Atlantic & Mississippi Flyways

Double-crested Cormorant Management Plan

Prepared by the
Cormorant Ad hoc Committees
Atlantic & Mississippi Flyway Council
Nongame Migratory Bird Technical Section

March 2010

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Accepted by the Atlantic Flyway Council
March

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EXECUTIVE SUMMARY

Long-range planning, cooperation, and coordination are essential elements for the successful management of any migratory resource. These elements have been used extensively in the Atlantic and Mississippi Flyways for more than 40 years to successfully manage populations of migratory waterfowl. Formulating a management plan for a migratory nongame species such as the double-crested cormorant (*Phalacrocorax auritus*) is a necessary step to developing a coordinated management system throughout the eastern United States. This plan provides basic principles and strategies to guide management of double-crested cormorants (DCCO) in the Mississippi and Atlantic Flyways. **The goal of the plan is to maintain the double-crested cormorant as a natural part of the waterbird biodiversity of the Atlantic and Mississippi Flyways, while minimizing significant negative ecological impacts to habitats, other species, or personal property and other socioeconomic interests.** The plan will encompass all DCCOs breeding and wintering in the Atlantic and Mississippi Flyways.

Double-crested cormorant (DCCO) (*Phalacrocorax auritus*) populations declined throughout the 1800s as cormorants were greatly reduced and/or extirpated in many areas (Wires and Cuthbert 2006). Some recovery occurred during the 1900s, but the populations declined sharply during the 1960s and 1970s due primarily to DDT and

other environmental toxins. The situation began to change in the late 1970s in Canada and in the 1980s and 1990s in the U.S. when DCCOs began a dramatic recovery.

The double-crested cormorant is the most abundant cormorant species in North America. In the 2003 Final Environmental Impact Statement on Double-crested Cormorant Management in the United States, the USFWS estimated the total double-crested cormorant population to be 2 million. Nearly 70 percent of this number is in the Interior population, concentrated in the northern prairies on the large, shallow lakes of Manitoba. Nearly 23% of North America's DCCOs are found in the Atlantic population and approximately 4% are breeding in the southern states.

With the establishment of the Public Resource Depredation Order and the Aquaculture Depredation Order by the USFWS, double-crested cormorants were managed as discrete populations at specific sites (e.g., breeding colonies, fish hatcheries, fish spawning areas, stocking sites) within individual tribal reservations, ceded territories, and states. Provincial policies have also dictated a site-specific approach to localized conflicts. However, DCCOs move throughout and between the Flyways, thus the DCCO population must be thought of in a broader scale. This plan outlines an approach to gather data needed to address the maintenance of sustainable populations of DCCOs distributed across their range, cognizant of social and ecological carrying capacities. The measurement and monitoring of the population will be conducted through breeding and wintering population surveys, banding and color marking programs, and identification of staging sites.

The large numbers of DCCOs have exceeded acceptance capacity with several wildlife stakeholder groups throughout Canada and the United States. Stakeholder concerns predominantly focus around social, ecological, and economic values associated with habitat destruction, impacts to recreational fisheries, impacts to co-nesting species, and loss of production at aquaculture facilities. The plan has an i**mpact reduction objective that allows individual state and tribal wildlife agencies, with the concurrence of the USFWS, to reduce local populations of double-crested cormorants where they create conflicts such as damaging habitats important to other wildlife populations, negatively impacting fisheries, affecting aquaculture operations, or creating other injurious or nuisance situations. Canadian provinces will also contribute to this objective in ways that are consistent with their respective cormorant policies.** DCCOs will continue to be managed on a state, provincial, and tribal basis, however, steps will be taken to further develop an international conflict reporting process as well as identifying the locations of the conflicts. Best management practices will be developed to provide the most effective and efficient management techniques available to the agencies. Various research and management projects will be reviewed at the Flyway level with possible multi-agency funding providing the means to conduct the projects.

FOREWORD

Long-range planning, cooperation, and coordination are essential elements for the successful management of any migratory resource. These elements have been used extensively in the Atlantic and Mississippi Flyways for more than 40 years to

successfully manage populations of migratory waterfowl. However, until recently, management of migratory nongame bird species has been given little consideration at the Flyway level.

Double-crested cormorant (DCCO) (*Phalacrocorax auritus*) populations declined throughout the 1800s as cormorants were greatly reduced and/or extirpated in many areas (Wires and Cuthbert 2006). Some recovery occurred during the 1900s, but the populations declined sharply during the 1960s and 1970s due primarily to DDT and other environmental toxins. The situation began to change in the late 1970s in Canada and in the 1980s and 1990s in the U.S. when DCCOs began a dramatic recovery. Recent monitoring data compared to available historic records suggest that breeding DCCO populations have reached record highs on the Great Lakes, but in inland waters, they may not yet be as abundant as historically reported (Wires et al. 2001, Wires and Cuthbert 2006). In recent years, DCCO numbers have stabilized or declined somewhat in parts of the Central and Mississippi Flyways. Large numbers of cormorants, typically found in dense nesting or roosting colonies, can negatively impact other waterbirds, rare species, vegetation, fisheries, and aquaculture facilities.

In the US, cormorants are managed cooperatively by the United States Fish and Wildlife Service (USFWS), USDA/APHIS/Wildlife Services (WS), state agencies, and federally recognized tribes. In Canada, the birds were not included in the Migratory Birds Convention Act and are therefore managed under regulations and policies established by provincial ministries. In 1998, the USFWS created the Aquaculture Depredation Order (AQDO). In 2003 the AQDO was modified and a new Public Resource Depredation Order (PRDO) was created. Both of these depredation orders were designed to resolve DCCO conflicts at a local scale. Creating a cormorant management plan that increases coordination among the USFWS, WS, states, tribes, and provinces will enhance existing research, management, and monitoring efforts. It may also help guide development of future policies and protect both cormorant populations and the habitats and prey species they depend upon.

State, provincial, federal, and tribal wildlife agencies responsible for the management of double-crested cormorants have cooperatively drafted this plan and agreed to support the basic concepts as guidelines for management of this international resource. It is only through such cooperative efforts that coordinated programs can be implemented to ensure the wise use and future well-being of migratory waterbird populations.

SCOPE

This plan will encompass the region within the Atlantic and Mississippi Flyways inhabited by *Phalacrocorax auritus auritus* and *Phalacrocorax auritus floridanus* during the breeding, migrating, and wintering portions of their lifecycles (Fig. 1). Both subspecies are included in the plan because several studies have suggested there is enough gene flow between the subspecies to warrant managing them as the same subspecies (Waits et al. 2003, Green et al. 2006, Mercer 2008). Some states are included under the AQDO (Oklahoma and Texas) and PRDO (Kansas, Oklahoma, and Texas), but are not within the Atlantic or Mississippi Flyways. These particular states will not be addressed by this plan. However, those states may participate where appropriate.

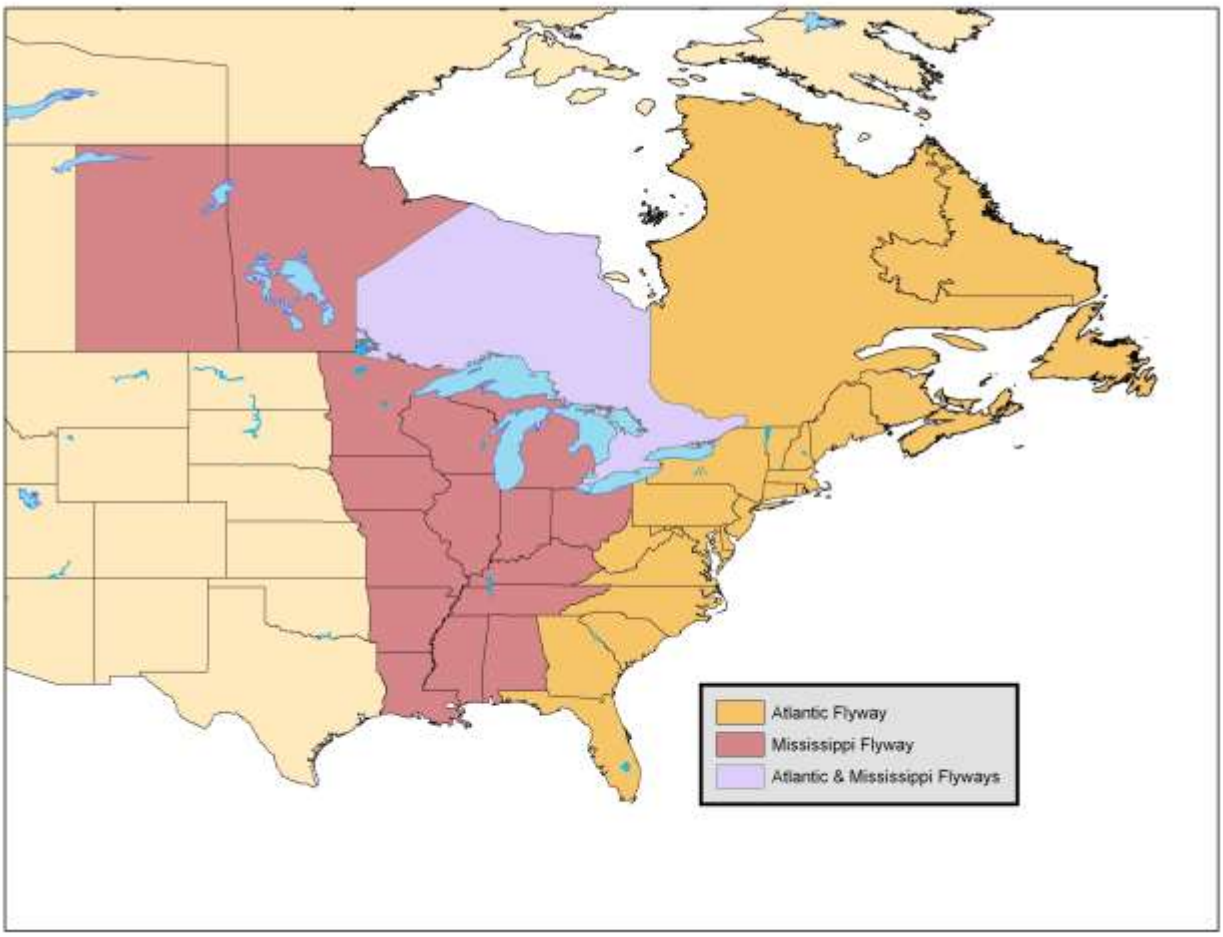

Fig. 1. States and provinces involved in implementation of the Atlantic and Mississippi Flyway Double-crested Cormorant Management Plan.

PURPOSE

The plan provides basic principles and strategies to help guide management of DCCOs in the Atlantic and Mississippi Flyways. It is not intended to provide prescriptive regulations or dictate management policies. Principles and strategies are provided in the form of management guidelines that allow for adjustment as more is learned about the size and distribution of the DCCO population, the impact this population has on the environment, its biology, socioeconomic factors, and its response to management activities. The plan will assist in development of research questions which will address cormorant-related issues throughout the flyways and will complement localized studies undertaken by individual agencies and universities. The plan will also facilitate the fiscal collaboration on research and/or management projects by states, tribes, provinces, and/or federal agencies.

GOAL

Maintain the double-crested cormorant as a natural part of the waterbird biodiversity of the Atlantic and Mississippi Flyways, while minimizing significant negative ecological impacts to habitats, other species, or personal property and other socioeconomic interests.

Part I. History, Distribution, Biology, and Status

A. History and Distribution

European explorers reported an abundance of cormorants along coastal islands in the Atlantic Ocean in the 17th and 18th centuries (Wires and Cuthbert 2006). By the late 19th and early 20th centuries, however, the abundance of cormorants across much of North America had greatly diminished (Wires and Cuthbert 2006). Between the 1920s and 1940s, DCCOs began a period of population recovery and expansion in several areas (Wires and Cuthbert 2006). However, this period was relatively short-lived when widespread use of DDT beginning in the 1940s, legal and illegal control activities, and habitat changes such as increased water pollution led to a second major period of DCCO population decline (Hatch 1995; Weseloh *et al.*1995, Hatch and Weseloh 1999).

Conversely, the history of the species during the last third of the 20th century can be described as one of protection and conservation efforts. In 1972 the DCCO was given protection in the U.S. under the Migratory Bird Treaty Act (MBTA) through an amendment to the Mexico Convention, and DDT was banned by the U.S. Environmental Protection Agency. These actions, along with changes in the prey base (e.g., invasion of the Great Lakes by exotic forage fish and development of large-scale aquaculture facilities on the wintering grounds) contributed to the recent period of spectacular population growth and return of DCCOs to many portions of the historic range from which they had long been absent (Hatch and Weseloh 1999, Wires and Cuthbert 2006).

Double-crested cormorants are long-lived, colonial-nesting waterbirds native to North America. One of 38 species of cormorants worldwide, and one of six species in North America, they are usually found in flocks, and are sometimes confused with geese or loons when on the water. Double-crested cormorants nest in many coastal and lake locations throughout North America in five breeding areas: Alaska (*P.a. cincinatus*), Pacific Coast (*P.a. albociliatus*), Canadian and U.S. Interior (*P.a. auritus*), Northeast Atlantic Coast (*P.a. auritus*), and Southern U.S. (*P.a. floridanus*) (Fig. 2). The Canadian and U.S. Interior breeding population is the largest, extending from the Canadian Prairie Provinces eastward to the Great Lakes and surrounding smaller lakes. There is high variation in the migratory tendencies of these different breeding populations. Birds that breed in Florida are essentially sedentary; those along the Pacific coast are only slightly migratory, while Atlantic and Interior birds show the greatest seasonal movements (Johnsgard 1993). The two primary migration routes for Atlantic and Interior cormorants are down the Atlantic coast and through the Mississippi-Missouri-Ohio River valleys to the Gulf coast (Palmer 1962, Dorr et al. in press, King et al. 2009a, King et al. 2009b)

with increasing numbers of birds remaining in the Mississippi Delta (Jackson and Jackson 1995, King et al. 2009a, King et al. 2009b). The scope of this management plan focuses on the Interior population of the double-crested cormorant within the Atlantic and Mississippi Flyways due to the mixing of birds between both flyways (Fig. 3).

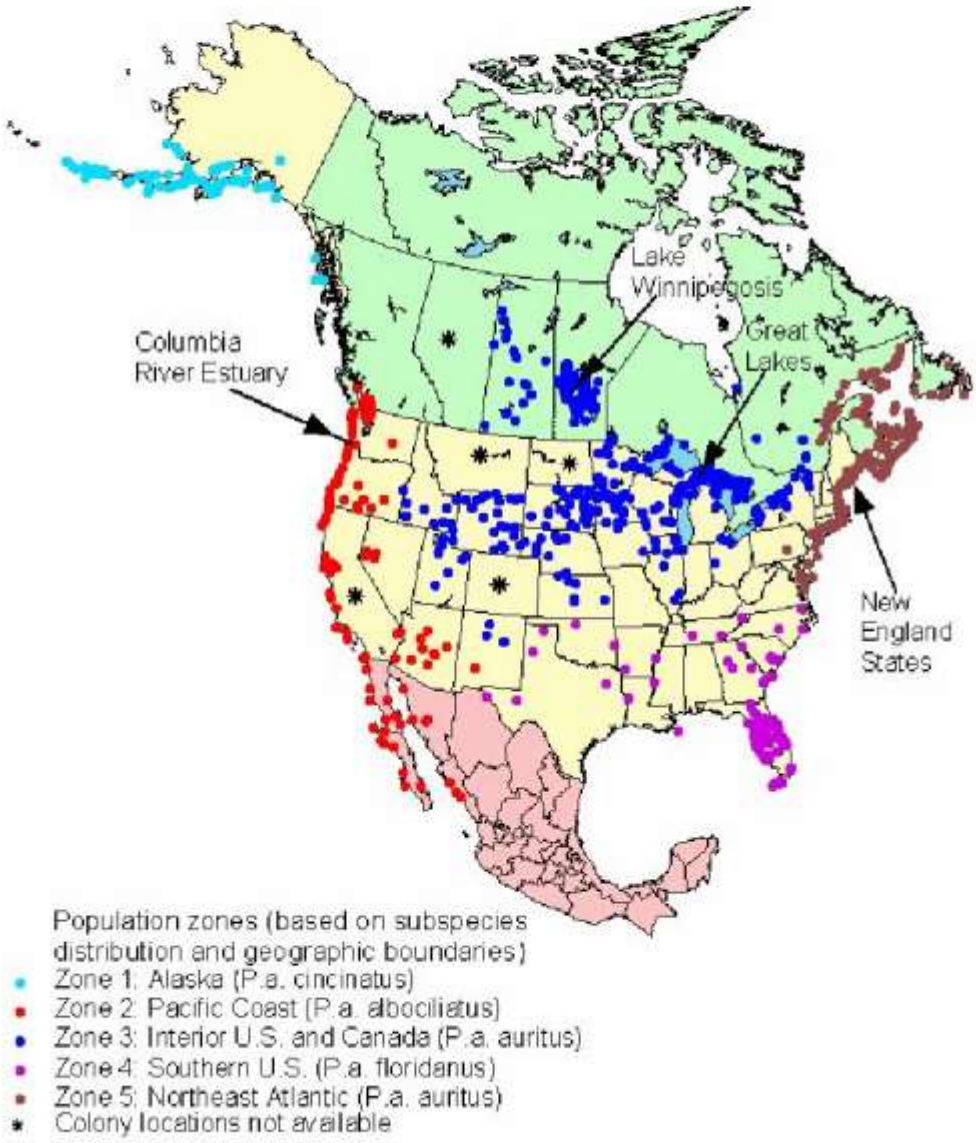

Fig. 2. Distribution of double-crested cormorant breeding colonies in North America, 1970-2000 (USFWS 2003).

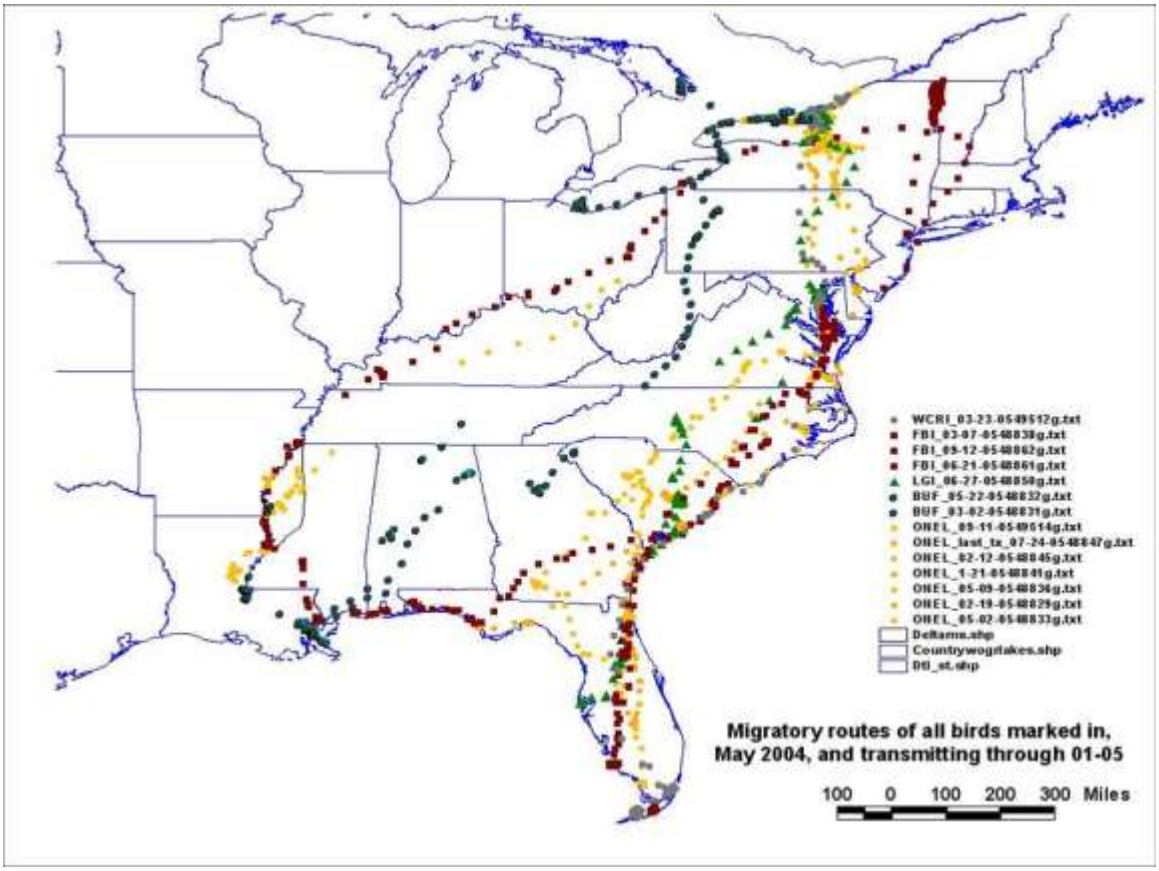

Fig. 3. Migratory routes of marked DCCOs, May 2004 – January 2005 (source: USDA APHIS Wildlife Services – unpublished).

B. Biology

Managers must understand the biology of double-crested cormorants to formulate effective management strategies. Double-crested cormorants breed in colonies ranging from several pairs to several thousand birds. Nests are placed in trees or on the ground. Nesting often occurs on islands favored by other colonial nesting birds, like great blue herons, great egrets, black-crowned night-herons, cattle egrets, pelicans, gulls, and terns. When large numbers of cormorants nest in trees, they can potentially kill the trees within 3-10 years from guano deposition (Wires et al. 2001). Typically, at age three or four, adults are ready to breed. An average nest has two or three chicks. These chicks can fly at 5–6 weeks and will accompany adults to feed at 7 weeks. They are independent of the adult birds at 10 weeks.

Cormorants are opportunistic feeders that prey upon the most abundant species of fish that are easy to catch (Hatch and Weseloh 1999, Wires et al. 2001). Cormorants eat fish that range in length from 3-40 cm with most fish <15 cm and individual birds consume about 0.45 kg (1lb.) of fish per day. The majority of their foraging occurs in shallow water (< 8m) within 5 km of shore. Cormorants respond rapidly to high concentrations of fish and often congregate where fish are easily caught, such as spawning sites, put and take lakes, fish stocking release sites, aquaculture ponds, dams, and other areas where fish are concentrated.

C. Population Status

The double-crested cormorant is the most abundant cormorant species in North America. In the 2003 Final Environmental Impact Statement (FEIS) on Double-crested Cormorant Management in the United States, the USFWS estimated the total double-crested cormorant population to be 2 million. Nearly 70 percent of this number in the Interior population is concentrated in the northern prairies on the large, shallow lakes of Manitoba (Hatch 1995, Wires et al. 2001). Nearly 23% of North America's DCCOs are found in the Atlantic population and approximately 4% are breeding in the southern states (Tyson et al. 1999).

While the total North American population increased rapidly from the 1970s into the 1990s (7.9 percent average annual growth), the overall rate of growth in the U.S. and Canada slowed during the 1990s (USFWS 2003). A coordinated survey of the Great Lakes in 2007 which included all 5 Great Lakes, their connecting channels, the St. Lawrence River, and large nearby inland lakes (i.e., Oneida Lake and Lake Champlain) recorded 115,006 cormorant nests (Fig. 4). This survey yielded an estimated Great Lakes population, including nonbreeders, of 345,000–460,000 individuals, based on an estimate of 3-4 birds per nest. Tyson et al. (1999) reported over 170,000 breeding birds for the Atlantic population and 27,000 breeders in the southern states.

Double-crested cormorant numbers have shown a slight decline in various areas of the Great Lakes. The declines are often attributed to direct control efforts such as the U.S. islands in western Lake Erie. However, other locales such as the Ontario side of Lake Huron have experienced breeding population reductions over the last five years, which are not wholly the result of control activities.

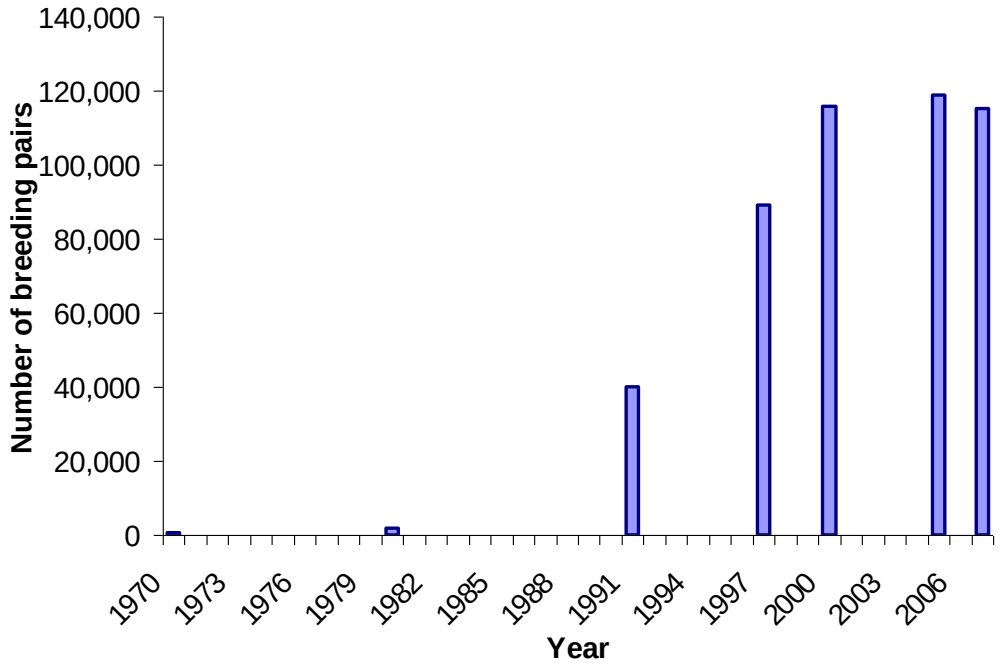

Fig. 4. Number of breeding pairs of double-crested cormorants counted in the Great Lakes, 1970-2007.

Annual mid-winter (January-February) cormorant night roost counts have been conducted by the USDA/Wildlife Services/National Wildlife Research Center and the Mississippi and Alabama Wildlife Services programs since 1990 and 1996, respectively. Counts are conducted in aquaculture producing regions of the alluvial flood-plain of the Mississippi River in Mississippi using ground surveys, and in west-central Alabama using aerial surveys and are used as indices of abundance. Trends in cormorant numbers are similar between locations over time. In recent years, cormorant numbers have been at approximately 50-60,000 cormorants in Mississippi and 20-25,000 cormorants in Alabama (Fig. 5).

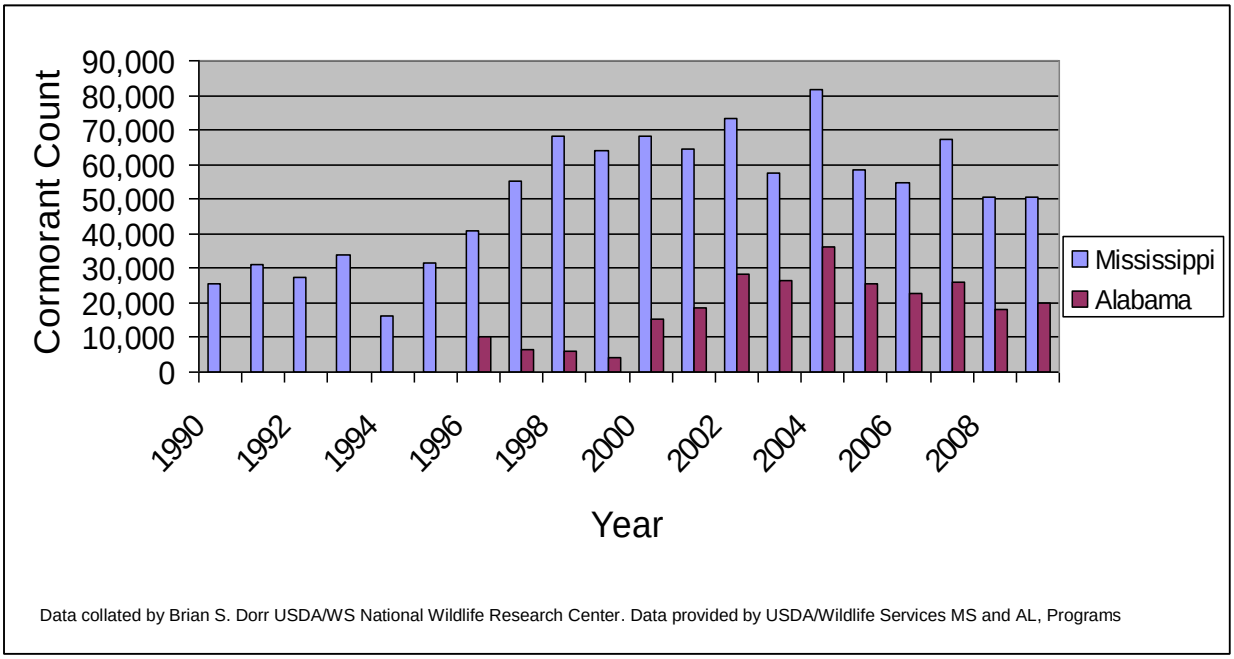

Fig. 5. Annual mid-winter (January-February) cormorant night roost counts conducted by the USDA/Wildlife Services/National Wildlife Research Center and the Mississippi and Alabama Wildlife Services programs.

In 2006-2008, nest counts were conducted in several southeastern states to better quantify the Southern breeding population of cormorants. However, the effort has been sporadic in some states and funding to conduct counts has been lacking. Data to date likely do not provide a complete or accurate count of southern breeding cormorant colonies. In addition, breeding colonies in Arkansas and Mississippi have been managed by lethal control at least since initiation of the PRDO. Colonies in Alabama were managed in 2007 and collections for a food habits study were conducted there in 2008 and continued in 2009.

Table 1. Number of DCCO nests counted in the Southern states, 2006-08 during breeding season.

	Year		
State	2006	2007	2008
AL	675	486	550
AR	37	22	0
MD[1]	~1,900	n/a	2,829
MS	135	362	183
SC[2]	128	72	88
Total	2,875	942	3,650

Data collated by Brian S. Dorr and Scott C. Lemmons of the USDA/WS National Wildlife Research Center. Data provided by USDA/Wildlife Services AL, AR, MD, MS, and SC.
[1]Data from the Maryland Department of Natural Resources, Natural Heritage Program
[2]SC data from SCDNR statewide wading bird counts conducted aerially May to July.

D. Legal Status

Double-crested cormorants have different legal protection in the United States and Canada. In the U.S., cormorants are protected under the MBTA and cannot be taken except under the following regulations:

CORMORANT DEPREDATION ORDERS: In response to persistent conflicts and complaints relating to DCCOs, in 2003 the USFWS in cooperation with the USDA, Animal and Plant Health Inspection Service, Wildlife Services (WS) completed an Environmental Impact Statement on the management of DCCOs in the United States (USFWS 2003). Included in the selected management alternative was the modification of one depredation order and the establishment of a new depredation order to address DCCO damage.

Aquaculture Depredation Order: The purpose of this order, which was established in 1998, is to reduce DCCO depredation on aquaculture stock at freshwater commercial aquaculture facilities. In conjunction with a non-lethal harassment program, it authorizes aquaculture producers (or their employees/agents) who meet specific requirements in 13 states (AL, AR, FL, GA, KY, LA, MN, MS, NC, OK, SC, TN, and TX) to shoot DCCOs "committing or about to commit depredations to aquaculture stocks" on their property or areas where they are permitted to conduct their operations. In 2003, the AQDO was amended to include State and Federal fish hatcheries and allow WS to shoot birds at winter roost sites near aquaculture facilities, with landowner permission.

Public Resource Depredation Order: The purpose of this order is to reduce the actual occurrence, and/or minimize the risk, of adverse impacts of DCCOs to public resources. Public resources include fish (both free-swimming fish and stock at Federal, State, and Tribal hatcheries that are intended for release in public waters), wildlife, plants, and their habitats. It authorizes WS, State fish and wildlife agencies, and Federally-recognized Tribes (acting on tribal or ceded lands) to control DCCOs, without a Federal permit, in

24 States (AL, AR, FL, GA, IL, IN, IA, KS, KY, LA, MI, MN, MS, MO, NY, NC, OH, OK, SC, TN, TX, VT, WV, and WI). It authorizes control on "all lands and freshwaters." This includes private lands, but landowner permission is required. It protects "public resources," which are natural resources managed and conserved by public agencies, as opposed to private individuals. Under the PRDO, DCCOs may be killed or harassed, their eggs oiled or destroyed, and their nests destroyed.

Both depredation orders require documentation of impacts, have reporting requirements, and are subject to National Environmental Policy Act (NEPA) compliance when significant control activities are planned. Environmental Assessments (EAs) that involved opportunities for public input have been developed for state-level activities (Michigan, Minnesota, Ohio, and Wisconsin) in the Great Lakes (see http://www.fws.gov/midwest/midwestbird/cormorants.htm). They identify DCCO-related conflicts and options for addressing them – including the PRDO, the AQDO (Minnesota is the only northern state where this order is in effect), and migratory bird permits (see below) – as well as assess potential impacts of DCCO management activities on affected public resources, regional DCCO populations, and Federally-listed species and other birds species that co-occur with DCCOs. The EAs also set statewide caps on the annual take of DCCOs and they establish State-level DCCO Working Groups to coordinate management activities.

MIGRATORY BIRD DEPREDATION PERMITS (DP): The MBTA allows the USFWS to authorize the take of birds (including DCCOs) protected under the act in order to reduce damage to property and "other interests" and address risks to human health and safety. For example, permits can and have been issued for reduction of DCCO damage to vegetation on private property, reduction of damage to private fish stocks in situations that are not covered by the AQDO, reduction of hazards to aircraft, and reduction of damage to structures from DCCO guano. DPs may also be requested and issued for the reduction of DCCO impacts on sensitive species or their habitats (e.g., vegetation), but, with the exception of research projects, have generally not been requested or issued for birds taking free-swimming fish from public waters (unless the project involved sensitive/T&E species protection or protection of recently stocked fish). Depredation permit applicants initially contact WS, which assesses the need for a permit and recommends to the USFWS appropriate lethal and nonlethal options for resolving conflicts; the USFWS then decides if a permit will be issued and what its conditions will be.

SCIENTIFIC COLLECTING PERMITS: The MBTA allows the USFWS to authorize the take of DCCOs and other birds for research purposes (e.g., food habits studies).

In Canada, cormorants are not included in the federal Migratory Birds Convention Act and are therefore managed under provincial laws and policies.

ALBERTA: Egg addling and shooting of adults has taken place in several specific locations in Alberta.

NOVA SCOTIA: Double-crested and Great Cormorants are protected under the Nova Scotia Wildlife Act but there are provisions in the Act and its regulations that allow the

issuance of permits for the removal of nuisance wildlife. Permits are not issued between 1 November and 31 March when DCCO are mostly absent from the province, and to prevent the killing of Great Cormorant that winter along the coast.

For DCCO, permits do not allow the holder to enter any cormorant colony for purposes of disturbing, harassing or killing double-crested cormorants. Permits are usually only issued to limit depredation on-site. Conditions on the permit include the specific period when cormorants are a problem to an identified commercial operation, and may include others to minimize conflict with other groups/individuals that frequent the area. Regional staff may issue a permit to kill or harass DCCO:

- to "bona fide" commercial fishermen - either part time or full time. Applicants must produce a commercial fishing license issued by a Department of Fisheries and Oceans officer; and
- to owners/operators of stocked fish ponds, but only after reasonable attempts to reduce fish losses to cormorants have failed.

The Director of Wildlife may issue permits for other circumstances such as requests from organizations involved with the release of salmon smolt undertaken in cooperation with a fisheries department. If granted, the Director's permit will designate individuals to undertake general harassment, and may allow the killing of a specified number of foraging birds. This will typically occur immediately prior and following release of the smolt. The latter must be retrieved and submitted to the Department. Additional restrictions may be required to minimize conflicts with other user groups along the river.

ONTARIO: In Ontario, cormorants are protected under the provincial Fish and Wildlife Conservation Act (FWCA), which prohibits the hunting and trapping of cormorants. The FWCA also prohibits the destruction, taking and/or possession of nests or eggs without authorization from the Ontario Ministry of Natural Resources (OMNR). However, the FWCA does allow landowners to harass, capture, or kill cormorants on their own property, without a permit, to prevent damage, but there are a number of legal requirements and conditions that must be adhered to.

The current provincial policy for cormorant management was consulted on in 1997 on Ontario's Environmental Bill of Rights (EBR) registry and was approved for implementation in 1998. Ontario's policy states that "control of cormorant numbers should only be considered in specific local areas if the birds are found to be having significant negative, ecological impacts on specific habitats or other species."

This guiding policy direction leads to the application of a site-by-site approach for cormorant management, and requires OMNR to confirm reasonable evidence of impacts at a site before considering control activities. OMNR must also consult with the public as part of the process to consider any new cormorant management programs. OMNR's policy approach was reconfirmed following a review in 2006.

QUEBEC: In Quebec, cormorants are protected under the *Lois sur la conservations et mise en valeur de la faune* (LCMVF), which prohibits the hunting and trapping of cormorants. The LCMVF also prohibits the destruction, taking and/or possession of

nests or eggs without authorization from the *Ministère des Ressources naturelles et de la Faune* (MRNF). However, the LCMVF does allow landowners to harass, capture, or kill cormorants on their own property, without a permit, to prevent damage, but there are a number of legal requirements and conditions that must be adhered to.

SASKATCHEWAN: DCCO, including their nests and eggs, are fully protected under Saskatchewan's Wildlife Act, but there are provisions in the Act that allow the Saskatchewan Ministry of Environment to issue permits to remove any problem wildlife species. These are applied on a case by case basis where warranted. To date, DCCO control has not been conducted in Saskatchewan.

Part II. Conflicts

Cormorant numbers have exceeded acceptance capacity with several wildlife stakeholder groups throughout Canada and the United States (Taylor and Dorr 2003). Stakeholder concerns predominantly focus around social, ecological, and economic values associated with habitat destruction, impacts to recreational fisheries, impacts to co-nesting species, and loss of production at aquaculture facilities (Taylor and Dorr 2003).

A. Impacts to habitat and other waterbirds

While DCCOs can negatively impact other waterbirds directly through nest takeovers and aggressive behavior (Skagen et al 2001), their indirect impacts on waterbirds through habitat degradation are more significant. Several colonial waterbird species can impact vegetation to varying degrees, but cormorant impacts are often magnified where they nest in large numbers.

DCCOs can displace colonial species such as black-crowned night-herons, great egrets, great blue herons, gulls, common terns, and Caspian terns through habitat degradation and nest site competition (USFWS 2003). DCCOs have been known to take over heron nests. For example, of 81 nest acquisitions observed by Skagen et al (2001), 57 were instances of DCCOs taking over great blue heron nests. However, it should be noted that in the remaining 24 instances, great blue herons took over DCCO nests. Cuthbert et al. (2002) examined potential impacts of DCCOs on great blue herons and black-crowned night-herons in the Great Lakes and found that DCCOs have not negatively influenced breeding distribution or productivity of either species at a regional scale, but did contribute to declines in heron presence and increases in site abandonment at a local scale. A study by Weseloh (2005) reviewed current and historical data on 43 breeding colonies of black-crowned night-herons on Lakes Huron, Erie and Ontario and the Detroit, Niagara and St. Lawrence Rivers. Eleven of the sites also had nesting great egrets and eight also had nesting great blue herons. Nesting cattle egrets and snowy egrets were present at two and one colonies, respectively. The study assessed trends in each species nesting relative to changes in co-nesting DCCO populations. Thirty-eight percent of black-crowned night-heron colonies were not affected, 23% showed potential or probable conflict and 39% showed nest take-overs or colony decline/abandonment. At least nine black-crowned night-heron colonies appear to have been abandoned after nest take-overs by DCCOs. More than half of great egret and great blue heron colonies showed probable (or higher) threat from cormorants. All black-crowned night-heron colonies under threat were located between Lake Erie and

the St. Lawrence River. Weseloh (2005) recommended that managers monitor DCCO nest placement when DCCOs nest with herons and assess if threats occur.

DCCOs can have a negative impact on vegetation that provides nesting habitat for other birds (Jarvie et al. 1999, Shieldcastle and Martin 1999) and wildlife, including State and federally-listed threatened and endangered species (Korfanty et al. 1999). Cuthbert et al. (2002) did find that DCCOs have negative effects on normal plant growth and survival on a localized level in the Great Lakes region. Wires and Cuthbert (2001) also identified vegetation die off as an important threat to 66% of the colonial waterbird colony sites identified as priority conservation sites in the U.S. Great Lakes. Based on survey information provided by Wires et al. (2001), biologists in the Great Lakes region reported DCCOs as having an impact to herbaceous layers and trees. An accumulation of DCCO guano (which contain high amounts of ammonium nitrogen), stripping branches and leaves for nesting material, and the combined weight of the birds and their nests may break branches and kill trees within 3 to 10 years of the establishment of a colony (Daniel 1989, Bédard et al. 1995, Korfanty et al. 1999, Hebert et al. 2005). Ammonium toxicity may be an important factor contributing to island forest decline (Hebert et al. 2005). Lewis (1929) considered the killing of trees by nesting DCCOs to be very local and limited, with most trees he observed to have no commercial timber value. However, vegetation damage can be a problem if the affected plant species or vegetative communities are rare, aesthetically or otherwise socially valued (e.g., cedars on S. Manitou Island, MI are sacred to local tribes), are important habitat for other species (Bédard et al. 1999, Hatch and Weseloh 1999), or if their loss affects private property values. In addition, survey respondents reported that DCCO impacts to avian species were mainly through habitat degradation and competition for nest sites (Wires et al. 2001).

Research and monitoring has concluded that Middle Island, part of Point Pelee National Park, is experiencing significant and potentially irreversible impairment of the island's rare Carolinian ecosystem, including nine species at risk protected by the federal Species at Risk Act due to the high nesting population of the DCCO colony. Middle Island is located in the Carolinian ecozone of the St. Lawrence Lowlands, the southern most ecological region of Canada. The Carolinian ecozone represents only 0.25% of the landmass in Canada but supports 25% of the Canadian human population. The vegetation communities on these islands are significant because they are distinct from the mainland (Boerner 1984). They contain populations of rare and threatened flora, some of which do not occur anywhere else in Canada, and are also often rare or threatened in the northeastern United States (Kirk 2007).

Hebert et al (2005) conducted a study of the relationship between DCCO density and vegetation on East Sister Island and Middle Island in Lake Erie. The habitat degradation on these two islands is important because both islands represent the Carolinian forest habitat which is extremely rare in Ontario. In 2000, the year prior to their study, there were 5,485 DCCO nests on the 37.5-acre East Sister Island and 5,202 nests on the 45-acre Middle Island. In their study, the spatial use of habitat by nesting DCCOs was negatively correlated with forest cover. Whole island tree cover on East Sister Island decreased 15% in six years concurrent with trends in DCCO use of the island. The largest decline in tree cover occurred in one transect in Middle Island that

was heavily used by DCCOs. Tree cover at the site declined from 92% in 1995 to 40% in 2001. Although the results of the study were correlational in nature and cannot prove that damage by DCCOs caused the decline in vegetation, review of other potential factors including pests, disease, human disturbance and weather did not provide any trends or data that would explain the observed declines. The authors also observed that DCCOs tended to prefer live trees for nesting and did not use dead trees. There appeared to be a pattern of expanding habitat loss that developed as trees used by DCCOs died and DCCOs moved on to healthy, more stable nesting sites.

Double-crested cormorants can also have a negative impact on ground-nesting waterbirds. In Minnesota, the Leech Lake Band of Ojibwe has conducted a program for many years to protect common terns and enhance their reproductive efforts on Little Pelican Island in Leech Lake. DCCOs also nest on the island and the increase in their population on the island has displaced ring-billed gulls that in turn displaced common terns. The threat that further increases in the number of DCCOs nesting on Little Pelican Island could jeopardize or displace the island's common terns, which are a state and Tribally listed threatened species, was one reason for the initiation of DCCO control at Leech Lake (Mortensen 2004).

B. Impacts to fisheries

The rapid increase in DCCO populations over the last 25 years has led to an increase in human conflicts relating to DCCO impacts on sport fisheries (USFWS 2003). DCCOs are opportunistic feeders and, therefore, feed on a wide diversity of fish species, dependent upon location (USFWS 2003). DCCO diet is reflective of the relative abundance and population dynamics of prey species in a specific water body (Belyea et al. 1999, Bur et al. 1999, Rudstam et al. 2004). In the Great Lakes, fish species such as the alewife and gizzard shad, appear to be important prey items. Stickleback, sculpins, cyprinids, and yellow perch, and at some localities, burbot, freshwater drum, and lake/northern chub are also important prey fish species (Wires et al. 2001). As distribution and numbers of non-native round gobies have increased in the Great Lakes, they are also becoming a larger part of the cormorant diet at some colonies (Ebener 2007, Olsen and Winkler 2008). DCCO foraging can have a negative impact on recreational fishing on a localized level (USFWS 2003). However, review of the literature indicates that the effects of DCCOs on game fish vary from lake to lake, from year to year and even from one time of the year to another in the same lake (Belyea et al. 1999).

The impact of DCCO predation on fish in a given body of water is dependent on a number of variables, including the number of birds present, the time of year when predation occurs, prey species composition, abundance and distribution, and physical characteristics of the body of water such as depth or proximity to shore (which affect prey accessibility). Environmental and human-induced factors also affect aquatic ecosystems and fish populations. These can be classified as biological/biotic (overfishing, exotic species, etc.), chemical (water quality, nutrient and contaminant loading, etc.) or physical/abiotic (dredging, dam construction, hydropower operation, siltation, weather induced year-effects, global warming, etc.). Such activities and factors may lead to changes in fish species density, diversity, and/or composition due to direct effects on year class strength, survival, recruitment to older age groups, spawning

success, spawning or nursery habitat, and competition (USFWS 1995).

Efforts to asses cormorant predation impacts on fisheries have typically consisted of cormorant diet studies, with qualitative conclusions based solely on the percent diet composition of sport fish relative to prey fish (Neuman et al. 1997, Bur et al. 1999). In addition, diet studies are often based on small sample sizes (regurgitant, pellets) collected over a relatively short time period (Craven and Lev 1987, Neuman et al. 1997). While a number of studies have concluded that cormorant predation poses little or no impacts on fish populations (Mendall 1936, Craven and Lev 1987, Campo et al. 1993, Sheppard 1994, Trapp et al. 1999), a growing body of science has emerged demonstrating that cormorants do have the potential to substantially impact localized fish populations. Several studies have found deleterious effects on juvenile anadramous fishes in rivers (Krohn et al. 1995, Blackwell and Krohn 1997, Blackwell et al. 1997), on catfish in aquaculture ponds (Glahn and Stickley 1995, Glahn et al. 2000) and on walleye and yellow perch in a moderate-sized lake (Van De Valk et al. 2002, Rudstam 2004). Localized impacts on fish populations in large lakes have been documented on smallmouth bass (Lantry et al. 2002) and yellow perch (Fielder 2008, Burnett et al. 2002). As summarized by Stang et al. (2004) the body of evidence that now includes more recent comprehensive studies, clearly demonstrates that double-crested cormorants can have deleterious effects on fish populations in small to moderate size aquatic ecosystems, and locally deleterious effects in large aquatic ecosystems. It is important to note that fish mortality attributable to cormorants can be additive to other sources of mortality including weather, fish predation, ecosystem change, commercial and recreational fisheries, habitat disturbances, etc.

Relying on relatively small sample sizes, limited prey identification/size determination techniques, and abbreviated sampling periods; several studies have concluded that cormorant predation poses little or no impact on fish populations. Mendall (1936) reported dietary contributions of flounders (9.8%), herring (3.7%), and eel (2.7%), and concluded that cormorant predation “does little if any damage to man’s interests.” Craven and Lev (1987) investigated cormorant impacts in the Apostle Islands of Lake Michigan. The authors analyzed cormorant regurgitant and pellets to determine percent diet frequency, but do not state the sample sizes of regurgitant/pellets examined, nor the frequency and duration of their collections. While lake whitefish and lake trout each contributed approximately 1% to cormorant diets, the authors concluded that “cormorants did not appear to eat fish of commercial species and sizes.” Glahn et al. (1999) examined intact fish and otoliths from a total of 193 cormorant stomachs and concluded “with the possible exception of harvestable size bluegill, burgeoning cormorant populations do not appear to have an appreciable negative impact on southern sport fisheries.” Campo et al. (1993) examined 420 cormorant stomachs from eight Texas reservoirs over a five month period and concluded that “sport fishes made up a substantial portion of cormorant food by weight, but not by number on some reservoirs. Cormorants ate very few large sport fish, however.” Although Neumann et al. (1997) stressed the importance of accounting for temporal variation in cormorant diets, their study of Little Galloo Island (Lake Ontario) cormorant diets ended on 27 July, prior to a shift in diets with an increasing emphasis on yellow perch and smallmouth bass (Johnson et al. 2002).

Rendering conclusions regarding cormorant impacts to fisheries based solely on percent diet composition can be misleading. Johnson et al. (2002) estimated that smallmouth bass contributed only 1.5% percent (by number) to the diets of Little Galloo Island (Lake Ontario) cormorants in 1998, however, this translated to approximately 1.3 million bass consumed. While Great Lakes cormorants have been shown to prey predominately on smaller baitfish species (i.e. alewife; Craven and Lev, 1987, Neuman et al. 1997, Johnson et al. 2002), and small-bodied sportfish, the average size of smallmouth bass consumed by Little Galloo Island cormorants in 1993-1994 was 256 mm with a mean age of 4.4 years (Adams et al. 1999). In addition, 14.1% of bass consumed were "legal" size (> 305 mm total length).

Johnson et al. (2002) clearly demonstrated that cormorant diet studies conducted over relatively short time periods can result in erroneous conclusions on prey consumption. They found substantial temporal variation in the diets of Little Galloo Island (Lake Ontario) cormorants, with yellow perch dominating diets in April and May (pre-chick period), followed by alewife dominance in June and July (chick feeding period), and a reversal to yellow perch dominance in August and September (post-chick period). They also found that percent composition of smallmouth bass in cormorant diets increased substantially as the season progressed (0.8% to 7.2%), with a concomitant seasonal decrease in mean bass length (>205mm pre-chick to approx. 140 mm post-chick). The average size of smallmouth bass consumed during the pre-chick period is particularly noteworthy, as a 205 mm long bass was approximately 4 years old.

Long-term fisheries assessment data have been utilized in concert with cormorant diet information, providing more rigorous evaluations of cormorant impacts. Subsequent to angler complaints regarding declines in smallmouth bass fishing success and reduced bass catches in agency assessment netting (1976-1995), Lantry et al. (2002) determined that smallmouth bass mortality between ages 3 and 6 had increased dramatically after the number of cormorant nests on Little Galloo Island (Lake Ontario) exceeded 3,500 in 1989. The authors noted that while a number of environmental conditions were changing during the time period studied, including nutrient reduction and invasive species colonization, similar declines in smallmouth bass abundance in other areas of Lake Ontario subject to the same environmental changes were not apparent (Eckert 1999).

Diana et al. (2006) concluded that recruitment failure, and not cormorant predation, led to the collapse of Les Cheneaux Islands (Lake Huron) yellow perch fishery in 2000. Recruitment failure would have resulted in an increase in the mean age of the perch population, however, subsequent analyses by Fielder (2008) utilizing long term fisheries data determined that mean age had actually declined, and gill net catches not only confirmed continued recruitment, but also the production of a very strong year class. Regression analysis of six possible independent variables that could account for the perch decline (cormorant abundance, walleye abundance, fishing effort, perch recruitment, spring water levels, and spring water temperatures) revealed that cormorant abundance accounted for five relationships significantly correlated with perch population trends.

Rudstam et al. (2004) studied Oneida Lake, a moderately large New York lake, utilizing

cormorant diet studies and a 40 year fisheries data series to assess cormorant predation impacts on yellow perch and walleye populations. Yellow perch and walleye populations declined in the 1990s attendant with dramatic increases in cormorant nests on Oneida Lake and numbers of migrating cormorants. Total consumption by cormorants increased from 44,000 kg in 1995 to 73,000 kg in 1997, with yellow perch and walleye representing 55-77% of cormorant diet by mass and 40-81% by number. Similar to Johnson et al. (2002), cormorant predation on sportfish was not limited to younger, smaller fish, but included adult yellow perch up to age 3 and adult walleye up to age 4. The authors concluded that increased cormorant induced mortality of sub-adult yellow perch and walleye compared to previous decades was a major factor leading to their declines.

A number of studies have focused on potential impacts of DCCOs on smallmouth bass populations in the Beaver Archipelago (BA), Lake Michigan. Smallmouth bass supported a very popular sportfishery in the BA during the 1970s and 1980s, but by 1999 angler participation had declined due to poor catches (Kaemingk 2008). The breeding population of BA DCCOs increased from 250 nesting pairs in 1984 (Ludwig 1984) to 880 nesting pairs in 1989 (Scharf and Shugart 1998), and peaked at 11,709 pairs in 1997 (Cuthbert et al. 1997). Seider (2003) studied smallmouth bass population attributes in the nearshore waters of the BA from 1999-2002. Based on a number of population parameters including population estimates, high adult survival (i.e., low angler exploitation), increased growth and condition, and mortality of age 3 to 5 bass as high as 99%, Seider concluded “These data suggest that cormorant predation is limiting smallmouth bass abundance.” Seider’s study and conclusions, however, may be compromised by sampling exclusively for smallmouth bass in shallow embayments, disregarding the range of habitats used by Great Lakes smallmouth bass, which typically move offshore to greater water depths after spawning. It is not uncommon for Lake Michigan smallmouth bass to inhabit water depths as deep as 25 m during the summer months (Randy Claramunt, Michigan Department of Natural Resources, Charlevoix, personal communication), and Seider’s mortality estimates could have been confounded by seasonal smallmouth bass movements from his nearshore study areas to deeper, offshore habitats (Kaemingk 2008).

Seefelt (2005) characterized DCCO diets in the BA in 2000 and 2001. From a collective 14,005 food items examined, only one smallmouth bass was identified. Seefelt and Gillingham (2006) used VHF radio telemetry and boat surveys to locate DCCO foraging locations in the BA during the summer of 2003. Both methods resulted in similar DCCO foraging patterns. Radio-marked birds foraged approximately 2.5 km from breeding colonies in an area with a steep depth contour dropping from 1 m to over 18 m. DCCO rafting locations overlapped with the area frequented by radio-marked birds. Based on the works of Becker (1983) and Seider (2003) citing typical summer smallmouth bass habitat ranging from 2-6 m in depth, Seefelt (2005) concluded that while cormorants do forage in the range of depths occupied by smallmouth bass, “important habitat areas for smallmouth bass are not used extensively by DCCOs in the study area.” A subsequent acoustic telemetry study of smallmouth bass in the BA identified offshore movements of post-spawning bass, with 2 of 16 tagged fish caught by anglers 33 km and 59 km away from their respective tagging sites (Kaemingk 2008).

In a study similar to that of Seider (2003), Kaemingk (2008) used trap and fyke nets to study smallmouth bass population parameters and movements in the Beaver Archipelago during the summers of 2005-2008. Kaemingk identified low apparent summer survival of bass, and of three potential causal mechanisms (natural mortality, angler exploitation, and permanent emigration), he discounted DCCO predation on bass and concluded that emigration explained the occurrence. His conclusions were supported by recaptures of tagged bass up to > 100 km from the BA tagging site.

The Beaver Archipelago studies have contributed considerably to our understanding of DCCOs, however, due to the timing and nature of the studies little can be reliably concluded regarding DCCO impacts on local fish populations, including smallmouth bass. Foremost, the above referenced studies were conducted years after reported declines in smallmouth bass and the period of most rapid growth in the DCCO population. The lack of a long-term annual fisheries assessment program compromises the ability to monitor trends in bass year class strength formation and subsequent recruitment to the adult population. In addition, corresponding long-term DCCO diet information is also necessary, as substantial inter-annual shifts in diet can occur.

In summary, historic assessments of and conclusions regarding cormorant impacts on fish populations and fisheries were largely based on insufficient information. Recent, more scientifically rigorous analyses have demonstrated the potential for double-crested cormorants to negatively impact localized fish populations in small to large ecosystems, and have established a higher standard for future investigations.

C. Impacts to aquaculture

Aquaculture is the intensive commercial propagation of various fin fish, crayfish or shrimp. Southern aquaculture is devoted primarily to the culture of catfish, baitfish and crayfish in large (> 2 ha) shallow (< 2 m) ponds. Aquaculture facilities are located primarily in the states of Alabama, Arkansas, Louisiana, and Mississippi. More than 90 percent of all catfish production in the United States occurs in these four states (USDA 1998). Although southern aquaculture farms vary greatly in size, a typical Mississippi catfish farm has 20 ponds, each containing about 6 surface hectares of water. Because of the size of baitfish and crayfish and multi-batch cropping systems with catfish, almost all ponds are vulnerable to predation by fish-eating bird species, particularly DCCOs (Glahn et al 2000).

Southern aquaculture production has seen phenomenal growth from the 1980s through the turn of the century, primarily due to the expansion of the catfish industry (Glahn et al. 2000). At approximately the same time the catfish and baitfish industry were experiencing rapid growth, breeding DCCO populations across the United States, and specifically the Great Lakes Region were experiencing exponential growth. However, in the past five years the acreage of catfish farms has been reduced by 8,000 ha (20%) in Mississippi (Mississippi State University 2009), and this may have important implications on DCCO management in the Southeast in future years.

Most DCCOs that affect southern aquaculture breed in the northern United States and Canada (Dolbeer 1991). From 1995 to 1998, the number of DCCO wintering in the catfish production region of Mississippi more than doubled, and exceeded 60,000 birds

by 2000. Also in 1998, breeding colonies of DCCO were discovered in Mississippi and Arkansas for the first time in decades. Dolbeer (1991) found that prior to 1998 up to 70% of the cormorant band recoveries from the lower Mississippi River Valley originated from colonies in Saskatchewan through the Great Lakes. Dolbeer (1991) also found that band recovery analysis revealed no specific geographic area for breeding birds which migrate south to create conflicts with aquaculture. However, it seems clear that the conflict involves DCCOs associated with the Mississippi Flyway and to a lesser extent, the Great Lakes region of the Atlantic Flyway (Glahn et al. 2000).

Catfish farming is an important economic activity. In 2001, the industry produced 270 million kgs of catfish valued at $444 million at the farm level (National Agricultural Statistics Service 2002). Unfortunately, fish-eating birds have had a substantial economic impact on aquaculture production. Aquaculture industry costs associated with bird damage and damage prevention are estimated to exceed $25 million annually (Barras 2004). While there are a number of fish-eating bird species that negatively impact aquaculture production, the DCCO is most often cited by catfish producers to be of serious concern (Wywialowski 1999). Each DCCO can consume 0.45 – 0.68 kgs of catfish per day. The birds not only eat catfish, but also affect production by injuring catfish, and disrupting daily feeding. (Wywialowski 1999).

Fish aquaculture ponds are stocked at extremely high densities ranging from 5,000 to 150,000 fish/ha with catfish and 123,000 to almost 500,000 fish/ha with baitfish. Such crowding makes fish highly susceptible to bird predation, particularly by DCCOs (Glahn et al. 2000). In contrast to the early industry days when ponds were drained for harvest each fall, catfish production ponds are now usually drained every 8 to 12 years. This change in pond/fish management makes direct measurement of catfish losses in pond environments practically impossible to accurately attribute to one mortality cause (Hanson 2001). The majority of catfish losses come from disease, followed by bird predation. Wildlife Services has a fully staffed operation in Mississippi that investigates DCCO-catfish interactions. Starting in the late 1980s, WS quantified catfish losses due to DCCO depredation through catfish producer surveys (Stickley and Andrews 1989, Wywialowski, 1999), bio-energetic models (Glahn and Brugger 1995), observational experiments (King et al. 1995, Stickley et al. 1992), and controlled experiments with captive birds on catfish research ponds (Glahn, unpublished data).

The aquaculture industry has small profit margins; therefore, even a small percentage reduction in the farm gate value due to predation is an economic issue (Price and Nickum 1995). The magnitude of economic impacts that cormorants have on the aquaculture industry can differ depending upon many different variables including the value of the fish stock, number of depredating birds present, and the time of year the predation is taking place (Booth and Hoy 2004). Bioenergetics modeling on the impact of DCCOs on the Mississippi Delta catfish industry estimated that in 1989-90 and 1990-91, losses approximated 20 million and 18 million catfish fingerlings (10 to 20 cm), respectively (Glahn and Brugger 1995). This was equivalent to approximately 4 percent of the fingerling class during the November to April study periods, and represented approximately $2 million in fish losses. Although losses were documented over a six-month period, the majority (about 64-67 percent) occurred in February and March (Glahn and Brugger 1995) when wintering and migrating DCCO populations are at or

near their highest numbers.

Glahn et al. (2000) used this same model to predict predation rates on fingerling catfish in the delta region of Mississippi and based it upon the doubling in the wintering cormorant population in that state. They estimated that cormorant predation losses resulted in the annual removal of 49 million fingerlings valued at $5 million. Glahn et al. (1999) stated that as much as 75% of the diet of cormorants in certain roosting areas of the Mississippi Delta consisted of catfish. As indicated by bioenergetics models, cormorants can exploit as much as 940 metric tons of catfish per winter. Some agricultural economists suggest that a 20% loss in production would result in a 100% loss in profits (Carole Engle, pers. comm.). Hanson (2001) examined the effect of increasing catfish stocking rates on mitigating DCCO predation through the development of a DCCO-inflicted threshold level of mortality on catfish farmer returns analysis. He found evidence the increasing DCCO population will increasingly consume more farm-raised catfish and increasing catfish stocking rates alone cannot mitigate DCCO damage to acceptable economic levels to the catfish farmer.

D. Impacts to structures

Double-crested Cormorants are known to nest on artificial structures such as bridge understructures and lattice transmission towers. Damage to these structures can result from guano and control measures may be needed. Allowing the imprinting of DCCO chicks to nesting on these artificial nesting substrates will quickly exacerbate the problem. All states are encouraged to manage DCCO nesting on artificial structures so that this issue does not escalate and become a human-wildlife nuisance problem.

Part III. Population Management

A. Population Dynamics, Monitoring, & Assessment Objective:

<u>Objective:</u> To maintain sustainable populations of DCCOs distributed across their range, cognizant of social and ecological carrying capacities, by developing data collection and assessment procedures and tools to guide management.

With the establishment of the PRDO and the AQDO by the USFWS, double-crested cormorants have been managed as discrete populations at specific sites (e.g., breeding colonies, aquaculture facilities, fish hatcheries, fish spawning areas, stocking sites) within individual tribal lands, ceded territories, and states. Provincial polices have also dictated a site-specific approach to localized conflicts. However, satellite telemetry work by Dorr et al. (2003), Dorr et al. (In Press), and King et al. (2009b) has shown that individual cormorants have the ability to move extensively throughout the Great Lakes region over the course of the breeding season. This compels biologists to think of the double-crested cormorant population on a broader scale and to want to understand the species' meta-population dynamics. The cumulative impact of site-specific cormorant management actions on the interior population is not well understood, but is currently being studied by WS. Similarly, any large-scale population objective for DCCOs must take into account differences in breeding and wintering population levels, policies (i.e., between states and tribes, which operate under USFWS policy, and provinces), and the management capabilities of individual states, tribes, or provinces.

Due to the lack of accurate population data and the difficulty in quantifying tolerable population levels for each state and province, a range of population levels is given for a number of states and for the flyways (Table 2). A tolerable level can be defined as the approximate number of double-crested cormorant breeding pairs within a state or province in which the viability of the population would not be impaired (if so desired) and other species and habitats would not be significantly impacted. This definition incorporates the states which choose not to have a viable population of cormorants as well as those which do not feel a need for cormorant management at the present time. A breeding population within a state or province that is above or below the tolerable level does not imply that a state or province needs to institute management or protection. Wintering DCCOS in the southeast are also significant from a population impact; however, lack of information makes this difficult to assess at this time.

Table 2. Tolerable breeding pair population levels and estimated number of breeding pairs of double-crested cormorants in states and provinces in the Atlantic and Mississippi Flyways.

State/Province	Tolerable number of pairs	Estimated number of breeding pairs	State/Province	Tolerable number of pairs	Estimated number of breeding pairs
Alabama			New Hampshire		
Arkansas	0	150	New Jersey		
Connecticut	2,400	1,250	New York		10,500
Delaware			Newfoundland		
Florida	Not established	8,000	North Carolina		250
Georgia			Nova Scotia	14,000-15,000	12,000-14,000
Illinois	900-1,600	Unknown	Ohio	2,500	3,500
Indiana	500-1,000	1,800	Ontario		61,000
Iowa	1,100-1,600	1,100-1,600	Pennsylvania	122	122
Kentucky	500-1,000	800	Prince Edward Isl.		
Louisiana	150	150	Quebec		Unknown
Maine	100*		Rhode Island	2,000	2,000
Manitoba		36,947	Saskatchewan		Unknown
Maryland	3,000-5,000	2,829	South Carolina	100-500	200
Massachusetts	8,000	5,963	Tennessee	500	500
Michigan	5,000-12,500	25,000-30,000	Vermont	0**	
Minnesota		16,000	Virginia	1,200	
Mississippi	0	200-500	West Virginia	0	0
Missouri	300-500	300-500	Wisconsin	7,500-8,000	17,945
New Brunswick					

* Refers to inland nesting pairs only (i.e., excludes coastal breeding population)

** Due to the current lack of information and pending further evaluation and development of a Lake Champlain Colonial Waterbird plan, Vermont will be entering zero for tolerable breeding pairs. This number will not commit/mandate Vermont to conduct additional control actions to maintain a zero breeding pair level.

Strategy 1:
Implement a biennial operational breeding population survey for double-crested cormorants by 2012 that produces a population estimate with confidence limits of approximately ± 25% at the state or province level for each state or province that has an estimated population of at least 2,500 double-crested cormorant nests.

Rationale: A reliable estimate of the interior double-crested cormorant population is essential to develop and evaluate the effectiveness of appropriate conservation/management strategies. Surveys of cormorant colonies on the Great Lakes have been conducted every other year for the past 4 years. Thus, adding inland colonies and the reservations, states and provinces that are not already surveyed should provide a reasonable estimate.

Strategy 2:
Initiate a banding and color marking program with isotope analysis of feathers to identify breeding and wintering associations and origins of "replacement" breeding birds. Initiate surveys at staging areas, wintering areas, and areas where cormorants cause problems to look for color marked birds.

Rationale: Many northern states and some tribes have initiated cormorant control to reduce the impact of cormorants on fisheries or habitat with varying degrees of success. However, the number of culled birds is often greater than the corresponding decrease in the breeding population. There is a need to determine where these "replacement" birds originate. In addition, many cormorants are shot in southern aquaculture facilities, but we have little information to determine the origins of these birds. A banding program with isotope analysis of feathers would allow us to determine breeding locations and wintering areas. Wildlife Services/NWRC has conducted some research on this subject which shows the colony locations and breeding regions of the DCCOs captured or recovered around Southeastern US aquaculture facilities (King et al. 2009a, King et al. 2009b, King et al. 2009c, Chastant 2008).

Estimates of survival within areas that conduct management, age of breeding, and population size could be obtained through re-sightings of marked individuals via mark-and-recapture analyses. Moreover, survival estimates of birds using aquaculture facilities, and those not using the facilities could be compared to understand if aquaculture is contributing to an overpopulation of DCCOs (this would require not culling at some aquaculture facilities serving as control sites). Another aspect would be to band and color mark adults on breeding areas where nests are oiled to monitor dispersal of the birds after the nests are oiled.

Strategy 3:
Implement a wintering ground survey of double-crested cormorants throughout the southern Atlantic and Mississippi Flyway states.

Rationale: Cormorants have negatively impacted aquaculture facilities and some other natural resources in the southeastern states. A wintering ground survey throughout these states and reservations would provide an estimate of the total number of cormorants wintering in the area as well as their spatial distribution. It will be especially

important to survey winter roost sites. The USDA/WS/NWRC and WS Alabama and Mississippi programs currently have annual night roost counts conducted in the aquaculture producing regions of Mississippi and Alabama. These counts are used as indices of abundance in these regions. However, the proliferation of roost sites has made counts logistically difficult. Cormorants have proved difficult to count within acceptable confidence limits on both aquaculture ponds (Dorr et al. 2008) and in night roosts (B. Dorr unpublished data) without increasing survey effort and expense considerably (Dorr et al. 2008). The southern states could use the survey results to create tolerable wintering population objectives for each state.

Strategy 4:
Identify staging sites and double-crested cormorant abundances at each site.

Rationale: As cormorants migrate north and south, they congregate in various staging areas throughout the Flyways. These large flocks may have negative impacts on various habitats resulting from heavy feces deposition over a short period. Similarly, these flocks can apply significant pressure to the local fish populations at a time when species may be in shallower water spawning and more vulnerable to predation. Identifying staging areas and monitoring the numbers of cormorants using these areas will enable agencies to assess the relative role of staging cormorants on observed impacts.

Information Needs:

1. Catalog and map (i.e., develop a geodatabase) of existing breeding colonies, banding locations, wintering roosts, and staging areas.
2. Identify the most cost-effective double crested cormorant breeding, wintering, and migration population survey techniques and procedures for obtaining precise state and provincial estimates.
3. Modeling of population dynamics with specific attention paid to survival and movement of both non-breeders and breeders to predict or estimate the effects of management actions and aid in identification of those management actions that can most efficiently and effectively yield desired results. Wildlife Services/NWRC is currently conducting research projects which are examining these needs (Chastant 2008, Dorr pers. comm.).
4. Separate the effects of management from those of non-management. Establish some control sites where no management is being conducted and monitor those sites. A starting point may be mixed species colonies where disturbance should be minimized.

B. Impact Reduction Objective

<u>Objective:</u> Individual state and tribal wildlife agencies with the concurrence of the USFWS will control and/or reduce local populations of double-crested cormorants where they create conflicts such as damaging habitats important to other wildlife populations, negatively impacting fisheries, affecting aquaculture operations, or creating other injurious or nuisance situations. Canadian provinces will also contribute to this objective in ways that are consistent with their respective cormorant policies.

Many states, provinces, and some tribes in the Flyways are dealing with habitat degradation, fishery depredation, and aquaculture depredation situations arising from increased numbers of cormorants. In addition, some states are dealing with problems arising from DCCOs nesting on artificial structures. The frequency and magnitude of depredation or degradation impacts vary widely across the Flyways. In most cases, agencies have employed conflict abatement techniques (e.g., harassment) and/or direct population control techniques to reduce or eliminate these conflicts. In areas where conflicts occur, action should be taken to resolve these situations which may include reducing local cormorant populations. It is important that the lethal and non-lethal solutions used to resolve the conflicts are balanced with the scale of the problems and are responsive to the underlying source of the problem. It is equally important that local management actions being considered include consideration of their possible impacts on the flyway population. A regional plan will facilitate the accomplishment of the objective through increased communications and coordination between the United States and Canada and increased funding opportunities for research and management projects.

Strategy 1:
Develop an international conflict reporting process which feeds information back into the Flyways.

Rationale: A comprehensive conflict reporting system would enable federal, state, tribal, and provincial agencies to do a better job of managing double-crested cormorants in the two flyways. The USFWS monitors the results of cormorant management through annual reports under depredation permits and the depredation orders. Annual reports from the USFWS and the Canadian Provinces that summarize all double-crested cormorant take could be presented at the Nongame Technical Sections. Sharing this information combined with the biennial breeding surveys (Population Assessment, Strategy 1) would enhance our understanding of the effectiveness and impact of management actions throughout the region. This information would also aid an individual state, tribe, or province in their education and outreach efforts regarding cormorant management.

Strategy 2:
Identify locations of conflicts.

Rationale: Mapping the spatial and temporal distribution of cormorant conflicts is another tool to aid in monitoring and reporting on conflicts. Mapping of conflicts would also help assess whether successive conflicts are related to previous management efforts. Strategies 1 and 2 combined may also allow agencies to better coordinate localized efforts where appropriate to resolve common issues on a broader geographic scale. Incorporating a GIS component into strategies 1 and 2 is essential. Establishing a geodatabase is recommended.

Strategy 3:
Develop Best Management Practices for cormorants.

Rationale: As cormorant conflicts continue to arise, managers need to address problems using the most cost efficient, effective, and humane techniques available.

Committees consisting of two or three representatives from agencies which employ the various techniques should be formed to evaluate techniques and strategies to manage cormorants. These practices would also recommend measures for minimizing impacts of DCCO management activities on co-nesters. DCCO nesting colonies should be limited to natural areas or sites that do not pose issues for increasing nuisance nesting behavior. A set of guidelines which highlight Best Management Practices for different situations would be appended to this management plan.

Strategy 4:
Update the Double-crested Cormorant Environmental Impact Statement.

Rationale: A periodic review of the EIS that affects DCCO management in the United States should be done to determine if the implemented strategy is effectively managing cormorant impacts to maintain a desired balance between the species, its habitat, and other wildlife. An examination of the PRDO and AQDO needs to be performed, including a comprehensive analysis of the cost-effectiveness of these strategies, to evaluate their performance and consider whether any modifications are necessary. In particular, as information needed to implement a regional approach to cormorant management is obtained, that alternative should be reexamined in the EIS update

Strategy 5:
Incorporate multi-agency agreements to fund research and/or management projects.

Rationale: The ever-increasing cost of conducting research or management actions often causes individual agencies to forgo various projects because of funding shortfalls. However, different projects often have benefits that are applicable to multiple states, reservations, or provinces. Multi-agency funding has been used for many years to conduct research projects with good success. A variety of funding options should be explored, including multi-agency agreements and public-private partnerships, to fund research and management projects.

Strategy 6:
Conduct an integrated assessment of regional double-crested cormorant management.

Rationale: The goal of an Integrated Assessment (IA) project is to guide decision-making around a particular environmental issue such as the effects of high cormorant abundance. Based on needs identified by community leaders, technical assessment teams gather and summarize data that can inform planning and policy-making. The approach combines data analysis (e.g. GIS and modeling) with stakeholder engagement (e.g. meetings). An IA is needed because increased distribution and abundance of DCCO populations are creating numerous stakeholder-perceived impacts to ecosystems and the economy. DCCO management is characterized by conflicting objectives held by resource professionals and external stakeholders. Thus, IAs are an effective decision aid for this problem because the process synthesizes and integrates relevant independent scientific input through a comprehensive analysis of existing ecological, economic, and social scientific information. An IA would complement

ongoing agency efforts, and assimilate necessary southern states' concerns and expertise as well as those from existing U.S. interests.

Information Needs:

1. Catalog and map locations (i.e., develop a geodatabase) of double-crested cormorants that are causing significant conflicts.
2. Assess the efficiency and effectiveness of various DCCO conflict resolution techniques.

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APPENDIX

Distribution and Status of Double-crested Cormorants in States, Reservations, and Provinces in the Atlantic and Mississippi Flyways

ALABAMA -

ARKANSAS - Little is known about historic nesting populations of DCCOs in Arkansas. James and Neal (1986) and Jackson and Jackson (1995) report former Arkansas breeding sites in Mississippi and Phillips Counties during the early 1900s, but the last known nesting in the State, prior to the 1980s occurred at Grassy Lake in Hempstead County in 1951. In 1988 DCCOs were reported as breeding in Arkansas with a colony documented at Millwood Lake in Little River County. Charles Mills (pers. comm..) reported five nests with young at Millwood Lake on June 24, 1989. One hundred seventeen active DCCO nests were documented on Millwood Lake by WS in 2003. Incidental observations by WS field personnel also suggest an increase in the number of DCCOs throughout Arkansas during the breeding season (spring and summer months). Other than the Millwood Lake colony, no documented breeding sites currently exist in other parts of the State. The Arkansas Game and Fish Commission issued a minute order stating a “no tolerance” policy for breeding cormorants in the state. Wildlife Services has been actively controlling the number of breeding DCCO at the Millwood Lake site.

CONNECTICUT - Nesting cormorants were first documented in Connecticut in 1979, with the report of a single nesting pair on East White Rock in Westport. In 1982 a small colony formed on Goose Island of off Guilford. This colony expanded to 125 pairs in 1986. The current breeding population in Connecticut is largely confined to the coast, where a comprehensive survey is conducted every 3 years. Anecdotal spring and

summer observations of cormorants on inland reservoirs, major rivers, and larger freshwater wetlands occur, however, inland nesting has not been confirmed. The current population estimate is approximately 1,250 nesting pairs. Conflicts with cormorants are largely with recreational and commercial fishing interests, and at this juncture, widespread negative impacts to fisheries resources are unsubstantiated. A recent study conducted by the University of Connecticut and Connecticut Department of Environmental Protection on the effects of DCCO predation on anadromous alewives indicated that DCCO were significant predators of spawning adult alewives, but did not negatively impact alewives at the population level. Due to the large colonies of DCCO that do exist in certain reaches of Connecticut's coast, small scale impacts to fish resources are inevitable. However, at current DCCO population levels, these impacts do not seem to be great.

DELAWARE - Prior to 1991, Delaware has no substantiated records of breeding double-crested cormorants. In 1991, five nests were noted on pilings along the Delaware Bay at Port Mahon, near Little Creek (Kent County) (Hess, et. al. 2000). Since then, no additional records of DCCO breeding were reported until 2003 and no survey specific to DCCO has ever been conducted in Delaware. During Osprey surveys in 2003 and 2007, incidental observations of DCCO breeding activity were noted with at least two nests in 2003 and seven in 2007. The nests in both years were restricted to navigation aids and markers in the northern reaches of the Delaware River within the state's boundaries. In 2009, a small colony of DCCO was discovered in the Delaware River approximately six miles downstream from the Delaware Memorial Bridge. This colony is currently using an electrical transmission tower for utility lines spanning the river from Salem County, NJ to New Castle County, DE. A survey conducted in July 2009 confirmed nesting. Over 50 adult cormorants were observed in addition to approximately the same number of juveniles. In total, 36 complete nests (not partials) were observed. This is Delaware's first significant colony of DCCO. Double-crested cormorants occur widely throughout Delaware in all months of the year, although larger concentrations occur along the immediate Delaware Bay coastline and within the inland bays of southern Delaware (Rehoboth and Indian River Bays) during migration and overwintering periods. At this time, there are no known complaints to the Delaware Division of Fish and Wildlife regarding DCCO and no current management of Delaware's DCCO population is occurring or planned.

FLORIDA - Historically double-crested cormorants bred primarily in the southern two-thirds of the state with occasional colonies occurring further north (Howell 1932). Current breeding distribution is similar with birds concentrated in central Florida along both coasts with additional colonies inland on marshes, lakes, and phosphate mine settling ponds. Few nests are found in north Florida or the Panhandle. During statewide surveys conducted between 1976 and 1978 more than 28,000 breeding birds were found (Kale et al. 1992). However, Runde (1991) found only 16,000 breeding birds statewide in surveys conducted between 1986 and 1989. Cormorant colonies have increased from 77 colonies during 1976-78 (Kale et al. 1992) to 110 colonies during 1986-87 (Runde et al. 1991), but decreased to 83 colonies in 1999. Nevertheless, cormorant numbers have increased overall since the 1970s (Rodgers et al. 2002).

Double-crested Cormorants are also common winter residents throughout Florida,

except in the interior of the Panhandle. The species appears to be increasing in numbers during the winter (Stevenson and Anderson 1994).

GEORGIA-

ILLINOIS - The double-crested cormorant was first reported to nest in Illinois in the late 1800's. Cormorant numbers were very low in the 1980's (Bohlen and Zimmerman1989) with probably fewer than 7 known colonies. Cormorant numbers increased and there were a total of 14 known nesting colonies in 1997 (Wires et al. 2001). Between 1986 and 1997, complete survey data was available for only 7 years. The seven years of data for that time period indicated an average annual increase of 11.6% in the surveyed colonies (Wires et al. 2001). Cormorants were listed as either endangered or threatened in Illinois until the late 1990's when they were no longer regularly counted during colonial surveys. Spring bird count data, however, recorded approximately 100 cormorants per party hour in 2007, up from 10 per party hour in 1990. The current nesting population is unknown, but anecdotally is believed to be increasing. Most of the nesting cormorants are likely found along the Illinois and Mississippi River corridors but there are also colonies at many inland lakes. Cormorants appear over most of the state during the breeding season and there are likely many smaller nesting colonies that are unknown at the present time. Reported conflicts with cormorants are few and usually involve predation at fish farms in southern Illinois.

INDIANA - Double-crested cormorants were suspected of breeding in extreme southwestern Indiana prior to 1900, and were documented nesting (fewer than a dozen nests annually) at Hovey Lake Fish and Wildlife Area (Posey County) from about 1930 until at least 1953. Also in 1953, 9 abandoned nests were observed at Willow Slough Fish and Wildlife Area (Newton Co.) in northwestern Indiana. As numbers of migrating and summering cormorants have increased in recent decades, sporadic reports of small numbers of nesting pairs were received beginning in 1999. In 2004, the first sizable colony (~65 pairs) was discovered along Lake Michigan in association with a nesting colony of black-crowned night-herons, great egrets, ring-billed gulls, and herring gulls. Cormorants and herons at this site have been surveyed annually and the cormorants have shown a dramatic increase in numbers (1,075 nests in 2008). Displacement by cormorants of black-crowned night-heron nests in small trees has been noted, although numbers of herons increased moderately (from 125 to 255 nests) until 2008 when beavers felled most of the nesting trees and only 27 night-heron nests were present. Cormorant numbers were generally unaffected as ground nesting became more prevalent. No cormorant control efforts have been attempted at this site. Thousands of staging cormorants have also been reported at lakes near the junction of the Ohio and Wabash rivers in southern Indiana, while numbers are much less but widely reported throughout the rest of Indiana and during other times of the year.

IOWA - Iowa's peak cormorant nesting year was 2004 when 1,490 nests were counted on the Mississippi River. The current number of nesting cormorants for Iowa is a range from 1100 to 1600 pairs. This species was listed Iowa Endangered from 1985-1994, with very limited nesting on the Mississippi River at that time. Now there are at least three significant nesting populations on the Mississippi River and one known interior nesting population (+40 nesting pairs) at the Hawkeye Wildlife Area near Iowa City in

Johnson Co.

KENTUCKY - Double-crested cormorants are a traditional breeding bird in western parts of Kentucky. Prior to DDT declines, the 3 Kentucky colonies were found in Fulton, Ballard, and Henderson counties. They were associated with great blue heron and great egret colonies in swamp forests close to the Ohio and Mississippi rivers. Cormorants were considered extirpated in Kentucky until 2002 when a small colony (~25 pairs) appeared on Kentucky Lake. Since that time small numbers of cormorants have nested on a number of islands in Kentucky Lake. These small colonies have caused some concerns about damage to the islands where they nest. In 2008, up to 800 pairs of cormorants were discovered nesting on three islands in nearby Barkley Lake. These nesting colonies have become established at traditional migratory staging and wintering locations on these two large reservoirs, where thousands of DCCOs are regularly tallied collectively during peak periods of migration. Cormorants may also be found in smaller numbers statewide during migration and winter. They are generally concentrated in major reservoirs, and along the lower Ohio and Mississippi rivers.

LOUISIANA - Determination of the status of breeding cormorants in Louisiana is greatly hindered by the fact that there are two fairly similar looking cormorants in the state – both Double-crested and Neotropic occur in Louisiana during the breeding season. The majority of colonial nesting waterbird surveys are performed via aircraft, both single-engine, fixed wing and helicopter. Frequently, cormorants discovered during aerial surveys cannot be identified to species. For example, helicopter surveys performed by Louisiana Department of Wildlife and Fisheries (LDWF) in 2008 (Seymour, Carloss, and Susko *Unpublished data*) located verifiable Neotropic Cormorants nesting as well as unidentified cormorants (that is, views were less than ideal for identification purposes).

Some assumptions regarding identification can be made by geographic location of the colony in the state, although LDWF is hesitant to confirm nesting without concrete evidence. In general, Neotropic Cormorants, based on confirmed identifications, nest with few exceptions in Louisiana's coastal zone, with the majority of records in southwestern La., especially Cameron and Vermilion parishes. Reports from 1997 and, again, in 2003 from the Morganza Spillway, Morganza, LA. are the farthest inland Neotropic Cormorants have been presumed nesting in LA. (Cardiff and Dittmann *Unpublished data* and Remsen *Unpublished data*); these sightings, unfortunately, provided only circumstantial evidence of actual nesting. At least a handful of recent cormorant nesting colonies in southeastern La. have been confirmed as Neotropics in 2008 (Seymour, Carloss, and Susko *Unpublished data*). In addition to the more than twenty cormorant colonies located in south La. during statewide surveys in 2004, three cormorant colonies were located north of the 31st parallel north (Green *et al.* 2006) – one in Catahoula parish, one in Sabine parish, and one in Caddo parish. No additional details on species identification are available regarding the Catahoula or Caddo colonies. However, the Sabine parish colony, located on the Toledo Bend Reservoir, contained both Double-cresteds and Neotropics, although only Double-cresteds were verified as actually nesting there (Jeske *Unpublished data*). Whether or not the Neotropics are breeding in the Sabine colony is further complicated by the fact that loafing, non-nesting cormorants are frequently observed in well-established colonies (e.g., Double-cresteds at Lake Martin, St. Martin parish; Martin *Unpublished data*).

Vermillion and Shively (*Unpublished data*) observed Double-cresteds nesting at Toledo Bend Reservoir as early as 1996, in perhaps, the same colony reported from 2004. Reports of the numbers of nesting pairs have never surpassed more than a couple of hundred DCCOs in any identification-verified colonies. And, currently, there are probably no more than a handful of small colonies of this species in Louisiana.

MAINE - Double-crested Cormorants are a common nesting species on islands along the entire Maine coast. Few records exist of nesting on inland lakes and may be as few as 2 sites, although no formal surveys have been conducted. The statewide population has fluctuated greatly in the past 100 years with numbers increasing to over 10,000 pairs coastwide by the mid 1940s with approximately 2,100 pairs in Muscongus Bay alone. In the mid 1990s, as many as 20,000 pairs were recorded on 125 coastal islands. Today, that number may be less as predation on young cormorants by a burgeoning bald eagle population has caused complete abandonment of many nesting sites. During mid to late summer, it is not uncommon to see them on inland lakes, ponds, and rivers prior to southward migration. For many years, cormorants were controlled either by oiling eggs or by shooting to reduce predation on coastal fisheries; the latter was used to promote restoration of Atlantic Salmon by improving survival of stocked smolts.

MANITOBA – An assessment of all birds in Manitoba in 2005 placed double-crested cormorants in the most category of > 10,000 birds which was the highest category. The 2003 edition of "Birds of Manitoba" listed a 1999 estimate of 36,497 nests and suggested that the population may have stabilized at this high level.

MARYLAND - The first record of breeding Double-crested Cormorants occurred in 1990 when a colony of 55 pairs formed on Poplar Island in the central portion of the Chesapeake Bay. Prior to this nesting there were no historic records of cormorants breeding in the state. The Maryland breeding population has increased to 2,829 pairs of double-crested cormorants at 11 colonies during 2008. There are two relatively small colonies in the coastal bays and one small colony on an island in the Potomac River near just above Washington, DC. Most of the remaining colonies are on natural islands throughout the Chesapeake Bay. Three colonies breed on artificial structures, two on bridge understructures and one on an electrical transmission tower. Maryland DNR is working with infrastructure managers to eliminate bridge nesting. The Chesapeake Bay is used by substantial numbers of migrating cormorants during both spring and autumn migration periods.

MASSACHUSETTS- The most recent coastwide survey of breeding DCCOs in Massachusetts (2006-07) tallied 5,963 pairs at 31 colonies. Numbers of pairs declined by 20% between surveys in 1994-95 and 2006-07, based on comparison of sites that were surveyed using comparable methods.

The "tolerable breeding pairs" for Massachusetts is greater than or equal to 8,000 pairs which approximates the largest total reported from any of the four coastwide surveys conducted in Massachusetts since the mid-1970s (7,837 pairs in 1994-95). An increased breeding population may be an appropriate management objective; however,

Massachusetts Wildlife and various cooperators and stakeholders have not conducted any formal management planning exercise to arrive at this number. At present, there is no evidence of adverse effects of DCCOs on either fish populations or breeding habitat of other coastal waterbirds that would warrant a management goal of reducing Massachusetts' breeding population of cormorants. Going forward, there is concern about potential adverse effects of sea level rise on cormorant nesting habitat in Massachusetts, and uncertain effects of predicted increases in ocean temperature on cormorant prey.

MICHIGAN - While Barrows (1912) could find no documentation of double-crested cormorants breeding in Michigan, he does cite numerous specimens taken on migration statewide and references known nesting colonies in Ohio and Minnesota. By the 1940s, estimates of breeding cormorants were as high as 500 nesting pairs in Michigan. Subsequent to declines in the 1950s and 1960s due to organochlorine pesticide use (Michigan DNR 2005), the species has rebounded with recent population estimates of 25,000 to 30,000 nesting pairs in the state. While little or no breeding activity has been documented at inland sites (i.e. not on the Great Lakes), flocks of nonbreeding birds are regularly observed at inland lakes and along rivers foraging. These flocks may consist of migrating birds or summer residents and are often concentrated at fish stocking sites. In response to documented declines in recreational fisheries within the state, population control efforts were undertaken beginning in 2004. Since that time, population control efforts have been expanded and now encompass several locations throughout the Great Lakes: Les Cheneaux Islands, Beaver Island Archipelago, Bays de Noc, Thunder Bay, Ludington, and several small islands in northern Lake Michigan, the St. Marys River, and Lake Superior. In addition to these projects, mitigation of impacts on local fisheries have been accomplished by targeted harassment at a number of inland lakes, shallow bays on the Great Lakes, and fish stocking locations along rivers and bays of the Great Lakes. Responses measured in local fisheries since the instigation of control projects suggest that some of these fisheries have experienced a recovery concomitant with reduced numbers of cormorants.

MINNESOTA - The double-crested cormorant was historically a widespread migrant and breeding bird in Minnesota, but no reliable estimates of breeding numbers exist prior to the 20th century (Roberts 1932). Early accounts cited by Wires and Cuthbert (2003) mentioned significant breeding colonies at several sites in west-central Minnesota. In the early 1900's flocks of 10,000 or more DCCO were reported during migration in the Minnesota River valley; much larger flocks of up to 1 million birds were reported from the Mississippi River valley near LaCrosse, WI (Roberts 1932). In response to perceptions about depredation on fish, DCCO were killed during migration and at breeding colonies. Populations are believed to have declined in the first half of the 20th century because of persecution by humans and environmental contamination with organochlorine pesticides. By 1925, the Minnesota breeding population was estimated to be about 1,000 birds, and by 1932, only 3 colonies were noted by Roberts (Roberts 1932). Surveys conducted by the MnDNR Nongame Wildlife Program from the 1960's to 2004 indicate an increase in the breeding population (MNDNR Natural Heritage Information System). By 1990, cormorants were documented at 44 sites, and the population was estimated to be about 15,900 breeding pairs. Large flocks comprising 1000's of birds were reported at various lakes during migration (MNDNR

files). A statewide nesting survey was conducted in 2004 in collaboration with partners, including Leech Lake band of Ojibway and USFWS, and with funding from State Wildlife Grants and the MNDNR Nongame Wildlife Program. Nesting DCCO were documented at 39 sites in 23 counties; most colonies were found in a band between Ottertail County in the north to Faribault County in the south (Wires et al, 2006). The total number of active DCCO nests estimated from this survey was approximately 16,000, of which 4,370 were at 5 colonies in Lake of the Woods. Colonies ranged in size from 4 to 2,500 nests; the largest colony was in Leech Lake, Cass County. Thirteen colonies had more than 400 nests, and 10 had less than 50 nests. In more than 87% of colonies, DCCO occurred with other colonial waterbirds, most commonly great blue herons and great egrets; at 11 colonies there were 3 or more co-nesting species. Since 2004, DCCO breeding populations have declined steeply at some colonies. Surveys at Lake of the Woods colonies conducted since 2004 have documented a decline in the number of nesting pairs from 4,370 in 2004 to 650 in 2009; anecdotal reports indicated 100% reproductive failure in 2009 at Lake of the Woods colonies. Reasons for the decline and reproductive failure are unknown, although there was an outbreak of Newcastle's disease in these colonies in 2008. Another statewide survey is planned for 2010. DCCO were protected under state game and fish laws in 1895, but by 1945 were designated as an unprotected species, and continue unprotected by state law today. By the mid-1990's, public concern about cormorant numbers and their potential impact on aquaculture and fisheries was high. A 2002 project funded by Minnesota Sea Grant surveyed fish producers regarding losses to fish-eating birds and effectiveness of management practices (Wires and Cuthbert 2003). Producers reported that losses to bird predation at aquaculture facilities were highest in the spring and fall. Also, GIS analysis of aquaculture facilities and waterbird colonies revealed that the largest DCCO and white pelican breeding colonies were not in areas of the state with high numbers of aquaculture facilities. Producers reported that barriers were not effective in reducing losses, and shooting was considered the best control strategy (Wires and Cuthbert, 2003). From 2003-2008, 10,446 DCCO (annual mean=1740) were taken under the Aquaculture Depredation Order. Concerns about impacts to fisheries and vegetation have resulted in several other control efforts. At Leech Lake control has been done under the Public Resource Depredation Order (see Leech Lake Reservation summary). Control efforts have been conducted at Lake Waconia, Carver Co. (2008:100 birds; 2009: 400 birds); and Wells Lake, Rice Co. (2008:100 birds; 2009: 400 birds) by USDA-APHIS Wildlife Services under depredation permits issued to private landowners to alleviate economic impacts caused by loss of private property (trees) from DCCO guano deposition. No impacts to fishery resources have been detected at the latter two sites. Concerns among the public and elected officials about cormorant impacts to fisheries continue at several other sites, but to date are not supported by fisheries data.

LEECH LAKE RESERVATION (within Minnesota) - Double-crested cormorants have been documented on the Leech Lake Reservation at least as far back as the early 1800 when they were reported by early European explorers and individuals involved in the fur trade (Mortensen and Ringle 2007). Construction of dams on many of the lakes on the reservation in the mid to late 1800s probably resulted in the flooding of many traditional DCCO nesting colonies. This, combined with human exploitation was likely the cause of the extirpation of the species from the reservation before 1900. Nesting cormorants were absent or only found in small numbers for almost 100 years before returning as a

consistent nester in the late 1990s when a colony became reestablished on a tribal island in Leech Lake. Within less than a decade this population increased to a peak of 2524 nests in 2004. Concerns about cormorants displacing gulls that in turn displace common terns, as well as circumstantial evidence that cormorants might be reducing the number of small walleyes resulted in the Leech Lake Band of Ojibwe reducing the number of cormorants to 500 reproducing pairs. Despite a significant number of birds being removed from 2005-2008 to reach this level, upwards of 4000 pairs are returning to nest each year. A three-year diet study initiated during the same period found that the cormorant diet consisted of 50-75% small yellow perch by both weight and numbers. The fish population appears to be doing well at this level of predation despite having high numbers of cormorants in the early part of the summer far in excess of what was predicted would be needed for fish populations to recover. Efforts continue to assess effects of cormorant predation on walleyes in the lake.

MISSISSIPPI - Historic breeding records of double-crested cormorants are sparse for Mississippi. According to Reinhold et al. (1998), the first reported observation of nesting cormorants occurred in 1952 in Tunica County near Clayton. Four nesting pairs of double-crested cormorants were found during the 1998 annual Mississippi colonial waterbird survey. Two of these pairs were found at Lewis Swamp in Coahoma County, MS and the two other pairs were found at Jones Lake in Warren County, MS. The two nests at Lewis Swamp were removed shortly after their discovery and the nesting colony at Jones Lake increased to 31 nests over a four-month period; 13 of the 31 nests successfully fledged at least one young.

Since these earlier records, USDA – Wildlife Services' counted 135,362, and 183 double-crested cormorant nests in Mississippi in 2006, 2007, and 2008, respectively (B. Dorr, personal communication). These estimates are likely a conservative estimate because counts only occurred near catfish aquaculture areas. Nevertheless, catfish aquaculture facilities have likely reduced the tendency for some cormorants to migrate because of the abundant food source they provide (King et al. 2009). Because Mississippi only had sporadic nesting of Double-crested Cormorants historically and because of the negative impacts they have on catfish aquaculture and other waterbird colonies, Mississippi has adopted a breeding population goal of zero pairs. Mid-winter cormorant night roost counts in the Mississippi Delta region typically range from 50-60,000 birds annually.

MISSOURI - Current breeding DCCO numbers in Missouri are estimated between 300-500 birds, dispersed between a handful of colonies, predominantly in the Osage River Bottoms/Truman lake area. Annual breeding DCCO populations fluctuate widely in response to water conditions.

NEW BRUSWICK-

NEW HAMPSHIRE – New Hampshire has a single known DCCO colony offshore that supports a variable number of nests. It is not actively monitored. There were an estimated 85 nests in 2001, down from 483 (on a different island) in 1995. Presently, we are not aware of any inland breeding colonies.

NEW JERSEY - New Jersey is currently not actively tracking populations of DCCO and does not have population information readily at hand. Currently there are no plans to gather this information.

NEW YORK - Breeding records for double-crested cormorant in New York are lacking prior to 1945 (Kutz and Allen 1947). Eaton (1910) characterized cormorants in central and western New York as uncommon migrants at inland sites based on autumnal reports dating back to 1865. The coastal population has been more prevalent historically. Giraud (1844) and Eaton (1910) described cormorants as common visitants to Long Island. During the first New York State Breeding Bird Atlas (1980-1985), cormorants established breeding colonies at Oneida Lake (Claypoole 1988) and at Four Brothers Islands in Lake Champlain (Peterson 1984). The previously existing colony at Little Galloo Island in eastern Lake Ontario was on its way to becoming the largest in the U.S., reaching 8,410 nesting pairs in 1996. On Long Island, cormorants first nested on Fishers Island in 1977 (Bull 1981), then spread to nearby Gardiners Island and to South Brother Island in the Bronx. The second New York State Breeding Bird Atlas (2000-2005) has revealed considerable geographic expansion throughout New York, most notably along the Lake Erie/Niagara River Frontier, the St. Lawrence River, central New York, the Hudson Valley, central Long Island, and within the New York Harbor. Cormorants have increased in New York from approximately 2,100 breeding pairs in 1985 (Miller 1998) to approximately 10,500 breeding pairs in 2003 (NYSDEC 2004).

Cormorant control efforts have been underway in the eastern basin of Lake Ontario, central New York (Oneida and Onondaga Lakes), and the Lake Erie/Niagara River Frontier since the 1990's. Management of cormorants was initiated on the St. Lawrence River in 2006 and on the New York side of Lake Champlain in 2008. On Lake Ontario, recent data suggest that black-crowned night heron nesting success and smallmouth bass recruitment is improving. It is too early to see improvement to public resources as a result of the recent cormorant management activities on the St. Lawrence River and on the New York side of Lake Champlain. Continued management of cormorants at all of these locations is necessary to protect and restore vegetation on nesting islands and enhance colonial waterbird populations.

NEWFOUNDLAND-

NORTH CAROLINA - North Carolina's breeding population of DCCOs belongs to the subspecies that breeds in FL (*Phalacrocorax auritus floridanus).* This subspecies in not covered in the management plan, which encompasses the region within the Atlantic and Mississippi Flyways inhabited by *Phalacrocorax auritus auritus* during its breeding and wintering lifecycles. *P. a. auritus* can be found in NC during migration and the winter months when most economic conflicts are likely to occur. However, data on their distribution and abundance is lacking, as are reports of significant negative impacts upon economic or natural resources.

According to Southeast US Regional Waterbird Conservation Plan, most southeastern breeding colonies are in locations and numbers of pairs that do not yet exceed our best understanding of pre-1900 populations. The Plan suggests maintaining breeding population levels even if efforts are undertaken to reduce overall wintering populations.

It should be noted that birds that breed in the southeast US are essentially sedentary so breeding birds could be impacted by depredation control done during the non-breeding season. The plan gives a current population estimate of 2,050 pairs for South Atlantic Coastal Plain (500 breeding pairs for NC) and suggests maintaining no more than 4,000 pairs for entire South Atlantic Coastal Plain. Limited efforts are ongoing to assess North Carolina breeding populations, however current anecdotal information suggests a more likely estimate of 250 pairs.

NOVA SCOTIA - The Double-crested Cormorant is widely distributed in numerous colonies along the coast, including the Bay of Fundy, Northumberland Strait, Gulf of St. Lawrence, and the Atlantic coast of Cape Breton Island and mainland Nova Scotia. There has been only one known colony on inland waters and this was not active in 2009.

Lewis (1929) reported only 67 breeding pairs in Nova Scotia in the 1920s but noted they were reportedly much more abundant at the time of European arrival. Information for the period between 1925 (Lewis 1929) and 1971 (Lock and Ross 1973) is minimal except for Erskine's (1972) summary and internal department reports (Lewis 1956, 1957). By the mid to late 1950s, numbers are estimated to have increased to 1,300-1,500 pairs, reaching 4,150 pairs in 1971 (Lock and Ross 1973). The number of pairs increased to greater than 12,100 by 1982 (Milton and Austin-Smith 1983). Unpublished surveys reported in Milton et al (1995) had DCCO increasing to 15,700 by 1985 before declining to approximately 12,000 pairs in 1992. Since then, numbers are believed to have ranged between 12,000 and 14,000 pairs (G. R. Milton, unpubl. data), and this has been accompanied by changes in the number and size of individual colonies.

OHIO - Double-crested cormorants can be found in Ohio on Lake Erie Islands and on various inland lakes. Cormorants have colonies on 3 Lake Erie islands with an estimated collective breeding population of 7,000 adults. There are 4 inland colonies with an estimated breeding population of 100 adults. Since 2006, cormorants have been culled from the island colonies and one inland colony under the Public Resource Depredation Order. The cormorants were removed to protect valuable nesting habitat for state-listed egrets and herons. The cull has reduced the total number of cormorants breeding in the state, but 2 new inland colonies have appeared in 2008.

ONTARIO - Lake Superior - On the Ontario side of Lake Superior, cormorant nest numbers increased by approximately 52% from 1996 to 2007 (Weseloh et al. 2006, Weseloh *unpublished data*). However, with just over 3,000 nests on the Ontario side of the lake in 2007 (Weseloh *unpublished data*), the nesting population remains relatively low compared to populations in the other Great Lakes.

Lake Huron - Cormorant nesting populations on the Ontario side of Lake Huron increased dramatically from the late 1980s until approximately 2000 when 33,914 nests were counted at 90 colonies (Weseloh *et al*. 2002). Since 2000 the number of nests and colonies has declined significantly. In 2008, 19,421 nests were counted at 84 active colonies (OMNR unpublished data), a 42.7% decline. OMNR undertook a multi-year cormorant study on Lake Huron from 2000-2005 that included control of cormorant

numbers using egg-oiling in some areas to evaluate subsequent fish response (Ridgway et al. 2006).

Lake Ontario - In 2002, the Lake Ontario nesting population peaked at around 28,000 nests and has since declined by almost 20% (Weseloh et al. unpublished data). Twenty-two nesting colonies have been found on the Ontario side of Lake Ontario, although not all are active every year. The main Ontario nesting colonies occur in Hamilton Harbor, Toronto Waterfront, Presqu'ile Provincial Park, False Duck Islands, and Kingston waterfront (Weseloh and Shutt 2005, Weseloh et al. in press).

OMNR undertook a management program at Presqu'ile Provincial Park from 2003 to 2007 to reduce cormorants that were causing damage to woodland habitat on park islands (Ontario Parks 2008a, Ontario Parks 2008b). The management program included culling of adults, destruction of tree nests, egg-oiling of ground nests, and disturbance of roosting birds. The management program was effective at reducing cormorant numbers and allowed vegetation to begin to recover.

Lake Erie - The majority of cormorant nesting occurs in the western basin of Lake Erie, where there are a number of uninhabited islands that provide suitable nesting habitat. East Sister Island and Middle Island in Ontario represent two of the larger nesting colonies in the Great Lakes basin, with over 4,500 cormorant nests reported on both islands in 2005 (Weseloh et al. in press). The cormorant population peaked on Lake Erie in 2004 and has since declined by about 17% to 15,769 nests in 2008 (Weseloh et al. in press, Weseloh unpublished data). Among Ontario colonies, cormorant management to date has only been undertaken by Parks Canada at Middle Island.

St. Lawrence River - Nine active nesting colonies were found on the Ontario side of the upper St. Lawrence River in 2007 (Weseloh et al. 2007). Nest numbers have continued to increase slowly on the Ontario side of the upper St. Lawrence in recent years, while overall number of nests peaked in 2005 at just under 3,000 nests and have since declined slightly. Private landowners at a few islands in the Ontario portion of the river have taken action to manage cormorants to protect their own property, and Weseloh et al. (2006) reported several cases of unsanctioned control activities at cormorant colonies in this area.

Inland Lakes - Our knowledge of the status of double-crested cormorant populations on inland lakes in Ontario is incomplete. It is difficult to monitor cormorants on inland lakes because of the size of the province, the vast number of inland lakes, and the isolation of many of Ontario's inland lakes. Movement between lakes is common among non-breeding cormorants, with birds typically residing on a lake (or group of lakes) for relatively short periods of time to feed and loaf (Alvo et al. 2002).

The most recent assessment of population status for inland lakes was obtained from a combination of sources including province-wide OMNR surveys to gather information from field offices, information gathered as part of primary research projects, and from the Ontario Breeding Bird Atlas (OMNR 1997, Alvo et al. 2002, Rowe 2003, Weseloh 2007). As of 2006, available information suggested that approximately 40 inland lakes in Ontario had confirmed cormorant nesting populations (OMNR 2006). Ontario Ministry

of Natural Resources continues to explore options for effective monitoring of inland nesting cormorants.

PENNSYLVANIA - This species has increased in population and nesting range in Pennsylvania since the first historic nesting event was observed at Wade Island, Dauphin County in July 1996 with a single nest in a mixed colony of Great Egrets and Black-crowned Night-Herons (McConaughy 1996, McWilliams and Brauning 2000). It has been steadily increasing at that location, and in 2009, increased to 120 active nests. This count represents a 7% increase from 2008 and is 74% above the five year (2004-2008) average of 69 nests (Haffner and Gross 2009).

A second double-crested cormorant colony in Pennsylvania was documented 2009 by volunteer observer Tom Raub connected with the 2nd PA Breeding Bird Atlas (Haffner and Gross 2009, Mulvihill 2009). A minimum of two double-crested cormorant nests were identified from shore at the Safe Harbor great blue heron colony in Lancaster County. This was observed at Safe Harbor where great blue herons arrived in late March and established nest sites by early to mid-April. Although double-crested cormorants were in the area, nesting was not observed until May. The island is only accessible by boat, so a complete nest count was not possible in 2009.

Cormorants migrate through the state in large numbers and some remain in summer where not known to nest on large water bodies such as the Susquehanna River (Mulvihill 2009).

As part of a site management plan, Master (2001) recommended that control measures be implemented at Wade Island if the population sustained increases at the same rate in the years subsequent two years to his study, 2002-2004. Following through with that recommendation, a total of 64 cormorants were removed (by agreement, not to exceed more than 75% of the cormorant population) from Wade Island in 2006 by U.S. Department of Agriculture (USDA) Wildlife Services. The following year, cormorants increased slightly. Control measures were not implemented in 2007-2009. The double-crested cormorant population has increased, while the great egret and black-crowned night-heron populations also appear to be stable to increasing. Black-crowned night-herons began declining before cormorants colonized the island, following the peak of 345 nests in 1990, suggesting need for further study in their relationships. The need for cormorant control measures will be assessed on an annual basis in the future. Dr. Terry Master, at East Stroudsburg University, is revising the 2001 Wade Island management plan to incorporate recent research. This is expected to be completed in 2009.

PRINCE EDWARD ISLAND-

QUEBEC - Quebec is currently not actively tracking populations of DCCO at province scale and we have some information on DCCO population, dating from 1986 to 2004 (see below). Actually, there are no plans to gather further information.

Abitibi-Témiscamingue – DCCO are found, in 2004, in 8 colonies; 500 à 600 nests are found in the Quebec side of the Abitibi Lake.

Anticosti Island – about 100 nests in 2004.

Saguenay—Lac-Saint-Jean - Few inventories were done in this region. We count some individuals at Saint-Jean Lake and about 200 individuals (adults et sub-adults) in Saguenay River.

Saint-Lawrence River - We count 37 colonies in this region and the last inventory, in 1999, report 13,000 breeding pairs.

St-Lawrence Estuary – In 1999, this area counted about 3,900 breeding pairs of DCCO.

St-Lawrence Gulf – No precise data, but about 10,000 nests.

Saint-Pierre Lake - Number of nests was about 500 in 2001, and up to 1,000 in 2004.

RHODE ISLAND - DCCO nests are counted every year. In 2009, there were about 2,000 nests. The numbers fluctuate somewhat from year to year, but have held at about 2,000 pairs for several years.

SASKATCHEWAN -Saskatchewan has significant colonies at between 15 and 20 known locations (a number of colonies are located on southern lakes that are drought prone and so the number that are active in any year can vary). No formal population surveys have been conducted since the 1970s with the exception of work by graduate students that has taken place more recently at Dore Lake where a large DCCO colony has been a concern for commercial fishermen for several decades. Provincial populations, breeding and non-breeding, are not of the magnitude of what is experienced further east but there is anecdotal evidence from the Saskatchewan Ministry of Environmental Fisheries staff that the size and number of colonies is continuing to increase. Dore Lake is the only location where there have been significant ongoing conflicts with DCCOs although intermittent concern has been expressed over colonies at several other locations. The species is not a concern provincially.

SOUTH CAROLINA - Early documented reports of DCCO in South Carolina are from Wayne (1910, as reported in Wires and Cuthbert 2006), that the species “nests somewhere in the state.” Sprunt and Chamberlain (1949) indicated the Florida Cormorant as a permanent resident in the state chiefly along the coast, but not nesting records are available; and wintering birds (P.a.a.) are recorded as abundant. The first breeding record for South Carolina was established in 1985 at the east end of Lake Marion, Clarendon County where the entire colony contained 15 nests (Post 1988). The number of nesting pairs increased from 60 in 1986 to 186 in 1989 (Post and Seals 1991). All of these colonies (1986 in 2 and 1989 in 7) were located on inland lakes (Marion and Moultrie, also referred to as the Santee Lakes as they were constructed in the early 1940s by Santee-Cooper Electric) in the upper Cooper River drainage. A complete ground count was conducted for all areas containing at least 30 nesting birds (as observed from aerial surveys) in 1996 and 895 nests were counted on 10 different sites (SCDNR; reported in Wires and Cuthbert 2006). All of the colonies continued to be located on inland lakes. Total nest numbers and average colony size declined in

2004 (457, std 45.7), 2005 (381, 27.2), 2006 (128, 11.6), 2007 (72, 18.0), and 2008 (88, 11.0) (SCDNR unpublished data). Counts were conducted from the air where some birds could have been missed due to dark coloration and the vegetative structure of colonies. It is estimated that 90% of all colonies were covered (T. Murphy, retired SCDNR, pers com 2009). The inland lakes, associated canals and waterways continue to have the largest recorded nesting numbers. However, additional sites across the state have recorded low nest numbers in recent years (Jasper County, 2 nests in 2006; York County, 2 nests in 2007; Fairfield County 17 nests in 2005, 3 2006, and 16 in 2008) (SCDNR unpublished data). Reports of nesting birds are also reported for the Broad River near Moniticello Reservoir in Fairfield and Newberry Counties (N. Myers, APHIS-WS, pers com. 2009).

The only long term winter monitoring that has occurred in South Carolina has been the Christmas Bird Count (CBC). The highest number of birds counted was 26,974 in 2005; 19,870 of those birds were from the Santee NWR count that encompasses a portion of Lake Marion. The majority of other birds counted were on the coast. The Santee count in 2008 was 17,537, contributing to a state count of 23,595. Kelly (2008) reported 6000 birds wintering on both Santee Lakes in 2008, a drought year with water levels 20-25 feet below average. The five-year average CBC count for 2009-2005 was 23,461.2 (std 2626.0), 2004-2000 was 9710.6 (std 6289.1), 1999-1995 was 6097.4 (std 2850.6), 1994-1990 was 8199.8 (std 5315.7), 1989-1985 2774.8 (std 967.4), 1984-1980 was 2467.4 (std 815.1), 1979-1975 was 935.2 (std 666.3), and 1974-1970 was 225.2 (std104.5). The results of telemetry studies suggest that DCCO move though out the state during the winter (USDA APHIS Wildlife Services – unpublished). This characteristic is likely to make single count day data inherently variable, but is all that is available to establish trends.

Cormorant control measures have been carried out at the local level in South Carolina through the use of depredation permits. Management, both lethal and nonlethal, is recommended to protect aquaculture, natural resources, and property. Generally protection of property includes aviation safety threats or excessive droppings to docks/marinas. Natural resources primarily involves the protection of prey base (e.g., golden shiners, shad, and bream) for private fishing lakes while aquaculture includes protection of both freshwater and mariculture species. Limited numbers of breeding cormorants were removed by WS for research purposes during summer 2007. Cormorant damage to the aquaculture industry in the southern U.S. alone is estimated to be in the millions of dollars (Dorr et al. 2004). Damage to other resources (e.g., native forage and game fish, native vegetation associated with rookeries, etc.) is relatively unknown, but thought to be significant. In winter 2005, $42,225 in losses to wild fisheries was reported to Wildlife Services in addition to impacts on freshwater and mariculture research at the Waddell Mariculture Center in Beaufort County, SC (N. Myers, APHIS-WS, pers comm. 2006).

Post (1988) suggested that it was not possible to identify the subspecies colonizing the state as the measurements of collected birds overlapped those of P. a. auritus and P. a. floridaus. Hatch (1995) further suggests that although 5 subspecies have been described the measurements of each overlap making the significance of each subspecies unclear in some locations. Green et al (2006) found statistically significant

genetic differentiation among populations but the degree of differentiation was small. It is likely that the nesting birds in South Carolina are populations of the Florida subspecies or a non-migratory population of mixed lineage each of which have benefited from the construction of large interior lakes. Based on telemetry studies birds wintering in South Carolina are from the breeding populations in the Great Lakes and Champlain Valley and these birds are found throughout the state during the winter (See Figure 3 above). The Atlantic subspecies also winters in South Carolina but is chiefly found along the coast (Hatch 1995).

TENNESSEE - Double-crested Cormorants have not traditionally been a common nesting bird in Tennessee until approximately the mid-2000's. We have little information on nesting status over the years, but TWRA has attempted to gather information on rookeries statewide since 2008 to monitor all wading birds, but specifically cormorant numbers over time. In 2008, we documented at least 427 DCCO nests scattered in several rookeries across Tennessee. The known rookery sites are equally distributed across the state, with one of the biggest colonies being in east Tennessee with approximately 142 nests. However, we are likely unaware of major rookeries on Kentucky Lake and other large lakes and rivers.

A sustainable population of nesting cormorants should be maintained at 500 pairs; however measuring this directly is difficult. Research needs to be done to assess winter populations and the growing nesting populations, which are primarily on major rivers and waterways. TWRA's state ornithologist is planning on beginning discussion amongst state and federal partners on the cormorant issue, hopefully leading to more rookeries reported, winter numbers documented, and possible management being undertaken to protect sensitive riparian areas.

VERMONT - There are no known historical records of cormorants nesting in the state of Vermont prior to 1981. However, double-crested cormorants are well known to have nested along the coastlines of New England and the Canadian Maritime Provinces. It is probable that they passed through Vermont only during migration or storm events. Their current nesting status in Vermont is part of the range expansion that cormorants have undergone in the 20th century throughout North America.

VFWD purchased Young Island, located within the Lake Champlain basin in 1959. According to photographs, surveys, and wildlife studies done during the 1950s and 1960s, the island supported a mosaic of tree, shrub, and herbaceous plant communities. Double-crested cormorants first nested on the island in 1981. Gull populations greatly increased on Lake Champlain during the 1970s and 1980s, and cormorant numbers increased dramatically during the 1990s. The buildup of guano on the island and the stripping of branches from the trees by cormorants caused the eventual loss of trees on the island by 1998. Until 1995, and average of 30 black-crowned night heron nests were found on Young Island each year. As the cormorants took over the trees for nesting the herons tried unsuccessfully to nest on the ground. In 1996, herons deserted Young Island. Currently, the island vegetation is dominated by stinging nettle, thistle, and lamb's quarters (pigweed).

Cormorants and ring-billed gulls have decimated the native vegetation of Young Island

and have subsequently seriously impacted its habitat and wildlife diversity. This island served as a source population for cormorants in the northern half of Lake Champlain and the large number of cormorants it harbored threatened other islands on the lake. This can be seen in the number of repeated colonization attempts on these islands for the last 15 years. In 2008, as in the previous two years, there were no new nesting attempts in this part of the lake. A few of these islands contain the only common tern nesting colonies on Lake Champlain, a state endangered species. Double-crested cormorants and gull species are considered a potential threat to the recovery of this species and other bird species. It is hoped that this reduction in the local cormorant population will help further the recovery of the terns, black-crowned night-herons, and other species.
Results of a telemetry study in 2006-2007 and studies by the University of Vermont (UVM) reveal the close connection between Vermont's Young Island birds and New York's Four Brothers Islands (FBI) colonies. There is also movement between the Lake Champlain population and cormorants in the St. Lawrence River of New York and Quebec. Cormorant numbers are expected to gradually decrease on FBI due to control efforts being implemented by The Nature Conservancy. In the past, the productivity of this colony had been much less than the Young Island colony according to research by UVM. However, it is uncertain what the impact of the new alewife population will now have on this productivity. Field notes by researchers and managers on Lake Champlain have all noted the prevalence of alewives being brought to the nests by adult cormorants and it appears that alewives are now making up a majority of the cormorant diet, at least during some parts of the breeding season.

VFWD initiated a cormorant egg-oiling program in 1999. The egg-oiling was successful in controlling the nest productivity at Young Island and the number of breeding adults had decreased substantially. Supplemental lethal control since initiation of the PRDO also assisted in decreasing the number of breeding adults. Cormorants did not attempt to nest on Young Island in 2008 for the first time since nesting started in 1981. However, cormorants were seen loafing and roosting on the island throughout the spring and summer. Continuing control efforts were done on these birds in 2008 in order to further reduce the likelihood of cormorants nesting on this island and neighboring islands in the future. Young Island habitat is still heavily impacted by large numbers of nesting gulls but it is clear that the island is trying to restore itself even though it is dominated by invasive plants. It is hoped that with the aid of some well-planned herbicide treatments coupled with some grass, shrub, and tree plantings that the plant communities will begin to include some native plants, although this will likely be a long process of secondary succession.

It is not known what effect egg-oiling alone has had on the lake-wide cormorant population. In 2008, The Nature Conservancy, in coordination with New York DEC, USDA-Wildlife Services, and the University of Vermont initiated an egg-oiling experiment on the Four Brothers Islands, the remaining large cormorant colony on Lake Champlain. In all likelihood, this may further reduce the number of cormorants on Lake Champlain. However, it is not known whether continued immigration by cormorants into the Lake Champlain Basin from other regions will reduce the effect of egg-oiling. Anecdotal evidence suggests that egg-oiling and lethal control on the Young Island colony reduced the number of cormorants in the northern part of Lake Champlain and

may have even stabilized the overall lake cormorant population.

Impacts from control efforts to other colonial waterbird species on Lake Champlain have been either negligible, or in some instances may have been beneficial in reducing competition for nesting space with other colonial waterbird species. This includes the return of black-crowned night-herons to Young Island after an 8-year absence. Common tern numbers have also increased on their breeding islands in the last few years in large part due to the efforts of Audubon Vermont staff, but we also feel that the reduction of cormorants in this area of the lake may also be assisting in those conservation efforts.

The recent invasion of the alewife in Lake Champlain and its subsequent large population expansion is likely providing a very large new food source and may be affecting the distribution of cormorants on Lake Champlain and their nesting productivity. A USDA-Wildlife Services' study was implemented in 2008 to determine the changing diet of cormorants on Lake Champlain and the importance of alewives in the cormorant diet during different parts of the breeding period.

Cormorants are also found in other regions of Vermont such as Lake Memphremagog and the Connecticut River watersheds. No known nesting colonies have been located in these other watersheds or regions of the State. Cormorants have been observed feeding and loafing along the major rivers and inland lakes to the east of the Lake Champlain basin.

Vermont is currently working with neighboring States, Provinces, and partners within the region to develop a Lake Champlain Colonial Waterbird management plan. The plan will include efforts to identify population goals associated with current scientific knowledge and impacts on habitat of other species. Due to a lack of regional information and pending further evaluations regionally we will be placing a zero within the tolerable nesting pairs table with the understanding that this number may be increased if determined to be desirable in the future. It is also understood that a zero breeding pair entry will not mandate additional control efforts where personnel and funding do not exist or impacts to habitat are tolerable.

VIRGINIA-

WEST VIRGINIA - There are no historical or current records of cormorants nesting in West Virginia although small numbers of non-breeders are present during the summer. The numbers of migrant and wintering birds is low, but increasing. Complaints about cormorant depredation are rare.

WISCONSIN - Historically, Double-crested Cormorants (DCCO) nested at isolated lakes in northern and central Wisconsin during the early 1900s (Matteson et al. 1999). The first published reports of colony sites occurred in 1919 and 1921, with colonies on Lake Wisconsin in south-central Wisconsin. Between 1919 and the mid 1960s, Wisconsin DNR (WDNR) records indicated that there were a total of 17 known DCCO colony locations in the state, although no more than 7 of these locations were in use in any given year (Matteson 1985, Matteson et al. 1999). In peak years, there were at least several hundred nesting pairs statewide. During the 1950s and 1960s, however, the

DCCO breeding population declined sharply, and by 1966 a statewide survey found only 24 nesting pairs in 3 active colony sites. DCCOs were officially listed as an endangered species by the State of Wisconsin in 1972 (Matteson et. al 1999). During the period of 1974 to 1985, a total of 1,199 DCCO nesting platforms were established at 13 locations as part of the WDNR effort to restore the DCCO population (Matteson 1985). Prior to 1980, inland colonies supported more nesting DCCOs than the colonies on the Great Lakes.

Restoration efforts by WDNR in addition a nationwide the ban on organochlorine pesticides (DDT) and its metabolite (DDE), resulted in DCCO population increases. By 1982, the state DCCO population had increased to 1,028 pairs in 16 colonies and the state status was changed to "threatened". Some of the earliest complaints about DCCO impacts on fish came in 1982, when commercial fishermen in the Apostle Islands (Lake Superior) reported losing 30-40% of their whitefish pound-net catch. Response to the conflict included research into deterrent devices (Craven and Lev 1987) and an eventual switch by fishermen from pound nets to cage-type nets that were less vulnerable to foraging DCCOs (Matteson et al. 1999).

The WI DCCO population continued to increase throughout the 1980s. Beginning in 1980, the majority of the state's nesting DCCOs occurred at Great Lakes' colonies, a trend that presently continues. By 1985, the Wisconsin DCCO population was estimated at 2,213 pairs in 21 nesting colonies. The total DCCO population in 1985 including non-breeding birds was estimated to be at or above 5,000 birds (Matteson 1985). In 1986, the species was removed from Wisconsin's list of threatened and endangered species (Matteson 1985, Matteson et al. 1999). By 1997, the state's cormorant population had increased to 10,546 nesting pairs at 23 colony sites, with 82% of the population occurring on 4 Green Bay/Lake Michigan islands (Matteson et al. 1999).

In 2005, a statewide survey coordinated by USDA Wildlife Services (C. Lovell pers. comm.) showed that the DCCO population had increased 37% since 1997 to 14,462 nesting pairs, but that DCCO colonies in other regions of the state, with the exception of the East Central Region, had declined or become inactive (USDA 2009).

In 2009, the state's population increased 24% to 17,945 nesting pairs at 20 colony sites (Jones and Lovell 2009) despite annual control (egg oiling and limited shooting) activities initiated in 2006 by Wildlife Services at some Green Bay/Lake Michigan islands. Under a Public Resource Depredation Order established by the USFWS in 2003, control activities were initiated due to concerns about impacts on yellow perch populations and subsequent concerns about the impacts on island vegetation. Meadows (2006) found that yellow perch, gizzard shad, round goby, and white sucker were the dominant species consumed by DCCO in southern Green Bay. She estimated that the Cat Island colony of DCCO consumed an annual average of 34,081 kg (75,135 lb) of yellow perch between 2004 and 2006. During those years, the total annual allowable commercial harvest set by WDNR for Green Bay yellow perch was 60,000 lbs.

Green Bay/Lake Michigan islands comprised 85% of the state's population in 2009, with

approximately 15,000 nesting pairs using 8 islands in Lake Michigan waters. Through the public input process of an Environmental Assessment and Wisconsin Natural Resources Board policy development, a population goal for the Green Bay and Lake Michigan islands has been set at 6,000 nesting pairs, limited to 5 islands that have had a long history of colony activity in Green Bay and Lake Michigan (J. Pritzl pers, comm.). The joint Flyway management plan has set a statewide cormorant breeding population goal of 7,500 – 8,000 nesting pairs.

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