuronectidae— righteye flounder
Limanda aspera— yellowfin sole
Platichthys stellatus— starry flounder

Classification of Invertebrates Found in Ringed and Bearded Seal Stomachs

Porifera (Sponges)
Cnidaria
Class: Hydrozoa
Order: Hydroida
Suborder: Gymnoblastea
Genus: *Hydractinia**
Class: Anthozoa
Subclass: Alcyonaria
Sipunculida
Priapulida
Echiuroidea
Genus: *Echiurus*
Species: *echiurus**
Annelida
Class: Polychaeta (worms)
Hirudinea (leeches)
Arthropoda
Subphylum: Mandibulata
Class: Crustacea
Order: Copepoda
Subclass: Cirripedia (barnacles)
Order: Thoracica
Genus: *Balanus*
Subclass: Malacostraca
Order: Mysidacea
Genus: *Neomysis*
Species: *rayi*
Order: Cumacea
Order: Isopoda
Genus: *Mesidotea*
Order: Amphipoda
Suborder: Gammaridea
Family: Gammaridae
Genus: *Ampelisca*

*Identification probable.

Order: Euphausiacea
- Genus: *Euphausia*
  - Species: *pacifica**
  - *? Thysanoessa*
  - Species: *longipes**
  - *? Thysanopoda*

Order: Decapoda
- Suborder: Natantia (Macrura)
  - Tribe: Carides (shrimp)
    - Family: Hippolytidae
      - Genus: *Lebbeus*
        - Species: *groenlandicus*
          - *polaris**
        - *Heptacarpus*
        - Species: *tridens**
        - *Eualus*
        - Species: *fabricii**
          - *macrophthalmus**
          - *gaimardii belcheri**
        - *Spirontocaris*
        - Species: *kincaidii*
    - Family: Crangonidae
      - Genus: *Crangon*
        - Species: *dalli*
          - *septemspinosa**
        - *Argis*
        - Species: *crassa**
          - *dentata**
          - *lar**
          - *levior**
    - Family: Crangonidae
      - Genus: *Sclerocrangon*
        - Species: *boreas*
    - Family: Pandalidae
      - Genus: *Pandalus*
        - Species: *borealis*
          - *goniuras*
        - *Pandalopsis*
        - Species: *aleutica*
- Suborder: Reptantia (crabs)
  - Tribe: Brachyura
    - Family: Maiidae
      - Genus: *Chionoecetes*
        - Species: *bairdi*, *opilio* (tanner crabs)
        - *Hyas*
        - Species: *coarctatus alutaceus*
          - *lyratus*
    - Family: Atelecyclidae
      - Genus: *Telmessus*
        - Species: *cheirogonus* (hairy crab)
        - *Erimacrus*
        - Species: *isenbeckii* (hairy crab)
  - Tribe: Anomura
    - Family: Lithodidae
      - Genus: *Hapalogaster*
        - *Placetron**

*Identification probable.

Family: Paguridae
Genus: *Pagurus*
Species: *capillatus** } (hermit crabs)
brandti
splendescens
Subphylum: Pycnogonida (sea spider)
Mollusca
Class: Amphineura (chiton)
Class: Gastropoda
Subclass: Prosobranchia (snails)
Family: Buccinidae
Genus: *Buccinum*
Fusitriton
Species: *oregonensis*
Family: Naticidae
Genus: *Natica*
Species: *clausa**
Polinices
Family: Lamellariidae
Genus: *Velutina*
Species: *velutina**
Family: Muricidae
Genus: *Boreotrophon**
Family: Turridae
Genus: *Oenopota**
Subclass: Euthyneura
Order: Opistobranchia
Suborder: Tectibranchiata
Suborder: Nudibranchiata (sea slug)
Class: Cephalopoda
Order: Dibranchia
Suborder: Octopoda
Class: Pelecypoda (clams)
Order: Teleodesmacea
Suborder: Diogenodonta
Family: Astartidae
Genus: *Astarte*
Suborder: Asthenodonta
Family: Hiatellidae
Genus: *Hiatella**
Echinodermata
Class: Holothuroidea* (sea cucumbers)
Tunicata
Genus: *?Boltenia*

*Identification probable.

Reproduction

MALES The materials and methods described on the pages that follow were used in the study of reproduction in male ringed seals. The size and weight of the testes in the fresh state were determined although in small testes only the weight was recorded. The testes were then preserved in formalin. Approximately 650 microscopic sections have been prepared, mostly of adult specimens, although a generous number of samples from immature specimens have also been included. Each section contains a portion of the epididymis. The sections were examined for evidence of spermatogenesis and for sperm in the epididymis. The

baculum *(os penis)* was obtained from each specimen, and the flesh was removed by boiling. Weights and lengths have been determined on 1056 specimens (Fig. 4). These data have been plotted against the time of year and age. Several samples of animals were aged by dental annuli.

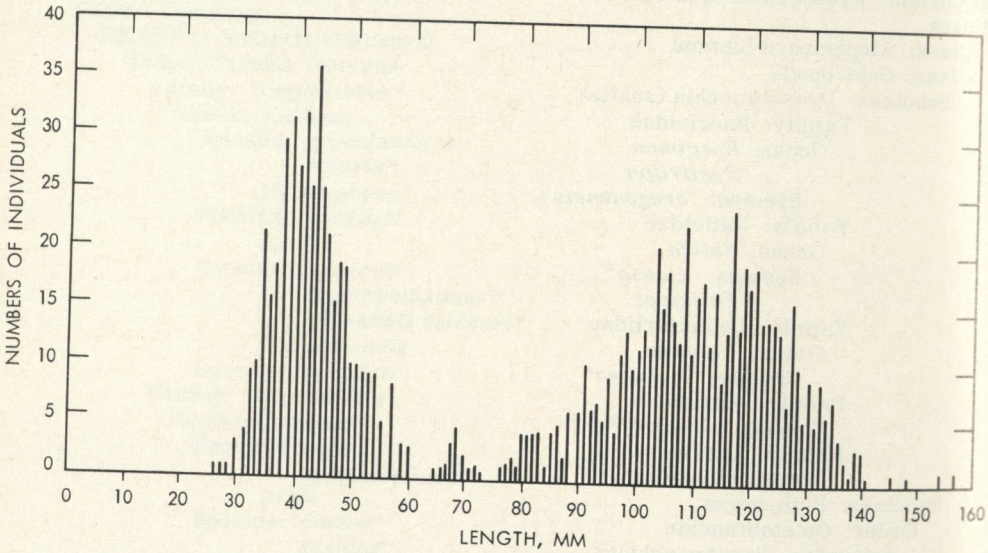

Fig. 4—Length distribution in 1056 bacula of Pusa hispida *(ringed seals).*

With these data we have attempted to understand the sexual development and activity of the male ringed seals during the months of their presence in the Cape Thompson area. We believe that completing the sampling and subjecting our data to further analysis will tend to verify the conclusions stated below. The works of McLaren (1958) have been used by us with appreciation.

Microscopic examination of the testis was considered the most accurate method of determining sexual activity. The appearance of the immature specimen, including the epididymis, was characteristic. The small 2- to 4-g testis was universally found in the 2-, 3-, and 4-year groups (Table 9). A slight increase in size was seen in the fifth year, and a moderate increase (to 9 g, average 5.9 g) was seen in the sixth year. A spurt of growth was noted in the seventh year; the testis averaged 16.2 g, the size ranging from the immature 3 g to a fully mature 37 g. Spermatogenesis was well correlated with this increase in size; none was seen in testes below 20 g. Residual sperm in the epididymis were seen, however, in one 14-g testis taken June 12. The testis itself showed an extreme degree of degeneration with no suggestion of spermatogenesis.

The testes in our samples were all immature through the sixth year. Abruptly in the seventh year most of those examined beyond March showed spermatogenesis and much sperm in the epididymis. Beyond the eighth year sperm was found in an increasing number of specimens in the epididymis during the months of December and January, the most active spermatogenesis occurring during January, February, March, April, and May. The most potent males, as indicated by the epididymides packed with sperm, were found in March, April, and early May. An

increase in testis size was apparent during the active breeding months. The weight in grams may be converted into measurements in millimeters (including the epididymis) by the following representative figures: 4 g is 30 by 15 mm; 14 g is 40 by 22 mm; 20 g is 50 by 25 mm; and 40 g is 58 by 36 mm. Most of the testes of breeding animals were approximately 25 to 45 g although one unusual specimen weighed 71 g.

Table 9—RELATION OF THE WEIGHT OF TESTES (INCLUDING EPIDIDYMIDES) TO WEIGHT AND LENGTH OF BACULA IN VARIOUS AGE GROUPS OF RINGED SEAL

Age Group	Number of Specimens	Testis weights, g		Baculum weights, g		Baculum lengths, mm	
		Range	Mean	Range	Mean	Range	Mean
2 year	30	1.9–4.0	2.6	0.10–0.22	0.15	31–44	34.2
3 year	17	2.0–4.0	2.9	0.19–0.58	0.32	38–52	40.7
4 year	11	2.0–4.0	2.9	0.15–0.78	0.26	34–57	42.3
5 year	12	3.0–5.0	3.9	0.33–0.74	0.55	41–62	45.6
6 year	8	5.0–9.0	5.9	0.46–3.81	1.56	48–90	62.0
7 year	16	3.0–37	16.2	0.96–5.62	3.13	51–96	75.2
8 year	16	6.0–46	23.6	1.68–9.26	5.44	63–107	89.1
9 year	21	13.0–43	23.4	3.38–13.63	7.33	80–120	99.1
10 to 11 year	91	13.0–62	30.6	3.25–14.24	7.38	87–127	102.6
12 to 15 year	142	10.0–66	32.3	4.03–20.20	9.02	80–140	107.6
16 to 19 year	83	16.0–50	30.5	6.83–19.65	12.02	98–135	115.9
Over 20 year	48	14.0–71	33.7	6.47–21.20	13.30	101–152	124.0

The baculum is a good indicator of relative age (Table 9). According to our data there is a continuous growth of the bone throughout life, which is reflected by the weight and length. The largest percentage of growth is between the fifth and eighth years. Evidence of further growing, however, was made clear by the more than doubling in weight between the 8- and the 16- to 19-year group and an increase by a third of the average length after the 8-year group.

Figure 4 illustrates the relative age makeup of the entire population of 1056 males. The large numbers of immature and adult seals were widely separated by relatively few in the transitional size, which indicates a rapid period of growth of the baculum as maturity is achieved. The factors of availability and selectivity of hunter success must be considered in interpreting these data, but we do not believe them to be of great consequence here.

Three conclusions may be drawn regarding the sexual activity of the male ringed seal. Maturity is obtained in the seventh year. There appears to be some breeding potential in the older age groups in each of the winter and spring months, but the prime season is March, April, and May, which corresponds to the parturition dates of late March and early April. There is a striking loss of breeding potential after the first part of June.

FEMALES Maturing of the female seal was indicated by signs of ovulation. The most striking and easily recognized evidence of ovulation was the formation of the corpus luteum. If pregnancy did not occur, the corpus luteum was small and disappeared gradually. During pregnancy the corpus luteum persisted until delivery. Corpora lutea undergo cellular degeneration into corpora albicantia, which may be identifiable in the ringed seal for several years. Determinations were made by

macroscopic examination of serially sliced ovaries; microscopic examination confirmed the gross appearance when necessary.

In the ringed seal the pregnancy was usually in the uterine horn on the side of the corpus luteum. It is quite well established that delayed implantation occurs, but we did not examine our specimens for blastocysts.

Table 10—PERCENTAGE OF PREGNANCY IN ADULT FEMALE RINGED SEALS COLLECTED BETWEEN NOV. 17, 1960 AND APR. 8, 1961

Month	Number pregnant	Number of adults	Percentage pregnant
November	19	17	89.5
December	34	27	79.4
January	92	79	85.9
February	111	98	88.3
March	21	17	81.0
April (to April 8)	3	2	66.7
Total	280	240	85.7

Table 11—DEVELOPMENT OF CORPORA LUTEA IN PREGNANT RINGED SEAL, NOV. 25 TO APR. 8, 1961

Month	Length × width		Mean
	Range, mm	Mean, mm	(length + width)
November	(9–16 × 5–9)	12.1 × 6.9	19
December	(11–17 × 7–15)	13.8 × 9.9	23.7
January	(8–19 × 6–16)	14.3 × 10.6	24.9
February	(11–20 × 8–16)	15.3 × 10.7	26
March	(12–16 × 10–13)	14.8 × 11.5	26.3
April	(16–19 × 7–14)	17.5 × 10.5	28

A high percentage of adult ringed seals were found pregnant (Table 10). Approximately 14% of the mature females, however, either had not conceived (missed pregnancy) or had aborted. In several cases where an abortion was fairly definite, there appeared to be a rapid regression of the corpus luteum into a large corpus albicans.

Table 11 shows the development of corpora lutea in pregnant seals between November 25 and April 8. Length increased from 12.1 mm in November to 17.5 mm in April, which is an average increase of 0.9 mm per month. The mean width increased from 6.9 mm in November to 10.5 mm in April, which is an average increase of 0.6 mm per month. If the sum of the length and width is taken for each month, an average increase of 1.5 mm per month in each corpus luteum is seen.

Follicle activity appeared to increase gradually from November. At this time the largest follicles in the ovary with the corpus luteum were 4.1 mm and in the opposite ovary were 5.4 mm. In April the follicles in the ovaries with corpora lutea measured 7 mm and in the ovaries without, 9 mm. An average increase of 0.5 mm per month occurred. In nearly all cases the ovary lacking the corpus luteum had the larger follicles.

SUMMARY OF REPRODUCTIVE STATUS BY AGE GROUP Ovaries were examined for: (1) follicular development, (2) corpora lutea size and condition (whether proliferating, mature, or regressing), and (3) corpora albicantia size and type (line, stellate, oval, or amorphous).

The ovaries from seals ranging in age from 4 to 10 years were particularly examined to determine the age at which sexual maturity occurred. Adult animals are those that have ovulated and have a corpus luteum or corpus albicans. No differentiation of adolescents was made in this study.

Fourth Year. In the 4-year group, each of the 14 specimens was immature. Only two (14%) showed any increased follicular activity. No follicles measured more than 1 mm in diameter.

Fifth Year. The 5-year group was composed of 12 animals. Eleven (92%) were classified as immature. One individual killed on January 11 had ovulated and was supporting a 9- by 9-mm corpus luteum in her left ovary. Both ovaries contained developing follicles. The right ovary had five follicles in the 3- to 4-mm range; the left had seven. The largest follicles were in the left ovary and measured 4 mm in diameter. Another on June 2 was supporting a large follicle (13 by 7 mm) in its left ovary. It is not known whether this follicle was involuting. If not, then a late ovulation would probably miss fertilization.

Sixth Year. Ten seals made up the 6-year group. Six (60%) were classified as adults. They had ovulated and were supporting corpora lutea. Specimen M1610, killed May 28, supported a large (12 by 8 mm), compact, and presumably active corpus luteum in its left ovary. The right ovary contained a corpus albicans measuring 6 by 3.5 mm. This indicates a previous ovulation in the fifth year. It is possible that at the time of death the seal was carrying an unimplanted blastocyst (as indicated by the functioning corpus luteum). Specimen M1770, killed June 3, had in its right ovary a newly formed corpus luteum 8.5 by 7 mm. Blood was still present in the antrum of the former follicle; this suggests that the ovulation had been very recent. The left ovary contained a 4-mm corpus albicans, which indicates, as in M1610, that ovulation had first occurred during the fifth year. The four remaining adults had all apparently ovulated only one time. They were killed December 20, January 15, May 21, and June 6. The December and January specimens held regressing corpora lutea 6.5 by 5 mm and 8 by 6 mm. The May specimen had a corpus hemorrhagicum in its right ovary 8 by 7 mm in diameter, and the June individual supported a recent but a regressing corpus luteum measuring 9 by 5 mm. This indicates ovulations for the first time in the sixth year. The five juveniles all showed mild follicular development.

Seventh Year. Nine animals made up the 7-year group. Five (55%) were adults. Pregnancies first occurred in this age group; three of the five adults were carrying fetuses. Of the three pregnant seals, two were killed in late January; the third was killed early in February. All fetuses were developing normally. The corpora lutea of pregnancy measured 15 by 11 mm, 13 by 10 mm, and 14.5 by 10 mm, and all appeared to be functioning normally. Two of the three pregnant adults carried one corpus albicans each. All showed high follicular activity in both ovaries, the largest follicles ranging from 3.5 to 9 mm. The two nonpregnant adults apparently had ovulated only once. Specimen M196, killed on December 22, carried a corpus albicans in the right ovary and a large 7.5-mm follicle in the left. Specimen M1322, killed on April 1, carried a regressing 7- by 6.2-mm corpus luteum; this suggests a very late ovulation in the breeding season of

the past year. There were no corpora albicantia visible in either of these last two seals. The four juveniles showed mild follicular development, but no follicles measured more than 4 mm.

Eigth Year. Fourteen seals made up the 8-year series. Of these, 13 (93%) were classified as adults. The juvenile had mild follicular activity but nothing else. It was killed January 17. There were seven adult seals representing the time between December 29 and April 8. Only three of the seven contained fetuses. Of the four remaining, only one had a corpus luteum. It was killed February 21, and the corpus luteum (7 by 5 mm) was regressing. The three without corpora lutea all contained fairly large corpora albicantia (5 by 3, 3 by 3, and 3 by 3 mm), which suggests ovulations in the past season but failure of fertilization. An average of two corpora albicantia per seal was found in the three pregnant seals. Corpora albicantia occurred in five of the six ovaries. In the nonpregnant seals only 0.75 corpus albicans per seal was recorded. The three pregnant adults had corpora lutea of comparable sizes (14 by 8, 12 by 10, and 13 by 9 mm). Folliculation was active in all three, the largest follicles ranging in size from 5 to 8.5 mm. Follicular activity in the nonpregnant seals was less, the largest ranging from 1 to 6 mm in diameter. Six adults were taken between April 8 and June 28. All but one had corpora lutea. That one had a corpus albicans (5.5 by 4.5 mm) in the right ovary. The left ovary was lost. Examination of the corpora lutea suggested that not all were pregnant. Specimen M1459, killed on April 29, had a degenerate corpus luteum in its left ovary (the corpus had almost reached the albicans stage). Ovulation was suggested by the presence of a large follicle in the right ovary. The remaining four seals had recent and active corpora lutea with an average size of 9.5 by 7.2 mm. This would indicate probable pregnancies; securing the blastocysts would be the only means of confirmation. Corpora albicantia occurred in four of the six seals examined; the two without contained questionable scar tissue.

Ninth Year. There were 20 specimens in the 9-year group. All were adults, and eleven were pregnant. There was an average of 1.8 corpora albicantia per seal in this pregnant group. The largest follicles ranged between 2 and 8.5 mm. The nonpregnant animals up to April 8 numbered five. Three of the five had corpora lutea. Of the two remaining, M303 had one ovary lost, and M268 had a large corpus albicans (4 by 3 mm). The corpora lutea in the three nonpregnant seals measured, respectively, 6 by 5.5 mm (November 29), 9.5 by 5 mm (January 15), and 7 by 5.5 mm (January 16). All corpora lutea were regressing. Recent abortions might have occurred in the seals killed January 15 and 16. The size of the corpora lutea and the late date suggest this possibility. The four remaining 9 year olds collected between April 8 and June 27 all supported very active corpora lutea with an average size of 10 by 7 mm. All contained more than one corpus albicans. Follicular activity was low in comparison with the prepartum period of high activity.

Tenth Year. Eighteen seals composed the 10-year group. All were mature. The group taken between November and April was made up of seven pregnant and two nonpregnant animals. Specimen M181, collected on December 19, was not

visibly pregnant and had an unusually large (10.5 by 7 mm) corpus luteum. An early abortion or a late ovulation is suggested. Specimen M585, collected on February 7, had no corpus luteum but several corpora albicantia. The mean corpus-luteum size in this group was 12 by 10 mm. The only twins recorded in the entire study were taken from a 10 year old, M615, on February 7. The fetuses were in both horns, and both ovaries contained corpora lutea. That on the right measured 17 by 11 mm, and that on the left, 15 by 5 mm. This suggests that ovulation had occurred nearly simultaneously in both ovaries.

Nine seals composed the group between April 8 and June 28. All but one contained corpora lutea. A date centering between May 15 and May 21 is suggested here as the approximate time when ovulation occurred. Specimen M1541, killed on May 19, supported a 2- by 2-mm corpus hemorrhagicum, and M1555, taken on May 21, held a recent corpus luteum measuring 8 by 7 mm.

The corpora albicantia averaged 1.5 per seal. The average size of the corpora lutea in this group was 10.9 by 7.4 mm. All appeared normal and functional.

The seal without the corpus luteum supported a large (11 by 3.5 mm) corpus albicans. It was collected June 18. It is probable that this specimen had been pregnant and that the corpus was that of the pregnancy. The large size of the corpora albicantia in many of the nonpregnant animals indicates probably that after parturition the size of the corpus is not affected as much as are the luteal cells. Several of the corpora albicantia compared in size to functional or regressing corpora lutea except that the luteal cells had lost their characteristic yellow color.

Eleventh Year. Twenty specimens made up the 11-year group. Fourteen were collected between November and April 8, and thirteen of them were pregnant. The nonpregnant seal supported a 6- by 6-mm corpus luteum; there were four corpora albicantia in the two ovaries. Six seals of this age were collected between April 8 and June 27. Five had corpora lutea. Specimens M1419 and M1452, collected on April 19 and 21, respectively, had regressing corpora lutea (10 by 8 mm and 7 by 5.5 mm). Specimens M2041 and M2098, collected on June 17 and 19, respectively, were supporting active corpora lutea (14 by 7 and 10 by 4 mm). The animal lacking a corpus luteum was collected on April 21 and had a large (4 by 3 mm) corpus albicans.

Twelfth Year Plus. An analysis of specimens in the 12^+-year group showed a pregnancy rate of approximately 85%, and the same general pattern of ovarian activity prevailed. In several of the very old (20^+ years) seals, ovaries occurred with little or no follicular activity. These were classified as senile. The exact ages at which the cessation of follicular activity occurs is difficult to determine with the present aging techniques.

The most abnormal ovaries were from a 20^+ year old, M200, collected on December 22. The left ovary contained one corpus albicans 5 by 4 mm in diameter; two large (5+ mm) follicles, the largest being 10.5 by 6 mm; two follicles in the 3 to 5 mm range; and four follicles in the 1 to 3 mm range. Also contained in the left ovary were two corpora lutea measuring 12 by 11 mm and 5 by 4 mm. The right ovary showed similar activity with three corpora albicantia (11 by 11, 5 by 5, and 3-mm line scar); two large 5^+-mm follicles, the largest being 10 by

6 mm; and two 1- to 3-mm follicles. In addition, the ovary supported a 6.5- by 4-mm corpus luteum.

REPRODUCTIVE CYCLE There was a striking conformity of the reproductive cycle in the population of ringed seals examined. In 1960 on April 8, we attempted to secure fresh specimens of "unborn young." We had seen many frozen specimens secured and held by the Eskimos prior to this, but not a single fetus was brought in after this date. Likewise in 1961, April 8 was the last date on which a pregnant female was taken.

PUPPING LAIRS There was a large population of pregnant females in the Cape Thompson area and no reason to suggest that they went elsewhere to pup. The Eskimos tell of pupping lairs rarely discovered—snow houses with a breathing hole in the ice. These are usually found where sea ice is piled up and irregular. None were reported during our studies. We were informed that occasionally, with proper conditions for travel on the melting spring ice, many fallen-in birth lairs can be found where it would have been impossible to discover them before the melting of the ice.

An examination was made of considerable sea-ice structure. There is much honeycombing and opportunity for large air spaces throughout the massive jumbles of rough ice, and it is possible that suitable pupping spots are abundant over wide areas near Cape Thompson.

MATING Mating usually takes place within the first month after parturition. The males were potent primarily before the end of March, as evidenced by our finding epididymides packed with sperm at that time. Pregnant females disappeared the last of March and first of April. The males remained potent until the first part of June, according to the microscopic appearance of the testes and epididymides. The corpus luteum of pregnancy regressed rapidly, and by about May 20 the new corpora lutea were found. This indicates that in most females ovulation (and presumably fertilization) had occurred before this date.

IMPLANTATION The fertilized ovum develops to the blastocyst stage and then is arrested for a period of about $3\frac{1}{2}$ months (McLaren, 1958b). Implantation then occurs, and the development of the fetus begins. McLaren notes that he found the smallest fetus in mid-August, and he suggests that this had been implanted 1 to 2 weeks earlier.

We found no abnormal implantations in the Cape Thompson area, but a unique specimen, M2217, was sent to us from Barrow. This was an apparent abdominal pregnancy in which death of the fetus occurred at a late stage of development. This specimen was brought in to Gary J. Brusca on May 5, 1962, by Daniel and Clyde Okomailuk and Billy Ahlalook. It consisted of a 7-lb fetus, 24.5 in. long, lying in a thickened amniotic sac free in the peritoneal cavity. Inflammation with dilated vessels over the kidneys, swelling of the organs, and considerable peritoneal fluid was described grossly in the well-nourished female. There was extensive slippage and accumulations of lanugo hair. Microscopic examinations of several tissues showed recognizable structure with loss of cellular detail. The cyst wall contained considerable calcium; this was a beginning lithopedion. We judge this to be an excessively rare phenomenon in pinnipeds

because of the presence of a tentorium around the ovary, which probably restricts movement of the ovum. Implantation is usually on the same side as the ovulation.

DEVELOPMENT OF FETUS Observations were made on 240 fetuses of the ringed seal collected at Point Hope (a few from Kivalina) in 1960-1961. The sex ratio was approximately equal: 113 males (49.14%) and 117 females (50.86%). No disparity of size of the fetuses was noted between the sexes.

The fetuses in November and early December varied from 173 to 287 mm in length and from 245 to 896 g in weight. In March and early April, the specimens varied from 512 to 660 mm in length and from 3.4 to 4.5 kg in weight.

No body hair except vibrissae and eyebrows was found on M49, collected on November 25. On the following day, however, a fetus with hair extending from the nose to the dorsum of the head was taken. On November 29 a fetus had hair extending from the nose to the scapular region. The mid-dorsal hair was 2 mm in maximum length. There is a progressive covering of the fetus with this lanugo hair, which is pure white and wooly and measures in the mid-dorsal area up to 50 mm in length. This fetus is the "unborn seal" used by the Eskimos for items of clothing. McLaren (1958b) substantiates other workers in stating that in the eastern Arctic the fetal coat begins to shed about 2 weeks after birth. We found that several of the fetuses obtained in late March and early April showed the darkening of the skin beginning the juvenile molt. There is a great tendency for the hairs of these late fetuses to be shed.

More than 50 fetus skulls were prepared for study. These showed the milk teeth to resorb completely before birth.

On May 17 and 21 two young-of-the-year weighed, respectively, 16 and 18 lb. These weights suggest a doubling in weight during the nursing period. The lengths were 640 and 602 mm, respectively, which indicates little increase in length. The blubber thickness, however, increased from a probable 4 mm thickness at birth to 11 mm.

According to McLaren (1958b), weaning takes place before or at the time of ice breakup. Lactation was found definitely in only two females, one on April 30 and the other on May 7. An interesting phenomenon was found on May 21, when a 44-lb male, judged to be a yearling, was taken with milk in its stomach.

Distribution and Migration

The essential general distribution of the ringed seal is polar and is limited more or less by the distribution of the ice. It is found in several land-locked lakes in Europe and North America. In the Bering Sea it extends as far south as St. Michael and Bristol Bay; on the Asiatic side this species extends to Hokkaido and the Sea of Okhotsk (Scheffer, 1958).

As with some other marine mammals, migration is not complete since a few individuals are regularly obtained in Bering Sea localities during the ice-free months. The relation of the population to the south on the Asiatic side is not clear at this time. If the movement of this population in the Bering Sea is similar to that on the Alaskan side, we must assume that it also migrates into the Arctic for the summer months. The seals in the Sea of Okhotsk, however, apparently remain

here (Tikhomirov, 1961) and thus are analogous to populations of some other species of marine mammals, such as the gray whale and the bowhead whale, which complete their northward migration in the Sea of Okhotsk.

The Cape Thompson area is ideal for studying migratory phenomena of the ringed seal because of the large harvest there. Definite migration is evident; in the ice-free months there are no seals present. With the formation of ice in November (occasionally in October), seals are suddenly present, and they persist through June. Again in late June or July, there is a dramatic disappearance of seals until the next cycle is repeated. We have similar reports from other villages of the Arctic and Bering Sea; there appears to be little doubt that a mass migration of great numbers and over many hundreds of miles is the usual seasonal occurrence. It is likely that this large Bering Sea winter population is a direct southward migration of the summer arctic seals.

There are, in addition to the general migration, movements of populations. Table 2 shows the large differences in the makeup of the ringed seal harvest month by month and in shifts of adults compared to immatures and males to females. Whether or not this is a usual phenomenon every year we do not know. Certainly the great preponderance of immature specimens in the month of June is usual; these individuals are known as "spring seals" by the Eskimos. A studied examination of the catch during the ice months gives us the definite feeling that, although there may be static populations in the Cape Thompson area, there is a dynamic flow of seal groups. This is equalled by the ebb and flow of the ice, with its open leads, frozen packs, and drifting, moving ice fields. We believe that only by considerable long-term research on the seal populations and by correlation with oceanographic and meteorologic winter data will these phenomena be properly understood.

BIOLOGY OF THE BEARDED SEAL

Age and Sex Distribution by Month

Age determination is difficult in the bearded seal. The only recommended method for establishing age groups by year is to examine the claws for annual banding (McLaren, 1958a). Although our data tend to support this hypothesis, we do not consider the reliability satisfactory enough at the present time. Refinements of this or other methods should be made and are being investigated.

For our purposes we are classifying the bearded seal only as immature and adult. One hundred and seventy-three specimens had sufficient data for classification. In the female the criterion for determining adults was the formation of a corpus luteum or corpus albicans in the ovary. In the male the criterion was evidence of spermatogenesis in the testis and the size of the baculum. The general length and body weight were correlated with evidence of sexual activity (Table 12).

The bearded seal is usually absent from the general Cape Thompson area during the ice-free months. Occasional immature individuals are taken in the lower reaches of the Kukpuk River in the fall. We believe the fluctuations in abundance are primarily part of the mass migration with the ice edge. As with

Table 12—SUMMARY OF GROWTH OF TOTAL LENGTH, LENGTH OF BACULUM, AND WEIGHT OF TESTES OF 68 SPECIMENS OF BEARDED SEAL

Length of body, mm	Number of specimens	Weight of testis, g		No. of specimens* with indicated length of baculum, mm			
		Average	Extreme	<50 mm	50–74 mm	75–99 mm	100–151 mm
<1300	1	4		1			
1300–1399	0						
1400–1499	4	5.8	4–7	4			
1500–1599	5	7.6	5–13	4	1		
1600–1699	8	6.6	4–13	5	3		
1700–1799	6	16.8	12–23		6		
1800–1899	6	16.7	11–23	1	4		
1900–1999	4	19.5	13–29		2	2	
2000–2099	9	45.7	22–89			3	5
2100–2199	14	47.4	19–93			3	10
2200–2299	10	57.1	34–75			1	9
2300–2399	1	67					1

*Discrepancies in totals are due to lack of parts.

walrus and beluga, there are apparently residual populations to the south although concentrations of bearded seal are not found except during migration.

Table 1 shows the hunters' take during the winter of 1960-1961. The ugruk (bearded seal) is always a desirable catch, and hunters go to considerable effort to secure one; thus, the table probably represents rather accurately the relative abundance during the winter and spring. Shot animals tend to sink even in midwinter; so the loss ratio is probably greater than that for the ringed seal. The Eskimos state that pregnant females are likely to float. This may give the bias noted on Table 2 (for adult females over adult males) in the small series available. Immature seals make up the larger proportion in the winter months; the entire catch of this species is, however, spotty until June. At this time there is an almost two for one preponderance of adult females over adult males and a definite preponderance of adults over immature specimens.

Size and Growth

Two specimens indicate the size at birth. A male fetus (MLJ4075) at term on Apr. 21, 1960, weighed 74 lb and was 1310 mm long. A male pup (M1474) taken May 4, 1961, weighed 67 lb and was 1275 mm in length.

The sizes of the adults were approximately equal. A sample of 20 consecutive adult males and 20 consecutive adult females taken June 17 to 19, 1961, showed an approximate 4% greater total length in the females. They ranged from 2000 to 2370 mm, the average length being 2224.6 mm. The males ranged from 1982 to 2330 mm and averaged 2160.4 mm in total length. It was not possible to secure weights on the larger animals; one female (M1374) weighed 793 lb, with no allowance for blood and body fluids spilled.

Food Habits

The stomachs from 164 bearded seals collected from the middle of November 1960 to the middle of June 1961 at Point Hope and from 29 bearded seals collected in February, April, and June 1960 at Kivalina were available for comparative examination. The results of the examination appear in Tables 7 and 8. The

classification list of fishes and invertebrates that were found in stomachs of ringed and bearded seals shows the species that were identified. A description of the collection area and laboratory methods is included in the section on ringed seal.

The bearded seals apparently could reach the bottom to feed and had the same opportunities for obtaining food that the ringed seals had; however, they fed on the slower moving and sedentary food species.

There appeared to be no significant difference in feeding habits between sexes. An analysis of feeding habits by year class, age group, or locality was not made. There is undoubtedly local variation in food species taken because of the bearded seal habit of feeding on sedentary bottom dwellers whose distribution over the ocean floor is irregular. There were no significant differences between the food species found in stomachs from Point Hope or Kivalina.

More than 50% of the bearded seal stomachs examined contained pebbles (up to 30 mm), sand, or gravel; and in one instance mud was found. Stomachs contained the largest amounts of this material in June when the seals were feeding extensively on clams. More than half the stomach contents of one specimen was sand and gravel. The high incidence of inorganic matter in bearded seal stomachs was to be expected in animals that feed to a great extent on bottom-dwelling forms.

The stomach contents of individual seals exhibited greater variety than did those of the ringed seals. Only a few stomachs were examined in which the contents consisted entirely of one food species. Although there were only six stomachs collected during December, January, and February, the bearded seals, presumably having the same opportunities as the ringed seals, failed to take arctic cod in appreciable amounts. This could be an indication of food preference. Food preference was possibly indicated again in June when clams formed a large part of the diet.

Variety in the contents of a bearded seal stomach was illustrated by a stomach collected Mar. 11, 1961. The stomach contained 5 sand lance (*Ammodytes hexapterus*), 12 shrimp (*Crangonidae*), 8 shrimp (*Sclerocrangon boreas*), 2 shrimp (*Lebbeus groenlandicus*), 1 crab (*Brachyura*), and 11 hermit crabs (*Paguru brandti*). Apparently the seal took whatever he could find on the bottom and on his way to and from the bottom.

Although the sample size was small for some months, it would appear that the average volume of stomach contents reached a peak in February and then gradually dropped until the end of the study period in June. No abrupt drop in volume comparable to that observed in the ringed seal during this same period was apparent.

Changes occurred in numbers and variety of food species during the collection period. These changes might be due to several factors, including availability, abundance, and preference. An indication of availability might be interpreted by the sudden appearance in stomachs in June of large numbers of clams (*Pelecypoda*). One possible explanation for this could have been a shift in the ice or the opening of a lead, making available clam beds that had not previously been open to the seals. Seasonal changes in the abundance of the various food species also

occurred. The percentages of the total volume of major food species by month are

November: shrimp, 60%
January: shrimp, 85%
February: shrimp, 52%; arctic cod, 24%
March: hermit crabs, 56%; shrimp, 25%
April: shrimp, 51%; crabs (Brachyura), 14%
May: shrimp, 27%; crabs, 24%; unidentified decapods, 23%
June: clams, 38%; crabs, 24%; and shrimp, 13%

Fish were of relatively minor importance as food for the bearded seals. As would be expected in a bottom-feeding animal, the few fish that were present were primarily benthic types. In February, the only month when an appreciable amount of fish was present in the stomachs, arctic cod formed 24% of the total stomach volume. In contrast, arctic cod at this same time formed 90% of the total stomach volume of the ringed seal.

Shrimp were of major importance in the diet of the bearded seals throughout the study period. The families Hippolytidae and Crangonidae were present in all months. Shrimp of the family Pandalidae were present in the collection during all months but November, when only one stomach was collected. The large shrimp *(Sclerocrangon boreas)* was identified in more stomachs than any other species. *Lebbeus groenlandicus* was identified in six of the seven collection months. *Argis lar* was identified in five of the seven months. *Pandalus goniurus* appeared in four monthly collections. Nine species of shrimp were identified from stomachs of bearded seals.

Hermit crabs were present in collections from all months. In March, when they formed 56% of the total stomach volume, they were found in three of the six stomachs collected. Crabs were well represented in the collection; they formed major parts of the food species in April, May, and June. However, in most instances only the abdomens appeared in the stomachs. An unidentifiable species of gastropod was present in two stomachs collected in June. No shells were found, but 171 operculums were counted in one stomach. Unidentified clams were major food species in June and were found in 35 stomachs. In one individual 183 clams were counted. No shells were present in any of the stomachs; clam feet and siphons were the countable parts present.

Many other species were identified one or more times in the collection, but their occurrence here is thought to be accidental. Hydractinia colonies were present on shells. The large amount of sponge (Porifera) in the June collection is of interest. From the amount taken, almost 2000 cm^3 in six stomachs, it would appear that the sponges were taken deliberately rather than accidentally. Leeches (Hirudinea) were identified in four stomachs. MacGinitie (1955) mentions that the only species of leech he obtained at Point Barrow was a specific parasite of the shrimp *(S. boreas)*, which occurred commonly in our collection.

Reproduction

Bearded seals were usually born in the last part of April. The Eskimos state that during whaling season they occasionally have seen mothers and young

ugruk on the ice. We have seven specimens of fetuses taken during the months January through April (Table 13).

The fetal coat of the bearded seal is a crinkly dense black to dark-brown hair; the texture of the hair is much the same as that of the ringed seal but denser. Several specimens show light, nearly white patches dorsally without differences in texture. In the two specimens taken in early April, coarse straight fur was replacing the lanugo (fetal) hair but could be seen only by spreading the fur.

Table 13—WEIGHTS AND LENGTHS OF SEVEN BEARDED SEAL FETUSES COLLECTED AT POINT HOPE, 1960–1961

Specimen No.	Date collected	Sex	Weight, lb	Length, mm
M363	Jan. 17, 1961	Female	18	680
MLJ4076a	January 1960	Male		
M664	Feb. 10, 1961	Female	42	982
M1095	Mar. 1, 1961	Male	45	1005
M1370	Apr. 7, 1961	Male	76	1228
M1375	Apr. 8, 1961	Female	56	1170
MLJ4075	Apr. 21, 1960	Male	74	1310

A fetus taken on April 21 had completely shed its fetal hair and was uniformly covered with its short straight first molt. This animal must have been almost at term because, on being removed from its mother, it was so lively it had to be killed. We have only one pup of the year (M1474), which was secured on May 4, 1961. This was a male that weighed 67 lb and was 1272 mm long. In comparison with the April 21 specimen, its pelage was slightly longer and more uniformly silver gray, without the considerable mottling present on the fetus.

According to previous research the female bearded seal breeds only every other year. The age of onset of breeding is 6 years in the female and 7 years in the male. Delayed implantation after about $2\frac{1}{2}$ months apparently occurs (MacLaren 1958a). Without more confidence in our aging techniques, we are in no position to verify these observations. During the months January through April, we examined six adult female bearded seals; five of them were pregnant.

Table 12 shows the development of sexual characteristics in 68 male specimens. It appears that the length of the animal is well correlated with a progressive growth of the baculum and with increase in size of the testis. The evidence of maturity occurs in the 2000-mm-total-length category. Several of the Eskimos have described a dwarf group of ugruks, occurring particularly in the Kotzebue area, called "ugruchats." Some of the natives consider these fully mature animals; others say that they are the young ugruk. From the data at hand, we find no evidence of dwarfing among the adult animals and thus at present consider "ugruchats" as immature seals.

Distribution and Migration

The general distribution of the bearded seal is "circumboreal at the edge of ice" (Scheffer, 1958). It ranges as far south as Bristol Bay, Alaska, and northern Hokkaido and the Sea of Okhotsk. It appears to be intensely migratory and associated with the ice edge although individuals may be found throughout its range

during the ice-free months (compare with other marine mammals such as the walrus and beluga).

The bearded seal is generally scattered in the Cape Thompson region except during the northward spring migration. Of the 173 bearded seals cataloged at Point Hope in 1961, 92 were recorded during the 3 days June 17 to 19, and an additional number that could not be examined were secured at this time. Whether herding occurs during the southward migration in the fall, as it does in walrus and harbor seal, is not known. Although the sample is small, there is a suggestion of early northward migration of adult males in May. The total picture of migration and local movements related to age groups and sex is a largely unknown entity that deserves further study.

REVIEW OF SPECIES OCCURRING IN CHUKCHI SEA OTHER THAN RINGED AND BEARDED SEALS

Except for the ringed and bearded seals, no species was collected in sufficient quantity for biological analyses. We have brought together the available information on other species to give a reasonable picture of each one. The treatment is irregular according to what is judged to be of importance in this chapter.

Not all the species discussed have been observed in the immediate Cape Thompson area; however, all have been reported in the Arctic Ocean.

Walrus

In the study area the walrus is essentially an animal of the edge of the ice pack. The general migration picture may be pieced together thus: During the maximum advance of the ice pack in March and April, large numbers of walrus (70,000 estimated) are scattered over the Bering Sea (Kenyon, 1960). Large numbers pass by St. Lawrence Island and particularly the Bering Strait in spring and again in the fall as the ice boundary moves with the seasons. Some animals, probably predominantly males, remain in the Bering Sea in the summer. Summer stragglers are occasionally present in the general Cape Thompson area, and small groups occur rarely.

According to the hunting records, it appears probable that the main migration route of the walrus is out beyond the usual hunting area of the Eskimos at Point Hope and Kivalina, but a few are regularly obtained. Likewise some walruses may frequent the ice pack along the open leads during the entire winter. These are occasionally available to the hunters, as in the winter of 1959-1960. On Nov. 6 and 7, 1960, a southward migration of several hundred was visible from the plane off Point Hope. Walruses were audible from the beach at Point Hope during the ensuing week. Ice conditions prevented hunting.

The published records (Nelson and True, 1887; Bailey, 1948; Brooks, 1954; Scheffer, 1958) indicate clearly that the summer distribution is spread out along the ice edge from about 170°W east to beyond Point Barrow. On either extremity of this distribution, walruses occur rarely. Except for unusual distribution records, the ranges of the Atlantic and Pacific walruses do not meet; this is primarily a function of the ice conditions. Certainly there is no opportunity for any

significant populations to be in contact during the breeding season, which is reputed to be in May. A single calf is born on the ice in April or May (Nelson and True, 1887). These animals are gregarious and occur in herds or "pods." They are bottom feeders, which limits their general distribution to relatively shallow seas.

Economically the walrus is of moderate importance to the Point Hope Eskimos because it supplies ivory for carving and meat for dog food.

Harbor Seal

In the Arctic the harbor seal is better known as the spotted seal. Its distribution is general, and probably it is common on the floating ice in June. It regularly occurs during the summer in scattered numbers, particularly around river mouths. It is rarely taken in the Cape Thompson area during the ice-fast months, although Nelson and True (1887) state that it is resident wherever found. Concentrations in the fall have frequently been reported. This phenomenon occurs regularly in the Kukpuk estuary a few miles north of Point Hope. It is evident that the harbor seal is strongly migratory in this part of the Arctic and responds to the advance and recession of the ice pack.

The harbor seal is reported to have its single young on the ice in April or May (Nelson and True, 1887). It probably subsists largely on bottom fish.

Economically the harbor seal is not of great importance in the Cape Thompson area. The hide is the part most used by the Eskimos. The meat is less palatable than that of the ringed seal but is eaten by some people and is used for dog food.

Ribbon Seal

The ribbon seal is primarily of eastern Arctic distribution and ranges from the Sea of Okhotsk into the Siberian Arctic Ocean. It apparently migrates with the floating ice much as does the walrus and must be classified as of casual occurrence in North American waters. References to concentrations of this species have been made by summer travelers into Siberian waters (Nelson and True, 1887; Borden, 1928).

According to Tikhomirov (1961), the young are born in April and molt shortly thereafter in the Sea of Okhotsk. Aggregations of nursing individuals are related to the central ice sheet in the western and northern parts of the sea. Although statements are made about the departure of ribbon seals from the Okhotsk Sea, it is not yet documented that this population migrates northward through the Bering Sea and into the Arctic Ocean.

In the Cape Thompson area, there are records of ribbon seals each year from Point Hope and occasionally from Kivalina. Most occurrences here are in June during the northward migration; occasionally specimens are secured in November. This species must be involved in mass or herd migration. Specimens obtained from St. Lawrence Island are grouped strongly. In 1961 five specimens were taken over a 4-day period at Point Hope. Three were adult females, and two were adult males. A single specimen taken in November 1959 was an adult male. In all cases the stomachs were empty of food.

Fur Seal

The normal northern limit of the fur seal is approximately their summer breeding ground on the Pribilof Islands. In the winter months they spread out over the North Pacific, and some go as far south as Mexican waters. Individual wanderers have penetrated into the Arctic as far as Letty Harbour, Northwest Territories (Maher, 1960). The fur seal was, however, apparently unknown at Point Hope until the summer of 1960, when two specimens were secured. In the summer of 1961, one specimen was taken.

Beluga or White Whale

The beluga, or white whale, is a common species with definite migratory habits. Ordinarily it first appears in the open leads at Kivalina and Point Hope in early April before the great black (bowhead) whales appear. In 1960, however, no belugas were seen until after the bowhead whales began passing by; this was the first time this had happened in the memory of the hunters in the Point Hope–Kivalina area.

Belugas apparently remain in the Arctic as far east as the MacKenzie River until ice formation forces them south again. As with other arctic marine mammals, all individuals do not migrate. Summer populations are recorded as far south as Bristol Bay.

Belugas, defintely gregarious, occur in groups of up to a hundred individuals and are well known for their habit of ascending freshwater streams. Nelson and True (1887) state that they are found more commonly in the shallow water of the Alaskan coast than in the deeper waters of Siberia.

The young are produced singly about the middle of June (Nelson and True, 1887). A fetus weighing 50 lb and measuring 1240 mm was secured on Apr. 21, 1962. This is considerably smaller than data cited by Tomilin (1957) for Greenland specimens in April.

Two stomachs were examined from specimens taken in May 1961. They contained arctic cod and shrimp of at least three species. These are the food items of major importance to the seals in this area also.

The beluga is of considerable importance for food and for sinews for sewing in the Cape Thompson area.

Narwhal

The narwhal has not been reported from the Chukchi Sea, but Geist, Buckley, and Manville (1960) report two specimens from the Bering Sea. This indicates that individuals may wander beyond their usual range (westward to Barrow from the eastern Arctic). Old tusks occasionally obtained at Wainwright suggest that this species formerly was more abundant in the western Arctic.

The narwhal is reported to migrate in large herds in the eastern Arctic and to feed on fish and shrimp. The tusk, which may reach 9 ft in length, is the left upper canine tooth; there are no other functional teeth.

Pacific Killer Whale

The Pacific killer whale, with its characteristic high dorsal fin, is reported from the Eskimo villages north to Barrow, including Kivalina and Point Hope. No

utilization is adequately reported from any area. Several Eskimos stated that these whales are fierce and dangerous, but we have no firsthand report of attacks on boats.

The predatory proclivities of killer whales against other marine mammals of all species are well documented.

Harbor Porpoise

The small (less than 6 ft) harbor porpoise is regularly recorded from as far east as Barrow (Bee and Hall, 1956) and the Chukchi Sea (Tomilin, 1957). It is a common species in more southern waters but has not been reported from the immediate Cape Thompson area.

Gray Whale

The gray whale, as the bowhead, is protected from commercial whaling by international agreement. The gray whale is well known for its remarkable migration. It has been publicized in the past few years because it concentrates along the California coast where accurate censusing may be done. From November to May it formerly was found in the lagoons and along the coast of California and Baja California (Scammon, 1874). Gradually it was restricted to the coast of Baja California, Sonora, and Sinaloa (Hall and Kelson, 1959), where calving occurs. The migration path fans out above the California coast, some individuals continuing along the coast and others at sea. During the summer months it is found in widely scattered areas of the North Pacific, Bering Sea, and Arctic Ocean. There is also a Korean population that has similar migration patterns, but it probably goes into the Sea of Okhotsk. It is not known if these two herds mingle.

A number of observations identify the gray whale in the Cape Thompson region. During oceanographic surveys in August, 1959, Ford Wilke on the *John Cobb* saw many gray whales bottom feeding. Several strandings have occurred near Cape Thompson. Bailey and Hendee (1926) state: "These whales are occasionally seen in the Arctic in summer . . . One or two were seen from the beach at Wainwright . . . ."

We do not know when these whales leave the Chukchi Sea, but Scammon (1874) states that they appear on the Oregon coast in October and November. Since their arrival in California is as late as February, it is possible that the departure could be as late as October.

To our knowledge Point Hope people have not hunted the gray whale. In the years 1954 to 1959 during the months of July, August, and September, one gray whale had been killed at Wainwright, and nine had been killed at Barrow. Most of these were young animals, but several were lactating females (Maher, 1960).

The original population of the California gray whale was estimated at "not over 30,000" (Scammon, 1874). It is now estimated at between 8000 and 9000 (Rice, 1961).

Finback Whale

The finback, a baleen whale, is streamlined and speedy and may reach a length of 80 ft. It has been reported from the western Chukchi Sea (Borden, 1928;

Tomilin, 1957). It has a worldwide distribution and is commercially widely utilized. It feeds on crustaceans and fish.

It is marked by numerous well-defined throat grooves and a moderate-sized dorsal fin posteriorly.

Sei Whale

The sei whale is a smaller, somewhat chunkier edition of the finback whale and has been reported from the eastern Chukchi Sea (Tomilin, 1957). It differs from the common finback in having less than 340 major baleen plates, which are blackish (not purple and white as in the finback whale), and in having the ventral surface of the flukes dark blue to brown instead of white. The general distribution is worldwide. It feeds on plankton.

Little Piked Whale

Reported from the Chukchi Sea by Scammon (1874) and Tomilin (1957), the little piked whale is similar in general form and character to the other fin-backed whales but is less than 33 ft long. The white to yellowish-white baleen is short (less than 10 in.). A characteristic marking is a broad white band crossing the upper side of the foreflipper. It feeds on fish.

Humpback Whale

The humpback whale is a cetacean of worldwide distribution which ranges into the Chukchi Sea in the summer (Tomilin, 1957). The thickset body, not over 50 ft long, and long foreflippers give a characteristic form to the animal. It feeds primarily on shrimplike crustaceans.

Bowhead Whale

The bowhead whale and the Pacific right whale are protected from commercial whaling by international agreement. The general distribution is Arctic, both Atlantic and Pacific. It is rarely found far from the ice and occurs with regularity well under the pack. It regularly passes the Cape Thompson area in April when the southern limit of the pack is many hundred miles south of Bering Strait. There is evidence of passage from the Atlantic to the Pacific Arctic in the finding of a British harpoon in a whale killed in the Kotzebue area in 1880 (Nelson and True, 1887).

The bowhead whale was the major species secured by the great arctic whaling fleets between 1848 (Scammon, 1874) and 1908 (Brower, 1954). During the latter years the numbers were greatly depleted, and all commercial hunting finally stopped because of the drop in the price of baleen.

It may be assumed from present fragmentary observations of these whales that a reasonably large population now exists. The total yearly kill in Alaskan waters by the Eskimos probably never exceeds 30 to 40 animals, including those killed and lost. Whaling is now done at St. Lawrence Island, Point Hope, Wainwright, and Point Barrow. In the days of extensive commercial whaling, the harvest of whales was many times the kill taken over the last 60 years.

We can piece together bits of information to get a reasonable idea of the general migration cycle. The population in the Sea of Okhotsk is probably separate since bowhead whales remain there after the ice has melted. Bowhead whales are not seen south of the southern edge of the ice pack in the Bering Sea (Scammon, 1874). Kenyon, in extensive surveys for walrus in 1960, saw only one whale in this area. Bowhead whales may first appear at Kivalina and Point Hope as early as the end of March. They are regularly present in April, through May, and occasionally into June. All movement of the whales is toward the west, parallel with the south shore, and it is assumed that these whales turn north to pass Point Lay, Wainwright, and Barrow. In 1960 we received an unconfirmed report that a whale was seen at Barrow on April 15; the first whales were seen at Point Hope on April 11. The first whale was struck but not secured on April 15. On Apr. 13, 1961, three bowhead whales were sighted. The first whale was struck on April 29. Bailey and Hendee (1926) and Bailey (1948) report that in 1922 the first whales passed the Bering Strait on April 13, a few days before they appeared at Wainwright. Hendee (1930) stated that the whaling teams were out from May 1 until June 15. Rainey (1945) reports that at Point Hope the whales had appeared in late March or early April and had passed by early in June. Murdoch (1892) states that at Barrow the bowhead whales travel along the leads of open water from the middle of April to the latter part of June in large numbers and return about the end of August. Brower (1954) states that the dates of the native whaling season at Barrow are usually in April and May. The fall return migration is generally unnoticed in the Cape Thompson region, which may be an indication of an offshore passage. Don Foote, in the fall of 1960, observed westward-moving whales (not identified) on the north shore near Point Hope.

We examined three bowhead whale specimens. Specimen M39 was a young male 30 ft long, which was taken Apr. 18, 1960. The testis measured 9 in. in diameter. The stomach was empty. Specimen M1527 was a young female 26 ft long, which was taken May 13, 1961. The stomach was nearly empty, containing fragmentary remains of Polychaeta, Reptantia, Gastropods, Crustacea, Echinoidea, and sand and gravel. The ovaries had a maximum diameter of 190 mm and were immature. Specimen M1571 was a lactating female 46½ ft long. The ovaries had a maximum diameter of 330 mm; one ovary contained a corpus luteum 83 by 45 mm, and the other, a degenerative corpus luteum 47 by 21 mm. The stomach was empty.

The following two generalizations are probably true: Migrating whales do little feeding, and most of the catch of the Eskimos consists of immature individuals.

The prestige of the hunt and more particularly of the capture must be seriously considered in regarding the pattern of utilization of the bowhead whale in the Cape Thompson area. At Point Hope there were 13 whaling crews during the period of our study. Usually each crew has approximately eight men, all of whom may not be present on the ice at one time. A woman or girl cook and some older boys may be part of the camp crew. When all the crews are out on the ice, it is possible that as many as 130 persons are away from the village for the length of the stay on the ice. This maximum figure is probably seldom realized. If the whaling season lasts as long as 6 weeks or more, considerable time and effort

of the village goes into this activity. In addition, before the season considerable time is expended in carving paddles, making bleached ugruk skin boats, and preparing the seal-poke floats, lines, harpoons, bombs, and other necessary paraphernalia. If a whale is secured, most of the able-bodied villagers go out on the ice to assist in processing it or simply to enjoy the excitement.

During the time of whaling, the hunters also secure ringed seals, bearded seals, and belugas.

Traditionally, when a whale is secured, eight teams get a share according to the order in which they reach the struck whale (Rainey, 1945). In 1959, when only one whale was secured, the effort was obviously inefficient from the man-hour point of view. In 1960, when four whales were secured, the economy was better justified. In 1961, two whales were secured. However, for these traditionally whale-hunting and proud people, to consider only the economy of the situation would show a lack of perspective on our part.

The alternative for whale hunting is caribou and ringed and bearded seal hunting, and the returns are greater for the effort spent on these species.

An interesting correlation of migratory patterns is noted here. Bailey and Hendee (1926) quote the Eskimos at Wainwright as stating, "The first living creatures to appear in the spring are the gulls, the second the white whales . . . , the third, the bowhead . . . , all three arriving ahead of the eider ducks." (Actually at Point Hope there are seabirds out on the open leads all winter.) Bailey (1948) further specifies that no two years are alike in the Arctic but that, when the first white-winged gulls appear along the coast in early spring, the Eskimos know that soon the great bowhead whales will be working the open leads.

Rainey (1945) states that in late March or early April the snowbirds arrive and whales follow (the beluga first and then the large whales).

In 1960 we first saw snow buntings on April 9. The Eskimos told us that they had been present for 2 days. On April 11 the first whales were sighted far out on a large area of open water. Gulls were first seen by us on April 22 although they might have been present earlier. Belugas, however, did not arrive until later. This was the first time in the memory of the hunters that the belugas did not arrive before the big whales; this unusual occurrence was noted in Kivalina as well as Point Hope. In 1961 belugas were first sighted on April 10, and the bowheads, on April 13.

Polar Bear

Approximately 18 polar bears were secured by the native hunters in 1959-1960, and 3 were taken in 1960-1961. One bear was shot near Kivalina in 1960. After the airplane hunters began to fly in February, few bears (none in 1960 and 1 in 1961) were taken by the Eskimos. The question has been raised that increased airplane hunting destroys or herds the bears before they arrive in the Eskimo hunting area. Whether or not there will be a place for airplane hunting in harvesting otherwise untapped populations remains to be biologically proved. The evidence at hand indicates that populations now are greatly reduced in numbers, particularly below Bering Strait, where formerly they were abundant (Nelson and True, 1887). Competent biologists are studying this problem and should have information pertaining to it within the next few years.

Polar bears may occur at any time during the ice season but are more common in the winter months. Hunting results showed that the density of the population is extremely irregular.

What is probably the largest bear of any species ever collected was taken in the Chukchi Sea on Mar. 3, 1961. It was shot north of the Diomede Islands by Arthur Dubs when he was flying out of Kotzebue. Approximately eight bears were seen in the 5 days of flying before this large specimen was sighted. The bulk and measurements of the skin and the size of the skull make it likely that this specimen far exceeds the 1700-lb polar bear from James Bay, Canada, a specimen now at the Carnegie Museum.

INTERNAL PARASITES OF MARINE MAMMALS

The collection of parasitic helminths was incidental to other work since it was impossible to undertake the careful dissections necessary for complete examination of the marine mammals. Much of the available material was taken from stomachs preserved for the food-habit investigations, but some specimens were collected from other organs. Although a detailed study of the helminths has not been completed, several species have been identified. These are listed here by host.

Bearded Seal

Phocanema decipiens (Krabbe, 1878) was the common helminth collected from bearded seals. Many specimens were found in the stomachs, and some were taken also from the duodenum. It occurs in several species of marine mammals, and infection results when fishes containing the larvae are eaten. Immature stages of *Phocanema* were commonly represented in the available material from preserved stomachs.

Although bearded seals often harbor cestodes, comparatively few were included in this material. Because its scolex is usually attached to the gastric mucosa of the seal, *Pyramicocephalus phocarum* (Fabricus, 1780) was found in many stomachs. Although its larvae occur in various species of cods and sculpins, the adult cestode exhibits a high degree of host specificity. A small cestode, *Diphyllobothrium schistochilus* (Germanos, 1895), was collected from the intestine of one animal. Two additional species of *Diphyllobothrium, D. cordatum* (Leuckart, 1863) and *D. lanceolatum* (Krabbe, 1865), both common parasites of bearded seals, were not recorded; they perhaps escaped detection because of their typical localization in the more posterior portions of the intestine.

Only one trematode, *Orthosplanchnus arcticus* Odhner, 1905, was recorded. It inhabits the gall bladder and bile ducts and sometimes the pancreatic ducts. The life cycle is unknown.

Ringed Seal

Larval ascarids of the genus *Contracaecum,* probably *C. osculatum* (Rudolphi, 1802), were often found in ringed seals and were usually attached to the stom-

ach wall. This is another species of nematode that occurs in various pinnipeds. *Phocanema decipiens* was also recorded from the ringed seal.

Acanthocephalans of the genus *Corynosoma* were collected from one of the ringed seals examined. These parasites occur in various species of marine mammals and usually inhabit the lower intestine. A campulid trematode, not yet identified, was found in the bile ducts of one seal.

Harbor Seal

Unidentified ascarids were collected from a harbor seal. Both *Phocanema decipiens* and *Contracaecum osculatum* have been recorded from this host in the Alaskan waters.

White Whale

Nematodes of large size, as yet unidentified, were found in a white whale. The species *Stenurus pallasii* (van Beneden, 1870) has previously been recorded from this mammal in arctic waters. A large trematode, *Odhneriella seymouri* (Price, 1932), is found rather commonly in the intestine of this whale and presumably was overlooked in the present survey.

Polar Bear

The larvae of *Trichinella spiralis* Owen, 1835, were observed in the musculature of one bear. This is a common parasite of polar bears, and the rate of infection increases with the age of the host. Ascarids *(Contracaecum)* have been found in polar bears in arctic Alaska but are found only rarely. Few species of helminths are known to occur in this mammal.

SUMMARY

The marine mammals are the most important natural resource for the Eskimos at Point Hope and Kivalina. Six species of pinnipeds, two of cetaceans, and one of carnivore (the polar bear) were collected during this study. The ringed seal and the bearded seal occurred in sufficient numbers for biological analysis.

On census flights most seals were observed within a few miles from shore. Maximum concentrations occurred south rather than north of Point Hope. The average number of seals observed was 32 per 100 square miles, and the range was 1 to 237.

Data were collected from 2028 ringed seals obtained from November through June. The sex ratio was equal in fetuses, but males were predominant in the hunter's catch. Marked fluctuations of numbers and mature–immature ratios occurred. Pups are born in late March, and the birth weight is about 9 lb. Adult males reach a weight of about 225 lb and are slightly larger than the females. Food is primarily arctic cod in the winter and invertebrates in the spring. Breeding is in April and May; 86.7% of mature females are pregnant.

Data on 208 bearded seals were obtained. There was a preponderance of adult females; 80% of the total catch of the year was in June. A completely molted, ap-

proximately 70-lb fetus is usually born in late April and measures about 1300 mm in length. Adults weigh up to 800 lb and are up to 2300 mm long; both sexes are equal in size. Food is principally invertebrates.

All species of marine mammals in the area investigated are migratory. Their migration is related to the ice conditions.

Our specimens and data are subject to considerably more analysis than was possible for this chapter, and such analyses are being carried on.

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