

MANAGEMENT PLAN FOR THE INTERIOR POPULATION OF TRUMPETER SWANS

(2026)



Ontario Trumpeter Swan Family, photo courtesy of Kimberly Stevenson

A MANAGEMENT PLAN FOR THE INTERIOR POPULATION OF TRUMPETER SWANS

Prepared by the Ad Hoc Interior Population
Trumpeter Swan Management Plan Committee

February/2026

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Prepared for

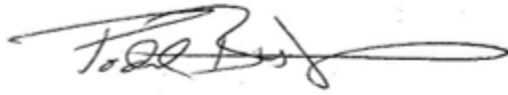
The Mississippi, Central and Atlantic Flyway Councils

Prepared by

The Ad Hoc Interior Population Trumpeter Swan Management Plan Committee

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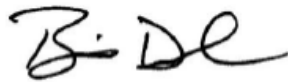
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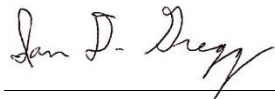
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Table of Contents

Executive Summary.....	5
Introduction.....	6
Section 1 – Historical Population, Range and Restoration Efforts to Establish the Interior Population of Trumpeter Swans	7
Pre-reintroduction history	7
Early IP Reintroduction Efforts.....	8
Region-specific Reintroduction and Monitoring Efforts.....	9
Interior Population Abundance and Trends	10
Section 2 – Interior Population Trumpeter Swan Summer/Breeding Status and Ecology.....	12
Breeding Status and Distribution	12
Breeding Ecology.....	15
Section 3 - Interior Population Trumpeter Swan Fall Migration	15
Section 4 – Interior Population Trumpeter Swan Wintering Behavior and Ecology	17
Section 5 – Interior Population Trumpeter Swan Spring Migration	20
Section 6 – Differences in Behavior and Ecology IP Trumpeter Swan Adults and Subadults.....	22
Section 7 – IP Trumpeter Swan Molt Migration Movement and Behavior	22
Section 8 – IP Trumpeter Swan Genetic Diversity and Influence on Behavior and Ecology	24
Section 9 – IP Trumpeter Swan Management Issues and Information Needs	26
Management Issues	26
Information Needs.....	31
High Priority	31
Medium/Low Priority	32
Interior Population Trumpeter Swan Management Plan Goal, Objectives and Strategies.....	33
Objectives and Management Strategies.....	33
References	36
Figures and Tables	48
Appendix A	60
State/Province-specific Reintroduction and Monitoring Efforts.....	60

Executive Summary

Over the past three decades, coordinated restoration efforts across the Upper Midwest and Canada have transformed the future of the Interior Population (IP) of Trumpeter Swans (*Cygnus buccinator*). Once nearly extirpated from their historical range due to overharvest and habitat loss, the IP has experienced a remarkable recovery. Today, the population far exceeds the original recovery goal established in the 1998 plan of 2,000 individuals and 180 breeding pairs.

The IP consists of two primary subpopulations: the Mississippi and Atlantic Flyways flock, which has shown rapid growth due to extensive reintroduction programs, and the High Plains flock, which remains smaller and more isolated but continues to expand slowly. As restoration goals have been met, management priorities now focus on maintaining a self-sustaining migratory population, facilitating range expansion to historical locations that are compatible with existing waterfowl management programs and priorities, and addressing emerging and continuing conservation and management challenges.

The 2026 Interior Population Trumpeter Swan Management Plan update provides a science-based framework to guide conservation, monitoring, and management actions. It emphasizes maintaining high quality habitat across breeding, migration, and wintering ranges, while balancing ecological needs with human-wildlife interactions and tribal rights. It also recognizes the need to adapt to changing environmental conditions, including the impacts of landscape and climate change on the distribution and behavior of swans.

The plan identifies critical information needs to guide future conservation, including developing cost-effective monitoring alternatives to the discontinued North American Trumpeter Swan Survey, implementing integrated population models to better understand population dynamics, expanding monitoring to track range expansion, developing a potential take limit assessment to inform how sources of take impact this population, and quantifying impacts of swan herbivory on key habitats.

The overarching goal of the 2026 plan is to maintain a self-sustaining Interior Population of Trumpeter Swans with sufficient recruitment and dispersal to recolonize the historical range where suitable habitat exists, when compatible with existing waterfowl management programs, while providing societal benefits and minimizing human-wildlife conflicts. Strategies to achieve this include:

- Developing robust population indices and monitoring tools.
- Enhancing and protecting critical habitats across the annual cycle.
- Promoting public engagement and recreational opportunities.

- Minimizing mortality from anthropogenic sources such as lead poisoning and power line collisions.
- Ensuring compatibility of waterfowl hunting regulations with Trumpeter Swan conservation without negatively impacting any existing and potential hunting opportunities.
- Supporting collaborative research and adaptive management to address emerging issues.

Through these actions, the plan aims to secure the long-term future of Trumpeter Swans across their historical range, ensuring they remain a thriving and integral part of North America's wetland ecosystems for generations to come.

Introduction

The Trumpeter Swan is North America's largest native waterfowl species and has made a remarkable comeback continentwide over the last several decades, with over 63,000 birds estimated by 2015. Trumpeter Swan restoration efforts in the Upper Midwest and Canada during the past three decades have led to a dramatic increase in the Interior Population (IP), which comprises Trumpeter Swans located primarily in the midwestern US and the provinces of Ontario, Manitoba, and Saskatchewan (Figure 1, Groves 2017). When the 1998 IP Management Plan was finalized, Trumpeter Swans were approaching 1,000 individuals (Ad Hoc Committee 1998), but as of 2015 the IP had blossomed to over 63,000 birds (Groves et al. 2017). These remarkable increases have created a need for revision of the 1998 IP Trumpeter Swan Management Plan (Ad Hoc Committee 1998), to address new conservation and management issues, while celebrating the achievement of restoration programs.

The Interior Population is generally divided into two sub-populations – the Mississippi and Atlantic Flyways flock, located primarily in the upper Midwestern States and Ontario, and the High Plains flock, found in Nebraska and Saskatchewan (Figure 1, Groves 2017). The Mississippi and Atlantic Flyways flock has accounted for most of the growth, from 6,770 in 2010 to 26,591 in 2015, whereas the High Plains flock, which was only briefly augmented by releases in the early 1960s (Comeau 2015), only increased from 384 to 484 between 2010 and 2015. Considerations of the differences between these flocks need to be addressed.

The original IP Management Plan provided a framework for state, provincial and federal agencies, and private organizations to continue the restoration of Trumpeter Swans throughout their former range. The IP Management Plan goal was “at least 2,000 birds and 180 successful breeding pairs by 2001.” With the IP now 10-fold above the original goal, and restoration objectives largely achieved, the focus of this updated plan is on

maintaining a self-sustaining IP, allowing for range expansion to historical locations where suitable habitat exists and conflicts to existing waterfowl management programs and activities do not arise, and outlining management activities that will allow the public to continue to enjoy Trumpeter Swans for generations to come.

The updated IP Management Plan features management actions designed to maintain a self-sustaining migratory population with adequate breeding and wintering sites, while minimizing conflicts with other waterfowl management objectives. Additionally, considering the needs of tribal hunting rights in the ceded territories is important. The revised IP Management Plan (hereafter IPMP) endorses the development of monitoring efforts that will produce a population estimate/index to address new opportunities and changing conditions, such as conditions influenced by a changing climate. This revised IPMP establishes a framework for addressing emerging key issues and provides guidelines for the short-term and long-term management of the IP.

The revised IPMP was prepared by the Swan Committee of the Mississippi Flyway Council, comprised of state representatives from the Game Bird and Nongame Bird Technical Sections, co-written with Dr. David Wolfson, United States Fish and Wildlife Service, and with additional input from the Central Flyway, Atlantic Flyway, The Trumpeter Swan Society, and Trumpeter Swan Conservation Ontario.

Section 1 – Historical Population, Range and Restoration Efforts to Establish the Interior Population of Trumpeter Swans

Pre-reintroduction history

Trumpeter Swans were historically widespread across North America (Banko 1960; Bellrose 1976). Although historical records mostly consist of anecdotal accounts from hunting reports, fur traders and explorers records, and naturalist field-notes, there is sufficient evidence to suggest that their breeding range previously extended from Alaska eastward through Canada to James Bay; as far south as Indiana, Missouri, and Nebraska; and west to Oregon and Washington (Banko 1960; Schorger 1964; Alison 1975; Lumsden 1984; Bent 1987). The historical wintering range is less certain but is speculated to extend south to California in the western U.S., the central Mississippi River Valley and the Ohio River Valley, and east to the Atlantic seaboard in the eastern U.S. (Banko 1960; Scott 1972; Bellrose 1976).

Due to unregulated market hunting and commercial harvest for meat, skins and quills from the late 18th to the early 20th century, Trumpeter Swans were nearly extirpated

across their range (Banko 1960; Houston et al. 1997). According to Banko and Mackay (1964), 108,000 swan skins were sold by the Hudson Bay Company in London during 1823–1880; the majority of these likely were Trumpeter Swans. By 1900, only three isolated remnant breeding populations remained, with most swans in Alaska and smaller populations in Alberta and the Tri-State area (i.e., at the confluence of Montana, Idaho, and Wyoming; Banko 1960; Hansen 1971; Gale et al. 1987). The population within the contiguous United States reached a historical low of only 69 individuals in 1933. To protect the remaining flock, the Red Rock Lakes Migratory Waterfowl Refuge was established in 1935 (later renamed Red Rock Lakes National Wildlife Refuge [RRLNWR] in 1961; Shea et al. 2002).

The flock at RRLNWR persisted due to protection from hunting and the presence of ice-free open water throughout the winter from geothermal activity in the area (Banko 1960). In 1946, a small flock of Trumpeter Swans breeding in the Grande Prairie Region along the Alberta-British Columbia border was discovered via aerial surveys, and banding studies revealed that this group joined the resident flock in RRLNWR each year to overwinter in the Tri-State Area.

In the 1950s, aerial surveys and subsequent field investigations in Alaska documented the existence of the Pacific Coast Population (PCP), a substantial breeding population of Trumpeter Swans (> 3,000 individuals) that wintered throughout British Columbia, Washington, and Oregon (Hansen et al. 1971). This population was, at the time, the only known segment of Trumpeter Swans with a healthy and increasing population trajectory.

Early IP Reintroduction Efforts

Most early attempts to reintroduce IP Trumpeter Swans to their historical breeding range in the Midwest United States struggled to maintain and increase breeding pairs and often were not successful. In 1954, there was an effort to establish a local breeding flock of Trumpeter Swans at Delta Waterfowl Research Station in Manitoba (Banko 1960; Nelson 1997). They maintained captive breeding pairs, but efforts to raise broods were not successful. By 1972–1973, three pairs were reported but they eventually became unaccounted for, and the restoration efforts were discontinued.

By 1960, Trumpeter Swan abundance at RRLNWR was at sufficient levels for managers to translocate individuals to zoos, private breeders, and for reintroductions in the former breeding range (Shea et al. 2002). The first successful reintroduction to former IP breeding range was the transfer of 57 Trumpeter Swan cygnets from RRLNWR to Lacreek National Wildlife Refuge in South Dakota during 1960–1962 (Monnie 1966). The unique geology of the Sandhills area in southwestern South Dakota and adjacent Nebraska contributed to the persistence of Trumpeter Swans because the underground aquifer feeds

an extensive stream network that flows year-round and supports submergent wetland vegetation that provides food for over-wintering Trumpeter Swans (Schneider et al. 2011). Although the number of individuals used in this reintroduction effort was relatively low, the abundance of the subpopulation, known as the High Plains flock, has gradually increased over time, and Trumpeter Swans are now common across the greater Sandhills area of north-central Nebraska (Vrtiska and Comeau 2009). Though there have been reports of High Plains Trumpeter Swans from as far away as Oklahoma, Arkansas, and Illinois, individual-based tracking studies suggest long-distance migratory behaviors are rare, and the High Plains flock is considered to be a relatively isolated component of the greater IP (Kraft 1997; Vrtiska et al. 2024a).

In 1966, managers from Hennepin Parks (later renamed Three Rivers Park District) in Minnesota initiated the next reintroduction effort for the IP, relocating a pair of adults and 40 sub-adult Trumpeter Swans from RRLNWR to the Minnesota park system over the course of several years (Hansen 1973; Linck 2015). Due to high mortality from shooting, disease, lead poisoning, and power line collisions, the reintroduced flock did not thrive. By 1980, there were only 34 individuals, despite a captive breeding program to supplement the low levels of natural breeding. Another unsuccessful reintroduction effort took place during 1982–1987; approximately 35 swans were moved from the Lacreek flock to Mingo National Wildlife Refuge or nearby locations in southeastern Missouri (Kraft 1991). Many reintroduced swans died shortly after translocation, and although predation was ultimately the cause of death, biologists reported that stress related to the transfers was the primary factor leading to death by predation (Smith 1986; 1988). Eventually, struggles with limited breeding and high mortality prevented the success of this effort (Kraft 1991).

Region-specific Reintroduction and Monitoring Efforts

The 1980s marked a turning point in IP restoration as many states and provinces established formal reintroduction programs. The first groups were the Minnesota Department of Natural Resources (DNR) and the Ministry of Natural Resources in Ontario, both of which began reintroduction programs in 1982, followed by the Michigan DNR in 1986, the Wisconsin DNR in 1987, the Iowa DNR in 1993, and the Ohio DNR in 1996.

Starting in 1986, permission was granted to collect eggs from wild Trumpeter Swans in Alaska, which provided more individuals for translocation than those through captive breeding and relocations from RRLNWR. Most of the eggs taken from the Minto Flats area of Alaska were hatched at cooperating avicultural facilities, and cygnets were raised until either 1 or 2 years-old (except many Wisconsin cygnets that had imprinted on life-size decoys at the Milwaukee County Zoo, then were transferred at about 1 week of age to wildlife areas and allowed to fly free when they reached fledging age), and then released at IP reintroduction sites. Minnesota, Michigan, and Wisconsin were the first states to collect eggs, taking 639 Alaskan eggs from 1986–1997, of which they released 297 swans on the

landscape (Johnson 2000). During the 1990s, Ontario, Iowa, and Ohio also collected Alaskan eggs, taking 230 eggs and releasing 123 swans.

For additional information on Interior Population Trumpeter Swan reintroduction and monitoring efforts in specific states and provinces within the IP please refer to Appendix A.

Interior Population Abundance and Trends

The main approach to quantifying trends in IP abundance has been the North American Trumpeter Swan Survey (NATSS), a cooperative range-wide survey to monitor the status of Trumpeter Swans in North America (Groves 2017). The NATSS was established in 1968 and was conducted every five years from 1975 through the last occurrence in 2015 by a partnership of federal, state, and provincial agencies across the United States and Canada (Groves 2017; Vrtiska et al. 2024b). The objectives of the NATSS were to estimate the abundance, productivity, and distribution of Trumpeter Swans in late summer–early fall for the three populations of Trumpeter Swans in North America (Figure 1).

Trumpeter Swan restoration efforts in the Upper Midwest and Canada during the past four decades have led to a dramatic increase in IP Trumpeter Swan abundance, with a substantial increase in abundance recorded by the last two quinquennial surveys (Table 2; Table 3). The 2015 IP white swan (i.e., breeding pairs, mature nonbreeders, and subadults) estimate reached 27,055, nearly a four-fold increase over the 2010 estimate of 7,154. The Mississippi and Atlantic Flyways flock accounted for most of the growth, from 6,770 in 2010 to 26,591 in 2015. The average annual growth rate of white swans in the IP was +14.4% during 1968–2015 (Groves 2017). The growth rate increased substantially in the 1980s, when swan restoration programs became established and annual releases of captive bred birds supplemented the Mississippi and Atlantic Flyways flocks with additional translocations (Figure 2). Although most of the IP restoration programs ended by the first decade of the 2000s, the Iowa DNR continued to release swans, including 1,218 cygnet and subadult swans between 1994–2022 (D. Hoffman pers. Comm; see Appendix A).

The High Plains flock, which was only briefly augmented by releases in the early stages of IP reintroductions, increased an average of 5.0% per year during 1968–2015. The High Plains flock also increased between 2010 (384 white swans) and 2015 (464 white swans). The 2010 and 2015 High Plains counts were minimum estimates, because only one small area in the Canadian portion of the High Plains range was surveyed. This area, Riding Mountain National Park in Manitoba, hosted 97 white swans in 2015, 185% more than were observed there in 2010 (Groves 2017). The supplemented Mississippi and Atlantic Flyways flocks, in contrast, increased 23.5% annually during 1980–2015.

Continentially, the 2015 NATSS estimate of white swans was 63,016, substantially higher than the 2010 estimate (34,249), and it was the highest estimate since surveys began in 1968. North American survey results during 1968–2015 show that the number of white swans increased continually throughout the 47-year period, at an estimated average rate of 14.4% per year. Because survey methods changed substantially in Minnesota, Wisconsin, and Michigan in 2015, however, the 2010 and 2015 estimates are not directly comparable. Nevertheless, a major increase in abundance very likely occurred during the period between those surveys.

Due to logistical difficulties related to COVID-19 (e.g., travel restrictions), the 2020 NATSS was canceled. Additionally, the increased distribution of Trumpeter Swans across the continent had increased the cost of monitoring, and there was a belief that NATSS was not critical to inform management decisions; therefore, the NATSS Steering Committee recommended in January 2020 that the survey be discontinued indefinitely (Vrtiska et al. 2024b). Suggested proposals for alternative methods to monitor Trumpeter Swan status have included: 1) the Waterfowl Breeding Population and Habitat Survey (WBPHS); 2) the Mid-Winter Waterfowl Survey; 3) the Breeding Bird Survey (BBS); 4) the Christmas Bird Count (CBC); and 5) Cornell Lab of Ornithology eBird Database (Vrtiska et al. 2024b; Figure 3; Table 5). Vrtiska et al. (2024b) also suggested a variety of alternative tools tailored to specific objectives. For example, to document breeding range expansion, a combination of citizen science reporting (e.g., eBird, Trumpeter Watch) and the WBPHS may be sufficient (The Trumpeter Swan Society 2024).

Vrtiska et al. (2024b) also suggested using Bayesian integrated population models (IPMs) to estimate Trumpeter Swan demographic parameters by systematically monitoring adult/cygnets ratios during the post-breeding period. Bianchini and Tozer (2023) found that multiple survey efforts including the Great Lakes Marsh Monitoring Program (delivered by Birds Canada), the Breeding Bird Survey, and eBird all found similar abundance trends in Trumpeter Swans in southern Ontario.

The Iowa DNR banded cygnets and GPS-collared flightless adults from 12 Trumpeter Swan family groups during August–September 2020 and used tracking data from each adult to monitor each family group (a total of 40 cygnets) over the subsequent four months to document survival trends. Data from this monitoring effort contributed to a better understanding of Iowa cygnet survival rates. Cormack-Jolly-Seber models provided weekly cygnet survival rate estimates of $\phi=0.98$ (95% CI: 0.96–0.99) and an overall winter period (21 Sep to 28 Feb) survival rate estimate of $\phi=0.78$ (95% CI: 0.61–0.89). These data will help parameterize an integrated population model for the Iowa population (DNR and Iowa State University, Anna Buckardt Thomas, pers. comm.).

An IPM focusing on southern Ontario (Brook et al. 2025) provided vital rate estimates and predicted growth rates leading to a doubling of the population every 5 years. In

Minnesota, researchers are in the initial stages of constructing an IPM covering the majority of the IP breeding range (David Wolfson, pers. comm.).

Section 2 – Interior Population Trumpeter Swan Summer/Breeding Status and Ecology

Breeding Status and Distribution

The core portion of the IP, referred to as the Mississippi and Atlantic Flyway flock, currently breeds throughout most of the western Great Lakes region, including Iowa, Manitoba, Michigan, Minnesota, Ohio, Ontario, and Wisconsin (Figures 1 & 4). The High Plains flock, a segment of the IP considered to be isolated from the rest of the population, breeds in the Sandhills region of southwestern South Dakota and northern Nebraska (Comeau and Vrtiska 2012). As the IP breeding distribution has expanded over time, records of breeding Trumpeter Swans have been reported more frequently in eastern North and South Dakota, western Pennsylvania, and upstate New York (Sherony and Bolsinger 2007; Fisher 2017).

Although primarily designed to assess trends in population abundance of Trumpeter Swans, the NATSS also provided useful information on the distribution of breeding Trumpeter Swans, although such information is limited to the geographic distribution of survey flights. Information from the NATSS complemented other survey information from two additional sources: 1) the Waterfowl Breeding Population and Habitat Survey (WBPHS), also referred to as BPOP or the May Survey, conducted by the U.S. Fish and Wildlife Service and the Canadian Wildlife Service, which covers potential IP breeding range in Manitoba and Ontario, and 2) Spring breeding waterfowl surveys conducted by the Wisconsin DNR, Michigan DNR, and Minnesota DNR that cover IP breeding range in those states (Table 4) and the Canadian Wildlife Service that covers much of the breeding range in Ontario. One difference between the May Surveys and the NATSS is that the NATSS was specifically designed to capture information on Trumpeter Swans, whereas the BPOP surveys are a more general survey designed to track trends in all waterfowl species with a focus on ducks and geese rather than swans.

Despite the relative success of the reintroduction of IP Trumpeter Swans, major gaps remain in the knowledge of IP distribution, especially as certain portions of the population rapidly expand. During more intensive periods of state reintroductions (e.g., 1990s, 2000s), a relatively high proportion of wild Trumpeter Swans were reintroduced and marked at the time of release with auxiliary information such as colored neck bands or patagial tags. These auxiliary markers facilitated the resighting of specific individuals that could be tracked throughout their lifetimes. Using such resighting efforts, states and provinces had the potential to monitor movements, site fidelity, and population dynamics.

Citizens contributed resighting information to the USGS Breeding Bird Laboratory (BBL), the Trumpeter Swan Society's Trumpeter Watch program, and the Ontario Trumpeter Swan Restoration Group sighting program. The proportion of the IP, however, that is marked with auxiliary tags decreases each year and is now relatively minimal. Widespread resighting at the current distribution levels would necessitate large efforts, and many swans don't spend sufficient time close to people to facilitate their resighting, with the exception of southern Ontario; therefore, the potential for resighting tagged individuals to inform analyses based on vital rates is diminishing (but see Brook et al. 2025). Additionally, unlike data submitted to the BBL, observations submitted to the Trumpeter Watch program before 2018 were not consistently maintained (M. Smith, pers. comm.) and current submissions are not in standardized data formats, thereby limiting their use for research and monitoring efforts. Trumpeter Swan Conservation Ontario (the non-profit group that succeeded the Ontario Trumpeter Swan Restoration Group) has an extensive database of over 100,000 sightings of over 2,400 individually-coded patagial tagged Ontario swans, which is curated by volunteers and incorporates all data received from citizens in a standardized format (Brook et al. 2025, K. F. Abraham, pers. comm.),

Although the reduced prevalence of tagged individuals limits opportunities for individual-based resighting, efforts such as eBird and state/provincial Breeding Bird Atlases continue to provide valuable occurrence data of Trumpeter Swans to fill gaps in knowledge of range. For example, in eBird, a relative abundance and range map from 2009 – 2023 data (Fink et al. 2024) and change in relative abundance trends from 2011 – 2021 (Fink et al. 2023) are publicly available. In late 2025, recent Breeding Bird Atlases are nearing completion in New York, Ontario, and Wisconsin and one is in progress in Pennsylvania. All of these atlases also contribute data to eBird, and the expanded coverage of remote areas provided by the atlases helps to document Trumpeter Swans in new areas. Particularly for states/provinces on the edge of the IP breeding range (New York, Pennsylvania, Ontario), these efforts are essential to documenting the expansion of the IP.

An alternative to resighting-based approaches is to directly track individuals via telemetry transmitters. The first project involving IP Trumpeter Swans individually tracked with satellite telemetry occurred in 1999, when 10 Trumpeter Swans in Wisconsin were fitted with neck collars mounted with battery-powered Platform Transmitting Terminal (PTT) transmitters (Diebold et al. 2008). Diebold et al. (2008) tracked 10 Trumpeters Swans the first year and six the following year, finding that approximately 66% of the tracked individuals migrated to southern Illinois during the winter, while some stayed in northern Wisconsin throughout the year. Vrtiska et al. (2024a) fit 38 High Plains Trumpeter Swans with PTT transmitters from 2014 to 2018, although their objective was to quantify winter movements and fidelity of Trumpeter Swans in the Nebraska Sandhills instead of describing movements throughout the annual cycle.

The next major IP tracking project began in 2019. GPS-GSM transmitters were deployed across the majority of the IP breeding range. Capture locations included breeding sites in Manitoba, Minnesota, Wisconsin, Iowa, Michigan, and Ohio, nearly the complete breeding range with the exception of Ontario. Wolfson et al. (2024) tracked 125 breeding Trumpeter Swans across 252 annual cycles. The study, however, was not designed to add knowledge of the IP breeding range distribution, but instead to focus on Trumpeter Swan movements during the nonbreeding period.

As the IP Trumpeter Swan breeding distribution has increased over the last 10–20 years, some agencies have attempted to document these increases via supplemental aerial surveys that cover areas not already covered by the quinquennial NATSS or annual state/provincial surveys. Examples include surveys conducted by Ontario Ministry of Natural Resources and Forestry, Canadian Wildlife Service and U.S. Fish and Wildlife Service staff in northwestern Ontario in 2015 (Badzinski and Earsom 2015) and by Minnesota DNR staff in northeastern Minnesota in 2015 and 2022 (Herwig and Giudice 2015, Herberg and Rettler 2022). These efforts may be better suited than individual-based tracking studies to complement annual efforts such as state waterfowl breeding population surveys and increase knowledge of IP breeding range.

Research conducted in Alaska on PCP Trumpeter Swans found that occupancy was positively related to season length (defined as the length of ice-free days), which was consistent with the northward expansion of PCP breeding range during 1968–2005 (Schmidt et al. 2011). If trends are similar for IP Trumpeter Swans, climate change may extend the breeding range northward, potentially expanding the breeding range into less-developed areas. The potential for northward expansion is already evident in Ontario where Trumpeter Swans are increasingly reported in summer from the far northern parts of the province including the Hudson Bay Lowlands (S. Badzinski, pers. comm.) and where breeding records have been reported in Breeding Bird Atlas programs (Lumsden 2007b). Trumpeter Swans breeding at the northern range of their distribution are thought to be limited by needing approximately 145–150 days of ice-free conditions to successfully nest and produce fledged young (Hansen et al. 1971). A northward shift of IP Trumpeter Swan breeding range, however, may lead to competition with species already present on breeding grounds farther north, including Tundra Swans (*Cygnus columbianus*) in the Hudson Bay Lowlands. In addition to direct resource competition, increasing species overlap would result in monitoring and management challenges due to difficulty in field identification and conflicting species management goals.

To estimate future breeding distribution of the IP, researchers from the U.S. Fish and Wildlife Habitat and Population Evaluation Team (HAPET), University of Minnesota, and Minnesota Cooperative Fish and Wildlife Research Unit are quantifying the projected rates of range expansion in IP Trumpeter Swans. They used GPS telemetry data from Wolfson et al. (2024) and remotely sensed landscape environmental data to create a habitat suitability

model for IP Trumpeter Swans. They then combined the output of that habitat suitability model with structured (BBS) and unstructured occurrence data (eBird, iNaturalist) to inform a spatially explicit range expansion model for IP Trumpeter Swan distribution. They estimated that during 2023–2033, the IP breeding range will have an annual expansion rate of 4.4% (95% CI: 2.0–6.9%), with expansion occurring in the Prairie Pothole Region of the Dakotas and the Boreal Shield and James Bay Lowlands of Canada (Barnes et al. 2025).

Breeding Ecology

Suitable habitats for breeding territories include shallow lakes, ponds, and wetlands (<1.2m depth) with abundant submerged aquatic vegetation (some examples include *Chara* and *Potamogeton* species, and *Zizania palustris*; Hansen et al. 1971; Owen and Kear 1972; Mitchell and Eichholz 2020). Other beneficial characteristics include limited human disturbance, and habitat features such as muskrat or beaver structures that can be used as nesting substrates, sufficient open water areas for adults to use as runways for taking flight, irregular shoreline and tall emergent vegetation to serve as protective cover from predators, and a diverse collection of aquatic plants for foraging (Mitchell and Eichholz 2020).

Additionally, sites without a history of hunting and fishing may have a lower risk for lead poisoning (associated with spent lead shot and lost fishing tackle), and those sites far from power lines and fences reduce the risk of mortality and injury from collisions. Trumpeter Swans are also capable of adapting to areas with a high degree of anthropogenic influence, and have been observed nesting in golf courses (L. Kearns, pers. comm.).

Mitchell and Eichholz (2020) summarized that Trumpeter Swan breeding season territoriality ranges widely from 1.5 to >100 ha. Interestingly, in a comparative analysis of space-use by GPS-collared IP Trumpeter Swans, Barnes et al. (2025) found that paired swans (i.e., those with a partner, but without cygnets at the time of capture) had home-range estimates during the breeding season approximately twice the size of those of successful breeders (i.e., pairs with cygnets present at the time of GPS-collaring). However, more research is needed to understand the wide range of variation in breeding swan territories and home ranges.

Section 3 - Interior Population Trumpeter Swan Fall Migration

Across all three populations in North America, Trumpeter Swans exhibit a variety of movement strategies that range from local movements to long distance seasonal movements often traveling to areas with open water (i.e., without persistent ice formation) and sufficient food resources (Banko 1960; Hansen et al. 1971). Additionally, for species such as Trumpeter Swans that are long-lived and provide care for their young during their

first year of life, migratory habits are thought to be heavily influenced by the cultural transmission of information between generations. This inherent flexibility to be able to respond to local environmental conditions, coupled with the relatively short period of migratory traditions since the establishment of IP restoration programs, likely contributes to the current levels of high variability in IP migration strategies during the nonbreeding season (Wolfson et al. 2024).

The prevalence of long-distance migration in the IP is reportedly increasing, although empirical studies involving resighting of marked swans or individual tracking with telemetry are relatively rare (Mitchell and Eichholz 2020). Babineau and Holm (2004) examined resighting data during 1985–2001 in Illinois and found that wintering sites were increasingly being used by swans breeding farther north. Some of the uncertainty in understanding population-wide migration habits stems from long-term supplemental feeding, especially during the early periods of IP reintroduction. Varner and Eichholz (2012) asserted that by 2005, 90% of IP swans traveled only short distance during the winter to supplemental feeding areas, and that only 10% of the population migrated longer distances to areas with adequate open water and forage occur. Many of these supplemental feeding programs have since been discontinued.

Handrigan et al. (2016), using resighting data of reintroduced IP swans in southern Ontario during 1982–2010, found that most swan breeding and wintering areas were close to release sites (median migration distance = 4.6 km), and that 40% of swans were non-migratory (although their definition of migratory doesn't necessarily conform to definitions used in other studies). Of those swans that were leaving southern Ontario during the winter, Lumsden (2007a) documented resightings throughout the Mid-Atlantic States, though it was unclear what portion of the south-central Ontario flock those birds represented. Although Wolfson et al. (2024) didn't collar Trumpeter Swans in Ontario or the High Plains flock, the sample of marked swans in their study had relatively good coverage throughout the rest of the IP breeding range and included 125 GPS-collared individuals that provided individual tracking data during 2019–2023. They found that 59% of swans moved to distant nonbreeding period areas (long-distance migration, defined as moving >100 km from the breeding site), 16% exhibited regional migration (25–100 km from the breeding site), 19% exhibited nonmigratory but local movements (<25 km from the breeding site), and 6% exhibited multiple migration strategies between years.

Migratory strategies and nonbreeding period movements, however, had high variability between different regions of the IP. In some parts of the IP such as Manitoba and Wisconsin, almost all individuals made relatively long-distance movements south during the fall. In Ohio and Michigan, almost no individuals made long-distance movements (with the exception of some swans moving from the Upper Peninsula to the Lower Peninsula of Michigan). In Minnesota and Iowa, there was a relatively even mixture of migratory strategies. Some of this variation can be attributed to environmental conditions, such as

water bodies in Manitoba having almost complete ice formation, whereas many Ohio water bodies are ice-free all winter. In areas such as northern Michigan, central Minnesota, and northern Iowa, many individuals had regional migrations, relocating to a large river, lakes with aerators, or gravel quarries; all places that likely also remained ice-free most of the winter.

The timing of departure of Trumpeter Swans from breeding areas during the fall is variable and corresponds to environmental conditions, as swans depart their territories when ice forms on shallow lakes and wetlands. The overall average fall departure date of IP swans from breeding grounds during 2019–2023 (Wolfson et al. 2024), in which the swan then made long-distance movement >100 km, was 7 November with a standard deviation of 25 days, though departures ranged from September to December. The yearly averages for this period (2019–2023) ranged from 31 October to 17 November, with yearly standard deviations varying from 7–28 days. Overall, most fall departures of individuals that traveled >100 km from their breeding/summering areas occurred near the beginning of November.

Using a linear mixed effects model with fall departure as the response variable, Wolfson et al. (2024) found that sex was not a statistically significant predictor of fall departure by long-distance migrants, but that breeding status and breeding/capture latitude were significant predictors. Swans that underwent migration >100 km left, on average, four days earlier (95% CI: -6.3 to -1.8) for every increase of 1° of breeding latitude (corresponding to ~111 km), and the average departure date for breeding swans (those with cygnets at the time of capture) was 18 days later than nonbreeders (95% CI: 2.9–33.9).

Some important staging areas during IP fall migration are the Minnesota Valley National Wildlife Refuge in Minnesota, Loess Bluffs National Wildlife Refuge and Riverlands Migratory Bird Sanctuary in Missouri, the St. Croix River that defines a portion of the border between Minnesota and Wisconsin, and the entire Mississippi River corridor along the western edge of Illinois and the central Illinois River Valley (Mitchell and Eichholz 2020).

Section 4 – Interior Population Trumpeter Swan Wintering Behavior and Ecology

The nonbreeding season may represent the most physiologically challenging period of the year for many avian species, with competition for limited food resources potentially influencing mortality risk and migration strategies (Newton 2006). During the early years of IP reintroductions, managers were concerned that Trumpeter Swans would experience high mortality during the winter due to the potential for lead poisoning and other fatal accidents associated with long-distance movement (Subcommittee on the Interior Population of Trumpeter Swans 1998). Therefore, managers and volunteer-run advocacy groups provided supplemental food for wintering swans at a number of sites including

Lacreek NWR in South Dakota; Fergus Falls, Monticello, and Hennepin Parks in Minnesota; and Wye Marsh, LaSalle Park and other sites along the northern shore of Lake Ontario, and the Metro Zoo in Ontario (Ad hoc Committee 1998; Lumsden et al. 2020).

At the time of the first IP management plan, authors estimated that >80% of the >900 IP swans were receiving supplemental food during the winter (Ad hoc Committee 1998). By 2007, 1,200 pounds of corn were being distributed each day in Monticello, Minnesota, to >1,000 Trumpeter Swans (Lawrence 1997). Although supplemental feeding has since been discontinued by some agencies, non-profit advocacy groups and private individuals still currently feed large numbers of IP swans throughout the winter (M. Smith pers. comm.; K. Abraham pers. comm.).

Managers and private individuals also installed lake aerators to maintain open water during periods of sub-freezing winter temperatures at locations including Hennepin Parks properties and Wye Marsh, an overwintering area for some IP swans in Ontario. Other major overwintering areas at northern latitudes include areas that maintain open water for other reasons, such as just below the outflow of dams (e.g., the Otter Tail River near Fergus Falls, Minnesota and along the North Platte River in Nebraska), and the Monticello, Minnesota site downstream of a large power plant that releases warm effluent thereby maintaining ice-free conditions on the Mississippi River all winter except in the occasion of severe weather events (Slater 2006). Other adaptations to anthropogenic environments across the IP range include the winter use of quarry lakes and gravel ponds, often in proximity to fields with post-harvest grain that is used as a food source.

Although prior human interventions (supplemental feeding and lake aeration) were considered necessary to stabilize and support early stages of IP reintroductions, they have always been somewhat controversial, and there have always been concerns about their effects on IP annual movements and the ability for the newly reintroduced population to establish migratory traditions (Gillette 1997; Linck 1997; Gillette and Linck, 2004; Slater 2006). In more recent years, there is also increasing concern about high densities of swans at supplemental feeding sites being more susceptible to large mortality events from disease outbreaks. Supplemental feedings may also increase the probability of and affinity to non-migratory behavior of IP Tundra Swans, with year-round herbivory of native vegetation has the potential to impact wetland plant communities negatively.

To test the assumption that supplemental feeding of swans in ice-free areas increases annual survival, Varner and Eichholz (2011) compared survival rates of IP Trumpeter Swans that had either short-distance (~100–150 km) or longer-distance (~700 km) migration patterns using 576 encounter histories of swans breeding in Wisconsin that were marked with neckbands. They found that swans that flew to southern Illinois instead of remaining on wintering sites in Monticello, Minnesota (along the Mississippi River) and Hudson, Wisconsin (along the St. Croix River), had higher survival rates; therefore,

concerns about high mortality during migration and lack of wintering areas were not supported by their results.

Movements during the nonbreeding period and the choice of overwintering areas can also have substantial impacts on the overall mixing and genetic health of a waterfowl population. Unlike other avian species, which typically have pair formation on the breeding grounds, most waterfowl form breeding pairs while on the wintering grounds (Robertson and Cooke 1999). Swans, like other waterfowl, have been documented to have high rates of winter philopatry, meaning the wintering areas they visit (and therefore the migratory strategy) early in life will likely be repeatedly visited in subsequent years (Rees 1987; Vrtiska et al. 2024a). Therefore, in addition to implications for population demographics, gene flow, and genetic structure, high winter philopatry in IP Trumpeter Swans may exacerbate ‘sedentary’ migration strategies and delay the ability of the population to establish long-distance migration, because residents and migrants overwinter in different areas and don’t form pair bonds with those in the other group.

Despite the importance of quantifying IP Trumpeter Swan wintering and migration patterns, only a few studies have provided information on these topics. Additionally, the term ‘migration’ or ‘long-distance migration’ lacks consistent definition, making it harder to generalize results among studies. Lumsden (2007) found that among 703 Trumpeter Swans (age 4 years or older) wing-tagged in Ontario between 1982 – 2005, only 43 (6%) traveled ~150 km between Wye Marsh (where supplemental feeding and lake aeration occurs year-round) and the north shore of Lake Ontario (where supplemental feeding occurs only in the winter). Only four were considered ‘true migrants’, using the definition of a return movement between specific breeding and wintering grounds (however, the component of distance was not considered). Handrigan et al. (2016) next evaluated the status of Ontario IP Trumpeter Swan migration, using resighting data from 1982–2010, approximately the period of captive-reared releases in Ontario (1998 – 2007). They found that most swan wintering locations were close to release sites, with 40% of individuals remaining at the same site during the breeding and wintering periods, and a median ‘migration’ distance of 4.6 km (Handrigan et al. 2016).

The High Plains flock of Trumpeter Swans, a small but numerically stable subpopulation of the IP since its reintroduction in the 1960s (Table 4), is geographically and genetically (Wolfson 2024) isolated from the rest of the IP, based on relatively scant information from a small number of marked individuals and low reporting rates. The High Plains flock differs from the rest of the IP in that much of their range has low human population densities and the High Plains Aquifer feeds springs that naturally maintain unfrozen rivers and creeks throughout the winter (Novacek 1989). To quantify the winter movement and fidelity of Trumpeter Swans in the Nebraska Sandhills, Vrtiska et al. (2024a) fit 38 Trumpeter Swans in the High Plains flock with PTT transmitters during the summer molting period during 2014–2018. Transmitters provided telemetry data for one wintering

period for 11 swans (mortality or loss of signal after first year) and data for at least two wintering periods for 16 swans. Marked High Plains swans had minimal movements during the wintering period, with only one swan leaving Nebraska and a mean distance between breeding area and wintering complex of 53.4 (\pm 52.7) km. Winter fidelity to a larger wetland complex was high (proportion returning = 0.72), although swans often made shorter movements to different areas within their primary complex throughout the winter. Rivers and creeks with open (i.e., unfrozen) water provided important wintering habitat for swans in this flock, a trend also observed among other IP Trumpeter Swans in the Upper Midwest states (Wolfson et al. 2024).

It is currently not clear what drivers influence IP Trumpeter Swan movement during the nonbreeding period or what factors lead an individual to choose one wintering area over another. For example, although it is widely presumed that Trumpeter Swans relocate from breeding territories during the winter to find areas with open water and food, it is unclear why some individuals travel as far as Heber Springs, Arkansas, each year when such a decision likely entails skipping over other suitable wintering areas farther north. Tagged swans in the Wolfson et al. (2024) study separated into two divergent groups in terms of their migration strategy. A latent state model assuming different functional relationships between breeding latitude and migration extent (i.e., maximum distance traveled from the breeding period throughout the year) indicated that one group of Trumpeter Swans had a consistent, linear relationship between latitude and distance traveled, and another group of tagged swans exhibited very short-distance movements at lower latitudes with a nonlinear trend in movement distances at higher breeding latitudes (Wolfson et al. 2024).

As IP abundance continues to increase, swans will either require alternative habitat during the nonbreeding season or will occupy nonbreeding season habitat at higher densities. Therefore, delineating the extent, types, and quality of nonbreeding season habitat (while also considering how behavior such as field-feeding may influence habitat availability and quality) and factors that influence migration distance will be critical information for Trumpeter Swan conservation. Increased IP abundance on wintering areas will result in competition for resources with other migratory waterfowl populations such as Tundra Swans unless additional habitat is created to sustain the growing population.

Section 5 – Interior Population Trumpeter Swan Spring Migration

Although Trumpeter Swans typically have lower feeding and higher sleeping rates during the winter, as soon as temperatures increase towards the end of winter, these activity rates shift, and swans spend more time during the day feeding, likely to improve

body condition in anticipation of spring migration (Gale et al. 1987; Squires and Anderson 1997; Slater 2006).

Starting in February and March (dependent on local conditions), Trumpeter Swans begin to spend more time in nearby fields as the snow melts and forage to accumulate energy stores (Southwell 2002). Lawrence (1999) found that Trumpeter Swans overwintering at Monticello, Minnesota, presumably mostly resident or short-distance migrants, began leaving the site by late February and all swans had left by mid-March. Mitchell and Eichholz (2020) reported that IP long-distance migrants follow similar timing, starting to leave wintering areas by mid-late February and completely leave areas used during the nonbreeding season by the second week of March, with known spring staging areas along the central Illinois River Valley. LaMontagne et al. (2003) investigated pond habitat use by Trumpeter Swans at spring migration stopover areas in southern Alberta during 1999–2000 and found that the most used areas had high food availability (particularly *Potamogeton pectinatus* tubers and rhizomes) and high conductivity (used as an indicator for lake chemistry).

Because Trumpeter Swans arrive on spring staging areas before new macrophyte growth has started for the season, underground storage structures of macrophytes (e.g., tubers and rhizomes) at an attainable depth for foraging (i.e., <1.2 m deep) were critical for Trumpeter Swans foraging on stopover ponds (LaMontagne et al. 2003). Spring migration duration is shorter on average than autumn migration, with Trumpeter Swans arriving on breeding territories just before or at the time of ice breakup, approximately late February to late March in the Upper Midwest (Mitchell and Eichholz 2020).

Trumpeter Swans are one of the first waterfowl species to arrive on their breeding grounds. Banko (1960) found that historical observations indicated that Trumpeter Swans arrived on their northern nesting grounds in Alaska and Canada among the earliest of any migratory Arctic avifauna. The average spring arrival on the previous year's breeding territory for tagged swans that were considered long-distance migrants (i.e., had traveled >100 km from breeding site during the winter and returned within 30 km of the previous year's territory) in the recent Midwest-wide tracking study was 4 March with a standard deviation of 15 days, and yearly averages during the four years of 2020–2023 ranged only between 2 March and 6 March (Wolfson et al. 2024). Summary statistics from this study indicated that breeders returned up to two weeks earlier than nonbreeders; however, after accounting for sex and breeding latitude (which had a significant positive relationship with spring arrival time) in a linear mixed effect model with a random intercept for swan ID, breeding status did not have a significant effect on spring arrival time (Wolfson et al. 2024). On average, Trumpeter Swans that made long-distance migratory movements arrived 3.5 days (95% CI: 2–5) later for every increase of 1° of breeding latitude (Wolfson et al. 2024).

Section 6 – Differences in Behavior and Ecology IP Trumpeter Swan Adults and Subadults

There is relatively little information on differences in movement and behavior between different age groups of IP Trumpeter Swans, which Mitchell and Eichholz (2020) identified as an important information need. Although cygnets are closely associated with parents during their first year of life, it is assumed that after immature Trumpeter Swans spend their first winter with their parents and return to their natal area they disperse, often joining other immature swans and failed breeders on larger wetlands with ample forage (Slater 2006; Mitchell and Eichholz 2020). Anecdotal evidence suggests that, similar to other waterfowl species, subadults are more mobile than adults during the breeding season (Slater 2006; Wolfson unpublished data). Several factors likely contribute to this difference, primarily breeding requirements that tie breeding adults to their territory (i.e., nest construction and incubation, care of flightless cygnets, etc.). Given that there is high variability in movement and migration patterns among IP Trumpeter Swans, it may be helpful to quantify differences between age groups to better understand varying drivers of movement, habitat use, and behavior. Although not specifically focused on differences in movement between adults and subadults, the study by Varner and Eichholz (2012) is one of few to consider both age groups in IP Trumpeter Swans. They used band and neck collar resighting data from 2000–2008 (576 encounter histories) to estimate survival rates for different groups of IP Trumpeter Swans, comparing differences by age, sex, and origin (e.g., from wild or captive sources). At the time of their study, ~90% of IP Trumpeter Swans migrated only short distances to wintering sites where supplemental feeding occurred, an evaluation of which was an objective of their study.

Although many managers thought that supplemental feeding was necessary to keep overwinter survival high, Varner and Eichholz (2012) explicitly tested this theory with resighting data. They found that adult long-distance migrants that were not dependent on supplemental feeding survived as well as short-distance migrants that had access to supplemental food (mortality was 19% in both groups). Sub-adult survival rate was higher for long-distance migrants (mortality was 14% in long-distance migrants but 30% in short-distance migrants).

Section 7 – IP Trumpeter Swan Molt Migration Movement and Behavior

Geese and swans in North America exhibit a ‘Complex Basic Strategy’ molt cycle, including a prebasic molt the first year, and a definitive molt each subsequent year, but no prealternate molt (i.e., no alternate plumage; Pyle 2008). This effectively means that unlike

ducks, geese and swans have a single plumage and molt only once during the annual cycle (Hohman et al. 1992).

The flightless period while molting primaries typically lasts 30–40 days for Trumpeter Swans and occurs from mid-June to mid-August (Hansen 1971; Bellrose 1980; Mitchell and Eichholz 2020) in Trumpeter Swans breeding in northern latitudes. Little information on the length of flightless periods exists for reintroduced temperate-breeding Trumpeter Swans. Nonbreeding individuals typically molt before breeders and often congregate in larger groups that undergo molt at the same time (Hansen et al. 1971; Bellrose 1980; Wolfson unpublished data). Breeding pairs usually molt and are flightless asynchronously, although simultaneous molt in breeding pairs has also been documented (Wolfson unpublished data). Although it is more likely for females to molt before males, some studies provide contrasting evidence, with males reportedly molting first in Ontario (Lumsden 2018) and in some sites in Alaska (Banko 1960; Salomonsen 1968; Hansen et al. 1971). A study of Mute Swans (*Cygnus olor*) in Poland found that in 191 breeding adults, females initiated molt earlier than males (from 20 June to mid-August for females, and mid-July to 1 September for males), and in 735 nonbreeding individuals timing was roughly aligned between sexes (Czapulak 2002). Most Trumpeter Swan research on the timing of molt is from the RMP and PCP, and a better understanding of the phenology of molt (and differences between sexes) is an information need for the IP.

The location of molting sites in Trumpeter Swans also needs further study (Mitchell and Eichholz 2020). Breeding pairs molt directly on the breeding territory, as both parents participate in guarding the young from predators. Nonbreeders often congregate in larger groups, although whether they typically make long-distance northward flights to molt is not well understood (Hansen et al. 1971; Rees et al. 2005). Nonbreeding subadults and failed adult breeders, however, are more likely to travel from their summer territory to a separate molting site, although the frequency and extent of these movements are not well understood (Scott and The Wildfowl Trust 1972). The first published example of a molt migration in Trumpeter Swans was an individual GPS-collared during August in Iowa as a cygnet that spent the following summer (June–August) near Great Slave Lake in the Northwest Territories, Canada (Harms and Dinsmore 2022). Another incidence of potential molt migration was recorded during surveys in the Hudson Bay Lowlands from 2015 – 2024, during which many Trumpeter Swans were observed, and the majority were presumed to be likely non- or pre-breeding individuals (S. Badzinski, unpublished data)

Although the recent Midwest tracking study documented a potential molt migration by a second-year Trumpeter Swan to the Hudson Bay Lowlands, that project focused on capturing adult swans, and only six of 126 GPS-collared individuals were cygnets; therefore, study design prevented robust description of differences in the prevalence of molt migration among different age classes in Trumpeter Swans (Wolfson unpublished data). Of the 126 individuals in that study, however, 73 were breeding adults (i.e., cygnets

present at the time of capture), 23 were adults with mates present but no cygnets present at the time of capture, and 24 were nonbreeding adults captured while in large groups; long-distance molt migration was not a common occurrence for any of these groups of tracked individuals.

Molt migration is thought to have evolved because replacing flight feathers at sites with abundant forage and lower predation risk was hypothesized to confer higher survival rates (Salomonsen 1968; Fox et al. 2014). In a study by Sheaffer et al. (2007), researchers destroyed the nests of late-stage incubating GPS-collared Canada Geese (*Branta canadensis*), expecting that nest destruction would initiate a long-distance northward molt migration. Only about half of the geese made a molt migration after nest destruction, however, with the others remaining within 60 km of their banding site; a result that the authors attributed to the historical origins of these birds from captive-reared sources. Likewise, it may be that many nonbreeding IP Trumpeter Swans remain relatively close to their natal areas because developing a tradition of long-distance molt migration may take considerable time.

Section 8 – IP Trumpeter Swan Genetic Diversity and Influence on Behavior and Ecology

Although genetic considerations are an important aspect of successful wildlife reintroductions, IP reintroductions have been primarily focused on goals such as minimum population abundance and number of breeding pairs (Allendorf and Leary 1986; Ad hoc Drafting Committee for the Interior Population of Trumpeter Swans 1998). During most IP translocations (1980s until early 2000s), genetic techniques were expensive, and technologies were still relatively crude, making genetic testing of Trumpeter Swans logistically infeasible (Ransler et al. 2011). Many translocations during the IP reintroduction, however, had small sample sizes (e.g., High Plains flock, $n=57$; Monnie 1966), which can lead to lower genetic diversity through a higher likelihood of genetic drift (i.e., loss of variation due to random mating) and founder effects (i.e., when a few individuals used to establish a new group only represent a small fraction of the genetic variability of the source population).

Range-wide studies on Trumpeter Swans provide evidence that the entire species may have gone through two separate population bottleneck events: the first likely during the Pleistocene period due to widespread glaciation, and the second during the early 20th century due to overharvest (Oyler-McCance et al. 2007). These bottlenecks resulted in lower overall genetic diversity in Trumpeter Swans compared to other waterfowl species, and the small sample sizes of local translocations to the historical IP breeding range then potentially further reduced genetic variability (Jamieson 2011). Marsolais and White (1997) found that the Ontario flock had less genetic diversity than other groups from the RMP and

PCP. Ransler et al. (2011) found that flocks restored from multiple populations, which includes most of the IP, had higher levels of genetic variation than the High Plains flock, which came from a single source (Tri-State swans from the RMP, Figure 1).

During 2019–2022, Wolfson (2024) and collaborators conducted a contemporary analysis of Trumpeter Swan genetics throughout North America. They collected 147 genetic samples from wild IP Trumpeter Swans throughout their current breeding range (i.e., Minnesota, Wisconsin, Michigan, Iowa, Ohio, and Nebraska) and analyzed those in tandem with 79 archived genetic samples from Trumpeter Swans in the RMP and PCP (i.e., Alaska, Alberta, Idaho, Wyoming, and Washington) collected during 1997–2013 to serve as a reference to IP source populations. Their objectives were to quantify the population structure and genetic diversity and the degree of genetic differentiation among Trumpeter Swan populations in North America. The study used double-digest restriction site-associated reduced-representation DNA (ddRAD) sequencing methods and produced three main findings: 1) the three populations of Trumpeter Swans (i.e., IP, RMP, PCP) and the High Plains flock are genetically distinct groups; 2) genetic differentiation between the IP and its source populations (RMP and PCP) is low, likely due to a diverse mix of reintroduction sources and the relatively recent divergence between source and reintroduced populations (i.e., less time for mutations to occur); and 3) the High Plains flock has lower genetic diversity than the other populations, likely a result of smaller population size, less interbreeding with other groups of Trumpeter Swans due to relative geographic isolation, and potential founder effects due to a one-time reintroduction with relatively few individuals (Wolfson 2024).

The lack of genetic distinctness in the IP versus its source populations was somewhat unexpected; however, given the high number and diverse mix of sources used for reintroductions (e.g., the Iowa reintroduction program used swans from 132 sources and partnerships from 26 different states; Hoffman 2019), any distinct genetic signatures from Minto Flats, Alaska, or RRLNWR have likely attenuated in the current IP gene pool, which has high genetic admixture.

Increased interbreeding between the High Plains flock and other IP Trumpeter Swans will likely alleviate the lowered genetic diversity currently existing in the High Plains flock. Although a recent telemetry-based study by Vrtiska et al. (2024a) revealed a lack of long-distance movement during the nonbreeding period, the overall distribution of the IP is expanding, and current breeding isolation of the High Plains flock may soon be mitigated by expansion from Minnesota, westward through the Dakotas (Fisher et al. 2017; Barnes et al. 2025).

Section 9 – IP Trumpeter Swan Management Issues and Information Needs

Management Issues

Although the reintroduction of the IP is generally considered a success, an increasing swan population also presents new potential management issues. Foremost among these are spatial overlap with Tundra Swans in areas that have swan hunting seasons, potential disease transmission (e.g., highly pathogenic avian influenza H5N1), herbivory of wild rice and other important aquatic vegetation resources, power line collisions, and competition from Mute Swans.

Tundra Swan Hunting

As the geographic distribution of IP swans increases, the potential for range expansion into areas that currently allow hunting of Tundra Swans (e.g., the Dakotas, Virginia, North Carolina, and Delaware) increases as does the occurrence of incidental take of Trumpeter Swans (Barnes et al. 2025). Trumpeter Swan population increases and range expansion on the western edge of the current IP breeding range in the eastern Dakotas, and further to the east within the IP range potentially brings wintering Trumpeter Swans into Virginia, North Carolina and Delaware. Currently, North Dakota and South Dakota hold hunting seasons on Tundra Swans during the fall migration from their arctic breeding areas to nonbreeding areas along the Atlantic coast, and Virginia, North Carolina and Delaware hold Tundra Swan seasons targeting swans during their overwintering period. To anticipate the growing possibility of incidental take of Trumpeter Swans during a Tundra Swan hunting season, the U.S. Fish and Wildlife Service completed a General Swan Hunting Season Environmental Assessment (EA) in 2019 to establish a general framework for establishing hunting regulations for swans given the expansion and growth of Trumpeter Swan populations across the Atlantic, Mississippi, and Central Flyways (U.S. Fish and Wildlife Service 2019). The intent of the EA was not to open a hunting season for Trumpeter Swans, but to provide some legal protections for swan hunters that incidentally harvest a Trumpeter Swan because they are difficult to distinguish from a Tundra Swan and are becoming increasingly abundance. To date, no states within the IP range have implemented a general swan hunt, but predictions by Barnes et al. (2025) indicate this will be something to consider in the immediate future as the IP range expands into jurisdictions that permit tundra swan hunting.

The Pacific Flyway, facing similar conditions involving the mixing of Trumpeter Swans and Tundra Swans, implemented a general swan plan in 1995, and since then their flyway regulations have allowed a limited number of Trumpeter Swans to be lawfully taken

by hunters during hunting seasons established primarily for Tundra Swans (U.S. Fish and Wildlife Service 2019; Trost et al. 2003).

To address such management challenges associated with increasing Trumpeter Swans in the Atlantic Flyway, a management plan was created by the Atlantic Flyway Council Snow Goose, Brant, and Swan Committee and The Trumpeter Swan Society in 2011. The goal of this plan was to manage Trumpeter Swan range expansion into the U.S. portion of the Atlantic Flyway such that it is compatible with existing waterfowl management programs and human activities. The plan highlighted that a small amount of incidental take of Trumpeter Swans was likely and should be acceptable given that population objectives have met and well exceeded stated goals both in distribution and total numbers of breeding pairs. To assess and plan for incidental take, the plan called for the EA, that was ultimately completed in 2019 (U.S. Fish and Wildlife Service 2019).

Wintering Tundra Swan populations in the mid-Atlantic are an important resource for both consumptive (hunting) and non-consumptive purposes. Frewe et al. (2018) evaluated the market and non-market values of North Carolina's Tundra Swans and estimated that individual hunters spent an average of \$408.34 per year, generating an added value between \$306,155 and \$920,161 per year to the state's economy. A significant portion of that estimated added value went to the rural economy of eastern North Carolina where wintering Tundra Swans concentrate. This research highlights the importance of maintaining Tundra Swan populations and both the existing and possible hunting seasons in the Atlantic Flyway. The IP Trumpeter Swan range expansion should remain compatible with this important resource (Atlantic Flyway Council Snow Goose, Brant, and Swan Committee and The Trumpeter Swan Society 2011) and the evaluation in the 2019 EA (U.S. Fish and Wildlife Service 2019) has provided the groundwork to address this.

While increases in IP Trumpeter Swans and range expansions are occurring, migratory birds wintering in mid-Atlantic Flyway states are likely to increase. However, a significant management issue is the establishment of non-migratory flocks and a breeding population due to the potential negative impacts to emergent wetlands and reduced habitat availability and quality for other migratory waterfowl populations (Atlantic Flyway Council Snow Goose, Brant, and Swan Committee and The Trumpeter Swan Society 2011). Hence breeding populations of IP Trumpeter Swans in mid-Atlantic states should be discouraged (Atlantic Flyway Council Snow Goose, Brant, and Swan Committee and The Trumpeter Swan Society 2011).

Disease

As IP abundance increases over time, insufficient overwintering habitat in the southern extent of the range may result in higher swan densities, particularly at existing wintering locations. Such conditions increase the potential threat of transmissible diseases affecting large portions of the population. Waterfowl are considered reservoir

species (i.e., occurrence is widespread and maintained over time) in which low pathogenicity avian influenza (LPAI) is endemic; LPAI is either asymptomatic or produces only minor clinical signs of infection in waterfowl (Olsen et al. 2006; Garamszegi and Møller 2007).

Alternatively, highly pathogenic avian influenza (HPAI) causes illness and mortality in wild waterfowl populations and can be spread via multiple pathways including 1) wild birds to domestic livestock, 2) wild bird to wild bird, and 3) human-based commercial movements of livestock, causing outbreaks in both wild birds and domestic livestock (Gauthier-Clerc et al. 2007; McDuie et al. 2022). HPAI has also been shown to have spillover effects reaching many other species of birds and >200 species of mammals (Peacock et al. 2024). Brown et al. (2008) experimentally infected six species of geese and swans with HPAI subtype H5N1 and found that 100% of Trumpeter Swans exhibited high rates of viral shedding and died within 3–5 days of being exposed to the virus.

The H5N1 strain of HPAI, which has been responsible for past major pandemics (including waterfowl, poultry, and humans) in southeast Asia, developed a particularly virulent new subtype (clade 2.3.4.4b), which reached North America in 2021, and had spread to every continent except Australia by 2024 (Graziosi et al. 2024). There were >33,000 suspected or confirmed detections of H5N1 in the United States between December 2021 and March 2023, and ~1,700 cases in Canada during the same period (Harvey et al. 2023; Canadian Food Inspection Agency Government of Canada 2023). Of the publicly available information on the USDA APHIS online dashboard, only 48 of the H5N1 cases are confirmed to be Trumpeter Swans, of which, 2/3 ($n=31$) were likely from the IP based on the location of the samples collected. Minnesota, however, which contains the largest portion of IP Trumpeter Swans, is the state with the highest number of HPAI detections between 2022 and 2025, and the number of confirmed cases of H5N1 within the IP was likely an underestimate due to limited surveillance and monitoring (USDA APHIS 2025). To minimize further risks from H5N1 outbreaks, Satterfield et al. (2018) recommended that all supplemental feeding, which can artificially increase densities of IP Trumpeter Swans, be immediately discontinued.

Wild Rice and Other Aquatic Vegetation or Crop Depredation

Although swans (Trumpeter and Mute) can have a dramatic impact on submerged-aquatic biomass through their foraging, their impact on wild rice (*Zizania palustris*), an emergent grass species is a growing concern throughout the IP range. Wild rice, which grows in shallow lakes and slow-moving rivers as well as cultivated paddies, is a food source for swans and other waterfowl species and is a commercially important agricultural crop that holds cultural significance for many Native American Tribal communities within the IP breeding range (Porter 2019; McNally 2021; McGilip et al. 2023). Due to its high nutritional content, wild rice, is an important component of the diet of waterfowl in North America (Huseby et al. 2001; Hansen 2008). As the IP population has grown, there have

been increasing depredation conflicts reported for important Tribal wild rice beds and for commercial rice paddies in the Upper Midwest with much of the damage suspected to be caused by molting subadult swans that aggregate during the molting period (T. Cooper USFWS, pers. comm.).

Although targeted research is needed to quantify the effects of herbivory by Trumpeter Swans in general, preliminary evidence suggests swans can damage natural stands of wild rice, particularly during the structurally vulnerable ‘floating leaf’ stage of plant growth (Haramis and Kearns 2007; Hansen 2008; Kjeller et al. 2024). Because there are significant portions of the IP that are essentially non-migratory, herbivory may also occur in localized areas year-round, resulting in degradation of aquatic vegetation resources that are important forage for other existing migratory waterfowl populations (Atlantic Flyway Snow Goose, Brant, and Swan Committee and The Trumpeter Swan Society 2011). Other examples of management challenges due to excess herbivory by non-migratory species include resident Canada geese, and mute swans. Therefore, as Trumpeter Swan abundance increases, localized levels of damage may increase, and to avoid potential loss to wild rice stands, efforts to disperse or remove groups of Trumpeter Swans may be requested.

The DNR launched a study in July 2023 to assess the impacts of Canada Goose and Trumpeter Swan herbivory on wild rice growth. The objectives of the study include measuring how the timing of herbivory during the growing season affects wild rice, whether geese and swans have different impacts, and whether they prefer wild rice over other aquatic plants (Wisconsin DNR 2023). Results, expected in 2026, may inform the most effective sites for wild rice restoration and whether goose and swan abundance, nesting activity, or signs of herbivory might be related to wild rice crop productivity (Wisconsin DNR 2023). Preliminary results suggest that muskrats also may be responsible for wild rice herbivory, so ongoing fieldwork is needed to determine the relative extent of herbivory attributable to swans, geese, and mammals.

Power line Collisions

Trumpeter Swans have large wingspans and heavy bodies, increasing their likelihood of colliding with power lines because they are unable to quickly reroute their flight. Recently fledged cygnets may be more threatened by power line collisions as they learn to fly. Weather conditions such as dense fog and high winds also increase incidence of power line collision across all ages of Trumpeter Swans. Collisions may cause instantaneous fatality, or may injure swans so they cannot fly and do not survive for long. In some cases, swans that collide with power lines can successfully recover and be released if taken to a licensed wildlife rehabilitator. Iowa DNR recorded 186 Trumpeter Swan deaths associated with power line collisions between 1997 and 2021 (A. Buckardt pers. comm.). The majority of reported collisions in Iowa occur between October and December each year, when family groups are dispersing from breeding areas and wintering flocks are

forming (A. Buckardt pers. comm.). A total of 33% of reported swan deaths in Iowa are due to power line collisions (A. Buckardt pers. comm.).

Competition with Mute Swans

Mute Swans, a species native to Eurasia, were introduced to North American city parks, zoos, and private collections during the late 1800s and early 1900s (Baldassarre 2014). After both intentional and accidental releases from these environments, they spread throughout New England, and the Great Lakes and the Mid-Atlantic regions. Specializing in submerged aquatic vegetation (SAV), the diet of Mute Swans broadly overlaps with the diet of Trumpeter Swans and other native waterfowl species, and herbivory from Mute Swans can have considerable impacts on aquatic plant communities (Bailey et al. 2007; Stafford et al. 2012; Guillaume et al. 2013). A single Mute Swan can uproot 20 pounds of SAV and consume eight pounds of SAV each day, and their lack of long-distance seasonal migration further amplifies the foraging pressure that Mute Swans apply on aquatic ecosystems (Allin and Husband 2003; Tatu et al. 2007; Arsnoe and Duffiney 2018). Additionally, Mute Swans can compete with Trumpeter Swans for territories and nest sites and become aggressive towards other waterfowl species and sometimes towards humans due to their strong territoriality (Phillips 2010; Lumsden 2016).

In 1986, the Atlantic Flyway started an aerial Mid-Summer Mute Swan Survey (MSMSS), which was flown every three years, to monitor abundance and population growth rates of Mute Swans (Meyer et al. 2012). Survey results from the MSMSS show that overall abundance of Mute Swans in the Atlantic Flyway increased during 1986–2002 before decreasing during 2002–2011, though regional numbers were more variable, with Ontario abundance steadily increasing during 1986–2011 (Meyer et al. 2012; Davies and Padding 2015). The three most established regions for Mute Swans within the IP breeding range are Michigan, Ontario, and Ohio, although Mute Swan observations regularly occur throughout the IP breeding range (Meyer et al. 2012; ODNR-DOW 2013; Arsnoe and Duffiney 2018).

In Ontario, the Canadian Wildlife Service, which conducts the MSMSS, found that in the lower Great Lakes region, the estimated number of Mute Swans increased from 1,373 in 2002 to 7,951 individuals in 2024 (Badzinski and Wood 2025). The long-term establishment of Mute Swans in southcentral Ontario has also prompted concerns about potential for interbreeding with Trumpeter Swans, which may introduce maladapted variants into the Trumpeter Swan genome (Badzinski and Wood 2025).

In the United States, management efforts to control Mute Swan populations occur on a state-by-state basis and can vary widely based on legal protections and public sentiment; in Canada, Mute Swans remain federally protected under the Migratory Birds Convention Act (Davies and Padding 2015; Environment and Climate Change Canada 2017). Control measures currently allowed in parts of Canada include egg/nest destruction and some small-scale lethal removals, but large-scale lethal removal has not yet been

authorized (Badzinski and Wood 2025). In the United States, the Migratory Bird Treaty Reform Act of 2004 clarified that non-native avian species (i.e., including Mute Swans), are not protected under the original Migratory Bird Treaty Act, and therefore there is not a prohibition on lethal removal (ODNR – DOW 2013). Several states (Ohio, Indiana, Illinois, Michigan, and Wisconsin) and USDA APHIS Wildlife Services have coordinated Mute Swan management efforts via the Great Lakes Mute Swan Summit, which occurred multiple times from 2013 – 2017. Michigan and Ohio each formally created management plans addressing Mute Swan concerns and have seen decreases in Mute Swan numbers following management actions, but some states and provinces in the IP breeding range do not have formal policy documents regarding Mute Swan control efforts (MI DNR 2012; ODNR – DOW 2013; Gehring et al. 2020; Kearns et al. 2024).

Information Needs

While conservation efforts have led to significant recovery in Trumpeter Swans within the Interior Population range, the management of this species faces new complexities as their numbers grow. The information needs outlined in this section were developed to identify the critical knowledge gaps regarding Trumpeter Swan monitoring, movement, habitat use, and population dynamics to inform future conservation strategies.

High Priority

- **Identify the most practical methods for monitoring IP Trumpeter Swan population trends and breeding distribution.**
 - Developing a cost-effective, annual or biennial monitoring regime is essential to track the IP's status in the absence of NATSS.
 - Monitoring efforts are especially needed as well as an annual review of current surveyed areas to document expansion in breeding distribution into areas and jurisdictions that do not currently support breeding Trumpeter Swans.
 - Population monitoring (e.g., Audubon Christmas Bird Count and eBird databases) serving as population indices (that may also index population change without the expense of a dedicated survey) is also needed.
 - Explore the utility of alternative population indices (e.g., Audubon Christmas Bird Count data, eBird, Breeding Bird Survey, Waterfowl Breeding Population and Habitat Survey). These could complement or replace dedicated Trumpeter Swan surveys and could provide continuous data to index population change without the expense of stand-alone surveys.

- **Consider analytical methods to better understand population growth rates and mortality factors for IP Trumpeter Swans.**

- The development of an integrated population model (IPM) for the whole IP would assist in determining variation in vital rates among cohorts (breeding status, sex, age) and projected population growth rate and should remain a priority research tool to help parse natural growth vs. additive losses.
- Complete a Potential Take Limits (PTL) assessment for the IP to better inform managers on what level of take (incidental or purposeful via permits) is sustainable for the population. Additionally, require that the PTL assessment is recalculated on a regular basis or as often as we update the population estimate to ensure accuracy
- **Better quantify the amount and extent of wild rice and other crop damage if caused by Trumpeter Swans and develop best management practices for reducing such damage.**
 - This will inform management responses to depredation complaints and guide habitat management. Ongoing studies will help, but additional work may be needed to separate swan impacts from those of other waterfowl and mammalian sources.
- **Identify the protection and management status of important habitat sites used by Trumpeter Swans during breeding, staging, migration, and wintering.**
 - This comprehensive inventory would allow development of appropriate strategies (land protection, habitat management, policy changes) to maintain those sites' value to the swan population.
- **Investigate incidental take of Trumpeter Swans associated with Tundra Swan hunting seasons.**
 - Investigate the level of incidental take during Tundra Swan hunting seasons that would not impact this plan's goal for stable or increasing IP Trumpeter Swans.
 - Identify strategies to minimize incidental take of Trumpeter Swans where Tundra Swans are currently hunted, and Trumpeter Swans may soon be present as their breeding and wintering ranges expand, while ensuring no negative impacts to existing and future Tundra Swan hunting opportunities.

Medium/Low Priority

- **Quantify the diet and nutritional needs of individuals, particularly during the nonbreeding season.**
 - Do migrants and residents have differences in foraging ecology?
 - What is the prevalence and extent of field-feeding, and is it becoming more common as the IP grows?

- **Quantify the extent of molt migration and other movements of non- and failed breeding Trumpeter Swans throughout the IP and describe any differences in behavior among individuals of different ages, breeding latitude, and breeding status.**
 - Focus on GPS-collaring cygnets and/or 2nd year swans to better understand the prevalence of molt migration in subadults.
- **Investigate whether Trumpeter Swan population growth and range expansion negatively impacts other species or wetland ecosystems, as well as how other species (e.g., Mute Swans) affect Trumpeter Swans.**
- **Develop, evaluate and/or utilize current disease surveillance protocols to monitor the prevalence and impact of diseases and other mortality factors in/on Trumpeter Swans.**
 - This would include avian influenza and other associated pathogens, in Trumpeter Swans, perhaps in conjunction with other efforts to monitor disease in waterfowl and other wild birds.

Interior Population Trumpeter Swan Management Plan Goal, Objectives and Strategies

The goal of this 2026 Management Plan is to maintain a self-sustaining Interior Population of Trumpeter Swans, with recruitment and dispersal levels adequate to recolonize the species historical range where adequate habitat exists, and to provide benefits that meet societal needs and expectations.

Objectives and Management Strategies

1. **Maintain a robust population of IP Trumpeter Swans throughout their present breeding range and allow for expansion into the under-populated or vacant historical range, where conflicts to existing waterfowl management programs do not arise.**
 - Management Strategy - Develop a population index to monitor change in the species status (and to update/establish future population objectives) utilizing the best data available from spring waterfowl surveys as well as spring and winter count data to develop a minimum population estimate.

- Management Strategy – Use e-Bird, state and provincial waterfowl surveys, breeding bird atlas surveys, the North American Breeding Bird Survey and other means to measure expansion into former Trumpeter Swan range over the next 10 years.
- Management Strategy – Develop programs to estimate the vital rates necessary to create an integrated population model for the IP Trumpeter Swan population or key subpopulations.
- Management Strategy - Continue control of non-native Mute Swans throughout the range of IP Trumpeter Swans to minimize competition for resources.

2. Encourage dispersal and migration by a) providing and maintaining adequate habitats within wintering, migration, and breeding ranges; b) when possible, improve quantity and quality of habitats to support population objectives throughout the annual cycle; and c) by sustaining sufficient Trumpeter Swan populations within core breeding areas to provide for ongoing dispersal into suitable historical ranges, where conflicts to existing waterfowl management programs do not arise.

- Management Strategy – Reference and utilize Upper Mississippi River Great Lakes Joint Venture emergent wetland and aquatic bed habitat goals to improve Trumpeter Swan breeding, brood rearing, molting, staging and wintering habitat.
- Management Strategy – Reference and utilize regional spatial habitat modeling tools developed by the Prairie Pothole and Prairie Habitat Joint Ventures to improve Trumpeter Swan breeding, brood rearing, molting, and staging habitat.
- Management Strategy – Reference and utilize the Rainwater Basin Joint Venture waterfowl and waterbird management plans habitat goals and objectives improve Trumpeter Swan breeding, brood rearing, molting, staging and wintering habitat.
- Management Strategy – Reference and utilize Lower Mississippi Valley and East Gulf Coast Joint Venture habitat goals to improve Trumpeter Swan staging and wintering habitats.

3. Manage Trumpeter Swan populations to provide increased recreational benefits while minimizing human-swan conflicts.

- Management Strategy - Promote viewing opportunities of IP Trumpeter Swans on their migratory and wintering concentration areas.

- Management Strategy – Collaborate with USDA Wildlife Services and USFWS related to nuisance/damage permit requests and create a repository/database for nuisance/damage permits, claims, and nuisance-related concerns and actions.
- Management Strategy - Update the General Swan Hunting Environmental Assessment to acknowledge the abundance and recovery of Trumpeter Swan populations.
- Management Strategy – Identify and provide tools to federal, state, and local agencies and the public to minimize human-swan conflicts and create educational materials to inform management actions.

4. Identify management actions to mitigate and/or reduce factors that contribute to Trumpeter Swan mortality.

- Management Strategy – Support and promote initiatives that aim to reduce deposition and accumulation of lead in wetland environments used by Trumpeter Swans.
- Management Strategy – Support and promote power line visibility initiatives.
- Management Strategy – Support and promote management of diseases that affect Trumpeter Swans.
- Management Strategy – Support educational efforts of The Trumpeter Swan Society and federal, state, and provincial agencies to inform hunters of the differences between Trumpeter Swans, Tundra Swans, white geese, and other large white waterbirds.

5. Strive to ensure IP Trumpeter Swan conservation programs and expansion are compatible with and do not reduce ongoing Tundra Swan and other waterfowl hunting seasons and recreational opportunities.

- Management Strategy – Continue inter-flyway and federal collaboration and communication to address any concerns or conflicts between Tundra Swan hunting and the expansion of IP Trumpeter Swans.

6. Support research, management and conservation efforts for Trumpeter Swans.

- Management Strategy - Develop and continually update a prioritized list of research and information needs that will lead to enhanced Trumpeter Swan conservation efforts and management actions.
- Management Strategy – Encourage collaborative research projects on impacts of lead, power lines, diseases and other factors affecting the health and survival of Trumpeter Swans.

7. Continue to educate the public about the success story of Trumpeter Swan restoration efforts, the importance of wetland habitat, and what is still needed to meet this plan’s goals for Trumpeter Swan conservation.

- Management Strategy - Collaborate with partners (The Trumpeter Swan Society, Ducks Unlimited, etc.) to educate others of the importance of wetlands and to promote wetland conservation for swans and the many other additional benefits for wildlife and humans.

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Figures and Tables

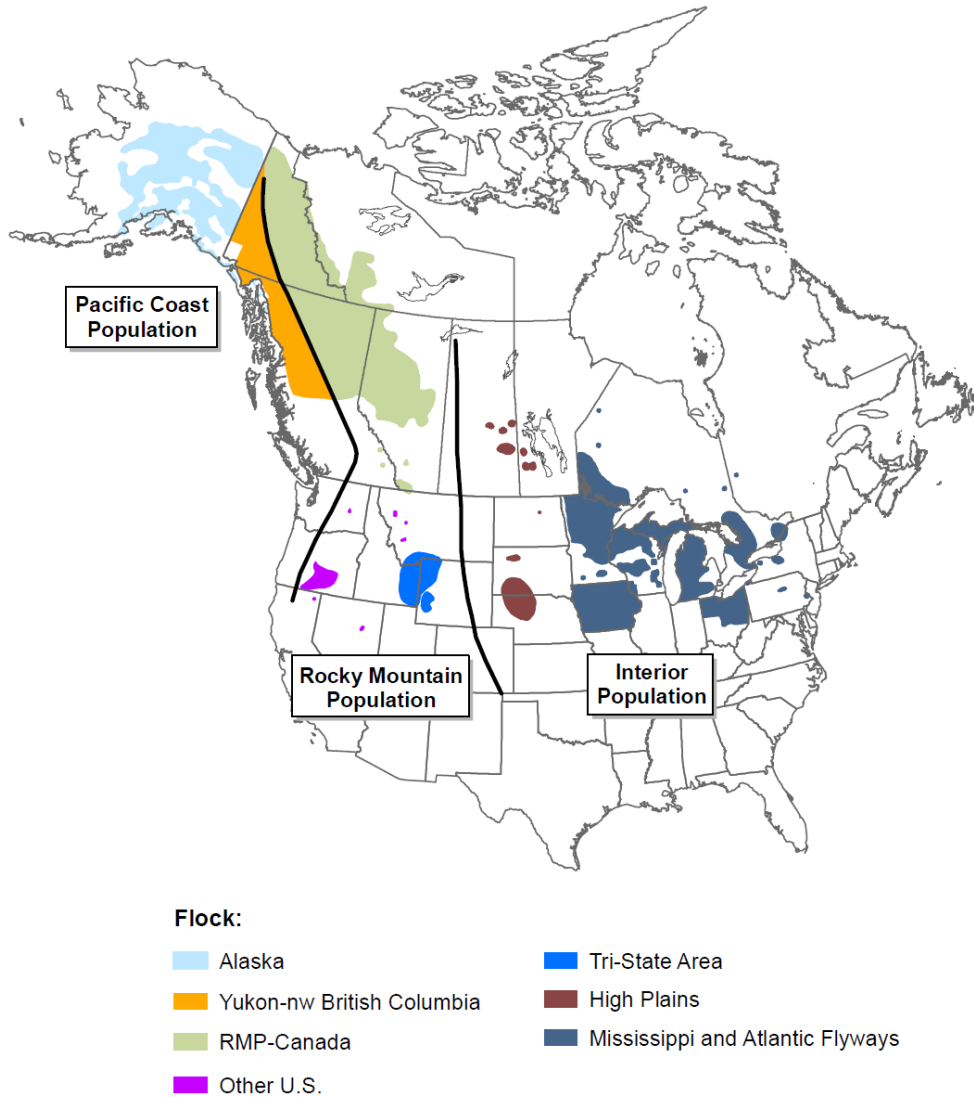


Figure 1. Breeding ranges of Trumpeter Swans (*Cygnus buccinator*), as reported by the North American Trumpeter Swan Survey (NATSS) cooperators (Groves 2017). Black lines show approximate boundaries of the breeding ranges of the three populations.

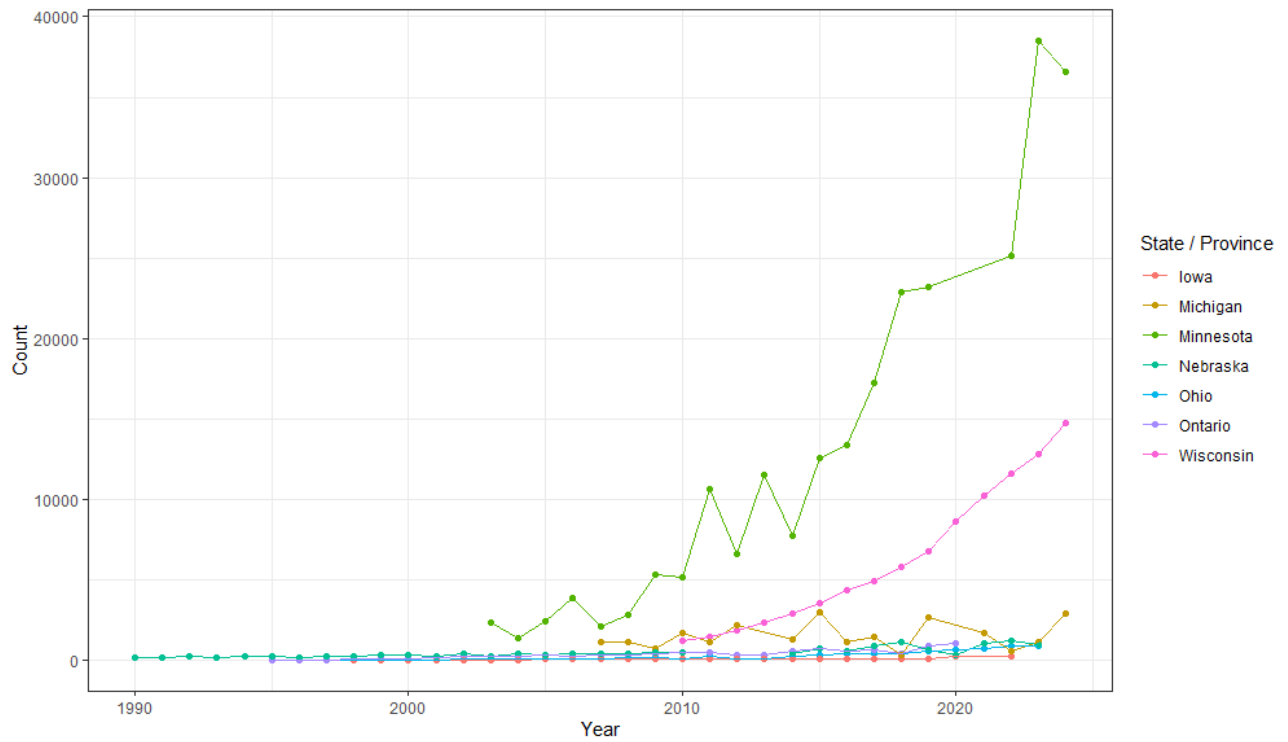


Figure 2. State estimates of Interior Population Trumpeter Swan (*Cygnus buccinator*) abundance (1990 – 2024) based on either state-coordinated breeding waterfowl surveys (e.g., Wisconsin, Minnesota, and Michigan), or specific Trumpeter Swan surveys (e.g., Iowa, Ohio, Nebraska). Specific count information in Table 4 and Table 5.

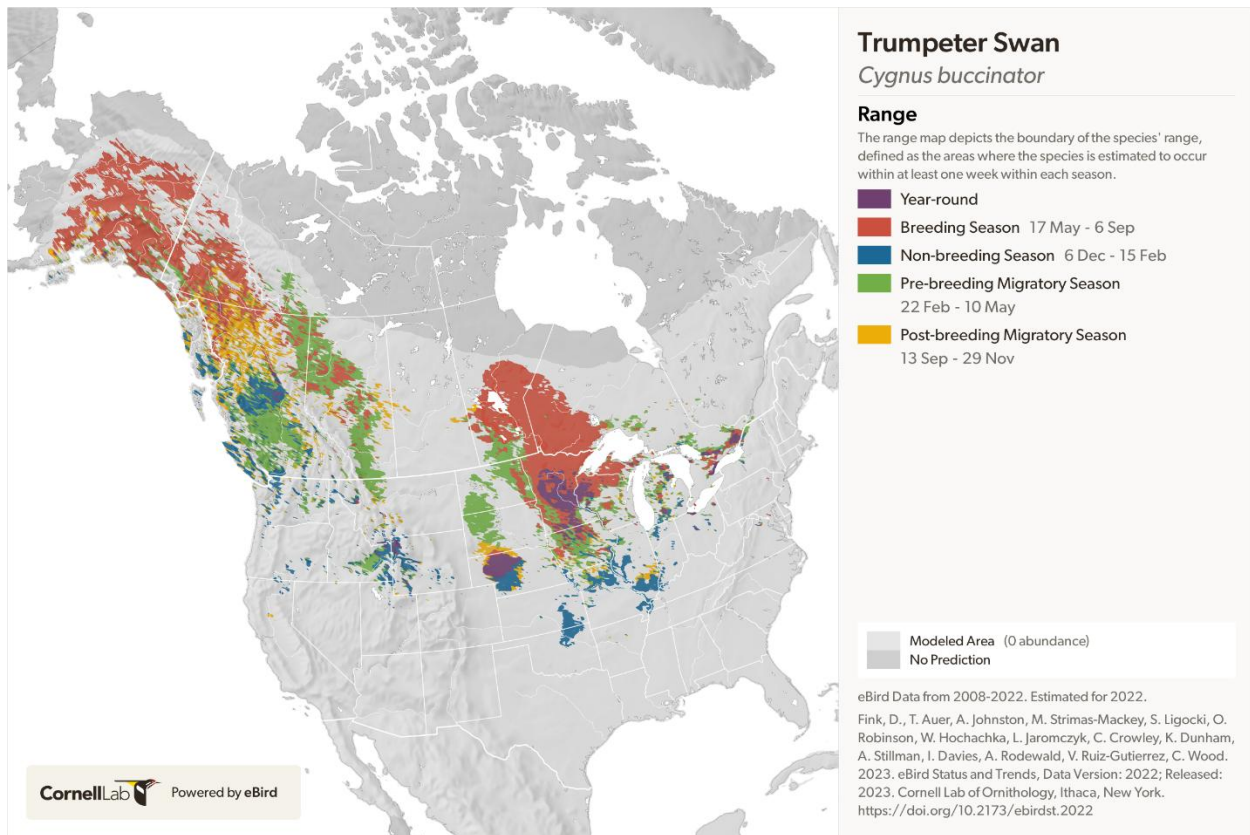


Figure 3. Range distributions of Trumpeter Swans in North America based on citizen science observations submitted to eBird during 2008–2022. Data from Fink et al. (2023).

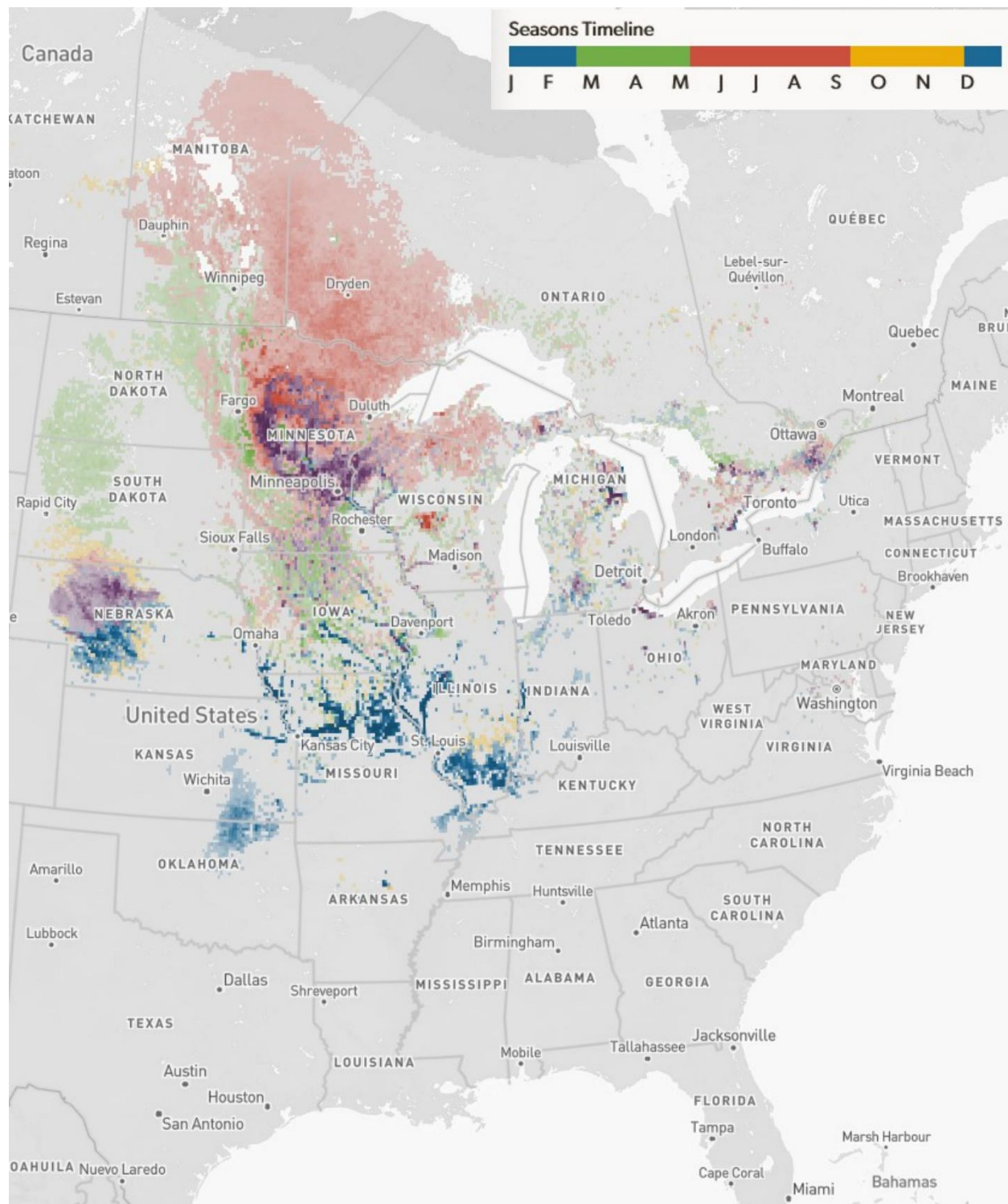


Figure 4. Range distributions of Interior Population Trumpeter Swans (*Cygnus buccinator*) in North America based on citizen science observations submitted to eBird during 2008–2022. Purple cells indicate year-round residency, red cells are breeding season range (17 May–6 Sep), yellow cells are post-breeding migration (13 Sep–29 Nov), blue cells are non-

breeding season (6 Dec–15 Feb), and green cells are pre-breeding migration (22 Feb–10 May). Data from Fink et al. (2023).

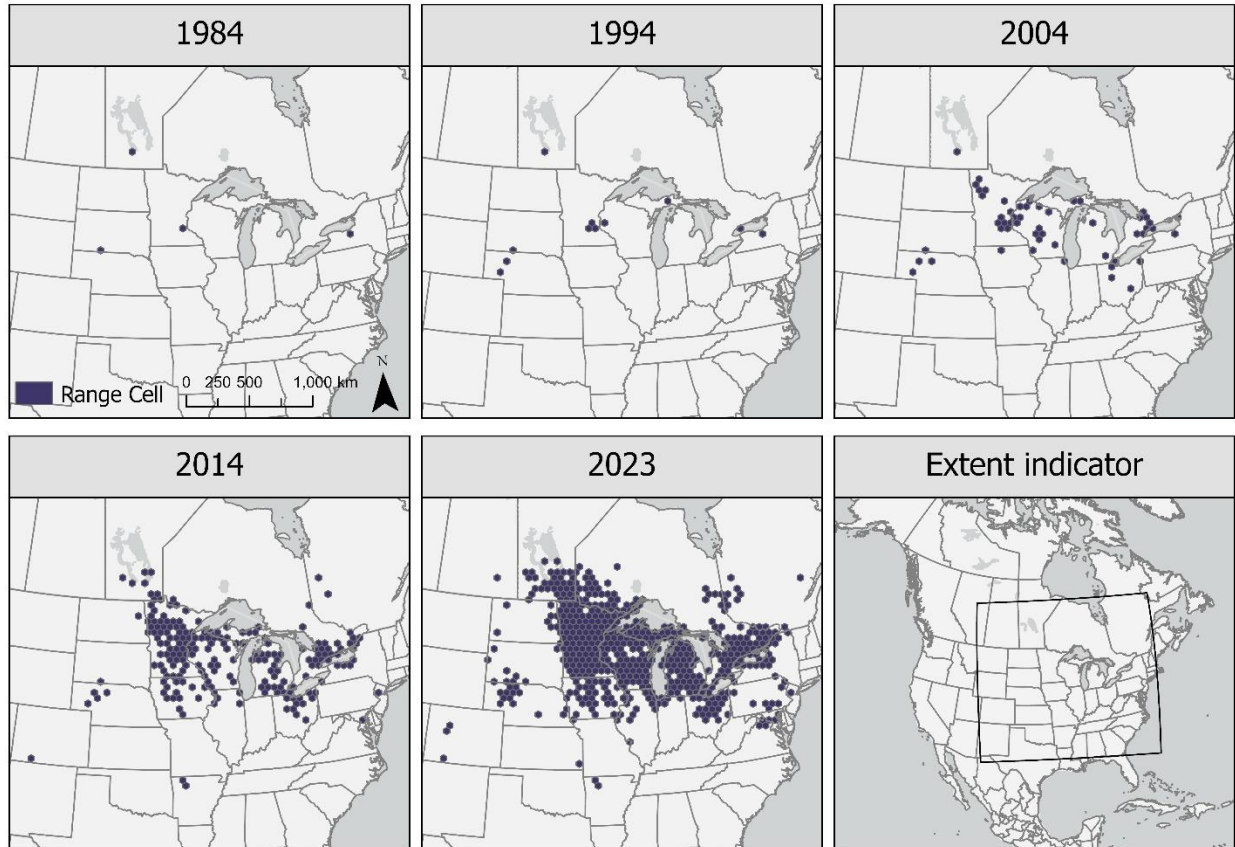


Figure 5. Trumpeter Swan (*Cygnus buccinator*) occurrence data during 1984–2023 from long-term structured (e.g., North American Breeding Bird Survey) and semi-structured citizen science datasets (e.g., eBird and iNaturalist). Occurrence data were used to inform the range expansion model in Figure 6 (Barnes et al. 2025).

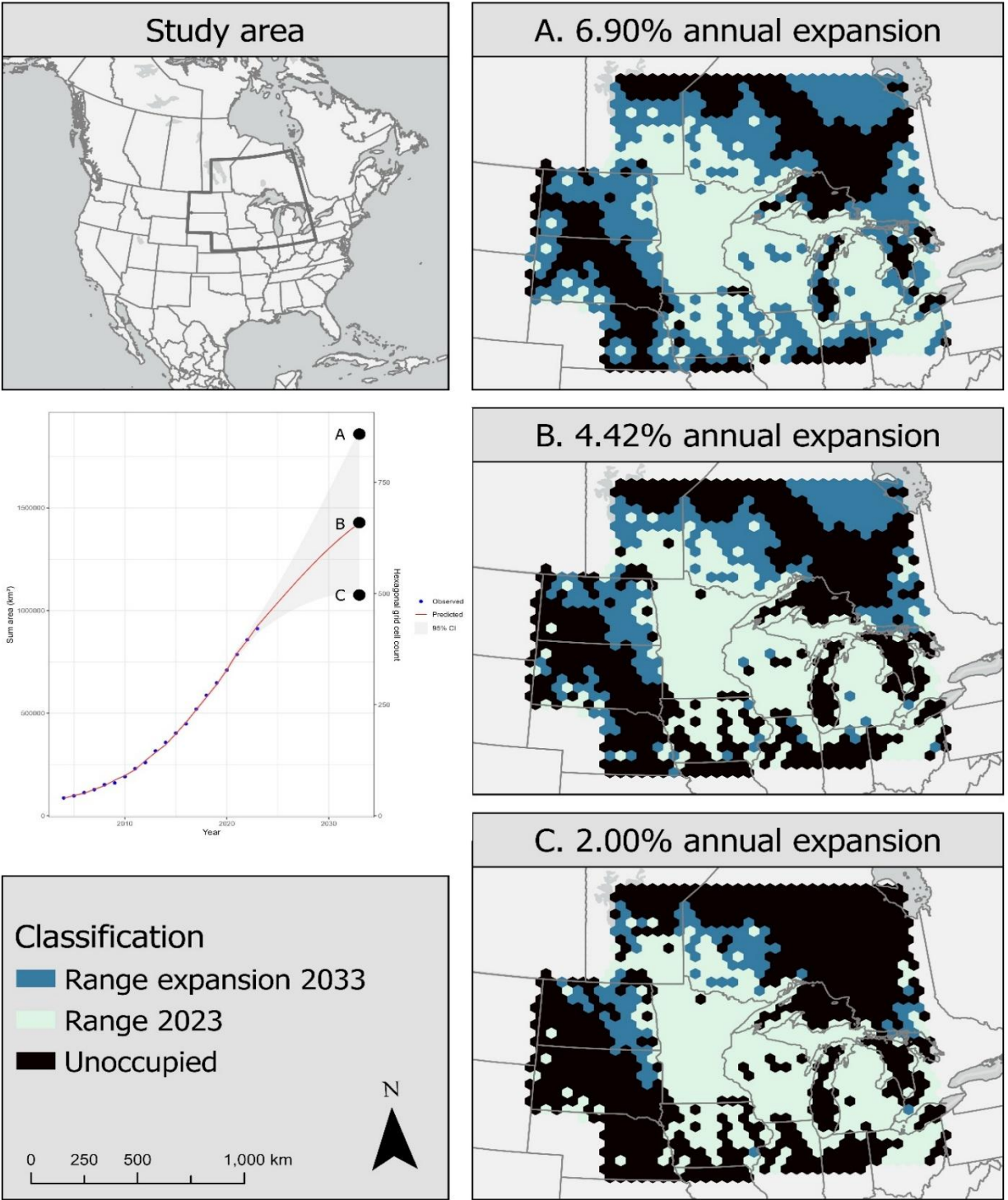


Figure 5. Predicted IP Trumpeter Swan (*Cygnus buccinator*) range expansion by 2033 within the western Great Lakes region of North America derived from a logistic regression range expansion model informed by a habitat suitability layer, distance to previously occupied grid cell, year, and survey effort. Box B represents the predicted expansion rate, and A and

C are the upper and lower 95% confidence limits, respectively, for the predicted expansion rate (Barnes et al. 2025).

Table 1. Wisconsin Trumpeter Swan (*Cygnus buccinator*) population growth and productivity, 1989–2014

Year	Active Nests	Successful Nests	Failed Nests	Fledged Young
1989	1	1	0	2
1990	2	2	0	5
1991	2	0	2	0
1992	6	4	2	10
1993	9	7	2	21
1994	10	8	2	24
1995	11	8	3	21
1996	18	9	9	20
1997	17	15	2	63
1998	18	15	3	51
1999	32	23	9	63
2000	44	31	13	114
2001	45	30	15	93
2002	53	34	19	104
2003	61	42	19	143
2004	83	62	21	181
2005	94	68	26	245
2006	98	74	24	235
2007	113	58	55	160
2008*	133	68/112*	44*	258*
2009*	183	93/179*	86*	311*
2010*	176	94/165*	71*	319*
2011*	197	101/185*	84*	306*
2012*	217	117/194*	77*	374*
2013*	220	116/179*	63*	349*
2014*	253	151/242	91*	455

*Results based only on nests with known outcome

Table 2. Estimates of Interior Population white swan (adult and subadult) abundance from the North American Trumpeter Swan Survey, 1968–2015.^{a,b} (Groves 2017)

Flock	1968	1975	1980	1985	1990	1995	2000	2005	2010	2015
High Plains	43	81	120	95	123	189	267	362	384	464
Mississippi and Atlantic Flyways	---	---	12	44	174	509	1,443	2,858	6,770	26,055
IP Total	43	81	132	139	297	698	1,710	3,220	7,154	27,055 ^c

^a Estimates for 1968–1990, 1995, 2000, 2005, and 2010 were from USFWS et al. 1994, Caithamer 1996, Caithamer 2001, Moser 2006, and Groves 2012, respectively.

^b “---” denotes the area was not surveyed.

^c Several cooperators in the Mississippi Flyway used different survey methods in 2015 than in previous years.

Table 3. Estimated average annual growth rates (%) for Interior Population adult and subadult swans (“white swans”) by flock, from the North American Trumpeter Swan Survey, 1968–2015. (Groves 2017)

Flock	Annual Growth Rate ^{a,b}			
	1968–1985	1985–2000	2000–2015	1968–2015
High Plains	5.3*	7.3	3.5	5.0
Mississippi and Atlantic Flyways	--- ^c	27.2 ^d	21.2	23.5 ^e
IP Total	7.5	18.3	19.9	14.4

^a Trend (regression slope) was statistically significant ($p < 0.05$) unless noted with an asterisk.

^b Some flocks were supplemented through releases of captive stock during restoration efforts.

^c First surveyed in 1980.

^d Annual growth rate 1980–2000, represents population supplementation, translocations, captive rearing and natural reproduction.

^e Annual growth rate 1980–2015, represents population supplementation, translocations, captive rearing and natural reproduction.

Table 4. Interior Population Trumpeter Swan (*Cygnus buccinator*) state breeding season abundance estimates from surveys conducted April–September. Numbers followed by an asterisk (*) were estimated by doubling the number of active Trumpeter Swan nests found during annual nesting surveys. Abundance estimates are derived from a combination of surveys including the federally coordinated Waterfowl Breeding Population and Habitat Survey (e.g., South Dakota), state-coordinated breeding waterfowl surveys (e.g., Wisconsin, Minnesota, and Michigan), or specific Trumpeter Swan surveys (e.g., Iowa, Ohio, Nebraska). Wisconsin abundance numbers from 2010–2024 are predicted estimates from a Bayesian state-space model.

Year	Nebraska	Wisconsin	Minnesota	Michigan	Ohio	Iowa	Illinois	South Dakota
1976	187							
1977	191							
1978	174							
1979	184							
1980	196							
1981	230							
1982	215							
1983	263							
1984	237							
1985	187							
1986	229							
1987	268							
1988	247							
1989	282	2 *						
1990	225	4 *						46
1991	206	4 *						
1992	228	12 *						
1993	173	18 *						
1994	249	20 *						
1995	214	22 *						34
1996	207	36 *						
1997	257	34 *			6			
1998	275	36 *			10	2 *		
1999	311	64 *			3	2 *		
2000	321	88 *			27	4 *	0	33
2001	222	90 *			40	18 *	0	
2002	385	106 *			66	20 *	0	
2003	264	122 *	2,341		61	28 *	0	
2004	391	166 *	1,355		67	28 *	1	
2005	358	188 *	2,400		81	52 *	2	73

Year	Nebraska	Wisconsin	Minnesota	Michigan	Ohio	Iowa	Illinois	South Dakota
2006	427	196 *	3,855		87	58 *	5	
2007	398	226 *	2,074	1,148	99	62 *	9	
2008	429	266 *	2,823	1,101	133	52 *	0	
2009	523	366 *	5,336	702	153	82 *	3	
2010	524	1,192	5,148	1,723	126	84 *	5	36
2011		1,467	10,626	1,148	230	102 *	11	467
2012		1,880	6,611	2,174	93	98 *	5	
2013		2,314	11,500	17,859	97	92 *	5	374
2014	444	2,879	7,700	1,319	246	90 *	7	
2015	692	3,531	12,575	3,021	299	98 *	6	54
2016	595	4,361	13,412	1,135	410	100 *	26	187
2017	870	4,932	17,230	1,428	375	108 *	20	
2018	1,157	5,774	22,847	293	411	108 *	11	
2019	665	6,785	23,187	2,653	551	110 *	32	187
2020	342	8,646			641	238 *	22	
2021	1,039	10,213		1,683	721			
2022	1,235	11,632	25,113	572	870	270 *		393
2023	962	12,798	38,527	1,158	895			499
2024		14,781	36,592	2,893	918			

Table 5. Interior Population Trumpeter Swan (*Cygnus buccinator*) state/province winter abundance estimates. Counts are from Audubon Christmas Bird Count results (not corrected for effort) in Ontario conducted in December–January and the Central Flyway Mid-Winter Waterfowl Surveys in South Dakota and Kansas conducted in January.

Year	Ontario	South Dakota	Kansas
1995	26		
1996	21		
1997	44		
1998	73		
1999	85		
2000	102		
2001	147		
2002	210		
2003	253		
2004	273		
2005	288		
2006	247		
2007	340		
2008	342		
2009	442		
2010	449		
2011	491		
2012	332		
2013	340		
2014	575	2	12
2015	692	35	8
2016	580	4	13
2017	647	9	14
2018	430	51	44
2019	852	598	62
2020	1,068	260	105
2021	1,129	511	135
2022	1,508	500	40
2023	1,576	36	210

Appendix A

State/Province-specific Reintroduction and Monitoring Efforts

Minnesota

Trumpeter Swans were extirpated from Minnesota by the 1880s (Herwig and Henderson 2019). Although the early efforts by Hennepin Parks starting in the 1960s were not considered successful, Trumpeter Swan reintroductions in the state received a boost in the 1980s when the Minnesota DNR Nongame Program started their own reintroduction program. Swans came from a variety of sources including RRLNWR; Lacreek National Wildlife Refuge in South Dakota; Minto Flats, Alaska; the Minnesota Zoo; the Brookfield Zoo; Delta Waterfowl Research Station; and a number of private breeders. Between 1987 and 1994, the Minnesota DNR released 374 swans throughout the state (120 from Alaska, 170 from a long-term propagation program at the Minnesota Zoo, and 84 from other captive sources with unknown origins) after first holding swans in captivity until the age of 2 (C. Henderson pers. comm.).

Swans from the Minnesota DNR program were first released near Tamarac National Wildlife Refuge in west-central Minnesota due to the abundance of wetlands that provided high quality breeding habitat. Release sites were chosen with minimal lakeshore development and to minimize risks due to hunting, fishing, and human disturbance. The original program goal was 15 breeding pairs, a goal reached by 1995 (Herwig and Giudice 2015). Trumpeter Swans in Minnesota currently represent the largest segment of IP abundance, breed in 80 of the 87 counties in the state, and have expanded into nearby areas of southern Manitoba, western Ontario, eastern North Dakota, eastern South Dakota, and northern Iowa. Estimates of Minnesota IP Trumpeter Swans are calculated each year from the annual Waterfowl Breeding Population Survey, although some portions of the state breeding population (far northwest, northeast, and southeast) are not covered by that survey; however, the northeast section of Minnesota has been surveyed by periodic supplemental survey efforts throughout the state (Herwig and Giudice 2015; Herberg and Rettler 2022).

Ontario

The original breeding population of Trumpeter Swans in Ontario was likely extirpated in the late 18th or early 19th century (Lumsden et al. 2012). The Ontario Ministry of Natural Resources began their restoration program in 1982 using eggs taken from a group of Trumpeter Swans in Grande Prairie, Alberta and breeding pairs acquired from aviculturists in portions of the Rocky Mountain Population (RMP). In 1993, managers also obtained 50 eggs from Alaska in an effort to increase the genetic diversity of the Ontario flock (Lumsden and Drever 2002).

The reintroduction program consisted of three techniques for raising cygnets: 1) placing eggs in nests of feral Mute Swans on the northwest shore of Lake Ontario for foster-raising; 2) hatching eggs in incubators and raising cygnets by humans; and 3) leaving eggs with captive breeding pairs of Trumpeter Swans for incubation and rearing (Lumsden and Drever 2002). Updates from the restoration program in 2002 indicated that wild-hatched cygnets had higher survival than captive-hatched ones, and that the introduction of Alaskan breeding stock into the program's Yellowstone-based captive breeding stock improved hatchability (Lumsden 2004).

The original objective of 1,000 swans was achieved and the active restoration program was discontinued in 2006 (Lumsden et al. 2012). There are currently three distinct sub-populations of Trumpeter Swans in Ontario with minimal evidence of interchange among the groups (Atlantic Flyway Council Snow Goose, Brant, and Swan Committee and the Trumpeter Swan Society 2011).

Michigan

The Michigan DNR Nongame Program began their state Trumpeter Swan reintroduction program in 1986 in cooperation with the Michigan State University Kellogg Bird Sanctuary, The Trumpeter Swan Society, the U.S. Fish and Wildlife Service, and several zoos and private breeders (Johnson 1989). The initial goal was 200 Trumpeter Swans in two flocks by 2000, which was achieved by 1997 (Johnson 2007). Michigan tried multiple methods including: 1) cross-fostering with feral Mute Swans, 2) releasing 2-year-old swans from private breeders and Alaskan eggs, 3) translocating pinioned pairs, from which the young would be able to fly freely, and 4) translocating wild-caught Pacific Coast Population (PCP) Trumpeter Swans.

Michigan has a relatively high number of feral Mute Swans; therefore, cross-fostering was attempted, but this method was discontinued due to problems with predation losses and parental abandonment (Johnson 1989). Between 1986 and 1988, 44 Trumpeter Swan eggs were placed in Mute Swan nests and 35 hatched, although only six cygnets survived until fledging. Starting in 1989, the reintroduction program shifted to using eggs collected from Alaska and rearing swans in captivity until the age of 2, similar to the method used in Minnesota. Between 1989 and 1990, 91 eggs were collected in the Minto Flats area, 88 hatched, and 80 cygnets survived until fledging. Between 1989 and 2005, 346 swans were released, approximately half of which were of Alaskan origin—the others were from zoos and private breeders (Johnson 2007). Seney National Wildlife Refuge was chosen as the site receiving the most reintroductions due to its protected status, remoteness, and habitat quality (Corace et al. 2006). Current estimates of Michigan IP Trumpeter Swans are calculated based on interpolation from the annual Waterfowl Breeding Population Survey (Table 4).

Wisconsin

The Wisconsin DNR began a Trumpeter Swan restoration program in 1987 with a recovery plan goal of establishing at least 20 breeding and migratory pairs by the year 2000 (Matteson et al. 1986). The Wisconsin DNR Trumpeter Swan recovery program employed four techniques: 1) cross-fostering Trumpeter Swan eggs from game farms using Mute Swans (in the wild during 1987–1988; 2) captive-rearing release of 2-year-old swans raised from eggs collected in Alaska and hatched at the Milwaukee County Zoo during 1989–1997, and releases of swans from avicultural sources during 1987 and 1988; 3) decoy-rearing of “Alaskan” cygnets (from eggs collected in Alaska and hatched at the Milwaukee Country Zoo) by University of Wisconsin interns using a life-size decoy at selected wetland sites with cygnets allowed to fly free when they reached fledging age at about 15 weeks; and 4) limited yearling releases of birds produced by captive pairs at selected wetlands in central and northern Wisconsin (Matteson et al. 1988; Matteson et al. 2007).

From 1989 through 1997, Wisconsin DNR staff collected 385 Trumpeter Swan eggs in east-central and southeastern Alaska; 92.5% (356) of these eggs hatched in incubators at the Milwaukee County Zoo. The Alaskan cygnets from this program were placed into the captive-rearing and decoy-rearing programs described above. Three-hundred ninety-four Trumpeter Swans were released in Wisconsin during 1989–2005: 196 using decoy-rearing, 32 using captive-parent rearing, six released as captive-reared yearlings, and one swan of ‘miscellaneous origin’ (Matteson et al. 2007; Table 1). In 2004, Wisconsin DNR staff assessed the origins of the state’s breeding pairs and concluded that 62% were wild-produced birds, 14% were captive-reared and released birds, 11% were decoy-reared, 8% came from out-of-state, and 5% were captive parent-reared birds (Matteson et al. 2007).

Monitoring by canoe, kayak, airboat, and airplane from 1989 through 2014 allowed Wisconsin DNR staff to annually assess the distribution and number of nesting Trumpeter Swans across Wisconsin (Table 1). In 2015 the Wisconsin DNR discontinued efforts of trying to document every nesting pair, and instead transitioned to aerial surveys (i.e., annual state-wide breeding waterfowl surveys) as a more cost-effective approach (Matteson 2019).

Iowa

In 1993, the Iowa DNR developed a Trumpeter Swan Restoration Plan with two main goals: 1) to restore a self-sustaining migratory population of Trumpeter Swans to its former range in Iowa, and 2) to “Trumpet the cause for wetlands” through outreach and education that utilized Trumpeter Swans as ambassadors for water quality and the importance of wetlands. The initial population goal was to establish 15 wild nesting pairs of Trumpeter Swans by 2003, with releases focused on the northcentral Prairie Pothole Region of the state.

The first four Trumpeter Swans were released in Iowa in 1994. The restoration program acquired swans from zoos, private propagators, and other swan restoration programs across the country. In later years as the wild Interior Population grew, swans were also acquired from multiple wildlife rehabilitation facilities. In the early years of restoration, Iowa DNR had as many as 50 flightless captive breeding pairs. Initially, cygnets from these pairs were captured just before they fledged and their wings were clipped. They were held in wintering pens at natural wetlands in the southern part of the state and then transferred to summer pens on wetlands in the Prairie Pothole Region in the northern part of the state to encourage migratory behavior. These birds were released in spring as free-flying 2-year-olds at wetlands across the Prairie Pothole Region in Iowa. These captive pens were phased out by 2001 after determining the system did not encourage migratory behavior as intended. From that point on, cygnets were held over winter and released during the first spring after hatching.

Over the winters of 2008–2010, the Iowa DNR partnered with the Arkansas Game and Fish Commission to release 51 Trumpeter Swans on Arkansas wintering areas in another attempt to establish migratory behavior. Free-flying Trumpeter Swans were captured in Iowa then marked and relocated to the Buffalo National River and Holla Bend National Wildlife Refuge in Arkansas during mid-winter. Limited resighting of released individuals found five birds relocated over the following summers to Minnesota, Iowa, and Illinois, and one pair attempted to breed in Arkansas, which was never the intent of the project. As of 2020, Iowa-marked swans have been reported in 17 states, as far west as Colorado, east to Virginia and north into three Canadian provinces. After 20 years of migration observations, the largest concentrations of migrating Iowa swans are wintering in northeastern and east-central Kansas and northwestern and west-central Missouri.

The first modern-day pair of wild Iowa Trumpeter Swans successfully nested in Dubuque County in 1998. In 2000, a second pair hatched young in Winnebago County. The initial restoration goal of 15 nesting pairs of Trumpeter Swans in Iowa was met in 2004. A secondary goal was to establish 25 nesting pairs by 2006; a goal reached in 2005. Forty-two nesting attempts were reported in 2010, 49 in 2015, and 119 in 2020. A more recent goal of the project has been to establish eight breeding pairs south of interstate I-80 in central Iowa, which was accomplished by 2020. Iowa also hosts many wintering Trumpeter Swans. A total of 3,918 Trumpeter Swans were tallied in 51 of 99 Iowa counties during the mid-winter waterfowl survey in January 2020, up from 2,470 Trumpeter Swans tallied in January 2019.

Since 1994, Iowa DNR has released 1,218 Trumpeter Swans from 132 sources. Between 2010 and 2020, an average of 22 sub-adult Trumpeter Swans were released each year, with the majority of birds released in the southern part of the state. As of 2020, there are 16 captive breeding pairs in the state, and Iowa DNR is working to revise their Trumpeter Swan management plan to better align conservation efforts with the state's well-

established wild breeding population. Iowa DNR ended releases of Trumpeter Swans in 2022, and any future actions will be determined by the forthcoming Iowa Trumpeter Swan management plan.

Ohio

The Ohio Department of Natural Resources – Division of Wildlife (DNR-DOW) initiated a Trumpeter Swan reintroduction program in 1996 calling for the release of 150 Trumpeter Swans with a goal of at least 15 breeding pairs by 2006 (Sherman 2007). Swans were released in four phases: 1) adult Trumpeter Swans (>2 years), obtained from private breeders across the United States and Canada, were released during 1996–1997, 2) Trumpeter Swans captive-reared by zoos from eggs obtained from wild populations in Alaska were released during 1997–2000, 3) parent-reared swans obtained from private breeders were released during 2001–2003, and 4) swans translocated from Kellogg Bird Sanctuary in Michigan were released in 1997 and 2003 (Tori 1997; Sherman 2007).

Approximately half of the released birds were of Alaskan origin, 10% were from the Kellogg Bird Sanctuary, and the rest were from private breeders (Kearns et al. 2024). One hundred fifty-four swans were released at 11 wildlife conservation areas during 1996–2003 (Sherman 2007). The released swans began breeding by 1997, and by 2003, 117 cygnets had fledged (Ohio DNR-DOW unpublished data). In 2010, the Ohio DNR-DOW, along with consultation with the Mississippi Flyway Council and the Great Lakes Mute Swan Task Force, released the Ohio Swan Management Plan, which included recovery goals for Trumpeter Swans in the state and management goals for reducing the Ohio Mute Swan population (Ohio DNR-DOW 2013; Kearns et al. 2024). Since 1996, the Ohio Trumpeter Swan population has been monitored annually by the Ohio DNR-DOW during an aerial summer breeding survey (Table 4), the annual Midwinter Waterfowl Survey (until 2024), and using additional information submitted through the annual Christmas Bird Count (Kearns et al. 2024). Since 2014, additional reports from eBird and the Ohio DNR-DOW's wildlife reporting website has contributed to the annual summer breeding census for areas not surveyed by air (Ohio DNR-DOW 2013; Kearns et al. 2024).

Illinois

Although Illinois never implemented Trumpeter Swan reintroduction, Illinois has twice (1996 and 2005) assembled interagency working groups to review the status of IP Trumpeter Swan restoration efforts and determine how Illinois could best aid those efforts. The working groups were also tasked with providing guidance for Trumpeter Swan management activities in Illinois. The interagency groups had representatives from the Illinois Endangered Species Protection Board, two divisions within the Illinois DNR (Natural Heritage and Wildlife Resources), and the Illinois Natural History Survey.

Each group reviewed the management plans set forth by the Mississippi and Central Flyways, and relevant literature on Trumpeter Swan restoration efforts. They determined

that although captive-release efforts elsewhere were adequate to reach stated population goals, information regarding migratory and wintering ecology was still lacking. Based on this position, the working groups suggested that Illinois direct efforts towards wintering ground management to increase understanding of wintering ecology and help identify factors that promote survival of established Trumpeter Swan breeding pairs (a necessary goal to deem the recovery effort a success). Graduate research focusing on winter survival and foraging by Trumpeter Swans in Illinois was completed by students at Southern Illinois University (SIU) in 2008 (Varner 2008).

In 2008, the Cooperative Wildlife Research Laboratory at SIU in Carbondale conducted a habitat assessment to identify suitable sites for future Trumpeter Swans release efforts. That research yielded six potentially suitable bodies of water (based on nesting and foraging habitat, and potential human disturbance), but also noted that certain factors that contribute to swan mortality (lead poisoning from fishing gear and collisions with obstructions like power lines) could not be evaluated.

Since the early 2000s, Illinois DNR has monitored annual changes in fall and winter migration chronology along with changes in distribution and abundance of Trumpeter Swan as part of its aerial waterfowl surveys and midwinter waterfowl surveys. Additional information on fall and winter population estimates, distribution, and habitat use is collected annually through Illinois Natural History Survey aerial waterfowl surveys and through sightings reported by hunters and the public. Illinois DNR also directed effort into public education about swans and restoration programs in local publications, hunting regulations, and at public waterfowl areas.