DRAFT ENVIRONMENTAL ASSESSMENT

MANAGEMENT OF DOUBLE-CRESTED CORMORANTS UNDER 50 CFR 21.47 AND 21.48

U.S. FISH AND WILDLIFE SERVICE
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In cooperation with

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services

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SUMMARY

• In 2003, we published a Final Environmental Impact Statement and made changes to the regulations governing the take of Double-crested Cormorants (*Phalacrocorax auritus*; DCCO). The final rule, published in the Federal Register in November 2003, established a Public Resource Depredation Order (PRDO; 50 CFR 21.48) and made changes to the 1998 Aquaculture Depredation Order (AQDO; 50 CFR 21.47). The final rule for the depredation orders is available at *http://www.fws.gov/migratorybirds/ CurrentBirdIssues/Management/ cormorant/FinalRule/fed1regdccofinalrule.pdf*.

• In 2009, the depredation orders were extended an additional five years. If not renewed, the PRDO and the AQDO will expire on 30 June 2014.

• The purpose of this Environmental Assessment is to determine whether the depredation orders should be continued, and if doing so is likely to have a significant effect on the environment.

• In this Assessment, we considered three alternatives: allowing the depredation orders to expire in 2014—the "no action" alternative; a five-year extension of the regulations (our preferred alternative); and eliminating the expiration dates on the depredation orders. We have analyzed the effects of the three alternatives on: DCCOs, fish, wildlife and their habitats (co-nesting birds), plants and their habitats (vegetation), threatened and endangered species, the economic environment, and existence and aesthetic values. Extending the depredation orders for 5 years would not adversely affect populations of DCCOs or other birds that nest or roost with them; would not adversely affect threatened and endangered species; would benefit resources that are negatively impacted by DCCOs (fish, co-nesting birds, and vegetation); would minimize negative economic impacts on aquaculture businesses and recreational, fishing-dependent economies; would have no effect on existence values; and would have varying effects on aesthetic values.

• With the limits on DCCO depredation management actions, review of impacts of the current program, and the expectation that future actions are likely to be similar in magnitude and nature to those which have occurred, population monitoring, and our review of annual reports and proposed DCCO depredation management activities, we are confident that continued operations under the depredation orders will not threaten the long-term conservation of DCCO populations.

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PURPOSE AND NEED FOR THE PROPOSED ACTION

On 11 August 2003, we published a Final Environmental Impact Statement (FEIS) on Double-crested Cormorant (*Phalacrocorax auritus*; DCCO*)* management in the United States. You may view or download the FEIS online at *http://www.fws.gov/ migratorybirds/CurrentBirdIssues/Management/ cormorant/CormorantFEIS.pdf*, or you can request a copy by writing the Division of Migratory Bird Management. The programmatic FEIS analyzed the anticipated effects of six alternatives on: DCCOs; other birds; fish; vegetation; federally-listed threatened and endangered species; water quality and human health; aquaculture and recreational fishing economies; fish hatcheries; property losses; and existence and aesthetic values. The FEIS also considered direct, indirect, and cumulative effects and discussed mitigating measures. The proposed action or preferred alternative in the FEIS was Alternative D: Public Resource Depredation Order. This alternative entailed two regulation changes (described below): revision of the 1998 Aquaculture Depredation Order; and creation of a Public Resource Depredation Order.

On 8 October 2003 (68 FR 58022; *http://www.fws.gov/migratorybirds/ CurrentBirdIssues/Management/cormorant/FinalRule/fed1regdccofinalrule.pdf*), we published final regulations for an Aquaculture Depredation Order (50 CFR 21.47) and a Public Resource Depredation Order (50 CFR 21.48), including all associated terms and conditions. The final rule also gave background information on the development of the regulations, presented our responses to significant comments received on the proposed rule, and, pursuant to the National Environmental Policy Act, presented our Record of Decision. On 6 April 2009 (74 FR 15394-15398; *http://www.fws.gov/policy/library/ 2009/ E9-7650.pdf*), we extended the expiration dates of the two orders. We noted that "The data do not indicate that the orders will substantially adversely affect cormorant populations, nor cause them to reach dangerously low population levels."

The Aquaculture Depredation Order (AQDO) applies to 13 States – Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Minnesota, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas. In those States it authorizes freshwater commercial aquaculture producers to take DCCOs committing or about to commit depredation of aquaculture stocks. It also authorizes the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) Wildlife Services (WS) employees to control DCCOs at roosts that are near aquaculture facilities. Numerous terms and conditions apply, including recordkeeping and reporting requirements.

The Public Resource Depredation Order (PRDO) applies to 24 States – Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, New York, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, Texas, Vermont, West Virginia, and Wisconsin. It authorizes State fish and wildlife agencies, federally-recognized Tribes, and USDA APHIS Wildlife Services to take DCCOs to protect fish, wildlife, plants, and their habitats that are managed by public resource agencies for public benefit. Numerous terms and conditions apply, including annual notification and reporting requirements.

The purposes of the proposed action in the FEIS were to: (1) reduce resource conflicts associated with DCCOs in the contiguous United States; (2) enhance the flexibility of natural resource agencies in dealing with DCCO-related resource conflicts; and (3) ensure the long-term conservation of DCCO populations. The purpose of the alternatives B and C in this Environmental Assessment (EA) is to continue to meet the three objectives stated in the FEIS.

The conservation of DCCO populations is a fundamental responsibility of the USFWS. However, because of the problems associated with abundant DCCOs, that responsibility includes being responsive to damages or conflicts caused by this species. Wildlife damage management, or DCCO depredation management, is the alleviation of damage or other problems caused by or related to the presence (and often overabundance) of wildlife. It allows wildlife officials to balance the positive and negative impacts associated with wildlife in a world where humans and wildlife must coexist (Conover 2002) and it is an essential and responsible part of wildlife management (Leopold 1933, The Wildlife Society 2010, Berryman 1991). The Migratory Bird Treaty Act allows the USFWS to write regulations that authorize the taking of migratory birds to control depredation and other problems.

As DCCO populations expanded (numerically and, to some extent, geographically) during the 1970s to 1990s, fish and wildlife managers (and members of the public such as fish farmers and sport anglers) began to associate DCCOs with a host of resource conflicts. These included damage to trees and other vegetation, depredation on fishery and aquaculture stock, and competition with co-nesting species. Both scientific and anecdotal evidence support the premise that DCCOs can have significant localized impacts on resources. When the USFWS issued the DCCO depredation orders in 2003, it did so in the understanding that DCCOs can cause real resource damages.

On 8 November 2011, we published a notice of intent to prepare an EA or EIS to review potential revisions to regulations governing the management of double-crested cormorants, and requested public comments to aid the analysis. Eighty one letters from the public and agencies with substantive suggestions for cormorant management were received during the comment period. Resource limitations preclude completion of a thorough review of potential revisions to the regulations prior to the 30 June 2014 expiration dates for the depredation orders. However, we anticipate a continuing need to manage DCCOs to protect aquaculture and public resources beyond the expiration dates of the PRDO and AQDO. This EA evaluates an interim measure of addressing the anticipated need for DCCO damage management by continuing the depredation orders. The proposed regulation changes would not result in changes to current management strategies.

AUTHORITY AND COMPLIANCE

The mission of the USFWS is “working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people.” USFWS manages the 93-million-acre National Wildlife Refuge System, which encompasses more than 520 national wildlife refuges, thousands of small wetlands, and other special management areas nationwide. It also operates 66 national fish hatcheries, 64 fishery resource offices, and 78 ecological services field stations. The agency enforces Federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat such as wetlands, and helps foreign governments with their conservation efforts. It also oversees the Wildlife and Sport Fish Restoration Program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to State fish and wildlife agencies.

MIGRATORY BIRD TREATY ACT (16 U.S.C. 703-712)

USFWS has the primary statutory authority to manage migratory bird populations in the U.S., authority which comes from the Migratory Bird Treaty Act (MBTA). The original treaty was signed by the U.S. and Great Britain (on behalf of Canada) in 1918 and imposed certain obligations on the U.S. for the conservation of migratory birds, including the responsibilities to: conserve and manage migratory birds internationally; sustain healthy migratory bird populations for consumptive and non-consumptive uses; and restore depleted populations of migratory birds. Conventions with Mexico, Japan, and Russia occurred after the original convention with Great Britain and these gave MBTA protection to additional migratory bird species. The cormorant taxonomic family, *Phalacrocoracidae*, and 31 other families were added to the List of Migratory Birds (that is, those bird species protected by the MBTA) in 1972 as a result of an amendment to the 1936 "Convention between the United States of America and the United Mexican States for the Protection of Migratory Birds and Game Mammals."

ENDANGERED SPECIES ACT (16 U.S.C. 1531 *et seq*.)

Under the Endangered Species Act (ESA), all Federal agencies must conserve threatened and endangered species and use their authorities in furtherance of the purposes of the Act (Section 2(c)). In accordance with Section 7 of the Act, the USFWS Migratory Bird Program is preparing a Biological Evaluation and conducting informal consultation with the USFWS Endangered Species program to evaluate federally-listed species that may be affected by activities carried out under the depredation orders.

NATIONAL ENVIRONMENTAL POLICY ACT (42 U.S.C. 4321 *et seq*.)

The National Environmental Policy Act (NEPA) is our national charter for protection of the environment. It requires Federal agencies to evaluate the potential environmental impacts when planning a major Federal action and ensures that environmental information is available to public officials and citizens before decisions are made and actions are taken. NEPA neither requires a particular outcome, nor that the "environmentally-best" alternative is selected. It mandates a process for thoroughly considering what an action may do to the human environment and how any adverse impacts can be mitigated. This EA was prepared in compliance with NEPA.

COMPLIANCE WITH OTHER FEDERAL LAWS AND REGULATIONS

Environmental Justice and Executive Order 12898. Executive Order 12898, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," promotes the fair treatment of people of all races, income levels and cultures with respect to the development, implementation and enforcement of environmental laws, regulations, and policies. Environmental justice is the pursuit of equal justice and protection under the law for all environmental statutes and regulations without discrimination based on race, ethnicity, or socioeconomic status. This EA and the 2003 FEIS address environmental justice.

AFFECTED ENVIRONMENT

The purpose of this section is to establish a baseline for analysis of the alternatives. We incorporate by reference the material contained in Chapter 3 of the FEIS. This EA excludes information pertinent to Pacific Coast and Alaska DCCO populations because it concerns only the 24 States to which the depredation orders apply. In addition to the information in the FEIS, we provide updates where applicable.

DOUBLE-CRESTED CORMORANT POPULATIONS

Although the Service has authorized increased levels of lethal take of DCCOs in recent years, the goal is not to dramatically reduce DCCO populations on a regional or continental scale but rather to manage DCCOs on a limited, localized basis to reduce or prevent resource damages. By reference, we incorporate here the information found in pages 22-31 of the FEIS concerning the basic biology and ecology of DCCOs. More information on the natural history of DCCOs can also be found at *http://www.fws.gov/migratorybirds/CurrentBirdIssues/ Management/cormorant/cormorant.html*.

As noted in the FEIS, the North American DCCO population was estimated to be approximately two million birds (including breeding and non-breeding birds). Wetlands International (2006) estimated the continental population at between 1,080,800 and 2,163,600 birds of four recognized subspecies (Table 1).

Table 1. Population estimate of Double-crested Cormorant in North America by subspecies (Wetlands International 2006).

Breeding Range	Subspecies	Minimum Estimate	Maximum Estimate
Northeast and Central North America	*P. a. auritus*	943,000	1,890,000
Southern US	*P. a. floridanus*	37,000	73,000
Pacific Coast	*P. a. albociliatus*	90,000	179,000
Alaska	*P. a. cincinatus*	10,800	21,600
	Totals	1,080,800	2,163,600

For this discussion, DCCO populations are divided into four groups: Interior (*P. a. auritus*), Atlantic (*P. a. auritus*), Southern (*P. a. floridanus*), and Pacific Coast-Alaska (as stated above, the latter is excluded from this analysis). Approximately 70% of DCCOs occur in the Interior population (Tyson *et al.* 1999), which includes Great Lakes DCCOs, and it is this population that is most intensively managed.

Analysis of impacts of management activities can occur at several different scales: continental, Atlantic/Interior/Southern population, regional (such as the Great Lakes), metapopulation (such as Lake Champlain-St. Lawrence River-Lac St. Pierre), or local (such as the Les Cheneaux Islands). Under the PRDO, managers work at the local scale. In this EA, we analyze the cumulative impacts of local management on regional populations wherever possible.

Because DCCO populations have been well-studied in the Great Lakes and the bulk of public resource conflicts with DCCOs occur there, the Great Lakes population is an important population on which to focus. The Great Lakes region consists of all five Great Lakes and their connecting channels, and the St. Lawrence River. American and Canadian wildlife officials conducted a Great Lakes-wide DCCO survey in 1997, 2005, 2007, and 2009. Only the US side of the Great Lakes was counted in 2011, and did not include a complete survey of Lake Superior (Table 2).

Table 2. Number of nests (breeding pairs) during Great Lakes-wide surveys from 1997 to 2011.

Location	**Year**				
	1997	2005	2007	2009	2011
US Great Lakes	49,328	53,802	52,626	49,855	45,626
Canada Great Lakes	36,497	60,705	57,791	58,737	Not surveyed
Totals	85,825	114,507	110,417	108,592	

Great Lakes-wide, the number of nesting DCCOs declined 5.2 percent from 2005 to 2009, from 114,507 breeding pairs in 2005 to 108,592 pairs in 2009. The population declined 3.2 percent on the Canadian side from 2005 to 2009, and 7.3 percent on the US side. More DCCO damage management takes place on the US side. The number of breeding DCCO pairs on the US side apparently decreased an additional 6.5 percent from 2009 to 2011. However, the survey that year was not complete.

Most DCCOs generally do not begin to breed until they are 3 years old (FEIS Section 3.2.1). Consequently the DCCO population contains a number of non-breeding individuals. The total DCCO population (breeders and non-breeders) for the Great Lakes region can be estimated at 325,776 birds (3 times the 108,592 nests, conservatively calculated by multiplying each nest by two adults and one young; see FEIS Section 3.2.1). Table 3 provides an overview of DCCO populations in each State covered by the PRDO and AQDO.

Many DCCOs (from the Interior and Atlantic populations) winter in the southeastern U.S. USDA APHIS WS and the USDA APHIS National Wildlife Research Center (NWRC), conducted an annual mid-winter roost survey in Mississippi and Alabama from 1990 to 2013 (Figure 1). Numbers of DCCOs declined 46% in both Mississippi and Alabama from the peak count in 2004.

The Southeast U.S. Waterbird Conservation Plan notes the following about DCCOs in that region (Hunter *et al.* [2006], Figure 2).

> *[DCCOs] have undergone dramatic increases in the last 20 years coming into major economic conflicts with aquaculture and possibly other resources, mostly during the winter months. This is especially an issue at aquaculture facilities in Alabama and Arkansas, where it has been suggested that populations be reduced to 1980s levels. However, most Southeast U.S. breeding colonies are in locations and numbers of pairs that do not yet exceed our best understanding of pre-1900 populations (except potentially in the Mississippi Alluvial Valley). Perhaps existing breeding population levels should be maintained, even if efforts are to be undertaken to reduce overall wintering populations in the Southeast U.S. (especially in the Lower Mississippi Flyway States). In Mississippi, [DCCOs] have been increasing to the point that populations at some colonies are likely greater than the pre-1900 levels.*

Figure 3 shows the annual movements of 119 DCCOs, and demonstrates the connectivity between DCCO breeding, migrating, and wintering grounds. There is a tendency for birds breeding in the eastern Great Lakes to use the Atlantic Flyway, and those breeding in the western Great Lakes to use the Mississippi Flyway.

FISH

We incorporate here, by reference, pages 31 through 35 of the FEIS, which discuss relationships between DCCOs and fish. The DCCO is a generalist, fish-eating bird, though occasionally other aquatic species are found in its diet. Over 250 species of fish have been reported in the DCCO diet, but the species of greatest concern for negative impacts caused by DCCO predation are sport fish such as Walleye (*Sander vitreus*), Yellow Perch (*Perca flavescens*), Smallmouth Bass (*Micropterus dolomieu*), and salmonid species.

There have been several changes to the fish communities within the range of DCCOs since publication of the FEIS. In the Great Lakes, the Alewife (Alosa pseudoharengus) population declined drastically in the mid-2000s, especially in Lake Huron. At about the same time, the Round Goby (Apollonia melanostoma) became established in the Great Lakes and replaced the Alewife as the most prevalent invasive exotic fish in the Great Lakes. Consequently, the Round Goby has become prevalent in the DCCO diet (Johnson *et al.* 2010). The Alewife was discovered in Lake Champlain (WS VT 2008), and the population expanded rapidly. The Alewife is one of the highest calorie fish in the diet of DCCOs, but round gobies are much less so (Johnson *et al.* 2010).

Table 3. Number of breeding pairs of Double-crested Cormorants in the 24 States included in the depredation orders. Estimates are based upon information in the Flyway management plans (Atlantic & Mississippi Flyway Council 2010 and Central Flyway Council 2011), unless otherwise noted.

State	Statewide Population of Breeding Pairs
Alabama	Not in Flyway Plan 486 (Lemmons 2007)
Arkansas	150
Florida	8,000
Georgia	Not in Flyway Plan At least 7 colonies discovered since 1990 (Wires *et al.* 2001)
Illinois	Not in Flyway Plan At least 754 at 6 colonies, as of 1997 (Wires *et al.* 2001)
Indiana	1,800
Iowa	1,100-1,600
Kansas	Not in Flyway Plan Confirmed breeding at 3 sites; numbers small (Wires *et al.* 2001)
Kentucky	800
Louisiana	150
Michigan	25,000-30,000
Minnesota	15,400 (Wires *et al*. 2011)
Mississippi	200-500
Missouri	300-500
New York	10,500
North Carolina	250
Ohio	3,500
Oklahoma	50-100
South Carolina	200
Tennessee	500
Texas	Not in Flyway Plan 4 confirmed colonies in east Texas; overall breeding numbers are unclear (Benson and Arnold 2001; Wires *et al.* 2001); Lemmons (2007) reported a colony of 60 nests
Vermont	Not in Flyway Plan 4,200 (WS 2007a)
West Virginia	0
Wisconsin	9,300 (2013 survey; WS Wisconsin, Unpublished data)

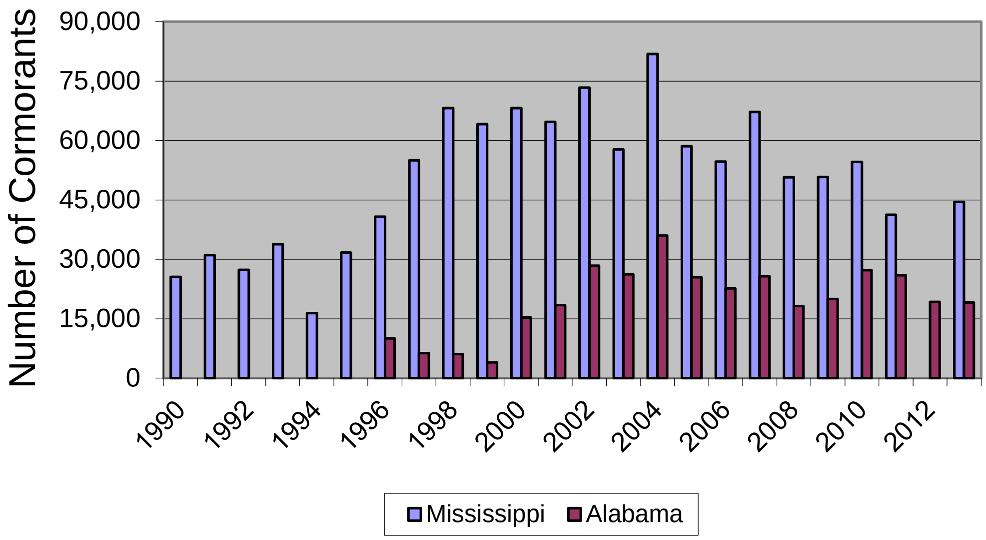

Figure 1. Numbers of DCCOs observed during an annual mid-winter roost survey in Mississippi and Alabama. Surveys on the Mississippi Delta were ground counts. Surveys in eastern Mississippi and Alabama were done from the air. No surveys were done in Mississippi in 2012. Unpublished data from USDA APHIS National Wildlife Research Center.

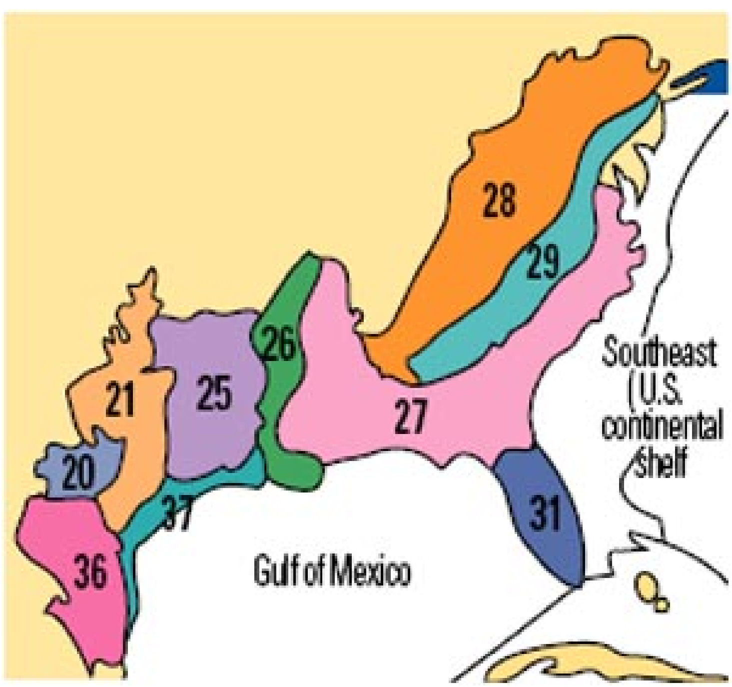

Figure 2. Area co covered by the Southeast U.S. Waterbird Conservation Plan. Bird Conservation Regions (U.S. NABCI Committee 2000) are numbered.

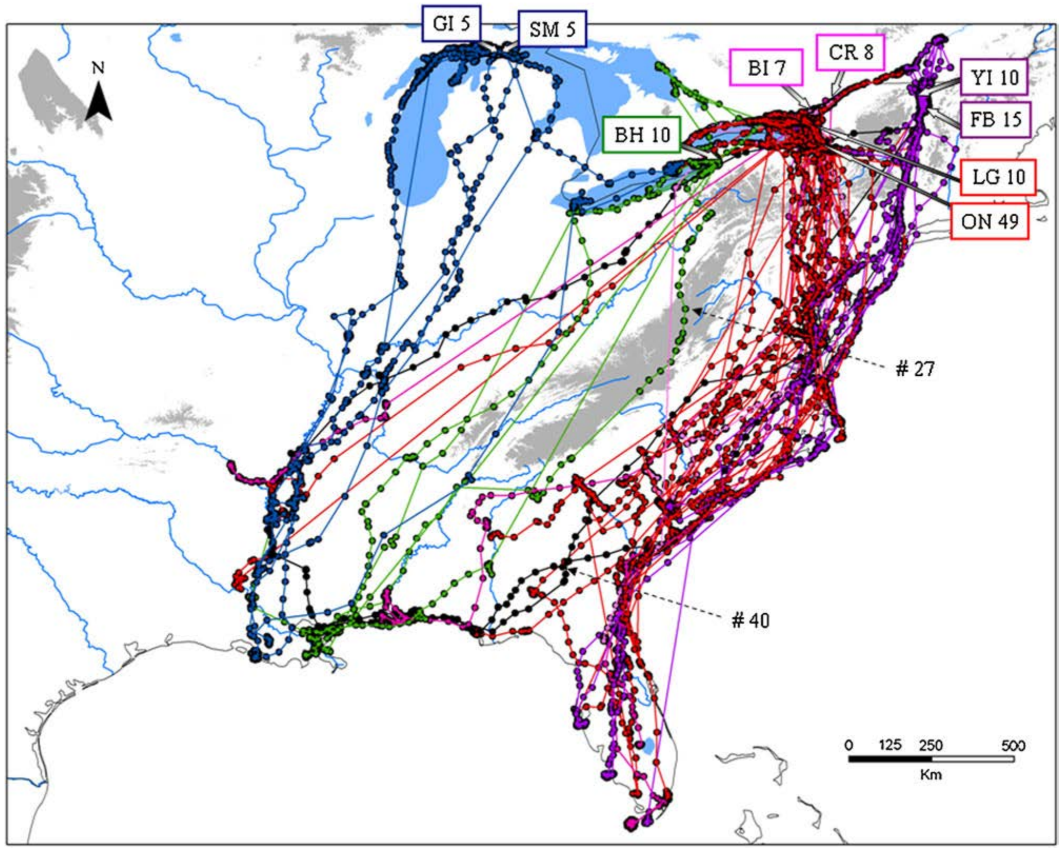

Figure 3. GPS telemetry tracks of 119 double-crested cormorants fitted with GPS transmitters in 2004–2007. Colonies were (number refers to sample size): Four Brothers (FB) and Young Island (YI) in Lake Champlain (purple, except # 40 from FB in black); Crossover (CR) and Blanket Island (BI) on the St. Lawrence River (pink); Oneida Lake (ON) and Little Galloo (LG) in Lake Ontario (red); North Breakwater at Buffalo Harbor (BH) in Lake Erie (green); St. Martin Shoal (SM) in Lake Huron and Green Island (GI) in Lake Michigan (blue). Bird # 40 (Black) is an example of loop migration, with 2 fall migrations using the Atlantic Flyway and 1 spring migration along the Mississippi Flyway. *From Guillaumet et al. 2011. Determinants of local and migratory movements of Great Lakes Double-crested Cormorants. Behavioral Ecology 22:1096-1103. Used with permission of Oxford University Press.*

Finally, there have been several changes in the aquaculture industry, especially in Mississippi and Arkansas, the two primary states that implement the AQDO (Figure 4, Appendix 1). For a variety of reasons discussed in the Economic Environment section, there have been gradual changes in the composition of the aquaculture industry, away from catfish (*Ictluridae*) and toward other species. The number of water acres in Arkansas decreased 78 percent from a peak production of 38,000 acres (15,378 ha) in 2002 to 8,200 acres (3,318 ha) in 2013, and the number of water acres in Mississippi decreased 57 percent from a peak production of 112,700 (45,608 ha) in 2001 to 48,600 (19,968 ha) in 2013, and in Alabama the number of water acres in catfish production decreased from 25,900 (10,481 ha) in 2002 to 18,200 (7,365 ha)in 2013. The net result is that there are fewer fish available to DCCOs. The change in the number of DCCOs counted at roosts in Alabama and Mississippi closely follows the change in pond acres in aquaculture production. King *et al.* (2010) documented that changes in southeastern aquaculture industry have influenced DCCO movements and migration patterns.

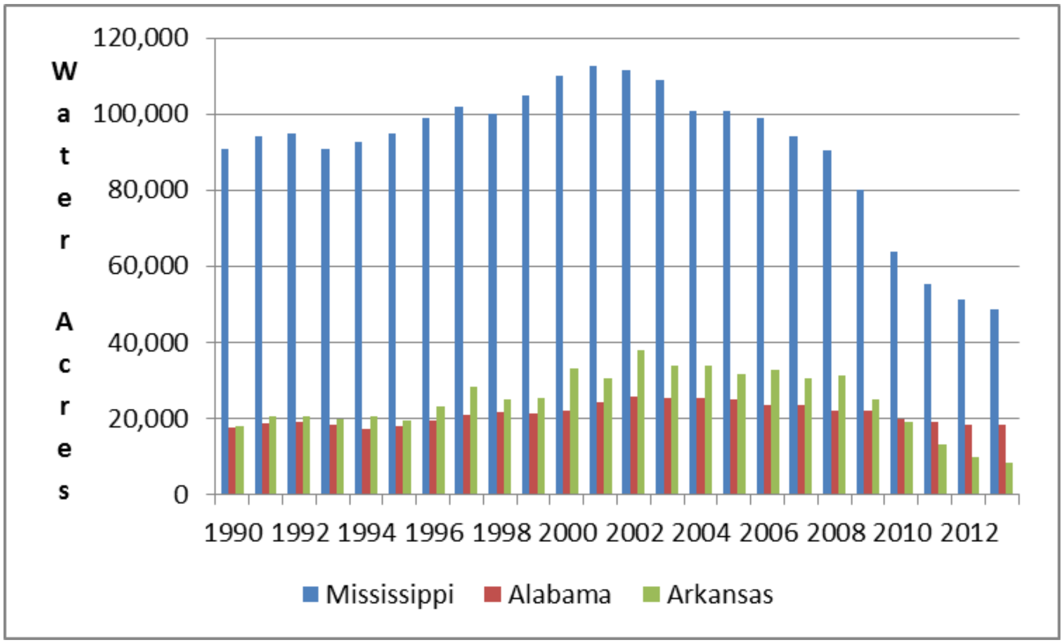

Figure 4. Water surface acres in catfish production from 1990 to 2013 in Mississippi, Alabama, and Arkansas. Data from USDA National Agricultural Statistics Service. http://www.nass.usda.gov/Surveys/ Guide_to_NASS_Surveys/Catfish_Production/ index.asp.

The wide range of biotic and abiotic factors that impact fish populations and the complexity and challenges in studying aquatic systems make it difficult to demonstrate a cause and effect relationship between DCCOs and fish. For example, in the Great Lakes, ecosystem-level changes in invasive species populations such as zebra mussels (*Dreissena polymorpha*), alewife, and round goby result in a highly dynamic system. Quantifying the impacts of any one factor on the system can be an expensive, labor intensive and lengthy process (Ridgeway *et al.* 2006a, b; Diana 2010; Fielder 2008, 2010a, b). For some fish species, annual recruitment may be highly variable. The variability makes it difficult to detect trends in fish populations and responses to management actions. Additionally, foraging by DCCOs may be a least partially compensatory to other forms of mortality (*i.e.*, fish might have died from other causes if they hadn't been taken by DCCOs). This makes it difficult to distinguish between real and perceived impacts.

Studies documenting the interaction between DCCOs and fish populations are few and typically data intensive (either temporally or geographically); the results of which are not easily transferable to other geographic areas. Some studies are inconclusive, whereas in other areas no attempt is made to quantify impacts. However, recent and ongoing research continues to provide insight into DCCO and fish interactions including yearly, seasonal and local (within lake) variations in DCCO diets in response to changes in availability of fish species (Johnson *et al.* 2010*b*; Duerr 2012, DeBruyne *et al.* 2012, 2013; Van Guilder and Seefelt 2013).

Some of the earliest work documenting impacts of DCCOs on fish populations was conducted at Oneida Lake, in central New York. Analysis of a 40 year data set suggested that DCCO predation increased subadult mortality of yellow perch and walleye, and was a significant factor contributing to the decline in percid populations in the lake (Rudstam *et al*. 2004). Ongoing studies at Oneida Lake (DeBruyne *et al.* 2013) have documented shifts in prey consumption with shifts in fish populations over time (seasonal and across years). Study findings indicated that DCCO consumption of gizzard shad (*Dorosoma cepedianum*) and emerald shiner (*Notropis atherinoides*) was positively related to species abundance as would be expected of an opportunistic forager, but consumption of walleye, yellow perch and white perch (*Morone americana*) did not. The observed pattern may indicate prey switching by DCCO to a preferred species when abundant.

Researchers with the Ontario Ministry of Natural Resources conducted an intensive study of nearshore fish populations and DCCO populations in Georgian Bay and North Channel of Lake Huron from 2000-2005 (Ridgway *et al*. 2006*a, b*). Data from these studies indicated there were negative relationships between nearshore fish abundance and fish consumption by nesting DCCOs. In some study areas and years, particularly in Georgian Bay, estimates of annual fish consumption by DCCOs greatly exceeded annual nearshore fish production, and DCCOs were associated with “significantly altered and redistributed nearshore fish resources and [had] broad-scale impacts on prey-fish abundance” (Casselman and Marcogliese 2006).

More recently, in the Les Cheneaux Islands on Lake Huron in Michigan, Fielder (2008, 2010a) studied the impact of DCCOs on Yellow Perch populations. They documented a relationship between DCCOs and Yellow Perch growth rate, mean age, recruitment, and overall survival (resulting in increased abundance, increased angler catch rate, and increased harvest). Although the causative nature of this relationship has been questioned (Diana 2010, Fielder 2010b), we have reviewed the relevant material and determined that the limitations of the study do not compromise the utility of the work (WS Michigan 2011, USFWS 2011).

On Leech Lake in Minnesota, catch rates of walleye and yellow perch declined as the number of DCCOs breeding on the lake increased. The strength of each walleye year class also declined.

The situation is less clear in other areas. For instance, in the Beaver Archipelago of Lake Michigan, early studies documented a relationship between DCCO abundance and small mouth bass mortality rates for ages 3-5 (Seider 2003). However, other studies found no such relationship (Kaemingk 2008, Seefelt 2005).

In lower Green Bay, Wisconsin, early review of data demonstrated that the amount of yellow perch in DCCO diets increased in response to a strong 2003 perch year class (Meadows 2007). However in the absence of data on the total amount of fish biomass, the actual impact of DCCO foraging on the overall fishery in Lower Green Bay was unclear. Preliminary review and modeling indicated that although DCCO foraging did not appear to be jeopardizing the perch population, it was possible that DCCO foraging reduced the magnitude of increase in the yellow perch population that resulted from the 2003 year class (USDA WS 2009). For most years since 2003, there have been good perch year classes in lower Green Bay. However, these year classes do not appear to be surviving to harvest age at the rate that would be expected (T. Paoli, WDNR, personal communication.). A recent model by Bacheler *et al.* (2011) indicated that DCCO abundance was negatively related to yellow perch catch per unit effort (CPUE), with declines being especially obvious near DCCO nesting islands in far northern and southern Green Bay. Perch CPUE also varied depending on water quality (clarity and dissolved oxygen), and perch densities (for Age-0 perch). However, the authors note that their information is based on correlations and is not necessarily causative in nature. A number of other factors could influence the correlations in their study including availability of alternative prey for predators (DCCO and other fish), changes in populations of other predators such as walleye, and competitors such as alewife and round goby.

WILDLIFE AND THEIR HABITATS (Co-nesting Birds)

We incorporate here, by reference, the information in pages 35-38 of the FEIS concerning avian associates of DCCOs. As noted, DCCOs nest with several other bird species, including American White Pelican (*Pelecanus erythrorhynchos*), Great Blue Heron (*Ardea herodias*), Great Egret (*Casmerodius albus*), Black-crowned Night-Heron (*Nycticorax nycticorax*), and several species of gulls and terns. The ability of DCCOs to have negative impacts on co-nesters, through habitat destruction, nest take-over, or reduction of available nesting space, is of particular concern in areas where an affected species is declining or where local management goals exist for that species. See Appendix 2 for more on the population status of species that nest in association with DCCOs.

The species that come into conflict with DCCOs most often in the Great Lakes region are the Great Blue Heron, Great Egret, and Black-crowned Night-heron (which are tree-nesting species). In the Upper Mississippi Valley/Great Lakes Waterbird Conservation Plan (Wires *et al.* 2010), the conservation concern status is listed as “Moderate” for American White Pelicans in BCR 12 and 23 (See Figure 5 for a map of the BCRs), Moderate for Snowy Egrets in BCR 23, Moderate for Black-crowned Night-Herons in BCR 12, 13, and 23; and “High” for Common Terns (*Sterna hirundo*) in BCRs 12, 13, and 23). All other species were ranked as either low or not currently at risk.

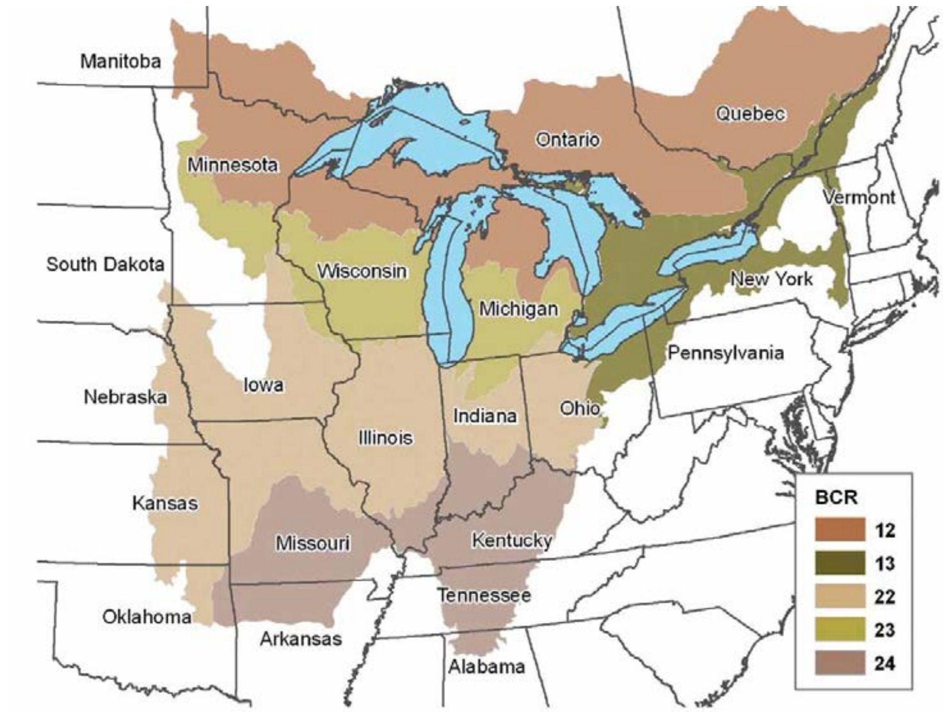

Figure 5. Area covered by the Upper Mississippi Valley / Great Lakes Waterbird Conservation Plan. Bird Conservation Regions (U.S. NABCI Committee 2000) include Boreal Hardwood Transition (BCR 12), Lower Great Lakes/St. Lawrence Plain (BCR 13), Eastern Tallgrass Prairie (BCR 22), Prairie Hardwood Transition (BCR 23), and the Central Hardwoods (BCR 24).

Researchers collected data on Black-crowned Night-heron and DCCO interactions at four locations in the Canadian Great Lakes and found that where the two species nested close to one another, heron nests were taken over or destroyed by DCCOs in some cases. They also found evidence that DCCOs displaced herons from preferred nesting sites within trees and noted, in summary, that "negative impacts of co-nesting with DCCOs. . . may explain recent declines in the number of heron colonies in the Great Lakes" (C. Weseloh and D. Moore, CWS, unpublished data).

Conflicts with nesting DCCO are not limited to tree-nesting species. On Leech Lake in Minnesota, DCCOs displaced Ring-billed Gulls, which in turn competed with Common Terns for nest space (Mortensen and Ringle 2007). On Oneida Lake, ground nesting DCCOs Herring, and Ring-billed gulls often displace Common Terns from nesting areas (Mattison 2006).

Although Herring Gulls are not a species of conservation concern in the Great Lakes, Somers *et al.* (2007) observed that at a mixed colony in western Lake Ontario, Canada, DCCOs competed directly with Herring Gulls (*Larus argentatus*) for nest sites and materials, and contributed to reduced Herring Gull reproductive success.

In the Great Lakes, DCCO management has been conducted at West Sister Island in Lake Erie (part of the Ottawa National Wildlife Refuge) since 2006 to prevent further destruction of habitat for a regionally-significant wading bird colony that includes Great Blue Herons, Great Egrets, Snowy Egrets, and Black-crowned Night-Herons. Management efforts were initiated because of concerns that increasing numbers of DCCOs on West Sister Island were decreasing the area within which Great Blue Herons can nest, shifting the distribution of Great Egrets, and increasing nest competition with BCNH (Ohio Division of Wildlife *et al.* 2012).

In the southeastern U.S., DCCO management occurs at a Mississippi River oxbow lake containing mature cypress and ash woodlands in the Yazoo National Wildlife Refuge in Mississippi. Refuge biologists are concerned about habitat destruction caused by DCCOs negatively affecting wading birds such as Great Blue Herons, Great Egrets, and Snowy Egrets (*Egretta thula*). Lemmons (2007) reported that all known DCCO colonies in Alabama, Arkansas, and Mississippi contained other species. Anhingas (*Anhinga anhinga*) and Great Blue Herons (*Ardea herodias*) were the species most often associated with DCCOs. Black-crowned Night-herons (*Nycticorax nycticorax*), Cattle Egrets (*Bubulcus ibis*), Great Egrets (*Ardea alba*), Snowy Egrets (*Egretta thula*), and Little Blue Herons (*Egretta caerulea*) also were present. The most diverse rookeries were those in Mississippi (Lemmons 2007).

Neotropic Cormorants (*Phalacrocorax brasilianus*) have expanded their range in the US recently (Arterburn and Shepperd 2009), bringing that species in closer proximity to areas where DCCOs are controlled, such as the Mississippi Delta (Hanson *et al.* 2010). There have been several instances of Neotropic Cormorant taken during DCCO control activities in Mississippi.

PLANTS AND THEIR HABITATS (Vegetation)

By reference, we incorporate here the information on page 38 of the FEIS. The effects of DCCOs on vegetation are direct and relatively easy to document. Through physical and chemical means, DCCOs damage, and often kill, shrubs and trees where they nest and roost. Concerns surrounding such damage have to do with aesthetics, soil stability, or biodiversity (with regard to the plant community itself or, secondarily, with regard to habitat for other bird species).

Hebert *et al.* (2005) assessed the relationship between forest health and nesting DCCO distribution and found that forest cover was lower in areas with high numbers of breeding cormorants, and concluded that, "Cormorants appear to pose a threat to unique Lake Erie island plant communities." DCCO management to protect vegetation has occurred at both U.S. and Canadian sites over the past several years.

In the Great Lakes, DCCO management has been conducted at Green Island in Lake Erie since 2006 to prevent further destruction of habitat for six State-listed plant species. The State-threatened rock elm (*Ulmus thomasii*) seems particularly sensitive to the damage caused by increasing numbers of DCCOs (Ohio Division of Wildlife *et al*. 2012).

One of the few locations with long-term vegetation monitoring is at Presqu'ile Provincial Park on Lake Ontario. Here the Ontario Ministry of Natural Resources monitored DCCOs, co-nesting species, and vegetation from 2002 to 2010. DCCO management was conducted from 2003-2007, but the remaining live trees succumbed rapidly to the effects of DCCO nesting. McGrath and Murphy (2012) found subtle changes in the herbaceous diversity and seed bank composition across islands in Lake Erie affected by DCCOs. Boutin *et al.* (2011) reported similar findings: the plant community on Middle Island in Lake Erie had been greatly modified by DCCOs. Vegetation species richness had been reduced by DCCOs, including both the tree canopy and the understory. However, they appeared to have had little influence on seedbank richness, abundance, and composition.

THREATENED AND ENDANGERED SPECIES

In the 2003 FEIS, USFWS concluded that DCCO management activities under the PRDO and AQDO had the potential to affect four species listed under the ESA: Bald Eagle (*Haliaeetus leucocephalus*), interior Least Tern (*Sterna antillarum*), Wood Stork (*Mycteria americana*), and Piping Plover (*Charadrius melodus*). As a result, we completed an intra-Service biological evaluation and informal Section 7 consultation. The following conservation measures were incorporated into the depredation orders to help agencies avoid any take of ESA-protected species.

> *All control activities [under the Aquaculture Depredation Order] are allowed if the activities occur more than 1500 feet from active wood stork nesting colonies, more than 1000 feet from active wood stork roost sites, and more than 750 feet from feeding wood storks, and if they occur more than 750 feet from active bald eagle nests.*
>
> *At their discretion, landowners, operators, and tenants may contact the Regional Migratory Bird Permit Office to request modification of the above measures. Such modification can occur only if, on the basis of coordination between the Regional Migratory Bird Permit Office and the Endangered Species Field Office, it is determined that wood storks and bald eagles will not be adversely affected. If adverse effects are anticipated from the control activities, either during the intra-Service coordination discussions described above or at any other time, the Regional Migratory Bird Permit Office will initiate consultation with the Endangered Species Field Offices.*
>
> *[Under the Public Resource Depredation Order,]:*
>
> *(i) discharge/use of firearms to kill or harass double-crested cormorants or use of other harassment methods are allowed if the control activities occur more than 1000 feet from active piping plover or interior least tern nests or colonies; occur more than 1500 feet from active wood stork nesting colonies, more than 1000 feet from active wood stork roost sites, and more than 750 feet from feeding wood storks; or occur more than 750 feet from active bald eagle nests;*
>
> *(ii) other control activities such as egg oiling, cervical dislocation, CO_2 asphyxiation, egg destruction, or nest destruction are allowed if these activities occur more than 500 feet from active piping plover or interior least tern nests or colonies; occur more than 1500 feet from active wood stork nesting colonies, more than 1000 feet from active wood stork roost sites, and more than 750 feet from feeding wood storks; or occur more than 750 feet from active bald eagle nests; and*

(iii) to ensure adequate protection of piping plovers, any Agency or their agents who plan to implement control activities that may affect areas designated as piping plover critical habitat in the Great Lakes Region are to make contact with the appropriate Regional Migratory Bird Permit Office prior to implementing control activities. The Regional Migratory Bird Permit Office will then coordinate with the Endangered Species Field Office staff to determine if the above measures are adequate.

At their discretion, agencies or their agents may contact the Regional Migratory Bird Permit Office to request modification of the above measures. Such modification can occur only if, on the basis of coordination between the Regional Migratory Bird Permit Office and the Endangered Species Field Office, it is determined that no adverse effects to any of the four listed species will occur. If adverse effects are anticipated from the control activities, either during the intra-Service coordination discussions described above or at any other time, the Regional Migratory Bird Permit Office will initiate consultation with the Endangered Species Field Offices.

In June 2007, the Bald Eagle was delisted from the protection of the ESA. Therefore the distance requirements for Bald Eagles noted above no longer apply. The species is still protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act, and USFWS encourages agencies and individuals conducting DCCO depredation management in the vicinity of bald eagle nests, roosts, or foraging areas to follow the recommendations found in the National Bald Eagle Management Guidelines to reduce any potential liability for take or harassment of bald eagles. This document is available at: *http://www.fws.gov/migratorybirds/CurrentBirdIssues/Management/ BaldEagle/ NationalBaldEagleManagementGuidelines.pdf*.

EXISTENCE AND AESTHETIC VALUES

By reference, we incorporate the material from pages 46 to 47 and 96-98 of the FEIS. Existence value is the value a person associates with the knowledge that a resource (such as the DCCO, fish, and co-nesting species) exists, even if that person has no plans to directly use that resource. Individuals may hold this value for a number of reasons: 1) they wish to preserve the resource for future generations; 2) they wish to hold open the option to use the resource in some way in the future although they have no immediate plans to do so; or 3) they may simply feel that preservation of a resource is the right thing to do, and therefore attach a value to it (USFWS 2003). Existence value is independent of the size of the wildlife population (Conover 2002).

Aesthetic value refers to our sense of beauty and is, by nature, subjective and difficult to quantify. Because humans appreciate and are inspired by the beauty of wildlife, it has aesthetic value (Decker *et al*. 2001). An individual's perception of the beauty of a given animal can be affected by the extent to which members of that species have negatively impacted something of value to the individual. However, individual perceptions of beauty and aesthetic value vary. For example, a large DCCO breeding colony may be a thing of beauty and a wonder of nature to one person, but may also be perceived as aesthetic detriment by another because of noise, smell or, in some cases the loss of vegetation that may have been associated with high numbers of nesting DCCOs.

ECONOMIC ENVIRONMENT

Economic analysis in this EA will focus on recreational fishing and aquaculture. In 2011, over 33 million anglers 16 years and older in the U.S. (13% of the American population) engaged in fishing, and spent almost $42 billion doing so. In the Great Lakes, 1.7 million anglers fished during 2011 (USDI 2012). This figure represents a 32% decline from 2.5 million anglers in 1991, but a 21% increase from the 1.4 million anglers in 2006.

An ongoing concern is the effect of cormorants on local businesses that gain significant economic benefits from recreational fishing. If DCCO predation depresses a fishery and it results in lower angler activity, negative economic consequences are likely to result for businesses dependent on fishing-related revenue.

To evaluate the economic impact of DCCOs and DCCO management on local economies, the USDA APHIS NWRC conducted a study in central New York evaluating the impact that DCCOs and DCCO management had on the local economy (Shwiff *et al.* 2009). They asserted that from 1990 to 2005, the total estimated revenue lost in the Oneida Lake region averaged between $6.7 million and $33.3 million annually, and the number of jobs lost averaged between 200 and 800 annually. They estimated that, from 1998 to 2005, for every dollar spent on the cormorant management program, $13.58 to $48.37 in benefits were realized, and saved between 1,500 and 5,000 jobs.

In the Les Cheneaux Islands of Lake Huron in Michigan, Yellow Perch experienced an unprecedented collapse in 2000. Though it is unlikely that the collapse was entirely due to DCCO predation, the economic loss of this collapse was valued at 5 million dollars per year. In contrast, it was estimated that DCCO control cost $31,000 per year from 2004 to 2008 (Fielder 2010).

Dorr *et al.* (2004) used VHF telemetry to document cormorant movements between night roosts and aquaculture producing areas in eastern Mississippi and western Alabama. They found that 64% of the 25 cormorants they marked had daytime locations within the primary aquaculture producing areas and 55% of all day locations within that area were on catfish ponds. The authors recommended that roost harassment efforts be focused on specific roost sites and that some roost sites from which cormorants are less likely to cause damage to aquaculture should not be harassed.

Particularly in the winter months, DCCOs can cause extensive depredation at fish farms (primarily catfish) in the southeastern U.S. The economic issues associated with DCCO depredation at fish farms are presented on pages 40-42 in the FEIS. Catfish growers in the United States had sales of $341 million dollars in 2012 (USDA-NASS 2013), compared to $488 million in 1999 (USDA-NASS 2000). Mississippi, Alabama, Arkansas, and Texas accounted for 95 percent of those sales, with Mississippi alone accounting for 51 percent (USDA-NASS 2013). The number of acres in catfish production as of 1 January 2013 was 83,000 (33,589 ha, USDA-NASS 2013), compared to 436,418 acres (176,612 ha) on 1 January 2000 (USDA-NASS 2000). However, the changes in production appear to have resulted from market factors more than from losses due to cormorant depredation. For example, see *http://msbusiness.com/blog/2013/02/22/ catfish-farming-future-fading-on-a-a-great-*

american-story/ and *http://usatoday30.usatoday.com/ news/nation/2010-10-20-catfish20_ST_N.htm*. Anecdotal observations from APHIS-WS indicate that changes in aquaculture may be leading to greater concentrations of DCCO in some remaining areas with aquaculture as incidence of damage at remaining facilities often appear to be more severe than has been previously observed (C. Godwin and T. Booth, personal communications).

Double-crested cormorants can have positive economic impacts. According to the 2011 national survey of fishing, hunting and wildlife associated recreation, 71.8 million Americans enjoyed watching and feeding birds and approximately 17.8 million Americans traveled to see birds in 2011 (USDI and USDC 2011). An estimated $55 billion is spent on birdwatching equipment and travel in the U.S. Viewing colonial waterbird colonies, including cormorants, and enjoying cormorants in other locations is included in this estimate, but no data are available on the specific impact of DCCOs.

ISSUES NOT CONSIDERED IN DETAIL

We received several suggestions for new alternatives and modifications to alternatives analyzed in the FEIS in response to our requests for public and agency input published on 8 November 2011 (Federal Register 76:69225-69230). Due to resource limitations, we are unable to complete full analysis of these proposals prior to the expiration of the AQDO and PRDO. However, we anticipate a continuing need to manage DCCOs to protect aquaculture and public resources beyond the expiration dates of the PRDO and AQDO. This EA addresses the anticipated need to for DCCO damage management by extending the effective period of the existing depredation orders. Based on issues raised in comment letters, we recognize that the current system may not be ideal, but given its implementation over the last nine years, it does enable damage management actions which would not be possible if the orders were allowed to expire. Issues raised in public comments will be addressed in detail in a subsequent analysis.

Water Quality and Human Health

Though concerns about water quality around DCCO colonies and roosting sites exist, we are not aware of any studies since publication of the FEIS that have examined the relationship between DCCOs and water quality in the United States. It is widely known that high numbers of waterbirds concentrated in an area can be a source of nutrient and pathogenic pollution. For example, high numbers of resident Canada geese have been found to negatively affect water quality near beaches and in wetlands (USFWS 2005). However, since no formal studies of the effects of DCCO management on water quality and human health have been conducted, it is our opinion that we cannot meaningfully evaluate the effects of the depredation orders on this issue.

Fish Hatcheries and Environmental Justice

USFWS has a responsibility to conserve, restore, enhance, and manage America's fishery resources and aquatic ecosystems for the benefit of future generations. The National Fish Hatchery System (NFHS) was established in 1871. The NFHS has a unique responsibility in providing fish to benefit Tribes. From 2004 through 2012, at least 13 State and Federal hatcheries in the 24 States (specifically, in Arkansas, Georgia, Indiana, Iowa, Kentucky, Louisiana, Michigan, Ohio, and Wisconsin) took DCCOs to protect fish stock.

Executive Order 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations") requires Federal agencies to make environmental justice part of their mission, and to identify and address disproportionately high and adverse human health and environmental effects of Federal programs, policies and activities on minority and low-income persons or populations. If excessive DCCO predation at a NFH that raises fish for Tribes impacts the hatchery's ability to meet Tribal needs, an environmental justice concern could be raised. However, given the ability of State and Federal hatcheries in the 24 States to control depredating cormorants, this issue does not amount to "disproportionately high and adverse" effects on minority and low-income persons if the depredation orders remain in place.

Regardless of changes to the depredation order, management of DCCO depredation at fish hatcheries would still be possible. Depredation permits could be issued to a hatchery after it has attempted nonlethal depredation control methods.

Property Losses

Private property losses associated with DCCOs include impacts to fish in privately-owned lakes and ponds, damage to boats and marinas or other properties found near DCCO breeding or roosting sites, and damage to vegetation on privately-owned land. One measure of damage to property comes from the WS Management Information System (MIS) database which documents the number of requests for assistance received by WS officials to address wildlife damage (not including requests received by local, State or Federal agencies). WS data showed there was an annual average of 23 requests for assistance with property damage in the 24 PRDO States from 2009 through 2013. Damage to private property is addressed through the issuance of depredation permits by USFWS with technical input from WS. Because the depredation orders do not deal directly with property losses, we did not consider it in this analysis.

ALTERNATIVES

ALTERNATIVE A (No Action)

No change to regulation; allow depredation orders to expire.

Under this alternative, no revision to the regulations would occur and the AQDO and PRDO would expire on June 30, 2014, thus requiring that DCCO management activities be conducted under the authority of depredation permits. As implemented by the action agencies, migratory bird permits could be requested and issued for the reduction of DCCO impacts on sensitive species or their habitats (vegetation), but, with the exception of research projects, would generally not be requested or issued for birds taking free-swimming fish from public waters. Non-lethal activities such as inactive nest destruction and harassment could continue and would not require approval from USFWS. As noted in the description of this alternative, depredation permits are unlikely to be issued for management of some types of damage to public resources. Consequently, total impacts on DCCOs are likely to be lower than under Alternatives B and C.

ALTERNATIVE B (Five-year Extension) – Preferred Alternative

Amend regulation to extend expiration date of depredation orders, change the 21.48 reporting period to a calendar year, and change the guidance regarding bald eagles. Under this alternative, we would change the expiration dates found in 50 CFR 21.47(f) and in 50 CFR 21.48(f) from 30 June 2014 to 30 June 2019. Management activities such as culling and egg oiling that have been conducted under the depredation orders could therefore continue in the States to which the orders apply and new activities could be implemented, as deemed necessary. All management activities would need to comply with the terms and conditions stated in the depredation orders. We would delete management of bald eagles from the regulation because they should be managed under the national plan. The purpose for changing the reporting period and report date for the Public Resource Depredation Order (PRDO) would be to bring the reporting period in line with other regulations regarding Double-crested Cormorant management, in particular the Aquaculture Depredation Order (50 CFR 21.47) and various permits. This will facilitate data summaries by those operating under the PRDO and the Service. It will also allow more meaningful summaries and interpretations of take that are comparable across different authorities.

ALTERNATIVE C (No expiration)

Amend regulation to remove expiration date from depredation orders, change the 21.48 reporting period to a calendar year, and change the guidance regarding bald eagles. Under this alternative, we would eliminate the expiration dates found in 50 CFR 21.47(f) and in 50 CFR 21.48(f). Thus, management activities conducted under the depredation orders would continue until the depredation orders were revised or rescinded. All management activities would need to comply with the terms and conditions stated in the depredation orders. We would delete management of bald eagles from the regulation because they should be managed under the national plan. The purpose for changing the reporting period and report date for the Public Resource Depredation Order (PRDO) would be to bring the reporting period in line with other regulations regarding Double-crested Cormorant management, in particular the Aquaculture Depredation Order (50 CFR 21.47) and various permits. This will facilitate data summaries by those operating under the PRDO and the Service. It will also allow more meaningful summaries and interpretations of take that are comparable across different authorities.

ALTERNATIVES NOT CONSIDERED IN DETAIL

We received several suggestions for new alternatives and modifications to alternatives analyzed in the FEIS in response to our requests for public and agency input published on 8 November 2011 (Federal Register 76(216):69225-69230). Due to resource limitations, we are unable to complete full analysis of these proposals prior to the expiration of the AQDO and PRDO. However, we anticipate a continuing need to manage DCCOs to protect aquaculture and public resources beyond the expiration dates of the PRDO and AQDO. This EA evaluates an interim measure of addressing the anticipated need for DCCO damage management by extending the effective period of the existing depredation orders. Based on issues raised in comment letters, we recognize that the current system may not be ideal, but given its implementation over the last 9 years, it does enable damage management actions which would not be possible if the orders were allowed to expire. Issues raised in public comments will be addressed in detail in a subsequent analysis.

ENVIRONMENTAL IMPACTS

We analyzed the environmental consequences of each of the alternatives with respect to the issues identified in the Affected Environment section, and in comparison to the No Action alternative to determine if impacts would be greater, less, or the same.

ALTERNATIVE A (No Action)

No change to regulations; allow depredation orders to expire. Under this alternative, the depredation orders would expire on 30 June 2014 and any resource or property damages caused by DCCOs would be addressed via depredation permits thereafter. Because of different standards for issuance of depredation permits, it is highly likely that fewer agencies would conduct DCCO depredation management under this alternative. As noted in the description of Alternative A, depredation permits are unlikely to be issued for management of some types of damage to public resources. Consequently, because of different standards for issuance of depredation permits, it is highly likely that fewer agencies would conduct DCCO depredation management under this alternative. Impacts on DCCOs are likely to be lower than under Alternatives B and C. Review of state-level consequences for DCCO damage management if the depredation orders expire can be found in state environmental assessments on DCCO depredation management (USDA WS 2005, Ohio 2006, and Wisconsin 2009).

Impacts on DCCO Populations

Average annual take of DCCOs by depredation permits, the AQDO, and the PRDO, for all 24 States from 1999 through 2012 was 36,165 per year (Table 4). DCCOs taken under airport permits and scientific collecting permits are not included in this analysis, and respectively average 210 and 420 bird per year nationally. Over 85 percent of this take occurred in seven States: Arkansas, Mississippi, Michigan, Minnesota, Texas, Ohio, and New York. Take occurred on both breeding and wintering grounds and impacted, predominantly, the Interior DCCO population, and to a lesser extent, the Southern population.

Table 4. Number of DCCOs taken in 24 States covered by the depredation orders from 1999 through 2012.

Year	Depredation Permits	AQDO	PRDO	Totals
1999	1,932	20,016	n/a	21,948
2000	2,233	18,237	n/a	20,470
2001	2,867	17,829	n/a	20,696
2002	3,719	19,736	n/a	23,455
2003	6,650	22,292	n/a	28,942
2004	4,822	25,296	2,395	32,513
2005	4,745	21,513	11,221	37,479
2006	3,435	32,057	21,043	56,535
2007	3,980	17,393	20,256	41,629
2008	5,102	17,561	18,889	41,552
2009	4,659	16,338	25,612	46,609
2010	6,883	14,632	18,637	40,152
2011	6,542	12,980	28,704	48,226
2012	5,583	14,216	26,313	46,112
Totals	63,152	270,096	173,070	506,318
1999-2012 Mean	4,510.9	19,292.6	n/a	36,165.6
2004-2012 Mean	5,083.4	19,109.6	19,230.0	43,423.0

An estimate of the number of DCCOs that would be killed under depredation permits and the depredation orders was provided in the 2003 FEIS (USFWS 2003). The estimate was that as many as 60,275 DCCOs would be killed under a combination of depredation permits and the modified Aquaculture Depredation Order, and an additional 99,360 DCCOs killed under the Public Resource Depredation Order, for a total estimate of 159,635 killed. Since that time, the actual number killed has been approximately 27 percent of that amount, or a mean of 43,423 per year (Figure 6).

For reasons noted earlier, our analysis will focus on the Great Lakes DCCO population. In this DEA, we use a figure of 325,776 (108,592, which is the number of nests counted in the Great Lakes in 2009, multiplied by 3 to account for breeding and non-breeding individuals) for the total Great Lakes regional DCCO population.

DCCO take can be put into perspective by calculating the percentage of the total regional population removed by management activities. The total take at breeding colonies from 2004 through 2009 under the PRDO in the Great Lakes (including Canada) was 65,218 birds, which amounts to a mean annual take of 10,870 DCCOs or 3.3% of the total Great Lakes population in 2009. The highest level of take in the Great Lakes during that time was in 2009 (13,780), or approximately 4.4% of the Great Lakes population (Table 5).

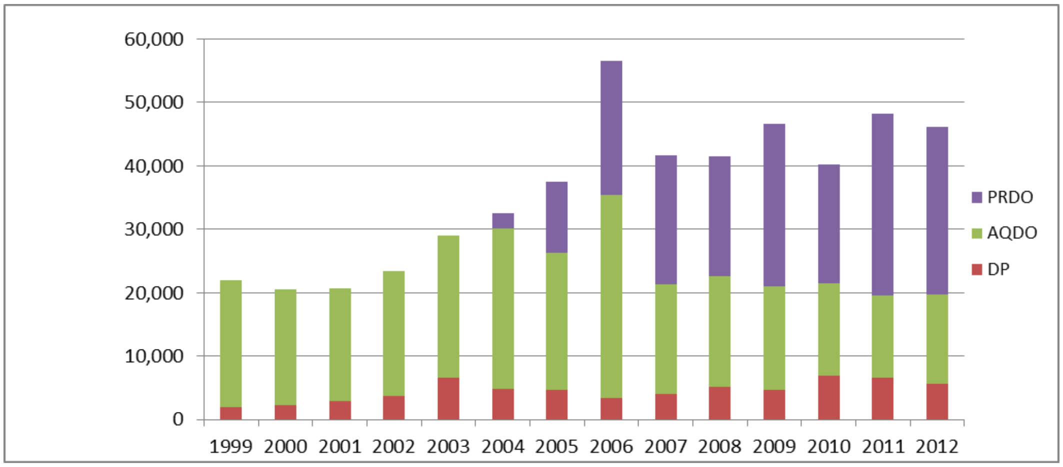

Figure 6. Number of Double-crested Cormorants killed under depredation permits (DP), the Aquaculture Depredation Order (AQDO), and the Public Resource Depredation Order (PRDO) from 1999 through 2012.

Table 5. Population estimate, number of DCCOs culled at breeding colonies, and percentage of the population culled in the Great Lakes in 2009, not including connecting waterways.

Lake	**Lakewide population estimate***	**Number of cormorants killed in 2009**	**% of population culled**
Superior	10,500	43	.04%
Michigan	107,094	6,032	5.6
Huron	76,698	2,948	3.8
Erie	44,595	3,957	8.9
Ontario	72,930	800	1.1
Totals	311,817	13,780	4.4

* Derived from nest count x 3 (unpublished data); includes U.S. and Canadian sites.

Nest surveys conducted across the Great Lakes in 2005, 2007, and 2009 indicate that the number of DCCO breeding pairs declined by 3.6% from 2005 to 2007 (114,507 to 110,417), and 1.7% from 2007 to 2009 (110,417 to 108,592). This is consistent with analyses of DCCO banding data for birds banded in the Great Lakes from 1979-2006 by Seamans *et al.* (2012) indicated that the two depredation orders have likely had a negative effect on annual survival of "hatch year" age-class DCCOs in the Great Lakes. The effect of the depredation orders on survival of "second year" and "after second year" birds was unclear.

To gauge the effects of different management scenarios on DCCOs in the Great Lakes, we used equilibrium harvest dynamics and sustained yield methodologies (*e.g.* Williams *et al.* 2002) to estimate population dynamics and sustainability of various harvest and egg oiling levels. The specific model and parameter estimates we used (and relevant assumptions) are discussed in Appendix 3.

We estimated the effect of various levels of harvest and egg oiling on the Great Lakes DCCO population by projecting abundance for 20 years under the following harvest and oiling scenarios:

Population Model Scenario 1 (the No Action Alternative): cease all removal and egg oiling. DCCO management activities would be much more restricted if the depredation orders expire, though DCCO take could still be authorized under depredation permits;

Population Model Scenario 2: continue harvest and egg oiling at 2007 rates (h [harvest rate] = 0.06 and p [nest oiling rate] = 0.14);

Population Model scenario 3: double annual harvest rate (h = 0.12) and keep egg oiling constant (p = 0.14);

Population Model Scenario 4: double egg oiling rate (p = 0.28) and keep harvest constant (h = 0.06); and

Population Model Scenario 5: double both harvest and egg oiling rates.

Population Model Scenario 1

If harvest and egg oiling cease, the population should remain near carrying capacity (Figure 7; it was assumed the population is currently at or near carrying capacity). The estimated population size of breeding individuals in 2014 would be 217,200 (80% confidence interval [indicated with dashed lines in the figures] = 155,600 to 300,200), and in 2027 the estimated size would be 215,600 (80% confidence interval = 155,100 to 295,700). These figures represent the number of breeding *individuals* and must be divided by two to obtain the number of breeding pairs/nests. (The most recent estimate of the Great Lakes breeding population is 230,052 [115,026 multiplied by 2]).

Impacts to Fsh

Protection of public fish resources is the primary reason most states take actions under the PRDO to control DCCOs (Table 3, Appendix 2). Scientific assessment of the impacts of DCCO on fish and the consequences of DCCO depredation management is often expensive and can take years to complete. As noted in the Affected Environment section on DCCO impacts to fishery resources, aquatic systems are complex and challenging to study. Even when detailed assessments are in place, determinations regarding the impact of DCCO and DCCO depredation management may be confounded by changes in management practices, introduced species, climate factors, and changes in factors such as the extent of aquaculture production in a state. Variability in fisheries systems may also mean that it can take years for a response to management to be detectable by some research methods, even when the DCCO depredation management is having a beneficial impact. Consequently, some states may not have the resources to invest in detailed review of the impacts of DCCO depredation management at every site where DCCO depredation management is conducted.

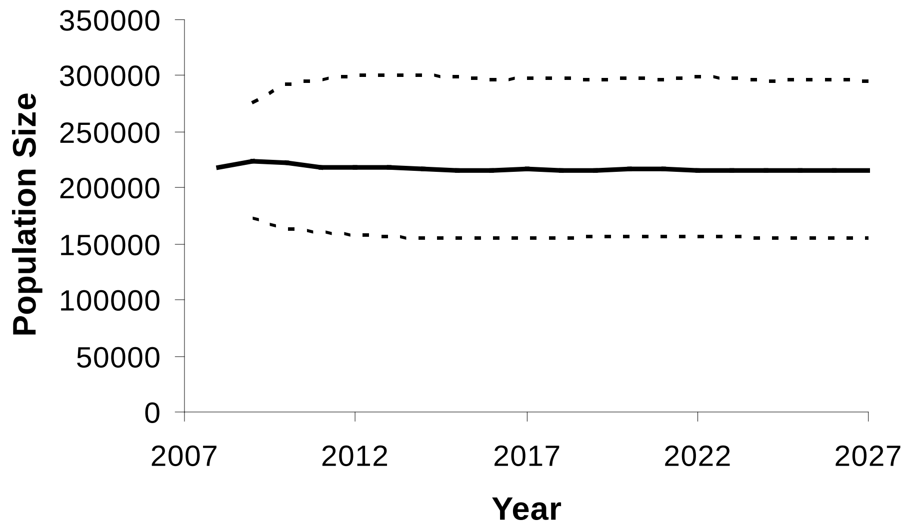

Figure 7. Estimated population trajectory of breeding DCCOs in the Great Lakes, assuming harvest and egg oiling are discontinued. The dashed lines represent the 80% confidence intervals.

Decisions to conduct DCCO depredation management are commonly based on a combination of factors which may include detailed studies (if available), data from surveys such as creel surveys which indicate a reduction in fish populations or catch per unit effort, DCCO diet studies, and estimates of DCCO fish consumption relative to estimates of available biomass or human harvest. Agency experience in other areas or detailed data from other studies may also impact management decisions. Complaints from user groups (Tribes, sport and commercial anglers) may trigger action agency investigations into the impact of DCCO on a fishery and, if warranted, subsequent management action.

A brief synopsis of the management actions taken in each state follows. Information used to determine need for action is provided. Additional details are provided for locations where more extensive study has been conducted.

In Arkansas and Alabama, the fishery concern has been impacts to the sport/recreational fisheries, primarily on reservoirs. In Alabama, bass and bream have been found in the stomachs of DCCOs, along with rough fish such as shad. In Arkansas, bluegill sunfish, crappie, spotted bass, largemouth bass, channel catfish, and gizzard shad have been found in the stomachs of DCCOs at some locations (USDA WS 2008a, AGFC 2012). In both states, there is also concern about the negative impacts that DCCOs could have to forage fish that would adversely affect the game fish (USDA WS 2012a). Similar concerns regarding the impact of nesting and/or roosting DCCO on sport fish and forage fish have resulted in DCCO depredation management in Mississippi (USDA WS 2012b).

In Georgia, Indiana, and Iowa, the concern has been the impact of DCCOs at State fish hatcheries. In Georgia, 30 DCCOs were killed at five hatcheries in 2004, but none since. In Indiana, a total of 7 DCCOs were killed from 2008 to 2012 at one hatchery. Likewise in Iowa, a total of 105 DCCOs were killed from 2007 to 2009 at one hatchery.

Michigan has the most diverse, complex, and comprehensive DCCO depredation management program for the protection of public fishery resources of any state and has the highest statewide breeding population of DCCOs. In addition to USDA WS acting as an agent for the State, several Tribes are involved with DCCO management. Fishery issues in Michigan include conflicts with sport fish, hatchery stock, and commercial whitefish. DCCO populations are controlled at breeding colonies throughout much of the state. USDA WS and the Tribes have reduced DCCO populations at breeding colonies using a combination of shooting and egg oiling in the Les Cheneaux Islands, Thunder Bay, Bays de Noc, the Beaver Islands, and at the Ludington Pump Storage breakwall. In addition, harassment during spring migration is conducted at many locations within the State, often with the use of agents.

In the Les Cheneaux Islands region of northern Lake Huron, fisheries biologists with the Michigan Department of Natural Resources concluded that DCCO predation was the cause of or an important contributor to the yellow perch fishery collapse in 2000 (Fielder 2004, USDA WS 2011). Other factors that may have contributed to the decline included human harvest, declines in water levels, establishment of invasive species such as zebra and quagga (*Dreissena rostriformis bugensis*) mussels and implementation of a neighboring walleye stocking plan that may have increased predation on yellow perch (USFWS 2003, Fielder 2008).

The MDNR and USDA WS initiated DCCO depredation management in 2004 with the objective of reducing DCCO foraging as a means of improving the perch fishery. MDNR fisheries biologists use seven indicators to assess whether DCCO control has benefited the perch fishery (Fielder 2010). As DCCO abundance decreased they observed: 1) an increase in yellow perch abundance, 2) an increase in angler catch rate of yellow perch, 3) and increase in harvest of yellow perch, 4) a decrease in the total mortality rate of yellow perch, 5) an increase in the mean age of yellow perch, 6) an increase in yellow perch recruitment, and 7) a decrease in yellow perch growth rate. The yellow perch recovery was aided by improved reproductive success starting in 2004, but the reduction in local DCCO numbers due to control is credited with allowing the increased survival and longevity of yellow perch that was a significant part of the fishery recovery (Fielder 2010). While the catch per unit effort has returned to pre-collapse levels, fishing effort and harvest have not.

In Thunder Bay, DCCO depredation management was initiated in 2006 to reduce DCCO impacts to the fishery including lake whitefish, brown trout and yellow perch. Prior to management, the MDNR had observed marked declines in young lake whitefish in survey trawl catches from Thunder Bay (USDA WS 2011). The trawl surveys also indicated declines in catch rates of all fish species caught in Thunder Bay. Reasons for the sharp decline in the total trawl catch in are unclear. However, similar trends were observed in USDI, U.S. Geological Survey trawl surveys from other near-shore areas of Lake Huron (Bence *et al.* 2008). Some of the declines may be from decreases in plankton and the benthic amphipod *Diporeia*, which are food for small fish including juvenile whitefish. Data indicated that plankton productivity may be only one third of normal levels. The decline in plankton productivity has been attributed to the impacts of introduced zebra and quagga mussels that lock nutrients in the bottom of the lake where they are not available to zooplankton. Consequently, availability of prey fish for predatory fish and birds has declined. This may have increased competition among fish and avian predators for the diminishing supply of prey fish. Growth of Chinook salmon and lake trout has declined since the alewife population, the predominant food for both species, collapsed in 2003. Presumably DCCOs are similarly coping with reduced prey availability. Biologists from the MDNR were concerned that the continued presence of high DCCO densities may lead to increased competition between DCCOs and predatory fish and adverse community-level effects on the fishery.

The DCCO population in the Thunder Bay archipelago grew from an estimated 452 to 3,702 nesting pairs (Gull, Scarecrow, Bird and Grass Islands) between 1989 and 2005. Assuming 1 non-breeding bird per nest (lower end of range from Wires *et al.* (2001)), a total of 11,106 adult and non-breeding cormorants resided in Thunder Bay in 2005. At 1 pound (454 g) of consumption per bird per day (Wires *et al.* 2001), cormorants in Thunder Bay consumed approximately 1,110,400 pounds (503,669 kg) of fish in 2005. If all DCCO feeding was in Thunder Bay, consumption would have been at a rate of 34 pounds (~15 kg) per acre, which far exceeds the trawl-based standing crop (instantaneous total fish biomass) of bottom oriented fish in Thunder Bay in recent years. This estimate is not a precise calculation of fish consumption and not all DCCO foraging occurs in Thunder Bay. However, these calculations do provide an indication of possibility of competition for prey-fish resources and potential impacts of DCCO foraging on local fishery resources (USDA WS 2011).

Cormorant damage management has been conducted in Bays de Noc, since 2006 to reduce DCCO impacts to the fishery. In 2006 the MDNR conducted an analysis to assess the amount of fish taken from Bays de Noc by DCCOs. The consumption demand in the Bays de Noc area was estimated to be 15.48 kg (~34 pounds)/ha. For purposes of comparison, a multi-year detailed analysis conducted in the North Channel region of Lake Huron estimated annual total standing biomass at 30 kg/ha and annual fish production at 12.5% of the total standing biomass. For DCCO consumption (15.48 kg to equate to the production of the system (12.5%, the standing total biomass) the standing biomass in Bays de Noc would have to be approximately 124 kg (~273 pounds)/ha. This level of biomass production is likely not achieved anywhere in the Great Lakes. It is likely that fish populations in the open bays are replenished by schools of fish in the main basin of Lake Michigan. The influx of fish from the larger system may allow the bays to support larger DCCO populations than could be sustained if the bays were an isolated system. These calculations provide an indication that the level of DCCO foraging in Bays de Noc is placing a considerable demand on fishery resources in the area. It is hypothesized that without intervention, over time, DCCO numbers would eventually come into balance with available resources. However, the fish biomass remaining for other uses (*e.g.*, predatory fish, human consumption) would likely be greatly reduced (USDA WS 2011).

Cormorant damage management was initiated in the Beaver Islands in 2007 ~~to~~ because of concerns regarding impacts on the fishery, particularly smallmouth bass.

Determining the impact of DCCOs on smallmouth bass in the Beaver Islands area has been challenging (Seider 2003, Seefelt 2005, Kaemingk 2008). Seider (2003) assessed the local bass population during 1999-2002. Based on concurrent declines in non-game fish, high survival rates for adult fish (fish age 6 and older) and low levels of angler effort and harvest of smallmouth bass in the area, Seider (2003) concluded that angler harvest was not limiting the smallmouth bass population. Growth rates and condition of the fish were high indicating that food supplies were not limiting the population. Predation by other fish could have caused the unusually high juvenile mortality rates but few predatory fish (northern pike or bowfin) were captured during survey efforts. The size of the fish age groups with the high mortality rates were approximately 150-300 mm in total length, a size range readily taken by DCCOs (Craven and Lev 1987, Hobson *et al.* 1989, Campo *et al.* 1993, Modde *et al.* 1996, Neuman *et al.* 1997, Adams *et al.* 1999, Johnson *et al.* 2002). However, only only 1 smallmouth bass was found in the stomachs of 50 DCCOs that were taken for a 2001 diet study (J. Gillingham, Central Michigan University, pers. com. used in Seider (2003)). Seider (2003) noted that, because the smallmouth bass population was extremely low (approximately 2,000 fish) and the DCCO population in the area was high (approximately 6,657 breeding pairs plus non-breeding birds in 2001; Seefelt 2005), even an extremely low occurrence of smallmouth bass in DCCO diets could have a detrimental impact on the bass population. Seider (2003) concluded that a mortality problem that was consistent with high predation by DCCOs was likely preventing or slowing the recovery of the smallmouth bass population but that additional information was needed.

Kaemingk (2008) observed that the apparent survival of smallmouth bass was very low during the summer months (June through August) and improved during the winter months (August through the next June). This pattern of loss is consistent with predation by cormorants, which inhabit the region for nesting during April through September. A competing hypothesis, however, is that these differences are related to fish emigrating from the study area. Kaemingk (2008) speculated that smallmouth bass left the archipelago and traveled large distances to occupy near shore waters throughout northern Lake Michigan thereby accounting for the high loss rate. However, the high recapture rate is inconsistent with this contention.

Seefelt (2005) evaluated population size, diets and foraging behavior of DCCOs in the Beaver Archipelago from 2000-2004. Only 1 smallmouth bass was found in the 150 DCCO stomachs and 978 regurgitate samples examined. Seefelt (2005) used telemetry data from 10 DCCOs and observations of rafts of DCCOs to conclude that DCCOs from Pismire and the Southeast Garden colonies spent relatively little time in areas identified by Seider (2003) as having historically supported good smallmouth bass fisheries. However, her data do show some observations of rafts in and near St James Harbor on Beaver Island. Data from models indicated that DCCO predation contributed to the decline of smallmouth bass in the area, but the models also projected eventual recovery of bass in the absence of DCCO depredation management providing the sport fishing mortality remained zero or very low. However the MDNR has expressed concerns that the assumptions in the model regarding fish mortality rates may not accurately represent what may happen if the bass population starts to recover. DCCOs are opportunistic feeders and bass mortality from DCCO foraging may increase if the bass population increases and may not remain a constant portion of the population. Similarly fishing pressure may also increase as the population increases and need to be addressed through regulatory changes.

Aside from direct effects on smallmouth bass, there is also concern regarding DCCO impacts on forage fish. This consumption may reduce prey resources available to desired game fish species such as lake trout, Chinook salmon, smallmouth bass, yellow perch, and others. Based on nest numbers in 2005 and applying the consumption bioenergetics values of Seefelt (2005), it is estimated that the 11,071 cormorants in the Beaver Island archipelago consumed almost 7½ million pounds (~3,402,000 kg) of fish biomass that year. At the same time, alewives were at some of their lowest levels in Lake Michigan since their original invasion. Chinook salmon stocking had also been reduced by 30% by the Michigan DNR over concerns of the declining prey base (USDA WS 2011). However, recently DCCO diets have shifted to the newly established abundant invasive round goby (VanGuilder and Seefelt 2013).

The Beaver Islands Archipelago includes Ile aux Galets. The Little Traverse Bay Band of Odawa Indians (LTBB) has been conducting DCCO depredation management on Ile aux Galets in conjunction with overall DCCO depredation management efforts in the archipelago (Donner 2012). The LTBB has treaty-protected fishing rights in the 1836 ceded waters of the Great Lakes and some tribal members rely on fishing for subsistence or income. Perch populations in the area have been at low levels since the 1990s due to low recruitment. The East Beaver Island Reef complex (Ile aux Galets/Dalia shoal/Hog Island shoal) area is a priority site for lake trout population recovery efforts and approximately 600,000 yearling lake trout are stocked in the area each spring. The tribe is concerned that DCCOs may be adversely impacting and/or threatening the recovery of yellow perch and lake trout (USDA WS 2011)

DCCOs are controlled at several Michigan inland lake locations during spring migration to reduce predation on spawning yellow perch, walleye, smallmouth bass, and northern pike, using harassment with lethal reinforcement. Dorr *et al.* (2010) found that harassment deterred 90% of DCCO foraging attempts at Drummond Island and Brevoort Lake. Fishery data suggest that fish populations increased following this effort. DCCOs are also controlled at several hatchery stock releases of brown trout, Steelhead trout, and Chinook salmon. It is too soon to say whether these control efforts have been successful. Angler reports indicate a positive improvement of the steelhead fishery, which may be related to the reduction of cormorant pressure at stocking sites.

The Bay Mills Indian Community controlled DCCO nesting on several small islands in eastern Lake Superior from 2004-2011 to Improve survival rates of stocked walleye fingerlings. The effect and response has been monitored by the Sault Ste. Marie Tribe. The Sault Ste. Marie Tribe has also controlled DCCO populations at several breeding locations since 2006 to protect fingerling walleye and yellow perch in the St. Marys River and to reduce scarring of lake and round whitefish in northern Lake Michigan. The Tribe established the following objectives: 1) protect fingerling walleye stocked in the St. Marys River and Epoufette Bay, 2). Protect naturally reproducing populations of yellow perch in the St. Marys River, 3) Reduce the incidence of cormorant scarring on lake whitefish in northern Lake Michigan, and 4) Reduce the incidence of cormorant scarring on round whitefish and protect their populations in northern Lake Michigan. Following DCCO control, relative abundance of walleye captured during fall electrofishing surveys in the St. Mary's River has shown some signs of responding to the control actions. In both the upper and lower St. Marys River relative abundance of both age-0 and age-1+ walleye increased substantially from 2011 to 2012 and in the lower river relative abundance has been slowly increasing since 2006. Scarring rates on lake whitefish have not exceeded 0.3 marks per 100 fish during 2000-2012 and no cormorant scars have been observed on round whitefish since 2004 (Ebner 2012). Relative abundance of lake whitefish peaked in 2007 and has declined since. Whereas relative abundance of round whitefish was lowest during 2004-2006, prior to control actions, and has increased four-fold since then.

The Grand Traverse Band of Ottawa and Chippewa Indians have reduced the number of nesting DCCOs on Bellow Island in Grand Traverse Bay of Lake Michigan since 2007 to protect stocked walleye, and reduce predation on stocked lake trout. There has been an 84% reduction in the number of DCCOs at this colony, from 1500 pairs in 2006 to 247 pairs in 2012, and ultimately a decrease in overall forage consumption from the colony. However, gut analysis of culled birds indicated that DCCOs are opportunistic in their feeding, and preyed primarily on round gobies (Olsen 2012).

In Minnesota, most of the concern has been impacts to sport fish resources at Leech Lake, primarily walleye and yellow perch. Catch rates of both species declined as the number of DCCOs breeding on the lake increased, as did the strength of the walleye year class. The goal has been to reduce the number of nesting DCCOs from 2,524 pairs in 2004 to 500 pairs. Control efforts appear to be at least partially successful. The DCCO population objective was reached in 2010. Catch rates and year class strength of walleye have increased to levels not observed since the late 1990s, even before the DCCO population objective was reached. Catch rates of yellow perch showed a dramatic increase initially following DCCO control, but have since dropped to levels observed prior to control (Mortense 2012). In one year, seven DCCOs were taken at the mouth of Knife River to protect recently released steelhead salmon smolt into Lake Superior.

In New York, there is concern that DCCOs affect smallmouth bass in eastern Lake Ontario, walleye and yellow perch on Oneida Lake, and smallmouth bass and yellow perch on the St. Lawrence River. USDA WS conducted a "harassment with lethal enforcement" program on Oneida Lake to minimize stopover of fall migrating DCCOs. As part of this program, they utilized trained members of the public as agents. The harassment operation was taken over by the State in 2010.

USDA WS implemented an expanded hazing program that significantly reduced the DCCO population, and consequently DCCO predation, on Oneida Lake in spring, summer, and fall. As a result of the intensive DCCO management program there, Cornell University researchers documented a 50% reduction in predation pressure (as compared to 1997 levels) on the fishery and have noted that increasing numbers of adult walleye are likely the result of DCCO management (J. Coleman, Cornell Univ., personal communication). Fisheries biologists now consider DCCO predation an insignificant influence on walleye and yellow perch populations (USDA WS 2006a).

In the eastern basin of Lake Ontario, New York, the New York State Department of Environmental Conservation and U.S. Geological Survey researchers documented a link between DCCO predation and smallmouth bass declines (Johnson *et al.* 2006). Reductions in DCCO populations are expected to prevent further fishery declines, and possibly allow for recovery of affected fish stocks. According to NYSDEC, efforts to measure a fishery response to DCCO control are underway but will require several years of study before conclusions can be drawn (NYSDEC 2007 annual report). Fish consumption on Lake Ontario is estimated to have declined to a level of 0.88 million cormorant feeding days, down from 3.0 million prior to implementation of management in 1998 (J. Farquhar, NYSDEC, unpublished data).

In Texas, the State issues residents with a valid State Hunting License, a "Nuisance Double-crested Cormorant Control Permit" for the purpose of protecting sport fish, on public and private lands and waters (*http://www.tpwd.state.tx.us/business/permits/land/wildlife/cormorant/*). However, there is little or no evidence that DCCOs are adversely impacting fishery resources in Texas, nor that DCCO control activities are having a beneficial effect on those resources (TPWD 2012).

In Wisconsin, the primary fishery concern has been impacts to sport fish resources in Green Bay, specifically yellow perch and brown trout. The initial focus in Wisconsin was to reduce fish consumption by eliminating recruitment at accessible islands by oiling eggs and destroying nests. In recent years, adults have also been culled. Anecdotal information indicates that catch rates may have improved recently (WDNR 2012).

In conclusion, the consensus from most action agencies is that DCCO depredation management, as currently practiced, has the potential to benefit public fishery resources. If the depredation orders are allowed to expire under this alternative, there would likely be substantial decreases in the level of DCCO depredation management which would be conducted to protect free-swimming fish populations and associated declines in potential benefits from DCCO depredation management in these areas. Consequently this alternative may result in decreases in fish populations of interest to commercial or sport fisheries.

Impacts to Wildlife and Their Habitats (Co-nesting birds)

From 2004 through 2012, management was conducted under the PRDO in Michigan, Minnesota, Mississippi, New York, Ohio, and Wisconsin for the purpose of reducing negative impacts to wildlife, primarily co-nesting birds. DCCO management can help protect habitat and alleviate competition between DCCOs and other species. However, there are also concerns that CDM activities may disrupt breeding by and have adverse impacts on co-nesting birds.

In Michigan, the Grand Traverse Band of Ottawa and Chippewa Indians has conducted DCCO depredation management on Bellow Island since 2007 to protect co-nesting bird species. The herring gull population has held relatively stable. Though the population of ring-billed gulls has not been monitored, they have increased their nesting area on the island. There was a single colony present in 2007, but beginning in 2009 there have been four colonies, including two within established herring-gull nesting areas (Olsen 2012). In 2012, the WS controlled DCCOs at Pointe Mouillee State Game Area to protect the largest colony of Black-crowned Night-herons in the state. On Green Island in northern Lake Michigan (part of the Les Cheneaux archipelago), a Great Egret nest found in 2006, and noted as being the northernmost breeding record for this species in Michigan, was successful even with several visits to the island for DCCO management purposes (WS MI 2007).

In Minnesota, DCCO nests are removed from Hennepin Island, on Mille Lacs NWR, to protect a population of Common Terns from being displaced by DCCOs (McDowell 2011). One of the reasons DCCOs are controlled at Leech Lake is to reduce the likelihood that nesting DCCOs will displace ring-billed gulls into common tern nesting areas. Harassing DCCOs prior to the arrival of terns has been tried at Leech Lake as an additional means of discouraging DCCOs from nesting there. These measures seem to have had limited success for the Common Terns. However, in 2007, Caspian Terns nested at Leech Lake for the first time in recorded history, and have increased since then, producing 174 young in 2012 (Mortensen 2012).

In Mississippi, nesting DCCOs were controlled at a mixed species colony on Yazoo National Wildlife Refuge. However, little improvement in the diversity of co-nesters was observed after seven years of DCCO management (WS 2012b).

In New York, there is concern that DCCOs may displace other nesting waterbird species either through direct competition or by altering habitat. Of specific concern are common terns on Oneida Lake, Black-crowned Night-herons on Lake Ontario, Great Blue Herons, Great Egrets, Black-crowned Night-herons, and common terns on Lake Erie/Niagara River, and Great Blue Herons nesting near Canastota. Since DCCO depredation management efforts were implemented, common terns returned to nest on an island on Oneida Lake, and by 2009 produced 324 nests (Cranker and Cranker 2009). In addition, population declines of Black-crowned Night-herons on Lake Ontario were reversed and the Great Blue Heron population at Canastota stabilized (New York Department of Environmental Conservation [NYDEC] 2008). After six years of DCCO control, Great Blue Herons, Great Egrets and Black-crowned Night-herons began nesting on Strawberry Island along the Niagara River (NYDEC 2009).

In Ohio, the Lake Erie islands provide important nesting habitat for Black-crowned Night-Herons, Great Egrets, Snowy Egrets, Little Blue Herons, and Cattle Egrets (Bubulcus ibis) and DCCOs. West Sister Island, part of Ottawa National Wildlife Refuge, hosts one of the largest nesting colonies of herons and egrets in the U.S. portion of the Great Lakes, including Ohio's largest Black-crowned Night-heron breeding colonies. There is concern that increasing DCCO populations may be displacing other colonial species through nest site competition and habitat degradation. DCCO breeding populations are also managed on two other islands in Lake Erie and two inland colonies to reduce impacts on co-nesting birds and vegetation. During the course of management activities, observers were paired with shooters to observe the behavior of co-nesting species. They found that over 60 percent of the birds stayed on the nest during the management activities. Those that flushed from the nest, returned within 8 minutes (ODW *et al.* 2012; USDA WS 2013). Based on study information, management measures on West Sister Island were adjusted to further minimize impacts on nesting birds. The overall impacts of CDM on co-nesting birds are being monitored at West Sister Island but data on whether CDM benefits co-nesting species are inconclusive. Vegetative changes on the island and weather events contribute to variations in bird populations which make it difficult to determine CDM impacts (USDA WS 2013). However, preliminary indications are that, with the protective measures in place, management actions are not adversely impacting co-nesting species populations on the island.

In Vermont, CDM is conducted to protect vegetation and co-nesting species (USDA WS 2012c). Black-crowned night-herons nested on Young Island in 2006, two years after DCCO control was initiated, which was the first time black-crowned night-herons were found to nest in Vermont since 1998 (USDA WS 2006c). Great blue herons nested on Young Island in 2009, for the first time since 1954. An increase in common tern nesting was observed at another CDM site beginning in 2006, and Common Terns appeared for the first time in 10 years at an additional CDM site in 2007 (USDA WS 2008b).

In Wisconsin, there is a concern about competition for nest sites between DCCO and other colonial nesting species such as great egret and black-crowned night-heron. Beginning in 2007, DCCO nests were removed from a mixed species colony on Hog Island (Green Bay National Wildlife Refuge), primarily to protect the habitat of co-nesting birds (USFWS 2007). Beginning in 2008, DCCOs were also culled from mixed species colonies on Lake Winnebago (WDNR 2008). Colonial waterbird nesting populations at these sites appear stable (WDNR 2010).

Impacts of CDM Methods on other Non-target Species

As outlined in the terms and conditions of the PRDO, agencies are required to conduct CDM in such a way that negative impacts on co-nesting species are avoided. Although there are concerns that DCCO control, including non-lethal harassment activities, can negatively impact co-occurring bird species, past experiences indicate that carefully planned and implemented DCCO management can have a positive effect or negligible adverse impact on species that nest with or near DCCOs.

Researchers in Canada examined the effects of DCCO culling on co-nesting species (Great Egrets and Great Blue Herons) at sites around Lake Ontario and found that, in 2005, nesting success did not differ between managed and control sites for either species. In 2006, nest failure rate was higher for both species at the managed site (D. Moore, CWS, unpublished data). Mattison (2006) measured different types of disturbance affecting the Common Tern colony on Oneida Lake, New York, and found that tern research activities caused the most disturbances while noting that further research is needed to quantify impacts of cormorant hazing activities on terns.

Some of the precautions that have been taken by agencies to avoid affecting co-nesting species include using suppressed firearms to minimize noise disturbance, suspending harassment or control activities during critical nesting periods (*e.g.*, for common terns), avoiding activities during severe temperature extremes and heavy precipitation, minimizing the amount of time spent on a colony, maintaining a buffer distance around nesting colonies, ensuring that field personnel can distinguish different types of birds and their eggs, wearing camouflage clothing, and moving slowly through nesting areas. In Ohio, shooters were paired with observers whose job it was to monitor co-nesting species and take note of disturbance behavior, if any. These observations were used to improve management operations so that disturbance to co-nesting species could be reduced.

Evidence suggests that American White Pelicans abandoned their breeding colony of 102 nests on Long Point Island on Lake Winnebago, Wisconsin following a second visit to that island to cull DCCOs in 2010. However, the impact was temporary and pelicans resumed nesting on the site the subsequent year (132 nests in 2011).

There have been some instances of direct mortality of other bird species as a result of DCCO control activities. They include: two instances of Neotropic Cormorant taken during DCCO control activities in Mississippi in 2007 and 2008, one Ring-billed Gull injured and subsequently euthanized in Vermont in 2004, two ring-billed gulls shot in New York in 2006 and 2009, one ring-billed gull shot in New York during 2010, and one American White Pelican and one Great Egret accidentally shot in Wisconsin in 2009. These incidents, although regrettable, are extremely low relative to the number of DCCO which are removed and are not of sufficient magnitude or frequency to adversely impact non-target species populations.

Predation by gulls during CDM can be an issue in some waterbird colonies. In colonies of ground nesting birds, DCCO and co-nesting species may leave nests in response to proximity of CDM crews (*e.g.*, crews on site for egg oiling, carcass retrieval, nest counts). Some gulls (commonly Ring-billed Gulls) return to the area sooner than other birds. These gulls may prey on the nests and eggs of other birds (including their own species) which have been left exposed by the departure of the adults from the nest. The agencies continue to strive to find ways to reduce this impact. Strategies which may be used to reduce problems include visiting colonies at night, minimizing the duration of time in the colony and the number of people in the colony. No treatment zones around particularly sensitive bird species (*e.g.*, terns and night-heron) may also be used to reduce risk that birds may leave nests. At present, there is no evidence that these incidents are adversely impacting target species populations although there may be some reduction in productivity at specific colonies.

Under this alternative, the unmanaged growth of DCCO populations after expiration of the depredation orders would likely be detrimental to colonial waterbirds and other co-nesting species at select locations. Incidents of unintentional mortality have been limited and do not appear to be adversely impacting nontarget species populations.

Impacts to Plants and Their Habitats (Vegetation)

DCCO management to protect vegetation has been carried out in Alabama, Michigan, Minnesota, Mississippi, New York, Ohio, Vermont and Wisconsin. At all of these sites, DCCOs have caused damage by either physical (breaking branches) or chemical means (guano), or both. Because of the documented adverse impacts of high DCCCO densities on vegetation health (Hebert *et al.* 2005, McGrath and Murphy 2012), it can be inferred that DCCO management will help alleviate vegetative damage, as long as damage is not irreversible or significantly affected by factors other than DCCOs.

In Alabama, the concern was vegetation damage potentially leading to the erosion of island habitats in a reservoir that is a popular recreational destination. Control efforts had limited success in preventing the damage, but may have slowed it down (USDA WS 2012a).

In Michigan, there was concern about the impact of nesting DCCOs on old growth cedars at Sleeping Bear Dunes National Lakeshore. DCCOs were controlled there in 2006 and 2007. The need for action (preventive versus responsive management) and management strategy are the subjects of an ongoing review between the National Park Service, Michigan Department of Natural resources, Native American tribes and APHIS-WS. Additionally, the Grand Traverse band of Ottawa and Chippewa Indians controlled DCCOs on Bellow Island since 2007 to reduce vegetation damage and encourage recovery of native plants. Since DCCO control was initiated, vegetative damage has been reduced. While it may take years with a significantly reduced cormorant population for the soil chemistry to return to normal to lead to a recovery of native trees, vegetation on the island appears to be responding. Areas of the island where DCCO have been reduced or eliminated are seeing a substantial rebound in vegetative growth (Olsen 2012).

In New York, there is a concern that DCCOs are having a detrimental impact on island vegetation along the Niagara River, St. Lawrence River, and Lake Champlain (NYDEC 2008). After six years of CDM, island vegetation on the Niagara River began showing signs of recovery (NYDEC 2009). It is believed that habitat loss has been stabilized at the other locations (NYDEC 2012).

In Ohio, damage to habitat used by co-nesters, through both chemical and physical means, is a concern and one of the primary reasons for CDM in the state. The DCCO breeding population at four sites was reduced from 5,159 pairs in 2005 to 3,968 pairs in 2012. Preliminary results from vegetation monitoring, conducted on West Sister Island since 2005, indicate that vegetation is recovering throughout the island, not just in areas where CDM is conducted (ODW *et al.* 2012). There are six State listed plants on Green Island, but no monitoring has been conducted to see if the status of those species has changed since CDM started in 2006.

In Vermont, CDM was conducted at several locations on Lake Champlain to protect wildlife habitat and other vegetation. DCCOs nesting on Young Island have killed all the trees and reduced what was once a mosaic of tree, shrub, and herbaceous plant communities into vegetation dominated by stinging nettle, thistle, and lamb's quarters. Following three years of CDM on Young Island, habitat restoration activities began and included herbicide application to control invasive plants, and planting native species in order to restore the native vegetation (USDA WS 2007b).

Several studies have been completed on the impacts of DCCOs on soils vegetation in the Great Lakes since the FEIS was completed (Boutin *et al.* 2011, Rush *et al.* 2011, McGrath and Murphy 2012). In a study conducted on Middle and East Sister Islands in Lake Erie, soil pH decreased and phosphorous concentrations increased with cormorant density (Rush *et al.* 2011). Patterns in soil nitrate levels varied between islands. On

Middle Sister Island, soil nitrate concentrations increased with nest density, with highest concentrations during the early and mid-nesting seasons. Soil nitrate concentrations were also elevated on East Sister Island but but did not correlate with temporal or spatial patterns of DCCO nesting. Nitrate concentrations returned to pre-cormorant conditions 3 years after DCCO removal on a section of Middle Sister Island but remained elevated 10 years post DCCO use on East Sister Island.

Boutin *et al.* (2011) reported reductions in vegetation species richness after DCCO colonization. Cormorant impacts included damage to the tree canopy where they nested and associated understory vegetation. However, DCCO appeared to have little impact on seedbank species richness, abundance or composition which is a positive sign for site restoration efforts post-DCCO management. However, changes caused by DCCO may alter microclimates to favor invasive species. Managers may need to consider management of invasive species as part of site recovery programs. Size and shape of the island ecosystem and area impacted by DCCOs may also impact microclimate conditions, site resilience to adverse impacts of DCCOs and vegetation recovery efforts (McGarth and Murphy 2012).

Under this alternative, the unmanaged growth of DCCO populations after expiration of the depredation orders would likely be detrimental to plants and vegetation at select locations.

Impacts to Threatened and Endangered Species

Before we completed the FEIS and final regulations we completed a consultation under the Endangered Species Act with the Service's Division of Consultations, HCPs, Recovery and State Grants. Based on information from the proposed rule and an intra-Service Biological Evaluation, we determined that incorporating conservation measures, such as safety zones inside of which DCCO control activities are prohibited, would avoid adverse effects to interior Least Tern, Wood Stork, and Piping Plover. No reported take of ESA-listed species has occurred since implementation of the PRDO and AQDO and no negative impacts have been documented.

The USFWS is preparing a new intra-Service Biological Evaluation to evaluate potential risks to newly listed and proposed species.

Existence and Aesthetic Values

Although management under the two depredation orders leads to localized killing and even local population reduction in some cases, DCCOs are still present for people to enjoy. USFWS, USDA WS, and other agencies involved with DCCO depredation management have no intention of eradicating DCCOs. As for impacts on aesthetic values, this varies depending on an individual's perspective on the beauty of DCCOs and the environments they inhabit and may affect. For example, many landowners and managers may prefer the aesthetic appeal of healthy trees over that of nesting DCCOs and thus want to prevent DCCOs from killing trees. Regardless of individual perspectives, we foresee no significant change on these values if the depredation orders are allowed to expire.

Socioeconomic Environment

Since the 2003 AQDO revision to allow control at roost sites in the vicinity of aquaculture facilities, Mississippi aquaculture producers have reported reduced depredation on ponds in localized areas where roost control has occurred. DCCOs tend to remain thinned out for three to five days after roost control and historical roost sites seem to be used less often in areas where control efforts have been concentrated. DCCO roost sites have become more evenly distributed, as opposed to a few roost sites with large numbers (K. Godwin, WS, personal communication). We are not aware of any formal economic evaluations of the effects of the depredation orders on aquaculture production and have no way to gauge effectiveness in this area beyond this qualitative assessment. Allowing the AQDO to expire would require that aquaculture producers, hatchery managers, and WS officials wait to receive depredation permits before they could conduct control and in some cases this would affect their ability to respond quickly to depredation problems which would limit effectiveness. This alternative has the potential to increase adverse impacts on minority and low-income persons because DCCO control at fish hatcheries might be reduced, thereby reducing the abilities of hatcheries to provide fish for members of Native American tribes or other low-income groups.

With regard to economic impacts associated with recreational fishing, the PRDO has allowed several management activities for the benefit of sport fisheries and to the extent that fisheries recover and angler participation increases accordingly, effects on local fishing-related businesses will benefit. In the Les Cheneaux Islands of Michigan, for example, the angler catch rate of Yellow Perch has returned to a level not seen since 1995 (WS 2007a). We would expect such an improvement to eventually result in higher angler participation and for that to provide economic benefits to the local area.

ALTERNATIVE B - Preferred Alternative

Amend regulations to extend the expiration dates by five years. Under this alternative, DCCO management under the depredation orders would continue until 2019.

Impacts to DCCO populations

Total annual take (PRDO, AQDO, permits) under this alternative will likely be similar to levels seen from 2007 to 2012 (35,000 to 45,000 birds). Most of this take will continue to constitute birds from the Interior population (especially in the Great Lakes), both on their breeding and wintering grounds.

Annual DCCO take under the PRDO, though not specifically limited in the regulation or the 2003 FEIS, is limited by the numbers set forth in the statewide EAs (WS EAs on DCCO management can be found at *http://www.aphis.usda.gov/ regulations/ws/ ws_nepa_environmental_documents.shtml#EAs*. Annual take under the PRDO in the 24 States was estimated to be 99,360 in the 2003 FEIS (page 56). With frequent population monitoring, and the Service’s review of annual reports and of proposed control activities to take more than 10% of local breeding populations, we predict with confidence that continued cormorant control under the depredation orders will not threaten the long-term conservation of DCCO populations.

Population Model Scenario 2

If harvest and egg oiling remain at current rates, we estimate the population would decline approximately 20% by 2014 (Figure 8), or to approximately three times the size of the population in the early 1990s (estimated at 38,000 nests in 1991 by Weseloh and Collier [1995]). The estimated population size of breeding individuals in 2014 would be 172,400 (80% confidence interval: 123,600 to 237,000), and in 2027 the estimated population size would be 164,300 (117,200 to 228,400). This scenario is our prediction of what would occur under Alternatives B and C, with 2014 being the timeframe for Alternative B and 2027 the timeframe for Alternative C. Under this scenario, Alternative B would result in approximately 60,000-120000 breeding pairs in the Great Lakes population in 2014.

Population Model Scenario 3

If harvest rate is doubled and egg oiling remains at the current rate, we estimate the population would decline approximately 35% by 2014 (Figure 9). The estimated population size of breeding individuals in 2014 would be 140,600 (80% confidence interval: 98,900 to 196,900), and in 2027 the estimated size would be 121,700 (84,400 to 172,800). Under this scenario, Alternative B would result in about 42,000-86,000 breeding pairs in the Great Lakes population in 2014.

Population Model Scenario 4

If egg oiling is doubled and harvest remains at the current rate, we estimate the population would decline approximately 27% by 2014 (Figure 10). The estimated population size of breeding individuals in 2014 would be 158,500 (80% confidence interval: 112,800 to 217,900) and in 2027 the estimated size would be 139,900 (80% confidence interval = 97,800 to 196,500). Under this scenario, Alternative B would result in approximately 56,000 to 108,000 breeding pairs across the Great Lakes population in 2014.

Population Model Scenario 5.

If egg oiling and harvest are doubled from 2007 rates, we estimate the population would decline approximately 48% by 2014 (Figure 11). The estimated population size of breeding individuals in 2014 would be 113,300 (80% confidence interval = 78,700 to 160,300) and in 2027 the estimated size would be 80,000 (80% confidence interval = 51,100 to 121,100). Under this scenario, Alternative B (2014) would result in approximately 39-80,000 DCCO breeding pairs remaining across the Great Lakes population in 2014.

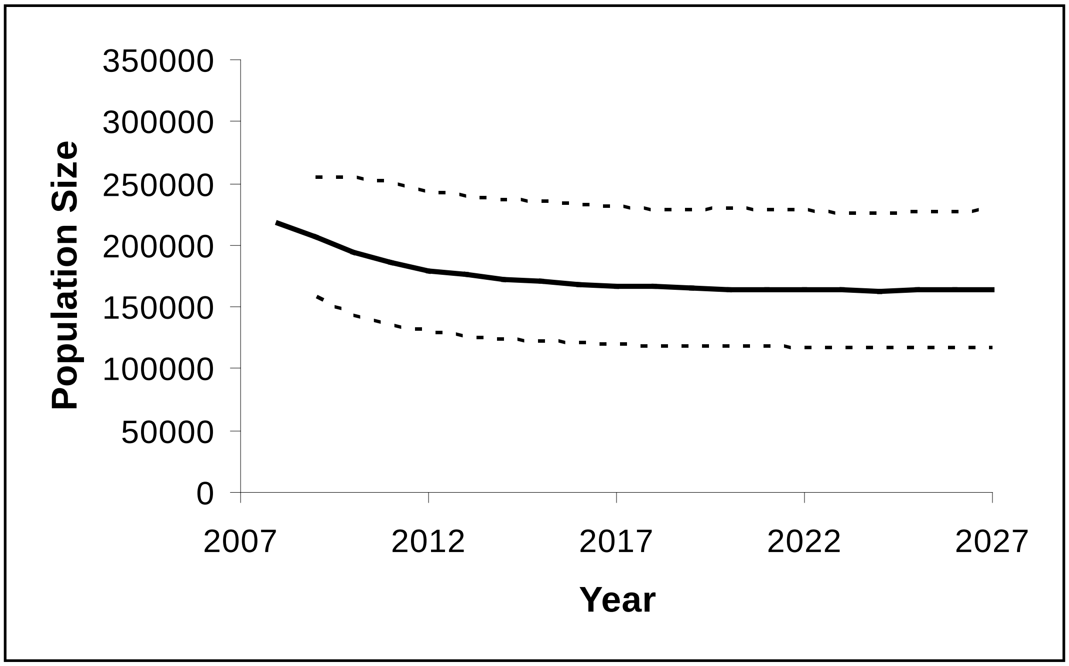

Figure 8. Estimated population trajectory for breeding DCCOs in the Great Lakes assuming harvest and egg oiling remain the same as rates in 2007 (h = 0.06, p = 0.14). The dashed lines indicate the 80% confidence interval on the estimate.

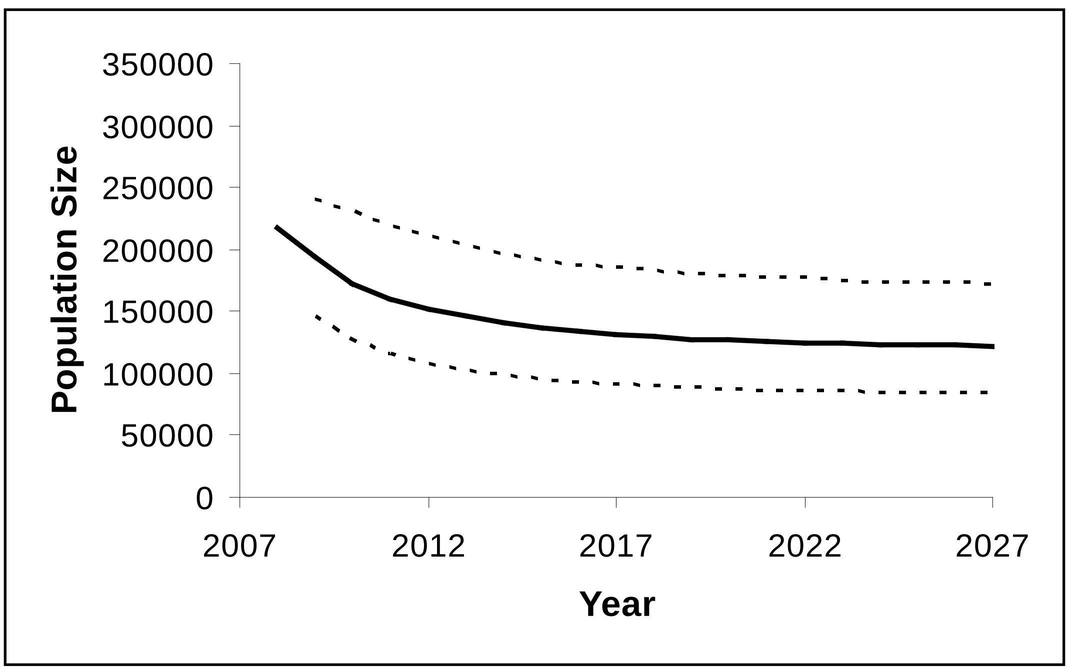

Figure 9. Estimated population trajectory of breeding DCCOs in the Great Lakes assuming harvest rate is twice the 2007 rate and egg oiling rate remains the same as 2007 (h = 0.12, p = 0.14). The dashed lines indicate the 80% confidence interval on the estimate.

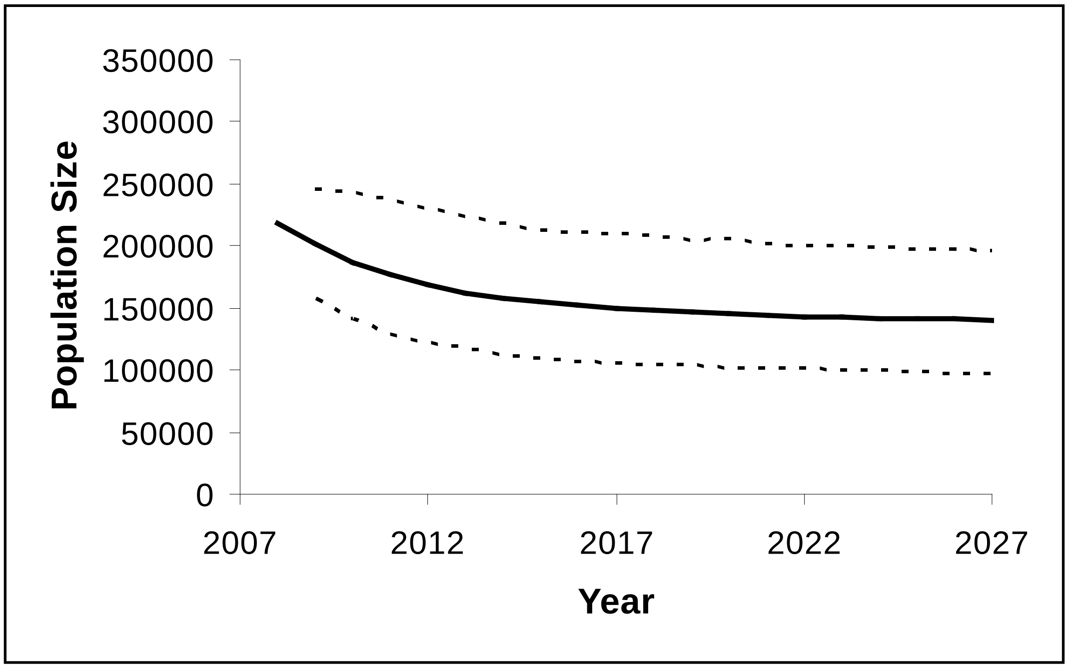

Figure 10. Estimated population trajectory of breeding DCCOs in the Great Lakes assuming harvest rate remains the same as 2007 and egg oiling rate is twice the 2007 rate (h = 0.06, p = 0.28). The dashed lines indicate the 80% confidence interval on the estimate.

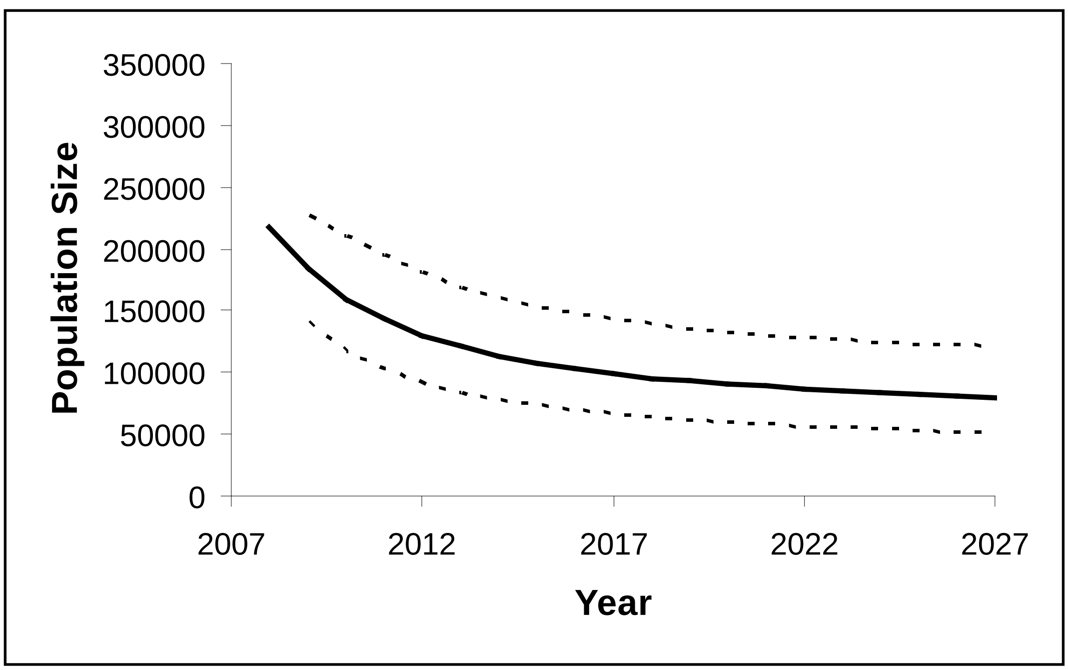

Figure 11. Estimated population trajectory of breeding DCCOs in the Great Lakes assuming harvest and egg oiling rates are both doubled from 2007 rates (h = 0.12, p = 0.28). The dashed lines indicate the 80% confidence interval on the estimate.

Essentially, these models indicate that, even under doubled harvest and egg oiling rates (which we do not expect to occur due to costs and other logistical factors), the Great Lakes DCCO population would be lower than current numbers but would remain at over 50% of its carrying capacity and significantly higher than populations in the early 1990s.

Fish

As discussed above, there is evidence in some areas that DCCO management has effectively reduced predation on fisheries of concern. We would expect to find the same results at other locations in the future as the PRDO continues to allow managers to address localized problem situations between DCCO and fisheries. Overall, this alternative would be more effective than the No Action alternative at resolving DCCO-fisheries conflicts.

One possibility at locations where DCCOs are managed to protect fisheries is that of DCCOs returning to pre-management numbers in a local area (if management is stopped) when multi-year DCCO population suppression has allowed a fishery to recover. This dilemma may require that management be continued indefinitely to protect a fishery, although not necessarily at the same levels as the first few years. In such a case, harassment and selected removal may suffice.

Other Wildlife

Continuing the PRDO for another 5 years will benefit species that have been negatively affected by DCCO abundance and habitat intrusion or destruction. Annual reports and discussions at DCCO management meetings indicate that agencies have followed the requirement in the PRDO to minimize disturbance to non-target species. As noted above, efforts to reduce the size of DCCO colonies under the PRDO have benefitted co-nesting species at some locations. No major unanticipated results or unintended consequences have been reported. Given the experiences of the past nine years, it appears that DCCO management, when carefully planned and implemented, can benefit species of interest while avoiding negative impacts on non-target species and we would not expect this to change between now and 2019.

Vegetation

Alternative B would allow vegetation/habitat damage to continue to be addressed as agencies deem it necessary and would be more effective than the No Action Alternative.

Threatened and Endangered Species

DCCO management activities over the past few years have had no deleterious effects on ESA-listed species and we have no reason to anticipate that will change given continued observance of the conservation measures laid out in the depredation orders.

Existence and Aesthetic Values

This alternative will allow thousands of DCCOs to be killed, and their eggs to be oiled, until 2019. To some, this might be aesthetically offensive but to many others who do not value high numbers of DCCOs and/or who dislike the damage caused by nesting DCCOs, continued management would provide aesthetic benefits. Take over the past few years has actually removed only a low percentage of the DCCO regional population and does not affect overall existence value.

Socioeconomic Environment

Under this alternative, aquaculture producers, hatchery managers, and WS, State, and Tribal professionals could respond quickly to localized DCCO depredation problems and this would allow for more effective management of such problems than if the depredation orders were allowed to expire.

ALTERNATIVE C

Under this alternative, the depredation orders would have no expiration dates. As indicated by the analyses of the different scenarios considered above, the biological effects of this alternative differ little from those under Alternative B over the course of the period modeled. In addition, this alternative would reduce the administrative work and expenses for the U.S. Fish and Wildlife Service.

Impacts to DCCO populations

Total annual take (PRDO, AQDO, permits) under this alternative will likely be similar to or less than levels seen from 2007 to 2012 (35,000 to 45,000 birds). Declines in take may occur as states achieve management objectives for local DCCO populations. Most of this take will continue to fall on birds from the Interior population (especially Great Lakes birds), both on their breeding and wintering grounds. Given the oversight functions built into the PRDO and permitting system, the regular monitoring of DCCOs across the Great Lakes, and ongoing DCCO research (as well as the fact that the aim of agencies managing DCCO damages is not to eliminate or threaten population viability), the long-term conservation of DCCO populations would not be threatened if the depredation orders were put into effect indefinitely. Management under this alternative could result in a decreased Great Lakes DCCO population ranging from approximately 40,000 to 82,150 breeding pairs (see scenarios 2 and 5 above).

As noted above, continued implementation of DCCO management under the PRDO would allow managers to address local situations where DCCO predation is having negative impacts on fisheries. It would, therefore, be more likely to benefit fisheries than the No Action Alternative.

Wildlife and Their Habitats

Continuing the depredation orders indefinitely would allow managers to continue to address problem situations where DCCOs are having negative impacts on wildlife, particularly co-nesting birds or their habitat. We have no reason to believe that agencies would not continue to be highly conscientious in avoiding negative impacts to bird species associated with DCCOs at management sites and therefore we conclude that overall this alternative would have beneficial or neutral effects on other birds.

Plants and Their Habitats

This alternative would be more effective than the No Action Alternative at reducing damage to plants, vegetation, and habitat caused by nesting DCCOs since it would allow the PRDO to continue indefinitely, thereby maximizing management responsiveness at sites where DCCOs have caused or are beginning to cause vegetation destruction.

Threatened and Endangered Species

Similar to the discussion above, we have no reason to anticipate that ESA-protected species would be harmed if the depredation orders are extended indefinitely given the existing conservation measures.

Existence and Aesthetic Values

Same as Alternative B.

Socioeconomic Environment

Same as Alternative B.

CLIMATE CHANGE

A serious concern is the impact global climate change may have on migratory bird habitats and populations. Simulations of the atmosphere and ocean are the principal tool for predicting the projected outcome of global climate change and most models make projections for the year 2100 and beyond. The rate of global climate change is accelerating, and many areas are predicted to experience extensive warming, changing precipitation patterns, shifts in vegetation, rising sea levels, increased frequency and intensity of severe weather events such as fires, hurricanes, floods, and drought; increased numbers of pests; pathogens; and invasive species (MacCracken *et al.* 2000, Inkley *et al.* 2004, International Panel on Climate Change 2007). These effects may impact DCCOs, particularly those in coastal environs. The specific impacts will depend greatly upon local conditions and the ability of the species to respond to the changing environment.

The projected impacts of climate change are subject to considerable uncertainty. Furthermore, the extent to which DCCOs will be able to adapt to changes is not known. Complete adaption by all species, however, is viewed as highly unlikely (Crick 2004). The Service's approach to DCCO management will continue to be one of regular assessment and regulation of control efforts to be consistent with the population status. If monitoring programs indicate that DCCOs are unable to withstand the control of their populations, the population control efforts may be made more restrictive.

SUMMARY

Scale is an important factor to consider when drawing conclusions about whether DCCO management activities have been effective (Table 6). The goal of both depredation orders is to allow managers (aquaculture producers in the case of the AQDO) to take actions to reduce or to prevent specific resource damages at the local scale (such as reducing predation of Yellow Perch in the Les Cheneaux island region of northern Lake Huron or to stop habitat destruction on West Sister Island in Lake Erie). Therefore, the measure of success of specific actions taken under the depredation orders is whether those damages were lessened or eliminated, not whether management efforts caused large (over 25%) localized or regional population reductions.

Table 6. Comparison of alternatives.

Affected Entities	**Alternative A No Action**	**Alternative B 5-year extension on expiration dates (PREFERRED)**	**Alternative C Removal of expiration dates**
DCCO populations	No significant impact at regional scale; local populations would not be reduced after mid-2014.	No substantial changes anticipated from current levels.	No substantial changes anticipated from current levels.
Fish	Beneficial in some situations; after mid-2014 management to address fishery concerns would be much more limited.	Beneficial in some situations (more effective than No Action because of longer timeline).	Beneficial in some situations (more effective than No Action because of longer timeline).
Other birds	Some disturbance but beneficial or neutral overall with beneficial impacts declining after mid-2014. Potential for increased adverse impacts if DCCO numbers increase after mid 2014.	Some disturbance associated with DCCO control, but beneficial when DCCO competition and habitat destruction are reduced (more effective than No Action because of longer timeline).	Some disturbance associated with DCCO control, but beneficial when DCCO competition and habitat destruction are reduced (more effective than No Action because of longer timeline).
Vegetation	Beneficial where damage can be prevented or reversed; effectiveness would decline after mid-2014.	Beneficial where damage can be prevented or reversed (more effective than No Action because of longer timeline).	Beneficial where damage can be prevented or reversed (more effective than No Action because of longer timeline).
Threatened or Endangered species	No effect as long as conservation measures are implemented.	No effect as long as conservation measures are implemented.	No effect as long as conservation measures are implemented.
Existence and aesthetic values	Generally neutral or positive, though effect differs with perspective.	Generally neutral or positive, though effect differs with perspective.	Generally neutral or positive, though effect differs with perspective.
Economic Environment	Presumably positive because depredation is reduced; effectiveness would decline after mid-2014 when depredation orders expire.	Presumably positive because depredation would be reduced (more effective than No Action because of longer timeline).	Presumably positive because depredation would be reduced (more effective than No Action because of longer timeline).

CONSULTATION AND COORDINATION

PERSONS, GROUPS, AND AGENCIES CONSULTED

Much of the information used for the analysis in this EA came from agency PRDO annual reports. Unpublished survey data for the Great Lakes came from Linda Wires (University of Minnesota), Dave Moore and Chip Weseloh (Canadian Wildlife Service), Jamie Stewart (Ontario Ministry of Natural Resources), Tony Aderman (WS), and Jim Dastyck (USFWS). Jim Lyons and Mark Seamans (USFWS) did the population modeling.

The authors conferred with biologists and managers from several of the action agencies and researchers from the USDA NWRC and cited those individuals where appropriate.

SUMMARY OF PUBLIC PARTICIPATION

Issues related to the proposed action were originally identified during the NEPA process for completion of the 2003 FEIS. That process entailed the following (from page 116 of the FEIS).

> *On November 8, 1999, we published a Notice of Intent to prepare an Environmental Impact Statement and national management plan for the DCCO in the Federal Register (64 FR 60826). The notice solicited public participation in the scoping process. Scoping is the initial stage of the EIS process used to identify issues, alternatives, and impacts to be addressed in the NEPA analysis. A Notice of Meetings was subsequently published in the Federal Register (65 FR 20194) on April 14, 2000, to announce twelve public scoping meetings. Public comments were accepted from the date of publication of the Notice of Intent on November 8, 1999 until June 30, 2000. Over 900 people attended the public scoping meetings (of which 329 gave verbal testimony) and over 1,450 submitted written comments, either electronically or by mail. A notice of availability published on December 3, 2001 (66 FR 60218) announced completion of the DEIS and its availability for public comment. Ten public meetings were held in early 2002 and nearly 1,000 written comments were received. After publication of the proposed rule on March 17, 2003 (68 FR 12653), we received nearly 10,000 letters, emails, and faxes during a 60-day public comment period.*

Since the FEIS and original rulemaking, several interagency DCCO meetings have been held and, in the preparation of statewide EAs, there have been additional public comment opportunities. We do not think that the issues raised during these previous NEPA processes have changed considerably.

TRANS-BOUNDARY EFFECTS OF THE ALTERNATIVES

To the best of our knowledge, the preferred alternative will not have a significant negative impact on DCCOs outside the borders of the United States. As noted in the FEIS (USFWS 2003), DCCOs "that breed in Florida and elsewhere in the Southeastern U.S. are essentially sedentary, those along the Pacific coast are only slightly migratory, while Atlantic and Interior birds show the greatest seasonal movements (Johnsgard 1993)." Cormorant damage management in the U.S. has apparently had only a limited effect on the population in Canada. The DCCO population in the Canadian Great Lakes declined 3.2% from 2005 to 2009, whereas the U.S. Great Lakes population declined 7.3%

FUTURE ACTIONS

We anticipate a continuing need to manage DCCOs to protect public resources beyond the 30 June 2014 expiration dates of the PRDO and AQDO. However, the proposed regulation change will not result in a change to current management strategies. This EA is sufficient to assess the environmental impacts of this action and assist our decision-making process. An Environmental Impact Statement is not needed for the regulations change.

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APPENDIX 1

Cormorant Management Activities, 1999-2012

Take of DCCOs comes from several sources including airport permits, scientific collecting permits, depredation permits, the Aquaculture Depredation Order (AQDO), and the Public Resource Depredation Order (PRDO). Nationwide, airport permits average about 210 DCCOs annually and scientific collecting permits average around 420 DCCOs annually, and will not be discussed further.

Take Under Depredation Permits, 1999-2012

Depredation permits were the mechanism used to manage conflicts with DCCOs before the depredation orders were enacted. Depredation permits are still used in states for which the depredation orders do not apply, or in instances where DCCOs are causing damage not covered by the depredation orders, such as property damage.

On average, roughly 5,800 DCCOs are taken nationally by depredation permits, with about 4,500 per year taken within the 24 states covered by the depredation orders. Approximately 80 percent of those have come from the six States of Arkansas, Minnesota, Texas, Alabama, Vermont, and Michigan (Table 1-1).

Take Under the Aquaculture Depredation Order, 1999-2012

In 13 States, commercial aquaculture producers can take depredating DCCOs at their fish farms under the Aquaculture Depredation Order (50 CFR 21.47; AQDO). Starting in 2004, employees of WS can also take DCCOs at roosts located in the vicinity of fish farms. Over 90 percent of take under the AQDO comes from the three States of Arkansas, Mississippi, and Minnesota (Table 1-2). Overall, there has been a gradual decline in take under the AQDO since 2007

Take Under the Public Resource Depredation Order (PRDO), 2004-2012

Reasons for operating under the PRDO vary from State to State, and by agency within State (Table 1-3). Though the preponderance of resource conflicts are sport fish related, some are strictly vegetation- or co-nesting bird- related. More than half the 24 States authorized to operate under the PRDO have done so sporadically or not at all.

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Table 1-1. Number of Double-crested Cormorants taken under depredation permits within the 24 States covered by the depredation orders, by year.

State	Number of DCCOs Taken Under Depredation Permits															
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Total**	**Ave**
Alabama	1,356		312	217	207	121	236	430	436	689	246	378	282	183	5,093	363.8
Arkansas		1,542	1,341	849	2,961	2,627	2,481	1,655	1,924	2,048	1,837	1,847	1,883	2,181	25,176	1,798.3
Florida	67	58	59	92	86	236	328	281	319	254	20	13	294		2,107	150.5
Georgia	57	22	103	13	110	17	38	27	54	89	67	67	73	107	844	60.3
Illinois							4	10							14	1.0
Indiana													1	3	4	0.3
Iowa		3	25	9	11	18	18	31	7	22	39	7	18	6	214	15.3
Kansas		113	85	22	24				30		50	50	4	50	428	30.6
Kentucky												17			17	1.2
Louisiana		2	100	28	147	39	154	39	66	213	95	251	68	234	1,436	102.6
Michigan	34		136	282	479	557	430	267	227	157	141	65	67	36	2,878	205.6
Minnesota	24	20	9	13	9	25	50	50		374	868	1,700	2,398	1,859	7,399	528.5
Mississippi	45	9	7	6	61		71		10			90			299	21.4
Missouri	148	158	222	166	169	164	140	96	77	132	85	102	116	201	1,976	141.1
New York		4	1	48	143	61	90	90	98	215	27	122	137	139	1,175	83.9
North Carolina	10	6	2	1	32	19									70	5.0
Ohio	63	142	166	63	179	216	203	92	125	116	49	28	27	53	1,522	108.7
Oklahoma								97							97	6.9
South Carolina					30	30	100		127	75	167	156	138	132	955	68.2
Tennessee	20	20							66	62	100		153	177	598	42.7
Texas	100	130	292	1,908	1,810	595	379	225	320	352	324	215	177	154	6,981	498.6
Vermont		2			186				21	122	458	1,656	664	4	3,113	222.4
Wisconsin	8	2	7	2	6	31	27	18	23	182	86	119	42	64	617	44.1
Total	**1,932**	**2,233**	**2,867**	**3,719**	**6,650**	**4,822**	**4,745**	**3,435**	**3,980**	**5,102**	**4,659**	**6,883**	**6,542**	**5,583**	**63,152**	**4,510.9**

Table 1-2. Number of Double-crested Cormorants (DCCOs) taken under the Aquaculture Depredation Order (AQDO), by State and year.

State	Number of DCCOs Taken Under the AQDO															
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Total**	**Ave**
Alabama	12		25		11	1,303	1,102	1,552	775	314	2,442	506	165	195	8,402	600.1
Arkansas	15,251	13,905	12,260	6,513	8,393	9,438	7,504	9,454	6,919	6,083	5,946	4,310	6,252	6,377	118,605	8,471.8
Florida				70	48						55	41	50		264	18.9
Georgia			27			32	63	55	75	75	236	44	33	110	750	53.6
Kentucky		27	16	19	18	14	4	24	7	12	12		9	7	169	12.1
Louisiana	631	1,305	341	1,518	1,491	993	732	234	111				24	26	7,406	529.0
Minnesota					1,249	2,553	1,857	1,865	1,246	1,676	1,725	1,667	1,748	1,540	17,126	1,223.3
Mississippi	3,998	2891	5,070	10,038	10,905	9,116	10,057	18,111	7,191	8,424	4,432	6,876	4,010	3,910	105,029	7,502.1
North Carolina	124	109	90	79	162		165	695	1,035	774	719	588	512	1,259	6,311	450.8
Oklahoma																
South Carolina													3		3	0.2
Tennessee																
Texas				1,499	15	1,847	29	67	34	203	771	600	174	792	6,031	430.8
Total	**20,016**	**18,237**	**17,829**	**19,736**	**22,292**	**25,296**	**21,513**	**32,057**	**17,393**	**17,561**	**16,338**	**14,632**	**12,980**	**14,216**	**270,096**	**19,292.6**

Table 1-3. Resource issues identified by action agencies in 24 States covered under the Public Resource Depredation Order.

State (Action Agency)	Public Resource Issue
Alabama (WS)	2005-2012: Fish (sport), Plants (island habitat)
Alabama (State)	2008-2009: Fish (sport)
Arkansas (WS)	2004-2009: Fish (sport)
Arkansas (State)	2004-2012: Fish (sport)
Florida	None
Georgia (State)	2004: Fish (hatchery)
Illinois	None
Indiana (State)	2008-2009,2012: Fish (hatchery)
Iowa (State)	2007-2009: Fish (hatchery)
Kansas	None
Kentucky	None
Louisiana	None
Michigan (WS)	2004: Fish (sport) 2005, 2008-2011: Fish (sport, hatchery release) 2006-2007: Fish (sport, hatchery release), Plants 2012: Fish (sport, hatchery release), Wildlife (co-nesting birds)
Michigan (Tribes)	2004-2006: Fish (subsistence, commercial, recreational, hatchery) 2007-2012: Fish (subsistence, commercial, recreational, hatchery), Wildlife (co-nesting birds), Plants (vegetation)
Minnesota (Tribe)	2005-2007: Fish (sport) 2008-2012: Fish (sport), Wildlife (Common Tern)
Minnesota (WS)	2005-2007, 2009-2012: Wildlife (Common Tern) 2007: Fish (hatchery)
Mississippi (WS)	2006: Fish (sport), Plants (vegetation) 2007-2012: Fish (sport), Plants (vegetation), Wildlife (co-nesting birds)
Missouri	None
New York (WS)	2004, 2008: Fish (sport), Wildlife (co-nesting birds) 2005: Fish (sport) 2006-2007, 2009: Fish (sport), Wildlife (co-nesting birds), Plants (vegetation)
New York (State)	2004: Fish (sport), Wildlife (co-nesting birds, habitat) 2005-2012: Fish (sport), Wildlife (co-nesting birds, habitat), Plants (vegetation)
North Carolina	None
Ohio (State and WS)	2006-2012: Wildlife (co-nesting birds, habitat, Federal and State listed snake), Plants (State-listed species)
Oklahoma	2008 – Unknown
South Carolina	None
Tennessee	None
Texas (State)	2005-2012: Fish (sport)
Vermont (WS and State)	2004-2011: Wildlife (habitat), Plants (vegetation) 2012: Wildlife (habitat, co-nesting birds), Plants (vegetation)
West Virginia	None
Wisconsin (State and WS)	2006: Fish (sport), Wildlife (co-nesting birds) 2007-2012: Fish (sport), Wildlife (co-nesting birds, habitat)

From 2004 to 2012, a total of 173,070 DCCOs were taken under the PRDO, averaging 19,230 per year (Table 1-4).

Table 1-4. Number of Double-crested Cormorants taken under the Public Resource Depredation Order (PRDO), by State and year.

State	Number of Double-crested Cormorants Taken Under the PRDO										
	Year									Total	Mean
	2004	2005	2006	2007	2008	2009	2010	2011	2012		
Alabama		1,143	1,523	700	122	348	98	45	2	3,981	442
Arkansas	254	134	145	321	148	165	131	241	117	1,656	184
Georgia	30							69		99	11.0
Indiana					1	1			5	7	0.98
Iowa				50	50	5				105	11.7
Michigan	1,421	2,429	5,242	7,772	8,223	9,768	7,119	8,093	11,024	61,091	6,788
Minnesota		2,793	3,103	2,461	2,601	3,084	2,222	1,848	1,582	19,694	2,188
Mississippi			633	697	426	458	303	218	226	2,961	329
New York	482	1,665	1,924	1,669	1,418	1,808	601	1,215	718	11,500	1,278
Ohio			5,873	3,725	2,664	2,357	2,206	3,727	6,596	27,148	3,016
Oklahoma					8						
Texas[1]		2,599[2]	2,272[2]	2,636[2]	2,500[2]	5,198[3]	4,452[3]	6,051[3]	4,033[3]	29,741	3,305
Vermont	208	458	328	222	503	1,001	631	4,000	1,134	8,485	943
Wisconsin				3	225	1,419	874	3,197	876	6,594	733
Totals	**2,395**	**11,221**	**21,043**	**20,256**	**18,889**	**25,612**	**18,637**	**28,704**	**26,313**	**173,070**	**19,230**

[1]Texas reported take according to their fiscal year, and would not provide the information to determine take by calendar year.
[2]Reporting period of September 1 to August 1
[3]Reporting period of September 1 to August 31

Nest management

Data on nest management are in tables 1-5, 1-6, 1-7, and 1-8. Egg oiling and destruction of nests are two other management techniques used to minimize DCCO impacts. The vast majority of nest management was done by oiling eggs, which has been done only in the Great Lakes States (Tables 1-3 and 1-4) of Michigan, New York, Vermont, Wisconsin and a trial year in Minnesota. Nests within a colony are often oiled during repeated visits, maximizing the effectiveness of the methodology. Duerr *et al.* (2007) studied breeding dispersal of DCCOs at colonies in Lake Champlain and observed that although oiling eggs did slightly increase breeding dispersal (movement to other nesting sites), such dispersal did not significantly influence effectiveness of management when egg oiling was carried out in a way that avoided predation of DCCO eggs by co-nesting species such as gulls.

Nest destruction is used less often, but consistently in the places where it is conducted (Tables 1-4 and 1-5), particularly New York and Wisconsin, and to a lesser extent in Arkansas, Michigan, Minnesota, and Vermont. Nest destruction is typically considered to be less effective at controlling DCCO populations as birds either readily rebuild nests, or abandon colonies to nest elsewhere.

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Table 1-5. Peak number of Double-crested Cormorant (DCCO) nests oiled under the Public Resource Depredation Order (PRDO) by State and year. The peak number factors out multiple oilings of a single nest, but does not take into account new nests that may be oiled in subsequent visits, and therefor underestimates the number of nests oiled (USFWS unpublished data).

State	Peak Number of DCCO Nests Oiled Under the PRDO										
	Year									Total	Mean
	2004	2005	2006	2007	2008	2009	2010	2011	2012		
Michigan	1,505	1,244	6,202	8,418	7,197	4,092	6,802	2,185	1,583	39,228	4,359
Minnesota		6								6	0.7
New York	3,344	2,999	2,593	2,639	4,413	4,659	3,195	5,094	2,996	31,932	3,548
Vermont	1,458	1,102	610	529						3,699	411
Wisconsin			4,710	7,281	5,920	5,776	4,260	3,571	1,649	33,167	3,685
Totals	**6,307**	**5,351**	**14,115**	**18,867**	**17,530**	**14,527**	**14,257**	**10,850**	**6,228**	**108,032**	**12,004**

Table 1-6. Total number of DCCO nests oiled under the PRDO by State and year. The total number of nests oiled over estimates the number of nests oiled as some nests are oiled during multiple visits. The true number of nests oiled lies somewhere between these two estimates, and is closer to the peak than the sum (USFWS unpublished data).

State	Total Number of DCCO Nests Oiled Under the PRDO										
	Year									Total	Mean
	2004	2005	2006	2007	2008	2009	2010	2011	2012		
Michigan	3,137	2,991	13,891	17,486	15,710	8,431	12,394	3,329	2,949	80,318	8,924
Minnesota		6								6	0.7
New York	11,446	8,864	9,686	7,714	8,231	9,268	6,327	9,788	7,139	78,463	8,718
Vermont	2,866	2,041	1,097	1,413						7,417	824
Wisconsin			9,748	18,864	14,897	13,599	11,377	8,588	3,692	80,765	8,974
Totals	**17,449**	**13,902**	**34,422**	**45,477**	**38,838**	**31,298**	**30,098**	**21,705**	**13,780**	**246,969**	**27,441**

Table 1-7. Peak number of DCCO nests destroyed under the PRDO by State and year.

State	Peak Number of DCCO Nests Destroyed Under the PRDO										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	Mean
Arkansas	95	47	21	22	18	3				206	22.9
Michigan			57	69	45	6	35	74	11	297	33.0
Minnesota		11	23	13	79	6	387	6	18	543	60.3
New York	1,421	517	967	781	1,125	624	734	749	1,423	8,341	927
Vermont		70	57	21	1	37	38	245	68	537	59.7
Wisconsin				386	492	785	832	464		2,959	329
Totals	**1,516**	**645**	**1,125**	**1,292**	**1,760**	**1,461**	**2,026**	**1,538**	**1,520**	**12,883**	**1,431**

Table 1-8. Total number of DCCO nests destroyed under the PRDO by State and year.

State	Number of DCCO Nests Destroyed Under the PRDO										
	2004	2005	2006	2007	2008	2009	2010	2011	2012	Total	Mean
Arkansas	95	47	37	22	18	3				222	24.7
Michigan			57	124	45	6	42	74	11	359	39.9
Minnesota		14	42	13	87	19	610	6	18	809	89.9
New York	2,845	1,013	2,888	2,854	1,973	1,529	1,322	1,326	2,069	17,819	1,980
Vermont		70	57	21	1	103	146	253	89	740	82.2
Wisconsin				713	715	1,027	875	528		3,858	429
Totals	**2,940**	**1,144**	**3,081**	**3,747**	**2,839**	**2,687**	**2,995**	**2,187**	**2,187**	**23,807**	**2,645**

APPENDIX 2

Status of Co-nesting Species

Though poorly suited for our purposes because the surveys are not designed for waterbird and shorebird surveys, Breeding Bird Survey (BBS) trends were acquired at *http://www.mbr-pwrc.usgs.gov/ bbs/trend/tf11.html* on 2 September 2013 (Sauer *et al.* 2012). We know of no better data to use in assessing population status of many bird species in North America. Trend estimates (average percent change per year) were determined using a hierarchical model and are presented along with credible intervals (2.5% and 97.5%) of the estimate. The regional waterbird plans cited below can be accessed at *http://www. waterbirdconservation.org/ nawcp.html*.

Neotropic Cormorant
BBS trend not available.
Southeast Regional Waterbird Conservation Plan: "Neotropic Cormorant appears to be expanding from Texas and Louisiana northward . . . Although Neotropic Cormorants are not nearly as common in economic conflicts as [the Double-crested Cormorant; DCCO], this species is widespread and abundant … and keeping populations stable as opposed to encouraging increases seems the best course of action."

Anhinga
BBS trends, 2000-2011:
Southeastern U.S (USFWS Region 4): 4.90% (1.68 to 11.18%);
Texas: -1.52% (-8.35 to 4.01%).
Southeast United States Regional Waterbird Conservation Plan: "Although their status is likely stable, little information is known about the migration, movements, or demography of this species. Additional monitoring is needed to understand the status, trends and threats for this species in the Southeast U.S. region."

American White Pelican (*Pelecanus erythrorhynchos*)
BBS trend not available.
Upper Mississippi Valley/ Great Lakes (UMVGL) Waterbird Conservation Plan: Increasing in region, mostly due to population recovery and re-colonization.
Special listings - Special Concern in Minnesota and Wisconsin.

Great Blue Heron (*Ardea herodias*)
BBS trends, 2000-2011:
Mississippi Flyway: 3.00% (0.72 to 4.77%);
Upper Midwest (USFWS Region 3 excluding Missouri and Iowa, plus Ontario): 4.37% (1.27 to 6.91%);
Southeastern U.S. (USFWS Region 4): 3.36% (2.07 to 4.69%).
UMVGL Waterbird Conservation Plan: Some declines reported for Bird Conservation Regions (BCRs) 12 (Boreal Harwood Transition) and 23 (Prairie Hardwood

Transition); and some increases for BCRs 13 (Lower Great Lakes/St. Lawrence Plain) and 22 (Eastern Tallgrass Prairie). (For a map of BCRs, see: *http://www.nabci-us.org/map.html*).

Special listings - Special Concern in Wisconsin.

Great Egret

BBS trends, 2000-2011:

Mississippi Flyway: 2.01% (-4.90 to 7.25%);

Upper Midwest (USFWS Region 3, excluding Missouri and Iowa, plus Ontario): 2.98% (-4.20 to 8.52%);

Southeastern U.S (USFWS Region 4): 4.02% (1.17 to 7.12%).

UMVGL Waterbird Conservation Plan: Increasing trend across most of region, but declining in parts of Michigan and Wisconsin.

Special listings - Special Concern in Indiana and Ohio; Threatened in Wisconsin.

Snowy Egret

BBS trends, 2000-2011:

Mississippi Flyway: not available;

Upper Midwest (USFWS Region 3, excluding Missouri and Iowa, plus Ontario): not available;

Southeastern U.S (USFWS Region 4): 2.82% (-3.4 to 7.82%).

UMVGL Waterbird Conservation Plan: Unknown trend where species is peripheral (BCRs 22 and 23), declining in BCR 24 (Central Hardwoods).

Special listings - Endangered in Illinois, Missouri, and Ohio.

Black-crowned Night-heron

BBS trends, 2000-2011:

Upper Midwest (USFWS Region 3, excluding Missouri and Iowa, plus Ontario): 6.93% (-5.91 to 25.73%);

Mississippi Flyway: 1.08% (-8.03 to 11.74%);

Southeastern U.S (USFWS Region 4): 6.30% (1.89 to 11.60%).

UMVGL Waterbird Conservation Plan: Trend over last 10-30 years varies depending on area within region. Is a monitoring priority at sites shared with cormorants. Conservation actions include "managing cormorants on a site-by-site basis if negative impacts to night-herons occur from cormorant breeding activities."

Special listings - Special Concern in Michigan and Wisconsin; Threatened in Ohio; Endangered in Illinois and Indiana.

Ring-billed Gull (*Larus delawarensis*)

BBS trends, 2000-2011:

Upper Midwest (USFWS Region 3, excluding Missouri and Iowa, plus Ontario): 0.19% (-4.09 to 4.42%);

Mississippi Flyway: 0.36% (-5.49 to 7.24%).

UMVGL Waterbird Conservation Plan: Low concern in BCR 22, otherwise not at risk.

Herring Gull (*Larus argentatus*)
BBS trends, 2000-2011:
Michigan: -4.57% (-15.65 to 7.79%);
New York: -1.40% (-5.80 to 4.30%);
Upper Midwest (USFWS Region 3, excluding Missouri and Iowa, plus Ontario): -3.14% (-10.89 to 2.07%);
Mississippi Flyway: -5.71% (-19.45 to 2.90%).
UMVGL Waterbird Conservation Plan: Low concern.

Caspian Tern (*Hydroprogne caspia*)
BBS trends, 2000-2011:
BCR 12 (Boreal Hardwood Transition): 1.65% (-27.79 to 37.68%);
BCR 13 (Lower Great Lakes/St. Lawrence Plain): 5.72% (-1.77 to 12.09%).
UMVGL Waterbird Conservation Plan: Increasing in BCRs 12 and 13. Conservation actions include assessing potential impacts from cormorant control activities (presumably assuming that control activities will not be positive), and developing alternative strategies to reduce cormorant conflicts if [*sic* negative] impacts do occur.
Special listings – Endangered in Wisconsin, threatened in Michigan.

Common Tern (*Sterna hirundo*)
BBS trends not available.
UMVGL Waterbird Conservation Plan: Overall high conservation concern. Conservation actions include "site enrichment, protective structures, predator control, interspecific competitor removal, and restrictions on human access at sites with high potential for long-term use and high productivity."
Special listings - Threatened in Michigan, Minnesota, and New York; Endangered in Illinois, Ohio, Vermont, and Wisconsin.

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APPENDIX 3

Population Model Data and Assumptions

Data available for modeling population dynamics were: annual counts of nests from Lakes Erie, Huron, and Ontario 1979-2009; annual harvest of individuals from each lake in the Great Lakes 2003-2009; the number of nests oiled in each lake 2005 to 2009; and the number of nesting individuals in each lake 2005 and 2009. Banding and band-recovery data, 1979-2009, were available and were analyzed separately (Seamans *et al*. 2012).

We used the following model to assess the effect of harvest and egg oiling on the population:

$$N_{t+1} = sN_t[1 + (1 - p_t)(a + bN_t)] - h_t \times N_t$$

where N_t is the abundance in year t, h_t is the harvest rate in year t, and p_t is the annual proportion of nests oiled in year t. Annual survival of nesting individuals (s; individuals $\geq$2 years old) was taken from Seamans *et al*. (2012; s = 0.884, SE = 0.020). An age ratio (a) and density dependent term (b) were estimated using the above equation and data from Lakes Erie, Huron, and Ontario; N_t = 2x number of nests each year, p = proportion of nests oiled each year; and h = number of individuals harvest each divided by N_t. Parameter estimates were: a = 0.5215 (SE = 0.1339); and b = -0.00000205 (SE = 0.00000116).

Uncertainty in parameter estimates, and harvest and egg oiling rates, was incorporated into projections using a simulation approach. Ten thousand simulations were executed for each harvest/oiling scenario. Parameter values for a, b, and s were randomly drawn from a normal distribution for each year in each simulation. Normal distributions for each parameter were based on estimated standard errors. Harvest and egg oiling rates were randomly drawn from a uniform distribution for each year in each simulation, with the distribution encompassing values 20% above and below target rates. Eighty percent confidence intervals were reported for scenario and projected values were rounded to the nearest 100.

We assumed that multiplying nest counts by 2 accurately represented the population of breeding individuals. Unless double-counting of nests is a serious problem, nest counts probably underrepresent the breeding population, because not all birds are likely to breed each year. Therefore, there likely are more birds than the counts suggest.

For projecting the population, we assumed that the abundance of breeding individuals in the Great Lakes was at or very near carrying capacity. Models of population dynamics suggested that the population in Lakes Erie, Huron, and Ontario was at carrying capacity (estimation of carrying capacity using logistic regression is not shown in our results). Further, Ridgway *et al*. (2006b) also estimated that the DCCO population in the northern portion of Lake Huron reached carrying capacity around 2003. Regardless of whether the Great Lakes population is slightly under or over carrying capacity, harvesting and egg oiling at constant rates will result in equilibrium populations similar to those represented in the text and figures.

The mean annual harvest rate (0.06) and egg oiling rate (0.14) from 2004-2009 from Lake Erie, Huron, and Ontario were used as baselines for simulations. However, it was not clear if the harvest reported for the Great Lakes accurately reflected the harvest of individuals from these population for two reasons. First, harvest of Great Lakes double-crested cormorants wintering in the southeastern U.S. also occurs but was not included during estimation of model parameters. It was not clear how many or at what rate individuals that breed in the Great Lakes are harvested in the Southeast.

Second, harvest reported from the Great Lakes likely includes non-breeders. This was also not accounted for; instead the total harvest was used for estimation of model parameters. Thus, it was not clear if harvest of breeding individuals should be adjusted upwards or downwards. However, because maximum population growth occurred before implementation of the 1999 and 2003 depredation orders, the estimate of carrying capacity (accounted for by the density dependent term in the population model) for the population is likely confounded by implementation of the depredation orders. In other words, it may be the carrying capacity is slightly higher than that estimated. If this is the case then the estimated population trajectories are conservative. If the carrying capacity is lower, then the equilibrium population sizes suggested by the trajectories will overestimate population size.

APPENDIX 4

Analysis of Prescribed Take Level for Double-crested Cormorants

Background

Wade (1998) developed Potential Biological Removal (PBR) as a risk assessment framework for incidental take of marine mammals. The goal of the PBR framework was to determine a limit to human-caused mortality that would ensure populations remain above the level of maximum net productivity. The PBR framework was precautionary in some ways given conservation concerns related to human-caused mortality of marine mammals and did not include cases in which management goals may include population reduction to reduce human-wildlife conflicts. Runge (2009) extended the PBR framework with a more explicit development related to harvest theory and yield curves, and provisions for population reduction as a management goal. The mortality limit define by the Runge *et al*. (2009) framework is called Potential Take Level (PTL) and is estimated by

$$PTL = \widetilde{N}\,\frac{\tilde{r}_{max}}{2}\,F_O \qquad (1),$$

where N is estimated population size, r_{max} is maximum population growth rate, and F_O is a factor between 0 and 2 related to management objectives; a tilde (~) indicates parameters sampled from uncertainty distributions (Runge *et al*. 2009). Management factor, F_O, is used to express desired long-term population size as a function of carrying capacity and target harvest rate as a function of population growth rate (Runge *et al*. 2009). With F_O = 1, harvest rate is ½ r_{max} and the equilibrium population size will be ½ K, where K is carrying capacity. For values of F_O between 0 and 1, harvest rate will be between 0 and ½ r_{max} and long-term population size will approach carrying capacity as F_O approaches 0. Alternatively, as F_O approaches 2, harvest rate will approach r_{max} and long-term population size will be a small fraction of carrying capacity (Runge *et al*. 2009). Thus F_O expresses overall management objective and desired long-term population size relative to carrying capacity.

Population size and growth rate are seldom known without error. The PTL framework provides a flexible means to accommodate uncertainty in population size and growth rate in a manner that reflects the decision maker's attitude to risk. As part of the PTL assessment, uncertain demographic variables are represented by probability distributions that reflect degree of uncertainty in their values. Using a Monte Carlo simulation, random values are drawn from each probability distribution and combined using equation 1 such that uncertainty in all parameters is propagated into the prescribed take level.

We used the PTL framework to assess allowable take of Double-crested Cormorants (*Phalacrocorax auritus*) in North America. In an attempt to provide an assessment that was consistent with the species biology and regional ecology, we made take assessments for two regions of North America: the combined Northeast and Central zones and the Southeast zone. We evaluated the same population data that were available for the 2009 Environmental Assessment and more recent population data compiled by L. R. Wires (*unpublished data*). We provide an assessment of allowable take that accounts for uncertainty in the population data and the demography of these populations. (Compare take that has occurred under PRDO and AQDO to estimates of allowable take under the PTL framework.)

Population Data and Management Objectives

Population size

We used two sources of population data and conducted two analyses of prescribed take level. Our first data source was Wetlands International (2006), who derived population size estimates from Hatch (1995). Hatch (1995) reported counts of breeding pairs and suggested that one to four nonbreeding birds per pair should be added to the breeders to estimate total population size. Hatch (1995) acknowledged that there was substantial uncertainty about the age distribution of these populations and that the number of nonbreeding birds per pair was not well known. Using the counts of breeding pairs provided by Hatch (1995), Wetlands International (2006) reported total population size for each region as a range bounded by low and high estimates (Table 1). The exact factor used to account for nonbreeding birds when extrapolating from the pair counts in Hatch (1995) was not provided by Wetlands International (2006).

Our second source of population data comprised more recent counts of breeding pairs conducted mainly between 2005 and 2012 and compiled by L. R. Wires (2014). Similar to the surveys reported by Hatch (1995), counts of breeding pairs were not always completed in the same year in all parts of a region; timing of surveys may have varied with a region; some counts were based on extrapolated older counts or other informed estimates; and in some cases breeding pairs were counted using different survey methods. Given uncertainty resulting from survey information, agencies and institutions monitoring cormorant populations in the Central and Southeast regions specified a range for number of breeding pairs; in the Northeast region a single estimate for number of breeding pairs, rather than a range, was provided by reporting agencies and cooperators. To account for nonbreeding individuals in the pair count data of Wires (2014), we derived a stable age distribution from a population projection model and results of Seamans *et al*. (2012). Seamans *et al*. (2012) estimated annual survival (± SE) of hatch year, second year, and after second year cormorants as S_{HY} = 0.45 ±0.02, S_{SY} = 0.84 ±0.03, and S_{ASY} = 0.88 ±0.02, respectively. To derive the stable age distribution and determine the proportion of nonbreeding birds, we use these estimates of annual survival and iteratively applied the post-breeding projection model

$$\begin{bmatrix} N_{HY}(t+1) \\ N_{SY}(t+1) \\ N_{ASY}(t+1) \end{bmatrix} = \begin{bmatrix} 0 & 0 & S_{ASY}b \\ S_{HY} & 0 & 0 \\ 0 & S_{SY} & S_{ASY} \end{bmatrix} \begin{bmatrix} N_{HY}(t) \\ N_{SY}(t) \\ N_{ASY}(t) \end{bmatrix} ,$$

to find a value of *b* (per capita number of chicks for ASY individuals) that resulted in a stable age distribution. Regardless of population growth rate, the relative sizes of adjacent age classes in a stable age distribution vary only with survival rate and not birth rates (Williams *et al*. 2002, p. 150). For a population with age-specific survival rates given above, b = 0.36 and the stable age distribution is [0.217, 0.098, 0.685]. Therefore, we multiplied the number of breeding pairs reported by Wires (2014) by a factor of 2.92 = 1/(0.685/2) to estimate total population size, breeders and nonbreeders.

Wetlands International (2006) reported population size estimates for Northeast and Central North America (N.A.) combined, corresponding to *P. a. auritus*, and for Southeast North America, corresponding to *P. a. floridanus* (Table 1); we estimated Prescribed Take Level for these two regions. Wires (2014) reported data broken down by three main regions: Central, Northeast, and Southeast N.A. (Table 1). We evaluated prescribed take level based for the three regions of Wires (2014) to take advantage of the extra information provided by this breakdown. However, to facilitate comparisons with the Wetlands International (2006) data, we also evaluated prescribe take levels after aggregating the Wires (2014) data into the same two regions: Northeast & Central N.A. combined and Southeast N.A.

Population growth rate.

Seamans *et al*. (*unpublished data*) estimated maximum population growth rate (r_{max}) for the Great Lakes region. Seamans *et al*. developed a population model of Double-crested Cormorants in order to assess the impacts of lethal control, including killing birds and oiling eggs in the nest. The population model was parameterized with nest census data, harvest data, and band recovery data. Outputs from the integrated population model included estimates of maximum population growth rate. Seamans *et al*. provide the 2.5%, 50%, and 97.5% percentiles of the posterior distribution of r_{max} as 0.131, 0.235, and 0.316, respectively. We used these percentiles and a quantile matching approach to estimate the mean and standard deviation of the posterior distribution of r_{max}; quantile matching was carried out using the “fitdist” function in R. Quantile matching suggested that the mean and standard deviation of r_{max} were 0.224 and 0.045, respectively. At each iteration of our simulation, we therefore sampled r_{max} from a Normal distribution with mean $\mu_{r_{max}}$ equal to 0.224 and standard deviation $\sigma_{r_{max}}$ equal to 0.045. The same uncertainty distribution for r_{max} was used for all regions in our analysis.

Management Factor F_O.

Decision makers must choose a value for management factor F_O in order to calculate allowable take in a manner consistent with management objectives and what is known about population status (and the degree of uncertainty in available information on population status). Originally called “recovery factor” in the development of Wade (1998), this factor was designed as an additional measure of conservatism to the assessment of allowable human-caused mortality of marine mammals. In the case of rare, declining or otherwise at risk species of conservation concern, it may be appropriate for managers to set F_O below 1 to ensure that populations will reach and maintain a level above maximum net productivity (Johnson *et al*. 2012); Wade (1998) suggested that a recovery factor between 0.1 and 1 was appropriate for marine mammals. The management factor F_O of Runge *et al*. (2009) provides a more comprehensive treatment of management objectives, including cases where population control may be a management objective. In the case of wildlife-human conflicts and when population reduction may be a management goal, it may be appropriate to choose a value for F_O greater than 1.0 (Runge *et al*. 2009, Johnson *et al*. 2012). It is possible to express target harvest level and long-term equilibrium population size in terms of management factor F_O (Runge *et al*. 2009). Target harvest rate using the PTL framework is

$$h = \frac{r_{max}}{2} F_O$$

and equilibrium population size as a fraction of carrying capacity is

$$\frac{N_{eq}}{K} = 1 - \frac{F_O}{2}$$

where N_{eq} is equilibrium population size and K is carrying capacity (Runge *et al*. 2009). In our assessment of allowable take of cormorants, we evaluated a range of values for management factor, including 0.5, 1.0, 1.5, and 2.0.

Monte Carlo Simulation Model to Determine Prescribed Take Level

Model description.

We used a Monte Carlo simulation approach in which we sampled from uncertainty distributions for key parameters and propagated uncertainty into estimates of prescribed take level. When a range of values was available to represent uncertainty in population size, we sampled from a uniform distribution bounded by the lower and upper ends of the range. This process allowed for uncertainty related to incomplete counts, counts completed in different years, *etc*. We also allowed for uncertainty related to the count or observation process; we included multiplicative, random observation error, $\theta \sim Normal(0, \sigma_{obs}^2)$, with σ_{obs}^2 drawn from a uniform distribution between 0.2 and 0.4 (i.e., observation error produced a CV = 20 – 40%). Population growth rate was sampled from a normal distribution with mean and SD based on results of Seamans *et al*. (*unpublished data*). Our final model then to assess allowable take of cormorants while accounting for uncertainty in population size, survey sampling error, observation error, and uncertainty related to population growth rate was:

$$N = Cexp(\theta)$$
$$C \sim Uniform(C_{low}, C_{high})$$
$$\theta \sim Normal(0, \sigma_{obs}^2)$$
$$\sigma_{obs} \sim Uniform(0.20, 0.40)$$
$$r_{max} \sim Normal(\mu_{r_{max}}, \sigma_{r_{max}}^2),$$

A simulation with 10,000 iterations from the model above was used to estimate Prescribed Take Level for each both the Northeast/Central and Southeast regions using equation 1 (see Appendix).

Allowable take of Double-crested Cormorants in North America

Population growth.

Population growth was represented in the assessment of prescribed take using the uncertainty distribution in Figure 4-1. Mean (± SD) population growth was 0.224 (± 0.045); the central 50% of values used in the simulation were between 0.193 and 0.254.

Allowable take using the population data of Wetlands International (2006).

For the Northeast and Central region, with F_O = 1.0 (target harvest rate of ½ r_{max}) take of < 154,188 birds will ensure long-term population size close to K/2 (Table 2). For the Southeast region, with the same target harvest rate and F_O = 1.0, take of < 5,998 birds would ensure that long-term population size was close to K/2 (Table 2).

Allowable take of cormorants using the population data of Wires (2014).

Population estimates of Wires (2014) are in most cases smaller than estimates by Wetlands International (2006; Table 1), and allowable take estimates are therefore smaller when based on these data. In the Northeast and Central zone, with F_O = 1.0 (target harvest rate of ½ r_{max}), take of < 109,309 birds will ensure long-term population size close to K/2 (Table 3). In the Southeast region, with F_O = 1.0 (target harvest rate of ½ r_{max}), take of < 2,584 birds will ensure long-term population size close to K/2.

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Table 4-1. Regional population estimates (breeders and nonbreeders). Wires (2014) reported breeding pairs; population size calculated as number of breeding pairs × 2.92 (see text). Data sources: Wires (need book citation); WPE4 is Wetlands International 2006.

Region	Population size			
	Wires		WPE4	
	Low	High	Low	High
Northeast North America				
Atlantic Canada[1]	112,356	112,356		
Quebec[2]	81,150	81,150		
Atlantic US[3]	79,850	79,850		
Northeast Subtotal	*273,356*	*273,356*		
Central North America				
Canada[4]	466,184	489,544		
US[5]	231,016	245,131		
Central NA Subtotal	*697,200*	*734,675*		
NE & Central Subtotal	970,556	1,008,031	943,000	1,890,000
Southeast US[6]	22,732	23,754	37,000	73,000

[1] 1990s-2011, range (low & high estimates) not available
[2] 2007-2011, range not available
[3] mostly 2006-2011, range not available
[4] mostly 2006-2012
[5] mostly 2005-2011
[6] most birds in FL, no survey there since 1999

Table 4-2. Prescribed Take Level (number of individuals) for two region s of North America based on population data from Wetlands International (2006; see Table 1).

F_O	Median	2.5%	97.5%
Northeast and Central			
0.5	76,304	33,730	167,579
1.0	154,188	65,858	340,142
1.5	230,942	98,434	508,839
2.0	307,267	129,858	676,257
Southeast			
0.5	2,987	1,271	6,595
1.0	5,998	2,528	13,073
1.5	8,946	3,815	19,601
2.0	11,998	5,130	27,012

Table 4-3. Prescribed Take Level (number of individuals) for two regions of North America, based on population data from Wires (2014; see Table 1).

F_O	Median	2.5%	97.5%
Northeast and Central			
0.5	54,407	25,227	110,945
1.0	109,309	50,399	219,474
1.5	164,184	75,690	338,924
2.0	217,784	102,421	444,089
Southeast			
0.5	1,294	601	2,607
1.0	2,584	1,191	5,109
1.5	3,846	1,802	7,787
2.0	5,131	2,369	10,433

Table 4-4. Prescribed Take Level (number of individuals) for three regions of North America, based on population data from Wires (2014; see Table 1).

F_O	Median	2.5%	97.5%
Northeast			
0.5	15,049	7,010	30,884
1.0	30,602	14,381	60,496
1.5	45,372	20,936	92,461
2.0	60,230	28,074	121,939
Central			
0.5	39,338	18,276	80,402
1.0	79,082	36,450	158,859
1.5	118,898	54,744	244,796
2.0	157,634	74,020	321,549
Southeast			
0.5	1,287	601	2,569
1.0	2,556	1,227	5,091
1.5	3,885	1,799	7,809
2.0	5,128	2,353	10,530

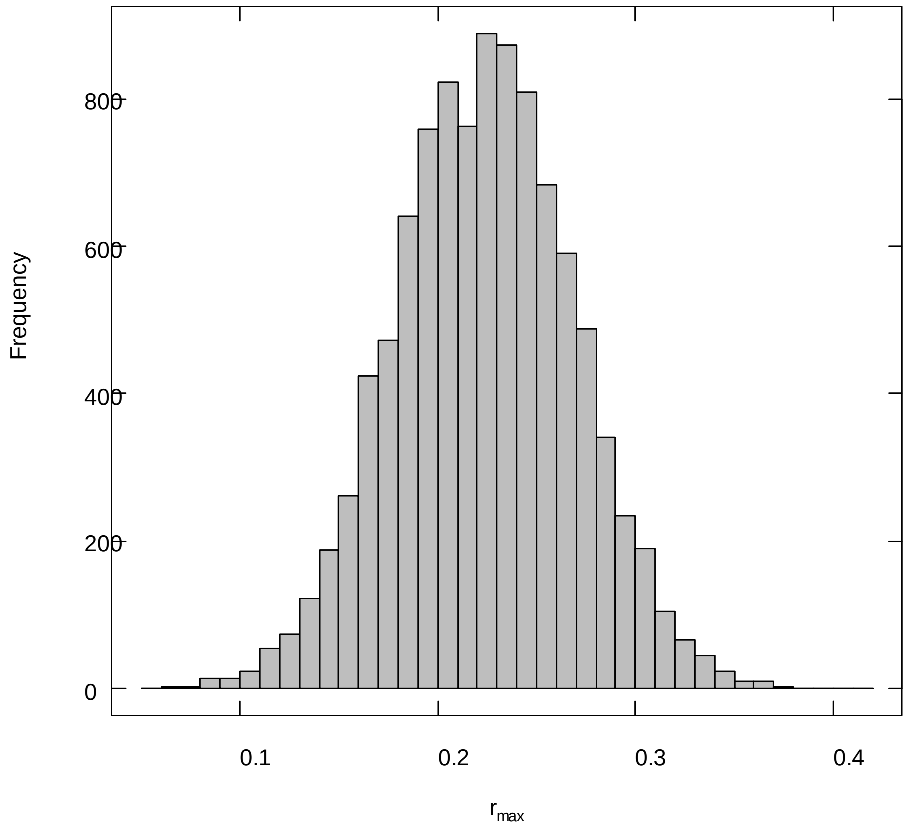

Figure 4-1. Probability distribution for maximum population growth rate of Double-crested Cormorants used in assessment of allowable take. Uncertainty if population growth rate is based on results of Seamans *et al*. (*unpublished data*).

R code for Monte Carlo simulation of Prescribed Take Level.

```
Library (fitdistrplus)

Counts <- read.csv("Pop Estimates Draft EA.csv")

n.sim <- 10000
Fvec <- c(0.5, 1.0, 1.5, 2.0)
# w is r-max%tiles (2.5%, 50%, 97.5%) from Seamans et al.
w <- c(0.131, 0.235, 0.316)
fdobj <- fitdist(w, "norm", method="qme", probs=c(0.025,0.975))
rmparms <- fdobj$estimate

PTL <- array(NA, dim=list(n.sim, length(Fvec), dim(Counts)[1]))

CC <- numeric()
logCC <- numeric()
theta <- numeric()
sigma.obs <- numeric()
logN <- numeric()
rmax <- numeric()

for (k in 1:dim(PTL)[3]) {
  for (j in 1:length(Fvec)) {
    for (i in 1:n.sim) {
      CC[i] <- runif(1, Counts[k,"lower"], Counts[k,"upper"])
      logCC[i] <- log(CC[i])
      sigma.obs[i] <- runif(1, 0.2, 0.4)
      theta[i] <- rnorm(1, 0, sigma.obs[i])
      logN[i] <- logCC[i] + theta[i]
      rmax[i] <- rnorm(1, rmparms[1], rmparms[2])
      PTL[i,j,k] <- exp(logN[i])*(0.5*rmax[i])*Fvec[j]
      } # i
    } # j
  } # k
```

DIVISION OF MIGRATORY BIRD MANAGEMENT