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Pheasant Nesting and Vegetation Development in Dense Nesting Cover Established Under the South Dakota Pheasant Restoration Program

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PHEASANT NESTING AND VEGETATION DEVELOPMENT IN DENSE NESTING COVER ESTABLISHED UNDER THE SOUTH DAKOTA PHEASANT RESTORATION PROGRAM

BY

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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.

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Abstract

EMMETT J. KEYSER III

Pheasant (*Phasianus colchicus*) nest use of dense nesting cover (DNC) established under the Pheasant Restoration Program was evaluated in Beadle, Codington, Tripp, and Walworth Counties in South Dakota from 1978 to 1981. Nest densities and success in DNC plots were compared to those found in roadsides and privately owned alfalfa (*Medicago sativa*) fields, pastures, and small grain fields. Vegetation density and cover development were monitored on DNC plots. Nest densities were generally greatest in DNC plots followed by roadsides and alfalfa fields. Pastures and small grain fields contained the lowest nest densities. No relationship was detected between nest success and landuse. Overall nest success was 33.9%. Depredation by mammalian predators was the greatest cause for nest failure in all landuses and study areas. No relationship was detected between nest density or success and vegetation density in DNC plots. Species composition of DNC areas followed a successional pattern. Sweet clover (*Melilotus spp.*) tended to dominate DNC plots at age 2 years while alfalfa and finally wheatgrasses (*Agropyron spp.*) dominated DNC plots at age 5. Although DNC plots provided secure pheasant nesting habitat and harbored high nest densities, depredation of nests by mammalian predators appeared to offset major gains in nest success on these plots.

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INTRODUCTION

Since their introduction to South Dakota in the early 1900's, populations of ring-necked pheasants (*Phasianus colchicus*) have fluctuated considerably. Many factors have contributed to these oscillations, but among them, habitat and weather are felt to affect pheasant numbers to the greatest degree (Dahlgren and Linder 1981). Trautman and Dahlgren (1965) felt that habitat and weather were keys to pheasant populations chiefly through their influence on reproduction. Since little can be done to limit the effects of weather on pheasant reproduction, habitat manipulation provides the only available tool for pheasant population management.

The Soil Bank Program of the late 1950's and early 1960's provided a substantial amount of grass-legume cover that afforded pheasants secure nesting habitat (Schrader 1960). Erickson and Wiebe (1973) found that South Dakota data indicated a positive relationship between pheasant populations and Soil Bank acreage when Soil Bank acreage was lagged by one year. Pheasants responded very positively to Soil Bank cover and by 1961, the population in South Dakota had reached 11 million birds (Dahlgren and Linder 1981).

As Soil Bank contracts expired and land was put back into crop production, pheasant numbers began to decline. By 1966, South Dakota's pheasant population was estimated at 2.2 million birds (Dahlgren and Linder 1981), and for the next decade fluctuated only slightly about this level (Trautman 1982).

Labisky (1976) stated that from 1970 to 1975 declines in pheasant abundance also occurred in Colorado, Illinois, Indiana, Iowa, Kansas, Nebraska, Ohio, and Pennsylvania. Changes in landuse were felt to have contributed substantially to the decline in pheasant numbers (Labisky 1976, Nomsen 1969, Taylor et al. 1978) and the loss of nesting cover through intensive agricultural practices was largely responsible for pheasant habitat deterioration throughout the United States (MacMullan 1961).

In a study comparing pheasant nesting between public and private areas in South Dakota, Elliott and Linder (1972) found that undisturbed nesting cover was the most important reason for nesting success on public land. Trautman (1960) felt that maintenance and improvement of pheasant nesting habitat were paramount to maintaining a desireable population level. Perhaps Labisky (1976) summed up the pheasant population delemma best in stating that "any substantial increase in pheasant abundance in the Midwest will be contingent on the restoration of pheasant habitats on agricultural lands".

In November 1975, Governor Richard Kneip formed the South Dakota Pheasant Congress to identify alternatives to restore the state's pheasant population. The Pheasant Congress was composed of over 150 state and private organizations who had both sporting and economic interests in South Dakota's pheasant population. In April 1977, the South Dakota Department of Game, Fish and Parks received a legislative appropriation of $125,000 to initiate the Pheasant Restoration Program. The plan was to be supported by the purchase of an annual $5 Pheasant Restoration Stamp by the public and all small game hunters. Habitat manipulation practices under the Program would also be supported through cost sharing by the Agricultural Stabilization and Conservation Service (United States Department of Agriculture) and the United States Fish and Wildlife Service (United States Department of Interior).

The major thrust of the Pheasant Restoration Program is to restore and maintain adequate nesting cover for pheasants by retiring small areas of existing cropland, generally 4.05 to 24.48 hectares in size. Under the Program, landowners enter into 6-year contracts with the Department of Game, Fish and Parks to establish and maintain areas of dense nesting cover (DNC) consisting of an alfalfa (*Medicago sativa*), sweet clover (*Melilotus spp.*), and wheatgrass (*Agropyron spp.*) mixture. The landowner is allowed to seed the DNC mixture with a nurse crop (generally oats (*Avena sativa*)) and may harvest this crop the first year. Following this, the areas must be protected from all forms of disturbance and noxious weeds are to be controlled only with spot mowing and limited spraying.

This study was conducted to evaluate the extent to which pheasants utilized the DNC areas set aside under the Pheasant Restoration Program in South Dakota. The objectives were: 1) to determine the extent and success of nesting by pheasants in the DNC areas, 2) to compare the nesting use and success in DNC areas with that found in privately owned small grain fields, pastures, alfalfa fields, and roadsides, and 3) to evaluate vegetation development in the DNC areas and relate it to pheasant nest use and success.

STUDY AREA

Pheasant nesting studies were conducted from 1978 to 1980 in Beadle and Walworth Counties and from 1979 through 1981 in Codington and Tripp Counties in South Dakota (Appendix A). The counties chosen for study were those that contained not only adequate pheasant populations, but also a sufficient number of Pheasant Restoration contract areas for evaluation.

Beadle County lies in east-central South Dakota almost entirely within the James River Lowland Region. The James River drains the eastern one third of the county from north to south. Topography of the area is flat to gently undulating with elevations of 396 to 426 meters above sea level. Soils are generally silt loam to clay loam which are typical of a warm, dry plain (Westin and Malo 1976). Average annual precipitation is 48.3 cm while annual mean minimum and maximum temperatures are -0.3° C and 14.3° C, respectively (Spuhler et al. 1971). The majority of the county (60%) is in rangeland or pasture with corn (*Zea mayes*), alfalfa, oats, and spring wheat (*Triticum aestivum*) comprising the major crop types (Westin and Malo 1976).

Walworth County is situated in north-central South Dakota on the Coteau du Missouri. This highland area is covered with glacial deposits and underlain by Pierre shale (Westin and Malo 1976). It is bordered on the west by the Missouri River (Lake Oahe). Topography is gently undulating to undulating with silt loam to clay soils prevalent (Westin and Malo 1976). Annual average temperature is 7.2° C and average annual precipitation is 41.6 cm (Spuhler et al. 1971). Spring wheat, oats, alfalfa, and barley (*Hordeum vulgare*) are the major crops while 63% of the land remains in pasture and rangeland (Westin and Malo 1976).

Codington County is located in northeastern South Dakota on the Coteau des Prairies, a glaciated highland drained by the Big Sioux River. Topography is gently to strongly undulating and soils are generally silty and loamy, typical of a cool, moist prairie (Westin and Malo 1976). Annual mean minimum temperature is -0.3^{o} C and mean maximum temperature is 12.7^{o} C with an annual average of 6.5^{o} C. Average annual precipitation is 52.8 cm (Spuhler et al. 1971). Oats, flax (*Linum usitatissimum*), spring wheat, and alfalfa are the major crop types and 50% of the county remains in pasture (Westin and Malo 1976).

Tripp County is situated in south-central South Dakota and lies within 3 major land regions. The majority of the county and all study areas were located in the Pierre Hills and Southern Plateau Regions while a small portion of the county is found in the Sand Hills Region (Westin and Malo 1976). The Pierre Hills consist of a series of smooth hills and ridges with rounded tops. Pierre shale comprises the soil parent material. The Southern Plateau Region is a series of benches and buttes underlain by Tertiary sandstones, siltstones, and shale (Westin and Malo 1976). Of the 4 study areas, Tripp County has the highest annual average mean temperature (8.9^{o} C) while precipitation averages 50.8 cm annually (Spuhler et al. 1971). Alfalfa, sorghum (*Sorghum vulgare*), winter wheat, and oats are the major crop types and 68% of the land remains in rangeland (Westin and Malo 1976).

METHODS

Selection of Study Plots

Dense nesting cover plots were selected at random from those available within each county prior to initiating field studies. Following the 1978 field season, DNC plots were sampled to compare nest density and vegetation development between plots of various ages (ie. planted in different years) within individual counties.

Dense nesting cover plots served as the center of each study unit (Appendix B). A study unit consisted of a DNC plot and four corresponding cover types (small grain, alfalfa, pasture, and roadside). Corresponding cover type plots were located more than 1 mile but not more than 4 miles from the central DNC plot to minimize the effect of pheasant population variations on nest densities between cover types. With the exception of roadsides, efforts were also made to secure corresponding cover type plots which were similar to their central DNC plots in size, shape, and surrounding landuse to help eliminate biases between the plots. Due to the vast amount of roadside required for size similarity, roadside plots selected were one fourth the size of the DNC plots.

Nesting Studies

Nest searching was conducted once on each plot, generally from 15 May to 15 July. Dense nesting cover, pasture, and roadside were randomly selected as to specific date of search, while small grain and alfalfa plots were searched the day of harvest (ie. windrowing, mowing, or combining). Small grain plots were often harvested after 15 July and if harvest was later than 15 August, these plots were not searched.

Two subsamples within each DNC, pasture, small grain, and alfalfa plot were laid out the length of each field as random transects (Appendix C). Subsamples were plotted on aerial photographs obtained from the Agricultural Stabilization and Conservation Service (USDA). The width of each transect was adjusted to cover one eighth of the total area of the study plot with the two subsamples comprising one fourth of the total area. Roadside plots were divided into two subsamples and thoroughly searched from road edge to fence slope. Subsamples within a given type were searched the same day if possible.

Three person nest searching crews systematically traversed each subsample plot. Hockey sticks were used to lift and part vegetation where required.

Data were collected on all active pheasant nests, but nests which were determined to be abandoned, depredated, or destroyed at the time of search were also tallied in computing nest densities and nest fates. Only active nests (ie. nests with hens present or with clean, shiny eggs) were marked and later revisited to determine nest fate. Any nest form containing one or more eggs was classified as a nest (Linder et al. 1960). Date, location, plot number, cover type, number of eggs, and nest fate were recorded for all active nests. Data concerning vegetation density (Robel et al. 1970) and major species of vegetation at the nest site were also recorded for active nests. State of incubation was determined by embryonic examination (Fant 1957).

Analysis of variance (Steel and Torrie 1980) was used to determine differences in nest densities between cover types and years. Least Significant Difference (LSD) tests for unequally replicated means (Steel and Torrie 1980) were used to determine differences in nest densities among cover types. Chi-square analysis was used to detect differences in nest success between cover types and between DNC plots of varying ages.

Vegetation Measurements

Visual obstruction readings (VOR) (Robel et al. 1970) were made immediately following nest searching to document vegetation development on DNC plots and to relate vegetation to number of nests and to nest success. Two randomly located transects, 15.24 m in length, were established in each subsample searched (ie. 4 transects per DNC plot). At 10 randomly selected points along each transect, visual obstruction measurements were read from a 1.5 m X 5.0 cm round pole at a distance of 4 m and a height of 1 m parallel to the transect. The pole was painted with alternating dm sections of white and brown. The midpoint of each section was also painted with a black stripe to allow measurements to the nearest one half dm. A visual obstruction reading was interpreted as the point where vegetation obscured the pole and no portion of the pole below that point could be seen. Chi-square analysis was used to detect differences in nest success as related to visual obstruction readings in DNC. Correlation coefficients were computed to measure the effect of vegetation density on nest densities of pheasants in the DNC plots.

A 1 m X 0.5 m metal frame (0.5 m^2) was used to determine species composition and percent coverage of vegetation on DNC plots and to further document vegetation development. The frame was divided into quarter sections painted alternating white and brown to facilitate coverage estimations. At 5 randomly located points along each 15.24 m transect, plant species composition and percent coverage readings were recorded. Percent coverage was recorded in 5 percent increments with trace coverage being recorded as 1 percent. To determine the amount of ground litter present, percent bare soil and dead vegetation readings were also tallied. Frequency of occurrence and mean percent coverage were the descriptors used for each species found in the DNC plots:

$$\text{Frequency of Occurrence} = \frac{\text{No. sample frames in which species occurred}}{\text{Total no. sample frames}}$$

$$\text{Mean Percent Coverage} = \frac{\Sigma \text{ percent coverage of a species in all frames}}{\text{Total no. sample frames}}$$

RESULTS AND DISCUSSION

Sampling

A total of 1656.80 ha was searched for nests on 1274 subsamples in 637 study plots during the 4 years of study (Appendix D). Number of study plots and number of hectares searched per year varied among counties as well as between years. Variation was most often due to the influence of weather conditions and vegetation density. Lack of moisture in some years had a direct effect on vegetation density allowing searches to be conducted in less time. Conversely, daytime rains during the study served to delay field work. The total number of hectares searched in a given season and on a study area was similar to the area searched by Trautman (1960), Olson and Flake (1975), and Vandel (1978) in their South Dakota studies.

Nest Densities Among Cover Types

During the four years of study, 514 pheasant nests were found. The number of pheasant nests found varied between years, study areas, and cover types. In 1978, 1 pheasant nest was found in Beadle and Walworth Counties while 189 nests were found during 1981 in Tripp County alone.

Analysis of variance showed no significant difference ($P < 0.05$) in the mean densities of pheasant nests between cover types in Codington and Tripp Counties in 1979 (Table 1). Due to lack of data, no statistical analysis were performed on the Beadle and Walworth County

Table 1. Mean number of pheasant nests/hectare found in four study areas. Includes all nests found.

County	Year	Landuse*				
		DNC	Roadside	Alfalfa	Pasture	Small Grain
Beadle	1978	0.0	0.0	0.05	0.0	0.0
	1979	0.14	0.08	0.0	0.05	0.0
	1980	0.22	0.16	0.16	0.0	0.08
Codington	1979	0.07	0.12	0.03	0.05	0.0
	1980	0.37	0.13	0.25	0.03	0.06
	1981	0.88	0.67	0.17	0.09	0.15
Tripp	1979	0.36	0.48	0.83	0.67	0.24
	1980	1.37	1.34	1.13	0.33	0.33
	1981	2.40	1.61	1.32	0.30	0.11
Walworth	1978	0.0	0.0	0.0	0.0	0.0
	1979	0.04	0.0	0.04	0.0	0.0
	1980	0.12	0.02	0.04	0.05	0.03

* Those underlined are not significantly different at the P < 0.05 level.

data. The general analysis of variance table is included in Appendix E.

In 1980 in Codington County, mean nest density in DNC plots was significantly different ($P < 0.05$) from pasture and small grain, but not significantly different from roadside and alfalfa. There was also no significant difference in mean nest densities between roadside, alfalfa, pasture, and small grain plots.

There was no significant difference ($P < 0.05$) in mean nest densities between DNC and roadside plots during the 1981 field season in Codington County. However, these cover types had significantly greater mean nest densities than alfalfa, pasture, and small grain plots sampled that year. No significant difference in mean nest densities was detected between alfalfa, pasture, and small grain study plots sampled in 1981.

No significant difference ($P < 0.05$) was detected in mean nest densities between DNC, roadside, and alfalfa plots in Tripp County, 1980. DNC and roadside plots, however, contained significantly greater mean nest densities than pasture and small grain plots. There was no significant difference detected in alfalfa, pasture, and small grain mean nest densities.

In 1981, DNC, roadside, and alfalfa plots were again found to be significantly different ($P < 0.05$) from pasture and small grain plots in Tripp County. There was no difference detected between DNC and roadside and between roadside and alfalfa nest densities. Mean nest densities in DNC, however, were found to be significantly greater than in alfalfa plots.

In this study, mean pheasant nest densities were generally greatest in DNC, roadside, and alfalfa, while pasture and small grain plots consistently harbored few nests. In 1977 and 1978 in Brookings County, Vandel (1980) found the greatest nest densities in fence rows and roadsides, while small grain and grazed pasture contained the lowest density of pheasant nests. Trautman (1960) found a similar distribution of pheasant nests in his study, but densities were much greater. Olson and Flake (1975), Baxter and Wolfe (1973), Gates and Hale (1975), and Baskett (1947) also reported similar distributions of pheasant nests among cover types in their respective studies.

Higher mean nest densities in DNC and roadside are no doubt related to the availability of residual cover at the onset of nesting. The rapid growth of alfalfa early in the nesting season also serves to attract nesting pheasant hens to this cover type. Grazed pasture and small grain, on the other hand, offer little protection to birds initiating nests during April and early May and nest densities in these cover types are low. Later in the nesting season, however, small grain fields do contain sufficient nesting cover, but the majority of the nests here are felt to be renesting attempts (Linder et al. 1960, Baxter and Wolfe 1973, Trautman 1960).

Nest Fates Among Cover Types

Chi-square analysis detected no relationship between the number of successful and unsuccessful nests within each of the cover types in the Codington and Tripp County study areas. Due to the low number of nests found in certain years, nest fate data were pooled for the 3 years of study within these two counties while no statistical analysis was performed on the Beadle and Walworth County nest fate data.

In Beadle County, success rates within cover types varied from 0% in roadside and small grain to 100% in pasture study areas (Table 2). These data, however, were based on very few nest observations (N=31). Overall nest success for all cover types was 22.6%. In DNC, 38.5% of the nests were successful while 61.5% of the nests were determined to be depredated. A large percentage of nests established in small grain (100%) and alfalfa fields (71.4%) were destroyed by various farming practices. No successful nests were found in roadsides with nest abandonment and depredation primary causes for nest failure.

In Codington County, nest success averaged 24.4% (Table 3). Highest nest success occurred in pasture (40.0%), DNC (27.5%), and alflafa (27.3%). Roadside and small grain, again, displayed lowest success. Nest abandonment occurred to a greater degree in all cover types in Codington County than in Beadle County. The overall percentage of nests depredated, however, was approximately the same between the two study areas. Similarly, a large percentage of nests found in alfalfa (36.4%) were determined to be destroyed by haying practices.

In Tripp County, overall nest success was high (36.2%) when compared to other study areas (Table 4). Pasture, alfalfa, and DNC ranked highest in nest success exhibiting 50.0, 38.2, and 37.8 percent success within each cover type, respectively. Nest depredation was

Table 2. Number of nests* by nest fate and landuse for Beadle County 1978-1980.

	Landuse					
NEST FATE	DNC	Small Grain	Alfalfa	Pasture	Roadside	Total
Successful	5 (38.5)	-	1 (14.3)	1 (100.0)	-	7 (22.6)
Abandoned	-	-	-	-	3 (37.5)	3 (9.7)
Depredated	8 (61.5)	-	-	-	3 (37.5)	11 (35.5)
Destroyed	-	2 (100.0)	5 (71.4)	-	-	7 (22.6)
Other	-	-	1 (14.3)	-	2 (25.0)	3 (9.7)
Total	13	2	7	1	8	N=31

* Includes all nests found.
( ) = Column Percent

Table 3. Number of nests* by nest fate and landuse for Codington County 1979-1981.

NEST FATE	LANDUSE DNC	Small Grain	Alfalfa	Pasture	Roadside	Total
Successful	11 (27.5)	1 (12.5)	3 (27.3)	2 (40.0)	5 (19.2)	22 (24.4)
Abandoned	12 (30.0)	1 (12.5)	3 (27.3)	-	11 (42.3)	27 (30.0)
Depredated	17 (42.5)	4 (50.0)	1 (9.1)	3 (60.0)	10 (38.5)	35 (38.9)
Destroyed	-	1 (12.5)	4 (36.4)	-	-	5 (5.6)
Other	-	1 (12.5)	-	-	-	1 (1.1)
Total	40	8	11	5	26	N=90

* Includes all nests found.
(   ) = Column Percent

Table 4. Number of nests* by nest fate and landuse for Tripp County 1979-1981.

NEST FATE	DNC	Small Grain	Alfalfa	Pasture	Roadside	Total
	LANDUSE					
Successful	56 (37.8)	5 (33.3)	29 (38.2)	17 (50.0)	32 (28.8)	139 (36.2)
Abandoned	39 (26.4)	3 (20.0)	9 (11.8)	3 (8.8)	22 (19.8)	76 (19.8)
Depredated	46 (31.1)	6 (40.0)	10 (13.2)	13 (38.2)	42 (37.8)	117 (30.5)
Destroyed	6 (4.1)	1 (6.7)	20 (26.3)	1 (2.9)	5 (4.5)	33 (8.6)
Other	1 (0.7)	-	8 (10.5)	-	10 (9.0)	19 (4.9)
Total	148	15	76	34	111	N=384

* Includes all nests found.
( ) = Column Percent

highest in small grain, pasture, and roadside while alfalfa again displayed a large percentage of destroyed nests. The overall nest abandonment rate was 19.8% for all cover types in Tripp County.

Few nests were found in the Walworth County study area (Table 5). Collective nest success, however, was high (66.7%) with depredation and abandonment appearing comparitively low in all cover types.

The overall nest success found in each study area is similar to success found in other studies in South Dakota. Trautman (1960) found success rates of 20.0 and 24.3 percent during his 2 years of study while Vandel (1978) found a 27.0% success rate during his study of the same area in Brookings County. Olson and Flake (1975) reported nest success rates of 20 and 28 percent during 1973 and 1974 in their study in Brookings County, also. Ranges for overall nest success rates reported by others include: 24 - 46% by Gates and Hale (1975), 10.9 - 21.1% by Linder et al. (1960), 23.2 - 36.0% by Baskett (1947), and 7.7 - 43.5% by Schick (1952).

Though harboring few nests, success rates from nests found in pastures were high in all four study areas. Trautman (1960) and Vandel (1978) also found relatively high nest success rates in pastures, whereas Linder et al. (1960) found only 7.1% of nests successful in this cover type.

Rates of abandonment varied between study areas. Only 9.7% of nests were abandoned in Beadle County whereas 30.0% of the nests in Codington County were abandoned. Trautman (1960) found abandonment to

Table 5. Number of nests* by nest fate and landuse for Walworth County 1978-1980.

	LANDUSE					
NEST FATE	DNC	Small Grain	Alfalfa	Pasture	Roadside	Total
Successful	2 (50.0)	1 (100.0)	1 (50.0)	1 (100.0)	1 (100.0)	6 (66.7)
Abandoned	1 (25.0)	-	-	-	-	1 (11.1)
Depredated	1 (25.0)	-	1 (50.0)	-	-	2 (22.2)
Destroyed	-	-	-	-	-	-
Other	-	-	-	-	-	-
Total	4	1	2	1	1	N=9

* Includes all nests found.
( ) = Column Percent

be the cause of nest failure in 24% of the nests in his study.

Rates of abandonment were generally highest in roadside and DNC. Abandonment probably resulted in large part from predator activity and perhaps livestock and man to a lesser degree. Therefore, although DNC was protected from most types of disturbances, the areas may have attracted greater numbers of predators.

Depredation of nests, primarily by mammalian predators, was the greatest cause of nest failure in all study areas. The percentage of nests depredated varied between cover types and study areas, but on average over 30% of all nests were destroyed by predators. DNC and roadsides consistently ranked high in the number of nests lost to predators. DNC areas undoubtedly harbored greater populations of small mammals and were therefore hunted more heavily by predators than other cover types. Long narrow roadsides serve as travel lanes for predators and nests are easily detected within the confines of these areas.

As expected, nest destruction (primarily by farming activities) was highest in alfalfa fields. In most years, haying of alfalfa coincided with the peak of hatch and many nests were destroyed. Harvest activities also affected nests in small grain fields, but due to the low number of nests located in these areas, losses were considerably less than losses in alfalfa fields.

Nest Densities Among Various Age DNC Plots

DNC plots of various ages were searched in an attempt to determine the age at which the plots harbored the greatest densities of pheasant nests (Table 6). Due to the low number of plots of certain age classes available to search some years and the effect of a changing pheasant population during the course of study, no statistical analysis was performed on these data. However, in most instances, pheasants tended to nest in greater densities in 4-year-old DNC plots, nest densities increased as plot age progressed from 2 to 4 years, established stand DNC plots (ie. plots of unknown age which were planted to a grass-legume mixture prior to being contracted) contained relatively low nest densities when compared to other age stands searched the same year, and a decrease in nest density occurred between the age 4 and 5 year stands in Codington County.

Nest Fates Among Various Age DNC Plots

With the exception of Codington County, chi-square analysis detected no significant relationship between nest success and DNC plot age (Table 7). Due to the low number of nest fate observations within the various age DNC plots, data from age 2-3 year and 4-5 year plots were combined for analysis. Data were pooled for the 3 years of study while Beadle and Walworth Counties were deleted from any statistical analysis.

Chi-square analysis indicated a significant difference ($P < 0.05$) in number of successful and unsuccessful nests in Codington County when DNC plots of age 2-3 years and plots of age 4-5 years were compared. Greatest differences in nest success occurred in the 4-5-year-old DNC plots. According to nest fate determinations made by field

Table 6. Mean number of pheasant nests/hectare by age of dense nesting cover plots in four study areas

		Plot Age (Years)				
County	Year	2	3	4	5	Established* Stand
Beadle	1978	0.00	--	--	--	--
	1979	0.10	0.16	--	--	--
	1980	--	0.24	0.31	--	0.08
Codington	1979	0.14	0.00	--	--	--
	1980	0.30	0.35	0.46	--	--
	1981	--	0.27	1.36	0.87	--
Tripp	1979	0.42	--	--	--	0.00
	1980	--	2.06	--	--	0.00
	1981	--	--	3.34	--	0.52
Walworth	1978	0.00	--	--	--	--
	1979	0.10	0.00	--	--	--
	1980	0.00	0.23	0.07	--	--

* Unknown age plots-areas previously seeded to alfalfa or some other type of nesting cover mixture prior to being contracted.

Table 7. Number of successful and unsuccessful clutches as related to plot age of DNC in four study areas.

County	Nest Fate	Plot Age (yrs.) 2	3	4	5	E.S.	Total
Beadle	Successful	0	2	2	-	1	5
	Unsuccessful	1	3	4	-	0	8
	Total	1	5	6	-	1	13
Codington	Successful	2	5	1	3	-	11
	Unsuccessful	2	3	13	11	-	29
	Total	4	8	14	14	-	40
Tripp	Successful	3	14	37	-	2	56
	Unsuccessful	9	33	47	-	3	92
	Total	12	47	84	-	5	148
Walworth	Successful	0	2	0	-	-	2
	Unsuccessful	1	0	1	-	-	2
	Total	1	2	1	-	-	4

crews, this difference was due to high rates of nest abandonment and from nest depredation by mammalian predators.

Vegetation Density Among Various Age DNC Plots

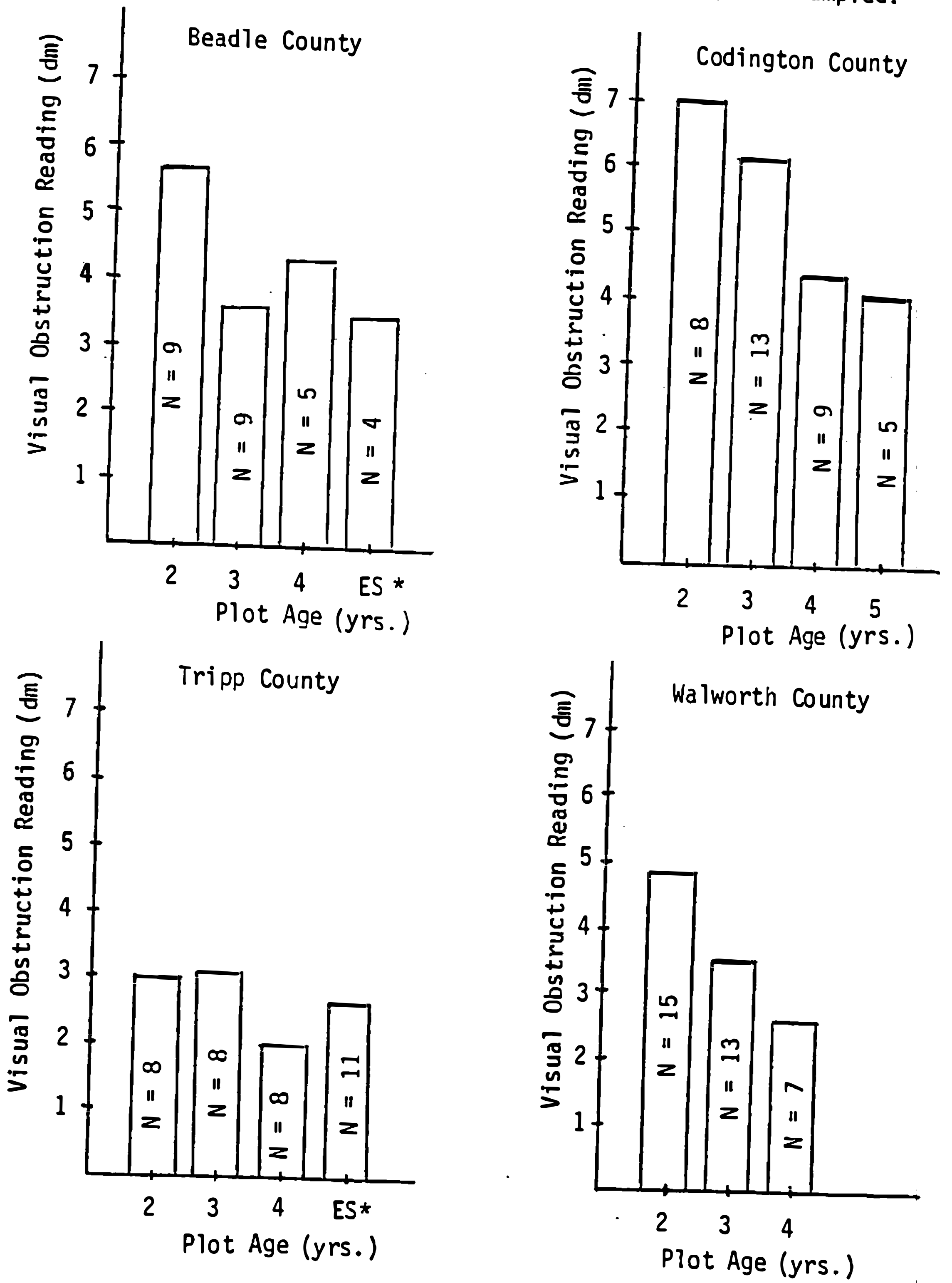
Mean visual obstruction readings (VOR) were quite variable and ranged from 2.0 dm to 7.0 dm in the four study areas (Figure 1). Lowest overall mean VOR occurred in Tripp County while Codington County exhibited the highest overall mean VOR in the DNC plots sampled. The 3 years of data for each county were pooled in order to make generalizations about vegetation growth in each of the DNC age classes and to reduce the effects of precipitation differences which occurred during the study.

In general, as plot age increased, vegetation density decreased. During growing year two, sweet clover was the dominant DNC species present and VOR were reflective of the tall, rank cover afforded by this species. Alfalfa and wheatgrass matured in the years following and lower VOR resulted. Higgins (1981) found mean VOR to range from .2 dm to 4.3 dm during his study of seeded nesting cover in South Dakota, North Dakota, Montana, and Minnesota. His readings, however, were taken prior to 15 May of each year and did not reflect the new year's growth.

Nest Density and Vegetation Density in DNC Plots

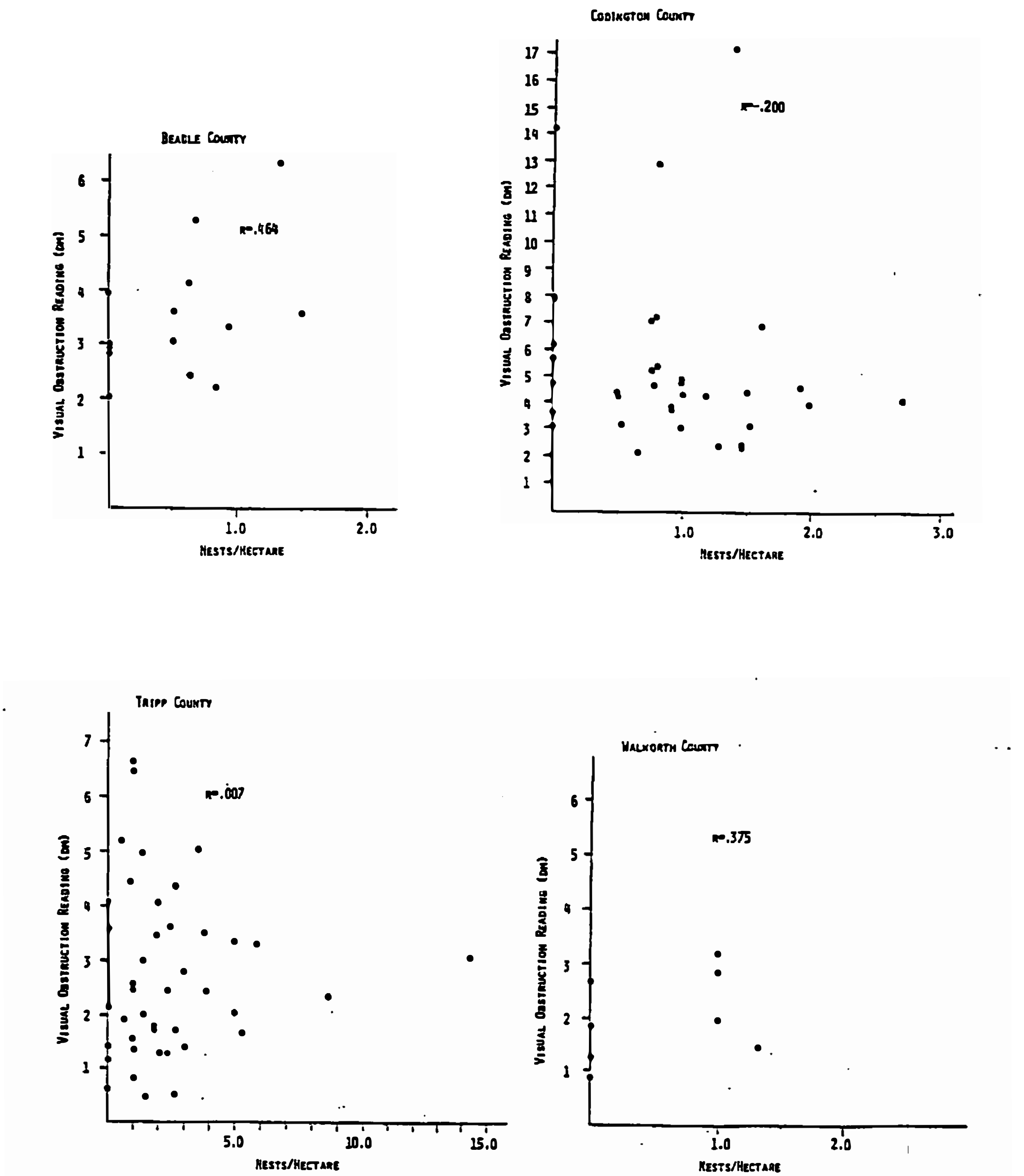
Correlation coefficients were computed to determine the effect of vegetation density on pheasant nest densities in DNC plots in the four study areas (Figure 2). Positive correlation coefficients were

Figure 1. Mean visual obstruction readings in seeded DNC by plot age in four study areas. N = number of DNC plots sampled.



* Established Stands

Figure 2. Scattergrams and correlation coefficients comparing nest densities and visual obstruction readings in DNC in four study areas.



found in Beadle (R = 0.464) and Walworth (R = 0.375) Counties. Little relationship was found between the vegetation density and pheasant nest density in Tripp County (R = 0.007) while Codington County data (R = -0.200) indicated a slightly negative relationship between the two variables.

Kirsch et al. (1978) found a strong relationship between density of residual vegetation and duck nest density. Trautman (1982) stated that pheasants were highly dependent upon residual cover during the first one-third of the pheasant nesting season in South Dakota. Though there was a positive relationship between nest density and vegetation density in two study areas, it was felt by field crews that vegetation density alone did not adequately reflect the quality of cover in the DNC plots. In dense stands of sweet clover, for example, VOR is quite high but cover near the ground is not adequate for nesting pheasants.

Nest Success and Vegetation Density in DNC Plots

Chi-square analysis indicated no significant relationship between mean VOR and nest fate within DNC plots in Codington and Tripp Counties (Table 8). Nest fates were compared between plots with mean VOR of 0 to 4 and those with mean VOR of greater than 4 within the two counties. No statistical analysis was conducted on the Beadle and Walworth County data.

Olson and Flake (1975) and Wright and Otte (1962) also found no relationship between cover density and condition and nest success in their studies. During the course of this study, field crews felt that

Table 8. Number of successful and unsuccessful clutches as related to mean vegetation density of DNC in four study areas.

County	Nest Fate	Visual Obstruction Reading (dm) 0 - 2	2 - 4	4 - 6	>6	Total
Beadle	Successful	0	4	0	1	5
	Unsuccessful	0	3	2	2	7
	Total	0	7	2	3	12*
Codington	Successful	0	2	6	3	11
	Unsuccessful	0	12	14	3	29
	Total	0	14	20	6	40
Tripp	Successful	14	36	5	1	56
	Unsuccessful	22	61	8	1	92
	Total	36	97	13	2	148
Walworth	Successful	2	0	0	0	2
	Unsuccessful	0	2	0	0	2
	Total	2	2	0	0	4

* Data for 1 nest missing due to recorder error

factors such as localized predator populations and other nest disturbances affected nest success to a greater degree.

Vegetation Composition of DNC Plots

The number of plant species found in DNC plots varied both between study areas and between DNC plots of different ages (Figure 3). The number of plant species found in all DNC plots varied from 32 in Beadle County to 68 in Tripp County. The number of plant species within different age DNC plots varied from 56 in established stands to 22 in 5-year-old stands of DNC. Higgins (1981) identified 115 plant species present in seeded nesting cover stands during his study. Appendix F lists the scientific and common names of all plant species found in DNC plots studied.

Frequency of occurrence and mean percent coverage estimates of seeded DNC species and ground litter were monitored (Figures 4 and 5), and data were compiled on other plant species which occurred at a frequency of 10% or greater (Appendices G.1 - G.5). Wheatgrasses (*Agropyron spp.*) were combined as field identification of young plants by field crews was often difficult.

Frequency of occurrence and mean percent coverage of sweet clover steadily decreased as DNC plots matured. In most DNC plots, sweet clover was the dominant plant species during the second year of growth. The dead stalks of sweet clover remaining following the second year provided winter cover and served to attract pheasants during winter storms and blizzards. The residual cover left in the DNC plots also

Figure 3. Number of plant species found in seeded DNC by study area and plot age.

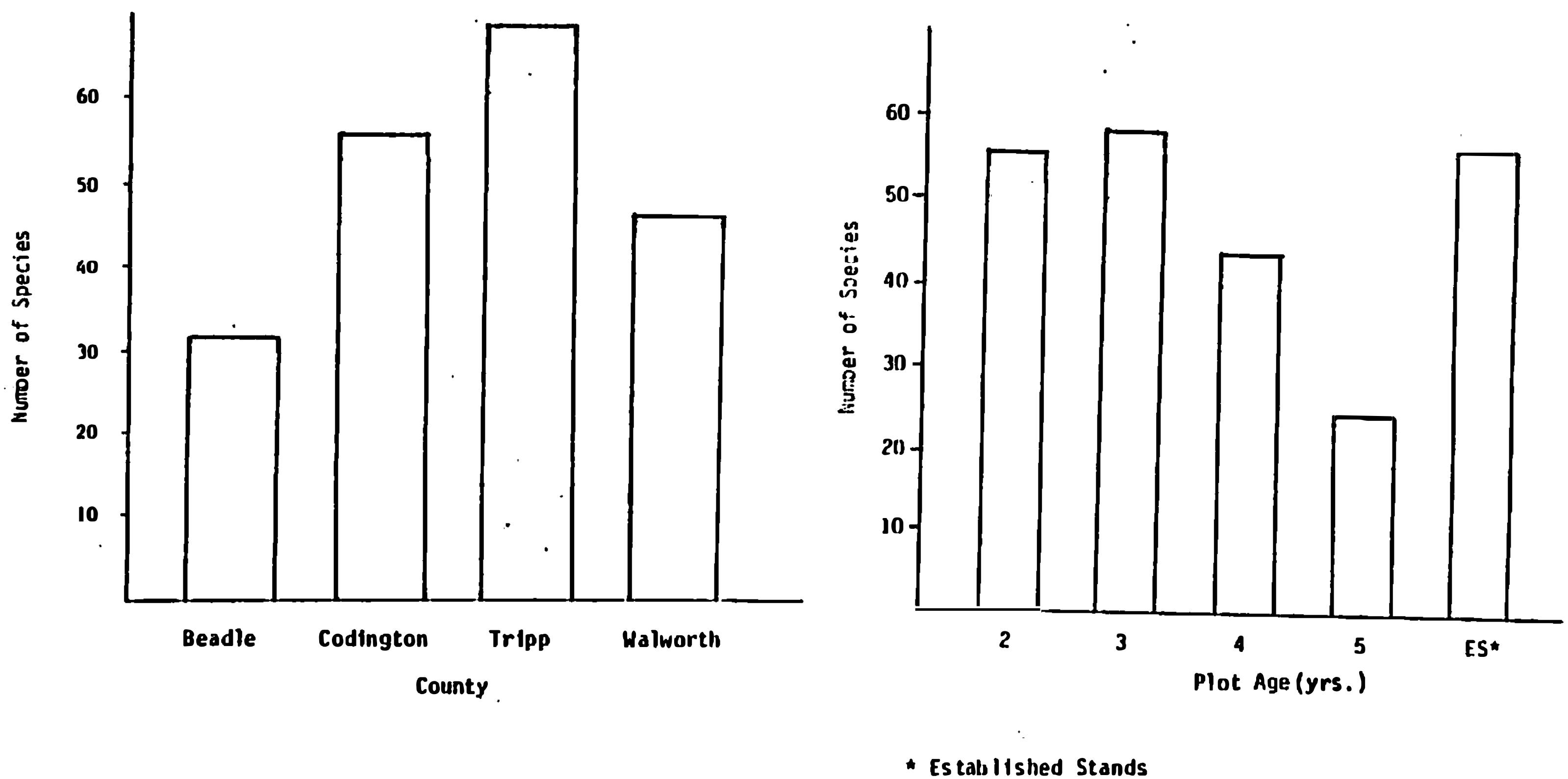
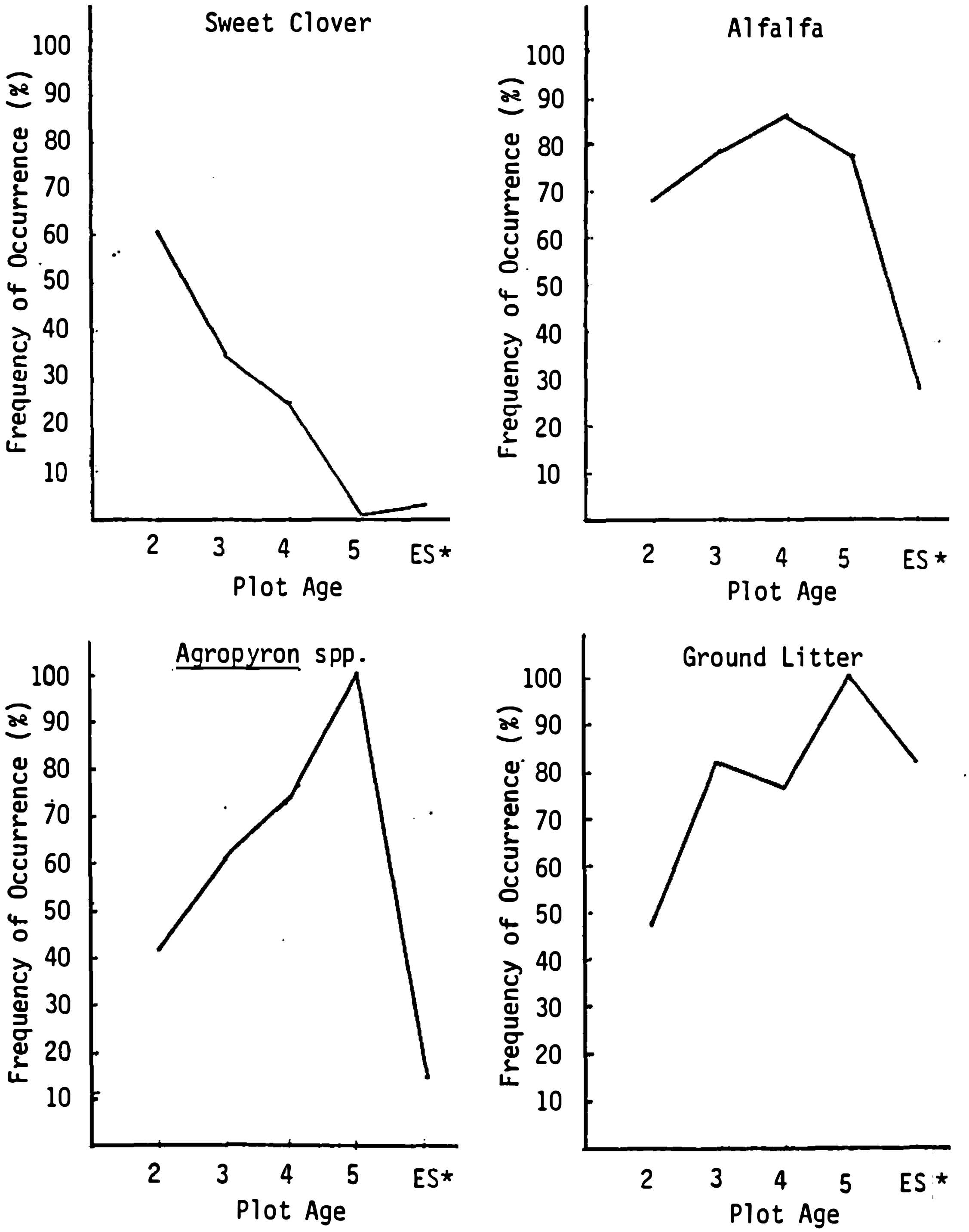
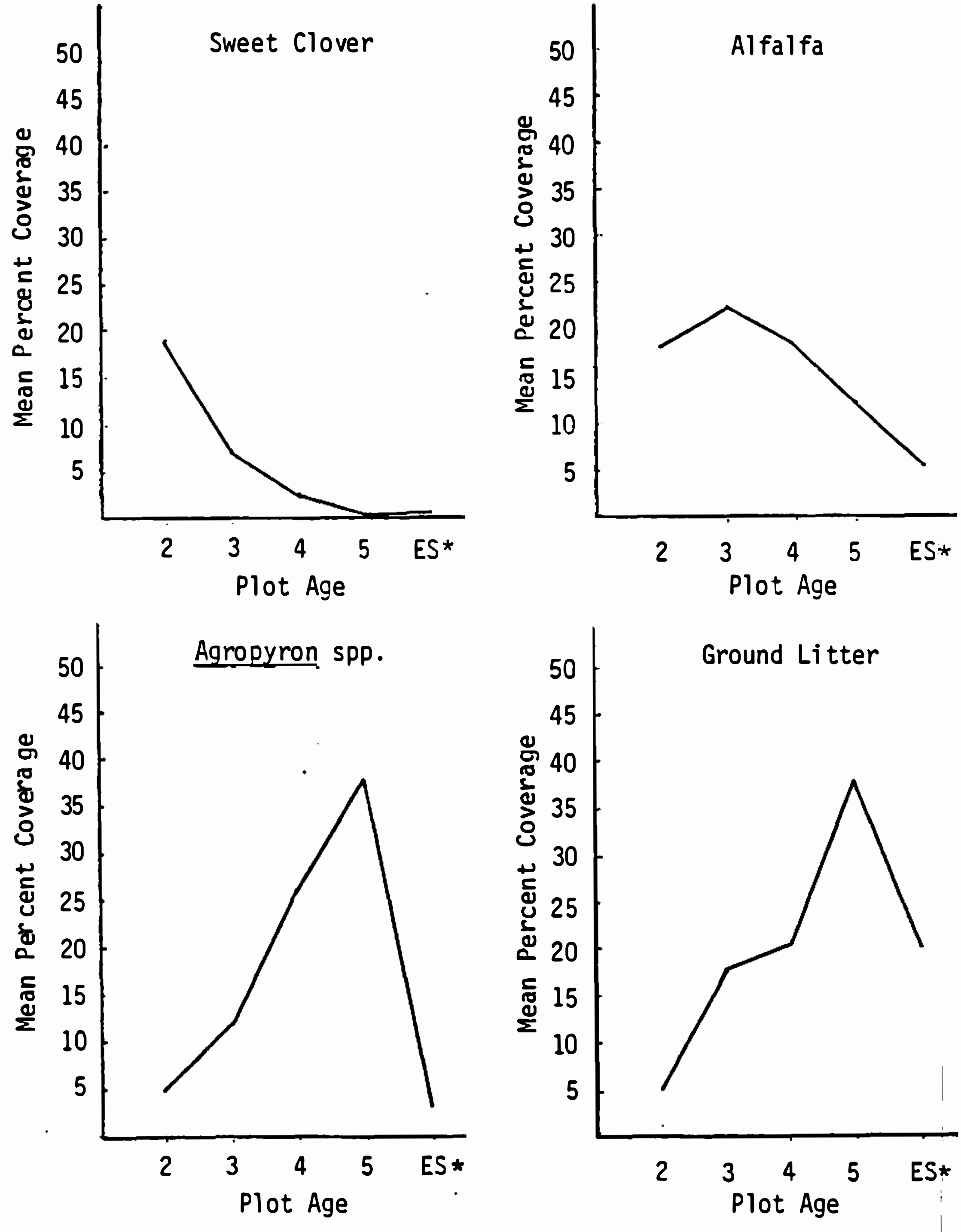


Figure 4. Changes in frequency of occurrence of seeded DNC species and ground litter with age.



* Established Stands

Figure 5. Changes in mean percent coverage of seeded DNC species and ground litter with age.



* Established Stands

provided nesting cover early the following spring and attracted large numbers of pheasants to those plots.

Alfalfa did not become dominant until the third and fourth seasons of DNC growth. Mean percent coverage of alfalfa peaked at 23.1% during the third growing season while frequency of occurrence was highest during the fourth season of growth. Alfalfa, in established stands of DNC, occurred less frequently and covered less total area in these plots.

Wheatgrass did not become dominant until year 5 in those DNC plots sampled. Both frequency of occurrence and mean percent coverage rose quite rapidly from the second to the fifth growing season. Wheatgrass was not found to be present in great quantity in established stands of DNC as smooth brome (*Bromus inermis*), Kentucky bluegrass (*Poa pratensis*), and other grass species tended to dominate these areas.

Ground litter was monitored closely during vegetation sampling as it was felt that lack of adequate ground cover may have affected pheasant nesting densities in DNC plots. Ground litter initially occurred at a relatively high frequency in DNC plots but represented very little of the sample as mean percent coverage was quite low. Coverage of ground litter increased as DNC plots matured into the fifth year. Ground litter found in established stands of DNC was similar to that found in 3 and 4-year-old DNC plots.

Kochia (*Kochia scoparia*), Russian thistle (*Salsola iberica*), and field bindweed (*Convolvulus arvensis*) were the most frequently occurring cropland weeds, however, field bindweed is the only one listed as noxious in South Dakota (Kinch 1974). Although not planted, smooth brome occurred frequently in DNC plots of all ages. Other plants occurring at a frequency of 10% or greater included: downy brome (*Bromus tectorum*), Kentucky bluegrass, needle and thread (*Stipa comata*), common ragweed (*Ambrosia artemesiifolia*), and swamp smartweed (*Polygonum spp.*). Siberian elm (*Ulmus pumila*) was also present in a 5-year-old DNC plot which was in close proximity to a field shelterbelt.

CONCLUSIONS

The DNC plots established under the Pheasant Restoration Program in South Dakota served to increase the amount of nesting area available to pheasants. DNC plots harbored pheasant nest densities equal to and in many cases greater than other habitats known to harbor high pheasant nest densities (ie. roadside and alfalfa fields), but nest success in DNC plots was not found to be significantly greater than other cover types sampled. Although DNC plots were kept secure from disturbances by farm machinery and livestock, increased predator activity in these plots apparently offset any major gains in nest success.

Although no statistical analysis was performed, nest densities did increase as DNC plots matured. Established stands of DNC exhibited considerably lower nest densities when compared to other DNC plots in a given year. Undoubtedly, established stands were areas planted to a grass-legume mixture cover crop due to erosion or soil fertility problems and were not established with the intent of providing pheasant nesting cover.

Nest success rates in DNC plots of various age classes did not differ to any great degree. As pheasants began to nest in the more mature plots, however, predators also began to find benefit from these areas as evidenced by the decreased nest success in age 4 and 5 year plots in Codington County.

Mean VOR tended to decrease as DNC plots matured. Reduction in the amount of sweet clover present and matting and lodging of dead vegetation were primary reasons for this occurrence.

No relationship was found between pheasant nest densities and success and VOR in DNC plots. VOR were recorded on the same date as DNC plots were searched and indicated vegetation structure at that time. Vegetation structure during nest initiation (ie. the month of May) no doubt varied considerably from the readings found when the plots were nest searched.

Vegetation structure in DNC followed a successional pattern. Sweet clover was replaced by alfalfa and finally by wheatgrasses as plots matured. It is not known whether DNC plots of greater than age 5 will retain their usefulness as pheasant nesting cover. At some point, stand rejuvenation (ie. burning, mowing, grazing, plowing, etc.) may be required to prevent matting and lodging of dead vegetation and sustain vigor of plot vegetation.

RECOMMENDATIONS

The following recommendations are made with respect to the establishment of DNC under the Pheasant Restoration Program in South Dakota:

1) It is recommended that some type of predator control effort be coordinated in conjuction with the establishment of future DNC plots in order to offset increased use of these plots by mammalian predators;
2) It is recommended that stands of DNC established prior to contracting be carefully scrutinized and evaluated as potential pheasant nesting habitat before they are signed into the Pheasant Restoration Program;
3) It is recommended that DNC plots of age 5 years and greater be surveyed in future years in order to monitor plot vegetation as well as pheasant nest use, and;
4) It is recommended that vegetation analysis performed on future DNC plots include a series of visual obstruction readings during the month of May (just prior to green-up) in order to more fully evaluate the relationship between residual vegetation density and pheasant nest density and success.

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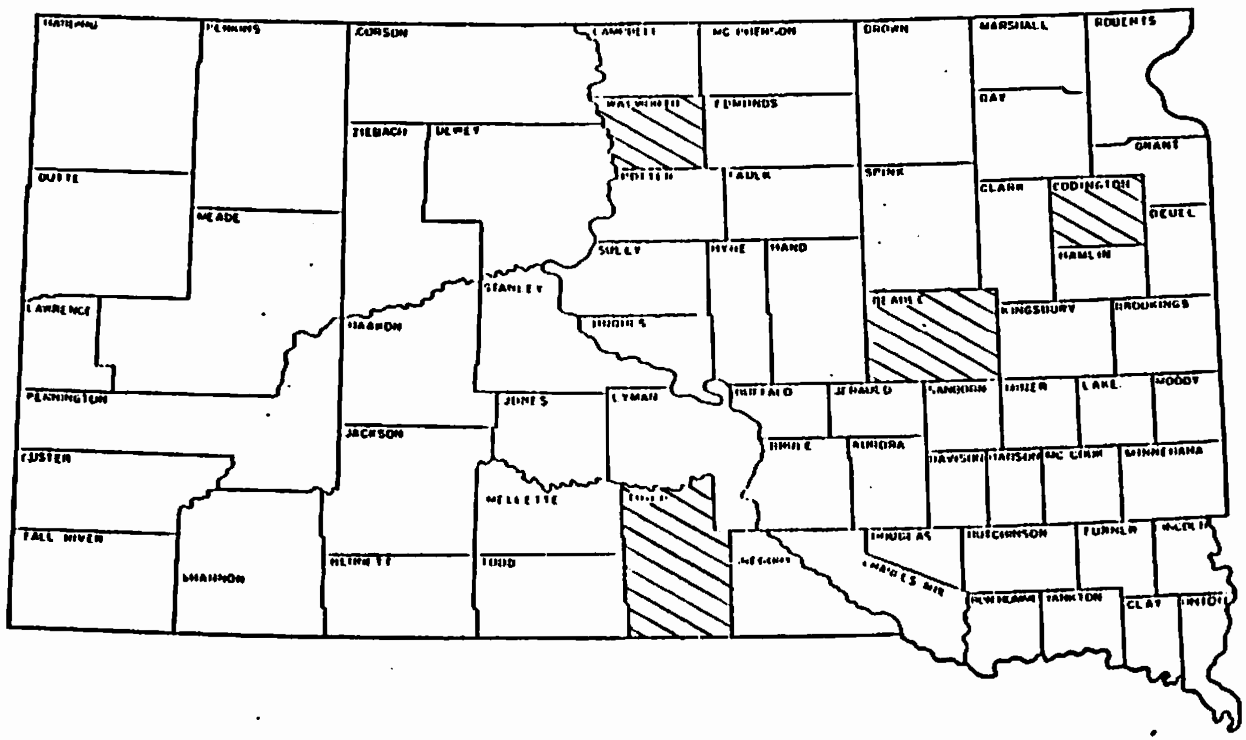
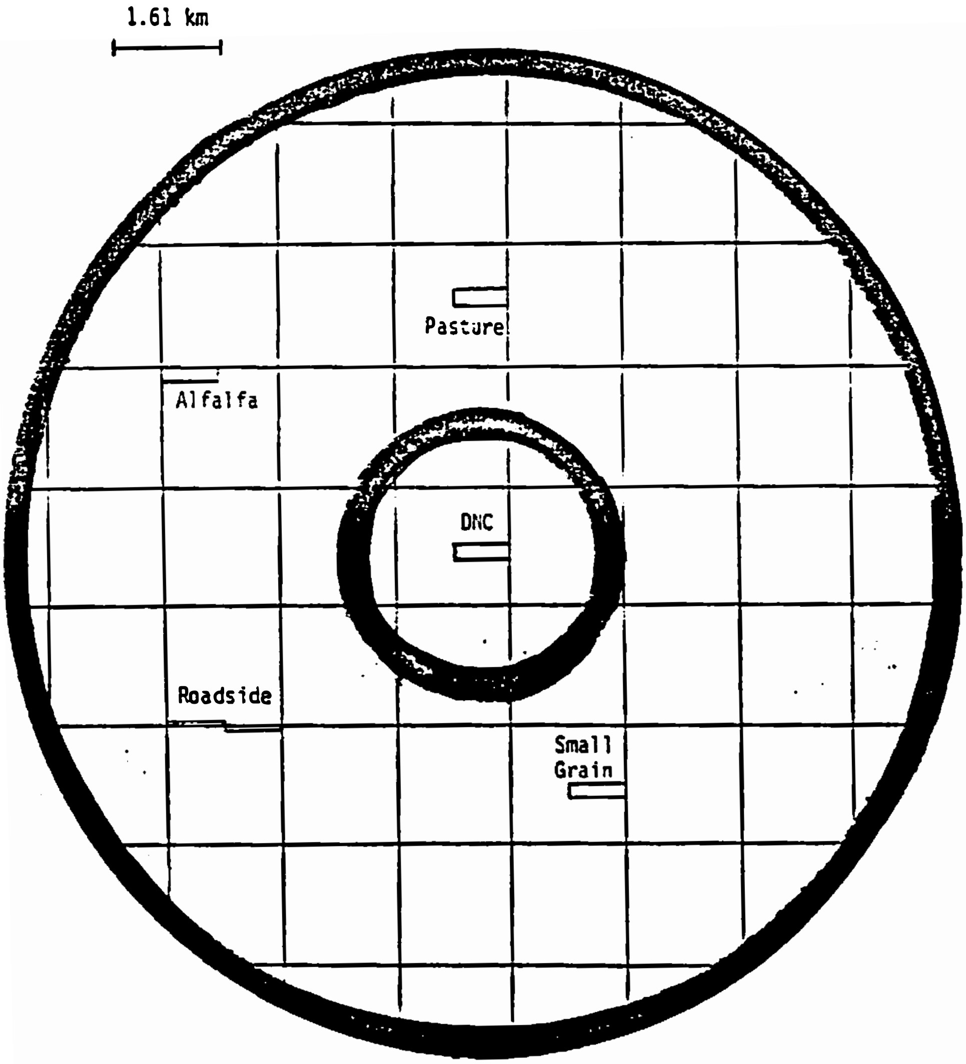
Appendix A

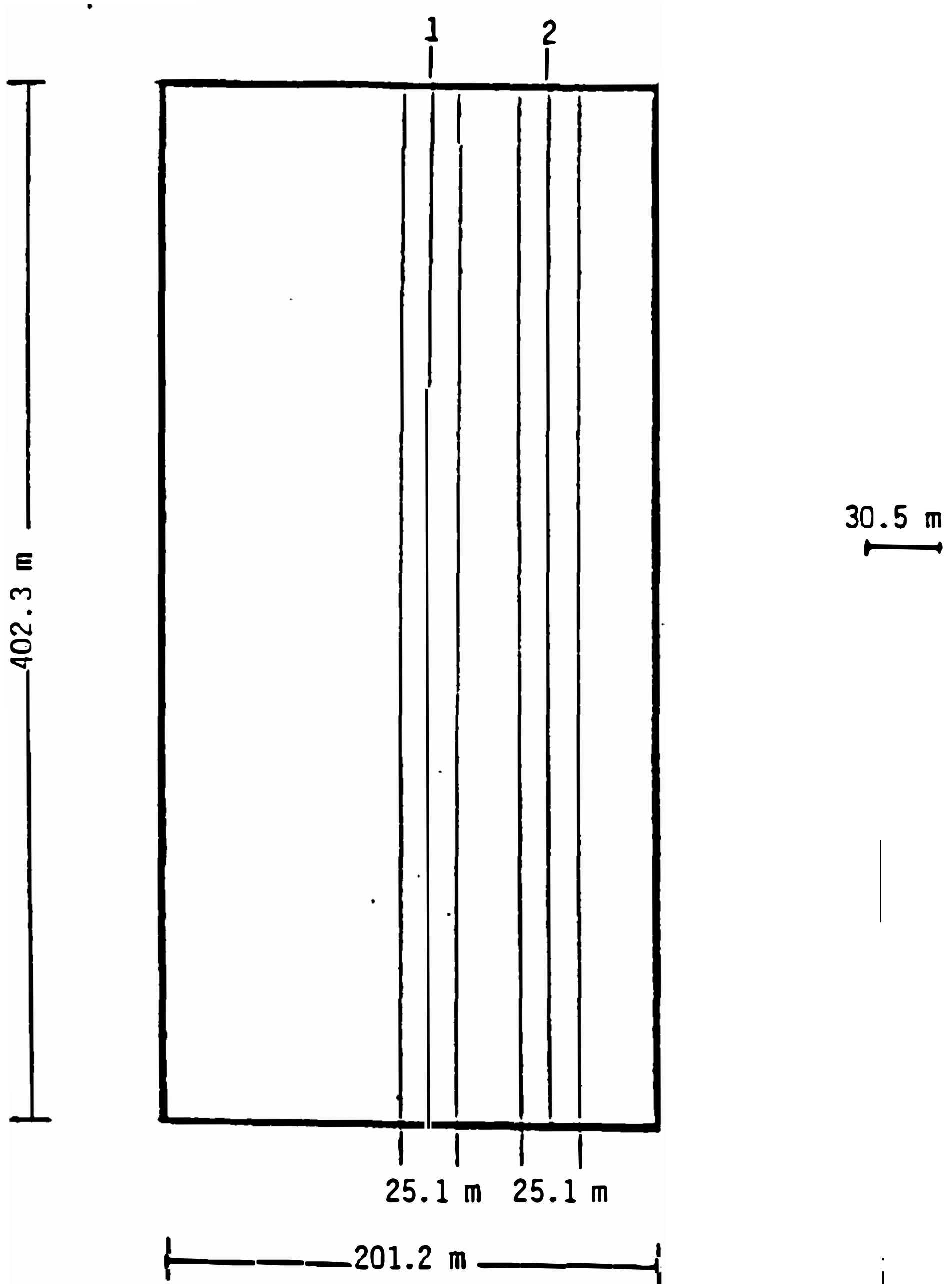
Pheasant Nesting Study Areas



Appendix B. Arrangement of study plots within a typical study unit.



Appendix C. Transect sampling within a typical study plot.



Appendix D. Mean number of hectares/subsample by landuse and year in four study areas. ( )=number of subsamples.

County	Year	LANDUSE DNC	Small Grain	Alfalfa	Pasture	Roadside	Total
	1978	1.70 (10)	1.58 (10)	1.94 (10)	1.90 (10)	1.70 (10)	87.82 (50)
Beadle	1979	1.62 (18)	1.34 (18)	1.21 (18)	1.42 (18)	0.85 (18)	115.87 (90)
	1980	1.58 (26)	1.30 (18)*	1.34 (26)	1.50 (26)	1.54 (26)	177.34 (122)
	Total	86.69 (54)	63.38 (46)	76.25 (54)	83.04 (54)	71.67 (54)	381.03 (262)
	1979	1.30 (20)	1.54 (20)	1.78 (18)**	1.34 (20)	1.30 (20)	141.08 (98)
Codington	1980	1.17 (28)	1.46 (28)	1.42 (26)**	1.17 (28)	1.21 (28)	176.69 (138)
	1981	1.05 (24)	1.46 (20)*	1.09 (24)	1.25 (24)	1.05 (24)	135.33 (116)
	Total	83.93 (72)	100.45 (68)	94.62 (68)	89.76 (72)	84.34 (72)	453.10 (352)
	1979	1.21 (24)	1.30 (12)*	1.38 (16)***	1.25 (24)	1.25 (24)	125.86 (100)
Tripp	1980	1.25 (24)	1.09 (24)	1.34 (16)***	1.50 (24)	1.30 (24)	144.07 (112)
	1981	1.17 (24)	1.17 (24)	1.21 (16)***	1.17 (24)	1.17 (24)	131.12 (112)
	Total	87.50 (72)	69.28 (60)	62.12 (48)	93.65 (72)	88.47 (72)	401.05 (324)
	1978	1.34 (16)	1.54 (16)	1.50 (16)	1.38 (16)	1.38 (16)	113.64 (80)
Walworth	1979	1.25 (26)	0.93 (16)*	1.25 (26)	1.25 (26)	1.21 (22)**	139.38 (116)
	1980	1.21 (28)	1.25 (28)	1.13 (28)	1.21 (18)	1.21 (28)	168.60 (140)
	Total	87.98 (70)	74.71 (60)	87.82 (70)	88.63 (70)	82.48 (66)	421.62 (336)
Grand Total		346.10 (268)	307.82 (234)	320.81 (240)	355.08 (268)	326.96 (264)	1656.80 (1274)

*Plots missing due to late harvesting
**Plots missing due to cutting prior to sampling
***No corresponding alfalfa plots for established stands

Appendix E. Analysis of variance of pheasant nest densities in Codington and Tripp Counties.

Codington County

Source	df	Mean Square	F	P
Year	2	3.206	13.06	0.0001
Landuse	4	1.915	7.80	0.0001
Year * Landuse	8	0.794	3.24	0.0015
Error	337	0.245		

Tripp County

Source	df	Mean Square	F	P
Year	2	10.022	4.23	0.0154
Landuse	4	15.551	6.56	0.0001
Year * Landuse	8	5.732	2.42	0.0151
Error	309	2.370		

Appendix F. Scientific and common names of plants found on DNC plots in four study areas.

Scientific Name	Common Name	*Counties in which found	**Age of DNC in which found
Abutilon theophrasti Medic.	Velvet-leaf	C	2
Achillea millefolium L.	Yarrow	C,W	3,4
Agropyron caninum (L.) Beauv.	Slender Wheatgrass	B	3
Agropyron cristatum (L.) Gaertn.	Crested Wheatgrass	B,C,T,W	2,3,4,ES
Agropyron elongatum (Host) Beauv.	Tall Wheatgrass	C	3,4,5
Agropyron intermedium (Host) Beauv.	Intermediate Wheatgrass	B,C,T,W	2,3,4,5,ES
Agropyron repens (L.) Beauv.	Quackgrass	W	2,4
Agropyron smithii Rydb.	Western Wheatgrass	C,T,W	2,3,4,5,ES
Amaranthus albus L.	Tumble Pigweed	T,W	2,ES
Amaranthus retroflexus L.	Common Pigweed	W	3
Ambrosia artemesiifolia L.	Common Ragweed	B,C,T,W	2,3,4,5,ES
Ambrosia psilostachya DC.	Western Ragweed	T	ES
Ambrosia trifida L.	Giant Ragweed	C,T	3
Amorpha canescens Pursh.	Leadplant	T	ES

Appendix F. (continued)

Andropogon gerardi Vitm.	Big Bluestem	T	ES
Aristida spp.	Threeawn	T	ES
Artemisia biennis Willd.	Biennial Wormwood	C,W	2,3,4
Artemisia campestris L.	Green Sagewort	W	2,3
Artemisia frigida Willd.	Fringed Sage	C,W	3,4
Artemisia dracunculus L.	Green Sage	T	ES
Artemisia ludoviciana Nutt.	Cudweed Sagewort	T,W	3,ES
Asclepias spp.	Milkweed	B,C	3,5
Aster falcatus Lindl.	White Prairie Aster	T	ES
Avena fauta L.	Wild Oats	C,T	2,3
Avena sativa L.	Oats	C,W	2,4
Brassica kaber (DC.) Wheeler	Wild Mustard	C,W	2,3
Bromus inermis Leyss.	Smooth Brome	B,C,T,W	2,3,4,5,ES
Bromus japonicus Thunb.	Japanese Brome	B,C,T	4,ES
Bromus tectorum L.	Downy Brome	T,W	2,3,4,ES
Buchloe dactyloides (Nutt.) Engelm.	Buffalograss	T	ES

Appendix F. (continued)

Calamagrostis spp.	Reed Grass	C	4
Cardaria draba (L.) Desu.	Hoary Cress	T	3
Carex eleocharis Bailey	Needleleaf Sedge	T	4
Carex filifolia Nutt.	Threadleaf Sedge	B	2
Carex heliophila Mackenzie	Sun Sedge	W	4
Centaurea maculosa Lam.	Spotted Knapweed	T	2
Chenopodium album L.	Lamb's Quarters	B,C,T,W	2,3,4,5,ES
Cirsium arvense (L.) Scop.	Canada Thistle	C	2,3,4
Cirsium flodmanii (Rydb.) Arthur	Flodman's Thistle	C	3,5
Cirsium undulatum (Nutt.) Spreng.	Wavy-leaf Thistle	C,T	2,3,4,5,ES
Cirsium vulgare (Savi) Ten.	Bull Thistle	C	2,5
Convolvulus arvensis L.	Field Bindweed	B,C,T,W	2,3,4,5
Convolvulus sepium L.	Hedge Bindweed	B	4
Conzya canadensis (L.) Cronq.	Horseweed	C,T,W	2,3,4,5
Coreopsis tinctoria Nutt.	Plains Coreopsis	B	3
Daucus carota L.	Wild Carrot	B	3,ES

Appendix F. (continued)

Descurainia sophia (L.) Webb.	Flixweed	C,W	2,3
Elymus canadensis L.	Canada Wild Rye	C	2
Erigeron strigosus Muhl.	Daisy Fleebane	C	4
Equisetum arvense L.	Horsetail	C	3
Glycyrrhiza lepidota Pursh	Wild Licorice	C	4
Helianthus annus L.	Annual Sunflower	B,C,T	2,3,ES
Hordeum jubatum L.	Foxtail Barley	T,W	3,ES
Iva xanthifolia Nutt.	Marsh Elder	B	3
Kochia scoparia (L.) Schrad.	Kochia	B,C,T,W	2,3,4,ES
Koeleria cristata (L.) Pers.	Prairie Junegrass	T	ES
Lactuca oblongifolia Nutt.	Blue Lettuce	C,W	2,5
Lactuca serriole L.	Prickly Lettuce	B,C,T,W	2,3,4,5,ES
Lepidium densiflorum Schrad.	Greenflower Pepperweed	C,T,W	2,3
Liatris punctata Hook.	Dotted Gayfeather	C	3
Lygodesmia juncea (Pursh) Hook.	Skeleton Weed	C,T,W	2,3,ES
Matricaria matricarioides (Less.) Porter	Pineapple Weed	T	ES

Appendix F. (continued)

Medicago sativa L.	Alfalfa	B,C,T,W	2,3,4,5,ES
Melilotus spp.	Sweet Clover	B,C,T,W	2,3,4,5,ES
Nepeta cataria L.	Catnip	T	ES
Opuntia polyacantha Haw.	Prickly Pear Cactus	T	ES
Oxalis stricta L.	Common Yellow Wood Sorrel	B,C,W	2,3
Panicum scribnerianum Nash	Scribner Panicum	T	ES
Panicum virgatum L.	Switchgrass	B,T	2,4
Phalaris arundinacea L.	Reed-canary Grass	W	3,4
Plantago patagonica Jacq.	Wooly Plantain	W	3
Poa pratensis L.	Kentucky Bluegrass	B,C,T,W	2,3,4,5,ES
Polygonum spp.	Smartweed	B,C,T,W	2,3,5,ES
Populus tremuloides Michx.	Quaking Aspen	C	2
Potamogeton spp.	Pondweed	T	3,ES
Prunus americana Marsh.	Wild Plum	T	ES
Ratibida columnifera (Nutt.) Woot. & Standl.	Prairie Coneflower	B,T	4,ES
Rhus radicans L.	Poison Ivy	T	ES

Appendix F. (continued)

Ribes missouriense Nutt.	Missouri Gooseberry	T	ES
Rosa spp.	Wild Rose	B,C,T,W	2,3,4,5,ES
Rumex spp.	Dock	C,T,W	2,3,4,ES
Salix bebbiana Sarg.	Beaked Willow	T	ES
Salsola iberica Sennen & Pau	Russian Thistle	B,C,W	2,3,4,5,ES
Setaria glauca (L.) Beauv.	Yellow Foxtail	C,T	3,4
Setaria viridis (L.) Beauv.	Green Foxtail	B,C,T,W	2,3,4
Setaria verticillata (L.) Beauv.	Bristly Foxtail	W	2,3
Sisymbrium altissimum L.	Tumble Mustard	B,W	2
Solanum rostratum Dunal.	Buffalobur	W	2
Solidago rigida L.	Stiff Goldenrod	W	4
Sonchus spp.	Sow Thistle	B,C,T,W	2,3,4,5,ES
Sorghastrum nutans (L.) Nash	Indiangrass	C	2
Sphaeralcea coccinea (Pursh) Rydb.	Scarlet Globemallow	T	4
Sporobolus cryptandrus (Torr.) A. Gray	Sand Dropseed	T	ES
Stellaria media (L.) Cyrill	Chickweed	W	2

Appendix F. (continued)

Stipa comata Trin. & Rupr.	Needle and Thread	B,T	2,ES
Stipa spartea Trin.	Porcupinegrass	T	ES
Stipa viridula Trin.	Green Needlegrass	T	ES
Tanacetum vulgare L.	Tansy	W	2
Taraxacum officinale Weber	Common Dandelion	B,C,T,W	2,3,4,5,ES
Thlaspi arvense L.	Field Pennycress	B,T	2,4
Tradescantia bracteata Small	Bracted Spiderwort	T	ES
Tragopogon spp.	Salsify	C,T	2,3,ES
Trifolium spp.	Clover	C,T,W	2,3,4,5,ES
Typha spp.	Cattail	T	ES
Ulmus pumila L.	Siberian Elm	C	3,5
Urtica dioica L.	Stinging Nettle	C	3
Verbascum thapsus L.	Flannel Mullein	T	ES
Verbena stricta Vent.	Hoary Vervain	C,T	3,4
Vicia americana Muhl.	American Vetch	C,T	2,ES
Xanthium spp.	Cocklebur	T	2

Appendix F. (continued)

Yucca glauca Nutt.	Yucca	T	ES

* B = Beadle County, C = Codington County, T = Tripp County, W = Walworth County

** ES = Established Stand

Appendix G.1. Frequency of occurrence and mean percent coverage of vegetation*, bare soil, and ground litter found in 2-year-old DNC.

Species	Frequency of Occurrence (%)	Mean Percent Coverage
Sweet Clover	60.0	18.0
Alfalfa	68.7	17.1
*Agropyron spp.***	41.8	5.2
Smooth Brome	10.5	3.1
Field Bindweed	24.6	2.8
Kochia	28.0	7.2
Russian Thistle	23.3	6.3
Bare Soil	89.2	21.2
Ground Litter	47.3	6.3
	N = 790 frames	Total 87.2%

* In addition to sweet clover, alfalfa, and *Agropyron spp.*, this table includes only those species which occurred at a frequency of 10.0% or greater.

** Includes crested, intermediate, pubescent, slender, tall, and western wheatgrass.

Appendix G.2. Frequency of occurrence and mean percent coverage of vegetation*, bare soil, and ground litter found in 3-year-old DNC.

Species	Frequency of Occurrence (%)	Mean Percent Coverage
Sweet Clover	35.0	7.0
Alfalfa	78.5	23.1
*Agropyron spp.***	61.0	12.8
Smooth Brome	18.0	5.2
Field Bindweed	23.4	3.2
Kochia	30.9	8.4
Russian Thistle	11.3	3.0
Bare Soil	65.8	10.9
Ground Litter	82.0	17.8
	N = 860 frames	Total 91.4%

* In addition to sweet clover, alfalfa, and *Agropyron spp.*, this table includes only those species which occurred at a frequency of 10.0% or greater.

** Includes crested, intermediate, pubescent, slender, tall, and western wheatgrass.

Appendix G.3. Frequency of occurrence and mean percent coverage of vegetation*, bare soil, and ground litter found in 4-year-old DNC.

Species	Frequency of Occurrence (%)	Mean Percent Coverage
Sweet Clover	25.1	2.5
Alfalfa	86.9	18.5
*Agropyron spp.***	74.0	26.2
Smooth Brome	18.0	5.1
Field Bindweed	12.8	0.9
Kochia	19.2	5.4
Bare Soil	58.7	13.2
Ground Litter	77.3	20.8
	N = 578 frames	Total 92.6%

* In addition to sweet clover, alfalfa, and *Agropyron spp.*, this table includes only those species which occurred at a frequency of 10.0% or greater.

** Includes crested, intermediate, pubescent, slender, tall, and western wheatgrass.

Appendix G.4. Frequency of occurrence and mean percent cover of vegetation*, bare soil, and ground litter found in 5-year-old DNC.

Species	Frequency of Occurrence (%)	Mean Percent Coverage
Sweet Clover	1.0	0.1
Alfalfa	78.0	12.8
*Agropyron spp.***	100.0	37.8
Siberian Elm	11.0	4.3
Bare Soil	14.0	1.8
Ground Litter	100.0	37.6
	N = 100 frames	Total 94.4%

* In addition to sweet clover, alfalfa, and *Agropyron spp.*, this table includes only species which occurred at a frequency of 10.0% or greater.

** Includes crested, intermediate, pubescent, slender, tall, and western wheatgrass.

Appendix G.5. Frequency of occurrence and mean percent coverage of vegetation*, bare soil, and ground litter found in established stands of DNC.

Species	Frequency of Occurrence (%)	Mean Percent Coverage
Sweet Clover	3.0	0.7
Alfalfa	28.3	6.6
*Agropyron spp.***	15.7	3.6
Smooth Brome	29.0	12.0
Downy Brome	12.3	2.7
Kentucky Bluegrass	24.3	6.4
Needle and Thread	13.7	4.3
Kochia	12.7	2.4
Common Ragweed	10.0	1.1
Swamp Smartweed	16.7	9.5
Bare Soil	62.3	15.5
Ground Litter	83.3	20.9
	N = 300 frames	Total 85.7%

* In addition to sweet clover, alfalfa, and *Agropyron spp.*, this table includes only those species which occurred at a frequency of 10.0% or greater.

** Includes crested, intermediate, pubescent, slender, tall, and western wheatgrass.