BATHURST CALVING GROUND SURVEYS

1965 - 1996

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ABSTRACT

The Bathurst caribou herd's calving grounds have been surveyed 16 times from 1965 to 1996. A composite map was created by overlaying calving grounds for 14 of the years surveyed. Changes in survey design, criteria for defining the calving ground, timing and coverage of surveys, and weather conditions have varied from year to year. In the years surveyed from 1965 to 1984, there was a high degree of overlap of areas used for calving. These areas extended from approximately 40 km east of Bathurst Inlet to Perry River. Parts of the calving grounds have been used for as many as 11 years out of the 14 years mapped. In 1969 and after 1986, calving was concentrated further west along the east and west shores of Bathurst Inlet. This is consistent with historical records which report that both sides of Bathurst Inlet were used for calving.

EKWǪ WEGHǪ HAXOĮWǪ

1965 eyıts'ǫ 1996 gots'ǫ̀ Bathurst Inlet ekwǫ̀ nàłeshe k'è sìı, hǫǫ̀nǫ dats'ǫ ek'etaı wedànahoèt'ǫ ɻlè. Ndè nɻhtɬ'è netłǫ ełek'è whela ageʔɻh t'à wegodı nàtsɻgele sìı hǫǫ̀nǫ dats'ǫ dɻɻ xǫ hagɻʔɻh. Edàanɻ wedànahoèta eładɻ at'ɻh, ekwǫ̀ nàłeshe k'e ayìì awets'edı eładɻ at'ɻh, ayìì dzę gogha hoèhʔǫ eyıts'ǫ̀ sǫ̀mba wets'ǫ̀ k'ehoèhwı nàeta eyıts'ǫ̀ xò taot'e ełegoɻt'e-le hǫt'e. 1965 eyıts'ǫ̀ 1984 gots'ǫ̀ wedànahoèt'ǫ̀ sìı, eyìì zǫ làanı ekwǫ̀ nàłeshe k'è hoʔǫ. Bathurst Inlet ts'ǫ̀ k'àbatsǫ̀ǫ̀ dąą Perry Rıver gots'ǫ̀ awets'ɻdı hǫt'e. Hǫǫ̀nǫ dats'ǫ̀ dɻɻ xò k'è wedanahoètǫ sìı, hǫǫ̀nǫ dats'ǫ ɻlè xò t'à eyìì ekwǫ̀ nàłezhe k'è mǫǫ̀da zǫ t'à ageàt'ɻ. 1969 eko, eyıts'ǫ̀ 1986 tɬ'àxǫ dąą nɻhts'ı ts'ǫǫ̀k'è ekwǫ̀ nałeshe ajà, Bathurst Inlet k'àbatsǫ̀ǫ̀ eyıts'ǫ̀ dąą nɻhts'ı làanɻ tɻ baa. ɻnę̀ę whaà gots'ǫ̀ enɻhtɬ'è whela sìı, Bathurst Inlet ełats'ǫ̀ wets'ǫǫ̀k'e ekwǫ̀ nàłeshe k'è hoʔǫ ɻlè wegodı dek'etɬ'è ɻlè.

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ᓭᑲᒥᐅᑕᐅᓂᕐᖃᑕᐅᖅᑕᕐᕋᑦ ᑐᖃᑐᐃᑦ ᓄᕐᓚᓴᖏᓂᒋᓪᓗᑎᑦ ᖃᐅᔨᓴᖃᑕᐅᓱᒪᓕᕐᖃᑦ ᐊᓴᖃᑕᐅᓱᒪᓕᕐᖃᑦ 16-ᖏᑎᖃᓱᖃᓪᓗᑎᒃ 1965-ᒥᑦ 1996-ᒧᑦ. ᑕᓀᑎᕋᐱᑎᒃᓴᓂᒃ ᓄᓇᖏᔪᐊᓕᐅᖅᑕᐅᓱᒪᓕᕐᓂ ᓄᕐᓚᓴᐱᕐᒃᑕᕐᑎᑦ 14-ᖏᑎᖃᓱᖃᓪᓗᑎᒃ ᑭᒃᓀᓇᓂ ᐊᓴᖃᑕᐅᓴᐱᓪᓚᐅᐅᖅᑕᕐᖓᓂᓂ ᐅᑭᐅᓂ. ᐊᖏᑭᐊᖅᑕᐅᓪᓚᐅᕐᒥᔪᓪᒪᑕ ᖃᐅᔨᓴᖃᑎᑦ ᓴᓇᒪᓂᖏᑦ, ᐊᐅᐊᔪᖏᑦᓪᓗ ᐊᓇᓴᐅᐃᓴᐊᓪᓚᐅᖅᑕᕐᖃᑦ ᓄᓇᓂᓂ ᐊᓇᖅᑕᐅᖅᑕᕐᖃᑦ ᓄᓇᓴᐅᖅᑕᕐᖃᑦ. ᓄᓇᓚᐅᖅᑕᕐᖃᓂ ᓄᓇᓴᐅᖅᑕᕐᖃᑦ ᖃᐅᔨᓴᖃᑕᐅᓱᒪᓕᕐᖃᑦ ᓄᓇᓴᐅᖅᑕᕐᖃᑦ. ᐊᓪᓚᑦᑐᐊ ᓄᓇᐃᑦ ᖃᐅᔨᓴᖃᑕᐅᓱᒪᓕᕐᖃᑦ ᐅᑐᓇᓂ 40-ᑭᓪᓕᒋᑎᒃ ᐅᖏᓪᓗᓂᒍᖏᑦ Bathurst Inlet ᖃᓄᖏᐅᒥᑦ ᑲᖏᓄᓂᑦ Perry River-ᒧᑦ. ᐃᓕᖏᑦ ᑭᒃᑐᐊ ᓄᓇᐃᑦ ᓄᓇᓴᐅᖅᑕᕐᖃᓱᖏᓕᑕ ᐅᑭᐅᓂᒃ 11-ᓂᒃ ᑭᒃᑐᓇᓂ 14-ᓂ ᐅᑭᐅᓂ ᖃᐅᔨᓴᖃᓴᐅᐱᑦ ᓄᓇᖏᔪᐊᓕᐅᖅᑕᐅᓂᒋᓪᓗᑎᑦ. 1969-ᒥ ᐊᓘᓚᓪ 1986 ᑭᖏᔪᓂᖏᓂ, ᓄᓇᖃᑕᕐᓂᓂᖅᓴᐅᓕᐅᕐᖓᓕᑕ ᐅᐊᓕᓂᓂᖏᓂᐅᓂᓂᖅᓴᖃᖅ ᑕᒧᒪᓂ ᖃᓄᖏᐅᑦ ᓂᓴᖏᓂ ᐅᐊᓕᓂᓂᖏᓂᓪᓗ ᖃᓄᖏᐅᑦ ᑲᓀᖏᔪᖏᓕᑕ. ᑭᒃᑐᐊ ᑕᐃᔪᒪᖏᓂᓂᐊᓗᒃ ᑕᐃᒪᐃᓂᐅᓂᕐᖓᓕᑕ ᖃᐅᔨᓴᒪᕐᐅᓂᐅᖅᑐᒃ ᒪᓕᓪᓗᑎᒃ ᑎᑎᕋᖅᑕᐅᖃᑦᑕᕐᖃᔪᓂᐅᖅᑐᒃ ᑕᒪᐃᑕ ᖃᓄᖏᐅᑦ ᑲᓀᖏᔪᖏᓕᑕᕐᖃᖅ ᓄᓇᓕᒫᓂ ᓄᓇᓴᐅᖅᑕᕐᖃᑦᑕᕐᒪᑦ.

NOITANGITTOK

TABKOA KENGGAOKMIOT TUKTUT NUGGALIOKVIIT EHIVGIOKTAOHIMAYUT 16-NIK 1965-MIT 1996-MOT. OKOAT NUNAOYAT TITIGAKTAOHIMAYUT HOMI TUKTUT NUNALIOKPAKTOT OKOANI 14-NI OKIONI NAONAIYAKTAOVAKTOT. ALLANGOKPAKTOT ELAIT, HOMILIKIAK NUGGALIOKPAKVIITNIK, KANGANGOGANGATLO HOKOTLO EHIVGIOKTAOVAKTOT, OVALO HILALO KANOGILIGANGAT OKIOTOAK. OKONANI OKIONI EHIVGIOKHIKMATA 1965-MIT 1984-MOT, TUKTUT AHIANOT NUGGALIOGIAKTOKPAKTOT. OKOA KIGLIKAKTOT 40 KM KIVATAANI KENGGAOP TAONONGA KUGYOAMOT. ELAIT TAHAPKOA NUGGALIOKVITOKAIT 11-NI OPINGANI 14-NIK EHIVGIOKTITLOGIT NUNAOYANOT NAONAIKTAIT. OVANI 1969-MI ONALO OKIOK 1986 ENIKMAT, TUKTUT NUGGALIOKPAKTOT UMINGMAKTOP KIVATAANI OVANILO KENGGAOP OATAANI. HAPKOA NAONAITTOT INUIT ELIHMAYAIT NUGGALIOKVITOKAIT KENGGAOP NUNAGANI.

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INTRODUCTION

Caribou (*Rangifer tarandus)* annually return to calve on an area that largely overlaps with the areas used in previous years. The Department of Resources, Wildlife and Economic Development defines ***traditional calving grounds*** as the total area known to be used for calving over many years by caribou from a particular herd, which includes all known annual calving grounds for that herd. The ***annual calving ground*** is the area known to be used for calving in one year by caribou from a particular herd using the best data available on the distribution of calving caribou.

The possibility for mines on and near traditional caribou calving grounds is raising questions about how calving grounds are defined and mapped. The Bathurst herd is one herd whose calving grounds in the vicinity of Bathurst Inlet are also the area for recent mining exploration (Fig. 1). Those activities and our on-going requirements for efficient and economic survey designs indicate a need for predictive capability on the probability that caribou will calve at a given location. The first step is to compile the annual calving grounds in order to map the traditional calving ground and to justify its boundaries.

Calving grounds are mapped during the aerial surveys used to estimate caribou numbers. The Department of Renewable Resources (DRR), the precursor to the Department of Resources, Wildlife and Economic Development, has surveyed the Bathurst herd's calving grounds 16 times from 1965 to 1996.

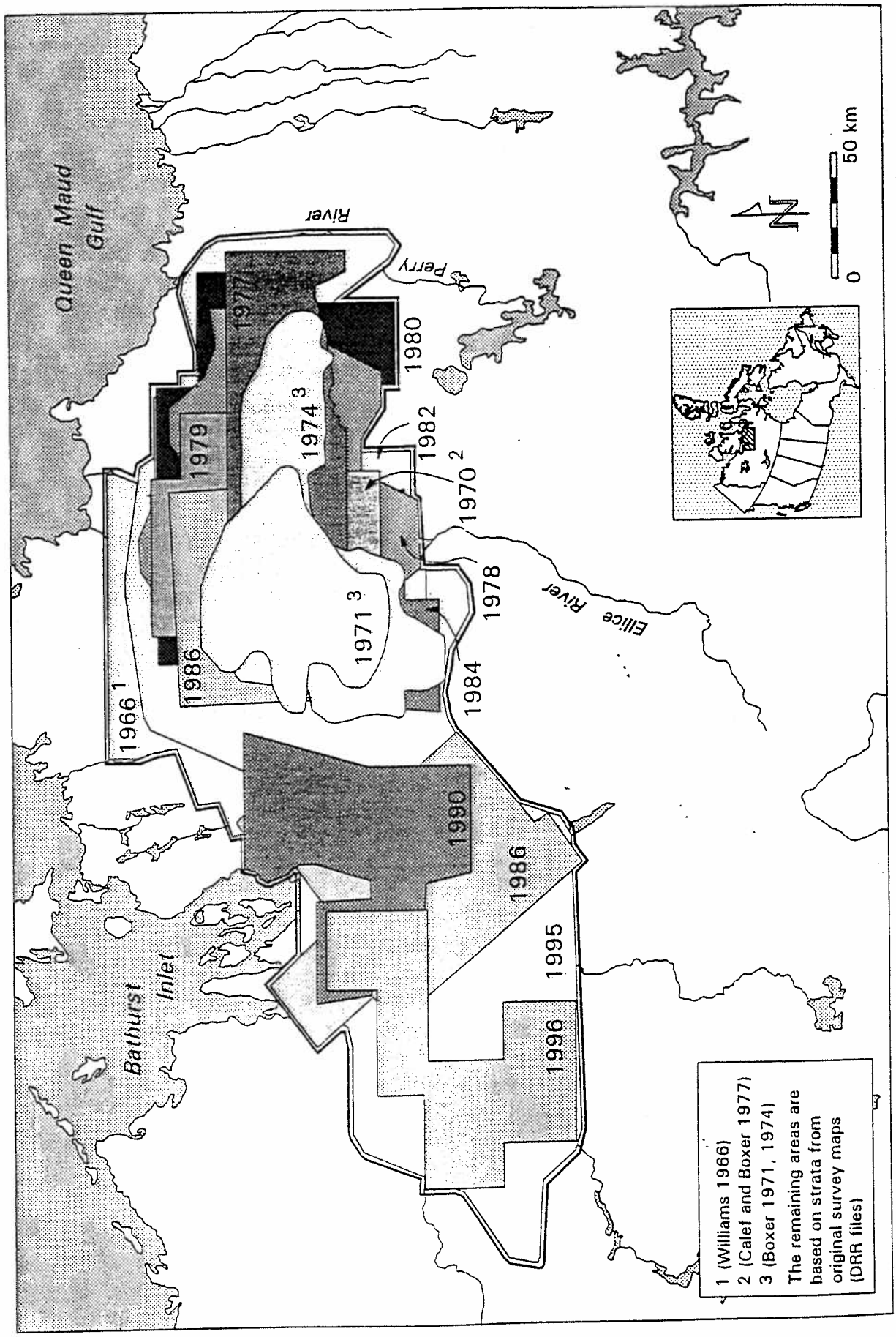

Figure 1. Superimposed annual calving grounds delimited during systematic and unsystematic reconnaissance surveys on the Bathurst calving grounds, 1966-1996

Not all of the survey reports have been published and some reports have not included flight line maps.

Our objectives in this report were: 1) to map the Bathurst caribou herd's traditional calving grounds from the 1965-1996 surveys and 2) to collect flight lines and survey strata for each annual calving ground survey into one report.

METHODS

The Department of Renewable Resources (DRR) surveyed the Bathurst herd's calving grounds 16 times between 1965 and 1996 (1965, 1966, 1969, 1970, 1971, 1974, 1977, 1978, 1979, 1980, 1982, 1984, 1986, 1990, 1995, 1996). A composite map (Fig. 1) was prepared by overlaying the calving areas delimited during each survey[1]. These calving areas were the areas covered by systematic transects (1966, 1995); areas delimited during unsystematic reconnaissance (1970, 1971, 1974); or, after stratification, the strata delimited during the surveys.

Each calving ground survey started with an unsystematic search of the calving grounds to find caribou. This is termed unsystematic or spaghetti reconnaissance. In 1996, an unsystematic survey was not required. Ten middle-aged cows from the Bathurst caribou herd were caught and fitted with satellite collars in April. Caribou locations were received once a week until 25 May and then daily during the calving period.

After locating the caribou, a transect survey was conducted with the transects systematically spaced at equal intervals and these transects extended until no more cows were observed. From 1965 to 1974, areas with caribou (mainly cows, but also including bands of yearlings at periphery) were located

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[1] This does not include the 1965 and 1969 surveys as maps of the calving ground delineation for these years were not available.

and outlined during the unsystematic reconnaissance. Transects were spaced over this area and extended past the delimited area. In 1965, 1966 and 1970, the number of caribou was estimated from this systematic transect survey. This method of estimating numbers continued in 1971 and 1974; but in addition, the area covered by the transects and within the caribou distribution (delimited during unsystematic reconnaissance) was divided into equal-area blocks. Randomly selected blocks were searched and caribou counted. In subsequent years, these random block surveys were not used and caribou numbers were again estimated from counts along fixed-width (0.8 km wide) transects.

Stratification was part of the evolving design for calving ground surveys. It was added in 1977 to increase precision by adjusting survey intensity proportional to caribou density. The strata were blocks of similar caribou densities (low, medium and high) either approximated from unsystematic surveys or determined more precisely from systematic surveys. In 1977, 1979 and 1984, counts from the spaghetti reconnaissance were used to stratify the area and each stratum was then systematically covered with transects spaced at intervals dependent on caribou density. In 1978, 1980, 1982, 1986, 1990, and 1996, stratification was based on the systematic reconnaissance. Evenly-spaced transects covered the area in which caribou were seen during the spaghetti reconnaissance. Densities were estimated for 10-km segments along the transects and then areas with similar densities were grouped together to form strata.

In 1980, and for subsequent years, high altitude aerial photography added another phase to the survey design. A photographic survey aircraft reflew all (1980, 1982) or some of the strata (1984, 1986) to photograph the caribou. Strata for the photographic surveys were based on the transect survey strata boundaries, except in 1984, when strata were delimited by grouping similar densities along 10-km segments of the transect survey. In 1990, the stratified transect survey was dropped and only a photographic estimate was obtained.

In 1984 and during subsequent years, unsystematic flights were made to sample the sex and age composition of caribou on the calving grounds. These flights were done after the area had been stratified and the visual estimate survey had been completed. In 1996, composition counts were also done from the ground in high and medium density areas.

In this report, the survey design has been described in only enough detail to explain the different mapped flight lines for each survey. The rationale for the design and other details are in the cited reports.

Figures

From 1977-1996, original spaghetti reconnaissance flight lines were recorded on 1:500,000 scale maps. Flight lines for the systematic reconnaissance, stratified transect, photographic, and composition surveys when completed were recorded on 1:250,000 scale maps. From these original survey maps, all flight lines for the nine years from 1977 to 1996 were transferred to

basemaps in *Freelance Graphics*[2]. (Basemaps were imported into *Freelance Graphics* from *QUIKMap*[3]). All lines were drawn by hand.

For surveys in 1966, 1971, and 1974, all information was taken from unpublished reports (Williams 1966; Boxer 1971, 1974) and transferred to maps in the same manner as stated above.

Strata density classifications (high, medium, low) were taken from unpublished reports, survey and file notes, or original survey maps.

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[2] *Freelance Graphics* is a graphics software package from Lotus Development Corporation.

[3] *QUIKMap* is a software package used to put geo-referenced information on maps. It is produced by ESL Environmental Services Limited, Sydney, BC.

RESULTS AND DISCUSSION

The Bathurst herd's traditional calving grounds (Fig. 1) were mapped from the location of cows and yearlings from 1966 to 1974 and then from the location of parturient cows and cows with calves from 1977 to the present. There is a high degree of overlap between the annual surveys from 1966[4] to 1984. More recently, since the mid-1980s, the annual calving grounds have shifted to lie west of Bathurst Inlet which in turn extends the traditional calving grounds further west. The highest frequency of overlap is concentrated east of Bathurst Inlet where areas have been used for 11 of the 14 years in which they were delineated (Fig. 2). Mapping just the areas designated as high density (Fig. 3) shows a clustering between the Perry and Ellice rivers until the mid-1980s. Subsequent to 1984, during the four surveys between 1986 and 1996, calving was clustered around Bathurst Inlet. In 1996, the highest concentration was found approximately 100 km west of the previous high density clustering.

We have a scattering of information to suggest that calving west of Bathurst Inlet is not a new phenomenon, which is to say that the area was part of the traditional calving grounds prior to the mid-1980s and 1990s, but we are handicapped in reaching any conclusions as most reconnaissance flights were only conducted east of the Inlet. Additionally, in making conclusions about

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[4] The report on the 1965 survey (Williams, R.W. 1965. Bathurst Inlet caribou survey. 5 pp) was not available.

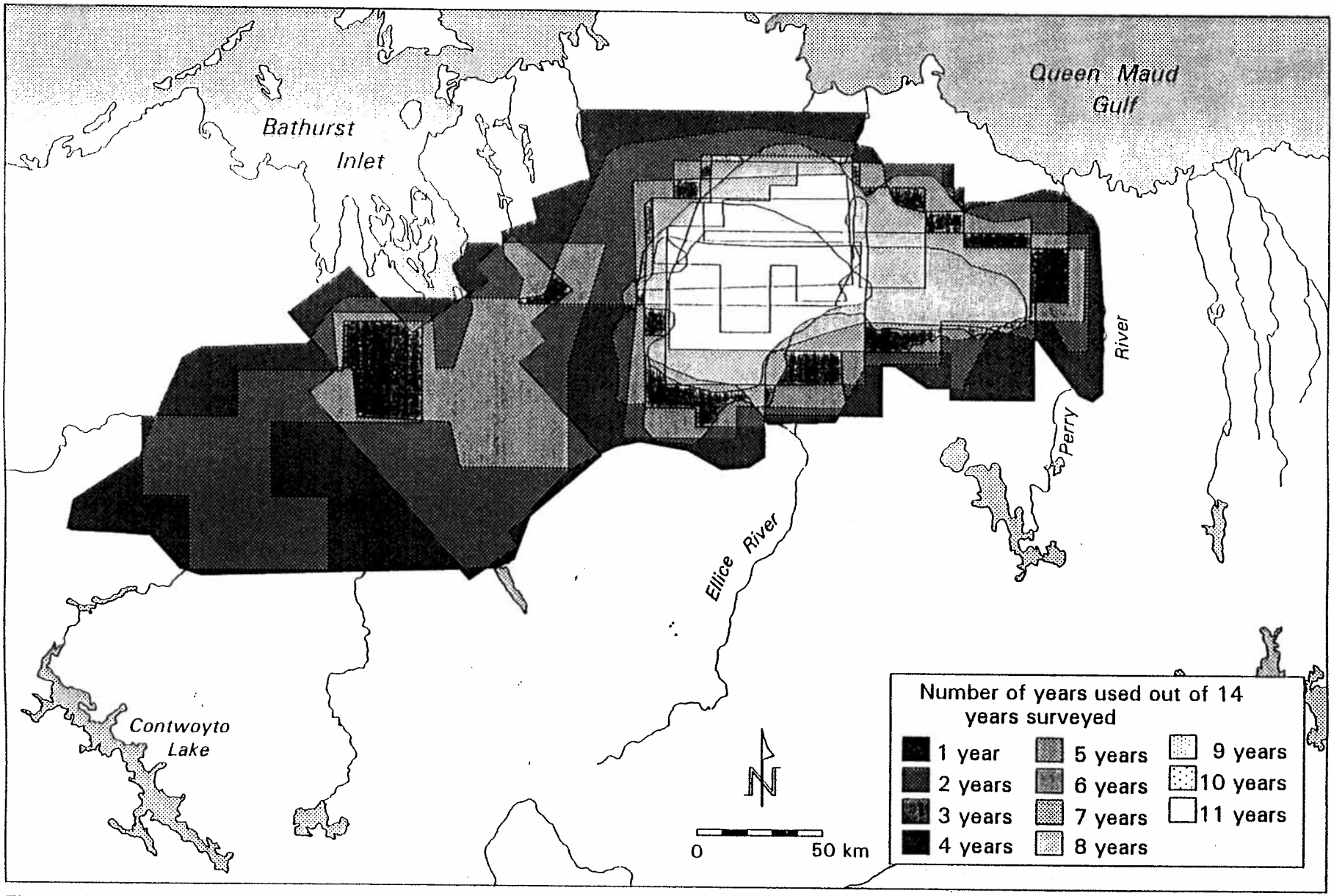

Figure 2. Frequency of use on the Bathurst calving grounds, 1966-1996

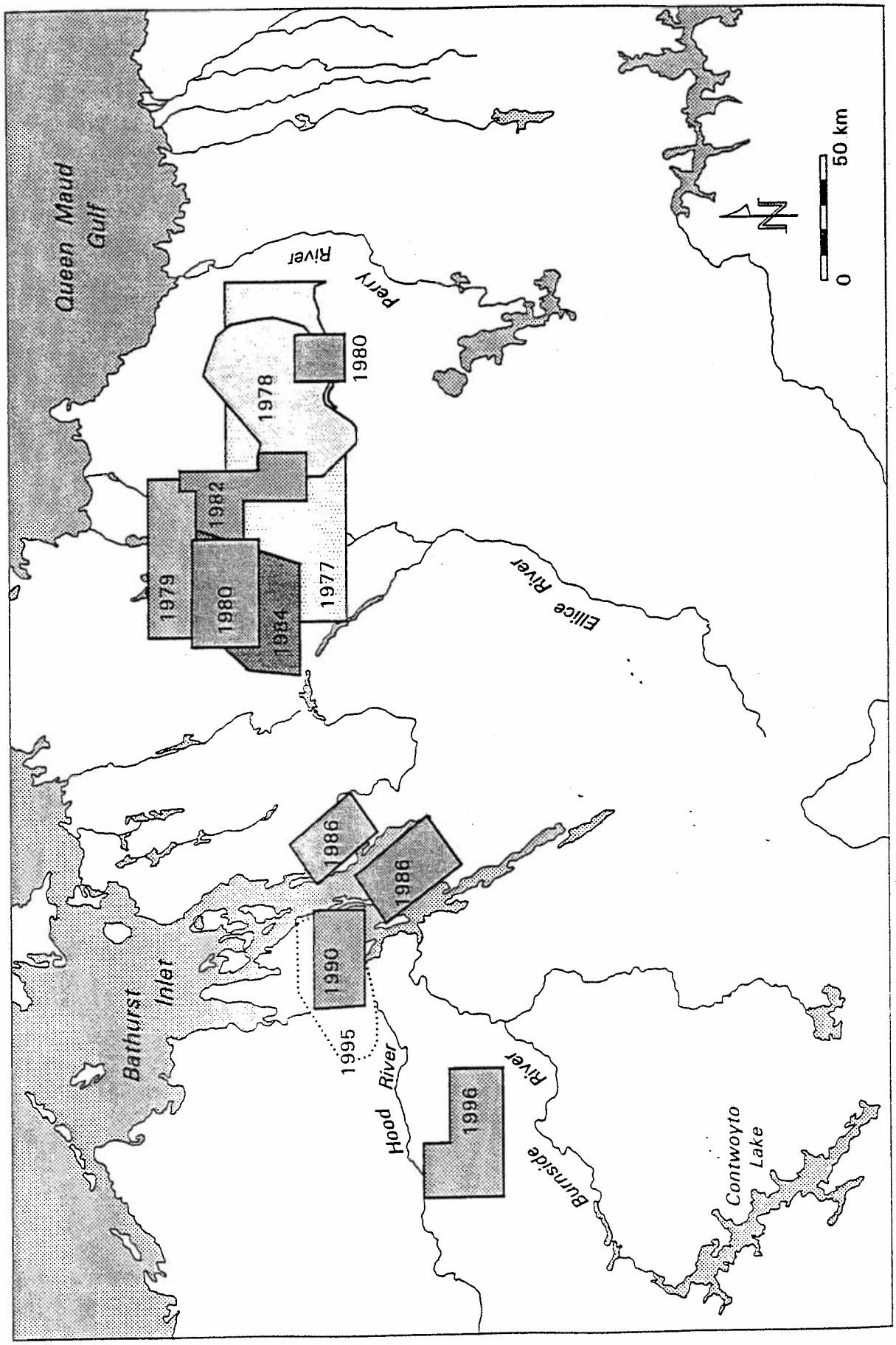

Figure 3. High density strata from 1977-1996 surveys and approximated area of high density from the 1995 survey of the Bathurst calving herd.

calving west of the Inlet, we are further handicapped by missing maps and reports. The following paragraphs contain details on the reconnaissance flights relative to Bathurst Inlet and while giving those details, we recognise that our comments have the acuity of hindsight and are not a criticism of the surveys.

Information prior to the beginning of regular surveys is sporadic and sparse. Urquhart's (1981) compilation on the Bathurst herd's seasonal movements reports that observations in the 1930s indicate calving was east, west and south of Bathurst Inlet. Kelsall (1951) reported caribou calving west of Bathurst Inlet in 1950 and 1951, although he suspected that they were not the main body of the herd as the percentage of adult females was low and the percentage of yearlings and 2-year-olds was high. Kelsall in a 1953 report described caribou calving on both sides of Bathurst Inlet, but in a later publication (Kelsall 1955), he concluded that in most years the caribou calved east of the Inlet.

During the first two systematic surveys, Williams (1966) reported that, in 1965, a smaller area was used for calving but in the same location as in 1966 which was east of Bathurst Inlet (Figs. 4 and 5)[5]. Unfortunately, we do not have maps for the 1965 survey, but in 1966, there were no reconnaissance flights conducted west of Bathurst Inlet. Again, we do not have a record of the reconnaissance flights for the next survey in 1969; however, Ruttan (1969) reported concentrations of cows in valleys on both the east and west sides of the

[5] Figures 4 to 62 appear together in the main body of this report beginning on page 23.

Inlet in 1969 (Fig. 6). He also commented that a severe snowstorm and freezing rain may have affected calving distribution during the first week of June and also prevented the survey's completion (Ruttan 1969).

For the four surveys from 1970 to 1977, calving was mapped east of Bathurst Inlet (Figs. 7 - 16) and the country west of the Inlet was not apparently surveyed, although we do not have maps for the reconnaissance flights in 1970. The calving ground boundary in 1970 appears to differ from that previously reported (Fleck and Gunn 1982, Urquhart 1981). The original maps (Boxer 1970) were not available and, therefore, the calving ground outline in this report (Fig. 7) was taken from a summary map of calving grounds from 1966-1977 (Calef and Boxer 1977, DRR files). This discrepancy may be a result of the transect survey having been completed twice in 1970.

In 1971 (Fig. 8), 1974 (Fig. 11) and 1977 (Fig. 14), all reconnaissance flights were conducted east of Bathurst Inlet, but in 1977, there was an observation of calving west of Bathurst Inlet. Urquhart (1981:C4) commented that "calving probably also took place in the James River region" and he cited Calef and Boxer (1977) as the source, but we could not find the observation in that reference. The observation was for 10 June, one day after the survey was completed (31 May - 9 June 1977). Fleck and Gunn (1982:10) comment that "calving caribou have also been reported in the hills west of Bathurst Inlet in 1951, 1977 and 1979 ... and on the Kent Peninsula in 1936, 1937 and 1938".

The next two surveys were carried out in 1978 and 1979 and, as with the previous surveys in the 1970s, aerial coverage over western Bathurst Inlet was sporadic. Most recorded calving and the calving ground surveys were east of the Inlet, but tantalizingly, we have brief reports that indicate calving west of the Inlet.

Starting with 1978, the single reconnaissance flight west of Bathurst Inlet on 4 June (Fig. 17) found no calving caribou. Observers spotted caribou on the west side of the Inlet along the Burnside River, but the animals were mainly bulls and dry cows. There were extensive trails in the area (SW-NE) probably of caribou migrating from Contwoyto Lake and the Burnside River to the calving grounds east of Bathurst Inlet. There were also extensive trails (N-S) in an area just north of the Burnside River and about 10 km west of the Mara River (DRR files). The remainder of the survey was conducted east of the Inlet (Figs. 18 - 20). The stratified census in 1978 was not completed for administrative rather than technical reasons (DRR files).

In 1979, cows and calves were reportedly seen on the southwest side of Bathurst Inlet on the 4 June reconnaissance flight (Fig. 21). Caribou were also seen during the one reconnaissance flight along the western coast of southern Bathurst Inlet on 6 June (Fig. 21), although observers noted that "many of the caribou were not cows but yearlings and immatures" (DRR files). The observers decided that a visual census was not viable as they did not record caribou densities similar to previous years. They assumed that, because the caribou

were found in small scattered groups, they had not located the main calving area (Urquhart 1981). The calving grounds were not delineated during the systematic reconnaissance (Fig. 22), but survey strata were drawn based on the caribou distribution on 14 June 1979 (Figs. 23 and 24). This may not accurately reflect the entire calving area.

In the early 1980s, most survey efforts were concentrated east of Bathurst Inlet. The reconnaissance flights in 1980 did include a single flight south of Bathurst Inlet and west to the Burnside River (Fig. 25), but calving cows were not seen. The calving ground was delimited east of the Inlet and, as in 1977, its eastern boundary was close to the Perry River (Figs. 26 - 30). In the survey report, Heard (1980:6) commented: "The 1980 calving ground estimate was the lowest ever recorded and suggests a decline of the herd that may have begun 6 years earlier...Some cows calved on the northwest side of Bathurst Inlet but apparently, not enough to make up the difference." The surveys in 1982 and 1984 were similar in that reconnaissance flights and the mapped calving grounds were located east of Bathurst Inlet (Figs. 31 - 43). In 1980 and 1984, some reconnaissance flight lines may be missing from the figures (Figs. 25 and 38) (DRR files).

From 1986 to 1996, both the survey effort and the mapped calving distribution were located progressively more west of Bathurst Inlet (Figs. 44 - 60). However, the westward shift in the high density strata (Fig. 3) makes it highly probable that the trend in calving west of Bathurst Inlet was real and not

simply a consequence of more time spent looking there. In 1986 and 1995, spring melt was late and the cows may have been delayed during migration which would have encouraged a more westward distribution for calving. In 1995, the survey aircraft and pilot became unavailable during the middle of the survey period. Due to this unexpected interruption, the survey could not be completed. In 1990, with an average spring, many caribou calved on both sides of Bathurst Inlet with highest concentrations along the western shore.

Satellite telemetry replaced the unsystematic reconnaissance in 1996. The 10 cows, when collared in April, were in two different areas; although by 4 June, they were clumped together in what was determined to be the high density stratum southwest of Bathurst Inlet between the Hood and Burnside rivers (Fig. 58).

Our composite map (Fig. 1) reveals that within the Bathurst herd's traditional calving grounds, the annual calving grounds have shifted to the west of Bathurst Inlet. Our experience with the Beverly herd's calving grounds (Sutherland and Gunn in prep.) over four decades also reveals a progressive shift in the location of the annual calving grounds. The shift is a retreat back along the general direction of late spring migration. Our observations over four decades are too brief for us to discern if the shift is a rotation onto areas previously used and we would be as equally ill-acquainted with long-term calving distribution to predict whether the Bathurst herd will return to calving east of the Inlet. Our definition for ***traditional calving grounds*** is the total area known to

be used for calving over *many* years and 16 surveys during 4 decades may not be an adequate sample.

The high degree of overlap among annual calving grounds indicates that the location is relatively predictable over the short term (years rather than decades), but we caution that our mapped (Fig. 1) traditional calving grounds have limitations in predicting the location for future annual calving grounds. We have already suggested that the sample period (1966-1996) is too short. A survey of Inuit traditional knowledge on calving distribution may extend the sample period. In addition, the map only applies to the distribution at or close to the calving peak for 2 or 3 days when each annual calving ground was surveyed. The cows are on the calving ground for about 2 weeks during the ***calving period***, which is the interval between the earliest and latest births. Within this period, there is a 5-day peak when most calves are born (Fleck and Gunn 1982). Therefore, our mapped annual calving grounds are only a snapshot of the calving distribution during a survey that lasts 2-3 days or about 15% of the time that the cows are on the calving grounds. The distribution immediately before or after peak calving is not included.

The probability that the map predicts future calving locations also incorporates two quite separate sources of uncertainty - technical and environmental. We list here five technical uncertainties which are: changes in survey design, changes in timing, weather, adequacy of coverage, and missing data.

1. Survey design has evolved over the years (Table 1) as well as the criteria used for delineating calving grounds (Table 2). Prior to 1977, the location of the calving ground was determined on the basis of cow and yearling locations (Boxer 1971). Bands of yearlings that congregated just outside the area occupied mainly by cows were also included. In 1977 and afterwards, the calving ground was defined as the area occupied by cows and calves (Calef and Boxer 1977).

2. Timing of surveys has varied relative to peak calving dates (Fig. 61). Peak calving is important to survey timing because the optimum time for surveying is during the peak when caribou are relatively dispersed (as compared to clumped) and are not extensively moving. It is also important for mapping and defining calving boundaries in that, before the peak, cows may still be arriving at the calving ground and their distribution may thus be more extensive. After the peak and once the calves are a few days old, the cows start to move together into larger groups which can travel swiftly. Those movements before and after the peak mean that the mapped boundaries can and do change rapidly. The median dates for the Bathurst herd are 5-9 June. The peak of calving in 1969, 1979, and 1986 was conspicuously late. Peak calving dates were taken from unpublished and draft reports when available from 1966-1977. In the remaining years, peak calving dates were approximated from raw data (Appendix A).

Table 1. Summary of survey dates and details, Bathurst calving grounds, 1965-1996

Year	Unsystematic Reconnaissance	Systematic Reconnaissance	No. of strata	Random block survey	Stratified transect survey	Photographic survey	Composition survey	Comments
1965	after 10 June	after 10 June	--	--	--	--	--	Original report not available.
1966	31 May	6 June	--	--	--	--	--	
1969	11-14 June	--	--	--	--	--	--	Survey not completed .
1970	8 June	9-10 June	--	--	--	--	--	Ground classification (16-19 June)
1971	4,5,7 June	8,9,12 June	--	14-15 June	--	--	--	
1974	31 May,1,4,5 June	6-7 June	--	8-9 June	--	--	--	
1977	1,2,5 June	--	4	--	6-8 June	--	--	
1978	2-4 June	5-7 June	3	--	13 June	--	--	Stratified transect survey was begun but not completed.
1979	4-6 June 10,11,14 June	7 June	2	--	--	--	--	Survey not completed. Strata are based on 14 June unsystematic reconnaissance.
1980	31 May - 1 June	2 June	2 (high) 3 (med) 8 (low)	--	4-6 June	3,6,8 June	--	
1982	2-3 June	3-4 June	2 (high) 1 (med) 4 (low)	--	5-6 June	10,12 June	10-13 June	
1984	3-4 June	--	5	--	5-6 June	8-9 June	7-10 June	
1986	8-9 June	10,15,16 June	2 (high) 2 (med) 3 (low)	--	17-18 June	16-17 June	17-19 June	
1990	2,3,9,10 June	11 June	4	--	--	14-15 June	11,14 June	
1995	7,8,15,16 June	--	--	--	--	--	--	Survey not completed.
1996	--	6-8 June	4	--	--	9-11 June	9-11 June	

Table 2. Size of the annual calving grounds (km^2) of the Bathurst barren-ground caribou herd, 1966 to 1996*

Year	Survey used to delineate calving grounds	Criteria used to delineate calving grounds	Area (km^2)	Source/Comments
1966	unsystematic reconnaissance	location of cows and yearlings	8,340	Williams 1966
1970	unsystematic reconnaissance	location of cows and yearlings	5,996	Boxer 1970
1971	unsystematic reconnaissance	location of cows and yearlings	4,299	Boxer 1971
1974	unsystematic reconnaissance	location of cows and yearlings	6,879	Boxer 1974
1977	unsystematic reconnaissance	location of parturient cows and cows with calves	7,778	Calef and Boxer 1977
1978	systematic reconnaissance	location of parturient cows and cows with calves	10,070	DRR files
1980	systematic reconnaissance	location of parturient cows and cows with calves	10,195	Heard 1980
1982	systematic reconnaissance	location of parturient cows and cows with calves	11,545	DRR files
1984	unsystematic reconnaissance	location of parturient cows and cows with calves	8,550	DRR files
1986	systematic reconnaissance	location of parturient cows and cows with calves	11,560 7,622	Heard and Williams 1991a Area not including S8 (DRR files)
1990	systematic reconnaissance	location of parturient cows and cows with calves	5,714	Heard and Williams 1991b
1995	unsystematic reconnaissance	location of parturient cows and cows with calves	35,250	estimate calculated from figure in *Freelance* (Fig. 36)
1996	systematic reconnaissance	location of parturient cows and cows with calves	5,300	calculated from original maps; includes area between strata
TOTAL			44,000	estimate calculated from figure in *Freelance* (Fig. 1)

* Individual strata and transect areas are in Appendix C.

3. Weather conditions at survey time may have had an effect. Breaks or delays in surveying are most often the result of bad weather which prevents flying.

4. Coverage of the entire traditional calving grounds in some years may not have been adequate and areas with calving caribou may have been missed. Urquhart (1981) commented on the area west of Bathurst Inlet stating that it was not adequately covered by reconnaissance flights in surveys from 1977-1980.

5. Flight lines may not have been recorded. The figures in this report (Figs. 4 - 60) contain flight lines and strata (when applicable) for 13 Bathurst calving ground surveys. Flight lines for the 1965 (Williams 1966, Urquhart 1981), 1969 (Ruttan 1969), and 1970 (Boxer 1970) surveys were not available. Information for these years was taken from the reports cited and from DRR files. In 1980 and 1984, some reconnaissance flight lines may be missing from the figures (Figs. 25 and 38) (DRR files).

The environmental uncertainties that are incorporated in our map are those ecological variables, unpredictable from year to year, that affect the caribou's distribution and behaviour. The most prominent is annual variations in weather. If the caribou have to trudge through deep, wet or crusted snow during spring migration, some cows may be delayed reaching the calving ground and the annual calving ground may be larger than usual. Snow depths and melt rate on the calving ground may influence the cows' distribution. If the cows are in poor physical condition after the previous year's severe insect harassment and/or a

severe winter, gestation may be prolonged (Bergerud 1975, Espmark 1980) and calving may peak later than normal (Gunn 1984). We are not yet at the stage where we can quantify the environmental effects. If they could be quantified, then the probability of predicting the location of the calving ground in any one year could be refined.

The degree of overlap between annual calving grounds partly reflects survey frequency - the more frequent the surveys, the greater the overlap assuming there is a consistent directional shift as appears to be the case. The overlap in the high density strata is high until 1984, which to some extent may reflect the frequency of those surveys. From 1977 up to and including 1984, the 6 surveys were at a mean frequency of 2 years. The survey frequency was a mean of 4 years from 1986 to 1996 when the high density strata did not overlap (Fig. 2).

The degree of overlap may also be influenced by calving ground size (Table 2, and thus the caribou densities Appendix B). Variations in calving ground size are due to ecological factors, survey timing and how the boundary was determined. Intuitive thought would suggest that the larger the population, the larger the calving ground, but this appears to be too simple at the current range of population sizes. Calving ground size for 1977 to 1986 does not correlate with population size. The criteria for determining boundaries, which was different for surveys from 1970 to 1974, and the timing of surveys relative to the peak of calving are two additional factors that may affect calving ground size (Fig. 62).

The 1996 survey found caribou calving east of Bathurst Inlet, but for the following reasons it was assumed that they were not the Bathurst herd. Firstly, the high densities and the location of the 10 satellite-collared cows west of the Inlet were suggestive that the Bathurst herd was calving west of Bathurst Inlet. Secondly, calving from east to west across the Inlet was discontinuous: immediately east of Bathurst Inlet, we found few cows found until we flew east of Spyder Lake. Thirdly, four satellite-collared cows presumed to be from the Queen Maud Gulf herd were located east of Bathurst Inlet, and fourthly, calving was continuous east to Adelaide Peninsula. The evidence for and implications of an overlap in two traditional calving grounds are explored by Gunn and Nishi (in prep.).

In conclusion, we note that our emphasis in this report was compilation - to pull together the maps and dates from a disparate set of reports and field maps and to produce and justify a composite map of the Bathurst herd's calving grounds. The factors that influence the probability that the traditional calving ground map can be used to predict future calving ground locations have also been discussed. We recognise that this report is but the first step and in a future report we will present an analysis of the Bathurst herd's calving distribution.

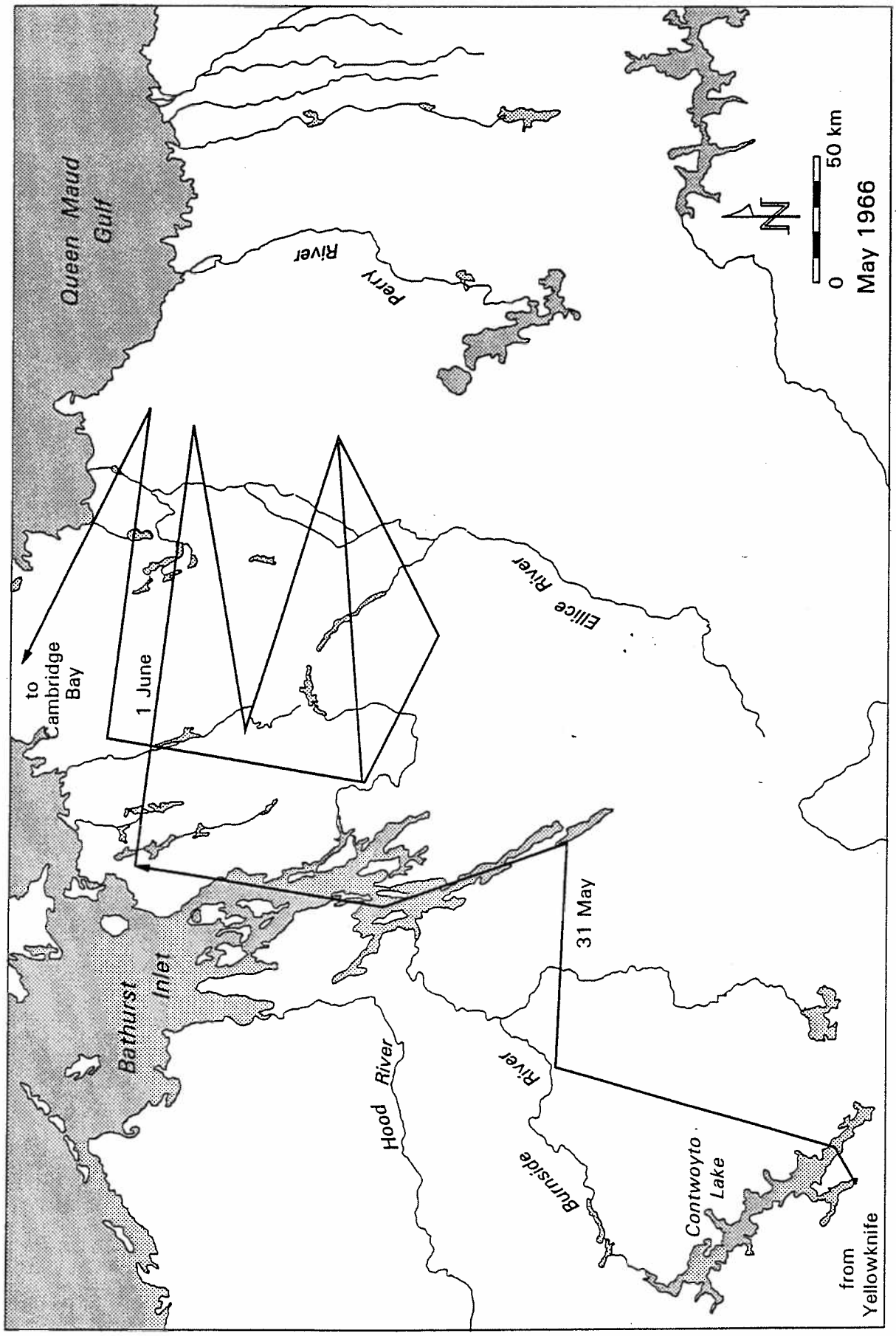

Figure 4. Bathurst calving ground unsystematic reconnaissance flight lines, 31 May - 1 June 1966 (Williams 1966)

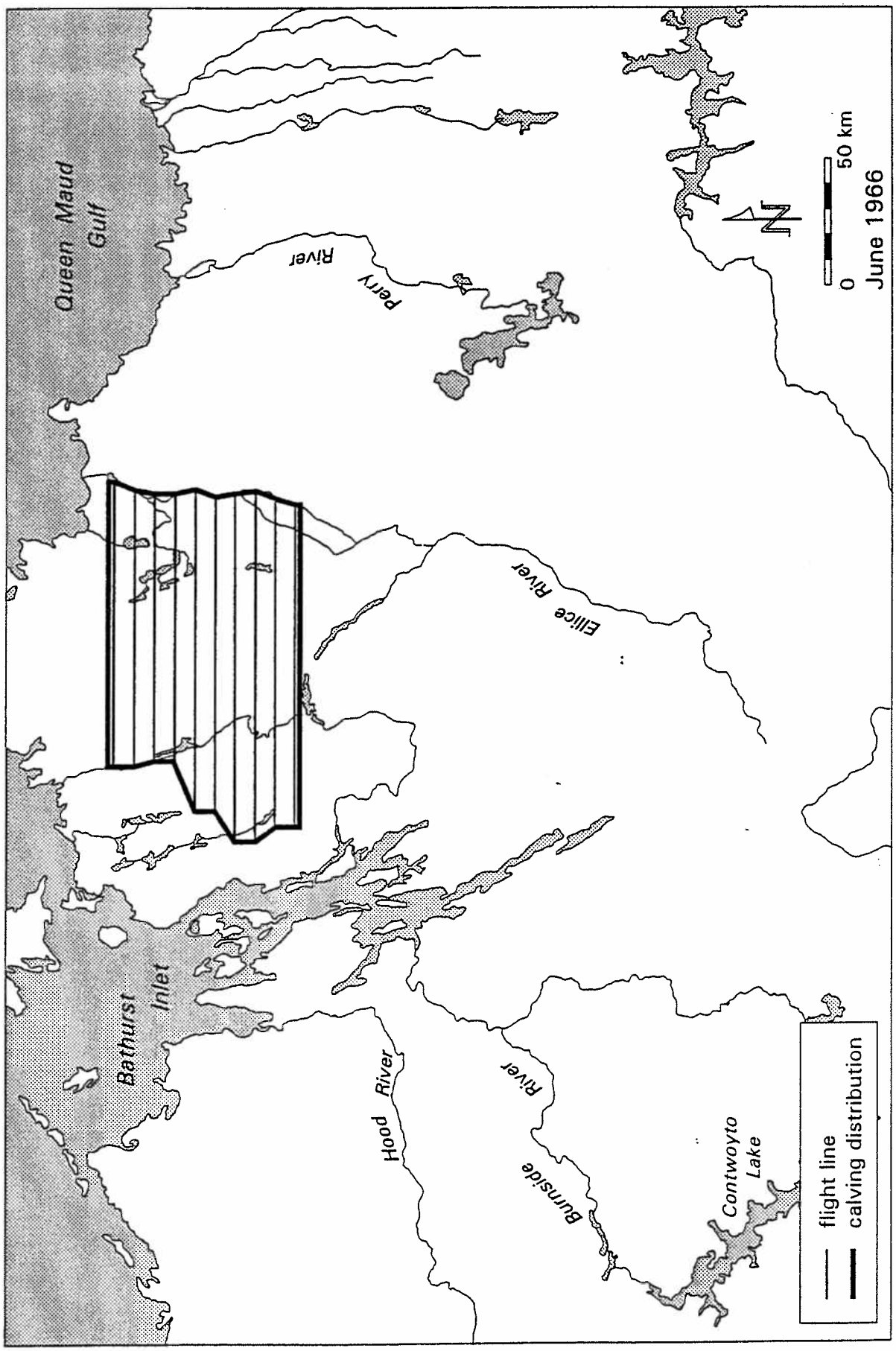

Figure 5. Bathurst calving ground systematic transect survey flight lines, 6 June 1966 (Williams 1966)

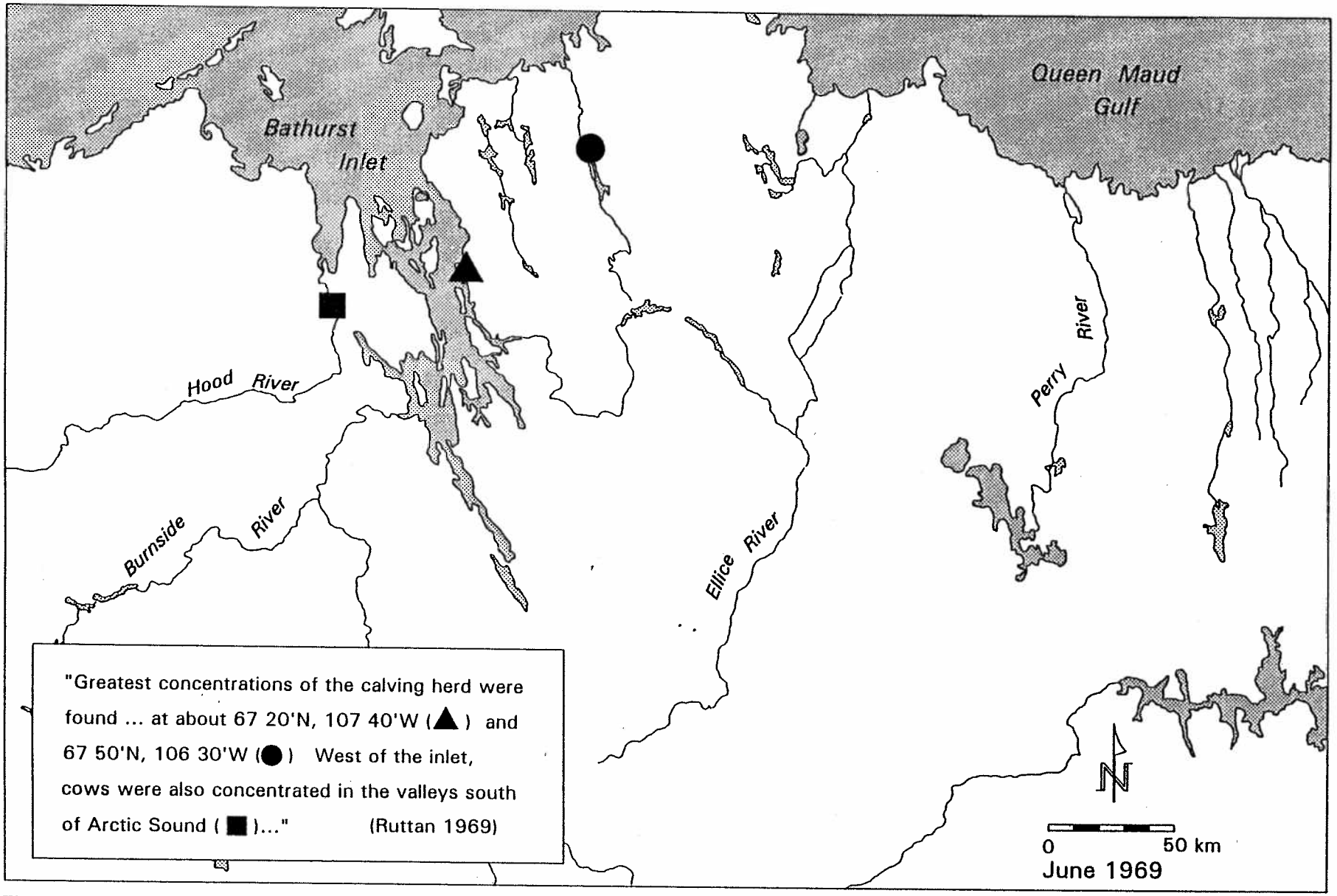

Figure 6. Greatest concentrations of the Bathurst calving herd, 11-14 June 1969

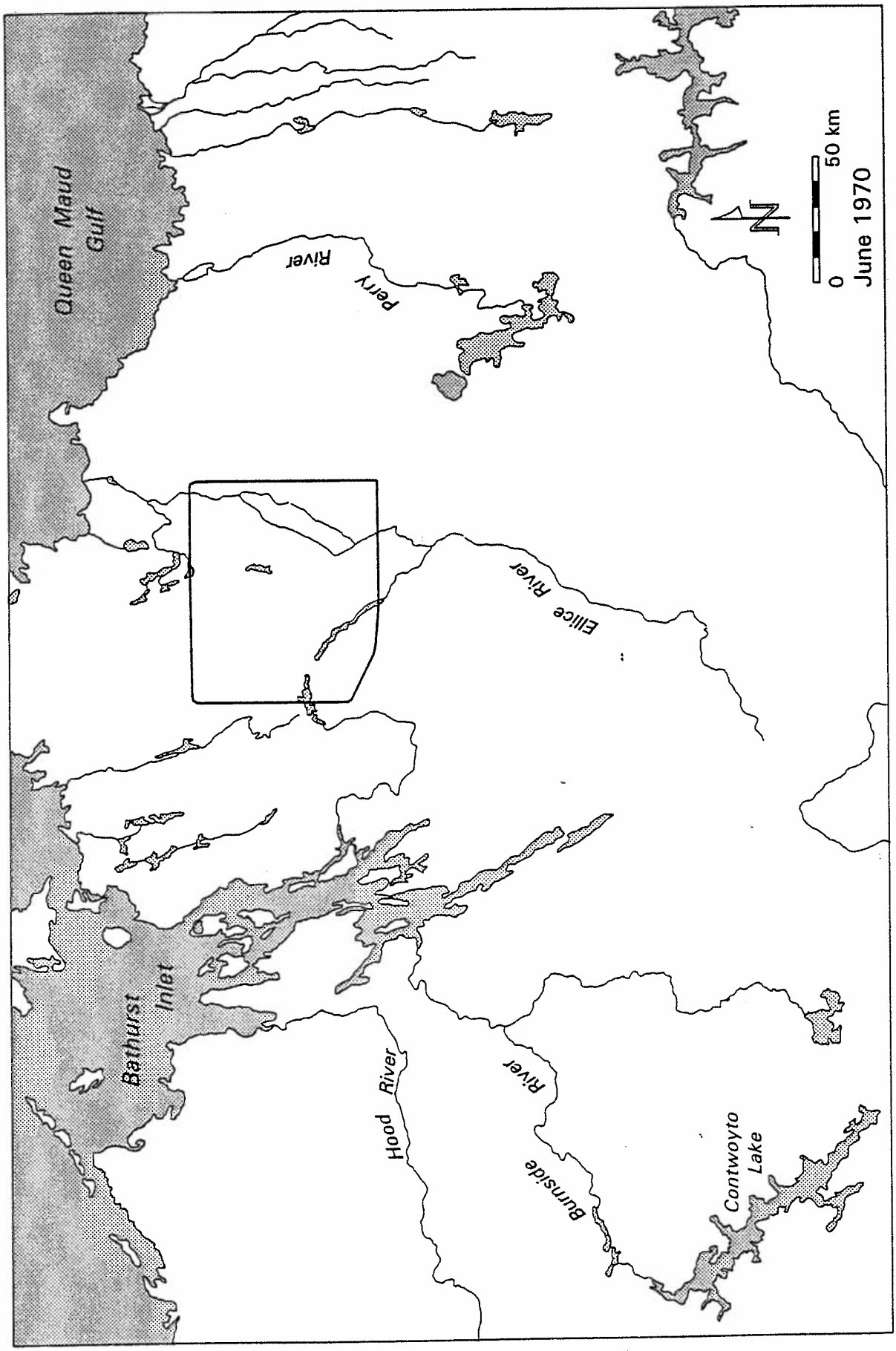

Figure 7. Bathurst calving distribution as delimited during unsystematic reconnaissance flights, 8 June 1970 (Calef and Boxer 1977)

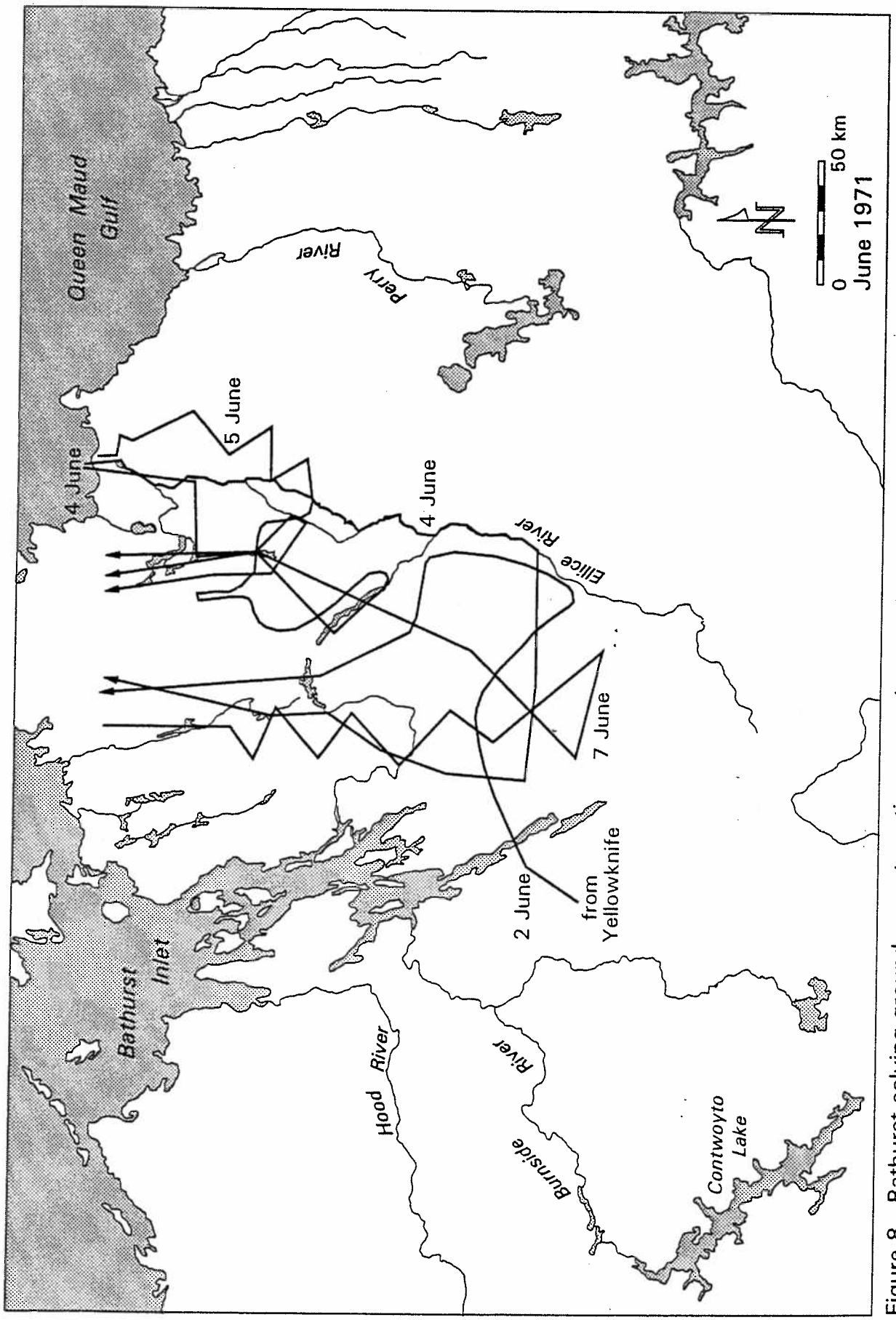

Figure 8. Bathurst calving ground unsystematic reconnaissance flight lines, 4-7 June 1971 (Boxer 1971)

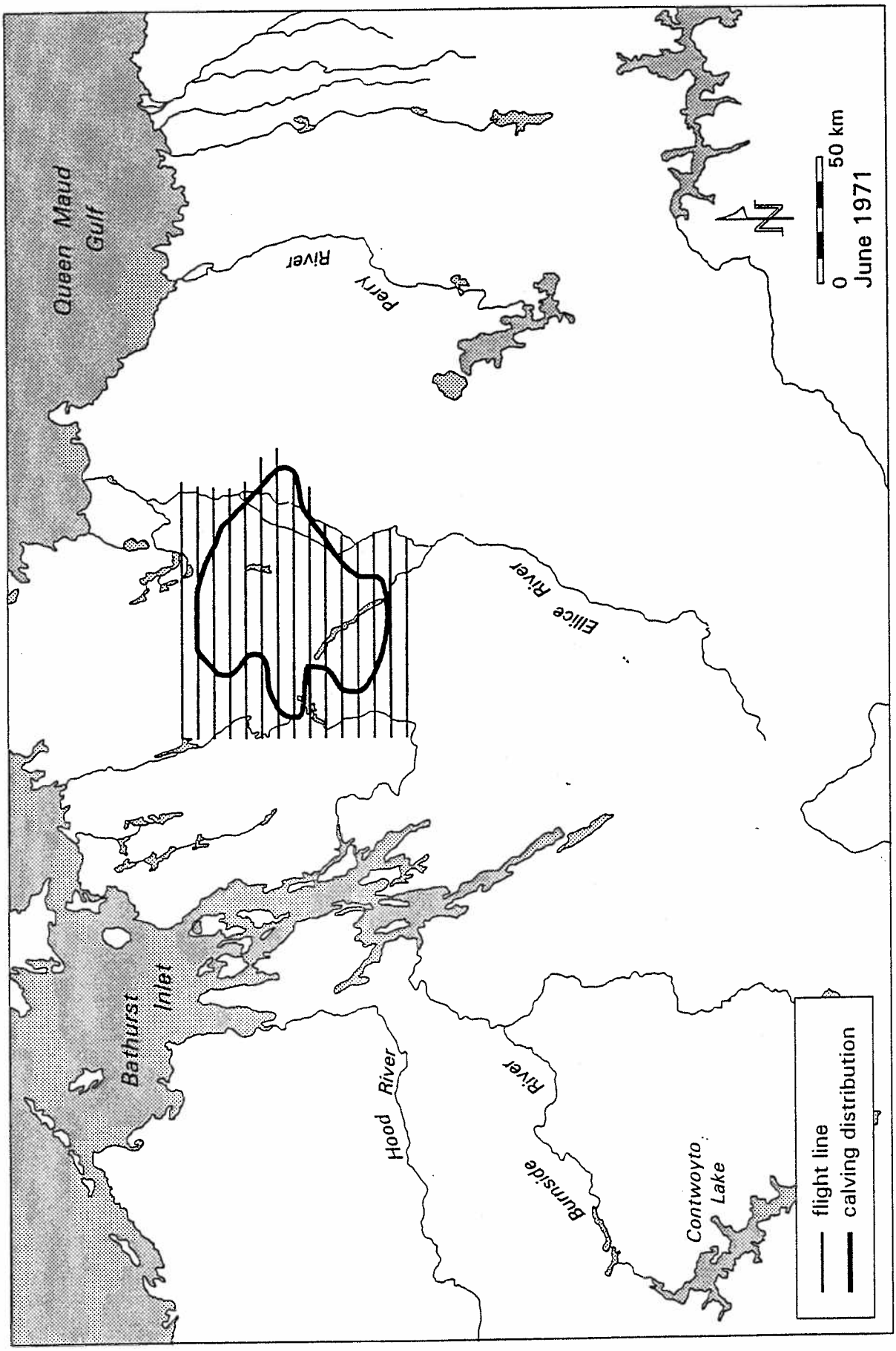

Figure 9. Bathurst calving ground systematic transect survey flight lines, 8-12 June 1971 (Boxer 1971)

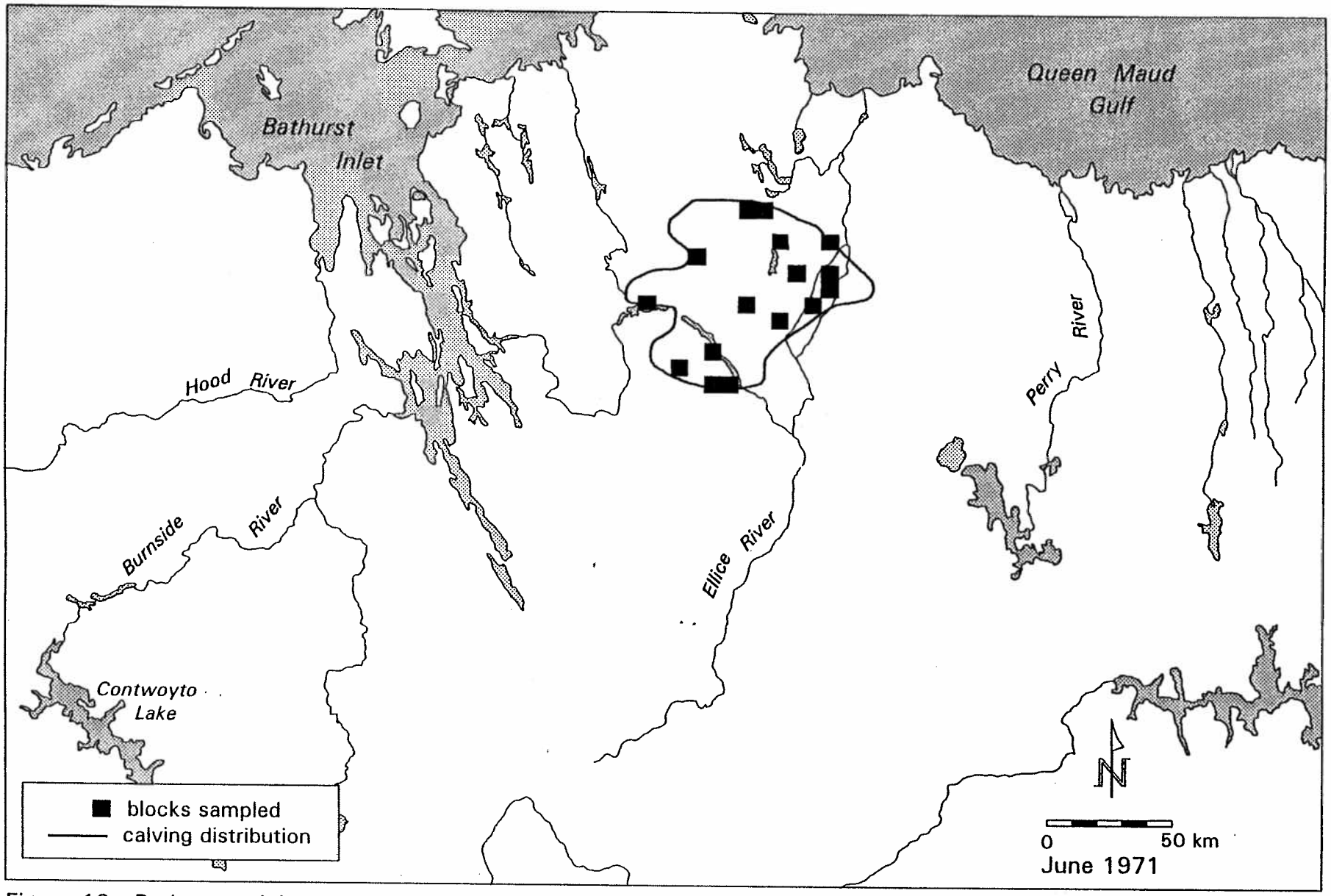

Figure 10. Bathurst calving ground random block survey, 14-15 June 1971 (Boxer 1971)

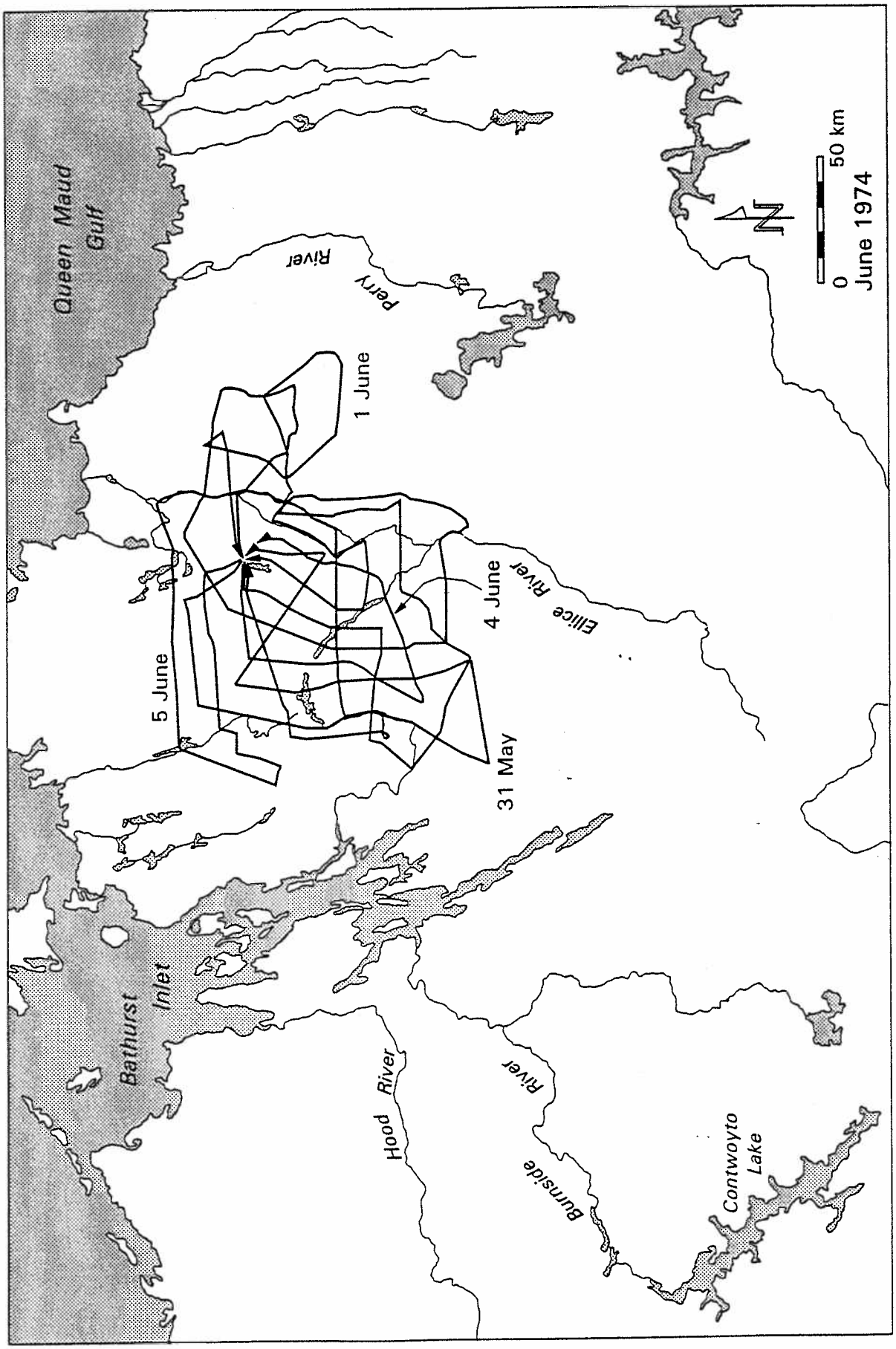

Figure 11. Bathurst calving ground unsystematic reconnaissance flight lines, 31 May - 5 June 1974 (Boxer 1974)

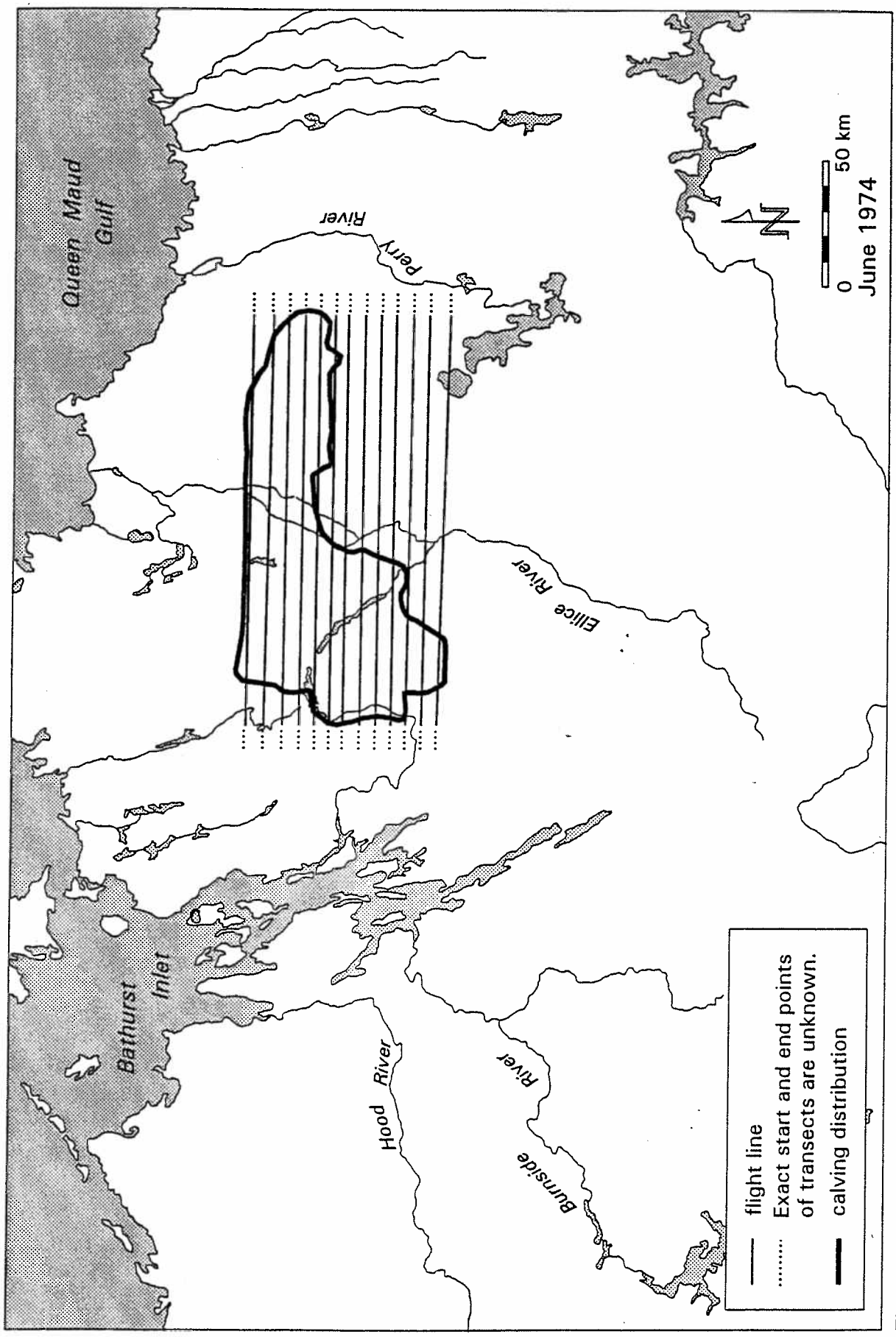

Figure 12. Bathurst calving ground systematic transect survey flight lines, 6-7 June 1974 (Boxer 1974)

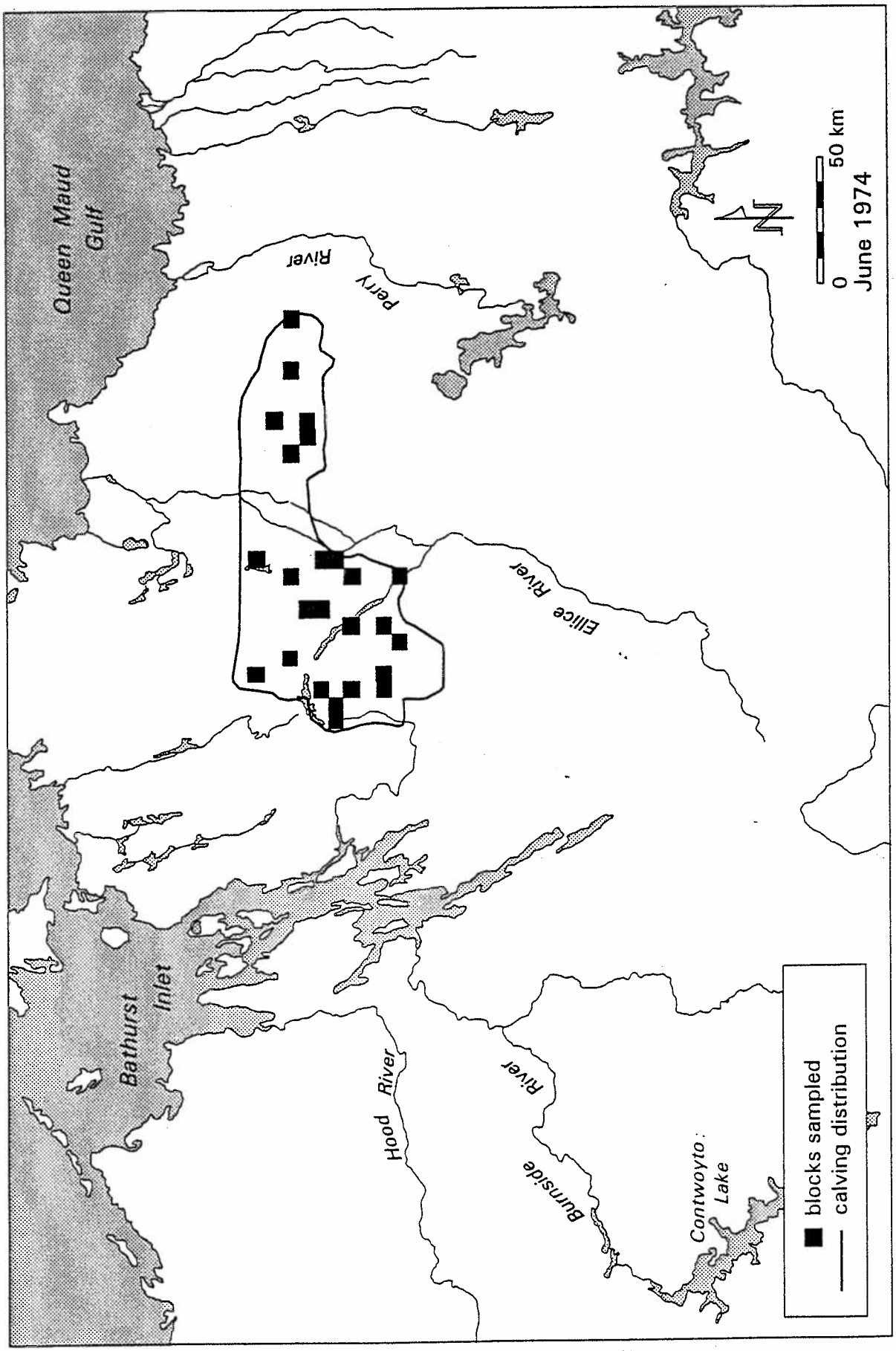

Figure 13. Bathurst calving ground random block survey, 8-9 June 1974 (Boxer 1974)

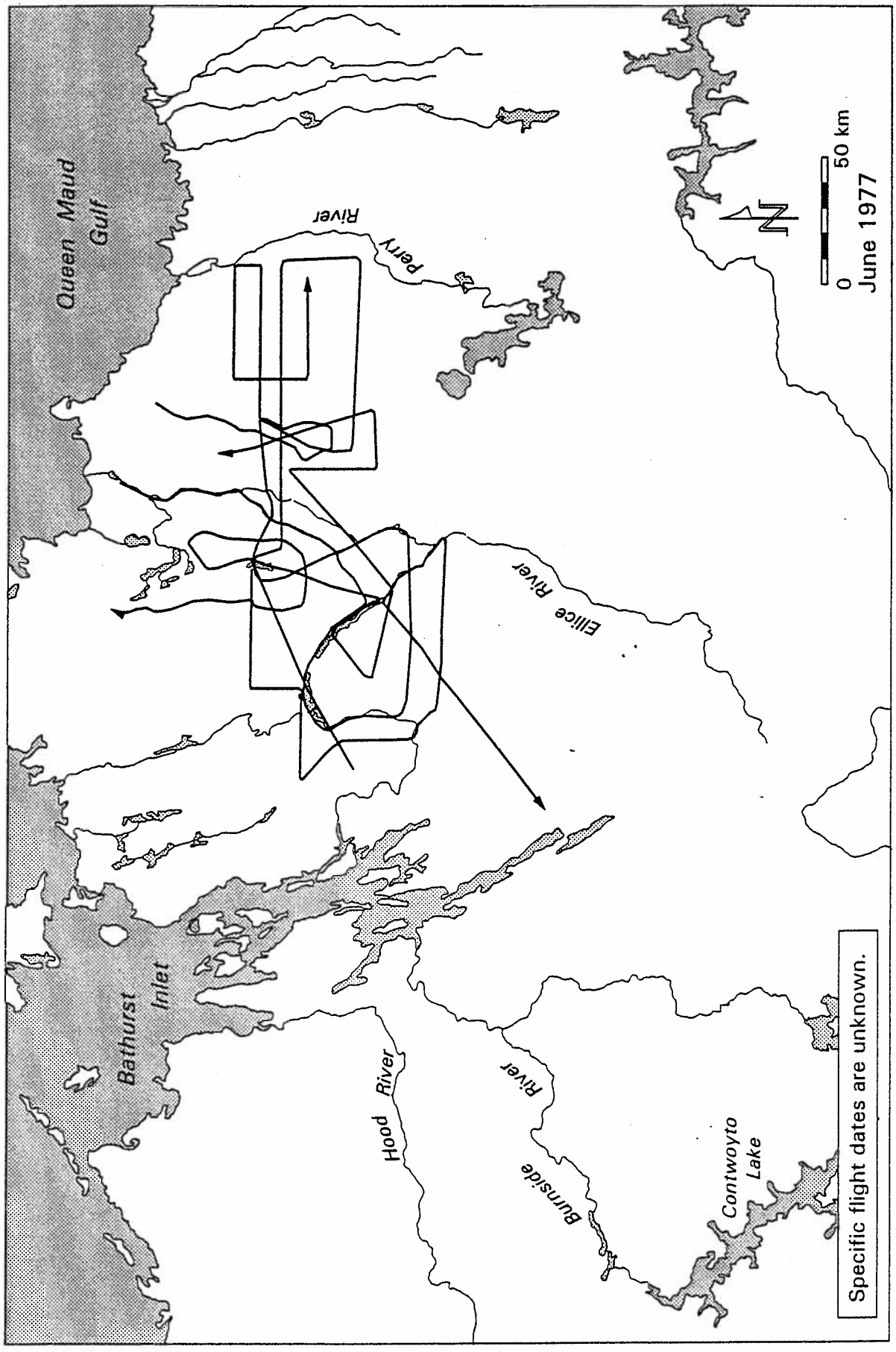

Figure 14. Bathurst calving ground unsystematic reconnaissance flight lines, 1-5 June 1977

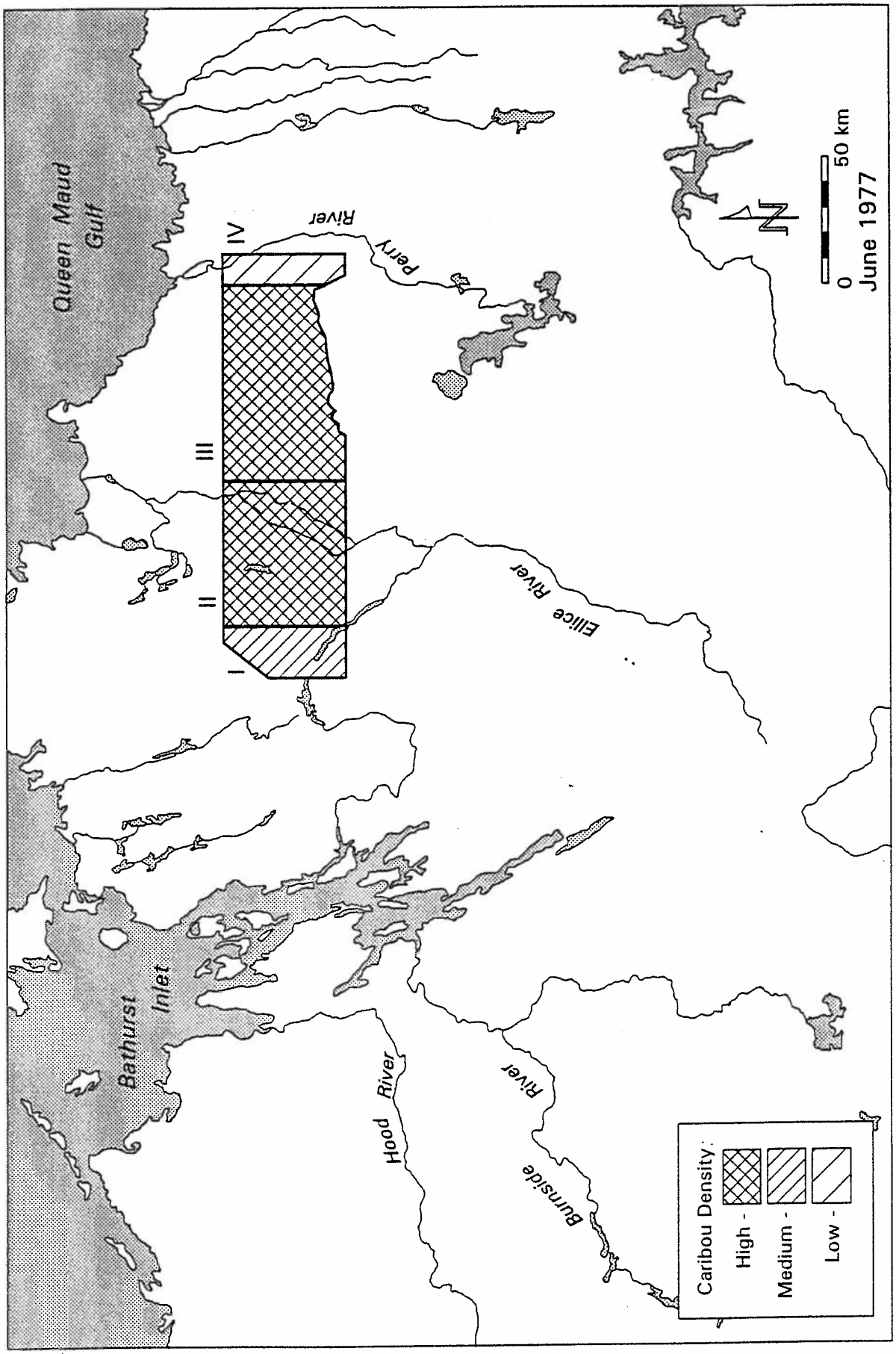

Figure 15. Bathurst calving ground strata, 5-8 June 1977

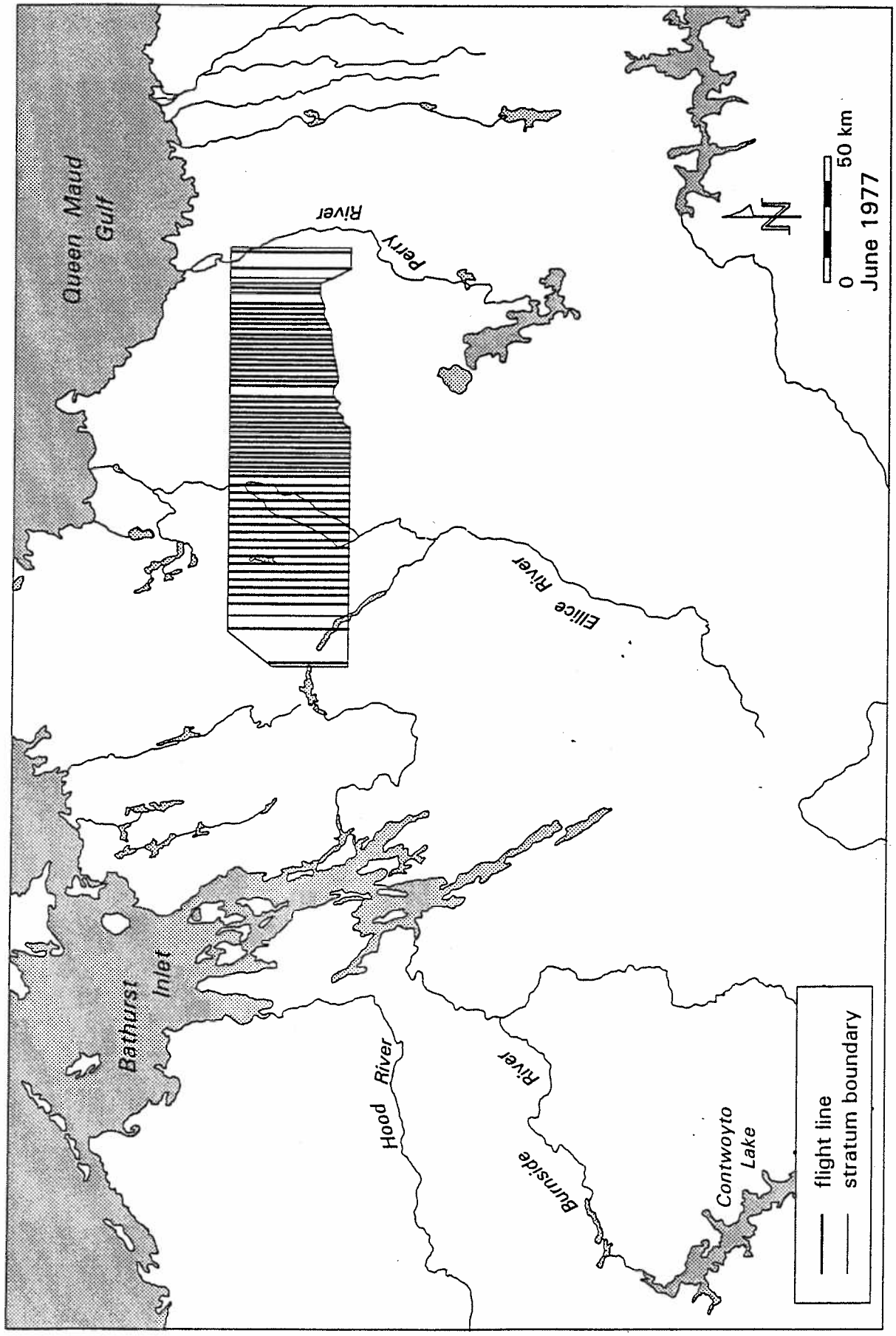

Figure 16. Bathurst calving ground stratified transect survey flight lines, 6-8 June 1977

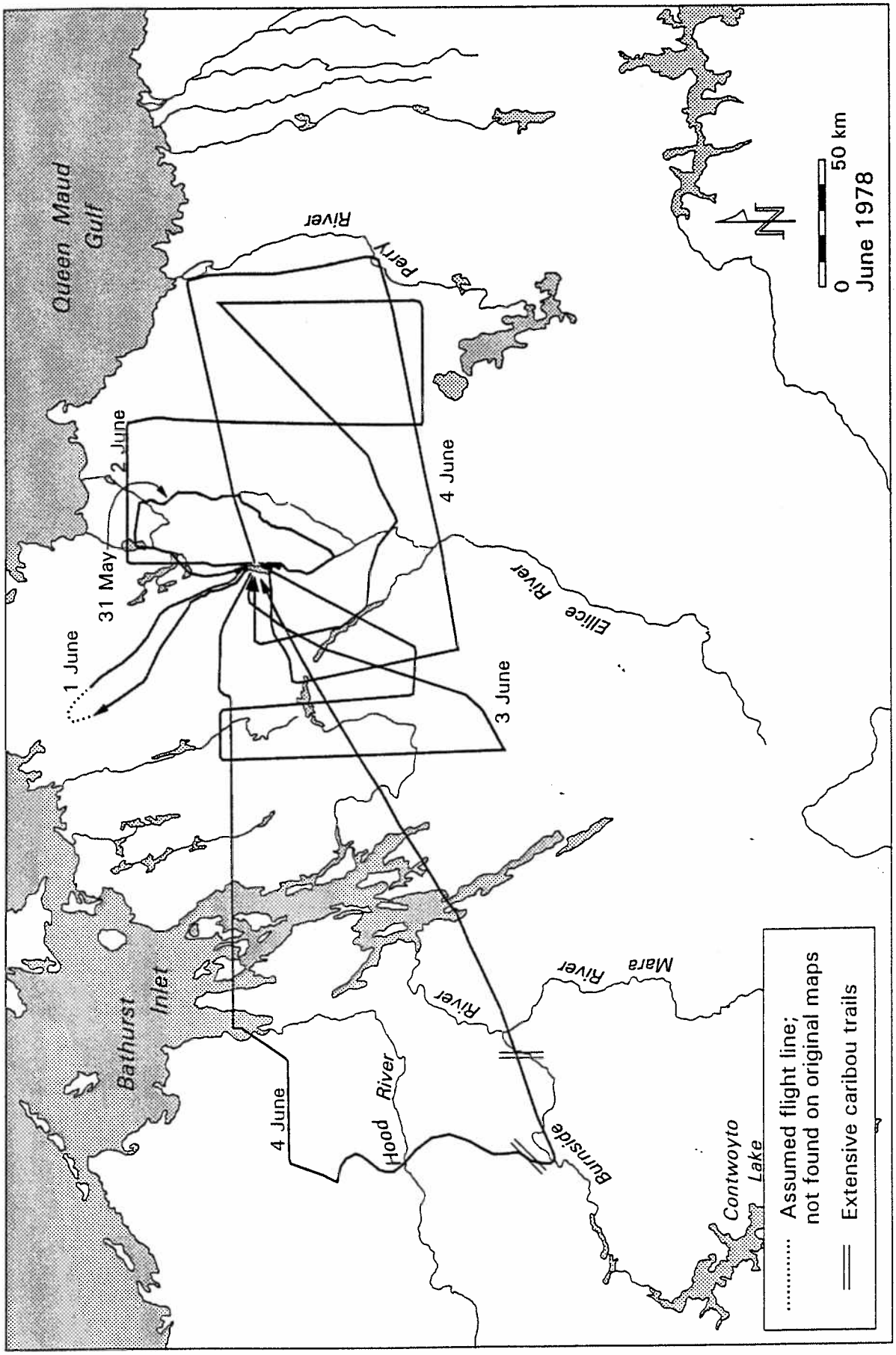

Figure 17. Bathurst calving ground unsystematic reconnaissance flight lines, 31 May - 4 June 1978

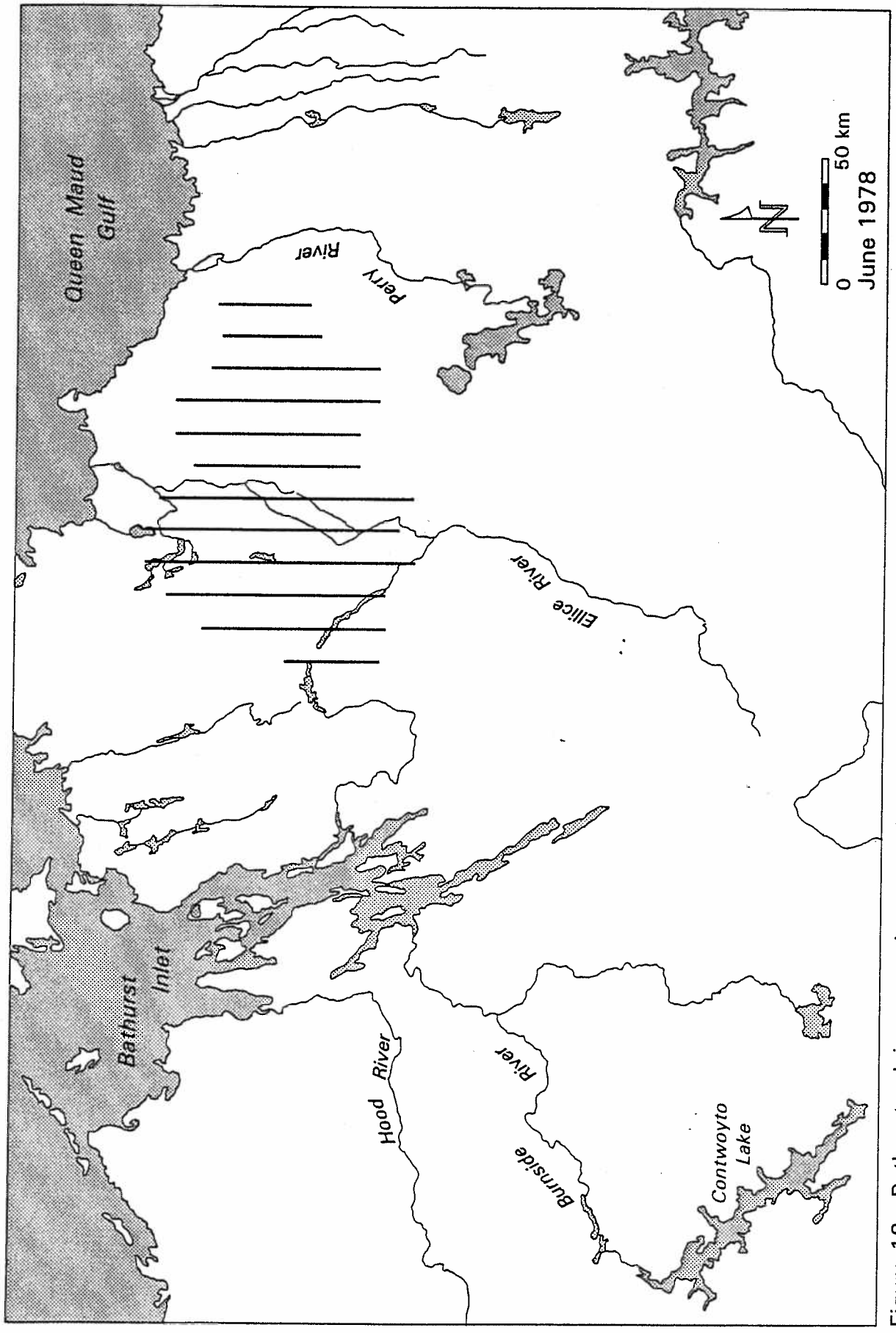

Figure 18. Bathurst calving ground systematic reconnaissance flight lines, 5-7 June 1978

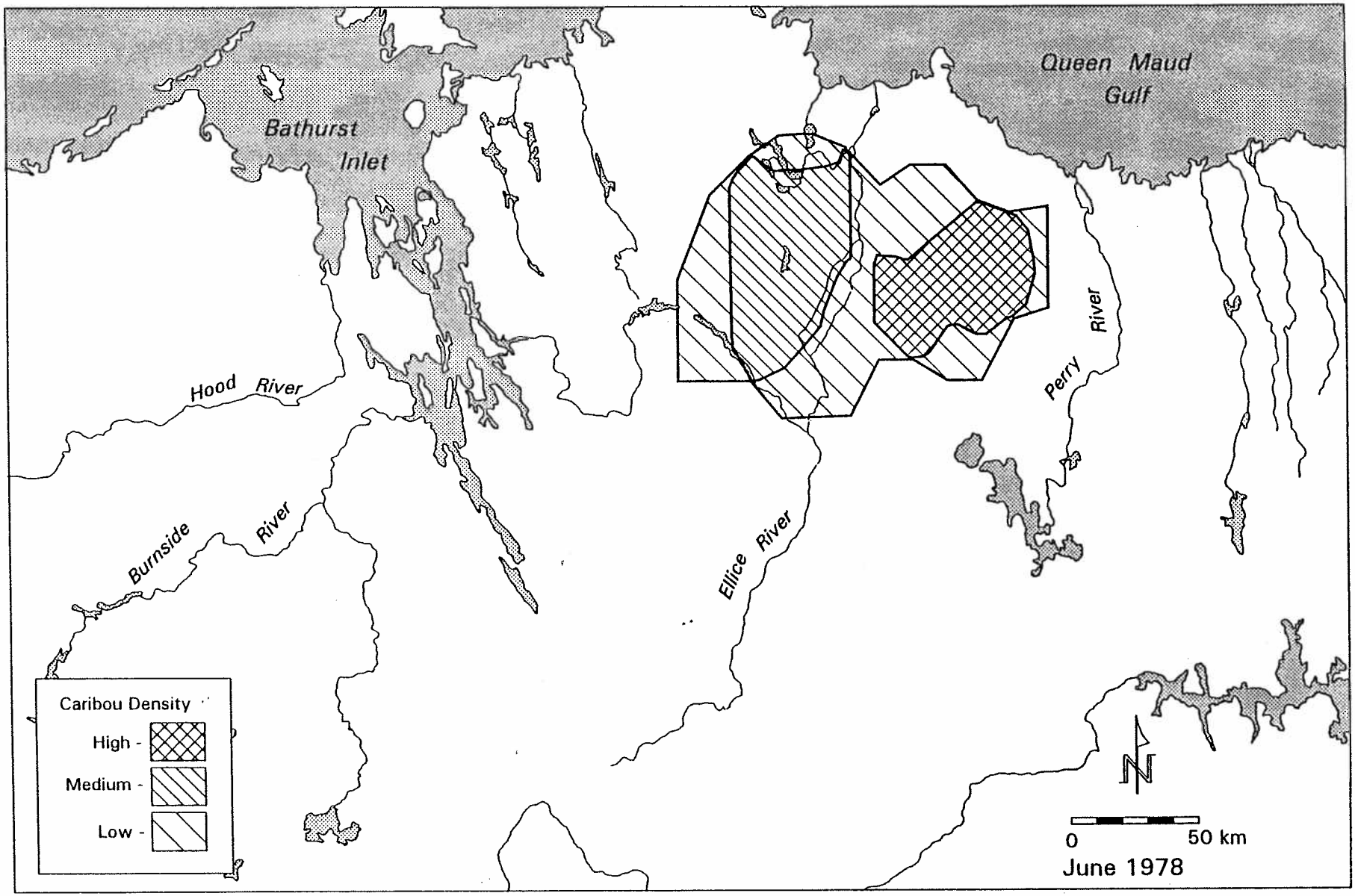

Figure 19. Bathurst calving ground strata, 5-7 June 1978

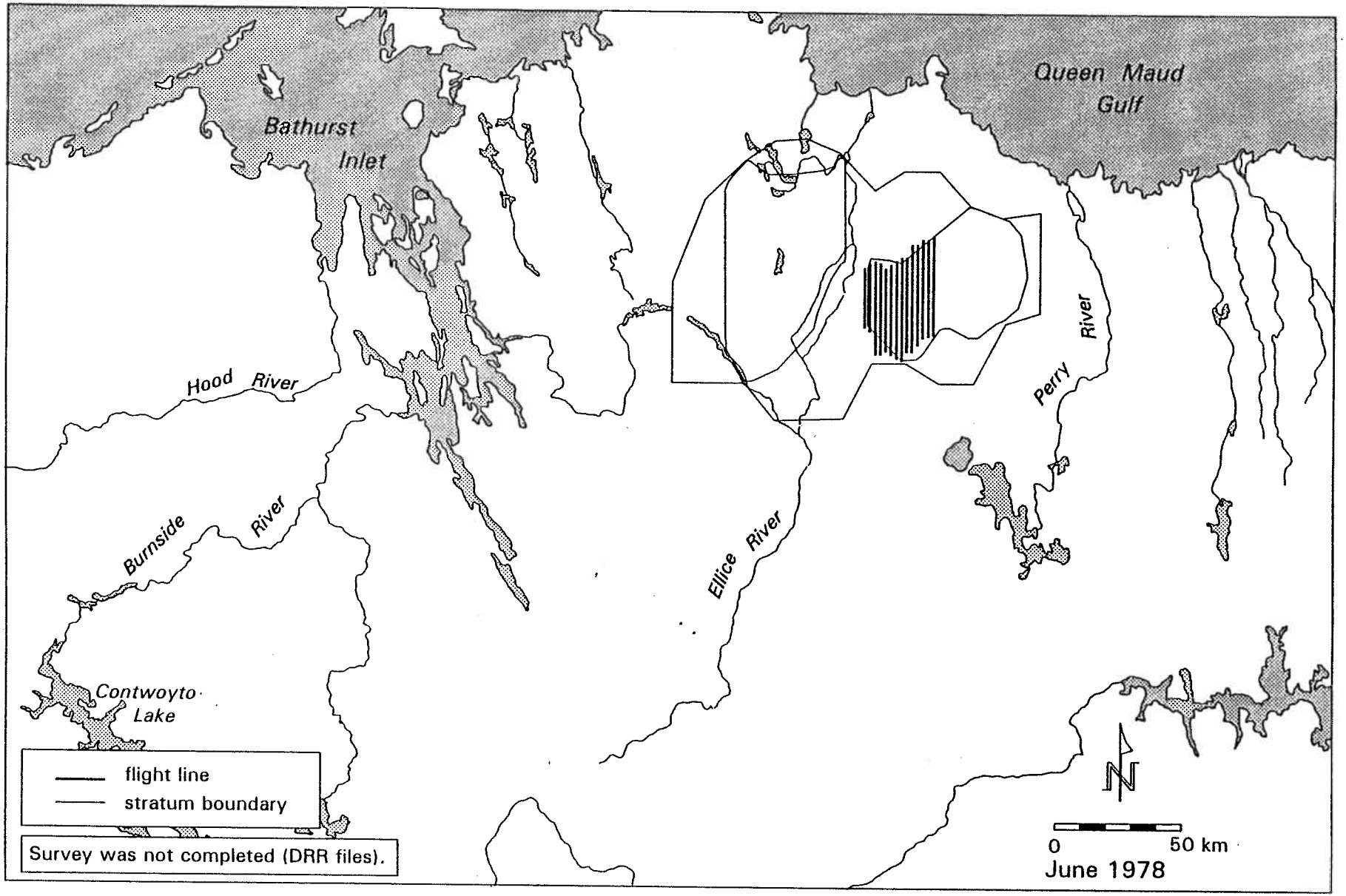

Figure 20. Bathurst calving ground stratified transect survey flight lines, 13 June 1978

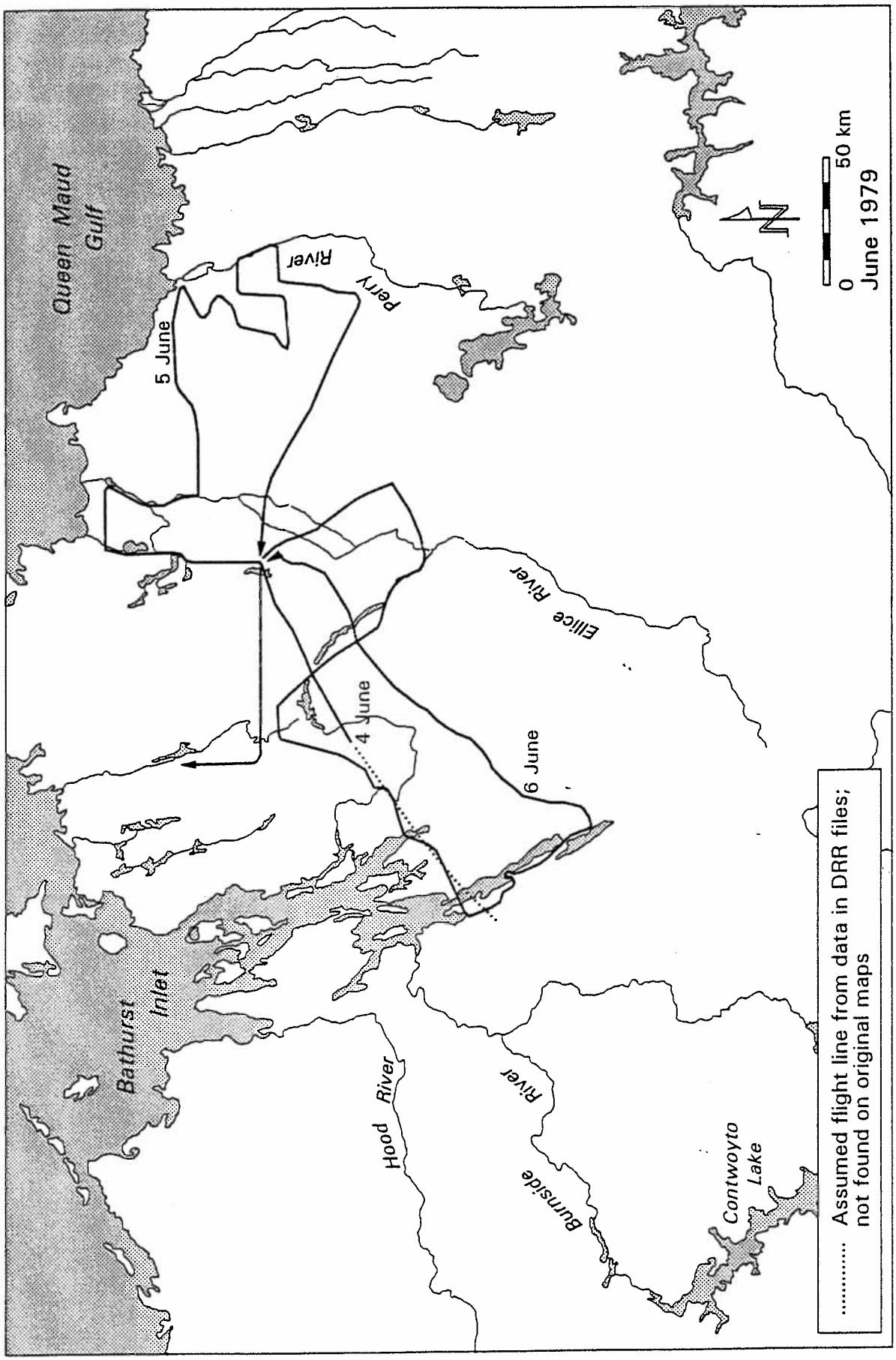

Figure 21. Bathurst calving ground unsystematic reconnaissance flight lines, 4-6 June 1979

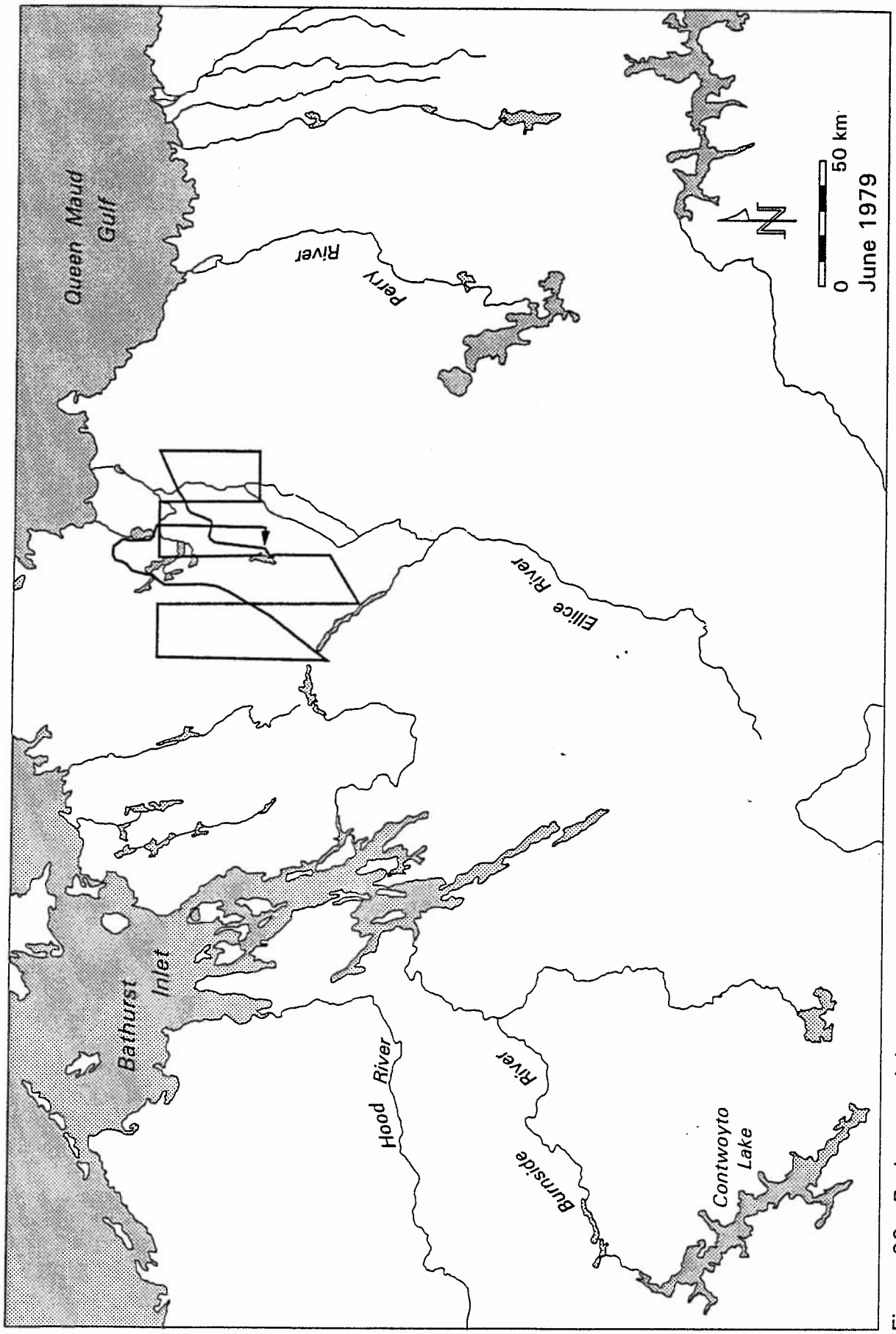

Figure 22. Bathurst calving ground systematic reconnaissance flight lines, 7 June 1979

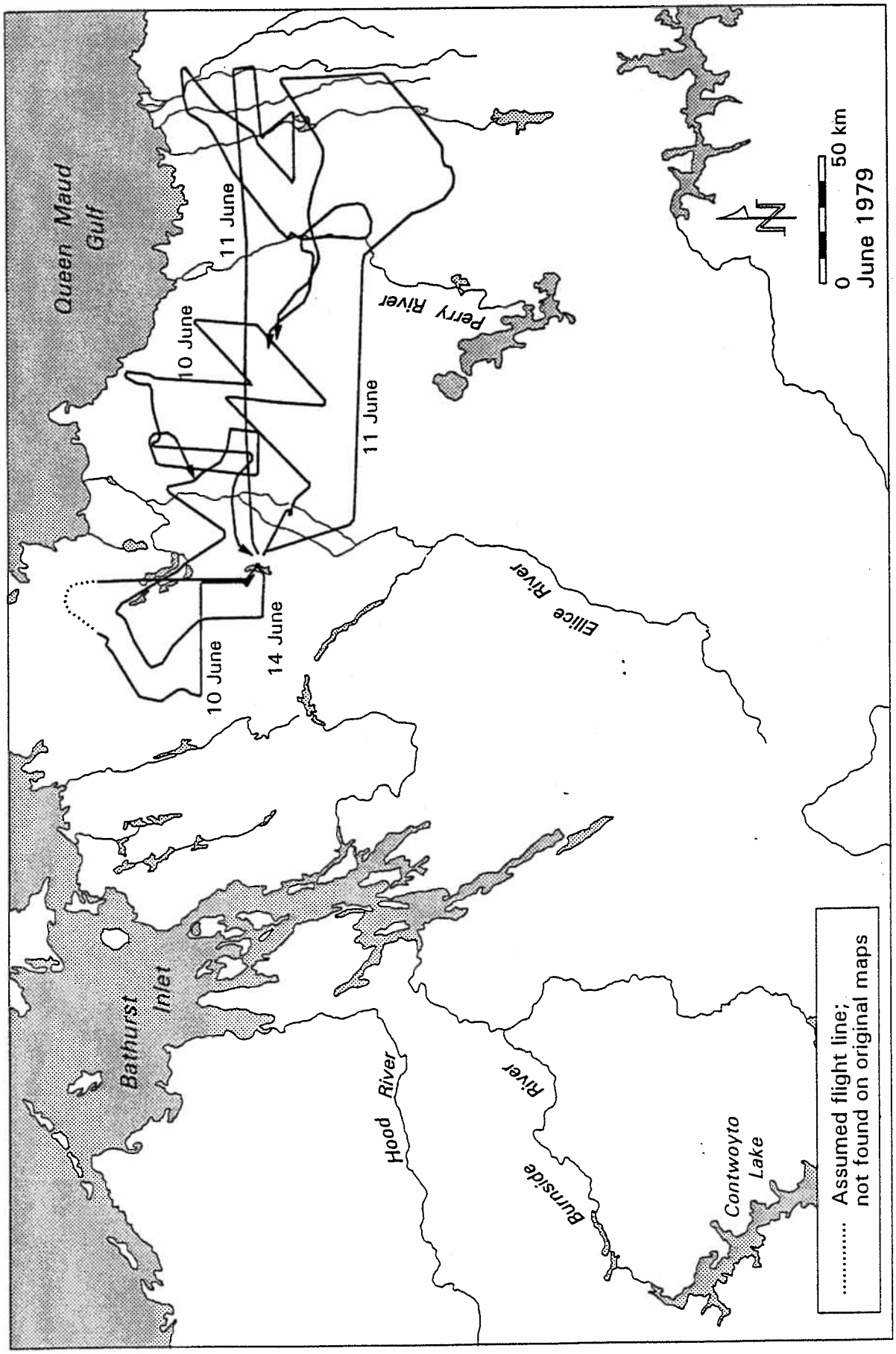

Figure 23. Bathurst calving ground unsystematic reconnaissance flight lines continued, 10-14 June 1979

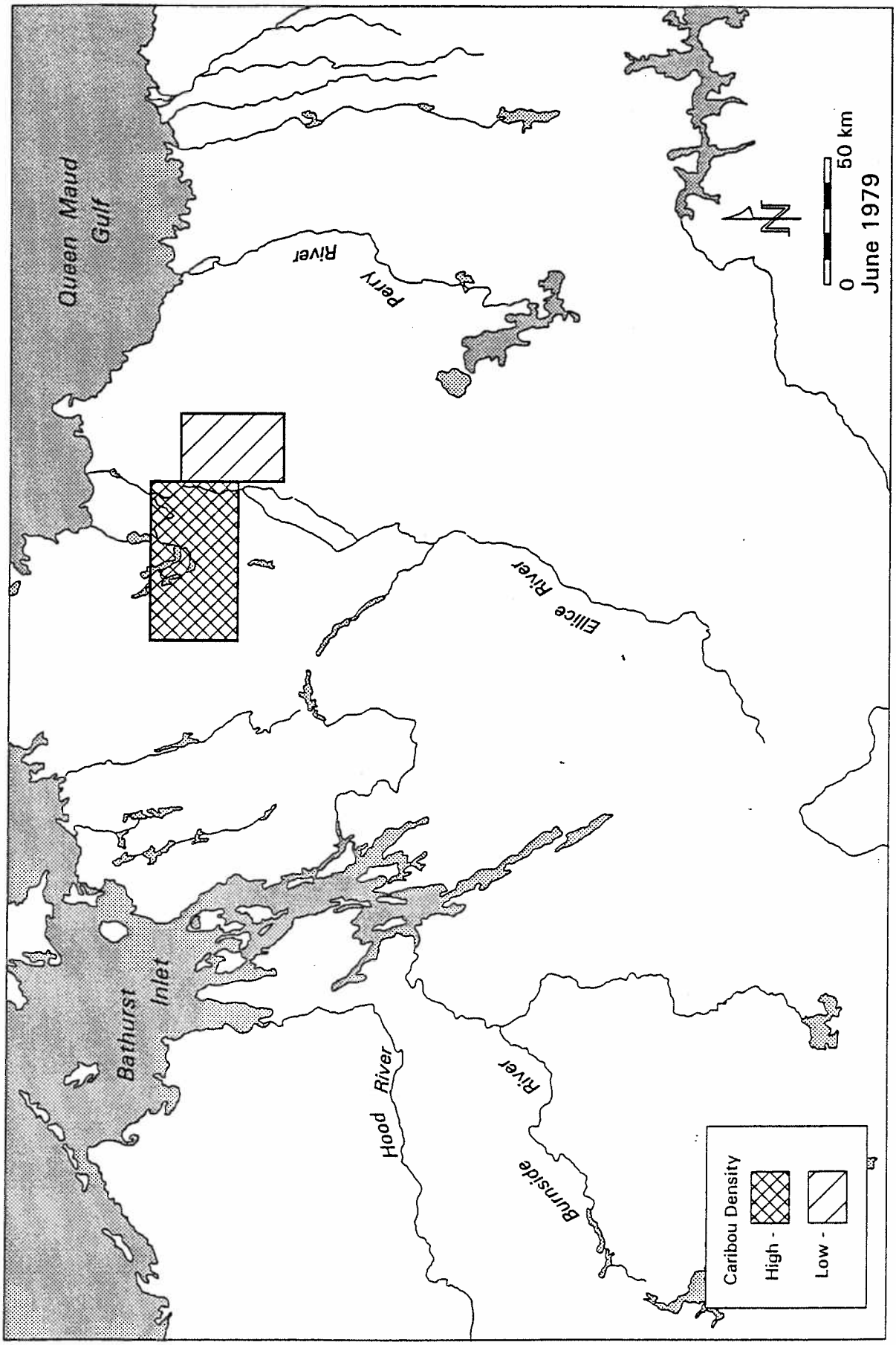

Figure 24. Bathurst calving ground strata based on reconnaissance flight, 14 June 1979

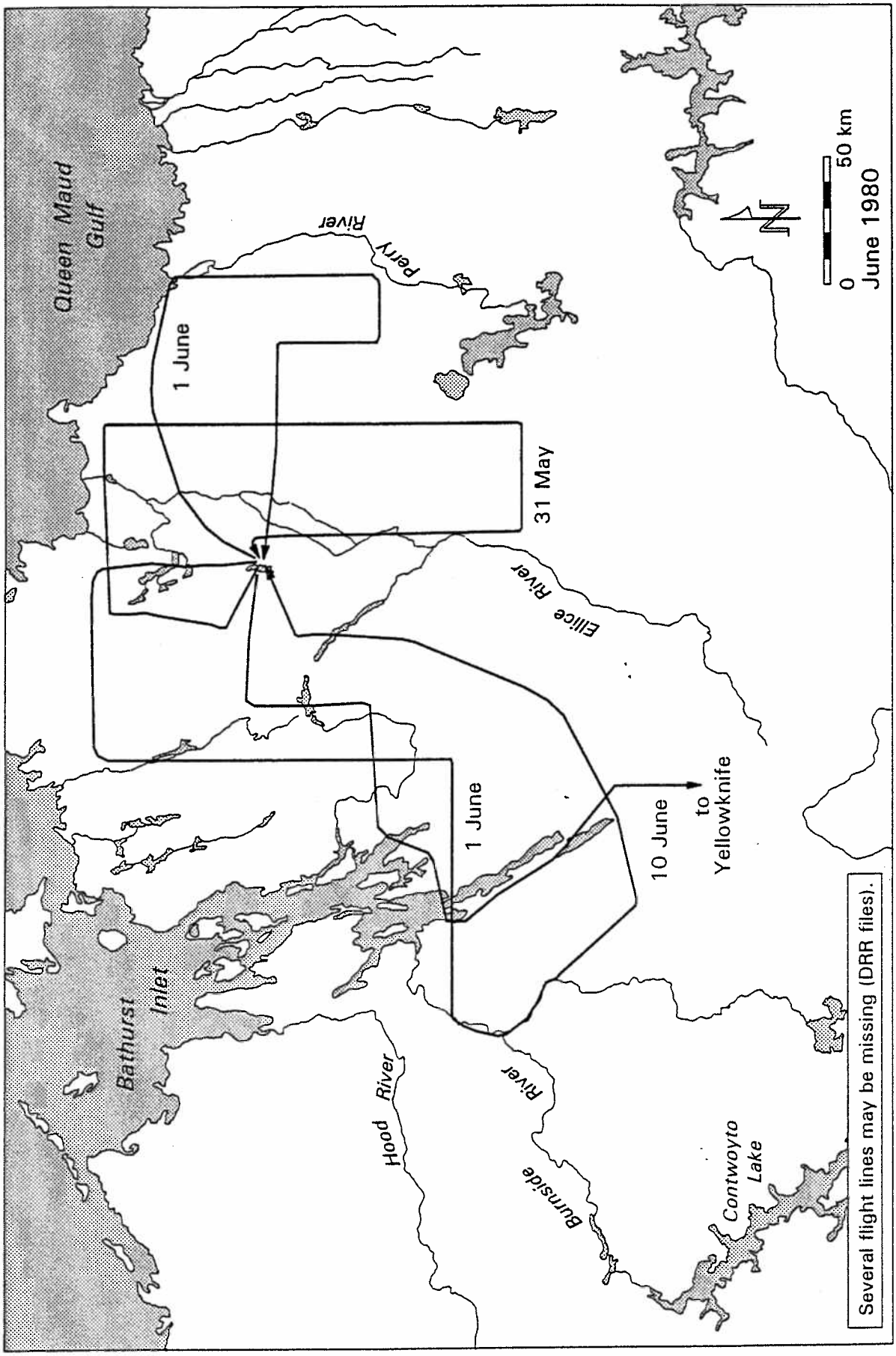

Figure 25. Bathurst calving ground unsystematic reconnaissance flight lines, 31 May - 1 June 1980

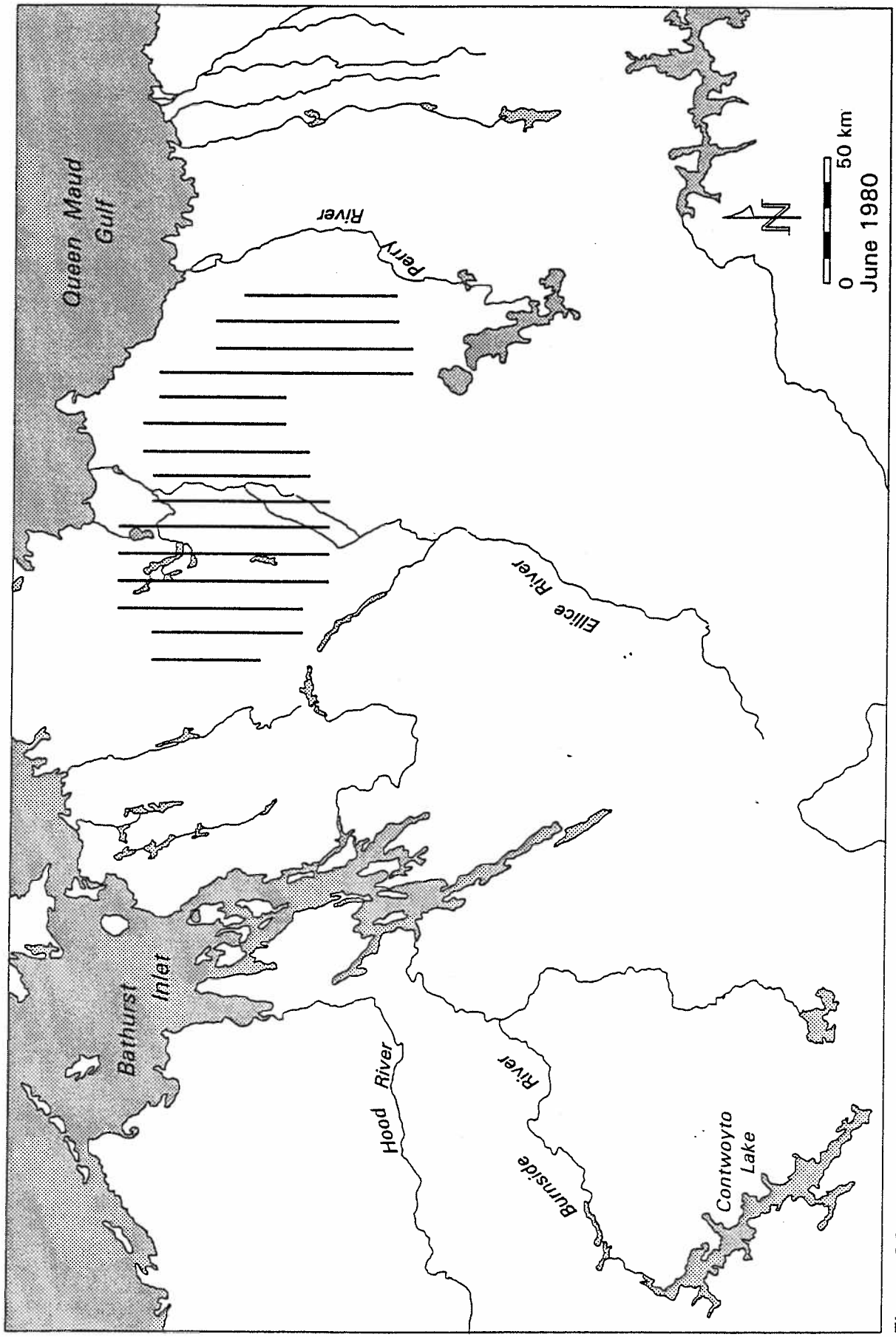

Figure 26. Bathurst calving ground systematic reconnaissance flight lines, 2 June 1980

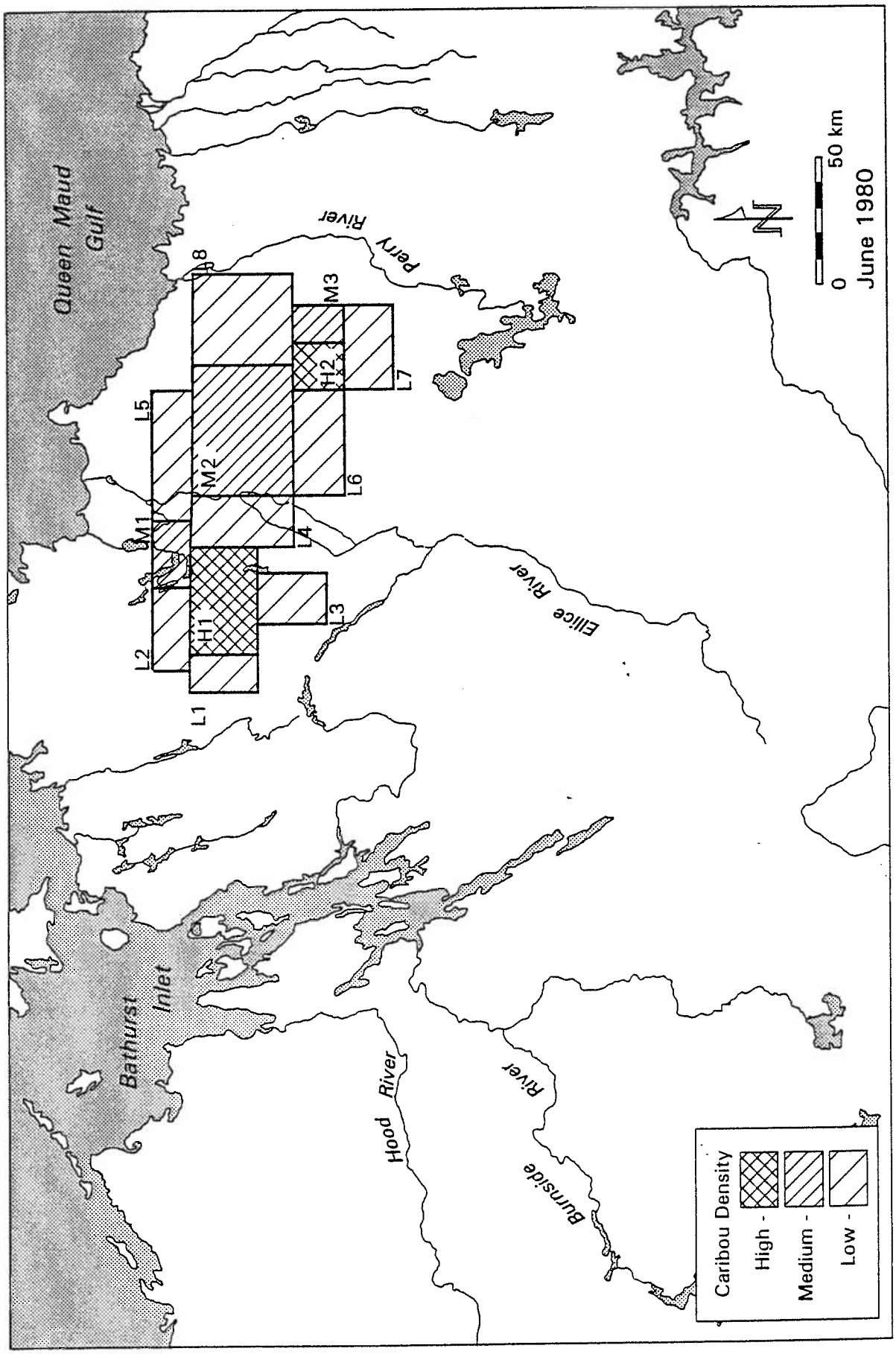

Figure 27. Bathurst calving ground strata, 2 June 1980

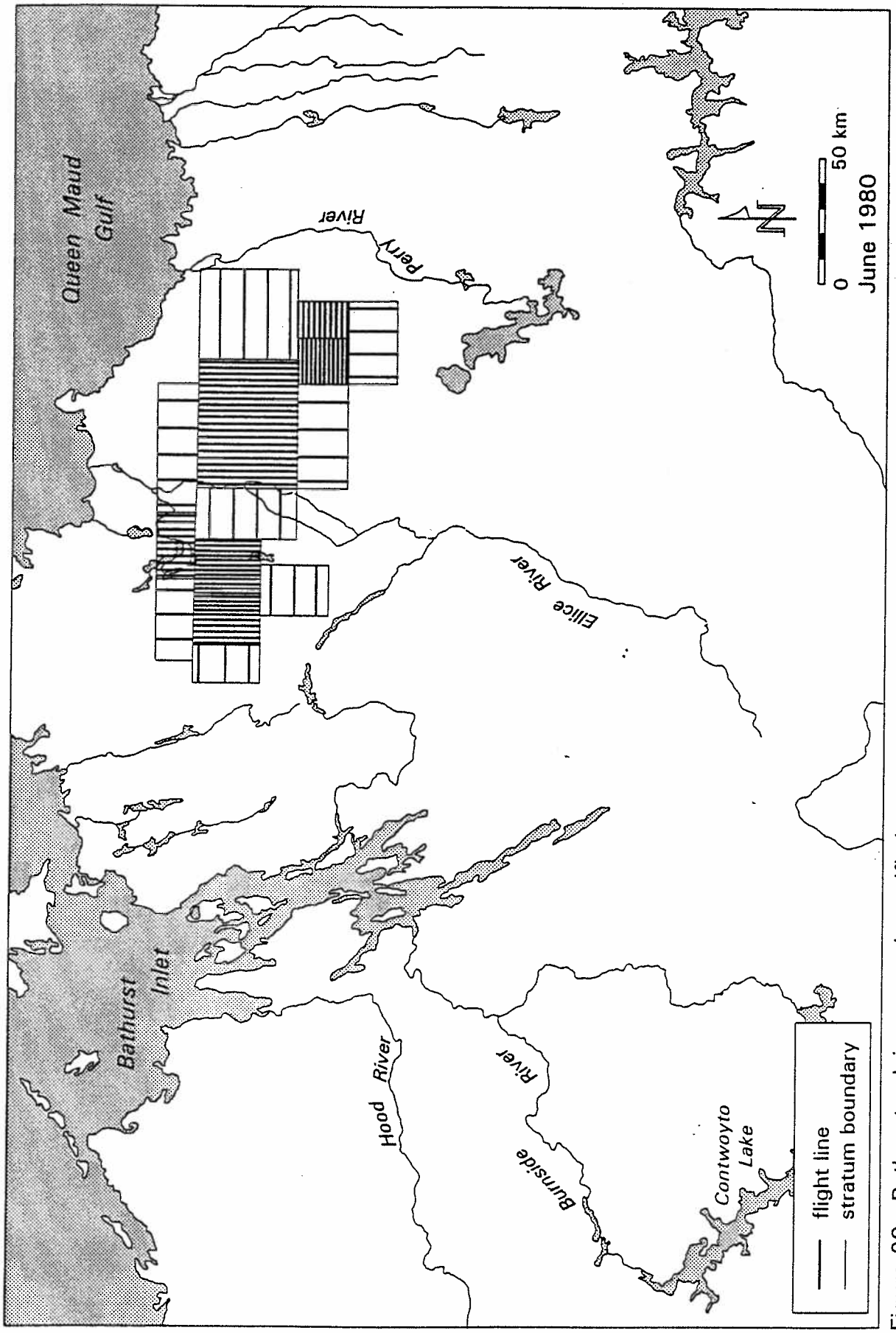

Figure 28. Bathurst calving ground stratified transect survey flight lines, 4-6 June 1980

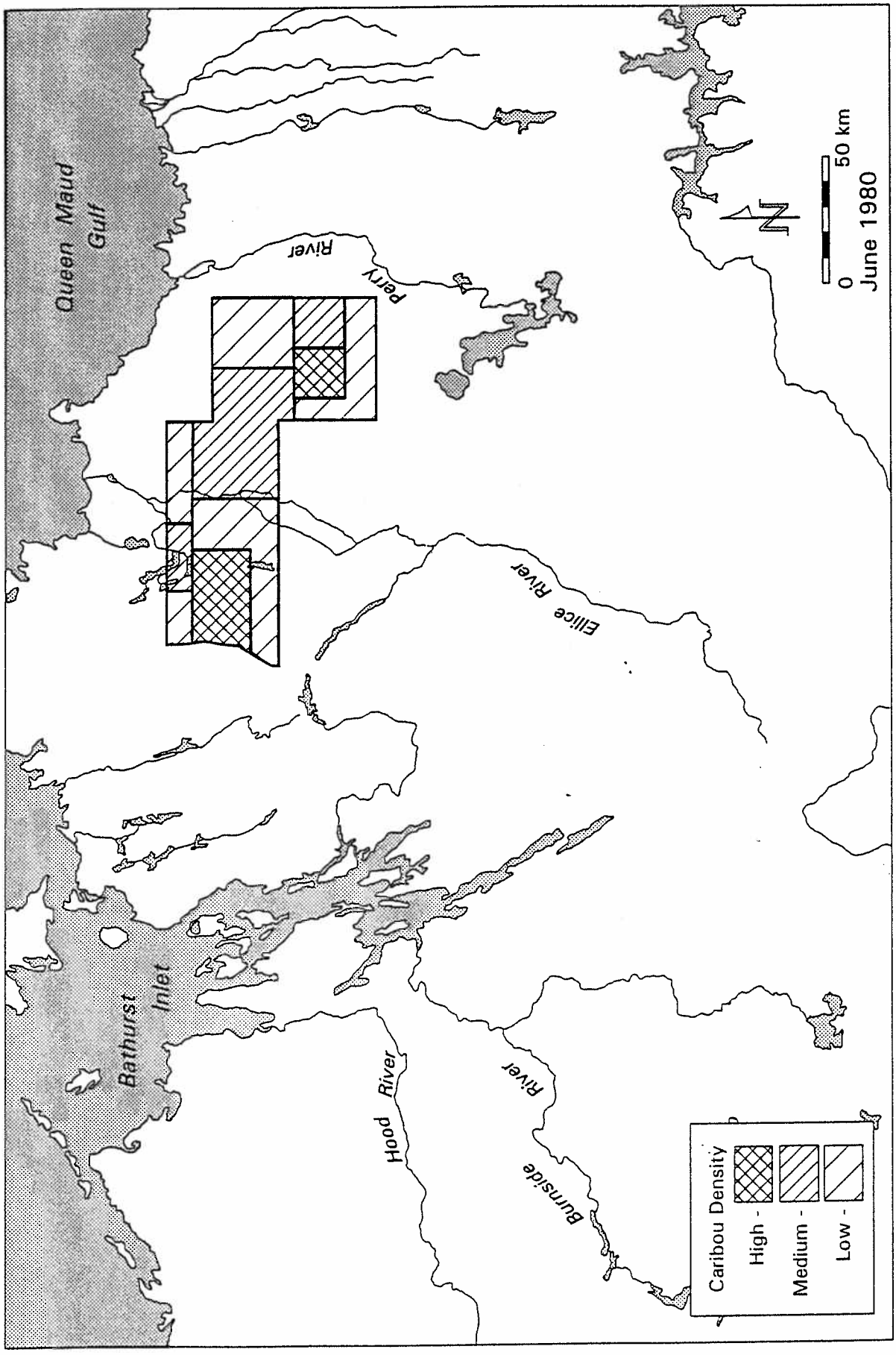

Figure 29. Bathurst calving ground photographic survey strata, 3-8 June 1980

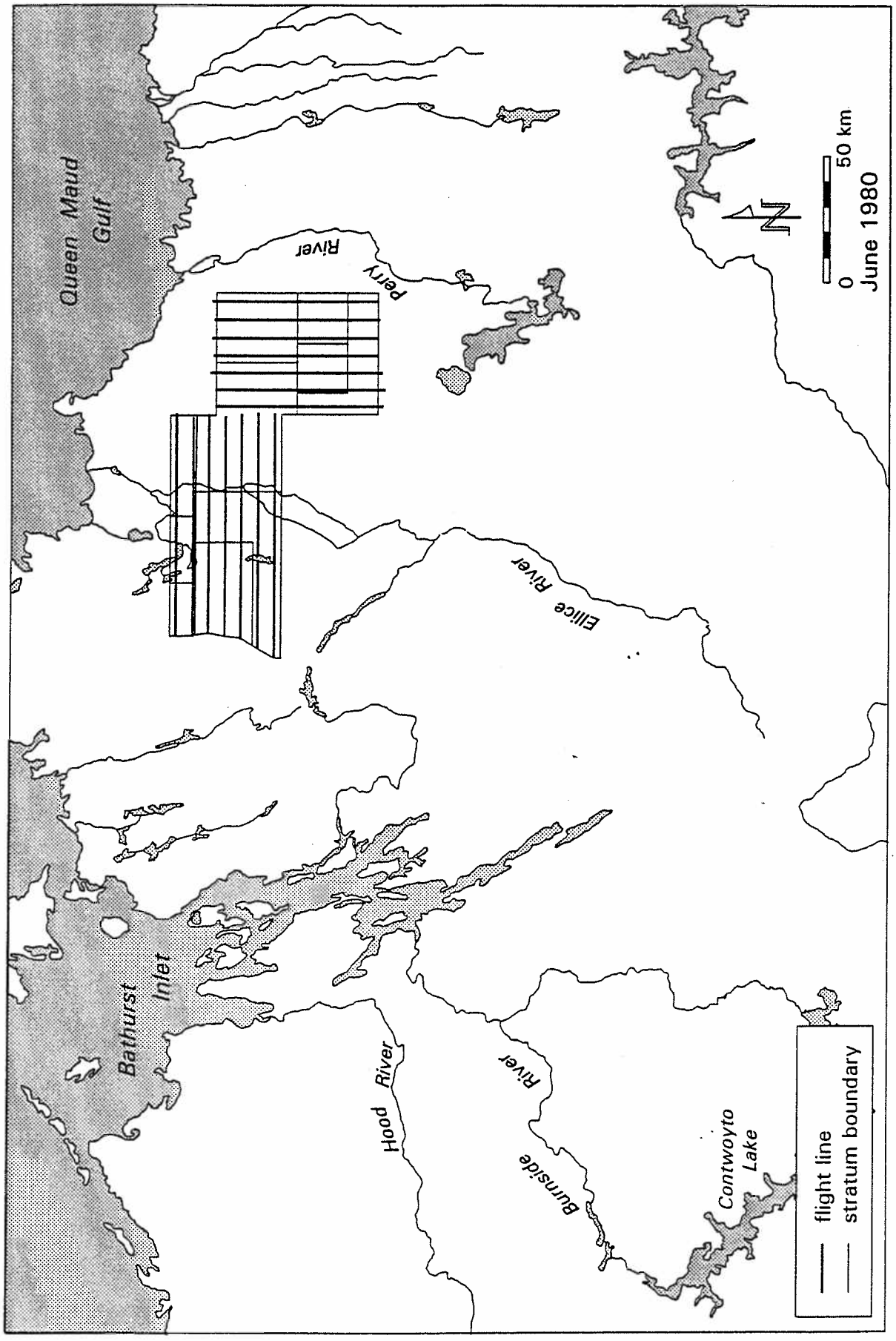

Figure 30. Bathurst calving ground photographic survey flight lines, 3-8 June 1980

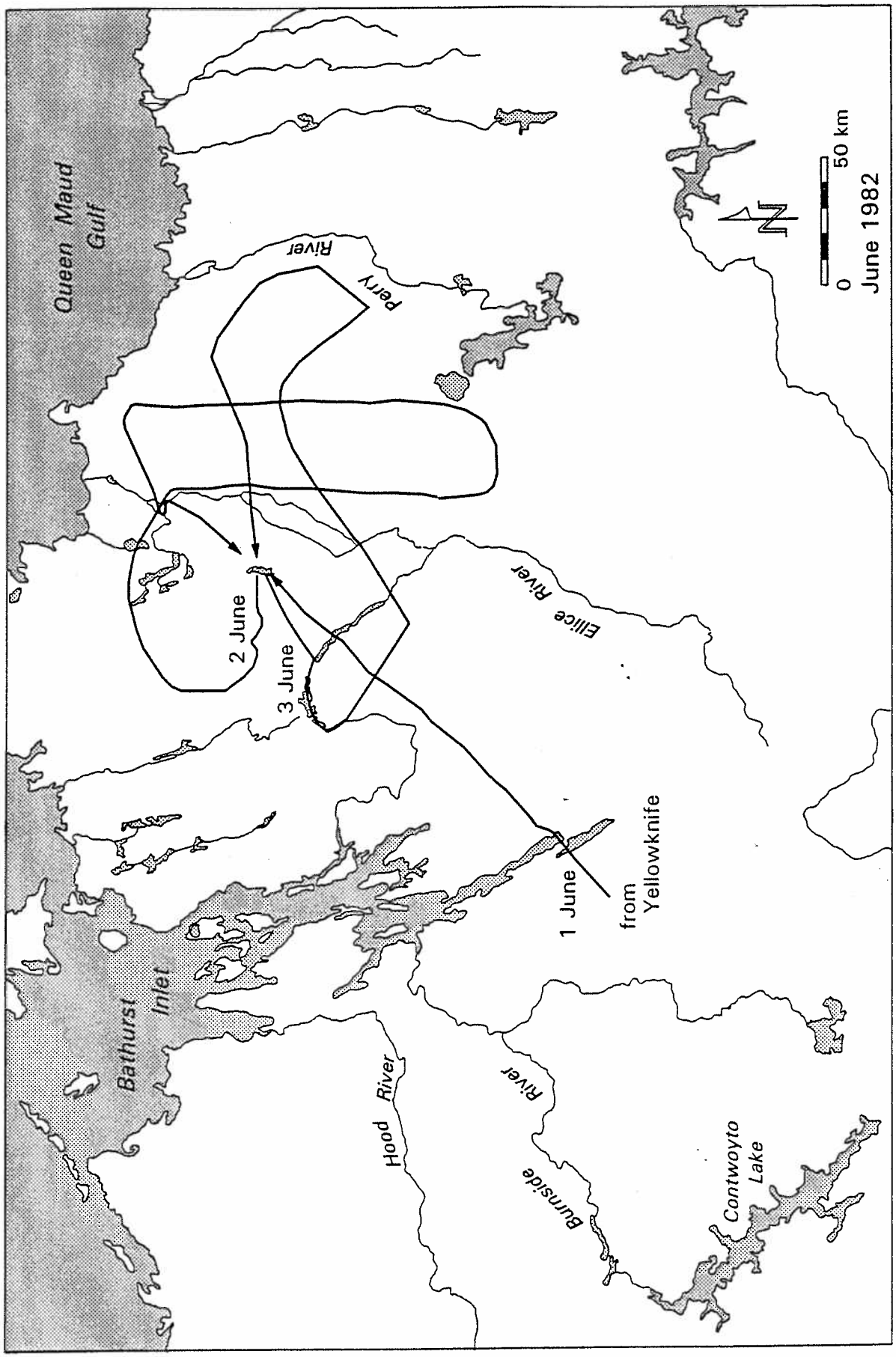

Figure 31. Bathurst calving ground unsystematic reconnaissance flight lines, 2-3 June 1982

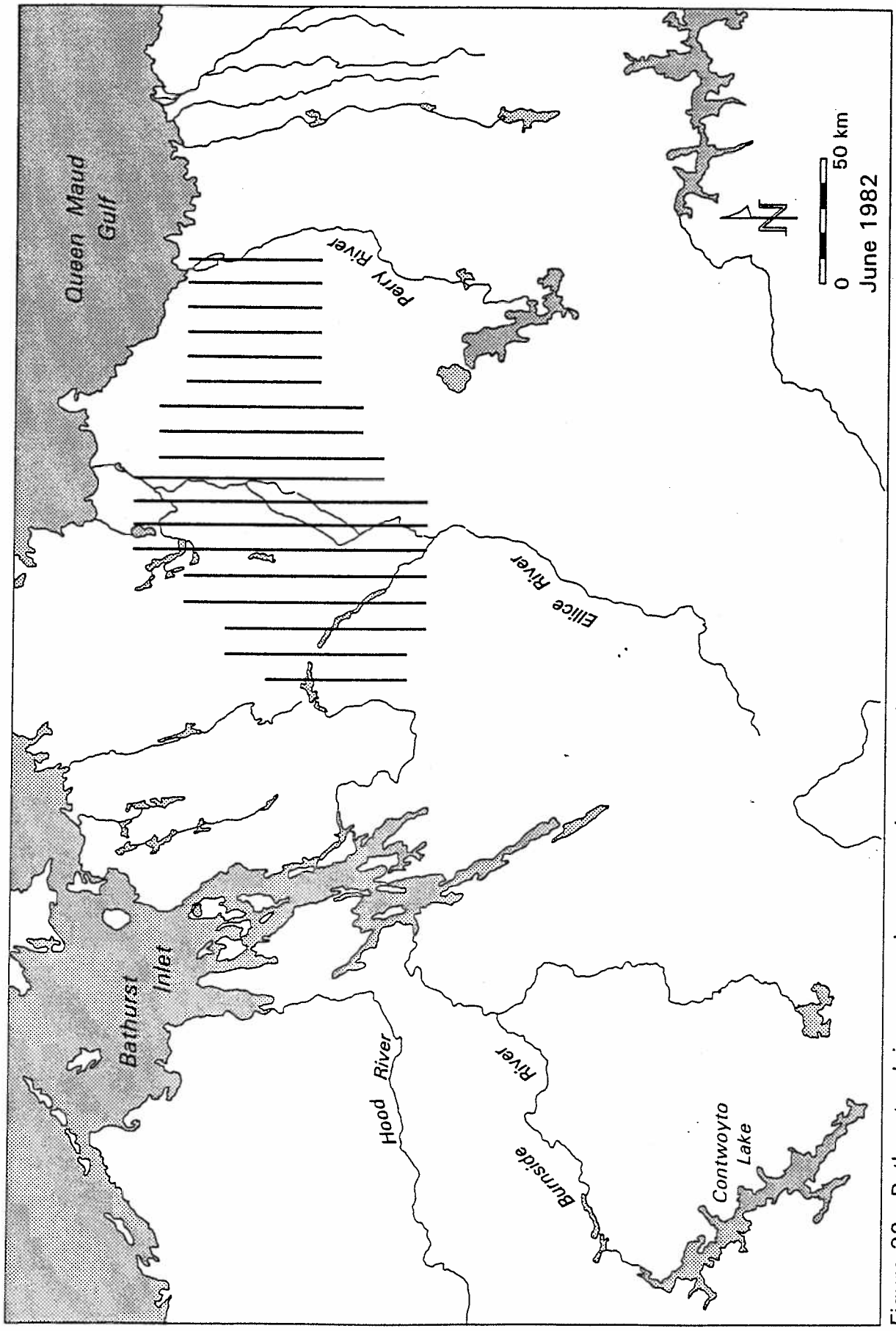

Figure 32. Bathurst calving ground systematic reconnaissance flight lines, 3-4 June 1982

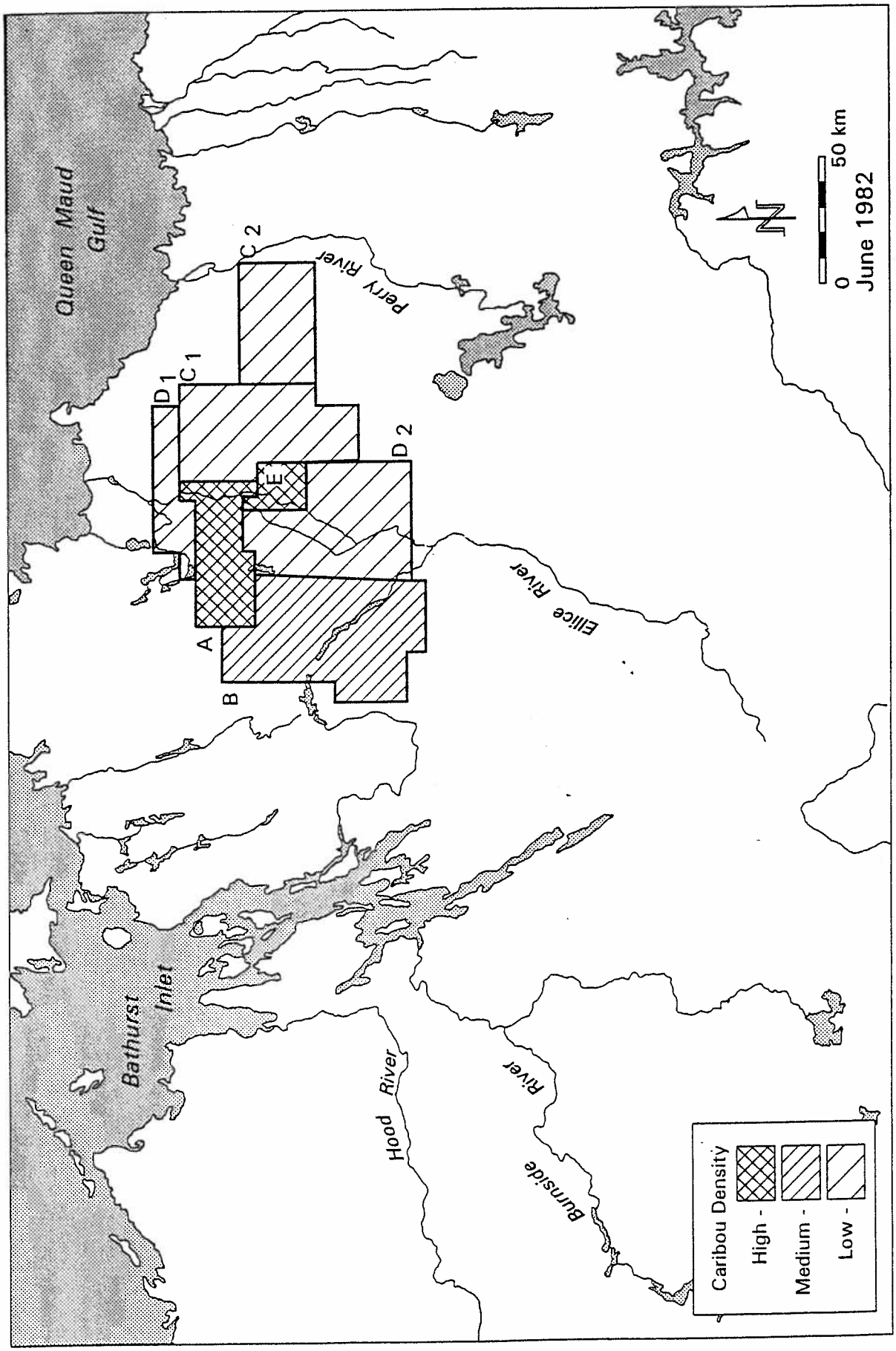

Figure 33. Bathurst calving ground strata, 3-4 June 1982

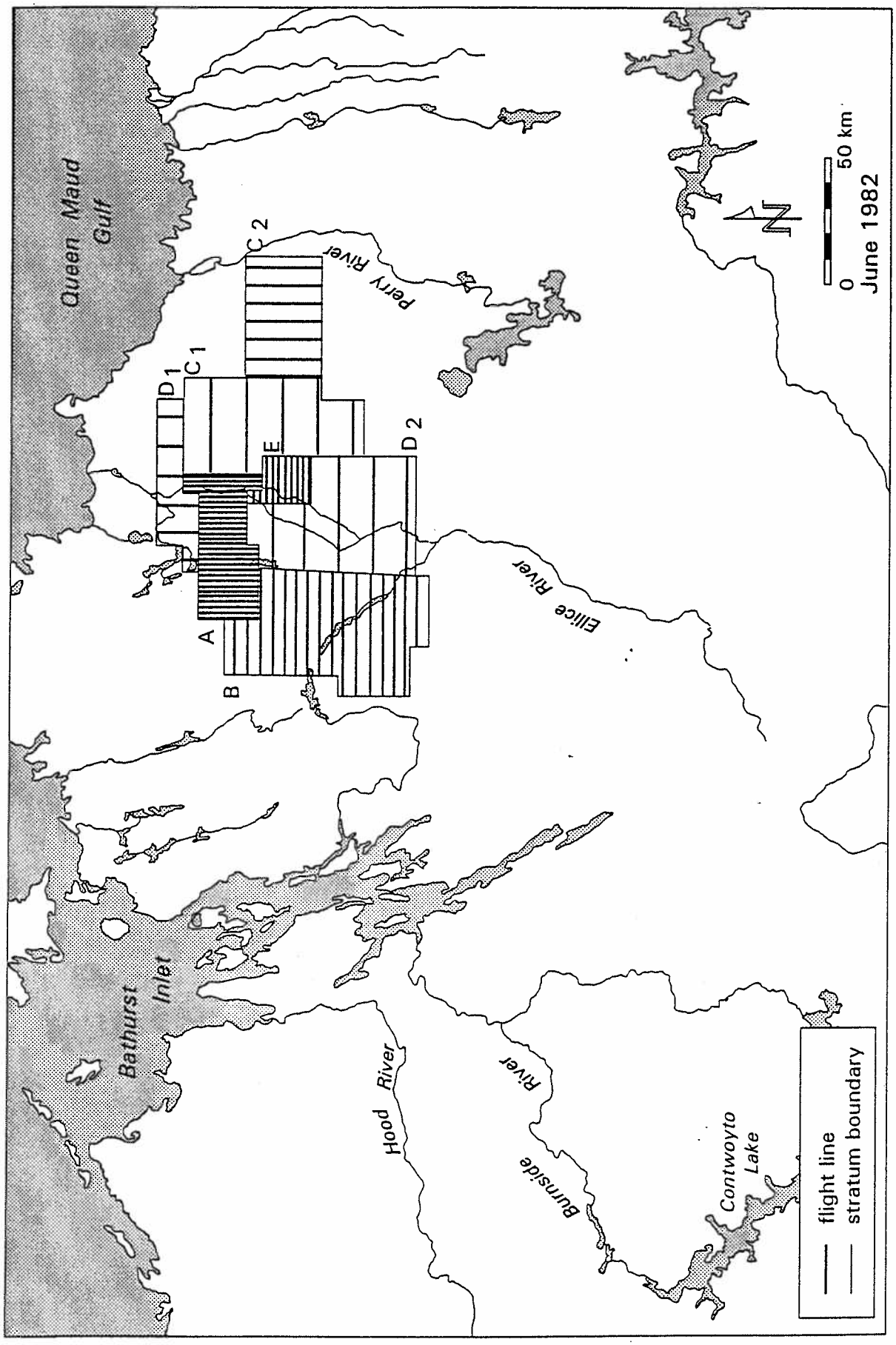

Figure 34. Bathurst calving ground stratified transect survey flight lines, 5-6 June 1982

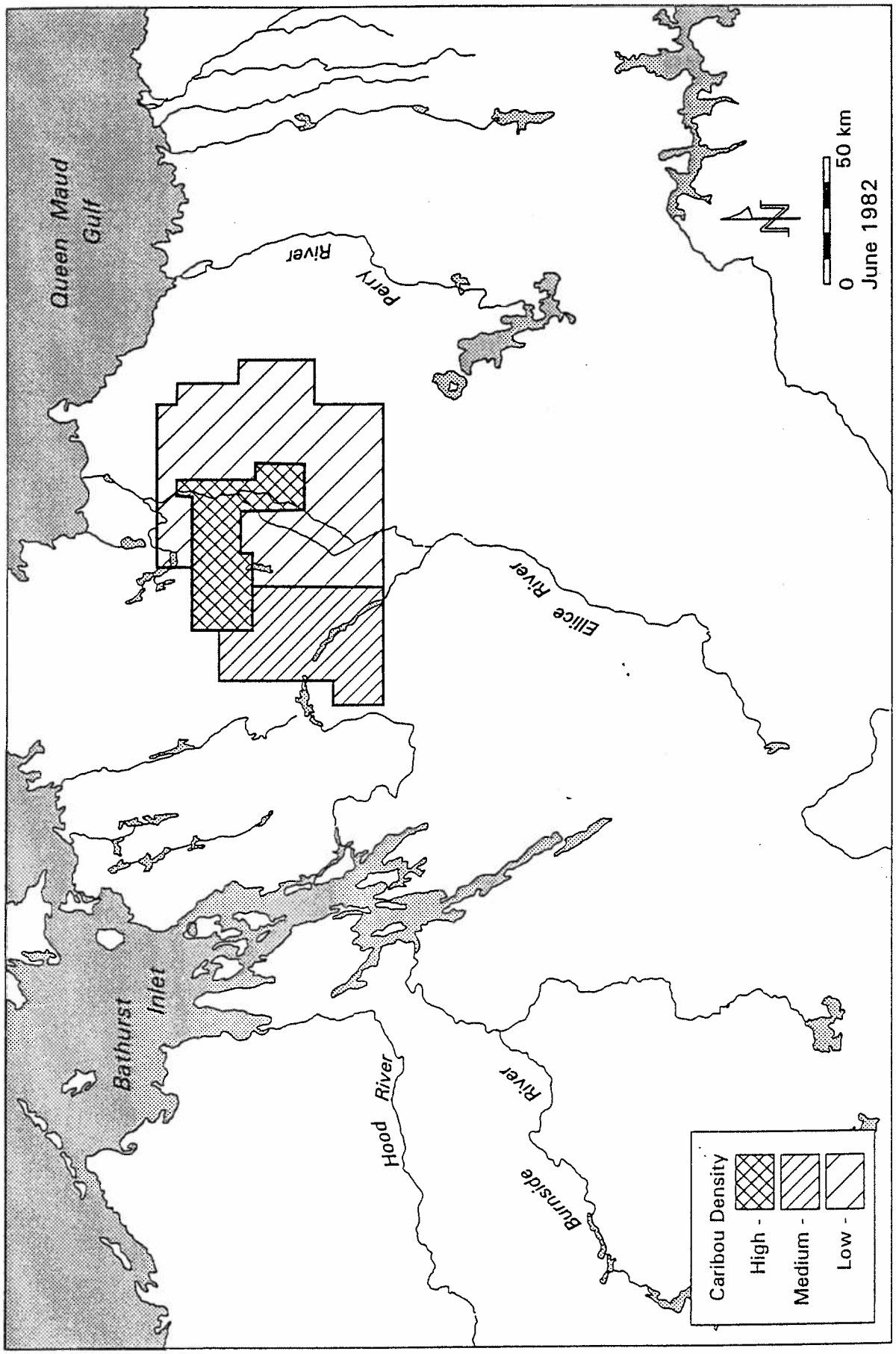

Figure 35. Bathurst calving ground photographic survey strata, 10-12 June 1982

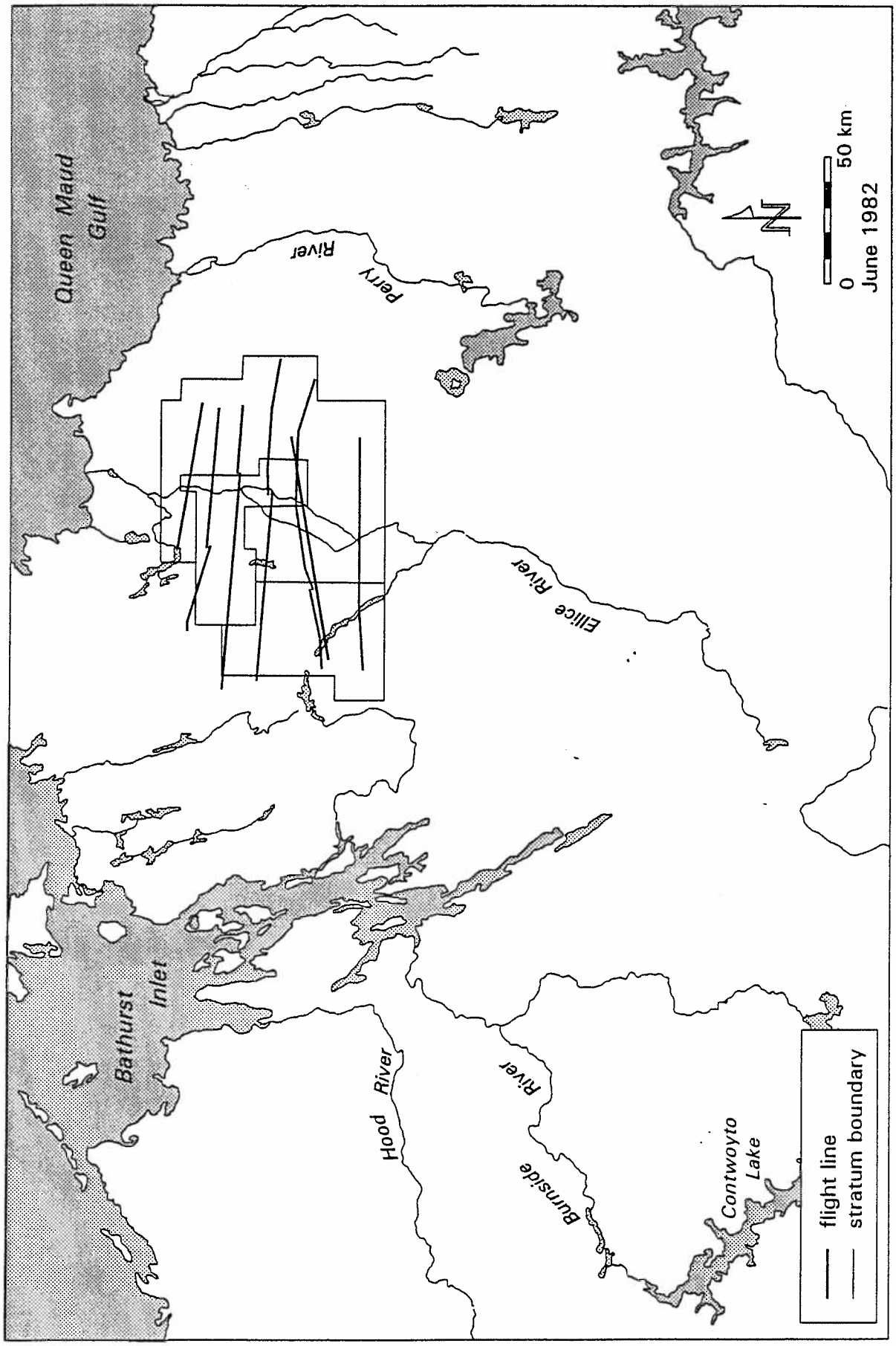

Figure 36. Bathurst calving ground photographic survey flight lines, 10-12 June 1982

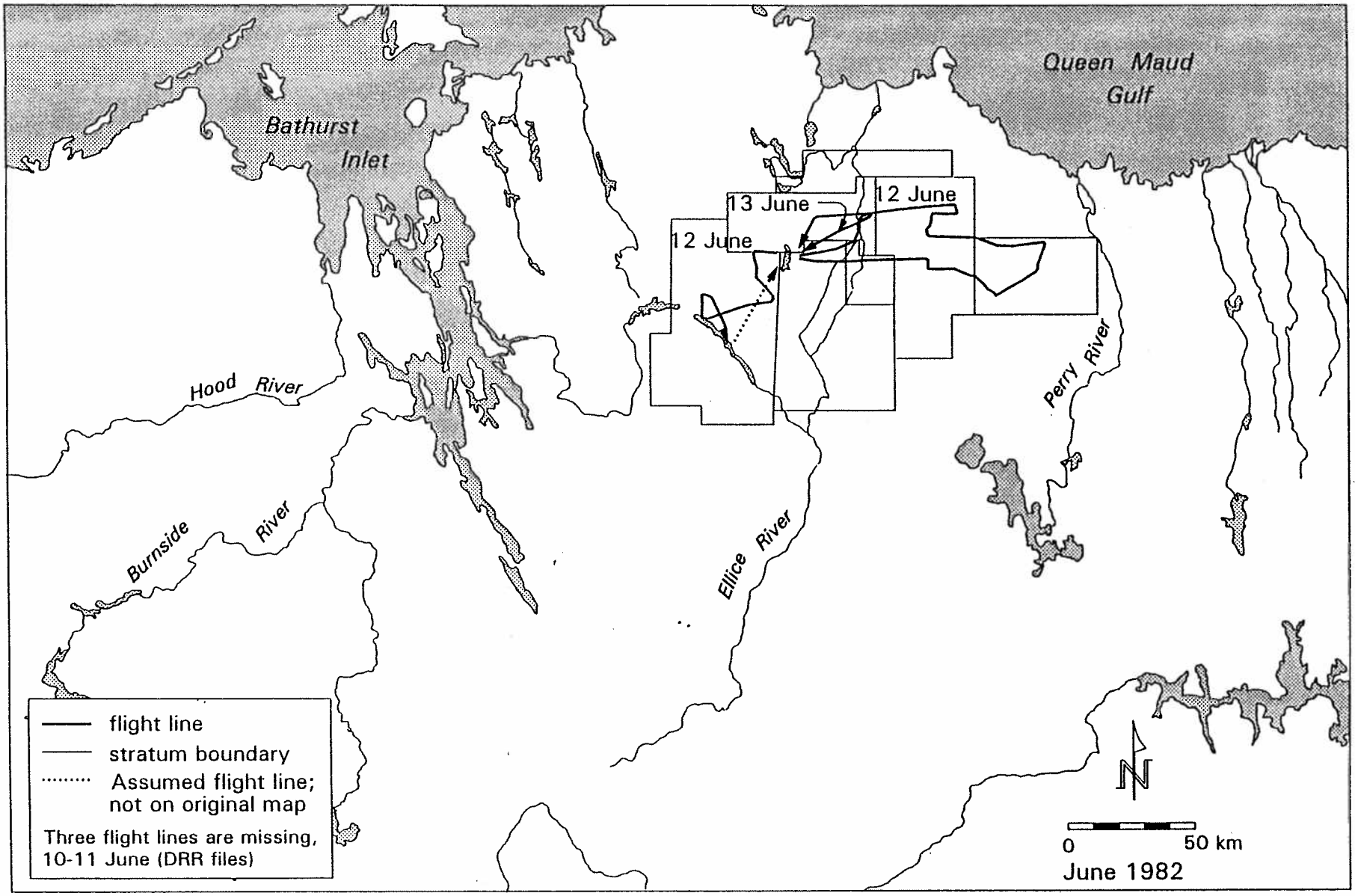

Figure 37. Bathurst calving ground composition survey flight lines, 10-13 June 1982

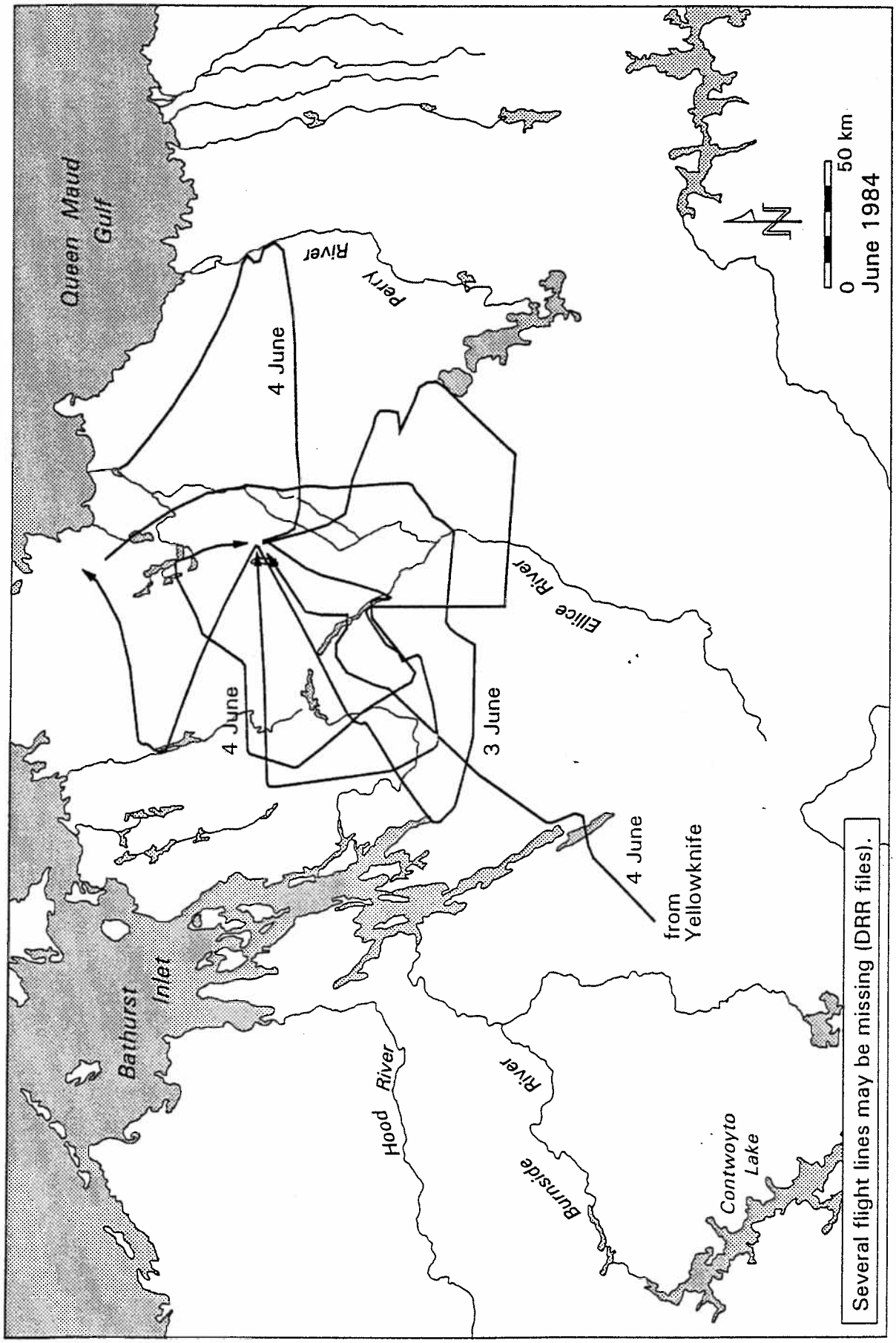

Figure 38. Bathurst calving ground unsystematic reconnaissance flight lines, 3-4 June 1984.

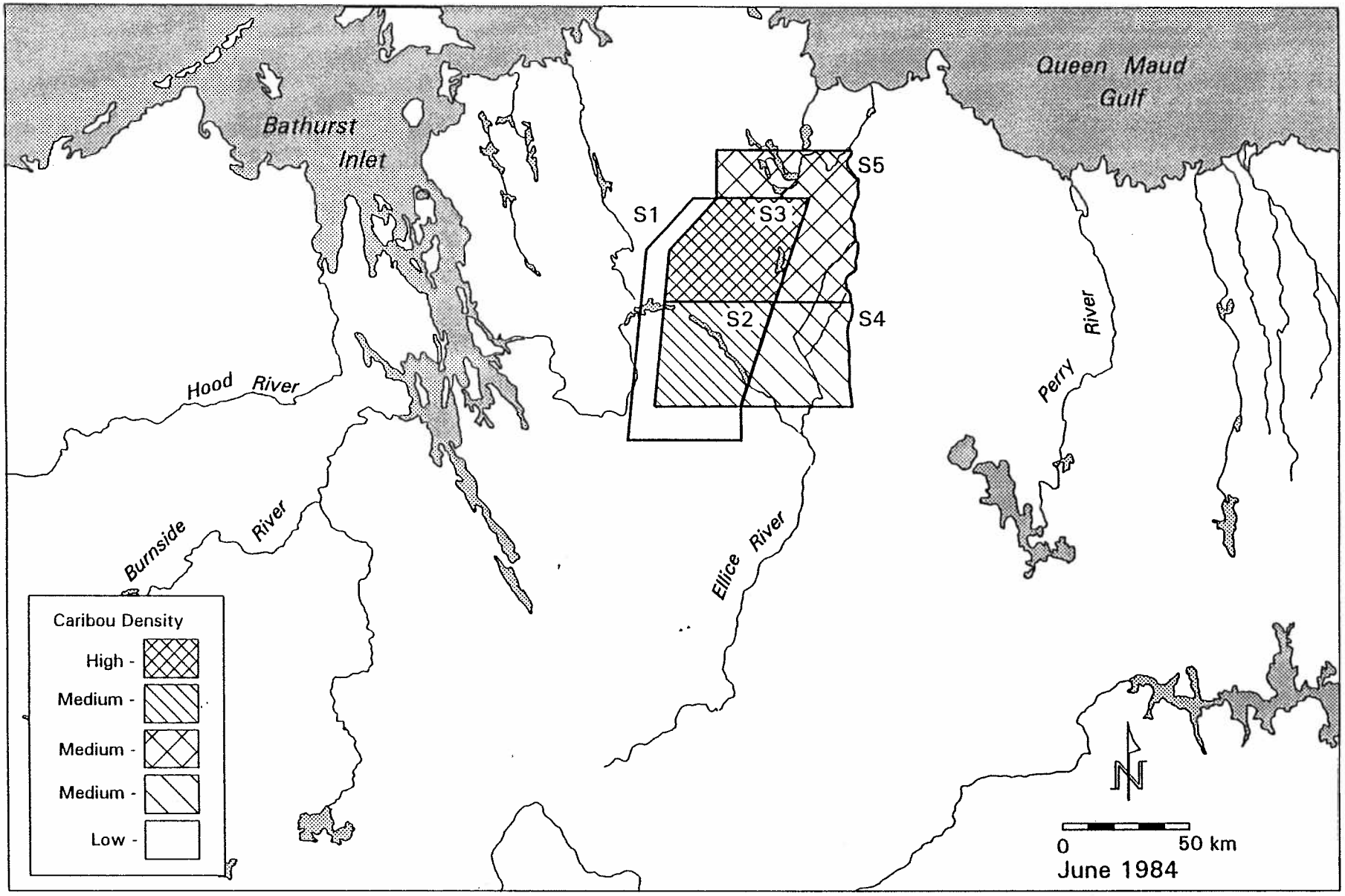

Figure 39. Bathurst calving ground strata, 3-4 June 1984

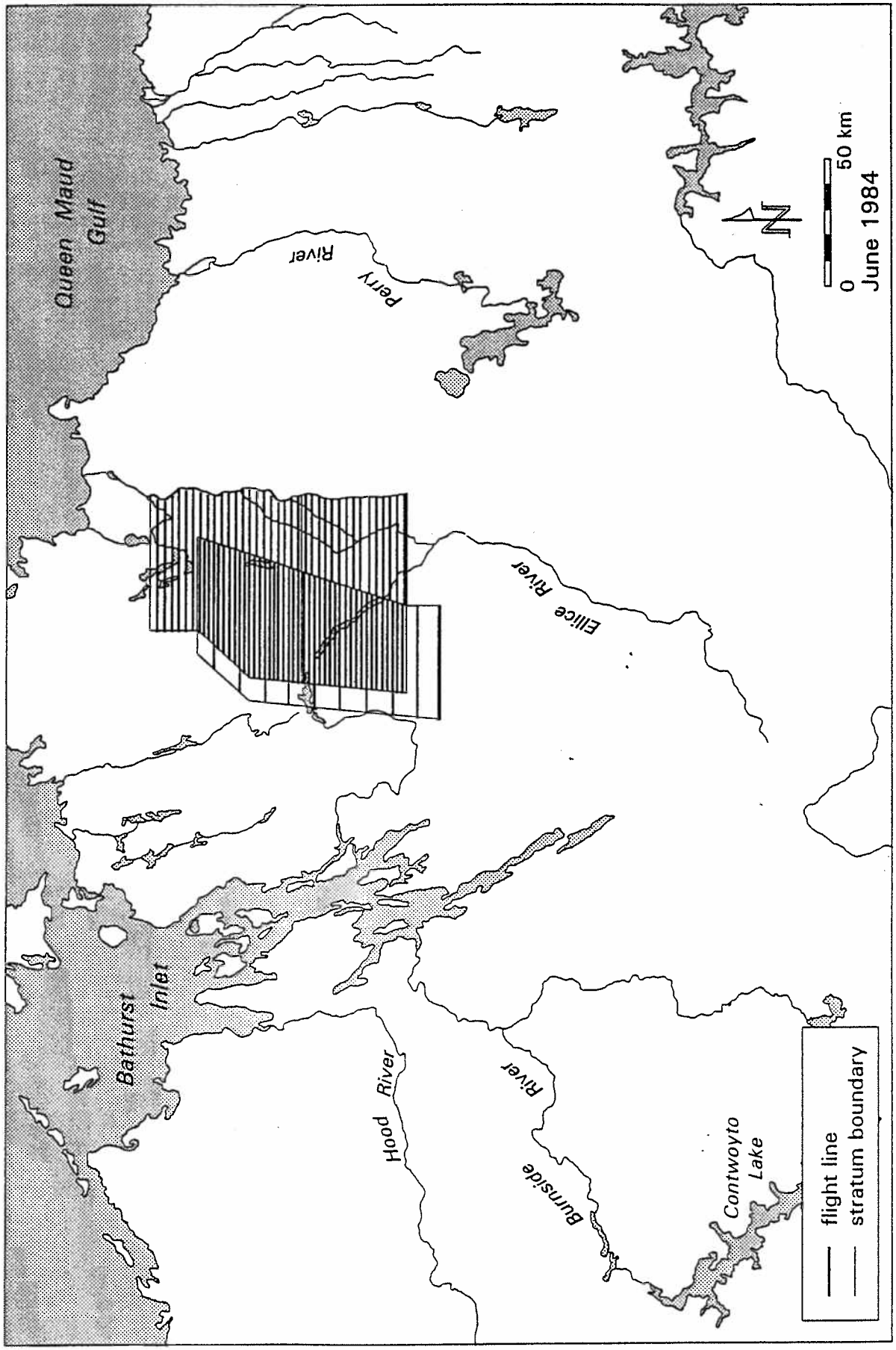

Figure 40. Bathurst calving ground stratified transect survey flight lines, 5-6 June 1984

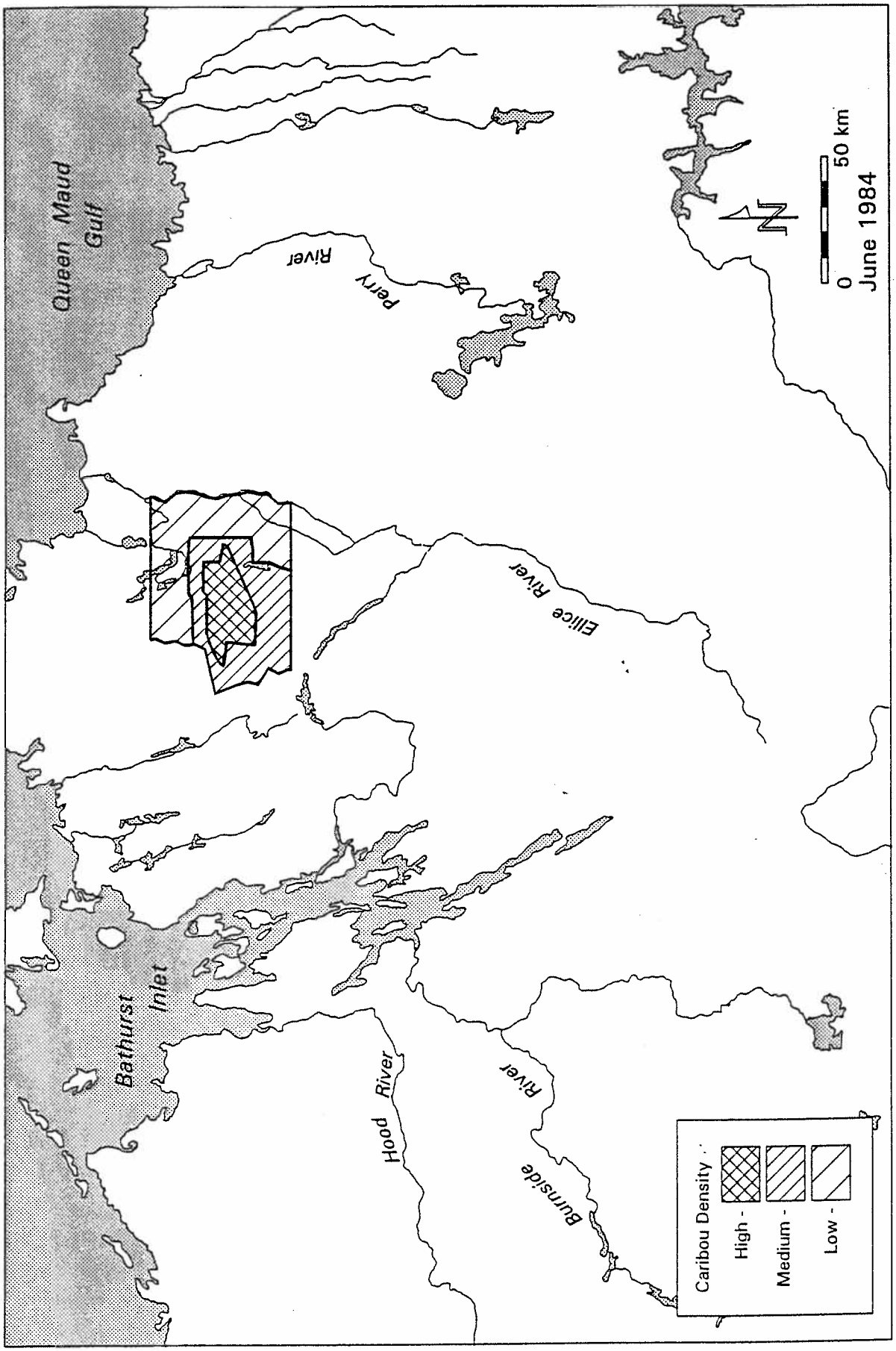

Figure 41. Bathurst calving ground photographic survey strata, 8-9 June 1984

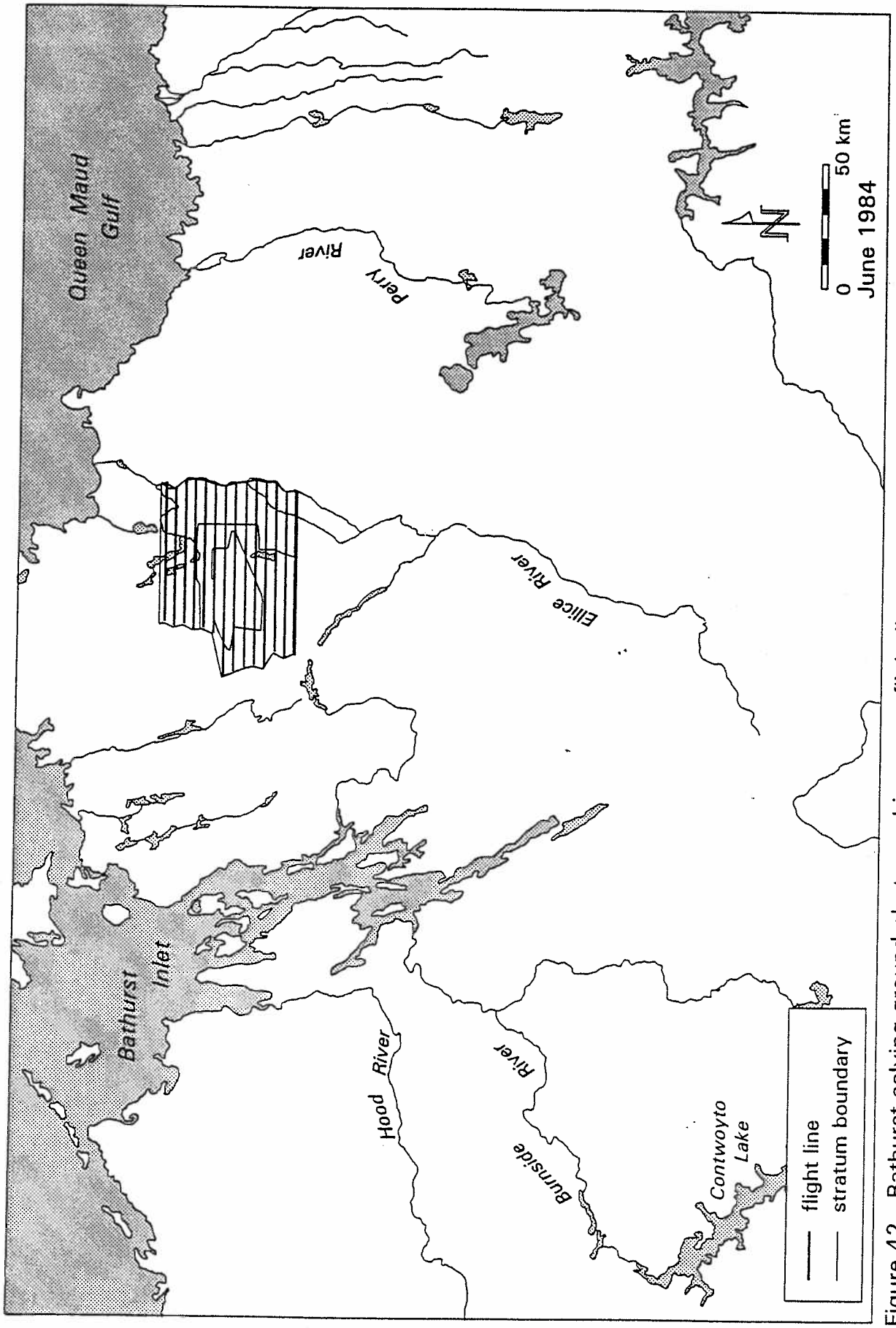

Figure 42. Bathurst calving ground photographic survey flight lines, 8-9 June 1984

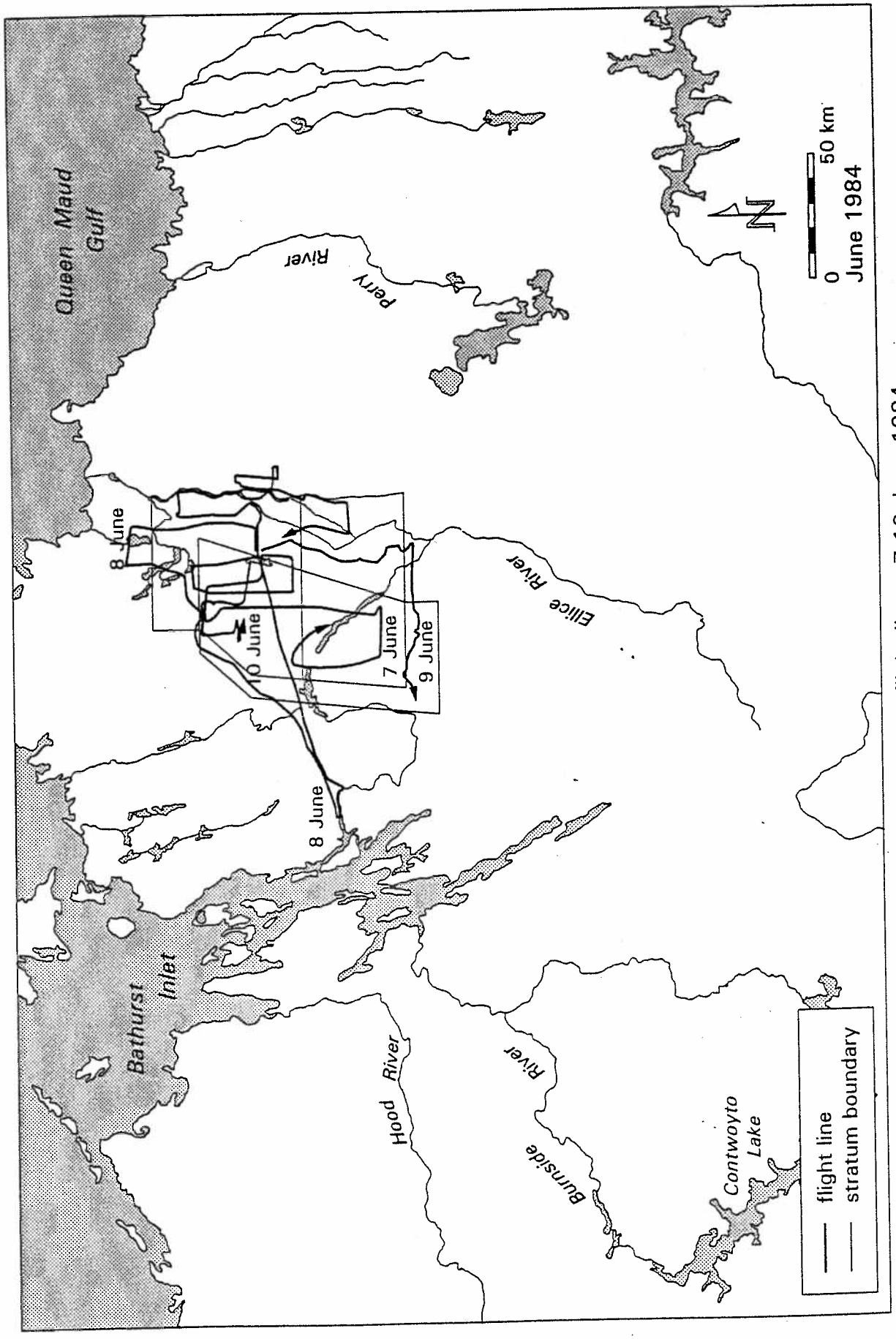

Figure 43. Bathurst calving ground composition survey flight lines, 7-10 June 1984

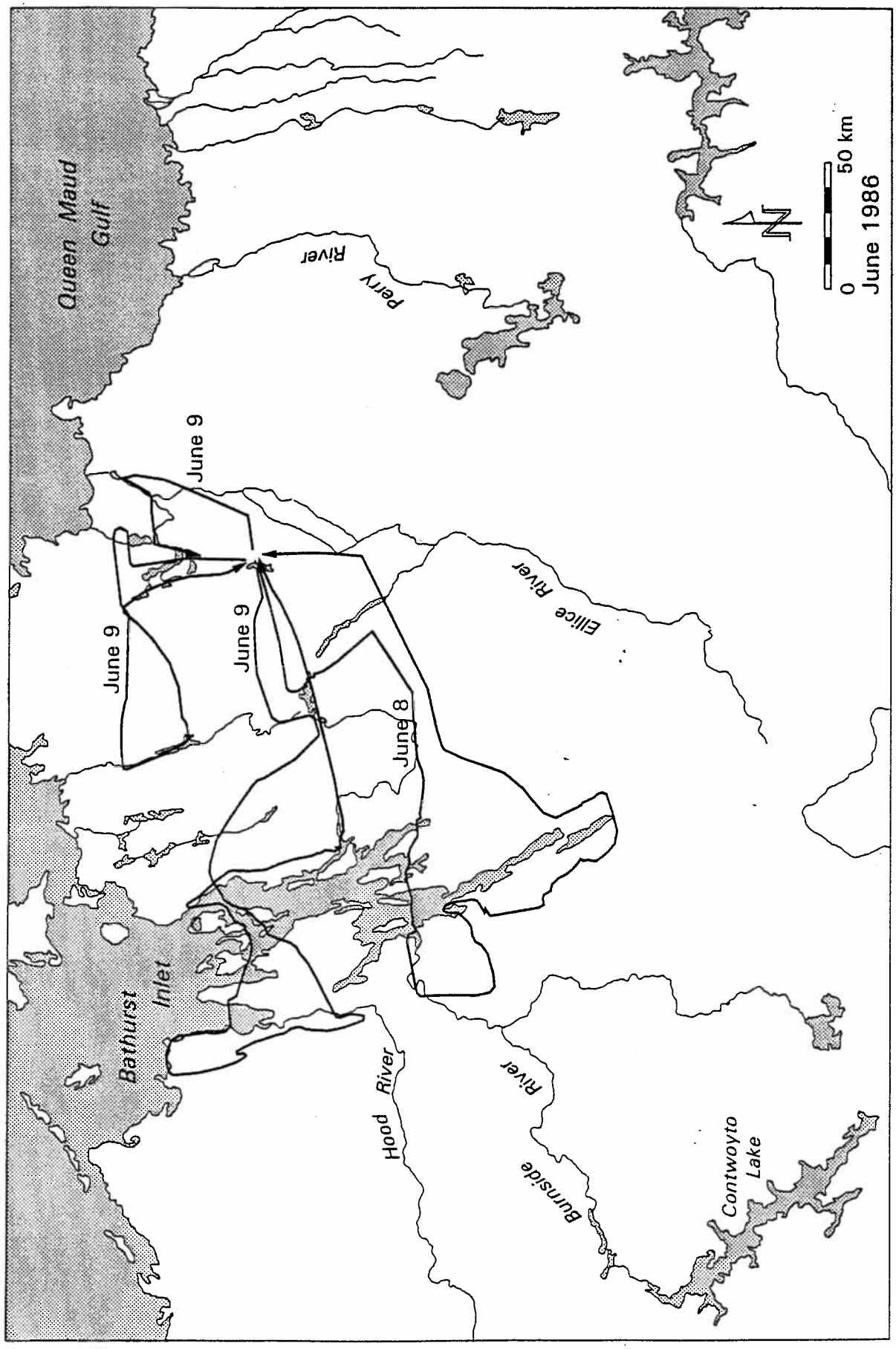

Figure 44. Bathurst calving ground unsystematic reconnaissance flight lines, 8-9 June 1986

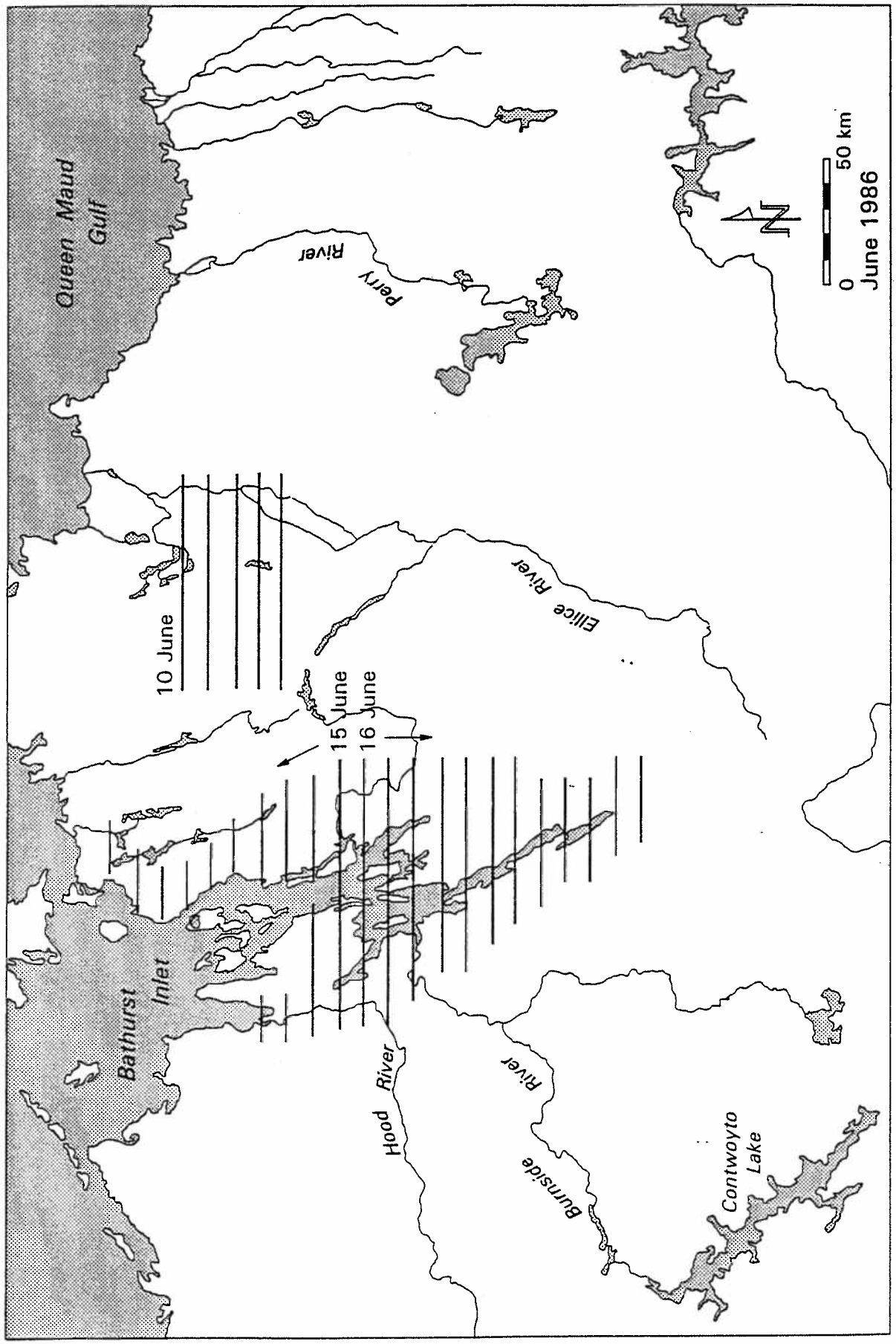

Figure 45. Bathurst calving ground systematic reconnaissance flight lines, 10-16 June 1986

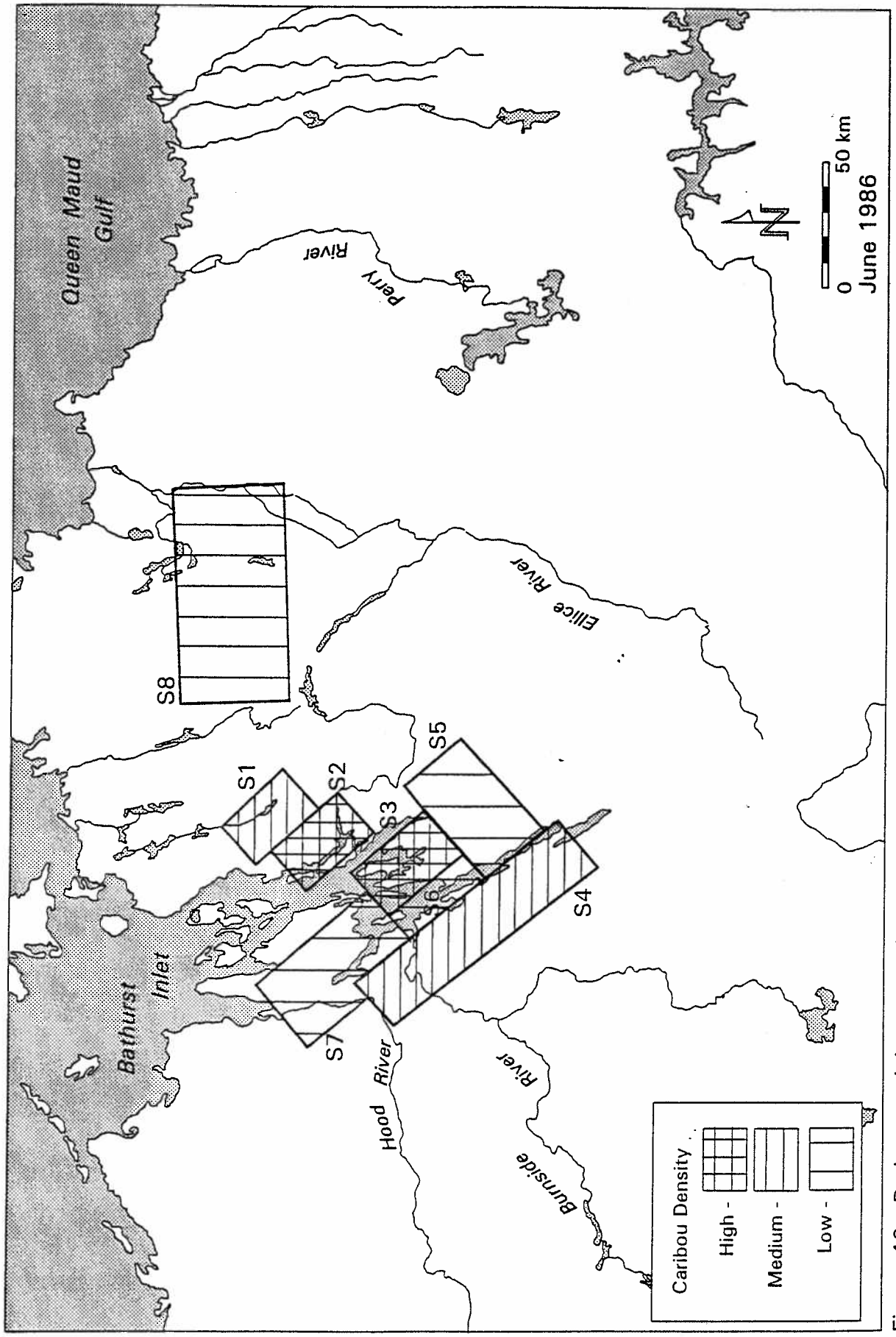

Figure 46. Bathurst calving ground strata, 10-16 June 1986

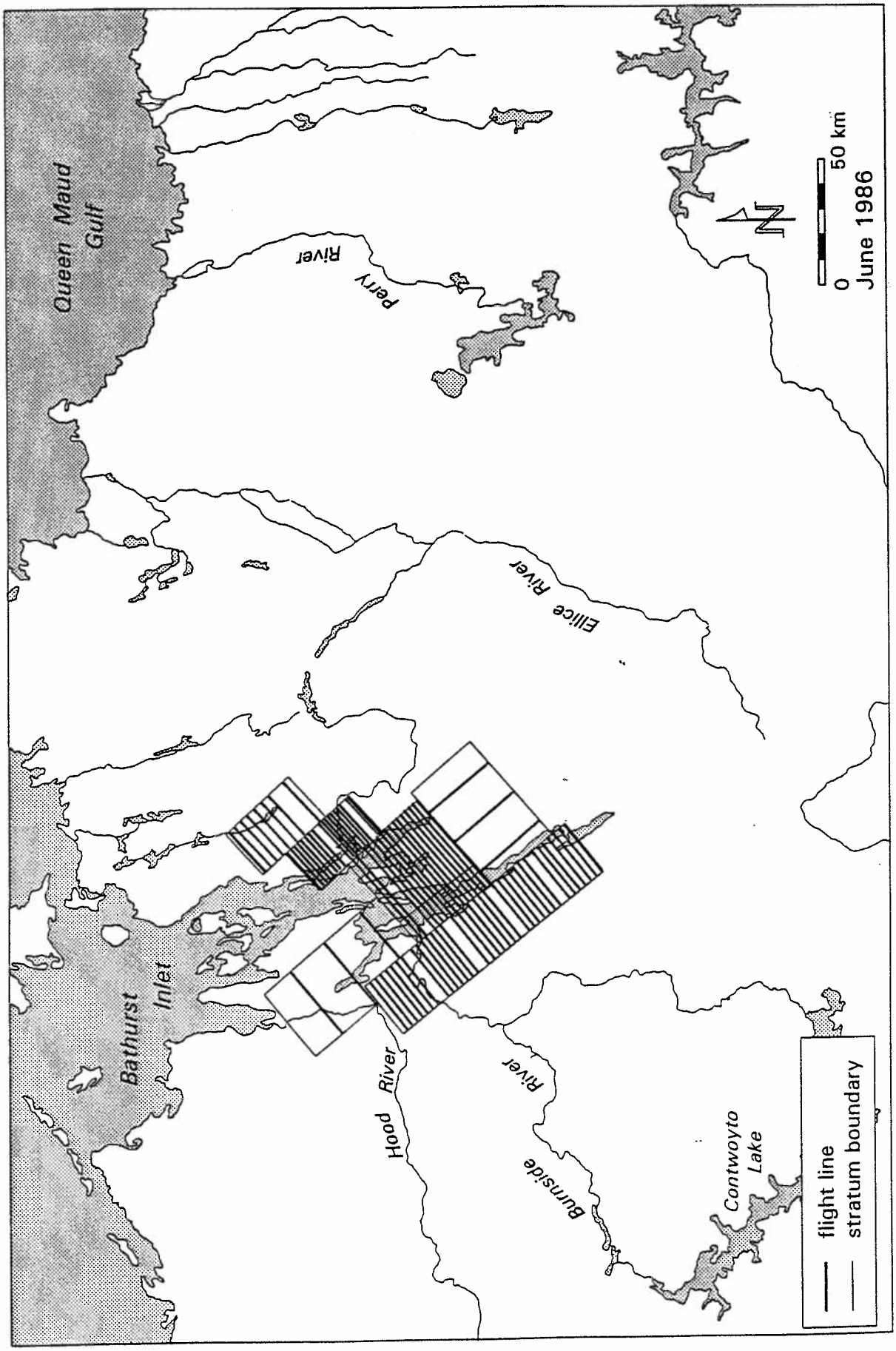

Figure 47. Bathurst calving ground stratified transect survey flight lines, 17-18 June 1986

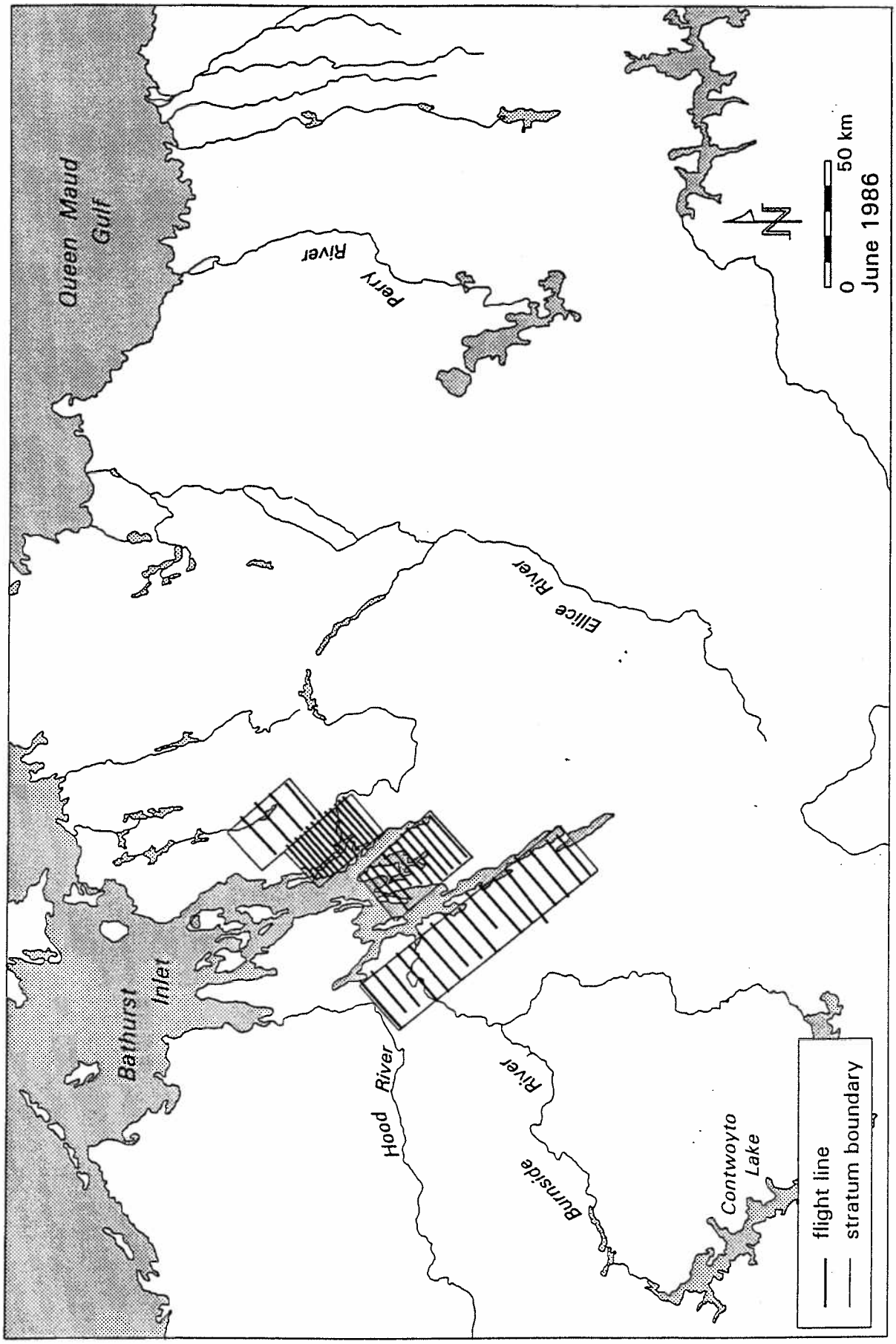

Figure 48. Bathurst calving ground photographic survey flight lines, 16-17 June 1986

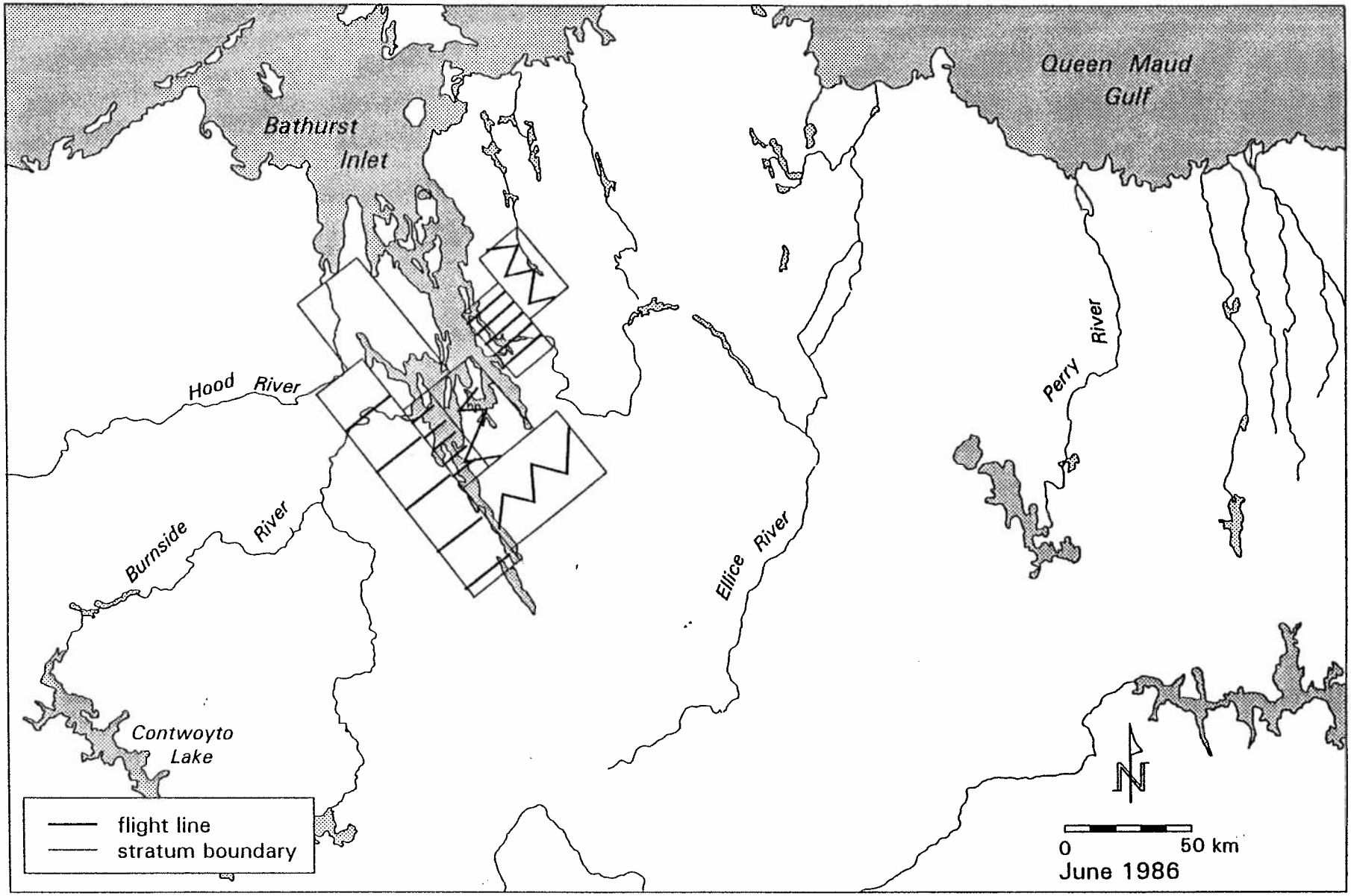

Figure 49. Bathurst calving ground composition survey flight lines, 17-19 June 1986

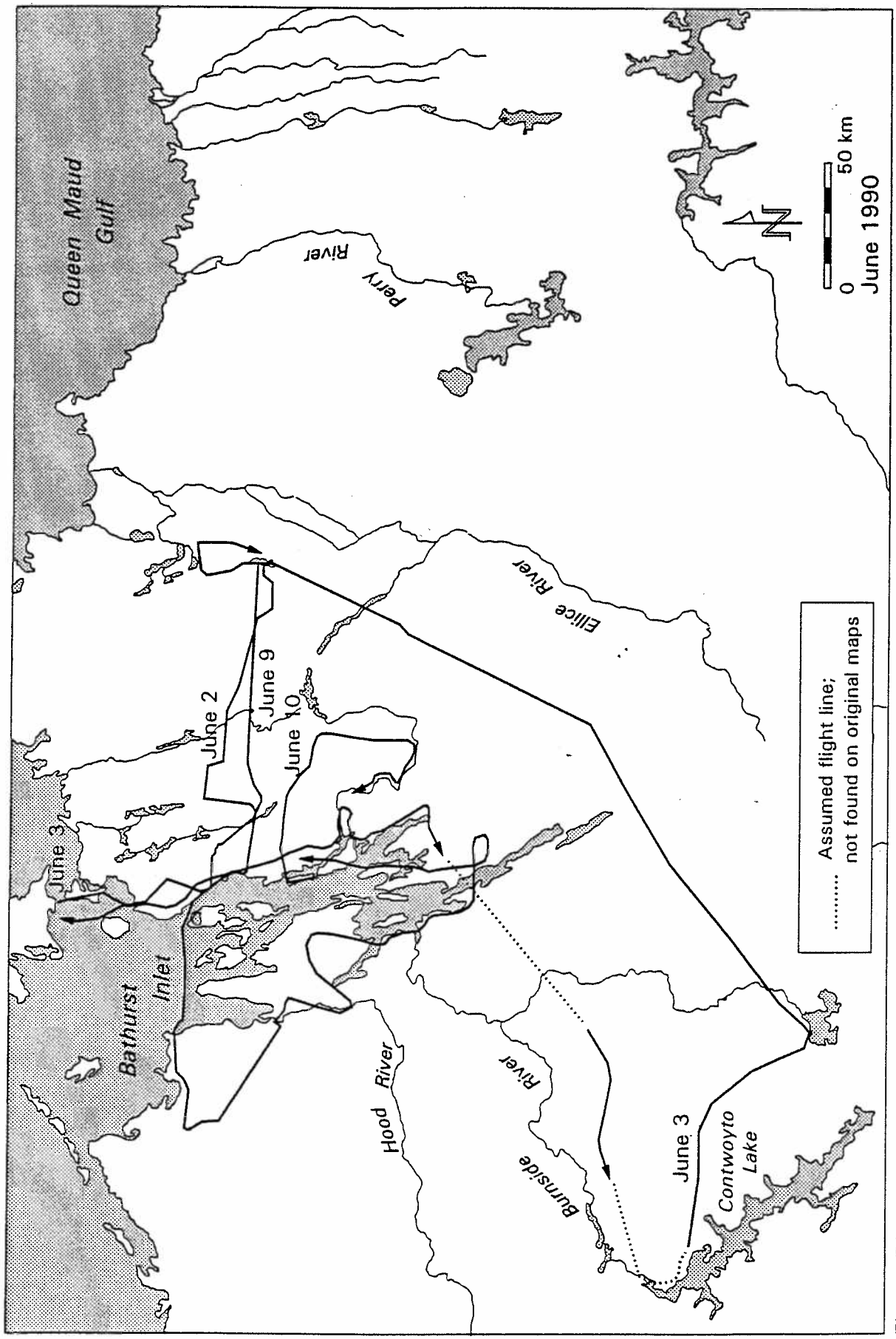

Figure 50. Bathurst calving ground unsystematic reconnaissance flight lines, 2-10 June 1990

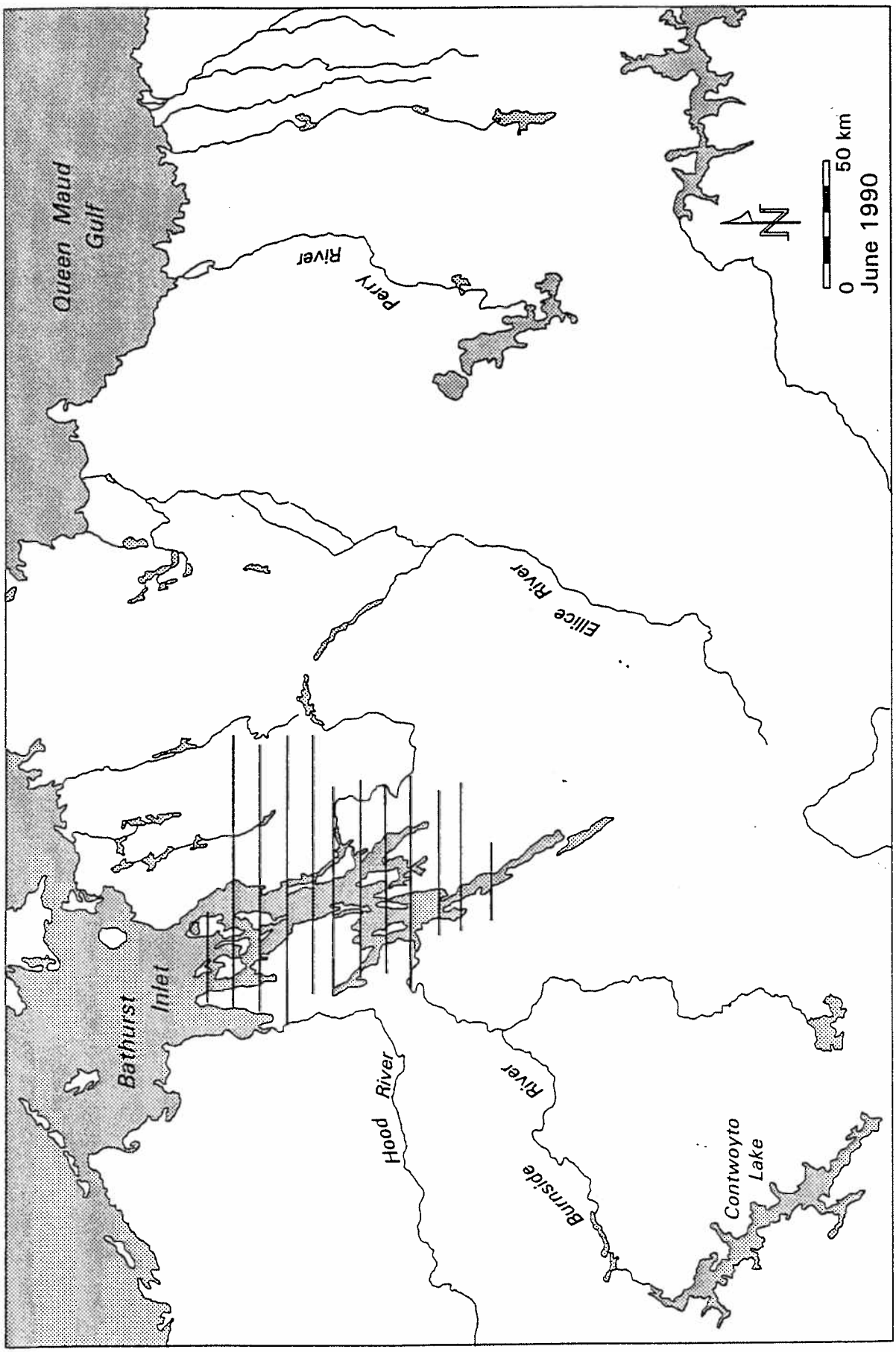

Figure 51. Bathurst calving ground systematic reconnaissance flight lines, 11 June 1990

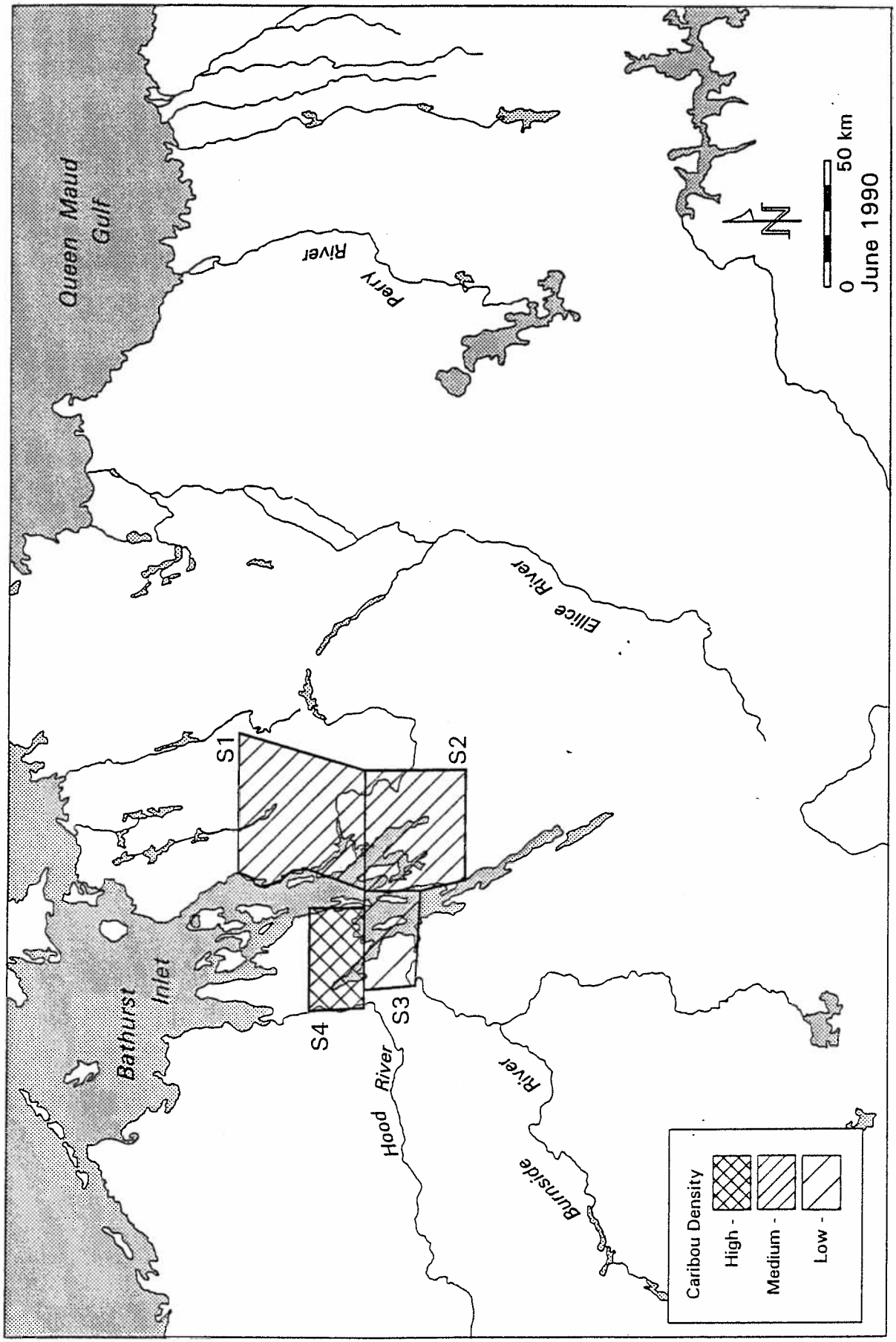

Figure 52. Bathurst calving ground strata, 11 June 1990

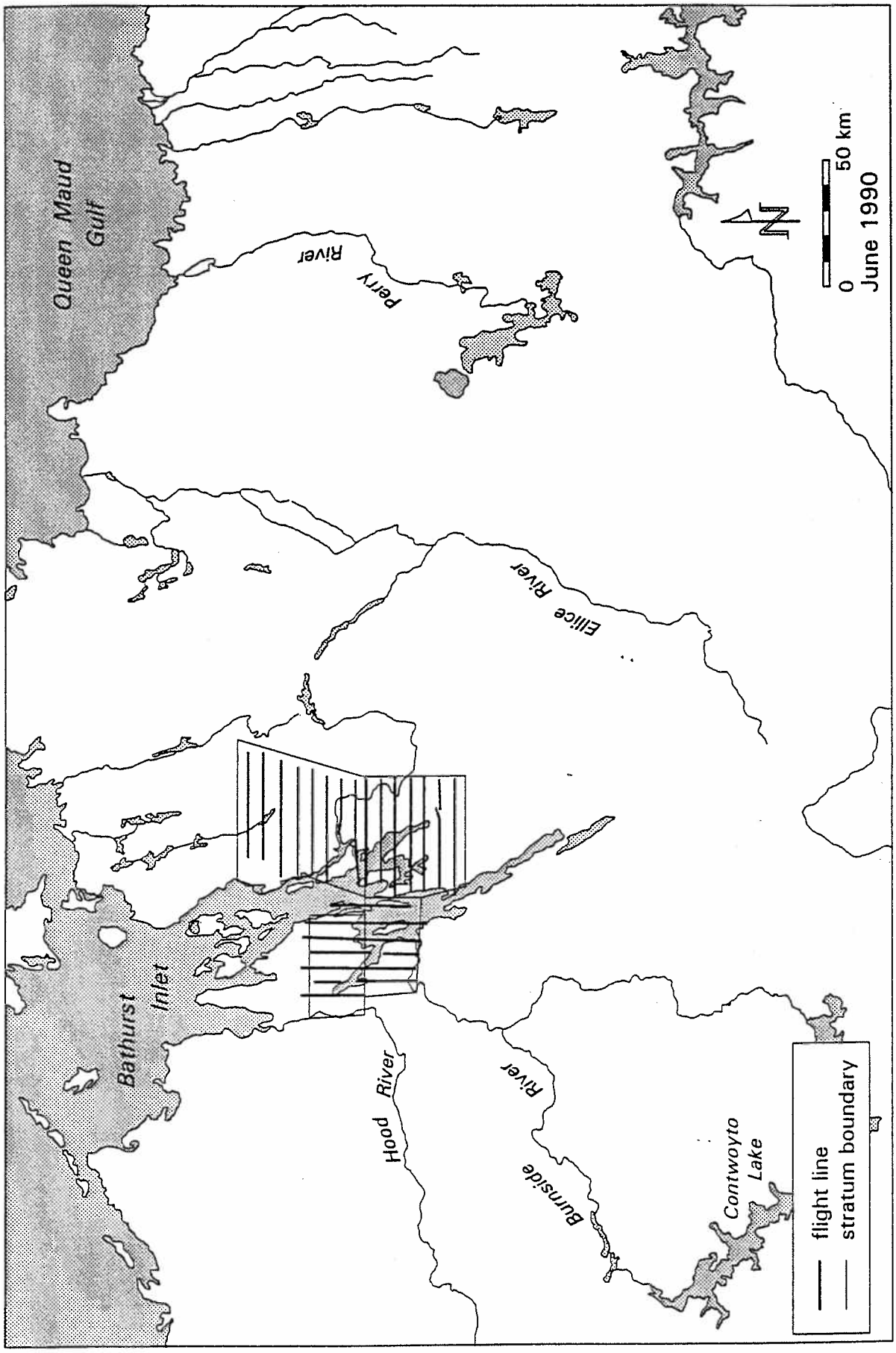

Figure 53. Bathurst calving ground photographic survey flight lines, 14-15 June 1990

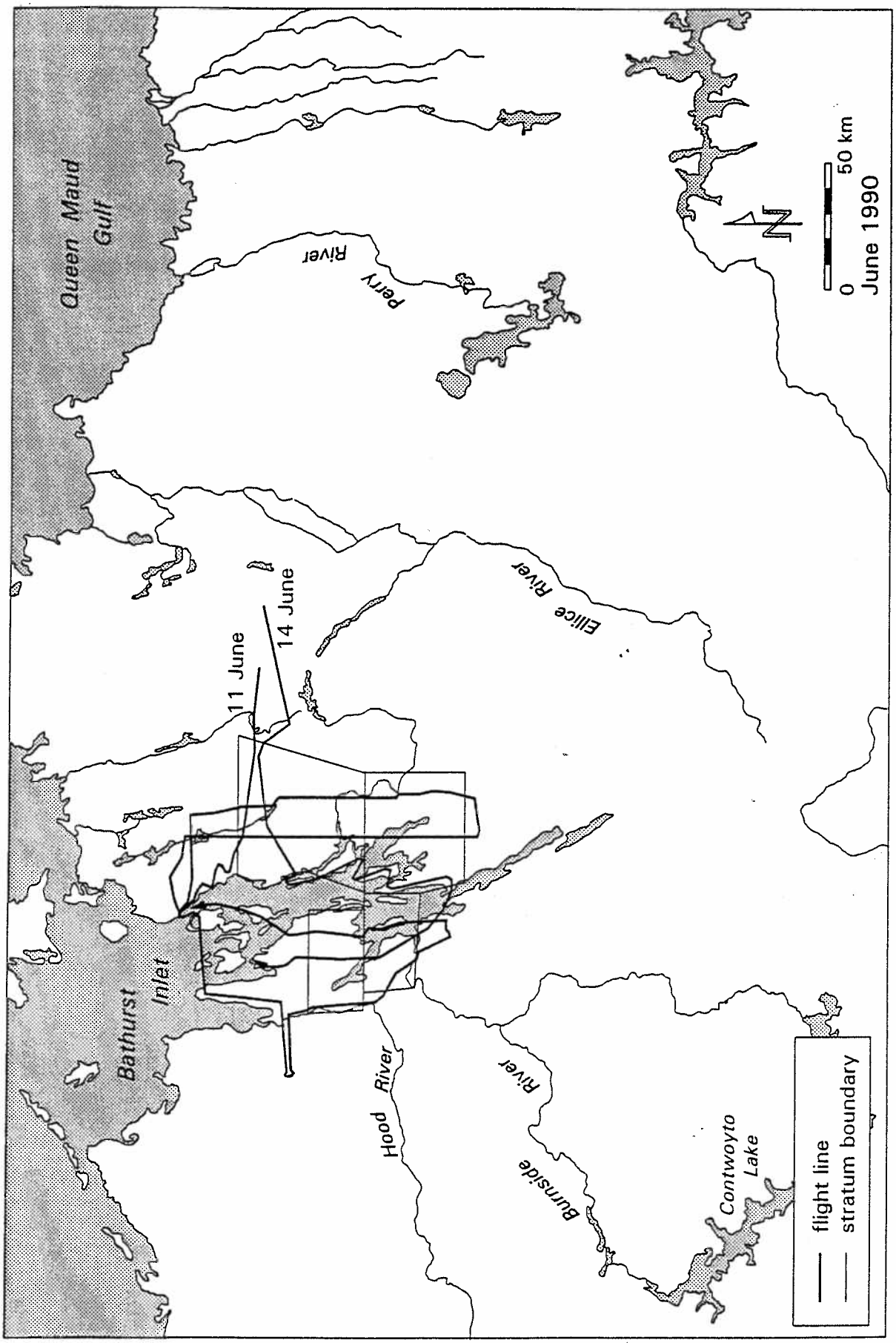

Figure 54. Bathurst calving ground composition survey flight lines, 11-14 June 1990

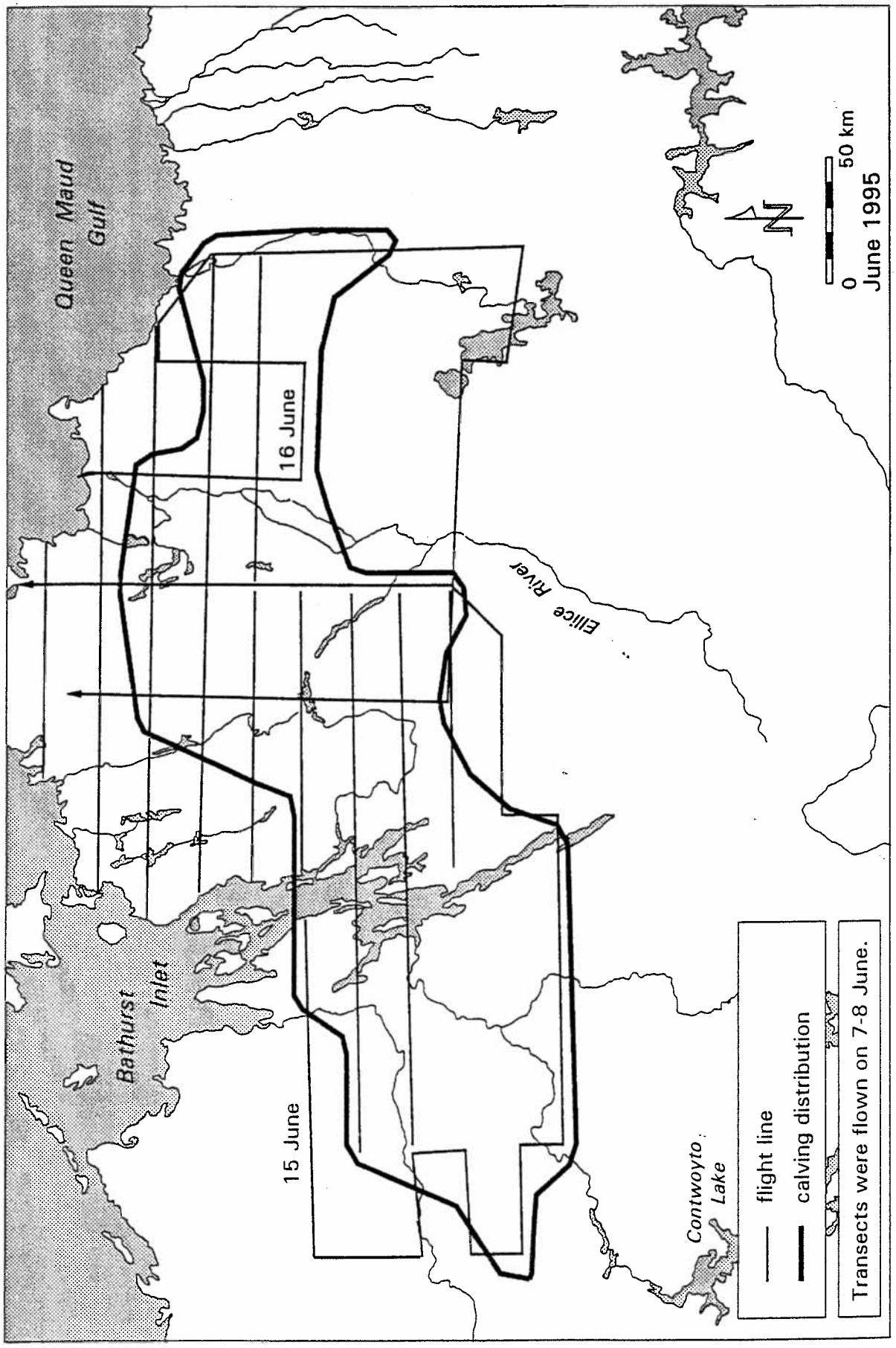

Figure 55. Bathurst calving ground survey flight lines and calving distribution, 7-16 June 1995

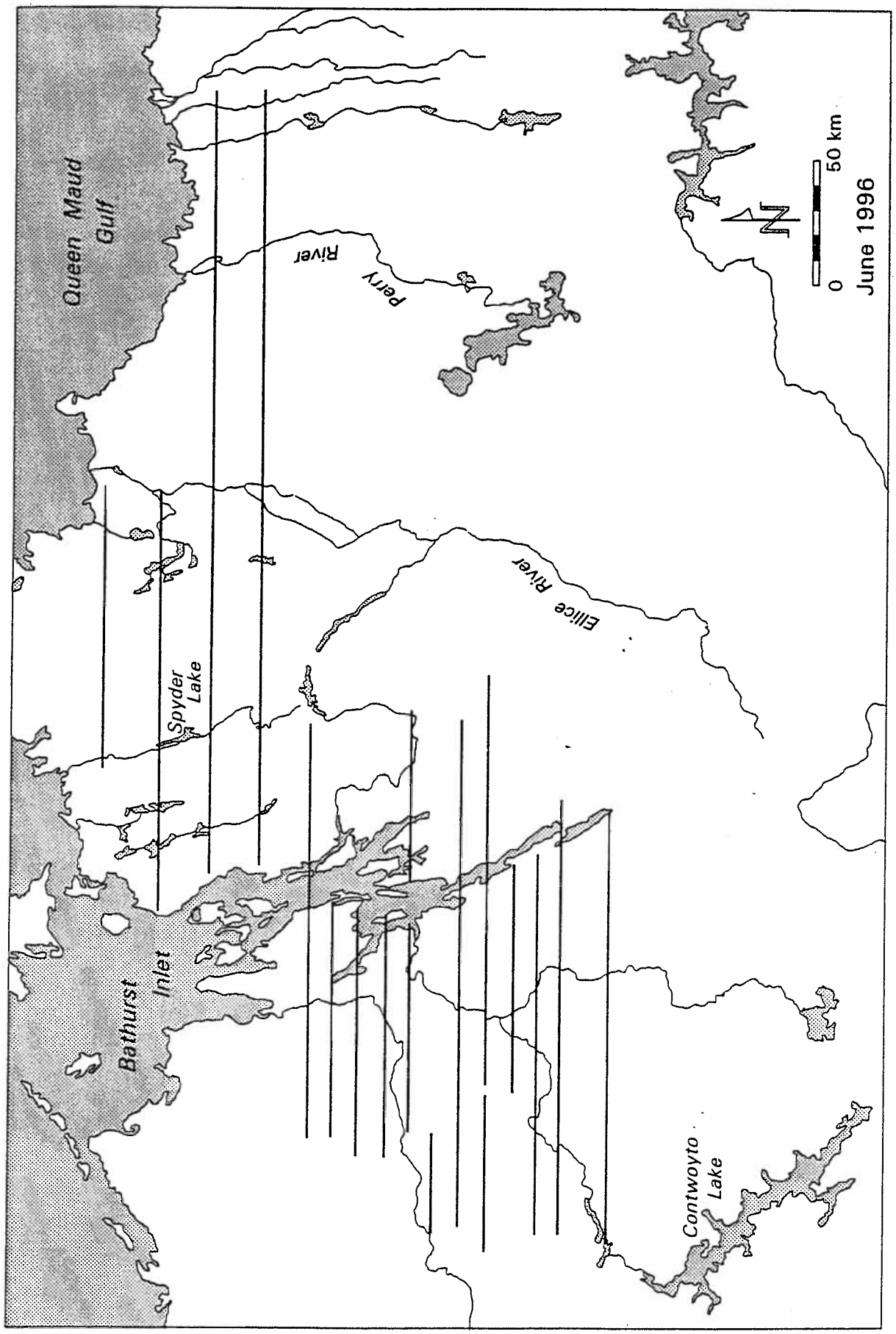

Figure 56. Bathurst calving ground systematic reconnaissance flight lines, 6-8 June 1996

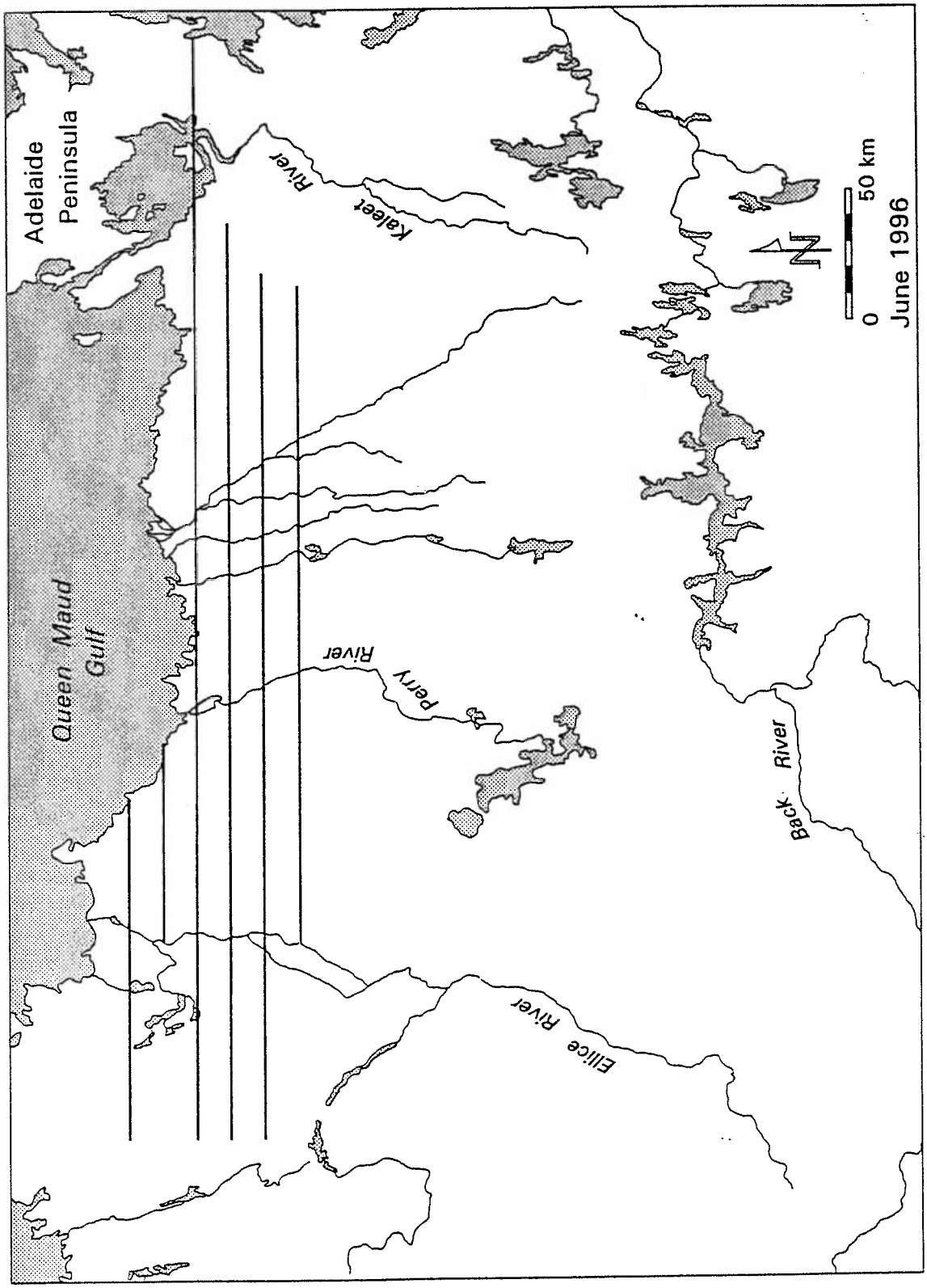

Figure 57 . Queen Maud Gulf calving ground systematic reconnaissance flight lines, 12-13 June 1996

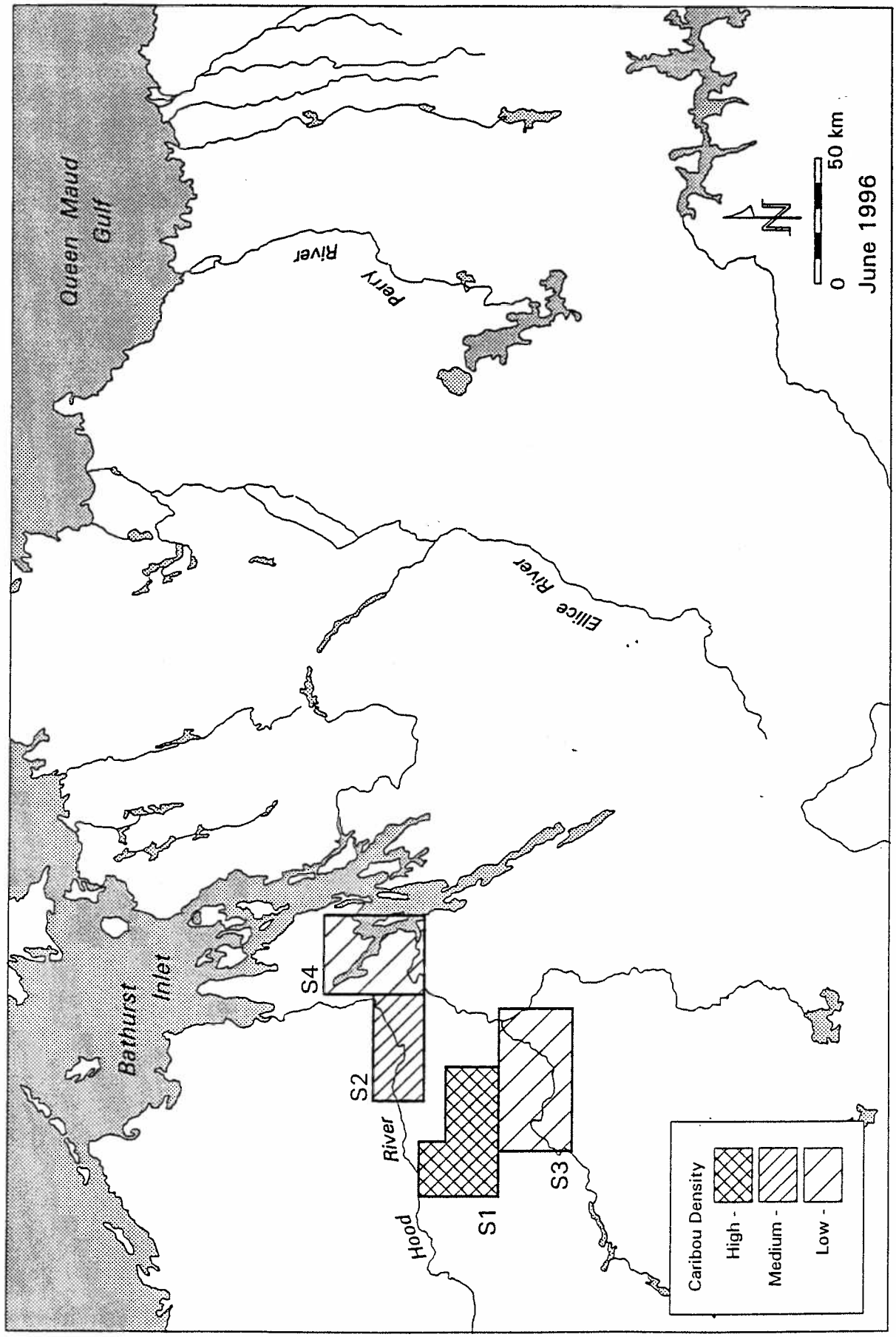

Figure 58. Bathurst calving ground strata, 6-11 June 1996

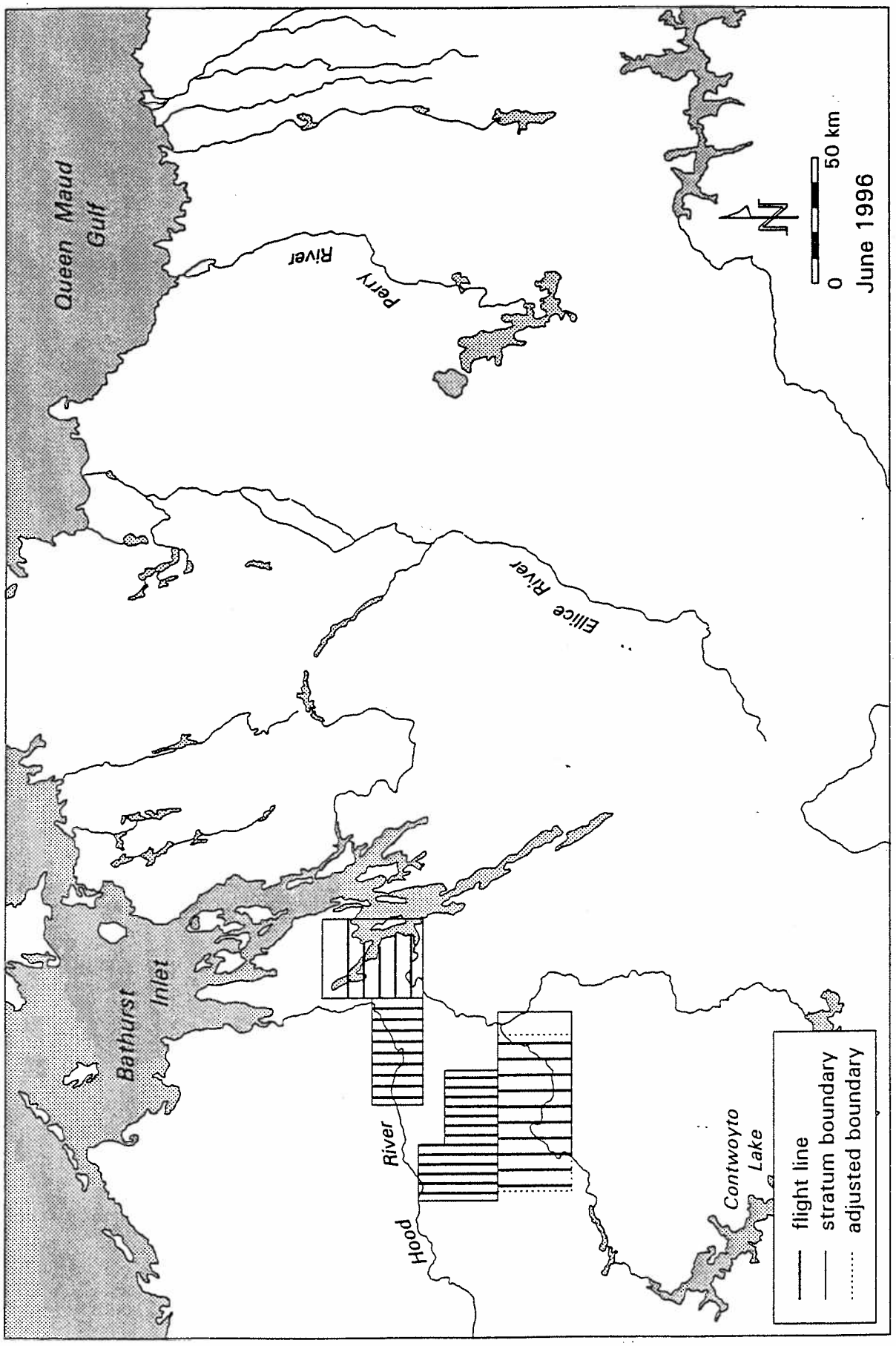

Figure 59. Bathurst calving ground photographic survey flight lines, 9-11 June 1996

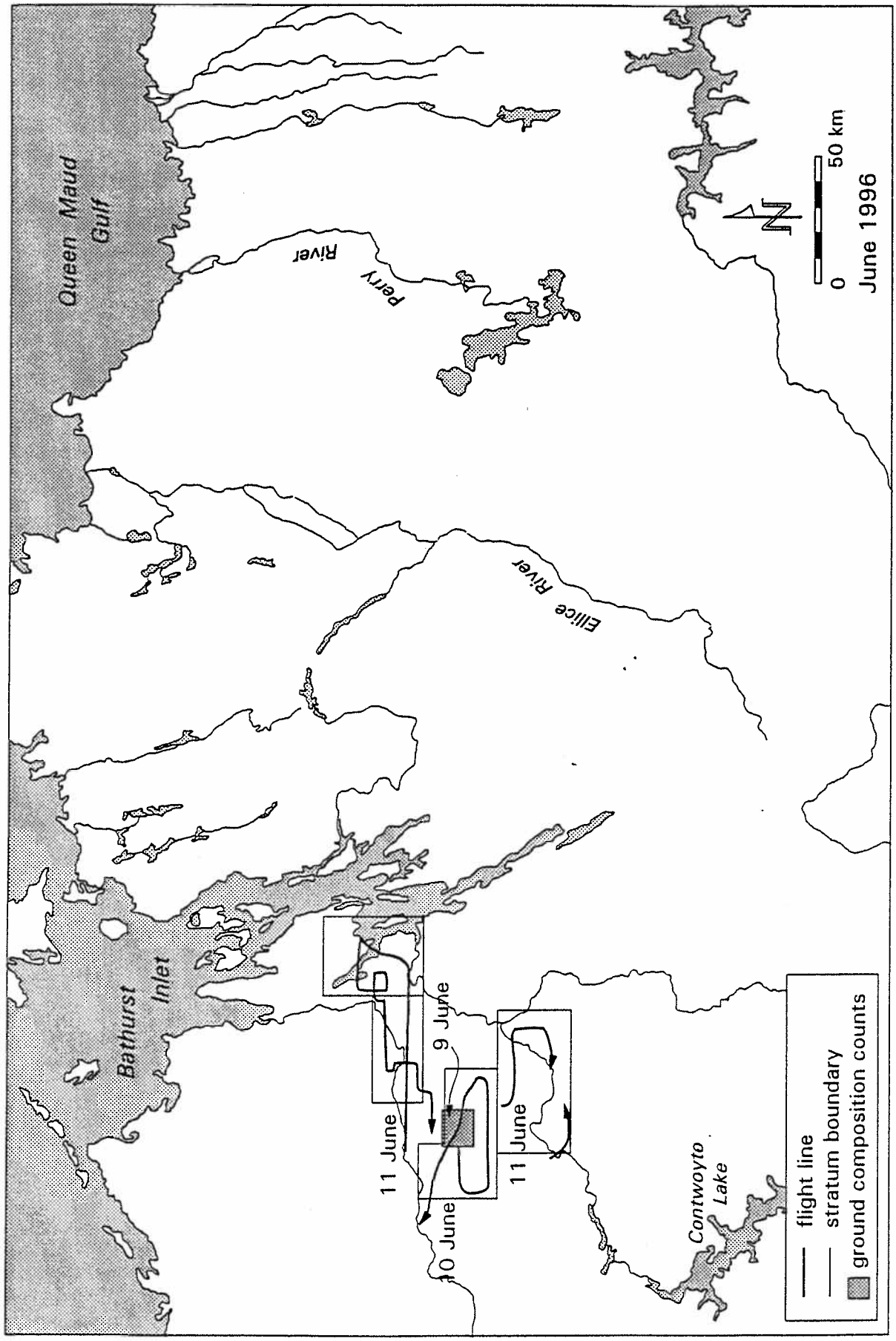

Figure 60. Bathurst calving ground composition survey flight lines, 9-11 June 1996

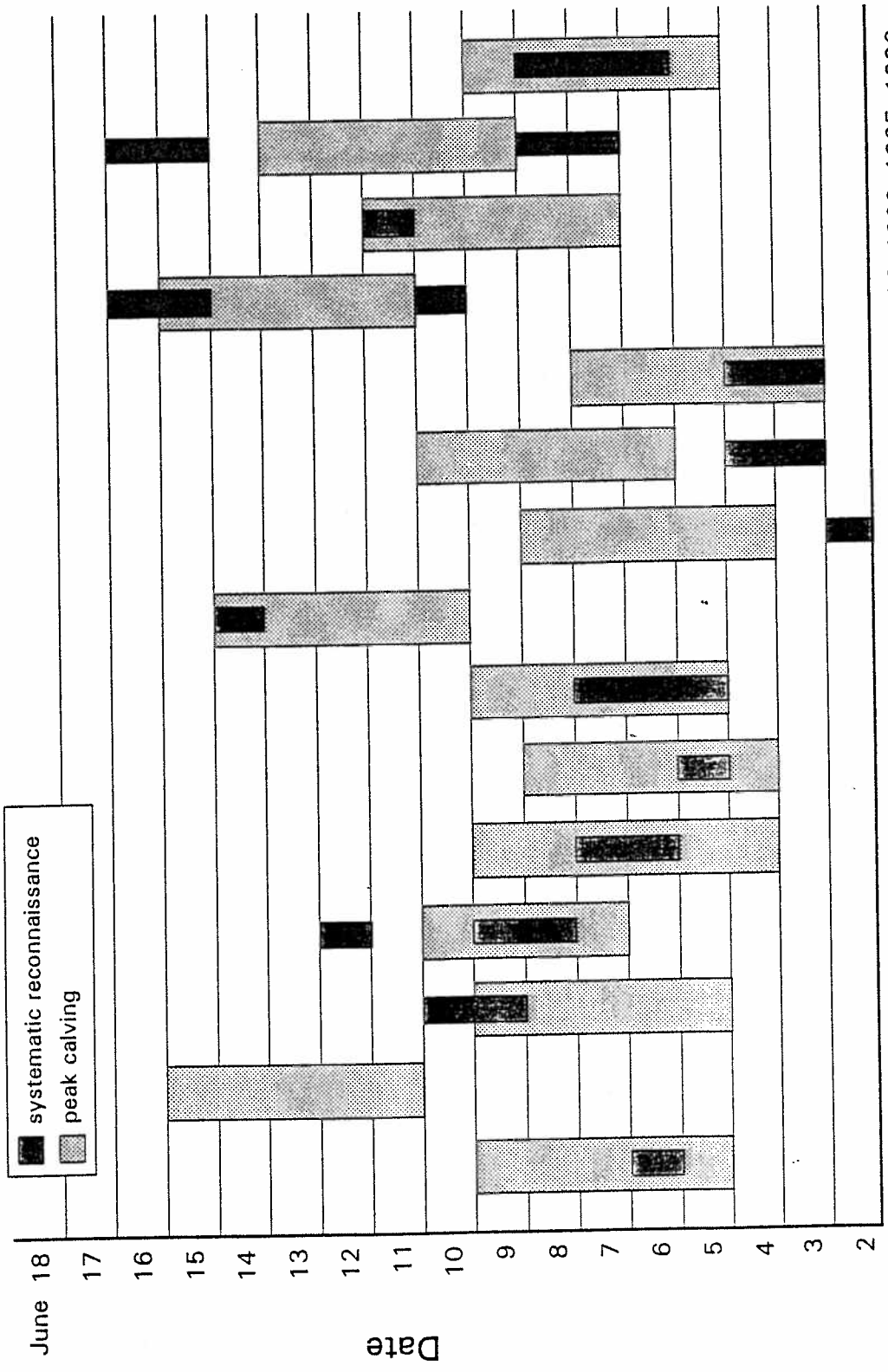

Figure 61. Peak calving dates (approximate) and dates of systematic reconnaissance flights used to delineate the Bathurst calving grounds, 1966-1996

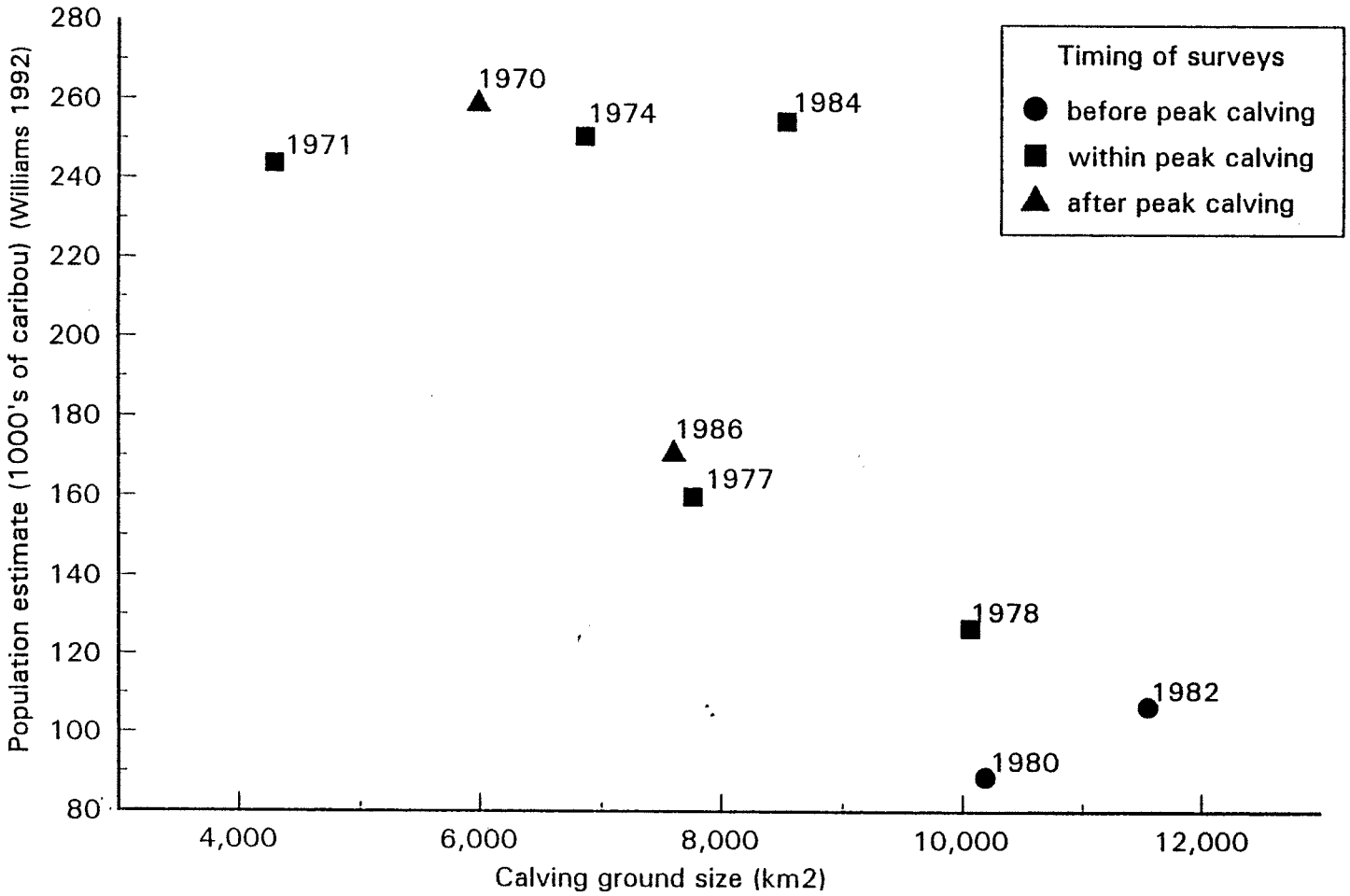

Figure 62. Calving ground size in relation to population estimate (visual survey) for the Bathurst caribou herd and timing of surveys, 1971 - 1986. In 1970, 1971 and 1974, criteria for calving ground delineation differs from remaining years. The 1986 calving ground area does not include the low density stratum delineated on 10 June.

RECOMMENDATIONS

1. In order to ensure that no calving areas are missed, reconnaissance flights should cover the entire traditional calving grounds.

2. Dates when the calving grounds are in use should be investigated to provide more information for defining a critical period when activity in the area should be avoided.

3. Traditional knowledge of use of Bathurst Inlet by calving caribou should be obtained.

ACKNOWLEDGEMENTS

We would like to thank Ray Case for reviewing the first draft of this report. We also thank Susan Fleck for reviewing the draft report. Her input was greatly appreciated because of her extensive experience with these surveys.

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[6] These reports are in DRR Caribou Project files. All remaining reports can be found in the DRR library.

APPENDIX A. Calculation of peak calving dates for the Bathurst caribou herd, 1966-1996.

Peak calving dates were taken from reports when available, and when not, dates were estimated according to the following assumptions:

"Within the calving period, most cows calve during a 5-7 day peak. In the central and eastern Arctic, the calving period is approximately 31 May - 15 June with peak occurring around 4-10 June." (Fleck and Gunn 1982)

"If calving occurred as in the Kaminuriak herd in 1977, where there were 20% calves in herd 1-2 days before the peak...(the day when most calves are born; ~45% calves)." (Heard 1980)

"Peak calving is defined as the point at which one half of the breeding females have given birth."

$$\frac{\text{(\#cows with calves + \#antlerless cows with udder but no calf)}}{\text{(total \#breeding females)}}$$

(Williams 1994)

1966 1 June - "Very few new born calves were spotted on June 1st and many of the cows were still travelling north-east..." (Williams 1966)

5 June - "On June 5th hundreds of new born calves were observed and the cows were fairly evenly distributed on the calving grounds." (Williams 1966)

6 June - Transect survey:

Cows	Calves	Yearlings	Unknown	Total
4449	2930	1955	114	9448

therefore, 31% calves in herd on 6 June (Williams 1966)

PEAK 5-9 June

1969 "Although calves were observed in late May, the number of calves born prior to June 10 was rather small particularly among those females that remained on or returned to the west side of Bathurst Inlet...calves began to appear after June 11, and almost all other adult females still carried their antlers which are normally shed very soon after the calves are

born...of cows observed east of the Inlet, more than 70 percent had given birth to calves by June 14 and of those west of the Inlet more than 30 percent had dropped calves by that date." (Ruttan 1969)

PEAK 11-15 June

1970 9 June - Survey #1: 33% calves in herd on 9 June. (Boxer 1970)
10 June - Survey #2: 40.5% calves in herd on 10 June. (Boxer 1970)
16-19 June - Ground survey: 42% calves in herd 16-19 June. (Boxer 1970)

"...the majority of calves were born between June 5 to June 9." (Boxer 1970)

PEAK 5-9 June

1971 "...approximately four to five days before the calving has reached its peak the cows tend to remain dispersed more or less randomly over the calving area." (Boxer 1971)

"...the majority of the calves were born between June 7 and June 10." (Boxer 1971)

PEAK 7-10 June

1974 "...majority of the calves were born between June 4 and June 9." (Boxer 1974)

PEAK 4-9 June

1977 "Transects were flown on 6, 7, and 8 June; during and just after the peak of calving." (Calef and Boxer 1977)

PEAK 4-8 June

1978 % calves on calving grounds: (DRR files)
4 June - 2.3% (unsystematic reconnaissance)
5 June - 10.0% (systematic reconnaissance)
6 June - 17.4% "
7 June - 47.8% "

PEAK 5-9 June

1979 % calves on calving grounds: (DRR files)
5 June - 1% (unsystematic reconnaissance)
6 June - 1% "
7 June - 4% (systematic reconnaissance)
10 June - 13.7% (unsystematic reconnaissance)
11 June - 34.2% "

PEAK 10-14 June

1980 "...peak of calving was estimated at 7 June from aerial segregation data but Fleck's subjective impression was that it may have been earlier (4-5 June)." (Heard 1980)

% calves on calving grounds: (Heard 1980)
2 June - 4% (systematic reconnaissance)
4 June - 19% (stratified transect)
5 June - 26% "
6 June - 20% "

PEAK 4-8 June

1982 % calves on calving grounds: (DRR files)
5 June - 5% (stratified transect)
6 June - 17% "
10 June - 38% (composition)
11 June - 35% "
12 June - 43% "
13 June - 45% "

% breeding females that have given birth: (DRR files)
10 June - 74% (composition)
11 June - 84% "
12 June - 88% "
13 June - 93% "

PEAK 6-10 June

1984 3 June - very early spring, 20% snowcover (DRR files - black binder)
- groups of caribou (100s) seen with many calves

% calves on calving grounds: (DRR files - black binder)
~4 June - 15% (unsystematic reconnaissance)
7 June - 35% (composition)
8 June - 27% "
9 June - 14% "
10 June - 35% "

% breeding females that have given birth: (DRR files)
7 June - 80% (composition)
8 June - 73% "
9 June - 78% "
10 June - 76% "

PEAK 3-7 June

1986 9 June - 85-95% snowcover (-2°C)
17 June - 10-70% snowcover (+10°C) (H1&2, M2)

% calves on calving grounds:
9 June - ~3% (unsystematic reconnaissance)
16 June - 42% (H) (composition)
17 June - 43% (M) "
- 35% (L) "
18 June - 43% (H) "
19 June - 19% (M) "

% breeding females that have given birth: (DRR files)
16 June - 98% (composition) (H)
17 June - 97% " (M)
- 98% " (L)
18 June - 80% " (L)
- 98% " (H)
19 June - 90% " (M)

PEAK 11-15 June

1990 4-7 June weather out; 11 June - 10-25% snowcover

% calves on calving grounds: (Heard and Williams 1991b)
11 June - 32.7% (composition)
14 June - 39.5% "

% breeding females that have given birth: (Heard and Williams 1991b)
11 June - 77% (composition)
14 June - 92% "

PEAK 7-11 June

1995 peak occured between survey flights 7-8 June and 15-16 June

PEAK 9-13 June

1996 % breeding females that have given birth:
9 June - 96.2% (composition) (S1)
10 June - 83.4% " (S1)
- 95.5% " (S4)
11 June - 88.6% " (S3)

PEAK 5-9 June

APPENDIX B. Caribou densities in each stratum of the transect and photographic surveys on the Bathurst calving grounds from 1977-1990[7]

	Stratified Transect Survey			Photographic Survey			
Year	High Density caribou/km² (stratum)	Medium Density caribou/km² (stratum)	Low Density caribou/km² (stratum)	High Density caribou/km² (stratum)	Medium Density caribou/km² (stratum)	Low Density caribou/km² (stratum)	Source/ Comments
1977	9.9 (II) 9.8 (III)	2.7 (I)	0.5 (IV)	--	--	--	Calef & Boxer 1977
1978	13.4	6.5	2.0	--	--	--	Densities are from the systematic reconnaissance (DRR files).
1979	7.7	--	1.9	--	--	--	Densities are from the unsystematic reconnaissance, 14 June 1979 (DRR files).
1980	7.4	5.3	1.5	--	--	--	Heard 1980
1982	10.2 (A) 8.2 (E)	4.0 (B)	1.6 (C1) 1.4 (C2) 1.0 (D1) 1.6 (D2)	15.9 (A) 11.0 (E)	9.0 (B)	13.6 (C1) 0.9 (D1) 3.0 (D2)	DRR files
1984	43.0 (S3)	13.1 (S2) 6.6 (S5)	4.9 (S4) 4.6 (S1)	203.4	33.3	4.2	Photo strata and stratified transect survey strata are different (DRR files).
1986	36.6 (S2) 13.9 (S3+ S6)	9.2 (S1) 10.7 (S4)	5.6 (S5) 8.2 (S7) 0.5 (S8)	111.0 (S2) 61.9 (S3)	25.9 (S1) 38.1 (S4)	--	Stratified transect survey strata S3 was extended and combined with S6. (Heard and Williams 1991a)
1990	28.0 (S4)*	14.7 (S1)* 16.1 (S2)*	7.4 (S3)*	36.9 (S3+S4)	46.2 (S1) 26.2 (S2)	--	These densities (*) are from the systematic reconnaissance. No stratified transect survey was completed. For the photo survey, S3 and S4 were combined. (Heard and Williams 1991b)

[7] Data for the 1996 survey were not yet available.

APPENDIX C. Tables containing strata and transect areas (km^2) for the Bathurst calving grounds, 1966-1996[8]

[8] All strata and transect areas were taken from original data sheets, survey and file notes, or unpublished reports. Sources are noted in each table. Areas from surveys before 1980 that were originally recorded in square miles were converted to square kilometres.

Table C1. Survey and transect areas, Bathurst calving grounds, 1966-1974

Year	Type of Survey	Survey area (km^2)	Transect area (km^2)	% Coverage	Source/ Comments
1966	systematic transect	8,340	907	10.9	Estimated from report (Williams 1966)
1970	systematic transect	5,996	499	8.3	Boxer 1970
1971	systematic transect	–	–	12.5	Coverage is 12.5% of total area (Boxer 1971)
	random block	4,299	663	15.4	Survey area is the "total calving area" (Boxer 1971),that is the area within the calving herd boundary.
1974	systematic transect	–	–	12.5	Coverage is 12.5% of total area (Boxer 1974)
	random block	6,879	1,036	15.1	As in 1971 above. (Boxer 1974)

Table C2. Strata and transect areas, Bathurst calving ground, June 1977

Type of Survey	Stratum	Stratum area (km^2)	Transect area (km^2)	% Coverage	Source/ Comments
Stratified transect	I	1,285	81	6.3	Calef & Boxer 1977
	II	2,730	682	40.0	
	III	3,160	1,264		
	IV	603	80	13.3	
Total		**7,778**	**2,107**	**27.1**	

Table C3. Strata and transect areas, Bathurst calving ground, June 1980

Type of Survey	Stratum	Stratum area (km^2)	Transect area (km^2)	% Coverage	Source/ Comments
Stratified transect	H1	1,022	448.8	43.90	Heard 1980
	H2	440	204.1	46.40	
	Total H	1,462	652.9	44.70	
	M1	376	121.0	32.20	
	M2	2,017	646.0	32.00	
	M3	336	122.0	36.30	
	Total M	2,729	889.0	32.60	
	L1	391	36.6	9.40	
	L2	456	36.6	8.00	
	L3	613	48.6	7.90	
	L4	826	66.4	8.00	
	L5	768	61.0	7.90	
	L6	816	64.8	7.90	
	L7	706	64.8	9.20	
	L8	1,428	114.8	8.00	
	Total L	6,004	493.6	8.20	
Total		**10,195.00**	**2,035.50**	**20.00**	
Photographic	High	1,368	224.1	16.40	DRR files
	Medium	2,294	475.4	20.70	
	Low	3,596	734.3	20.40	
Total		**7,258**	**1,434**	**19.80**	

Table C4. Strata and transect areas, Bathurst calving ground, June 1982

Type of Survey	Stratum	Stratum area (km^2)	Transect area (km^2)	% Coverage	Source/ Comments
Stratified transect	A	1,237	494.6	40.0	DRR files
	B	2,985	504.8	16.9	
	C1/C2	3,615	297.2	8.2	
	D1/D2	3,272	210.8	6.4	
	E	436	136.8	31.4	
Total		**11,545**	**1,644.2**	**14.2**	
Photographic	High	1,673	249.0	14.9	DRR files
	Medium	2,429	268.0	11.0	
	Low	5,262	443.6	8.4	
Total		**9,364**	**960.6**	**10.3**	

Table C5. Strata and transect areas, Bathurst calving ground, June 1984

Type of Survey	Stratum	Stratum area (km^2)	Transect area (km^2)	% Coverage	Source/ Comments
Stratified transect	S1	1,551	132.8	8.6	DRR files
	S2	1,681	602.8	35.9	
	S3	1,883	690.1	36.6	
	S4	1,908	427.6	22.4	
	S5	1,527	530.4	34.7	
Total		**8,550**	**2,383.7**	**27.9**	
Photographic	High	1,628	375.9	23.1	DRR files
	Medium	1,212	297.2	24.5	
	Low	605	124.8	20.6	
Total		**3,445**	**797.9**	**23.2**	

Table C6. Strata and transect areas, Bathurst calving ground, June 1986

Type of Survey	Stratum	Stratum area (km^2)	Transect area (km^2)	% Coverage	Source/ Comments
Stratified transect	S1	632	126.4	20.0	Heard & Williams 1991a,
	S2	603	273.6	45.4	DRR files
	S3/S6	1,566	534.4	34.1	
	S4	2,170	616.0	28.4	
	S5	1,179	70.8	6.0	
	S7	1,472	65.8	4.5	
(Systematic)	S8	3,938	319.2	8.1	DRR files
Total		**11,560**	**2,006.2**	**17.4**	
Photographic	S1	645	63.6	9.9	Heard & Williams 1991a,
	S2	645	221.4	34.3	DRR files
	S3	833	169.4	20.3	
	S4	2,175	279.0	12.8	
Total		**4,298**	**733.4**	**17.1**	

Table C7. Strata and transect areas, Bathurst calving ground, June 1990

Type of Survey	Stratum	Stratum area (km^2)	Transect area (km^2)	% Coverage	Source/ Comments
Photographic	S1	2,251	317.3	14.1	Heard & Williams 1991b
	S2	1,836	287.2	15.6	
	S3+S4	1,627	240.6	14.8	
Total		**5,714**	**845.1**	**14.8**	

Table C8. Strata and transect areas, Bathurst calving ground, June 1996

Type of Survey	Stratum	Stratum area (km^2)	Transect area (km^2)	% Coverage	Source/ Comments
Photographic	S1	1,223			calculated from original maps
	S2	845			
	S3	1,710			
	S4	1,245			
Total		**5,023**			