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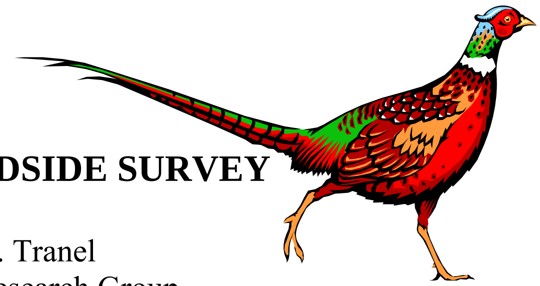

2009 MINNESOTA AUGUST ROADSIDE SURVEY

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ABSTRACT

This report is a summary of the 2009 Minnesota August roadside survey. Population indices for ring-necked pheasants and cottontail rabbits in 2009 declined from last year. Gray partridge and white-tailed jackrabbit indices were similar to 2008, whereas white-tailed deer and mourning dove indices increased significantly. Conservation Reserve Program (CRP) enrollment in Minnesota declined by 97,000 acres from 2008, including 72,000 acres from the pheasant range. The winter of 2008-09 was moderate to severe throughout much of Minnesota's agricultural zone. Spring weather was cooler and (except for the Northwest) drier than normal. One notable spring weather event was a 3-day period during June 7-9 (the normal peak of pheasant hatch in Minnesota) characterized by rain and high temperatures below 60^{o}F. Conditions for overwinter survival of farmland wildlife in 2009 were probably below average, but reproductive conditions were generally favorable in many areas except for 1 untimely weather event and significant loss of CRP grassland habitat.

The 2009 pheasant index (58.5 birds/100 mi) declined 27% from 2008 and was 27% below the 10-year average, 43% below the long-term average, and 78% below the benchmark years of 1955-64 (soil-bank years with marginal cropland in long-term set-aside, a diversified agricultural landscape, more small grains and tame hay, and less pesticide use). The 2009 hen pheasant index was significantly lower than last year and the 10-year average, which reflected reduced overwinter survival associated with the first moderately severe winter since 2001. The number of broods observed was 25% below last year, which reflected fewer hens available for nesting. Overall, the size of the fall population will be close to that in 2004, when 420,000 roosters were harvested. The best opportunity for harvesting pheasants appears to be in the Southwest region, although good opportunities will likely also be available in the West Central, Central, and South Central regions.

The gray partridge index was similar to last year, but 71% below the 10-year mean and 81% below the long-term average. Observed regional changes were not significant, but were based on small samples. Although most adults in 2009 were with broods, the number of adults and average brood size declined from last year and the 10-year average. Gray partridge counts were highest in the Southwest and South Central regions.

The cottontail rabbit index declined 42% from last year, 46% from the 10-year average, and 39% from the long-term average. Counts of cottontail rabbits were highest in the Southwest, South Central, Southeast and East Central regions. The jackrabbit index did not change significantly in 2009, but was 86% below the long-term average. The range-wide jackrabbit population peaked in the late 1950's and declined to its lowest level in 1993 (and again in 2008), from which populations have not recovered. Counts of white-tailed jackrabbits were highest in the Southwest region.

The number of mourning doves observed in 2009 increased 26% from last year, but was similar to the 10-year

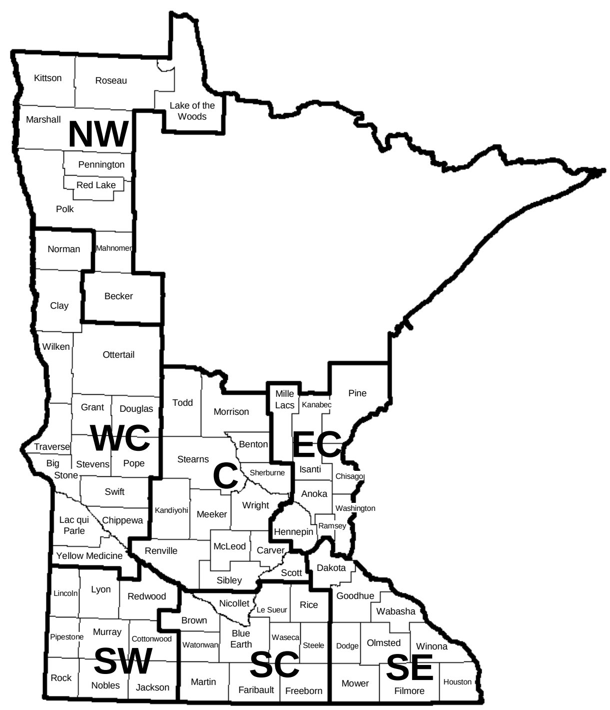

Figure 1. Survey regions for Minnesota's August roadside survey.

and long-term averages. Likewise, the white-tailed deer index increased by 30% from last year, with a significant regional increase in the Southwest.

INTRODUCTION

This report is a summary of the 2009 Minnesota August roadside survey. The annual survey is conducted during the first 2 weeks in August by Minnesota Department of Natural Resource (MNDNR) enforcement and wildlife personnel throughout the farmland region of Minnesota (Figure 1). The August roadside survey consists of 171 25-mile routes (1-4 routes/county); 152 routes are located in the ring-necked pheasant range.

Observers drove each route in the early morning at 15-20 miles/hour and recorded the number of pheasants, gray (Hungarian) partridge, cottontail rabbits, white-tailed jackrabbits, and other wildlife they saw. 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. The 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 were 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.

ACKNOWLEDGMENTS

We thank all cooperators for their efforts in completing routes in 2009; without their help the survey would not be possible. Tonya Klinkner provided assistance with data entry. John Giudice reviewed an early draft of this report. Tabor Hoek of the Minnesota Board of Water & Soil Resources (BWSR) provided enrollment data on cropland-retirement programs in Minnesota.

WEATHER SUMMARY

Winter severity, which is determined primarily by duration of snow cover, was moderate to severe throughout most of the farmland region in Minnesota during 2008-09 (the first moderately severe winter since 2001). Most of the farmland zone was snow covered during December – January. An early February thaw opened croplands in the southern agricultural regions and gave food-stressed birds a reprieve (Minnesota Climatology Working Group [MCWG], http://climate.umn.edu/doc/snowmap.htm). However, snow cover persisted through mid-March in the Central and East Central agricultural regions and through early April in the West Central and Northwest agricultural regions. Regional temperatures averaged 2.9ºF below the long-term average for each month, December - March (range +2ºF to -7ºF, MCWG, http://climate.umn.edu/cawap/monsum/monsum.asp). Below normal temperatures continued in all farmland regions from April – July. The spring nesting period was also drier than average in all agricultural regions except the Northwest. One notable spring weather event was a 3-day period during June 7-9 (the normal peak of pheasant hatch in Minnesota) characterized by rain and high temperatures below 60^{o}F. Thus, conditions for over-winter survival of farmland wildlife should have been below average throughout most of the farmland region (especially the Northwest and West Central agricultural regions), but reproductive conditions were generally favorable except for 1 untimely event.

HABITAT CONDITIONS

Conservation Reserve Program (CRP) enrollment in Minnesota’s pheasant range declined by nearly 72,000 acres from 2008, following a 38,000 acre loss the previous year. However, gains in Wetlands Reserve Program (WRP) enrollment and acquisitions of Wildlife Management Areas (WMA) and Waterfowl Production Areas (WPA) in the pheasant range partially offset CRP losses, yielding a net loss of about 64,000 acres of protected habitat since 2008. Habitat enrolled in farm programs (e.g., CRP, Conservation Reserve Enhancement Program, Reinvest In Minnesota, WRP) fell below 1 million acres in the pheasant range for the first time since 2004, whereas habitat protected as WMAs and WPAs grew to 676,000 acres. Within the pheasant range, protected grasslands account for about 5.9% of the landscape (range: 2.9-10.1%; Table 1).

Farm programs make up the largest portion of protected grasslands in the state. The expiration of a large proportion of existing CRP contracts is still a major concern for future wildlife populations, with nearly 63,000 acres in Minnesota scheduled to expire on September 30, 2009. However, interest is high in Minnesota's new CRP SAFE practice, and conservation interests have requested expansion of this popular program. The future of farmland retirement programs remains under threat due to continued high land rental rates and competing economic opportunities (e.g., ethanol production).

The MNDNR continues to expand the habitat base through accelerated WMA acquisition with 2,500 acres of new WMAs in the pheasant range in the last year. New funding from the Lessard-Sams Outdoor Heritage account is expected to further accelerate acquisition of WMAs and WPAs beginning in 2010. In addition, the Working Lands Initiative will attempt to protect and expand large wetland-grassland complexes in 12 counties in western Minnesota.

SURVEY CONDITIONS

Cooperators completed 170 of the 171 routes in 2009. Weather conditions during the survey ranged from excellent (calm, heavy dew, clear sky) to medium (light dew and overcast skies). Medium-to-heavy dew conditions were present at the start of 94% of the survey routes, which was slightly less than for 2008 (98%) but better than the 10-year average (92%). Clear skies (<30% cloud cover) were present at the start of 83% of routes, with wind speeds <7 mph recorded for 96% of routes. The survey period was extended to July 27th - August 17th to allow most routes to be completed.

RING-NECKED PHEASANT

The average number of pheasants observed (58.5/100 mi) decreased 27% from 2008 (95% CI: -41 to -13%; Table 2). The 2009 pheasant index was also 27% below the 10-year average (95% CI: -38 to -16%; Table 2; Figure 2A), 43% below the long-term average (95% CI: -53 to -32%; Table 2), and 78% below the benchmark years of 1955-64 (95% CI: -89 to -66%). Total pheasants observed per 100 miles ranged from 9.6 in the Southeast to 115.8 in the Southwest (Table 3, Figure 5). Declines from last year were significant only for the West Central and South Central regions (Table 3).

The range-wide hen index (9.4 hens/100 mi) declined 34% (95% CI: -51 to -17%) from last year, 22% (95% CI: -35 to -10%) from the 10-year average (Table 2), and varied from 1.4 hens/100 miles in the Southeast to 19.6 hens/100 miles in the Southwest. The cock index (7.6 cocks/100 mi) declined 39% (95% CI: -54 to -23%) from 2008, but was similar to the 10-year average (Table 2). The 2009 hen:cock ratio was 1.24, which was below average (1.53) for the CRP years (1987-2009). A low sex ratio may reflect a delayed nesting effort, but evidence of this is relatively weak for 2009.

The number of pheasant broods observed (9.0/100 mi) declined 25% (95% CI: -40 to -9%) from last year, 28% (95% CI: -38 to -19%) from the 10-year average, and 33% (95% CI: -44 to -21%) from the long-term average (Table 2). The brood index remains far below the benchmark years of 1955-64 (34.7 broods/100 mi). Regional brood indices ranged from 1.6 broods/100 miles in the Southeast to 17.0 broods/100 miles in the Southwest. Average brood size in 2009 (4.6 ± 0.1 [SE] chicks/brood) was similar to last year (4.5 ± 0.1 [SE] chicks/brood), but below the 10-year mean (4.8 chicks/brood) and the long-term average (5.6 chicks/brood; Table 2). The median hatch date for pheasants was June 12 (n = 340), the same as last year and 4 days later than the 10-year average (Table 2). The distribution of estimated hatch dates for observed broods was unimodal and approximately normally distributed, which suggests that many early nesting attempts were successful (vs. wide-spread nest failure, which often leads to an extensive renesting effort and a wide or bimodal peak in hatch dates). However, successful late-season nests will likely be underrepresented in roadside data. Median age of broods observed was 8 weeks (range: 1-16 weeks).

A moderately severe winter throughout the pheasant range (the first since 2001) resulted in reduced hen counts. In addition, habitat loss reduced nesting opportunities and one period of cool and wet weather at the normal peak of pheasant hatch appeared to reduce early brood survival. Thus, a decrease in the range-wide pheasant index was not surprising. Overall, the size of the fall population will be close to that in 2004, when 420,000 roosters were harvested. The best opportunity for harvesting pheasants appears to be in the Southwest region, although good opportunities will likely also be available in the West Central, Central, and South Central regions.

GRAY PARTRIDGE

Range-wide, the gray partridge index (2.7 partridge/100 miles) was similar to last year but 71% below the 10-year average (95% CI: -101 to -41%) and 81% below the long-term average (95% CI: -99 to -63%, Table 2, Figure 2B). Within regions, the partridge index ranged from 0.0/100 miles in the East Central and Southeast regions to 8.2/100 miles in the Southwest (Table 3, Figure 6). There were no significant regional changes from last year (Table 3).

The number of adults observed per 100 miles declined 56% from last year (95% CI: -103 to -10%), 75% (95% CI: -100 to -49%) from the 10-year mean, and 82% (95% CI: -98 to -66%) from the long-term average (Table 2). The ratio of broods per 100 adult partridge (46%) was 98% above 2008, 46% above the 10-year average, and 40% above the long-term average (Table 2). Average brood size in 2009 (6.7 chicks/brood) was smaller than in 2008 (9.3 chicks/brood), the 10-year average (7.8 chicks/brood), and the long-term average (8.9 chicks/brood). Total broods observed per 100 miles was similar to the 2008 estimate, but 64% below the 10-year average (95% CI: -94 to -34%), and 77% below the long-term average (95% CI: -96 to -59%, Table 2). The median hatch date was June 15, which was 10 days earlier than in 2008 and 8 days earlier than the 10-year average, but estimated from a small sample of observations ($n = 12$).

Conversion of diversified agricultural practices to more intense land-use with fewer haylands, pastures, small grain fields, and hedgerows have 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 only produce well in the Midwest during dry or drought years. Consequently, gray partridge are more strongly affected by weather conditions during nesting and brood rearing than are pheasants. The Southwest and South Central regions offer the best opportunity for harvesting gray partridge in 2009.

COTTONTAIL RABBIT and WHITE-TAILED JACKRABBIT

The eastern cottontail rabbit index (3.7 rabbits/100 mi) declined 42% from last year (95% CI: -61 to -23%), 46% from the 10-year average (95% CI: -59 to -33%), and 39% from the long-term average (95% CI: -52 to -27%, Table 2, Figure 3A). The cottontail rabbit index ranged from 0.2 rabbits/100 miles in the Northwest to 6.3 rabbits/100 miles in the Southwest region (Table 3, Figure 7). Declines from 2008 were significant in the Central, East Central, and South Central Regions (Table 3). The best opportunities for harvesting cottontail rabbits are in the Southwest, South Central, Southeast, and East Central regions.

The index of white-tailed jackrabbits did not change significantly from 2008 or the 10-year average but was 86% below the long-term average (95% CI: -102 to -70%, Table 2, Figure 3B). The range-wide jackrabbit population peaked in the late 1950's and declined to its lowest level (0.2 rabbits/100 mi) in 1993 and again in 2008 (Figure 3B). The long-term decline in jackrabbits probably 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, Figure 8). However, indices of relative abundance and annual percent change should be interpreted cautiously because estimates are based on low numbers of sightings.

WHITE-TAILED DEER

The index for white-tailed deer (17.8/100 mi) increased by 30% (95% CI: 2 to 58%) from last year, and was 31% above the 10-year average (95% CI: 8 to 54%) and 104% above the long-term average (95% CI: 61 to 147%, Table 2, Figure 4A). Among regions, deer indices increased significantly from 2008 only in the Southwest region (Table 3).

MOURNING DOVE

The number of mourning doves observed (244.1/100 mi) in 2009 increased 26% (95% CI: 8 to 44%) from last year and was similar to the 10-year average and the long-term average (Table 2, Figure 4B). The mourning dove index ranged from 63.4 doves/100 miles in the Northwest region to 330.3 doves/100 miles in the South Central Region. The number of mourning doves heard along U.S. Fish and Wildlife Service call-count survey (CCS) routes (n = 9) in Minnesota was similar to last year. Trend analyses indicated the number of mourning doves heard along the CCS routes declined 0.8% per year (90% CI: -64 to 4.7%) during 2000-2009 and 2.0% per year (90% CI: -3.4 to -0.6%) during 1966-2009 (Dolton et al. 2009).

SANDHILL CRANE

For the first time in 2009, observers were asked to report the number of adult and juvenile sandhill cranes observed on the August Roadside Survey. Range-wide, the 2009 index averaged 8.2 cranes/100 miles of survey, including 1.2 juveniles/100 miles (Table 2). Among regions, crane indices ranged from 0.0/100 miles in the West Central, Southwest, and Southeast regions to 36.7 cranes/100 miles in the Northwest region (Table 3). Juvenile cranes were observed in the Central (2.0/100 mi), East Central (5.4/100 mi), and Northwest (3.8/100 mi) regions.

OTHER SPECIES

Notable incidental sightings: 2 bald eagles (Faribault and Norman Counties), 1 barred owl (Pennington County), 1 Coopers hawk (Rice County), 2 northern harriers (Redwood and Steele Counties), 6 great blue herons (Nobles, Pennington, Rock, Waseca, and Watonwan Counties), 1 green heron (Rock County), 1 loggerhead shrike (Brown County), 1 red-headed woodpecker (Redwood County), 2 upland sandpipers (Mower and Traverse Counties), 1 prairie chicken (Red Lake County), 18 sharp-tailed grouse (Lake of the Woods and Marshall Counties), 315 wild turkeys (Benton, Blue Earth, Chisago, Dodge, Douglas, Freeborn, Kandiyohi, Le Sueur, Marshall, Martin, Mille Lacs, Morrison, Mower, Nicollet, Otter Tail, Pennington, Polk, Pope, Renville, Rice, Scott, Stearns, Todd, Traverse, Waseca, Washington, and Winona Counties), 1 moose (Marshall County), 1 wolf (Marshall County), 3 coyotes (Red Lake, Rice, and Winona Counties), and 1 gray fox (Martin County).

LITERATURE CITED

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Table 1. Abundance (total acres) and density (acres/mi^2) of undisturbed grassland habitat within pheasant range, 2009[a].

	Cropland Retirement									Density
AGREG	CRP	CREP	RIM	RIM-WRP	WRP	USFWS[c]	MNDNR[d]	Total	%	ac/mi^2
WC[b]	329,754	37,450	17,079	2,592	19,659	173,067	104,534	684,134	10.1	64.4
SW	105,963	24,549	12,214	713	830	17,546	54,338	216,154	5.7	36.6
C	138,057	14,490	17,028	785	3,212	84,626	45,691	303,889	5.0	32.2
SC	90,595	27,610	11,813	4,707	9,367	8,382	30,640	183,113	4.5	29.0
SE	79,026	2,262	5,554	556	620	18,470	51,548	158,036	4.3	27.3
EC	4,367	0	1,265	0	4	2,504	84,314	92,453	2.9	18.4
Total	747,761	106,360	64,953	9,353	33,692	304,596	371,065	1,637,779	5.9	38.0

[a] Unpublished data, Tabor Hoek, BWSR, 5 August 2009.

[b] Does not include Norman County.

[c] Includes Waterfowl Production Areas (WPA), USFWS easements, 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, 1955-2009.

Species	Change from 2008[a]					Change from 10-year average[b]				Change from long-term average[c]			
Subgroup	*n*	2008	2009	%	95% CI	*n*	1999-08	%	95% CI	*n*	LTA	%	95% CI
Ring-necked pheasant													
Total pheasants	152	80.3	58.5	-27	±14	150	81.0	-27	±11	151	102.4	-43	±10
Cocks	152	12.4	7.6	-39	±15		8.0	-4	±16		11.5	-33	±14
Hens	152	14.3	9.4	-34	±17		12.3	-22	±12		14.8	-36	±12
Broods	152	11.9	9.0	-25	±16		12.7	-28	±10		13.4	-33	±12
Chicks per brood	341	4.5	4.6	3			4.8	-4			5.6	-17	
Broods per 100 hens	341	83.1	94.5	14			103.8	-9			101.4	-7	
Median hatch date	340	Jun 12	Jun 12				Jun 08						
Gray partridge													
Total partridge	170	4.8	2.7	-44	±68	168	9.3	-71	±30	151	16.2	-81	±18
Adults	170	1.5	0.7	-56	±46		2.6	-75	±26		4.1	-82	±16
Broods	170	0.4	0.3	-13	±75		0.9	-64	±30		1.4	-77	±18
Chicks per brood	12	9.3	6.7	-28			7.8	-15			8.9	-25	
Broods per 100 adults	12	23.4	46.4	98			31.8	46			33.1	40	
Median hatch date	12	Jun 25	Jun 15				Jun 23						
Eastern cottontail	170	6.4	3.7	-42	±19	168	6.9	-46	±13	151	6.8	-39	±12
White-tailed jackrabbit	170	0.2	0.3	39	±108	168	0.4	-36	±43	151	1.9	-86	±16
White-tailed deer	170	13.7	17.8	30	±28	168	13.7	31	±23	169	8.8	104	±43
Mourning dove	170	193.4	244.1	26	±18	168	220.3	12	±16	151	275.1	-3	±16
Sandhill Crane													
Total cranes	170		8.2										
Juveniles	170		1.2										

[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 = 1955-2008, except for deer = 1974-2008. 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, 1955-2009.

Region	Change from 2008[a]					Change from 10-year average[b]				Change from long-term average[c]			
Species	*n*	2008	2009	%	95% CI	*n*	1999-08	%	95% CI	*n*	LTA	%	95% CI
Northwest[d]													
Gray partridge	18	1.8	0.2	-88	±189	18	0.4	-41	±141	18	3.9	-94	±74
Eastern cottontail		0.4	0.2	-50	±241		1.1	-80	±69		1.0	-77	±56
White-tailed jackrabbit		0.4	0.2	-50	±50		0.5	-57	±88		0.7	-68	±78
White-tailed deer		44.7	48.2	8	±68		44.0	9	±53		28.4	70	±100
Mourning dove		88.4	63.4	-28	±51		88.0	-28	±37		128.1	-51	±27
Sandhill Crane			36.7										
West Central													
Ring-necked pheasant	37	90.4	65.2	-28	±17	36	75.1	-11	±16	37	103.8	-37	±19
Gray partridge		1.6	1.0	-40	±205		2.8	-64	±89		10.5	-91	±27
Eastern cottontail		3.6	2.7	-24	±51		3.5	-20	±43		4.2	-36	±36
White-tailed jackrabbit		0.1	0.1	0	±291		0.6	-83	±62		2.5	-96	±21
White-tailed deer		11.6	17.3	50	±59		11.3	57	±62		8.2	111	±87
Mourning dove		185.0	309.4	67	±52		267.8	18	±34		381.5	-19	±25
Sandhill Crane			0.0										
Central													
Ring-necked pheasant	30	61.2	59.2	-3	±40	29	68.8	-11	±24	29	76.4	-20	±28
Gray partridge		2.3	0.8	-65	±155		4.5	-82	±58		10.3	-92	±45
Eastern cottontail		6.9	3.2	-54	±28		7.1	-53	±25		6.5	-49	±27
White-tailed jackrabbit		0.0	0.3				0.2	32	±175		1.3	-79	±36
White-tailed deer		6.2	8.7	39	±61		6.5	39	±53		4.0	123	±99
Mourning dove		159.8	255.3	60	±43		191.9	37	±37		236.0	11	±35
Sandhill Crane			7.1										
East Central													
Ring-necked pheasant	14	78.3	44.6	-43	±45	14	58.6	-24	±40	14	87.4	-49	±29
Gray partridge		0.0	0.0				0.0	-100	±216		0.2	-100	±133
Eastern cottontail		13.1	4.3	-67	±43		11.6	-63	±24		8.7	-51	±30
White-tailed jackrabbit		0.0	0.0				0.0				0.2	-100	±59
White-tailed deer		18.0	17.4	-3	±62		15.7	11	±42		7.8	125	±86
Mourning dove		87.1	115.7	33	±56		93.3	24	±46		128.0	-10	±44
Sandhill Crane			36.6										

Table 3. Continued.

Region / Species	*n*	2008	2009	%	95% CI	*n*	1999-08	%	95% CI	*n*	LTA	%	95% CI
	Change from 2008					Change from 10-year average				Change from long-term average			
Southwest													
Ring-necked pheasant	19	158.5	115.8	-27	±40	19	161.5	-28	±32	19	119.9	-3	±38
Gray partridge		15.8	8.2	-48	±131		35.8	-77	±32		43.7	-81	±23
Eastern cottontail		3.8	6.3	67	±87		9.1	-31	±32		8.3	-24	±28
White-tailed jackrabbit		0.8	1.3	52	±170		1.0	30	±117		4.0	-69	±41
White-tailed deer		11.8	19.1	63	±56		12.0	60	±62		7.6	152	±109
Mourning dove		353.4	327.8	-7	±20		342.7	-4	±20		316.2	4	±27
Sandhill Crane			0.0										
South Central													
Ring-necked pheasant	32	81.1	52.5	-35	±32	32	90.8	-42	±16	32	136.4	-62	±14
Gray partridge		5.0	7.5	50	±208		16.0	-53	±70		19.8	-62	±46
Eastern cottontail		10.9	4.9	-55	±37		9.8	-50	±27		7.8	-37	±31
White-tailed jackrabbit		0.1	0.0	-100	±204		0.3	-100	±57		1.8	-100	±25
White-tailed deer		4.9	6.3	28	±72		5.4	16.1	±46		3.3	91	±75
Mourning dove		266.6	330.3	24	±45		257.3	28	±49		257.0	29	±55
Sandhill Crane			0.3										
Southeast													
Ring-necked pheasant	20	15.7	9.6	-39	±58	20	33.2	-71	±28	20	77.0	-88	±32
Gray partridge		9.8	0.0	-100	±106		6.8	-100	±65		14.6	-100	±32
Eastern cottontail		6.6	4.6	-30	±58		8.2	-44	±42		7.8	-41	±35
White-tailed jackrabbit		0.0	0.2				0.2	11	±240		0.6	-69	±60
White-tailed deer		13.5	22.4	65	±92		14.9	51	±71		9.6	134	±136
Mourning dove		159.0	141.8	-11	±33		208.8	-32	±29		227.9	-38	±25
Sandhill Crane			0.0										

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

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

[c] LTA = 1955-2008, except for Northwest region (1982-2008) and white-tailed deer (1974-2008). Estimates based on routes (*n*) surveyed ≥40 years (1955-2008), 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.

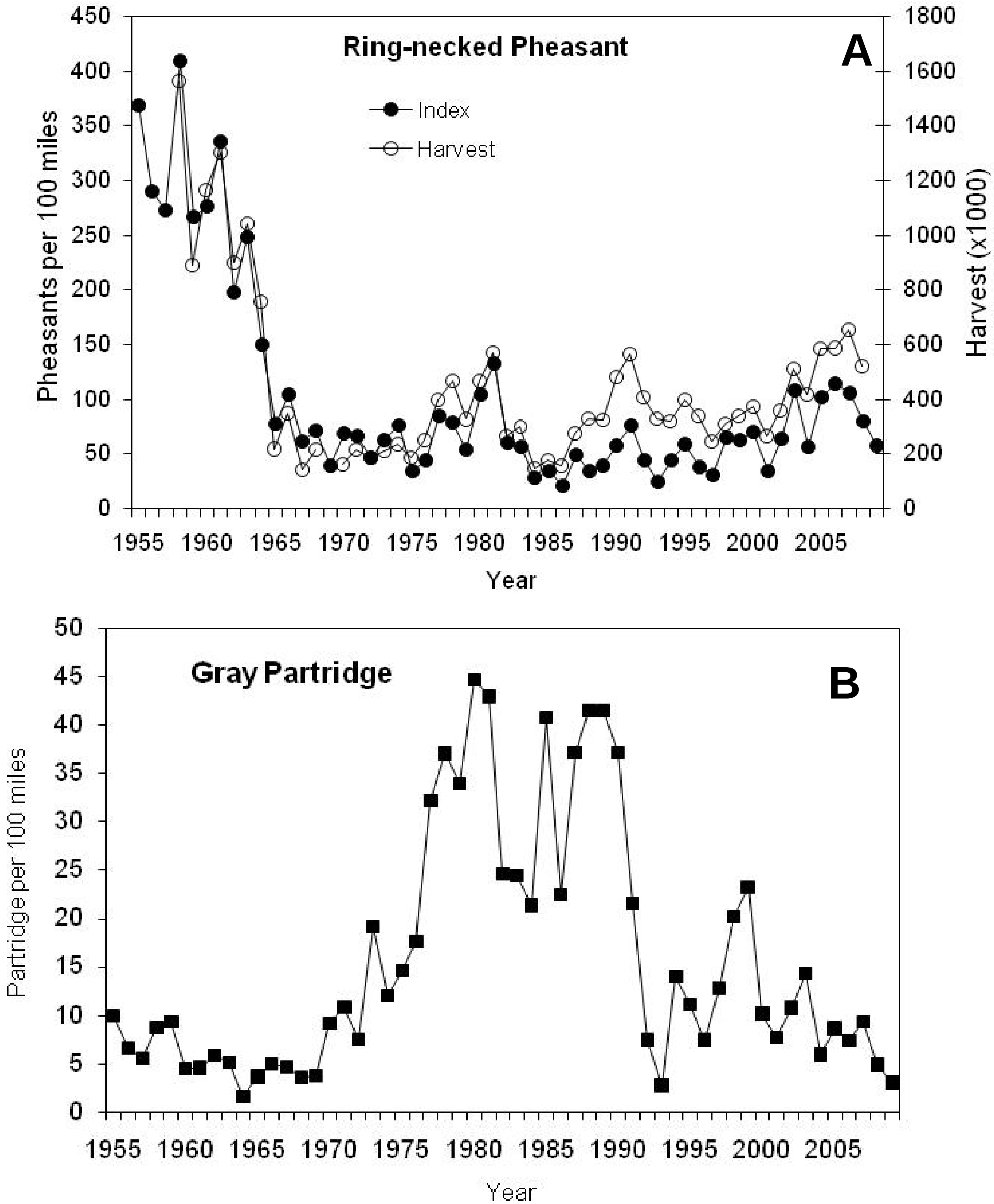

Figure 2. Range-wide index of ring-necked pheasants (**A**) and gray partridge (**B**) seen per 100 miles driven. Does not include the Northwest region. Based on all survey routes completed.

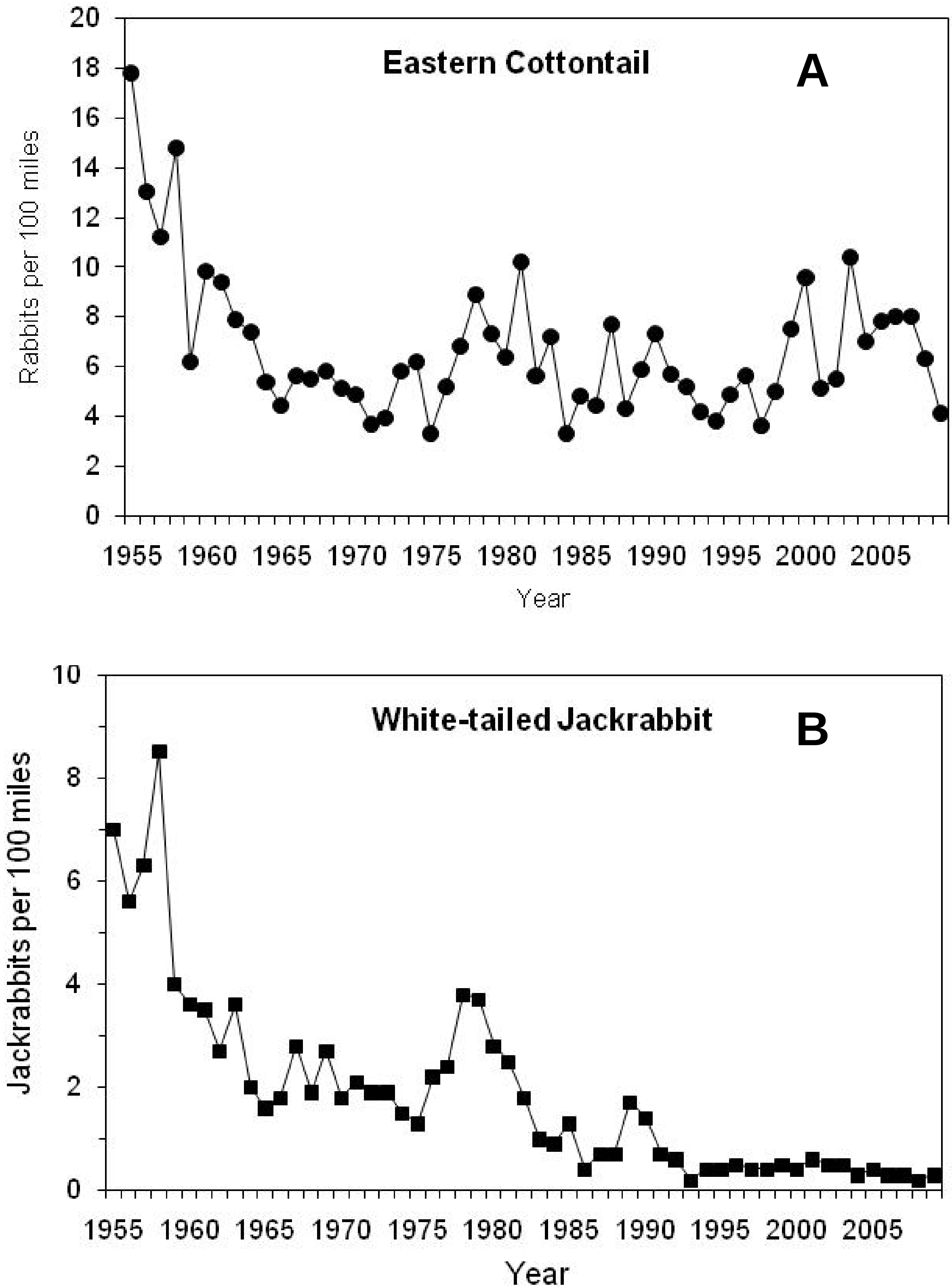

Figure 3. Range-wide index of eastern cottontail (**A**) and white-tailed jackrabbits (**B**) seen per 100 miles driven. Does not include the Northwest region. Based on all survey routes completed.

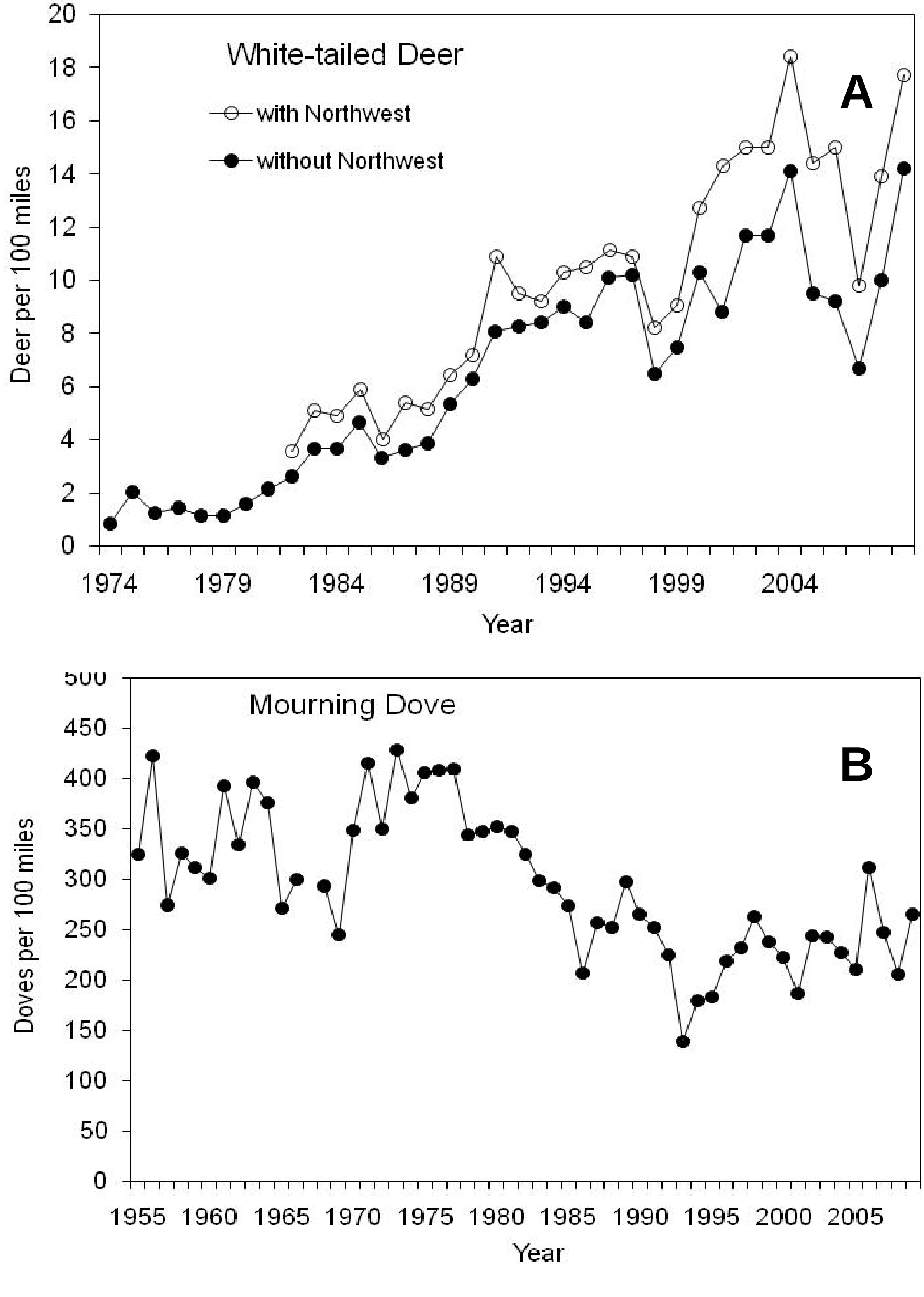

Figure 4. Range-wide index of white-tailed deer (**A**) and mourning doves (**B**) seen per 100 miles driven. Doves were not counted in 1967 and the dove index does not include the Northwest region. Based on all survey routes completed.

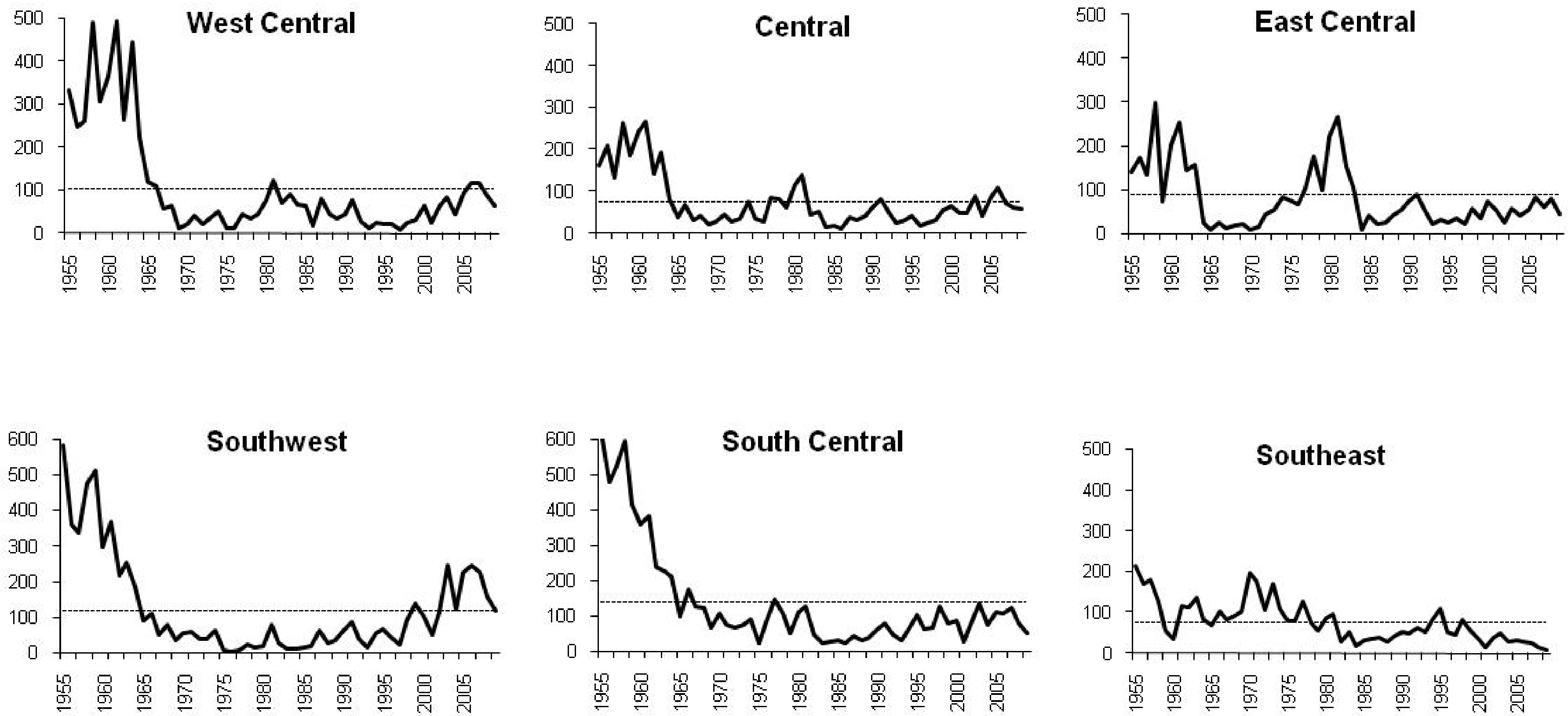

Figure 5. Regional index (**——**) and long-term average (......) of **ring-necked pheasants seen per 100 miles driven**, Minnesota August roadside survey (1955-present). Based on all survey routes completed. **Note:** scale of vertical axis is not the same scale among survey regions.

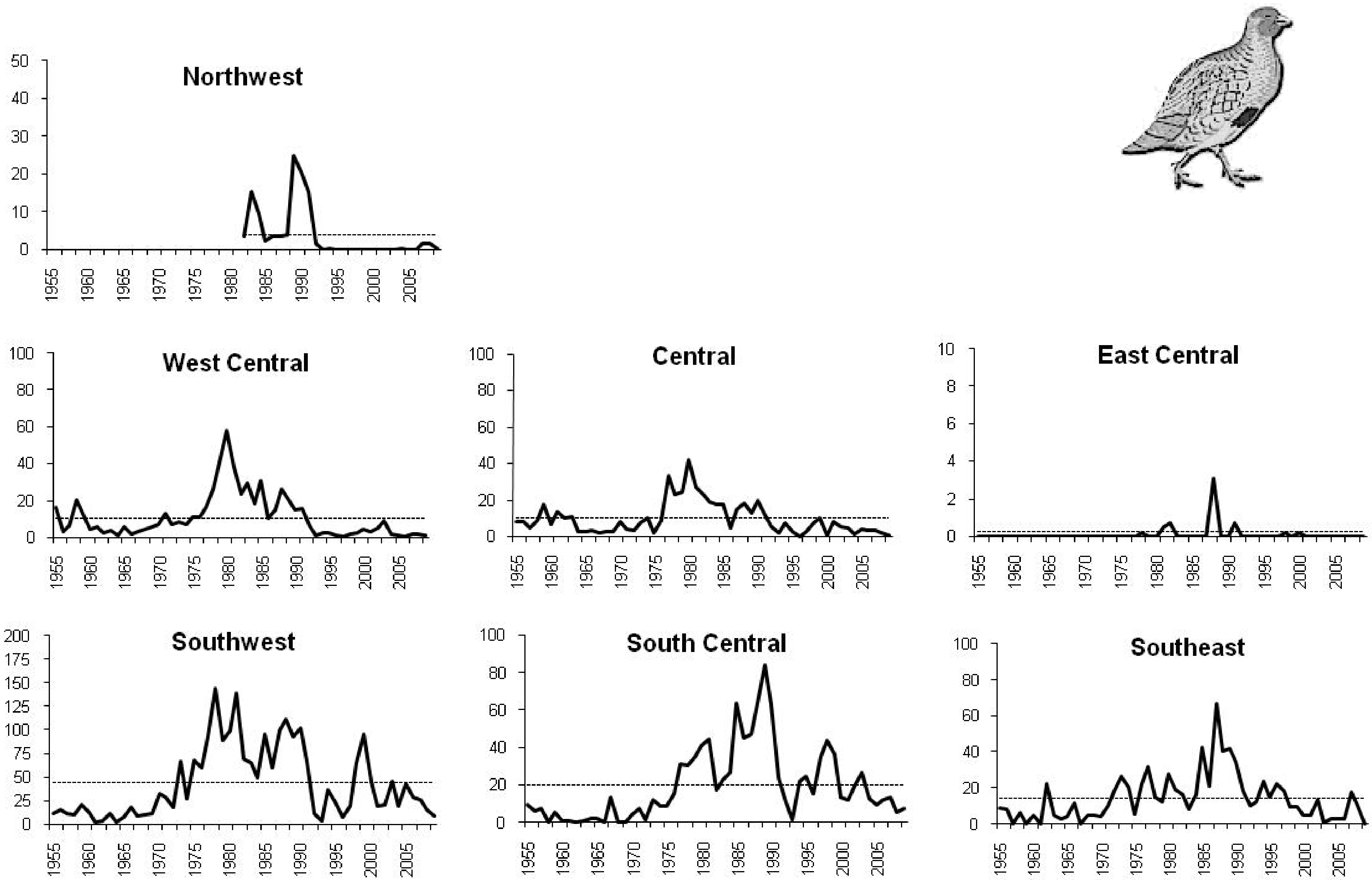

Figure 6. Regional index (——) and long-term average (......) of **gray partridge seen per 100 miles driven**, Minnesota August roadside survey (1955-present). Based on all survey routes completed. **Note:** scale of vertical axis is not the same scale among survey regions.

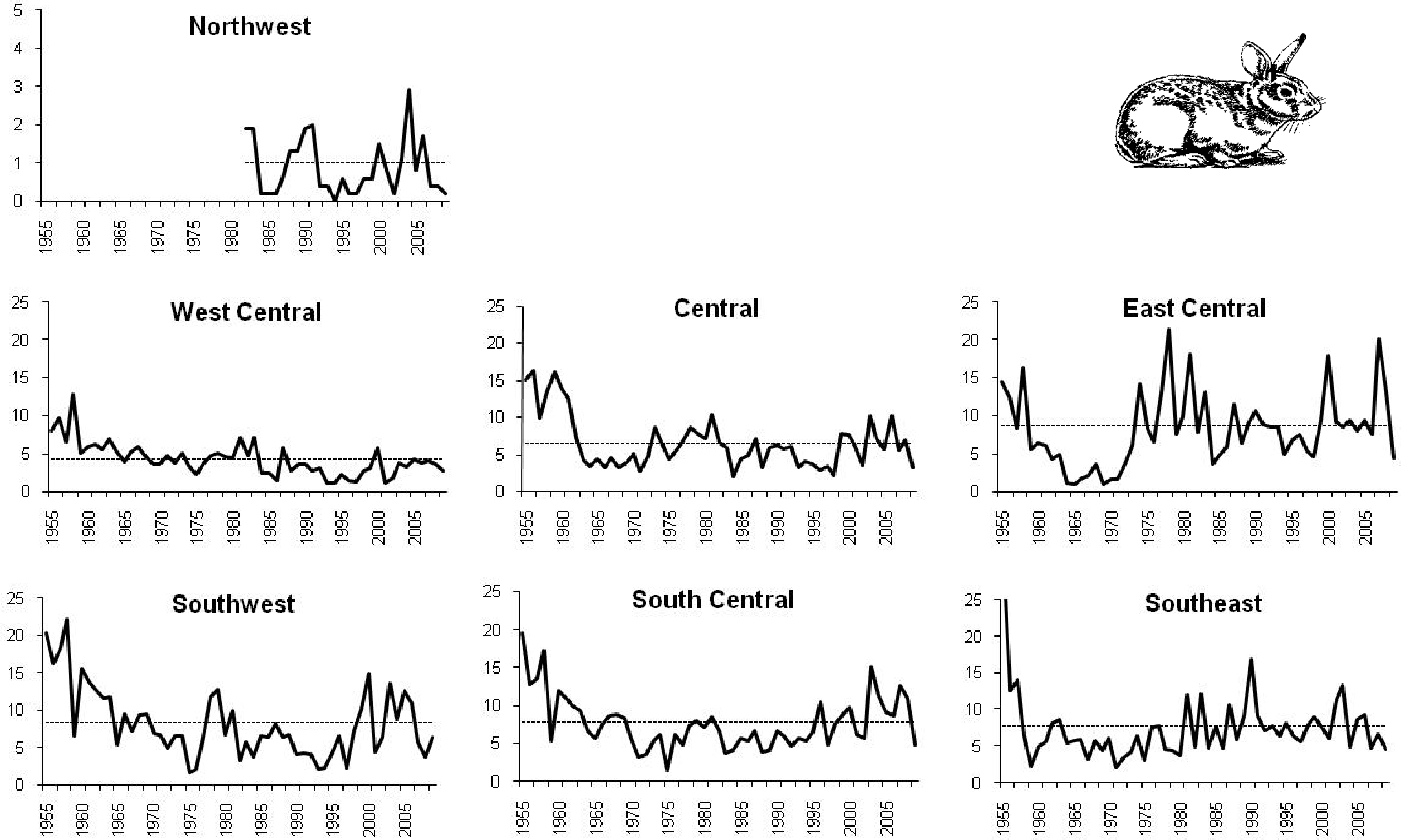

Figure 7. Regional index (——) and long-term average (·······) of **cottontail rabbits seen per 100 miles driven**, Minnesota August roadside survey (1955-present). Based on all survey routes completed. **Note:** scale of vertical axis is not the same among survey regions.

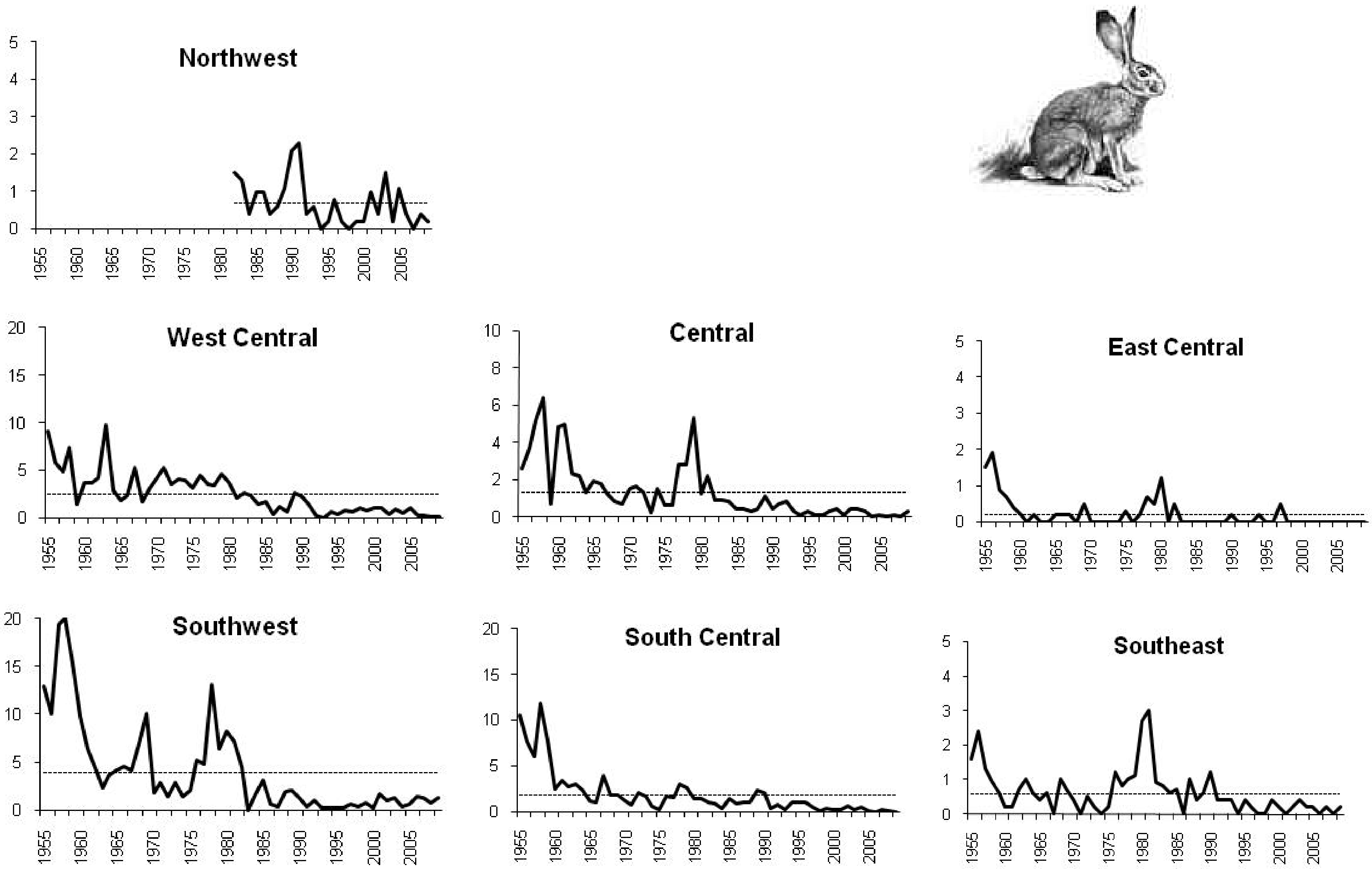

Figure 8. Regional index (____) and long-term average (.......) of **white-tailed jackrabbits seen per 100 miles driven**, Minnesota August roadside survey (1955-present). Based on all survey routes completed. **Note:** scale of vertical axis is not the same among survey regions.

MONITORING POPULATION TRENDS OF WHITE-TAILED DEER IN MINNESOTA'S FARMLAND/TRANSITION ZONE – 2009

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) identifies where the farmland population model was applied to model deer population dynamics in Minnesota, 2) describes the structure of and data inputs for the farmland population model, and 3) discusses general trends of deer density and current abundance.

METHODS

Minnesota Farmland/Transition Zone

The farmland/transition zone encompasses >46,000 square miles and 73 permit areas (PAs). I arbitrarily pooled PAs into 11 geographic units to describe general population trends and management issues at a broader scale (Figure 1). Several management strategies were available including: 1) youth-only lottery with varying number of permits, 2) lottery with varying number of antlerless permits, 3) managed, and 4) intensive (Figure 2). The strategy employed during a given year depended upon where the population density was in relation to the population density goal (Figure 3).

We began using a youth-only antlerless permit system for the first time in 2009, which was the most conservative management strategy available to Minnesota wildlife managers. The Twin Cities metro region (PA 601) was not modeled due to limited hunting opportunities, and PAs 224, 235 and 238 were not modeled due to demographic stochastic error associated with their small population sizes (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 is partitioned into 4 sex-age classes (fawns, adults, males, and females). The 12-month year is divided into 4 periods representing important biological events in the deer's life (hunting season, winter, reproduction, and summer). The primary purposes of the farmland model were to 1) organize and synthesize data on farmland deer populations, 2) advance the understanding of farmland deer populations through population analysis, 3) provide population estimates and simulate vital rates for farmland 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). Embryo 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 regions. Although summer mortality rates were low, they did represent a reduction in the annual deer population. In farmland deer herds, 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. In heavily hunted deer populations, like those in the farmland/transition region, 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 farmland 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 Densities

<u>Northwest Management Units</u>

Karlstad Unit – Populations were generally stable (Table 1) and most PA densities were at deer density goals established in 2005. However, some populations were being managed aggressively and additional population reductions were expected due to concerns about potential transmission of Bovine Tuberculosis into adjacent permit areas. Deer densities averaged 6 deer per square mile (SD = 2 deer per square mile). A primary concern was over-harvesting deer on the Agassiz National Wildlife Refuge where hunter access was unlimited and the area was designated as intensive.

Crookston/TRF Unit – Populations were generally stable with 2 PA populations showing declines due to the use of early antlerless seasons over the past 4 hunting seasons. However, deer densities remain well above goal and the intent was to further reduce most deer densities. Similar to the Karlstad unit, deer densities averaged 6 deer per square mile (SD = 2 deer per square mile). This area was active in the *Alternative Deer Management* (ADM) *Study* and the study will be completed following the 2009 hunting season. Preliminary findings suggested the primary problem facing managers in this region who desire further population reductions is low hunter participation rates. Managers have suggested adding a late antlerless hunting season to increase hunter effort and remedy the low hunter participation rate issue. Many of these populations will be surveyed using aerial surveys prior to framing management recommendations in 2010.

Mahnomen Unit – With the exception of PA 297, all PA populations were near goal or the densities were moving toward goal densities established in 2006. Permit Area 297 was designated as a lottery PA in 2009 to relieve hunter pressure on antlerless deer. The deer density averaged 6 deer per square mile (SD = 4 deer per square mile) and managers expressed few management concerns in this region.

<u>Central Management Units</u>

Morris Unit – Some data were showing that populations were moving toward goal, but all populations remained well under goal and conservative management strategies were generally employed during 2009. Managers will consider using youth-only antlerless permits if data are not more conclusive that populations are increasing in 2010. Population densities varied in this region and averaged 4 deer per square mile (SD = 3 deer per square mile).

Osakis Unit – Most populations have increased and were at or near goal densities. Conservative management strategies were used in most PAs of this unit during 2009 due to densities being near goal. Population densities averaged 13 deer per square mile (SD = 3 deer per square mile) and managers expressed few management concerns in this region.

Cambridge Unit – Deer densities were generally stable or slightly declining. However, all PA populations remained well above goal in 2009. This unit was an active participant in the ADM study and most managers are inclined to designating areas as intensive in 2010 due to the success of the early antlerless season. Population densities averaged 12 deer per square mile (SD = 3 deer per square mile) and many of these deer populations will be surveyed using aerial surveys or distance sampling prior to next spring as part of the ADM study.

Hutchinson Unit – Deer populations were generally well below density goals and the population dynamics have at best been stable over the past 3 years. Therefore, managers used youth-only antlerless permits for the 2009 hunting season in attempt to reduce antlerless harvests and allow populations to move toward goal in some PAs. Densities varied considerably in this unit and averaged 6 deer per square mile (SD = 4 deer per square mile).

Southern Management Units

Minnesota River Unit – Deer densities were at or near goal densities in all PAs and the goal was to stabilize deer numbers in the future. Lottery management strategies have been used in the past to achieve sustainable harvests. Deer densities have not declined along the Minnesota River valley like in the farmland PAs just to the north and south of this unit. Deer densities averaged 6 deer per square mile (SD = 2 deer per square mile).

Slayton Unit – Population densities were well below goal in all PAs in this unit. Deer density goals were established in 2007 with the goal of increasing deer numbers by 25-50%. While several populations have remained stable, most have declined over the past 2 years and no data suggest these deer densities are moving toward goal. Consequently, youth-only antlerless licenses were offered in many PAs and will likely be offered again in 2010 so that progress is made to achieve these established goals. Deer densities averaged 4 deer per square mile (SD = 2 deer per square mile) in spring 2009.

Waseca Unit – Population densities have generally been stable over the past few years and are at or near density goals. There was relatively little variability in deer densities across the unit and deer densities averaged 5 deer per square mile (SD = 1 deer per square mile). Deer will be tested for chronic wasting disease in a small area of the eastern portion of this unit.

Rochester Unit – Most deer densities were at or near goal with the exception of PA 346 and 349 where early antlerless seasons have been used the past 2 years. Although deer densities have begun to decline in those 2 PAs, early antlerless seasons will be used again in 2009 to further move the populations toward goal. Deer densities were much lower in the northern portion of the unit and deer densities averaged 13 deer per square mile (SD = 6 deer per square mile) throughout this entire unit. Harvested deer will be tested for chronic wasting disease in this unit during 2009.

LITERATURE CITED

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GRUND, M. D., and A. WOOLF. 2004. Development and evaluation of an accounting model for estimating deer population sizes. Ecological Modeling 180:345-357.

Figure 1. Deer management units in the farmland zone of Minnesota, 2009.

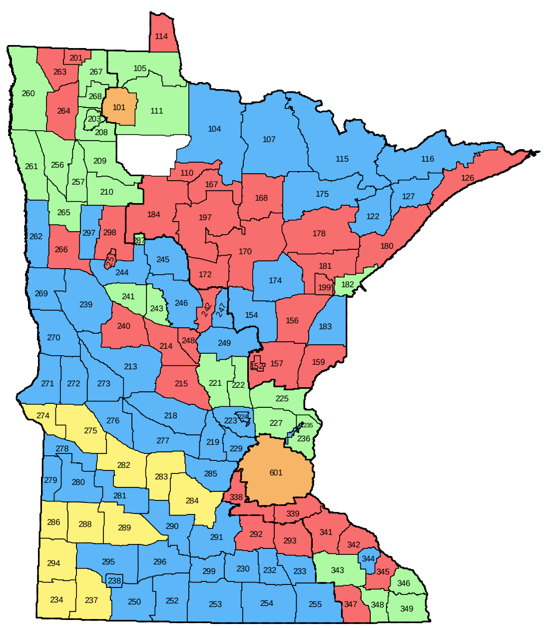

Figure 2. Deer management strategies used in permit areas throughout Minnesota, 2009.

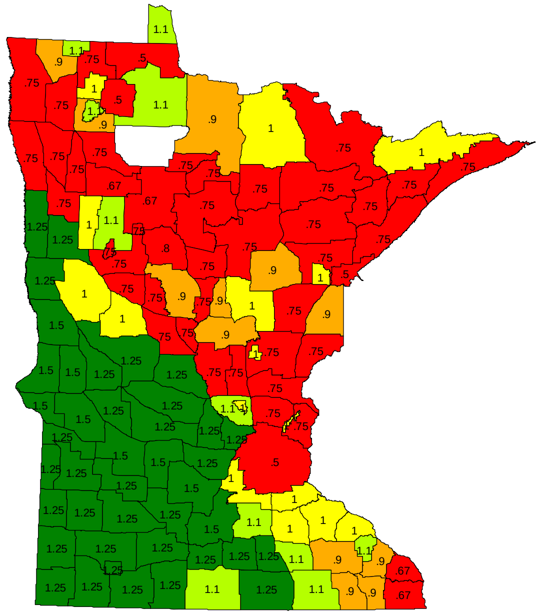

Figure 3. Population density goals in deer permit areas in Minnesota, 2009.

Table 1. Pre-fawn deer density (deer/mi^2) as simulated from population modeling in each permit area of Minnesota's Farmland/Transition Zone, 1997-2009.

Region		Pre-fawning Density												
Permit Area	Area (mi^2)	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Karlstad														
201	161	2	2	3	4	4	5	5	4	3	4	3	3	4
260	1249											7	7	7
263	512											5	5	5
203	118	2	3	4	5	5	6	8	7	5	4	5	6	5
208	379	2	3	3	4	4	4	5	4	4	4	4	4	4
267	472											5	4	5
268	229											9	10	11
264	669											7	7	7
Total	3789	2	3	3	4	4	5	6	5	4	4	6	6	6
Crookston														
261	795											3	4	4
256	653	6	6	6	6	7	8	8	8	7	7	7	7	7
257	413	7	8	8	8	8	8	7	6	7	7	7	7	6
209	639	5	6	6	6	7	7	7	7	7	7	7	6	5
210	615	10	10	11	11	11	12	11	11	12	11	11	10	9
Total	3115	7	8	8	8	8	9	8	8	8	8	7	7	6
Mahnomen														
262	677											3	3	4
265	494											10	10	10
266	617										5	6	8	8
297	438										4	3	3	2
Total	2226										5	6	6	6

Region Permit Area	Area (mi²)	Pre-fawning Density 1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Morris														
269	650	3	3	3	3	4	4	4	4	4	3	2	3	3
270	748	3	3	3	3	3	3	4	4	2	1	1	1	1
271	632	2	2	2	2	2	2	3	3	4	2	1	1	2
272	531	4	3	3	3	3	4	4	2	2	2	2	2	2
273	572										7	7	8	9
274	360	7	6	6	5	4	4	4	4	4	4	4	4	5
275	764	5	4	4	4	3	3	3	3	4	4	3	3	4
276	543	9	9	9	8	8	8	8	7	7	7	6	6	7
282	779	1	1	1	1	1	1	1	1	2	1	1	2	2
Total	5579	4	4	4	4	4	4	4	4	4	3	3	3	4
Osakis														
239	922	13	13	15	16	16	15	14	13	12	12	11	10	11
240	642	20	21	23	25	26	27	26	21	21	20	19	18	17
213	1057										14	13	13	14
214	557	17	17	18	18	19	19	19	20	19	18	18	16	14
215	701	9	9	9	9	9	10	10	9	8	9	8	8	9
Total	3879	15	15	16	17	18	18	17	16	15	15	14	13	13
Cambridge														
221	642	10	10	11	12	11	12	13	13	12	13	13	12	11
222	413	13	13	14	14	14	15	15	14	14	14	13	11	10
223	377	10	9	8	11	10	9	11	9	8	11	11	10	11
225	618	14	14	15	18	19	16	16	15	13	13	14	14	13
227	471	13	13	13	13	12	11	11	10	9	13	14	13	13
229	287	5	5	5	6	6	6	7	7	6	7	7	6	7
236	372	16	16	17	17	16	17	17	18	18	18	18	18	17
Total	3180	12	11	12	13	13	12	13	12	11	13	13	12	12

Region Permit Area	Area (mi^2)	Pre-fawning Density												
		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Hutchinson														
218	884										7	6	6	6
277	813										6	6	7	8
219	392	9	8	8	9	7	7	8	7	7	7	7	7	8
229	287	5	5	5	6	6	6	7	7	6	7	7	6	7
285	550	4	3	4	4	4	4	5	6	4	3	3	3	3
283	614	3	3	3	3	3	4	4	3	3	3	4	4	5
284	838	2	1	1	2	2	2	2	2	3	2	3	2	2
Total	4378	5	4	4	5	4	5	5	5	5	5	5	5	6
Minnesota River														
278	401	9	9	8	8	8	8	9	10	8	8	8	8	9
281	575	5	5	5	5	4	4	5	5	6	4	4	5	6
290	662	4	4	4	4	4	4	4	4	4	4	4	5	5
291	802	4	4	4	4	4	4	5	5	5	4	4	5	5
Total	2440	6	6	5	5	5	5	6	6	6	5	5	6	6
Slayton														
279	344	7	6	7	7	6	6	6	5	5	4	4	5	6
280	675	2	2	2	2	2	2	2	2	3	2	3	3	4
286	446	2	2	2	3	4	4	4	4	4	4	4	4	5
288	625	3	3	2	3	4	4	4	4	4	5	5	6	6
289	816	2	1	2	1	1	1	2	2	1	2	2	2	2
294	686	3	3	3	3	3	3	3	4	3	3	3	3	3
295	840	3	3	3	3	3	3	4	4	5	4	4	4	4
296	666	2	2	3	3	3	3	3	3	3	2	2	2	2
234	636	3	3	3	4	4	4	4	5	4	4	4	4	4
Total	5734	3	3	3	3	3	3	4	4	4	3	3	4	4

Region Permit Area	Area (mi²)	Pre-fawning Density												
		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Waseca														
292	480	9	8	8	8	7	7	8	7	7	8	7	6	5
293	511	9	8	8	8	8	8	7	7	8	8	7	7	7
299	386	6	6	6	6	5	5	5	5	6	5	6	5	6
230	452	3	3	3	3	3	3	4	4	4	4	5	5	4
232	377	4	4	4	4	4	4	4	4	4	5	5	5	5
233	385	5	4	4	4	4	4	5	5	4	4	4	4	4
253	974	3	3	3	3	3	3	3	4	3	3	3	3	4
254	930	4	4	4	4	4	4	4	4	5	4	5	5	6
255	774	4	3	4	4	4	4	4	4	4	4	4	3	4
Total	5269	5	5	5	5	5	5	5	5	5	5	5	5	5
Rochester														
338	454	4	4	4	4	4	5	5	4	4	4	4	4	5
339	394	5	5	5	4	5	5	4	4	5	5	4	5	5
341	611	9	9	9	9	9	10	10	9	10	9	9	9	8
342	350	10	11	11	12	11	13	15	17	13	13	13	14	15
343	662	8	8	8	9	9	11	13	11	13	14	11	11	10
344	189	16	15	14	14	14	15	17	15	15	17	12	14	18
345	326	11	11	11	11	10	10	11	12	11	12	13	13	13
346	319	18	18	18	19	19	19	20	20	21	22	23	22	22
347	434	10	9	9	9	9	10	11	12	13	13	12	11	10
348	332	17	17	17	16	15	15	16	17	17	16	16	18	18
349	492	14	15	16	17	17	18	21	19	20	21	21	20	20
Total	4563	11	11	11	11	11	12	13	13	13	13	13	13	13

FALL WILD TURKEY POPULATION SURVEY, 2008

Eric Dunton and Jennifer Snyders, Farmland Wildlife Populations and Research Group

Changes in distribution and abundance of wild turkeys (*Meleagris gallopavo*) in Minnesota are monitored using a mail survey of white-tailed deer (*Odocoileus virginianus*) hunters in the state's wild turkey range and potential range. The survey is scheduled once every 2 years and consists of asking randomly selected deer hunters where they hunted (permit area [PA]), if they saw wild turkeys while hunting, and the approximate location (miles and direction from nearest town) of turkey sightings. The purpose of the survey is to calculate a wild turkey population index based on the proportion of deer hunters observing wild turkeys (HOWT) in 16 turkey management units (TMU) and their subset PAs, describe relative changes (increase, decrease, none) in the HOWT index compared to previous surveys, describe changes in wild turkey distribution, and estimate the average finite rate of population change over the last 4 surveys.

METHODS

We randomly selected 20,617 permit holders for the regular firearms deer season in 16 TMUs, which included 106 PAs (Figure 1). Prior to 2006, the survey consisted of a stratified sample of antlerless deer hunters, where the PA of each hunter was known prior to drawing the sample. Beginning in 2006, the sampling frame was modified because regulation changes allowed hunters in managed or intensive areas to hunt anywhere within their selected hunting period and zone. But because most hunters pursue deer within relatively small, traditional areas (Welsh and Kimmel 1990), we used PAs listed in the Electronic Licensing System (ELS) as a stratification variable and we selected a random sample of regular firearm deer hunters from each PA.

Turkey PA boundaries were identical to deer permit area boundaries except where several deer PAs were combined into 1 turkey permit area. However, names and boundaries of several permit areas changed since the 2006 survey. The 400 series of deer PAs were changed to a 200 series prior to the 2008 deer season but turkey PAs retained the 400-series names and, therefore, data presented in this report use the 400 series names. Several changes to PA boundaries affected the boundary of TMU O. Turkey PA 425 was combined with PA 435 prior to 2008 and the resulting PA spanned two TMUs (i.e., H and I). We retained the original boundaries of PAs 425 and 435 for this report.

We estimated sample size for each TMU based on a family-wise Type I error rate of 0.15 (per-contrast alpha (α_c) = 0.15/16 TMUs = 0.01), a desired margin of error = 0.07 (half-width of CI for HOWT change), mean HOWT = 0.5, a finite population correction factor, and a response rate of 60%. We used a α_c of 0.01 as a tradeoff between controlling the Type I error rate (probability of rejecting a true null) and having reasonable power to detect a change of $\geq$7% at the TMU scale. Each estimated TMU sample size was then divided among PAs based on the proportion of hunters in each PA (ELS database).

We mailed selected hunters a postcard questionnaire requesting information on PA hunted, number of turkeys observed while hunting, and location of turkey observations (miles and direction from nearest town). We delivered the first mailing on 7 November 2008 and a second mailing on 9 January 2009 to all non-respondents. We did not conduct a third mailing because previous surveys showed that the proportion of useable returns decreased with mailing and by the third mailing >30% of the returns had missing data or were unusable.

We estimated HOWT for each TMU and PA and compared estimates to those of the previous survey (Kimmel and Brinkman 2000, Kruger and Dingman 2003, Isackson et al. 2007). We used log-linear models (Eberhardt and Simmons 1992) to estimate the mean annual rate of change (λ) in HOWT during the past 4 surveys (1999-2008). We constructed an 85% family of confidence intervals (CI) for parameter estimates at the TMU scale. These are equivalent to 99% CIs where the per-family Type I error rate is 0.15 (see above). We constructed standard 95% asymptotic confidence intervals at the PA scale because of the large number of comparisons and small sample sizes. Estimated changes in HOWT (compared to 2006) were considered meaningful if the CI did not include zero, and precision was deemed acceptable if the CI was less than ±7% (desired margin of error). Likewise, we interpreted estimated finite rates of change (λ) as meaningful if the CI did not include 1, and we deemed precision as acceptable if the CI was less than ±0.07.

We generated maps of turkey observations to monitor potential range changes. We excluded questionable observations (where distance between the turkey observation and the center of the hunter-listed PA was >3 times the diameter of the PA) and locations that were outside the state boundary.

RESULTS

The overall response rate was 44.0%, which was lower than the expected response rate (60%) used in sample-size calculations. The response rate decreased from 30.9% in mailing 1 to 19.2% in mailing 2. The percentage of hunters that reported seeing turkeys was independent of mailing (χ^2_2 = 0.586, P = 0.44), which indicated that non-response bias was negligible (at least at the range-wide scale).

Compared to 2006, the HOWT index increased in 6 TMUs (E, F, H, J, L, and N) and was unchanged (CI included zero) in 10 TMUs (Table 1, Figure 1). However, the desired level of precision (±7%) was achieved in only 20% of the TMUs with “no change” (Table 1). Thus, conclusions about “no change” at the TMU scale should be viewed cautiously. Ninety-seven PAs (92%) had comparable data for estimating change in HOWT from the 2006 survey (Table 2). The HOWT index increased in 22 PAs (156, 183, 215, 222, 239, 241, 244, 245, 246, 247, 249, 346, 412, 425, 427, 433, 435, 442, 447, 454, 461, and 462); whereas the remaining 75 CIs included zero (indicating no meaningful change or the change was undetectable due to poor precision). Most estimates at the PA scale were imprecise, e.g., only 3 PAs (170, 172, and 184) achieved the desired level of precision (Table 2). This lack of precision primarily reflected small sample sizes.

Four TMUs (D, E, G, and M) exhibited a positive annual rate of change during 1999-2008 (Figure 2). No negative trends were detected, but 11 TMUs had CI’s that included λ = 1 with levels of precision > 0.07 (Table 1). Thus, estimates of λ were generally imprecise and conclusions about “no change” at the TMU scale should be interpreted cautiously. Eighty-seven PAs had comparable data for estimating λ. Based on the 95% CI of λ, 2% of PAs exhibited a negative rate of change, 31% exhibited positive rates of change, and 67% PAs had CIs that included λ = 1 (no change; Table 2). However, most estimates of change were imprecise (Table 2). Likewise, only 26% of the PAs with “no change” achieved the desired precision (Table 2). Thus, estimates of “no change” should be viewed cautiously at both the TMU and PA scale.

A comparison of the distribution of turkeys sighted by deer hunters during fall 2006 versus 2008 (Figure 3) suggests that wild turkey range continues to expand in Minnesota.

DISCUSSION

Although we were not able to precisely detect changes in population indices, our data suggest that turkey populations increased since 2006 in TMUs E, F, H, J, L, and N (Figure 1). Population trend data based on the 4 most recent surveys (1999 – 2008) indicate a positive population trend (i.e., the 95% confidence interval [lambda] > 1) in TMUs D, E, G, and M (Figure 2). Turkey populations in the northern portions of TMUs E, J, and N were recently established and are believed to be reproducing and expanding northward. In southeastern Minnesota, population indices and finite rates of change are relatively stable (λ = 1). Turkey populations in these areas are well established, with population indices probably reflecting random fluctuations around a relatively stable long-term mean.

Population indices from this survey are used to predict future population levels, allocate turkey-hunting permits, and provide information to make management decisions (Kimmel 2000). This report improved measures of uncertainty for population indices and estimated rates of change (previously assumed to be measured without error). These measures of uncertainty can be incorporated into turkey population models to realistically account for precision in management decisions. Estimating HOWT at the PA level is not reliable and increasing sample size to achieve the desired precision is not economically feasible. Options for dealing with uncertainty at the PA scale include managing at a broader scale (e.g., TMU) or using alternative techniques to interpret data (e.g., small-area estimation) at the PA level.

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Table 1. Percent of deer hunters that observed wild turkeys (HOWT) by turkey management unit (TMU) in Minnesota, 2008.

	2008			Absolute change from 2006				Historic mean[b]			Mean finite rate of change			
TMU	*n*	HOWT	SE	*n*	Δ HOWT	SE	99% CI[a]	*n*	HOWT	SE	Interval	*n*	λ	99% CI[a]
A	575	66.8	2.0	1,036	2.7	3.0	(-5.0, 10.4)	13	63.3	2.1	(1999-2008)	4	0.99*	(0.94, 1.04)
B	374	59.8	2.5	729	-1.0	3.6	(-10.3, 8.3)	12	60.9	2.8	(1999-2008)	4	0.98	(0.89, 1.07)
C	691	70.0	1.7	1,219	1.8*	2.7	(-5.2, 8.8)	12	52.2	4.7	(1999-2008)	4	0.99	(0.91, 1.09)
D	573	66.7	2.0	1,041	7.7	3.1	(-0.3, 15.7)	12	20.1	4.0	(1999-2008)	4	1.06*	(1.04, 1.07)
E	646	42.6	2.0	1,235	8.0	2.8	(0.8, 15.2)	12	8.0	1.8	(1999-2008)	4	1.15*	(1.09, 1.20)
F	477	63.7	2.2	960	9.7	3.2	(1.5, 17.9)	12	19.2	4.0	(1999-2008)	4	1.03	(0.96, 1.12)
G	464	38.5	2.3	987	3.2	3.2	(-5.0, 11.4)	12	7.2	1.9	(1999-2008)	4	1.07*	(1.02, 1.11)
H	532	64.0	2.2	1,098	11.3	3.1	(3.3, 19.3)	12	21.5	4.0	(1999-2008)	4	1.03	(0.95, 1.13)
I	418	40.7	2.4	877	6.8	3.3	(-1.7, 15.3)	10	6.6	2.2	(1999-2008)	4	1.08	(0.99, 1.19)
J	621	39.1	2.0	1,155	9.0	2.8	(1.8, 16.2)	9	5.2	2.1	(1999-2008)	4	1.11	(0.96, 1.30)
K	739	56.6	1.9	1,356	5.9	2.8	(-1.3, 13.1)	12	9.7	2.8	(1999-2008)	4	1.09	(0.99, 1.20)
L	515	54.2	2.3	950	11.1	3.3	(2.6, 19.6)	8	4.6	2.4	(1999-2008)	4	1.15	(0.91, 1.45)
M	396	30.7	2.4	861	7.2	3.3	(-1.3, 15.7)	8	5.2	1.4	(1999-2008)	4	1.18	(1.01, 1.37)
N	699	49.0	1.9	1,270	19.0*	2.7	(12.0, 26.0)	8	3.9	1.7	(1999-2008)	4	1.18	(0.93, 1.51)
O	629	17.4	1.9	888	4.2	3.0	(-3.5, 11.9)	8	3.4	0.9	(1999-2008)	4	1.17	(0.70, 1.97)
P	627	5.8	0.9	1,104	1.3*	1.4	(-2.3, 4.9)	1	4.4		(2006-2008)	2	1.12	

[a] 85% family of confidence intervals (type I error rate controlled at $\alpha = 0.15$).

[b] Mean HOWT index over all available surveys (*n*) prior to 2008.

*Desired level of precision achieved

Table 2. Percent of deer hunters that observed wild turkeys (HOWT) by turkey permit area (PA) in Minnesota, 2008.

	2008			Absolute change from 2006				Historic mean[b]			Mean finite rate of change			
TMU-TPA	*n*	HOWT	SE	*n*	Δ HOWT	SE	95% CL[a]	*n*	HOWT	SE	Interval	*n*	λ	95% CL[a]
A-345	123	66.8	4.2	204	1.8	6.6	(-11.1, 14.7)	12	56.3	3.6	(1999-2008)	4	0.99*	(0.94, 1.03)
A-346	143	70.6	3.8	269	12.8	5.8	(1.4, 24.2)	12	57.2	2.7	(1999-2008)	4	1.00*	(0.94, 1.07)
A-348	140	60.0	4.1	226	-3.4	6.5	(-16.1, 9.3)	12	73.0	2.1	(1999-2008)	4	0.97*	(0.97, 0.98)
A-349	162	68.4	3.6	329	0.3	5.1	(-9.7, 10.3)	13	66.5	1.8	(1999-2008)	4	0.99*	(0.98, 1.00)
B-344	374	59.8	2.5	729	-1.0	3.6	(-8.1, 6.1)	12	60.9	2.8	(1999-2008)	4	0.98*	(0.94, 1.02)
C-341	215	64.1	3.2	401	2.6	4.8	(-6.8, 12.0)	12	48.7	5.5	(1999-2008)	4	0.98	(0.88, 1.10)
C-342	149	68.5	3.8	262	1.0	5.8	(-10.4, 12.4)	12	50.3	5.3	(1999-2008)	4	1.00*	(0.97, 1.03)
C-343	191	74.6	3.1	323	2.0	5.0	(-7.8, 11.8)	12	48.1	6.3	(1999-2008)	4	1.00*	(0.98, 1.02)
C-347	133	72.6	3.9	220	-1.2	6.2	(-13.4, 11.0)	12	63.9	2.1	(1999-2008)	4	1.01*	(0.99, 1.02)
D-227	182	63.8	3.6	356	6.3	5.2	(-3.9, 16.5)	10	15.1	4.1	(1999-2008)	4	1.11*	(1.07, 1.14)
D-235	29	33.5	8.1	49	-8.1	12.8	(-33.2, 17.0)	12	17.2	2.9	(1999-2008)	4	1.03	(0.88, 1.20)
D-236	146	70.0	3.7	261	11.3	5.9	(-0.3, 22.9)	11	22.6	5.6	(1999-2008)	4	1.04*	(1.01, 1.08)
D-338	86	65.3	5.1	151	8.2	7.8	(-7.1, 23.5)	12	27.2	4.7	(1999-2008)	4	1.00*	(0.96, 1.04)
D-601	129	74.4	0.1	211	7.5	5.3	(-2.9, 17.9)	12	16.7	4.0	(1999-2008)	4	1.05	(0.91, 1.22)
E-152	13	45.6	12.4	27	26.3	15.5	(-4.1, 56.7)	3	27.6	7.9	(1999-2008)	4	0.99	(0.74, 1.33)
E-156	143	31.6	3.9	257	10.7	5.4	(0.1, 21.3)	3	10.6	4.5	(1999-2008)	4	1.22*	(1.16, 1.28)
E-157	196	46.9	3.6	377	7.1	5.1	(-2.9, 17.1)	8	3.3	2.1	(1999-2008)	4	1.23	(1.10, 1.37)
E-159	102	39.1	4.8	195	-5.1	7.1	(-19.0, 8.8)	8	4.3	2.1	(1999-2008)	4	1.17	(0.99, 1.38)
E-183	104	38.8	4.8	203	14.3	6.4	(1.8, 26.8)	3	15.1	4.5	(1999-2008)	4	1.13	(0.90, 1.41)
E-225	88	60.5	5.1	170	10.1	7.4	(-4.4, 24.6)	12	10.4	2.1	(1999-2008)	4	1.09	(1.00, 1.20)
F-339	99	55.5	4.9	185	-2.3	7.2	(-16.4, 11.8)	12	32.9	3.7	(1999-2008)	4	1.00	(0.91, 1.08)
F-461	82	72.8	5.0	160	24.1	7.5	(9.4, 38.8)	12	16.9	4.0	(1999-2008)	4	1.06	(0.94, 1.19)
F-462	100	70.4	4.7	186	20.7	7.1	(6.8, 34.6)	12	34.3	4.8	(1999-2008)	4	1.01	(0.91, 1.12)
F-463	46	46.0	7.1	88	0.1	10.2	(-19.9, 20.1)	12	10.6	2.8	(1999-2008)	4	1.04	(0.94, 1.14)

Table 2. Continued.

TMU-TPA	2008			Absolute change from 2006				Historic mean[b]			Mean finite rate of change			
	n	HOWT	SE	*n*	Δ HOWT	SE	95% CL[a]	*n*	HOWT	SE	Interval	*n*	λ	95% CL[a]
F-464	43	61.7	7.1	78	1.0	10.7	(-20.0, 22.0)	12	7.4	2.9	(1999-2008)	4	1.07	(1.00, 1.16)
F-465	34	57.0	8.2	60	11.0	12.1	(-12.7, 34.7)	12	10.8	3.1	(1999-2008)	4	1.03*	(0.97, 1.08)
F-466	20	65.9	10.2	97	15.0	11.8	(-8.1, 38.1)	12	18.8	4.0	(1999-2008)	4	1.03	(0.89, 1.20)
F-467	42	67.8	6.8	94	-3.3	9.3	(-21.5, 14.9)	12	14.8	4.9	(1999-2008)	4	1.04*	(0.98, 1.11)
G-446	28	42.1	8.9	65	0.0	11.8	(-23.1, 23.1)	9	7.7	3.1	(1999-2008)	4	1.02*	(0.97, 1.07)
G-447	32	48.8	8.6	72	21.9	10.9	(0.5, 43.3)	9	4.5	1.9	(1999-2008)	4	1.07	(0.92, 1.25)
G-448	37	51.6	8.4	81	2.5	11.2	(-19.5, 24.5)	7	17.5	5.8	(2002-2008)	3	1.00	(0.90, 1.11)
G-449	40	51.0	7.9	84	-8.8	10.7	(-29.8, 12.2)	8	10.5	4.4	(2002-2008)	3	1.06	(0.58, 1.96)
G-450	27	52.0	9.0	47	16.7	13.7	(-10.2, 43.6)	9	9.3	3.0	(1999-2008)	4	1.02	(0.92, 1.14)
G-451	93	22.8	4.3	174	-6.0	6.8	(-19.3, 7.3)	8	7.4	2.2	(1999-2008)	4	1.01	(0.87, 1.18)
G-454	62	38.0	6.4	139	17.3	8.3	(1.0, 33.6)	8	7.1	2.2	(1999-2008)	4	1.04	(0.88, 1.22)
G-456	41	17.5	5.7	76	-9.3	9.2	(-27.3, 8.7)	11	6.3	1.5	(1999-2008)	4	1.08	(0.89, 1.32)
G-457	35	51.7	8.4	79	11.8	11.0	(-9.8, 33.4)	8	12.7	3.1	(1999-2008)	4	1.15*	(1.12, 1.17)
G-458	22	27.2	9.1	64	-3.8	11.5	(-26.3, 18.7)	8	6.9	1.8	(1999-2008)	4	1.14	(0.96, 1.35)
G-459	38	55.4	7.9	96	6.9	10.1	(-12.9, 26.7)	12	11.7	3.0	(1999-2008)	4	1.05*	(1.01, 1.10)
H-435	156	64.9	3.8	319	12.7	5.6	(1.7, 23.7)	8	19.4	5.0	(1999-2008)	4	1.04*	(0.98, 1.09)
H-431	37	35.9	7.7	77	-19.7	10.8	(-40.9, 1.5)	12	7.2	1.9	(1999-2008)	4	1.08	(0.90, 1.29)
H-433	83	52.3	5.5	161	18.9	7.7	(3.8, 34.0)	8	9.0	2.9	(1999-2008)	4	1.11	(1.01, 1.21)
H-440	103	61.6	4.9	213	8.5	6.8	(-4.8, 21.8)	8	29.0	5.9	(1999-2008)	4	1.02*	(0.99, 1.05)
H-442	136	68.5	4.0	291	16.6	5.6	(5.6, 27.6)	12	31.2	4.3	(1999-2008)	4	1.00	(0.92, 1.10)
H-443	65	67.7	5.7	142	9.3	7.9	(-6.2, 24.8)	10	23.1	5.9	(1999-2008)	4	1.01*	(0.97, 1.06)
I-425	156	64.9	3.8	319	12.7	5.6	(1.7, 23.7)	8	19.4	5.0	(1999-2008)	4	1.04*	(0.98, 1.09)
I-426	103	19.9	4.0	217	-0.6	5.4	(-11.2, 10.0)	9	6.5	2.1	(1999-2008)	4	1.00*	(0.99, 1.01)
I-427	117	46.8	4.6	236	12.6	6.3	(0.3, 24.9)	10	7.1	2.5	(1999-2008)	4	1.07	(0.94, 1.22)
I-428	155	50.7	4.1	323	6.2	5.6	(-4.8,17.2)	10	8.0	3.0	(1999-2008)	4	1.11	(1.00, 1.23)

Table 2. Continued.

TMU-TPA	2008			Absolute change from 2006				Historic mean[b]			Mean finite rate of change			
	n	HOWT	SE	*n*	Δ HOWT	SE	95% CL[a]	*n*	HOWT	SE	Interval	*n*	λ	95% CL[a]
J-154	180	15.7	2.7	324	3.8	3.8	(-3.6, 11.2)	3	5.2	2.3	(1999-2008)	4	1.16	(0.92, 1.46)
J-221	92	59.1	5.0	160	8.0	7.8	(-7.3, 23.3)	9	4.7	2.2	(1999-2008)	4	1.13*	(1.07, 1.19)
J-222	77	59.2	5.5	153	20.2	7.7	(5.1, 35.3)	9	4.4	1.6	(1999-2008)	4	1.22	(1.02, 1.44)
J-223	19	65.3	9.8	65	-10.3	11.6	(-33.0, 12.4)	9	8.1	4.4	(1999-2008)	4	1.06	(0.97, 1.15)
J-224	16	54.6	11.4	28	4.6	11.5	(-17.9, 27.1)	6	41.7	7.4	(1999-2008)	4	1.07	(0.82, 1.39)
J-242	50	18.9	5.8	94	9.7	7.3	(-4.6, 24.0)	2	8.3	0.6	(2002-2008)	3	1.13	(0.43, 2.96)
J-247	72	34.4	5.4	133	16.7	7.3	(2.4, 31.0)	3	7.1	2.7	(1999-2008)	4	1.21	(0.95, 1.54)
J-249	105	53.1	4.8	182	19.5	7.3	(5.2, 33.8)	3	18.3	5.4	(1999-2008)	4	1.17	(1.06, 1.29)
K-215	235	65.7	3.3	425	9.8	4.9	(0.2, 19.4)	9	8.1	4.2	(1999-2008)	4	1.09*	(1.06, 1.12)
K-218	196	57.3	3.6	360	-6.3	5.3	(-16.7, 4.1)	12	8.5	3.1	(1999-2008)	4	1.09	(0.98, 1.20)
K-219	116	53.8	4.6	203	12.6	6.9	(-0.9, 26.1)	12	11.1	1.5	(1999-2008)	4	1.16*	(1.12, 1.21)
K-229	31	50.0	8.8	70	10.9	11.6	(-11.8, 33.6)	6	14.8	4.7	(1999-2008)	4	1.08*	(1.02, 1.14)
K-417	164	45.4	3.9	302	7.5	5.7	(-3.7, 18.7)	8	7.3	3.1	(1999-2008)	4	1.07*	(1.03, 1.11)
L-213	74	49.4	5.7	125	0.5	8.9	(-16.9, 17.9)	8	4.5	1.9	(1999-2008)	4	1.27	(1.02, 1.57)
L-239	212	63.6	3.4	365	11.8	5.3	(1.4, 22.2)	8	4.9	2.6	(1999-2008)	4	1.19*	(1.12, 1.26)
L-412	144	51.1	4.3	281	17.3	5.9	(5.7, 28.9)	8	5.9	2.8	(1999-2008)	4	1.09	(0.93, 1.27)
L-416	83	39.7	5.4	177	-0.1	7.3	(-14.4, 14.2)	8	7.1	3.2	(1999-2008)	4	1.06*	(1.02, 1.10)
M-420	72	37.5	5.6	161	10.6	7.3	(-3.7, 24.9)	8	8.0	2.1	(1999-2008)	4	1.25	(0.95, 1.63)
M-421	50	22.4	6.4	116	-2.9	8.7	(-20.0, 14.2)	8	3.2	0.9	(1999-2008)	4	1.25	(0.87, 1.79)
M-422	64	53.5	6.3	119	4.4	9.0	(-13.2, 22.0)	8	9.0	3.8	(1999-2008)	4	1.10*	(1.06, 1.14)
M-423	82	19.2	4.3	176	6.3	5.6	(-4.7, 17.3)	8	5.0	1.0	(1999-2008)	4	1.13	(0.93, 1.37)
M-424	129	28.0	4.1	292	7.5	5.2	(-2.7, 17.7)	8	5.1	1.4	(1999-2008)	4	1.17*	(1.15, 1.19)
N-214	66	66.4	5.9	129	10.4	8.6	(-6.5, 27.3)	8	5.3	2.5	(1999-2008)	4	1.25	(1.15, 1.37)

Table 2. Continued.

TMU-TPA	2008			Absolute change from 2006				Historic mean[b]			Mean finite rate of change			
	n	HOWT	SE	*n*	Δ HOWT	SE	95% CL[a]	*n*	HOWT	SE	Interval	*n*	λ	95% CL[a]
N-240	71	54.9	5.7	115	8.0	9.3	(-10.2, 26.2)	8	4.9	1.9	(1999-2008)	4	1.15*	(1.11, 1.20)
N-241	52	61.6	6.5	110	25.9	9.1	(8.1, 43.7)	7	3.6	1.4	(2002-2008)	3	1.28	(1.16, 1.41)
N-243	73	46.2	5.8	121	11.7	8.8	(-5.5, 28.9)	3	14.7	6.8	(1999-2008)	4	1.21	(1.07, 1.37)
N-244	126	42.6	4.3	233	13.4	6.2	(1.2, 25.6)	8	3.4	1.7	(1999-2008)	4	1.11*	(1.06, 1.17)
N-245	127	31.1	4.0	218	22.8	4.9	(13.2, 32.4)	3	8.1	0.3	(1999-2008)	4	1.13	(0.82, 1.55)
N-246	145	54.8	4.1	280	33.1	5.4	(22.5, 43.7)	3	10.9	4.2	(1999-2008)	4	1.22	(0.93, 1.62)
N-248	36	52.7	7.9	61	-0.3	12.2	(-24.2, 23.6)	3	31.0	9.4	(1999-2008)	4	1.13	(1.04, 1.22)
O-201	10	31.7	14.3	17	13.4	18.1	(-22.1, 48.9)	2	17.5	0.8	(2002-2008)	3	1.10	(0.52, 2.32)
O-208	22	12.3	6.5	36	-6.9	12.6	(-31.6, 17.8)	3	9.8	2.6	(1999-2008)	4	1.06	(0.86, 1.31)
O-209	4	25.0	2.2	35	8.2	6.7	(-4.9, 21.3)	3	7.6	2.4	(1999-2008)	4	1.16	(0.97, 1.39)
O-210	65	13.4	4.2	131	4.8	5.4	(-5.8, 15.4)	3	4.6	1.6	(1999-2008)	4	1.13	(1.03, 1.25)
O-251	8	27.1	13.3	21	-10.8	18.5	(-47.1, 25.5)	3	16.2	6.1	(1999-2008)	4	1.13	(0.94, 1.35)
O-256	32	20.1	6.7	60	2.0	9.6	(-16.8, 20.8)	1	18.1	.	(2006-2008)	2	1.05	
O-257	21	29.1	9.0	40	18.5	11.7	(-4.4, 41.4)	8	3.5	0.5	(1999-2008)	4	1.14	(0.92, 1.42)
O-260	49	25.8	6.6											
O-261	47	13.5	4.8											
O-262	31	40.4	8.5											
O-263	46	16.1	5.2											
O-264	53	19.4	5.3											
O-265	40	20.2	6.1											
O-266	43	24.4	6.5											
O-267	26	8.2	6.1											
O-268	34	6.5	4.8											

Table 2. Continued.

TMU-TPA	2008			Absolute change from 2006				Historic mean[b]			Mean finite rate of change			
	n	HOWT	SE	*n*	Δ HOWT	SE	95% CL[a]	*n*	HOWT	SE	Interval	*n*	λ	95% CL[a]
O-298	67	26.5	6.1	112	9.9	8.1	(-6.0, 25.8)	3	10.1	3.1	(1999-2008)	4	1.16*	(1.09, 1.23)
P-170	141	7.6	2.2	237	2.4*	3.3	(-4.1, 8.9)	1	5.1		(2006-2008)	2	1.19	
P-172	116	7.2	2.4	207	1.9*	3.3	(-4.6, 8.4)	1	5.2		(2006-2008)	2	1.15	
P-174	78	4.8	2.4	132	-0.9	4.0	(-8.7, 6.9)	1	5.7		(2006-2008)	2	0.93	
P-181	67	8.5	3.3	123	1.4	4.7	(-7.8, 10.6)	1	7.1		(2006-2008)	2	1.08	
P-182	8	23.8	12.4	17	-6.3	17.6	(-40.8, 28.2)	1	30.0		(2006-2008)	2	0.89	
P-184	159	7.5	2.1	264	1.1*	3.1	(-5.0, 7.2)	1	6.4		(2006-2008)	2	1.07	
P-197	48	6.1	3.4	87	0.0	5.9	(-11.6, 11.6)	1	6.1		(2006-2008)	2	1.00	
P-199	6	20.0	1.5	12	-8.0	14.7	(-36.8, 20.8)	1	28.0		(2006-2008)	2	0.85	
P-287	2	32.1	18.5	12	17.5	20.6	(-22.9, 57.9)	1	14.6		(2006-2008)	2	1.46	

[a] Confidence intervals are not adjusted for multiple comparisons, i.e., $\alpha \geq 0.25$.

[b] Mean HOWT index over all available surveys (*n*) prior to 2008.

*Desired level of precision achieved

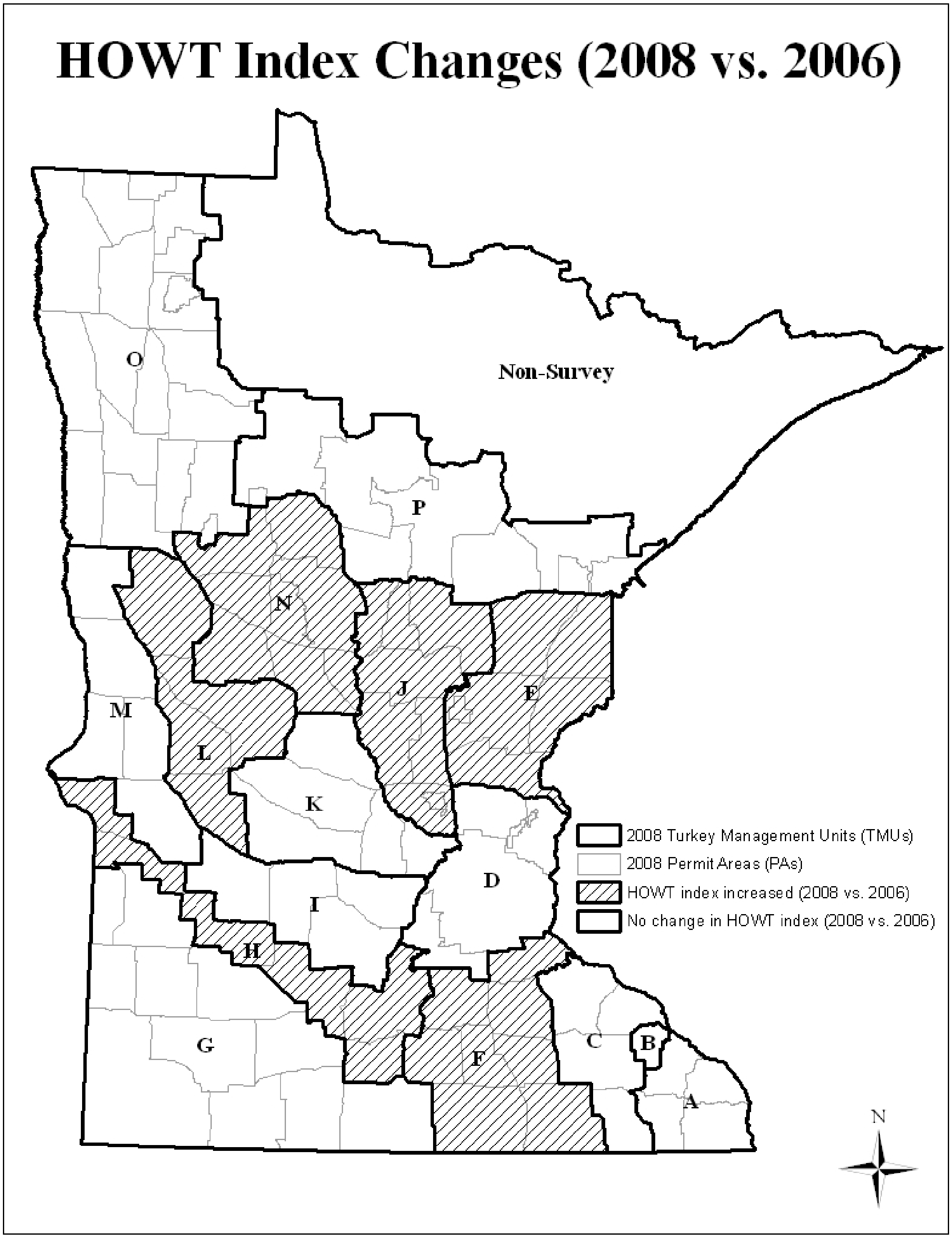

Figure 1. Shaded regions show TMUs where HOWT (population index) increased between the 2006 and 2008 fall wild-turkey population survey. Non-shaded TMUs had no change in HOWT or the desired level of precision was inadequate to detect change.

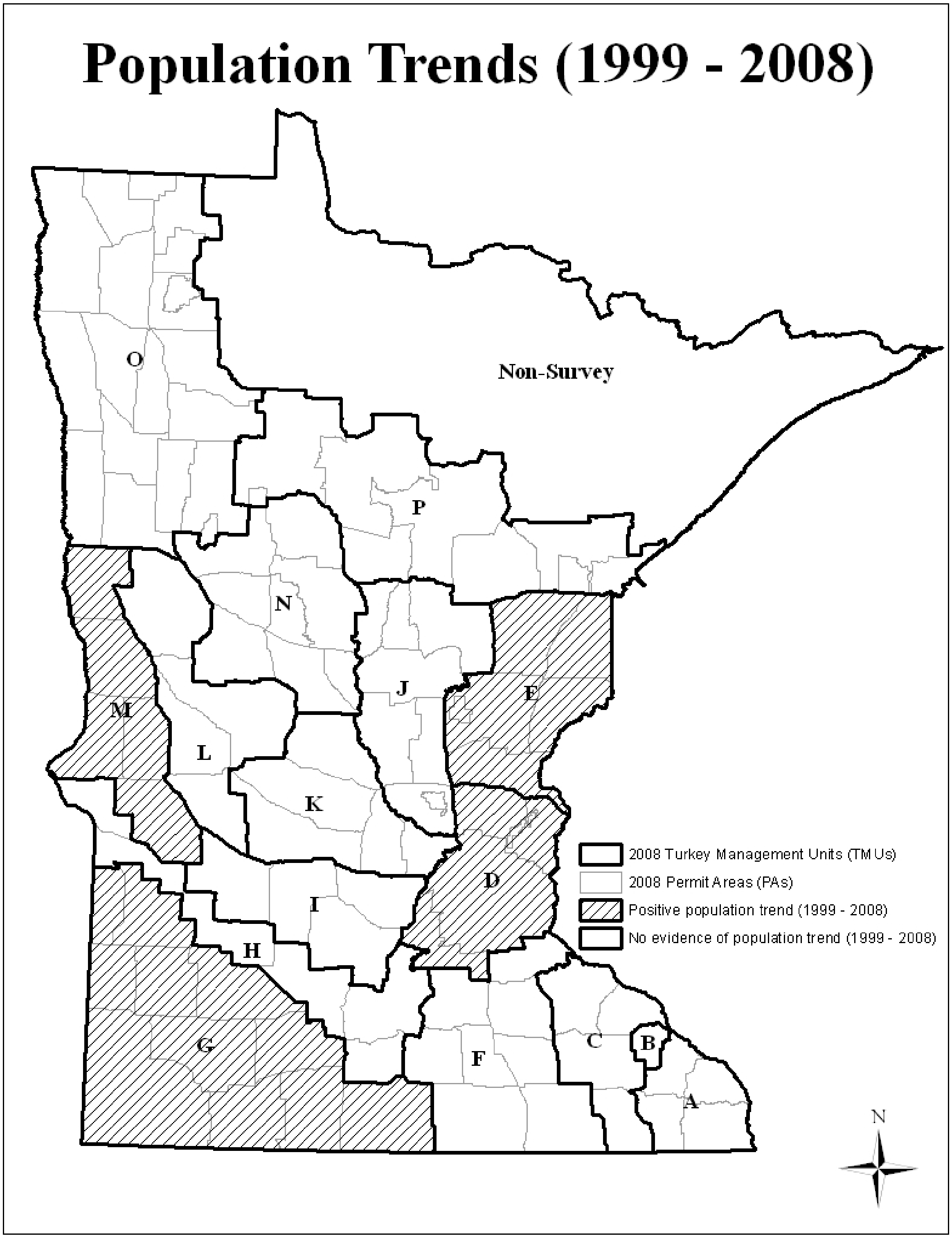

Figure 2. Shaded TMUs had positive population trends during 1999 – 2008 (i.e., the 95% confidence interval [lambda] > 1). Non-shaded TMUs had no evidence of a population trend (linear increase or decrease).

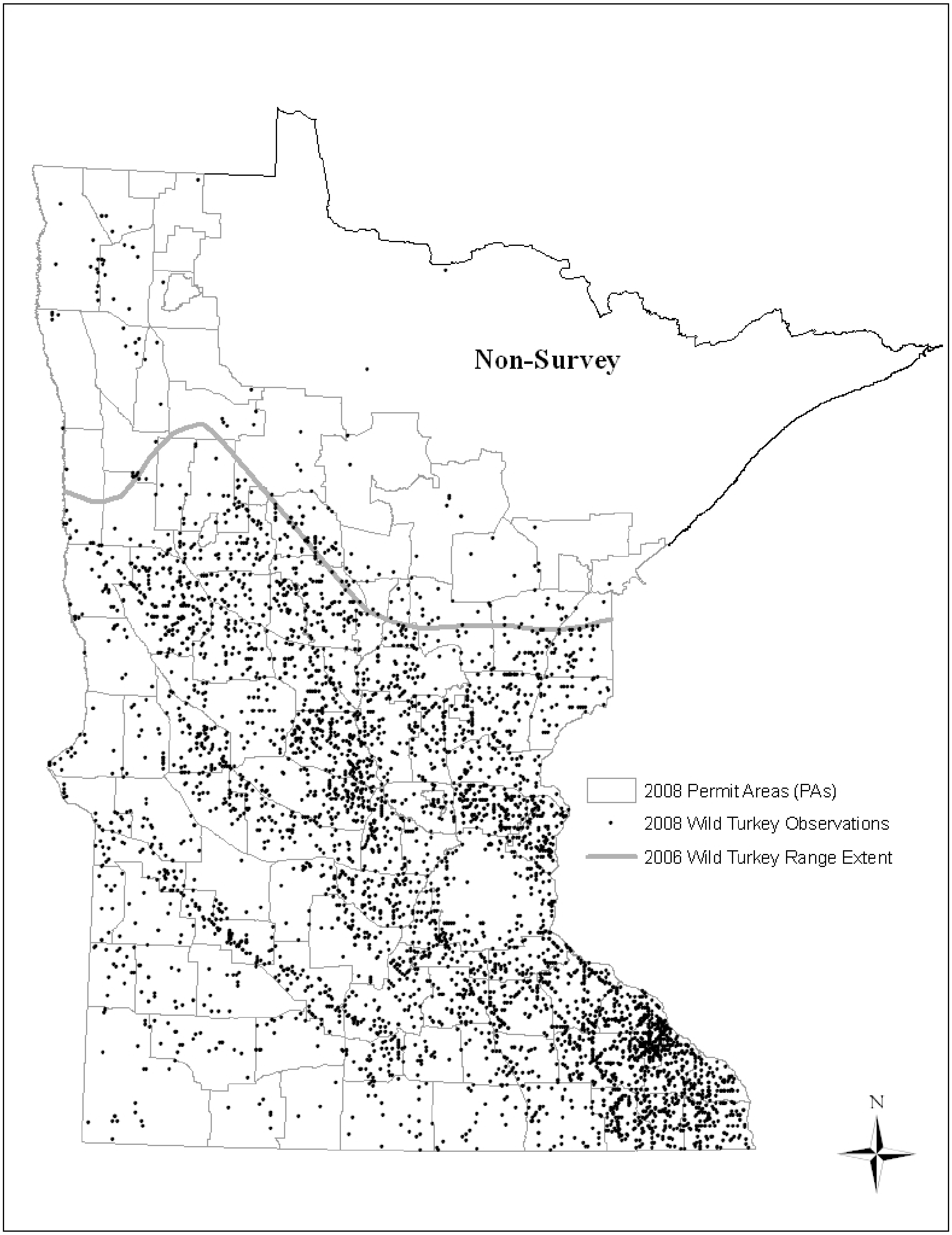

Figure 3. Distribution of wild turkeys based on observations by deer hunters in Minnesota, fall 2008. The solid gray line indicates turkey range extent based on turkey distribution data from the 2006 survey.