1980

Land Use Changes and Pheasant Declines in Eastern South Dakota

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LAND USE CHANGES AND PHEASANT DECLINES IN EASTERN SOUTH DAKOTA

BY

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A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in
Wildlife and Fisheries Sciences
South Dakota State University

1980

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IN EASTERN SOUTH DAKOTA

This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Major Department Representative

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Abstract

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Changes in pheasant (Phasianus colchicus) nesting habitat were investigated on Windsor Township, Brookings County, South Dakota. The population was censused, nesting densities determined, cover was mapped, and an interspersion index determined in 1977 and 1978. Comparison to a similar study conducted in 1958 and 1959 indicated a decrease in pheasant numbers of 93% for crow counts and 94% in brood counts. Nesting densities decreased by 96%. Pheasant nests were found in about the same proportions per cover type for the two time periods. Hatching success, clutch size, rates of abandonment, and nest destruction were also similar. Nesting habitat occurred on 70% of the study area in 1958, 62% in 1959, 74% in 1977, and 66% in 1978. The mean field size was 6.7 ha in 1958, 6.9 ha in 1959, 10.2 ha in 1977, and 8.0 ha in 1978. The interspersion index decreased by 4% from 1958-59 to 1977-78. Although land use changes have resulted in reduction of habitat in twenty years the amount of habitat reduction does not compare to the reduction in pheasant numbers. Factors such as cover quality, which could not be measured quantitatively, may be more responsible for decreasing the pheasant population in eastern South Dakota than cover quantity.

ACKNOWLEDGEMENTS

Many people deserve my sincerest thanks for help and inspiration towards completion of my thesis and I can only mention a few. First, my parents are due thanks for providing me with continuous help and support throughout my life and college career. My wife and family also deserve my thanks for their love and understanding.

Dr. Lee Tucker receives my appreciation for his help with the statistical work. Dave Nomsen who provided me with two summers of hard diligent field work also deserves more than a mere mention of thanks.

Last but not least, Dr. Ray Linder who had faith in me and an unbelievable amount of patience cannot possibly be shown the proper amount of thanks and admiration.

These people and many others made my Masters Degree possible and I humbly thank them.

INTRODUCTION

The population of ring-necked pheasants (Phasianus colchicus) in eastern South Dakota has declined since the soil bank era of the late fifties and the sixties. Long term land use changes are believed to be one of the factors responsible for the decline (Erickson and Wiebe 1973).

The effect of land use changes on pheasant numbers has been documented in many states. Factors responsible for a 25% decrease between 1970 and 1975 in Illinois were primarily associated with a reduction in habitat quantity and a degradation in quality (Labisky 1976). Land use changes were also responsible for pheasant declines in Nebraska (Taylor et al. 1978). In Iowa the acreage of safe nesting cover is only a fraction of its former abundance (Nomsen 1969). Mohlis (1974) reported a 44.3% loss in area of nesting habitat and a decline in habitat quality in north-central Iowa over a 36 year period.

In 1958 and 1959 Trautman (1960) studied pheasant production in relation to land use on a study area in Brookings County, South Dakota. Trautman found that nearly 70% of the total production of young pheasants in both years came from small grains, pastures, wetlands, and roadsides. Although small grains had less than average nesting density, more young pheasants were produced there than in any other cover type because of high hatching success.

The objectives of this study were to compare pheasant production and land use in 1977-78 with production and land use in 1958-59 on Trautman's Brookings County study area.

STUDY AREA

The Brookings County study area (T111N R52W Sec. 13-36 and T110N R52W Sec. 1-12) is in the Coteau des Prairies region and is typified by gently rolling hills interspersed with glacial wetlands. Major soil types are of the northern Chernozem series and consist of Poinsette, Waubay, Ahnberg and Parnell (Westin et al. 1967). Of the 36 sections used in 1958-59 (Trautman 1960), only 30 could be used in my study due to refusal of permission of 2 land owners.

Climate of the area is continental with maximum temperatures usually rising above 38 C in the summer and minimum temperatures dropping to -29 C in the winter. Average date for first frost is 21 September with an average growing season of 127 days. Average annual precipitation for the County is 52.3 cm of which 80% falls during the growing season (April-September). Snowfall averages 60.96 cm annually. Strong winter winds often cause large snow drifts in sheltered areas. Prevailing winds are southerly and average 10-16 kmph during the summer and northwesterly at 18-19 kmph during the winter. Winds of 80 kmph or more are associated with passage of cold fronts or low pressure areas in the winter and thunderstorms during the summer (Spuhler et al. 1971). Precipitation during the nesting season (April to August) for 1958-59 was 97 cm and 112 cm in 1977-78.

Land use is a cash grain and livestock economy. Cover types and vegetation were classified as described by Trautman (1965).

METHODS

Breeding Population

Breeding populations of pheasants were estimated from crowing counts (Dahlgren 1960) of cocks and ratio of hens to cocks in the spring. Crowing counts were conducted from 7 April to 3 May 1977 and from 15 April to 2 May 1978 on the same routes used by Trautman (1965) in 1958-59. Eight counts in 1977 were made on prime mornings (wind less than 16 kmph and clear skies). In 1978, 5 counts were made on prime mornings. Triangulation technique as described by Robertson (1958) was used to locate crowing cocks on 36 quarter sections to estimate the number of cocks. Ratio of cocks to hens was calculated from observations of birds during crowing counts in April and May.

Brood Counts

Pheasant broods were counted on 48 km routes from 14 July to 19 August 1977, and on 32 km routes from 19 July to 17 August 1978. Counts were made on clear, calm (wind less than 16 kmph using the Beaufort scale) mornings with heavy dew. Routes were driven at a speed of 24 kmph and birds were flushed to determine brood size and age of chicks. Routes started at sunrise and were completed within 2 hours. Finishing point for the first count became the starting point for the next count and the route was traveled in the opposite direction. Seven counts were made in 1977 and 11 counts in 1978.

Nest Searching

Nest searching in 1977-78 was conducted by 4 field workers between 15 May and 22 August each year. Hectarages to be searched were on 36 quarter sections (64.8 ha) randomly drawn from the 30 sections (259.0 ha) where permission had been obtained from landowners. Ten percent of all wetlands, pastures, and shelterbelts, and 17% of all remaining nesting cover were searched in 1977. The dry edges of all wetlands, 10% of grazed pastures, and 33% of all remaining nesting cover were searched in 1978. To establish plots in uniform shaped fields, the fields were divided into tenths, sixths, or thirds and segments for plots were randomly chosen. Plots in irregular shaped fields were transects with the starting point randomly chosen from aerial photographs. Transects were then walked until the required hectarage was covered.

In 1977 sampling rate was 3.2% of the study area and ranged from 0.0% of wetlands to 4.9% of roadsides. Due to heavy April rainfall (15.2 cm in 24 hours), all wetlands and wetland edges were under water for the remainder of the nesting season. The sampling rate in 1978 was 5.6% of the study area and varied from 2.5% of wetlands to 15.6% of alfalfa. In 1958, 6.5% of the study area was searched for nests (Trautman 1960). The sampling rate varied from a minimum of 3.2% of the flax to 17.5% of the wetlands (Trautman 1960). The 1959 sampling rate was 3.6% and ranged from 3.3% of the small grain fields (small grains) and shelterbelts to 4.1% of the flax (Trautman 1960).

Alfalfa, small grains, and flax were searched after harvest to avoid crop damage. Alfalfa was searched twice, once after each cutting.

Roadsides, railroad right-of-ways (ROW), fence rows, pastures, wetlands, shelterbelts, and idle farm acres were searched once. If the cover was cut for hay, an additional search was made to determine if nests were missed.

A nest was considered to be a "form" with an egg (Linder et al. 1960). Date, section, plot number, cover type, species of residual and new growth vegetation, density of residual and new growth vegetation, density of dominant plant species, number of eggs, number of incubated and unincubated eggs, and nest fate were recorded for each nest found. All active nests were marked and revisited until fate of the nest could be determined.

Land Use

The area was cover mapped using aerial photographs and ground verification measurements. Cover maps made by Trautman were used as a basis for cover types for 1958-59. Hectarages of each field were recorded for size comparisons. Aerial photographs from 1970 were acquired from the Agricultural Stabilization and Conservation Service (ASCS) office in Brookings and land use was updated by field workers in 1977 and 1978. Hectarages were obtained by using a polar planimeter. Results were then totaled and analyzed for comparisons. Cover quality and amount of fall plowing were not recorded for 1958 or for 1959 by Trautman (1960).

An interspersion index (Baxter and Wolfe 1972) was calculated using ASCS aerial photographs from 1956 and 1970, as well as cover maps. Two diagonal lines were drawn across each quarter section on all maps.

The number of times a line crossed a different cover type was considered a habitat change. These changes were then counted and totaled for each quarter section to determine the interspersion index.

Analysis of variance using the least squares method (Steel and Torrie 1960) was calculated on land use data and interspersion data. Tukey's w-procedure (Steel and Torrie 1960) was used to determine significant means.

RESULTS AND DISCUSSION

Population

Crowing counts, brood counts (Table 1), and nesting densities (Table 2) declined 93, 94, and 96% respectively, on the study area between 1958-59 and 1977-78. Population declines have also been reported in Illinois (Labisky 1976), Nebraska (Taylor et al. 1978), and throughout South Dakota (Dahlgren 1967, Erickson and Wiebe 1973).

In 1977 ungrazed pasture and roadside had the highest nesting density followed by oats and alfalfa (Table 3). Fence row, ungrazed pastures, roadsides, and shelterbelt contained the highest densities of nests in 1978. The small sample size, 8 nests in 1977, may account for the high variation between the two years. Trautman (1960) found the highest nesting densities in fence row, roadside, wetlands, and ROW (Table 3). Alfalfa had the highest density of nests in cropland (Trautman 1960). Also in Brookings County, South Dakota, Olson and Flake (1975) found the highest nesting densities in hay and roadsides. In Iowa, Fischer (1974) found raodsides with the highest nesting density.

Production

Trautman (1960) found that over 70% of the chicks were produced in small grains, pasture, wetlands, and roadsides in 1958-59 (Table 4). Only 0.2% of the nesting cover was in soil bank in 1958 and 4.4% in 1959 (Trautman 1960); soil bank accounted for 4.7% of the chick production in 1958-59 (Table 4) (Trautman 1965).

Table 1. Crowing counts, brood counts, and sex ratios of pheasants on the Brookings County study area 1958-59[a] and 1977-78.

Year	Crowing cocks/ stop	Broods/km	Sex ratio (cocks/100 hens)
1958	73.5	1.4	31
1959	72.5	1.7	35
Average	72.0	1.6	33
1977	3.5	.097	50
1978	6.4	.083	60
Average	5.0	.09	55
% Change	-93	-94	+40

[a] Crowing counts from Dahlgren (1958, 1960). Brood routes from Popowski (1960) and Dahlgren (1961). Sex ratio from Trautman (1965).

Table 2. Number of pheasant nests found and density of nests on Brookings County study area 1958-59 (Trautman 1960) and 1977-78.

Year	Nests No.	Hectares searched	Nests/ hectare
1958	791	426	1.86
1959	409	208	1.97
Average	600	317	1.92
1977	8	245	0.03
1978	44	427	0.10
Average	26	336	0.07

Table 3. Nesting densities per cover type found on Brookings County study area 1958-59 (Trautman 1965) and 1977-78.

Cover type	Nests/No. hectare					
	1958	1959	Average	1977	1978	Average
Fence row	28.6	32.1	30.4	0.0	3.8	1.9
Roadside	4.6	7.0	5.8	0.2	0.5	0.3
Alfalfa	3.2	3.9	3.6	0.1	0.2	0.2
Ungrazed pasture	2.5	2.6	2.5	0.2	0.4	0.3
Grazed pasture	0.6	0.9	0.8	0.0	0.0	0.0
Oats	0.2	1.3	0.8	0.1	0.1	0.1
Wheat	0.6	1.3	1.0	0.0	0.1	0.1
Flax	0.3	0.8	0.6	0.0	0.0	0.0
Wetland	4.9	5.7	5.3	0.0	0.0	0.0
Shelterbelt	1.8	2.5	2.2	0.0	0.8	0.4
ROW	4.3	3.3	3.8	0.0	0.2	0.1
Waterway	-	2.4	1.4	0.0	0.3	0.2

Table 4. Percentage of pheasant chicks produced in various cover types on Brookings County study area 1958-59 (Trautman 1965) and 1977-78.

Cover type	Chick production (%)	
	1958-59 Average	1977-78 Average
Small grains	35.6	17.0
Pasture	13.9	25.0
Alfalfa	5.1	42.0
Roadside	10.8	ND[a]
Fence row	2.3	8.0
Wetland	11.2	ND
Shelterbelt	1.1	8.0
Soil bank	4.7	ND
Other	15.3	ND

[a] No data in these cover types.

In 1977-78, 84% of the chicks were produced in alfalfa, small grains, and pasture (Table 4). Results in 1958-59 and 1978-79 showed that small grains and pastures were important pheasant producers. In Nebraska, Linder et al. (1960) reported that 90% of the pheasant chicks were produced in wheat and roadsides. Olson and Flake (1975) reported that idle farm land, roadsides, and small grains contributed the highest percentage of nests with hatched clutches in another township in Brookings County.

Nest Fate

Trautman (1960) found the highest hatching success of nests in small grains and ROW (Table 5). Nests in pastures, roadsides, and wetlands also had above average hatching success (Trautman 1960). Nests in ungrazed pastures and small grains had the highest hatching success in 1977-78 (Table 5). High hatching success of nests in small grains was also observed in other parts of the pheasant range (Linder et al. 1960, Baxter and Wolfe 1973, Gates and Hale 1975, Olson and Flake 1975). Alfalfa had a high hatching success of nests in 1978 that resulted from late mowing of the first cutting because of the wet spring. Low success of nest hatching in roadsides in 1978 may be explained by disturbance due to rural water installation where about one-half of the road ditches were disturbed by heavy equipment.

Trautman (1965) found that abandonment accounted for 24% of the unsuccessful nests, farm machinery 46%, and predators 31%. In 1977-78 abandonment accounted for 26% of the unsuccessful nests, farm machinery 44%, and predators 31% (Table 6). Fates of nests were similar in both periods.

Table 5. Hatching success in cover types that produced pheasants, Brookings County study area 1958-59 (Trautman 1965) and 1977-78.

Cover type	Hatching success (%)	
	1958-59	1977-78
Small grains	40	75
Pasture	32	70
Alfalfa	7	26
Roadside	24	0
Fence row	9	25
Wetland	25	0
Shelterbelt	11	33
ROW	41	0
Miscellaneous	27	0
Average	22	27

Table 6. Causes and percentages of pheasant nest losses and clutch sizes for Brookings County study area 1958-59[a] and 1977-78.

	1958-59	1977-78	Change (%)
Nests (No.)	1,337	39.0	- 97
Nests abandoned (%)	23.6	25.6	+ 2
Nests destroyed (%)	75.7	74.4	- 1.3
Predators (%)	30.7	30.8	+ .1
Farm machinery (%)	45.7	43.6	- 2.1
Eggs/nest	8.2	7.7	- 6
Eggs/successful nest	8.9	12.0	+ 26
Eggs hatched (%)	86.4	81.9	- 4.5

[a] Nest loss data from Trautman 1965; clutch size data from Trautman 1960.

When nesting parameters such as hatching success, rates of abandonment, rates of destruction, and clutch size are compared they are similar between periods.

Land Use

Large scale losses of nesting cover did not occur between 1958-59 and 1977-78 as shown by small changes in land use (Table 7). Nesting cover occured on 70% of the study area in 1958, 62% in 1959, 74% in 1977, and 66% in 1978. Roseberry et al. (1979) found that bobwhite quail (Colinus virginianus) abundance apparently declined in response to a deterioration of habitat because of land use changes. In 1964 their study area consisted of about 24% cropland and 33% pastures and hay fields. By 1972 pastures and hay fields had declined to 11% while cropland occupied 39%.

In southeastern Illinois, Vance (1976) found a seven-fold increase in hectares of soybeans and the near elimination of grasses from 1939 to 1974. The study area supported at least 131 male prairie chickens (Tympanuchus cupido pinnatus) in 1939. Prairie chickens were extirpated on the area by 1969. He also found that bobwhite quail and cottontail rabbits (Sylvilagus floridanus) were drastically reduced over 35 years of intensified agriculture.

In 1939, nesting cover in north-central Iowa (Mohlis 1974) occurred on 62.3% of the study area and 34.7% in 1972. Small grains (specifically oats), hay, and pasture were replaced by corn, soybeans, and land retired in annual programs. Losses of hay included acreages of late maturing grasses that were lost or replaced by alfalfa. Important losses of wetlands due to drainage were also documented.

Table 7. Percentage of pheasant nesting cover on Brookings County study area (7,783 ha) in 1958-59 (Trautman 1960) and 1977-78.

Nesting cover	1958	1959	1977	1978
Hectares	5,448	4,825	5,627	5,053
% of area in nesting cover	70	62	74	66
% oats	26	27	29	16
% wheat	2	4	9	17
% flax	13	10	8	8
% pasture	20	24	21	21
% alfalfa	12	14	14	15
% roadside	3	3	3	3
% other cover types	24	19	16	20

Although major changes among cover types in my study area did not occur, some changes were evident. Acreages of oats, barley, and flax decreased but the percentage of small grains remained the same due to an increase in wheat acreage (Table 8). Alfalfa comprised 72% of the hay acreage in 1958, 75% in 1959, and 95% in both 1977 and 1978. In 1958-59 ungrazed pasture involved less than 1.0% of the area. Ninety-nine hectares of farm land were purchased by the U.S. Fish and Wildlife Service in 1967 and 1968 as a Waterfowl Production Area. This production area was classified as ungrazed pasture and represented 3% of the study area. Average size of fields on the study area increased 25% from 6.8 ha in 1958-59 to 9.1 ha in 1977-78 (Table 9). This difference in size was significant ($P < .001$). The mean field size for 1977 was the only significant difference ($P < .01$) among the means. When field size for each cover type was placed in order of size for each study (Table 9), a significant difference was observed ($P < .05$). The major change was an increase in wheat field size.

Differences in the interspersion indexes for 1958, 1959, 1977, and 1978 (Table 10) were not significantly different ($P < .01$). Taylor et al. (1978) found a decrease of 41% in the interspersion index on their study area in Nebraska. Irrigated land on their area increased from 64 ha in 1955 to 1,440 in 1976. Row crops increased from 1955 to 1976 and winter wheat, alfalfa, native hay, and pasture decreased. In southeastern Illinois, the interspersion index decreased by 67% (Vance 1976) compared to 4% in my study area.

Table 8. Land use on the Brookings County study area 1958-59 (Trautman 1965) and 1977-78.

Cover type	Hectares				Area (%)				
	1958	1959	1977	1978	1958	1959	1977	1978	Change
Corn	2,094	2,601	1,840	2,173	27	34	24	28	- 15
Oats	1,400	1,304	1,633	810	18	17	21	11	- 10
Alfalfa	664	665	767	783	8	9	10	10	+ 14
Grazed pasture	1,087	1,129	999	836	14	15	13	11	- 17
Ungrazed pasture	2	5	170	221	<1	<1	2	3	+ 98
Barley	352	357	234	70	5	5	3	1	- 57
Flax	723	461	470	242	5	6	6	3	- 40
Wheat	130	173	491	876	2	2	7	11	+ 78
Clover	95	81	1	23	1	1	<1	<1	-[a]
Soybeans	180	49	0	0	2	<1	0	0	-100
Sunflower	0	0	0	58	0	0	0	<1	-
Rye	0	0	26	13	0	0	<1	<1	-
Millet	0	3	40	1	0	<1	<1	<1	-
Sorghum	40	12	29	45	<1	<1	<1	<1	-

Cont.

Table 9. Field size by cover type and average size of fields for Brookings County study area 1958-59 and 1977-78.

1958-59		1977-78	
Cover type	Average Hectares/field	Cover type	Average Hectares/field
Corn	36	Corn	38
Oats	32	Wheat	33
Pasture	27	Oats	33
Flax	25	Flax	32
Barley	22	Pasture	30
Alfalfa	18	Alfalfa	25
Wheat	13	Barley	25
Wetland	13	Ungrazed pasture	24
Tame hay	7	Wetland	14
Ungrazed pasture	4	Tame hay	9
Farm yard	3	Farm yard	5
Shelterbelt	2	Shelterbelt	3
Average field size	6.8	Average field size	9.1

Table 10. Mean interspersion index for Brookings County study area 1956, 1958-59, 1970, and 1977-78.

Year	Interspersion index
1958	34.4
1959	33.2
1977	30.4
1978	34.4
Average 1958-59	33.8
Average 1977-78	32.4
Change (%)	4.0

CONCLUSIONS

Populations of pheasants have decreased more than 90% on the study area in the past 20 years. Nesting densities and production have decreased in about the same proportions. These changes were not fully explained by changes in quantity of cover as has been reported for other parts of the pheasant range (Mohlis 1974, Vance 1976, Taylor et al. 1978, and Roseberry et al. 1979). Amounts of nesting cover remained at about 70% of the total area. Interspersion of cover did not decrease significantly from 1958-59 to 1977-78. Hatching success, nest destruction, and use of nesting cover showed little change between the 2 periods.

One aspect of the habitat that could not be examined was quality of the cover. In southern Illinois Roseberry et al. (1979) found that land use changes did not result in large scale destruction of permanent cover. Their study revealed that subtle changes in cover quality that could not be detected from aerial photos may be affecting the bobwhite quail carrying capacity. Land use in north-central Iowa (Mohlis 1974) caused a decline in quality and quantity of pheasant habitat from 1939-1972. Cover quality losses resulted from increased field size, clean farming, removal of fence rows, and reduced interspersion of cover types.

Plant species diversity as well as vegetation height and density were not measured in 1958-59 for comparisons. Changes in farming operations such as use of herbicides may have altered the percentages

of annual weeds among many of the cover types thereby making the fields less diverse and decreasing their wildlife quality. This change in cover quality may be a factor limiting pheasant populations. The loss of quality habitat may be as important in pheasant management as the loss of acres of different cover types.

LITERATURE CITED

Baxter, W. L., and C. W. Wolfe. 1972. The interspersion index as a technique for evaluation of bobwhite quail habitat. Pages 158-165 in Morrison, J. A., and J. C. Lewis, eds. Proc. First Natl. Bobwhite Quail Symp. Oklahoma State Univ., Stillwater. 390pp.

_____, and _____. 1973. Life history and ecology of the ring-necked pheasant in Nebraska. Nebraska Game and Parks Comm., Lincoln. 58pp.

Dahlgren, R. 1958. Spring pheasant crowing counts and sight records, 1958. P-R Job Completion Report, Proj. No. W-17-R-12. South Dakota Dept. of Game, Fish and Parks, Pierre. 4pp.

_____. 1960. Crowing count and spring roadside pheasant census, 1959. P-R Job Completion Report, Proj. No. W-75-R-1. South Dakota Dept. of Game, Fish and Parks, Pierre. 6pp.

_____. 1961. Pheasant reproduction survey, 1959. P-R Job Completion Report. Proj. No. W-75-R-2. South Dakota Dept. of Game, Fish and Parks, Pierre. 14pp.

_____. 1967. The pheasant decline. South Dakota Dept. of Game, Fish and Parks, Pierre. 44pp.

Erickson, R. E., and J. E. Wiebe. 1973. Pheasants, economics and land retirement programs in South Dakota. Wildl. Soc. Bull. 1:22-27.

Fischer, W. A. 1974. Nesting and production of the ring-necked pheasant on the Winnebago research area, Iowa. M.S. Thesis. Iowa State Univ., Ames. 61pp.

Gates, J. M., and J. B. Hale. 1975. Reproduction of an east-central Wisconsin pheasant population. Tech. Bull. No. 85, Wisconsin Dept. Nat. Res., Madison. 70pp.

Labisky, R. F. 1976. Midwest pheasant abundance declines. Wildl. Soc. Bull. 4:182-183.

Linder, R. L., D. L. Lyon, and C. P. Agee. 1960. An analysis of pheasant nesting in south-central Nebraska. Trans. North Am. Wildl. Nat. Res. Conf. 25:214-230.

Mohlis, C. K. 1974. Land use and pheasant habitat in north-central Iowa, 1938-1973. M.S. Thesis. Iowa State Univ., Ames. 84pp.

Nomsen, R. C. 1969. Land use changes and the ring-necked pheasant in Iowa. Proc. Iowa Acad. Sci. 76:223-225.

Olson, R. A., and L. D. Flake. 1975. Nesting of ring-necked pheasants in eastern South Dakota. Proc. S. Dak. Acad. Sci. 54:126-136.

Popowski, J. 1960. Pheasant reproduction survey, 1958. P-R Job Completion Report, Proj. No. W-74-R-1, South Dakota Dept. of Game, Fish and Parks, Pierre. 16pp.

Robertson, W. B. 1958. Investigations of ring-necked pheasants in Illinois. Illinois Dept. Conser. Division of Game Manage. Tech. Bull. No. 1, Springfield. 138pp.

Roseberry, J. L., B. G. Peterjohn, and W. D. Klimstra. 1979. Dynamics of an unexploited bobwhite population in deteriorating habitat. J. Wildl. Manage. 43:306-315.

Spuhler, W., W. F. Lytle, and D. Moe. 1971. Climate of South Dakota. South Dakota State Univ. Agric. Exp. Stn. Bull. 582, Brookings. 30pp.

Steel, R. G. D., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co. Inc., New York, Toronto, and London. 481pp.

Taylor, M. W., C. W. Wolfe, and W. L. Baxter. 1978. Land-use change and ring-necked pheasants in Nebraska. Wildl. Soc. Bull. 6:226-230.

Trautman, C. G. 1960. Evaluation of pheasant nesting habitat in eastern South Dakota. Trans. North Am. Wildl. Nat. Res. Conf. 25:202-213.

_____. 1965. Evaluation of pheasant nesting habitat in eastern South Dakota. P-R Study Completion Report, Proj. No. W-75-R-6 and 7. South Dakota Dept. of Game, Fish and Parks, Pierre. 103pp.

Vance, D. R. 1976. Changes in land use and wildlife populations in south-eastern Illinois. Wildl. Soc. Bull. 4:11-15.

Westin, F. C., L. F. Puhr, and G. J. Buntley. 1967. Soils of South Dakota. South Dakota State Univ. Agric. Exp. Stn. Soil Surv. Ser. No. 3, Brookings. 32pp.