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Harold H. Prince
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HABITAT UTILIZATION AND PREFERENCE OF CANADA GEESE ON A HABITAT COMPLEX IN SOUTH-CENTRAL MICHIGAN

By

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ABSTRACT

HABITAT UTILIZATION AND PREFERENCE OF CANADA GEESE ON A HABITAT COMPLEX IN SOUTH-CENTRAL MICHIGAN

By

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Use of agricultural habitats in south-central Michigan by giant Canada geese (Branta canadensis maxima) during the fall, winter and spring months has increased substantially during the last decade. The impact of geese on a 1089 ha study area at Michigan State University was determined during 1988-89 and 1989-90 overwinter seasons.

The local breeding population size within a 40-km radius of the wintering site in 1989 was 975 birds. The average size of the wintering local population remained relatively constant at 750 birds during the 1989-90 season.

Canada geese preferred fields with fresh manure compared with other habitats. Winter wheat was preferred over manure in early fall of 1988. Other habitats utilized included alfalfa, turf grass, corn and wetlands. The pattern of habitat use was not predictable.

To assess impacts of grazing on crops, exclosures were established in winter wheat and alfalfa seedling fields in the fall of 1988. Yield measures did not differ significantly between grazed and ungrazed plots.

ACKNOWLEDGEMENTS

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Thanks are also extended to the Michigan Department of Natural Resources, Wildlife Division for their cooperation. Personnel that provided assistance associated with my field season included Jerry Martz, Al Stewart and Barry Loper. Working with these individuals was not only a educational experience, but a pleasure.

No graduate student would succeed without the support of his/her peers. For this reason I would like to extend my appreciation to my fellow graduate assistants, Paul Padding, Jerome Leonard and Gregg Hancock for their moral support. I would also like to thank Tom Eitniear and Sara Thompson for their patience in processing my winter wheat samples.

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INTRODUCTION

Reestablishment of giant Canada geese (Branta canadensis maxima) in southern Michigan began in the mid-1920's (Martz and Soulliere 1990). The Department of Conservation (now the Department of Natural Resources; hereafter MDNR) engaged in propagation and release programs in the 1950's and early 1960's to aid with reestablishment of giant Canada geese (Martz and Soulliere 1990). Since that time, numbers of giants have increased statewide as well as nationally.

Nationwide, giant Canada geese were estimated at 54,600 (Bellrose 1980) in 1960. In the Mississippi Flyway, numbers reached 103,000 in 1981 and increased to 180,000 by 1986. The MDNR estimated that local goose populations in Michigan grew four-fold from 1977 through 1985 with the final September 1985 estimate at 54,800 birds (Martz and Soulliere 1990).

As early as 1970, complaints about excessive numbers of local giant Canada geese had become common in urbanized portions of southern Michigan (Martz and Soulliere 1990). The MDNR responded to complaints of geese fouling beaches, lawns and boat docks by implementing trap-release (translocation) programs during the mid-summer adult molt. From 1972 to 1982, state personnel moved over 12,000 nuisance birds (Martz and Soulliere 1990).

Increased numbers of geese, although responsible for increased complaints, also afforded increased hunting opportunities. In 1986 Michigan received authorization to conduct an additional early hunting season during the first 10 days of September in the Lower Peninsula only. These dates were specifically chosen to target local geese for migrant interior Canada geese (Branta canadensis interior) were believed not to be in the area until mid-September. During the first 3 years of this early hunt, numbers of Michigan hunters increased from 9,950 to 12,590 and the number of geese harvested increased from 7,515 to 14,532 (Martz and Soulliere 1990).

Local geese began staging during the fall in Ingham County in south-central Michigan during the 1970's. By the early 1980's, noticeable numbers of geese were present throughout the fall, winter and spring months. In the Lansing area, birds roost overnight on open water at a city park and fly to surrounding farm lands to feed and loaf during the day. The experimental agricultural fields at Michigan State University (hereafter MSU) currently hosts a large concentration of wintering geese. Although MSU's agricultural practices has always provided good goose habitat, completion of 4 large palustrine (Cowardin et al. 1979) wetlands of the Inland Lakes Project and the east 18 holes of Forest Akers Golf Course in the early 1970's, created prime habitat. By the late 1980's, this 1572 square kilometer area (hereafter the wintering study area) offered geese sanctuary with traditional waste corn, winter wheat, alfalfa and pasture, as well as permanent water and large expanses of turf grass.

Migration movements for giant Canada geese are short and in some instances nonexistent (Bellrose 1980). Wintering geese habitually utilize the wintering study area and move south only when weather conditions deteriorate. It appears that local giants attract migrant interior Canada's (*B. c. interior*) which now also winter in the Lansing area.

Concern over the impact of increased goose use of the wintering study area prompted this study. To assess the impact of geese on the wintering study area it was necessary to determine 1) the local population size, 2) the proportion of local verses migrant geese, as determined by subspecies, that utilize the wintering study area, 3) the overall crop use and preference of geese through time, and 4) the impact of grazing on yields of winter wheat and alfalfa through a controlled field experiment.

STUDY AREA

Local breeding geese are evenly distributed on lakes and ponds within a 40 km radius of the wintering study area which is located in Ingham County in south-central Michigan (Fig. 1). The topography of the encompassing counties reflects past glacial retreat and is best described as a mixture of rolling moraines, till plains, and numerous pond depressions.

The 2030 ha (5010 acres) of wetlands surrounding the wintering study area are most numerous in the northeast quadrant (Table 1). Distribution of wetlands within the area defined by the 20 and 40 km radii are similar. Most wetlands (73%) are of pond size (0.1 to 1.9 ha). According to MDNR banding records, the majority of local geese are evenly distributed on ponds, and only occasionally are found on medium to large lakes during the brood rearing phase. Local citizen responses to a MSU news release and visitation to potential banding sites in early June of 1989 verified this trend.

Michigan State University in E. Lansing is located in northwestern Ingham County. The wintering study area, which encompasses approximately 1,089 ha (2690 acres) of prime agricultural research area, is located south of the main campus (Fig. 1). The majority of the area (52%) is maintained

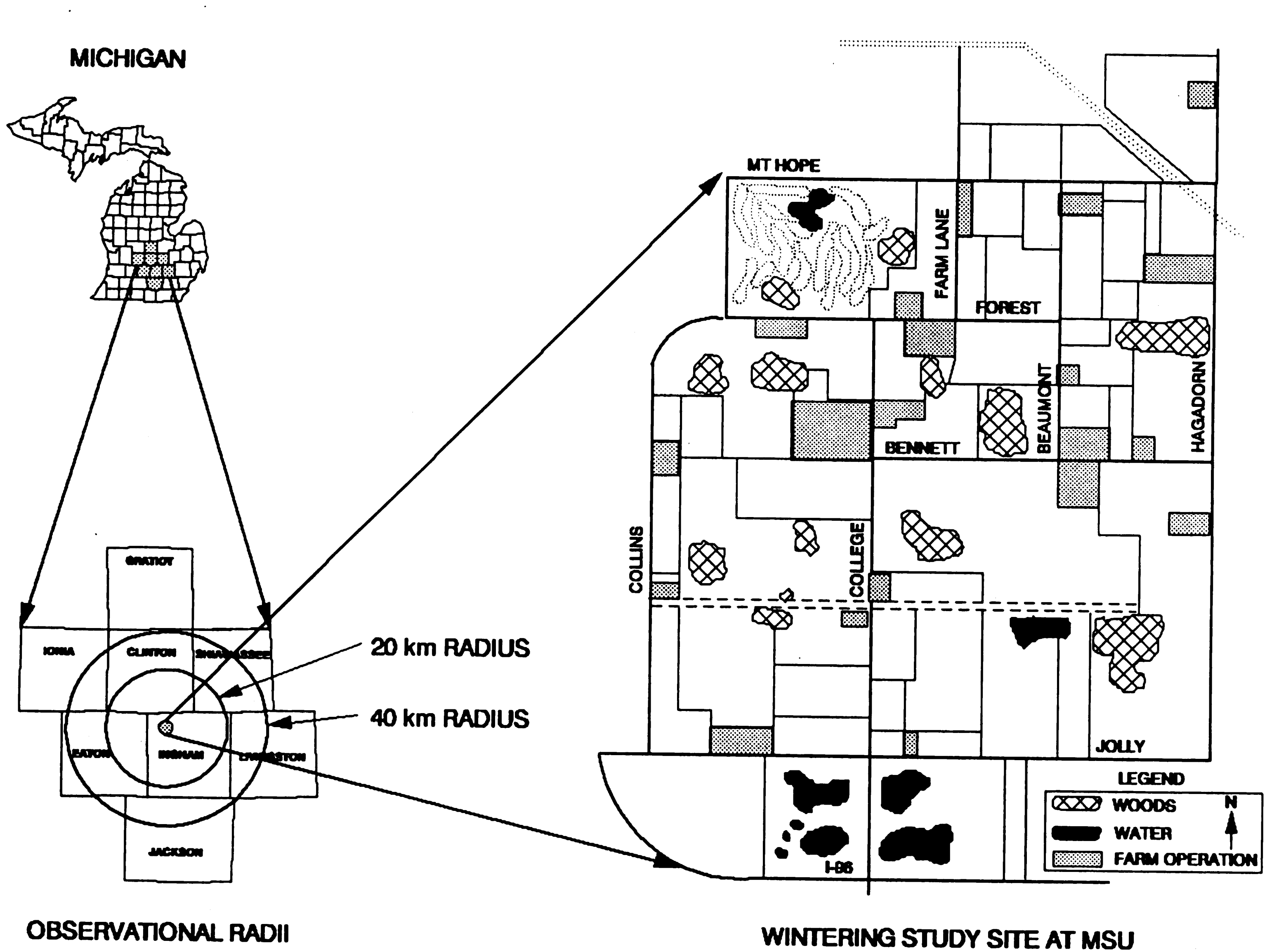

Figure 1. Canada goose wintering study area and associated counties.

Table 1. Percent of wetlands available to local Canada geese within a 40 km radius of E. Lansing, MI. (compiled from Humphrys and Green (1962)).

Location	Wetland Size				Total
	Pond	Small	Medium	Large	
Northwest	13	3	0	0	16
Northeast	22	5	2	1	30
Southeast	20	3	4	0	27
Southwest	18	4	4	1	27
Total	73	15	10	2	100

Ponds = 0.1 to 1.9 ha
Small = 2.0 to 4.9 ha
Medium = 5.0 to 17.9 ha
Large = 18.0+ ha

as agricultural crops: 29% corn (Zea mays), 14% alfalfa (Medicago sativa), and 9% winter wheat (Tirticum aestivum). The remaining areas are interspersed with the agricultural crops and include: livestock pasture (18%), fallow fields and meadows (6%), golf course and/or turf grass (7%), experimental crops (5%), woodlots (5%), orchards (3%) and palustrine wetlands (4%). In 1988 and 1989, agricultural crops consisted of corn (54%), alfalfa (28%) and winter wheat (18%).

Mean winter temperature is -3.9 C and the average daily minimum temperature is -8.1 C. First fall freezing temperatures usually occur between 22 September to 5 October (U.S. Dept. Ag. 1979). The palustrine wetlands became ice covered on 8 December, 1988 and 2 December, 1989. Ice cover remained until 31 March, 1989 and 12 March, 1990. Total annual precipitation is 0.46 meters, and 61% usually falls on growing crops (April through September). Average seasonal snowfall of 1.0 meters begins in November and continues through April. An average of 65 days had at least 2.54 cm of snow cover during both winters, however coverage varied between years and with topography. During 1988-89, snowfall was 100.3 cm and snow cover lasted 43 days. More snowfall, 143.3 cm, occurred during 1989-90, however snow cover lasted approximately the same number (41) of days.

METHODS

This study was inclusive of 2 seasons, the 1988-89 and 1989-90 winter seasons. The size of the local breeding population within a 40 km radius of the wintering study area was determined in the summer of 1989. Research during the 1988-89 season included: 1) determining habitat use and preference of geese utilizing the wintering study area and 2) determining the effects of free ranging geese on yields of specific habitats, ie. winter wheat and alfalfa, through use of a controlled field experiment. Research during the 1989-90 season included: 1) determining the proportion of the local verses migrant geese utilizing the wintering study area through time, and 2) determining habitat use and preference of geese utilizing the wintering study area.

Observations of neck-banded geese were used to determine both the size of the local breeding population and the proportion of locals utilizing the wintering study site. The Mississippi Flyway goose banding program allows for the identification of population affiliation of individual neck-banded geese based on neck-band color and alpha-numeric code. Orange, blue, and green neck-bands were observed during this study. Orange neck-bands with white alpha-numeric codes represent interior Canada geese banded on Akimiski Island in

James Bay, Ontario, Canada. Blue neck-bands with white alpha-numeric codes represented migrant geese that were banded on various wintering grounds during previous seasons. Geese captured in Michigan were fitted with green neck-bands bearing a white alpha-numeric code.

Within 40 km of the wintering study area, 73 local adult and juvenile Canada geese were captured and fitted with a green neck-bands bearing a white alpha-numeric code. Banding effort was distributed in proportion to the number of known breeding pairs. An additional 27 neck-banded geese (7 adults and 20 juveniles) were translocated by the MDNR to the Milli-Ander Project of the Maple River State Game Area located 42 km north of E. Lansing in Gratiot County.

Local Population

Observations on a stratified sample of lakes and ponds were used to estimate the number of geese within the 0-20 km radius and the 20-40 km radius of the wintering study site in E. Lansing. Sixty percent of the observations were made within the 0-20 km radius.

Counts were conducted for 30 days commencing 20 August, 1989. The entire observational period was inclusive of three, 10 day observational intervals. Morning counts, because of their consistency, were used to estimate the local population. The interval of 20-30 August was the period 10 days prior to Michigan's early goose hunting season. 1-10 September was the

10 days during, and 11-20 September the 10 days after this early season. With the aid of binoculars and a spotting scope, number of geese present, number of neck-banded geese and neck-band color and codes were recorded. Flocks were scanned such that the alpha-numeric code of each neck-band sighted was verified at least once.

Both the modified version of the Lincoln-Petersen estimator (Chapman 1954) and the Schnabel (1938) method were used to obtain an estimate of the size of the local population within the 40 km radius in 1989. Estimates were generated from neck-band sightings obtained during the first 2 observational intervals (20-30 August and 1-10 September). Occurrence of orange and blue neck-bands in the third observational interval indicated the local population was no longer closed to immigration. Since translocated neck-banded birds from Maple River and Gratiot Saginaw State Game Areas or unfamiliar neck-bands were not sighted within the 40 km radius during the first 2 observational intervals, only marked geese within the 40 km radius were used to calculate the Lincoln-Petersen and Schnabel estimates.

The Lincoln-Petersen estimate was calculated as follows:

$$\hat{N} = \frac{M\,(C + 1)}{(R + 1)}$$

where:
- $\hat{N}$ = estimate of population size
- M = known number of marked individuals in the population
- C = total number of individuals captured in the sample
- R = number of marked individuals in C

The Schnabel method is a simple approximation of a maximum likelihood estimate calculated as follows:

$$\hat{N} = \frac{\text{Sum } (M_i C_i)}{\text{Sum } R_i} \qquad i = 1.....k$$

where:

M_i = the number of marked individuals in the population at the sample i.
C_i = the total number of individuals caught in the sample i.
R_i = the number of marked individuals in sample i.

k = last sampling period

An estimate of the proportion of local birds neck-banded within the 40 km radius was obtained by dividing the number of neck-banded birds (73) by the estimate of the size of the local breeding population.

Wintering Population at MSU:

Observations of local geese with green neck-bands were used to estimate the number of local birds utilizing the wintering study site during the 1989-90 field season. Systematic observations began on 8 August, 1989, when geese began utilizing this area. Number of geese, neck-band color and alpha-numeric code, and habitat occupied were recorded. Observations were made twice a week, approximately 2 hours after sunrise. Flocks were scanned at least 3 times and each neck-band's color and alpha-numeric code was verified at least once.

Numbers of local birds utilizing the study area were determined using a modified Jolly-Seber model (Jolly 1965, Seber 1965) in which re-sightings of neck-banded birds was substituted for recaptures. The Jolly-Seber model is as follows:

$$\hat{N}_i = \frac{n_i M_i}{m_i}$$

where: $\hat{N}_i$ = estimate of marked population in interval i.
n_i = number of individuals sighted in interval i.
$\hat{M}_i$ = number of marked individuals that potentially could be sighted just prior to interval i.
m_i = number of marked individuals sighted in interval i.

and: $$\hat{M}_i = m_i + \frac{R_i z_i}{r_i}$$

where: R_i = number of individuals seen in interval i that are previously marked, or receive new marks, and are released.
z_i = number of marked individuals in interval i, that were not seen then, but were seen in a later interval.
r_i = number of individuals in R_i which are subsequently seen again.

Neck-band resighting data were processed with the aid of a computer program entitled JOLLY (Pollock et al. 1990). Model A was selected so that immigration and emigration could be accommodated. The program JOLLY allows for only 30 observation periods, therefore the 60 total observation periods were combined into pairs such that if a marked individual was seen in both observational periods, it was counted as being seen only once. The size of the local population was derived by adjusting the size of the local marked population generated from JOLLY by the percent of local birds marked. Remaining individuals on the wintering study area were assumed to be migrants.

Wintering Habitat

Habitats used by Canada geese on the wintering study area were classified as winter wheat, alfalfa, turf grass, corn, manure and wetland. Winter wheat included waste grain wheat in early fall and winter green wheat in late fall, winter and early spring. Alfalfa included both established and seedling fields. Turf grass habitat consisted of the east 18 holes of Forest Akers Golf Course and all grassy borders surrounding agricultural fields. Corn habitat consisted of waste grain and stubble. Manure habitat was created by either spreading or spraying manure on harvested fields, usually corn. Wetland habitat included the palustrine wetlands associated with the Inland Lakes Project and an assortment of persistent pasture floodings.

Habitats available to wintering Canada geese was determined for 5 intervals within each of the 2 winter seasons (1988-89 and 1989-90). These intervals are subsequently referred to as the: 1) early-harvest, 2) mid-harvest, 3) late-harvest, 4) freeze and 5) thaw intervals. The length of intervals are dependent on harvesting schedules which varied between seasons. Availability of an individual habitat (winter wheat, alfalfa, turf grass, corn, manure, or wetland), expressed as the percent of all habitats available within each time interval, was determined for each season. Differences in percent availability of habitats between years was tested for significance using Student's t-tests on arcsine transformed data.

Habitats used by wintering Canada geese were recorded for the 1988-89 and 1989-90 seasons. Biweekly observations were made approximately 2 hours after sunrise and the number of birds present and habitat utilized were recorded for all habitat types on the wintering study area. Use, expressed as the mean percent of geese present during each biweekly interval, was determined for each habitat type. Additional information on neck-band colors and codes was collected during the 1989-90 season. A nested ANOVA analysis on arcsine transformed data was used to test for differences in the percent use of habitats between seasons. Differences were considered significant if $P \leq 0.05$.

Habitat electivity indices for wintering habitat, expressed as mean percent use divided by the mean percent availability (Ivlev 1961), were determined for each time interval within both seasons. Index values > 1.0 indicate preference for a habitat type, where as values < 1.0 indicate the habitat type was not preferred. One-sample runs tests (Siegel 1956) were performed for each habitat type during each time interval for both seasons to test for the randomness of use. Seasonal habitat electivity indices were tested for significant differences between seasons using Student's t-tests.

Grazing Experiments

A paired plot design was employed to investigate if goose presence resulted in crop damage to either alfalfa seedlings or winter wheat. These experiments were conducted on the wintering study area during the 1988-89 season.

In early September of 1988, 33, 2 x 5 m, control exclosures (ungrazed) were randomly placed in a 24.3 ha (60 ac) alfalfa seedling field. Exclosures were removed after the geese migrated out of the wintering study area in mid-April of 1989. A treatment plot (grazed) was then randomly established within 15 m of each of the control plots.

One meter plots were hand harvested from both the control (ungrazed) and treatment (grazed) plots on 27-29 April and 18-19 May. The first clip occurred when conditions were favorable for spring grazing by cattle, while the second clip coincided with standard agricultural practices for harvesting alfalfa for haylage.

At the time of clipping, the percent of weeds present and species composition within the one meter plots was recorded. Composition of weedy species included: <u>Capsella bursa-pastoris</u> (Shepherd's purse), <u>Taraxacum officinale</u> (dandelion), <u>Cerastium vulgatum</u> (mouse-ear chickweed), <u>Thlaspi arvense</u> (penny cress) and <u>Rumex cripus</u> (curly dox). Wet weights (g/m^2) were recorded for each sample. Samples were then oven dried for 72 hours at 47 C and dry weights (g/m^2) were recorded for each sample. Paired t-tests were used to test for significant differences ($P \leq 0.05$) between paired plots.

Following the corn harvest of 1988, a 13.8 ha (34 acre) field was planted with winter wheat at 2 and 3 bu/ac seeding rates in alternating 20 m wide strips. Seventeen, 2 x 5 m control (ungrazed) exclosures were randomly established within each seeding rate in early September of 1988 prior to arrival of geese on the wintering study area. Exclosures remained in place through the winter and were removed in mid-April of 1989 after the departure of geese. A treatment (grazed) plot was then randomly located within 15 m of each control plot.

Winter wheat plots were hand harvested on 17-18 July, 1989, in accordance with standard agricultural practices. Data collected at the time of clipping included stem density of the clip plot, expressed as mean number of heads per five-1 meter rows. Twenty heads (outside of clip plot yet adjacent to it) were also collected to obtain a later measure of the mean number of seed/head. The 1 m samples were bagged and later threshed using a small-hand thresher. Yields (g/m^2) for plots were then recorded. The final measurement included the mean weight (g) of 500 seeds randomly selected from the clipped plot.

Analysis of yield components between paired plots was achieved using paired t-tests. Student's t-tests were employed to analyze yield components within plot type (ie., control to control, treatment to treatment) and between seeding rates. Differences were tested for significance at the alpha 0.05 level.

RESULTS

Local Population

The local population of geese within a 40 km radius of the wintering site in E. Lansing was estimated according to the Lincoln-Petersen method to be 975 $\pm$ 230 birds, indicating 7.5% of the population were marked with green neck-bands. The local breeding population according to the Schnabel method was 1030 $\pm$ 290 birds, indicating 7.1% of the local population was marked. Although both methods approximated the local population to be around 1000 birds, the Lincoln-Petersen was selected for use in further analyses because of a narrower confidence interval.

Wintering Population at MSU

Utilization of the agricultural fields on the wintering study area began as early as August, shortly after harvesting of the winter wheat fields. A 4 week shift in arrival and departure was noted between seasons with geese arriving earlier the second season (Fig. 2). The average number of geese present on the overwintering study site was 1290 $\pm$ 157 SE birds during the 1988-89 season, and 2160 $\pm$ 312 SE birds during the 1989-90 season.

Estimates of the size of the local population present on

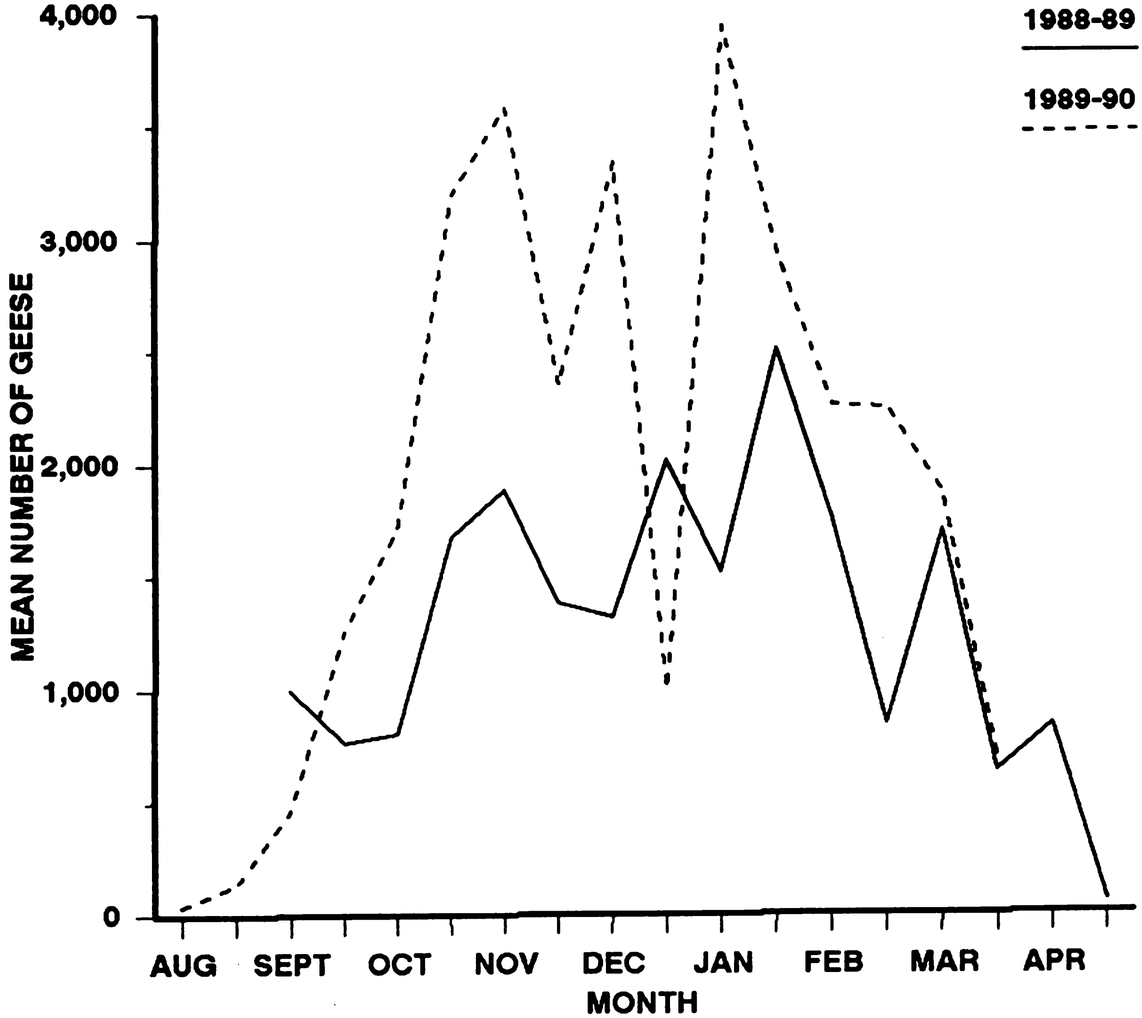

Figure 2. Mean number of Canada geese present on the wintering habitat during the 1988-89 and 1989-90 seasons.

the wintering study area during the 1989-90 season were based on the assumption that 7.5% of the local population was marked. Local geese arrived 4 weeks prior to, and departed 2 weeks earlier than migrants (Fig. 3). Although the total number of geese varied, results of the Jolly-Seber analysis indicated that the average number of local birds remained relatively constant at 750 $\pm$ 87 SE birds, or 35% of all birds present (Fig 3). Changes in the number of migrants was the primary cause in the fluctuations of the total number of geese present during the 1989-90 season.

Wintering Habitat

Diurnal use of the 6 habitat types on the wintering study site began with flights from open water roost sites at a local city park 1 to 2 hours after sunrise. The birds remained on these 6 habitats throughout the day with peak numbers being present in mid-morning and afternoon. Flights to the roost areas began 1 to 1-1/2 hours before sunset and all birds were gone from the wintering study area within 1/2 hour after sunset.

The early-harvest interval was from 7 to 27 September and 8 August to 28 September for the 1988-89 and 1989-90 field seasons respectively. During both seasons, the greatest proportion of habitat available during this interval was alfalfa (Fig. 4). All winter wheat habitat and approximately one-half of the season's corn habitat was available in the

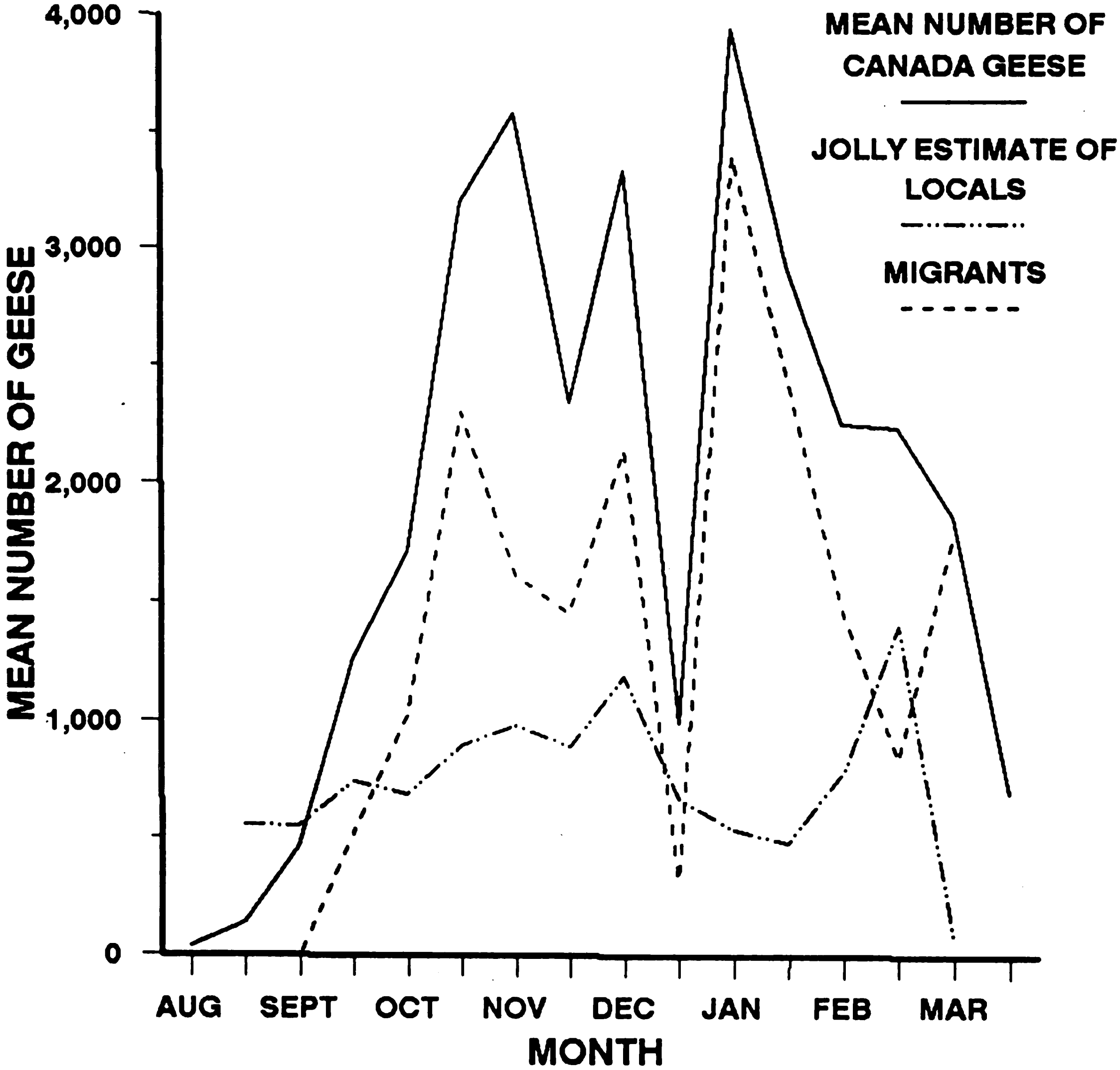

Figure 3. Mean number of Canada geese, Jolly-Seber estimate of the mean number of local geese, and the mean number of migrants present on the wintering study site during the 1989-90 season.

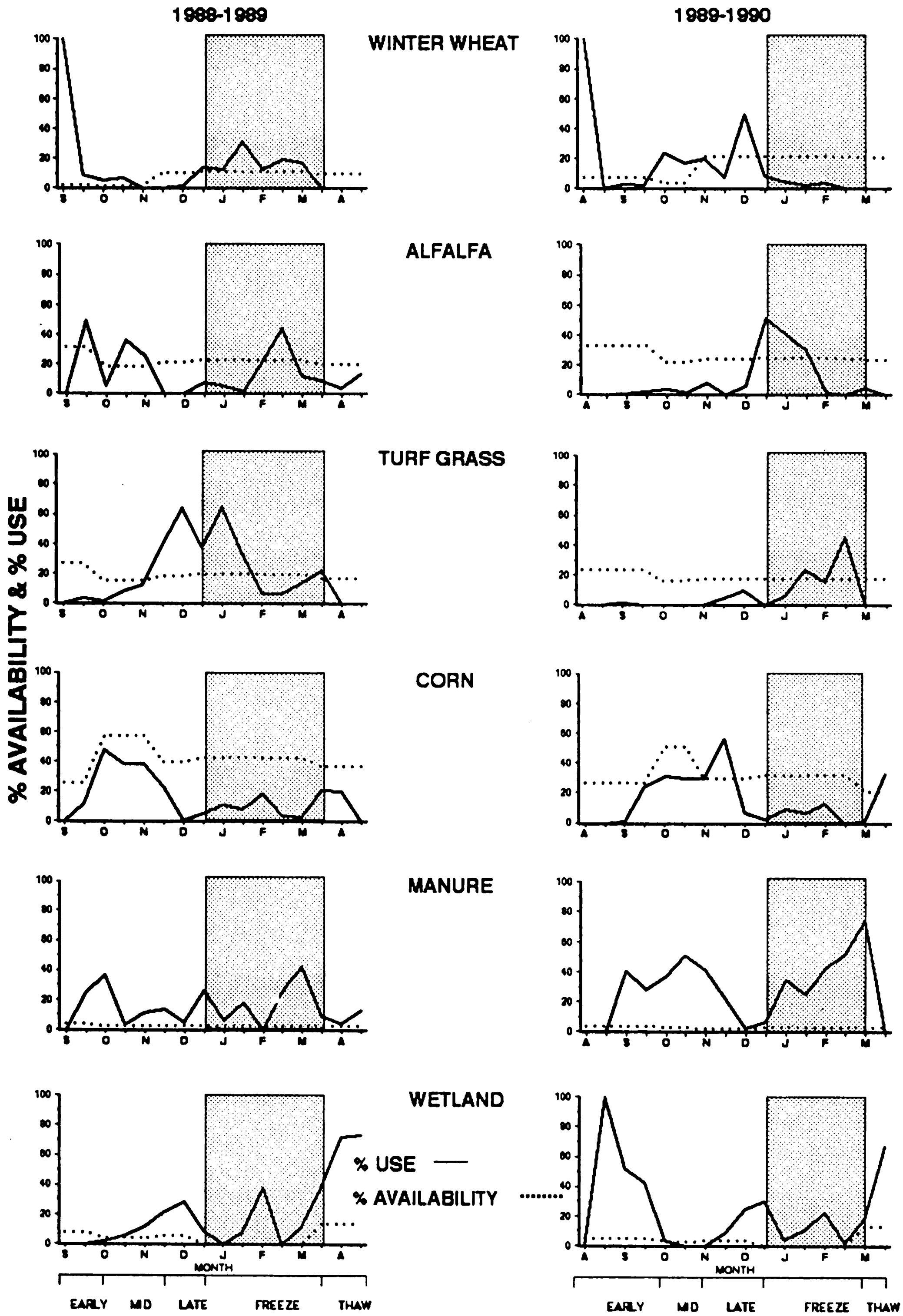

Figure 4. Availability and use of wintering habitats by year and interval. Shaded areas indicate the period when the Inland Lakes palustrine wetlands were frozen.

form of waste grain and stubble due to standard harvesting practices during this interval.

During the mid-harvest interval all corn habitat was available as waste grain and stubble, and corn represented the majority of all the habitats available (Fig. 4). This interval spanned from 28 September to 11 November 1988, and from 29 September to 2 November 1989. Availability of winter wheat habitat decreased due to fall plowing and replanting.

The late-harvest interval was from 12 November to 8 December 1988, and from 3 November to 18 December 1989. This interval was characterized by a reduction in the availability of corn habitat due to fall plowing and an increase in availability of green winter wheat habitat (Fig. 4). Despite the reduction, corn habitat still represented the majority of all the habitats available during this interval for both seasons (Fig 4).

Icing of the palustrine wetlands associated with the Inland Lakes Project marked the beginning of the freeze interval. This interval was from 9 December to 10 March 1988-89, and 19 December to 2 March 1989-90. Open water was unavailable except when mild temperatures during 1988-89 resulted in occasional ephemeral flooding of pasture areas. Availability of green winter wheat and corn habitat remained high during this interval (Fig. 4).

The spring thaw interval began on 11 March 1989 and 3 March 1990, and persisted until geese departed in mid-April.

This interval was marked by rains, substantial ephemeral flooding of pastures, and eventual open water on the inland lakes. Availability of corn habitat was reduced, while availability of wetland habitat increased during this interval for both seasons. The availability of the remaining 4 habitats were similar to the previous interval (Fig 4).

Although availability varied within seasons, no significant differences in availability of habitat types between seasons was noted. The ranking of availability from high to low of: corn > alfalfa > turf grass > winter wheat > wetland > manure remained the same for both seasons.

Use of winter wheat by geese during the 1988-89 season was high (100%) in early September and fell thereafter until the palustrine wetlands froze in early December (Fig. 4). Use of winter wheat was moderate during the freeze interval and tapered off to no use during the thaw interval. During the 1989-90 season use of winter wheat began in early August. This 4 week temporal shift was due to changes in harvest schedules between seasons. Use decreased to low levels until the mid-harvest interval and then increased to moderate levels until just prior to the mid-December freeze. Average use of winter wheat during the entire season (15%) was similar ($t = -0.064$, 30 df, $P = 0.950$) in both seasons.

Use of alfalfa during the 1988-89 season occurred in mid-September (50%), mid-October (33%) and in mid-February (44%) (Fig. 4). Geese concentrated on alfalfa during the 1989-90 season from mid-December (52%) to mid-January (30%). Total seasonal use between years was similar (12% verses 10% for 1988-89 and 1989-90 respectively) ($t = 0.457$, 30 df, $P = 0.651$).

Use of the turf habitat began in mid-September 1988 and peaked during December (64%) and January (65%) (Fig. 4). Use ceased in mid-March just prior to the spring thaw. Use during the 1989-90 season differed from the previous season with peak use occurring in mid-February (45%). Total seasonal use during 1989-90 was down significantly ($t = 2.078$, 30 df, $P = 0.046$) from 20% to 7% compared to the 1988-89 season.

A major proportion of use during the mid and late-harvest intervals of 1988 was on corn stubble (Fig. 4). Over the 1988-89 season, 16% of the use was on corn. Corn again represented a major proportion of the use during the early and late-harvest intervals of 1989, peaking later at 56% in mid-November. On average, corn represented 15% of the use during the second season, a value similar ($t = -0.056$, 30 df, $P = 0.962$) to the previous season.

Use of manure coincided (or supplemented) with use of corn (Fig. 4). Most manure was consistently applied on the same corn stubble fields, and geese appeared to be consuming the undigested corn present in the manure. The response by geese however, was specific to the strip of fresh manure. Use throughout the 1988-89 season was constant. During the 1989-90 season use peaked in mid-October (51%) and early March

(75%). Seasonal use of manure was significantly higher (t = -2.069, 30 df, P = 0.047) during 1989-90 (29%) compared to 1988-89 (12%).

Use of the wetland habitat during the 1988-89 season occurred in early December (28%) just prior to freeze up, in early February during a thaw (38%), and in late April (73%) (Fig. 4). Use during the 1989-90 season occurred in early September (47%), in mid-December (30%) just prior to freeze up, and in mid-March (67%). Although seasonal use of wetland habitat decreased from 20% to 18% during the 1988-89 and 1989-90 seasons respectively, the decrease was not significant (t = -0.060, 30 df, P = 0.952).

Results of a nested ANOVA indicated that there were no differences between use of habitats between years ($F_{1,10}$= 0.004, P > 0.05). Canada geese were also present on fallow fields, pasture (without water) and beans. Because geese utilized these habitats on average 5% and 9% of the time during the 1988-89 and 1989-90 seasons respectively, they were not included in further analyses.

Spearman rank correlation coefficients (Table 2) suggest migrant neck-banded geese did not use winter wheat, alfalfa, or wetland habitats in a manner similar to unmarked geese during the 1989-90 season. Also, local neck-banded geese did not use winter wheat, alfalfa, turf grass, or wetland habitats in a manner similar to unmarked geese. Freidman's test (P = 0.5488) however, suggests there is no significant difference

Table 2. Spearman rank correlations between the mean percent of unmarked geese verses mean percent of local or migrant marked geese utilizing habitats on the wintering study area during the 1989-90 season.

Habitat Type	Local vs. Unmarked	Migrant vs. Unmarked
Winter wheat	0.688	0.379
Alfalfa	-0.003	0.400
Turf Grass	0.735	0.867*
Corn	0.946**	0.866*
Manure	0.908*	0.925**
Wetland	0.776	0.621

* $P < 0.05$
** $P < 0.01$

in habitat use between local marked or migrant marked geese when compared to all unmarked geese during the 1989-90 season.

Canada geese exhibited high electivity indices for winter wheat during the early-harvest intervals for both seasons (Table 3), indicating high preference for this habitat. Although variation occurred resulting in intervals when winter wheat was not preferred, overall geese preferred winter wheat during both seasons. The mean index value (5.26) for the first season was not significantly higher ($t = 0.745$, 8 df, $P = 0.477$) than that of the second season (2.05). During the thaw interval of the 1988-89 season, winter wheat was used in a non-random manner.

Electivity indices for alfalfa varied between seasons. During the first season, index values were greater than 1.0 during the mid-harvest interval, indicating preference, whereas index values during the second season indicated no preference. Overall, alfalfa was not a preferred habitat for either season and the mean electivity index for the first season (0.63) was not significantly higher ($t = 1.271$, 8 df, $P = 0.239$) than the second season (0.29). During the mid-harvest interval of both seasons, alfalfa was used in a non-random manner.

Initially electivity indices for turf grass habitat were low and did not increase to levels indicating preference until the late-harvest and freeze intervals during the 1988-89 season. This pattern was similar during the second field

Table 3. Canada goose electivity indices for habitat types on the wintering study site, by season and time interval.

Habitat Type	Time Interval											
	1988-1989						1989-1990					
	Early	Mid	Late	Freeze	Thaw	Mean	Early	Mid	Late	Freeze	Thaw	Mean
Winter Wheat	21.82	2.78	0.11[b]	1.57	0.01[b]	5.26	3.57	5.33	1.19	0.18	0.00	2.05
Alfalfa	0.77	1.24[b]	0.02	0.67	0.44	0.63	0.03	0.12[b]	0.19	0.99	0.11[b]	0.29
Turf Grass	0.07	0.48	2.78	1.37	0.44	1.03	0.02[b]	0.00	0.27	1.02	0.01	0.26
Corn	0.23	0.73	0.29	0.19	0.37	0.36	0.23	0.60	1.05	0.20	0.81[b]	0.58
Manure	2.93	6.94	3.35	6.48	3.40[b]	4.62[c]	4.67	14.65	7.67	10.74	11.72	9.89[c]
Wetland	0.00	1.39	4.46	NA	4.32	2.54	9.91	0.61	3.15	NA	3.28	4.24

[a] Preference index expressed as mean percent use divided by mean percent availability, index values > 1.0 indicate a preference for the habitat type, whereas index values < 1.0 indicate the habitat type is not preferred; NA indicated habitat type was unavailable for use.

[b] Runs test significant at $P < 0.05$

[c] Student's t-test significant at $P < 0.05$

season, with the greatest preference occurring during the freeze interval. Canada geese avoided the turf grass habitat during the mid-harvest interval of the second season resulting in no index. Overall, geese preferred golf course habitat during the first season (1.03) but not during the second season (0.26), however this difference was not significant (t = 1.455, 8 df, P = 0.184). Turf grass habitat was used in a non-random manner during the early harvest interval of the second season.

Corn electivity indices never exceeded 1.0 except during the late-harvest interval of 1989-90. Mean electivity indices for corn were similar (t = 1.131, 8 df, P = 0.291) for both seasons (0.36 and 0.58 during the 1988-89 and 1989-90 seasons respectively). During the thaw interval of 1989-90, corn was used in a non-random manner.

Electivity indices for manure were always greater than 1.0, indicating continued preference. Mean index value for manure during the second season (9.89) was significantly higher (t = 2.745, 8 df, P = 0.025) than the previous season (4.62). During the thaw interval of 1988-89, manure was both preferred and used in a non-random manner.

Although wetland habitat was available to geese during the early-harvest interval, geese did not use this habitat during the first field season. During the 1988-89 season, the highest index of electivity (4.46) occurred during the late-harvest interval, whereas the highest index value (9.91) occurred during the early-harvest interval the following season. Wetland habitat was unavailable during the freeze interval for both seasons, therefore no index was possible. Overall, the mean indices were similar ($t = 0.045$, 8 df, $P = 0.484$) between seasons, (2.54 and 4.24 for the 1988-89 and 1989-90 seasons respectively), indicating an overall preference for water. Geese always used water habitat in a random manner.

Average electivity indices indicate geese preferred winter wheat > manure > wetland > turf grass during the 1988-89 season. The pattern of preference during the second season was manure > wetland > winter wheat. Overall, geese showed no preference for alfalfa or corn for either year, or for turf grass habitat during the second season.

Grazing Experiments

Mean wet weights (g/m^2) of alfalfa from the paired plot field experiment (Table 4) were not significantly different between ungrazed and grazed plots for the early clip ($t = 1.194$, 32 df, $P = 0.241$) or for the late clip ($t = 1.357$, 19 df, $P = 0.191$). Dry weight (g/m^2) showed similar results (early clip: $t = 0.717$, 32 df, $P = 0.479$; late clip: $t = 1.418$, 19 df, $P = 0.173$). The percent of weeds present (arcsine transformed) was similar in ungrazed and grazed plots (early clip: $t = 1.623$, 32 df, $P = 0.114$; late clip: $t = 0.156$, 19 df, $P = 0.878$).

Results from the paired plot field experiments in 1988-89 indicated that at the 2 bu/ac seeding rate of winter wheat, grazing decreased yields 3.3%, however this decrease was not significant ($t = 0.350$, 16 df, $P = 0.731$). Stem density was significantly greater ($t = 4.145$, 16 df, $P < 0.001$) in ungrazed verses grazed plots, however seed density did not differ significantly ($t = 0.269$, 16 df, $P = 0.791$) nor did seed weight ($t = 0.107$, 16 df, $P = 0.916$) between plot types (Table 5). At the 3 bu/ac seeding rate, grazing increased yields 18.2%, however this increase was border line

Table 4. Alfalfa seedling yield components ± SE from an experimental field located on the wintering study area in E. Lansing, MI., that was utilized by Canada geese during the 1988-89 season.[a]

Clip Date	Plot	Yield Components: Wet Wt. g/m^2	Dry Wt. g/m^2	Percent Weeds[d]
Early[b]	Ungrazed	507.6 ± 45.3	101.2 ± 7.0	37.1 ± 3.9
	Grazed	463.4 ± 44.1	96.3 ± 6.9	37.9 ± 3.6
Late[c]	Ungrazed	1270.8± 157.0	194.2 ± 21.4	45.2 ± 4.8
	Grazed	1493.3 ± 204.8	225.8 ± 23.3	47.6 ± 4.8

[a] all comparisons between paired plots within clip date are not significant at $P < 0.05$, Paired t-test.
[b] = plots clipped on 4-27-89, n=33
[c] = plots clipped on 5-18-89, n=20
[d] = *Capsella bursa-pastoris*
Taraxacum officinale
Cerastium vulgatum
Thlaspi arvense
Rumex crispus

Table 5. Winter wheat yield and yield components ± SE from an experimental field located on the wintering study area in E. Lansing, MI., that was utilized by Canada geese during the 1988-89 season.

			Yield Components			
Seeding Rate	Plot Type	Sample Size	Total Yield	Stem Density	Seed Density	Seed Weight
bu/acre		n	g/m^2	heads/1 m row	kernels/head	g/500 seeds
2	Ungrazed	17	279.5 ± 24.8	49.5 ± 2.6[a]	36.6 ± 0.9	13.9 ± 0.5
	Grazed	17	270.3 ± 24.5	43.3 ± 3.1[a]	36.9 ± 1.0	13.8 ± 0.6
3	Ungrazed	17	225.3 ± 28.7	52.6 ± 2.6	32.4 ± 0.9	12.8 ± 0.6
	Grazed	17	275.5 ± 30.3	53.2 ± 1.7	34.5 ± 0.9	14.0 ± 0.6

[a] means differ at $P < 0.05$ using a paired t-test.

significant ($t = 2.045$, 16 df, $P = 0.057$). Stem density between grazed and ungrazed plots was not significantly different ($t = 1.155$, 16 df, $P = 0.879$), nor was seed density ($t = 1.723$, 16 df, $P = 0.104$), nor was seed weight ($t = 1.601$, 16 df, $P = 0.129$) (Table 5).

DISCUSSION

Local Population:

This population has developed during the past 10 years and has established a tradition of using open water areas in the Lansing and E. Lansing areas for roosting at night and utilizing the surrounding agricultural areas and golf courses during the day. The 1089 ha area on the southern part of the MSU campus has become a site of traditional use; one in which geese experience sanctuary from hunting.

Accuracy of the Lincoln-Petersen population estimate depends on meeting underlying assumptions (Bailey 1951, 1952). One major assumption is that the population is closed (Seber 1982). Estimates during the first two observational intervals were similar (996 and 954), suggesting losses due to either hunting or emigration of locals was minimal. The assumption of a closed population was no longer valid during the third (11-20 September) interval when migrant geese with orange and blue neck-bands (19 individuals) were observed.

The Lincoln-Petersen method assumes no mark loss. Six local neck-banded birds were never sighted after initial banding. Craven (1979) reported only 2% of the hunters selectively shot neck-banded geese at Horicon National Wildlife Refuge. Hunters selectively harvesting neck-banded birds was probably not a problem during this study. Increased natural mortality may occur for a short period of time after banding but after some period of adjustment, birds are no longer adversely affected by neck-bands (Samuel et al. 1990). In subsequent observations all remaining geese neck-banded in this study were seen at least once on the overwintering study site. Neck-banded geese were moving less than 20 km from their original banding sites. Small dispersal distances have been observed in other resident populations of Canada geese (Flegler 1989, Zicus 1981). Since re-sightings of neck-bands were employed instead of recaptures, there were no problems associated with trap response. Finally, all animals in the second sample were reported (Seber 1982), because flocks were scanned such that each neck-band code was verified at least once.

A local population size of 1000 geese is sufficient to generate isolated summer nuisance complaints (Al Stewart, MDNR Rose Lake Research Facility 1989 pers. comm.). Currently the MDNR employs translocation programs in response to these complaints. Of the 27 translocated neck-banded geese, 5 (18.5%) were subsequently observed on the wintering study site between 13 September 1989 and 15 January 1990. Translocation may alter migration affiliation or result in differential mortality rates, however it remains expensive and thereby restricted in its use.

Wintering Population at MSU:

Kautz (1985) estimated with high precision the population size of rock doves, Columba livia, through resightings of numbered patagial tags. The assumptions underlying the Jolly-Seber model of equal catchability, no mark loss, and instantaneous sampling and release, were required under the Lincoln-Petersen (Pollock et al. 1990). An additional assumption, in which every marked animal present in the population immediately after the i^{th} sample has the same probability of survival until the $(i+1)^{th}$ sampling time, is necessary (Pollock et al. 1990). Heterogeneity in survival of neck-banded individuals by age or sex may violate this assumption (Samuel et al. 1990).

Estimates of age-specific survival probabilities of neck-collared geese vary. Samuel et al.(1990) recorded higher annual survival for neck-banded adult Canada geese ($\bar{X}$ = 0.769 $\pm$ 0.034 SE) compared to neck-banded juveniles ($\bar{X}$ = 0.586 $\pm$ 0.063 SE) at Horicon NWR from 1974 to 1980. Zircus (1981) recorded minimum survival for neck-banded adults varied from 0.75 to 1.0 and for neck-banded juveniles from 0.24 t 1.0 within the same year but between subflocks at Crex Meadows, Wisconsin. Samuel et al. (1990) found no consistent reduction in survival of adult or juvenile geese associated with neck-bands.

If survival probabilities were lower for juvenile neck-banded geese in this study, the resulting Jolly-Seber population estimate would be positively biased (Manly 1970). The computer program JOLLY is a fairly general model that can process one age class (Pollock et al. 1990). Of the 6 neck-collared geese that were never sighted after initial banding, 4 were juveniles. Trost (1983) found retention of neck-bands was 80% annually for adults and 91% in-season for juveniles. This suggests the marked juveniles experienced higher initial mortality compared to marked adults. Age-specific heterogeneity in prolonged survival of neck-banded geese was unlikely in this study for the number of sightings of marked juveniles on the wintering study site ($\bar{X}$ = 8.6 ± 0.721 SE) was not significantly different from marked adults ($\bar{X}$ = 10.3 ± 0.935 SE).

Icing of neck-bands on Canada geese has been documented (Ballou and Martin 1964, Sherwood 1966, MacInnes et al. 1969, Greenwood and Blair 1974, Zircus et al. 1983) and may influence Jolly-Seber population estimates. Zircus et al. (1983) estimated ice-related mortality ranged from 30% to 68% for neck-banded geese at Talcot Lake Wildlife Management Area, Minnesota. Greenwood and Blair (1974) found that icing severe enough to induce mortality occurred only when temperature fell to -27 C and the wind speed reached 30 km/h resulting in a windchill of -40 C. Weather conditions necessary to induce mortality due to severe neck-band icing is unlikely in south-central Michigan. Average wind speed in southern Michigan is highest at 16.1 km/h in January at which time the minimum daily temperature averages -9.1 C. One migrant neck-banded goose was observed once during this study with ice on his/her's neck-band. During subsequent observations this same individual was sighted with his/her neck-band free of ice.

Local Canada geese appeared to attracted migrant Canada geese to the wintering study area. Although migrant geese represented 65% of the total number of geese present, 77% of the locals remained on the wintering study site. Local marked geese tended to remain on the study area longer ($\bar{X}$ = 4.5 verses 2.2 months) compared to marked migrants. Overall, the average number of geese increased 26% between 1988-89 and 1989-90.

Relocation to the Milli-Ander Project at the Maple River State Game Area may alter fall migration patterns of local nuisance geese. The number of times translocated neck-banded geese were sighted on the overwintering study site was significantly lower ($\bar{X}$ = 1.4 $\pm$ 0.25 SE) compared to local neck-banded birds ($\bar{X}$ = 9.3 $\pm$ 0.57 SE). Translocations of 40 to 50 km may be sufficient to alter fall flock affiliations and result in these individuals wintering in other areas.

Wintering Habitat:

Preference for winter wheat was high both years during the early-harvest interval, despite the availability of corn, alfalfa and turf grass habitats. Geese may have avoided other available habitats based on field composition and activity levels. Activities, such as haying, coupled with the height of plants may have deterred use of established alfalfa fields. Although some use of the golf course did occur, active public play appeared to disturb geese. The decline in electivity indices between years for winter wheat was probably due to increased use of wetland habitat the second year.

Use of waste grain winter wheat waned during mid-harvest intervals as fields were fall plowed and replanted and corn harvesting activities increased. Preference for winter wheat did not occur again until green wheat approached the dormant stage in early winter. Frederick and Klaas (1982) recorded seasonal winter wheat use by snow geese, Anser caerulescens, at DeSoto NWR to be 32% ± 1.7 SE with the majority of use occurring in October through November. Use of winter wheat by Canada geese in this study were less, 17.3% and 4.2% during the 1988-89 and 1989-90 seasons respectively, during this time period.

Geese grazed on winter wheat at different times during the 2 winter seasons. Utilization of forage may be dependent upon the amount of moisture on the foliage. Bell and Klimstra (1970) noted heavy dew, frost, light rain or light snow resulted in geese concentrating in pastures or small-grain fields rather than in corn or soybean fields. Milder temperatures and little snow cover during the first season was probably responsible for use occurring during the freeze interval. Similar conditions occurred during the mid to late-harvest intervals of the second season.

Alfalfa was preferred during the early and mid-harvest intervals of the first but not the second season, probably due to the growth stage of the plants and field location. Taylor (1957) noted geese preferred very short tender winter-green plants, and once vegetation became 10 to 13 cm (4 to 5 inches) high, geese ceased foraging on it until all other forage was exhausted. During 1988-89, 32% of alfalfa was available as short seedlings compared to 17% the following season. Definite preference for open spaces with nearby access to water by Canada geese has been demonstrated (Taylor 1957). Although the topography of all alfalfa fields during both seasons was such that water collected providing geese with feeding and loafing opportunities within the same field, one open 23 ha (58 ac) alfalfa seedling field located adjacent to palustrine wetlands was used extensively in the early and mid-harvest intervals of 1988-89. This field was also free of visual blocks such as woodlots or hedgerows, which may decrease preference for areas by geese (Taylor 1957).

Similar seasonal alfalfa use (15.6%) by Canada geese was reported at Horicon Marsh, Wisconsin (Craven 1984). Geese have been observed heavily foraging in alfalfa after heavy snows (Taylor 1957) and this may account for the increased use of alfalfa during the freeze intervals of both seasons.

Geese are almost entirely grazers, and they often select patches of a given plant species that are higher in nitrogen

(Lieff et al. 1970, Lieff 1973, Harwood 1977, Owen 1975, Buchsbaum et al. 1984). Harwood (1975) found that the application of nitrogenous fertilizer to grass increased the water content. Owen et al. (1977) found that preference of barnacle geese, Branta leucopis, was more closely related to water than protein content. Golf course personnel often highly fertilize greens and fairways in the fall to minimize ice and snow accumulation (Converse 1985) and to stimulate spring growth. Depredation of lawns is often greater in winter because grasses are fragile and dormant and the ground is usually wet (Converse 1985). Mild winter conditions coupled with discontinued public play and traditional fall turf management resulted in preference for turf grass habitat during the late-harvest and freeze intervals of 1988-89. Persistent snow cover was probably responsible for the decrease in goose use of the turf grass habitat during the second season.

Canada geese readily utilize corn. As early as the late 1940's, feeding in shocked or standing corn fields by overwintering giant Canada's was reported in Rock and Waushara Counties in Wisconsin (Hunt and Bell 1973). Corn was the most common food item present in the gizzards of Canada geese at Horicon Marsh in east-central Wisconsin (Craven 1984). Although corn was identified as the crop most frequently associated with crop depredation in Wisconsin (Hunt and Bell 1973), Craven (1984) was unable to substantiate damage claims.

Results of his study indicate most corn was taken as waste grain soon after harvest. Corn, although preferred only once, was consistently utilized by Canada geese throughout this study, and is considered a continuing major contributor to the diet of wintering geese.

Damage to unharvested corn was unlikely on the wintering study area considering the availability of corn stubble and climatic conditions. Patches of corn were purposely left standing both years and geese were sighted in these plots only after winter conditions became severe. Geese foraging in corn may aid in alleviating the later agricultural problem of volunteer corn germinating during the next growing season.

The role of fresh manure as habitat for Canada geese has not been documented. Preference for manure was high, and geese were observed concentrating feeding and loafing activities in narrow strips of spread manure. Geese habituated to the daily spreading activities, returning to manure strips even before the tractor and spreader had left the field. The high food value, mainly cracked corn, seems to be the main attractant. Fresh manure was heavily used during periods of heavy snow cover. Overall higher preference for manure during the second season was probably a reflection of more persistent snow cover during that season. Strategic placement of manure appears to have the potential of altering daily feeding locations of Canada geese.

Open water was an important component of the habitat used by wintering Canada geese. Preference for wetland habitats prior to winter freeze up reflected primary roosting activities on the palustrine wetlands associated with the Inland Lakes Project by migrant geese. Geese also concentrated activities around 0.5 ha (1 ac) pond located on the golf course after play discontinued in mid-October. Preference during the freeze interval reflected secondary roosting activities on ephemeral pasture floodings created by mild winter conditions. Migrant geese arriving to the area appeared to initially concentrate on the palustrine wetlands resulting in high preference for wetland habitat during the early harvest interval of 1989-90.

Grazing Experiments:

The effects of grazing geese on agricultural crops, specifically winter wheat, _Triticum aestivum_, and alfalfa seedlings, _Medicago sativa_ is not well understood. Yields from plots grazed by geese have been recorded for winter wheat (Pernie 1954, Taylor 1957, Sturdy 1967, Kear 1970, Humburg 1980, Kahl and Samson 1984, Flegler et al. 1987) and alfalfa (Taylor 1957, Bedard et al. 1986) with mixed results. Occurrence of wintering geese in E. Lansing area offered the opportunity to investigate crop yields under natural goose grazing conditions.

Economic loss from geese grazing on alfalfa can be severe. Castelli et al. (1985) reported $1,320.00 worth of damage to a field only 3 acres in size in Hunterdon County, New Jersey. Such economic losses of alfalfa usually result from grazing by spring staging geese in April or May. Bedard et al. (1986) reported a 14.3% reduction in potential yield of the first crop of alfalfa when spring grazed by greater snow geese (Chen caerulescens atlantica). Kahl (1979) recorded a significant loss in spring livestock forage when grazing occurred in early spring. However, Hunt and Bell (1973) note, that although in wet spots trampling and puddling does occur, grazing by geese is not a factor in alfalfa loss.

Natural grazing by free ranging Canada geese did not significantly reduce alfalfa seedling yields on the wintering study site. Damage to alfalfa is most likely to occur in early spring. During this study, geese avoided alfalfa during this period.

Although it was not possible to determine what proportion of local verses migrant geese utilized alfalfa, only 1 local verses 4 migrant neck collars were observed during the 1989-90 season on this habitat type. Local geese moved out of the wintering study site (as indicated by the absence of green neck-bands) 2 weeks prior to the departure of migrants. It is feasible that if weather conditions delay the departure of migrants to northern breeding areas in the spring, that alfalfa may be at risk from goose grazing.

Sturdy (1967) reported green forage to be 90% of the total food volume, of which winter wheat was the most common, in the stomachs of Canada geese shot by hunters in Salt Plains National Wildlife Refuge, Oklahoma. Taylor (1957) found that preference for winter wheat was equal to that of Ladino clover (Trifolium repens), a highly preferred green forage species. In this study, although geese preferred winter wheat on a seasonal basis, variation within a season occurred.

The effect of grazing by Canada geese on yields of green forage crops such as winter wheat has been given considerable attention (Pernie 1954, Sturdy 1967, Taylor 1957, Kear 1970, Clark and Jarvis 1978, Humburg 1980, Kahl and Samson 1984, Flegler et al. 1987) with mixed results. Some light utilization of winter grain crops can actually increase yields (Taylor 1957, Clark and Jarvis 1978). Grazing of seeds first shoots stimulates vigorous resprouting often resulting in three or more new shoots (Ogilvie 1978). In England, farmers allow sheep, and in the southern U.S., cattle, to graze green winter forage crops to provide this regrowth benefit which is referred to as tillering. Geese may actually benefit farmers by the fertilization effect of their droppings (Kear 1963, Marriott 1973).

However, Humburg (1980) reported winter wheat losses from 14% to 47% by free ranging geese during the fall and winter months in Missouri. Kahl and Samson (1984) reported excessive yield losses when wheat was heavily grazed in November. They also noted damage was severe for wheat stressed by poor growing conditions and harsh winter weather, or on wet clay soils. Flegler et al. (1987) reported mean yield was reduced by 18, 30, and 16% respectively, for young, dormant, and tillering wheat by captured geese.

My study supports earlier contentions that free-ranging Canada geese do not significantly reduce winter wheat yields. Flegler et al. (1987) reported the number of kernels/head was correlated inversely to plant density, suggesting plants may partially compensate for reduced density of stems by producing more kernel/head. Similar results were noted in this study. The significantly higher number of heads per one meter row at the 3 bu/ac seeding rate appeared to be compensated by the significantly higher seeds per head at the 2 bu/ac seeding rate. All other yield components indicated no negative effect from grazing by geese. Flegeler et al. (1987) suggests increasing seeding rates of winter wheat by 34-68 kg/ha in areas where goose depredation is anticipated. This study suggests that increased seeding rates will not increase yields in areas either grazed or not grazed by Canada geese.

MANAGEMENT IMPLICATIONS

The wintering study site in E. Lansing will continue to be a major overwintering area for Canada geese. The area has been established as a refuge during hunting seasons and a source of continuous food through out the winter. Traditional migrational use of the area has been established, as evidenced by the presence of neck-banded migrants.

Hunting is not an alternative on a 1089 ha agricultural research area interspersed with a well developed system of public roads. Conflicting interests, due to the variety of visitors pass through this area, the year round production of forage and grains crops, and the several ongoing farm operations, also exists. Finally, Canada geese share the overwintering study site with joggers, bicyclists and cross county skiers.

The question that remains is one of managing goose pressure on specific habitats. Since geese utilize the area in basically a random fashion, employment of scare devices are unlikely to be effective. Also, hazing geese only works if the birds have an alternative. The area surrounding the wintering study site is mainly corn or residential and many areas are actively used by hunters.

The following are suggestions the agricultural community may employ to reduce or redirect use of specific areas by Canada geese.

1. Apply manure in areas isolated from crops that are known to be susceptible to damage.

2. Haze geese utilizing alfalfa in the spring.

3. Plant crops that are susceptible to damage away from water areas.

4. Leave harvested corn in the form of corn stubble when adjacent to fields susceptible to damage.

5. Plant vulnerable crops in fields surrounded by woodlots or hedge rows.

6. Promote human activity on the east 18 holes of Forest Akers Golf Course.

CASE STUDY

In spring of 1990, a 16 ha (40 ac) winter wheat field located on Powerline Road within the wintering study site (Fig. 5), was declared a failure by the university farm manager. This open field, located adjacent to the palustrine wetlands, allegedly suffered irreparable damage from grazing geese during the 1989-90 season (Fig. 5). Total monetary loss was estimated at $12,000.00 (Barry Darling, MSU farm manager, pers. comm.). Blocks of winter wheat were left for later harvesting and a comparison of yield measures from the Powerline Road field with the 1988-89 experimental winter wheat field located on Bennett Road was made (Fig. 5).

The Powerline Road field was planted to corn in 1988-89 and then to winter wheat in 1989-90. The Bennett Road field was planted to winter wheat, then alfalfa seedlings, during the 1988-89 and 1989-90 seasons respectively. Comparisons of the mean number of geese present on the 2 fields during both seasons (Fig. 6) revealed similar intensity of use. The greatest number of geese present on the Bennett Road field was just over 3,000 in late January of 1989 (habitat type = winter wheat), and just over 7,000 in early January of 1990 (habitat type = alfalfa seedlings). Use of the Powerline Road field during the 1988-89 season peaked at just under 5,000 early

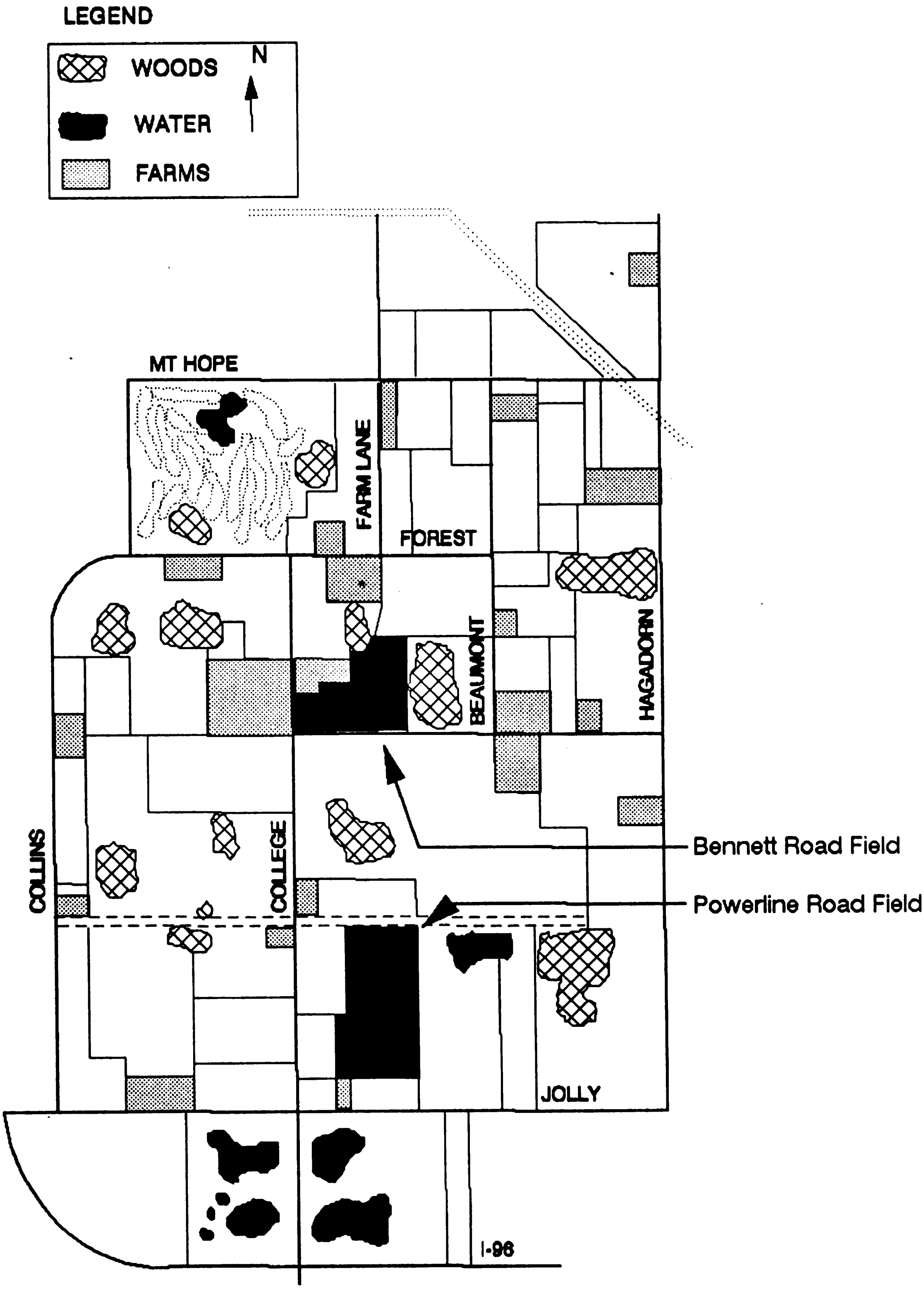

Figure 5. Bennett and Powerline Road fields located on the wintering study site, E. Lansing, MI.

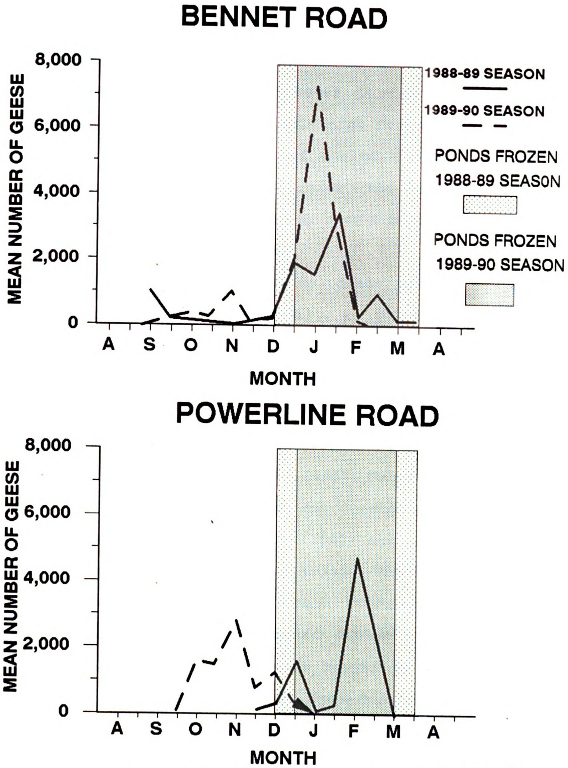

Figure 6. Number of geese present on Bennet and Powerline Road fields, which are located on the wintering study site, by season.

February (habitat type = corn) and at 3,000 birds in early November during the 1989-90 season (habitat type = winter wheat). More geese utilized winter wheat during 1989-90 ($\bar{X}$ = 1347 ± 357 SE) compared to 1988-89 ($\bar{X}$ = 837 ± 322 SE), however this difference was not significant ($t = 0.669$, 15 df, $P = 0.510$). Since the intensity of use of winter wheat by geese was similar between the 2 fields, the timing of the majority of the use, which differed by over 2 months, may have contributed to the alleged damage.

Conditions under which Canada geese reduce yields include: 1) young wheat in early fall, 2) jointing wheat in late spring, and 3) during wet field conditions. Kahl (1979) documented that heavy grazing of young wheat in fall significantly reduced yields by 97%, whereas grazing of older, established wheat in fall did not significantly reduce yields. Yields were reduced in Flegler et al.(1987) controlled grazing experiments by 18, 30 and 16% for young, dormant and tillering wheat respectively. Flegler et al. (1987) suggests that rain during the dormant wheat grazing trial, which left plots extremely muddy and subject to goose trampling, may have amplified reduced yields from grazed dormant wheat. Kear (1970) reported no significant grain losses attributable to grazing in England during December, January, February, March or April. Heavy grazing of established wheat in fall under dry conditions on well drained sites did not reduce yields in Missouri (Kahl 1979). This suggests that geese may have concentrated use on the Powerline Road field at a stage when winter wheat was more venerable.

Kahl and Samson (1984) reported that although fall grazed plots looked bare at the end of grazing trials and significant differences were evident through early May when compared to ungrazed plots, seed yields were not significantly different between fall harvested grazed and ungrazed plots. They suggest a landowner may prematurely assume a loss in kernel yield based on loss of foliage to geese in late fall, and recommend damage to winter wheat be appraised at or just prior to harvest.

Geese had an impact on the Powerline Road winter wheat which was seeded at 3 bu/ac during 1989-90. Ungrazed plots from this field had significantly higher yields ($t = 5.981$, 18 df, $P < 0.001$), stem densities ($t = 8.786$, 18 df, $P < 0.001$) and seed densities ($t = 5.480$, 18 df, $P = < 0.001$), however, seed weight was significantly higher ($t = 6.076$, 18 df, $P < 0.001$) in grazed plots suggesting a trade-off.

Flegler et al. (1987) suggested increasing seeding rates in areas where depredation by Canada geese was anticipated. Results of this study suggest no advantage to increasing seeding rates in fields utilized by free-ranging Canada geese. Fields traditionally utilized by wintering geese, those located near wetlands, or those free of visual blocks (ie: woodlots and hedgerows) should be planted into crops not highly preferred by Canada geese.

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