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DISTURBANCE TO BIRDS BY GAS COMPRESSOR NOISE SIMULATORS, AIRCRAFT AND HUMAN ACTIVITY IN THE MACKENZIE VALLEY AND THE NORTH SLOPE, 1972

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CANADIAN ARCTIC GAS STUDY LIMITED

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EFFECTS OF GAS COMPRESSOR NOISE SIMULATOR DISTURBANCE TO TERRESTRIAL BREEDING BIRDS, BABBAGE RIVER, YUKON TERRITORY, JUNE, 1972

M. A. GOLLOP
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INTRODUCTION

Plans for the proposed pipeline across the North Slope of the Yukon Territory call for the establishment of gas compressor stations at regular, (approximately 50 mile) intervals along the route. Considerable noise is created by the machinery and passage of gas at these stations. Bartonek (1969a) referred to the possibility that pumping stations in the Atigun River Valley, Alaska, would disrupt Dall sheep populations there, but the impact, if any, of these stations on bird populations has not been studied. For that reason, this study was implemented to discover how compressor station noise would affect population densities and reproductive success of breeding birds on the tundra.

Many species of birds breed on the Arctic tundra of the North Slope. Lists of species in the form of biological notes are abundant in the literature (Anderson 1913, 1915, Leffingwell 1919, Dixon 1943, Bee 1958, Kessel and Cade 1958, West and White 1966). Quantitative data on breeding birds has been largely oriented toward waterfowl (for summary, see Bartonek 1969b). Recent gas pipeline plans for the North Slope make it important that other species, as well as waterfowl be quantitatively studied on the North Slope.

SITE DESCRIPTION

The study site was located along the Babbage River, approximately 12 miles southeast of Phillips Bay, Yukon Territory (N.T.S. map 117D; 1:250,000; Herschel Island) and directly along the Inshore route of the proposed pipeline (Figure 1).

Topography in the general area is typically rolling tussock tundra containing flat polygonal areas and cut by braided meandering streams (Figure 2).

Some seismic trails are present, generally running in a north-south direction.

VEGETATION AND HABITAT TYPES

Classification of habitat types was based on guidelines established the previous year (LGL 1971), in order to maintain consistency and to allow easy comparison of continuing data. Three types were recognized as occurring in the study area: tussock-heath tundra, sedge-grass marsh, and willow-birch brush.

To further describe these habitat types, a classification was also established to delineate non-floristic features of habitat, based on land physiography. Four classes were recognized on this basis: dry tussock tundra, wet polygonal tussock tundra, wet polygonal smooth tundra, and stream bottom.

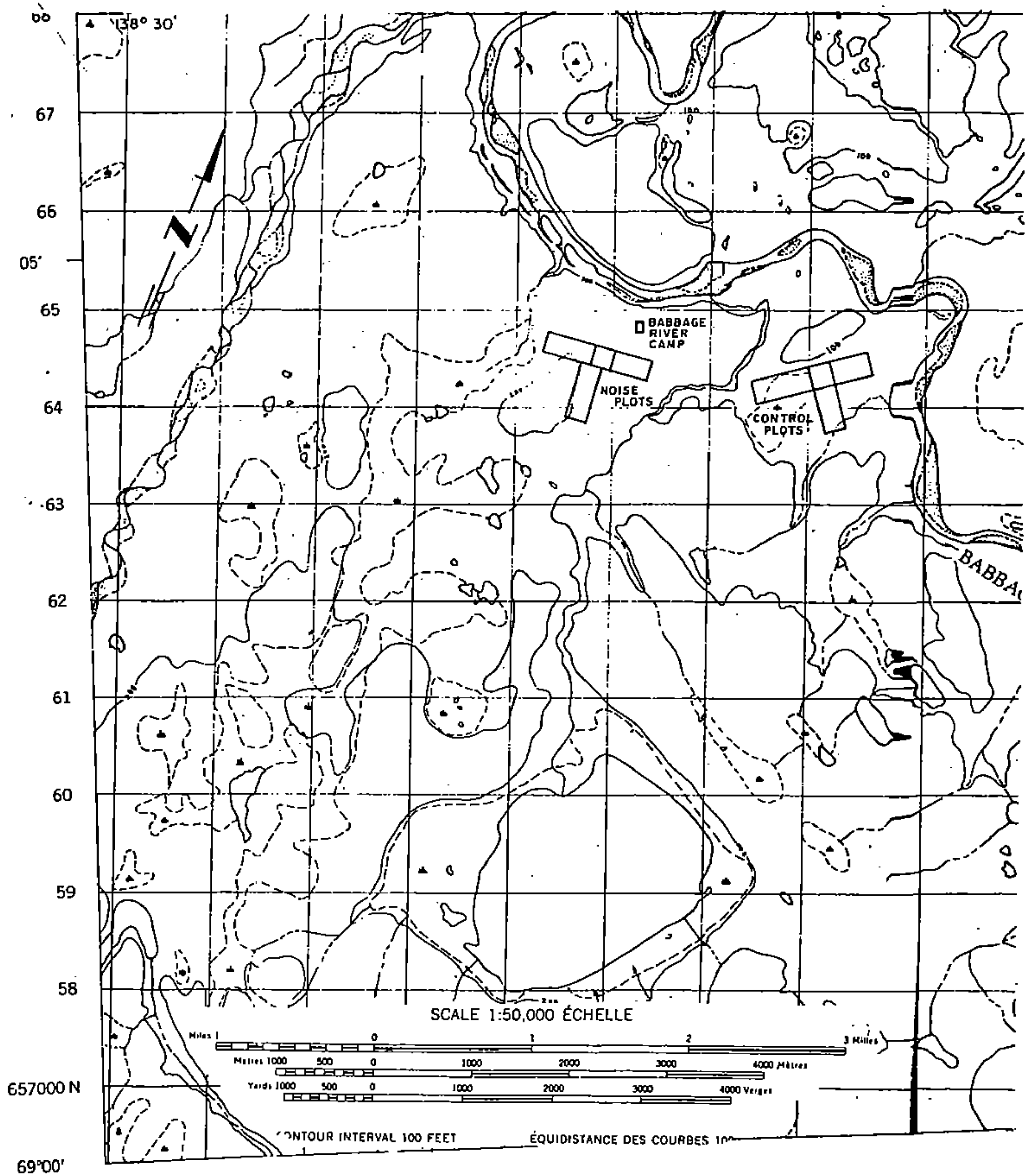


FIGURE 1 - MAP OF THE GENERAL STUDY AREA.

Dry tussock tundra was associated with hillsides. Tussocks varied in size from six inches to 48 inches in diameter and from six inches to 18 inches in height.

Wet polygonal tussock tundra was associated with flat, basin areas, broken by frost action into polygons. Each polygon was usually surrounded by water. Tussock size and height was similar to that of the dry tussock tundra.

Wet polygonal smooth tundra also occurred in polygonal basin areas. Tussocks were non-existent or smaller than those found elsewhere, being rarely more than six inches high.

Stream bottom was associated with areas immediately adjacent to streams or rivers and consisted primarily of flood plain.

The following description of vegetation types should help to establish the association between the physiographic and vegetative habitat descriptions. In all cases, primary species have been listed in descending order of occurrence.

Tussock-heath tundra was generally associated with dry tussock tundra areas and typically exhibited the greatest diversity of plant species. Primary species were sedges (Carex spp.), birches (Betula glandulosa and Betula nana), moss (Musci spp.), lichen (Cladonia spp.), lingonberry (Vaccinium vitis-idaea), cottongrass (Eriophorum vaginatum) and labrador tea (Ledum palustre).

TABLE 1. DISTRIBUTION OF HABITAT TYPES, BABBAGE RIVER, Y.T.; 1972

PHYSIOGRAPHIC TYPES	NOISE PLOTS						
	Left		Center		Right		M
	Acres	%*	Acres	%*	Acres	%*	Ac
Dry Tussock Tundra	7.02	27	15.08	58	12.22	47	2.
Wet Polygonal Tussock Tundra	9.88	38	4.16	16	7.54	29	7
Wet Polygonal Smooth Tundra	7.02	27	6.76	26	6.24	24	2
Stream Bottom	2.08	8					
Seismic Trail							
TOTAL	26.00		26.00		26.00		1
VEGETATIVE TYPES							
Tussock Heath Tundra	7.02	27	15.08	58	12.22	47	
Sedge Grass Marsh	16.90	65	10.92	42	13.78	53	1
Willow-Birch Brush	2.08	8					
Seismic Trail							
TOTAL	26.00		26.00		26.00		1

* Percentages are somewhat high as water areas were not evaluated.

				CONTROL PLOTS									
Middle		TOTAL		Left		Center		Right		Middle		TOTAL	
Acres	% *	Acres	% *	Acres	% *	Acres	% *	Acres	% *	Acres	% *	Acres	%
2.60	20	36.92	41					5.20	20			5.20	6
7.80	60	29.38	32	13.26	51	18.46	71	9.96	36	7.80	60	49.48	54
2.60	20	22.62	25	10.40	40	7.54	29	8.44	34	5.20	40	31.58	35
		2.08	2										
				2.34	9			2.40	10			4.72	5
13.00		91.00		26.00		26.00		26.00		13.00		91.00	
2.60	20	36.92	41					5.20	20			5.20	6
10.40	80	52.00	57	23.66	91	26.00	100	18.40	70	13.00	100	81.06	89
		2.08	2										
				2.34	9			2.40	10			4.74	5
13.00		91.00		26.00		26.00		26.00		13.00		91.00	

Sedge-grass marsh varied slightly according to which of the two wet polygonal physiographic types it occurred in. The primary species of sedge-grass marsh occurring in wet polygonal tussock tundra were sedges, moss, lingonberry, labrador tea, birch (Betula glandulosa), and cottongrass. Sedge-grass marsh occurring in wet polygonal smooth tundra typically displayed the least plant diversity. The primary species were sedges, labrador tea, moss, birch and cottongrass.

Willow-birch brush associations were typical of stream bottom areas.

The extent of area covered by each habitat type is summarized in Table 1. Table 2 shows the frequency of plant species in the three major physiographic types. Figures 3 and 4 map the distribution of the physiographic areas on the study plots.

WEATHER

Clear weather prevailed on 17 days during the study period, overcast with rain showers occurred on 15 days, overcast without rain on three days, and fog on two days.

Two storms occurred during the course of the study, the first on 3 and 4 June and the second from 26 through 29 June. Strong winds and rain accompanied both storms.

There was light snowfall on 4 and 29 June.

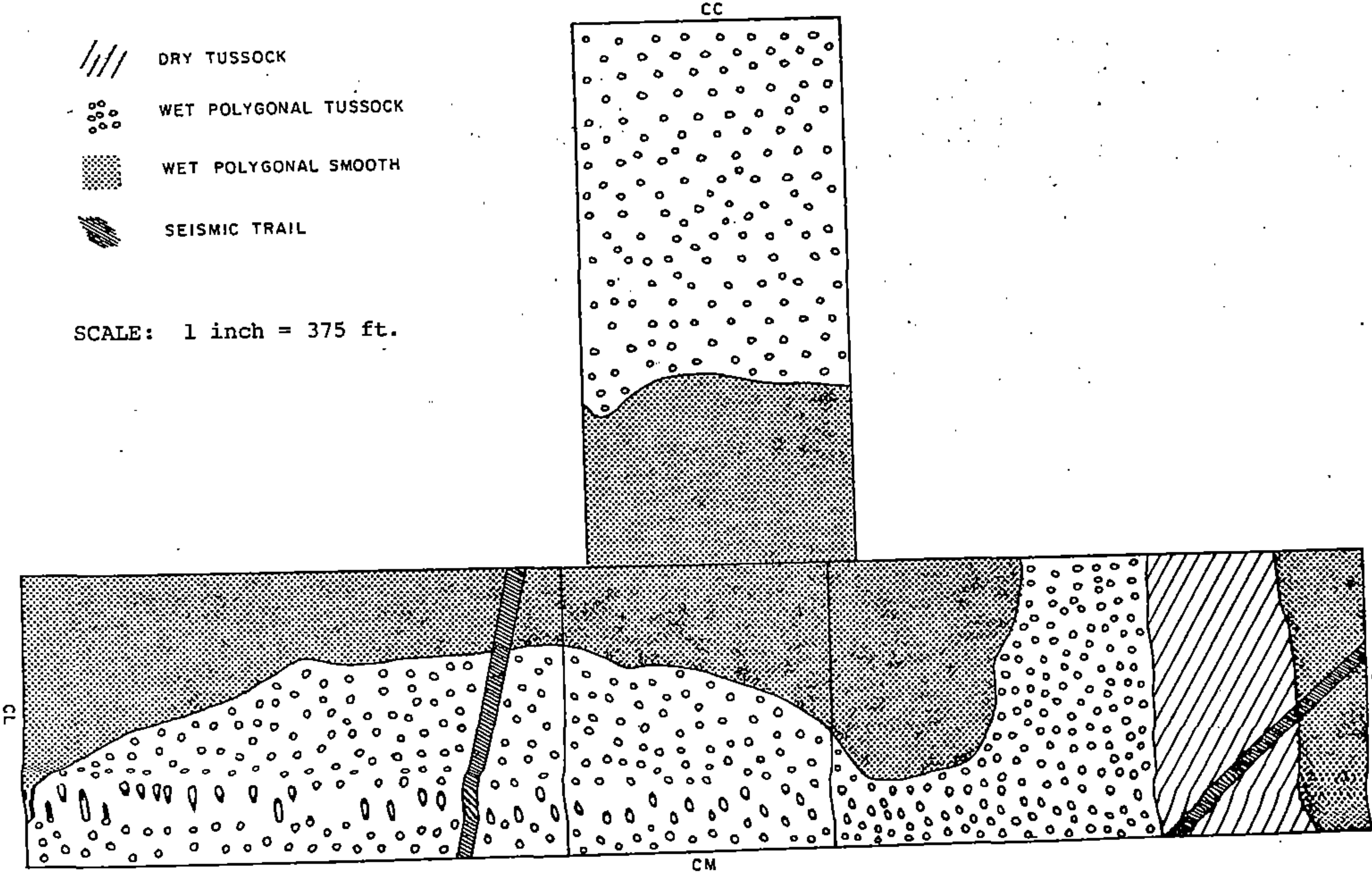
Complete weather data are presented in Appendices 1 and 2.

TABLE 2. FREQUENCY OF PLANT SPECIES IN THE THREE MAJOR PHYSIOGRAPHIC TYPES, BABBAGE RIVER, Y.T.: 1972

SPECIES	Tussock-Heath Tundra		Wet Polygonal Tussock Tundra		Wet Polygonal Smooth Tundra	
	No. of sites species * occurred at	% of sites species occurred at	No. of sites species ** occurred at	% of sites species occurred at	No. of sites species *** occurred at	% of sites species occurred at
Carex spp.	21	95.4	24	100.0	16	88.9
Eriophorum vaginatum	16	72.7	16	66.7	12	66.7
Dryas integrifolia	4	18.2				
Mosses (Musci, Hylocomium spp.)	22	100.0	22	91.7	16	88.9
Cladonia spp.	20	90.9	16	66.7	10	55.5
Salix spp.	14	63.6	13	54.2	8	44.4
Lupinus arcticus	4	18.2				
Pedicularis capitata	4	18.2	1	4.2	1	5.5
Pedicularis kenai	13	59.1				
Betula glandulifera	22	100.0	18	75.0	15	83.3
Betula nana	22	100.0	19	79.2	15	83.3
Pyrola grandiflora	14	63.6				
Liverwort	3	13.6	10	41.7		
Composite	6	27.3	2	8.3		
Polygonum bistorta	11	50.0	4	16.7		
Cassiope spp.	1	4.5	2	8.3	4	22.2
Vaccinium vitis-idaea	20	90.9	22	91.7	15	83.3
Vaccinium uliginosum	7	31.8			2	11.1
Arctostaphylos rubra	5	22.7	2	8.3	1	5.5
Large lichen	13	59.1	8	33.3	7	38.9
Ledum palustre	16	72.7	22	91.7	16	88.9
Sphagnum spp.	3	13.6	7	29.2	13	72.2
Andromeda polifolia			1	4.2	2	11.1
Lagotis glauca			2	8.3		

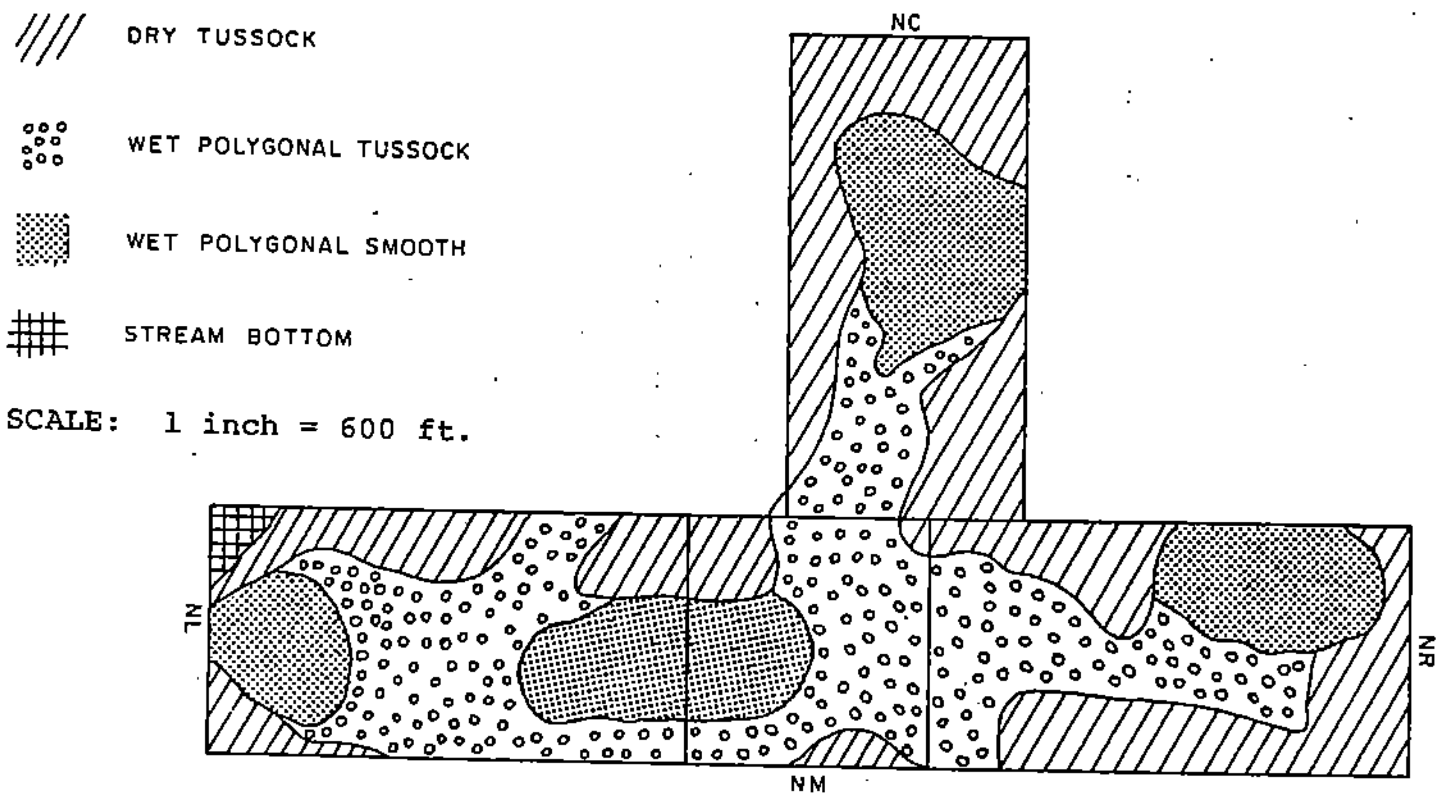
* Number of samples taken in tussock-heath tundra - 22.
** Number of samples taken in wet polygonal tussock tundra - 24.
*** Number of samples taken in wet polygonal smooth tundra - 18.

FIGURE 3-HABITAT FEATURES OF CONTROL PLOTS,
BABBAGE RIVER, Y.T., 1972.



SCALE: 1 inch = 375 ft.

FIGURE 4 - HABITAT FEATURES OF NOISE PLOTS, BABBAGE RIVER, Y.T., 1972.



Wind

Maximum daily wind velocity averaged 10.6 miles per hour while minimum daily wind velocity averaged 4.5 miles per hour. Extremes of wind velocity ranged from 0 to 30 miles per hour.

Wind direction was predominately northerly, varying from northwest to northeast but occasionally coming from the east or southeast. No winds from the south, southwest or west were encountered during the study.

Temperature

Temperatures ranged from a high of 88°F. on 17 June to a low of 26°F. on 8 June. The average daily high was 51.5°F. while the average daily low was 32.5°F.

Daily temperature range was greatest on 17 June, when there was 58°F. variation and least on 29 June when there was 2°F. variation. The average daily temperature range was 19.2°F.

Daily temperatures are presented graphically in Appendix 2.

AVIFAUNA OF THE SITE

Sixty-eight species were observed in the study area. A complete list of the species observed, along with our migration data from the area, is presented in Appendix 3.

The study area, as used in compiling the list of species observed, is shown in Figure 1. As might be expected, more species occurred on the total study area than on the actual study plots, but the plots contained a representative cross-section of the total sample.

Lapland longspurs (Calcarius lapponicus) were by far the most common species in the area and for this reason, most of the work was centered on them. The density of willow ptarmigan (Lagopus lagopus), golden plover (Pluvialis dominica), and northern phalaropes (Lobipes lobatus), was also quite high and these should be considered as important species in the area.

Predatory species most frequently observed were parasitic jaegers (Stercorarius parasiticus), long-tailed jaegers (Stercorarius longicaudus), glaucous gulls (Larus hyperboreus), short-eared owls (Asio flammeus), marsh hawks (Circus cyaneus), and golden eagles (Aquila chrysaetos) in that order.

METHODS

Since it was not possible to conduct studies at an actual compressor station, it was necessary to simulate the sounds that would be produced by such a station. J-Mar Electronics Limited of Toronto designed and built the sound simulators used in this study.

GAS COMPRESSOR NOISE SIMULATORS

Two simulators were run simultaneously during the study. Each unit had loud-speakers which simulated the exhaust, scrubber, air intake and bypass loop at the same sound levels as those found in a gas compressor. The electronics consisted of a white noise generator, active filters to synthesize the separate sounds, amplifiers and loud-speakers. Power was supplied by a Kohler generator mounted on the simulator platform (Figure 5).

The simulators were brought into the study area on 20 and 21 May. They were tested on 21 and 22 May but were not left running since it was not yet possible to station observers at the site.

On 28 May, the simulator was turned on and left running continuously through the study period until 7 June. Shutdowns were kept to normal maintenance or minor repair and at all times at least one simulator was in operation.

STUDY PLOTS

On 28 May, the area in front and on both sides of the simulators was divided into three study plots, each plot being 500 yards long and 250 yards wide and gridded into 50 equal segments. These three plots are referred to in this paper as "adjacent" disturbed areas.

In addition to these three plots surveyed adjacent to the noise source, a fourth plot, 250 yards long and 250 yards wide, was established immediately around the simulators. This plot is referred to in this paper as the 'immediate' disturbed area.

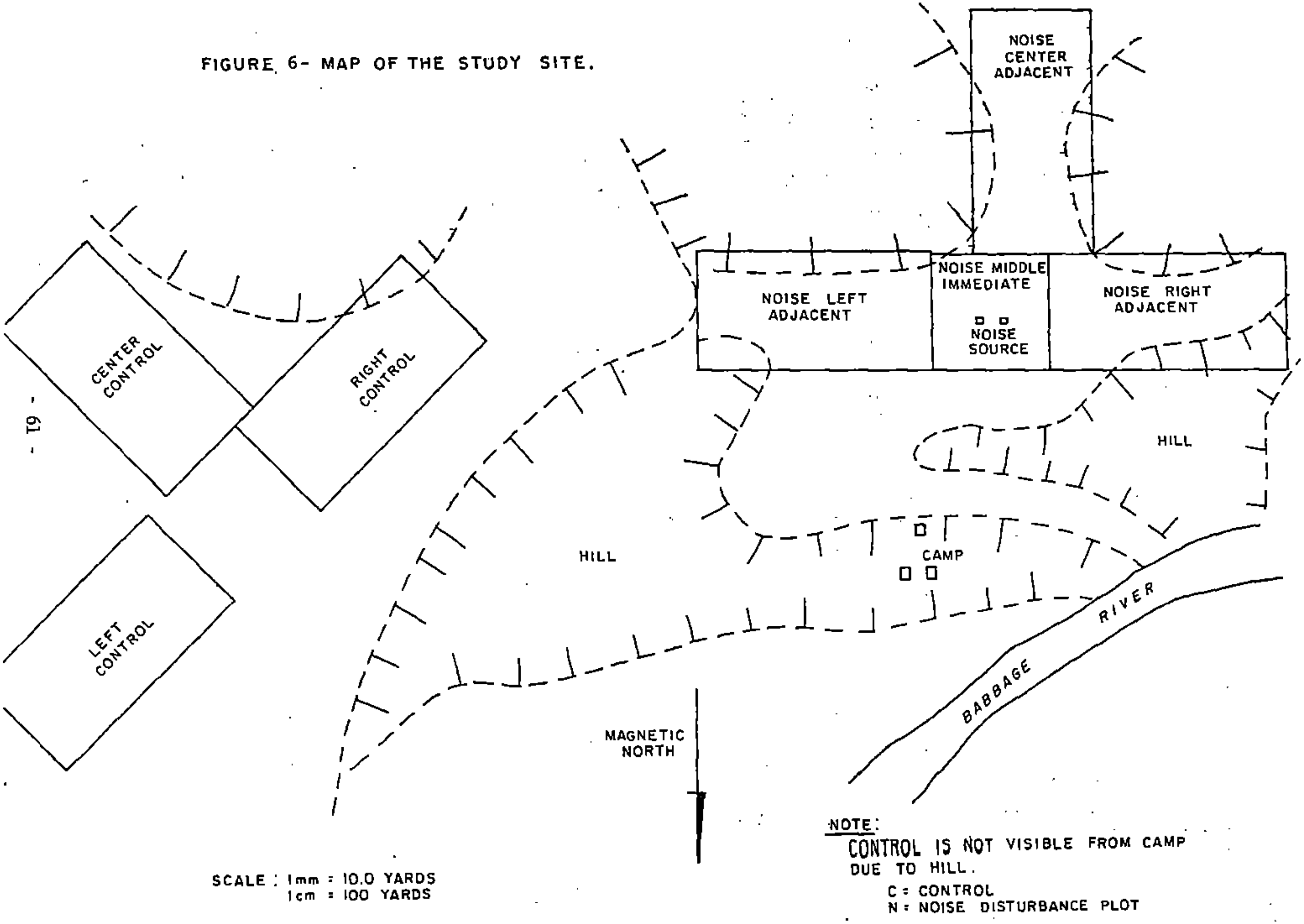
On 29 May, a grid arrangement similar to the 'adjacent' disturbed plots was laid out east of the simulators. The distance from these control plots to the nearer of the two sound simulators ranged from 1,050 yards at the closest point of the right plot, to 2,240 yards at the farthest point of the left plot. The normal ambient level of sound on the North Slope is very low and, under ideal conditions (light favoring wind), the sound of the simulators could be heard faintly at a distance of up to eight miles. The location of the control plots, however, was such that they were to the side (rather than the front) of the simulators and were also largely shielded from them by a hill (Figure 6). The sound of the simulators on the control plots therefore usually ranged from "not detectable" on the left plot to "detectable at a low level" on the right plot.

Figure 6 shows the arrangement of the camp and the two study areas.

TERRITORY DETERMINATION

The Lapland longspur was the only species whose population density was sufficient to allow systematic study within

FIGURE 6- MAP OF THE STUDY SITE.



a small area such as that encompassed by the plot system employed. Data on populations and nesting of other species have been used in drawing general conclusions about their reactions to disturbance.

In order to assess the populations of longspurs present on the study plots, censuses were conducted during the course of the breeding season and territories were determined using the "singing-male" technique described by Kendeigh (1944). The movements and behavior of male birds were plotted on grid maps (Figure 7) and, after a sufficient number of censuses had been conducted, the maps were analyzed and territories delineated. Seven censuses were considered sufficient to furnish the required data.

The method employed in interpreting the number of territories on the grid was to count only those territories wherein the center of territorial activity was entirely on the plot. Because of the fluid nature of the territorial boundaries of longspurs, it would be misleading to include territories which did not at least have their activity center on the censused area. Activity centers were determined by frequency of observations and nest location.

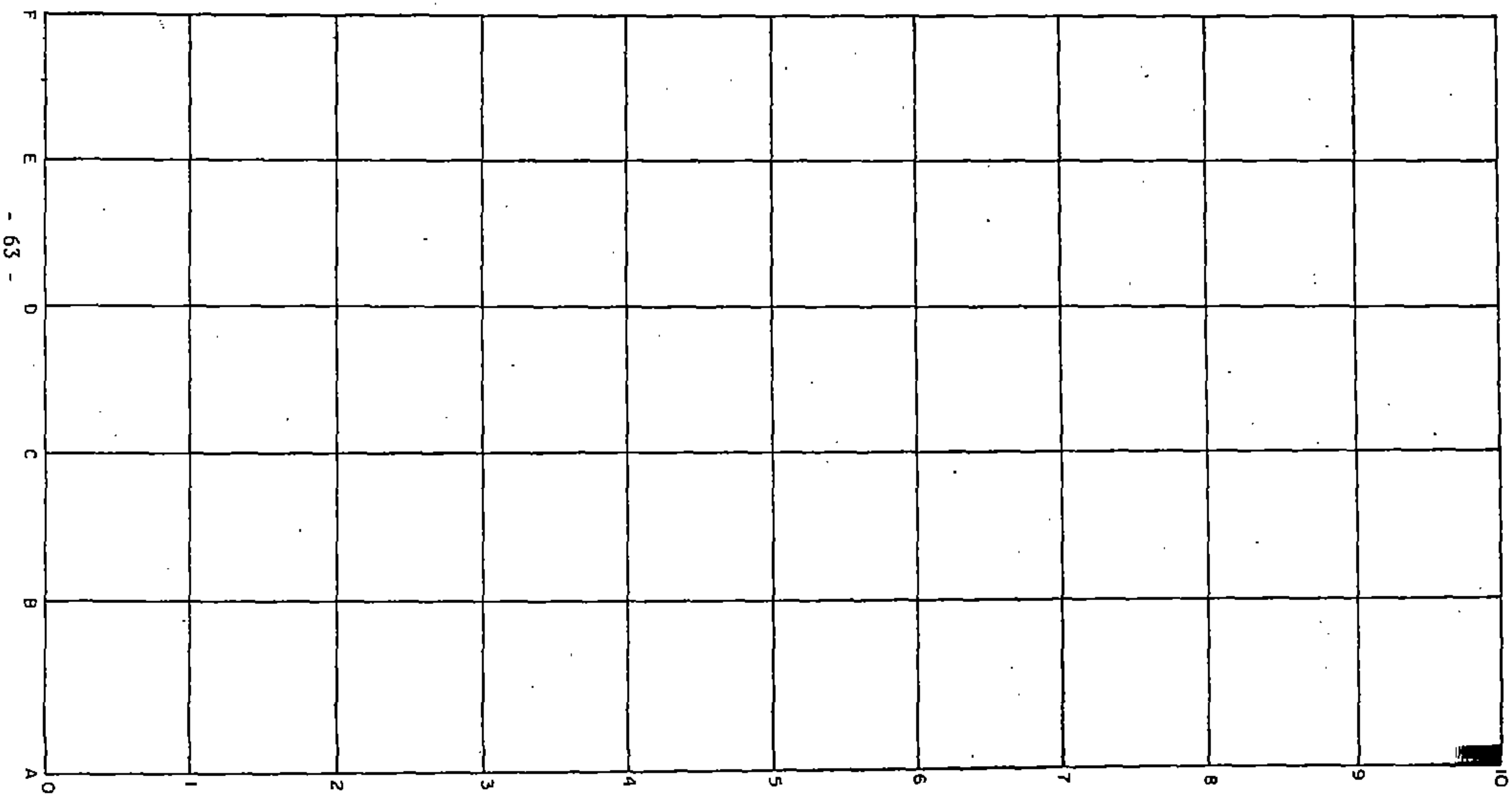
Each territorial male was treated as implying two birds when population densities were calculated. Polygyny is not known in longspurs.

FIGURE 7 - SAMPLE OF PLOT CENSUS SHEET.

DATE ____________ LOCATION ____________

TIME ____________ NAME ____________

WEATHER ____________



REPRODUCTIVE SUCCESS AND PRODUCTIVITY

It was also important to find as many nests as possible on the study plots in order to obtain sufficient data on reproductive success. The most successful techniques for finding nests was to locate a female bird and watch her until she returned to her nest. The male bird was also watched, mainly as a method of locating the female, but this proved extremely time-consuming. Despite these efforts, the majority of the nests were discovered during census work or other activity.

Periodic checks were made on each nest in order to determine the complete history of each clutch. Severe weather conditions during a critical stage late in the nesting period interfered with the schedule of nest checks and created problems in interpreting the complete history of several nests.

VEGETATION ANALYSIS

The vegetation analysis considered only those plant species which were available as food or cover during the nesting season and the list of species obtained should by no means be considered as including all the species which might occur in the area.

Plants were identified within a ½ meter square at each nest site. In addition, five random ½ meter square plots were assessed around each nest.

The component species of each vegetative type were determined by assessing random ½ meter square plots.

NOISE LEVELS ON DISTURBED AREAS

On 30 May, noise levels were measured at 50-yard intervals in front of the simulator using the 'C'-scale of a Bruel and Kjaer Sound Level Meter, Type 2205 with a windscreen VA 0207. Maximum and minimum noise levels were recorded over a 30-second interval, which was considered long enough to allow for all possible values at any one point. Wind, on this date, was typically from the north at less than two miles per hour, though it rose briefly to five miles per hour. Fog was present at times during the period. Data from these readings are shown in Figures 8 and 9.

CALCULATIONS AND DEFINITIONS

The calculations and definitions used in this paper are summarized in Disturbance Studies of Terrestrial Breeding Birds, Firth River, Yukon Territory (LGL 1973a).

RESULTS

LAPLAND LONGSPURS

Arrival

Lapland longspurs began arriving at the Babbage

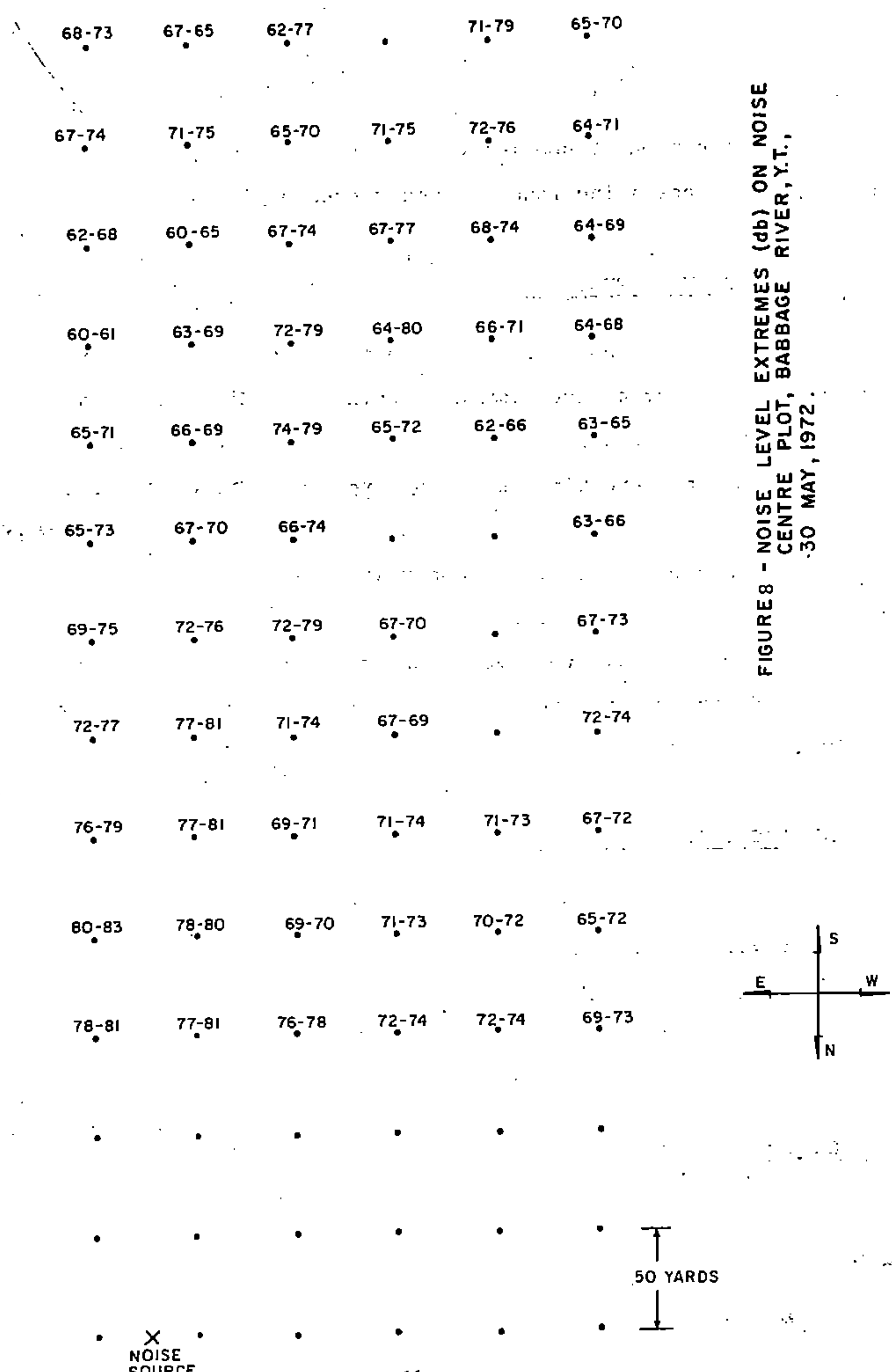
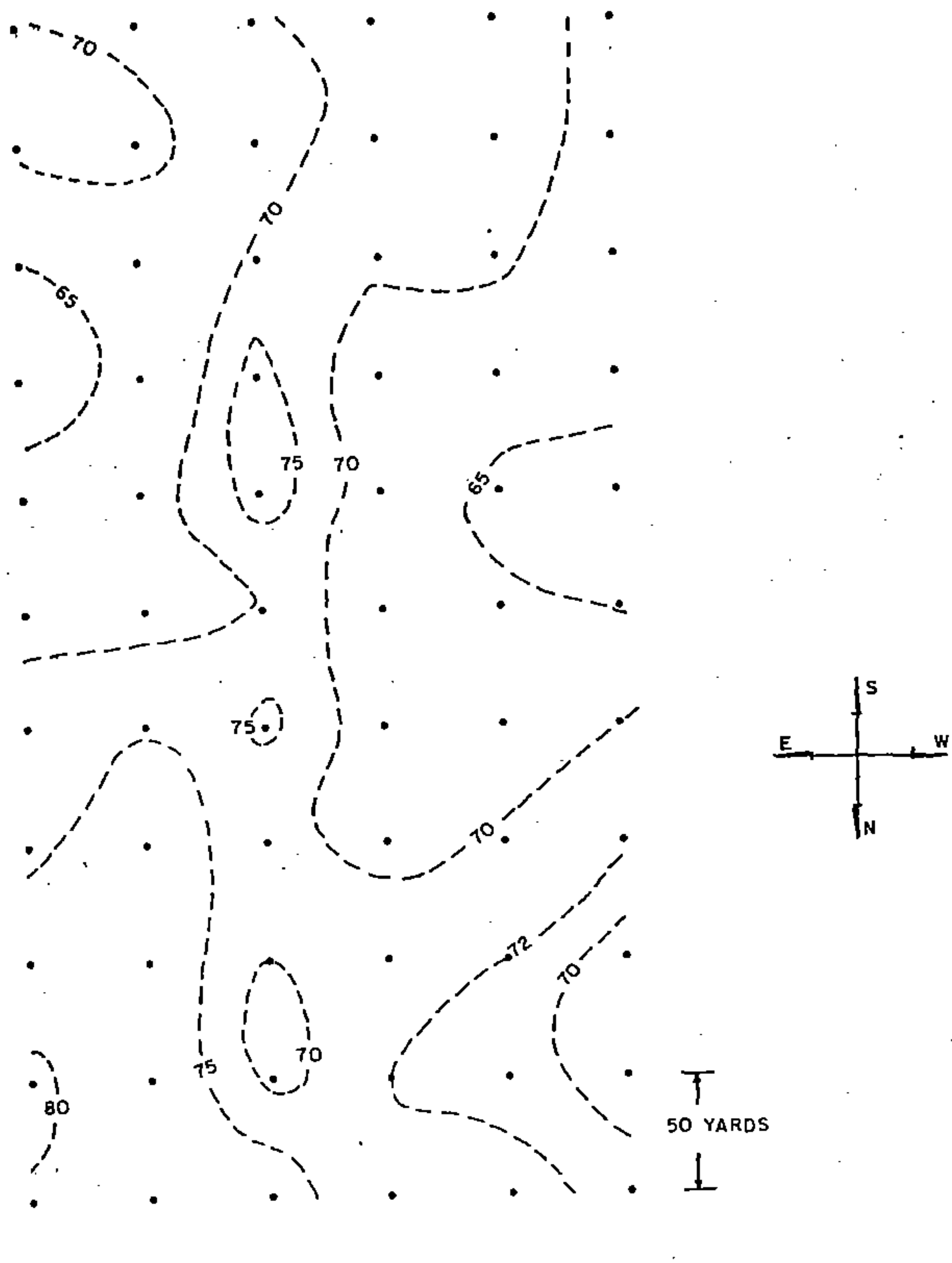


FIGURE 8 - NOISE LEVEL EXTREMES (db) ON NOISE CENTRE PLOT, BABBAGE RIVER, Y.T., 30 MAY, 1972.



X NOISE SOURCE

FIGURE 9 - AVERAGE NOISE LEVEL CONTOURS (db) ON NOISE CENTRE PLOT, BABBAGE RIVER, Y.T., 30 MAY, 1972.

River in conjunction with snow melt on 22 May, 1973. Females were first observed on 24 May.

Populations

Treatment densities

Noise area

A total of 29 territories were present on the three 'adjacent' noise plots (Noise Left - 12; Noise Center - 8; Noise Right - 9) for an average of 9.7 territories per plot or 2.68 acres per territory. Three territories were present on the smaller, 'immediate' noise plot.

Control area

A total of 30 territories were present on the three control plots (Control Left - 9; Control Center - 10; Control Right - 11) for an average of 10 territories per plot of 2.60 acres per territory.

General population densities

The longspur population in the general area, based on figures from the undisturbed area (2.60 acres per territory), would be 492 birds per square mile; based on figures from the disturbed area (2.68 acres per territory), the population would be 478 birds per square mile. Averaged together, the two study areas yielded an overall population figure of 485 birds per square mile.

Territorial singing

Intermittent singing was noted on 24 May, but strong territorial singing was not noted until 28 May. Singing activity increased to a maximum between 4 and 15 June, then declined to a complete lack of singing by 6 July.

Territory and nest selection

Habitat data were collected at 20 nest sites on the plots. In dry tussock tundra, 12 nests were found (0.28 nests/acre of this habitat); in wet polygonal tussock tundra, six nests were found (0.07 nests/acre of this habitat); in wet polygonal smooth tundra, two nests were found (0.04 nests/acre of this habitat). No nests were found in the seismic trail or stream bottom types.

All nests were located at the basal region of tussocks composed of _Carex_ spp. or _Eriophorum_ spp. and were constructed so that vegetation in most cases completely overhung the nest. Frequency of plant species occurring in longspur territories and at nest sites is shown in Table 3. Nest orientation was generally southerly (i.e., S, SE or SW) (Table 4) with 59% facing this direction as opposed to 41% facing the other five compass directions (X^2 = 3.50; df = 1; 0.1 > P 0.05).

Figures 10 and 11 show the relationship between territory distribution and optimum habitat areas.

The locations of each nest are shown in Figures 12 and 13.

TABLE 3. VEGETATION SPECIES FREQUENCY IN LAPLAND LONGSPUR TERRITORIES AND NESTING SITES, BABBAGE RIVER, Y.T.; 1972

SPECIES	TERRITORY Number of samples *	TERRITORY Per cent of total samples	NEST SITE Number of samples **	NEST SITE Per cent of total samples
Carex spp.	147	94.8	21	95.4
Eriophorum vaginatum	103	66.4	17	77.3
Dryas integrifolia	4	2.6	1	4.5
Mosses (Musci, Hylocomium spp.)	145	93.5	22	100.0
Cladonia spp.	127	81.9	20	90.9
Salix spp.	91	58.7	15	68.2
Lupinus arcticus	12	7.7	2	9.1
Pedicularis capitata	22	14.2	5	22.7
Pedicularis kenai	4	2.6	2	9.1
Betula glandulifera	138	89.0	20	90.9
Betula nana	142	91.6	21	95.4
Pyrola grandiflora	42	27.1	8	36.4
Liverwort	42	27.1	6	27.3
Composite	29	18.7	1	4.5
Polygonum bistorta	42	27.1	5	22.7
Cassiope tetragona	2	1.3	1	4.5
Cassiope spp.	19	12.3	1	4.5
Vaccinium vitis-idaea	138	89.0	19	86.4
Vaccinium uliginosum	27	17.4	1	4.5
Arctostaphylos rubra	35	22.6	6	27.3
Large lichen	65	41.9	8	36.4
Ledum palustre	123	79.3	20	90.9
Sphagnum spp.	37	23.9	5	22.7
Andromeda polifolia	3	1.9	-	-
Rubus arcticus	9	5.8	3	13.6
Poa arctica	3	1.9	1	4.5
Potentilla palustris	1	Trace		
Saxifraga sp.	1	Trace		

* Total number of samples collected from longspur territories.

** Total number of samples collected from longspur nest sites.

TABLE 4. NEST SITE ORIENTATION, BABBAGE RIVER, Y.T.; 1972

Nest Facing	Noise Plots		Control Plots		Combined	
	No.	Per cent	No.	Per cent	No.	Per cent
Northeast	2	12.5		-	2	
East	3	18.7	2	33.3	5	
Southeast	5	31.2		-	5	
South	3	18.7	3	50	6	
Southwest	1	6.3	1	16.7	2	
West	1	6.3		-	1	
Northwest	1	6.3		-	1	
North	0		0	-	0	

Employment of Chi^2 tests , indicated the number of nests facing south rather than other directions, was statistically significant.

FIGURE 10 - LAPLAND LONGSPUR TERRITORIES ON CONTROL PLOTS, BABBAGE RIVER, Y.T., 1972.

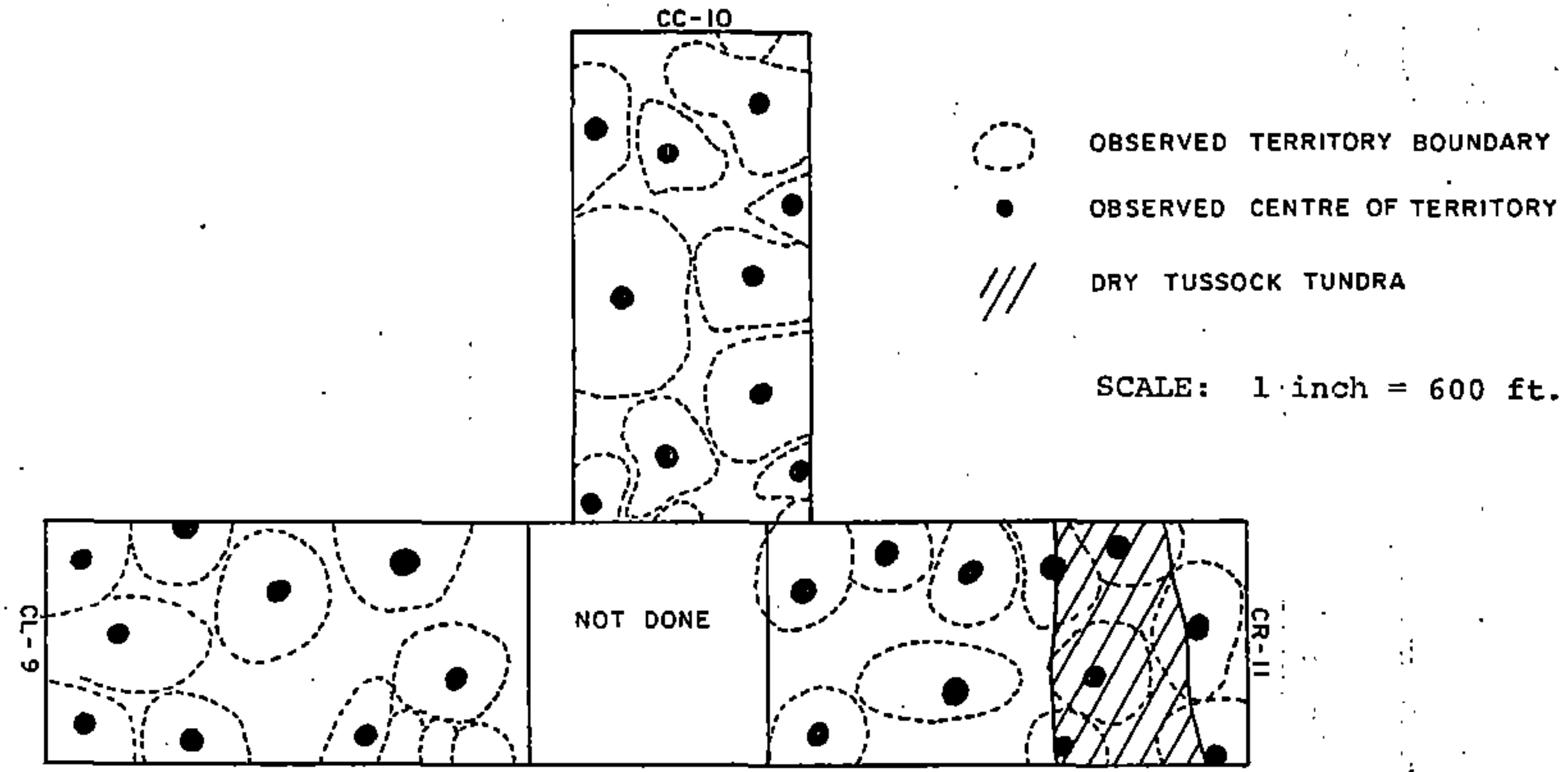


FIGURE 11- LAPLAND LONGSPUR TERRITORIES ON NOISE PLOTS, BABBAGE RIVER, Y.T., 1972.

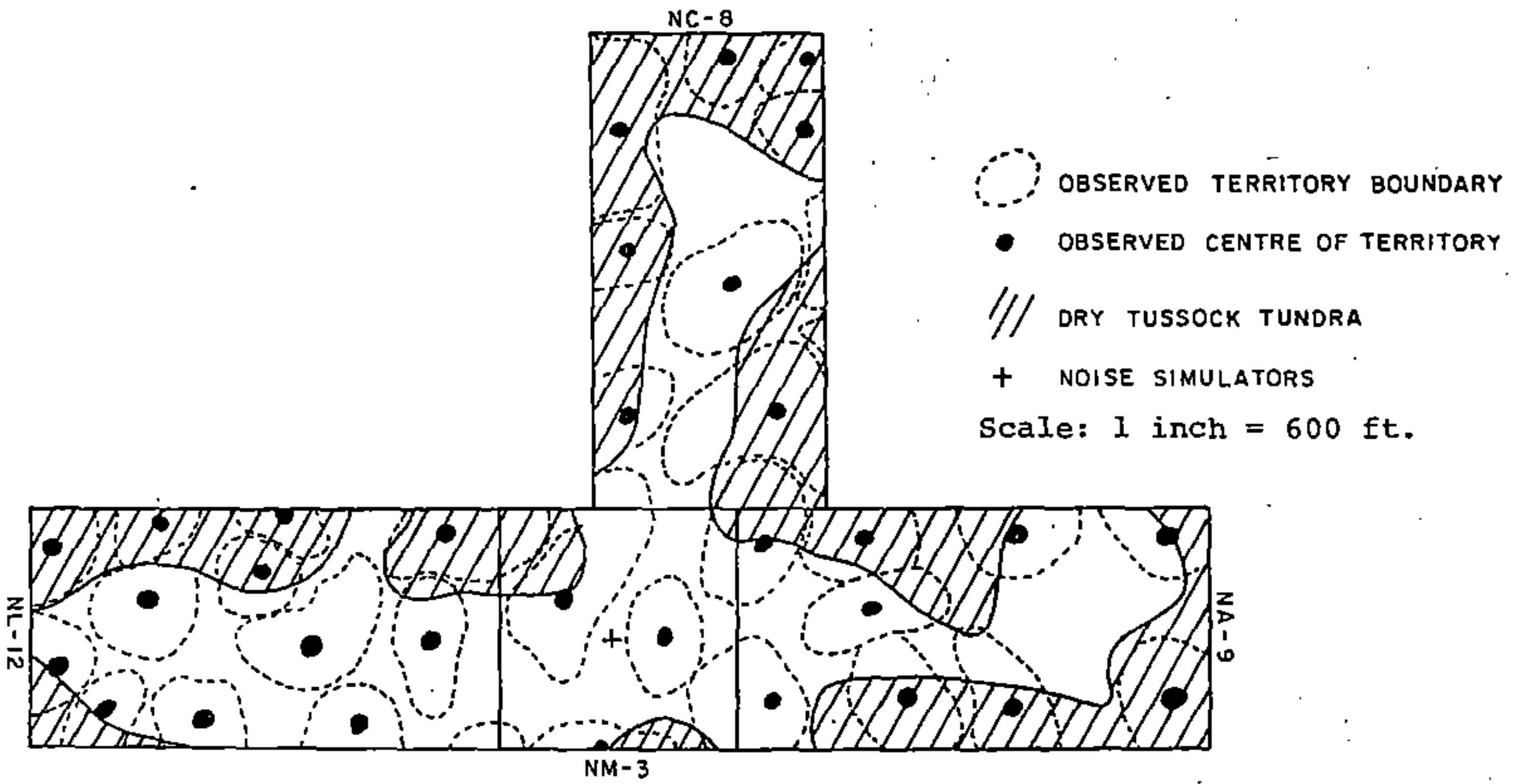
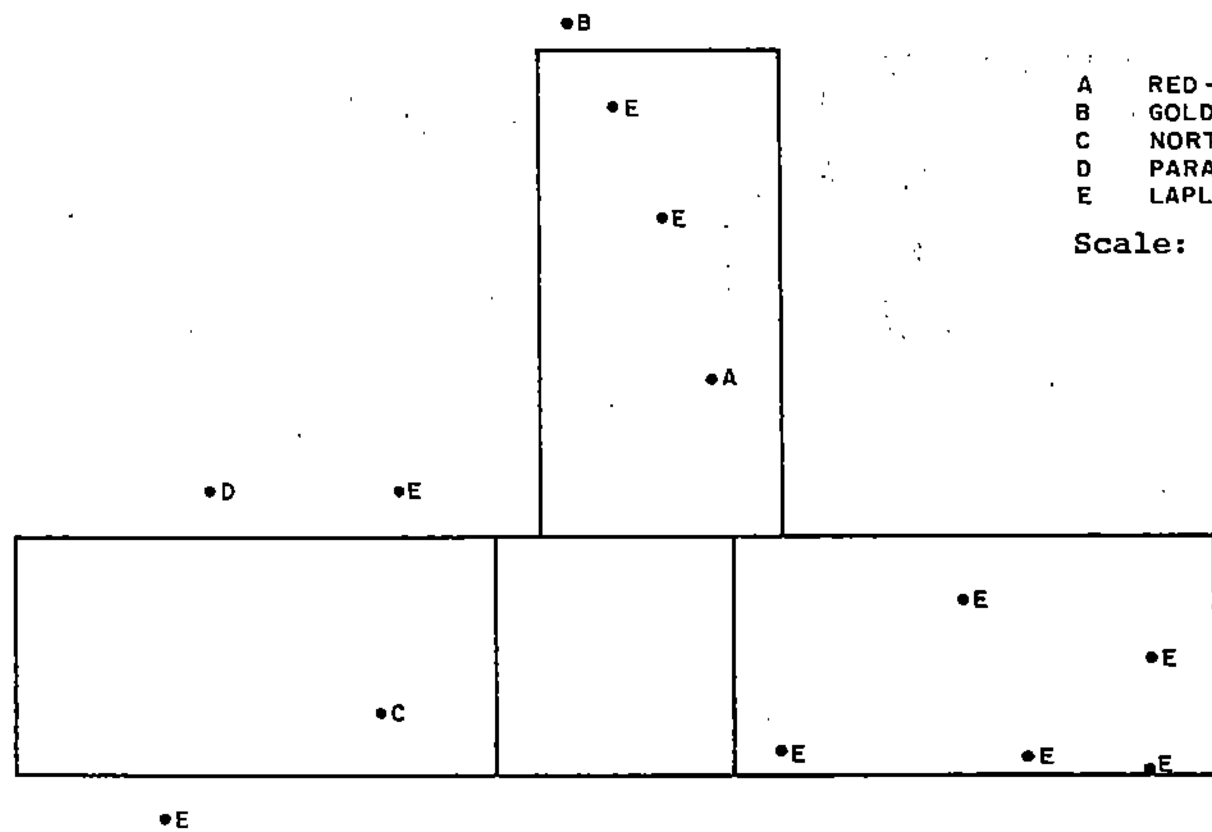


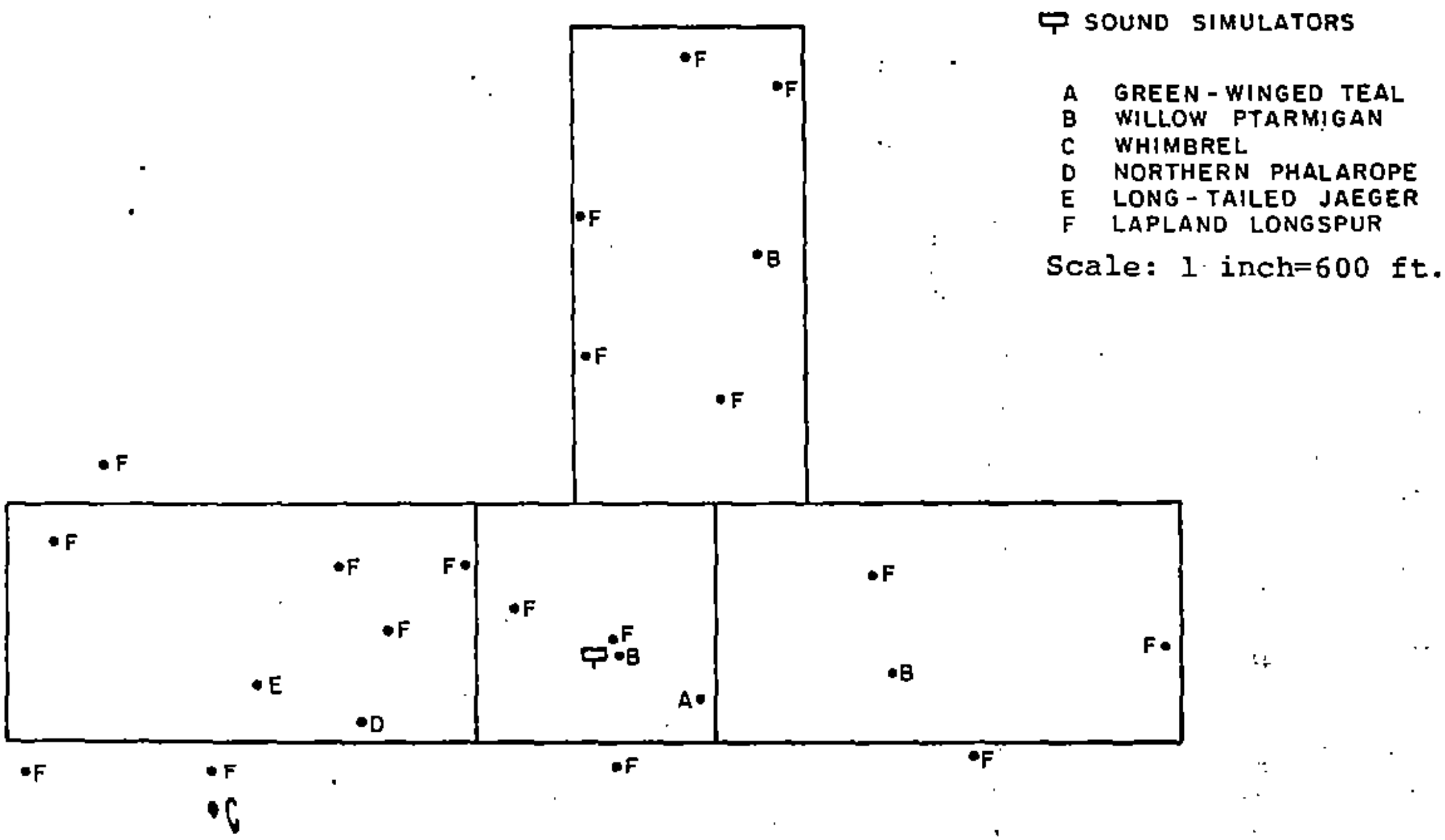
FIGURE 12- LOCATION OF NESTS (ALL SPECIES) ON CONTROL PLOTS, BABBAGE RIVER, Y.T., 1972.



A RED-THROATED LOON
B GOLDEN PLOVER
C NORTHERN PHALAROPE
D PARASITIC JAEGER
E LAPLAND LONGSPUR

Scale: 1 inch=600 ft.

FIGURE 13 - LOCATION OF NESTS (ALL SPECIES) ON NOISE PLOTS, BABBAGE RIVER, Y.T., 1972.



Nest initiation

Nest building began about 27 May and continued through to at least 10 June.

Clutch initiation

Data indicate that the earliest clutches were initiated by 29 May and laying continued through till 12 June. The peak of clutch initiation was reached about 5 June.

Hatching period

The earliest hatching date noted on the study plots was 15 June, and the latest was 28 June. Most nests hatched between 17 and 22 June. There was no evidence that nest initiation, clutch initiation or hatching period occurred at different times on the control versus the disturbance plots.

Reproductive Success

Clutch size

Data on clutch sizes are summarized in Table 5. There was no significant difference in clutch size between the disturbed area and the control area ($X^2 = 0.307$; df = 1; $P > 0.5$ for the ratio of five- to six-egg clutches on the control plots and the combined disturbance plots). It can be concluded then, that the noise disturbance had no effect on the clutch size of Lapland longspurs.

TABLE 5. CLUTCH SIZE OF LAPLAND LONGSPURS, BABBAGE RIVER, Y.T.; 1972

CLUTCH SIZE	CONTROL AREA		DISTURBANCE AREA						TOTAL	
			Immediate		Adjacent		Combined			
	No. Nests	Frequency %	No. Nests	Frequency %	No. Nests	Frequency %	No. Nests	Frequency %	No. Nests	Frequency %
5	6	66.7	3	100	7	46.7	10	55.6	16	59.3
6	3	33.3			8	53.3	8	44.4	11	40.7
TOTALS	9		3		15		18		27	
MEAN CLUTCH SIZE	5.33		5.0		5.53		5.44		5.41	

In fact, the mean clutch size of 5.41 is comparably large for the Lapland longspur anywhere on the mainland of North American (Hussell 1972). Moreover, it was unusual to find no clutches with less than five eggs (op. cit.).

Prenatal mortality

Prenatal mortality (Table 6) was low on both the control and disturbance areas. Predation was higher on the disturbance area with 13 (13.3%) eggs suffering predation compared with none on the control plots. Three of 21 nests on disturbance areas suffered predation, whereas none of nine nests on control areas had predation. This might indicate a trend toward increased predation on disturbed areas, but it was not significant ($X^2 = 1.43$; df = 1; $P > .1$). This rate of predation did not produce a significant difference in the hatching success between the control and disturbance areas on a per nest basis ($X^2 = 0.75$; df = 1; $P > 0.1$ -- eleven of 18 nests on disturbed areas lost no eggs, whereas seven of nine on control areas lost no eggs). However, when the overall hatching rates were examined, it was found that eggs laid on control plots had a greater chance of hatching (93.7%) than did eggs laid on disturbance plots (80.6%).

Postnatal mortality

Abandonment of nestlings, due mainly to the influence of a severe storm from 26 - 29 June, was the major

TABLE 6. PRENATAL MORTALITY IN NESTLING LAPLAND LONGSPURS, BABBAGE RIVER, Y.T.; 1972

CAUSE	CONTROL AREA		DISTURBANCE AREA						TOTAL	
			Immediate		Adjacent		Combined			
	No.	%	No.	%	No.	%	No.	%	No.	%
Suffered Predation	0	-	0	-	13	15.7	13	13.3	13	8.9
Addled	2	4.2	0	-	5	6.0	5	5.1	7	4.8
Other Mortality	1	2.1	0	-	1	1.2	1	1.0	2	1.4
Hatched	45	93.7	15	100	64	77.1	79	80.6	124	84.9
TOTAL Eggs Produced	48		15		83		98		146	

cause of postnatal mortality (Table 7). The percent of abandonment on both control and disturbance areas was approximately equal ($X^2 = 0.209$; df = 1; $P > 0.9$).

Predation accounted for only 2.4% of the nestlings observed and though all predation again occurred on the disturbed areas, the number involved was not statistically significant (24.4% on control vs. 20.2% on combined disturbance plots - Table 7).

Overall fledging success was virtually the same on the disturbance areas and on the control areas and so it is concluded that the noise disturbance had no effect on the postnatal mortality of Lapland longspurs.

Fledgling production and population turnover rate

The number of nestlings which reached fledging as a percentage of the total eggs laid, multiplied by the mean clutch size yields the fledgling production per nest (or per pair) of nesting birds.

The population turnover rate for any animal population is the ratio between biomass (number of individuals) entering the system (production) and the amount already present in the system (standing crop) (Kale 1965; Petrusewicz and MacFadyen 1970). This figure is calculated by taking the number of fledglings produced per nest and dividing by the number of adult birds (two) per nest.

TABLE 7. POSTNATAL MORTALITY IN NESTLING LAPLAND LONGSPURS, BABBAGE RIVER, Y.T.; 1972

CAUSE	CONTROL AREA		DISTURBANCE AREA						TOTAL	
			Immediate		Adjacent		Combined			
	No.	%	No.	%	No.	%	No.	%	No.	%
Hatched	45		15	-	64		79	-	124	-
Suffered Predation	0	-	0	-	3	4.7	3	3.8	3	2.4
Abandoned	11	24.4	2	13.3	14	21.9	16	20.2	27	21.8
Other Mortality *	3	6.7	0	-	0	-	0		3	2.4
Fledged	31	68.9	13	86.7	47	73.4	60	76.0	91	73.4

* Disappeared from nest prematurely. Cause unknown, but did not fledge.

Fledgling production and population turnover rate probably provide the most indicative measurement of the reproductive success of a breeding bird population. The figures obtained from this study (Table 8) when tested using Chi^2 Statistical tests, clearly indicate that there was no significant difference in the fledgling production and population turnover rates between the control and disturbance areas (64.6% of eggs produced fledglings on control plots and 61.2% produced fledglings on disturbance plots and population turnover rates were 1.72 and 1.66 respectively - Table 8).

It is concluded then, that the noise disturbance produced by the simulators had no measurable effect on the reproductive success of breeding Lapland longspurs.

OTHER BIRDS

Most species population densities within the treatment areas proved too small to accurately determine effects of disturbance. Density estimates for a few of the more common species have been derived from the census plot areas and are illustrated in Table 9. Only birds actually found nesting on the plots have been considered in this section. A pintail (*Anas acuta*) brood was found on the control area on 21 July, but it is not known whether this species actually nested on the study plots. The locations of all nests are shown in Figures 12 and 13.

TABLE 8. FLEDGLING PRODUCTION AND POPULATION TURNOVER RATE OF LAPLAND LONGSPURS, BABBAGE RIVER, Y.T.; 1972

	CONTROL AREA	DISTURBANCE AREA			TOTAL
		Immediate	Adjacent	Combined	
Number Fledged	31	13	47	60	91
Number Fledged as a Per cent of Eggs Hatched	68.9	86.7	73.4	76.0	73.4
Number Fledged as a Per cent of Total Number of Eggs	64.6	86.7	56.6	61.2	62.3
Fledglings per Nest	3.44	4.33	3.13	3.33	3.37
Population Turnover Rate	1.72	2.16	1.56	1.66	1.68

TABLE 9. POPULATIONS AND DENSITIES OF OTHER BIRD SPECIES AT BABBAGE RIVER, Y.T.; 1972

SPECIES	NOISE PLOTS			CONTROL PLOTS			COMBINED TOTAL		
	No. Birds	Acres per Individual	Individuals per square mile	No. Birds	Acres per Individual	Individuals per square mile	No. Birds	Acres per Individual	Individuals per square mile
Red-throated Loon	0	-	-	2	*	*	1	*	*
Green-winged Teal	1	*	*	0	*	*	1	*	*
Oldsquaw	0	-	-	1	*	*	1	*	*
Willow Ptarmigan	10	9	71	4	19	34	14	13	49
Golden Plover	4	22	29	2	39 + *	*	6	28 ± *	22 ±
Whimbrel	1	89 + *	*	1	78 + *	*	2	83 ± *	*
Pectoral Sandpiper	0	-	-	1	78 + *	*	1	167 + *	*
Semipalmated Sandpiper	1	89 + *	*	1	78 + *	*	2	83 ± *	*
Buff-breasted Sandpiper	0	-	-	1	78 + *	*	1	167 + *	*
Northern Phalarope	4	22	29	6	13	49	10	17	38
Parasitic Jaeger	0	-	-	2	39 + *	*	2	167 + *	*
Long-tailed Jaeger	2	44 + *	*	0	-	-	2	167 + *	*
Savannah Sparrow	4	22	29	0	-	-	4	42 ± *	15 ±

* Insufficient data.

Red-throated loon (Gavia Stellata)

First seen on 12 June when a pair was noted on a small tundra pool on the central control plot. These birds were noted occasionally on the same pond, throughout the study period. On 21 July when observers visited the plots to remove the grid markers, a nest with one egg was located near the edge of the pond. No visits were made to the study area after this date, so the fate of this nest is not known.

Green-winged teal (Anas carolinensis)

One nest was located in wet polygonal tussock tundra in the immediate area of the sound simulators. Nest construction began about 6 June and the first eggs were laid on 9 June. The clutch of 7 eggs was completed between 9 and 14 June. Incubation continued until between 6 and 13 July. All seven eggs hatched.

Willow ptarmigan

All habitat types were utilized as defended territory and for nest sites. The three nests in the disturbed area were all associated with small patches of Salix spp. or Betula spp. This was the only consistent association we observed.

Males began territorieal display about 24 May and continued to display until about the last week in June. Based on data from the three nests found on the plots, nest initiation began between 31 May and 2 June (Figure 14). There were 38 eggs under study in the three nests; 26 (68%) of these in two nests suffered predation and 12 (32%) in one nest were abandoned when the nest was flooded following several days of heavy rainfall during the last week of June. One of the nests suffering predation was located only 15 yards west of the sound simulators and consequently received a great deal of disturbance from the activities of people working on and immediately around the machines. It should be noted that three additional nests within 500 yards of the simulators but not on the plots hatched successfully, producing a total of 33 young.

Golden plover

First noted in the area on 28 May with males commencing territorial displays shortly afterward. Adults were observed in all habitat types, but demonstrated a preference for dry tussock tundra as nesting habitat. The only nest on the study plots was found on the control area and was situated in wet polygonal tussock tundra. This nest hatched four young on 6 July.

Whimbrel

First noted on 30 May. Whimbrels were mainly noted in dry tussock tundra and wet polygonal tussock tundra. One nest was located near the disturbance area in dry tussock tundra. Egg-laying was still in progress when this nest was discovered 14 June. There were two eggs on the morning of 14 June and five eggs in the afternoon. There were four eggs on 28 June. The nest hatched successfully by 6 July.

Northern phalarope

First noted on 20 May. These birds frequented both wet habitat types and frequented the polygon pools. One nest was found on the disturbed area and one on the control, both being located in wet polygon tussock tundra in the immediate proximity of tundra pools. Nests were associated with dense growths of Carex spp. Clutch initiation began about 10 June. There were four eggs in each of the two nests. The complete history of each nest is not known but at least three of the eggs in the nest on the disturbed area suffered predation by 6 July. The male was still incubating the fourth egg in this nest at that time.

Parasitic jaeger

First noted on 28 May. One nest was located near the control plots in an area of wet polygonal tussock tundra. The nest consisted of a hollowed bowl on the top of a large tussock. The one egg clutch was laid about 6 June. The one egg hatched successfully.

Long-tailed jaeger

A large migration into the area occurred on 28

May. These birds frequented all habitat types. One nest was found on the disturbed area in wet polygonal tussock tundra. The clutch was initiated about 9 June and was completed (two eggs) about 12 June. The two eggs hatched successfully.

DISCUSSION

The sound emitted by the gas compressor noise simulators had no measurable short-term effect on Lapland longspurs breeding in their vicinity. Sample sizes of other species were too small to base conclusions on. The study could not be initiated until shortly after the majority of the resident species had arrived and so it is not known what effect the presence of a compressor station operating at the time when the birds first arrive would have an effect on territory selection. The long term effect of a permanent installation and its support activities on the more sensitive species have alos not been tested. Care should also be taken in selecting locations for the compressor stations. It would be best if the stations could be kept away from waterfowl areas, as these birds are likely to be far more sensitive to disturbance of this type.

SUMMARY

1. No statistically significant difference in population density was noted in Lapland longspurs on the control and disturbance sites.

2. No overall measurable differences were noted in the reproductive success of Lapland Longspurs on the control and disturbance sites.

3. Lapland longspurs were the most abundant species on the site with a mean density of 485 birds per square mile.

4. Mean clutch size of Lapland longspurs was 5.41 eggs.

5. Prenatal mortality accounted for the loss of 15.1% of the total longspur eggs. Postnatal mortality accounted for the loss of 26.6% of the longspur nestlings.

6. The long term effects of disturbance are unknown.

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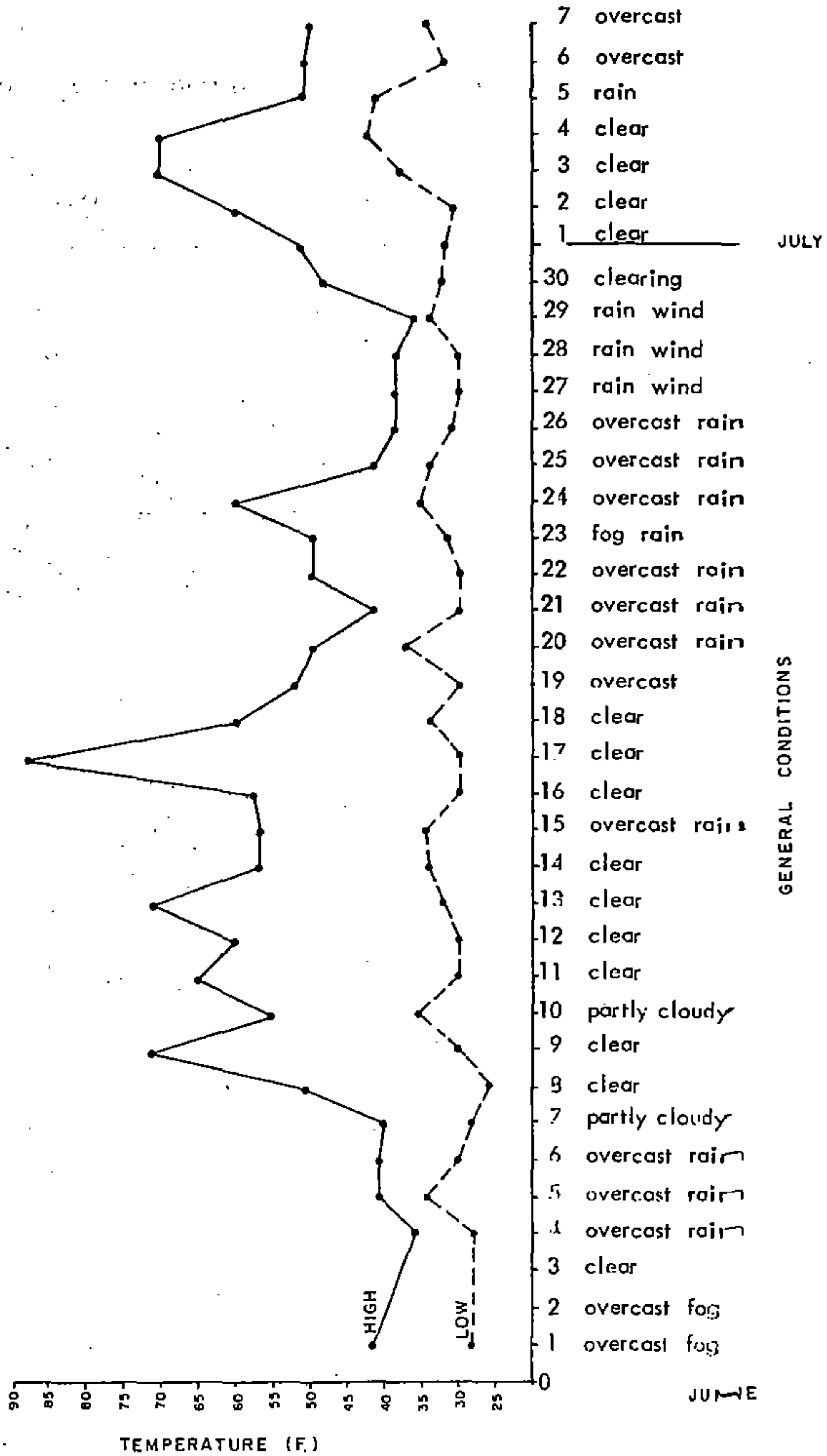
APPENDICES

APPENDIX 1. WEATHER DATA FROM BABBAGE RIVER, Y.T.; 1972

Date		Temperature (F.) Max.	Min.	Mean	Wind Dir.	Wind Speed (mph)	Baro. Pressure (in.)	Relative Humidity (%)
June	1	42	36	39	E	3 - 7	29.73	92
	2	40	28	34	-	-	-	-
	3	37	28	32.5	-	-	-	-
	4	36	28	32	NE	0 - 4	29.81	91
	5	41	34	37.5	N	0 - 7	29.85	96
	6	41	30	35.5	NE	3 - 5	29.95	100
	7	40	28	34	NE	0 - 5	30.02	83
	8	39	26	32.5	N	0 - 5	29.85	83
	9	66	30	48	NE	0 - 7	29.76	35
	10	55	36	45.5	NW	5 - 25	29.67	71
	11	66	30	48	E	3 - 12	30.01	59
	12	60	30	45	NE	0 - 5	30.16	75
	13	72	33	52.5	NW	3 - 5	29.96	74
	14	57	34	45.5	N	3 - 10	30.00	81
	15	57	35	46	SE	0 - 14	30.07	100
	16	58	30	44	SE	3 - 3	30.02	80
	17	88	30	59	SE	0 - 20	29.80	57
	18	60	34	47	NW	3 - 14	29.83	70
	19	53	30	41.5	NE	0 - 5	29.97	79
	20	50	37	43.5	NE	5 - 8	30.08	100
	21	42	30	36	NE	0 - 5	30.08	100
	22	50	30	40	E	3 - 10	30.02	93
	23	50	32	41	N	0 - 3	29.92	100
	24	60	36	48	N	0 - 5	29.80	100
	25	42	34	38	N	4 - 20	29.92	92
	26	38	32	35	NW	10 - 15	29.70	100
	27	38	30	34	NW	15 - 25	29.78	100
	28	38	30	34	NW	15 - 25	29.78	100
	29	36	34	35	NW	20 - 30	29.84	100
	30	48	33	40.5	NE	5 - 5	30.30	-
July	1	52	33	42.5	NE	5 - 5	30.43	80
	2	60	31	45.5	E	8 - 13	30.58	76
	3	71	38	54.5	SE	10 - 18	30.51	67
	4	71	43	57	SE	8 - 8	30.39	71
	5	51	42	46.5	N	5 - 10	30.32	93
	6	51	33	42	N	10 - 15	30.40	92
	7	50	34	42	E	10 - 15	30.33	82
MEAN TOTALS		51.5	32.5	42.0				

APPENDIX 2. - DAILY TEMPERATURES AT BABBAGE RIVER, Y.T., 1 JUNE - 7 JULY, 1972.



APPENDIX 3. LIST OF SPECIES OBSERVED AND MIGRATION DATA FROM BABBAGE RIVER, Y.T.; 1972

SPECIES	Arrival Date		Number Moving Eastward	Number Moving Westward
Arctic Loon	2	June		
Red-throated Loon	30	May		
Whistling Swan	30	May		32
Canada Goose	31	May		9
Black Brant	2	June		16
White-fronted Goose	28	May		124
Snow (Blue) Goose	28	May	5	314
Mallard	12	June		
Pintail	28	May	22	10
Green-winged Teal	29	May		
American Widgeon	5	June		
Shoveler	29	May		
Scaup spp.	1	June		
Oldsquaw	1	June		
Harlequin Duck	1	June		
White-winged Scoter	5	June		
Surf Scoter	20	June		
Common Merganser	7	June		
Red-breasted Merganser	30	May		
Sharp-shinned Hawk	28	May	1	
Rough-legged Hawk	28	May		
Golden Eagle	1	June		
Marsh Hawk	28	May		
Gyrfalcon	13	June		
Pigeon Hawk	28	May	1	
Willow Ptarmigan	21	May		
Rock Ptarmigan	1	June		
Sandhill Crane	28	May		1
Semipalmated Plover	1	June		
American Golden Plover	28	May		25
Black-bellied Plover	30	May		
Ruddy Turnstone	5	June		
Common Snipe	2	June		
Whimbrel	30	May	3	
Spotted Sandpiper	13	June		
Lesser Yellowlegs	(25	July)		
Pectoral Sandpiper	28	May		150
Baird's Sandpiper	(25	July)		
Long-billed Dowitcher	(25	July)		
Stilt Sandpiper	14	June		

Appendix 3 continued...

APPENDIX 3 continued:

SPECIES	Arrival Date	Number Moving Eastward	Number Moving Westward
Semipalmated Sandpiper	30 May		
Buff-breasted Sandpiper	28 May		60
Sanderling	31 May		
Northern Phalarope	30 May		
Parasitic Jaeger	31 May	4	
Pomarine Jaeger	28 May		
Long-tailed Jaeger	28 May	68	
Unidentified Jaegers	28 May - 5 June	450	
Glaucous Gulls	28 May		
Herring Gull	31 May		
Sabine's Gull	5 June		
Arctic Tern	28 May		
Snowy Owl	31 May		
Short-eared Owl	29 May		
Tree Swallow	28 May	3	
Cliff Swallow	13 June		
Common Raven	28 May		
Gray-cheeked Thrush	13 June		
Hermit Thrush	20 June		
Yellow Wagtail	5 June		
Yellow Warbler	5 June		
Rusty Blackbird	1 June		
Common Redpoll	28 May		
Savannah Sparrow	31 May		
Tree Sparrow	1 June		
White-crowned Sparrow	5 June		
Fox Sparrow	5 June		
Lapland Longspur	22 May		
Snow Bunting	28 May		

Appendix "A"

PHOTOGRAPHS

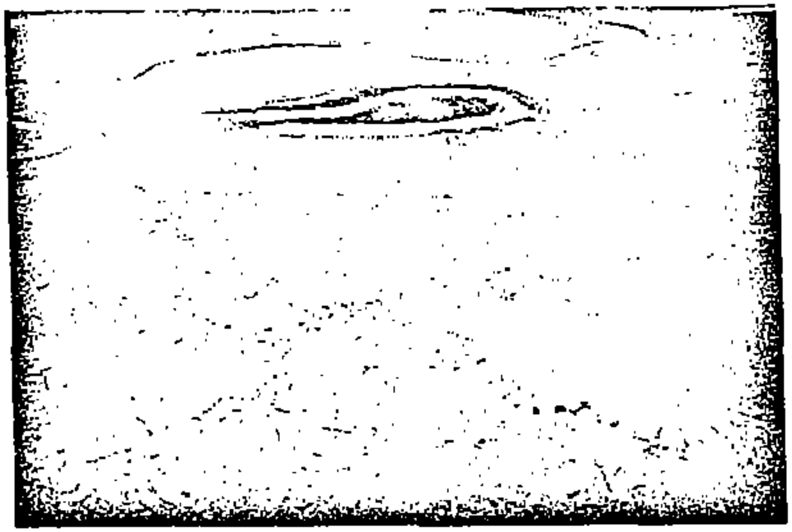


FIGURE 2 - Tussock Tundra inhabited by Lapland Longspurs.

FIGURE 14 - Willow Ptarmigan female in nest.

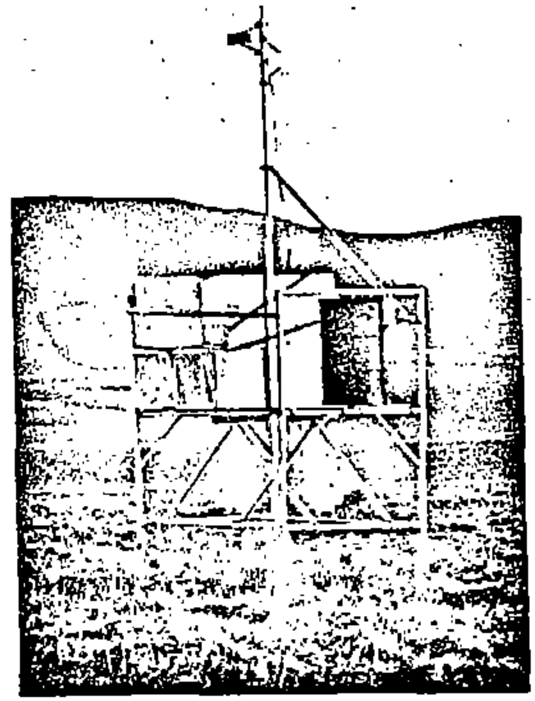


FIGURE 5 - Sound simulator.