FARMLAND WILDLIFE POPULATIONS

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2014 MINNESOTA AUGUST ROADSIDE SURVEY

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SUMMARY OF FINDINGS

Population indices for ring-necked pheasants and eastern cottontail rabbits increased from 2013 but remained below the long-term averages. The white-tailed jackrabbit index was similar to last year and remains at a historic low. The population indices for gray partridge and mourning doves decreased slightly from last year and also remain below the long-term averages. The population index for white-tailed deer was similar to 2013 and was well above the long-term average. The index for total sandhill cranes decreased but the index for juvenile cranes increased from 2013.

Conservation Reserve Program (CRP) enrollment declined by 82,340 acres statewide in 2013. Increases in enrollment of other farm programs and acquisition of public lands only partially offset CRP losses, yielding a net loss of 51,375 acres of protected habitat for wildlife. Within the pheasant range, there was a net loss of 7,706 acres of set-aside habitat. The winter of 2013-14 was more severe than normal, especially for the Central and East Central regions. Spring temperatures and precipitation were highly variable across the farmland regions of Minnesota. Excessive rainfall occurred during June; however, temperatures were slightly above normal. Overall, conditions for overwinter survival of farmland wildlife were below average to severe and nesting season conditions, especially during the peak hatching period for pheasants, were fair to poor in many regions within the farmland zone.

The 2014 range-wide pheasant index (28.7 birds/100 mi) increased 6% from 2013 but was 58% below the 10-year average and 71% below the long-term average. Minnesota's pheasant population has steadily declined since the mid-2000s in conjunction with the loss of CRP acres, and indices over the past 4 years are comparable to the indices calculated in the mid-1980s. The hen index (4.1 hens/100 mi) increased 18% from 2013 but was 61% below the 10-year average. The cock index (4.6 cocks/100 mi) decreased 11% from 2013 and was 44% below the 10-year average. An improved hen:cock ratio (0.99) compared to 2013 (0.68) provides further evidence that hens were undercounted in last year's surveys due to the delayed nesting season, and the 2014 surveys were likely more representative of population trends in recent years. The pheasant brood index (4.4 broods/100 mi) increased 28% from last year but remained 58% below the 10-year average and 66% below the long-term average. Average brood size in 2014 (4.6 chicks/brood) decreased 15% compared to 2013 (5.4 chicks/brood) but was comparable to the 10-year average (4.7 chicks/brood). The median hatch date for pheasants was 16 June 2014, approximately 5 days later than the 10-year average. Projecting from the roadside index, an estimated 224,000 roosters may be harvested this fall. The best opportunity for harvesting pheasants appears to be in the Southwest, South Central, and West Central regions.

The gray partridge index decreased 16% from 2013 and remained well below the 10-year and long-term averages (-81% and -93%, respectively). Partridge counts were highest in the South Central region. The eastern cottontail rabbit index was 11% greater than last year, but 5% below the 10-year average and 12% below the long-term average. Counts of cottontail rabbits were highest in the Southeast, South Central, Southwest, and East Central regions. The white-tailed jackrabbit index did not change from 2014 and is 94% below the long-term average. The jackrabbit population peaked in the late 1950s but declined to low levels in the 1980s and has not recovered. The white-tailed deer index was similar to 2013, 34% above the 10-year average, and 109% above the long-term average. In contrast, the number of mourning doves observed was 5% lower than last year, 24% below the 10-year average, and 36% below the long-term average. Mourning dove counts were highest in the Southwest, South Central, and West

Central regions. The total sandhill crane index decreased 13% but the juvenile crane index increased 17% from last year.

INTRODUCTION

This report summarizes the 2014 Minnesota August roadside survey. The survey is conducted annually during the first half of August by Minnesota Department of Natural Resources (MNDNR) enforcement and wildlife personnel throughout Minnesota's farmland region (Figure 1). The 2014 August roadside survey consisted of 173 25-mi routes (1-4 routes/county); of which, 154 were located in the ring-necked pheasant range. Two new routes in Chippewa and Lac qui Parle Counties were added in 2014.

Observers drove each route in the early morning at 15-20 mi/hr and recorded the number of pheasants, gray (Hungarian) partridge, cottontail rabbits, white-tailed jackrabbits, and other wildlife they observed. Counts conducted on cool, clear, calm mornings with heavy dew yield the most consistent results because wildlife, especially pheasants, gray partridge, and rabbits, move to warm, dry areas (e.g., gravel roads) during early-morning hours. These data provide an **index of relative abundance** and are used to monitor annual changes and long-term trends in regional and range-wide populations. Results are reported by agricultural region (Figure 1) and range-wide; however, population indices for species with low detection rates are imprecise and should be interpreted cautiously.

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WEATHER SUMMARY

Winter 2013-2014 had colder than normal temperatures that extended through April across the farmland region of Minnesota. Snow cover in the southern regions of the state (Figure 1) was intermittent in December but became deeper (>6 inches) and more persistent from mid-January through early March. The West Central, Central, East Central, and Northwest regions had snow depths that exceeded 6 inches for 16-20 consecutive weeks, and snow cover persisted into April for each of these regions (Minnesota Climatology Working Group [MCWG], Climate snow map). In addition, monthly temperatures averaged 5.1° F below normal (range = 4.5° to 13.7° F; MCWG, Monthly temperature and precipitation summary) in all farmland regions from December through March.

Spring precipitation and temperatures were highly variable across regions and months. April was slightly wetter than normal (1.8 inches above normal) across the farmland region with the Central and East Central regions receiving the most precipitation (2.5 and 3.1 inches above normal, respectively) and the Southwest region receiving the least precipitation (0.8 inches below normal). May had normal precipitation, on average, but the Central region was wetter and the Southwest was drier than normal (1.9 inches above and 1.0 inches below normal, respectively). Average temperatures across the farmland region were cooler than normal in April and May (4.3° F below normal and 1.0° F below normal, respectively). June was extremely wet and precipitation amounts averaged 4.1 inches above normal (range: 2.0-5.8 inches above normal). The Southwest and South Central regions saw the heaviest rainfall amounts in June, and many local areas reported >10 inches of total rain for the month. However, June temperatures across the farmland region were slightly above average during these rains (average: 0.9° F above normal; range: 0.1° to 1.7° F above normal). By July, conditions were again drier and cooler than normal (1.9 inches and 2.4° F below normal, respectively).

Overall, the conditions for over-winter survival of wildlife ranged from below average to severe throughout the farmland region in 2014. Conditions for production of young were poor due to cooler, wetter weather in the spring and extremely heavy rainfall amounts in June. Warmer temperatures in June may have partially offset the excessive rains for nesting birds and young chicks, and the drier conditions in July were beneficial for re-nesting birds.

HABITAT CONDITIONS

Minnesota's farmland landscape continued to undergo considerable changes in the last year. Conservation Reserve Program (CRP) enrollment declined by 82,340 acres statewide with losses in northwestern Minnesota's prairie chicken range (54,201 acres lost) compounded by a loss of 30,352 acres in Minnesota's pheasant range (Figure 2). There were also losses in Conservation Reserve Enhancement Program (CREP) acres throughout the state whereas acres enrolled in Reinvest in Minnesota (RIM), Wetlands Reserve Program (WRP), and RIM-WRP increased slightly. Acquisitions of Wildlife Management Areas (WMA) and Waterfowl Production Areas (WPA) only partially offset CRP and CREP losses, yielding a net loss of 51,375 acres statewide. The net loss of protected habitat in Minnesota's pheasant range was 7,706 acres, and remaining protected habitat accounts for 5.9% of the landscape (range: 3.1-9.7%; Table 1).

Protecting grassland and wetland habitat is one of the most critical environmental challenges facing Minnesota. Farm programs, especially CRP, make up the largest portion of protected grasslands in the state. The expiration of a large proportion of existing CRP contracts continues to be a major concern for future wildlife populations, with the biggest loses yet to come (e.g., >290,000 acres in Minnesota scheduled to expire in the next 2 years). New funding from the Legacy Amendment has accelerated acquisition of WMAs and WPAs throughout Minnesota's farmland zone. In addition, the Minnesota Prairie Conservation Plan provides a blueprint for moving forward and demonstrates unprecedented cooperation between federal agencies, state agencies, and the state's most active conservation organizations. The plan identifies core conservation areas and creates a vision of a connected landscape from Canada to Iowa. The plan is being carried out through local teams (Local Technical Teams [LTTs]) that are using various state and federal funding sources to protect, restore, and enhance grasslands and wetlands. For more info, please visit: Minnesota Prairie Plan.

Efforts to increase public hunting opportunities on private lands, especially land enrolled in a conservation program (e.g., CRP, CREP, RIM), have continued in 2014. The 2012 Minnesota Legislature established a Walk-in Access (WIA) program to provide public access to wildlife habitat on private land. The WIA program compensates landowners for providing hunter access through an agreement with MNDNR Wildlife. For the 2014-2015 hunting season, the program has enrolled >180 sites in 35 counties in the Southwest and South Central regions and made >21,000 acres of private land available for public hunting. Walk-in Access sites are open for public hunting from September 1 – May 31 where boundary signs are present. Hunters must have a $3 WIA Validation to legally access WIA lands. For more information on the WIA program, including a printable atlas of enrolled sites by county, aerial photos of each site, interactive maps, and Global Positioning System (GPS) downloads, please visit the WIA program website at: www.mndnr.gov/walkin.

SURVEY CONDITIONS

The survey period was extended (29 July – 19 August) to allow routes to be completed, and observers completed 171 of 173 routes in 2014. One route in Washington County was not completed due to concerns related to traffic safety and one route in Isanti County was not completed within the survey's timeframe. Weather conditions during the survey ranged from excellent (calm, heavy dew, clear sky) to medium (light breeze and dew, overcast skies). Medium-to-heavy dew conditions were present at the start of 94% of the survey routes, which was less than 2013 (98%) but slightly better than the 10-year average (93%). Clear skies (<30% cloud cover) were present at the start of 88% of routes and wind speeds <7 mph were recorded for 97% of routes. Overall, survey conditions were excellent in 2014.

RING-NECKED PHEASANT

The average number of pheasants observed (28.7 birds/100 mi) increased 6% from 2013 but remained 58% below the 10-year average (Table 2; Figure 3A), 71% below the long-term average, and 89% below the benchmark years of 1955-64. The pheasant population has steadily declined since the mid-2000s in conjunction with the loss of CRP acres (Figure 2), and pheasant indices over the past 4 years are comparable to the indices calculated in the mid-1980s (Figure 3A). Total pheasants observed per 100 mi ranged from 10.4 in the Southeast region to 62.1 in the Southwest (Table 3). The pheasant roadside index increased in the three southern regions (Southwest, 22%; South Central, 17%, and Southeast, 40%), but decreased slightly in the West Central (-5%) and Central regions (-1%; Table 3). The most substantial decrease occurred in the East Central region (-33%; Table 3).

The range-wide hen index (4.1 hens/100 mi) increased 18% from 2013 but was 61% below the 10-year average (Table 2). The hen index varied from 1.0 hens/100 mi in the Southeast to 6.7 hens/100 mi in the Southwest region. The hen index increased in all regions (range: 14-50% increase) except the East Central region (-28%). The range-wide cock index (4.6 cocks/100 mi) decreased 11% from 2013 and was 44% below the 10-year average (Table 2). The cock index increased in the West Central (13%) and Southwest (6%) regions but decreased 8-42% in the other regions of the pheasant-range. The 2014 hen:cock ratio was 0.99, which was greater than 2013 (0.68) but still below average (1.42 ± 0.36) for the CRP years (1987-2013).

Across their range, the average number of pheasant broods observed (4.4 broods/100 mi) increased 28% from last year but remained 58% below the 10-year average and 66% below the long-term average (Table 2). Regional brood indices ranged from 1.4 broods/100 mi in the Southeast to 9.1 broods/100 mi in the Southwest. Only the East Central region showed a decrease (-37%) in the brood index compared to 2013. Average brood size in 2014 (4.6 ± 0.2 [SE] chicks/brood) decreased 15% compared to 2013 (5.4 ± 0.3 [SE] chicks/brood) but was comparable to the 10-year average (4.7 ± 0.1 [SE] chicks/brood; Table 2). The 2014 brood size index was 16% below the long-term average (5.5 ± 0.1 [SE] chicks/brood; Table 2). The median hatch date for pheasants was approximately 16 June 2014 (n = 177 broods), 5 days later than the 10-year average (Table 2). The distribution of estimated hatch dates for observed broods was relatively unimodal and normally distributed, which suggests that the late spring and heavy rains in June may not have been disruptive to nest incubation across the entire pheasant range. In fact, our survey data indicate that 22% of broods were estimated to have hatched in the 2-week time period after the heaviest of the June rainfall events. Estimated median age of observed broods was 8 weeks (range: 1-14 weeks), but successful late-season nests tend to be underrepresented in roadside data because very young chicks are hard to detect during surveys.

The modest increase in pheasant counts may be partially attributed to a less severe winter in the southern regions of the state. Winter conditions for pheasants are considered severe when the temperature is ≤0° F and snow cover exceeds 6 inches. The southern regions did not experience as prolonged of severe winter conditions compared to other regions of the state, and this likely helped reduce winter mortality, thereby allowing more hens to survive through spring. Further, two reproductive indices (broods/100 mi and broods/100 hens) increased in 2014, indicating that early-season nesting conditions were better than 2013. However, the lower chicks/brood index might suggest that chick survival was below normal due to the heavy rains in June. The slight delay in peak hatch likely helped improve chick survival during this period. Hens that are unsuccessful in hatching a clutch of eggs will persistently renest throughout the summer; historically, hens and chicks from late-season nests tend to be underrepresented in roadside survey data. Therefore, pheasant numbers will be greater than forecasted if these hens and their chicks were underrepresented in the 2014 surveys. Projecting from the roadside index, an estimated 224,000 roosters may be harvested this fall (Figure 2A). The best opportunity for harvesting pheasants appears to be in the Southwest, South Central, and West Central regions of Minnesota during fall/winter 2014.

GRAY PARTRIDGE

Range-wide, the gray partridge index (0.9 birds/100 mi) decreased 16% compared to 2013 and remained well below the 10-year and long-term averages (-81% and -93%, respectively; Table 2, Figure 3B). The partridge index ranged from 0.0 birds/100 mi in the Southeast, East Central, and Northwest regions to 3.6 birds/100 mi in the South Central region (Table 3). Similar to 2013, observations of gray partridge broods (n = 2 broods statewide) were too few for analysis by age class.

Conversion of diversified agricultural practices (e.g., haylands, pastures, small grains, and hedgerows) to more intense land-use (e.g., corn and soybeans) has reduced the amount of suitable habitat for the gray partridge in Minnesota. Gray partridge in their native range (southeastern Europe and northern Asia) are associated with arid climates and their reproductive success is limited in the Midwest except during successive dry or drought years. Consequently, gray partridge are more adversely affected by heavy precipitation during nesting and brood rearing than are pheasants. The South Central and Southwest regions will offer the best opportunity for harvesting gray partridge in 2014.

COTTONTAIL RABBIT and WHITE-TAILED JACKRABBIT

The eastern cottontail rabbit index (5.2 rabbits/100 mi) was 11% greater than last year, but 5% below the 10-year average and 12% below the long-term average (Table 2; Figure 4A). The cottontail rabbit index ranged from 0.4 rabbits/100 mi in the Northwest to 11.2 rabbits/100 mi in the Southeast (Table 3). The Southeast, South Central, Southwest, and East Central regions will provide the best opportunities for harvesting cottontail rabbits.

The index of white-tailed jackrabbits (0.1 rabbits/100 mi) remains at a historic low (94% below the long-term average of 1.7 rabbits/100 mi). The range-wide jackrabbit population peaked in the late 1950s and declined to low levels in the 1980s (Figure 4B). The long-term decline in jackrabbits reflects the loss of their preferred habitats (i.e., pasture, hayfields, and small grains). The greatest potential for white-tailed jackrabbit hunting is likely in the Southwest region (Table 3). However, indices of relative abundance and annual percent change should be interpreted cautiously because estimates are based on a small number of jackrabbit sightings.

WHITE-TAILED DEER

The index for white-tailed deer (20.8 deer/100 mi) was similar to 2013, 34% above the 10-year average, and 109% above the long-term average (Table 2, Figure 5A). Roadside indices for deer ranged from 5.5 deer/100 mi in the South Central region to 45.9 deer/100 mi in the Northwest (Table 3).

MOURNING DOVE

The number of mourning doves observed (169.5 doves/100 mi) in 2014 was similar to 2013, 24% below the 10-year average (211.3 doves/100 mi), and 36% below the long-term average (271.2 doves/100 mi; Table 2, Figure 5B). The mourning dove index ranged from 68.7 doves/100 mi in the Southeast to 335.6 doves/100 mi in the Southwest region (Table 3).

The U.S. Fish and Wildlife Service conducted call-count surveys (CCS) for mourning doves from 1966-2013 to obtain annual indices of abundance but discontinued these surveys in 2014. Trend analyses indicated the number of mourning doves detected along CCS routes (n = 13) in Minnesota declined 1.6% per year (95% CI: -3.7 to 0.3%) during 2004-2013 and declined 1.5% per year (95% CI: -2.2 to -0.7%)

during 1966-2013 (Seamans et al. 2013). The North American Breeding Bird Survey (BBS), completed in June each year, provides additional independent estimates of trends in mourning dove abundance. Analysis of BBS trend data for Minnesota indicates that mourning doves declined 1.8% (95% CI: -3.2 to -0.5%; n = 71) during 2004-2013 and declined 1.1% (95% CI: -1.6 to -0.7%; n = 77) during 1966-2013 (Seamans and Sanders 2014).

SANDHILL CRANE

Range-wide indices of sandhill cranes averaged 8.9 total cranes/100 mi and 1.3 juvenile cranes/100 mi in 2014, representing a 13% decrease in total cranes but a 17% increase in juvenile cranes compared to 2013 (Table 2). Indices ranged from 0.0 total cranes/100 mi in the Southwest and Southeast regions to 43.2 total cranes/100 mi in the East Central region (Table 3). Juvenile cranes were observed in the Northwest (3.8 juveniles/100 mi), Central (1.5 juveniles/100 mi), East Central (7.3 juveniles/100 mi), and South Central (0.4 juveniles/100 mi) regions. Overall, regional indices for the total number of cranes increased in the Northwest region (32% increase), remained the same in the Southwest and South Central regions, and decreased in all other regions (range: -7 to -100%).

OTHER SPECIES

Other notable wildlife sightings included: American badger (Brown County), black-crowned night heron (LeSueur County), black-billed cuckoo (Polk County), black-billed magpie (Polk County), greater yellowlegs (Murray County), northern harrier (Norman County), belted kingfisher (Renville County), loggerhead shrike (Dakota County), meadowlark spp. (Goodhue, Redwood, Renville, and Wabasha Counties), merlin (Goodhue County), greater prairie-chicken (Clay and Norman Counties), red-headed woodpecker (Big Stone, Olmsted, Redwood, and Sibley Counties), red fox (Yellow Medicine County), striped skunk (Norman, Pipestone, and Rice Counties), sharp-tailed grouse (Polk County), trumpeter swan (Brown and Washington Counties), upland sandpiper (Mower and Redwood Counties), and western kingbird (Polk County). Wild turkeys, including poults, were recorded in 13 counties.

LITERATURE CITED

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Table 1. Abundance (total acres) and density (acres/mi^2) of undisturbed grassland habitat within Minnesota's pheasant range, 2014[a].

	Cropland Retirement									Density
AGREG	CRP	CREP	RIM	RIM-WRP	WRP	USFWS[c]	MNDNR[d]	Total	%	ac/mi^2
WC[b]	271,295	37,670	19,739	12,747	19,576	190,345	109,473	660,845	9.7	62.2
SW	91,817	24,763	16,076	1,777	661	20,751	60,116	215,960	5.7	36.5
C	123,263	14,325	27,609	5,771	3,069	88,941	48,634	311,612	5.2	33.0
SC	83,938	27,656	11,722	8,637	9,165	9,086	33,768	183,972	4.6	29.1
SE	59,553	2,706	6,968	661	995	36,731	53,574	161,187	4.3	27.8
EC	3,343	0	1,132	0	4	4,994	90,557	100,030	3.1	19.9
Total	633,208	107,120	83,246	29,592	33,470	350,848	396,122	1,633,606	5.9	37.9

a. Unpublished data, Tabor Hoek, BWSR, 1 August 2014.

b. Does not include Norman County.

c. Includes Waterfowl Production Areas (WPA) and USFWS refuges.

d. MNDNR Wildlife Management Areas (WMA).

Table 2. Range-wide trends (% change) in number of wildlife observed per 100 miles driven, Minnesota August roadside survey, 1955-2014.

Species	Change from 2013[a]					Change from 10-year average[b]				Change from long-term average[c]			
Subgroup	*n*	2013	2014	%	95% CI	*n*	2004-13	%	95% CI	*n*	LTA	%	95% CI
Ring-necked pheasant													
Total pheasants	149	27.2	28.7	6	±26	148	68.0	-58	±12	149	97.9	-71	±8
Cocks	149	5.1	4.6	-11	±23	148	8.1	-44	±12	149	11.1	-59	±10
Hens	149	3.5	4.1	18	±29	148	10.6	-61	±13	149	14.2	-71	±8
Broods	149	3.4	4.4	28	±31	148	10.6	-58	±11	149	12.9	-66	±8
Chicks per brood	177	5.4	4.6	-15			4.7	-2			5.5	-16	
Broods per 100 hens	177	98.5	101.7	3.3			99.3	2			101.3	0.4	
Median hatch date	177	Jun 20	Jun 16				Jun 11						
Gray partridge	168	1.1	0.9	-16	±112	167	4.7	-81	±31	149	15.2	-93	±16
Eastern cottontail	168	4.7	5.2	11	±27	167	5.5	-5	±19	149	6.6	-12	±18
White-tailed jackrabbit	168	0.1	0.1	0	±137	167	0.2	-51	±55	149	1.7	-94	±15
White-tailed deer	168	20.9	20.8	-1	±16	167	15.6	34	±16	168	9.9	109	±31
Mourning dove	168	169.5	160.4	-5	±15	167	211.3	-24	±10	149	271.2	-36	±10
Sandhill crane													
Total cranes	168	10.2	8.9	-13	±36								
Juveniles	168	1.1	1.3	17	±60								

[a] Includes Northwest region, except for pheasants. Estimates based on routes (*n*) surveyed in both years.

[b] Includes Northwest region, except for pheasants. Estimates based on routes (*n*) surveyed at least 9 of 10 years.

[c] LTA = 1955-2013, except for deer = 1974-2013. Estimates for all species except deer based on routes (*n*) surveyed ≥40 years; estimates for deer based on routes surveyed ≥25 years. Thus, Northwest region (8 counties in Northwest were added to survey in 1982) included only for deer.

Table 3. Regional trends (% change) in number of wildlife observed per 100 miles driven, Minnesota August roadside survey, 1955-2014.

Region	Change from 2013[a]					Change from 10-year average[b]				Change from long-term average[c]			
Species	*n*	2013	2014	%	95% CI	*n*	2004-13	%	95% CI	*n*	LTA	%	95% CI
Northwest[d]													
Gray partridge	19	0.0	0.0			19	0.6	-100	±93	19	3.4	-100	±67
Eastern cottontail		0.6	0.4	-33	±124		0.8	-44	±58		0.8	-48	±70
White-tailed jackrabbit		0.2	0.2	0	±305		0.4	-40	±153		0.6	-67	±88
White-tailed deer		36.6	45.9	25	±38		43.6	5	±22		29.8	54	±55
Mourning dove		102.4	78.3	-24	±77		84.9	-8	±45		120.7	-35	±29
Sandhill crane		22.7	29.9	32	±69								
West Central[e]													
Ring-necked pheasant	36	30.0	28.4	-5	±55	35	74.8	-61	±24	37	99.1	-72	±16
Gray partridge		0.0	0.3				1.0	-64	±112		9.7	-97	±22
Eastern cottontail		1.7	2.8	66	±90		2.8	2	±52		4.0	-32	±38
White-tailed jackrabbit		0.0	0.2				0.3	-21	±169		2.3	-91	±27
White-tailed deer		20.9	24.4	17	±42		14.1	79	±56		9.3	158	±89
Mourning dove		211.8	177.2	-16	±23		248.3	-30	±18		371.2	-52	±13
Sandhill crane		1.4	1.0	-31	±66								
Central													
Ring-necked pheasant	30	20.7	20.4	-1	±58	30	56.8	-64	±24	29	73.3	-71	±14
Gray partridge		0.1	0.3	100	±464		1.9	-86	±82		9.4	-97	±45
Eastern cottontail		2.9	1.9	-36	±77		5.5	-66	±41		6.3	-69	±26
White-tailed jackrabbit		0.1	0.0	-100	±205		0.1	-100	±103		1.2	-100	±22
White-tailed deer		18.1	14.4	-21	±41		9.3	54	±62		5.2	183	±127
Mourning dove		129.9	105.8	-19	±36		193.5	-45	±18		232.3	-54	±19
Sandhill crane		20.4	10.8	-47	±84								
East Central													
Ring-necked pheasant	12	30.6	20.4	-33	±81	12	59.8	-66	±31	12	91.2	-78	±19
Gray partridge		0.0	0.0				0.0	-100	±220		0.2	-100	±148
Eastern cottontail		9.0	7.0	-23	±95		10.8	-36	±43		9.0	-23	±65
White-tailed jackrabbit		0.0	0.0				0.0				0.2	-100	±71
White-tailed deer		27.6	22.2	-20	±42		17.2	30	±58		9.4	137	±99
Mourning dove		83.8	78.4	-7	±61		100.7	-22	±39		119.6	-34	±37
Sandhill crane		46.3	43.2	-7	±43								

Table 3. Continued.

Region / Species	Change from 2013					Change from 10-year average				Change from long-term average			
	n	2013	2014	%	95% CI	*n*	2004-13	%	95% CI	*n*	LTA	%	95% CI
Southwest													
Ring-necked pheasant	19	50.7	62.1	22	±56	19	131.4	-53	±31	19	115.4	-46	±23
Gray partridge		3.6	0.8	-77	±157		16.5	-95	±29		40.4	-98	±16
Eastern cottontail		5.3	7.6	44	±88		6.4	18	±56		8.0	-5	±51
White-tailed jackrabbit		0.2	0.4	100	±371		0.7	-43	±80		3.7	-89	±24
White-tailed deer		28.4	23.4	-18	±41		16.0	46	±47		9.1	158	±80
Mourning dove		245.9	335.6	37	±48		307.2	9	±31		310.0	8	±33
Sandhill crane		0.0	0.0										
South Central													
Ring-necked pheasant	32	27.1	31.6	17	±67	32	68.4	-54	±23	32	127.7	-75	±13
Gray partridge		3.3	3.6	12	±173		8.2	-56	±69		18.5	-80	±27
Eastern cottontail		9.5	8.1	-15	±30		8.2	-0.4	±25		7.6	7	±29
White-tailed jackrabbit		0.3	0.0	-100	±142		0.2	-100	±68		1.7	-100	±25
White-tailed deer		10.6	5.5	-48	±43		5.8	-5	±45		3.7	49	±70
Mourning dove		230.2	225.8	-2	±36		274.7	-18	±23		257.9	-13	±27
Sandhill crane		1.6	1.6	0	±141								
Southeast													
Ring-necked pheasant	20	7.4	10.4	40	±93	20	16.9	-38	±45	20	70.8	-85	±30
Gray partridge		0.2	0.0	-100	±209		5.0	-100	±78		13.6	-100	±32
Eastern cottontail		5.8	11.2	93	±109		6.4	74	±76		7.7	46	±70
White-tailed jackrabbit		0.0	0.0				0.1	-100	±122		0.6	-100	±42
White-tailed deer		15.7	21.0	34	±56		15.5	35	±34		10.3	104	±64
Mourning dove		98.7	68.7	-30	±29		166.6	-59	±23		218.1	-69	±22
Sandhill crane		0.4	0.0	-100	±209								

[a] Based on routes (*n*) surveyed in both years.

[b] Based on routes (*n*) surveyed at least 9 of 10 years.

[c] LTA = 1955-2013, except for Northwest region (1982-2013) and white-tailed deer (1974-2013). Estimates based on routes (*n*) surveyed ≥40 years (1955-2013), except for Northwest (≥20 years) and white-tailed deer (≥25 years).

[d] Eight Northwestern counties (19 routes) were added to the August roadside survey in 1982.

[e] Two routes were added to the West Central region in 2014.

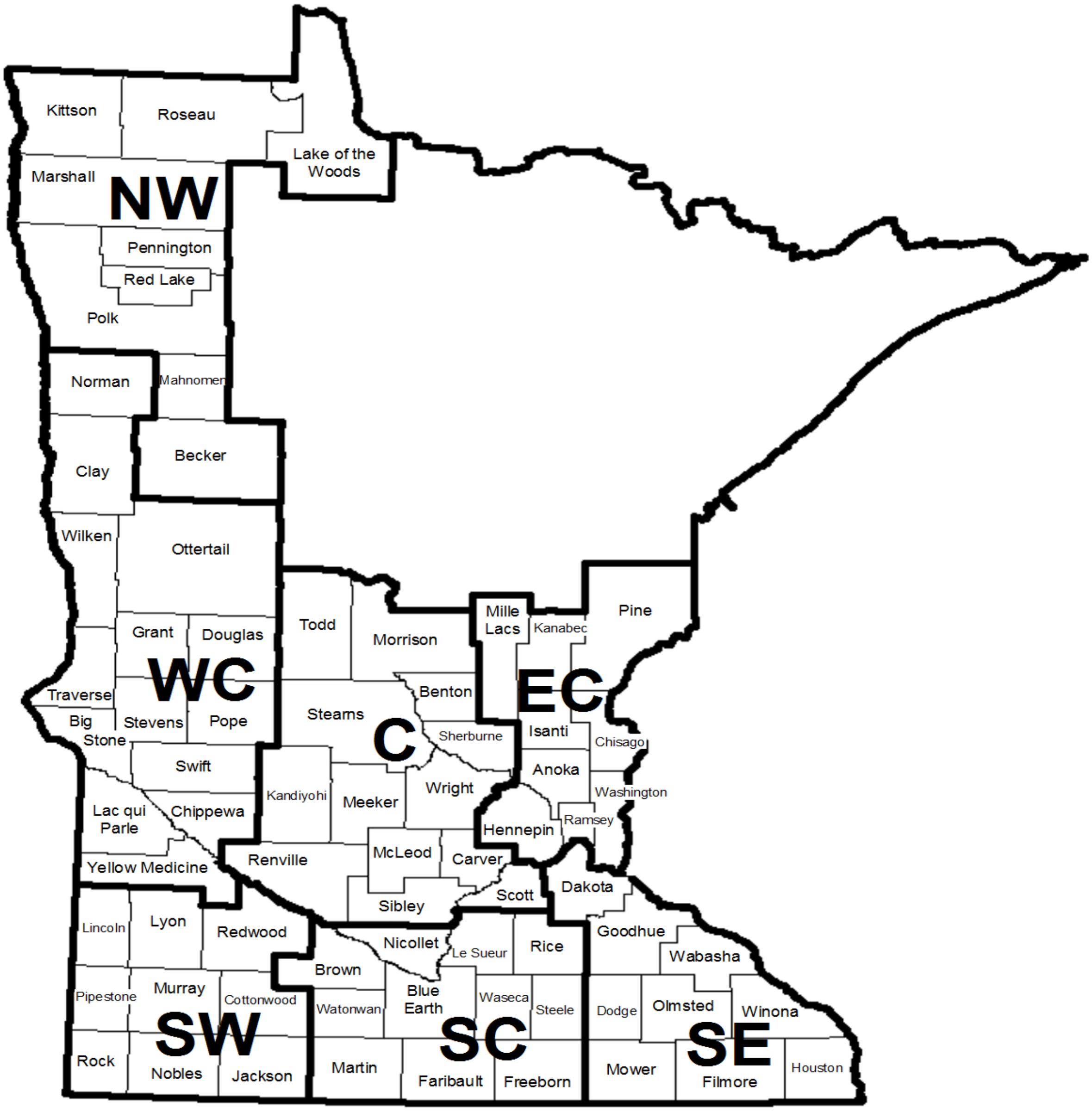


Figure 1. Survey regions for Minnesota's August roadside survey, 2014.

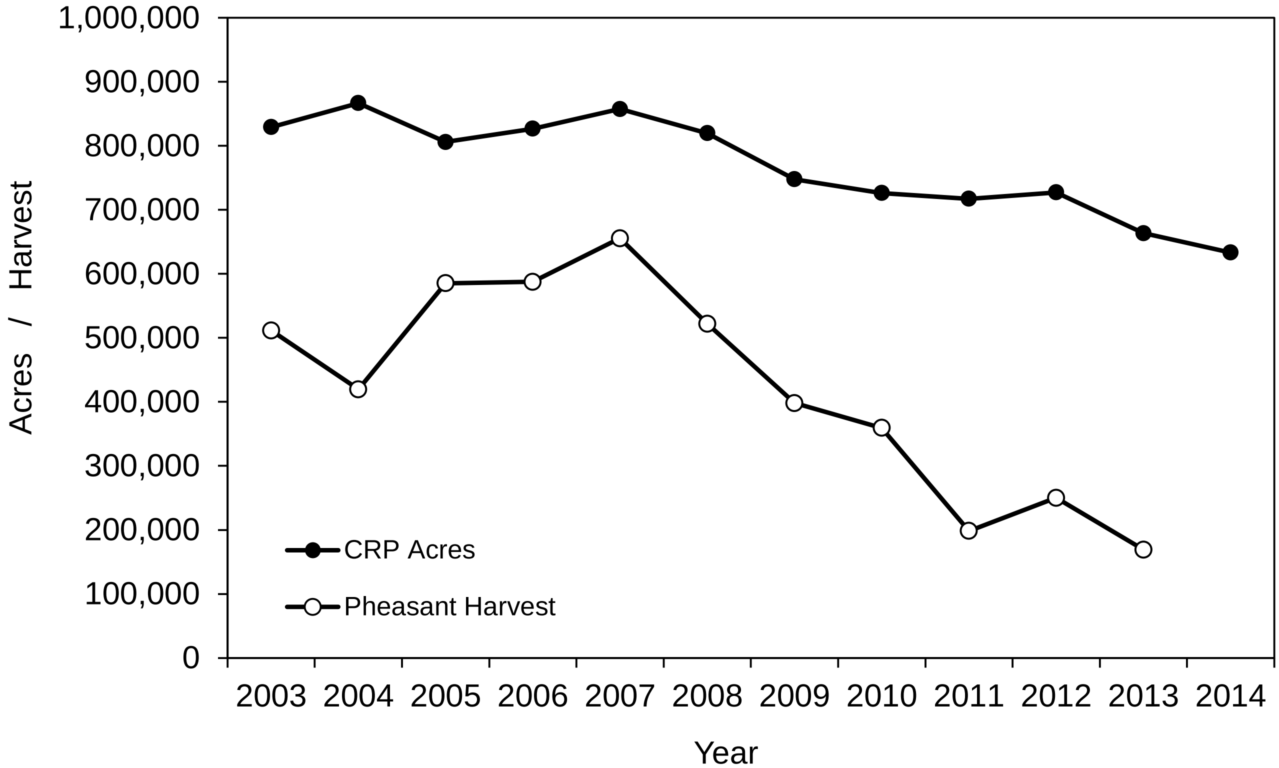
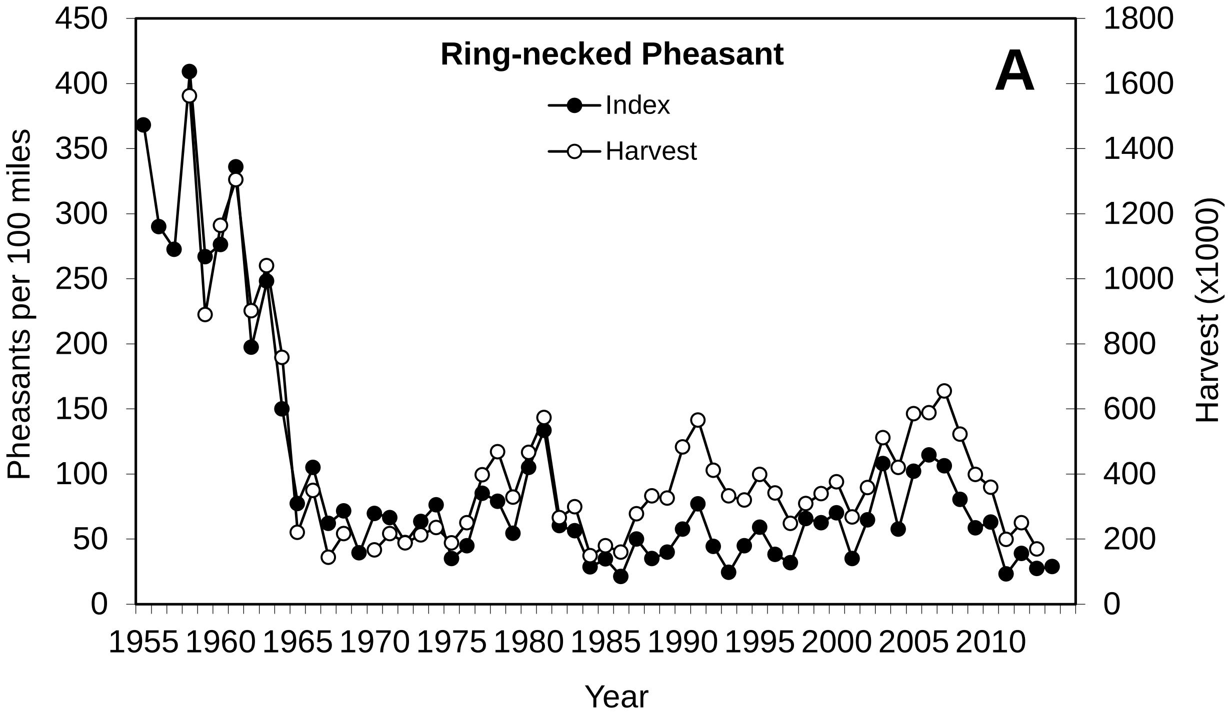


Figure 2. Acres enrolled in the Conservation Reserve Program (CRP) vs. ring-necked pheasant harvest trends in Minnesota, 2003-2014. CRP acres are calculated for the pheasant range only.



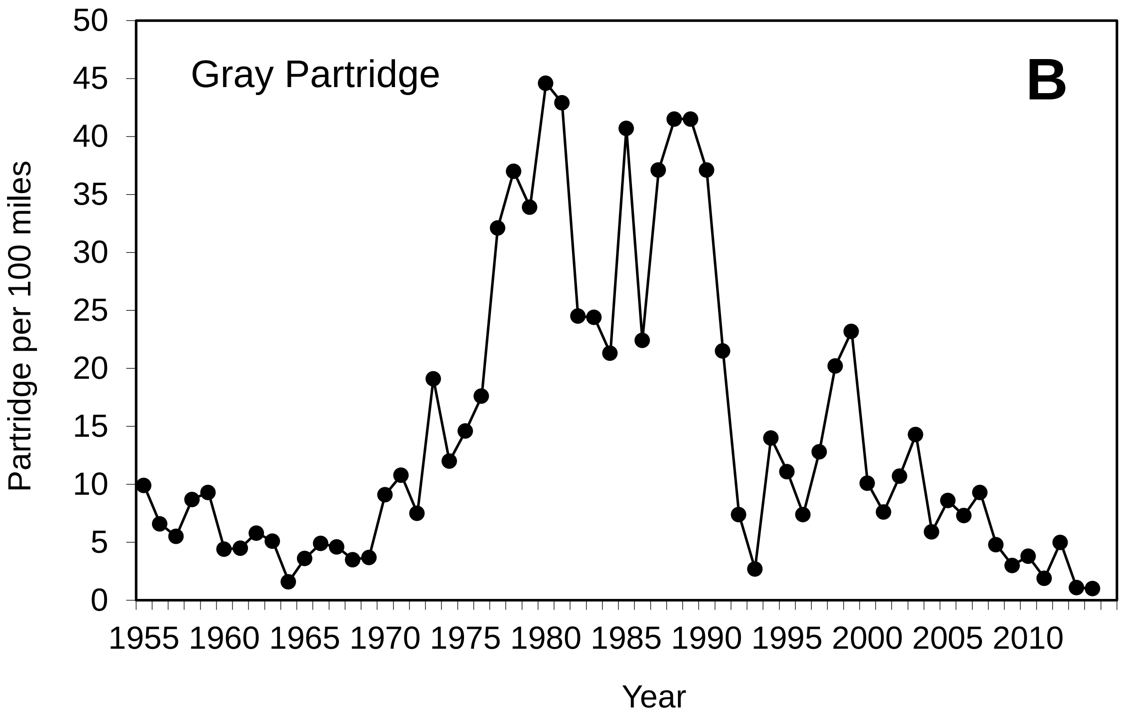


Figure 3. Range-wide index of ring-necked pheasants (**A**) and gray partridge (**B**) seen per 100 miles driven in Minnesota, 1955-2014. Does not include the Northwest region. Based on all survey routes completed.

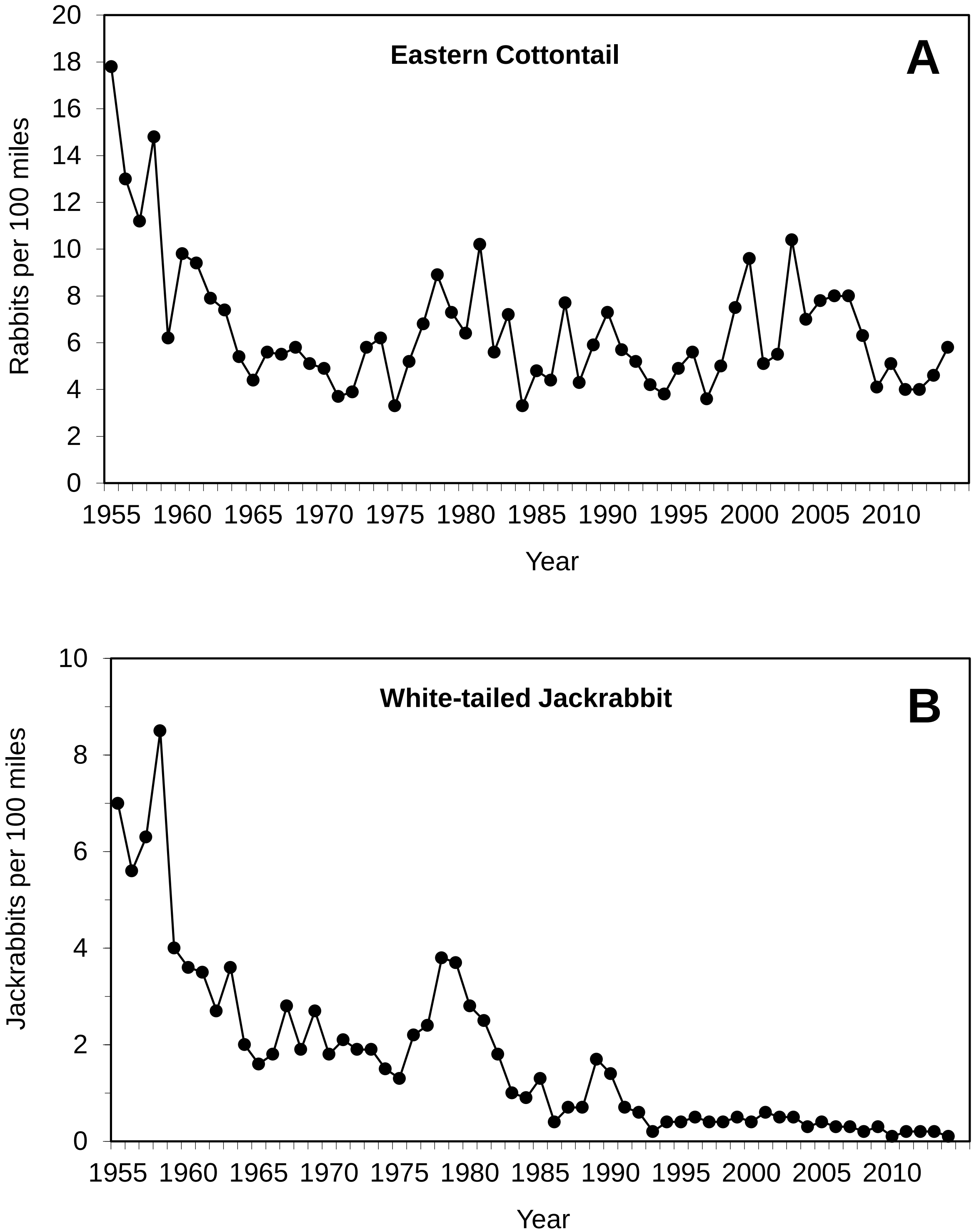
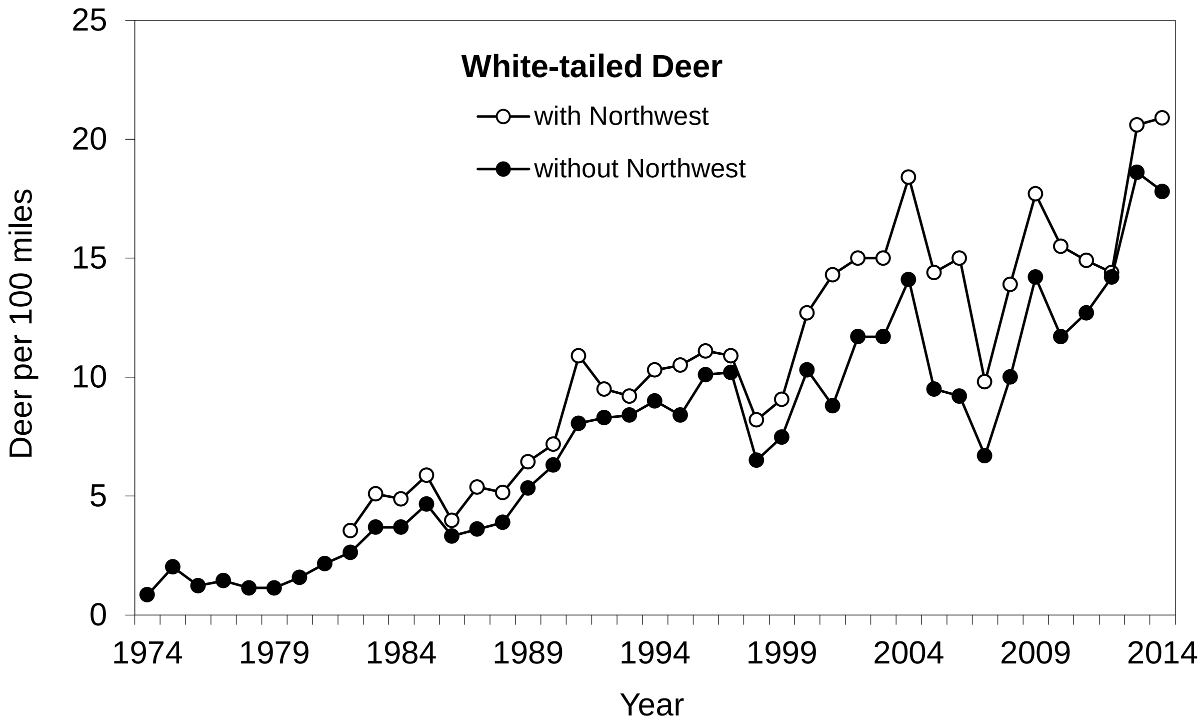


Figure 4. Range-wide index of eastern cottontail (**A**) and white-tailed jackrabbits (**B**) seen per 100 miles driven in Minnesota, 1955-2014. Does not include the Northwest region. Based on all survey routes completed.



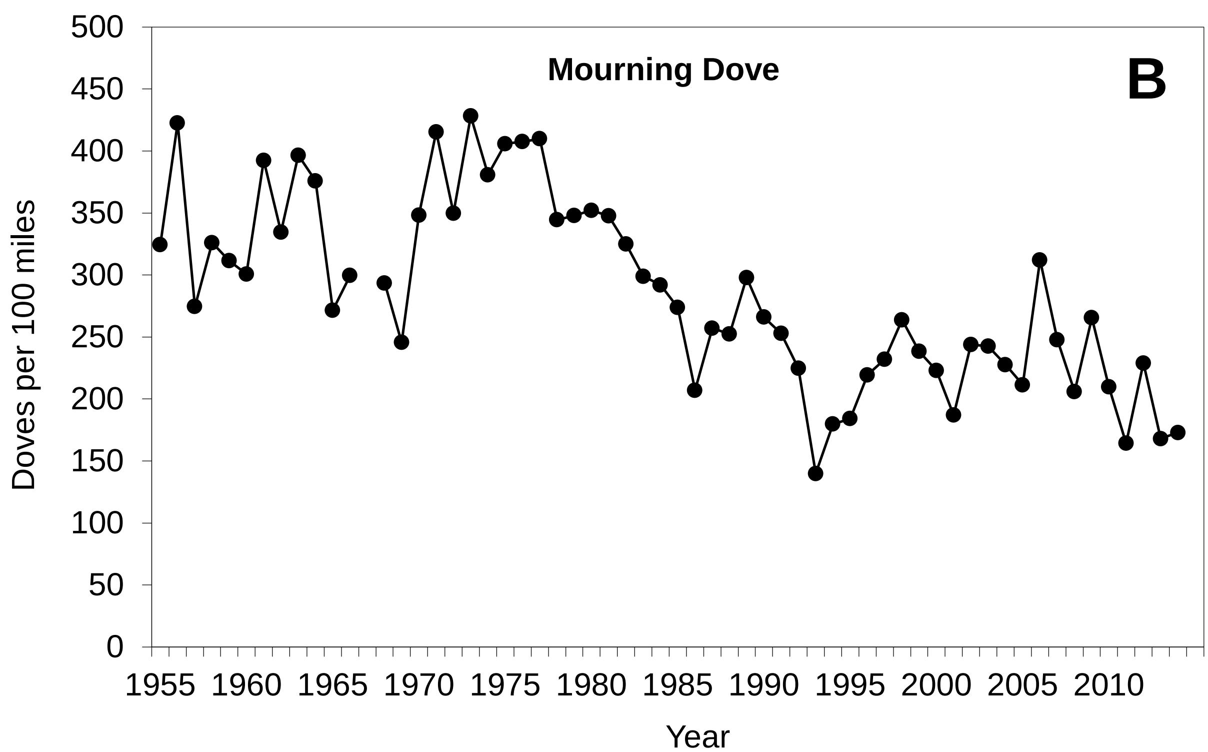


Figure 5. Range-wide index of white-tailed deer (**A**) and mourning doves (**B**) seen per 100 miles driven in Minnesota, 2014. Doves were not counted in 1967 and the dove index does not include the Northwest region. Based on all survey routes completed.

MONITORING POPULATION TRENDS OF WHITE-TAILED DEER IN MINNESOTA - 2014

Marrett Grund, Farmland Wildlife Populations and Research Group

INTRODUCTION

White-tailed deer (*Odocoileus virginianus*) represent one of the most important big game mammals in Minnesota. Although viewed as being important by both hunters and non-hunters, deer also pose serious socioeconomic and ecological challenges for wildlife managers, such as deer-vehicle collisions, crop depredation, and forest regeneration issues. Thus, monitoring the status of deer populations is critical to determine appropriate harvest levels based on established management goals.

This document 1) describes the structure of and data inputs for the population model used on white-tailed deer in Minnesota, and 2) discusses general trends of deer density and current abundance.

METHODS

I arbitrarily pooled deer permit areas (DPAs) into 12 geographic units to describe population and harvest trends and management issues at a broader scale (Fig. 1). Several management strategies were available in 2013 including: 1) lottery with varying number of antlerless permits, 2) hunter's choice where hunters could hunt either-sex, 3) managed, 4) intensive, and 5) no limit antlerless. The strategy employed during a given year depended upon where the population trend was in relation to the population goal. Some DPAs were not modeled due to light harvest pressure and/or due to having small population sizes which causes stochastic error (Grund and Woolf 2004).

Population Modeling

The population model used to analyze past population trends and test harvest strategies can be best described as an accounting procedure that subtracts losses, adds gains, and keeps a running total of the number of animals alive in various sex-age classes during successive periods of the annual cycle. The deer population was partitioned into 4 sex-age classes (fawns, adults, males, and females). The 12-month annual cycle was divided into 4 periods representing important biological events in the deer's life (hunting season, winter, reproduction, and summer). The primary purposes of the population model were to 1) organize and synthesize data on deer populations, 2) advance the understanding of Minnesota's deer population through population analysis, 3) provide population estimates and simulate vital rates for deer populations, and 4) assist with management efforts through simulations, projections, and predictions of different management prescriptions.

The 3 most important parameters within the model reflect the aforementioned biological events, which include reproduction, harvest, and non-hunting mortality. Fertility rates were typically estimated at the regional level via fetal surveys conducted each spring (for details, see Dunbar 2005). Fertility rates were then used to estimate population reproductive rates for each deer herd within a particular region. The deer population increased in size after reproduction was simulated. Non-hunting mortality rates occurring during summer months (prior to the hunting season) were estimated from field studies conducted in Minnesota and other agricultural and forested regions. Although summer mortality rates were low, they did represent a reduction in the annual deer population. Previous research suggests virtually all mortality occurring during the year can be attributed to hunter harvests. Annual harvests were simulated in the model by subtracting the numerical harvest (adjusted for crippling and non-registered deer) from the pre-hunt population for each respective sex-age class. Because these modeled deer herds are heavily exploited by deer hunters, the numerical harvest data "drive" the population model by substantially reducing the size of the deer herd (Grund and Woolf 2004). Winter mortality rates were estimated from field studies conducted in Minnesota and other Midwest regions, similar to summer mortality. After winter mortality rates were simulated, the population was at its lowest point during the 12-month period and the annual cycle began again with reproduction.

RESULTS

Population Trends and Population Management

Northwest Management Units

Karlstad Unit – Deer numbers have moderately declined over the past 5 years in this unit and most populations are near goal (Table 1). Deer populations immediately to the west of PA 101 were well below goal due to prior TB management efforts, but management strategies have been more conservative over the past few years to allow populations to increase.

Crookston/TRF Unit – Deer densities have slightly declined in several areas, but population trends are relatively stable throughout the unit. Harvest sex ratios were heavily skewed toward antlerless deer from 2005 through 2011 to bring deer numbers down. However, these ratios have stabilized over the past few years suggesting that deer numbers are stabilizing.

Mahnomen Unit – Population trends in most areas are relatively stable, modeling indicates deer numbers have moderately declined in DPA 265 and buck harvest trends declined in a similar fashion. In other DPAs, however, modeling suggests fairly stable deer densities and harvest trends and harvest sex ratios agree with that pattern.

Central Management Units

Morris Unit – Population trends over the past 5-10 years have been stable, but deer numbers have significantly declined since the mid-90s in many permit areas. Harvest trends over the past 5-10 years are relatively stable as well, indicating the modeled trends throughout the unit likely reflect the true population dynamics between years in these areas.

Osakis Unit – Population trends have been stable in most DPAs over the past 5-10 years, but population trends in DPA 240 suggest a declining population and the harvest trends agree with that assessment. However, harvest sex ratios in the past two years are indicative of population increases, so I would expect trends to increase over the next few years in DPA 240.

Cambridge Unit – Modeled trends and harvest trends both indicate deer numbers have been relatively stable over the past 5-10 years in most DPAs. The exception is DPA 223 where modeled trends have increased approximately 45% over the past 5 years and harvest trends have increased 30-35% over the past 5 years, these percentages are indicative of a substantial population increase.

Hutchinson Unit – Modeled trends and harvest trends suggest deer populations have been relatively stable in the southern DPAs in this unit, but the same trends suggest increasing deer densities in the northern DPAs over the past 5-10 years. Permit Area 284 was slow to respond to the conservative management strategies around 2005-2007, but trends suggest deer numbers have increase over the past 5 years.

Southern Management Units

Minnesota River Unit – Modeled trends and harvest trends both indicate that populations in these DPAs have been relatively stable over the past 5-10 years despite using relatively conservative management strategies. The eastern DPAs show slightly better patterns for an increasing deer population, but not significant increases as observed in some DPAs in other units.

Slayton Unit – Modeled deer densities are relatively low in southwestern Minnesota due to limited woody cover. Modeled trends and harvest trends are slowly increasing in some areas over the past 5 years, but in other areas those trends are relatively flat indicating a relatively stable deer population. Management strategies have been very conservative over the past 5-7 years, so it is noteworthy that the trends are not increasing at a faster rate.

Waseca Unit – Modeled trends and harvest trends suggest deer populations have been stable over the past 5-10 years. Modeled densities are higher to the eastern side of the unit where there is more woody cover available. Trends in those DPAs suggest stable to slightly increasing deer numbers over the past few years.

Rochester Unit – Modeled trends suggest relatively stable populations throughout most DPAs in this unit. Harvest trends are difficult to interpret due to the antler-point restriction that has been in effect since 2010. Permit areas 346 and 349 are perhaps the two most concerning DPAs in Minnesota this year. These areas were surveyed last winter and both DPAs had population estimates where the lower boundary of the confidence interval was nearly 30 deer per square mile.

Forest Unit – Deer populations in the forest zone have changed remarkably over the past 10 years. Deer densities and numeric harvests were high from 2004 through 2007 then deer numbers declined in most DPAs from 2007 through 2009. Short-term trends in modeled deer densities and numeric harvest trends indicated that 15 of the 36 modeled DPAs have populations that continued to decline from 2009 through 2014, primarily in more northern DPAs where winter severity indices were relatively extreme during the previous two winters. The more conservative harvest management strategies used throughout the forest zone used in 2012 and 2013 have helped offset the population declines, but winter mortality rates were very high and significantly reduced deer numbers from 2009 through 2014. Some of the most notable DPAs that have declining modeled and harvest trends from 2009 through 2014 include DPAs 110, 111, 122, 126, 177, 178, 180, 181, 197 and 298. Trends in modeled deer densities and numeric harvests were relatively stable from 2009 through 2014 in most southern forest zone DPAs (south of Park Rapids and Duluth). No modeled forest zone DPAs had trends that suggested an increasing deer population from 2009 through 2014.

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Figure 1. Deer management units in Minnesota, 2014.

Table 1. Pre-fawn deer density (deer/mi^2) as simulated from population modeling in each permit area in Minnesota, 2009-2014.

Region		**Pre-fawning Density**					
Permit Area	**Area (mi^2)**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Karlstad							
201	155	6	6	5	5	5	5
208	443	4	4	4	3	3	3
260	1249	4	3	2	2	2	2
263	512	5	5	4	4	4	4
264	669	7	6	5	6	6	6
267	472	4	3	3	3	2	2
268	230	9	8	7	7	6	5
Total	3,838	6	5	5	4	4	4
Crookston							
209	576	9	9	9	7	7	7
210	485	12	11	11	10	10	10
256	654	6	5	5	5	5	5
257	413	8	8	6	6	7	7
261	795	2	2	2	2	2	2
Total	3,053	7	6	6	6	7	7
Mahnomen							
262	677	2	2	2	2	2	2
265	494	10	10	10	9	8	7
266	617	6	5	4	4	4	4
297	438	2	3	3	2	3	3
Total	2,226	5	5	5	5	4	4

Morris							
269	651	2	2	2	2	2	2
270	749	2	2	2	2	2	2
271	634	2	3	3	2	3	3
272	531	2	2	2	2	2	2
273	575	5	4	4	4	5	5
274	360	3	4	3	3	3	3
275	766	4	5	4	3	3	4
276	544	4	4	4	3	4	4
282	779	1	1	1	1	2	2
Total	5,589	2	3	3	3	3	3
Osakis							
213	1058	12	13	10	11	12	14
214	557	19	19	19	19	19	19
215	702	10	10	10	10	10	10
239	924	9	10	8	9	9	9
240	642	17	17	13	14	14	15
Total	3,879	14	14	12	13	14	14
Cambridge							
221	642	13	13	13	13	13	13
222	412	16	16	16	16	16	15
223	376	9	9	10	10	12	13
225	619	16	16	15	14	15	14
227	472	13	14	13	13	14	14
229	287	6	7	6	6	7	8
236	374	16	15	14	15	15	16
Total	2,895	13	13	12	12	13	14

Hutchinson							
218	813	7	8	8	9	10	11
219	393	8	9	9	10	11	10
229	288	6	7	6	6	7	8
277	885	5	5	5	4	4	5
283	614	3	3	3	3	4	4
284	837	2	3	3	3	4	4
285	550	4	4	4	4	5	6
Total	4,380	5	6	5	5	6	7
Minnesota River							
278	397	6	7	6	5	6	7
281	575	4	4	4	3	4	5
290	662	3	4	4	4	5	5
291	806	4	5	4	4	5	5
Total	2,440	4	5	5	5	6	6
Slayton							
234	637	2	3	2	2	2	3
237	729	2	2	3	3	3	3
250	712	2	2	2	3	3	3
279	345	3	3	3	3	4	4
280	675	2	3	2	2	3	3
286	447	3	3	3	3	4	4
288	625	2	2	2	3	3	3
289	816	1	1	1	2	2	2
294	687	2	2	2	2	2	2
295	839	2	2	2	2	2	3
296	666	2	2	2	3	3	3
Total	7,178	2	2	2	3	3	3

Waseca							
230	453	3	4	4	4	4	4
232	377	4	4	4	5	5	5
233	390	4	4	4	4	4	4
252	715	2	2	2	3	3	3
253	974	2	2	2	2	3	3
254	931	3	3	3	3	3	3
255	774	3	3	3	3	4	4
292	481	8	9	8	9	10	10
293	506	7	8	8	8	8	8
299	386	4	5	4	4	5	5
Total	5,987	4	4	4	4	5	5
Rochester							
338	452	5	5	4	5	4	5
339	409	5	6	5	5	5	6
341	596	10	10	10	10	10	11
342	352	13	14	14	14	14	13
343	663	11	10	10	10	10	11
345	326	9	8	8	9	9	9
346	319	20	23	23	23	27	30
347	434	8	7	8	8	8	8
348	332	15	14	14	14	14	13
349	492	21	22	22	23	25	28
Total	4,564	12	12	11	11	11	13

Forest							
103	1824	5	5	4	4	4	4
105	932	12	11	9	9	8	7
108	1701	6	6	6	7	7	6
110	530	20	18	15	15	15	13
111	1440	4	3	3	3	3	3
118	1445	4	4	4	4	5	4
119	946	4	4	3	4	4	3
122	622	5	5	5	5	5	4
126	979	4	4	3	3	3	2
155	639	12	13	14	14	14	11
156	834	15	15	15	14	13	10
157	904	19	19	19	18	17	14
159	575	16	16	15	14	15	14
169	1202	9	9	9	9	9	7
171	729	9	9	10	10	10	9
172	786	13	13	13	13	13	12
173	617	9	9	9	10	10	9
176	1150	8	9	8	9	9	7
177	553	14	15	12	12	13	10
178	1325	16	16	14	13	13	10
179	939	15	15	14	14	13	10
180	999	8	7	7	6	6	5
181	746	15	15	12	11	11	9
183	675	11	11	11	11	12	9
184	1318	16	16	16	16	17	15
197	1343	7	7	5	5	6	5
241	1047	28	27	25	24	24	22
242	307	22	22	22	21	20	18

246	860	14	15	15	15	14	13
247	263	17	18	18	18	18	16
248	229	23	23	23	22	21	18
249	729	11	11	11	11	11	10
258	381	19	19	18	18	19	17
259	546	23	24	23	21	21	18
298	677	13	11	8	9	8	8
Total	32,907	11	11	11	10	10	9

2014 WHITE-TAILED DEER SURVEYS

Brian S. Haroldson, Farmland Wildlife Populations and Research Group

INTRODUCTION

Management goals for animal populations are frequently expressed in terms of population size (Lancia et al. 1994). Accurate estimates of animal abundance allow for documentation of population trends, provide the basis for setting harvest quotas (Miller et al. 1997), and permit assessment of population and habitat management programs (Storm et al. 1992).

The Minnesota Department of Natural Resources (MNDNR) uses simulation modeling within 125 permit areas (PA) to estimate and track changes in white-tailed deer (*Odocoileus virginianus*) abundance and, subsequently, to aid in developing harvest recommendations to manage deer populations toward goal levels. In general, model inputs include estimates of initial population size, and spatial and temporal estimates of survival and reproduction for various age and sex cohorts. Because simulated population estimates are subject to drift as model input errors accumulate over time, it is imperative to collect additional data to develop ancillary indices of changes in deer populations or to periodically recalibrate models with independent deer population estimates (Grund and Woolf 2004).

Our objective was to use aerial surveys by helicopter to provide independent estimates of deer abundance in select deer PAs that were within 20% of the true population size with 90% confidence (Lancia et al. 1994). Estimates within these bounds were used to recalibrate population models to improve population management.

METHODS

We estimated deer populations in selected PAs using a quadrat-based, aerial survey design. Quadrat surveys have been used to estimate populations of caribou (*Rangifer tarandus*; Siniff and Skoog 1964), moose (*Alces alces*; Evans et al. 1966), and mule deer (*O. heimonus*; Bartmann et al. 1986) in a variety of habitat types. Within each PA, quadrats were delineated by Public Land Survey section boundaries. In PAs with woody cover distributed uniformly across the landscape, we used a simple random sampling frame. In PAs with abundant woody cover and past survey data, we used regression trees (Fabrizi and Trivisano 2007, Fieberg and Lenarz 2012), the R programming language (R Core Team 2012), and R package ’stratification’ (Baillargeon and Rivest 2012) to stratify the sampling frame into 2 categories (low, high) based upon past helicopter counts of deer and abundance of woody cover within each quadrat. Woody cover data were derived from the 2006 National Land Cover database (Fry et al. 2011). In some PAs, an additional stratum was constructed to encompass State Park boundaries where applicable. We used optimal allocation, R package ‘spsurvey’ (Kincaid and Olsen 2012), and a generalized random tessellation stratified procedure (GRTS; Stevens and Olsen 2004) to draw spatially balanced simple or stratified random samples within each PA.
During all surveys, we used Bell OH-58 helicopters and attempted to maintain flight altitude at 60 m above ground level and airspeed at 64-80 km/hr. A pilot and 2 observers searched for deer along transects spaced at 270-m intervals until they were confident all “available” deer were

observed. When animals fled the helicopter, direction of movement was noted to avoid double counting. We used a real-time, moving-map software program (DNRSurvey; Wright et al. 2011), coupled to a global positioning system receiver and a convertible tablet computer, to guide transect navigation and record deer locations, direction of movement, and aircraft flight paths directly to ArcGIS (Environmental Systems Research Institute, Redlands, CA) shapefiles. To minimize visibility bias, we completed surveys during winter (December-March) when snow cover measured at least 15 cm and we varied survey intensity as a function of cover and deer numbers (Gasaway et al. 1986). We estimated deer abundance using R package 'spsurvey' (Kincaid and Olsen 2012). We evaluated precision using coefficient of variation (CV), defined as standard deviation of the population estimate divided by the population estimate, and relative error, defined as the 90% confidence interval bound divided by the population estimate (Krebs 1999).

We implemented double sampling (Eberhardt and Simmons 1987, Thompson 2002) on a subsample of quadrats in each PA to estimate sightability of deer from the helicopter. For each PA, we sorted the sample of survey quadrats by woody cover abundance, excluded quadrats likely to contain no deer (e.g., low stratum quadrats or quadrats where woody cover < 0.17 km^2), and selected a 4% systematic subsample of sightability quadrats. Immediately after completing the operational survey on each sightability quadrat, a second more intensive survey was flown at reduced speed (48-64 km/hr) to identify animals that were missed (but assumed available) on the first survey (Gasaway et al. 1986). We used geo-referenced deer locations, group size, and movement information from DNRSurvey (Wright et al. 2011) to "mark" deer (groups) observed in the operational survey and help estimate the number of "new" (missed) animals detected in the sightability survey. We used a binary logistic model to estimate average detection probabilities (i.e., the conditional probability of detection given animals are present in the sampling unit and available for detection) for each PA. We computed population estimates adjusted for both sampling and sightability.

RESULTS AND DISCUSSION

We completed 6 surveys during 2014 (Table 1). We utilized a simple random sample in PAs 221, 222, 239, and 346, whereas PAs 342 and 349 were stratified using the relationship between woody cover abundance per quadrat and historic deer density. In PAs 346 and 349, sampling rate exceeded 20% to incorporate additional quadrats within Great River Bluffs State Park and Beaver Creek Valley State Park, respectively. Deer density estimates ranged from 7-35 deer/mi^2 throughout all PAs and all estimates met precision goals (relative error $\leq$ 20%; Table 1). Deer were observed in 43-90% of sample quadrats in the 6 surveyed areas, with greater occupancy in PAs with more woody cover (Table 2). In addition, although mean group size was similar across all areas, mean number of groups per "occupied" quadrat varied nearly 2-fold (range = 4-7; Table 2) in all areas.

Estimates of sightability ranged from 0.633 (SE = 0.034) in PA 222 to 0.757 (SE = 0.017) in PA 349 and averaged 0.710 (SE = 0.018 Table 1), which were similar to sightability estimates during 2009-2013 (range = 0.655-0.909). Correcting for sightability increased relative variance (CV [%]) of population estimates by 3.5-16.9%, which was a reasonable tradeoff between decreased bias and increased variance, although costs associated with the sightability surveys are also important. However, we caution that our sightability estimates are conditional on animals being available for detection (Johnson 2008, Nichols et al. 2009). Unfortunately, like many other wildlife surveys, we have no estimates of availability or how it varies over space and time. Our approach also assumes that sightability is constant across animals and quadrats. Heterogeneity in detection probabilities can lead to biased estimates of abundance. Common methods for correcting for heterogeneous detection probabilities include distance sampling, mark-recapture methods, and logistic-regression sightability models (based on radio-marked animals). We did not have marked animals in our populations, and relatively high densities of deer in our survey areas would present serious logistical and statistical problems for distance-sampling and double-observer methods. Therefore, our double-sampling approach is a reasonable alternative to using unadjusted counts or applying more complicated methods whose assumptions are tenuous. Nevertheless, our "adjusted" population estimates must still be viewed as approximations to the truth.

ACKNOWLEDGEMENTS

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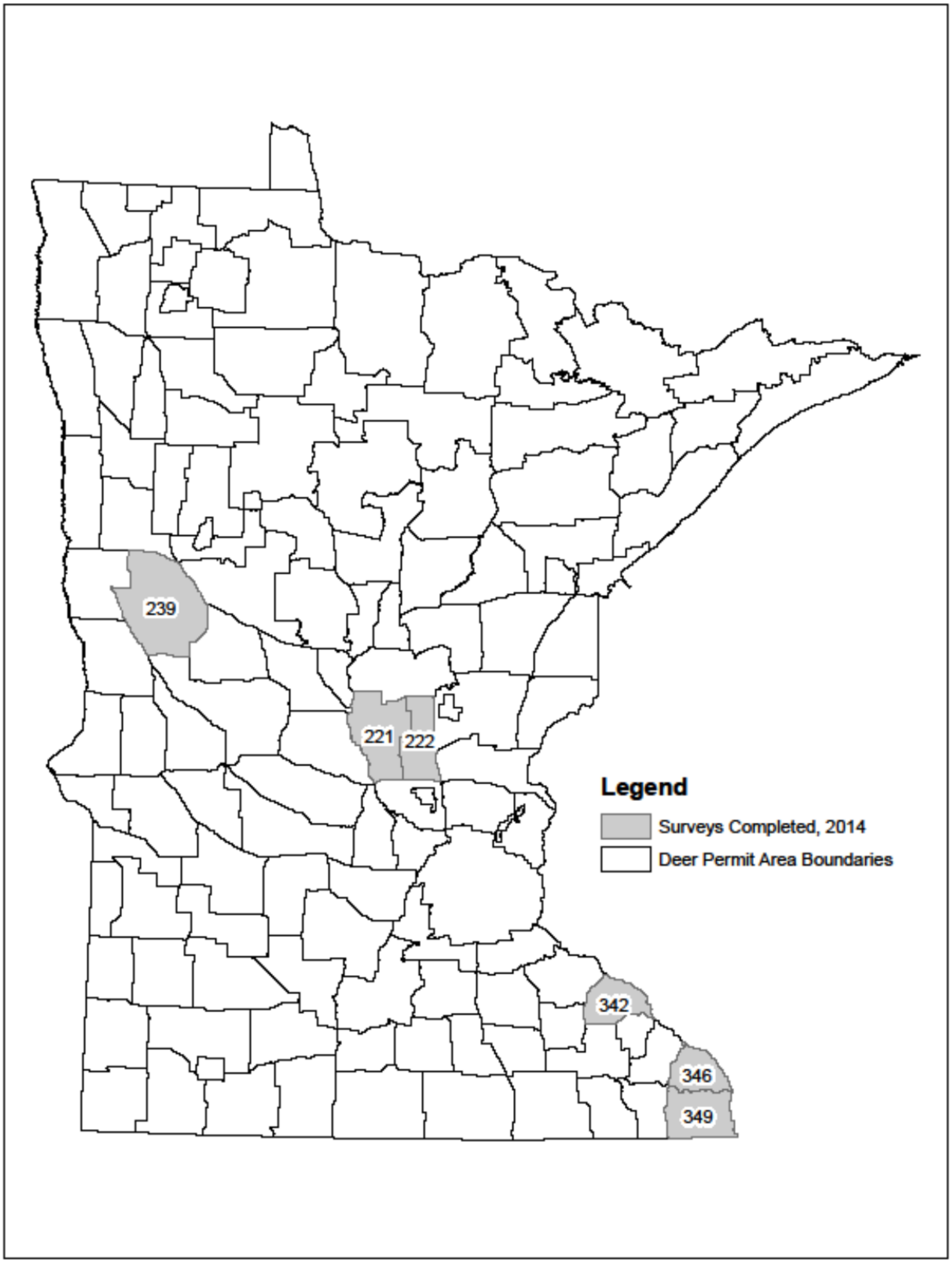

Figure 1. Aerial deer surveys completed in Minnesota, 2014.

Table 1. Deer population and density (deer/mi^2) estimates derived from aerial surveys in Minnesota, 2014.

Permit area	Sampling rate	Detection rate	Population estimate		CV (%)	Relative error (%)[a]	Density estimate	
			N	90% CI			Mean	90% CI
221	0.20	0.752	4,560	3,670 – 5,450	11.9	19.6	7	6 – 9
222	0.20	0.633	6,320	5,240 – 7,410	10.4	17.1	15	13 – 18
239	0.20	0.714	10,510	8,480 – 12,540	11.7	19.2	10	8 – 12
342	0.20	0.712	3,690	3,000 – 4,380	11.4	18.8	10	8 – 12
346[b]	0.24	0.693	11,550	9,820 – 13,280	9.1	15.0	35	30 – 41
349[c]	0.22	0.757	14,860	13,040 – 16,670	7.4	12.2	30	26 – 33

[a]Relative precision of population estimate. Calculated as 90% CI bound/*N*.
[b]Includes Great River Bluffs State Park.
[c]Includes Beaver Creek Valley State Park.

Table 2. Sampling metrics from aerial deer surveys in Minnesota, 2014.

Permit area	Total quadrats	Sample quadrats	Occupied quadrats[a]	Deer observed	Deer groups observed	Groups / occupied quadrat			Group size / occupied quadrat			Maximum quadrat count
						min	mean	max	min	mean	max	
221	635	127	55	686	199	1	4	10	1	3	32	46
222	418	84	60	803	263	1	4	13	1	3	21	45
239	1,050	210	94	1,500	353	1	4	20	1	4	35	115
342	366	74	48	670	173	1	4	10	1	4	22	66
346	327	80	72	1,937	519	1	7	18	1	4	46	121
349	500	112	95	2,831	678	1	7	19	1	4	33	103

[a]Number of quadrats with ≥1 deer observed.