

Final Report: State Wildlife Grants Program

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Project Title: **The Double-crested Cormorant and American White Pelican in Minnesota: A Statewide Status Assessment**

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This project is a cooperative venture between the Department of Natural Resources, Nongame Wildlife Program, and the University of Minnesota, Dept. of Fisheries, Wildlife, and Conservation Biology.

Introduction

In North America, numbers of the federally protected fish-eating bird species, Double-crested Cormorant (*Phalacrocorax auritus*) (DCCO) and American White Pelican (*Pelecanus erythrorhynchos*) (AWPE), have increased dramatically over the last 20-25 years in many portions of their ranges (Wires et al. 2001; Evans and Knopf 1993). In Minnesota, data collected from the 1960s to present suggest that both species have increased since the 1960s (DNR Natural Heritage Program Data Base). As these species have become more abundant, citizens in some regions of Minnesota have expressed concern over potential impacts on aquaculture and sport fishing (Wires et al. 2003; K.V. Haws, pers. comm., S. Mortensen, pers. comm.). Both species are perceived to affect recreation opportunities and local business economies. Despite public interest in management of these species and the inclusion of Minnesota in the Depredation Order (established by U.S. Fish and Wildlife Service in 1998 to allow individual fish farmers to kill unlimited numbers of cormorants at their ponds), little is known about current distribution and abundance of cormorants or pelicans in Minnesota. Both species occur in the state as migrants and breeders but no complete statewide census for either species has ever been undertaken in one year despite the fact that numbers are thought to be increasing..

In 2003, a federal EIS was issued and a Public Resource Depredation Order established for the Double-crested Cormorant (USFWS 2003 a,b). The Public Resource Depredation Order allows federal, state and tribal agencies to “take” (kill) Double-crested Cormorants believed to be impacting public resources on public and private (with owner permission) lands without acquiring a permit. Because control efforts for DCCOs in MN are under consideration, the MN DNR needs accurate and current data on the number of breeding pairs and location of colony sites to monitor effects on Minnesota’s DCCO population if control is undertaken. Although there is currently no management plan for the American White Pelican, and this species is listed as Special Concern in MN, concern about impacts related to its consumption of fish have been documented (Wires and Cuthbert 2003). Because this species is highly sensitive to human disturbance and known to commonly occur with DCCOs in Minnesota, control efforts for DCCOs could significantly impact pelicans. Given the fish-eating behavior of pelicans, this species is likely to be targeted by local citizens for illegal control efforts and may become a management issue in the future. Thus, the MN DNR also needs to establish baseline information on distribution and numbers for this species.

In addition to information on cormorants and pelicans, data are also needed on other species of colonial waterbirds (e.g., herons, gulls, terns) that co-occur with DCCOs at their breeding colonies. These data will help the MN DNR make informed decisions about management and conservation on a site basis and monitor impacts of DCCO control on other species.

Project Goals: The primary goal of this project was to obtain statewide breeding population estimates for the American White Pelican and Double-crested Cormorant in Minnesota, using data recorded from detailed ground surveys of all reported pelican and cormorant colonies in 2004, and aerial surveys of the primary pelican colony (e.g. Marsh Lake) in 2004 and 2005. The project also has two secondary goals: a) verify current breeding locations of pelicans and cormorants, and enter this information into the Natural Heritage Data Base and b) document presence and/or obtain estimates of nests of co-occurring colonial waterbird species (e.g. gulls,

terns, herons) at all active cormorant colonies, because cormorant management activities, if undertaken, are likely to impact these other species.

Funding: This project was funded with a \$32,720.00 grant to the University, and a \$23,464.00 allocation to the Nongame Program. In 2004, these funds covered the hiring of a part time project coordinator, two field technicians, travel expenses and equipment. The grant included Federal funds and required a state match. The total cost of this project was \$56,464.00

Methods

Locating active DCCO and AWPE colonies: Historic nesting locations for DCCOs and AWPEs were determined by acquiring colony locations from the MN DNR's Natural Heritage colonial waterbird database. Additional potential colony locations were obtained from DNR Fisheries and Wildlife field staff through an e-mail solicitation requesting information. All historic and potential sites were checked during a field visit to determine activity status.

Censusing DCCO and AWPE colonies:

- *Timing.* Efforts were made to time field visits (15 May-30 July) to capture peak numbers of nesting birds. Based on previous survey dates and assuming southern colonies would reach peak numbers earlier than more northern ones, technicians generally worked from South to North throughout the state. However, field conditions, logistics and support from area personnel frequently influenced when sites could be censused.
- *Direct Ground Counts.* At all active sites the number of AWPE and DCCO nests was tallied using "tally-whackers" (hand-held counters). At sites with large numbers of nests (~ 100), ground nests were marked with spray paint or colored sticks. At tree colonies, trees were marked with flagging tape to help keep track of tree nests counted. Each nest was assumed to represent one breeding pair. When possible, the number of nests of other co-occurring colonial waterbirds at all active DCCO colonies was also estimated. However, at some tree colony sites, it was not possible to count nests of all co-occurring colonial bird species, but nesting activity was noted for those present. Most sites were reached by boat, and censuses were conducted from the ground. At a few sites, however, it was not logistically feasible to census birds by direct ground counts. Therefore for some sites estimates were obtained through careful counts made from the shore.
- *Aerial Counts.* Aerial photography was utilized at three sites (Marsh Lake, Little Pine Island, and Little Massacre Island) to obtain data on numbers of nesting birds.

Marsh Lake: In both 2004 and 2005, a small fixed-wing aircraft was used to fly over Marsh Lake islands and peninsula to photograph nesting AWPEs with a handheld 35mm camera from an altitude of 500 ft. In 2004, photos were taken on 14 June of islands and the peninsula used by nesting pelicans. These photos were scanned at 1200 DPI resolution and projected in ArcView 3.3; individual adult AWPEs in select areas were counted and used to estimate numbers of nesting pelican pairs. In 2005, photos were taken on 16 May. They were sent to the Northern Prairie Research Center where numbers of nesting pelicans were estimated using the following method. The photos were scanned at 600 dpi and imported into Map and Imaging

Processing System (MIPS), MicroImages Inc. Through an automated process, individual white pixels were identified as a pelican (between 80-200 white pixels were needed to fully identify a pelican, depending upon the altitude from which the photo was taken. The pixels were converted to a feature map and a database report was created and exported to Excel. Results are expressed in the number of pixels per bird. In areas where birds were densely clustered, the number of birds in a group was manually counted (R. Woodward, pers. comm.).

Little Massacre Island: Nesting cormorants were photographed at this site from a small fixed-wing aircraft used to fly over the island. Photos of birds were taken with a 35 mm camera from an altitude of 500 ft. Photos were scanned at 1200 DPI resolution and projected in ArcView 3.3. All individual birds were counted manually; each bird was assumed to represent one nesting pair of DCCO.

Little Pine Island, Voyager's National Park (VNP): Double-crested Cormorants were photographed at this site from a small fixed-wing aircraft. Photos of birds were taken with a 35 mm camera from an altitude of 500 ft. Photos were scanned at 1200 DPI resolution and projected in ArcView 3.3, and all individual birds were counted manually; each bird was assumed to represent one nesting pair of DCCO. This information was reported by Steve Windels of VNP, to the DNR.

At all sites, photos were taken of birds and nesting habitat, and latitude – longitude information were recorded using a GPS. All data were summarized and entered into the MN DNR Natural Heritage Data Base.

Technicians and field assistance: Two primary DNR Technicians were hired for this project, Nancy Drilling and Don Carlson III. They were directed by U of MN Research Associate Linda Wires. Nick Myatt worked as a DNR technician for one month on this project. Katie Haws, Bruce Lenning, Lisa Gelvin-Innvaer, and Steve Kittelson (MN DNR), Michelle McDowell (Rice Lake National Wildlife Refuge), Steve Mortensen (Leech Lake Band of Ojibwe), Steve Windels (VNP), John Wollenberg (Lac Qui Parle Wildlife Management Area), and others also assisted with the fieldwork during the summer.

Results

Double-crested Cormorant Distribution, Numbers and Colony Composition

Distribution. Between May 15-July 30, 142 sites were field checked in 2004 (Appendix 1). All spatially unique land masses with breeding birds were considered individual sites, even when islands were near one another. Of these, 39 were utilized by DCCOs as nesting colonies; breeding sites were distributed across much of the state, with the exception of the northwest, southwest and southeast corners. Most colonies were located 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 1). The Natural Heritage database contained locations for 89% of active colony sites; only four colonies were found at new sites reported by DNR field staff (Table 1).

Numbers. The total number of DCCO nests estimated by the 2004 survey was 16,006-16,106. Colonies ranged in size from 4-2,524 nests, with an average colony size of 411 nests. The largest DCCO colony in the state was at Little Pelican Island, Leech Lake, in Cass County, with an estimated 2,524 pairs. Lake of the Woods had the largest number of nests for a single lake, with an estimated 4,370 nests located at 5 sites. In general, timing of site visits was based on previous survey dates and phenology in an effort to estimate peak numbers of nesting birds. Precise numbers at Coney Island and Pigs Eye colonies could not be obtained because of difficulty counting nests in densely vegetated trees; for these colonies, aerial observations made throughout the season provided the narrowest range of estimates possible (S. Kittelson, pers.comm.).

The number of nesting DCCO pairs at Little Massacre Island, Lake of the Woods, was estimated by counting birds on nests from an aerial photograph taken 11 June 2004 and donated by the Ontario Ministry of Natural Resources. Likewise, the estimate for Little Pine Island, Voyageur's National Park, was also based on an aerial photograph taken on 7 July 2004 and provided to the project courtesy of the National Park Service.

DCCO colony compositions. At most colonies ($\geq 87\%$), DCCOs occurred with other colonially nesting waterbirds. Only 5 sites may have been exclusively occupied by Double-crested Cormorants, but at this time we can verify exclusive nesting at only one site, Lindquist WMA. Two sites, MN DNR 36 Guano Rock and Barry Lake WPA, had other colonial species present but their breeding status was not documented. At Little Elk WMA and Halderson Lake, counts were done from shore. Technicians did not see evidence of nesting by other species but this observation was not confirmed due to limited site access; herons and egrets were visible at Halderson Lake, and Sandhill Cranes (*Grus canadensis*) were present at Little Elk WMA.

The Great Blue Heron (*Ardea herodias*) is the most frequent nest associate with cormorants, present at ≥ 19 ($\geq 49\%$) DCCO sites, followed by the Great Egret (*Ardea alba*), present at ≥ 13 ($\geq 33\%$) DCCO sites. The American White Pelican occurred at 11 DCCO sites (29%), Herring Gulls (*Larus argentatus*) at ≥ 9 DCCO sites (23%), Ring-billed Gulls (*Larus delawarensis*) at ≥ 7 DCCO sites (18%), and Black-crowned Night-Herons (*Nycticorax nycticorax*) at ≥ 5 DCCO sites (13%). Common Terns (*Sterna hirundo*) were found at 3 sites (8%) and Cattle Egrets (*Bubulcus ibis*) were found at one DCCO site, Egret Island, Pelican Lake (Table 1). From a conservation and management perspective, the most important nest associate documented at DCCO colonies was the Common Tern, a Threatened Species in Minnesota. This species breeds at only 5 sites in the state; of these, three (60%) are shared with DCCOs.

Eleven of the 39 active DCCO sites are locations of high colonial waterbird diversity, defined as sites with ≥ 4 nesting colonial waterbird species (Wires and Cuthbert 2001). These sites are found in the north and in the diagonal swath that cuts across the central portion of the state (Figure 2). Most of these sites (64%) have large numbers of DCCOs (> 500 pairs) and significant concentrations of other colonial nesters (Table 1). Additionally, most have a long history of use by DCCOs and other colonial waterbirds. The colonies in the central western portion of the state have been utilized since at least the 1960s and 1970s (MN DNR Natural Heritage database). In the MN portion of Lake of the Woods, DCCOs have been documented as a nesting species since 1915 (Roberts 1932), but have been known as a nesting species in the lake for hundreds of years (Tanner 1994).

Most DCCO colonies were tree colonies; 53% of colonies consisted of birds nesting exclusively in trees. An additional 13% of colonies were composed of a mix of tree and ground nesting pairs. However, nearly twice as many birds nested on the ground (approximately 10,300 pairs or 64% of nesting birds) on rocky or sandy islands versus in trees. Many of the large ground colonies occur in Lake of the Woods, while the large tree nesting colonies occur in the western and central portion of the state.

Abandoned Colonies: Colonies were not monitored by project technicians to determine nest success but three sites were found abandoned during the course of the survey. These were Little Elk WMA, Morrison County; Hennepin I., Mille Lacs County; and Titlow Lake, Sibley County. At Little Elk WMA, DCCO tree nests were viewed from shore and all were deserted. No adult DCCOs were seen in the area. An active Turkey Vulture (*Cathartes aura*) nest with at least two large chicks was located about 40 m from the DCCO colony. At Hennepin Island, 6 DCCO nests were found on 28 May by Rice Lake National Wildlife Refuge personnel when refuge biologists installed gull-deterrent string grid for Common Terns nesting on the island. No DCCO eggs were observed and nests were abandoned after gull-deterrent string grid was installed (M. McDowell, pers. comm.). At Titlow Lake, a small tree colony with 4 nests was documented on 26 May and > 100 DCCOs were counted loafing in the colony. When the site was re-visited one week later, the nests appeared abandoned and the number of loafing adults had declined to 30.

American White Pelican Distribution and Numbers

Distribution. Sixteen sites were utilized by nesting American White Pelicans in 2004, and occurred in the northern, western-central and southern portions of the state (Figure 3). The Natural Heritage database contained locations for 81% of active colony sites; three colonies were found at locations where AWPE had not been previously recorded (Table 2). Only one historic site, Pelican Lake, Wright County, was inactive, due to inundation by high water. Additionally, loafing pelicans were observed in virtually every western county in Minnesota. These birds may have originated from the recently abandoned (2004) Chase Lake colony in North Dakota (formerly the largest pelican colony in North America). Some small new colony locations with very late nesting dates were also documented (Big Twin Lake, Martin County); birds at these colonies may have been re-nesters from the Chase Lake colony.

Four of the sites utilized by AWPE in both 2004 and 2005 occur in Marsh Lake in western Minnesota; of these, three are islands and one is the Marsh Lake peninsula (Figures 4-7b). Though each of these sites is distinct and has a unique occurrence number, the islands and peninsula are close together and the birds breeding on them are monitored as subunits of one colony. Therefore, the Marsh Lake colony refers to the complex of birds breeding on the three islands and the peninsula.

Other significant nesting locations included islands in Lake of the Woods, Red Lake and Minnesota Lake in the south. Additionally, several other smaller sites were documented throughout the state (Figure 3).

Numbers and the Marsh Lake estimate. In 2004, a statewide total of 15,824 nesting pairs was estimated (Table 2); 13,392 pairs (85%) were estimated to nest in the Marsh Lake complex located in Big Stone and Lac Qui Parle counties. Because of difficulties counting the large number of birds at Marsh Lake, and because we missed the peak date for counting birds at this

site by at least three weeks, we utilized data from both ground counts and aerial photography to estimate the number of pelicans nesting at the Marsh Lake colony. As a result of these problems, we decided to repeat the estimate the following year. In 2005, a total of 13,178 pairs of pelicans was estimated to nest on the three islands and peninsula of Marsh Lake, based on analysis of aerial photography (R. Woodward, pers. comm.).

Ground counts. In 2004, ground counts were conducted on three of the four Marsh Lake sites: the Banding Island, Big Island and the Peninsula. Total ground counts were conducted on the Eight Acre / Banding Island and the Peninsula on 19 June; on the former, 4,361 nests were estimated and on the latter, 2,031 nests were estimated. Technicians reported they were not confident in the count conducted at the Banding Island because prior to the census the annual banding effort occurred and disturbed chicks moved around the island in large groups and obliterated many nests. Thus it is likely that the number of nests on this island was underestimated. At the Big Island, a ground count was conducted on 25 June, a week later than the other sites because of the disturbance from the banding activity and time constraints. On this island, 4,044 nests (pairs) were estimated based on the ground count, but technicians reported this as an underestimate because they were able to count nests on only 40% of the island, and many nests had been obliterated. No ground count was undertaken at Small Island due to time constraints.

Aerial photography. On 14 June 2004, we flew over Marsh Lake and photographed birds on all 4 islands. At the time photos were taken chicks were ambulatory and many adults were no longer on nests. Comparisons between adults counted in the photos in select areas on two islands to nests counted via later ground counts in the same areas indicated counts based on aerial photos of adults underestimated the number of nesting birds. Therefore, total counts from the aerial photos were not undertaken because they would not produce a reliable estimate. However, aerial data from two of the Marsh Lake sites, One Acre/Small Island and Big Island, were incorporated to produce minimum estimates for these sites. At Small Island a total of 432 adults was counted in the aerial photograph. This was the only count information available and represents a minimum number of nests on the island. At Big Island, aerial photos of the areas not included in the ground count (approximately 60% of the island) yielded an estimate of 882 adults. This number was combined with the ground count for a total estimate of 4,926 nests. However, the refuge biologist at Marsh Lake believed this count still underestimated the number of pairs nesting on Big Island by at least 25% or 1,642 nests (J. Wollenberg, pers. comm.). Thus, to provide a more realistic estimate for Big Island, the combined aerial and ground count sum was increased by 1,642 to produce an estimate of 6,568 nests for this site (Table 3).

On 16 May, 2005, we flew over Marsh Lake and again photographed nesting pelicans on Big Island, the Peninsula, Eight Acre/Banding Island and One Acre/Small Island. The photos indicated that chicks had not yet hatched and the vast majority of adult birds were on nests. Therefore, estimates from aerial photographs were assumed to produce a reliable estimate of the number of nesting birds, and no ground counts were necessary. The method used to estimate numbers of pelicans via the MIPS program was compared to manual counts of pelicans from aerial photographs at Chase Lake taken over the last 6 years. Comparison of these two methods indicated an error of 4-6%.

Abandoned Colonies. Colonies were not monitored by project technicians to determine nest success but two colonies were found abandoned. A large colony with 340 AWPE nests was

abandoned at Red Lake. The colony appeared to have been deserted early in the nesting cycle; there were no signs of chicks or hatching but many broken and scattered eggs. Bear, wolf and raccoon tracks and sign were present. An abandoned small new colony of 16 nests was discovered at Big Twin Lake. Adult pelicans were seen loafing nearby. Some eggs remained in the nests and others were scattered (L. Gelvin-Innvaer, pers. comm.). Though the cause leading to desertion of these colonies was not determined, human disturbance, possibly vandalism, may have been a factor.

Double-crested Cormorant and American White Pelican colonies found in 2005. Though the focus of this study was to census all active colonies for cormorants and pelicans in 2004 (with the exception of Marsh Lake) a few additional colonies were discovered in 2005. These are reported in Appendix 2.

Discussion

Context for current numbers and distribution. This census effort represents the first complete inventory of distribution, colony size and location of Double-crested Cormorants and American White Pelicans in Minnesota. As an inventory, it constitutes an important database of great value to natural resource agencies, nongovernmental organizations (NGOs), and academic institutions. It lays the foundation for future work that may include detecting population trends and assessing impacts of waterbird control efforts on site-specific and statewide populations.

The MN DNR collected data on both Double-crested Cormorants and American White Pelicans during the 1980s and 1990s, and had some indication that these species were increasing in the state based on consistent monitoring at selected colonies and discovery of new colonies. Because no statewide censuses were completed prior to 2004, it is not possible to estimate the rate at which these species have increased across the state. It is also not known if these species are continuing to increase. Several more years of consistent statewide monitoring will be required to determine the current population trend. At Marsh Lake, we collected 2 years of population data for the American White Pelican. Population data are also available for 2003, from an aerial survey for American White Pelicans at Marsh Lake conducted in mid-May. Based on analysis of aerial photography, approximately 16,000 nesting pairs was estimated in the Marsh Lake complex in 2003 (J. Dimatteo, pers. comm.). Researchers were highly confident in this estimate because nesting birds were obvious and the computer program used to count individual birds had high precision. However, not enough data points, (i.e. previous to 2003), are available to determine if changes in numbers between 2003-2005 represent population decline or temporary fluctuation.

Because some portions of the public perceive current populations as overabundant (Wires and Cuthbert 2003), it is important to consider the history and range-wide distributions of these species when interpreting current population estimates. For both species, there is an historic precedent for abundant and widely distributed populations in the state (pre-European settlement). Both species have a long history as nesting birds in Minnesota, known since at least the late 1800s. Additionally, both species experienced substantial population declines during the late 19th and much of the 20th centuries, largely due to human persecution because of their consumption of fish. No nests of the American White Pelican were found in the state after 1878 (Roberts 1932); nesting was not again documented until 1968, when 25 nests were found at Marsh Lake. Numbers there consistently increased and new sites became active in the 1970s-2000. Prior to extirpation as a breeding species in Minnesota, the AWPE was abundant; early

records of the species document nesting at many different sites, including southern and western Minnesota (Hatch 1892; Roberts 1932). Thus, current numbers and distribution should be considered a re-colonization rather than a range expansion. The same is true for the Double-crested Cormorant. This species has a long and well documented history of human persecution across its range, and by 1925 most colonies in Minnesota had been abandoned; only three active colonies were known in the state at this time (Lewis 1929; Roberts 1932). Prior to this decline, the DCCO was very abundant in the state; Hatch (1892) reported that it was “occasional to innumerable” across Minnesota depending on how near its breeding places observations were made. Roberts (1932) also described the former existence of very large colonies. Though the species remained extant in the state as a breeding species in the 20th century, its numbers were small and its distribution limited. After the DCCO was added to the Migratory Bird Treaty Act (MBTA) protected bird species list in 1972 and other legislation was passed to ban DDT, the DCCO began to reoccupy many of its former breeding places and numbers began to increase (Wires et al. 2001).

Large aggregations at few sites. Though the AWPE was observed breeding at 16 sites, 85% of the state’s breeding population occurs at the Marsh Lake complex. This colony is uniquely large, and with the abandonment of the Chase Lake colony in North Dakota, is currently the largest known colony in North America (King and Anderson 2005). As such, Marsh Lake represents a very important site for this species continentally as well as in Minnesota. The aggregation of most of the state’s population at the Marsh Lake complex makes the state’s population highly vulnerable to stochastic events such as storms or disease, and human caused disturbance.

Though DCCOs utilized 39 sites for breeding in Minnesota, 62% of breeding pairs occurred at six sites. These included Little Pelican Island, Egret Island, Pigeon Lake, Long Lake, O’Dell Island, and Little Massacre Island; each supported > 1000 pairs of nesting DCCOs (Table 1). The aggregation of the majority of the state’s population at just six sites increases the population’s vulnerability to stochastic events, including storms and disease, and human caused disturbances. Additionally, these large aggregations are highly visible and more likely to come into conflicts with humans. This in turn increases their focus for potential control efforts. Because 5 of these 6 sites are high colonial waterbird diversity sites (≥ 4 species), control efforts for DCCO at these locations would likely impact the other co-occurring colonial species.

Recommendations:

- **Monitoring American White Pelicans:** Because of the importance of the Marsh Lake complex to the state and continental American White Pelican population, we recommend that the Marsh Lake complex be carefully monitored annually. However, entering the colony and counting nests from the ground is not recommended (Evans and Knopf 1993). Aerial censusing can be undertaken to estimate numbers and discern trends with a high level of confidence and no impact to nesting birds. In our experience, individual nesting birds are clearly distinguishable in photos taken from an altitude of approximately 500 feet, and flights over the colony at this distance do not cause birds to leave nests. Because the Marsh Lake complex is earlier in its nesting activity than other colonies located at this or more southern latitudes, the ideal time to survey this complex is approximately mid-May (J. Dimatteo, pers. comm.; this study.). We also recommend that the other significant AWPE colonies (> 100 pairs) in the state be monitored regularly

(~ every three years) and in a coordinated fashion. This includes the colonies in Lake of the Woods, Minnesota Lake, Red Lake and Pigeon Lake. Although we recommend aerial photography whenever possible because it is the least invasive method for censusing pelicans, ground counts can be conducted with minimal disturbance at these sites if gulls are not present, visits are short (≤ 1 hour), chicks are not ambulatory, nesting is well underway, and attention is paid to appropriate weather conditions.

- **Monitoring Double-crested Cormorants:** Because large numbers of DCCOs (> 1000 pairs) are aggregated at a few sites in Minnesota, we recommend large colonies be monitored regularly (\leq every three years) and in a coordinated fashion. If control efforts are undertaken at colonies, these colonies must be monitored yearly to assess effectiveness and impacts of control. Generally most sites can be counted from the ground with minimal disturbance if attention is paid to appropriate weather conditions, sites do not have gulls, visits are short (≤ 1 hour), and chicks are not ambulatory but nesting is well underway. Aerial photography may also offer a less invasive and efficient way to monitor cormorant numbers; research on detectability of nesting cormorants through aerial photography is currently being conducted by investigators at the University of Minnesota (F.J. Cuthbert, L.R. Wires). At tree colonies, counts can be made from the shore with high confidence if all nests can be seen clearly. At tree colonies where ground counts are undertaken, technicians need to carefully monitor reactions of young birds in nests; juvenile birds sometimes jump or fall from trees if technicians approach trees too closely. To estimate statewide numbers and distribution and to discern population trends, a complete census should be undertaken regularly (appropriate time frame for census intervals is beyond the scope of this project). Alternatively, a sampling strategy could be developed through which trends can be detected with confidence. Development of a sampling design to detect population trends is recommended for monitoring this high profile species.
- **Protecting Common Terns at colony sites shared with Double-crested Cormorants:** There are several important conservation and management issues that arise when Common Terns nest at sites also utilized by DCCOs. First, some agencies have argued that DCCOs negatively impact breeding productivity of terns and may cause desertion. Despite these claims, evidence is limited to suggest this impact occurs and that DCCO control is warranted. For example, potential control efforts for DCCOs at Leech Lake, Cass County, have been justified, in part, by arguing that cormorants crowded Ring-billed Gulls into habitat used by Common Terns, which resulted in a decline of 71 pairs (28%) of Common Terns between 2003 and 2004 (Mortensen 2005). Statements of this nature must be supported by careful study and documentation because they can drive cormorant control policy. Another concern related to the co-occurrence of Common Terns and cormorants is that terns may be negatively impacted if DCCO control is done at sites occupied by terns. Common Terns are very sensitive to multiple factors, including human disturbance during the breeding season. Managers should take special care to carefully monitor reactions of Common Terns and make special efforts to minimize impacts if conducting DCCO control activities at sites occupied by Common Terns.
- **Protecting sites with high colonial waterbird diversity and or significant concentrations of waterbirds:** This census effort identified several sites with high

colonial waterbird diversity (sites with ≥ 4 nesting colonial waterbird species). Sites with diverse aggregations of nesting colonial waterbirds are relatively uncommon in the Great Lakes (Wires and Cuthbert 2001), and are uncommon in MN as well, although all waterbird sites in the state were not visited. Because of the uniqueness of these sites we recommend the following colony locations be considered for special designations: Pigeon Lake, Lake Johanna, Leech Lake and Lake of the Woods and receive some form of special protection. All of these sites have been nominated for Important Bird Area (IBA) status (J. Cecil, pers. comm.) and receive some form of special protection. If DCCOs are targeted for control efforts at these sites, the benefits of these activities must be carefully weighed against the impacts such activities will likely have on other colonial species and the unique natural resource these assemblages represent. In tree colonies, cormorants often nest in the same trees with herons and egrets, which are also highly sensitive to human disturbance. Disturbance to non-target birds due to cormorant control efforts will be particularly difficult to minimize in these colonies. We also recommend that Marsh Lake be considered for designation as an Important Bird Area because of its importance to American White Pelicans.

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Table 1. Numbers of Double-crested Cormorant nests and colony composition at Minnesota sites in 2004 (all estimates of DCCO based on ground counts unless otherwise noted).

NC = Not censused, S = Counted from shore, A = Estimate based on aerial count, B = Counted from boat

Oc. #	Site Name	County	DCCO nests	AWPE Nests	COTE Nests	GBHE nests	GREG nests	BCNH nests	HERG nests	RBGU nests	Comments
973	Barry Lake WPA	Big Stone	79	0	0	0	0	0	0	0	S*, other species present but no nesting observed
new	Lindquist WMA	Big Stone	32	0	0	0	0	0	0	0	S, No other species present
39	Marsh Lake (Rock Island)	Big Stone	414	0	0	0	0	0	0	0	150 chks
972	Swenson Lake	Big Stone	271	0	0	5	0	0	0	0	S
863	Coney Island, Waconia Lake	Carver	250-300	0	0	350	350	0	0	0	A, range of weekly counts
916	Little Pelican Island, Leech Lake	Cass	2,524	11	186	0	0	0	0	1277	
422	MNDNR 36 Guano Rock	Cook	24	0	0	0	0	0	Adults present	0	
new	Clifford Lake (Swim Lake)	Douglas	48	0	0	47	0	0	0	0	
69	Minnesota Lake	Faribault	725	974	0	25	20-25	0	0	0	
10	Egret Island	Grant	1,385	0	0	170	271	47	0	0	CAEG, 18 nests
206	Long Lake	Kandiy-ohi	1,363	0	0	140	427	207	0	0	
New	Little Pine Island, Voyageurs N.P.	Koochi-ching	173	0	0	0	0	0	Nesting (NC)	0	A
813	Bolland Slough	Lac Qui Parle	50	0	0	16	0	0	0	0	B
890	Marsh Lake (Big Island)	Lac Qui Parle	264	6,568	0	10	30	0	0	0	
471	BLM 80-Knife Island	Lake	26	0	0	0	0	0	200-250	0	
229	Crowduck Island	Lake of the Woods	447	242	0	0	0	0	27	2	
112	Gull Rock	Lake of the Woods	66	0	0	0	0	0	4	0	
319	Little Massacre Island	Lake of the Woods	1,363	277	0	0	0	0	8 chks	0	

231	O'Dell Island.	Lake of the Woods	1,889	25	250	0	0	0	18	7	
235	Techout Island	Lake of the Woods	605	25	0	0	0	0	0	177	
1031	Pigeon Lake	Meeker	1,450	357	0	91	84	0	0	0	
1031	Pigeon Lake-South Island	Meeker	53	0	0	32	29	22	0	0	
103	Hennepin Island	Mille Lacs	5	0	138	0	0	0			nesting
102	Spirit Island	Mille Lacs	95	0	0	0	0	0	1	8	
805	Little Elk WMA	Morrison	49	0	0	NC	NC	NC	0	0	S
68	Chautauqua Lake	Otter Tail	401	0	0	0	0	0	1	0	
	Haldorsen Lake	Otter Tail	20	0	0	?	?	?	?	?	S, no others observe
1004	Lake Alice	Otter Tail	49	0	0	0	117	0	0	0	S
117	Lake Johanna	Pope	580	97	0	20	500	15	0	0	
90	Pigs Eye Lake	Ramsey	150-200	0	0	400-500	500-600	?	0	0	A, range of weekly counts
new	Preston Lake	Renville	186	0	0	30	0	0	0	0	B
new	Wells Lake	Rice	472	0	0	87	144	0	0	0	
481	Titlow Lake	Sibley	4	0	0	35	8	0	0	0	B
326	Dark River Tailings Pond	St. Louis	70	0	0	15-20	0	NC	0	0	S
749	Vermillion Rocks #1 (Vermillion Lake)	St. Louis	32	0	0	0	0	0	chicks	NC	
325	West Two Reservoir	St. Louis	47	0	0	6	0	0	0	0	B
47	Lake Hassel	Swift	54	19	0	36	4	0	0	0	
522	Elysian Lake	Waseca	205	0	0	48	0	0	0	0	B
879,	Swartout Lake, Swart										
208	Watts Lake	Wright	86	49	0	~65	~45	~14	0	0	
			16,006								
			-								
	Totals		16,106	8,644							

Table 2. Numbers of American White Pelican nests and co-occurrence with Double-crested Cormorants in Minnesota, 2004.

Oc. #	Site	County	AWPE nests	Count Method	Previousl y Used	DCCO nests
850	Red Lake	Beltrami	340		Y	0
	Marsh Lake island #2 (Eight Acre /			G	Y	
633	Banding Island)	Big Stone	4,361			0
	Marsh Lake			G	Y	
353	Peninsula	Big Stone	2,031			0
	Little Pelican			G	Y	
916	Island, Leech Lake	Cass	11			2,524
69	Minnesota Lake	Faribault	974	G	Y	725
	Marsh Lake (Big			G, A, E	Y	
890	Island)	Lac Qui Parle	6,568			264
	Marsh Lake (One Acre / Small			A	Y	
none	Island)	Lac Qui Parle	432			0
229	Crowduck Island	Lake of Woods	242	G	Y	447
	Little Massacre			?	Y	
319	Island	Lake of Woods	277			1,363
231	O'Dell Island	Lake of Woods	25	G	Y	1,889
235	Techout Island	Lake of Woods	25	G	Y	605
new	Big Twin Lake	Martin	16	G	N	0
1031	Pigeon Lake	Meeker	357	G	Y	1,450
117	Lake Johanna	Pope	97	G	Y	580
47	Lake Hassel	Swift	19	G	N	54
	Swartout Lake,			G	N	
879, 208	Swart Watts Lake	Wright	49			86
Totals			15,824			9,987

G = Ground count, A = Aerial survey, E = extrapolation

Table 3. Estimates of nesting American White Pelicans at Marsh Lake, 2004 and 2005.

Island	Ground count (nests) (2004)	Aerial count of adults on nests (2004)	Extrapolation (2004)	Total Estimate (2004)	Aerial count of adults on nests (2005)
Big Island	4,044	882	1,642	6,568	5,292
One Acre Island (Small Island)		432		432	1,020
Peninsula	2,031	NA		2,031	2,706
Eight Acre Island (Banding Island)	4,361	NA		4,361	4,160
Total	10,436	1,314	1,642	13,392	13,178

Figure 1. Active Double-crested Cormorant Colonies in Minnesota, 2004.

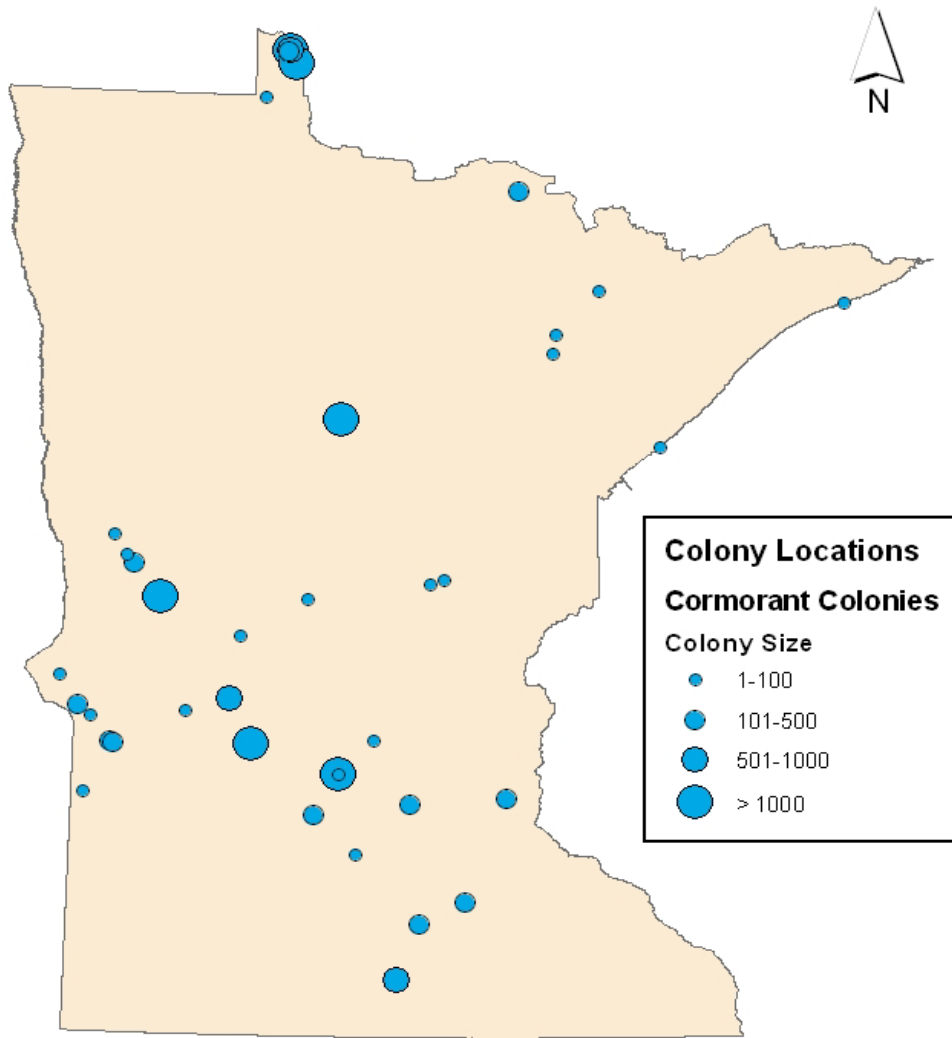


Figure 2. Minnesota DCCO colonies with ≥ 4 colonially nesting waterbird species, 2004

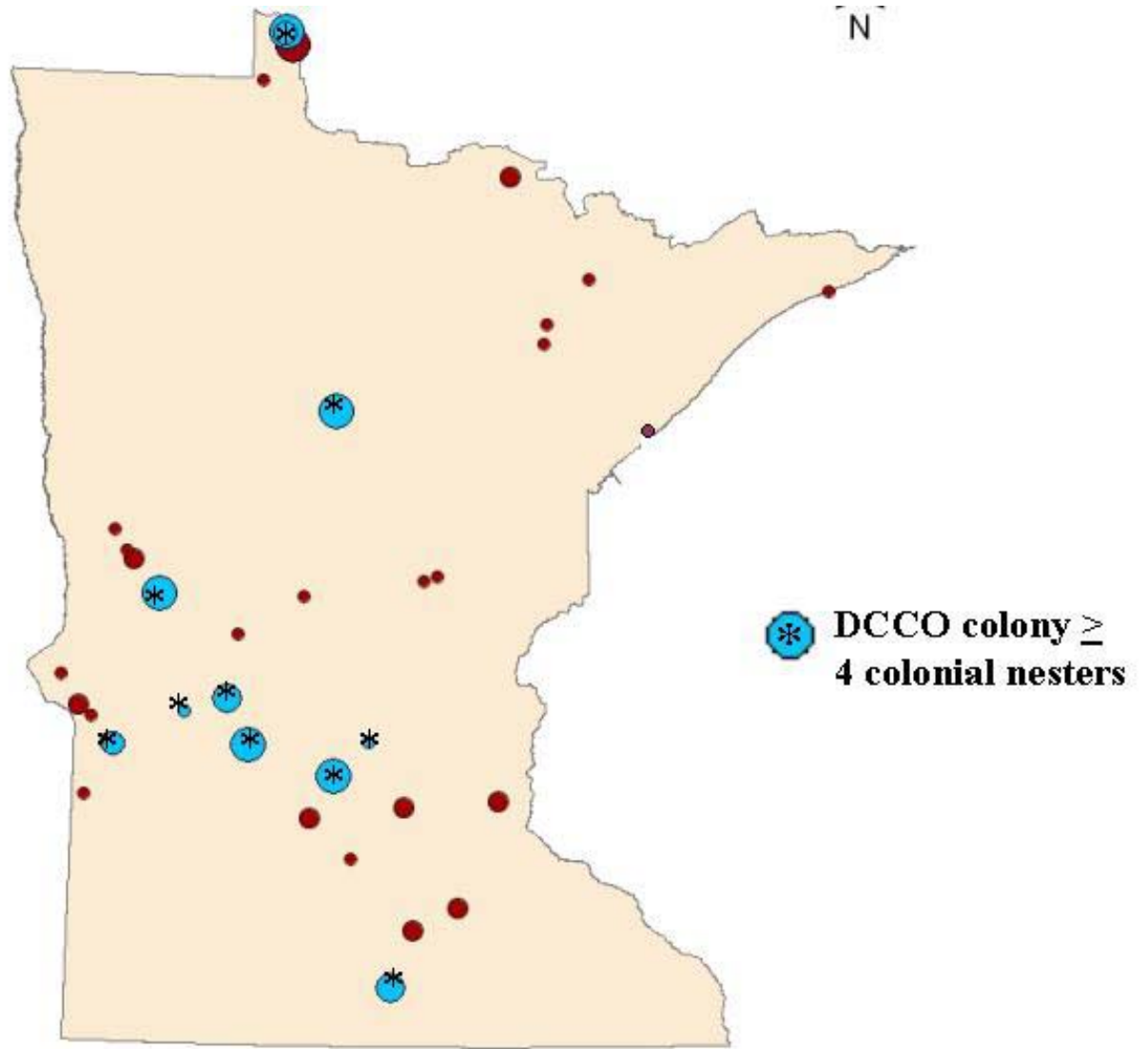
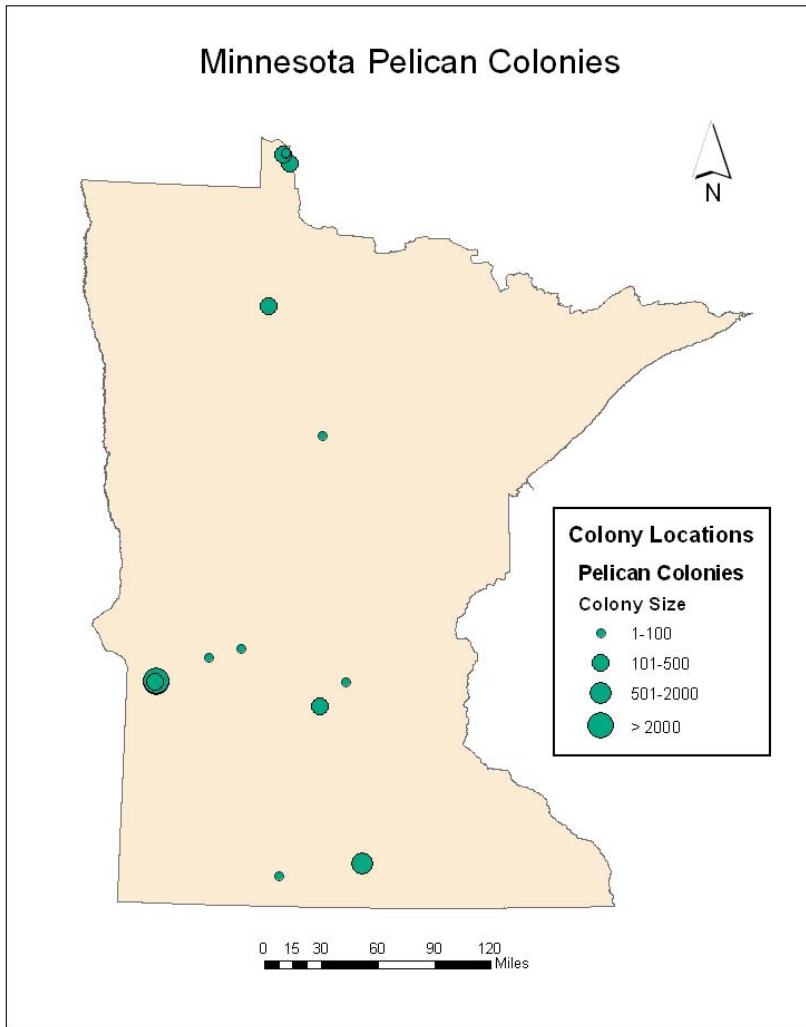


Figure 3. Active American White Pelican Colonies in Minnesota, 2004.



Figures 4-7. Marsh Lake Complex.

Figure 4a. Eight Acre / Banding Island



Figure 4b. Eight Acre / Banding Island detail.

Figure 5a. Big Island



Figure 5b. Big Island detail.

Figure 6. One Acre / Small Island



Figure 7a. Peninsula



Figure 7b. Peninsula detail

Figure 8. Don Carlson, and survey boat.



Appendix 1. Sites that were field checked during the 2004 AWPE – DCCO census.

Oc. #	Site	County	Latitude	Longitude	DCCO Nests
122	Rice Lake Island.	Aitkin	46.50972	93.38806	0
194	Rice Lake Ridge	Aitkin	46.5275	93.31667	0
14	Rice River	Aitkin	46.5558	93.394	0
95	Howard Lake	Anoka	45.26611	93.03611	0
195	Big Cormorant Lake	Becker	46.77194	96.05361	0
251	Boyer Lake	Becker	46.87111	96.04667	0
216	Sand Lake	Becker	46.87083	96.17417	0
506	Blackduck Lake Island	Beltrami	47.73417	94.62111	0
850	Red Lake	Beltrami	48.08972	95.0075	0
New	Lindquist WMA	Big Stone	45.34304	96.31565	32
152	Artichoke Lake	Big Stone	45.36111	96.14028	0
973	Barry Lake WPA	Big Stone	45.57278	96.57778	79
241	Eli Lake	Big Stone	45.4661	96.4306	0
1023	Hanson Slough (Lake)	Big Stone	45.3793	96.3015	0
242	Lyseng Lake	Big Stone	45.4177	96.4215	0
633	Marsh Lake Island #2 (Eight Acre / Banding Island)	Big Stone	45.1934	96.1278	0
39	Marsh Lake Island (Rock Island)	Big Stone	45.198	96.1525	414
353	Marsh Lake Peninsula.	Big Stone	45.1945	96.1312	0
240	Otrey Lake	Big Stone	45.3553	96.33	0
972	Swenson Lake	Big Stone	45.39974	96.41886	271
155, 156	Thielke Lake, Thielke Lake #2	Big Stone	45.38889	96.39167	0
638	W. Toqua L. Mainland	Big Stone	45.55194	96.46111	0
863	Coney Island, Waconia Lake	Carver	44.86122	93.7842	400
839	New Germany	Carver	44.88	94.00194	0
162	Gull Island, Leech Lake	Cass	47.10194	94.375	0
916	Little Pelican Island, Leech Lake	Cass	47.10611	94.37194	2,524
716	Little Pelican Spit	Cass	47.1088	94.3725	0
101	Rush Lake	Chisago	45.67333	93.09583	0
110	Clearwater River	Clearwater	47.85278	95.45083	0

	321	Red Lake River.	Clearwater	47.96056	95.29722	0
	425	Butterwort Cliffs	Cook	47.71639	90.48333	0
	422	MNDNR 36 Guano Rock	Cook	47.76352	90.23685	24
	423	MNDNR 37 Rock Island, Terrace Point Rock	Cook	47.72694	90.41028	0
	54	Mission Creek	Crow Wing	46.5127	94.0774	0
	62	Gun Club Lake	Dakota	44.8536	93.1952	0
New		Clifford Lake (Swim Lake)	Douglas	45.83724	95.15697	48
	341	Lura Lake	Faribault	43.84583	94.04528	0
	69	Minnesota Lake	Faribault	43.83472	93.87639	725
New		Albert Lea Lake	Freeborn	43.62314	93.32545	0
	10	Egret Island	Grant	46.05111	95.80389	1385
	589	Crane Island, Lake Minnetonka	Hennepin	44.90083	93.66194	0
	811	Diamond Lake	Hennepin	45.2033	93.5089	0
	64	Root River Delta (Hokah #2)	Houston	43.7675	91.25278	0
	8	Kabekona Lake	Hubbard	47.1664	94.7703	0
	714	Smith Slough	In WI			0
	570	Lone Pine - 1(Pond 2 North)	Itasca	47.35917	93.08028	0
Not In Database		Lone Pine - 2 (Pond 6)	Itasca	47.3751	93.0846	0
Not In Database		Lone Pine - 3 (Pond 2)	Itasca	47.3583	93.1018	0
	897	O'Brien Lake	Itasca	47.32278	93.13528	0
	582	Sugar Impoundment	Itasca	47.45611	94.34917	0
	620	North Heron Lake	Jackson	43.77417	95.26722	0
	177	South Heron Lake	Jackson	43.74861	95.25333	0
	210	Dog Lake	Kandiyohi	44.95556	94.8375	0
	211	Lake Lillian	Kandiyohi	44.9436	94.8797	0
	43	Lake Monongalia	Kandiyohi	45.33417	94.94444	0
	616	Little Kandiyohi Lake	Kandiyohi	45.0717	94.9467	0
	206	Long Lake	Kandiyohi	45.2	95.04167	1363
	478	Nest Lake	Kandiyohi	45.25917	94.96361	0
	516	Sunburg L. Peninsula Little Pine I., Voyageurs	Kandiyohi	45.32972	95.25056	0
None		N.P.	Koochiching	48.45328	92.92125	173
	153	Big Stone NWR	Lac Qui Parle	45.2375	96.3125	0
	813	Bolland Slough	Lac Qui Parle	44.89587	96.35827	50

890	Marsh Lake (Big Island)	Lac Qui Parle	45.1884	96.1311	264
None	Marsh Lake (One Acre / Small Island)	Lac Qui Parle	45.189	96.1354	0
471	BLM 80-Knife Island	Lake	46.94686	91.77413	26
340, 469	Encampment Island, MNDNR 79	Lake	46.94686	91.77413	0
320	Bridges Island	Lake of Woods	49.125	94.77694	Assumed Inactive
224	Rocky Point	Lake of Woods	48.96	95.034	0
229	Crowduck Island	Lake of Woods	49.25389	94.88556	447
112	Gull Rock	Lake of Woods	48.98472	95.05917	66
319	Little Massacre Island	Lake of Woods	49.18639	94.81056	1363
231	O'Dell Island	Lake of Woods	49.26083	94.86333	1889
230	Red Lake Rock	Lake of Woods	49.26361	94.86861	0
235	Techout Island	Lake of Woods	49.26611	94.87139	605
37	Lake Jefferson	Le Sueur	44.26528	93.77639	0
940	Anderson Lake WMA	Lincoln	44.44583	96.32083	0
941	Coon Creek WMA	Lyon	44.34028	96.04861	0
636	Lady Slipper Lake	Lyon	44.5717	95.6313	0
601	Agassiz. NWR - Ditch 11 Bank	Marshall	48.31778	95.995	0
602	Agassiz. NWR - Madsen Pool	Marshall	48.32028	96.02667	0
5	Agassiz NWR-Cormorant Island	Marshall	48.33	95.97389	0
New	Big Twin Lake	Martin	43.72899	94.75044	0
164	Campbell Lake	Mcleod	44.94082	94.0151	0
44	Cedar Lake	Mcleod	44.98194	94.45833	0
788	Otter Lake	Mcleod	44.865	94.41722	0
36	Dassel Marsh	Meeker	45.08833	94.27111	0
1031	Pigeon Lake	Meeker	45.03472	94.34722	1,450
1031	Pigeon Lk-South Island	Meeker	45.03472	94.34722	53
86	Sioux Lake	Meeker	45.025	94.46528	0
103	Hennepin Island	Mille Lacs	46.1792	93.5311	5
102	Spirit Island	Mille Lacs	46.1519	93.6444	95
805	Little Elk WMA	Morrison	46.05946	94.61743	49
68	Chautauqua Lake	Otter Tail	46.2375	96.02139	401
New	Grove Lake	Otter Tail	46.63333	96.15845	0
648	Haldorsen Lake	Otter Tail	46.41028	96.18278	20
1004	Lake Alice	Otter Tail	46.2886	96.0761	49

883	Maplewood	Otter Tail	46.51917	95.97722	0
685	Upper Lightning Lake East.	Otter Tail	46.138	96.15833	0
720	Goose Lake	Pope	45.44278	95.33	0
117	Lake Johanna	Pope	45.46326	95.22311	580
634	Lake Reno South	Pope	45.72556	95.43611	0
734	Pelican Lake Island	Pope	45.6527	95.449	0
90	Pigs Eye Lake	Ramsey	44.9	93.02583	200
New	Preston Lake	Renville	44.78847	94.53983	186
832	Lake Sakahta.	Rice	44.22972	93.5175	0
185	Shields Lake	Rice	44.37083	93.45	0
New	Wells Lake	Rice	44.28919	93.34843	472
215	Roseau WMA Pool 1	Roseau	48.9601	96.54	0
52	Blue Lake	Scott	44.80556	93.44028	0
89	Durgin Slough	Sherburne	45.47579	93.75995	0
30	E. Black Cinder SW	Sherburne	45.47917	93.70556	0
59	Schilling Lake	Sibley	44.6981	94.2119	0
481	Titlow Lake	Sibley	44.56556	94.21278	4
326	Dark River. Tailings Pond	St. Louis	47.61408	92.6209	70
378	Manganika Lake South Potato Island, Vermillion	St. Louis	47.4906	92.5728	0
379	Lake	St. Louis	47.85694	92.3075	0
611	Stuntz	St. Louis	47.52	92.97722	0
71	Taconite Pond	St. Louis	47.34417	92.55333	0
	Vermillion Rocks #1				
749	(Vermillion Lake)	St. Louis	47.86879	92.27105	32
757	Vermillion Rocks #2	St. Louis	47.86793	92.26357	0
?	Vermillion Rocks #3	St. Louis	47.87164	92.26322	0
325	West Two Rivers Reservoir	St. Louis	47.49889	92.64722	47
121	Clear Lake	Stevens	45.5578	96.0722	0
151	Gorder Lake	Stevens	45.518	96.0204	0
New	Harstad Slough North	Stevens	45.69667	96.00056	0
733	Lake Charlotte Mainland	Stevens	45.61778	95.77444	0
47	Lake Hassel	Swift	45.3925	95.56667	54
751	Lake Oliver	Swift	45.32806	96.00972	0
548	Schible Lake	Swift	45.25389	96.05083	0
806	Staples WMA	Todd	46.28806	94.79222	0
531	Mud Lake	Traverse	45.8617	96.5728	0
522	Elysian Lake	Waseca	44.1575	93.70278	205
542	Moonan WMA	Waseca	44.11667	93.43139	0

764	N. School Section Lake	Washington	45.14417	92.915	0
329	Burlington	Winona			0
849	Cormorant Island 2	Winona	43.89194	91.29333	0
848	Cormorant Island	Winona	43.89194	91.29333	0
491	Trempealeau NWR	Winona	44.05	91.5875	0
33	Pelican Lake	Wright	45.22778	93.77222	0
590	Pelican Lake South	Wright	45.21389	93.75444	0
	Swartout Lake, Swart Watts				
879, 208	Lake	Wright	45.23	94.08	86
523	North Spellman Lake	Yellow Medicine	44.6716	95.7735	0

Appendix 2. New sites / additional data for Double-crested Cormorants and American White Pelicans in 2005.

Site	County	Latitude	Longitude	DCCO	BCNH	AWPE	GBHE	GREG	RBGU
<i>Nesting documented</i>									
Hawksnest Lake	Lincoln	44.47551	96.20155	174	7	3 ¹	2	20	0
Big Twin Lake	Martin	43.72899	94.75044	0	0	8 ¹	0	0	0
Norway Lake	Ottertail	46.31648	95.89724	23	0	9	2	0	0
<i>Nesting suspected</i>									0
Twin Rocks #1	Lake of the Woods	48.97391	95.02931	X	0	0	0	0	
Twin Rocks #2	Lake of the Woods	48.97460	95.03273	X	0	0	0	0	X
East Twin Lake	Lyon	44.21617	96.04472	X	0	0	0	0	0

1 = Abandoned