WEST KITIKMEOT / SLAVE STUDY SOCIETY

Re: Summer Behaviour of Bathurst Caribou at Mine Sites and Response of Caribou to Fencing and Plastic Deflector

And

Effect of Gravel Road and Tailing Pond Dust on Tundra Plant Communities Near Lupin Mine, NWT

Disclaimer

These Reports are the result of a project conducted under the West Kitikmeot / Slave Study. The Reports have not been peer reviewed or approved by the Board, and the contents and opinions are considered the sole responsibility of the author.

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Feb 20/02

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SUMMER BEHAVIOUR OF BATHURST CARIBOU AT MINE SITES

and

RESPONSE OF CARIBOU TO FENCING AND PLASTIC DEFLECTOR (July 1997)

Final Report to the West Kitikmeot / Slave Study submitted by:

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April 1998

The Contents of the report are the sole responsibility of the authors

SUMMARY

The report provides baseline information on caribou behaviour at a mine site in summer 1996 and 1997. A few caribou were seen consistently from mid-July to early August 1996 but numbers seen did not exceed 100 at any one time. Caribou used the airstrip and tailings pond for resting and they would forage nearby. Our supposition that caribou rested on bare ground to reduce their exposure to mosquitos is supported by mosquito counts. But caribou still used the tailings pond and airstrip when mosquitos were few or absent which suggests that the caribou are also selecting bare areas to rest on perhaps because of the lack of cover to conceal predators.

In 1997, our objective was to test methods to guide caribou away from mine structures. We tested two types of barriers for guiding caribou at the Lupin minesite from 28 June to 8 July 1997 to observe how caribou would react when they came into contact with the structures.

The first barrier was an 85-metre length of 1-metre-wide heavy-duty clear plastic that was laid flat on the tundra and kept in place by rocks. It was easily visible as a solid white colour when it was on the ground. Approximately 45 caribou were observed close to the plastic on 8 occasions from 1 - 6 July 1997 and about 40% of them crossed over it. The caribou first sniffed the plastic and then walked or rarely they would jump across. Some did not stop at all or sniff the plastic before they crossed.

The second type of barrier was a modified form of a traditional fence used by Dogrib hunters to divert caribou. It was a 3-foot-high wood and rope fence festooned at 30-cm intervals with ripstop nylon flags, either red or white and of varying lengths (30-45 cm) that would flap easily in the wind. About 170 caribou were observed near the fences on 12 occasions from 27 June - 6 July 1997. A total of two caribou crossed, each on a separate occasion and in both cases, the fence had not been completely finished.

ACKNOWLEDGEMENTS

The West Kitikmeot Slave Study Society and Department of Resources, Wildlife and Economic Development funded the research. Echo Bay Mines Ltd. donated in-kind support at Lupin mine.

The Kitikmeot Hunters' and Trappers' Association, the Kugluktuk Angoniatit Association, the Omingmaktok Hunters' and Trappers' Association and the Burnside Hunters' and Trappers' Association, the Dogrib Renewable Resources Committee, the Yellowknives Dene Land and Environment Committee and the Lutsel K'e Land and Wildlife Committee have all contributed information on caribou. Harry Apple (elder) and Richard Weyallon (translator) from Rae examined the fencing and provided useful comments.

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OBJECTIVES

1) To describe caribou use of mine structures during summer.
2) To test methods to guide caribou away from mine structures.
3) To measure the effect of dust on plant communities in the vicinity of tailings ponds.

This report describes the research for our first two objectives. Our third objective - to measure the effect of dust on plant communities in the vicinity of tailings ponds will be reported separately.

BACKGROUND

Mining exploration and development is occurring on the traditional ranges of the Bathurst caribou herd. The West Kitikmeot Slave Study Partners have identified caribou as a priority, specifically such issues as how much time caribou spend at mine tailings ponds and how this can be mitigated. A related issue raised during the January 1996 Environmental Assessment Panel hearings was the effect of dust from tailings ponds and roads on caribou forage.

The issue is why and under what conditions will caribou be in the vicinity of mine structures including tailings ponds. In summer caribou balance their efforts between obtaining food and avoiding insect harassment. Biting insects are an affliction for caribou which can lose foraging time and expend energy trying to escape the flies. If the harassment is severe, the caribou lose condition. For example, warm summers (and more insects) correlate with lower calf weights in the fall (Helle and Tarvainen 1984). Lighter calves are less likely to survive the winter especially if the snow is deeper than average (Eloranta and Nieminen 1986).

We lack information on what strategies Bathurst caribou use to reduce their exposure to biting insects. Most research has been done in Alaska where caribou move to the coast or mountains to avoid insect harassement. As the Bathurst herd does not have those options, smaller scale insect relief habitat (bare ground such as eskers) are likely to be important. And choosing bare ground may be partly why caribou use tailings ponds, roads and airstrips at mines. The Department of Renewable Resources initiated a preliminary study of

caribou behaviour at tailings ponds with the support of Echo Bay Ltd. at their Lupin property (Fig.1) in 1993. Behavioural observations (Mueller and Gunn 1996) suggested that at Lupin caribou feed in the vicinity and then move to the bare ground to avoid insects. Vegetation close to roads and tailings ponds may be affected by dust. Caribou may also be attracted to vegetation growth where dust has advanced the spring melt and then, later in the summer, to plants growing in the seepage line along road berms. And they may be attracted to reclamation areas where vegetation is being established.

The emphasis for mitigation is to keep caribou away from selected sites and this could be done using traditional methods to guide the caribou. Those measures may be especially required during summer weather favourable for insect harassment. Traditional knowledge is already available for guiding caribou but testing is necessary as caribou may respond differently during migration and insect harassement.

Traditional Dogrib methods to direct caribou in the spring include attaching ribbons or flags along the sides (nots á) of funnel structures used to direct caribou to snares (Zoe *et al.* 1995). This information was the basis of one test design which also had to be relatively inexpensive, easy to erect and not have the risk of causing problems for the caribou if they did try to cross it.

We have also observed that caribou at the edge of bare ice or crossing a road, will stop and sniff the surface and may then move parallel to the area with a different (novel) surface texture. To take advantage of that behaviour and that caribou are often reluctant to walk on glare ice, our second diversion technique was a “horizontal” fence - a strip of clear polyethylene laid on the ground.

METHODS

Behavioural observations, 4-7 July and 9-10 August 1996

In July and August 1996, we made systematic observations of caribou near the roads and airstrip at Lupin mine using instantaneous scan sampling and focal animal sampling techniques (Altmann 1974, Martin and Bateson 1993) as in 1993 (Mueller and Gunn 1996). During instantaneous scan sampling, we

scanned all caribou in a defined area at 10-minute intervals and recorded the number of animals in each behaviour category. The percentage of animals in each behaviour category gives us an estimate of the percentage of time spent at each type of behaviour (Altmann 1974, Martin and Bateson 1993. Behaviour categories included: bed, walk, forage, stand and trot. During focal animal sampling, we observed individual caribou and recorded their behaviour and the time (in minutes and seconds) that each new behaviour began. Behaviour categories used for focal animals were the same as those used for instantaneous scans but also included: alert, head down, toss, twitch, stamp, scratch, defecate and nurse. We usually observed an individual until it disappeared from sight. Both techniques were used simultaneously whenever possible. Observations were made using binoculars and 25x spotting scopes.

To obtain additional observations, we set up two remote cameras (Pentax Zoom 90-WR) on the roads and airstrip (Fig. 2) when caribou were observed in those areas. Cameras were set to take exposures at 10-minute intervals. We changed camera positions depending on time of day for optimal lighting. We projected the processed slides and when caribou were present, we recorded the number, behaviour, if distinguishable, and the approximate distance to structure.

We recorded numbers and movement of caribou and muskoxen around the minesite (Appendix A). These observations were descriptive and unsystematically collected. We also monitored abundance of insects by conducting insect sweeps. A net was held parallel to the ground and at a height of approximately 1m and swept from side-to-side in a 180º arc for 30 seconds. At each of 4 sites, we completed five repetitions into the wind and five downwind (Appendix E). Temperature, and wind speed and direction were obtained from the Lupin weather station.

Construction of fencing and plastic deflector, 28 June - 8 July 1997

We constructed and monitored two types of deflectors at Lupin mine from 28 June - 8 July 1997. The first was a vertical fence and the second, a plastic horizontal barrier . Both were located west of the winter road between the airstrip and Contwoyto Lake (Fig. 3).

Fencing

We constructed a total of approximately 410 m of fencing in two lengths; the first ran N-S (280 m) and the second E-W (130 m) (Fig. 3). To build the fence, we used the following materials:

- 2x4's, 8-ft (2.4-m) long cut in half crosswise with a point cut at one end of each 4-ft (1.2-m) length,
- 6 rolls of 3/8 in (1 cm) yellow twist polyester rope (192m per roll), cut into 11.5- m lengths,
- 15 m of ripstop nylon (150-cm wide) in red and white, cut crosswise into 4-cm strips and each strip into 4 flags (2 of 30 cm and 2 of 45 cm).

The fence was constructed in 10-m sections to allow an animal to escape if it became entangled in the horizontal ropes (Fig. 4). Rope for each section was cut in advance into 11.5-m lengths. An adjustable loop was tied at each end so that ropes could be easily tightened. Flags were also prepared in advance. The first post was hammered into the ground to a depth of 30 cm with 95 cm of the stake left above ground level. Two ropes were placed between each set of posts: one at approximately 45 cm above the ground and the second near the top of the stake at approximately 90 cm above the ground. Ropes were tightened by pulling on the knots that formed the loops. Flags were tied on both ropes approximately 30 cm apart in alternating colours (red and white) and varying lengths (30 cm or 45 cm).

For the first 80m of fencing, we tried stapling the ropes to the wooden posts. We found, however, that the staples were not holding the ropes securely. Using loops, we were able to keep the ropes taut. It also made the fences easier to erect and take down and staples were not inadvertently left on the tundra.

Plastic

We cut heavy-duty clear plastic sheeting (30-m long x 3-m wide) lengthwise into 3 pieces giving us 1-m-wide strips. We arranged the strips flat on the ground, end-to-end about 50 m west of and parallel to the winter road (Fig. 3). The total length of the plastic deflector was approximately 85 m. Rocks were used to keep the plastic strips in place.

While fences were being built and after they were constructed, we compiled descriptive notes of the reactions of caribou to the fencing and plastic.

Behavioural observations, 28 June - 8 July 1997

In addition to the descriptive notes and as in 1996, we conducted behavioural observations using the instantaneous scan sampling and focal animal sampling techniques described earlier. However, in 1997, we focused on observations of caribou near the fences and plastic. During instantaneous scan sampling, in addition to reporting the overall percentages of caribou in each behaviour category, we also determined the percentages of caribou in each behaviour category at different distances from the fences (<5m, 5-30m, >30m). During focal animal sampling, we limited our observations of individuals to 30 minutes.

In 1997, we set up three remote cameras (Pentax Zoom 90-WR) as in 1996, although cameras were placed to monitor the fencing and plastic: one was set up facing each section of fence and one on the length of plastic (Fig. 3).

As in 1996, we monitored abundance of insects at 3 sites (Appendix E) and recorded numbers and movement of caribou around the minesite (Appendix B) as well as sightings of muskox and other wildlife (Appendices C and D).

RESULTS

Behavioural observations, 1996

From 4-5 July and 9-10 August 1996, we completed 12 and 4 instantaneous scan samples, respectively, of caribou near the minesite (Table 1) and from 4-7 July, we completed 43 focal animal samples (Table 2). From instantaneous scan sampling in July, we estimated that caribou spent a mean of 64% of the time foraging (Table 3) followed by 22% walking and 9% trotting. Less than 5% of time was spent standing or bedded. In August, caribou spent a mean of 38% of the time foraging (Table 3) and 37% bedded down followed by 17% walking and 7% standing. Durations of scan samples in July (averaging 10 minutes or 2 scans) were shorter than in August (averaging 70 minutes or 8 scans). Scans sites in July were concentrated between the minesite and Contwoyto Lake and sites in August were nearer the minesite and in the tailings area (Table 1, Fig. 2). No caribou were seen close to the mine and near the tailings ponds in July as they were in August.

To summarize results from focal animal sampling, we separated focal samples that were recorded at the same time as instantaneous scan samples (Table 4a) from the remaining focal samples taken (Table 4b). Focal samples taken during the same time as instantaneous scan samples showed that caribou spent a mean of 89% of their time foraging followed by 9% walking (Table 4a). These samples were from 5 to 10 minutes in duration and were between the mine and Contwoyto Lake.

In contrast, results for the remaining focal animal observations showed that caribou spent most of their time bedded (42%) or foraging (31%) followed by walking (14%) and standing (8%) (Table 4b). The cows' behaviour differed from caribou in the other sex classes with cows spending less time foraging (12%) and more time walking (29%). Sampling sites were concentrated around the airstrip and roads or in the tailings area (Table 2, Fig. 2). Only three of the 12 sites were between the mine and Contwoyto Lake. Samples less than 10 minutes in duration (Table 2) were arbitrarily excluded from the analysis. Samples which were included fell into two main categories: those lasting between 10 and 20 minutes and those lasting longer than an hour. There was a high degree of variation in samples of 10 to 20 minutes duration. Among samples of an hour or longer, the variation decreased considerably.

Caribou spent more time foraging in the more vegetated areas between the mine and lake in July (Table 3, Table 4a) and more time bedded in open developed areas (airstrip/ tailings) in August (Table 3, Table 4b).
Insect levels probably had little effect on caribou behaviour during the study period as winds were strong (35 km/h) on days with high insect levels (Table 2).

During sampling in July 1996, skies were clear on 5 July and there was broken cloud cover on the remaining days (4, 6 and 7 July). Both days in August had broken cloud cover. An increase in cloud cover could mean an increase in warble fly activity. However, no warble flies were seen during the entire study period. Observers varied position (cross wind, downwind, upwind) in relation to the caribou during both July and August sampling with no measurable effects.

Behavioural observations, 1997

In 1997, we made only a small number of systematic observations as there were few caribou that remained in the fenced area for a sufficient length of time.

From 28 June to 6 July 1997, we completed 9 instantaneous scan samples of caribou near the fenced area (Table 5). We estimated that caribou spent a mean of 75% of the time foraging (Table 6) followed by 18% walking. Less than 5% of the time was spent standing (4.7%) or bedded down (1.6%). Most caribou (74%) observed during instantaneous scans stayed >30m away from fencing (Table 7). Of the caribou that were >5 m from the fencing (99%), most were observed foraging. Three of the four that were seen <5m from the fencing were walking.

In 1997, we completed only 5 focal animal samples (Table 8). Caribou spent a mean of 76% of the time foraging (Table 9) followed by 17% walking. This concurs with results obtained from instantaneous scan sampling.

Descriptive observations of caribou near fencing and plastic, 1997

These descriptive observations were made in addition to the systematic observations, although several coincide with focal and instantaneous scans (Table 10).

<u>Fencing</u>

The flags on the fencing were very conspicuous and made a light rustling noise when the wind was blowing. From 27 June - 6 July 1997, about 170 caribou were observed near the fences on 12 occasions. A total of two caribou crossed, each on a separate occasion and in both cases, the fence was not completely finished (Table 10). In the first instance, there were only 5 red flags per 10-metre section when a small yearling passed between the two ropes. In the second instance, a young bull jumped over an area in the fence where the ropes had not yet been tightened and no flags had been attached.

During the time that the fences were being built, some caribou would approach close enough to sniff at them. However, after the fences were completed (that is, all the flagging was attached), no caribou were observed sniffing the fences. They would not usually get within 10 metres of a fence (Table 7). Most caribou would turn parallel to a fence, follow it to the end and continue in that direction or

go around (Table 10).

In most of our observations of caribou near the fences, they grazed relatively undisturbed and continued in this way as they passed by the fences. However on one occasion, a group of 86 caribou and 1 muskox that were bedded or grazing near the fences were startled by a truck travelling on the winter road (Table 10). In under one minute, the group galloped towards the fence, turned when they were within about 50 metres and headed up and around the end. The muskox was bedded down at the time that the truck passed and did not move until about 2 to 3 minutes later after the caribou had gone. It got up and walked out of the area parallel to the fence and around the end.
The same herd of 12 muskoxen and 3 calves were seen on two occasions in the area near the fence. Most animals stayed about 30-50 metres away and only 2 animals approached close enough to sniff the fence.

Most caribou seen in the Lupin area and near the fences were bulls. We saw fewer than 10 cows with calves in the 10 days of observing and none were near the fences.

Plastic

The plastic deflector was also easily visible and was a solid white colour when on the ground. From 1 - 6 July 1997, approximately 45 caribou were observed close to the plastic on 8 occasions and about 40% of these animals crossed over it (Table 11). Usually, the caribou would first sniff the plastic and then walk across, or rarely, they would hop or jump across. Some did not stop or sniff the plastic before they crossed. Most of the caribou crossed in a flat section mid-way along the length of the plastic.

Remote Cameras, 1996 and 1997

From 4-16 July 1996, 16 rolls of film were shot from the two remote cameras. However, no caribou were captured on film from remote cameras in July (approximately 580 exposures over a total period of 96 hours). From 10-12 August 1996, 4 rolls of film were shot from the remote cameras and 2 rolls on 26-27 August 1996. In 23 frames out of 193 exposures (32 hours) taken in August, caribou were observed on or near the airstrip and standing near or bedded next to tanks in the tank farm (Appendix F).

From 29 June - 6 July 1997, 35 rolls of film were shot from three remote cameras set up on each of the fences and the plastic deflector. Of 1150 exposures (190 hours), caribou were observed in 16 frames (Appendix G). Of caribou near the fencing whose actions are discernable (approximately 37 different caribou in nine observations), 72% ± 43.5 were observed foraging followed by 23% ± 43.8 walking. Less than 5% were either standing (4% ± 11.1) or bedded (1% ± 4.4).

DISCUSSION

In 1996 our observations were similar to 1993 (Mueller and Gunn 1996) and were that caribou used mine structures (tailings ponds, airstrip, road and tank farm) during July and August. Caribou tend to bed or move across those areas and feed in their proximity. Our data do not allow us to test whether the caribou preferentially sought those areas in comparison to natural features. However, the caribou's use especially of the tailings ponds has raised concerns that led to the 1997 work which was to test fences to divert caribou.

The vertical fence with the nylon flags fluttering in the wind holds promise as a relatively cheap, portable and easily erected means to divert caribou. Our design is an adaptation of Dogrib traditional means to divert caribou in winter south of the treeline. The plastic sheet on the ground was ineffective as a diversion at the width (1 m) that we tested.

Okarma and J drzejewski (1997) used *fladry* (rope with brightly coloured strips of cloth, 30-40 cm long and 15 cm wide, hanging every 50 cm) to trap wolves in Belarussia. The *fladry* was draped over branches, bushes and trees to create a fence-like structures with flags moving freely. They stated that "ungulates are not afraid of *fladry*".

We recognize that the caribou were not highly motivated to cross the vertical fence as they were mostly undisturbed by human or mosquito activity or warble flies during the observations. The test line was long enough to divert the caribou but short enough that they could pass around it. We believe from observing two caribou cross the fence (before the flagging) was added that the caribou could

cross the fence without injury or becoming entangled.

The number of variables (insect activity, weather and location, sex-age class) and relatively small sample sizes (number of caribou observations and their duration) confounds analysing the behavioural observations taken in 1996. The small sample size reflects only two observers watching caribou for 7 days. Although they counted up to 420 caribou during the July observations, those caribou were mostly walking and foraging and would move out of sight, so few scans were possible. In August 1996, fewer caribou were seen (about 20), but as they bedded more than in July, more scans were possible. Further evidence to low caribou numbers during the 7 days the observers were at Lupin in 1996 comes from the cameras. In July-August 1996, only 3% of the single frames taken at 10-minute intervals over 128 hours at the airstrip and tank farm showed 7 observations of 14 caribou and that includes consecutive shots of probably the same caribou.

In 1997, the same problem of sample size hinders analyses, but also the emphasis was on testing the fences. About 200 caribou were watched during scan sampling over 7 days in June-July 1997, but only 1% of the single frames taken at 10-minute intervals over 190 hours at the fence test site showed caribou.

Mostly we recorded the behaviour of bulls and juveniles and we observed relatively few cows and calves. Observations at the Jericho site north of Lupin (Appendix B) and from the satellite-collared caribou suggest that in late June 1997, the majority of cows and their calves moved around the north end of Contwoyto Lake and continued south west of the lake during their postcalving movement from the calving ground west of Bathurst Inlet. Cows and calves tend to be more responsive to human activity (for example see Miller and Gunn 1979) but it is premature to assume that their increased responsiveness causes them to divert around Lupin. The terrain may divert the caribou and this could be examined through modelling with ground-truthing based on examining existing trails.

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APPENDIX A. Miscellaneous caribou and muskox observations, Lupin mine, Contwoyto Lake, NWT, 5 July - 10 August 1996.

Obs #	Date	Time	
1	5 July	14:00	80^{+} caribou near satellite dish on main road
2	12 July	--	lone caribou by main road (Insect site 1)
3		--	Mother and yearling near Insect site 2
4	16 July	09:00	1 caribou eating on 30m transect of Road dist site 1
5		07:00	1 caribou on baseball diamond
6	17 July	08:00	15 muskoxen bedded down at site 1 100-200m SE
7	20 July	10:25	caribou on tailings (uncapped) drinking water from a pool on tailings (by tailings sites NW)
8		11:23	1 caribou on golf course walking W cross wind
9		--	14 muskoxen walking SE pond 2 west side into wind
10		--	14 muskoxen walking on Boomerang Lake SW shore
11	21 July	10:41	caribou walking down wind on tailings pipe road
12	23 July	11:45	bull bedded down between sleeping quarters; still there at 13:00
13		14:00	2 caribou sleeping on capped tailings
15	24 July	16:00	caribou at dust site 2, walking on road to dust site 1
16		18:00	4 caribou SE side of lagoon 1
17	25 July	12:00	1 bull bedded down between sleeping quarters
18	26 July	12:00	1 caribou bedded on capped tailings
19		12:20	caribou walking S end of capped tailings on edge of tailings (<5m)
20		13:30	caribou at tailings pond standing Cell 1
21		14:00	caribou walking cross wind on capped tailings
22		17:00	1 yearling walking into wind 20m from road - dust site 1-2
23	29 July	12:00	muskox 50 m W of runway
24		13:00	caribou running dust site 2 (road) on main road, head down running
25	31 July	07:00	caribou bedded down on baseball diamond
26		10:30	caribou walking 30m NW of main road towards me. Warble fly found on crowberry patch dust site 3.
27	5 August	09:00	caribou running crossed road and airstrip
28		15:00	2 caribou walking S of main road - end of airstrip / dust road site 1
29	6 August	14:30	20-30 caribou spread from site 1 to tailings (pictures)

30	9 August	20:00	3 caribou on airstrip edge one male 30m from airstrip
31	10 August	09:00	2 caribou bedded down between fuel tanks
32		09:30	4 caribou bedded in turn of shoulder of main road (road dust site 1)

APPENDIX B. Miscellaneous caribou observations, Lupin mine, Contwoyto Lake, NWT, 25 June - 8 July 1997.

Obs #	Date	Time	
1	25 June	16:30	3 groups of 20-40 ~15 km S of Lupin
2			~10 caribou between airstrip and road
3			~10 caribou at N end of airstrip
4		18:30	~30 grazing between mine and lake near pumphouse; on both sides of winter road and pipeline
5	26 June	07:00	30-40 in same area as above; most bedded down
6		09:30	~300 total in groups of 30-50; around tailings area mainly SW and W of pond 2 (saw at least 4 cows with calves)
7		10:30	~100 west of winter road grazing and slowly heading S
8		14:00	30+ E of pumphouse between Contwoyto Lake and sewage lake 2 (SL2) in wet meadow
9			2 groups of 10-15 E of main road between mine and satellite dish
10			50 NW of junction and N of pond 2
11		14:00 - 16:00	50+ grazing and bedded down W of pond 2 in “the environment” outside ring road
12			3 smaller groups of 6-7 inside ring road in fairly rocky area along SW edge of pond 2
13			2 larger groups of 30-40 in hills to SW outside ring road
14	27 June	08:30	30+ crossing pipeline from E to W between Contwoyto Lake and mine
			Report from Steve Moore (6 July) that he counted ~35 000 caribou on the Jericho property (66 00'N 111 17'W) 28 km N of Lupin (Fig. B1) and then stopped counting; the caribou stretched to the horizon in 3 different directions and kept going by for about 2 days; by Saturday evening, they were seeing the end. He estimated from the ground ~100 000 animals heading S through camp.
15	28 June	13:30	~20 near S-side of Boot Lake
16			~30 N-side of Boot Lake
17			100+ W-side of winter road in valley heading N-S also E-W across road to pumphouse and pipeline
	30 June	11:00	Report of ~100 000 caribou passing by Sun Bay, 10 km W of Lupin (Fig. B1) and heading S and SE. Continued throughout the day beginning around 11:00
18		15:40	51 caribou (possibly more out of sight) moving fairly quickly W up over hills NW of winter road
19		16:20	23 caribou heading NW over hills
		eve	Twin otter pilot reported ~5-10 000 animals at N-end of Contwoyto Lake.
20	1 July	morn	~100 caribou reportedly seen in tailings area
		11:00	Report of 50-100 caribou by edge of lake E of pumphouse

APPENDIX B (continued). Miscellaneous caribou observations, Lupin mine, Contwoyto Lake, NWT, 25 June - 8 July 1997.

Obs #	Date	Time	
21		13:30	50+ caribou grazing in meadow and heading W; 14:30 - part of group (~30) headed toward lake; 15:30 - group of 30 now between pipeline and winter road; 15:40 - group, startled by van on pumphouse road, crossed winter road N of fences and continued trotting to meadow in W.
22		15:45	28 caribou (over ½ group prime bulls) grazing and slowly moving W in small valley / meadow NW of fence.
		16:30	2 groups of ~100 caribou reportedly seen E of tailing area heading N towards Contwoyto Lake (These are probably the ones that we're seeing crossing the pipeline and heading W).
23		16:30	Group of ~50 caribou near the edge of Contwoyto Lake E of the pipeline grazing and heading E.
24		21:10	Hundreds of caribou E of pipeline ~500m along valley E to lake and on
25			far side of lake:
26			2 groups of 250+ and ~100 moving W ~ 5 caribou-wide 1 group ~100 grazing and bedded 1 group ~ 50 bedded in wet meadow toward E before lake more in meadow at far side of lake
27	2 July	19:20	From cafeteria, can see 300+ caribou heading NW and moving quickly; by 19:27, half had disappeared over ridge to NW.
28		19:30 - 20:30	2 groups of ~100 caribou each are heading NW from E side of pipeline; ~20:15 - part of 1st group going around N-end of fence 2 (roll#7); ~20:30 - most of 2nd group heading up far ridge to NW; most of animals look like bulls.
29		21:30	300+ caribou E of pipeline (very far)
30	3 July	09:15	80+ caribou E of mine complex moving S from wet meadow
31			40+ also moving S, SE from hill N of lake past wet meadow.
32		10:45	Small group (hard to see thru fog) on shore of lake E of mine complex (part of group of 40 seen earlier?)
33		13:15	~10 caribou E of pipeline and N of camp between small lake and lakeshore (looking towards peninsula from guest house)
34		16:15	Can see a few (#?) caribou far to E past pipeline
		17:00	On trip to Ulu (Fig. B1): N side of Contwoyto - 4 cows with calves in 2 different areas + 4 caribou ½-way to Ulu - ~200 animals bedded down and grazing on a high area Return trip from Ulu: 2 groups of ~50 and ~20 caribou (closer to Ulu) not sure if there were calves
35			3 groups of 5-10 caribou ~15 caribou between sewage lakes and tailings area
36	4 July	11:15	Group of ~50 W of camp in wet sedge meadow heading N (NW?) towards Contwoyto Lake.
37		14:45	~20 caribou heading NW over hills to the NW of fence area (probably crossed pipeline and roads close to lakeshore below ridge).

APPENDIX B (continued). Miscellaneous caribou observations, Lupin mine, Contwoyto Lake, NWT, 25 June - 8 July 1997.

Obs #	Date	Time	
38		22:15	2 bulls bedded down ~50m W of winter road (~300m S of fence 1) After we passed them, they got up and trotted behind us; grazed a bit ~20m ahead of us; then ~50m ahead of us, they crossed the road to the mine side and proceeded to graze on that side.
39	5 July	15:45	15+ caribou in wet meadow / drainage E of camp (can see several prime bulls in group)
40			20+ caribou on hill NE of drainage; at 17:00, grazing and moving closer to wet meadow
41		20:15	Large group (#?) near pipeline heading W.
42		20:50	200+ caribou E of pipeline heading E over hill towards meadow (didn't see them when we checked earlier - think they may have been headed this way and changed direction)
43	6 July	10:20	Can see a few (#?) caribou nearing shore N of fence 2
44		11:20	1 young bull crossing winter road from E to W (travelled down road to N ~50m before disappearing over ridge).
45		11:45	15 caribou grazing just W of airstrip (S end).
46		15:30	1 prime bull heading NW (NW of fences and stream connecting Boot Lake with Contwoyto.
47	7 July	morn	1 cow and calf reportedly seen near tank farm
			Harry Apple and Richard Weyallon (Rae) saw ~1-2000 caribou (including calves) just S of Lupin on flight from Yellowknife to Lupin by Cessna 185. 6 of 7 collared cows are S of Lupin near S-end of Contwoyto; 1 between Jericho and Rockinghorse Lake (Fig. B1).
	8 July	10:00	Helicopter (Bell 206 Long Ranger) flight: Group of ~50 caribou at 65º30'N 111º01'W Group of ~30 at 65º22'N 111º00'W
48		12:30	1 caribou grazing between winter road and road to pumphouse (heading SE).

APPENDIX C. Muskox observations, Lupin mine, Contwoyto Lake, NWT, 25 June - 8 July 1997.

Obs#	Date	Time	
1	27 June	morn	6 muskoxen reportedly seen along shore just E of mine complex
2		09:30	14 muskoxen grazing E of pipeline near shacks
3	29 June	13:35	12 adults and 3 calves grazing near fence; after noticing us, they headed W parallel to fence 30-40m away on S side. At 13:45, muskoxen are now past the fence heading NW.
4		20:00	Same group of muskoxen are back S of fence 1; a couple approached to within 5m of the fence between 30 and 50m from E end and then went around.
5	3 July	17:00	On trip to Ulu: N side of Contwoyto - 2 muskox ½-way to Ulu - 8 muskoxen; 16 muskoxen with 2 calves
6	5 July	20:30	1 muskox grazing between fences 1 and 2 (along with 86 caribou).
7	6 July	11:20	1 muskox spotted W of fence 2 (travelling N); 13:30 - seen again grazing on W-side of ridge where cam3 sits.
8	8 July	11:30	Helicopter (Bell 206 Long Ranger) flight: Group of muskoxen (#?) on mine property between tailings ponds and mine complex.

APPENDIX D. Additional wildlife observations, Lupin mine, Contwoyto Lake, NWT, 25 June - 8 July 1997.

Obs #	Date	Time	
1	27 June	09:00	1 small grizzly reported in tailings area (Dam 3) headed N toward Contwoyto Lake.
2		09:30	3 grizzlies (sow and 2 cubs) on ice heading NE towards point.
3	28 June	13:35	1 “scraggly-looking” dark wolf following caribou on W-side of airstrip
4	30 June	23:00	Saw large light-coloured wolf near Contwoyto Lake.
5	3 July	07:00	1 grizzly near pumphouse

APPENDIX E. Insect sweeps, Lupin mine, Contwoyto Lake, NWT, 1996 and July 1997: total of 5, 30-second sweeps.

Insect sweeps, 7 July - 10 August 1996.

Date	Time	Temp (ºC)	Wind (km/h)	Site †	Road		5 m		30 m	
					In wind	Down wind	In wind	Down wind	In wind	Down wind
7 July	08:00	18	SW 20	A	0*	2M**	0	1F	0	10M;1L;1B
9 July	02:00	8	NE 20	A	0	0	0	0	0	0
10 July	02:00	8	SSE 15	A	0	0	0	2M	0	2M
16 July	17:00	16	calm	3	no wind - 5M		no wind - 3M		no wind - 15M	
17 July	19:36	18	10	3	0	0	0	1M	1M	3M;21L
19 July	13:15	19	10	1	0	0	0	3M;3L; 2F	1L	4M;12F;2L
19 July	14:20	19	10	2	0	1M;13fl	0	21fl	3fl	7M;10L;4F;9 W
20 July	13:45	22	10	4	0	3L	0	1M;5L; 2F;3MD	2L;1G	2L;4F; 4MD
20 July	14:39	22	10	3	0	2F	1F; 1MD	2F	1M;1L; 1F;1MO	2M;7L; 8F
21 July	13:35	20	10	2	0	10L; 1F;1D	1F	1M;3L; 1F	0	1M; 9L;1F;1W;1D; 1MD
21 July	14:30	20	10	1	0	0	1F	3L;3F	1F	17L
22 July	13:13	12	5	3	0	0	0	2L;1F	1MD	1M;20L;1F
22 July	14:00	11	0-2	4	0	0	no wind - 14L		no wind - 6L	
25 July	15:00	18	15	4	0	0	0	0	2M	1M;1F; 2W
25 July	15:30	18	15	3	0	0	0	0	1M	1F
25 July	16:00	18	15	2	0	0	0	0	0	2W
25 July	16:34	18	15	1	0	0	1M	1F;2W	0	2M;4W
2 Aug	13:58	11	15	3	0	0	0	1W	0	13W
2 Aug	14:45	11	15	2	0	0	0	0	0	0
2 Aug	15:23	11	15	1	0	0	0	0	0	0
10 Aug	14:30	8	10	3	0	0	0	0	0	0

† See Fig. E1.
* Only this observation contains a total of 10 sweeps
**M - mosquito; D - deer fly; B - black fly; L - little fly; W - small fly with white marks on legs ; F - house fly ; MD - midge; MO - moth

APPENDIX E (continued).

Insect sweeps, 1-7 July 1997.

Date	Time	Temp (ºC)	Wind (km/h)	Location*	In wind**	Down wind
1 July	10:30	15	SW 15	Site 1	1 ff	5 mo; 2 ff
	10:45			Site 2	32 mi; 14 mo	19 mi; 37 mo; 1 cf; 1 gn
5 July	11:17	14	NW 13	Site 1	0	0
	11:06			Site 2	2 mo	1 mo; 1 ff
	10:25			Site 3	2 mo; 1 hf	2 mo; 2 ff
7 July	11:10	6	NE 5	Site 1	8 mo	4 mo
	10:55			Site 2	13 mo	30 mo; 1 ff
	10:30			Site 3	29 mo	45 mo

* Site 1 - on winter road; Site 2 - between start of fence 1 and plastic ~75m from winter road in dry area with
birch; Site 3 - near middle of fence 2 in area of wet sedge (Fig E2).
** mo - mosquito; mi - midge; ff - flesh fly; hf - hover fly; cf - crane fly; gn - gnat

APPENDIX F. Remote cameras, Lupin mine, Contwoyto Lake, NWT, July - August 1996.

Details of camera locations and times, 1996.

Date	Time	Comments
4 July	10:58 - 16:58	2 roads, buildings
5 July	12:07 - 17:47	paved road, barrel
6 July	09:18 - 15:18	2 roads, buildings
6 July	11:45 - 17:45	2 roads, buildings
6 July	15:20 - 21:20	2 roads, buildings
7 July	10:20 - 16:20	2 roads, buildings
7 July	08:51 - 14:41	paved road, red barrels
8 July	11:56 - 17:56	paved road, barrel
8-9 July	20:38 - 02:38	2 roads, buildings (airstrip and gravel rd)
9-10 July	20:10 - 02:10	paved road, barrel - dark slides
11 July	08:58 - 14:58	paved road, barrel
11 July	16:51 - 22:51	paved road, barrel
12 July	16:41 - 22:41	2 roads, buildings - dark slides
15 July	16:35 - 22:35	road, buildings
16 July	08:53 - 14:03	2 roads, buildings
16 July	16:47 - 22:37	paved road
10 August	11:52 - 15:22	airstrip
10 August	11:17 - 17:17	gravel road, mud flats
10 August	16:51 - 22:51	airstrip - dark (exposures 36, 37)
11-12 August	21:51 - 03:51	airstrip
26-27 August	19:18 - 01:18	side of gravel road, two lakes - dark (exposure 36)
27 August	15:02 - 19:12	tank farm

APPENDIX F (continued).

Caribou observed on slides from remote cameras, Lupin mine, Contwoyto Lake, NWT, August 1996.

Date	Time	Location	Comments
10 August	16:51	airstrip	1 caribou on airstrip
	17:01		1 caribou on airstrip
	17:11		1 caribou at 50 m
	17:21		1 caribou at 50 m
	17:31		1 caribou at 50 m
	17:41		3 caribou, 25-30m from airstrip
	17:51		1 caribou on side of airstrip
	18:11		1 caribou on airstrip
	18:21		1 caribou on airstrip
	22:01		2 caribou, 10m from airstrip
11 August	23:21	airstrip	3 caribou, 50m from airstrip
	23:31		3 caribou feeding 10m from airstrip
	23:51		1 caribou feeding 50m
12 August	02:21		2 caribou on airstrip
26 August	19:28	gravel road; two lakes in view	15^{+} muskox between lake and road, 100m
	19:38		15^{+} muskox between lake and road, 500m
	20:48		1 muskox 150m from road
	21:08		1 muskox 200m from road
	23:08		1 muskox 100m from road
27 August	16:32	near red tank farm	2 caribou (1 near tanks, the other 15m away)
	16:52		1 caribou 10m from tanks
	17:42		1 caribou
	18:12		5 caribou next to tanks
	18:22		1 caribou bedded down next to tanks
	18:32		1 caribou bedded down next to tanks
	18:42		2 caribou bedded down next to tanks

18:52	2 caribou bedded down next to tanks
19:02	2 caribou bedded down next to tanks

APPENDIX G. Remote cameras, Lupin mine, Contwoyto Lake, NWT, July 1997.

Details of camera locations and times, 1997.

Roll #	Expo-sure #	Date	Time	Zoom (mm)	Comments
2	16-33	29-30 June	13:55 - 16:55	--	constructing fence 1
3	2-37	30 June - 1 July	22:16 - 04:06	65	plastic
4	1-37	30 June - 1 July	22:03 - 04:03	80	fence 1
5	1-37	1-2 July	23:06 - 05:06	--	fence 1 - fog (exposures 11-28)
6	1-37	1-2 July	23:06 - 05:06	--	plastic - fog (exposures 18-24)
7	1-26	2 July	18:36 - 22:36	--	fence 2
8	1-37	2-3 July	22:42 - 04:42	80	fence 1 - dark (exposures 13-30)
9	1-37	2-3 July	22:30 - 04:30	--	plastic - dark (exposures 13-31)
10	2-37	2-3 July	22:40 - 04:30	--	fence 2 (print film)
11	1-37	3-4 July	22:25 - 04:25	--	fence 1
12	1-37	3-4 July	22:36 - 04:36	50	plastic
13	1-36	3-4 July	22:25 - 04:15	wide	fence 2
14	1-37	4 July	16:10 - 22:10	70	fence 2
15	1-37	4-5 July	22:33 - 04:33	80	fence 1
16	1-37	4-5 July	22:38 - 04:38	60	plastic
17	1-37	4-5 July	22:30 - 04:30	38	fence 2
18	1-37	5-6 July	21:22 - 03:22	70	fence 1
19	1-37	5-6 July	21:34 - 03:34	60	plastic
20	1-37	5-6 July	21:28 - 03:28	wide	fence 2
21	1-37	6 July	10:29 - 16:29	wide	fence 2
22	1-30	6 July	11:25 - 16:15	55	fence 1
23	1-36	6 July	16:35 - 22:25	--	fence 1 - dark (exposures 32-36)
24	1-36	6 July	16:29 - 22:19	wide	fence 2
25	1-37	6-7 July	22:35 - 04:35	50	fence 1
26	1-37	6-7 July	22:35 - 04:35	50	plastic
27	1-37	6-7 July	22:43 - 04:43	wide	fence 2
28	1-37	7 July	10:50 - 16:50	wide	fence 2
29	1-35	7 July	11:31 - 17:11	50	fence 1

30	1-30	7 July	17:18 - 22:08	wide	fence 2
31	1-30	7 July	17:16 - 22:06	wide	fence 1
32	1-37	7-8 July	22:21 - 04:21	--	fence 1
33	1-17	7-8 July	22:30 - 01:10	wide	plastic
34	1-37	7-8 July	22:23 - 04:23	wide	fence 2
35	1-37	8 July	08:41 - 14:41	50	fence 1
36	1-37	8 July	08:42 - 14:42	wide	fence 2

APPENDIX G (continued).

Caribou observed on slides from remote cameras, Lupin mine, Contwoyto Lake, NWT, July 1997.

Date	Time	Structure	Comments
29 June	14:45	Fence 1	1 caribou grazing S of fence 1 (5-30m)
	16:25		1 caribou grazing N of fence 1 (>30m)
1 July	1:43	Fence 1	6 caribou grazing E of winter road (>30m)
	1:53		6 caribou grazing just W of winter road NE of fence 1 (>30m) near plastic
1 July	23:06	Plastic	1 caribou walking N toward camera
1 July	23:35	Fence 1	1 caribou grazing W of fence 1 (>30m)
2 July	19:15	Fence 2	3 caribou (2 grazing, 1 bedded) E of fence 2 (>30m)
	19:25		4 caribou (3 grazing, 1 bedded) E of fence 2 (>30m) ~200 caribou on hills in background, NW of fence area
	19:35		8 caribou in close group (5 standing or walking?, 3 foraging) E of fence 2 (5-30m)
	20:05		4 caribou (walking parallel to fence?) E of fence 2 (>30m)
3 July	2:14	Fence 2	5 caribou (4 grazing, 1 walking) E of fence 2 (1 at 5-30m, 4 at >30m)
	2:24		10 caribou grazing E of fence 2 (3 at 5-30m, 7 at >30m)
	2:34		1 caribou grazing E of fence 2 (>30m)
	2:44		1 caribou grazing E of fence 2 (>30m)
5 July	22:18	Fence 2	4 caribou grazing E of fence 2 (5-30m)
6 July	3:18		2 caribou heading up over ridge SW of fence area (>30m)

Table 1. Details from instantaneous scans, Lupin mine, Contwoyto Lake, NWT, 4- 5 July and 9-10 August 1996.

Sample* ID	Date	Site**	Start Scan	Finish	No. of scans	No. of caribou	Temp (EC)	Wind (km/h)	Insects
4-S1	4 July	B	13:25	13:55	3	9-110	15	SE 35	--
4-S2	4 July	B	14:00	14:10	2	56-58	15	SE 35	many mosquitoes
4-S3	4 July	B	14:55	14:55	1	26	15	SE 35	none
5-S1	5 July	C	07:20	07:20	1	55	--	--	many mosquitoes
5-S2	5 July	C	07:23	07:23	1	84	--	--	many mosquitoes
5-S3	5 July	C	--	--	1	120	--	--	many mosquitoes
5-S4	5 July	C	07:40	07:40	1	53	--	--	many mosquitoes
5-S5	5 July	D	08:00	08:10	2	285-305	--	--	few mosquitoes
5-S6	5 July	C	08:12	08:12	1	32	--	--	--
5-S7	5 July	C	08:25	08:55	4	39-46	--	--	none
5-S8	5 July	D	09:16	09:26	2	73-101	--	--	none
5-S9	5 July	C	13:10	13:10	1	160	18	30-40	none
9-S1	9 August	H	14:20	15:30	8	2-7	10	20	none
9-S2	9 August	I	16:00	16:50	6	4-5	10	20	none
10-S1	10 August	J	10:10	11:20	8	1-4	6	15	few black flies
10-S2	10 August	K	11:40	13:10	10	1-3	6	15	few black flies

* date in July/August(4) - sample type(S) for instantaneous scan and sample number(1) = 4-S1
**Sites B, C, D - between mine and Contwoyto Lake; sites H and I - near minesite; sites J and K - tailings area (Fig. 2).

Table 2. Details from focal animal sampling, Lupin mine, Contwoyto Lake, NWT, 4-7 July 1996. Shaded samples are used in later analysis.

Sample* ID	Site**	Start Scan (hh:mm:ss)	Finish (hh:mm:ss)	Sex	Temp (EC)	Wind (km/h)	Insects[H]	Scan[I] sample
4-F1	A	11:25:00	12:25:34	bull			many mo	--
4-F2	B	13:30:00	13:34:57	bull	15	SE 35	many mo; few bf	4-S1
4-F3	B	13:40:00	13:43:20	cow/calf	15	SE 35	many mo; few bf	4-S1
4-F4	B	13:46:00	13:47:36	cow/calf	15	SE 35	many mo; few bf	4-S1
4-F5	B	13:50:00	13:51:24	cow/calf	15	SE 35	many mo; few bf	4-S1
4-F6	B	14:10:00	14:19:37	cow/calf	15	SE 35	few mo	4-S2
4-F7	B	14:27:00	14:34:22	cow/calf	15	SE 35	none	--
4-F8	B	14:35:00	14:36:44	cow/calf	15	SE 35	none	--
4-F9	B	14:40:00	14:45:17	cow/calf	15	SE 35	none	--
5-F1	C	07:44:00	07:47:59	cow/calf	--	--	many mo	--
5-F2	D	08:00:00	08:01:54	bull	--	--	--	5-S5
5-F3	C	08:27:00	08:34:46	cow	--	--	none	5-S7
5-F4	C	08:37:00	08:45:30	cow/calf	--	--	none	5-S7
5-F5	C	08:50:00	08:57:48	cow	--	--	none	5-S7
5-F6	D	09:20:00	09:20:51	bull	--	--	none	5-S8
5-F7	D	09:21:00	09:24:48	cow	--	--	none	5-S8
5-F8	D	09:29:00	09:39:00	bull	--	--	none	5-S8
5-F9	C	13:08:00	13:12:13	cow/calf	18	30-40	none	5-S9
5-F10	C	13:15:00	13:21:39	bull	18	30-40	none	--
5-F11	C	13:28:00	13:31:43	cow	--	--	none	--
5-F12	C	13:33:00	13:39:12	cow/calf	--	--	none	--
5-F13	C	13:47:00	14:05:05	bull	--	--	none	--
5-F14	C	14:15:00	14:28:30	bull	--	--	none	--
5-F15	C	14:30:00	14:35:17	cow	--	--	none	--
5-F16	C	14:45:00	14:46:13	cow	--	--	none	--
5-F17	C	14:49:00	14:54:28	cow	--	--	none	--
5-F18	C	15:03:00	15:11:00	cow	--	--	none	--
5-F19	C	15:15:00	15:22:52	cow/calf	--	--	none	--
5-F20	C	15:25:00	15:27:05	bull	--	--	none	--
5-F21	C	15:30:00	15:34:02	bull	--	--	none	--
5-F22	C	15:35:00	15:35:47	cow/calf	--	--	none	--
5-F23	C	15:40:00	15:55:12	bull	--	--	none	--
5-F24	C	16:00:00	16:01:04	cow/calf	--	--	none	--
5-F25	C	16:10:00	16:14:54	cow/calf	--	--	none	--
6-F1	E	09:30:00	10:39:17	bull	--	--	none	--
6-F2	F	11:00:00	11:17:10	cow	--	--	few mo	--
6-F3	A	total time	- 01:09:59	unknown	--	--	few mo	--
6-F4	A	total time	- 00:20:00	cow	--	--	few mo	--
6-F5	A	11:25:00	11:38:35	cow	--	--	few m; few bf	--
6-F6	A	total time	- 01:33:09	bull	--	--	none	--
7-F1	G	07:37:00	09:11:03	cow/calf	--	--	few mo	--
7-F2	G	08:45:00	08:45:59	unknown	--	--		--
7-F3	G	09:30:00	10:27:12	cow	--	--	few mo; few bf	--

* date in July(4) - sample type(F) for focal and sample number(1) = 4-F1

**sites A, E, F - airstrip and roads; sites B, C, D - between mine and Contwoyto Lake; site G - near tailings area (Fig. 2).

H mo - mosquitoes; bf - black flies

I from Table 1.

Table 3. Mean percent time " SD (standard deviation) of caribou activities determined from instantaneous scan sampling, Lupin mine, Contwoyto Lake, NWT, 4-5 July and 9-10 August 1996.

	n	bed	stand	forage	walk	trot	twitch
4-5 July	1 2	0.3 " 0.9	4.2 " 7.3	64.3 " 23.8	21.6 " 16.6	8.9 " 21.0	0.7 " 1.8
9-10 August	4	36.5 " 25.6	7.4 " 6.4	38.0 " 30.7	16.5 " 11.4	1.6 " 1.6	0.0

Table 4. Mean percent time " SD (standard deviation) of caribou activities determined from focal animal sampling, Lupin mine, Contwoyto Lake, NWT.

(a) Samples taken at the same times as the instantaneous scan sampling, 4-5 July 1996[H].

sex	n	bed	stand	forage	walk	trot	other*
All caribou**	5	0.0 " 0.0	1.3 " 2.1	88.8 " 9.8	8.7 " 9.7	0.0 " 0.0	1.3

[H] Samples 4-F6, 5-F3 to F5, 5-F8 (Table 2). Sample durations range from 5 to 10 minutes.
* Includes: alert, head down, toss, twitch, stamp, scratch, defecate.
**Two cows, two cow/calf pairs and one bull.

(b) Samples excluding those taken at the same times as the instantaneous scan sampling, 4-7 July 1996[H].

sex	n	bed	stand	forage	walk	trot	other*
Bull	6	34.2 " 25.6	12.9 " 8.6	39.3 " 21.6	8.2 " 4.0	0.4 " 0.7	5.0
Cow	4	51.3 " 43.2	4.6 " 4.3	12.0 " 8.3	29.4 " 34.6	2.4" 4.0	0.3
Cow and calf	1	44.4	0.5	48.4	6.6	0.0	0.0
Unknown	1	48.3	3.4	37.2	5.0	0.0	6.1
All caribou	12	41.9 " 29.6	8.3 " 7.9	30.7 " 20.7	14.9 " 21.2	1.0 " 2.4	3.1

[H] Samples 4-F1, 5-F13, 5-F14, 5-F23, 6-F1 to F6, 7-F1, 7-F3 (Table 2). Sample durations range from 10 minutes to 2 hours.
* Includes: alert, head down, toss, twitch, stamp, scratch, defecate.

Table 5. Details from instantaneous scan sampling, Lupin mine, Contwoyto Lake, NWT, 30 June - 6 July 1997.

Date	Start Scan	Finish	No. of scans	No. of caribou	Temp (EC)	Wind (km/h)	Cloud	Obser-vers	Insects
28 June	14:15	15:15	2	6	4	N 30-35	over-cast	down wind	none
30 June	10:00	10:20	3	11-22	8	NW 20	broken	down wind	none
30 June	16:05	16:35	4	7	12	NW 20	broken	cross wind	few mosquitoes
1 July	22:21	22:51	4	7-16	11	SW 10	clear	cross wind	few mosquitoes
2 July[H]	17:30	18:00	4	5-8	21	NW 10	broken	down wind	few mosquitoes
2 July	18:35	18:45	2	50-53	21	NW 10	broken	down wind	few mosquitoes
4 July	14:17	15:47	10	2	7	NW 15	over-cast - broken	cross wind	none
5 July[H]	20:45	20:45	1	86	15	NW 15	broken	cross wind	few mosquitoes
6 July	9:45	9:55	2	1-8	15	SW 15	broken	cross wind	few mosquitoes

[H] Descriptive observations also recorded (Table 10).

Table 6. Mean percent time " SD (standard deviation) of caribou activities determined from instantaneous scan sampling (n= 9), Lupin mine, Contwoyto Lake, NWT, 30 June - 6 July 1997.

bed	stand	forage	walk	trot	scratch
1.6 " 3.4	4.7 " 7.2	75.0 " 27.7	17.8 " 21.1	0.3 " 0.8	0.7 " 1.7

Table 7. Percentages of caribou observed in different behaviour categories at distances of <5m, between 5 and 30m and >30m from fencing during instantaneous scan sampling, Lupin mine, Contwoyto Lake, NWT, 30 June - 6 July 1997.

Distance to fence	No. of caribou	Percentage of animals				
		bed	stand	forage	walk	scratch
<5 m	4	0.0	0.0	25.0	75.0	0.0
5-30 m	81	1.2	2.5	92.6	3.7	0.0
>30 m	240	0.8	3.3	87.1	7.9	0.8

Table 8. Details from focal animal sampling, Lupin mine, Contwoyto Lake, NWT, 30 June - 6 July 1997.

Date	Start Scan (hh:mm:ss)	Finish (hh:mm:ss)	Sex/age	Temp. (EC)	Wind (km/h)	Cloud	Obser-vers	Insects
30 June	10:00:00	10:24:50	young bull	8	NW 20	broken	down wind	none
2 July[H]	17:30:00	18:05:00	prime bull	21	NW 10	broken	cross wind	few mosquitoes
4 July	14:20:00	14:50:00	bull	7	NW 15	over-cast 90%	cross wind	none
4 July	15:08:00	15:48:00	yearling	6	NW 15	broken	cross wind	none
6 July	09:57:00	10:06:07	young bull	15	SW 15	broken	cross wind	few mosquitoes

[H] Descriptive observations were also recorded (Table 10).

Table 9. Mean percent time (SD) of caribou activities determined from focal animal sampling (n= 5: 4 bulls and 1 yearling), Lupin mine, Contwoyto Lake, NWT, 30 June - 6 July 1997.

bed	stand	forage	walk	trot	alert	twitch	stamp	scratch	defecate
1.1 (2.5)	3.2 (1.4)	76.4 (6.8)	16.6 (8.7)	1.0 (1.9)	0.4 (0.9)	0.1 (0.1)	0.1 (0.2)	0.6 (0.8)	0.5 (0.7)

Table 10. Observed reactions of caribou (Cb) and muskoxen (Mx) to fences, Lupin mine, Contwoyto Lake, NWT, 27 June - 6 July 1997. An >**X**= indicates an occasion when the fence was crossed.

Date	Time	No. of animals		Observations
FENCE 1 - construction of first 80m with ropes stapled to 2x4's and 5 red flags per 10m section.				
27 June	after noon	1 Cb		Yearling approached us from downwind to 50-75m (N side) as we were building fence 1. Seemed curious but not threatened; continued grazing and moving slowly W and parallel to fence.
28 June	13:45	21 Cb		Caribou (N-S) near fence 1 as we approached on winter road: - 15 stayed 10-20m from fence and went around, - 2 stopped (at ~10 m), looked at fence and continued grazing, - 3 sniffed at rope/flagging, then walked around end,
			X	- 1 went between ropes; was small (probably yearling).
FENCE 1 - construction of second 80m with ropes fastened to poles using loops and 30 flags per 10m section.				
29 June	08:30	1 Cb		One young bull grazing on S-side of fence 1 undisturbed.
	13:35	15 Mx		Twelve adults and 3 calves near fence 1 grazing. After noticing us, they headed W parallel to and 30-40m S of fence 1.
				Group of 15 muskoxen back again at 15:00 and grazing S of fence 1. Two muskoxen approached the fence to within 1m between 30-50m from the end and went around.
	15:00	1 Cb	**X**	One young bull jumped fence 1 in an area were ropes were still slack and flags were not yet attached.
		8 Cb		Came within 5-10m of fence 1 and headed parallel to it and around the end.
FENCE 1 - 280m completed.				
30 June	06:45	10 Cb		Approximately 10 caribou grazing and bedded down N of fence 1. Still N of fence at 09:45. The animals stayed N of the fence and at 10:25, they headed W. **IS**, **FS**
1 July	09:30	9 Cb		One prime bull, 5 young bulls and 3 yearlings grazing between plastic and fence 1; 6 trotted off to NW, 3 remained grazing for 10 minutes until startled by machinery when they also trotted off to NW.
FENCE 1 - 280m completed and FENCE 2 - 130m completed.				
2 July	17:30	~15 Cb		Two approached within 10-30m of fence 2 and headed parallel, some towards N and some towards S; by 18:00 they had gone around both ends. **IS**, **FS**
4 July	13:45	1 Cb		As we approached fence area, 1 young bull was passing between fences 1 and 2 and heading W.
5 July	20:30	86 Cb + 1 Mx		Large group of caribou grazing between fences 1 and 2 was startled by a van travelling on the winter road (19 were within 30m of fence 2); in under 1 minute, they galloped around N side of fence 2 and headed NW. **IS** One muskox was bedded down amongst the group of caribou when the van drove by. About 2-3 minutes after the caribou left, it stood and walked parallel to and within 10m of fence 1 and headed W. Stopping to look at us several times, it passed between fences 1 and 2.
6 July	08:45	10 Cb		Grazing between 3 fences; by 9:00 were beginning to head E
	09:45	8 Cb		Walking/trotting quickly by fences (<50m from Fence 2) heading NW. **IS**

IS - An instantaneous scan sample (Table 5) was completed on this group of caribou.

FS - A focal animal sample (Table 8) was completed on this group of caribou.

Table 11. Observed reactions of caribou (Cb) to plastic deflector, Lupin mine, Contwoyto Lake, NWT, July 1997. An >**X**= indicates an occasion when the plastic was crossed.

Date	Time	No. of * animals		Observations
1 July	22:21	19 Cb		Approached plastic from E side about 50m from N end: **IS** - 5 came within 5-30m, - 11 stayed more than 30m away and went up and around the end,
			X	- 3 bulls approached plastic, sniffed, walked alongside it for about 1m and crossed (1 hopped and 2 walked). Found 1muddy track at about 25m from N end.
	23:06	1 Cb		Went around N end of plastic.
2 July	14:30		**X**	Found more tracks on plastic in flat section about 25m from N end.
2 July	18:10 - 18:15	11 Cb (in a group of 22)		Group of about 22 caribou crossed winter road heading W: - Aseveral@ reached plastic at N end and went around the top.
			X	- 18:10 - 4 reached plastic mid-way, stopped, sniffed and walked across (1 slipped while crossing),
			X	- 18:12 - 1 prime bull; sniffed and leisurely strolled across plastic (mid-way along length)
			X	- 18:14 - 2 young bulls; stopped, sniffed and crossed plastic - 1 hopped and 1 walked (mid-way along length),
			X	- 18:15 - 1 bull; walked across (mid-way along length), did not stop or sniff plastic,
				- the remainder reached W side of the winter road N of plastic.
	18:19	2 Cb	**X**	Prime bulls; stopped, sniffed and walked across plastic.
	18:30	2 Cb	**X**	Stopped, sniffed and walked across plastic.
4 July	14:00	2 Cb	**X**	Crossed winter road to W side and within 5 minutes had both leisurely walked across plastic (1 sniffed, the other did not).
6 July	9:00	8 Cb (in a group of 13)		Bulls, yearlings; were grazing in fence area and began to head E. Eight approached plastic about 30m from N end:
			X	- 1 crossed,
				- 7 veered N at about 5-10m.
	9:25	2 Cb		- 1 stayed E of plastic,
			X	- 1 approached plastic while grazing, sniffed, travelled S 5-10m, sniffed again and then walked across

* Number of animals whose intended course would be broken by plastic deflector.

IS - An instantaneous scan sample (Table 5) was completed on this group of caribou.

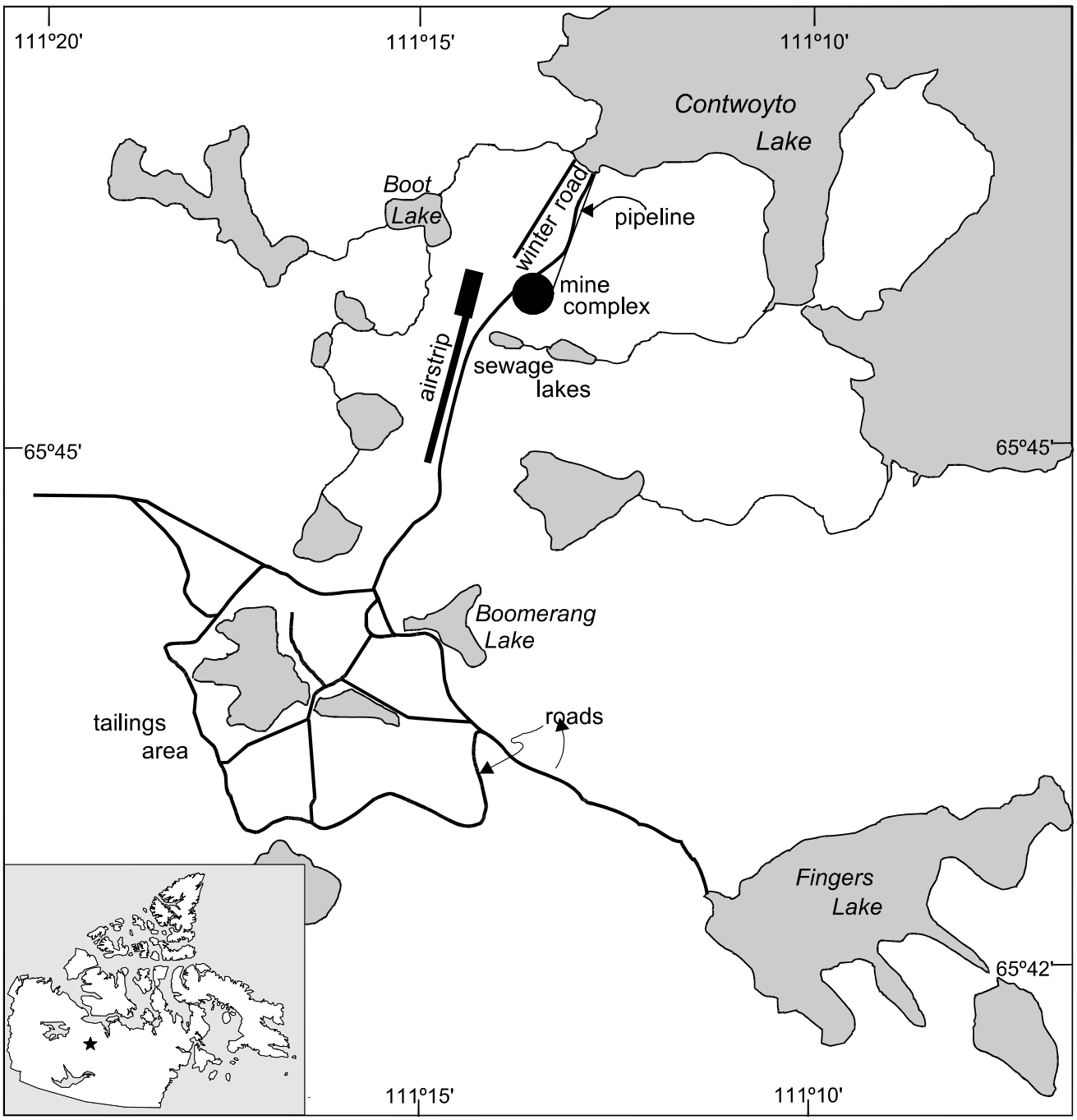


Figure 1. Lupin mine, Contwoyto Lake, NWT.

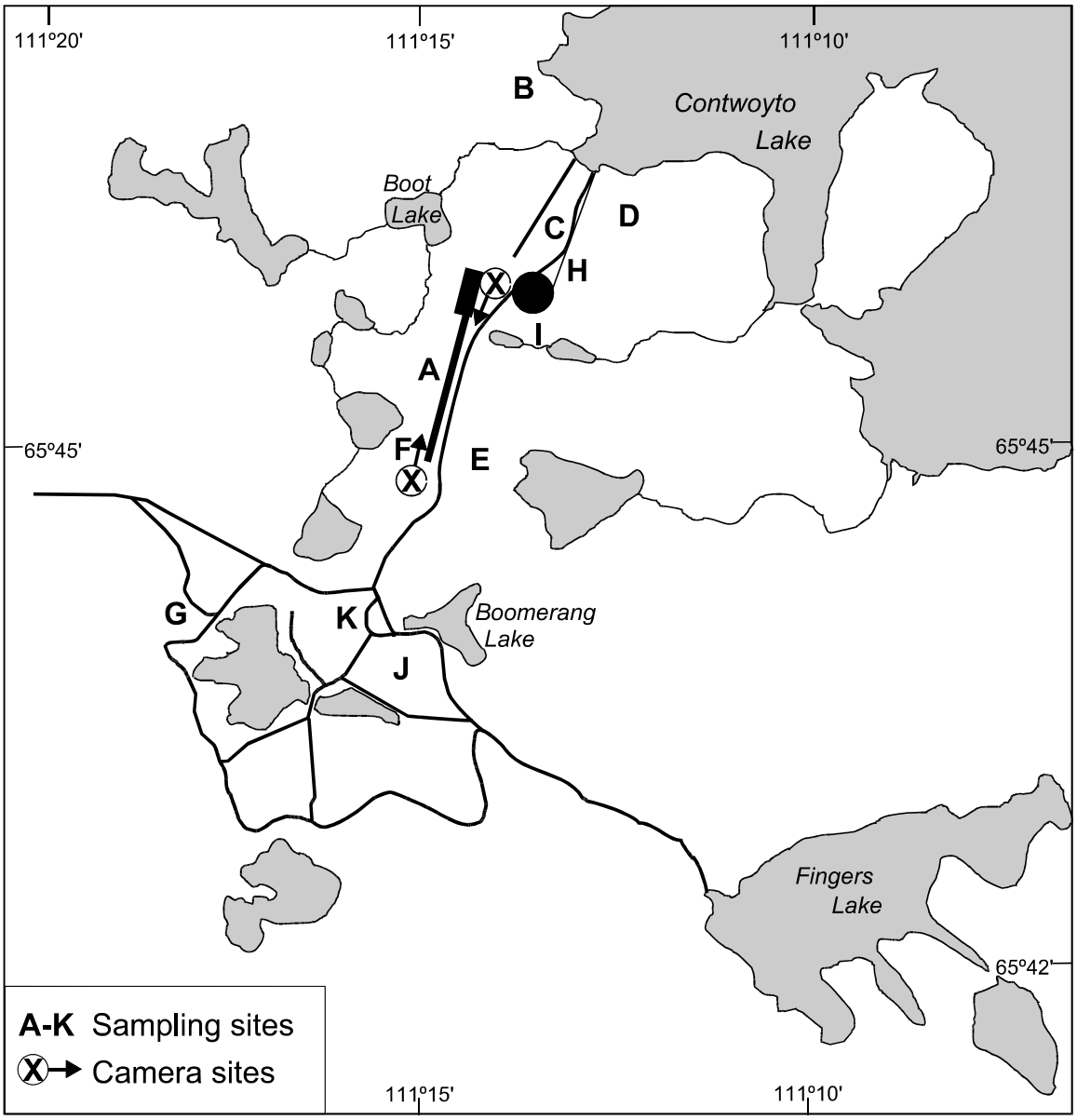


Figure 2. Study area, Lupin mine, Contwoyto Lake, NWT, July - August

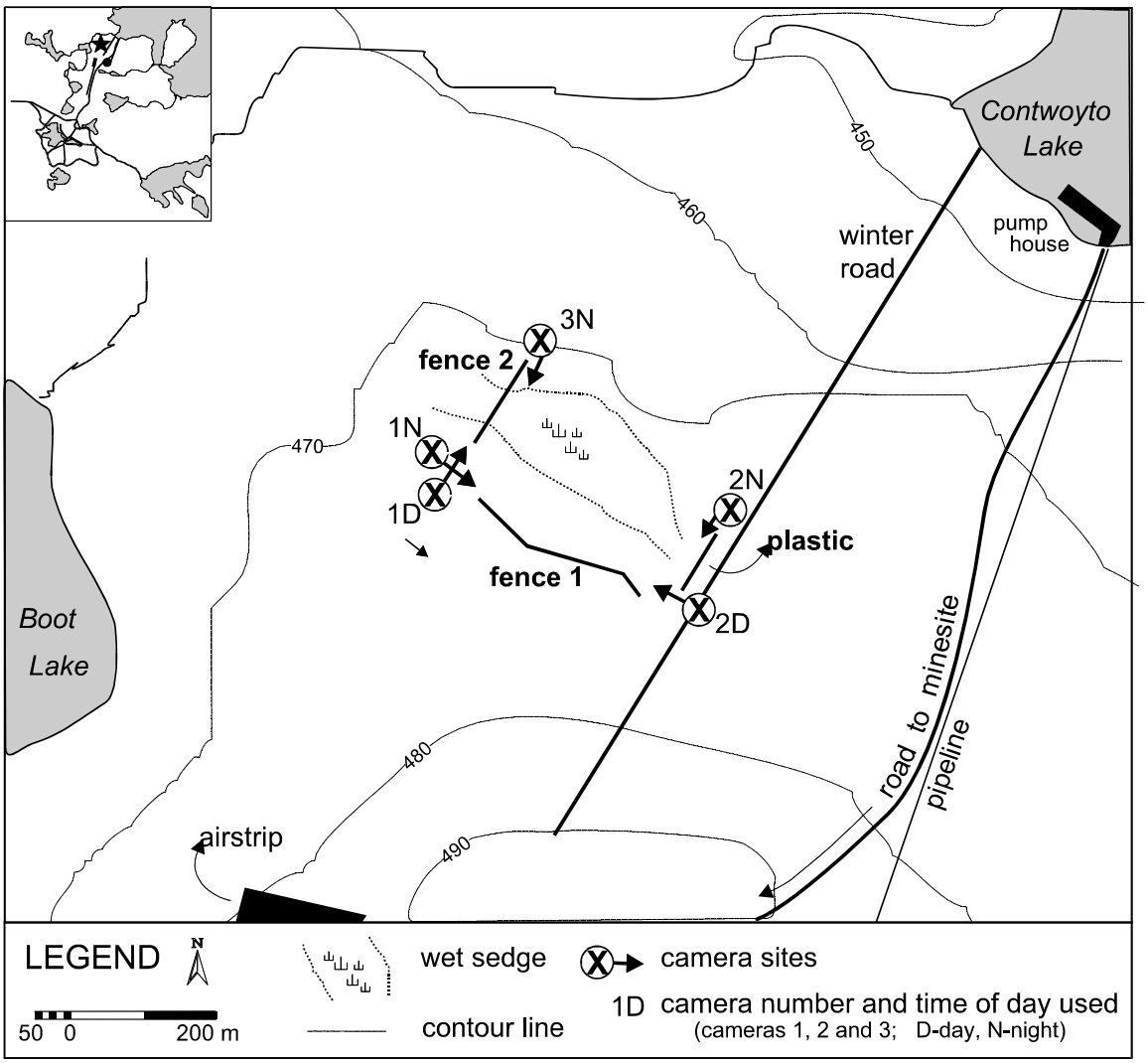
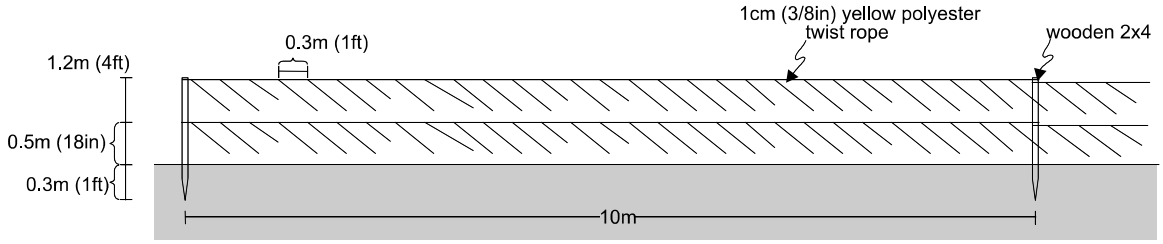


Figure 3. Study area, Lupin mine, 28 June - 8 July 1997

(a)



(b)

Figure 4. Fence diagram (a) and photo (b), Lupin mine, Contwoyto Lake, NWT, July 1997.

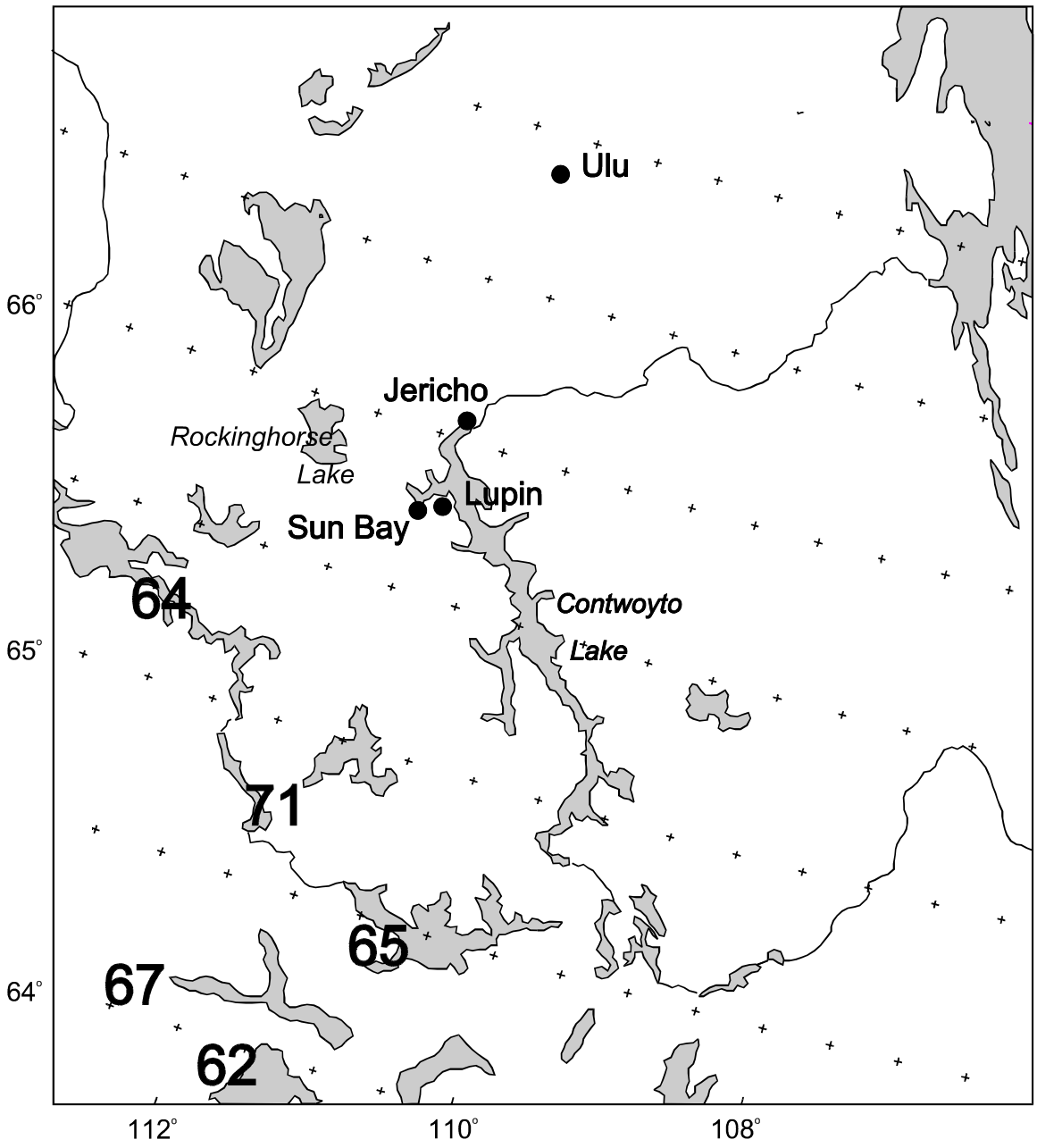


Figure B1. Place names near Lupin mine.

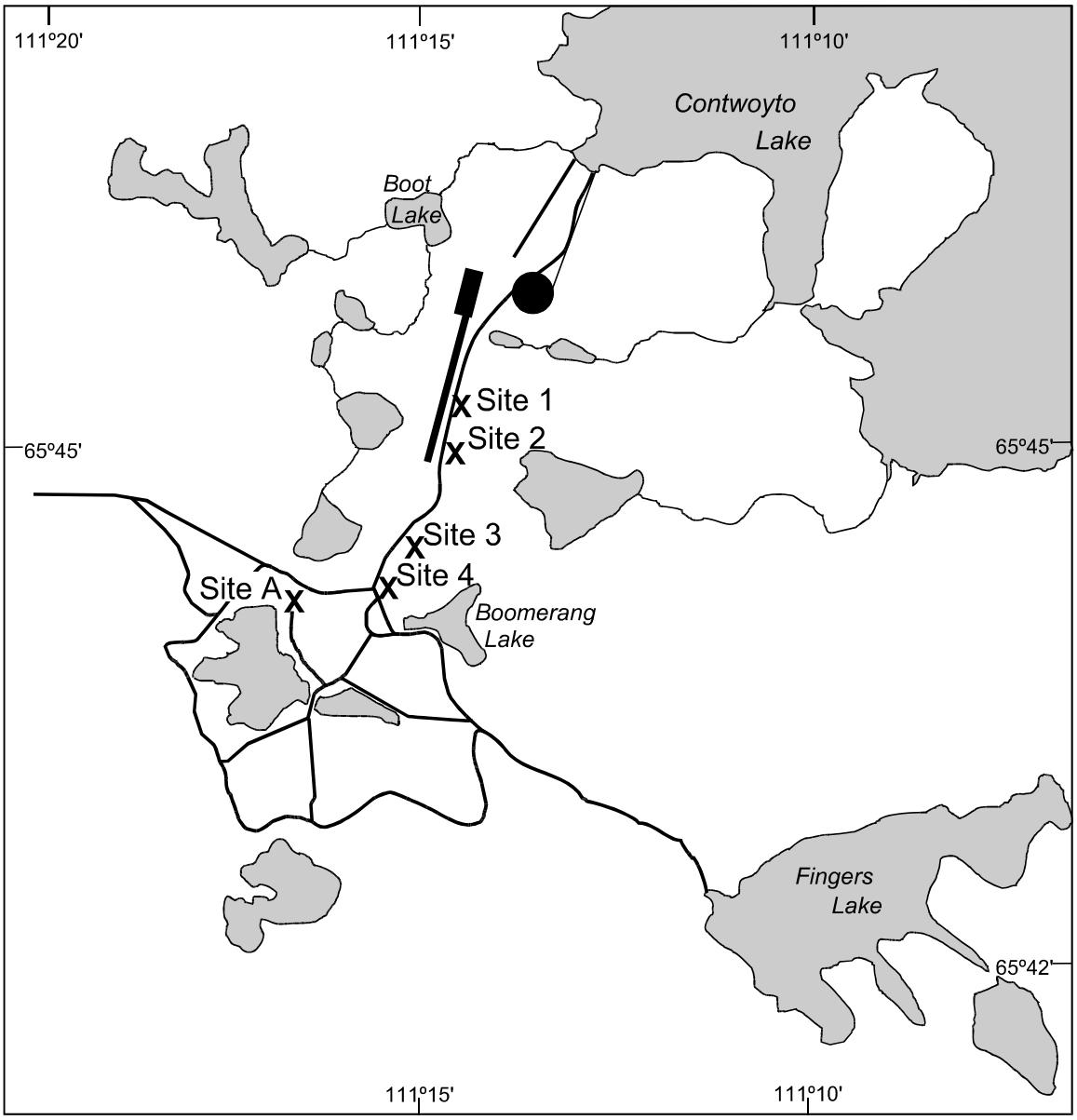


Figure E1. Insect sweep sites, Lupin mine, Contwoyto Lake, NWT, 7 July - 10 August 1996.

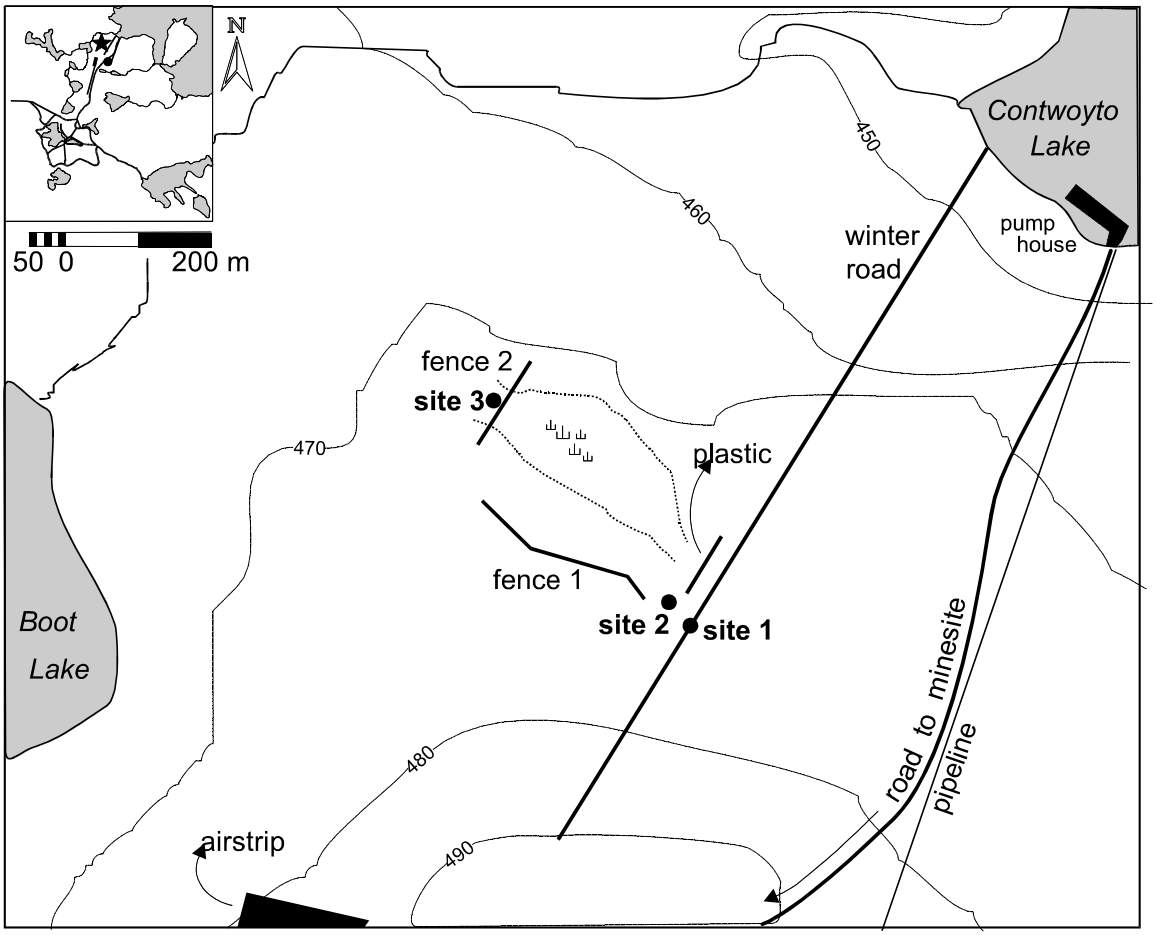


Figure E2. Insect sweep sites, Lupin mine, Contwoyto Lake, NWT, July 1997.