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# Double-crested Cormorants in Michigan: A review of history, status, and issues related to their increased population

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## Introduction

The double-crested cormorant (hereafter referred to as cormorant) is widely distributed throughout North America. It is the only cormorant of six species in North America with a large population in the interior of the continent, and the only species to breed in Michigan. Once on the verge of extirpation in the Great Lakes region, the cormorant population has rebounded in response to changes in human disturbance, changing environmental factors (e.g., chemical and biological conditions, water quality), and changes in fish populations. The increased number of cormorants in the Great Lakes has raised concerns regarding impacts on game fish species, the forage base (smaller fish consumed by larger predatory fish and birds), island resources, and other colonial water birds. Cormorant populations in the Great Lakes have increased from very few nests in 1977 to an estimated 30,000 nests in 2001 (Wires et al. 2001). In the past few years, the rise in abundance of breeding cormorants has slowed and may be stabilizing in the U.S. waters of lakes Michigan and Huron (Trexel 2003). Trexel identified saturation of nesting habitat, human disturbance, and predation at cormorant colonies as likely limiting factors.

### Great Lakes Population History

While not abundant historically in the Great Lakes, documentation of cormorants in Michigan can be found dating to the 1800s. Barrows (1912) suspected some scattered breeding occurred at the turn of the century, but did not report any occurrences of breeding in his publication on Michigan birds. Lewis (1929) documented reports of cormorant breeding colonies in both Ohio and Illinois in the late 1800s and early 1900s. In addition, Barrows (1912) identified numerous reports of migratory cormorants throughout the state.

Based on active breeding colonies, Lewis (1929) identified two major cormorant breeding populations, one on the St. Lawrence River estuary and a second interior population centered on the North American prairie pothole region. The upper Great Lakes portion of the interior breeding range as described by Lewis included colonies at Duluth, Minnesota; Agawa Rocks, Ontario (eastern Lake Superior); and La Crosse, Wisconsin. No nesting was noted on the Great Lakes despite the apparent availability of suitable nesting sites (Lewis 1929). However, by the 1930s breeding colonies had been documented at several sites in Michigan: St. Martin's Shoal (Lake Huron), Isle Royale (Lake Superior), Black River Island (Alcona Co), Huron Islands (Lake Superior), and Bond Falls Flowage (Iron Co.) (Ludwig 1984, Wood 1951). During the same period, records of occasional breeding were noted by F.E. Ludwig (unpublished data) for Scarecrow and Thunder Bay Islands (Lake Huron) and Pismire and Hat Islands (Beaver Island archipelago, Lake Michigan).

Early populations of cormorants were likely influenced by direct human impacts (Wires et al. 2001, Lewis 1929). Historical references used by Lewis indicated human disturbance and persecution at several of the pre-1900s nesting sites, which were later abandoned. Lewis also identified a number of historical references to cormorants and their eggs being used for food by Native Americans and by explorers, and as a source of protein for livestock feed.

Commercial fisherman viewed cormorants as competitors for fisheries resources. Lewis (1929) identified accounts of cormorants being trapped during commercial fishing operations and destruction of nests and eggs during the 1800s and early 1900s.

By the 1940s, breeding population estimates in Michigan ranged from 200 to 500 nesting pairs with an additional population of up to 2,000 nesting pairs in Canadian waters of Lakes Huron and Erie (Diana et al. 1997).

Numerous shallow impoundments were created on inland waters throughout much of the 20th century. These were similar to water bodies in the cormorants' interior breeding range in the North American prairie pothole region. Breeding records on these impoundments date back to the 1940s and impoundments in northern Wisconsin later served as refuges for Great Lakes cormorant populations decimated by DDE and PCBs (Ludwig 1984).

The Great Lakes cormorant population declined during the late 1950s and 1960s, to near zero. Surveys conducted from 1960-67 found no evidence of cormorants nesting in Michigan waters of the Great Lakes (Ludwig 1962, 1968, 1974). As a top-level predator, cormorants have the potential to bioaccumulate high levels of contaminants and studies have linked the decline to organochlorine pesticides used throughout the Great Lakes region (Postupalsky 1978, Weseloh et al. 1983). Across the Great Lakes, cormorant breeding populations reached their lowest point in 1972 and 1973 with an estimate of only 125 breeding pairs. Small colonies also remained in Canadian waters of Lakes Huron and Erie (Weseloh et al. 1983).

Double-crested cormorants were placed on Michigan's endangered species list in 1976 as "probably extirpated." Similar declines in other North American cormorant populations led to inclusion on the National Audubon's "blue list" from 1972 to 1981 (Tate and Tate 1982).

The passage of laws banning use of organochlorine pesticides (e.g., DDT), PCBs and other water quality improvement measures allowed cormorant populations to rebound along with a number of other fish-eating birds including the bald eagle, osprey, herring gull, Caspian tern and common tern. The level of measurable contaminants in these birds continued to decline throughout the 1990s (Hatch and Weseloh 1999).

By 1976, cormorant populations had begun recovering with the first observations of nesting in Michigan (Scharf 1978). By 1981, colonies had been established at seven sites in Michigan with an estimated 318 nesting pairs (Ludwig 1984). Five years later, the number of nests had increased to 1,094 (Ludwig and Summer 1997). Wires et al. (2001) estimated the abundance in Michigan at over 30,000 nesting pairs with a total population estimate of 115,000. Similar increases in cormorant populations have been identified across their range in North America (Vermeer and Rankin 1984). Two of the most dramatic increases documented were a nearly five-fold increase in Manitoba's cormorant population between 1969 and 1979 and a nine-fold increase from 1,078 nests to 9,877 nests between 1968 and 1983.

In addition to reduced contaminant levels, the rapid population increase observed in the Great Lakes is likely the result of changing biological factors influencing cormorant breeding and food habits. During the 1940s and early 1950s the invasion of alewives and rainbow smelt into the upper Great Lakes (above Lake Ontario) changed the forage base dramatically (Christie 1974, Postupalsky 1978, Hatch and Weseloh 1999). Previously confined to Lake Ontario, alewives were first discovered in the upper Great Lakes during the mid 1900's. This species gained access to the upper Great Lakes through construction of the Welland Canal around Niagara Falls in 1829.

Increased productivity and survival of cormorant fledglings have been correlated with high alewife abundance (Weseloh and Ewins 1994). In 1912, rainbow smelt were introduced into Crystal Lake, Michigan, and shortly thereafter escaped into Lake Michigan. Both of these species found excellent conditions for reproduction and survival and spread rapidly throughout lakes Erie, Huron, and Michigan.

Other bird species were also influenced by changes occurring in the Great Lakes. For example, ring-billed gulls were once considered a non-breeder in Michigan and surveys conducted between 1905 and 1926 did not document any breeding activity. The first breeding colony was documented in northern Lake Huron in 1926 (Ludwig 1943). Ring-billed gulls numbered 27,000 nesting pairs in 1960, increasing to over 141,000 by 1967 (Ludwig and Summer 1997). Ring-billed gulls were less affected by contaminants and populations continued to increase. By the late 1970s, nest counts ranged from 400,000 to 500,000 (Scharf and Shugart 1991). More recently (late 1990s to 2005), observations of white pelicans have been increasing in Lake Michigan and they have been nesting in Green Bay, Wisconsin, with estimates of up to 220 nests on Cat Island (Matteson 2002).

Other factors contributing to the rapid population increase in cormorants have been changes in wintering areas, primarily caused by increases in the aquaculture industry and the associated rise in available food resources. Large scale aquaculture facilities have attracted significant numbers of wintering cormorants. The lower Mississippi River wintering population has been increasing since the 1970s (Reinhold and Sloan 1999) and cormorants using aquaculture resources have improved winter survival and are in better health when they arrive in their breeding areas (Glahn et al. 1999).

There also has been a reduction in human persecution of cormorants and their colonies. In 1972, cormorants became protected under the federal Migratory Bird Treaty Act (U.S. Fish and Wildlife Service (USFWS) 2003). Prior to protection under this act, destruction of nests, eggs, young, and adults was a common practice carried out by private individuals and government control programs (Ludwig 1984, Weseloh et al. 1995).

Most recently, cormorant populations in several areas (Beaver Island archipelago, Green Bay, and Les Cheneaux Islands) appear to be stabilizing or have declined slightly, possibly from water level changes or lack of suitable additional of nesting sites (Seefelt and Gillingham 2004; Trexel 2003; unpublished data U.S. Department of Agriculture, Wildlife Services; unpublished data Michigan Department of Natural Resources). In Georgian Bay and the North Channel of Lake Huron, Ontario, Ridgeway (2005) identified a declining cormorant population, with the recent decline in alewives being the primary cause.

**Diet**

Dietary studies have indicated cormorants consume a wide range of prey species and are opportunistic, generalist feeders (Hatch and Weseloh 1999, Ludwig et al. 1989). Prey selection primarily depends upon abundance, availability (distribution in the water column), and catchability (size, predator avoidance behaviors) of prey species near colonies (Marucca 1997). Prey sizes range from 3-40cm (1.2-16 in.), but optimally are less than 15 cm (6 in.) (USFWS 2003). The abundance and

composition of potential prey are key factors determining prey selection and contribute to the observed seasonal variation in diet (Neuman et al. 1997). Belyea et al (1997) found that primary prey species varied over six seasonal periods in the Les Cheneaux islands and were related to the abundance and composition of species using the study area. Yellow perch represented 41% of the total biomass consumed by cormorants during the first study period (approximately mid-April to mid-May). This percentage declined to less than 5% once spawning was completed and increased to 14% during the sixth period (mid-September to October 6).

Seefelt and Gillingham (2004), in a study conducted around the Beaver Island archipelago, found that alewives comprised about 72 percent by weight of the cormorant diet. This study found similar dietary results using two separate methods of analysis: regurgitated food items and stomach contents. During the study, a single individual game fish (smallmouth bass) was found.

Local cormorant populations respond quickly to high concentrations of fish and will congregate in areas where fish are easily caught, a behavior that can have potential negative impacts on fish stocking activities (Wires et al. 2001). When feeding on abundant schooling prey, cormorant flocks have been observed feeding in a forward moving line, leap-frogging to the front to feed (Hatch and Weseloh 1999).

Dietary studies in the Great Lakes have confirmed repeatedly that alewife form the foundation of cormorant diets (Ludwig et al. 1989, Belyea et al. 1997, Hatch and Weseloh 1999, Wires et al. 2001). Other widely eaten prey species include yellow perch, sticklebacks, sculpin, rainbow smelt, and suckers (Trapp et al. 1999, Wires et al. 2001). Over 75 fish species as well as crustaceans, insects, reptiles, and amphibians have been identified in diets (Hatch and Weseloh 1999).

Dietary and behavioral information of cormorants migrating through Michigan and for resident non-breeders (subadults and nonbreeding adults) are generally lacking (Gremillet et al. 2000). A review by Wires et al. (2001) found that population estimates for non-breeders ranged from one to four non-breeders for each breeding pair.

## Biological Issues Related to Double-crested Cormorant Populations

The increase in cormorant populations in Michigan has resulted in numerous claims of damage to fisheries, wildlife, and habitat resources.

In order to better identify the range of specific issues, and to determine what management actions could be implemented to respond to the issues, both Fisheries and Wildlife Divisions completed inquiries to local biologists in regards to concerns expressed about increased cormorant populations.

Results of discussions with Fisheries Division staff are summarized in Appendix A. The summary identifies three primary fisheries-related issues including: predation on post-stocked fish, predation on sport fish by migrating birds, and predation on sport fish by nesting and resident birds. In addition, concerns regarding indirect impacts (i.e., changes in population dynamics and age structures) to fisheries populations have arisen. Cormorants feed on the same forage consumed by sport fish and high

population levels of cormorants may influence the forage base, thus reducing survival and growth of game fish species.

In discussion with Wildlife Division field personnel, the potential for cormorants to impact other colonial nesting birds (common and Caspian terns, great blue, green and black-crowned night herons), and the vegetation on breeding or roost islands was raised as a concern.

**Fisheries Issues**

*Cormorant Predation on Post-stock Fisheries*: As noted above, cormorants have shown the ability to identify and quickly respond to high fish concentrations or fish made vulnerable by human activity. This is of particular concern to both aquaculture and stocking programs. During the last several years, a private club in the Upper Peninsula received animal depredation permits from the USFWS to control cormorants on a privately stocked pond. Observations had indicated heavy predation by cormorants on stocked trout in this pond.

Of even greater concern are the potential impacts of cormorants on stocking programs carried out by State and Federal agencies. Many observers have reported large numbers of cormorants foraging on juvenile fish and stocked salmonids tend to be more vulnerable to cormorant predation than their wild counterparts (Collis 2000; Derby et al. 1997; Modde et al. 1996). The difficulty in evaluating the impacts of cormorant predation on Great Lakes stocking programs is documenting survival and return rates to fisheries and quantifying diets and total consumption of predators. Johnson and Rakoczy (2004) concluded post-stocking predation caused the collapse of the Thunder Bay brown trout fishery. The report also noted declines in alternative prey species such as alewives and prey shifts by various predators. Diet information from cormorants was not available to determine their impacts to this fishery.

Milton et al. (1992) noted reductions in cormorant predation could be achieved by altering the timing or location of stocking releases. While these actions may reduce initial predation it may take several days for some species of newly released fish to orient themselves in their environment, leaving them vulnerable to predation.

*Fish Population Effects:* Documented mortality of game fish species has been associated with proximity to cormorant breeding colonies. Freshwater game fish species of concern include yellow perch, smallmouth bass, stocked salmonids, and occasionally walleye. Studies clearly documenting negative influences of cormorants on freshwater sport fisheries include two investigations conducted on Oneida Lake showing influences on yellow perch and to a lesser extent on walleye populations (VanDeValk et al. 2002, Rudstam et al. 2004). Published accounts do not clearly document significant mortality and losses due to cormorant predation but provide correlations between cormorant abundance and reduction in game fish stocks (Collis et al. 2001; Derby et al. 1997; Elrod et al. 1997; Ross et al. 1995). Several other studies indicate that cormorants likely had little impact on sport-fish populations (Somers et al. 2003; Diana et al. 1997; Karwowski et al. 1994; Craven et al. 1987). Many investigations have shown that cormorants are opportunistic foragers and that their diet will change with shifts in forage populations (Collis et al. 2002; Neuman et al. 1997; Ross et al. 1995). Where cormorants are abundant and alternate prey species

are not available, sport-fish populations are more likely to experience the negative influences of cormorant predation. Lantry et al. (2002) calculated that cormorants annually reduced the population of age three to age five (prerecruit) small-mouth bass in Lake Ontario by 23% in 1993-4 and 36% in 1998. Based on the 1998 estimate, the cumulative effect of cormorant predation on juvenile year classes in Eastern Lake Ontario could suppress smallmouth bass recruitment by 78%. Other studies in Lake Ontario estimated the average annual consumption of yellow perch by cormorants was 7.7 million during the 1990s (Burnett et al. 2002). This rate of consumption by cormorants was considered sufficient to dramatically reduce recruitment to the older ages desired by the fishery. A recent reevaluation of work conducted in the Les Cheneaux Islands concluded that cormorant predation may have contributed to the decline of yellow perch and is a factor in the continued suppression of the perch population in the area (Fielder 2003).

*Forage Base Impacts:* Additional concerns have been raised regarding indirect impacts on fisheries, stating that cormorant predation may reduce the available forage for other species. Forage studies have produced varying results to date. A bioenergetics study conducted by Madenjian and Gabrey (1995) in the western Lake Erie basin estimated that cormorants consumed 1,224 tons of fish, and amount equivalent to 1.1% of the consumption of the prey base necessary to support the annual walleye population. Another study estimated cormorants consumed approximately 13.9 million kg of fish in Lake Huron, an amount similar to the forage consumed by the walleye population (Dobiesz et al. in preparation).

**Terrestrial Issues**

*Impacts on Other Colonial Nesting Birds:* A regional survey conducted by Wires et al. (2001) indicated 11 states had reported cormorants impacting other colonial waterbirds. The groups of species of greatest concern were tree-nesting herons and egrets. In the western Lake Erie basin (West Sister Island), concerns have been raised regarding nesting black-crowned night herons, snowy egrets and great blue herons (Shieldcastle and Martin 1999). The USFWS has identified West Sister Island National Wildlife Refuge as an important nesting site for colonial wading birds. The site accounts for approximately 40% of all heron and egret nesting on the U.S. side of the Great Lakes. In Hamilton Harbors on Lake Ontario, black-crowned night herons abandoned a nesting site as cormorant populations increased (Moore et al. 1995).

Cormorants may also compete with ground-nesting colonial waterbirds. Reports of changes in nesting areas as a result of cormorant population increases have been noted on West Sister Island in Lake Erie (Unpublished data, Ohio Division of Wildlife).

Data collected during three Great Lakes colonial waterbird census (1976 to 1977, 1989 to 1991, and 1997 to 1999) indicates an increase in great blue herons and a decline in black-crowned night herons (Cuthbert 2002). Cuthbert also noted that excluding the black-crowned night heron declines on West Sister Island in Lake Erie (87% decline), which can be attributed to vegetative succession, the Great Lakes population actually increased from 1977-1999. Her analysis found that cormorant impacts on colonial waterbirds could only be documented at a single site; Little Galoo Island, Ontario.

The Department of Natural Resources (Department) in cooperation with Michigan Natural Features Inventory, Michigan State University Extension (MNFI) maintains a database of plant and animal species listed as threatened, endangered, or identified as special concern by MNFI. This database information does indicate some smaller nesting colonies of great blue-herons, and black-crowned night herons may have been displaced. Colonial nesting birds like herons will change nesting locations periodically. These recent colony relocations do not differ from patterns normally observed through time.

*Vegetative Damage:* Damage to vegetation by cormorants results from chemical and physical factors (USFWS 2003). Droppings contain high levels of nitrogen, phosphorus, and potassium, and over time, changes in soil chemistry can eliminate vegetation from nesting or roosting areas. Accumulations of the acidic fecal matter on leaves can damage leaves and kill plants by inhibiting photosynthesis. Nest sites are subject to additional damage as cormorants break branches used for nest material. The combination of these activities can remove most trees in a nesting area within three to ten years after colony establishment (Bedard et al. 1995, Korfanty et al. 1999, Lemmon et al. 1994). Herbert et al. (2005) investigated impacts by cormorants on islands in the western basin of Lake Erie. Their findings suggest cormorant nesting decreased canopy cover on two forested Lake Erie islands (East Sister and Middle Sister).

Vegetation affects are of most concern when they represent unique flora or lead to abandonment of areas by other nesting birds. Impacts to unique vegetative communities and rare species are a concern on Little Galoo Island and Presque Isle Park in Lake Ontario where control efforts have been implemented to protect the resource (personal communication, Chip Weseloh, Ontario Ministry of Natural Resources). While tree nesting sites and vegetation diversity have been impacted on islands utilized by breeding cormorants, a. review of the current known nesting colonies of cormorants in Michigan using the Department's database of locations for rare plants, and habitats does not indicate a threat to any known unique plant or habitats, at these colony locations.

**Management Authorities:**

*Federal Authority*
The United States Department of Interior (USDA), Fish and Wildlife Service has the primary statutory authority to manage migratory birds. In the case of cormorants, this authority resulted from a 1972 amendment to the *Convention between the United States of America and the United Mexican States for the Protection of Migratory Birds and Game Animals* (23 U.S.C.260, T.I.A.S. 7302) developed under the Migratory Bird Treaty Act (16 U.S.C. 703-711:40 Stat. 755). The take of cormorants was strictly prohibited except as authorized by implementing regulations of the Migratory Bird Treaty Act.

In 1999, the USFWS announced (Federal Register, 64 FR 60826) their intent to prepare an Environment Impact Statement to address "impacts caused by population and range expansion of the double-crested cormorant." This process was completed with the rules amending Migratory Bird Permits Section (50 CFR Part 21) by establishing "Regulations for Double-crested Cormorant Management." (Federal

Register, 68 FR 58022). The purpose of the depredation order was "to reduce the occurrence and/or minimize the risk of adverse impacts to public resources (fish, wildlife, plants, and their habitats)" on a local basis. Local control actions can be initiated by the USDA, Wildlife Services; State Fish and Wildlife Agencies; or Federally-recognized Tribes. Any of these agencies may designate agents to carry out control actions.

These changes do not authorize the general take of cormorants nor do they authorize any state or federal agency or tribe to conduct state or regional cormorant population reduction efforts. No direct federal funding was provided to carry out control activities with this new authority.

*State Authority*
The Michigan Department of Natural Resources under P.A 451 of 1994 is empowered to "protect and conserve the natural resources of this state (MCL 324.503 (1))." In addition MCL 324.40105 states, "All animals found in this state, whether resident or migratory and whether native or introduced, are the property of the people of the state, and the taking of all animals shall be regulated by the Department as provided by law."

Further, the Department has authority to issue orders determining the kinds of animals that may be taken and determining the animals or kinds of animals that are protected (MCL 324.40107 (1)).

These regulations are incorporated under the Wildlife Conservation Order as amended by the Natural Resources Commission and Director. Section 9.1 (Permitted Acts, Certain Species) identifies the following methods in which cormorants may be harassed or taken or their eggs may be taken:

> (a) Double-crested cormorants may be harassed without a permit by nonlethal means to deter or prevent damage to private property or to public fishery resources using such devices as noise makers or scare devices and other recognized and recommended means of preventing damage which do not kill, harm, capture, trap, or collect animals.
>
> (b) Double-crested cormorants may be taken and their eggs destroyed or oiled by department employees and designated agents of Department employees at times and by manners identified through a state breeding colony or local breeding population control action which has been submitted to the United States Fish and Wildlife Service.

**Department of Natural Resources Planned Cormorant Management Actions**

1. In cooperation with the USFWS, and USDA, Wildlife Services, the Department will develop and conduct tri-annual surveys documenting cormorant colonies and populations in Michigan waters and continue to support and conduct annual cormorant population surveys in areas where cormorant harassment or control efforts are being implemented. The next Great Lakes colonial waterbird census (including cormorants) is scheduled to begin in 2007.

2. Prior to the spring migration in 2006, the Department will establish a web-based nuisance complaint form to monitor citizen concerns and issues related to cormorants.

3. The Wildlife Division will conduct an environmental review and identify islands holding significant resources (rare natural communities or endangered, threatened, or rare plants and animals) that could be impacted by an expanding cormorant population and initiate control activities should these resources be threatened by future expansion or establishment of a colony.

4. On an annual basis, the Department in cooperation with USDA, Wildlife Services and the USFWS will develop a plan to initiate control and harassment activities in areas where scientific information indicates that natural resources are being negatively impacted, and population control activities will alleviate the impacts. Monitoring the results (both cormorant and resource response) of these actions will be included as part of these efforts.

5. The Department will continue to encourage the USFSW, to develop a long term double-crested cormorant management plan involving USDA, Wildlife Services, State Agencies and other Great Lakes partners. In lieu of a Great Lakes plan the Department will initiate development of a state level management plan.

6. Cooperate with University of Minnesota and USFWS in study to potential use of aerial surveys to determine cormorant nesting numbers as an alternative to ground counts.

7. In order to better determine the impacts of cormorants and the appropriate management actions, the Department will initiate or encourage other appropriate research facilities to initiate research/information projects in the following areas.

    - Cormorant foraging patterns (distance from breeding colony, use of inland lakes by Great Lakes colonies).

    - Movement and life history information on non-breeding juveniles and adults.

    - Identify and research the potential for negative impacts from cormorants on inland lake fisheries.

    - Migration activities and potential fisheries impacts from short-term, high concentrations of cormorants.

    - Evaluate the breeding and population dynamics of cormorants across their range in the Great Lakes and St. Lawrence Seaway.

    - Development of models that can predict the contribution of predation by cormorants the Great Lakes forage base and its relationship to the overall forage base.

## 2005 Planned Activities

Cooperate with the USDA, Wildlife Services in current control study being conducted at Les Cheneaux islands (the Department will be collecting the Fisheries data for this project).

Wildlife and Fisheries Divisions will meet with the USDA, Wildlife Services to develop a process to identify appropriate areas for future harassment and control activities.

Provide information on legal, non-fatal harassment activities that can be initiated by private citizens.

## Need for Federal Management

The double-crested cormorant is a common summer resident in Michigan's Great Lakes waters. In addition, the Great Lakes and nearby inland lakes are used by spring and fall migrating cormorants. Cormorants currently are protected under the Federal Migratory Bird Treaty Act and take is further regulated under Michigan's Wildlife Conservation Order. Increased populations in the Great Lakes are the results of environmental changes in both the northern breeding grounds and in the southern wintering areas. Cormorant populations in both United States and Canadian waters are related and these birds winter broadly across the southern U.S. The resolution of issues related to the management and control of population overabundance across states and international boundaries must include the USFWS as the primary planner and manager on a regional scale. Local population control of cormorants will be a long-term and costly endeavor. The USFWS has responsibility for similar issues such as sea lamprey and snow goose population control.

**Appendix A.**

## POTENTIAL CORMORANT/FISHERIES CONFLICT AREAS: A summary of responses provided by Fisheries Division personnel

Fisheries Division personnel identified potential problem areas regarding cormorants and the fisheries resource in roughly three categories: seasonal post-stocking predation on hatchery products, predation on game fish by migratory birds, continued predation on game fish by resident, and migratory birds.

1. Seasonal post-stocking cormorant predation on stocked salmonids
    a. Generally in spring during bird migration.
    b. Believed to have varying impact, potentially locally significant, on survival of stocked fish.
    c. Concentration of stocked fish, either at stocking site, or in small lake, makes fish susceptible to efficient removal by cormorants.
    d. Reduces cost/benefit of hatchery product.
    e. Timing of stocking events and hazing of birds at stocking sites may have some mitigation potential.
2. Predation on game fish by migratory cormorants
    a. It is suspected that coincidental congregations, seasonally, of gamefish and cormorants may combine to reduce game fish populations.
    b. Heavy use of cormorants on a body of water for a short period of time may inflict significant mortality on game fish, the impact depending on size of water body and number of birds.
3. Predation on game fish by resident and migratory cormorants
    a. Continued cormorant predation pressure on a waterbody is suspected to reduce availability of game fish, and/or preclude recovery of depressed game fish populations.
    b. Sport fishery catch rates are believed to be reduced (documented in some cases, for example, in the Les Cheneaux islands), with cormorants identified to be at least a contributing factor.

Impact of cormorants on the fisheries resource appears to depend on the fish species available to the birds. If abundant non-game fish forage is available, impact on game fish may be minimal, with competition for forage species a greater issue. In the absence of alternative forage, game fish populations may be directly impacted through predation by cormorants.

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