WETLAND WILDLIFE POPULATIONS

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2013 WATERFOWL BREEDING POPULATION SURVEY MINNESOTA

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ABSTRACT:

The number of breeding waterfowl in a portion of Minnesota has been estimated each year since 1968 as a part of the overall inventory of North American breeding waterfowl. The survey consists of aerial observations in addition to more intensive ground counts on selected routes to determine the proportion of birds counted by the aerial crew. Procedures used are similar to those used elsewhere across the waterfowl breeding grounds. The 2013 aerial survey portion was flown from May 12 to May 27. Both the start and end dates were about 10 days later than normal due to the extremely late spring and late ice out. Spring ice-out dates were 10-20 days later than average across the state and ~6 weeks later than 2012. Temperatures were well below normal in April with above average snowfall. Temperatures in May were also below normal with above average precipitation, most of which was rain in mid to late May. Spring wetland conditions were very dry early spring but improved in mid to late May with significant rainfall events. Overall, wetland numbers (Types II-V) increased 13% compared to 2012 and were near both the 10-year (-3%) and long-term (+2%) averages.

The 2013 estimated mallard breeding population was 293,000, which was 30% higher than last year's estimate of 225,000 mallards, but statistically unchanged (P=0.36). Mallard numbers were 14% above the 10-year average and 30% above the long-term average of 226,000 breeding mallards. The 2013 estimated blue-winged teal population was 144,000, which was 33% higher than last year's estimate of 109,000 blue-winged teal, but statistically unchanged (P=0.53). Blue-winged teal numbers remained 19% below the 10-year average and 33% below the long-term average of 216,000 blue-winged teal. The combined population index of other ducks, excluding scaup, was 246,000 ducks, which was 82% higher than last year's estimate and 25% above the 10-year average and 39% above the long-term average of 177,000 other ducks. Population estimates of wood duck (72,000), ring-necked duck (60,000), northern shoveler (27,000), and gadwall (24,000) accounted for most (75%) of the total population of other ducks.

The estimate of total duck abundance (683,000), which excludes scaup, was 46% higher than last year's estimate of 469,000 ducks and was 8% above the 10-year average and 10% above the long-term average of 620,000 ducks. The estimated number of Canada geese was 209,000 and 32% higher than last year and 18% above the 10-year average. Very few goose broods were observed this year during the survey due to the late spring and late and likely reduced nesting effort by Canada geese this year.

METHODS:

The aerial survey is based on a sampling design that includes three survey strata (Table 1, Figure 1). The strata cover 39% of the state area and are defined by density of lake basins (>10 acres) exclusive of the infertile northeastern lake region. The strata include the following:

Stratum I: high density, 21 or more lake basins per township.

Stratum II: moderate density, 11 to 20 lake basins per township.

Stratum III: low density, 2 to 10 lake basins per township.

Areas with less than two basins per township are not surveyed. Strata boundaries were based upon "An Inventory of Minnesota Lakes" (Minnesota Conserv. Dept. 1968:12). Standard procedures for the survey follow those outlined in "Standard Operating Procedures for Aerial Waterfowl Breeding Ground Populations and Habitat Surveys in North America" (USFWS/CWS 1987). Changes in survey methodology were described in the 1989 Minnesota Waterfowl Breeding Population Survey report. Pond and waterfowl data for 1968-74 were calculated from Jessen (1969-72) and Maxson and Pace (1989).

All aerial transects in Strata I-III (Table 1) were flown using a Cessna 185 (N805NR). Wetlands were counted on only the observer's side of the plane (0.125 mile wide transect); a correction factor obtained in 1989 (123,000/203,000 = 0.606) was used to adjust previous estimates (1968-88) of wetland abundance (Type II-V) that were obtained when the observer counted wetlands on both sides of the plane (0.25 mile wide transect). All wetland and waterfowl data were recorded on digital voice recorders by the pilot and observer and transcribed by the observer from the digital files. On some transects with low waterfowl abundance, the observer recorded all observations so transcription would be easier.

Visibility correction factors (VCFs) were derived from intensive ground surveys on 14 selected routes flown by the aerial crew. Many of these routes use a county road as the mid-point of the transect boundary which aids in navigation and helps ensure the aerial and ground crews survey the same area. Ground routes each originally included about 100 wetland areas; however, drainage has reduced the number of wetlands on most of the routes. All observations from both ground crews and aerial crews were used to calculate the VCFs.

The SAS computer program was modified in 1992 to obtain standard errors for mallard and blue-winged teal breeding population estimates. These calculations were based upon SAS computer code written by Graham Smith, USFWS-Office of Migratory Bird Management. Estimates for 2012 and 2013 were compared using two-tailed Z-tests.

SURVEY CHRONOLOGY:

The 2013 aerial survey began on 12 May in southern Minnesota and concluded in northern Minnesota on 27 May. The start date was 2 weeks later than last year and delayed due to the late spring. Transects were flown on 10 days, May 12-13, May 15-17, and May 23-27. Flights began no earlier than 7 AM and were completed by 12:30 PM each day. The median date for survey completion was May 23, which was 10 days later than last year and one of the latest surveys on record.

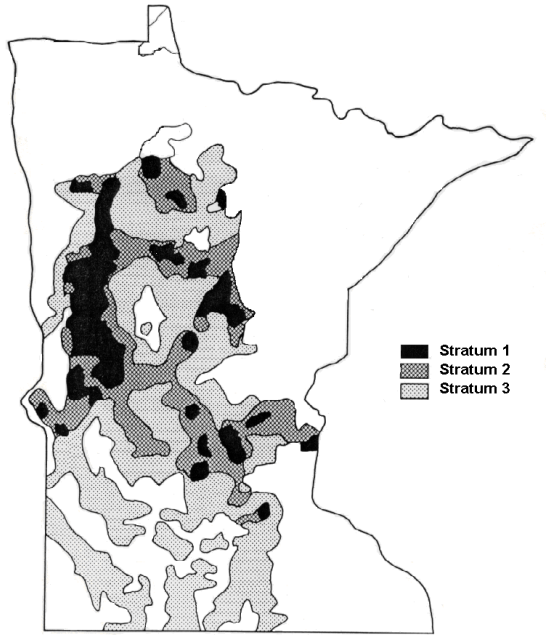

Figure 1. Location of waterfowl breeding population survey strata in Minnesota.

WEATHER AND HABITAT CONDITIONS:

For the majority of Minnesota lakes, ice out was the latest or almost latest on record. Temperatures in March averaged 7°F below normal and precipitation was 0.3 inches above normal statewide. Temperatures in April averaged 9°F below normal, was the 5th coldest April on record statewide. April precipitation was 1.05 inches above normal statewide and ranged from 0.1 inches below normal in west central Minnesota to 2.6 inches above

normal in south east Minnesota. May temperatures averaged 1.9°F below normal statewide. May precipitation was 1.5 inches above normal statewide and ranged from 0.3 inches above normal in northwest Minnesota to 4.9 inches above normal in south east Minnesota (http://climate.umn.edu). Additional temperature and precipitation data are provided in Appendix A.

Wetland conditions in the state were extremely dry in early April but improved dramatically by the end of May. In early May, 40% of the state was abnormally dry, 45% moderate to severe drought and 15% of the state was under no drought designation. By late May, 20% of the state was abnormally dry, 20% moderate to severe drought, and 60% of the state was under no drought designation. In late April 2013, statewide topsoil moisture indices were rated as 17% very short or short, 64% adequate and 19% surplus moisture. By late May, topsoil moisture indices were rated as 4% very short or short and 70% adequate and 26% surplus moisture. (http://droughtmonitor.unl.edu).

Planting dates for row crops were extremely late in 2013. By May 14, only 18% of the corn acres had been planted statewide compared to 86% in 2012 and 68% for the previous 5-year average. By June 2, only 2% of alfalfa hay had been cut compared to 58% in 2012 and a 5-year average of 32% (Minnesota Agricultural Statistics Service Weekly Crop Weather Reports, (http://www.nass.usda.gov/mn/).

Due to the late spring, leaf-out dates and wetland vegetation growth was 3-4 weeks later than average and visibility was excellent during the survey.

Wetland numbers (Type II-V) increased 13% from 2012 and were 3% below the 10-year average and 2% above the long-term average (Table 2; Figure 2). The number of temporary (Type 1) sheet water wetlands was 85% below the long-term average. In general, wetland conditions improved dramatically in mid to late May, particularly in the east and southeastern portions of the survey region.

WATERFOWL POPULATIONS:

The number of ducks, Canada geese, and coots, by stratum, are shown in Tables 3-5; total numbers are presented in Table 6. These estimates are expanded for area but not corrected for visibility bias. Table 7 and Table 8 provide the unadjusted population index (Unad. PI), which is multiplied by the visibility correction factor (VCF) to obtain the population index (PI) for ducks and Canada geese. The standard error (SE) of the estimate is also provided for mallard and blue-winged teal estimates.

The 2013 breeding population estimate of mallards was 293,239 (SE = 58,463), which was 30% above the 2012 estimate of 224,965 mallards, but statistically unchanged (Z = 0.93, P = 0.36) (Table 7, Figure 3). Mallard numbers were 14% above the 10-year average and 30% above the long-term average of 226,000 mallards. In 2013, the mallard population was comprised of 58% lone males, 32% pairs, and 10% flocked mallards. The 5-year average is 75% lone males, 18% pairs, and 7% flocked mallards. The higher number of pairs this year and lower number of lone males this year likely reflects a later nesting effort due to the extremely late spring.

The estimated blue-winged teal population was 143,927 (SE = 46,635), which was 33% above the 2012 estimate of 108,607 blue-winged teal, but statistically unchanged (Z = 0.63, P = 0.53). Blue-winged teal numbers were 19% below the 10-year average and 33% below the long-term average (Table 7, Figure 4). The blue-winged teal population was comprised of 16% lone males, 37% pairs, and 48% flocks. The 5-year average is 17% lone males, 50% pairs, and 33% flocks. The lower number of pairs this and higher number of flocks likely reflects a later nesting effort due to the extremely late spring.

The combined population estimate of other ducks (excluding scaup) was 245,729 which was 82% above last year's estimate of 135,000 other ducks and 25% above the 10-year average and 39% above the long-term average (Table 7, Figure 5). Population estimates of wood duck (72,000), ring-necked duck (60,000), northern shoveler (27,000), and gadwall (24,000) accounted for most (75%) of the total population of other ducks. Scaup numbers (43,000) were 41% above the 10-year average and 32% below the long-term average.

The total duck population index, excluding scaup, was 683,000 ducks and was 46% higher than last year's index of 469,000 ducks and 8% above the 10-year average and 10% above the long-term average (Table 8, Figure 6).

The population index for total ducks was 726,000 ducks, which was 9% above the 10-year average and 6% above the long-term average.

Visibility Correction Factors (VCFs) for mallards, blue-winged teal, and other ducks were all higher in 2013 than 2012 and above the long-term average (Table 7). The mallard VCF (2.64) was 2% below the 10-year average and 19% above the long-term average. The blue-winged teal VCF (5.29) was 40% above the 10-year average and 37% above the long-term average. The VCF for other ducks (3.57) was 25% above the 10-year average and 39% above the long-term average.

Canada goose numbers (uncorrected for visibility) increased 8% compared to 2012 and remained 105% above the long-term average (Table 8). The VCF for Canada geese was 2.22 and 2% below the 10-year average of 2.26. The population estimate of Canada geese (adjusted for visibility) was 209,000, which was 18% above the 10-year average of 177,000 geese (Table 8, Figure 7). Only 5 Canada goose broods were observed, compared to 70 in 2012, even though the survey start date was 2+ weeks later than last year, which reflects how late the spring was this year.

The estimated coot population, uncorrected for visibility, was 40,500 compared to 26,000 in 2012.

The estimated number of swans (likely trumpeters) was 11,500 swans and considerably higher than last year's estimate of 6,600. This estimate is expanded for area but not visibility and lone swans are not doubled. Trumpeter swans continue to expand their range and dramatically increase in number.

SUMMARY:

Wetland conditions were dry throughout most of the state in early spring but improved in mid to late May with rainfall events. Overall, wetland numbers were 13% higher than last year and near both the 10-year (-3%) and long-term (+2%) averages. Mallard abundance in 2013 was 293,000 mallards, which was 30% higher than last year and 14% above the 10-year average and 30% above the long-term average of 226,000 mallards. Blue-winged teal abundance (144,000) was 33% higher than 2012 but 33% below the long-term average of 216,000 blue-winged teal. The combined population index of other ducks (246,000) was 82% higher than 2012 and 39% above the long-term average of 177,000 other ducks. Total duck abundance (683,000), excluding scaup, was 46% higher than 2012 (469,000) and was 10% above the long-term average. Canada goose numbers, adjusted for visibility bias, increased 32% from 2012.

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DATA SUPPLIED BY: Minnesota Department of Natural Resources (MNDNR) and U.S. Fish and Wildlife Service (USFWS)

Air Crew: Pilot/Observer: Tom Buker, Conservation Officer Pilot, MNDNR, Division of Enforcement; Observer: Steve Cordts, Waterfowl Staff Specialist, MNDNR, Division of Wildlife

Ground Crew Leaders: Sean Kelly, Deputy Chief, Migratory Birds, USFWS, Region III, Twin Cities; Wayne Brininger, USFWS, Tamarac National Wildlife Refuge; Dan Hertel and Fred Oslund , USFWS, HAPET, Fergus Falls; Paul Richert, Tom Cooper, and Jim Kelley, USFWS, Region III, Twin Cities; Kim Bousquet, USFWS, Big Stone National Wildlife Refuge; Greg Dehmer and Sally Zodrow, USFWS, Sherburne National Wildlife Refuge

Ground Crew Assistants: Brad Nylin, Minnesota Waterfowl Association; K. Fritz and J. Berens, USFWS, Big Stone National Wildlife Refuge; Lowell Deede, Gina Kemper, and C. Okeson , USFWS, Tamarac National Wildlife Refuge, Paul Soler and Tony Hewitt, USFWS, Sherburne National Wildlife Refuge, M. Oehler and Tyler Zimmerman, USFWS, HAPET, Fergus Falls; A. Forbes, USFWS, Region III, Twin Cities

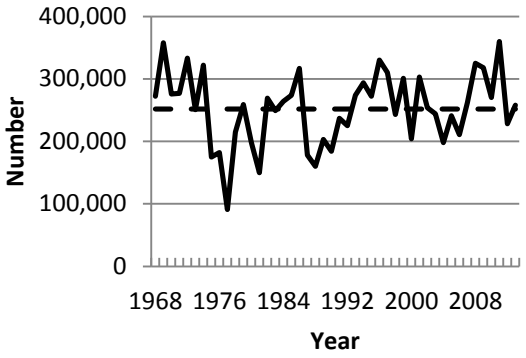

Figure 2. Number of May ponds (Types II-V) and long-term average (dashed line) in Minnesota, 1968-2013.

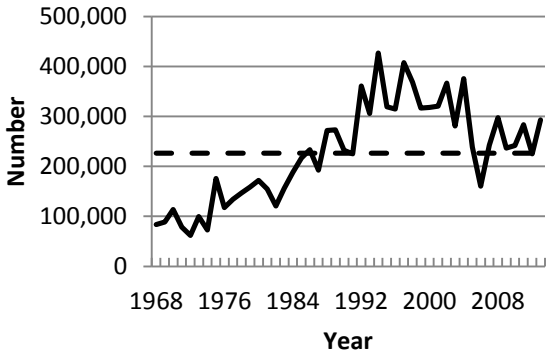

Figure 3. Mallard population estimates (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1968-2013.

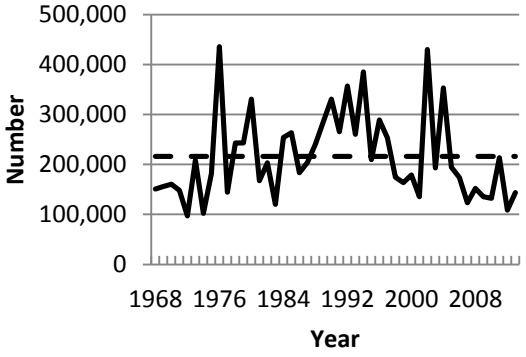

Figure 4. Blue-winged teal population estimates (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1968-2013.

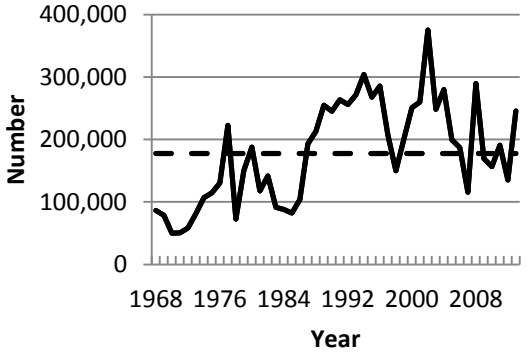

Figure 5. Other duck (excluding scaup) population estimates (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1968-2013

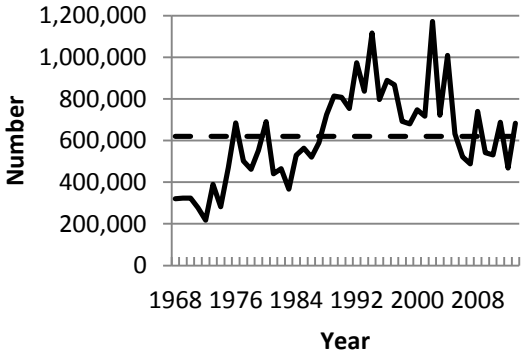

Figure 6. Total duck (excluding scaup) population estimates (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1968-2013

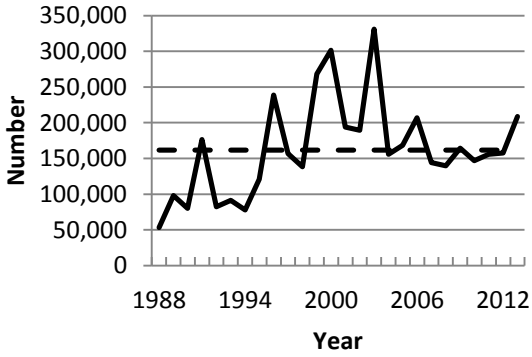

Figure 7. Canada goose population (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1988-2013.

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Table 1. Survey design for Minnesota, May 2013.[1]

	Stratum			
	1	2	3	Total
Survey design				
Square miles in stratum	5,075	7,970	17,671	30,716
Square miles in sample - waterfowl	182.75	136.375	203.125	522.25
Square miles in sample - ponds	91.375	68.1875	101.5625	261.125
Linear miles in sample	731.0	545.5	812.5	2,089.0
Number of transects in sample	39	36	40	115
Minimum transect length (miles)	5	6	7	5
Maximum transect length (miles)	36	35	39	39
Expansion Factor - waterfowl	27.770	58.442	86.996	
Expansion Factor - ponds	55.540	116.884	173.991	
Current year coverage				
Square miles in sample - waterfowl	182.75	136.375	203.125	522.25
Square miles in sample - ponds	91.375	68.1875	101.5625	261.125
Linear miles in sample	731.0	545.5	812.5	2,089.0
Number of transects in sample	39	36	40	115
Minimum transect length (miles)	5	6	7	5
Maximum transect length (miles)	36	35	39	39
Expansion Factor - waterfowl	27.770	58.442	86.996	
Expansion Factor - ponds	55.540	116.884	173.991	

[1] Also, 8 additional air-ground transects (total linear miles = 202.5, range - 10-60 miles) were flown to use in calculating the VCF.

Table 2. Estimated May ponds (Type 1 and Types II-V), 1968-2013.

	Year	Type I	Number of ponds[1]
	1968		272,000
	1969		358,000
	1970		276,000
	1971		277,000
	1972		333,000
	1973		251,000
	1974		322,000
	1975		175,000
	1976		182,000
	1977		91,000
	1978		215,000
	1979		259,000
	1980		198,000
	1981		150,000
	1982		269,000
	1983		249,000
	1984		264,000
	1985		274,000
	1986		317,000
	1987		178,000
	1988		160,000
	1989		203,000
	1990		184,000
	1991	82,862	237,000
	1992	10,019	225,000
	1993	199,870	274,000
	1994	123,958	294,000
	1995	140,432	272,000
	1996	147,859	330,000
	1997	30,751	310,000
	1998	20,560	243,000
	1999	152,747	301,000
	2000	5,090	204,000
	2001	66,444	303,000
	2002	30,602	254,000
	2003	34,005	244,000
	2004	9,494	198,000
	2005	30,764	241,000
	2006	56,798	211,000
	2007	32,415	262,000
	2008	69,734	325,000
	2009	39,078	318,000
	2010	26,880	270,000
	2011	89,218	360,000
	2012	30,910	228,000
	2013	9,813	258,000
Averages:	10-year	41,930	266,000
	Long-term	65,022	252,000
% change from:	2012	-68%	13%
	10-year	-77%	-3%
	Long-term	-85%	2%

Table 3. Minnesota waterfowl breeding populations by species for Stratum I (high wetland density), expanded for area but not visibility, 1995-2013.

	Year																		
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Dabblers:																			
Mallard	20,494	25,104	26,992	33,157	26,576	26,604	28,742	29,297	25,937	29,381	19,050	16,829	16,357	25,104	19,467	18,439	19,856	18,911	21,161
Black Duck	0	0	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	333
Gadwall	1,055	1,083	611	1,111	1,777	833	1,333	944	1,250	2,111	1,166	1,444	889	1,166	1,055	1,000	167	1,389	722
American Wigeon	194	0	0	56	56	56	111	0	56	555	167	0	56	111	56	56	111	222	222
Green-winged Teal	0	278	56	333	0	278	56	278	222	444	56	56	167	278	167	56	56	56	0
Blue-winged Teal	7,609	6,720	6,387	8,220	6,998	11,247	7,387	14,218	9,664	23,771	9,303	5,665	5,332	9,942	5,998	7,304	4,665	5,110	4,193
Northern Shoveler	111	1,277	1,500	500	555	1,055	305	1,277	278	1,166	333	167	56	1,000	666	1,027	111	56	333
Northern Pintail	167	167	111	111	167	167	389	56	111	56	0	56	0	56	56	0	111	0	111
Wood Duck	6,831	6,498	9,497	12,302	5,582	10,219	6,720	2,888	4,499	8,081	5,498	3,555	2,666	6,665	4,277	3,999	3,416	4,138	3,249
Dabbler Subtotal	36,461	41,127	45,154	55,790	41,711	50,459	45,043	48,958	42,017	65,565	35,629	27,772	25,523	44,322	31,742	31,881	28,493	29,882	30,324
Divers:																			
Redhead	639	722	778	944	500	583	1,444	750	333	805	666	666	916	1,389	472	944	805	750	861
Canvasback	3,860	1,166	1,333	1,777	2,971	1,222	2,027	1,833	1,333	666	972	833	1,000	2,277	1,333	1,222	833	722	1,555
Scaup	7,192	13,829	3,416	9,247	1,750	7,415	5,832	2,444	2,055	5,971	4,110	111	555	6,276	8,553	2,777	2,222	1,055	1,000
Ring-necked Duck	1,583	3,166	2,694	2,749	2,360	4,776	2,444	2,777	1,361	5,165	1,722	2,055	1,555	21,494	6,859	3,138	4,804	2,666	3,582
Goldeneye	111	167	0	111	56	56	333	111	0	222	222	56	222	278	278	222	56	56	333
Bufflehead	56	278	0	56	111	56	111	222	111	389	167	222	56	1,611	833	389	278	56	611
Ruddy Duck	167	139	528	11,052	972	0	83	1,305	417	305	1,222	305	0	1,027	861	28	56	0	305
Hooded Merganser	278	611	555	389	722	500	722	555	333	278	333	555	111	666	944	555	500	555	333
Large Merganser	0	0	56	0	0	0	111	0	972	0	111	0	278	333	333	333	111	56	222
Diver Subtotal	13,886	20,078	9,360	26,325	9,442	14,608	13,107	9,997	6,915	13,801	9,525	4,803	4,693	35,351	20,466	9,608	9,665	5,916	8,802
Total Ducks	50,347	61,205	54,514	82,115	51,153	65,067	58,150	58,955	48,932	79,366	45,154	32,575	30,216	79,673	52,208	41,489	38,158	35,798	39,126
Other:																			
Coot	611	3,055	5,054	555	83	3,999	1,722	2,888	2,666	21,411	2,444	639	139	16,829	2,166	139	2,194	444	10,386
Canada Goose	14,413	12,774	10,330	16,967	19,495	22,160	24,882	24,104	22,160	23,160	22,938	21,633	29,797	18,717	16,523	16,440	13,691	26,437	23,771

Table 4. Minnesota waterfowl breeding populations by species for Stratum II (medium wetland density), expanded for area but not visibility, 1995-2013.

	Year																		
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Dabblers:																			
Mallard	42,896	48,507	54,643	53,942	52,247	49,559	44,650	43,773	34,715	44,474	26,883	25,130	24,779	27,935	23,494	21,507	30,974	29,689	27,409
Black Duck	0	0	0	0	0	0	117	0	0	0	0	0	0	0	0	0	0	0	0
Gadwall	1,052	935	468	584	1,519	3,039	1,636	701	584	3,565	584	1,052	234	3,039	1,169	1,286	935	1,987	701
American Wigeon	0	468	351	818	0	468	0	0	0	2,513	117	0	0	351	0	351	0	117	234
Green-winged Teal	0	935	234	351	117	117	117	468	234	234	0	117	0	0	234	117	0	0	117
Blue-winged Teal	10,636	13,851	13,792	13,208	10,578	19,637	9,701	21,390	15,955	30,624	11,513	9,000	8,416	12,740	11,104	8,474	12,390	9,000	4,383
Northern Shoveler	818	1,636	2,571	701	2,104	4,675	1,052	2,221	1,403	1,753	234	584	351	468	701	2,513	1,052	0	351
Northern Pintail	234	117	234	468	117	117	117	0	117	0	0	0	234	0	0	0	234	0	0
Wood Duck	6,662	8,708	11,338	10,520	19,753	13,792	7,831	5,143	4,558	8,766	3,273	1,753	2,221	6,546	5,260	6,312	6,955	5,143	4,792
Dabbler subtotal	62,298	75,157	83,631	80,592	86,435	91,404	65,221	73,696	57,566	91,929	42,604	37,636	36,235	51,079	41,962	40,560	52,540	45,936	37,987
Divers:																			
Redhead	1,403	1,110	1,987	935	1,636	2,805	2,455	234	584	1,110	292	175	935	935	584	760	1,578	468	468
Canvasback	0	234	701	117	117	935	0	468	1,052	234	0	0	1,169	468	234	117	584	117	935
Scaup	7,831	21,916	18,935	4,032	3,331	6,779	3,039	5,961	2,279	7,188	2,981	468	643	3,097	2,104	0	1,929	935	2,045
Ring-necked Duck	1,403	7,714	3,565	2,279	2,221	5,610	3,799	6,370	2,455	5,377	1,929	3,331	1,578	13,149	9,117	2,396	11,455	1,695	6,253
Goldeneye	701	1,753	818	234	935	584	468	234	234	351	117	117	0	351	584	468	468	584	935
Bufflehead	0	117	117	0	0	0	0	1,169	117	468	351	117	117	1,403	818	643	1,403	468	0
Ruddy Duck	117	58	117	0	468	0	0	1,870	2,688	0	351	58	0	0	175	409	58	234	117
Hooded Merganser	117	234	468	117	701	935	1,403	701	701	234	234	351	234	584	701	117	2,221	1,636	701
Large Merganser	0	0	0	0	0	117	117	0	0	234	351	0	0	351	0	0	234	0	234
Diver subtotal	11,572	33,136	26,708	7,714	9,409	17,765	11,281	17,007	10,110	15,196	6,606	4,617	4,676	20,338	14,317	4,910	19,930	6,137	11,688
Total Ducks	73,870	108,293	110,339	88,306	95,844	109,169	76,502	90,703	67,676	107,125	49,210	42,253	40,911	71,417	56,279	45,470	72,470	52,073	49,675
Other:																			
Coot	526	7,013	5,026	643	234	1,110	468	4,909	1,519	8,007	584	292	409	23,961	0	117	292	292	2,571
Canada Goose	12,682	13,559	16,364	19,812	18,585	25,831	24,604	20,688	22,091	28,461	20,688	26,825	25,890	19,753	22,675	18,935	14,201	23,260	22,442

Table 5. Minnesota waterfowl breeding populations by species for Stratum III (low wetland density), expanded for area but not visibility, 1995-2013.

	Year																		
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Dabblers:																			
Mallard	79,166	79,862	78,993	101,873	90,390	81,690	72,642	72,121	55,156	84,561	36,539	30,884	35,843	50,371	35,408	40,976	51,415	47,848	62,638
Black Duck	0	0	0	0	0	0	0	0	0	174	0	0	174	174	0	0	0	174	174
Gadwall	3,306	3,306	2,436	3,045	2,436	2,610	10,701	3,306	1,566	6,960	2,001	5,568	4,176	870	1,392	1,392	4,089	1,566	5,220
American Wigeon	0	1,044	348	696	0	522	174	1,218	174	1,566	1,044	174	348	348	174	348	1,044	174	348
Green-winged Teal	0	957	348	174	0	1,218	1,392	522	174	0	174	522	0	0	0	0	174	348	696
Blue-winged Teal	29,492	36,625	25,316	26,360	18,530	29,405	20,618	56,374	21,140	39,758	27,578	23,663	15,659	18,095	20,183	16,964	44,716	35,669	18,617
Northern Shoveler	5,307	12,701	11,049	4,176	4,002	20,444	10,701	6,264	870	3,828	348	522	870	4,002	2,088	6,873	2,088	8,265	6,786
Northern Pintail	174	870	522	870	870	696	522	0	174	348	174	174	348	174	0	174	0	174	174
Wood Duck	16,355	27,926	14,268	23,837	20,531	25,055	17,225	13,572	12,702	20,705	7,482	7,308	5,394	14,442	10,266	12,354	13,659	10,962	12,180
Dabbler subtotal	133,800	163,291	133,280	161,031	136,759	161,640	133,975	153,377	91,956	157,900	75,340	68,815	62,812	88,476	69,511	79,081	117,185	105,180	106,833
Divers:																			
Redhead	7,134	1,044	1,044	2,001	3,480	2,523	3,654	1,305	174	1,740	1,479	0	522	783	870	174	4,350	3,306	1,827
Canvasback	174	1,392	0	3,306	174	3,915	522	696	1,131	2,784	0	0	348	1,566	1,218	348	1,044	1,044	696
Scaup	13,397	29,840	8,787	15,137	8,961	18,182	6,873	4,611	783	17,747	5,307	1,392	696	5,481	1,914	522	5,133	696	8,874
Ring-necked Duck	1,044	12,875	3,654	2,958	1,479	8,178	8,526	7,395	1,479	5,133	10,179	6,699	1,392	8,526	6,525	3,045	6,264	9,135	6,960
Goldeneye	1,479	1,914	522	696	696	1,044	1,566	3,132	1,305	696	1,044	1,044	870	348	522	174	870	0	348
Bufflehead	0	1,044	174	348	0	0	0	1,218	783	2,088	0	174	696	1,218	870	174	2,871	174	3,915
Ruddy Duck	2,349	1,740	348	0	174	0	696	18,878	87	2,262	870	696	261	87	348	0	3,828	522	522
Hooded Merganser	1,044	1,566	696	696	1,218	957	174	2,175	174	1,740	1,218	870	174	696	348	1,218	1,044	1,044	348
Large Merganser	174	0	0	0	0	0	0	522	0	0	261	957	348	348	348	348	174	174	0
Diver subtotal	26,795	51,415	15,225	25,142	16,182	34,799	22,011	39,932	5,916	34,190	20,358	11,832	5,307	19,053	12,963	6,003	25,578	16,095	23,490
Total Ducks	160,595	214,706	148,505	186,173	152,941	196,439	155,986	193,309	97,872	192,090	95,698	80,647	68,119	107,529	82,474	85,084	142,763	121,275	130,323
Other:																			
Coot	3,828	182,953	24,620	5,133	14,702	67,684	3,132	14,007	7,134	77,427	8,613	14,702	5,742	15,137	7,047	435	1,479	25,664	27,578
Canada Goose	30,971	34,537	33,755	42,368	41,933	57,940	39,932	33,407	43,412	46,717	39,758	27,230	42,629	31,841	28,274	30,710	32,711	37,496	48,022

Table 6. Minnesota waterfowl breeding populations by species for Stratum I-III combined, expanded for area coverage but not for visibility, 1995-2013.

	Year																		
Species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Dabblers:																			
Mallard	142,556	153,473	160,628	188,972	169,213	157,853	146,034	145,191	115,974	158,416	82,472	72,843	76,979	103,411	78,368	80,922	102,245	96,448	111,208
Black Duck	0	0	0	0	0	0	117	0	0	174	56	0	174	174	0	0	0	174	507
Gadwall	5,413	5,324	3,515	4,740	5,733	6,482	13,670	4,951	3,400	12,635	3,752	8,064	5,298	5,075	3,616	3,677	5,191	4,941	6,643
American Wigeon	194	1,512	699	1,570	56	1,045	285	1,218	230	4,634	1,327	174	404	810	230	754	1,155	513	804
Green-winged Teal	0	2,170	638	858	117	1,613	1,564	1,267	630	678	230	694	167	278	400	172	230	404	813
Blue-winged Teal	47,737	57,196	45,495	47,788	36,106	60,288	37,706	91,982	46,759	94,152	48,394	38,328	29,407	40,777	37,286	32,742	61,772	49,779	27,194
Northern Shoveler	6,236	15,614	15,120	5,377	6,661	26,175	12,058	9,762	2,550	6,747	915	1,273	1,276	5,469	3,456	10,413	3,251	8,320	7,470
Northern Pintail	575	1,154	867	1,449	1,153	979	1,028	56	402	404	174	230	582	230	56	174	345	174	285
Wood Duck	29,848	43,132	35,103	46,659	45,866	49,067	31,777	21,603	21,759	37,553	16,253	12,616	10,281	27,652	19,802	22,664	24,029	20,242	20,221
Dabbler subtotal	232,559	279,575	262,065	297,413	264,905	303,502	244,239	276,030	191,704	315,393	153,573	134,222	124,568	183,876	143,214	151,518	198,218	180,995	175,145
Divers:																			
Redhead	9,176	2,876	3,809	3,880	5,616	5,911	7,552	2,289	1,092	3,656	2,438	842	2,373	3,107	1,926	1,878	6,733	4,523	3,155
Canvasback	4,034	2,792	2,034	5,200	3,262	6,072	2,549	2,996	3,516	3,684	972	833	2,517	4,311	2,785	1,687	2,461	1,883	3,186
Scaup	28,420	65,585	31,138	28,416	14,041	32,376	15,743	13,016	5,117	30,906	12,397	1,971	1,894	14,854	12,571	3,299	9,283	2,686	11,919
Ring-necked Duck	4,030	23,755	9,913	7,986	6,060	18,565	14,768	16,542	5,294	15,675	13,829	12,085	4,525	43,169	22,501	8,579	22,523	13,495	16,795
Goldeneye	2,291	3,834	1,340	1,041	1,687	1,684	2,367	3,477	1,539	1,269	1,383	1,216	1,092	976	1,384	864	1,393	640	1,616
Bufflehead	56	1,439	291	404	111	56	111	2,609	1,011	2,944	517	513	868	4,231	2,521	1,206	4,551	697	4,526
Ruddy Duck	2,633	1,937	993	11,052	1,613	0	779	22,054	3,192	2,567	2,443	1,060	261	1,114	1,384	437	3,942	756	944
Hooded Merganser	1,439	2,411	1,719	1,202	2,641	2,392	2,299	3,432	1,209	2,251	1,785	1,776	519	1,947	1,993	1,890	3,765	3,236	1,383
Large Merganser	174	0	56	0	0	117	228	522	972	234	723	957	626	1,032	681	681	519	230	456
Diver subtotal	52,253	104,629	51,293	59,181	35,031	67,173	46,396	66,937	22,942	63,186	36,487	21,253	14,675	74,741	47,746	20,521	55,170	28,146	43,980
Total Ducks	284,812	384,204	313,358	356,594	299,936	370,675	290,635	342,967	214,646	378,579	190,060	155,475	139,243	258,617	190,960	172,039	253,388	209,141	219,125
Other:																			
Coot	4,965	193,021	34,700	6,331	15,020	72,793	5,321	21,804	11,319	106,845	11,641	15,633	6,290	55,927	9,213	691	3,965	26,401	40,535
Canada Goose	58,066	60,870	60,449	79,147	80,012	105,932	89,418	78,200	87,663	98,339	83,384	75,688	98,316	70,311	67,473	66,085	60,603	87,193	94,235

Table 7. Mallard, blue-winged teal, and other duck (excluding scaup) populations in Minnesota, 1968-2013.

	Mallard				Blue-winged teal				Other ducks (exc. scaup)		
Year	Unad. PI	VCF	PI	SE	Unad. PI	VCF	PI	SE	Unad. PI	VCF	PI
1968	41,030	2.04	83,701		61,493	2.44	151,141		41,419	2.08	86,152
1969	53,167	1.67	88,789		45,180	3.45	155,871		34,605	2.27	78,553
1970	67,463	1.69	113,945		31,682	5.06	160,343		30,822	1.62	49,932
1971	47,702	1.65	78,470		42,445	3.49	148,218		29,520	1.71	50,450
1972	49,137	1.27	62,158		49,386	1.96	96,895		34,405	1.69	58,127
1973	56,607	1.76	99,832		53,095	3.92	208,292		33,155	2.45	81,362
1974	44,866	1.62	72,826		39,402	2.59	102,169		38,266	2.79	106,609
1975	55,093	3.19	175,774		45,948	3.95	181,375		34,585	3.31	114,459
1976	69,844	1.69	117,806		89,370	4.87	435,607		39,022	3.35	130,669
1977	60,617	2.21	134,164		37,391	3.86	144,187		18,633	11.95	222,748
1978	56,152	2.61	146,781		28,491	8.53	242,923		22,034	3.30	72,798
1979	61,743	2.57	158,704	28,668	46,708	5.21	243,167	62,226	39,749	3.79	150,545
1980	83,775	2.05	171,957	22,312	50,966	6.49	330,616	40,571	47,322	3.97	188,020
1981	79,562	1.95	154,844	16,402	64,546	2.59	167,258	23,835	30,947	3.80	117,667
1982	51,655	2.33	120,527	17,078	42,772	4.75	203,167	34,503	32,726	4.32	141,501
1983	73,424	2.12	155,762	15,419	42,728	2.81	119,980	20,809	32,240	2.84	91,400
1984	94,514	1.99	188,149	24,065	89,896	2.82	253,821	33,286	40,326	2.18	87,709
1985	96,045	2.26	216,908	32,935	90,453	2.91	263,607	33,369	35,018	2.35	82,383
1986	108,328	2.16	233,598	30,384	68,235	2.69	183,338	28,204	38,900	2.67	103,851
1987	165,881	1.16	192,289	23,500	102,480	1.99	203,718	32,289	76,746	2.51	192,947
1988	155,543	1.75	271,718	38,675	101,183	2.38	240,532	39,512	81,514	2.61	212,988
1989	124,362	2.19	272,968	26,508	90,300	3.16	285,760	39,834	88,109	2.89	254,887
1990	140,879	1.65	232,059	26,316	107,177	3.09	330,659	44,455	124,531	1.97	245,152
1991	128,315	1.75	224,953	28,832	91,496	2.90	265,138	42,057	93,784	2.81	263,619
1992	144,126	2.50	360,870	43,621	93,107	3.83	356,679	53,619	109,779	2.33	255,774
1993	123,771	2.47	305,838	31,103	64,670	4.02	260,070	36,307	82,612	3.28	271,263
1994	138,482	3.08	426,455	66,240	70,324	5.48	385,256	82,580	85,671	3.55	303,847
1995	142,557	2.24	319,433	48,124	47,737	4.40	210,043	40,531	66,096	4.05	267,668
1996	153,473	2.05	314,816	53,461	57,196	5.05	288,913	64,064	107,950	2.64	285,328
1997	160,629	2.54	407,413	65,771	45,496	5.57	253,408	67,526	76,095	2.72	207,316
1998	188,972	1.95	368,450	61,513	47,788	3.66	174,848	33,855	91,478	1.64	149,786
1999	169,213	1.87	316,394	51,651	36,106	4.53	163,499	36,124	80,459	2.49	200,570
2000	157,853	2.02	318,134	36,857	60,288	2.97	179,055	32,189	120,158	2.09	250,590

Table 7. Cont.

	Mallard				Blue-winged teal				Other ducks (exc. scaup)		
Year	Unad. PI	VCF	PI	SE	Unad. PI	VCF	PI	SE	Unad. PI	VCF	PI
2001	146,034	2.20	320,560	39,541	37,706	3.60	135,742	19,631	91,152	2.85	260,051
2002	145,191	2.53	366,625	46,264	91,982	4.67	429,934	87,312	92,778	4.04	374,978
2003	115,974	2.42	280,517	34,556	46,759	4.13	193,269	36,176	46,796	5.30	248,019
2004	158,416	2.37	375,313	57,591	94,152	3.75	353,209	56,539	95,105	2.94	279,802
2005	82,472	2.89	238,500	28,595	48,394	4.01	194,125	37,358	46,797	4.26	199,355
2006	72,843	2.21	160,715	24,230	38,328	4.53	173,674	60,353	42,333	4.41	186,719
2007	76,979	3.15	242,481	30,020	29,407	4.20	123,588	20,055	30,963	3.73	115,390
2008	103,411	2.88	297,565	27,787	40,777	3.74	152,359	24,157	99,575	2.91	289,629
2009	78,368	3.02	236,436	36,539	37,286	3.63	135,262	32,155	62,725	2.70	169,568
2010	80,922	2.99	241,884	33,940	32,742	4.04	132,261	27,430	55,076	2.84	156,599
2011	102,245	2.77	283,329	49,845	61,772	3.46	213,584	88,720	79,743	2.39	190,586
2012	96,448	2.33	224,965	45,057	49,779	2.18	108,607	31,971	60,228	2.24	135,017
2013	111,208	2.64	293,239	58,463	27,194	5.29	143,927	46,635	68,804	3.57	245,729
Averages:											
10-year	96,808	2.70	258,171	36,816	52,160	3.77	177,994	41,491	61,934	3.37	197,068
Long-term	102,313	2.22	226,119	36,571	58,984	3.85	216,337	42,459	60,932	3.13	177,386
% change from											
2012	15%	13%	30%	30%	-19%	143%	33%	46%	14%	59%	82%
10-year average	15%	-2%	14%	59%	-5%	40%	-19%	12%	11%	6%	25%
Long-term average	9%	19%	30%	60%	-16%	37%	-33%	10%	13%	14%	39%

	Scaup			Total Ducks (exc. scaup)		Total ducks		Canada geese		
Year	Unad. PI	VCF	PI	Unad. PI	PI	Unad. PI	PI	Unad. PI	VCF	PI
1968	22,834	2.08	47,495	144,392	320,994	167,226	368,488			
1969	9,719	2.27	22,062	132,952	323,213	142,671	345,275			
1970	12,105	1.62	19,610	129,967	324,219	142,072	343,829			
1971	5,713	1.71	9,764	119,667	277,137	125,380	286,901			
1972	12,062	1.69	20,379	132,928	217,181	144,990	237,560	366		
1973	10,633	2.45	26,093	142,857	389,486	153,490	415,580	1,965		
1974	18,378	2.79	51,201	122,534	281,605	140,912	332,806	8,835		
1975	9,563	3.31	31,649	135,626	471,608	145,189	503,257	5,997		
1976	22,494	3.35	75,323	198,236	684,082	220,730	759,405	5,409		
1977	2,971	11.95	35,517	116,641	501,099	119,612	536,616	7,279		
1978	14,774	3.35	48,812	106,677	462,502	121,451	511,314	7,865		
1979	92,134	3.79	348,948	148,200	552,416	240,334	901,364	4,843		
1980	12,602	3.97	50,070	182,063	690,593	194,665	740,663	6,307		
1981	19,844	3.88	75,451	175,055	439,769	194,899	515,220	10,156		
1982	21,556	4.32	93,204	127,153	465,195	148,709	558,399	6,600		
1983	9,551	2.84	27,077	148,392	367,142	157,943	394,219	11,081		
1984	15,683	2.18	34,111	224,736	529,679	240,419	563,790	14,051		
1985	7,409	2.35	17,430	221,516	562,898	228,925	580,328	16,658		
1986	6,247	2.67	16,678	215,463	520,787	221,710	537,465	19,599		
1987	10,306	2.51	25,910	345,107	588,954	355,413	614,864	29,960		
1988	10,545	2.61	27,553	338,240	725,238	348,785	752,791	39,057	1.36	53,004
1989	71,898	2.89	207,991	302,771	813,615	374,669	1,021,606	51,946	1.88	97,898
1990	40,075	1.97	78,892	372,587	807,870	412,662	886,761	58,425	1.37	80,147
1991	40,727	2.81	114,480	313,595	753,710	354,322	868,191	42,231	4.18	176,465
1992	66,071	2.33	153,939	347,012	973,323	413,083	1,127,262	33,965	2.43	82,486
1993	11,801	3.28	38,750	271,053	837,172	282,854	875,921	43,858	2.08	91,369
1994	57,670	3.55	204,536	294,477	1,115,558	352,147	1,320,095	48,595	1.68	77,878
1995	28,421	4.05	115,096	256,390	797,144	284,811	912,241	58,065	2.08	120,775
1996	65,585	2.64	173,351	318,619	889,057	384,204	1,062,408	60,870	3.92	238,708
1997	31,138	2.72	84,834	282,220	868,137	313,358	952,971	60,449	2.59	156,817
1998	28,416	1.64	46,528	328,238	693,084	356,654	739,612	79,147	1.75	138,507
1999	14,041	2.49	35,002	285,778	680,463	299,819	715,465	80,012	3.35	268,168
2000	32,376	2.09	67,520	338,299	747,779	370,675	815,299	105,932	2.84	301,298
2001	15,743	2.85	44,914	274,892	716,353	290,653	761,267	89,418	2.17	193,887
2002	13,016	4.04	52,606	327,951	1,171,537	340,967	1,224,143	78,200	2.42	189,353

	Scaup			Total Ducks (exc. scaup)		Total ducks		Canada geese		
Year	Unad. PI	VCF	PI	Unad. PI	PI	Unad. PI	PI	Unad. PI	VCF	PI
2003	5,117	5.30	27,120	209,529	721,805	214,646	748,925	87,663	3.78	331,094
2004	30,906	2.94	90,926	347,673	1,008,324	378,579	1,099,250	98,339	1.58	155,859
2005	12,397	4.26	52,811	177,663	631,980	190,060	684,791	83,384	2.02	168,469
2006	1,971	4.41	8,692	153,504	521,109	155,475	529,801	75,688	2.73	206,757
2007	1,894	3.73	7,058	137,349	488,517	139,243	495,575	98,316	1.47	144,289
2008	14,854	2.91	43,205	243,763	739,553	258,617	782,758	70,311	1.99	139,708
2009	12,571	2.70	33,979	178,379	541,266	190,950	575,245	67,473	2.44	164,405
2010	3,299	2.84	9,380	168,740	530,744	172,039	540,124	66,085	2.22	146,960
2011	9,283	2.39	22,186	244,105	687,499	253,043	709,685	60,603	2.57	155,750
2012	2,686	2.24	6,021	206,455	468,589	209,141	474,610	87,193	1.81	157,706
2013	11,919	3.57	42,568	207,206	682,895	219,125	725,463	94,235	2.22	208,825
Averages:										
10-year	9,498	3.37	30,138	206,716	633,939	216,179	664,076	79,506	2.26	177,100
Long-term	21,313	3.13	62,759	221,988	620,000	243,293	682,759	45,907	2.35	161,510
% change from										
2012	344%	59%	607%	0%	46%	5%	53%	8%	23%	32%
10-year average	25%	6%	41%	0%	8%	1%	9%	19%	-2%	18%
Long-term average	-44%	14%	-32%	-7%	10%	-10%	6%	105%	-5%	29%

Appendix A. Temperature and precipitation at selected cities in, or adjacent to, Minnesota May Waterfowl Survey Strata, 28 April - 26 May 2013 (Source: Minnesota Climatological Working Group, http://climate.umn.edu/cawap/nwssum/nwssum.asp).

		Temperature (F) for week ending:										Total weekly precipitation (inches)					Precipitation departure from normal
		28-April		5-May		12-May		19-May		26-May							
Region	City	Avg[1]	Depart[2]	Avg[1]	Depart[2]	Avg[1]	Depart[2]	Avg[1]	Depart[2]	Avg[1]	Depart[2]	28-April	5-May	12-May	19-May	26-May	1 April-1-May 26
NW	Crookston	38.6	-8.3	41.4	-8.5	51.8	-0.9	61.4	6.1	56.4	-1.4	0.08	0.20	0.00	1.22	0.80	-0.73
NC	Grand Rapids	41.5	-4.8	41.5	-7.6	49.0	-2.8	58.1	3.8	53.0	-3.7	0.02	0.16	0.01	0.32	1.25	-0.25
	Itasca	36.0	-7.7	38.0	-8.8	m	m	58.2	5.8	54.1	-0.9	0.28	0.54	m	0.48	2.09	1.44
WC	Alexandria	40.2	-8.0	41.4	-9.7	52.0	-1.8	65.2	8.9	54.0	-4.7	0.20	0.03	0.28	1.24	1.50	-0.03
	Fergus Falls	Missing															
	Montevideo	38.8	-10.5	43.6	-8.6	50.4	-4.6	64.7	7.0	56.4	-3.8	0.56	0.10	0.67	0.32	1.42	0.80
	Morris	37.6	-11.0	41.6	-10.0	51.0	-3.4	63.7	6.7	54.9	-4.6	0.31	0.03	0.07	0.38	1.65	-0.91
C	Becker	41.6	-9.0	50.7	-2.7	54.0	-2.1	63.6	5.1	56.3	-4.3	0.10	0.13	0.10	0.07	1.46	-1.11
	Hutchinson	41.7	-8.4	46.7	-6.2	54.0	-1.5	63.6	5.6	56.6	-3.9	0.42	0.20	0.04	2.51	0.84	2.60
	St. Cloud	44.1	-4.7	45.3	-6.2	51.4	-2.7	63.3	6.7	53.2	-5.7	0.28	0.21	0.14	2.39	1.96	2.66
	Staples	Missing															
	Willmar	38.8	-11.0	44.1	-8.7	51.0	-4.6	62.3	4.1	55.5	-5.2	0.38	0.11	0.40	0.79	1.11	-0.60
EC	Aitkin	38.2	-7.8	42.2	-6.4	47.8	-3.2	58.2	4.8	53.3	-2.5	0.12	1.00	0.02	0.52	2.09	2.79
	Cambridge	Missing															
	Msp Airport	48.7	-2.9	49.1	-5.1	56.3	-0.4	67.6	8.5	57.2	-4.3	0.94	0.63	0.22	2.89	0.96	4.52
SW	Pipestone	39.2	-10.1	45.9	-6.2	50.0	-4.8	66.4	9.0	55.8	-4.0	0.27	0.19	0.94	0.88	0.64	-1.35
	Redwood Falls	46.0	-4.9	45.7	-8.1	52.8	-3.7	67.5	8.4	55.5	-6.1	0.12	0.14	0.44	0.94	0.51	-0.69
	Worthington	40.0	-9.1	43.8	-8.2	50.2	-4.5	66.6	9.1	55.5	-4.6	0.30	1.01	1.18	0.74	0.89	1.44
SC	Faribault	Missing															
	Waseca	43.2	-7.2	47.2	-6.1	53.8	-2.3	63.7	4.9	56.8	-4.6	1.10	2.26	0.16	1.24	1.76	4.92
	Winnebago	42.7	-7.9	46.3	-7.1	54.6	-1.5	66.9	8.1	57.4	-3.9	1.13	1.23	0.04	1.04	1.77	3.30
Statewide		41.1	-6.8	44.0	-6.7	51.0	-2.4	61.3	5.5	54.8	-3.5	0.42	0.77	0.28	1.18	1.57	

[1] Average temperature (°F) for the week ending on the date shown.
[2] Departure from normal temperature.
M=missing data.

Waterfowl information is taken from the U.S. Fish And Wildlife Service report Waterfowl Population Status, 2013 by Kathy Fleming, Pamela Garrettson, Walt Rhodes, And Nathan Zimpfer. The entire report is available on the Division Of Migratory Bird Management website (http://www.fws.gov/migratorybirds/reports/reports.html).

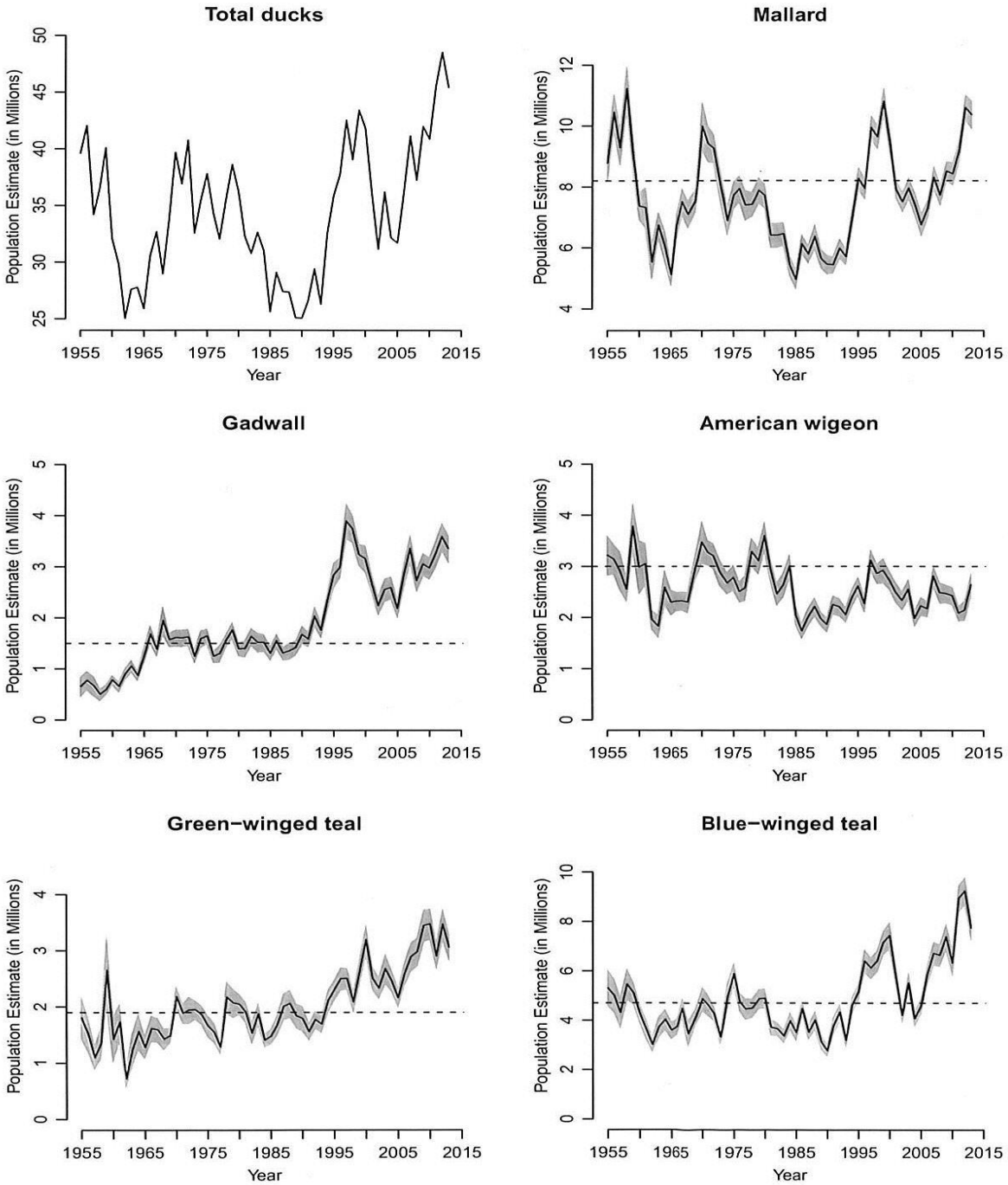

Figure 1 Estimates of North American breeding populations, 95% confidence intervals, and North American Waterfowl Management Plan population goal (dashed line) for selected species and number of water areas in May in Prairie Canada and Northcentral U.S (from: U.S. Fish and Wildlife Service 2013).

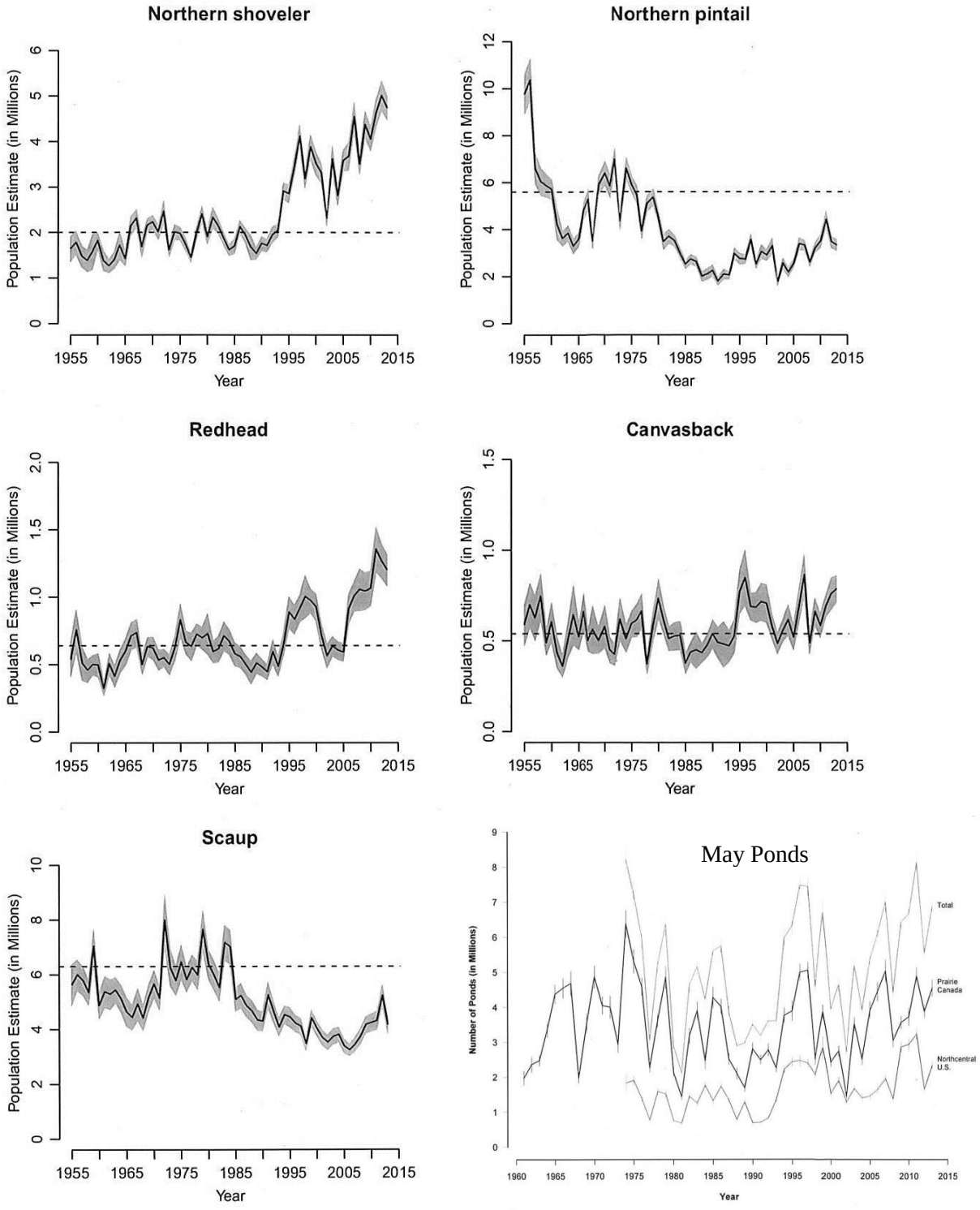

Figure 1 (continued).

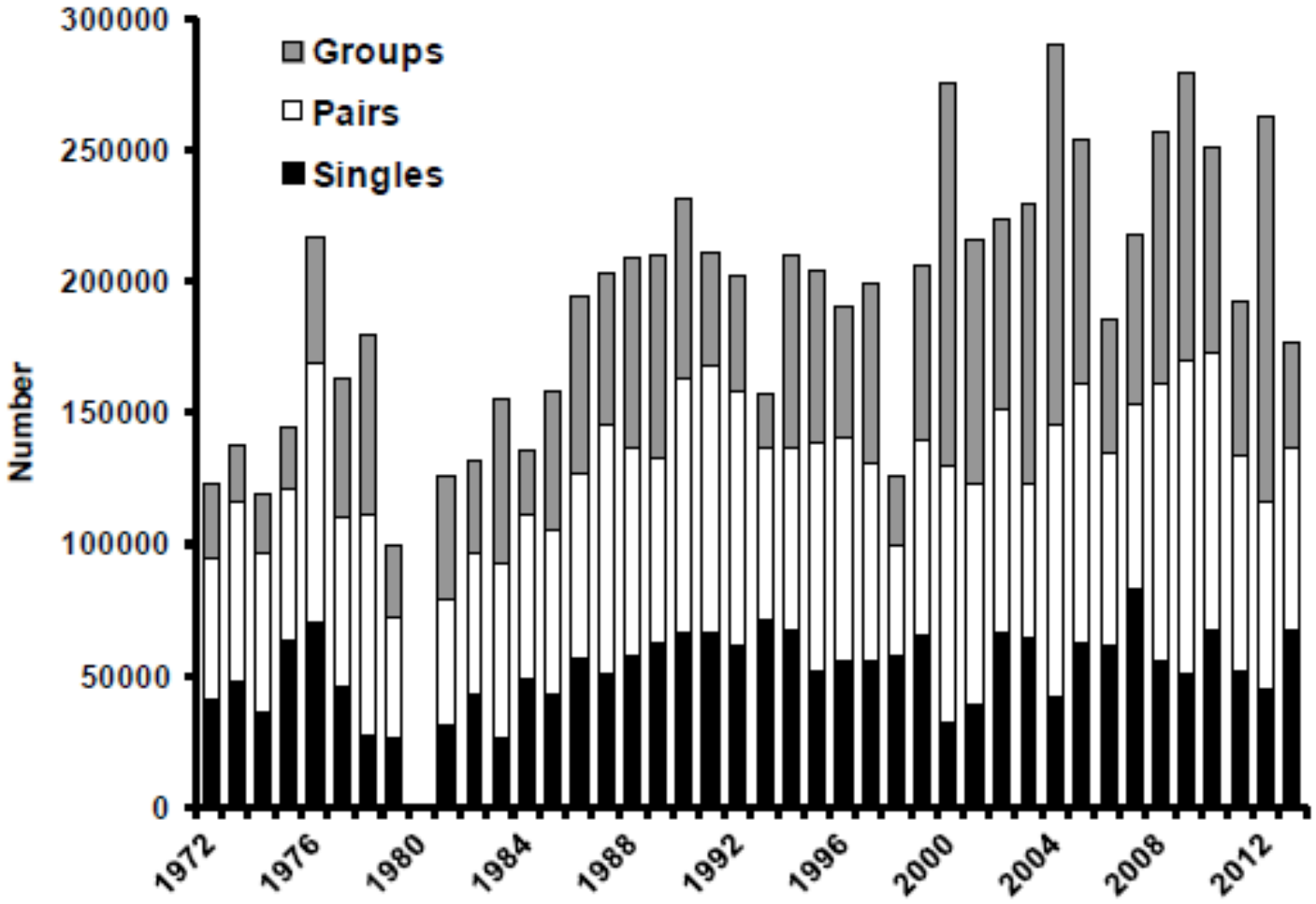

Figure 2 Breeding ground survey estimates of the Eastern Prairie Population of Canada geese, 1972-2013. (from: Baldwin, F., J. Wollenberg, and B. Lubinski. 2013. 2013 EPP Breeding Population Survey. Unpublished report prepared for the Mississippi Flyway Council Technical Section). Data not available for 1980.

2013 MINNESOTA SPRING CANADA GOOSE SURVEY

David Rave, Wetland Wildlife Populations and Research Group

INTRODUCTION

This report presents results from the thirteenth year of a spring helicopter survey of resident Canada geese in Minnesota. The survey was developed to comply with a Mississippi Flyway Council request to produce a statewide population estimate of resident giant Canada geese having 95% confidence intervals (C.I.'s) that are within $\pm$ 25% of the estimate.

METHODS

The original survey was initiated in 2001 using a double sampling design where an annual stratified sample was randomly selected from 900 plots in each ecoregion (Maxson 2002). I eliminated the double sampling design in 2008 by stratifying all potential plots in each ecoregion, and randomly sampling from the entire sampling frame (i.e., it is now a simple stratified sampling design with new sample plots drawn each year).

The state was divided into three ecoregions (Prairie Parkland, Eastern Broadleaf Forest/Tallgrass Aspen Parklands, Laurentian Mixed Forest) hereafter referred to as Prairie, Transition, and Forest. The 7- county Metro area was excluded from the Transition ecoregion. Similarly, Lake and Cook Counties plus the Boundary Waters Canoe Area and the Northwest Angle were excluded from the Forest ecoregion. Four Statewide ArcView shapefiles were then unioned together: National Wetlands Inventory circular 39, DNR 1:24k lakes, Public Land Survey Quarter section Boundaries, and ECS provinces, to assign each quarter section plot to the appropriate strata.

Four new fields were then computed: total acres of Type 3, 4, and 5 wetlands per quarter section (Circ39_acr) , total acres of 1:24k lakes per quarter section (Lakes_acr), total acres of type 3 wetlands per quarter section (Sum_type3_acr) and total acres of river per quarter section (Sum_Riv_acr). A summary table was created with text fields for each of the 8 strata (habitat-quality class x ecoregion). Using the query builder in ArcMap, quarter sections in each ecoregion were assigned to habitat-quality classes for resident geese: 1) not nesting habitat – expect no geese, 2) limited nesting habitat – habitat capable of supporting 1 or 2 pairs of geese, 3) prime nesting habitat – habitat capable of supporting 3 or more pairs.

Habitat-classification criteria for each ecoregion was:

Prairie

No geese =	Type 3-4-5 <0.5 acres and rivers <10 acres or plot is all water. (n = 61,597 plots).
1-2 pairs =	Type 3-4-5 $\geq$ 0.5 acres but Type 3 <15 acres or Type 3-4-5 <0.5 acres and rivers >10 acres. (n = 30,874 plots).
3+ pairs =	Type 3 >15 acres, but plot is not all water. (n = 9,537 plots).

Transition

No geese =	Type 3-4-5 <1 acre and rivers <8 acres or plot is all water. (n = 39,484 plots).
1-2 pairs =	Type 3-4-5 = 1-25 acres or Type 3-4-5 >25 acres, but Type 3 <15 acres or Type 3-4-5 <1 acre and rivers >8 acres. (n = 31,091 plots).
3+ pairs =	Type 3-4-5 >25 acres, but Type 3 >15 acres and plot is not all water. (n = 7,988 plots).

Forest

No geese =	Type 3-4-5 <2 acres and rivers <2 acres or plot all water. (n = 75,835 plots).
1-2 pairs =	Type 3-4-5 $\geq$2 acres, but not all water or Type 3-4-5 <2 acres and rivers >2 acres. (n = 51,155 plots).
3+ pairs =	None.

Plots in the "no geese class" are not flown and there are no plots in the "3+ pairs" class in the Forest ecoregion. Prior to 2011, 30 plots were randomly selected in each of the 5 remaining strata using ArcView's AlaskaPak extension, and these 150 plots were surveyed at low level using a helicopter. The stratification was modified slightly in 2011 to include a binary stratification variable (zone), which permitted a domain analysis of total geese in a proposed new hunting zone (Figure 1). Thus, the 9 strata for 2013 were Forest–12, Transition–12new, Transition–12other, Transition–3new, Transition– 3other, Prairie–12new, Prairie–12other, Prairie–3new, and Prairie–3other. Thirty plots (quartersections) were randomly selected from strata in the new zone (using proportional allocation) and 130 plots were selected from strata not in the new zone for a total of 160 sample plots (Figure 1). Ideally, the survey should be conducted during mid-incubation.

Pilot John Heineman and I flew the survey on 6 days between 6 and 14 May, 2013. This is the latest this survey has ever started, and about 2.5 weeks later than the average start date over the past 12 years. Canada geese seen within plot boundaries were recorded as singles, pairs, and groups. We also recorded whether singles and pairs were observed with a nest. The number of singles and pairs was doubled when the total number of geese per plot was calculated.

RESULTS AND DISCUSSION

The total Canada goose population estimate in the surveyed area for 2013 was 250,600 ($\pm$73,100). Adding 17,500 for the Twin Cities metro area (Cooper 2004) yields a statewide estimate of 268,100 (Table 1). Relative error (95% CI half-width) was 29.2% of the estimate. The survey tallied 27.0% singles, 68.0% pairs, and 5% groups (Table 2). Typically, some of the pairs seen on this survey are not associated with nests and are likely non-breeders. An index to nesting effort (i.e., Productive Geese) was obtained by combining singles and pairs associated with nests. In 2013, 30.0% of the geese seen were classified as Productive Geese (Table 2).

The 2013 Canada goose breeding population estimate for the surveyed area was 40% lower than the estimate in 2012. Goose numbers were lower than 2012 in all regions (Table 1). A time-series plot suggests the goose population in the survey area has been reasonably stable over the last 13 years (Figure 2). The estimated breeding population in a proposed new hunting

zone was 79,701 (±24,619), which was similar to the 2012 estimate for this zone 127,220 (±64,628)

Weather conditions in April and May of 2013 were the coldest and snowiest ever recorded during the Canada goose survey, and lake ice-out dates statewide were some of the latest ever recorded in Minnesota's history. The extreme cold and late ice-out conditions likely affected Canada goose population estimates in 2013. When the survey started, approximately 3 weeks later than normal, resident Canada geese were in various, and extremely asynchronous, stages of pairing, laying and incubation. This is very different than the norm, when there is a slight difference in stages between geese in the southern portions of the state, and the north. Late and frequent snowstorms, and temperatures well below freezing, caused birds in the southern third of the state to be anywhere from seeking nest sites to mid-incubation when the survey started. Ice, which still covered lakes in the northernmost portions of the state on the final day of the survey, may actually have prevented breeding birds from even arriving before the survey was concluded in northern portions of the state. The extremely late spring, with many late failed nests, likely influenced the number of productive geese observed this year. The late spring, low numbers of productive geese, and a low estimate of overall breeding geese all indicate that 2013 will likely not be a very good year for Canada goose production. Weather conditions throughout June and July may influence goose productivity. Regardless, the total 2013 Canada goose population estimate was above the state Canada goose population goal of 250,000 geese.

Wetland and habitat quality were variable in the state this year. Wetland conditions were drier than average throughout most the state, and wetlands were frozen in much of the state well into May. Heavy rainfall in late May moderated the dry conditions, however, were likely too late to improve goose production this year. Due to the extremely cold spring weather conditions, which will lead to fewer and smaller goose broods, I expect below average Canada goose production throughout the state in 2013.

ACKNOWLEDGMENTS

Frank Martin (Univ. of MN) and Steve Maxson were instrumental in the original design of this survey. Steve also was the principal observer during the first 6 years of the survey. Tim Loesch, Christopher Pouliot, and Shelly Sentyrz set up the original 2,700 ¼-section plots using ArcView and were very helpful in getting the survey up and running in 2001. Shelly Sentyrz was also instrumental in helping to restratify plots statewide for the 2008 survey. Chris Scharenbroich provided GPS coordinates of plots to the pilot, and printed out maps of the 150 plots flown this year. John Heineman and Michael Trenholm piloted the helicopter and served as the second observer. Robert Wright provided GIS expertise. John Giudice provided statistical assistance, and analyzed the data. Christine Herwig helped with printing aerial photos. Cindy Kuettel helped with excel graphics.

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Table 1. Spring Canada goose population estimates in Minnesota, 2001-2013.

Year	Prairie	Transition	Forest	Subtotal	95% CI	Metro	**TOTAL**
2001	77,360	95,470	92,390	265,220	±69,500	20,000	**285,220**
2002	135,850	144,900	33,940	314,690	±134,286	20,000	**334,690**
2003	106,520	121,290	56,420	284,230	±78,428	20,000	**304,230**
2004	128,501	130,609	95,636	354,747	±107,303	20,000	**374,747**
2005	113,939	149,286	57,529	320,754	±90,541	17,500	**338,254**
2006	126,042	164,085	67,994	358,071	±108,436	17,500	**375,571**
2007	137,151	99,274	25,509	261,933	±80,167	17,500	**279,433**
2008*	113,483	127,490	30,400	271,372	±69,055	17,500	**288,872**
2009	129,115	114,737	23,644	267,496	±70,607	17,500	**284,996**
2010	83,911	151,902	57,421	293,234	±70,760	17,500	**310,734**
2011	143,266	117,711	91,199	352,175	±119,814	17,500	**369,674**
2012	144,762	166,727	104,710	416,198	±132,344	17,500	**433,698**
2013	104,907	91,652	54,044	250,602	±73,122	17,500	**268,102**

*Prior to 2008, double-sampling for stratification was used to estimate stratum weights. The entire frame was re-stratified in 2008 (double-sampling was eliminated) and Lake of the Woods and the NW Angle were removed from the frame. The sampling frame was adjusted slightly in 2009 because of some processing errors in 2008. The population estimates for 2008-2013 are based on the updated sampling frame.

Table 2. Percent of Canada Geese seen as singles, pairs, groups, and productive geese on the Minnesota Spring Canada Goose Survey, 2001-2013.

Year	Singles[1]	Pairs[1]	Groups	Productive Geese[2]	Dates of Survey	Number of productive geese
2001	27.0	63.9	9.1	36.4	4/14 to 5/02/2001	103,820
2002	30.7	52.0	17.2	41.5	4/26 to 5/11/2002	138,896
2003	27.9	58.2	13.9	29.3	4/22 to 5/01/2003	89,139
2004	26.5	57.5	16.0	35.5	4/22 to 5/04/2004	133,035
2005	33.0	50.2	16.8	40.7	4/20 to 5/03/2005	137,679
2006	43.5	45.9	10.6	50.3	4/24 to 5/05/2006	188,912
2007	31.0	51.5	17.5	36.2	4/23 to 4/28/2007	101,154
2008	38.4	55.4	6.2	42.6	4/23 to 5/05/2008	123,059
2009	41.8	50.7	7.5	45.2	4/21 to 5/01/2009	128,818
2010	42.5	48.2	9.3	46.6	4/15 to 4/20/2010	144,802
2011	50.3	47.2	2.6	55.7	4/21 to 4/29/2011	205,908
2012	30.0	49.6	20.4	35.1	4/16 to 4/23/2012	152,228
2013	27.0	68.0	5.0	30.0	5/06 to 5/14/2013	80,431

[1]Singles and pairs were doubled before calculating proportions.

[2]Productive geese equals Singles + Pairs with nests.

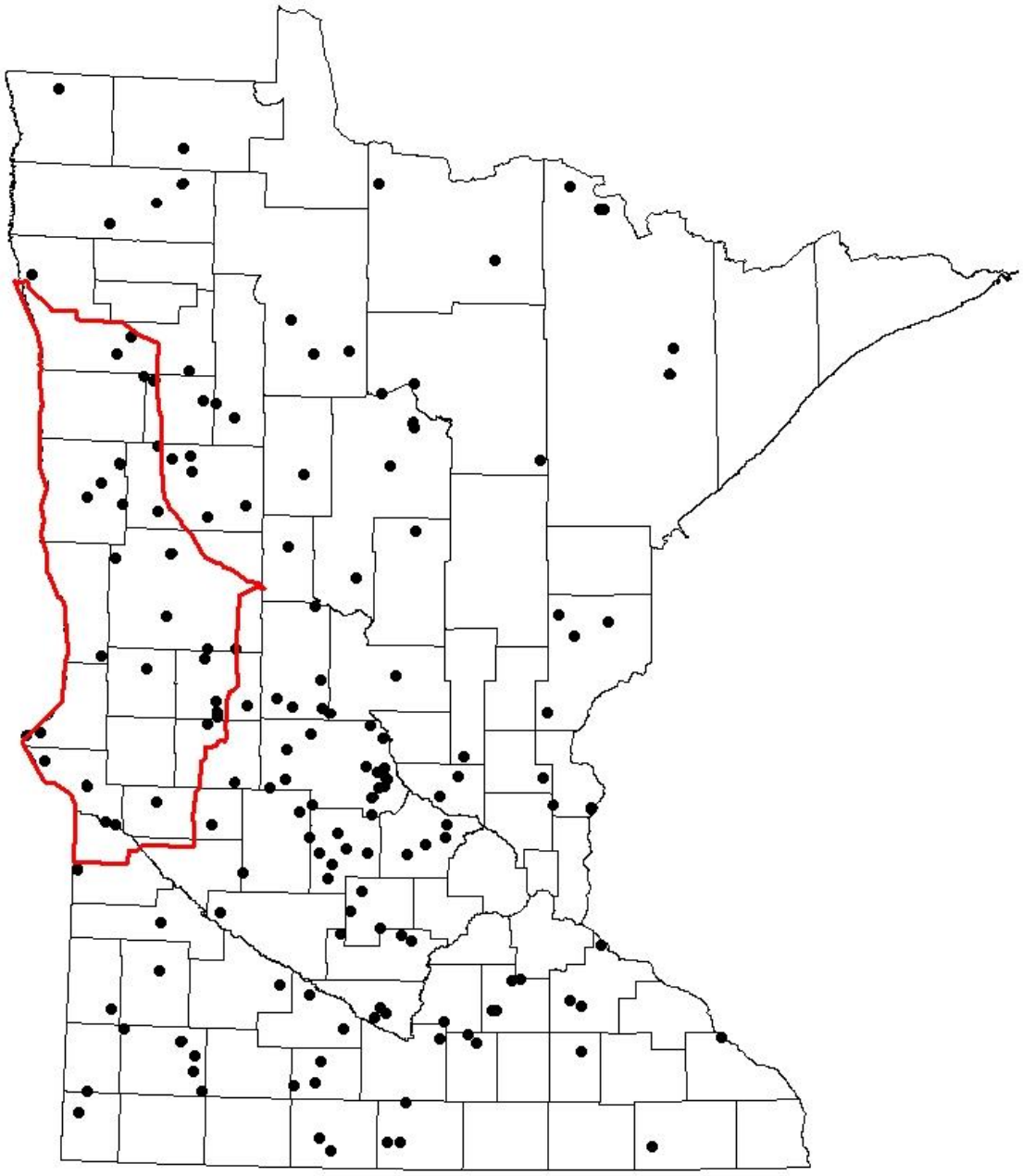

Figure 1. Location of 160 ¼ mi^2 plots surveyed for the 2013 Canada goose breeding pair survey within 3 ecoregions of Minnesota; forest, transition, and prairie. Red outlined polygon was the original location of a possible "new" Early Season Canada goose hunting zone

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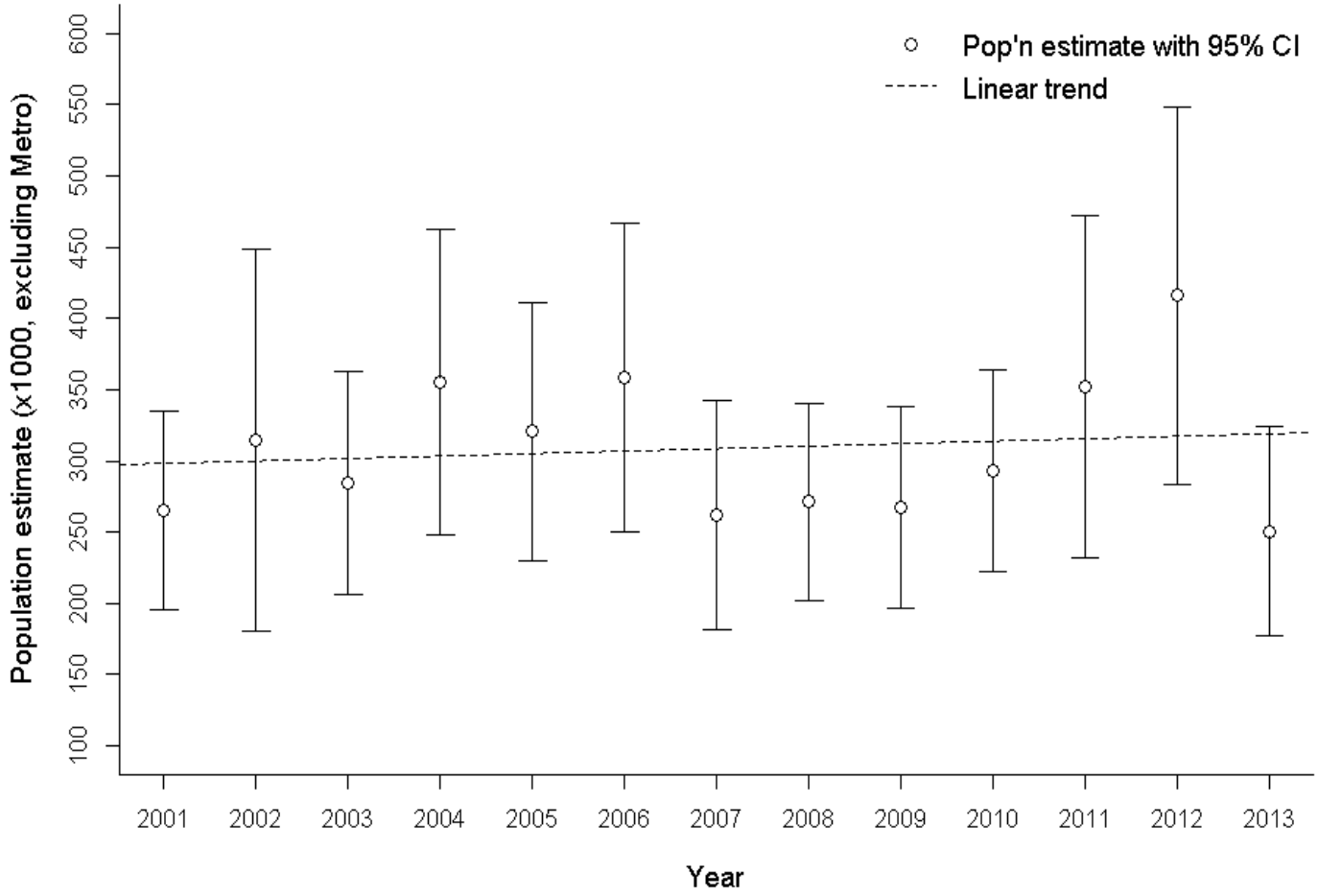

Figure 2. Spring Canada goose population estimates (±95% CI) in Minnesota, 2001-2013. (Does not include Metro area.)

Mourning dove information is taken from the U.S. Fish and Wildlife Service report by Seamans, M.E., R.D. Rau, and T.A. Sanders. 2013. Mourning dove population status, 2013. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. 36 pp. The entire report is available on the Division of Migratory Bird Management web site (http://www.fws.gov/migratorybirds/NewReportsPublications/PopulationStatus.html).

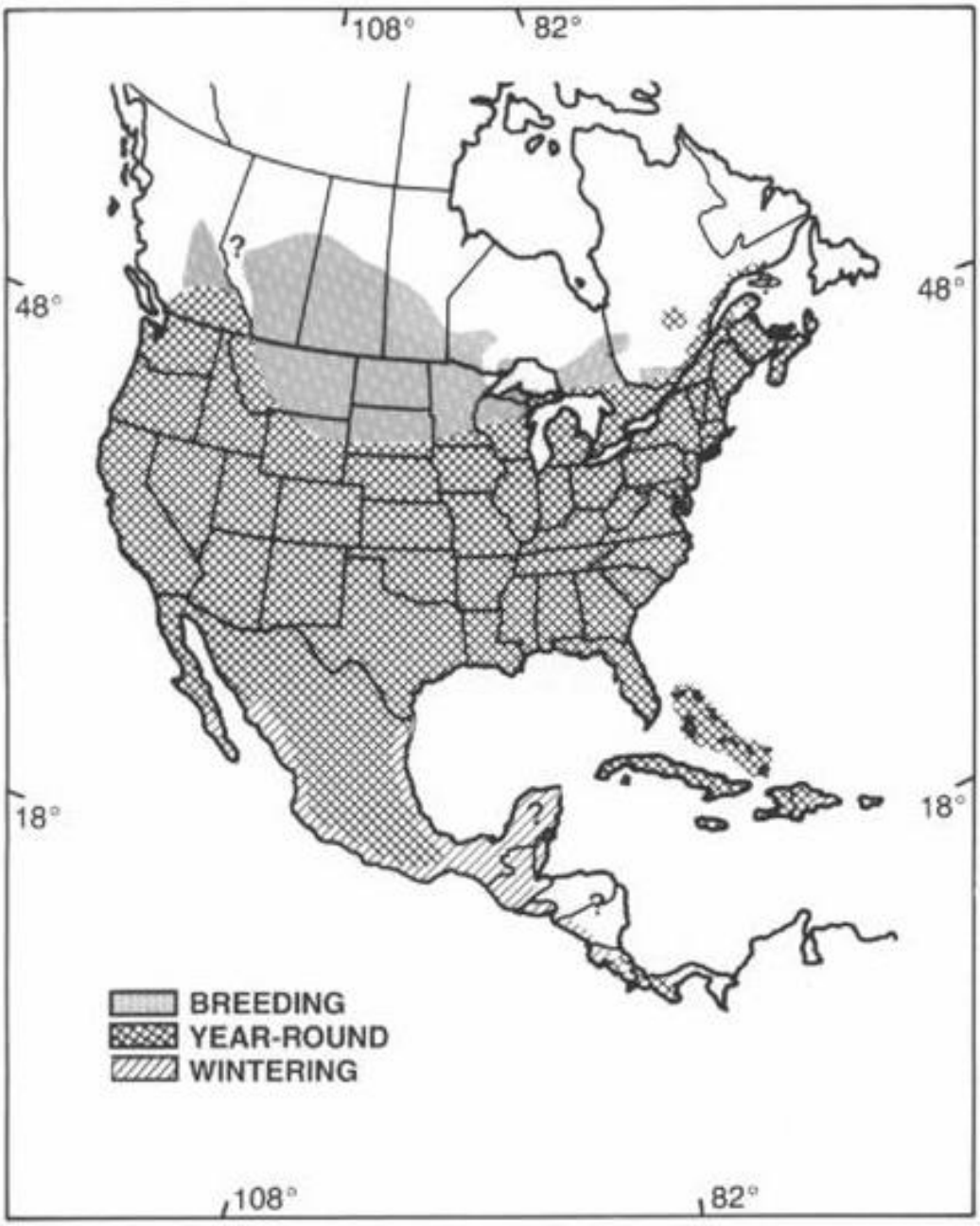

Figure 1. Breeding and wintering ranges of the mourning dove (adapted from Mirarchi and Baskett 1994). (From: Seamans, M.E., R.D. Rau, and T.A. Sanders. 2013. Mourning dove population status, 2013. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. 36 pp.)

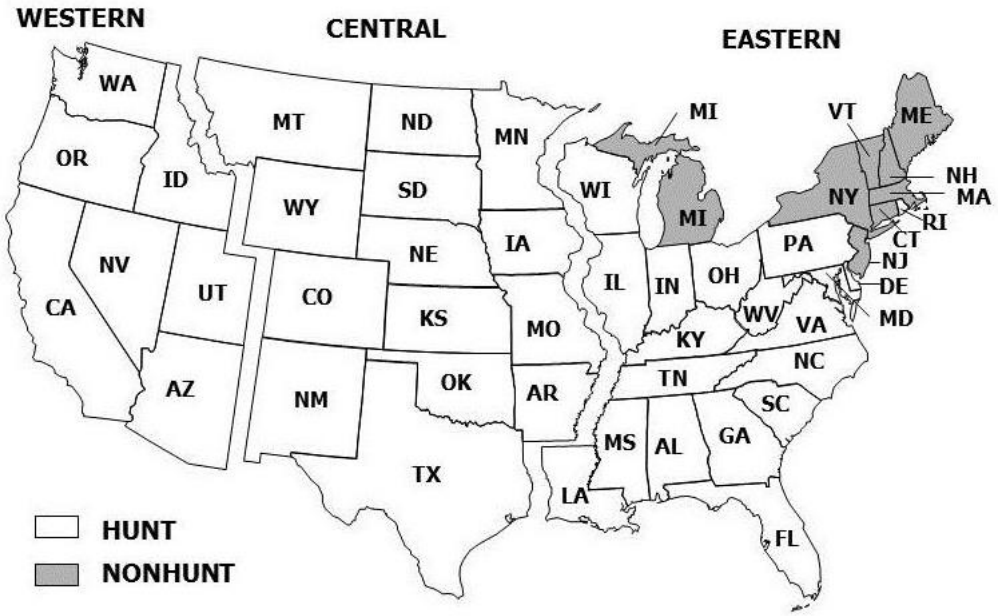

Figure 2. Mourning dove management units with 2012 hunting and non-hunting states. (From: Seamans, M.E., R.D. Rau, and T.A. Sanders. 2013. Mourning dove population status, 2013. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. 36 pp.)

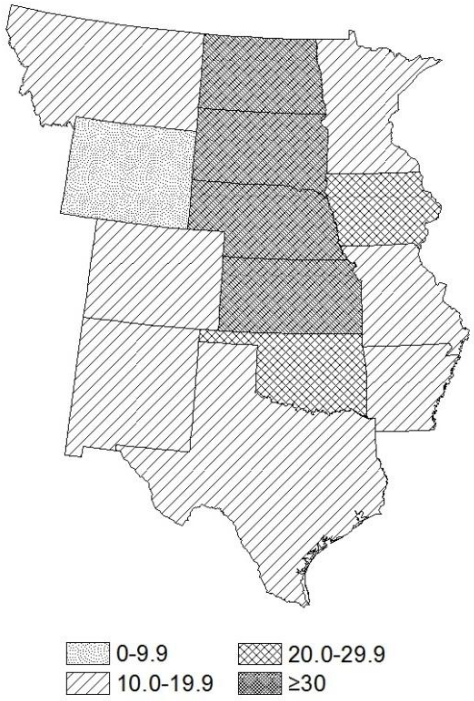

Figure 3. Mourning dove abundance in the Central Management Unit, based on the mean of the 2 CCS-heard index values from the last 2 years (2012-13). (From: Seamans, M.E., R.D. Rau, and T.A. Sanders. 2013. Mourning dove population status, 2013. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. 36 pp.)

Table 1. Preliminary estimates and 95% confidence intervals (CI, expressed as the interval half width in percent) of mourning dove harvest and hunter activity for the Central management unit during the 2010, 2011 and 2012 seasons [a]. (From: Seamans, M.E., R.D. Rau, and T.A. Sanders. 2013. Mourning dove population status, 2013. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. 36 pp.)

Management unit / State	Active Hunters			Hunter Days Afield			Total Harvest		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
CENTRAL	406,100 †	427,700 †	338,700 †	1,362,300	1,444,800±11	1,108,700 ±11	7,194,900 ± 10	7,657,700 ±9	6,361,600 ±14
AR	23,900 ±20	25,300 ±20	21,400 ±22	63,300 ± 28	63,800 ±34	57,600 ±26	446,400 ± 28	519,300 ±43	494,200 ±30
CO	15,900 ± 14	15,300 ±14	17,000 ±18	38,400 ± 19	44,500 ±24	43,800 ±26	172,000 ± 18	178,700 ±14	204,300 ±26
IA	†[b]	5,800 ±11	†[b]	†[b]	19,000 ±17	†[b]	†[b]	56,800 ±21	†[b]
KS	28,200 ± 10	32,800 ±10	12,200 ±39	93,900 ± 13	95,800 ±15	49,100 ±52	511,200 ± 15	534,800 ±18	244,800 ±62
MN	10,000 ± 42	9,400 ±49	6,800 ±52	55,300 ± 115	25,100 ±51	21,600 ±48	98,900 ± 58	57,300 ±40	65,400 ±75
MO	29,300 ± 10	31,600 ±11	23,800 ±29	75,200 ± 14	74,600 ±14	51,400 ±50	426,000 ± 20	359,600 ±16	296,600 ±81
MT	1,600 ± 35	2,200 ±37	200 ±87	4,700 ± 44	5,900 ±47	500 ±120	17,400 ± 36	14,400 ±61	2,600 ±161
NE	15,800 ± 14	15,500 ±16	13,200 ±17	49,700 ± 21	46,900 ±28	39,000 ±17	276,400 ± 19	265,500 ±23	223,400 ±20
NM	5,900 ±20	6,700 ±39	9,000 ±11	21,000 ± 20	24,600 ±49	38,000 ±17	128,000 ± 29	76,900 ±42	160,100 ±17
ND	3,800 ± 28	3,700 ±25	4,900 ±30	11,800 ± 37	10,400 ±29	17,400 ±36	54,200 ± 38	41,800 ±31	78,900 ±37
OK	19,500 ± 14	17,100 ±15	15,700 ±14	51,300 ± 22	54,200 ±25	49,200 ±19	268,700 ± 28	379,400 ±33	349,700 ±26
SD	5,000 ± 21	6,200 ±21	4,500 ±22	14,200 ± 26	16,300 ±26	14,700 ±28	64,300 ± 23	87,200 ±26	65,500 ±28
TX	244,600 ± 10	253,200 ±11	207,200 ±13	876,500 ± 10	958,600 ±16	720,200 ±16	4,699,300 ± 14	5,061,100 ±13	4,150,800 ±20
WY	2,700 ± 26	2,700 ±30	2,700 ±32	7,100 ± 32	5,100 ±38	6,300 ±38	32,100 ± 36	25,000 ±52	25,300 ±40

[a] Hunter number estimates at the Management Unit and national levels may be biased high, because the HIP sample frames are state specific; therefore hunters are counted more than once if they hunt in >1 state. Variance is inestimable.

[b] † No estimate available.

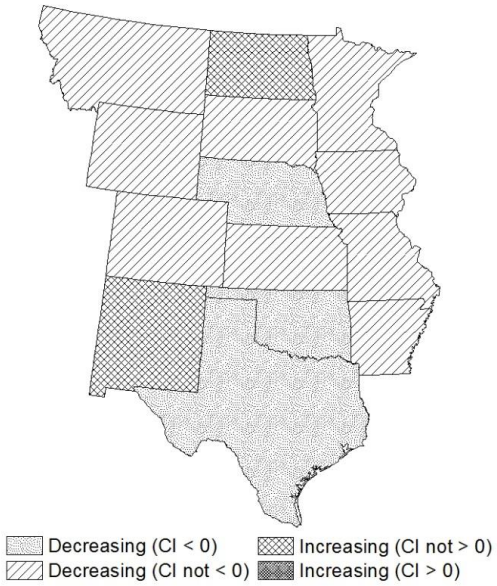

Figure 4. Trend in mourning dove abundance by state in the Central Management Unit over the last 10 years (2004-2013) based on CCS-heard data. Credible intervals (CI, 95%) that exclude zero provide evidence for an increasing or decreasing trend (From: Seamans, M.E., R.D. Rau, and T.A. Sanders. 2013. Mourning dove population status, 2013. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. 36 pp.)

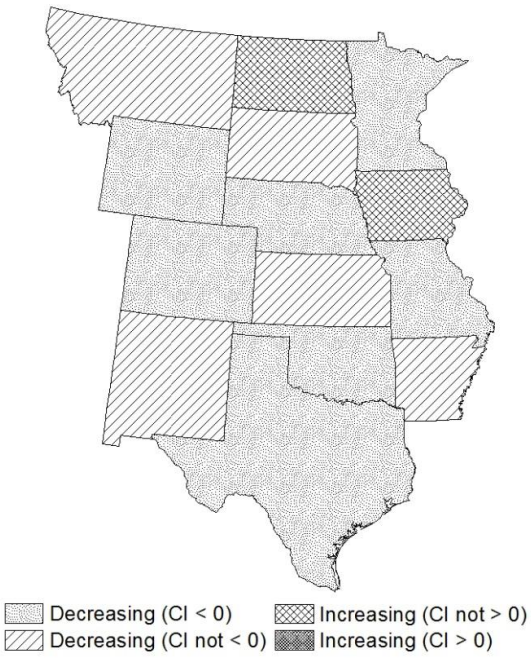

Figure 5. Trend in mourning dove abundance by state in the Central Management Unit over the last 48 years (1966-2013) based on CCS-heard data. Credible intervals (CI, 95%) that exclude zero provide evidence for an increasing or decreasing trend. (From: Seamans, M.E., R.D. Rau, and T.A. Sanders. 2013. Mourning dove population status, 2013. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. 36 pp.)

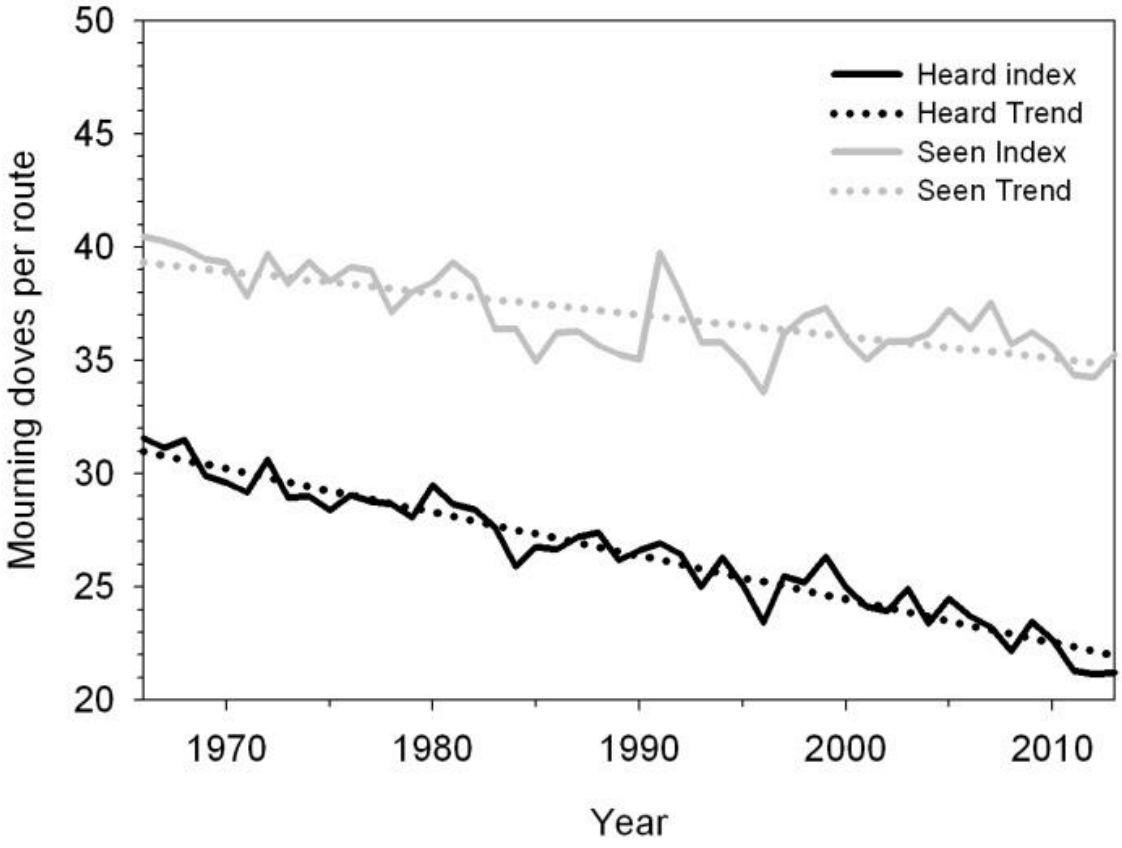

Figure 6. Mourning dove abundance indices and predicted trends in the Central Management Unit based on CCS data, 1966-2013. Trend lines are predicted values from fitting a simple linear regression line through the annual indices. (From: Seamans, M.E., R.D. Rau, and T.A. Sanders. 2013. Mourning dove population status, 2013. U.S. Department of the Interior, Fish and Wildlife Service, Division of Migratory Bird Management, Washington, D.C. 36 pp.)

American Woodcock information is taken from the U.S. Fish and Wildlife Service report American Woodcock Population Status, 2013. Cooper, T.R. and R.D. Rau. U.S. Fish and Wildlife Service, Laurel, MD. 16 pp.
The entire report is available on the Division of Migratory Bird Management home page (http://www.fws.gov/migratorybirds/NewReportsPublications/PopulationStatus.html).

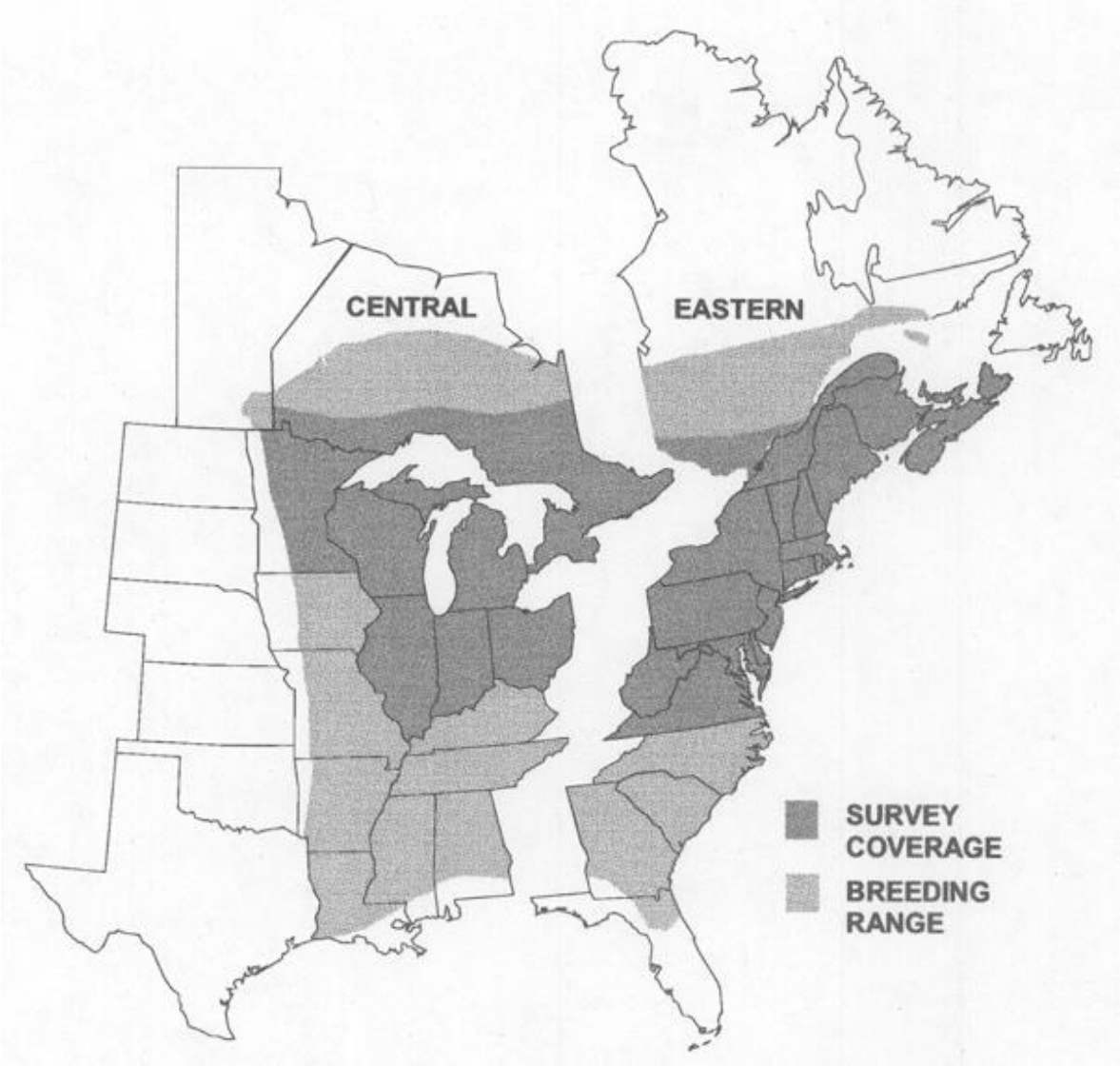

Figure 1. Woodcock management regions, breeding range, singing-ground survey coverage, (from: Cooper, T.R. and R.D. Rau. 2013. American woodcock population status, 2013. U.S. Fish and Wildlife Service, Laurel, MD. 16 pp.).

Table 1. Short term (2012 – 13), 10 –year (2003-2013), and long-term (1968-2013) trends (% change per year [a]) in the number of American woodcock heard during the Singing-ground Survey as determined by using the hierarchical log-linear modeling technique (Sauer et al. 2008) (from: Cooper, T.R. and R.D. Rau. 2013. American woodcock population status, 2013. U.S. Fish and Wildlife Service, Laurel, MD. 16 pp.).

Management Unit/State	Number of Routes[b]	n[c]	2012-13			2003-13			1968-13		
			% Change	95%	CI[d]	% Change	95%	CI[d]	% Change	95%	CI[d]
CENTRAL	449	722	-1.13	- 8.14	6.48	- 0.08	-0.97	0.80	- 0.80	-1.06	-0.55
IL	30	45	- 0.85	-65.62	182.06	- 15.10	-24.14	-6.46	- 1.28	*4.17	1.77
IN	18	60	- 7.26	-47.09	55.63	- 2.95	- 7.74	3.08	- 4.17	-5.56	-2.92
MB[e]	19	30	- 11.90	-39.33	24.19	- 0.10	- 3.57	3.70	- 0.45	-2.60	1.80
MI	106	151	5.73	-6.58	19.54	0.05	- 1.32	1.49	- 0.72	-1.11	-0.33
MN	75	120	- 12.89	-26.13	2.58	0.74	- 1.04	2.54	- 0.03	-0.62	0.60
OH	34	72	1.35	-20.53	31.74	- 0.12	- 2.64	3.77	- 1.55	-2.29	-0.77
ON	87	156	- 3.64	-17.59	12.68	- 0.57	- 2.50	1.47	- 0.89	-1.38	-0.40
WI	80	118	2.06	-13.36	20.32	1.96	0.10	4.03	- 0.28	-0.79	0.26

[a] Median of route trends estimated used hierarchical modeling. To estimate the total percent change over several years, use: $100(\%\ change/100+1)^{y})-100$ where y is the number of years. Note: extrapolating the estimated trend statistic (% change per year) over time (e.g., 30 years) may exaggerate the total change over the period.

[b] Total number of routes surveyed in 2013 for which data were received by 5 June, 2013.

[c] Number of routes with at least one year of non-zero data between 1968 and 2013.

[d] 95% credible interval, if the interval overlaps zero, the trend is considered non-significant.

[e] Manitoba began participating in the Singing-ground survey in 1992.

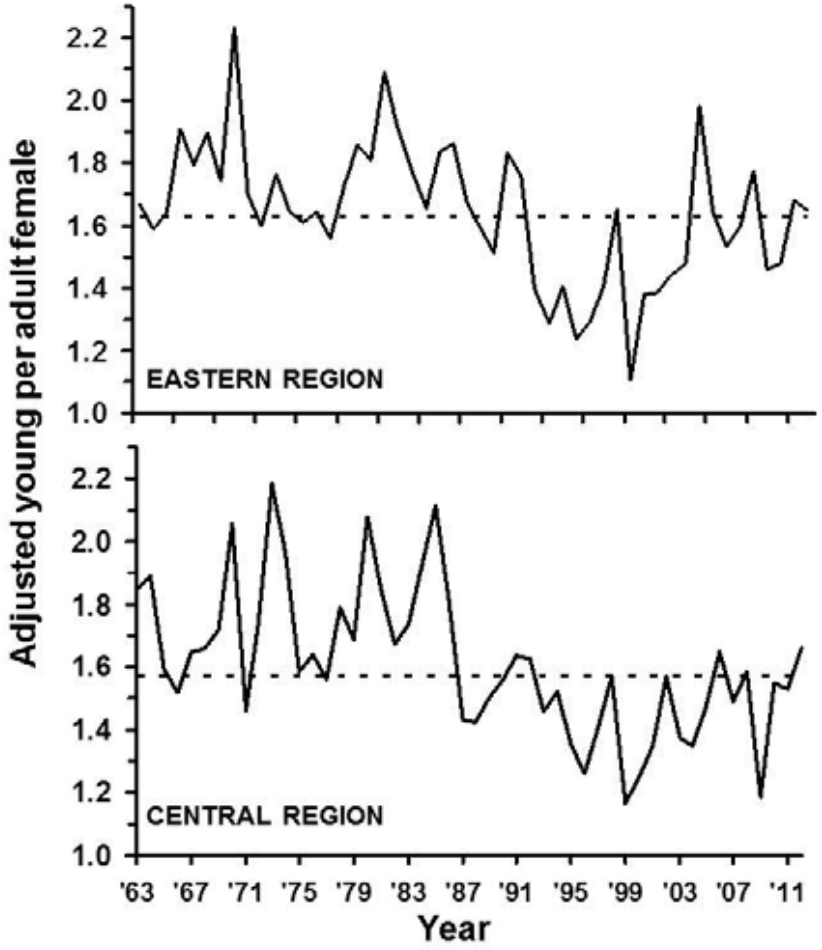

Figure 2. Weighted annual indices of American woodcock recruitment, 1963-2012. Dashed line is the 1963-2011 average. (from: Cooper, T.R. and R.D. Rau. 2013. American woodcock population status, 2013. U.S. Fish and Wildlife Service, Laurel, MD. 16 pp.).

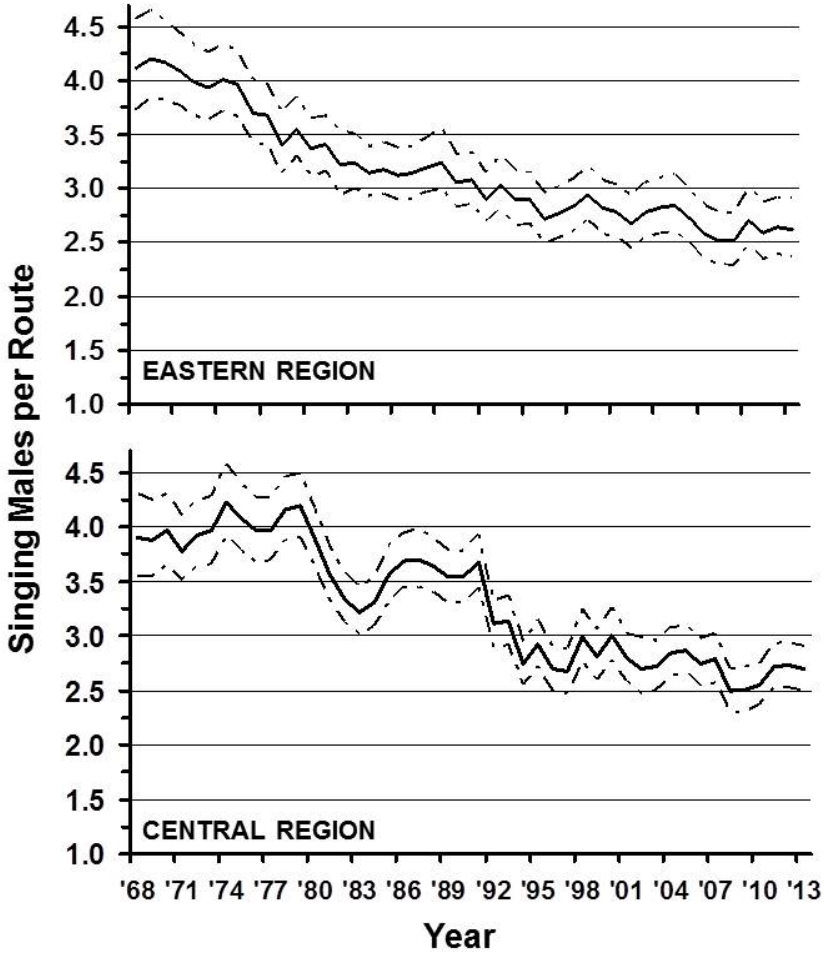

Figure 3. Annual indices of the number of woodcock heard on the Singing-ground Survey, 1968-2013. The dashed lines represent the 95th percentile credible interval. (from: Cooper, T.R. and R.D. Rau. 2013. American woodcock population status, 2013. U.S. Fish and Wildlife Service, Laurel, MD. 16 pp.).

Table 2. Preliminary estimates of woodcock hunter numbers, days afield, and harvest for selected states, from the 2009-10, 2010-11, 2011-12 and 2012-13 Harvest Information Program surveys. Note: beginning 2008-09 all estimates rounded to the nearest 100 for harvest, hunters, and days afield. (from: Cooper, T.R. and R.D. Rau. 2013. American woodcock population status, 2013. U.S. Fish and Wildlife Service, Laurel, MD. 16 pp.).

Management Unit / State	Active woodcock hunters ([a])				Days afield ([a, c])				Harvest ([a, c])			
	2009-10	2010-11	2011-12	2012-13	2009-10	2010-11	2011-12	2012-13	2009-10	2010-11	2011-12	2012-13
Central Region	n.a. [b]	n.a. [b]	n.a. [b]	n.a. [b]	322,300 ± 14	392,400 ± 20	350,500 ± 16	276,900 ± 16	175,100 ± 17	233,100 ± 20	231,700 ± 20	193,100 ± 23
IL	1,800 ± 98	800 ± 171	2,900 ± 108	900 ± 175	6,200 ± 91	1,200 ± 123	8,800 ± 131	3,500 ± 172	5,300 ± 142	900 ± 106	3,700 ± 195	1,900 ± 160
IN	1,100 ± 63	1,000 ± 66	1,100 ± 79	400 ± 119	4,000 ± 80	3,900 ± 89	4,100 ± 86	1,500 ± 122	1,700 ±79	3,000 ± 134	1,800 ± 102	600 ± 84
MI	26,400 ± 15	31,100 ± 14	28,400 ± 15	25,700 ± 17	146,200 ± 21	159,200 ± 19	144,000 ± 18	121,400 ± 22	80,900 ± 22	93,200 ± 21	106,900 ± 28	74,100 ± 28
MN	9,700 ± 37	13,900 ± 32	17,000 ± 29	11,200 ± 36	38,300 ± 44	55,400 ± 33	76,900 ± 46	40,400 ± 34	16,00 ± 48	34,800 ± 39	44,200 ± 42	31,000 ± 59
OH	1,600 ± 82	1,800 ± 98	3,100 ± 98	600 ± 115	7,200 ± 94	4,300 ± 70	10,200 ± 96	2,600 ± 83	1,200 ± 63	1,700 ± 93	2,300 ± 74	1,500 ± 80
WI	19,400 ± 22	14,600 ± 25	15,200 ±25	13,700 ± 28	77,100 ±24	65,700 ± 40	69,000 ± 30	58,000 ± 33	29,200 ± 24	42,300 ± 22	42,600 ± 31	40,400 ± 37

[a] All 95% Confidence Intervals are expressed as a % of the point estimate.

[b]. Regional estimates of hunter numbers cannot be obtained due to the occurrence of individual hunters being registered in the Harvest Information Program in more than one state.

[c]. Days afield and Harvest estimates are for the entire 18 state Central Region.

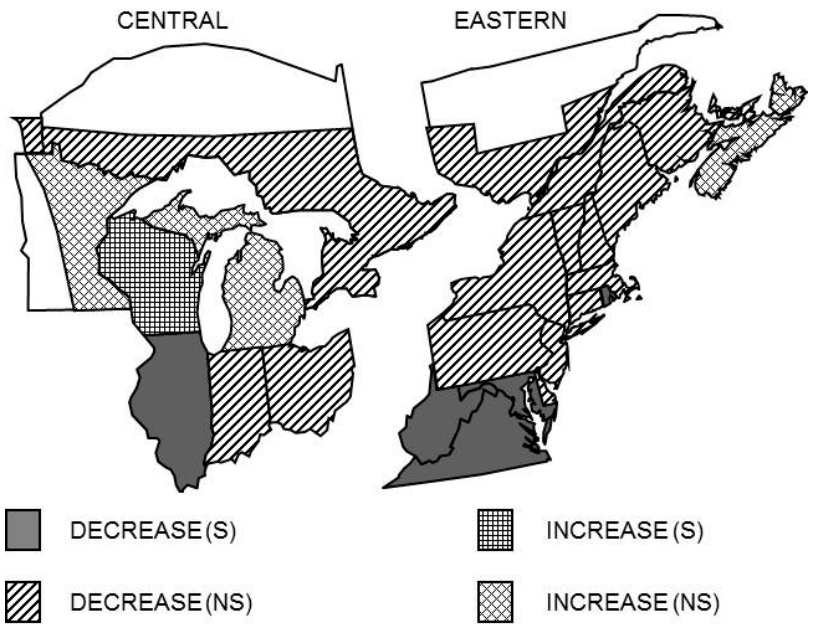

Figure 4. Ten-year trends in number of American woodcock heard on the Singing-ground Survey; 2003-13, as determined by the hierarchical modeling method. A significant trend (S) does not include zero in the 95% credible interval, while a non-significant (NS) trend does include zero. (from: Cooper, T.R. and R.D. Rau. 2013. American woodcock population status, 2013. U.S. Fish and Wildlife Service, Laurel, MD. 16 pp.).

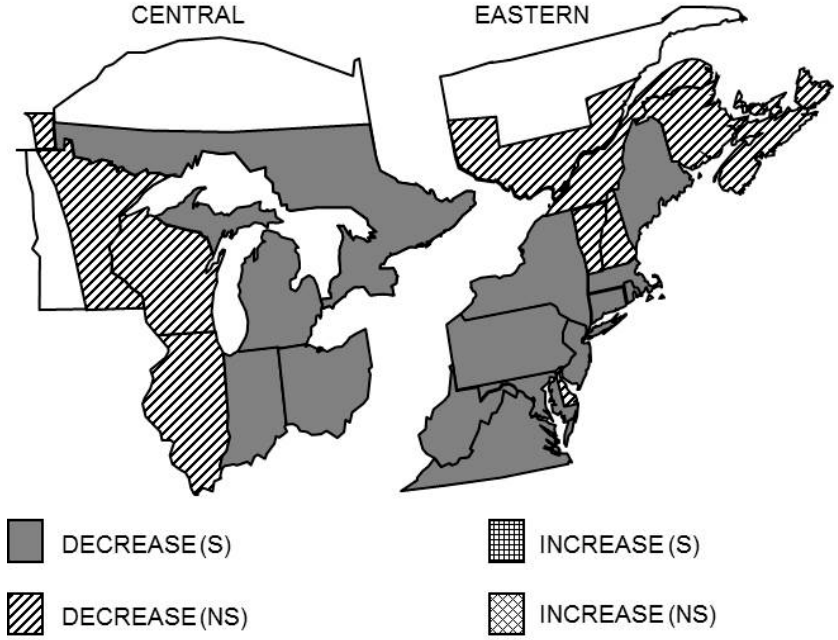

Figure 5. Long-term trends in number of American woodcock heard on the Singing-ground Survey; 1968-2013, as determined by the hierarchical modeling method. A significant trend (S) does not include zero in the 95% credible interval, while a non-significant (NS) trend does include zero. (from: Cooper, T.R. and R.D. Rau. 2013. American woodcock population status, 2013. U.S. Fish and Wildlife Service, Laurel, MD. 16 pp.).

2013 RING-NECKED DUCK BREEDING PAIR SURVEY

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John H. Giudice, Wildlife Biometrics Unit

SUMMARY OF FINDINGS

Since 2006, we have used comparable methods to estimate the number of ring-necked ducks (RNDU, *Aythya collaris*) in either 3 or 6 Ecological Classification System (ECS) Sections in Minnesota. In 2006 and 2007, we estimated RNDU numbers in 6 ECS Sections that contained potential RNDU breeding habitat; but beginning in 2008, we surveyed 3 ECS sections. However, in 2013 we decided to repeat the plots flown in all 6 ECS Sections during the 2007 survey. We used helicopters to survey 195 of 200 plots that had been surveyed in 2007 and 49 resample plots. The survey was flown from 4-18 June. Survey timing was appropriate based on RNDU lone male to indicated breeding pair (IBP) ratios. There were an estimated 11,660 IBP (SE = 2,256) and 24,590 RNDU (SE = 4,660) in the survey area, which was similar to previous estimates. The majority of RNDU observations were in the Northern Minnesota Drift and Lake Plains ECS Section.

INTRODUCTION

Ring-necked ducks (RNDU) are an important breeding waterfowl species in portions of Minnesota. They are also important to Minnesota's waterfowl hunters and often rank 3rd most abundant duck in the State's annual waterfowl harvest (U.S. Fish and Wildlife Service, unpublished data). Continental populations of RNDU have increased since the 1950s (Zicus et al. 2008, U.S. Fish and Wildlife Service, unpublished data); however, a survey of 14 important RNDU breeding lakes in north central Minnesota indicated a decline in numbers since the early 1970s (Zicus et al. 2004). This apparent decline led to concern about the status of breeding RNDU in the state. To monitor the population, Minnesota Department of Natural Resources (MNDNR) initiated a survey in 2004 to estimate the number and distribution of breeding RNDU in Minnesota (Zicus et al. 2008).

The RNDU aerial breeding population survey has been conducted in Minnesota for 10 years. The survey has changed over time, as we have worked to balance budget needs and improve sampling schemes to monitor this important resource. The first 2 years were pilot years and results are not directly comparable to later years, thus results are not presented here.

The basic design developed by Zicus et al. (2008) used Public Land Survey (PLS) Sections as the primary sampling unit (plots). Plots were assigned to strata based upon the amount of RNDU habitat determined from Geographic Information Systems (GIS) land cover data (Habitat classes (HC) 1-2 = with RNDU nesting habitat and water, HC 3 = with water but no nest cover, HC 4 = with no water or potential nesting habitat) and location (ECS Section) (Fig. 1a). Survey designs included:

- 2004-2005: Pilot study with extensive sampling frame (Zicus et al. 2006, 2007, 2008).

- 2006-2007: Stratified Random Sample Design (SRSD) with 12 strata based on 6 ECS Sections (used to spatially allocate the sample) and HC 1 or 2 plots based upon relative

abundance of nesting cover. There was also a separate stratum of all HC 3 and 4 plots combined that were surveyed using double-sampling (see Zicus et al. 2007, Rave et al. 2008 for details).

- 2008-2009: SRSD with 6 strata. We restricted the sampling frame to 3 ECS Sections within the RNDU range in Minnesota and only surveyed HC 1 and 2 plots (HC 3 and 4 stratum was not surveyed) (Sousa et al. 2009, 2010).

- 2010: Same sampling frame as in 2008-2009, but used a SRSD with 7 strata (3 ECS sections X 2 HC, and an additional stratum consisting of 49 of the 174 plots that were surveyed in 2009 [stratum = resample]) (Herwig 2010).

- 2011-2012: Generalized random tessellation stratified design (GRTS) with 3 strata (HC 1 and 2, plus 49 'resample' plots). Same sample frame as in 2008-2010, but used GRTS rather than ECS sections to obtain a spatially balanced sample (Herwig and Giudice 2011, Lawrence et al. 2012).

Prior to beginning the 2013 RNDU breeding population survey, we decided that we would not continue this survey every year due to budget considerations and the lack of trend in population estimates since 2006. Given that this would be the last year of the survey for a period of years, we decided to survey the same HC 1 and 2 plots that were surveyed in all 6 ECS Sections in 2007, along with 49 resample plots that have been surveyed since 2009. Our objective was to estimate breeding pair numbers and monitor population trends for RNDU in northern Minnesota. We also summarize data and correct errors from previous reports.

METHODS

Since 2006, we have used Public Land Survey (PLS) sections (~2.6-km^2 plots, range = 1.2 – 3.0 km^2) as primary sampling units (Zicus et al. 2008). The sampling frame for HC 1-2 plots had been defined as PLS sections that contained any potential RNDU nesting cover, which Zicus et al. (2008) defined as Minnesota Gap Analysis Project (MNGAP) level 4 land cover data that was either:

- Class 10 = lowlands with <10% tree crown cover and >33% cover of low-growing deciduous woody plants such as alders and willows,
- Class 14 = wetlands with <10% tree crown cover that is dominated by emergent herbaceous vegetation such as fine-leaf sedges, or
- Class 15 = wetlands with <10% tree crown cover that is dominated by emergent herbaceous vegetation such as broad-leaf sedges and/or cattails,
- That were within 250 m of and adjacent to:
    - Class 12 = lakes, streams, and open-water wetlands, or
    - Class 13 = water bodies whose surface is covered by floating vegetation.

MNGAP class 10, 14, and 15 cover associated with lakes having a General or Recreational Development classification under the Minnesota Shoreland Zoning ordinance was excluded, because pilot surveys indicated that breeding RNDU seldom used this habitat. Plots that met the

criteria were assigned to HC 1 if they contained ≥ median amount of this cover; otherwise they were HC 2 (Figure 1A).

Rave et al. (2008) noted "However, the habitat layer that we used in 2006 and 2007 included some MNGAP class 10, 14, and/or 15 cover that was **within** 250 m **but not** necessarily **adjacent** to that patch of MNGAP class 12 and/or 13 cover." They recommended either correcting this problem with GIS work to reclassify sample plots or changing the definition of RNDU nesting cover used in this survey. There is no record that this change was made for the 2008-2012 surveys; thus, the definition of potential RNDU nesting cover in the years 2006-2012 (Zicus et al. 2007, Rave et al. 2008, Sousa et al. 2009, 2010, Herwig 2010, Herwig and Giudice 2011, Lawrence et al. 2012) should be modified from above to be:

- That were within 250 m of ~~and adjacent to~~:
    - Class 12 = lakes, streams, and open-water wetlands, or
    - Class 13 = water bodies whose surface is covered by floating vegetation.

In 2013, we planned to survey the same HC 1 and 2 plots that were surveyed in 2007 (Figure 1B). This included plots in 3 ECS Sections (Southern/Western Superior Uplands [combined and considered 1 ECS Section for these surveys], Northern Superior Uplands, and Northern Minnesota and Ontario Peatlands) that had not been surveyed since 2007. As in 2007, the Boundary Waters Canoe Area was excluded from the survey area. We did not survey the 50 HC 3 and 4 PLS sections (expected to have low densities or no breeding RNDU) that had been surveyed in 2007. Few ducks were seen on those plots in 2007 (1 pair, 1 lone male, 4 flocked males, group of 3). Instead, we invested that survey effort to resurvey 49 plots we surveyed annually since 2009. These resample plots were randomly selected in 2010 from the 174 plots sampled in 2009 and represented a range of RNDU counts and IBP (Herwig 2010). The 49 plots have been consistently surveyed since 2009 and were treated as a third stratum (sampling rate = 1). Our sample in 2013 should have included 249 plots (102-HC 1, 98-HC 2, and 49 resample plots); however, 1 plot was both a HC 1 and a resample plot. Thus, only 248 plots were selected to be surveyed. The 3 ECS Sections that have been consistently surveyed since 2006 were considered the 'core' survey area. The 3 ECS Sections that were only surveyed in 2006, 2007, and 2013 were considered the 'exterior' survey area. All 49 resample plots were in the core survey area.

We surveyed plots from a MNDNR Division of Enforcement helicopter (Bell OH-58 [Jet Ranger]) flying ~30–45 meters above ground level and ~75–130 km/h. A 2-person survey crew (pilot + 1 observer) recorded RNDU observations by sex and social status (Zicus et al. 2008). We considered pairs, lone males, and flocked males (2–5) to indicate breeding pairs (Zicus et al. 2008). The breeding population in the survey area was considered to be twice the Indicated Breeding Pairs (IBP) plus the number of birds in groups. Originally, lone and flocked females were included in the breeding population estimate calculated for this survey; but, we chose to exclude these females and recalculated previous year's estimates to reflect this change. We made this change because neither the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987) nor MNDNR include lone females in their spring aerial breeding waterfowl population surveys. Lone or flocked females were not included because they are represented by the lone or flocked males that are doubled to account for hens sitting on the nest. The number of lone females ranged from 0-11 observed/year and only 4 groups of flocked females (size = 2, 2, 3, 4) were recorded from 2006-2013.

From 2007 through 2011, observations were recorded on aerial photos and transcribed to data sheets following the survey. In 2012 and 2013, observations were recorded in digital voice files, each associated with a UTM location, on a tablet computer using the DNRSurvey software program developed by MNDNR Wildlife and GIS staff (Wright et al. 2011). Data were transcribed and proofed following the survey. We used the R libraries survey (Lumley 2009, R Development Core Team 2009) and spsurvey (Kincaid and Olsen 2011) to estimate IBP and the total breeding population.

RESULTS

We completed the survey in 8 days flight time. MNDNR pilot John Heineman flew the entire survey. There were 4 observers: John Giudice (4, 11 June), Brian Lueth (6, 7 June), Jeff Lawrence (8, 12, 18 June), and Steve Cordts (13 June). We were unable to survey 5 plots from the 2007 sample. These included:

1. 2 plots on Agassiz National Wildlife Refuge that we were not allowed to survey because of nesting Franklin's gulls (*Leucophaeus pipixcan*),
2. 1 plot on Camp Ripley that was in the active firing range,
3. 1 plot near Detroit Lakes that had an active mink farm,
4. 1 plot near Grand Portage (far NE MN) that was too far from helicopter fuel.

In addition, one of the Northern Minnesota Drift and Lake Plains HC 1 plots was also a resample plot and we included it as part of the 49 resample plots; thus, there were 6 total 2007 plots that were not included to estimate the population in the 2013 sample.

The survey was conducted from 4-18 June 2013 (Figure 2). Survey start dates have ranged from 4-9 June and end dates ranged from 11-18 June (6-16 June 2006, 5-13 June 2007, 9–17 June 2008, 5–12 June 2009, 7–16 June 2010, 6–11 June 2011, and 4-8 June 2012). The surveys have varied in duration due to number of plots, size of the survey area, weather, availability of a second helicopter and crew, and scheduling conflicts.

We surveyed approximately 1% of the survey plots in each of the ECS Sections (Table 1). The survey plots from 2007 were well distributed throughout the survey area (Figure 1B). There were only 6 random survey plots flown in the Lake Agassiz, Aspen Parklands section, but 10 of the 49 resample plots were in this section.

A total of 242 RNDU (excluding 7 lone females) was detected on 55 (23%) of the 243 sample plots (Table 2). The habitat class stratification implemented by Zicus et al. (2008) continues to be effective as ring-necked ducks in the core survey area were present on twice as many HC 1 as HC 2 plots (Figure 3). This relationship was not as strong in the exterior area (Figure 3). Plot occupancy was also higher in the core survey area (Table 2). RNDU occupied 27% of the plots in the core area compared to 15% of the plots in the exterior area. The proportion of pairs was approximately 50% of all IBP (Figure 4).

We estimated 11,660 IBP (SE = 2,256) and 24,590 RNDU (SE = 4,660) in the entire survey area (Table 3, Figures 5 and 6). In the core area, the RNDU breeding population was an estimated 18,300 birds, which was not statistically different than previous years and similar to the 17,860 estimated in 2007. The IBP estimate in the core area was also similar to 2007. While the point estimates for the exterior were lower than the 2007 survey, they were not statistically different. The number of birds observed on the 49 resample plots was similar to previous years (Figures 5, 6).

We were unable to fly 5 of the 2007 plots, 3 that had above average numbers of RNDU in 2007 (1 in Northern Superior Uplands that had 9 IBP, 2 in Lake Agassiz, Aspen Parklands that had 7 and 8 IBP). When we exclude these plots from the 2007 data and compare the number of RNDU seen on the same plots in 2007 and 2013, we observed more IBP during the 2013 survey in the Northern Minnesota Drift and Lake Plains and Northern Superior Uplands, and similar or fewer numbers in the other ECS Sections (Table 4). The 5 missed plots were important and accounted for 15% of the IBP counted in the core survey area and 25% of the IBP counted in the exterior area in 2007 (Table 2). Few birds were observed in the Western and Southern Superior Uplands in 2007, but no birds were recorded there in 2013.

As in previous years, the majority of the birds were located in the Northern Minnesota Drift and Lake Plains ECS Section (Figures 7, 8) and few birds were reported in the southern portion of the survey area. In 2009, several RNDU were incorrectly reported in the southern portion of the survey area (Sousa et al. 2010). We found an error in the GIS file and provide annual depiction of survey plots and distribution of RNDU, including a corrected 2009 map (Figure 7). The 2009 distribution was similar to other years.

DISCUSSION

We have used the same habitat classification to select survey plots since 2006, but we reduced the scope of the survey in 2008 (Sousa et al. 2009). The population of RNDU breeding in areas we surveyed all years has shown no definitive trend the past 8 years. There was a low population estimate in 2010. However, based on the full time series, the extremely low count in 2010 was probably due in part to sampling error (i.e., the true population decline probably was not as great as depicted by the 2010 estimate) (Herwig and Giudice 2011). When we resurveyed the exterior survey area in 2013, it accounted for 26% of the breeding RNDU this year vs. 31-33% of the population estimate in 2006 and 2007. The change in numbers was not significant, but warrants monitoring in future surveys. We did not resurvey HC 3 and 4, which accounted for 9% of the population estimate in 2006 and 2007.

The timing of the 2013 survey was appropriate because the proportion of pairs was approximately 50% of all IBP (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1987). Spring phenology was very late in 2013, especially compared to 2012 (http://climate.umn.edu/doc/whatsnew.htm, accessed 29 Oct 2013), but by June 2013 conditions were closer to normal.

Given that we planned to suspend the annual survey effort beginning in 2014, it made sense to survey the original area (all 6 ECS Sections) and repeat much of the 2007 survey this year. The original survey design was developed to achieve a balance between determining spatial distribution and abundance of RNDU (Zicus et al. 2008). Our objective this year was to detect any change in the population between 2007, when we last surveyed all 6 ECS Sections, and 2013. Periodically surveying the same plots provides the best method to determine population trend (Zicus et al. 2008). It is unfortunate that in 2013 we were unable to survey 5 of the 2007 HC 1-2 plots. Three of these plots contained several RNDU in 2007 and contributed to the 2007 population estimate. It would have improved the comparison between years if we had flown these plots; but, we do not have a good method to adjust for this after the 2013 survey.

We changed survey design several times over the 8-year period of this survey, but the estimates for the same survey areas are comparable among years. In 2011 and 2012, we used a generalized random tessellation stratified (GRTS) design to obtain a spatially balanced sample of

plots (Stevens and Olsen 2004) instead of stratifying based upon ECS Section. The GRTS design ensures that sampling units are dispersed across the sampling frame. The changes were implemented in order to increase the relative precision of the estimates (Herwig and Giudice 2011). While the GRTS design has inherent benefits for this type of survey, we recommend resurveying a previous set of plots (e.g. repeat the 2007 and 2013 plots) when the survey is conducted again in 3-5 years. While this is not ideal for estimating the size or distribution of the population, we have gained insight on both of these population characteristics during the past surveys. Resurveying plots will provide better information on population change among years, thus will be most informative for conducting an occasional survey (e.g. every 3-5 years) in the future.

The Northern Minnesota Drift and Lake Plains ECS Section had the highest number or breeding RNDU in Minnesota. This area contains large amounts of potential RNDU breeding habitat (Figure 1A) and breeding RNDU are well distributed throughout this ECS Section (Figure 8). In contrast, while the Minnesota and Northeast Iowa Morainal section has substantial potential breeding habitat (Figure 1A), breeding RNDU mostly occur in the northern portion of this ECS Section (Figure 7). Also, few RNDU were recorded in the Western and Southern Superior Uplands ECS Sections. The Lake Agassiz, Aspen Parklands ECS Section has limited potential breeding habitat (Figure 1A), but RNDU are relatively abundant in the limited habitat. Much of the habitat is located on large tracts of public land, such as Agassiz National Wildlife Refuge and Thief Lake and Roseau River wildlife management areas. In the exterior area, the Northern Superior Uplands was the most important RNDU breeding area (Rave et al. 2008, this survey), and both this area and the N. Minnesota & Ontario Peatlands had numerically more RNDU than the Lake Agassiz, Aspen Parklands. We selected the Lake Agassiz, Aspen Parklands as part of the core survey area in 2008 because it had higher densities of ducks on the available RNDU habitat. Also, in their review of the survey, Zicus et al. (2008) stated "In this survey, plots in northeastern Minnesota could be eliminated because they are remote, proved to be expensive to survey, and had few breeding pairs."

Resample plots may provide more reliable information on population trends because the same plots are surveyed each year (i.e., sampling variation is minimized). For example, RNDU counts on resample plots have not demonstrated a changing trend during 2009-2013, whereas the population estimate (based on all plots) for 2010 was substantially lower than previous and subsequent estimates (Figure 6). This suggests that the 2010 population estimate may have been partially an artifact of the random sample.

This survey has increased our understanding or RNDU breeding population size and distribution in Minnesota. The RNDU is the 4th most abundant breeding duck in Minnesota, following mallards (*Anas platyrhynchos*), blue-winged teal (*A. discors*), and wood ducks (*Aix sponsa*) (Cordts 2013, this survey). When we began the pilot survey in 2004, we discussed whether population size, trend or distribution was the most important parameter to monitor the population. The original design allowed us to determine population size, thus trend, and the stratification into 6 ECS sections ensured that plots were distributed across the landscape. While it is possible the breeding RNDU population was larger in Minnesota during the 1970s and 1980s as indicated by the 14-lake survey (Zicus et al. 2008), the helicopter survey indicates that breeding populations do not show a strong changing trend in Minnesota. The 14 lakes RNDU survey has also not indicated a positive or negative trend since 2006 (Figure 11) (Lawrence 2011, MNDNR unpublished data).

We recommend that 2013 be the last year this survey is flown until 2016-2018. The decision on which year to reinstitute the survey will depend on results from the 14 lake survey and perhaps other anecdotal information. We should consider flying the survey 2 years in a row (e.g. 2016 and 2017) to reduce the influence of annual variability in the counts. We also recommend resurveying the 2013 plots, because the resample design will be more informative for estimating trends from a periodic survey. If the survey crew can obtain permission or deal with the other issues that were problems in 2013, we recommend that the 5 plots from 2007 that not flown in 2013 be surveyed in future surveys. We recognize that conducting this survey on an annual basis would yield the best population status information; but, balancing costs and the lack of trend in the population, we believe a periodic survey is a reasonable compromise. While we have not detected trend in this population during the past 8 years, we think that periodic breeding pair surveys of Minnesota's RNDUs will be essential to monitor status and ensure maintenance of this resource.

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David Rave (2004-2007) and Christine Herwig (2008-2011) coordinated and were the lead observers for previous surveys. They also provided helpful reviews of earlier versions of this report. Thanks for their work, along with Mike Zicus and the original collaborators (see Zicus et al. 2008) that made this survey a success. Pilot John Heineman has flown all or most of this survey during all years. In addition to his skills as a helicopter pilot, he has helped with survey planning, observed ducks, and provided good company. Bryan Lueth and Steve Cordts were also observers on a portion of this year's survey. Thanks also to Bob Wright who set up the DNRSurvey program and Chris Scharenbroich who created the navigation maps.

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Table 1. Number of plots surveyed (*n*) and sampling rate (%) by Ecological Classification System (ECS) Section and habitat class for Minnesota's ring-necked duck breeding-pair survey, 2006–2013.

			Survey Year													
	Habitat		2006-07		2008		2009		2010		2011[d]		2012[d]		2013	
ECS Section	class[a]	N plots[b]	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
W. & S. Superior Uplands	1	1118	10	0.9	0		0		0		0		0		10	0.9
	2	1100	10	0.9	0		0		0		0		0		10	0.9
N. Superior Uplands	1	1810	14	0.8	0		0		0		0		0		13	0.7
	2	2399	19	0.8	0		0		0		0		0		19	0.8
N. MN & Ontario Peatlands	1	1321	17	1.3	0		0		0		0		0		17	1.3
	2	1068	13	1.2	0		0		0		0		0		13	1.2
N. MN Drift & Lake Plains	1	3828	41	1.1	83	2.2	56	1.5	55	1.5	64	1.7	63	1.6	39	1.0
	2	3317	36	1.1	25	0.8	47	1.4	47	1.4	52	1.6	56	1.7	36	1.1
MN & NE Iowa Morainal	1	1638	15	0.9	31	1.9	24	1.5	24	1.5	24	1.5	29	1.8	14	0.9
	2	1923	17	0.9	22	1.1	27	1.4	27	1.4	31	1.6	32	1.7	17	0.9
Lake Aggasiz, Aspen Parklands	1	216	5	2.3	9	4.2	10	4.6	10	4.9	3	1.4	4	1.9	3	1.4
	2	124	3	2.4	4	3.2	10	8.1	10	8.8	2	1.6	1	0.8	3	2.5
All	3/4	26369	50	0.2	0		0		0		0		0		0	
Resample 2009 plots[c]	1/2	49	0		0		0		49	100.0	49	100.0	49	100.0	49	100.0
Total			250		174		174		222		225		234		243	

[a]-Habitat class 1 and 2 contain likely RNDU nesting cover, Habitat 3 and 4 are unlikely RNDU nesting habitat. See methods for details.

[b]-Number of Public Land Survey sections by ECS section and habitat class.

[c]-Resample plots include 12 Habitat Class (HC) 1 plots and 12 HC 2 plots in N. MN Drift & Lake Plains; 8 HC 1 and 7 HC 2 plots in MN & NE Iowa Morainal; and 5 HC 1 and 5 HC 2 plots in Lake Agassiz, Aspen Parklands.

[d]-Plots in 2011 and 2012 were selected using a GRTS analysis (Lawrence et al. 2012) and are assigned to the ECS section using a domain analysis.

Table 2. Plot occupancy, number, and density of indicated breeding pairs (IBP) and total birds observed on Habitat Class 1 and 2 plots during the ring-necked duck breeding pair survey in Minnesota, 2006-2013.

			Plots with birds		IBP[d]			Birds[e]		
Strata	Year	No. of plots surveyed	*n*	%	Total	Per plot[f]	Per occupied plot[f]	Total	Per plot[f]	Per occupied plot[f]
Core[a]	2006	117	27	23	120	1.03	4.44	198	1.69	7.33
	2007	117	33	28	101	0.86	3.06	164	1.40	4.97
	w/o 2013 skipped plots	113	31	27	86	0.76	2.77	134	1.19	4.32
	2008	174	57	33	173	0.99	3.04	287	1.65	5.04
	2009	174	56	32	173	0.99	3.09	269	1.55	4.80
	2010	173	38	22	105	0.61	2.76	156	0.90	4.11
	2011	176	56	32	166	0.94	2.96	245	1.39	4.38
	2012	185	53	29	196	1.06	3.70	303	1.64	5.72
	2013	113	30	27	87	0.77	2.90	143	1.27	4.77
Exterior[b]	2006	83	21	25	47	0.57	2.24	77	0.93	3.67
	2007	83	14	17	36	0.43	2.57	59	0.71	4.21
	w/o 2013 skipped plots	82	13	16	27	0.33	2.08	43	0.52	3.31
	2013	82	12	15	29	0.35	2.42	40	0.49	3.33
Resurvey[c]	2009	49	13	27	44	0.90	3.38	67	1.37	5.15
	2010	49	14	29	42	0.86	3.00	64	1.31	4.57
	2011	49	13	27	54	1.10	4.15	79	1.61	6.08
	2012	49	15	31	33	0.67	2.20	67	1.37	4.47
	2013	49	13	27	39	0.80	3.00	59	1.20	4.54

[a]Core includes N MN Drift and Lake Plains, MN & NE Iowa Morainal, and Lake Aggasiz, Aspen Parklands

[b]Exterior includes W/S Superior Uplands, N Superior Uplands, and N MN & Ontario Peatlands.

[c]49 resurvey plots, 2009 resample plots are also included in the core numbers for 2009.

[d]The number of indicated breeding pairs (IBP) is the sum of the pairs, lone males, and males in flocks of 2–5 birds.

[e]Total number of ring-necked ducks counted during the survey (excluding lone and flocked females).

[f]These naïve calculations of density (*n* /plots) are not directly comparable with the weighted density estimates presented in Table 3.

Table 3. Breeding population (BPOP) and indicated breeding pair (IBP) estimates for ring-necked ducks on habitat class 1 and 2 areas in portions of Minnesota, 2006-2013.

		Plots		Indicated Breeding Pairs (IBP)				Breeding Population (BPOP)			
Area	Year	N	n	IBP/plot	SE	IBP	SE	BPOP/plot	SE	BPOP	SE
Core[a]	2006	11,046	117	0.892	0.213	9,850	2,348	1.978	0.456	21,850	5,040
	2007	11,046	117	0.788	0.157	8,700	1,729	1.617	0.316	17,860	3,487
	2008	11,046	174	0.855	0.143	9,440	1,582	1.764	0.293	19,490	3,240
	2009	11,046	174	0.991	0.141	10,950	1,562	2.069	0.310	22,850	3,422
	2010	11,046	222	0.483	0.098	5,340	1,082	1.020	0.220	11,270	2,433
	2011	11,046	225	0.942	0.120	10,410	1,325	1.997	0.250	22,060	2,764
	2012	11,046	234	1.052	0.166	11,620	1,833	2.137	0.332	23,610	3,664
	2013	11,046	161	0.771	0.172	8,510	1,898	1.656	0.360	18,300	3,971
Exterior[b]	2006	8,816	83	0.558	0.128	4,920	1,127	1.222	0.297	10,770	2,620
	2007	8,816	83	0.463	0.165	4,080	1,457	0.926	0.331	8,160	2,915
	2013	8,816	82	0.357	0.138	3,150	1,219	0.714	0.276	6,300	2,438
All	2006	19,862	200	0.744	0.131	14,770	2,604	1.642	0.286	32,620	5,680
	2007	19,862	200	0.644	0.114	12,790	2,261	1.310	0.229	26,030	4,545
	2013	19,862	243	0.587	0.114	11,660	2,256	1.238	0.235	24,590	4,660
Resample[c]	2009	174	49	0.898	0.267	44	-	1.796	0.534	88	-
	2010	49	49	0.857	0.302	42	-	1.714	0.604	84	-
	2011	49	49	1.102	0.382	54	-	2.204	0.764	108	-
	2012	49	49	0.673	0.201	33	-	1.633	0.611	80	-
	2013	49	49	0.796	0.272	39	-	1.592	0.543	78	-

[a]Core includes N MN Drift and Lake Plains, MN & NE Iowa Morainal, and Lake Aggasiz, Aspen Parklands

[b]Exterior includes W/S Superior Uplands, N Superior Uplands, and N MN & Ontario Peatlands.

[c]49 resurvey plots, 2009 resample plots are also included in the core numbers for 2009.

Table 4. Number of ring-necked duck indicated breeding pairs (IBP) and breeding population (BPOP) counts on plots surveyed during both 2007 and 2013 ring-necked duck breeding pair surveys.

	N observed by year			
	IBP[a]		BPOP[b]	
ECS Section	2007	2013	2007	2013
Lake Agassiz, Aspen Parklands	6	4	12	8
Minnesota & NE Iowa Morainal	19	11	38	22
N. Minnesota & Ontario Peatlands	9	11	18	22
N. Minnesota Drift & Lake Plains	61	73	125	159
Northern Superior Uplands	12	18	24	36
Western (& S.) Superior Uplands	6	0	12	0
Total	113	117	229	247

[a]Indicated breeding pairs (IBP) is the sum of the pairs, lone males, and males in flocks of 2–5 birds.

[b]Breeding population is IBP * 2 + ducks in groups.

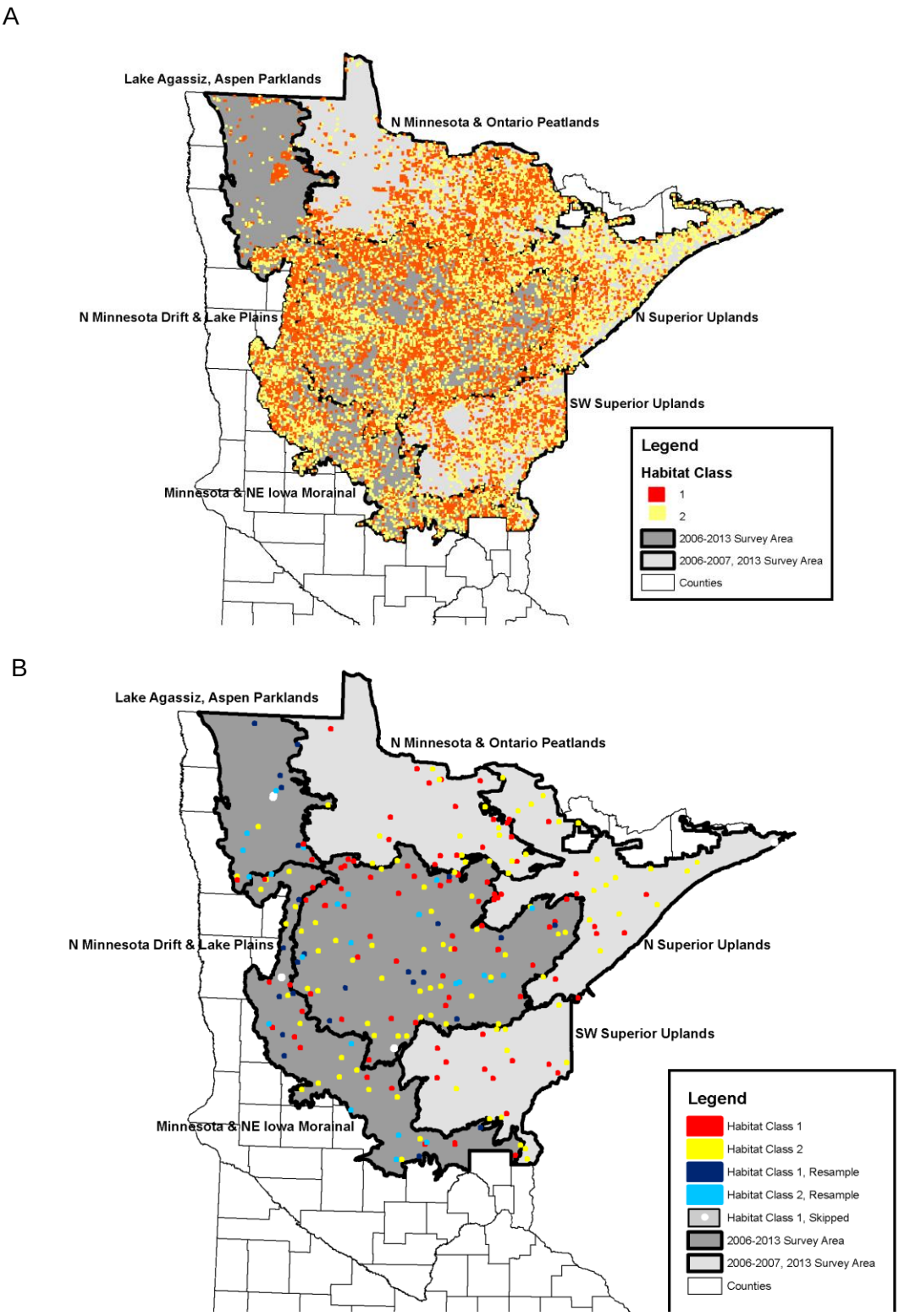


Figure 1. (A) Sampling frame showing Habitat Class 1 and 2 Public Land Survey plots for the ring-necked duck breeding pair survey, 2006-2013, and (B) random, resample, and skipped plots surveyed in 2013 (enlarged for visibility) by Habitat Class.

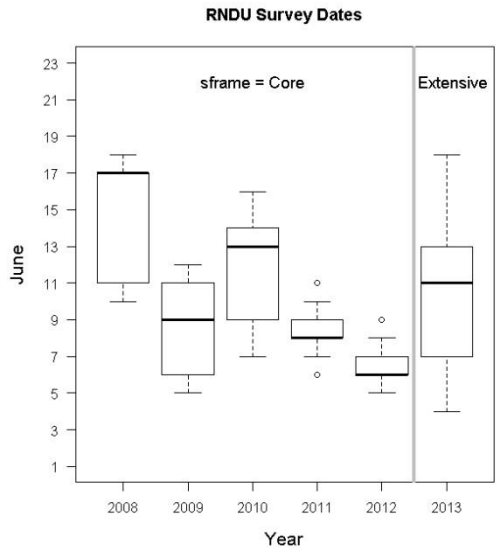


Figure 2. Box plot showing dates ring-necked duck breeding pair survey plots were completed, 2008-2013. Note that in 2013 both the core and exterior survey areas was flown, but included a similar number of survey plots.

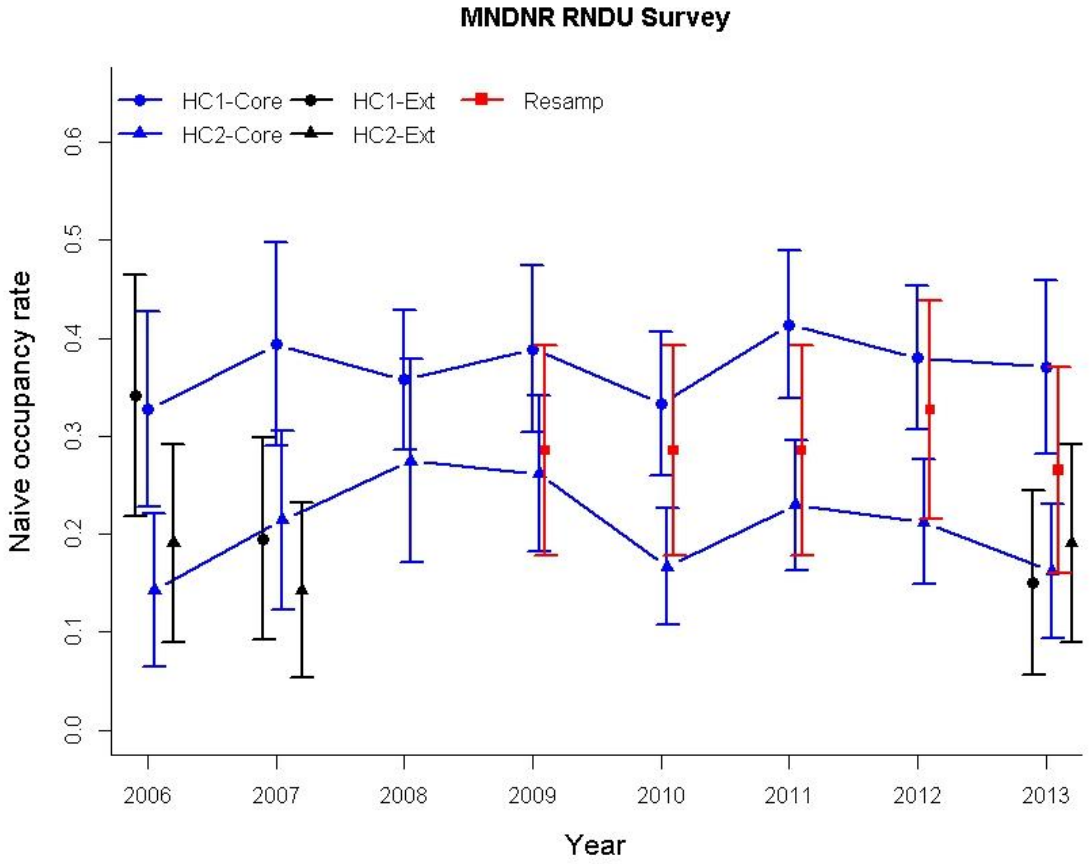


Figure 3. Proportion of occupied plots (naïve occupancy rate is unweighted number of occupied plots/total plots surveyed) by Habitat Class during the 2006-2013 ring-necked duck breeding pair surveys for the Core, Exterior (Ext), and resample survey plots.

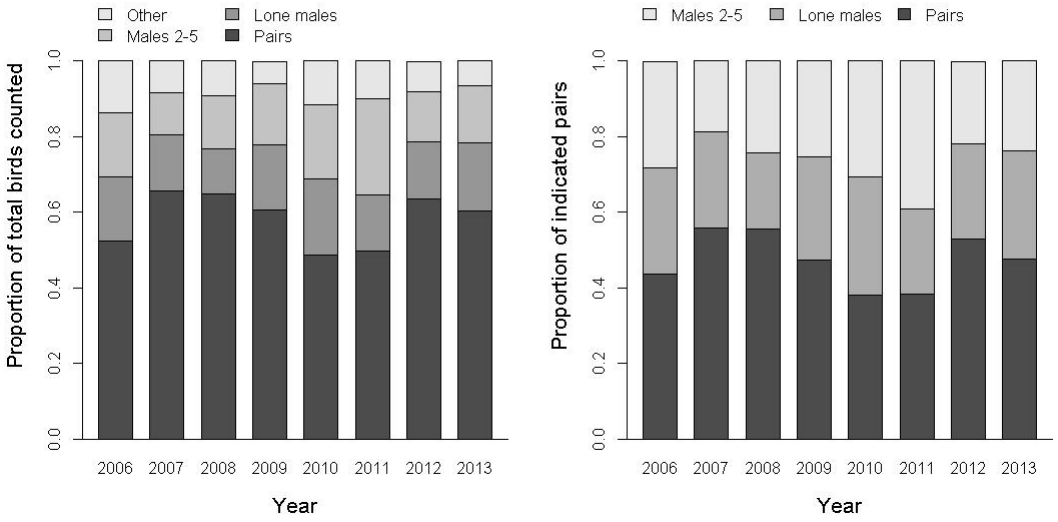


Figure 4. Social grouping of ring-necked ducks counted on 2006-2013 ring-necked duck breeding pair surveys for all ducks counted (left panel) and indicated breeding pairs (right panel).

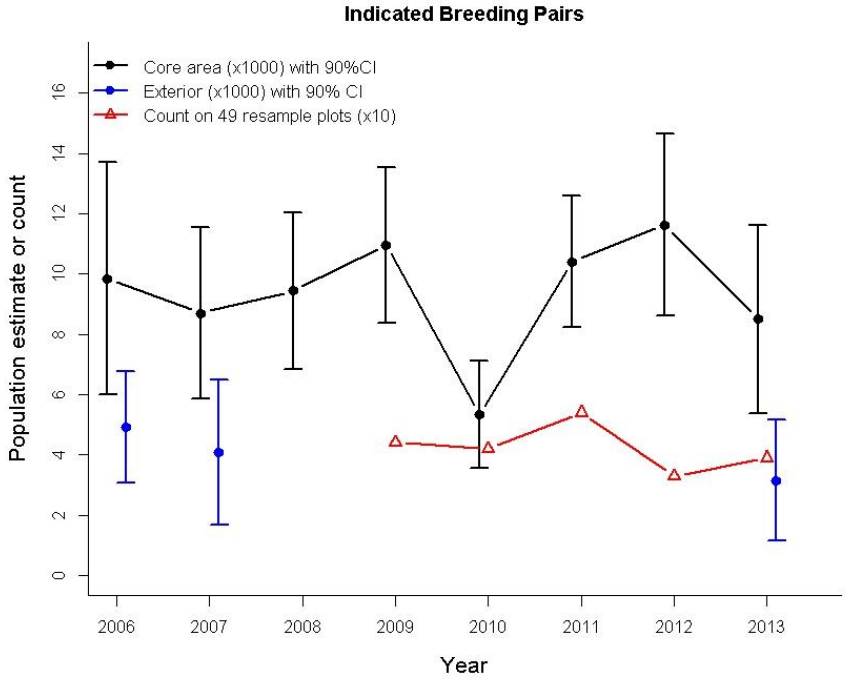


Figure 5. Estimated indicated breeding pairs with 90% Confidence Intervals for the for the core and exterior survey areas (x1000) during the Minnesota ring-necked duck breeding pair survey, 2006–2013. Counts for the 49 resample plots (x10) are also shown.

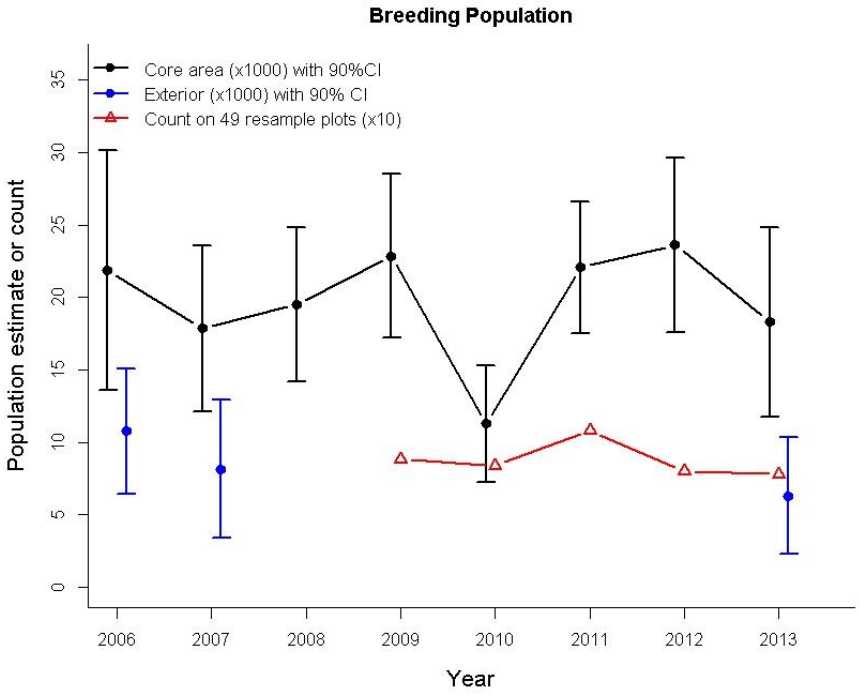


Figure 6. Estimated breeding population with 90% confidence intervals for the for the core and exterior survey areas (X1000) during the Minnesota ring-necked duck breeding pair survey, 2006–2013. Counts for the 49 resample plots (x10) are also shown.

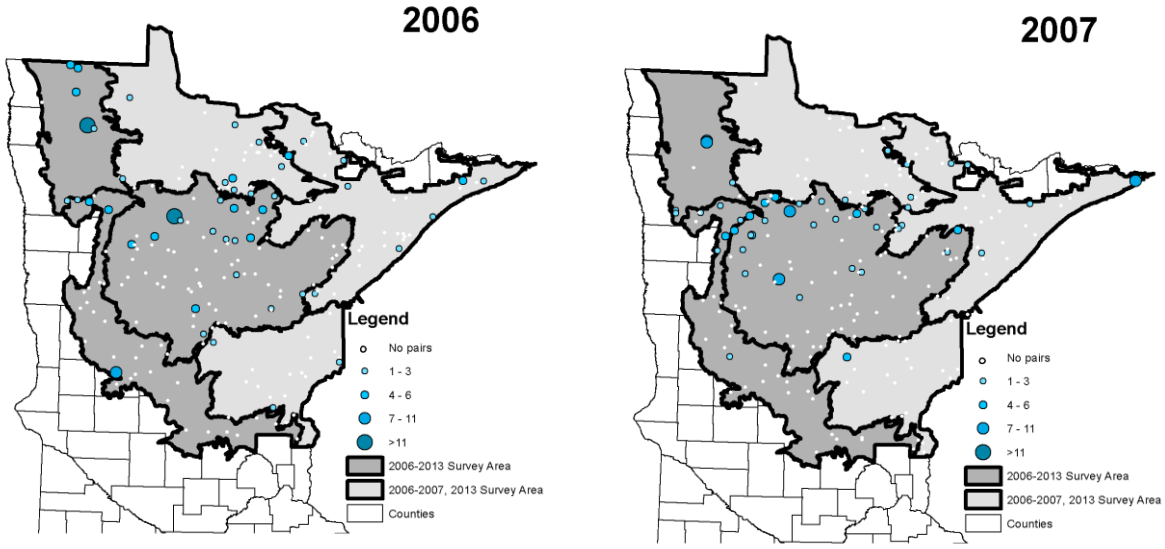
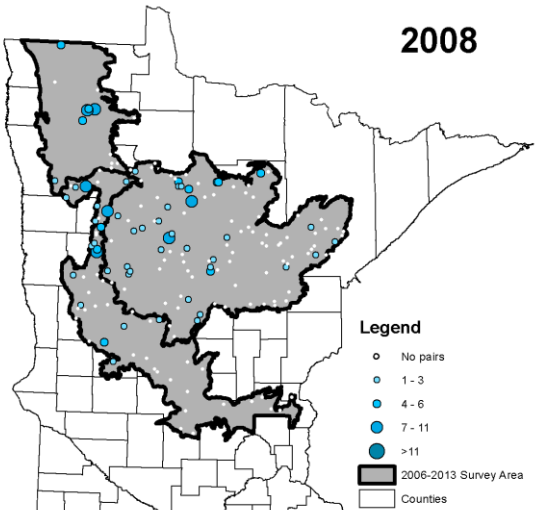
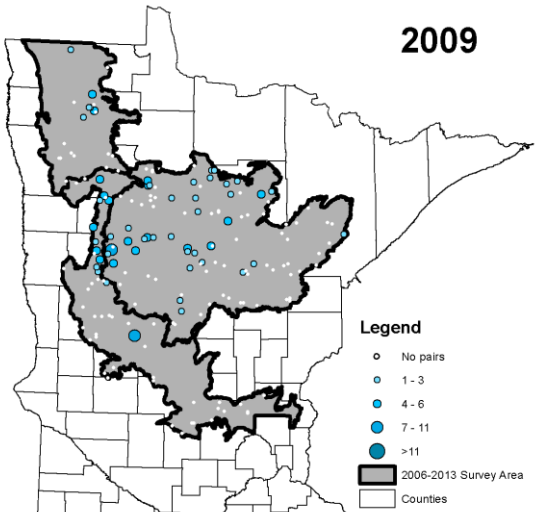
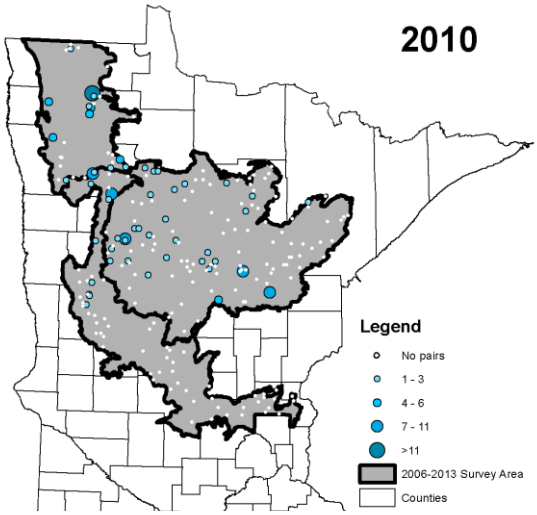
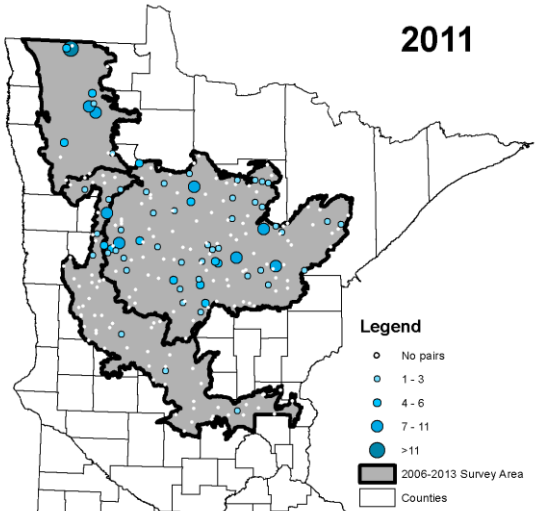


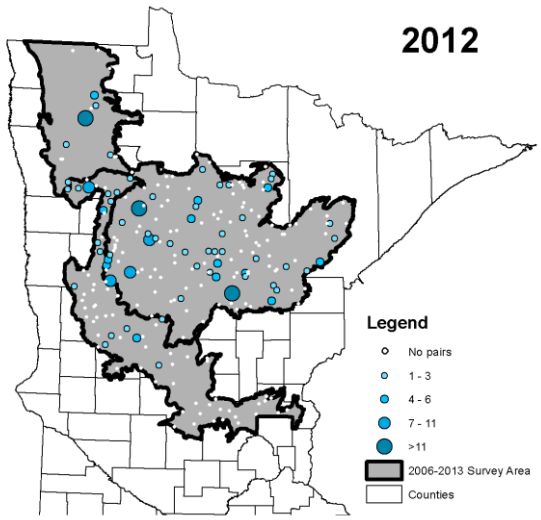
Figure 7. Ring-necked duck survey plots in Habitat Classes 1 and 2 and number of indicated breeding pairs/plot during annual ring-necked ducks breeding pair surveys in northern Minnesota, 2006-2013.











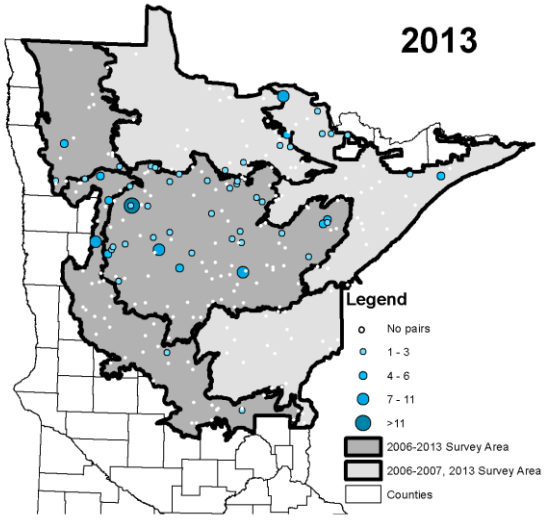


Figure 7 (continued).

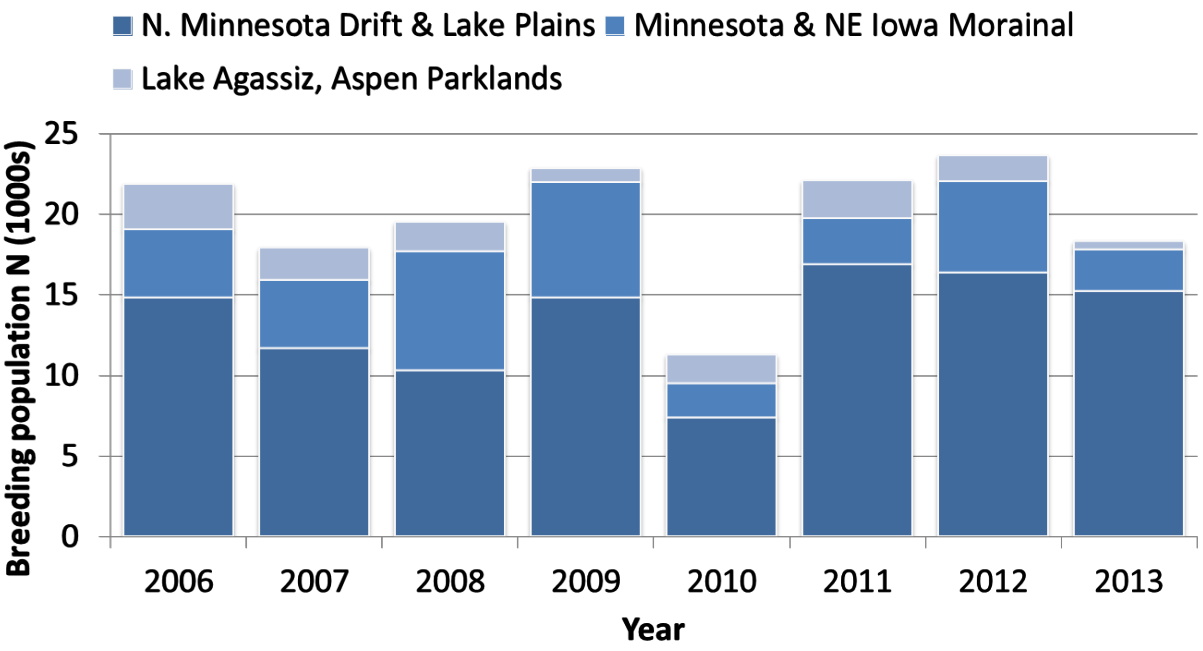


Figure 8. Estimated ring-necked duck breeding population in 3 Ecological Classification System Sections, Habitat Classes 1 and 2, during annual June ring-necked ducks breeding pair surveys in northern Minnesota, 2006-2013.

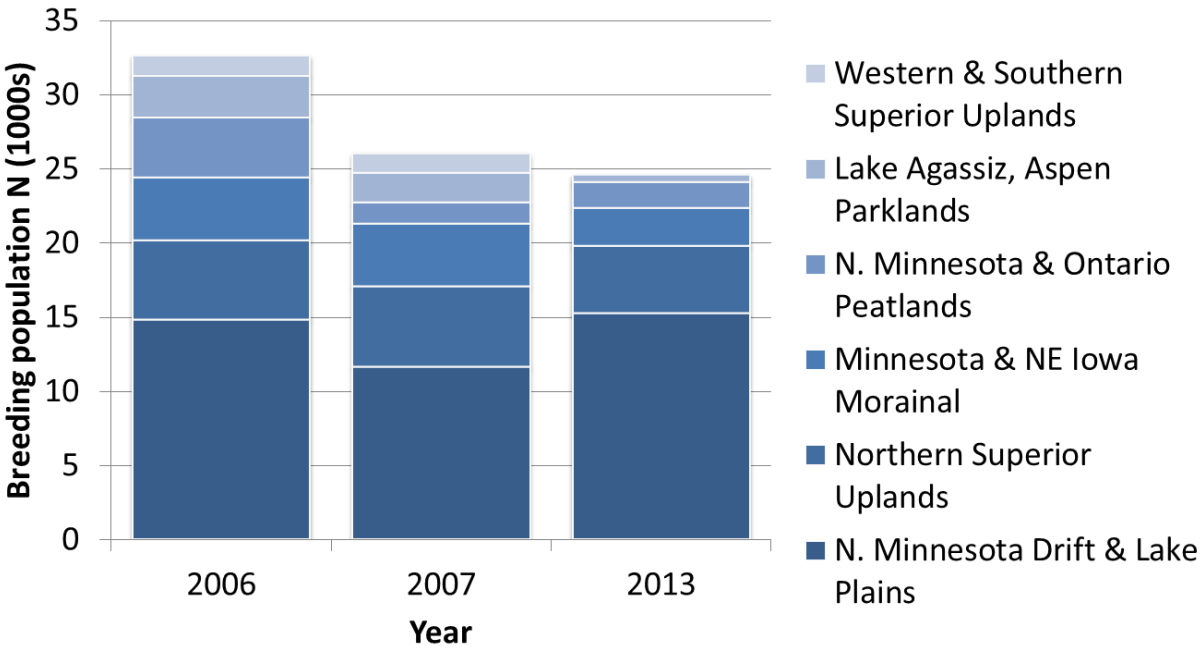


Figure 9. Estimated ring-necked duck breeding population in 6 Ecological Classification System Sections, Habitat Classes 1 and 2, during annual June ring-necked ducks breeding pair surveys in northern Minnesota, 2006, 2007, and 2013.

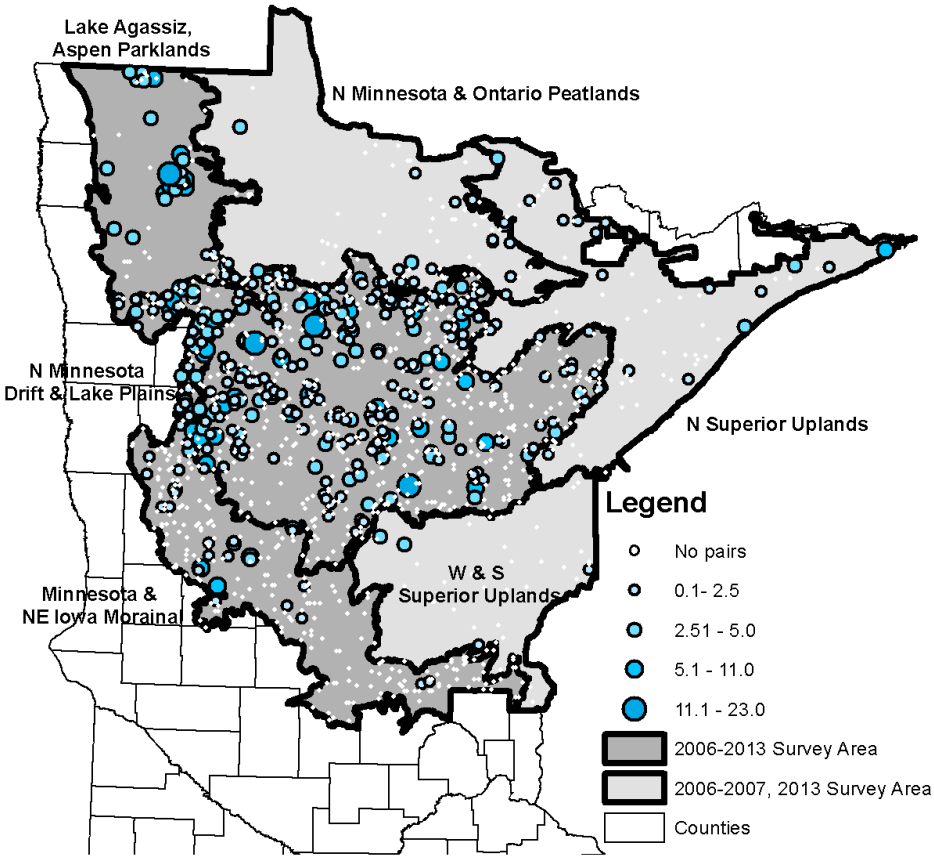


Figure 10. Sample plot locations and number of indicated breeding pairs observed/plot on the Minnesota ring-necked duck breeding pair survey, June 2006-2013. Value is average number of IBP per year for plots surveyed > 1 year. White circles indicate plots where no indicated pairs were seen.

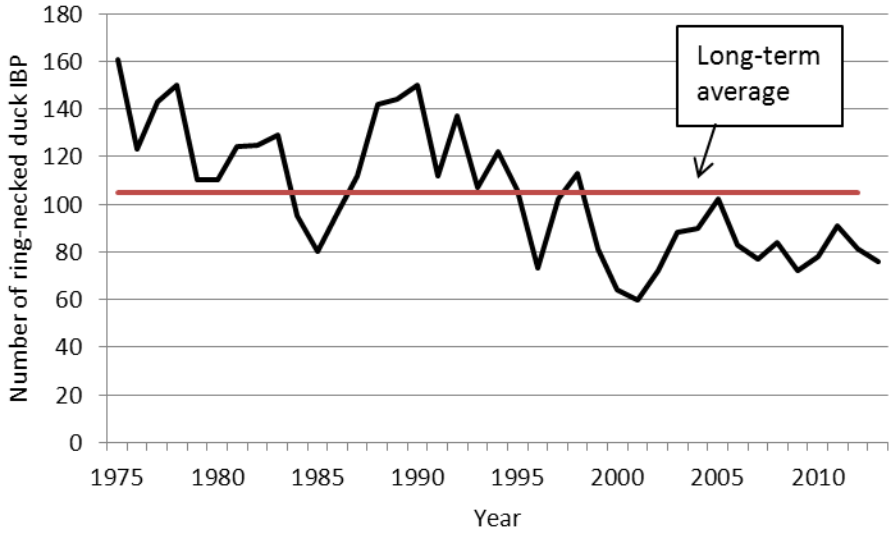


Figure 11. Number of ring-necked duck Indicated Breeding Pairs (IBP) observed on 14 lakes in north central Minnesota, 1975-2013 (Lawrence 2011, MNDNR unpublished data).

ESTIMATING NUMBERS OF BREEDING SANDHILL CRANES IN NORTHWEST MINNESOTA - 2013

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SUMMARY

In 2013, we conducted the 2nd year of a sandhill crane (*Grus canadensis*) breeding population survey in northwest Minnesota. Based upon results from the 2012 survey, we excluded the portion of the Red River Prairie Ecological Classification System (ECS) Subsection that was within the Northwest Goose and Sandhill Crane Hunting Zone (NWGCZ). We then used the same sampling frame of 4-km^2 plots that was created by GIS in 2012. We did not survey plots with no potential crane breeding habitat. We used a generalized random-tessellation stratified (GRTS) design to select a spatially balanced sample of 115 plots. We surveyed each sample plot once during 17-23 May 2013 using a Bell OH-58 helicopter with a 2-person crew. We counted and classified all crane observations in each plot based on their social status (individuals, pairs, groups) and evidence of breeding status (e.g., nest, colts, territorial behavior).

We estimated there were 5,550 sandhill cranes (SACR) in the Aspen Parkland and some adjacent areas within the NWGCZ compared to 7,710 SACR in the same survey area in 2012. In 2013, there were an estimated 950 breeding birds, 2,310 birds in groups, and 2,290 cranes whose breeding status was unknown (i.e., singles or pairs observed without a nest or young and not exhibiting territorial or defense behavior). We will use data obtained in 2012 and 2013 to improve survey stratification and design in 2014.

INTRODUCTION

SACR in northwest Minnesota are part of the mid-continent population, which is hunted in Canada and several Central Flyway states (Central Flyway Webless Migratory Bird Technical Committee 2006). In 2010, Minnesota began a hunting season on SACR in the NWGCZ (Figure 1). The majority of midcontinent SACR harvest in other states and provinces occurs on migration, staging, and wintering areas (Krapu et al. 2011), yet in northwestern Minnesota, harvest was comprised of local breeding cranes and likely migrant cranes from elsewhere. We previously reviewed the history and status of SACR and the hunting season (Lawrence et al. 2012). There were some indications that harvest on Minnesota-breeding SACR was greater than expected (Lawrence et al. 2011); thus, in 2012, we conducted a pilot survey of breeding SACR in northwestern Minnesota.

When we began the survey, there was no template for a large-scale, aerial survey specifically designed for breeding SACRs. Thus, we proposed conducting a pilot survey for three years to provide sufficient information for making intelligent survey-design choices, including developing and evaluating a stratification scheme (e.g., Zicus et al. 2008), answering questions about bias-precision-cost tradeoffs (e.g., Giudice et al. 2010), and identifying

important sources of variation in estimates of abundance and population trends (Thompson et al. 1998:149).

In 2012, we stratified 4 km^2 plots in the NWGCZ and adjoining Aspen Parkland Habitat based upon amount of expected crane nesting habitat in each plot (Lawrence et al. 2012), and surveyed 60 plots in more likely crane nesting habitat (mostly associated with the Aspen Parkland (Figure 2) and 30 plots in less likely habitat, which was mostly associated with the Red River Valley. We also surveyed one 100-km^2 plot in an area with previous records of nesting cranes. We did not survey plots that were not expected to have any cranes. We estimated there were 7,210 cranes in the survey area and that 96% of the cranes were associated with plots that contained potential nesting habitat (Figure 3). However, there was not a strong relationship between the amount of crane nesting habitat and the number of cranes/plot.

For the second year of this pilot survey, we used results from 2012 to modify the survey area and focus on parkland habitat where most of the breeding cranes were located. The survey was designed to provide an estimate of the number of breeding cranes in northwest Minnesota that was within ±25% of the true population size with 90% certainty (i.e., if we could replicate the sample survey many times, 90% of the population estimates will be within ±25% of the true population size).

The breeding population size estimates obtained from this survey, combined with data on crane harvest, harvest derivation, and other parameters will allow us to better manage hunting of cranes in northwest Minnesota and may provide insights to hunting cranes in other portions of their breeding range. The survey design will also provide the potential to monitor breeding crane populations in other areas, e.g. east-central Minnesota.

Here, we describe modifications to the survey sampling scheme in 2013, present population estimates, and discuss plans for the 2014 survey.

STUDY AREA

In 2012, we selected the NWGCZ and portions of the Aspen Parklands ecological subsection that extended beyond the NWGCZ as our primary sampling frame (Figure 2). This included the Aspen Parklands ecological subsection, northwestern portions of the Red River Prairie Subsection, and a small portion of the Agassiz Lowlands subsection.

In 2013, we reduced the size of the survey area to only include plots in the Aspen Parkland ECS subsection and the small area of Agassiz Lowland subsection that was contained in the NWGCZ. We did not survey any plots in the Red River Prairie ECS Subsection. While there are a few Stratum 2 plots (some nesting cover) and several Stratum 3 plots (no nesting cover, but other possible habitat) in this subsection, based on the plots flown in 2012, we believe the likelihood of finding nesting cranes in this area was low (only 2 SACR observations in 2012).

METHODS

Sampling frame

We used ArcGIS 10.1 (Environmental Systems Research Institute, Redlands, CA) to develop an overlay grid of 4-km^2 plots for the northwestern Minnesota study area (Figure 2). The grid was rotated approximately 2.5 degrees east to orient it with Public Land Survey (PLS)-based features such as roads and property boundaries. We treated 4-km^2 plots as the primary sampling unit (PSU) and excluded any PSUs not located entirely within the boundary of the SACR survey area (Figure 2).

Sampling design

We used descriptions of crane nesting habitat in northwest Minnesota (DiMatteo 1991, Provost et al. 1992, Maxson et al. 2008) and 2006 National Land Cover Data (NLCD) (Fry et al. 2011) to identify potential nesting cover. We defined potential nesting cover as NLCD cover type 95 (emergent herbaceous wetland).

We used NLCD to quantify the amount (m^2) of potential SACR habitat in each 4-km^2 plot. NLCD is a Landsat-based, 30-meter resolution, land cover database created by the Multi-Resolution Land Characteristics (MRLC) Consortium, a partnership of Federal agencies led by the U.S. Geological Survey (USGS National Land Cover Database). We used the same definition of SACR habitat in 2012 and 2013. We defined "SACR nesting habitat" as NLCD cover class 95 (emergent herbaceous wetland) and "other SACR habitat" as NLCD cover classes 11 (open water) and 90 (woody wetlands). We then classified each 4-km^2 plot into 4 categories:

NLCD-1: $\geq$ median amount of nesting habitat,

NLCD-2: 0 < m^2 of nesting habitat < median,

NLCD-3: nesting habitat = 0 but other SACR habitat > 0,

NLCD-4: no SACR habitat.

In 2012, the NLCD plot classifications were strongly correlated with ecological subsections (Figure 2). Therefore, we stratified the sampling frame (4-km^2 plots) into 3 strata:

1. NLCD12 plots – Stratum 1 and 2 plots; 71% of sampling frame; mostly associated with Aspen Parklands and Agassiz Lowlands.
2. NLCD3 plots – 11% of sampling frame; mostly associated with Red River Prairie.
3. NLCD4 plots – 18% of sampling frame; mostly associated with Red River Prairie.

We assumed that SACR density in the NLCD4 stratum was very low (approaching zero) and did not sample stratum NLCD4. Likewise, we expected SACR density to be low (but > 0) in the NLCD3 stratum. For NLCD12 and NLCD3 strata in 2012, we drew a spatially-balanced, Generalized Random-Tessellation Stratified (GRTS) sample (Stevens and Olsen 2004) with n = 60 (sampling rate = 2.2%) and 30 (sampling rate = 7.3%), respectively. We sampled the NLCD3 stratum at a higher rate to ensure we had a sufficient sample size to evaluate the feasibility of estimating SACR numbers in this low-density stratum. We also surveyed a 100-km^2 block (n = 25 4-km^2 plots) to better examine distribution of cranes within a specific area. Thus, the total sample size in 2012 was 115 4-km^2 plots (Table 2, Figure 3).

The 2012 results indicated that few cranes used habitats in the Red River Prairie in May (Figure 3); thus, we chose to exclude this area from the 2013 survey. We decided to include the 95 Stratum 3 plots in the reduced survey area in the sample of plots, but not survey the 74 Stratum 4 plots in this area. In 2013, we used the GRTS design to select 115 plots from within all the Aspen Parkland ECS subsection and parts of the Agassiz Lowlands subsection within the NWGCZ. We surveyed plots within Stratum 1, 2, and 3 combined, without further stratification. We also recalculated the 2012 estimates based upon the 2013 sample frame.

Target population(s)

In 2013, we chose to not survey the Red River Prairie, thus we did not have an estimate of cranes for the entire NWGCZ and adjacent parkland habitats. However, 2012 results suggest that the area we surveyed in 2013 provides a good approximation of the total number of cranes in the zone. As in 2012, separating breeding and non-breeding components of the population was problematic. We recorded crane observations as singles, pairs, and groups. Groups of SACR likely contain mostly non-breeders (subadults, non-territorial adult birds, and, possibly, failed breeders), whereas the breeding status of singles and pairs is more difficult to determine (Hayes and Barzen 2006). Therefore, for the purposes of this survey, we classified crane observations as follows:

1. *Breeding birds* = singles or pairs that were observed with a nest or young, or birds that were suspected of having a nest or young (but it was not detected) based on their behavior (reluctance to fly or leave the area, broken-wing displays, etc.).
2. *Groups* = flocks of $\geq$3 cranes.
3. *Status unknown* = singles or pairs whose breeding status could not be determined (e.g., nest or young was not detected, and did not exhibit any territorial or defense behavior).

For population estimates, we considered doubling observations of single 'breeding' birds (e.g., similar to indicated pairs in waterfowl surveys), but this could result in a positive bias for the estimate of breeding birds. For example, if single breeding birds were truly paired and their mate was missed (not detected) because it was located off the survey plot, then the missed mate is accounted for when we expand the counts for sampling (i.e., it is not necessary to double the observed count). Conversely, if the mate was on the plot but was not detected, then doubling the observed count is equivalent to applying a sightability correction factor = 2 for single crane observations. In reality, both cases likely occurred and we could not distinguish between them. Therefore, we used a conservative approach when estimating population size by taking observations of single birds at their face value (i.e., count = 1) regardless of their breeding status.

Survey Procedures

The survey was conducted during mid-May, which is the peak incubation period for cranes in northwest Minnesota (DiMatteo 1991, Provost et al. 1992, Maxson et al. 2008). All plots were surveyed using Bell OH-58 [Jet Ranger] containing a pilot and one observer. Surveys were flown at 5-45 meters above ground level and from 10-100 km/hr, depending upon the cover. Observations were recorded in digital voice files, each associated with a UTM location, on a tablet computer using the DNRSurvey software program developed by Minnesota DNR Wildlife and GIS staff (Wright et al. 2011).

RESULTS

Survey effort

The survey was conducted over 3 days (17, 22, 23 May), averaging 38 plots/day (range: 27-47). The survey team (DNR pilot John Heineman and observer Jeff Lawrence) conducted surveys (plots, transit, and refuel time included) an average of 10 hr/day (range: 7.3-11.6 hr) and spent an average of 7 min surveying a plot (range: 2-14 min) (Table 1). Total transit time averaged 5 min/plot. Refueling time averaged 40 min/stop (including an estimate of 30 minutes for end-of-day refueling) with typically 3 stops required for a full day of surveys. Average total time (survey + transit + refueling) per plot was 15.6 min. Forty-three percent of total survey effort (total minutes; all activities) in 2013 was associated with surveying plots, 34% with transit time, and 23% with refueling stops.

Sampling statistics

We detected SACR on 49 (43%) of the 115 sample plots (Table 2). The average count per occupied plot was 4.4 birds (SE=1.1, range: 1 to 46). We counted 216 SACR on sample plots, of which 43% were pairs, 16% were singles, and 42% were groups (Table 3). We observed 8 groups, which ranged in size from 3 to 43 birds. Twenty-nine percent of observed pairs and singles exhibited some evidence of being breeding birds (30% of pairs and 26% of singles; Table 3). We detected 20 nests, and eggs were observed at 17 nests (the status of the other 3 nests could not be determined). Crane observations were distributed throughout the survey area (Figure 4).

Population estimates

The estimated total number of cranes in the survey area was 5,550 (90% CI: 3,580–7,510) compared to 7,710 (90% CI: 4,520–10,900) in 2012 (Table 4). This is a minimum estimate because we did not adjust for detection probabilities (which are likely <1, at least for singles and pairs in dense cover). If our sample of singles and pairs exhibiting breeding behavior was representative of the relative abundance of breeding birds in the target population, then we estimated there were a minimum of 950 (90% CI: 690-1,210) breeding birds in the survey area, and another 2,290 (90% CI: 1,760-2,810) singles and pairs whose breeding status was uncertain (Table 4).

As in 2012, the bound on the estimated total (all strata) was greater (CV = 22% and relative bound = 35%) than the usual target level for a Minnesota Department of Natural Resources (MNDNR) wildlife survey (i.e., CV = 15% and relative bound = 25%), which partly reflects the influence of 1 extremely large plot count (46 birds) on the estimated population variance. The estimated CV for breeding birds and status-unknown birds was reasonably good ($\leq$17%; Table 4).

Habitat associations

We did not stratify the plots by amount of potential crane habitat in 2013 because we saw little benefit to this during the 2012 survey (Lawrence et al. 2012). In 2013, there were only weak relationships between plot counts (total birds or breeding birds) and amount of potential nesting cover as defined by NLCD and GAP cover data (Figure 5). We used the same definitions for GAP cover as we used in 2012 (Lawrence et al. 2012).

DISCUSSION

Survey Effort and Design Considerations

We completed the survey in only 3 days compared to 7 days in 2012. This was in part due to the reduced survey area, but was also due to flying longer each day due to other scheduling conflicts. We determined the number of plots to survey in 2013 based upon time to survey plots in 2012 and estimated we would fly the plots in 35 hours. However, we actually flew all 115 plots in 28 total hours of helicopter time compared to 37 hours in 2012.

We began the survey on 17 May 2013, later than the 15 May survey completion date in 2012. 2013 was characterized by a late spring and near record late ice out on Minnesota lakes (2013 Ice-out summary). This was in contrast to the near record early spring in 2012 (Record Warm Spring: 2012). In 2012, we observed some colts even though we began the survey 1 week earlier than scheduled and 10 calendar days earlier than in 2013. We did not observe any colts in 2013 and believe our survey timing was good and likely near mid-incubation.

We flew one day (17 May) and then rainfall (~7.4 cm in Thief River Falls) caused us to delay the survey until 22 May. The landscape changed dramatically during this period, with standing water in many fields, flooded rivers, and likely increased water levels in many wetlands when we resumed the survey (Figure 6). We suspect some nests were flooded. Conditions were wetter than the extremely dry conditions observed during the 2012 survey.

Population Estimate

The number of cranes was not different between 2012 and 2013 although the point estimate declined by 28% (95% CI =-62% to +38%). Generally, precision of our aerial breeding population surveys (e.g. May waterfowl, Canada goose) is not adequate to determine annual changes to populations, but the surveys provide guidance on long-term population trends. For the SACR survey, we would need approximately a 50% change in the breeding population or a 40% change in the breeding pair estimate to detect a difference between years. This was only the second year of the crane survey, thus we do not know how much annual variability in population estimates we will observe. The late spring chronology may have influenced the estimate too. The 2013 Minnesota Canada goose population estimate was 250,600, 40% less than the 2012 estimate (416,200); yet, this decline may have been due to survey conditions during the late spring rather than an actual decline in the population (Rave 2013). It is possible the decline in the point estimates observed in crane population size was also partially due to spring phenology. Future surveys will provide insights on changes in estimates of population size and whether there is a trend.

We reduced the size of the survey area to what we believe, and the 2012 survey supported, was the core SACR breeding habitat in the Northwest Crane Zone. While there were a few nesting birds in the Red River Prairie Subsection in 2012, they accounted for 290 of the 7,200 birds estimated last year (Lawrence et al. 2012). We do not know how strong the affinity is for nonbreeding birds to be associated with SACR nesting habitat that we used to select the survey plots. We did not record any flocks in the Red River Prairie in 2012, but it is possible that nonbreeders may use these agricultural habitats. We suspect there may have been a reduced nesting effort in 2013 due to the delayed spring, and a larger proportion of the population may have been nonbreeders. This was evident in Minnesota's Canada goose breeding population (Rave 2013); however, the timing of goose nesting is earlier than SACR nesting. We note that in 2012, we questioned if some birds had foregone nesting due to the extremely dry conditions.

Even though we reduced the size of the area surveyed, our estimate of SACR for 2012 in the new area was 7,710 compared to 7,210 for the larger area we presented in 2012 (Lawrence et al. 2012). This was because we expand counts by area surveyed and in the Red River Prairie we had many plots with few birds. When we excluded this area, our estimates actually increased, although the area was reduced. The stratified mean increased from 2.3 birds/plot in the estimate previously reported (Lawrence et al. 2012) to 2.6 birds/plot in the reduced sample frame reported here.

Our estimates of breeding and status unknown birds was reasonably precise (CV% $\leq$ 17%). Much of the variability in the population estimates is due to the groups that tend to use agricultural fields, thus their distribution on the landscape is difficult to predict relative to nesting cranes. As in 2012, we had one plot with a large count of cranes (n=43) that accounted for 48% of all birds observed in groups. We also had a plot with 28 birds in groups (flock of 11 and 17); but only 5% of all the plots had groups present. In 2012, one plot contained 42% of the cranes in groups. As noted in 2012, if the sample does not include a plot(s) with a large group, the number of birds in groups would probably decline (Lawrence et al. 2012). We may consider using breeding and status unknown birds (singles and pairs) to provide a better index of the status of population trends in the future.

As in 2012, we suspected most of the unknown-status pairs were likely nonbreeders, although some may have been failed nesters. Some nests were likely flooded with the increase in water levels following the rainfall during the 2013 survey. A portion of the unknown-status singles likely had a mate on an undetected nest. All 9 singles recorded as breeders were observed on a nest and it is likely that these birds had an undetected mate in the vicinity, although some may have been off plot. There were no other singles on any of these plots that could have been mates.

Evaluation of sampling design

Similar to the previous year, post-hoc stratification analyses of plot counts suggested that NLCD was not a very effective stratification variable, although there was a weak positive correlation (Figure 5). Additional cover attributes may be needed to increase stratification effectiveness. For example, many crane observations were in or adjacent to agricultural fields (e.g., feeding sites). Thus, developing an effective stratification scheme for the SACR survey may require a more sophisticated suite of habitat metrics.

We have UTM coordinates of crane nests and approximate locations of crane observations, which will allow us to examine NLCD habitat associations at finer scales (e.g., 1-km^2 subplot) and explore the utility of using other land-cover data sources to stratify the sampling frame. Our efforts to stratify were based upon potential nesting cover, which may not reflect the distribution of nonbreeding cranes. Many of these birds were observed in agricultural habitats.

We will further evaluate the habitat associated with crane observations and consider other options for improving the survey prior to next year. We plan to fly the survey again in May 2014.

ACKNOWLEDGEMENTS

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Table 1. Summary of survey effort (minutes) by activity for an aerial survey of sandhill cranes in Minnesota, May 2012 and 2013.

		Survey time			Transit time				Refueling stops				Total time[a]	
Year	Stratum	Total minutes	Plots	Min/ plot	Total minutes	Number transits	Min/ transit	Min/ plot	Total minutes	Number stops	Min/ stop	Min /plot	Total minutes	Min/plot
2012	NLCD-123	822	90	9.1	663	104	6.4	7.4	482	13	37.1	5.4	1,967	21.9
	EspTwp	310	25	12.4	16	6	2.7	0.6	97	3	32.3	3.9	423	16.9
	All	1,132	115	9.8	679	110	6.2	5.9	579	16	36.2	5.0	2,390	20.8
2013	All	766	115	6.7	620	125	5.0	5.4	405	10	40.5	3.5	1,791	15.6

[a]excludes visibility surveys conducted in 2012.

Table 2. Sampling statistics [a] for an aerial survey of sandhill cranes in northwestern Minnesota, May 2012 and 2013.

								Counts/occupied plot				
Year	*n* strata	Sampling allocation	nh	Nh	srate	n.occ	p.occ	min	max	med	mean	SD
2012	3	~Optimal	89	2,953	0.030	47	0.529	1	43	2	4.94	0.940
2013	1	SRS	115	2,953	0.039	49	0.426	1	46	2	4.41	1.062

[a]nh = sample size (4-km^2 plots), Nh = stratum size, srate = sampling rate, n.occ = number of "occupied" plots (>1 sandhill crane detected), p.occ = proportion of plots with >1 crane detected, and count statistics for "occupied" plots.

Table 3. Social and breeding classification of sandhill crane observations, 2012 and 2013.

	2012[b]			2013		
Social class[a]	Count	Percent of total	Percent of pairs or singles	Count	Percent of total	Percent of pairs or singles
Pairs (x2)	110	46.6		92	42.6	
Breeding birds	46	19.5	41.8	28	13	30.4
Status unknown	64	27.1	58.2	64	29.6	69.6
Singles	37	15.7		34	15.7	
Breeding birds	8	3.4	21.6	9	4.2	26.5
Status unknown	29	12.3	78.4	25	11.6	73.5
Groups	89	37.7		90	41.7	
Total	236	100		216	100	

[a]- Breeding birds = singles or pairs that were observed with a nest or young, or birds that were suspected of having a nest or young (but it was not detected) based on their behavior (reluctance to fly or leave the area, broken-wing displays, etc.); Groups = flocks of >3 cranes; or status unknown = singles or pairs whose breeding status could not be determined (e.g., nest or young was not detected, and did not exhibit any territorial or defense behavior).

[b]-2012 data adjusted to reflect 2013 sampling frame.

Table 4. Population estimates (N) by indicated breeding status for sandhill cranes in northwestern Minnesota, May 2012 and 2013.

Year	Status	Plots surveyed	Total plots	n plots with cranes	Minimum cranes/plot	Maximum cranes/plot	Avg. birds/plot	SE birds/plot	^ N	SE	LCB (90%)	UCB (90%)	CV %
2012[a]	Breeding birds[b]	89	2,953	26	1	4	0.5	0.10	1,500	281	1,040	1,960	19
	Groups	89	2,953	9	3	37	1.1	0.56	3,240	1,650	530	5,960	51
	Status unknown[c]	89	2,953	40	1	6	1.0	0.15	2,970	441	2,240	3,690	15
	Total	89	2,953	49	1	43	2.6	0.66	7,710	1,939	4,520	10,900	25
2013	Breeding birds[b]	115	2,953	22	1	2	0.3	0.05	950	158	690	1,210	17
	Groups	115	2,953	6	3	43	0.8	0.38	2,310	1,122	470	4,160	49
	Status unknown[c]	115	2,953	36	1	6	0.8	0.11	2,290	317	1,760	2,810	14
	Total	115	2,953	49	1	46	1.9	0.40	5,550	1,195	3,580	7,510	22

[a] 2012 data adjusted to reflect 2013 sampling frame.

[b] Singles and pairs (x2) with a nest or young, or exhibiting some type of breeding or territorial behavior.

[c] Singles and pairs (x2) without a nest or young, and no behavioral evidence that they were breeding birds.

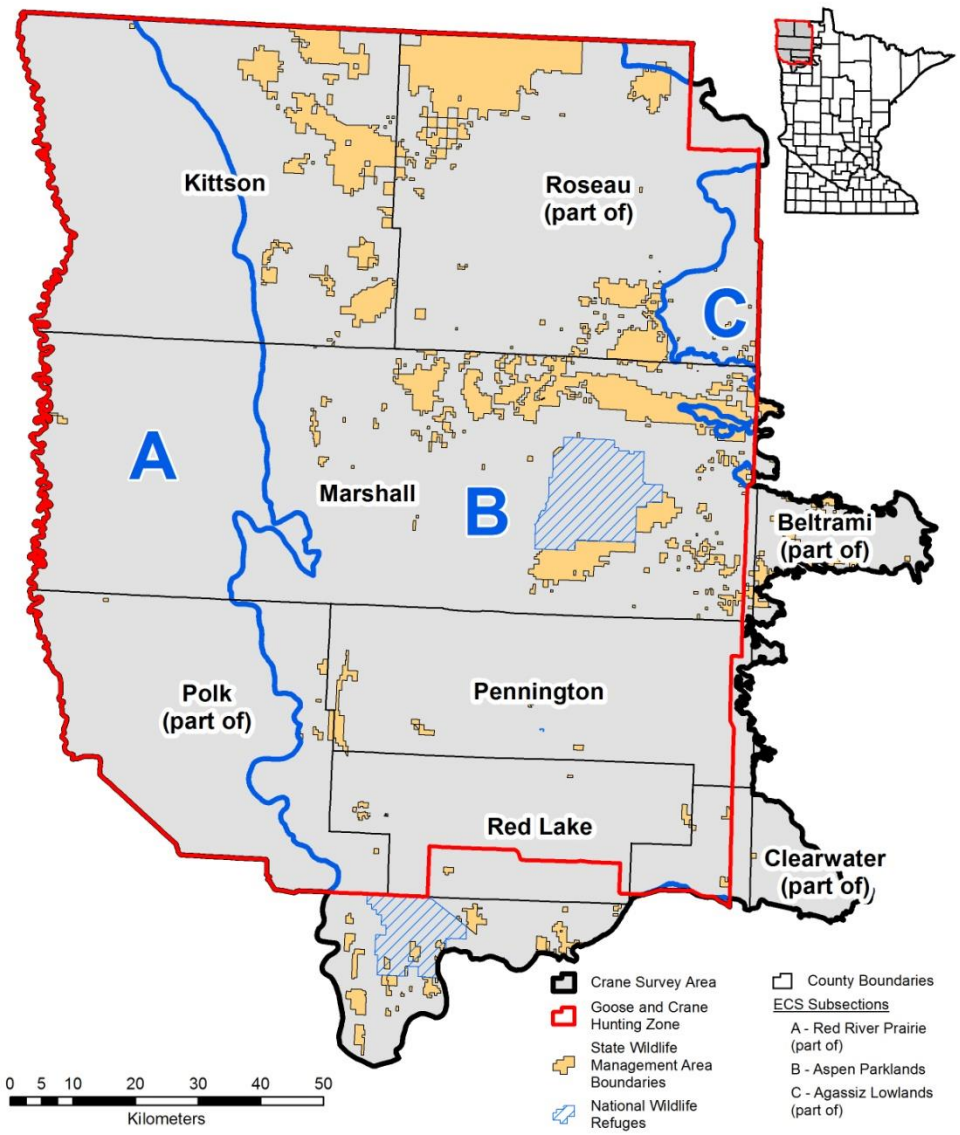

Figure 1 Location of the Northwest Goose and Sandhill Crane Hunting Zone in Minnesota and the sandhill crane survey area. Ecological Classification Area A (Red River Prairie) was not surveyed in 2013.

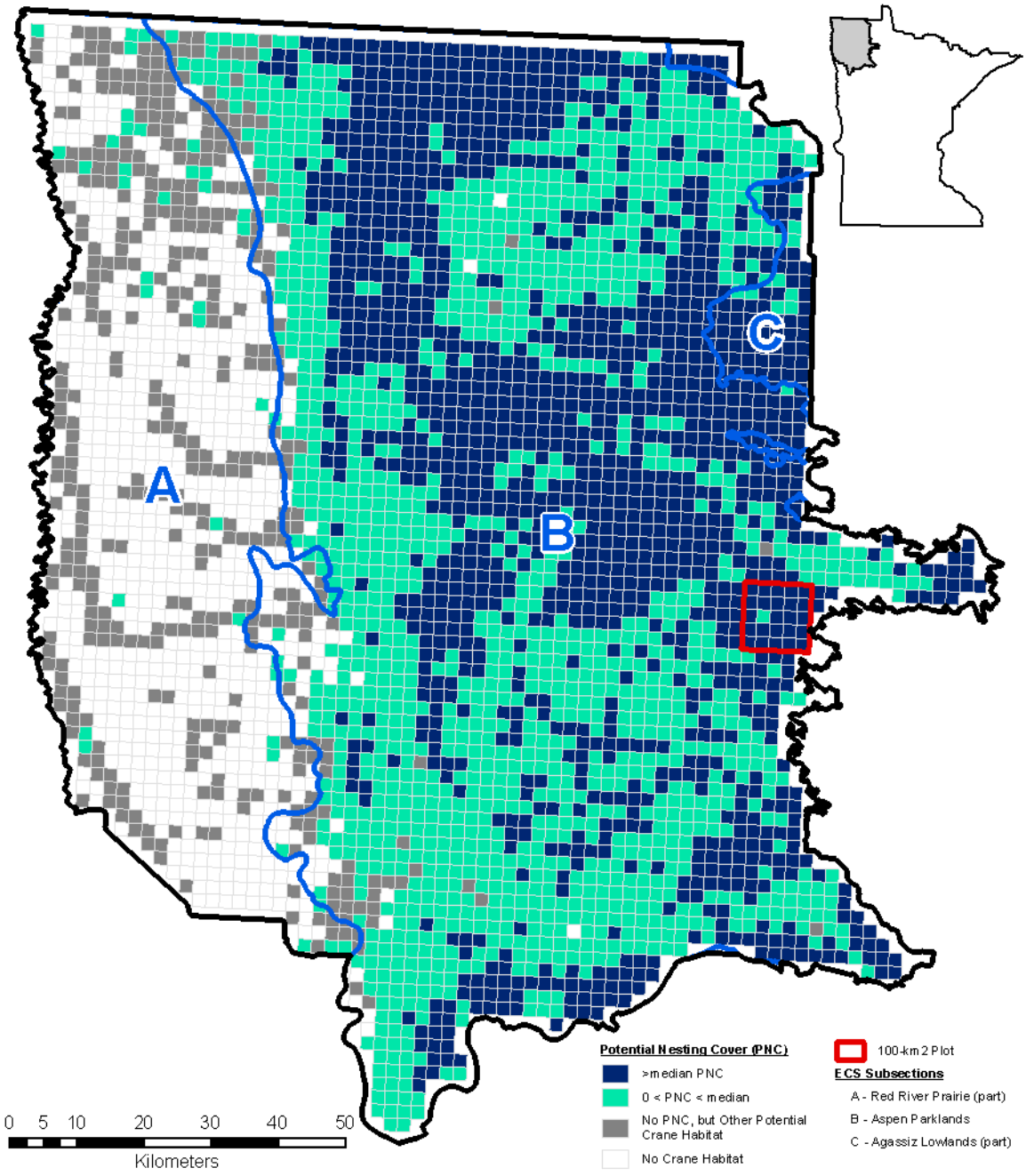

Figure 2. Sampling frame for the spring aerial survey of sandhill cranes, northwestern Minnesota. The primary sampling unit was 4-km^2 plots. Colored squares denote plots by strata as defined by National Land Cover Data: dark blue = NLCD-1 (>median amount of potential crane nesting cover), turquoise = NLCD-2 (0 < potential nesting cover < median), gray = NLCD-3 (no nesting cover but other potential crane cover), white = NLCD-4 (no crane habitat). Black lines denote the boundaries of the survey area and blue lines note boundaries of ecological subsections. In 2012, we selected plots from strata 1-3 in the 3 subsections above (see text). In 2013, we excluded plots in the Red River Prairie ECS Subsection (A above) and did not survey the 100-km^2 plot.

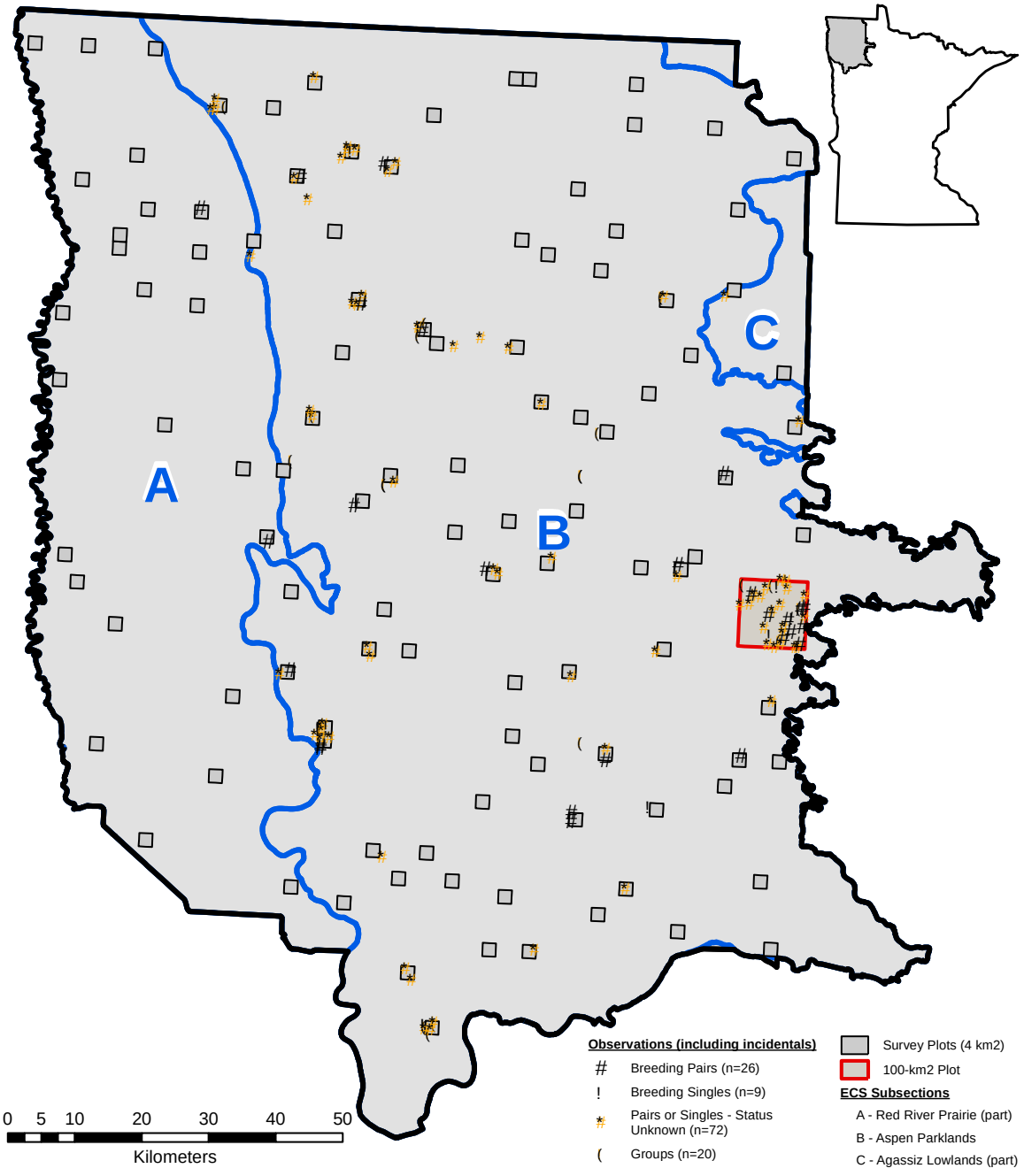

Figure 3. Distribution of sample plots (n = 115) and sandhill crane observations by type (including incidental sightings) in the 2012 MNDNR spring aerial survey, northwestern Minnesota. Each sample plot was 4 km^2 and the SACR survey area was 16,350 km^2.

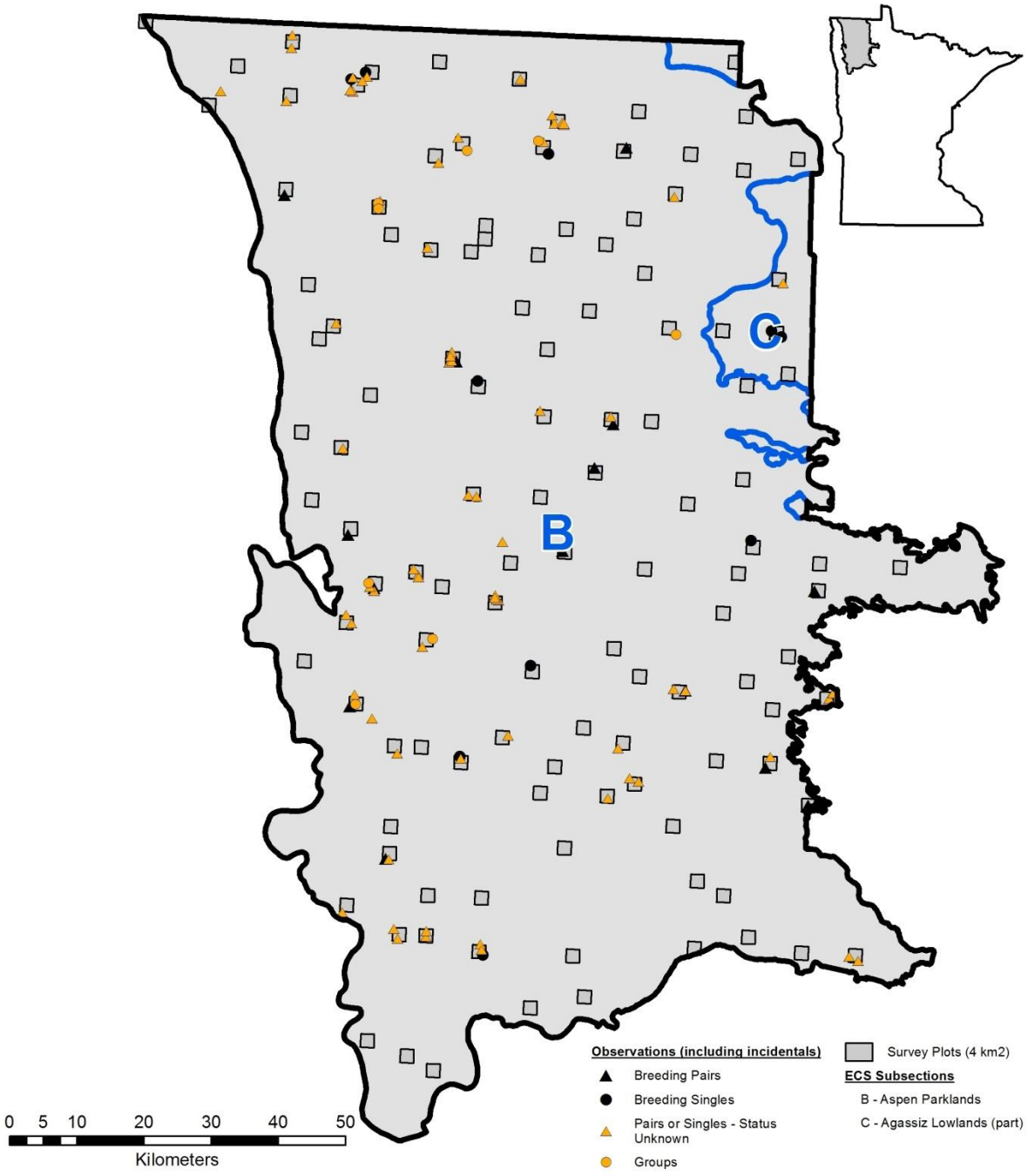

Figure 4. Distribution of sample plots (n = 115) and sandhill crane observations by type (including incidental sightings) in the 2013 MNDNR spring aerial survey, northwestern Minnesota. Each sample plot was 4 km^2 and the SACR survey area was 11,812 km^2.

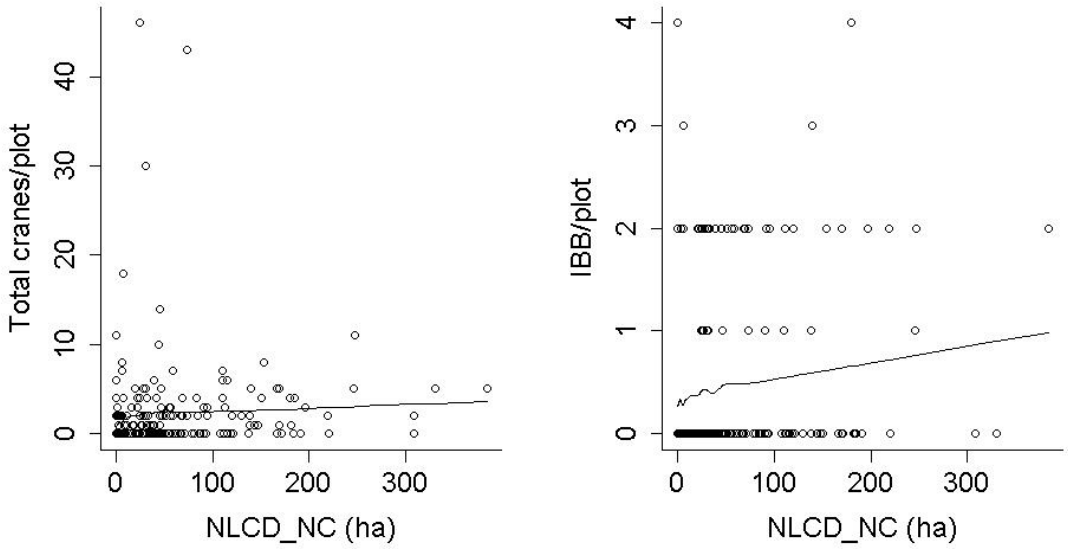

Figure 5. Relationship between sandhill crane observations (total SACR and Indicated Breeding Pairs [IBB]) and habitat abundance (as defined by NLCD classification schemes) based on 114 4-km^2 plots surveyed in May 2013, northwest Minnesota.

Figure 6. Field sheet water observed during the SACR breeding population survey, 22 May 2013.