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G.R. Dyke, D.A. Birdsall, P.L. Sharp

LGL Limited

TEST OF A BIRD DETERRENT DEVICE AT A TAILINGS POND, ATHABASCA OIL SANDS, 1974

Syncrude Canada Ltd.
10030 - 107 Street
Edmonton, Alberta
T5J 3E5

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ABSTRACT

Between 26 August and 30 October 1974, a reflector device was tested as a deterrent to birds at a small tailings pond (Lower Camp Tailings Pond) located on Syncrude's lease 17, approximately 40 km (25 mi) north of Fort McMurray, Alberta. This tailings pond provided a situation analogous (though on a smaller scale) to that expected to occur at the Mildred Lake Tailings Pond that will be constructed on lease 17.

The discovery of two bitumen-covered ducks and the remains of approximately 25 other birds along the shore of the small tailings pond on 6 August 1974, indicated that birds had died at this pond. Accordingly, the results of this study also provided information on the extent to which this tailings pond was hazardous to water-associated birds.

The results of this study indicated that the reflector device did not sufficiently deter shorebirds and passerines from landing along the shoreline of this pond. Few ducks and no geese were observed to land at this pond; consequently, it was not possible to determine the effectiveness of reflectors as a deterrent to these birds. Analysis of the data did indicate that such birds might be deterred by reflectors.

Because few ducks or coots and no geese landed at the small tailings pond, the hazard of this pond was considered small to such birds. Evidence did indicate, however, that the risk of contacting bitumen was great for any such birds that did land on the tailings pond.

Shorebirds readily landed on the shore of this pond and were observed to pick up bitumen on their feet and legs. The hazard to these birds was considered small--although some shorebirds are known to have died at this pond. The hazard of this pond to passerines was also considered small.

ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

INTRODUCTION

Syncrude Canada Limited is presently constructing a tar sands mining and extraction plant on Alberta Bituminous Sands Lease No. 17, which is located approximately 40 km (25 mi) north of Fort McMurray, Alberta. This plant will include a tailings pond* that will eventually cover 30 sq km (11.5 sq mi) and that will receive and retain effluents--water, bitumen, and other chemicals--from the extraction process.

The results of previous studies (Syncrude Canada Ltd. 1973; Schick and Ambrock 1974; Sharp *et al.* 1975) indicate that large numbers of water-associated birds occur on lease 17 and in the areas surrounding it. Moreover, during the study reported in Sharp *et al.* (1975), two live bitumen-covered ducks and the bitumen-covered remains of approximately 25 birds were found around the periphery of the abandoned tailings pond† located near the Lower Camp of Syncrude Canada Ltd. Because experiments have established that ducks whose plumages have become heavily oiled will die (Hunt 1961; Hartung 1967; McEwan and Koelink 1973), it was suspected that the above-mentioned remains were those of birds that had died because they had contacted the bitumen present on the Lower Camp Tailings Pond. Given the number of water-associated birds that have been recorded in the general lease area, the area that the Mildred Lake Tailings Pond will cover, and the effluents that this pond will retain, it has been hypothesized (e.g., Schick and Ambrock 1974) that the Mildred Lake Tailings Pond will be attractive and hazardous to large numbers of water-associated birds.

Because the Lower Camp Tailings Pond provided a situation analagous (though on a smaller scale) to that of the proposed Mildred Lake Tailings Pond, it was decided to use the Lower Camp Tailings Pond as an area on which to test a deterrent device intended to discourage birds from land-

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* Referred to as the Mildred Lake Tailings Pond throughout this report.
† Referred to as the Lower Camp Tailings Pond throughout this report.

ing at this pond. The deterrent device (described in METHODS) tested during this study was similar to one known to prevent Whistling Swans (*Olor columbianus*) from landing on particular areas of Chesapeake Bay, United States (R.E. Schweinsburg, pers. comm.). Equally important, a study at the Lower Camp Tailings Pond would also provide information on the extent to which this pond was hazardous to birds in the study area.

This study sought to meet the following specific objectives:

1) to compare the behaviour of birds that approached the pond during control (no deterrent present) and experimental (deterrent present) periods;
2) to assess the extent to which the deterrent device prevented birds from being attracted to or contacting the Lower Camp Tailings Pond;
3) to provide a partial basis for the design and testing of deterrent devices during subsequent studies;
4) to determine the species and numbers of birds that passed through the immediate area of the Lower Camp Tailings Pond and the species and numbers of birds that landed on the pond or its shoreline; and
5) to assess the extent to which the Lower Camp Tailings Pond was hazardous to birds in the study area.

2. STUDY AREA

The Lower Camp Tailings Pond, located in the southeast portion of lease 17 (Figure 1), was constructed by Cities Services Athabasca Ltd. to retain the effluents from their pilot tar sands extraction plant. When the plant ceased operations in 1963, the tailings pond was abandoned. In addition to the effluent that was contained in the pond when operations ceased, the pond was further contaminated by bitumen that continued to seep into the pond from the adjacent mining face.

At the time of this study, the Lower Camp Tailings Pond (Figure 2) was 0.4 ha (1.09 acres) in area and 796 m (870 yds) in perimeter. Most of its shoreline consisted of bare sand or gravel, which in places was saturated with bitumen (Figure 2). Some patches of cattails and small areas with aspen shrubs and sparse ground vegetation were present (Figure 2). Floating mats of bitumen were present on the pond surface; in places, these mats were adjacent to the shoreline. During this study the portion of the pond's surface that was covered with a film of bitumen varied from less than 10% to 100%. The viscosity of the bitumen both on the shore and in the water varied according to the ambient temperature. The shoreline was soft and sticky on warm days and very hard on cold days. The floating bitumen was generally thin and extensive on warm days and thicker and less extensive on cold days.

Two small 46 m (50 yds) x 23 m (25 yds) dugouts, the shorelines of which were lined with cattails, were present to the north and east of the tailings pond (Figure 2); a marsh was located to the north of the north dugout. Bitumen was present on the surfaces of these waterbodies.

Storage tanks (locations shown on Figure 2) and buildings, both associated with the abandoned pilot plant, were located on higher ground immediately to the south of the pond. During the study, there were unregulated movements of people, of vehicles, and of heavy equipment near the tailings pond; these activities were associated with the nearby housing units for Syncrude employees.

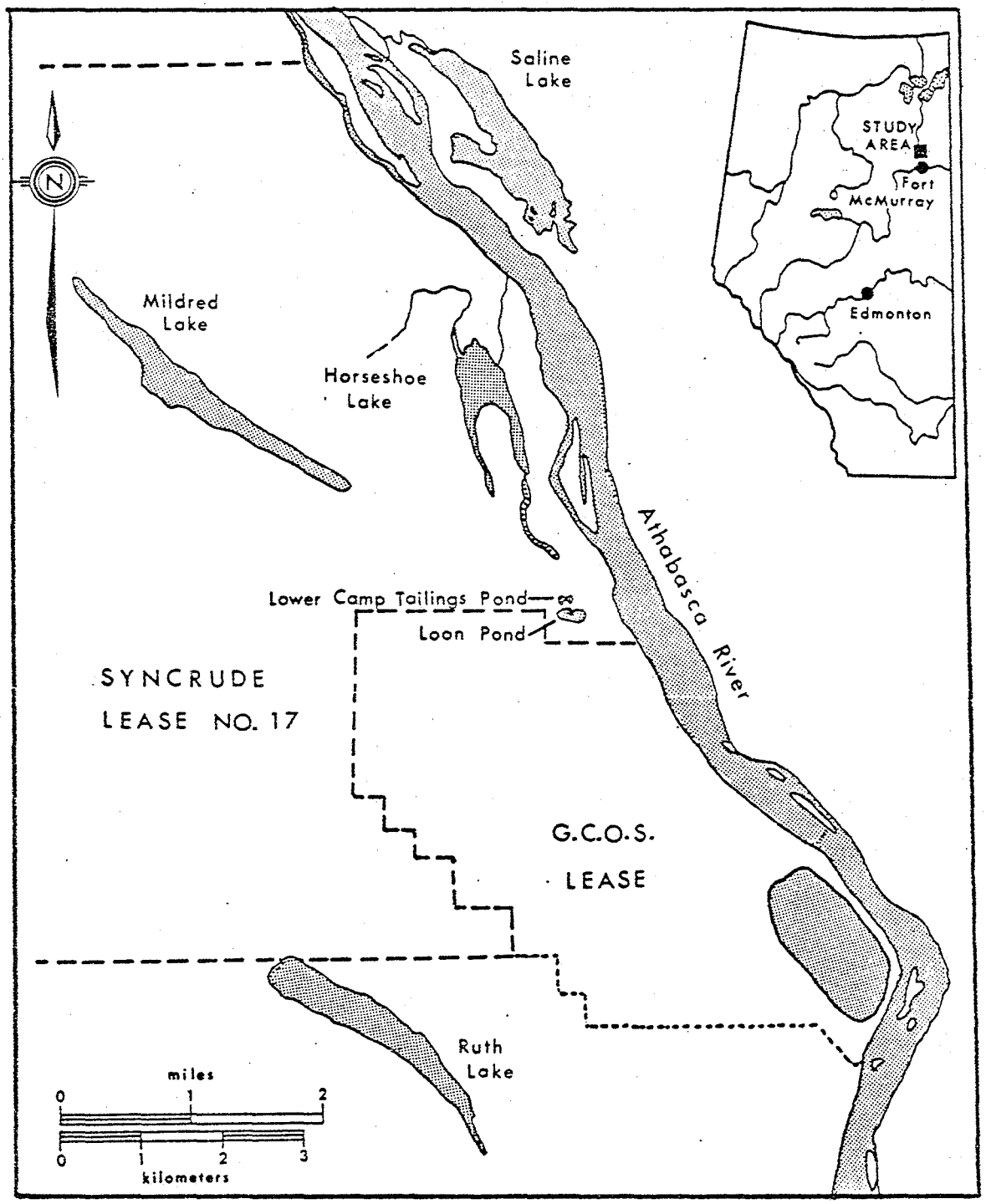

Figure 1. Map of the Syncrude Lease Area Showing the Location of the Lower Camp Tailings Pond and Adjacent Water Bodies.

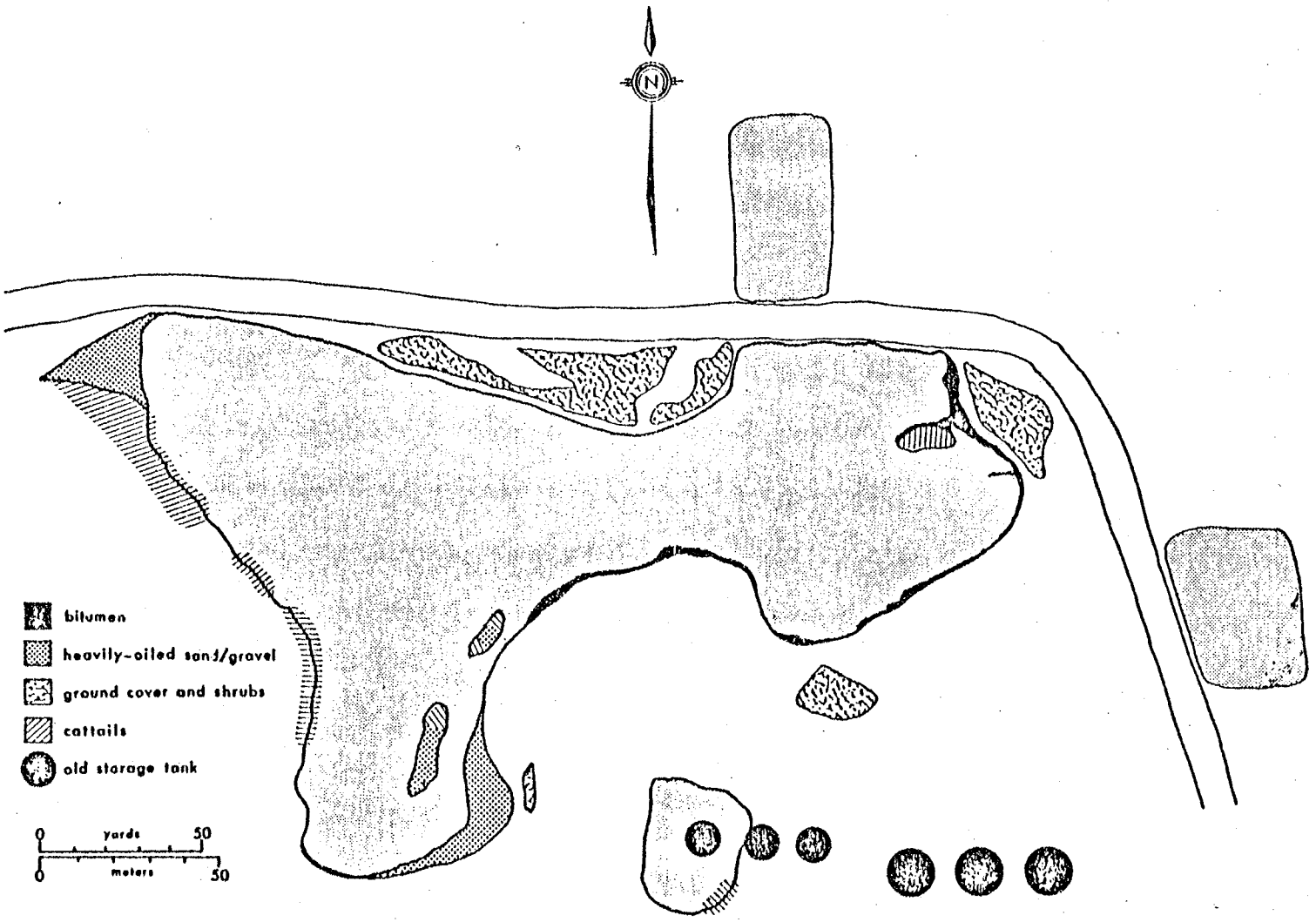

Figure 2. Map of the Study Area Showing the Lower Camp Tailings Pond with Vegetated and Heavily Oiled Portions of the Shore Indicated, the Two Dugouts, and the Small Pool of Water Near the Old Storage Tanks.

Loon Pond* (2.6 ha, 6.3 acres), which is located approximately 37 m (40 yds) south of the Lower Camp Tailings Pond (Figure 1), contains fresh and clear water and has less bare shoreline, has more emergent and submergent vegetation, and is exposed to less disturbance than the Lower Camp Tailings Pond.

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* This pond was referred to as the Lower Camp Pond by Sharp *et al* (1975). To avoid confusion in this report between the Lower Camp Pond and the Lower Camp Tailings Pond, the Lower Camp Pond has been called Loon Pond.

3. METHODS

3.1 Preliminary Investigation

On 6 and 7 August 1974, a preliminary investigation was conducted at the Lower Camp Tailings Pond in order to determine the experimental and logistic requirements of testing a deterrent at this site. On 6 August, an observer was stationed at point A (Figure 3) from 12:05 to 17:05 hours (control period); this observer recorded the number and species of all birds sighted flying near the pond, their time of appearance, the number that landed, their length of stay, and their behaviour. Also, this observer recorded the temperature, percentage of cloud cover, and wind speed and direction at hourly intervals or whenever these conditions markedly changed.

On the evening of 6 August, a deterrent that consisted of aluminum pie plates attached at 10-ft intervals to a nylon rope was erected at a height of 2.75-3.7 m (3-4 ft) over the pond (Figure 3). The pie plates were attached to the rope in a manner that permitted them to swing in the wind. On the following day during the entire daylight period (experimental period), an observer watched the pond from point A and recorded the same types of information that were recorded on 6 August. A blind was not used during either day of this preliminary investigation.

The methods of data processing, classification of data, and data analyses are included in the pertinent sub-sections that describe the methods used in the deterrent investigation.

3.2 Deterrent Investigation

3.2.1 Experimental Procedure

The observation periods of the deterrent investigation were conducted daily (except on 5, 6, 24, and 26 October) from 26 August to freeze-up on 30 October. During this time, control periods (deterrent absent) were alternated with experimental periods (deterrent present); periods of each

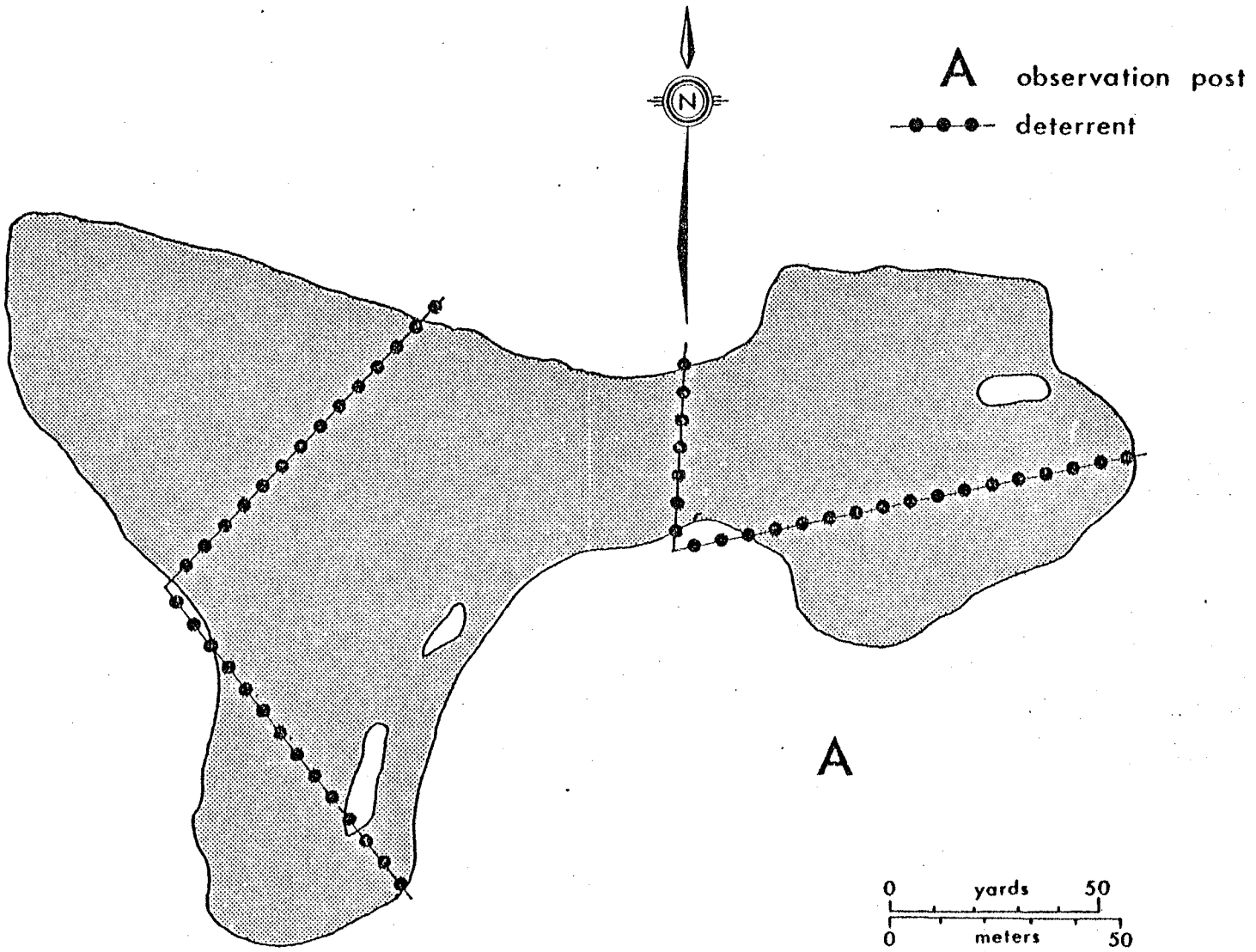

Figure 3. Lower Camp Tailings Pond Showing the Position of the Deterrent (Strings of Aluminum Pie Plates) on August 7, 1974 During the Preliminary Investigation.

type were three or four days in length (see Appendix 1 for schedule). The deterrent used during the experimental periods was the same as that used during the preliminary investigation. During the first two experimental periods in September (5 to 9 and 13 to 18), the deterrent was strung only around the periphery of the pond. During subsequent experimental periods, an additional two ropes, with plates attached, were strung across the pond (Figure 4).

From 26 to 29 August, observations were conducted throughout the daylight hours in order to determine the hours during which the largest number of birds would be sighted. As a result of these observations, subsequent observations were conducted from first light in the morning to 11:00 hours; after 2 September, observations were conducted for an additional one to one and one-half hours at dusk.

During the morning observation periods, two observers were stationed at point A (see Figure 3 or 4). One observer recorded specific information (as related to this study) about all birds sighted in the vicinity of the Lower Camp Tailings Pond; the second observer recorded migration information about all flying birds that he sighted from the blind. The data collected by the second observer is presented by Sharp *et al.* (1975). During the evening, one observer was stationed at point A.

From 2 September to 30 October, observations were conducted from a blind constructed at point A. Previous to this period, a blind was not used.

In order to permit a meaningful description of the locations and movements of birds that landed on this pond, the shoreline was measured (by pace) and marked with survey tape at 90-meter (100-yd) intervals.

Throughout the deterrent investigation, daily counts of birds present on Loon Pond between 08:00 and 08:30 hours were conducted by an observer who scanned the surface of the pond with binoculars.

3.2.2 Data Recorded

During the observation periods at the Lower Camp Tailings Pond, the following data were recorded hourly: number of observers, names of observers,

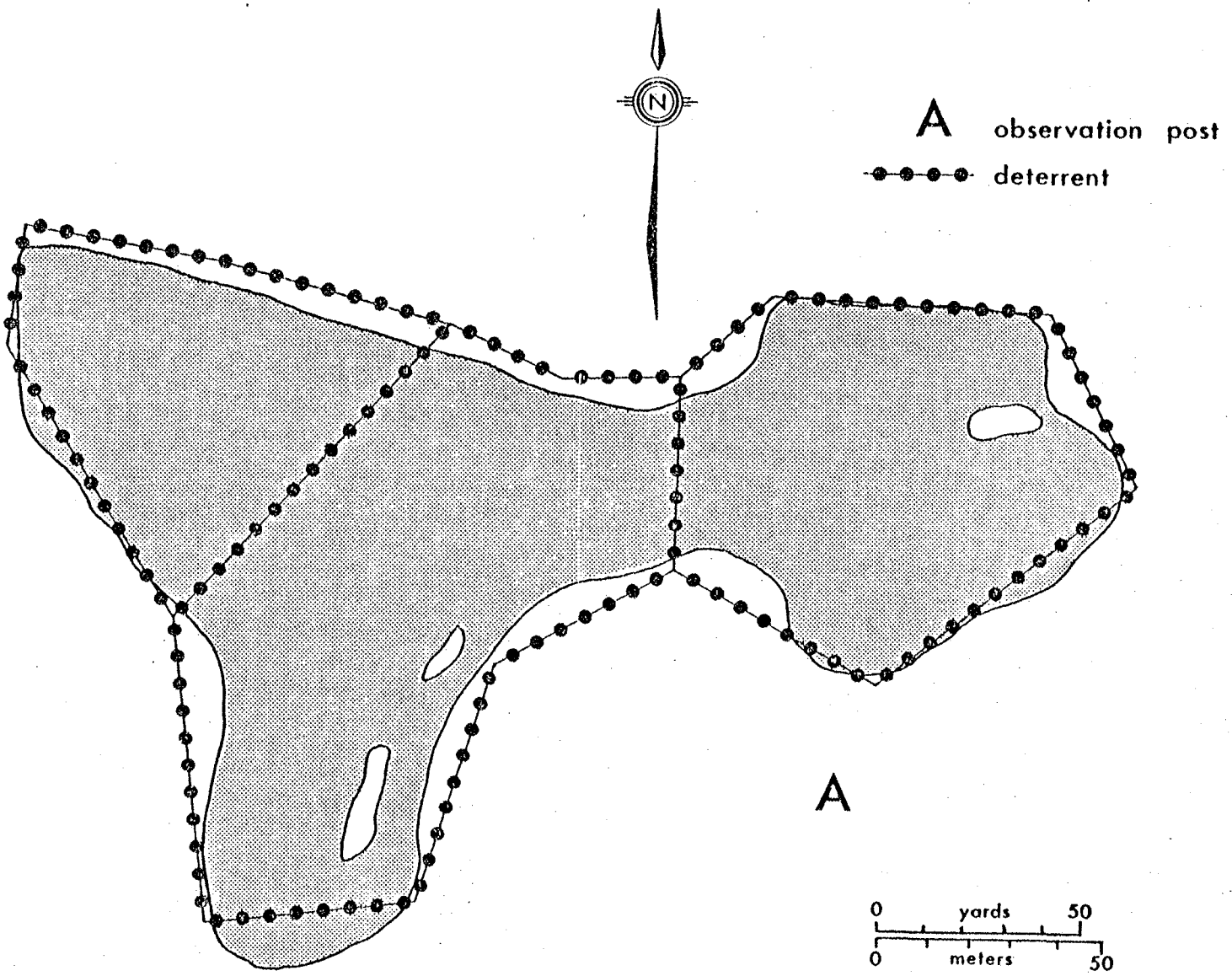

Figure 4. Lower Camp Tailings Pond Showing the Position of the Deterrent During the Deterrent Investigation. Only the Peripheral Strings of Reflectors Were in Place During the First Two Deterrent Experiments (5-9 and 13-18 September 1974).

experiment number, date, time, temperature, wind speed and direction, cloud cover, precipitation, snow cover, percentage of ice cover on the pond, percentage of pond surface covered by oil, percentage of shoreline covered by oil, wave height, and visibility. These data were also recorded when weather conditions changed markedly within an hour.

Because birds in a flock generally move and behave as a single unit, each flock sighted during this study has been treated as a single unit for the purposes of describing and analyzing the behaviour of birds in relation to the tailings pond. A single bird flying by itself was also treated as a single unit in such descriptions and analyses. In cases where a flock or an individual bird joined another, or where a flock split during the observation, each flock or individual was recorded as separate to the point of association or after the time of separation. For the purposes of this report, the term *flock* is used to refer to a unit which may be a single bird that was flying by itself or to a group of two or more birds that were flying together.

The following data (when applicable) on flocks of birds flying over the area were recorded: species or species group (if specific identification not possible), total number seen in each flock, number of adult males and of adult females identified, time when first sighted, behaviour when first sighted, altitude when first seen, direction of flight when first seen, behaviour and height at closest approach, distance from pond at closest approach, time spent landed, behaviour while landed, extent of oiling, location on the pond, and habitat in which landed.

If the bird(s) moved while on the pond or its shore, the following data were recorded: location, habitat, time spent in each location, behaviour, and extent of oiling.

If a bird became trapped in the bitumen, the following data were recorded: time when trapped, behaviour, how trapped, extent of oiling, ability to move, and length of time the bird was visible.

If the bird(s) left the area, the following data were recorded: time of departure, behaviour, and direction of departure.

3.2.3 Data Processing

Observational data were recorded in field notebooks at the pond site. Data were subsequently coded numerically on data sheets; after the coded data were checked, they were key-punched and key-verified on computer cards. A computer validation program was used to detect recognizable key-punching or coding errors that had been overlooked. Following error correction, computer programs were used to generate summary tables from the data.

3.2.4 Classification of Data

Flocks of birds that were observed during the preliminary investigation and the deterrent investigation were placed into one of the following three behaviour categories:

1) flocks that flew directly by the pond and that did not conspicuously alter their flight path or altitude;
2) flocks that landed on the pond or its shoreline; and
3) flocks that did not land but that, while flying past the pond, altered their flight patch or altitude in one of the following ways:
   a) approached and circled the pond and then flew away,
   b) approached the pond and then flared (i.e., the birds in the flock suddenly reoriented their bodies from horizontal to near vertical positions and simultaneously slowed their forward motion,
   c) approached the pond and then increased altitude (regarded as less extreme form of flaring),
   d) approached the pond and then changed direction (usually to the right or left of the original line of flight),
   e) approached the pond and then reversed direction (regarded as an extreme form of the above-described action), and
   f) approached the pond and then broke formation (i.e., disruptions that ranged from small dispersals within the flock to a complete scattering of the flock in different directions).

Any of the above six actions were considered to constitute an *avoidance response*, a term that is used throughout the remainder of the report.

For the purposes of this report, one- or two-word names are used to refer to species or species groups likely to occur in the study area (see Appendix 2, 3, and 4 for complete listing of species or species groups sighted). These names and the species or species groups that each refers to are as follows:

1) large waterbirds: loons, grebes, swans, geese, ducks, cranes, and coots;
2) 'peep' sandpiper species: White-rumped Sandpiper (*Calidris fuscicollis*), Baird's Sandpiper (*C. bairdii*), Least Sandpiper (*C. minutilla*), Semipalmated Sandpiper (*C. pusilla*), and Western Sandpiper (*C. mauri*);
3) charadriiforms: shorebirds (includes 'peep' sandpiper species), gulls, and terns, (these birds are members of the order Charadriiformes);
4) open-country nesters: Water Pipit (*Anthus spinoletta*), Lapland Longspur (*Calcarius lapponicus*), Horned Lark (*Eremophila alpestris*), Savannah Sparrow (*Passerculus sandwichensis*), Snow Bunting (*Plectrophenax nivalis*), Hoary Redpoll (*Acanthis hornemanni*), and Common Redpoll (*Acanthis flammea*);
5) blackbirds: Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*), Red-winged Blackbird (*Agelaius phoeniceus*), Rusty Blackbird (*Euphagus carolinus*), Brewer's Blackbird (*E. cyanocephalus*), Common Grackle (*Quiscalus quiscula*), Brown-headed Cowbird (*Molothrus ater*);
6) passerines: small or medium-sized perching birds that are members of the order Passeriformes (also includes open-country nesters and blackbirds but does not include Common Raven [*Corvus corax*] or Common Crow [*Corvus brachyrhynchos*]).

3.2.5 Data Analyses

Data gathered during the preliminary investigation (6 and 7 August) and during periods 1 and 2 (26 to 29 August and 30 August to 1 September, respectively) of the deterrent investigation were treated separately from each other and from data gathered during the remainder of the study. As mentioned previously, no blind was used during these early parts of the study; consequently, the extent to which the observer was conspicuous to birds possibly caused the data gathered during these parts to differ from data gathered during periods 3 through 17 when the observer was hidden in a blind.

Periods 3 through 16 of the deterrent investigation have been treated as a sequence of seven individual experiments; each experiment consisted of a control period followed by an experimental period (schedule in Appendix 1). Period 17 has been excluded from the analyses because the Lower Camp Tailings Pond was frozen during this period.

Data gathered during the control and experimental periods were compared according to four criteria:

1) behaviour of flocks that flew in the vicinity of the pond (e.g., landed or did not land)*;
2) distance at closest approach;
3) height at closest approach; and
4) length of time landed.

It is possible that observers were unable to detect avoidance responses of flocks of large waterbirds at extreme distances from the pond; therefore, it is also possible that a comparison of proportions of flocks of large waterbirds that showed avoidance responses during control and experimental periods would have been biased had the above-mentioned possibility not been taken into account. In order to determine the maximum distance beyond which flocks of large waterbirds should not be in-

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*In the cases of large waterbirds which seldom landed, it was necessary to base comparisons on the proportions of flocks with birds that showed avoidance responses as they approached the pond.

cluded in such a comparison, a frequency distribution was constructed that showed, relative to the distance at closest approach and for each species or species group of large waterbirds, the numbers of flocks containing birds that showed an avoidance response.

Tests for statistical significance of differences in proportions between control and experimental periods were conducted through use of Fisher's exact test for independence between samples (Sokal and Rohlf 1969:593). Fisher's exact test is designed for a somewhat different experimental design than the one in this study, but because of the small sample sizes obtained in this study, it was used in preference to the Chi-square test (see Sokal and Rohlf 1969:589). In practice, Fisher's exact test provides acceptable results, even when applied to the experimental design used in this study (Sokal and Rohlf 1969:589). For all these analyses, the probabilities were calculated separately for each tail of the test and were then summed to produce the two-tailed probability.

The Mann-Whitney U-test (two-tailed)(Siegel 1965) was used to test for differences in distances at closest approach and heights at closest approach during control and experimental periods.

Probabilities (P) equal to or less than 0.05 were considered to be statistically significant.

4. RESULTS

4.1 Preliminary Investigation

Appendix 3 shows the number of individuals and flocks of each species* or species group seen in the immediate area of the Lower Camp Tailings Pond during the control period conducted on 6 August and the experimental period conducted on 7 August.

No flocks of large waterbirds were sighted during the control period on 6 August. Four flocks of large waterbirds (Common Loon, Mallard, goldeneye spp., and unidentified duck spp.) were sighted during the experimental period on 7 August; none of these flocks landed, but the flock of goldeneye spp. showed an avoidance response.

Flocks of shorebirds constituted 67 of the 75 flocks observed during these two days. During the control on 6 August, six (67%) of nine shorebird flocks landed. During the experimental period on 7 August, 18 (31%) of 58 flocks landed. The difference between the proportions of shorebird flocks observed to land during the experimental and control periods was close to being statistically significant (Fisher's exact test, $P = 0.06$).

Of the 67 shorebird flocks sighted on these two days, 34 consisted of 'peep' sandpiper species; this was the only species group (or species) of shorebird observed often enough during both the experimental and the control period to permit a statistical test of differences at the species or species group level. During the control period, five (71%) of seven flocks of this species group landed; during the experimental period, six (22%) of 21 flocks of this species group landed. The difference between the proportions of flocks that landed during the control and experimental periods was statistically significant (Fisher's exact test, $P = 0.05$).

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*The scientific names of all species sighted during the study are listed in Appendix 2.

4.2 Deterrent Investigation

4.2.1 Numbers of Birds Observed in Relation to Dates of Observation

Appendix 4 shows the number of individuals of each species or species group observed during each day of the study. Figures 5, 6, and 7 show (respectively) the average numbers per three-day periods of large waterbirds, charadriiforms, and passerines observed during the deterrent investigation.

The migration of geese through the study area occurred during late August and September (Figure 5). This migration reached a conspicuous peak in early September; during the remainder of the study low numbers of geese were observed. No geese were observed during October. The numbers of other large waterbirds that were observed flying in the study area and which consisted almost entirely of ducks (see Appendix 3) remained relatively constant throughout late August, September and the first half of October--except for the marked peak that occurred in late September. This peak coincided with a short period of freezing temperatures that subsequently moderated. By late October few ducks were observed in the study area.

When the deterrent investigation began in late August, the numbers of charadriiforms (shorebirds and gulls) observed flying in the study area (Figure 6) already appeared to have been declining. The numbers of shorebirds continued to decline until mid-September, after which only a few stragglers were observed. The majority of gulls had left the study area by the end of August, and by the end of September none were observed in this area.

The autumn migration of passerines through the study area was in progress when the deterrent investigation began. Two general peaks of occurrence were apparent: one in mid-September and another in mid-October (Figure 7). A decline in the numbers of passerines observed between late September and early October occurred during a period of low temperatures, when some of the waterbodies in the area were partially or entirely frozen. Blackbirds were most numerous during mid-September; nearly all of these

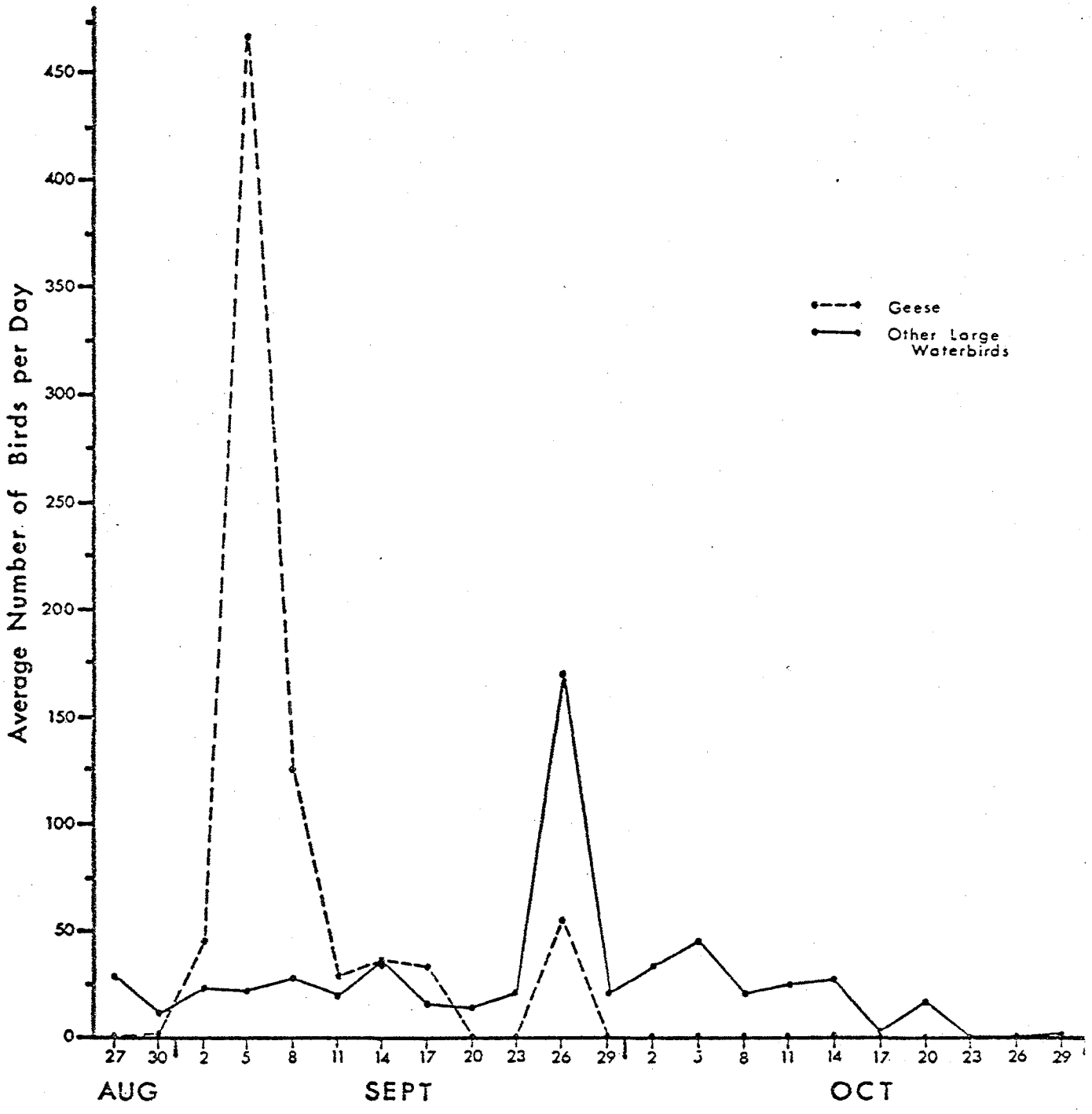

Figure 5. Average Numbers of Large Waterbirds Observed Per Three-Day Periods During the Deterrent Investigation.

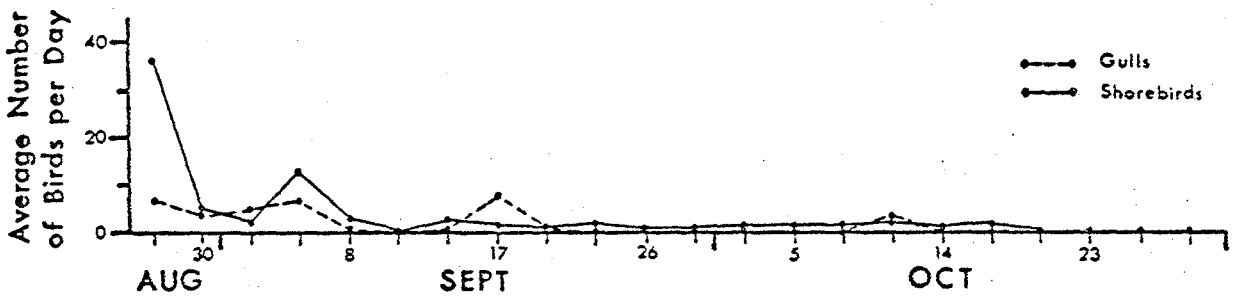

Figure 6. Average Numbers of Charadriiforms Observed Per Three-Day Periods During the Deterrent Investigation.

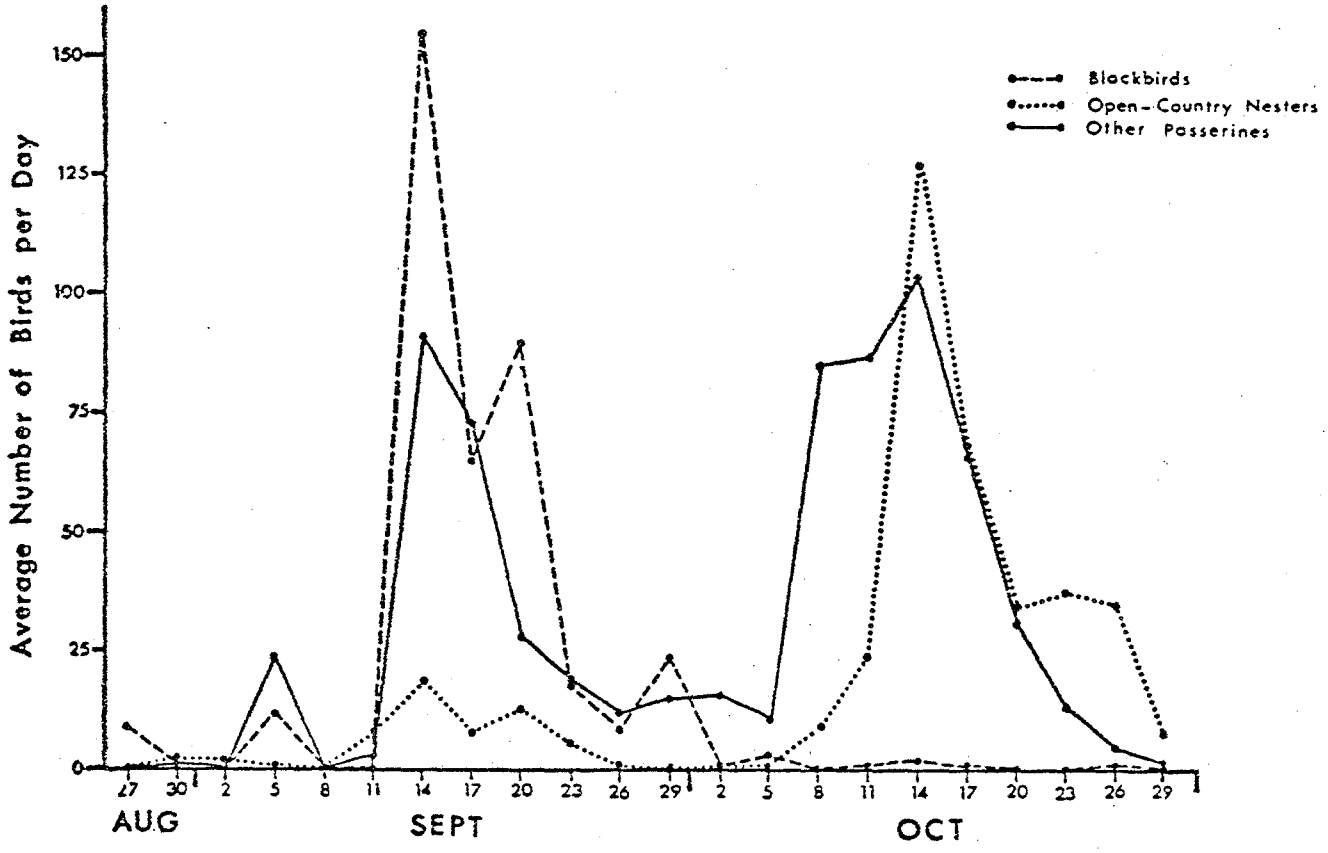

Figure 7. Average Numbers of Passerines Observed Per Three-Day Periods During the Deterrent Investigation.

birds had left the area by the end of this month. The numbers of open-country nesters observed in the study area formed two peaks; the first peak was comprised mainly of Water Pipits and Lapland Longspurs and the second almost entirely of Snow Buntings and redpolls. Other passerines (Figure 7) consisted, to a large extent, of birds that could only be identified to the passerine species level (see Appendix 4).

4.3 Comparisons of Data Gathered During Control and Experimental Periods

4.3.1 Avoidance Responses and Landing

Table 1 shows, for each species or species group of large waterbirds, the numbers of flocks that did and that did not show avoidance responses and the distances of these flocks from the Lower Camp Tailing Pond at the points of their closest approaches to this pond. With the exception of one flock of ducks that changed direction when 400 yds (365 m) away from the pond, flocks of large waterbirds that showed an avoidance response were always within 320 yds (292 m) of the tailings pond at their closest approach. It was therefore decided that only flocks of large waterbirds that approached to within 320 yds of the pond should be considered in the comparisons of the proportions of flocks that showed avoidance responses during control periods with the proportions that showed such responses during experimental periods.

During periods 1 and 2 (both control periods) of the deterrent investigation when a blind was not used by the observers, none of the 45 flocks of large waterbirds (all ducks) that were observed, landed at the Lower Camp Tailings Pond, and only one of these flocks (diving duck spp.) showed an avoidance response (Appendix 5a). During these same two periods, 28 (49%) of the 57 flocks of shorebirds that were observed, landed at the tailings pond (Appendix 5b).

During periods 3 through 16 (experiments one through seven), no flocks of geese or swans landed at the tailings pond. The proportion of flocks of geese and swans that showed avoidance responses during all control periods combined (17%) was lower than the proportion of such flocks

TABLE 1. Frequency Distribution with Respect to Distance of Closest Approach of Flocks of Large Waterbirds That Showed an Avoidance Response (R) and That Did Not Show an Avoidance Response (NR) as They Approached the Lower Camp Tailings Pond (26 August - 28 October 1974).

SPECIES/GROUP	BEHAVIOUR	TOTAL FLOCKS	DISTANCE (20 YARD INTERVALS) OF CLOSEST APPROACH																												
			0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-179	180-199	200-219	220-239	240-259	260-279	280-299	300-319	320-339	340-359	360-379	380-399	400-419	420-439	440-459	460-479	480-499	500-1000
Whistling Swan	R	0																													
	NR	4					1						1					1												1	
Canada Goose	R	1											1																		
	NR	22		2			1	1	1	2	1		1					1					1							11	
White-fronted Goose	R	2								1								1													
	NR	2				1		1																							
Snow Goose	R	1		1																											
	NR	0																													
Ross' Goose	R	0																													
	NR	1								1																					
Canada & White-fronted Goose	R	1							1																						
	NR	1							1																						
Mallard	R	4	1	2		1																									
	NR	16	8	2	2		1			1			1										1								
Pintail	R	1		1																											
	NR	5	1	3	1																										
Green-winged Teal	R	1	1																												
	NR	0																													
Blue-winged Teal	R	0																													
	NR	1		1																											
Teal species	R	0																													
	NR	2	1	1																											
Dabbling Duck species	R	4	1	1	1													1													
	NR	21	4	12	3					1				1																	
Common Goldeneye	R	0																													
	NR	1	1																												
Bufflehead	R	0																													
	NR	1		1																											
Ruddy Duck	R	0																													
	NR	1		1																											
Scaup species	R	2	1	1																											
	NR	6	4	2																											
Goldeneye species	R	0																													
	NR	1			1																										
Diving duck species	R	4	1	1	1								1																		
	NR	15	2	8	5																										
Duck species	R	30	9	11	4	2		3															1								
	NR	165	18	46	16	11	2			6	1		7	1	2			10		3	1		8		2			31		
American Coot	R	0																													
	NR	1		1																											

that showed avoidance responses during all experimental periods combined (33%; Table 2). The difference between these proportions was not statistically significant (Fisher's exact test, $P = 0.61$).

On three separate occasions during periods 3 to 16, a single duck landed at the tailings pond. The proportion of flocks of ducks that showed avoidance responses during each experimental period was consistently higher than the proportion of flocks of ducks that showed such reactions during each of the corresponding control periods (Table 2). Of these experiments only the difference between the proportions of the fifth experiment was statistically significant (Fisher's exact test, $P = 0.01$). When the pertinent probabilities from the seven experiments were combined, the result was not statistically significant ($0.1 > P > 0.05$).

The number of flocks of charadriiforms observed during each of the seven experiments was generally too small to permit meaningful comparisons (Table 3). The proportion of flocks of shorebirds that landed at the tailings pond during all control periods combined (24%) was higher than the proporition of such flocks that landed during all the experimental periods combined (11%). The difference between these proportions, however, was not statistically significant (Fisher's exact test, $P = 0.39$). Of the 20 flocks of gulls that were observed during the seven experiments of the deterrent investigation, only one landed (during an experimental period) at the Lower Camp Tailings Pond.

Of the flocks of open-country nesters that were observed during each period of each experiment, a higher proportion landed at the tailings pond during the control periods than during the corresponding experimental periods, with the exception of experiment 5; during that experiment, a higher proportion of flocks of open-country nesters landed during the experimental period than during the control period (Table 4). Statistically, the difference between the proportions of flocks of open-country nesters that landed during the control and experimental periods of the seventh experiment was highly significant (Fisher's exact test, $P = 0.01$); the difference between the proportions of such flocks that landed during the control and experimental periods of the other experiments was not

Table 2. Numbers of Flocks of Large Waterbirds That Did and Did Not Show Avoidance Responses During the Control and Experimental Periods of Each Experiment of the Deterrent Investigation (2 September-28 October 1974).

EXPERIMENT NUMBER	CONTROL PERIOD			EXPERIMENTAL PERIOD			FISHER'S EXACT TEST (TWO-TAILED) PROBABILITY
	TOTAL FLOCKS	NUMBER OF FLOCKS		TOTAL FLOCKS	NUMBER OF FLOCKS		
		AVOIDANCE RESPONSE	NO AVOIDANCE RESPONSE		AVOIDANCE RESPONSE	NO AVOIDANCE RESPONSE	
GEESE AND SWANS							
1	5	0	5	5	3	2	.17
2	2	0	2	3	0	3	†
3	1	0	1	1	0	1	†
4	4	2	2	0			†
5	0			0			†
6	0			0			†
7	0			0			†
Totals	12	2	10	9	3	6	P = 0.61††
DUCKS							
1	14	1	13	29	5	24	.65
2	18	2	16	23	8	15	.14
3	17	0	17	11	2	9	.15
4	27	10	17	13	5	8	1.00
5	18	0	18	11	4	7	.01
6	7	0	7	7	3	4	.19
7	5	1	4	1	1	0	.33
Totals	106	14	92	95	28	67	0.1 > P > 0.05†††

† Sample sizes of individual experiment too small for statistical testing.
†† Probability calculated by applying Fisher's exact test to totals obtained by summing all the experiments.
††† Probability obtained by combining probabilities of individual experiments through the method described by Sokal & Rohlf (1969:621).

TABLE 3. Numbers of Flocks of Charadriiforms Landing and Not Landing During the Control and Experimental Periods of Each Experiment of the Deterrent Investigation (2 September-28 October 1974).

EXPERIMENT NUMBER	CONTROL PERIOD			EXPERIMENTAL PERIOD			FISHER'S EXACT TEST (TWO-TAILED) PROBABILITY
	TOTAL FLOCKS	NUMBER OF FLOCKS		TOTAL FLOCKS	NUMBER OF FLOCKS		
		LANDING	NOT LANDING		LANDING	NOT LANDING	
SHOREBIRDS							
1	4	0	4	11	2	9	1.00
2	3	2	1	8	3	5	0.55
3	5	1	4	1	0	1	1.00
4	5	0	5	1	0	1	†
5	3	3	0	1	0	1	1.00
6	1	0	1	1	0	1	†
7	1	0	1	1	0	1	†
Totals	22	6	16	24	5	19	P = .39††
GULLS							
1	6	0	6	3	0	3	†
2	1	0	1	5	1	4	1.00
3	2	0	2	0			†
4	1	0	1	1	0	1	†
5	1	0	1	0			†
6	0			0			†
7	0			0			†
Totals	11	0	11	9	1	8	P = 0.57††

† Sample sizes of individual experiments too small for statistical testing.
†† Same as Table 2.

Table 4. Numbers of Flocks of Passerines Landing and Not Landing During the Control and Experimental Periods of Each Experiment of the Deterrent Investigation (2 September-28 October 1974).

EXPERIMENT NUMBER	CONTROL PERIOD			EXPERIMENTAL PERIOD			FISHER'S EXACT TEST (TWO-TAILED) PROBABILITY
	TOTAL FLOCKS	NUMBER OF FLOCKS		TOTAL FLOCKS	NUMBER OF FLOCKS		
		LANDING	NOT LANDING		LANDING	NOT LANDING	
OPEN-COUNTRY NESTERS							
1	3	1	2	0			†
2	15	4	11	35	6	29	.70
3	15	2	13	7	0	7	.55
4	2	0	2	5	0	5	†
5	4	0	4	19	4	15	.56
6	18	3	15	11	0	11	.27
7	19	9	10	28	3	25	.01
Totals	76	19	57	105	13	92	0.2 > P > 0.1†††
OTHER PASSERINES							
1	7	2	5	1	0	1	1.00
2	14	1	13	181	12	169	1.00
3	58	5	53	21	0	21	.32
4	38	2	36	35	1	34	1.00
5	31	1	30	33	3	30	.61
6	34	2	32	25	0	25	.50
7	37	1	36	28	5	23	.08
Totals	219	14	205	324	21	303	0.5 > P > 0.3†††

† Sample sizes of individual experiments too small for statistical testing.
††† Same as Table 2.

significant (Fisher's exact test, $P > 0.05$). When the pertinent probabilities from the seven experiments were combined, the result was not statistically significant ($P > 0.1$).

During the first, third, fourth and sixth experiments, the proportions of flocks of other passerines (Table 4) that landed at the tailings pond during control periods were higher than the proportions that landed during the corresponding experimental periods; in the other three experiments, opposite differences were found. None of the differences between these proportions were statistically significant; nor was the pertinent combined probability statistically significant.

4.3.2 Distance from and Altitude above the Pond at Closest Approach

Tables 5 to 7 show the average distances from and altitudes above the pond of flocks of large waterbirds, charadriiforms, and passerines (respectively) at their closest approaches to the pond during the control and experimental periods of each experiment. Statistically, these distances and altitudes did not differ significantly during control and experimental periods (two-tailed Mann-Whitney U-test) except for Common Raven. For this species the distance of closest approach during experimental periods was significantly greater statistically than that during control periods ($P = 0.005$).

4.3.3 Length of Time Landed

The lengths of time that shorebirds, open-country nesters, and blackbirds spent on the Lower Camp Tailings Pond or its shore after landing are shown in Appendix 6. During periods one and two, shorebirds spent an average of 6.3 min landed for each of 21 such sightings; during the control periods they spent an average of 2.5 min landed for each of five sightings; during experimental periods they spent an average of 6.1 min landed for each of four sightings.

During the control periods open-country nesters spent an average of 2.3 min landed for each of 10 sightings and during the experimental periods they spent an average of 1.6 min landed for each of five sightings. There

Table 5. Average Distance and Height of Closest Approach of Large Waterbirds During the Control and Experimental Periods of Each Experiment of the Deterrent Investigation (2 September-28 October 1974).

EXPERIMENT NUMBER	CONTROL PERIOD			EXPERIMENTAL PERIOD		
	TOTAL FLOCKS	CLOSEST APPROACH		TOTAL FLOCKS	CLOSEST APPROACH	
		AVERAGE DISTANCE (YD)	AVERAGE HEIGHT (FT)		AVERAGE DISTANCE (YD)	AVERAGE HEIGHT (FT)
GEESE AND SWANS						
1	15	767	763	15	887	270
2	5	614	214	2	89	240
3	1	133	400	1	67	200
4	6	389	317	0	-	-
5	0	-	-	0	-	-
6	0	-	-	0	-	-
7	0	-	-	0	-	-
Weighted mean		631	549		753	263
OTHER LARGE WATERBIRDS						
1	21	229	80	31	49	80
2	22	151	107	32	256	118
3	18	105	127	11	53	104
4	37	161	106	20	210	100
5	15	100	108	13	120	83
6	8	111	66	7	27	70
7	5	31	82	1	50	150
Weighted mean		147	107		142	97

Table 6. Average Distance and Height of Closest Approach of Charadriiforms During the Control and Experimental Periods of Each Experiment of the Deterrent Investigation (2 September-28 October 1974).

EXPERIMENT NUMBER	CONTROL PERIOD			EXPERIMENTAL PERIOD		
	TOTAL FLOCKS	CLOSEST APPROACH		TOTAL FLOCKS	CLOSEST APPROACH	
		AVERAGE DISTANCE (YD)	AVERAGE HEIGHT (FT)		AVERAGE DISTANCE (YD)	AVERAGE HEIGHT (FT)
SHOREBIRDS						
1	4	63	14	6	33	65
2	1	100	5	3	25	49
3	3	39	57	1	10	30
4	4	13	40	1	5	40
5	0	-	-	1	13	40
6	1	20	60	1	25	70
7	1	20	60	1	13	40
Weighted mean		40	37		24	54
GULLS						
1	9	244	157	3	36	98
2	1	100	300	5	38	113
3	1	80	100	0	-	-
4	2	192	150	1	80	150
5	1	100	200	0	-	-
6	0	-	-	0	-	-
7	0	-	-	0	-	-
Weighted mean		204	165		42	112

Table 7. Average Distance and Height of Closest Approach of Passerines During the Control and Experimental Periods of Each Experiment of the Deterrent Investigation (2 September-28 October 1974).

EXPERIMENT NUMBER	CONTROL PERIOD			EXPERIMENTAL PERIOD		
	TOTAL FLOCKS	CLOSEST APPROACH		TOTAL FLOCKS	CLOSEST APPROACH	
		AVERAGE DISTANCE (YD)	AVERAGE HEIGHT (FT)		AVERAGE DISTANCE (YD)	AVERAGE HEIGHT (FT)
COMMON RAVENS						
1	0	-	-	0	-	-
2	0	-	-	0	-	-
3	2	13	50	3	41	123
4	2	33	100	9	40	98
5	1	33	100	8	45	115
6	7	29	85	7	34	102
7	19	23	56	18	60	94
Weighted mean		29	66		48	102
BLACKBIRDS						
1	1	30	80	0	-	-
2	2	64	65	27	73	77
3	15	76	60	1	50	150
4	16	216	90	3	193	77
5	1	17	50	2	100	75
6	0	-	-	2	49	73
7	1	120	40	0	-	-
Weighted mean		136	73		83	79
OTHER PASSERINES						
1	6	123	53	1	30	25
2	19	34	51	158	47	65
3	47	48	75	20	23	66
4	19	93	93	21	42	44
5	21	40	91	32	36	55
6	30	48	78	22	52	89
7	24	24	61	17	27	69
Weighted mean		50	74		43	64

were only three such sightings for blackbirds and these were in an experimental period. These birds were landed an average of only 0.9 min for each sighting.

4.4 Birds that Landed at the Lower Camp Tailings Pond

Appendix 5 gives the details of the timing, location, and extent of oiling of the water-associated birds that were observed to land at the Lower Camp Tailings Pond during the deterrent investigation.

On three separate occasions, individual ducks were observed to land on the pond and then fly away, apparently without having picked up any bitumen (Appendix 6). These birds were observed to stay on this pond for 10 sec, 90 sec, and 67 min (respectively).

In addition to the three above-mentioned ducks, three Lesser Scaup were observed swimming in the Lower Camp Tailings Pond at daybreak of 8 October. These birds, which had landed sometime after sunset the previous night, were extensively covered with bitumen and were observed to make unsuccessful attempts to fly and to dive. They were observed to preen their breast feathers, both while swimming and while standing in cattail clumps on the shore and on islands. Later in the day, they had tired considerably and made few attempts to dive or fly. These scaup were killed when they came on the shore, and an external post-mortem examination of these birds showed that their contour feathers were saturated with bitumen but that their down feathers were still clean and dry.

On 8 October, an American Coot was observed to fly low over the tailings pond, to land on the ice of a small pool near one of the storage tanks (location shown in Figure 2), and to stand in shallow water and preen its feathers for over an hour. The legs, wings, and undertail coverts of this bird were heavily covered with bitumen, and lumps of bitumen hung from its abdomen. The coot was not present two hours later; its departure from the pond was not observed.

In addition to the ducks observed during the deterrent investigation, two live ducks (a Mallard and a Green-winged Teal) that were extensively covered with bitumen and the bitumen-covered remains of approximately 25

birds were found around the shore of the Lower Camp Tailings Pond on 6 August. The two live ducks were in a weak condition and died later. The remains of the other birds varied in condition from bitumen-covered bones to bitumen-covered carcasses in early stages of decomposition. Sixteen of the carcasses were identified as follows: one dabbling duck species, one Bufflehead, six duck species, one yellowlegs species, one plover species, one 'peep' sandpiper species, one shorebird species, and two passerine species. The other remains were not identified to species or group level.

Shorebirds that landed on floating mats of bitumen generally picked up some bitumen. The extent of observed oiling varied from on the feet only to on feet and legs and depended on the length of time landed. Shorebirds that landed on the bitumen-covered portions of the shoreline picked up bitumen on their feet. In no instances did the shorebirds display a detectable response (e.g., preening) to the bitumen on their feet or legs, and their flying ability did not appear to be impaired.

Of the 24 flocks of passerines that were observed to land on the shore of the pond or in the cattails around its edge, one flock of Water Pipits contained birds that picked up bitumen on their feet. Most of the open-country nesters that landed along the shore were observed feeding here; it could not be determined whether they ingested any bitumen-covered items during their feeding.

4.5 Birds on Loon Pond

The results of daily counts of the water-associated birds seen on Loon Pond are given in Appendix 8. Diving ducks and coots were the most frequently observed birds on Loon Pond and were most abundant in the first two weeks of October. No shorebirds were seen on Loon Pond during these counts. The 'Others' group in Appendix 6 included passerine species and Belted Kingfishers, which were occasionally sighted; birds of the latter mentioned species belong to the order Coraciiformes.

5. DISCUSSION

5.1 Effectiveness of the Tested Reflector Device

Deterrent techniques similar to the technique tested during this study have been used in different situations with differing results. Zwicky (1965, cited by Brown 1974) strung lines with lengths of aluminum foil attached across a vineyard and moved the lines back and forth by means of a pulley system and a small motor. This technique gave almost complete protection to the vineyard. Brown (1974) employed the same technique in a vineyard in the Niagara Peninsula, Ontario; however, he found little difference between the extents to which American Robins and Starlings damaged the vineyard during control and experimental periods.

Hochbaum *et al.* (1954) tested a deterrent system in unharvested grain fields in Manitoba. This system consisted of brightly coloured mesh bags filled with straw and swung from angled poles and of metal stripping or some other metal "flasher" added to the top of each pole. These authors reported that this system prevented ducks from feeding in these fields. Schweinsburg (pers. comm.) reported that tinfoil pie plates attached by ropes to posts in a section of Chesapeake Bay deterred Whistling Swans from landing in this section.

During this study, it was not possible to determine the usefulness of the tested reflector technique as a deterrent to ducks and geese because few of these birds were observed to land at the Lower Camp Tailings Pond. Comparisons between the proportions of flocks of ducks and geese that showed avoidance responses as they approached the pond during control and experimental periods indicated that a greater proportion of flocks showed avoidance responses during experimental periods. However, only during the fifth experiment was the difference between these proportions statistically significant. Without further pertinent data, the functional value of the reflector device as a deterrent intended to discourage ducks and geese from landing on a waterbody cannot be reliably assessed.

The results of this study indicate that the tested technique was only partially effective in deterring shorebirds from landing at the Lower Camp Tailings Pond. During the deterrent investigation, the proportions of shorebird flocks that landed at this pond during experimental periods was lower than the proportions that landed during corresponding control periods; the differences between these proportions, however, were not statistically significant. During the preliminary investigation, the proportion of flocks of 'peep' sandpiper species that landed at the pond during the experimental period was significantly lower statistically than the proportion that landed during the control period. The difference, however, between the proportions of flocks of all shorebird species that landed at the pond during the control and the experimental periods of the preliminary investigation was only of marginal statistical significance ($P = 0.06$).

The deterring effect of the tested reflector device on flocks of passerines was very weak. With the exception of the fourth and fifth experiment, the proportion of flocks of open-country nesters that landed during the control period of each experiment was larger than the proportion of flocks of such birds that landed during the corresponding experimental period. Only the difference in the seventh experiment was statistically significant. The results indicate that the device had no deterring effect on other passerines.

The results of this study did not indicate that the deterrent device caused birds to fly higher or at a greater distance (except for Common Ravens) from the Lower Camp Tailings Pond while they were in the study area. The average distances from the pond and the average altitudes of flocks at their closest approaches to the pond were not consistently larger or higher during experimental periods than during control periods. In some instances, birds appeared to approach the pond more closely during experimental periods than during control periods. Boudreau (1972) and Yakobi (1971) have pointed out the tendency of birds to fly toward unfamiliar objects or sounds; the above-mentioned behaviour of birds during this study may have been similar in nature to the behaviour these authors have described.

On the basis of the results pertinent to shorebirds and passerines, it is concluded that the tested reflector device would not itself constitute an adequate deterrent system for use on the proposed Mildred Lake Tailings Pond. This is not, however, to conclude that reflectors should not be incorporated into a more comprehensive deterrent system. Further experimentation with reflectors on a waterbody known to be attractive to large waterbirds would permit determination of whether reflectors deter these birds from landing on this pond.

An important limitation of reflector devices is their inability to function effectively during the night. For instance, the three Lesser Scaup that were found covered with bitumen on the morning of 8 October had landed on the Lower Camp Tailings Pond during the night. Moreover, Harrison (1967, reported in Nelson-Smith 1972) discusses evidence that birds are more likely to contact oil-contaminated water during the night than during the day. If reflectors were to prove to be effective in preventing ducks and geese from landing at a waterbody during daylight hours, the use of brightly flashing lights to illuminate reflectors would possibly deter these birds during the night. However, specific reactions of birds to such lights have not been determined (LGL Limited 1974).

5.2 Hazard to Birds of the Lower Camp Tailings Pond

The results of this study indicated that the extent of hazard of the Lower Camp Tailings Pond to birds that occur in the study area is generally small and that different species are differently affected as a result of having contacted this pond.

Because few ducks and American Coots and no geese were observed to land on the Lower Camp Tailings Pond, it was assumed that this pond was unattractive and therefore not hazardous to large numbers of these birds. By contrast, relatively large numbers of diving ducks (as many as 92) and coots (as many as 23) were observed on Loon Pond--situated only 36.5 m (40 yds) from the Lower Camp Tailings Pond--during the study period. It is probable that the general lack of shoreline vegetation and the small

size of the Lower Camp Tailings Pond rendered it unattractive to ducks, and that the relative abundance of vegetation around Loon Pond and the greater size of this pond rendered it more attractive to these birds. Three of the six ducks that were known to have landed on the Lower Camp Tailings Pond during this study became so heavily covered with bitumen (see Appendix 5) that they were incapable of flying or diving.

The hazard of the Lower Camp Tailings Pond to shorebirds and passerines that landed along its shore was also considered to have been small. Although many of these birds picked up bitumen on their feet, such contact with oil was not observed to have negatively affected these birds. Bourne (1968) and Smith and Bleakney (1969) have pointed out that the feet and abdominal plumages of shorebirds that land on oil-covered shores are likely to become oiled but not to a serious extent.

It should be noted that the carcasses of four shorebirds were found on the shore of the Lower Camp Tailings Pond on 6 August. The cause of deaths of these birds is unknown. Weseloh and Weseloh (pers. comm.) observed a shorebird (yellowlegs species) that landed on a mat of floating bitumen, became trapped, and then sank out of sight; it is possible that the above-mentioned carcasses were those of shorebirds that had become trapped in the floating mats of bitumen present on the Lower Camp Tailings Pond and that such mats therefore constitute a hazard to birds that would land on them. Although during this study flocks of 'peep' sandpiper species were observed to land on floating bitumen and to take flight before they sank too far into this bitumen, it is possible that larger species of shorebirds (such as the yellowlegs species observed by Weseloh and Weseloh) would not be able to take flight after having landed in such bitumen. It is also possible that floating bitumen would be more hazardous on warm days, when it would be softer and therefore less capable of supporting the weight of birds. However, because the results of this study do not permit accurate assessment of the hazard to shorebirds or passerines of floating bitumen, such bitumen can only be considered as a potentially serious hazard to these birds.

The general absence of vegetation, the presence of gently sloping shorelines, and the presence of mud at the Lower Camp Tailings Pond probably made this pond a much more attractive landing site for shorebirds than Loon Pond which is more heavily vegetated and where few shorebirds were sighted.

5.3 Experimental Procedures for Future Testing of Deterrent Devices

The results of this study and of the study reported by Sharp *et al.* (1975) indicate that during migration individual species or species groups are generally present in the study area for only short periods. During future deterrent experiments, it is therefore necessary that alternating control and experimental periods continue to be of short duration. Such scheduling would ensure that similar amounts of data on individual species or species groups would be obtained during each type of period.

Further tests pertinent to a deterrent system that would be applicable to the Mildred Lake Tailings Pond should attempt to determine whether particular devices are more or less effective against resident birds and juvenile birds as compared to visiting migrant birds and adult birds. It is probable that visiting migrant birds will react to a deterrent device differently than resident breeding birds. It is, for instance, possible that resident birds would be more difficult to deter from a particular area than would be visiting migrants. Also, Hochbaum *et al.* (1954) has indicated that juvenile ducks are more difficult to deter from an area than adult ducks. Given the above possibilities, it is important that future testing of deterrent devices be conducted both during the migration periods of species that occur on lease 17 and during the breeding and moulting periods of those species that carry out such activities on lease 17.

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APPENDICES

APPENDIX 1. Schedule of Control and Deterrent Periods on the Lower Camp Tailings Pond, 1974.

PERIOD	EXPERIMENT NUMBER	DATE	DESCRIPTION
Preliminary		August 6	Control. 1205-1705 hours. No blind.
Preliminary		August 7	Deterrent, plates across. Daylight hours. No blind.
01		August 26-29	Control. Daylight hours. No blind.
02		August 30-September 1	Control. Predawn-1100 hours. No blind.
03	1	September 2-4 afternoon	Control. Predawn-1100 hours. Evening observations. Blind.
04		September 5-9 afternoon	Deterrent, plates around periphery.
05	2	September 9 evening-13 afternoon	Control, same as 03.
06		September 13 evening-18 afternoon	Deterrent, plates around periphery.
07	3	September 18 evening-22 afternoon	Control.
08		September 22 evening-26 afternoon	Deterrent, plates around periphery and across the pond.
09	4	September 26 evening-29 afternoon	Control.
10		September 29 evening-October 7 afternoon	Deterrent, same as 08.
11	5	October 7 evening-10 afternoon	Control.
12		October 10 evening-13 afternoon	Deterrent, same as 08.
13	6	October 13 evening-16 afternoon	Control.
14		October 16 evening-19 afternoon	Deterrent, same as 08.
15	7	October 19 evening-22 afternoon	Control.
16		October 22 evening-28 afternoon	Deterrent, same as 08.

APPENDIX 2. Common Names and Scientific Names of Species Sighted During the Preliminary and Deterrent Investigations.

COMMON NAME	SCIENTIFIC NAME
Common Loon	*Gavia immer*
Whistling Swan	*Olor columbianus*
Canada Goose	*Branta canadensis*
White-fronted Goose	*Anser albifrons*
Snow Goose	*Chen caerulescens*
Ross' Goose	*Chen rossii*
Mallard	*Anas platyrhynchos*
Pintail	*Anas acuta*
Green-winged Teal	*Anas crecca*
Blue-winged Teal	*Anas discors*
Lesser Scaup	*Aythya affinis*
Common Goldeneye	*Bucephala clangula*
Bufflehead	*Bucephala albeola*
Ruddy Duck	*Oxyura jamaicensis*
Rough-legged Hawk	*Buteo lagopus*
Bald Eagle	*Haliaeetus leucocephalus*
Marsh Hawk	*Circus cyaneus*
Ruffed Grouse	*Bonasa umbellus*
Sandhill Crane	*Grus canadensis*
American Coot	*Fulica americana*
Semipalmated Plover	*Charadrius semipalmatus*
Killdeer	*Charadrius vociferus*
Common Snipe	*Capella gallinago*
Spotted Sandpiper	*Actitis macularia*
Solitary Sandpiper	*Tringa solitaria*
Greater Yellowlegs	*Tringa melanoleuca*
Lesser Yellowlegs	*Tringa flavipes*
Pectoral Sandpiper	*Calidris melanotos*
Semipalmated Sandpiper	*Calidris pusilla*
Dowitcher species	*Limnodromus* spp.

APPENDIX 2 (cont'd)

COMMON NAME	SCIENTIFIC NAME
Common Nighthawk	*Chordeiles minor*
Belted Kingfisher	*Megaceryle alcyon*
Common Flicker	*Colaptes auratus*
Horned Lark	*Eremophila alpestris*
Gray Jay	*Perisoreus canadensis*
Blue Jay	*Cyanocitta cristata*
Black-billed Magpie	*Pica pica*
Common Raven	*Corvus corax*
Common Crow	*Corvus brachyrhynchos*
Black-capped Chickadee	*Parus atricapillus*
American Robin	*Turdus migratorius*
Water Pipit	*Anthus spinoletta*
Waxwing spp.	*Bombycilla* spp.
Yellow-rumped Warbler	*Dendroica coronata*
Rusty Blackbird	*Euphagus carolinus*
Common Grackle	*Quiscalus quiscula*
Evening Grosbeak	*Hesperiphona vespertina*
Redpoll spp.	*Acanthis* spp.
Pine Siskin	*Spinus pinus*
Savannah Sparrow	*Passerculus sandwichensis*
Dark-eyed Junco	*Junco hyemalis*
Tree Sparrow	*Spizella arborea*
Lapland Longspur	*Calcarius lapponicus*
Snow Bunting	*Plectrophenax nivalis*

APPENDIX 3. Numbers of Birds and Flocks Observed During the Control and Deterrent Periods of the Preliminary Investigation on 6 and 7 August 1974.

SPECIES	NUMBER OBSERVED			
	CONTROL (AUGUST 6)		DETERRENT (AUGUST 7)	
	Birds	Flocks	Birds	Flocks
Common Loon			1	1
Mallard			2	1
Goldeneye spp.			4	1
Unidentified duck spp.			5	1
Semipalmated Plover			3	2
Killdeer	2	1	5	2
Spotted Sandpiper	1	1	2	2
Solitary Sandpiper			1	1
Greater Yellowlegs			4	3
Lesser Yellowlegs			18	3
Yellowlegs spp.			31	10
Pectoral Sandpiper			4	2
Dowitcher spp.			3	1
Peep sandpiper spp.	17	7	98	27
Sandpiper spp.			2	1
Shorebird spp.			30	4
Common Nighthawk	1	1		
Blue Jay			2	1
Common Grackle	1	1		
Pine Siskin			1	1

APPENDIX 4. Numbers of Individuals of Each Species or Species Group of Birds Observed Near the Lower Camp Tailings Pond Each Day of the Deterrent Investigation (26 August - 30 October 1974).

SPECIES/GROUP	NUMBERS OBSERVED																																		
	AUGUST						SEPTEMBER																														
	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25				
Common Loon												1			1																				
Whistling Swan												16																							
Canada Goose				2			52			596		395	22	73	125		85		1				42												
White-fronted Goose							85			20			57						95										1						
Snow Goose												3																							
Ross's Goose																	1																		
White-fronted and Canada Geese										290					101									60											
White-fronted and Snow Geese																			8																
Unidentified geese										93																									
Mallard		6		3		2				1				2	2			2		1	5		1			3								
Pintail	2					2													1					4	1						5				
Green-winged Teal					11								2																						
Blue-winged Teal																								1											
Teal spp.				1																															
Dabbling duck spp.		14					1	3	1				10	7	11			3	1	1			12	1	7			1							
Goldeneye spp.		1				1																													
Bufflehead																		3																	
Ruddy Duck																															1				
Diving duck spp.		9		7			1						1				3				1														
Unidentified duck spp.	11	33	12	4	3	1	4	37	25	46	3	16	41	10	10	1	16	22	47	9	44	17		16	28	3	3	50	2	11	25				
Rough-legged Hawk																								1		1									
Sandhill Crane										17																									
Semipalmated Plover	3	4	2	2							1		3	1							1														
Killdeer						2																													
Plover spp.																								1											
Common Snipe																							2	1		1		1							
Spotted Sandpiper	1																																		
Greater Yellowlegs		2	2	2			2						2						1	1	1														
Lesser Yellowlegs	1			2																															
Yellowlegs spp.		4	3	1																															
Pectoral Sandpiper	10	27	21	2		1			3										4	2							1		6						
Semipalmated Sandpiper	1																																		
Sandpiper spp.										3																	1								
Shorebird spp.	13	15		5						32	1	2	1	2									3				1								
Gull spp.		22		11		2	8	6		20	2				1		1			1	1	3	22			2								
Belted Kingfisher			1					1		1									1	1	1	1		1		1								
Common Flicker																			2																
American Robin																							22												
Water Pipit					6				4	1	1						23		11	7	19	2	3	13	15	4	6	3	4	4					
Warbler spp.																			4																
Rusty Blackbird																								81		65									
Blackbird spp.	27									35									18	410	37	24	21	69	1	135	69	49		5					
Evening Grosbeak												18									4														
Savannah Sparrow							2												6																
Dark-eyed Junco																					1														
Tree Sparrow																					1			5											
Sparrow spp.					2														6					1											
Lapland Longspur																				7	6			6	3	9	1	1		6					
Unidentified passerine spp.					1					55							8		53	112	94	43	20	125	13	23	47	34	3	20	2				

APPENDIX 4. (cont'd)

SPECIES/GROUP	NUMBERS OBSERVED																														
	SEPTEMBER					OCTOBER																									
	26	27	28	29	30	1	2	3	4	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	25	27	28	29	30
Whistling Swan			1										4																		
Canada Goose		17																													
White-fronted Goose	12	30																													
Snow Goose		110																													
Mallard		44						6		1							21														
Pintail							1																								
Teal spp.		1																													
Dabbling duck spp.	2							1											2												
Scaup spp.										7	4			1		2					3	3									
Bucephala spp.																5															
Diving duck spp.													18					1	7		2		1								1
Unidentified duck spp.	38	399	57	4		2	11	83	46	1	25	25	20	2	34	21	16	10		1	2	7	2	41			1				
Rough-legged Hawk																												1		1	
Bald Eagle		1								1			26						2									1			
Marsh Hawk									1										1												
Hawk spp.		2																													
Ruffed Grouse															1					1											
Grouse spp.													3																		
American Coot						1																									
Common Snipe										1								1		3	1			1				1			
Greater Yellowlegs											2				5				1												
Yellowlegs spp.			2																												
Pectoral Sandpiper		1										1																			
Shorebird spp.		2							1																						
Gull spp.		1				1							8																		
Owl spp.									1																						
Belted Kingfisher		3																													
Woodpecker spp.															1												1				
American Robin		3																		1		1									
Thrush spp.																				3											
Water Pipit		1								2								1													
Rusty Blackbird		1																			1						1	2			
Blackbird spp.		25	64	8		4			3				2			7				1					1					1	
Evening Grosbeak											5	4																1			
Redpoll spp.															12	89			80	8	66		18		13	9	37	16		3	
Dark-eyed Junco										23																					
Tree Sparrow																	2														
Lapland Longspur	1	1							1	2	8						1				29										
Snow Bunting										16			4	45	11	13	168	110	14		1	24	28	32	27	28	2	14	10	11	
Unidentified passerines	12	19	38	4	3	12	2	33	11	124	85	14	69	119	74	31	277	2	75	118	9	15	31	45	28		9		1	0	

APPENDIX 5a. Numbers of Flocks of Large Waterbirds That Did and Did Not Show an Avoidance Response During Control Periods 1 and 2 (26 August - 1 September 1974).

SPECIES/GROUP	TOTAL FLOCKS	NUMBER OF FLOCKS	
		AVOIDANCE RESPONSE	NO AVOIDANCE RESPONSE
Mallard	5	0	5
Pintail	2	0	2
Green-winged Teal	1	0	1
Teal spp.	1	0	1
Dabbling duck spp.	3	0	3
Common Goldeneye	2	0	2
Diving duck spp.	8	1	7
Unidentified duck spp.	23	0	23
TOTALS	45	1	44

APPENDIX 5b. Numbers of Shorebird Flocks Landing and Not Landing During Control Periods 1 and 2 on 26 August - 1 September 1974.

SPECIES/GROUP	TOTAL FLOCKS	NUMBER OF FLOCKS	
		LANDING	NOT LANDING
Semipalmated Plover	8	6	2
Killdeer	2	2	0
Greater Yellowlegs	7	5	2
Lesser Yellowlegs	2	2	0
Yellowlegs spp.	5	3	2
Pectoral Sandpiper	16	3	13
Semipalmated Sandpiper	2	2	0
Peep sandpiper spp.	4	3	1
Shorebird spp.	11	2	9
TOTALS	57	28	29

APPENDIX 6. Landing, Location, and Extent of Oiling of Water Associated Birds Observed Landing on the Lower Camp Tailings Pond or its Shore During the Deterrent Investigation (26 August - 30 October 1974).

DATE	SPECIES	NUMBER OF INDIVIDUALS	WHERE LANDED	LENGTH OF TIME LANDED* MIN:SEC	EXTENT OF BITUMEN ON BIRD(S)
SHOREBIRDS					
August 26	Semipalmated Sandpiper	1	On floating bitumen	2:50	Above ankle
	Small shorebird spp.	3	Sandy shore, some bitumen present	5:00	
			Mud shore, some bitumen present	:10	
			Sandy shore, some bitumen present	9:00	
	Semipalmated Plover	1	Mud Shore, some bitumen present	1:00	None
	Peep sandpiper spp.	4	Sandy shore, some bitumen present	2:00	Feet only
	Pectoral Sandpiper	1	On bitumen-covered shore	1:50	Feet only
			On bitumen-covered shore	5:00	Feet only
			On bitumen-covered shore	2:00	Feet only
	Lesser Yellowlegs	1	On bitumen-covered shore	1:30	Feet only
			On bitumen-covered shore	:30	Feet only
August 27	Yellowlegs spp.	3	Mud shore, some bitumen present	1:00	Feet only
			Mud shore, some bitumen present	2:00	
	Yellowlegs spp.	1	Mud shore, some bitumen present	1:00	
	Semipalmated Plover	4	On bitumen-covered shore	3:00	None
			On bitumen-covered shore	:10	None
August 28	Greater Yellowlegs	1	On bitumen-covered shore	:45	Feet only
			On bitumen-covered shore	:10	Feet only
			Rock in water	7:00	Feet only
	Greater Yellowlegs	1	On bitumen-covered shore	14:00	To ankle
	Yellowlegs spp.	1	On floating bitumen	:10	Feet only
	Pectoral Sandpiper	2	On floating bitumen	:10	Feet only
	Semipalmated Plover	1	On bitumen-covered shore	4:00	None
			Mud shore, some bitumen present	:10	None
	Pectoral Sandpiper	5	On bitumen-covered shore	5:00	None
	Semipalmated Plover	1	On bitumen-covered shore	5:00	None
August 29	Greater Yellowlegs	1	On bitumen-covered shore	1:00	Feet only
			On bitumen-covered shore	8:00	Feet only
			On floating bitumen	6:00	To ankle
			Sandy shore, some bitumen present	2:00	On feathers of leg
	Lesser Yellowlegs	2	On bitumen-covered shore	1:00	Feet only
			Mud shore, some bitumen present	8:00	Feet only
			On floating bitumen	6:00	Feet only
			Sandy shore, some bitumen present	2:00	Feet only
	Peep sandpiper spp.	2	On bitumen-covered shore	1:00	Feet only
	Peep sandpiper spp.	2	On floating bitumen	:15	Feet only
	Shorebird spp.	1	On floating bitumen	8:00	
			Sandy shore, some bitumen present	5:00	
			Sandy shore, some bitumen present	9:00	

DATE	SPECIES	NUMBER OF INDIVIDUALS	WHERE LANDED	LENGTH OF TIME LANDED* MIN:SEC	EXTENT OF BITUMEN ON BIRD(S)
	Greater Yellowlegs	1	Sandy shore, some bitumen present	1:00	
			Sandy shore, some bitumen present	1:00	
	Semipalmated Plover	1	On floating bitumen	4:00	None
August 30	Killdeer	1	Sandy shore, some bitumen present	4:00	None
	Killdeer	1	Sandy shore, some bitumen present	8:00	None
September 1	Greater Yellowlegs	1	Sandy shore, some bitumen present	1:00	
September 5	Semipalmated Plover	1	Sandy shore, some bitumen present	:15	
			Sandy shore, some bitumen present	:03	
September 13	Pectoral Sandpiper	2	On bitumen-covered shore	1:00	Feet only
			On bitumen-covered shore	:45	
	Pectoral Sandpiper	2	On bitumen-covered shore	5:00	None
			On bitumen-covered shore	5:00	
September 14	Greater Yellowlegs	1	On floating bitumen	1:00	None
	Pectoral Sandpiper	1	Sandy shore, some bitumen present	2:00	Half-way to ankle
			Sandy shore, some bitumen present	21:00	Half-way to ankle
September 15	Greater Yellowlegs	1	On floating bitumen	:10	To ankle
			On floating bitumen	:02	
September 21	Pectoral Sandpiper	1	On floating bitumen	:30	Feet only
October 7	Common Snipe	1	Cattails		
October 8	Greater Yellowlegs	1	On floating bitumen	:01	Half-way to ankle
	Greater Yellowlegs	1	On floating bitumen	:01	None
LARGE WATERBIRDS					
August 27	Dabbling duck spp.	1	In water	:10	
August 31	Common Goldeneye	1	In water	1:30	None
September 17	Mallard	1	In water	67:00	
October 1	American Coot	1	In ice/water	180:00	Completely covered
October 8	Lesser Scaup	1	In water	unknown**	Completely covered
	Lesser Scaup	2	In water	unknown**	Completely covered
BLACKBIRDS					
September 14	Blackbird spp.	50	Cattails	:05	None
October 25	Rusty Blackbird	1	Sandy shore, some bitumen present	1:30	None
			Sandy shore, some bitumen present	:10	None
October 27	Rusty Blackbird	2	Sandy shore, some bitumen present	1:00	None

DATE	SPECIES	NUMBER OF INDIVIDUALS	WHERE LANDED	LENGTH OF TIME LANDED* MIN:SEC	EXTENT OF BITUMEN ON BIRD(S)
RAVENS					
October 15	Common Raven	1	On bitumen-covered shore	:25	None
OPEN-COUNTRY NESTERS					
August 30	Water Pipit	2	Sandy shore, some bitumen present	1:00	
	Water Pipit	2	Sandy shore, some bitumen present	1:00	
			Sandy shore, some bitumen present	1:00	
	Sparrow spp.	2	Sandy shore, some bitumen present		
September 1	Savannah Sparrow	2	Sandy shore, some bitumen present	6:00	None
September 11	Water Pipit	2	On bitumen-covered shore	:10	None
	Water Pipit	7	On bitumen-covered shore	1:00	None
			On bitumen-covered shore	:05	None
September 13	Savannah Sparrow	3	On bitumen-covered shore	2:00	None
			On bitumen-covered shore	1:00	
September 14	Lapland Longspur	1	Sandy shore, some bitumen present	:20	
September 15	Water Pipit	1		:10	None
	Water Pipit	3	Sandy shore, some bitumen present	3:15	None
September 19	Water Pipit	10	On bitumen-covered shore	1:00	Feet only
October 11	Snow Bunting	2	On floating bitumen	2:00	None
	Snow Bunting	1	Sandy shore, some bitumen present	2:00	None
October 14	Snow Bunting	12	Cattails		
October 15	Water Pipit	1	Sandy shore, some bitumen present	4:20	None
October 20	Snow Bunting	6	Sandy shore, some bitumen present	3:10	None
	Snow Bunting	1	In water	:01	None
	Snow Bunting	3	Sandy shore, some bitumen present	2:50	None
			On bitumen-covered shore	3:55	None
	Snow Bunting	5	On bitumen-covered shore	2:10	None
October 22	Snow Bunting	14	Mud shore, some bitument present	1:00	None

* time spent landed at one location, i.e. between movements

**birds landed sometime during the night and were extensively covered with bitumen by the next morning

APPENDIX 7. Daily Counts of Water-Associated Birds Observed on Loon Pond (26 August - 30 October 1974).

DATE		NUMBERS OBSERVED							TOTAL
		LOONS	GREBES	DABBLING DUCKS	DIVING DUCKS	COOTS	SHOREBIRDS	OTHERS*	
August	26-30	----------	----------	----------	No	Count	----------	----------	----------
	31				1				1
September	1	----------	----------	----------	No	Count	----------	----------	----------
	2	1							1
	3	1						4	5
	4								0
	5	1		1	2				4
	6	1		1				2	4
	7	2		1				1	4
	8	1							1
	9	1		1	2				4
	10	1			3				4
	11	1							1
	12	1			3				4
	13								0
	14							1	1
	15								0
	16								0
	17								0
	18								0
	19								0
	20							2	2
	21							2	2
	22			1					1
	23				2				2
	24								0
	25								0
	26							2	2
	27			1	1				2
	28							3	3
	29			3				3	6
	30			4	10				14
October	1			4	11			3	18
	2				13				13
	3				19				19
	4			3	9				12
	5,6	----------	----------	----------	No	Count	----------	----------	----------
	7				63				63
	8				92				92
	9				71	23		2	96
	10				44	16			60
	11				50	7			57
	12		2		29	22			53
	13				28	6			34
	14			1	29	15		29	74
	15			1	51	11			63
	16				35	10			45
	17				34	8			42
	18		1	2	12	14		16	45
	19		1	2				5	8
	20		1		16	5			22
	21				8	3		16	27
	22				9	1			10
	23				2			3	5
	24	----------	----------	----------	No	Count	----------	----------	----------
	25			2					2
	26-30	----------	----------	Frozen	(No	Birds)	----------	----------	----------

*This group consists almost entirely of passerines but does include the occasional sighting of Belted Kingfishers, a member of the order Coraciiformes.

Conditions of Use

Dyke, G.R., D.A. Birdsall and P.L. Sharp, 1976. Test of a bird deterrent device at a tailings pond, Athabasca oil sands, 1974. Syncrude Canada Ltd., Edmonton, Alberta. Professional Paper 1976-1. 50 pp.