

TITLE: Waterfowl Breeding Population Survey for Minnesota

STRATA SURVEYED: Minnesota Strata 1, 2, and 3

DATES: May 2-May 16, 2016

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

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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 2016 aerial survey portion was flown from May 2 to May 16. Spring ice-out dates in the southern 2/3 of the state were near record early and ~3 weeks earlier than median dates. In the northern 1/3 of the states, ice out dates were about 1 week earlier than median dates. Temperatures were well above normal in March and near normal in April and May. Precipitation was below normal in April and May except for portions of southwest Minnesota. Overall, wetland numbers (Types II-V)

were unchanged from 2015 but 21% below the 10-year average and 13% below the long-term average.

The 2016 estimated mallard breeding population was 243,000, which was 18% higher than last year's estimate of 206,000 mallards, but statistically unchanged ($P=0.51$). Mallard numbers were unchanged from the 10-year average and 7% above the long-term average of 228,000 breeding mallards. The estimated blue-winged teal population was 317,000, which was 88% higher than last year's estimate of 169,000 blue-winged teal, but statistically unchanged ($P=0.17$). Blue-winged teal numbers were 50% above the long-term average of 211,000 blue-winged teal. The combined population index of other ducks, excluding scaup, was 208,000 ducks, which was 39% higher than last year's estimate and 18% above the 10-year average and 17% above the long-term average of 177,000 other ducks.

The estimate of total duck abundance (768,000), which excludes scaup, was 47% higher than last year's estimate of 524,000 ducks and was 36% above the 10-year average and 25% above the long-term average of 616,000 ducks. The estimated number of Canada geese was 108,000 and 33% lower than last year and 32% below the 10-year average.

METHODS: The aerial survey is based on a sampling design that includes three survey strata (Table 1, Fig. 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 an American Champion Scout. 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; Table

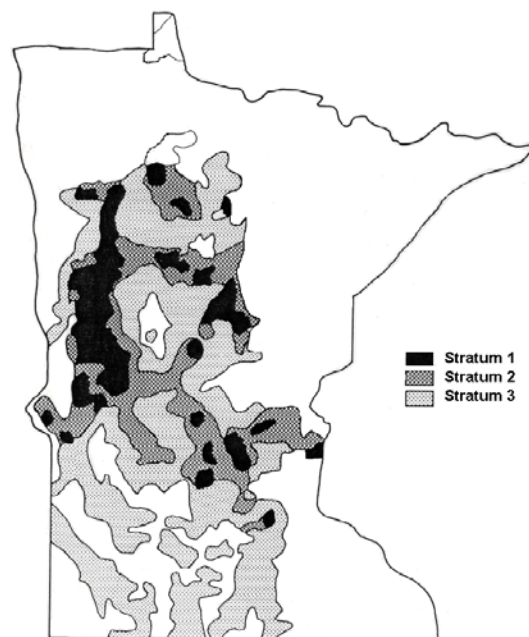


Fig. 1. Location of waterfowl breeding population survey strata in Minnesota.

2) 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 and transcribed by the observer from the digital files.

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 2015 and 2016 were compared using two-tailed Z-tests.

SURVEY CHRONOLOGY: The 2016 aerial survey began on 2 May in southern Minnesota and concluded in northern Minnesota on 16 May. Transects were flown on 10 days, May 2-9 and May 15-16 and completed in 54 flight hours. Flights began near 7 AM and were completed by 12:00 PM each day. The median date for survey completion was May 7, which was 2 weeks earlier than last year.

WEATHER AND HABITAT CONDITIONS: For the southern 2/3 of the state, ice out was extremely early with many lakes at or near their earliest dates on record and in general, about 3-4 weeks earlier than median ice out dates. In northern Minnesota, ice out dates were later but still about 1 week earlier than median dates. Temperatures in March averaged 7.6°F above normal and precipitation was 0.8 inches above normal statewide. Temperatures in April averaged 0.2°F below normal and precipitation was 0.3 inches below normal statewide. Temperatures in May averaged 1.0°F above normal statewide and precipitation was 0.5 inches below normal statewide (<http://climate.umn.edu>). Precipitation during the period of time just prior to and during the survey showed above average precipitation only in southwest MN and below average precipitation across the rest of the state (Appendix A).

Overall wetland conditions in spring 2016 were dry but similar to last year. In early May 2016, 91% of the state was under no drought designation and 9% of the state was classified as abnormally dry. By early June 2016, 57% of the state was under no drought designation and 43% was classified as abnormally dry. In early May 2016, statewide topsoil moisture indices were rated as 1% very short, 6% short, 80% adequate and 13% surplus moisture. By early June 2016, statewide topsoil moisture indices were rated as 2% very short, 9% short, 77% adequate and 12% surplus moisture (<http://droughtmonitor.unl.edu>).

Wetland (Types II-V) numbers in 2016 were 221,000 ponds and unchanged from last year's estimate of 222,000 ponds. This was 21% below the 10-year average and 13% below the long-term average (Table 2; Fig. 2). The number of temporary (Type 1) sheet water wetlands was 43% below the long-term average and very few sheet water wetlands were observed except in southwest Minnesota.

Planting dates for row crops were extremely early in 2016. By May 1, about 59% of the corn acres had been planted statewide compared to 27% for the previous 5-year average. By May 29th, about 38% of alfalfa hay had been cut, 12 days ahead of last year and average (Minnesota Agricultural Statistics Service Weekly Crop Weather Reports, (<http://www.nass.usda.gov/mn/>)).

Due to the early spring, leaf-out dates and wetland vegetation growth was about 2-3 weeks earlier than average and visibility was poor during the entire survey.

WATERFOWL POPULATIONS: The number of ducks, Canada geese, coots, and swans, 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 2016 breeding population estimate of mallards was 243,189 (SE = 42,502), which was 18% higher than the 2015 estimate of 206,229 mallards, but statistically unchanged ($Z = 0.65$, $P = 0.51$) (Table 7, Fig. 3). Mallard numbers were similar to the 10-year average and 7% above the long-term average of 228,000 mallards. In 2016, the mallard population was comprised of 80% lone or flocked males, 15% pairs, and 5% flocked mallards. The 5-year average is 71% lone or flocked males, 21% pairs, and 8% flocked mallards.

The estimated blue-winged teal population was 317,464 (SE = 92,149), which was 88% higher than the 2015 estimate of 168,615 blue-winged teal, but statistically unchanged ($Z = 1.38$, $P = 0.17$). Blue-winged teal numbers were 118% above the 10-year average and 50% above the long-term average (Table 7, Fig. 4). The blue-winged teal population was comprised of 7% lone males, 43% pairs, and 49% flocks. The long-term average is 16% lone males, 53% pairs, and 31% flocks. A number of fairly large flocks of teal were observed early in the survey in southwest Minnesota that influenced both the estimate and the standard error.

The combined population estimate of other ducks (excluding scaup) was 207,593 which was 39% above last year's estimate of 149,330 other ducks and 18% above the 10-year average and 17% above the long-term average (Table 7, Fig. 5). Scaup, ring-necked ducks and wood ducks were the most abundant species of other ducks (Table 6). Scaup numbers (54,000) were 54% above last year's estimate but 11% below the long-term average.

The total duck population index, excluding scaup, was 768,000 ducks and was 47% above last year's index of 524,000 ducks and 36% above the 10-year average and 25% above the long-term average (Table 8, Fig. 6).

The population index for total ducks was 822,000 ducks, which was 40% above the 10-year average and 21% above the long-term average.

Visibility Correction Factors (VCFs) were lower for mallards, blue-winged teal, other ducks, and Canada geese in 2016 compared to 2015 (Table 7, Table 8). The mallard VCF (2.07) was 22%

below the 10-year average. The blue-winged teal VCF (4.48) was 14% above the 10-year average. The VCF for other ducks (2.67) was 12% below the 10-year average. The VCF for Canada geese (1.62) was 22% below the 10-year average.

The population estimate of Canada geese (adjusted for visibility) was 108,000, which was 33% below last year's estimate and 32% below the 10-year average (Table 8, Fig. 7). A total of 56 Canada goose broods were observed, compared to 23 in 2015.

The estimated coot population, uncorrected for visibility, was 16,000 compared to 10,000 in 2015.

The estimated number of swans (likely trumpeters) was 13,400 swans compared to last year's estimate of 12,600 (Table 6). Lone swans are not doubled and the estimate is expanded for area but not visibility, although visibility of swans is extremely high. Trumpeter swans continue to expand their range and dramatically increase in number.

ACKNOWLEDGMENTS: Thanks to the ground crews and the pilot for all of their efforts. This project was funded in part by the Wildlife Restoration (Pittman-Robertson) Program.

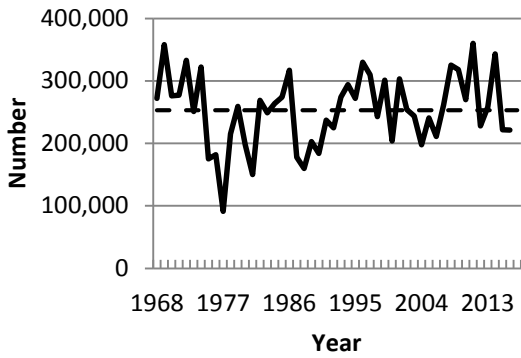


Fig. 2. Number of May ponds (Types II-V) and long-term average (dashed line) in Minnesota, 1968-2016.

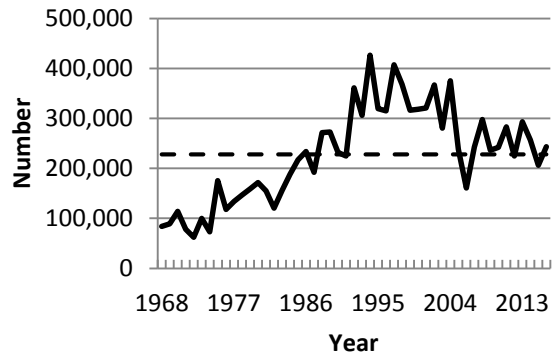


Fig. 3. Mallard population estimates (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1968-2016.

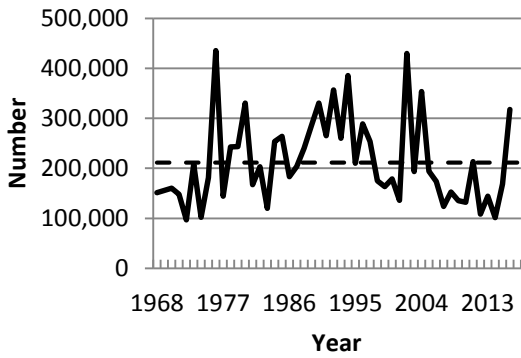


Fig. 4. Blue-winged teal population estimates (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1968-2016.

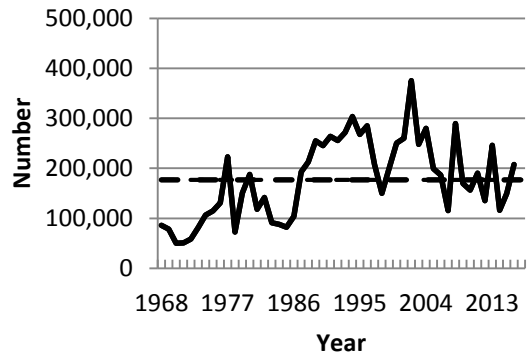


Fig. 5. Other duck (excluding scaup) population estimates (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1968-2016

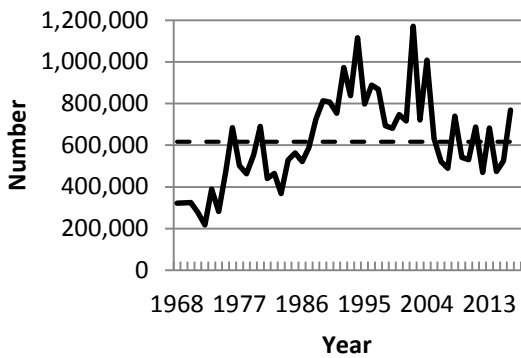


Fig. 6. Total duck (excluding scaup) population estimates (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1968-2016

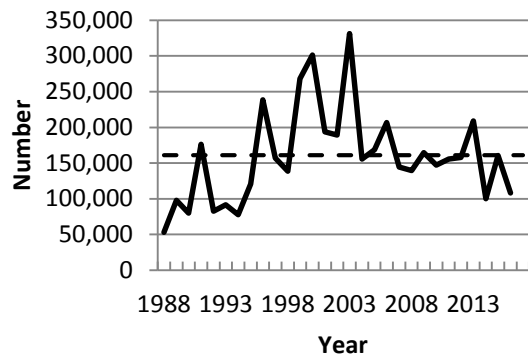


Fig. 7. Canada goose population (adjusted for visibility bias) and long-term average (dashed line) in Minnesota, 1988-2016.

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Table 1. Survey design for Minnesota, May 2016.¹

	Stratum			Total
	1	2	3	
<u>Survey design</u>				
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	
<u>Current year coverage</u>				
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), 1968-2016.

Year	Number of Ponds ¹		Year	Type 1 wetlands	Number of Ponds ¹
1968	272,000		1991	82,862	237,000
1969	358,000		1992	10,019	225,000
1970	276,000		1993	199,870	274,000
1971	277,000		1994	123,958	294,000
1972	333,000		1995	140,432	272,000
1973	251,000		1996	147,859	330,000
1974	322,000		1997	30,751	310,000
1975	175,000		1998	20,560	243,000
1976	182,000		1999	152,747	301,000
1977	91,000		2000	5,090	204,000
1978	215,000		2001	66,444	303,000
1979	259,000		2002	30,602	254,000
1980	198,000		2003	34,005	244,000
1981	150,000		2004	9,494	198,000
1982	269,000		2005	30,764	241,000
1983	249,000		2006	56,798	211,000
1984	264,000		2007	32,415	262,000
1985	274,000		2008	69,734	325,000
1986	317,000		2009	39,078	318,000
1987	178,000		2010	26,880	270,000
1988	160,000		2011	89,218	360,000
1989	203,000		2012	30,910	228,000
1990	184,000		2013	9,813	258,000
			2014	54,300	343,000
			2015	22,056	222,000
			2016	34,487	221,000
		Averages:	10-year	43,120	279,700
			Long-term	60,666	253,833
		% change from:	2015	56%	0%
			10-year	-20%	-21%
			Long-term	-43%	-13%

¹ Type II-V, correction factor from 1989 (123,000/203,000=0.606) used to adjust 1968-88 pond numbers.

Table 3. Minnesota waterfowl breeding populations by species for Stratum I (high wetland density), expanded for area but not visibility, 1998-2016.

Species	Year																		
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Dabblers:																			
Mallard	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	19,522	19,633	26,020
Black Duck	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	333	167	222	0
Gadwall	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	555	1,083	1,000
American Wigeon	56	56	56	111	0	56	555	167	0	56	111	56	56	111	222	222	167	111	111
Green-winged Teal	333	0	278	56	278	222	444	56	56	167	278	167	56	56	56	0	0	56	111
Blue-winged Teal	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	3,388	4,360	6,998
Northern Shoveler	500	555	1,055	305	1,277	278	1,166	333	167	56	1,000	666	1,027	111	56	333	722	111	666
Northern Pintail	111	167	167	389	56	111	56	0	56	0	56	56	0	111	0	111	167	222	0
Wood Duck	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	2,527	2,222	5,610
Dabbler Subtotal	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	27,215	28,020	40,516
Divers:																			
Redhead	944	500	583	1,444	750	333	805	666	666	916	1,389	472	944	805	750	861	1,333	583	2,166
Canvasback	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	1,777	1,027	1,944
Scaup	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	1,250	5,526	10,969
Ring-necked Duck	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	4,554	3,110	8,220
Goldeneye	111	56	56	333	111	0	222	222	56	222	278	278	222	56	56	333	444	278	278
Bufflehead	56	111	56	111	222	111	389	167	222	56	1,611	833	389	278	56	611	56	278	500
Ruddy Duck	11,052	972	0	83	1,305	417	305	1,222	305	0	1,027	861	28	56	0	305	111	694	1,500
Hooded Merganser	389	722	500	722	555	333	278	333	555	111	666	944	555	500	555	333	666	1,000	1,222
Large Merganser	0	0	0	111	0	972	0	111	0	278	333	333	333	111	56	222	139	167	56
Diver Subtotal	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	10,330	12,663	26,855
Total Ducks	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	37,545	40,683	67,371
Other:																			
Coot	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	2,360	1,972	10,608
Canada Goose	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	18,578	23,077	17,995
Swan	56	139	0	0	111	1,000	305	417	861	389	694	500	694	1,611	1,277	2,944	1,944	2,472	3,693

Table 4. Minnesota waterfowl breeding populations by species for Stratum II (medium wetland density), expanded for area but not visibility, 1998-2016.

Species	Year																			
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
Dabblers:																				
Mallard	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	28,987	24,078	32,085	
Black Duck	0	0	0	117	0	0	0	0	0	0	0	0	0	0	0	0	0	117	0	
Gadwall	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	234	818	1,286	
American Wigeon	818	0	468	0	0	0	2,513	117	0	0	351	0	351	0	117	234	0	234	234	
Green-winged Teal	351	117	117	117	468	234	234	0	117	0	0	234	117	0	0	117	351	584	0	
Blue-winged Teal	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	7,364	5,026	10,753	
Northern Shoveler	701	2,104	4,675	1,052	2,221	1,403	1,753	234	584	351	468	701	2,513	1,052	0	351	935	877	935	
Northern Pintail	468	117	117	117	0	117	0	0	0	234	0	0	0	234	0	0	117	0	0	
Wood Duck	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	1,636	1,753	4,149	
Dabbler subtotal	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	39,624	33,487	49,442	
Divers:																				
Redhead	935	1,636	2,805	2,455	234	584	1,110	292	175	935	935	584	760	1,578	468	468	526	468	1,110	
Canvasback	117	117	935	0	468	1,052	234	0	0	1,169	468	234	117	584	117	935	1,286	1,169	1,403	
Scaup	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	2,396	4,909	5,318	
Ring-necked Duck	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	5,143	4,325	4,792	
Goldeneye	234	935	584	468	234	234	351	117	117	0	351	584	468	468	584	935	1,519	935	1,169	
Bufflehead	0	0	0	0	1,169	117	468	351	117	117	1,403	818	643	1,403	468	0	818	0	234	
Ruddy Duck	0	468	0	0	1,870	2,688	0	351	58	0	0	175	409	58	234	117	0	351	643	
Hooded Merganser	117	701	935	1,403	701	701	234	234	351	234	584	701	117	2,221	1,636	701	234	1,169	2,455	
Large Merganser	0	0	117	117	0	0	234	351	0	0	351	0	0	234	0	234	117	234	117	
Diver subtotal	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	12,039	13,560	17,241	
Total Ducks	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	51,663	47,047	66,683	
Other:																				
Coot	643	234	1,110	468	4,909	1,519	8,007	584	292	409	23,961	0	117	292	292	2,571	877	0	0	
Canada Goose	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	20,572	24,312	17,533	
Swan	117	117	58	117	292	994	701	1,461	994	468	1,519	2,922	2,279	7,188	3,507	6,604	3,740	5,318	4,325	

Table 5. Minnesota waterfowl breeding populations by species for Stratum III (low wetland density), expanded for area but not visibility, 1998-2016.

Species	Year																		
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Dabblers:																			
Mallard	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	62,899	51,154	59,593
Black Duck	0	0	0	0	0	0	174	0	0	174	174	0	0	0	174	174	0	0	0
Gadwall	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	1,914	2,088	9,570
American Wigeon	696	0	522	174	1,218	174	1,566	1,044	174	348	348	174	348	1,044	174	348	174	1,566	870
Green-winged Teal	174	0	1,218	1,392	522	174	0	174	522	0	0	0	0	174	348	696	0	348	0
Blue-winged Teal	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	21,227	24,098	53,155
Northern Shoveler	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	522	1,914	4,959
Northern Pintail	870	870	696	522	0	174	348	174	174	348	174	0	174	0	174	174	0	174	522
Wood Duck	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	9,657	8,265	8,700
Dabbler subtotal	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	96,393	89,607	137,369
Divers:																			
Redhead	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	1,566	1,305	1,044
Canvasback	3,306	174	3,915	522	696	1,131	2,784	0	0	348	1,566	1,218	348	1,044	1,044	696	522	696	348
Scaup	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	2,871	435	3,915
Ring-necked Duck	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	5,568	3,480	4,089
Goldeneye	696	696	1,044	1,566	3,132	1,305	696	1,044	1,044	870	348	522	174	870	0	348	174	1,218	870
Bufflehead	348	0	0	0	1,218	783	2,088	0	174	696	1,218	870	174	2,871	174	3,915	4,698	522	2,523
Ruddy Duck	0	174	0	696	18,878	87	2,262	870	696	261	87	348	0	3,828	522	522	174	0	87
Hooded Merganser	696	1,218	957	174	2,175	174	1,740	1,218	870	174	696	348	1,218	1,044	1,044	348	348	522	1,392
Large Merganser	0	0	0	0	522	0	0	261	957	348	348	348	348	174	174	0	0	0	870
Diver subtotal	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	15,921	8,178	15,138
Total Ducks	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	112,314	97,785	152,507
Other:																			
Coot	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	15,746	7,917	5,829
Canada Goose	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	24,707	43,498	31,145
Swan	0	348	348	174	0	348	348	522	2,001	1,218	609	1,914	2,175	1,827	1,827	2,088	2,001	4,785	5,394

Table 6. Minnesota waterfowl breeding populations by species for Stratum I-III combined, expanded for area coverage but not for visibility, 1998-2016.

Species	Year																		
	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Dabblers:																			
Mallard	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	111,408	94,866	117,698
Black Duck	0	0	0	117	0	0	174	56	0	174	174	0	0	0	174	507	167	339	0
Gadwall	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	2,703	3,989	11,855
American Wigeon	1,570	56	1,045	285	1,218	230	4,634	1,327	174	404	810	230	754	1,155	513	804	341	1,911	1,215
Green-winged Teal	858	117	1,613	1,564	1,267	630	678	230	694	167	278	400	172	230	404	813	351	988	111
Blue-winged Teal	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	31,979	33,484	70,907
Northern Shoveler	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	2,179	2,902	6,560
Northern Pintail	1,449	1,153	979	1,028	56	402	404	174	230	582	230	56	174	345	174	285	284	396	522
Wood Duck	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	13,820	12,240	18,459
Dabbler subtotal	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	163,232	151,115	227,327
Divers:																			
Redhead	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	3,425	2,356	4,320
Canvasback	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	3,585	2,892	3,694
Scaup	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	6,517	10,870	20,202
Ring-necked Duck	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	15,265	10,915	17,101
Goldeneye	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	2,138	2,431	2,317
Bufflehead	404	111	56	111	2,609	1,011	2,944	517	513	868	4,231	2,521	1,206	4,551	697	4,526	5,572	800	3,257
Ruddy Duck	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	285	1,045	2,229
Hooded Merganser	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	1,248	2,691	5,068
Large Merganser	0	0	117	228	522	972	234	723	957	626	1,032	681	681	519	230	456	256	400	1,042
Diver subtotal	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	38,291	34,400	59,230
Total Ducks	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	201,523	185,515	286,557
Other:																			
Coot	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	18,984	9,888	16,437
Canada Goose	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	63,857	90,887	66,672
Swan	172	604	406	291	403	2,341	1,355	2,400	3,855	2,074	2,823	5,336	5,148	10,626	6,611	11,500	7,700	12,575	13,412

Table 7. Mallard, blue-winged teal, and other duck (excluding scaup) populations in Minnesota, 1968-2016.

Year	Mallard				Blue-winged teal				Other ducks (exc. scaup)		
	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
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

Table 7. Cont.

Year	Mallard				Blue-winged teal				Other ducks (exc. scaup)		
	Unad. PI	VCF	PI	SE	Unad. PI	VCF	PI	SE	Unad. PI	VCF	PI
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
2014	111,408	2.31	256,996	55,366	31,979	3.18	101,640	24,089	51,619	2.24	115,751
2015	94,866	2.17	206,229	37,498	33,484	5.04	168,615	56,787	46,295	3.23	149,330
2016	117,698	2.07	243,189	42,502	70,907	4.48	317,464	92,149	77,750	2.67	207,593
Averages:											
10-year	92,870	2.65	244,384	39,875	38,275	3.93	145,352	41,235	59,736	3.03	175,432
Long-term	102,533	2.23	227,747	37,695	57,027	3.89	211,445	42,463	60,597	3.12	176,942
% change from											
2015	24%	-5%	18%	13%	112%	-11%	88%	62%	68%	-17%	39%
10-year average	27%	-22%	0%	7%	85%	14%	118%	123%	30%	-12%	18%
Long-term average	15%	-7%	7%	13%	24%	15%	50%	117%	28%	-14%	17%

Table 8. Scaup, total ducks (excluding scaup), total ducks, and Canada goose populations in Minnesota, 1968-2016.

Year	Scaup			Total Ducks (exc. scaup)		Total ducks		Canada geese		
	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
2003	5,117	5.30	27,120	209,529	721,805	214,646	748,925	87,663	3.78	331,094

Table 8. Cont.

Year	Scaup			Total Ducks (exc. scaup)		Total ducks		Canada geese		
	Unad. PI	VCF	PI	Unad. PI	PI	Unad. PI	PI	Unad. PI	VCF	PI
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
2014	6,517	2.24	14,614	195,006	474,387	201,523	489,001	63,857	1.57	100,255
2015	10,870	3.23	35,062	174,645	524,174	185,515	559,236	90,887	1.77	160,427
2016	20,202	2.67	53,939	266,355	768,246	286,557	822,185	66,672	1.62	108,009
Averages:										
10-year	7,586	3.03	22,277	190,915	565,873	198,467	588,150	77,465	2.08	158,508
Long-term	20,591	3.12	60,758	220,131	616,280	240,716	677,038	48,436	2.30	160,974
% change from										
2015	86%	-17%	54%	53%	47%	54%	47%	-27%	-8%	-33%
10-year average	166%	-12%	142%	40%	36%	44%	40%	-14%	-22%	-32%
Long-term average	-2%	-14%	-11%	21%	25%	19%	21%	38%	-29%	-33%

Appendix A. Precipitation in selected regions of Minnesota, 20 April - 20 May 2016 (Source: Minnesota DNR; <http://www.dnr.state.mn.us/climate/historical/summary.html>).

Region	Precipitation	Departure from normal
Northwest	1.47	-1.08
North Central	1.71	-0.98
Northeast	1.65	-1.14
West Central	2.44	-0.28
Central	3.00	-0.39
East Central	3.17	-0.02
Southwest	4.47	1.20
South Central	4.12	-0.14
Southeast	2.80	-0.43
Statewide	2.80	-0.43