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036

Distribution, Abundance and Behaviour of White Whales in the MacKenzie Estuary

Canada

June 1986

Environmental Studies Revolving Funds
Report No. 036
June 1986

DISTRIBUTION, ABUNDANCE, AND BEHAVIOUR OF WHITE WHALES IN THE MACKENZIE ESTUARY

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The correct citation for this report is:

Norton, P. and L.A. Harwood. 1986. Distribution, abundance, and behaviour of white whales in the Mackenzie estuary. Environmental Studies Revolving Funds, Report No. 036. Ottawa. 73 p.

Published under the auspices
of the Environmental Studies
Revolving Funds
ISBN 0-920783-35-X

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ACKNOWLEDGEMENTS

This study was funded by the Environmental Studies Revolving Funds. We would like to thank Evan Birchard of Esso Resources Canada Ltd. for his support and involvement in the project and John Ward of Dome Petroleum Ltd. who, as interim Scientific Authority, provided much support and advice during the field program. Records of white whale sightings by industry and support personnel were provided by John Ward, Jim McComiskey (Gulf Canada Resources Inc.), and Ron Quaife (Esso). Ian Robertson provided the results of the 1983 white whale monitoring program for the review. We appreciated the useful observations and kind co-operation of other investigators conducting whale studies in the region: Tom Strong, Patt Weaver, and Dave Barber.

Gord Johnson, Ron Garton, Bob Allan, and Ross Peden of Kenn Borek Air Ltd. did an excellent job of arranging and maintaining the survey aircraft, and flying us where we wanted to go safely. Employees of the Atmospheric Environment Service (AES) in Inuvik and Tuktoyaktuk kindly provided daily weather reports and current ice information. We thank Randy Silkie of Esso Resources Canada Ltd. and Del Trobak of Dome Petroleum Ltd. for providing information on industry activities and local conditions. Richard Barnes and Wally Kowalzyk of the Department of Fisheries and Oceans (DFO), Inuvik, provided advice and support at needed times.

We thank Dr. Jim Gilbert of the University of Maine, John Ward of Dome and Tom Strong of DFO for their helpful comments on this report, Irene Sipila for word processing and preparation of the report, and Brian Sawyer for preparation of the figures.

SUMMARY

Reconnaissance aerial surveys were conducted along the fast-ice edge from Stokes Point to Baillie Islands to monitor white whale movement to the Mackenzie estuary. Once the estuary was accessible to whales, all available areas within the estuary were examined by systematic aerial surveys. Survey timing, coverage, and procedures were similar to those of previous programs for monitoring white whales; an attempt was made to survey all estuary sub-areas within a 30-h period. The field season extended from June 23 through July 25. Sightings of white whale neonates and information on social and feeding behaviours were extracted from data collected during previous programs, and the results from 1976 through 1985 were tabulated, mapped, and summarized.

The white whale migration to the estuary was well in progress by June 24. The estuary was not accessible to whales at that time, but 168 white whales were recorded at the westernmost end of the lead, north of Stokes Point. The west side of the estuary became accessible to whales on June 26, and by July 03, 5,841 whales were estimated in Niakunak Bay. Kugmallit Bay became accessible on July 06, but only from the west side between Richards Island and Pullen Island. Two white whales were observed in Kugmallit Bay during a ferrying flight on July 08. The peak estimate for Kugmallit Bay was 371 white whales on July 16. Areas within the estuary used by large numbers of whales in 1985 were similar to those in previous years.

The peak number of white whales using the Mackenzie estuary in 1985 was 6,938 ± 1,582 animals on July 15-16. This estimate has been corrected for unsampled portions of the sub-areas and animals missed (either beneath the surface or at the surface and not seen). Calculated correction factors for animals missed ranged from 1.80 to 3.83, depending on observation conditions. Whale "sightability" in estuary waters also varied with distance from the flight line. Because the results were based on few sightings and were, therefore, considered to be preliminary, no correction factor for "sightability" was applied.

Previous yearly peak estimates of white whales using the Mackenzie estuary were corrected for observation conditions, and a range of 3,100 (1981) to 11,000 (1982) animals per year was found. No trend of increasing or decreasing numbers was evident. In spite of variations in the number of sub-areas surveyed, the time of the survey

producing the peak estimate, the precision in defining the observation conditions, and, possibly, whale behaviour from year-to-year, the large discrepancies among some years suggest that variable numbers of white whales use the Mackenzie estuary from year-to-year.

The frequency with which splashing and gamming have been observed in the estuary suggests that this is an important area for white whales that are socializing. These commonly observed white whale behaviours have been seen almost exclusively within the estuary and have been most common during the period when large numbers were in the estuary. Mud trails were also commonly observed in the estuary and may indicate that white whales rub on the ocean floor to moult old skin. Some feeding behaviours have been seen in the estuary, but these sightings were more common along the coast near points of land and peaked later, in late August, when few whales were in the estuary.

The Mackenzie estuary does not appear to be important for calving. Many neonates have been observed along the ice edge prior to the opening of the estuary. Cow-neonate pairs may remain in the Beaufort Sea region longer than other segments of the population.

RESUME

Des relevés aériens de reconnaissance ont été effectués le long du bord de la glace stable de la Pointe Stokes jusqu'aux Isles Baillie en vue d'étudier le mouvement des bélugas. A la fois que l'estuaire devenait accessible aux bélugas, toutes les régions disponibles dans l'estuaire ont été examinées par des relevés aériens systématiques. Le temps, le couvert and les procédures du relevé étaient semblables aux ceux des programmes antérieurs d'étudier des bélugas; on a essayé de recenser toutes les régiones de l'estuaire sur une période de 30 heures. La saison de champ durait du 23 juin au 25 juillet. On a tiré des résultats des études antérieurs les données provenant des nombres de bélugas nouveaux-nés, des conduites sociales et des actions de nourrir; les données de 1976 à 1985 ont été disposées en tableaux, faites à la carte et résumées.

La migration des bélugas à l'estuaire était en cours pendant le 24 juin. L'estuaire n'était pas accessible aux bélugas à ce temps, mais on a enregistré 168 bélugas au bout ouest de la tête, au nord de la Pointe Stokes. La côte ouest de l'estuaire devenait accessible aux bélugas le 26 juin, et on a évalué 5841 bélugas à la Baie de Niakunak le 3 juillet. La Baie de Kugmallit devenait accessible le 6 juillet, mais seulement du côté ouest entre l'Isle Richards et l'Isle Pullen. Pendant un relevé aérien de reconnaissance le 8 juillet, deux bélugas furent observés à la Baie de Kugmallit. L'estimation du nombre maximum de bélugas à la Baie de Kugmallit est 371 le 16 juillet. Les régions de l'estuaire utilisées par les grands nombres de bélugas pendant 1985 étaient semblables à celles des années antérieures.

Le nombre maximum de bélugas qui utilisait l'estuaire de Mackenzie en 1985 était 6938 ± 1582 le 15-16 juillet. Ce chiffre estimatif a été corrigée pour les portions des sous-régions qui n'etaient pas échantillonées et pour les animaux qui ont été manqués (ou sous la surface ou à la surface et inapersus). Les facteurs correctifs pour les animaux manqués variaient de 1.80 à 3.83, dépendant des conditions d'observation. La capacité pour voir des bélugas variait aussi avec la distance de la ligne de vol. Parce que les résultats s'étaient basés sur l'observation de peu de bélugas et ont été considérés préliminaires, un facteur correctif n'a pas été appliqué pour la capacité pour voir.

Les estimations annuelles antérieures de la nombre de bélugas qui utilisait l'estuaire de Mackenzie ont été corrigées pour les conditions d'observation, alors la nombre d'animaux par année variait de 3100 (1981) à 11000 (1982). Aucune tendance d'augmentation ou de diminution a été observée. Malgré des variations en la nombre de sous-régions levées, le temps de l'estimation maximum, la précision des déscriptions des conditions d'observation et, peut-être, la conduite des bélugas d'un an a l'autre, la variation parmi quelques anneés suggèrent que des nombres variables de bélugas utilisent l'estuaire d'un an à l'autre.

La fréquence d'éclaboussage et de se groupage suggère que c'est une région importante pour les bélugas qui socaliser. Ces condiutes des bélugas ont été communément observées, mais presque seulement à l'estuaire, et elles ont étés plus evidentes pendant le temps qu'il était un nombre grand de bélugas à l'estuaire. On a aussi vu communément des traces de boue à l'estuaire et elles peuvent indiquer que les bélugas vivotent sur le fond de l'océan pour muer la peau vielle. Nourrissement a été vue à l'estuaire, mais elles étaient plus ordinaires au littoral près des pointes de terre, et elles arrivaient à un maximum plus tard, au fin du mois d'août, quand peu de bélugas étaient à l'estuaire.

Il ne semble pas que l'estuaire de Mackenzie est une région importante pour mise bas. On a vu quelques nouveaux-nés au bord de la glace avant l'ouverture de l'estuaire. Les paires mère nouveau-né peuvent rester à la région de la Mer de Beaufort plus longtemps que les autres segments de la population.

INTRODUCTION

Monitoring of white whales in the Mackenzie estuary was started in 1972; the 1985 program was the 13th in this program series. The design of the surveys and most of the survey lines were standardized in 1976, although the size of the study area was expanded in 1977. This monitoring program was in response to the initiation of exploration in marine areas by the oil and gas industry. Exploration continues, and now involves onshore, coastal, and offshore areas. Because the timing and location of broad-scale whale movements into, within, and out of the estuary have been well documented by annual studies (1972-1983), the white whale monitoring program was changed to a biannual program following the 1983 study year.

The Beaufort white whale stock, which winters in the Bering Sea, starts to move north in late March-early April, eventually reaching Point Barrow (Fraker et al. 1978). At this point, the whales turn east, following a system of leads far offshore to the Banks Island shelf-Amundsen Gulf area (Marko and Fraker 1981). The whales stay in this area until the latter half of June, when the migration to the Mackenzie estuary begins. Whales travel through a system of leads off the Tuktoyaktuk Peninsula to reach the estuary (see reports of previous white whale programs, such as Fraker and Fraker 1981; Norton Fraker 1983). If access to the estuary is blocked by a fast-ice barrier, the whales appear to travel to the western end of the lead and then to turn back to an area where warm river water flows out from under the ice barrier. The whales wait there until the ice barrier breaks and then move into the estuary. Large numbers of whales occur in specific locations within the estuary, termed concentration areas, until late July. However, some white whales are in offshore areas at the same time that large numbers are present in the estuary (Norton and Harwood 1985). During August, most white whales are in offshore areas or in Amundsen Gulf (Davis and Evans 1982). Few white whales remain in the Beaufort Sea region in September, but the timing and pathways of the fall migration are not well known.

In most years, white whales do not occupy areas coincident with industry activities until early July, because few industry activities start prior to ice break-up, and most initial activities are at support bases and staging areas which are close to land (i.e., near Herschel Island, Tuktoyaktuk, and McKinley Bay). In recent years, most vessels and aircraft have operated out of Tuktoyaktuk, with little activity in the west side of the Mackenzie estuary, Shallow Bay, and Niakunak Bay (Fig. 1). However, in 1985, Esso Resources Canada Limited and Chevron Canada Resources Limited were dredging southwest of Garry Island, in the Adgo and North Ellis areas respectively, (see Fig. 1). Work started in these areas during mid-July; onshore rigs were also operating in the area, at Taglu (Esso) and at Upluk (Chevron) (see Fig. 1).

During the late June-July period, drilling platforms in offshore locations were found at: Tarsiut (Molipaq/Beaudril); Akpak (Kulluk/Beaudril); Nipterk (Rig 3/Esso); and Amerk (Rig 7/Esso). The Gulf Beaufort (fuel storage ship) was temporarily located offshore during late June (see Fig. 1). Dome's drillships were moored in McKinley Bay until August.

The primary objectives of the 1985 program were to monitor the white whale migration to the Mackenzie estuary, to determine white whale distribution and abundance within the estuary, and to record any interactions between white whales and industry activities that might occur. Secondary objectives of this program were to determine appropriate correction factors to apply to the population estimate and to review white whale uses of the Mackenzie estuary and offshore areas from previous years' data. The white whale harvest within the Mackenzie estuary and white whale distribution in offshore areas during July were monitored by the Department of Fisheries and Oceans.[1]

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1 T. Strong, Western Region, pers. comm.

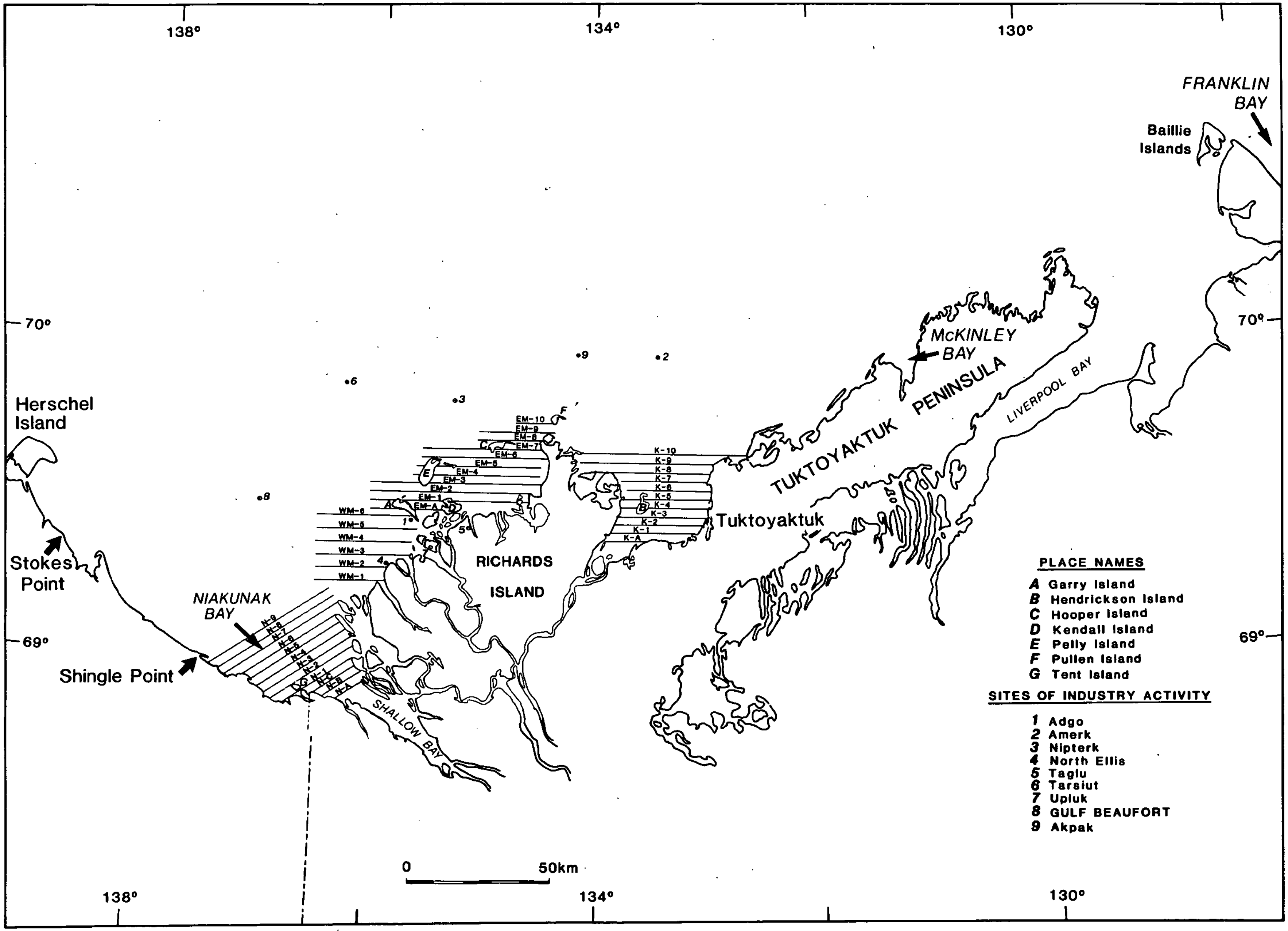

Figure 1. Place names, standard transect lines, and sights of industry activity, MacKenzie estuary, June–July 1985.

METHODS

The 1985 study area, survey timing, and survey procedures were similar to those in previous years. The white whale migration to the estuary was monitored during reconnaissance aerial surveys; whale distribution, abundance, and behaviour within the estuary was monitored during systematic aerial surveys. Information needed to calculate appropriate factors to correct for whales missed by observers was obtained by surveying one or two additional lines in the middle or at the end of each systematic survey. Data on white whale behaviour, neonate sightings, and association with seabirds were summarized from previous white whale monitoring programs and were supplemented with similar, accessible information on white whales collected during bowhead whale monitoring programs.

SURVEY AREA

Whale movement to the estuary was monitored in the system of leads that developed seaward of, and adjacent to, the fast-ice edge offshore of the Mackenzie estuary and the Tuktoyaktuk Peninsula, from Stokes Point to Baillie Islands. Although the specific area surveyed depends on the location of the leads, year-to-year variation is slight.

The Mackenzie estuary was divided into four sub-areas in each of which standard transect lines flown (see Fig. 1, and Appendix A): Niakunak Bay (N), West Mackenzie Bay (WM), East Mackenzie Bay (EM), and Kugmallit Bay (K). These sub-areas include all white whale concentration areas. Transect lines were spaced at 3.2-km intervals, except in West Mackenzie Bay, where the lines were 4.8 km apart. The transect width was 1.6 km, so coverage was about 50 per cent, except for West Mackenzie Bay, where it was 33 per cent. Using an inclinometer (at 305 m, an 800-m distance from the flight line = 21° drop from the horizon), strips of tape were placed on the windows to help observers confine their viewing to the transect area.

SURVEY TIMING AND PROGRESSION

The reconnaissance survey program started two days before the fast-ice barrier across the estuary broke.

Subsequent surveys were planned at four-day intervals from the start until either the migration was complete or whales had unlimited access to all of the estuary sub-areas. Each survey was begun in Shallow Bay or along the Yukon coast and proceeded eastward to Baillie Islands or as far as weather conditions or aircraft capabilities would allow.

The systematic survey program started seven days after whales first gained access to the estuary. An attempt was made to survey all accessible sub-areas within a 30-h period; after 48 h, a survey was terminated regardless of the area not surveyed. The sub-areas were always surveyed in the following order: Niakunak Bay, West Mackenzie Bay, East Mackenzie Bay, and then Kugmallit Bay.

SURVEY PROCEDURES

All surveys were conducted from a deHavilland DHC-6 (Twin Otter) aircraft chartered from Kenn Borek Air Ltd. in Inuvik, Northwest Territories. A pilot and at least two observers were present during each flight. A co-pilot was present during each systematic survey to provide relief for the pilot. A third observer, who boarded in Tuktoyaktuk, participated in three of the four reconnaissance flights as part of the whale hunter liaison program conducted by Tuk-Tuk Tours and Services for Esso, Dome, and Gulf. After each 3.5-4 h of surveying, a stop was made in Tuktoyaktuk or Shingle Point, so that the observers could rest and the plane could be re-fuelled.

A survey altitude of 305 m was planned for all flights, but was not always achieved. Altitude was checked using a radar altimeter. Survey altitude was approximately 305 m for 84.2 per cent of the time spent surveying during reconnaissance flights and for 91.4 per cent of the time spent surveying during systematic flights. Survey altitude was 367 m for the remainder of the reconnaissance survey time. Low-lying cloud and fog necessitated a survey altitude of 152 m for the remainder of the systematic survey time. Changes in survey altitude did not alter the transect width. Planned ground speed was 193 km/h during all survey flights and 278 km/h while ferrying. However, because of the effects of wind, mean ground speed during survey flights was 188.1 km/h, and ranged from 144.7 to 240.8 km/h.

The left observer occupied the same seat during all flights, namely the left window seat in the second row of passenger seats. The right observer occupied the co-pilot's seat during reconnaissance flights, the right window seat in the second row of passenger seats during all systematic flights, and the last window seat on the left side during lines flown specifically to obtain information to calculate a correction factor for whales missed by observers. All of the observation posts were equipped with bubble windows, with the exception of the co-pilot's seat; bubble windows eliminate the usual blind spot beneath the aircraft.

Communication between observers and between observers and pilots was maintained using an intercom system. Communication was maintained at regular intervals with other whale researchers in the area, both in the air and on the ground.

All data on whale sightings, habitat, observation conditions, and survey locations were recorded immediately onto audio tapes, which were transcribed between surveys. Tapes were not re-used during the field season, and they are stored at PN Research Projects, Sidney, British Columbia.

At the start and end of each survey line, time (± 1 s), observation conditions, radar altimeter reading, ice type, and ice cover were recorded by both observers. Any changes in observation conditions, habitat, or altitude along the transect line were recorded.

Data recorded regularly on observation conditions included: amount and direction of glare, per cent or relative reduction in visibility resulting from cloud or fog, relative amount of precipitation, and sea state according to the Beaufort Scale of Wind Force. In addition, a relative rating of observation conditions (excellent, good, fair, poor) was assigned according to standards used in previous white whale monitoring programs. Ice was classified as first-year or multi-year on the basis of colour, surface regularity, drainage pattern, and type and extent of ridging. World Meteorological Organization (1970) ice cover categories were used: ice-free (0/10 cover), open water (<1/10 cover), very open pack-ice (1-3/10 cover), open pack-ice (4-6/10 cover), close pack-ice (7-8/10 cover), and very close pack-ice (9-9+/10 cover). The ice information recorded by observers was modified and expanded using information obtained from the Atmospheric Environment Service offices in Inuvik and Tuktoyaktuk. A water colour rating was determined by the left observer using a standardized six-point colour chart. Marine mammal sightings made both during surveys and when ferrying to and from surveys were recorded.

The information noted for each white whale sighting included:

- time of sighting (= sighting location);
- on or off transect;
- species;
- number of whales seen and number of whales per group;
- age subclass (adult, sub-adult, yearling, neonate or calf);
- direction of movement (compass points);
- relative rate of movement;
- position in water (in clear water only);
- whale behaviour;
- presence and behaviour of sea birds; and
- habitat characteristics, including mud trails.

Whales within five whale lengths of each other or within about 100 m and engaged in the same apparent activity were considered a "group".

Age subclasses were assigned according to Brodie (1971):

adult:	any "white" whale;
sub-adult:	a "grey" whale greater than two-thirds the length of an adult;
yearling:	a "grey" whale greater than one-half but less than two-thirds the length of an adult;
neonate:	a "grey" or dark brown whale less than one-half the length of an adult; and
calf:	a "grey" whale for which a relative length could not be determined.

Sightings in muddy waters were often so brief and so little of the animal was exposed that colour shades and relative length could not always be determined. Most sightings consisted of a flash of white, and these animals were assumed to be adults unless there was evidence to the contrary.

The following whale behaviours were recorded: type of dive, splashing, spy-hopping, gamming, and orientation of animals in a group. Dives were categorized according to the part of the body seen: blowhole only, blowhole and back, and head to tail. Splashing behaviours, defined by Fraker and Fraker (1981), include: tail lobbing, head slapping, and breaching. When spy-hopping, the whale is in a vertical position and raises at least its head out of the water. Gamming has been defined as a group of whales remaining almost motionless at the surface, sometimes in a recognizable pattern such as a rosette (Fraker et al. 1979). Orientation of animals in a group was recorded if the whales' positions remained fixed relative to one another.

During each systematic survey, and generally within each sub-area, one, two, or three additional transect lines were surveyed solely for the purpose of collecting data on the number of whales missed by observers (one or two lines) and on lateral distance of sightings from flight line (one line only when included). The additional lines surveyed were representative of the observation conditions that day and were selected on the basis of the white whale distribution observed during the regular survey. Procedures for the additional lines were the same as those for the regular systematic survey, except for the noted difference in seat position (right observer only) and the collection of information on distance of each sighting from the flight line. On lines with an observer on both the right and left sides, the deviation of the sighting from the horizontal (in degrees) was recorded, using Suunto PM-5/360S inclinometers, when the animal's location was directly opposite the observer. Using this information and the altitude of the plane, the distance from the flight line (in metres) was calculated. On lines with both observers on the left, only the relative distance from the flight line (inner third of transect, middle third, outer third, off transect) was determined.

During one ferrying flight at surveying speed, both observers measured the length of time (in seconds) specific stationary objects stayed in focus using normal surveying procedures. Several objects at different relative locations from the flight path were timed.

REVIEW PROCEDURES

The review included all data collected during previous white whale monitoring programs, starting in 1976; data from programs prior to 1976 were not available. Available data collected during bowhead monitoring programs were scanned for information on white whales; the inclusion of these data expanded the time period and geographic scope of the review.

For compilation and mapping purposes, the open-water season was divided into bi-monthly intervals from the second half of June to the first half of September. No systematic surveys for whales were made outside this time frame. Some programs included in the review involved surveys extending northward to the 7-9/10 ice edge or the 100-m isobath, from the Alaska-Yukon border to Franklin Bay. North-south transect lines, spaced at 20- or 32-km intervals, were flown and a 2.0- or 1.6-km transect width was used. Coverage ranged from about 5 to 10 per cent. Readers should refer to the original reports for more details of the study areas (Harwood and Ford 1983; Harwood and Borstad 1985; Norton and Harwood 1985). Geographic sub-areas outside the 1985 study area were identified, and the total number of surveys that included at least some of a sub-area were determined for each time interval.

The data were scanned for sightings of:

- neonates;
- splashing;
- gamming;
- spy-hopping;
- association with seabirds;
- mud trails; and
- darting.

Each sighting was tabulated and mapped by type of sighting and time interval. Information on sightings of calves, yearlings, sub-adults, and specific types of splashing behaviours was not extracted. The total number of white whales seen on transect during reconnaissance and systematic surveys during each time interval was tabulated.

DATA ANALYSIS

White whale sightings made during the 1985 reconnaissance and systematic surveys were mapped using 15-s time intervals. This procedure was used in previous white whale monitoring programs.

The size of each sub-area was measured using a 1:500,000 Mercator projection map. The sub-area boundaries were either land or 1.6 km from the first or last line surveyed. Island areas were subtracted from the total. Because the number of lines surveyed within a sub-area varied from survey to survey, the size of the study area varied (see Appendix B). The length of each transect line in a sub-area was measured (in kilometres) using the 1:500,000 map, and the line lengths were multiplied by the transect width (1.6 km) to determine the surveyed area. The surveyed area and per cent coverage also varied from survey to survey (see Appendix B).

Uncorrected densities were calculated for each sub-area using equation 1:

$$\text{density of sub-area} = \frac{\Sigma y_i}{\Sigma a_i} \qquad (1)$$

where: y_i = number of animals seen on line i;
a_i = area of transect line i;
i = 1 to n; and
n = number of transects surveyed.

The uncorrected estimate of the number of whales in each sub-area was calculated by multiplying the sub-area density (whales per square kilometre) by the size of the sub-area (square kilometres). The variance of each estimate was calculated using equation 2 (from Cochran 1977):

$$V_y = \frac{L\ (A - n\bar{a})A}{n\bar{a}} \qquad (2)$$

where: V_y = variance of sub-area population estimate;
A = total area of the sub-area;
n = number of lines flown in sub-area;
$\bar{a}$ = average area of transect lines flown in sub-area; and

$$L = \frac{\Sigma(y_i^2 \div a_i) - D\Sigma y_i}{n - 1}$$

where: $D = \dfrac{\bar{y}}{\bar{a}}$.

The uncorrected estimate for the number of whales in the entire estuary was calculated by summing the sub-area estimates. The standard error of the uncorrected estimate was found by taking the square root of the sum of the sub-area variances. The number of degrees of freedom of the uncorrected estimate was the sum of $(n_h - 1)$ over all sub-areas, where h = 1 to m and m = the number of sub-areas surveyed.

The proportion of whales seen by each observer was calculated by comparing the number of different groups seen by both observers to the number of different groups seen by either one or the other observer on lines when both observers were viewing the same area (i.e., both were on the left side). The proportion missed by an observer was calculated by subtracting the proportion seen from unity. Duplicate sightings were determined on the basis of time of sighting, number of whales in group, relative location across transect width, and, occasionally, behaviour. If two sightings were made within one or two seconds of one another, were of the same number of whales, and were in the same third of the transect, they were assumed to be duplicates. Some sightings met one or two but not all three criteria; these sightings were identified as "possible duplicates".

The derivation of the formula used to calculate the proportion of whales seen by an observer is as follows:

p = proportion of whales seen by one observer;
$1-p$ = proportion of whales missed by one observer;
p^2 = proportion of whales seen by both observers (duplicates);
$(1-p)^2$ = proportion of whales missed by both observers; and therefore,
$1-p^2-p^2+2p-1$ or
$-2p^2+2p$ = proportion of whales seen by just one observer.

Data from lines with both observers on the left were used to solve the ratio of the proportion of whales seen by both observers (p^2) to the proportion seen by just one observer ($-2p^2+2p$) for p. This procedure for calculating p assumes that equal numbers of whales were seen by both observers.

A correction factor for whales missed by an observer was given by 1/p. Two correction factors were calculated for each sub-area survey, one assuming that all of the possible duplicates were actual duplicates, and the other assuming that all of the possible duplicates were non-duplicates. A mean correction factor, calculated for each set of surveys, was multiplied by the uncorrected population estimate to get the corrected population estimate.

Because the data used to calculate the uncorrected population estimate were independent of those used to obtain the correction factor, the variance of the corrected population estimate were calculated using equation 3 (from Goodman 1960):

$$V_{cy} = C^2V_y + Y^2V_c - V_yV_c \qquad (3)$$

where: V_{cy} = variance of corrected population estimate;
C = correction factor;
V_y = variance of uncorrected population estimate;
Y = uncorrected population estimate; and
V_c = variance of correction factor.

The corrected standard error was obtained by taking the square root of the corrected variance. Approximate 95-per cent confidence limits were calculated by taking the corrected population estimate plus, and then minus, the corrected standard error times Student's t-statistic for the effective degrees of freedom of the uncorrected population estimate.

The degree of correlation between the correction factors and the observation conditions was examined using the Spearman rank coefficient test (Steel and Torrie 1960).

The relative frequency of sightings of particular white whale behaviours and of neonates was calculated by dividing the number of sightings made during a time interval by the total number of whales ($\times 10^3$) seen on transect during the same interval. Number of sightings was used rather than the number of whales exhibiting a particular behaviour because often the number of whales was not specified. Presence or absence was all that was indicated.

WHITE WHALE SIGHTINGS BY INDUSTRY PERSONNEL

Information on white whales sighted by industry and support personnel in the southeast Beaufort Sea region from June to October 1985 was provided by Dome, Chevron, Esso, and Gulf.

Environmental observers stationed on drillships operated by, or on behalf of, Dome and Gulf recorded wildlife sightings during 10- or 15-min observation periods, once every 3 h if possible. Sightings made by the observers during periods other than the designated watch periods and by other industry personnel on drillships and support vessels were included. Esso and Chevron did not have a formal scheme for recording wildlife observations in 1985. However, some incidental sightings were recorded by personnel on vessels operated by, or on behalf of, these companies.

RESULTS

Only white whale sightings are discussed in the remainder of this report. Seal and bowhead whale sightings recorded during the reconnaissance and systematic aerial surveys are provided in Appendix C.

WHITE WHALE DISTRIBUTION AND ABUNDANCE, 1985

Ice Conditions and Movement to the Estuary

Cracks and leads formed in the transition zone ice off the Tuktoyaktuk Peninsula and Mackenzie estuary earlier in 1985 than in most years.[1] By mid-June, there was a large area of open water north of the fast ice off the estuary, and it appeared that break-up was imminent. However, at that time, the predominant wind direction changed to northerly and temperatures fell. Pan ice moved south and leads between the pans froze over.

On June 24, when the first reconnaissance survey was flown, the lead north of the Tuktoyaktuk Peninsula was 4.0-6.5 km wide (Fig. 2). No lead was apparent within much of the area north of Kugmallit Bay and off the eastern half of Richards Island, but a broad expanse of open water was found seaward of the fast ice off the west side of the estuary. A total of 502 white whales was seen during this survey (see Fig. 2). About one-third of the animals were seen in the westernmost section of the lead, north of Stokes Point. Most animals for which directional movement was evident were moving toward the narrowest point in the fast ice, 60 km north-northeast of Shingle Point. The ice barrier broke at this point on June 26.

The extent of open water continued to decline, and by the second reconnaissance flight (June 28), no lead was apparent in much of the area (Fig. 3). Six white whales were observed entering the estuary. An additional 165 whales (171 in total) were seen, most of which were moving toward the break in the ice.

The extent of open water off the west side of the estuary increased between the second and third (July 04)

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1 E. Hudson, Atmospheric Environment Service, pers. comm.

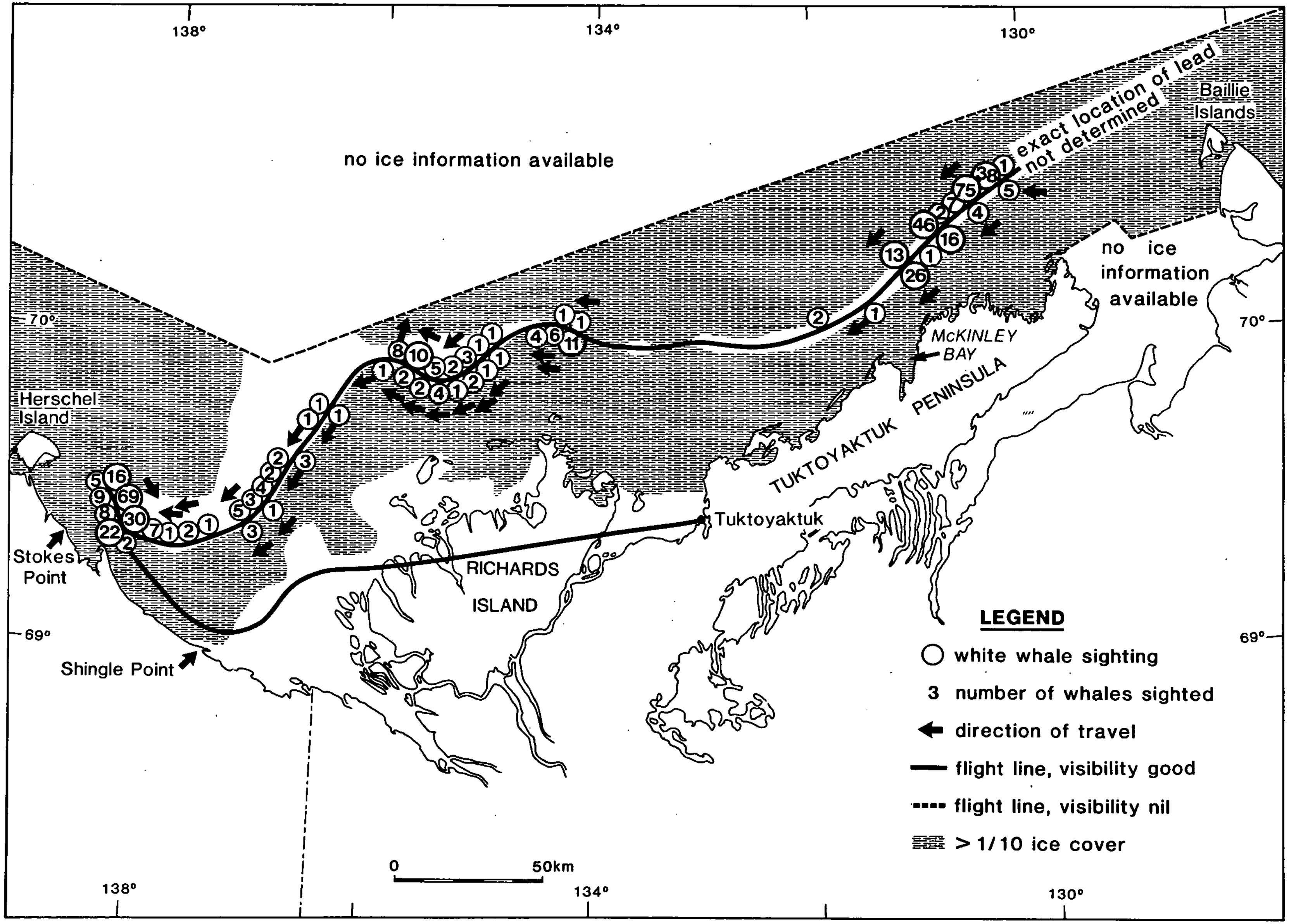

Figure 2. Ice reconnaissance survey, 1985 June 24.

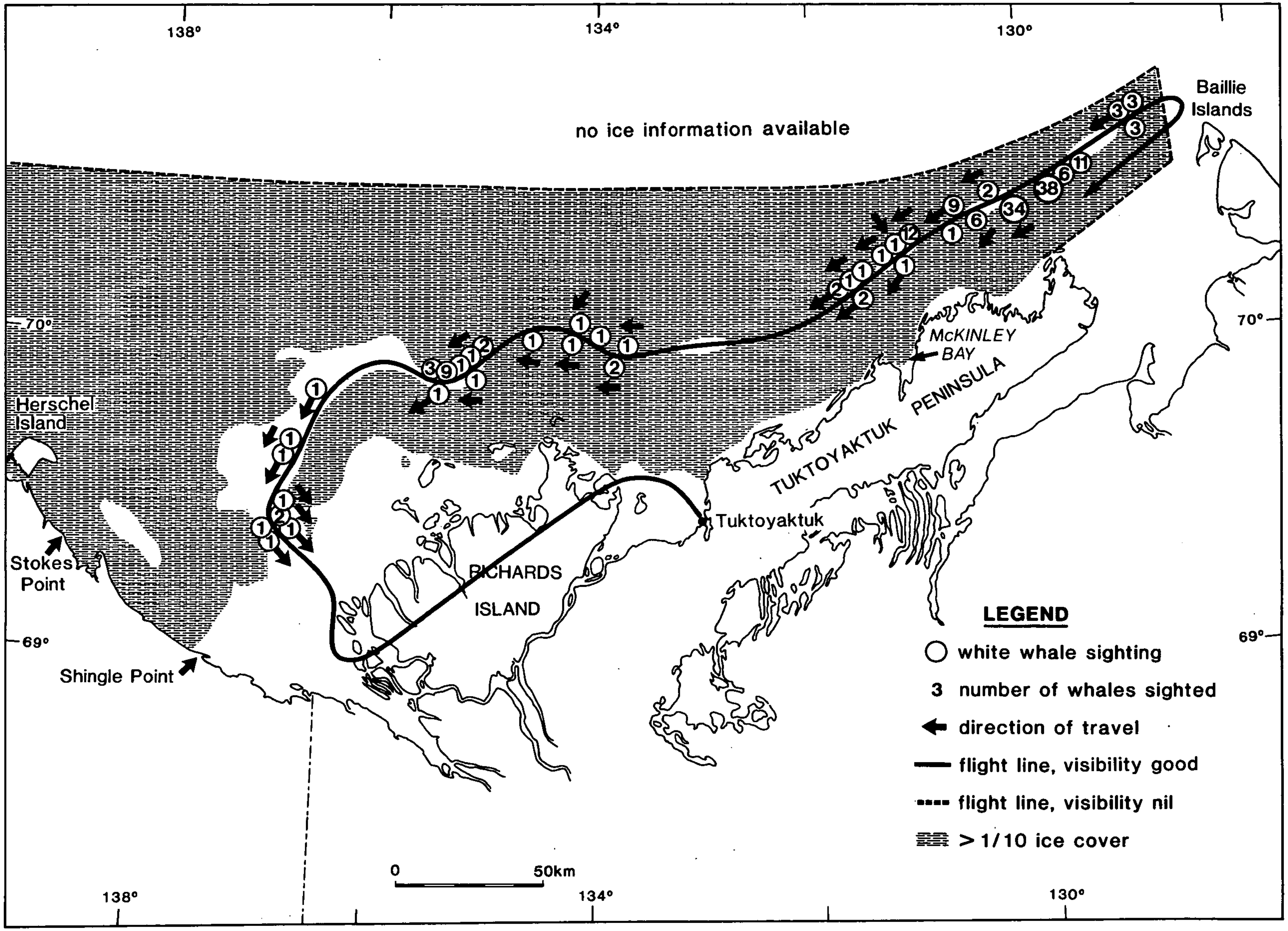

Figure 3. Ice reconnaissance survey, 1985 June 28.

reconnaissance flights, and the lead opened north of portions of the fast-ice zone off the Tuktoyaktuk Peninsula and Richards Island. However, there were still areas with no apparent lead (Fig. 4). A total of eight white whales were seen, two south of the fast ice in East Mackenzie Bay.

The east side of the estuary (Kugmallit Bay) was not accessible to whales until July 06, when open water developed between Richards Island and Pullen Island. At that time, there was ice in all other northern areas of the Bay. This ice barrier did not deteriorate until the last week in July. The close pack-ice off the Tuktoyaktuk Peninsula deteriorated between August 06 and August 08.

A fourth and final reconnaissance flight was made on July 24 through Liverpool Bay, around Baillie Islands, through Franklin Bay and farther east. Much of the southern portion of Franklin Bay was ice-covered. A total of 119 white whales was observed; 104 of these (including nine neonates and two calves) were in Franklin Bay. Fourteen white whales (including one neonate) were recorded east of Franklin Bay and one adult was seen in Liverpool Bay.

Distribution and Movements Within the Estuary

White whale distribution within the estuary was monitored during systematic surveys. The extent of area available to whales that was surveyed and the length of time between surveys varied from survey to survey, primarily as the result of weather and ice conditions. The first systematic survey was on July 03, and included only the Niakunak Bay sub-area. The extent of area unsurveyed but available to whales in West Mackenzie Bay and East Mackenzie Bay is not known; these areas were not surveyed because a higher priority was given to doing a reconnaissance survey on July 04. Kugmallit Bay was not yet accessible to the whales. Whales were recorded on every line in Niakunak Bay, except N-A, and distribution was relatively uniform throughout most of the bay (Fig. 5). Whales were observed close to sites traditionally used as whaling camps.

The second systematic survey started four days later and extended over 47 h, ending on July 09. All four sub-areas were surveyed, although one line in West Mackenzie Bay and two lines in East Mackenzie Bay with extensive ice-free areas were not included (Fig. 6). Whales were recorded on every line in Niakunak Bay, but the largest concentrations were in the southeast portion of the survey area (see Fig. 6). Smaller concentrations were observed

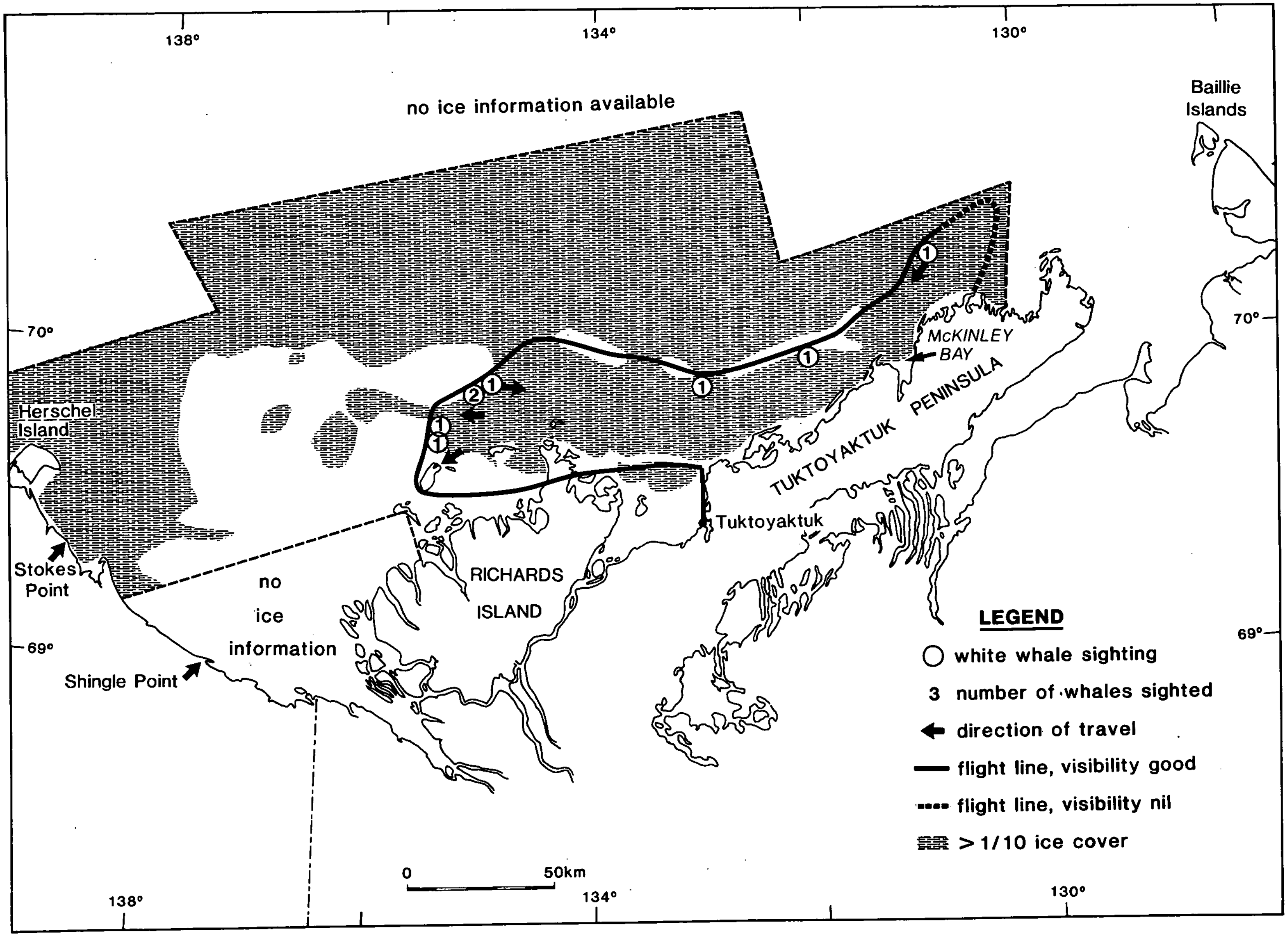

Figure 4. Ice reconnaissance survey, 1985 July 04.

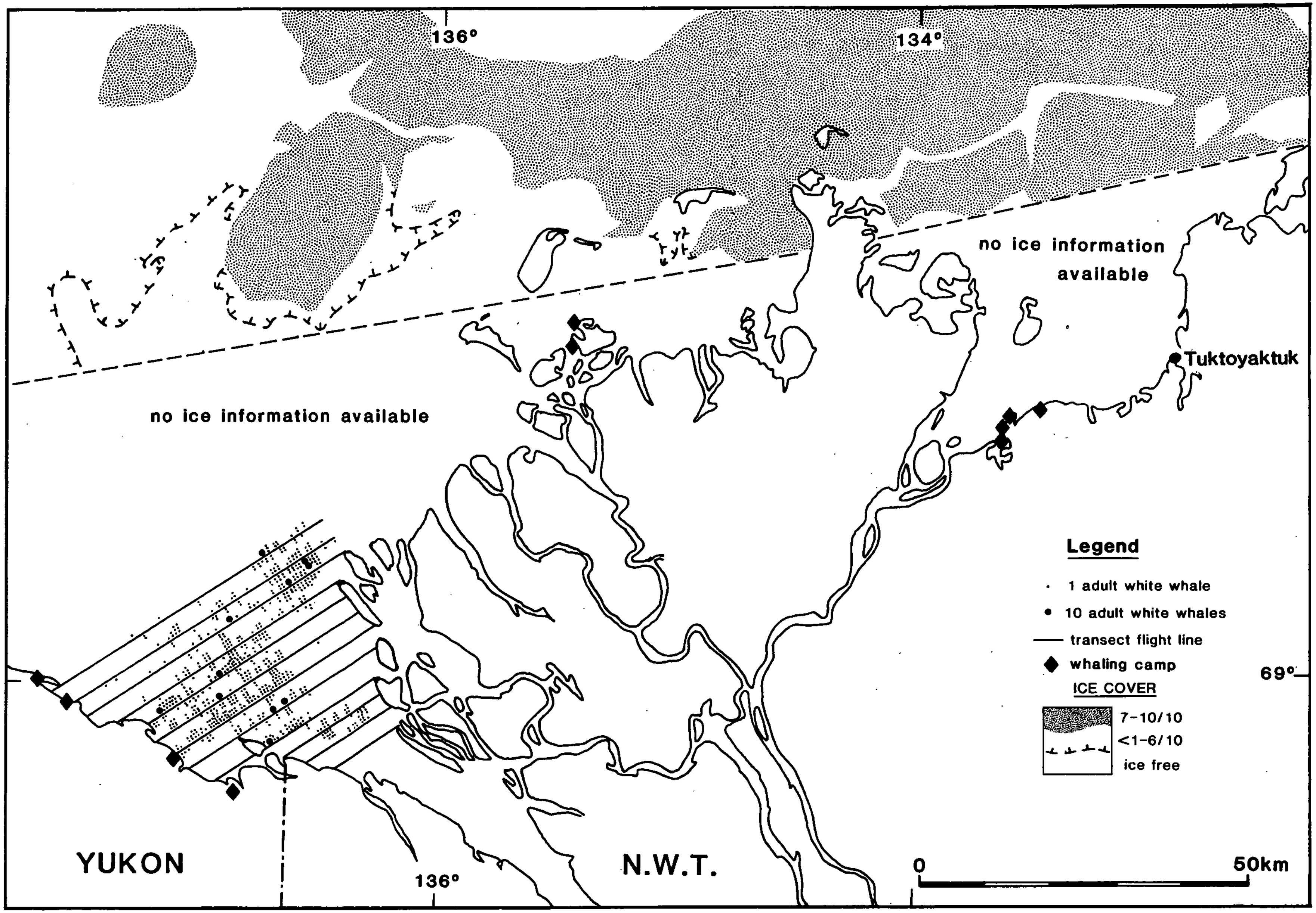

Figure 5. Observed distribution of white whales, MacKenzie estuary, 1985 July 03.

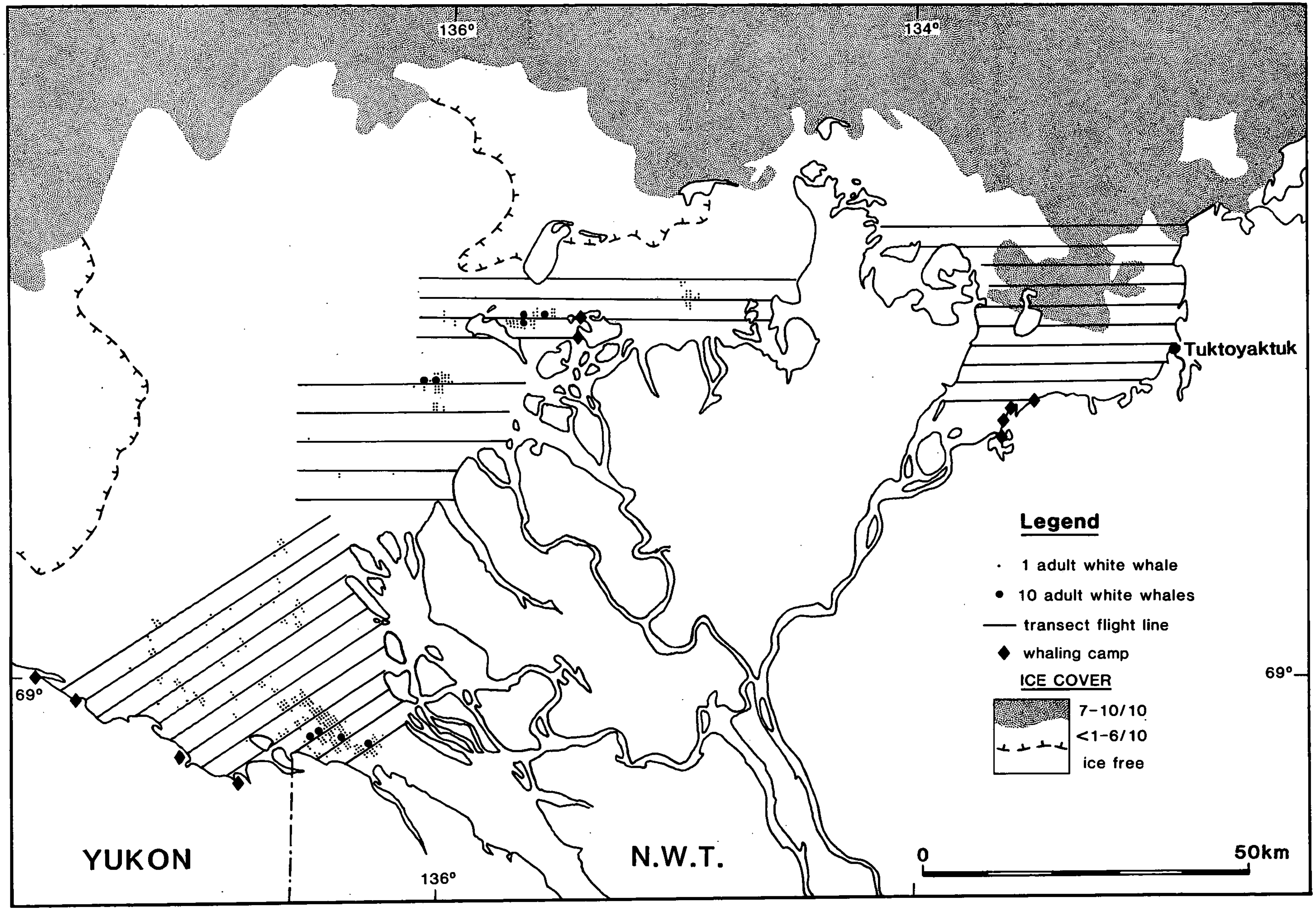

Figure 6. Observed distribution of white whales, MacKenzie estuary, 1985 July 07–09.

southwest of Garry Island and between Garry Island and Kendall Island. Although Kugmallit Bay was accessible to whales, none were recorded there during the systematic survey. Two white whales were observed south of Hendrickson Island during a ferrying flight on July 08.

The third systematic survey started on July 15 and extended over a 29-h period. All ice-free areas within all sub-areas were surveyed. An apparent increase in the number of whales observed suggested that whales had moved into the study area between the second and third systematic surveys. Whale distribution within the estuary was clumped (Fig. 7); concentrations of whales were observed on the southeast side and in the centre of Niakunak Bay, southwest of Garry Island, between Garry Island and Pelly Island, and south of Hendrickson Island. Small groups were seen throughout most of the estuary, but only a few animals were in areas with ice (see Fig. 7). No whales were observed in the vicinity of the whaling camps near Tent Island or along the Yukon coast.

The last systematic survey started at 1600 on July 22 and was completed within 27 h. All sub-areas were surveyed, with the exception of a small, ice-free area at the north end of Kugmallit Bay. Most surveyed areas were ice-free. Whale distribution was generally less clumped than that observed during the third survey, except in Niakunak Bay (Fig. 8). Whales were observed in deep water (>2 m) areas in West Mackenzie Bay.

Abundance Within the Estuary

Although whale densities varied from sub-area to sub-area and from survey to survey, densities were consistently higher in Niakunak Bay than in the other sub-areas (Table 1). Whale density in Niakunak Bay peaked during the first survey, declined by more than 50 per cent during the second survey, increased during the third survey, and then declined again during the fourth survey. The trends observed in West Mackenzie Bay and Kugmallit Bay were similar to those in Niakunak Bay for the second to fourth survey. Whale density in East Mackenzie Bay remained relatively constant throughout the survey period (see Table 1).

Correction factors. The strip transect method used in this study assumes equal "sightability" of whales across the width of the transect strip. To test if this assumption was met, information on distance from flight line was recorded

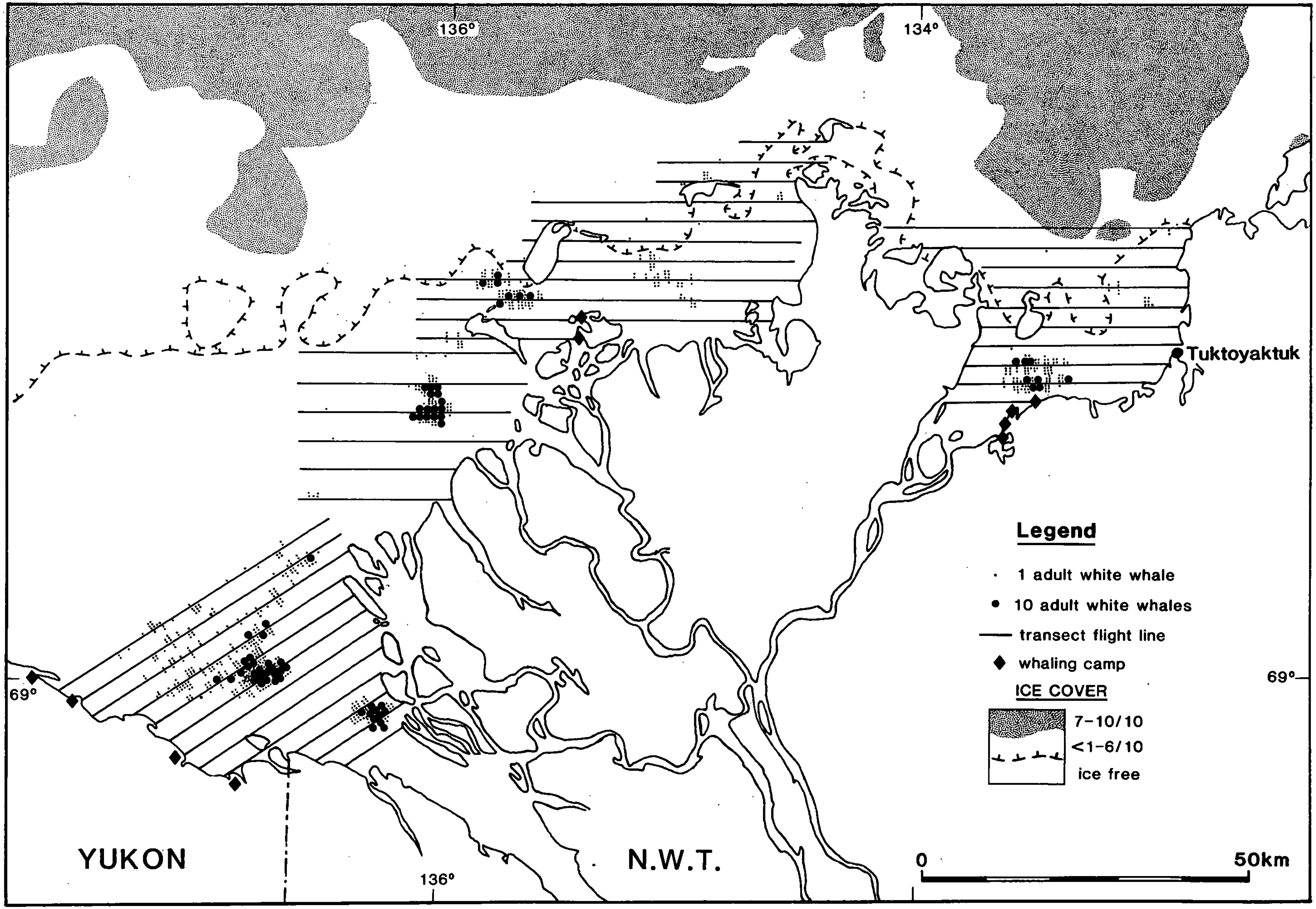

Figure 7. Observed distribution of white whales, MacKenzie estuary, 1985 July 15-16.

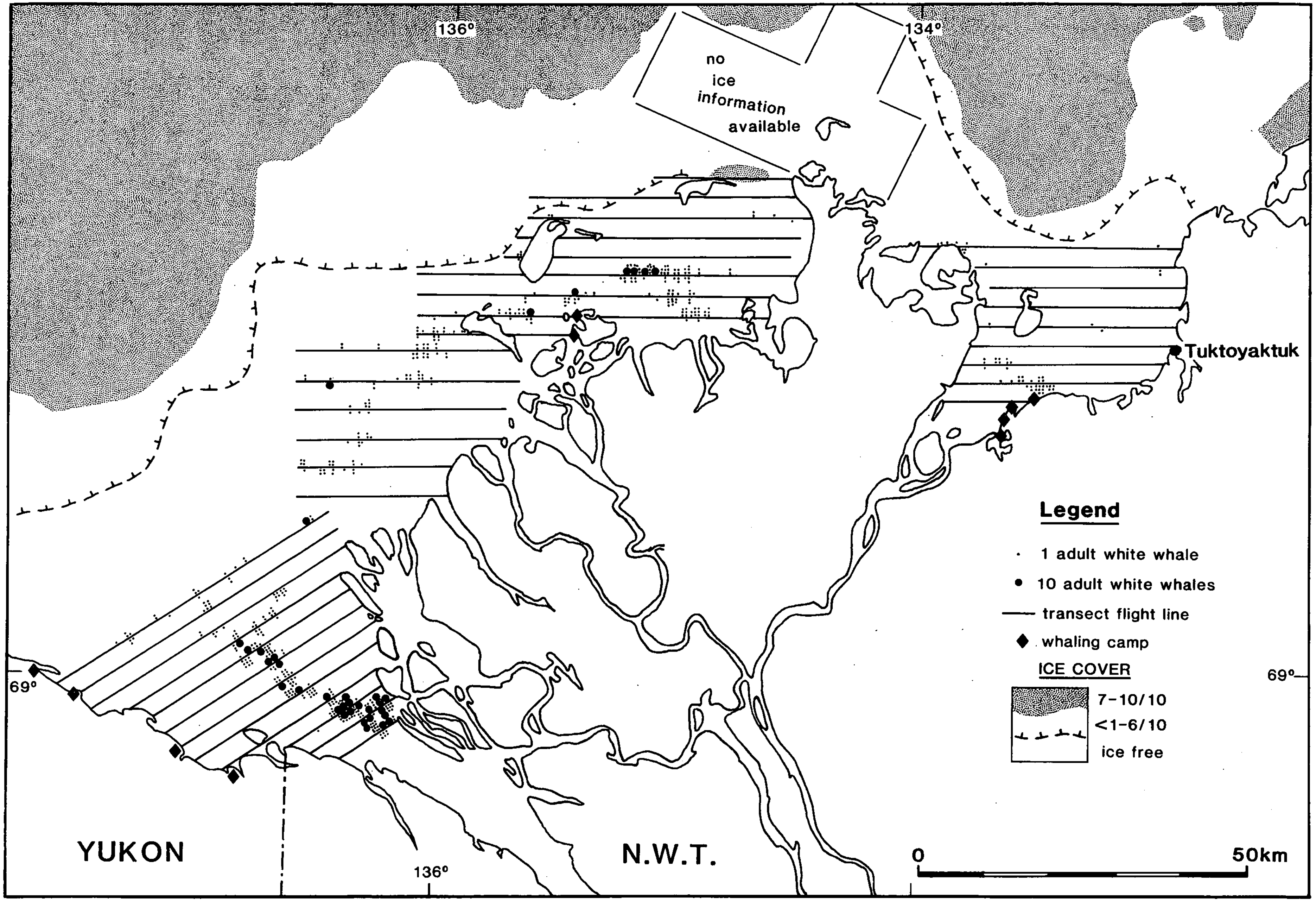

Figure 8. Observed distribution of white whales, MacKenzie estuary, 1985 July 22-23.

TABLE 1

Estimates of white whale densities during July 1985 systematic surveys by sub-area

Sub-area	Survey period July 03	July 07-09	July 15-16	July 22-23
Niakunak Bay	1.227[a]	0.450	1.144	0.804
West Mackenzie Bay	NS[b]	0.235	0.704	0.302
East Mackenzie Bay	NS	0.269	0.313	0.332
Kugmallit Bay	NS	0.0	0.377	0.128

[a]Densities shown are whales/km^2.

[b]NS = not surveyed.

for a total of 189 sightings made at the survey altitude (305 m). Of these sightings 154 (81.5 per cent) were of individuals, not groups. (Although distance from flight line was recorded when the plane altitude was 152 m, these data were not analysed because only 14 sightings were made.) The peak in the number of sightings was at the 301- to 400-m interval (Fig. 9). There was a large decline at the 601- to 700-m interval.

A model was constructed in an attempt to understand the relationship between number of sightings and distance from flight line. The frequency with which white whales will be seen within a given interval along the transect width depends upon the ease and speed with which white whales can be differentiated from white caps or ice, and the length of time the area is in view; the latter depends upon the forward motion of the plane and the apparent size of the area. The detectability of white whales across the 800-m transect width is probably fairly uniform, unless there are many white caps or small pieces of ice, or both, present. Because of the forward motion of the plane, the length of time a given 100-m interval was in view varied from 3-4 s for the 1- to 100-m interval to 10-11 s for the 701- to 800-m interval. For this model, time in view because of forward motion was assumed to increase 1 s/100-m interval, starting with 3 s. Apparent size of a given interval was measured by number of degrees between the inner and outer edge of that interval as measured by the inclinometer (e.g., 201 m ≐ 55 and 300 m = 44, so relative size of 201- to 300-m interval is 11 degrees). The theoretical frequency of number of white whale sightings per interval was obtained by multiplying the time in view because of the forward motion by the relative size. The expected frequency distribution peaks at 101- to 200-m and shows a sharp decline at 600 m (Fig. 10).

The model predicted the observed initial drop and the decline at the 601- to 700-m interval. However, more sightings than expected were made within the 201- to 300-m and 301- to 400-m intervals. An inherent assumption in the strip transect method is that the search pattern will be evenly distributed across the apparent area and no one area will be favoured. The observed results may indicate that observers concentrate relatively more effort within the mid-transect area than at the outer edges of the transect.

Although the results strongly suggest that sightings are not equally distributed across the transect width, no correction for effective transect width was made because the data are considered preliminary. There have been no similar

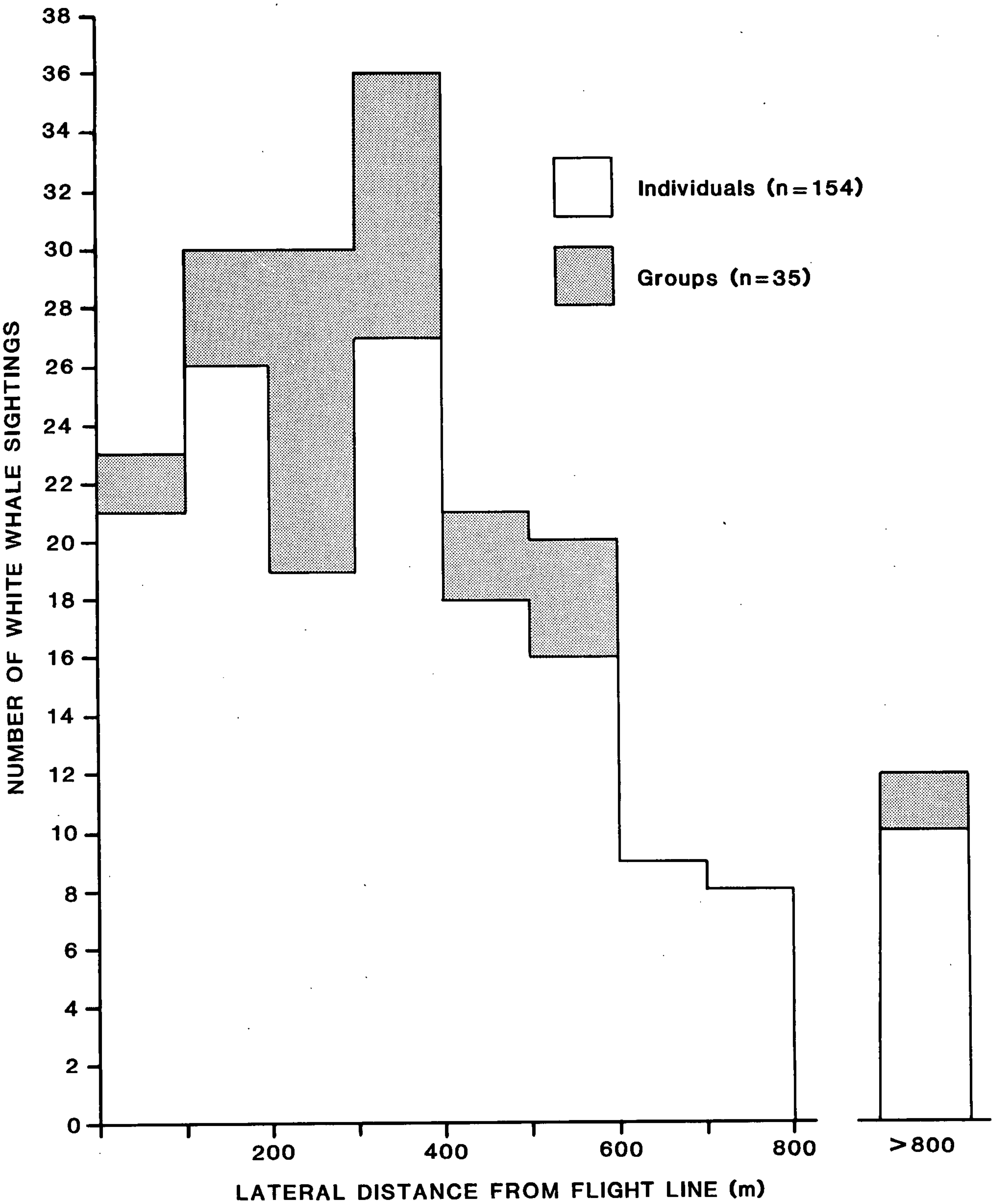

Figure 9. Frequency distribution of distance from flight line of white whale sightings in estuarine waters, 1985.

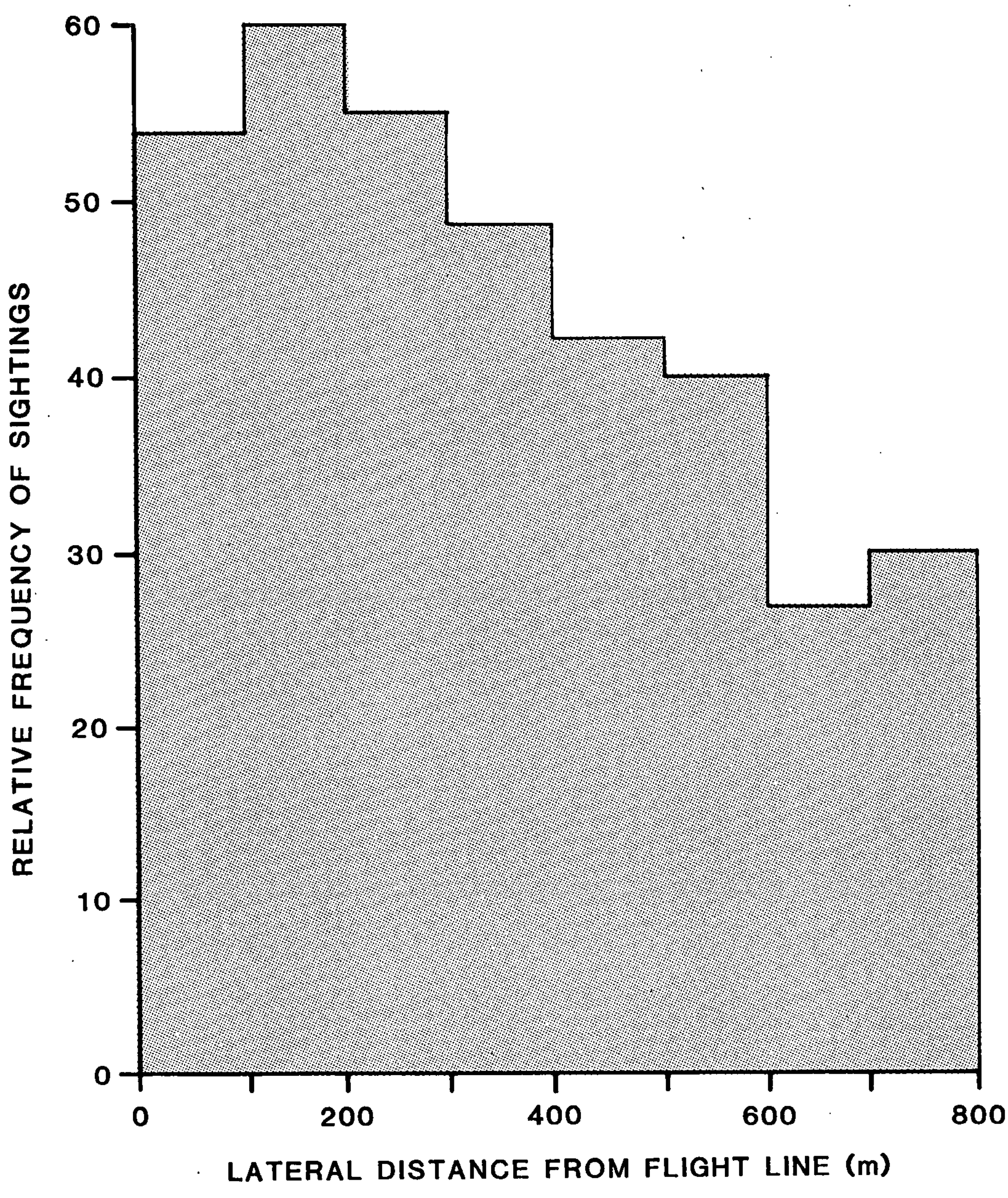

Figure 10. Theoretical frequency distribution of lateral distance from flight line of white whale sightings. (See text for explanation)

data collected during previous surveys of the estuary, and the 1985 data were obtained by flying one survey line on four occasions and represent less than seven per cent of the 1985 systematic survey whale sightings.

Additional lines were surveyed with both observers on the left side of the plane in the middle or at the end of most systematic sub-area surveys. The number of duplicate sightings and possible duplicates varied from survey to survey (Table 2). The proportion of whales seen by one observer varied from 17.4 to 46.9 per cent if no questionable sightings are considered to be duplicates. If all questionable sightings are considered duplicates, then 33.3 to 66.7 per cent of the whales present are seen by an observer. The calculated correction factors ranged from 1.80 to 3.83 (see Table 2).

Variations in the calculated correction factor were compared to variations in sea state, in amount of glare, and in both sea state and glare. A non-parametric test (Spearman's coefficient of rank correlation) was used because observation conditions were measured according to a finite scale. The calculated correction factor was significantly correlated with both sea state and glare (r_s = 0.815, t = 3.444, d_f = 6, p $\sim$ 0.007), strongly correlated with just sea state (r_s = 0.643, t = 2.056, d_f = 6, p $\sim$ 0.045) but weakly correlated with glare (r_s = 0.357, t = 0.936, d_f = 6, p $\sim$ 0.20). Because of the small number of samples, the proportion of whales seen by each observer was compared separately to observation conditions to determine if the same correlation was found. When observation conditions were good (glare and sea state), both observers consistently saw a higher proportion of whales than when conditions were poor. There was more variability in the proportion seen when conditions were poor.

Population estimates. An uncorrected population estimate was calculated for white whales in the area bounded by each survey (Table 3). Each uncorrected estimate was multiplied by the mean correction factor for the appropriate survey period; for the first and second surveys, only one reliable correction factor was determined (see Table 2). The corrected population estimates ranged from 2,664 white whales during the second survey to 6,938 during the third survey. Uncorrected standard errors were calculated for all surveys; these were corrected only for the third and fourth surveys. Although the 95 per cent confidence intervals (see Table 3) are large, fewer whales were probably in the estuary during the fourth survey than during the third. The calculated population estimates do not account for white

TABLE 2

Variation in proportion of white whales seen by an observer, by survey

Date	Line(s) flown	Total number of sightings without (with) questionable sightings considered to be duplicates	Total number of duplicate sightings without (with) questionable sightings considered to be duplicates	Proportion of whales seen by one observer (p)	Correction factor
July 03	N-C	21 (19)	2 (4)	0.174-0.348	3.83
July 07	N-C and N-B	49 (45)[a]	14 (18)[a]	0.445-0.571[a]	1.97[a]
July 08	EM-1	15	3	0.333	3.00
July 15	N-C	18 (16)	3 (5)	0.286-0.476	2.62
July 15	WM-4	36 (32)[b]	11 (15)[b]	0.469-0.639[b]	1.81[b]
July 16	EM-1	41 (36)	10 (15)	0.392-0.589	2.04
July 16	K-1	46 (44)	9 (11)	0.328-0.400	2.75
July 22	N-6	42 (37)	12 (17)	0.445-0.629	1.86
July 23	WM-2	14 (12)	4 (6)	0.445-0.667	1.80
July 23	EM-3	21 (18)	5 (8)	0.384-0.615	2.00

a Proportion of whales seen and correction factor based on observations made at 152 m altitude; all other observations made at 305 m.

b Proportion of whales seen and correction factor based on observations of tightly-clustered whale groups; calculated p-value likely higher than actual and correction factor, lower.

TABLE 3

White whale abundance in Mackenzie estuary, 1985

	Survey period			
	July 03	July 07-09	July 15-16	July 22-23
Uncorrected population estimate	1525	888	2809	1762
Uncorrected standard error	124.3	192.8	480.5	293.1
Degrees of freedom	11	27	35	32
Mean correction factor	3.83[a]	3.00[a]	2.47	1.89
Corrected population estimate	5841	2664	6938	3330
Corrected standard error	NC[b]	NC	1582	581
Student's t-statistic	NA[b]	NA	2.042	2.042
95% confidence interval	NC	NC	3708-10168	2144-4516

a Correction factor based on results from one survey.

b NC = not calculated
NA = not applicable.

whales not in the estuary (e.g., those in Franklin Bay during the July 24 reconnaissance flight and those observed offshore during DFO surveys).

Neonate Sightings

A total of 27 neonate sightings were made during the 1985 white whale monitoring program. Seven sightings were made during the June 24 reconnaissance survey, and one was made during the June 28 survey. All neonates seen during these flights were along the ice edge; most were moving toward the estuary. The number of neonates sighted within the estuary varied from one, during the first and second surveys, to four, during the third survey. Of the estuary sightings, six (67 per cent) were made in Niakunak Bay. Ten neonates were seen in Franklin Bay or in areas farther east during the July 24 reconnaissance flight.

Sightings Made by Industry Personnel and Relationship of Distribution to Industry Activities

Industry personnel reported seeing five whales south of Akpak, eight whales north of Stokes Point, and a large group of white whales migrating past the Rig 7 drilling site in late June (Appendix D). There were five reports of white whales in the area of East and West Mackenzie bays during the systematic survey field program (July 03-23). At least two sightings were of large groups (see Appendix D). Industry personnel reported whales southeast of Herschel Island on and off throughout the field program. During the systematic surveys, white whales were observed within about 10 km of activities at both Adgo and North Ellis (see Fig. 1). White whales were also seen within 3-4 km of industry vessels moving between Tuktoyaktuk and North Ellis.

Following the survey period (i.e., after July 24), a total of 30 white whales (13 sightings) was reported by industry personnel, primarily observers on Dome's drillships stationed at Adlartok (69°39'N, 137°47'W) and in McKinley Bay (see Appendix D). White whales were seen southeast of Herschel Island through early August.

WHITE WHALE BEHAVIOUR, 1976-1985

Survey effort has varied in intensity and has been concentrated in different areas at different times. Much effort has been expended during late June and early July, and then effort has declined through early September. In late June, most of the effort has been expended along the fast-ice edge from Baillie Islands to beyond Herschel Island and, to a lesser extent, in Niakunak Bay (Fig. 11A). During early July, Niakunak Bay, Kugmallit Bay, to a lesser extent East and West Mackenzie bays, and a portion of the ice edge (Baillie Islands to Shingle Point) have been intensively surveyed (Fig. 11B). In late July and early August, the effort has still been concentrated in the estuary, in particular Kugmallit Bay, but has also included the nearshore area off the Tuktoyaktuk Peninsula (Figs. 11C,D). Some effort has been expended in the offshore areas during late June-early August (see Figs. 11A,B,C,D). However, in late August, only the offshore areas and Kugmallit Bay have been surveyed (Fig. 11E), and in September, only the offshore areas (Fig. 11F).

The total number of white whales observed on transect per time interval peaked in early July (Table 4). Both the number of whales observed and the location of the sightings are related to the intensity of survey effort. Maps illustrating locations where specific behaviours were observed have been included only if necessary to illustrate specific points.

Possible Feeding Behaviours

Two types of white whale behaviours have been identified as being possible indicators of feeding: association with seabirds and rapid, erratic, "darting" movements. Association with seabirds was much more common than darting (Table 5).

Few white whale-seabird associations have been recorded during late June. There was a gradual increase in this type of behaviour, which peaked in late August (Fig. 12); no such associations have been recorded in early September. The locations where white whales have been seen in association with seabirds has varied. In early July, most sightings were in estuarine waters (Fig. 13A), but starting in late July, many sightings were also recorded near points of land (Fig. 13B). This trend continued during August (Fig. 13C). Only occasional sightings of white whales in association with seabirds have been made in offshore waters (see Figs. 13A,B,C).

Darting has only been observed during late July and late August (see Table 5). This behaviour has been recorded near points of land (see Fig. 13B) and in offshore areas

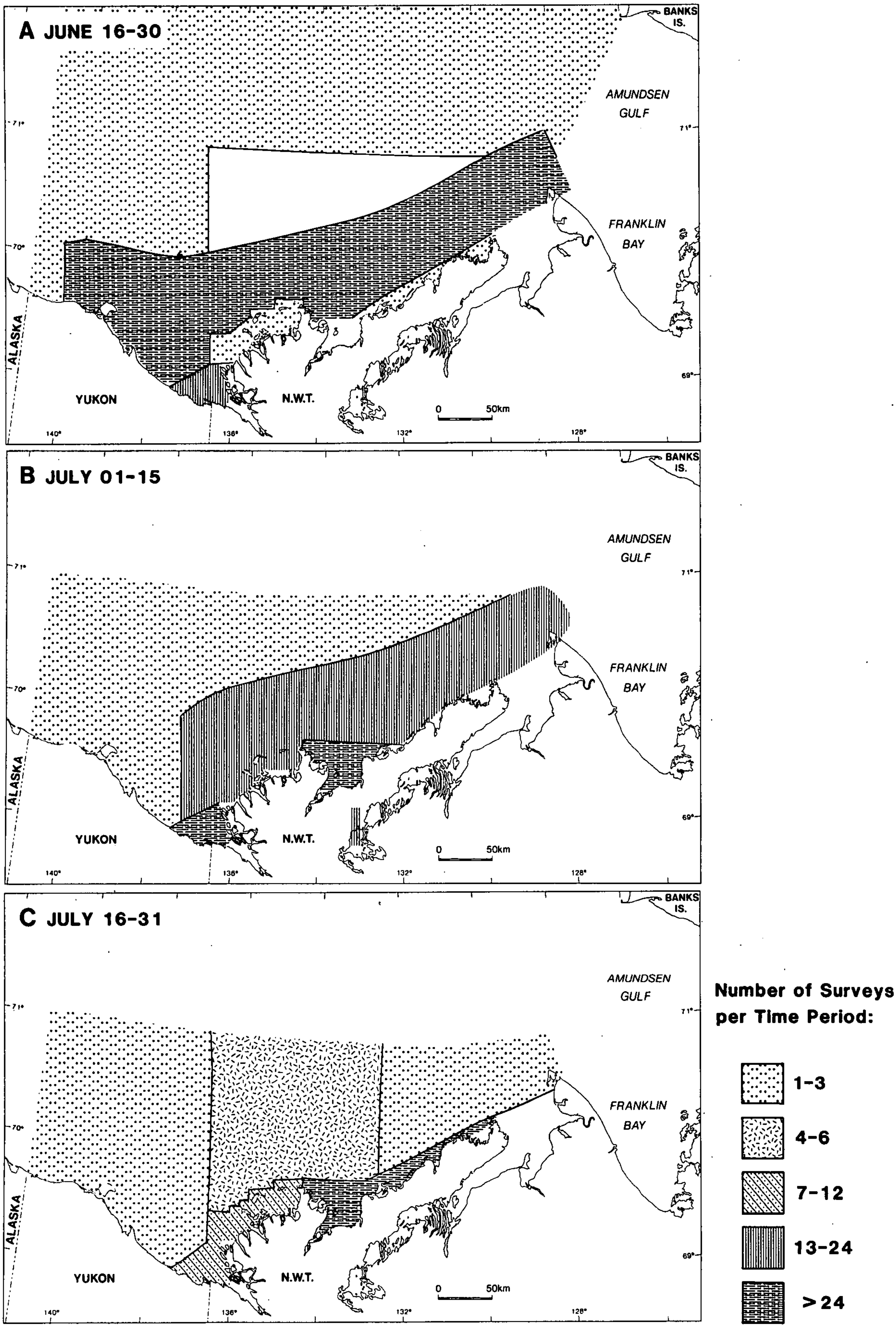

Figure 11. Relative survey effort, by sub-area, 1976-1985.

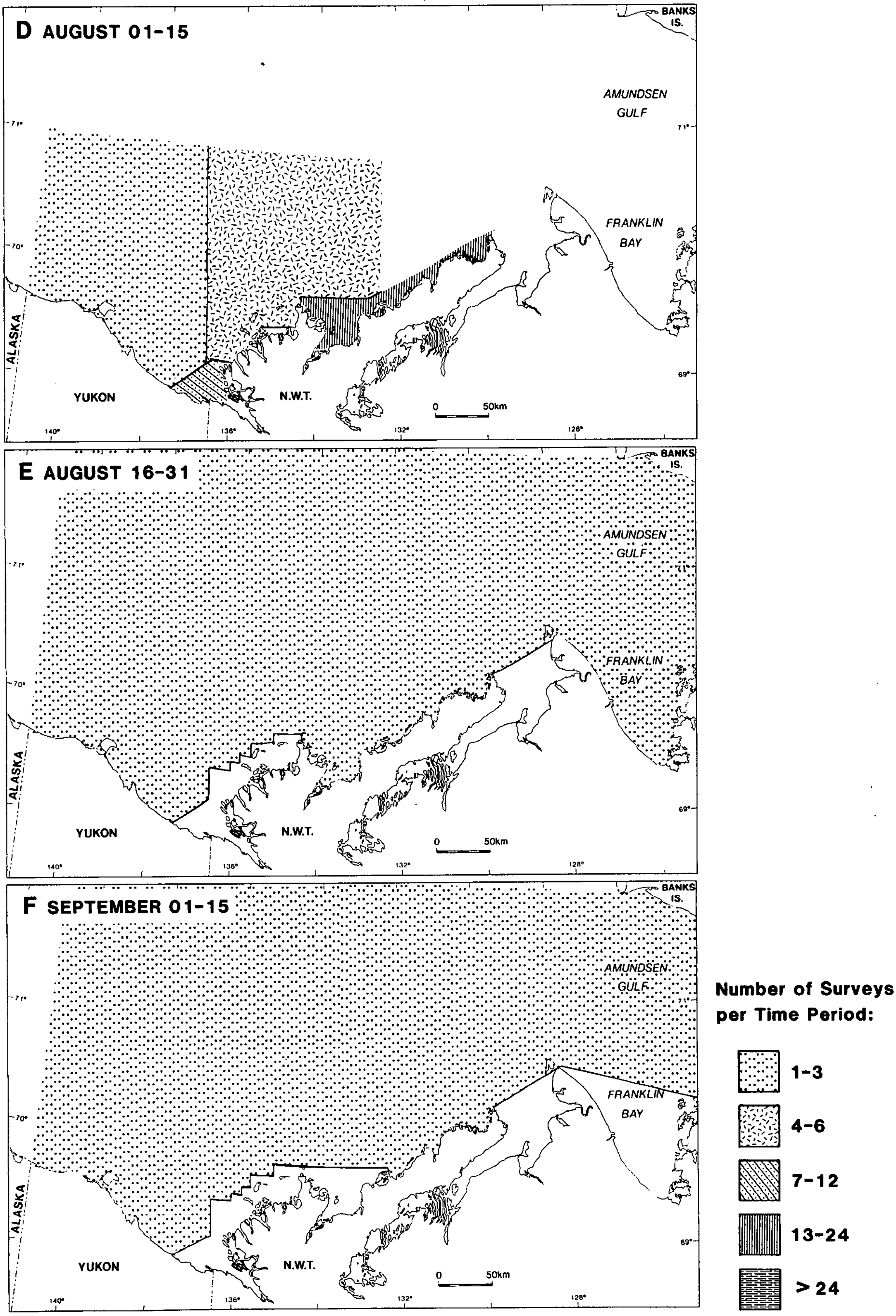

Figure 11 continued.

TABLE 4

Total number of white whales seen on transect from 1976 through 1985, by time interval[a]

Time interval		Number seen ($x10^3$)
June	late	14.08
July	early	35.63
	late	16.10
August	early	3.12
	late	0.35
September	early	0.06
late June to early September		69.34

[a] Includes white whales seen during reconnaissance and systematic surveys included in the 1976-1983 and 1985 white whale monitoring projects, the 1984 white whale offshore project, and the 1982, 1984, and 1985 bowhead monitoring projects.

TABLE 5

Number of white whale sightings of specific behaviours per 1,000 white whales seen on transect, 1976-1985, by time interval

	Time interval						
	June	July		August		Sept	all
Behaviours	late	early	late	early	late	early	times
Association with seabirds	0.28	0.93	4.35	9.29	25.71	0.0	2.09
Darting	0.0	0.0	0.19	0.0	2.86	0.0	0.06
Mud trails	0.0	0.53	1.55	2.24	0.0	16.67	0.75
Splashing	1.28	4.69	3.66	1.28	0.0	0.0	3.58
Gamming	1.35	2.95	1.86	0.0	0.0	0.0	2.22
Spy-hopping	0.21	0.48	0.87	0.32	0.0	0.0	0.50

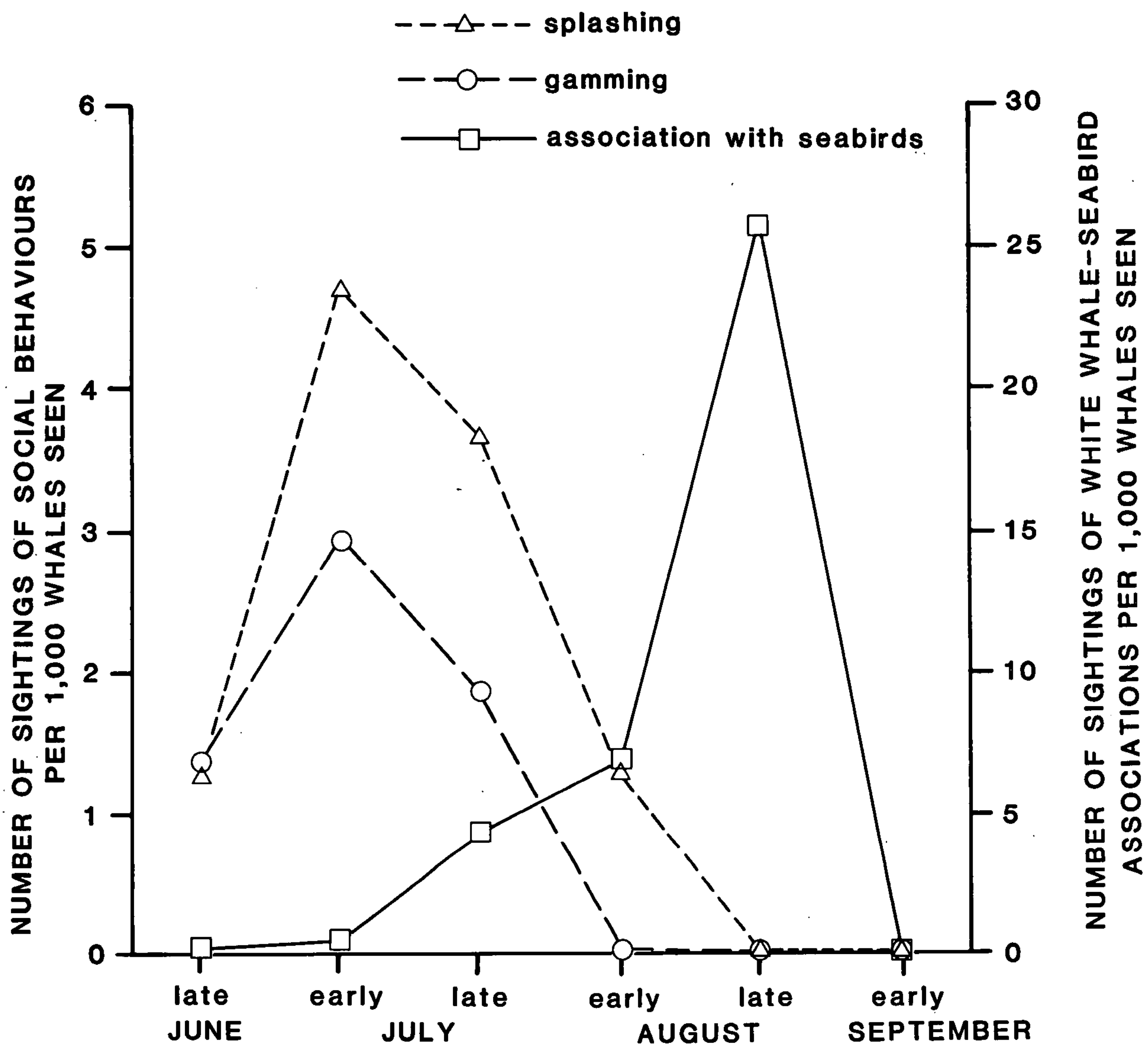

Figure 12. Frequency of sightings of specific white whale behaviours, by time period, 1976–1985.

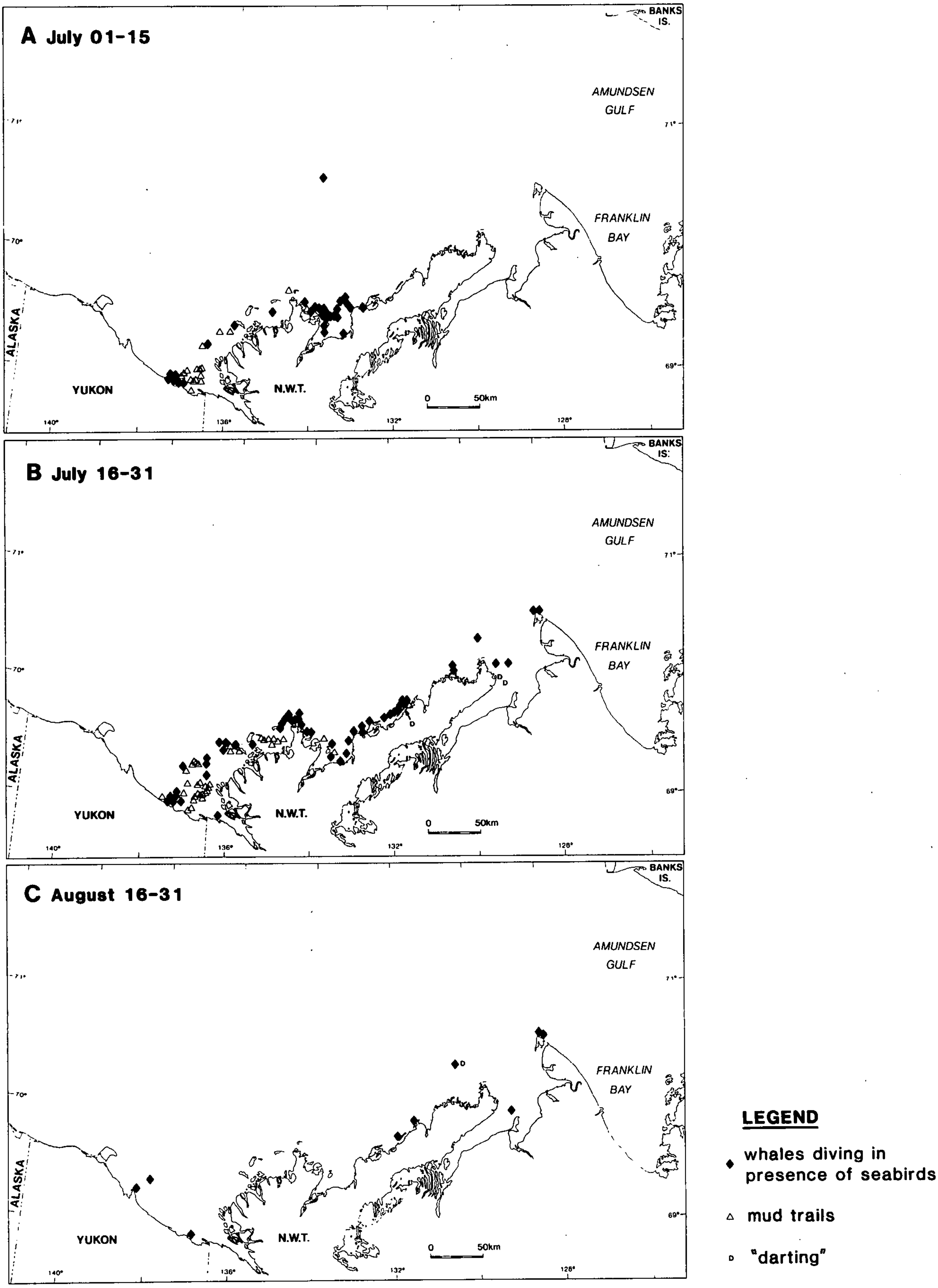

Figure 13. Locations of white whale sightings– possible feeding behaviours.

(see Fig. 13C) and generally coincided with associations with seabirds.

Mud Trails

Mud trails around white whales have first been recorded in early July (see Table 5); there was a steady increase in this type of sighting through early August. The high proportion of sightings which include mud trails in early September is questionable as it was based on one sighting. All but a few sightings of white whales with mud trails have been made in the estuary (see Figs. 13A,B). However, because mud trails are difficult to detect in muddy estuarine waters, it is probable that the calculated incidence of white whale-mud trail sightings is lower than actual.

Possible Social Behaviours

Splashing was the most common social behaviour observed (see Table 5). Sightings of splashing were made frequently in late June, peaked in early July, and then declined to no sightings in late August and early September (see Fig. 12). All but two of the sightings of splashing were in estuarine waters (Figs. 14A,B,C). In late June and early July, more splashing sightings were made on the west side of the estuary, but in late July and early August, the sightings were throughout the estuary.

Gamming was the second most common social behaviour observed (see Table 5), and the number of sightings of gamming per time interval was highly correlated with the number of sightings of splashing ($r = 0.993$, $d_f = 5$). Gamming was most frequently observed during early July; no sightings of gamming were made during August or early September. Gamming was primarily observed in estuarine waters. The relative frequency of gamming among sub-areas was similar to the relative frequency of splashing in early July (compare Figs. 15A and 14B), but less similar during late July (compare Figs. 15B and 14C).

Spy-hopping was observed less frequently than either splashing or gamming (see Table 5). The number of sightings of spy-hopping increased from late June through late July and then declined (see Table 5). Most spy-hopping sightings were in estuarine areas; one sighting was made along the Tuktoyaktuk Peninsula (Fig. 15C). The observed incidence of spy-hopping may be under-represented because spy-hopping is

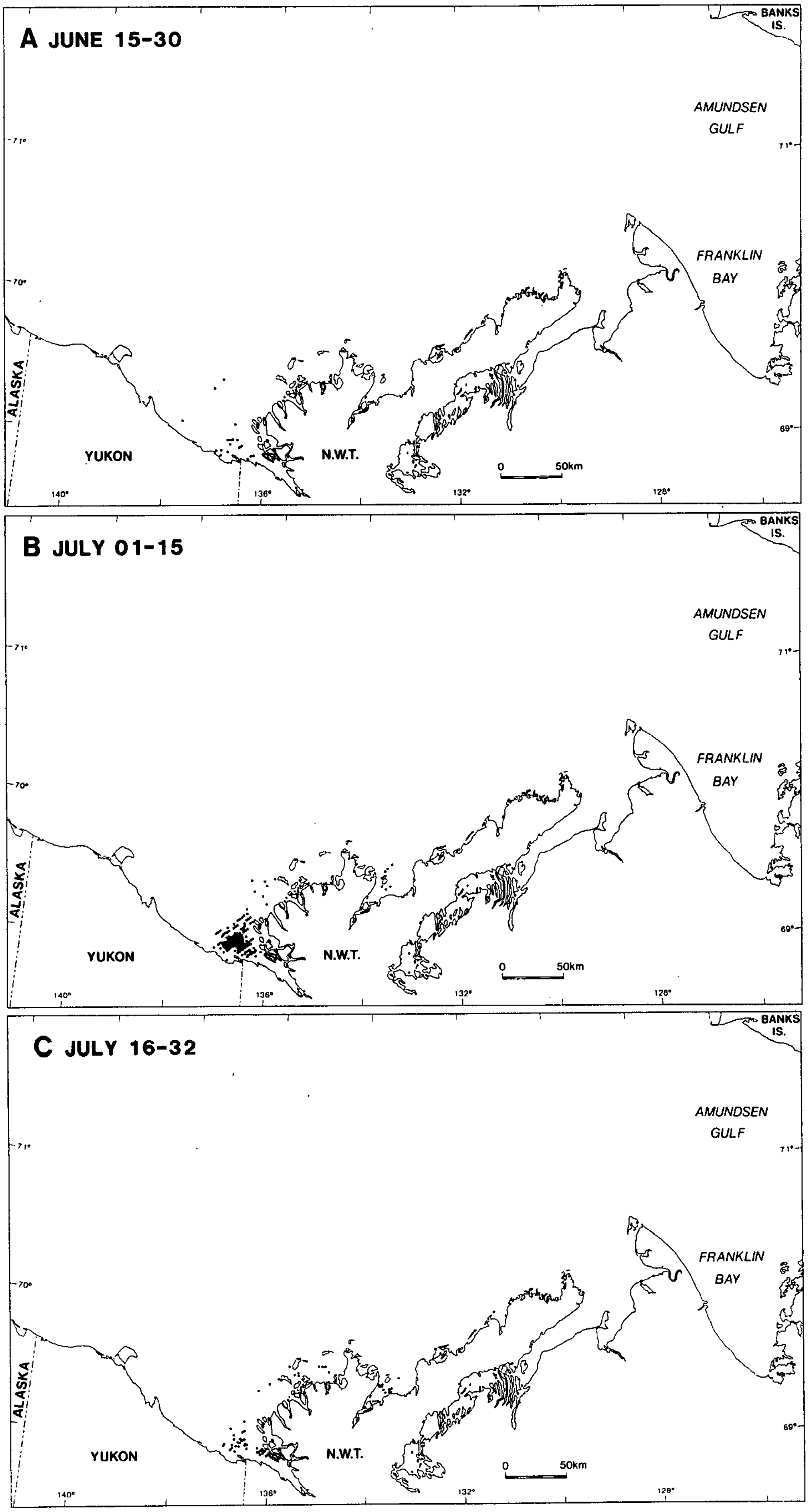

Figure 14. Locations of white whale sightings– splashing behaviours.

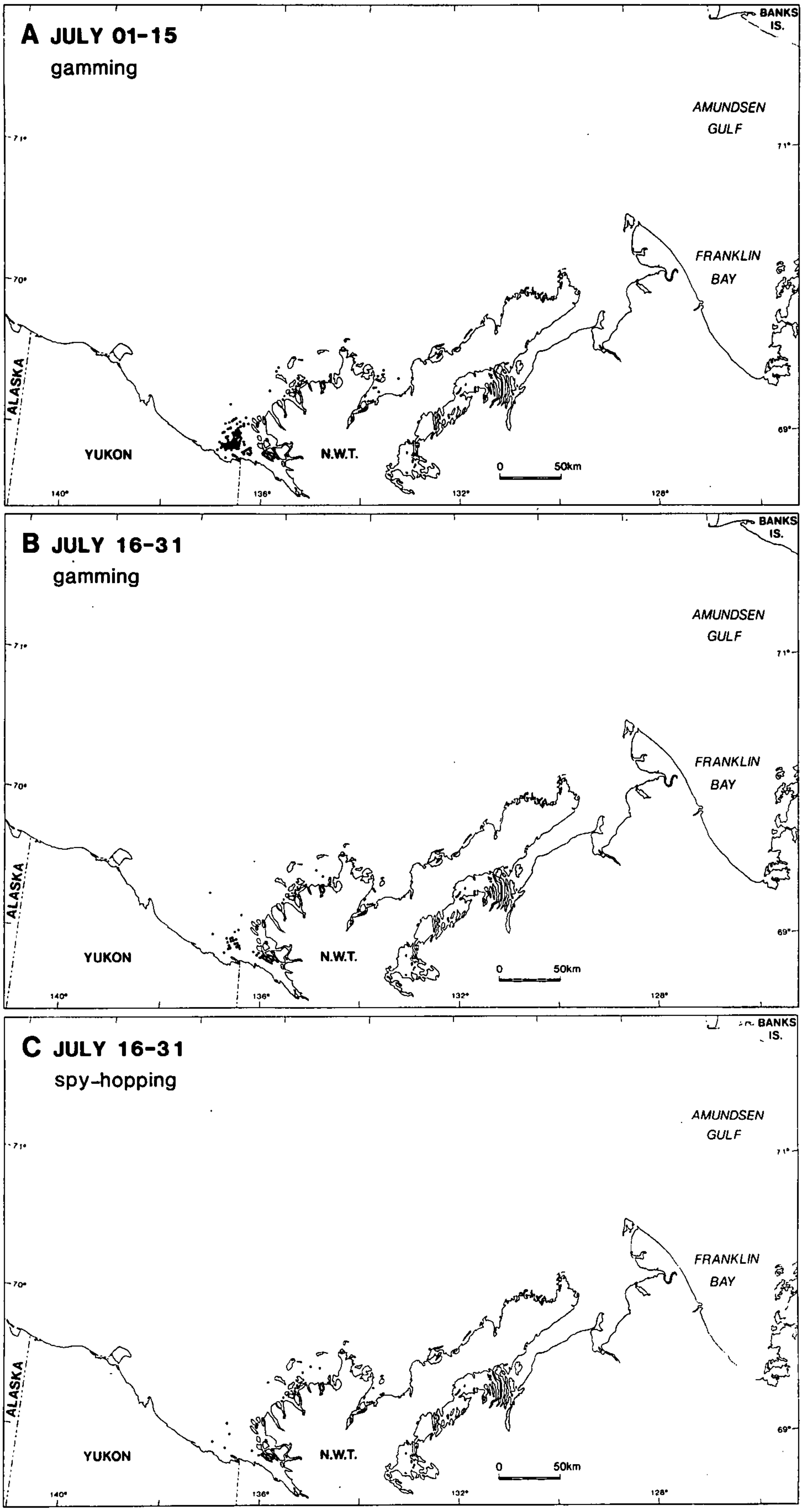

Figure 15. Locations of white whale sightings- gamming and spy-hopping behaviours.

much more difficult to detect than splashing or gamming in muddy water. Spy-hopping sightings were less tightly clustered than sightings of splashing or gamming (compare Figs. 15C, 14C, and 15B).

NEONATE SIGHTINGS, 1976-1985

Neonate sightings have been recorded during each time interval. The relative number of neonate sightings (per 1,000 whales seen on transect) was much lower during late June, July, and early August, in comparison to late August and early September (Fig. 16). The relative number of sightings decreased between late June and early July, and then increased in late July.

Some of this variation in relative number of neonates sighted may have resulted from the types of habitats surveyed and changes in the location of survey effort. For example, neonates are difficult to identify in estuarine (muddy) waters and less effort has been expended in offshore (clear) areas during early July than during late June. The increase in sightings from early July to late July may indicate calving is occurring in the region, because survey effort was relatively consistent in July. The marked increase in the relative frequency of neonate sightings in late August was unlikely the result of calving because the actual number of sightings was lower than in late July (31 sightings in late August compared to 90 sightings in late July). This increase may be because more effort was expended in offshore areas during late August than during early August or it may indicate that cow-neonate pairs stayed in the surveyed areas longer than the non-cow-neonate segments of the population.

During late June, neonates were observed along the fast-ice edge north of the Tuktoyaktuk Peninsula, Mackenzie estuary, and Yukon coast (Fig. 17A). In July, neonate sightings were made throughout most of the region, including a few in the estuary (Fig. 17B; sightings in early July show a similar pattern). Only eight sightings were made in early August. In late August, neonates were recorded throughout the offshore areas from Banks Island to the Alaska-Yukon border, but few were seen in the estuary (Fig. 17C). One of the five sightings in early September was in Franklin Bay.

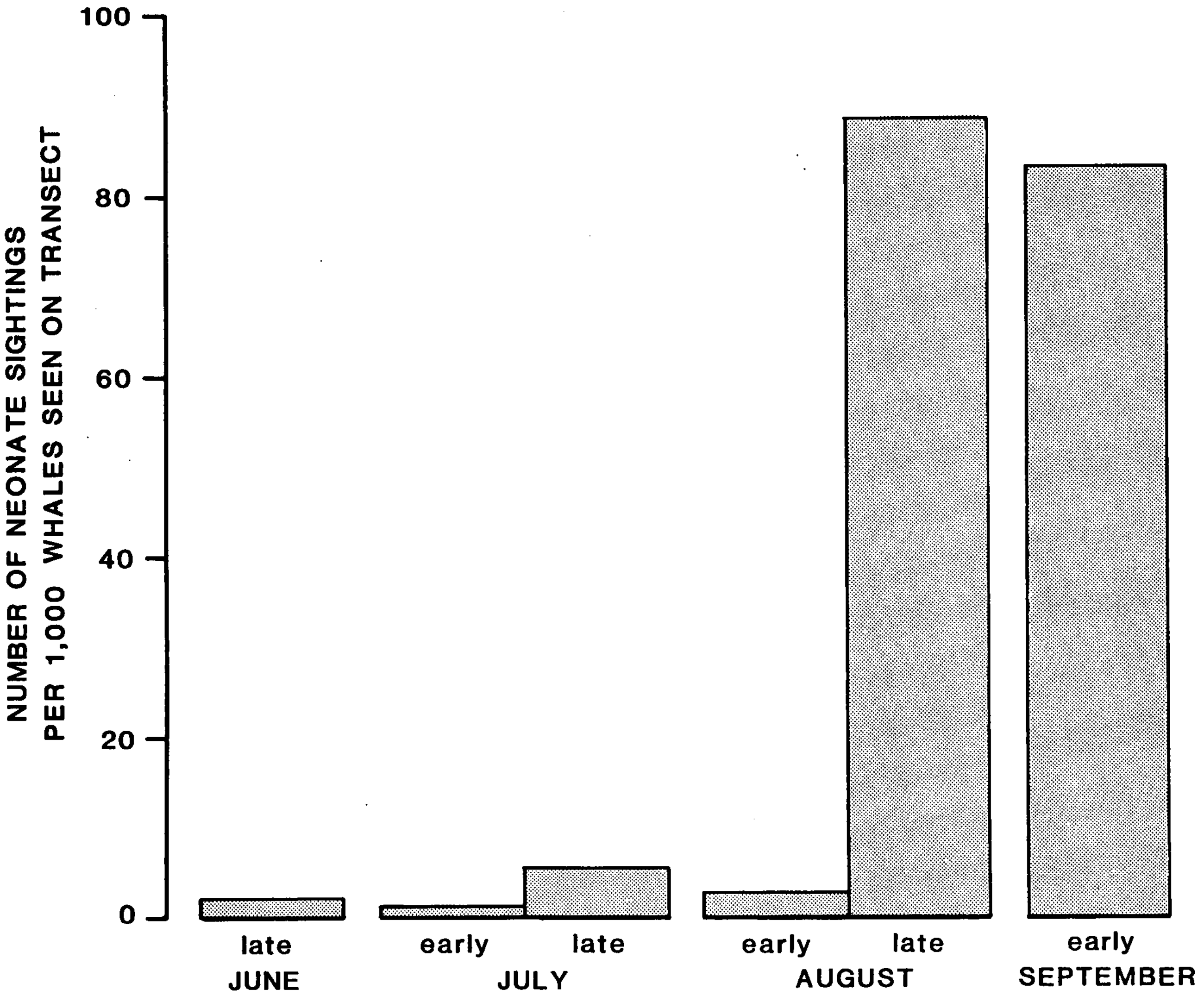

Figure 16. Relative frequency of white whale neonate sightings.

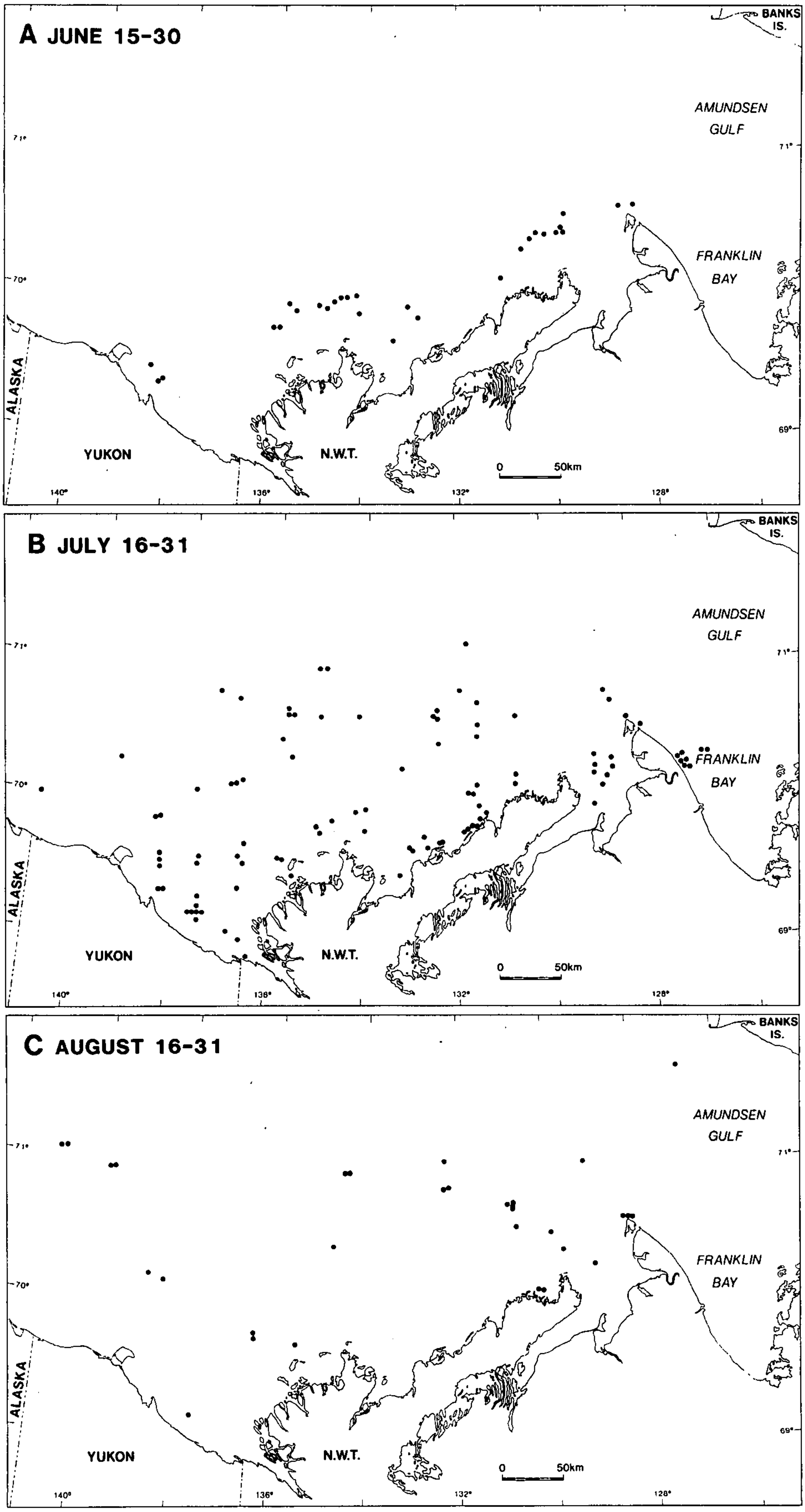

Figure 17. Location of white whale neonate sightings.

DISCUSSION

WHITE WHALE MOVEMENT TO AND DISTRIBUTION WITHIN THE ESTUARY

The timing and pattern of white whale movement to the Mackenzie estuary in 1985 was similar to that observed in previous years. The 1985 migration started prior to June 24 and whales used the system of leads offshore of the Tuktoyaktuk Peninsula, Mackenzie estuary, and Yukon coast. During late June, the lead was closed in several places, but whales continued to move through these areas (see Figs. 2,3,4). On July 04, whales were seen moving west in areas of 7/10-8/10 ice cover. Whales travelling through areas with heavy ice cover were also reported in 1978 (Fraker 1978).

In 1985, white whales appeared to wait at the western end of the lead for the ice to break up (see Fig. 2). This pattern differed from that observed in 1973 and 1978, when whales congregated seaward of the narrowest section of fast ice (Slaney and Company Ltd. 1974; Fraker 1978). In both those years, turbid river water was apparent in the area where the whales congregated. In 1985, no turbid water was apparent seaward of the fast ice in any of the areas surveyed. Turbid (estuarine) water may indicate where the ice will break up first. If this indicator is not present, the whales continue to travel as far west as the end of the lead system. In 1972 and 1975, white whales were reported to have entered the estuary from the west (Fraker 1977); these animals may have waited north of the Yukon coast for access to the estuary, as was observed in 1985.

The lead off the Tuktoyaktuk Peninsula (see Fig. 4) became consolidated during early July, which may have prevented late migrants from approaching the estuary from the east. Certainly white whales were present in areas to the east of the estuary during July. For example, on July 24, 104 white whales were observed during a single pass through Franklin Bay and 14 animals were seen in areas farther east. Other researchers recorded white whales in Franklin Bay and Amundsen Gulf throughout July.[1] In 1981, 728 white whales were seen in Franklin Bay and Amundsen Gulf during the latter half of July (Davis and Evans 1982). Because there was no ice blockage preventing westward

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1 DFO, Western Region, unpubl. data.

movement to the estuary in that year (Norton Fraker and Fraker 1982), the 1981 data suggest that a portion of the white whale population may occur in Amundsen Gulf during July, irrespective of ice conditions to the west.

In 1985, the west side of the estuary became accessible to whales one-two days later than average, and Kugmallit Bay, three-four days later (Table 6). Whales probably entered Niakunak Bay as soon as it opened, because few were seen along the fast-ice edge on June 28. Although no whales were seen on the easternmost side of the bay during the June 28 flight, several thousand whales were in Niakunak Bay on July 03. A decline in numbers in Niakunak Bay between the July 03 and July 07-09 surveys was accompanied by an increase in numbers in other areas, which suggests that whales may have moved to other parts of the estuary from Niakunak Bay. The whales first seen in Kugmallit Bay on July 08 probably came from East Mackenzie Bay, because the only access to Kugmallit Bay was via the waterway between Richards Island and Pullen Island. Whales entered Kugmallit Bay from the west in 1976 and, possibly, in 1983 (Fraker 1977; Robertson and Millar 1985). This pattern of concentrating in one area and then spreading out to other areas of the estuary may have occurred in other years. However, this pattern is unconfirmed because 1985 was the first year in the series that an attempt was made to cover all of the estuary sub-areas within a 30-h time period. In 1977, Niakunak Bay and West Mackenzie Bay were intensively surveyed and the pattern of abundance suggested that whales were moving from one area to the other (Fraker et al. 1979).

The areas within the estuary where concentrations of whales were observed in 1985 were similar to those used in previous years. During the July 22-23 survey, whales were observed closer to the eastern shore of Shallow Bay than had been seen previously. However, small year-to-year variations in distribution have been documented during previous programs (e.g., Norton Fraker 1983). The apparent movement of whales away from the Yukon coast and Tent Island between the July 07 and July 15 surveys of Niakunak Bay corresponds with the beginning of hunting in the area. The first whales were landed at Bird Camp and Running River along the Yukon coast on July 08 and July 10, respectively.[1]

During the July 03 and July 07-09 surveys, white whales were fairly evenly distributed throughout the areas

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1 P. Weaver, DFO, Western Region, pers. comm.

TABLE 6

Approximate date when ice barriers across Mackenzie Bay and Kugmallit Bay broke

Year	Mackenzie Bay	Kugmallit Bay
1972	NA[a]	NA
1973	June 22-23	June 27
1974	July 10-11	July 10-11
1975	late June	late June
1976	NA	NA
1977	June 17	NA
1978	July 05	July 05-06
1979	June 19	July 01
1980	June 27	June 30
1981	June 15	June 27
1982	June 22	July 10
1983	June 23	June 29
1984	NA	NA
1985	June 26	July 06
Mean 1972-1984	June 24-25	July 02-03

a NA = no data available.

surveyed. During the survey when peak numbers were obtained (July 15-16), white whales were commonly seen in tight clusters. Remnants of this distribution pattern were found during the July 22-23 survey.

WHITE WHALE ABUNDANCE IN THE ESTUARY

Estimates of the total numbers of white whales using the Mackenzie estuary have varied from year-to-year. Since 1976, when most of the survey sub-areas and survey techniques were standardized, the published estimates of the peak number of white whales in the estuary has ranged from 3,500 in 1981 (Norton Fraker and Fraker 1982) to 7,500 in 1983 (Robertson and Millar 1985). Suggested reasons for this variability have included weather precluding surveys when peak numbers were present or whales spending differing proportions of time at the surface from year-to-year (Norton Fraker and Fraker 1982) or a varying portion of the population using the estuary from year-to-year, or some combination of these three. In 1985, several sources of bias were examined for their possible contribution to the variations observed.

Survey Technique Biases

The strip transect method of censusing whales may lead to biases in the results for three reasons.

a) "Sightability" (the probability that an animal in an observer's field will be seen) varies with strip width, altitude, and observation conditions (Caughley 1974) and size of group (Eberhardt et al. 1979).

b) There are differences in observers' abilities to detect animals (Caughley et al. 1976).

c) Only a portion of the individuals present will be at the surface at any one time (Eberhardt 1978).

Data on the effects of strip width, observation conditions, group size, and observers' abilities were collected in 1985. Observer ability was not differentiated from seat position (i.e., observers did not change front-rear positions). Systematic surveys of the estuary were generally conducted at 305 m so the effect of altitude was not examined.

Observation conditions were found to have a significant effect on the number of whales not counted (either because they were beneath the surface or were at the surface and missed). If observation conditions (sea state and glare) were excellent, the calculated correction factor for missed animals was 1.80-1.86. As observation conditions deteriorated from excellent to good to fair, the calculated correction factor essentially doubled (3.00-3.83). The value of the correction factor for poor conditions in the estuary was not determined as surveying was not attempted during poor conditions.

As part of another study funded by Indian and Northern Affairs Canada (INAC), the authors determined a correction factor for missed white whales under ideal, offshore conditions of 1.54 (Norton et al., in prep.). This factor was calculated using data collected in Amundsen Gulf where the water was clear blue, glare was absent, the sea was calm (Beaufort Scale = 0), there was no ice, and both observers had extensive, recent experience surveying for whales. It is difficult to imagine conditions better than that for censusing whales in the Beaufort region, and therefore, 1.54 is considered a "minimum" correction factor.

Whale behaviour affects the proportion of individuals present that will be at the surface at any one time (Leatherwood et al. 1982). For example, on 1979 June 30, whales appeared to be remaining at the surface longer than usual (Fraker and Fraker 1979) and no correction factor for whales beneath the surface was considered necessary or applied. During the 1985 surveys, this behaviour was not found.

Sightability did vary over the 1.6-km strip. A model based just on the time an interval was in focus because of the forward motion of the plane and the apparent size of each interval explained some of the results obtained: the fewer sightings recorded in the first interval and the drop in the seventh interval. However, the model did not explain the peak in the fourth interval. Patterns of white whale sightability across the width of the transect strip in estuarine waters are not available from other studies. Two studies examining white whale sightability in offshore Beaufort waters obtained similar results: very few sightings in the first interval, a peak number of sightings in the second interval, a noticeable decrease in the fourth interval, and a smaller decrease in the sixth or seventh interval (Davis and Evans 1982; Norton and Harwood 1985). White whale sightability in the estuary appears to be better than in the offshore for the middle intervals. This difference may result from the use of different scanning patterns or observers may spend less time per sighting because the animals are seen for less time in the estuary.

Limited data on the effect of group size on whale sightability were obtained in 1985; 23 of the 35 group sightings for which lateral distances were calculated included group size. The larger groups observed (seven and eight white whales per group) and groups of two had essentially the same mean inclinometer reading, 47° and 48° respectively (n = 2, 15, respectively). Groups of three tended to be sighted farther away ($\bar{x}$ = 34.8°, n = 6). These results should be considered preliminary because of the small sample sizes.

Differences in observers' abilities were examined by comparing the number of non-duplicate sightings made by each of the two observers when both were on the left side of the aircraft. The observers' totals were 119 and 114 sightings; these figures include possible duplicates. Large differences between the number of sightings of the two observers were noted on some days (e.g., 25 sightings by the front observer and 10 by the rear on July 07; 9 by the front and 28 by the rear on July 16) and not on others (e.g., 8 sightings by the front observer and 7 by the rear on July 15). The largest differences between the number of sightings of the two observers occurred when observation conditions were fair. These data indicate that the assumption involved in the calculation of the correction factors, equal sightings by the two observers, is essentially valid.

Yearly Trends in Numbers Using the Estuary

The peak number of white whales estimated to be in the estuary has varied from year-to-year (Table 7). The estimates have been obtained over the period from June 30 through July 16, under varying observation conditions, and with various portions of the areas available to whales surveyed. In previous years, a standard correction factor (2.0) was applied to the results to account for whales missed (beneath the surface or at the surface and not seen). The 1985 results suggest that observation conditions have a noticeable effect on the proportion of whales missed. To correct previous estimates for observation conditions, a sliding scale was set up based on this year's results; the scale ranged from 1.8 for excellent conditions to 2.7 for good conditions to 3.6 for fair conditions. Applying the factors calculated using 1985 data to previous estimates is

TABLE 7

Peak number of white whales estimated in the Mackenzie estuary by year (Data are from previous and present white whale monitoring programs.)

Year	Survey period	Observation conditions	Accessible sub-areas not surveyed[a]	Peak # of white whales[b]	Correction for observation conditions[c]	Revised estimate
1976	July 12-13	NA[d]	W. and E.Mac.	5,496	NA	--
1977	July 08	Excell./Good	W.Mac.	5,660	2.25/2	6,400
1978	July 08-09	Good	W. and E.Mac.	6,604	2.7/2	8,900
1979	June 30-July 01	Excellent	none	6,733[e]	--	6,700
1980	July 09-10	Good	none	4,500	2.7/2	6,100
1981	July 06	Excellent	W. and E.Mac.	3,500	1.8/2	3,200
1982	July 14	Good/Fair	W. and E.Mac.	7,008	3.15/2	11,000
1983	July 06-07	Good	W. and E.Mac.	6,764	2.7/2	9,100
1984	NS[d]	NS	NS	NS	NS	NS
1985	July 15-16	Excell./Good	none	5,644	2.25/2	6,400

a Sub-areas not surveyed within the survey period have been listed; W.Mac. = West Mackenzie Bay, E.Mac. = East Mackenzie Bay.

b Number given may not correspond to value given in annual report for that particular year. These values were not rounded off and no extrapolation was made for unsurveyed sub-areas.

c Correction factors = 1.8 (Excellent); 2.25 (Excellent/Good); 2.7 (Good); 3.15 (Good/Fair); 3.6 (Fair), cf 2.0 used in previous years.

d NA = no data available
NS = not surveyed.

e No correction factor applied for whales beneath the surface because whales remained at the surface.

reasonable because one of the authors was involved in almost every previous program, the methods used over the years have been the same, and, unlike the previous standard correction factor, the 1985 factors are based on data collected in the estuary. The revised peak estimates were rounded off to the nearest hundred and are generally higher than previous estimates (see Table 7); a broader range of values was observed (3,200 white whales in 1981 to 11,000 in 1982).

There was no noticeable trend in the peak estimates. Thus, the different estimates are unlikely to represent actual changes in the population size. The extent of available area surveyed also does not account for the variation observed. Data from the three years in which the entire estuary was surveyed produced similar estimates: 6,700 animals in 1979 (with no correction factor applied), 6,100 in 1980, and 6,400 in 1985. However, these estimates are much lower than some estimates made in years when only some of the sub-areas were surveyed (e.g., 8,900 and 11,000 animals in 1978 and 1982, respectively). There is no noticeable correlation between survey date and peak estimate (i.e., estimates obtained in mid-July are not consistently higher than those obtained in early July). The three highest estimates (8,900 in 1978, 11,000 in 1982, and 9,100 in 1983) were all done, at least partially, under good conditions. The calculated correction factor is the most variable for good conditions probably because "good" is harder to define than "excellent" or "fair". Conditions may be rated "good" because sea state or glare, or both, present a problem, and sea state has a greater effect than glare on the proportion of whales seen. Thus, the 1978, 1982, and 1983 estimates may over-represent, to some extent, the number of whales actually present. Whale behaviour may also affect the number of whales seen. In spite of these two factors, it seems clear that different peak numbers of white whales use the estuary in different years.

Except for 1982, peak estimates for the estuary have been much lower than the 1981 population estimate of 11,500 white whales (Davis and Evans 1982). During 1984 surveys of the Mackenzie estuary and offshore Beaufort, the authors found about one-third of the whales in offshore areas and two-thirds in the estuary during early July (Norton and Harwood 1985). Consequently, during the period of peak numbers in the estuary, a proportion of the population occurs offshore. It is not known if there is an exchange of whales between the estuary and the offshore or if a segment of the population stays in the estuary for the entire concentration period and another segment stays offshore. Only by following tagged whales could this question be resolved.

WHITE WHALE USES OF THE ESTUARY

White whales throughout their range make use of estuarine areas (Kleinenburg et al. 1964), but the reason for this behavioural pattern is not clear. Several reasons have been proposed; some of these are supported by our review of white whale behaviour in the Mackenzie estuary and some are not.

The Mackenzie estuary appears to be an important area for white whales engaged in social behaviour. Both splashing and gamming behaviours have been found almost exclusively within the estuary and sightings of these behaviours peaked during the period when the greatest numbers of whales used the estuary.

Spy-hopping has a different pattern than splashing and gamming. The number of sightings peaked later, in late July, and the sightings were not so tightly clustered, although still primarily in the estuary. These differences suggest that spy-hopping is not related to splashing and gamming. It may simply be a "curious" reaction to airborne stimuli.

Finley (1982) suggested that white whales use estuarine areas for moulting old skin. Mud trails have been seen in the estuary and are not closely associated, temporally or spatially, with obvious indications of feeding (i.e., association with seabirds and darting). Thus, these mud trails may indicate places where whales are rubbing off old skin on the ocean floor. White whales landed in the estuary have smooth skin, but there are no indications (old pieces of skin still present) that the old skin has been sloughed recently.[1]

Feeding has been suggested as the reason white whales come into estuaries each year (Kleinenberg et al. 1964). Feeding may be an important activity in some specific, deeper areas of the estuary (e.g., areas in West Mackenzie Bay; Fraker et al. 1979), but most available information suggests that the estuary is of limited importance as a feeding area. Many sightings of association with seabirds and of darting have been recorded in coastal areas, near points of land, which are areas where fish are likely to concentrate (Norton Fraker and Fraker 1982). Fewer such sightings have been made in the estuary, in spite of the

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1 DFO, Western Region, unpubl. data.

presence of many more whales in estuarine areas. Few whales landed in the estuary have had food in their stomachs, and squid beaks isolated from white whale stomachs were identified as being a typical offshore species (Fraker et al. 1978). In addition, sightings with obvious indications of feeding peak during late August, a period when few whales are in the estuary.

Estuaries may be used as calving areas by white whales (Sergeant 1973), or the warm, river water may provide a thermal advantage, particularly to neonates (Fraker et al. 1978; Fraker et al. 1979). However, the review presented here suggests that the Mackenzie estuary is not an important area for calving or for rearing neonates. Frequently, neonates have been sighted along the ice edge in late June before the estuary is accessible, suggesting at least some calving must occur before the period of estuarine occupation. During July and August, many neonates have been sighted offshore; Norton and Harwood (1985) suggested that calving probably occurred there. The 10 neonates seen east and southeast of Baillie Islands during the July 24 flight probably did not enter the Mackenzie estuary in July 1985 because the ice along the Tuktoyaktuk Peninsula did not deteriorate until early August. The possibility that white whales enter the estuary for the thermal advantage cannot be discounted, but the likelihood of this is diminished by the fact that the whales leave before any degree of cooling has occurred (Fraker et al. 1979).

Our review of white whale behaviour in the Mackenzie estuary suggests that the whales use this area to socialize and, possibly, to moult old skin. Some feeding and some calving occur in the area, but areas outside the Mackenzie estuary appear to be more important for these activities. The thermal advantage provided by the estuary does not appear to be that important for the population.

EFFECTS OF INDUSTRY ACTIVITIES ON WHITE WHALES

Industry personnel located at sites near the fast-ice edge (i.e., Rig 3, Rig 7, and Kulluk) recorded white whales travelling near the sites and white whales were frequently seen near these active sites during the reconnaissance surveys. No potential white whale-industry interactions were noted during the systematic aerial surveys. Frequent sightings of white whales were made by industry personnel on active offshore platforms. There is no indication that industry activities had any effect on the 1985 white whale migration to the estuary or on their distribution and abundance within the estuary.

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APPENDICES

APPENDIX A

Transect location and line lengths by sub-area

APPENDIX A

Transect location and line lengths by sub-area

Niakunak Bay

Transect Number	EAST ENDPOINT °N	°W	WEST ENDPOINT °N	°W	LENGTH (km)
N-A	68 55.8	136 00.7	68 52.6	136 14.5	10.6
N-B	68 58.0	136 00.3	68 53.0	136 21.6	16.2
N-C	68 58.9	136 05.1	68 53.8	136 26.6	16.2
N-1	69 00.4	136 07.3	68 51.7	136 43.1	27.5
N-2	69 02.4	136 07.1	68 52.2	136 49.2	32.1
N-3	69 04.2	136 08.0	68 53.3	136 53.1	34.5
N-4	69 05.6	136 11.1	68 54.5	136 56.5	34.6
N-5	69 07.0	136 14.1	68 55.9	136 59.4	34.8
N-6	69 08.5	136 16.5	68 56.5	137 05.3	37.5
N-7	69 10.9	136 15.7	68 56.3	137 14.4	45.3
N-8	69 12.2	136 18.3	68 57.8	137 16.4	44.7
N-9	69 13.5	136 20.9	68 58.4	137 22.5	46.9

West Mackenzie Bay

Transect Number	EAST ENDPOINT °N	°W	WEST ENDPOINT °N	°W	LENGTH (km)
WM-1	69 14.8	135 50.7	69 14.8	136 30.0	25.5
WM-2	69 17.3	135 50.9	69 17.3	136 30.0	25.2
WM-3	69 19.9	135 39.0	69 19.9	136 30.0	33.1
WM-4	69 22.4	135 37.8	69 22.4	136 30.0	34.2
WM-5	69 25.0	135 34.8	69 25.0	136 30.0	36.0
WM-6	69 27.6	135 37.6	69 27.6	136 30.0	34.1

APPENDIX A
(continued)

East Mackenzie Bay

Transect Number	EAST ENDPOINT °N	EAST ENDPOINT °W	WEST ENDPOINT °N	WEST ENDPOINT °W	LENGTH (km)
EM-A	69 28.7	135 20.8	69 28.7	136 00.0	25.7
EM-1	69 30.4	134 35.9	69 30.4	136 00.0	54.4
EM-2	69 32.1	134 35.2	69 32.1	136 00.0	54.8
EM-3	69 33.8	134 34.0	69 33.8	136 00.0	55.6
EM-4	69 35.6	134 30.6	69 35.6	135 39.1	44.3
EM-5	69 37.3	134 28.9	69 37.3	135 36.3	43.6
EM-6	69 39.0	134 26.2	69 39.0	135 33.5	43.4
EM-7	69 40.7	134 29.6	69 40.7	135 33.5	41.2
EM-8	69 42.3	134 30.2	69 42.3	135 03.5	21.5
EM-9	69 44.0	134 22.6	69 44.0	135 03.5	26.3
EM-10	69 45.7	134 23.4	69 45.7	134 43.2	12.8

Kugmallit Bay

Transect Number	EAST ENDPOINT °N	EAST ENDPOINT °W	WEST ENDPOINT °N	WEST ENDPOINT °W	LENGTH (km)
K-A	69 22.7	133 35.6	69 22.9	133 55.0	12.5
K-1	69 24.2	133 09.5	69 24.6	133 52.5	28.0
K-2	69 25.9	133 03.5	69 26.2	133 50.4	30.4
K-3	69 27.6	132 59.2	69 28.0	133 47.9	31.5
K-4	69 29.4	133 00.0	69 29.7	133 46.5	30.1
K-5	69 31.1	132 58.8	69 31.4	133 40.8	29.5
K-6	69 32.7	132 58.3	69 33.1	133 40.0	29.3
K-7	69 34.4	132 59.7	69 34.9	133 46.0	29.4
K-8	69 36.2	132 58.2	69 36.7	133 58.8	38.9
K-9	69 37.8	132 56.9	69 38.5	134 07.7	45.5
K-10	69 39.4	132 39.0	69 40.2	134 07.6	56.9
K-11	69 41.1	132 37.6	69 41.8	134 13.9	62.0

APPENDIX B

Location and size of surveyed area
and percent coverage of study area

Survey period	Sub-area	Lines flown	km^2 surveyed	Sub-area size (km^2)	% coverage
July 03	Niakunak Bay	NA-N9	609.5	1,242.6	49.1
July 07-09	Niakunak Bay	NA-N9	609.5	1,242.6	
	West Mackenzie Bay	W1-WS	246.4	698.8	
	East Mackenzie Bay	EA-E3	304.8	612.9	
	Kugmallit Bay	KA-K9	488.1	983.2	
			1,648.8	3,537.5	46.6
July 15-16	Niakunak Bay	NA-N9	609.5	1,242.6	
	West Mackenzie Bay	W1-W6	301.0	862.5	
	East Mackenzie Bay	EA-E10	677.8	1,307.9	
	Kugmallit Bay	KA-K9	488.1	983.2	
			2,076.4	4,396.2	47.2
July 22-23	Niakunak Bay	NA-N9	609.5	1,242.6	
	West Mackenzie Bay	W1-W6	301.0	862.5	
	East Mackenzie Bay	EA-E8	615.2	1,193.7	
	Kugmallit Bay	KA-K8	415.3	834.1	
			1,941.0	4,132.9	47.0

APPENDIX C

Other marine mammals sighted during reconnaissance and systematic surveys for white whales, June 24-July 24, 1985

APPENDIX C

Other marine mammals sighted during reconnaissance and systematic surveys for white whales, June 24-July 24, 1985

DATE	SPECIES	APPROXIMATE LOCATION	OBSERVATION	SURVEY TYPE[a]
June 24	ringed seal	69°30'N, 136°55'W	2 seals, hauled-out on ice pan	R
June 24	bearded seal	69°30'N, 136°55'W	1 seal, hauled-out on ice pan	R
June 24	ringed seal	70°32'N, 130°05'W	1 seal	R
June 24	ringed seal	70°18'N, 131°00'W	1 seal, bobbing in water	R
June 28	ringed seal	70°15'N, 131°16'W	1 seal	R
June 28	ringed seal	69°54'N, 135°38'W	1 seal	R
June 28	bearded seal	70°34'N, 129°31'W	1 seal	R
June 28	ringed seal	70°40'N, 129°00'W	1 seal	R
June 28	ringed seal	70°40'N, 128°28'W	1 seal	R
July 22	ringed seal	near Tent Island	1 seal, next to log	S
July 22	ringed seal	near Tent Island	1 seal	S
July 23	ringed seal	west of Hooper Island	1 seal, hauled-out on pan	S
July 23	ringed seal	northeast Summer Island	1 seal, hauled-out	S
July 24	bowhead whale	Franklin Bay	2 whales, swimming and diving	R

[a] R = Reconnaissance
S = Systematic.

APPENDIX D

White whales observed by industry and support personnel in the southeast Beaufort Sea, July-October 1985

APPENDIX D

White whales observed by industry and support personnel in the southeast Beaufort Sea, July-October 1985

DATE/TIME	LOCATION	NO. OF WHALES	OBSERVATION	SOURCE
June 20/1100	5 mi. south of Akpak	4	"included female and calf"	Helicopter Pilot
June 23/NS	just north of Stokes Point	8	seen in a small lead	Pilot, Kenn Borek Air
June 24/1300[a]	east of Herschel Island	10-40	seen all afternoon	Gulf (Arctic Kiggiak)
June 25/0700[a]	69°30'N, 138°58.9'W	8	"mixed adolescent and adult" group seen for 2-3 days	Gulf (W.D. Gateway)
June 28/1000[a]	69°57.6'N, 133°31.4'W	"large school"	seen from drilling platform in a lead	Esso (Rig 7)
July 07/NS[a]	southwest corner offshore Garry Island	15-20	---	Esso
July 07/NS[a]	northwest or northeast (?) of Pelly Island	± 200	"some very large animals and some calves" headed toward Shallow Bay	Esso

APPENDIX D
(continued)

DATE/TIME	LOCATION	NO. OF WHALES	OBSERVATION	SOURCE
July 08/NS[a]	near Kendall Island	± 100	---	Helicopter Pilot
July 08/NS[a]	near Hooper Island	some	---	Helicopter Pilot
July 11/1015[a]	69°31.5'N, 138°54.4'W	2	remained 40 m from tanker for 5 min	Gulf (*Gulf Beaufort*)
July 15/NS[a]	north of Garry Island	1	---	Chevron
July 28/2140	10 n.mi. west of Akpak	1	resting at surface	Gulf
July 29/0500	69°33'N, 138°56'W	3	travelling south, near ship's anchor	Dome (*Canmar Teal*)
July 31/1547	southeast of Herschel Island	2	remained 6 m from tanker for 10 min	Gulf (*Gulf Beaufort*)
Aug 02/0125	69°32'N, 138°55.3'W	1-4	whale(s) around vessel on and off for last 2 weeks	Gulf (*Gulf Beaufort*)
Aug 05/NS	10 n.mi. northeast of Adlartok	1	---	Dome (*Explorer III*)
Aug 07/1100	McKinley Bay	1	travelling various directions	Dome (*Sea Eagle*)

APPENDIX D
(continued)

DATE/TIME	LOCATION	NO. OF WHALES	OBSERVATION	SOURCE
Aug 11/1045	Adlartok	1	swimming inside marker buoys for anchor of drillship	Dome (*Explorer III*)
Aug 13/1645	McKinley Bay	3	appeared to be feeding - gulls in vicinity	Dome (*Explorer I*)
Aug 14/NS	Tarsiut	1	near caisson	Gulf (*Molipaq*)
Aug 15/2005	70°14'N, 131°51'W	1	diving, moving north, described as "young"	Dome (*Canmar Tugger*)
Aug 18/0800	McKinley Bay	2	feeding in bay	Dome (*Explorer I*)
Aug 25/NS	McKinley Bay	9	---	Dome (*John Wurmlinger*)
Sep 04/0801	70°19'N, 131°53'W	1	swimming east	Dome (*Kigoriak*)

NS = not specified.
a = indicates sightings made during time frame of this study.
n.mi. = nautical miles.