FOOD AND HABITAT SELECTION BY FALL MIGRANT SANDHILL CRANES IN KIDDER COUNTY, NORTH DAKOTA

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ABSTRACT

FOOD AND HABITAT SELECTION BY FALL
MIGRANT SANDHILL CRANES IN
KIDDER COUNTY, NORTH DAKOTA

By Carl R. Madsen

During their fall migration, sandhill cranes concentrate in a series of gathering places along their migratory routes in the western United States and Canada. On the northern prairie grain-producing areas, these cranes, at times, are involved in crop depredations. This thesis is a report of a study of food and habitat selection of sandhill cranes, conducted in the fall of 1965 near Horsehead Lake, North Dakota. This area is visited annually by upward of 8,000 fall migrant cranes.

A 36 square-mile study area was cover-mapped to determine habitat availability. Crane use of the habitats on this area was observed from August through October, and a total of 4,500 individual crane occurrences were observed on known habitats. Results of this study indicate that these cranes selected wheat and barley fields as their preferred feeding sites, with less feeding on oat fields. Corn is probably a high-preference food of these cranes, although the data in this report do not prove this.

Carl R. Madsen

Thirty-three cranes were collected for food-selection studies, and the habitats from which they were taken were analyzed for food availability. By comparing food availability with food consumption, it was shown that the cranes selected grain as their principle food from an abundance of grain and "weed" seeds. Some insects were taken but therewas little evidence of cranes feeding on other "native" foods. From the food-availability studies it was estimated that there was enough waste grain in the area studied to feed many more cranes than were present in the fall of 1965.

This report includes suggestions of crop management for future evaluation in crane control measures.

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By

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INTRODUCTION

During their southward migration, sandhill cranes, Grus canadensis, stop at a number of gathering points located along their migratory routes in the western United States and Canada. These gathering places are used each fall by thousands of lingering migrants between late July or early August and the winter freeze-up in October or November (Buller and Boeker, 1965). In the grain-producing areas of the northern prairies, there has been a long history of crop depredations by cranes near these gathering places. Precise knowledge of crane behavior in relation to land use is needed for successful management of both land and cranes to minimize losses of agricultural crops and, at the same time, give consideration to the cranes as a valuable resource.

This thesis is a report of a study done during the fall migration of sandhill cranes in the Horsehead Lake region of North Dakota. The study took place from July to December, 1965, and was a work unit of the Northern Prairie Wildlife Research Center, Jamestown, North Dakota.

The main objectives of this study were to determine habitat selection and feeding habits of

sandhill cranes on the northern prairies during the fall stop-off. To meet these objectives, habitat use and crane behavior were observed in the field and 33 feeding cranes were collected for study of food selection from habitats where food availability was measured.

The Area Studied

This study was done in south-central North Dakota near Horsehead Lake in Kidder County, midway between Jamestown and Bismarck. Over the years Horsehead Lake has become well-known as a fall concentration point for migrant cranes. Local residents have reported crane gatherings prior to 1900 (Clayton Maw, per. com.). As many as 15,000 cranes have been recorded in recent years (Buller and Boeker, 1965) in approximately 200 square miles around Horsehead Lake.

This region is characterized by gently rolling prairie, with scattered clusters of small morainic hills with local relief of about 250 feet. Large, shallow, alkaline lakes are common in the region, and there are a few deeper freshwater lakes. Alkaline and fresh-water sloughs or "potholes" are common throughout the area.

This part of North Dakota is farm country and was settled soon after 1880 (Marschner, 1959). Most farms in this part of the state are a full section or more

in size and most are owner-operated. The principle cash crops grown here are wheat, oats, and barley; and to a lesser extent, flax and rye. Corn and sorghum are grown for livestock feed but are not major crops. The annual precipitation fluctuates widely from year to year, and grain yields vary with the amount of rainfall (Marschner, 1959).

Livestock production centers around beef cattle and sheep, and grazing by these animals, along with haying, accounts for the chief uses of the grasslands and lower marshlands. Dairying is not widespread but is practiced as a supplement to beef and grain production by relatively few operators. Even fewer farmers raise hogs.

Timmerman (1958) reports that farmers of the Horsehead Lake area had complained of crop depredations by cranes for "approximately 10 years." U. S. Game Management Agent Harry Jensen (per. com.) said that complaints of crane damage to crops have increased since about 1945. Most common are complaints of cranes eating swathed small grains and unharvested corn.

In some years there are no complaints of crane depredations (Timmerman, 1958; Buller and Boeker, 1965), and the major factor is weather. Small grains are mowed, put into windrows (called "swaths") and under ideal conditions the grain dries and ripens in

about a week and is picked up and threshed with a combine. Harvest is begun in late July and usually is finished in about a month; but when the harvest is interrupted by rains, the grain may lie in the swath for several weeks before it can be threshed. When this happens, cranes arriving from the North may find ideal feeding situations in the grain fields and can cause considerable damage by eating and trampling the unharvested grain. But in most years the harvest is completed prior to the arrival of all but a few hundred cranes, and few crops are exposed to crane damage.

Most corn is cut for ensilage and is not exposed to depredations, but a few farmers prefer to allow their corn to ripen and then turn livestock into the standing fields for a direct harvest. This once was a common practice and saved farmers the expense of picking a usually poor crop of corn. This practice also "opens up" a corn field which makes it more attractive to cranes. Most farmers have abandoned such field feeding of stock partly because it seems to invite crane damage.

Some farm operators are very outspoken in their wrath against cranes and argue that since cranes are protected by law, then state and federal authorities should provide protection for crops or compensation for losses. Others are more resigned to the realities of the situation and take measures to protect their crops if the need arises. It seems that each farmer has his own

views on the topic but all agree that cranes can pose a serious threat to their crops.

Farmers can get permits from federal wildlife authorities to scare cranes from their crops. Federal game men working in the area assist farmers by scaring cranes and by showing farmers how to use acetylene exploders and various forms of fire-crackers to drive cranes from the fields. A popular and effective method of scaring used by both farmers and by game men is to shoot a rifle into the ground near a flock of cranes. Most scaring, however, is effective only if the threatened fields are kept under constant surveilance--a task usually beyond the game managers and, surprisingly, not often done by the land owner with the problem.

The Sandhill Cranes

Three subspecies of sandhill crane occur in migration and on wintering grounds in the Central Flyway. By far the most numerous of the three is the Lesser Sandhill Crane, (G. c. canadensis), which breeds in arctic regions of Canada, Alaska, and Siberia (Walkinshaw, 1949:64). The medium-sized Canadian Sandhill Crane, (G. c. rowani), apparently nests in northern Alberta and Saskatchewan and southern McKenzie (Walkinshaw, 1965a). The largest subspecies, the Greater Sandhill Crane, (G. c. tabida), formerly nested in southern Canada and northern United States from the Pacific coast to Lake

Ontario, but is now extirpated over much of its range (Walkinshaw, 1949:130). Cranes presently nest both east and west of North Dakota, but Walkinshaw (1949:183) gives 1920 as the date of the last crane nesting record for the state.

The chief wintering areas of sandhill cranes are in the southwestern United States and northern Mexico. During the spring migration, cranes gather in concentrations of up to 240,000 in the Platte River Valley of Nebraska during February and March (Buller and Boeker, 1965). From there, the northward migration begins in earnest, and large flocks of cranes are not seen on the northern prairie stop-off sites as they are in the fall. In the Horsehead Lake region of North Dakota, only "a few" cranes are seen on the fields in the spring (Ralph Robinson, per. com.).

The fall migration begins in late July or early August when large flocks of southbound cranes congregate at certain gathering points which form a chain of stop-off places from Saskatchewan to Texas. Some of these areas are visited annually by 50,000 cranes (Buller and Boeker, 1965).

Crop depredations by cranes have been reported from fall gathering sites in the northern prairies (Boeker, Aldrich, and Huey, 1961; Buller and Boeker, 1965; Munro, 1950; Smith and Boeker, 1958; Timmerman, 1958) and around wintering grounds in New Mexico (Sperry, 1939).

Walkinshaw (1949:136) states that cranes have undoubtedly benefited from long-time protection from hunting and by the establishment of many of our wildlife refuges. He also says that the greater sandhill crane has been increasing in numbers. But whether or not all of the subspecies increase in numbers or remain at present levels, crane management will certainly be concerned with problems of crop depredations.

THE STUDY

Crane Activities

Crane behavior and activities were observed from early August until the last cranes left the Horsehead Lake region in early November. The crane activities I observed are similar to those described in whole or in part by other workers (Allen, 1932; Sprunt, 1939; Walkinshaw, 1949:43, 1950; and Miller and Stephen, 1966).

In the Horsehead Lake area, the life of a migrant crane centers around a roosting site where large flocks gather in the evening to spend the night. Shortly after sunrise a steady procession of small flocks of three or four to 10 or more cranes leave from these roosting concentrations to feed on nearby fields. I observed cranes going five miles to feed, but typically they use fields closer to the roost. At the feeding sites, cranes once again form large flocks and feed until shortly before noon, frequently lifting their heads, and occasionally hopping and jumping about with outstretched wings.

If disturbed at the feeding grounds, the whole flock takes off at once with a great deal of calling and goes to another field, usually not far away. Even when not disturbed, cranes often leave a feeding site and go to others at their own choosing, but they ordinarily do

so in small groups. Miller and Stephen (1966) have stated that small groups of birds function as units within the large crane flocks in Saskatchewan. I have observed both adults and birds of the year in the same flocks, indicating that these flocks may be made up of family groups as Walkinshaw (1950) has suggested of the large crane flocks seen in the fall.

About noon, cranes leave the morning feeding areas, again in small groups, and return to the roosts at the mud-flats and marshes of the lake shores where they loaf during the middle of the day. On some days they return to the midday roost in a leisurely flight and soar to great altitudes, calling loudly and circling about almost out of sight, eventually dropping down to the loafing areas.

In late afternoon they again take off from their roosts in small flocks and return to the feeding fields. If undisturbed, they feed until shortly after sunset when they return to the roosts for the night.

In the Horsehead Lake region, eleven roosting sites were used by cranes repeatedly throughout the fall of 1965 (Figure 3). At each of these roosts there are flowing springs which probably provide a key component of the roost--fresh water. Walkinshaw (1950) states that water for drinking is essential to cranes; and since most of the crane roosts in the Horsehead Lake region

Figure 1.--Flock of feeding sandhill cranes on grain stubble, Kidder County, North Dakota, August, 1965. Photo by M. D. Pirnie.

Figure 2.--Small group of sandhill cranes returning to a roost, Kidder County, North Dakota, August, 1965. Photo by M. D. Pirnie.

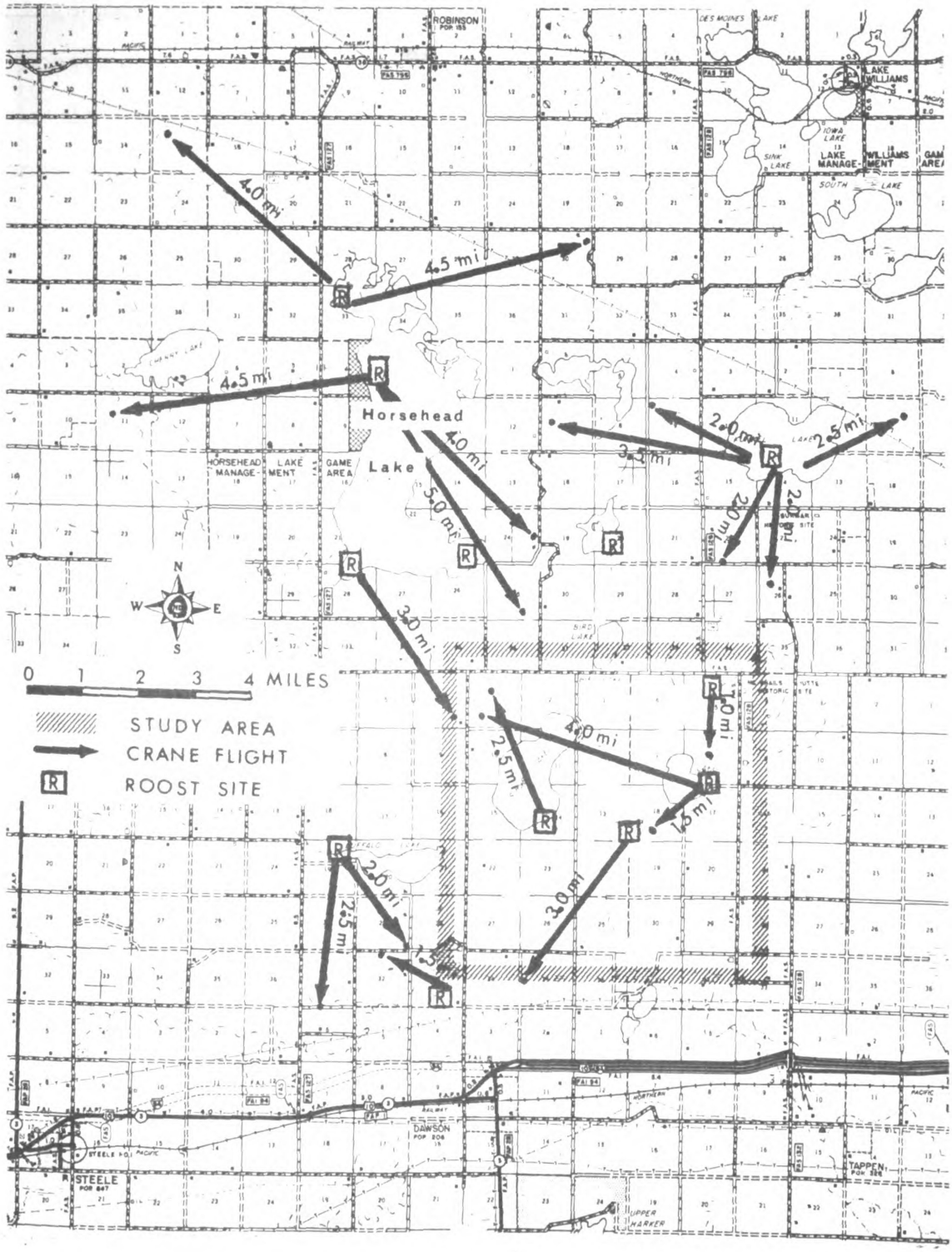

Figure 3.--The Horsehead Lake region of North Dakota with some crane flights observed in the fall of 1965.

are on the shores of alkaline lakes, the fresh water springs may well be an important factor in the selection of roosts.

In addition to regular use of a few roosts, cranes also fed regularly on certain fields for several weeks. I had planned to follow a group of cranes from the morning roost and continue to follow them throughout the day and, if possible, into the next day to determine if the same cranes continually returned to favored feeding and roosting sites. The cranes were easily followed by motor vehicle in this open prairie country, but at their destination, the flocks I followed invariably joined other cranes and became indistinguishable among them. It soon became apparent that marked birds would be needed for continual observation of individual cranes, and marking birds was beyond the scope of this project. This phase of the study was unsuccessful from the standpoint of meeting the objectives, but a number of crane flights were followed from roosts to feeding sites, or, in some cases, return flights were followed. These movements are plotted on the map in Figure 3.

Population Levels

Apparently the fall crane population at Horsehead Lake varies from year to year as Buller and Boeker (1965) give peak numbers of 8,000 to 15,000 cranes in the area during the fall migrations from 1961 to 1964.

Walkinshaw (1949:129) quotes "Fish and Wildlife Service Notes" claim of 100,000 sandhills in this area in 1930, but apparently that many cranes have not been there in recent years.

At various intervals during the fall migration of 1965, I counted the cranes in the Horsehead Lake region to determine the crane population levels I was dealing with. The first cranes to arrive in the area were reported to me by a farmer, and I made 11 counts of the population from July to November--seven from a motor vehicle and four from an airplane. When counting from a vehicle, I used a spotting scope and binoculars to avoid flushing the cranes by approaching them too closely. To conserve flying time, aerial counts were made during the early afternoon while the cranes were concentrated at the roosts.

On November 2, there were many cranes in the area, but I do not have a population estimate for that day. During the night, cold weather, accompanied by strong northwest winds moved in; and on the following morning, I could find relatively few cranes. An aerial count in the afternoon showed only 300 cranes left in the area.

On November 12, a farmer reported to me that he had seen four cranes earlier that day; and these were the last cranes reported in the area for 1965.

Table 1.--The chronology of the Sandhill Crane population build-up during the 1965 fall migration in the Horsehead Lake region, Kidder County, North Dakota.

Date	Number of Cranes	Source
15 July	40	Farmer's report
26 July	"small flock"	Farmer's report
31 July	140	Observation from vehicle
14 Aug.	400	Observation from vehicle
22 Aug.	700+	Observation from vehicle
6 Sep.	4,500 (est.)	Observation from vehicle
21 Sep.	7,700	Observation from aircraft
5 Oct.	7,200	Observation from aircraft
20 Oct.	5,200	Observation from aircraft
2 Nov.	many	Observation from vehicle
3 Nov.	300	Observation from aircraft
7 Nov.	300	Observation from vehicle
9 Nov.	150	Observation from vehicle
12 Nov.	4	Farmer's report

Habitat Selection

Selection of feeding habitats by sandhill cranes in the area studied was determined by observing habitat use by feeding cranes in relation to habitat availability on a 36 square-mile study area, located two miles southeast of Horsehead Lake. This study area was selected because cranes had been observed in large numbers there in previous years, it was accessible by motor vehicle, and could be inventoried for cranes by one man in one day. Also, it was large enough to include a variety of physiographic features and a thorough representation of the agriculture in this part of North Dakota. See Figure 3 for location.

My land-use cover map of the study area included identification and location of all croplands, pasture and other grasslands, lakes and wetlands, and important landmarks such as roads and farmsteads. From this base map, each square mile of the study area was enlarged to full-page size for use in the field.

Acreages devoted to each land use were estimated from the cover map and were used to determine availability of each habitat type (Tables 2 and 3). Cranes were counted on the study area at frequent intervals during the fall migration and the habitats on which they were found were noted directly on the enlarged maps. See Figure 4 of crane sightings in fields and Table 3. These inventories were made from a pick-up truck, using a spotting scope and binoculars.

Table 2.--Land-use on the 36 square-mile study area in Kidder County, North Dakota, Autumn, 1965.

Land-Use	Acres	% of Total
Pasture	7,335	34.0
Hayland	4,718	21.9
Wetlands	4,360	20.2
Cropland	3,983	18.0
Soil Bank & Non-Use	920	4.3
Fallow	260	1.2
	21,576*	

*Represents a 6.4% error of estimation from the actual 23,040 acres total.

Table 3.--Habitat availability and use by feeding sandhill cranes on the 36 square-mile study area in Kidder County, North Dakota, Autumn, 1965.

Habitat	No. of Fields	No. Acres*	No. Observations	No. Cranes Observed	Cranes per Acre
Wheat Fields	51	1,581	45	2,857	1.81
Barley Fields	10	250	8	337	1.35
Corn Fields	31	796	10	554	0.70
Oat Fields	30	1,096	10	358	0.33
Sorghum Fields	4	60		14	0.23
Hayland	83	4,718	11	380	0.08
Flax Fields	10	200	—	0	0
			85	4,500	

*Values given include a 6% error of estimation.

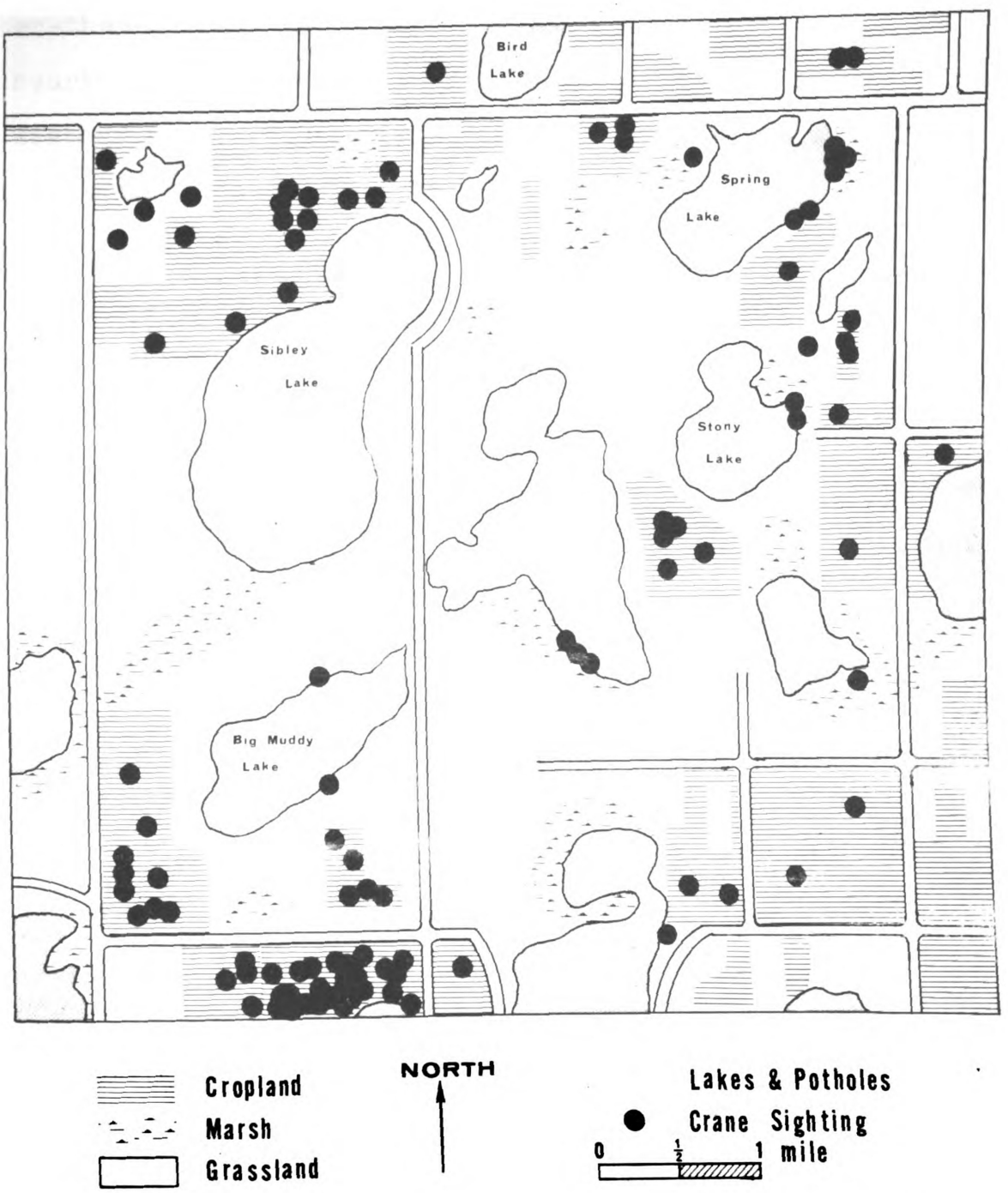

Figure 4.--General cover map of the intensive study area showing locations of crane sightings. Kidder County, North Dakota, Autumn, 1965.

According to local farmers, 1965 was a good year for grain production in North Dakota because of the better-than-average rainfall. Harvest of a bumper crop was nearing completion early in September when prolonged wet weather prevented combining the last fields. Thus, most of the cranes observed on the study area were using harvested fields, along with pastures and marshes.

Shortly after a killing frost on September 5, farmers cut most of their corn for ensilage. All corn on the study area was harvested in this way and only a few corn fields on nearby farms were left standing to ripen. Cranes used this standing corn and seemed to show a particular liking for it. I feel that a higher preference for corn would have been shown in Table 3, had there been standing corn on the study area; but only a few rows of corn with small ears, left in the fields as wind breaks, along with scattered kernels of waste corn, was the only corn available to cranes on the study area.

More than 1,200 cranes were seen on pastures and roosts on the study area, but were not included in Table 3 because I believe cranes used these habitats chiefly for loafing or roosting and not primarily for feeding. I once saw cranes apparently hunting insects on a pasture, but never saw them eating at the roosts. Later stomach analyses of cranes collected from roosts

indicated no feeding there, and of three cranes taken on grasslands, one had one grasshopper in the gullet.

On the study area I observed no cranes using unmowed grasslands or fallow fields, so I have not considered them as feeding sites. Similarly, I saw no cranes on flax fields of the study area; but Tanner (1941) has listed flax as a food of Minnesota cranes, so in Table 3, I have considered flax fields as possible feeding sites. The same is true of haylands since Martin, Zim, and Nelson, (1951); McLeod, (1954); and Boeker, et al., (1961); have reported alfalfa eaten by cranes.

Food Habits

Food habits studies of birds too often deal with stomach contents with no regard for food availability at the time and place from which the birds are collected. To study the food habits of sandhill cranes for this study, 33 cranes were collected from nine different habitats, and food availability was determined at each collection site. The stomach contents of each crane were compared to food availability at the place from which it was collected. The results of these investigations are given in Table 4.

To get a good representation of feeding cranes, I wanted to collect four or five birds from each type of cropland and natural habitat used by the cranes. As cranes are wary and not easy to approach, a high-powered

rifle was used for most of the collecting. Five of the 33 cranes were taken with a shotgun from flocks leaving known feeding spots. Most collecting was done during the morning and afternoon feeding periods; but in spite of this timing, five cranes taken on grain fields had empty gullets.

To determine the nature of crane feeding at roosts, two cranes were shot shortly after sunrise while leaving a roosting site. Both of these birds had empty gullets, indicating they did not feed prior to their morning flight. To avoid upsetting the habitat selection studies, no cranes were shot on the 36 square-mile study area, but were taken from other farms of the Horsehead Lake region.

Shortly after the cranes were shot, they were frozen and stored until the field work was completed, when they were thawed and the food materials removed. Foods from the gullets were kept separate from the gizzard contents and were sorted, identified, and measured.

Materials taken from the gullets are better indicators of the last food eaten then are the gizzard contents. For this reason only the gullet contents have been used for comparison with food availability in Table 4. The gizzard contents are listed in Appendix C.

In the studies of food availability, no single method of habitat evaluation was suitable for use on all the habitats from which cranes were collected. As a result, various existing methods of habitat analysis were tried on several different habitats, but with varying degrees of success.

A variation of the loop frequency method (Am. Soc. Range Mgt., 1962; Hutchings and Chase, 1963) was tried on grainfields, and a new method was developed for measuring density of waste grain and "weed" seeds on harvested grain fields. Both are presented below and are discussed with observations made on other habitats.

My initial food availability measurements on grainfields dealt with frequency of occurrence of plant seeds as possible crane foods. To determine frequency, a one-inch diameter wire loop was placed on the ground 100 times at 10-step intervals along a line across the field to be inventoried. At each stop the seeds within the loop were identified and recorded as "present" without regard for density.

Frequency of each food item was determined from the field observations by the following formula:

$$\frac{\text{no. of times the species occurred in plots}}{\text{total no. of plots in which food items occurred}} \times 100 = \text{\% frequency}$$

Six grainfields from which cranes were collected were inventoried by this method, but the results of these observations could be expressed only as frequency. There was no measurement of density for determination of actual quantities of each food available, and all seeds are ranked alike, in spite of differences in size. The frequency of occurrence of the seeds I have listed in Table 4 is of value only for comparison with comparable data within the table. These are the inherent shortcomings of frequency which must be dealt with if one is limited to this type of data.

After considerable experimentation I developed another technique to measure density and at the same time be practical for field use. I have called this method the variable-plot-size method. For this I constructed a 5-foot square wood frame and divided the area within into 25 one-foot squares by stretching wires across the frame. Five of these squares were randomly selected and were painted white for use as a sample of the area within the frame.

In the field the wood frame was placed on the ground at five randomly selected stations within a 10,000 square-foot area centering around the spots where cranes were collected. (I have assumed that the 10,000 square-foot area included a large part of the area on which the cranes fed just prior to collection.)

All large seeds found within the five previously selected one-foot squares were identified and counted at each station. Thus, 25 samples were taken on each habitat.

For efficiency in counting the numerous small seeds found on the fields, I constructed a wire frame enclosing an area of 1/2 square-foot. This square was further divided by a square frame of 1/4 square-foot and by cross wires forming various sized triangles from 1/4 to 1/32 square-foot (Figure 5). This frame was placed within each of the 25 one-foot plots and from it a convenient sized plot was selected for counting each kind of seed, depending on the numbers and sizes of the seeds present.

The average weight of each species of seed was determined from a sample of seeds weighed to the nearest .00001 gram. The average weight of seed of each species was multiplied by the numbers of seed observed per square foot. The results of these observations, expressed as pounds of seed per acre, is used as food availability in Table 4 for the habitats inventoried by the "variable-plot-size" method.

The variability of pounds of seed per acre (expressed as the standard error in Table 4) is from the variability among the 25 samples taken in the field. No variance term was computed around the values for seed

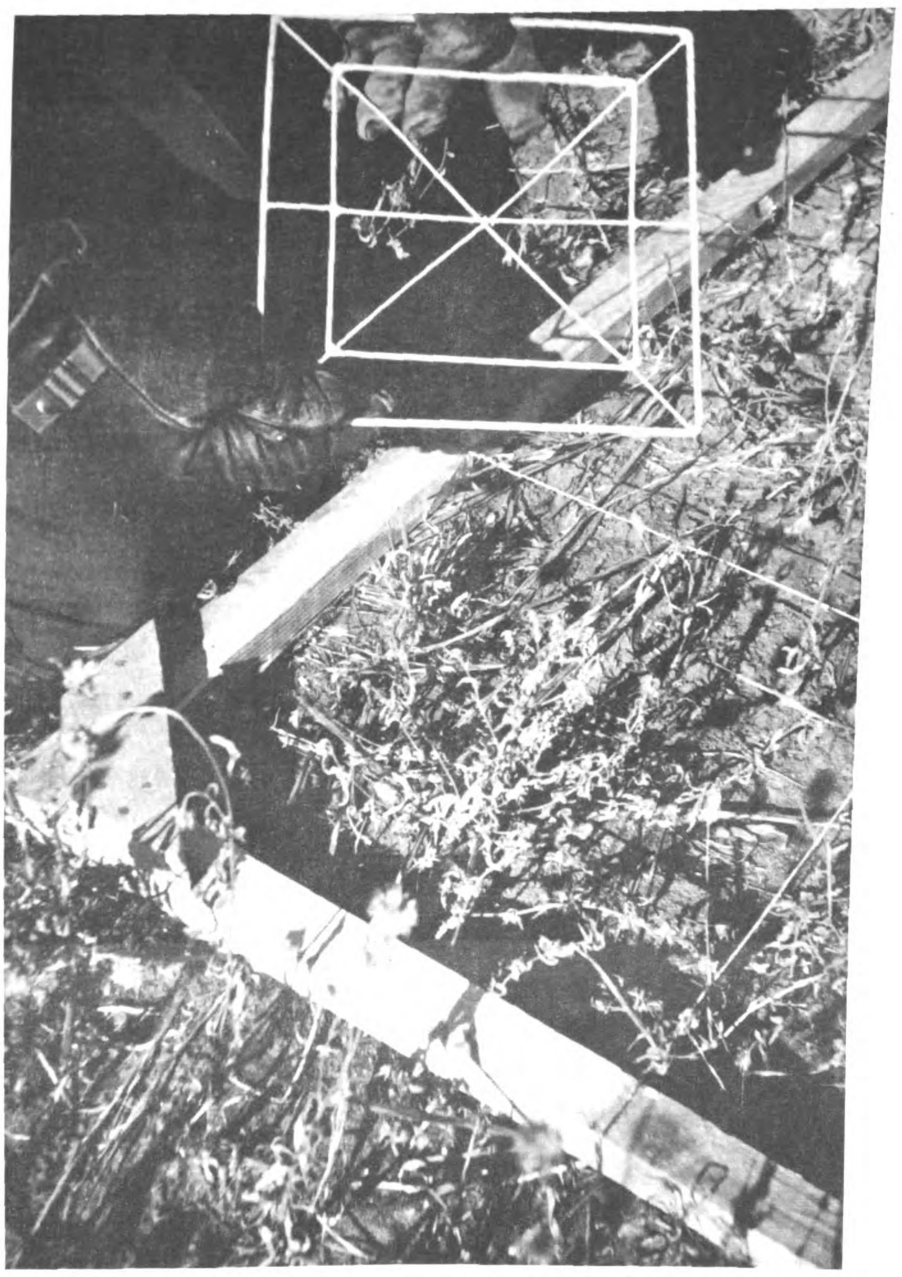

Figure 5.--Apparatus used for measuring seed density with the variable-plot-size method. November, 1965, Kidder County, North Dakota. Photo by Aileen Madsen.

weights because the average seed weight was determined from a single sample of each species of seed. Admittedly, this is a serious error in the data in the way I have used it.

The inventory methods I used on the stubble fields were adapted for measuring high densities of seeds on the ground and were not suited for use on habitats with standing plants. So instead of precise measurements, value judgments such as abundant, common, etc. were used to indicate food availability on cornfields, grasslands, a roost, and on a newly sown rye field. Cain and Castro (1959) refer to this as reconnaissance. Information from this type of survey is not as accurate as a more precise measurement; but it gives some indication of what food materials are on a given habitat.

Initial attempts to measure insect abundance quantitatively were unsuccessful, so only the large insects were rated as abundant, common, or present based on sight observations of grasshoppers (Acrididae) and beetles (Coleoptera), and by listening for crickets (Gryllidae). These observations were made some time after the cranes were collected, and, because insect activity apparently varies with weather conditions, I do not intend to imply much accuracy in the estimate of insect abundance given in Table 4.

Table 4.--Food availability and comsumption by Sandhill Cranes in Kidder County, North Dakota, Autumn, 1965.

Specimen No. 3, adult male
Shot: 11:45 A.M., Oct. 28, 1965
Habitat: Wheat Stubble

Item	Availability on Site n	$\bar{x}$	SE	Gullet Contents
		Lbs./acre		grams
Wheat	25	337.5	51.9	7.6
Wild Oats	25	26.5	6.6	tr.
Wild Buckwheat	25	13.3	3.7	---
Pigeon Grass	25	3.7	2.4	tr.
Ragweed	25	1.6	0.5	---
Barley	--	-------	----	tr.
Grasshopper		Present		2*
Gravel		Unknown		tr.

Specimen No. 27, immature male
Shot: 2:00 P.M., Sept. 22, 1965
Habitat: Wheat Stubble

Wheat	25	45.8	10.3	1.3
Pigeon Grass	25	36.6	8.1	---
Wild Buckwheat	25	15.9	3.8	---
Wild Oats	25	2.3	1.1	---
Ragweed	25	0.5	0.3	---
Dipteran Insects		Unknown		2
Gravel		Unknown		1 pc.

*Insects are listed as numbers of individuals, not grams.

Table 4 (continued)

Specimen No. 12, adult female
Shot: 12:35 P.M., Sept. 22, 1965
Habitat: Wheat Stubble

Item	Availability on Site	Gullet Contents Bird No. 12
	% Frequency	grams
Wheat	44.9	24.5
Pigeon Grass	50.7	tr.
Field Bindweed	8.6	----
Wild Buckwheat	4.3	----
Russian Thistle	2.8	----
Wild Sunflower	1.4	----
Wild Oats	1.4	----
Spider	----	2
Gravel	----	----

Specimen No. 6, adult sex unknown.
Specimen No. 26, adult male
Specimen No. 32, adult male
Shot: 10:00 A.M., Sept. 22, 1965
Habitat: Swathed Wheat

		No. 6*	No. 26*	No. 32
	% Frequency		grams	
Wheat	26.6	10.60	12.58	34.79
Pigeon Grass	86.6	-----	tr.	-----
Wild Oats	17.7	-----	-----	-----
Wild Buckwheat	2.2	-----	-----	-----
Wild Sunflower	1.1	-----	-----	-----
Grasshoppers	Abundant	-----	-----	-----
Crickets	Present	-----	-----	-----
Ground Beetles	Present	-----	-----	-----
Tiger Beetles	Present	-----	-----	-----
Gravel		3.12	-----	tr.

*Shot on a nearby pasture after being flushed from this field of wheat stubble or adjacent field from which specimen No. 12 was taken.

Table 4 (continued)

Specimen No. 15, immature male
Specimen No. 16, adult female
Shot: 10:00 A.M., Oct. 29, 1965
Habitat: Barley Stubble

Item	Availability on Site n	$\bar{x}$	SE	Gullet Contents No. 15	No. 16
	Lbs./acre			grams	
Barley	25	371.6	81.1	19.85	14.66
Wild Buckwheat	25	9.8	3.4	-----	-----
Pigeon Grass	25	7.0	2.2	-----	-----
Wild Oats	25	1.6	0.8	-----	-----
Wild Sunflower	25	12.0	3.4	-----	-----
Oats		-----		tr.	-----
Wheat		Adjacent field		3.22	
Grasshoppers	--	Present		-----	1
Gravel	--	-----		-----	tr.

Specimen No. 24, adult female
Specimen No. 33, adult sex unknown.
Shot: 12:00 noon, Oct. 21, 1965
Habitat: Barley Stubble

				No. 24	No. 33
Barley	25	31.2	4.8	10.08	12.41
Pigeon Grass	25	48.1	8.6	-----	-----
Wild Oats		tr.		-----	-----
Wild Buckwheat		tr.		-----	-----
Wheat		tr.		-----	14.54
Oats	--	-----	----	-----	tr.
Gravel	--	-----	----	-----	tr.

Specimen No. 2, adult male
Specimen No. 9, immature male
Shot: 10:00 A.M., Nov. 2, 1965
Habitat: Standing Corn

		No. 2	No. 9
Corn	Abundant	14.88	17.30
Pigeon Grass	Common	-----	-----
Ragweed	Fairly Common	-----	-----
Gravel	----------	tr.	tr.

Table 4 (continued)

Specimen No. 23, adult sex unknown,
Specimen No. 30, adult male
Shot: 4:40 P.M., Oct. 26, 1965
Habitat: Oat Stubble

Item	Availability on Site n	$\bar{x}$	SE	Gullet Contents No. 23	No. 30
		lbs./acre		grams	
Oats	25	39.2	7.4	1.48	12.12
Barley	25	4.0	16.2	tr.	tr.
Pigeon Grass	25	13.2	3.5	----	tr.
Wild Oats	25	34.9	5.8	----	-----
Wild Buckwheat	25	tr.		----	-----
Wheat	25	tr.		----	-----
Grasshoppers		Present		----	1
Gravel		----		----	tr.

Specimen No. 25, adult male
Shot: 6:15 P.M., Sept. 21, 1965
Habitat: Oat Stubble

	% Frequency	
Oats	13.2	----
Barley	6.0	3.74
Pigeon Grass	90.3	----
Wild Oats	4.8	----
Wild Buckwheat	3.6	----
Gravel	----	tr.

Specimen No. 8, adult female
Specimen No. 31, adult female
Shot: 9:00 A.M., Oct. 4, 1965
Habitat: Native Grass Pasture

		No. 8	No. 31
Native Grasses	Abundant	----	----
Pasture Sage	Common	----	----
Wolfberry	Common	----	----
Wild Rose	Fairly Common	----	----
Grasshoppers	Common	1	----
Crickets	Under Cattle Dung	----	----

Table 4 (continued)

Item	Availability on Site	Gullet Contents
		grams
Specimen No. 19, immature sex unknown. Shot: 11:35 A.M., Sept. 22, 1965 Habitat: Corn Stubble		
Corn	Common	17.17
Sunflower	Abundant	-----
Russian Thistle	Common	-----
Pigeon Grass	Common	-----
Wild Buckwheat	Occasional	-----
Wild Rose	Occasional	-----
Grasshoppers	Unk.	1
Ground Beetle	Unk.	1
Specimen No. 14, adult female Shot: 1:30 P.M., Oct. 5, 1965 Habitat: Corn Stubble		
Corn	Occasional	2.40
Alfalfa and	mowed to 3"	-----
Brome Grass	in adjacent field	-----
Grasshoppers	Abundant	1
Crickets	Present	-----
Specimen No. 29, adult male Shot: 3:00 P.M., Oct. 26, 1965 Habitat: Weedy Fallow Field		
Russian Thistle	Scattered	-----
Common Ragweed	Scattered	Empty
Specimen No. 22, adult male Shot: 10:00 A.M., Oct. 26, 1965 Habitat: Small lowland hay meadow		
Various Grasses	Mowed	-----
Barley	Apparently spilled while harvesting adjacent field.	tr.

Table 4 (continued)

Specimen No. 1, adult female
Specimen No. 4, adult female
Shot: 7:00 A.M., Oct. 28, 1965
Habitat: Roost at Horsehead Lake

Item	Availability on Site	Gullet Contents No. 1	No. 4
Alkalai Bullrush	Abundant	-----	-----
Red Samphire	Abundant	-----	-----
Salt Grass	Abundant	-----	-----
Alkalai Grass	Abundant	-----	-----
3-Square Bullrush	Common	-----	-----
Spike Rush	In Spring Areas	-----	-----
Filamentous Green Algae	In Spring Waters	-----	-----

Specimen No. 10, adult male
Specimen No. 18, adult female
Specimen No. 20, adult male
Shot: 6:00 P.M., Oct. 21, 1965
Habitat: Newly sprouted rye, sown on plowed under oat stubble.

		No. 10	No. 18	No. 20
		grams		
Rye (sprouted)	Abundant	1.00	tr.	tr.
Oats	Abundant	18.85	11.68	tr.
Barley	Abundant on Adjacent Field	13.50	17.52	17.90
Pigeon Grass	Fairly Common	tr.	-----	tr.
Wild Sunflower	Fairly Common	-----	-----	-----
Grasshopper	Unk.	1	2	6
Ground Beetle	Unk.	1	-----	1
Gravel		tr.	5.84	tr.

DISCUSSION

Problems of Determining Habitat Selection

By using habitat use as a measure of habitat selection by the cranes I studied, I have encountered some problems which should be considered in interpreting the data in Table 3. I determined habitat availability by estimating the acreages of each habitat on my study area and then assumed that each acre was available to cranes at all times. This may not be the case, because some fields next to roads or farmsteads or those being worked by farm machinery are, for all practical purposes, not available to cranes because of disturbances. I have not taken disturbance factors into consideration. As I believe this is a minor factor and in constant change, I have ignored it and for expediency have assumed that all sites were equally available at all times, and that disturbances equally influenced all habitats.

Cranes are gregarious and gather in large flocks at the feeding sites, and this behavior brings up another consideration in determining habitat selection based on use and availability. Cranes leave their roosting marshes in small groups and almost invariably join other cranes at the feeding sites. Thus, only the first cranes to arrive at a particular habitat actually selected that

habitat. All others I have counted may have decoyed to cranes already there and were on that habitat because of their gregarious nature and not because of some quality of the habitat. I have tried to account for this in Table 3 by indicating the number of flocks observed on each habitat in addition to the number of cranes observed per acre.

Walkinshaw (1950) observed that cranes in Michigan returned to the same feeding sites for extended periods, and I regularly saw cranes using certain fields throughout the autmn. It appears, then, that cranes may have favorite feeding places. If this is the case, then some cranes I have included in my counts on certain habitats may have been there because they were at a favorite place and not on a "selected" habitat. In my measurement of habitat selection, I did not take this behavior into consideration, and this should also be considered when analyzing this study.

But even with these shortcomings in mind, one can expect that if certain habitats were selected by the cranes, this selection should become apparent after a large number of cranes are observed on the known habitats. In Table 3 I have reported 4,500 cranes observed in 85 flocks on feeding sites of the study area. I believe the data in the table show selection of wheat and barley fields as the favored feeding sites of these cranes.

I had hoped that many more observations could have been recorded in one season, but movement of cranes out of the study area made this impossible. In late September more than 2,000 cranes were on the study area, but by early October most of them had moved. This is not the usual case according to local residents who told of large numbers of cranes throughout October in previous years on the area chosen for these studies.

At the time cranes left the study area, a new crane concentration developed around Horsehead Lake, about five miles from the study area. But I had no way of knowing if these were the cranes from my study area or new arrivals from the North. According to local residents more cranes are seen around Horsehead Lake in wet years (like 1965) than when the lake is dry, and it is possible that the cranes merely left my study area and went to Horsehead Lake.

About 50 acres of oats lay unharvested for several weeks in the northwest corner of the study area, and when cranes began using this field in late September the farmer scared them away. This was about the same time the cranes left the study area, and the scaring may have driven cranes off that part of the study area; but that would account only for a small number of the missing cranes, and probably was not a major cause of the loss of cranes from the study area.

A number of cranes were collected with high-powered rifles for the food habits studies, but to avoid disturbing habitat selection studies, none was taken on the special study area, so collecting could not have caused the cranes to leave. In any case, few cranes remained on my study area and time did not permit cover-mapping a second area; so the habitat selection studies had to be completed with fewer cranes than was anticipated.

Food Habits

Evaluation of food availability was not done on the same days the cranes were collected, but was done some time later as time permitted. In most cases habitat evaluations were made within two weeks of when a crane was collected, but at some collection sites six weeks had elapsed from the time of collection to the time of determination of food availability.

This later measurement of food availability may have introduced some error into the study, because cranes continued to feed on some of the fields before food availability was measured. Thus, preferred foods may have been more available at the time of collection than is shown by my measurements which were made after cranes had opportunity to continue feeding on these fields. In spite of this, I do not believe that the error is serious because the strong selection of grain

probably would have been no different had a slightly higher availability of grain been shown.

It is difficult to collect feeding cranes and even more difficult when the collecting is limited to cranes feeding on certain habitats. For this reason it was not possible to watch cranes very long prior to collecting them, and as a result there is some uncertainty as to where the food from the gullets of the cranes was picked up. Food found in most of the crane gullets consisted of items found on the habitat from which the bird was taken. Others (birds number 6, 26, 33, Table 4) obviously show feeding on other fields prior to collection as is indicated by gullet contents not available on the habitats from which they were collected. Five cranes shot on grain fields had no food in the gullets and were not included in Table 4. But here again, the overwhelming selection of grain as the chief food of these cranes makes the shortcomings of the techniques used in this study of little apparent consequence.

Some Considerations of Crane Feeding

Apparently the sandhill crane is a very adaptable feeder and is able to make use of a wide variety of food materials found from artic breeding grounds to their wintering grounds in the Southwest. During the spring migration in California, McClean (1930) saw cranes feeding on a plowed field of "gyp corn" where a bird picked up

and ate a "blue-bellied lizard." McCleod (1954) reported cranes feeding on sprouted grain and alfalfa seedlings near Meiss Lake in northern California during the spring migration. Five cranes killed accidently in Nebraska during late March had corn in their "stomachs" (Walkinshaw, 1956). Jollie (1955) found snails and algae in the stomach of a sandhill taken during March in Idaho. Walkinshaw (1953) reported cranes apparently eating acorns in southern Michigan in March of 1948, and that in 1951, a captive crane ate acorns at the Kellogg Bird Santuary in Michigan.

In Alaska, Blackwelder (1919) reports blueberries (Vaccinium sp.) as a late summer food of cranes. Hanna (1920) collected two cranes from St. Paul Island of the Pribilof group which had "gormandized on maggots from a seal killing field." From Siberia, Vorobev (1963) reports that sandhill cranes he collected ate willow buds, beetles, and berries (probably blueberries). Walkinshaw (per. com.) said that a young crane he collected in the Canadian Arctic had eaten unidentified leaves.

Cranes nesting in southern Michigan feed at fields near the nesting marshes where they eat grain, insects, and earthworms (Walkinshaw, 1950). Frogs (Hyla crucifer: Rana pipiens) and several snails (Helisoma trivolus; H. companulatum: H. anceps) are "exceedingly abundant"

and contribute to a "super-abundance" of (crane) food at the Haehnle Sanctuary, a crane nesting marsh in southern Michigan (Walkinshaw, 1965b). He further states (1965c) that nesting sandhill and European cranes (Grus grus) fed on snails, crabs, frogs, insects, and often dug for earthworms. Bent (1926) lists "mice, berries, shrews, frogs, snakes, etc." as the food of cranes but also says that they eat grain during the fall migration.

Other workers have also reported that grain makes up an important part of the fall and winter diet of sandhill cranes. Hamerstrom (1938), in his report on cranes in central Wisconsin, says that buckwheat, corn, and oats are eaten by cranes in the fall and that many droppings he examined were stained purple by elderberries. In 30 droppings he examined Hamerstrom (op. cit.) also found the remains of huckleberry (Gaylussacia baccata), blueberries, grasshoppers (Melanoplus femur-rubrum), beetles (Coleoptera), and unidentified twigs. Tanner (1941) examined 70 fecal droppings taken in the fall in Minnesota and found that corn hulls made up 95% of the volume. He found lesser amounts of sweet clover leaves and the remains of flax, oats, grasshoppers, twigs, Setaria, and small insects. Stephen (1965) reported that grain made up the bulk of the food taken by cranes during the fall in Saskatchewan.

Martin et al. (1951) lists wheat, corn, alfalfa, rice, oats, and grasses as the general fall and winter foods of sandhill cranes. Boeker et al. (1961) found alfalfa and sorghum grains in the gizzards of cranes killed on wintering grounds in New Mexico in 1961.

In this study I believe I have shown that fall migrant sandhills feed almost exclusively on grain, and I have found very little evidence of cranes feeding on native materials with the exception of insects. This brings one to wonder what cranes ate along their migratory paths prior to the settlement of the prairies in the 1880's when grain became available, and I have not answered that question.

Undoubtedly cranes have passed through the western states long before the coming of the plow since Lewis and Clarke reported "sandhill crains" in Montana and Idaho in 1805 and 1806 (Burroughs, 1961). John J. Audubon saw "many" cranes pass over the Missouri River in North Dakota in October, 1843 (M. R. Audubon, 1897) and Sugden (1938) reports that Fremont saw "many" cranes over Idaho in August of the same year. That the migrating cranes quickly learned to eat grain on the new fields is indicated by Sugden's report (op. cit.) that Dr. H. C. Yarrow found cranes to be "very fond of frequenting the stubble fields in the vicinity of the settlements" of Utah in 1872. Bosenmeir and Marshall (1958) have reported

that geese fed on stubble fields of the first grain crops on the newly broken Manitoba prairies.

If we consider the availability of waste grains or unharvested grains, and that cranes are very adaptable feeders, it is not surprising that grain makes up nearly the entire fare of the Dakota birds. From minimal measurements of wheat availability as given in Table 4, we might expect about 45 pounds of waste (wheat) per acre of wheat stubble. From Tables 2 and 3 I have calculated that wheat fields make up about 7.3% of the total area of Kidder County (based on estimates from the study area). I have further estimated that cranes use about 200 square miles (128,000 acres) of the county. We might expect, then, about 9,300 acres of wheat and at 3/4 bushels (45 lbs.) of waste wheat per acre there may have been 7,000 bushels of waste wheat on the ground in the Horsehead Lake region in the fall of 1965. Further, we might expect about 1,000 bushels of waste barley and 7,000 bushels of oats in addition to corn (for which I have no measurement of density) or perhaps a total of 15,000 bushels of waste grain--8,000 of them preferred crane food.

Admittedly, this is going far beyond the normal acceptable limits of my data, but it may serve to indicate the tremendous quantity of waste grain available to wildlife. Bossenmeir and Marshall (1958) found from

1.5 to 3.6 bushels of waste wheat and from 4.7 to 7.1 bushels of waste barley per acre in Manitoba. Baumgras (1943) found 2.4 bushels of waste wheat and 3.5 bushels of waste oats per acre in Michigan.

Stephen (1965) estimated that a bushel of grain will feed 200 sandhill cranes for one day. If 8,000 cranes stayed at the Horsehead Lake region from September 1st to November 1st, there would accumulate about 480,000 crane days of use, and they may have consumed about 2,400 bushels of grain. Since I have estimated a minimum of 15,000 bushels of waste grain available to these birds there was enough food for six times the number of cranes present in 1965, assuming all of it could be utilized by cranes.

It is unfortunate that crop depredations sometime occur in spite of the high availability of waste grain. This is even more unfortunate because cranes do not appear to select unharvested grain over waste grain. Even while feeding on fields of swathed grain, cranes did not concentrate their feeding on the swaths as I have seen ducks do, but fed between the swaths as well as on them. It should be possible in most years, then, to scare cranes from unharvested fields and to expect them to get enough food from waste grain.

Management

In light of present knowledge of sandhill cranes, I believe it cannot be denied that they constitute a possible threat to grain crops in local areas of the northern prairies. Present and future management of cranes must deal with this problem while recognizing the aesthetic and sporting values of the bird.

Present management has included legal hunting of cranes on the wintering grounds in New Mexico since 1961. Hunting was permitted in part to reduce the size of the western crane population for relief from depredations on the northern prairies (Buller and Boeker, 1965). By hunting only in certain areas of New Mexico and Texas and in Alaska, it was thought that the more numerous lesser sandhill could be exposed to hunting without endangering the Greater Sandhill Crane (Boeker et al., 1961).

In 1964, legal crane hunting was begun in Saskatchewan and Manitoba near fall concentration places which reported serious crop depredation problems. There is current interest in more widespread hunting of sandhill cranes in the western states (Unpub. Repts. BSF&W Files).

If more hunting of cranes is to be done I believe we need more information on recruitment and survival in the crane populations. Stephen, Miller, and Hatfield (1966) have stated that there is a low frequency of

juveniles in fall crane flocks, and they observed from 15 to 41 juveniles per 100 adults in hunters' bags in Canada over a 5-year period.

Novakowski (1966) has indicated that there is a high mortality among whooping cranes (Grus americana) during their second year; and if the same if true of sandhill cranes, then the number of juveniles in a fall flock is not a good indicator of recruitment to the breeding population. It appears that much research is needed in the area of the population dynamics of these cranes--especially if cranes are to be hunted.

SUMMARY AND CONCLUSIONS

This study was undertaken to determine which feeding habitats and foods cranes preferred at a fall gathering point in North Dakota where cranes were reported to be involved in crop depredations. My studies in North Dakota showed that these fall migrants fed almost exclusively on grain. Data given in this report show that wheat and barley were selected over other grains. Under some circumstances corn also may be a favored food of cranes, although my data do not prove this.

Weed seeds were found to be abundant on the feeding habitats and roosting marshes, but there was little evidence to indicate that the cranes fed on these or other "native" food materials except that large insects were taken with fair regularity.

This information should be useful in crane management, both for knowing which crops are most likely to be damaged by cranes and which crops may be best for attracting cranes.

In the area studied, cranes fed at unharvested grain fields as well as on waste grain of the stubble fields. In years of a late harvest, crane concentrations may build up before the grain harvest is finished, and the cranes may damage unthreshed grain. However, in most

years the harvest has been completed before the large flocks of cranes arrive in North Dakota, and there should be enough waste grain to meet their needs. But even under ideal harvest conditions, early arrivals may concentrate their feeding at a few local areas, and some farmers may suffer losses to their unharvested grain.

To manage land and crops effectively so as to avoid depredations by cranes, farmers might recognize that wheat and barley are the favored foods of cranes and so plan to minimize exposure of these crops to cranes.

Certain fields on some farms seem to be favorite feeding sites of the cranes. Farmers should recognize these sites and plan their crop programs giving consideration to possible depredations on these fields. Cranes should be scared from unharvested fields at their first appearance, but should be left undisturbed to feed on the harvested fields since they often return to established feeding sites.

Apparently there are tremendous amounts of waste grain available to the cranes and it seems reasonable to expect that they can fare well enough on the waste grain of the stubble fields, when they are kept off unharvested fields. Also, more waste grain can be available to the cranes if fall plowing is not done until all crops have been brought in.

"Stocking"* ripe corn probably invites damage by cranes and should be avoided when possible.

On the other hand, if management calls for attracting cranes (as to a refuge) probably wheat and barley are the best lure crops if such is to be used. Corn probably would be equally good. Grain used to bait cranes should not be left standing, but should be mowed or chopped to invite crane use.

Currently there is interest in a crane hunting season in North Dakota and other states in the Central Flyway. Farmers in the Horsehead Lake region have been interested in a crane hunting season there to help reduce crop depredations (unpub. Repts. BSF&W Files). I believe we should know more about the population dynamics of cranes before they are hunted on a widespread scale and probably they should not be hunted just to save relatively little grain.

I do not imply that the management suggestions I have made here will end the crane problems in the West, but they may be taken as suggestions for further study and individual evaluation.

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*Grazing by livestock.

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APPENDICES

APPENDIX A

Appendix A.--Sandhill crane specimens taken by Carl Madsen and Jerome Stoudt in Kidder County, North Dakota, Autumn, 1959.

Field No.	Date	Wgt.*	Exposed Culmen	Culmen From Post. Nares	Wing chord	Bare-tibia	Tarsus
Grus canadensis rowani							
Adult Males							
2	2 Nov.	5221 gm.	124mm	--	486mm	84mm	216mm
3	28 Oct.	5334	116	--	502	99	211
5	21 Oct.	5446	114	84mm	489	91	211
10	21 Oct.	5443	115	81	504	103	224
11	23 Oct.	5221	118	91	511	98	223
17	29 Sept.	5221	112	84	488	87	208
20	21 Oct.	5108	116	94	505	94	224
21	26 Oct.	5675	128	97	486	97	209
23	26 Oct.	5108	121	97	515	94	221
25	21 Oct.	5221	134	93	498	100	220
26	22 Sept.	5221	123	90	503	96	225
29	26 Oct.	4880	122	88	484	97	221
30	26 Oct.	5675	120	91	522	93	225
32	22 Sept.	5221					
Extremes		(4880-5675)	(99-128)	(81-97)	(472-522)	(84-103)	(202-225)
Averages		5273	121	91	501	95	217
Immature Males							
9	2 Nov.	----	103	92	464	102	194
15	29 Oct.	4313	113	--	472	93	208
27	22 Sept.	3838	99	--	488	87	214
Extremes		(3838-4313)	(99-113)	(92)	(464-488)	(87-102)	(194-214)
Averages		3971	105	92	475	94	205

Appendix A (continued)

Adult Females								
1	28 Oct.	[illegible]	113mm	--	[illegible]	[illegible]	[illegible]
4	28 Oct.	4650	[illegible]	83mm	[illegible]	[illegible]	[illegible]
12	22 Sept.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
15	3 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17	6 Oct.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
20	19 Oct.	[illegible]	[illegible]	--	[illegible]	[illegible]	[illegible]
24	21 Oct.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
27	21 Oct.	[illegible]	[illegible]	--	[illegible]	[illegible]	[illegible]
28	22 Sept.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Extremes		(4086-5211)	(108-118)	(88-94)	(478-489)	(84-100)	(197-216)
Averages		4715	116	88	486	91	205
Immature Female								
5	5 Oct.	4767	112	--	476	87	218
Adults-Sex Unknown								
23	26 Oct.	5201	128	100	511	86	203
33	21 Oct.	4540	114	91	505	96	217
Immature-Sex Unknown								
19	22 Sept.	4086	111	82	505	90	227
Grus canadensis canadensis								
Adult Females								
8	4 Oct.	----	99mm	--	411mm	64mm	179mm
31	4 Oct.	3632gr.	95	74mm	448	68	168
Adults-Sex Unknown								
6	22 Sept.	4767	91	68	407	68	159
7	6 Oct.	3745	97	--	438	73	157

*Approximate weight-from field measurements to nearest 1/4 lb. measurements are after Baldwin et al. (1932).

APPENDIX B

Appendix B.--Field Counts of age ratios of sandhill crane flocks in Kidder County, North Dakota, Autumn, 1965.

Date	Adults	Juveniles*	Date	Adults	Juveniles
14 Aug.	4	0	23 Sept.	8	2
28 Aug.	5	0		4	0
6 Sept.	16	2		10	3
	11	2		2	0
	7	1		19	3
	7	1		156	7
	21	2		3	1
	7	2	25 Sept.	171	9
	15	5		32	6
	177	13		7	3
	13	0		56	9
16 Septs.	12	1		23	3
	8	0	28 Sept.	26	3
	3	1		16	5
	4	1		3	1
	28	0	1 Oct.	17	5
	8	6	4 Nov.	8	1
	8	2			
	50	2	Totals	1183	123
	20	5			
	2	1	10 juveniles/100 adults		
23 Sept.	6	1			
	115	18			

*Cranes with feathered foreheads.

APPENDIX C

Specimen No.	1	2	3	4 …	Total	% Occurrence
Wheat			4	[illegible]	141	[illegible]
Barley			tr.	[illegible]	[illegible]	[illegible]
Corn		4		[illegible]	[illegible]	[illegible]
Oats				[illegible]	[illegible]	[illegible]
Unident. Hulls	15		41	[illegible]	[illegible]	[illegible]
Corn Hulls		[illegible]		[illegible]	[illegible]	[illegible]
Wild Oats				[illegible]	tr.	[illegible]
Wild Buck-wheat	tr.			tr. [illegible]	tr.	[illegible]
Pigeon Grass				[illegible]	tr.	[illegible]
Beetles				tr. [illegible]	tr.	[illegible]
Grasshoppers		tr.		tr. tr. tr. [illegible]	tr.	[illegible]
Other Insects				[illegible]	tr.	[illegible]
Gravel	1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	100.0
Wood Chips		tr.			tr.	[illegible]
Bone Chips				tr. [illegible]	tr.	[illegible]
Mammal Teeth				tr.	2	[illegible]

tr = trace

Appendix [illegible]--[illegible]

APPENDIX D

Appendix D.--List of common and technical names of plants mentioned after Fernald (1959).

Common Name	Scientific Name
Brome Grass	*Bromus sp.*
Alkalai Grass	*Pucinellia nuttalliana*
Salt Grass	*Distichlis stricta*
Barley	*Hordeum vulgare*
Rye	*Secale cereale*
Wheat	*Triticum aestiuum*
Wild Oat	*Avena fatua*
Oat	*Avena sativa*
Corn	*Zea maize*
Pigeon Grass	*Setaria glauca, S. viridis*
Spike Rush	*Eleocharis acicularis*
Three-Square Bulrush	*Scirpus americana*
Alkalai	*Scirpus paludosus*
Wild Buckwheat	*Polygonum convolvulus*
Red Samphire	*Salicornia rubra*
Russian Thistle	*Salsola kali*
Wild Rose	*Rosa sp.*
Alfalfa	*Medicago sativa*
Creeping Jenny	*Convolvulus arvensis*
Wolfberry	*Symphoricarpus occidentalis*
Ragweed	*Ambrosia sp.*
Sunflower	*Helianthus sp.*
Pasture Sage	*Artemisia frigida*