FOREST WILDLIFE POPULATIONS

Forest Wildlife Populations and Research Group
1201 East Highway 2
Grand Rapids, MN 55744
(218) 327-4432

2013 MINNESOTA SPRING GROUSE SURVEYS

Charlotte Roy, Forest Wildlife Populations and Research Group

SUMMARY OF FINDINGS

Each spring, the Minnesota DNR coordinates statewide ruffed grouse (*Bonasa umbellus*) and sharp-tailed grouse (*Tympanuchus phasianellus*) surveys with the help of wildlife managers, cooperating agencies, and organizations (e.g., tribal agencies, U.S. Forest Service, college wildlife clubs). In 2013, ruffed grouse surveys were conducted between 16 April and 29 May, which was later than usual, but it allowed the peak of drumming activity to be captured during the unusually late spring. Mean ruffed grouse drums per stop (dps) were 0.9 (95% confidence interval = 0.7–1.0) and declined 10% from the previous year. This was expected, given that the birds have been in a declining phase of the 10-year cycle since the last peak in 2009.

Sharp-tailed grouse surveys were conducted between 23 March and 15 May 2013, with 1,284 birds observed at 139 leks. The mean numbers of sharp-tailed grouse/lek were 4.8 (3.8-5.9) in the East Central (EC) survey region, 10.5 (9.3–11.7) in the Northwest (NW) region, and 9.2 (8.2–10.2) statewide. Comparisons between leks observed in consecutive years (2012 and 2013) were similar in the NW region and statewide, but in the EC region sharp-tailed grouse counts declined substantially.

INTRODUCTION

The ruffed grouse (*Bonasa umbellus*) is the most popular game bird in Minnesota, with an annual harvest averaging >500,000 birds (~150,000 -1.4 million birds). Ruffed grouse hunter numbers have been as high as 92,000 during the last decade, although hunter numbers did not peak with the recent peak in grouse numbers, as they have traditionally. Sharp-tailed grouse (*Tympanuchus phasianellus*) are also popular among hunters, with an annual harvest of 6,000-22,000 birds since the early-1990s and 5,000-10,000 hunters in Minnesota.

The Minnesota DNR coordinates grouse surveys each year to monitor changes in grouse populations through time. These surveys provide a reasonable index to population trends, when the primary source of variation in counts among years is change in densities. However, weather, habitat conditions, observer ability, and grouse behavior, also vary over time and can influence survey counts. Thus, making inferences from survey data over short time periods (e.g., a few years) can be tenuous. Nevertheless, over longer time periods and when large changes in index values occur, these surveys can provide a reasonable index to long-term grouse population trends. Spring surveys, in combination with hunter harvest statistics, provide evidence that the ruffed grouse population cycles at approximately 10-year intervals.

The first surveys of ruffed grouse in Minnesota occurred in the mid-1930s, and the first spring survey routes were established along roadsides in 1949. By the mid-1950s, ~50 routes were established with ~70 more routes added during the late-1970s and early-1980s. Since that time, spring drumming counts have been conducted annually to survey ruffed grouse in the forested regions of the state where ruffed grouse habitat occurs. Drumming is a low sound produced by males as they beat their wings rapidly and in increasing frequency to signal the location of their territory. These drumming displays also attract females that are ready to begin nesting, so the frequency of drumming increases in the spring during the breeding season. The sound produced when male grouse drum is easy to hear and thus drumming counts are a convenient way to survey ruffed grouse populations in the spring.

Sharp-tailed grouse were first surveyed in Minnesota between the early-1940s and 1960. The current survey is based on counts at dancing grounds during the spring and was first conducted in 1976. Male sharp-tailed grouse display, or dance, together in open areas to attract females in the spring. This display consists of the males stomping their feet with out-stretched wings. Females visit the dancing grounds to select males for breeding. These dancing grounds, or leks, are reasonably stable in location from year to year, allowing surveyors to visit and count individuals each spring. Surveys are conducted in openland portions of the state where sharp-tailed grouse persist, although they were formerly much more widely distributed in Minnesota at the early part of the 20th century.

METHODS

Ruffed Grouse

Surveys for ruffed grouse were conducted along 117 of 167 possible established routes throughout the state. Each route consisted of 10 listening stops at approximately 1.6-km (1-mile) intervals. The placement of routes on the landscape was determined from historical survey routes, which were originally placed near ruffed grouse habitat in low traffic areas. Annual sampling of these historical routes provides information about temporal changes along the routes, but may not be representative of the counties or regions where the routes occurred.

Survey observers were solicited from among state, federal, tribal, private, and student biologists. Each observer was provided a set of instructions and route location information. No formal survey training was conducted but all observers had a professional background in wildlife science, and most had previously participated in the survey. Participants were asked to conduct surveys at sunrise during peak drumming activity (in April or May) on days that had little wind and no precipitation. Each observer drove the survey route once and listened for drumming at each stop for 4 minutes. Observers recorded the number of drums heard at each stop (not necessarily the number of individual grouse), along with information about phenology and weather at the time of the survey.

The number of drums heard per stop (dps) was used as the survey index value. I determined the mean dps for each route, for each of 4 survey regions (Figure 1), and for the entire state. For each survey region, I calculated the mean of route-level means for all routes partially or entirely within the region. Routes that traversed regional boundaries were included in the means for both regions. Because the number of routes within regions was not related to any proportional characteristic, I used the weighted mean of index values for the 4 Ecological Classification Sections (ECS) in the Northeast region and the 7 ECS sections in the state. The geographic area of the section was used as the weight for each section mean (i.e., Lake Agassiz, Aspen Parklands = 11,761 km^2, Northern Minnesota and Ontario Peatlands = 21,468 km^2, Northern Superior Uplands = 24,160 km^2, Northern Minnesota Drift and Lake Plains = 33,955 km^2, Western Superior Uplands = 14,158 km^2, Minnesota and Northeast Iowa Morainal (MIM) = 20,886 km^2, and Paleozoic Plateau (PP) = 5,212 km^2). The area used to weight drum index means for the MIM and PP sections was reduced to reflect the portion of these areas within ruffed grouse range (~50%) using subsection boundaries. A 95% confidence interval (CI) was calculated to convey the uncertainty of each mean index value using 10,000 bootstrap samples of route-level means for survey regions and the whole state. Confidence interval boundaries were defined as the 2.5th and 97.5th percentiles of bootstrap frequency distributions.

Sharp-tailed Grouse

Wildlife Managers and volunteers surveyed known sharp-tailed grouse lek locations in their work areas in the Northwest (NW) and East Central (EC) portions of the state (Figure 2). The NW region consisted of Lake Agassiz & Aspen Parklands, Northern Minnesota & Ontario Peatlands, and Red River Valley ECS sections. The EC region consisted of selected subsections of the Northern Minnesota Drift & Lake Plains, Western Superior Uplands, and Southern Superior Uplands sections. Some leks may have been missed, but most managers believed that they included most of the leks in their work area. Given the uncertainty in the proportion of leks missed, especially those occurring outside traditional areas, the survey may not necessarily reflect sharp-tailed grouse numbers in larger areas such as counties or regions.

Each cooperator was provided with instructions and asked to conduct surveys on ≥1 day in an attempt to obtain a maximum count of male sharp-tailed grouse attendance at each lek. Observers were asked to conduct surveys within 2.5 hours of sunrise under clear skies and during low winds (<16 km/hr, or 10 mph) when lek attendance and ability to detect leks were expected to be greatest. Data recorded during each lek visit included the number of males, females, and birds of unknown sex.

The number of sharp-tailed grouse per dancing ground was used as the index value and was averaged for the NW region, the EC region, and statewide, using known males and birds of unknown sex. Observations of just 1 grouse were not included. Data from former survey years were available for comparison, however, survey effort and success varied among years rendering comparisons of the full survey among years invalid. Therefore, to make valid comparisons between 2 consecutive years, only counts of birds from dancing grounds that were surveyed during both years were considered. Confidence intervals (95%) were calculated using 10,000 bootstrap samples of lek counts for each region and statewide.

RESULTS & DISCUSSION

Ruffed Grouse

Observers from 14 cooperating organizations including DNR Divisions of Fish & Wildlife and Parks & Trails; Chippewa and Superior National Forests (USDA Forest Service); Fond du Lac, Grand Portage, Leech Lake, Red Lake, and White Earth Reservations; 1854 Treaty Authority; Agassiz and Tamarac National Wildlife Refuges (U.S. Fish & Wildlife Service); Vermilion Community College; Cass County Land Department; and UPM Blandin Paper Mill, participated in surveys. Cooperators surveyed routes between 16 April and 29 May 2013. Most routes (75%) were surveyed between 6 May and 16 May, with the median date (10 May) much later than in previous years (compare to April 25 last year, and May 1 and 3 in 2009 and 2011). Excellent (61%), Good (32%), and Fair (6%) survey conditions were reported for 111 routes reporting conditions, which has been consistent in recent years.

Statewide counts of ruffed grouse drums averaged 0.9 dps (95% confidence interval = 0.7–1.0 dps) during 2013 (Figure 3). Drum counts were 0.9 (0.8–1.1) dps in the Northeast (n = 97 routes), 0.7 (0.4–0.9) dps in the Northwest (n =8), 0.9 (0.3–1.6) dps in the Central Hardwoods (n = 13), and 0.4 (0.1–0.6) dps in the Southeast (n = 7) regions (Figure 4a-d).

Statewide drum counts declined 10% this year. This decline was expected based on the current position of the population within the 10-year cycle, with the most recent peak in drum counts during 2009. Thus, in the context of the long-term survey data, which is the appropriate context for interpretation of these results, the ruffed grouse population decline is part of a larger cycling pattern, with the expected low point in the cycle occurring within the next few years.

Sharp-tailed Grouse

A total of 1,284 male sharp-tailed grouse and grouse of unknown sex was counted at 139 leks (Table 1) during 23 Mar-15 May 2013. Fewer leks (9%) were observed in 2013 than during 2012, in part due to DNR Wildlife staff vacancies in northwestern Minnesota. Leks with ≥2 grouse were observed an average of 2.0 times.

The statewide index value of 9.2 (8.2–10.2) was centrally located among values observed since 1980 (Figure 5). In the EC survey region, 163 grouse were counted on 32 leks, and 1,121 grouse were counted on 107 leks in the NW region. The index value (i.e., grouse/lek) in the NW region was similar to 2012, but a decline was noted in the EC region (Table 1). Counts at leks observed during both years were the same statewide and in the NW region, but declined (50%) in the EC region (Table 2). This marks the third year of significant declines in the EC region, and counts are lower than they have been during the preceding 10 years. However, in the context of the 10-year grouse cycle, these values are comparable to lows obtained in 1986 (5.7) and 1995 (5.1). Sharp-tailed grouse population index values peaked with those for ruffed grouse in 2009, although sharp-tailed grouse peaks can follow those of ruffed grouse by as much as 2 years.

ACKNOWLEDGEMENTS

I would like to thank DNR staff, partners, and volunteer cooperators for help with grouse surveys. Laura Gilbert helped enter data. Gary Drotts, John Erb, and Rick Horton organized an effort to enter the ruffed grouse survey data for 1982–2004, and Doug Mailhot and another volunteer helped enter the data. I would also like to thank Mike Larson for his assistance in the transition coordinating the surveys this year, and for making helpful comments on this report. This work was funded in part through the Federal Aid in Wildlife Restoration Act.

Table 1. Sharp-tailed grouse / lek (≥2 males) at all leks observed during spring surveys each year in Minnesota.

	Statewide			Northwest[a]			East Central[a]		
Year	Mean	95% CI[b]	*n*[c]	Mean	95% CI[b]	*n*[c]	Mean	95%CI[b]	*n*[c]
2004	11.2	10.1–12.3	183	12.7	11.3–14.2	116	8.5	7.2– 9.9	67
2005	11.3	10.2–12.5	161	13.1	11.5–14.7	95	8.8	7.3–10.2	66
2006	9.2	8.3–10.1	161	9.8	8.7–11.1	97	8.2	6.9– 9.7	64
2007	11.6	10.5–12.8	188	12.7	11.3–14.1	128	9.4	8.0–11.0	60
2008	12.4	11.2–13.7	192	13.6	12.0–15.3	122	10.4	8.7–12.3	70
2009	13.6	12.2–15.1	199	15.2	13.4–17.0	137	10.0	8.5–11.7	62
2010	10.7	9.8–11.7	202	11.7	10.5–12.9	132	8.9	7.5–10.5	70
2011	10.2	9.5–11.1	216	11.2	10.2–12.2	156	7.8	6.7–8.9	60
2012	9.2	8.2–10.3	153	10.7	9.3–12.3	100	6.3	5.4–7.3	53
2013	9.2	8.2–10.2	139	10.5	9.3–11.7	107	4.8	3.8–5.9	32

[a] Survey regions; see Figure 1.
[b] 95% CI = 95% confidence interval
[c] *n* = number of leks in the sample.

Table 2. Difference in the number of sharp-tailed grouse / lek observed during spring surveys of the same lek in consecutive years in Minnesota.

	Statewide			Northwest[a]			East Central[a]		
Comparison[b]	Mean	95% CI[c]	*n*[d]	Mean	95% CI[c]	*n*[d]	Mean	95%CI[c]	*n*[d]
2004 - 2005	-1.3	-2.2– -0.3	186	-2.1	-3.5– -0.8	112	0.0	-1.0– 1.1	74
2005 - 2006	-2.5	-3.7– -1.3	126	-3.6	-5.3– -1.9	70	-1.1	-2.6– 0.6	56
2006 - 2007	2.6	1.5– 3.8	152	3.3	1.7– 5.1	99	1.2	0.1– 2.3	53
2007 - 2008	0.4	-0.8– 1.5	166	0.0	-1.6– 1.6	115	1.2	0.1– 2.5	51
2008 - 2009	0.9	-0.4– 2.3	181	1.8	-0.1– 3.8	120	-0.8	-2.1– 0.6	61
2009 - 2010	-0.6	-1.8– 0.6	179	-0.8	-2.6– 1.0	118	-0.1	-1.2– 1.0	61
2010 - 2011	-1.7	-2.7– -0.8	183	-1.8	-3.1– -0.5	124	-1.5	-2.8– -0.3	59
2011 - 2012	-2.0	-2.9– -1.1	170	-1.7	-2.9– -0.4	112	-2.4	-3.3– -1.6	58
2012 - 2013	-0.8	-2.0– 0.4	140	0.4	-1.3– 2.3	88	-2.9	-4.2– -1.8	52

[a] Survey regions; see Figure 1.
[b] Consecutive years for which comparable leks were compared.
[c] 95% CI = 95% confidence interval
[d] *n* = number of leks in the sample.

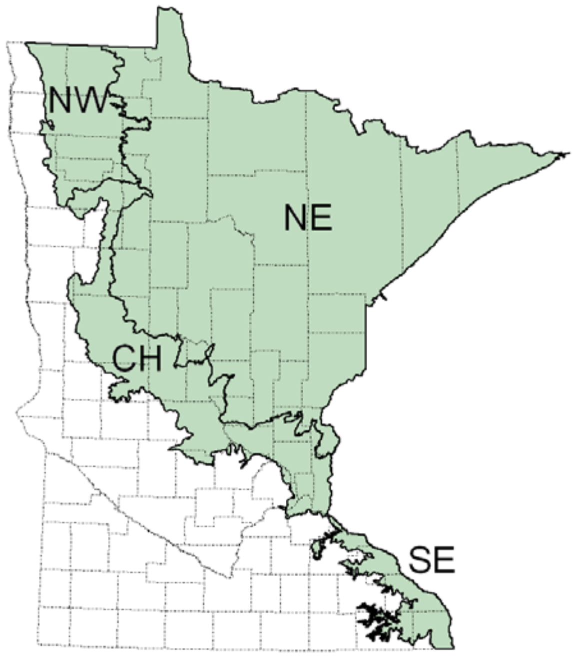


Figure 1. Survey regions for **ruffed grouse** in Minnesota. Northwest (NW), Northeast (NE), Central Hardwoods (CH), and Southeast (SE) survey regions are depicted relative to county boundaries (dashed lines) and influenced by the Ecological Classification System.

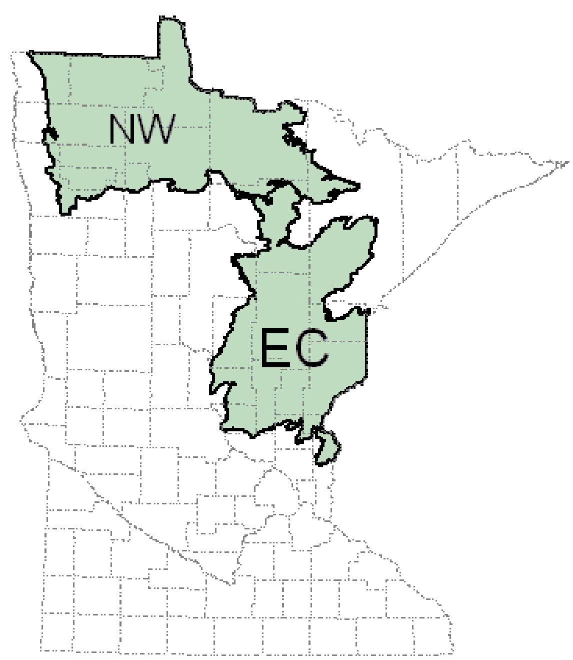


Figure 2. Survey regions for **sharp-tailed grouse** in Minnesota. Northwest (NW) and East Central (EC) survey regions are depicted relative to county boundaries (dashed lines) and influenced by Ecological Classification System Subsections boundaries.

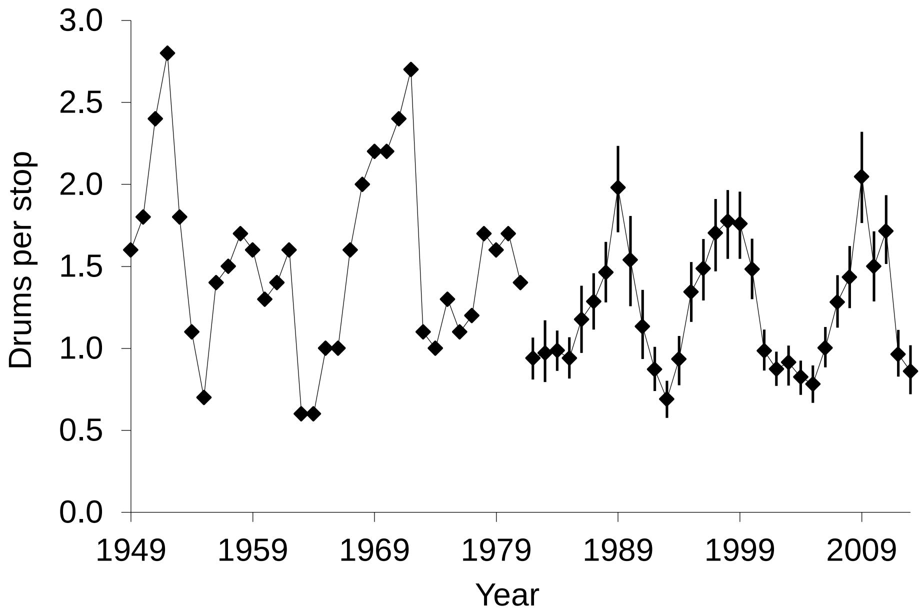
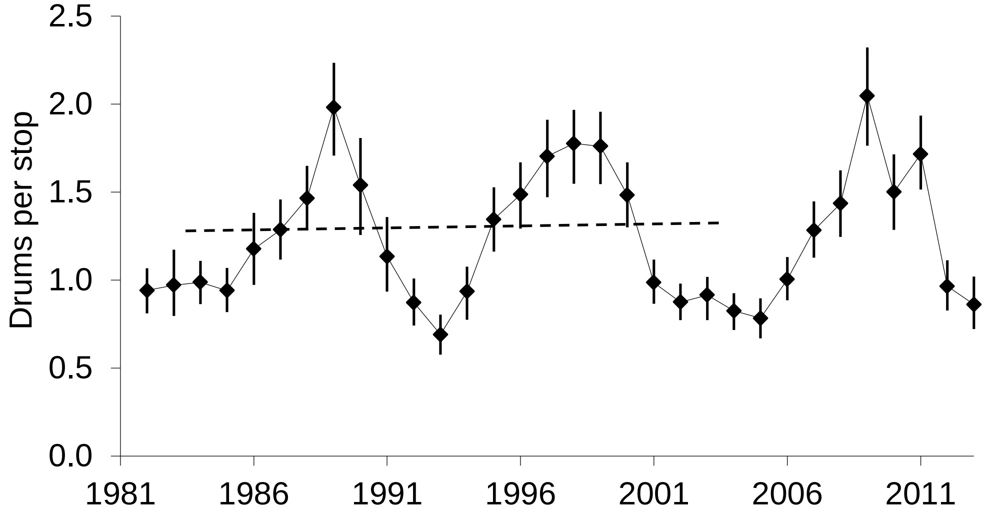


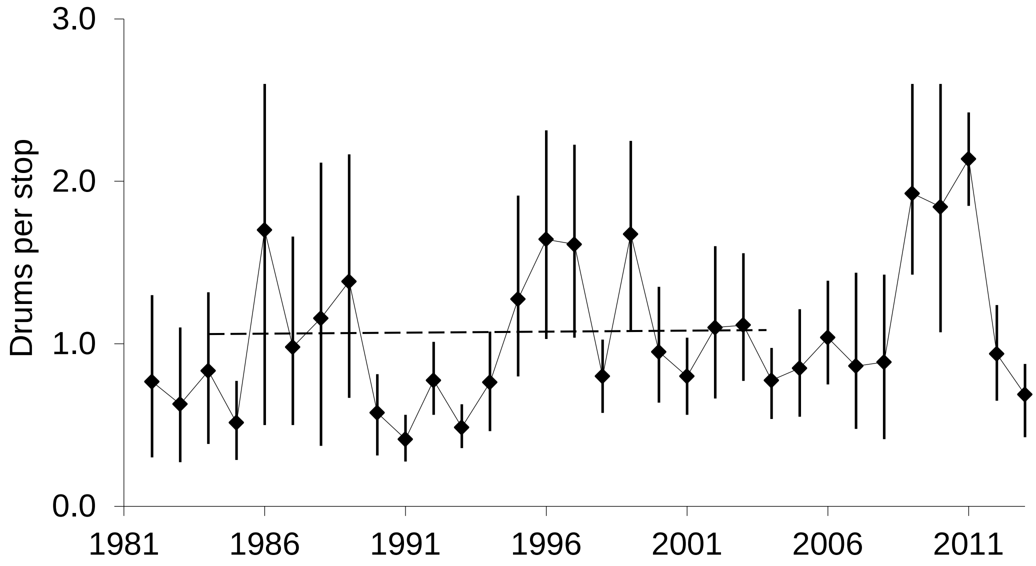
Figure 3. Statewide ruffed grouse population index values in Minnesota. Bootstrap (95%) confidence intervals (CI) are provided after 1981, but different analytical methods were used prior to this and thus CI are not available for earlier years. The difference between 1981 and 1982 is biological and not an artifact of the change in analysis methods.

a.



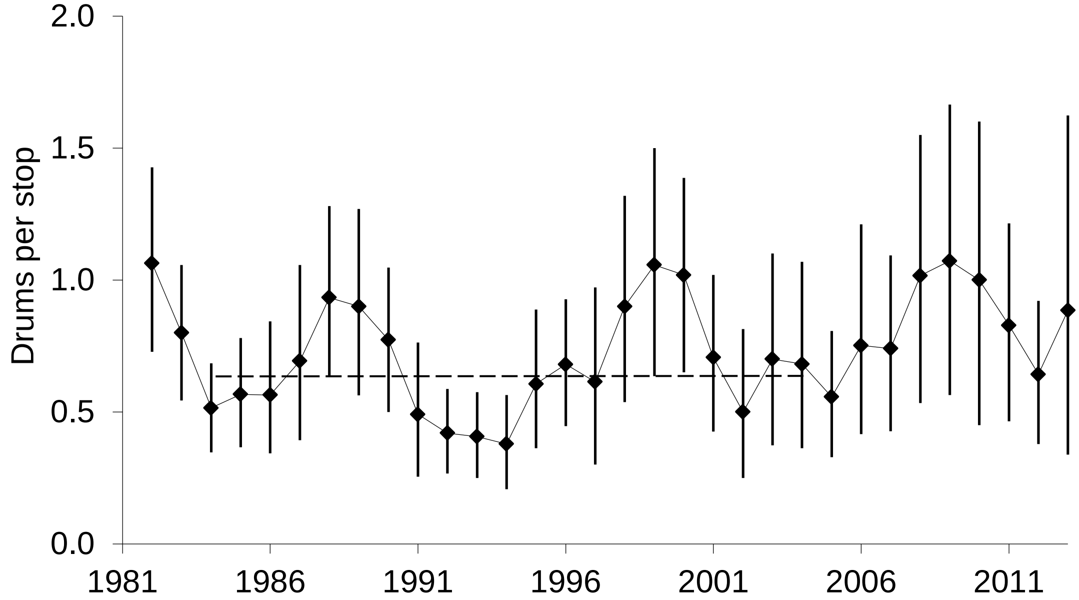
2.5
2.0
1.5
1.0
0.5
0.0
Drums per stop
1981
1986
1991
1996
2001
2006
2011

b.



3.0
2.0
1.0
0.0
Drums per stop
1981
1986
1991
1996
2001
2006
2011

c.



d.

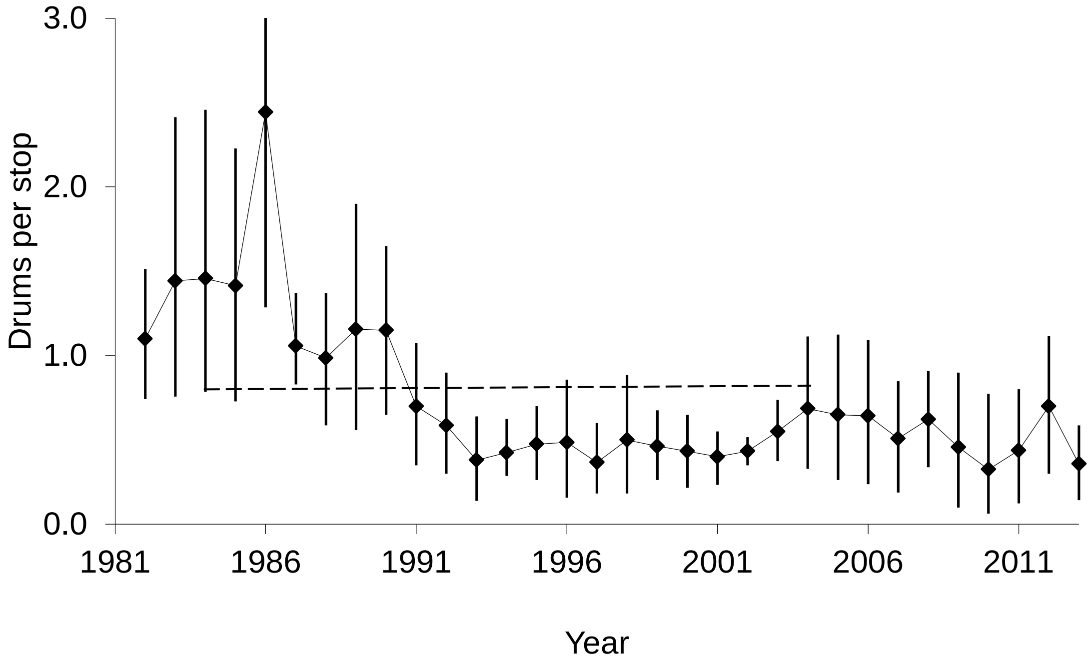


Figure 4a, b, c, d. Ruffed grouse population index values in the **Northeast** (a), **Northwest** (b), **Central Hardwoods** (c), and **Southeast** (d) survey regions of Minnesota. The mean for 1984-2004 is indicated by the dashed line. Bootstrap (95%) confidence intervals are provided for each mean. In the bottom panel, the CI for 1986 extends beyond area depicted in the figure.

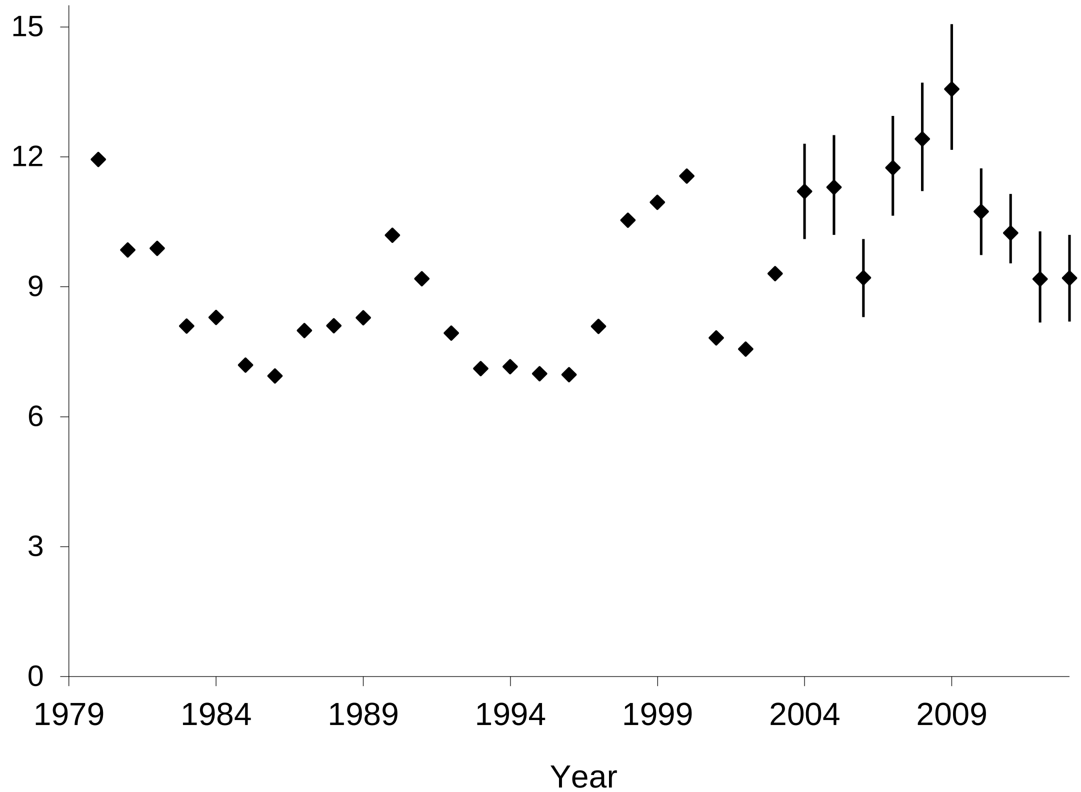


Figure 5. **Sharp-tailed grouse** counted in spring lek surveys statewide during 1980–2013. Bootstrap (95%) confidence intervals are provided for recent years. Annual means are not connected by lines because the same leks were not surveyed every year.

2013 MINNESOTA PRAIRIE-CHICKEN SURVEY

Charlotte Roy, Forest Wildlife Populations and Research Group

SUMMARY OF FINDINGS

Greater prairie-chickens (*Tympanuchus cupido pinnatus*) were surveyed in 15 of 17 survey blocks during the spring of 2013. Observers located 188 booming grounds and counted 1,415 male prairie-chickens and 528 birds of unknown sex. Estimated densities of 0.10 (0.06-0.14) booming grounds/km^2 and 11.4 (9.9-13.0) males/booming ground within the survey blocks were similar to densities during recent years and during the 10 years preceding modern hunting seasons (i.e., 1993–2002).

INTRODUCTION

Historically, greater prairie-chicken (*Tympanuchus cupido pinnatus*) range in Minnesota was restricted to the southeastern portion of the state. However, dramatic changes in their range occurred in the 19th century as settlers expanded and modified the landscape with farming and forest removal, providing abundant food sources and access to new areas. However, as grass continued to be lost from the landscape, prairie-chicken populations began to decline, their range contracted, and hunting closed after 1942. In an attempt to bolster populations and expand prairie-chicken range, the Minnesota Department of Natural Resources (DNR) conducted a series of translocations in the Upper Minnesota River Valley during 1998-2006. Today, the beach ridges of glacial Lake Agassiz hold most of Minnesota's prairie-chickens, but their populations do extend southward (Figure 1). Hunting was re-opened using a limited-entry season in 2003, and approximately 120 prairie-chickens are now harvested annually.

With the opening of the new hunting season, the DNR had a greater interest in the monitoring of prairie-chicken populations, which the Minnesota Prairie-Chicken Society (MPCS) had been coordinating since 1974. The DNR, in collaboration with MPCS members, began coordinating prairie-chicken surveys and adopted a standardized survey design in 2004. These surveys are conducted at small open areas called leks, or booming grounds, where male prairie-chickens display for females in the spring and make a low-frequency booming vocalization that can be heard for miles.

Prairie-chickens continue to be surveyed to monitor changes in population densities over time. However, density estimates can be costly and difficult to obtain, so instead we count individuals and make the assumption that changes in density are the primary source of variation in counts among years. If true, counts should provide a reasonable index to long-term trends in prairie-chicken populations. However, counts are also influenced by weather, habitat conditions, observer ability, and bird behavior among other factors, which make it difficult to make inferences over short periods of time (e.g., a few annual surveys) or from small changes in index values. Nevertheless, over long time periods and when changes in index values are large, inferences from prairie-chicken surveys are more likely to be valid.

METHODS

Cooperating biologists and volunteers surveyed booming grounds in 15 of 17 designated survey blocks in western Minnesota (Figure 2) during late-March through mid-May. Each survey block was nonrandomly selected so that surveys would be conducted in areas where habitat was expected to be good (i.e., grassland was relatively abundant) and booming grounds were known to occur. Each surveyor attempted to find and observe each booming ground repeatedly in his assigned block, which was comprised of 4 sections of the Public Land Survey (approximately 4,144 ha). We obtained multiple counts at each booming ground in the morning because male attendance at leks varies throughout the season and throughout the day.

During each survey, observers obtained visual counts of males, females, and birds of unknown sex from a distance with binoculars. Sex was determined through behavior; males display conspicuously, and females do not. If no birds were displaying during the survey period, then sex was recorded as unknown. When a reliable count could not be obtained visually because vegetation or topography prevented it, birds were flushed for counts and sex was recorded as unknown. Most birds for which sex was unknown were likely male because female attendance at leks is sporadic, and they are less conspicuous during lek attendance than displaying males.

In the analysis, I used counts of males and unknowns at each booming ground but not females. Booming grounds were defined as having ≥2 males, so observations of single males were not counted as leks. Data were summarized by hunting permit area and spring survey block. The survey block data were separated into a core group and a periphery group for analysis. The core group had a threshold density of approximately 1.0 male/km^2 during 2010, and was located proximally to other such blocks (Figure 2). I compared densities of leks and prairie-chickens to estimated densities from previous years.

I also encouraged surveyors to submit observations of booming grounds outside the survey blocks because these observations may provide additional information that is helpful to prairie-chicken management. These data were included in estimates of minimum abundance of prairie-chickens. However, these data were not used in the analysis of lek and prairie-chicken densities because effort and methods may have differed from those used in the survey blocks.

RESULTS & DISCUSSION

Observers from DNR Division of Fish and Wildlife, the U.S. Fish & Wildlife Service, and The Nature Conservancy, as well as many unaffiliated volunteers counted prairie-chickens between 24 March and 16 May 2013. Observers located 188 booming grounds and observed 1,415 male prairie-chickens and 528 birds of unknown sex within and outside survey blocks during 2013 (Table 1). These counts represent a minimum number of prairie-chickens in Minnesota during 2013, but because survey effort outside of survey blocks is not standardized among years, these counts should not be compared among years or permit areas.

Within the standardized survey blocks, 794 males and birds of unknown sex were counted on 69 booming grounds during 2013 (Table 2). Each lek was observed an average of 2.0 times (median = 2), with 44% of booming grounds observed just once. Densities of prairie-chickens in the 10 core survey blocks were 0.13 (0.08–0.19) booming grounds/km^2 and 12.1 (10.4–13.9) males/booming ground (Table 2, Figure 2). In 5 of the 7 peripheral survey blocks, densities were 0.04 (0.02–0.07) booming grounds/km^2 and 8.5 (5.4–11.7) males/booming ground.

Table 1. Minimum abundance of prairie-chickens within and outside hunting permit areas in Minnesota during spring 2013. Lek and bird counts are not comparable among permit areas or years.

Permit Area	Area (km^2)	Leks	Males	Unk [a]
803A	1,411	17	139	0
804A	435	13	43	122
805A	267	50	206	264
806A	747	13	48	36
807A	440	23	174	54
808A	417	16	263	0
809A	744	16	196	0
810A	505	12	133	0
811A	706	11	59	22
812A	914	2	30	0
813A	925	9	57	30
PA subtotal	7,511	182	1,348	528
Outside PAs[b]	NA[c]	6	67	0
Grand total	NA[c]	188	1,415	528

[a] Unk. = prairie-chickens for which sex was unknown, but which were probably males.
[b] Counts done outside permit areas (PA).
[c] NA = not applicable because the area outside permit areas was not defined.

The density of 0.10 (0.06-0.14) booming grounds/km^2 in all survey blocks during 2013 was similar to densities during recent years (Table 2, Figure 3) and the average of 0.08 (0.06–0.09) booming grounds/km^2 during the 10 years preceding recent hunting seasons (i.e., 1993–2002). Similarly, the density of 11.4 (9.9-13.0) males/booming ground in all survey blocks during 2013 was comparable to densities during recent years and similar to the average of 11.5 (10.1–12.9) males/booming ground observed during 1993–2002 (Table 2, Figure 3). These counts should not be regarded as estimates of abundance because detection probabilities of leks and birds have not been estimated. However, if we assume that detection probabilities are similar among years, then this index can be used to monitor changes in abundance among years.

Table 2. Prairie-chicken counts within survey blocks in Minnesota.

			2013		Change from 2012[a]	
Range[b]	Survey Block	Area (km^2)	Booming grounds	Males[c]	Booming grounds	Males[c]
Core	Polk 1	41.2	7	62	1	21
	Polk 2	42.0	14	148	6	38
	Norman 1	42.0	2	16	-1	-6
	Norman 2	42.2	7	70	1	14
	Norman 3	41.0	5	58	-4	-20
	Clay 1	46.0	6	97	0	24
	Clay 2	41.0	2	49	0	10
	Clay 3	42.0	6	86	-2	9
	Clay 4	39.0	2	27	-1	-5
	Wilkin 1	40.0	5	67	-1	-8
	Core subtotal	415.0	56	680	-1	77
Periphery	Mahnomen	41.7	2	16	NA[d]	NA[d]
	Becker 1	41.4	NA	NA	NA	NA
	Becker 2	41.7	2	34	-3	3
	Wilkin 2	41.7	2	15	0	-17
	Wilkin 3	42.0	4	29	1	-6
	Otter Tail 1	41.0	3	20	2	8
	Otter Tail 2	40.7	NA	NA	NA	NA
	Periphery subtotal	290.6	13[e]	114[e]	0[e]	-16
Grand total		705.5	69[e]	794[e]	-1[e]	61[e]

[a] The 2012 count was subtracted from the 2013 count, so positive values indicate increases.
[b] Survey blocks were categorized as within the core or periphery of the Minnesota prairie-chicken range based upon bird densities and geographic location.
[c] Includes birds recorded as being of unknown sex but excludes lone males.
[d] Surveys were not conducted in this block during 2012.
[e] These totals only reflect blocks for which count data were available.

ACKNOWLEDGMENTS

I would like to thank cooperators within the DNR, The Nature Conservancy, the US Fish and Wildlife Service, and numerous volunteers who conducted and helped coordinate the prairie-chicken survey. This survey was funded in part by the Wildlife Restoration (Pittman-Robertson) Program W-69-S-13 Project #16. Mike Larson provided assistance and comments which improved this report.

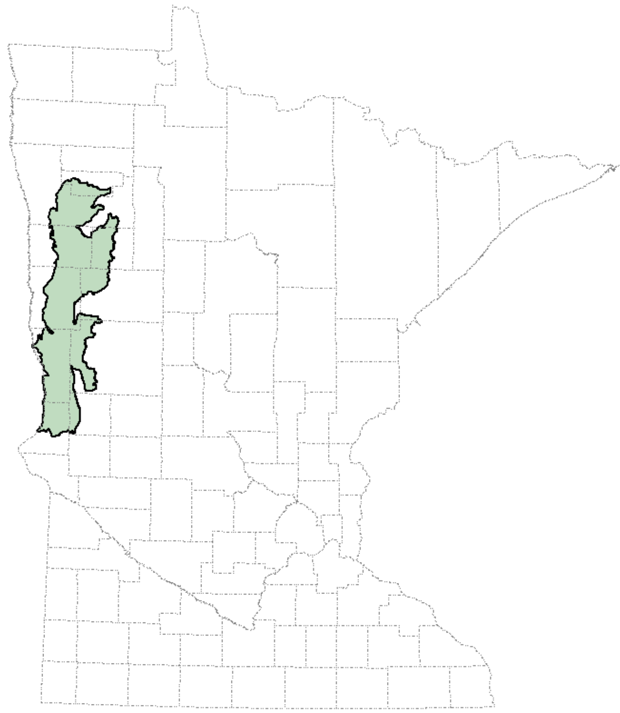


Figure 1. Primary greater prairie-chicken range in Minnesota (shaded area) relative to county boundaries. The range boundary was based on Ecological Classification System Land Type Associations and excludes some areas known to be occupied by prairie-chickens.

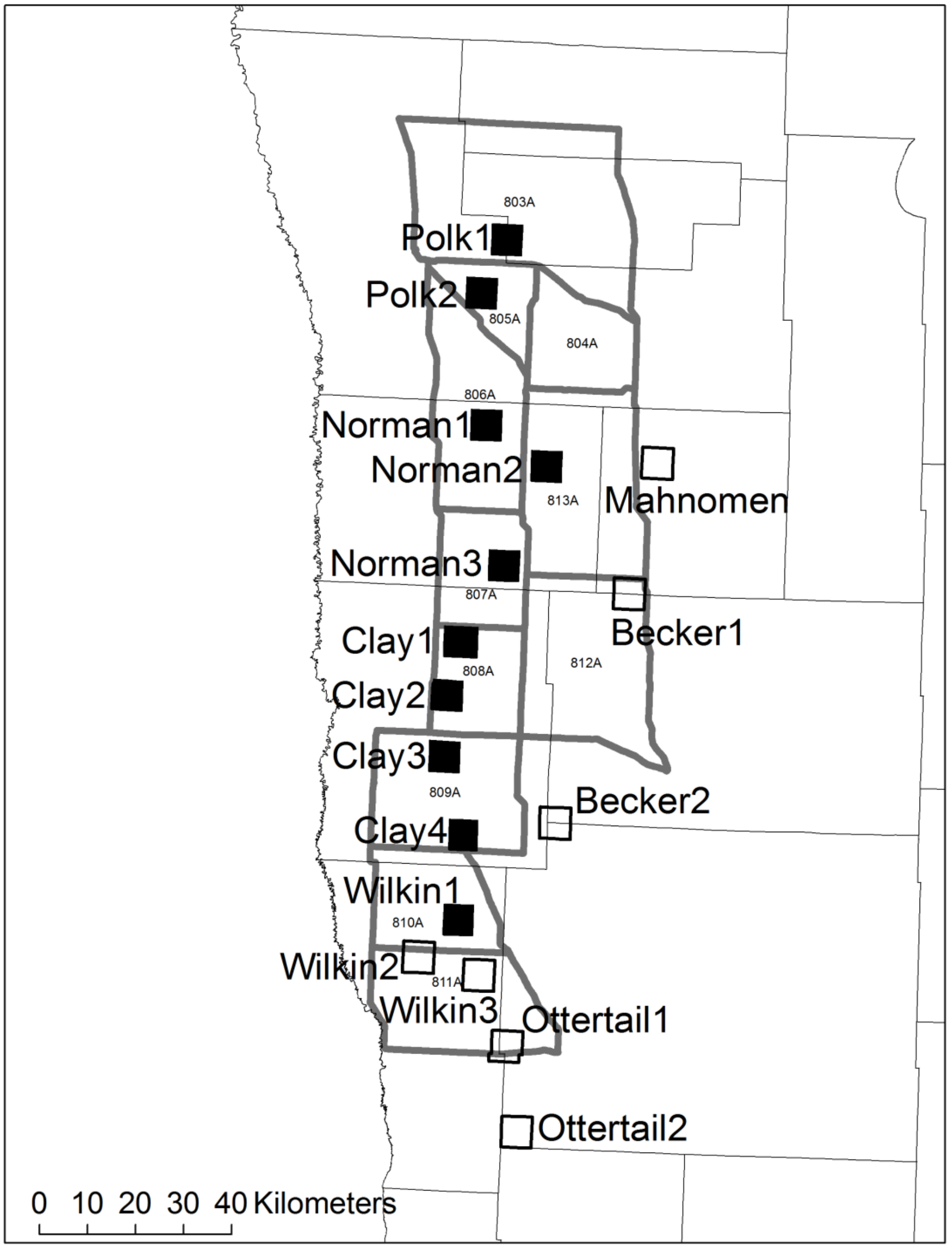


Figure 2. Prairie-chicken lek survey blocks (41 km^2, labeled squares) and hunting permit areas (thick grey lines) in western Minnesota. Survey blocks were either in the core (black) or periphery (white) of the range with a threshold of 1.0 male/km^2 in 2010, and were named after their respective counties (thin black lines). Permit areas were revised in 2013 to eliminate 801A and 802A, modify 803A, and add 812A and 813A. See previous reports for former permit area boundaries.

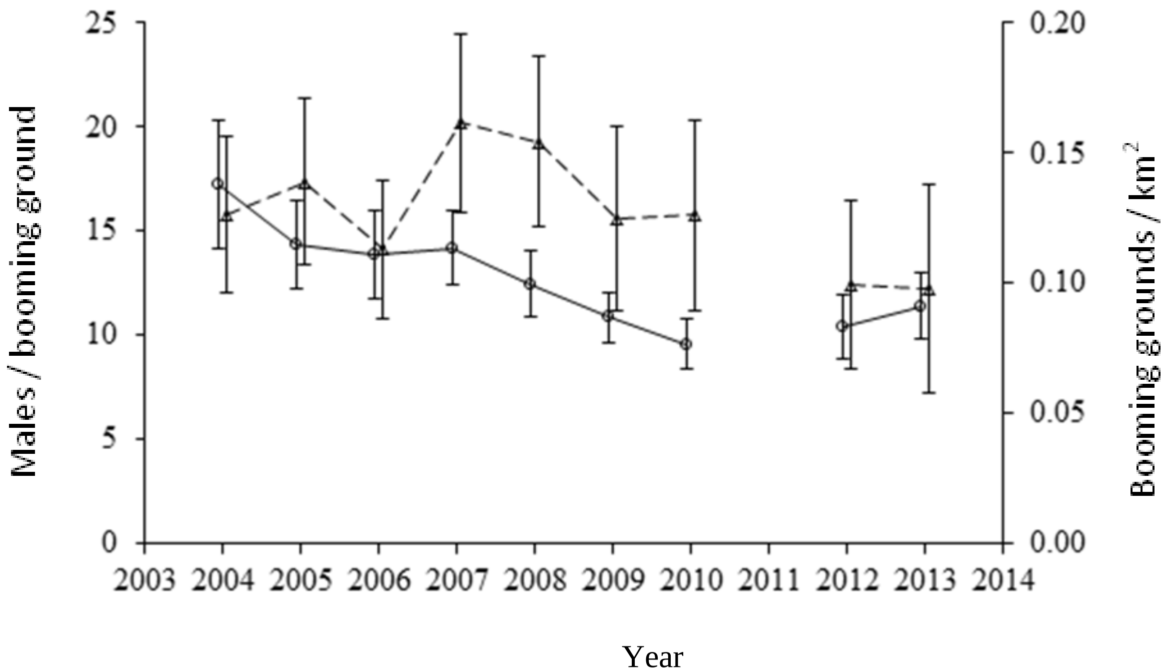


Figure 3. Mean prairie-chicken males/booming ground (circles connected by solid line) and booming grounds/km^2 (triangles connected by dashed line) in survey blocks in Minnesota with 95% confidence intervals. Counts for 6 of the survey blocks in 2011, including 4 blocks in the core, were not available for this report.

2013 AERIAL MOOSE SURVEY

Glenn D. DelGiudice, Forest Wildlife Populations and Research Group

INTRODUCTION

Each year, we conduct an aerial survey in northeastern Minnesota in an effort to monitor moose (*Alces alces*) numbers and fluctuations in the status of Minnesota's largest deer species. The primary objectives of this annual survey are to estimate moose numbers, calf:cow and bull:cow ratios. We use these data to determine and examine the population's trend and composition, to contribute to our understanding of moose ecology, and to set the harvest quota for the subsequent hunting season.

METHODS

We estimated moose numbers, age and sex ratios by flying transects within a stratified random sample of survey plots (Figure 1). Survey plots were last stratified as low, medium, and high moose density in 2009. As in previous years, all survey plots were rectangular (5 x 2.67 mi.) and all transects were oriented east to west. DNR Enforcement pilots flew the Bell Jet Ranger (OH-58) helicopters used to conduct the survey. We sexed moose using the presence of antlers or the presence of a vulval patch (Mitchell 1970), nose coloration, bell size and shape, and identified calves on the basis of size and behavior. We used the program DNRSurvey on Toughbook® tablet style computers to record survey data. DNRSurvey allowed us to display transect lines superimposed on a background of aerial photography, observe the aircraft's flight path over this background in real time, and record data using a tablet pen with a menu-driven data entry form.

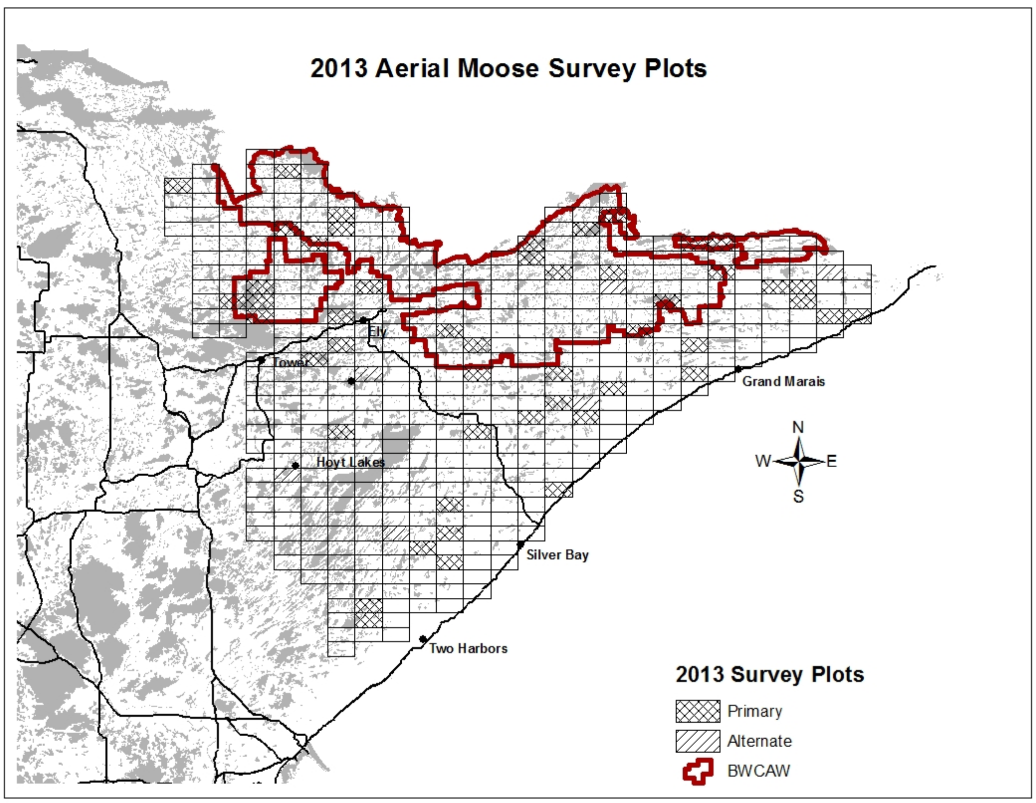


Figure 1. Northeast moose survey area and sample plots (cross hatching) flown in the 2013 aerial moose survey. The red line delineates the boundary of the Boundary Waters Canoe Area Wilderness.

In previous years, we used 3 strata based on expected moose density (low, medium, and high) in an effort to optimize precision of our survey estimates. In 2012, we added a 4th stratum to represent a series of 9 plots that have undergone disturbance by wild fire, prescribed burning, and timber harvest. Each year, these same 9 plots will be surveyed in an effort to evaluate the effect of disturbance on moose density over time.

We accounted for visibility bias by using a sightability model (Giudice et al. 2012). We developed this model between 2004 and 2007 using moose that were radiocollared as part of research on the dynamics of the northeastern moose population. Logistic regression indicated that the covariate "visual obstruction" (VO) was the most important covariate in determining whether radiocollared moose were observed. We defined VO as the proportion of vegetation within a circle (10-m radius or roughly 4 moose lengths) that would prevent you from seeing a moose when circling that spot from an oblique angle. If we observed more than one moose at a location, VO was based on the first moose sighted. We used uncorrected estimates (no visibility bias correction) of bulls, cows, and calves to calculate the bull:cow and calf:cow ratios.

Recent research indicated that variance calculations used in earlier analyses underestimated the total variance of survey estimates (Fieberg 2012). We reanalyzed survey data from 2004 to 2011 using the package Sightability Model in Program R (R Development Core Team 2011, Fieberg 2012) to recalculate confidence intervals. Based on this approach, confidence intervals are asymmetrical around the estimates. Minor corrections to our sightability model also modified population estimates slightly (0-4%) from those previously reported.

RESULTS AND DISCUSSION

We initiated the survey on 3 January and completed it on 15 January 2013. It consisted of 9 actual survey days. Sixty-seven percent of plots were surveyed under snow conditions classified as "good," 33% as marginal, and 0% as "poor," not dissimilar from the past 2 years' surveys. During the survey flights, observers detected 251 moose for 49 plots (653 mi^2) flown, including 109 bulls, 99 cows, 34 calves, and 9 unidentified moose. Estimates of the calf:cow and bull:cow ratios adjusted for sampling-only were 0.33 and 1.23, respectively (Table 1). In 2012, the first year 49 plots (versus 40 in the previous 5 years) were surveyed, 344 moose were observed, including 144 bulls, 140 cows, 55 calves, and 5 unidentified.

After adjusting for sampling and sightability, we estimated the population in northeastern Minnesota at 2,760 (2,120 – 3,580) moose (Table 1). Based on the log rate of change (-0.427, -0.762, -0.093 [90% confidence limits]), the 2013 population estimate was significantly lower (35%) than the 2012 estimate. Gasaway and Dubois (1987) indicated that even with relatively precise survey estimates, a change of at least 20% may be required to detect a significant change in population size. However, time series analysis of estimates since 2005 indicates a significant downward trend (Figure 2, $P = 0.0005$). This corroborates several data sets which suggest the northeastern Minnesota moose population is declining. Lenarz et al. (2010) had used simulation modeling to integrate survival and reproductive rates measured between 2002 and 2008 and found that the population was decreasing approximately 15% per year over the long-term. The 2013 estimate indicates a significant (52%) decline in the population since 2010, not inconsistent with that finding (Table 1).

Table 1. Estimated moose numbers, 90% confidence interval, and calves:cow, percent calves, percent cows with twins, and bulls:cow observed from aerial surveys in northeastern Minnesota, 2005-2013.

Survey	Estimate	90% Confidence Interval	Calves: Cow	% Calves	% Cows w/ twins	Bulls: Cow
2005	8,160	5,960 – 11,170	0.52	19	9	1.04
2006	8,840	6,670 – 11,710	0.34	13	5	1.09
2007	6,860	5,230 – 9,000	0.29	13	3	0.89
2008	7,890	5,970 – 10,420	0.36	17	2	0.77
2009	7,840	6,190 – 9,910	0.32	14	2	0.94
2010	5,700	4,480 – 7,250	0.28	13	3	0.83
2011	4,900	3,810 – 6,290	0.24	13	1	0.64
2012	4,230	3,190 – 5,600	0.36	15	6	1.08
2013	2,760	2,120 – 3,580	0.33	14	3	1.23

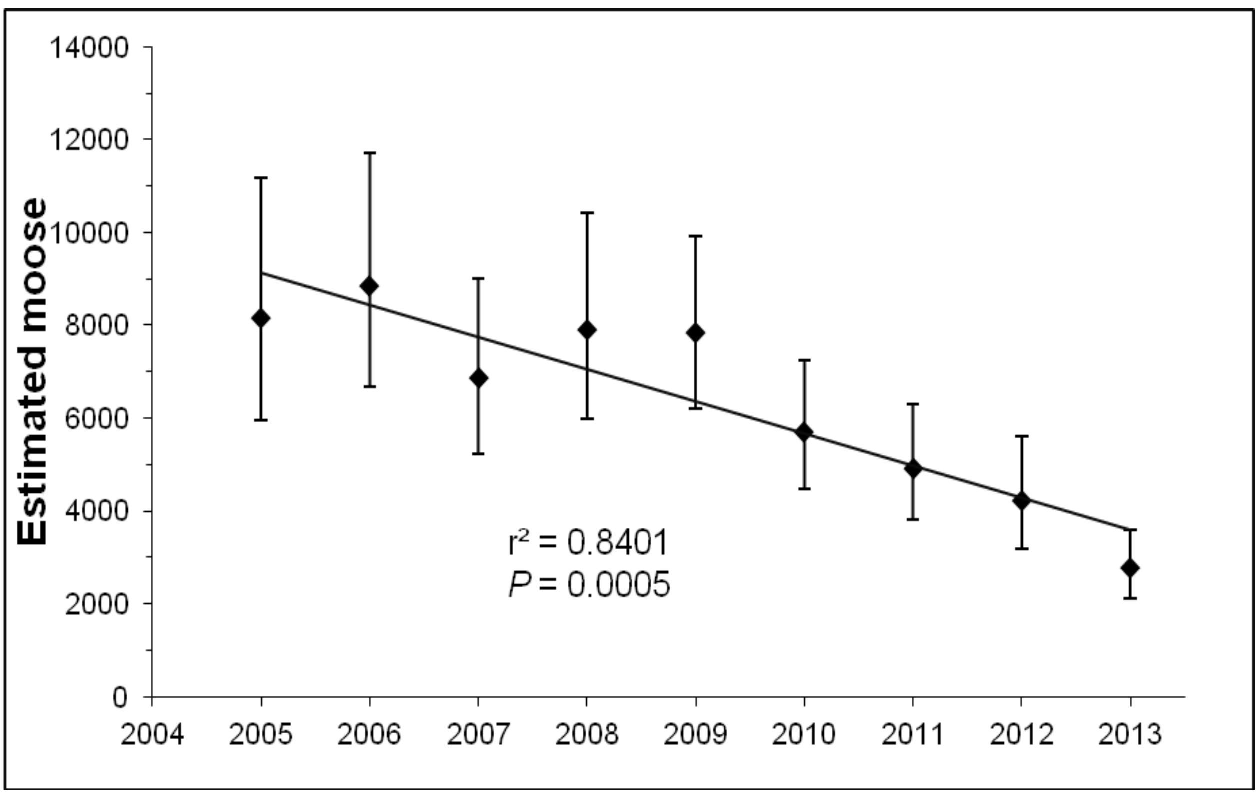


Figure 2. Point estimates, 90% confidence intervals, and trend line of estimated moose numbers in northeastern Minnesota, 2005-2013. (Note: The 2005 survey was the first to be flown with helicopters, and to include a sightability model and a uniform grid of east-west oriented rectangular 5 x 2.67 mi^2 plots).

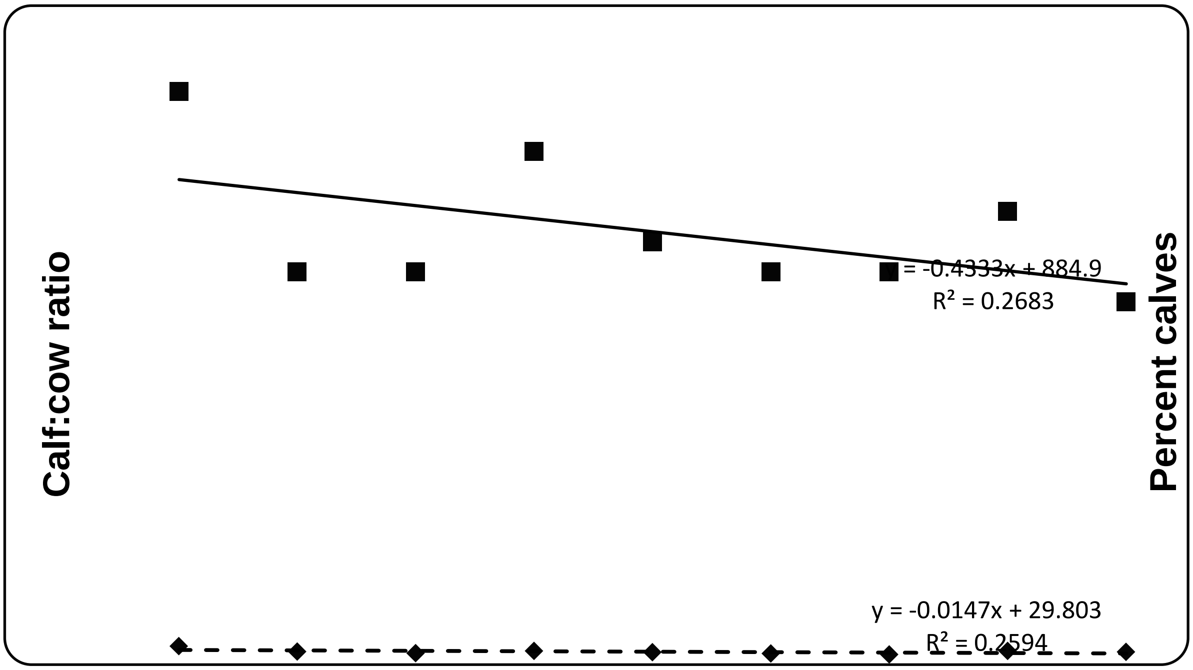


Figure 3. Estimated calf:cow ratios (solid diamonds, dashed trend line) and percent calves (solid squares, solid trend line) from aerial moose surveys in northeastern Minnesota, 2005-2013.

Estimated calf recruitment from this year's survey remained *relatively* high and similar to last year's estimate (Table 1). The calf:cow ratio in mid-January 2013 was 0.33 and calves represented 14% of the total moose observed (Table 1). Only 3% of the cow moose were accompanied by twins (Table 1), down from 6% in 2012. In 2012, the close agreement between calf:cow ratio and % calves (r = 0.94, $P < 0.001$) indicated that classification of adult moose to sex is accurate. Despite the apparent stability of calf survival through to the January 2013 survey compared to the 2012 survey, it is important to note that annual adult survival is more important to the population growth rate than calf survival (Lenarz et al. 2010). Further, *annual* recruitment of the calves is not actually determined until the next spring calving season when winter survey-observed calves become yearlings. At this point little is known about the survival rates of moose calves during the period between the annual winter survey and subsequent spring calving.

The estimated bull:cow ratio (Table 1; Figure 4) increased considerably since 2011 and is the highest it's ever been since 2005. Further, this year's estimated bull:cow ratio indicates that adult bulls may somewhat outnumber adult females, although there is a great deal of variability associated with these annual ratio estimates. Consequently, there is no clear upward or downward long-term trend (2005-2013) in bull:cow ratios. Despite the higher bull:cow ratios during this year's survey, the number of bulls observed over 49 survey plots surveyed decreased 24% from last year's (2012) 49 plots flown, and was less (31%) than the average annual number of bulls observed (158) from 2007 to 2011.

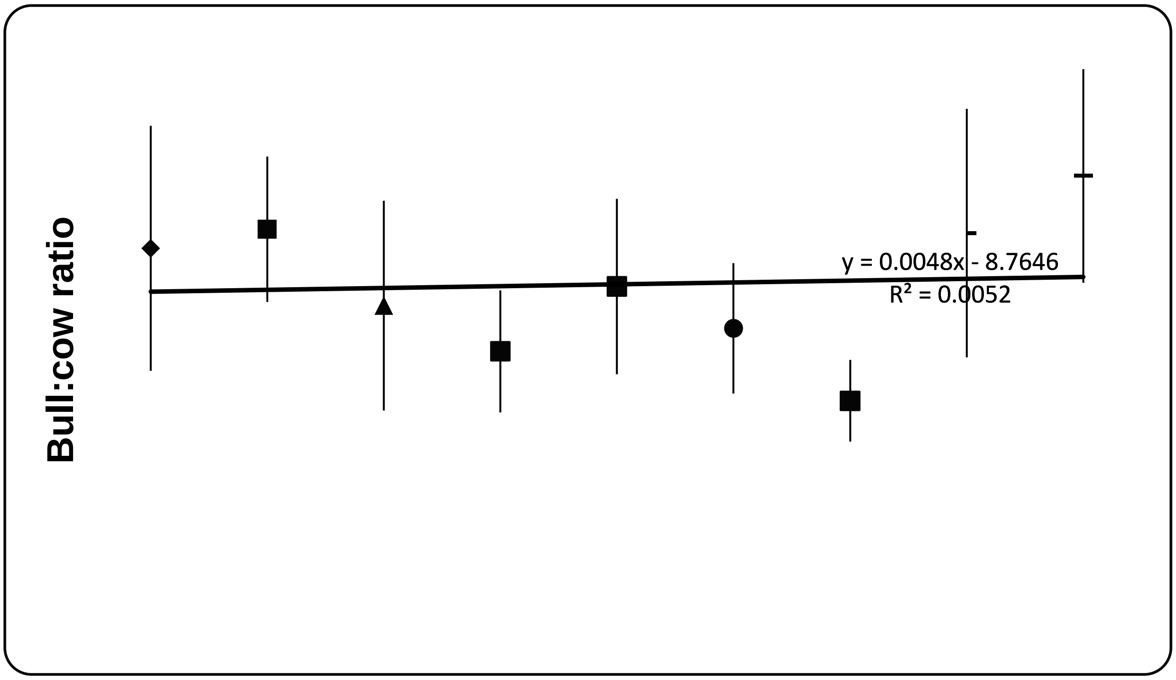


Figure 4. Estimated bull:cow ratios, 90% confidence intervals, and trend line from aerial moose surveys in northeastern Minnesota, 2005-2013.

ACKNOWLEDGMENTS

These surveys would not be possible without the excellent partnership between the Division of Enforcement, the Division of Fish and Wildlife, the Fond du Lac Band of Lake Superior Chippewa and the 1854 Treaty Authority. In particular, I would like to thank Thomas Pfingsten, Chief Pilot, for coordinating all of the aircraft and pilots; Tom Rusch for coordinating flights and survey crews; and Mike Schrage (Fond du Lac Band of Lake Superior Chippewa) and Andy Edwards (1854 Treaty Authority) for securing supplemental survey funding from their respective groups. Enforcement pilots, Brad Maas, John Heineman, Thomas Pfingsten, and Luke Ettl skillfully piloted the aircraft during the surveys, and Tom Rusch, Andy Edwards, Mike Schrage, and Nancy Gellerman flew as observers; their efforts are gratefully appreciated. I also want to thank John Giudice who continues to provide critical statistical consultation and analyses. I also want to acknowledge Barry Sampson for creating the process to generate the GIS survey maps and GPS coordinates for the transect lines, and Bob Wright, Brian Haroldson and Chris Pouliot for the creation of the program DNRSurvey. Bob also modifies the software as needed and provides refresher training for survey observers using DNRSurvey each year.

LITERATURE CITED

Fieberg, J. 2012. Estimating population abundance using sightability models: R sightability model package. Journal of Statistical Software 51:1-20.

Gasaway, W. C., and S. D. DuBois. 1987. Estimating moose population parameters. Swedish Wildlife Research (Supplement) 1:603–617.

Giudice, J. H., J. R. Fieberg, M. S. Lenarz. 2012. Spending degrees of freedom in a poor economy: a case study of building a sightability model for moose in northeastern Minnesota. Journal of Wildlife Management. In press.

Lenarz, M. S., J. Fieberg, M. W. Schrage, and A. J. Edwards. 2010. Living on the edge: viability of moose in northeastern Minnesota. Journal of Wildlife Management. 74:1013-1023.

Mitchell, H.B. 1970. Rapid aerial sexing of antlerless moose in British Columbia. Journal Wildlife Management. 34: 645-646.

R Development Core Team. 2011, R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Version 2.13.1, ISBN 3-900051-07-0 http://www.r-project.org/.