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RING-NECKED PHEASANT UTILIZATION OF MANAGED HABITATS IN THE THUMB REGION OF MICHIGAN

By

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ABSTRACT

RING-NECKED PHEASANT UTILIZATION OF MANAGED HABITATS IN THE THUMB REGION OF MICHIGAN

By

Laura Baird Grantham

Populations of ring-necked pheasants (Phasianus colchicus) in Michigan have decreased since the 1950's. This investigation was designed to compare differences in pheasant numbers, predator abundance, and patterns of land use on 5 1/4 township study areas in the thumb region of Michigan. Similar numbers of crowing cocks were heard each spring. Predator numbers and activity varied among areas and years during the summer. During the winter of 1984-1985, 45 pheasant carcasses were found at 3 state game areas, of which hens represented 91%. Predation was evident in 98% of the carcasses. This resulted in a significant decrease in broods observed and cocks harvested in 1985 on the 5 study areas. Although predation during the winter of 1985 influenced the decline of pheasants on the study areas, this does not explain the long term decrease in productivity. Future research integrating population size, habitat, biocides, predation, and energetics is suggested.

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This project was funded by the Michigan Department of Natural Resources. I would like to thank Bud Jarvis, Glenn Belyea, and the Rose Lake Wildlife Research Center staff for use of their equipment, and their assistance with surveys, pathology and winter field work.

I have made many good friends that have been important influences in the past 2 years. Special thanks to my colleagues in 2C (Dave, Dean, Rique, and Tom) who have not only provided sound statistical advice and laughs, but also reminded me (constantly) that humility is a virtue. A sincere appreciation is felt for my listeners in 2B (Bobbi and Laura), who helped me wrangle through some difficult times with their obvious concern and their sound advice. I am grateful to Dale, who has helped me to realize that sometimes life is much too serious, and that laughter is a necessary reaction to some situations. To Brian, heartfelt thanks to someone whose logic often frustrated me, but whose friendship I never doubted. And to Carolyn, the best of friendships has resulted from shared laughter, pain, anger, and comraderie, and I will never forget all you have done for me.

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INTRODUCTION

Ring-necked pheasants (Phasianus colchicus) were first successfully introduced to Michigan in 1918 (Allen 1956). This exotic species flourished and huntable numbers were present by 1925 (MacMullen 1957). Their numbers fluctuated until 1935 and then dramatically increased in the 1940's, with a peak harvest of 1,404,076 cocks taken in 1944 (MacMullen 1957, Michigan Department of Natural Resources, unpubl. rep., 1980). Pheasant numbers then began their 3 decade decline which has resulted in hunter harvests of less than 150,000 cocks in recent years (Michigan Department of Natural Resources, unpub. rep., 1984).

The decline of the ring-necked pheasant is not unique to Michigan. In fact, the trend is similar throughout the traditional pheasant range of the United States (Fouch 1979, Crawford and Meyers 1980). Many studies have tested a variety of hypotheses that have identified possible limiting factors of ring-neck populations, yet no satisfactory understanding has emerged.

A combination of variables that have temporal and geographical dimensions appear to limit pheasant numbers. With the growth of agriculture in the United States, recent areas of research have included the effects of changes in land use, in particular, the loss of quality

nesting and winter habitat due to the elimination of fencerows, draining of low areas by tiling, and the trend towards row crops rather than small grains (Leedy and Dustman 1947, Labisky 1976, Warner 1979, Warner et al. 1984). In addition to land use trends, the increased mechanization and efficiency of agricultural processes (Errington and Hamerstrom 1937, Eklund 1942, Dustman 1950, Kozicky 1951) as well as the negative impact of pesticides and herbicides have also been investigated (Adams and Prince 1972, 1976; Stromborg 1977,1979; Fredrickson et al. 1978, Bennett and Prince 1981).

A combination of severe winter weather and the lack of quality winter cover can result in death from starvation, exposure, and suffocation (Green 1938, Buss and Swanson 1950, Kopischke and Chesness 1967, Wood and Brotherson 1981), as well as increasing pheasants' vulnerability to predation (Dumke and Pils 1973). Those birds that survive the winter may suffer from suboptimal body conditions and may be more vulnerable to predation during the nesting season. Dumke and Pils (1973) found mortality due to predation to be highest during the winter, and that predation was the factor limiting pheasant abundance at Waterloo Wildlife Area, Wisconsin. Similarly, studies in Minnesota and South Dakota designed to control predators have demonstrated increases in pheasant populations during times of control (Chesness et

al. 1968, Trautman et al. 1973).

Although there is evidence that habitat changes, biocides and predation are dominant factors in the population decline of the pheasant, an understanding of the mechanisms is still lacking. This has resulted in management practices, developed by responsible agencies under strong public pressure, that are not cohesive and have a low probability of success until more data are available. At this point, it is uncertain that it is possible to arrest or reverse the current population trends.

This investigation was designed to develop hypotheses centering around habitat and predator interactions based on population surveys of pheasants and predators (avian and mammalian) on 5 1/4 township study areas containing state-owned pheasant management areas. Pheasant management areas, despite similar agricultural use that provides food, nesting and winter cover for pheasants, have experienced varying degrees of success not only between areas, but within areas over several years. The game areas within each 1/4 township differ in the amount of agricultural land available, as well as differing in pheasant numbers, yet no correlation between land use and pheasant abundance is evident. This project was designed to compare and contrast differences in pheasant numbers, predator abundance, and patterns of land use.

STUDY AREA DESCRIPTION

The investigation took place on 5 areas in Huron and Tuscola counties in Michigan's thumb region (Fig 1). Each study area is comprised of a section containing state owned land and the surrounding 8 sections. The parcels of state land were purchased from area farmers and carry their family name. Such parcels are managed primarily for pheasants and because of their relatively small size are designated by the state as mini-game areas. In Tuscola county, the study areas are: Bell-Seed, in Elkland township (Sec 13-15,22-27, T14N, R11E), Winchester-O'Dell, in Elmwood township (Sec 13-15,22-27, T14N, R9E), Rieck-Lehman-Scharf, in Columbia township (Sec 16-21,28-30, T13N, R9E), and Findlay, in Almer township (Sec 16-21,28-30, T13N, R9E). Peters-Kretzschmer is located in Brookfield (Sec 12, 13,24, T15N, R10E) and Grant townships (Sec 7,8,17-20, T15N, R11E) in Huron county.

The number of frost free days averages 134 for the thumb region. Yearly precipitation is approximately 78.8 cm rain and 123.7 cm snow, with a relative humidity of 61% (Deeter and Matthews 1926, Linsemier 1980).

The topography of the region ranges from nearly level lowlands in the western portion of the thumb, where the

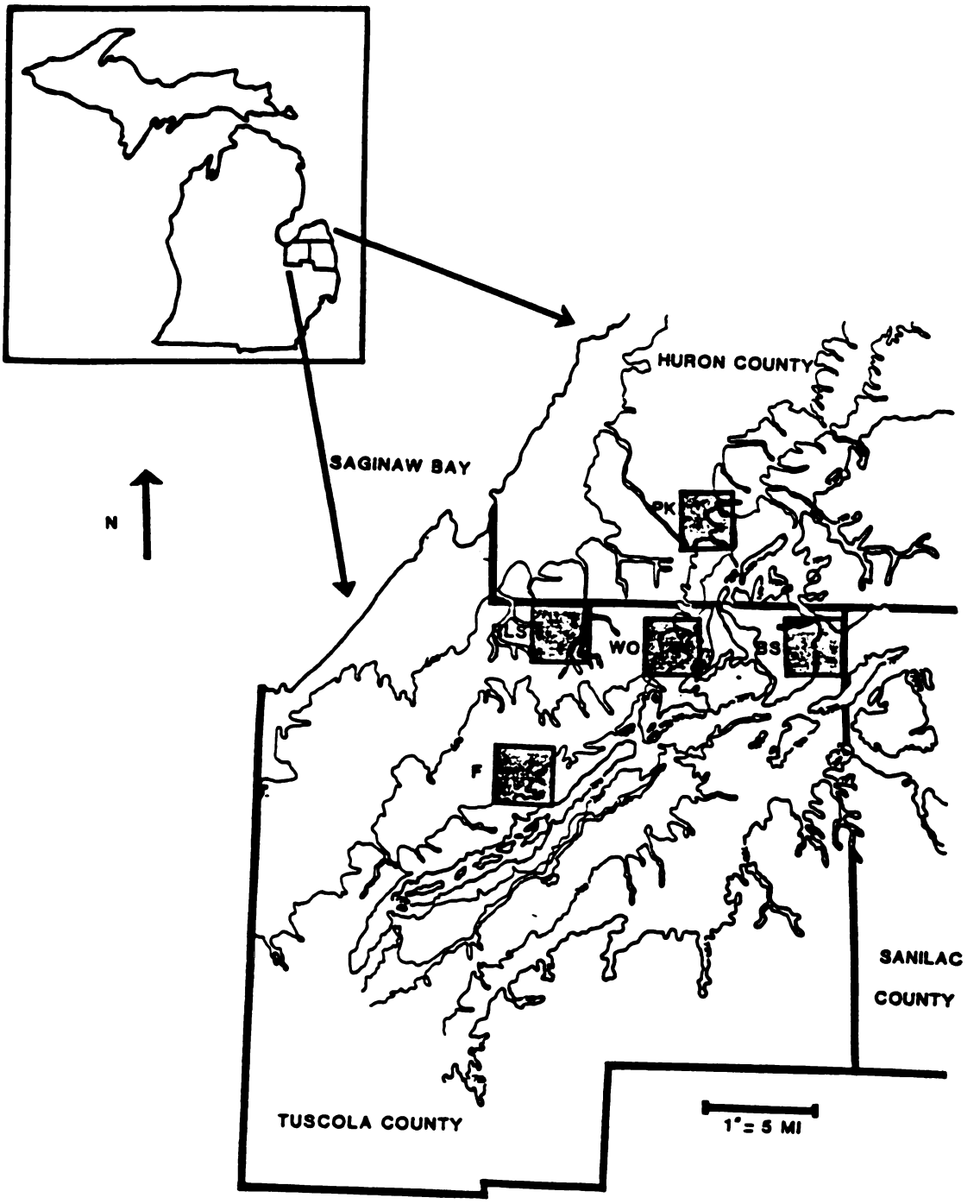

Fig. 1. Location of study areas in relation to the paleo-shoreline in the thumb region of Michigan.

ancient lake bed is evident, to gently rolling and hilly country beyond the lake terrace (Fig. 1). Three of the study areas , Findlay (F), Rieck-Lehman-Scharf (RLS), and Peters-Kretzschmer (PK), are located within the old lake bed zone (Fig. 1) and their topography is characteristically level.

Land use of the areas within the lake bed zone is predominantly agricultural, averaging 65%, while woodlands comprise an average of only 6% (Table 1). For the most part, the mini-game areas within each 1/4 township reflect the patterns of land use noted for the study area, although they are generally less intensively farmed.

Bell-Seed (BS) and Winchester-O'Dell (WO) study areas lie east of the paleo-shoreline, and are characterized by nearly level to gently rolling topography (Fig. 1)(Deeter and Matthews 1926). Land is less intensively farmed in the 1/4 townships in this area (53%), compared with the lake bed zone. Although agriculture represents the majority of the land use, woodlots do account for about 18% of the area (Table 1).

Soils for the region were formed in glacial drift or lacustrine sediments, and range from light colored, well drained sandy loams to dark, poorly drained muck and peat (Table 2)(Deeter and Matthews 1926, Linsemier 1980). Cash crops grown on these soils consist primarily of row crops such as corn (Zea mays), navy beans (Phaseolus vulgaris),

Table 1. Land use characteristics of 5 mini-game areas (MGA) and the 1/4 townships where each are located, in the thumb region of Michigan, 1980-1985.[a]

	Land use (% of total area)					
	Agriculture		Woodland		Other[b]	
Area	1/4 twn	MGA	1/4 twn	MGA	1/4 twn	MGA
Bell-Seed	46	68	23	32	31	-
Winchester-O'Dell	61	81	13	19	26	-
Rieck-Lehman-Scharf	69	69	4	31	27	-
Findlay	70	100	6	-	24	-
Peters-Kretzschmer	56	99	9	<1	35	-
MEAN	60	83	11	17	29	-

[a] Data from U.S. Dept. of Agriculture, Agricultural Stabilization and Conservation Service and Michigan Dept. of Natural Resources.

[b] Land incorporating towns, dwellings, outbuildings, roads and drains.

Table 2. Soil types found within 5 1/4 township study areas in Huron and Tuscola counties in the thumb region of Michigan.

Area	Soil type[a]
Bell-Seed	Miami loam, Brookston loam, Macomb loam, Rifle peat
Winchester-O'Dell	Gagetown loam, Fox sandy loam, Granby loam
Rieck-Lehman-Scharf	Brookston loam, Gilford fine sandy loam, Berrein loamy fine sand, burned muck over clay
Findlay	Brookston loam, Oshtemo loamy sand, Conover loam, Allendale fine sandy loam, Gilford sandy loam
Peters-Kretzschmer	Avoca-Pipestone-Covert, Guelph-Londo-Parkhill

[a] Information from soil survey of Tuscola County (Deeter and Matthews 1926) and Huron County (Linsemier 1980).

soybeans (Glycine max), sugar beets (Beta vulgaris); and small grains such as wheat (Triticum aestivum), barley (Hordeum vulgare), oats (Avena sativa) and rye (Secale cereale). Other important crops include alfalfa (Medicago sativa), livestock and dairy products (Deeter and Matthews 1926, Linsemier 1980).

Within each 1/4 township study area, row crops constitute the majority of the agriculture (Table 3). Small grains average 20% of the cash crops produced and forage crops, primarily alfalfa, represents 5%. Set-aside acreage, tillable land left with undisturbed cover for the production year, comprises 3% of the cropland (Table 3).

Table 3. Percent of area planted to major crops in 5 1/4 township study areas in the thumb region of Michigan, 1980-1985.

Area	Area under cultivation (ha)	Crops planted (% of area under cultivation)[a] row crops	small grains	forage	set-aside
Bell-Seed	857	54	31	9	6
Winchester-O'Dell	1141	70	20	6	4
Rieck-Lehman-Scharf	1191	79	16	2	3
Findlay	1284	80	17	1	2
Peters-Kretzschmer	1188	76	16	6	2
TOTAL	5661				
MEAN		72	20	5	3

[a] Data from U.S. Dept. of Agriculture, Agricultural Stabilization and Conservation Service.

MATERIALS AND METHODS

Study area selection

Mini-game areas were chosen on the basis of variation in pheasant numbers and available habitat (Table 4). Two areas, Peters-Kretzschmer and Findlay, are intensively farmed with little or no woody cover. Although both areas had high wintering populations of pheasants in the late 1970's (>100 birds), Peters-Kretzschmer is the only area where numbers remained high up to 1984 (C. Jarvis, pers. comm.). Bell-Seed and Rieck-Lehman-Scharf mini-game areas have extensive woodland areas. A wintering population of 40-60 birds has been noted at Rieck-Lehman-Scharf, while Bell-Seed has never attracted many pheasants during the winter (C. Jarvis, pers. comm.). Winchester-O'Dell has moderate woodland area, although land use is predominantly agricultural. This area has had increasing numbers of pheasants in the past, with >100 wintering there in 1984 (C. Jarvis, pers. comm.).

The relationship between pheasant numbers on the mini-game and surrounding areas and land use provided a design for comparison. Implicit in this was the potential for differences in numbers of predators that could affect pheasant numbers. This resulted in a series of

Table 4. Land use, topography, and winter pheasant numbers on 5 1/4 township study areas in the thumb region of Michigan at the start of the investigation.

Area	Description			
	Agricultural use	Woody cover	Topography	Winter pheasant population
Bell-Seed	low	high	rolling	low
Winchester-O'Dell	med	med	rolling	high
Rieck-Lehman-Scharf	med	med	flat	med
Findlay	high	low	flat	low
Peters-Kretzschmer	high	low	flat	high

surveys designed to observe pheasant and predator use of the study areas throughout the year.

Pheasant and predator surveys

Spring crowing cock counts were initiated on 7 May in 1984 and 1985. A standardized route of 19.2 km was established through each 9 section study area, with stops every 1.6 km. Surveys began 40 min before sunrise. The initial weather conditions, such as temperature, wind speed, cloud cover, and amount of precipitation during the previous 24 h, were recorded. Any change in weather conditions during the survey was noted. At each stop, all pheasant crows heard during 2 minutes were counted. There was no attempt to count individual birds. All pheasants seen along the route were also recorded. The survey was run twice each year.

An evaluation of numbers of predators and their possible impact on pheasants in each study area began in May 1984. Dummy nest transects were established in a nesting meadow on each area to establish an index of the number of eggs destroyed over a 40 day period. Forty days represents the length of time for laying and incubation of a successful nest. Nesting meadows consisted of wheat stubble fields that had been sown to alfalfa and sweet clover (Melilotus spp.). Meadows were left for 3-5 years without disturbance of any kind, except periodic burning

in early spring to control perennial weeds and rejuvenate alfalfa and clover growth.

In 1984, two eggs, one each of a domestic chicken (Gallus gallus) and mallard (Anas platyrynchos), were set out 25 m apart along a line that bisected the nesting meadow on each mini-game area. Since the meadows varied in size between areas, the total number of nests established varied as well. Rubber gloves were worn to handle the eggs to avoid human scent on them. No attempt was made to make a nest or to cover the eggs. Nests were marked by flags set 10 m away in a consistent direction.

The eggs were checked between day 2 and day 5 after establishment, and every 7 days thereafter for a total of 37-40 days, A nest was considered destroyed if one or both eggs were broken or missing. Einarsen (1956) provided guidelines for identification of predators, although definitive identification was not attempted.

In 1985, pheasant eggs were obtained from the Michigan Department of Natural Resources' Mason Wildlife Facility. In addition to nests established along a transect, as in 1984, several nests were set out randomly to see if placement in a regular pattern increased the rate of destruction. The number of nests per meadow totaled 35 for each area. To check whether weekly visitation had any effect on the number of nests destroyed, eighteen of the total number of nests were randomly

selected to be checked weekly. The remaining nests were not checked until the end of the 37-40 day trial.

Scent post stations were constructed to determine the species and relative abundance of mammalian predators in 1984 and 1985. A transect of 46-48 stations, each 0.4 km apart, was established along the roadsides for each 1/4 township study area. For each station, all roadside vegetation and some topsoil was cleared with a scythe and shovel, creating a circle 1 m in diameter. The remaining topsoil was packed down. Sand was sifted through aluminum screening to cover the topsoil with a depth of approximately 2 cm. The fine sand was smoothed with a small brush and one scent wafer was placed in the middle of the station. Scent wafers, purchased from the United States Fish and Wildlife Service's Pocatella Supply Depot, Pocatella ID, consisted of plaster disks impregnated with a fatty acid scent. The transect was checked for 4 consecutive mornings. If tracks were present, they were identified and recorded. Any disturbance was smoothed over and the scent wafer replaced if destroyed or missing. Stations that had been disturbed so as to destroy tracks, such as by livestock, human interference or machinery, were designated as inoperative and were not included in the analysis. An index of relative abundance, as described by Linhart and Knowlton (1975), was determined for each species as follows:

$$\frac{\text{total animal visits}}{\text{total operative station-nights}} \times 1000$$

Brood surveys to evaluate pheasant production began in July 1984 and 1985. Initiation of the surveys depended on the harvesting of small grains on each study area, which increased the range of observer visibility from the vehicle. Standardized routes of 56-59.2 km were repeated 3 times through each area. Surveys started 30 minutes after sunrise. All broods observed from the vehicle were recorded, as well as any adult pheasants seen along the route.

In the fall, a hunter harvest survey provided information on pheasant recruitment and hunter effort. For the opening 2 days of pheasant season in 1984 and 1985, workers distributed a survey packet consisting of a short cover letter and a business-reply card questionnaire in zip closure bags on the windshields of all vehicles parked along the roads of each study area. Hunting parties were interviewed directly whenever possible to obtain information about their hunt. Workers drove a standard route through each study area to ensure that surveys were issued to parties hunting on private lands as well as state lands.

Roadside counts of pheasant numbers in the winter began on 9 February 1985, after heavy snow was present.

The standard route devised for brood surveys was repeated twice, covering each 9 section area. At the start of each survey, wind speed, cloud cover, and amount of precipitation during the previous 24 h were recorded. All pheasants observed from the vehicle were sexed, counted and recorded.

In preparation to estimate spring dispersal distance of wintering pheasants, trapping on 3 mini-game areas was initiated in late December 1984 and continued through March 1985. The areas chosen were Bell-Seed and Winchester-O'Dell in Tuscola county and Peters-Kretzschmer in Huron county.

Three methods were used for trapping pheasants. Cloverleaf traps, modified from Leedy and Hicks' design (1945), were constructed at each area. Trap sides were 72 cm high turkey wire. Nylon netting was used for the trap tops to reduce the potential for scalping or other injury to trapped birds. Initially, the tops and ends of the traps were left open for a pre-baiting period of 17 days. Ear corn from the mini-game areas provided the bait. Once set, the traps were checked daily. Captured hens were weighed, banded, fitted with radio transmitters and released immediately. Radio transmitters, purchased from Telonics, Inc., Mesa, AZ, were attached to the hen in the manner described by Brander (1968) and successfully used by the Oregon Department of Fish and Wildlife.

Mist nets, purchased from Bleitz Wildlife Foundation, Hollywood, CA, were set in cover known to be used by pheasants at Peters-Kretzschmer in February 1985. Workers walked slowly through fields, driving pheasants towards the net. When approximately 3-5 m away, workers converged toward the net to flush pheasants into the trap.

Nightlighting was the third method used to trap pheasants. Weather conditions, terrain, and vegetation made it impossible to use a vehicle for nightlighting. However, a backpack frame was used to carry a battery to power a 100,000 candle power hand held lamp and a crew of workers systematically covered roosting areas on foot to capture pheasants similar to the method described by Labisky (1959).

Two techniques were used to evaluate the relative abundance of avian predators on the study areas. For hawks, a roadside survey was conducted along the standard route devised for brood surveys. Surveys were repeated at each area. All hawks observed from the vehicle were identified and recorded.

A recording of calls was broadcast to survey owls on each area. All woodlots on an area were sampled from stops along the road. The number of stops varied according to the size of the woodlot and its location in relation to the road. The tape, recorded from Peterson's Field Guide to Bird Songs, included calls of screech owls (Otus

asio), great horned owls (Bubo virginianus), and barred owls (Strix varia). The tape was amplified and broadcast from a loudspeaker out of the vehicle. For each call heard, the species was identified and the direction of the call noted in order to avoid duplicating counts at successive stops. Each survey started at dusk and continued until all woodlots were sampled at one area.

In addition to predator surveys, a record of all pheasant mortalities discovered on the mini-game areas was maintained during the 1984-1985 winter field work. The record includes not only those birds found incidentally during trapping activities, but includes mortalities discovered during systematic searches of the mini-game areas as well. For each kill, the location and sex, if discernable, was recorded and the site was marked with flagging tape in order to prevent duplication of counts by various workers. Any intact bird was collected for necropsy. Necropsies were performed by the Wildlife Disease Laboratory, Rose Lake Wildlife Research Center.

Data Analysis

Randomization test for matched pairs (Siegel 1956) was used to test whether differences in the number of crowing cocks heard and the number of broods observed occurred between 1984 and 1985. Chi-square for independent samples (Siegel 1956) tested whether the total number

of nests destroyed in 1985 was significantly different from 1984, and whether a difference in the number of nests destroyed occurred between randomly placed nests, transect nests, and nests not checked until the end of the trial.

Scent post data were analyzed by chi-square for independent samples to test if the rate of visitation to scent stations was significantly different between 1984 and 1985.

Spearman rank correlation (Siegel 1956) was used to determine whether a correlation between numbers of broods observed and relative abundance of mammalian predators existed.

Hunter harvest data were analyzed by the Mann-Whitney U test (Siegel 1956) to determine whether differences between numbers of hunters, hours hunted, cocks bagged, and birds flushed existed between 1984 and 1985.

RESULTS

The total number of crowing cocks heard during 2 surveys was 289 and 287 in 1984 and 1985, respectively. Although there are differences among areas (Fig. 2), yearly differences in the total number of crowing cocks heard at all areas was not significant ($p>.05$).

Destruction of eggs in dummy nests was greater than 50% on 4 of 5 areas in 1984 (Fig. 3). At Bell-Seed, 16 of 22 nests, or 73%, were destroyed 2 days after nest establishment. The lowest number of nests were destroyed at Winchester-O'Dell, where the first depredation was not detected until 21 days after nest establishment. Although the percent of nests destroyed was similar to 1984, depredation was highest at Findlay mini-game area in 1985. A significantly lower number of nests were destroyed on all areas in 1985 compared to 1984 ($p<.05$). The rate of egg destruction was not significantly different between nests placed along a transect and those placed randomly (Fig. 4), as well as nests not checked until the end of the trial ($p>.05$).

Tracks of species identified at scent post stations were raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), and opossum (*Didelphis*

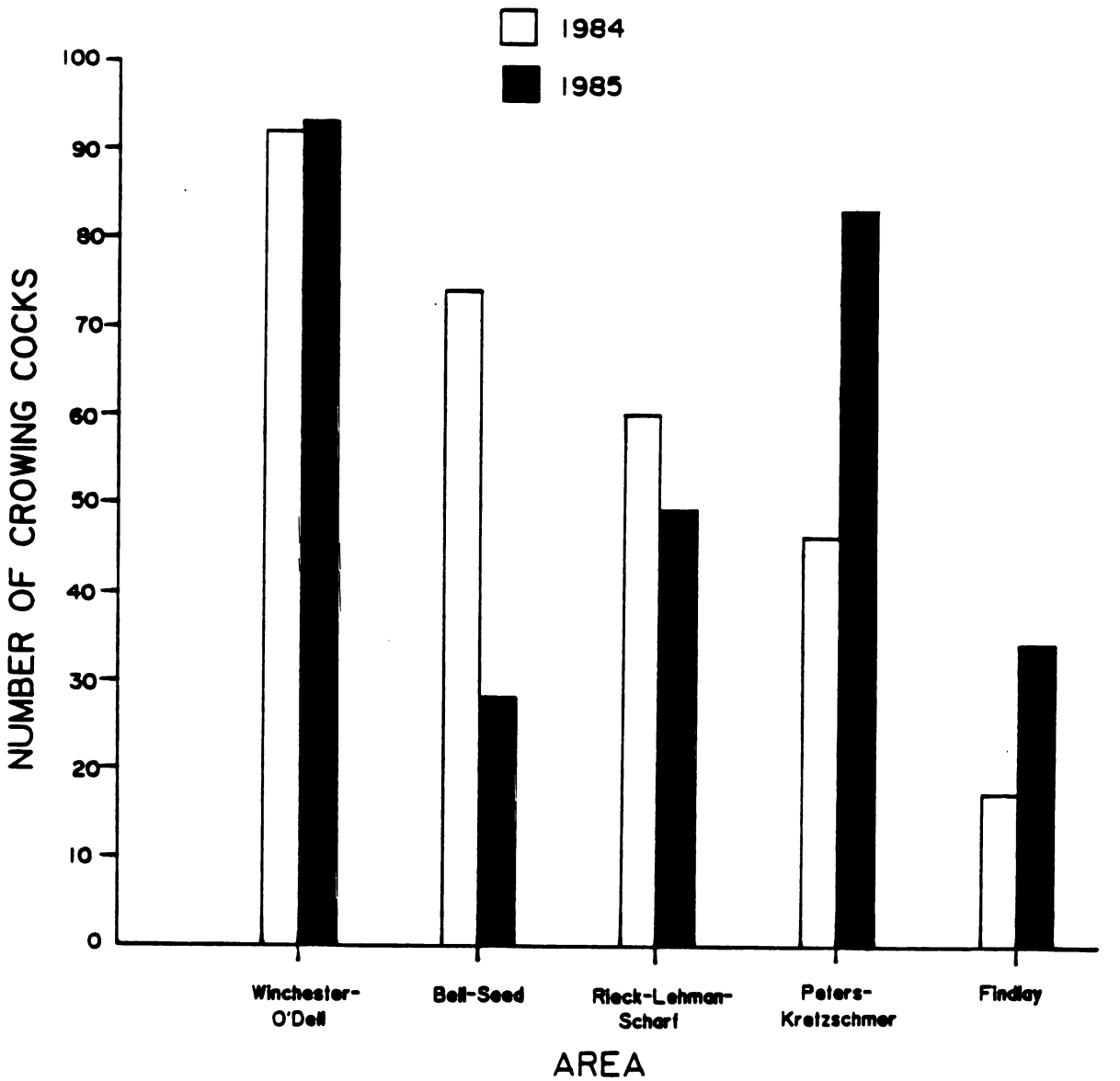

Fig. 2. Number of crows heard during 2 crowing cock surveys at 5 study areas in 1984 and 1985.

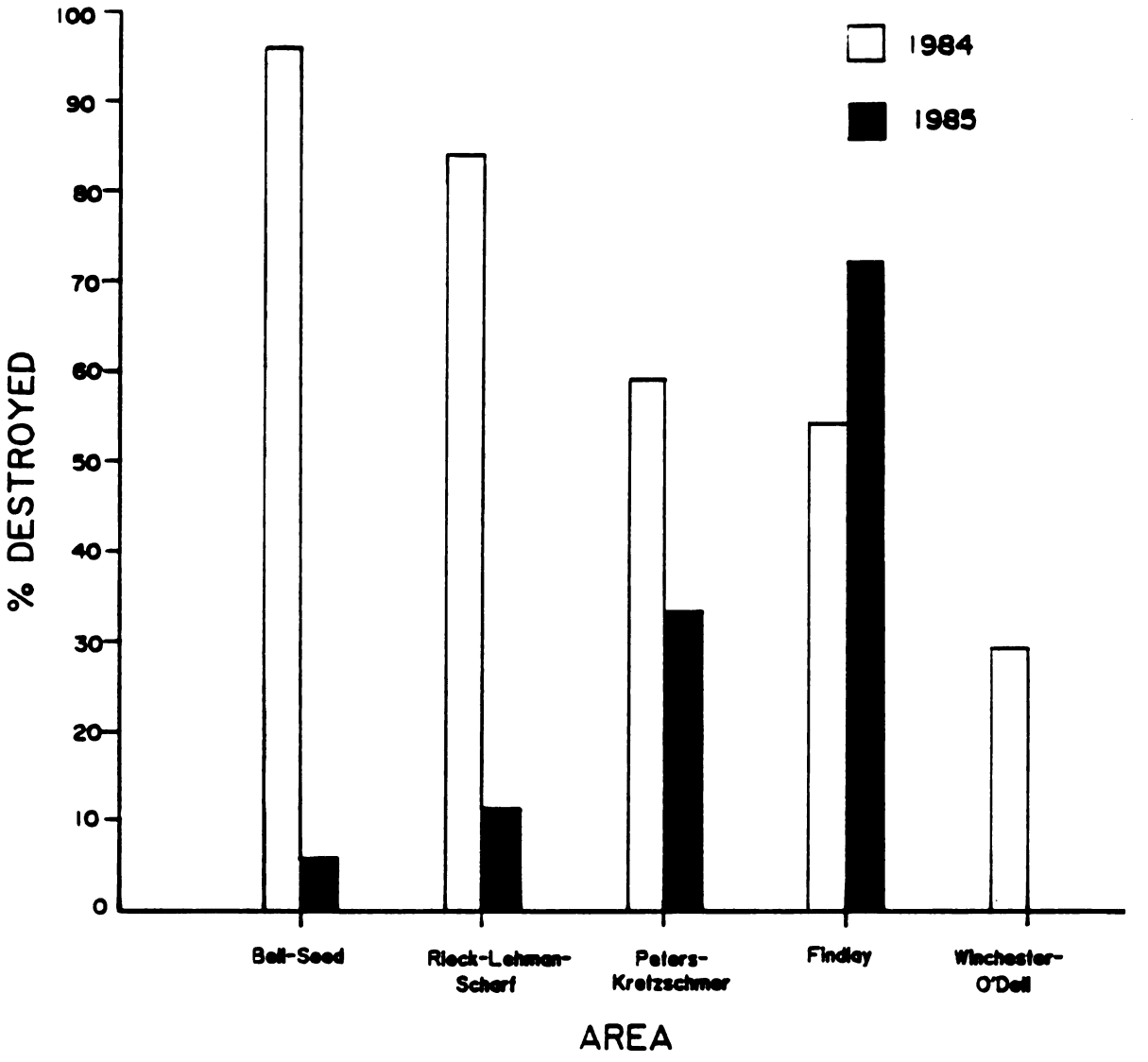

Fig. 3. Percent of dummy nests with one or more eggs destroyed or missing at 5 study areas in 1984 and 1985.

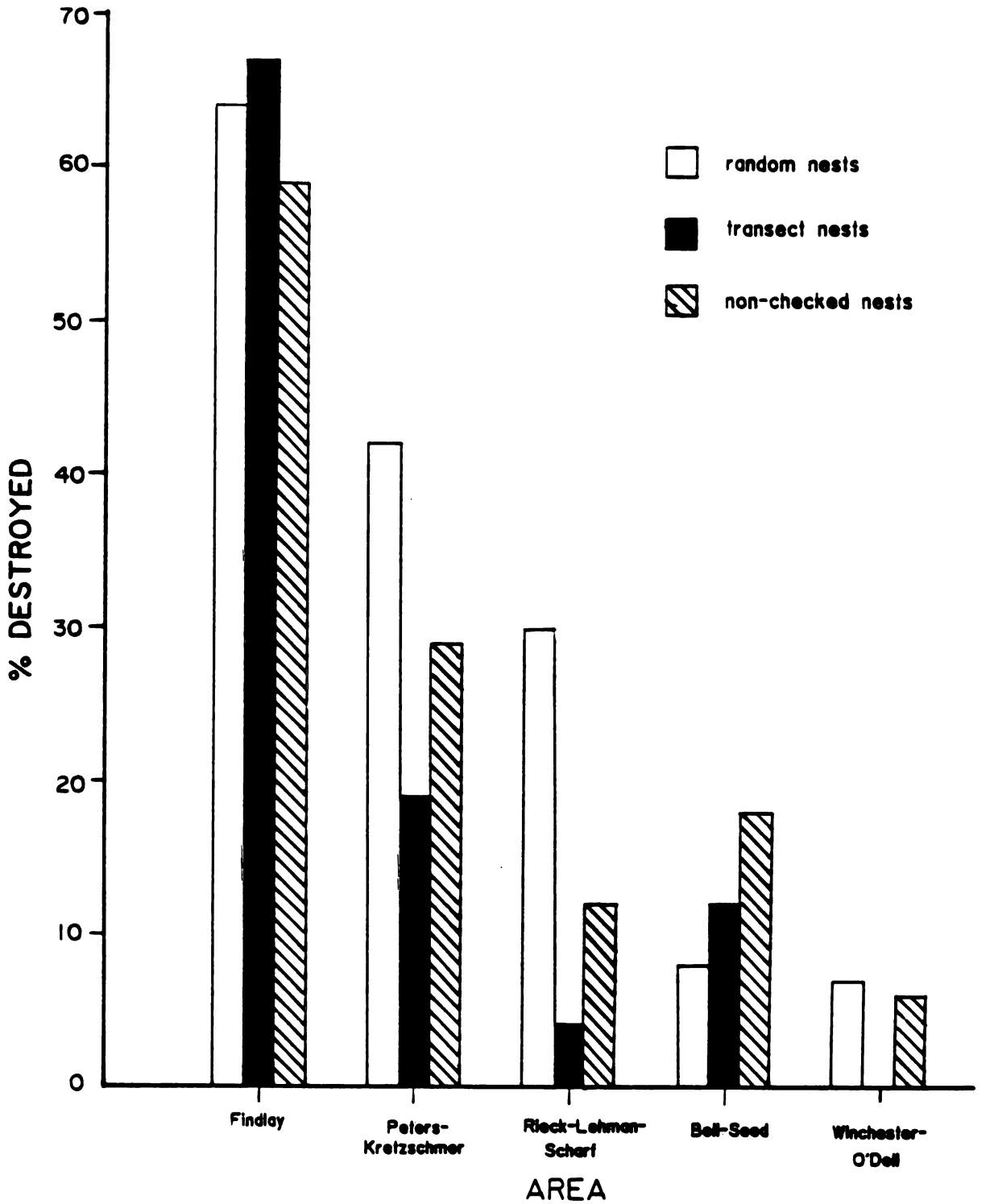

Fig. 4. Percent of dummy nests with one or more eggs destroyed or missing in randomly placed nests, transect nests, and non-checked nests at 5 study areas in 1985.

Table 5. Index[a] of relative abundance of 6 species of mammalian predators on 5 1/4 township study areas located in the thumb region of Michigan in 1984 and 1985.

	Bell-Seed	Peters-Kretzschmer	Findlay	Rieck-Lehman-Scharf	Winchester-O'Dell	Avg (X)
Raccoon						
1984	89	75	17	11	5	39
1985	111	21	15	33	22	40
Skunk						
1984	83	0	11	0	22	23
1985	61	28	38	22	7	31
Red fox						
1984	17	27	6	16	5	14
1985	39	21	8	11	0	16
Opossum						
1984	17	43	17	22	27	25
1985	17	7	7	0	7	8
Dog						
1984	33	123	68	33	54	62
1985	83	85	128	33	126	91
Cat						
1984	56	59	34	66	38	51
1985	17	63	45	16	15	31
TOTAL						
1984	295	327	153	148	151	214
1985	328	225	241	115	177	217

[a] Index = $\frac{\text{Total animal visits}}{\text{Total operative station nights}}$ X 1000

virginianus). Other species visiting scent post stations were domestic dogs and cats. Domestic animals constituted the majority of visitors to scent post stations, representing a combined index of 113 and 122 for 1984 and 1985, respectively (Table 5). Of the native species, raccoons were the most numerous visitor to scent posts, followed by skunks, opossums and red fox. Tracks were evident in less than 35% of scent post stations for both 1984 and 1985. There was no significant difference in the rate of visitation to scent posts between years ($p>.05$)

A total of 22 broods, 10 hens and 10 cocks were observed during surveys in 1984 (Table 6). During the 1985 surveys, only 5 broods, 5 hens and 6 cocks were seen. This is a significant decrease of 77% from the previous year for broods ($p<.05$), while the total number of chicks observed decreased by 61% in 1985 (Table 6). In addition, the number of adult pheasants seen along the route declined by 44% in 1985.

Three of the study areas had fewer numbers of chicks observed in 1985 compared to 1984. These areas corresponded to the areas having a higher total index for mammalian predators visiting scent post stations in 1985. The two areas with higher numbers of chicks observed in 1985 showed a lower index of mammalian predators compared to 1984. Although there may be a trend for an inverse relationship between numbers of chicks observed and the

Table 6. Number of ring-necked pheasant broods observed during surveys along a standard route at 5 1/4 township study areas in the thumb area of Michigan in 1984 and 1985.

Area	Distance Traveled (km)		Broods		Chicks		Hens		Cocks	
	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985
Rieck-Lehman-Scharf	173	173	6	2	19	27	0	3	1	1
Bell-Seed	168	168	5	0	59	0	2	0	3	0
Peters-Kretzschmer	173	178	4	2	10	16	3	1	1	2
Winchester-O'Dell	173	173	4	1	19	7	2	1	3	2
Findlay	173	173	3	0	22	0	3	0	2	1
TOTAL	859	864	22	5	129	50	10	5	10	6

index of relative abundance, the relationship is not significant (r_s= -0.8).

Information regarding hunter effort and success from the opening 2 days of pheasant season was received from 157 hunters in 1984 and 120 hunters in 1985, which represents a return of 50% and 42% of the surveys issued (Table 7). Although the total number of hunters declined in 1985, there was not a significant difference in the average hours hunted per party between 1984 and 1985 ($p>.05$).

A reported total of 23 cocks were harvested during the first 2 days of the hunting season on 5 areas in 1984 (Table 8). Twelve cocks were taken in 1985, a decrease of 48%. The total birds shot decreased by 62%. The number of hours per bird flushed increased from 4.7 in 1984 to 10 in 1985 for cocks, and from 3.4 to 12.6 for hens. This is a 2 and 3 fold increase for cocks and hens, respectively. The difference between 1984 and 1985 for hens is significant ($p<.05$).

A total of 60 pheasants were observed during the 560 km survey route traveled in February of 1985. The highest number of pheasants noted was at Peters-Kretzschmer, where 19 hens and 26 cocks were observed on the state owned land (Table 9). All pheasants observed on the other study areas were on private land. The observed sex ratio of cocks:hens was 1.6:1.0.

Table 7. Hunting party information from the opening 2 days of pheasant season at 5 1/4 township study areas in the thumb region of Michigan in 1984 and 1985.

	Surveys issued	Surveys returned	Percent returned	No. hunters	Hunters/ party (x̄)	Hrs. hunted/ party (x±S.E.)
Bell-Seed						
1984	20	8	40	23	3	3 ±.6
1985	22	11	50	31	3	3 ±.6
Peters-Kretzschmer						
1984	19	9	47	23	3	4 ±.8
1985	27	9	33	22	2	3 ±.7
Winchester-O'Dell						
1984	27	14	52	29	2	3 ±.5
1985	30	8	27	27	3	4 ±.9
Findlay						
1984	21	13	62	39	3	3 ±.7
1985	19	11	58	26	2	2 ±.3
Rieck-Lehman-Scharf						
1984	25	12	48	43	4	4 ±.8
1985	8	6	75	14	2	2 ± 1
TOTAL						
1984	112	56	50	157	3	3 ±.3
1985	106	45	42	120	2	3 ±.3

Table 8. Hunter harvest data from the opening 2 days of pheasant season at 5 1/4 township study areas located in the thumb region of Michigan in 1984 and 1985.

	cocks bagged	cocks HBNR[a]	gun-hours[b]	gun-hr/ cock bagged	gun-hr/ cock flushed	gun-hr/ hen flushed
Bell-Seed						
1984	3	1	73	24.3	3.3	2.8
1985	0	1	92	0	23.0	8.4
Peters-Kretzschmer						
1984	5	10	86	17.2	2.9	2.7
1985	3	1	46	15.3	3.5	7.7
Winchester-O'Dell						
1984	8	3	80	10.0	2.2	1.5
1985	6	1	174	29.0	10.9	17.4
Findlay						
1984	3	0	148	49.3	11.4	5.3
1985	2	0	41	20.5	8.2	20.5
Rieck-Lehman-Scharf						
1984	4	0	174	43.5	9.2	6.9
1985	1	0	37	37.0	37.0	18.5
TOTAL						
1984	23	14	561	24.4	4.7	3.4
1985	12	3	390	32.5	10.0	12.6

[a] Hit but not retrieved

[b] No. hunters/party X hrs. hunted/party

Table 9. Numbers of pheasants observed during winter roadside surveys at 5 1/4 township study areas in the thumb region of Michigan in 1985.

Area	Distance Traveled (km)	Hens	Cocks	Total pheasants observed
Peters-Kretzschmer	110	19	26	45
Winchester-O'Dell	115	1	4	5
Bell-Seed	104	5	0	5
Rieck-Lehman-Scharf	115	1	2	3
Findlay	115	2	0	2
TOTAL	560	23	37	60

For 242 trap nights, 6 hens were captured and fitted with radio transmitters. Problems encountered in bait trapping included persistent snow that continually covered the bait and eventually drifted over many of the traps. At Bell-Seed, white-tail deer (Odocoileus virginianus) tore the nylon net tops in repeatedly successful attempts to feed on the bait. In addition, drifting snow precluded travel to the areas at one point, resulting in 2 hens lost to exposure in one trap at Bell-Seed. On 24 January 1985, all traps were closed to prevent further mortality in traps.

No pheasants were captured in mist nets. Although the pheasants that were driven toward the net by workers did not flush until close to the net, birds were able to avoid the net. Pheasants that had entered the cover containing the mist nets before the drivers were close apparently avoided the net, running around the ends. One hen did flush into the net, yet was able to escape before workers converged on the net. One female Cooper's hawk (Accipiter cooperii) was trapped and released during this effort.

Nightlighting crews operated 5 times during the winter of 1985, for a total effort of 41 man-hours (Table 10). One hen was captured. Most of the pheasants flushed wildly, out of range of crew members with nets.

Three species of hawks were observed wintering on

Table 10. The number of pheasants flushed and caught during nightlighting efforts at Peters-Kretzschmer mini-game area during the winter of 1985.

Date	Nightlighting effort (h)	Pheasants flushed	Pheasants caught	Flushes/ effort (h)
1-8-85	9	30	-	3.3
1-9-85	6	5	-	0.8
2-20-85	3	4	1	1.3
2-28-85	8	2	-	0.3
3-20-85	15	3	-	0.2
TOTAL	41	44	1	1.1

some of the mini-game areas (Table 11). The most numerous species observed during the 560 km survey was the red-tailed hawk (Buteo jamaicensis). Other species observed were the rough-legged hawk (Buteo lagopus) and Cooper's hawk.

The playback recording of owls was unsuccessful in 1985, due to the severe weather that characterized that winter. In particular, high winds distorted the sound and direction of the recording and caused the detection of responses to be extremely poor.

A systematic search for pheasant carcasses was conducted on 3 mini-game areas during the winter of 1985 (Table 12). Hens constituted 41 out of 45 birds found during searches. In addition, 44 of those mortalities were either partially (some or most of the body discovered) or completely (only feathers or appendages left) consumed by a predator. Positive identification of predators from the carcasses was not possible in most cases. However, at Peters-Kretzschmer, 5 hens were found in an apparent cache in a brush pile on successive visits. One additional hen was found nearby, with numerous red fox tracks around it. Also at Peters-Kretzschmer, a complete pheasant skeleton was discovered in a tree, approximately 3 m above ground. A pair of red-tailed hawks was frequently observed perched in trees on this game area, particularly at dusk when pheasants were traveling to their

Table 11. Number and species of hawks observed during roadside surveys along a standard route at 5 1/4 township study areas in the thumb region of Michigan in 1985.

Area	Distance traveled (km)	Species			
		Red-tailed	Rough-legged	Cooper's	Unident.
Winchester-O'Dell	115	6	-	-	-
Peters-Kretzschmer	110	5	1	-	-
Findlay	115	3	-	-	-
Rieck-Lehman-Scharf	115	2	-	-	1
Bell-Seed	104	1	-	1	-
TOTAL	560	17	1	1	1

Table 12. Pheasant mortalities found during searches of 3 study areas in the thumb area of Michigan, during the winter of 1985.

Area	Search time (h)	Pheasants Found			Search time/ Pheasant (h)
		Hens	Cocks	Total	
Peters-Kretzschmer	151	27	2	29	5
Winchester-O'Dell	47	11	2	13	4
Bell-Seed	33	3	0	3	11
TOTAL	231	41	4	45[a]	5

[a] 44 of 45 birds located were either partially or completely consumed by a predator.

roosting sites. This pair of red-tails nested 1 km away, successfully fledging 2 young this past summer.

The determination of the cause of death is subject to bias because there exists the likelihood that predators may have taken advantage of a pheasant found dead. Other causes of death for wintering pheasants include starvation and exposure (McClure 1948, Kopischke and Chesness 1967), yet it is unlikely that either was the initial cause of death. The 5 birds collected for necropsy were determined to have good body conditions, with fat deposits present. Predation was diagnosed as the cause of death for 2 of the 5 birds; 2 died as a result of self-inflicted trauma while in bait traps. A diagnosis was not made for the cause of death in the final bird collected.

In order to evaluate winter severity, data was collected from the Michigan Weather Service for January through June 1985. Temperatures and amount of precipitation (rain and snow) were compiled from Bad Axe (Huron County) and Caro (Tuscola County), and compared with the means of these measurements from the period 1940-1969 (Michigan Weather Service 1975). Temperatures during January and February were lower than the long term average (departure from the norm = -1.36 C^{o}), while rain and snowfall were greater (Table 13). Spring in 1985, however, showed higher temperatures in April and May, with precipitation near the long term mean. In January 1985,

Table 13. Mean monthly temperatures and amount of precipitation for the period January through June 1985 in Bad Axe and Caro, Michigan.

Month		Temp. (°C)		Rain (cm)		Snowfall (cm)		Days with >15 cm snow cover	
		Bad Axe	Caro	Bad Axe	Caro	Bad Axe	Caro	Bad Axe	Caro
Jan	1985	-7.7	-7.6	10.3	3.8	87.6	45.9	31	18
	x̄[b]	-5.8	-5.5	4.6	3.7	32.0	22.9		
Feb	1985	-6.1	-5.1	10.5	6.1	57.7	35.3	24	22
	x̄	-5.3	-4.8	4.7	3.2	32.3	19.6		
Mar	1985	0.7	2.6	14.8	8.9	43.7	10.4	5	0
	x̄	-0.6	0.3	4.9	4.9	18.8	13.7		
Apr	1985	9.2	10.8	8.8	6.9	6.4	T	0	0
	x̄	6.8	7.7	6.3	6.1	4.6	2.5		
May	1985	13.4	15.4	6.6	8.4	0	0	0	0
	x̄	12.4	13.3	7.2	7.0	.3	T		
Jun	1985	16.3	16.9	4.4	4.9	0	0	0	0
	x̄	18.3	19.2	7.6	7.7	0	0		

[a] Data from the Michigan Weather Service (1985).
[b] Long term average for 1940-1969 (Michigan Weather Service 1975).

there were 31 days with greater than 15 cm of snow in Bad Axe, while Caro had 18. In February, Bad Axe and Caro were similar, with 24 and 22 days of snow cover, respectively.

DISCUSSION

Pheasant numbers in the thumb region of Michigan were known to be low, but not to the extent the data collected have illustrated. The continued decrease in pheasant numbers has now reached an all-time low.

The study was designed to compare and contrast pheasant numbers on 5 study areas which incorporated pheasant management areas within each. Mini-game areas were designed to provide habitat for the basic needs of pheasants since the surrounding private lands are intensively farmed. Although agricultural crops such as small grains and forage crops (alfalfa) are preferred nesting and brood rearing cover (Gates and Hale 1975, Warner 1979, Snyder 1982,1984), mortality from agricultural practices is well documented (Kozicky 1951, Linder et al. 1960, Gates and Hale 1975). The economy of Michigan's thumb region is based on agriculture, and recent trends of large, more efficient farm machinery have resulted in the elimination of fence rows and roadside strip cover while increasing field size. Intensive farming practices such as fall plowing have reduced the amount of residual cover and waste grains available for pheasants during the fall and winter. Mini-game areas are managed to provide secure

nesting cover and brood rearing cover as well as winter foods and cover in close proximity to counteract the lack of quality habitat on surrounding lands (C. Jarvis, pers. comm.). Pheasants have responded to management on game areas, but there has been no stability in pheasant numbers. Numbers of breeding and wintering ring-necks have been variable, suggesting that habitat management on parcels of land covering 64 to 113 ha is not sufficient to maintain stable numbers of ring-necks and that other factors are affecting populations. Frank and Woehler (1969) monitored the response of pheasants to habitat manipulations designed to provide food and cover in Wisconsin. They found no measurable increase in pheasant density on management areas relative to regional population trends. Data collected from 2 years in the thumb region suggest that this may be occurring in Michigan as well.

This investigation occurred during a period with an exceptionally harsh winter, with snow depths ranging 23 to 55 cm greater than the long term average. Drifting snow severely reduced the amount of quality winter cover and foods on the mini-game areas. This resulted in documented mortality of pheasant hens that was substantial enough to reduce productivity to even lower levels than observed in 1984. This was reflected in the dramatic decrease in broods observed during brood surveys in 1985.

Spring crowing cock counts have been used as an index for breeding populations of pheasants (Kimball 1949, Gates 1966). Crowing cock counts in 1985 were not affected by the large mortality of hens noted over the winter field season. Although past counts by Michigan Department of Natural Resources (MDNR) personnel are not directly comparable to the surveys in 1984 and 1985, counts the past 2 years on the study areas are lower than surveys conducted in past years by the MDNR on 2 of the mini-game areas. Crowing counts appear to reflect the availablity of territorial habitat for males. The number of crowing sites on the areas between years was constant, with a population of males large enough to fill the territories.

Mortality of pheasants during the nesting and brood rearing period did not appear to be significant. Dummy nest transects did not show a consistent trend between years, as only Findlay showed a rate of egg destruction >40% in 1985. Areas having the highest rate of depredation in 1984 and 1985 had mammalian predators known to inhabit the mini-game areas. In 1984, Bell-Seed had a red fox with kits denning near the meadow where the dummy nest transect was set out, while a striped skunk was encountered when checking nests at Findlay in 1985. The lower rate of egg destruction in 1985 can be attributed to the mild spring weather (Michigan Weather Service 1985), which promoted early vegetative growth. In 1985, new herbaceous

growth covered the eggs when they were set out. In 1984, residual vegetation offered little or no cover until late May, and dummy nests were often quite visible.

Scent post surveys did not indicate an abundance of predators within each 1/4 township study area, although those species that have been identified as predators of pheasants did visit scent post stations. The rate of visitation was always under 10% for each species. This is a low value compared with Conner et al. (1983), who reported a 27%, 48%, 9.9% visitation rate for raccoon, grey fox, and opossum, respectively.

Although hunter effort was intensive on most areas, success was limited in both 1984 and 1985. Hunters removed few cocks and the decline in pheasants in 1985 resulted in a decrease of 31% in hunter effort. Comments received from hunters on the 1984 and 1985 harvest surveys indicate their increasing discouragement for pheasant hunting in the thumb region. This discouragement is reflected not only in the lower numbers of hunters, but also in the decreased hours spent hunting in 1985.

Numbers of pheasants wintering on mini-game areas have declined for all areas. In 1978, Findlay had 200-300 pheasants wintering on the area, while 150 birds were observed at Peters-Ketzschmer (MDNR, unpubl. rep., 1978). Winchester-O'Dell had steadily increasing numbers of wintering pheasants, with >100 birds noted in 1984

(C.Jarvis, pers.comm.), yet in 1985, no more than 45 pheasants were observed on any 9 section study area.

Predation had a notable effect on pheasant numbers during the winter of 1984-1985 on the three study areas where mortalities were monitored. The most significant impact was the number of hens removed from the population. This is reflected by the sex ratio of flocks wintering on the study areas in 1985. Normally, because of the gregarious behavior of hens in the winter, any type of count that tends to seek out concentrations of birds would be biased towards hens (Wagner et al. 1965). The observed sex ratio of flocks in 1985 was skewed to cocks, indicating poor reproductive potential for a polygynous species. Snyder (1985) reported high losses of hens during the early spring in Colorado, especially in the spring of 1980 when snow cover was extensive. Cocks did not appear to experience the same degree of late winter mortality as ring-necked hens. Einarsen (1956) stated that hens show poor defensive habits against predators. Dumke and Pils (1973) noted that predators are opportunists, and have been observed testing prey to detect an easy kill. Mammalian and avian predation has been documented to be significant during the winter period of snow cover (Dumke and Pils 1973, Petersen 1979, Snyder 1985). At the Waterloo Wildlife Area, Wisconsin, red fox were implicated in 64% of pheasant losses to mammalian predat-

ors, while the red-tailed hawk and great horned owl were felt to be responsible for the majority of the avian mortalities (Dumke and Pils 1973). In Colorado, Snyder (1985) found that predation was the only documented source of natural mortality among radio-marked hens. Great horned owls, Cooper's hawks, and prairie falcons (Falco mexicanus) were believed to be responsible for 51% of predator caused deaths (Snyder 1985). Snyder (1985) found that survival of ring-necked hens was lowest in April, primarily as a result of avian predation. At the Waterloo Wildlife Area, Wisconsin, Dumke and Pils (1973) dicovered that predation was the only cause of death in radio-collared hens during the brood rearing, post-brood rearing, and late winter periods. Although the study at Waterloo did not include a demographic analysis, predation appeared to be the factor limiting pheasant abundance (Dumke and Pils 1973). In a follow-up investigation, Petersen (1979) determined that great horned owls and red-tailed hawks, along with other pheasant predators, depress the pheasant population below the carrying capacity of the habitat at Waterloo. Raptor predation, therefore, appeared to be an additive, rather than a compensatory form of mortality (Petersen 1979).

The decline of pheasant populations is an intricate matter, with a complex of factors responsible. Severe winter weather and the impact of predators during the

winter of 1985 clearly influenced the decline of pheasants on the 5 study areas. This, however, does not explain the lack of productivity on the long term basis. Populations of pheasants have been declining over the past 3 decades and more work needs to be done to explain the decrease in productivity. A series of experiments integrating populations sizes, habitat, predation, biocides, and energetics is needed before this perplexing decline of the ring-necked pheasant can be resolved.

APPENDIX

MICHIGAN STATE UNIVERSITY

DEPARTMENT OF FISHERIES AND WILDLIFE
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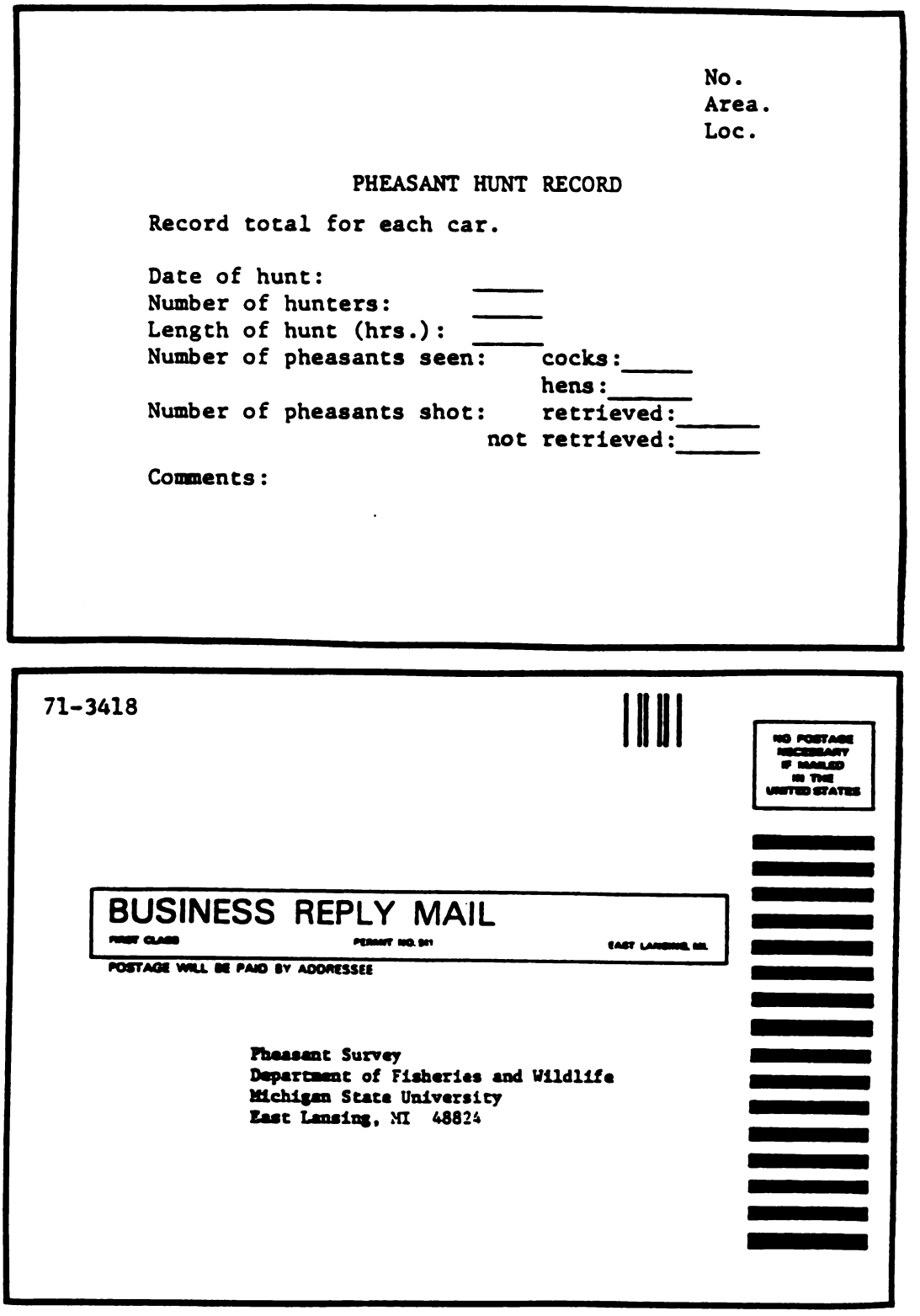
ATTENTION RING-NECKED PHEASANT HUNTERS

Researchers in the Department of Fisheries and Wildlife at Michigan State University, in cooperation with Michigan Department of Natural Resources Wildlife biologists, are collecting data on the status of ring-necked pheasants in the "Thumb" region.

We need to obtain harvest information for Tuscola and Huron counties. Please complete the attached card for only the period of time that you have been hunting at this location.

Your contribution will be very helpful as we evaluate the response of the birds to current patterns of land use.

Fig. 5. Cover letter for the hunter harvest survey in 1984 and 1985.



No.
Area.
Loc.

PHEASANT HUNT RECORD

Record total for each car.

Date of hunt: _____
Number of hunters: _____
Length of hunt (hrs.): _____
Number of pheasants seen: cocks:_____
hens:_____
Number of pheasants shot: retrieved:_____
not retrieved:_____

Comments:

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Fig. 6. Hunter harvest survey for 1984 and 1985.

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LITERATURE CITED

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