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MOVEMENTS OF GIANT CANADA GEESE AND EFFECTS
OF THEIR GRAZING ON WINTER WHEAT YIELD

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Harold H. Prince
Major professor

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MOVEMENTS OF GIANT CANADA GEESE AND EFFECTS OF THEIR GRAZING ON WINTER WHEAT YIELD

By

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ABSTRACT

MOVEMENTS OF GIANT CANADA GEESE AND EFFECTS OF THEIR GRAZING ON WINTER WHEAT YIELD

By

Earl John Flegler, Jr.

Establishment of giant Canada geese in southwest Michigan has led to subsequent nuisance and depredation problems. During 1981 and 1982, goose population size and movements in southwest Michigan were evaluated and the affect goose grazing has on winter wheat was assessed.

Based on stratified random sampling, an estimated 2,818 ± 548 (SE) adults and young were present within the study area. Neckband observations suggest short dispersal movements, subflock integrity, and a northward molt migration by 1 year old-birds. Most geese remained during a mild winter but migrated south during a severe winter.

The effect of grazing on wheat yield was determined by comparing ungrazed plots to plots grazed at various stages of growth. A single intense grazing reduced yield by 18, 30, and 16%, respectively, for young, dormant, and tillering wheat. Repeated grazing resulted in a 47% yield decline. A decrease in stem density and kernel weight caused reduced yields.

ACKNOWLEDGMENTS

Funding for this project was provided by the Michigan Agriculture Experiment Station. The Michigan Department of Natural Resources, Wildlife Division, provided aerial flight time. Research facilities were provided by the W. K. Kellogg Biological Station. Mr. Harold Webster and staff at the W. K. Kellogg Farm planted the wheat for the depredation study.

I am indebted to Dr. Harold H. Prince, my major professor, for his understanding, encouragement, and insightfulness. He guided when I needed it and allowed me the freedom to make my own mistakes and grow from them. May I learn from his wisdom. Thanks also to Dr. Stuart Gage, Mr. Wilbur C. Johnson, Dr. George H. Lauff, and Mr. Roswell VanDeusen, committee members, for their review of the final manuscript. A special thanks to Mr. Wilbur C. Johnson whose knowledge of southwest Michigan, its people, and its Canada geese made this project possible and who taught me that a good biologist believes only half of what he sees and none of what he hears.

Field assistance along with comradery during the project were received from Brian Gray, John Jackson, Dave Pingel, Charles Rewa, and Rick Rusz. My thanks to Dr. John L. Gill for statistical advice and Mary Rabe for review of an earlier draft. Julie Hammill and Myra Fraidenburg typed portions of the manuscript. Dorothy Spinner answered numerous phone calls pertaining to neckbanded geese and their locations.

I am grateful to my parents, Ethel and (the late) Earl Sr. for encouraging my interests in the outdoors and to my family, Laurie, Benjamin, and Rebecca, who sacrificed and endured when I was not there. You are my love, my inspiration, and my purpose.

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INTRODUCTION

Canada geese (<u>Branta canadensis</u>) are distributed throughout North America with 11 recognized subspecies that developed as a result of ecological or geographical isolation on their breeding grounds (Bellrose 1980). Breeding grounds, migration routes, and wintering grounds of 16 Canada goose populations in North America have been described (Can. Wildl. Serv. and U.S. Fish and Wildl. Serv. 1986). Each specific population may be composed of more than 1 subspecies, and the various subspecies may mix together during migration and wintering.

Although the original breeding population of Canada geese was probably eliminated from Michigan by the early 1900's, most efforts to restore the geese to their historical range have been successful (Hanson 1965). In southwest Michigan, approximately 30 pinioned geese were released at the W. K. Kellogg Bird Sanctuary (KBS) in 1927 (Pirnie 1938). During the early 1960's, the Michigan Department of Natural Resources (MDNR) released giant Canada geese (<u>B. c. maxima</u>) in the area. Currently, Canada geese nest throughout southern Michigan and do especially well in urban areas (Kaminski 1975).

As goose numbers increased, problems involving crop depredation and nuisance complaints developed. Tacha et al. (1979) reported that although 23% of the farmers said they had been subject to damage by a local goose flock, only 6% complained about the geese. Damages caused by the geese included trampling and eating swathed grain, grazing young shoots of small grain, and trespassing by goose hunters. These damages were most common near goose concentrations. Tolerance for goose expansion was determined by the percentage of farmers receiving damages and the amount of the damages. Knittle and Porter (1988) and Hunt and Bell (1973) summarized the history of crop depredation by waterfowl on agricultural crops. Serious crop depredation did not begin until the mid-1940's when refuge establishment, waterfowl concentration, wetland drainage, and increased farming combined to create the right conditions for depredation.

Canada geese often feed on early stages of green winter wheat (Arthur 1968). While the wheat plants may appear to be damaged by goose grazing due to loss of green vegetation, a reduction in yield was not always detected (Pirnie 1954, Kear 1970) and yield might even be increased (Quinn 1952). However, more recent research has documented that wheat yield under grazed conditions is affected by growth stage, growing conditions, soil type, and soil moisture (Kahl and Samson 1984, Allen et al. 1985).

Recent establishment of giant Canada geese in urban settings has led to nuisance problems on beaches, lawns, and golf courses (Hawkins 1970, Coleman et al. 1982, Converse and Kennelly 1982, Forbes 1982, Laycock 1982, Martz et al. 1982, Cleary and Reynolds 1983, Conover and Chasko 1985). One family of geese using an area is usually acceptable to property owner's and aesthetically pleasing. People often begin feeding the geese, however, creating dependency, attracting other geese, and ultimately leading to increased fecal contamination and subsequent nuisance problems and complaints.

Raveling (1969) described discrete subflocks of Canada geese wintering at the Crab Orchard National Wildlife Refuge which utilized specific areas for roosting and feeding. He suggested that these subflocks may maintain their integrity during migration and throughout the winter. Kennedy and Arthur (1974) studying the Mississippi Valley Population and Koerner et al. (1974) studying the Tennessee Valley Population also identified distinct subflocks during migration and wintering. Raveling (1979) demonstrated the year-around association of subflocks. Zicus (1981b) described subflocks within a reestablished local flock of Canada geese in Wisconsin. These subflocks were composed of groups of families which formed from different brood-rearing areas. The subflocks roosted and fed as units until freeze-up of shallow marshes which altered subflock composition and roosting locations. However, data from Anderson and Joyner (1985) question the integrity of wintering subflocks. Tacha et al. (1988) suggested that wintering subflocks in the Mississippi Valley Population do not occupy distinct nesting areas in the spring and summer.

Knowledge of flock composition, distribution, and movement in southwest Michigan is limited. Pirnie (1938) reported that none of the 95 Canada geese raised and banded at KBS had been shot more than a few miles away. Rudersdorf (1962) found that Canada geese migrating through KBS wintered in southern Illinois and Missouri, while others went to Kentucky, Tennessee, the Alabama-Georgia border, or further east. While some flocks of giant Canada geese are known to migrate long distances (Raveling 1979), others are essentially nonmigratory (Converse 1985).

This investigation is separated into 2 experiments. Experiment I tests the hypothesis that brood-rearing groups of locally reared giant Canada geese in southwest Michigan move as distinct groups and do not migrate. Experiment II tests the hypothesis that grazing by Canada geese on winter wheat reduces yield.

EXPERIMENT I

STUDY AREA

Observations were concentrated within a 40 km radius of KBS, which is 26 km northwest of Battle Creek, Michigan (Fig. 1). The area included parts of the following 8 counties: Allegan, Barry, Eaton, VanBuren, Kalamazoo, Calhoun, St. Joseph, and Branch. The 3 large metropolitan areas are Kalamazoo, Portage, and Battle Creek.

Topography of the area resulted from the complex action of glaciers and consists of a mixture of moraines, till plains, outwash plains, and ponded areas (Austin 1979). A concentrated band of marshes and kettle lakes stretches across the area from the southwest to the northeast. A total of 607 wetlands 2 ha or larger, the size of wetlands that contain most goose nests (Kaminiski and Prince 1977), occur within the study area (Table 1).

The average winter temperature is -2.8 degrees C, and the average summer temperature is 22.1 degrees C. Average annual precipitation is 88.2 cm (Austin 1979).

The primary crops are corn, soybeans, wheat, oats, and hay (Mich. Dep. Agric. Stat. Serv. 1988). For the 8 county area, corn production averages 30,970 ha/county (Table 2). Wheat production averages 6,452 ha/county, with Calhoun and Eaton counties having the highest production. Allegan and Barry counties are the largest hay producers, 15,372 ha/county and 11,226 ha/county, respectively. Hog, beef, and dairy farming are also important.

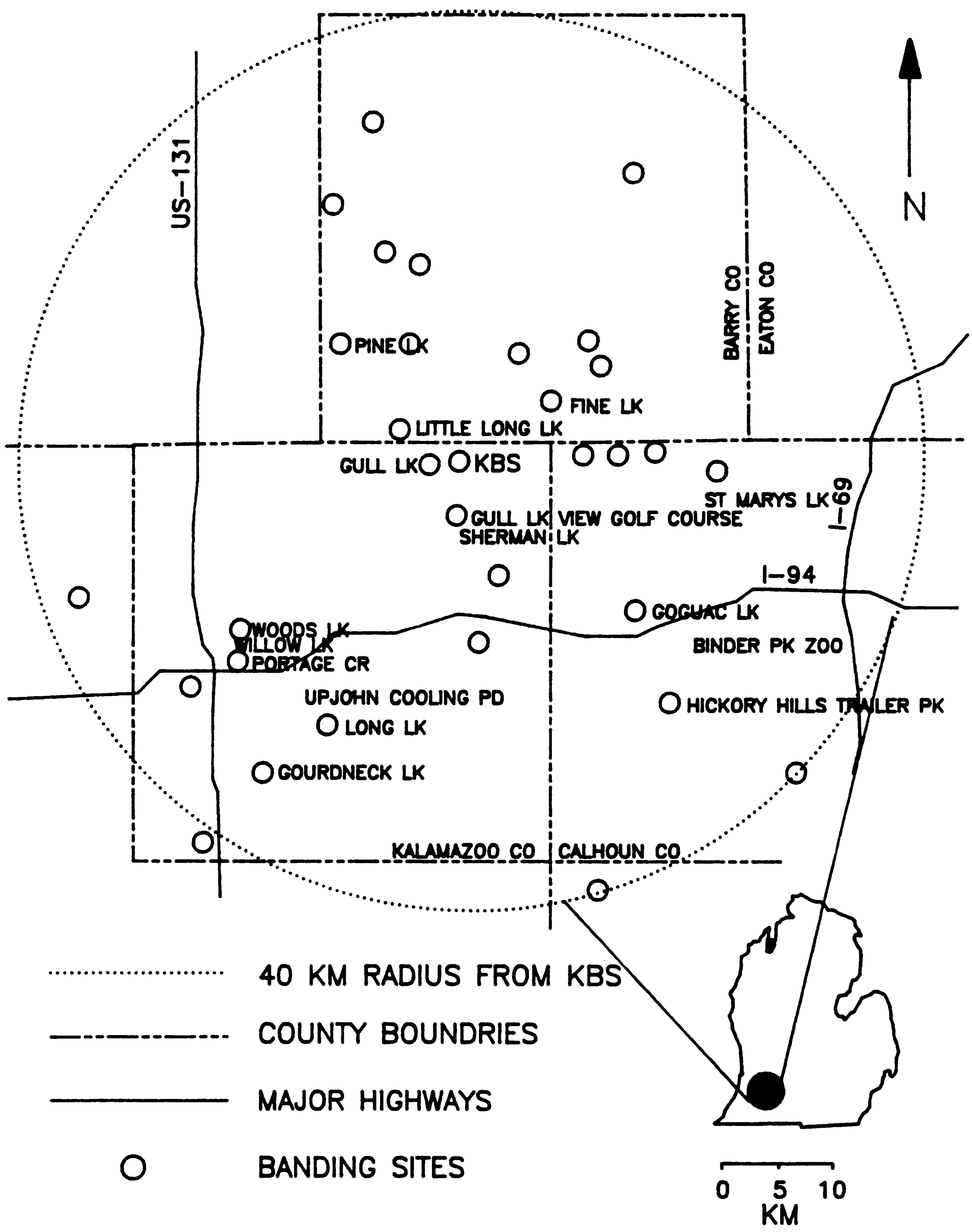

Fig. 1. Location of the W. K. Kellogg Bird Sanctuary (KBS), other banding sites, and locations mentioned in text, southwest Michigan, 1982.

Table 1. County breakdown of number of lakes within 40 km of the Kellogg Bird Sanctuary stratified according to distance from the Kellogg Bird Sanctuary and size of lake (small = 2.0-4.9 ha, medium = 5.0-24.9 ha, large = 25.0+ ha).

	Distance from KBS					
	0.0-20.0 (km)			20.1-40.0 (km)		
County	Small	Medium	Large	Small	Medium	Large
Allegan	1	0	1	22	26	8
Barry	66	61	23	61	35	12
Branch	0	0	0	0	2	2
Calhoun	19	9	4	30	29	11
Eaton	0	0	0	4	2	2
Kalamazoo	25	31	7	26	30	27
St. Joseph	0	0	0	1	1	1
Van Buren	0	0	0	17	6	5
Total	111	101	35	161	131	68

Table 2. Crop data for southwest Michigan, 1986, from Mich. Dep. Agric. Stat. Serv. (1988).

County Name	Corn Production (ha)	Soybean Production (ha)	Wheat Production (ha)	Oat Production (ha)	Hay Production (ha)
Allegan	37,935	1,943	4,858	1,943	15,372
Barry	20,162	3,968	6,073	1,417	11,226
Branch	38,340	16,113	6,073	1,215	4,910
Calhoun	36,316	10,850	9,717	2,227	9,635
Eaton	30,243	8,866	14,170	1,215	8,592
Kalamazoo	23,765	9,231	5,263	1,012	5,566
St. Joseph	43,348	13,279	4,049	607	5,660
Van Buren	17,652	3,320	1,417	607	5,380

Land use in the 8 county area averages 43.3% cropland, 20.3% forest, 4.9% pasture, 2.0% water, and 29.5% other (Mich. Dep. Agric. Stat. Serv. 1988). Significant portions of public land in the vicinity include the Middleville State Game Area, the Barry State Game Area, and the Yankee Springs Recreation Area in Barry County, and the Gourdneck State Game Area and the Fort Custer Recreation Area in Kalamazoo County.

METHODS

Banding

Geese were captured for banding between 18 June and 15 July 1982 and between 25 June and 3 August 1983 by herding into portable V-shaped traps (Cooch 1953). Birds were aged and sexed based on criteria described by Hanson (1967). Up to 50% of all geese captured, but not more than 10 from any age-sex group per banding site, received 7.5 cm gray 2-ply gravoply II (New Hermes, Inc., 3642 West 128th Place, Alsip, Ill. 60658) neckbands. Each neckband contained an individual 4 digit alpha-numeric code in white 2.6 cm high characters. The neckbands were constructed using the technique reported by Craven (1979). All geese received U.S. Fish and Wildlife Service aluminum leg-bands.

Observation

Geese were monitored by searching known concentration areas and by searching a randomly selected group of lakes. Searching known concentration areas provided a minimum population estimate and increased the percentage of marked geese that could be observed during each time period. Marked geese were observed to determine their movements and to calculate a population estimate based on the following formulas for mark/recapture estimates (Bailey 1951).

$$N = \frac{Mn}{m} \qquad SE^2 = \frac{M^2 n(n-m)}{m^3}$$

Where N = the total population, M = the number neckbanded, n = total geese observed, and m = total geese observed with neckbands.

The mark/recapture estimates are based on the following assumptions (Tanner 1978:31): 1) Trapping, marking, and releasing did not affect the probability of recapture. 2) Neckbands did not fall off and were always recognized. 3) No emigration or death occurred between release and recapture or the number marked can be adjusted for disappearance.

Goose counts on a stratified random sample of lakes (Cochran 1963) provided a technique from which a population estimate with confidence intervals could be derived while at the same time maintaining consistency in searching intensity. Stratification allows for division of a heterogeneous population into fairly homogeneous subpopulations which are less variable than the original population. With homogeneous subpopulations in each stratum, a precise estimate of any stratum mean can be obtained from a small sample in that stratum. The stratum estimates can then be combined into a precise estimate for the whole population. This may result in a substantial gain in precision over simple random sampling procedures (Cochran 1963).

When considering design of stratified waterfowl surveys, Rutherford and Hayes (1976) suggested exclusion of non-wetlands and stratification of data from different wetland types. The random sample of lakes was stratified by lake size, which affects goose density (Kaminski and Prince 1977), and distance from KBS, the site of the initial release and establishment in the region.

Therefore, a sample of 15 lakes from each of 6 strata was selected based on the combination of lake size (2.0-4.9 ha, 5.0-24.9 ha, 25.0+ ha) and distance from KBS (0.0-20.0 km, 20.1-40.0 km). The list of potential lakes for sampling was selected from an inventory of Michigan lakes (Humphrys and Green 1962).

A variety of techniques were employed to monitor goose numbers and to observe neckbanded geese a least once during the approximately bi-weekly time periods between 20 July 1982 and 5 March 1983. At the beginning of all time periods except the last, an aerial flight was conducted to locate and count geese. Follow-up ground surveys were conducted to confirm counts and read neckbands. Sightings were made with the aid of a 15x60 variable zoom spotting scope. Neckbands were readable at 300+ m under good light conditions. Total number of geese with and without neckbands and code number of each neckband were recorded.

For analysis, time periods were lumped into biological seasons of before hunting season (20 July 1982-21 October 1982), during hunting season (22 October 1982-18 November 1982), after hunting season (19 November 1982-13 January 1983), and after freeze-up (14 January 1983-2 February 1983).

During the first time period, the random lakes were searched more intensively on the ground to obtain information on brood production. If no geese were observed on the lakes, at least 3 landowners on different parts of each lake were asked if and where geese could be found. Lakes that were inaccessible by vehicle, were surveyed by airplane on 27 July 1982 (n=24).

To solicit observations of neckbanded geese from local citizens, a newspaper press release (Fig. 2 Appendix) along with a black and white photo were sent to 25 newspapers in southern Michigan explaining the project and requesting information on locations of neckbanded geese. Responses from the newspaper articles helped to identify a group of people who frequently observed geese at feeding stations and were willing to report neckband observations.

No surveys were conducted during 1983-84 to follow goose movements. However, sightings of neckbanded geese and band returns were recorded.

Confusion has arisen in recent literature concerning the term subflock. Kennedy and Arthur (1974) and Tacha et al. (1988) described subflocks (subpopulations) as segments of the Mississippi Valley Population which use distinct refuges or parts of refuges during staging and wintering. However, Zicus (1981b) and Schultz et al. (1988) described subflocks as multi-family groups from the same brood-rearing site which feed and roost together. The term brood-rearing groups will be used here to describe multi-family groups from the same banding site (brood-rearing area).

RESULTS

Trapping, Banding, and Observation Effort

During 1982, 926 Canada geese were leg-banded with 506 receiving neckbands at 32 sites (Table 3). An additional 723 geese were banded in 1983 with 318 of these receiving neckbands. A detailed list of lakes and neckband codes is presented in Tables 4-5 Appendix.

A total of 3,383 observations occurred between 20 July 1982 and 5 March 1983 for the 506 geese neckbanded during 1982. Only 4 geese were not observed at least once (Table 6). Throughout the 13 time periods, the minimum number of neckbanded geese observed per time period was 164 and the maximum was 353. By early February, a minimum of 41% of the geese still remained in the study area.

Direct return hunting mortality rates were similar for the 1982 neckbanded and leg-banded only cohorts, 7.5% versus 6.2% ($\underline{X}^2 = 0.25$, d.f. = 1, $\underline{P} > 0.30$), but differed for the 1983 neckbanded and leg-banded cohorts, 8.8% versus 3.7% ($\underline{X}^2 = 8.29$, d.f. = 1, $\underline{P} < 0.01$). Assuming all of the 1982 neckbanded cohort not observed after the hunting season were shot and not reported or recovered, maximum 1982 hunting mortality was 20%. Known non-hunting mortality represented less than 2% of the neckbanded cohort.

Population Estimates

During the brood survey (20 July 1982-25 August 1982), a total of 84 pairs of geese with 362 young were present on the 90 randomly stratified lakes surveyed. This represents a total of 2,818 ± 548 ($\underline{\bar{X}} \pm$ SE) geese for the 607 lakes in the study area (Table 7). Of the total,

Table 3. Age/sex breakdown of total number of geese banded and available to be observed within 40 km of the Kellog Bird Sanctuary during summers 1982-83.

		1982			1983			Total		
Age	Sex	Leg-Band	Neckband	Total	Leg-Band	Neckband	Total	Leg-Band	Neckband	Total
Local	Male	139	139	278	158	123	281	297	262	559
Local	Female	133	131	264	178	103	281	311	234	545
Adult	Male	51	108	159	33	48	81	84	156	240
Adult	Female	61	97	158	30	44	74	91	141	232
Local	Unknown	36	31	67	0	0	0	36	31	67
Unknown	Unknown	0	0	0	6	0	6	6	0	6
Total		420	506	926	405	318	723	825	824	1649

Table 6. Status by time period of 506 Canada geese neckbanded in southwest Michigan and monitored between 20 July 1982 and 5 March 1983.

Status[a]	Time Period												
	7/20 - 8/25	8/26 - 9/16	9/17 - 9/30	10/1 - 10/21	10/22 - 11/4	11/5 - 11/17	11/19 - 12/2	12/3 - 12/16	12/17 - 12/30	12/31 - 1/13	1/14 - 1/27	1/28 - 2/10	2/11 - 3/5
Survival[b]	495	480	475	450	427	413	401	397	383	376	322	268	164
Mortality													
Non-hunting	7	8	8	8	8	8	8	8	8	8	8	8	8
Hunting	0	0	0	25	32	37	38	38	38	38	38	38	38
Unknown[c]	4	18	22	23	39	48	59	63	77	84	138	192	296
Observed	344	275	204	261	245	237	353	305	272	283	250	190	164

[a]Survival + Mortality + Unknown = 506
[b]Observed in that time period or any future time period.
[c]Not observed in that time period or any future time period. Includes geese from within and outside of the study area not located, unreported mortality, and hunting crippling loss.

Table 7. Brood survey results from 90 lakes stratified according to distance from the Kellogg Bird Sanctuary and size of lake (small = 2.0-4.9 ha, medium = 5.0-24.9 ha, large = 25.0+ ha), 1982.

	Distance from KBS					
	0.0-20.0 km			20.1-40.0 km		
Parameter	Small	Medium	Large	Small	Medium	Large
Lakes Present	111	101	35	161	131	68
Lakes Surveyed	15	15	15	15	15	15
Lakes with Broods	2	6	10	1	4	6
Pairs/lake ($\bar{X}\pm SE$)	0.27±0.70	1.33±1.84	1.93±2.02	0.27±1.03	0.60±1.18	1.20±1.97
Young/lake ($\bar{X}\pm SE$)	1.67±4.72	5.93±8.68	8.20±9.62	1.27±4.91	2.00±4.26	5.07±9.25
Geese/lake ($\bar{X}\pm SE$)	2.33±6.50	8.60±12.29	12.13±13.47	1.93±7.49	3.13±6.52	8.00±13.50

848 (30%) were successful adults (435 breeding pairs), 1,882 (67%) were young-of-the-year and 88 (3%) were unsuccessful breeders and nonbreeders. Mean brood size was 4.3 young/pair.

Occupancy rates were affected by lake size ($\underline{X}^2$ = 12.9, d.f. = 2, $\underline{P} \leq 0.01$) but not distance from KBS ($\underline{X}^2$ = 2.5, d.f. = 1, $\underline{P}$ = 0.11). Small lakes (2.0-4.9 ha) were occupied at a lower rate than large lakes (25.0+ ha) ($\underline{X}^2$ = 13.0, d.f. = 1, $\underline{P} \leq 0.05$). However, no differences in occupancy rates existed between small and medium lakes ($\underline{X}^2$ = 4.8, d.f. = 1, $\underline{P} \geq 0.05$) or between medium and large lakes ($\underline{X}^2$ = 2.4, d.f. = 1, $\underline{P} \geq 0.05$). Although medium size lakes composed 38% of the lakes, they contained 49% of the breeding pairs. Large lakes represented 17% of the total and contained 34% of the breeding pairs.

The mid-summer population estimate of 2,818 ± 548 based on the random lakes stratified sample agreed closely with the mark/recapture estimate of 2,936 ± 178 and was twice as high as the minimum ground count of 1321 (Fig. 3). Based on mark/recapture, numbers increased sharply between 17 September and 30 September to 13,430 ± 1045 and then made minor fluctuations until mid-late January estimated when numbers peaked at 22,727 ± 1,556.

Based on actual counts, goose numbers rose to 4,288 between 17 September and 30 September and then steadily increased to 10,215 by mid-to-late January. Random lake estimates showed similar trends until late-October (22 October-4 November) when random lakes estimates were consistently less than actual counts which represent a known minimum number.

A total of 33 neckbanded geese originally marked outside of the study area were observed during the study. Twenty were from northern

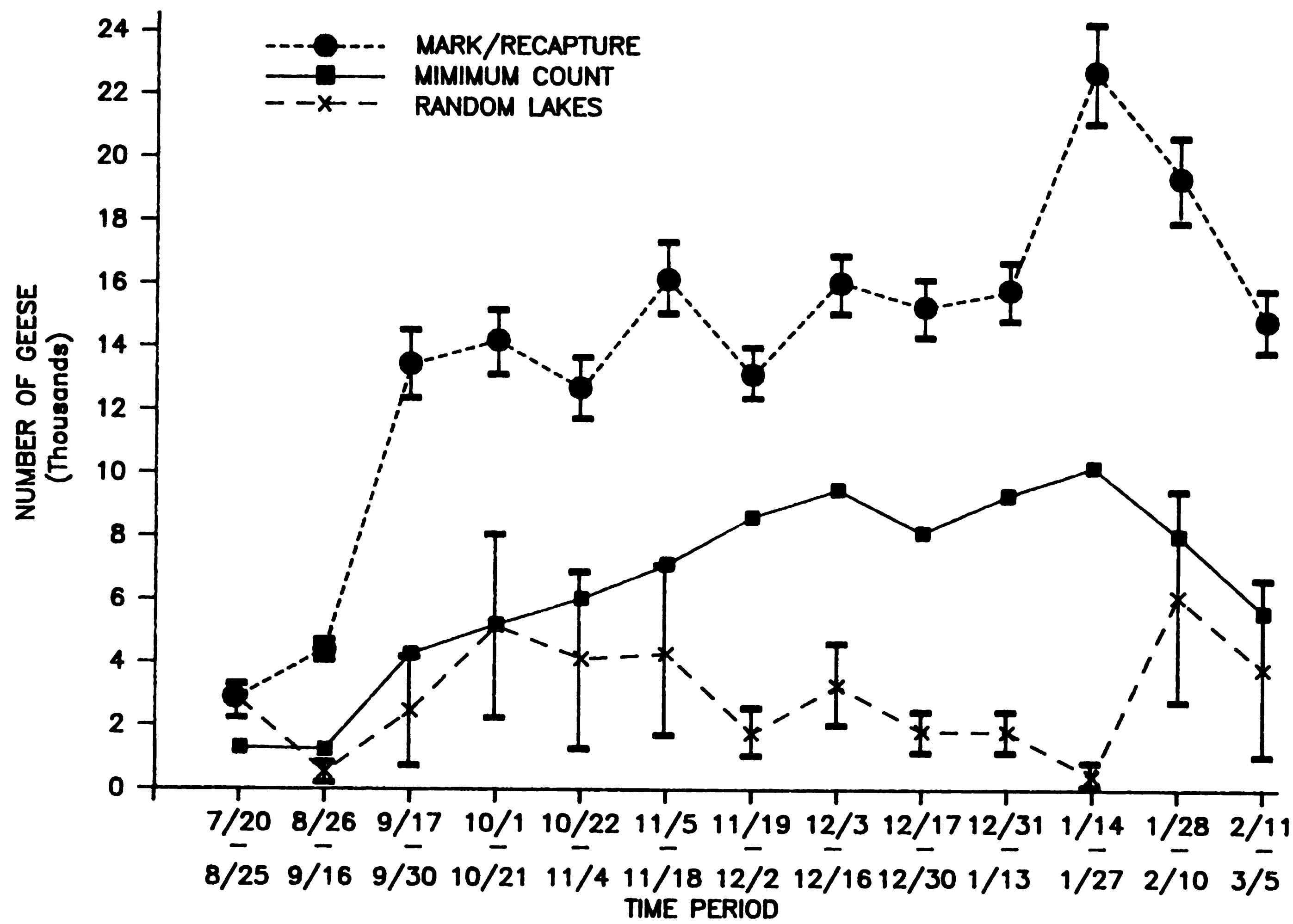

Fig. 3. Population estimates ($\bar{x} \pm$ SE) by time period of the number of Canada geese within 40 km of the W. K. Kellogg Bird Sanctuary, 1982-83, based on mark/recapture, minimum counts, and a stratified random sample.

Michigan and 13 were from outside of Michigan. Neckbanded geese started moving into the area in mid-September (Fig. 4). Numbers of neckbanded geese gradually increased until mid-December when 25 were present. Most neckbanded geese moving into the area remained until early February.

Movements

Dispersal of neckbanded geese from banding sites was minimal throughout the first year of the study. Between banding and the opening of hunting season, over 90% of the observations of neckbanded geese were within 10 km of the banding site (Fig. 5). Dispersal distance gradually increased throughout the year. Even after freeze-up, however, over 85% of the observations where within 20 km of the banding site.

Goose movement from roosts between consecutive time periods averaged less than 3.0 km (Fig. 6). Within each season, however, movements were generally larger in the beginning and decreased with time until the start of the next season. The largest movement between consecutive time periods occurred immediately after the hunting season with a mean movement of 6.2 $\pm$ 0.9 km/bird ($\bar{x}$ $\pm$ SE).

Prior to the hunting season, approximately one-third of the brood-rearing groups continued to use the wetland where they were banded. These groups were joined by others to form larger groups at KBS (from 5 other brood-rearing groups), at Hickory Hills Trailer Park and at Portage Creek in Kalamazoo (Fig. 7).

During the hunting season, roost sites changed as geese moved to numerous locations protected from hunting. The group of geese using the Hickory Hills Trailer Park moved to the Binder Park Zoo. Three

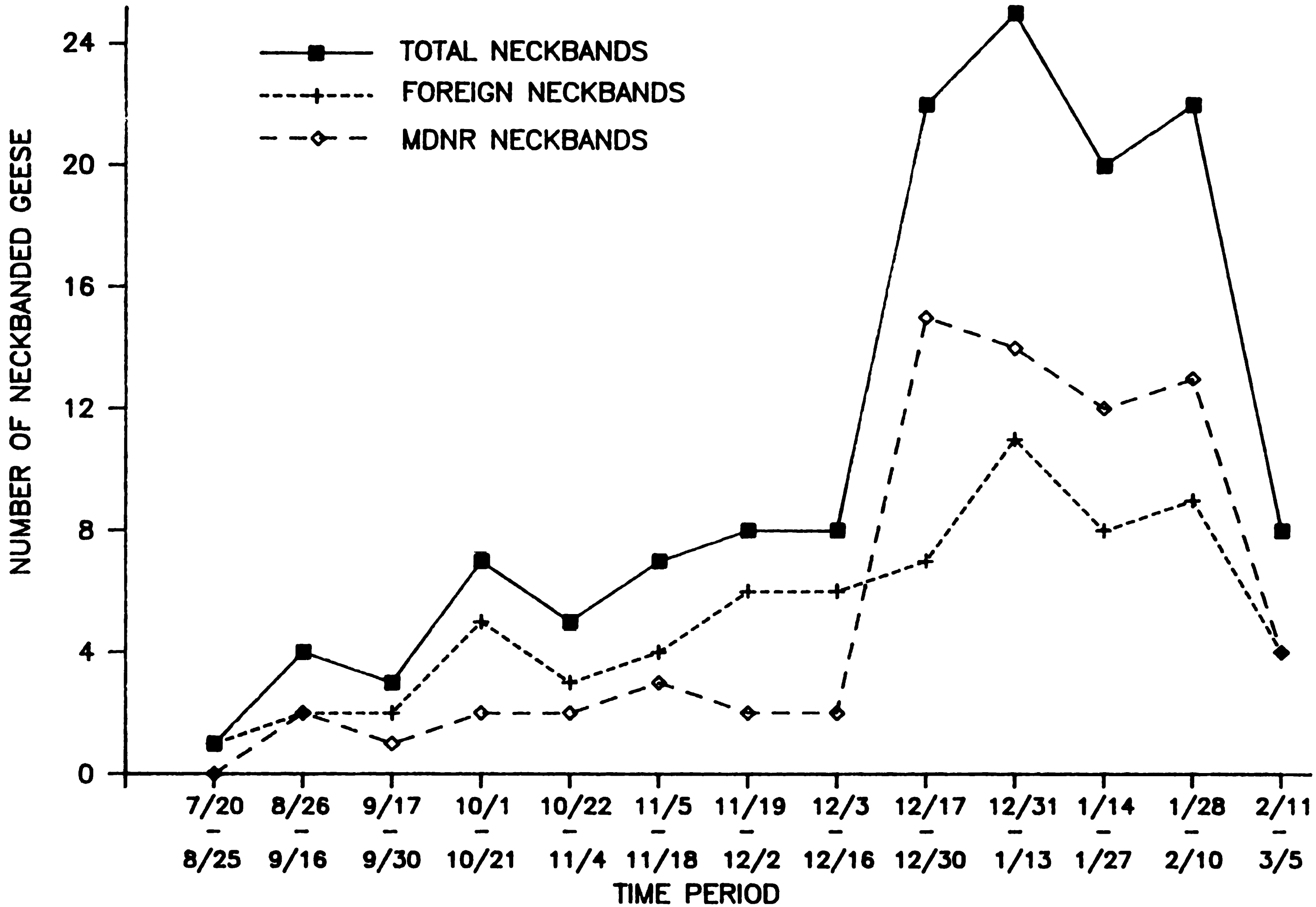

Fig. 4. Number of neckbanded Canada geese banded outside of Michigan (foreign) or banded within Michigan outside of the study area (MDNR) and observed within 40 km of the W. K. Kellogg Bird Sanctuary, 1982-83.

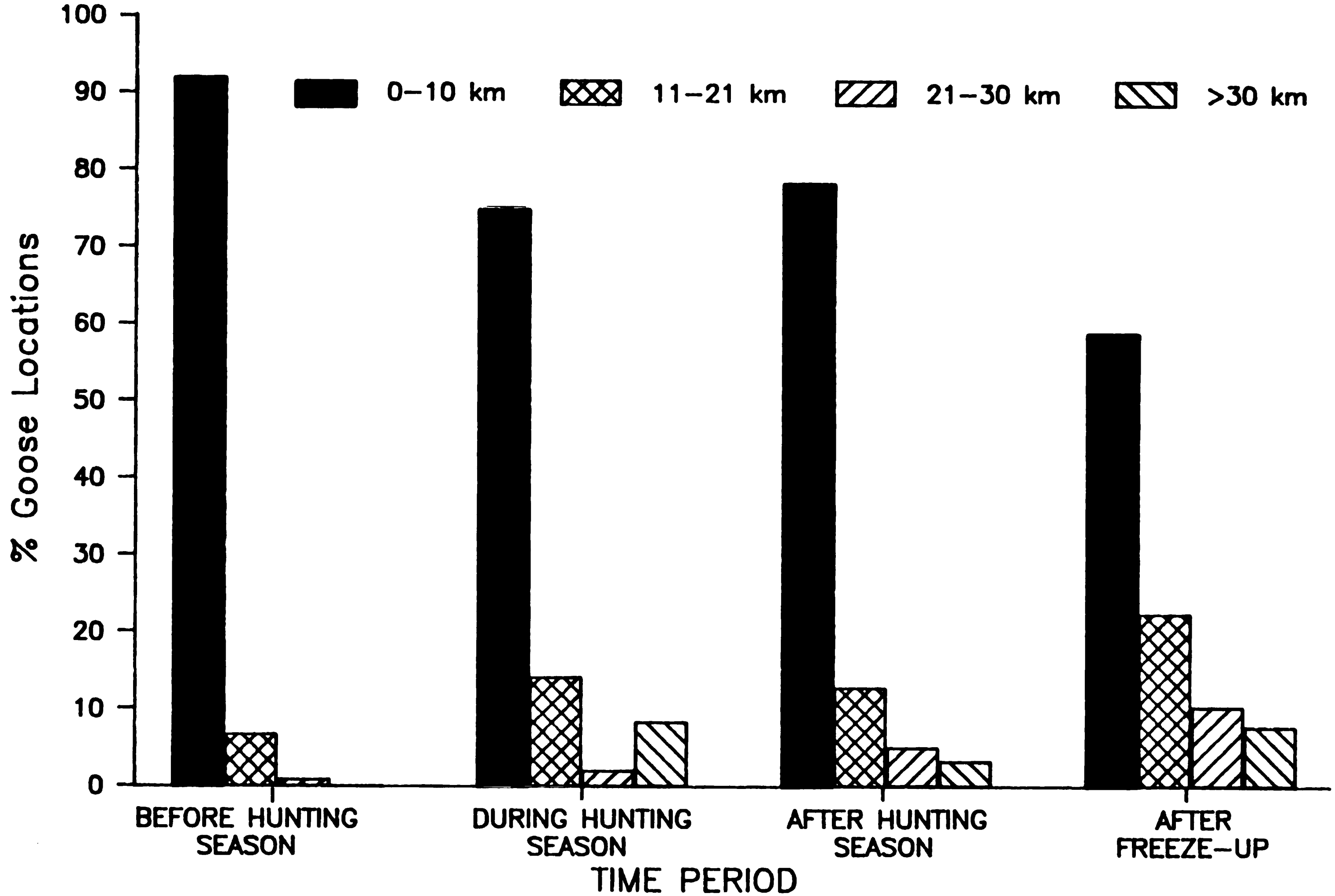

Fig. 5. Seasonal distribution of Canada goose movement distances from banding site to primary roost before hunting season (17 Sep 1982 - 30 Sep 1982) (N = 204), during hunting season (5 Nov 1982 - 18 Nov 1982) (N = 224), after hunting season (17 Dec 1982 - 30 Dec 1982) (N = 269), and after freeze-up (28 Jan 1983 - 10 Feb 1983) (N = 190).

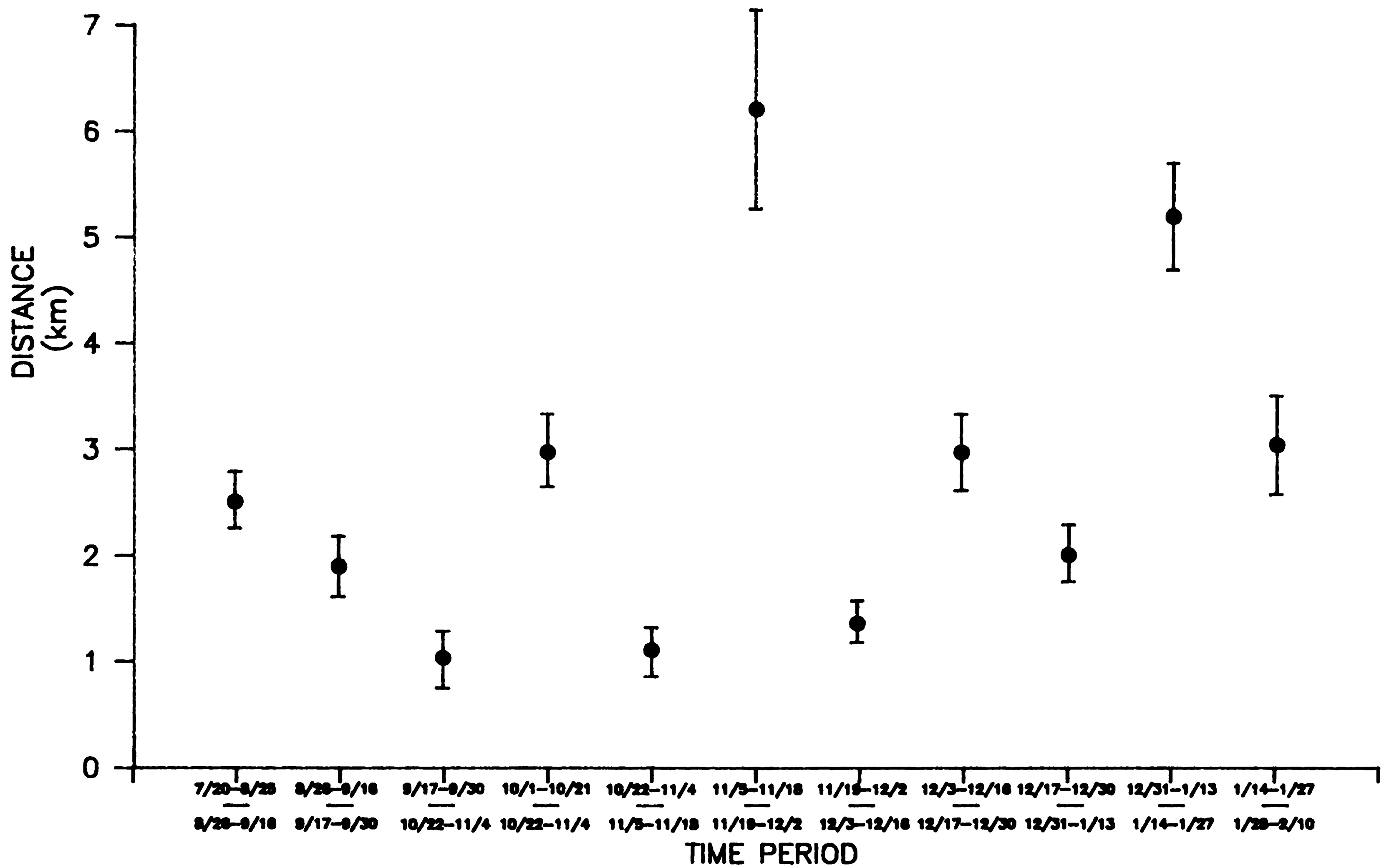

Fig. 6. Movement distance ($\bar{x} \pm$ SE) between consecutive time periods of neckbanded geese in southwest Michigan, 1982-83.

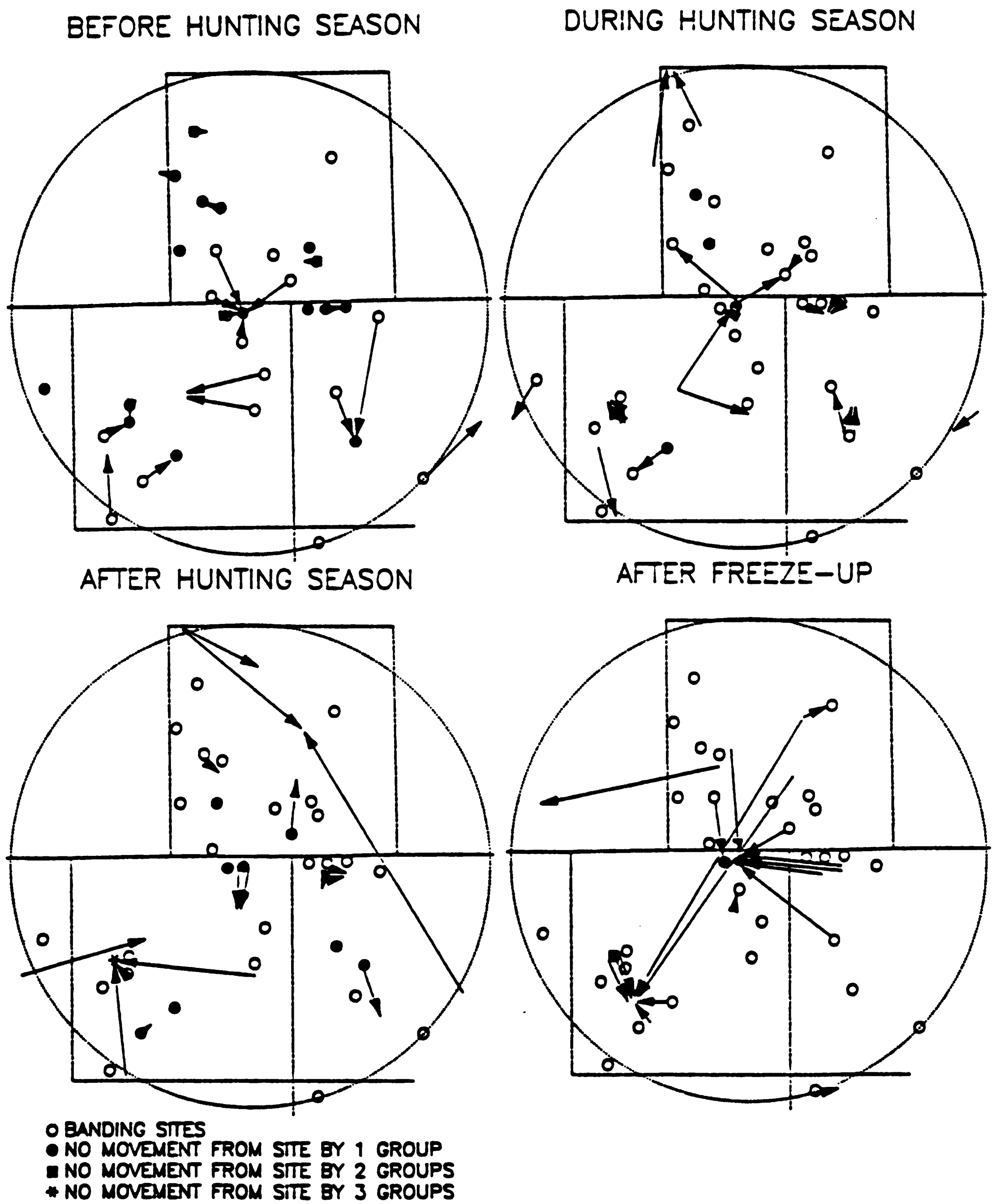

Fig. 7. Seasonal movement of neckbanded Canada geese from each brood-rearing site, southwest Michigan, 1982-83.

groups from northwest Calhoun County moved to a private pond 1 km northwest of St. Marys Lake. The 3 groups of geese using Portage Creek moved 1 km north to Willow Lake. Geese from Goguac Lake, Pine Lake, Fine Lake, Gourdneck Lake, and Gull Lake moved back to the lakes where they where originally banded.

After the hunting season, 3 additional groups moved into the Kalamazoo area which already consisted of birds from 3 brood-rearing sites. Two of the 3 groups using KBS went to Sherman Lake, 5 km south. After the majority of lakes froze, however, brood-rearing groups in the study area concentrated primarily into 2 large groups. Ten groups used the Kalamazoo area, primarily the Upjohn Company Cooling Pond or Willow Lake. The KBS area group, using KBS, Gull Lake, and the Gull Lake View Golf Course consisted of 12 groups. Brood-rearing groups tended to move to the closest winter concentration of geese. However, 2 groups made large movements, probably flying by KBS to go to the Kalamazoo area. The distance geese moved from banding to the Kalamazoo site, 14.1 ± 1.0 km ($\bar{x} \pm SE$), was significantly larger than the distance geese moved from banding to KBS (7.4 ± 0.6 km) ($z = -5.6$, $P = 0.01$).

Geese from certain brood-rearing sites consistently remained at those sites throughout the seasons. Geese banded near KBS (KBS, Gull Lake, Gull Lake View Golf Course, and Little Long Lake) and near Kalamazoo (Portage Creek, Woods Lake, and Long Lake) were found near their respective brood-rearing sites through at least 3 of the 4 seasons.

During the 1982-83 seasons, only one bird was observed further than 40 km from where it was banded. It was a leg-banded juvenile male that was shot 50 km west of the banding site (16 km west of Allegan).

During 1983-84, a total of 45 geese were reported shot, and 54 geese with neckbands were observed outside of the degree block where they were banded (Fig. 8). Twenty-four of the returns/observations were north of the banding degree block, 9 were at the same latitude, and 66 were south of the degree block. All but 3 of the returns/observations north of the study area were from 1 year old birds banded as locals in 1982. These birds were primarily observed near the shores of Lake Michigan, Lake Superior and James Bay, Ontario. Major southern observations occurred in southwestern Indiana, western Kentucky, western Tennessee, southern Illinois, and central Ohio.

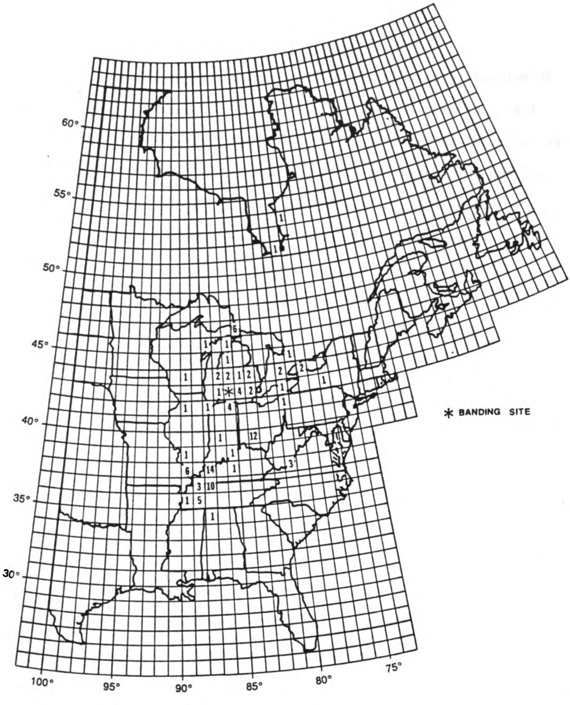

Fig. 8. Neckband observations and legband recovery locations between 11 May 1983 and 11 April 1984 for Canada geese banded in southwest Michigan.

DISCUSSION

The widespread use of neckbands for individual identification of large birds has both advantages and disadvantages. Advantages over traditionally used leg-bands include repeated information on individual birds (Limpert 1981) and information on birds not exposed to hunting (Raveling 1978, Limpert 1981). Possible disadvantages include inhibition of reproduction (Lensink 1968), starvation (Ankney 1975, Raveling 1976), differential reporting rates of neckbanded and leg-banded birds shot by hunters (Raveling 1978, Craven 1979, MacInnes and Dunn 1988), icing (Greenwood and Bair 1974, Craven 1979, Zicus et al. 1983), and unknown retention rates (Zicus and Pace 1986).

Problems with neckbands in this study were minimal. No evidence of icing on neckbands was observed in this study although 2 geese with ice on their neckbands were reported in the area the winter before the study started. Only 1 bird was known to have lost its neckband during the first 12 months although several neckbands were cracked at 12 months and probably fell off soon afterwards. Zicus and Pace (1986) reported no loss during the first 4 months and 2.8% loss during the first 15 months. Limpert (1981) reported no detection of neckband loss for up to 18 months after marking. Public reaction to the neckbands was positive although 1 negative comment was received from a person who did not like to see neckbands on geese.

The amount of information obtained on each neckbanded bird was extremely high. Over 99% of geese neckbanded during summer 1982 were observed at least once after capture compared to 89% for geese marked at Chesapeake Bay (Limpert 1981) and 78% for geese marked at Horicon National Wildlife Refuge in Wisconsin (Craven 1979). This high observation rate was probably caused by the concentration of geese into highly visible areas due to artificial feeding, by the short distances geese moved after banding, and by the long duration of time geese spent in the area.

The differences in direct recovery rates between neckbanded and leg-banded only geese in 1983, but not 1982, was probably caused by hunters being curious about neckbanded geese and therefore more likely to report shooting geese wearing neckbands than leg-bands. Craven (1979) reported that although neckbands did not noticeably reduce goose survival, 29 of 152 hunters who shot geese with neckbands saw the neckbands before they shot, and 3 volunteered that they had been waiting for marked geese. However, the orange, blue, and white neckbands used in that study were probably more visible than the gray neckbands used here. Direct recovery rates for leg-banded only geese (6.2% in 1982 and 3.7% in 1983) were similar to the 5.7% observed for giant Canada geese in southeast Michigan (Tacha et al. 1980) and the 3.45% observed for Mississippi Valley Population geese marked at Horicon National Wildlife Refuge (Craven 1979). Tacha et al. (1980) reported that 94% of annual mortality of flighted birds in southeast Michigan was from hunting.

Observed breeding pair densities were 32% larger on a per wetland basis and 21% larger on a per km^2 basis than observed in southeast Michigan (Kaminiski et al. 1979). Although in southeast Michigan, the largest percentage of breeding pairs (74%) occupied large lakes, in this study the largest percentage (49%) used medium size lakes.

Population estimates derived from the 3 techniques; mark/recapture, minimum counts, and random lake surveys reveal trends but not absolute numbers. Estimation based on the stratified random lakes survey gave results much lower than the known minimum count in all time periods except the first. Distribution of the survey and the geese affected results. Geese were in larger groups and occupied fewer lakes (2-7 occupied out of 90 lakes) during the later time periods.

The actual counts are known minimum counts and their accuracy increased with time as the observer learned locations of goose concentration areas and as numbers of geese increased in each concentration area.

Mark/recapture was probably the most accurate survey method at least through the beginning of January. However, the sharp increase in goose numbers during mid-January based on mark/recapture was not reflected by the minimum count. Either large numbers of geese were missed at this time or some of the marked geese migrated from the area and thus inflated the mark/recapture estimate. Neckband observations suggest that most geese remained at least until early February when ice break-up occurred. No neckband observations or band returns occurred outside of the study area at this time. However, hunting seasons were closed in Ohio and Illinois by January 1 and in Indiana, Kentucky, and Tennessee by January 20 so few band returns would be expected.

Based on band returns, Tacha et al. (1980) reported that a major migration of geese from southeast Michigan occurs in late December and January. This was not observed during the mild winter of 1982-83. However, neckband observations of geese marked in northern Michigan suggest major migration into southwest Michigan during late-December.

Contrary to the lack of observable migration during the mild winter of 1982-83, numerous observations of migrating geese occurred during the harsh winter of 1983-84. The Kellogg Biological Station National Weather Service Station recorded 80 negative degree-Celsius day for December 1982 and 303 negative degree-Celsius days for December 1983. The harsher early winter weather of 1983-84 froze most sources of water in the study area by late December. Terrill and Able (1988) described the process where individuals may or may not migrate in a given year depending upon environmental conditions as facultative partial migration. While the large body size of giant Canada geese allows them to physiologically tolerate cold weather; food habits, availability of food, and the presence of open water also influence distribution (Lefebvre and Raveling 1967). Wege and Raveling (1983) reported that the last major departure of geese from Marshy Point, Manitoba occurred 2-3 days before water roosting areas became totally unavailable due to freeze-up.

The northward molt migration of 1 year-old geese observed in this study has also been observed in geese from southeast Michigan (Sherwood 1966), Wisconsin (Zicus 1981c), the midwestern U.S. (Davis et al. 1985), and the western U.S. (Krohn and Bizeau 1979). Sterling and Dzubin (1967) suggested that the molt migration reduced mortality since the birds moved to areas of low human and predator populations with unlimited visibility and no competition with breeders for food.

Once young were capable of flight, the general movement pattern of brood-rearing groups was to join with other nearby broods and remain close to the banding site throughout the summer and early fall. When hunting season started, these groups moved to numerous sites protected from hunting and were joined by other migrating geese. After the hunting season, when lakes began to freeze, some groups remained in the same area, some split and moved short distances, and others made large moves. After freeze-up, most groups moved to either the KBS area or to the Kalamazoo urban area depending on which was closest.

The small dispersal distances observed in this study were similar to those observed in other resident populations of giant Canada geese. In southeast New York, Converse (1985) reported median seasonal dispersal ranged from 2.6 km to 17.1 km. Longest distances were travelled during winter and spring to find available food, water, or nest sites. When fresh water completely froze, geese congregated in large numbers along coastal areas.

In northwest Wisconsin, Zicus (1981a) reported movements of pairs immediately after hatch ranged from 0.7 to 8.4 km. Once on a brood-rearing marsh, families rarely moved to another. Distinct groups of families (subflocks) formed at 5 different brood-rearing areas. The composition of these subflocks remained intact through the hunting season but changed after freeze-up.

Combs (1982) identified 2 subflocks composed of multi-family groups on the Eufaula National Wildlife Refuge in Alabama which consistently used the same feeding, loafing, molting, and nesting locations. Geese associated with members of their own subflock even when both were observed together and rarely changed subflocks.

IMPLICATIONS

As the number of resident geese and nuisance complaints increased state-wide, the Michigan Department of Natural Resources initiated a transplant program in 1971 on lakes where at least 70% of the landowners requested removal of nuisance geese. From 1971-80, 6600 geese were trapped and translocated. The first translocation of geese in southwest Michigan occurred in 1980 (G. Martz, Michigan Dep. Nat. Resour., pers. commun.). A total of 403 geese were translocated from 1980-88. Nuisance complaints, which were infrequent before 1983 in southwest Michigan, averaged 27 calls/year from 1983-88 (M. Bailey, Michigan Dep. Nat. Resour., pers. commun.).

In an effort to control resident nuisance geese, special hunting seasons have been established in Michigan (Soulliere et al. 1988). A special late goose season (December-February) was initiated in southeast Michigan in 1977. The boundaries were extended to include southwest Michigan in 1984. A special early September goose season was initiated in most of lower Michigan in 1986.

Several aspects of this study have direct implications concerning nuisance problems and special goose seasons. The low mortality experienced by resident geese in southwest Michigan suggests that goose numbers and nuisance complaints will continue to increase until social factors limit goose numbers or human intolerance results in increased control measures. With lower numbers of people and lower property values in southwest Michigan as compared to southeast Michigan, higher densities of geese will probably be tolerated.

The integrity of brood-rearing groups, along with their short dispersal distances, suggest that control measures could be successful in controlling local problems. Geese using urban areas closed to shooting will rarely be vulnerable to hunting, however, and translocation should be more effective.

While brood-rearing groups in southwest Michigan tended to remain intact from late summer to the following spring, these groups were joined by migrant geese from Ontario as early as mid-September and by geese from northern Michigan during late-December. Wintering subflocks, therefore, were composed of geese from at least 3 different brood-rearing groups from widely separated geographical areas. Therefore, efforts to control only resident nuisance geese in southern Michigan by hunting would be most effective before the arrival of migrant geese in mid-September.

The facultative partial migration exhibited by geese in southwest Michigan suggested that during mild winters most geese will not migrate and be vulnerable to hunting in other states. During the severe winter of 1983-84, however, 41.9% of the hunting mortality occurred in states south of Michigan, based on direct returns. Therefore, winter severity strongly influences hunting mortality.

The molt migration of 1 year-old geese has significant management implications regarding distribution of harvest. Geese hatched and reared in Michigan are potentially available for harvest in Ontario. Similarly, geese hatched in Indiana and Ohio may be vulnerable to hunting in Michigan during their molt migration.

The influence on breeding populations from population mixing both during the molt migration and on the wintering grounds is unknown.

Indirect evidence suggests that most surviving geese in southwest Michigan return to their original natal areas, thus retaining discrete population integrity. However, differential return rates by sex may occur. As numbers of resident geese increase and migrant geese mix with them on northern wintering grounds, discrete breeding populations conforming to our existing knowledge may change. More analysis of this phenomenon is needed to understand potential management implications.

EXPERIMENT II

METHODS

Grazing Trails

Study plots were in Kalamazoo County, 26 km northwest of Battle Creek, Michigan, on the W. K. Kellogg Farm owned by Michigan State University. Augusta variety wheat was planted by drill at a rate of 168 kg/ha in early October 1982 using normal cultural practices for the area. The soil type was Kalamazoo loam (Austin 1979). All plots were randomly located within a 0.1-ha area of the field.

Stages of growth for grazing treatments were (1) 2 days before emergence (preemergence), (2) wheat at 5 cm height (young wheat), (3) wheat in early December (dormant wheat), and (4) early spring growth during tillering (the time when leaves expand in number and length) (tillering wheat). Corresponding classification for the treatments based on the Feekes scale (Large 1954) were young wheat--stage 1, dormant wheat--stage 3, and tillering wheat--stage 4. No Feekes scale classification exists for preemergence. Specific dates for grazing within each growth stage were determined by observation of heavy use of nearby wheat fields by migrant Canada geese. Grazing dates for each treatment were preemergence--16 October, young--27 October, dormant--2 December, and tillering--12 April.

Each grazing treatment was replicated 15 times on 1.0 X 4.9-m plots. A replication consisted of grazing 2 Canada geese in covered

1.0 X 4.9-m welded wire pens enclosing each plot. Comparisons were made with 30 control plots (1.0 X 4.9-m) where no grazing occurred.

The desired grazing intensity for all treatments, except preemergence, was to remove visible wheat down to 0.5 cm in height. This intensity was selected because it was comparable to severe grazing intensities observed for free-ranging geese in wheat fields nearby and also in Washington (Anon. 1953).

The desired grazing intensity was obtained in 6 hours (24,600 goose-hours/ha) during the young treatment and 8 hours (32,800 goose-hours/ha) for the dormant treatment. However, even after 14 hours on the tillering treatment (43,100 goose-hours/ha), the large amount of forage prevented the geese from grazing the wheat to 0.5 cm.

As suggested by Kahl and Samson (1984), grazing intensity was defined by grazing height instead of goose-hours/unit area. Comparisons based on goose-use hours are confounded since geese may spend considerable time loafing in winter wheat (Kahl 1980, Frederick and Klass 1982). Using grazing height as a measure of grazing intensity bases comparisons on amount of vegetation removed and not on the amount of time geese spend in the field, allows for valid comparisons between studies, and eliminates the necessity for constant monitoring in field studies. Estimates of goose-hours/ha were adjusted to show intensity as a function of daylight grazing hours.

The afternoon prior to each grazing treatment (except preemergence), the geese were conditioned to grazing on wheat by placing them into a 4.9 X 4.9-m pen in the wheat field adjacent to the treatment area. The following morning the geese were removed from the conditioning pen and placed in the appropriate randomly selected treatment plot. When the desired grazing intensity on the treatment plot was obtained, the geese were removed and held in a pen away from the wheat field until the next stage of wheat growth had developed. Between grazing treatments, water and a mixture of whole corn and duck maintenance pellets were provided ad libitum. After the grazing trials, plots were marked with flags and pens were removed.

Grazing Effects

Canada geese near the W. K. Kellogg Bird Sanctuary are often observed feeding in newly planted winter wheat fields before green vegetation has emerged. Therefore, the preemergence treatment was selected to determine if geese remove wheat seeds from the field surface, and if so, what impact they have on yield. Kear (1967) reported greylag geese (Anser anser) removing barley from the surface of broadcast fields but did not measure its affect on yield. Sampling to determine the number of uncovered wheat seeds available occurred adjacent to the study plots on the same day as the preemergence treatment. Locations for sampling were determined by tossing a 1-m^2 frame 30 times. Visible seeds within the frame were counted.

Plots were harvested by hand clipping during early August and threshed using a small-plot thresher. Measurements for each plot included total yield, number of heads in 5 1-m rows, number of seeds/20 randomly selected heads, and weight of 500 seeds.

Multiple comparisons of means for yield components were conducted using the Scheffe interval (Gill 1978:177). A modified Scheffe interval was used for plot yield since its variance was heterogeneous. Correlation analysis was performed using Spearman's coefficient of rank correlation analysis.

RESULTS AND DISCUSSION

Overall Wheat Yield

The density of visible wheat seeds on the field surface in the preemergence treatment was 0.8 $\pm$ 0.4 seeds/m^2 ($\bar{x} \pm$ SE). The geese removed all visible seeds after the 8.5-hour (34,900 goose-hours/ha) period. However, yield of preemergence plots revealed a 3% nonsignificant ($P > 0.05$) increase from control plots, possibly caused by the additional fertilizer from goose droppings (Bell and Klimstra 1970). Little food was available for the geese before green vegetation emerged because weed growth was minimal and there was no evidence of geese digging for buried seeds. Therefore, no negative effects were observed from geese feeding on winter wheat before the vegetation had emerged.

All treatments except preemergence yielded less wheat than the control ($P < 0.01$, Table 8). Mean yield was reduced by 18, 30, and 16%, respectively, for young, dormant, and tillering wheat. Although wheat grazed during dormancy yielded the least wheat, 1 cm of rain fell during the dormant wheat grazing trial, leaving the plots extremely muddy. A surface crust then formed because of goose trampling, and this could have reduced leaf and stem growth (Kahl and Samson 1984).

In England, under a similar grazing intensity (25,000 goose-hours/ha), Kear (1970) reported no significant grain losses attributable to grazing during December, January, February, March, or April. In addition, the common practice of grazing cattle on wheat during early stages of growth on the southern Great Plains does not

Table 8. Yields and yield components ($\bar{x} \pm SE$) of winter wheat as affected by Canada geese grazing at different wheat growth stages, Michigan, 1983.

Treatment	_n_	Yield (g/m^2)	Yield component (mg/kernel)	Yield component (Kernels/head)	Yield component (Heads/1-m row)
Control	30	422 ± 11B[a]	36.3 ± 0.4B	34.5 ± 0.4D	80 ± 2B
Preemergence	15	436 ± 9B	35.6 ± 0.7BC	35.6 ± 0.6CD	82 ± 2B
Young	15	344 ± 10C	32.8 ± 0.6D	38.1 ± 0.5BC	64 ± 2C
Dormant	15	295 ± 8D	32.9 ± 0.6D	40.7 ± 0.8B	49 ± 2D
Tillering	15	355 ± 12C	33.5 ± 0.2CD	35.8 ± 0.6CD	81 ± 2B

[a]Values within a column followed by the same letter are similar ($P > 0.05$).

seriously affect yield (Staten and Heller 1949). However, the dormant period during winter in the Midwest may prevent the wheat from fully recovering from the grazing by reducing the length of the growing season. The data for tillering wheat directly conflict with Pirnie (1954), who found no differences between yield of control plots and those grazed during mid-April.

Kahl and Samson (1984) found reduced wheat yields when geese grazed on young wheat (2.9 cm), wheat under wet field conditions on clay soils or stressed by poor growing conditions, and jointing wheat in late spring. No other known grazing studies have found reduced yield during dormancy and tillering. Thus, these results, in combination with Kahl and Samson (1984), suggest the potential for reduced yield by severe grazing any time between emergence in early fall and jointing in late spring.

Wheat Component Parts

Grazing by geese reduced stem density of young and dormant wheat ($\underline{P} < 0.01$) but not wheat grazed before emergence or during tillering. The reduced stem density probably was caused by lowered nutrient reserves for wheat grazed before and during dormancy (Bell and Klimstra 1970).

Biehn (1951) reported that waterfowl grazing caused increased production in small grains due to an increase in stem density, if the soil was not saturated. However, this study, Bell and Klimstra (1970), and Kahl and Samson (1984) contradicted these findings.

The decrease in yield also was caused by a decrease in kernel weight (mg/kernel) for wheat grazed during young, dormant, and tillering stages ($\underline{P} < 0.01$). Bell and Klimstra (1970) reported that grazed wheat fields had yields reduced 54-79% due to the reduction in head density and kernel weight. The number of kernels/head was correlated inversely to plant density ($\underline{r} = -0.6$, 92 df, $\underline{P} < 0.01$) and yield ($\underline{r} = -0.5$, 92 df, $\underline{P} < 0.01$); thus, plants may partially compensate for the reduced density of stems by producing more kernels/head in the young and dormant treatments ($\underline{P} < 0.01$).

IMPLICATIONS

Numbers of resident Canada geese are increasing throughout the eastern and mid-eastern states (Oetting 1982). Thus, depredation on winter wheat and other agricultural crops is likely to increase. Managers should determine minimum levels of grazing intensity and cost effectiveness of control measures in consideration of future management plans for Canada geese. Furthermore, since the stage of growth at which grazing occurs influences the extent of the reduction in yield, future studies should use a uniform scale, such as Feekes (Large 1954), to describe the stage of growth.

In areas where depredation by Canada geese is anticipated, increasing seeding rates by 34-68 kg/ha may help maintain yields by partially compensating for reduced stem densities (R. Freed, Michigan State Univ., pers. commun.).

APPENDIX

WANTED!

Wanted: Information leading to the location and identification of Canada geese with neck collars. These geese are part of 2 research projects conducted by a graduate student from Michigan State University and the Michigan Department of Natural Resources. The purpose of the project is to determine the distribution and movements of Canada geese in Michigan.

In the early summer of 1982, 506 Canada geese in southwest Michigan received gray plastic neck collars with unique codes. The collars allow identification of individual geese from long distances.

In addition to the gray collars, you may also see blue collars with white letters and white collars with black letters. These were placed on geese which were removed from lakes in southeast Michigan.

Anyone observing a Canada goose with a collar is asked to report the following information: number and color of collar, location, date, number of other geese without collars, and number of young, if any. The information can be reported to the wildlife biologist at your nearest DNR office, or by phoning (616) 671-5721 or writing to Earl Flegler, Kellogg Bird Sanctuary, Augusta, MI 49012.

Fig. 2. Newspaper press release used to solicit neckband observations.

Table 4. Location, neckband codes, number of geese neckbanded, and number of geese captured within 40 km of the Kellogg Bird Sanctuary-summer 1982.

Lake	County	Neckbands	Total Neckbands	Total Captured
Blue/Portage	Kalamazoo	XC01-18	18	35
Cotton	Calhoun	XC19-25	7	22
Oliverda	Branch	XC26-38	13	23
Goguac	Calhoun	XC39-47	9	19
Bedford Valley Country Club, 0.5km S Wabascon Lake	Calhoun	XC48-56	9	17
Private Pond, 10 km N Battle Creek on M-66	Calhoun	XC57-72	16	26
Warner	Calhoun	XC73-79	7	19
Pond NW Side Bear	Calhoun	XC80-93	14	24
Burns #2 2 km W Bedford	Calhoun	XC94-00 XT33 XT72-75 XT83-87	17	27
Lawler/Whitford Fort Custer Rec Area	Kalamazoo	XT01-32 XT34-37	36	70
Gull Lake View Golf Course, 5 km E Richland	Kalamazoo	XT38-50 XT51-57 XT88-90 XK75 XK96-00	29	56
Upper Crooked	Barry	XT58-71	14	25
Fair	Barry	XT76-82	7	12
Wolf Lake Fish Hatchery	Van Buren	XT91-00	10	16
Bristol	Barry	XE01-06	6	12
Long, 3 km NE Banfield	Barry	XE07-13	7	14

Table 4. - Cont'd:

Lake	County	Neckbands	Total Neckbands	Total Captured
Gurnsey	Barry	XE14-16 XE18-26	12	22
Private Pond 6 km N Prairieville	Barry	XE27-32	6	16
Pine 5 km N Orangeville	Barry	XE33-34 XE36-47	14	34
Fine 9 km E Hickory Corners	Barry	XE17 XE35 XE48-50 XE98-00	8	15
Bassett 5 km S Middleville	Barry	XE51-55	5	9
Gun	Barry	XE56-83	28	52
Thornapple	Barry	XE84-97	14	25
Gourdneck	Kalamazoo	XU01-12	12	21
Attwater Mill Pond	Kalamazoo	XU13-27	15	26
Long 6 km N Vicksburg	Kalamazoo	XU28-44	17	39
Woods	Kalamazoo	XU45-53	9	18
W Branch Portage Creek-Angling Rd	Kalamazoo	XU54-91	38	38
Wintergreen KBS	Kalamazoo	XK02-04 XK06-50 XK82-95	2	164
Gull	Kalamazoo	XK51-74 XK76	25	44
Little Long 5 km N Richland	Barry	XK77-81	5	16
Old Mill Golf Course, 5 km SW Schoolcraft	Kalamazoo	XJ01-17	17	26
Totals			506	1012

Table 5. Location, neckband codes, number of geese neckbanded, and number of geese captured within 40 km of the Kellogg Bird Sanctuary-summer 1983.

Lake	County	Neckbands	Total Neckbands	Total Captured
W Branch Portage Creek - Angling Rd.	Kalamazoo	XU92-00 XA93-95	12	28
Long, 6 km N Vicksburg	Kalamazoo	XJ18-37	20	51
Sunset	Kalamazoo	XJ38-50	13	25
Twin	Kalamazoo	XJ51-75	25	72
Lawler/Whitford Fort Custer Rec Area	Kalamazoo	XJ76-00	25	60
Blue/Portage	Kalamazoo	XA01-07	7	19
Goguac	Calhoun	XA08-18	9	21
Wintergreen KBS	Kalamazoo	XA19-23 XF11-20 XF26-27	17	26
Barbour	Kalamazoo	XA24-31	8	17
Willow Parkview Hills	Kalamazoo	XA32-38 XA96-00	12	56
Gull	Kalamazoo	XA39-52	14	34
Old Mill Golf Course, 5 km SW Schoolcraft	Kalamazoo	XA53-74	22	31
Campbell	Kalamazoo	XA75-83	10	17
Lyons	Kalamazoo	XA84-92	9	17
Upper Crooked	Barry	XP01-18	18	45
Pine, 5 km N Orangeville	Barry	XP19-34	16	34
Long 3 km NE Banfield	Barry	XP35-46	12	27
Bristol	Barry	XP47-50	4	9
Gull Lake View/Golf Course 5 km E Richland	Kalamazoo	XP51-72	22	52

Table 5. - Cont'd:

Lake	County	Neckbands	Total Neckbands	Total Captured
Eagle	Kalamazoo	XP73-87	15	28
Pleasant	Barry	XP88-96	9	26
Thornapple	Barry	XP97-00 XF21-25	9	25
Fair	Barry	XF01-10	10	36
Three	Kalamazoo	None	0	30
Fine	Barry	None	0	39
TOTALS			318	825

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