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Project Title: Assessing Distribution, Abundance, and Population Change in the American White Pelican and Double-crested Cormorant in Minnesota: Comparison to Three Census Periods, 2004/05, 2010, and 2015

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INTRODUCTION

In many portions of North America, significant increases in numbers of the American White Pelican (*Pelecanus erythrorhynchos*) (pelicans) and the Double-crested Cormorant (*Phalacrocorax auritus*) (cormorants) occurred between 1970 and 2000 (Wires and Cuthbert 2006; Evans and Knopf 1993). Minnesota was no exception; data from survey efforts in the 1960s to the year 2000 indicate both species increased in the state during this period (Minnesota Department of Natural Resources, (MN DNR), Natural Heritage Information System). As these species became more abundant in the state, both were perceived to affect recreation opportunities and local business economies because they consume fish (Wires and Cuthbert, 2003; K.V. Haws, personal communication, S. Mortensen, personal communication).

Concern over increases in numbers of cormorants at the national level led to establishment of the Public Resource Depredation Order (PRDO) for cormorants in 2003. This order authorized federal, state, and tribal agencies in 24 states to “take” (kill) cormorants believed to be impacting public resources on public and private (with owner permission) lands without acquiring a permit (USDI/USFWS 2003). As of 2015, cormorant management under the PRDO in Minnesota had been undertaken on Knife Island, Lake Superior; Little Pelican Island, Leech Lake; Potato Island, Lake Vermilion; and Lake of the Woods. Additionally, control also occurred on Waconia and Wells lakes under animal damage/depredation permits.

Currently, no policy exists that allows the reduction of large numbers of pelicans, but public concerns about impacts related to consumption of fish by this species have been expressed (Wires and Cuthbert 2003; King 2005), as have concerns related to potential property damage. For example, in 2012, a farmer was fined for destruction of nests, eggs, and chicks in a colony that was located on the periphery of an agricultural field he had leased for crop production. He was concerned that the nesting birds would damage his crop. It is likely that such conflicts will increase if pelicans recolonize areas that have not been occupied for several generations.

In addition to population increases and potential or perceived negative impacts to people, several other diverse issues related to these species provide justification for tracking their population trends in MN, including:

- 1) Cormorants are managed at a number of sites, and monitoring the statewide population is needed to evaluate how control is affecting Minnesota’s cormorant population.

- 2) Pelicans are a State-listed Special Concern Species and are also classified as a species of greatest conservation need (SGCN) in Minnesota's State Wildlife Action Plan (MN DNR 2006), along with the Common Tern (*Sterna hirundo*, State Threatened) and Black-crowned Night-Heron (*Nycticorax nycticorax*). Potential for disturbance to all three of these SGCN species, along with other co-nesting colonial waterbirds (e.g., herons, egrets, gulls) at cormorant colonies, is a significant concern because cormorant management occurs at several diverse locations, and because cormorant nesting activity can change habitat for tree-nesting birds.
- 3) On 20 April 2010, the Deepwater Horizon Explosion occurred on the Gulf Coast, resulting in the largest oil spill in history in U.S. waters. Following this event came concern regarding the potential of this disaster to impact pelicans; this species overwinters in the area affected by the oil spill.
- 4) Cormorants and pelicans are sensitive to environmental contaminants (Evans and Knopf 1993, Hatch and Weseloh 1999).
- 5) Both cormorants and pelicans have often been targets of illegal control.
- 6) Monitoring long-term changes in SGCN populations and habitats is a goal of Minnesota's State Wildlife Action Plan, and identifying and addressing the effects that emerging issues (e.g. impact of cormorant populations and control efforts) may have on populations of SGCN species, is one of the Plan's objectives (MN DNR 2006).

In 2004/05, the first statewide breeding census for cormorants and pelicans in MN was undertaken (Wires et al. 2006). This census established important baseline data for these species, describing their distribution and estimating the sizes of their breeding populations. This census also documented presence of other nesting colonial waterbird species at cormorant colonies and provided estimates of their nest numbers. In 2010, a second complete census found that cormorants and pelicans were relatively abundant and also stable relative to the 2005 census. During the summer of 2015, a third complete census was conducted to meet the following objectives:

- 1) Obtain location information for all active cormorant and pelican colonies in 2015. We estimated this number to be no more than 60 sites based on 46 active sites located in 2010.

- 2) Estimate number of nests for cormorants and pelicans at all colonies active in 2015.
- 3) Survey colonial waterbird use at a maximum of 10-25% of the colonies found to be inactive in 2004/05 and 2010.
- 4) At a minimum, obtain presence / absence information for all other species of colonial waterbirds that co-occur at cormorant and pelican colonies active in 2015; if possible, obtain estimates of number of nests or provide size range category (e.g., 1-50, 51-100).
- 5) Obtain specific nesting numbers for Black-crowned Night-Herons, Piping Plovers (*Charadrius melodus*), or Common Terns where they co-occur at cormorant and pelican colonies active in 2015.
- 6) Evaluate changes in distribution and numbers of cormorants and pelicans that have occurred between the three survey periods (2004/05, 2010 and 2015 censuses) to the extent data are available.
- 7) Evaluate changes in numbers of other colonial waterbird species where they co-occur at cormorant and pelican colonies that were active between the 2004/05, 2010 and 2015 census periods to the extent data are available.

This report summarizes results of the Third census.

METHODS

Potential nesting locations and site visits. Nesting locations chosen for site visits were determined through four strategies:

- 1) Review of all sites visited in previous census efforts (n = 161).
- 2) E-mail solicitation to MN DNR field staff by the DNR liaison requesting information on new colonies not identified previously, and on colonies inactive in previous census efforts but known to have become active since that time.
- 3) Incidental observation while traveling between ground-counted sites or during flights.
- 4) Revisits to a subset of colonies (~28%) that were inactive during previous census efforts, and for which no subsequent information was available. This was done to determine if inactive sites remain inactive.

Sites selected using these strategies (n = 88) were visited on the ground or by aircraft to determine activity status.

Field survey crews accessed colonies from land, by watercraft or from the air, depending on accessibility of the site. Watercraft used included a 17 ft. Lund boat with 40 hp motor, an 18 ft. Zodiac with 90 hp motor, and kayaks. Aircraft used included a Cessna 185 with floats and an American Champion Scout. At a few locations, it was not logistically feasible to census birds by direct ground counts but good views of the colony were available from the shore so estimates were obtained through careful counts made from the shore with a spotting scope.

Nest estimates. Estimates were obtained on numbers of breeding cormorant and pelican pairs at all sites where these species nested. The count datum was the active nest and it was considered to represent one pair of birds. Active nests were defined as nests containing eggs and/or chicks, or apparently occupied nests (obvious nests that may lack eggs or chicks but have signs of active use (e.g. fresh nesting material, well formed)). In aerial photos, active nests were defined by birds apparently sitting on or tending nests. For tree-nesting cormorants counted during ground counts, apparently occupied nests with signs of active use (e.g. recently formed and upright aggregations of sticks, herbaceous vegetation) were counted when nest contents were not visible. We also documented presence of co-nesting colonial waterbird species at all sites where they occurred. When possible, we obtained estimates of their nest numbers. Count datum for these species was also the active or apparently active nest, which was identified by the same criteria used for cormorants.

Multiple census techniques were used to obtain estimates of nesting birds. Method used depended on accessibility and sensitivity of a particular site and species. Techniques included direct ground counts of marked nests at colony sites, nest counts made from boats, and counts of nests based on aerial photographs. All counts were conducted following Great Lakes Colonial Waterbird Survey protocol (Cuthbert and Wires 2011), mostly by field assistants and project personnel. A small number of sites were counted by other individuals who have familiarity and expertise with colonial nesting waterbirds and regularly monitor these sites (e.g., Minnesota Lake Ag Field, Potato Island at Lake Vermilion, Big and Little Pelican Island at Leech Lake, and Hennepin and Spirit islands at Mille Lacs Lake).

During ground counts, technicians walked through colonies and tallied the number of active nests on hand-held tally counters. At sites with >25 breeding pairs, ground nests were

marked with spray paint using a construction wand. To count nests in trees, trees were marked with flagging tape and the number of nests in each tree for each species was counted. In counts made from a boat, birds visible sitting on nests were counted to represent a pair.

In counts based on aerial photographs, photos of nesting birds were obtained while flying over the colony site in a small fixed-wing aircraft at approximately 80-115 knots (J. Jensen, personal communication, April 14, 2016) using a hand-held digital camera equipped with an image stabilized lens. Photos were taken from approximately 500 feet above the colony site producing either oblique or vertical images. Photos were downloaded from memory cards to a computer and three categories of birds were marked and hand counted using the software program ArcMap. Birds sitting on nests typically have distinct postures and were easily recognizable as nesting birds by technicians trained to identify and count birds on photographs. Birds standing or loafing that were obviously not on a nest were marked and distinguished from nesting birds to avoid including them in the nest estimate. For photos of moderate to low quality, birds with uncertain status (i.e., could not distinguish if they were nesting or standing) were also marked and distinguished from the other two categories. We then used the proportion of nesting to non-nesting birds to estimate the number of birds with uncertain status that were likely nesting; these likely nesting birds were then added to the total nest estimate for a particular location. The uncertain category was used very infrequently during this census due to consistently high photo quality.

Detectability of nests. Although no studies were conducted to assess detectability rates for the species censused in MN, field work utilizing a double-observer approach to estimate detection probability and abundance (Nichols et al. 2000) for five ground-nesting species during ground counts was conducted in the Great Lakes (Cuthbert and Wires 2007). This work demonstrated that marking nests greatly increases estimate accuracy at sites with > 25 nests; when nests were marked, detection probability was on average high (95% for single observers). Of the five species considered in the study, observers had the highest detection of ground-nesting cormorants; on average, 98% of their nests were detected in a sample by one observer. This work also compared counts between observers and concluded that trained observers were equal in their ability to detect nests; the observer sample size was small ($n = 2$), however. Although no information was available on detectability rates for tree nesting birds, marking trees and counting

the number of nests in a tree is known to increase estimate accuracy (D.V. Weseloh, personal communication, April 15, 2016).

Detectability rates have not been obtained for nests estimated based on aerial photographs, nor have differences in observer skill in estimating birds through this method been measured. However, measurement error (the amount of error obtained in measuring the same object more than once) for estimates of cormorants at 15 sites in the Great Lakes and MN obtained through paired ground counts and aerial photographs was very low, 0.5% of total variation between colonies considered (L.R. Wires and F.J. Cuthbert, unpubl. data). Additionally, for the 15 sites considered, aerial estimates were on average within 9% of estimates based on ground counts, indicating that estimates based on high quality aerial photographs are good predictors of numbers on the ground. Although similar comparisons were not made for pelicans, this species is large and easy to see, and therefore aerial estimates for these birds are also assumed to closely predict numbers on the ground. More work needs to be done to assess the accuracy of the method for tree-nesting cormorants, egrets, and herons, but preliminary data from the Great Lakes indicate that high quality photos can produce similar results as ground counts, and in some cases may provide more accurate counts (Cuthbert and Wires 2011). For example, birds on nests are sometimes more visible when viewing from the top of the canopy than from below, and because birds typically remain on nests during aerial photography, it is often much easier to positively identify owners of nests in mixed species colonies.

Census Timing. The goal for all species was to estimate the peak number of nests at each site. The optimal time for conducting counts was based on several considerations:

- 1) Review of previous census dates at all active colonies and nest stages observed.
- 2) An initial reconnaissance flight in late April to assess colony activity and status from the metro area south to Faribault and Martin counties (n = 13 sites);
- 3) Communication with individuals who regularly visit individual sites and are familiar with phenology.

The typical survey period to meet this goal in MN is May 15-June 15, although the survey window stretched from April 29 to June 15.

RESULTS

Potential nest sites and site visits. A total of 171 sites were identified as potential breeding locations for cormorants and pelicans. All spatially unique land masses with potential for breeding birds were considered individual sites, even when islands were near one another. Of the 171 sites, 146 were identified in the 2004 census, 18 were added during the 2010 census, and 7 more were added during the census of 2015. A total of 88 sites were visited between 29 April and 15 June to determine status. Of the 171 total sites, 58 were assumed inactive in 2010 based on factors that made breeding at these sites unlikely (e.g., habitat change, time since last active, reports from professionals familiar with current conditions at these sites). In 2015, 79 sites were assumed to be inactive with the same justification. A few sites were determined in 2010 to be outside the study area (n=3) or to no longer exist (n=1). All potential sites and their survey status are shown in Table 1.

Active sites, species composition and nest estimates. Of the 171 potential sites, a total of 40 had nesting cormorants (n=36), pelicans (n=15) or both (n=11) (Figure 1). The total number of nests estimated for pelicans was 16,406; for cormorants, the total number estimated was 15,421 (Table 2). In addition to cormorants and pelicans, nesting by the following colonial waterbird species was documented at 36 of the 40 sites: Black-crowned Night-Heron, Caspian Tern, Common Tern, Great Blue Heron (*Ardea herodias*), Great Egret (*Ardea alba*), Ring-billed Gull (*Larus delawarensis*) and Herring Gull (*Larus argentatus*) (Figure 1). Numbers of nests estimated for each species at each site are shown in Table 2.

Re-visits to subset of sites inactive in previous census efforts. In 2015, we revisited 31 sites that were inactive in both previous censuses (n=12) or not censused in one and not active in the other (n=19) to determine if inactive sites remain inactive. Of these 31, only 7 (23%) were active in 2015 (Tables 3 and 4). These included Artichoke Lake, Gull Island (Leech Lake), East Chain Lake, Goose Lake, Lake Benton, Norway Lake, and Shields Lake. Of the 7, 4 supported cormorants and/or pelicans (Gull Island, Goose Lake, Lake Benton, and Norway Lake). Only Great Blue Herons were present on Artichoke and Shields lakes.

Changes in distribution and numbers of the American White Pelican. The number of pelican nests estimated in this survey (16,406) was very similar to the number estimated in 2004/05 and 2010 (n=15,610 and n=15,999 respectively; Table 3). The 2015 estimate was higher by 5% and 2.5% respectively, a difference that could represent a true increase in numbers or be

simply due to sampling error. Of special note, the 2015 count is substantially lower than that of statewide pelican surveys (Wires et. al 2012) that were conducted in 2011 and 2012 (n=22,506 and n=22,023 respectively; Table 3). Despite the fluctuations in total counts, breeding distribution across the state remained essentially the same, with colonies located in the northern, west-central and southern portions of the state (Figure 2). During all survey periods, nearly the entire population (97.5-98.9%) occurred on six lakes; however, numbers changed significantly at several of these locations (Table 3; Figure 3).

A marked decrease in nesting pairs occurred in the Marsh Lake Complex in 2015 which reflected a lack of nesting on the Peninsula and Currie Island sites. Failure to nest successfully at these sites may have been due to water level fluctuations resulting in flooding and/or increased predator access (DiMatteo et. al 2015). The vegetation on Big Island partially obscured our view of some birds and thus the count for this site represents a minimum. We assume 5-10% were obscured from view but were not confident enough in this assumption to adjust the counts accordingly. Overall, our results suggest that numbers at the Marsh Lake complex have declined by as much as 33.8% since 2012.

On Minnesota Lake, numbers decreased overall by 47.6% since 2012, returning to numbers similar to those reported in 2004. Nesting on the island site was limited by high water levels. Nesting on the adjacent agricultural field was initiated early in the summer (L. Gelvin-Innvaer, personal communication) but abandoned prior to the time we obtained aerial photographs.

At Lake of the Woods, numbers decreased by 15.3% as compared to 2012. Significant decreases occurred on Crowduck and Little Massacre Island. Nesting was not initiated on Red Lake Rock which was densely populated by Ring-billed Gulls.

A 12% increase in pelican numbers was estimated at Leech Lake in 2015. Nesting on Little Pelican Island decreased, but nesting was initiated on Pelican Island and Gull Island, both of which had not been utilized by pelicans in previous census years.

Although nesting was limited to the Vegetated Island site, Pigeon Lake experienced an increase in pelican numbers of 21.9% from 2012 to 2015. This represents the highest abundance on this lake since the beginning of formal statewide census efforts for this species in Minnesota.

Swartout Lake and Lake Johanna also had marked increases (53.4% and 3.2% respectively; Table 3) in pelicans. Nesting was also observed for the first time on a small island on Goose Lake in Pope County.

Changes in distribution and numbers of the Double-crested Cormorant. Cormorant nest estimates in 2015 (15,421) were very similar to numbers reported in 2004 and 2010 (16,002 and 15,425 respectively) (Table 4). The 2015 estimate was essentially identical to the 2010 count. Breeding distribution also remained approximately the same, with colonies located across much of the state, except for the northwest, southwest and southeast corners. Most colonies were documented in a region running diagonally through the central portion of the state between Ottertail County in the North, and Faribault County in the South (Figure 4).

As with previous surveys, 10 lakes and islands comprised more than 75% of the state's population; however, numbers changed significantly at several of these locations (Table 4; Figure 5). The most significant reduction occurred at Wells Lake, where cormorant numbers declined by 76%, representing a loss of 912 nests. As was the case in 2010, nesting on Lake of the Woods declined, this time by an additional 26% (452 nests). Noteworthy declines totaling 876 nests were also recorded at Pigeon, Leech, Hawks Nest, and Minnesota lakes. In addition, no nests were recorded at 9 lakes in 2015 that supported cormorant nesting in 2010, including Long Lake and Lake Waconia.

These substantial reductions were offset, however, by increases at other sites. Nesting on Lake Johanna increased by 58% (1,059 nests). Numbers on Upper Sakatah Lake and Egret Island increased by 68% (549 nests) and 20% (412 nests) respectively. In addition to the increase in 2010, Swartout Lake experienced an additional gain of 25% (235 nests). Several smaller but notable increases also occurred on Preston Lake, Marsh Lake, Chautauqua Lake, Mille Lacs, and Gooseberry Island. In total, these five locations accounted for 1,372 additional nesting pairs. Four previously inactive/uncensused sites (Grotto, Goose, Norway lakes and Lake Benton) supported an additional 104 nests.

Presence and estimates of other colonial waterbird species at cormorant colonies. In addition to cormorants and pelicans, six other nesting colonial waterbird species were documented during this census, including Black-crowned Night-Heron, Great Blue Heron, Great Egret, Ring-billed Gull, Herring Gull, Common Tern and Caspian Tern (Table 2). Figure 6 shows the locations of cormorant sites (approximately 30% of total) that had relatively high

colonial waterbird diversity (≥ 4 species). Great Blue Herons were the most common nesting associate, followed by Great Egrets, present at 17 (59%) and 14 (42%) of active cormorant colonies, respectively. Nesting by Black-crowned Night-Herons was confirmed at three sites; however, this species may have been present at additional sites but were missed due to census technique used or limitations at certain sites. As with previous census efforts, care taken to reduce disturbance to pelicans and cormorants (quick ground counts or aerial counts) reduced detectability of the secretive Black-crowned Night-Herons and thus estimates provided for this species should be regarded as minimum numbers. Figure 7 shows locations of cormorant sites (69% of total) shared with ≥ 1 wading bird species. Figures 6 and 7 also indicate that the 10 sites comprising most of the state's cormorant population were also characterized by high colonial waterbird diversity (70%), and were typically shared with waders (70%) and pelicans (60%). Results suggest that these sites are important for colonial waterbirds in general. As such, these sites should be considered priority monitoring sites during future monitoring efforts.

The percentage (100%) of Common Tern sites shared with cormorants increased in 2015 while the percentage that other species shared with cormorants either decreased or remained constant (Table 4). Pelican, Great Blue Heron, and Great Egret sites shared with cormorants have declined by 13%, 14%, and 12%, respectively, since 2010. There were marginal decreases in Ring-billed and Herring gull sites shared with cormorants.

It was not possible to accurately summarize numbers of cormorant sites shared with Black-crowned Night-Herons for reasons noted above. The large island on Long Lake, which supported two-thirds of Minnesota's night-heron population in 2004, had marked reductions in 2010 and no nesting by any species in 2015. However, a small mixed colony of Great Blue Herons and Great Egrets was established on the mainland to the northeast side of the lake. Another night-heron colony, Coney Island on Lake Waconia, was also lacking nests of any species in 2015.

As part of this census effort, we attempted to obtain estimates of Common Terns Co-occurring at cormorant sites. Common Tern nesting presence was verified at only 4 sites shared with cormorants and/or pelicans in 2015. These sites were: Hennepin Island, Mille Lacs; Pelican and Little Pelican Island, Leech Lake; and Techout Island, Lake of the Woods.

As in 2010, Caspian Tern nesting was limited to Little Pelican Island, Leech Lake. Since 2010, nests at this location have nearly tripled.

Monitoring changes in numbers of species at sites with control. During the summer of 2015, Wildlife Services oiled 391 nests at Potato Island, Lake Vermilion, and shot 1,040 adult cormorants on Leech Lake (G. Nohrenburg, personal communication, February 16, 2016). As mentioned above, control efforts in previous years have been undertaken on Knife Island, Lake Superior; Little Pelican Island, Leech Lake; Potato Island, Lake Vermilion; Lake of the Woods, Wells Lake, and Lake Waconia. Table 5 provides a summary of nest estimates from cormorant colonies where control was undertaken. Overall, sites with control had a 68% reduction in cormorant nests.

DISCUSSION

Detecting active sites. Efforts to detect active sites in 2015 appear adequate to determine current distribution and abundance for both pelicans and cormorants. In Minnesota, colonies of both species are typically very conspicuous and are usually discovered shortly after initiation. Given public concern about the fish consumption behavior of both species, new colonies are frequently reported to the DNR soon after they form. Therefore, “advertising” the census effort to wildlife personnel leads to more complete information on current distribution.

As was documented in the previous report, reviewing information on previous activity of individual sites helps to minimize the cost and effort of the census by eliminating visits to sites that have a high probability of inactivity. We now have a database with pertinent information to identify sites with high potential for nesting activity. Of the four cormorant/pelican sites that were inactive during previous surveys, and found to be active during this survey, one (Pelican Island) was associated with a lake (Leech Lake) that had other active colonies. Because this lake was visited to check on active sites, the previously inactive site (Pelican Island) that had recently become active had a high probability of being detected. The other three sites (Lake Benton, Norway Lake, and East Chain Lake) were identified as potential sites during the 2004 census, although they were found to be inactive at that time. These three sites only represented 43 cormorant nests and 48 pelican nests and do not show much potential for growth due to limited availability of nesting substrate. It is recommended that site history documented in this and the previous census be reviewed prior to subsequent surveys to help identify sites that will require visits and sites that can be assumed inactive.

Changes in numbers of pelicans. The complex of islands in Marsh Lake constitutes the most significant area in the state for breeding pelicans, but also one of the most important sites on the continent for this species (King and Anderson 2005). Despite the lowest recorded nest count during the five census periods, Marsh Lake persists as the site with the greatest portion of the Minnesota population. Nesting at this location spiked in 2004 and 2011 and dipped in 2010 and 2015. Given this cyclical pattern, it may be that the birds have reached carrying capacity at this site. Observed fluctuations may result from changes in water level and increased predator access (DiMatteo et. al 2015). Numbers may also be influenced by dispersal from other sites, especially the large colony at Chase Lake, ND. Despite lower than average numbers in 2015, the colony appears healthy (i.e. no unusual mortality; regular production of fledged juveniles) and Marsh Lake continues to support the majority of the state's population.

Several other large pelican colonies also exhibited cyclical trends similar to that observed at Marsh Lake. The population on Swartout Lake is increasing after a large decline in 2011. Nesting trends at this location appear to be driven primarily by highly variable water levels. Lake of the Woods and Minnesota Lake have returned to numbers closer to those recorded in 2004/05. At Lake of the Woods, reductions may be related to increasing Ring-billed Gull numbers but it is unclear whether these gulls are displacing other nesting species, or merely taking advantage of vacant habitat. The island on Minnesota Lake has become so dense with both nesting cormorants and pelicans that there is little space for colony growth. As a result, nest numbers at this site appear directly related to available habitat which is closely tied to water level. Lake Johanna and Pigeon Lake colonies have been steadily increasing in size since 2004. Johanna is not as susceptible to changes in water level as many other sites because of higher elevation; it also appears to have habitat for additional growth in coming years. Pelicans were densely packed on the Vegetated Island on Pigeon Lake with nearly all suitable habitat occupied by nesting birds.

Cormorant control was undertaken at only one site used by nesting pelicans in 2015, Little Pelican Island in Leech Lake. Despite repeated cormorant control efforts at Leech Lake, pelican numbers have steadily been increasing since 2004. As in previous years, Little Pelican and Gull islands both supported nesting birds. In addition, nesting was initiated on the larger Pelican Island to the north. This steady increase in nests suggests that disturbance caused by Leech Lake cormorant control is having little impact on pelicans. While this observation suggests cormorant management is not impacting pelicans, it is important to note that pelicans

are typically quite sensitive to human disturbance and we recommend that potential impacts of cormorant management be carefully considered prior to initiating control efforts at sites with pelicans and other nesting species.

Overall it appears that pelican numbers are relatively stable in Minnesota with few factors other than water level and predator access placing limitations on nesting. However, the portion of Minnesota's pelican population that nests on Marsh Lake has steadily decreased since 2004 from 84% to 63% as birds have apparently dispersed and other sites have become more established. This dispersal may make the state's population less vulnerable to site specific stochastic events such as storms, disease, and human caused disturbance. It is also possible that pelicans may move to sites outside of Minnesota if conditions at former breeding sites in the state are not suitable. Reciprocal movement between MN and ND may also account for notable fluctuations in Marsh Lake numbers since 2004. Data from banding efforts conducted during the last decade suggest some individuals from Marsh Lake disperse to adjacent states and Canadian provinces and that Marsh Lake may even be acting as a source population for new colonization (Jeff DiMatteo personal communication, May 2, 2016, unpublished data). Further efforts to color-mark or capture/recapture banded individuals from this and other sites are needed to better understand pelican movement among sites and ultimately to track population trends in Minnesota.

Changes in numbers of cormorants. While cormorant numbers and distribution across the state remained similar overall to results reported in 2004/05 and 2010, there have been substantial changes at individual sites. For example, declines continued to occur at Lake of the Woods and this decline was also observed in pelicans. The cause of these declines is uncertain as there was no obvious evidence of predator presence. An outbreak of Newcastle Disease was reported on Lake of the Woods in 2008 (White et al., 2015). Concern also exists that cormorants and pelicans may have been killed illegally on this lake. One or both of these events may have affected numbers in Lake of the Woods. O'Dell Island, which was abandoned in 2010 due to presence of a family of red foxes (*Vulpes vulpes*), has since been recolonized by cormorants and other nesting birds. Red Lake Rock however was not used by cormorants, but was instead occupied almost entirely by nesting Ring-billed Gulls. Cormorant numbers were greatly reduced on Techout Island but much of the habitat supported a dense Ring-billed Gull colony. Little

Massacre Island had fewer gulls in comparison to Techout but still had substantial declines in cormorant nesting.

The island on Long Lake, which supported more than 1,300 cormorant nests in 2004, was completely vacant during the summer of 2015. A quick survey of the island provided no clear indication of disturbance. There were a few old nests that could have been remnants of a failed attempt at nest initiation earlier in 2015 or perhaps nests still remaining from a previous year.

Changes related to cormorant control. Of the 10 lakes with the largest cormorant declines in 2015, three received control in 2010. Cormorants at Leech Lake, which has been the site of multiple cormorant control efforts over the last decade, declined approximately 80% since 2004. In 2015 1,040 adults were culled from Leech Lake between April 16 and June 25 (G. Nohrenburg, personal communication, February 16, 2016).

Coney Island on Lake Waconia had no nesting cormorants in 2015. Unfortunately, other nesting colonial waterbirds were also absent. Nesting was initiated by Great Blue Herons early in the season but they abandoned the site later in the season. The reason for abandonment is unknown.

Similar to Leech Lake and Lake Waconia, the number of nesting pairs also declined at Wells Lake between 2010 and 2015. However, there was a large increase in number of nesting Great Blue Herons. It is quite clear that cormorant control efforts are reducing cormorant numbers at this site, at least temporarily. What is less clear is the impact management may have on other species.

Other colonial waterbird species at cormorant sites. Counts of Black-crowned Night-Herons, Great Egrets and Common Terns decreased in 2015, while Great Blue Herons, Ring-billed and Herring gulls, and Caspian Terns increased.

The overall decline observed in numbers of Black-crowned Night-Herons is likely the result of several factors including cessation of nesting on Swartout and Long Lake, high numbers of other species on Egret Island, and a heavy reliance on aerial photography during this census. It is important to note that sites were visited based on cormorant or pelican presence and therefore several Black-crowned Night-Heron colonies likely have become established elsewhere.

Great Egret declines were minor and likely a function of redistribution among nest sites. As with herons, nests at Long Lake, which had been numerous in the past, were limited to a small colony on a peninsula in the northeastern part of the lake. Great Egrets also declined on

Egret Island possibly in response to the increased cormorant population at this site. Overall, Minnesota's nesting Great Egrets appear to be doing well and seem to have leveled off at numbers similar to those seen in 2010.

Both Common and Caspian terns were rarely observed during this census. Both species are uncommon nesters in Minnesota. A ground survey found Caspians in Leech Lake but using aerial photos, we were only able to document Common Terns breeding at one site in Lake of the Woods, Techout Island. A concurrent ground based effort (Herwig and Birchem, unpublished data) found Common Terns at two additional sites, Crowduck Island and Pine and Curry Island, in Lake of the Woods. Pine and Curry Island, however, was not included in our 2015 census. Common Terns were also recorded at two sites in Leech Lake and one in Mille Lacs.

It was also difficult to identify presence of Common Terns at some sites during the census. Reasons were related to census methods. We attempted to obtain and evaluate aerial photos at previously documented Lake of the Woods Common Tern sites and only could confirm presence of Common Terns at one site (Techout Island) in 2015. A concurrent effort (Herwig and Birchem, unpublished data) that visited potential Common Tern colony sites in the Northwest Angle found terns at Techout and Crowduck islands. Failure to find Common Terns in our Crowduck Island photos may have been due to nest habitat (dense vegetation that obscured or partially obscured the birds) or turbulence during the flight which limited the photographer's ability to locate terns and obtain in-focus photos. The best method to accurately census Common Terns is a direct ground count although presence of investigators in the colony may lead to predation on eggs or chicks by co-nesting gulls. Flights over potential tern colony sites can be useful to initially detect terns but ground visits are often necessary to confirm nesting, obtain estimates of breeding pairs and productivity.

Again, Ring-billed Gull abundance may have played a role in limiting nesting habitat available to other species on this lake but Commons have a history of variable numbers and movement among sites in Lake of the Woods so it is likely nesting birds were missed or relocated in Canadian waters during 2015. Common Tern numbers on Mille Lacs and Leech Lake were similar to those reported during previous census years.

CONCLUSIONS AND RECOMMENDATIONS

Double-crested Cormorants. Results of this census indicate that the breeding population of cormorants is stable and the species continues to be relatively abundant and wide spread in Minnesota. Additionally, significant declines due to unknown causes have occurred in specific areas, such as Lake of the Woods. Important questions regarding effectiveness and effect of cormorant control on numbers of nesting cormorants remain unanswered and require further study. The effect of cormorant control on the productivity of non-target cormorants is also unknown. Therefore, we have the following recommendations:

- 1) Continue statewide monitoring for cormorants every five years as long as cormorant management is undertaken to determine population trends, identify locations where important changes may be occurring, and to evaluate how cormorant management is affecting the state's population.
- 2) As a starting point, conduct complete nest counts of cormorants at all sites where cormorant control is undertaken both before and after control occurs to determine how control affects nesting numbers.
- 3) Obtain observations on cormorant productivity at sites where cormorant control has occurred to determine effect on non-target cormorants.
- 4) Conservation status should be considered for yet unprotected cormorant priority monitoring sites (those with the greatest number of cormorant nests in 2015) because they have high colonial waterbird diversity and are typically shared with waders and pelicans. We suggest these sites are important for colonial waterbirds in general. Sites fitting this description include Chautauqua, Minnesota, Swartout, and Upper Sakatah lakes, as well as Lake of the Woods (specifically Crowduck, Little Massacre, O'Dell, Red Lake Rock, and Techout islands).

American White Pelican. Results of this census indicate that the breeding population of pelicans in Minnesota may be stabilizing (at least temporarily) between 16,000 and 22,000 nesting pairs. Several sites experienced substantial declines since the peak in 2011. Declines may be due to water level fluctuations and/or other unknown factors (e.g. predation; disease; immigration outside of Minnesota; illegal control; delayed effect of the Deep Water Horizon

spill; sampling error). Because the exact cause of these recent declines is unknown, we make the following recommendations:

- 1) Continue statewide monitoring for pelicans every five years, as long as public requests for their management are made, in order to estimate population trends and identify locations where important changes may be occurring.
- 2) Maintain current status as Special Concern. The limited number of breeding sites used by this species and the resulting aggregation of pairs at particular locations makes this species vulnerable to stochastic events.

Other colonial waterbird species. Great Blue Herons, Great Egrets and Black-crowned Night-Herons are frequent nesting associates at cormorant colonies, and besides pelicans, the species most likely to be impacted by cormorant nesting and/or control activities. Although changes have occurred in their numbers at cormorant colonies, it is not possible to determine if these changes are meaningful at a state population level because no statewide census has been undertaken and complete information on the distribution and abundance of these species is lacking. Such information is particularly important for the Black-crowned Night-Heron, which is identified as a SGCN in Minnesota. Also, no information exists on how cormorant management at tree-nesting colonies affects productivity of these species. Therefore, we have the following recommendations:

- 1) Determine distribution and abundance of the Great Blue Heron, Great Egret and Black-crowned Night-Heron in Minnesota through a statewide census for these species before the next cormorant census. This information will provide important data on percent of site overlap with cormorants, and status of each species.
- 2) Determine pre- and post-control nesting numbers of each species present at cormorant colonies where control occurs.
- 3) Estimate productivity for these three wader species at sites where cormorant management has occurred.

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Table 1. Potential American White Pelican and Double-crested Cormorant sites and survey status in MN in 2015.

Occ #	Colony	County	Ownership ¹	Latitude	Longitude	Status ²
973	Barry Lk WPA	Big Stone	USFWS	45.5728	-96.5778	1
471	BLM 80-Knife Is	Lake	BLM	46.9469	-91.7741	1
68	Chautauqua Lk	Otter Tail	BLM	46.2383	-96.0202	1
10	Egret Is	Grant	TNC	46.0511	-95.8039	1
720	Goose Lk	Pope	Goose Lake Gun Club Inc.	45.4428	-95.3300	1
881	Gooseberry Is	Crow Wing	Private	46.5825	-94.1847	1
NA-026	Grotto Lk	Ottertail		46.2762	-96.0625	1
1054	Hawks Nest Lk	Lincoln	State of MN (Sec of Wildlife)	44.4755	-96.2017	1
103	Hennepin Is	Mille Lacs	USFWS	46.1792	-93.5311	1
1004	Lk Alice	Otter Tail	City of Fergus Falls	46.2886	-96.0761	1
520	Lk Benton	Lincoln		44.2726	-96.2589	1
47	Lk Hassel	Swift	Swift Co.	45.3925	-95.5667	1
117	Lk Johanna	Pope	DNR (SNA)	45.4633	-95.2231	1
162	Leech Lk - Gull Is	Cass	BIA - Leech Lake Band of Ojibwe	47.1019	-94.3750	1
916	Leech Lk - Little Pelican Is	Cass	BIA - Leech Lake Band of Ojibwe	47.1061	-94.3719	1
NA-028	Leech Lk - Pelican Is	Cass		47.1113	-94.3720	1
379	Lk Vermilion - Potato Is	St. Louis	BLM	47.8567	-92.3076	1
229	LOW - Crowduck Is	Lake of the Woods	BIA - Red Lake Band of Ojibwe	49.2539	-94.8856	1
112	LOW - Gull Rock	Lake of the Woods		48.9847	-95.0592	1
319	LOW - Little Massacre Is	Lake of the Woods	BIA - Red Lake Band of Ojibwe	49.1864	-94.8106	1
231	LOW - O'Dell Is	Lake of the Woods	BIA - Red Lake Band of Ojibwe	49.2608	-94.8633	1
235	LOW - Techout Is	Lake of the Woods	DNR	49.2661	-94.8714	1
633	Marsh Lk - Banding Is	Big Stone	DNR Wildlife	45.1934	-96.1278	1
890	Marsh Lk - Big Is	Lac Qui Parle	DNR Wildlife	45.1884	-96.1311	1
39	Marsh Lk - Rock Is	Big Stone	DNR Wildlife	45.1980	-96.1525	1
NA-007	Marsh Lk - Small Is	Big Stone	DNR Wildlife	45.1890	-96.1354	1
NA-019	Mink Lk	Wright	The Courage Center	45.2695	-94.0427	1
69	Minnesota Lk	Faribault	MNDNR	43.8347	-93.8764	1
1051	Norway Lk	Otter Tail		46.3159	-95.8972	1
897	O'Brien Lk	Itasca	Blandin Paper	47.3228	-93.1353	1
1031	Pigeon Lk	Meeker	DNR Wildlife	45.0399	-94.3509	1
1031.2	Pigeon Lk (Veg-Middle)	Meeker		45.0371	-94.3490	1
90	Pigs Eye Lk	Ramsey	Ramsey Co.	44.9000	-93.0258	1
1040	Preston Lk	Renville	Private	44.7885	-94.5398	1
102	Spirit Is	Mille Lacs	USFWS	46.1519	-93.6444	1
879	Swartout Lk	Wright	Private - Larry Hoffman	45.2300	-94.0800	1
972	Swenson Lk	Big Stone	Maurice Swenson	45.3997	-96.4189	1
832	Upper Sakatah Lk	Rice		44.2302	-93.5194	1
1002	Wells Lk	Rice	Private - Elmer and Alice Fuchs	44.2892	-93.3484	1
325	West Two Rivers Reservoir	St. Louis	US Steel	47.4990	-92.6472	1
940	Anderson Lk WMA	Lincoln	DNR	44.4458	-96.3208	2
152	Artichoke Lk	Big Stone		45.3553	-96.1403	2
NA-025	Ash Lk	St. Louis		48.2075	-92.9324	2
153	Big Stone Lk (NWR)	Lac Qui Parle	USFWS	45.2375	-96.3125	2

Table 1. Potential American White Pelican and Double-crested Cormorant sites and survey status in MN in 2015.

Occ #	Colony	County	Ownership ¹	Latitude	Longitude	Status ²
1043	Big Twin Lk	Martin		43.7290	-94.7505	2
52	Blue Lk (MN Valley NWR)	Scott	USFWS	44.8056	-93.4403	2
813	Bolland Slough	Lac Qui Parle	DNR Wildlife	44.8959	-96.3583	2
1041	Clifford Lk	Douglas	Private	45.8372	-95.1570	2
NA-013	Crystal Lk	Hennepin		45.0270	-93.3271	2
326	Dark River Tailings Pond	St. Louis	US Steel - MN Tac	47.6141	-92.6209	2
811	Diamond Lk	Hennepin	Minneapolis Park Board	45.2033	-93.5089	2
NA-014	E Chain Lk	Martin		43.5248	-94.3676	2
522	Elysian Lk	Waseca	Private (Several) - Kent Barbknecht	44.1575	-93.7028	2
NA-016	Geneva Lk	Freeborn		43.8083	-93.2393	2
597	Gull Lk	Beltrami		47.6618	-94.7185	2
648	Haldorsen Lk	Otter Tail	Private	46.4170	-96.1828	2
NA-017	Hanska Lk	Brown	DNR Wildlife	44.1402	-94.6124	2
NA-018	Iverson Lk	Otter Tail		46.2246	-96.0605	2
636	Ladyslipper Lk	Lyon		44.5717	-95.6313	2
NA-027	Lk Washington	Le Sueur		44.2468	-93.8682	2
1042	Lindquist WMA	Big Stone	DNR Wildlife	45.3430	-96.3157	2
805	Little Elk WMA	Morrison	DNR Wildlife	46.0595	-94.6174	2
656	Little Pine Is, Voyageurs NP	St. Louis	USNPS	48.4534	-92.9212	2
206	Long Lk	Kandiyohi	Private	45.2000	-95.0417	2
320	LOW - Bridges Is	Lake of the Woods		49.1250	-94.7769	2
NA-015	LOW - Fourblock Is	Lake of the Woods		49.2750	-94.8858	2
NA-031	LOW - Joshua's Reef	Lake of the Woods		49.2580	-94.8892	2
230	LOW - Red Lk Rock	Lake of the Woods	Private	49.2636	-94.8686	2
NA-029	LOW - Stoney Point	Lake of the Woods		49.1536	-95.1450	2
242	Lyseng Lk	Big Stone	Private - C. Fletcher	45.4177	-96.4215	2
NA-006	Marsh Lk - Currie Is	Big Stone	DNR Wildlife	45.1894	-96.1194	2
353	Marsh Lk - Peninsula	Big Stone	DNR Wildlife	45.1945	-96.1312	2
NA-008	Minnesota Lk Ag field	Faribault	Private	43.8271	-93.8747	2
422	MNDNR-36 Guano Rock	Cook	MNDNR	47.7635	-90.2369	2
620	N Heron Lk	Jackson	Private - A. Thompson	43.7626	-95.2625	2
240	Otrey Lk	Big Stone	Hanson-Otrey Hunting Club	45.3553	-96.3300	2
NA-020	Pelican Lk	St. Louis		48.0639	-92.9471	2
NA-021	Ramsey Lk	Wright		45.2082	-93.9965	2
850	Red Lk (Resv)	Beltrami	BIA - Red Lake Band of Ojibwe	48.0897	-95.0075	2
NA-022	Rothi WPA	Big Stone		45.3256	-96.2889	2
185	Shield's Lk	Rice	Rice Co.	44.3708	-93.4500	2
NA-023	Swede's Bay	Le Sueur		44.2638	-93.7658	2
155	Thielke Lk	Big Stone	MNDNR	45.3889	-96.3917	2
481	Titlow Lk	Sibley	Town of Gaylord	44.5656	-94.2128	2
NA-024	Vinge Lk	Otter Tail	Private	46.1615	-95.8801	2
638	W Toqua	Big Stone	Big Stone Hutterian Brethren Inc.	45.5519	-96.4614	2
863	Waconia Lk	Carver	Private - Norm Hoffman	44.8612	-93.7842	2
NA-030	Wheeler Lk	Kandiyohi		45.1701	-94.7960	2

Table 1. Potential American White Pelican and Double-crested Cormorant sites and survey status in MN in 2015.

Occ #	Colony	County	Ownership ¹	Latitude	Longitude	Status ²
601	Agass. NWR - Ditch 11 Ban	Marshall	USFWS	48.3178	-95.9950	3
602	Agass. NWR - Madsen Pool	Marshall	USFWS	48.3203	-96.0267	3
5	Agass. NWR-Cormorant Is	Marshall	USFWS	48.3300	-95.9739	3
NA-001	Albert Lea Lk	Freeborn	Private - Al Batt	43.6231	-93.3255	3
195	Big Cormorant Lk	Becker		46.7719	-96.0536	3
NA-010	Big Sandy	Aitkin		46.7641	-93.2730	3
NA-011	Blackduck Lk	St. Louis		48.2012	-92.8192	3
506	Blackduck Lk Is	Beltrami	DNR	47.7342	-94.6211	3
251	Boyer Lk	Becker	BLM	46.8711	-96.0467	3
425	Butterwort Cliffs	Cook	DNR Parks	47.7164	-90.4833	3
164	Campbell Lk	McLeod		44.9408	-94.0151	3
44	Cedar Lk	McLeod	Private - C. Stone and R. & G. Mills	44.9819	-94.4583	3
121	Clear Lk	Stevens		45.5578	-96.0722	3
110	Clearwater R	Clearwater	BIA - Red Lake Band of Ojibwe	47.8528	-95.4508	3
941	Coon Creek WMA	Lyon	DNR Wildlife	44.3403	-96.0486	3
36	Dassel Marsh	Meeker	Private - D. Arnlend	45.0883	-94.2711	3
89	Durgin Slough	Sherburne	USFWS	45.4758	-93.7600	3
30	E Black Cinder Swamp	Sherburne	USFWS	45.4792	-93.7056	3
NA-002	Grove	Otter Tail	Private(several) - Wayne Augustus	46.6333	-96.1585	3
62	Gun Club Lk	Dakota	DNR Parks	44.8536	-93.1952	3
37	Lk Jefferson	Le Sueur	Private - O. Schickling	44.2653	-93.7764	3
43	Lk Monongalia	Kandiyohi	Private	45.3342	-94.9444	3
751	Lk Oliver	Swift	Private - H. & L. Heinecke	45.3281	-96.0097	3
634	Lk Reno South	Pope	Private - L. & H. Landa	45.7256	-95.4361	3
616	Little Kandiyohi Lk	Kandiyohi		45.0717	-94.9467	3
589	Lk Minnetonka - Crane Is	Hennepin	Crane Island Association	44.9008	-93.6619	3
224	LOW - Rocky Point	Lake of the Woods	DNR Wildlife	48.9600	-95.0340	3
341	Lura Lk	Faribault		43.8458	-94.0453	3
378	Manganika Lk South	St. Louis	US Steel	47.4906	-92.5728	3
883	Maplewood	Otter Tail	DNR Parks	46.5192	-95.9772	3
54	Mission Creek	Crow Wing	MN Lung Association, DNR Forestry	46.5127	-94.0774	3
423	MNDNR-37 Rock Is, Terrace Point Rk	Cook	MNDNR	47.7269	-90.4103	3
340	MNDNR-79 Encampment Is	Lake	MNDNR	46.9469	-91.7741	3
764	N School Section L	Washington		45.1442	-92.9150	3
478	Nest Lk	Kandiyohi		45.2592	-94.9636	3
839	New Germany	Carver	Private - R. & J. Anderson	44.8800	-94.0019	3
523	North Spellman Lk	Yellow Medicine		44.6716	-95.7735	3
788	Otter Lk	McLeod	Private - F. & A. Wendroth	44.8650	-94.4172	3
33	Pelican Lk	Wright	MNDNR	45.2278	-93.7722	3
734	Pelican Lk Is	Pope		45.6527	-95.4490	3
590	Pelican Lk South	Wright	MNDNR	45.2139	-93.7544	3
NA-012	Prairie Farms Marsh	Lac Qui Parle		44.9196	-96.3651	3
321	Red Lk River	Clearwater	BIA - Red Lake Band of Ojibwe	47.9606	-95.2972	3

Table 1. Potential American White Pelican and Double-crested Cormorant sites and survey status in MN in 2015.

Occ #	Colony	County	Ownership ¹	Latitude	Longitude	Status ²
122	Rice Lk Is	Aitkin	USFWS	46.5097	-93.3881	3
194	Rice Lk Ridge	Aitkin	USFWS	46.5275	-93.3167	3
14	Rice River	Aitkin	DNR Wildlife	46.5558	-93.3940	3
64	Root River Delta (Hokah #2)	Houston	USFWS	43.7675	-91.2528	3
215	Roseau WMA Pool 1	Roseau	DNR Wildlife	48.9601	-96.5400	3
101	Rush Lk	Chisago	DNR Wildlife	45.6733	-93.0958	3
177	S Heron Lk	Jackson	Private - W. Pohlman	43.7486	-95.2533	3
216	Sand Lk	Becker	Private - J. & M. Rian	46.8708	-96.1742	3
548	Schible Lk	Swift		45.2539	-96.0508	3
59	Schilling Lk	Sibley		44.6981	-94.2119	3
86	Sioux Lk	Meeker	Private - G. Wolfe	45.0250	-94.4653	3
806	Staples WMA	Todd	DNR Wildlife	46.2881	-94.7922	3
582	Sugar Impoundment	Itasca	DNR	47.4561	-94.3492	3
516	Sunburg Lk Peninsulas	Kandiyohi		45.3297	-95.2506	3
685	Upper Lightening Lk East	Otter Tail		46.1380	-96.1583	3
749	Vermilion Rocks #1 (Vermilion Lk)	St. Louis	BLM	47.8681	-92.2636	3
757	Vermilion Rocks #2 (Vermilion Lk)	St. Louis	BLM	47.8689	-92.2710	3
NA-009	Vermilion Rocks #3 (Vermilion Lk)	St. Louis	BLM	47.8716	-92.2632	3
848	Cormorant Is	Winona	USFWS	43.8919	-91.2933	4
849	Cormorant Is 2	Winona	USFWS	43.8919	-91.2933	4
210	Dog Lk	Kandiyohi		44.9556	-94.8375	4
241	Eli Lk	Big Stone		45.4661	-96.4306	4
151	Gorder Lk	Stevens		45.5180	-96.0204	4
1023	Hanson Slough (Lk)	Big Stone		45.3793	-96.3015	4
NA-003	Harstad Slough North	Stevens		45.6967	-96.0006	4
95	Howard Lk	Anoka	DNR Wildlife	45.2661	-93.0361	4
8	Kabekona Lk	Hubbard	DNR Wildlife	47.1664	-94.7703	4
211	Lk Lillian	Kandiyohi		44.9436	-94.8797	4
733	Lk Charlotte Mainland	Stevens		45.6178	-95.7744	4
570	Lone Pine - 1 (Pond 2 North)	Itasca	US Steel, Kee Tac	47.3592	-93.0803	4
NA-004	Lone Pine - 2 (Pond 6)	Itasca	US Steel, Kee Tac	47.3751	-93.0846	4
NA-005	Lone Pine - 3 (Pond 2)	Itasca	US Steel, Kee Tac	47.3583	-93.1018	4
542	Moonan WMA	Waseca	DNR Wildlife	44.1167	-93.4314	4
531	Mud Lk	Traverse		45.8617	-96.5728	4
611	Stuntz	St. Louis	US Steel, Hubb Tac	47.5200	-92.9772	4
71	Taconite Pond	St. Louis	US Steel, Utac	47.3442	-92.5533	4
329	Burlington	Winona				5
714	Smith Slough	In Wisc.				5
491	Trempealeau NWR	Winona	USFWS	44.0500	-91.5875	5
716	Little Pelican Spit	Cass	BIA - Leech Lake Band of Ojibwe	47.1088	-94.3725	6

¹ For all active cormorant and pelican breeding sites ownership information was provided with the exception of Gull Rock/Lake of the Woods and Upper Sakatah Lake, where ownership could not be obtained. Additionally, for a few active sites ownership category was determined to be private, but individual owner could not be identified. For all other sites ownership information was provided when available.

² Site Status: 1 = site visited, cormorants and/or pelicans nesting; 2 = site visited, no cormorant or pelican nesting; 3 = site not visited, assumed inactive due to various factors (e.g., time since last active, predators); 4 = site not visited due to inappropriate habitat; 5 = site outside study area; 6 = site no longer exists.

Table 2. Species composition, nest numbers & survey methodology at American White Pelican & Double-crested Cormorant colonies, 2015 (Species codes¹). * Indicates individual count, not nest number.

Oc. #	Site Name	Date	AWPE	DCCO	BCNH	GBHE	GREG	RBGU	HERG	COTE	CATE	Count Method ²
973	Barry Lk WPA	5/19	0	131	PND	10	0	0	0	0	0	ATC
471	BLM 80-Knife Is	5/27	0	116	0	0	0	0	1536	0	0	GTC, GPC (HERG)
68	Chautauqua Lk	6/8	0	693	0	0	0	0	0	0	0	ATC
1041	Clifford Lk (Swim Lk)	5/15	0	0	PND	9	0	0	0	0	0	GTC
863	Coney Is, Waconia Lk	4/29	0	0	PND	69 ³	0	0	0	0	0	ATC
10	Egret Is	5/22	0	2065	6	275	1532	0	0	0	0	GTC
720	Goose Lk	4/29	48	37	PND	8	0	0	0	0	0	ATC
881	Gooseberry Is	6/5	0	415	0	20	0	3000	0	0	0	GTC, Est. (RBGU)
NA-026	Grotto Lk	5/15	0	46	1	0	106	0	0	0	0	GTC
1054	Hawks Nest Lk	5/13	0	238	0	0	12	0	0	0	0	GTC
656	Little Pine Is, Voyageurs N.P.	6/9	0	P	PND	0	0	0	37	0	0	ATC
1004	Lk Alice	5/15	0	42	0	0	0	5	0	0	0	GTC
520	Lk Benton	5/19	P	6	PND	6	0	P	P	P	0	ATC
47	Lk Hassel	4/29	0	307	PND	84	205	0	0	0	0	ATC
117	Lk Johanna	4/29	1966	1841	PND	68	338	P	0	0	0	ATC
206	Long Lk	5/23	0	0	PND	81	9	0	0	0	0	GTC
NA-019	Mink Lk	5/8	0	37	PND	110	2	0	0	0	0	GTC
69	Minnesota Lk	5/19	979	1097	0	5	2	P	0	0	0	ATC
422	MNDNR 36 Guano Rock	6/9	0	0	0	0	0	0	59	0	0	ATC
1051	Norway Lk	6/8	0	15	PND	0	0	0	0	0	0	ATC
897	O'Brian Lk	6/8	P	25	PND	14	0	0	0	0	0	ATC
90	Pigs Eye Lk	5/21	0	118	2	253	181	0	0	0	0	GTC
379	Potato Is, Lk Vermilion	5/12	0	339	0	0	0	0	254	0	0	GTC
1040	Preston Lk	4/29	0	450	PND	69	55	0	0	0	0	ATC
879	Swartout Lk	5/19	378	937	PND	44	253	P	0	0	0	ATC
972	Swenson Lk	5/19	P	142	PND	30	0	0	0	0	0	ATC
832	Upper Sakatah Lk	4/29	P	808	PND	105	149	0	0	0	0	ATC
1002	Wells Lk	4/29	0	285	PND	302	126	0	0	0	0	ATC
325	West Two Rivers Reservoir	6/8	P	51	0	0	0	0	0	0	0	ATC
Lake of the Woods												
229	Crowduck Is	6/9	70	P	0	0	0	3416	0	PND	0	ATC, APC (RBGU)
112	Gull Rock	6/9	0	64	0	0	0	0	14	PND	0	ATC
319	Little Massacre Is	6/9	167	323	0	0	0	150	120	PND	0	ATC, APC (RBGU, HERG)
231	O'Dell Is.	6/9	527	823	0	0	0	0	8	PND	0	ATC
230	Red Lk Rock	6/9	0	0	0	0	0	3000	0	PND	0	ATC, APC (RBGU)
235	Techout Is	6/9	113	30	0	0	0	2000	0	167*	0	ATC, APC (RBGU)
Lake of the Woods Total			877	1240	0	0	0	8566	142	167*	0	
Leech Lake												
162	Gull Is	6/10	23	105	0	0	0	0	19	0	0	ATC
916	Little Pelican Is	6/9	108	391	0	0	0	2920	0	78	130	ATC, GTC (COTE, CATE)
NA-028	Pelican Is	4/29	226	0	0	0	0	250	0	85	0	ATC, GTC (COTE)
Leech Lake Total			357	496	0	0	0	3170	19	163	130	

Table 2. Species composition, nest numbers & survey methodology at American White Pelican & Double-crested Cormorant colonies, 2015 (Species codes¹). * Indicates individual count, not nest number.

Oc. #	Site Name	Date	AWPE	DCCO	BCNH	GBHE	GREG	RBGU	HERG	COTE	CATE	Count Method ²
Marsh Lake												
633	Banding Is	5/19	4159	0	0	0	0	0	0	0	0	ATC
890	Big Is	5/19	5376	914	0	0	41	0	0	0	0	ATC
39	Rock Is	5/19	P	225	0	0	0	500	0	0	0	ATC, APC (RBGU)
NA-007	Small Is	5/19	754	0	0	0	14	0	0	0	0	ATC
Marsh Lake Total			10289	1139	0	0	55	500	0	0	0	
Mille Lacs												
103	Hennepin Is	6/8	0	5	0	0	0	188	0	118	0	ATC
102	Spirit Is	6/8	0	514	0	0	0	0	P	0	0	ATC
Mille Lacs Total			0	519	0	0	0	188	0	118	0	
Pigeon Lake												
1031	Bare Is	5/28	0	826	0	8	7	P	0	0	0	GTC
1031.2	Vegetated Is	4/29	1512	960	PND	171	6	0	0	0	0	GTC (AWPE), ATC (DCCO, GBHE, GREG)
Pigeon Lake Total			1512	1786	0	179	13	0	0	0	0	
Total Nests			16406	15421	9	1741	3038	15429	2047	281	130	

¹Species Codes: AWPE = American White Pelican, DCCO = Double-crested Cormorant, BCNH = Black-crowned Night-Heron, GBHE = Great Blue Heron, GREG = Great Egret, RBGU = Ring-billed Gull, HERG = Herring Gull, COTE = Common Tern, CATE = Caspian Tern.

²NA = Not applicable, no use by DCCO/AWPE; ATC = Aerial Photo, Total Count; APC = Aerial Partial Count w/ Extrapolation; BUK = Boat, Unknown/Not recorded; GTC = Ground Total Count; GPC = Ground Partial Count; PND = Possible/Not Detected

³Nests were abandoned later in the season.

P = Present Not-Nesting

Table 3. American White Pelican Sites & Nest Counts from Five Censuses from 2004 to 2015.

Site	2004/05	2010	2011	2012	2015
Big Twin Lk	16	0	0	0	0
Goose Lk	0	0	0	0	48
Hanska Lk	0	3	0	0	0
Lk Hassel	19	0	0	0	0
Lk Johanna	97	735	1203	1904	1966
Red Lk	340	0	0	0	0
Swartout Lk	49	913	11	176	378
Lake of the Woods					
Crowduck Is	242	408	160	193	70
Little Massacre Is	277	185	533	248	167
O'Dell Is	25	0	450	442	527
Red Lk Rock	0	292	43	60	0
Techout Is	25	143	126	93	113
LOW Total	569	1028	1312	1036	877
Leech Lake					
Gull Is	0	0	0	0	23
Pelican Is	0	0	0	0	226
Little Pelican Is	11	174	239	314	108
Leech Lake Total	11	174	239	314	357
Marsh Lake					
Banding Is	4160 ¹	684	1074	3579	4159
Big Is	5292 ¹	1082	279	6465	5376
Currie Is	0 ¹	4813 ²	6245	5163	0
Peninsula	2706 ¹	4650 ²	8983	0	0
Small Is	1020 ¹	4	0	337	754
Marsh Lake Total	13178	11233	16581	15544	10289
Minnesota Lake					
Minnesota Lk	974	622	429	1868	979
Ag Field	0	748	1458	0	0
Minnesota Lake Total	974	1370	1887	1868	979
Pigeon Lake					
Bare Is	357	24	6	115	0
Vegetated Is	0	519	1267	1066	1512
Pigeon Lake Total	357	543	1273	1181	1512
Total	15610	15999	22506	22023	16406

¹ Counts for these sites were conducted in 2005

² Based on total count and extrapolation, see Table 2.

Table 4. Estimates for each colonial waterbird species in 2004, 2010, and 2015 at American White Pelican and Double-crested Cormorant Colonies; * indicates individual count, not nest count.

Oc. #	Site Name	AWPE			DCCO			BCNH			GBHE			GREG			RBGU			HERG			COTE			CATE		
		2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015
973	Barry Lk WPA	0	0	0	79	42	131	0	0	PND	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
1043	Big Twin Lake	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
471	BLM 80-Knife Is	0	0	0	26	103	116	0	0	0	0	0	0	0	0	0	0	0	225	729	1536	0	0	0	0	0	0	
813	Bolland Slough	0	P	0	50	19	0	0	0	0	16	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
68	Chautauqua Lk	0	0	0	401	414	693	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
1041	Clifford Lk (Swim Lk)	0	0	0	48	30	0	0	0	PND	47	26	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
863	Coney Is, Waconia Lk	0	0	0	250 ¹	425	0	0	11	PND	350	156	69 ²	350	169	0	0	0	0	0	0	0	0	0	0	0	0	
326	Dark River Tailings Pond	0	NA	0	70	NA	0	NC	NA	0	17	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	
10	Egret Is	0	0	0	1,385	1653	2065	47	46	6	170	292	275	271	1734	1532	0	0	0	0	0	0	0	0	0	0	0	
522	Elysian Lk	0	NA	0	205	NA	0	0	NA	0	48	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	
720	Goose Lk	0	NC	48	0	NC	37	0	NC	PND	0	NC	8	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	
881	Gooseberry Is	NA	0	0	NA	50	415	NA	0	0	NA	25	20	NA	0	0	NA	1500	3000	NA	4	0	NA	0	0	NA	0	
NA-026	Grotto Lk	NC	NC	0	NC	NC	46	NC	NC	1	NC	NC	0	NC	NC	106	NC	NC	0	NC	NC	0	NC	NC	0	NC	NC	
648	Haldorsen Lk	0	NA	0	20	NA	0	?	NA	0	?	NA	0	?	NA	0	?	NA	0	?	NA	0	0	NA	0	0	NA	
NA-017	Hanska Lk	NA	3	P	NA	38	P	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	
1054	Hawks Nest Lk	NA	0	0	NA	408	238	NA	0	0	NA	0	0	NA	69	12	NA	0	0	NA	0	0	NA	0	0	NA	0	
1042	Lindquist WMA	0	0	P	32	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
805	Little Elk WMA	0	0	P	49	0	0	P	0	PND	P	0	0	P	0	0	0	0	0	0	0	0	0	0	0	0	0	
656	Little Pine Is, Voyageurs N.P.	0	0	0	173	123	P	0	0	PND	0	0	0	0	0	0	0	0	0	N-NC	0	37	0	0	0	0	0	
1004	Lk Alice	0	0	0	49	88	42	0	0	0	0	0	0	117	55	0	0	0	5	0	0	0	0	0	0	0	0	
520	Lk Benton	NC	0	P	NC	0	6	NC	0	PND	NC	0	6	NC	0	0	NC	0	P	NC	0	P	NC	0	P	NC	0	
47	Lk Hassel	19	0	0	54	264	307	0	0	PND	36	28	84	4	35	205	0	0	0	0	0	0	0	0	0	0	0	
117	Lk Johanna	97	735	1966	580	782	1841	15	NC	PND	20	23	68	500	449	338	0	0	P	0	0	0	0	0	0	0	0	
206	Long Lk	0	0	0	1,363	747	0	207	7	PND	140	243	81	427	233	9	0	0	0	0	0	0	0	0	0	0	0	
NA-019	Mink Lk	NA	0	0	NA	43	37	NA	0	PND	NA	96	110	NA	0	2	NA	0	0	NA	0	0	NA	0	0	NA	0	
422	MNDNR 36 Guano Rock	0	0	0	24	14	0	0	0	0	0	0	0	0	0	0	0	0	P	32	59	0	0	0	0	0	0	
1051	Norway Lk	NC	NC	0	NC	NC	15	NC	NC	PND	NC	NC	0	NC	NC	0	NC	NC	0	NC	NC	0	NC	NC	0	NC	NC	
897	O'Brian Lk	NA	0	P	NA	43	25	NA	0	PND	NA	0	14	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	
90	Pigs Eye Lk	0	0	0	150 ³	169	118	NC	13	2	450	154	253	550	203	181	0	0	0	0	0	0	0	0	0	0	0	
1040	Preston Lk	0	P	0	186	253	450	0	0	PND	30	43	69	0	17	55	0	0	0	0	0	0	0	0	0	0	0	
850	Red Lake	340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
879	Swartout Lk	49	913	378	86	703	937	14	NC	PND	65	17	44	45	103	253	0	0	P	0	0	0	0	0	0	0	0	
972	Swenson Lk	0	P	P	271	230	142	0	0	PND	5	40	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
832	Upper Sakatah Lk	NA	P	P	NA	259	808	NA	0	PND	NA	9	105	NA	19	149	NA	0	0	NA	0	0	NA	0	0	NA	0	
NA-024	Vinge Lk	NA	0	0	NA	12	0	NA	0	PND	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	
1002	Wells Lk	0	0	0	472	1197	285	0	0	PND	87	138	302	144	201	126	0	0	0	0	0	0	0	0	0	0	0	
325	West Two Rivers Reservoir	0	0	P	47	102	51	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lake Vermilion																												
379	Potato Is	NA	P	0	NA	307	339	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	287	254	NA	0	0	NA	0	0
749	Vermillion Rocks #1	0	NA	0	32	NA	0	0	NA	0	0	NA	0	0	NA	0	NC	NA	0	chicks	NA	0	0	NA	0	0	NA	0
Lake Vermilion Total		0	0	0	32	307	339	0	0	0	0	0	0	0	0	0	0	0	0	0	287	254	0	0	0	0	0	0

Table 4. Estimates for each colonial waterbird species in 2004, 2010, and 2015 at American White Pelican and Double-crested Cormorant Colonies; * indicates individual count, not nest count.

Oc. #	Site Name	AWPE			DCCO			BCNH			GBHE			GREG			RBGU			HERG			COTE			CATE				
		2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015		
Lake of the Woods																														
229	Crowduck Is	242	408	70	447	73	P	0	0	0	0	0	0	0	0	0	0	0	2	0	3416	27	0	0	0	195	PND	0	0	0
112	Gull Rock	0	0	0	66	65	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	N-NC	14	0	0	PND	0	0	0
319	Little Massacre Is	277	185	167	1,363	918	323	0	0	0	0	0	0	0	0	0	0	0	0	500	150	8 chicks	N-NC	120	0	0	PND	0	0	0
231	O'Dell Is.	25	0	527	1,889	0	823	0	0	0	0	0	0	0	0	0	0	0	7	0	0	18	0	8	250	0	PND	0	0	0
230	Red Lk Rock	NA	292	0	NA	159	0	NA	0	0	NA	0	0	NA	0	0	NA	2000	3000	NA	P	0	NA	0	PND	NA	0	0	0	
235	Techout Is	25	143	113	605	477	30	0	0	0	0	0	0	0	0	0	0	0	177	500	2000	0	0	0	0	87	167*	0	0	0
Lake of the Woods Total		569	1028	877	4370	1692	1240	0	0	0	0	0	0	0	0	0	0	0	186	3000	8566	49	0	142	250	282	0	0	0	0
Leech Lake																														
162	Gull Is	0	NC	23	0	NC	105	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	0	NC	19	0	NC	0	0	NC	0	0
916	Little Pelican Is	11	174	108	2,524 ³	688 ³	391	0	0	0	0	0	0	0	0	0	0	0	1277 ³	5000 ³	2920	0	23 ³	0	186	127	78	0	46	130
NA-028	Pelican Is	NC	NC	226	NC	NC	0	NC	NC	0	NC	NC	0	NC	NC	0	NC	NC	250	NC	NC	0	NC	NC	85	NC	NC	0	0	0
Leech Lake Total		11	174	357	2524	688	496	0	0	0	0	0	0	0	0	0	0	0	1277	5000	3170	0	23	19	186	127	163	0	46	130
Marsh Lake																														
633	Banding Is	4160 ⁵	684 ⁶	4159	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	P	0	NA	0	0	NA	0	0	NA	0	0	0	0
890	Big Is	5292 ⁵	1082 ⁶	5376	264	303	914	0	0	0	10	0	0	30	35	41	0	2000	0	0	0	0	0	0	0	0	0	0	0	0
353	Peninsula	2706 ⁵	4650 ⁶	0	NA	103	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	NA	0	0	0	
39	Rock Is	0	0	P	414	504	225	0	0	0	0	0	0	0	0	0	0	600	500	0	0	0	0	0	0	0	0	0	0	
NA-006	Currie Island	0	4813 ⁵	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
NA-007	Small Is	1020 ⁵	4 ⁶	754	NA	0	0	NA	0	0	NA	0	0	NA	0	14	NA	0	0	NA	0	0	NA	0	0	NA	0	0	0	
Marsh Lake Total		13178	11233	10289	678	910	1139	0	0	0	10	0	0	30	35	55	0	2600	500	0	0	0	0	0	0	0	0	0	0	
Mille Lacs																														
103	Hennepin Is	0	0	0	5	16	5	0	0	0	0	0	0	0	0	0	0	0	nesting	236	188	0	3	0	138	216	118	0	0	0
102	Spirit Is	0	0	0	95	201	514	0	0	0	0	0	0	0	0	0	0	0	8	0	0	1	2	P	0	0	0	0	0	
Mille Lacs Total		0	0	0	100	217	519	0	0	0	0	0	0	0	0	0	0	0	8	236	188	1	5	0	138	216	118	0	0	
Minnesota Lake																														
69	Minnesota Lk	974	622	979	725	1252	1097	0	0	0	25	16	5	22	37	2	0	0	P	0	0	0	0	0	0	0	0	0	0	
NA-008	Ag Field	0	748	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Minnesota Lake Total		974	1370	979	725	1252	1097	0	0	0	25	16	5	22	37	2	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pigeon Lake																														
1031	Bare Is	357	24	0	1,450	1846	826	0	NC	0	91	36	8	84	11	7	0	P	P	0	0	0	0	0	0	0	0	0	0	
1031.2	Vegetated Is	0	519	1512	53	299	960	22	NC	ND	32	15	171	29	18	6	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pigeon Lake Total		357	543	1512	1,503	2145	1786	22	0	0	123	51	179	113	29	13	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total Nests		15610	15999	16406	16,002	15425	15421	305	77	9	1645	1358	1741	2573	3388	3038	1471	12336	15429	276	1080	2047	574	625	281	0	46	130		
Total Sites		16	17	15	38	42	36	5+	4+	3	19	18	21	13	16	17	7	8	10	9	9	8	3	4	3	0	1	1		

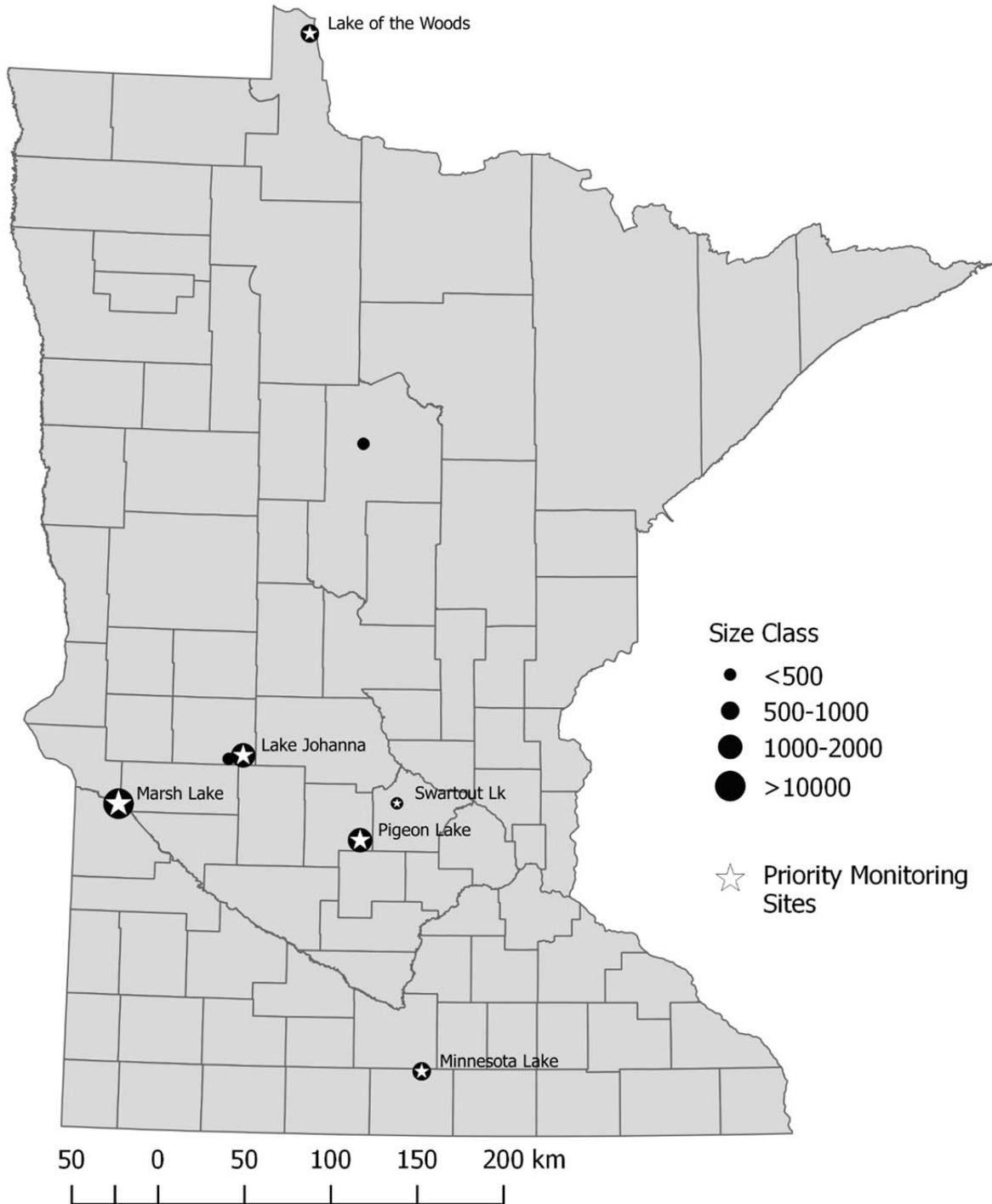
NA=Not applicable, no cormorants present at site. NC=Species was not censused, P = Present Not-Nesting
¹Estimate was obtained based on weekly counts; number of nests estimated ranged between 250 and 400. Used minimum number in this report.
²Nests were abandoned later in the season.
³Estimate was obtained based on weekly counts; number of nests estimated ranged between 150 and 200. Used minimum number in this report.
⁴Estimates for DCCO, HERG and RBGU combine numbers on Little Pelican and Gull islands.
⁵Pelican counts for these sites were conducted in 2005.
⁶Based on total count and extrapolation.

Table 5. Estimates for each colonial waterbird species in 2004, 2010, and 2015 at colonies where cormorant control occurred. * Indicates individual count, not nest number.

Site Name	AWPE			DCCO			BCNH			GBHE			GREG			RBGU			HERG			COTE			CATE		
	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015	2004	2010	2015
BLM 80-Knife Is	0	0	0	26	103	116	0	0	0	0	0	0	0	0	0	0	0	0	225	729	1536	0	0	0	0	0	0
Coney Is, Waconia Lk	0	0	0	250	425	0	0	11	PND ¹	350	156	69	350	169	0	0	0	0	0	0	0	0	0	0	0	0	0
Wells Lk	0	0	0	472	1197	285	0	0	PND	87	138	302	144	201	126	0	0	0	0	0	0	0	0	0	0	0	0
Leech Lake (Total)	11	174	357	2524	688	496	0	0	0	0	0	0	0	0	0	1277	5000	3170	0	23	19	186	127	163	0	46	130
Lake Vermilion (Total)	0	0	0	32	307	339	0	0	0	0	0	0	0	0	0	0	0	0	0	287	254	0	0	0	0	0	0
Lake of the Woods (Total)	569	1028	877	4370	1692	1240	0	0	0	0	0	0	0	0	0	186	3000	8566	49	0	142	250	282	167*	0	0	0
Total	580	1202	1234	7674	4412	2476	0	11	0	437	294	371	494	370	126	1463	8000	11736	274	1039	1951	436	409	230	0	46	130

¹ PND = Possible/Not Detected

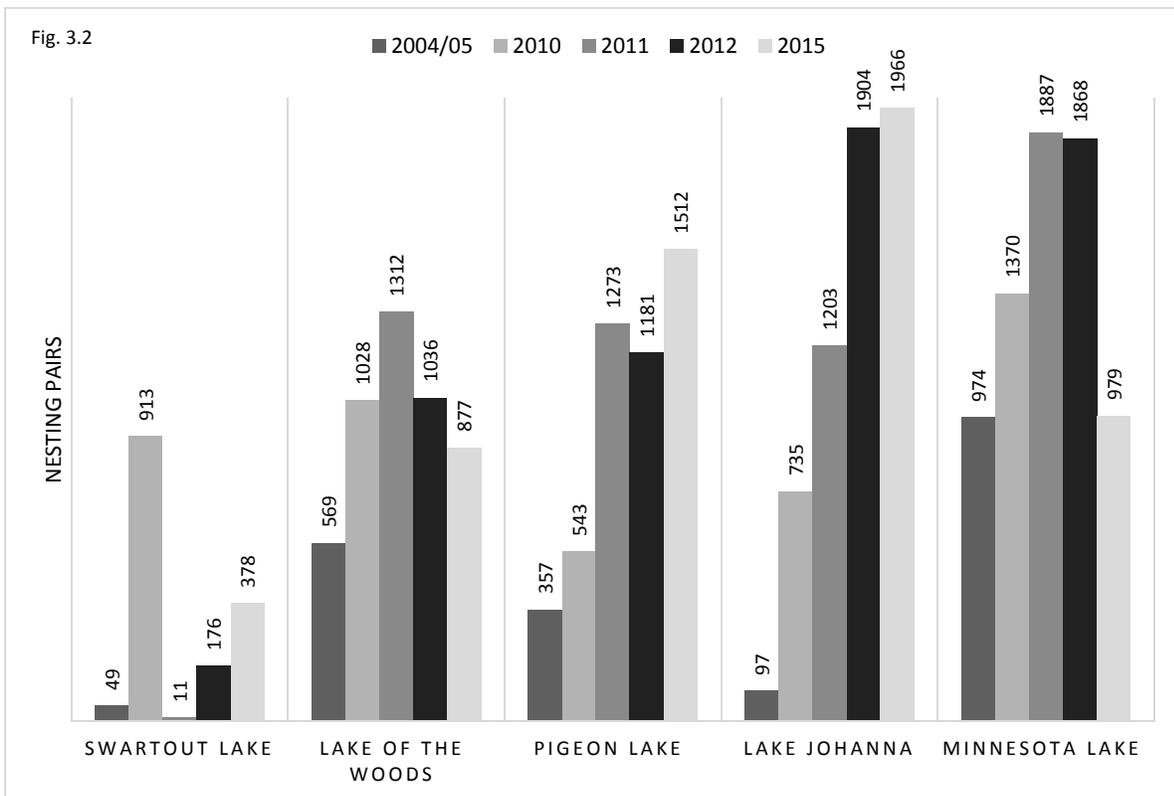
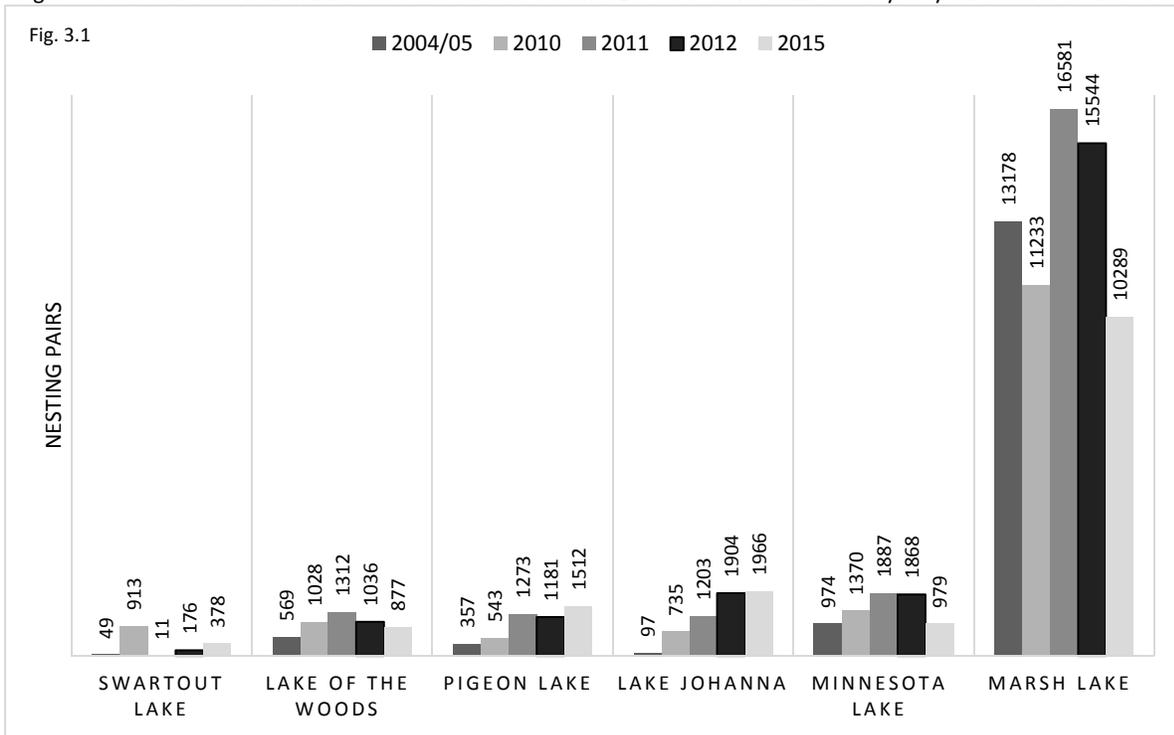
Figure 2. Minnesota AWPE colony distribution in 2015 by size class (sites starred and labeled identify location of priority monitoring sites¹ with nesting AWPE).



¹ "Priority Monitoring Sites" are sites with the greatest number of cormorant nests in 2015 (see page 11 for more about the importance of these sites). The six priority sites with nesting pelicans also happen to support the greatest numbers of nesting pelicans.

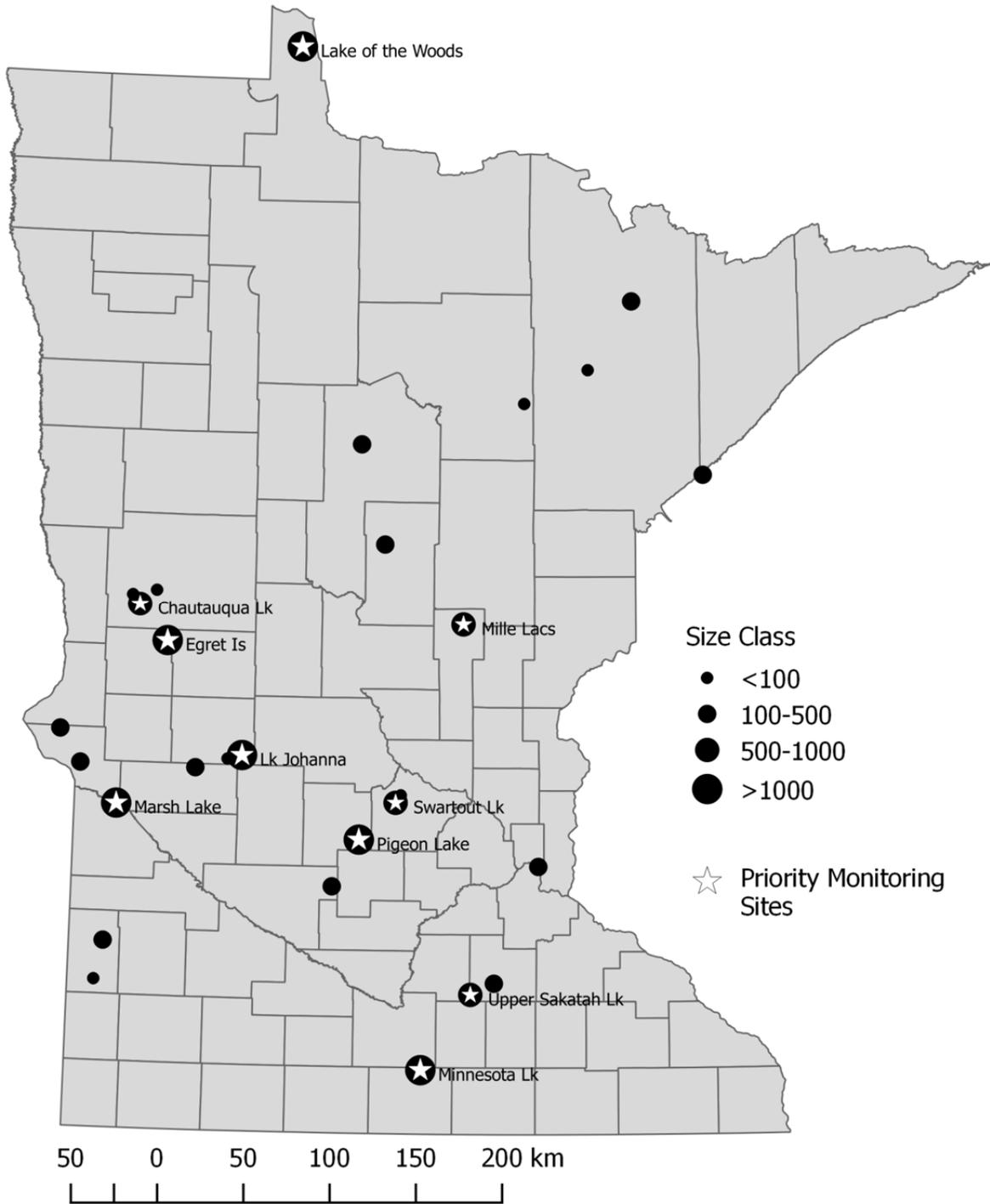
Figures 3.1 and 3.2. Number of AWPE nests at priority monitoring sites¹ in Minnesota, 2004-2015.

*Figure values identical. Marsh Lake has been excluded from 3.2 for better visualization of yearly variation at smaller colonies.



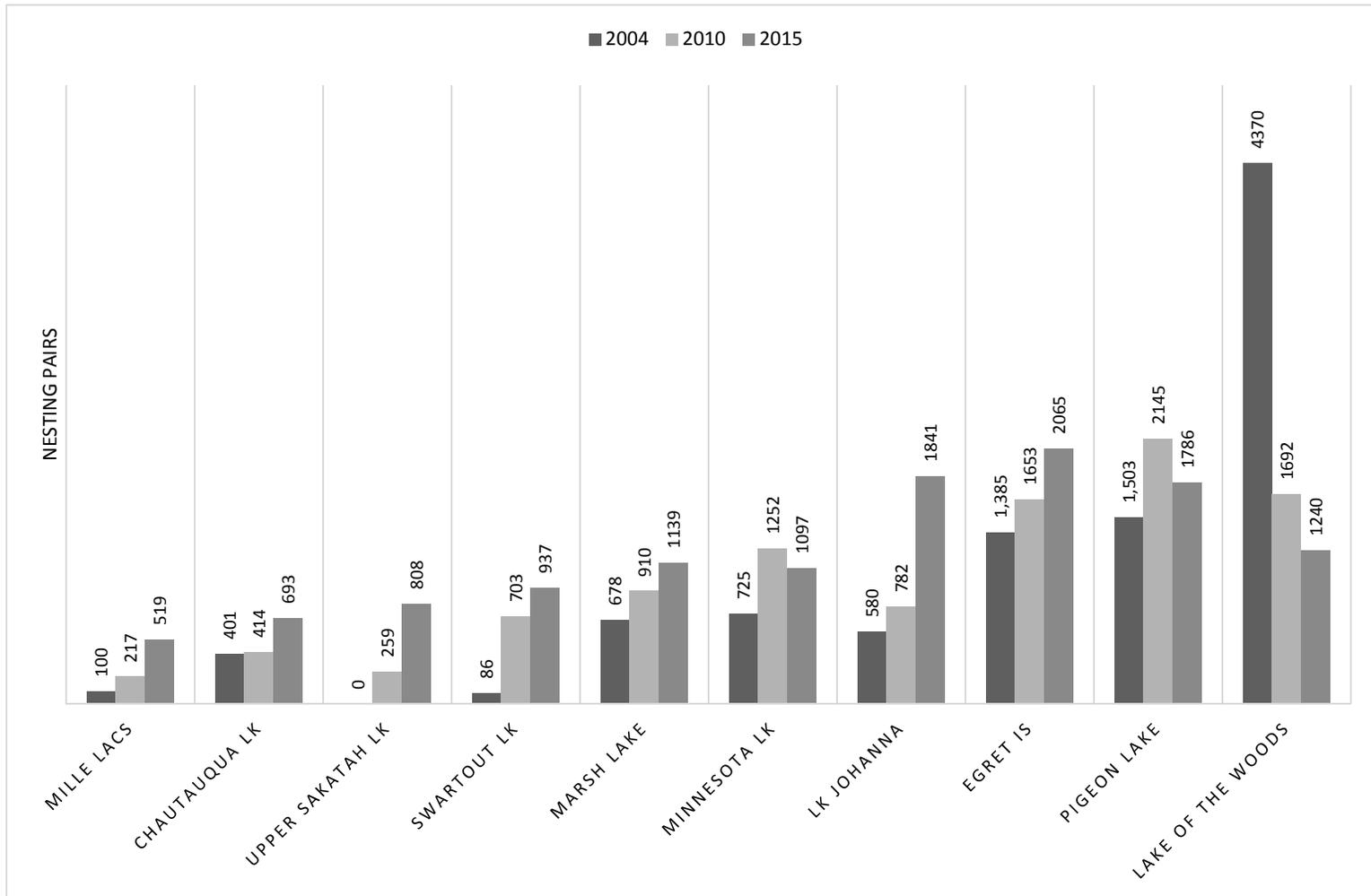
¹ "Priority Monitoring Sites" are the 10 sites with the greatest number of nesting cormorants in 2015. See page 11 for more about the importance of these sites.

Figure 4. Minnesota DCCO colony distribution in 2015 by size class (lakes and islands starred and labeled are priority monitoring sites¹).



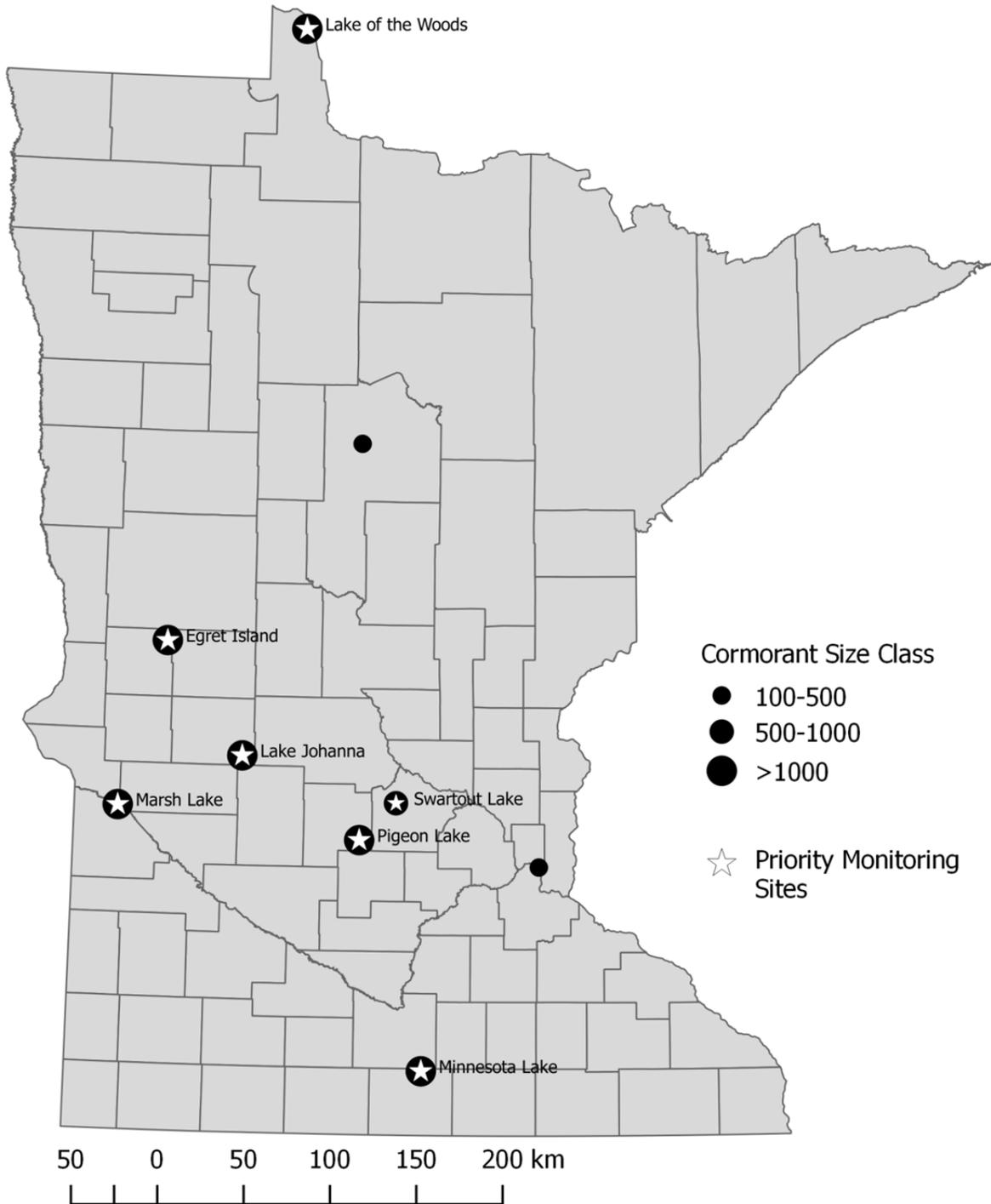
¹“Priority Monitoring Sites” are the 10 sites with the greatest number of nesting cormorants in 2015. See page 11 for more about the importance of these sites.

Figure 5. Number of DCCO nests at priority monitoring sites¹ in Minnesota, 2004-2015.



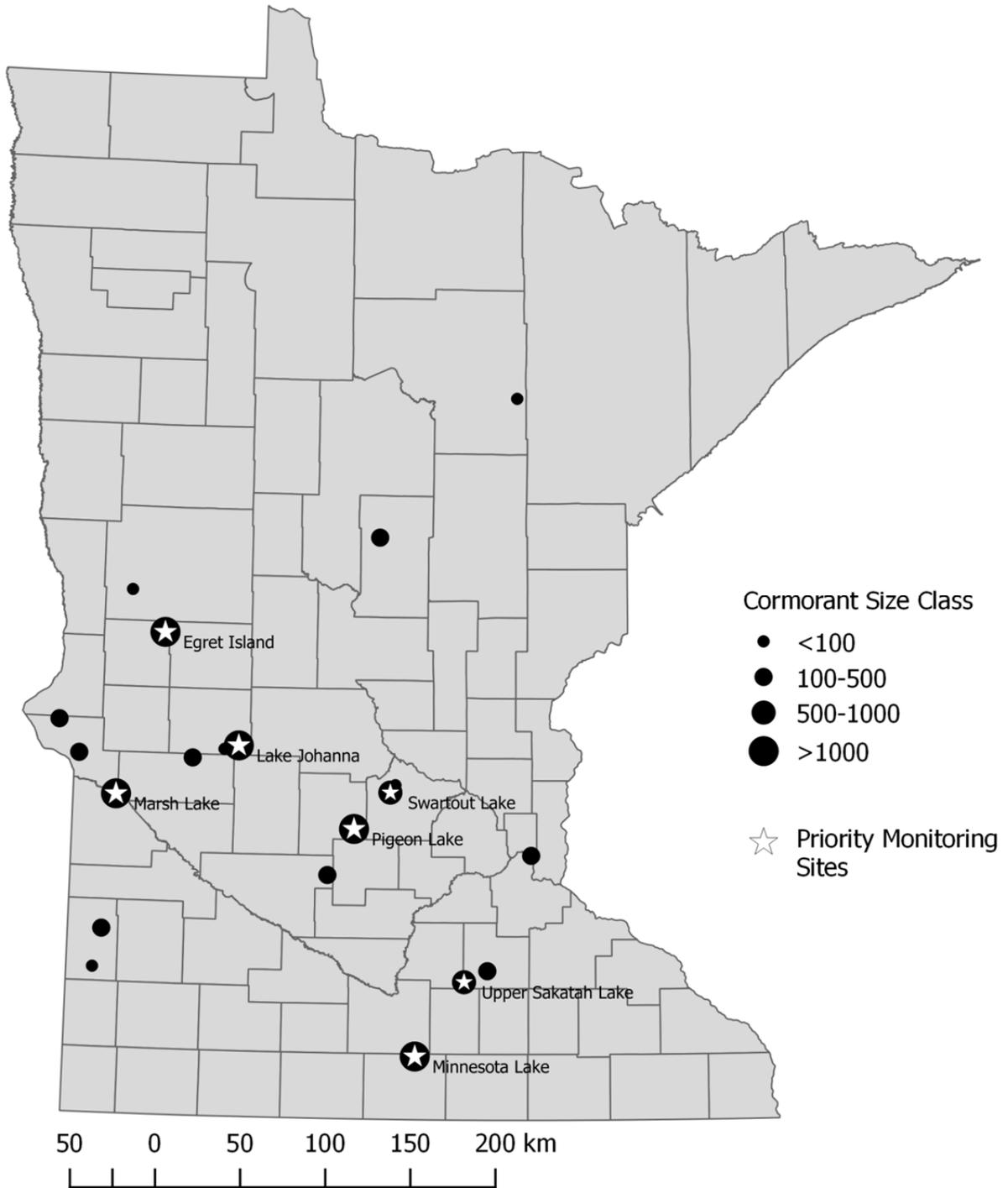
¹ "Priority Monitoring Sites" are the 10 sites with the greatest number of nesting cormorants in 2015. See page 11 for more about the importance of these sites.

Figure 6. DCCO sites with four or more colonial waterbird species in 2015 (lakes and islands starred and labeled are priority monitoring sites).



¹ "Priority Monitoring Sites" are the 10 sites with the greatest number of nesting cormorants in 2015. See page 11 for more about the importance of these sites.

Figure 7. DCCO sites shared with wading birds in 2015 (GBHE, GREG, and or BCNH) (lakes and islands starred and labeled are priority monitoring sites¹).



¹ "Priority Monitoring Sites" are the 10 sites with the greatest number of nesting cormorants in 2015. See page 11 for more about the importance of these sites.