ARCTIC GAS

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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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CHAPTER VIII

GAS COMPRESSOR NOISE SIMULATOR DISTURBANCE TO SNOW GEESE, KOMAKUK BEACH, YUKON TERRITORY, SEPTEMBER, 1972

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INTRODUCTION

Recent observations indicate large numbers of snow geese utilize the North Slope of the Yukon and eastern Alaska as a staging ground (Bartonek 1969, T. Barry pers. comm.). The period of staging activity in the area lasts from four to six weeks, and is characterized by extensive feeding activity which results in the buildup of a supply of fat which will serve the geese as fuel during flight on the southward migration (Figure 1). Although availability of a plentiful food supply is prerequisite in building fat reserves, it does not in itself insure that such reserves will accumulate. An equally important condition is that the geese remain undisturbed and keep any activity not related to feeding to a minimum. Only when both these requirements have been met is it possible for the geese to accumulate the vital energy reserves.

Plans for the proposed pipeline call for the construction of gas compressor stations at regular approximately 50 mile intervals along the route. It was the objective of this study to determine whether these stations would disturb the snow geese and if so, what the form and extent of the disturbance would be.

SITE DESCRIPTION

The study site was located 2.5 miles south-

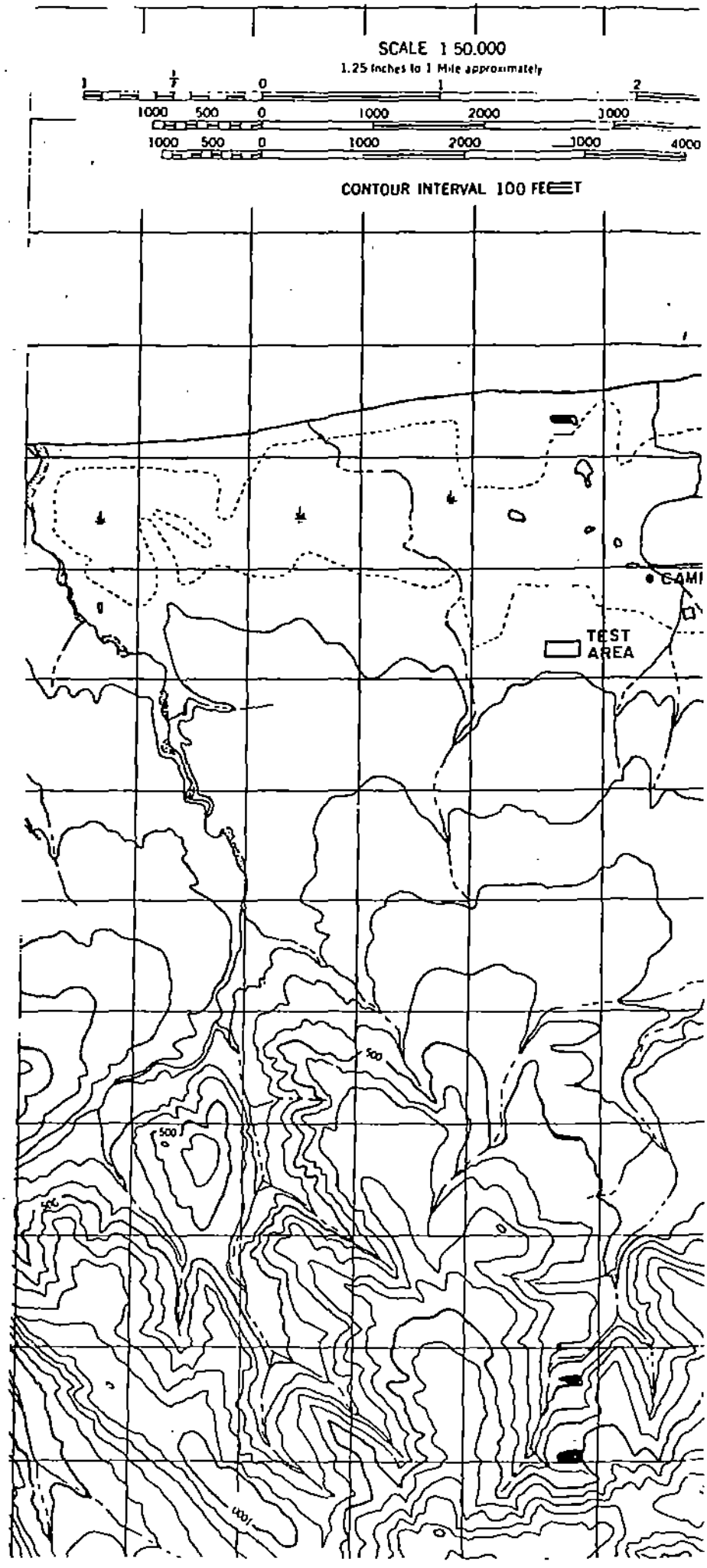
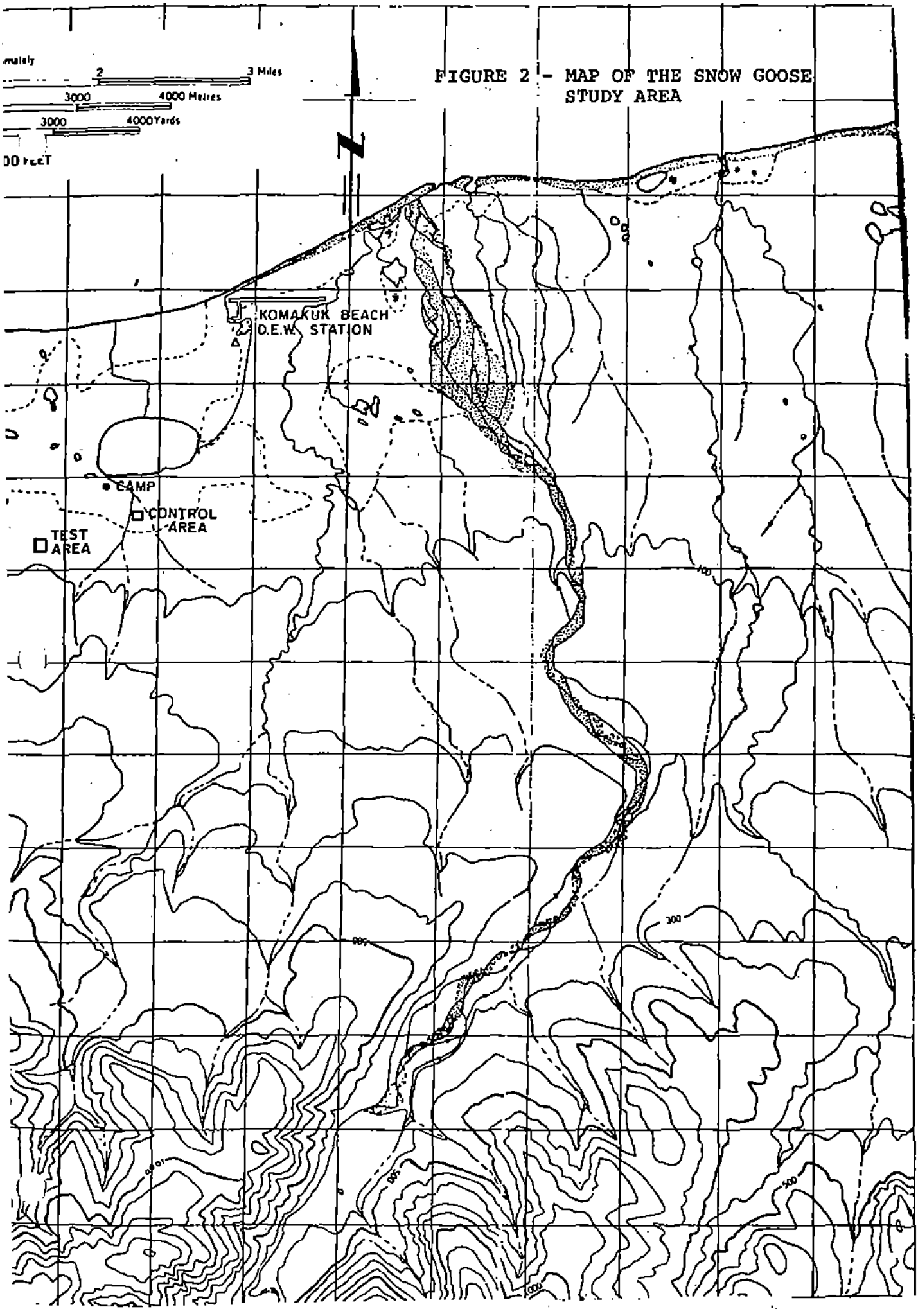

SCALE 1 50.000
1.25 inches to 1 Mile approximately
1 0 1 2
1000 500 0 1000 2000 3000
1000 500 0 1000 2000 3000 4000
CONTOUR INTERVAL 100 FEET
TEST AREA
500
500
100

FIGURE 2 - MAP OF THE SNOW GOOSE STUDY AREA



southeast of the Komakuk Beach D.E.W. station on the coastal plain of northwestern Yukon (N.T.S. map 117D; 1:250,000, Demarcation Point) (Figure 2). The plain is extremely constricted at this point, with less than eight miles separating the foothills of the British Mountains from the shore of the Arctic Ocean (Figure 3). Low hills and large flat basin areas characterize topography in the area.

WEATHER

Weather data for the four days of the study, 7 - 10 September were taken from the Komakuk Beach D.E.W. station and are summarized in Appendix 1.

METHODS

The types and levels of sound which would normally be encountered at a gas compressor station were reproduced by using a sound simulator system, as described in previously in this report. Although two simulators were set up at the study site, only one was functioning during the study.

At the test treatment site, goose decoys were set out at various distances in front of the simulator (Figure 4) to attract geese to the area and thus assure that a sufficient sample size was obtained. On September 7, the simulator was turned on and observers were stationed where they could see the entire area, but where they would not disturb the geese. Notes were taken on numbers, flight direction, altitude, and reaction behavior

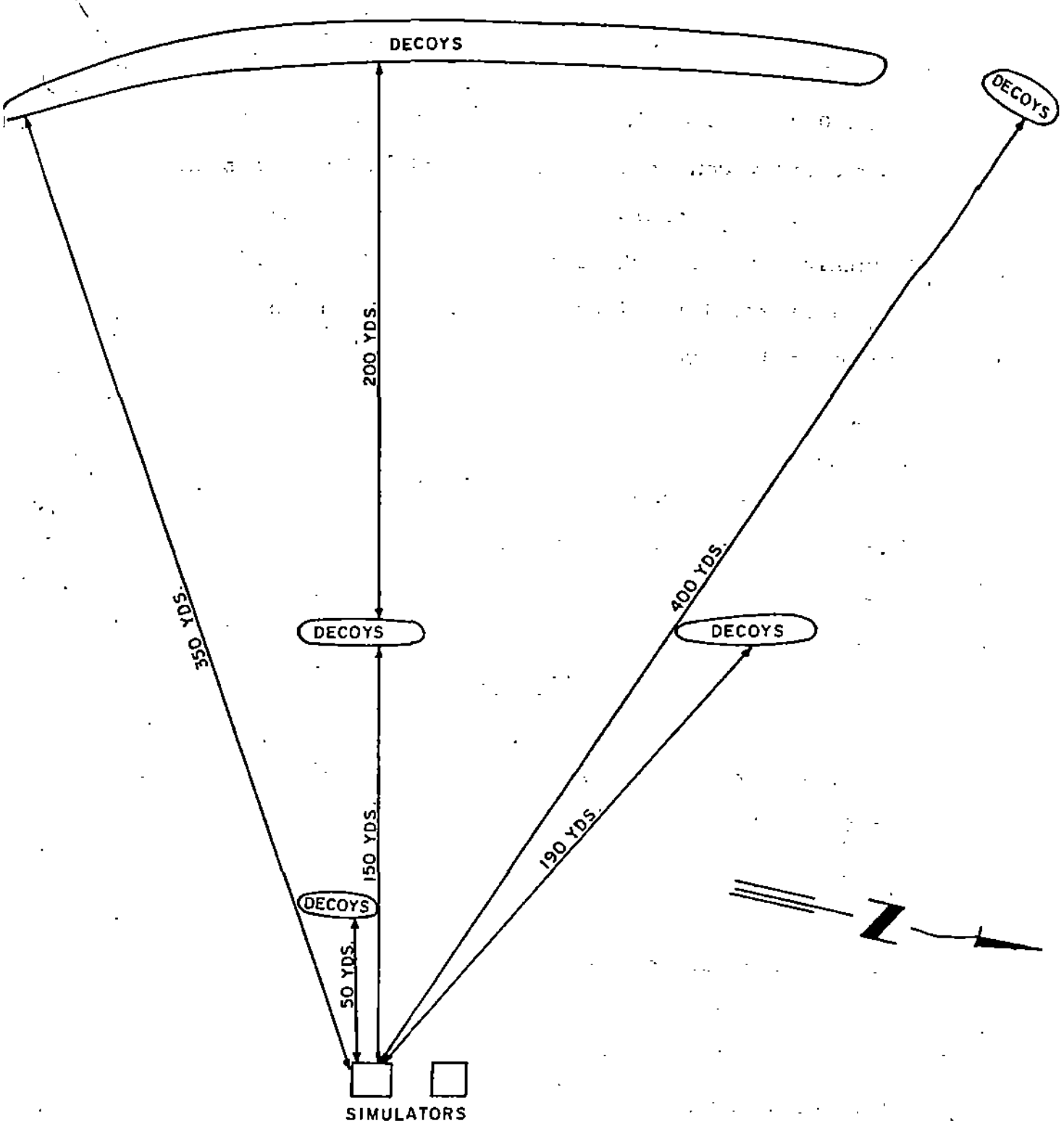


FIGURE 4 - LOCATION OF DECOYS IN RELATION TO SOUND SIMULATORS.

of all geese which came into the area of the simulator.

On the third day of the study, 9 September, the machine was turned off and data were gathered on the behavior of the geese towards the same physical features (simulators and decoys) but without the presence of high noise levels (Figure 5). This treatment is referred to in the text and tables as the test control.

Tests with the sound simulator ended with two minor experiments, on 9 September. The first of these consisted of allowing the geese to come in to the decoys then turning on the machine and noting the reaction. In the second, the generator which powered the simulator was left running, but the simulator was not turned on. Observations of the geese were recorded as before.

Decoys were also set out in an undisturbed (control) area, 2/3 miles east of the simulators, and observers recorded the behavior of the geese coming into the area. Observations at the control area were run concurrently with observations at the experimental site.

Methods of adequately quantifying the behavioral data were largely worked out as the study progressed with the result that data collected on the first day of the study were less complete than those on ensuing days. For example, details of circling and flaring behavior were not recorded on the first day but were recorded on the following days. This tended to dilute the comparative value of some of the earlier data. Despite these problems, sufficient information was obtai-

ned during the entire study to yield significant results on most of the important points.

Behavioral observations were recorded under two major types, circling and flaring. Circling behavior was characterized by an orderly circular movement of geese over the decoys. This action usually occurred after the geese had set their wings and glided into the decoy area. Flaring occurred as a response to some startling feature (sound or decoys) and was characterized by a sharp wheeling of the flock and a simultaneous rise in altitude.

In calculating the results, each flock was considered as a separate unit. Only those flocks arriving at least five minutes after the last flock had left were utilized in the analyses. It was felt that this insured the statistical independence of each unit.

RESULTS

Table 1 shows the number of individuals, number of flocks and average flock size of snow geese observed during the course of this study. As mentioned in the Methods section, not all flocks were used when calculating results, since certain restrictions had to be imposed to assure the independence of each unit. To assure the validity in combining all independent units, flocks of various size were tested; there was found to be no significant difference in behavioral responses relative to flock size.

TABLE 1. NUMBERS OF SNOW GEESE OBSERVED DURING SIMULATOR STUDY AT ALL TREATMENTS, KOMAKUK BEACH, Y.T.; 1972.

Treatment	Date	No. Geese	No. Flocks	Average Flock Size
CONTROL	7 Sept.	997	18	55
	8 Sept.	1,590	24	66
CONTROL-TOTAL		2,587	42	61
TEST-CONTROL	9 Sept.	6,414	44	145
TEST	7 Sept.	2,278	25	91
	8 Sept.	6,554	54	121
TEST TOTAL		8,832	79	112

RESPONSE TO DECOYS

Geese flying past the area of the test and control sites were recorded as "decoying" if they altered course, dropped in altitude or set their wings to come in to the decoys. Table 2 presents data on the number of flocks which decoyed, partially decoyed or did not decoy. There was no significant difference in the number of flocks decoying under each treatment. Flocks recorded during the test treatment, especially those approaching from the west, would begin to decoy long before they reached the area where noise from the simulators would be very noticeable. This probably explains the similarity in decoying behavior under the various treatments.

In the remainder of the tables, flocks which did not decoy are not considered.

LANDING

The landing of geese among the decoys might be considered as the single most important indicator of acceptance of a particular treatment. Table 3 shows clearly that under control or test control conditions a statistically significant greater number of geese landed than under test conditions.

Generally, family groups were the first to land, with young birds first to touch down. Even under control conditions, adult birds became wary of the decoys and did not land unless the young geese called them in. With one exception, the geese did not land at all if the simulators were on.

TABLE 2. REACTIONS TO DECOYS OF FLOCKS OF FLYING SNOW GEESE UNDER VARIOUS EXPERIMENTAL CONDITIONS ON THE YUKON NORTH SLOPE (7-9 SEPTEMBER 1972)

EXPERIMENTAL TREATMENT	Number of flocks in which all birds decoyed	part of flock [1] decoyed	none of the flock decoyed	TOTALS
CONTROL	25	2	5	32
TEST CONTROL	24	4	3	31
TEST	33	0	5	38
TOTALS	82	6	13	101

[1] This column is excluded from statistical analysis due to small sample size.

$X^2 = 0.386$; df = 2; P >0.5

TABLE 3. NUMBER OF FLOCKS OF SNOW GEESE WHICH APPROACHED THE DECOYS, ARRANGED ACCORDING TO WHETHER THEY LANDED AT THE DECOYS, UNDER THREE EXPERIMENTAL CONDITIONS ON THE YUKON NORTH SLOPE (7-9 SEPTEMBER, 1972)

EXPERIMENTAL TREATMENT	Number of flocks which landed at decoys [1]	Number of flocks which did not land at decoys	TOTALS
CONTROL	10	17	27
TEST CONTROL	16	12	28
TEST	1	32	33
TOTALS	27	61	88

[1] Includes flocks in which some but not all the individuals landed at the decoys.

Comparison of all treatments employing Chi Square statistical test: $X^2 = 21.595$; df = 2; $P < 0.005$

Comparison of control vs. test control: $X^2 = 2.223$; df = 1; $P > 0.1$

CIRCLING

Circling of the decoys was significantly more prevalent under control and test control conditions than under test conditions (Table 4). This would probably indicate that under control conditions the geese were more relaxed, circling until they were satisfied that the decoys did or did not present a threat to their safety.

Under test conditions, circling was usually interrupted when the geese reached the point where the sound became noticeable; the geese would then leave the area.

It should be noted that the number of flocks circling the control area differed significantly, statistically, from the number which circled the test control area. There was no apparent explanation for this. The difference between the control and the test was, however, highly significant, statistically, and it is possible that a larger sample size from the control area might have brought it more in line with results from the test control.

Number of times circled

Although flocks of geese occasionally circled the decoys under test conditions, they seldom circled more than once. Apparently the cumulative effect of the sound and decoys was quick to discourage the geese. Without the noise (test-control), birds tended to circle two, three or even four times before landing or leaving the area. Table 5 shows that the number of times which geese circled the simulators was significantly

TABLE 4. CIRCLING BEHAVIOR OF FLOCKS OF SNOW GEESE, AFTER THE INITIAL POSITIVE RESPONSE TO THE DECOYS, UNDER THREE EXPERIMENTAL CONDITIONS ON THE YUKON NORTH SLOPE (7-9 SEPTEMBER, 1972)

EXPERIMENTAL TREATMENT	Number of flocks in which [1] all individuals circled	some but not all [2] individuals circled	no individuals circled	TOTALS
CONTROL	12	2	7	21
TEST CONTROL	26	0	2	28
TEST	5	2	26	33
TOTALS	43	4	35	82

[1] Restricted to flocks whose behavior was completely recorded.

[2] This column is excluded from statistical analysis due to small sample size.

Comparison of all 3 treatments

Employing Chi Square statistical test: $X^2 = 36.356$; df = 2; $P < 0.005$

Comparison of control vs. test control: $X^2 = 6.449$; df = 1; $P < 0.01$

Comparison of control vs. test $X^2 = 11.611$; df = 1; $P < 0.005$

TABLE 5. NUMBER OF TIMES THAT DECOYED FLOCKS OF SNOW GEESE CIRCLED THE DECOYS (TWO EXPERIMENTAL TREATMENTS ON THE YUKON NORTH SLOPE, 7 - 9 SEPTEMBER, 1972)

EXPERIMENTAL TREATMENT	Number of flocks which circled the decoys: one time	more than one time	TOTALS
TEST CONTROL	4	24	28
TEST	7	2	9
TOTALS	11	26	37

[1] Restricted to flocks whose behavior was completely recorded. Insufficient data recorded on Control.

Comparison of Test vs. Test Control employing Chi Square statistical test: $X^2 = 13.142$; df =1; P <0.005

greater, statistically, for the test control than for the test treatment.

FLARING

Flaring usually occurred under test conditions and seemed to be a direct response to the sound of the simulators. Table 6 shows that there was a significant difference in the incidence of flaring between the control treatments and the test treatment, being much more common under test conditions.

Flock height at time of flaring

At very low altitudes the geese occasionally flared from the decoys, so the estimated height at the time of flaring was recorded under test control and test conditions. Results indicated in Table 7 show that birds flared at statistically significant higher altitudes under test conditions. This would seem to indicate that under test conditions the geese were flaring as a result of the sound, whereas under test control conditions they were flaring at low altitudes - most likely in response to recognition of the decoys.

Distance from simulator at which flocks flared

The distance from the simulator at which flocks flared was tested (Table 8) but, although the mean distance was somewhat less under test conditions, it was not significantly so. Distance when flaring, whether as a result of noise or decoys, operated mainly in the vicinity of the furthest decoys from the simulator and it was for this reason that no statistically significant results

TABLE 6. FLARING RESPONSE OF FLOCKS OF SNOW GEESE, AFTER THE INITIAL POSITIVE RESPONSE TO THE DECOYS, UNDER THREE EXPERIMENTAL CONDITIONS ON THE YUKON NORTH SLOPE (7 - 9 SEPTEMBER, 1972)

EXPERIMENTAL TREATMENT	Number of flocks in which [1] all individuals flared	some but not all individuals flared [2]	no individuals flared	TOTALS
CONTROL	8	0	13	21
TEST CONTROL	13	1	14	28
TEST	29	1	3	33
TOTALS	50	2	30	82

[1] Restricted to flocks whose behavior was completely recorded.

[2] This column is excluded from statistical analysis due to small sample size.

Comparison of all 3 treatments employing Chi Square statistical test: $X^2 = 18.509$; df = 2; $P < 0.005$

Comparison of control vs. test control: $X^2 = 0.485$; df = 1; $P > 0.1$

TABLE 7. HEIGHT (FT) OF FLOCKS OF SNOW GEESE WHEN FLARING UNDER TEST AND TEST CONTROL TREATMENTS, YUKON NORTH SLOPE, 7-9 SEPTEMBER, 1972

	TEST	TEST CONTROL
Mean height	79.0	9.4
S D	13.74	0.63

Comparison of means: $t = 3.66$; $df = 21$; $P < 0.01$

t - test for samples with unequal variances -- Steel and Torrie 1960:81

TABLE 8. DISTANCE (YDS) FROM SIMULATOR AT WHICH FLOCKS OF SNOW GEESE FLARED, UNDER TEST AND TEST CONTROL TREATMENTS, YUKON NORTH SLOPE, 7-9 SEPTEMBER, 1972.

	TEST	TEST CONTROL
Mean distance	365	337.5
S D	45.3689	12.5

Comparison of $\bar{X}_1$ and $\bar{X}_2$ - $t = 0.567$, $df = 27$

∴ No differecne in distance from simulator at which flocks flare, for the test and test control when using t test for samples with unequal variances.
($t = 0.567$; $df = 27$; $P > 0.5$)

were found.

Behavior of flocks after flaring

Whether the flocks remained or left the area after flaring was recorded in order to further identify the cause of the flaring. Under test control conditions, statistically significant greater number of the flocks remained in the area after flaring than did so under test conditions (Table 9). This would appear to indicate that the birds were probably flaring from the decoys (since no sound) under test control conditions and that their fright was not enough to drive them away. However, under test conditions, where the birds seem to have been flaring as a result of the sound of the simulators, the geese were affected far more drastically and in all cases left the area immediately.

FLIGHT DIRECTION

The direction that the birds used to approach and leave the study area was recorded, to determine if the simulator had any effect on the movements of the geese. It was found that a statistically significant greater number of birds altered direction when the simulator was turned on than under either of the control treatments (Table 10). Further, of the 26 flocks which changed direction during observations at the test site, 16 (61%) of these altered their course by more than 90%, which means that they were either turned back completely or that their flight distance was greatly increased by the detour.

TABLE 9. BEHAVIOR OF FLOCKS OF SNOW GEESE AFTER THEY HAD FLARED, UNDER TEST CONTROL AND TEST TREATMENTS, (YUKON NORTH SLOPE 7-9 SEPTEMBER 1972)

EXPERIMENTAL TREATMENT	Number of flocks which left the area	Number of flocks which did not leave the area	TOTALS
TEST CONTROL	3	11	14
TEST	15	0	15
TOTALS	18	11	29

Table does not include 2 flocks which split-up with part leaving the area and part staying in the area.

Comparison of test control and control areas employing Chi square statistical test:

$$X^2 = 18.99;\ df = 1;\ P < 0.005$$

TABLE 10. DIRECTION TAKEN BY FLOCKS OF SNOW GEESE WHEN LEAVING THE AREA AFTER HAVING APPROACHED THE DECOYS (THREE EXPERIMENTAL TREATMENTS ON THE YUKON NORTH SLOPE, 7 - 9 SEPTEMBER, 1972) [1]

EXPERIMENTAL TREATMENT	Number of flocks which [2] changed direction	did not change direction	TOTALS
CONTROL	1	9	10
TEST CONTROL	4	20	24
TEST	26	3	29
TOTALS	31	32	63

[1] Restricted to flocks whose behavior was completely recorded.

[2] Table does not include 3 flocks in which some individuals changed direction and others did not change directions.

Comparison of all 3 treatments employing Chi Square statistical test: $X^2 = 35.301$; df = 2; $P < 0.005$

Comparison of control vs. test control: $P = 0.5347$ (Fisher's Exact test)

DISCUSSION

The results of this experiment indicate that snow geese were disturbed by the sound produced by the gas compressor simulator. The most direct effect to the geese would be the loss of feeding areas within the vicinity of a gas compressor station. That this area might be quite large is evidenced by the fact that, when the simulator was first turned on, flocks of geese which had been feeding within three miles of the simulator got up and moved further away. Some of these birds eventually returned, venturing to within 1 1/2 miles of the machines. However, the arrival of a floatplane on a nearby lake on 8 September succeeded in driving the birds completely away from the area again, and this time they did not return. Since any compressor station would need to be maintained and air traffic is the likely means of maintenance support, the presence of the floatplane in this experiment is probably quite valid and as noted, the effect was quite drastic. Snow geese feeding on the Hudson Bay lowlands also react strongly to aircraft (R.A. Davis, pers. comm.).

Another obvious effect of this disturbance is to cause the birds to make large detours in order to avoid the disturbed areas. It is improbable that a single compressor station would act as a total barrier to the east-west movement of geese along the North Slope. The stations will probably, however, cause the birds to make extensive detours. It is very difficult

to calculate how this might affect the importance of the North Slope as a feeding area. Presumably, under undisturbed conditions the geese spend the least time possible in moving from one feeding area to another. This is in order to conserve as much energy as possible. Disturbance factors which decrease energy conservation by geese are likely to be detrimental to the population. This may be most critical in late breeding seasons where the geese reach the staging areas in lighter condition than normal (Cooch 1958).

Because the North Slope is currently an area where geese can feed under relatively undisturbed conditions, every effort should be made to keep this area intact. Cooch (1958) emphasizes the importance of staging areas in the eastern Arctic to the blue goose. He has demonstrated that geese which leave the staging areas before acquiring sufficient food energy (this is especially likely in late breeding seasons) are later forced to interrupt their migration, stopping in areas normally avoided. Barry (1967) re-emphasised this, stating that such resting areas for Mackenzie Valley migrations might be found among the islands in the Mackenzie River or at lakes such as Brackett Lake, near Norman Wells, N.W.T. These additional stopovers result in increased hunting mortality and may thus be detrimental to the population. If compressor stations are to be built on the North Slope, then their locations should be carefully chosen so as to place them in areas where they are likely to cause the least

possible disruption to the geese. Further, if optimum goose areas cannot be avoided when building the stations, then either the stations should be shut down during the staging period, or an efficient muffler system should be incorporated in order to reduce the area affected by the noise. Finally, servicing of the stations by aircraft should be kept to a minimum or suspended entirely during the staging period.

SUMMARY

1. There was no statistically significant difference in the number of flocks of snow geese which approached the decoys under test and control conditions.

2. A statistically significant greater number of flocks of geese landed under control treatments than under the test treatment.

3. A statistically significant greater number of flocks of geese circled under control treatments than under the test treatment. Also, geese circling under control conditions circled a statistically significant greater number of times.

4. A statistically significant greater number of flocks of geese flared under the test treatment than under control treatments. Birds flaring under control conditions did so at a statistically significant lower height and a statistically significant greater number remained in the area after flaring.

5. A statistically significant greater number of flocks of geese altered direction when leaving the experimental area under the test treatment than under the control treatments.

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APPENDICES

APPENDIX 1. WEATHER DATA FROM KOMAKUK BEACH, Y.T.; 7 - 10 SEPTEMBER, 1972

Date - Time (A.D.S.T.)		Temp.	Wind Dir.	Wind Speed	Baro. Pressure (inches)	Vis.(miles)
7 Sept.	04:00	35	E	10	29.97	15
	16:00	36	E	11	30.02	15
8 Sept.	04:00	33	W	3	30.06	7
	16:00	35	-	0	30.09	15
9 Sept.	04:00	31	W	17	30.11	15
	16:00	34	N	7	30.01	15
10 Sept.	04:00	32	NW	6	29.91	15
	16:00	30	W	31	29.96	15

Appendix "A"

PHOTOGRAPHS

FIGURE 1 - Snow Geese feeding on the north slope.

FIGURE 5 - Snow Geese reacting to non-operational noise simulators.

FIGURE 3 - Coastal plain with British Mountains in the background, near Komakuk Beach, Y. T.