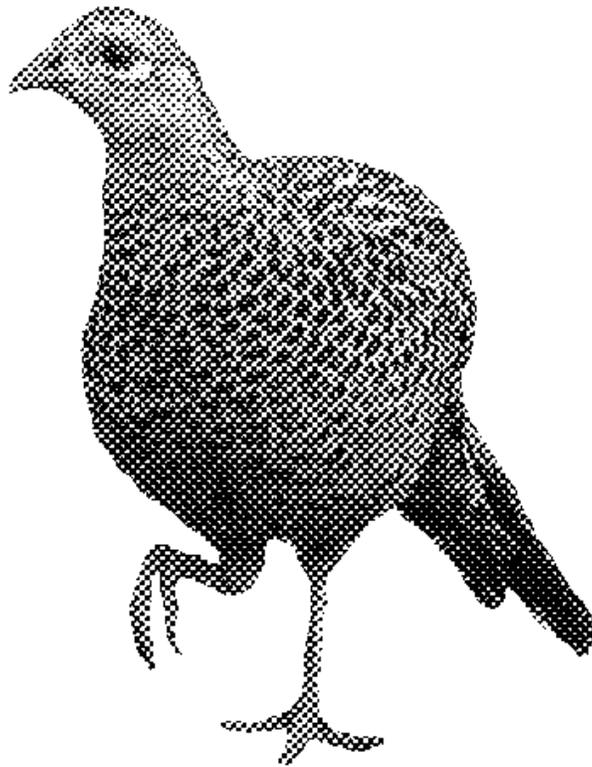

GAME REPORT

Avian Nest Densities and Success in State Highway Roadsides in South Dakota

Anthony P. Leif



**South Dakota
Department of
Game, Fish and Parks**

Wildlife Division
Joe Foss Building
Pierre, South Dakota

**Completion Report
2004-11**

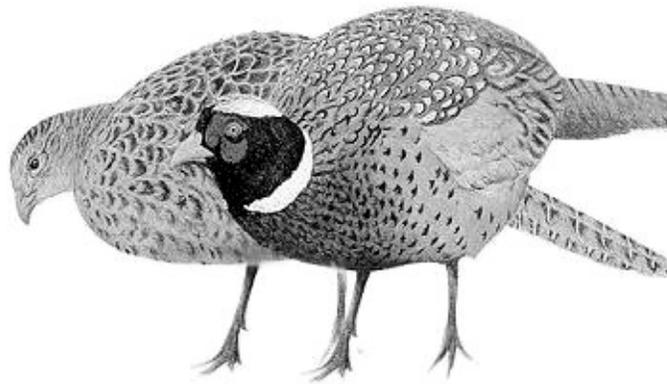
Avian Nest Densities and Success in State Highway Roadsides in South Dakota

Completion Report

by

Anthony P. Leif

Publication Date November, 2003



Editors:

Assistant Director – Technical Services
George Vandel

Wildlife Program Administrator (retired)
Ronald Fowler

Department Secretary
John Cooper

Division Director
Douglas Hansen

Avian Nest Densities and Success in State Highway Roadside in South Dakota

Abstract

The utility of restricting mowing of state highway roadsides has recently been scrutinized by those that believe that the current regulations are of little value to ground-nesting birds, and in particular, ring-necked pheasants (*Phasianus colchicus*). Consequently, mowing chronology and nesting activity were evaluated along 4 stretches of state highway roadsides in South Dakota in 2004. An average of 18% of state highway roadsides in 3 study areas east of the Missouri River were mowed for hay prior to 10 July 2004, whereas 39% of roadsides in Tripp and Gregory Counties where mowing is allowed after 15 June were mowed prior to 10 July 2004. A total of 55 half-mile study plots (175.2 acres) that were mowed prior to 2 July 2004 and an equal number of study plots (176.5 acres) mowed after 9 July 2004 were searched for nests. Nest densities varied from zero in roadsides in the Arlington area mowed prior to 2 July 2004 to 1.13 nests per acre in roadsides in the Winner study area that were mowed after 9

July 2004. Overall, roadsides mowed after 9 July 2004 (0.41 nests/acre) contained more than double the number of pheasant nests as roadsides mowed prior to 2 July 2004 (0.19 nests/acre). Hatching success (31%) of pheasant nests was not affected by the timing of mowing. One of 29 (3%) hen pheasants nesting in roadsides mowed prior to 2 July 2004 and 7 of 64 (11%) hens that were nesting in ditches mowed after 9 July 2004 were killed by hay-mowing equipment. It appears that pheasants nested in state highway roadsides where ever surrounding landscapes supported pheasant populations. In addition, the current Department of Transportation rule that restricts hay mowing until 10 July enhances avian production in state highway roadsides although deaths of nesting pheasants caused by hay mowing equipment are relatively high. A mowing release date later than 10 July for state highway roadsides would reduce nesting pheasant mortality and enhance avian production.

Preface

This report summarizes results of data collected by South Dakota Department of Game, Fish and Parks and South Dakota State University personnel in July and August, 2004 on avian nesting in state highway roadsides in South Dakota.

This study was initiated to evaluate reproductive and survival parameters of birds nesting in state highway roadsides in South Dakota. These objectives were accomplished by searching

roadsides that had been mowed during different time periods in 2004. Results of this study will be used to make recommendations for management of roadsides for avian production.

Material in this report may be cited only with permission from the author or Director of the Wildlife Division. Copies of the report are available from the Department of Game, Fish and Parks, 523 East Capitol, Pierre, South Dakota 57501-3182.

Table of Contents

	<u>Page</u>
Abstract	i
Preface	i
Table of Contents	ii
List of Tables	iii
List of Figures	iii
List of Appendix Tables	iii
Introduction	1
Objectives	1
Study Areas	1
Methods	2
Results	2
Discussion	5
Management Implications	6
Acknowledgements	7
Literature Cited	7
Appendix	8

List of Tables

<u>Table</u>		<u>Page</u>
1	Area searched and numbers of nests found in state highway roadsides that were mowed for hay prior to 2 July 2004 (early) and after 9 July (delayed) in South Dakota, 2004	3
2	Densities (nests per acre) of nests in state highway roadsides that were mowed for hay prior to 2 July 2004 (early) and after 9 July (delayed) in South Dakota, 2004	4
3	Numbers of pheasants found that died from unidentified causes (dead) and from contact with hay-mowing equipment (killed) in state highway roadsides that were mowed for hay prior to 2 July (early) and after 9 July (delayed) in South Dakota, 2004	5

List of Figures

<u>Figure</u>		<u>Page</u>
1	Hay-mowing chronology of state highway roadsides in South Dakota, 2004	3
2	Fates of pheasant nests found in state highway roadsides that were mowed for hay prior to 2 July 2004 (early) and after 9 July (delayed) in South Dakota, 2004	4

List of Appendix Tables

<u>Table</u>		<u>Page</u>
1	Numbers of nests and dead pheasants found in state highway roadsides mowed before 2 July (Early) or after 9 July (Delayed) in Beadle and Spink Counties (Doland study area), South Dakota, 2004.	9
2	Numbers of nests and dead pheasants found in state highway roadsides mowed before 2 July (Early) or after 9 July (Delayed) in Codington, Hamlin, Brookings and Lake Counties (Arlington study area), South Dakota, 2004	10
3	Numbers of nests and dead pheasants found in state highway roadsides mowed before 2 July (Early) or after 9 July (Delayed) in Hutchinson and Douglas Counties (Parkston study area), South Dakota, 2004	11
4	Numbers of nests and dead pheasants found in state highway roadsides mowed before 2 July (Early) or after 9 July (Delayed) in Tripp and Gregory Counties (Winner study area), South Dakota, 2004	12

Avian Nest Densities and Success in State Highway Roadsides in South Dakota

Anthony P. Leif

Over the past few years, debates on the values and uses of state highway roadsides in South Dakota have occurred both in legislative sessions and in recent Department of Transportation Commission meetings. These discussions have centered on whether or not roadsides should be protected from hay mowing during the period when ground-nesting birds are nesting. In particular, current rules are designed to offer some protection to nesting ring-necked pheasants (*Phasianus colchicus*).

South Dakota's Interstate Highway and State Trunk Highways encompass approximately 8,000 miles of roadways in the state. In accordance with DOT rule § 70:04:06:06, the roadsides in these highway systems may not be mowed for hay before June 15th in 3 counties (Lyman, Gregory and Tripp) west of the Missouri River and before July 10th in all counties east-river. Hay mowing activities are not regulated by these rules on an additional 80,000 miles of County and Township roadways.

The intent of hay-mowing restrictions is to protect birds nesting in roadsides. In the spring and early summer, hen pheasants seeking suitable nesting locations are attracted to the vegetation in roadsides. Pheasant production in roadsides is diminished when roadsides are mowed prior to completion of nesting activity. Equally if not more detrimental, incubating hens nearing their hatch dates can be struck and killed by hay mowing equipment. Additionally, hens and newly hatched broods remain susceptible to hay mowing equipment for another 2 weeks after hatching due to the restricted mobility of chicks and the tendency of the hen and young to hide from approaching danger rather than flushing to escape. GFP research has documented that almost all deaths of incubating pheasants are the result of being struck by hay mowing equipment and regardless of whether or not hens are incubating clutches, hay mowing is leading cause of hen pheasant deaths during the months of June and July.

Past studies in South Dakota have documented the value of roadsides to pheasants for nesting. The proportion of overall pheasant production coming from nests in roadsides was 14% in Brookings County (1973-74, Olson and Flake 1975) and 23% in Tripp County (1979-81, Keyser 1986). These data offer support for current restrictions on roadside hay mowing. Notwithstanding, some feel that the current use of roadsides by nesting birds is not as prominent as it was back when these studies were conducted. Consequently, the South Dakota Game, Fish and Parks in cooperation the South Dakota Department of Transportation and the South Dakota Department of Agriculture implemented this research project to evaluate nesting activity in state highway roadsides.

Objectives

1. Estimate and compare nest densities of ground-nesting birds in state highway ditches that were mowed in June versus those mowed in mid-July.
2. Estimate and compare nest success of ground-nesting birds in state highway ditches that were mowed in June versus those mowed in mid-July.

Study Areas

Four study areas in eastern South Dakota were selected. The Doland study area contained 61 mile sections along Highway 37 from the north edge of Huron to the junction with Highway 212, east on Highway 37/212 to Doland, north on Highway 37 to the junction with Highway 20, and east on highway 20 to the Clark/Spink County line. The Arlington study area contained 59 mile sections along Highway 81 from the starting point on the south edge of Watertown to the north edge of Madison. The Parkston study area contained 64 mile sections of roadsides along Highway 44 from Parker west to the junction of Highway 44 and Highway 281 north.

The Winner study area was 69 mile sections long from the junction of Highways 44 and 47 south on Highway 47 to the junction with Highway 18, west on Highway 18 to the junction with Highway 49, and north on Highway 49 to Hamill. The study area continued from the junction of Highways 44 and 49 east on Highway 44 to the junction with Highway 47 and north on Highway 47 to the Gregory/Lyman County line.

Methods

Study area highway ditches were censused by vehicle on 5 occasions in 2004. On 5 May study highways were driven to document which ditches were not mowed in 2003. Then on 2 July, 9 July, 16 July and 20 October all study highways were driven and mowing activity was mapped. Highway stretches were divided into ½-mile sections according to platted ownership lines. Consequently, mile sections do not directly translate into miles of highways because roads occasionally curve and extend longer than if always running directly north/south or east/west. However, land ownership and thus mowing chronology are associated with section lines not actual miles of highway.

The first study site selection criterion was for ditches that were not flooded as a part of an adjacent permanent wetland. The second criterion was that each had been mowed in 2003. Of those mowed in 2003, our objective was to then select ½-mile stretches of ditches that were mowed “early” (prior to 2 July 2004) that were adjacent to ½-mile ditches that were mowed according to current state regulations for eastern South Dakota (after 9 July 2004, “delayed”). Although this mowing date regulation is not applicable to the Winner study area, the same selection protocol was applied to retain a consistent study design. To find a sufficient sample of road ditches that were mowed after 9 July next to early-mowed ditches, study highways were revisited again a few days before the nest search crew arrived to select treatment pairs.

Through a contract with South Dakota State University, a 3 person crew was used to search mowed highway ditches for nests. Ditches were searched by crewmembers walking abreast at 2-meter spacings. Each crewmember was

responsible for searching the ground 1 meter to either side of them as the crew walked along the length of the ditch. All hayed portions of study ditches from the edge of the maintained highway shoulder mow line to the fence line were searched using this protocol. Portions of study ditches that were not mowed and those that were routinely mowed as an extension of farmstead lawns were not searched for nests.

Coordinates of the lengthwise ends of study ditches were recorded from a Global Positioning System (GPS) and the total area of the ditch was calculated by multiplying the distance between coordinates by the average width of the ditch that was search for nests. Calculated areas of study ditches that were not searched were subtracted from the total ditch area to come up with an estimate of the area searched for nests.

Evidence of nesting activity (nest bowl, eggs, egg shells or feathers) detected in study ditches was documented by recording the GPS coordinates of the evidence location and marking sites with surveyor’s flags. When possible, fates of nests were determined from evidence at nest sites. In addition, any evidence of avian mortality in ditches, whether associated with or independent of nests, was also noted on data sheets. Eggs and egg fragments found unassociated with a nest bowl were documented and recorded but not interpreted as nests in analyses. Active nests were revisited at a later date to determine fates. Densities of nests were estimated by dividing the total number of nests found in each treatment (early or delayed) of each segment by the total area searched in that treatment. Numbers of nests found were compared between ditches mowed early and delayed using Wilcoxon sign-rank tests with each early-delay pair included in the analysis as a paired replicate. Nest success was evaluated using Chi-square analysis.

Results

On the selected study highway segments, 4% of the Doland, 14% of the Arlington, 3% of the Parkston and 4% of the Winner study areas could not be mowed because there was no adjacent roadside where the highways passed through urban areas or the majority of the ditch

Table 1. Area searched and numbers of nests found in state highway roadsides that were mowed for hay prior to 2 July 2004 (early) and after 9 July (delayed) in South Dakota, 2004.

Study Area	Roadside miles searched		Acres searched		Number of nests found					
					Pheasant		Waterfowl		Other	
	Early	Delayed	Early	Delayed	Early	Delayed	Early	Delayed	Early	Delayed
Doland	8.0	8.0	53.7	52.6	6	12	0	0	0	0
Arlington	6.0	6.0	31.0	33.9	0	0	0	4	0	0
Parkston	7.0	7.0	48.3	48.3	5	9	0	0	1	0
Winner	6.5	6.5	42.2	41.7	18	43	0	1	4	3
Total	27.5	27.5	175.2	176.5	29	64	0	5	5	3

was flooded. The mowing chronology on the ditches potentially mowed for hay differed among study areas (Figure 1). Only 11% of ditches along the 3 study highways where mowing was prohibited by state law until after 10 July were mowed for hay prior to 2 July 2004 whereas 30% of the Winner study area roadsides were mowed for hay by this date. Fairly equal proportions of all 4 study areas (range: 6.5% – 7.9%) were mowed from 3 July 2004 through 9 July 2004. In the first week that mowing was allowed east of the Missouri River, 37% of Doland, 25% of Arlington, 27% of Parkston and 25% of Winner study areas were mowed for hay. From 17 July through 20 October, 41% of Doland, 49% of Arlington, 54% of Parkston and 29% of Winner study area roadsides were mowed for hay. This left 1% of

Doland, 9% of Arlington, 3% of Parkston and 8% of Winner study area roadsides unmowed as of 20 October 2004.

The nest search crew found a total of 106 nests (Table 1). Of the total, 93 were pheasant nests, 5 were waterfowl nests (4 mallard [*Anas platyrhynchos*] and 1 blue-winged teal [*Anas discors*]), 7 were mourning dove (*Zenaida macroura*) nests and 1 was a western meadowlark (*Sturnella neglecta*) nest. Evidence (eggs or egg shells) of pheasant nesting activity was also found at an additional 14 locations (5 at Winner, 6 at Parkston, 2 at Doland and 1 at Arlington). However, these sites were not counted as nesting attempts due to the lack of a discernable nest bowl.

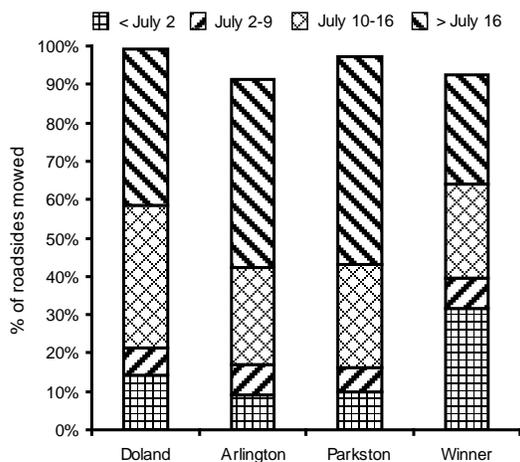


Figure 1. Hay-mowing chronology of state highway roadsides in South Dakota, 2004.

Mowing period (early or delayed) had an effect on nest densities in state highway roadsides (Table 2). Because of the lack of sufficient number of nests of species other than pheasants, only pheasant nest density data were tested statistically. Also, only Doland, Parkston and Winner were included in the statistical model since no pheasant nests were detected in the Arlington study area. Pheasant nest densities were higher in delay-mowed ditches than early-mowed ditches on the Doland ($Z = 1.65$, $df = 15$, $P = 0.099$) and Winner ($Z = 2.76$, $df = 12$, $P = 0.006$) study areas whereas nest densities did not differ ($Z = 0.67$, $df = 13$, $P = 0.500$) with treatment on the Parkston study area. Study areas pooled, pheasant nest densities were higher ($Z = 3.12$, $df = 42$, $P = 0.002$) in delay-mowed than early-mowed roadsides.

Table 2. Densities (nests per acre) of nests in state highway roadsides that were mowed for hay prior to 2 July 2004 (early) and after 9 July (delayed) in South Dakota, 2004.

Study Area	Pheasant		Waterfowl		Other		Total	
	Early	Delayed	Early	Delayed	Early	Delayed	Early	Delayed
Doland	0.112	0.228	0	0	0	0	0.112	0.228
Arlington	0	0	0	0.118	0	0	0	0.118
Parkston	0.104	0.186	0	0	0.021	0	0.124	0.186
Winner	0.427	1.031	0	0.024	0.095	0.072	0.521	1.127
Total	0.166	0.363	0	0.028	0.029	0.017	0.194	0.408

Even within treatments, nests were not randomly distributed among ditches. On the Arlington study area all 4 duck nests were found in 3 study plots (½-mile ditches) that were mowed after 9 July 2004. No nests were found in any of the Arlington study area ditches that were mowed early. On the Doland study area, searchers found nests in only 5 of 16 study plots mowed early and 9 of 16 mowed late. On the Parkston study area, only 4 of 14 study plots of each treatment type contained nests whereas 9 of 13 early-mowed ditches and all of the delay-mowed ditches contained nests on the Winner study area.

Proportionally, fates of pheasant nests were similar ($\chi^2 = 0.584$, $df = 5$, $P = 0.989$) between treatments (Figure 2). Thirty-one percent of pheasant nests found in both early-mowed and

delay-mowed ditches hatched and 14% of nests in each treatment were depredated. Seventeen percent of pheasant nests in early-mowed ditches and 23% of nests in delay-mowed ditches were destroyed by hay-mowing equipment. Of remaining pheasant nests, 7% (early-mowed) and 5% (delay-mowed) were abandoned, 24% (early-mowed) and 22% (delay-mowed) were unsuccessful for unidentifiable reasons, and fates of 7% (early-mowed) and 5% (delay-mowed) of pheasant nests were unknown.

While searching for nests, the search crew located evidence of 25 adult and 9 juvenile pheasant mortalities (Table 3). Seventeen (10 in early-mowed and 7 in delay-mowed ditches) of the 25 adults found did not have any evidence that they were killed by hay mowing equipment.



Figure 2. Fates of pheasant nests found in state highway roadsides that were mowed for hay prior to 2 July 2004 (early) and after 9 July (delayed) in South Dakota, 2004.

Table 3. Numbers of pheasants found that died from unidentified causes (dead) and from contact with hay-mowing equipment (killed) in state highway roadsides that were mowed for hay prior to 2 July (early) and after 9 July (delayed) in South Dakota, 2004.

Study Area	Treatment	Adults		Chicks	
		Dead	Killed	Dead	Killed
Doland	Early	0	0	1	0
	Delayed	0	1	0	0
Arlington	Early	2	0	0	0
	Delayed	0	0	0	0
Parkston	Early	2	0	0	0
	Delayed	1	2	1	1
Winner	Early	6	1	1	0
	Delayed	6	3	5	0
All	Early	10	1	2	0
	Delayed	7	7	6	1

However, evidence at nest sites indicated that 7 hens in delay-mowed ditches and 1 hen in an early-mowed ditch had been killed by hay mowing equipment. Of the 9 dead pheasant chicks found, 1 had injuries that indicated that it was killed by hay-mowing equipment.

Discussion

In April, hen pheasants begin their search for mates and nest sites and most have selected the site for their initial nesting attempt by early May (Leif 1996). For these initial nests, nesting cover is almost exclusively comprised of plant material that remains from the previous year's growth (Trautman 1982). This residual cover can only be found in grassy areas that were left unmowed and ungrazed during the previous year. Consequently, roadsides that were mowed in 2003 were unattractive to nesting pheasants in 2004 until the current year herbaceous growth was dense enough to conceal hens and their nests. This typically occurs some time in early to mid May (Leif 2004). Since the study plot selection protocol dictated that all study plots were mowed in 2003, only late-nesting hens and those attempting to re-nest following the loss of their initial attempt were likely attracted to study plots to nest.

Observed nest densities were within ranges of previous studies. Olson and Flake (1975) found

an average of 0.86 pheasant nests per acre in roadsides in Brookings County. From 1979 through 1981, yearly averages of densities of pheasant nests varied from 0.05 to 0.27 nests per acre in Codington County roadsides and 0.19 to 0.65 nests per acre in Tripp County ditches (Keyser 1986). In comparison, a recent study in east-central South Dakota found average pheasant nest densities ranging from 0.81 to 1.58 nests per acre in idled crop fields (Rohlfing 2004). Oetting and Cassel (1971) found an average 0.23 waterfowl nests for every acre of roadsides searched in North Dakota.

Due to the time period between mowing and nest searches, it is possible that some nesting attempts were not found. However, this study was designed simply to see if pheasants and other ground-nesting birds were still using roadsides for nesting. The lack of pheasant nests in the Arlington study area may be partially attributable to the location of study plots. Some of the study plots were located immediately south of Watertown where ditches were being used as 4-wheeled ATV trails. This likely had some impact on their attractiveness to nesting birds.

Throughout study areas, it was apparent that nesting activity was not randomly distributed among study plots. This was likely caused by a clumped distribution of pheasants around study areas. Simply stated, we found pheasant nests



Searchers found pheasant nests in state highway roadsides that were located in areas that supported pheasant populations.



On average, roadsides that were not mowed until mid-July contained twice as many pheasant nests as roadsides that were mowed in June.

in state highway ditches that were in landscapes that contained essential habitats necessary to support populations of pheasants. Where pheasants were abundant (Tripp County), we found high densities of pheasant nests and in areas where pheasant numbers were low (portions of all other study areas) searchers found no pheasant nests.

In designing this study, we anticipated that nest distributions would be clumped and selected pairs of study plots to neutralize the effects of various pheasant distributions in evaluating the effectiveness of current mowing restrictions. This study offers support for current mowing restrictions. However, even when state highway ditches were mowed in compliance with current regulations, 11% (7 of 64) of hens that initiated nests in these ditches were killed by hay-mowing equipment. Although current regulations allow for some pheasant reproduction in state highway rights-of-way they also result in the death of 1 of every 10 pheasants that nest in ditches that are mowed soon after currently established mowing release date (10 July).

Management Implications

This research documents that nesting activity in state highway roadsides can contribute to local pheasant abundance. Based on these results, state highway roadsides can be managed as

pheasant nesting habitat at differing degrees of priority. The following management recommendations are based solely on avian nesting activity and no attempt is made to address the alternate management objective of forage production. Accordingly, management options for state highway roadsides for avian reproduction can be partitioned into 5 categories: Exclusive, Emphasis, Minimal Impact, Allowance, and Disregard.

Exclusive – State highway ditches could be managed exclusively for avian production by forbidding almost all hay mowing activity. Under this option, roadsides could only be mowed for hay once every five years. In years when mowing is allowed, it should be restricted until after August 1st. The occasional disturbance from mowing would allow for rejuvenation of vegetation vigor and occasional utilization of grass for forage.

Emphasis – The management emphasis of state highway roadsides could be established as for avian production by restricting hay mowing to every other year. Under this option mowing eligibility could be established by rule to be allowed on one side (north or south, east or west) of each highway in alternating years. Like the previous option, mowing would only be allowed in the designated year after August 1st. Under this option one-half of state highway roadsides would contain the residual cover that pheasants and upland-nesting waterfowl are searching for



One of every 10 hen pheasants nesting in state highway roadsides that were mowed after 9 July 2004 was killed by hay-mowing equipment.

when they initiate their first nests of the breeding season. Nest densities would likely increase over current rates of usage and production would also go up.

Minimal Impact – The impact of hay mowing on avian reproduction could be minimized if the current rules were amended to restrict hay mowing of state highway roadsides until after August 1st. Data from this study demonstrate that nesting hen and newly-hatched pheasant chicks are killed by hay mowing equipment even when ditches are mowed in accordance with current mowing date restrictions. A restriction date of August 1st would not protect all pheasant hens and chicks, but the majority would be spared exposure to hay mowing equipment.

Allowance – The current regulations can be best described as an avian reproduction allowance option. The mowing date of July 10th allows for some reproduction in state highway ditches. However, even mowing activity after July 10th results in nest failures and significant hen pheasant mortality. Maintaining status quo will allow for some avian reproduction but mowing activity in July will diminish the annual production levels.

Disregard – The final option available would be disregard avian reproduction in state highway roadsides and remove all restrictions intended to enhance reproduction. Under current rules avian production in state highway ditches appears to contribute to local avian abundance. However, if decision makers deem this contribution to be disposable, current mowing restriction could be removed.

Acknowledgements

Field data were collected by Randi Biever, Jed Vonnahme, Tyler Trees and Nora Kohlenberg. Chad Switzer assisted with mowing censuses.

Literature Cited

Keyser, E. J. 1986. Pheasant nesting and vegetation development in dense nesting cover established under the South Dakota Pheasant Restoration Program. Thesis, South Dakota State University, Brookings, South Dakota, USA.



Pheasant production in state highway roadsides could be enhanced if hay mowing was not allowed until after 1 August.

Leif, A. P. 1996. Survival and reproductive chronology of female ring-necked pheasants in South Dakota. *Prairie Naturalist*: 28:189-198.

Leif, A. P. 2004. Spatial ecology and habitat selection of breeding male pheasants. *Wildlife Society Bulletin*. In press.

Olsen, R. A. and L. D. Flake. 1975. Nesting of ring-necked pheasants in eastern South Dakota. *Proceedings of the South Dakota Academy of Sciences* 54:126-136.

Oetting, R. B. and J. F. Cassel. 1971. Waterfowl nesting on interstate highway right-of-way in North Dakota. *Journal of Wildlife Management*. 35:774-781.

Rohlfing, M. B. 2004. Avian nesting density and success in introduced cool-season grass-legume plantings versus warm-season native grass plantings in South Dakota. Thesis, South Dakota State University, Brookings, South Dakota, USA.

Trautman, C. G. 1982. History, ecology and management of the ring-necked pheasant in South Dakota. South Dakota Department of Game, Fish and Parks Wildlife Research Bulletin 7, Pierre, South Dakota, USA.

APPENDIX

Appendix Table 1. Numbers of nests and dead pheasants found in state highway roadsides mowed before 2 July (Early) or after 9 July (Delayed) in Beadle and Spink Counties (Doland study area), South Dakota, 2004.

Plot	Area	Treatment	Nests						Pheasant mortality			
			Pheasant ^a		Waterfowl ^a		M. Dove ^a		Hens ^b		Chicks ^b	
			T	H	T	H	T	H	Dead	Killed	Dead	Killed
0.5E	2.79	Delayed	2	0	0	0	0	0	0	0	0	0
1.0E	2.74	Early	1	0	0	0	0	0	0	0	0	0
4.5W	2.98	Early	0	0	0	0	0	0	0	0	0	0
4.5E	2.73	Delayed	1	0	0	0	0	0	0	0	0	0
5.5W	2.98	Early	1	0	0	0	0	0	0	0	0	0
5.5E	2.99	Delayed	0	0	0	0	0	0	0	0	0	0
6.5W	3.04	Early	0	0	0	0	0	0	0	0	0	0
6.5E	3.02	Early	0	0	0	0	0	0	0	0	0	0
16.5E	3.62	Delayed	1	0	0	0	0	0	0	0	0	0
17.0E	3.62	Early	0	0	0	0	0	0	0	0	0	0
17.5W	3.67	Early	0	0	0	0	0	0	0	0	0	0
18.0W	3.63	Early	0	0	0	0	0	0	0	0	0	0
18.5W	3.63	Delayed	2	0	0	0	0	0	0	0	0	0
18.5E	3.62	Delayed	1	0	0	0	0	0	0	0	0	0
23.5W	3.56	Delayed	0	0	0	0	0	0	0	0	0	0
23.5E	3.40	Delayed	0	0	0	0	0	0	0	0	0	0
24.0W	3.63	Early	1	0	0	0	0	0	0	0	0	0
24.0E	3.61	Early	1	1	0	0	0	0	0	0	1	0
24.5W	3.57	Delayed	1	0	0	0	0	0	0	0	0	0
24.5E	3.63	Delayed	0	0	0	0	0	0	0	0	0	0
25.0W	3.71	Early	0	0	0	0	0	0	0	0	0	0
25.0E	3.67	Early	0	0	0	0	0	0	0	0	0	0
25.5W	3.56	Delayed	0	0	0	0	0	0	0	0	0	0
25.5E	3.55	Early	0	0	0	0	0	0	0	0	0	0
27.5W	3.81	Early	0	0	0	0	0	0	0	0	0	0
27.5E	3.80	Delayed	1	0	0	0	0	0	0	1	0	0
59.0N	2.05	Delayed	0	0	0	0	0	0	0	0	0	0
59.5N	2.52	Early	0	0	0	0	0	0	0	0	0	0
59.5S	3.32	Delayed	2	0	0	0	0	0	0	0	0	0
60.0N	3.33	Early	2	0	0	0	0	0	0	0	0	0
60.5N	3.29	Early	0	0	0	0	0	0	0	0	0	0
60.5S	3.34	Delayed	1	1	0	0	0	0	0	0	0	0

^a T = total; H = hatched

^b Dead = unidentified mortality; Killed = killed by hay-mowing equipment

Appendix Table 2. Numbers of nests and dead pheasants found in state highway roadsides mowed before 2 July (Early) or after 9 July (Delayed) in Codington, Hamlin, Brookings and Lake Counties (Arlington study area), South Dakota, 2004.

Plot	Area	Treatment	Nests						Pheasant mortality			
			Pheasant ^a		Waterfowl ^a		M. Dove ^a		Hens ^b		Chicks ^b	
			T	H	T	H	T	H	Dead	Killed	Dead	Killed
0.0E	2.89	Delayed	0	0	0	0	0	0	0	0	0	0
0.0W	2.87	Early	0	0	0	0	0	0	0	0	0	0
0.5E	2.76	Early	0	0	0	0	0	0	0	0	0	0
0.5W	3.05	Early	0	0	0	0	0	0	0	0	0	0
1.0E	3.01	Delayed	0	0	0	0	0	0	0	0	0	0
1.0W	2.77	Delayed	0	0	0	0	0	0	0	0	0	0
3.5E	3.06	Early	0	0	0	0	0	0	0	0	0	0
3.5W	2.43	Early	0	0	0	0	0	0	0	0	0	0
4.0W	2.91	Early	0	0	0	0	0	0	0	0	0	0
5.0W	3.00	Early	0	0	0	0	0	0	0	0	0	0
5.5W	2.80	Early	0	0	0	0	0	0	1	0	0	0
6.0W	3.04	Early	0	0	0	0	0	0	1	0	0	0
6.5W	2.99	Early	0	0	0	0	0	0	0	0	0	0
7.5E	2.13	Delayed	0	0	2	1	0	0	0	0	0	0
8.0W	2.68	Delayed	0	0	1	0	0	0	0	0	0	0
8.5W	2.69	Delayed	0	0	0	0	0	0	0	0	0	0
9.0E	2.71	Delayed	0	0	0	0	0	0	0	0	0	0
9.5W	3.05	Delayed	0	0	0	0	0	0	0	0	0	0
10.0E	2.84	Delayed	0	0	0	0	0	0	0	0	0	0
10.0W	3.86	Delayed	0	0	0	0	0	0	0	0	0	0
45.5E	2.71	Delayed	0	0	1	1	0	0	0	0	0	0
46.5E	0.94	Early	0	0	0	0	0	0	0	0	0	0
46.5W	1.11	Early	0	0	0	0	0	0	0	0	0	0
47.0W	2.59	Delayed	0	0	0	0	0	0	0	0	0	0

^a T = total; H = hatched

^b Dead = unidentified mortality; Killed = killed by hay-mowing equipment

Appendix Table 3. Numbers of nests and dead pheasants found in state highway roadsides mowed before 2 July (Early) or after 9 July (Delayed) in Hutchinson and Douglas Counties (Parkston study area), South Dakota, 2004.

Plot	Area	Treatment	Nests						Pheasant mortality			
			Pheasant ^a		Waterfowl ^a		Meadowlark ^a		Hens ^b		Chicks ^b	
			T	H	T	H	T	H	Dead	Killed	Dead	Killed
26.5N	3.71	Delayed	0	0	0	0	0	0	1	0	0	0
26.5S	3.59	Delayed	0	0	0	0	0	0	0	0	0	0
27.0N	3.93	Early	0	0	0	0	0	0	0	0	0	0
27.0S	3.72	Early	0	0	0	0	0	0	0	0	0	0
32.5N	3.65	Early	0	0	0	0	0	0	0	0	0	0
32.5S	3.65	Delayed	0	0	0	0	0	0	0	0	0	0
34.0N	3.62	Early	3	1	0	0	0	0	0	0	0	0
34.0S	3.60	Delayed	1	0	0	0	0	0	0	0	0	0
34.5S	3.64	Early	1	0	0	0	0	0	0	0	0	0
35.0S	3.64	Delayed	0	0	0	0	0	0	0	0	1	0
36.5S	3.58	Delayed	0	0	0	0	0	0	0	0	0	0
37.0N	3.61	Early	0	0	0	0	0	0	0	0	0	0
37.0S	3.36	Delayed	0	0	0	0	0	0	0	0	0	0
37.5S	3.22	Early	0	0	0	0	0	0	0	0	0	0
38.0N	3.32	Early	0	0	0	0	1	0	0	0	0	0
38.0S	3.65	Early	0	0	0	0	0	0	0	0	0	0
38.5N	3.56	Early	1	0	0	0	0	0	0	0	0	0
38.5S	3.57	Delayed	2	0	0	0	0	0	0	1	0	1
39.0N	3.62	Delayed	0	0	0	0	0	0	0	0	0	0
39.0S	3.48	Delayed	0	0	0	0	0	0	0	0	0	0
49.5S	2.95	Delayed	0	0	0	0	0	0	0	0	0	0
50.0N	2.99	Early	0	0	0	0	0	0	0	0	0	0
54.5N	2.86	Delayed	5	4	0	0	0	0	0	0	0	0
54.5S	2.66	Early	0	0	0	0	0	0	1	0	0	0
56.5N	3.06	Early	0	0	0	0	0	0	0	0	0	0
56.5S	3.03	Delayed	0	0	0	0	0	0	0	0	0	0
59.0N	3.63	Delayed	1	0	0	0	0	0	0	1	0	0
59.0S	3.64	Early	0	0	0	0	0	0	0	0	0	0

^a T = total; H = hatched

^b Dead = unidentified mortality; Killed = killed by hay-mowing equipment

Appendix Table 4. Numbers of nests and dead pheasants found in state highway roadsides mowed before 2 July (Early) or after 9 July (Delayed) in Tripp and Gregory Counties (Winner study area), South Dakota, 2004.

Plot	Area	Treatment	Nests						Pheasant mortality			
			Pheasant ^a		Waterfowl ^a		M. Dove ^a		Hens ^b		Chicks ^b	
			T	H	T	H	T	H	Dead	Killed	Dead	Killed
0.5E	3.32	Delayed	4	1	1	1	0	0	0	0	0	0
0.5W	3.81	Early	0	0	0	0	0	0	1	0	0	0
11.0N	2.50	Early	0	0	0	0	0	0	0	0	0	0
11.0S	2.26	Delayed	2	1	0	0	0	0	0	0	0	0
17.5N	3.66	Early	1	0	0	0	0	0	1	0	1	0
18.0N	3.78	Delayed	2	2	0	0	0	0	0	0	0	0
20.0N	3.59	Delayed	1	0	0	0	1	0	0	0	0	0
20.5N	3.54	Early	0	0	0	0	0	0	1	0	0	0
23.5S	3.62	Early	3	1	0	0	1	0	0	0	0	0
24.0S	4.00	Delayed	2	1	0	0	0	0	2	0	0	0
36.0E	3.60	Delayed	5	2	0	0	0	0	3	0	3	0
36.5E	3.57	Early	2	2	0	0	0	0	1	0	0	0
37.0E	3.34	Early	1	0	0	0	0	0	1	0	0	0
37.0W	2.66	Early	1	0	0	0	0	0	0	0	0	0
37.5E	2.71	Delayed	5	3	0	0	0	0	1	1	1	0
37.5W	2.33	Delayed	4	2	0	0	1	1	0	0	0	0
46.5E	3.55	Delayed	4	0	0	0	0	0	0	1	0	0
46.5W	3.03	Early	1	0	0	0	0	0	1	0	0	0
50.0N	2.97	Delayed	7	3	0	0	0	0	0	0	1	0
50.5N	2.96	Early	6	4	0	0	3	2	0	1	0	0
54.5N	3.64	Delayed	1	0	0	0	0	0	0	0	0	0
55.0N	3.63	Early	2	0	0	0	0	0	0	0	0	0
56.0N	3.50	Early	1	0	0	0	0	0	0	0	0	0
56.0S	3.53	Delayed	4	0	0	0	0	0	0	2	0	0
61.5N	2.46	Delayed	2	0	0	0	1	0	0	0	0	0
61.5S	2.34	Early	0	0	0	0	0	0	0	0	0	0

^a T = total; H = hatched

^b Dead = unidentified mortality; Killed = killed by hay-mowing equipment