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USING DISTANCE SAMPLING TO ESTIMATE DENSITIES OF WHITE-TAILED DEER IN WATONWAN COUNTY, MINNESOTA

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SUMMARY OF FINDINGS

We present an alternative approach to estimating white-tailed deer (*Odocoileus virginianus*) density in Minnesota's southern, farmland region. We collected data from spotlight surveys to estimate deer density in Watonwan County, Minnesota. We estimated time required to collect field data, mean cluster sizes of deer, and mean distances of deer from observers. We then calculated population densities using the program DISTANCE (Thomas et al. 2002). We found a relationship between survey time and number of routes conducted indicating observers became more efficient at collecting data with increased experience. We observed more deer at greater distances during the post-hunt trial period than the pre-hunt trial period. As expected, the population density estimate was lower after deer were harvested during the hunting season. We recommend selecting survey routes using a randomized design to improve accuracy of density estimates derived by distance sampling.

INTRODUCTION

Numeric and geographic expansion of white-tailed deer populations provide increased recreational opportunities for hunters, but also create more challenges and problems for wildlife managers. Effective management decisions are predicated, in large part, on the number of deer within a permit area relative to the population goal. Wildlife managers in Minnesota's farmland region recommended the agency improve techniques to estimate and monitor deer abundance (Haroldson 2003). This management recommendation is congruent with previous research recommendations (Grund and Woolf 2004).

A variety of techniques are available to estimate populations of deer, and each has associated advantages and disadvantages. Most wildlife agencies use some analytical technique to evaluate harvest data, and these data form the basis of population assessment and trend analysis (e.g., population reconstruction (Roseberry and Woolf 1991), harvest-age-structure (Harris 1984), life table (Caughley 1977), and catch-per-unit effort (Lancia et al. 1996)). Most techniques for analyzing harvest data require age-at-harvest data (Roseberry and Woolf 1991). Age-at-harvest data are not routinely collected from hunter-killed deer in Minnesota, so options for population assessment are limited to simulation modeling (Grund and Woolf 2004) and field techniques. Available field techniques include aerial surveys (Potvin et al. 2005), collecting mark-recapture data and utilizing Schnabel estimators (Lopez et al. 2004), or Lincoln-Peterson estimators (McCullough and Hirth 1988). Osborn et al. (2003) used an aerial survey technique to recalibrate Minnesota's farmland model. Although using aerial surveys to recalibrate a population model is recommended (Grund and Woolf 2004), the technique is expensive and requires aircraft and staff to be available under certain snow conditions. Snow conditions limit the application of aerial surveys, in most years, to northern Minnesota during winter. Our intent was to provide an alternative framework for wildlife managers to estimate deer population

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size in areas and situations where aerial surveys may not be feasible or appropriate.

Distance sampling is a technique that has been increasingly used during the past 2 decades (Thompson et al. 1998). Distance sampling is based on the concept that not all animals will be observed during surveys due to visibility bias caused by visual impediments and observer error (Buckland et al. 1993). A detection function is generated which estimates how detection of objects changes with increasing distance from the observer. The detection function is used to estimate the area from which objects are observed from transects. Density is then computed as the number of animals observed divided by the area sampled. Thus, density can be estimated as $D = nf(0) / 2L$ where D=density of animals of the surveyed area, n=number of animals observed, $f(0)$=value of the detection function of perpendicular distances, and L=the length of the transect traveled during surveys (Buckland et al. 1993). There are 3 assumptions associated with distance sampling: 1) all animals on transect lines are observed, 2) detected individuals or clusters of individuals are observed at their original location, and 3) sighting distances are measured without error. Buckland et al. (1993) provides a comprehensive review of the technique and Rivera-Milan et al. (2005) provides an application of the technique.

OBJECTIVES

- To collect field data on deer in Watonwan County to derive pre-hunt and post-hunt population densities using the program DISTANCE (Thomas et al. 2002); and
- To examine factors that may affect density estimates using distance sampling.

METHODS

We conducted 24 spotlight surveys in Watonwan County, MN, from 21 October – 28 December 2004. Twelve surveys were conducted prior to the regular firearms deer season (21 October – 4 November) and 12 surveys were conducted after the season (15 November- 28 December). During surveys, observers searched for deer using hand-held spotlights while a pickup truck traveled 2 east-west transects, approximately 40 km in length (25 miles; Figure 1) at speeds <32 km/hour (<20 miles/hour). Our starting point varied each night to reduce the probability of observing the same deer in the same places at corresponding times of surveys. Surveys began at dusk and were completed after traveling the 2 east-west transects. Survey start and end times ranged from 1700 – 2300 hours, respectively. Observers estimated distance to centers of deer clusters with a laser range finder and determined angles to centers of clusters using a prismatic compass. We defined a cluster of deer as a group of deer that were observed in the same field. Observer location (universal transmercator coordinates) at the time of each deer sighting was determined using a global positioning system receiver after distances and angles were recorded. We also recorded whether animals were observed in cropland, forest, or tall grass habitat types.

We performed a least-squares regression analysis with survey completion times and Julian date data to examine the relationship between observer experience and time spent afield. We used SAS (SAS Institute 1999) to calculate all descriptive and inferential statistics. A 2-way analysis of variance model was fitted to test survey period effects, habitat effects and their interactions on distance and cluster size data. We used the computer program DISTANCE to estimate detection functions, population densities, and precision. Density estimates and associated standard errors were adjusted to the proportion of woody habitat present in Watonwan County. To make this adjustment, land cover data were obtained and proportions of woody cover within the county were calculated using geographic information system maps within ArcView (Environmental Systems Research Institute 1999). Original population densities estimated by DISTANCE were then adjusted so that the sampled area represented the composition of woody cover in Watonwan County.

RESULTS

Time spent afield per survey during pre- and post-hunting periods was 4.4 (SD = 0.7) and 3.5 hours (SD = 0.4), respectively. There was a negative, curvilinear relationship (P<0.01) between time spent afield per survey and Julian dates (Figure 2).

Mean deer cluster size during pre- and post-season periods was 2.1 (SE = 0.1) and 2.9 deer/cluster (SE = 0.2), respectively. The survey period x habitat interaction effects for cluster sizes was significant ($F_{2,467}$ = 7.4, P < 0.001). There was a simple habitat effect during the post-hunt survey period ($F_{2,467}$ = 12.9, P < 0.01). Post hoc Tukey comparisons indicated that more deer (P < 0.05) were observed in tall grass habitat during the post-hut period than in forests or cropland habitats (Figure 3). The simple effect for habitat during the pre-hunt period was not significant ($F_{2,467}$ = 0.6, P > 0.05).

The survey period x habitat interaction effect for distances was not significant ($F_{2,467}$ = 1.7, P > 0.18). Post hoc Tukey HSD comparisons indicated distances from observer to clusters differed (P < 0.05) between seasons (pre-hunt = 128 m, SE = 5 and post-hunt = 145 m, SE = 7). Deer were also observed at greater distances (P < 0.05) in cropland habitats (mean = 153 m, SE = 6) than in forested (mean = 123 m, SE=11) or tall grass habitats (mean = 108 m, SE = 5; Figure 4).

We observed 259 clusters of deer (537 individuals) during the pre-season period and 215 clusters (620 individuals) during the post-season period. The unadjusted pre- and post-hunt population density estimates for Watonwan County were 7 ± 2 and 5 ± 2 deer/km^2, respectively (17 ± 4 and 14 ± 4 deer/mile^2, respectively). The adjusted pre-hunt density estimate was 2.5 deer/km^2 (6.4 deer/mile^2) and the adjusted post-hunt estimate was 2.0 deer/km^2 (5.3 deer/mile^2). These estimated densities are comparable to simulated output from Minnesota's farmland model in Permit Areas 457 and 458, both of which encompass Watonwan County (Figure 5).

DISCUSSION

We were encouraged that estimated densities were comparable between survey periods and the estimates were logical with the post-hunt density being lower than the pre-hunt density. It is noteworthy that we would have concluded that the population had increased after the hunting season if we just conducted spotlight surveys (537 deer observed during pre-hunt and 620 deer observed post-hunt). Probably due to crop harvest and leaf drop, we were able to observe more deer (n) during the post-hunt period. However, we also sampled a larger area (a) during the post-hunt period due to our ability to see farther distances. Thus, the estimated post-hunt population density (D) was lower than the pre-hunt density even though we observed more deer during the post-hunt period ($D = n/a$).

Our adjusted distance sampling estimates generally agreed with modeled deer densities in Permit Areas 457 and 458. The 2 distance sampling estimates are not directly comparable to modeling estimates because Permit Areas 457 and 458 extend beyond the boundaries of Watonwan County. Thus, we cannot conclude that the estimates derived from distance sampling were more accurate than modeling estimates. However, we believe an improved sampling design for Permit Areas 457 and 458 could produce accurate distance sampling estimates for those units. We needed to adjust the original distance sampling density estimates because we repeatedly over-sampled woody cover using our sampling design. We believe collecting field data in randomly-selected units or stratifying the survey routes by cover type within a study area would remedy this problem, and this sampling scheme should be evaluated.

We believe further evaluation of this technique is warranted due to the need to: 1) recalibrate Minnesota's farmland deer model for improved deer management, 2) estimate population sizes of white-tailed deer for research purposes, and 3) potentially estimate population sizes during non-winter months to respond to unforeseeable management crises, such as an outbreak of chronic-wasting disease.

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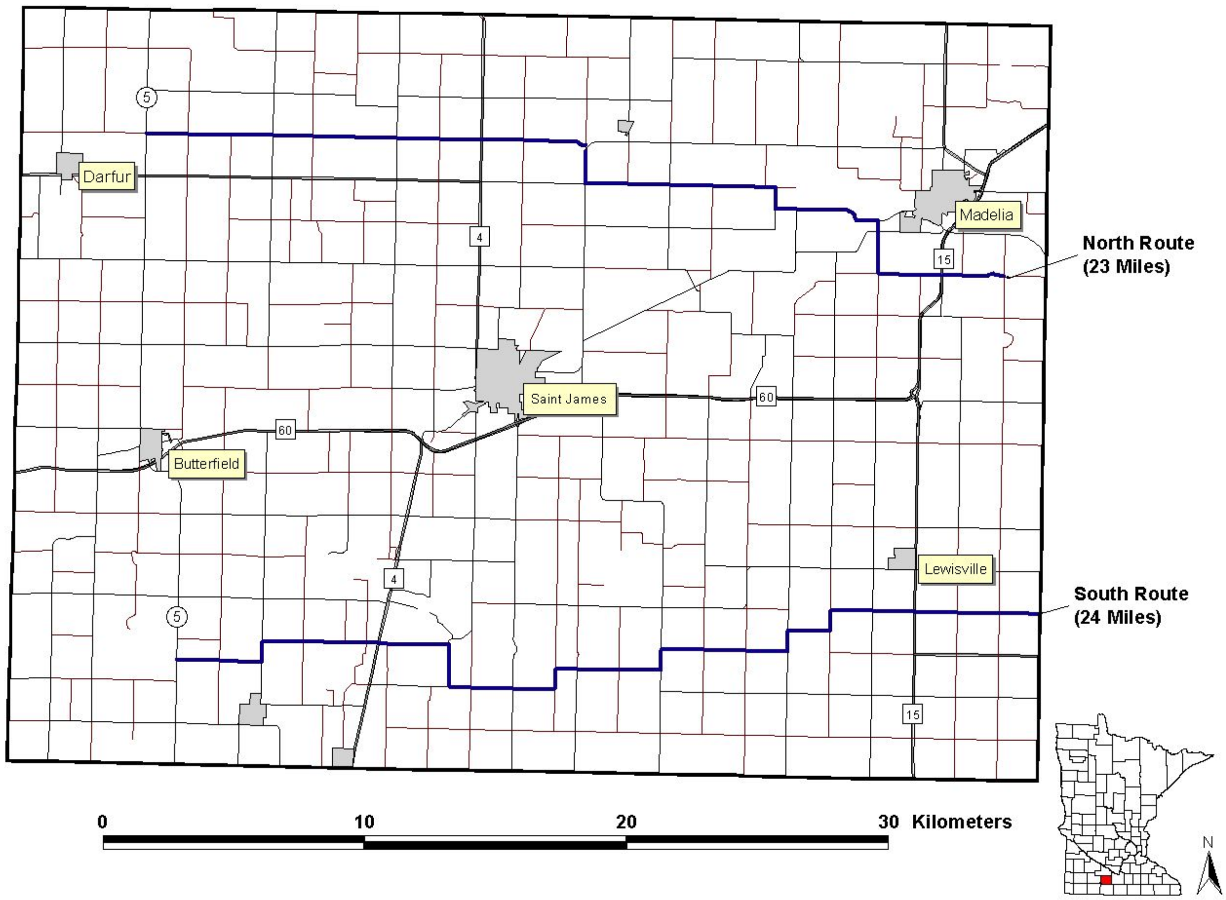

Figure 1. Transects driven in Watonwan County to collect field data for distance sampling analysis, Minnesota, 18 Oct – 28 Dec 2004.

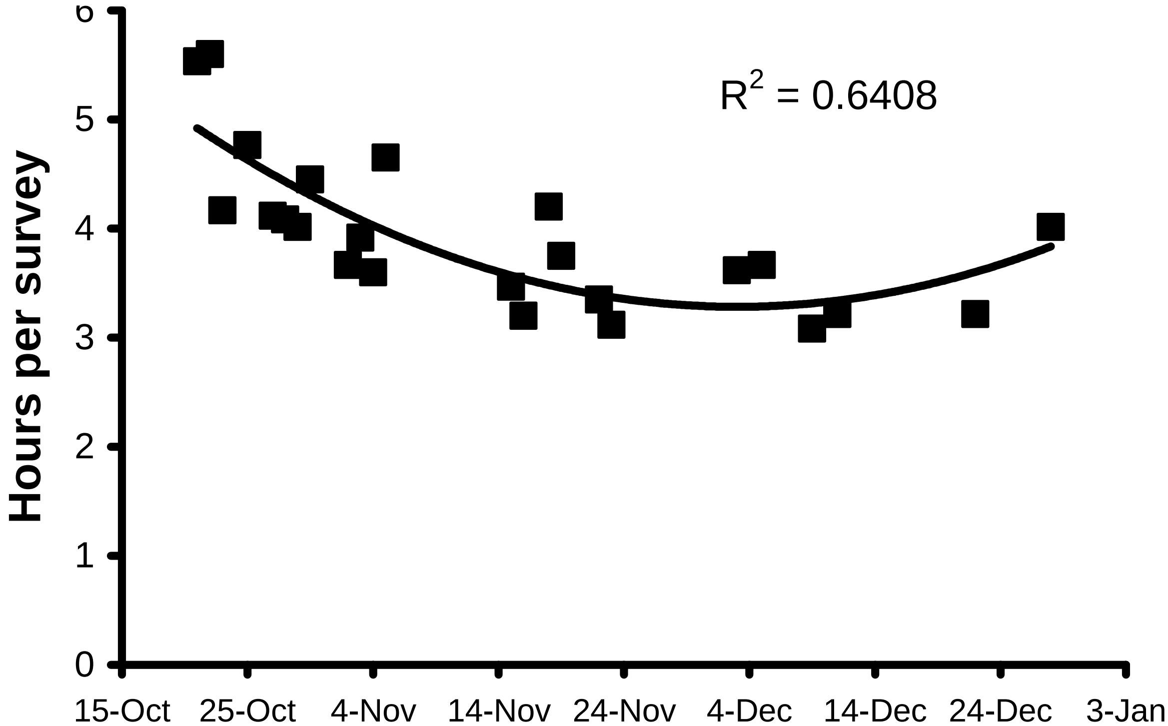

Figure 2. Time required to collect spotlight survey data on white-tailed deer versus Julian date Watonwan County, Minnesota, 2004.

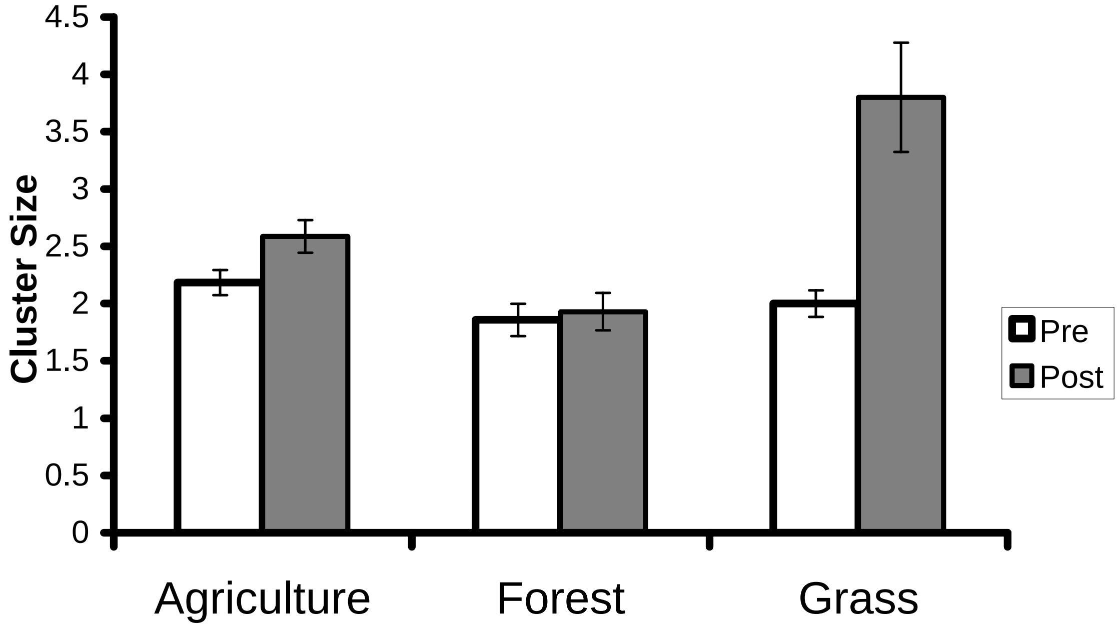

Figure 3. Mean cluster sizes (SE) of white-tailed deer by habitat type and survey period, Watonwan County, Minnesota, 18 October – 28 December 2004.

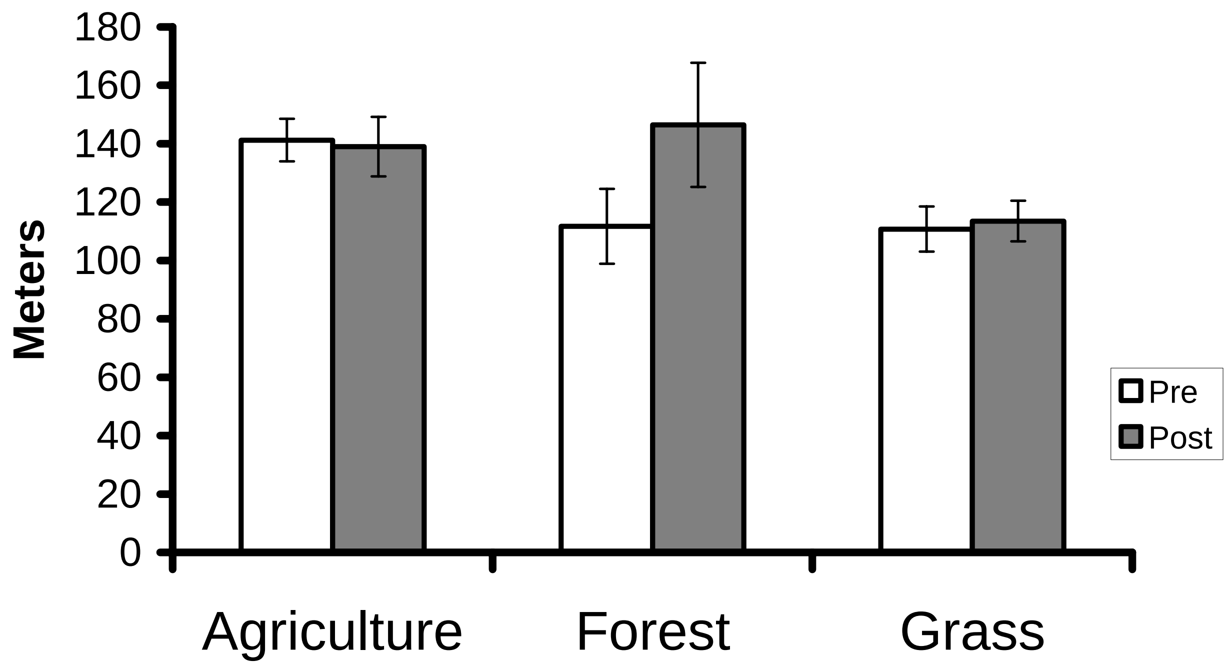

Figure 4. Mean distances (SE) between observers and deer by habitat type and survey period, Watronwan County, Minnesota, 18 October – 28 December 2004.

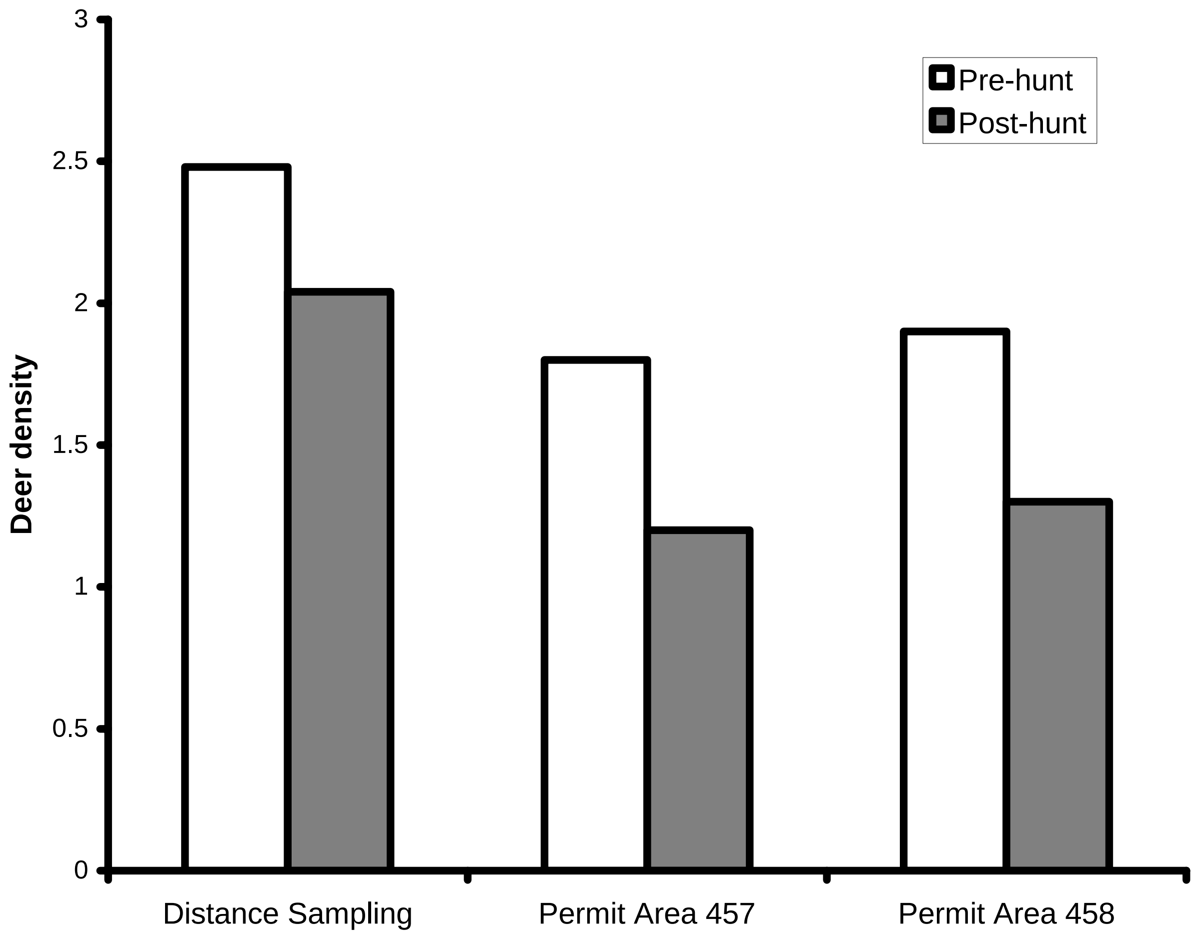

Figure 5. Comparison of deer densities (deer/km^2) estimated for Watonwan County through distance sampling and for Permit Areas 457 and 458 estimated through simulation modeling, Minnesota, 2004.

SIMULATING ANTLER POINT RESTRICTION REGULATIONS IN POPULATIONS OF WHITE TAILED DEER IN NORTHWEST MINNESOTA USING A GENERALIZED SUSTAINED YIELD MODEL.

Marrett D. Grund

SUMMARY OF FINDINGS

I developed a population model to simulate the effect antler-point restriction regulations (herein referred to as point rules) have on white-tailed deer (*Odocoileus virginianus*) populations and hunter harvests in northwest Minnesota. I used sustained yield theory as the foundation of the model so that the effect density-dependence has on deer populations could be evaluated. Six management strategies were modeled under low and high deer densities. Buck:doe ratios increased under point rules and were maximized when these regulations were coupled with high harvest rates of adult females. Buck harvests were variable, but generally decreased under point rules. Antlerless harvests responded more to herd size management strategies than to point rules. However, fewer antlerless deer were required to be harvested under a 4-point rule.

INTRODUCTION

Over the past 70 years, deer management has evolved from focusing on promoting deer population expansion through habitat protection, hunting regulations, and predator control, to serious concerns about how best to limit deer densities and the consequent impacts of deer on society (Conover 1997) and forest ecosystems (Garrott et al. 1993). Concurrent with managers' concerns regarding growth rates of deer populations, there is a growing interest by hunters, hunting organizations, landowners, and ultimately legislators to increase buck:doe sex ratios in deer populations. Most of these groups recommend some variation of selective harvest criteria on antlered deer such as point rules (Strickland et al. 2001).

A Senate bill passed during the 2004 legislative session mandating that the Department of Natural Resources (MNDNR) consider point rules in 5 northwestern Minnesota counties. Due to increasing interest of several organizations, individuals, and the legislation implied that the MNDNR would examine the issue. The MNDNR recognized the need to study social and biological impacts of alternative management strategies on Minnesota white-tailed deer populations. Consequently, I developed a simulation model to study effects point rules have on deer populations and hunter harvests in northwest Minnesota.

OBJECTIVE

- To develop a population model that will forecast effects various levels of point rules have on deer populations and harvest levels in northwest Minnesota.

METHODS

Population Model

I developed a computer model for simulating population dynamics of white-tailed deer under alternative harvest regimes. Similar to most big game models, my model explicitly tracked sex and age classes over time and was driven by 3 primary sets of variables representing harvest, recruitment, and natural mortality. I structured the model to generally reflect important biological periods during the life cycle of a white-tailed deer. Thus, the model operated in a similar fashion to many other deer population models (e.g., Walters and Gross 1972, Xie et al. 1999, Grund and Woolf 2004).

The model was partitioned into 3 distinct seasons of the year beginning with the pre-hunting season (June – early September), the hunting season (mid-September – December), and then the post-hunting season (January – May), (Figure 1.) The model simulated age, reproduction, and non-hunting survival for 4 sex and age classes (fawn male, fawn female, adult male, and adult female). Yearlings were separated from adults during the hunting season so that independent harvest rates could be applied to that cohort during that time period. For this paper, fawn refers to deer <1 years old and adult refers to deer >1 years old, except during the hunting season. During the hunting season, adult refers to deer >2 years old and yearling refers to deer approximately 1.5 years old.

Density-Dependent Vital Rates

The foundation of my model was based on a density-dependent relationship. Estimates for stage-specific, density-dependent parameters were derived from a generalized sustained yield model for white-tailed deer (Downing and Guynn 1985). Most parameters were stochastic so that variation in estimates could be modeled to simulate expected, temporal variation in population vital rates (Table 1).

Density-Independent Vital Rates

In Minnesota, winter severity has a direct and significant impact on deer populations by influencing winter mortality rates (DelGuidice 2003), and the winter weather parameter has substantial influence on model output (Grund and Woolf 2004). Verme (1977) also found that winter weather influenced fetal development during late gestation and, as a consequence, had a negative impact on natal survival. The impact winter conditions had on vital statistics were estimated and integrated into the model after density-dependent vital statistics were estimated.

To estimate winter mortality rates, I calculated winter severity indices (WSI) using minimum temperature and snow depth data from National Weather Service stations located throughout Minnesota from 1 January 1982 – 15 May 1999 (United States Department of Commerce, National Oceanic and Atmospheric Administration, 1999). The WSI value was calculated by summing the number of days temperature values were $<-17.8^{o}$ C and the number of days snow depths were >38 cm at each weather station for each month. These values were then spatially interpolated using the inverse distance weighting method based on the nearest 6 weather stations (Burrough and McDonnell 1998).

The model randomly generated WSI values based on a uniform distribution of probability categories representing mild, moderate, and severe winters for northwest Minnesota. Probability ranges for mild winters were based on the proportion of WSI values that were <100 from 1983-2000. The minimum WSI observed from 1983-2000 was the lowest value that could have been selected during simulations. Probability ranges for moderate winters were based on the proportion of WSI values that fell between 100-120 from 1983-2000. Probability ranges for severe winters were based on the proportion of WSI values that were >120 from 1983-2000. Maximum WSI values used in simulations was determined by the maximum WSI calculated from 1983-2000.

After the WSI value was randomly determined, winter mortality rates for adult female deer were estimated from a linear equation derived from a 14-yr winter mortality study conducted in north-central Minnesota (DelGuidice 2003). I assumed winter mortality for adult male deer was similar to adult female deer. I used linear equations based on a previous study to estimate winter mortality rates for fawns (Grund and Woolf 2004). Fawn summer survival was partitioned into a baseline survival rate derived from the sustained yield model and a neonatal survival rate based on the previous winter's WSI value (Verme 1977). The neonatal survival rate was then multiplied with the baseline survival rate to derive a composite fawn summer survival rate.

Harvest Management Strategies

Point rules are intended to protect some pre-determined proportion of antlered bucks during the hunting season. I examined antler and sex-age-kill data from deer at registration stations in Minnesota from 1993-2000 to determine protection levels (percentage of antlered deer protected by the point rule) of yearling and adult male deer under a 3-points-to-a-side (3-point) and 4-points-to-a-side (4-point) point rule in 4 deer management units (Tables 2 and 3). The model assumed harvest rates for antlered deer slightly increased as deer densities decreased (Roseberry and Woolf 1991). For this paper, I only modeled protection levels associated with yearling and adult bucks in northwest Minnesota.

There is not a direct link between decreasing harvest rates of adult males and increasing harvest rates of antlerless cohorts. Thus, managing antlerless harvests can be restricted or liberalized via antlerless license quotas in conjunction with point rules. I modeled adult female harvest rates that would achieve 2 different management goals over a 20-year period: 1) maintain stable population sizes (population size ±10% of population size in year 20), and 2) to reduce population size by 40-60%. Adult female harvest rates were randomly selected in 3 different range categories: low (10-20%), moderate (20-30%), and high (30-40%). Which range category was used to select an adult female harvest rate depended on where the population size was relative to its pre-determined goal. For example, the model would randomly select a value within the low harvest rate range if the population size was below the pre-determined population goal. The model would then simulate a population increase in response to a conservative management strategy of having a low harvest rate of adult females. Conversely, the model would select a value within the high harvest rate range if the population size was above the pre-determined population goal. Numerical fawn harvests were always about 50% of adult doe harvests. The composition of fawns in antlerless harvests fluctuates both across permit areas and years, but often comprises about one-half of the adult female harvest in Minnesota.

Initial Conditions and Simulations

I first determined initial sex and age compositions of deer populations by conducting 10-year simulations and calculating an average sex and age structure of the stable population for each modeling scenario. Initial sex and age compositions were adjusted based on the stable population then model runs were performed.

I allowed the model to simulate deer herd dynamics for 20 years to represent traditional rules (legal bucks had >3 inch antlers). Six management strategies were simulated beginning in year 21: 1) traditional rules with a management goal of maintaining a stable population size, 2) traditional rules with a management goal of reducing population size by 50%, 3) 3-point rules with a management goal of maintaining a stable population size, 4) 3-point rules with a management goal of reducing population size by 50%, 5) 4-point rules with a management goal of maintaining a stable population size, and 6) 4-point rules with a management goal of reducing population size by 50%. Each management strategy was simulated for 20 years during the second period (years 21-40).

Model simulations were performed with low and high deer densities to evaluate the effect density-dependence had on populations and hunter harvests. One simulation scenario had an initial population size starting at 30% of carrying capacity (carrying capacity=10,000 deer), and the second simulation had an initial population size starting at 90% of carrying capacity. Thus, 12 different simulation scenarios were modeled (6 strategies x 2 deer densities). I ran 500 simulations of each scenario so that different combinations of vital rates associated with stochastic model parameters were selected. Output generated by model runs were averaged and means were presented to depict population and harvest trends.

RESULTS

Population Output

Pre-hunt Deer Numbers—Regardless of management strategy and whether initial population size was low (Figure 1[a]) or high (Figure 1[b]), mean pre-hunt deer population sizes declined in similar fashions when the model simulated population reductions. Likewise, mean pre-hunt population sizes were similar when the model simulated stable population size strategies after year 20 (Figure 1).

Buck:Doe Ratios—Simulated post-hunt buck:doe ratios (fraction of adult males per adult female) differed substantially among management strategies for both low (Figure 2[a]) and high (Figure 2[b]) deer density simulations. Four-point rules had the most substantial effect on post-hunt buck:doe ratios (Figure 2). Further, post-hunt buck:doe ratios tended to be higher when deer populations were reduced rather than maintaining stable population sizes (Figure 2). A 3-point rule had minimal impact on simulated post-hunt buck:doe ratios when the population was high, and the objective was to maintain a stable population size (Figure 2[b]).

Harvest Output

Antlered Harvests—When deer populations were modeled at low densities, buck harvests were reduced in all simulations except for maintaining a stable deer population size under traditional rules (Figure 3[a]). Marked reductions in the buck harvest occurred during the initial year of point rules (year 21; Figure 3[a]). However, buck harvests increased in subsequent years as protected, yearling bucks matured to legal status as adults. Interestingly, mean buck harvests simulated under traditional rules with a management goal of population reduction were greater than mean buck harvests under a 3-point rules with population reduction. However, it was lower than mean buck harvests occurring when a 4-point rule was simulated and the management goal was population stability (Figure 3[a]).

No consistent trend in buck harvests was observed under any of the regulations associated with high deer densities (Figure 3[b]). When a high population density was reduced under traditional rules, buck harvests temporarily increased as pre-hunt densities declined (Figure 3[b]). Under 3-point rules, buck harvests temporarily increased for 1 or 2 years, but then buck harvests declined as pre-hunt population sizes were reduced. A marked reduction in buck harvest was apparent during the initial year of 4-point rules, but then buck harvests corresponded to changes in pre-hunt population sizes as well.

Antlerless Harvests—Antlerless harvests responded more to managing deer population sizes toward pre-determined goals than to point rules (Figure 4). However, it is noteworthy that the number of antlerless deer required for harvest was lower when 4-point rules were simulated compared to 3-point or traditional rules.

DISCUSSION

Pre-hunt population trends were similar among management strategies. This should be encouraging to wildlife managers. This suggests deer population dynamics occurring under alternative management strategies should mimic deer population trends observed in the past under traditional regulations. Thus, the public should not expect a change in population trends if point rules are adopted in the future.

As expected, buck:doe ratios increased when yearling bucks were protected from harvest. However, it is noteworthy that buck:doe ratios were higher when deer populations were reduced rather than maintained at original densities. This was a result of increasing the antlerless harvest rate to reduce population size. As a result of increasing the harvest rate on adult females, a smaller percentage of adult females existed in the post-hunt population. Consequently, a reduced number of adult females coupled with an increased number of adult bucks in the population under 4-point rules thereby maximized post-hunt buck:doe ratios. Managers concerned about skewed adult sex ratios and associated biological effects (Ditchkoff et al. 2001) should therefore liberalize antlerless harvest opportunities in concert with implementing point rules to maximize the potential of adjusting adult sex ratios.

With the exception to a marked reduction in buck harvest during the initial year of a 4-point rule, simulated buck harvests showed no consistent trends under any of the regulations. This should be somewhat alarming to managers wishing to provide the public some expectation of how much buck harvests might change under point rules. Perhaps even more concerning is the fact that this model only considered the effect age has on protecting bucks. Soil fertility and nutrition also effect antler development (Wood and Tanner 1985, Strickland and Demarais 2000). Variation in these factors would create even more variability in percentages of legal bucks vulnerable to harvest thereby making an accurate prediction of buck harvest almost impossible.

In the farmland region, managers should cautiously interpret buck harvests as an index to deer density even under traditional rules. Buck harvests increased as a result from reducing a high deer population density. This occurred because recruitment was stimulated as the population density reached about 50% of carrying capacity. This suggests that density-dependence effects may confound the straightforward interpretation of a relationship between buck harvest trends and deer population size (McCullough et al. 1990).

Antlerless harvests increased as a result of simulating higher antlerless harvest rates to achieve population reduction. In practice, increasing antlerless harvest rates has been challenging for a variety of reasons (Brown et al. 2000). An interesting finding from this modeling was that the number of antlerless deer required for harvest was slightly lower when point rules were implemented. This was likely due to density-dependent effects on population growth and the concept of sustained yield theory (Caughley 1977, McCullough 1979, Downing and Guynn 1985, Lancia et al. 1988). Under sustained yield theory, reproduction and mortality are negatively affected by increased population abundance. Thus, assuming principles of sustained yield theory operate in hunted deer populations, protecting bucks would negatively affect population reproductive and mortality rates. As a result, this may reduce the number of antlerless deer required for harvest to manage populations at a particular goal density. Whether this concept is true outside of a computer model warrants testing if managing antlerless harvests becomes a future concern to managers.

Possibly the most important, but least conspicuous finding from this modeling relates to comparing results from other wildlife agencies to those that could occur in Minnesota. Even within Minnesota, protection levels associated with point rules vary spatially, and the impacts different protection levels have on deer populations and harvests, particularly antlered harvests, can be substantial. Protection levels associated with different point rules likely differ in other areas of the United States where these regulations have been tested. Further, some wildlife agencies choose to manage deer populations near carrying capacity while others manage deer densities at or below a density that corresponds to maximum sustained yield. As discussed, where the deer population is relative to carrying capacity, and how population size is managed after implementation affects population and harvest trends. In addition, factors not considered in my model such as hunter density, land use patterns, hunter access, and deer accessibility vary from state-to-state, which also influences the outcome of alternative hunting regulations. Thus, it is not appropriate to expect similar population or harvest patterns from alternative management strategies employed in other states to occur in Minnesota. Expectations associated with alternative management strategies for

Minnesota should be based exclusively on data from and models developed for Minnesota.

FUTURE WORK

Additional modeling will include: 1) performing sensitivity analyses to systematically evaluate how changes in model parameters affect simulated output, 2) modeling different levels of "deer refugia" to determine how limited hunter access may affect alternative harvest regulations, 3) modeling additional alternative regulations such as earn-a-buck and buck lottery regulations, and 4) performing simulations in other deer management units where sex-age-kill and antler data have been collected.

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Table 1. Density-dependent parameter estimates used in the white-tailed deer population model to evaluate effects of altering harvest survival rates of antlered and antlerless deer.

Parameter	Predictive equation[a]	Range	References
Non-hunting survival			
Adult male	$(x^2*[3*10^{-9}]) + (x*[1*10^{-5}]) + 0.95$	Predicted value ± 0.05	Downing and Guynn (1985)
Adult female	$(x^2*[6*10^{-10}]) + (x*[6*10^{-6}]) + 0.96$	Predicted value ± 0.05	Downing and Guynn (1985)
Fawn	$(x^2*[6*10^{-9}]) + (x*[1*10^{-5}]) + 0.88$	Predicted value ± 0.10	Downing and Guynn (1985)
Recruitment rate			
Adult	$(x*[1*10^{-4}]) + 2.19$	Predicted value * y^b	Downing and Guynn (1985) McCullough 1979
Fawn	$(x*[1.6*10^{-4}]) + 1.12$	Predicted value * y^b	Downing and Guynn (1985) McCullough 1979
Sex ratio	$(x*[2*10^{-5}]) + 0.404$	Predicted value ± 0.04	Downing and Guynn (1985)

[a] x = population size
[b] y = random value between 0.8 — 1

Table 2. Sample sizes, mean maximum number of points to a side (SD), and protection levels of yearling males under a 3-point and 4-point rules in farmland deer management units. Antler data were collected periodically from 1993-2001. Means that have different letters are statistically different ($P < 0.05$) according to Tukey HSD comparisons.

Deer Management Unit	*n*	Average	Standard Deviation	3-Point Protection (%)	4-Point Protection (%)
Big Woods					
Central	331	2.77A	1.0	40	72
North	710	2.99B	1.0	30	67
Southeast	1,611	3.03B	1.0	28	65
Mille Lacs	196	2.67A	1.0	44	80
Northwest[a]	885	2.39D	1.0	56	84
Prairie					
North	216	2.97AB	1.0	29	68
River	1,287	2.97B	1.0	30	67
South[b]	500	3.15B	1.0	23	60

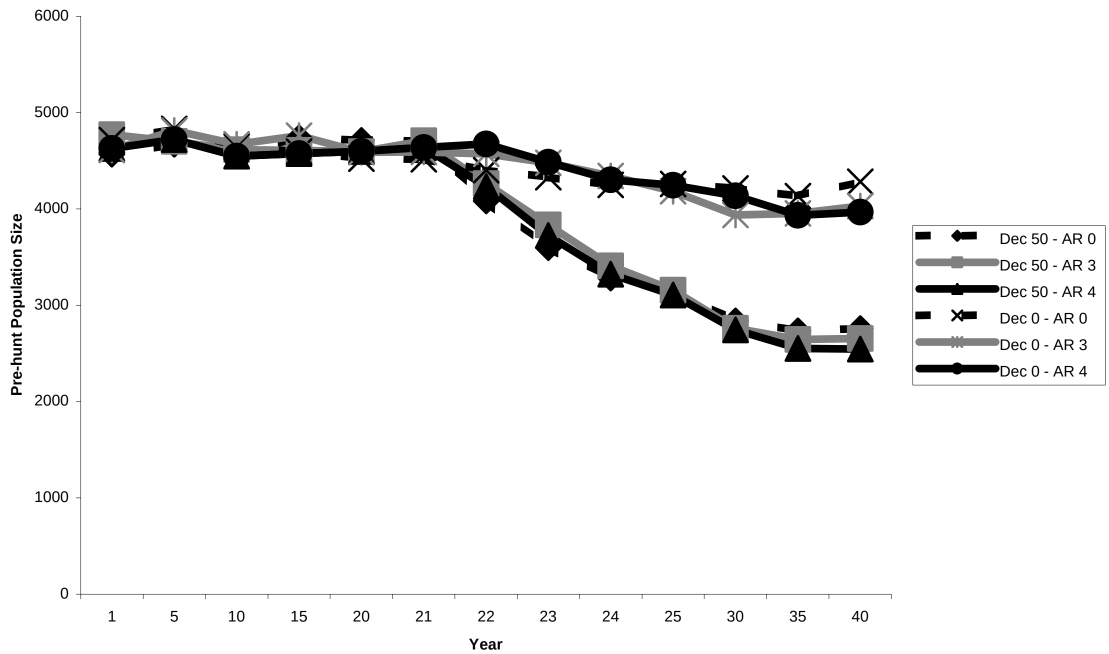
[a] Includes Red River and Agassiz Deer Management Units.
[b] Includes Southeast and Southwest Deer Management Units.

Table 3. Sample sizes, mean maximum number of points to a side (SD), and protection levels of adult males under a 3-point and 4-point rules in farmland deer management units. Antler data were collected periodically from 1993-2001. Means that have different letters are statistically different ($P < 0.05$) according to Tukey HSD comparisons.

Deer Management Unit	*n*	Average	Standard Deviation	3-Point Protection (%)	4-Point Protection (%)
Big Woods					
Central	132	4.33AB	1.0	2	13
North	316	4.76CDE	1.4	1	6
Southeast	853	4.39CB	1.0	2	10
Mille Lacs	92	4.10A	1.2	7	24
Northwest[a]	560	4.09A	1.1	8	20
Prairie					
North	102	4.50AD	0.9	3	7
River	393	4.24AE	0.8	2	11
South[b]	217	4.32A	0.8	1	9

[a] Includes Red River and Agassiz Deer Management Units.
[b] Includes Southeast and Southwest Deer Management Units.

(a



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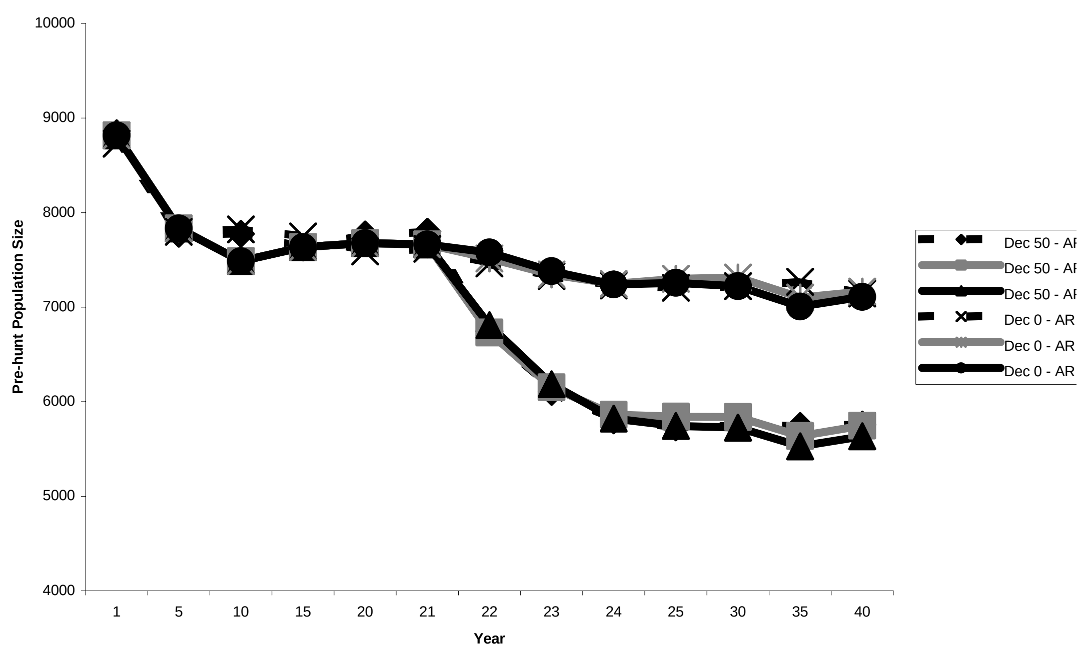


Figure 1. Temporal pre-hunt population trends of deer exposed to 6 different management strategies (Dec 50=50% population decline, Dec 0= Stable population size, AR0=Traditional point rules, AR 3=3-point rule, AR 4=4-point rule) in low (a) and high (b) deer densities, northwest Minnesota.

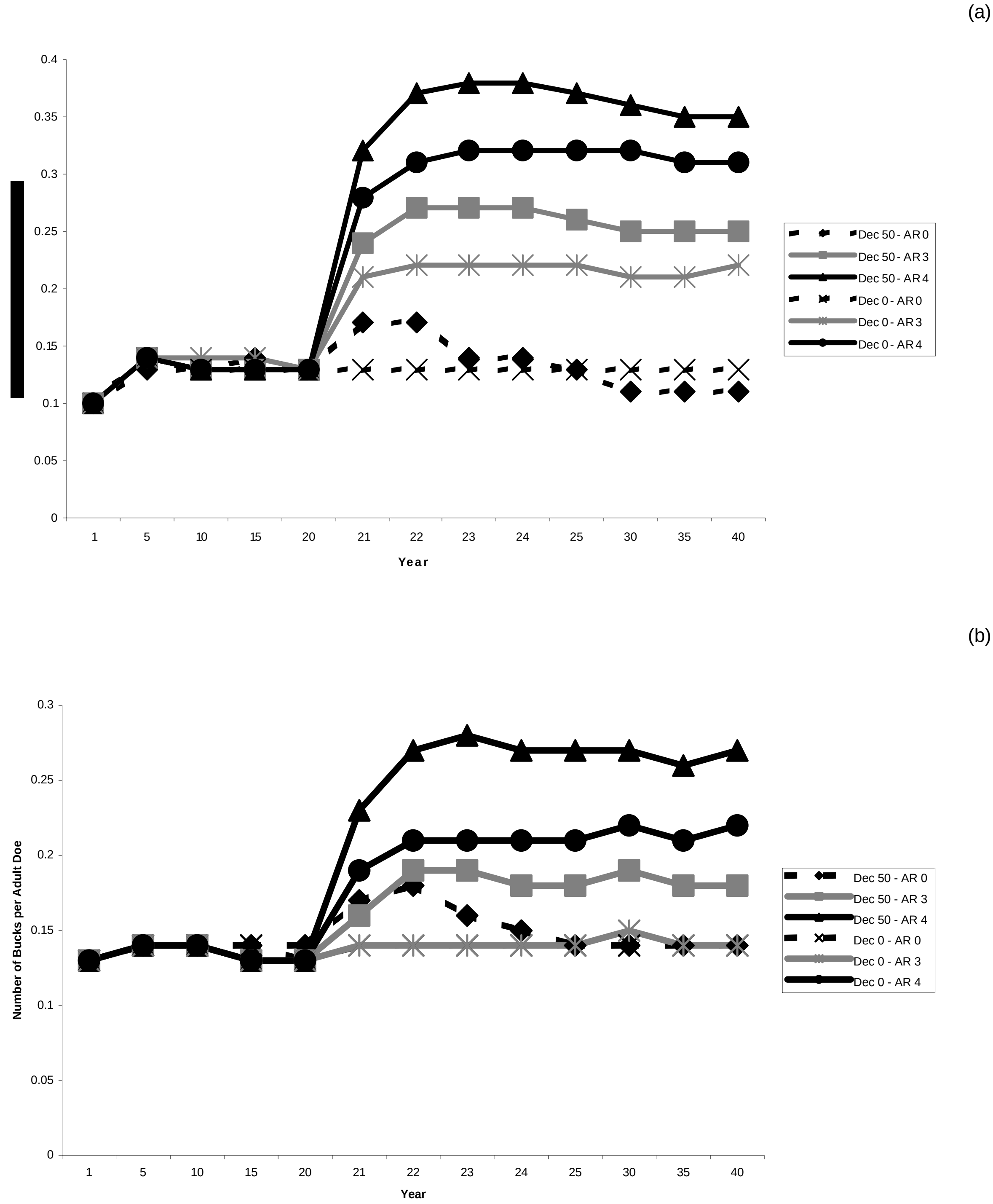
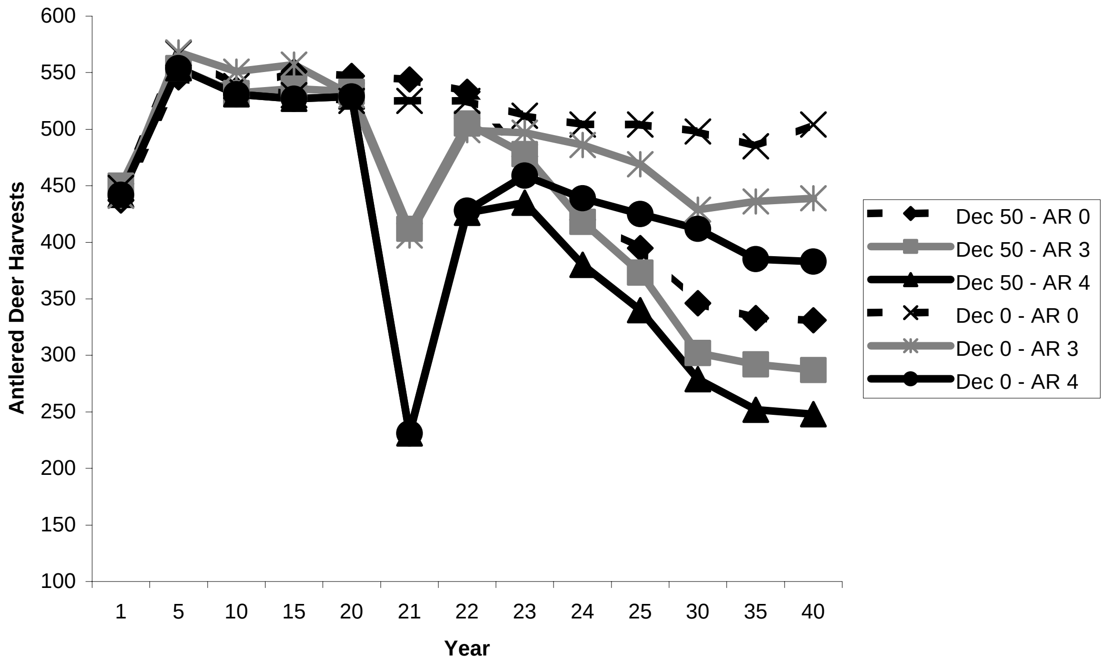


Figure 2. Temporal post-hunt buck:doe ratio trends of deer exposed to 6 different management strategies (Dec 50=50% population decline, Dec 0= Stable population size, AR0=Traditional point rules, AR 3=3-point rule, AR 4=4-point rule) in low (a) and high (b) deer densities, northwest Minnesota.

(a)



(b)

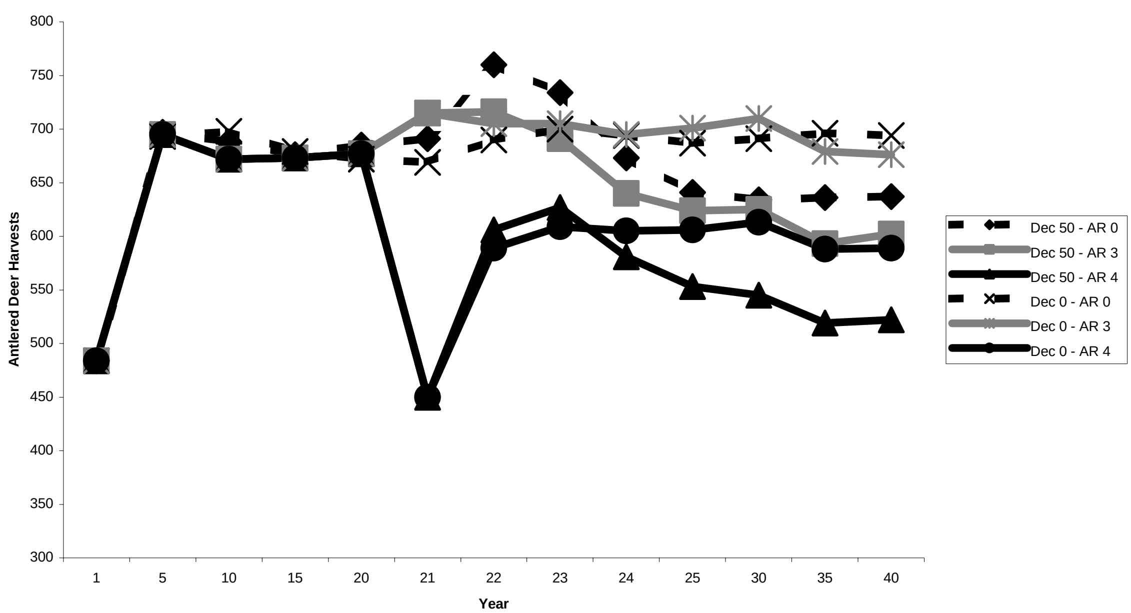


Figure 3. Temporal buck harvest trends of deer exposed to 6 different management strategies (Dec 50=50% population decline, Dec 0= Stable population size, AR0=Traditional point rules, AR 3=3-point rule, AR 4=4-point rule) in low (a) and high (b) deer densities, northwest Minnesota.

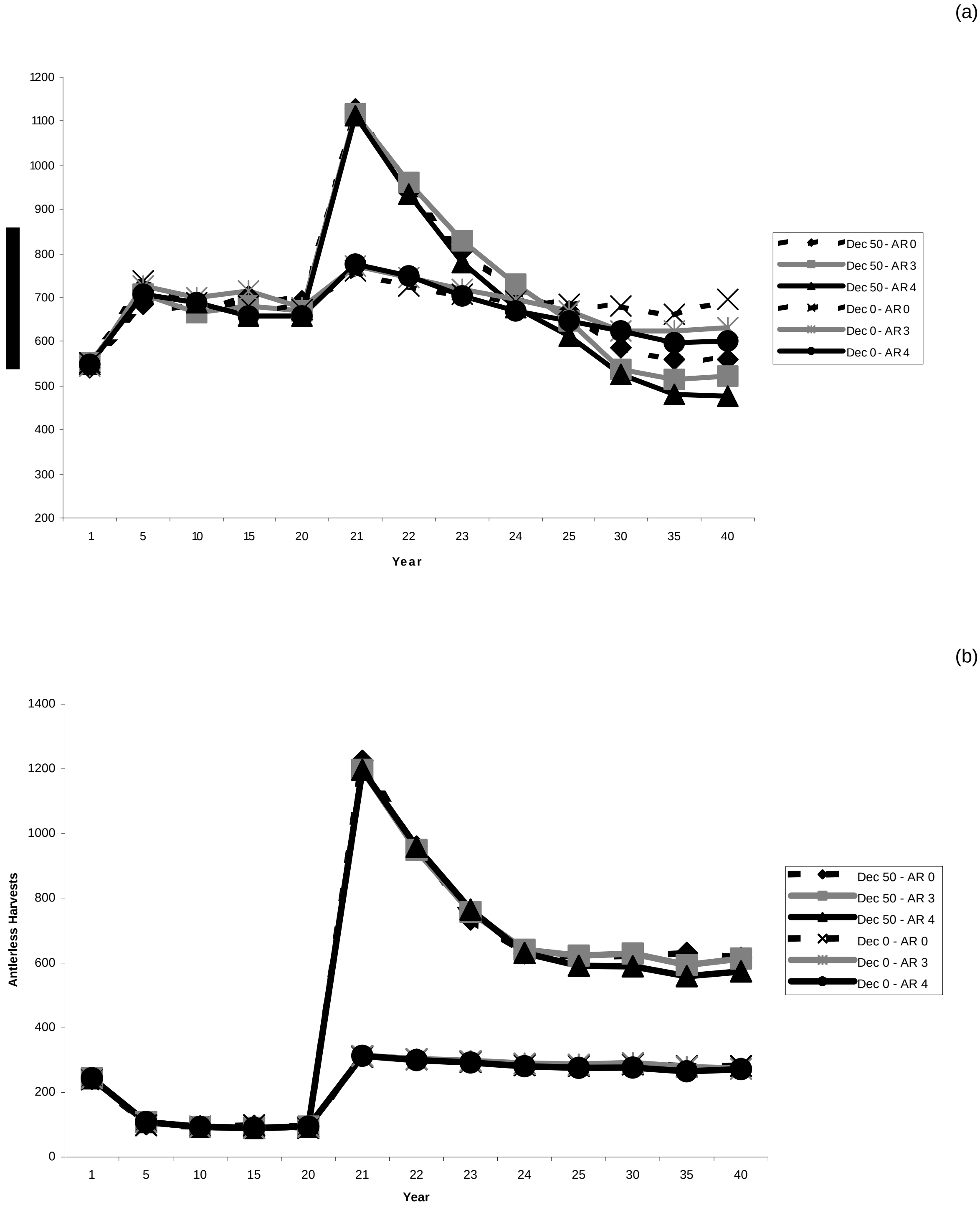


Figure 4. Temporal antlerless harvest trends of deer exposed to 6 different management strategies (Dec 50=50% population decline, Dec 0= Stable population size, AR0=Traditional point rules, AR 3=3-point rule, AR 4=4-point rule) in low (a) and high (b) deer densities, northwest Minnesota.

THE VALUE OF FARM PROGRAMS FOR PROVIDING WINTER COVER AND FOOD FOR MINNESOTA PHEASANTS

Kurt Haroldson, John Giudice, and Wendy Krueger

SUMMARY OF FINDINGS

The purpose of this study is to determine how much winter habitat is needed to sustain local populations of ring-necked pheasants (*Phasianus colchicus*) over a range of winter conditions. We estimated relative abundance of pheasant populations on 36 study areas using roadside surveys. In addition, we estimated amounts of winter cover, winter food, and reproductive cover on each study area by cover mapping to a geographic information system (GIS). During 2003-2004, pheasant indices varied in association with weather and habitat. A preliminary evaluation indicated that mean pheasant indices were positively related to habitat abundance in most, but not all, regions. Future work will include continued pheasant surveys for at least 3 additional years, improved estimates of habitat abundance, and more complex analysis of the association between pheasant indices and habitat parameters. A final product of this project will be a GIS habitat model that managers can use to target habitat development efforts where they may yield the greatest increase in pheasant numbers.

INTRODUCTION

Preferred winter habitat for ring-necked pheasants in the Midwest includes grasslands, wetlands, woody cover, and a dependable source of food (primarily grain) near cover (Gates and Hale 1974, Trautman 1982, Perkins et al. 1997, Gabbert et al. 1999). However, emergent wetlands and woody habitats that are large enough to provide shelter during severe winters have been extensively removed from agricultural landscapes, and grasslands and grain stubble are often inundated by snow. During severe winters, pheasants without access to sufficient winter habitat are presumed to perish or emigrate to landscapes with adequate habitat. Birds that emigrate >2 miles from their breeding range are unlikely to return (Gates and Hale 1974).

Almost 1 million acres of cropland in Minnesota's pheasant range are currently retired under the Conservation Reserve Program (CRP). Wetland restorations, woody habitats, and food plots are eligible cover practices in the CRP, but most are inadequate in size, design, or location to meet pheasant habitat needs. Furthermore, small woody covers commonly established on CRP lands may reduce the quality of adjacent grass reproductive habitat without providing intended winter cover benefits. Pheasants use grasslands for nesting and brood rearing, and we previously documented a strong relationship between grassland abundance and pheasant numbers (Haroldson et al. 1998). However, information is lacking on how much winter habitat is needed to sustain pheasant populations during mild, moderate, and severe winters. The purpose of this study is to quantify the relationship between amount of winter habitat and pheasant abundance over a range of winter conditions.

OBJECTIVES

- Estimate pheasant abundance on study areas with different amounts of reproductive cover, winter cover, and winter food over a time period capturing a range of winter severities (≥5 years);
- Describe annual changes in availability of winter cover as a function of winter severity; and.
- Quantify the association between mean pheasant abundance (over all

years) and amount of reproductive cover, winter cover, and winter food.

METHODS

We selected 36 study areas of contrasting land cover in Minnesota's core pheasant range to ensure a wide range of habitat configurations. Study areas averaged 9 $miles^2$ (5,760 acres) in size, and varied in the amount of winter cover, winter food, and reproductive cover. We defined winter cover as cattail (*Typha spp.)* wetlands ≥10 acres in area (excluding open water), dense shrub swamps ≥10 acres in area, or planted woody shelterbelts ≥3 acres in area, ≥200 feet wide, and providing dense cover at ground level (Gates and Hale 1974, Berner 2001). Winter food was defined as grain food plots left unharvested throughout the winter and located ≤1/4 mile from winter cover (Gates and Hale 1974). Reproductive cover included all undisturbed grass cover ≥20 feet wide. To facilitate pheasant surveys, 9 study areas were selected in each of 4 regions located near Marshall, Windom, Glenwood, and Faribault (Figure 1).

We estimated the amount of winter cover, winter food, and reproductive cover on each study area by cover mapping to a GIS from 2003 digital aerial photography. We used Farm Service Agency's GIS coverages of farm fields (Common Land Units) as base maps, and edited field boundaries to meet the habitat criteria of this project. Cover types were verified by ground-truthing all habitat patches visible from roads. Because cover mapping of cattail wetlands, shrub swamps, and undisturbed grasslands is still in progress, we made preliminary estimates of the amounts of these habitats from GIS coverages of the National Wetlands Inventory, Wildlife Management Areas, Waterfowl Production Areas, and CRP enrollments. We recognize that not all cattail wetlands, shrub swamps, and undisturbed grasslands are included in these GIS coverages. Furthermore, habitat omissions appear to be much more common on the Glenwood and Faribault study areas than on Marshall and Windom study areas.

We estimated relative abundance of pheasant populations on each study area using roadside surveys (Haroldson et al. 1998). Roadside surveys consisted of 10–12 mile routes primarily on gravel roads (≤ 4 miles of hard-surface road). Observers drove each route starting at sunrise at about 15 miles/hour and recorded the number, sex, and age of pheasants observed. Surveys were repeated 10 times on each study area during spring (April 20 – May 20) and summer (July 20 – August 20). Surveys were conducted on mornings meeting standardized weather criteria (cloud cover <60%, winds ≤10 miles/hour, temperature ≥32°F, dew present) 1–2 hours before sunrise; however, surveys were completed even if conditions deteriorated after the initial weather check. We attempted to survey all study areas within a region on the same days, and observers were systematically rotated among study areas to reduce the effect of observer bias on roadside counts.

Observers carried Global Positioning System (GPS) receivers while conducting roadside surveys. GPS receivers were used to record the time and position of observers throughout each survey (track logs), and to record the location of observed pheasants (waypoints). We inspected all track logs for each observer to ensure that surveys were conducted at the correct time, location, and speed of travel.

For each study area and season, we calculated an index of relative pheasant abundance (pheasants counted/100 miles surveyed) from the sum of the 10 counts/sum of total miles driven. To evaluate the effect of habitat on pheasant abundance, we calculated a cover index for each study area:

CI = [(UG/Max)x4 + (WCwFP/Max)x4 + (WCwoFP/Max)x2 + (FP/Max)] / 11 where UG = undisturbed grass (% of study area)

WCwFP = winter cover near a food plot (number of patches)

WCwoFP = winter cover without a nearby food plot (number of patches)
FP = food plot (number of patches)
Max = maximum observed value among all 36 study areas

The cover index combined the effects of reproductive cover, winter cover, and winter food into a single weighted average (weight based on a preliminary estimate of relative importance). Potential values of cover index ranged from 0.0 (poorest habitat) to 1.0 (best habitat). We acknowledge that the cover index is an oversimplification, and we used it only to make simple, 2-dimentional plots for this early progress report.

RESULTS

Spring 2004 Surveys

Observers completed all 360 surveys (10 repetitions on 36 study areas) during the spring 2004 season. Weather conditions during the surveys ranged from excellent (calm, clear sky, heavy dew) to poor (wind >10 mph, overcast sky, no dew, or rain). Over all regions, 78% of the surveys were started with at least light dew present, which was slightly less than last year (84%). Fifty-six percent of surveys were started under clear skies (<30% cloud cover), and 43% reported wind speeds <4 miles/hour. Only 4% of surveys were started on mornings with wind >10 miles/hour. Among regions, Glenwood experienced the least dew (43% of surveys started with no dew), and Windom experienced the most wind (61% of surveys started with wind speed ≥4 miles/hour).

Pheasants were observed on all 36 study areas during spring 2004, but abundance indices varied widely among areas from 11.6–359.7 pheasants observed per 100 miles (Table 1). Over all study areas, the mean pheasant index was 123.8 birds/100 miles, an increase from spring 2003 of 24% (95% CI: 9–39%). Total pheasants/100 miles varied among regions from 86.0 in the Faribault region to 179.7 in the Windom region (Table 2). Compared to 2003, total counts increased significantly only in the Marshall region (Table 2).

Hens were relatively abundant among study areas in spring 2004. The overall hen index averaged 69.4/100 miles, a 45% increase (95% CI: 13–77%) from 2003 (Table 2). Among regions, the hen index ranged from 38.8/100 miles in Faribault to 103.9/100 miles near Windom. Hen indices increased 55% (95% CI: 26–84%) from 2003 in the Marshall region, but were not significantly higher elsewhere. The observed hen:rooster ratio varied from 0.35 to 2.19 among study areas (Table 1). Fewer hens than roosters were observed on 1 study area in the Marshall and Glenwood region, 2 areas in Windom, and 6 areas in Faribault.

Summer 2004 Surveys

Observers completed 357 of the 360 surveys during the summer 2004 season. Weather conditions during the summer surveys ranged from excellent (calm, clear sky, heavy dew) to poor (light or no dew, overcast sky, or rain). Over all regions, 87% of the surveys were started with medium-heavy dew present, which was slightly better than last year (81%). Sixty-eight percent were started under clear skies (<30% cloud cover), and 76% reported wind <4 miles/hour. In comparison, 97% of the statewide August Roadside Surveys were started under medium-heavy dew conditions, 85% under clear skies, and 76% with winds <4 miles/hour. The less desirable weather conditions reported in this study probably reflects the study procedure of deciding whether to survey based on weather conditions 1–2 hours before sunrise at a location distant from the survey route.

Adult pheasants and broods were observed on all 36 study areas during 2004, but abundance indices varied widely from 4.1–335.0 pheasants observed per 100 miles (Table 3). Over all study areas, the mean pheasant index was 101.8 birds/100 miles, a 36% (95% CI: 21–51%) decrease from 2003. Total pheasant counts/100 miles varied among regions from 54.4 in the Faribault region to 180.1 in Windom (Table 4). Compared to 2003, total counts decreased significantly only in the Glenwood and Faribault regions (Table 4).

The overall hen index (hens/100 miles) decreased 29% (95% CI: 17–41%) from last year, and varied among regions from 12.3 in the Glenwood region to 36.3 near Windom (Table 4). Hen indices decreased 49% (95% CI: 33–65%) in the Glenwood region and 34% (95% CI: 18–50%) in the Faribault region, but were not significantly lower than 2003 in the Marshall and Windom regions (Table 4). In contrast, overall and regional cock indices were similar to last year (Table 4). The observed hen:rooster ratio varied from 0.3 to 2.9 among study areas (Table 3), and averaged 1.5 overall. Fewer hens than roosters were observed on 1 study area in Marshall, 2 in Glenwood, and 6 in the Faribault region.

The 2004 overall brood index (broods/100 miles) decreased 41% (95% CI: 29–53%) from 2003, with regional indices ranging from 6.8 in Faribault to 24.2 in Windom (Table 4). Regional brood indices decreased significantly only in the Faribault (95% CI: 48–78%) and Glenwood (95% CI: 52–68%) regions (Table 4). Mean brood size averaged 4.7 chicks/brood overall, and was relatively consistent among all regions (4.8 in Marshall, 5.0 in Windom, and 5.0 in Faribault) except Glenwood (4.1). Mean brood size in 2004 was similar to that in 2003, except in Glenwood, which experienced a decline of 17% (95% CI: 6–28%). On average, 23.1 broods were observed for every 100 hens counted during spring surveys, a 47% (95% CI: 33–61%) decline from last year. This brood recruitment index (broods/100 spring hens) varied among regions from 14.7 in Glenwood to 29.8 in Marshall. Brood recruitment indices declined significantly in all regions except Windom (Table 4).

Habitat Associations

The mean pheasant index (total pheasants/100 miles averaged over summer 2003–2004) was positively related to the cover index in all regions except Glenwood (Figure 2). Cover index explained 72% of the variation in pheasant indices in the Marshall region, 32% in Windom, 13% in Faribault, and 0% in Glenwood.

DISCUSSION

A high spring hen population in 2004, indicated by the 45% increase in the hen index from 2003, was expected given the mild winter of 2003-04. However, unusually cool weather during the reproductive period apparently prevented the abundant spring hens from recruiting large numbers of young into the summer population. The proportion of spring hens in 2004 that successfully recruited a brood into the summer population was only about one-half that of 2003. Furthermore, average brood size in the Glenwood region declined significantly. Thus, the summer 2004 pheasant index was 36% below the 2003 index. A large decrease in the summer hen index while the summer cock index remained stable suggested that some hens were still nesting or with young broods (which are typically undercounted in roadside surveys) during our survey period. Thus, the true population decrease may have been less than indicated by our population indices.

At this early stage in our evaluation, we cannot explain the weak association between summer pheasant indices and habitat abundance on the Glenwood and Faribault study areas (Figure 2). However, habitat estimates will be improved as we finish cover mapping the study areas. In addition, future analyses of pheasant-habitat associations will use multiple regression models that treat reproductive cover, winter cover, and winter food as independent predictor variables.

For the next reporting period, we will continue to survey pheasant populations during spring and summer. In addition, we hope to finish cover mapping all 36 study areas. During the next moderate-severe winter, we will assess winter habitat availability in relation to snow depth and drifting. Finally, we will begin to assess the potential for immigration to and emigration from the study areas by mapping large habitat blocks within a 2-mile buffer around the study area boundaries.

ACKNOWLEDGMENTS

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Table 1. Pheasant indices (birds/100 miles surveyed) and sex ratios (female:male) after 10 repeated surveys (n) on 36 study areas in Minnesota, spring 2004.

Region	Study Area	n	Total	Cocks	Hens	F:M Ratio
Marshall	1	10	133.3	55.9	77.4	1.4
	2	10	130.0	73.3	56.7	0.8
	3	10	135.0	49.5	85.4	1.7
	4	10	291.0	91.0	200.0	2.2
	5	10	102.5	45.4	57.1	1.3
	6	10	78.3	38.7	39.6	1.0
	7	10	81.7	32.1	49.5	1.5
	8	10	40.6	18.8	21.8	1.2
	9	10	54.4	21.9	32.5	1.5
Glenwood	10	10	57.1	24.5	32.7	1.3
	11	10	57.6	21.2	36.4	1.7
	12	10	101.9	58.6	43.3	0.7
	13	10	87.0	38.7	48.3	1.2
	14	10	107.9	46.5	61.4	1.3
	15	10	236.1	94.9	141.2	1.5
	16	10	187.6	70.5	117.1	1.7
	17	10	11.6	5.8	5.8	1.0
	18	10	170.4	63.9	106.5	1.7
Windom	19	10	312.6	105.3	207.4	2.0
	20	10	359.7	145.4	214.3	1.5
	21	10	205.3	81.1	124.2	1.5
	22	10	140.3	66.9	73.3	1.1
	23	10	223.8	106.9	116.8	1.1
	24	10	116.0	61.5	54.5	0.9
	25	10	134.0	51.4	82.5	1.6
	26	10	68.4	40.8	27.6	0.7
	27	10	57.4	22.6	34.8	1.5
Faribault	28	10	139.6	85.8	53.8	0.6
	29	10	55.8	41.1	14.7	0.4
	30	10	50.8	29.0	21.8	0.5
	31	10	112.0	60.9	51.1	0.8
	32	10	163.0	73.4	89.6	1.2
	33	10	110.3	49.1	61.2	1.2
	34	10	62.3	38.2	24.1	0.6
	35	10	41.7	27.5	14.2	0.5
	36	10	38.3	19.2	19.2	1.0

Table 2. Regional trends (% change) in pheasant population indices (birds counted/100 miles surveyed) on 36 study areas in Minnesota, spring 2003–2004.

Region	Group	Study areas	2003	2004	% change	95% CI
Marshall	Total pheasants	9	87.2	166.3	31	±16
	Cocks	9	43.1	47.4	11	±14
	Hens	9	44.1	68.9	55	±29
Glenwood	Total pheasants	9	100.9	113.0	12	±27
	Cocks	9	48.7	47.2	3	±25
	Hens	9	52.2	65.9	21	±31
Windom	Total pheasants	9	162.3	179.7	21	±39
	Cocks	9	69.4	75.8	13	±26
	Hens	9	92.9	103.9	31	±53
Faribault	Total pheasants	9	70.3	86.0	32	±32
	Cocks	9	37.1	47.1	30	±16
	Hens	9	33.2	38.8	72	±11
All	Total pheasants	36	105.2	123.8	24	±15
	Cocks	36	49.6	54.4	14	±10
	Hens	36	55.6	69.4	45	±32

Table 3. Pheasant indices (birds/100 miles surveyed) and sex ratios (female:male) after 10 repeated surveys (n) on 36 study areas in Minnesota, summer 2004.

Region	Study Area	n	Total	Cocks	Hens	F:M Ratio	Chicks	Broods	Chicks/ Brood	Broods/100 Summer Hens	Broods/100 Spring Hens
Marshall	1	10	198.2	27.9	34.2	1.2	136.0	24.3	5.6	71.1	31.4
	2	10	126.7	19.6	24.6	1.3	82.5	17.5	4.7	71.2	30.9
	3	9	91.7	4.3	11.9	2.8	75.5	12.9	5.8	109.1	15.2
	4	9	215.6	20.0	41.1	2.1	154.4	31.1	5.0	75.7	15.6
	5	10	95.8	15.0	23.3	1.6	57.5	13.3	4.3	57.1	23.4
	6	10	84.0	9.9	12.7	1.3	61.3	15.1	4.1	118.5	38.1
	7	10	107.3	10.9	18.2	1.7	78.2	20.0	3.9	110.0	40.4
	8	9	94.6	7.7	16.5	2.1	70.4	14.3	4.9	86.7	65.7
	9	10	20.2	6.1	1.8	0.3	12.3	2.6	4.7	150.0	8.1
Glenwood	10	10	65.7	3.5	9.6	2.7	52.5	11.1	4.7	115.8	34.0
	11	10	31.4	4.2	5.9	1.4	21.2	5.1	4.2	85.7	14.0
	12	10	36.2	7.1	11.0	1.5	18.1	4.8	3.8	43.5	11.0
	13	10	35.7	10.9	8.3	0.8	16.5	3.5	4.8	42.1	7.2
	14	10	74.6	5.7	16.2	2.8	52.6	14.0	3.8	86.5	22.9
	15	10	144.4	24.5	29.2	1.2	90.7	16.7	5.4	57.1	11.8
	16	10	67.6	10.5	17.1	1.6	40.0	9.5	4.2	55.6	8.1
	17	10	4.1	1.7	0.8	0.5	1.7	0.8	2.0	100.0	14.3
	18	10	61.1	6.9	12.5	1.8	41.7	9.3	4.5	74.1	8.7
Windom	19	10	206.3	21.1	61.1	2.9	124.2	29.5	4.2	48.3	14.2
	20	10	335.0	25.7	61.7	2.4	247.7	52.4	4.7	85.0	24.5
	21	10	120.0	22.1	29.5	1.3	68.4	12.6	5.4	42.9	10.2
	22	10	143.5	26.2	28.0	1.1	89.4	19.9	4.5	71.0	27.1
	23	10	222.8	37.6	38.6	1.0	146.5	29.7	4.9	76.9	25.4
	24	10	110.0	21.0	21.0	1.0	68.0	14.0	4.9	66.7	25.7
	25	10	255.7	29.2	38.7	1.3	187.7	29.2	6.4	75.6	35.4
	26	10	116.7	13.6	25.9	1.9	77.2	15.8	4.9	61.0	57.1
	27	10	111.3	16.1	22.2	1.4	73.0	14.8	4.9	66.7	42.5
Faribault	28	10	85.8	18.4	27.8	1.5	39.6	11.3	3.5	40.7	21.1
	29	10	33.0	7.8	5.8	0.8	19.4	3.9	5.0	66.7	26.5
	30	10	45.2	13.7	10.5	0.8	21.0	4.8	4.3	46.2	22.2
	31	10	62.7	23.5	15.7	0.7	23.5	7.8	3.0	50.0	15.4
	32	10	66.9	20.8	14.0	0.7	32.2	7.6	4.2	54.5	8.5
	33	10	89.6	7.8	22.6	2.9	59.1	13.9	4.3	61.5	22.7
	34	10	70.2	11.8	14.5	1.2	43.9	8.8	5.0	60.6	36.4
	35	10	21.3	7.1	3.5	0.5	10.6	0.9	12.0	25.0	6.3
	36	10	15.0	5.8	3.3	0.6	5.8	1.7	3.5	50.0	8.7

Table 4. Regional trends (% change) in pheasant population indices (birds counted/100 miles surveyed) on 36 study areas in Minnesota, summer 2003–2004.

Region	Group	n	2003	2004	% change	95% CI
Marshall	Total pheasants	9	142.6	114.9	–13	±29
	Cocks		12.7	13.5	23	±37
	Hens		25.6	20.5	–15	±28
	Broods		22.3	16.8	–21	±23
	Chicks/brood		4.6	4.8	8	±18
	Broods/100 spring hens		59.9	29.8	–49	±13
Glenwood	Total pheasants	9	139.9	57.9	–59	±10
	Cocks		9.2	8.3	–6	±40
	Hens		23.5	12.3	–49	±16
	Broods		20.2	8.3	–60	±8
	Chicks/brood		5.0	4.1	17	±11
	Broods/100 spring hens		44.7	14.7	–64	±8
Windom	Total pheasants	9	283.5	180.1	–18	±42
	Cocks		25.9	23.6	–3	±27
	Hens		50.9	36.3	–17	±27
	Broods		36.2	24.2	–21	±32
	Chicks/brood		5.4	5.0	–5	±16
	Broods/100 spring hens		47.1	29.1	–13	±43
Faribault	Total pheasants	9	164.6	54.4	–55	±16
	Cocks		9.5	13.0	56	±70
	Hens		23.6	13.1	–34	±16
	Broods		23.6	6.8	–63	±15
	Chicks per brood		5.5	5.0	–6	±38
	Broods per 100 hens		85.4	18.6	–63	±23
All	Total pheasants	36	182.6	101.8	–36	±15
	Cocks		14.3	14.6	17	±24
	Hens		30.9	20.5	–29	±12
	Broods		25.6	14.0	–41	±12
	Chicks/brood		5.1	4.7	–5	±12
	Broods/100 spring hens		59.3	23.1	–47	±14

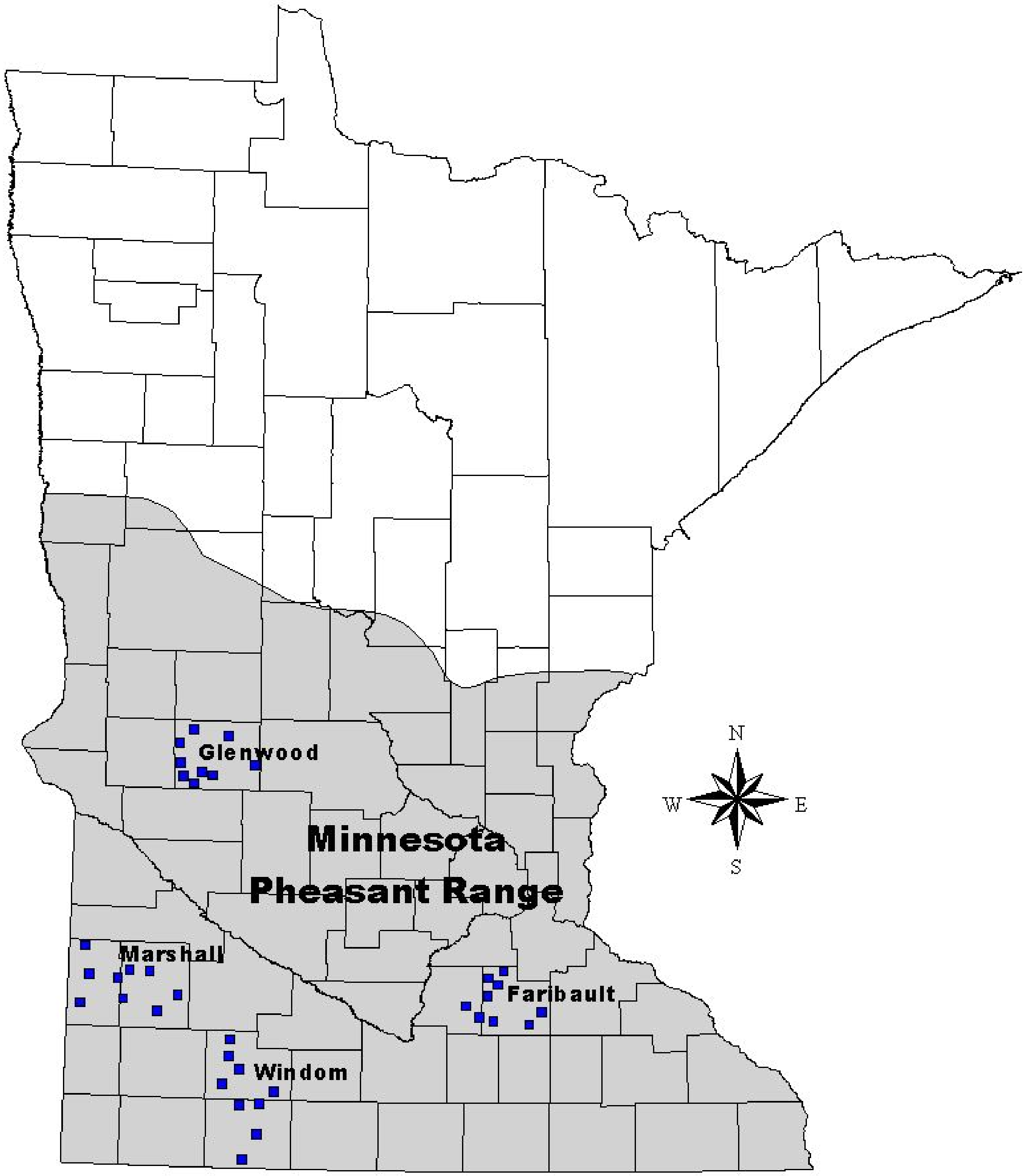

Figure 1. Locations of winter-habitat study areas within Minnesota's pheasant range, 2003-2004.

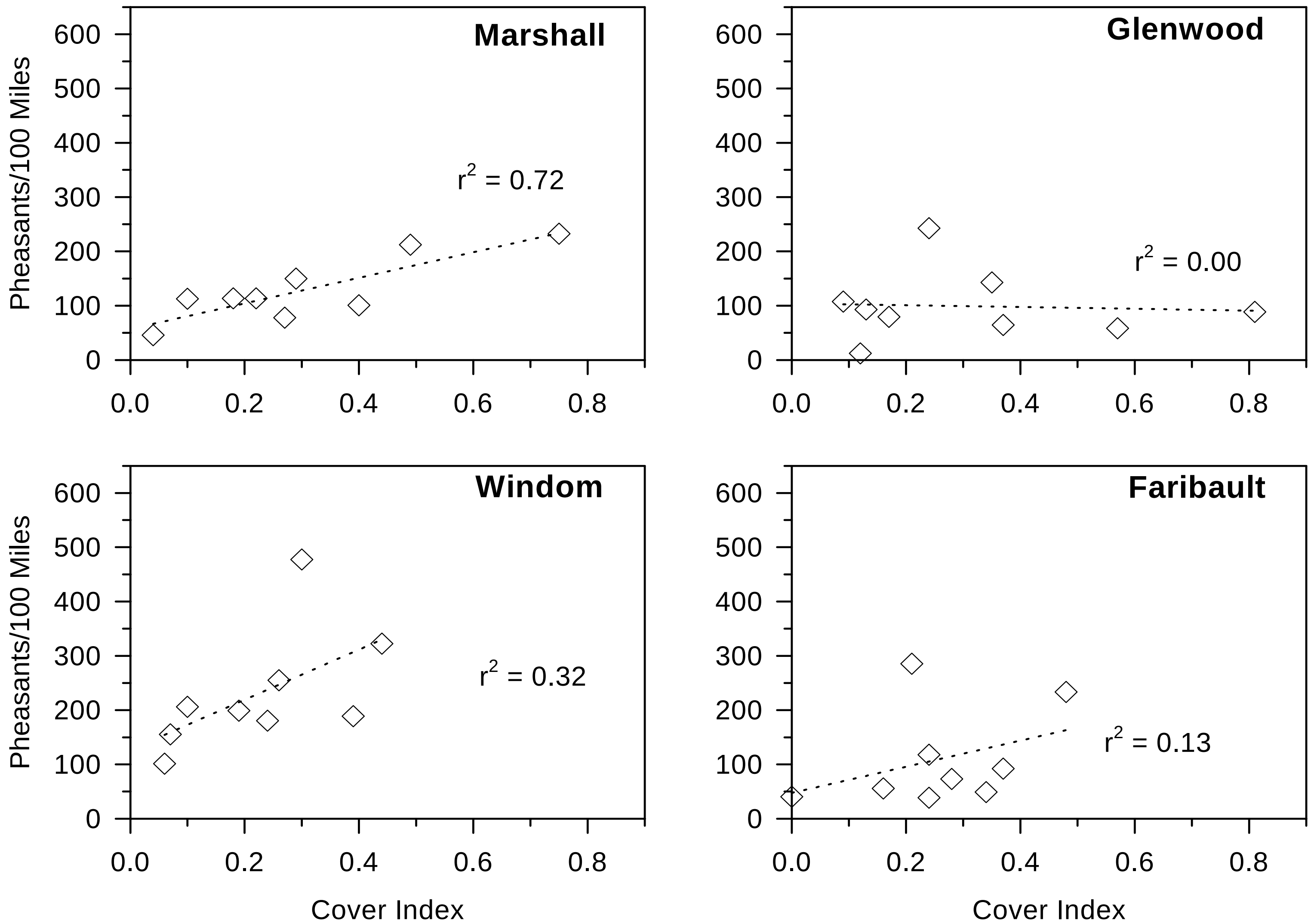

Figure 2. Relationship between relative pheasant abundance (pheasants counted/100 miles of survey) and amount of habitat (cover index) on 9 study areas in 4 regions in Minnesota during summer 2003-04.

MINNESOTA SPRING TURKEY HUNT LANDOWNER AND HUNTER SURVEY PILOT

Allison M. Boies[1], Sharon L. Goetz, Richard O. Kimmel, Wendy J. Krueger, Bryan D. Spindler[2], and Timothy J. Koppelman

SUMMARY OF FINDINGS

Increased spring wild turkey (*Meleagris gallopavo)* hunter densities have resulted in concerns regarding hunt quality, hunter safety, and landowner tolerance of turkey hunters. The purpose of this study was to create 2 survey instruments to assess if hunter density affects hunter satisfaction and landowner attitudes. We sought to develop methodology that could be used to conduct an expanded study during the 2005 and 2006 spring turkey hunting seasons. Surveys were tested on 1 permit area (PA) in southeastern Minnesota (PA 343) during the spring 2004 turkey hunting season. The 3 most important issues the study evaluated were hunter access and safety, interference, and hunt quality. Hunter concerns about safety were low. Overall landowner attitudes were positive and most hunters found it very easy to gain access to private land. Interference by hunters or other individuals was infrequent. Based on hunter satisfaction and landowner attitudes the study found that a quality hunt was maintained at a hunter density of 1.6 hunters/mi2 of huntable habitat (forested area with a 50 m buffer; <2.8 hunters/mi2 of forested habitat).

INTRODUCTION

It is important to carefully allocate permit numbers to ensure hunter safety, limit hunter access problems, ensure landowner and hunter satisfaction, maintain hunt quality, and best manage the wild turkey population. Kimmel (2001) noted that season management strategies in Minnesota initially restricted numbers of hunting permits to protect developing wild turkey populations. Currently, permit numbers are restricted to ensure hunt quality. However, Dingman (2003) found that current hunter interference levels did not significantly affect hunter satisfaction. Still, managers in southeastern Minnesota have expressed concern that increasing hunter densities would impact hunt quality, hunter safety, and especially landowner tolerance of turkey hunters (G. Nelson, Minnesota Department of Natural Resources, personal communication).

For the spring 2004 turkey hunting season in Minnesota, PA 343 had the highest hunter density at <1.6 hunters/mi2 of huntable habitat (forested area with a 50 m buffer; <2.8 hunters/mi2 of forested habitat). Conrad et al. (1995) found that increasing hunter densities in southeastern Wisconsin to 3.0 hunters/mi2 of forested habitat had little impact on either hunters or landowners. Subsequently, Wisconsin Department of Natural Resources has increased permit levels that result in hunter densities of >6 hunters/mi2 of forested habitat in some areas (K. Warnke, Wisconsin Department of Natural Resources, personal communication). Hunter interest groups, in particular the Minnesota Chapter of the National Wild Turkey Federation, are aware of the higher hunter densities in Wisconsin and are requesting Minnesota Department of Natural Resources to increase spring wild turkey hunting permit numbers.

OBJECTIVES

- Create and test survey instrument to evaluate the effect of hunter density on hunter satisfaction
- Create and test survey instrument to evaluate the effect of hunter density on landowner attitudes about hunters
- Set landowner selection criteria

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- Determine appropriate sample sizes for surveying hunters and landowners

METHODS

Permit Area Selection

One permit area was used to pilot the methods and survey instruments. Wild turkey hunting PA 343 was selected for its high hunter density and ease in landowner selection. Permit area 343 had the highest spring hunter density in Minnesota during spring 2004. This PA only contained 1 county, Olmstead, which facilitated landowner selection.

Hunter and Landowner Selection

A sample of hunters was randomly selected from PA 343 using the Electronic License System (ELS) database of spring turkey hunting permit recipients. The ELS database contained permit recipients from all 8 spring turkey hunt time periods.

A sample of landowners was drawn from a database developed from county parcel data. Criteria for surveyed landowners included: ownership of at least 40 acres of land that intersects turkey habitat, parcels located outside of city limits, and exclusion of non-agricultural businesses and organizations. Each parcel was evaluated using these criteria with ArcView (Environmental Systems Research Institute, Redlands, CA). An Olmstead County parcel shapefile was obtained from the county tax role data, which included the taxpayer address, parcel size, and parcel location. The huntable turkey habitat shapefile (Kimmel 2001) was used to determine location of wild turkey habitat for PA 343. A city limit shapefile that identifies subdivisions and limits was also obtained. This shapefile had to be reprojected into the UTM zone 15 coordinate system (Manual 1) from Lambert Conformal Conic.

The Olmstead County parcel shapefile was queried to eliminate all parcels of land that were less than 40 acres in size or that fell within the city limits of Olmsted County. The shape file for PA 343 huntable habitat was used to identify parcels of land that had the potential to contain huntable turkey habitat (forest cover with a 50 m buffer). Parcels that intersected the huntable habitat shape file in ArcView were selected.

The resulting taxpayer database file was imported into Microsoft Excel. The file was brought into SAS and queried to combine the acres of parcels that were owned by the same landowner. Parcel acre data were summed by address to eliminate different names associated with identical addresses. Any landowner that had an out-of-state mailing address or was a government entity was eliminated from the database.

Survey Methodology

A hunter survey instrument was created to evaluate hunter satisfaction at varying hunter densities. The hunter survey instrument consisted of questions regarding hunter success, access, satisfaction, number of days hunted, time period, and interference from other hunters (Appendix A). For the spring 2004 wild turkey hunter survey, 450 surveys were mailed to a sample of turkey hunt permit holders in PA 343. The selected hunters received a survey and return envelope on the first day of the last time period of the spring turkey hunting season, (21 May 2004). A second mailing of surveys was sent to non-respondents three weeks after the initial survey mailing, (11 Jun 2004).

A landowner survey instrument was created to evaluate landowner attitudes about hunters at various hunter density levels. The landowner survey instrument contained questions regarding landowner attitudes about allowing access for spring turkey hunting (Appendix B). For the spring 2004 landowner survey, 500 surveys were mailed the last day of the turkey hunting season to landowners in PA 343 randomly picked from all landowners meeting selection criteria. Selected landowners were sent a survey and a return envelope on 21 May 2004. A second mailing was sent to non-respondents 2 weeks after the initial mailing, (10 Jun 2004).

RESULTS

We received an overall response rate of 79% for the hunter survey. The average number of turkeys seen by hunters was 17.8. The average number of turkeys shot at was 0.77. Hunters were more successful at bagging turkeys in the morning (82%) than in the afternoon. A total of 53% of hunters were successful at bagging a turkey.

The majority of hunters hunted on private land (89%) and of these hunters an average of 0.43 landowners turned down their request for access. Access to hunting was reported as very easy for the majority (52%; 178) of hunters (Fig. 1). Overall 99% of hunters responded no when asked if other hunters put them in danger at any time while hunting.

Overall, 96% (340) of hunters saw 0-2 hunters that were not part of their own hunting group (Fig. 2). The rate of interference from other hunters was 8% (28; Fig. 3), and from non-hunters was 11% (40; Fig. 4). Eighty-seven percent (284) of turkey hunters rated hunt quality above average (Fig. 5).

We received an overall response rate of 66% for the landowner survey. The top 2 reasons for landownership were farming and enjoying wildlife that lives on the property. Ninety-seven percent of landowners reported they did not lease out their land for spring turkey hunting. Overall, 87% of landowners reported seeing turkeys on their land in the past year.

Ninety-five percent of landowners did not personally hunt their land during spring 2004. Overall, <50% of landowners were asked for permission to hunt their land by each of the following groups: family (136), acquaintances (112), and strangers (84; Fig. 6). The majority (≥50%) of landowners did not allow any hunters on their land. Of landowners who allowed 1 or more individuals to hunt on their property, they were more likely to allow friends or family 42% (137) compared to acquaintances 29% (97) or strangers 15% (50) to hunt their land during the spring season (Fig. 7).

The majority 63% (207) of landowners reported that the number of hunters asking permission to hunt stayed the same over the past 5 years (Fig. 8). Landowners most often (54%; 179) neither agreed nor disagreed that there were too many hunters wanting to hunt their land (Fig. 9). Eighty-eight percent of landowners did not have problems with hunters trespassing on their land during the spring hunting season. Overall, 60% of landowners did not post signs on their land to control hunter access.

DISCUSSION

The survey instruments provide a way to evaluate issues important to hunter satisfaction and landowner attitudes. These issues include: hunter access and safety, interference, and hunt quality. In the future, tracking hunter and landowner responses to instrument questions in relation to varying hunter density levels will help maintain acceptable permit levels.

Hunter access was not indicated as a problem for PA 343 during the Minnesota spring 2004 turkey hunting season. Most hunters used private land for turkey hunting and the majority found access to be very easy. Hunter requests to use land for hunting from landowners were rarely denied. Hunters saw few individuals while hunting. Hunting interference rates were low, which likely led to greater hunter safety and satisfaction. Hunt quality ratings were high.

Landowner attitudes about spring wild turkey hunters were positive. Trespassing issues were low and posting land was not used to control hunting. Landowner perception of hunter density did not indicate they felt too many hunters were asking for hunting access.

This study indicated that hunters were not concerned with access issues, interference rates, and safety. Landowner attitudes about hunters were found to be at a level that allowed hunters access to land and did not indicate that landowners felt pressured by hunters requesting access. PA 343 had the highest hunter density in

Minnesota in spring 2004 and hunter satisfaction and landowner attitudes were at levels that indicated a quality hunt.

The methodology and results from this study will be used for an expanded study during the spring turkey hunting seasons of 2005 and 2006. We will compare hunter satisfaction and landowner attitude responses at varying and higher hunter density levels. This study will help to allocate permits at levels that will ensure a quality spring wild turkey hunt.

ACKNOWLEDGEMENTS

We would like to thank J. Guidice for statistical and study design consulting and T. Klinkner for developing a landowner mailing list database.

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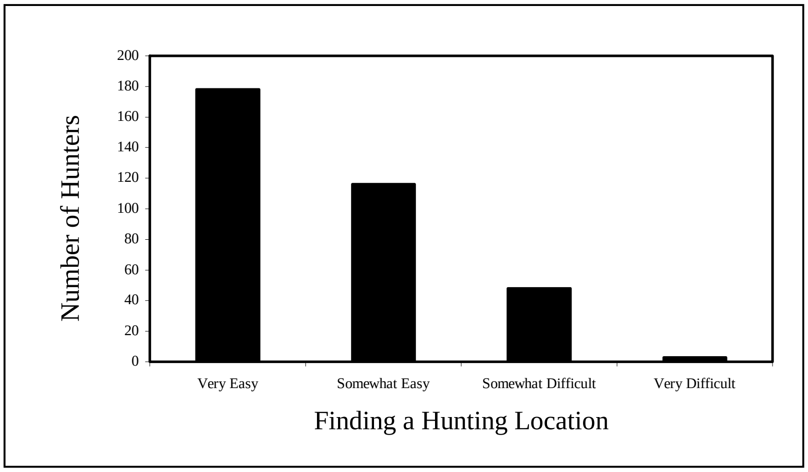

Figure 1. Difficulty ratings of finding a hunting location by Minnesota spring wild turkey, April-May 2004.

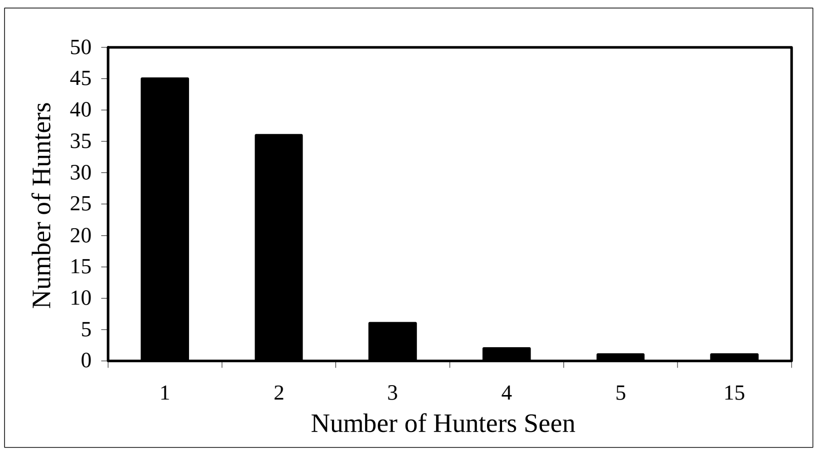

Figure 2. Number of hunters, not part of a hunter's own party, seen by hunters while hunting during the Minnesota spring wild turkey season, April-May 2004.

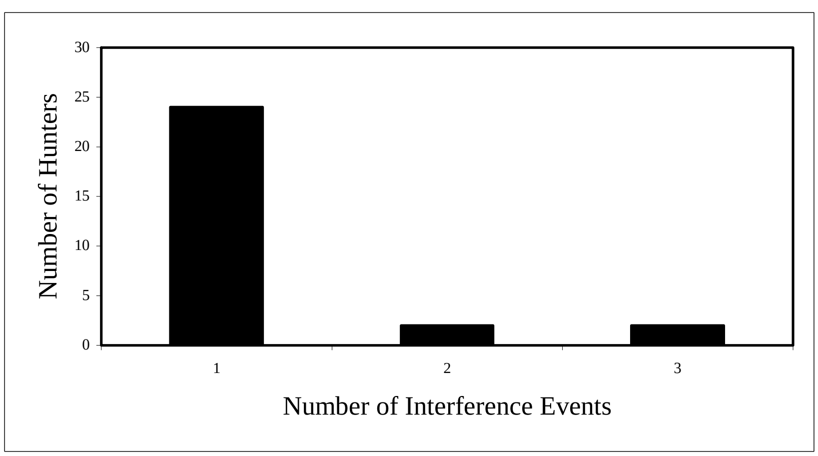

Figure 3. Number of times hunters were interfered with by other hunters while hunting during the Minnesota spring wild turkey season, April-May 2004.

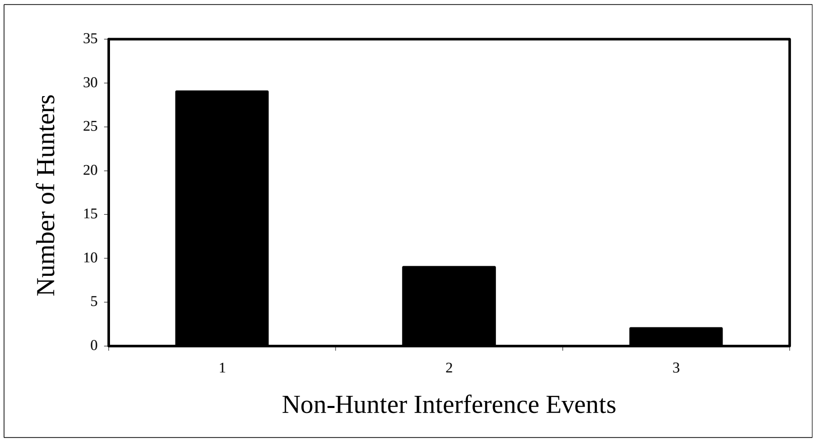

Figure 4. Number of hunters interfered with by non-hunters while hunting during the Minnesota spring wild turkey season, April-May 2004.

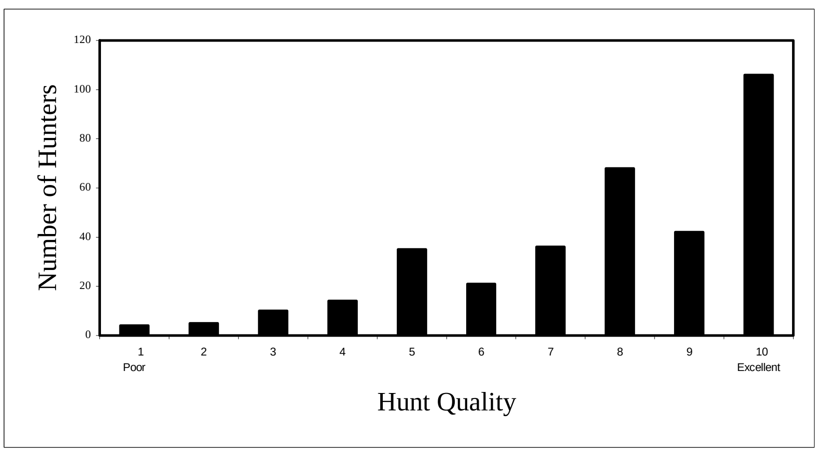

Figure 5. Hunt quality for the Minnesota spring wild turkey hunting season, April-May 2004.

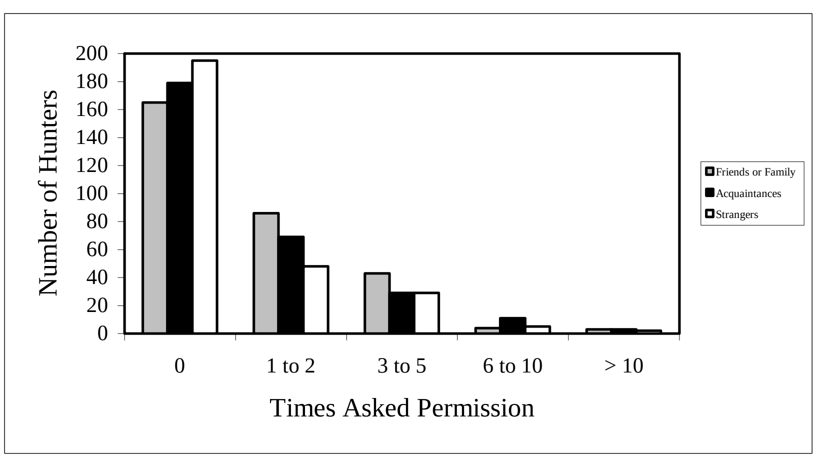

Figure 6. Number of times landowners were asked for permission to hunt their land by hunters for the Minnesota spring wild turkey season, April-May 2004.

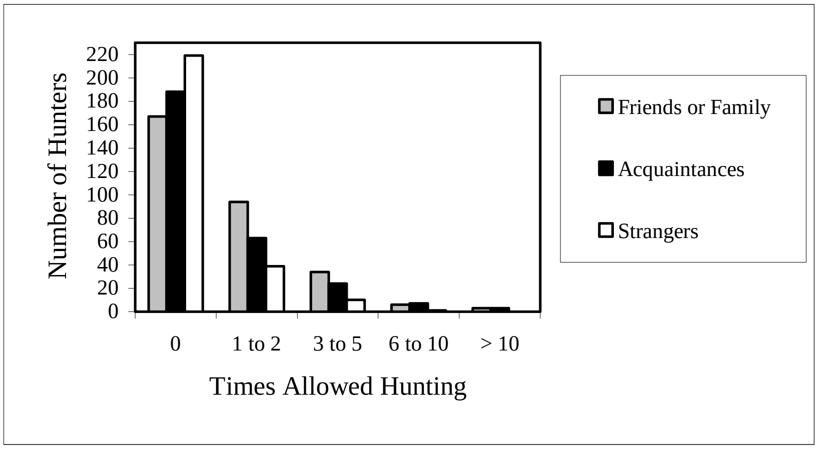

Figure 7. Number of times landowners granted hunting permission on their land during the Minnesota spring wild turkey season, April-May 2004.

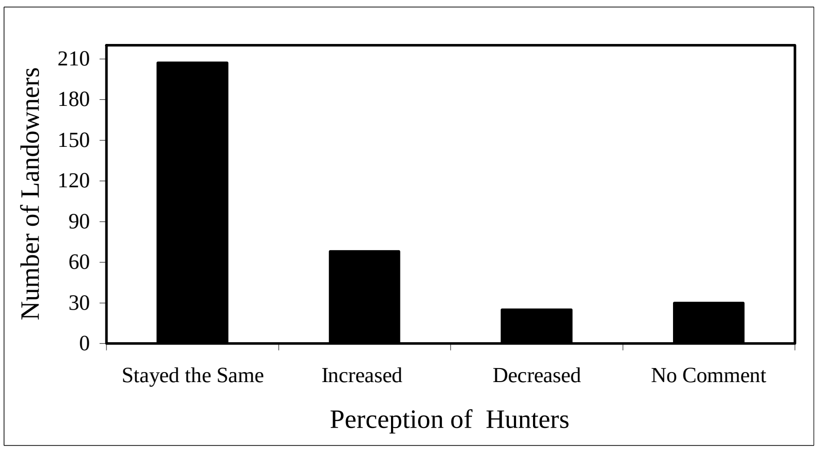

Figure 8. Landowner perception of the number of hunters requesting permission to hunt their land over the past 5 years, April-May 2004.

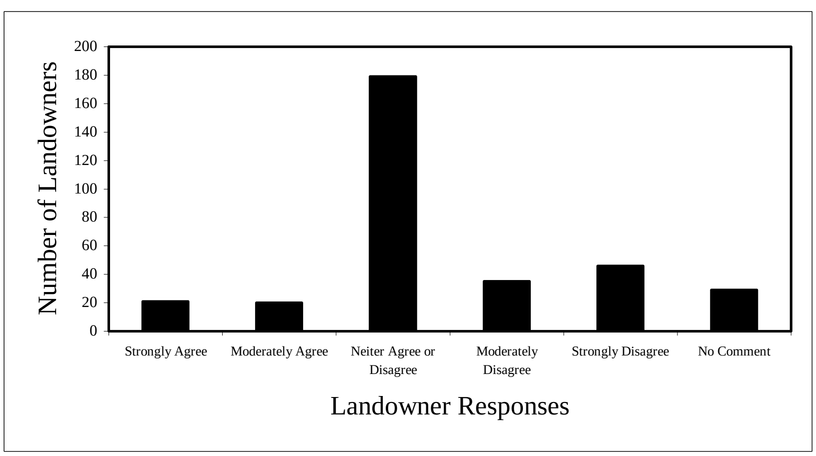

Figure 9. Landowner responses when asked if too many hunters wanted to hunt their land during the Minnesota spring wild turkey season, April-May 2004.

Appendix A. Hunter instrument for the 2004 Minnesota spring wild turkey hunting season survey.

Minnesota Spring Turkey Hunter Survey

*Please respond to all questions based on the **SPRING 2004 TURKEY SEASON**.

1. Did you hunt turkeys in Minnesota during the spring 2004 season? Yes____ No*____
   *If no, you do not need to continue but please return survey.

2. Which wild turkey permit area did you hunt in? _______

3. Did you have a landowner permit or a regular lottery permit? Landowner____Regular Lottery____

4. Which season did you hunt?

   April 14-18___ April 19- 23___ April 24-28___ April 29-May 3___ May 4-8___

   May 9-13___ May 14-20___ May 21-27____

5. How many days did you hunt turkeys during spring 2004? __________

6. How many turkeys did you see while turkey hunting in 2004? _______

7. How many turkeys did you shoot at? ______

8. Were you successful in bagging a turkey? Yes*____ No____
   *If yes, was it killed in the morning or afternoon? AM______ PM_______

9. How difficult was it for you to find a place to hunt during the spring 2004 wild turkey hunting season? (check one answer)
   Very easy____ Somewhat easy____ Somewhat difficult____ Very difficult____

10. Did you hunt on public land or private land during the spring 2004 season?
    Public_____ Private*_____ Both_____
    *If you hunted on private land, how many landowners turned down your request for permission? _____

11. Did you at any time feel you were put in danger by other hunters while turkey hunting?
    Yes____ No____

12. On average, how many hunters, other than members of your own party, did you see each day while you were actually in the field hunting during spring 2004? ______

13. How many times did hunters, other than members of your own party, interfere with your hunting during spring 2004? ______

14. How many times did people **other than hunters** interfere with your hunting during spring 2004? __

15. Rate the quality of your turkey hunting experience during spring 2004 on a scale of 1-10 (check one number):

Poor Quality | Average Quality | Excellent Quality

0____ 1____ 2____ 3____ 4____ 5____ 6____ 7____ 8____ 9 ____ 10____

Additional comments can be written on the back.

Appendix B. Landowner instrument for the 2004 Minnesota spring wild turkey hunting season survey.

Minnesota Spring Turkey Hunt Landowner Survey

*Please respond to all questions based on your land in **Olmsted County** for the **SPRING 2004** Turkey Hunting Season.

1) In what township is the majority of your land / farm located within Olmsted County?

______________________________Township

2) How many total acres of land do you own in Olmsted County?

Acres Cropland___________ Acres Woodland __________ Other Acres___________

3) How long have you owned your land?

☐ 0-5 years ☐ 6-10 years ☐ > 10 years

4) Is your primary residence on this land?

☐ Yes ☐ No

5) Which of the following are reasons for why you own this property? (Please check all that apply)

☐ I use it to make a living farming.
☐ I use it for non-hunting recreational purposes.
☐ I want to preserve the land for the future.
☐ I like the wildlife that lives on my land.
☐ I use it for hunting.
☐ I am using this land for investment or development.
☐ Other. please specify:___________________________________

6) Do you currently lease out any of your land for farming, spring turkey hunting, or other hunting? (Please check one response for each item.)

For farming	☐ Yes	☐ No
For spring turkey hunting	☐ Yes	☐ No
For other hunting	☐ Yes	☐ No

7) Have you seen wild turkeys on your land in the past year?

☐ Yes ☐ No

8) Did you personally hunt wild turkeys on your land during spring 2004?

☐ Yes ☐ No

9) During the spring of 2004, how many turkey hunters **asked permission to hunt** on your land that were family or friends, acquaintances, or strangers? (Please check one box for each category.)

Friends or Family	☐ 0	☐ 1-2	☐ 3-5	☐ 6-10	☐ >10
Acquaintances	☐ 0	☐ 1-2	☐ 3-5	☐ 6-1	☐ >10
Strangers	☐ 0	☐ 1-2	☐ 3-5	☐ 6-10	☐ >10

10) During the spring of 2004, how many turkey hunters did you **allow to hunt** on your land that were family or friends, acquaintances, or strangers? (Please check one box for each category.)

Friends or Family	☐ 0	☐ 1-2	☐ 3-5	☐ 6-10	☐ >10
Acquaintances	☐ 0	☐ 1-2	☐ 3-5	☐ 6-1	☐ >10
Strangers	☐ 0	☐ 1-2	☐ 3-5	☐ 6-10	☐ >10

11) Over the past 5 years do you think the number of hunters requesting permission to hunt wild turkeys during the spring season on your land has increased, decreased, or stayed the same?

☐ Increased
☐ Decreased
☐ Stayed the same

12) How do you feel about the following statement:

There are too many spring turkey hunters that want to hunt on my land?

☐ Strongly agree
☐ Moderately agree
☐ Neither agree or disagree
☐ Moderately disagree
☐ Strongly disagree

13) Did you have a problem with hunters trespassing on your property during the 2004 spring turkey hunt?

☐ Yes ☐ No

14) Do you post signs on your land in an effort to control hunter access?

☐ Yes ☐ No

15) Provide any additional comments.

ANNUAL SURVIVAL AND PRODUCTIVITY OF WILD TURKEY HENS TRANSPLANTED NORTH OF THEIR ANCESTRAL RANGE IN CENTRAL MINNESOTA

Cory M. Kassube[1], Marco Restani[1], Sharon L. Goetz, and Richard O. Kimmel

SUMMARY OF FINDINGS

Wildlife managers have succeeded in establishing wild turkey (*Meleagris gallopavo*) populations north of their suspected ancestral range. Supplemental food is being used to increase winter survival, but limited data exists regarding its influence on turkey condition. We tested 2 hypotheses: (1) supplemental food increases winter survival of transplanted wild turkey hens; and (2) although supplemental food increases winter survivorship, annual survivorship is similar due to increased predator abundance on supplemental food areas. During 2004, we conducted research on 6 113-km^2 study areas in rural, east-central Minnesota. Eastern wild turkey (*M. g. silvestris*) hens were captured in southeastern Minnesota and transplanted into study areas within 24 hrs of capture from January-March 2004. Hens were located via telemetry 3-5 times/week to determine fate (live/dead). Winter survival of transplanted wild turkey hens was higher on supplemental food study areas than on control study areas. Hen survival on the study areas was lowest during nesting and brood rearing. Over one half of mortalities occurred during these periods. Difference in survival rates of hens between supplemental food and control study areas was no longer apparent by December 2004.

INTRODUCTION

Wildlife managers have succeeded in establishing wild turkey populations north of the ancestral range reported by Leopold (1931). This expansion has lead to increased opportunity in hunting and wildlife viewing. How far north this range can be extended remains unanswered, and little information is available on the survival and productivity of transplanted turkeys to guide management. Porter et al. (1983) suggested severe winters can lower both over-winter survival, and the reproductive success of the surviving turkeys.

Supplemental food is being used to increase winter survival, but limited data exists regarding its influence on turkey condition. Porter et al. (1980) found corn is an important food resource that can increase survival and condition of wild turkeys during severe winter conditions (long periods of deep snow) in southeastern Minnesota. Kane (2003) also found higher winter survival of transplanted wild turkey hens in study areas with supplemental food plots in east-central Minnesota. Establishing supplemental food plots is expensive, and more information on winter survival is needed to justify these costs.

Although Kane (2003) found over-winter survival differed between treatment areas, annual survival of turkeys between supplemental food sites and control sites was similar. Hens on the supplemental food study areas had higher mortality during the nesting and brood rearing periods than hens on the control study areas. Kane (2003) did not evaluate nesting ecology of transplanted turkeys, and was unable to explain the cause for this difference, but higher predator abundance on the supplemental food study areas could explain this pattern. For example, Vander Haegen et al. (1988) and Palmer et al. (1993) found mortality of wild turkey hens is highest during the nesting period with predation being the dominant cause.

We tested 2 hypotheses: (1) supplemental food increases winter survival of transplanted wild turkey hens; and (2) although supplemental food

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increases winter survivorship, annual survivorship is similar due to increased predator abundance on supplemental food areas.

OBJECTIVES

- Monitor overwinter and annual survival;
- Determine productivity; and
- Determinepredator abundance.

STUDY AREA

We conducted our research on 6 113-km^2 study areas in rural, east-central Minnesota within the Mille Lacs Upland at the southern edge of the Laurentian Mixed Forest Province (Figure 1). The Mille Lacs Upland is characterized by level to rolling topography, and is a transitional zone between the Anoka Sand Plains (oak barrens, brushlands, and prairies) and the Tamarack Lowlands (lowland conifers, upland aspen-birch, upland conifers, and sedge meadows) (Marschner 1975, Hanson 2000). Evidence of past and present disturbances such as agricultural and forest clearings exists. With the exception of some state forest and state or county wildlife lands, the majority of land ownership is private. Historically, this region has a 30 day mean snow cover of $\geq$30.5 cm (Minnesota Department of Natural Resources 2004).

We added 2 study areas to Kane's (2003) study design. Morrison study area has supplemental food, and was located at approximately the same latitude as the 2 control study areas (Bradbury and Snake River; Figure 1). Sherburne study area served as a control, and was located at approximately the same latitude as the 2 supplemental food study areas (Foreston and Bock; Figure 1). The 3 supplemental food study areas (Foreston, Bock, and Morrison) were located in agricultural areas consisting primarily of corn, soybeans and hay, with dairy farms scattered throughout the landscape. Supplemental food plots consisted of standing corn left over-winter and some turkey feeders. Residual corn was available in some fields, as well as manure (potential food source) from livestock and dairy farms. Supplemental food study areas had a higher density of roads and buildings than control study areas, but large woodland and wetland patches also existed.

The 3 control study areas were located in areas where limited agriculture existed. However, some supplemental food was available in the form of bird feeders and the occasional resident leaving corn for wildlife. We assumed supplemental food, such as birdseed, was relatively constant among the 6 study areas. Large forest and wetland patches, and few roads and buildings characterized control study areas.

METHODS

Minnesota Department of Natural Resource (MNDNR) biologists used rocket nets to capture eastern wild turkey hens in southeastern Minnesota from January-March 2004. All hens were weighed to the nearest 0.23 kg, aged (juveniles or adults), leg-banded, fitted with a radio-transmitter, and transplanted to the study areas within 24 hrs of capture. Transmitters (95 - 104 g, 40 cm whip antenna) had a 3-year battery life and a mortality sensitive switch (Advanced Telemetry Systems-ATS, Isanti, MN, USA). Transmitters were positioned backpack style (Nenno and Healy 1979). We used model R2000 receivers (ATS) with either a handheld 3-element yagi antenna, or an omni-directional whip antenna attached to the roof of a pickup truck to monitor turkey movements and survival.

Winter Season

We designated the winter season as 1 January 2004 through 31 March 2004. Hens were located via telemetry 3-5 times/week to determine fate (live/dead). We investigated mortality sites the day of discovery, whenever possible, after a mortality signal was received. We determined causes of death by investigating the mortality site, and looking for species-specific predator sign such as tracks and hair or feathers. Mortalities were classified as mammalian or avian predation, emaciation, human (road kill), or unknown (See Miller et al. 1998).

White-tailed deer (*Odocoileus virginianus*) and other wildlife consumed all corn on all supplemental food plots prior to turkey releases. Therefore, we strategically placed "turkey feeders" on the supplemental food study areas to ensure food availability for the hens. We observed hens on the supplemental food study areas, and examined the crop contents of dead turkeys to determine the importance of supplemental food to over-wintering hens.

Summer Season

We designated the summer season as 1 April 2004 through 31 August 2004. We determined nest success of transplanted hens by radio-tracking twice/week from 1 April through 31 July. We considered hens that remain stationary for 7 days to be nesting (Vander Haegen et al. 1988), and we marked nests by flagging vegetation 30-50m around nest sites (Roberts et al. 1995, Badyaev and Faust 1996, Badyaev et al. 1996). We located and examined nests after hens and/or broods left the area to determine clutch size (number of unhatched eggs and egg caps), initial brood size (number of hatched eggs), and hatch success (proportion of hatched eggs/clutch; Vander Haegen et al. 1988). If a nest was depredated or an incubating hen was killed, we investigated the nest site and attempted to identify the predator.

We determined the relative abundance of mammalian predators by treatment type during the nesting season, because the majority of mortality on the supplemental food study areas occurred during summer (Kane 2003). We conducted scent-station surveys for mammalian predators. Surveys consisted of 10 linear stations placed $\geq$480 m apart along unpaved roads (Sargeant et al. 1998; M. Sovada, U.S. Geological Survey, personal communication). Scent discs were placed in the center of sand/soil areas approximately 1m in diameter. Stations were checked 48 hrs later and mammalian tracks were identified conservatively (a track was only added to the data if a positive identification was made). Identification of individuals of the same species could not be determined, and each species had a maximum of one track per station used in the analysis.

Data Summary

Because this is a preliminary report, survival analyses have not been conducted. Some of the hens survived the study conducted by Kane (2003) and were also used in the survival summary. Following Kane (2003), we censored newly released hens surviving <7 days post-release from the survival summary, because these deaths could have been associated with trapping-related stress or complications with the transmitter or harness (Vangilder 1996, Miller et al. 1998). Hens that disappeared from the study area, because of large movements or transmitter failure, were also censored from the survival summary during the period they disappeared.

We assumed that survival of each turkey was independent. Mortality dates were estimated using the midpoint between the last day we detected the bird alive and the first day we detected mortality.

RESULTS

The MNDNR trapped 62 hens for this study in 2004. Four hens were released on 9 January, 12 on 23 January, 10 on 27 January, 7 on 14 February, 7 on 21 February, and 22 on 13 March. We also monitored the movements and survival of 21 hens from Kane's (2003) study.

During 2004, we censored 8 of 62 (12.9%) hens from the overall survival summary, which reduced the total winter sample sizes to 36 hens on supplemental food study areas and 39 hens on control study areas. Three additional hens were lost from the study because of large movements or transmitter failure during the summer season, which reduced the supplemental food sample size to 33 hens for the summer season.

Winter survival was higher for hens on supplemental food study areas than on control study areas (Figure 2). In contrast, survival during summer was lower on supplemental food areas. Annual survival by treatment was similar.

Winter survival was 63% (20/32) for adults and 86% (6/7) for juveniles on control areas. Summer survival was 80% (16/20) for adults and 50% (3/6) for juveniles on control areas. Annual survival was 47% (15/32) for adults and 43% (3/7) for juveniles on control areas. Only adults were released on supplemental food areas during 2004.

Winter and annual survival was higher for previously released (residuals) than newly released hens (Figure 3). Summer survival was similar for newly released hens and residual hens.

The MNDNR trapped 57 hens for this study in 2005. Twenty-five hens were released on 12 January, 12 on 19 January, 9 on 20 January, and 11 on 21 January. We also monitored 27 hens remaining from previous releases.

During 2005, we censored 3 of 57 (5.3%) hens from the survival summary, which reduced the total winter sample sizes to 41 hens on supplemental food study areas and 39 hens on control study areas. Winter survival in 2005 was higher for hens on supplemental food study areas (95%; 39/41) than on control areas (74%; 29/39).

Causal Mortalities

Thirty-eight hens died during 2004 (30 newly released and 8 residual). We could not determine cause of death for 20 hens. Mammalian predation (coyote [*Canis latrans*], red fox [*Vulpes fulva*], and bobcat [*Lynx rufus*]) was the most common cause of mortality, followed by avian predation (great horned owl [*Bubo virginianus*] and bald eagle [*Haliaeetus leucocephalus*]), vehicle strikes, and starvation (Figure 4). Eight hens were censored from the survival summary and their causes of mortality included: avian predation (n = 3), trapping related stress (n = 2), unknown (n = 2), and mammalian predation (n = 1).

Scent survey results from June-September 2004 indicated higher predator abundance on control study areas. Predators visited 57% of the scent stations on control study areas. In contrast, mammalian predators visited only 12% of the scent stations on supplemental food study areas.

Crop contents of hens on supplemental food study areas included corn, soybeans and acorns during the winter months, and acorns, berries, grasses and invertebrates during the summer months. Crop contents of the hens on the control study area included acorns, berries and grasses throughout the year, and invertebrates when available.

Hens were observed nesting in tall grass, timber, and marshes in both supplemental food and control study areas. Brood sizes of both radioed and unmarked hens ranged from 1 – 13 poults/brood. Broods were observed on both supplemental food and control study areas.

DISCUSSION

Winter survival of wild turkey hens was higher on supplemental food study areas than on control study areas. Hens on supplemental food study areas were observed using the supplemental food during the majority of the winter. Winter survival was 100% in 2004 and 95% in 2005 for hens on supplemental food study areas. Kane (2003) found lower winter survival (81% in 2002 and 76% in 2003) for hens on supplemental food study areas. Kane (2003) also found winter survival of hens on control study areas to be 38.9% in 2002 and 45.5% in 2003. We found higher winter survival (67% in 2004 and 74% in 2005) for hens on control study areas.

Effects of supplemental food on winter survival should be interpreted with caution. The value of supplemental food may have been overestimated because 15 hens were released on 13 March 2004 into supplemental food study areas.

Survival may not be as high as indicated as these hens were only at risk for 2.5 weeks of the winter season on the study area. However, survival analyses taking time of survivorship into consideration may improve our understanding. The winter of 2003-2004 was relatively mild, only February had snow cover >20 cm (Minnesota Department of Natural Resources 2004). However, cold temperatures existed in January and February with 6 days $\leq$-29 C°. In a mild winter, Porter et al. (1980) found similar survival between hens with supplemental food and hens without supplemental food.

Consistent with other studies, hen survival on our study areas was lowest during nesting and brood rearing (Palmer et al. 1993, Wright et al. 1996, Kane 2003). Over one half of our mortalities occurred during these periods. Summer survival in 2004 was higher on control study areas than on supplemental food study areas. Predation, as in other studies, was the most common cause of mortality (Porter et al. 1980, Miller et al. 1998, Kane 2003). Preliminary predator survey results indicate a higher abundance of predators on control study areas, but data were very limited and more research is needed. Other factors may be responsible for decreased summer survival of hens on supplemental food study areas.

The difference in survival rates of hens between supplemental food and control study areas for winter and summer of 2004 was no longer apparent by December 2004. As noted above, summer survival was lower on supplemental food study areas. The reason for this remains unknown, but the increased number of individuals on supplemental food study areas could have caused a higher risk of mortality.

Our pooled 2004 winter survival of 83% is noticeably higher than winter survival rates in Minnesota found by Kane (60.4%; 2003) and Porter (59.7%; 1978). Pooled annual survival (47%) was similar to annual survival for established populations of turkeys in Wisconsin (53%; Wright et al. 1996), Mississippi (51%; Miller et al. 1998), and Missouri (44%; Kurzejeski 1987). Wild turkeys are resilient and can survive north of their ancestral range as long as reproduction and productivity compensate for losses.

Residual hens had higher winter and annual survival than newly released hens. Experience with local environments increases survival for residual versus transplanted hens (Miller 1990). Knowledge of local habitats provides an advantage for residual hens in finding food, roost sites, and potentially avoiding predators. However, newly released and residual hens had similar summer survival indicating transplanted hens became acclimated by summer.

Juvenile hens on control study areas had higher winter survival than adults. Kane (2003) also noticed this trend in mild winters. However, in a winter with deep snow, Porter et al. (1980) found adult survival to be higher than juveniles in study areas without corn. Adults had higher summer and annual survival than juveniles on control study areas.

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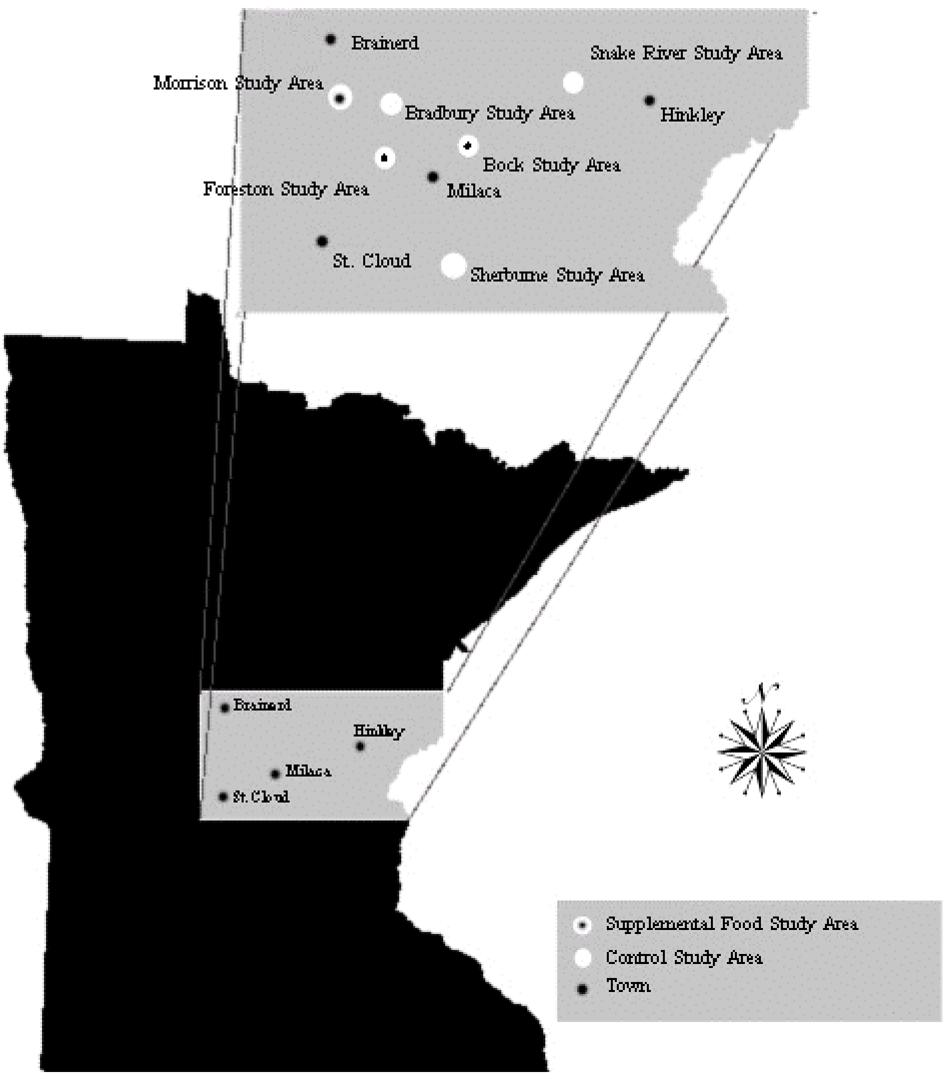

Figure 1. Locations of 6 wild turkey hen survival study areas (3 supplemental food and 3 control) north of presumed wild turkey ancestral range in east-central Minnesota, 2004.

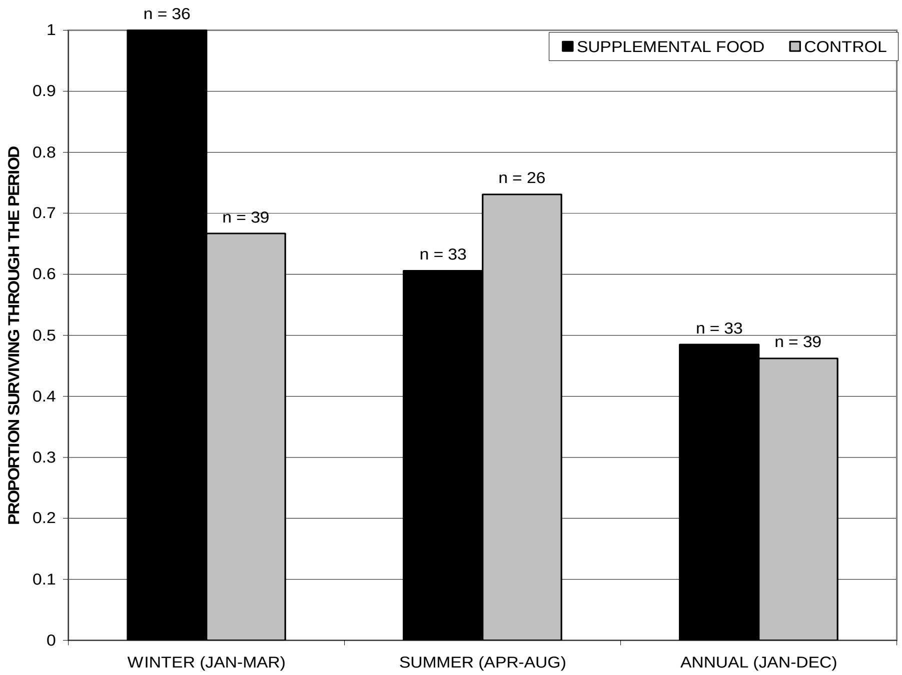

Figure 2. Seasonal and annual survival of eastern wild turkey hens in supplemental food and control study areas in east-central Minnesota, 2004.

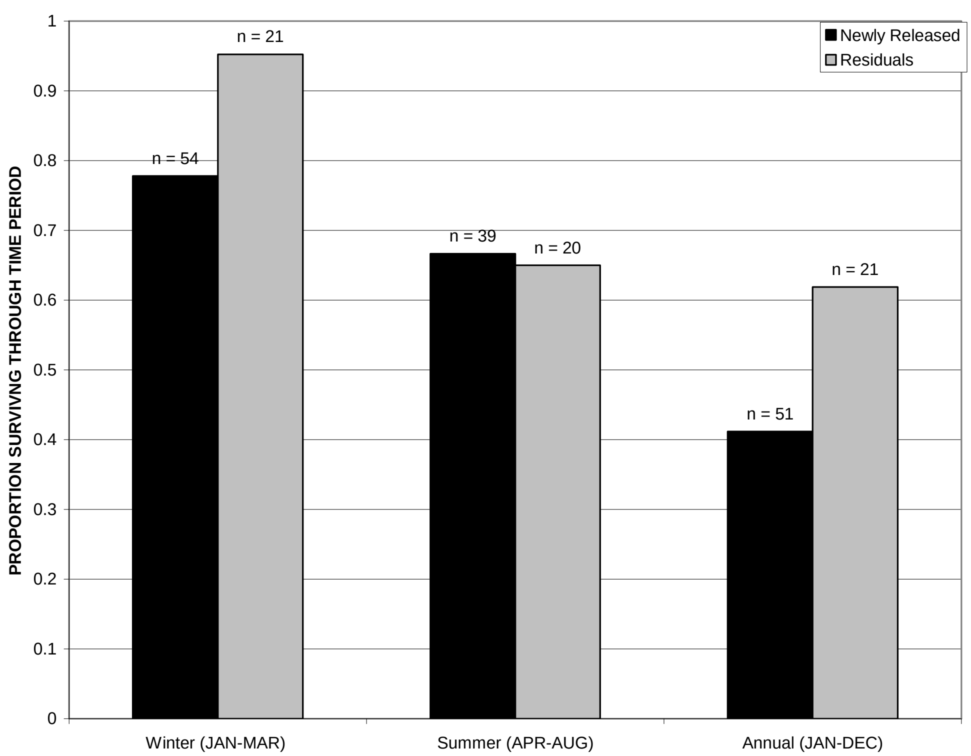

Figure 3. Seasonal and annual survival of newly released and residual eastern wild turkey hens in east-central Minnesota, 2004.

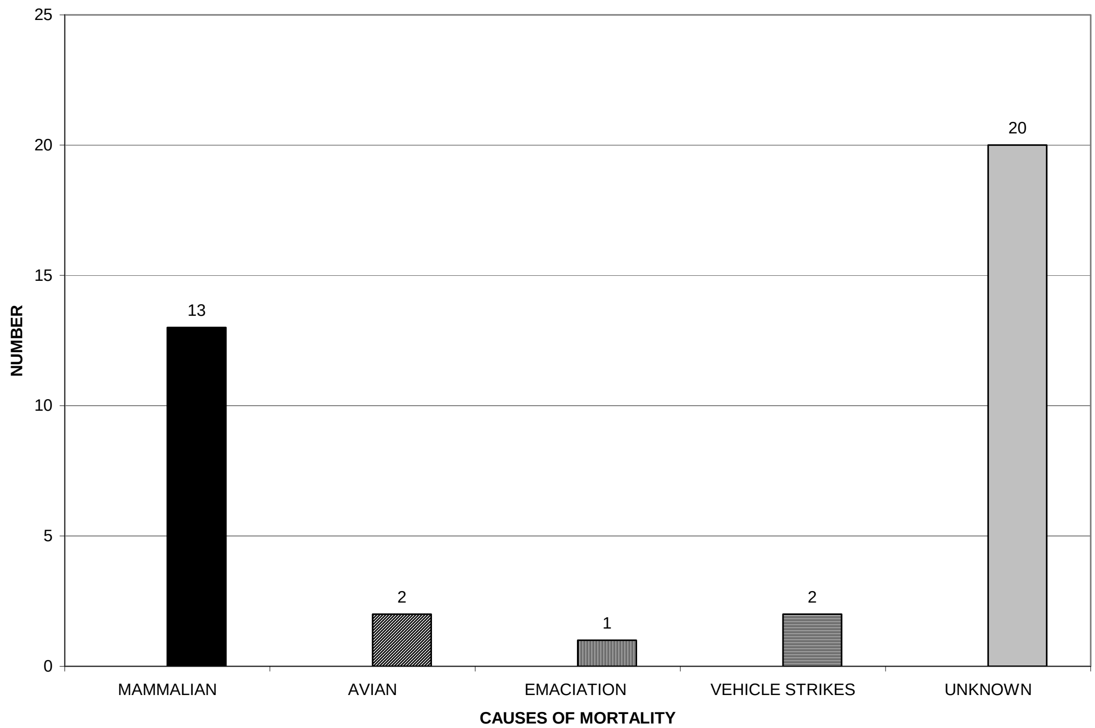

Figure 4. Causes of eastern wild turkey hen mortalities in east-central Minnesota, 2004. The emaciated hen weighed 5 kg at the time of the release and only 2.3 kg a month later.

WILD TURKEY DISTRIBUTION AND URBAN HUMAN/TURKEY INTERACTIONS ALONG THE RED RIVER VALLEY IN NORTHWESTERN MINNESOTA

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SUMMARY OF FINDINGS

This study was initiated in 2003 with an initial objective of using mail surveys to estimate the minimum wild turkey (*Meleagris gallopavo)* population in the Red River Valley in the Fargo, North Dakota/Moorhead, Minnesota (F/M) area. The Red River Valley offers suitable turkey habitat in a relatively narrow corridor surrounded in the F/M area by a dense human population. In 2004, we also monitored urban human/turkey interactions. In 2005, we added a survey to assess public opinion on wild turkey management options in the event abatement measures were necessary due to problems with urban turkeys.

A total of 537 and 368 turkeys were reported in 2003 and 2004, respectively. We consider this a minimum estimate of turkey populations in the area, because reports believed to be duplicates were eliminated. In 2004, 12.5 % of the survey respondents (n=40) reported negative human/turkey interactions. Landowners expressed concerns about turkeys at bird feeders, on decks, and in yards close to houses. To date, a higher number of complaints has been received for 2005, including reports of turkeys blocking a bridge, roads,, and driveways, as well as entering yards and eating from bird feeders and gardens. One report mentioned aggressive turkey behavior towards a young child.

Public opinion surveys of management options for abatement are currently being compiled. While initial opinions are mixed, approximately one-half of the survey respondents agreed or strongly agreed with a turkey hunting season option to reduce potential problems.

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INTRODUCTION

The Red River Valley, along the northwestern border between Minnesota and North Dakota, is near the northern range where turkey transplants have occurred in Minnesota. Records indicate that several releases of wild turkeys were conducted in the 1980s and 1990s surrounding F/M. Wild turkeys released along the Sheyenne River near Lisbon, ND are assumed to have spread to the F/M area (L. Tripp, North Dakota Game and Fish Department [retired], personal communication). Minnesota Department of Natural Resources (MNDNR) released turkeys in southeastern Clay County, Minnesota , but this release is approximately 40 miles from F/M and separated from F/M by open farmland (G. Nelson, MNDNR, personal communication). In addition, residents indicate that pen-raised turkeys were likely released in the F/M area. Turkey populations along the Red River Valley in F/M and surrounding areas have been increasing and expanding in recent years, as indicated by turkey population surveys conducted by MNDNR in 1999 and 2002.

The F/M area along the Red River Valley is an ideal place to evaluate human/turkey interactions in an urban setting. Turkeys use the narrow wooded riparian corridors along the Red and the Sheyenne rivers. Both rivers intersect a number of cities and towns, including the highly populated F/M area. Human/turkey interactions are increasingly becoming a problem in other urban areas where turkeys have been established for a longer time. Wild turkeys released on the fringes of the Twin Cities in Minnesota have expanded into urban areas resulting in increased complaints about problems with turkeys at bird feeders, in yards, and as threats to children (Moriarty and Lueth 2003).

The initial objective of this study in 2003 was to obtain a minimum estimate of the turkey population in the F/M area. However, in 2004 our focus shifted to monitoring human/turkey interactions, determining if urban turkey problems are developing, and determining possible abatement measures.

In this report, we summarize our methods and results from 2003, 2004, and early 2005. In 2005, we are concentrating on monitoring human/turkey interactions, and assessing public opinion on possible problem turkey abatement measures.

OBJECTIVES

- Estimate minimum wild turkey populations along the Red River Valley in the F/M area;
- Monitor urban human/turkey interactions and conflicts; and
- Conduct a public-opinion survey regarding abatement measures to reduce human/turkey problems.

METHODS

Study Area

The study area includes the Red River Valley in the F/M area. The area extends north along this riparian corridor to Georgetown, Minnesota (approximately 20.9 km north of Highway 10 in Moorhead, Minnesota) and south to Wahpeton, North Dakota/Breckenridge, Minnesota (approximately 72.4 km south of Moorhead). The Fargo, West Fargo, and Moorhead area has a combined human population of approximately 140,000. The Wahpeton/Breckenridge area has approximately 13,000 people, while Georgetown has a considerably lower human population (approximately 125). Most of the study area is included in Cass County, North Dakota and Clay County, Minnesota, but extends south into Richland County, North Dakota and Wilkin County, Minnesota.

Survey Methods

In spring 2003, we hand-distributed a 1-page survey, requesting information on numbers and locations of turkey observations, to landowners along the Red River Valley. We also requested turkey observation information in local news media: *The Barnesville Recorder* and *The (Fargo-Moorhead) Forum.* Local residents who saw turkeys were encouraged to contact us by phone, email, or by completing a survey. In spring 2004, surveys were mailed to respondents from 2003 along with newspaper requests. During winter 2005, surveys were mailed to all prior respondents in addition to randomly selected landowners obtained from the Cass and Clay County tax roles.

Surveys in 2003 contained questions about numbers of turkeys observed, and respondents were asked to indicate the location of the observation on a map of the local area. For survey maps and data summarization in 2003, the study area was divided into 3 sections covering a 24.1 km radius north and south of F/M: Red River North (the river corridor north of F/M), Red River South (south of F/M), and Fargo/Moorhead (the area within the cities). In 2004, we added a fourth section: Sheyenne River (the area southwest of F/M covering the Sheyenne River Valley near Horace, ND). Surveys distributed in 2004 included questions about human/turkey interactions. Two different surveys were mailed in 2005, one requesting turkey observation information and a second survey with opinion questions about landowner attitudes regarding wild turkey management options for potential problem turkey abatement measures. Questions for this survey requested opinions about such options as modifying habitat (exclosures for bird feeders, gardens, etc.), using visual/audio stimuli to deter turkeys, relocating problem turkeys, removing bird feeders/turkey attractants from yards, and opening a turkey hunting season. Sightings with similar numbers of turkeys in the same locations were considered duplicates and were eliminated from the analysis.

RESULTS AND DISCUSSION

In spring 2003, we distributed 100 surveys with 64 returned surveys and 11 e-mail responses. In spring 2004, we mailed 150 surveys with 40 returned surveys and 12 e-mail responses. Based on survey responses, the minimum wild turkey population was estimated at 537 for 2003 and 368 for 2004 (Tables 1 and 2). In winter 2005, we mailed 500 surveys and, at this writing, we have received 42 responses. Preliminary population estimates for 2005 appear to be similar to 2003. Even though we made an attempt to eliminate duplicate sightings, population estimates may be inflated due to repeat sightings of the same turkey flocks. However, we also assume that we are not receiving reports of all the turkeys in the area. Thus, we consider the estimates to be reasonable as minimum populations estimates for the F/M area.

In 2004, the reported negative interactions between wild turkeys and humans were quite low (12.5%, n = 40; Table 3). Complaints included turkeys at bird feeders, on decks, and close to landowner homes.

The reported human/turkey interactions from the 2005 surveys, while not complete, indicate a potential increase in negative interactions with urban turkeys. At this writing, we have received 10 complaints from 42 returned surveys (23.8%). For 2005, we have received reports of turkeys as a "traffic hazard." Four reports from Georgetown, Minnesota (north of F/M) noted turkeys blocking traffic on a main bridge. Other respondents reported turkeys blocking a driveway or a road. One response from a resident near Harwood, ND, reported turkeys on a lawn displaying aggressive behavior towards a 2-year old child.

Results are currently being compiled for the 2005 public opinion survey regarding problem turkey abatement measures. Although data are incomplete, approximately one-half of the returned surveys agreed or strongly agreed that a wild turkey hunting season would be an acceptable option to reduce potential urban turkey problems. Hunting restrictions within cities may limit possibilities of using this option.

During 2005, we plan to gather more data on human/turkey interactions in urban areas. We plan to identify what type of interactions occurred, where interactions occurred, and investigate whether types and frequency of turkey problems are related to turkey population density. We would like to conduct aerial surveys to refine population estimates in our study area.

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Table 1. Minimum wild turkey population estimates from landowner surveys distributed in the Red River Valley in the Fargo, ND/Moorhead, MN area in spring of 2003. Data are based on 64 surveys returned out of 100 distributed surveys plus 11 e-mails.

Section	Turkeys Observed	Known Males	Known Females
Red River North	287	27	47
Red River South	105	5	10
Fargo/Moorhead	145	19	37
Total	537	59	94

Table 2. Minimum wild turkey population estimates from landowner surveys distributed in the Red River Valley in the Fargo, ND/Moorhead, MN area in spring of 2004. Data are based on 40 surveys returned out of 150 distributed surveys plus 12 e-mails.

Section	Turkeys Observed	Known Males	Known Females
Red River North	47	30	8
Red River South	50	0	0
Fargo/Moorhead	211	13	5
Sheyenne River	60	14	6
Total	368	57	19

Table 3. Negative human-turkey interactions recorded from a landowner survey distributed in the Red River Valley - Fargo, ND/Moorhead, MN area in spring of 2004. Data are based on 40 returns from 150 mailed surveys and responses from people who responded to newspaper articles and did not receive a survey in the mail.

Section	Recorded Negative Interaction
Red River North	2
Red River South	0
Fargo/Moorhead	0
Sheyenne River	3
Total	5

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