Waterfowl Breeding Population Survey For Wisconsin, 1973-2021

Wisconsin Department of Natural Resources

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Contents

ABSTRACT

The 2021 Waterfowl Breeding Population Survey for Wisconsin was conducted April 26 to May 7 and followed methods of the North American waterfowl population survey. The information from this survey is used as part of the overall survey of breeding waterfowl in North America as well as in making state-level waterfowl management decisions. This survey has been conducted annually since 1973. While this survey was not conducted in 2020 due to the COVID-19 pandemic, data on Wisconsin waterfowl breeding populations are best interpreted as trends viewed over several years rather than as year-to-year changes.

Compared to the long-term average (1981-2010), fall and winter (October to February) precipitation levels were down 11% throughout most of the state and spring (March to May) precipitation was 12% below normal, resulting in below-average wetland conditions across the state. Total non-linear basins were down 37% from 2019 in the Southeast Central stratum (Table 2) but still 19% above the long-term (47-yr) mean. In the Northern High stratum, total non-linear basins were up 11% from 2019 (Table 2) and 25% above the long-term mean. Non-linear basins were up <1% from 2019 in the Northern Low stratum (Table 3) but still 39% above the long-term mean. Non-linear basins were down 50% from 2019 in the Southwest Driftless stratum (Table 2) and below 4% compared to this region’s long-term (23-yr) mean. Total linear basins were: up <1% from 2019 in the SEC (Figure 1) and 27% above the long-term mean, up 13% from 2019 in the NHI (Figure 2) and 33% above the long-term mean, and up 22% from 2019 in the NLO (Figure 3) and 48% above the long-term mean. Total linear basins were up 7% from 2019 in the SWD (Figure 4) and 38% above the long-term mean. The total breeding duck modeled population estimate of 522,546 is up 7% from the 2020 modeled estimate of 488,976 and is 19% above the long-term (47-year mean).

Overall, the total duck population estimate for 2021 is higher than what we have experienced the last few years (2015-2019) and above the total duck numbers experienced in the prior 10 years. The 2021 mallard modeled breeding population estimate of 171,345 is down 5% from the 2020 modeled estimate of 181,006 and is 4% below the long-term mean (47 years). The 2021 blue-winged teal modeled breeding population estimate of 65,124 is up 4% compared to 2020 modeled estimate but remains 37% below the long-term average (47-year mean). At 206,343 the 2021 population estimate for wood ducks is up significantly from the 2020 modeled estimate of 157,236 and 143% above the long-term mean. We should always consider the continental perspective for migratory birds when interpreting local surveys. Fortunately, in recent years the continental duck populations have been near all-time high estimates. However, it is clear that our continued commitment to protecting wetland and grassland habitat and regulating harvest impacts are both important to the future of Wisconsin breeding ducks. The statewide modeled breeding Canada goose population estimate of 181,430 is up 3% compared to the 2020 modeled estimate and 72% above the long-term (47-year) mean. Water conditions were average to below average prior to and during the time of the survey. This, coupled with an early spring prompted us to initiate the survey earlier than we have in previous years. Following the survey in May, we saw below-average rainfall, which may negatively impacted wetland conditions for the brood-rearing period. Average to above-average Canada goose breeding numbers should provide quality Canada goose hunting opportunities this fall.

INTRODUCTION

Decisions regarding hunting season structure and harvest limits in waterfowl management are based in part upon spring breeding pair surveys. The U.S. Fish and Wildlife Service's (USFWS) Waterfowl Breeding Population and Habitat Survey has been conducted for 66 years across the traditional survey area of north-central United States, Canada and Alaska. The Wisconsin Waterfowl Breeding Population Survey, which is modeled after the continental survey, has been conducted for 47 years and provides a long-term measure of waterfowl breeding trends in Wisconsin. These data are used at the national and state level for monitoring waterfowl populations and making management decisions. Wisconsin's breeding waterfowl survey data are included in the Waterfowl Population Status Report published annually by the USFWS on continental waterfowl populations. In addition, during a typical year mallard data from Wisconsin, Minnesota, and Michigan are combined with data from the traditional survey areas as a basis for the Adaptive Harvest Management Report that is used to establish federal waterfowl season frameworks, however due to pandemic related restrictions this will not occur in 2021. At the state level, waterfowl breeding survey data are used to inform annual hunting season regulations, identify long-term changes in species populations, and evaluate the impact of habitat changes and management. This report provides a summary and analysis of the 2021 survey data in support of these efforts.

METHODS

The breeding waterfowl survey in Wisconsin is a stratified double sampling scheme patterned after the North American Waterfowl Breeding Population Survey developed by the USFWS (Anon. 1977) but modified for local conditions (March *et al*. 1973). Fifty-five east-west aerial transects, each 30 miles long and 1/4-mile-wide, were randomly selected in 1973 within three strata of Wisconsin: Southeast Central (SEC), Northern High (NHI) and Northern Low (NLO), based on duck densities and habitat (Figure 5). These strata total 43,359 square miles. In 1997, eleven aerial transects were added within the unglaciated Southwest Driftless stratum (SWD) (12,311 square miles) and included in the statewide population estimates. This area was not surveyed prior to 1997 because of its low wetland density.

The 2021 aerial survey was conducted in 14 days, (April 26 to May 7) using a Cessna 182 aircraft, flying 80-85 mph at a maximum altitude of 200 feet. An observer recorded waterfowl data from each side of the plane, with the observer on the north side of the plane recording the number and type of wetland basins within a transect. Visibility correction factors (R) for waterfowl not seen by the aerial crew were determined by counting waterfowl from the ground on segments (10-15 miles long) of 26 transects and calculated as the ratio of ground counts to air counts. In this analysis, R was calculated independently for all priority waterfowl species pooling data from all 26 transects. When the Coefficient of Variation of R exceeded 20% for, data from prior years were iteratively added until the CV of R was below 20%.

The aerial surveys are generally initiated in the southern part of Wisconsin with the crews progressing to the northern transects. The ground surveys were done on 11 days that spanned April 27 to May 7. All ground counts were completed within two days of the air survey. Twenty-five people from two agencies were involved in the planning and implementation of the survey.

Survey results separate mallards, blue-winged teal, wood ducks and Canada geese. All other ducks are pooled into a category of “other ducks.” By 2004, wood duck populations had increased to the point where we were able to estimate them as a separate group rather than as part of "other ducks." This is significant because it allows us to provide independent breeding population estimates for three of the four duck species that constitute the majority of Wisconsin’s fall harvest.

This survey was not originally designed for surveying Wisconsin's resident Canada goose population. If a survey were specifically designed for breeding Canada geese in Wisconsin, it would be conducted earlier in the spring because of their earlier nesting chronology. Canada goose counts and population estimates were not included in this report prior to 1986 because of the small sample size. However, aerial counts of geese increased steadily from the mid-1980s through the early 2000s, making survey estimates useful indices to population trends of breeding Canada geese. Human-goose conflicts resulting from a growing goose population increase the importance of tracking the population status of breeding geese in Wisconsin.

Lesser scaup and bufflehead are not included in the state duck population estimates because they rarely breed in Wisconsin and when counted are assumed to be in migration to more northern breeding areas.

Observers counted occupied and unoccupied wetland types during the aerial survey. The determination of wetland type from the air is difficult to standardize when observers change over years. Pooling data into linear (streams and ditches) and nonlinear (types I-VIII) wetland groups resolves some of the typing problems. The same aerial observers are used for a minimum five-year period to limit problems with observer bias.

New to this year’s report and analysis we used a state-space model to determine population estimates. First, we calculated species abundance using the traditional formula B*A*R, or, Bird density/sq mile * Regional Area * Visibility Correction Factor (R). This results in the traditional annual abundance estimates. Second, we used the traditional annual abundance estimates from 1973-2021 as data in a state-space model to provide modeled abundance estimates that better account for observation error that inherently occurs in the survey. As a result of the state-space model, we get annual mean abundance estimates and associated 95% credible intervals. These credible intervals tell us the range of abundance estimate values within which we can be 95% certain to contain the true population value. Because annual spring breeding survey estimates are an unknown integration of both true annual population change and observation error, we elected to model all annual estimates for each priority species using a state-space modeling approach. State-space models are hierarchical models that decompose an observed time series of counts into a process variation (true population size change) and an observation error component (survey count biases). State-space models offer at least two important advantages. First, modeled survey estimates smooth out drastic annual changes in raw survey estimates that are biologically unrealistic (e.g., mallard abundance changing from roughly 250K in 1999, to 450K in 2000, and then to 180K in 2001). Secondly, a Bayesian state-space model allows for estimate prediction, even when counts are unavailable. In light of missing data for 2020, modeled estimates are available to fill in the gap. Therefore, in the following summaries of priority breeding waterfowl estimates, we reference abundance and percent changes in light of the *modeled survey estimates* rather than the raw survey estimates, but we provide both in the tables and figures for comparison.

RESULTS AND DISCUSSION

Survey Timing And Weather

In 2021, we saw warmer temperatures than normal across Wisconsin, with temperatures slightly warmer in the southern half of the state. In combination with below-average rainfall throughout much of the state, this required that we conduct this survey earlier than we have the past several years. We continued to see average and above average temperatures across most of the state in early May and mid-May, respectively. We initiated the breeding waterfowl survey on April 26, which appeared to be well timed with regards to mallards across much of the state. As in the past, the survey was initiated in the southern part of Wisconsin, progressing northward to account for the differences in phenology from south to north. The timing of the breeding waterfowl survey is always a challenge because variables such as weather, bird species phenology and tree leaf-out all impact the timing, visibility and accuracy of the survey. Weather was not much of an issue leading up to the survey, with dry and warm conditions statewide and most of the lakes in northern Wisconsin free of ice by early April. Conditions were mostly dry throughout the duration of the survey, so there was little influence on the number of temporary wetlands, which we often see when there are significant rain events as the survey is being conducted. There were some concerns with leaf-out on transects in the north-central portions of the state. When observers encounter transects that have leaf-out conditions it is considerably more difficult to observe birds in forested and shrub wetlands.

The crews encountered few problems with waterfowl in groups of four or more birds in 2021. Ten flocks of groups with more than 10 mallards were encountered, including one group of 50 ducks and another group of 100. Groups of five or more individuals made up 5% of the wood ducks, 16% of the Canada geese, 25% of the mallards, 69% of the blue-winged teal and 38% of the "other ducks" of the total indicated birds for each species. Flocks of >19 birds are not included in BPOP estimates as they are considered migrants or non-breeders.

Precipitation

Fall and winter (October to February) precipitation was down throughout most of the state by 11% compared to the normal average (1981-2010). Spring (March to May) precipitation statewide was 12% below normal. When migrating ducks arrived in Wisconsin this spring, the typical high-density duck nesting areas in southern and eastern Wisconsin had below-normal water conditions, which likely contributed to our decline in mallard numbers.

Wetlands

We had average to below-average precipitation throughout the fall and into the winter of 2020-21. Snowpack was average to below-average throughout much of the state. With average runoff from the melting snow and the average conditions going into the fall of 2020, we saw below-average wet conditions throughout March and April, which caused dry conditions across the entire state during the time of the survey. Conditions remained dry throughout much of May with some little rainfall in the latter half of May, resulting in below-average wetland conditions during the brood rearing period. During the 2021 survey we observed wetland conditions differing with wetter conditions in the north and drier conditions in the south (Table 2). Total non-linear basins were down 37% from 2019 in the SEC (Table 2) but still 19% above the long-term (47-yr) mean, up 11% from 2019 in the NHI (Table 2) and 25% above the long-term mean, and similar compared to 2019 in the NLO (Table 2) but still 39% above the long-term mean. Non-linear basins were down 50% from 2019 in the SWD (Table 2) and below 4% compared to this region's long-term (23-yr) mean. Total linear basins were: up <1% from 2019 in the SEC (Figure 1) and 27% above the long-term mean, up 13% from 2019 in the NHI (Figure 2) and 33% above the long-term mean, and up 22% from 2019 in the NLO (Figure 3) and 48% above the long-term mean. Total linear basins were up 7% from 2019 in the SWD (Figure 4) and 38% above the long-term mean. With the lack of precipitation in May, average to below average conditions for breeding and brood-rearing habitat in Wisconsin is expected.

Mallards

The 2021 modeled **mallard population estimate is 171,345 (95% CI: ± [123,840; 230,392]).** This estimate is 5% lower compared to the previous year's modeled estimate and 4% below the long-term (47-year mean) (Figure 7).

Among duck species, mallards are highly adaptable to annual weather variation and often begin nesting when conditions may not yet be ideal. The early initiation of mallard nesting in 2021 should allow ample time for re-nesting efforts that can make a considerable contribution to annual production. Breeding pair survey numbers combined with average to below-average wetland conditions in the key breeding areas suggest that we will have mallard production similar to or lower than the last 10-year period. As in previous years, the SEC still represented the largest portion of the breeding mallard population (48%) and was similar to that of 2019 (Table 2). Because of the importance of the SEC region to mallard production and the increasing land use pressures, a focus on land acquisition, habitat restoration and management along with private land management incentives such as those available through the federal Farm Bill programs continue to be a priority for the SEC. Waterfowl breeding population estimates are best interpreted from long term trends rather than year to year variation.

Blue-winged Teal

In 2021, warm March and April temperatures likely resulted in slightly earlier migration and waterfowl breeding cycles. As a result, the timing of the breeding waterfowl survey, which targets breeding mallards, may have occurred too late to capture peak detection of blue-winged teal. The 2021 modeled population estimate for **Blue-winged teal is 65,124 (95% CI: [38,293; 106,146])**. This estimate is 4% higher compared to the previous year's modeled estimate but remains 37% below the long-term (47-year mean) (Figure 8). The best approach when evaluating the blue-winged teal survey data is to look at long-term trends and continental context. In the late 1970s and 1980s, there was a clear decline in Wisconsin breeding blue-winged teal numbers concurrent with declines at the continental level. Since then, Wisconsin blue-winged teal breeding numbers have remained low compared to historic levels while continental numbers have shown dramatic increases during the late 1990s and in the last 10 years. We remain concerned about long-term decreases in secure grassland and nesting cover, particularly with fewer Conservation Reserve Program lands enrolled in Wisconsin. However, blue-winged teal are also known for shifting breeding locations around the continent in response to wetland habitat conditions. Continental blue-winged teal breeding populations have reached record highs over the past 7-8 surveys with estimates of 6-8 million breeding blue-winged teal reflecting good wetland conditions and good production in the prairies of Canada and the U.S. The abundant blue-winged teal populations in the prairies provide large fall flights of teal, which compensate for declines in Wisconsin. During the regular duck hunting season in Wisconsin, about two thirds of our blue-winged teal harvest is supported by teal that breed outside of Wisconsin.

Wood Ducks

The 2021 population estimate for **Wood ducks is 206,343 (95% CI: [116,816; 309,713])**. This estimate is a 31% increase from the previous year's modeled estimate and is 143% above the long-term (47-year mean) (Figure 9). A combination of survey timing, improved habitat statewide and dry conditions this year, which may have concentrated wood ducks into more visible bodies of water (compared to flooded forest-land), could have contributed to an increase in wood duck detection and thus higher estimates compared to what we have seen in the past. As always, we remind people that it is important to view these population estimates as trends rather than focusing on year to year changes. The breeding wood duck population showed significant gains in 1980s and early 1990s and appears to be leveling off around 100,000 after peaking about 10 years ago but has shown an increasing trend over the past five years. Based on improved water conditions and our best interpretation of the survey results, we expect wood duck production in 2021 to be excellent and up from recent years.

Other Ducks

The 2021 modeled population estimate for **"other ducks" is 105,042 (95% CI: [49,530;190,878])**. This estimate is a 17% decrease compared to the previous year's modeled estimate and 68% increase from the long-term (47-year mean). In 2021, species comprising "other ducks" were: ring-necked duck (43%), hooded merganser (32%), common merganser (13%), northern shoveler (7%), goldeneye (4%), gadwall (1%), and ruddy duck (1%).

Total Ducks

The **total state modeled breeding duck population estimate of 522,546 (95% CI: [385,000; 695,140])** is up 7% compared to the previous year's modeled estimate and is 19% above the long- term mean (Tables 3 and 4; Figure 10). As wetland and migratory wildlife species, ducks readily adjust behavior to weather and water conditions. As a result, variations in population estimates and breeding behavior from year to year are expected. While these annual variations draw considerable interest, particularly from duck hunters, looking at the long-range trends is most important for conservation purposes. Wisconsin is fortunate to have a substantial breeding population of ducks supported by mallards, wood ducks, blue-winged teal and others, which each taking advantage of a unique composition of wetland and nesting habitats. Overall, wood duck numbers appear to be increasing, blue-winged teal numbers in Wisconsin are highly variable and should be interpreted in the context of high continental populations, while mallard numbers have shown stabilizing to slight declines as described above. Current Wisconsin landscape conditions combined with a good rain/snowfall year appear capable of supporting total breeding duck numbers of 450,000 – 550,000. It appears that the Wisconsin landscape will provide good duck production in 2021.

Continentally, habitat conditions have been good and duck breeding populations high for several years. However, both habitat and duck numbers are beginning to show some declines as the US and Canadian prairies appear to be in a drying phase. The thousands of lakes and abundant permanent water in Wisconsin help to moderate the impact of drier wetland years by providing stable duck habitat here. The most significant change in current habitat conditions is the ongoing loss of grassland nesting cover in Wisconsin and across the U.S. prairies as a result of changes in federal farm policy. Continued efforts to protect wetland and grassland habitat will be needed to sustain current duck population levels.

Canada Geese

Based on the most recent harvest derivations, the proportion of the Wisconsin Canada goose harvest that consists of temperate breeding (formerly giant) Canada geese is about 60%, with most of those birds representing Canada geese that breed in Wisconsin (J. Dooley, 2017 USFWS memo). This proportion indicates the continued importance of in-state breeding Canada geese in our overall fall harvest. The 2021 population estimate for **Canada geese is 181,430 (95% CI: [128,909; 254,459]).** This estimate is a 3% increase compared to the previous year's modeled estimate and is 68% above the long-term (47-year mean) (Figure 11).

The long-term trend in goose numbers suggests a continued gradual increase in their population. Field staff indicated that Canada goose nesting and brood production was excellent across the state and we expect numbers similar to recent years going into the fall hunting season.

While the spring breeding waterfowl survey is designed primarily for ducks, it serves as a fairly reliable index of change in the Canada goose population. Temperate breeding Canada geese represent a positive resource for some Wisconsin residents, but they also represent a problem for other residents in cities and on farms where increasing populations have caused conflicts. Fortunately, there are solutions to the problems that resident geese cause. In Wisconsin, the management strategy for these geese is two-fold: 1) Manage the overall population through hunter harvest, and 2) Address property- or community-specific problems with professionally-guided, integrated management. The early goose hunting season, with a harvest of over 90% local birds during a two-week period, continues to be an important part of our management strategy. The early season now comprises roughly one third of the Canada geese harvested statewide each fall. In addition, site-specific Canada goose control measures are implemented in urban and agricultural areas to mitigate nuisance goose problems. We continue to adapt harvest strategies, banding plans, nuisance goose programs and survey strategies as the breeding population of giant Canada geese increases and expands across Wisconsin (Tables 3, and 4; Figure 11). A continued interest in the early September Canada goose hunting season is important to the overall management of this population.

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Appendix: Tables And Figures

Table 1. Wisconsin Precipitation:

Prepared by Wisconsin State Climatology Office
June 2019
Precipitation Data

	Oct. 1, 2020-February 28, 2021			March 1, 2021- May 31, 2021		
Division	**Total (inches)**	**Departure from Normal* (inches)**	**Percent Change from Normal***	**Total (inches)**	**Departure from Normal* (inches)**	**Percent Change from Normal***
1 (NW)	5.79	-2.25	-27.97%	8.42	0.77	10.10%
2 (NC)	6.85	-1.74	-20.24%	8.18	0.48	6.26%
3 (NE)	7.93	-0.74	-8.52%	7.15	-0.37	-4.92%
4 (WC)	6.43	-1.25	-16.30%	7.61	-1.11	-12.68%
5 (C)	8.27	0.26	3.31%	7.28	-1.09	-13.02%
6 (EC)	9.50	0.62	6.97%	6.54	-1.36	-17.18%
7 (SW)	8.78	0.11	1.30%	5.98	-3.60	-37.57%
8 (SC)	8.79	-0.57	-6.11%	5.96	-3.15	-34.55%
9 (SE)	9.04	-0.99	-9.86%	4.86	-4.15	-46.04%
Statewide Average	7.55	-0.95	-11.13%	7.26	-0.98	-11.64%

* 1981-2010 normal

Table 2. Numbers of wetlands per square mile observed, 2012-2021, SEC

Wetland Type	I, II, VI	III	IV, V	VII, VIII	Tot. Nonlin.	Stream	Ditch	Tot. Linear
2012	2.1	0.6	3.1	0.7	6.4	1.6	2.6	4.1
2013	2.5	1.0	3.2	0.6	7.3	1.8	2.5	4.2
2014	3	1.0	3.1	1.2	8.3	1.7	2.8	4.5
2015	1.3	0.8	2.7	0.7	5.6	1.8	2.4	4.2
2016	2.1	0.9	3.0	1.0	6.8	1.5	2.2	3.7
2017	9.2	1.1	3.6	1.9	15.8	1.9	3.2	5.1
2018	6.5	0.8	3.3	1.6	12.2	1.9	3.1	4.9
2019	7.7	2.1	4.7	2.3	16.9	1.5	3.8	5.4
2020	NA	NA	NA	NA	NA	NA	NA	NA
2021	2.9	0.9	5.0	1.8	10.6	2.6	2.8	5.4
% Change from Previous Year	-62.6%	-58.0%	7.4%	-22.5%	-37.2%	67.8%	-26.5%	0.7%
Long-term mean	3.9	0.9	3.0	1.1	8.9	1.8	2.5	4.2
% Change from Long-term mean	-25.4%	-2.2%	67.7%	62.9%	19.3%	48.2%	12.4%	27.5%
10 year mean (2012-2021)	4.1	1.0	3.5	1.3	10.0	1.8	2.8	4.6

*Wetland classification system from March et al. 1973

Figure 1. Annual variability in total non-linear and liner wetlands surveyed in the South-East Central region during the Wisconsin Spring Duck Survey.

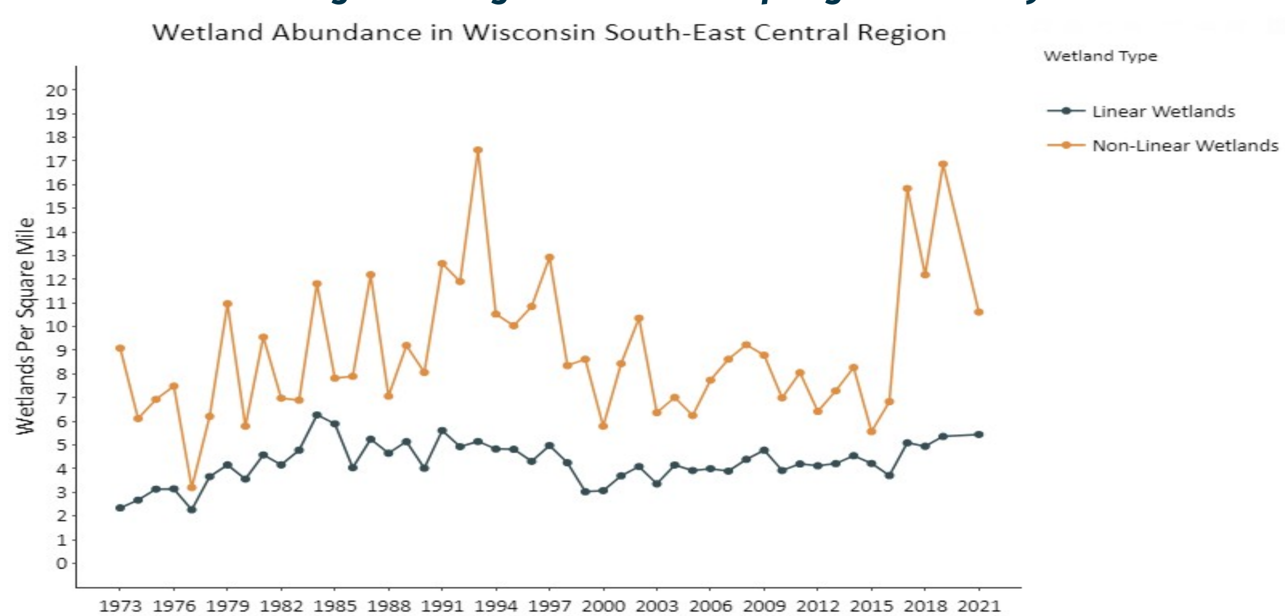

Table 2 Continued, **NHI**

Wetland Type	I, II, VI	III	IV, V	VII, VIII	Tot. Nonlin.	Stream	Ditch	Tot. Linear
2012	3.4	1	3.8	1.0	9.3	2.3	0.3	2.6
2013	2.9	2.1	4	0.6	9.6	2.8	0.6	3.3
2014	6.4	1.8	5.7	2.4	16.3	2.9	0.6	3.5
2015	2.6	1.3	3.5	1.7	9.1	2.1	0.6	2.7
2016	2.4	1.2	3.4	1.9	8.9	1.9	0.6	2.5
2017	3.5	2.0	3.6	3.4	12.5	1.8	0.9	2.7
2018	1.5	1.2	4.5	1.5	8.6	2.4	0.5	2.9
2019	2.4	2.6	5.5	1.7	12.2	2.8	0.4	3.2
2020	NA	NA	NA	NA	NA	NA	NA	NA
2021	1.4	1.1	5.8	5.3	13.5	3.2	0.3	3.6
% Change from Previous Year	-41.7%	-57.4%	5.3%	215.1%	10.9%	15.1%	-26.9%	12.9%
Long-term mean	3.4	1.4	4.0	2.1	10.8	2.3	0.4	2.7
% Change from Long- term mean	-58.6%	-18.9%	45.8%	157.6%	25.4%	41.1%	-32.9%	33.0%
10 year mean (2012-2021)	2.9	1.6	4.4	2.2	11.1	2.5	0.5	3.0

Figure 2. Annual variability in total non-linear and liner wetlands surveyed in the Northern High Density region during the Wisconsin Spring Duck Survey.

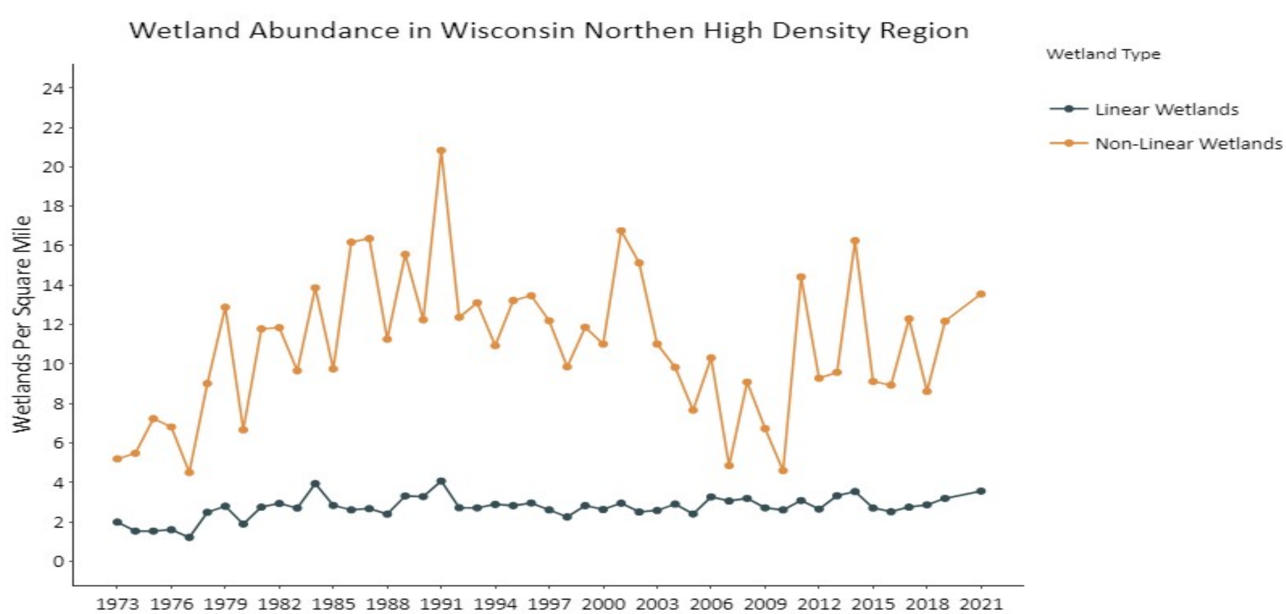

Table 2. Continued, **NLO**

Wetland Type	I, II, VI	III	IV, V	VII, VIII	Tot. Nonlin.	Stream	Ditch	Tot. Linear
2012	5	0.5	2.4	1.7	9.5	4.8	0.8	5.7
2013	3.4	1	2.5	0.7	7.6	3.8	0.8	4.6
2014	8.8	0.5	2.0	2.7	14.1	4.6	1.7	6.2
2015	1.7	0.6	1.8	1.1	5.2	3.0	0.9	3.9
2016	1.8	0.8	2.1	1.2	5.9	2.8	0.8	3.6
2017	4.7	0.8	2.1	2.9	10.6	2.9	1.4	4.2
2018	2.8	0.8	2.9	2.6	9.1	5.0	1.3	6.2
2019	5.6	1.7	3.5	1.9	12.6	4.0	1.2	5.2
2020	NA	NA	NA	NA	NA	NA	NA	NA
2021	3.0	1.2	3.8	4.7	12.7	4.9	1.3	6.3
% Change from Previous Year	-46.4%	-28.7%	9.6%	150.4%	0.6%	23.4%	8.3%	21.9%
Long-term mean	4.0	0.8	2.2	2.0	9.1	3.5	0.8	4.3
% Change from Long- term mean	-25.3%	50.9%	70.3%	131.9%	39.4%	40.8%	61.6%	47.5%
10 year mean (2012-2021)	4.2	0.8	2.4	1.8	9.3	3.9	1.1	4.9

Figure 3. Annual variability in total non-linear and liner wetlands surveyed in the Northern Low Density region during the Wisconsin Spring Duck Survey.

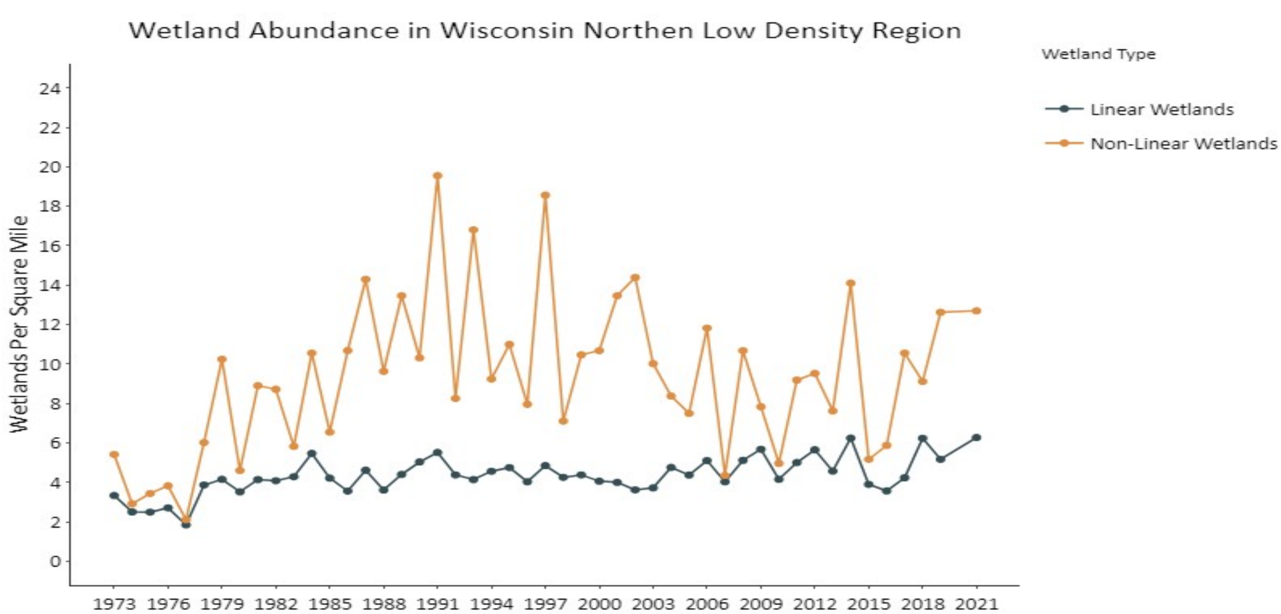

Table 2. Continued, **SWD**

Wetland Type	I, II, VI	III	IV, V	VII, VIII	Tot. Nonlin.	Stream	Ditch	Tot. Linear
2012	1	0.2	1.9	0	3.1	3.6	1	4.5
2013	1.4	0.5	1.3	0.4	3.6	3.6	0.8	4.4
2014	2.3	0.6	1.7	0.5	5.1	3.4	1.3	4.7
2015	0.7	0.2	1.3	0.3	2.6	2.8	0.7	3.5
2016	0.3	0.3	1.1	0.3	2	2.5	0.8	3.3
2017	3.4	0.5	1.9	0.7	6.5	3.6	1.2	4.8
2018	1.8	0.3	1.5	0.3	3.9	3.2	0.8	4.1
2019	3.2	1.0	1.8	0.7	6.7	3.6	1.4	5.0
2020	NA	NA	NA	NA	NA	NA	NA	NA
2021	0.8	0.4	1.9	0.2	3.4	4.8	0.6	5.4
% Change from Previous Year	-75.1%	-61.2%	8.1%	-73.0%	-49.6%	33.3%	-57.7%	7.6%
Long-term mean	1.5	0.3	1.6	0.3	3.5	4.6	1.1	3.9
% Change from Long- term mean	-48.0%	22.2%	20.5%	-23.8%	-4.1%	4.7%	-46.8%	38.0%
10 year mean (2012-2021)	1.7	0.4	1.6	0.4	4.1	3.5	1.0	4.4

Figure 4. Annual variability in total non-linear and liner wetlands surveyed in the South West Driftless region during the Wisconsin Spring Duck Survey

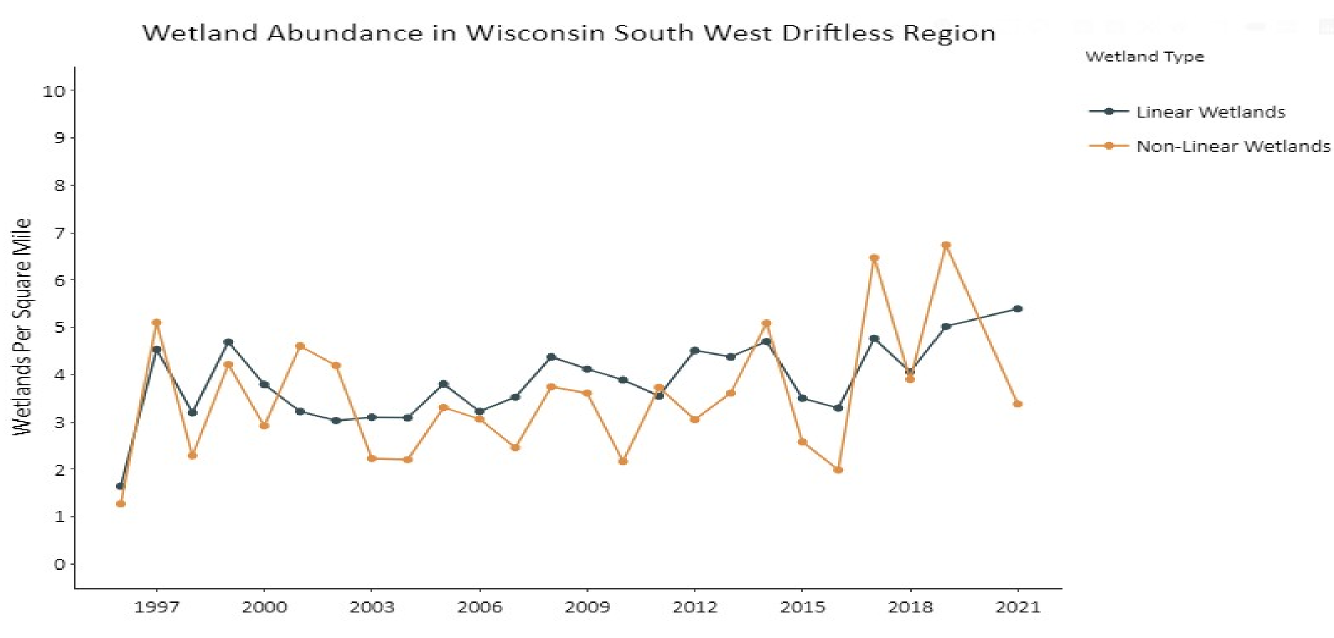

Table 4. Unmodeled 2021 Wisconsin Spring Duck Survey Waterfowl Breeding Population Estimates

Species	Area of stratum (mi²)	Bird density seen form the air (birds/mi²)	Aerial visibility correction factor[1]	Survey Estimate	Standard Error
Mallard					
Stratum[2]					
SEC	17,949	3.490	1.132	70,902	2,750
NHI	9,431	2.092	1.132	22,336	1,561
NLO	15,979	1.928	1.132	34,877	2,624
SWD	12,311	1.382	1.132	19,256	1,912
Subtotal				**147,371**	**2,402**
Blue-winged teal					
Stratum					
SEC	17,949	0.354	5.754	36,563	2,180
NHI	9,431	0.185	5.754	10,018	2,779
NLO	15,979	0.041	5.754	3,772	725
SWD	12,311	0.352	5.754	24,900	4,515
Subtotal				**75,253**	**2,667**
Wood duck					
Stratum					
SEC	17,949	0.975	6.614	115,713	4,969
NHI	9,431	0.492	6.614	30,708	2,341
NLO	15,979	0.533	6.614	56,365	4,406
SWD	12,311	0.461	6.614	37,505	4,998
Subtotal				**240,291**	**4,463**
Other duck species[3]					
Stratum					
SEC	17,949	0.216	5.323	20,644	1,912
NHI	9,431	1.221	5.323	61,266	6,266
NLO	15,979	0.472	5.323	40,125	5,807
SWD	12,311	0.000	5.323	0	0
Subtotal				**122,035**	**3,998**
Canada Geese					
Stratum					
SEC	17,949	2.906	1.817	94,790	3,110
NHI	9,431	1.456	1.817	24,963	2,282
NLO	15,979	1.015	1.817	29,487	2,816
SWD	12,311	0.933	1.817	20,883	1,972
Subtotal				**170,123**	**2,736**

[1] Aerial Visibility Correction Factor = ratio of number of species-specific individuals seen from the ground divided by the number seen from the air on air-ground segments, pooled across strata. To achieve a desirable coefficient of variation (CV) value in the aerial visibility correction factor, previous years of air-ground data were iteratively added until CV was <20%. In 2021, aerial visibility correction factors for mallards, blue-winged teal, wood ducks, Canada geese and “other ducks” were derived using 2, 13, 6, 2 and 13 years of air ground data, respectively.

[2] SEC = Southeast Central, NHI = Northern High, NLO = Northern Low, SWD = Southwest DriftlessStrata.

[3] Lesser scaup, buffleheads and all non-duck/goose waterbirds are excluded from analysis. Common duck species included as “other ducks” include ring-necked duck, common goldeneye, northern shoveler, hooded merganser, gadwall, green-winged teal and canvasback.

Figure 5. Transect Lines And Regions

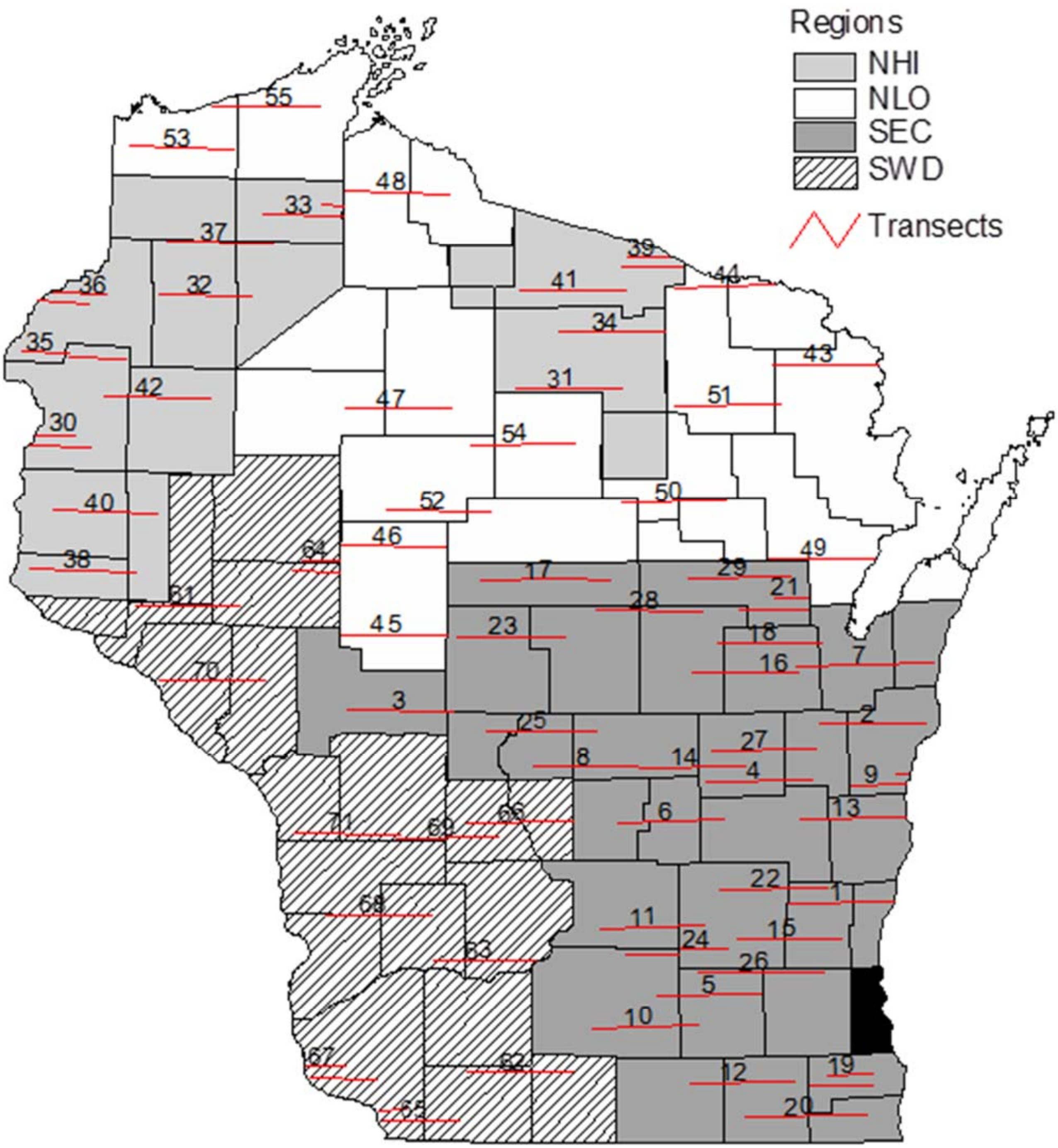

Figure 6. Climatology Divisions

Figure 7. Annual statewide estimates of breeding mallard abundance in Wisconsin, 1973-2021. Depicts abundance calculations from the Aerial Spring Waterfowl Survey (open circles), model predicted abundance estimates (solid line), and 95% credible intervals.

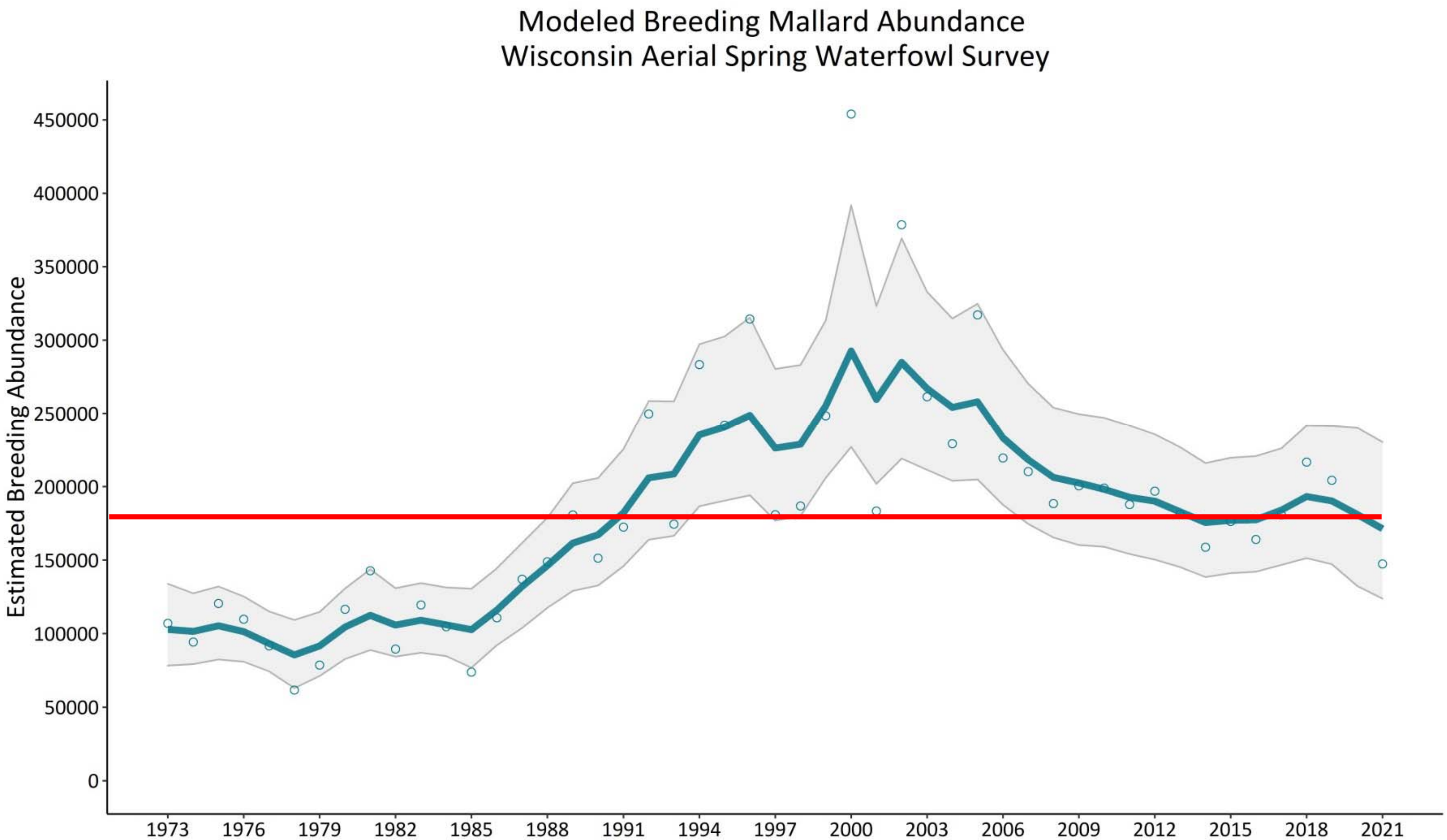

Figure 8. Annual statewide estimates of breeding blue-winged teal abundance in Wisconsin, 1973-2021. Depicts abundance calculations from the Aerial Spring Waterfowl Survey (open circles), model predicted abundance estimates (solid line), and 95% credible intervals.

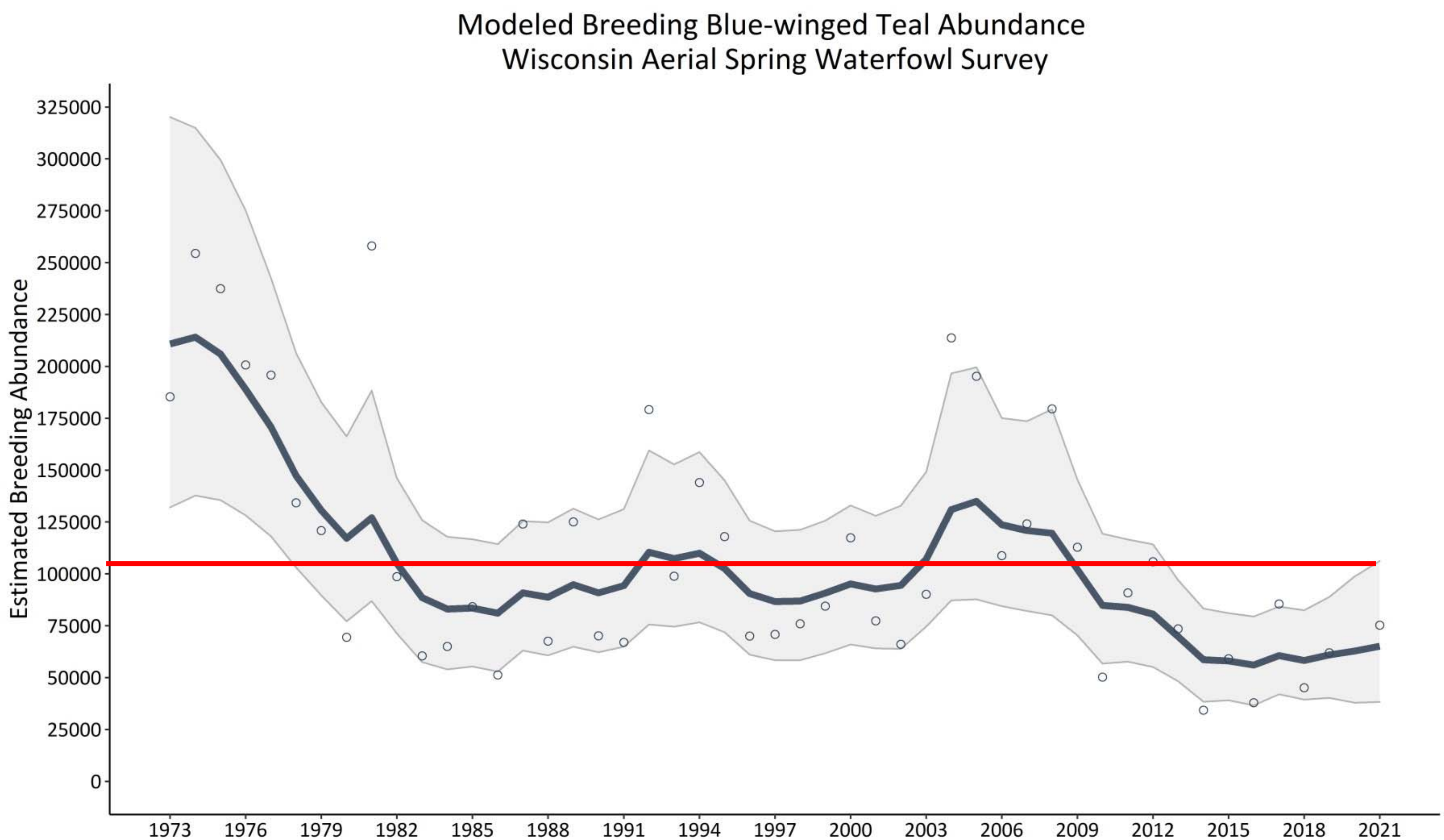

Figure 9. Annual statewide estimates of breeding wood duck abundance in Wisconsin, 1973-2021. Depicts abundance calculations from the Aerial Spring Waterfowl Survey (open circles), model predicted abundance estimates (solid line), and 95% credible intervals.

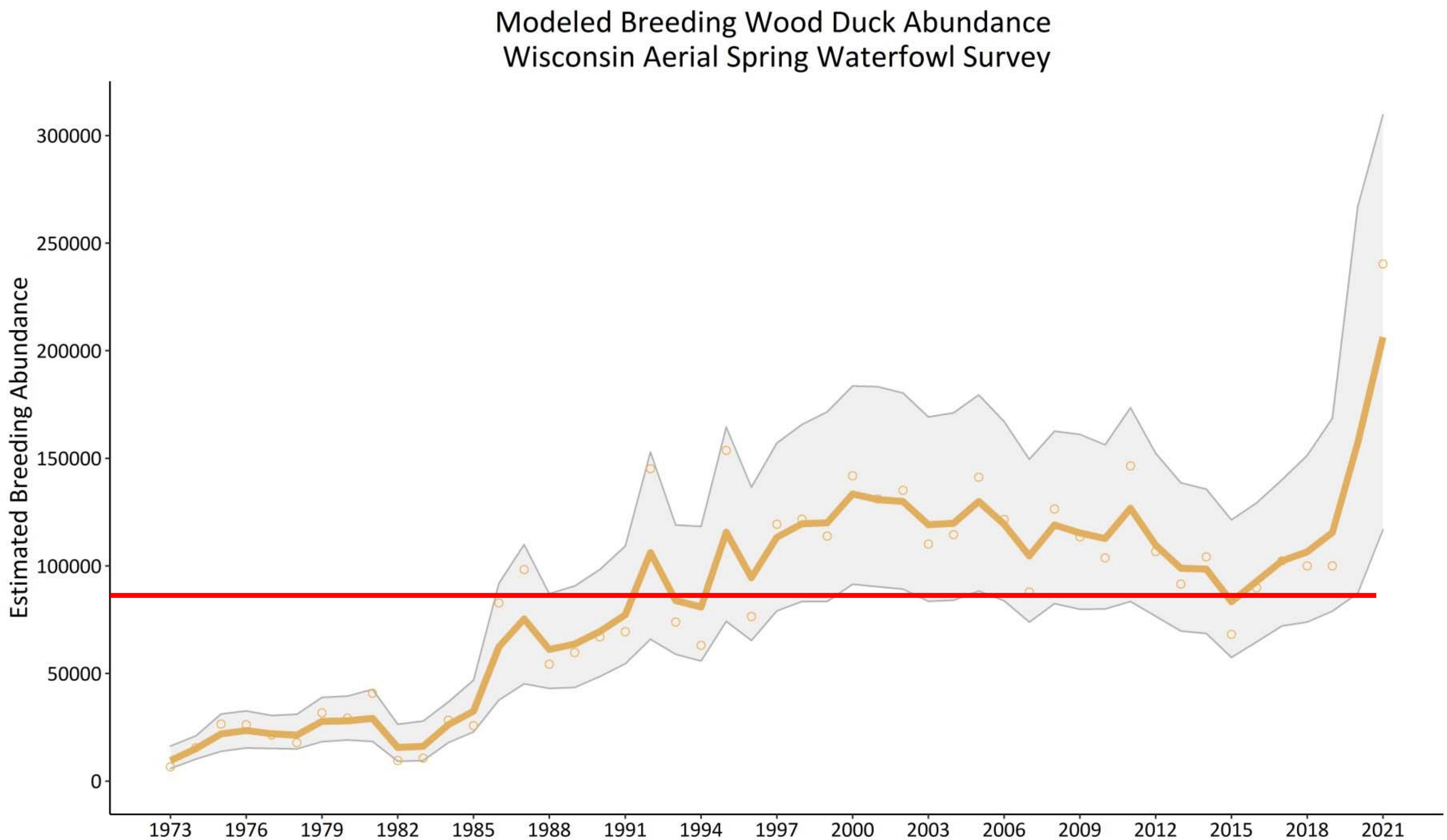

Figure 10. Annual statewide estimates of total breeding duck abundance in Wisconsin, 1973-2021. Depicts abundance calculations from the Aerial Spring Waterfowl Survey (open circles), model predicted abundance estimates (solid line), and 95% credible intervals.

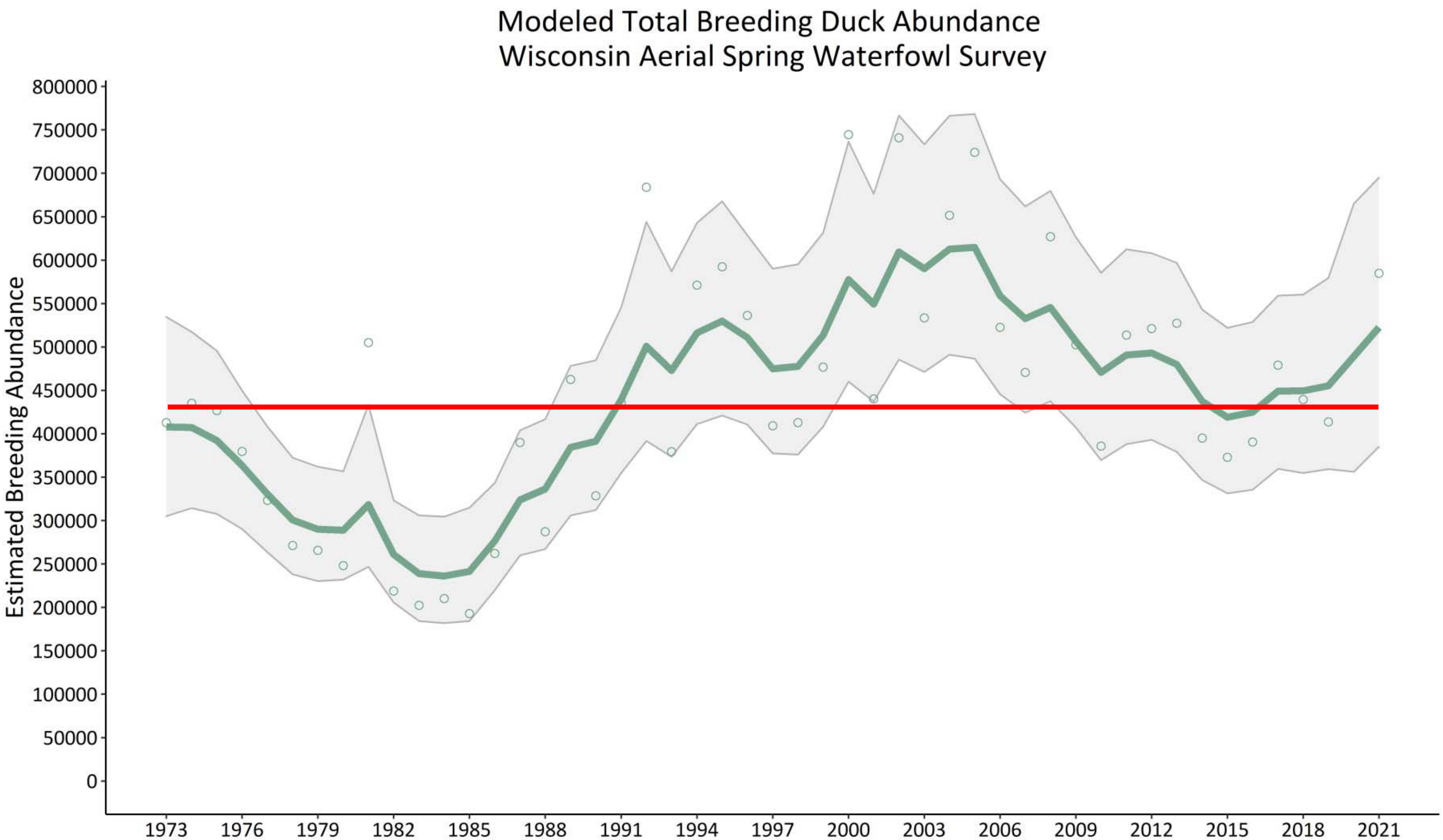

Figure 11. Annual statewide estimates of breeding Canada goose abundance in Wisconsin, 1973-2021. Depicts abundance calculations from the Aerial Spring Waterfowl Survey (open circles), model predicted abundance estimates (solid line), and 95% credible intervals.