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PRELIMINARY INVESTIGATION OF THE ATLANTIC WALRUS *Odobenus rosmarus rosmarus* (Linnaeus)

by

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Wildlife Management Bulletins are produced to make available to wildlife administrators the information contained in reports which are submitted by officers of the Canadian Wildlife Service.

The reports do not, in most cases, cover extensive studies and are not written primarily for publication. Recommendations arising from the studies are not included.

INTRODUCTION

In 1949, concern for the diminishing numbers of the walrus in the Canadian Eastern Arctic led to the passing of an act for its protection. The act forbade the killing of walruses except by Eskimos, half-breed Eskimos, and certain white residents. It set an annual quota of seven walruses for each married Eskimo and four for each single one. Only one hunt per year was to be made, under Royal Canadian Mounted Police supervision, from Walrus Island, Nottingham Island, and Salisbury Island. A sea mammal questionnaire designed jointly by the Canadian Wildlife Service, Department of Northern Affairs and National Resources, and the Department of Fisheries in 1952 was distributed to responsible persons in the Eastern Arctic.

The present investigation was initiated by the Northern Administration and Lands Branch as a result of reports from many northern sources that Eskimos were failing to obtain walruses in the traditional hunting-grounds, particularly along the west side of Hudson Bay in the Chesterfield Inlet region. The Canadian Wildlife Service undertook the investigation and the writer was assigned to it. Coral Harbour, Southampton Island was chosen as the centre of activity because large herds were reported in that vicinity and the economy of the natives of the area was known to be largely dependent upon the walrus. Also, Coral Harbour is relatively accessible from Churchill, Manitoba.

An extensive investigation was planned as a pilot study for more intensive research. Its general objectives were:

(a) to determine the present status, distribution and movements of the Atlantic walrus;

(b) to determine its current population trends;

(c) to investigate its life history and ecological relations;

(d) to analyse human utilization of the resource; and

(e) to suggest a program for future management.

This report presents the data which accrued from a review of the literature, from field and laboratory studies, and from other sources, which are designated.

ITINERARY

The writer flew a preliminary aerial survey in a Royal Canadian Air Force Lancaster bomber over White Island, Walrus Island, Nottingham Island, and Salisbury Island on August 5, 1952, and reached Coral Harbour on October 2 in the same year. That was too late for the last autumn hunt, but local white residents and English-speaking Eskimos were interviewed to obtain data on utilization.

In February, 1953, observations were made on walruses feeding at the floe edge off the south shore of Southampton Island. Several days were spent in March at an Eskimo camp on the east coast of Melville Peninsula, 25 miles south of Igloolik. From March 28 to April 16, the writer accompanied a departmental survey party that visited by air many of the mainland settlements in the Eastern Arctic and gathered data on the life history and utilization of the walrus at each settlement. During July, August and September the writer went out with the Eskimo hunters in their Peterhead boats hunting walruses off Coats Island and Seahorse Point, Southampton Island. Through the courtesy of the U.S. Fish and Wildlife Service, an aerial survey, accompanying one of their waterfowl survey parties, of Coats and Walrus Islands and the east coast of Southampton Island, was possible on July 16. The writer left Coral Harbour on October 15, 1953.

The 1954 field work began with a week spent observing a herd of some 300 walruses on Walrus Island and taking notes on their social behaviour. During August and September a tagging project was undertaken; a chartered Peterhead boat provided transportation and its Eskimo crew assisted with the tagging. Specimens were collected to provide biological data. On August 20 an aerial census was flown over known hauling-out grounds on Walrus, Bencas, and Coats Islands and Seahorse Point The final trip in the Peterhead was made in late August and early September. On September 13, the writer left Coral Harbour. During the following winter the biological material was worked up at Ottawa and at St. Andrews, N.B.

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Royal Canadian Mounted Police, the Royal Canadian Air Force, the National Research Council, the Department of Transport, the Hudson's Bay Company, the U.S. Fish and Wildlife Service, the University of Michigan, Walt Disney Productions Limited, the Roman Catholic and Anglican missions, Arctic Wings Limited, and the Eskimos of Southampton Island.

METHODS

Review of the Literature

Recourse to the literature aided greatly in directing research and in interpreting the results of field and laboratory studies. However, most of the references consulted were concerned largely with distribution, physical description, and utilization in restricted localities; only a few of them referred to food habits or reproductive biology. Very little has been published concerning the movements, ecological relations, behaviour, and human utilization of the Atlantic walrus anywhere in its range.

Considerable information of interest and data valuable for comparative purposes were found in the following studies which refer particularly to various phases of walrus biology: Allen, J.A. (1880); Baer (1838); Brooks (1954); Chapsky (1936); Collins, G., (1940); Dunbar (1949); Freuchen (1935); Johanson (1912); Nourse (1879); Ognev (1935); Sutton and Hamilton (1932); and Vibe (1950). Including the titles listed as references at the back of this report, the writer accumulated a bibliography of some 260 titles, and also made an effort to review all the pertinent data in R.C.M. Police game reports, reports of government field parties, and Hudson's Bay Company records.

Field Methods

Study of the life history and ecology of a large, Arctic marine mammal such as the walrus presents interesting challenges, not the least of which is the adaptation of standard field techniques to northern conditions.

The writer collected data and specimens from 27 walruses killed by the Eskimos in 1953 and from 12 killed in 1954. After killing, the walruses were hauled out either on an ice pan or on a suitable beach. In the

latter case the carcasses had to be secured at high tide so that they could be examined later when left exposed.

The standard post-mortem examination carried out included the following phases: taking gross body measurements; examination for and collection of external parasites; notation of scars or other traumatic injuries; notation of the condition of the mammae and vagina in females; examination of the viscera for parasites and taking samples of liver, spleen, heart, diaphragm, and somatic muscle; notation of the volume of the stomach contents and taking a sample; in males, removal of one testicle and epididymis for measuring, labelling, and preserving, and removal, fleshing and labelling of the baculum; in females, removal of the ovaries for measurement, labelling and preservation. The positions of placental scars, if present, were noted, and the scars were measured. If a calf had accompanied the female a notation was made of its size and actions.

Body weights were obtained for a series of 16 walruses of both sexes and various age groups, butchered and weighed piecemeal on a 400-pound spring scale suspended by block and pulley from a tripod of 12-foot poles. Thus the weights obtained were total body weights less blood weight, except for a calf small enough to be weighed whole. One large bull was flayed and the total weight obtained of its epidermis and subdermal adipose tissue (blubber). Another large bull was killed with one shot and immediately hauled-out on an ice pan. The wound was plugged, a ventral cut was made in the body wall, and the blood was drained from the heart, liver, large dorsal blood vessel, and body cavity into a dipper and collected in a five-gallon pail to obtain its volume and weight.

Adult weights were taken to the nearest pound, foetal weights to the nearest one-hundredth of a pound on a single-beam laboratory balance.

All gross body measurements except the circumference were straight-line measurements taken to the nearest centimetre. The thickness of the ventral epidermis and subdermal adipose tissue was measured to the nearest millimetre. Canine length was measured to the nearest millimetre along the curved, anterior face of the tusk from the gum line to the distal tip. Canine diameter was measured along the greatest diameter at the gum line.

Body temperature was recorded with a Weston, thermocouple, dial type, centigrade thermometer inserted in the deep body tissue immediately after death. The degree of error of the thermometer was later calculated by checking it with standard thermometers at the Defence Research Northern Laboratory, Churchill, Man.

A series of 15 skulls rough-fleshed, labelled and air-dried in the field was packed and shipped frozen to Ottawa.

Gross samples such as testes, ovaries, and foetuses were fixed in Lavdowsky's mixture (Guymer, M.F., 1947), modified by substituting sea water for distilled water (equal volumes of the sea water and the fixative) and stored in a five-gallon milk can. External parasites and tissue samples were preserved in 75 per cent alcohol. After the stomach contents were examined, representative contents were stored in quart sealers. Several dry preparations were made on microscope slides from fresh blood samples.

The herd of 300 walruses seen on Walrus Island in 1954 was observed intensively from July 26 to August 2, and further observations were made on a Bencas Island herd of 175 from August 7 to August 9. In both cases it was possible to approach the herd as close as 15 feet without disturbing it. From a point of vantage on the rocks it was usually possible to have most of the herd under observation. The notes made at those times were supplemented at various seasons during the course of the study.

Information on the human utilization of the walrus was collected on Southampton Island, the Keewatin mainland and Melville Peninsula. Particular attention was paid to the hunting techniques and equipment used by the Eskimos, and their methods of butchering and storing meat. Some information on the utilization of walruses at various settlements was obtained from the sea mammal questionnaires, and a record was compiled of the total kill by Southampton Eskimos from 1949 to 1954.

An 800-foot documentary film depicting summer walrus hunting by the Southampton Island Eskimos was produced and is on file with the Canadian Wildlife Service. Numerous 35 mm. Kodachrome and black and white photographs recording various phases of the study are now on file.

The methods used in census and tagging are described below in the section on Management Techniques.

Laboratory Methods

The series of 15 skulls shipped from the field was cleaned and prepared through the courtesy of the National Museum of Canada. They were measured according to standard procedures with a 120-millimetre vernier caliper and a tong caliper with a metal, metre rule. The nasal bone measurements of some older animals could not be obtained as the sutures had fused completely.

A series of 18 bacula of walruses for which other data were available was prepared, measured and weighed on a single beam, two-kilogram, balance with a sensitivity of 0.1 gr. The methods of cleaning and drying the bacula followed those of Didier (1949).

Walrus tooth sections were prepared at the Atlantic Biological Station, St. Andrews, N.B., using apparatus designed in 1954 by Dr. H.D. Fisher and B.A. Mackenzie, and with their assistance and guidance. The grinding process was designed for harp seal teeth; the cementum of walrus teeth was found more resistant and the process took somewhat longer than described by those authors. Molariform teeth of 20 walruses were sectioned and ground to a thickness of approximately 100 microns and preserved in glycerin.

A histological examination of the ovaries and testes obtained has not yet been undertaken.

Supplies and Equipment

Some account of the materials and equipment used in the present investigation may be of value to biologists undertaking studies of Arctic marine mammals.

In collecting specimens, pods of swimming walruses were pursued in a Peterhead boat and individuals were harpooned and then shot. Alternatively small pods were driven into shallow bays and individuals shot without harpooning. Occasionally walruses were collected as they lay on large ice floes. A high-powered rifle (30.06, 303 British, or 270 calibre) with metal-jacketed bullets, was found most satisfactory, because soft-nosed bullets often mushroomed in the soft blubber and caused only superficial wounds. The preferred spot to hit is in the region of the

temple, between the eye and the ear. Unfortunately the bullet frequently shatters the brain case, damaging the skull for taxonomic purposes.

A 20-foot freighter canoe with a 10-horsepower outboard engine was found useful in coastal travel and in working among ice floes. This item was hired locally.

All equipment used in measuring should be made of stainless steel or monel metal if possible, as contact with salt water will otherwise rust it despite constant precautions. A 50-foot steel measuring tape and a two-metre tape were used in the present study. The weighing scales and thermometer used are described above.

The following were found adequate for dissection and for storing specimens: an ordinary dissecting set with the addition of several large skinning knives of good quality; a carborundum and a file; a bone saw with spare blades; a pair of 12-inch forceps; cheesecloth; wooden greenhouse labels; spools of monel wire; gummed paper labels; microscope slides and slide box; small screw-top vials; large-mouthed screw-top bottles in several sizes; quart sealers; gallon paint cans; and five-gallon milk cans with tops to be wired down for shipping. Preservatives such as formalin, acetic acid, and alcohol were shipped and stored in metal containers.

Photographic equipment may be chosen according to the kind of records required and the investigator's experience and inclination.

CLASSIFICATION

Simpson (1945) gives the following classification for the walrus:

Class	Mammalia
Order	Carnivora
Suborder	Pinnipedia
Family	Odobenidae
Genera	Prorosmarus x
	Trichecodon x
	Alachtherium x
	Odobenus

X Extinct

Allen, J.A. (1880) listed the extinct genera Trichecodon and Alachtherium. They were established with reference to the lower jaws in comparison with the extant genus Odobenus. Simpson (op. cit.) added the extinct genus Prorosmarus, known as a fossil from the upper Miocene deposits.

The suborder Pinnipedia contains three extant families: the Otaridae, or eared seals; the Odobenidae, or walruses; and the Phocidae, or true seals.

Odobenidae, as well as Otaridae, are characterized by the ability to rotate the posterior limb forward, as an aid in terrestrial locomotion. This distinguishes them from the Phocidae. The Odobenidae lack the external pinnae of the ear, found in the Otaridae, and are characterized by well developed, tusk-like canines, present in both sexes.

Anderson (1946) lists two species for the genus Odobenus. These are: Odobenus rosmarus (Linnaeus), the Atlantic walrus and Odobenus divergens (Illiger), the Pacific walrus. Miller and Kellogg (1955) recognize but one species, rosmarus, with two subspecies, Odobenus rosmarus rosmarus (Linnaeus) and Odobenus rosmarus divergens (Illiger), the Atlantic and Pacific races, respectively.

The Atlantic and Pacific forms of the walrus are also treated as subspecies by recent Russian writers, including: Ognev (1935), Barabash-Nikiforov (1938), Nikulin (1941) and Bobrinsky et al. (1944).

A series of Atlantic walrus skulls, collected during the present study and representing both sexes and several age classes, has been deposited in the National Museum of Canada. Measurements of possible taxonomic significance are included in this report.

An explanation of the derivation of the popular term walrus is given by Kiparsky (1952), whose work is summarized by Bird (1953), as follows:

> "A recent study by V. Kiparsky ("L'histoire du morse", Ann. Acad. Scien. Fenn. Ser. B. Vol. 73/1952, pp 1-54) traces the evolution and relationship of the various names that have been given in European languages to walrus. He shows that most of the words may be traced back to the Lapp onomatopoeic word morsa derived from the grunting

sound produced by the animals. That word was brought to western Europe changing on the way to hross, with the addition of hval (whale) to ros-hval and eventually with inversion, to walrus. The Basque whalers brought the Lapp word directly to Britain in the fifteenth century as morse. A similar form of the word mors, reached central and western Europe by the sixteenth century by way of Finnish and Russian."

Eskimo Names

The Aivilingmiut Eskimos of Southampton Island refer to the various age classes of walruses as follows:

Eskimo Name	Meaning
ib lowk	foetus (general term for all animals)
eshak gak	yearlings
nowka too gahk	young walrus up to three years of age
noo cob look	young male, not fully grown
noo cob lee my yoot	full grown young male
tim mik tee	adult male
ung nuk	adult female (general term)
netchik tonerk (iyuk)	a walrus that eats seals.

DISTRIBUTION AND MOVEMENTS

The Environment

The walrus is circumpolar in distribution in arctic and sub-arctic seas with sufficient food and open water. It is a bottom feeder, feeding almost exclusively on bivalve molluscs. The availability of molluscs seems to be a major factor in determining its distribution, especially when many shallow waters freeze over.

Its distribution and movements are also closely associated with the formation and distribution of sea ice. The presence or absence of open water in winter determines whether or not foraging grounds are available. A northward spring movement of walruses may be impeded or prevented by excessively heavy drift southwards of the pack ice. In late summer and autumn walruses are often seen resting on pack ice.

Factors influencing ice formation and distribution include configuration of the coastline, depth of coastal waters, direction and strength of the wind, the currents, and the tides. Until 1949 some important factors such as the complete freezing over of central Hudson Bay were unknown (Hare and Montgomery, 1949). Indeed, aspects of the ice conditions in the Eastern Arctic are still imperfectly understood, although aerial reconnaissance has increased during the past decade. The typical patterns of sea ice and the normal conditions in the Eastern Arctic are outlined below using terminology from Armstrong and Roberts (1956).

In a large body of water such as Hudson Bay, ice begins to form in October or November, depending on latitude, in the shallow bays along the shore. The shelf of shore ice or fast ice thickens and gradually extends seaward. Its edge is usually formed parallel to the coastline. In many cases it reaches a more or less stable position during the winter, being prevented from further extension by the combined effects of currents, winds, and tides. The open water seaward of the fast ice is called the shore lead. New ice built out from the fast ice in cold weather is called rubber ice.

In the meantime a sheet of floating or pack ice forms in the centre of the large body of water and sheets of ice broken off the edge of the fast ice drift out and adhere to it. The central ice sheet is not usually anchored; it drifts to and fro, breaks off, rafts on top of itself, and refreezes. It may consist of solid sheets of unbroken ice at the centre with smaller broken pieces, brash ice, around the edges. Pressure ridges are formed in even the largest sheets, and leads of open water may appear in them from time to time.

An onshore wind and flood tide may drive the pack ice against the fast ice. This may open up small leads at right angles to the shore lead. If an offshore wind then drives the pack ice out to sea, it may carry

away with it large pieces broken off from the fast ice.

Hare and Montgomery (op. cit.) give an excellent technical account of ice conditions in the Eastern Arctic, and the surface currents are described by Dunbar (1951). According to the former, a large part of northern Baffin Bay (the so-called North Water) remains open all winter and there is usually a wide shore lead along the west coast of Greenland. On the west side of the bay in the Home Bay area the fast ice may build out 80 miles. Hudson Strait is never completely frozen over, as the current keeps it open, but the extent of the pack ice may vary approximately from 50 to 95 per cent. The whole centre of Hudson Bay is an almost unbroken ice sheet. The shore lead of the bay may vary in width from a mile to 40 miles, depending on the direction and strength of the wind. In the north end of the bay there is open water in Roes Welcome Sound, Fisher and Evans Straits, and Frozen and Comer Straits.

A shore lead forms parallel to the east coast of Melville Peninsula on the west side of Foxe Basin. When the writer visited the floe edge there in March and April, 1953, it was about four miles east of Igloolik Island and three to four miles east of the North Ooglit Islands in Foster Bay. In March, 1953, considerable open water and brash ice south of Jens Munk Island and in Ikpik Bay, north of the Baird Peninsula was noticed from the air.

On the east coast of Foxe Basin, in the shallow water off Baffin Island north of Foxe Peninsula, the ice freezes to the bottom and the underlying sand, gravel, and even rocks adhere to it. The prevailing northwest wind rafts it again and again on the reefs and tide flats, until several thicknesses are built up, with the "soil" distributed between the layers. The pack ice formed after the break-up does not usually pass out through Foxe Channel until late August or early September, probably delayed by the eddying effect of the surface currents in Foxe Basin. A west wind carries it through Hudson Strait, but an east wind brings it up against the east coast of Southampton Island. There the ice pans from Foxe Basin are recognized by their thickness (16 to 20 feet) and discoloration and are known locally as "Foxe Basin growlers". The soil melts down through the various layers and concentrates during the summer.

As shown later, the Foxe Basin ice has an important effect on the movements of walruses. It also

affects the distribution of polar bears and partly accounts for the large number of them found on Southampton Island.

For a detailed account of the bathymetry, salinity, temperature, and currents the reader is referred to Dunbar (op. cit.).

Historical Records

The ancestral stock of the genus Odobenus may have existed in the North Atlantic during the Pliocene or early Pleistocene epochs. During the glaciation period of the latter epoch they were forced southward. Osborn (1910) cites the location of a fossil, referable to Odobenus, from the coast of Georgia, as evidence of their extreme southern distribution during the Pleistocene. After the retreat of the glaciers, the walrus apparently moved northward again to its ancestral waters.

Allen, J.A. (1880) summarizes numerous historical records of the Atlantic walrus. One of the earliest authentic records for North America was that made by Jacques Cartier in 1534 at Sable Island. Other early records indicate that the walrus bred (or at least hauled out) on that island and on the Magdalen Islands, Cape Breton Island, and Miscou Island in the Gulf of St. Lawrence. It was hunted extensively at those locations during the 16th and 17th centuries but was exterminated in the gulf by the middle of the 18th century, except for occasional passengers on the polar pack ice drifting in through the Strait of Belle Isle.

In Europe, the walrus was recorded within historic times as a casual transient off the coast of Scotland. There is even an early record for the English Channel (Kiparsky, 1952). It was formerly common around the islands off the north coast of Finland, but by the early 17th century had been exterminated on that coast and at Bear Island. It was abundant in the waters around Spitzbergen, Franz Joseph Land, and Novaya Zemlya, but rarely recorded from Iceland.

In Asia, von Baer (1838) gives as the eastern limit of the range of the Atlantic walrus, the mouth of the Jenesei River. However, Allen, J.A. (op. cit.) cites von Middendorff to the effect that it was found during the 18th century as far east as the Lena River.

Map 1 depicts the former and present distribution of the walrus. The former distribution of the Atlantic walrus in Europe and Asia is adapted from Allen and from Ognev (1935), and its present distribution from Ognev and from Chapsky (1936). The distribution of the Pacific walrus is as given by Brooks (1954) who states as follows:

> "Thus, the original southern limit of the (Pacific) walrus' range was approximately a line from Lat. 54°N. in the eastern Aleutian Islands to Lat. 60°N. off the Siberian coast....".

He gives Point Barrow, Alaska as the present eastern limit of the Pacific walrus, although Anderson (1946) states that occasionally walruses are found at Herschel Island and along the west coast of Banks Island. Allen cites von Middendorff to the effect that (Pacific) walruses have not recorded west of Cape Schelatski (157° 30' east longitude) and large herds only as far west as Koljutschin (185° east longitude); and that females are rarely found west of the mouth of the Kolyma River.

Atlantic Walrus - Present Distribution in Europe and Asia

The relation between the two races along the north coast of Europe at present is difficult to interpret because of the paucity of information. Is there a wide zone unoccupied by walruses between the eastern limit of the range of the Atlantic race and the western limit of the range of the Pacific race? Ognev (op. cit. quotes several authors, chiefly Nordquist, to show that such a zone exists, but also presents the following evidence to the contrary:

> "According to material in the collection of of the Zoological Museum of the Academy of Science it can be seen that at Cape Chelyuskin and even to the south of Bennet Island (New Siberian Islands) are found walruses with characters of intermediate cranial structure, between western and eastern subspecies. The indistinct boundary between this and the other race (i.e. Odobenus rosmarus divergens) runs along the eastern edge of the Nordenskiold Sea, therefore significantly further west than was formerly believed. The walrus probably occurs in relatively small numbers in the New Siberian Islands. The subfossil skull of a male O.r. divergens was found in 1902 by the Russian Polar Expedition on the northern shore of New Siberia. All these facts strongly question the validity of the existence of

a zone of absence of walruses from Khatanga Bay to Cape Schelatski."

Ognev's distribution map shows both races occurring occasionally in that area, and also the dividing line between the two races running north from the Lena River Delta through the Nordenskiold Sea, which the writer has included in Map 1.

Chapsky (1936) discusses the zone where the two races meet along the coast of Asia:

> "The numerous data gathered since Laptev and Pronishchev and up to the present time show that walruses inhabit the Laptev Sea in considerable numbers and, as according to the latest observations, they remain there also throughout the winter, using patches of open water and leads in the ice, we may conjecture of their forming a special geographical race, an intermediate between the Atlantic and Pacific races.
>
> "In the light of this hypothesis the rare cases of the occurrence of walruses at Severnaya Zemlya, Western Taimyr and the shores of the Kariton Laptev Sea may be explained by their penetrating into these regions partly from the west and partly from the east. It is possible that the junction of the distribution zones of the herds from Novaya Zemlya and east of Taimyr lies precisely there and consequently there takes place some mixing of the representants (sic) of both herds, the eastern one, near Vilkitsky Strait, probably being the predominant element."

Atlantic Walrus - Present Distribution in North America

Anderson (1946) gives the following:

> "North Atlantic and Arctic Oceans within historic times as far south as Gulf of St. Lawrence to Magdalen Islands; now seldom if ever appearing south of Hudson Bay and Hudson Strait; north to northwest Greenland and Ellesmere Island; rare or casual west of Barrow Strait, Somerset Island and Fury and Hecla Strait."

The present distribution shown on Map 1 is based on a review of the literature, interviews with local residents, and personal observation. As walruses are less

widely distributed in winter than in summer their cycle of movements is traced below, in most cases, through the seasons. Map 2 shows many place names in the Eastern Arctic and Map 3 the winter distribution.

Labrador and Hudson Strait. - Low (1895) states:

> "This species once common along the entire Labrador coast and the Gulf of St. Lawrence, is now found only on the Atlantic coast and to the northward of Nachvak. It is common at all seasons in Hudson Strait, and also along the northern Hudson Bay coast. Large numbers are killed by the Eskimo on the chains of outer islands which stretch southward to opposite Little Whale River off that coast."

Hantzsch (1932) reported the species noticeably decreased in numbers in northeastern Labrador, and still secured most regularly at Ikkerasak, as long as there was thick pack ice in the vicinity. According to Freuchen (1935) walruses (mostly females) formerly wintered as far south on the Labrador coast as Battle Harbour.

At present they come only as far south as Hebron. Those that winter in that region commence northward movement as the ice breaks up and the pack ice clears from Hudson Strait. They reach the Button Islands off Cape Chidley in July or early August. J. Ford of the Hudson's Bay Company on a trip to Port Burwell in 1952 saw several herds totalling about 275 off the Labrador coast (Banfield, personal communication, 1955).

According to Freuchen (op.cit.) the walruses cross Ungava Bay directly from the Button Islands to Akpatok Island, and present reports appear to bear him out. They haul out and may spend several days resting on the fast ice around the island or the shore of the east and north coasts, although in occasional years the Eskimos do not find them there. During some winters walruses may remain in the open leads near the island; Elton (1942) quotes a Hudson's Bay Company report for 1897 and 1898 that Eskimos wintering on the island found them numerous. Tuck (1954) makes the following comments concerning the occurrence of walruses at Akpatok:

> "Akpatok Island is located along a migration route used by walrus, which according to native accounts winter in Davis Strait and follow the edge of the pack ice into Ungava Bay during

> July. Most natives say that the herd remains within the vicinity of Akpatok until early August and then gradually works westward to the Eider Island and follows the coast to Whales (sic) Island in Hudson Strait from which their movements are unknown. Others maintain that there are two distinct herds and that while one follows the route described the other moves eastward to Resolution or Baffin Island."

According to Dunbar (1955) walruses were formerly found in Ungava Bay at the Gyrfalcon Islands.

After leaving Akpatok they are encountered on the Eider Islands, near Cape Hopes Advance. They move west along the south shore of Hudson Strait during August and may haul out at several of the numerous offshore islands, such as Wales, Weggs, and Charles Islands. According to Father Charlie,O.M.I., they were formerly found on the islands at Sugluk, Deception Bay, and at Digges Island. Probably because of heavy hunting by the Eskimos from Wolstenholme after that post was established in 1909, and from Sugluk, they disappeared from that area.

The walruses do not appear to turn south along the east coast of Hudson Bay. Freuchen (op.cit.) states that after they leave Charles Island they go westward, the cows and calves to Salisbury Island. The bulls are reported to go to Nottingham Island, where they meet other walruses coming down from Foxe Basin.

There is some eastward movement of walruses out of Hudson Strait in the autumn and winter, chiefly along the northern or Baffin Island shore. Soper (1928) reported that they could be taken off Amadjuak Bay throughout the year if ice conditions were favourable. According to Freuchen (1935) the herds moving east along the north side of Hudson Strait split up at Resolution Island. Some turn south and winter along the Labrador coast; others pass through Gabriel Strait and continue east and north along the coast of Baffin Island. Evidence of the latter movement is that walruses are normally abundant in the late autumn at Cyrus Field Bay and Loks Land, north of Frobisher Bay. This was reported independently by N. Ross of the Hudson's Bay Company and Constable M. Donan of the R.C.M. Police in 1953 and 1952, respectively.

East Coast of Hudson Bay.- G.M. Allen (1942) states that walruses formerly occurred as far south as the Paint Islands in James Bay. At present their southernmost occurrence appears to be just south of the Belcher Islands (Burt, personal communication, 1956). They are still

found, although apparently in reduced numbers, in the vicinity of the Belcher, King George, Sleeper, and Ottawa Islands. Manning (1946) quotes P.A.C. Nichols of the Hudson's Bay Company as saying that they were commoner around the Belchers than around the Sleepers or Ottawas even in former years. Constable Decker of the R.C.M. Police attributed their decrease around the Sleepers to their withdrawal after a permanent Eskimo camp was established on those islands.

It is not certain but seems likely that they winter in the open water leads around the chain of islands from the Ottawas to the Belchers. Apparently they have never been recorded from Mansel Island.

Western Hudson Bay - Southampton Island.- This region has long been known as a stronghold of the walrus, and many of the early explorers there recorded its occurrence. Hearne (1795) referring to Seahorse Point, Southampton Island, says:

> "(We) saw such numbers of these animals lying on the shore, that when some swivel guns loaded with ball were fired among them, the whole beach seemed to be in motion."

Preble (1902) cites Bell to the effect that walruses were found formerly as far south as Cape Henrietta Maria. By 1900 they were scarce south of Dawson Inlet, a scarcity probably associated with the unsuitability of the muddy tide flats of the southwestern coast as foraging grounds and the fewness of islands to haul out on. North of the inlet, they hauled out then in considerable numbers on Bibby Island, Tern Point, "Little" Walrus Island, and Marble Island. The Eskimos from Chesterfield Inlet and vicinity hunted them extensively on those islands, and as a result the herds were exterminated or the remnant withdrew northward.

Lately walruses have been reported more frequently and in increasing numbers from the west side of the bay. Dr. C.H.D. Clarke (personal communication, 1956) informs me that a herd of more than 1,000 hauled out on the sandspit at Cape Henrietta Maria in the spring of 1955. In September of the same year the captain of the Fort Severn saw a herd off the coast at Winisk. G. Johnson of Churchill, reported seeing six walruses swimming off the coast near Cape Churchill in October, 1954. According to the R.C.M. Police reports from Eskimo Point (1953,1954) they have been seen in February at the floe edge off that settlement. Small numbers are also reported to haul out

in summer on Bibby Island, Little Walrus Island, Tern Point, and Sentry Island.

In the Chesterfield Inlet region they are reported from the offshore islands from Rankin Inlet to Cape Fullerton: Wagg, Marble, and Fairway Islands and possibly Depot Island.

Their distribution and annual cycle of movement in the Southampton Island region do not seem to have changed much since 1900. However, their movements vary from year to year depending on the extent of freezing of coastal waters, the movement of the pack ice, and to some degree the hunting pressure and other factors such as the condition of the foraging grounds. The following distribution pattern has been worked out from field observations, information from Eskimos, reports in the literature, and preliminary tagging results.

In the late summer walruses may be found almost anywhere in Fisher and Evans Straits in the vicinity of Walrus and Coats Islands and Seahorse Point. Normally they are in greatest numbers near or hauled out on the small islands and points of land along the east coast of Bell Peninsula. However, Constable Ripley of the R.C.M. Police reported seeing a herd of 1,000 on Walrus Island in October, 1952. At Seahorse Point during the aerial census in 1954, described later in this report, 2,000 were counted. They also occur along the north coast of Bell Peninsula as far as East Bay, where Manning (1942) saw a herd of 300 in August, 1936.

If wind brings the ice from Foxe Basin to the east coast of Southampton, walruses hauled out on islands and points of land take to the ice and are carried with it. The prevailing wind at that time of the year is from the northeast, and the ice drifts southwest. In 1954, the large herds seen on land in late August were found scattered from Leyson Point to well out in Evans Strait on the drifting ice that had moved in during the first week of September.

During the first week of October, when the ice is starting to form in sheltered bays, the walruses, mostly bulls, move west along the south coast of Bell Peninsula, drifting with the sea ice and feeding in the open leads. A bull tagged on drifting ice off Leyson Point in September was killed a week later by an Eskimo at Native Point. A bull tagged in late August on the south coast of Coats Island was killed at Native Point in

early October. Sutton and Hamilton (1932) recorded walruses in the open water off the floe edge at Bear Island and Native Point in October and November.

Although walruses can break through several inches of new ice with their heads (Nourse, 1879; Sutton and Hamilton, op. cit.), they usually retreat to the open leads as the land-fast ice builds seaward. By January the leads have grown smaller and the ice considerably thicker. In February, 1953, the writer saw a cow with a calf in the open water near the floe edge 20 miles south of Coral Harbour. Sutton also recorded walruses there during April. Eskimos camping at Ruin Point on the northeast side of Fisher Strait usually hunt them at the floe edge in March.

They follow the leads and appear in the vicinity of Roes Welcome Sound and south along the shore lead off the west coast of Hudson Bay. There is always some walrus movement in the sound in autumn and winter. They frequently haul out near the mouth of Wager Inlet, and may drift down the sound on the ice from there or from Repulse Bay. They may be found a considerable distance up the sound in winter (Nourse, op. cit.); perhaps only one winter in four does the sound freeze over completely. The Eskimos say that happens only when a strong west wind blows for several days and cold persists. The west wind holds the pack ice against the west shore of the island and prevents it from being carried along by the strong currents of the sound to break up newly-formed ice.

Sutton reported large numbers of walruses seen by the Eskimos during January at Capes Kendall and Low, and also remarked that they may winter in the open water off Seahorse Point.

During the winter the prevailing northwest wind constantly breaks off the land-fast ice in the Cape Dorset region and along the south coast of Hudson Strait, and the break-up comes earlier there than on the west coast of Hudson Bay. Walruses may then wander through Fisher and Evans Straits to the open water around Cape Dorset. In summer when the ice melts or drifts out over deep water, they usually remain close to land where they are able to haul out.

At the north end of Southampton, they are found on the drifting ice in Duke of York Bay in summer

and autumn. In winter they retreat to the open leads in Frozen and Comer Straits, around White Island and Vansittart Island. Freuchen (1935) saw a cow and calf in Frozen Strait in January. R. Milligan of the Hudson's Bay Company told the writer in 1955 that walruses are found occasionally in winter off the floe edge in the outer part of Repulse Bay.

Most of the bulls are still with the cows at the middle of July. The sea ice breaks up about that time and the walruses in Fisher Strait haul out on land. Thus, in late July 1954, a large herd was seen on Walrus Island in which the mature bulls formed a large percentage. The percentage of bulls appeared to decrease in late July and early August. At that time the herds apparently swim across the strait to Bencas and Coats Islands. On August 7 the writer met several small pods of cows and calves swimming in the direction of Bencas. They haul out on the east side of that island and along the north and east coasts of Coats Island. On August 8, in a herd of 75 on Bencas, a cow and a bull seen previously on Walrus Island were identified by tusk abnormalities. There were few bulls in that herd on August 8 and fewer still on the 9th.

From Bencas they seem to move eastward along the north coast of Coats Island and south around its northeast cape. That pattern of movement was indicated by a tag return from a walrus tagged near Bencas, and by identification off Coats of several walruses seen previously off Bencas. According to the Eskimos most of the walruses leave Coats during late August and early September and swim across to Seahorse Point.

Foxe Basin.- In Foxe Basin there is a general northward movement in winter. Walruses begin to appear along the floe edge at Igloolik in October when the first shore ice is forming. They are found all winter from the northern tip of Melville Peninsula to Cape Wilson, especially off the floe edge at Foster and Parry Bays. By early March the floe edge almost parallels the east coast of the peninsula. The Igloolik Eskimos are able to hunt walruses along it when an east wind combines with the tide to bring the Foxe Basin pack ice towards the landfast ice. The walruses either drift in on the pack ice or are driven before it; as it becomes more tightly packed, they keep to the open water on its western edge and are forced in towards the floe edge. The writer saw walruses being brought in with the pack ice when

spending a few days at an Eskimo camp on the south shore of Foster Bay in late March, 1953.

In the spring as the ice recedes and breaks up, walruses leave the Igloolik area and retire to the vicinity of the Spicer Islands. They are found in August hauled out on those islands or the nearby ice. The Eskimos believe they breed in that area. Formerly they hauled out in summer in considerable numbers on the North and South Ooglit Islands. A few continue to do so although they have been heavily hunted on that well-travelled coast, according to W. Calder of the Hudson's Bay Company reporting in 1953.

According to Manning (1943a) they are uncommon on Melville Peninsula south of Cape Wilson. He does not record them from the east side of Foxe Basin north of Cape Dorset (1943b).

As previously mentioned, under certain conditions some of the walruses of northern Foxe Basin may drift down with the Foxe Basin ice to Seahorse Point where they may meet those from Southampton Island. If the wind is from the north or west the ice moves out through Hudson Strait and the Foxe Basin walruses are found around Nottingham, Salisbury, and Mill Islands. In some years the Coats Island-Seahorse Point walruses may also move out to those islands in late September and October. There they may be hunted by the Eskimos from Sugluk and Cape Dorset.

Walruses occur in the northern part of Foxe Basin near Jens Munk Island. Although Fury and Hecla Strait usually remains open throughout the winter the writer does not believe that walruses move through it to the west. Father Treboal, O.M.I. reports that walruses are found near Crown Prince Frederick Island, but the writer suspects that they probably drift into the Gulf of Boothia from Prince Regent Inlet.

Baffin Bay and Davis Strait.- Walruses can winter in northern Baffin Bay and Davis Strait, the "North Water" of Hare and Montgomery (1949), as large areas remain open all winter. They drift on the pack ice, leaving it only when it carries them over water too deep for foraging. According to Vibe (1950) who has well documented their distribution and movements, they winter in considerable numbers between Northumberland Island and Etah, in the outer half of Jones Sound, and between Holsteinsborg and Egedesminde. All those places have extensive areas with depths less than 100 metres.

Along the west coast of Greenland they move north as the land-fast ice recedes, exposing the coastal mollusc beds. They move south again in late autumn when those areas freeze over. However, some apparently migrate from the Etah district across Kane Basin to Buchanan Bay, Ellesmere Island, where there are said to be considerable foraging grounds. Vibe reports that they do not winter there, but drift south with the ice. Some may winter in the outer half of Jones Sound and some are found in Lancaster Sound both in summer and winter. Soper (1928) stated:

> "Walruses are numerous in Smith Sound, in Jones Sound along the coast of Ellesmere, in Lancaster Sound and in Wellington Channel."

Dr. D.C. Rose, chief scientist on the H.M.C.S. Labrador reported seeing herds in Smith Sound totalling 100 to 200 during August, 1954. Mr. Ross of the Hudson's Bay Company informed the writer that walruses are found in Admiralty Inlet and Navy Board Inlet, northern Baffin Island, but are never common. Dr. Van Tyne stated in an interview in 1956 that Eskimos from his party reported walruses at the floe edge in June, 1954, near Button Point, southeastern Bylot Island. Along the east coast of Baffin Island walruses are reported numerous in the vicinity of Clyde Inlet. Later in the summer they are reported from Padloping. Wynne-Edwards (1952) reports seeing a herd of over 100 in August, 1950, off the northeastern cape of Padloping Island. According to Vibe (op. cit.) the walruses continue south along the east coast of Baffin Island and congregate in the Cumberland Peninsula area. In the late autumn they begin to appear on the ice out in Davis Strait. Apparently later in the spring they continue their eastward movement across Davis Strait to the Greenland coast where they move northward following the open leads. In the spring of 1951 the captain of a Norwegian sealer the Polarquest reported seeing large herds of walruses on the drifting pack ice in Davis Strait. (H.D. Fisher, personal communication, 1956.)

Both Vibe (op. cit.) and Freuchen (1935) note that harpoon heads or bullets recognized as having come from northern Baffin Island are found occasionally in walruses taken in northwestern Greenland. Similarly, Eskimos of northern Baffin Island are said to find harpoon heads from northern Greenland. This appears to confirm

the supposition that the walruses of Baffin Bay and Davis Strait belong to the same herd and that they have very widespread distribution and undertake considerable migrations.

In summary, the above account describes a counter-clockwise movement north along the west coast of Greenland, with some walruses crossing to Ellesmere Island, going south along the east coasts of Ellesmere and Baffin, and crossing back over Davis Strait to Greenland. As Vibe points out, the complete migration is probably not accomplished in one year. The distance is so great that the walruses probably winter several times along the way.

The extreme northern limit of distribution of the Atlantic walrus is 81°10' north latitude in Kane Basin (Johansen, 1912).

Arctic Archipelago.- Walruses have been reported from the waters surrounding Devon Island and from farther west in Barrow Strait to the west side of Cornwallis Island at least.

From Lancaster Sound they apparently drift southward on the ice down Prince Regent Inlet. They were formerly reported common at Port Leopold and Fort Ross (Learmouth, interview, 1952). Ross (1835) reported them from northern Prince Regent Inlet but said that they did not occur in the Gulf of Boothia. Until recently this was believed to be still the case, but Father Van de Velde, O.M.I. informed the writer in 1953 that a few are found in Lord Mayor and Tom Bays, on the west side of the gulf. Constable Sargent of the R.C.M. Police reported a walrus shot in 1951 near Ross Peninsula on the south side of Lord Mayor Bay. It was previously noted that they have been recorded from Crown Prince Frederick Island.

Extralimital Records

Records from the western extreme of the range of the Atlantic race or the eastern extreme of the Pacific race in North America are of particular interest because they indicate to what extent the two races remain discrete. Unfortunately most of the records were made by whites or Eskimos unfamiliar with either race. Accordingly it is impossible to determine which race they represent extensions of. Records of extreme southern occurrences are less significant; they usually refer to individuals that drifted on the ice down the Labrador coast.

Mr. Learmouth of the Hudson's Bay Company informed the writer in 1952 that some years earlier a walrus was found on one of the islands at the mouth of Bathurst Inlet. Tommy Goose, an Eskimo from Holman Island reported that in 1952 a walrus was killed near that island and the carcass was later found on the ice in Stapleton Bay. Johnny Norberg of Read Island stated that a walrus was shot in the spring of 1952 in Simpson Bay on the north side of Dolphin and Union Strait. He also referred to one found dead on the ice some 40 miles southwest of Read Island in the spring of 1952, apparently the one that Goose mentioned.

Anderson (1946) cites the following cases, apparently eastern extensions of the Pacific race.

> "A few casual records on the north coast of Alaska; one from Herschel Island, Yukon, and one reported by Eskimos stranded in Dolphin and Union Strait prior to 1914. Recent (1942) reports from western Eskimos colonized on west coast of Banks Island state that walrus are taken now and then on Herschel Island and on the west coast of Banks Island; probably referable to the Pacific form, although there is a possibility that eastern walrus may occasionally work around the north of the Arctic Archipelago."

Lewis and Doutt (1942) state that during the previous 60 years there had been five records of walruses in the Gulf of St. Lawrence, for the months of April, May, June, July, and December. All were from east of Cape Whittle. Wright (1951) reports a large male walrus killed in April, 1937, by two fishermen near Bear Cove at the mouth of the Bay of Fundy.

PHYSICAL DESCRIPTION

General Form and Structure

The walrus is the largest arctic or subarctic carnivore. Among the North American pinnipeds it is exceeded in size only by the elephant seal Mirouanga angustirostris (Gill). Morphologically it exhibits some remarkable characteristics of a land vertebrate adapted to an aquatic environment.

Its body is large, buoyant, and fusiform. Both anterior and posterior appendages are adapted for swimming and the posterior pair can be rotated forward to aid it in terrestrial locomotion. The tusk-like development of the upper canines in both sexes distinguishes it from all other pinnipeds. As the temperature of its arctic environment is cool and relatively constant, it normally has, in common with other arctic pinnipeds, a thick layer of subdermal fat or "blubber", which gives it insulation, buoyancy, and a reserve food supply.

Adult males are larger and more massive, particularly in the chest, shoulders, and neck, than adult females. Their tusks are usually longer and somewhat thicker in cross-section than those of the females.

The muzzle of the walrus is blunt anteriorly. Externally it is delimited by the fleshy mystacial pads on either side. Thick, quill-like vibrissae protrude from the pads; they are referred to as mystacial vibrissae. They vary in length in different individuals and apparently wear short in older animals. They are longest laterally and shortest medially (Figs. 6, 7). The average length of the longest vibrissae in the adults is between three and four inches; the longest measured (6.5 inches or 165 mm.) were those of a female. Allen, J.A. (1880, p. 28) gave lengths of only 2.25 and 2.75 inches for the vibrissae of walruses he examined.

The muzzle is mobile. The writer observed a walrus "yawning" and noted that when the lips were stretched the tension caused the vibrissae of each pad to elevate slightly and contract medially. The function of the vibrissae has not been determined definitely; it seems likely they play a role in food gathering, probably both sensory and mechanical. Howell (1930, p. 77) mentions a record of a captive walrus using the bristly mystacial pads to tear the flesh from a seal.

The eyes are small in proportion to the size of the animal and laterally located. The ear opening is small and has no external pinna, being surrounded by a fold of the skin. The nostrils are almost crescent-shaped; from observations of living animals they appear to be quite distensible. They are closed before submersion and kept closed under water.

The tail is short, varying in length from two to three inches. The caudal vertebrae are enclosed in a

fleshy fold of the integument, making it difficult to obtain accurate tail length measurements.

Allen, J.A. (1880, p. 27) gives the following graphic description of the appendages:

> "The fore limbs are free only from the elbow; as in the Pinnipeds generally, they are greatly expanded, flat, and somewhat finger-like, but with much more freedom of motion than is the case in the Phocidae. They are armed with five small flat nails, placed at a considerable distance from the end of the cartilaginous toe-flap. The first or inner digit is slightly the longest, the others being each successively a little shorter till the fifth, which nearly equals the first. The hind limb is enclosed within the teguments of the body nearly to the heel; the free portion when expanded is fan-shaped, but when closed the sides are nearly parallel. The first and fifth digits are considerably longer and larger than the middle ones, the fifth being also rather larger than the first. They are all provided with small nails, placed at some distance from the toe-flap. The soles of both fore and hind extremities are bare, rough, and "warty", and the dorsal surface of the digits as far as the proximal phalanges is also devoid of hair."

The penile opening lies rather far forward - in adult males usually seven to eight inches posterior to the navel. There are no external genitalia. The four mammary nipples of the female lie within folds of the skin. The anterior or abdominal pair are situated 22 inches in front of the posterior or inguinal pair, and three to six inches in front of the navel.

Size and Weight

The body length, tusk length, and weight of specimens collected are shown in Table I. The average length of 14 adult males was 2,816 mm. (110.8 in.), the longest being 3,150 mm. (124.0 in.). The average length of 12 adult females was 2,578 mm. (101.5 in.); the longest measured 2,900 mm. (114.0 in.). The average weight, less blood, of five adult males was 1,456.8 lbs.; the largest weighed 1,923.0 lbs. (blood weight 150 lbs.). The average weight of five adult females was 1,255.2 lbs.; the largest weighed 1,485.0 lbs. The males in the series averaged 9 per cent longer and 16 per cent heavier than the females.

Table II gives detailed body measurements of seven males and eight females of various ages.

In Table III, average lengths obtained by various authors are compared with those from the present study, which are less than any of the others. Sutton's measurements are particularly interesting, as his specimens were from the same area as the writer's. The large male measured by Sutton was two feet one inch longer and two feet two inches greater in girth than the largest measured by the writer. However, several bulls were observed hauled out on land that appeared much larger than any of those collected. Also, the generally small size of the walruses of the northern part of Hudson Bay may indicate that they are subject to heavy hunting pressure. An Eskimo who had hunted at both north and south ends of Southampton Island was firmly convinced that bulls in Duke of York Bay were much larger than those from the south side of the island.

Valid comparisons cannot be made with the measurements given by many of the earlier writers, who appear to have recorded the length from the nose to the end of the extended hind flipper. This accounts for their references to walruses 13 to 15 feet in length. The male Atlantic walrus probably attains a maximum length of 12 to 13 feet and a maximum weight of 2,500 to 3,000 lbs. Such large individuals will likely be recorded in future only from populations not subject to heavy hunting pressure.

Skull Measurements

Detailed skull measurements from 15 Atlantic walruses of both sexes and various age classes are presented in Table IV. In some cases it was not possible to record all measurements because portions of the skull had been shattered by bullets. In some old animals it was often impossible to delimit sutures, especially in the measurement of the nasal bones.

The series is not large enough for specific conclusions to be drawn regarding age-class and sex differences. However, it can be seen from the table that there is a considerable variation in individuals. With age, the bones of the skull and the processes for muscle attachment increase in thickness. Sexual differences, especially in the rostral area, are probably connected with greater development (thickness) of the canines in the males.

Integument and Pelage

An excellent graphic description of the integument and pelage is given by Chapsky (1936):

> "The hide surface of the walrus is distinguished by typical foldings, especially developed in the ventral part of the body, the folds (of which there are normally about eight) developing already in the embryonic stage. Besides the ventral folds there are analogical creases in the neck, at the base of the anterior fins, in short on those spots of the body that are the most in movement. Besides the distinctly marked folds the hide shows a dense net of cross wrinkles.
>
> Another characteristical peculiarity of the integument are the numerous and various traces of chiefly traumatic injuries, which have the appearance of pale angular spots concentrated on the anterior part of the body. Besides that the hide of the adult males possess a strongly pronounced tubercularity, which there is every reason to regard as a secondary sex feature."

For a detailed account of the pelage the reader is referred to Chapsky's paper. The writer can add little to his admirable treatment but to confirm his remarks concerning the various colours of individuals. The impression received in viewing a herd of walrus hauled out on land is of a general cinnamon to light grey colour, if the animals are dry. However, individuals, mostly males, are often suffused with pink or rose. That coloration is particularly noticeable at the base of the front flippers, the ventral thorax, and the throat. In some areas, especially on the throat, the pink is not solid, but shows only through the cracks in the skin between the scars and tubercles. Very old animals often appear very light in colour; this appears to be due to the fading of the pigment cells in the epidermis. In most cases such animals are almost without hair, which is rubbed off during the years. During the summer they looked very fat, as they had little folding of the skin along the sides, ventrally, or at the base of the neck, and the skin of the neck and chest was relatively smooth and unscarred.

Brooks (1954) agreed with Chapsky that the lumpy character of the skin of the neck and shoulder regions of the bulls is a secondary sexual characteristic.

From observation of bull walruses fighting the writer is rather inclined to believe that the lumps or warty protuberances result from the fighting. As noted later in the section on behaviour, the bulls inflict numerous tusk wounds on each other, and the wounds appear to become infected, suppurate freely, and finally heal, leaving considerable scar tissue.

The epidermis and connective tissue dermis together measure about one-half inch (13 mm.) in thickness in the midventral region.

Adipose Tissue

In the walrus, fat is not stored in the omenta and mesenteries, but chiefly as a subdermal layer of adipose tissue, the "blubber". A considerable amount of fat is also found in the muscle tissue.

The blubber appears to vary in thickness from season to season and in various age classes and sexes. In mature animals during the months of July to September, the thickness varied in the midventral region from four to six centimetres. The Eskimos believe that the blubber of the mature males increases in thickness in winter and decreases during spring and early summer, and that in cows it increases in thickness during pregnancy. As yet insufficient data have been gathered to corroborate that belief.

Skeleton and Musculature

The skeletal structure of the walrus is discussed in detail by Allen, J.A. (1880) and the musculature of a young walrus by Murie (1872). The writer has nothing to add to those descriptions.

The growth and structure of the baculum is presented in another section.

Internal Organs

The internal organs of the walrus are adapted to its arctic marine existence. It has a well developed circulatory system, with a large heart and blood vessels, and stomach and intestine developed for large ingestion and rapid digestion and assimilation.

Murie (op. cit.) gives the following measurements for the intestine of a young walrus four feet long;

"..... entire gut including caecum 76' 1½", small intestine 75', great intestine 1' and the caecum 1½"."

The liver is proportionately large, probably for the storage of energy reserves. As previously noted, adipose tissue is not stored in the mesenteries.

Table V gives the weights of internal organs of a male walrus weighing 2,084 pounds including blood weight, collected August 10, 1954, and weighed in the field.

The walrus has a pair of unique pharyngeal pouches. According to Brooks (1954) there are two out-pocketings on either side of the glottis. Several authors have attributed various functions to the pouches. Vibe (1950) discounts the theory that they may be connected in some way with the storage of food, and favours the hypothesis that they are inflated to support the animal's head while it sleeps in the water. Brooks also favours that hypothesis. The writer observed walruses sleeping in water in a vertical position and the Eskimos said they were kept erect by the inflated pouches. They may have a secondary use as a resonating device for the voice.

Dentition

There was formerly considerable controversy over the dentition of the walrus. Allen, J.A. (1880) summarized the discussion up to the date of his publication. Most of the confusion arose from abnormalities and variation from the normal pattern apparently caused by resorption of the successional tooth battery.

Cobb (1933) provides an excellent, detailed account of the dentition and gives the following formulae:

$$\text{Deciduous } I\ \frac{3}{3}\ C\ \frac{1}{1}\ PM\ \frac{3}{3} = 28$$

$$\text{Successional } I\ \frac{2}{0}\ C\ \frac{1}{1}\ PM\ \frac{4}{3}\ M\ \frac{1}{1} = 26$$

$$\text{Functional } I\ \frac{1}{0}\ C\ \frac{1}{1}\ PM\ \frac{3}{3}\ M = 18$$

Brooks (1954), in dealing with the Pacific walrus shifts the incisors from the deciduous to the successional battery:

Deciduous $I\ \frac{1 \text{ or } 2}{0}\ C\ \frac{1}{1}\ PM\ \frac{3}{3}$

Successional $I\ \frac{3}{3}\ C\ \frac{1}{1}\ PM\ \frac{4}{3}\ M\ \frac{1}{1}$

Functional $I\ \frac{1}{0}\ C\ \frac{1}{1}\ PM\ \frac{3 \text{ rarely } 4}{3}$

Dental formulae for 15 skulls in the series collected are presented in Table IV. Six, designated (F) in the table, have the functional battery corresponding to Cobb. Three of those designated (S/F) have a fourth upper premolar, probably that of the successional battery since other characteristics of the successional battery are present; and in all the specimens so designated, although a functional battery is dominant, remnant teeth of the successional battery, a lower incisor or a lower molar or both, are present. The remnant teeth were in various stages of resorption and were usually small. No specimen had more than two upper incisors or one lower incisor, which suggests that those teeth are probably resorbed during the first year.

One specimen in the writer's series had one less upper premolar than normal, and one collected by Dr. W.H. Burt in southeastern Hudson Bay had one less lower premolar than normal.

Data concerning the deciduous battery have not been obtained, as the foetal material has not been examined.

A unique modification of the functional molariform teeth of the walrus is hypercementosis - the presence of extreme amounts of cementum built up by accretion externally to the dentine. Apparently it occurs only in the walrus and the hooded seal, Cystophora cristata (Erxleben). In later years the diameter of the outer layer of cementum may exceed half the diameter of the whole tooth, thus quadrupling its functional surface. Cobb (1933) suggests that the phenomenon may be the result of abusive pounding received by the teeth in crushing the shells of molluscs. Definite concentric rings or layers of cementum were found in preparing tooth cross-sections. The function of these layers was not determined.

Tusks

The walrus is characterized by tusks - the extreme development of the upper canines in both sexes. The tusks are used for obtaining food, for fighting, and as an aid in hauling out on ice.

When the upper canine penetrates the gum line three to four months after birth, it is capped with enamel. Growth is of the kind known as growth from a persistent pulp - the addition of concentric cones of dentine proliferated from the pulp cavity. At one year of age the tusk is one to two inches in length. At two years of age it is two to three inches in length and the enamel cap is usually worn away. Growth decreases with age and ceases in very old animals.

In the meanwhile abrasion takes place on the anterior surfaces, and to a lesser extent on the lateral surfaces, of the distal tips, apparently from the wearing of the tusk on the sea bottom in feeding. At first growth exceeds wear, but as growth decreases, wear becomes the greater, and the tusk may be gradually worn away. very old animals with tusks worn down to six inches or less are not uncommon.

During growth, a thin layer of cementum is added to the external surfaces of the tusk, but it does not build up to as great an extent as on the molariform teeth.

As downward growth ceases, a polished concavity frequently forms on the medial surface of the tusk ventrally to the lower jaw. The writer believes that it results from the jaw rubbing against the tusk (Fig. 20). The wearing goes on through life but becomes obvious only when growth has stopped and the rubbing continues at one place for a long time. Among the walruses examined, the concavity was noted to be deepest in several old females, possibly because the bases of the tusks are closer together in females than in males.

Information concerning the growth and alignment of the tusks was obtained from the examination of 39 specimens and from observation of several hundred walruses hauled out on land. The terminal position of the tusks varies considerably in different individuals. The tusks of the males are larger in cross-section, especially at the base, and usually more strongly recurved than those of females. Formerly it was supposed that the tusks of males tend to diverge at the tips more than those of females (Allen, J.A., 1880, p. 35). From Table IV

it can be seen that in four of the five males and five of the six females the tusks diverge distally and the distance between the external edges of the tusks is greater at the tips than at the base. Individuals of either sex may have tusks that converge and even touch at the midline. The Eskimos said that in some cases they may even cross at the tip. Differences in the anterior-posterior angle of protrusion of the two tusks may occur in some individuals, so that the tips of the tusks are diagonally displaced.

Animals with one or both tusks broken off are fairly common (Fig. 6). This may result from their being hit by rifle bullets or from accidents. The animal in Figure 11 apparently broke off its small (approximately six-inch) tusks in attempting to extricate itself from a rock crevice.

Pomeolik, one of the Southampton Island Eskimos, reported that he once saw a walrus at Seahorse Point that had three tusks, two growing from one side. Allen, J.A. (op. cit.) mentions that Captain Lyon obtained the head of a small walrus which had three tusks, two growing from the right side, one behind the other.

Tusk lengths of some of the specimens collected are shown in Table I. The longest for males and females respectively are 361 mm. (14.3 inches) and 314 mm. (12.4 inches). None of them is considered exceptionally long. Dr. Burt collected a male in the vicinity of the North-east Sleeper Islands in 1953, with a tusk length of 440 mm. (17.3 inches) and weight of 3 pounds 13.5 ounces. Tusk lengths for the Atlantic walrus probably never exceed 600 mm. (23.6 inches).

REPRODUCTIVE BIOLOGY AND VITAL STATISTICS

A general understanding of the reproductive biology and vital statistics of the walrus resulted from the present investigation. To manage the species successfully, more information is needed on the age at sexual maturity of both sexes, the reproductive capacity of the individual, and the annual increment, as well as on the annual sexual cycle and sexual behaviour of the animal.

Calving

The time and place of calving of the Hudson Bay walruses is not known exactly. The Eskimos of the

region believe that the females give birth to their young on the floating ice from April to early June. Females with young of the year were observed on Walrus Island in late July, 1954. From their large size and the fact that their navels were healed, it was concluded that they had been born at least one or two months before. Dr. H.D. Fisher (personal communication, 1956) informed the writer that the captain of the Norwegian sealer Polarquest reported calving under way on the pack ice of Davis Strait in the spring of 1951.

Chapsky (1936) thought that the calving period of the walruses of the Kara Sea was approximately from April to early May. Vibe (1950) believed that walruses in the Thule district calve in late May or early June.

Measurements and weights of foetuses collected during the present study are given in Table VI. Foetuses collected on the same date differed considerably in size, indicating that the breeding period is extended. Vibe (op. cit.) states:

> "The female walruses which were caught in the last part of September might often have small foetuses measuring 10-20 cm., while the females which were caught early in the spring in February-March often had large well developed foetuses of the size of a small seal. A walrus caught on March 6th, 1941, thus had a foetus 0.98 m., a female. The gestation period is thus less than twelve months, perhaps about 10 months."

It will be noted from Table VI that the foetuses collected from Southampton Island in late September were one and one-half to two times as long as those collected by Vibe in the same period. This may indicate that mating takes place later in the more northerly waters. The young would thus be born at a later and presumably more favourable time.

That calves may occasionally be born earlier than usual is documented by Freuchen (1935):

> "January 31st a cow walrus with a newly-born calf caught in Frozen Strait. An Eskimo also caught one with a similar calf (the unbilical cord had not yet fallen off). None of the calves could dive down more than half a minute at a time."

There is no information to suggest twinning in walruses. Gibbons (personal interview, 1952) stated that he had never heard of finding twin foetuses *in utero*.

The Rut

The breeding period in the walrus appears to coincide to some extent with the calving period, although it probably extends somewhat later. According to the Southampton Island Eskimos, the rut occurs from June through early July while the animals are on the pack ice. They did not report observing the pairing act. At that time of year, travel by dog team is restricted to the narrow coastal ice shelf, and normally there is no travel by boat.

Walruses are often taken by the Eskimos in March off the floe edge at Ruin Point, Southampton Island, on the north side of Fisher Strait. In early June they often encounter mixed herds on the pack ice near Walrus Island. The herd observed at Walrus Island in late July, 1954, still included both sexes but by early August the bulls had commenced to leave. For these reasons the writer believes that mating may occur on the pack ice in Roes Welcome Sound and Fisher Strait.

The writer has no definite information whether walruses are monogamous or polygamous, but several considerations suggest that they are polygamous. In common with other polygamous pinnipeds, the mature males are considerably larger than the females. The aggressive behaviour of the adult bulls towards the subadult bulls is also characteristic of a polygamous species. The larger bulls easily dominated those from four to seven years of age in battles for position. Usually the large bull would have only to threaten or strike a single blow to drive the younger one out of the way. Bulls are mature at about five years of age, but the writer does not believe they mate normally until they are large enough to compete for mates with the older bulls.

As the walrus bull is incapable of rapid movement on land or ice, it probably does not collect a large harem as, for example, the bull fur seal does. Marauding bulls could easily separate cows from the fringe of the harem before the bull in charge could overtake them. It seems likely that the bulls attempt to mate with any unguarded cows that are receptive.

Besides mating on ice, some mating may take place in the water. It is assumed that cows with newborn calves are not receptive.

Sex Ratio

Few sex ratio data were obtained during the present investigation. Sex determination of walruses in large herds hauled out on land was difficult, unless an elevated vantage point was available. They lie so close together that the genital openings are often visible only on those around the periphery. Also, the females with calves often left the land and counts could not be representative. Probably the most favourable time for sex segregation is just after the mating period. Aerial photographs of the herds on the ice at that time may prove reliable.

Of six foetuses examined, four were males. Of seven sub-adult walruses (one to four years of age) collected, four were males. Because of hunting selectivity, no sex segregations of adult animals were made from the animals collected from the hunt.

Age at Sexual Maturity

Histological examination of formalin-fixed testes has not yet been undertaken, and no definite data concerning the age of sexual maturity or the season of greatest spermatogenesis are available. Chapsky (1936) states that males reach the age of puberty at the age of five years. He found little or no spermatogenesis in testes of animals collected during August and October.

Data on the testes dimensions and baculum lengths and weights are given in Table VII. The testes show a gradual increase in size, nearly doubling in length and width, from yearling age to adulthood. The bacula increase in length more than four times and in weight more than 100 times during the same period.

Data on the measurements of the ovaries collected during the present study are given in Table VIII. They have not yet been examined histologically. Chapsky (1936) gives the minimum age at sexual maturity for females of the Atlantic race as four years at the youngest.

Gestation Period

If the calving period is from April through May to early July, then the gestation period of the walrus must be in the order of 10 to 11 months. As foetuses examined in late September were small in size, it is possible that delayed implantation occurs.

Breeding Frequency

Chapsky (1936) and Brooks (1954) both state that female walruses breed in alternate years. Brooks concludes from his investigation of the Pacific race that old cows may breed only every third year.

Of the 16 females collected during the present investigation, 12 were of breeding age (four years or older) and six were pregnant. The ratio of pregnant to non-pregnant in the small sample is therefore 1:1. A much larger sample is required for certainty, but the ratio suggests that the females breed every other year after maturity. Gibbons, an Eskimo, said he believed that they breed in alternate years because they are fat only in alternate years and seem to suckle their young for a year or longer. As evidence that they do so, a calf approximately 16 months old, collected in September, 1953, had some partly digested milk in its stomach.

It seems likely that breeding in alternate years is the rule under normal circumstances. However, if a cow loses her calf shortly after its birth and no extensive lactation takes place, she probably breeds that season.

Annual Increment

An accurate figure for the annual increment on the walrus population of the Southampton Island area cannot be calculated until quantitative information is available on the sex ratio and age-group composition. However, such a figure is of so great importance in management that a theoretical figure has been postulated upon the following assumptions:

(1) an equal ratio of males to females;
(2) an average life span of 30 years;
(3) females sexually mature at four years of age;
(4) females barren during last four years of life;
(5) females bearing young in alternate years;
(6) complete impregnation of all fecund females.

Based on these assumptions, 73 per cent of the females, constituting 36.6 per cent of the total population, are of breeding age. In any year, 36.6 per cent of the females, or 18.3 per cent of the population bear calves. The last figure is the highest theoretical annual increment.

In a "real" population there would undoubtedly be proportionately more immature, non-breeding females. However, there would also be fewer old, barren cows. The two factors tend to cancel each other.

From a similar calculation using 40 years as the average life span, the annual increment would be 20 per cent of the total population.

If the sex ratio of females to males was 60:40, then the annual increment would be 22 per cent of the total population. With a reverse sex ratio (i.e. females to males 40:60) the annual increment would be 14.6 per cent of the total population.

All the above figures represent theoretical increment. The "real" increment would be somewhat lower than the theoretical through the combined effects of incomplete impregnation of fecund females and losses of foetuses and calves. At present it is not possible to evaluate those factors. The writer believes that the average annual calf crop, or increment, is between 12 and 20 per cent. The figure of 15 per cent is probably close enough for management purposes.

FOOD AND FEEDING HABITS

It has been pointed out that the walrus is a bottom feeder, largely upon bivalve molluscs. The tusks are no doubt a dental adaptation for procuring that type of food. The extreme hypercementosis of the functional molariform teeth is probably another dental adaptation for feeding.

Vibe (1950) states that molluscs form the main food item of the walruses of the Thule district, and lists the following species in order of preference: Cardium groenlandicum, Cardium ciliatum, Mya truncata, Saxicava arctica, and, in lesser quantities, Astarte borealis and Macoma calcaria. Those molluscs were found in the stomachs of walruses that had foraged at depths of 15 to 80

metres. Lamellibranchs of the genus Cardium were commonest in the stomachs of animals that had fed in shallow water, while the others were found mainly in the stomachs of those that had fed in deep water.

Location of Feeding Grounds

Vibe (op. cit) states that 80 metres is probably the maximum depth a walrus will dive for food. The above-mentioned molluscs are found in greatest numbers in shallow arctic and sub-arctic waters, usually less than 100 metres deep, with gravel and mud bottom. From the bathymetric map presented by Dunbar (1951, p. 21) it was noted that considerable stretches of the coastal waters of Hudson Bay, all Foxe Basin, a narrow shelf off eastern Baffin Island, and Ungava Bay are 100 metres or less in depth and hence suitable walrus foraging grounds.

Walruses seem to prefer to feed where either drifting ice or land areas suitable for hauling out are near at hand. Especially cows with calves appear to want to spend part of the time out of water. As mentioned in the section on distribution, the lack of suitable hauling-out areas may account for the absence of walruses in summer from the west coast of Hudson Bay south of Eskimo Point.

Time and Seasonal Pattern of Feeding

During the breeding season, and to a lesser degree throughout the early summer, adult male walruses do not appear to feed extensively. Of eight adult males collected during July, August, and September, six had empty stomachs. Pregnant or nursing females and immature walruses appeared to feed regularly throughout the year.

According to reliable Eskimo hunters, the walruses do most of their feeding in early morning, then haul out on land or ice and feed only sporadically, if at all, throughout the rest of the day.

They continue feeding in autumn in the shallow coastal waters until the ice becomes too thick (about two inches). Some Eskimos informed me that occasionally walruses keep breathing holes open in the shore ice by scraping with their tusks after it becomes too thick for them to break. In general, however, they retreat before the shore ice into open water. In areas where the shores

are precipitous and the water deep, shore ice may prevent them from obtaining food in shallow water and force them to emigrate or turn to other foods, such as seals.

Method of Feeding

The molluscs the walrus feeds on usually lie buried in several inches of mud and gravel. In feeding it dives to the bottom and assumes an inverted vertical position or "stands on its head". That wear on the tusks occurs on the anterior and lateral surfaces of the distal tips seems to indicate that it ploughs or scrapes the bottom with its tusks by a sideways and forward thrusting motion of the head. Johansen (1912) states that walruses feed by moving backwards and raking the bottom with their tusks. However, the lack of wear on the posterior surface of the tusks discounts this hypothesis.

The question of how the walrus ingests bivalve molluscs has long aroused the curiosity of zoologists. Recent investigators have found that the greater part of the stomach contents is made up of the fleshy feet and siphons of various species of Cardium, Mya and Saxicava, (Vibe, op. cit.; Brooks, 1954). Several accounts of stomach contents of walruses were reviewed; few refer to the presence of mollusc shells; in fact the absence of shells is usually commented upon. Allen, J.A. (1880), citing Malmgren, states as follows:

> "By the aid of their grinding teeth and tongue they remove the shells, and swallow usually only the soft parts of the animal. Only once among many thousands examined did Malmgren find any to which a piece of the shell adhered."

One record to the contrary appears equally incontestable. Elliot (1882) in his discussion of the habits of the Pacific walrus states:

> "I took from the paunch of the walrus above mentioned, more than a bushel of crushed clams in their shells, all of which that animal had evidently just swallowed, for digestion had scarcely commenced. Many of the clams in that stomach, large as my clenched hands, were not even broken ..... and it is in digging this shellfish food that the services rendered by the enormous tusks become apparent."

Several authors, including Vibe (op. cit.), report finding on the ice near the breathing holes, the spit-out remains of mussels. Most of them were empty shells, intact and connected, but some were whole mussels. Vibe suggests that the walrus bites off the foot or siphon of the mollusc. This seems improbable; the mollusc would undoubtedly withdraw the siphon as soon as disturbed by the foraging walrus, and moreover the walrus has no biting dentition. It seems more likely that the walrus crushes the shells of the large and heavy Cardium species with its molariform teeth, spits out the pieces of shell, and swallows the fleshy parts. The viscera and small pieces of shell must be digested much more rapidly than the dense tissue of the siphons. For that reason we could normally expect to find only the latter parts in a recognizable condition in the stomach contents. As Mya truncata and Saxicava arctica are not closed at the ends, their siphons and viscera may be sucked out and the whole shells ejected, a hypothesis also suggested by Vibe.

Stomach Contents

Fifteen of 20 stomachs examined during the period from early August to late September contained no food. One calf, previously mentioned, 1,270 mm. long and probably 16 to 17 months old, was found to have its stomach one-eighth full of milk, indicating that calves depend upon milk for at least part of their nourishment until they reach that age. The contents of the remaining stomachs have not yet been identified.

In several of the otherwise empty stomachs five to ten ounces of gravel was found. It is not known whether gravel is ingested accidentally in feeding or has some nutritional or mechanical function. Small piles of gravel were occasionally found on the hauling-out sites. Presumably they were defecated by the walruses and the soft parts of the defecations were washed away, leaving only the gravel.

Seal-Eating Habit

There are several accounts in the literature of walruses eating seals and other marine mammals. Gray (1939) cites Scoresby as finding the remains of seals in walrus stomachs and seeing in several instances walruses feeding on narwhals Monodon monoceros (Linnaeus). Brooks (1954) cites evidence that the Pacific walrus feeds occasionally on ringed seals Phoca hispida

(Schreber) and bearded seals Erignathus barbatus (Erxleben). Chapsky (1936) found pieces of skin and viscera from bearded seals in the stomachs of three walruses from the Kara Sea.

According to the Southampton Island Eskimos, they occasionally find the remains of ringed seals in walrus stomachs, usually only the skin with blubber attached. They said that the seal eaters are invariably males and can be recognized by their tusks, which are more than normally divergent, sharply pointed, scarred, and stained yellow by seal fat. Two males in the writer's collection showed those characteristics quite distinguishably. Their stomachs were found empty.

W.E. Taylor informed the writer that while visiting Coats Island with Eskimos from Southampton Island in July, 1954, they killed a walrus with fragments of seal skin in its stomach.

Eskimos in several localities in the Eastern Arctic reported seal-eating walruses commoner in the northern Baffin Island region than elsewhere. This may be because they are unable to obtain enough food of other kinds when the ice prevents them from reaching their foraging grounds.

Eskimos of the Southampton Island region consider the liver of the seal-eating walrus unfit for consumption. They say it is excessively oily and bad-tasting, although not considered poisonous like the liver of the polar bear. This is confirmed by Freuchen (1935, p. 250) who states;

> "September 14th. A number of walruses found in Repulse Bay. One of these tasted rank and bitter; the liver especially was almost uneatable, even to seasoned arctic travellers. It had seal-flesh, blubber and skin in its stomach, another confirmation that an old bull living on seals is unpalatable."

BEHAVIOUR

Walruses are essentially gregarious. They are usually found in herds of various sizes and only occasionally alone. In the water they may be found swimming in small pods of from several to a dozen, or, less frequently, in herds of up to several hundred. Hauled out

on the pack ice, a few dozen to a hundred may be seen on a small floe. If enough floating ice is available they are not so apt to crowd as closely together as on land. The writer has seen several herds of 300 to 500 and two groups of 1,000 hauled out on small rocky points or islands in northern Hudson Bay.

Those swimming in a pod stay quite close together. Frequently most of them break the surface and submerge in unison. Cows with calves or yearlings always keep them close, and the young walrus may at times ride on the back of the cow by grasping her back with its flippers. Even when closely pursued the pod does not scatter. This behaviour is distinctly to their disadvantage when hunted by the Eskimos, who can kill a large number in one drive. However, it is probably effective against natural predators such as killer whales and polar bears.

On land, certain localities are favoured for hauling out year after year. Certain features are common to all of them. They must be located adjacent to water that is sufficiently deep and has a shelving shoreline, so that the walruses can gain access from water to land or the reverse at either high or low tide. Shallow beaches are avoided because of the difficulty of getting over the exposed flats at low tide. In the northern Hudson Bay region the hauling-out areas seen were all situated on small islands or points of land of Precambrian rock. The rock surfaces might have frequent crevices and ledges but were usually smooth from glaciation and water erosion (Figs. 4, 9). On Bencas Island the hauling-out sites that had been used could be distinguished at a distance. The rocks on the sites seemed darker than the surrounding ones. Upon examination, it was found that the dark colour resulted from the accumulation of walrus hairs in the clefts of the rocks, especially about the perimeter of the site.

Individual Behaviour

Senses.- In the walrus, the sense of sight seems very poorly developed. It can probably distinguish large moving objects such as boats at a distance of several hundred feet. During the summer of 1954, an opportunity arose to test the visual perception of walruses hauled out on land. Approaching upwind, it was possible, by moving slowly and not presenting a silhouette, to crawl within 20 feet of a herd. At that point, the nearest

walruses usually became aware of the observer's movements, but apparently identified him as another walrus and relaxed their watch.

Its sense of smell is acute, and it seems to rely on that sense to a large degree to warn it of danger. The writer noted that a herd approached downwind by a man would stampede into the water even before they could see him. It also appears to rely on smell for warning when swimming or feeding in the water. Eskimos hunting walruses from the ice are fully aware of that and always approach feeding or resting walruses upwind.

Its sense of hearing seems fairly acute. However, there is little evidence that it relies much on that sense for warning. In many cases, the noise of water breaking on the ice or land and the clamour of the herd tend to obliterate extraneous sounds. On a calm day, hunters in the Igloolik region were able to elicit a response from animals feeding 1,000 yards away by imitating their voices.

The tactile sense of the walrus is probably not highly developed over the general body surface, even at the termination of the flippers. The thick integument and underlying layer of adipose tissue must render those surfaces fairly insensitive. It seems likely that the facial vibrissae are the only sensitive external tactile organs.

Voice.- Walruses are vociferous, especially when feeding in herds or hauled out on land or ice. In many cases, particularly when the visibility is poor, herds can be heard before they are seen. The adults have a number of vocal sounds, the commonest of which is easily imitated by human beings. A simple phonetic representation of the sound is a grunt-like "oogh", twice repeated. The calves, especially when separated from their mothers, call repeatedly. Their call is similar to that of the adults, but somewhat higher-pitched and more staccato. A threatening sound, usually uttered from the threat posture (Fig. 27), is made by exhaling through the lips. A single low, whistling note was heard occasionally; but whether it emanated from the buccal or nasal cavity could not be determined.

Locomotion.- On land the walrus is extremely ungainly and very slow and awkward (Fig. 3). When moving at leisure the following sequence is followed deliberately.

The fore flipper on one side is advanced. Then the other fore flipper is drawn up even. Next a hind flipper is advanced and then the other hind flipper brought into position. Finally the massive mid-section is "humped" forward in a ponderous caterpillar-like motion. Progressing over land in this fashion they pause, apparently to rest, every few yards.

In the water walruses are remarkably agile for such large animals. They have a maximum swimming speed of about six knots and can swim long distances. They usually swim with the whole body surmerged, just under the surface. The body is propelled through the water by the combined motion of the fore and hind flippers. The action of the fore flippers might best be described as a reverse breast stroke; they are extended, rotated at the shoulders, and pulled, with the webs extended, towards the chest. The whole body sways slightly from side to side and the hind flippers, which are kept parallel, move back and forth with a rudder-like, sweeping motion. After swimming several hundred feet under water the animal breaks the surface head first and swims with its head above water long enough to regain its wind.

Walruses usually emerge to land or ice where the gradient is not too steep. The writer has seen them take advantage of wave action to ascend when the water was rough, but in no case did one use its tusks for aid in coming to land. However, when hauling-out on ice they often hooked their tusks over the edge and dug them in as they drew themselves out of the water. Hauling out on land, walruses, if not disturbed, often remain for some time at the edge of the water, apparently resting.

Entering water from land or ice they move deliberately if not frightened. If, however, they are attempting to escape, they slide, dive, or even fall sideways into the water.

Walruses were several times seen floating motionless. One bull turned over and floated on its back, with its head and chest partly out of water and its hind flippers extended in a very man-like posture. Others were noted floating on their backs in a flexed position with their hind flippers against their chests.

Feeding.- The writer observed walruses feeding undisturbed on several occasions. The general pattern was as follows:

The walrus remained at the bottom up to ten minutes before surfacing to breathe and on the surface about three minutes breathing between dives. In breathing it rocked forward and backward so that its head was alternately submerged and lifted clear of the water. Before diving, it lifted its head high out of the water. According to the Eskimos it keeps its eyes closed while "blowing" and opens them for a final look around before diving. They take advantage of this when hunting walruses from the ice, remaining motionless only when the walrus is surfacing and when it is preparing to dive.

It makes a fairly vertical dive to the bottom. Some indication of how deep it is feeding can be obtained by noting how high it kicks with its hind flippers when diving. When feeding in very shallow water, it usually dives without a powerful kick.

A cow with a nine- or ten-month-old calf was observed feeding in the open water off Southampton Island in February. The calf remained on the surface while the cow was submerged, indicating that it was still too young to forage for molluscs. Calves were observed nursing both in water and on land. In water the cow assumed an upright vertical position and the calf an inverted vertical position with its head and most of its body beneath the surface. It clasped its fore flippers around the cow's lower abdomen and braced its hind flippers against her chest. The cow supported the calf by clasping it between its fore flippers. The calves remained in that position for up to five minutes. On land, the female usually lay on its side and the calf frequently assumed the same inverted position as in the water.

Once a walrus was observed that appeared to be drinking water. It had just extricated itself from a crevice in the rocks where it had been trapped for several days (Figs. 6, 11). It was exhausted and lay on the rocks for several hours. During that time it was seen to drop its head into a puddle of brackish water. It appeared to swallow some of the water with a sucking action.

Scratching.- Adult walruses are infested with lice in the furrows and folds of the skin. The lice evidently cause some discomfort. Walruses hauled out on land

spend much of their time scratching or rubbing themselves. The hind flipper is frequently used in a dog-like fashion to scratch the region of the head, neck, and shoulders (Fig. 10). When lying in a supine position, they rub themselves by rotating the upper half of the body and swaying the lower back and rump from side to side. A dozen or so of the massive animals writhing and scratching themselves ponderously is a rather grotesque sight. An individual may scratch for several minutes at a time, relax for a few minutes and then resume scratching and rubbing. Similar behaviour was observed among walruses hauled out on ice floes. They seemed to be able to rub almost every part of the body except the region where loose, integumental folds extend laterally from the base of the tail. It is likely that the rubbing, especially of the dorsal surface, together with the dragging of the chest and abdomen over the rocks, accounts for the fact that the hair is almost entirely worn off those parts in all the old animals.

Sleeping.- Walruses are apparently able to sleep in the water, at least if it is not too rough. In March, 1953, the writer observed two walruses sleeping in the open water off the floe edge of Parry Bay, Melville Peninsula. They had assumed an almost vertical position with the head extended and the muzzle out of water. One had remained in that position long enough for a thin layer of ice to form on the water around it, the air temperature being 20°F. As previously discussed, the distensible pharyngeal pouches may be inflated to support the head and help maintain the vertical position.

Hauled out on land, walruses usually sleep in rather closely packed groups (Fig. 9). Individuals sprawl out in almost every position on sides, back, or chest. If the rocks are crowded, they may lie partly on top of each other. One large bull with long tusks rested most of the time with its head supported on the back or flank of a neighbour (Fig. 8). It could not rest its head on its chest without digging the tips of its tusks into its chest; nor could it lie on its chest with its head outstretched, since the long tusks prevented its head from reaching the ground. Another bull, with slightly longer tusks that converged, had a raw wound on its chest under the tips of the tusks, which had apparently abraded that spot.

While the herd was under observation (during late July) the bulls remained ashore for long stretches.

A few were always leaving the land for water and a few hauling out, but many bulls did not alter position during five continuous hours of observation except to rub themselves or change sleeping posture. Cows with calves left the land for the water much more frequently, often swimming only a few yards from shore and diving for food.

Walruses sleeping on ice floes behaved in much the same way except that they did not crowd each other as much as on land. The Eskimos claim that walruses are much less wary sleeping on ice than on land. By way of illustration they said that it was possible to land down-wind from an animal sleeping on ice, walk up to it, and strike it with a rifle before it became aware of them.

Social Behaviour

Territoriality.- When swimming, walruses do not display intra-specific strife even though they come into very close contact with each other. On land, however, adjacent animals of both sexes often threaten one another and fight. In June and July, groups of both sexes and various age classes may be found hauled out together. It was noted that under those conditions they formed definite social strata. The adult bulls and subadult males usually hauled out farthest from the edge of the water. The cows, calves, and yearlings were always found closest to it.

Walruses of either sex are subject to jabbing and prodding by their neighbours attempting to force by on their way to the water or away from it. Occasionally a very large bull may intimidate the other animals to move out of its way simply by threatening them. On Walrus Island the writer observed a very large bull with extremely big tusks haul out and make its way through a group of about 30 without striking a blow or being struck. When a bull hauls out and moves through a closely-packed group of other bulls to a vacant space it usually attempts to make the nearest animals move out of the way by jabbing them in the flanks with its tusks. It then continues to press through the group, jabbing those in its way or threatening them to make them give passage.

Threatening is accompanied by the assumption of what I term the "threat posture" (Fig. 27). The animal raises itself on its fore flippers, with its chest expanded and head thrust forward, and often makes several jabs with its tusks. Frequently it also makes a threatening noise by blowing its breath through its lips. A newcomer

progresses very slowly through a group of closely-packed walruses. Unless it is very large, the animals it disturbs usually respond to its threats or jabs by jabbing it on the neck or back as it passes. Several bulls observed took from 15 to 20 minutes to cover some 50 feet from the edge of the water through perhaps 30 other animals to a clear space. By the time they reached it they were bleeding from half a dozen or more superficial wounds on neck, shoulders, back, and flanks. The same behaviour was observed in animals moving on land through a closely-packed herd toward the water.

In the dense groups hauled out on land the movement of a walrus usually disturbs the contiguous one, and it responds by jabbing the offender or the neighbour within easiest reach. Thus several in the group may become involved, and sparring, threatening, and jabbing may continue for several minutes before they resume resting positions. Often only two bulls may be involved and they may continue sparring for several minutes with fairly deep wounds being inflicted. In such battles, which the writer terms "position battles", the bull assumes the typical threat posture. When striking, it makes surprisingly rapid thrusts at the adversary's neck or shoulders. Its head and neck are often craned to one side, and it strikes from the side with a forward lunge of the upper half of the body, with sufficient force to draw considerable blood. After a herd of walruses had left a hauling-out site there was a surprising amount of blood spattered on the rocks.

Warning and Escape.- Walruses hauled out on land appeared to react to danger as individuals rather than as a group. The writer could not detect any distinct warning pattern or response to warning signals within the group. By comparison, a group of ringed seals sleeping on the ice respond quickly to escape signals; if one perceives danger and dives, the others dive immediately, without waiting to determine the reason. If a herd of walruses on land is approached upwind to within about 20 yards, the animals farthest from the water, usually old bulls, are the first to perceive the intruder. They rise up in either alert or threatening postures with their eyeballs protruding and nostrils distended and swing their heads from side to side, apparently trying to obtain a better view or the scent of the approaching object. The rest remain undisturbed. If the alarmed ones decide there is real danger they at once head for the water. The others may block their way, and much

crowding, bellowing, and apparent confusion may take place and gradually spread until those resting at the water's edge are disturbed and dive or are crowded into the water. It may take five or more minutes for all the members of a herd of several hundred to reach the water. Smaller herds are able to withdraw more rapidly and with considerably less confusion.

The type of escape pattern described above the writer calls a "crowding escape pattern" and a second pattern demonstrated by several herds of walruses on land, is termed the "stampede escape pattern". In that type of reaction all the herd, except perhaps the calves and yearlings, seem to become aware more or less simultaneously, of danger and head immediately for the water. That type of reaction is usually evoked by a scent undoubtedly associated with danger, as in the case described in the section on senses where a herd stampeded when deliberately exposed to the observer's scent but unable either to hear or see him. A similar reaction in response to the sound of low-flying aircraft was noted, especially if the herd was approached downwind. A stampede reaction evoked by sight warning stimulus was never observed.

In both escape patterns, when they reach the water the cows with their calves, the young animals, and some of the bulls swim out several hundred feet from shore. A few bulls stay quite close to land and swim back and forth. Every now and then they raise the upper half of their bodies out of the water, apparently to obtain either a better view, or, more likely, a better scent of the object which precipitated their departure. If no danger is perceived, the bulls usually commence to haul out again. Eventually the whole herd, unless further disturbed, reassembles on the rocks.

The escape pattern of herds hauled out on ice floes was noted to be similar, except that they are less apt to be crowded. They also seem to be less wary than on land.

When a boat comes too close to a pod of swimming walruses they change direction on the surface by lunging bodily to one side and under water by using their flippers.

The escape pattern of a herd fleeing from a natural predator such as the polar bear Thalarctos maritimus (Phipps) or the killer whale Grampus orca (Linnaeus)

was not observed. However, walruses may stampede when they scent or see a polar bear. W. Carrick, the writer's companion on Walrus Island in 1954, on checking the hauling-out site one evening, found that all the walruses had left the rocks even though he had approached upwind. Several minutes later he saw a female polar bear with two yearling cubs not far from the hauling-out site. It seems likely that the walruses had left the rocks because they became aware of the bears' presence.

Interspecific Relations

Seals.- As previously mentioned in the section on foods and feeding habits, certain walruses, usually adult males, have been recorded as having eaten both ringed seals and bearded seals. However, it seems improbable that large bearded seals are often killed by walruses. Harp seals Phoca groenlandica (Erxleben) are found in the same general area as walruses but they are rapid swimmers and usually travel in groups and they are probably seldom disturbed by walruses. Harbour seals Phoca vitulina (Linnaeus) may be preyed upon occasionally by seal-eating walruses, although there are no reports to that effect.

The food habits and foraging grounds of the walruses and bearded seals are similar. It is more than likely that bearded seals are forced to move elsewhere when their range is invaded by walruses. Ringed seals, according to the Eskimos, always leave when walruses appear.

Whales.- Several authors, among them Heptner (1930), assert that the walrus may occasionally prey upon the white whale Delphinapterus leucas (Pallas). Gray (1939) records that walruses occasionally prey on the narwhal Monodon monoceros (Linnaeus).

Freuchen (1935) reports that the killer whale, although found in Baffin Bay and Davis Strait, is not known to occur in Hudson Bay. However, the Southampton Island Eskimos claim it is occasionally seen off the southeast corner of that island. That it attacks walruses either in herds or singly is well documented in the literature for both the Atlantic and Pacific races (Ognev, 1935; Allen, J.A. 1880).

In September, 1954, the writer found a young bull (Fig. 5) and a cow with a calf on small ice pans off the Bell Peninsula. They were very loathe to take to water although the writer came right up to them in the

boat. When they did leave the ice, they immediately attempted to climb back up on it. The Eskimos suggested that there might be killer whales in the vicinity, and said that walruses cannot be made to leave the ice when those whales are present. Collins (1940) reports a large herd of Pacific walruses driven up on shore at St. Lawrence Island by killer whales. Freuchen (1935) gives evidence to the contrary.

> "The walrus does not seem to fear the killer (whale) at all. I have seen them lying quite undisturbed on the floes or swimming peacefully about while seals and narwhals were rushing about in terror of killer whales."

Polar Bear.- Various authors interpret differently the role of the polar bear as a predator or scavenger on the walrus. Allen, J.A. (1880) cites Brown to the effect that polar bears occasionally attack walruses, but are not always the victor, especially in combats with bull walruses. Manniche (1910) refers to a polar bear eating a walrus in northeast Greenland, but does not say whether the walrus had been killed by the bear or was carrion. Soper (1928) cites the following evidence from the Baffin Island district of the bear's role as a predator of the walrus:

> "The Eskimo assert that the polar bear also catches seals and young walruses by seizing them in the water, from underneath, and dragging them onto an ice pan. It is debatable whether or not the polar bear ever attacks an adult walrus. Hantzsch (1913, p. 155) cites a case reported to him by Eskimo, of a large bear in the vicinity of Kekerten Islands, Cumberland Gulf, attacking three walruses and killing a large male which he greatly tore about the head. Such cases must be rare."

The inability of a bear to kill an adult walrus is attested by Freuchen (1935):

> "A bear cannot overpower it (walrus) direct, as the walrus is too powerful, and I have once found a bear, a large one, killed by a walrus which had thrust its tusks into its side to their full length. The bear was dead and frozen stiff."

Ognev (1935) states that polar bears occasionally attack and kill walruses, usually choosing females and young. He cites supporting evidence from B.M. Zhitkov who obtained similar information from the Samoyeds.

Chapsky (1936) does not evaluate the role of the polar bear as a predator or scavenger, but points out that no remains of walrus have been found in the stomachs of polar bears caught in the Barents or Kara Seas.

The Southampton Island Eskimos are firm in the belief that polar bears kill and eat walruses, mostly calves and young. One reliable hunter told me that the bears along the east coast of the island live on walruses in summer. He said they catch the young on the rocks. He himself had seen that happen at Duke of York Bay.

On September 2, 1954, we found a polar bear on the shore at the entrance to the harbour at Back Peninsula, Southampton Island. It was a large male about eight feet long. It had just commenced feeding on the carcass of a male walrus two to three years of age. It had dragged the carcass over the rocks some 30 feet above the high tide (Fig. 13). The Eskimos thought the bear had killed the walrus on the floe ice lying just off the harbour and had swum ashore dragging the carcass.

On July 28, 1953, the writer examined the carcass of a large bull walrus shot and washed up on Walrus Island. The skin and fat on the top of the head had been chewed by a polar bear (Fig. 25).

On August 20, 1954, while flying an aerial census, the writer saw a large polar bear near a herd of about 500 walruses hauled out on the east shore of Coats Island. When first observed the bear was only about 300 yards from the herd. As previously described, three bears on Walrus Island appeared to have stampeded a herd of walruses from the rocks.

Factual accounts of bears seen killing walruses are scarce, but there can be little doubt that they do prey on them. Their predation is probably confined largely to calves and other subadults under five years of age. They may hunt by stalking single animals or small groups lying on land or ice. The writer believes they may also attempt to stampede herds, since stampeding frequently results in calves being separated from

the cows or crushed and smothered. It is almost certain that the polar bear feeds on the carcasses of walruses that drift ashore. It may even attack adults severely wounded by the Eskimos.

NATURAL MORTALITY AND DEBILITATING FACTORS

Predation

As discussed in the previous section, the only natural predators on the walrus are the polar bear and the killer whale and calves and immature animals appear to be the age groups most affected. Predation by polar bears is probably significant only where both bears and walruses are abundant, when it may play a small but significant part in the survival of the younger age groups. Presumably such concentrations occur on the east coast of Southampton Island. In late summer and early autumn an extremely large concentration of bears may build up along that coast if the wind blows in the Foxe Basin ice. To illustrate, an Eskimo said that he and his companion had counted 190 bears while travelling by boat up the east coast of the island about August, 1948. A party of Eskimo hunters saw 16 bears close to Seahorse Point in August, 1954, a few days after the writer counted some 2,000 walruses hauled out in that region. The bears had come with the pack ice that moved in in the meantime. The only other areas where large concentrations of the same kind are likely are along eastern Baffin Island and in Foxe Basin.

The killer whale may occur sparingly in northern Hudson Bay and Foxe Basin, as reported by the Eskimos, but cannot be considered a significant predator of walruses there. It may be important in Baffin Bay and Davis Strait and off northern Labrador but at present there is little evidence for or against it.

Ringed seals, which the bear preys upon, and the other seals and small whales which the killer whale preys upon, are much more widely distributed and probably more easily captured by those predators than walruses. They may therefore serve as important buffer species.

Parasites

Ectoparasites.- Allen, J.A. (1880) cites Brown to the effect that two species of Haematopinus are found on the walrus, one at the bases of the mystacial vibrissae and

the other in the folds of the skin of the body. Samples of body lice taken from three specimens during the present investigation have not yet been specifically identified. As noted in the section on scratching, the lice apparently cause considerable discomfort. One adult female collected in September, 1953, had a very large number of lice in the cracks in the integument of the throat.

Endoparasites.- No internal parasites were found in the intestines of 20 walruses examined in the field. Murie (1872) reported finding a pailful of round worms Ascaris bicolor in the stomach of a young walrus he autopsied.

Encysted trichinae of the roundworm Trichinella spiralis have been found in the striated muscles of the walrus and are reported by several authors. Samples of somatic muscles and diaphragm were taken from nine adult walruses during the present investigation. Examination of the material has not been completed. Detailed discussion of the occurrence of trichinosis in the walrus and other arctic mammals, and the significance of the infection as regards human health, is beyond the scope of this paper. An excellent review of the literature on trichinosis in the Arctic is provided by Connell (1949) who cites Brown's examinations of Eskimos on Southampton Island. Brown applied the skin test to two-thirds of the Eskimo population and found that 51 per cent reacted positively. Trichinella were found in the striated muscles of several walruses from the Southampton region examined by Kuitunen (personal communication, 1953). Vibe (1950) also reports trichinosis in the walruses in the Thule region.

Freuchen (1935) describes as follows an infection in the flipper of a walrus he collected:

> "It then proved that there was a large cavity in one flipper. The inflammation could not be seen from the outside, but had consumed the bone structure on both sides and the interstitial tissue."

One of the adult male walruses collected by the writer had what appeared to be arthritic lesions on the articular surfaces of the condyloid process of the lower jaw and the glenoid fossa.

Accidents

Accidents no doubt account for a small, undetermined percentage of the annual mortality in a walrus population. Judging from the actions of bulls during the post-rutting season, and from the number and extent of their injuries from fighting, it seems likely that they engage in heated battles. The tusk wounds are in most cases superficial, seldom penetrating the adipose layer; judging from that, death seldom results from fighting. However, the writer collected a young bull at Seahorse Point on September 12, 1953, which had a severe throat wound, apparently made by a tusk. It was 1½ inches deep and one inch in diameter at the surface and penetrated three to four inches into the throat muscles. Upon postmortem examination it was found that the wound terminated only one-quarter of an inch from the trachea. Unlike other bulls collected at that time of year the animal was in poor condition. Its subdermal fat layer was very thin.

Calves and yearlings probably sustain the greatest losses from accidents. Observations on Walrus Island showed that the cows normally protect their young from other cows and bulls. However, when a large herd stampedes from the rocks calves may become separated from the cows and crushed or suffocated. An instance of that was noted on Walrus Island. When a herd stampeded, a calf about three months old was found crushed on the rocks (Fig. 12). During a stampede it was noted that calves occasionally fell into crevices and were not able to extricate themselves.

A similar fate may occasionally befall even larger animals, as evidenced on Walrus Island on July 28, 1954. A walrus about four years old was found trapped in a crevice (Fig. 11). It had apparently broken off its tusks in its struggle to free itself. It remained trapped for several days until the tide was high and rough water flooded the lower half of the crevice, when it was able to partly float and scramble out of the crevice. It was so fatigued that upon reaching the flat rocks it rested for some time. It made no attempt to escape or defend itself when the writer approached to photograph it (Fig. 3). The skin on its back was scraped raw and bleeding in several spots.

Walruses are probably injured occasionally in falling off rocky ledges when attempting to escape, and perhaps by crushing amongst the ice floes.

Weather

Some newborn calves may perish from exposure during extremely severe weather, including subzero temperatures and high winds. There is no direct evidence of it, however.

It is not possible at present to estimate accurately the annual mortality from predation, diseases, accidents, and weather. It must, of course, vary from year to year and to some extent from locality to locality. In view of the low reproductive rate of walruses, calf mortality probably plays an important part in determining the rate of growth of the population.

HUMAN UTILIZATION OF THE WALRUS

Before commercial exploitation of the walrus in both eastern and western hemispheres, that is, before the early 17th century in Europe and Asia and the 16th century in North America, the natives of many cultures, Eskimo, Chucki, and Samoyed, depended upon it in varying degrees for meat, hides, and useful by-products. Times of abundance and scarcity of walruses were experienced from various causes, but a sort of dynamic balance between the human and walrus populations probably had been established.

That extensive commercial exploitation should upset or alter that balance was inevitable. The depletion of the herds and reduction of their ranges is well documented by Allen, J.A. (1880). A few examples may serve to illustrate. In Europe, he mentions their reduction and ultimate extermination off the coasts of Finland, Bear Island, Thousand Islands, and Hope Island, as well as their reduction around Novaya Zemlya. Hunting at Bear Island commenced in 1602 and in the six years 1604 to 1609 inclusive, an estimated 2,500 to 2,600 walruses were killed. Shortly afterwards they were exterminated from that location.

In North America, the pattern of slaughter and extermination was similar at Sable Island and the islands in the Gulf of St. Lawrence. Allen cites Fischere to the effect that in the year 1591, 1,500 were killed at Sable Island by the crew of one ship. Resident walrus herds appear to have been exterminated in the gulf about the middle of the 18th century.

Farther north, the whalers took walruses or traded with the Eskimos for them in Hudson Bay. Until quite recently (1948) Norwegian sealers made a practice of taking them on the ice floes in Davis Strait. In addition to commercial exploitation, factors which upset the balance between the native and the walrus populations included the introduction of modern firearms and power boats to the natives. A factor of considerable importance has been the increase in the number of dogs owned by the natives, a direct result of the change from a primarily hunting to a fur-trapping economy.

The arctic explorers of the 19th and early 20th centuries also took a heavy toll of walruses: for example, Peary (1904) reported killing 128 during July, near the Bache Peninsula, Ellesmere Island. From 1925 to 1933 the Hudson's Bay Company exported walrus hides and tusks in considerable numbers from the Eastern Arctic posts (Appendix I).

According to Burwash, cited by Anderson (1935), after the Scottish steamer Active commenced commercial operations in the eastern Baffin Island region in 1908 the number of walruses diminished rapidly, partly because of hunting methods so wasteful that only one walrus was secured out of four or five killed. The commercial value of the oil, skin, and ivory from each animal was less than $50. At Padlei (Padloping) more than 4,000 hides were received in trade by one company in a single year. The hides were used experimentally for lining automobile tires.

Former Eskimo Utilization

Primitive Eskimos of the Eastern Arctic doubtless depended heavily upon the walrus, especially in northern Hudson Bay, Foxe Basin, Baffin Island, Ungava, and some of the Arctic Islands. Most of the ruins of houses and tent rings of the old coastal culture are found in locations suitable for the pursuit of sea mammals such as seals, whales, and walruses. Collins, H.B. (1955) records the incidence of occurrence of walrus bones in the middens of an old village site at Native Point, Southampton Island. For the Dorset culture middens, walrus bones amounted to 10.2 per cent of the total bones; and for the Sadlermiut culture middens, 5.2 per cent.

The walrus seems to have played an especially important part in the economy of the Eskimos of South-

ampton Island, Repulse Bay, and Melville Peninsula. Numerous accounts of their hunting techniques are recorded in the literature. They appear to have hunted walrus at almost all times of the year. The largest numbers were often taken when new ice was forming and the walruses could be harpooned as they broke up through the ice. That method is still practised at Igloolik.

The native hunters must have killed fewer walruses in former days than at present. The difficulty of hunting with only harpoon and lance must have forced them to utilize the carcasses more fully. Since they did most of their hunting during autumn and winter, less meat was spoiled. As they did not travel extensively, the large dog teams they now keep were unnecessary; as Hall (in Nourse, 1879) records, several men usually had to pool their dogs for a long trip. When they began trading for arctic foxes they had to spend less time hunting and build up larger teams. More meat was required to feed them, and enough had to be stored before the trapping season to last all winter.

The rifle provided the Eskimo with a vastly superior killing instrument. It increased the number of walruses taken and also the losses from sinking. The Eskimo is still unfamiliar with the principle of conservation of natural resources. The primitive Eskimo took the abundance or scarcity of game more or less for granted, attributing both to supernatural causes. He regarded the loss or wastage of game as nothing more than momentary misfortune. He still thinks in that way and, now that he has a more efficient method of killing, the loss of a walrus is of less consequence than ever to him. A similar attitude among the caribou-hunting Eskimos after the introduction of firearms has been noted by Banfield (1954).

Contemporary Eskimo Hunting Methods

The following description of Eskimo walrus-hunting methods refers particularly to the Southampton Island Eskimos, whom the writer had the greatest opportunity to observe hunting at different seasons. Similar methods are used throughout the Eastern Arctic.

Tools.- The modern hunting instruments of that region are more or less direct homologues of primitive ones. The white man's tools and materials have helped the Eskimos modify their primitive weapons and produce more durable and efficient ones. The present walrus harpoon (Figs. 17 and 18) is similar to the primitive one pictured by Tyrrell (1908, p. 147), except that brass and steel

have been substituted for flint and some of the ivory components. They still use the break-away, toggle-type harpoon heads. In many cases the harpoon float of inflated sealskin, the "avatok", (Manning, 1944, p. 144), has been replaced by a 10-gallon drum (Fig. 19), which is much easier to prepare and more durable. The high-powered rifle with metal-jacketed bullet has entirely replaced the broad-headed killing lance (Nourse, 1879, p. 119). The old style landing gaff has been replaced by the multi-purpose boat hook. The weighted set of hooks "keeviurniut" for retrieving walruses or seals sunk in deep water is still of the old design, but now it is usually weighted with lead instead of walrus ivory.

Boats.- The modern Eskimo usually hunts walrus in summer from a boat often of Peterhead design, with an inboard engine (Fig. 15). Whale-boats, with or without engines, and freighter canoes, with outboard motors, are also used. Frequently several men pool resources to purchase a large boat and share the harvest from the hunt. Most of the Eastern Arctic Eskimos have settled around trading posts, missions, or schools and so may have to travel a considerable distance to the hunting grounds. Using a large Peterhead boat, they are able to secure up to 20 adult walruses in a week or two and bring them in one load to the settlement. Several trips are usually necessary to secure an adequate supply of meat for themselves and their dogs for the winter. The take of walruses in the Southampton Island area from 1952 to 1954, inclusive, is given in Table IX.

In some locations special conditions of ice and open water favour specialized types of hunting. In a few localities they still hunt walruses from the kayak.

The R.C.M. Police, the Hudson's Bay Company, the missions, and the Department of Northern Affairs and National Resources supervise the walrus hunts to some extent. The supervision varies a good deal. In some cases the supervisor organizes the hunt, in other cases he merely limits the supply of ammunition issued.

Summer Hunting Methods.- Hunting walruses from Peterheads and whale-boats in the open water during the summer and early autumn, the Eskimos travel to where the walruses habitually haul out on land. After locating a herd they cruise about, being careful not to alarm and stampede the resting animals, and look for small pods swimming in to the hauling-out site. When a pod of six to a dozen is sighted, they pursue it and attempt to

wind the animals, frequently shooting near them with .22 calibre rifles to prevent them from staying at the surface. When the walruses become tired, they are herded to shore by keeping the boat between them and the open water (Fig. 16). If the shore water is shallow, the Eskimos try to drive them into a shallow bay, where they can be shot without harpooning and danger of loss from sinking. In shallow-water hunting, they try to kill outright by a head shot in the temple region (Fig. 19). If a walrus is killed it sinks but is easily recovered from the shallow water with the long-handled boat hook.

If the coastal waters are deep and therefore unsuitable for that type of hunting, the Eskimos herd and tire the animals in the same way but harpoon them before shooting them (Figs. 17 and 18). Those the writer accompanied kept two men in the bow to act as harpooners and shooters. The 303 British and 250 calibre rifles are those most commonly used for walrus hunting. Metal-jacketed bullets are favoured since lead-nosed bullets frequently "mushroom" in thick hide and blubber and do not reach a vital region.

Occasionally a walrus sinks in fairly deep water after it has been shot. They then try to recover the carcass by dragging for it with a weighted grappling hook and line. If the bottom is not too uneven they usually succeed in depths of up to seven fathoms.

Another hunting method is used in summer when walruses are found sleeping or resting on ice floes where they are less wary than on land. The Eskimos approach upwind among the ice floes and are usually able to get close enough to kill some walruses instantly with head shots. Those killed drop on the ice without moving; however, those wounded even mortally usually slip into the water and cannot be retrieved. The Eskimo crew the writer travelled with in 1953 secured 27 walruses by both deep-water and shallow-water hunting, without losing a single animal. In 1954, the same crew lost three out of six walruses, hunting them on the ice floes.

Occasionally they shoot a walrus in the body (lung shot preferred) if it is in deep water and too far away to harpoon. An animal shot in that way remains on the surface long enough for them to approach and harpoon it before it sinks. Losses are most apt to occur when they indulge in promiscuous shooting in deep water without first using the harpoon. The result may be the loss of

two out of every three killed instantly and many of those mortally wounded. Wasteful killing of that kind is described by Tuck (1954) and Wynne-Edwards (1952) for the Ungava and Padloping Eskimos respectively. The latter reports that his crew secured only one walrus but mortally wounded and lost six others.

Autumn, Winter, and Spring Hunting Methods.- Somewhat similar methods are used from late October to June, when the walruses may be found sleeping or resting on the floating pack ice. The hunters approach upwind on foot across the ice and shoot them, which is possible only when the wind and tide bring the pack ice against the fast ice and hold it there, and they can move about on the pack ice without danger of being carried out to sea. If the wind or tide reverses, they may find themselves adrift without food or shelter until the pack ice drifts back to fast ice. At Igloolik in March, 1953, just before the writer's arrival there, seven hunters were carried out on the drifting pack for a week and suffered considerable hardship.

Walruses swimming and feeding in open water between the pack ice and the fast ice move before the pack if it is driven by wind and tide towards the fast ice. The Eskimos may then hide in the rough ice frequently formed at the edge of the fast ice, where they wait until an animal is within rifle range, shoot it, and then either harpoon it or launch a small skiff to retrieve it. The writer observed several hunts of that nature with the Igloolingmiut about 30 miles south of Igloolik, all of which were unsuccessful.

Mainly in the Igloolik region, walruses are hunted in the autumn on the "ice rind" that forms up to two inches thick after the freezing of the sludge ice. It is dark and rubbery, but can support the weight of a man and dog team. Walruses feeding at the edge of the new ice or under it can break breathing holes up through with their heads. The Eskimos harpoon them when they come up to breathe at the holes. The harpoon line is anchored by a peg in the ice, and the walrus is dispatched with a rifle. A fairly large dog team is required to pull a carcass out on the ice. One large walrus is a full load for the team to haul to the shore camp. The writer did not witness that type of hunting, but discussed it with the Eskimos of the region. Graphic accounts of the method are recorded by Tyrrell (1908, pp. 149-152), Vibe (1950, p. 51) and Hall (in Nourse, 1879, pp. 118-122).

Annual Cycle of Walrus Hunting Activity on Southampton Island.- In the Southampton Island area the heavy winter ice usually moves out during the first to third week of July. The Eskimos can then launch their Peterheads and whale-boats. As soon as the pack ice of Fisher and Evans Straits is open enough, they commence hunting walruses in those straits. The first trip is usually to the vicinity of Walrus Island. The walruses that winter in Roes Welcome Sound and Fisher Strait usually repair there after the calving and breeding period, and are shot in the water or on the ice floes. When the pack ice breaks up, usually in late July, herds of a few hundred to more than 1,000 may haul out on the island.

As noted in the section Distribution and Movements, during late July and early August the walruses leave Walrus Island and swim across to Bencas and Coats Islands. The Eskimos follow them, several boats usually travelling together, and use the shallow-water hunting method along the shallow coastline of those islands. Walruses haul out at several points on Bencas Island and at half a dozen or more places on Coats Island. In late August and September they appear to move to Seahorse Point, Southampton Island. There the Eskimos usually use the deep-water hunting method, except when they can corner the walruses in one of the few shallow bays. If the hunting pressure is heavy, the walruses may move north to East Bay. Only a few boats pursue them there because the trip takes so much gasoline, and because of the danger of being caught by the Foxe Basin ice.

If the Foxe Basin ice is brought to the Seahorse Point region, the walruses leave the land for the ice. The Eskimos then hunt them on the pack ice in Evans Strait.

Walruses, especially bulls, frequently drift westward on the ice and are taken in the vicinity of Native Point during early October.

At that time sludge ice is forming in the bays and the Eskimos haul their large boats out of the water. They do not hunt marine mammals again until the bay ice is thick enough to support travel. The Southampton Island Eskimos then commence to hunt seals at their breathing holes in the new ice. At Igloolik walruses are hunted on the new ice as described above.

During winter the Southampton Island Eskimos continue to hunt seals at their breathing holes, especially

in the thin ice along the edge of the fast ice. They also hunt seals in the open water leads, and occasionally obtain walruses there if the winds and tides are favourable.

During March and April a few families, chiefly Okomiut, move their camps to Ruin Point. There the shore lead is very close to land and they can transport their whale-boats by dog team to open water. They hunt seals, white whales, and walruses in that area, but usually do not get more than a half dozen walruses between April and June.

Butchering Methods

During a typical summer hunt several walruses may be taken in a day. The carcasses are retrieved and secured to the boat (Fig. 20) by passing a loop of rope through a slit cut in the upper lip, fastening the loop around a tusk, and tying the rope to the sides or stern. Two methods of butchering are employed, one on land or ice, the other in the water.

If the carcass is to be butchered on land it is towed ashore with a small boat at high tide, floated up as far as possible, and secured. At low tide it is exposed and the butchering commences. In most cases two or more men work together on a carcass to cut it up into about 10 pieces, each weighing 100 to 300 pounds (Fig. 21). If the carcass is very large it may be cut into smaller pieces to facilitate handling. The knife used may be either a large butcher knife of a kind stocked by the Hudson's Bay Company, or the all-purpose snow-knife (Fig. 22). The hide is so tough that the knives require constant sharpening, and most Eskimos carry small smooth stones for the purpose.

They commence butchering by piercing the abdominal cavity and cutting a large slab of hide and body muscle from the abdomen and flank. The cut may be continued forward through the ribs on either side of the sternum. The right and left halves of the rib basket are disarticulated at each side of the vertebral column. Frequently the meat is peeled from the ribs and the ribs and backbone are discarded. The four limbs are disarticulated and the head is severed at the neck. The heart is always retained, the liver not always. The lungs, stomach, and intestines are discarded. According to Tuck (1954), the Ungava Eskimos utilize the viscera, but not the backbone. No attempt is made to save the

blood. Piles of vertebral columns are to be found along the beaches of sheltered bays where the Eskimos have butchered for many years (Fig. 23).

When butchering is completed, slits are cut in the hide of the pieces to provide handholds and the pieces are dragged down to shore. They are then floated or pulled out to the Peterhead and loaded by block and tackle into the hold.

A similar technique of butchering is employed if the walrus has been killed on an ice floe. The boat is made fast to the floe and the butchering is done on the ice. If the animal has been killed in the water near the ice, a slit is cut in the skin of the back or chest, a skin line passed through it, and by block and line the animal is hauled up on the ice.

The Eskimos favour butchering in water, where the meat does not pick up sand and gravel and can be loaded directly into the boat. That method has been practised only since the introduction of the Peterhead. The water must be fairly calm. The animal is tied fore and aft along one side of the boat and the tender or a canoe is also tied to the side of the boat (Fig. 24). A hook from the block and tackle rigged on a short loading boom, is passed through a slit in the skin. One man sits in the tender and cuts pieces of meat from the carcass, in much the same way as on land. The others stay on board the Peterhead, and load the pieces into the hold with tackle and boom.

Storage of Meat and Fat Products

The meat of about 20 carcasses can be loaded into the hold of a Peterhead. The boat then returns to the settlement and the meat is unloaded and divided amongst the crew.

Meat taken during July and August stays fresh only long enough for a few meals to be eaten from it, then becomes too badly tainted for human consumption. Tainted meat is used mainly for dog food. Tainting results from decomposition, especially of the fat, partly in the hold of the boat and partly at the settlement where there are no cold storage facilities. The hold of the boat is cool and the late summer nights cold, but the latent heat of the meat dissipates very slowly. At the settlement the meat is usually stored under rock

caches. The fat and hide to be used for dog food are frequently stored in 45-gallon gasoline drums.

If more walruses are killed than can be transported to the settlement, they are butchered and cached under rocks at the hunting site. The caches are later used by the Eskimos as they travel by dog team along their traplines. Exposed caches of that kind are frequently subject to depredations by various animals, chiefly polar bears.

Utilization of the Meat

Most of the meat for human consumption is taken during September, when the night temperature is frequently below freezing. At that time it keeps fairly well in the hold of the boat and can be frozen and stored when brought back to the settlement. The heart is one of the favoured pieces. The liver is eaten, but is coarser than seal liver and not considered as tasty. The liver is fried, but most of the other meat is prepared for human consumption by boiling. Walrus meat is seldom eaten raw like caribou meat and fish.

Almost all the skin and underlying fat is fed to the dogs, along with the decomposed meat from the early summer hunts. On Southampton Island the Eskimos usually cut the hide up into fist-sized chunks before storing it in sacks or empty gasoline drums. Each dog is fed about two pounds of meat every other day with fair regularity as long as the supply lasts, usually till late in February.

Ringed seals are easier to obtain than walrus from March through the spring months, so the dogs eat mostly seal meat until the end of June, when they are retired for the summer.

Most of the dogs on Southampton Island scavenge for themselves during the summer along the shore and the coastal sloughs. A few in the settlement proper are kept chained and fed a little white whale meat, seal meat, fish offal - almost anything edible. When the Eskimos are interested in working their teams, usually in late September or early October, they "feed them up" again.

The total amount of walrus meat consumed by the dogs of Southampton Island in the six months from September to February, inclusive, may be estimated as follows:

$\frac{180}{2}$ (days) x 2 (lbs.meat) x 400 (dogs) - 72,000 pounds.

If 1,000 pounds is the average dressed weight of a walrus carcass, then 72,000 pounds consumed represents complete utilization of 72 carcasses for dog food.

A small amount only of spoiled or rancid meat is used for baiting fox traps. A small portion of the meat normally used for dog food is placed under a rock near the trap. The total amount of meat used annually for bait on Southampton Island is probably the equivalent of one walrus carcass or less. Carcasses cached under rocks along the coast serve the double function of a reserve supply of dog food on the trapline and an attraction for foxes and polar bears, which frequently congregate at the caches and are trapped or shot by the Eskimos.

The number of walruses taken annually by the Southampton Island Eskimos from 1950 to 1954, inclusive, ranged between 101 and 261. The average was 204 (Table IX). A provisional estimate of the utilization of the harvest is as follows: for dog food, 75 to 125; for human consumption, 75 to 100; miscellaneous, 1 to 5; total 151 to 230.

Utilization of the Hide and Ivory

During the period of the commercial exploitation of the walrus in both eastern and western hemispheres, the hide, tusks, and oil had commercial value. According to Allen, J.A. (1880, p. 133), the hides were used in Russia and Sweden for harness, sole leather, and ship's rigging. The ivory from the tusks was used for the same purposes as elephant ivory, but was considered inferior, since it was coarser and yellower. The blubber was rendered and the oil was mixed with and sold as seal oil.

In the primitive Eskimo culture walrus hide was an important material. Its chief uses were for covering the large women's boat or "umiak", for roof coverings for the sod houses, and for rawhide lines, lashings, whips, and dog harness.

From 1925 to 1933 the Hudson's Bay Company exported walrus hides from the Eastern Arctic (Appendix I). After 1933 no hides were purchased from the Eskimos

or exported. At present walrus hide is little used by the Eskimos, except as dog food. Occasionally it is substituted for bearded seal hide for lashings and whips. According to Lawrie (1950) the Danes were then exporting salted walrus hides from northwestern Greenland to the United States and Germany. The hides weighed from 50 to 70 kilos and were worth 16 krone.

The ivory had many uses in the primitive Eskimo culture. A few articles of ivory listed by Boas (1888) were needles, needle cases, handles, snow knives, drill shafts, sled shoeing, harness toggles, buckles, beads, combs, figurines, games, and sun goggles. In the present economy it has been largely replaced by materials from the white man's world. However, it is still used extensively for harpoon sockets and harness toggles.

In 1931 a regulation was passed to prohibit the export of raw ivory from the Northwest Territories. Before that time raw ivory had been shipped outside by the trading companies (Appendix I). The regulation specified that the ivory had to be carved by the Eskimos before export. The regulation was intended to ensure that the Eskimos derived the maximum value from the ivory. It is carved by the Eskimos at Repulse Bay, Chesterfield Inlet, Port Harrison, Lake Harbour, Cape Dorset, and Coral Harbour. The Igloolik Eskimos do not carve ivory themselves, but the Hudson's Bay Company at that settlement ships in the order of 1,000 pounds per year to other settlements. The total annual revenue from the trade at Igloolik settlement is from $500 to $750.

Ivory carvings are retailed through the Hudson's Bay Company, the missions, and the Canadian Handicrafts Guild, and a large quantity is sold or traded directly by the Eskimos.

They still trade raw ivory for export. They lose little or nothing through the practice, since only tusks cracked, twisted, or otherwise unsuitable for carving are traded and the value received, frequently in clothing, is usually more than the value of the tusk.

Utilization of Miscellaneous Walrus Products

The primitive Eskimo used other parts of the walrus with resourceful craftsmanship. For example, the writer has been informed (Macpherson, personal communication, 1956) that the roof supports of an old house ruin

on Melville Peninsula were fashioned from walrus baculae spliced together. Freuchen (1935) reports that the Eskimos used the elastic membranes from the pharyngeal pouches to cover their drums.

Besides ivory, molar teeth are purchased by the Hudson's Bay Company at five cents per pound and baculae at fifty cents each. The aggregate annual value of such products is insignificant.

Walrus Harvest in Various Geographic Areas

Eskimos and other residents of Eskimo descent take most of the annual harvest of walruses in the Canadian Eastern Arctic. However, a relatively insignificant number is taken by white residents, chiefly R.C.M. Police and missionaries. There is no sport hunting.

Annual harvest and Eskimo population figures for various regions are given in Appendix II. The information comes from many sources, including police reports and the sea mammal questionnaire mentioned in the introduction. The kill figures in the table do not represent total kill, as they do not include an estimate of the number killed or crippled and not retrieved.

Labrador and Ungava Bay.- The walrus harvest in this region varies considerably from year to year. Almost all of it is taken in special hunts during the open water season. The success of the hunt depends in large degree upon the variable ice conditions of Hudson Strait. According to Tuck (1954) most of the hunting by the Eskimos of Payne Bay, Fort Chimo, and Diana Bay is done from Peterhead boats during July and early August at Akpatok Island at the edge of the pack ice or occasionally in the open water off the coast. The number taken annually ranged from apparently none in 1953 to about 100 in 1950. On the Eskimo hunts Tuck accompanied in 1954, he noted wasteful and indiscriminate shooting into the herds and little effort to secure quickly those mortally wounded. In two days hunting only five walruses were secured out of a certain kill of nine and four probables, as well as a number of others wounded. On the hunts Tuck recorded, 100 rounds of 30-30, 65 rounds of 303, and 150 rounds of .22 ammunition were expended. He mentioned that the people from the Labrador and Ungava Bay settlements, especially Fort Chimo, are less dependent upon walruses than formerly as they can get work with various mining and prospecting companies, which may partly explain their carelessness and infrequent hunting.

In view of the large Eskimo population of the region (1,100) the average annual harvest of 41 is relatively light, and walrus meat appears to be rather insignificant as a food resource.

East Coast of Hudson Bay and Southern Hudson Strait.- The Eskimos from this region utilize walruses from two more or less discrete populations.

The hunters of Wakeham Bay, Sugluk, and Ivugivik hunt the walruses migrating through Hudson Strait. Those from Wakeham Bay usually get theirs in the vicinity of Wales Island during the westward early summer migration. Those from Sugluk and Ivugivik hunt in the waters around Nottingham and Salisbury Islands in the late summer or early autumn. Unfavourable weather and ice conditions at that time of year may reduce the kill for the year considerably. The writer had no first-hand experience with hunts in that area but the reports indicate that the wastage, especially by the Sugluk Eskimos, is very great. The estimates run as high as two walruses lost for one secured.

The Eskimos of the east coast of Hudson Bay depend upon the walrus population of the offshore chain of islands from the Belchers to the Ottawas. Those from Povungnituk and Port Harrison conduct summer hunts in the vicinity of the islands. Until the summer of 1954 some natives lived on the Sleeper Islands. Their move to the mainland may prove beneficial since the walruses of the islands will no longer be exposed to constant hunting pressure throughout the summer. From Appendix II it may be seen that the kill for those settlements varies considerably. To date, most evidence indicates that the walrus herd of the islands is more or less resident and is augmented by an influx from Hudson Strait. It also appears from the information presently available that the herd has maintained itself in the face of continuous although variable hunting pressure over the years. The average annual harvest is 169 walruses for a population of 1,000 Eskimos, an average of one walrus for every six people.

West Coast of Hudson Bay.- In former days the people of the west coast of Hudson Bay obtained a fair number of walruses at Repulse Bay, in Roes Welcome Sound, and around the offshore islands south of Chesterfield Inlet (Hall, in Nourse, 1879). South of the islands the coast is largely unsuitable for walrus or seal hunting, and the Eskimos living there were adapted to caribou-hunting

inland. That situation continues today and few or no walruses are taken by the Padlermiut of the Eskimo Point region.

The number of walruses in the northern part of the region has greatly diminished and the Eskimos do not hunt them as much as formerly. Repulse Bay and the adjacent coast was once the site of a thriving walrus-hunting culture of Aivilingmiut Eskimos. All but a few of the Aiviliks moved over to Southampton Island when the whalers operated from there. They were replaced gradually by Netsilingmiuts from Committee Bay and westward, who moved to the present site of the trading establishment at Repulse Bay. The Netsiliks, by tradition, are seal and caribou hunters. They do not often go after walrus and have no Peterhead boats for summer hunts in the waters around White Island. Walrus hunting by the Eskimos of the Chesterfield Inlet area has also fallen off since the great decrease in the herds which hauled out on Marble Island, "little" Walrus Island, and Bibby Island during the late 19th and early 20th centuries turned the people to other resources. At present few of them appear inclined or have boats to make the long trips to northern Roes Welcome Sound or Southampton and Coats Islands to obtain walruses.

Except for the dozen or so taken by the Repulse Bay Eskimos and a few by the Chesterfield Eskimos at the fast ice edge, most of the kill for the west coast of Hudson Bay is by the R.C.M. Police of the Eskimo Point and Chesterfield Inlet detachments. The Eskimo Point detachment usually hunts near Walrus Island or in Wager Bay, the Chesterfield detachment around the north end of Southampton Island and in Lyon Inlet. Both detachments use the meat to feed the dog teams of the police and special constables. The Chesterfield detachment often supplies walrus meat to the Baker Lake detachment. The annual harvest for the area is 48 walruses, and 728 Eskimos are registered in the district. The Eskimo utilization is almost negligible.

Southampton Island and Melville Peninsula.- The waters of Southampton Island and Foxe Basin have always been favourable for walrus hunting. More than one walrus per capita is taken in that region, a convincing indication that the hunting is still good, at least in comparison with other regions. The methods of hunting, the annual cycle of hunting activity, and other aspects of walrus hunting in the region have been dealt with previously in this section and elsewhere in this report.

The southern Southampton Eskimos get most of their walruses on the summer hunts at Coats Island and Seahorse Point. The natives residing at the head of Duke of York Bay take a few from that bay. Besides hunting on the new ice in autumn and at the edge of the fast ice in winter those at Igloolik and along the east coast of Melville Peninsula go in August and September to the islands in Foxe Basin, particularly the Spicers. The Igloolik district residents number 326 and they take an average of 425 walruses annually, giving them the highest per capita kill average of the Eastern Arctic settlements.

The combined annual average harvest of the region - more than 600 walruses - is nearly half that of the Canadian Arctic. Hunting losses there are less than in regions where the walrus is less important to the natives, although higher than it should be.

The trend in recent years at Southampton Island has been towards increased employment of the natives for manual labour and their boats for lightering. If it continues, there will undoubtedly be less hunting pressure on the walrus herds. A similar, although less noticeable, effect may be noted on Melville Peninsula if employment of the local Eskimos as labourers at the DEW line sites continues.

Baffin Island.- With an Eskimo population of nearly 2,200 and an average annual harvest of about 240 walruses, the per capita utilization is about one walrus per nine people on Baffin Island.

Most of the hunting at the southern settlements is done on organized Peterhead trips in the summer and early autumn to special areas. The Cape Dorset Eskimos hunt at Cape Dorchester and at Salisbury Island. The Salisbury hunt is organized by the Hudson's Bay Company and takes place in October. The Lake Harbour Eskimos get a few walruses in the vicinity of Pritzler Harbour, but most of their kill around Loks Land at the entrance to Frobisher Bay. The Frobisher Bay Eskimos also hunt around Loks Land. However, as activity at the air base is increasing and new jobs opening up, it seems likely they will take less interest in walrus hunting in future. At Pangnirtung most of the hunting is done from Peterheads in the vicinity of Leybourne Island. Little information is available concerning the hunting of the Cape Christian or Clyde River Eskimos, but they appear to harvest only approximately 20 walruses. DEW line construction in that

area also will likely provide temporary jobs. The Eskimos at Arctic Bay and Pond Inlet hunt little and more or less sporadically, taking between one dozen and three dozen walruses annually. Walruses occur in fair numbers in Lancaster Sound and Baffin Bay but are less common in the deep water of the inlets upon which the two settlements are located.

The ringed seal is of primary importance in the hunting economy of the Baffin Island Eskimos. If that resource is seriously depleted, hunting pressure on the walrus will undoubtedly be increased. If, however, as seems likely, more natives are employed in defence work and in native handicrafts and industries, the seal and walrus populations will, in all probability, be utilized less and may stabilize or increase.

Arctic Islands.- No Eskimos have settled permanently in the high Arctic Islands since 1900. The R.C.M. Police, however, have established detachments for varying lengths of time at several places on southeastern Ellesmere Island and on Devon Island. One or two Eskimo families are usually associated with the detachments. The number of walruses secured annually by the detachments for dog food amounts in aggregate to one or two dozen. In 1953, several Eskimo families were transferred under R.C.M. Police supervision from the Port Harrison district to Resolute Bay, Cornwallis Island. As the hunters become familiar with the country their kill of walrus increases. They get most of it on the pack ice in Allen Bay in the summer. The annual harvest, barring the introduction of more Eskimos, will likely stabilize at about 30.

Walruses winter in the open water of Lancaster and Jones Sounds and Baffin Bay. In summer they move westward through those sounds. The local wintering population may be supplemented from time to time by immigration from the Baffin Bay-Davis Strait population. The present hunting pressure exerted by the Eskimos at the above settlements is likely too light to be significant.

West Greenland.- According to Dunbar (1949) the average annual kill of walruses by the western Greenland Eskimos is between 400 and 600. Figures for the annual kill by the Thule Eskimos during the period 1948 to 1950, obtained by wildlife officers on the various task forces, were as high as 150. Dunbar states that the number of walruses lost in the summer hunts may be as high as two or three times the number taken.

Discussion

From the data presently available the average annual harvest of walruses by Eskimos in the Canadian Eastern Arctic is about 1,200.

It should be stressed that this figure does not take losses into account. Since hunting conditions, techniques, and disciplines vary from settlement to settlement, losses are extremely difficult to estimate. Apparently the heaviest losses occur in summer hunts when the natives pursue the herds in deep water and shoot promiscuously before using the harpoon. Losses as high as two out of three killed may result when natives unaccustomed to walrus hunting use .22 calibre and other low-powered rifles.

Considerable loss may occur when walruses are shot on drifting pack ice. Melgaard, an anthropologist who accompanied Igloolik Eskimos on a hunt of that nature near the Spicer Islands, informed the writer that one was lost for every two taken (personal interview, September, 1954).

Losses are fewest when the animals are first harpooned and then dispatched, or are harpooned through the ice.

From the writer's experience on Southampton Island, it is estimated that one or less than one in four taken by all methods is lost in that region. As 60 per cent of the total harvest is taken there, the writer would arbitrarily estimate that the loss from sinking or wounding is one-third the total harvest by all methods in the Eastern Arctic. On that basis, the losses amount to approximately 400 and the total annual kill is 1,600. A similar calculation for the west Greenland harvest would increase it to 666. Thus the total kill for the Eastern Arctic-Atlantic population would be 2,266.

It is difficult to compare past and present utilization. In northern Hudson Bay, Hudson Strait, and southern Baffin Island the herds are much smaller than formerly, and in some localities the harvest has greatly diminished. Elsewhere, as in the Southampton Island region, it may be as great as ever. The losses are probably greater because of more careless hunting and less complete utilization than in primitive times.

It is also difficult to estimate future utilization by the natives. The present is a period of transition, and many variable factors influence their economy.

The amount of walrus meat fed to dogs has been estimated equal to 50 to 75 per cent of the total harvest. Future utilization by the natives may perhaps be predicted on the basis of their requirements for dog teams. If more natives are employed in new ways, there should be a decrease in walrus hunting, especially during the open-water season. If fur prices remain low and other employment is available, there will probably be less trapping. Dog teams will probably still be used for transportation, but will be smaller. If salaries increase and there is less time to hunt game, more commercial dog foods will be bought. On the other hand, increased buying power will enable the natives to buy more rifles, ammunition, and boats. In combination with the continued loss of skill and pride in hunting, that factor may well increase wastage and utilization. Apparently it has already done so at Sugluk and elsewhere along the south shore of Hudson Strait.

Walrus products such as ivory and hides may never be very important in the native economy. However, there is a danger in the development of the carving industry that many walruses may be harvested for their tusks only. Up to the present there have been fortunately few cases of that nature in Canada, but in Alaska, where the sale of ivory handicrafts is considerable, "ivory hunting" has become a serious problem. Brooks (1953) estimates that 10 to 15 per cent of the total Alaska harvest is killed only for ivory.

The export of walrus hides has been attempted in the past with little success. At present the most expedient use of the hides appears to be for dog food.

Management of the walrus population depends largely upon regulation of human utilization. It will be necessary, therefore, for proper management, to maintain an accurate record of that utilization.

MANAGEMENT

No valid quantitative estimate of Atlantic walrus populations can be made from the information presently available. However, enough data have accrued to

permit the prediction of general population trends.

Changes in distribution outlined in the section on Distribution and Movements show a general pattern of extirpation in the southern part of the former range and depletion in the northern. Reports of recent increase like those from the west coast of Hudson Bay must be interpreted carefully - they may indicate an increase in the number of observations rather than an actual increase in numbers or that chance dispersal and population pressures are operating to extend the range.

Almost nothing is known of the carrying capacity of the range or the annual production of the molluscs and other bottom fauna, although an interesting investigation along that line has been reported by Vibe (1950). Equally unknown is the annual consumption of molluscs by the walrus and the effect of its feeding on the composition and regeneration of the bottom fauna. It seems likely that if annual increment exceeded annual decrement the food supply would be the final limitation on population increase. The availability of the food supply of the walrus appears to depend upon the rate of reproduction of the bottom fauna, the suitability of the sea bottom for growth, the depth, and the formation and distribution of sea ice.

Annual Increment and Decrement

In the section Reproductive Biology and Vital Statistics the writer has suggested 15 per cent as an acceptable estimate of the annual increment for management purposes. (Brooks (1954) estimated an annual increment of 13.3 per cent for the Pacific walrus population.) As no total population figure is available, it is not possible to give a figure for the total increment.

The decrement comprises losses from natural mortality, including predation, accidents, disease, and old age, and from human utilization. Natural mortality factors can be expected to operate with different intensity for different age groups. As noted in the section Natural Mortality and Debilitating Factors, the calf and subadult age groups appear to be most affected by predation by bears and killer whales and most vulnerable to crushing and suffocation. Bulls appear to be most prone to mortality or disability from fighting. In an animal such as the walrus, mortality from old age may be important, particularly in underutilized herds. No disease was found to contribute directly to mortality, but such

diseases as trichinosis may play an important role as debilitating factors.

Natural mortality may be expected to vary in different regions and from year to year, but the writer hazards a provisional estimate that it does not normally exceed 5 per cent of the population annually.

There can be little doubt that human utilization exceeded increment in many parts of the range during the period of commercial exploitation that ended in 1948. So little time has elapsed since then that trends in human utilization are difficult to establish. If the annual increment and natural mortality are 15 per cent and 5 per cent respectively, and if the present utilization is approximately 2,300 as estimated in the previous section, then the minimum basic population required to sustain the present human utilization is 23,000.

Regional Trends in Population and Utilization

Map 1 suggests a more or less continuous distribution of walruses in the coastal waters from northwest Greenland to southern Hudson Bay. However the distribution data suggest that three summer populations are geographically discrete. Their winter ranges overlap in certain areas, chiefly in Hudson Strait. When additional information accumulates it may be possible to subdivide them into a number of herds, each with a definite summer and winter range.

The breeding stock hereafter referred to as Stock 1 inhabits chiefly the waters of Baffin Bay and Davis Strait, including those of eastern and northern Baffin Island, the Arctic Islands, and western Greenland. From Appendix II, it may be calculated that the average annual utilization from it is 1,017, which would require a basic population of about 10,000. The fact that both Canadian and Greenland Eskimos utilize it complicates the problem of obtaining a total census, except by international agreement and effort. Recently walrus hunting has been more active in the Arctic Islands, but the kill is probably insignificant. Indications are that utilization is declining in western Greenland and eastern Baffin Island because of increased employment opportunities for the natives. The population may therefore increase up to the carrying capacity of the range and begin to repopulate some areas and replenish other stocks.

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A second discrete summer stock, Stock 2, inhabits the waters of Labrador, Quebec from Povingnituk north, western Hudson Bay, Southampton Island, Melville Peninsula, and western Baffin Island. Its winter range overlaps that of Stock 1 in the vicinity of Resolution Island and Loks Land at the entrance of Frobisher Bay. From Appendix II, the annual utilization is 1,309, which would require a basic population of about 13,000. Apparently it is more heavily utilized than Stock 1. It appears that it is in greatest danger of overutilization and may even be overutilized now.

Hunting pressure may decrease in the Southampton Island area during the next few years and possibly in the Cape Dorset and northern Ungava areas, but probably not on Melville Peninsula, where the utilization is heaviest. DEW line sites may provide some alternative employment, but the Igloolik Eskimos can get walrus all year and they appear inclined to be independent and to cling to the hunting economy.

Herds in excess of 1,000 have been reported for Foxe Basin (Melgaard, personal interview, 1954). The Southampton Island and Melville Peninsula Eskimos believe that the walruses of the basin tend to be larger and have heavier tusks than those of the islands. That may indicate that the hunting pressure is not so heavy. Taking the region as a whole, hunting pressure on Stock 2 is likely to continue heavy.

The third discrete population (Stock 3) inhabits the waters of eastern Hudson Bay from the Ottawas south to the Belchers. Its northern elements probably moved regularly into Hudson Strait by way of Nottingham Island at one time, but there now appears to be little or no interchange with Stock 2.

At present the annual utilization of Stock 3, calculated from Appendix II, is 80, which would require a basic population of 800 to 900. At present walrus hunting appears to be of minor importance to the natives of the region. They are relatively impoverished at present and there is little reason to expect that there will be more employment for them in future. Organized hunts have become unprofitable because the herds are depleted; decreased hunting pressure may allow them to build up.

The status, movements, and utilization of the herd of 1,000 reported by Dr. Clarke from Cape Henrietta

Maria in 1955 are unknown. It seems likely that it is more closely allied to the herds of the east side of the bay than to those of the west side. If so, it may well be underutilized at present, and may replenish the reduced herds of Stock 3.

Management Techniques

Census and tagging are familiar tools used by the wildlife investigator in gathering for management basic information on such factors as numbers, distribution, movements, and longevity. Their application to the investigation of a marine mammal involved some modifications devised and tested during the present study.

Aerial Census.- After some practice, the number of walruses in herds hauled out on off-shore islands and mainland points could be estimated with reasonable accuracy. Regional census from a Peterhead boat was impractical, however, because of the distances involved.

During July, August, and September the Atlantic walrus habitually hauls out on rocky offshore islands and exposed peninsulas of the mainland, particularly if no pack ice is available. This habit provides an excellent opportunity to count the herds. The most accurate counts are apt to be those of early summer, when the herds are most heterogeneous. The mature bulls do not feed very much at that time, and spend most of their time on land. Cows with calves of the year, and, to a lesser extent, cows with yearlings, are found on shore when the water is rough. It was noted that walruses are inclined to feed at sea during the early morning and late afternoon. Consequently, counts in mid-morning to mid-afternoon are most likely to be most complete.

On the preliminary aerial survey flown in a RCAF Lancaster bomber in August, 1952, several known hauling-out areas -- Nottingham, Salisbury, Walrus, and White Islands -- were surveyed at low altitude. No walruses were seen.

On July 16, 1953, while on the flight with E. Wellein of the U.S. Fish and Wildlife Service, walruses were observed at Coats Island and Walrus Island. The only sizable herd seen was one of 30 on Walrus Island. They started to scramble towards the water when the aircraft was still more than a quarter of a mile away, and had all reached it by the time the aircraft passed over them.

Their quick reaction to the sound of the aircraft made it doubtful whether aerial census would be successful.

On August 20, 1954, two survey flights were flown out of Coral Harbour, Southampton Island. The aircraft used was a twin-engine, land-based Anson with a cruising range of 800 miles.

Since a total count was desired, all known hauling-out areas had to be surveyed at the right time to catch most of the walruses hauled out. Ground observation and careful questioning of local Eskimos provided information not only on the islands and peninsulas, but also on the exact locations where walruses are known to haul out year after year. As previously noted, such favoured locations may often be spotted at a considerable distance, by the darkening of the rocks by excrement and the accumulation of rubbed-off hair in the crevices. It was necessary also to know the location of the floating pack ice. If it comes close to the hauling-out areas the walruses leave the land for the ice and spread out over a wide area.

The hauling-out areas were marked on the pilot's map, and a circuit was laid out to cover them all as economically as possible.

Walruses usually lie so close together on land that it is difficult to count them individually. Considerable experience in observing, counting, and estimating them on land is needed for making accurate visual estimates of herds numbering as many as 1,000. On the survey flights, an Eskimo of tested reliability in the work accompanied the writer and made separate estimates.

It was found that the noise of the aircraft disturbed the walruses more at low than at high altitudes. Moreover, at low altitude, it was difficult to make even a quick estimate because the time of observation was so short. The best results were obtained by making the initial run upwind at a height of 1,000 to 1,500 feet. It was then often possible to make a second run before all the animals took to the water. Large herds particularly were slow to leave the rocks.

Seven known hauling-out areas were surveyed in that manner on two flights totalling 500 miles. A total of 2,900 walruses was estimated. This figure was obtained by taking the mean of the highest and lowest estimates

and rounding it to the nearest 50. The total is believed to be within 15 per cent of accuracy.

Judging from the preliminary survey flights, close estimates of herds hauled out on land are possible by the described survey procedure if weather and ice conditions are favourable. Visual estimates could be checked by aerial photography if the aircraft was equipped for it. Telephoto photographs might permit calf segregation, which is not possible visually from the air. With experience and proper photographic equipment, sex and age groups might be identifiable from aerial photographs.

Tagging.- During the summer of 1953, the tag illustrated in Figure 28 was designed by the writer and manufactured in Ottawa. Essentially it was a modified Eskimo toggle-type, seal-harpoon head, with a numbered disc attached by a short chain. All components were of stainless steel, so that it would be less apt to suppurate out. The base of the harpoon head was drilled to receive the short metal shank of the throwing shaft, which was made about 1½ inches long. The head was held in place on the shank by a short seal-skin thong run through the last link of the chain and clipped to the shaft with a metal clip so that a considerable pull was required to free it, ensuring that the head toggled and set fast. Thus it was embedded in the blubber and set against the thick epidermis. The disc hung free on the chain.

Fifty tags were delivered in time to commence tagging in July, 1954. It was found on use that the harpoon head could not rotate and toggle because of the small size of the chain links. A modification was worked out in the field with the aid of two Eskimos. Also, the number was stamped on the head as well as the disc and the blade of the head was filed sharp. Thus modified, the tags seemed to hold fast and did not cause excessive haemorrhaging.

Eskimo harpooners threw the tags, trying to place them in the dorsal region, especially the neck or shoulder, where the blubber is thick. After a little practice they became quite adept.

Thirty-two walruses were tagged off Bencas, Coats, and Southampton Islands from August 9 to September 3, 1954.

The three tag returns are mentioned in the section Distribution and Movements. They corroborated Eskimo reports of movement in the Southampton Island region. The amount of abrasion or other injury caused by the tags was not ascertained.

Mansfield (1955) describes the above tag and also a tag used by Fisheries Research Board investigators on walruses.

Value of the Harvest

The total average annual harvest of walruses in the Canadian Eastern Arctic has been previously calculated at approximately 1,200. Probably only half the tusks are suitable for carving. The Eskimos receive for such carvings as cribbage boards, kayaks, and animal figurines about $5 to $10 per tusk. Thus they realize from the tusks $6,000 to $12,000 annually. The retail or market value is probably about double that.

The carcasses dress on the average about 1,000 pounds. Fifty cents a pound may be allowed for the meat. (A similar value was placed on walrus meat in Alaska by Buckley (1955).) On that basis, the meat alone is worth to the Eskimos $600,000. The theoretical value of the estimated loss of one-third of the harvest is $200,000.

It should be noted that the theoretical value of the meat is 50 to 100 times greater than that of the ivory. Brooks (1954) gives for the value of ivory carvings from a harvest of 1,300 in Alaska a wholesale value of $30,000 to $50,000 and a retail value of $150,000 to $200,000. However, the ivory carving industry has been established a long time in Alaska and the products are more skilfully worked than in Canada and so command a better price.

The value of the walrus to the Eskimos should not be measured in terms of money alone. Successful hunting for his family brings the hunter great pride of achievement and independence. In time they will no doubt become less dependent materially and spiritually upon the country resources. During the transition period, however, game will continue to provide part of their food and clothing and help them maintain their self-reliance. Even if jobs become available for all the Eskimos some of them will doubtless refuse to relinquish their former culture with its comparative freedom from regimentation.

Regional Management

The three regional populations discussed above differ in size and in the hunting pressure exerted on them. The Eskimo requirements in the various regions also vary at different settlements, depending on the state of their culture and standard of living and their job opportunities. Obviously no static program of management can be applied successfully. The solution appears to lie in regional management - the flexible management of each population according to its circumstances.

Accurate data are required on the number, distribution, annual increment, and movements of the populations, the total kill, the value of the harvest, and the carrying capacity of the range.

Stock 1 is apparently very large and at present does not appear to be overutilized. More information is needed on its movements. It presents special international problems in management.

Stock 2 provides most of the walruses for the Canadian Eastern Arctic Eskimos. It appears to be the stock in greatest danger of overutilization. Intensive investigation and rigorous regulation appear to be required for its successful management.

Stock 3 is the smallest. Present knowledge of its status is limited. It seems likely that it might respond to a period of protection during which the increment would be allowed to exceed the decrement.

SUMMARY

This report covers a general field investigation of the Atlantic walrus in the Canadian Eastern Arctic commenced in 1952 and continued in 1953 and 1954.

The present and past distribution are traced and the movements of the herds are outlined in relation to the formation and distribution of sea ice, particularly in the Southampton Island region.

A detailed physical description is given. Measurements were taken from 39 specimens killed by the Eskimos in hunting. The sexes are dimorphic. Adult males averaged 9 per cent longer and 16 per cent heavier than females. Walruses from Southampton Island averaged

somewhat smaller than those reported by previous writers. There was considerable variation in individual specimens. Individual differences in the functional tooth battery are attributed to variable resorption of the successional battery. The longest tusks measured were 361 mm. and 314 mm. for males and females respectively.

Parturition is believed to take place in Hudson Bay on the pack ice in April through June. The female normally gives birth to a single calf each alternate year. The breeding period partly coincides with the period of parturition. Males appear to reach puberty at five years, females at four. The gestation period is 10 to 11 months. The theoretical annual increment is calculated at between 14.6 and 22 per cent, the real increment at 12 to 20 per cent.

Various aspects of behaviour are discussed, including the escape patterns of herds from the hauling-out grounds. Walruses that prey on seals have recognizable characteristics. Natural mortality is attributed chiefly to predation by polar bears and killer whales, accidents and possibly adverse weather. Some mortality may result from fighting among the bulls, especially in the breeding season.

Present hunting techniques are similar to those of primitive times but are now based on the use of the power boat and the rifle. Hunting goes on throughout the year or is limited to certain seasons, depending on local conditions. Butchering and meat preservation are crude. Besides the meat, the hides, ivory, and other parts are used. The Eskimos take about 90 per cent of the harvest, which is valued at upwards of $600,000. The average annual kill is estimated at 2,666.

The existence of three more or less discrete populations is postulated and regional management based on them is suggested. Aerial census and tagging were tested during the investigation and adapted to the peculiar requirements. Annual increment and decrement are assigned provisional values of 15 per cent and 5 per cent respectively of the population, leaving 10 per cent for utilization. To sustain the population at the present rate of kill would take a minimum population of 23,000.

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TABLE I. Measurements and Weights of Atlantic Walruses from Northern Hudson Bay

NOTE: Standard length is straight line distance from tip of nose to tip of tail, to the nearest centimetre. Tusk length measured along the anterior surface, from gum line to distal tip. Weights not corrected for blood lost before weighing, except foetuses and calf No. 27.

MALES					FEMALES				
Field No.	Age	Standard Body Length (mm.)	Tusk Length (mm.)	Body Weight (lb.)	Field No.	Age	Standard Body Length (mm.)	Tusk Length (mm.)	Body Weight (lb.)
8-F	Foetus	250	-	127	54-8-F	Foetus	208	-	-
22-F	"	370	-	475	7-F	"	265	-	171
23-F	"	375	-	400					
17-F	"	440	-	700					
15	Calf	1,270	-	-					
27	"	1,320	-	212					
16	Sub-adult	1,770	38	-	20	Sub-adult	1,650	42	-
14	"	1,880	48	657	2	"	1,960	64	613
13	"	2,130	98	722	6	"	1,960	46	699
5	Adult	2,440	125	1,017	25	"	1,960	73	-
11	"	2,390	173	991	4	"	2,080	51	661
54-9	"	2,440	146	-	22	Adult	2,360	278	-
24	"	2,670	266	-	54-8	"	2,410	199	-
54-11	"	2,690	318	-	19	"	2,440	314	-
54-12	"	2,740	225	-	17	"	2,540	184	-
54-7	"	2,820	291	-	26	"	2,540	148	-
21	"	2,920	361	-	7	"	2,560	112	1,089
54-5	"	2,950	351	-	8	"	2,260	181	1,068
3	"	2,970	311	1,527	1	"	2,720	307	1,351
54-6	"	3,020	315	-	12	"	2,720	263	1,283
54-3	"	3,100	347	1,923	9	"	2,740	266	1,485
54-10	"	3,120	221	-	18	"	2,740	241	-
10	"	3,150	240	1,826	23	"	2,900	191	-

TABLE II. Detailed Body Measurements of Seven Male and Eight Female Atlantic Walruses

NOTE: C- calf; SA- subadult; A- adult. Weights in pounds and measurements in millimetres. All specimens collected on Seahorse Point except Field Nos. 1 and 2 on back Peninsula.

Field Number	Date Collected Sept., 1953	Sex	Age	Weight	Standard Length	Tail Length	Fore Flipper Length	Hind Flipper Length	Fore Flipper Expanded Width	Hind Flipper Expanded Width	Circumference Behind Fore Flipper	Tip of Nose to Insertion of Fore Flipper	Centre of Navel to Tip of Tail	Centre of Anus to Tip of Tail	Centre of Navel to Centre of Anus	Centre of Navel to Top of Lower Jaw	Distance Between Mammae (Medial) (Anterior)	Distance Between Mamme (Longitudinal) (Anterior & Posterior)	From Line Between Anterior Mammae to Centre of Navel	Centre of Eye to Centre of Ear	Penis Opening to Centre of Navel	Penis Opening to Centre of of Anus	Longest Mystacial Vibrissa	Upper canine-Length Gum Line to Distal Tip Along Anterior Surface	Upper Canine Greatest Diameter at Gum Line	Ventral Thickness of Epidermis	Ventral Thickness of Sub-cutaneous Adipose Layer
27	29	♂	C	212	1,320	12.7	285	285	190	355	1,210	510	495	25	420	875	x	x	x	65	89	340	23	x	x	6.4	44.5
14	12	♂	SA	657	1,880	50	455	415	290	495	1,880	735	735	63	685	1,190	x	x	x	79	140	590	76	48	17	12.7	38.2
13	12	♂	SA	722	2,130	25	430	380	305	485	1,880	735	795	32	790	1,330	x	x	x	80	165	635	82	98	31	12.7	38.2
5	10	♂	SA	1,017	2,440	50	520	455	305	520	1,980	965	775	51	735	1,650	x	x	x	89	180	610	115	125	30	12.7	38.2
11	12	♂	A	991	2,390	89	610	545	355	610	2,060	930	865	76	790	1,600	x	x	x	98	190	620	102	173	39	12.7	27.0
3	9	♂	A	1,527	2,970	64	660	610	380	710	2,290	1,090	1,000	63	940	1,900	x	x	x	102	180	760	90	311	51	12.7	38.2
10	12	♂	A	1,826	3,150	50	725	610	380	810	2,565	1,090	1,100	63	1,040	1,970	x	x	x	105	185	860	60	240	65	12.7	50.8
2	9	♀	SA	613	1,960	50	355	370	240	370	1,800	735	735	65	620	1,240	250	300	57	76	x	x	70	64	20	12.7	44.5
6	11	♀	SA	699	1,960	50	395	430	290	485	1,800	660	675	140	660	1,180	275	325	64	76	x	x	135	46	16	12.7	44.5
4	11	♀	SA	661	2,080	75	465	430	325	560	1,810	725	590	175	450	1,300	240	260	90	83	x	x	65	51	18	12.7	38.0
7	11	♀	A	1,089	2,560	90	595	495	340	560	1,980	940	940	100	875	1,750	330	340	76	100	x	x	76	112	32	12.7	32.0
8	11	♀	A	1,068	2,260	75	510	485	280	510	2,135	915	750	140	660	1,550	235	380	54	90	x	x	108	181	31	12.7	51.0
1	9	♀	A	1,351	2,720	63	560	595	340	680	2,340	1,015	-	63	-	-	430	560	-	105	x	x	100	307	53	-	-
12	12	♀	A	1,283	2,720	50	560	535	380	725	2,340	1,090	940	50	915	1,820	420	405	105	100	x	x	-	263	40	-	-
9	11	♀	A	1,485	2,740	45	635	560	370	710	2,515	1,040	940	100	915	1,850	400	470	130	100	x	x	165	266	42	11.0	57.0

TABLE III. Average Lengths of Adult Male and Female Atlantic Walruses Recorded by Various Authors

Author	Location	MALES		FEMALES	
		No.	Av. Length (mm.)	No.	Av. Length (mm.)
Loughrey	N. Hudson Bay	17	2,640	16	2,420
Allen, J.A. (1880)	Not known	3	3,113	--	--
Chapsky (1936)	Kara Sea	9	3,180	19	2,630
Sutton (1932)	N. Hudson Bay	1	3,780	1	3,240
Vibe (1950)	N.W. Greenland	1	3,130*	1	2,410*

* 50 mm. added to Vibe's measurements for tail length not included in his measurements.

Table IV. Skull Measurements in Millimetres of 15 Atlantic Walruses Collected at Seahorse Point

NOTE: Unless otherwise indicated jaw and cranium measurements taken on right side.

Field Number	Date Collected (Sept., 1953)	Sex	Age	Body Length	Length Foramen Magnum to Anterior Premaxillae	Breadth at Zygomata (Squamosal)	Breadth at Mastoid Processes	Least Breadth Between Temporal Fossae	Nasal Bones - Length	Nasal Bones - Width Posteriorly (at suture)	Nasal Bones - Width Anteriorly	Anterior Border of Pre-maxillae to Posterior End of Palate	(left) Canines, Gum Line to Distal Tip	(right) Along Anterior Curved Surface	(left) Canines - Diameter
15	12	♂	C	1,270	164	134	144	47.5	33.5	20.0	29.3	78.4	-	-	-
14	12	♂	SA	1,880	246	182	201	65.0	59.8	47.8	43.6	145	47	57	19.0
16	29	♂	SA	1,770	254	177	189	60.0	49.0	35.3	41.1	143	-	38	
5	11	♂	A	2,440	277	-	-	-	-	-	52.3	153	136	134	30.5
11	11	♂	A	2,390	308	-	235	62.2	68.8	40.5	53.7	-	166	173	35.5
24	29	♂	A	2,670	-	200	-	55.5	70.6	T.O.	T.O.	172	265	244	40.0
3	12	♂	A	2,440	277	-	-	-	-	-	52.3	153	136	134	30.5
10	12	♂	A	3,150	-	235	280	-	-	-	72.1	-	248	240	59.8
2	9	♀	SA	1,960	238	161	-	56.8	51.5	31.0	35.7	120	69	69	19.1
6	11	♀	SA	1,960	-	-	-	54.2	52.3	44.8	47.5	129	47	50	15.9
4	11	♀	SA	2,080	252	173	198	57.2	63.8	36.2	39.1	131	-	-	17.5
7	11	♀	A	2,560	285	197	223	66.0	58.2	40.4	48.2	162	121	122	31.4
8	11	♀	A	2,260	-	-	-	63.9	60.2	36.9	39.8	127	166	182	33.2
12	12	♀	A	2,720	286	204	242	70.5	57.6	T.O.	T.O.	165	276	264	42.7
9	11	♀	A	2,740	298	205	225	59.8	61.1	T.O.	T.O.	172	309	-	48.6

(right) At Gum Line	Canines - Distance Between External Edges at Base	Canines - Distance Apart at Tip	Length of Upper Molariform Series (Adult & Juvenile Meas.)	Width of Palate at Last Molar	Upper Incisors Between Distance	Rostrum - Greatest Breadth	Lower Jaw, Length	Lower Jaw, Height at Coronoid Process	Dental Formula
-	-	-	30	45.7	27.1	72	108.6	42.5	1/1 1/1 3/3 0/1 (S/F)
19.0	105.2	118	(A 55.6 (J 70.0	58.8	33.4	106.4	180	65.4	2/1 1/1 4/3 0/1 (S/F)
21.0	-	-	(A 54.4 (J 56.0	52.5	26.6	113.4	191	71.8	2/0 1/1 4/3 0/1 (S/F)
29.8	121	136	56.8	55.7	27.3	126	203	72.8	1/0 1/1 3/3 (F)
34.8	135	210	67.8	60.0	34.6	138	238	75.8	1/0 1/1 3/3 (F)
39.1	144	176	52.4	51.4	31.1	146	242	82.0	1/0 1/1 2/3
29.8	121	136	56.8	55.7	27.3	126	203	72.8	1/0 1/1 3/3 (F)
54.7	156	114	79.3	67.3	32.8	170	246	92.2	1/0 1/1 3/3 (F)
19.2	101.2	121	49.7	54.5	29.2	106.4	175	59.3	1/1 1/1 3/3 0/1 (S/F)
15.7	91.5	108.9	47.8	53.3	29.6	99.7	179	68.4	1/1 1/1 3/3 (S/F)
17.1	98.8	99.2	52.0	67.6	29.1	106.5	187	60.9	1/1 1/1 3/3 0/1 (S/F)
32.2	125	141	(A 66.2 (J 78.5	59.1	34.2	131	208	66.0	1/1 1/1 4/3 (S/F)
31.8	124	153	62.5	61.5	31.1	127	207	74.0	1/0 1/1 3/3 0/1 (S/F)
42.5	137	82.5	71.2	57.1	32.2	143	219	78.9	1/0 1/1 3/3 (F)
46.9	139	-	78.1	60.0	32.8	149	238	73.4	1/0 1/1 3/3 (F)

TABLE V. Weights of Various Internal Structures of an Adult Male Atlantic Walrus

Structure	Weight (lbs.)	Per cent of Total Body Weight (2,084 lbs.)
Integument and subdermal adipose tissue.....	632	30.32
Heart	11	0.53
Blood.....	160	7.68
Lungs.....	51	2.45
Liver	61	2.92
Stomach, spleen, pancreas and intestines.....	76	3.65

TABLE VI. Measurements and Weights of Atlantic Walrus Foetuses

Date Collected	Sex	Standard Length (mm.)	Circumference behind Fore Flipper (mm.)	Hind Flipper Length (mm.)	Foetuses Weight (gms.)
10/8/54	♀	208	150	30	-
11/9/53	♀	265	260	43	774.0
11/9/53	♂	250	226	43	587.4
29/9/53	♂	370	315	78	2,154.1
29/9/53	♂	375	296	80	1,814.5
29/9/53	♂	440	376	102	3,174.5

TABLE VII. Measurements of Testes and Bacula from Male Atlantic Walruses

NOTE: Weights not corrected for blood lost before weighing.

Field Number	Age	Standard Body Length (mm.)	Body Weight (lbs.)	Testes Length and Width (mm.)	Baculum Length (mm.)	Baculum Weight (gms.)
27	Calf	1,320	212	98 x 30	127	6.7
16	Sub-adult	1,770	-	86 x 23	230	27.2
14	"	1,880	657	110 x 25	255	55.0
13	"	2,130	722	124 x 31	280	65.1
5	Adult	2,440	1,017	125 x 33	345	118.0
11	"	2,390	991	126 x 41	399	210.5
54.9	"	2,440	-	120 x 35	308	127.1
24	"	2,670	-	180 x 58	495	390.9
54-11	"	2,690	-	178 x 64	473	295.4
54-12	"	2,740	-	198 x 55	495	491.2
54-7	"	2,820	-	170 x 72	512	563.6
21	"	2,920	-	208 x 70	505	649.4
54-5	"	2,950	-	175 x 73	454	503.1
3	"	2,970	1,527	197 x 55	510	491.8
54-6	"	3,020	-	205 x 70	515	768.3
54-3	"	3,100	1,923	205 x 65	485	551.4
54-10	"	3,120	-	190 x 63	535	673.1
10	"	3,150	1,826	218 x 62	517	603.3

TABLE VIII. Size of Ovaries in Female Atlantic Walruses

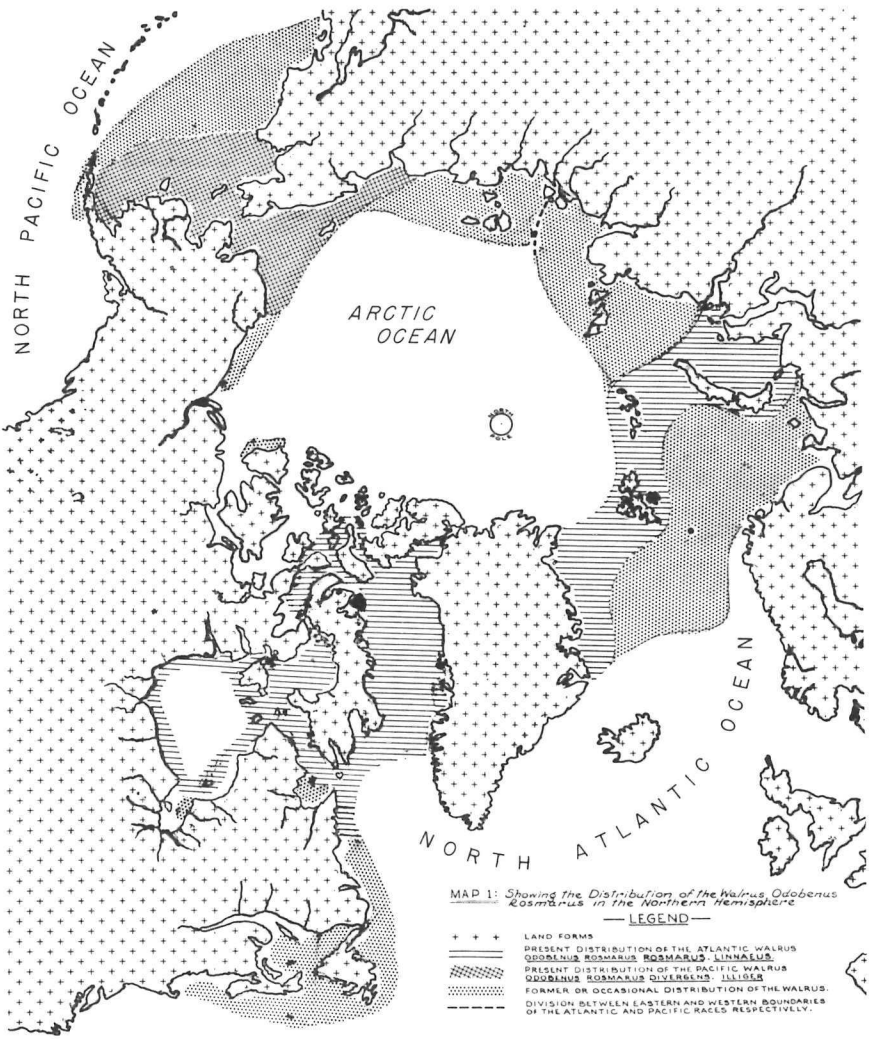
NOTE: Weights not corrected for blood lost before weighing.

Field Number	Age	Standard Body Length (mm.)	Body Weight (lbs.)	Dimensions of Ovaries (mm.)
20	sub-adult	1,650	-	47 x 25 x 15
2	"	1,960	613	-
6	"	1,960	699	-
25	"	1,960	-	63 x 29 x 15
4	"	2,080	661	70 x 25 x 21
22	adult	2,360	-	74 x 49 x 30
54-8	"	2,410	-	73 x 50 x 31
19	"	2,440	-	65 x 32 x 24
17	"	2,540	-	75 x 41 x 26
26	"	2,540	-	68 x 26 x 20
7	"	2,560	1,089	65 x 25 x 21
8	"	2,260	1,068	69 x 30 x 25
1	"	2,720	1,351	67 x 27 x 28
12	"	2,720	1,283	66 x 39 x 20
9	"	2,740	1,485	61 x 32 x 22
18	"	2,740	-	70 x 37 x 28
23	"	2,900	-	65 x 35 x 30

TABLE IX. Numbers of Walruses Harvested in Southampton Island Area, 1950-1954

NOTE: Including the waters about Walrus Island, Coats Island, Bell Peninsula, and Duke of York Bay, Southampton Island.

Type of boat and owner	1950	1951	1952	1953	1954
Peterhead Boats					
Joe Curly	-	-	42	45	27
Pommeeoolik	-	-	44	60	35
Sandy	-	-	48	48	33
Gibbons	-	-	41	9	-
Natakok	-	-	41	43	32
Kalogilik	-	-	-	-	25
Trap Boats					
Angnatweenak	-	-	21	-	-
Nuvenok	-	-	-	-	22
Whale Boats					
Shimout	-	-	-	1	-
Tommy Nakolak	-	-	10	13	18
M.T. Boat					
Noah	-	-	-	-	4
M.V. Calanus	-	-	-	4	8
Canoe					
Duke of York Bay, Mikitok	-	-	14	-	-
TOTALS	101	229	261	223	204


NORTH PACIFIC OCEAN
ARCTIC OCEAN
NORTH ATLANTIC OCEAN
MAP 1: Showing the Distribution of the Walrus, Odobenus Rosmarus in the Northern Hemisphere.
— LEGEND —
LAND FORMS
PRESENT DISTRIBUTION OF THE ATLANTIC WALRUS ODOBENUS ROSMARUS ROSMARUS, LINNAEUS.
PRESENT DISTRIBUTION OF THE PACIFIC WALRUS ODOBENUS ROSMARUS DIVERGENS, ILLIGER.
FORMER OR OCCASIONAL DISTRIBUTION OF THE WALRUS.
DIVISION BETWEEN EASTERN AND WESTERN BOUNDARIES OF THE ATLANTIC AND PACIFIC RACES RESPECTIVELY.


— MAP 2 —
CANADIAN EASTERN ARCTIC
SCALE: 160 Miles to 1 Inch
GREENLAND
ELLESMERE ISLAND
Kane Basin
Kennedy Channel
Smith Sound
ETAH
THULE
UPERNAVIK
Jones Sound
DEVON ISLAND
Wellington Channel
Cornwallis Is.
RESOLUTE BAY
BARROW STRAIT
LANCASTER SOUND
BAFFIN BAY
Disko Is.
EGEDESMINDE
DAVIS STRAIT
HOLSTEINBORG
BYLOT ISLAND
POND INLET
Admiralty Inlet
Prince Regent Inlet
SOMERSET ISLAND
ARCTIC BAY
River Clyde
Home Bay
BAFFIN ISLAND
FORT ROSS
BOOTHIA PEN
GULF OF BOOTHIA
Fury and Hecla Strait
Jens Munk Island
PANGNIRTUNG
Cumberland Sound
Spicer Islands
FOXE BASIN
MELVILLE PENINSULA
Committee Bay
FROBISHER BAY
Lake Land
Frobisher Bay
Resolution Is.
DISTRICT of KEEWATIN
Foxe Channel
FOXE PEN.
CAPE DORSET
LAKE HAREBOUR
Mill Is.
Salisbury Is.
HUDSON STRAIT
Big Is.
FORT BURWELL
Button Is.
Cone Creek
Nottingham Is.
Charles Is.
Wales Is.
HOPES ADVANCE
Cider Is.
Aspley Is.
UNGAVA BAY
Gyr Falcon Is.
Rowley Bay
Roes Welcome Sound
SOUTHAMPTON ISLAND
CORAL HARBOUR
Beechey Pt.
Walrus Is.
Evans Str.
Fisher Strait
Coats Is.
Digges Is.
Merkel Is.
Depot Is.
CHESTERFIELD
Marble Is.
Bibby Is.
POVUNGNITUK
Ottawa Islands
ESKIMO POINT
HUDSON BAY
PORT HARRISON
QUEBEC
Dresden Islands
Belcher Islands
Cape Churchill
CHURCHILL
YORK FACTORY
C. Henrietta Maria
WINISK
JAMES BAY
Dept of Northern Affairs & Natural Resources
National Parks Branch — Engineering Services
Prepared: March 21st/1966 — H. Dalenda

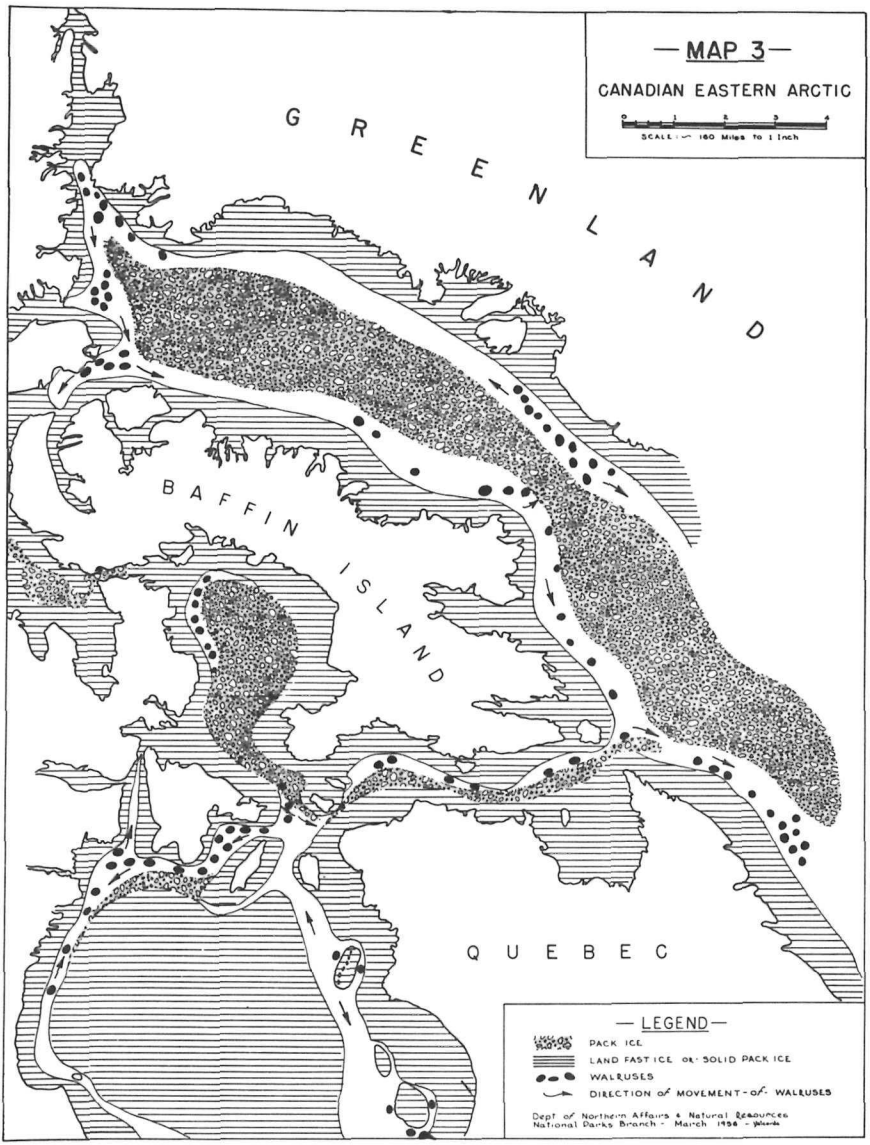

— MAP 3 —
CANADIAN EASTERN ARCTIC
SCALE :- 160 Miles to 1 Inch
G R E E N L A N D
B A F F I N I S L A N D
Q U E B E C
— LEGEND —
PACK ICE
LAND FAST ICE OR SOLID PACK ICE
WALRUSES
DIRECTION OF MOVEMENT OF WALRUSES
Dept. of Northern Affairs & Natural Resources
National Parks Branch - March 1958

Fig. 1. Walruses landed at high tide on shore at Back Peninsula, Southampton Island, for later examination.

Fig. 2. Weighing walrus' intestines on spring scale, Southampton Island, September, 1953.

Fig. 3. Photographing sub-adult walrus on Walrus Island, July, 1954.

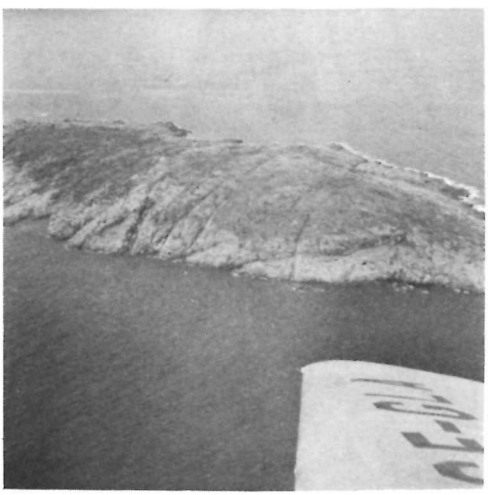


Fig. 4. Southern half of Walrus Island, showing typical walrus hauling-out area.

Fig. 5. Young male walrus on small ice pan in Evans Strait, September, 1954.

Fig. 6. Sub-adult male walrus on Walrus Island, July, 1954. Note broken tusks and long mystacial vibrissae.

Fig. 7. Close up of head of young bull walrus. Note pattern of mystacial vibrissae and patches of hair on shoulders.

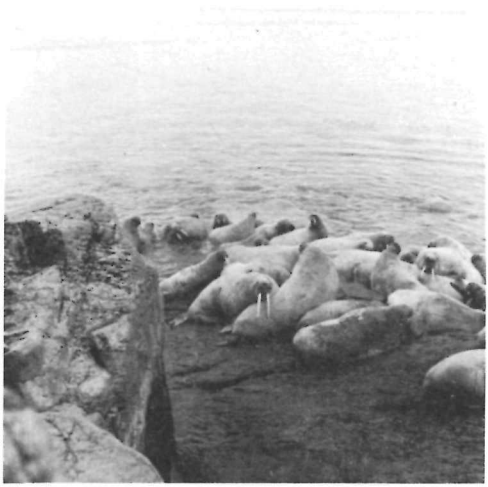


Fig. 8. Herd of walruses on Walrus Island, July, 1954. Note large bull with tusks hooked over flank of neighbour; also animal in water at left scratching head with hind flipper.

Fig. 9. Walruses sleeping on rocks on Walrus Island, July, 1954. Note various postures.

Fig. 10 Bull walruses on Walrus Island, July, 1954. Note "alert" posture of bull at right, and also bull at left scratching head with hind flipper.

Fig. 11. Young male walrus caught in crevice in rocks on Walrus Island, July, 1954.

Fig. 12. Dead calf on rocks on Walrus Island, July, 1954. It had been crushed during a stampede.

Fig. 13. Sub-adult male walrus, presumably killed by polar bear, Bell Peninsula, Southampton Island, September, 1954.

Fig. 14. Hunting walruses at floe edge South Bay, Southampton Island, February, 1953. Note shore lead beyond land-fast ice.

Fig. 15. Eskimos in Peterhead boat hunting walruses off Bencas Island, August, 1953.

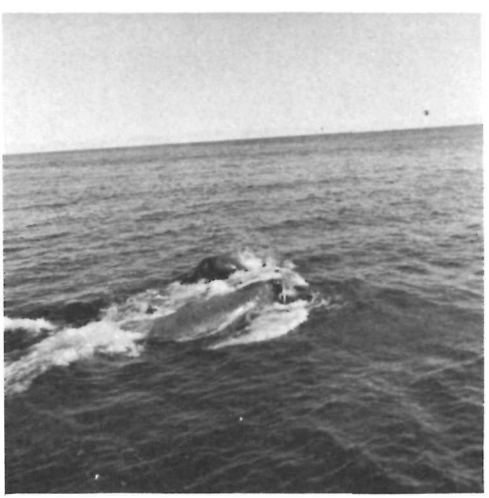


Fig. 16. Two swimming walruses attempt to escape pursuing boat.

Fig. 17. Eskimo "at ready" to harpoon walruses chased into shallow water off Bencas Island, August, 1953.

Fig. 18. Walrus breaking water just after being harpooned. Note harpoon shaft which has broken away.

Fig. 19. Eskimo preparing to shoot walrus which has been exhausted and chased into shallow water off Bencas Island, August, 1953. Note harpoon and 10-gallon drum used as float, on deck of boat.

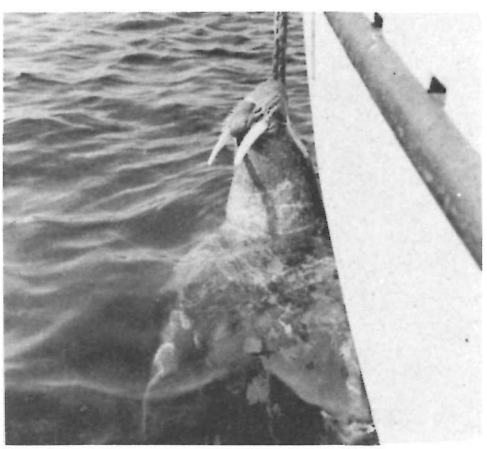


Fig. 20. Walrus secured to side of boat during hunt, to be landed on shore after hunt completed. Note flesh of lower jaw, which rubs against medial sides of tusks.

Fig. 21. Eskimos butchering walrus on Bencas Island, August, 1953. Note thick layer of adipose tissue.

Fig. 22. Eskimo butchering walrus. Note thickness of subdermal adipose layer.

Fig. 23. Backbones and ribs of walruses washed ashore at Bencas Island site of butchering used for many years by Eskimos.

Fig. 24. Eskimos butchering walrus in the water.

Fig. 25. Bloated and deteriorated walrus washed up on Walrus Island. Note torn head which polar bear had been feeding upon.

Fig. 26 Two bulls fighting battle for position, Walrus Island, July, 1954. Note wound on back of animal at left.

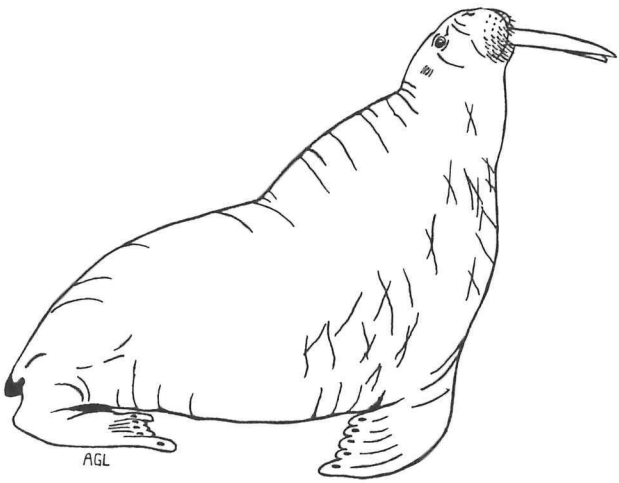


Fig. 27. Outline drawing of bull walrus depicting threat posture.

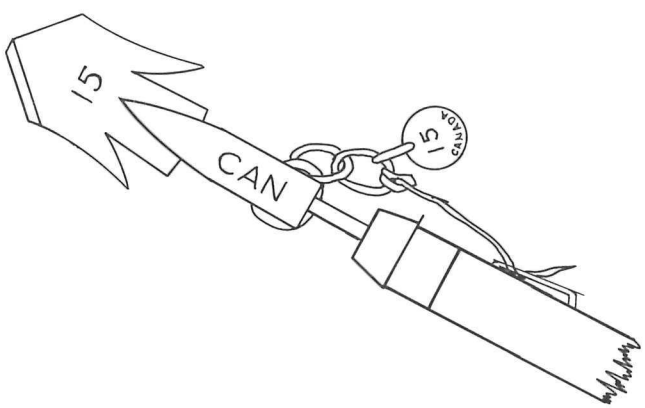


Fig. 28. Outline drawing of walrus harpoon tag.

APPENDIX I

Walrus Hides and Ivory Exports in Pounds

	1925	1926	1927	1928	1929	1930	1931	1932	1933
				HIDES					
Clyde	1,215	1,100	480	1,180	190	360	1,385	-	-
Pangnirtung	-	-	-	-	-	-	-	1,040	-
Blacklead Island	-	-	-	1,328	340	218	513	3,811	-
Frobisher Bay	-	-	-	-	-	-	1,026	-	145
Lake Harbour	-	-	-	-	-	-	4,530	-	-
Amadjuak	-	-	-	-	800	1,500	1,685	-	-
Cape Dorset	21,375	-	19,757	16,231	22,267	10,633	3,975	1,410	-
Southampton Island	600	5,721	1,276	8,594	5,185	5,221	3,891	-	-
Sugluk East	-	-	-	-	-	432	-	-	-
Stuparts Bay	-	-	-	3,210	-	9,883	1,438	264	-
Payne Bay	-	-	-	-	8,926	837	-	-	-
Leaf River	-	-	-	-	-	2,412	-	-	-
				IVORY					
Cape Dorset	-	-	240	481	359	-	-	-	-

APPENDIX II

Human Utilization of the Walrus in Various Geographic Areas

Labrador and Ungava Bay — No. of Eskimos: 1,099

Settlement	Years recorded	Range in No. of annual kill	Average annual kill	Source of information
	19-			
Port Burwell				
Fort Chimo				
Payne Bay	53-54	11-100	11	S.M.Q.[1]
Diana Bay	50-53		30	C.W.S.[2]
Total Av. Annual Kill			41	

East Coast of Hudson Bay and Southern Hudson Strait — No. of Eskimos: 1,008

Settlement	Years recorded	Range in No. of annual kill	Average annual kill	Source of information
	19-			
Port Harrison incl. Belchers	52-55	26-150	60	S.M.Q.
Povungnituk				
Ivuyivik	53-55		69	H.B.C.[3]
Sugluk			40	H.B.C.
Wakeham Bay				
Total Av. Annual Kill			169	

[1] Sea Mammal Questionnaire

[2] Canadian Wildlife Service

[3] Hudson's Bay Company

APPENDIX II (continued)

Human Utilization of the Walrus in Various Geographic Areas

West Coast of Hudson Bay — No. of Eskimos: 728

Settlement	Years recorded	Range in No. of annual kill	Average annual kill	Source of information
	19-			
Eskimo Point	53-55	2-15	10	S.M.Q., C.W.S.
Tavanni	52		6	R.C.M.P.[4]
Chesterfield Inlet	52-55	4.26	20	S.M.Q., C.W.S.
Repulse Bay	53		12	C.W.S.
Total Av. Annual Kill			48	

Southampton Island and Melville Peninsula — No. of Eskimos: 546

Settlement	Years recorded	Range in No. of annual kill	Average annual kill	Source of information
	19-			
Southampton Island	50-54	101-261	204	C.W.S.
Igloolik from Cape Wilson to Jens Monk Is.	52-54	350-500	425	C.W.S.
Total Av. Annual Kill			629	

[4]R.C.M. Police

APPENDIX II (continued)

Human Utilization of the Walrus in Various Geographic Areas

Baffin Island — No. of Eskimos: 2,179

Settlement	Years recorded	Range in No. of annual kill	Average annual kill	Source of information
	19-			
Cape Dorset	53-55	30-70	50	C.W.S.
Lake Harbour	53-55	35-70	55	C.W.S.
Frobisher Bay	49-54	20-75	50	R.C.M.P.
Pangnirtung	54-56	42-47	45	R.C.M.P.
Cape Christian	55		19	R.C.M.P.
Pond Inlet	52-55	6-21	15	S.M.Q.
Arctic Bay	53-54	6-12	8	C.W.S.
Total Av. Annual Kill			242	

Arctic Islands

Settlement	Years recorded	Range in No. of annual kill	Average annual kill	Source of information
	19-			
Resolute Bay				C.W.S.
Cornwallis Island	53-55	6-27	20	C.W.S.
Dundas Harbour	49-50		10	C.W.S.
Devon Island	56		31	R.C.M.P.
Craig Harbour	55-56	11-19	15	R.C.M.P.
Alexandra Fiord				
Total Av. Annual Kill			76	
Grand Total Canadian Av. Annual Kill			1,205	

APPENDIX II (concluded)

Human Utilization of the Walrus in Various Geographic Areas

West Greenland

Settlement	Years recorded	Range in No. of annual kill	Average annual kill	Source of information
Thule	19-48-50	19-150 *	100	C.W.S.
West Greenland incl. Thule	44	400-600	500	Dunbar (1949)
Total Av. Annual Kill			500	
Grand Total Av. Annual Kill for all Settlements			1,705	

* incomplete figures