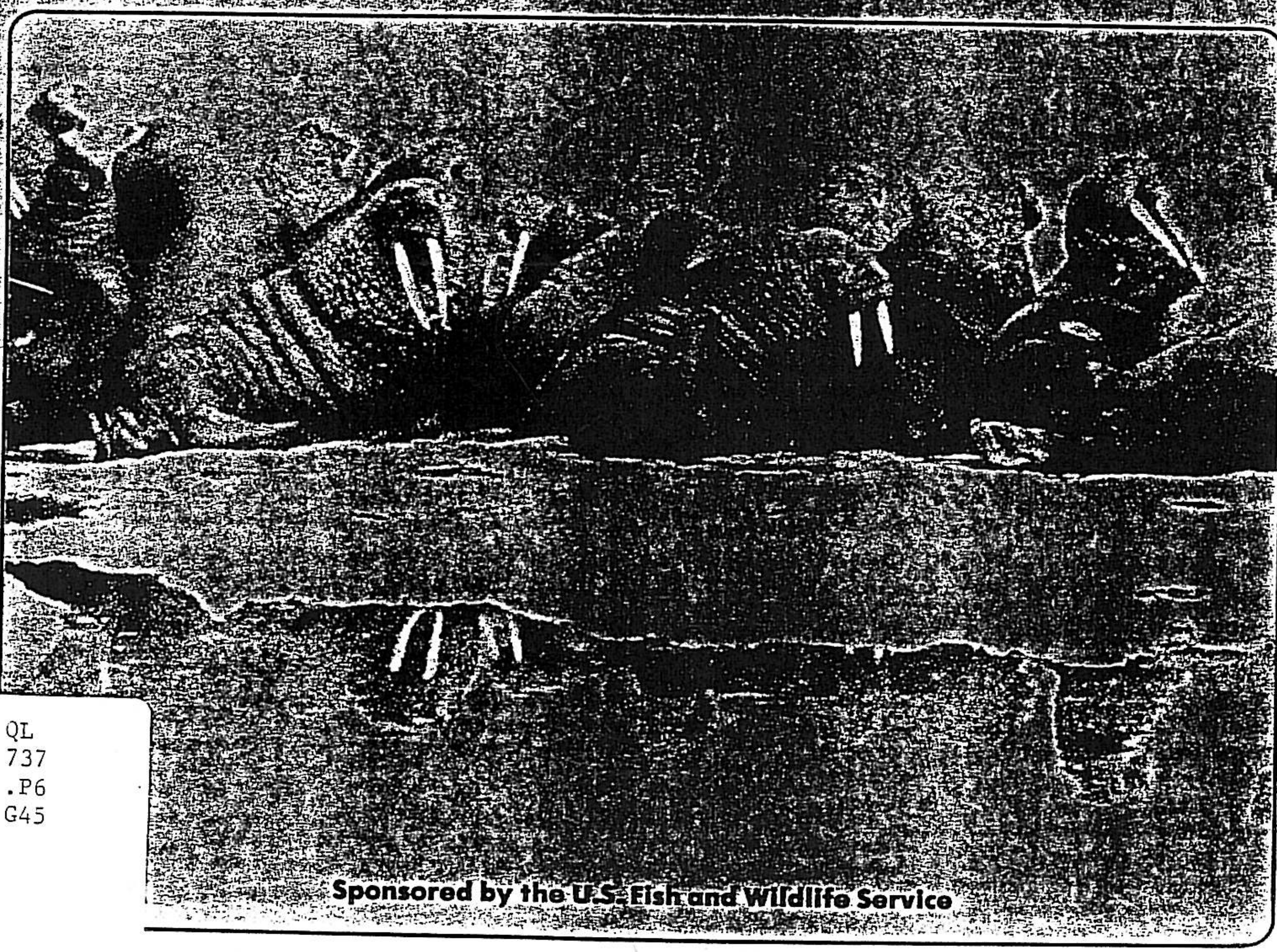
Aerial Survey of Pacific Walrus in the Chukchi Sea, 1985

James R. Gilbert

1986



Sponsored by the U.S. Fish and Wildlife Service

AERIAL SURVEY OF PACIFIC WALRUS IN THE CHUKCHI SEA, 1985

James R. Gilbert

1986

Wildlife Assistance

Region 7

U. S. Fish and Wildlife Service

1011 E. Tudor Road

Anchorage Alaska 99503

SUMMARY

The U.S. Fish and Wildlife Service conducted a survey of the walrus population in the pack ice of the Chukchi Sea between 16 September and 2 October, 1985. Observers conducted surveys from two aircraft (a Twin Otter and a Cessna Conquest) which flew from Pt. Barrow. I divided the survey area between 156°30'W and 174°W longitude into 4 strata based on relative distribution of walrus numbers. In each stratum the observers flew strip samples along randomly selected north-south lines. The observers counted walruses within a constant viewing angle which corresponded to a total strip width of 0.75 NM at 500 feet altitude.

We observed 15,312 walruses in 9 days of flying, of which 10,140 were on 3120 NM^2 of survey lines. We flew 79 random survey lines ranging in length from 22 to 107 NM. We saw very few walruses east of 161° W longitude or west of 170° W longitude. There were two or three areas of walrus concentration between 161° and 170° which shifted westward during the course of our surveys. On days when more walruses were in the water, they were found farther into the pack ice, and on days when nearly all the walruses were hauled out on the ice they were close to the southern edge of the pack.

I estimated the population size of observable walruses in pack ice of the Chukchi Sea to be 63,487 with a standard deviation of 10,921. This total is based on estimates of the number of groups on September 29 and October 1 combined with the average group size for those days. To this estimate

is added the number hauled out in Bristol Bay (15,238) and the estimate for the Soviet survey in their territory. They counted 39,572 on their beaches and estimated either 54,080 or 115,531 in pack ice of their sector. (They handled one large group observed while on survey as either part of the sample or extraordinary to the sample). Given this large group can be considered part of the sample, then the total in the Soviet sector would be 155,103. Therefore, the estimate of total population of the Pacific walruses in 1985 is 233,828.

While this estimate is comparable to earlier population estimates from operations conducted jointly by the U.S. and the Soviets, the lack of information about the fraction hauled out and the wide variances preclude using this for any more than trend information.

The Marine Mammal Protection Act of 1972 assigned to the U.S. Fish and Wildlife Service the responsibility for the management of the Pacific walrus (Odobenus rosmarus divergens). Cooperative U.S. - Soviet censuses of the shared walrus population were agreed upon in 1973 and 1974 as part of the 1972 "Agreement on Cooperation in the Field of Environmental Protection" between the two nations. The first such census was conducted in the fall of 1975 and reported by Estes and Gol'tsev (1984) with reports for individual countries by Estes and Gilbert (1978) and Gol'tsev (1976). A second census was conducted in the fall of 1980, with Soviet results reported by Fedoseev (1984) and U.S. results by Johnson, *et al*. (1982).

The Pacific walrus population is an important resource to the inhabitants of the Chukchi Peninsula and Western Alaska as a source of ivory and meat for native peoples. It is also a resource of significance to residents of the U.S. and other countries as a high visibility indicator of the health of the Arctic marine ecosystem. Because of the walrus's importance, the U.S. Fish and Wildlife Service has drafted a management plan for the walrus which has the general goal to maintain the walrus population within an optimum population range, giving consideration to the numbers of walrus, the ability of the habitat to sustain the population, and the importance of subsistence use of walrus. Among the management problems identified are: 1) a concern that walrus populations have increased to an unusually high level and may deliteriously impact the benthic resources upon which they depend, resulting in a population crash; 2) an indication that man, through increased exploitation of other natural resources and through increased subsistence harvest of walrus, may negatively impact the walrus population; and 3) a realization that the information available is not an adequate base from which to make sound management decisions.

From 1958 to 1975, several aerial surveys were conducted to estimate the size of the walrus population. However these were limited to surveys on one side or the other of the boundary between the U.S. and the Soviet territory. As such, the estimates were limited to some sub-area of the walrus's range. The first joint survey was conducted in the fall of 1975, with the U.S. effort being over the pack ice of the Chukchi Sea in early September and the Soviet effort concentrating on coastal haulout areas along the Chukchi and Bering coasts. A similar survey was conducted in 1980 in the same areas. Both of these surveys identified significant problems in obtaining a reliable estimate, among which were: 1) the large area that has to be covered, perhaps in a single day; 2) the extreme variability caused by the aggregation of the walruses into large groups and the aggregation of these groups in certain areas of the pack ice; 3) the bias in the survey because some of the walruses are diving in the water and cannot be observed, and there is evidence that the haulout regime of walruses is somewhat synchronized, resulting in few walruses being visible on some days and many being visible on other days; and 4) the large groups of walruses cannot be counted so their numbers must be estimated.

This is a report of the effort to estimate the walrus population in the U.S. sector of the Chukchi Sea in 1985. To this estimate will be added the numbers of walruses which hauled out in Bristol Bay and the numbers the Soviets estimate for their survey area. The objectives of this effort in the Chukchi Sea were:

1) To estimate the numbers of walruses occupying the pack ice of the Chukchi Sea to 174^{0}W. longitude,

2) To estimate the precision of the above population estimate, and

3) To determine the pattern of distribution of walruses in the pack ice.

METHODS

A group of 8 scientists used two aircraft to conduct a stratified sample of the pack ice between 156^{0}30'W and 174^{0}00'W. On each strip sample unit we counted or estimated the number of walruses in each group observed. I estimated the population size using procedures outlined by Estes and Gilbert (1978) and Cochran (1977).

Platform characteristics: We used two aircraft to conduct the censuses so as to cover more area in each survey day.

Estes and Gilbert (1978) had shown that group size could vary with day of survey such that the population estimate had to be based on a single survey day, thus I wanted to survey as much area as possible in each day. One aircraft we used was a twin otter which we leased from NOAA-OCSEAP. This plane (N600LJ) had been modified for surveys by incorporating an internal fuel tank which allowed survey flights of 7.5 h duration. The observation windows on each side of the aircraft were converted to large bubbles, permitting observation directly beneath the aircraft. An ICS communications system allowed all observers and recorders to communicate with each other and the pilot. A GNS-500 navigation system allowed us to locate our position to the nearest 0.1 degree of latitude and longitude. The aircraft was capable of flying between 90 and 160 knots, although we conducted our surveys at speeds between 120 and 130 knots. The aircraft had twin turbine engines and excellent de-icing equipment.

The other aircraft we used was a Conquest (Cessna 441) similar to the one used by Johnson, et al. (1982) in the 1980 survey. I selected this aircraft because it had twin turbine engines, excellent de-icing characteristics, the ability to travel to the survey area at 250+ knots at altitudes over 25,000+ feet, and a GNS navigation system. We modified the windows by removing the inner layer of plexiglas so we could keep the windows clear of frost and moisture. We added an ICS system for the observers and recorders. It was a less than ideal survey platform because the low wings restricted forward visibility.

Survey procedures: We flew surveys at 500 feet altitude if the ceilings allowed. We would drop to 400 feet or 300 feet if the ceilings were lower, but would stop surveying a line if visibility was poor at 300 feet. We would continue along the line until visibility improved and counting could resume. An observer on each side of the aircraft counted or estimated the size of each group of walrus in a field of vision between 33.4° and 9.4° from horizontal. These angles correspond to 0.125 and 0.5 nautical miles distance from the flight line at 500 feet altitude. Therefore each observer was counting in a strip which was 0.375 nautical miles wide at 500 feet. The angles remained the same as the aircraft changed altitude, thus the strip width changed with change in altitude.

Because groups were difficult to count from photographs and walruses would abandon an ice flow if the aircraft circled for an accurate count, the size of each group was estimated by the observers. The four primary observers all were experienced in counting pinnipeds on the ice, and several had participated in the walrus surveys in the past.

The observer would call his observations out to a recorder who would write the numbers on field forms. In addition, the recorder would note the time and latitude and longitude at the beginning and end of the line, whenever altitude or ice characteristics changed, and every five to ten minutes. Often a second recorder was along to back up the first recorder. If observations were being made too fast for one recorder, we assigned an individual to each observer. The recorder also kept notes on air temperature, wind speed and direction, cloud cover, and ice cover as each changed.

Survey design: Originally I planned to conduct a systematic survey of the entire study area using both planes to fly north-south strips at regular intervals to outline areas of high walrus concentration upon which we could stratify a random sample. When the Conquest was not available for the first 5 days (because of mechanical difficulties), I altered the systematic survey to a mapping survey in which we flew out and back parallel to the ice edge, noting where concentrations of walruses existed. I defined each stratum as an area with a relatively homogeneous walrus density.

In each stratum, north-south oriented flight lines were designated at 6-minute longitude intervals (approximately 1.8 nautical miles apart) from which a random sample was selected for each day's flights. These flight lines extended from the edge of the pack ice northward until the pack ice totally covered the surface (8 oktas), usually with very large floes; or until no evidence of walruses (sightings or holes on new ice) had been observed for some time.

The number of flight lines in each stratum was determined by the total flight time available in a day, the area of the stratum, and the relative density of walruses in the stratum. According to sample allocation rules for stratified random sampling (Cochran 1977), more samples should go into a stratum if it has more area or if it has more variability. Eberhardt (1979) has demonstrated that in most wildlife situations involving numbers or densities of animals, the variability in numbers is proportional to the number or density of animals. Therefore I allocated more samples to a stratum that had a larger density or a larger area. However, I allocated a minimum of 4 sample lines in each stratum surveyed.

In addition to the random survey flight lines, the observers could add extra flight lines when there was sufficient aircraft time. I did not use the data from these lines to estimate the walrus population size, but I did use the information to help define distribution and to better estimate group size. Often these lines were placed where the random lines were widely separated.

On a day we believed the weather to be adequate (sufficiently warm with winds below 20 knots), we attempted to maximize the flight time during daylight hours. We attempted to obtain two flights of about 5 h each from the Conquest and two flights of 6.5 h and 5.0 h with the Twin Otter. When we completed such a day's flying, we rested the pilots and observers the next day.

Statistical evaluation. In an effort to reduce variability, I used a stratified version of the ratio estimator used by Estes and Gilbert (1978) (Method I, which is also in Cochran 1977:159) to estimate the number of groups. I combined this with an estimate of mean group size to estimate the total walrus population in the survey area.

Let

y_{hi} = number of walrus groups observed in the i^{th} sample of the h^{th} stratum,

x_{hi} = area of the i^{th} sample of the h^{th} stratum,

Then the density of walrus groups in each stratum is

$$R_h = y_{hi} / x_{hi},$$

with variance

$$s_{Rh}^2 = [(y_{hi}^2/x_{hi}) - R_h \cdot y_{hi}] / (n-1)(x_{hi})$$

and the abundance of walrus groups the h^{th} stratum is

$Ty_h = R_h \cdot A_h$, where A_h is the area of the h^{th} stratum,

with variance

$$V_{Tyh} = A_h(A_h - x_{hi})s_{Rh}^2.$$

These estimates of numbers of groups were combined over the total area to estimate the total number of groups as

$$Ty = Ty_h$$

with variance

$$VTy = V_{Tyh}.$$

This estimate was then combined with the mean group size to obtain the total walrus population in the area

$Tw = Ty \cdot G$, where G is the mean group size

with variance

$$VTw = VTy \cdot G^2 + V_G \cdot Ty^2 - V_G \cdot VTy,$$

where V_G is the variance of G, the mean group size.

RESULTS

We observed 15,312 walrus in our surveys between 18 September and 1 October. Of these, 10,140 were observed on random or extra survey legs totaling 3610.7 nautical miles. On 18 September we flew the Twin Otter parallel to the ice edge out to 173°54' W longitude and returned (fig. 1), mapping the location of each walrus group observed in the survey track and outside the survey track. We observed 4395 walruses in track that day, most which were distributed around 163° and 167° with very few between 156°30' and 161° and only slightly higher numbers between 169° and 174° (Table 1). We saw very few walruses in the water (1.2%), and average group size was 18.47, leading us to believe most of the walruses in the area were hauled out the ice. Given this information, I divided the survey area for population estimation into 4 strata as follows: stratum 1 from 169°-174°, stratum 2 from 165°-169°, stratum 3 from 161°-165°, and stratum 4 from 156°30'-161°.

We flew stratified random aerial surveys on 22, 24, 25, 29 and 30 September, and 1 October. In addition, we aborted one survey on 20 September because of high winds. The Alaska Department of Fish and Game used the Twin Otter on 26 September to conduct a belukha whale survey in the pack ice east of Pt. Barrow (from 154° to 156°30' W), from which we were able to determine the absence of walrus in this area. On September 22, we were able to conduct two flights by each of the aircraft (fig. 2), but lost the Conquest to mechanical difficulties at the end of the day. Consequently, the surveys on 24 September and 25 September utilized the Twin Otter only, and mechanical and fueling difficulties limited our operations to one flight each day. Therefore in each of those two days, only one stratum was adequately covered (fig. 3). The survey on September 29 was limited to one stratum because we anticipated better weather the next day (fig. 4). On September 30, we conducted two flights with each aircraft, covering the outer three strata (fig. 5). We conducted two flights with the Conquest and one with the Twin Otter on October 1 (fig. 6). In all, we completed 79 random survey lines ranging from 22 to 107 nautical miles length (Table 2).

DISTRIBUTION

We observed very few walrus between 156° and 161° on all days (Table 1). Even on days when we did not census the area, observations enroute to and from other areas confirmed that walruses were infrequent in this area.

We also observed few walrus west of 170°. Those which we observed in this area on September 30 were along the flight line at 170°12'.

Most of the walruses we observed were located between 161° and 170° (Table 1). On September 22, the highest concentration of walruses was found between 167° and 169°, with secondary concentrations at 163°18' and 161°24'. The eastern concentrations appeared to shift to the west in subsequent surveys to between 164° and 167° (Table 1). The western concentration shifted slightly to the west to 169°. This movement to the west was counter to the eastward movement of the pack ice we observed during the surveys.

In 1975, Estes and Gilbert (1978) observed the highest concentrations of walruses between 162° and 165°, with very few east of 159° or west of 171°. In 1980, Johnson et al. (1982) found the primary area of walrus concentration to be between 166° and 170°, with secondary concentrations at 159° and 164°. The 1975 surveys were in early September, while the 1980 surveys were in mid September.

The information from previous surveys would support the observation we made in 1985 of a westward movement during September. The concentration area was between 162° and 165° on September 8 (1975), at 167° and 169° on September 15-16 (1980), and at 166° and 169° on October 1 (1985). Questions remain as to why the walruses are seldom seen west of 170°. Perhaps they move from the pack ice at 170° to the Chukotka Coast of Siberia.

Over 80 percent of the walruses we observed in the pack ice were within 20 NM of the ice edge. While some groups were inside along large leads among vast floes, most of the groups were associated with smaller floes found closer to the pack ice edge.

The distribution of walruses relative to the pack ice edge was not consistent among days. On September 22, a significant fraction of those walruses on ice and in the water were found further than 20 NM into the pack (Table 3).

In contrast, on October 1 over 90 percent of the walruses we observed were within 15 NM of the edge (Table 3). The distribution on September 30 was also aggregated at the pack ice edge. This agrees with Estes and Gilbert (1978) who observed nearly all the walruses in 1975 in the first half of their survey lines. For comparison, the observations for 1985 are arranged by percent interval of the individual survey line in Table 4. Because line lengths varied greatly, evaluation of distribution relative to the edge is better analyzed as in Table 3.

The difference among days in the distribution relative to the ice edge correlates with the fraction of walruses in the water (Table 5). On September 22, 18.1 percent of the walruses observed were in the water and these were distributed up to 70 NM into the pack ice. On that day, we saw relatively few walruses on the pack ice, and these were not aggregated at the pack ice edge as on September 30 or October 1 (Table 3). In contrast, on October 1 only 2.9 percent of the walruses were in the water (Table 5), and these were generally closer to the ice edge (Table 3).

Not only does this imply some synchrony in haulout at this time of year, but leads me to speculate that when they are not hauled out, they are probably feeding farther into the pack ice. The aggregation of hauled out walruses at the pack edge would then imply that they return to the edge after feeding. Alternatively, the aggregation at the edge we observed could be prepatory to migration across the western Chukchi Sea to the coast of Siberia. Hopefully, future studies will determine the reasons for such patterns.

POPULATION ESTIMATION

I estimated the population size of walruses in pack ice of the Chukchi Sea to be 63,487 with a standard deviation of 10,921. To obtain this estimate, I first estimated the number of walrus groups in the area, and then multiplied by the average walrus group size.

The number of walrus groups was estimated by estimating the density of walrus groups in each stratum for each day, then multiplying by the total area of each stratum (Table 6). On September 22, group densities in each stratum ranged from .02 to .35 walrus groups per square nautical mile, while on September 30 the range was .23 to .48 and on October 1 the range was .11 to .51. I estimated that there were 2369 groups on 22 September, 3754 on 30 September, and 2889 on 1 October between 161^{o} and 174^{o}.

The fraction of the walrus observed in the water varied significantly from day to day. On 22 September over 18 percent of the walrus groups observed were in the water, while on 18 September only 1.2 percent were in the water (Table 5). I found no relationship between the fraction in the water and the observed density or the density of vacant haulout sites. Observers noted all sightings of "walrus ice", i.e., where walruses had previously lain on a floe but were no longer present. If the numbers of these were proportional to the numbers of walruses in the water, there would be a correlation between the percent of the walruses in the water and the amount of vacant ice. Not only was there no correlation of the amount of vacant ice with the percent in the water, there was inconsistent correlation between the number of vacant floes and the number of walrus groups seen in each sample (Table 5). On some days we observed more vacant ice where there were more walrus groups. In fact we observed the highest density of vacant floes on October 1 when we observed the highest density of walrus groups (Table 6). On other days, we saw no such relationship. Because of these inconsistencies, I did not use the vacant ice in any subsequent evaluations. However, I did use the percent of walruses in the water as an indicator of the quality of the census day.

The average size of a group varied significantly among days (Table 7). We observed group sizes of up to 500 walruses, with an overall mean group size of 14.19 and an overall median group size of 5. Because the average group size was significantly different among days, the mean group size for each day was used to estimate population size. There was a significant difference among observers in the average group size estimate (Table 8). This was probably because the infrequent large groups were not equally available to the observers, and that a sighting of 350 or 500 in one group would raise the individual's average count significantly. This is supported by daily comparisons among observers (Table 8) which show that group sizes were significantly different among observers only on certain days, and no observer was consistently high or low.

From the estimates of the number of groups and the estimates of mean group size, I estimated the population size for each day (Table 9). My estimate for September 22 is 11,632 walrus in strata 1-3. I estimated 391 walrus were in stratum 4 on September 29. For September 30, my estimate is 49,965 walrus in strata 1-3, while on October 1 my estimate is 63,096. Overall, the best estimate would be that with the highest fraction hauled out, which would be that of October 1. Since stratum 2 on October 1 was expanded to include that part of stratum 1 which was known to have walrus, the estimate for that day should be a reasonable one for the area from 161° to 174°. To this must be added the walruses in stratum 4 for 29 September. Thus the total number of walrus in the pack ice of the Chukchi Sea during late September and the first of October is estimated to be 63,487 with a standard deviation of 10,921.

During the summer, counts of walrus were made at Round Island and Cape Pierce in Bristol Bay by personnel of Alaska Department of Fish and Game and the U. S. Fish and Wildlife Service (S. Mazzone, personal communication to Dale Taylor). The maximum count was of 15,238 on 27 July. At least 5950 walrus were observed at Cape Pierce as late as 24 September (Round Island counting had been discontinued at the end of August). It is doubtful that any of these walrus observed on 27 July were part of the population censused in the Chukchi

Sea in late September. Therefore the entire walrus population in the U.S. Sector of the Bering and Chukchi Seas would be 78,725.

In a preliminary document, Fedoseev and Razlialov (1986) report they counted 39,572 walruses on 15 coastal haulouts on the Siberian Coast in late October and early November. Earlier, between 27 September and 7 October, they conducted an aerial survey over the pack ice between 172° E and 176° W in the East Siberian and Chukchi seas. They sighted 5308 walruses in 769 km of track line (or 384.5 km^2). However, 3570 of those walruses were sighted in one 5-minute segment of the survey. Fedoseev and Razlivalov (1986) estimate the numbers of walruses as either 54,080 or 115,531, depending on whether the 3570 are included as part of the sample or added in separately at the end. I believe that they should be included as part of the sample as they were encountered while on survey. However, I do not know if they counted outside the survey strip or circled to obtain a complete count of the walruses in the area. At this time, I accept the number as part of the sample, giving 115,531 walruses in the pack ice of eastern Arctic and western Chukchi seas. The total walrus population in the Soviet sector of the Bering and Chukchi Seas is therefore 155,103.

My estimate of the total walrus population in the Bering and the Chukchi seas is 233,828. This compares to 221,360 in 1975 and 246,140 in 1980 (J. Gilbert re-evaluation of 1975 and 1980 censuses in letter to F. H. Fay and L. F.

Lowry, 1985). I must stress caution in interpreting these numbers. I have no estimate of the variation in the Soviet pack ice surveys, and I am not completely sure how the large group was observed in their surveys. My estimate for the pack ice in the Chukchi Sea has a 95-percent confidence limit of around 22,000 which is not sufficiently precise for anything other than trend information.

Many concerns expressed by Estes and Gilbert (1978) following the 1975 joint survey are still valid. The walrus population in the pack ice does not lend itself to being censused with any amount of precision. The clumped distribution of the animals, the large groups that cannot be counted because individuals are too close together and too indistinct for photography, the unknown fraction in the water and diving which are not seen, and the inability to obtain a sufficient number of samples in any one day all appear to be intractable problems in attempting a more precise census. With more information from other sources on diving times, segregation, and movements, it will be easier to interpret the information gathered from surveys.

OTHER SPECIES

We observed polar bears, belukha whales, bowhead whales, ringed seals, bearded seals, and gray whales during the conduct of the 1986 walrus census. A listing of the most commonly sighted species is summarized in Table 10. A few of the polar bears might have been outside the survey track, and some polar bear tracks were not recorded. We observed 18 bowhead whales during our surveys, including one in 6 oktas of ice at 169°24'. Polar bears and bear sign were observed throughout the survey area.

ACKNOWLEDGEMENTS

This survey would not have been possible without the cooperation and efforts of many individuals. I want to thank Bob Nelson, John Burns, Sue Hills, and Kathy Frost of Alaska Department of Fish and Game, Matthew Iya of the Eskimo Walrus Commission, and Dale Taylor and Scott Schleibe of the U.S. Fish and Wildlife Service for participating in the survey and offering suggestions for improvement of each day's effort. I want to thank the pilots and crew of each aircraft for their cooperation in making sure the planes were ready on time and that the lines surveyed were as straight as possible. I want to thank Ancel Johnson, Jim Estes, Kathy Frost, Lloyd Lowry, John Burns, William Dusenberry, and Bud Fay for reviewing the proposed research plan and an earlier draft of this report.

I want to especially thank Dale Taylor for all his help in arranging the logistics for the survey and providing support for my efforts in any way he could. He and Jim Baker arranged for my temporary appointment on an Interagency Personnel Assignment to the U.S. Fish and Wildlife Service as part of a sabbatical leave from the University of Maine.

LITERATURE CITED

Cochran, W. G. 1977. Sampling techniques, third edition. J. Wiley & Sons, N. Y. 428 pp.

Eberhardt, L. L. 1979. Appraising variability in population studies. J. Wildl. Manage. 42:207-238.

Estes, J. A., and J. R. Gilbert. 1978. Evaluation of an aerial survey of Pacific walruses (Odobenus rosmarus divergens). J. Fish. Res. Board Can. 35: 1130-1140.

Estes, J. A., and V. N. Gol'tsev. 1984. Abundance and distribution of Pacific walrus, Odobenus rosmarus divergens: results of the first Soviet-American joint aerial survey, autumn 1975. pp 67-76 in (Fay, F. H., and G. A. Fedoseev, eds.) Soviet-American Cooperative Research on Marine Mammals. Volume 1 - Pinnipeds. NOAA Technical Report NMFS 12.

Fedoseev, G. A. 1984. Present status of the population of uses (Odobenus rosmarus) in the eastern Arctic and walruses (Odobenus rosmarus) in the eastern Arctic and Bering sea. pp 73-85 in Marine Mammals of the Far East. TINRO, Vladivostok, 149 pp. (Translated by F. H. Fay).

Fedoseev, G. A., and E. V. Razlivalov. 1986. The distribution and number of walruses in the eastern arctic and Bering Sea in the autumn of 1985. VNIRO, Magadan mimeo report. (Translated by F. H. Fay).

Gol'tsev, V. N. 1976. Aerial surveys of the Pacific walrus in the Soviet sector during the autumn 1975. Unpublished report TINRO Magadan. 22 pp.

Johnson, A., J. Burns, W. Dusenberry, and R. Jones. 1982. Aerial survey of Pacific walrus, 1980. U. S. Fish and Wildlife Service, Anchorage. Mimeo report, 32 pp.

Table 1. Walrus numbers observed in each degree of longitude in the Chukchi Sea on Sepember 18,1985, and walrus densities observed in subsequent surveys.

	No. Walrus	Walrus Density (walruses/NM^2)			
Longitude	Sept 18	Sept 22	Sept 24-25	Sept 29-30	Oct 1
173 - 174	3			.00	
172 - 173	25			.00	
171 - 172	0	.02			
170 - 171	0			.82	
169 - 170	60	.07		57.43	19.19
168 - 169	118	5.67	3.42	.72	4.06
167 - 168	432	3.43	1.17	.23	4.55
166 - 167	748	.19	.15	7.35	17.53
165 - 166	441	.38	.00	.51	8.46
164 - 165	143	.02	.34	1.81	14.04
163 - 164	203	1.37	.10	.38	2.25
162 - 163	1188	.40	.88	5.47	.52
161 - 162	922	2.91	2.60	.48	.00
160 - 161	25		.42	.40	.00
159 - 160	87	.63			
158 - 159	0			.00	
157 - 158	0			.00	
156 - 157	0			.00	

Table 2. Location and area of each survey line segment flown during the walrus survey in the Chukchi Sea, 1985.

Date	Flight	Line[A]		Distance (NM)	Area (NM^2)	Beginning Lat.	Beginning Long.	End Lat.	End Long.
9 18	1	1	M	462.88	292.45	72.089	164.105	71.596	158.110
9 18	1	2	D	53.54	24.09	71.596	158.110	71.190	156.370
9 18	2	1	M	642.58	639.80	71.172	156.567	71.269	156.388
9 20	1	1	S	79.50	59.62		172.241		172.240
9 20	1	2	S	31.00	23.25	72.025	171.060	71.315	171.061
9 20	2	1	S	62.70	47.02	71.473	164.540	72.500	164.540
9 20	2	2	S	63.00	47.25	72.508	164.300	71.478	164.300
9 20	2	3	D	154.44	115.83	71.478	164.300	71.190	156.300
9 22	1	1	S	80.00	60.00	70.500	171.053	72.100	171.059
9 22	1	2	S	50.50	30.30	72.110	169.420	71.205	169.420
9 22	1	3	S	44.80	31.56	71.370	168.120	72.218	168.120
9 22	1	4	S	23.00	13.80	72.180	167.590	71.550	167.594
9 22	1	5	S	43.50	22.57	71.570	167.420	72.405	167.421
9 22	3	1	S	47.00	33.99	72.000	167.360	72.470	167.360
9 22	3	2	S	40.72	26.80	72.500	166.385	72.094	166.362
9 22	3	3	S	49.00	35.07	72.090	166.260	72.580	166.246
9 22	3	4	S	49.80	36.39	72.588	166.181	72.090	166.171
9 22	3	5	S	68.89	49.43	71.580	166.129	73.000	166.121
9 22	3	6	S	49.21	33.55	73.000	165.280	72.108	165.298
9 22	2	1	D	144.12	216.19	71.190	156.300	71.503	164.540
9 22	2	2	S	84.70	62.61	71.503	164.540	73.150	164.540
9 22	2	3	S	76.69	52.32	73.160	164.180	71.593	164.180
9 22	2	4	S	47.70	35.77	71.560	163.420	72.437	163.420
9 22	2	5	S	52.20	39.15	72.430	163.180	71.508	163.180
9 22	2	6	S	61.00	45.75	71.460	163.000	72.470	163.000
9 22	2	7	S	64.20	48.15	72.456	162.540	71.414	162.544
9 22	2	8	S	66.10	49.57	71.367	162.360	72.428	162.360
9 22	4	1	D	198.64	456.71	71.190	156.300	71.270	162.360
9 22	4	2	S	74.20	52.23	71.344	162.120	72.480	162.120
9 22	4	3	S	68.30	38.91	72.469	161.240	71.386	161.240
9 22	4	4	D	2.00	1.50	71.386	161.240	71.386	161.180
9 22	4	5	S	82.00	46.89	71.386	161.180	73.000	161.118
9 22	4	6	D	35.31	15.89	73.000	161.180	73.000	159.120
9 22	4	7	S	107.29	69.58	73.000	159.120	71.127	159.120
9 24	1	1	S	60.60	45.45	71.220	168.480	72.226	168.480
9 24	1	2	S	43.00	32.25	72.220	168.060	71.390	168.060
9 24	1	3	S	57.70	43.27	71.523	167.180	72.500	167.180
9 24	1	4	S	55.10	41.32	72.525	166.060	71.574	166.060
9 24	1	5	S	53.40	39.36	71.566	165.480	72.500	165.480
9 24	1	6	S	75.10	56.32	72.458	164.360	71.307	164.360
9 24	1	7	D	155.23	116.42	71.307	164.360	71.190	156.300
9 25	1	1	D	138.11	404.39	71.190	156.300	71.310	163.406
9 25	1	2	S	59.00	44.25	71.310	163.406	72.300	163.421
9 25	1	3	S	51.10	38.32	72.293	163.061	71.382	163.057
9 25	1	4	E	53.00	39.75	71.3	161.371		
9 25	1	5	D	27.06	20.29	72.260	162.300	72.444	161.237
9 25	1	6	S	75.70	56.77	72.444	161.237	71.287	161.242

Table 2. (Continued)

Date		Flight	Line[A]		Distance (NM)	Area (NM^2)	Beginning Lat.	Beginning Long.	End Lat.	End Long.
9	25	1	7	M	6.08	4.57	71.287	161.242	71.314	161.064
9	25	1	8	S	53.90	40.42	71.314	161.064	72.253	161.061
9	25	1	9	S	57.00	42.75	72.260	161.121	71.290	161.122
9	25	1	10	D	25.22	37.83	71.290	161.123	71.398	160.002
9	25	1	11	S	47.40	35.55	71.398	160.002	72.272	160.000
9	25	1	12	D	93.92	305.09[B]	72.272	160.000	71.190	156.300
9	26	1	1	M	52.56		71.190	156.300	71.160	154.010
9	26	1	2	B	70.01		71.160	154.010	72.260	154.000
9	26	1	3	B	63.68		72.260	154.293	71.212	154.301
9	26	1	4	B	46.65		71.300	155.001	72.166	154.598
9	26	1	5	B	45.05		72.168	155.291	71.318	155.295
9	26	1	6	B	50.10		71.300	156.004	72.201	156.000
9	26	1	7	B	54.98		72.173	156.295	71.258	155.296
9	29	1	1	D	84.37	94.52	71.190	156.300	70.588	160.415
9	29	1	2	S	59.60	44.70	70.588	160.415	71.584	160.420
9	29	1	3	D	37.19	27.90	71.584	160.420	71.596	158.418
9	29	1	4	S	41.20	30.90	71.596	158.418	71.184	158.419
9	29	1	5	S	34.70	26.02	71.242	158.061	71.589	158.062
9	29	1	6	S	30.60	22.95	71.594	157.480	71.288	157.478
9	29	1	7	D	11.83	7.93	71.288	157.478	71.275	157.116
9	29	1	8	S	37.20	25.68	71.275	157.116	72.047	157.120
9	29	1	9	E	29.00	21.75	72.053	156.448	71.363	156.449
9	30	1	1	S	38.00	28.50	71.490	166.480	72.270	166.481
9	30	1	2	S	76.40	57.30	72.274	166.302	71.110	166.300
9	30	1	3	D	16.03	12.03	71.110	166.300	71.073	165.417
9	30	1	4	S	74.70	56.02	71.073	165.417	72.220	165.418
9	30	1	5	S	74.10	55.57	72.220	165.358	71.079	165.360
9	30	1	6	D	24.74	18.56	71.079	165.360	71.027	164.355
9	30	1	7	S	82.30	61.72	71.027	164.355	72.250	164.359
9	30	1	8	D	23.45	17.59	72.250	164.359	72.266	163.184
9	30	1	9	S	80.80	60.60	72.266	163.184	71.058	163.181
9	30	2	1	S	69.63	32.55	71.149	173.559	72.245	173.539
9	30	2	2	S	63.70	28.66	72.226	172.178	71.189	172.184
9	30	2	3	S	36.21	25.99	71.043	170.513	71.404	170.539
9	30	2	4	S	50.30	35.88	71.416	170.360	70.513	170.372
9	30	3	1	S	81.20	60.90	71.040	162.480	72.252	162.479
9	30	3	2	S	80.70	60.52	72.253	162.423	71.046	162.418
9	30	3	3	S	56.00	42.00	71.040	162.302	72.000	162.300
9	30	3	4	S	53.50	40.12	72.000	162.060	71.065	162.060
9	30	3	5	E	22.20	16.65	70.518	161.300	71.140	161.302
9	30	3	6	E	25.00	18.75	71.140	161.003	70.490	161.000
9	30	4	1	S	68.01	39.98	70.582	170.131	72.062	170.117
9	30	4	2	S	44.60	25.13	72.047	169.416	71.201	169.423
9	30	4	3	S	39.00	27.81	71.385	168.117	72.175	168.122
9	30	4	4	S	36.60	26.11	72.179	167.475	71.413	167.478
9	30	4	6	S	81.50	61.12	72.195	164.482	70.580	164.482

Table 2. (Concluded)

Date	Flight	Line[A]			Distance (NM)	Area (NM^2)	Beginning Lat.	Beginning Long.	End Lat.	End Long.
10	1	1	1	S	41.20	30.90	71.316	169.243	72.128	169.241
10	1	1	2	S	33.00	24.75	72.100	168.420	71.370	168.421
10	1	1	3	S	34.00	25.50	71.383	168.120	72.123	168.122
10	1	1	4	S	20.43	15.32	72.113	167.360	71.511	167.361
10	1	1	5	S	41.90	31.42	71.445	167.118	72.264	167.127
10	1	1	6	S	41.70	31.27	72.266	167.059	71.449	167.063
10	1	2	1	S	26.30	19.72	70.587	164.543	71.250	164.537
10	1	2	2	E	24.90	18.67	71.236	164.242	70.587	164.235
10	1	2	3	E	26.30	19.72	70.587	164.000	71.250	163.599
10	1	2	4	S	21.60	16.20	71.236	163.421	71.020	163.418
10	1	2	5	S	40.90	30.67	71.041	163.188	71.450	163.177
10	1	2	6	S	42.80	32.10	71.451	163.000	71.023	162.595
10	1	2	7	S	38.70	29.02	71.041	162.537	71.428	162.535
10	1	2	8	S	54.00	40.50	71.410	162.120	70.470	162.120
10	1	2	9	E	45.40	34.05	70.441	161.480	71.295	161.482
10	1	2	10	S	41.60	31.20	71.285	161.240	70.469	161.241
10	1	2	11	S	26.70	20.02	70.467	161.180	71.150	161.178
10	1	2	12	E	50.60	37.95	71.244	158.596	72.150	159.002
10	1	2	13	D	73.07	54.80	72.150	159.002	71.190	156.300
10	1	3	1	S	85.10	63.83	70.364	166.277	72.015	166.247
10	1	3	2	S	84.30	61.83	72.010	166.060	70.367	166.063
10	1	3	3	E	47.41	27.83	70.313	165.300	71.187	165.300
10	1	3	4	S	46.80	32.21	71.185	165.249	70.317	165.238

[A]For each flight, lines were numbered sequentially and designated by type of line as follows: M = Mapping, D = Deadhead S = random survey E = nonrandom survey line B = belukha survey

[B]No areas were calculated, observers used a different set of sighting angles.

Table 3. Percent of walruses observed on ice and in water in each 5 NM interval northward from the pack ice edge on each of three days.

Interval (NM)	Sept 22				Sept 30				Oct 1			
	Water	Ice	Total	n[A]	Water	Ice	Total	n	Water	Ice	Total	n
0- 5	1.6	6.9	6.6	22	22.3	25.2	25.1	21	24.3	35.0	34.7	22
5- 10	16.0	14.7	14.9	22	13.1	46.5	44.5	21	18.1	47.8	46.9	22
10- 15	9.3	11.4	11.1	22	12.6	9.2	9.4	21	16.7	9.9	10.1	22
15- 20	27.2	7.8	11.0	22	14.1	0.1	0.9	21	3.5	1.6	1.7	22
20- 25	6.2	17.0	15.2	22	1.9	0.1	0.2	21	6.9	0.1	0.3	22
25- 30	10.5	4.4	5.4	21	4.4	0.0	0.2	19	0.7	0.1	0.1	19
30- 35	3.1	11.1	9.7	21	8.3	9.4	9.3	19	13.2	0.3	0.7	16
35- 40	6.2	17.7	15.8	21	3.9	T	0.2	19	0.0	4.8	4.6	14
40- 45	3.1	1.2	1.5	21	6.3	0.2	0.6	15	0.0	0.0	0.0	13
45- 50	4.9	0.1	0.9	18	0.0	0.0	0.0	14	4.2	0.0	0.1	7
50- 55	0.6	0.0	0.1	13	1.0	4.4	4.3	14	1.4	0.0	T	4
55- 60	0.0	2.2	1.8	11	6.8	1.6	1.9	12	2.1	0.0	0.1	2
60- 65	4.3	0.6	1.2	11	0.5	0.1	0.1	11	0.0	0.0	0.0	2
65- 70	2.5	0.0	0.4	9	0.0	3.2	3.0	10	0.0	0.0	0.0	2
70- 75	0.0	0.0	0.0	6	0.0	0.0	0.0	8	1.4	0.0	T	2
75- 80	0.0	0.0	0.0	5	4.9	0.0	0.3	6	7.6	0.3	0.6	2
80- 85	0.2	4.9	4.3	3	0.0	0.0	0.0	5	0.0	0.0	0.0	2
85- 90	0.0	0.0	0.0	1					0.0	0.0	0.0	1
90- 95	0.0	0.0	0.0	1								
95-100	0.0	0.0	0.0	1								
100-105	0.0	0.0	0.0	1								
105-110	0.0	0.0	0.0	1								
Total	100	100	100		100	100	100		100	100	100	
Sample Size	162	823	985		206	3410	3616		144	4749	4893	

[A]Number of north-south lines which sampled this 5 NM segment.

Table 4. Percent of walruses observed in water and on ice in each decile segment of the survey strip in each of three days.

Decile[A]	Sept 22			Sept 30			Oct 1		
	Water	Ice	Total	Water	Ice	Total	Water	Ice	Total
0 - 10	10.0	8.8	8.1	23.3	25.5	25.3	25.0	76.6	75.1
10 - 20	14.2	15.8	15.5	11.2	50.0	47.8	9.0	4.6	4.8
20 - 30	11.1	9.2	10.9	19.9	5.5	6.5	13.2	11.1	11.1
30 - 40	11.7	3.7	3.5	10.7	0.1	0.7	5.6	0.5	0.7
40 - 50	13.9	6.4	7.5	12.7	9.5	9.6	4.9	0.5	0.7
50 - 60	7.5	35.3	30.6	7.3	0.2	0.6	11.1	1.3	1.6
60 - 70	25.9	15.2	15.9	2.9	1.5	1.5	8.4	0.4	0.7
70 - 80	3.8	4.9	4.7	1.5	2.9	2.8	13.9	0.0	0.4
80 - 90	3.7	0.6	1.1	3.9	4.9	4.9	1.4	0.0	T
90 -100	1.2	2.2	2.0	4.9	0.0	0.3	7.6	4.8	4.8

[A]Percent Interval of the individual survey line in which observations were made (following Estes and Gilbert, 1978).

Table 5. The fraction of walrus groups in the water and the correlation between the density of walrus groups and vacant haulout sites in pack ice of the Chukchi Sea, 1985.

Date	Percent in Water	Walrus groups per NM^2	Vacant Sites per NM^2	Correlation (R)
9/18	1.2			
9/22	18.1	.241	.049	0.10
9/24	10.5	.248	.023	0.88
9/25	3.6	.132	.123	0.14
9/29	5.3	.026		
9/30	6.2	.319	.033	0.85
10/1	2.9	.421	.145	0.56

Table 6. Estimated number of walrus groups in each of the survey strata on each day during the 1985 walrus survey in the Chukchi Sea.

Day	H[a]	No Grps	Area (NM^2)	Density (No/NM^2)	S.D.	n lines	Total Area (NM^2)	Estimate (No Groups)	S.D.
20	1	0	82.87	.0000	.0000	2			
20	3	1	94.27	.0106	.0001	2			
22	1	2	90.30	.0221	.0001	2	6870.0	152	53
22	2	100	283.16	.3532	.0150	9	3436.0	1213	403
22	3	96	471.34	.2037	.0057	10	4930.0	1004	353
22	4	6	69.58	.0862		1			
24	2	58	201.65	.2876	.0124	5			
24	3	6	56.32	.1065		1			
25	3	39	222.52	.1753	.0038	5			
25	4	3	35.55	.0844		1			
29	4	4	150.25	.0266	.0004	5	3886.0	103	78
30	1	44	188.19	.2338	.0398	6	4759.0	1113	930
30	2	120	251.32	.4775	.0717	6	3968.0	1895	1028
30	3	88	386.99	.2274	.0047	7	3279.0	746	210
1	2[b]	151	317.03	.5078	.0031	9	5085.0	2582	335
1	3	24	219.44	.1094	.0025	8	2805.0	307	135

[a]Stratum number 1 = 169° to 174°W 2 = 165° to 169°W
3 = 161° to 169°W 4= 156°30' to 161°W

[b]On October 1, stratum 2 was extended from 169° to 171°W.

Table 7. Analysis of variance of the difference in walrus group size by day.

Day	18	20	22	24	25	29	30	1
Group Size	18.47	4.67	4.91	5.34	16.80	3.80	13.31	21.84
N	237	3	215	64	59	5	276	224

Source	Sum of Squares	D.F.	Mean Square	F
Among Groups	42,403	7	6058	6.869
Within Groups	947,995	1075	881	

Critical value at .01 = 2.66

Table 8. Mean group size recorded for each observer in each day and an Analysis of Variance Test for differences among observers.

Day(s)	Observer A	Observer B	Observer C	Observer D	F-statistic	Alpha
9 - 22	2.4 (53)[A]	6.9 (49)	3.8 (27)	5.8 (75)	3.17	0.025
9 - 24	4.4 (49)	---	---	8.5 (15)	1.99	0.164
9 - 25	---	17.9 (35)	15.2 (24)	---	0.20	0.659
9 - 30	7.5 (97)	6.9 (35)	28.4 (53)	13.2 (91)	3.71	0.012
10- 1	19.8 (28)	30.9(109)	7.4 (67)	23.8 (20)	5.21	0.002
22,30,1	7.9(178)	20.4(193)	14.3(147)	11.3(186)	4.59	0.003
Overall	7.2(227)	20.8(358)	14.3(174)	12.1(309)	10.32	0.001

[A]Number of groups observed is in parentheses.

Table 9. Estimates of Walrus population size in the Chukchi Sea for several days in the fall of 1985.

Day	Strata	Estimated Number of Groups	S.D.	Estimated Group Size	S.D.	Estimated Number of Individuals	S.D.
22	1,2,3	2369	538	4.91	.674	11,632	3,065
29	4	103	78	3.80	1.200	391	307
30	1,2,3	3754	1402	13.31	2.371	49,965	20,406
1	2[a],3	2889	361	21.84	2.633	63,096	10,917

[a]On October 1, the western border of stratum 2 was shifted from 165° to 171°W.

Table 10. Observations of other species during the 1985 walrus survey in the Chukchi Sea.

Date	Flight Number	Beginning Longitude	Belukha Whale	Ringed Seal	Polar Bear	Bear Kill	Bear Track	Walrus Ice	Other Spp.
9 18	M 1	164.105	10	3	6	1	32	0	4
9 18	D 2	158.110	0	0	0	0	0	0	1
9 18	M 1	156.567	7	2	2	1	1	0	9
9 20	S 1	172.241	0	0	0	0	1	0	0
9 20	S 2	171.060	0	0	0	0	1	0	0
9 20	S 1	164.540	2	1	0	0	2	1	0
9 20	S 2	164.300	0	0	0	3	1	3	0
9 20	D 3	164.300	3	0	0	1	1	6	2
9 22	S 1	171.053	0	0	0	0	1	0	0
9 22	S 2	169.420	0	0	0	0	0	0	1
9 22	S 3	168.120	0	0	3	0	0	0	0
9 22	S 4	167.590	0	0	0	0	0	0	0
9 22	S 5	167.420	0	0	0	0	1	0	1
9 22	S 1	167.360	0	0	0	0	1	3	0
9 22	S 2	166.385	0	0	0	0	0	7	0
9 22	S 3	166.260	0	0	0	0	1	4	0
9 22	S 4	166.181	0	0	0	0	0	3	1
9 22	S 5	166.129	0	0	1	0	0	5	0
9 22	S 6	165.280	0	1	0	0	1	0	0
9 22	S 2	164.540	0	0	0	0	0	2	1
9 22	S 3	164.180	0	1	0	0	0	0	0
9 22	S 4	163.420	0	0	0	0	0	1	1
9 22	S 5	163.180	0	0	1	0	0	1	0
9 22	S 6	163.000	0	0	0	0	0	2	0
9 22	S 7	162.540	0	0	0	0	1	0	0
9 22	S 8	162.360	1	0	0	0	0	1	0
9 22	S 2	162.120	0	0	1	0	0	4	0
9 22	S 3	161.240	0	3	0	0	0	3	1
9 22	D 4	161.240	0	0	0	0	0	0	0
9 22	S 5	161.180	0	0	0	0	0	4	0
9 22	D 6	161.180	2	0	0	0	1	0	0
9 22	S 7	159.120	1	6	1	0	1	1	1
9 22	D 1	156.300	2	2	0	1	0	7	0
9 22	D 1	156.300	0	0	0	1	3	0	2
9 24	S 1	168.480	0	1	1	0	0	4	1
9 24	S 2	168.060	0	1	1	0	0	1	0
9 24	S 3	167.180	0	0	1	0	0	1	0
9 24	S 4	166.060	0	1	0	0	0	0	3
9 24	S 5	165.480	0	4	2	0	0	0	0
9 24	S 6	164.360	0	10	2	1	0	0	0
9 24	D 7	164.360	1	0	0	0	0	0	2
9 25	S 2	163.406	1	0	0	0	0	0	0
9 25	S 3	163.061	2	5	1	1	0	1	1
9 25	E 4	162.313	0	7	0	1	3	3	5
9 25	D 5	162.300	0	0	0	0	0	0	0
9 25	M 7	161.242	0	0	0	0	0	1	0
9 25	S 6	161.237	0	8	0	0	1	2	7

Table 10. (Continued)

Date	Flight Number	Beginning Longitude	Belukha Whale	Ringed Seal	Polar Bear	Bear Kill	Bear Track	Walrus Ice	Other Spp.
9 25	D 10	161.123	67	0	0	0	0	0	1
9 25	S 9	161.121	1	2	0	0	2	11	4
9 25	S 8	161.064	0	3	0	0	1	2	2
9 25	S 11	160.002	0	2	0	0	0	8	2
9 25	D 12	160.000	0	1	2	2	0	0	1
9 25	D 1	156.300	1	0	0	1	4	1	0
9 26	M 1	156.300	0	0	0	0	0	0	2
9 26	B 7	156.295	4	3	0	0	2	0	4
9 26	B 6	156.004	16	0	0	1	1	0	1
9 26	B 5	155.291	13	0	0	0	0	0	0
9 26	B 4	155.001	19	0	0	0	10	0	1
9 26	B 3	154.293	31	0	1	1	13	0	0
9 26	B 2	154.010	10	0	0	0	8	0	0
9 29	D 3	160.420	0	0	0	0	1	0	0
9 29	S 2	160.415	2	2	0	0	0	0	0
9 29	S 4	158.418	0	0	0	0	2	0	0
9 29	S 5	158.061	0	0	1	0	1	0	1
9 29	S 6	157.480	0	0	0	0	1	0	0
9 29	D 7	157.478	1	0	0	0	0	0	0
9 29	S 8	157.116	0	0	1	0	1	0	0
9 29	E 9	156.448	0	0	0	0	0	0	0
9 29	D 1	156.300	5	0	0	0	0	0	0
9 30	S 1	173.559	0	1	0	0	1	0	0
9 30	S 2	172.178	0	1	0	0	2	0	3
9 30	S 3	170.513	0	1	0	1	0	0	1
9 30	S 4	170.360	0	0	0	1	0	0	2
9 30	S 1	170.131	0	7	0	0	3	0	1
9 30	S 2	169.416	0	6	0	0	1	1	0
9 30	S 3	168.117	30	7	0	0	0	0	0
9 30	S 4	167.475	5	4	0	0	0	2	0
9 30	S 1	166.480	9	3	0	0	0	0	1
9 30	S 2	166.302	0	3	0	1	2	10	0
9 30	D 3	166.300	0	0	0	0	0	0	0
9 30	S 4	165.417	2	4	0	0	8	2	1
9 30	D 6	165.360	0	0	0	0	0	0	0
9 30	S 5	165.358	0	16	1	0	3	1	1
9 30	S 6	164.482	0	56	3	2	6	8	1
9 30	D 8	164.359	16	0	0	0	0	0	0
9 30	S 7	164.355	0	5	0	0	3	1	0
9 30	S 9	163.184	0	5	1	0	2	1	0
9 30	S 1	162.480	0	23	0	0	2	0	6
9 30	S 2	162.423	0	59	0	0	2	0	2
9 30	S 3	162.302	0	12	1	0	8	1	3
9 30	S 4	162.060	0	16	0	0	10	0	1
9 30	E 5	161.300	0	0	0	0	2	0	1
9 30	E 6	161.003	0	2	0	0	0	0	0

Table 10. (Concluded)

Date		Flight Number		Beginning Longitude	Belukha Whale	Ringed Seal	Polar Bear	Bear Kill	Bear Track	Walrus Ice	Other Spp.
10	1	S	1	169.243	63	8	0	0	7	2	1
10	1	S	2	168.420	19	0	0	0	2	9	0
10	1	S	3	168.120	0	1	0	0	0	10	2
10	1	S	4	167.360	0	1	0	1	0	0	1
10	1	S	5	167.118	5	2	0	2	1	4	0
10	1	S	6	167.059	0	1	0	1	3	4	0
10	1	S	1	166.277	12	18	3	0	11	7	1
10	1	S	2	166.060	3	24	1	1	12	13	0
10	1	E	3	165.300	2	15	0	0	8	14	3
10	1	S	4	165.249	0	8	0	0	5	8	3
10	1	S	1	164.543	0	4	0	0	7	2	0
10	1	E	2	164.242	0	2	0	0	14	1	0
10	1	E	3	164.000	0	4	0	0	19	0	1
10	1	S	4	163.421	0	0	0	0	3	1	0
10	1	S	5	163.188	0	4	0	1	16	0	0
10	1	S	6	163.000	0	5	0	0	9	0	1
10	1	S	7	162.537	0	10	1	0	14	0	2
10	1	S	8	162.120	4	9	0	0	15	0	2
10	1	E	9	161.480	0	1	0	0	1	3	0
10	1	S	10	161.240	0	1	0	0	0	0	1
10	1	S	11	161.180	0	1	0	0	0	0	0
10	1	D	13	159.002	4	0	0	0	4	0	3
10	1	E	12	158.596	0	31	1	0	12	0	0

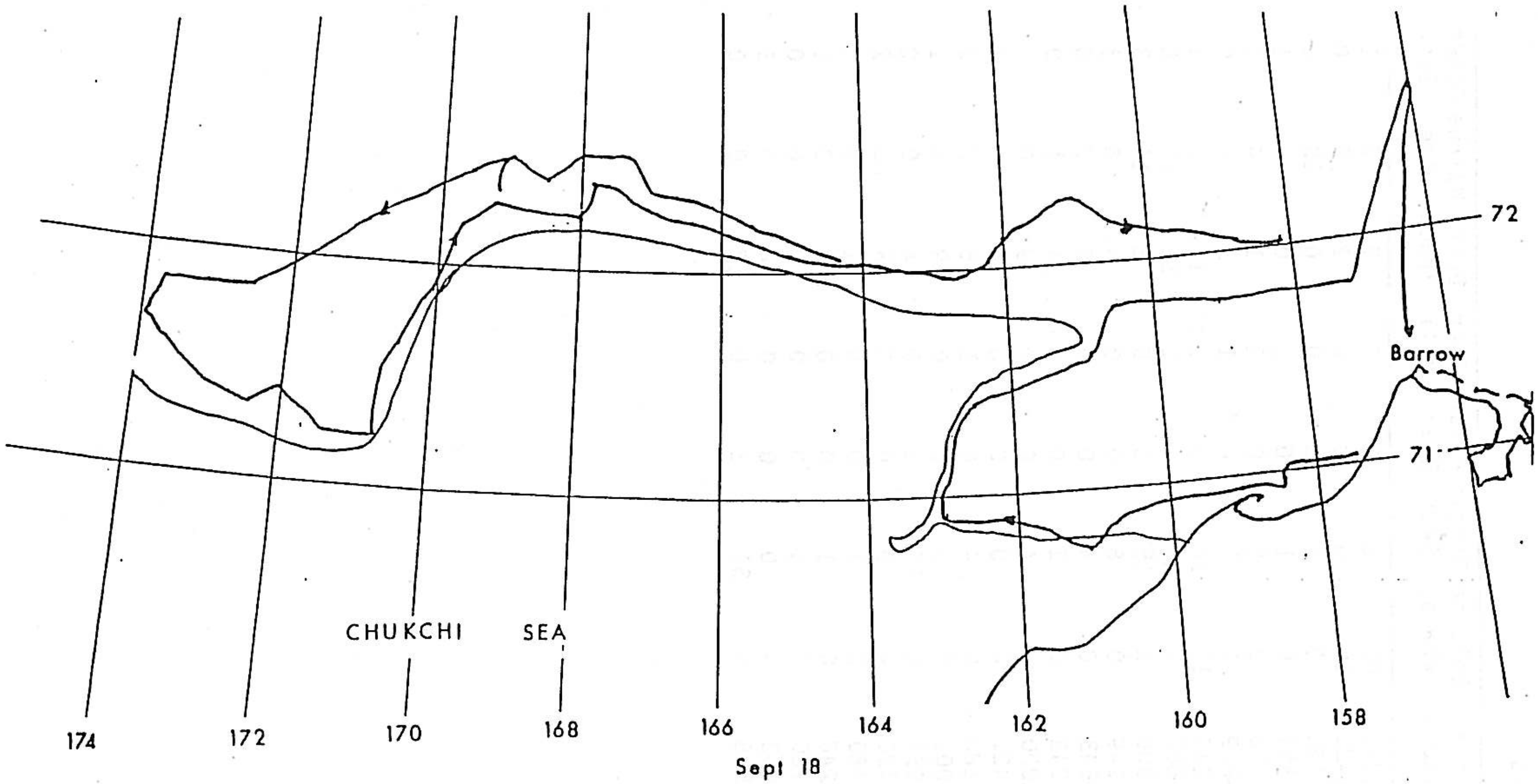


Figure 1. Location of the pack ice edge and the flight lines (with arrows) during the mapping survey on September 18, 1985.

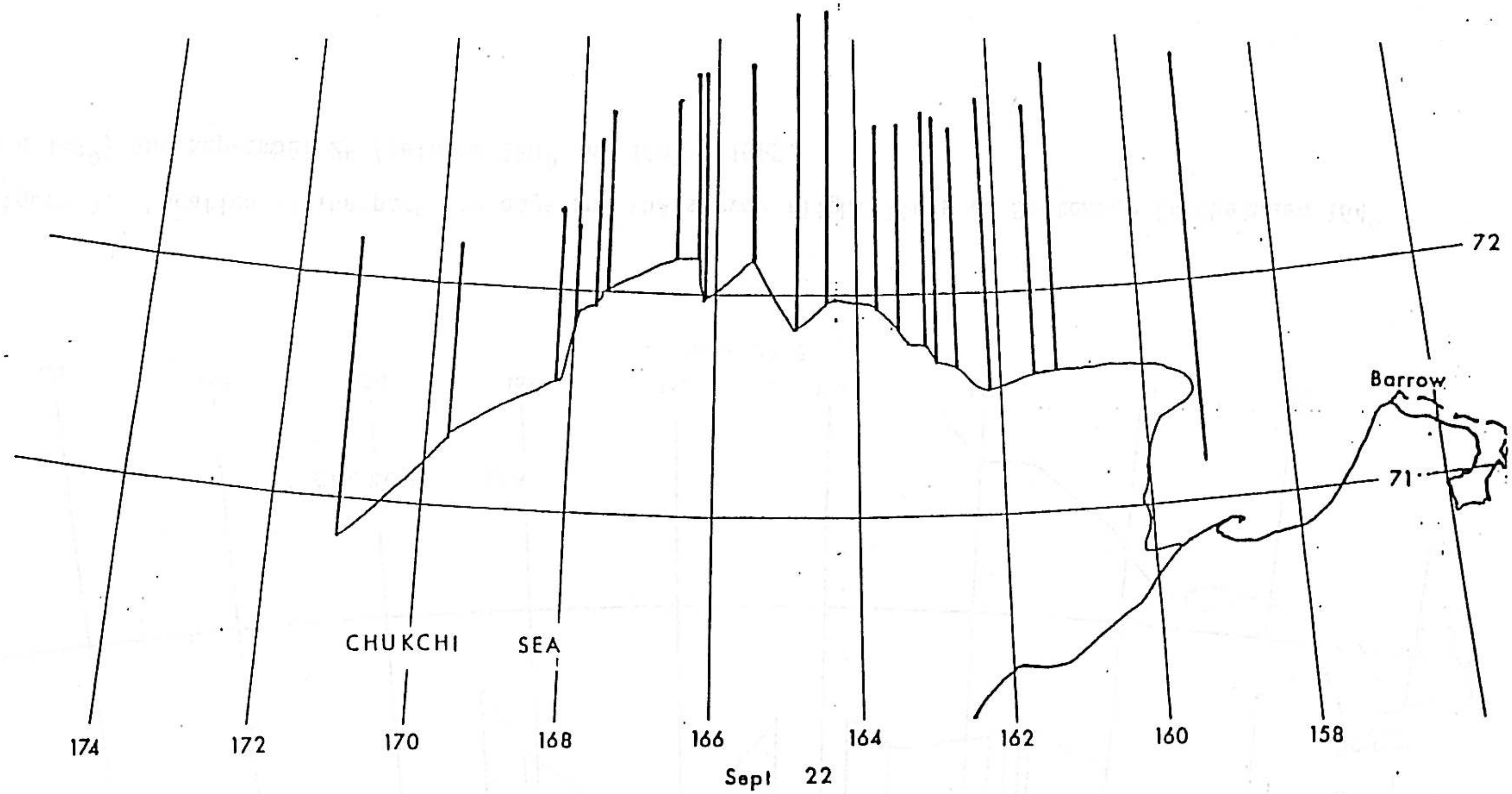


Figure 2. Location of the pack ice edge and the survey lines (heavy lines) on September 22, 1986.

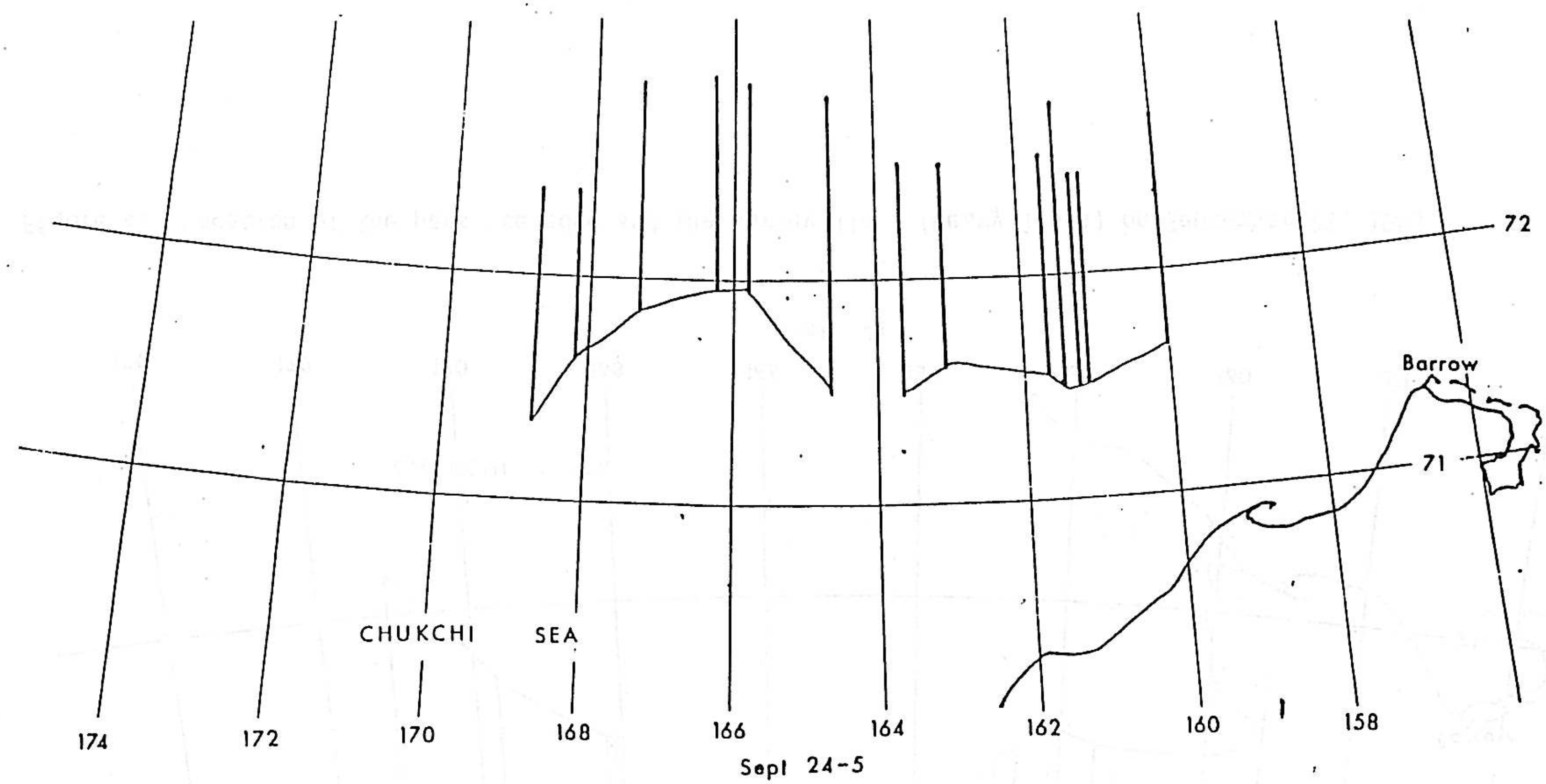


Figure 3. Location of the pack ice edge and the survey flight lines on September 24 (between 164^0 and 169^0) and September 25 (between 160^0 and 164^0), 1985.

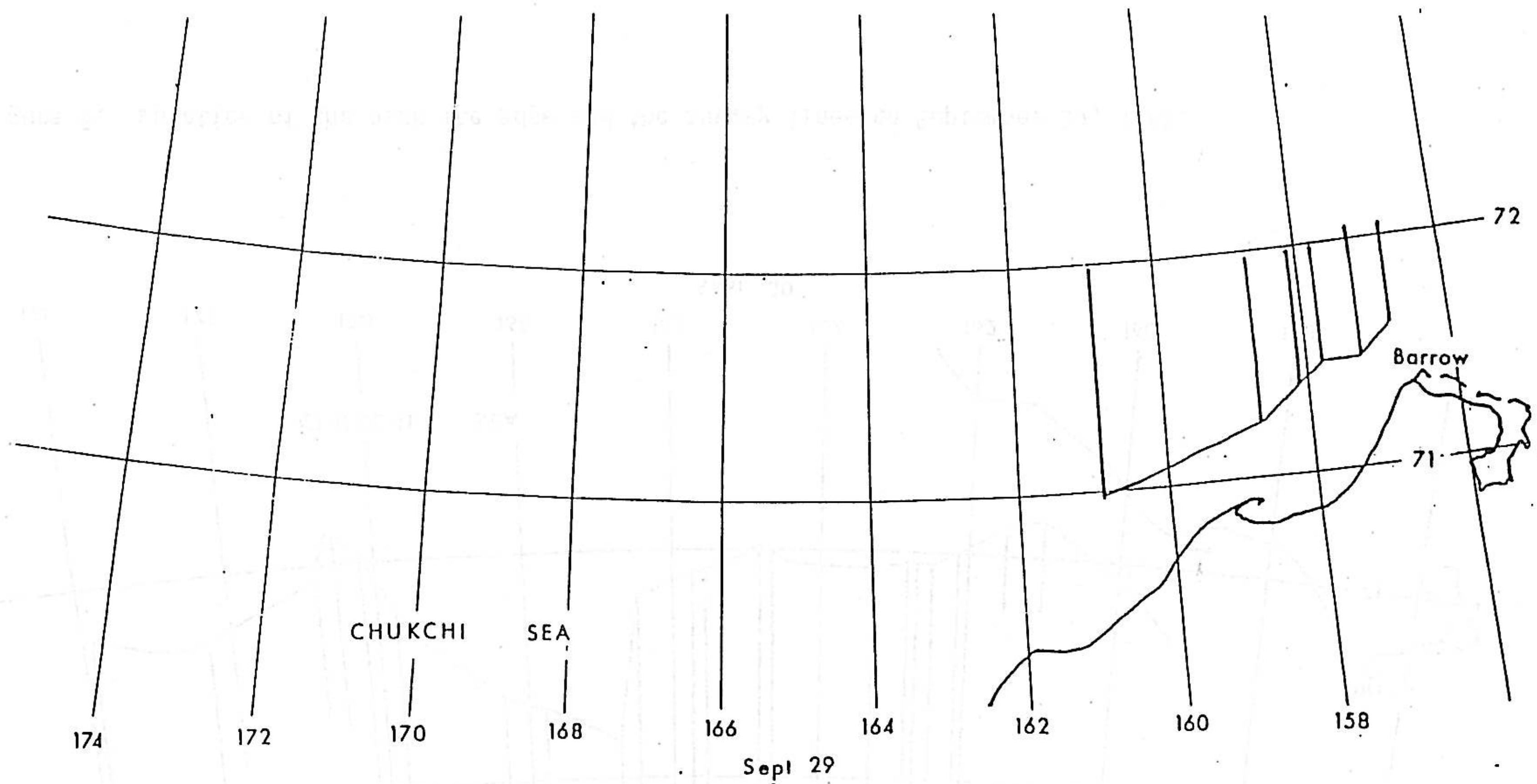


Figure 4. Location of the pack ice edge and the survey flight lines on September 29, 1986.

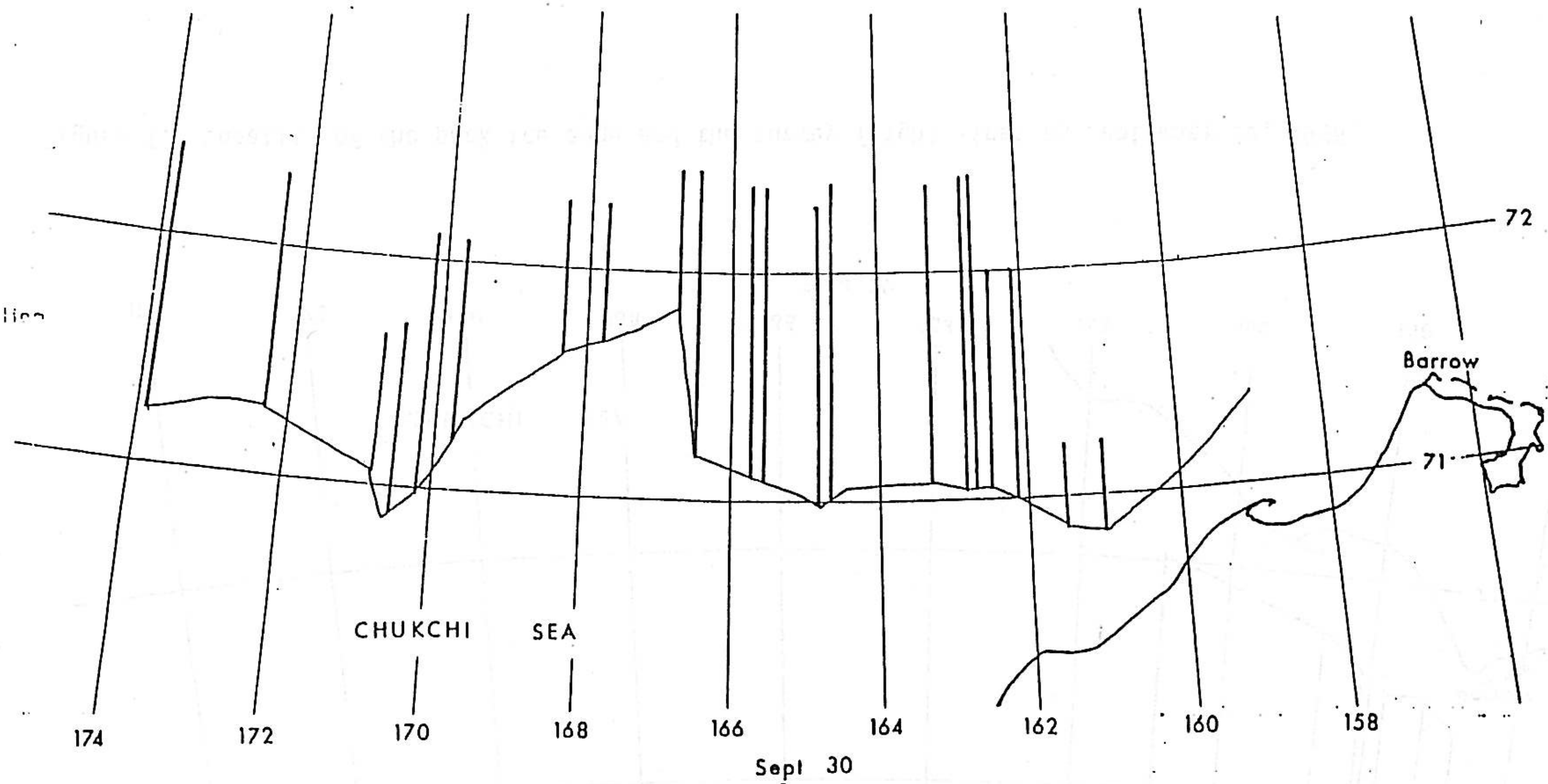


Figure 5. Location of the pack ice edge and the survey lines on September 30, 1986.

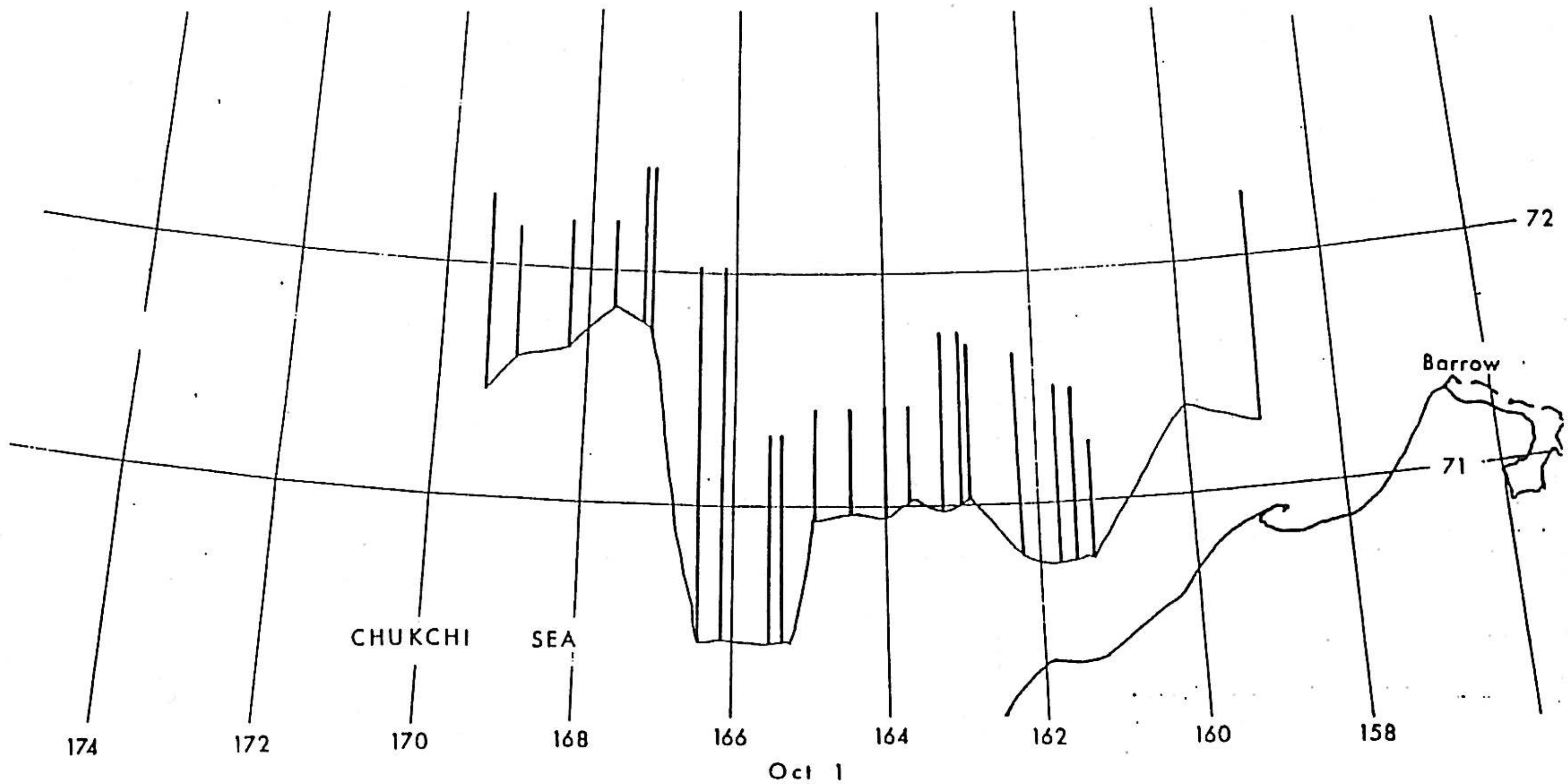


Figure 6. Location of the pack ice edge and the survey lines on October 1, 1986.