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# Productivity, Movements, and Habitat Use of Nesting and Brooding Wild Turkey Hens in Gregory County, South Dakota

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# PRODUCTIVITY, MOVEMENTS, AND HABITAT USE OF NESTING AND BROODING WILD TURKEY HENS IN GREGORY COUNTY, SOUTH DAKOTA

by
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PRODUCTIVITY, MOVEMENTS, AND HABITAT USE

OF NESTING AND BROODING WILD TURKEY HENS

IN GREGORY COUNTY, 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.

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Abstract

Keith S. Day

Radio-equipped wild turkey (Meleagris gallopavo) hens (n=53) were monitored in a prairie river breaks environment in southcentral South Dakota during 1986 and 1987. Seventy percent (36 of 47 adults and 1 of 6 juveniles) of the monitored hens nested. Hens that nested prior to 7 May selected nest sites in woodland habitats, while hens nesting later than 7 May selected nest sites in grassland habitats. Hens nested at sites with higher ($P<0.05$) percent visual obstruction, percent shrub cover, presence of overhanging vegetation, and habitat diversity than found at random control sites. Nest sites also allowed greater field of vision and opportunities for escape than random controls. Discriminant models developed from variables measured at nest and control sites were effective in distinguishing between the 2 categories.

Seventeen of 39 (43.6%) clutches hatched, and 11 broods survived to mid-August. Poult survival in 1986 was 42.9%, with all poult mortality occurring during the first 2 weeks post-hatch. Accurate data for poult survival was not obtainable during 1987, but survival appeared to be similar to 1986. Broods moved up to 3.5 km from nest sites before establishing definite ranges. Brood ranges were composed of ≥50% woodland types, while woodlands comprised only 30.8% of the study area. Mean range size increased 3-fold from the 0-4 week age class (Age 1) to the 4+ week age class (Age 2). Broods used habitats in proportion to availability within ranges. However, grasslands were used more than expected ($P<0.05$) between 0631 hr and 1130 hr over the summer, and less than expected ($P<0.05$) by Age 2 broods between 1131 hr and 1630 hr. Woodlands were used more than expected between 1131 hr and 1630 hr over the summer, but not significantly so. Seventy-seven percent of all brood sightings made between 0631 hr and 1130 hr, and 67% of all sightings made between 1631 hr and 2030 hr were in grassland habitats. Seventy-two percent of all brood sightings made between 1131 hr and 1630 hr were in woodlands.

Grassland brood use sites had greater forb cover, less grass cover, and were closer to habitat edges than random control sites ($P<0.05$). Discriminant analysis effectively reclassified grassland brood use sites, but not control sites. Age 1 broods used grassland sites with greater overhead (> 30 cm) shrub cover, and nearer habitat edges than sites used by Age 2 broods ($P<0.05$). Woodland brood use sites were nearer ($P<0.05$) habitat edges than random controls. No significant differences could be found between woodland sites used by Age 1 and Age 2 broods. Discriminant analysis was ineffective in distinguishing between classes for woodland brood use sites or between ages for either woodland or grassland brood use sites.

**This work is dedicated to...**

... my wife, Joyce, who could have chosen differently. For all the support, for suffering all the difficulties, and for trying to understand.

... our daughter, Patty, who had no choice, could not understand, and suffered most of all.

... our newborn son, Tom, and those yet to come, that this may be the end of an arduous trek, and that you will not have to endure what has gone before.

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## GENERAL INTRODUCTION

Wild turkey (*Meleagris gallopavo*) restoration and reintroduction programs in South Dakota began during the late 1940's (Petersen and Richardson 1975). During the ensuing 40 years populations have expanded rapidly. Turkeys (*M. g. merriami* and *M. g. intermedia*) have been very successful in the Missouri River drainage of the southcentral part of the state, Gregory County in particular. Turkeys have become numerous enough that 1715 spring and 1815 fall hunting permits were made available for prairie units in 1987. The population estimate for the winter of 1987-1988 in Gregory County, alone, was 9-12,000 birds (D. Lengkeek, pers. comm.). Five hundred hunting permits were issued in Gregory County for the spring of 1988.

The wild turkey is popular as both a game and non-game bird. Fowkes and Medve (1986) estimated that hunters in northwest Pennsylvania spent $311 per year to hunt turkeys, the equivalent of $4273 per turkey harvested. This can represent a substantial positive impact on local economies. Conversely, Korschgen (1967) reported that a flock of 100, 4.5 kg turkeys can consume as much as 1000 kg of food per month. During severe winters, when birds may depend more on agricultural food sources, consumption and fouling of feeds may become a problem. It is important to be able to balance the benefits of wild turkey populations with their detractions. This study was intended to explore the ecology of wild turkeys in southcentral South Dakota, and develop a data base from which to make suggestions for managing turkey populations to maintain this balance. The study focussed on 2 reproductive parameters of a prairie wild turkey population: nesting and brood rearing. Special attention was given to nesting habits and habitat, and brood movements, ranges, and habitat use. The following report will be divided into two chapters: the first addressing nesting ecology and the second brood rearing.

Research on a South Dakota prairie turkey population began in Gregory County in 1982 with the objective of developing guidelines for management (McCabe and Flake 1985). Studies concerning brood rearing (McCabe 1984, McCabe and Flake 1985), roosting (Craft 1986), and nesting (Wertz 1986, Wertz and Flake 1988) habits and habitats have been conducted in the interim. These studies have provided the basis from which plans for management of South Dakota's prairie populations of wild turkeys may be developed. The information presented here is a continuation of these earlier efforts.

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## STUDY AREA

This study was conducted on 6477 ha (25 sections) in the Missouri River Breaks region of Gregory County, South Dakota (Figure 1). Gregory County is located in the Pierre Hills division of the Missouri Plateau. It is bordered on the east by the Missouri River, on the south by Nebraska, and on the west by Tripp County, South

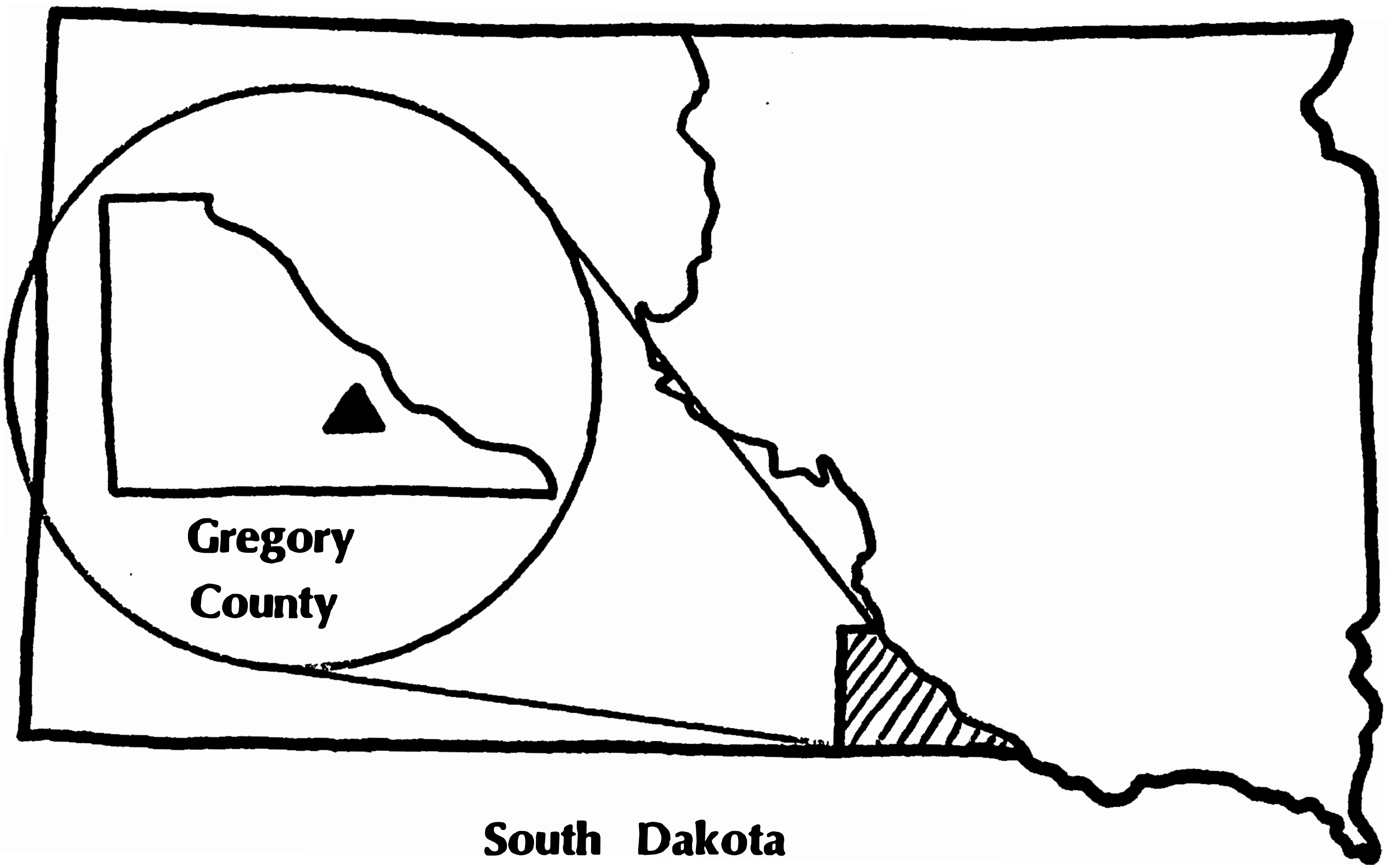



Figure 1. Location of Gregory County, South Dakota study area.

Dakota. The Breaks is an area of varied topography resulting from extensive erosion of the tablelands adjacent to the river. Elevations on the study area vary from 488 m to 640 m above mean sea level. Slopes range from 0% to 50%. Soils on the surrounding prairie plateau are silty clay loams. The steeper slopes of the Breaks are composed of clay soils underlain by shale and are broken by shale breaks. Mean annual precipitation is 57 cm and mean annual temperature is $9^{\circ}$ C. During the April to August reproductive period mean precipitation is 38 cm and mean temperature is $18.3^{\circ}$ C. The region is considered part of a warm, dry plain of mid to short grasses (Potas and Konrad 1969, South Dakota Agricultural Experiment Station 1978).

Habitats in the study area were classified into 4 land use/cover types: woodland, grassland, agricultural, and farmstead. Woodlands comprise 31% of the study area. Woodland types dominate bottomlands, and lower and steeper slopes; especially those with north and east aspects. McCabe (1984) reported average canopy closures ranging from 48% to 93%, and average tree basal areas ranging from 4.5 $m^2$/ha to 26.6 $m^2$/ha. Bur oak (Quercus macrocarpa) dominates the woodlands, but green ash (Fraxinus pennsylvanica), american elm (Ulmus americana), eastern cottonwood (Populus deltoides), basswood (Tilia americana), box elder (Acer negundo), and eastern red cedar (Juniperus virginiana) are common on moist sites and in bottoms.

Grassland types include both mixed and short grass prairie as well as shrub and grass/shrub communities. These types account for 52% of the area, and they are found primarily on upper slopes, ridge tops, and tablelands. Graminoid species commonly encountered ($\geq$10%)

include: green needle grass (Stipa viridula), needle and thread (S. comata), western wheatgrass (Agropyron smithii), blue grama (Bouteloua gracilis), sideoats grama (B. curtipendula), hairy grama (B. hirsuta), sand dropseed (Sporobolus cryptandrus), big blue stem (Andropogon gerardi), little blue stem (A. scoparius), and sedges (Carex spp.) (McCabe 1984). Shrub communities are dominated by wolfberry (Symphoricarpos occidentalis), american plum (Prunus americana), sand cherry (P. besseyi), choke cherry (P. virginiana), smooth sumac (Rhus glabra), leadplant (Amorpha canescens), and Rosa spp..

Small grains, row crops, and alfalfa comprise the 16% of the area under agricultural uses. Agricultural lands are located primarily on the prairie plateau surrounding the breaks. A few small fields are scattered throughout the breaks in bottoms and on flat ridges.

Farmsteads include all buildings and lands associated with the maintenance of farm and livestock operations. These account for 1% of the area.

All lands within the study area are privately owned and used primarily for livestock ranching operations. Nearly all available lands are grazed, hayed, or cropped at some time during the year.

## GENERAL METHODS

### Capture and Marking

A cannon net and portable walk-in traps were used to capture turkeys for marking. Trapping by cannon net occurred once each in

January and March of 1986 and 1987. Each trapping period lasted from 3 to 4 days. The net was set in proximity to silage and corn piles in a hay yard known to receive extensive winter use. The same site was used each year. Walk-in traps were placed throughout the study area during May and June each year. Both type traps were baited with whole corn.

All birds captured were weighed, aged, and sexed (Larson and Taber 1980). Birds which had not yet molted the 9th and 10th primaries were classified as juvenile birds. Aluminum butt-end leg bands (National Band and Tag Company, Newport, KY.) were placed around the right tarsometatarsus of each bird. Colored wing tags, each number coded to the leg bands, were attached to the wings through the patagia (Knowlton et al. 1964). In addition, 100 g radio transmitters, powered by lithium batteries, (Advanced Telemetry Systems Inc., Bethel, MN) were mounted on all adult and a small portion of juvenile hens captured. Transmitters operated in the 150 to 152 MHz range. They were mounted on the back, between the wings by looping a length of nylon parachute cord under each wing. Nenno and Healy (1979) concluded no bias could be attributed to studies of wild turkey populations due to radio transmitter attachment. Each bird was released at the capture site as soon as all measurements were taken and marking completed.

Telemetry

Locations of radio instrumented birds were determined at 1 hour intervals from 0600 hr to 2100 hr 2 days each week (usually

Monday and Thursday), as follows. Radio fixes were taken simultaneously from 2 of 3 permanent receiving stations placed in a triangular pattern on ridge tops near the center of the study area. Each station consisted of a 12.2 m tower equipped with 2, 4 element yagi antennas mounted parallel to each other on a rotatable mast. An Advanced Telemetry Systems "Challenger 200" receiver and null/peak combiner were used for signal reception. Bearings from the towers to each hen were read from a 360$^{o}$ compass plate placed at the base of the mast (Cochran et al. 1965). Antennas were calibrated prior to use each hour by taking a bearing on a fixed radio beacon and making any necessary realignments. Receiving stations had an accuracy of $\pm 2^{o}$ at 3.2 km. A collapsible 3 element yagi antenna was used for on-the-ground location of incubating hens, hens which had moved out of tower range, and for visual contact with broods.

## Cover Maps

Cover maps of the study area were developed by McCabe (1984) and Wertz (1986) from 1:7920 aerial photographs. The Prime 400 computer, electronic digitizing table, and Area Resource Analysis System (AREAS) available at the Remote Sensing Office, Engineering and Environmental Research Center, Engineering Experiment Station, South Dakota State University were used to map habitat types from the photographs and compute the percentage of the study area covered by each type. These maps were adapted for the purposes of this study.

# CHAPTER I

# PRODUCTIVITY AND HABITAT SELECTION OF NESTING WILD TURKEY HENS

# INTRODUCTION

General physical characteristics of wild turkey nest sites have been described previously (Mosby and Handley 1943, Dalke et al. 1946, Williams et al. 1968, Speake et al. 1975). Hens usually locate nests near openings in wooded habitats, or in the ecotone between wooded and open areas (Petersen and Richardson 1975, Hon et al. 1978, Porter 1978). The nest itself is located in such a way as to provide maximum concealment for the hen without hindering her field of vision or escape routes (Stoddard 1963, Logan 1973, Speake et al. 1975). These requirements are often met by brushy patches, slash piles, tree trunks, or a combination of these factors (Bailey et al. 1951, Hoffman 1962, Cook 1972, Petersen and Richardson 1975). Location of nests in proximity to permanent sources of water has also been reported (Blakey 1937, Bailey et al. 1951, Hoffman 1962, Cook 1972).

Qualitative descriptions of habitat parameters, such as those cited, are valuable for informative purposes. However, they provide little opportunity for quantifying the factors which influence statistical analyses for predicting habitat use. The use of quantitative measurements for describing turkey nesting habitats has become more common during the past decade. Healy (1981) was able to show that woody vegetation was moderately dense above 50 cm, and vegetation was sparse below 25 cm at wild turkeys nests in the southeast. Lazarus and Porter (1985) reported that the nest site proper did not differ from the 0.5 ha surrounding area, and the larger area may play a part in nest site selection in Minnesota. They indicated nest sites had more open canopy, higher stem density, and more forb cover than random sites. A study in South Dakota (Wertz and Flake 1988) showed that vegetation density below 90 cm was the discriminating factor for separating nest sites from random controls in grassland habitats. Visual obstruction and shrub density also played a key role in nest site determination in Oregon (Lutz and Crawford 1987).

The objectives of the first phase of this study were: to determine whether nesting wild turkey hens exhibited selection behavior when locating nests; and to make quantitative measurements of nest site characteristics for the purpose of classifying habitats, predicting use of habitats, and developing management suggestions.

## METHODS

### Productivity

Productivity measures were based on known nests and complete clutch counts. Clutch sizes were determined when possible, but this was not a primary concern and disturbance of nesting hens was kept to a minimum. Nesting rates were taken as the percentage of hens monitored known to nest. Likewise, nest success was defined as the percentage of nests which hatched. Egg hatchability was recorded as the percent of all eggs laid that hatched, and was based only on complete clutch and hatch counts. No attempt was made to measure egg fertility (percent of eggs laid which were fertile).

## Nest Location

When a hen had remained stationary for 2 to 3 telemetry days (see page 6) it was assumed she had begun incubation. A ground search was then made to locate the suspected nest. Care was taken to avoid disturbing the hen. Nest locations were plotted on a topographic map and a surveyor's flag was placed in the vicinity to facilitate relocation. The nest site was revisited to determine nest fate and take habitat measurements only after the hen had left the nest.

Straight-line distances travelled by hens from winter ranges to nest sites were determined using the TELEM computer program (Koeln 1980) and data acquired from the telemetry methods described (see page 6). Winter ranges could not be determined for birds captured in March 1987. Dispersal for these birds was based on the capture site and measured from 7.5 minute USGS topographic maps. The capture site was assumed to be within the winter range of all captured birds. Distances travelled between first and second nests, and between nests in consecutive years were measured from 7.5 minute USGS topographic maps. Birds marked in a previous study (Wertz 1986, Wertz and Flake 1988) and surviving through 1986 and/or 1987 were included in these measurements.

## Habitat Measurements

Vegetation/habitat characteristics of both the nest site and the surrounding 0.5 ha area (within a 40 m radius of the nest) were measured. A list of the parameters measured is given in Table 1. The nest was taken as the point of intersection of a set of north-south,

Table 1. Habitat variables measured at wild turkey nest sites and random control sites in Gregory County, South Dakota during 1986 and 1987.

| Variable | Method of Measurement |
|---|---|
| 0.001 ha nest site | |
| % grass cover | vegetation sampling frame |
| % forb cover | " |
| % shrub cover | " |
| % litter | " |
| % bare ground | " |
| % visual obstruction 0-60 cm | vertical profile board |
| % visual obstruction 60-180 cm | " |
| % nest covered from above | checkerboard |
| height of overhanging vegetation (cm) | meter stick |
| % slope | Abney level |
| aspect | compass |
| % canopy cover[a] | Model C densiometer |
| ave. dist. to nearest tree (cm)[a] | point-centered quarter |
| ave. dbh of nearest trees (cm)[a] | " |
| ave. dist. to nearest sapling (cm)[a] | " |
| ave. dist. to nearest shrub/seedling (cm) | " |
| 0.5 ha surrounding area | |
| dist. to nearest habitat edge (cm) | measuring tape/map |
| dist. to nearest water source (cm) | " |
| habitat diversity | line-intercept |
| % visual obstruction 0-60 cm | vertical profile board |
| % visual obstruction 60-180 cm | " |
| % canopy cover[a] | Model C densiometer |
| ave. dist. to nearest tree (cm)[a] | point-centered quarter |
| ave. dbh of nearest trees (cm)[a] | " |
| ave. dist. to nearest sapling (cm)[a] | " |
| ave. dist. to nearest shrub/seedling (cm) | " |

[a] measurements taken only at woodland sites

east-west axes and all measurements were made in relation to this configuration. Percent of the nest site (0.001 ha; a circle with a radius of 1.78 m) in 5 ground cover classes (grass, forbs, shrubs, litter, and bare ground) was estimated using a 20 x 50 cm vegetation sampling frame (Daubenmire 1959). The frame was placed along each axis a random distance (0 to 1.8 m) from the center of the nest in each cardinal direction. The percent of each cover type inside the frame was estimated, the total corrected to 100%, and the 4 site estimates averaged to give a value for the 0.001 ha nest site.

Visual obstruction of the nest (and hen) was estimated using a 1.8 m vertical profile board (Nudds 1977). The board was held upright in the nest and the percent of each of 6, 30 cm high sections obscured by surrounding vegetation visually estimated from a distance of 5 m and a height of 50 cm. Four readings were taken; one in each cardinal direction. These readings were then averaged to give a site value for each board section. Pooling of board sections occurred as necessary in analyses.

Presence or absence of understory vegetation hanging over the nest was noted. Percent of the nest bowl covered by overhanging vegetation was estimated by placing a 30 x 30 cm, 3 x 3 checkerboard in the nest bowl and viewing it from a height of 1.5 m. Each of the 9 squares $\geq$ 50% obscured by vegetation was counted and the total multiplied by 11% to give total cover.

Distances to the nearest habitat edge and water source were measured using a 100 m tape, by pacing, or were taken from aerial photographs. Slope was measured using an Abney level, and aspect with a pocket compass.

Nests located in woodlands, in addition to the above measurements, required forest measures. Canopy cover for the site was averaged from 4 readings of a model C densiometer (Lemon 1956) taken 2.5 m from the nest along each axis. The point-centered quarter method, as described by Cottam and Curtis (1956), was used to measure distance to the nearest tree (≥ 10 cm dbh), sapling (≥ 3 cm dbh and < 10 cm dbh), and shrub/seedling (< 3 cm dbh). The shrub/seedling measurement was also made at grassland sites.

Habitat values for the 0.5 ha area were calculated by averaging measurements made at 4 points located within the 40 m radius circle using a stratified random method. The surrounding area was divided into quarters along the previously established axes. A point was located a random distance (between 10 m and 40 m) from the nest along the line bisecting each quarter. Visual obstruction, canopy cover, and point-centered quarter measurements were taken at each point as described above. Adjustments were made in the distance the point was located from the nest, and division of the 0.5 ha area into quarters when necessary to assure that all measurements fell within the habitat type in which the nest was situated.

A habitat diversity index was established for the 0.5 ha surrounding area. Ten equally spaced ($36^{o}$ intervals starting at $0^{o}$) 40 m long transects were walked outward from the nest. Each change of habitat/community (woodland, savannah, shrub, grassland, agricultural or farmstead) encountered along the transects was counted. These tallies were totalled for the site and divided by 10 (the number of transects) to give a site index.

All the above measurements were replicated at an equal number of randomly located control sites. The pooled control sites were assumed to represent average study area conditions.

During 1987, the percent ground cover, visual obstruction, and canopy cover measurements were taken at 12 of the previous year's (1986) nest sites (4 woodland, 7 grassland, 1 agricultural) to determine vegetation growth trends. Measurements were taken at 2 week intervals beginning 12 April and ending 27 June.

## Statistical Analysis

Nest site characteristics were compared to the study area in general, as described by the pooled controls, through use of Statistical Analysis System (SAS) computer software (SAS Institute, Inc. 1985). Univariate tests (chi-square, analysis of variance [ANOVA], and categorical data modeling [CATMOD]) were used to test for differences in individual variables. These tests provided the basis for a general description of nest sites, relative to controls, based upon differences in individual habitat variables. Multivariate analysis of variance (MANOVA), stepwise discriminant analysis (STEPDISC), and discriminant analysis (DISCRIM) tests were conducted to determine the effect of variable interactions. These tests provided explanations of differences between sites due to the cumulative effects of groups of variables. Tests for habitat selection followed the method of Neu et al. (1974). Statistical tests were evaluated at the 0.01, 0.05, and 0.10 levels of probability.

## RESULTS

### Productivity

A sample of 53 hens (47 adult and 6 juvenile) was monitored through the nesting seasons of 1986 and 1987 using the telemetry methods described. Initiation dates and fates for the 39 nests located (19 in 1986, 20 in 1987) are given in Table 2. The nesting rates for 1986, 1987, and both years combined were; 76.0% (19 of 25), 64.3% (18 of 28), and 69.8%, respectively. The adult nesting rate was 76.6% (36 of 47). Only 1 of the 6 (16.7%) juvenile hens nested. Mean clutch size from 25 complete counts, including an 18 egg clutch, was 11.2 eggs. The mean clutch size was 10.9 eggs when the 18 egg clutch was excluded as a possible dump nest. Nest success was 43.6% (17 of 39)(Table 3). Renesting was not observed in 1986, but in 1987 2 of 7 hens unsuccessful in their initial nesting attempt (28.6%) renested. One of these second nests was successful. Hatchability was 91.8% over both years. Two fully developed embryos failed to hatch in 1987.

Unsuccessful nests were the result of predation in 19 of 22 cases (Table 2). What part investigators may have played in nest predation (Pharris and Goetz 1980) is not known, but there was no obvious relationship between visitations and nest success. Four hens were lost, or possibly lost, in relation to nesting activities. One hen was killed while incubating (possibly by a bobcat), one

Table 2. Initiation dates, clutch counts, and fates of 39 nests of radio-equipped wild turkey hens in Gregory County, South Dakota during 1986 and 1987.

| Bird | Date Initiated | #Eggs[a] | Fate[b] |
|---|---|---|---|
| 486 | 21 April 86 | 12 | Hatch (11) |
| 449 | 23 April 86 | 13 | Hatch (13) |
| 487 | 23 April 86 | — | Hatch |
| 433 | 30 April 86 | — | Predated |
| 471 | 30 April 86 | — | Predated |
| 405 | 03 May 86 | 10 | Hatch (10) |
| 426 | 14 May 86 | 10 | Predated |
| 283 | 20 May 86 | — | Hatch |
| 437 | 20 May 86 | 10 | Hatch (8) |
| 477 | 22 May 86 | 10 | Predated |
| 444 | 23 May 86 | 9 | Hatch |
| 429 | 27 May 86 | 9 | Abandoned |
| 424 | 28 May 86 | — | Predated |
| 427 | 31 May 86 | — | Predated |
| 286 | 02 June 86 | 8 | Predated |
| 421 | 03 June 86 | 16 | Trampled (?) |
| 472 | 07 June 86 | 9 | Abandoned |
| 483 | 15 June 86 | — | Predated |
| 452 | 17 June 86 | 8 | Predated |
| 452 | 09 April 87 | — | Predated |
| 487 | 09 April 87 | — | Predated |
| 450 | 10 April 87 | — | Predated |
| 483 | 10 April 87 | — | Predated |
| 471 | 16 April 87 | 18 | Hatch (18) |
| 649 | 17 April 87 | — | Hatch |
| 643 | 20 April 87 | 11 | Hatch (9) |
| 477 | 22 April 87 | 14 | Hatch (13) |
| 646 | 24 April 87 | 11 | Hatch (>7) |
| 476 | 27 April 87 | 16 | Predated |
| 645 | 27 April 87 | — | Predated |
| 485 | 28 April 87 | 11 | Predated |
| 605 | 28 April 87 | 13 | Predated |
| 658 | 05 May 87 | 9 | Hatch (>7) |
| 473 | 08 May 87 | 8 | Predated |
| 647 | 12 May 87 | 11 | Hatch (8) |
| 605[c] | 26 May 87 | 13 | Hatch (12) |
| 429 | 30 May 87 | — | Hatch |
| 615 | 01 June 87 | 10 | Hatch (10) |
| 483[c] | 13 June 87 | 11 | Predated |

[a] clutch sizes shown are for complete counts only
[b] number in parentheses is number of eggs hatched, if known
[c] designates second nest of the season

Table 3. Nest success by year (1986 and 1987) and habitat type for a Gregory County, South Dakota wild turkey population.

| | 1986 | | | 1987 | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | # Nests | # Succ | % Succ | # Nests | # Succ | % Succ | # Nests | # Succ | % Succ |
| Woodlands | 7 | 4 | 57.1 | 13 | 5 | 38.5 | 20 | 9 | 45.0 |
| Grasslands | 10 | 3 | 30.0 | 7 | 5 | 71.4 | 17 | 8 | 47.1 |
| Other | 2 | 0 | 0.0 | — | — | — | 2 | 0 | 0.0 |
| TOTAL | 19 | 7 | 36.8 | 20 | 10 | 50.0 | 39 | 17 | 43.6 |

disappeared while on the nest and was presumed killed, the juvenile was killed while off the nest to feed or water, and the remains of one hen were found near 2 eggs which may have represented a renesting attempt. These losses suggest a 10.8% mortality rate for nesting hens (4 of 37). Cattle may have been responsible for the destruction of 1 nest. One nest was abandoned due to alfalfa haying activities, and the final unsuccessful nest was abandoned for unknown reasons.

## Dispersal to Nest Sites

Average straight-line dispersal of 27 hens from the geometric center of the winter range to the nest was 2.6 km. The 9 hens for which no winter range data were available moved an average 3.4 km from the capture site to their nests (Table 4). Most movements followed the study area's major drainage to the south and east. Dispersal to the drainage north and west of the study area seemed to be restricted by the dividing ridges. However, 3 hens did nest north of the dividing ridge. One hen did so in both years, while the other 2 nested in the main drainage in 1986 and moved to the north in 1987.

Hens which nested in 2 consecutive years moved to nest sites an average 0.9 km from the preceding year's nest (Table 5). Three of these hens nested within 0.1 km of the previous nest. The remaining 6 hens nested at sites over 0.8 km from the preceding year's nest. The 2 hens which renested in 1987 each moved 0.4 km to establish second nests. Both hens nested initially in a woodland, but placed their second nests in a grassland types. A third hen may have moved 0.7 km

Table 4. Straight-line distances (km) covered by wild turkey hens in Gregory County, South Dakota during 1986 and 1987 when dispersing from winter ranges or capture site to nest sites.

| Dispersal From Winter Range | | | Dispersal From Capture Site | | |
|---|---|---|---|---|---|
| Year | Bird | Distance (km) | Year | Bird | Distance (km) |
| 1986 | 283 | 3.5 | 1987 | 450 | 3.8 |
| | 286 | 1.3 | | 605 | 2.6 |
| | 405 | 2.7 | | 615 | 6.5 |
| | 421 | 1.9 | | 643 | 2.7 |
| | 424 | 3.2 | | 645 | 1.7 |
| | 426 | 3.4 | | 646 | 4.2 |
| | 427 | 3.2 | | 647 | 4.3 |
| | 429 | 2.7 | | 649 | 0.9 |
| | 433 | 5.6 | | 658 | 3.9 |
| | 437 | 3.0 | | | |
| | 444 | 4.4 | | $\bar{X}$ | 3.4 |
| | 449 | 1.8 | | s.d. | 1.65 |
| | 452 | 2.0 | | | |
| | 471 | 1.9 | | | |
| | 472 | 3.4 | | | |
| | 483 | 3.1 | | | |
| | 486 | 1.4 | | | |
| | 487 | 1.4 | | | |
| 1987 | 429 | 3.8 | | | |
| | 452 | 1.6 | | | |
| | 471 | 1.7 | | | |
| | 473 | 1.4 | | | |
| | 476 | 2.3 | | | |
| | 477 | 2.2 | | | |
| | 483 | 3.1 | | | |
| | 485 | 2.4 | | | |
| | 487 | 1.8 | | | |
| | $\bar{X}$ | 2.6 | | | |
| | s.d. | 1.04 | | | |

Table 5. Straight-line distances (m) between nests established by the same wild turkey hen in succeeding years (1985 to 1987) in Gregory County, South Dakota.

| Bird | Year of First Nest | Fate of First Nest | Year of Second Nest | Distance (m) |
|---|---|---|---|---|
| 405 | 1985 | predated[a] | 1986 | 95[b] |
| 427 | " | predated | " | 70[b] |
| 429 | 1986 | predated | 1987 | 880 |
| 452 | " | predated | " | 1190 |
| 471 | " | predated | " | 2450 |
| 477 | " | predated | " | 830 |
| 483 | " | predated | " | 1850 |
| 487 | " | hatched | " | 92 |
| | | | $\bar{X}$ | 940 |
| | | | s.d. | 876.35 |

[a] this was a renesting attempt, the first nest was 1.0 km from the second

[b] approximate distance based on data from T. Wertz (pers. comm.)

from her initial nest to establish a second nest, but was killed before the existence of this nest could be verified.

## Habitat Selection

Analysis of habitat use versus availability (Neu et al. 1974) indicated selection for woodlands by nesting hens (Table 6). However, temporal analysis showed that habitat selection was related to date of nest initiation. Nests initiated prior to the first 7 to 14 days of May (depending on the year) were located primarily in woodlands, while those initiated later were located primarily in grasslands (Figure 2). Reanalysis of habitat use around an arbitrary 7 May cut-off date revealed that selection for woodlands early in the season was supplanted by selection for grassland types later (Table 7). Vegetation trend data showed that vegetation growth in grassland types was accelerating rapidly during this period (Figure 3).

Nest site selection in relation to grazing practices was not tested because of the difficulty in accurately determining proportions of the study area being grazed over time. However, no difference ($P>0.05$) in distribution of nest and random control sites between grazed and ungrazed habitats could be determined using a 2 x 2 contingency table analysis (Table 8). There did not appear to be any selection for slope or aspect.

## Characteristics of Nest Sites

**Woodlands.** Analyses of nest site characteristics in woodlands were based on 20 nests and their associated control sites.

Table 6. Habitat selection/avoidance (after Neu et al. 1974) by nesting wild turkey hens when choosing nest sites in Gregory County, South Dakota during 1986 and 1987.

| Habitat | Proportion of the Study Area | Number of Nests Observed | Number of Nests Expected | $X^2$ Value | Proportion Observed in Each Habitat | 95% Confidence Interval on Proportion Observed |
|---|---|---|---|---|---|---|
| Woodland | 0.308 | 20 | 12.012 | 5.31* | 0.513 | $0.326 \leq P \leq 0.710$[a] |
| Grassland | 0.524 | 17 | 20.436 | 0.58 | 0.436 | $0.246 \leq P \leq 0.626$ |
| Ag/Farm | 0.168 | 2 | 6.552 | 2.85 | 0.051 | $0.000 \leq P \leq 0.135$[b] |
| TOTAL | 1.000 | 39 | 39.000 | 8.74* | 1.000 | |

* $P<0.05$

[a] shows selection at 95% level because confidence interval is greater than expected proportion

[b] shows avoidance at 95% level because confidence interval is less than expected proportion

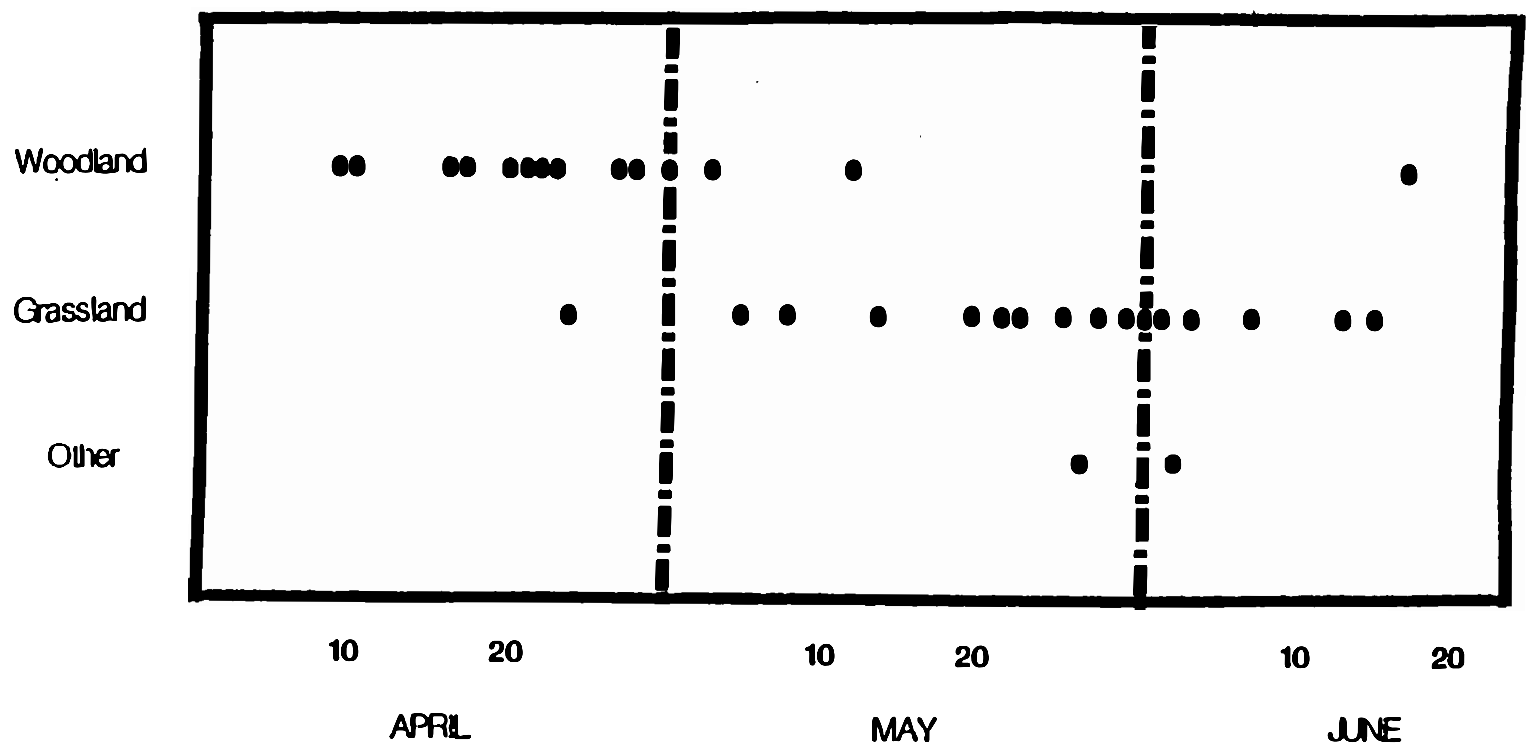



Figure 2. Initiation dates by habitat for 39 wild turkey nests located in Gregory County, South Dakota during 1986 and 1987.

Table 7. Habitat selection/avoidance (after Neu et al. 1974) by nesting wild turkey hens by date when choosing nest sites in Gregory County, South Dakota during 1986 and 1987.

| Habitat | Proportion of the Study Area | Number of Nests Observed | Number of Nests Expected | $X^2$ Value | Proportion Observed in Each Habitat | 95% Confidence Interval on Proportion Observed |
|---|---|---|---|---|---|---|
| **Nests initiated before 7 May** | | | | | | |
| Woodland | 0.308 | 18 | 6.16 | 22.76** | 0.90 | $0.739 \leq P \leq 1.000$[a] |
| Grassland | 0.524 | 2 | 10.48 | 6.86** | 0.10 | $0.000 \leq P \leq 0.261$[b] |
| Ag/Farm | 0.168 | 0 | 3.36[c] | — | 0.00 | — |
| TOTAL | 1.000 | 20 | 20.00 | 29.62** | 1.00 | |
| **Nests initiated after 7 May** | | | | | | |
| Woodland | 0.308 | 2 | 5.85 | 2.54 | 0.105 | $0.000 \leq P \leq 0.2739$[b] |
| Grassland | 0.524 | 15 | 9.96 | 2.56 | 0.790 | $0.566 \leq P \leq 01.000$[a] |
| Ag/Farm | 0.168 | 2 | 3.19[c] | — | 0.105 | — |
| TOTAL | 1.000 | 19 | 19.00 | 5.09* | 1.000 | |

*$P<0.05$
** $P<0.01$
[a] shows selection at the 95% level because confidence interval is greater then expected proportion
[b] shows avoidance at the 95% level because confidence interval is less than expected proportion
[c] not included in analysis because expected value is below 5.0

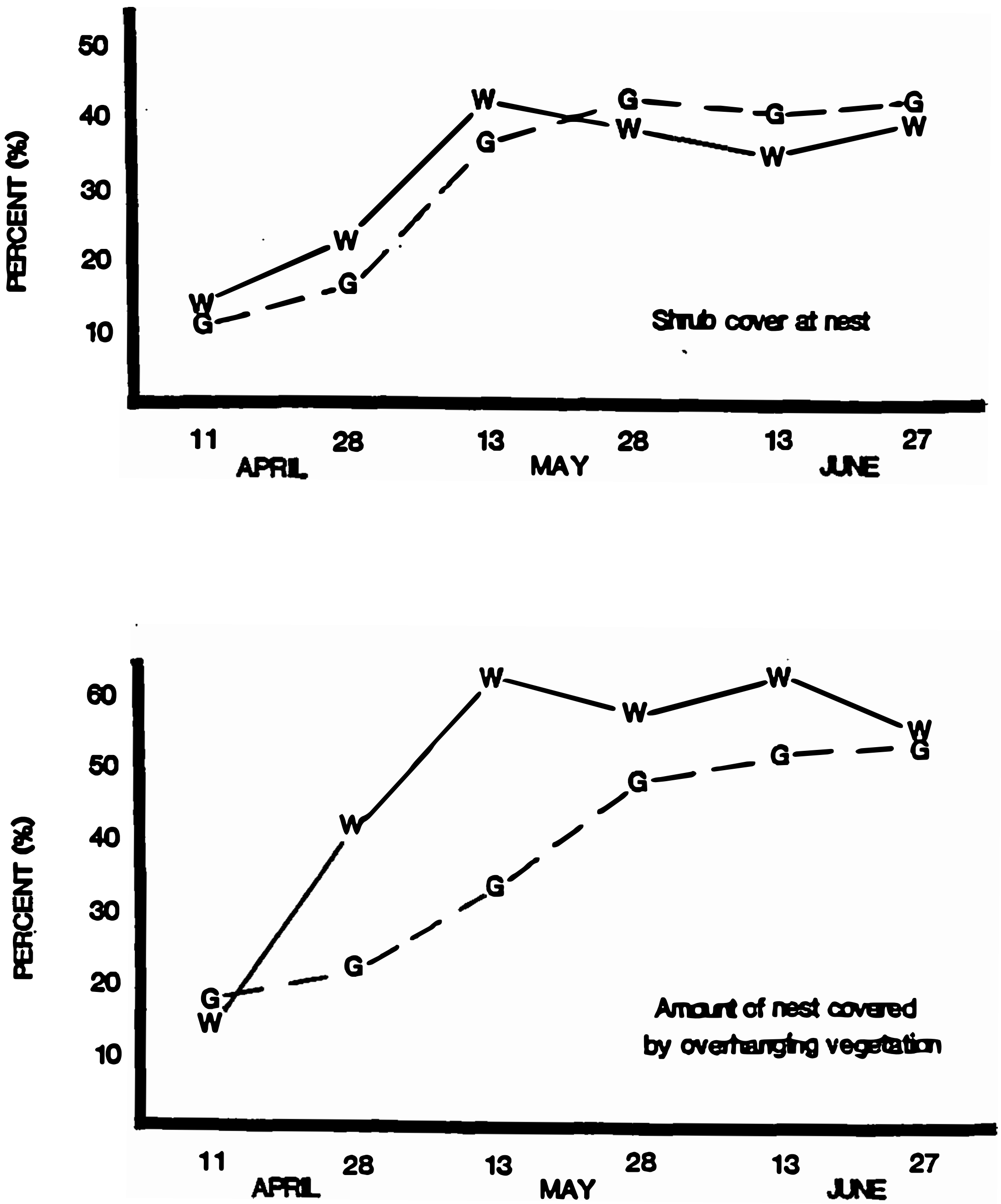
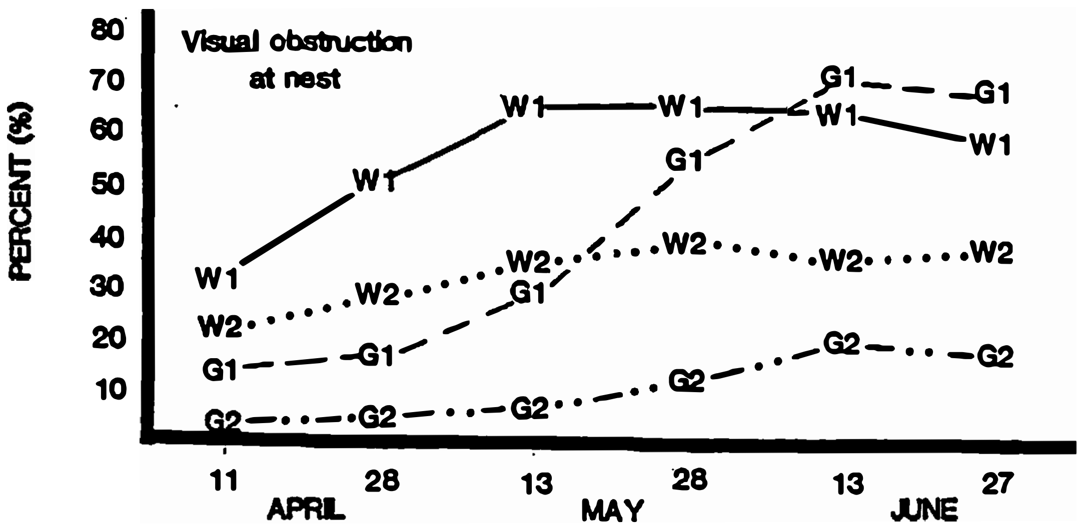



Figure 3. Seasonal trends of some important vegetation characters measured during 1987 at 12 1986 wild turkey nest sites in Gregory County, South Dakota. W= woodland. G= grassland.



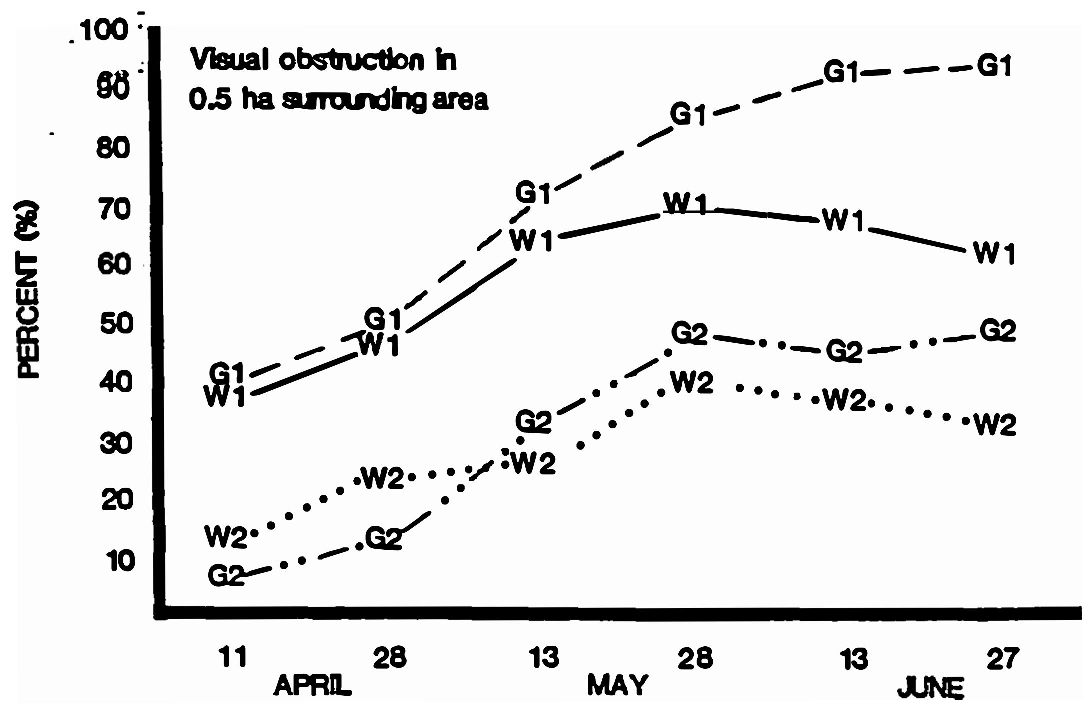




Figure 3 (cont). W1= visual obstruction below 60 cm in woodlands. W2= visual obstruction above 60 cm in woodlands. G1= visual obstruction below 60 cm in grasslands. G2= visual obstruction above 60 cm in grasslands.

Table 8. Contingency table analysis testing for a difference in the distribution of wild turkey nests and random control sites between grazed and ungrazed habitats in Gregory County, South Dakota during 1986 and 1987.

| Site | Number in Grazed Habitat | Number in Ungrazed Habitat | TOTAL |
|---|---|---|---|
| Nests | 14 | 23 | 37 |
| Controls | 17 | 20 | 37 |
| TOTAL | 31 | 43 | 74 |

$$X^2 = n(|f_{11}f_{22}-f_{12}f_{21}|-n/2)^2 \; / \; (C_1)(C_2)(R_1)(R_2)$$

$$= 74(|14[20]-17[23]|-[74/2])^2 \; / \; (31)(43)(37)(37)$$

$$= 405{,}224 \; / \; 1{,}824{,}877$$

$$= 0.2221$$

$df = 1$

$X^2_{0.05,1} = 3.84$

$0.50 < P < 0.75$

Univariate analyses showed that 8 of 23 variables differed significantly ($P<0.05$) between the 2 classes (Table 9). Percent visual obstruction below 60 cm, habitat diversity, percent shrub cover, mean distance to the nearest sapling, and mean distance to the nearest sapling in the 0.5 ha surrounding area were all greater ($P<0.05$) for nests than controls. In addition, overhanging vegetation was present at a significantly greater number of ($P<0.05$) nests than random sites. Distance to the nearest habitat edge and percent visual obstruction above 60 cm in the 0.5 ha surrounding area were less ($P<0.05$) at nest sites than controls. The MANOVA statistic for the cumulative effect of all 23 variables between classes was highly significant ($P<0.01$), but was no more descriptive of site differences than the individually significant variables. One variable, percent grass cover, was significantly different ($P<0.05$) between years and could not be used in further analyses.

Two models, Model I based on all variable measurements taken both at the nest and in the 0.5 ha surrounding area and Model II based on only those variable measurements taken in the 0.5 ha area surrounding the nest, were developed through STEPDISC to explain the variability between nests and controls (Table 10). Model I was a 3 variable model consisting of percent visual obstruction at the nest (both below and above 60 cm), and habitat diversity. These variables accounted for 57.1% of the total variability between classes. The DISCRIM procedure properly reclassified 95.0% of all sites using this model. In Model II, habitat diversity and average distance to the nearest sapling in the 0.5 ha surrounding area explained 30.6% of the

Table 9. Variable means showing significant differences ($P \leq 0.05$) between 20 wild turkey nest sites and random control sites located in woodland habitats in Gregory County, South Dakota during 1986 and 1987.

| | Site Means | | | | |
|---|---|---|---|---|---|
| Variable | Nests | Controls | F Value | $X^2$ | Probability |
| % shrub cover | 37.67 | 25.83 | 5.48 | — | 0.0245 |
| % visual obstruction 0-60 cm at nest | 84.33 | 66.72 | 10.59 | — | 0.0024 |
| distance to nearest habitat edge (cm) | 772.00 | 1486.00 | 5.76 | — | 0.0214 |
| mean distance to sapling nearest nest (cm) | 1015.35 | 480.65 | 6.28 | — | 0.0166 |
| habitat diversity | 1.17 | 0.78 | 9.74 | — | 0.0034 |
| % visual obstruction 60-180 cm in 0.5 ha surrounding area | 37.55 | 47.65 | 4.74 | — | 0.0358 |
| mean distance to nearest sapling in 0.5 ha surrounding area (cm) | 959.45 | 533.00 | 4.09 | — | 0.0501 |
| MANOVA statistic | — | — | 3.04 | — | 0.0102 |
| number of sites with/without overhanging vegetation | 20/0 | 12/8 | — | 7.66 | <0.01 |

Table 10. Two models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between wild turkey nest sites and random control sites located in woodland habitats, and their discriminating abilities. Based on data collected at 20 nest and control sites located in Gregory County, South Dakota during 1986 and 1987.

| Model | Variables Included | Cumulative Wilk's Lambda |
|---|---|---|
| I[a] | % visual obstruction 0-60 cm at the nest | 0.7820 |
| | % visual obstruction 60-180 cm in the 0.5 ha surrounding area | 0.5210 |
| | habitat diversity | 0.4288 |
| II[b] | habitat diversity | 0.7960 |
| | ave. dist. to nearest sapling in the 0.5 ha surrounding area | 0.6944 |

| | % Proper Reclassification | |
|---|---|---|
| | Nests | Controls |
| Model I | 95.0 | 95.0 |
| Model II | 45.0 | 90.0 |

[a] derived from all variable measurements made at the nest and in the 0.5 ha surrounding area

[b] derived from only those variable measurements made in the 0.5 ha area surrounding the nest

variability between classes, and provided 45.0% and 90.0% proper reclassification of nests and controls, respectively.

Grasslands. Analyses of habitat characteristics at nest sites in grassland types were based on data from 21 nests, including 4 located incidentally, and their associated controls. Univariate analyses revealed significant differences between classes (nests vs controls) for 10 of 15 variables (Table 11). Percent shrub cover, percent visual obstruction (below and above 60 cm) both at the nest and in the 0.5 ha surrounding area, and habitat diversity were greater ($P<0.05$) at nest sites than controls. Overhanging vegetation was present at significantly ($P<0.01$) more nests than controls. Percent litter and percent bare ground were less ($P<0.05$) at nest sites than controls. The MANOVA statistic derived from all 15 variables was highly significant ($P<0.01$), but was no better at defining the difference between sites than the individually significant variables.

Three models, Models I and II based on all variable measurements taken and Model III based on only those variable measurements taken in the 0.5 ha area surrounding the nest, were developed through STEPDISC procedures to explain the variability between the nests and controls (Table 12). Model I, percent visual obstruction below 60 cm, percent litter, and mean distance to the nearest shrub/seedling, explained 70.1% of the variability between nest and control sites. When entered in the DISCRIM function this model correctly reclassified 90.5% of all nest sites and 95.2% of all controls. The percent visual obstruction both above and below 60 cm made up the second discriminating model (II). Model II explained

Table 11. Variable means showing significant differences ($P<0.05$) between 21 wild turkey nest sites and random control sites located in grassland habitats in Gregory County, South Dakota during 1986 and 1987.

| Variable | Site Means: Nests | Site Means: Controls | F Value | $X^2$ | Probability |
|---|---|---|---|---|---|
| % shrub cover at nest | 39.79 | 9.14 | 20.46 | — | 0.0001 |
| % litter at nest | 8.79 | 27.15 | 37.49 | — | 0.0001 |
| % bare ground at nest | 0.10 | 6.78 | 14.12 | — | 0.0005 |
| % visual obstruction 0-60 cm at nest | 98.39 | 48.45 | 56.80 | — | 0.0001 |
| % visual obstruction 60-180 cm at nest | 58.74 | 9.92 | 46.00 | — | 0.0001 |
| mean distance to shrub/seedling nearest nest (cm) | 72.14 | 313.00 | 22.08 | — | 0.0001 |
| habitat diversity | 1.36 | 0.70 | 10.76 | — | 0.0022 |
| % visual obstruction 0-60 cm in 0.5 ha surrounding area | 72.06 | 54.58 | 6.13 | — | 0.0176 |
| % visual obstruction 60-180 cm in 0.5 ha surrounding area | 26.48 | 13.45 | 4.49 | — | 0.0404 |
| MANOVA statistic | — | — | 7.78 | — | 0.0001 |
| number of sites with/without overhanging vegetation | 18/3 | 1/20 | — | 24.60 | <0.01 |

Table 12. Three models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between wild turkey nest sites and random control sites located in grassland habitats, and their discriminating abilities. Based on data collected at 21 nest and control sites located in Gregory County, South Dakota during 1986 and 1987.

| Model | Variables Included | Cumulative Wilk's Lambda |
|---|---|---|
| I[a] | % visual obstruction 0-60 cm at the nest | 0.4132 |
| | % litter at the nest | 0.3376 |
| | mean distance from nest to nearest shrub/seedling | 0.2994 |
| II[a] | % visual obstruction 0-60 cm at the nest | 0.4132 |
| | % visual obstruction 60-180 cm at the nest | 0.3705 |
| III[b] | habitat diversity | 0.7880 |
| | % visual obstruction 0-60 cm in the 0.5 ha surrounding area | 0.7046 |

| | % Proper Reclassification | |
|---|---|---|
| | Nests | Controls |
| Model I | 90.48 | 95.24 |
| Model II | 95.24 | 85.71 |
| Model III | 76.19 | 76.19 |

[a] derived from all variables measurements taken at the nest and in the 0.5 ha surrounding area

[b] derived from only those variable measurements taken in the 0.5 ha area surrounding the nest

63.0% of the variability between sites and correctly reclassified 95.2% of all nests and 85.7% of all controls. The third model (III) consisted of percent visual obstruction below 60 cm in the 0.5 ha surrounding area and habitat diversity, and accounted for 29.5% of the variability between classes. DISCRIM correctly reclassified 76.2% of all sites using this model.

**Agricultural and Farmstead.** No analyses were run on the 3 nests located in these types due to the difficulty in randomly locating control sites and the variety of land use practices within these types. Although landowners often reported disturbing nests during alfalfa mowing operations, only 1 radio instrumented hen nested in this type. The 2 nests located in the farmstead type (1 located incidental to tracking the other hen) were placed 5 m apart in an overgrown, weedy hay yard 60 m from an occupied dwelling.

## DISCUSSION

The 69.8% nesting rate and 43.6% nest success rate for turkeys in this study differed considerably from those reported earlier for this population. Wertz and Flake (1988) reported a 42% nesting rate and McCabe (1984) reported nest success of 21%. Variable conditions between years and dissimilar sample sizes may be responsible for these differences. The low renesting and juvenile nesting rates do agree with Wertz and Flake (1988).

Productivity statistics for this population compare favorably with those reported elsewhere for stable turkey populations. Williams et al. (1968), Hon et al. (1978), Reagan and Morgan (1980), Everett et al. (1980), and Schemnitz et al. (1985) reported nesting rates between 53% and 86%. However, the juvenile nesting rate of 17% is considerably lower than most reports (Williams et al. 1971, Everett et al. 1980, Reagan and Morgan 1980). The nest success rate of 43.6% is nearly identical to the 43% average success rate Kalmbach (1939) reported for ground nesting birds, and the 45% success Hickey (1955) reported for galliform birds. Although Bailey et al. (1951) and Everett et al. (1980) have reported higher nest success for wild turkeys, most studies of stable populations show success rates lower than 40% (Mosby and Handley 1943, McDowell 1956, Cook 1972, Reagan and Morgan 1980). Egg hatchability (91.8%) was similar to many other reports (McDowell 1956, Hon et al. 1978, Everett et al. 1980, Lockwood and Sutcliffe 1985).

The 11% renesting rate observed was much lower than seen elsewhere. Renesting rates from 27% to nearly 100% have been reported (Williams et al. 1971, Schemnitz et al. 1985, Vangilder et al. 1987). There are 3 possible reasons for this. First, because nests were not located until after incubation had begun, there is no assurance that nests located later in the season were not renesting attempts. Second, the population may be at a density which suppresses nesting activity (Wertz and Flake 1988). And lastly, blizzard conditions during April 1986 may have interfered with normal nesting chronology during that year (Markley 1967).

Because no attempts were made to locate nests before the onset of incubation, data presented here will be biased. Nesting rates are probably lower, and nest success rates higher than the actual population values (Mayfield 1961, Speake 1980).

The distances other investigators have reported for dispersal of wild turkey hens from winter ranges to nest sites are variable. Logan (1973), Eaton et al. (1976), Burkert (1978), and Vander Haegen et al. (1988) reported mean dispersal distances in excess of 5.0 km. In contrast, mean dispersal was 3.1 km in Alabama (Speake et al. 1969), 1.9 km in Florida (Williams et al. 1974), and 2.1 km in Georgia (Hon et al. 1978). These lower dispersal distances may result from 2 situations: the population range is restricted by habitat and/or physiographic conditions, or adequate habitat is readily available and uniformly distributed (Speake et al. 1969, Williams et al. 1974). The relatively short dispersal distances (2.6 km from winter ranges and 3.4 km from the capture site) observed for nesting hens in Gregory County may be a result of both conditions. Although movement between the 2 major drainages in the area does occur, it appears to be somewhat restricted. Birds tended to stay in one or the other drainage system rather than cross dividing ridges and open country between these drainages. However, because hens did not generally move great distances within the drainages before establishing nests, and they often nested in areas other hens had vacated in order to nest elsewhere (Williams et al. 1974), nesting habitat is not thought to be limiting. The tendency for juvenile hens to disperse farther than adults (Eaton et al. 1976, Vander Haegen et al. 1988) could not be tested. The only juvenile to nest during this study dispersed 1.8 km.

It has been suggested that turkey hens show fidelity to nesting ranges (Hayden 1980). In a recent study in Massachusetts, Vander Haegen et al. (1988) reported 5 hens returning to their previous year's nesting range. Three of these hens nested within 200 m of the previous year's nest. However, Kulowiec (1986) reported that the average distance between nests in consecutive years in Michigan was 1.0 km. Although 3 hens from the present study nested within 0.1 km of the preceding year's nest, 6 nested farther than 0.8 km from the earlier nest. The average of these distances is 0.9 km. The distance between nests in succeeding years could not be linked to success of prior nesting attempts due to the low number of hens nesting in succeeding years (Table 5). Site fidelity, if it exists, is probably an individual attribute. The location of the 2 renests within 0.5 km of the initial attempt may indicate that renesting occurs in areas either within the original spring range, or at least familiar to the hen. Williams et al. (1974) reported the average distance hens moved to establish a second nest in Florida was ~~0.5~~ 1.3 km.

Nests in Gregory County were placed in positions providing concealment for both hen and nest, as evidenced by the higher ($P<0.01$) visual obstruction values at nest sites (Tables 9 and 11). The significantly higher percent shrub cover at both woodland ($P<0.05$) and grassland ($P<0.01$) nests, and significantly lower ($P<0.05$) distance to nearest shrub stem at grassland nests show the importance of shrub species in fulfilling this requirement (Tables 8 and 10). Grenon (1986) reported nesting hens in Michigan showed a preference for shrub types. <u>Gooseberry (*Ribes missouriense*)</u> was the most frequently chosen nesting cover (n=8) in woodland habitats in Gregory County. Prunus spp. (n=3), bur oak (n=3), eastern red cedar, American elm, wolfberry, dogwood, peach-leaved willow (Salix amygdaloides), and downed logs, as well as combinations of these, were also used as nest cover. Porter (1978) reported that gooseberry was often present within 10 m of hardwood nest sites in southeast Minnesota. Grassland nests were most frequently situated in wolfberry (n=8) and Prunus spp. (n=4). Other grassland nests were associated with smooth sumac, poison ivy (Toxicodendron rydbergii), eastern red cedar, iron weed (Vernonia fasciculata), yellow sweet clover (Melilotus officinalis), and smooth brome (Bromus inermis). The 2 farmstead nests were set in a dense tangle of dock (Rumex spp.), field bind weed (Convolvulus arvensis), and fireweed (Kochia scoparia). The use of low, dense vegetation for nest cover has also been reported by Healy (1981). Lower values for litter and bare ground at both woodland and grassland nest sites are related to the higher shrub cover, as is the higher incidence of overhanging vegetation.

The diversity indices for both woodland and grassland nest sites were significantly higher (P<0.01) than controls. In woodlands the high diversity is due to placement of nests near grassland edges (772 cm vs 1486 cm; P<0.05). Many investigators have pointed to a relationship between nests and open areas. Speake et al. (1975) showed 57.5% of nests in their study area were located in openings. Williams et al. (1971), Glidden (1977) and Hayden (1979) all reported nests located in proximity to open areas, trails, or other openings. Clark (1985) reported that hens nesting in woodlands in Ohio located their nests an average 28 m from openings. Location of nests in these situations places them in more diverse habitats. No relationship between edge and nest location could be determined for grassland nests. Nests in grasslands were located up to 195 m from a woodland edge. High diversity at grassland sites was related to placement in shrub communities.

Logan (1973) and Speake et al. (1975) have reported that hens, though seeking adequate cover, also require a site with a good field of vision and unobstructed escape routes. Analyses of nest characteristics show that hens in Gregory County also select sites with good visibility and escape opportunities. Woodland nest sites exhibited lower ($P<0.05$) sapling densities, both at the nest and in the 0.5 ha area surrounding the nest, than control sites. In addition, percent visual obstruction above 60 cm in the 0.5 ha surrounding area was significantly lower ($P<0.05$) for woodland nest sites. Fewer trees in the pole size class means less interference to visibility and movement. This relationship is not as easily seen in grassland habitats. Visual obstruction is greater ($P<0.05$) at grassland nests, and in the 0.5 ha surrounding area at both levels (below and above 60 cm) than at control sites. The explanation probably lies in the ability to see for great distances in grassland situations. Although hens have a greater field of vision while on the nest, they may also be more easily detected when approaching or leaving the nest. Therefore, it would behoove the hen to locate the nest in an area with vegetation dense enough to conceal her movements. Because grassland vegetation does not hinder hen movements, the greater density of surrounding vegetation should not impede escape routes.

Descriptions based on these individually significant variables are valuable for providing general knowledge of nest site characteristics. However, hens probably choose sites for a variety of conditions and combinations thereof. Because of this, multivariate techniques are effective for determining which habitat relationships may motivate nest site selection (Lazarus and Porter 1985). As with the univariate approach, STEPDISC and DISCRIM verify the reliance of hens on dense cover for nest sites. The first discriminating factor in woodland model I and grassland models I and II are visual obstruction (Tables 10 and 12). In fact, visual obstruction values are the only variables found in grassland model II. The inclusion of mean distance to the nearest shrub stem in grassland model I also shows the importance of shrub cover to meet security needs of hens.

Diversity is also an important factor in discriminating between nests and controls. The 0.5 ha area surrounding both woodland and grassland nests was significantly more diverse ($P<0.01$) than at control sites. Using this area measure, coupled with sapling density in woodlands or visual obstruction below 60 cm in grasslands, sites may be accurately differentiated in 45% or more of the situations. The general area characteristics, then, may play a role in nest site selection (Lazarus and Porter 1985).

The question still remains as to why nesting hens choose grassland habitats over woodlands late in the season. The 2 hens which renested in 1987 first nested in woodlands, but placed their second nests in grassland types. Wertz (1986) noticed the same shift for this population. A shift to cyprus forest from scrub oak ecotones was seen in Florida (Williams et al. 1968). The authors suggested that cyprus was preferred, but unavailable until early summer, too late for most hens to use. Lazarus and Porter (1985) reported hens selecting open types later in the season, but did not define 'open types'. They hypothesized that these later nests were renesting attempts and hens placed the nests in open habitats in order to be nearer good brood rearing habitat. In Gregory County, however, broods moved as much as 3.5 km from late initiated grassland nests before establishing definite ranges (see Chapter 2). The shift to grasslands occurred at the time vegetation characteristics in grasslands were approaching levels similar to those available in woodlands (Figure 3). Presumably, grasslands provide better nest concealment and field of vision, and better opportunities for escape. They may also provide relief from avian predation. Snyder (1985) showed that pheasant hens associated with trees in April had higher mortality than others, and related this to avian predation. Angelstam (1986) reported that destruction of ground-nests by avian predators was highest in and around woodlands. Avian predation of nests was observed in both habitats during this study, but was probably not greater than mammalian predation. Avian predation could be part of the reason many grassland nests were located so far (up to 195 m) from trees. The use of woodlands prior to May is a result of poor nesting conditions in grasslands. Because of the shift, grasslands should be considered important nesting habitats for late-nesting and renesting birds.

# CHAPTER II

# WILD TURKEY BROOD RANGES AND HABITAT USE PATTERNS

## INTRODUCTION

Lindzey (1967) and Hillestad and Speake (1970) emphasized the importance of high-quality brood rearing habitats to the stability of wild turkey populations. The availability and juxtaposition of such habitats greatly affect the movements, home range configurations, and habitat use patterns of broods (Hillestad and Speake 1970, Hillestad 1973, Hayden 1980).

Following hatching of a clutch, a hen may either remain in the vicinity of the nest, or immediately move her brood a considerable distance before establishing a brood range (Hon et al. 1978, Grettenberger 1979, Hayden 1980). In either case, regular shifts and increases in brood ranges occur throughout the season (Porter 1980, Crim 1981). These shifts are related to food and habitat requirements, as well as the increase in poult mobility with age. During the first few weeks of life, poults require high protein foods. These high protein requirements are met by animal matter, primarily insects (Blackburn et al. 1975, Hurst and Stringer 1975). Insect availability is higher in open than wooded areas (Martin and McGinnes 1975), and broods frequent open areas during this early period (Phillips 1983). As poults age, vegetative matter becomes a more important part of the diet (Hamrick and Davis 1971) and they are better able to negotiate the dense confines of wooded habitats. At this point, a shift to use of forested areas can be expected (Petersen and Richardson 1975, Pybus 1977, Grettenberger 1979).

Sizes reported for brood ranges vary considerably (Brown 1980), no doubt reflecting changes in poult mobility with age, differing reporting methods, and variability between habitats. Hayden (1979) reported summer brood ranges averaging as little as 92 ha in Pennsylvania, while Pack et al (1980) reported summer brood ranges averaging 455 ha in West Virginia.

Good brood habitat consists of a mix of forested cover and well interspersed openings (Hillestad and Speake 1970, Speake 1980). Broods prefer wooded habitats with open, herbaceous understory (Pybus 1977, McCabe and Flake 1985). Savannah types are used extensively when available (Hayden 1979). Healy (1981) determined that good brood habitat consisted of total coverage of forbs and grasses with canopy height of 40 to 70 cm, and standing crop of 600 to 3000 kg/ha dry weight under a sparse canopy. Metzler and Speake (1985) reported successful brood hens used areas with greater canopy coverage, lower basal area, greater herbaceous vegetation height, and which were closer to openings than areas used by less successful brood hens.

The second phase of this study was designed to determine brood movement and habitat use patterns, size and habitat composition of brood ranges, characteristics of brood use sites, and how each of these changes with brood age.

## METHODS

Radio equipped hens were monitored using the telemetry methods previously described (see page 6). Location data were analyzed with the TELEM computer program (Koeln 1980). The TELEM program plots animal locations from simultaneous fixes and, based on these locations, determines movement statistics, delineates home range boundaries, and calculates home range areas.

Hens that hatched a clutch were located as soon as possible after hatching to determine brood status and habitat use. Sightings were made on each brood every 3-4 days thereafter until mid-August. Sightings were staggered throughout the day to avoid bias due to diurnal activity patterns. Complete poult counts were made at each sighting, when possible. The center of each brood observation/flush site was flagged to facilitate future habitat measurements.

Brood Ranges and Movements

Brood ranges were plotted for each brood which met the minimum criteria for analysis (see Statistical Analysis). Ranges were plotted for these broods over 3 periods: early brood (Age 1; hatch to 4 weeks old), late brood (Age 2; older than 4, and up to 12, weeks), and total summer (SUMMER; hatch until mid-August). Brood range boundaries and areas were computed following the modified minimum area method of Harvey and Barbour (1965). Each home range plot was superimposed on the study area cover map and the AREAS program used to determine the area and proportion of each cover type within the home range.

Habitat Use

Radio locations were plotted by age class (Age 1 and Age 2) and time of day to test for habitat use patterns. Diurnal use was considered over 5 time periods: daybreak (0530 hr to 0630 hr), morning (0631 hr to 1130 hr), mid-day (1131 hr to 1630 hr), evening (1631 hr to 2030 hr), and dusk (2031 hr to 2130 hr). Plots of brood locations by age and time period were superimposed on the study area cover map and the number of locations in each habitat type tallied. Locations on the edge between 2 types were evenly divided between each type. Any odd locations were placed in the type with the greater number of observations. Daybreak and dusk time periods were established to account for roosting activity and were not included in analyses.

Characteristics of Brood Use Sites.

Habitat characteristics of brood use sites and an equal number of randomly located control sites were measured in a 5 x 5 m sampling plot centered on the flush site. The variables measured are presented in Table 13. Five transects were established parallel to the site contour within the sampling plot. Transects were 1 meter apart with the first and last set 0.5 m inside the plot boundary. Percent shrub cover below 30 cm, percent grass cover, percent forb cover, percent litter and percent bare ground were measured at 2 randomly located points along each transect. Measurements were made using a 20 x 50 cm vegetation sampling frame (Daubenmire 1959). The percent of each cover type within the frame was visually estimated. These estimates were corrected to 100% and the 10 readings averaged to

Table 13. Habitat variables measured at wild turkey brood use sites and random control sites in Gregory County, South Dakota during 1986 and 1987.

| Variable | Method of Measurement |
|---|---|
| % grass cover | Vegetation sampling frame |
| % forb cover | " |
| % shrub cover below 30 cm | " |
| % litter | " |
| % bare ground | " |
| % shrub cover above 30 cm | Line-intercept |
| % visual obstruction below 60 cm | Vertical profile board |
| % visual obstruction above 60 cm | " |
| distance to nearest habitat edge | Measuring tape/map |
| soft fruit abundance | count |
| arthropod abundance | " |
| aspect | Abney level |
| slope (1987 only) | Compass |
| ave. dist. to nearest shrub/seedling | Point-centered quarter |
| % canopy cover[a] | Model C densiometer |
| ave. dist. to nearest tree[a] | Point-centered quarter |
| ave. dbh of nearest trees[a] | " |
| ave. dist. to nearest sapling[a] | " |

[a] measurements taken only at woodland sites

.ve the site value. The line intercept method was used to measure ie shrub cover above 30 cm along each transect.

Visual obstruction provided by vegetation at brood flush .tes was estimated by placing a 1.8 m visual profile board (Nudds )77) at the site center and viewing from 4 different directions. The estimates were made from a distance of 5 m and height of 50 cm along ie lines which bisected each side of the 5 x 5 m plot. The percent : each of 6, 30 cm sections obscured by vegetation was estimated and ie 4 readings averaged to give a site value for each board section. oard sections were pooled as necessary during analyses.

Distance to the nearest habitat edge was measured from the enter of each flush site using a 100 m tape, by pacing, or from erial photographs. Aspect was measured using a pocket compass, and lope, measured only in 1987, with an Abney level.

Forest measurements were made at woodland sites. Canopy losure was estimated at the flush site center with a model C ensiometer (Lemmon 1956). The point-centered quarter method (Cottam nd Curtis 1956) was used to determine mean distances to the nearest ree (≥ 10 cm dbh), sapling (≥ 3 cm dbh but < 10 cm dbh), and hrub/seedling (< 3 cm dbh). Mean distance to the nearest hrub/seedling was also measured at grassland sites.

Food availability at flush sites was measured by making a otal count of all soft fruits within the plot boundaries and below 1 ı high, and by establishing an index of arthropod abundance. rthropod abundance was determined by counting all arthropods encountered while slowly walking the plot boundary, as well as in 4, 1 x 1 m plots placed randomly within the 5 x 5 m sampling plot.

## Statistical Analysis

Only those telemetry locations resulting from bearings with angles of intersection between $30^{\circ}$ and $150^{\circ}$ were used for analyses. This provided control of error polygons (Heezen and Tester 1967, Springer 1979) without compromising sample size or ignoring known brood behavior patterns. Broods whose ranges and/or behavior patterns were thought to affect signal reception or ability to locate them accurately were excluded from analyses.

Chi-square analysis was used to compare the proportion of each habitat type within the 3 brood ranges (Age 1, Age 2, and SUMMER) to the proportions for the study area. This was done for each brood individually, and for the average ranges of all broods. Differences in habitat proportions between Age 1 and Age 2 ranges, and between all broods were tested using contingency tables.

Habitat use in relation to availability was tested using chi-square analysis. Selection and avoidance of habitat types by age, by time of day, and by both age and time of day were analyzed at the 0.10 level of probability following the method of Neu et al. (1974). Expected values for these tests were derived from the proportion of habitat types in each of the previously delineated brood ranges.

Habitat measurements from brood flush sites were compared to those from controls to determine differences between brood use sites and the general study area, as defined by the pooled control values.

Data were analyzed using Statistical Analysis Systems (SAS) computer software (SAS Institute, Inc. 1985). Analysis of variance (ANOVA) and categorical data modelling (CATMOD) were used to test for differences between individual variables. Multivariate analysis of variance (MANOVA), stepwise discriminant analysis (STEPDISC), and discriminant analysis (DISCRIM) were used to test differences due to the combined effects of groups of variables. Statistical tests were evaluated at the 0.01, 0.05, and 0.10 levels of probability.

## RESULTS

### Brood Survival

Radio equipped hens produced 17 broods during the 2 year study period. Complete loss of 5 broods occurred during the first 2 weeks post-hatch, including the loss of a broody hen. A second broody hen was lost at 7 weeks, but because her 3 poults were last seen 8 days prior to her death, they were assumed dead. These figures indicated brood survival of 64.7% (11 of 17) for both years combined. Poult counts, including total brood loss, during 1986 showed poult survival of 42.9% from hatch to mid-August. All poult mortality in 1986 occurred in the first 2 weeks post hatch (Table 14). Loss of broody hens, brood behavior, and brood dynamics prevented accurate counts in 1987, but survival appeared to be similar to 1986 (Table 15).

Table 14. Poult survival[a] (%) for 7 wild turkey broods during the summer of 1986 in Gregory County, South Dakota.

| | | | | Survival | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Age 2 Weeks | | Age 4 Weeks | | Mid-August | |
| Brood | Clutch Size | Number Hatched | Number at First Sighting[b] | Number of Poults | Percent of Hatch[c] | Number of Poults | Percent of Hatch[c] | Number of Poults | Percent of Hatch[c] |
| 283 | — | — | 1 | 3[d] | — | 3[d] | — | 3[d] | — |
| 405 | 10 | 10 | 6 | — | — | 6[e] | 60.0 | 6[e] | 60.0 |
| 437 | 10 | 8 | 3 | 0 | 0.0 | — | — | — | — |
| 444 | 9 | — | 4 | 4[d] | — | 4[d] | — | 4[d] | — |
| 449 | 13 | 13 | 3 | 2 | 15.4 | 2 | 15.4 | 2 | 15.4 |
| 486 | 12 | 11 | 11 | 10[f] | 90.9 | 10 | 90.9 | 10 | 90.9 |
| 487 | — | — | 3 | 3 | — | 3[e] | — | 3[e] | — |
| TOTAL[c] | 45 | 42 | 23 | 18 | 42.9 | 18 | 42.9 | 18 | 42.9 |

[a] survival given is percent of total hatched
[b] these counts not exact due to difficulty of counting poults at early ages
[c] calculations made only on those broods for which accurate total counts for clutch size and hatch were available
[d,e] indicates broods which joined to form a creche
[f] poult lost due to observer interference

Table 15. Poult survival (%) for 10 wild turkey broods during the summer of 1987 in Gregory County, South Dakota.

| | | | First Sighting | | Survival | | |
|---|---|---|---|---|---|---|---|
| | | | | | Age 2 Weeks | | Age 4 Weeks |
| Brood | Clutch Size | Number Hatched | Number | Percent[a] | Number of Poults | Percent of Hatch[a] | Number of Poults |
| 429 | — | — | 1 | — | 0 | 0.0 | — |
| 471 | 18 | 18 | 10 | 55.6 | 0[b] | 0.0 | — |
| 477 | 14 | 13 | 12 | 92.3 | 5 | 38.5 | 4[b] |
| 605[c] | 13 | 12 | 7 | 58.3 | 0 | — | — |
| 615 | 10 | 10 | 0 | 0.0 | — | — | — |
| 643 | 11 | 9 | 2 | 22.2 | 1 | 11.1 | —[d] |
| 658 | 9 | >7 | 1 | — | —[d] | — | —[d] |
| 646 | 11 | >7 | 2 | — | 6 | — | —[d] |
| 647 | 11 | 8 | 4 | 50.0 | —[d] | — | —[d] |
| 649 | — | — | 1 | — | 7 | — | —[d] |
| TOTAL[a] | 77 | 70 | 35 | 50.0 | — | — | — |

[a] calculations based on broods with accurate total clutch and hatch counts only
[b] contact with brood lost due to death of hen
[c] indicates brood hatched from second nest
[d] accurate counts not possible because in very large or instable creche

## Brood Ranges and Movements

Brood movements following hatch varied. Some broods extended their range gradually with time. Other broods moved immediately to another area before establishing a definite range, covering as much as 3.5 km over a 2 week period. During this phase of movement, or around the time the range was established, all broods formed larger creches with other broods.

Because of the constraints placed on TELEM data (see Statistical Analysis), only 4 of the 12 broods that survived beyond 4 weeks could be used for home range and habitat use analyses. Two of these broods joined to form a creche. A total 637 locations were plotted for these 4 broods, and brood ranges were plotted from these locations. Some known use areas were excluded from these ranges because of the previously described telemetry constraints. The mean range sizes for the 4 broods were: 42.1 ha for Age 1, 126.7 ha for Age 2, and 198.2 ha SUMMER (Table 16). These figures represent an increase in brood range size of 3 times between Age 1 and Age 2. SUMMER ranges were larger than Age 1 and Age 2 ranges combined because the two smaller ranges were usually separated spatially to some degree and the SUMMER range included the area between, as well as that encompassed by these ranges.

Proportions of each habitat type within each brood range were significantly different ($P<0.05$) from the proportions in the study area. Broods established ranges with greater than expected areas of woodlands, and less than expected areas of agricultural lands/farmsteads for all 3 brood categories (Table 17). The

Table 16. Mean range sizes[a] (ha) and habitat proportions (%) from 593 telemetry locations on 4 wild turkey broods in Gregory County, South Dakota during 1986 and 1987.

| | AGE: 0-4 weeks | | | AGE: > 4 weeks | | | SUMMER | | |
|---|---|---|---|---|---|---|---|---|---|
| Habitat | Area (ha) | SD | Proportion of Range | Area (ha) | SD | Proportion of Range | Area (ha) | SD | Proportion of Range |
| Woodland | 22.6 | 13.02 | 53.7 | 74.6 | 24.60 | 58.9 | 110.9 | 31.81 | 56.0 |
| Grassland | 18.6 | 10.06 | 44.2 | 50.4 | 18.83 | 39.8 | 83.8 | 28.78 | 42.3 |
| Cultivated | 0.8 | 1.05 | 1.9 | 1.7 | 2.86 | 1.3 | 3.4 | 4.72 | 1.7 |
| Farmstead | 0.1 | 0.1 | 0.1 | 0.0 | — | 0.0 | 0.1 | 0.15 | 0.1 |
| TOTAL | 42.1 | 23.95 | 99.9 | 126.7 | 44.98 | 100.0 | 198.2 | 63.08 | 100.1 |

[a] modified minimum area method (Harvey and Barbour 1965)

Table 17. Chi-square analysis tests for differences between the proportion of habitat types within mean ranges of 4 wild turkey broods during 1986 and 1987 and habitat proportions within a Gregory County, South Dakota study area.

| | AGE: 0-4 weeks | | | AGE: > 4 weeks | | | SUMMER | | |
|---|---|---|---|---|---|---|---|---|---|
| Habitat | Obs | Exp | $X^2$ | Obs | Exp | $X^2$ | Obs | Exp | $X^2$ |
| Woodland | 22.6 | 12.97 | 7.15* | 74.6 | 39.02 | 32.44** | 110.9 | 61.05 | 40.70** |
| Grassland | 18.6 | 22.06 | 0.54 | 50.4 | 66.39 | 3.85 | 83.8 | 103.86 | 3.88 |
| Ag/Farm | 0.9 | 7.07 | 5.38* | 1.7 | 21.29 | 18.03** | 3.5 | 33.30 | 26.67** |
| TOTAL | 42.1 | 42.10 | 13.07** | 126.7 | 126.70 | 54.32** | 198.2 | 198.2 | 71.25** |

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

proportion of each habitat type within the brood ranges did not differ (P>0.10) between ages, or between the 4 broods individually.

## Habitat Use

Exclusion of the daybreak and dusk time periods from analyses left 593 of the 637 brood locations for habitat use comparisons. The distribution of telemetry fixes across time for the 3 remaining time periods was tested for each brood and for all 4 broods combined using a chi-square statistic. Expected values were based on the respective lengths of the 3 time periods. The result was not significant (P>0.10). Therefore, it was assumed brood signals were received proportionately across these time periods. Tests for habitat use versus availability for each brood period were not significant (P>0.10) (Table 18), suggesting that habitat use was in proportion to habitat availability within the ranges. Differences in habitat use were detected when the proportion of locations in each habitat type during each time period were compared to the proportions expected (Table 19). Grasslands were not used proportionately (P<0.05) over time for Age 2 or SUMMER broods. This was due to greater than expected use (P<0.05) in the morning (0631-1130 hr) and less than expected use (P<0.05) during mid-day (1131-1630 hr). Woodlands were used in proportion to expected amounts over the SUMMER when tested at the 0.05 level of probability, but were not at the 0.10 level of probability. This was the result of use less than expected in the morning and greater than expected during mid-day, although these differences were not significant. Despite these differences,

Table 18. Chi-square analysis for habitat use by 4 wild turkey broods in Gregory County, South Dakota during 1986 and 1987. Observed proportions based on the number of telemetry locations in each habitat type, and expected proportions based on habitat proportions for mean brood ranges.

| | AGE: 0-4 weeks | | | AGE: > 4 weeks | | | SUMMER | | |
|---|---|---|---|---|---|---|---|---|---|
| Habitat | Obs | Exp | $X^2$ | Obs | Exp | $X^2$ | Obs | Exp | $X^2$ |
| Woodland | 115 | 126.73 | 1.09 | 205 | 210.27 | 0.13 | 320 | 332.08 | 0.44 |
| Grassland | 119 | 104.31 | 2.07 | 149 | 142.09 | 0.34 | 268 | 250.84 | 1.17 |
| Ag/Farm | 2 | 4.72 | 1.57 | 3 | 4.64 | 0.58 | 5 | 10.08 | 2.56 |
| TOTAL | 236 | 235.76 | 4.73 | 357 | 357.00 | 1.05 | 593 | 593.00 | 4.17 |

Table 19. Chi-square analysis of habitat use by time of day, and age for 4 wild turkey broods in Gregory County, South Dakota during 1986 and 1987. Observed use is based on the number of telemetry locations in each habitat type during each time period, and expected use from the proportion of observations expected given the length of each time period.

| Time Period | AGE: 0-4 weeks | | | AGE: > 4 weeks | | | SUMMER | | |
|---|---|---|---|---|---|---|---|---|---|
| | Obs | Exp | $X^2$ | Obs | Exp | $X^2$ | Obs | Exp | $X^2$ |
| **WOODLAND** | | | | | | | | | |
| 0631-1130 | 44 | 41.07 | 0.21 | 68 | 73.21 | 0.37 | 112 | 114.29 | 0.05 |
| 1131-1630 | 46 | 41.07 | 0.59 | 85 | 73.21 | 1.90 | 131 | 114.29 | 2.44 |
| 1631-2030 | 25 | 32.86 | 2.32 | 52 | 58.57 | 0.74 | 77 | 91.43 | 2.28 |
| TOTAL | 115 | 115.00 | 3.12 | 205 | 204.99 | 3.01 | 320 | 320.01 | 4.77[a] |
| **GRASSLAND** | | | | | | | | | |
| 0631-1130 | 49 | 42.50 | 0.99 | 66 | 53.21 | 3.07 | 115 | 95.71 | 3.89* |
| 1131-1630 | 42 | 42.50 | 0.01 | 38 | 53.21 | 4.35* | 80 | 95.71 | 2.58 |
| 1631-2030 | 28 | 34.00 | 1.06 | 45 | 42.57 | 0.14 | 73 | 76.57 | 0.17 |
| TOTAL | 119 | 119.00 | 2.06 | 149 | 148.99 | 7.56* | 268 | 267.99 | 6.64* |

[a] $P<0.10$
* $P<0.05$

selection/avoidance could be demonstrated in only 2 instances (Table 20). Grasslands were selected (P<0.10) in the morning for the SUMMER period, and were avoided (P<0.10) during mid-day by Age 2 broods. Only 5 locations were recorded in agricultural and farmstead habitats for these four broods. Tests showed this use was in proportion to availability

## Characteristics of Brood Use Sites

Twice weekly observation of 17 broods resulted in 133 total sightings. In addition, 28 sightings of unmarked broods were made incidental to regular activities. All sightings of broods which were thought to have been influenced by investigator activity before visual contact was made, and the only 3 observations from agricultural types, were excluded from analyses. As a result, 86 grassland and 36 woodland sites were considered acceptable for analysis.

Grasslands. Analyses of grassland brood use sites and controls showed that 5 of 12 variables were significantly (P<0.05) different between the 2 classes (Table 21). Percent grass cover was less (P<0.01), percent forb cover was greater (P<0.05), distance to the nearest habitat edge was less (P<0.01), and soft fruit and arthropods were more abundant (P<0.01) for brood use sites than controls. However, soft fruit and arthropod abundance exhibited a site by year interaction (P<0.01), and percent shrub cover above 30 cm and the mean distance to the nearest shrub/seedling were different (P<0.05) between years. This prohibited using these 4 variables in analyses across years. The MANOVA statistic for the 8 remaining

Table 20. Habitat selection/avoidance of 4 wild turkey broods by time period in Gregory County, South Dakota during 1986 and 1987. Expected values are based on habitat proportions in mean brood ranges for each age class. Only habitat and age class combinations showing significance are listed.

| Time Period | Proportion of Total | Number of Telemetry Locations Observed | Number of Telemetry Locations Expected | $X^2$ | Proportion Observed | 90% Confidence Interval on Proportion Observed |
|---|---|---|---|---|---|---|
| **Grasslands: Age: > 4 weeks** | | | | | | |
| 0631-1130 | 0.357 | 66 | 53.21 | 3.07 | 0.443 | $0.356 \le P \le 0.530$ |
| 1131-1630 | 0.357 | 38 | 53.21 | 4.35* | 0.255 | $0.179 \le P \le 0.326$[a] |
| 1631-2030 | 0.286 | 45 | 42.57 | 0.14 | 0.302 | $0.222 \le P \le 0.382$ |
| TOTAL | 1.000 | 149 | 148.99 | 7.56* | 1.000 | |
| **Grasslands: SUMMER** | | | | | | |
| 0631-1130 | 0.357 | 115 | 95.71 | 3.89* | 0.429 | $0.365 \le P \le 0.493$[b] |
| 1131-1630 | 0.357 | 80 | 95.71 | 2.58 | 0.298 | $0.239 \le P \le 0.357$ |
| 1631-2030 | 0.286 | 73 | 76.57 | 0.17 | 0.272 | $0.214 \le P \le 0.330$ |
| TOTAL | 1.000 | 268 | 267.99 | 6.64* | 1.00 | |

* $P<0.05$

a shows avoidance at the 90% level because confidence interval is below expected proportion

b shows selection at the 90% level because confidence interval is above expected proportion

Table 21. Variable means showing significant (P<0.05) differences between wild turkey brood use sites and random control sites in Gregory County, South Dakota during 1986 and 1987.

| Variable | Site Means | | | | |
| --- | --- | --- | --- | --- | --- |
| | Use Sites | Controls | F Value | $X^2$ Value | Probability |
| **Grassland Sites** | | | | | |
| % grass cover | 42.12 | 49.20 | 7.68 | — | 0.0062 |
| % forb cover | 15.21 | 10.91 | 5.59 | — | 0.0192 |
| distance to nearest habitat edge (cm) | 2100.07 | 7215.98 | 24.24 | — | 0.0001 |
| MANOVA | — | — | 5.49 | — | 0.0001 |
| soft fruit abundance[a] | 72.37 | 88.65 | — | 66.01 | 0.01 |
| arthropod abundance[a] | 73.99 | 52.36 | — | 336.61 | 0.01 |
| **Woodland Sites** | | | | | |
| distance to nearest habitat edge (cm) | 843.61 | 1588.25 | 5.53 | — | 0.0215 |
| soft fruit abundance[a] | 48.67 | 106.31 | — | 777.96 | 0.01 |
| arthropod abundance[a] | 21.03 | 16.22 | — | 25.38 | 0.01 |

[a] also showed a site by year interaction (P<0.01), and could not be used in discriminant analysis tests over both years

variables (percent cover in grass, forb, shrub, litter and bare ground, percent visual obstruction below and above 60 cm, and distance to the nearest habitat edge) was significant (P<0.01), but was no better at describing the differences between sites than the 3 remaining individually different variables.

Because percent cover in grass, forb, shrub, litter and bare ground always totalled 100%, they were completely collinear. To correct for collinearity, discriminant analysis procedures were conducted 5 separate times, dropping one of these variables each time. Stepwise discriminant procedures developed 3 multi-variable models, from the 5 tests, which explained the variability between brood use sites and controls (Table 22). Model I consisted of 5 discriminating variables: distance to the nearest habitat edge, percent grass cover, percent forb cover, and visual obstruction both below and above 60 cm. These variables accounted for 20% of the variability between sites, and correctly reclassified 92% of brood use sites and 47% of controls when entered in the discriminant function. This model was developed in 3 (tests excluding percent shrub, percent litter, and percent bare ground) of the 5 discriminant situations and included all 3 significantly different variables. Model II (developed when percent forb was excluded) and Model III (developed when percent grass was excluded) were composed of nearly the same variables as Model I and showed approximately equivalent capabilities to explain variability and to discriminate between sites (Table 22).

Comparisons of grassland brood use sites by age class showed that 6 of 12 variables were significantly (P<0.05) different between

Table 22. Three models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between wild turkey brood use sites and random control sites located in grassland habitats, and their discriminating abilities. Based on data collected at 86 brood use and control sites located in Gregory County, South Dakota during 1986 and 1987.

| Model | Variables | Cumulative Wilk's Lambda |
|---|---|---|
| I | distance to nearest habitat edge | 0.8752 |
| | % grass cover | 0.8393 |
| | % forb cover | 0.8270 |
| | % visual obstruction above 60 cm | 0.8174 |
| | % visual obstruction below 60 cm | 0.7975 |
| II | distance to nearest habitat edge | 0.8752 |
| | % grass cover | 0.8393 |
| | % visual obstruction above 60 cm | 0.8299 |
| | % visual obstruction below 60 cm | 0.8024 |
| III | distance to nearest habitat edge | 0.8752 |
| | % forb cover | 0.8487 |
| | % bare ground | 0.8320 |
| | % visual obstruction above 60 cm | 0.8255 |
| | % visual obstruction below 60 cm | 0.8037 |

| | % Proper Reclassification | |
|---|---|---|
| | Brood Sites | Controls |
| Model I | 91.76 | 47.06 |
| Model II | 94.12 | 41.18 |
| Model III | 89.41 | 48.24 |

sites used by Age 1 and Age 2 broods (Table 23). Percent shrub cover above 30 cm was greater (P<0.05), distance to the nearest habitat edge less (P<0.05), percent visual obstruction both below and above 60 cm were greater (P<0.05), and soft fruit and arthropods were less abundant (P<0.01) at Age 1 than Age 2 use sites. However, an age by year interaction (P<0.01) existed for soft fruit and arthropod abundance. Percent visual obstruction below and above 60 cm, percent forb cover, and percent bare ground were different (P<0.05) between years. Because of these differences, only percent cover in grass, litter, and bare ground, distance to the nearest habitat edge, mean distance to the nearest shrub/sapling, and percent shrub cover above 30 cm could be used in pooled analyses. Stepwise discriminant analysis selected percent shrub cover above 30 cm and distance to the nearest habitat edge, the only remaining variables showing significance, to explain the variability between use sites of the 2 age classes. The model based on these variables explained 18% of the variability between age classes, and properly reclassified 73% of Age 1 and 63% of Age 2 use sites. However, 37.4 % of all reclassifications approximated chance occurrence. (Reclassification was assumed to approximate chance occurrence if the posterior probability of membership for an observation was between 0.4 and 0.6.)

Woodlands. Tests on woodland sites showed that only 3 of 16 variables were significantly (P<0.05) different between brood use sites and controls (Table 21). Brood use sites were significantly closer (P<0.05) to grassland edges than control sites, and they harbored less soft fruit (P<0.01) and more arthropods (P<0.01). Site

Table 23. Variable means showing significant ($P<0.05$) differences between brood use sites of of 2 age classes (0 - 4 and beyond 4 of wild turkey poults in Gregory County, South Dakota during 1986 and 1987.

| Variable | Site AGE: 0-4 wks | AGE: > 4 wks | F Value | $X^2$ Value | Probability |
|---|---|---|---|---|---|
| GRASSLANDS | | | | | |
| shrub cover above 30 m | 326.05 | 145.75 | 6.32 | — | 0.0138 |
| distance to nearest habitat edge (m) | 1312.78 | 2708.65 | 9.24 | — | 0.0032 |
| % visual obstruction below 60 cm[a] | 72.03 | 59.96 | 5.29 | — | 0.0240 |
| % visual obstruction above 60 cm[a] | 58.41 | 42.58 | 5.75 | — | 0.0187 |
| soft fruit abundance[b] | 6.92 | 112.76 | — | 2536.16 | 0.01 |
| arthropod abundance[b] | 70.81 | 76.80 | — | 12.10 | 0.01 |
| WOODLANDS | | | | | |
| soft fruit abundance[b] | 33.38 | 57.30 | — | 208.81 | 0.01 |
| arthropod abundance[b] | 32.62 | 14.48 | — | 155.70 | 0.01 |

[a] also shows a between year difference ($P<0.05$), and could not be used in pooled analyses
[b] an age by year interaction ($P<0.01$), and could not be used in pooled analyses

by year interactions (P<0.01) existed for both soft fruit and arthropod abundance, and percent shrub cover and percent litter were different (P<0.05) between years. These 4 variables were excluded from further analyses. As a result, the significant variable, distance to the nearest habitat edge, was the only variable selected by stepwise discriminant analysis to explain the variability between woodland brood use sites and controls. This variable properly reclassified 86% of brood use sites and 44% of controls when entered in the discriminant function. However, it explained only 7% of the variability between sites, and correct reclassification of sites approximated chance occurrence in 59% of the observations.

Analyses for differences in woodland brood use sites by age class detected differences (P<0.01) in soft fruit and arthropod abundance between the 2 classes (Table 23). However, these variables, along with percent shrub cover, exhibited between year differences (P<0.05), and all 3 were eliminated from further analyses. Stepwise procedures, based on the 13 remaining variables (Table 13), selected mean dbh of the nearest trees as the only variable which would discriminate between age classes at the 0.05 level of probability. This variable explained 10% of the variability between age classes and correctly reclassified 77% of Age 1 and 61% of Age 2 use sites. However, proper reclassification approximated chance occurrence in 41% of the observations.

# DISCUSSION

Brood and poult survival during 1986 and 1987 were markedly improved over 2 previous studies of this population (McCabe 1984, Wertz 1986, Wertz and Flake 1988). This may have been due to differences in sample sizes as well as weather conditions. 1986 and 1987 appeared to be ideal years for production of ground-nesting species. The small size and stability of broods in 1986 provided excellent conditions for monitoring poult survival. All poult mortality occurred in the first 2 weeks of life. Campo et al. (1984) and Holbrook et al. (1987) reported the same poult mortality patterns in Texas and Virginia, respectively. The 42.9% poult survival observed in 1986 is well within the minimum 20% suggested by Glidden and Austin (1975) for sustaining a population. The high poult survival rates may offset the somewhat low juvenile nesting and renesting rates.

After hatch, broods may adopt 2 patterns of movement: a restricted range in the vicinity of the nest which expands over time (Hillestad and Speake 1970, Grettenberger 1979, Hayden 1980), or a direct and immediate movement to a range at some distance from the nest. Reports of movements in this later category have ranged from 0.6 km to 2.7 km (Eaton et al. 1976, Burkert 1978, Hon et al. 1978, Hayden 1980). Both types of movement were observed in this population. Direct movement away from the nest to establish a brood range occurred over distances as much as 3.5 km and usually took 2 weeks. Some broods remained in the vicinity of the nest for the first

1-2 weeks, then moved away as they expanded their range. Still other broods did not include the nest within the early brood range, but returned to or crossed back through the nesting range during the late brood period. Extent of movements did not depend on hatch date, a point which challenges the contention of Lazarus and Porter (1985) that late nesting hens locate nests near good brood habitat. All broods formed creches, most during the first 2 weeks of random movements.

Hillestad and Speake (1970), Hillestad (1973), and Hayden (1980) related brood movements and home ranges to availability of adequate habitat: particularly the numbers of small openings, improved pasture, and amount of savannah. The mean summer range of 198.2 ha observed here is among the smallest reported for turkey broods. Speake et al (1975) reported brood ranges averaging 111 ha in Alabama, Hayden (1980) reported ranges as small as 92 ha in Pennsylvania, and Crim (1981) reported ranges of 146 ha in Iowa. Other investigators have reported ranges from 250 ha to 714 ha (Burkert 1978, Everett et al. 1980, Pack et al. 1980, Porter 1980). The small mean home range suggests that adequate habitat is available in this region. The increase of home range size from 42.1 ha to 126.7 ha (3x) with time is consistent with increasing poult mobility (Porter 1980, Crim 1981).

Few studies of wild turkey populations have been conducted in regions with as little forested area as the 30.8% in this study. Wunz (1971) and Grenon (1986) reported turkey populations existing in areas with as little as 25% forest cover, but their existence is largely aesthetic. Most studies have been conducted in heavily forested areas roken up by small openings and old fields. In contrast, Gregory ounty has vast expanses of grassland with few large blocks of ontiguous forest. Although openings are a critical component of rood ranges in heavily forested regions (Hillestad and Speake 1970, illestad 1973, Hayden 1980), woodland types appear to be of greater ignificance in range selection in this area. Brood ranges consisted f ≥ 50% woodlands and approximately 40% grasslands. These roportions are significantly different (P<0.01) from the proportions vailable in the study area, and are close to the 50% forested / 50% pen range suggested as being optimal by Little (1980). In Gregory ounty, forest openings are not numerous. The mosaic of interspersed inger-like extensions of grasslands and woodlands, in combination ith the availability of savannah types, provide the necessary mix of orested and open types.

Many investigators have reported that broods use forested over during the first few weeks and steadily increase use of openings s they age (Williams et al. 1973, Scott and Boeker 1975, Porter 1977, on et al. 1978). Others have shown that turkeys use open types arly and shift to denser habitat with age (Petersen and Richardson 975, Pybus 1977, Grettenberger 1979, McCabe and Flake 1985). Tests f habitat use versus availability did not show either pattern for roods in Gregory County. Both woodlands and grasslands were used in roportion to availability within brood ranges for both age classes nd over the entire summer (Table 18). Hayden (1979), Crim (1981), nd McCabe and Flake (1985) point out the importance of savannah oodlands to broods. This could not be measured in Gregory County because savannah woodlands were not identified as a separate vegetative class. Telemetry readings were not precise enough to justify finer delineation of the 4 major cover types. However, McCabe (1984) reported that 38% of the woodlands in this area were of the savannah type.

Although broods used habitats in proportion to availability, they did use habitats differently over time. Grasslands were selected (P<0.10) in the morning (0631 hr to 1130 hr) over the SUMMER period. Grasslands were avoided by Age 2 broods during mid-day (1131 hr to 1630 hr). Although no such relationship was found for woodlands, use of woodlands was not proportionate (P<0.10) over the 3 time periods. This was due to higher than expected use during mid-day and lower than expected use during the evening (1631 hr to 2030 hr). In addition, 77% of all morning and 67% of all evening brood sightings were in grasslands, and 72% of all mid-day brood sightings were in woodlands (Table 24). These findings fit with those of Raybourne (1968), Logan (1973), and Scott and Boeker (1975) who reported that feeding periods occurred during mid to late morning and late afternoon, and loafing occurred during mid-day.

Comprehensive descriptions of small habitat units used by broods is complicated by brood mobility. This enables the brood to utilize a large number of highly variable micro-habitats within any given type. These micro-habitats appear to be used for different purposes. When a brood was flushed, it's activity could not always be ascertained. The degree of disturbance prior to sighting could also influence site attributes. In this study, these factors may have been

Table 24. Distribution, by time of day, habitat, and age, of 146 visual sightings made on wild turkey broods between 0630 hr and 2030 hr in Gregory County, South Dakota during 1986 and 1987.

| | AGE: 0-4 weeks | | AGE: > 4 weeks | | SUMMER | |
|---|---|---|---|---|---|---|
| Time Period | Woodland | Grassland | Woodland | Grassland | Woodland | Grassland |
| 0630-1130 | 9 | 29 | 9 | 30 | 18 | 59 |
| 1131-1630 | 11 | 7 | 28 | 8 | 39 | 15 |
| 1631-2030 | 2 | 3 | 3 | 7 | 5 | 10 |
| TOTAL | 22 | 39 | 40 | 45 | 62 | 84 |

complicated by a small sample size and the small size of the sample plots. However, habitat use patterns can still be described from the data obtained.

The relationship of broods to edge/ecotone when using open habitats is well documented (Hillestad and Speake 1970, Williams et al. 1973, Speake et al. 1975). Although broods using grassland types in Gregory County were seen as much as 149 m from an edge, the mean distance to the nearest edge was 21 m. This was less than 1/3 of the mean distance (72 m) of control sites from edges.

Healy and Nenno (1983) stated that herbaceous vegetation was an essential feature of brood habitat. This is consistent with the greater forb cover found at brood use sites than at controls. Greater forb densities may also influence arthropod abundance and species composition. Percent grass cover may be lower at brood sites as a result of higher forb cover. Less dense grass cover might also allow greater poult mobility. The inclusion of visual obstruction measures in the discriminant procedures, despite the fact they were not different in analysis of variance tests, indicates that vertical structure of the habitat may be important in determining brood use (Crim 1981). The mean percent obstruction from 0 to 60 cm was 64% for brood sites. This would be quite adequate to provide concealment for poults. Above the 60 cm height, percent obstruction dropped to 15%, which would provide the hen a wide field of vision (Porter 1980). This condition approximates complete ground cover with a 40-70 cm canopy, which Healy (1981) described as good brood habitat in Pennsylvania.

Differences observed between grassland use sites for the 2 age classes can be explained by examining the difference in mobility between age classes. Healy (1981) stated that older broods are better adapted to exploit openings. Age 2 broods in Gregory County were found, on the average, twice as far from habitat edges as Age 1 broods. Also, the maximum distance an Age 2 brood was found from an edge (149 m) was nearly 3 times the corresponding distance for Age 1 broods (53 m). This is the logical conclusion when considering the flight capabilities of the 2 age classes. Age 1 broods depend more upon habitat structure for protection than do Age 2 broods. This is reiterated when analyzing the difference between age classes for percent shrub cover above 30 cm in grassland habitats. Shrub cover at this height provides a micro-canopy for poults which can protect them from predators and weather. Such cover was present at 78.4% of Age 1 use sites, but only 50.9% of Age 2 use sites. The mean amount of this cover was more than 2 times greater at Age 1 sites (13.4%) than Age 2 sites (5.8%).

The inability to differentiate and adequately discriminate between woodland brood sites and controls shows the variability of micro-habitats within this type. This may again be due to small sampling plots and sample size. However, the 2 variables which did show differences in woodland analyses may have biological validity. The fact that woodland use sites were, on average, 1/2 the distance from grassland edges that controls were (Table 21) may be related to propensity of broods to use open habitats. Woodland sites near grassland edges are generally less dense than other woodland sites, and may provide more forbs and arthropods. They would also provide better visibility for the broods and be less restrictive to movement. These sites would approximate the savannah type woodlands often preferred by broods (Hayden 1979, Nenno and Lindzey 1979). This would appear to be the situation when comparing Age 1 and Age 2 woodland sites. In this case Age 1 broods used areas with more open canopy than Age 2 broods. McCabe and Flake (1985) reported the same results.

One point which must be considered in discussing these results is the number of variables which could not be included in analyses due to between year differences or year interactions. The 2 of special consideration are arthropod and soft fruit abundance. The reason for these differences is probably related to weather conditions. A severe mid-April blizzard in 1986 effectively terminated all soft fruit production except wild strawberries (Fragaria virginiana). Whether this also affected arthropod abundance is unknown. Although these 2 variables could not be used for comparisons over both years, they are considered important brood range components (Barwick et al. 1973, Blackburn et al. 1975, Hurst and Stringer 1975) and did, in fact, show significance for each year individually. They were also important variables in some of the discriminant models for individual years (see Appendix). Problems related to between year differences can only be ameliorated by pooling data from multi-year studies. Rice et al. (1981) pointed out the importance of long-term studies for discriminant analysis techniques. The two years represented in this study, however, were not sufficient to offset this between year variability.

# RECOMMENDATIONS

Present land use practices in the Missouri River Breaks of Gregory County, South Dakota are compatible with wild turkey populations. Lands in this region are used primarily for grazing and hay production. Turkey hens in Gregory County showed no aversion to using grazed or hayed areas for brood rearing habitat. Although hens would locate nests in grazed habitats, vegetation measurements suggest that ungrazed areas are better nesting habitats than grazed areas. Light to moderate rotational grazing is most compatible with wild turkey needs (Baker 1979, Potter et al. 1985). Grazing keeps forest understory open, maintains openings and savannah habitats, and can prolong forb production into late summer (Stoddard 1963, Dellinger 1973, Evan 1987). Walker (1951) warned against overgrazing. Landowners in the Gregory County study area already graze under various rotational systems. This shows the presence of concern for range conditions and use. Deferred or rest rotation grazing systems should be encouraged for maintenance of wild turkey habitat.

Shrub encroachment of grasslands in the study area approaches 40% (Appendix 1), and though this is acceptable for turkeys, it decreases range productivity for livestock. Encroachment by shrub communities is a concern of landowners. Large scale shrub removal programs are not recommended for turkey management. However, selective control and management of shrub communities may be beneficial to both turkeys and domestic stock. Removal or thinning operations could open up rank stands of shrub, particularly sumac and _Prunus_ spp., to provide better foraging for both turkeys and cattle. Breaking up some large shrub stands to increase patchiness would also improve habitat diversity. However, particular care should be taken to maintain the woodland/grassland mosaic, and the shrubby ecotones between these types.

An important part of any management plan for species supported on private land is gaining the interest, involvement, and support of the landowners. Wild turkey management practices in South Dakota have enjoyed public support in the past (Hauk 1986). Cooperation between management authorities and landowners should be continued and expanded.

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# APPENDIX

Appendix 1. Percent shrub composition of grasslands by dominant shrub species as determined from 25, 200 m transects located randomly throughout the Gregory County, South Dakota study area.

| Dominant Species | Total Meters | Percent of Total |
|---|---|---|
| Grasses | 3,087.0 | 61.74 |
| *Rhus glabra* | 1,284.2 | 25.69 |
| *Symphoricarpus occidentalis* | 317.8 | 6.36 |
| *Prunus* spp. | 229.0 | 4.58 |
| *Shephardia argentea* | 40.0 | 0.80 |
| *Amorpha canescens* | 20.2 | 0.41 |
| *Cornus foemina* | 15.0 | 0.30 |
| *Quercus macrocarpa* | 4.5 | 0.09 |
| *Ribes missouriense* | 2.2 | 0.05 |
| TOTAL | 4,999.9 | 100.02 |

Appendix 2. A list of the dominant species of vegetation found associated with 20 wild turkey nests located in woodland habitats in Gregory County, South Dakota in 1986 and 1987.

| Year | Bird | Dominant Vegetation |
|---|---|---|
| 1986 | 405 | Prunus spp. |
| | 433 | Prunus spp./Ulmus americana/Bromus inermis/Poa pratensis |
| | 449 | Ribes missouriense |
| | 452 | Quercus macrocarpa/Stipa viridula/Poa pratensis |
| | 471 | Quercus macrocarpa/Ribes missouriense |
| | 486 | Fraxinus pennsylvanica/Ulmus americana/Prunus spp./downed log |
| | 487 | downed log/Ribes missouriense |
| 1987 | 450 | Symphoricarpos occidentalis/Rosa spp./Populus deltoides |
| | 452 | Juniperus virginiana/Quercus macrocarpa |
| | 471 | Ribes missouriense/Quercus macrocarpa |
| | 476 | Ribes missouriense/Zanthoxylum americanum |
| | 477 | Ulmus americana/Tilia americana |
| | 483 | Prunus spp./Ribes missouriense |
| | 485 | Ribes missouriense |
| | 487 | Salix amygdaloides |
| | 605 | Cornus foemina |
| | 643 | Juniperus virginiana/Quercus macrocarpa |
| | 645 | Ribes missouriense/Quercus macrocarpa |
| | 647 | Quercus macrocarpa |
| | 649 | Zanthoxylum americanum/Quercus macrocarpa |

Appendix 3. A list of the dominant species of vegetation found in association with 24 wild turkey nests located in grassland, agricultural, and farmstead habitats in Gregory County, South Dakota in 1986 and 1987.

| Year | Bird | Dominant Vegetation |
|---|---|---|
| 1986 | 283 | Symphoricarpos occidentalis |
| | 286, Unk #1 | Rumex spp./Kochia scoparia/Convolvulus arvensis/Helianthus spp. |
| | 421 | Symphoricarpos occidentalis |
| | 424 | Prunus americana/Toxicodendron rydbergii |
| | 426 | Symphoricarpos occidentalis/Rosa spp. |
| | 427 | Toxicodendron rydbergii/Prunus americana |
| | 429 | Medicago sativa |
| | 437 | Prunus americana/Toxicodendron rydbergii |
| | 444 | Bromus inermis |
| | 472 | Symphoricarpos occidentalis |
| | 477 | Symphoricarpos occidentalis |
| | 483 | Ribes missouriense/Rhus glabra/Symphoricarpos occidentalis |
| | Unk #2 | Symphoricarpos occidentalis/Rhus glabra |
| | Unk #3 | Cirsium undulatum |
| 1987 | 429 | Vernonia fasciculata |
| | 473 | Symphoricarpos occidentalis |
| | 483[a] | Melilotus officinalis |
| | 605[a] | Symphoricarpos occidentalis |
| | 615 | Melilotus officinalis/Agropyron smithii |
| | 646 | Juniperus virginiana/Rhus glabra/Prunus spp. |
| | 658 | Prunus americana/Rosa spp. |
| | Unk #4 | Rhus glabra/Melilotus officinalis/Poa pratensis |
| | Unk #5 | Rhus glabra/Melilotus officinalis/Poa pratensis |

[a] second nest; first nest in woodland habitat

Appendix 4. Three models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between wild turkey nest sites and random control sites located in woodland habitats, and their discriminating abilities. Based on data collected at 7 nest and control sites located in Gregory County, South Dakota in 1986.

| Model | Variables Included | Cumulative Wilk's Lambda |
|---|---|---|
| I[a] | % visual obstruction 0-60 cm at nest | 0.6101 |
| | distance from nest to nearest water | 0.4764 |
| | distance from nest to nearest habitat edge | 0.3859 |
| | % litter at nest | 0.3077 |
| | habitat diversity | 0.2131 |
| II[a] | % visual obstruction 0-60 cm at nest | 0.6101 |
| | ave. distance to nearest shrub stem in the 0.5 ha area surrounding nest | 0.4415 |
| | % shrub cover at nest | 0.3386 |
| | % litter at nest | 0.2677 |
| | ave. dbh of trees nearest nest | 0.1419 |
| III[b] | habitat diversity | 0.6737 |

| | % Proper Reclassification | |
|---|---|---|
| | Nests | Controls |
| Model I | 85.71 | 100.00 |
| Model II | 75.00 | 95.00 |
| Model III | 57.14 | 85.71 |

[a] derived from all measurements made at the nest and in the 0.5 ha area surrounding the nest

[b] derived from only those measurements made in the 0.5 ha area surrounding the nest

Appendix 5. Three models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between wild turkey nest sites and random control sites located in grassland habitats, and their discriminating abilities. Based on data collected at 12 nest an control sites located in Gregory County, South Dakota in 1986.

| Model | Variables Included | Cumulative Wilk's Lambda |
|---|---|---|
| I[a] | % visual obstruction 60-180 cm at nest | 0.4931 |
| | ave. distance from nest to the nearest shrub stem | 0.4257 |
| | % grass cover at nest | 0.3131 |
| II[a] | % visual obstruction 60-180 cm at nest | 0.4931 |
| | % litter at nest | 0.2925 |
| | ave. distance from nest to the nearest shrub stem | 0.2067 |
| III[b] | habitat diversity | 0.6171 |

| | % Proper Reclassification | |
|---|---|---|
| | Nests | Controls |
| Model I | 91.67 | 100.00 |
| Model II | 91.67 | 100.00 |
| Model III | 75.00 | 75.00 |

[a] derived from all variable measurements made at the nest and in the 0.5 ha surrounding area

[b] derived from only those variable measurements made in the 0.5 ha area surrounding the nest

Appendix 6. Two models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between wild turkey nest sites and random control sites located in woodland habitats, and their discriminating abilities. Based on data collected at 13 nest and control located in Gregory County, South Dakota in 1987.

| Model | Variables Included | Cumulative Wilk's Lambda |
| --- | --- | --- |
| I[a] | % visual obstruction 60-180 cm in the 0.5 ha area surrounding the nest | 0.6914 |
| | % visual obstruction 0-60 cm at nest | 0.4618 |
| II[b] | % visual obstruction 60-180 cm in the 0.5 ha area surrounding the nest | 0.6914 |
| | habitat diversity | 0.5460 |
| | ave. distance to the nearest tree within the 0.5 ha area surrounding the nest | 0.4255 |

| | % Proper Reclassification | |
| --- | --- | --- |
| | Nests | Controls |
| Model I | 92.31 | 76.92 |
| Model II | 92.31 | 100.00 |

[a] derived from all variable measurements made at the nest and in the 0.5 ha area surrounding the nest
[b] derived from only those variable measurements made in the 0.5 ha area surrounding the nest

Appendix 7. Two models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between wild turkey nest sites and random control sites located in grassland habitats, and their discriminating abilities. Based on data collected at 9 nest and control sites located in Gregory County, South Dakota in 1987.

| Model | Variables Included | Cumulative Wilk's Lambda |
|---|---|---|
| I[a] | % visual obstruction 0-60 cm at nest | 0.1806 |
| II[b] | % visual obstruction 60-180 cm in the 0.5 ha area surrounding the nest | 0.6462 |

| | % Proper Reclassification | |
|---|---|---|
| | Nests | Controls |
| Model I | 100.00 | 100.00 |
| Model II | 66.67 | 66.67 |

[a] derived from all variable measurements made at the nest and in the 0.5 ha area surrounding the nest

[b] derived from only those variable measurements made in the 0.5 ha area surrounding the nest

Appendix 8. A comparison of the discriminating abilities of nesting models developed from data collected in 1986 and 1987. Comparison made by entering data collected in each year into discriminant models developed from data collected in the other year. Method displays accuracy of single year models over time.

| 1987 Data Entered in 1986 Models | | | 1986 Data Entered in 1987 Models | | |
|---|---|---|---|---|---|
| | % Proper Classification | | | % Proper Classification | |
| Model | Nests | Controls | Model | Nests | Controls |
| GRASSLANDS | | | | | |
| I[a] | 91.67 | 75.00 | I[a] | 88.89 | 88.89 |
| II[b] | 58.33 | 50.00 | II[a] | 100.00 | 88.89 |
| -- | -- | -- | III[b] | 66.67 | 55.56 |
| WOODLANDS | | | | | |
| I[a] | 85.71 | 85.71 | I[a] | 84.62 | 76.92 |
| II[b] | 57.14 | 100.00 | II[a] | 92.31 | 92.31 |
| -- | -- | -- | III[b] | 69.23 | 61.54 |

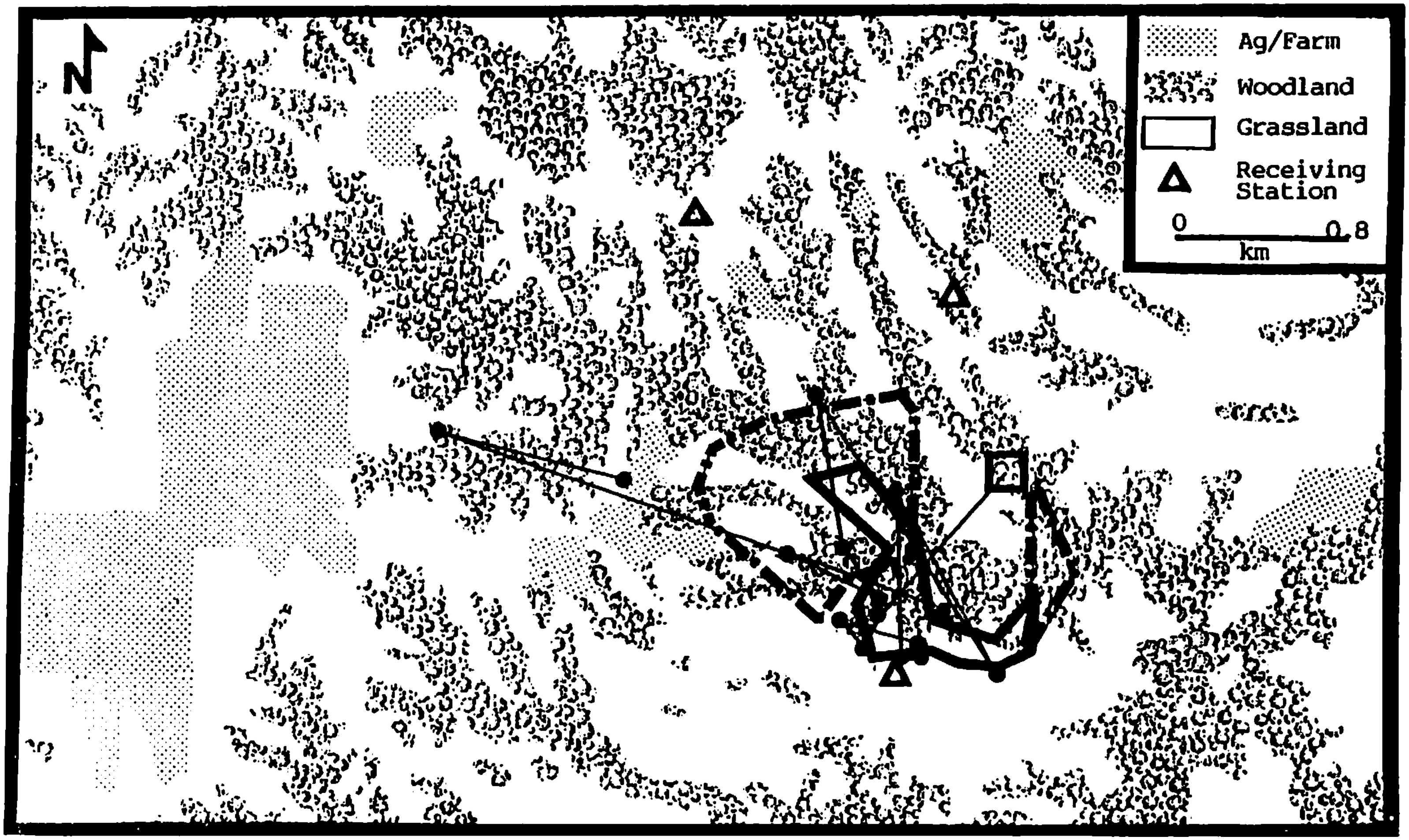
[a] derived from all variable measurements made at the nest and in the 0.5 ha area surrounding the nest
[b] derived from only those variable measurements made in the 0.5 ha area surrounding the nest

Appendix 9. Habitat composition of three brood ranges (Age 1: 0-4 weeks, Age 2: beyond 4 weeks, and total SUMMER) of wild turkey brood 405[a] during the summer of 1986 in Gregory County, South Dakota.

| | Woodland | | Grassland | | Ag/Farm | | SUMMER | |
|---|---|---|---|---|---|---|---|---|
| Range | ha | % | ha | % | ha | % | ha | % |
| age: 0-4 weeks | 15.2 | 49.7 | 15.3 | 50.3 | 0.0 | 0.0 | 30.5 | 100.0 |
| age: +4 weeks | 51.7 | 62.4 | 30.7 | 37.0 | 0.5 | 0.6 | 82.9 | 100.0 |
| age: SUMMER | 67.4 | 61.6 | 41.7 | 38.1 | 0.3 | 0.3 | 109.4 | 100.0 |

[a] this brood formed a creche with brood 487

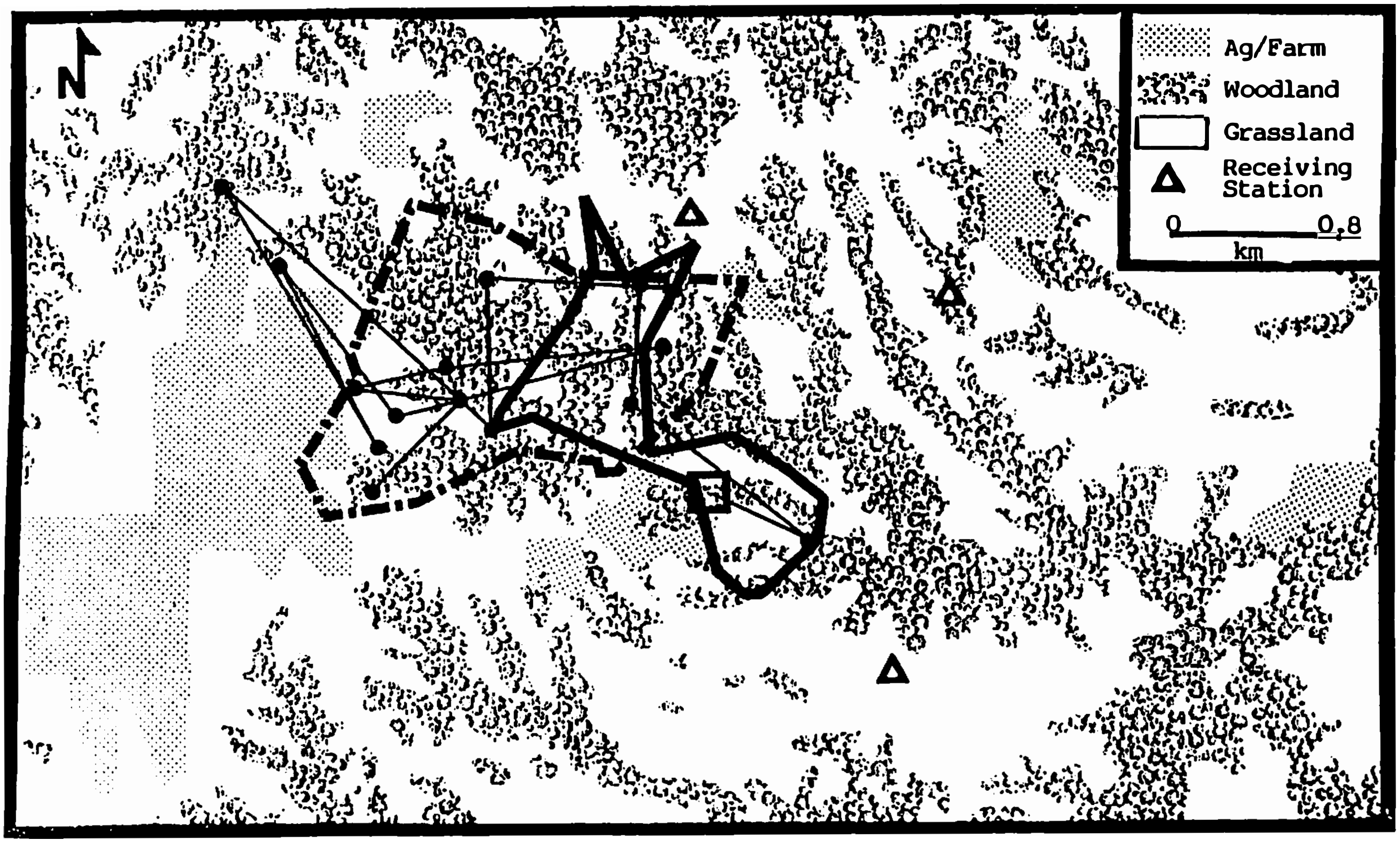
Appendix 10. Nest (□) location, movements, and Age 1 (▬) and Age 2 (▪▪▪) ranges for wild turkey brood 405 in Gregory County, South Dakota during the summer of 1986. Brood range boundaries were determined from telemetry locations, and movements from bi-weekly visual observation (●). Map represents a 2,462 ha subsection of the 6477 ha study area.



Appendix 11. Habitat composition of three brood ranges (Age 1: 0-4 weeks, Age 2: beyond 4 weeks, and total SUMMER) of wild turkey brood 486 during the summer of 1986 in Gregory County, South Dakota.

| | Woodland | | Grassland | | Ag/Farm | | SUMMER | |
|---|---|---|---|---|---|---|---|---|
| Range | ha | % | ha | % | ha | % | ha | % |
| age: 0-4 weeks | 42.1 | 54.0 | 33.6 | 43.1 | 2.2 | 2.9 | 77.9 | 100.0 |
| age: +4 weeks | 104.3 | 58.5 | 67.9 | 38.1 | 6.0 | 3.4 | 178.2 | 100.0 |
| age: SUMMER | 131.1 | 53.2 | 104.9 | 42.6 | 10.3 | 4.2 | 246.2 | 100.0 |

Appendix 12. Nest (□) location, movements, and Age 1 (▬▬) and Age 2 (▪▪▪) ranges for wild turkey brood 486 in Gregory County, South Dakota during the summer of 1986. Brood range boundaries were determined from telemetry locations, and movements from bi-weekly visual observation (●). Map represents a 2,462 ha subsection of the 6477 ha study area.

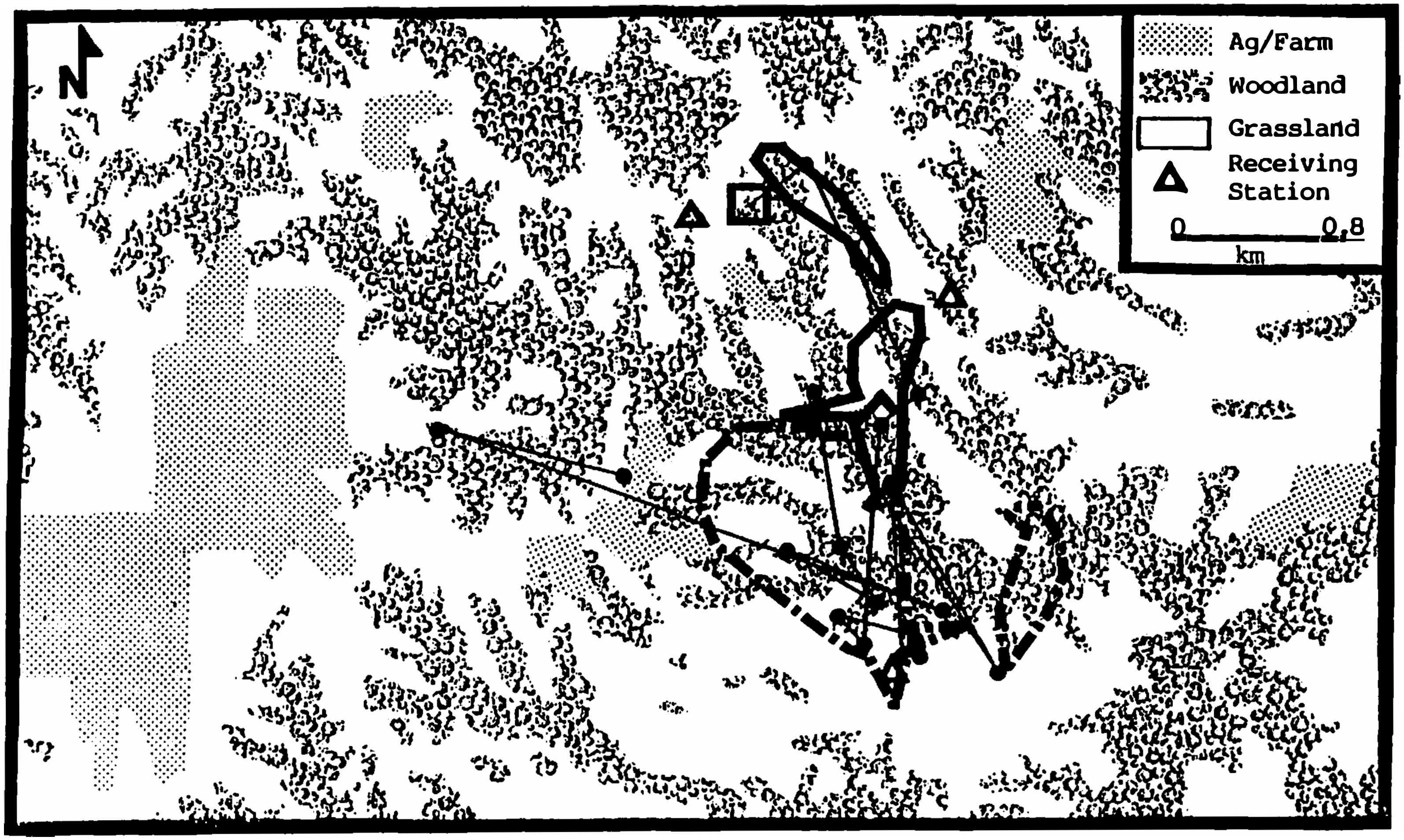


Appendix 13. Habitat composition of three brood ranges (Age 1: 0-4 weeks, Age 2: beyond 4 weeks, and total SUMMER) of wild turkey brood 487[a] during the summer of 1986 in Gregory County, South Dakota.

| | Woodland | | Grassland | | Ag/Farm | | SUMMER | |
|---|---|---|---|---|---|---|---|---|
| Range | ha | % | ha | % | ha | % | ha | % |
| age: 0-4 weeks | 17.5 | 56.6 | 13.2 | 42.7 | 0.2 | 0.7 | 30.9 | 100.0 |
| age: +4 weeks | 57.4 | 59.9 | 38.0 | 39.7 | 0.4 | 0.4 | 95.7 | 100.0 |
| age: SUMMER | 107.4 | 54.5 | 89.2 | 45.2 | 0.6 | 0.2 | 197.2 | 99.9 |

[a] this brood formed a creche with brood 405

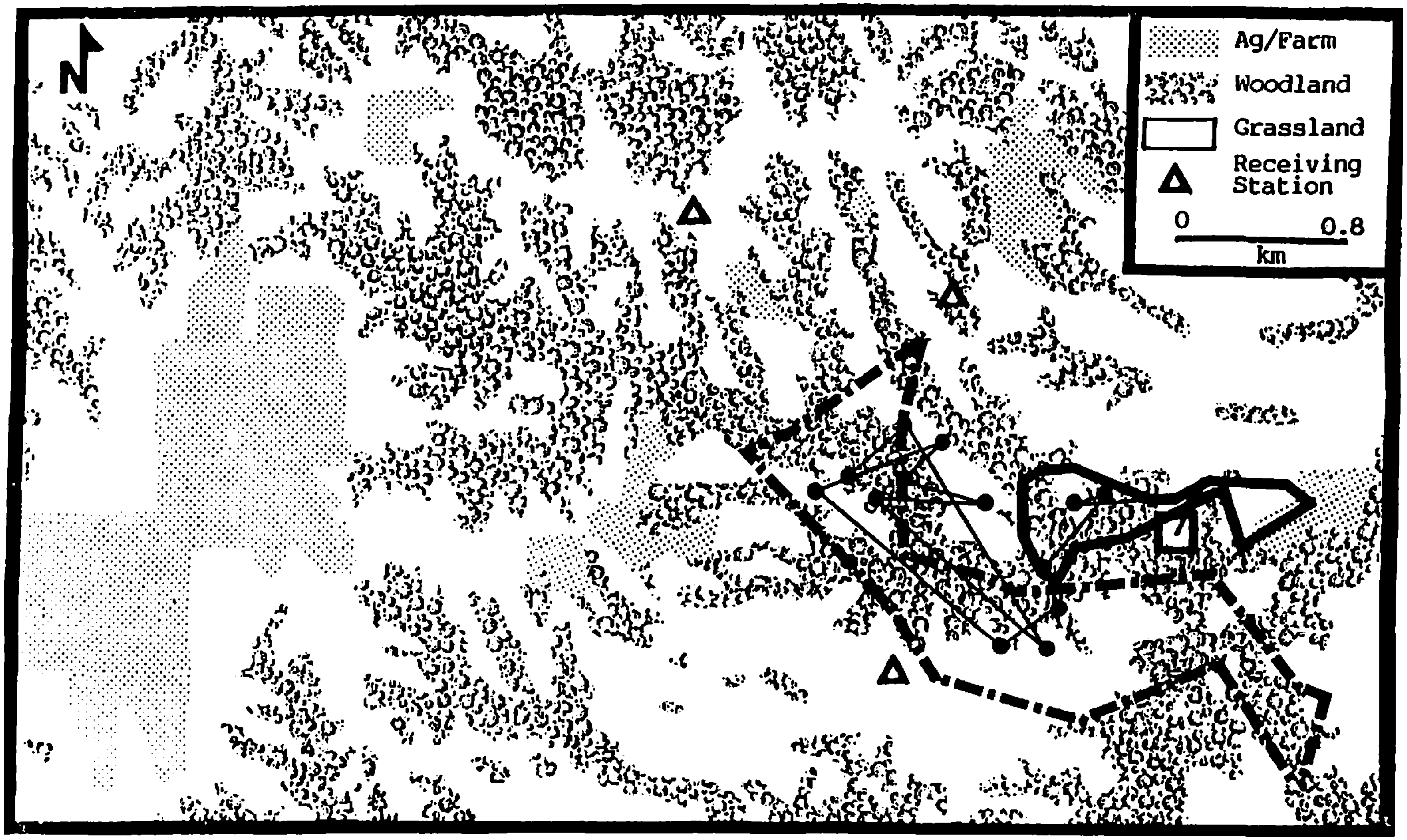
Appendix 14. Nest (☐) location, movements, and Age 1 (▬▬) and Age 2 (■■■) ranges for wild turkey brood 487 in Gregory County, South Dakota during the summer of 1987. Brood range boundaries were determined from telemetry locations, and movements from bi-weekly visual observation (●). Map represents a 2,462 ha subsection of the 6477 ha study area.



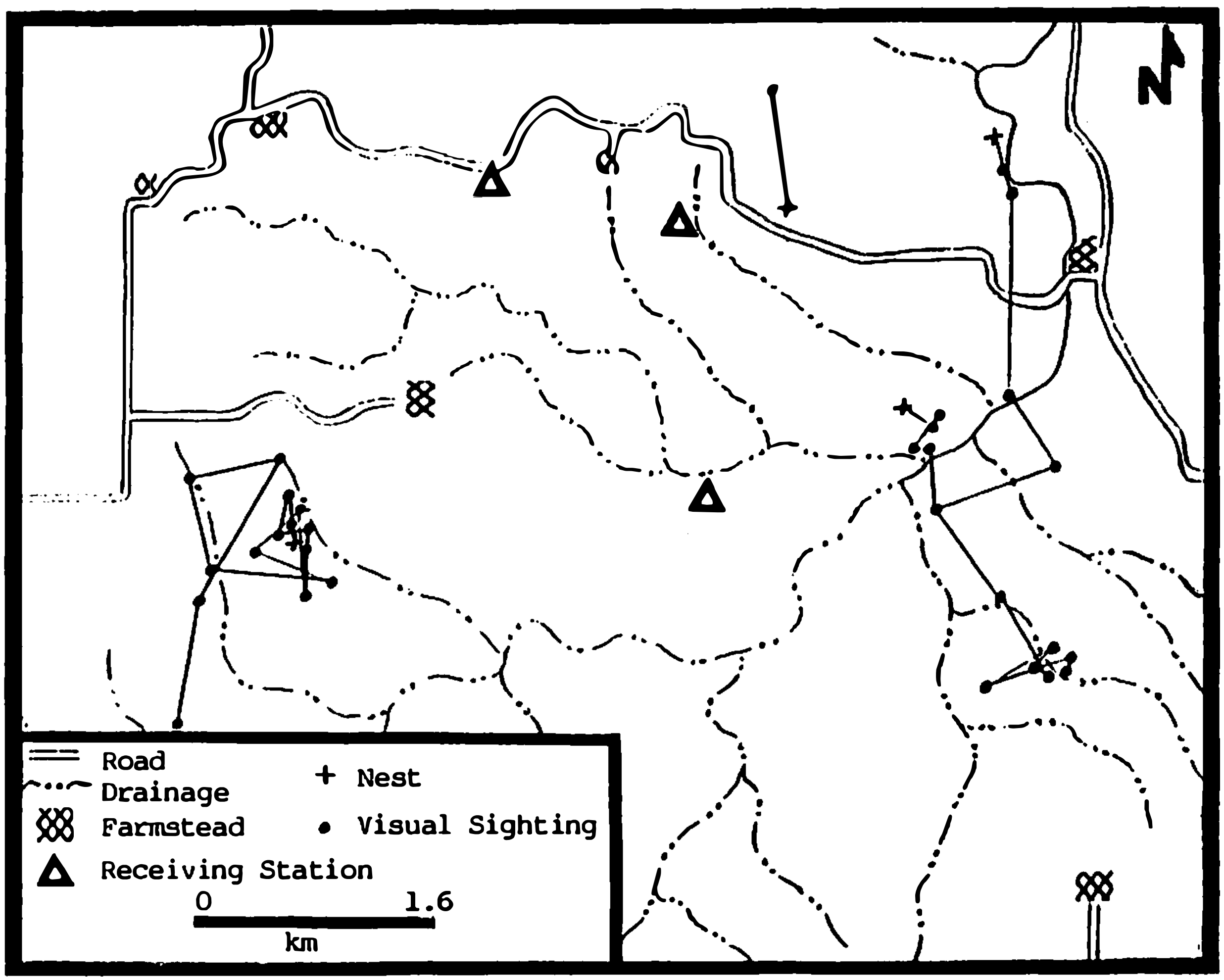
Appendix 15. Habitat composition of three brood ranges (Age 1: 0-4 weeks, Age 2: beyond 4 weeks, and total SUMMER) of wild turkey brood 643 during the summer of 1987 in Gregory County, South Dakota.

| | Woodland | | Grassland | | Ag/Farm | | SUMMER | |
|---|---|---|---|---|---|---|---|---|
| Range | ha | % | ha | % | ha | % | ha | % |
| age: 0-4 weeks | 15.7 | 54.0 | 12.4 | 42.6 | 1.0 | 3.4 | 29.1 | 100.0 |
| age: +4 weeks | 84.9 | 56.6 | 65.1 | 43.4 | 0.0 | 0.0 | 150.0 | 100.0 |
| age: SUMMER | 137.8 | 57.4 | 99.2 | 41.3 | 2.9 | 1.2 | 240.0 | 99.9 |

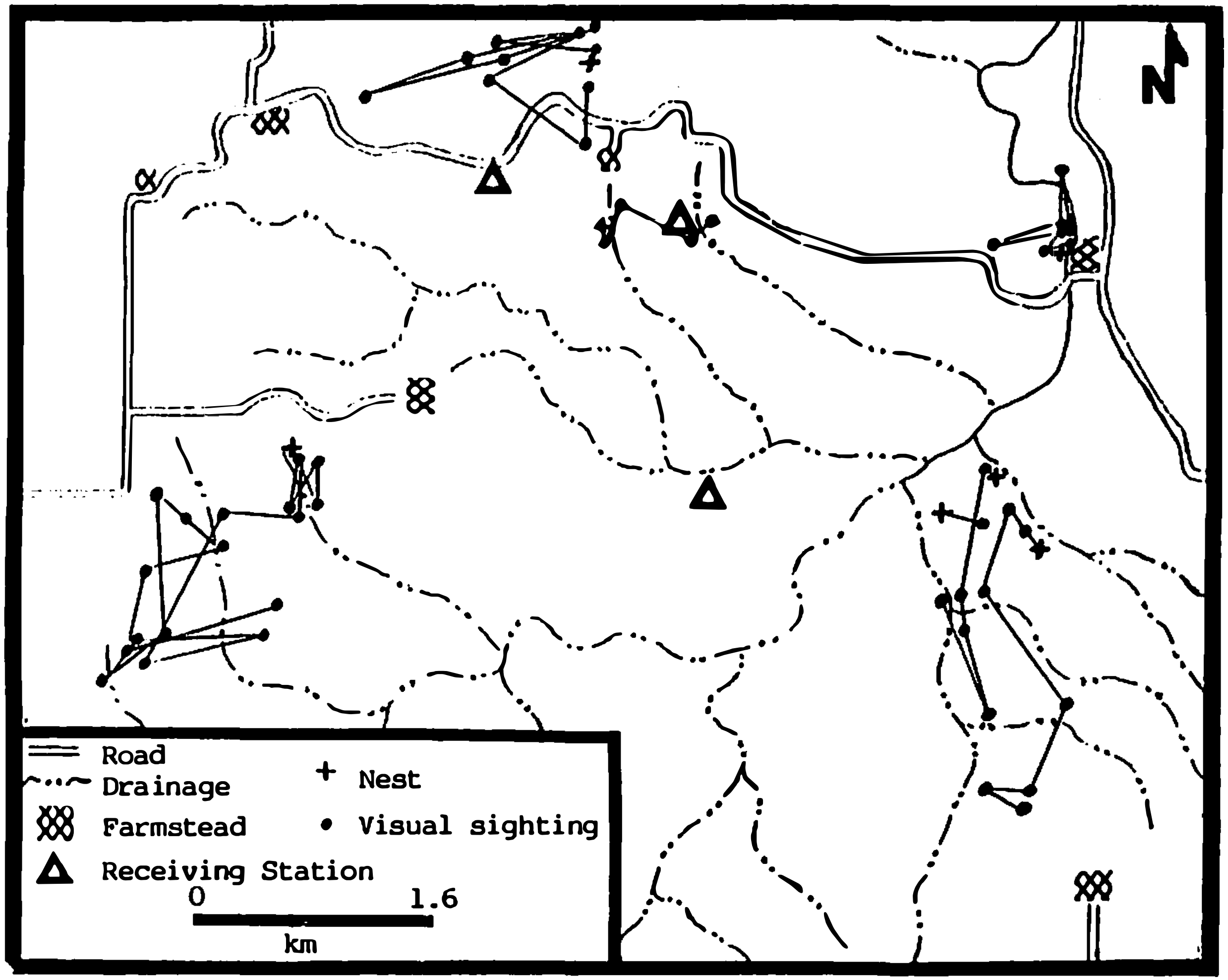
Appendix 16. Nest (□) location, movements, and Age 1 (▬) and Age 2 (▪▪▪) ranges for wild turkey brood 643 in Gregory County, South Dakota during the summer of 1987. Brood range boundaries were determined from telemetry locations, and movements from bi-weekly visual observation (●). Map represents a 2,462 ha subsection of the 6477 ha study area.



Appendix 17. Movements of 4 wild turkey broods which fell outside the range of telemetry stations in Gregory County, South Dakota during the summer of 1986 as determined from bi-weekly visual sightings.



Appendix 18. Movements of 6 wild turkey broods which fell outside the range of telemetry stations in Gregory County, South Dakota during the summer of 1987 as determined from bi-weekly visual sightings.



Appendix 19. A comparison of arthropod[a] abundance in grassland versus woodland habitats over time. Values shown were determined by calculating the means of counts made along three pairs of permanent 50 m transects randomly placed in the Gregory County study area. Counts include all arthropods flushed along the transect as well as those counted in each of 10, 1 $m^2$ plots placed at 5 m intervals along the transect.

| 1986 | | | 1987 | | |
|---|---|---|---|---|---|
| Date | Mean Number in Grassland | Mean Number in Woodland | Date | Mean Number in Grassland | Mean Number in Woodland |
| 5 July[b] | 20.00 | 14.33 | 14 June | 102.00 | 43.00 |
| 25 July | 59.33 | 40.00 | 17 July | 40.67 | 14.67 |
| 21 August | 51.33 | 16.67 | 7 August | 45.00 | 21.33 |

[a] includes representatives of the orders Coleoptera, Diptera, Hemiptera, Homoptera, Hymenoptera, Lepidoptera, and Orthoptera; and the classes Arachnida, Chilopoda, and Diplopoda

[b] plots used on 5 July 1986 were 0.78 $m^2$

Appendix 20. A comparison of soft fruit[a] abundance in grassland versus woodland habitats over time. Values shown were determined by calculating the means of counts made in three pairs of 50 x 4 m permanent strip transects randomly located in the Gregory County study area.

| 1986 | | | 1987 | | |
|---|---|---|---|---|---|
| Date | Mean Number in Grassland | Mean Number in Woodland | Date | Mean Number in Grassland | Mean Number in Woodland |
| 5 July | 646.67 | 252.00 | 14 June | 554.00 | 628.67 |
| 25 July | 719.33 | 395.00 | 17 July | 1593.33 | 791.67 |
| 21 August | 794.67 | 58.33 | 7 August | 943.00 | 250.00 |

[a] includes fruits of <u>Prunus americana, P. besseyi, P. virginiana, Ribes missouriensis, Fragaria virginiana, Toxicodendron rydbergii, Smilacina racemosa, Astragalus misouriensis, Parthenocissus quinquefolia, Crataqus succulenta, Symphoricarpos occidentalis, Vitis riparia</u>

Appendix 21. Two models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between wild turkey brood use sites and random control sites in grassland habitats, and their discriminating abilities. Based on data collected at 51 brood use and control sites in Gregory County, South Dakota in 1986.

| Model | Variables Included | Cumulative Wilk's Lambda |
|---|---|---|
| I | distance to nearest habitat edge | 0.8502 |
| | % grass cover | 0.7794 |
| | % visual obstruction 60-180 cm | 0.7416 |
| | % visual obstruction 0-60 cm | 0.7134 |
| | arthropod abundance | 0.6839 |
| II | distance to nearest habitat edge | 0.8502 |
| | % visual obstruction 60-180 cm | 0.8163 |
| | % bare ground | 0.7944 |
| | % visual obstruction 0-60 cm | 0.7703 |
| | arthropod abundance | 0.7437 |
| | % litter | 0.7138 |

| | % Proper Classification | |
|---|---|---|
| | Brood Sites | Controls |
| Model I | 95.00 | 55.00 |
| Model II | 93.33 | 63.33 |

Appendix 22. A model developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between brood use sites and random control sites located in woodland habitats, and its discriminating ability. Based on data collected at 17 brood use and control sites located in Gregory County, South Dakota in 1986.

| Variables Included | Cumulative Wilk's Lambda |
|---|---|
| % shrub cover above 30 cm | 0.8869 |
| % canopy cover | 0.7517 |

| % Proper Classification | |
|---|---|
| Brood Sites | Controls |
| 34.78 | 91.30 |

Appendix 23. A model developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between brood use sites and random control sites located in grassland habitats, and its discriminating ability. Based on data collected at 34 brood sites and controls in Gregory County, South Dakota in 1987.

| Variables Included | Cumulative Wilk's Lambda |
|---|---|
| distance to nearest habitat edge | 0.8977 |
| % forb cover | 0.8390 |

| % Proper Classification | |
|---|---|
| Brood Sites | Controls |
| 97.06 | 29.41 |

Appendix 24. Two models developed through stepwise discriminant analysis ($P \leq 0.05$) to explain the variability between brood use sites and random control sites located in woodland habitats, and their discriminating abilities. Based on data collected at 19 brood use and control sites in Gregory County, South Dakota in 1987.

| Model | Variables Included | Cumulative Wilk's Lambda |
|---|---|---|
| I | % visual obstruction 0-60 cm | 0.8999 |
| | % shrub cover above 30 cm | 0.8132 |
| | distance to nearest habitat edge | 0.7009 |
| II | % visual obstruction 30-60 cm | 0.8932 |
| | % shrub cover above 30 cm | 0.7805 |
| | distance to nearest habitat edge | 0.6808 |

| | % Proper Classification | |
|---|---|---|
| | Brood Sites | Controls |
| Model I | 68.42 | 73.68 |
| Model II | 79.85 | 73.68 |

Appendix 25. A comparison of the discriminating abilities of models of brood use sites developed from data collected in 1986 and 1987. Comparison made by entering data collected in each year data into discriminant models developed from data collected during the other year. Method displays accuracy of single year models over time.

| 1987 Data Entered in 1986 Models | | | 1986 Data Entered in 1987 Models | | |
|---|---|---|---|---|---|
| | % Proper Classification | | | % Proper Classification | |
| Model | Brood Sites | Controls | Model | Brood Sites | Controls |
| GRASSLANDS | | | | | |
| I | 94.29 | 37.14 | I | 90.16 | 40.98 |
| II | 94.29 | 48.57 | — | — | — |
| WOODLANDS | | | | | |
| I | 47.37 | 42.11 | I | 86.96 | 65.22 |
| — | — | — | II | 86.96 | 47.83 |