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Marine Mammal Studies in Southeastern Baffin Island

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December 1979

Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 1552

Government of Canada Fisheries and Oceans
Gouvernement du Canada Pêches et Océans

Canadian Manuscript Report of Fisheries and Aquatic Sciences

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MARINE MAMMAL STUDIES IN SOUTHEASTERN BAFFIN ISLAND

Final report to the
Eastern Arctic Marine Environmental Studies (EAMES) project

by

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DISCLAIMER

The data for this report were obtained as a result of investigations carried out under the Eastern Arctic Marine Environmental Studies (EAMES) program, sponsored by the Department of Indian Affairs and Northern Development (DIAND) to provide information necessary for the assessment of oil drilling proposals.

Any opinions or conclusions expressed in this report are those of the authors and are not necessarily shared by the Government of Canada.

Cat. no. Fs 97-4/1979-1552 ISSN 0706-6473

ABSTRACT

Smith, T. G., M. H. Hammill, D. W. Doidge, T. Cartier and G. A. Sleno. 1979. Marine mammal studies in southeastern Baffin Island. Final report to the Eastern Arctic Marine Environmental Studies (EAMES) project. Can. MS Rep. Fish. Aquat. Sci. 1552: 70 p.

Two camps on Beekman Peninsula, southeastern Baffin Island, were occupied from 3 May to 3 October 1978. Densities of one ringed seal birth lair per 9.7 minutes of searching time were found near Popham Bay. This value is similar to densities found in other highly productive areas. Behavioural work shows that ringed seals are site tenacious and aggressive, suggesting territorial partitioning of the fast ice breeding habitat and the possibility of homing in this species. Aerial surveys conducted after mid June in this area, in the absence of ground controls, may be highly inaccurate because of aggregation of seals in small bays and large variation in the time of day when peak numbers haul out. The summer paucity of ringed seals is surprising and not understood. Bearded seals are common in the area and appear to be subject to high predation by polar bears. Walruses are present throughout the summer at one or more hauling-out sites, and a large influx from Hudson Strait is seen in mid September. Most of these animals haul out and perhaps feed near Lady Franklin Island. Beluga, bottlenose whales and bowheads were also observed, the bottlenose whale being the most common summer cetacean in this area. Common terrestrial mammals observed included polar bears, wolves, foxes and caribou. The possible impacts of oil well blowouts and disturbance on the various species are discussed. General and specific recommendations are made for other impact-oriented studies.

Key words: Ringed seal, bearded seal, harp seal, walrus, age structure, reproductive status, behaviour.

RESUME

Smith, T. G., M. H. Hammill, D. W. Doidge, T. Cartier and G. A. Sleno. 1979. Marine mammal studies in southeastern Baffin Island. Final report to the Eastern Arctic Marine Environmental Studies (EAMES) project. Can. MS Rep. Fish. Aquat. Sci. 1552: 70 p.

Nous avons établi deux campements le long de la péninsule de Beekman entre le 5 mai et le 30 octobre 1978. Des densités de repère de naissance de l'orde d'un repère par 9.7 minutes de recherche ont été observées après une courte période de recherche aux environs de Popham Bay. Ces résultats se comparent facilement aux densités observées dans des régions hautement productives. Le travail sur le comportement montre que les phoques annelés sont agressifs et tenaces quant à des emplacements choisis, suggérant ainsi un morcellement territorial de l'habitat de reproduction sur les glaces côtières. Ceci suggère également la possibilité d'un retour annuel au même endroit pour l'espèce considérée. Les recensements aériens effectués après la mi-juin en l'absence de contrôle au sol, pourraient s'avérer inexacts à cause d'aggrégations dans les petites baies et de la grande variation au niveau du temps de la journée où le maximum de phoques se hissent hors de l'eau. La rareté du phoque annelé dans cette région durant l'été est surprenante et plutôt mal comprise. Les phoques barbus y sont communs et semblent être soumis à un taux élevé de prédation par l'ours polaire. Les morses sont présents tout au long de l'été à un ou plusieurs points de sortie de l'eau; une incursion importante d'animaux venant du Détroit d'Hudson a été observée vers la mi-septembre. La plupart de ces bêtes sortent de l'eau et possiblement se nourrissent au voisinage de l'Ile Lady Franklin. On a observé des Bélugas, des Baleines à bec commune de même que des Baleines franches du Groenland; durant l'été, la Baleine à bec commune est le plus commun des cétacés de la région. En ce qui a trait aux mammifères terrestres les plus rencontrés, on peut mentionner l'ours polaire, le loup, le renard et le caribou. L'impact d'un éventuel éclatement d'un puits de forage et les perturbations chez les différentes espèces, y sont discutés. Certaines recommandations d'ordre général et spécifique concernant la vocation des études d'impact sont faites.

ACKNOWLEDGEMENTS

We wish to thank Ipeelie Inookie, our Inuk assistant from Ukulialuit (Allen Island), who guided us around his country and proved to be an able and interested researcher. The Inuit from Ukulialuit and Frobisher helped us in many ways. It is gratifying to know that the people living in the north share our concerns for the environment and are beginning to actively participate in the kind of work needed to better understand and protect their livelihood.

Andy Theriault, District Manager, DIAND, kindly provided logistic support and liaison with the Inuit. Andrew Pelletier, manager of the Ikaluit Research Laboratory provided accommodation and communication facilities during the study. We also wish to thank Fred Anderka, Canadian Wildlife Service, Ottawa, for assistance in the design of electronic equipment used in this study.

Financial support for this study was provided by Esso Resources Canada Ltd., Aquitaine Company of Canada Ltd., and Canada Cities Services Ltd. through the Department of Indian Affairs and Northern Development.

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INTRODUCTION

This study had as its primary goal the assessment of the possible impacts of offshore oil well drilling on the marine mammal biota occupying the coastal areas between Cumberland Sound and Frobisher Bay on the eastern coast of Baffin Island. While preparations for implementing the study were begun in early March, it was not until 8 May 1978 that field work began. Studies were carried out through the spring fast ice season and summer open water period and terminated in early October 1978.

Five species of pinnipeds, the ringed seal (*Phoca hispida*), bearded seal (*Erignathus barbatus*), harbour seal (*Phoca vitulina*), harp seal (*Pagophilus groenlandicus*) and walrus (*Odobenus rosmarus*) are found in the area. In addition eight species of whales are also known to occur: the beluga (*Delphinapterus leucas*), bowhead (*Balaena mysticetus*), bottlenose (*Hyperoodon ampullatus*), killer (*Orcinus orca*), pilot (*Globicephala melaena*), minke (*Balaenoptera acutorostrata*), humpback (*Megaptera novaeangliae*) and sperm whale (*Physeter catodon*).

Literature dealing with the marine mammal studies done in areas adjacent to the present region has been reviewed in Smith (1973a). More recent pertinent literature on Inuit exploitation of marine mammals may be found in Kemp (1976); on survey work in the area in MacLaren Atlantic Limited (1978a, b); and on the effect of oil on marine mammals in Geraci and Smith (1976, 1977) and Englehardt, Geraci and Smith (1977).

THE STUDY AREA

Popham Bay (64°17'N, 65°30'W) was the site of the early spring behavioural work. The fiord-indented coastline with high precipitous cliffs remained ice covered until early July. The outer reaches of the bay, including the Leybourne Islands area, consisted of patches of open water and grey ice undercut by strong tidal currents. Polynyas existed in these places throughout the winter. Fig. 1 outlines the main study area and areas of fast ice where hauled-up ringed seals were counted during the two month behavioural study period.

The Winton Bay area was occupied during the open water season from mid June until early October. Fig. 2 shows the areas of Robinson Channel, the southern Lemieux Islands and Brevoort Island covered during the boat surveys. These waters were virtually ice free for this whole period. Fig. 3 gives a summary of ice conditions existing along the whole of the coastline under consideration for the winter of 1978. However, it does not accurately indicate the areas of undercut fast ice between islands and at headlands. Occasionally areas of open water are also seen during mid winter, deep into long fiords. These are apparently formed by a particular combination of bottom topography and tidal currents.

MATERIALS AND METHODS

Detailed behavioural observations were made in the area designated South Bay on Fig. 1. The ice surface in this area measured 2.31 km^2. Daily observations were maintained between 0800 and 1800 hours for the period 8 May to 6 July 1978.

The primary observation point was located midway along the north shore of the bay. Observations were made from the door of a small tent using a Bushnell Spacemaster 10 to 40 power spotting telescope. Every hour, total counts of seals were made in South Bay and in the area designated Outer Bay (Fig. 1). Wind direction, wind speed, cloud cover and type, and visibility were also recorded at this time. Every hour, on the half hour, compass orientation of seals within South Bay was recorded.

For the major part of the observation period it was possible to record the position of the seal holes being used. These positions were assigned letters, and their elevation and angle was recorded by theodolite with respect to a landmark on the south shore. This designation of positions was maintained until late June when the appearance of melt holes in the ice made this system too difficult to maintain. For the remainder of the observation period orange flags were erected along the south shore of the bay, which enabled us to divide the area into quadrats. The positions of these flags were established using the theodolite. Total counts now included counts in Outer Bay, and the numbers of seals in each quadrat in South Bay. Orientation checks were maintained on a subsample of seals at breathing holes. The positions of these holes were recorded on a daily basis.

Pelage patterns of recognizable individuals were recorded by freehand drawings. Attempts were also made to photograph individuals using a Nikon 1000 mm F11 lens mounted on a Nikkormat FT3 body and tripod. Resightings of recognizable individuals, sexes of individuals, behavioural interactions and miscellaneous game sightings were made throughout the observation period.

Birth lair surveys were carried out on 9 and 20 May using a trained dog, following the methods described in Smith and Stirling (1975). Only the areas designated as South South Bay, a small portion of Outer Bay and the extreme west end of South Bay, were searched. Because of the late date of commencement and the fact that most birth lairs had already melted open or collapsed, positive identification of subnivean structures was possible.

Biological collections were made during the open water period from 14 July until early October. Hunting was done from a small boat and freighter canoe powered by outboard motors. Standard measurements and whole body weights were recorded for each mammal collected and biological samples were processed as in Smith (1973a). Whole stomach contents were collected, preserved or frozen, and later weighed and identified in the laboratory.

Surveys were done by small boat, by Bell 206 helicopter and by De Havilland Twin Otter aircraft.

RESULTS

Birth Lair and Behavioural Observations

The number and type of subnivean ringed seal lairs found during the brief search are shown in Table 1. Coverage of South South Bay (9.19 km^2) was fairly complete and it is felt that the density of one birth lair found per 9.7 minutes of search is fairly representative. This compares quite closely to the density found in an area of prime breeding habitat in the western arctic during a good year (Smith and Stirling, 1978). The density of subnivean structures (one per 3.55 minutes of searching time) also compares closely to that found in the western arctic study (one per 4.1 minutes). If anything, because of the late date of this search, we might be underestimating the density of birth lairs in South South Bay.

No other birth lairs were found in the other search areas. South Bay probably contained birth lairs but we did not search the area intensely because we did not want to disturb the seals there which were being observed as part of the behavioural study. Only breathing holes were found at the extreme head of the bay where water depths were less than three metres.

Only breathing holes and one haul-out area, formed in a refrozen ice crack, were found in the short search of Outer Bay.

In South South Bay two of the four birth lairs had been entered by polar bears (*Ursus maritimus*) but no kills were made. One birth lair had also been opened by an arctic fox (*Alopex lagopus*). No predation attempts were seen at the breathing holes found in South Bay, but remains of one ringed seal pup were found in the rough ice at the end of the Bay (Table 2). Signs of fox predation were found on the ice surface in Outer Bay and two of the four subnivean seal structures had fox signs near them. A sleeping den made by a fox in a small ice hummock was also observed in this area.

Behavioural observations were conducted from points on the north side of the South Bay study area (Fig. 1) from 8 May until 7 July. A total of 437 hours of observations were made. A maximum of 71 individual ringed seals were identified, of which 18 were resighted at least on one other day after they had left the original position at which they were noted. The furthest seal position from the main observation point was at 1240 m distance. However it was not practical to attempt to identify individual seals further than the position located 462 m away from the main observation point. Only seven exit holes were close enough so that individual seals using them could be identified, but an additional six positions at the end of South Bay were observed from a secondary observation point, close enough to identify the seals hauled out (Fig. 4).

Table 3 shows the average weather conditions and visibility prevailing on all days when observations were made. The wind chill factor, expressed as kcal loss per m^2 per hour is calculated from the formula of Siple and Passel (1945): $H = (\sqrt{100V} + 10.45 - V)(33-Ta)$, where V = wind speed in m/sec and Ta is temperature in degrees Celsius. Mean wind direction is calculated from the formula in Batschelet (1965).

The number of individual positions or breathing holes at which seals hauled out are shown in Table 4. From 8 May to 2 June the number of positions identified varied only from 8 to 13. After this date a sudden increase of positions was noticed at the southwest corner of the bay. The ice in this area was observed to have become very thin and it is believed that seals were using the holes worn open by the swift tidal currents by which to exit onto the ice. In the more easterly part of South Bay, where the ice remained thicker for longer, there was a similar but not so drastic increase in the number of positions. These new positions are also thought to result from melt holes, rather than being actual seal breathing holes maintained by the seals through the winter.

Fig. 5 shows the increase in maximum daily density of seals on the fast ice of Outer Bay and South Bay for the whole period of observation. Near peak densities were apparently reached in Outer Bay by 1 June and a noticeable decrease is seen on 5-6 June, with a high variation in the densities observed after this date. In South Bay peak densities were not realized until 21 June and a noticeable rise in densities was observed on 4-6 June. This corresponds to the availability of new exit holes in the ice near shore in South Bay (Table 4).

Higher densities were reached in South Bay, where a maximum of 32.5 seals per km^2 was seen on 30 June compared to 19 seals per km^2 in Outer Bay. An overall peak density for the two areas combined of 22 seals per km^2 was observed on 29 June (Fig. 6).

Fig. 7 shows the time of day at which the maximum number of seals was hauled out for each observation day throughout the season. These records of diurnal peak of haul-out are heavily biased by the fact that on most observation days the work was terminated at 1800 hours. However it can be seen that for both Outer and South bays the peak number of seals was usually reached before 1800 hours from early May until approximately mid June. After this date seals began hauling out for much longer and peak numbers were often recorded late at night or during the early morning hours.

Figs. 8 and 9 are the result of continuous observations in South Bay and Outer Bay for the periods 13 to 16 June and 19 to 22 June respectively. During this period the mean daytime wind speeds varied from 5 to 14 m/sec and temperatures from 2 to 6°C. Peak numbers for 13, 14, 15 and 16 June were seen at 2300, 1600, 1000 and 1000 hours respectively for South Bay and 1900, 1900, 0800 to 1300 and 1100 hours respectively for Outer Bay. This large variation in the time of peak haul-out is likely to be related to wind speed and air temperature. A regression of hourly seal numbers in South Bay on wind chill factor during the two periods shown in Figs.

8 and 9 results in correlation coefficients of -0.60 and -0.79 ($P < 0.10$). Neither correlation coefficient was quite significant, probably because of the advanced season and the small variation in wind chill.

The fact that wind often decreased in the late evening probably accounted for occasional peak numbers on the ice in the late or early hours at this time of year. Earlier in the haul-out season peak air temperatures, usually achieved by mid day, are closely correlated to peak seal numbers (Smith 1973a; Smith, Hay, Taylor and Greendale 1978).

No large numbers of nursing pairs were seen during this study. In Outer Bay, where they were observed, the maximum number recorded was three. One or more pairs were seen until 16 June, after which none were observed. Smith (1973a) showed that the peak density of nursing pairs observed in Ekalugad Fiord, north of Broughton Island on the east coast of Baffin Island, occurred as early as 10 May. It is believed that we missed the peak in Outer Bay because of the late start and the more southerly location of the study area. The peak time of haul-out for groups of two or more seals occurred on 29 June. The period 29 June to 4 July saw the largest numbers of groups of seals hauled out around single holes. The large majority of these groups were of two animals, but groups of as many as 6 seals were seen at one breathing hole.

In general seals appeared to rest with their heads pointed downwind. The mean wind direction and direction of seal orientation were determined by calculating their mean vectors from the formulas in Batschelet (1965). Table 5 shows the results of a Stephens-Rayleigh test (Batschelet 1965) done on the wind directions and mean seal directions for four days. In all cases but one, the seals were definitely orienting in the same direction as the wind (significant at the one percent level). The weather conditions prevailing for these days were not very different, the wind chill factor varying only from 853 to 928 $kcal/m^2/hour$.

Individual seals identified by line drawings of their distinctive pelage patterns were resighted fairly frequently during the study period. Table 6 lists the individual seals resighted on more than one day. The maximum number of resightings for an individual seal was 18 days over the period 11 May to 6 June 1978. These were of a large male ringed seal occupying the positions A, B, C and I in front of the main observation tent. Nine of the resightings were made at position B, six at A, two at I and one at C. The second most frequently seen seal was resighted on 11 separate days during the period 15 May to 19 June. This was a medium size female apparently not accompanied by a pup. She most frequently occupied position A, being resighted there eight times, and was also seen five times at B and five times at I.

One seal was sighted over a seven day period from the secondary observation site. This seal was only seen at positions K and H, two holes in very close proximity. The remaining seals resighted during this study were seen on three days or less and are listed in Table 6. In addition another six seals were reidentified on the same day after they reentered the water and came back up onto the ice. In all cases these seals went down and came back up the same hole.

Because observations were not continuous it is not often possible to give accurate total times spent on the ice at a haul-out session by individually recognized seals. As the season progressed, so did the time spent on the ice by individual seals increase. Fig. 10 shows this increase of maximum observed time spent by any one seal in the study area during the season of observations. In cases where the maximum time of the sitting is underestimated a + is indicated on the histogram. On 19 June, during a series of three days of continuous observations, one seal was seen to spend 21 hours continuously on the ice. This was the actual time of the "sitting" since the seal was seen to emerge from and reenter the water.

Whenever possible the sex of the individually recognized seals in the study area was recorded. During the period 11 May to 22 June 72 males and 56 females were recognized. A chi square value of 2.00 indicates that there is no significant departure from a 1:1 sex ratio.

The main activities engaged in by seals hauled up on the ice can be classified as vigilance, aggressive displays towards other seals, mother-pup interactions, and movements around or near the breathing hole. Since the ringed seal has evolved in the presence of such predators as the polar bear, arctic fox and wolf (*Canis lupus*), its vigilance prior to emerging onto the ice and while it is basking on the ice is very important to its survival.

Ringed seals are known to approach a breathing hole with caution. During the winter months when the ice and snow dome covers the hole, a seal will not come to it if there is the least sign of surface disturbance. Inuit hunters are careful to create no noise whatever when they are waiting to harpoon the seals. During this study seals were often seen in the holes for varying periods before they decided to haul out. Often a seal would put its head out of the water and look around carefully before emerging from the hole.

Once on the ice seals maintained vigilance by putting up their heads and alternately lying down. For 12 individual seals lying alone by their hole, an analysis of variance revealed that there were significant differences between individuals for both the looking and lying phase ($F = 2.34$, $P = 0.008$, d.f. 11 and 324; $F = 10.27$, $P = 0.00001$ d.f. 11 and 312, respectively). For a group of four seals all lying together at a single hole the variance between individuals was just significant for the looking phase ($F = 3.07$, $P = 0.05$, d.f. 2 and 87), but not significant for the lying phase ($F = 1.70$, $P = 0.18$, d.f. = 2 and 84). This suggests that there is some effect between animals lying together which increases the variability of vigilant behaviour of the individual seals in the group. However this does not necessarily imply that groups as a whole are more vigilant than individual seals.

One group of four seals lying beside a single breathing hole was treated as an individual for a vigilance test. In 30 events of looking and lying the mean times were 8.9 sec. and 10.47 sec. respectively. This compares with the ranges of means of 1.27 to 14.63 sec. of looking and 4.11 to 32.4 sec. of lying for 12 individual seals, all seen singly at a breathing hole. A series of t tests, comparing the mean lying phase of the group to those of the most and least vigilant of individual seals, shows that this group was not significantly more or less vigilant than individual seals.

Stirling (1974) points out that the significant variance in vigilance between seals implies that polar bears could not successfully learn to stalk them based on any consistent average looking or lying periods. He also correctly states that groups do not appear to have sentinels and that the selective disadvantage of more than one seal hauled out from one hole probably far outweighs any increased alertness that a group might have over individuals.

Aggressive acts consisted primarily of slapping with the foreflipper, splashing with the foreflippers by seals in the water, lunging with neck extended and mouth open, and snapping or attempted bites. Only rarely did these displays actually result in contact between seals.

Table 7 lists the types of situation where aggressive behaviour was observed, and the results of such displays. The majority of aggressive displays were made by seals on the ice towards seals in the water of the exit hole by which they were lying. In 36 percent of instances (8 of 22), a seal emerged from the exit hole in spite of the agonistic behaviour. In 10 of the 22 instances of this type of aggressive behaviour the aggressor was definitely identified as a female. Only once was the aggressor identified as a male. In only four instances were there aggressive displays between seals lying on the ice by a breathing hole. In three cases aggression was triggered by a seal appearing in the water of the breathing hole, and once by accidental contact between seals lying in close proximity.

On only three occasions did a seal emerge from a hole where one or more seals were hauled up without eliciting an aggressive reaction. On several occasions a seal in the water of a breathing hole was observed splashing aggressively without eliciting a response from the seal on the ice. In one case also two heads of seals were seen in a breathing hole accompanied by splashing of water, suggesting that aggressive behaviour was occurring.

Agonistic behaviour appeared to continue throughout the study period, although detailed observations on individual seals became much less frequent after 23 June.

Mother pup pairs were definitely identified only three times in South Bay. All three sightings were made at position I with one other possible sighting at position A (Fig. 4). On the first occasion a pup was seen to attempt unsuccessfully to emerge from the breathing hole at position I. One week later a pup emerged at this position. Two other seals were present on the ice. Nuzzling occurred between the pup and a medium size seal assumed to be its mother. No suckling was seen however. Both the seal, assumed to be the female, and the larger seal made aggressive moves in the form of flipper slaps and bites toward the pup when they were all lying on the ice. The pup also made aggressive bites at the presumed mother. The only occasion of actual nursing was seen at position I on 31 May when a pup suckled for approximately five minutes.

All seals observed remained in close proximity to the breathing holes from which they emerged. They would lie on their ventral, lateral and dorsal sides and not shift very much unless weather conditions were variable. On warm calm days seals were often seen lying almost completely on their backs. Other forms of behaviour included scratching themselves with their foreflippers or scratching by wriggling on their backs in the snow. On three occasions seals were seen to take mouthfuls of snow and eat it.

While it is difficult to evaluate the magnitude of disturbance because of the many factors affecting the number of seals on the ice, several instances were observed of seals being scared into the water. Among the natural disturbances were the presence of a polar bear, arctic wolf, arctic fox and caribou (*Rangifer tarandus*) on the sea ice. The polar bear, the chief predator of ringed seals, caused the most noticeable disturbance. During days when bears were observed in South Bay and Outer Bay the numbers of seals observed were from one to 50 percent of numbers seen on preceding days when there were no bears. The duration of the disturbance is hard to evaluate since we were not able to ascertain whether the bear had completely left the area. Disruptions caused by the wolf, foxes and caribou were nowhere as large nor long-lasting as those caused by bears.

While seals were seen to go down their holes in response to disturbance from aircraft overflights or landings and from snowmobile travel on the sea ice, numbers appeared to return to normal the following day and the disruption did not appear to be large or long-lasting.

Summer Observations and Biological Collections

Occupation of the camp at Winton Bay began on 23 June. The fast ice in the bay broke up on 9-10 July and a boat was launched on 14 July. From then until October all work was based out of the Winton Bay camp and consisted of boat surveys and collection of specimens in the area of Brevoort Island, Popham Bay and Allen Island (Fig. 2).

Ringed seals

A total of 425.2 hours of boat hunting was done during the open water period with an overall sighting density of 1.37 ringed seals per hour. This species was the most abundant seal in the study area. Previous studies (McLaren, 1958, 1961; Smith, 1973a; MacLaren Atlantic, 1978a) have shown it to vary in its abundance in different coastal areas along eastern Baffin Island.

In general the overall impression from boat sightings and numbers of seals killed was that there were very few present in the study area during the open water period. Table 8 compares the catch per unit effort (boat-days) of hunting for several different studies. Cumberland Sound, immediately to the north of the present area, yielded three times the number of seals per unit of effort during the summer of 1969. Holman, in Amundsen Gulf on the west coast of Victoria Island, showed three to six times the yield of seals for two different summer hunting periods. However, it was felt that at Holman in 1975 the yield was exceptionally low, which seemed to be related to a corresponding low production of young seals in the area in 1974 and 1975 (Smith and Stirling, 1978). The low catch per unit of effort and few sightings therefore indicate a definite low number of seals in the present study area.

Whole body weights were recorded whenever possible. The mean weight for pups (0+ age seals) was 23.6 kg (52 lb) and for adults (7+ years and older) 68.1 kg (150 lb). The corresponding estimated mean weights calculated by the method of Usher and Church (1969) were 20.8 kg (45.7 lb) for pups and 67.9 kg (149.2 lb) for adults. In Table 9a the estimated weights of the present sample are compared to those of seals taken in Cumberland Sound and Home Bay (Smith, 1973a). Pup weights appear to fall between those from the two other areas. The small number of adults (17) are all quite large (Table 9b), resulting in a larger mean size than for those from Home Bay. This is believed to be a result of the small sample size making the apparent differences unreliable.

All ringed seals were processed and aged using the methods described in Smith (1973a). Specimens collected from Winton Bay in the summer of 1978 were combined with those bought from Inuit hunters for the period March 1977 to October 1978, resulting in a total sample of 252 seals. A chi square test of the sex ratio of this sample showed no significant departure from unity ($\chi^2 = 0.016$, P 0.01).

The sample from Winton Bay consisted of 32 males and 29 females. Twelve of the 14 females 4 years old and older, had a corpus luteum of pregnancy in the ovaries, giving an estimated reproductive rate of 85.7 percent. This may be a slight overestimate because of the small sample size, but it is in accord with more reliable estimates from samples collected in other areas; for example, 80 percent for Home Bay (Smith, 1973a) and 86 percent for Alaska (Johnson, Ostenson, Fiscus and Barbour, 1966). Nine of the 12 females (75 percent) with corpora lutea bore a visible embryo or foetus. The earliest embryo was recorded on 24 August; from then until 11 September crown-rump measurements varied from 4 to 91 mm.

Fig. 11 shows the age frequencies of ringed seals killed only in the summer open water period and those killed throughout the year.

Using a reproductive rate of 0.85 (see above) and a 1:1 sex ratio, the expected numbers of pups (0+ seals) for each of these distributions were estimated and are shown in Table 10 compared to the actual numbers of pups observed. As has been seen in summer age frequency distributions in other studies, pups are overrepresented mainly because of their increased catchability. They are also overrepresented in the lumped sample in Table 10 since most of this was taken in the summer months. However, the pups are underrepresented in the winter sample, indicating that they move out of the fast ice area exploited by the Inuit hunters.

In Table 11 the proportions of pups, adolescents and adults seen in this study are compared with those reported for Cumberland Sound and Home Bay (Smith, 1973a). The summer age structure is especially important, since it is at this time that all age classes are available to the hunters and therefore most representative of the actual age structure of the population. The summer age distribution of the seals taken in the present study compares quite closely with that of seals taken in the Home Bay region. In the Cumberland Sound sample there is a much higher proportion of adolescent seals and a corresponding lower proportion of adults.

As seen in other studies (McLaren, 1958; Johnson et al., 1966) the ringed seal appears to be an opportunistic feeder. During this study the mean total volumes and weights of stomachs collected were 207 cc and 193 g respectively. The food examined from 56 stomachs consisted of 10.6 percent fish remains, 87.2 percent planktonic crustaceans and 2.2 percent benthic organisms. The food organisms identified and their frequency of occurrence in the stomachs are shown in Table 12. The most common items were the planktonic crustaceans *Parathemisto libellula* and *Mysis oculata* and the arctic cod *Boreogadus saida*.

Only one important potential health problem was discovered from the necropsies of ringed seals collected at Winton Bay. Eleven of the 19 pups (0+ seals) were heavily infested with the lung nematode *Otostrongylus circumlatus*. This roundworm was found in high numbers in some of the lungs, virtually blocking the major air passages. In the western arctic, where this parasite has also been discovered, another smaller nematode *Parafilaroides* sp. is frequently associated with *Otostrongylus*. *Parafilaroides* was not recorded in this study owing to the difficulty in preparing tissues for examination in the field.

Otostrongylus appears to be confined to the first year class of ringed seals; it was not found in older seals in the present study and has only been seen a few times in adolescent seals from other arctic localities.

While the body measurements and weights of the parasitized seals are not significantly different from those of non-infested pups, the parasitized seals appear to be less capable of extended dives and are, therefore, probably more vulnerable to predation and less successful in feeding themselves. This could be especially important after freeze-up, when diving capabilities are even more important for successful feeding and mobility. The fact that seals older than 1+ years of age rarely show any degree of infestation might be indicative of significant natural mortality of the first year class as a result of this parasite.

Bearded seals

A total of 41 bearded seals were sighted from boats while hunting, giving a sighting density of 0.10 per hour. Bearded seals did not seem to be concentrated in any one part of the study area. They were generally sighted in the shallow waters of the small bays along the coastlines of Robinson Sound and Brevoort Island.

Of the 12 bearded seals shot, six were lost by sinking, a much higher loss than for the ringed seals (only 20.9 percent).

Three males and three females were collected. The females aged 5, 6 and 16 years were all sexually mature, two of which contained foetuses of 72 and 76 mm crown-rump length. The largest animal shot was a 20+ year old male with a nose-tail measurement of 275 cm. A 230 cm female aged 6+ years weighed 413 kg (910 lb) exclusive of blood lost.

Five of the six bearded seals had noticeable polar bear claw and bite marks on their bodies. One seal, the 16 year old female, had fresh bite and scratch marks on her. One of her rear flippers had been bitten and so fractured by a bear that the bone protruded from the skin. One of us (T.G.S.) saw a polar bear enter a melt hole in the fast ice and swim under the ice an estimated 400 metres over a period of 32 minutes, his head appearing several times at different holes. He finally emerged from a hole at which a bearded seal had hauled out and attempted to catch the seal, but it got away. We believe polar bear predation attempts on bearded seals are frequent, but the number of kills are probably much lower than those of the much smaller and more abundant ringed seal.

The mean volume and weight of the stomach contents of six bearded seals were 1045 cc and 776 g. They consisted of 20.5 percent fish remains, 38.6 percent planktonic crustaceans and 40.9 percent benthic organisms. The food organisms identified and their frequency of occurrence in the stomachs are listed in Table 13. The gastropod *Buccinum* was the most frequent food item found, followed by a pandalid shrimp, squid *Gonatus fabricii* and fish remains, mostly of the arctic cod *Boreogadus saida*; two other crustaceans *Sclerocrangon boreas* and *Spirontocaris spinus* were also common. Clam feet and siphons belonging to the species *Mya truncata* were also quite frequent.

Harp seals

These were the second most abundant seals in the area with a sighting density of 0.79 per hour. Several places in the study region were preferred by harp seals, such as Okalik Bay (64°04'N, 65°00'W) and the area offshore of Amor Smith Inlet (63°18'N, 64°31'W). Usually subadults or bedlamers (spotted seals with light saddle markings) were sighted singly or in small groups of three to five seals. Some large groups of 15-20 harp seals were sighted which appeared to be made up of mostly adults.

Four of the five harp seals collected were young of the year. One adult female aged 17+ years and weighing 107 kg (235 lb) was collected near Popham Bay. This animal was pregnant with a 17 mm embryo.

The mean volume and weight of the stomach contents were 396 cc and 349 g respectively. They consisted of 35.8 percent fish remains and 64.2 percent planktonic crustaceans. *Mysis oculata*, *Parathemisto libellula* and *Boreogadus saida* were the most common items. A pelagic shrimp *Sergestes arcticus* was found in large quantities in the stomach of the adult female seal shot at 64°09'N, 65°13'W near Popham Bay.

The food organisms identified and their frequency of occurrence are listed in Table 14.

Walruses

Table 15 lists the sighting locations and numbers of walruses seen during boat and aircraft surveys. Fig. 12 shows the haul-out areas identified during this study. The largest concentration was seen on 3 October at a haul-out site on the northwest coast of Loks Land at 62°32'N, 64°54'W. Prior to this sighting some 500 walruses had been sighted at Lady Franklin Island (J. Parsons, personal communication).

Our sightings of walruses in the waters of Cyrus Field Bay (62°51'N, 64°55'W) appear to be part of a general influx of animals into the area in mid September. However walruses appear to be in the area much earlier than this. Our first sighting was of a single adult male on 21 June at the mouth of Winton Bay, apparently in the process of killing and eating a seal. On 9 August approximately 100 walruses were seen at a haul-out site at 63°36'N, 64°12'W (a more accurate count of 139 walruses was later made from aerial photographs (D. Andriashek, Canadian Wildlife Service, personal communication)). The number was reduced to approximately 50 when we visited the site the next day, and on two subsequent visits on 6 and 19 September only 14 and 15 adult males were seen. We were told that some Inuit from Pangnirtung had been hunting in the area in early September and had probably disturbed this group. Another small haul-out site was located at 63°43'N, 64°14'W with 12-14 animals on it. This group had definitely been disturbed by hunters, as four headless carcasses and one intact carcass were found in the vicinity.

Table 16 lists the sizes, sex and ages of the four walrus specimens obtained. Only three stomach contents were obtained. The stomach of the lone bull examined by us at Winton Bay contained remains of two freshly killed seals, a ringed seal and an immature harp seal (bedlamer). The other two stomachs collected in Lupton Channel, west of Loks Land, had a mean volume and weight of 385 cc and 386 g respectively. Polychaetes, echinoderms, lamellibranchs and gastropods were the most common items in the stomachs. All materials were benthic in origin (Table 17).

Whales

Only one whale specimen was examined, a white whale *Delphinapterus leucas* taken in Winton Bay on 30 July 1978. It proved to be a large male weighing 156 kg (3441 lb) and very old, probably 47 years. The animal had a length of 405 cm and girth of 304 cm. Its stomach contents are listed in Table 18.

Table 19 lists sightings of all species of whales seen during the survey. The bottlenose whale *Hyperoodon ampullatus*, known as *tikarudlik* to the Inuit, appears to be the most common whale in the area. Only three bowhead *Balaena mysticetus* sightings were made, all in the Leybourne Islands. No killer whales *Orcinus orca* were seen in the area and they are not known to occur there by the Inuit of Allen Island. This is surprising in view of the fact that they are common in the waters of Cumberland Sound during the summer.

Terrestrial mammals

Polar bears were common and fairly abundant throughout the whole study area. Table 20 lists the sightings of bears made during our stay. Polar bear predation on both the ringed and bearded seal appears to be fairly high. Table 2 lists the remains of polar bear kills found during the few searches made on the sea ice. Doubtless, more extensive searches would show bear predation to be an important mortality factor for ringed seals.

Caribou were common along the coastal areas during the months of July to mid August. The early sightings of caribou were mainly of lone bulls, and no large groups were seen at any one time during the study. All sightings were made along the coast (Table 21). In one instance, a lone wolf was witnessed chasing and killing a large caribou on the sea ice of Popham Bay.

Sightings of other terrestrial mammals are listed in Table 22. Fox, either arctic or red fox, were not abundant in the area as evidenced by the number of tracks seen. Wolves appeared to be fairly abundant in Kamanialuk, the plateau area between Allen Island and Frobisher Bay.

DISCUSSION

General

Only a brief search for ringed seal birth lairs was made because of the late start of this study. Results indicate that the fast ice in the bays and fiords of this region is as productive, or possibly more so, than that of other areas that have been well studied (Smith and Stirling, 1975). More extensive birth lair surveys should be conducted over several years since this method is best suited to provide the least biased population estimates and will show variations in annual recruitment, should it occur.

Detailed behavioural observations of seals in the small South Bay study area reveals that the number of seals remains stable and probably reflects the actual number of seals present in the winter fast ice until about mid June. After this date seals tend to aggregate in certain deep bays because of the persisting fast ice, and because of the increasing number of exit holes creating by melting.

Peak numbers during the day appear to occur in mid afternoon until approximately mid June. After this date a large variation in the time of peak numbers occurs. Natural disturbance in the form of polar bears causes large scale reduction in numbers of hauled-out seals, sometimes lasting for several days. The above information indicates the difficulty of obtaining accurate population estimates based on aerial counts of hauled-out seals.

The vast majority of hauled-out seals are single animals at an exit hole. While up to six seals at a hole have been observed, the disadvantage of this type of behaviour in the face of polar bear predation is obvious. Stirling (1974) points this out and it is exemplified in the one successful stalk and kill seen by us which involved two seals hauled out of the same hole. Our vigilance studies confirm that a group of seals is not significantly more alert than a single animal, and that no one seal maintains the role of group sentinel.

Seals orient themselves with their head pointed downwind. While the proximate stimulus for this is probably the fact that the seal prefers not to have the wind in its face, a more advantageous reason might be hypothesized. If a seal lies looking in the direction that the wind is blowing it will more likely detect a predator that hunts it by olfaction, that is, by hunting into the wind. This is precisely the behaviour of the polar bear, the major predator of the ringed seal.

The identification of several seals during the study permits us to make several suggestions relating to the possibility of homing and territoriality. Seals were seen to be aggressive and at least two animals, a male and a female, were site-tenacious. The occupation of one of four breathing holes by this male and female for a period of over one month suggests that they probably occupied this territory during the winter. The proximity of another group of holes, the closest being only 600 m away, and the fact that neither of these well identified seals appeared at them further strengthens the territorial hypothesis. If we accept the fact that ringed seals partition their breeding habitat by territorial behaviour then, in view of the limited amount of breeding habitat and possibly other winter resources, it is probable that experienced seals come back to the same area year after year. This would not be unusual since many species of seals are known to home to the same breeding colony.

It is difficult at this stage to make definite statements about the size of the territory of ringed seals. From this study, based on four positions in the ice and the long occupation of this area by a male and a female, we perhaps can define this particular territory as covering a minimum area of 0.087 km^2. Large scale extrapolations from this sample of one would be tenuous, but nonetheless this is the first measure of size of territory for this species.

While the spring density of hauled-out seals is comparable to that of other east Baffin localities, the number of seals observed during the open water period appears to be very low. Sighting densities from the boat and catch-effort comparisons confirm this,but we do not yet know the cause or where the ringed seals go during this period. Stomach contents, age structure, reproductive rates and growth curves all show that the resident seals are in good condition in the summer and comparable to seals caught in summer in the Home Bay area. The presence of walruses, known to be predators on seals,and bottlenose whales which the seals might be scared of, are possible explanations for their observed low numbers.

The only other obvious sources of mortality for ringed seals are the yet unevaluated loss by predation from polar bears and by infection with the lung parasite *Otostrongylus* sp.

Bearded seals are common, fairly abundant and apparently successful feeders and reproducers in the area. A high incidence of polar bear attacks is shown by the scars left on their bodies. We have no estimate of predation rate, but it is probably an important source of natural mortality for this species.

Harp seals are common and fairly abundant. Adults remain in groups of 5-25 animals, while the young and adolescents are seen singly or in small numbers. The harp seal is a much faster swimmer than the ringed seal and, while it feeds on almost the same food items, it is capable of taking the faster pelagic fish and crustaceans not often seen in the stomach contents of the ringed seal.

Walruses remain in the area all summer. At least one and possibly several haul-out sites are occupied as early as the beginning of August in the Lemieux and Leybourne islands. A large scale movement of walruses into the area, probably from Hudson Strait, occurs in mid September. These animals initially aggregate around Lady Franklin Island and haul out there. Later on they appear to disperse to smaller haul-out sites in the Loks Land area and further up the coast in the Lemieux and Leybourne islands. An unknown number of walruses overwinter in the polynya formed at the mouth of Frobisher Bay.

Two stomachs of walruses collected in this study contained a variety of benthic organisms. There appears to be a sufficient abundance and variety of benthos in this region to support a considerable number of these animals. Walruses in this area also probably take a fair number of seals, and their role as a marine predator is probably underestimated. Neatby (1977) points out that the Inuit of Cumberland Sound thought that walruses commonly fed on seals.

Along Beekman Peninsula the most common cetacean is the bottlenose whale. The Resolution Island area has long been known as a good place to hunt this species. White whales are reported by the Inuit to move north along this coast, sometimes passing through Anderson Channel early in the year, after or before the fast ice is completely dispersed. Perhaps these animals are part of the summer population seen in Cumberland Sound.

The Question of Environmental Impact

Two kinds of impacts on marine mammals resulting from the development of offshore oil wells are possible. Direct impacts from a large scale blowout are of major concern and for some species such as the ringed seal we can begin to discuss the possible consequences. Of equal concern however are the effects of all other activities associated with drilling. What, in fact, will be the effect of continuing and increasing disturbance on the wildlife of the area? We cannot now even begin to predict in a quantitative sense the magnitude, persistence or permanence of such disturbance on any of the arctic marine mammal populations.

Only for the ringed seal has any actual experimentation been done to establish the indicators of stress in natural populations (Geraci and Smith, 1975) and to relate these to the stress experienced by seals subject to oil immersion and ingestion in a controlled situation (Geraci and Smith, 1976; Englehardt, Geraci and Smith, 1977). Because of our long experience with populations of ringed seals in the area of the Beaufort Sea it was possible to make some informed comments on the likely effects of short term exposure to oil.

In the present study several deficiencies exist in our baseline knowledge because of the short time spent in the area. We do not as yet have sufficient information by which to estimate population size since no extensive birth lair surveys have been conducted. These will be carried out during March to May 1979. However one year of work in an area will not provide us with any indication of the variations in annual production which have been shown to be very significant in other studies (Smith and Stirling, 1978). The present study and others (Smith, 1973a; Smith et al., 1978) have shown that aerial surveys alone are inadequate for estimating population size.

The small number of ringed seals present in the study area during the summer months also needs further investigation. Smith (1973a) suggested that Cumberland Sound probably receives seals from areas both north and south of it since the annual harvest from Pangnirtung appears to exceed the production of the region. It is important in this context to obtain information about the summer movements and distribution of ringed seals since several hunting communities might be affected by spills or disturbances remote from them.

The behavioural work carried out this year provides the first real evidence of territorial partitioning of the breeding habitat and suggests that homing to specific areas may occur. This in turn points to the important fact that long lived arctic marine mammals exploit limited resources and probably are dependent on lengthy learning situations for their survival. Although marine mammals are also mobile the limited resources existing in the arctic, especially in the winter months, suggest that any large scale catastrophe or increasing disturbance over a large area could result in permanent and significant reduction in seal numbers.

The bearded seal would probably react in a similar manner as the ringed seal to short term exposure to oil. Because of its greater dependence on long lived benthic invertebrates it might be exposed to greater quantities of ingested oil. The breeding habitat of this species, because it hauls out on pack ice to pup, is less limiting and therefore possibly less subject to disruption by large scale catastrophes. There is however some indication that this species maintains discrete groups in the summer months and their dependence on benthic food supplies, which have a patchy distribution, indicates a limited quantity of critical habitat.

The walrus is perhaps the most clearly threatened of the pinniped species by the impending offshore oil developments. A large movement of considerable numbers of this species into traditional haul-out and feeding areas in the fall would make them highly likely to come into contact with oil spills or to be disturbed by offshore activities. Their dependence on benthic food and the long lactation period of the calves would likely subject them to chronic oil ingestion, should a spill occur. This species is very easily disturbed and yet perhaps the most site-tenacious of the pinnipeds. Direct observation of aircraft flying over haul-out areas, disturbance by boats, and lasting disturbance by the construction of DEW line sites and associated activities near haul-out areas all point to the sensitivity of this species to any form of change in its environment.

No information exists by which we can begin to evaluate the effect of contact or ingestion of oil on any whale species. Because of the highly active epidermis of the white whale (J. R. Geraci, personal communication), prolonged contact with oil might have significant consequences. Contamination of bays or fiords used as traditional calving areas would likely be quite serious because of the initial low thermal tolerances of the neonates and increased likelihood of ingestion by suckling calves. In the event of whales moving along a coastline or in areas far offshore we do not know if they could detect the presence of an oil slick or if they would take evasive action if they did.

RECOMMENDATIONS

Several recommendations can be made stemming from this short study:

1) The fact of territorial partitioning of the ringed seal breeding habitat and the strong possibility of homing to an area should be further studied. A long term study of a small area occupied by breeding seals would provide us with the ability, eventually, to experimentally assess such questions as the effect of oil spills or disturbance on a population. We are now only beginning to appreciate how to do this.

2) A similar study should be made in an area where walruses are known to haul out in large numbers. The question of sensitivity of this species to disturbance can only be addressed by such a long term study.

3) Experimental studies, such as those of Geraci and Smith (1975, 1977), which provide a means of quantitatively evaluating the health status and stress levels of wild marine mammal populations should be continued. Without these tools we cannot hope to understand the impact of natural or man made catastrophes.

4) There is a definite need for an *in vitro* study of the metabolism of cetacean epidermis and the effect of contact with oil. We have good reason to expect that whales will be more adversely affected by oil immersion than seals, and no experimental data at all on which to predict the extent of the damage.

SUMMARY

1) Two camps at Popham Bay and Winton Bay in southeastern Baffin Island were occupied from 5 May to 3 October 1978.

2) Birth lair searches, though brief, indicate a high production of ringed seals in the fast ice of this region.

3) Behavioural studies show that ringed seals partition their breeding habitat by territorial behaviour, and strongly suggest that individuals might home to the same areas year after year.

4) Behavioural observations show that mid June appears to be the best time during which to carry out aerial surveys. After this, seals aggregate at the heads of small bays, thus not showing the true winter distribution. Also the time of day when peak numbers are hauled out varies greatly past this date.

5) Ringed seals are fewer during the summer than would be expected from their spring numbers seen during the haul-out period. It is not known where they go or what causes this apparent movement out of the area.

6) Bearded seals are common and fairly abundant in the area. The incidence of polar bear attacks on this species appears to be high.

7) Walruses are present in low numbers at one or more haul-out sites in the area from early July. A large number of walruses, apparently coming from Hudson Strait, enter the area in mid September. Lady Franklin Island has been identified as a major haul-out site and possible feeding area. An unknown number of walruses overwinter in the open water areas of Frobisher Bay.

8) White whales, bottlenose whales and bowheads were seen in the area. The bottlenose is the most frequently sighted cetacean.

9) The question of direct impacts such as oil spills and indirect impacts such as disturbance from development activities are reviewed for each major species.

10) It is felt that a new government policy regarding impact studies is needed. In this context, specific recommendations are made for the continuation of certain aspects of the present study.

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TABLES

Table 1. Number and type of subnivean lairs found in the Popham Bay area during searches with a trained dog followed by a snowmobile.

Search area	Type of subnivean structure: Birth lair	Haul-out lair	Male lair	Breathing hole	Total structures	Total search time	Minutes per structure	Minutes per birth lair
South Bay	-	1	-	2	3	12.10	4.04	-
Outer Bay	-	1	-	3	4	20.53	5.13	-
South South Bay	4	1	-	6	11	39.08	3.55	9.70

Table 2. Seals killed by polar bears in the study area.

Date	Location	Species	Age	Remarks
05-05-78	64°17'N, 65°05'W	Ringed seal	1+	Claw found on ice
04-06-78	64°17'N, 65°05'W	Ringed seal	?	Stalked and killed while out on ice
06-07-78	63°28'N, 64°30'W	Ringed seal	6+	Tooth found on ice
28-07-78	63°28'N, 64°30'W	Ringed seal	18+	Tooth found on ice
28-07-78	63°28'N, 64°30'W	Ringed seal	7++	Claw found on ice

Table 3. Mean daily weather conditions during the behavioural study at Popham Bay.

Date	Range of visibility (km)	Mean cloud cover (%)	Mean wind direction (°)	Mean maximum wind speed (m/s)	Mean temperature (°C)	Windchill (kcal/m²/hr)
8 5 78	24	0	-	-	-	-
9 5 78	0-3	100	090	3	-2	867
10 5 78	0-3	100	010	2	-2	791
11 5 78	24	30	-	4	1	846
12 5 78	24	40	090	1	-2	681
13 5 78	24	0	270	4	-2	926
14 5 78	24	0	260	5	-3	1,001
15 5 78	24	80	260	5	2	862
16 5 78	24	100	070	0	4	303
17 5 78	8-16	70	250	15	-8	1,401
18 5 78	16-24	90	260	9	-4	1,164
19 5 78	0-5	100	250	10	-3	1,155
20 5 78	24	70	260	7	-4	1,106
21 5 78	24	30	100	4	-2	926
22 5 78	24	50	050	2	0	746
23 5 78	24	20	280	4	-1	899
24 5 78	16-24	80	090	3	-3	892
25 5 78	24	40	100	4	0	873
26 5 78	16-24	100	250	5	-1	946
27 5 78	13-24	100	250	8	1	984
28 5 78	24	70	090	5	-1	946
29 5 78	13-24	30	090	3	2	768
30 5 78	24	80	090	7	0	987
31 5 78	5-24	100	270	4	-2	926
1 6 78	16-24	50	260	7	0	987
2 6 78	24	60	070	4	0	873
3 6 78	24	70	060	4	2	820
4 6 78	24	90	260	3	0	817
5 6 78	0-24	80	100	4	2	820

Table 3 (Continued)

Date	Range of visibility (km)	Mean cloud cover (%)	Mean wind direction (°)	Mean maximum wind speed (m/s)	Mean temperature (°C)	Windchill (kcal/m²/hr)
6 6 78	6-24	90	120	3	5	694
7 6 78	0-5	90	260	13	-3	1,206
8 6 78	2-24	70	250	9	1	1,006
9 6 78	24	100	240	4	2	820
10 6 78	24	80	170	3	2	768
11 6 78	24	50	260	10	0	1,058
12 6 78	24	70	250	13	2	1,039
13 6 78	22-24	70	260	6	3	868
14 6 78	0-24	100	120	3	4	718
15 6 78	0-16	100	270	3	2	768
16 6 78	19-24	80	260	4	7	688
17 6 78	24	70	080	3	5	694
18 6 78	0-2	10	120	5	1	890
19 6 78	24	60	300	6	6	782
20 6 78	24	50	270	11	4	946
21 6 78	24	60	280	2	10	520
22 6 78	24	60	060	1	6	525
23 6 78	24	40	260	5	8	695
24 6 78	24	50	250	3	7	644
25 6 78	24	70	070	0	8	261
26 6 78	24	70	270	7	6	808
27 6 78	24	30	220	7	8	748
28 6 78	24	30	110	3	8	619
29 6 78	13-24	100	110	4	3	794
30 6 78	2-19	100	090	4	2	820
1 7 78	24	100	110	3	6	669
2 7 78	0-24	100	150	2	5	632
3 7 78	2-24	100	090	2	4	655
4 7 78	3-19	100	-	0	4	303
5 7 78	24	100	100	3	10	570
6 7 78	24	50	-	0	13	209

Table 4. Increase in the number of individual positions on the ice at which ringed seals hauled out.

Date	Number of positions
08-05-78	8
12-05-78	4
14-05-78	8
15-05-78	8
16-05-78	8
17-05-78	6
18-05-78	2
21-05-78	12
22-05-78	10
23-05-78	10
24-05-78	12
25-05-78	13
26-05-78	10
27-05-78	13
28-05-78	12
29-05-78	13
30-05-78	12
31-05-78	10
01-06-78	12
02-06-78	13
03-06-78	15
04-06-78	15
05-06-78	21
06-06-78	27

Table 5. Statistical test on the orientation of seals with respect to wind direction in the behavioural study.

Date	Mean vector of seal orientation	Mean vector of wind direction	R_o value of Stephens-Rayleigh test	Significant at 0.01 percent level
26 05 78	69°	76°	46.33	accepted
28 05 78				
0830-1230	64°	90°	36.32	rejected
1330-1730	120°	90°	27.37	accepted
1 06 78	72°	85°	63.31	accepted
3 06 78	55°	66°	32.58	accepted

Table 6. Resightings of identified ringed seals during the behavioural study.

Seal identifying number	Number of days resighted	Position on ice where resighted (Fig. 4)	Date period of resightings	Sex of seal
PHD-78-2	18	A, B, C, I	11 05 78 to 05 06 78	Male
PHD-78-4	11	A, B, I	15 05 78 to 19 06 78	Female
PHD-78-20	7	K, H	28 05 78 to 05 06 78	Female
PHD-78-53	3	O	03 06 78 to 05 06 78	?
PHD-78-12	2	B	22 05 78 to 23 05 78	Male
PHD-78-14	2	I, C	23 05 78 to 24 05 78	Male
PHD-78-25	2	B, N	30 05 78 to 04 06 78	Male
PHD-78-31	2	B	31 05 78 to 04 06 78	Male
PHD-78-40	2	B	02 06 78 to 03 06 78	?
PHD-78-51	2	K, H	03 06 78 to 04 06 78	?
PHD-78-52	2	N, A	03 06 78 to 04 06 78	?
PHD-78-72	2	A, N	16 06 78 to 19 06 78	Male

Table 7. Aggressive behaviour of seals on the ice during the period 16 May to 20 June 1978.

Number and sex of seals involved (aggressor-victim)	Type and frequency of encounter		Result of aggression			
	Seal on ice aggressive to seal in water	Seals on ice aggressive to each other	No change	Seal went into water	Seal remained in water	Seal emerged
Female-Male	3				1	2
Female-?	7				6	1
Male-?	1	1	1		1	
Male-Male		1	1			
One seal sex unknown	6				3	3
More than one female	1				1	
Two or more seals sexes mixed	6	2	2		1	2

Table 8. Numbers of ringed seals shot, retrieved and lost by sinking during the present study compared with data from similar studies in other areas during the open water season.

	Total shot	Total retrieved	Total lost	Boat-days of hunting	Total seals retrieved per boat-day
Brevoort Island area, 14 July to 3 October 1978	72	57	15	61	1.18
Cumberland Sound, 10 July to 8 August 1969	67	45	22	20	3.35
Holman region, 7 July to 4 September 1975	76	64	12	23	3.30
Holman region, 22 June to 29 July 1977	143	88	53	19	7.53

Table 9. (a) Estimated weights (kg) of ringed seals taken in three localities: Brevoort Island 1978, Cumberland Sound 1969, and Home Bay 1967.

	Pups (0+)	Adults (7+>)
Brevoort Island area 1978	20.8	67.9
Cumberland Sound 1969	18.0	41.0
Home Bay 1970	22.0	49.1

(b) Nose tail lengths (cm) of seals from the same samples.

	Pups (0+)	Adults (7+>)
Brevoort Island area 1978	87	131
Cumberland Sound 1969	85	114
Home Bay 1970	91	123

Table 10. Comparison of observed and expected numbers of pups (0+ seals) in three different samples from the present study.

	Sample size	Observed number of pups	Expected number of pups
All samples	252	44	38
Open water sample	84	24	9
Winter sample	64	9	13

Table 11. Comparison of the percentage of pups, adolescents, and adult ringed seals in summer samples from three different areas.

	Pups (0+)	Adolescents (1 to 6+)	Adults (7 and older)	Sample size
Brevoort Island 1978	30	37	33	84
Cumberland Sound 1969	25	59	16	971
Home Bay 1967	27	42	41	729

Table 12. Food organisms and their frequency of occurrence in the stomach contents of 56 ringed seals.

Species	Frequency of occurrence
Boreomysis mobilis	2
Mysis oculata	29
Mysis relicta	9
Gammarus setosus	1
Onisimus glacialis	4
Anonyx nugax	3
Anonyx sp.	1
Stegocephalus inflatus	1
Parathemisto libellula	33
Lebbeus polaris	2
Decapoda	8
Crustacea	1
Boreogadus saida	11
Otoliths	8
Fish lenses	1
Gonatus fabricii	1
Miscellaneous	
Bird feather	2
Plant material	1
Kelp	1
Pebble	6

Table 13. Food organisms and their frequency of occurrence in the stomach contents of 6 bearded seals.

Species	Frequency of occurrence
Rhachotropis aculeata	1
Stegocephalus inflatus	1
Pandalid shrimp	4
Sclerocrangon boreas	3
Spirontocaris spinus	1
Buccinum sp.	5
Mya truncata	3
Gonatus fabricii	4
Boreogadus saida	2
Otoliths	4
Pebbles	1

Table 14. Food organisms and their frequency of occurrence in the stomach contents of 5 harp seals.

Species	Frequency of occurrence
Boreomysis mobilis	1
Mysis oculata	2
Mysis relicta	1
Parathemisto libellula	2
Sergestes arcticus	1
Crustacea	1
Boreogadus saida	2
Otoliths	1
Plant material	1

Table 15. Walrus sightings during boat and aerial surveys from 21 July to 3 October 1978.

Date	Location	No. of walruses Males	Females	Calves	Total
21 07 78	63°28'N, 64°30'W	1			1
09 08 78	63°36'N, 64°12'W				139
10 08 78	63°36'N, 64°12'W				50
12 08 78	63°47'N, 64°27'W				7
06 09 78	63°36'N, 64°12'W	14			14
11 09 78	63°28'N, 64°30'W	1	2	1	4
17 09 78	63°36'N, 64°12'W	15	2		17
17 09 78	63°35'N, 64°08'W				3
17 09 78	64°50'N, 64°10'W	2	2		4
17 09 78	63°43'N, 64°14'W				12-15
17 09 78	63°42'N, 64°11'W				1
18 09 78	62°50'N, 64°53'W				7
18 09 78	62°51'N, 64°55'W			4	40
18 09 78	62°02'N, 64°31'W				3
29 09 78	63°29'N, 65°02'W		1	1	2
29 09 78	63°15'N, 64°50'W				3
02 10 78	62°35'N, 64°47'W				85
03 10 78	62°32'N, 64°54'W				200
03 10 78	62°32'N, 64°53'W	10	27	16	53

Table 16. Size, sex and age of walruses collected during the open water season.

Nose-tail length	Girth	Age	Sex
276	262	9+	Male
297	-	29+	Male
209	184	2+	Male
262	230	-	Male

Table 17. Food organisms and their frequency of occurrence in the stomach contents of two walruses.

Species	Frequency of occurrence
Anthozoans	1
Flabelligera affinis	1
Nereis pelagica	1
Nereis sp.	1
Balanus balanus	1
Balanus crenatus	1
Natica clausa	1
Buccinum nivale	1
Buccinum tenue or *undatum*	1
Lepeta caeca	1
Margarites sp.	1
Hiatella arctica	2
Mya truncata	2
Musculus discors	1
Strongylocentrotus droebachiensis	2
Prolus fabricii	1
Fish bone	1
Pebbles	1

Table 18. Food organisms found in the stomach contents of a white whale.

Species
Turbellaria
Nereis pelagica
Mysis oculata
Parathemisto libellula
Sclerocrangon boreas
Margarites sp.
Natica clausa
Gonatus fabricii
Boreogadus saida
Cottidae sp.
Otoliths
Shells
Plant material

Table 19. Sightings of whales during boat and aerial surveys from 14 July to 3 October 1978.

Species	Date	Location	Number	Remarks
Delphinapterus leucas	30 07 78	63°08'N, 64°30'W	5	In Winton Bay
	29 08 78	63°33'N, 65°03'W	1	Near Allen Island
Hyperoodon ampullatus	16 07 78	63°28'N, 64°30'W	1	Winton Bay
	30 08 78	63°18'N, 64°31'W	1	Amor Smith Inlet
	06 09 78	63°31'N, 64°08'W	2	One large, one small
	12 09 78	63°23'N, 64°28'W	1	
	13 09 78	63°23'N, 64°35'W	1	Possible sighting only
	17 09 78	63°48'N, 64°17'W	1	
Balaena mysticetus	18 08 78	64°10'N, 64°43'W	1	Possible sighting
	17 09 78	63°54'N, 64°16'W	2	1 large, 1 small
	17 09 78	63°43'N, 64°21'W	1	

Table 20. Sightings of polar bears in the Popham Bay and Winton Bay areas from 5 May to 3 October 1978.

Date	Location	Number	Remarks
04 06 78	64°17'N, 65°25'W	1	Large bear killed ringed seal on fast ice.
25 06 78		3	Female and 2 cubs on land at head of Winton Bay.
28 06 78	64°17'N, 65°05'W	1	On fast ice.
30 06 78	64°17'N, 65°05'W	1	On fast ice.
01 07 78	64°17'N, 65°05'W	1	Probably same bear.
06 07 78	64°17'N, 65°05'W	1	On fast ice.
06 07 78	63°28'N, 64°30'W	1	Winton Bay--Bear stalking a bearded seal.
12 07 78	64°47'N, 64°40'W	1	Bear on ice in Andersen Channel.
06 09 78	63°18'N, 64°32'W	2	Amor Smith Inlet--one bear with red ear tags.
08 09 78	63°41'N, 64°16'W	6	One female with 2 yearling cubs and three other large bears; possibly feeding on walrus carcass.
12 09 78	63°28'N, 64°20'W	1	Brevoort Island--feeding on bearded seal carcass.
17 09 78	64°07'N, 64°26'W	1	Bear in water.
	64°13'N, 64°38'W	1	Bear in water.
	64°12'N, 64°40'W	1	Bear on land.

Table 21. Caribou sightings made during boat and aerial surveys.

Date	Location	Number	Remarks
25 05 78	64°17'N, 65°25'W	1	Killed by wolf on sea ice.
29 05 78	64°17'N, 65°25'W	2	On sea ice, Popham Bay.
01 07 78	63°28'N, 64°43'W	1	Winton Bay
10 07 78	64°17'N, 65°30'W	8	Five miles W of Popham Bay
18 07 78	63°28'N, 64°30'W	1	Winton Bay
23 07 78	Coast of Andersen Channel	15-20	All lone bulls
23 07 78	64°02'N, 65°13'W	3	At head of Okalik Bay
27 07 78	63°28'N, 64°30'W	2	Swimming across Winton Bay
31 07 78	64°28'N, 64°18'W	1	Brevoort Island
01 08 78	64°18'N, 64°35'W	1	Amor Smith Inlet
16 08 78	64°04'N, 65°00'W	1	Okalik Island
17 08 78	-- --	1	In water
21 08 78	64°18'N, 64°35'W	1	Amor Smith Inlet
22 08 78	64°30'N, 64°18'W	6	Brevoort Island
30 08 78	-- --	4	Allen Island
04 09 78	63°33'N, 64°32'W	1	--
17 09 78	63°28'N, 64°43'W	2	Winton Bay
23 09 78	63°28'N, 64°43'W	2	Winton Bay

Table 22. Miscellaneous mammal sightings during the study period.

Species	Date	Location	Number	Remarks
Vulpes fulva	14 05 78	64°17'N, 65°25'W	1	On sea ice.
Alopex lagopus	22 08 78	64°28'N, 64°18'W	1	Brevoort Island.
Canis lupus	22 04 78	64°00'N, 67°30'W	5	Family group on Kamanialuk
	25 05 78	64°17'N, 65°05'W	1	Killed caribou on sea ice
	26 05 78	64°17'N, 65°05'W	1	Same wolf
Lepus arcticus	24 05 78	64°17'N, 65°30'W	1	Popham Bay
	10 06 78	64°17'N, 65°30'W	2	
	21 08 78	64°28'N, 64°42'W	1	Winton Bay
	24 08 78	64°22'N, 65°10'W	1	
	23 09 78	64°28'N, 64°42'W	1	Winton Bay
	03 10 78	62°32'N, 64°59'W	1	

FIGURES

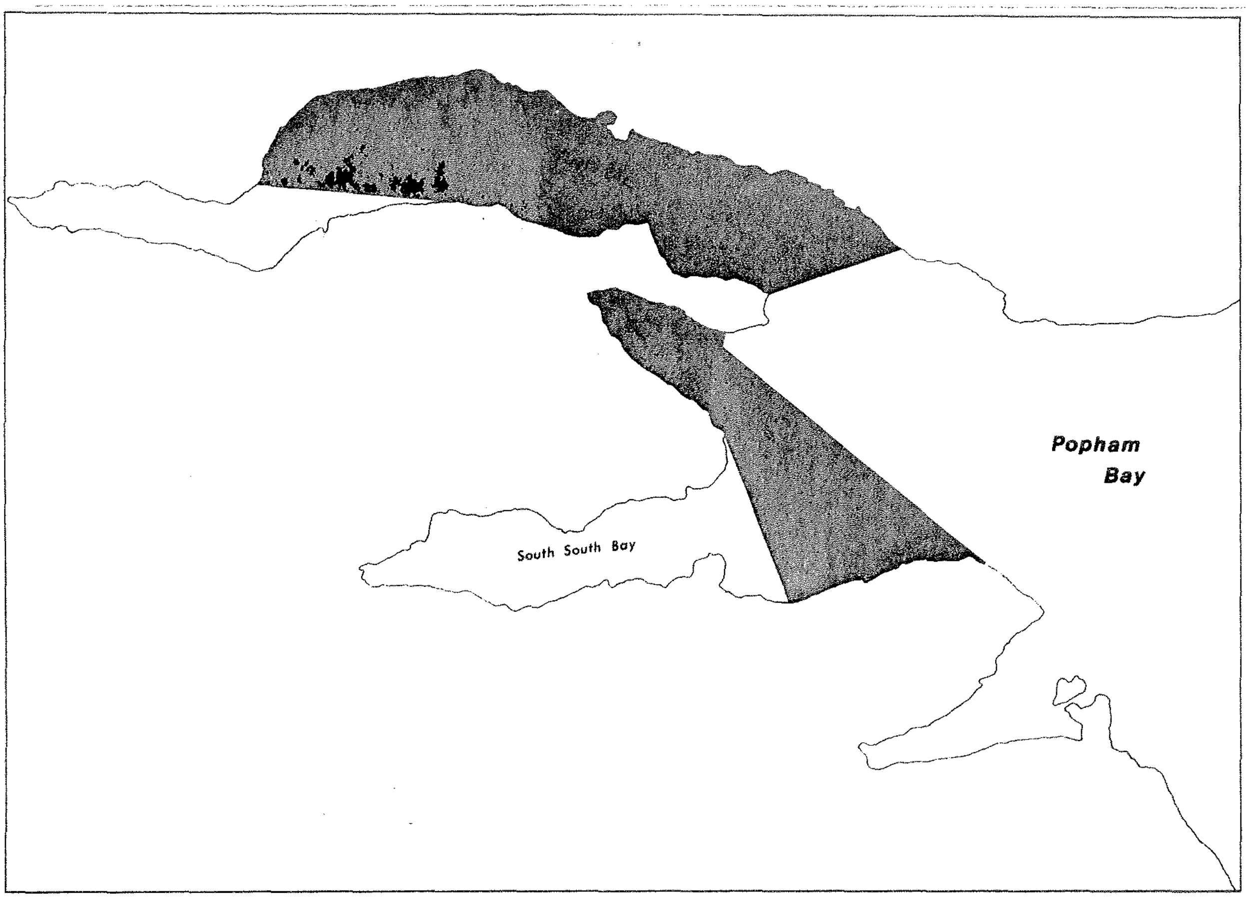

Fig. 1. The Popham Bay study area (64°17'N, 65°30'W) north of Brevoort Island, showing the three sub-areas where counts of hauled-up seals were made.

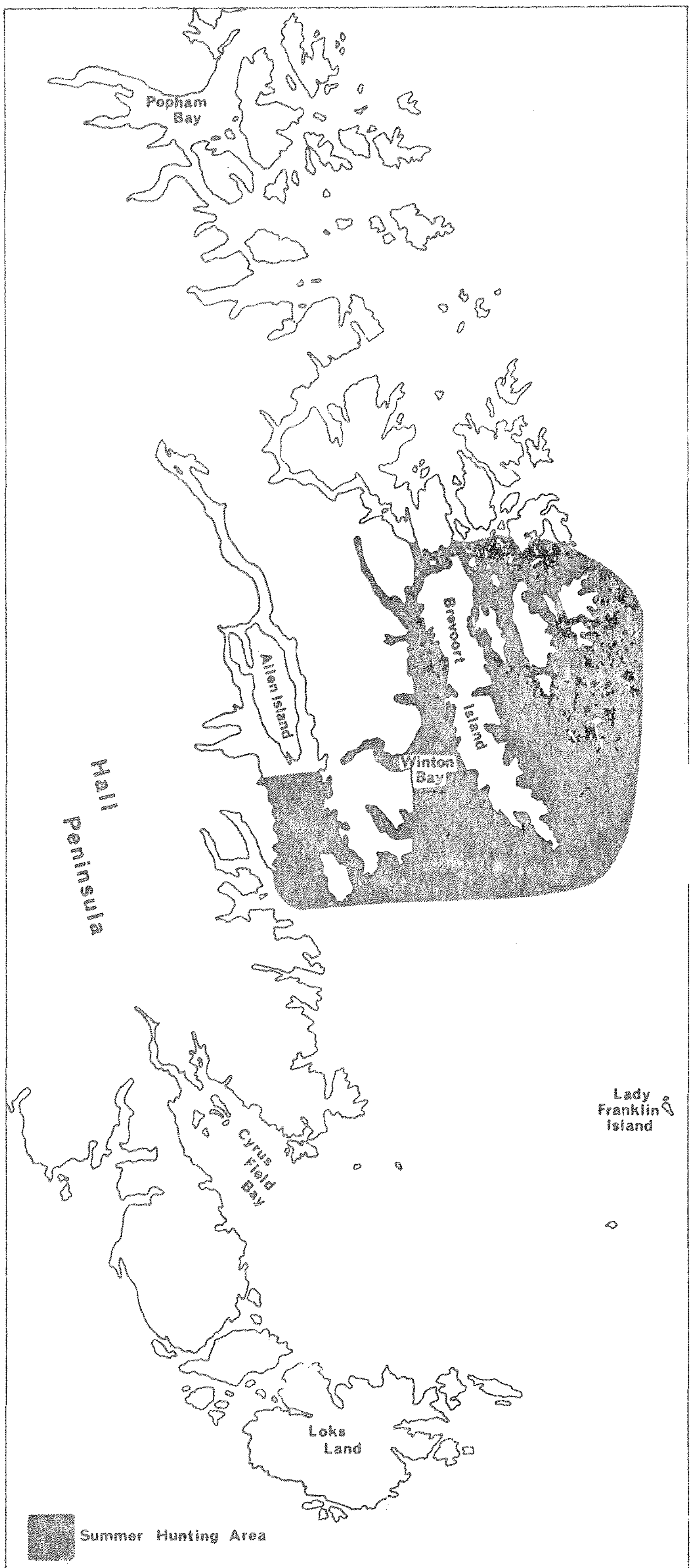

Fig. 2. The Winton Bay study area showing the region hunted by boat. Winton Bay lies on Beekman Peninsula, Robinson Sound extends northwards between Beekman Peninsula and Brevoort Island, and the Lemieux islands lie to the north and east of Brevoort Island.

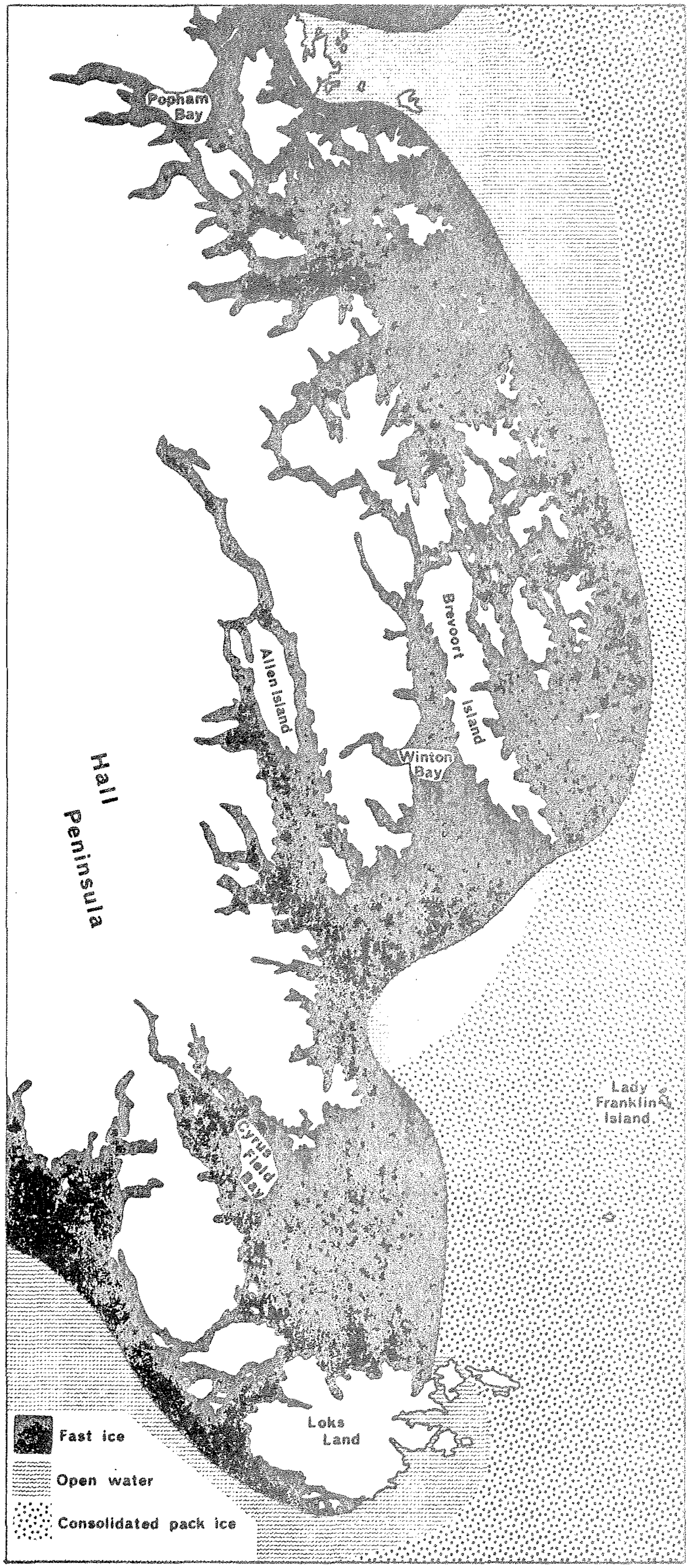

Fig. 3. Summary of winter ice conditions existing along the coast of southeastern Baffin Island from Popham Bay to Loks Land.

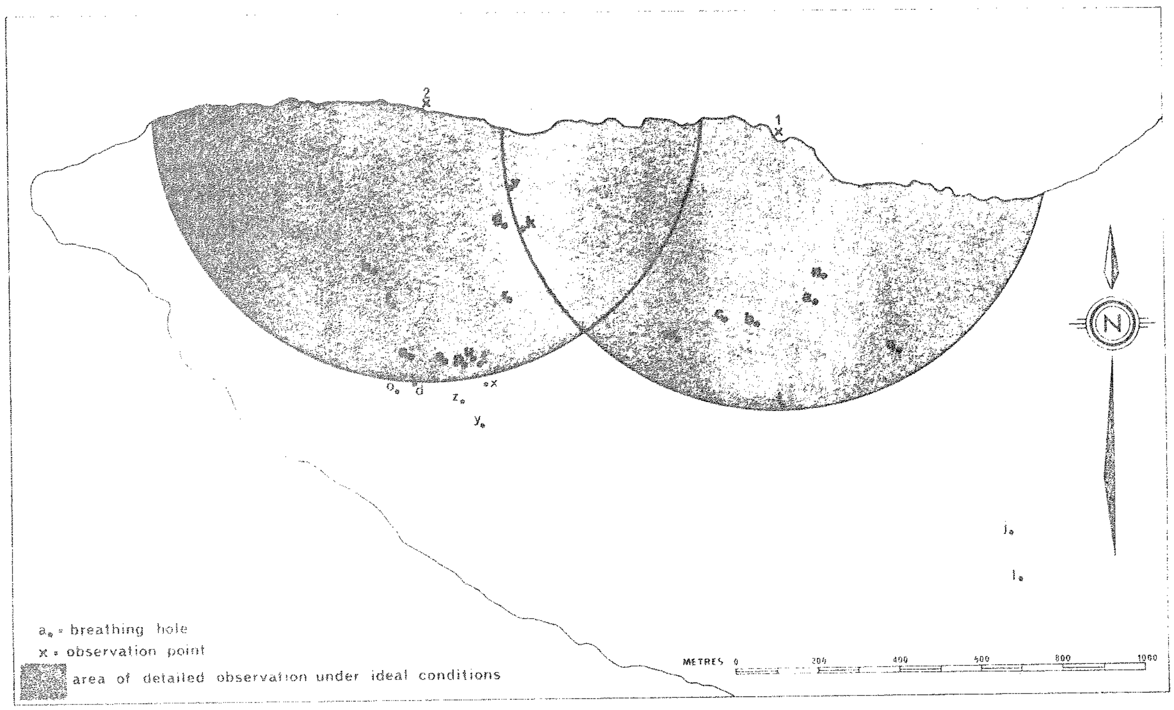

Fig. 4. Map of the South Bay behavioural study area showing the positions of holes from which seals hauled out onto the ice.

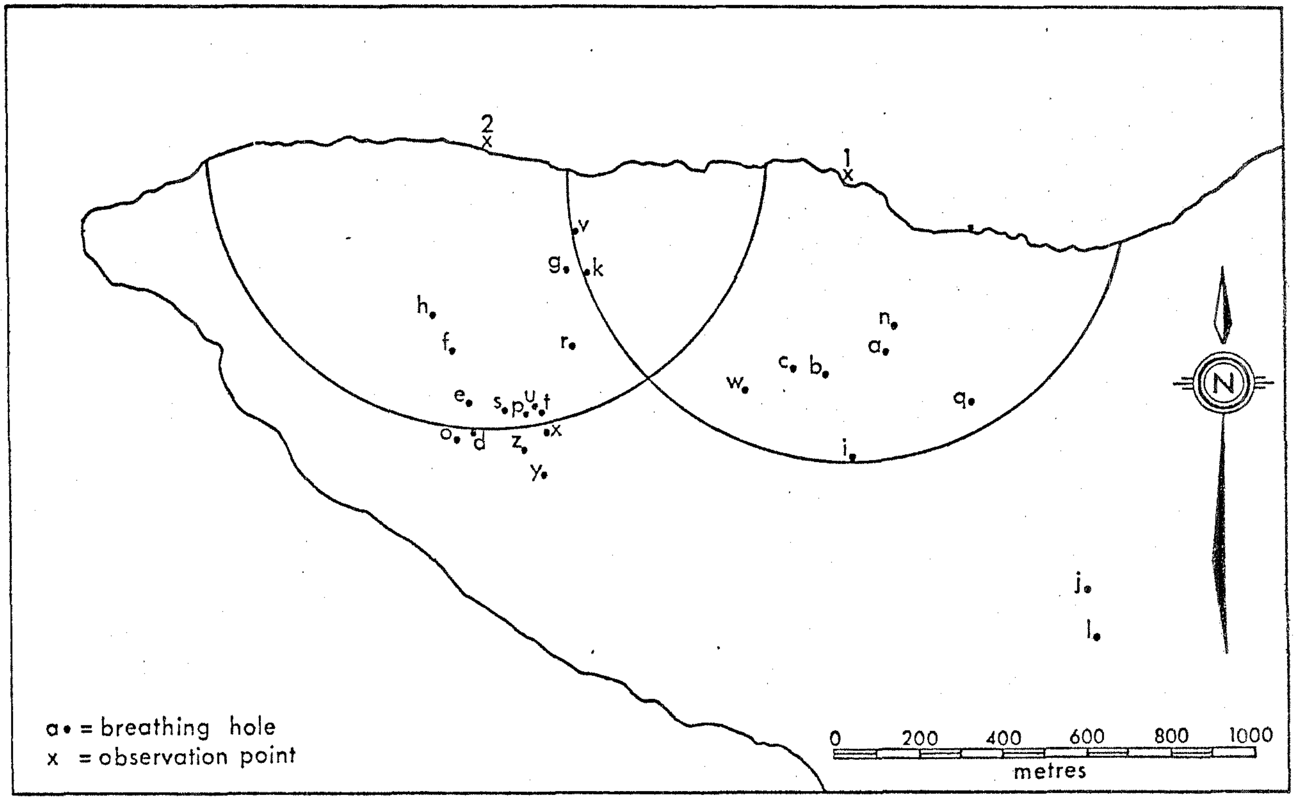

Fig. 4. Map of South Bay behavioral study area showing the positions of holes from which seals hauled out onto the sea ice. Circles designate areas of detailed observation under ideal conditions.

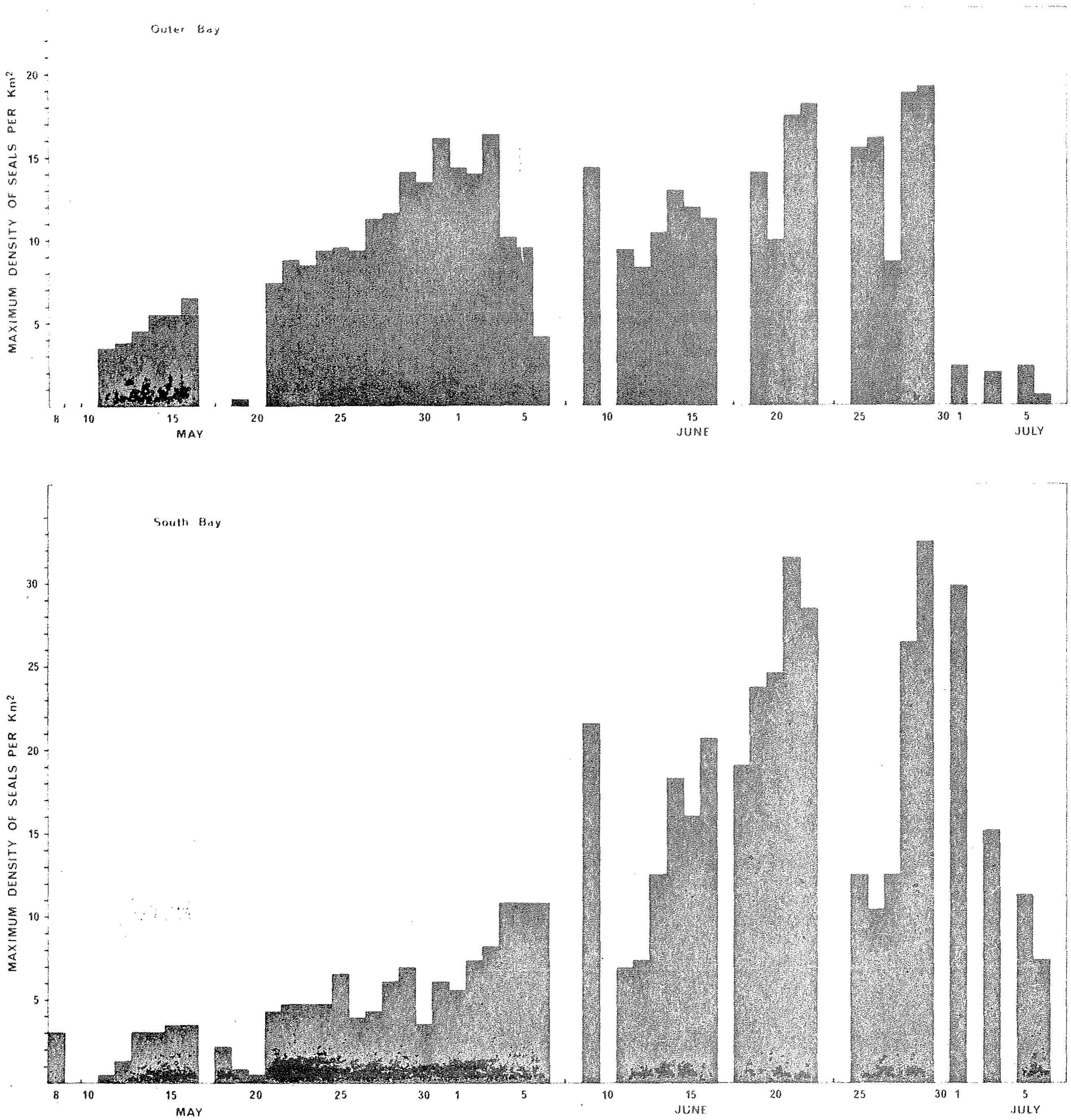

Fig. 5. Maximum density of seals per km^2 per day in Outer Bay and South Bay.

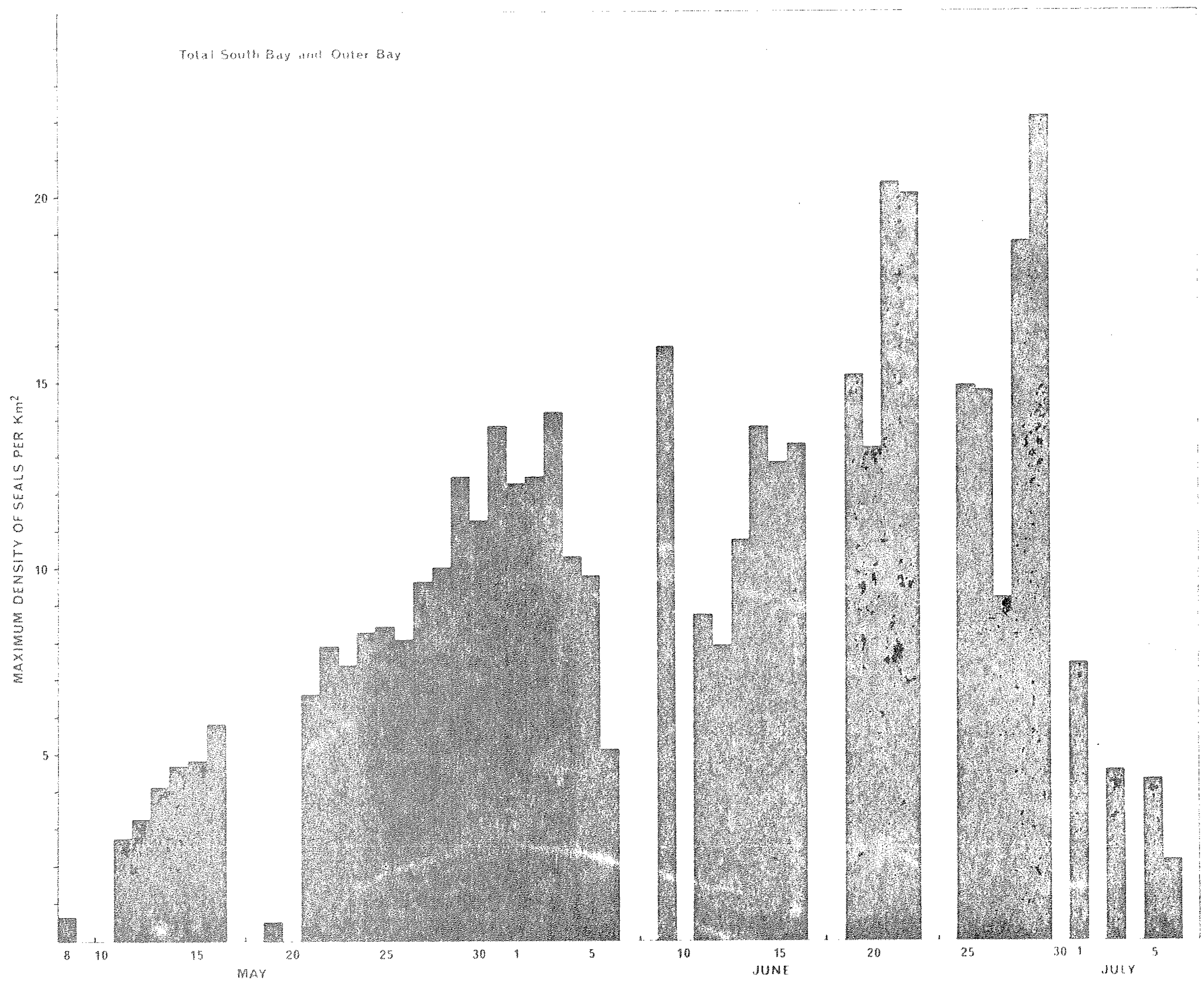

Fig. 6. Combined maximum densities of seals for Outer and South bays.

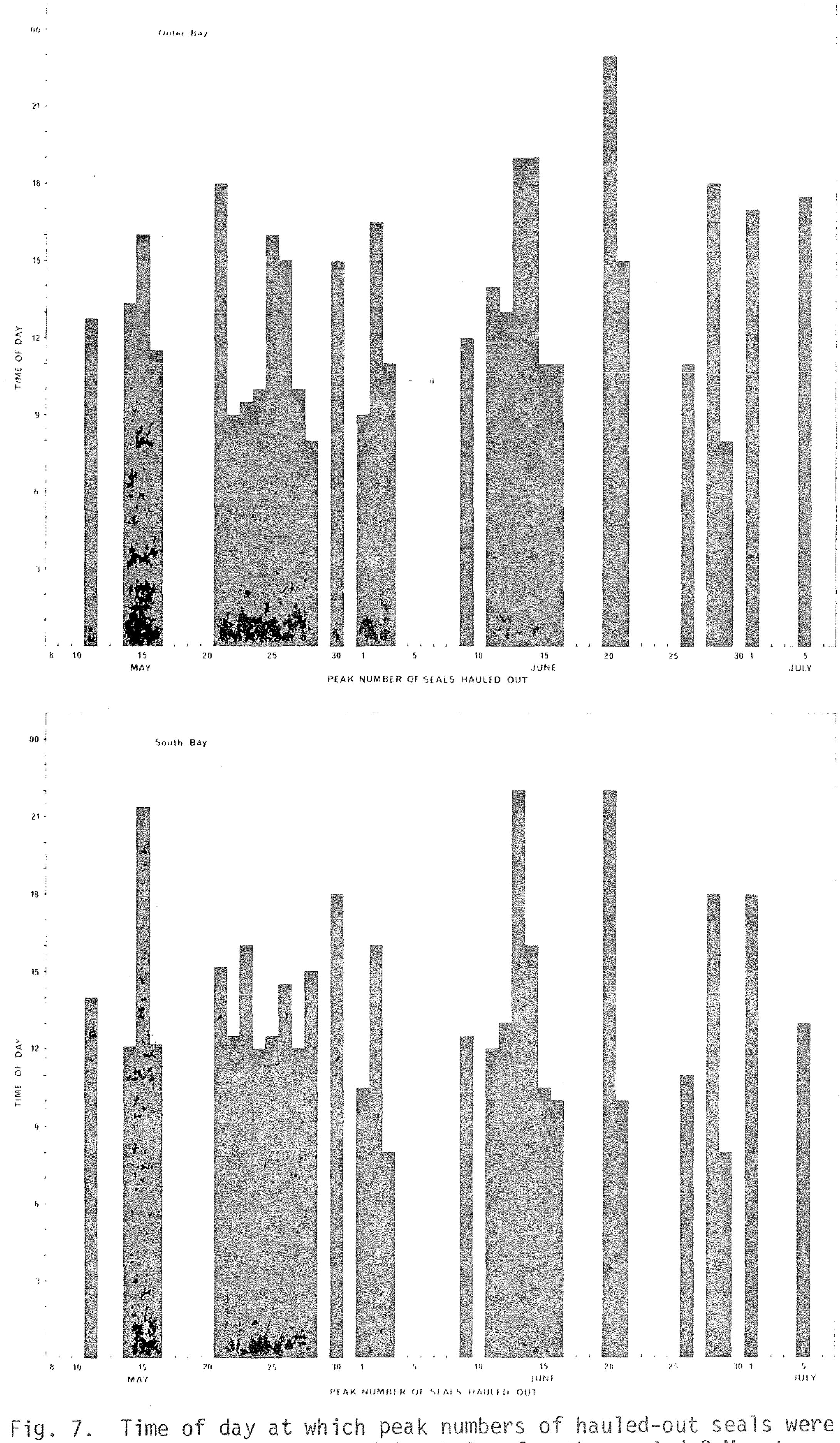

Fig. 7. Time of day at which peak numbers of hauled-out seals were seen in Outer Bay and South Bay for the period 8 May to 5 July 1978.

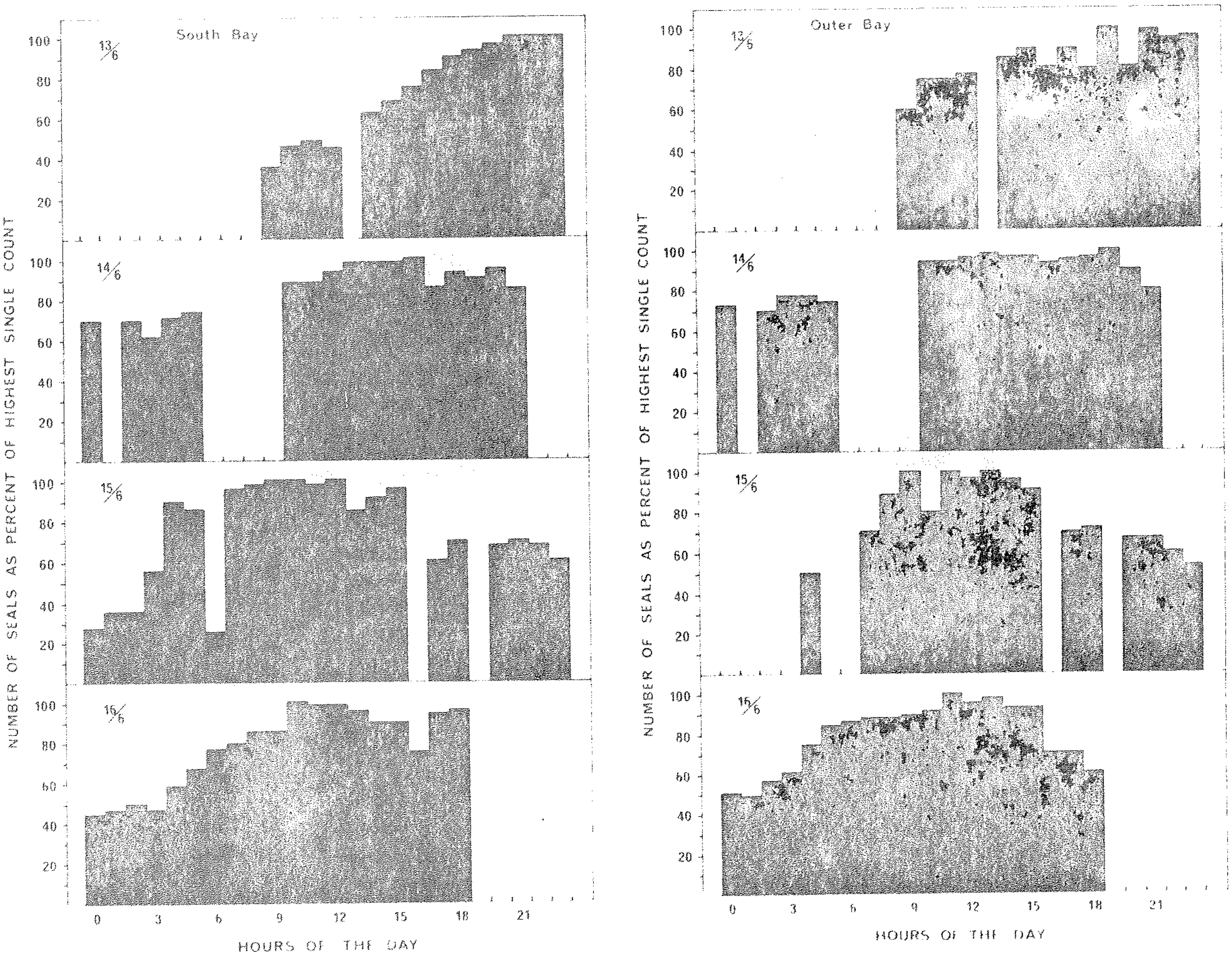

Fig. 8. Hourly numbers of seals as a percentage of the maximum daily count for Outer Bay and South Bay during continuous observations from 13 June to 16 June 1978.

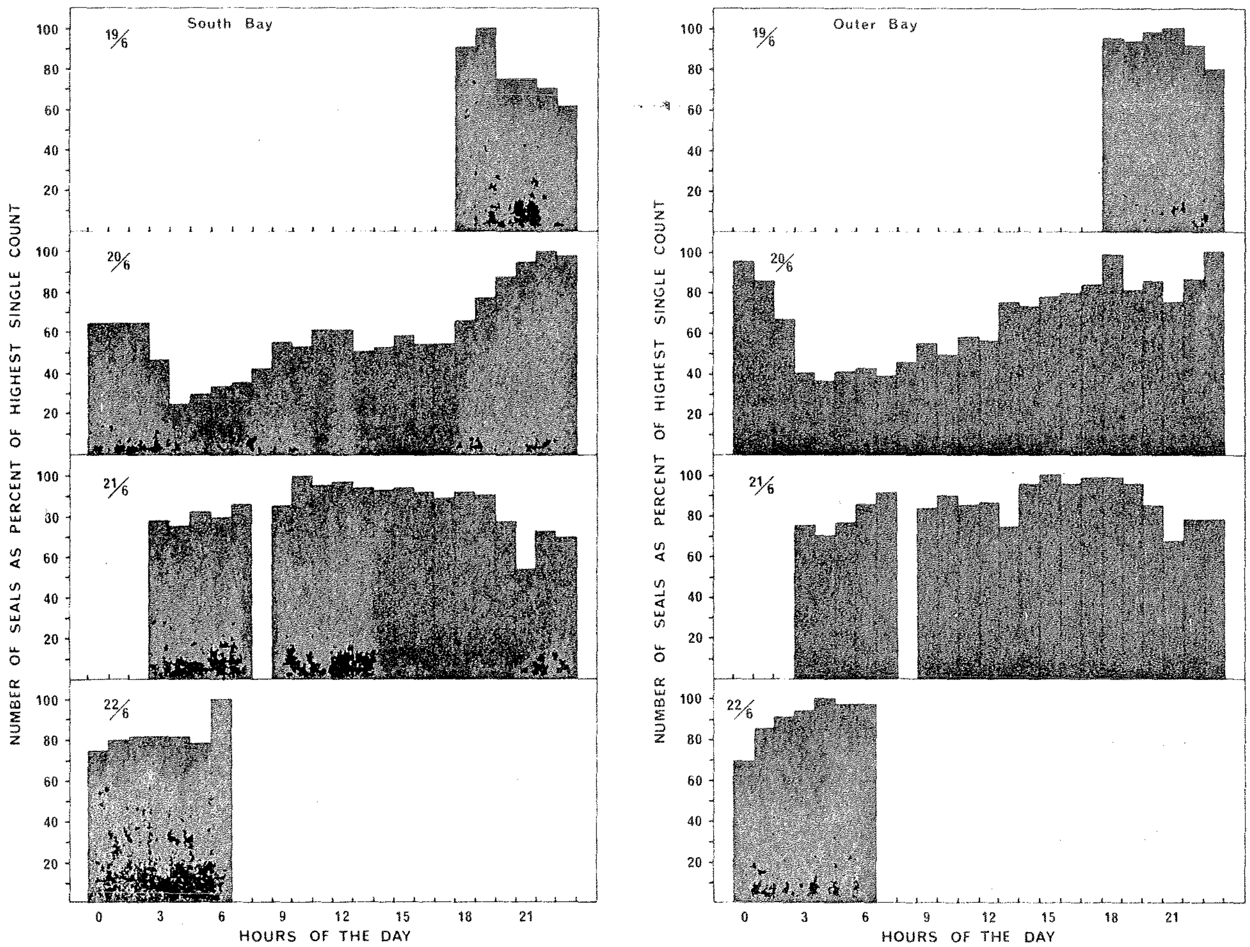

Fig. 9. Hourly numbers of seals as a percentage of the maximum daily count for Outer Bay and South Bay during continuous observations from 19 June to 22 June 1978.

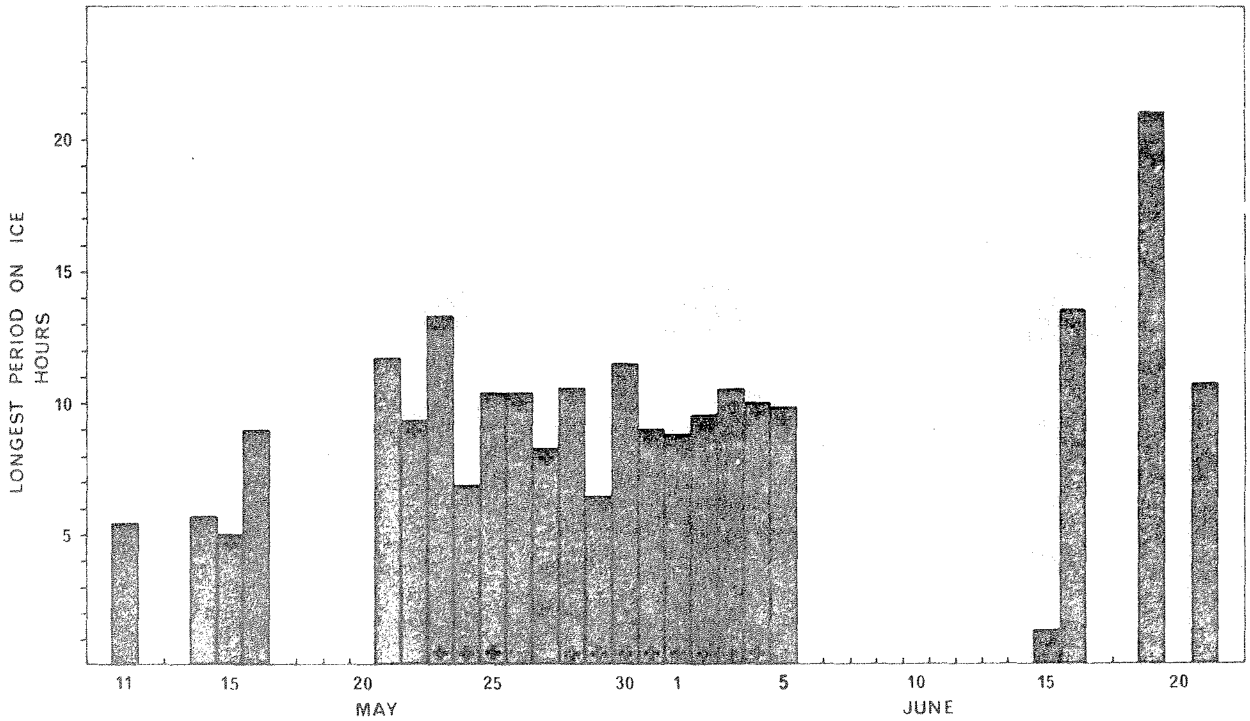

Fig. 10. Longest time spent on the ice for an individual seal in the South Bay area for the period 11 May to 21 June 1978 (+ sign indicates seal was up before or after observations began or were terminated).

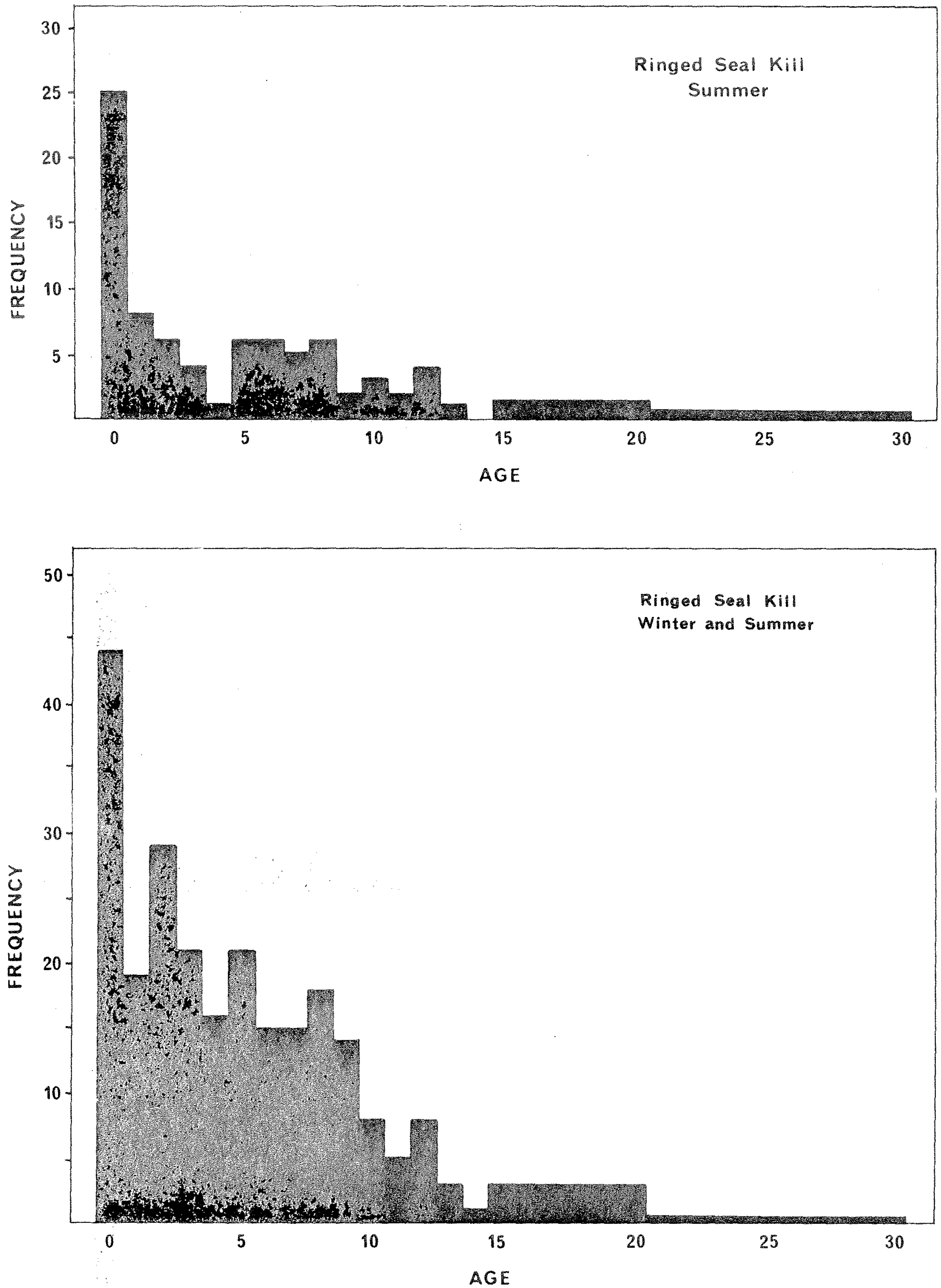

Fig. 11. Age frequency distributions of ringed seals killed during the summer, and the combined summer and winter seasons.

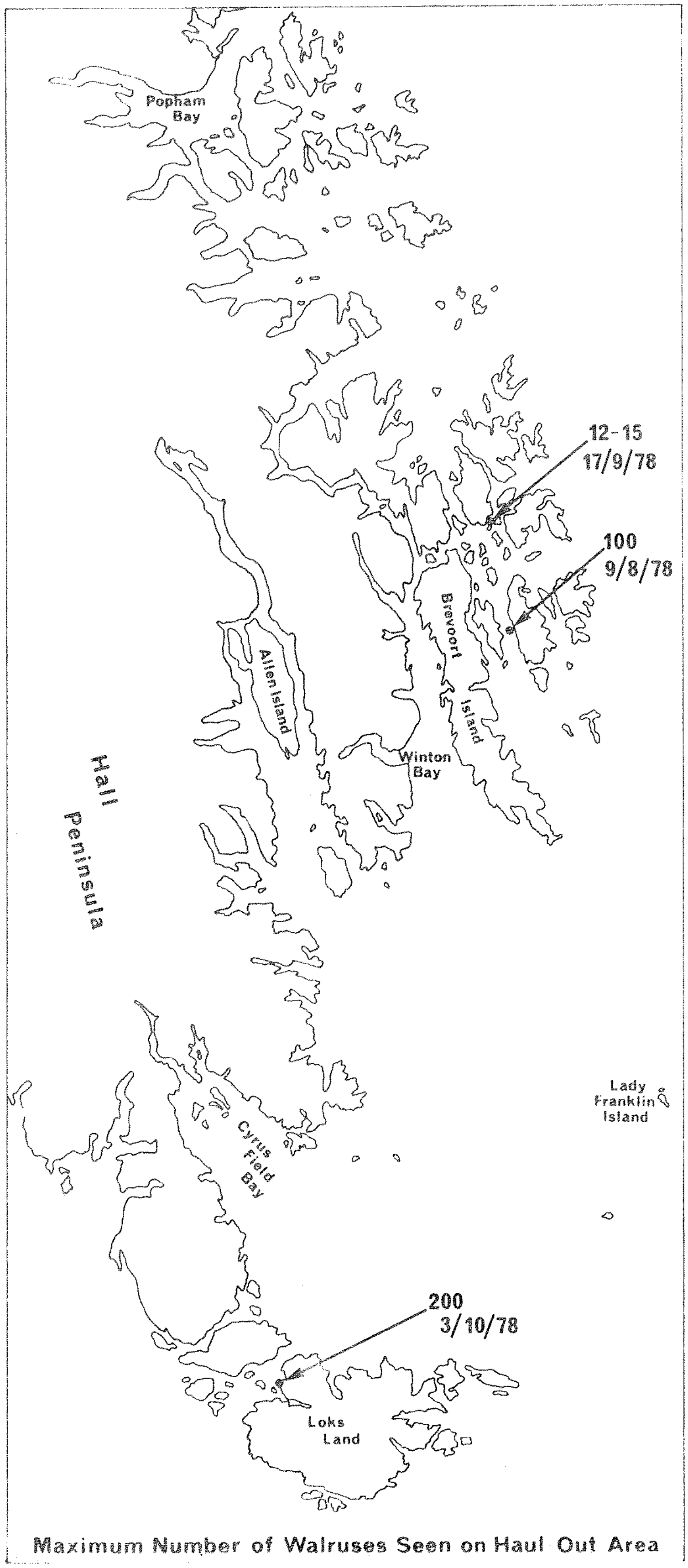

Fig. 12. Location of walrus haul-out sites and number of walruses observed.