2003

# Final Environment Impact Statement: Double-crested Cormorant Management in the United States

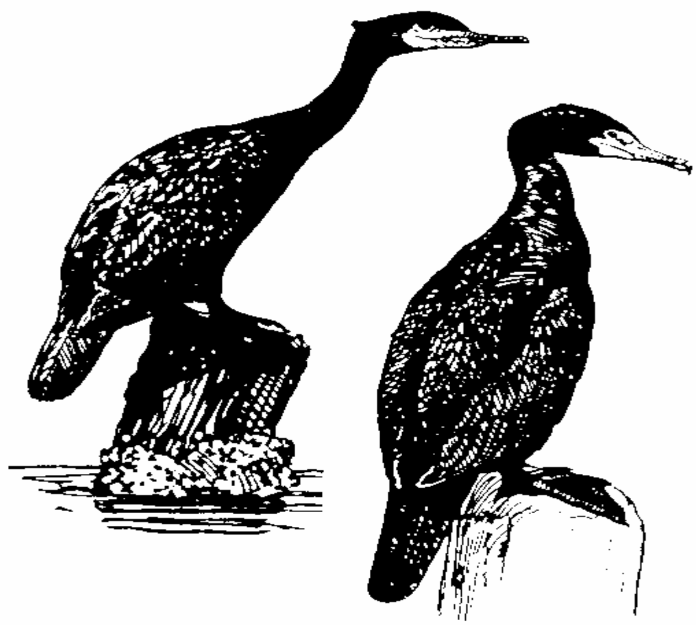
Shauna Hanisch
*U.S. Fish and Wildlife Service*, Shauna_Hanisch@fws.gov

Brian Millsap
*U.S. Fish and Wildlife Service*, brian_a_millsap@fws.gov

U.S. Fish and Wildlife Service

# Final Environmental Impact Statement

*Double-crested Cormorant Management in the United States*



**U.S. Department of Interior Fish and Wildlife Service**
"Working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people"

*in cooperation with*

**U.S. Department of Agriculture APHIS Wildlife Services**
"Providing leadership in wildlife damage management in the protection of America's agricultural, industrial and natural resources, and safeguarding public health and safety"

**2003**

**FINAL ENVIRONMENTAL IMPACT STATEMENT:**
***Double-crested Cormorant Management***

| | |
|---|---|
| RESPONSIBLE AGENCY: | Department of the Interior<br>U.S. Fish and Wildlife Service |
| COOPERATING AGENCY: | Department of Agriculture<br>Animal and Plant Health Inspection Service<br>Wildlife Services |
| RESPONSIBLE OFFICIAL: | Steve Williams, Director<br>U.S. Fish and Wildlife Service<br>Main Interior Building<br>1849 C Street<br>Washington, D.C. 20240 |
| FOR FURTHER INFORMATION CONTACT: | Shauna Hanisch, EIS Project Manager<br>Division of Migratory Bird Management<br>U.S. Fish and Wildlife Service<br>4401 N. Fairfax Drive MS-MBSP-4107<br>Arlington, Virginia 22203<br>(703) 358-1714<br><br>Brian Millsap, Chief<br>Division of Migratory Bird Management<br>U.S. Fish and Wildlife Service<br>4401 N. Fairfax Drive MS-MBSP-4107<br>Arlington, Virginia 22203<br>(703) 358-1714 |

**SUMMARY**

Populations of Double-crested Cormorants have been increasing rapidly in many parts of the U.S. since the mid-1970s. This abundance has led to increased conflicts, both real and perceived, with various biological and socioeconomic resources, including recreational fisheries, other birds, vegetation, and hatchery and commercial aquaculture production. This document describes and evaluates six alternatives (including the proposed action) for the purposes of reducing conflicts associated with cormorants, enhancing the flexibility of natural resource agencies to deal with cormorant conflicts, and ensuring the long-term conservation of cormorant populations. There are four chapters that make up the critical components of an Environmental Impact Statement. Chapter 1, *Purpose and Need*, describes the purpose of and need for the action. Chapter 2, *Alternatives*, describes the six management alternatives that we considered: (1) Continue current cormorant management practices (No Action); (2) implement only non-lethal management techniques; (3) expand current cormorant damage management practices; (4) establish a new depredation order to address public resource conflicts (PROPOSED ACTION); (5) reduce regional cormorant populations; and (6) establish frameworks for a cormorant hunting season. Chapter 3, *Affected Environment*, introduces the reader to the environmental categories upon which the analysis of alternatives in chapter 4 is based: cormorant populations, fish, other birds, vegetation, Federally-listed Threatened and Endangered species, water quality and human health, economic impacts, fish hatcheries and environmental justice, property losses, and existence and aesthetic values. Chapter 4, *Environmental Consequences*, analyzes the predicted impacts of each alternative on the environmental categories outlined in chapter 3 and in comparison to the No Action alternative. The environmental analysis presented in Chapter 4 indicates that the PROPOSED ACTION: will cause the estimated take of <160,000 DCCOs, which is not predicted to have a significant negative impact on regional or continental DCCO populations; will cause localized disturbances to other birds but these can be minimized by taking preventive measures, leading to the action having beneficial effects overall; will help reduce localized fishery and vegetation impacts; will not adversely affect any Federally-listed species; is likely to help reduce localized water quality impacts; will help reduce depredation of aquaculture and hatchery stock; is not likely to significantly benefit recreational fishing economies or commercial fishing; may indirectly reduce property damages; and will have variable effects on existence and aesthetic values, depending on perspective.

# TABLE OF CONTENTS

# CHAPTER 1: PURPOSE OF AND NEED FOR ACTION

## 1.1 Introduction

The persistence of conflicts associated with Double-crested Cormorants (hereafter, DCCOs or cormorants; see Appendix 1 for a list of scientific names), widespread public and agency dissatisfaction with the status quo, and the desire to develop a more consistent and effective management strategy for DCCOs led the U.S. Fish & Wildlife Service (Service or we) to reexamine, and if deemed necessary, to amend our policies and practices for the management of cormorants in the contiguous United States.

We chose to prepare an Environmental Impact Statement (EIS), as suggested by National Environmental Policy Act (NEPA) guidelines, including: (1) Council on Environmental Quality (CEQ) regulations in 40 CFR 1508.18, which define a "major Federal action" as "adoption of formal plans, such as official documents prepared or approved by Federal agencies which guide or prescribe alternative uses of Federal resources, upon which future agency actions will be based;" and (2) Service policy in section 550FW 3.3B(2) which states that criteria triggering the preparation of an EIS include precedent-setting actions with wide-reaching or long-term implications, changes in Service policy having a major positive or negative environmental effect, and/or conflicts with local, regional, State or Federal proposed or adopted plans or policies.

As stated in 40 CFR 1502.1, the purpose of an EIS is to provide a detailed explanation of the significant environmental consequences, both good and bad, of a proposed action. This explanation includes significant effects on the natural, economic, social, and cultural resources of the affected environment. An EIS is to be prepared to inform decision-makers and the public of the proposed action and its reasonable alternatives. It should focus on *significant* environmental issues. This Final EIS (FEIS) identifies and provides an evaluation of six alternative approaches for managing DCCOs, including the proposed action (Alternative D). Each alternative is analyzed based on anticipated impacts to various biological and socioeconomic impact areas. This FEIS is a comprehensive, programmatic plan intended to guide and direct DCCO management activities in the 48 States (excluding Hawaii and Alaska). Where NEPA analysis is suggested or required for site-specific control projects carried out under the guidance of this document, analyses would "tier to" or reference the FEIS. Site-specific NEPA analysis would focus on issues, alternatives, and environmental effects unique to the project.

Because of the important role of the Wildlife Services program of the USDA Animal and Plant Health Inspection Service (APHIS/WS) in DCCO management and research, and the need for interagency coordination in developing future cormorant management strategies, this FEIS is being prepared cooperatively by the Service and APHIS/WS.

This section of the FEIS discusses the purpose of and need for the action, gives background information on the lead and cooperating agencies and the legal and policy context of the action, describes current DCCO management activities, and summarizes public involvement in this issue.

## 1.2 Purpose of Action

In recent years, increasing populations of DCCOs have led to growing concern from the public and natural resource management professionals about impacts of DCCOs on various human and natural resources. Based on internal and interagency scoping and the direction set forth in 40 CFR 1508.18 and 550 FFW3.3B (described in further detail below), we published a Notice of Intent in the Federal Register on November 8, 1999 (64 FR 60826) announcing that we would prepare, in cooperation with APHIS/WS, an EIS and national management plan "to [address] impacts caused by population and range expansion of the double-crested cormorant in the contiguous United States."

The purpose of the proposed action is threefold: to reduce resource conflicts associated with DCCOs in the contiguous United States, to enhance the flexibility of natural resource agencies in dealing with DCCO-related resource conflicts, and to ensure the long-term conservation of DCCO populations.

## 1.3 Need for Action

While cormorant-human conflicts are not new, from either a historical or a global perspective (Siegel-Causey 1999; Hatch 1995, van Eerden et al. 1995, Wires et al. 2001), the DCCO's rapid population increase over the past 25 years has brought these conflicts in the U.S. to the point of justifying greater management attention. There is a need for the Service to allow others to conduct DCCO control to limit negative impacts to the maximum extent practicable.

The issue of "need" can also be considered from the perspective of other agencies and parties with a stake in DCCO management. APHIS/WS issued a position statement emphasizing the need for scientifically-based DCCO population reduction in order to reduce impacts to aquaculture producers and other resources. Of the 27 States that commented during the public scoping period, 16 of these expressed desire for increased management flexibility and/or greater population management of DCCOs. Many non-agency stakeholders also stated that there is a need for increased DCCO control to reduce resource impacts.

### 1.3.1 Biological

The recent increase in the North American DCCO population, and subsequent range expansion, has been well-documented (Scharf and Shugart 1981, Milton and Austin-Smith 1983, Buckley and Buckley 1984, Hatch 1984, Ludwig 1984, Blokpoel and Harfenist 1986, Price and Weseloh 1986, Roney 1986, Craven and Lev 1987, Hobson et al. 1989, Hatch 1995, Weseloh et al. 1995, Glahn et al. 1999, Tyson et al. 1999, Hatch and Weseloh 1999, Wires et al. 2001). There is a need to reduce the biological impacts resulting from this population increase which include: adverse effects on other bird species through habitat destruction, exclusion, and/or nest competition; declines in fish populations associated with DCCO predation; destruction of vegetation, particularly where DCCOs nest; and predation on Federally-listed fish species. There is a need to provide for localized variation in DCCO control because the occurrence and severity of these impacts varies from region to region.

### 1.3.2 Socioeconomic

Socioeconomic impacts include economic losses to aquaculture producers, commercial fisheries, and fishing-related businesses; losses to private resources (including fish in private lakes and damaged trees); and compromised water quality. As with biological impacts, the occurrence and severity of these impacts varies from region to region. There is a need to reduce these impacts.

## 1.4 Background Information

### 1.4.1 Lead and Cooperating Agencies

*USDI Fish and Wildlife Service.* The primary responsibility of the Service is fish, wildlife, and plant conservation. Our mission is "working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." While some of the Service's responsibilities are shared with other Federal, State, Tribal, and local entities, we have special authorities in managing the National Wildlife Refuge System; conserving migratory birds, endangered species, certain marine mammals, and nationally significant fisheries; and enforcing Federal wildlife laws. The Division of Migratory Bird Management mission is "providing global leadership in the conservation and management of migratory birds for present and future generations." One of the Service's long-term goals, as stated in the 2000-2005 Service Strategic Plan, is "migratory bird conservation." The purpose of this goal is "to improve the status of migratory bird populations that have evidenced decline or other significant problems, including overabundance."

*USDA Animal and Plant Health Inspection Service-Wildlife Services.* The Wildlife Services program of the U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS/WS) is responsible for managing conflicts with and damages caused by wildlife, including migratory birds. APHIS/WS' mission is to "provide leadership in wildlife damage management in the protection of America's agricultural, industrial and natural resources, and to safeguard public health and safety." This is accomplished through: training of wildlife damage management professionals; development and improvement of strategies to reduce economic losses and threats to humans from wildlife; collection, evaluation, and dissemination of management information; cooperative wildlife damage management programs; informing and educating the public on how to reduce wildlife damage and; providing data and a source for limited use management materials and equipment, including pesticides (USDA-APHIS 1989).

### 1.4.2 Policy, Authority, and Legal Compliance

*Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. 703-711: 40 Stat. 755).*
The Service has the primary statutory authority to manage migratory bird populations in the United States, 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 in later years. 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" (23 U.S.T. 260, T.I.A.S. 7302). Thus, since 1972, DCCOs have been a trust resource managed by the Service for the American people under the authority of the MBTA.

*Animal Damage Control Act of 1931 and Rural Development, Agriculture, and Related Agencies Appropriations Act of 1988 (7 U.S.C. 426-426c; 46 Stat. 1468).*
The U.S. Department of Agriculture is directed by law to protect American agriculture and other resources from damage associated with wildlife. The primary statutory authority for the APHIS/WS program is the Animal Damage Control Act of March 2, 1931 (7 U.S.C. 426-426c; 46 Stat. 1468), as amended in the Fiscal Year 2001 Agriculture Appropriations Bill, which provides that:

The Secretary of Agriculture may conduct a program of wildlife services with respect to injurious animal species and take any action the Secretary considers necessary in conducting the program. The Secretary shall administer the program in a manner consistent with all of the wildlife services authorities in effect on the day before the date of the enactment of the Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act, 2001.

Since 1931, with the changes in societal values, APHIS/WS policies and programs place greater emphasis on the part of the Act discussing "bringing [damage] under control," rather than "eradication" and "suppression" of wildlife populations. In 1988, Congress strengthened the legislative mandate of APHIS/WS with the Rural Development, Agriculture, and Related Agencies Appropriations Act. This Act states, in part:

That hereafter, the Secretary of Agriculture is authorized, except for urban rodent control, to conduct activities and to enter into agreements with States, local jurisdictions, individuals, and public and private agencies, organizations, and institutions in the control of nuisance mammals and birds and those mammal and bird species that are reservoirs for zoonotic diseases, and to deposit any money collected under any such agreement into the appropriation accounts that incur the costs to be available immediately and to remain available until expended for Animal Damage Control activities.

*Endangered Species Act (ESA), as amended (7 U.S.C. 136; 16 U.S.C. 460 et seq.).*
It is Federal policy, under the ESA, that all Federal agencies seek to conserve threatened and endangered species and utilize their authorities in furtherance of the purposes of the Act (Sec.2(c)). In accordance with section 7 of the Act, the Service has prepared a Biological Evaluation and conducted informal consultation with the Service Endangered Species Program to evaluate Federally-listed species that may be affected by the proposed action.

*National Environmental Policy Act of 1969 (NEPA), as amended (42 U.S.C. 4321-4347).*
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 before actions are taken.

In general, the NEPA process entails: determining what need must be addressed; identifying alternative ways of meeting the need; analyzing the environmental impacts of each alternative; and deciding which alternative to pursue and how. While NEPA does not place environmental protection over all other public values, it does require a thorough consideration of the environmental impacts associated with management actions. 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 (http://npi.org/nepa/process.html).

More specifically, there are seven major steps in the planning process for the development of an EIS and the implementation of the proposed action. These include:
1) Publication of Notice of Intent – The Notice of Intent to prepare an Environmental Impact Statement and national cormorant management plan was published in the Federal Register (64 FR 60826) on November 8, 1999. This initiated the scoping process.

2) Identification of Issues and Concerns – The Notice of Intent solicited public participation in the scoping process, which is the chief way that issues, concerns, and potential management options are communicated from the public to the lead agency. In addition to writing or e-mailing comments, citizens could attend any of twelve public meetings held across the country. The scoping period ended on June 30, 2000. All comments were read, compiled, and summarized in a public scoping report.

3) Development of Alternatives – Following scoping, six alternatives were developed to offer a range of options for managing DCCOs. These were based on NEPA regulations, public comments, interagency meetings, internal discussion, and review of available scientific information.

4) Analysis of Environmental Effects – After significant issues and alternatives were established, the environmental analysis was prepared in order to help the public and decision-makers understand the environmental consequences of the various alternatives.

5) Publication of Notice of Availability of Draft Environmental Impact Statement – The notice of availability for the DEIS was published in the Federal Register on December 3, 2001 (66 FR 60218) and announced the completion of the DEIS and its availability for public review. It was followed by 10 public meetings and a 100-day comment period.

6) Publication of Notice of Availability of Final Environmental Impact Statement – This Federal Register publication follows the public comment period for the DEIS and announces the completion of the Final EIS, followed by a 30-day waiting period.

7) Publication of Record of Decision – This is the final step of the EIS decision-making process, which states the selected alternative and why it was chosen. The actions associated with the EIS cannot be taken until the Record of Decision is issued.

*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.

*Executive Order 13186.* Executive Order 13186, entitled "Responsibilities of Federal Agencies to Protect Migratory Birds," directs any Federal agency whose actions have a measurable negative impact on migratory bird populations to develop a Memorandum of Understanding (MOU) with the Service to promote conservation of migratory birds. The MOUs would identify positive actions that Federal agencies can apply to ensure their activities consider the conservation of migratory birds. The Executive Order (EO) also requires the Secretary of Interior to establish a Council for the Conservation of Migratory Birds to oversee implementation of the EO. The council will be composed of representatives from the Departments of Interior, Commerce, Agriculture, State, Transportation, Energy, and Defense; the Environmental Protection Agency; and other agencies as appropriate.

### 1.4.3 Other Considerations

*Conceptual Foundations.* "Conceptual foundations" are the set of principles and assumptions that direct management activities (Anderson 1991). They influence how we interpret information, identify problems, and select approaches to their resolution (ISG 1999). Similarly, they are an expression of agency goals and philosophy, which guide management decisions. The following five statements form the conceptual foundations on which DCCO management is based:

(1) DCCOs are an international migratory bird resource and as such they have inherent value regardless of their direct use to humans;
(2) While DCCOs have undergone recent range expansions, they are *native* to North America;
(3) DCCOs are predators that, while a natural part of the ecosystem, can compete with humans for fisheries, with consequences of varying ecological and socioeconomic significance;
(4) DCCO populations have increased significantly in the past 25 years in North America and this increase has led to both real and perceived resource conflicts;
(5) There are sound biological and socioeconomic rationales for developing a comprehensive DCCO management strategy in the U.S.

*Human Dimensions.* Wildlife management is fundamentally a human, or social, construct. One popular introductory wildlife ecology text noted that, "the practice of wildlife management is rooted in the intermingling of human ethics, culture, [and] perceptions" (Robinson and Bolen 1989). As human populations have grown and placed greater demands on nature, and as human values toward wildlife resources have become increasingly diverse, the need to better understand the "human dimensions" side of

wildlife management has increased. Human dimensions entail "identifying what people think and do regarding wildlife, understanding why, and incorporating that insight into policy and management decision-making processes and programs" (Decker and Lipscomb 1991). Thus, human dimensions address the *social* nature of today's natural resource problems (Manfredo et al. 1998), with particular relevance to "people-wildlife problems" in which the behavior of wildlife creates a negative impact for some stakeholders, or is perceived by some stakeholders as having adverse impacts (Decker and Chase 1997). In a paper discussing the "social causes of the cormorant revival in the Netherlands" (where Great Cormorants have become an overabundant species) the authors (van Bommel et al. 2003) stated:

> Ecological processes determine the potential cormorant population but social processes play a large role in determining the actual cormorant population. Ecological systems function within the subjective boundaries set by [people]… A problem situation can occur in which different parties disagree on the definition of these boundaries (Pretty 1995, Pimbert and Pretty 1995). This is often the case in nature conservation because ecosystems carry a high level of intrinsic uncertainty… When dealing with these uncertainties, people will have different views and opinions on reality.

At a 1998 workshop on cormorant management in New York, participants agreed that human dimensions are important in the DCCO issue because: (1) economics and recreation are important factors; (2) it is an emotional issue that can cause polarization; and (3) it accentuates the conflict between politics and science-based management. For these reasons and others, the DCCO conflict can be viewed as a classic "people-wildlife problem," entailing both biological and social elements. The social element is made prominent by the fact that, just as with other examples of abundant species management, from white-tailed deer to Canada Geese, public perception of the proper way to deal with the problem varies considerably. Conover (2002) wrote that the government's role in wildlife management is "to regulate the harvest of wildlife by people, to restrict human behavior that would be detrimental to the wildlife resource, to conduct largescale management activities, and to manage wildlife for the benefit of society." Naturally, the difficulty in doing so is because society is made up of diverse individuals who vary in their perceptions of wildlife and how they want that resource managed. When conflicts occur between wildlife and other resources that humans value, wildlife damage management decisions must be made; these are difficult decisions to make because stakeholder opinions are often highly polarized.

In regard to societal expectations in natural resource controversies, the Great Lakes Fishery Resources Restoration Study (USFWS 1995), in a discussion on decision-making and public expectations, stated:

> When different segments of society place competing demands on nature, conflicts are inevitable and often contentious... Agencies and publics are often prevented from realizing resource potential when special interest groups fail to recognize public trust responsibilities…and the legitimacy and roles of other users.

The director of the Montana Department of Fish, Wildlife, and Parks, in the July/August 2002 edition of Montana Outdoors, succinctly described the unique position of public agencies when he wrote:

> Some have accused us of [being extreme], of being far too biased on one issue or another. Usually the charge comes from those who disagree with our position… The fact is, we're rarely on the extreme ends of any issue. Nor should we be. We're a public agency representing the diverse interests of all [Americans]. Not just the ones who yell the loudest. Not just the ones with the most money and political clout. And not just the ones who buy licenses. What that means is that we often take a moderate position on issues. If it appears that we ever go "too far" on any issue or policy, believe me when I say that I could always find a group of citizens angry that we didn't go nearly far enough… No matter how hard we try, we won't be able to make everyone happy. There will always be committed, well-meaning people on either side of an issue who think we either sold out and didn't do enough—or that we went way too far.

In sum, management of abundant wildlife populations is a particularly challenging aspect of wildlife conservation, one that demands that decision-makers consider a number of important biological and socioeconomic factors. As a public agency, the Service recognizes the importance of social, political, and economic factors in policy-making, but emphasizes that the foundation of the Service's mission is fish and wildlife biology. Thus we are committed to pursuing biologically justified management strategies that are based on the best available science and, additionally, on the knowledge and experience of wildlife resource professionals. It is here where Romesburg's (1981) advice that "science and planning are different kinds of decision-making" is most relevant. Planning is the domain of wildlife management and it:

> exposes alternative images of a future possible world to the decision-maker's values, or preferences, and selects the best image…the images in planning are composed of scientific knowledge, common sense, rule-of-thumb knowledge, and theories that are as yet untested… Although science and planning share common tools, science and planning have different norms for certifying ideas, and hence criticism of these tools must take into account the domain of their use.

The Service and APHIS/WS recognize both the controversial nature of DCCO management and the range of values reflected in public and professional views about best management actions. This FEIS reflects full consideration of the diverse views brought forth during public scoping and the DEIS comment period and provides an analytical foundation on which to base final management decisions.

### 1.4.4 Cormorant Management Practices

*Depredation Permits.* While the MBTA provides migratory birds with protection from unauthorized take, it maintains a high degree of flexibility for dealing with human-bird conflicts (Trapp et al. 1995). According to the MBTA, the "take" of DCCOs is strictly prohibited except as allowed under the terms of a migratory bird permit or pursuant to regulations.

Depredation permits to take DCCOs have been issued by the Service since 1986 and may allow the take of eggs, adults and young, or active nests. Guidelines governing permit issuance for migratory birds are authorized by the MBTA and subsequent regulations (50 CFR Parts 13 and 21). Specifically, Part 21.41 of Subpart D of these regulations outlines procedures for issuing permits for the control of depredating birds. These regulations state that all private individuals, organizations, and Federal and State agencies seeking to control migratory birds must file an application for a depredation permit that contains the following information: (1) a description of the area where depredations are occurring; (2) the nature of the crops or other interests being injured; (3) the extent of such injury; and

(4) the particular species of migratory birds committing the injury. Thus, Part 21.41 authorizes the take of migratory birds that are injuring “crops or other interests.” In issuing depredation permits, the Service has historically interpreted “other interests” to mean threatened and endangered species, property damage on private or public land, and human health and safety, although permits have been issued to protect natural resources. In 1990, Director’s Order No. 27 was instated which clarifies that the Service can issue depredation permits for migratory, fish-eating birds preying on fish aquaculture and hatchery facilities.

APHIS/WS typically responds to requests for assistance with bird depredation and damage by collecting information on the type of resource being damaged, where the damage is occurring, the number and species of birds responsible for the damage, the economic losses resulting from the damage, and the control methods which have been used in attempting to resolve the damage. Based upon these evaluations, APHIS/WS personnel recommend an Integrated Damage Management approach for resolving bird depredation and damage conflicts, which could include providing recommendations to the Service for issuance of a depredation permit. While APHIS/WS provides recommendations to the Service for the issuance of migratory bird depredation permits to private entities in the cases of severe bird depredation and damage (Mastrangelo et al. 1997), the responsibility of issuing these permits rests solely with the Service (Trapp et al. 1995). In most States, a permit is also needed from the State fish and wildlife agency.

APHIS/WS maintains a Management Information System (MIS) database documenting the assistance that the agency provides in resolving wildlife damage conflicts. A review of MIS data collected from FY 1995-2001 revealed that the agency responded to 1,916 technical assistance requests (“the provision of advice, recommendations, information, or materials for use in managing wildlife damage problems” [USDA-APHIS 1997b]) to reduce DCCO conflicts in 42 States, with Alabama, Arkansas, Florida, Louisiana, Mississippi, and Texas representing 65 percent of the requests over the 7-year period. MIS resource categories included aquaculture (commercially propagated finfish and shellfish) with 72 percent of technical assistance requests; natural resources (habitat, wildlife, wild fisheries) with 19 percent of requests; property (structures, boats, automobiles, aircraft, pets, timber/trees) with 6 percent of requests; and human health and safety (disease transmission to humans, wildlife aircraft strikes, direct personal injury) with 3 percent of requests. Of those 1,916 requests, APHIS/WS recommended the issuance of 533 depredation permits to the Service, of which over 95 percent were for the protection of aquaculture and natural resources.

*Depredation Order*. In 1998, the Service issued a depredation order (USFWS 1998b; 50 CFR 21.47 ) authorizing commercial freshwater aquaculture producers in 13 States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Minnesota, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas) to take DCCOs, without a Federal permit, when found committing or about to commit depredations to aquaculture stocks. The depredation order states that DCCOs may be taken by shooting only during daylight hours, and only when necessary to protect freshwater commercial

aquaculture and State-operated hatchery stocks and that such actions must be carried out in conjunction with a non-lethal harassment program certified by APHIS/WS officials.

*Research and Population Surveys.* Prior to 1950, the U.S. Biological Survey (predecessor of the Fish and Wildlife Service) conducted extensive food habits studies on DCCOs and other fish-eating birds across the continent, with particular emphasis on potential economic impacts. More recently, the Service has conducted or funded several site-specific studies of cormorant food habits in areas such as the Penobscot River and upper Penobscot Bay, Maine; Les Cheneaux Islands, Michigan; and the Mississippi River Delta, Mississippi. In 1999, the Service provided funding for a DCCO population status assessment to be prepared by researchers from the University of Minnesota and utilized in the development of this EIS (Wires et al. 2001). This report, "The Status of the Double-Crested Cormorant *(Phalacrocorax auritus)* in North America," is available online at http://migratorybirds.fws.gov/issues/cormorant/status.pdf.

DCCO population monitoring is carried out cooperatively by the Service, APHIS/WS, the Canadian Wildlife Service, the States, and various universities. The U.S. Geological Survey (Patuxent Wildlife Research Center) and non-governmental organizations participate in recording and analyzing the population data. The various types of surveys include the Great Lakes Colonial Waterbird Survey, Atlantic Coast Colonial Waterbird Survey, winter roost surveys, Christmas Bird Counts, and Breeding Bird Surveys.

Additionally, the APHIS/WS National Wildlife Research Center is involved in a variety of DCCO research projects, including controlled experiments to assess DCCO impacts to gross catfish production; a two-year satellite telemetry study in Alabama, Arkansas, Louisiana, and Mississippi aimed at monitoring migratory movements of DCCOs captured at aquaculture areas; a two-year satellite telemetry study in eastern Lake Ontario (in cooperation with the New York State Department of Environmental Conservation) aimed at assessing the efficacy of control activities at the Little Galloo Island breeding colony in eastern Lake Ontario; development of a deterministic population model for DCCOs; and preparation of a report titled "A Science-Based Initiative to Manage Double-Crested Cormorant Damage to Southern Aquaculture."

*Information and Education Outreach.* The Service participates in outreach activities to respond to public concerns and to educate the public about DCCOs. In 1998, the Service's Division of Migratory Bird Management developed a fact sheet on DCCOs, and placed it on its website at http:// migratorybirds.fws.gov/issues/cormorant/ cormorant.html. Subsequently, the cormorant subcommittee of the Service's Great Lakes Ecosystem Team, with involvement by State fish and wildlife agency personnel, has produced a cormorant fact sheet series. Additionally, the Service provided funding and production assistance to New York Sea Grant to produce the video "Managing Cormorants in the Great Lakes."

Service personnel have attended numerous public workshops pertaining to DCCOs and their management, often participating with State fish and wildlife agency personnel. In 1997, the Service, together with APHIS/WS, organized a symposium on the biology and

management of DCCOs in the Midwest and published the proceedings (Tobin 2000). In November 2000, the Service cooperated with University of Minnesota researchers in putting together a one-day workshop on the DCCO-fisheries conflict, which brought together biologists and managers from around the nation and the world. Service personnel have also accepted many invitations to speak to citizens around the U.S. who are interested in cormorants and the Service's role in managing migratory birds.

### 1.4.5 The Role of Other Agencies in Cormorant Management

Because DCCOs fall under the authority of the MBTA, the Service has the primary responsibility for establishing guidelines for the take of cormorants. Consequently, management options available to States and other agencies are limited by our policies and practices. However, some States have been and continue to be actively engaged in research activities and the implementation of management activities authorized by the Service.

*Control Activities.* A survey completed by Wires et al. (2001) found that 10 States (out of 37 States and provinces that responded to the survey) reported the use of DCCO control methods. Six of the States employing control measures were in the southern U.S.; these States were conducting control programs because of depredations at aquaculture facilities and fish hatcheries. All of these States incorporated lethal and non-lethal control measures. In the Northeast, New York and Vermont are employing control measures due to habitat destruction and impacts to other colonial waterbirds in Lake Ontario and Lake Champlain. Massachusetts has undertaken limited control measures at specific sites. Additionally, the State of Oregon conducts annual DCCO harassment programs near the Oregon coast.

Table 1. States Practicing DCCO Control (from Wires et al. 2001)

| State | Lethal measures | Non-lethal measures |
|---|---|---|
| AL | Shooting | Harassment |
| AR | Shooting | Harassment, noise-making, decoys |
| LA | Shooting | Multiple harassment techniques |
| MA | None | Harassment |
| MS | Shooting | Harassment; Night roost dispersal program |
| NY | Egg destruction, egg oiling | Nest destruction |
| OK | Shooting | Hazing |
| TX | Shooting | Harassment |
| VA | Yes[1] | Yes[1] |
| VT | Egg oiling | Harassment; nest destruction |

1 Both lethal and non-lethal measures are undertaken, but details on specific measures employed were not provided.

DCCOs also occur in Canada and Mexico. In Canada, DCCOs are not protected federally and thus are managed at the provincial level. The Province of Québec has conducted limited DCCO population control and Ontario is in the process of evaluating the need for such action. As in the U.S., Canadian DCCO populations are generally increasing. We are currently unaware of any involvement by Mexico in management of DCCOs. The precise status of DCCO populations in Mexico is unknown but probably

stable (Wires et al. 2001). It was last estimated by Carter et al. (1995b) at about 6,969 breeding pairs.

# CHAPTER 2: ALTERNATIVES

## 2.1 Introduction

This chapter, considered the "heart of the environmental impact statement" (40 CFR 1502.14), describes the six alternatives being evaluated for the purpose of managing DCCOs in the contiguous United States. It also states the "proposed action" (Alternative D), which is our preferred alternative for meeting the purpose and need stated in Chapter 1.

## 2.2 Rationale for Alternative Design

All alternatives considered were evaluated in relation to their ability to reduce resource conflicts associated with DCCOs, increase management flexibility, and conserve healthy populations of DCCOs over the long term. NEPA regulations require the analysis of a No Action (or "status quo") alternative. The other alternatives were developed after evaluating comments received during the public scoping period, holding interagency meetings and internal discussions, and reviewing the best available information. After the DEIS public comment period, we discussed and developed changes to the proposed action to improve its potential for efficacy in dealing with cormorant conflicts and in ensuring the conservation of populations of DCCOs and other Federally-protected species. Each alternative described below is analyzed in more detail in Chapter 4, ENVIRONMENTAL CONSEQUENCES.

## 2.3 Proposed Action

The agency's proposed action is the alternative that the agency believes would satisfy the purpose and need (as stated in Chapter 1) and fulfill its mission and statutory responsibilities, while giving consideration to economic, environmental, technical, and other factors. The proposed action, **Alternative D**, would: (1) create a public resource depredation order to authorize State fish and wildlife agencies, Tribes, and APHIS/WS in 24 States to control DCCOs on public and private lands and freshwaters to protect public resources; (2) expand the aquaculture depredation order to allow winter roost control by APHIS/WS in 13 States; and (3) allow take of DCCOs at public fish hatcheries under the depredation orders. Based on our analysis, the proposed action would be more effective than the current program; is environmentally sound, cost effective, and flexible enough to meet different management needs around the country; and does not threaten the long-term sustainability of DCCO populations or populations of any other natural resource.

## 2.4 Description of Alternatives

### 2.4.1 Alternative A: No Action (Continue existing DCCO damage management policies)

Under this alternative, existing wildlife management policies and practices would continue with no additional regulatory methods or strategies being authorized. This alternative includes non-lethal management techniques (as described under Alternative B) and activities carried out under depredation permits and the aquaculture depredation order. Control techniques include the take of adults and young (by shooting), eggs (by means of oiling or destruction), and active nests (by removal or destruction). Because of Director's Order No. 27, "Issuance of Permits to Kill Depredating Migratory Birds at

Fish Cultural Facilities," depredation permits are not issued for the take of DCCOs at National Fish Hatcheries. However, the aquaculture depredation order allows DCCOs to be killed at State-operated fish hatcheries in 13 States (and at commercial freshwater aquaculture facilities). All other conflicts are dealt with on a case-by-case basis, requiring a Federal permit for every locality and occurrence where DCCO control actions take place. All depredation permits would continue to be issued by the appropriate Service Regional Office. Population surveys on breeding grounds would continue to be conducted at regular intervals.

The issuance of depredation permits to take cormorants and other depredating migratory birds is guided by the regulations found in 50 CFR §21.41. There it states that an application for a depredation permit must be submitted to the appropriate Service Regional Director and that each application must contain a description of the area where depredations are occurring; the nature of the crops or other interests being injured; the extent of such injury; and the particular species of migratory birds committing the injury. The following table describes how the Service Regional Migratory Bird Permit Offices have interpreted 50 CFR §21.41 and §21.47 for various resource categories.

Table 2. Service Practice for Issuance of Depredation Permits for DCCOs under Alternative A (No Action)

| |
|---|
| ***Aquaculture*** |
| Private and State facilities in 13 States do not require a permit because they fall under the aquaculture depredation order (AL, AR, FL, GA, KY, LA, MN, MS, NC, OK, SC, TN, and TX). |
| In States not covered by the depredation order APHIS/WS makes recommendations and USFWS issues permits to take birds, eggs, and/or active nests. |
| Director's Order No. 27 prohibits lethal control of fish-eating birds at "public" hatcheries except when an "emergency" exists. |
| ***Natural Resource Issues on Public Lands/Waters*** |
| Permits issued by USFWS when action is considered necessary to ensure survival and/or recovery of Federal- or State-listed threatened and endangered species. |
| Permits may be issued by USFWS if there exists convincing evidence that a regionally significant bird population or rare and declining plant communities are being adversely affected by DCCOs. |
| Permits may be issued by USFWS to alleviate depredation at the site of fish stocking but requests for permits are generally not issued for birds taking free-swimming fish in public waters. |
| ***Other Natural Resource and Economic Issues*** |
| Permits may be issued by USFWS if there is significant economic damage to privately-stocked fish on a privately-owned water body that maximizes fishing opportunities for patrons, whether done for a fee or for recreation. |
| Permits typically issued by USFWS for significant property damage (for example, physical structures or vegetation) on public or private lands and waters. |
| ***Human Health and Safety*** |
| Permits issued by USFWS when evidence exists of significant human health and safety risks (for example, airports or water quality). |

### 2.4.2 Alternative B: Non-lethal Management (Do not allow lethal management actions)

Under this alternative, permits allowing the lethal take of DCCOs or their eggs would not be issued. The aquaculture depredation order would be revoked and depredation permits would not be issued. To reduce impacts associated with DCCOs, this option would allow only non-lethal management techniques such as harassment, habitat modification, exclusion devices at production facilities, and changes in fish stocking practices. Essentially, only those management techniques not currently requiring a Federal depredation permit would be continued under this alternative. Population surveys would be conducted at regular intervals.

### 2.4.3 Alternative C: Increased Local Damage Control (Expand current wildlife damage management policy)

The intent of this alternative would be to expand the current DCCO depredation policy to address a broader range of resource conflicts than under the No Action (see Table 3 below). The permit renewal period for DCCO depredation permits would change from annual to biennial in order to help alleviate the increased permit review requirements (this means that permittees would reapply for a permit every two years instead of each year). The aquaculture depredation order would continue to allow DCCOs to be killed at commercial freshwater aquaculture facilities and State-owned fish hatcheries in 13 States and would be expanded to include winter roost control at aquacultural facilities in those States. Director's Order No. 27 prohibiting lethal control of DCCOs at public fish hatcheries would be revoked. Non-lethal techniques would remain part of the management program. Population surveys would be conducted at regular intervals.

Table 3. Service Policy for Issuance of Depredation Permits for DCCOs under Alternative C

| |
|---|
| ***Aquaculture*** |
| Private and State facilities in 13 States do not require a permit because they fall under the aquaculture depredation order (AL, AR, FL, GA, KY, LA, MN, MS, NC, OK, SC, TN, and TX). (Same as No Action) |
| In States not covered by the depredation order APHIS/WS makes recommendations for permit issuance and USFWS may issue permit to take birds, eggs, and/or active nests. (Same as No Action) |
| Aquaculture depredation order expanded to include lethal control at winter roost sites in those 13 States. (Different than No Action) |
| Director's Order No. 27 prohibiting lethal take at public hatcheries revoked. (Different than No Action) |
| ***Natural Resource Issues on Public Lands/Waters*** |
| Permits issued by USFWS when action is considered necessary to ensure survival and/or recovery of Federal- or State-listed threatened and endangered species. (Same as No Action) |
| Permits issued by USFWS for conflicts with fish, wildlife, plants, and other wild species when there is documentation of significant impacts or when best professional judgment has determined that there is a high likelihood that DCCOs are a significant detriment to the resource in question. In the latter case, a permit will be issued when the control efforts will not threaten the viability of DCCO or other wildlife populations and the agency requesting the permit prepares a site-specific management plan containing: (1) a definition of the conflict(s) with DCCOs, including a statement of the management objectives for the area in question; (2) a description of the evidence supporting the hypothesis that DCCOs are contributing to these resource conflicts; (3) a discussion of other limiting factors affecting the resource (e.g., biological, environmental, socioeconomic); and (4) a discussion of how control efforts are expected to alleviate resource conflicts. (Different than No Action) |
| ***Other Natural Resource and Economic Issues*** |
| Permits issued by USFWS if there is significant economic damage to privately-stocked fish on a privately-owned water body that maximizes fishing opportunities for patrons, whether done for a fee or for recreation. (Same as No Action) |
| Permits issued by USFWS for significant property damage (for example, physical structures or vegetation) on public or private lands and waters. (Same as No Action) |
| ***Human Health and Safety*** |
| Permits issued by USFWS when evidence exists of significant human health and safety risks (for example, airports water quality). (Same as No Action) |

### 2.4.4 PROPOSED ACTION – Alternative D: Public Resource Depredation Order (Establish a new depredation order to address public resource conflicts)

Alternative D creates a public resource depredation order to authorize State fish and wildlife agencies, Federally-recognized Tribes, and APHIS/WS to take DCCOs found committing or about to commit, and to prevent, depredations on the public resources of fish (including hatchery stock at Federal, State, and Tribal facilities), wildlife, plants, and their habitats. This authority applies to all lands and freshwaters (with appropriate landowner permission) in 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). This alternative also revises the aquaculture depredation order by specifying that it is applicable to commercial freshwater facilities and State and Federal fish hatcheries, and by authorizing APHIS/WS employees to take DCCOs at roost sites in the vicinity of aquaculture facilities during the months of October, November, December, January, February, March, and April. Director's Order No. 27 prohibiting lethal control of DCCOs at public hatcheries will not be revoked at this time, as was stated in the DEIS. Depredation permits would continue to be used to address conflicts outside the authority of the depredation orders. Agencies acting under the public resource depredation order will be required to comply with monitoring and reporting requirements and persons operating under the aquaculture depredation order must annually provide a current mortality log. Population surveys will be conducted at regular intervals.

Table 4. Service Depredation Policy under Alternative D (PROPOSED ACTION)

Comment:

| |
|---|
| ***Aquaculture*** |
| Private, State, and Federal facilities in 13 States do not require a permit because they fall under the aquaculture depredation order. (Different than No Action) |
| In States not covered by the depredation order APHIS/WS makes recommendations for permit issuance and USFWS may issue permit to take birds, eggs, and/or active nests. (Same as No Action) |
| Aquaculture depredation order expanded to include lethal control at winter roost sites in 13 States. (Different than No Action) |
| ***Natural Resource and Economic Issues on Public Lands/Waters*** |
| In 24 States, State fish and wildlife agencies, Tribes, and APHIS/WS may take DCCOs to protect public resources (fish, wildlife, plants, and their habitats) on private and public lands and freshwaters. In non-depredation order States, depredation permits for public resource damages will be issued in accordance with 50 CFR 21.41 and applicable Service policies. (Different than No Action) |
| Permits issued by USFWS for significant property damage (for example, to physical structures or vegetation) on public or private lands and waters. (Same as No Action) |
| ***Human Health and Safety*** |
| Permits issued by USFWS when evidence exists of significant human health and safety risks (for example, at airports or when water quality is compromised). (Same as No Action) |

### 2.4.5 Alternative E: Regional Population Reduction (Develop population objectives and implement actions aimed at reducing overall DCCO populations)

This alternative would entail the development of regional DCCO population objectives designed to reduce damages associated with DCCOs. Population objectives would be developed on an interdisciplinary, interagency basis and would be based on the best available data, while giving consideration to other values. Control would be carried out at nesting, roosting, wintering and all other sites in order to achieve those objectives as rapidly as possible without adversely affecting other protected migratory birds or threatened and endangered species. The aquaculture depredation order would allow DCCOs to be killed at commercial freshwater aquaculture facilities and Federal, State, and Tribal fish hatcheries in 13 States and would be expanded to include winter roost control in those States. For all conflicts not addressed under the aquaculture depredation

order or the special statewide cormorant permit, depredation permits would be issued according to the policy outlined in Alternative C above. Non-lethal techniques would remain part of the management program, but only voluntarily. Population surveys would be conducted at regular intervals.

### 2.4.6 Alternative F: Regulated Hunting (Establish frameworks for a hunting season on DCCOs)

Under this alternative, frameworks to develop seasons and bag limits for hunting DCCOs would be established jointly by Federal and State wildlife agencies. These seasons would coincide with those for waterfowl hunting. Additionally, the depredation policy outlined in Alternative C, above, would address DCCO conflicts (issuance of depredation permits and the aquaculture depredation order). Population monitoring would be conducted at regular intervals.

## 2.5 Alternatives Considered but Eliminated from Detailed Study

### 2.5.1 No Management Alternative

This alternative would not allow for any Federal management or control of DCCOs (no depredation permit issuance, no depredation order, no harassment or habitat modification, etc.). To implement this alternative would be to ignore conflicts associated with cormorants that must be addressed if we are to fulfill our duties to manage America's migratory birds responsibly. Since there is real biological and socioeconomic evidence (as described in Chapter 3, AFFECTED ENVIRONMENT) justifying the need for DCCO management, we find this alternative to be unreasonable (NEPA states that only "reasonable" alternatives must be considered).

### 2.5.2 Rescindment of Migratory Bird Treaty Act Protection Alternative

This alternative would entail amending the MBTA and associated international conventions to remove the DCCO from the List of Migratory Birds (those species protected under the MBTA). DCCOs would still be protected under the laws of most States. This action would require amending the Mexican treaty and could have the undesirable result of losing protection for all species in the cormorant family (*Phalacrocoracidae*). We feel that this would be a drastic action that would establish precedent for removing other species and would undermine the authority of the MBTA.

## 2.6 Comparison of Alternatives

Each alternative described above would utilize a variety of non-lethal management techniques. All of the alternatives we analyzed, except Alternative B, would allow for limited lethal take (shooting, egg oiling or destruction, and/or nest destruction), either through depredation orders or the issuance of depredation permits. Additionally, Alternative F would develop hunting frameworks for DCCOs. Differences among alternatives in the degree of lethal take are primarily related to the circumstances under which permits are issued (to control local damages or to reach population objectives) and which depredation order is in effect (aquaculture, expanded aquaculture, and/or public resource).

Table 5. Actions by Alternative

| Alternative | Actions |
|---|---|
| **Alternative A – No Action** | non-lethal management[1]; aquaculture depredation order[2]; depredation permits[3] |
| **Alternative B – Non-lethal management** | non-lethal management[1] |
| **Alternative C – Increased Local Damage Control** | non-lethal management[1]; expanded aquaculture depredation order[2]; depredation permits[3] |
| **Alternative D – PROPOSED ACTION** | non-lethal management[1]; expanded aquaculture depredation order[2]; depredation permits[3]; public resource depredation order[4] |
| **Alternative E – Regional Population Reduction** | non-lethal management[1]; expanded aquaculture depredation order[2]; depredation permits[3] |
| **Alternative F – Regulated Hunting** | non-lethal management[1]; aquaculture depredation order[2]; depredation permits[3], hunting seasons in participating States |

[1] = includes all management techniques that are not considered "take" and thus do not require a depredation permit (harassment, exclusion devices, habitat modification, etc.)
[2] = under the aquaculture depredation order, DCCOs may be taken by shooting with firearms during daylight hours; those using shotguns are required to use nontoxic shot
[3] = under depredation permits, shooting, egg oiling or destruction, and nest destruction are the most common techniques utilized
[4] = under the public resource depredation order, DCCOs may be taken by shooting, egg oiling or destruction, nest destruction, cervical dislocation, and $CO_2$ asphyxiation (all of which are classified as humane euthanasia techniques for birds by the American Veterinary Medical Association)

Table 6. Actions by Alternatives

| | A: No Action | B: Non-lethal Management | C: Increased Local Damage Control | PROPOSED ACTION D: Public Resource Depredation Order | E: Regional Population Reduction | F: Regulated Hunting |
|---|---|---|---|---|---|---|
| New regulatory strategies | no | no | no | yes | yes | yes |
| Continued issuance of depredation permits | yes | no | yes | yes | yes | yes |
| Continuation of aquaculture depredation order | yes | no | yes | yes | yes | yes |
| Expansion of aquaculture depredation order | no | no | yes | yes | yes | yes |
| Creation of public resource depredation order | no | no | no | yes | no | no |
| Allows take of nests | yes | yes | yes | yes | yes | yes |
| Allows take of eggs | yes | no | yes | yes | yes | yes |
| Allows take of adults and young | yes | no | yes | yes | yes | yes |
| Allows harassment of adults and young | yes | yes | yes | yes | yes | yes |
| Development of regional population objectives | no | no | no | maybe | yes | no |
| Management activities occur on public lands | yes | yes | yes | yes | yes | yes |
| Management activities occur on private lands | yes | yes | yes | yes | yes | yes |
| Requires additional monitoring and evaluation | no | no | no | yes | yes | yes |

# CHAPTER 3: AFFECTED ENVIRONMENT

## 3.1 Introduction

The "affected environment" section of an EIS should "succinctly describe the environment of the area(s) to be affected by the alternatives under consideration" (40 CFR 1502.15). Thus, this chapter contains a discussion of the biological and socioeconomic environments relevant to the issues raised during scoping.

## 3.2 Biological Environment

### 3.2.1 Double-crested Cormorants

The Service's goals in migratory bird management are to conserve DCCO populations at sufficient levels to prevent them from becoming threatened or endangered and to ensure that American citizens have continued opportunities to enjoy DCCOs.

*Species Range.* DCCOs are native to North America and range widely there. There are essentially five different breeding populations, variously described by different authors as: Alaska, Pacific Coast, Interior, Atlantic, and Southern. Recent population expansion, however, has blurred the boundaries for the Interior, Atlantic, and Southern populations (Hatch and Weseloh 1999, Wires et al. 2001). There is high variation in the migratory tendencies of these different breeding populations. Birds 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). The two primary migration routes appear to be down the Atlantic coast and through the Mississippi-Missouri River valleys to the Gulf coast (Palmer 1962) with increasing numbers of birds remaining in the Mississippi Delta (Jackson and Jackson 1995). Refer to Appendix 2 for a map of the distribution of DCCO breeding colonies in North America.

*Habitat Requirements.* In the breeding season, two factors are critical to DCCOs: suitable nesting sites and nearby feeding grounds (van Eerden and Gregersen 1995, Hatch and Weseloh 1999, Wires et al. 2001). Ponds, lakes, slow-moving rivers, lagoons, estuaries and open coastlines are utilized. Small rocky or sandy islands are utilized when available. Nests are built in trees, on structures, or on the ground. Nesting trees and structures are usually standing in or near water, on islands, in swamps, or at tree-lined lakes.

Nonbreeding habitats are diverse and include lakes, ponds, rivers, lagoons, estuaries, coastal bays, marine islands, and open coastlines (Johnsgard 1993). Wintering DCCOs require similar characteristics in feeding, loafing, and roosting sites as when breeding. Where DCCOs winter on the coast, sandbars, shoals, coastal cliffs, offshore rocks, channel markers, and pilings are used for roosting. Birds wintering along the lower Mississippi River roost on perching sites such as trees, utility poles, or fishing piers and in isolated cypress swamps (Reinhold and Sloan 1999, Wires et al. 2001). In all seasons DCCOs require suitable places for nighttime roosts and daytime resting or loafing. Roosts and resting places are often on exposed sites such as rocks or sandbars, pilings, wrecks, high-tension wires, or trees near favored fishing locations (Wires et al. 2001).

From the time DCCOs return to their breeding colonies in the spring until the adults are brooding young, the colony site is their main "center of activity," (i.e., they roost at the colony overnight and their daily foraging activities emanate from there). While most adults are attending young, however, auxiliary overnight roosts begin to develop. These may be on nearby unoccupied islands or they may be several miles away. The origin of the birds forming these roosts is not known for certain but they are most likely adults who have failed in their breeding attempts and/or non-breeding birds. The net result is that a new or additional "center of activity" is created in an area where the birds themselves do not otherwise breed. These late season roosts often remain active until the birds have left on migration in September or October. For example, DCCOs do not breed in the Bay of Quinte, a 60 mile-long, Z-shaped bay in northeastern Lake Ontario. However, in June, well before the migratory season, DCCOs begin to roost, at night, on islands in the bay and their numbers increase there through September. Birds come from these islands on daily foraging trips and have, in essence, established new centers of activity that are not related to the breeding colony, nor are they (yet) comprised of migrant birds (D.V. Weseloh, CWS, pers. comm.).

*Double-crested Cormorant Demographics.* The DCCO is the most abundant of five species of cormorants occurring in the contiguous United States (the other species are Great Cormorant, Neotropic Cormorant, Pelagic Cormorant, and Brandt's Cormorant). A conservative estimate of the total population of DCCOs in the U.S. and Canada is greater than 1 million birds, including breeding and non-breeding individuals, but is probably closer to 2 million (Tyson et al. 1999). We estimate that the current continental population of DCCOs is approximately 2 million birds. This number was derived by consulting the literature and discussing our estimate with waterbird biologists Linda Wires (University of Minnesota), Dr. Francie Cuthbert (University of Minnesota), Dr. Chip Weseloh (Canadian Wildlife Service), and John Trapp (USFWS). We used the Tyson et al. estimate of 372,400 breeding pairs as our base number. We multiplied that by 2 to get the number of breeding individuals (744,280). Then we multiplied that by 2.26, an estimate for the ratio of non-breeding to breeding birds (Weseloh unpubl. data) that is well within the published estimates ranging from 1-4 nonbreeders per breeder). This amounts to 1,682,073 and adding that to 744,280 comes to 2,426,353 birds total. In 2000, Chip Weseloh (unpubl. data) estimated the North American population for breeding and non-breeding immature DCCOs (but not adult non-breeders) at 1.850 million. Based on this information and discussions with the individuals mentioned above, we adjusted our estimate of 2.4 million to 2.0 million.

While the total number of DCCOs in North America increased rapidly from the 1970s into the 1990s (Hatch 1995), estimates of Tyson et al. (1999) indicated that the overall rate of growth in the U.S. and Canada slowed during the early 1990s. This is consistent with declines in the growth rate of expanding Great Cormorant populations in northwestern Europe (van Eerden and Gregersen 1995) and with the general rule that the growth rate of wildlife populations decreases as it gets closer to carrying capacity.

For the U.S. as a whole, according to Breeding Bird Survey (BBS) data (which are indices of *relative* abundance), the breeding population of DCCOs increased at a statistically significant rate of approximately 7.5 percent per year from 1975-2002 (Sauer et al. 2003). Within this period, growth rates of regional populations varied substantially and thus it is important to look at DCCO population growth rates from a regional perspective as well. The table below summarizes the regional populations as described in Tyson et al. 1999. The narratives that follow integrate the populations delineations used by Tyson et al. 1999 and Wires et al. 2001. See Appendix 2 for the distribution of DCCO breeding colonies in North America.

Table 7. DCCO Breeding Population Estimates (from Tyson et al. 1999)

| | Estimated # of nesting pairs | Percent of continental population | Estimated population growth rate * |
|---|---|---|---|
| Atlantic | 85,510 | 23% | -6.5% (15.8%) |
| Interior | 256,212 | 68% | 6.0% (20.8%) |
| Southeast | 13,604 | 4% | 2.6% (76.9%) |
| West Coast-Alaska | 17,084 | 5% | -7.9% (-0.6%) |
| TOTAL | > or = 372,410 | | 2.6% (16.2%) |

* number in parentheses indicates "category A" estimates (i.e., results of surveys in which nests were systematically counted)

**Atlantic**

Twenty-three percent of North America's DCCOs are found in the Atlantic population (Tyson et al. 1999). In this region, DCCOs are strongly migratory and, on the coast, occur with smaller numbers of Great Cormorants. From the early 1970s to the early 1990s, the Atlantic population increased from about 25,000 pairs to 96,000 pairs (Hatch 1995). While the number of DCCOs in this region declined by 6.5 percent overall in the early to mid-1990s, some populations were still increasing during this period (Tyson et al. 1999). Very large numbers breed in Quebec and the surrounding area (including the St. Lawrence River and its estuary) and in Nova Scotia and Prince Edward Island. Very large breeding concentrations also occur in New England along the coasts of Maine and Massachusetts. With the exception of Maine (where numbers began declining between the mid-1980s and early 1990s), rapid increases have occurred since the 1970s (Wires et al. 2001). From 1977 to the 1990s, the number of DCCOs in the northeastern U.S. increased from 17,100 nesting pairs to 34,200 pairs (Krohn et al. 1995). In parts of southern New England (Connecticut, Rhode Island, coastal New York) the DCCO has recently been documented as a breeding species and numbers are growing fairly rapidly. First breeding records were obtained in New Jersey and Pennsylvania between the late 1970s and 1990s (Wires et al. 2001). The total estimated number of nesting pairs in this population is ≥85,510 (Tyson et al. 1999).

Small numbers of DCCOs winter in some New England States but most Atlantic birds winter along the coast from Virginia (where numbers of wintering birds are increasing) southward, along the Gulf of Mexico, and in the lower Mississippi valley (Dolbeer 1991, Hatch 1995, Wires et al. 2001).

**Interior**
Nearly 70 percent of North American DCCOs are found in the Interior region (Tyson et al. 1999). DCCOs in this region are highly migratory and are concentrated in the northern prairies, particularly on the large, shallow lakes of Manitoba (Canada), which has the largest number of breeding DCCOs in North America (Hatch 1995, Wires et al. 2001). A large number of Interior DCCOs nest on or around the Great Lakes as well, and recent evidence indicates that they are beginning to establish themselves at small inland lakes in the vicinity (Alvo et al. 2002). Since the early 1970s, numbers of Interior DCCOs have increased rapidly.

From 1990 to 1997, the overall growth rate in the Interior region was estimated at 6 percent (Tyson et al. 1999) with the most dramatic increases occurring on Ontario, Michigan, and Wisconsin waters (Wires et al. 2001). From 1970 to 1991, the Great Lakes breeding population alone increased from 89 nests to over 38,000 nests, an average annual increase of 29 percent (Weseloh et al. 1995). From 1991 to 1997, the number of nests in the Great Lakes further increased to approximately 93,000, an average annual increase of 22 percent. Nest counts in 2000 estimated 115,000 nests in the Great Lakes (Weseloh et al. 2002). Average annual growth rates in the Great Lakes were lower for the period 1990-2000 than the period 1980-1990 (Weseloh et al. 2002). The total estimated number of nesting pairs in the Interior population (including Canada) is ≥256,212 (Tyson et al. 1999).

**Southern**
Most DCCOs in this region are wintering migrants from the Interior and Atlantic regions (Dolbeer 1991, Jackson and Jackson 1995). However, nesting DCCOs in this region are on the rise with some nesting occurrences representing first record and others recolonizations (Wires et al. 2001). Historically, sedentary breeding populations of DCCOs occurred in Florida and other southern states north to North Carolina (Hatch 1995), while in recent years DCCOs have started breeding again in Arkansas, Georgia, Mississippi, and Tennessee (Wires et al. 2001). Today, four percent of the North American breeding population of DCCOs occurs in the Southeast region (Tyson et al. 1999). Currently, breeding colonies exist in Arkansas, Delaware, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennesee, Texas, and Virginia (Wires et al. 2001). The total estimated number of nesting pairs in this population is >13,604 (Tyson et al. 1999).

Over the last few decades, numbers of wintering DCCOs have dramatically increased in several southern States. Since the late 1970s, wintering DCCOs have increased by nearly 225 percent since the early 1990s in the Mississippi Delta. From an average of 30,000 DCCOs counted during the winters of 1989-93 (Glahn et al. 1996) to over 73,000 counted in the winter of 2001-2002 (G. Ellis, APHIS/WS, unpubl. data). Data from Christmas Bird Counts conducted between 1959-1988 show increases ranging from 3.5-18.7 percent in several States within this region, with the largest increases occurring in Louisiana, Mississippi, and Texas (Wires et al. 2001). In New Mexico, Texas, and Louisiana DCCOs overlap in range with Neotropic Cormorants.

**Pacific Coast-Alaska**

Approximately 5-7 percent of North America's DCCOs are found in this population, which has approximately 27,500 nesting pairs according to Carter et al. (1995b) or $\geq$17,084 pairs according to Tyson et al. (1999). Alaska DCCOs represent approximately 12 percent of the entire Pacific coast marine population (Carter et al. 1995b) and occur with Red-faced Cormorants. Throughout their coastal range DCCOs exist with larger numbers of Pelagic and Brandt's Cormorants and at the southern extent of their range in Mexico they occur with Neotropic Cormorants (Hatch 1995). Alaska breeding populations (*P. a. cincinatus*) are thought to have declined since historical times, but recent population trends are not known (Wires et al. 2001). Non-Alaska Pacific coast breeding DCCOs (*P. a. albociliatus*) occur from British Columbia through Sinaloa, Mexico. Historical declines throughout the range are well documented and recent population status and trends for coastal populations, from British Columbia through California, are reasonably complete. However, because recent data are not available for significant portions of this subspecies range (e.g., Mexico and some interior areas) it is not possible to summarize recent trends for the population as a whole. Carter et al. (1995) documented recent increases in California and Oregon, and declines in British Columbia, Washington, and Baja California. Tyson et al. (1999) did not consider Mexican populations and calculated a decline for the entire West Coast-Alaska region. In the past 20 years, the largest increases in the region have taken place in the Columbia River Estuary, where East Sand Island supports the largest active colony along the coast with 6,390 pairs in 2000 (Carter et al. 1995b, Collis et al. 2000, Wires et al. 2001). Increases at East Sand Island coincided with declines in British Columbia, Washington, and locations in interior Oregon and the rapid increase undoubtedly reflected some immigration from these other areas (Carter et al. 1995).

Another area of recent explosive population increase is Salton Sea, California. Complete surveys of interior California populations were conducted between 1997-1999 (Shuford 2002). Shuford estimated 6,825 pairs breeding at 29 active colonies and 80 percent of all interior pairs occurred at Salton Sea. DCCOs at Salton Sea, increased from zero (1990-1994) to 5,600 pairs in 1999, and then back to zero from 2001 through 2003 (Shuford 2002, C. Pelizza pers. comm.).

*Factors associated with population increases*. Factors contributing to the resurgence of DCCO populations include reduced levels of environmental contaminants, particularly DDT; increased food availability in breeding and wintering areas; and reduced human persecution (Ludwig 1984, Vermeer and Rankin 1984, Price and Weseloh 1986, Fox and Weseloh 1987, Hobson et al. 1989, Weseloh et al. 1995, Wires et al. 2001). A brief case study of DCCOs in the Great Lakes provides an example of factors associated with changes in DCCO population numbers:

In the early 1940s, DCCO populations in the American and Canadian Great Lakes were increasing rapidly (Postupalsky 1978, Weseloh et al. 1995). After 1945, however, organochlorine pesticides came to be widely used in the Great Lakes basin. The residues of such chemicals, particularly DDT, are ecologically persistent and rapidly bioaccumulate in the aquatic food web, and this led to severe eggshell thinning in DCCOs and other waterbirds. Cormorant eggs with thinned shells broke easily during incubation and led to a period, in the 1950s and 1960s, of almost zero productivity due to low hatching success (Postupalsky 1978, Weseloh et al. 1983, Weseloh et al. 1995). Similar eggshell thinning and reproductive failure were

also found in DCCOs in southern California in the late 1960s (Gress et al. 1973). Following restrictions on the use of DDT in 1972, levels of organocholorine contaminants found in DCCO eggs declined in much of the Great Lakes (Ryckman et al. 1998) and DCCO productivity increased accordingly during the late 1970s (Scharf and Shugart 1981, Ludwig 1984, Noble and Elliot 1986, Price and Weseloh 1986, Bishop et al. 1992a and b). Organochlorine contaminant-related eggshell thinning no longer appears to be a major limiting factor for DCCO reproduction on the Great Lakes (Ryckman et al. 1998), even though there are still lingering effects of these chemicals in parts of this ecosystem three decades after they were banned (Custer et al. 1999).

Changes in the food supply available to Great Lakes cormorants, on both the breeding and wintering grounds, have also played a role in their population increase. Great Lakes fish populations underwent major changes in the 20th century. Populations of forage fish species increased significantly during the late 1950s through the 1980s, likely as a result of dramatic declines in large, native predatory fish, such as lake trout and burbot, that occurred during the 1940s and 1950s. These declines in larger predatory fish were brought about by a combination of such factors as overfishing, sea lamprey predation, and loss of spawning habitat (Weseloh et al. 1995) and led to population explosions of smaller forage fish species. In particular, rainbow smelt and alewife, neither of which are native to the upper Great Lakes, became very abundant in Lakes Michigan, Huron, Ontario, and Erie through the 1970s and 1980s (Environment Canada 1995). Various studies suggest that annual productivity and post-fledging survival of DCCO young are high in years of alewife abundance (Palmer 1962; van der Veen 1973, Weseloh and Ewins 1994). In fact, changes in prey abundance have been associated with increases in populations of several fish-eating bird species worldwide (Environment Canada 1995).

The growth of the aquaculture industry has provided DCCOs with an abundant food supply on their southern wintering grounds. The aquaculture industry (consisting largely of channel catfish production) has experienced significant growth in the southern U.S. over the last 20 years. While Great Lakes DCCOs historically migrated down to the coastal areas of the Gulf of Mexico to winter, since the early 1970s wintering populations of DCCOs in the lower Mississippi valley have been increasing (Reinhold and Sloan 1999, Glahn et al. 1996). The DCCO is the primary avian predator utilizing channel catfish stocks (Wywialowski 1998, Reinhold and Sloan 1999). Glahn et al. (1999b) analyzed monthly changes in body mass of wintering DCCOs in the delta region of Mississippi and in areas without extensive aquaculture production and found that DCCO utilization of catfish has likely increased winter survival and contributed to the cormorant's recent population resurgence.

Human persecution has also been a factor. DCCOs were not Federally protected until 1972. Weseloh et al. (1995) suggested that the cormorant's initial rate of colonization into the Great Lakes was suppressed by human persecution until the 1950s. Indeed, destruction of DCCO nests, eggs, young, and adults, by fishermen and government agencies, was a common occurrence in the Great Lakes basin from the 1940s into the 1960s (Baillie 1947, Omand 1947, Postupalsky 1978, Ludwig 1984, Craven and Lev 1987, Ludwig et al. 1989, Weseloh and Ewins 1994, Weseloh et al. 1995, Matteson et al. 1999) and in the Pacific Northwest (Gabrielson and Jewett 1940, Ferris 1940, Mathewson 1986, Bayer and Ferris 1987, Carter et al. 1995a). Similar control efforts, involving large-scale spraying of eggs, occurred in Maine in the 1940s and 1950s (Gross 1951,

Krohn et al. 1995, Hatch 1995) and in Manitoba on Lake Winnipegosis during the same period (McLeod and Bondar 1953, Hatch 1995). In 1972, DCCOs were added to the list of birds protected by the MBTA, which made it illegal to kill them in the U.S. without a Federal permit.

*Double-crested Cormorant Population Parameters*. Compared to other common colonial waterbirds, the population dynamics of DCCOs have not been well-studied (Wires et al. 2001, Hatch and Weseloh 1999). The similar life histories of DCCOs and Great Cormorants (i.e., their being ecological counterparts), however, allow North American managers to gain insight from management efforts in Europe (Glahn et al. 2000b). Due to their large clutch size and persistent renesting efforts, DCCO breeding success is fairly high compared to other North American cormorants and colonial waterbirds in general (Johnsgard 1993).

**Age at First Breeding**

Van der Veen (1973) found that most birds bred for the first time at age 3 (i.e., entering their fourth year). Johnsgard (1993, citing van Tets *in* Palmer 1962) also stated that "the usual age of initial breeding in this species is probably three years, although successful breeding has occurred among two-year-olds." In the early 1990s, Weseloh and Ewins (1994) observed first-breeding by many 2-year olds on Little Galloo Island in Lake Ontario. Blackwell et al. (2002) estimated that at least 17 percent of 2-year old, and 98.4 percent of age-3+, Lake Ontario DCCOs breed.

**Clutch Size**

Average clutch sizes observed over the years include: 3.8 eggs in Utah (Mitchell 1977); 3.5 eggs in Maine (Mendall 1936); 3.11 eggs in Ontario (Peck and James 1983); 3.2 eggs in Alberta (Vermeer 1969); 3.6 and 3.2 on the Madeleine Islands in Quebec (Pilon et al. 1983); 2.7-4.1 eggs, with a mode of 4, in British Columbia (van der Veen 1973); an average of 3.12 eggs over four years on Little Galloo Island, Lake Ontario (Weseloh and Ewins 1994); and 4.1-4.2 eggs at Columbia River Estuary colonies in Oregon (Roby et al. 1998, Collis et al. 2000).

**Hatching Success**

Van der Veen (1973) found that hatching success varied from 50-75 percent in DCCOs in British Columbia. Drent et al. (1964) reported an average hatching success of 60.4 percent on Mandarte Island in British Columbia, while Mitchell (1977) observed a hatching success of 54.2 percent in Utah. During two years of study on the Madeleine Islands, Quebec, hatching success rates of 74.5 and 71.8 percent were observed by Pilon et al. (1983). Roby et al. (1998) estimated hatching success in the Columbia River Estuary to be 56 percent. Wires et al. (2001) reported that DCCO hatching success is usually 50-75 percent.

**Fledging Success**

Van der Veen (1973) estimated fledging success at 74-95 percent (1.2-2.4 young per nest). Drent et al. (1964) observed a 95 percent fledging success rate on Mandarte Island, British Columbia, or an average of 2.4 young fledged per nest. In Utah, Mitchell (1977)

reported a 72 percent fledging success rate. Pilon et al. (1983) reported fledging success rates of 2.1 and 2.4 young per year in Québec. Slightly lower average rates of 1.8 young fledged per nest (Hobson et al. 1989) and 1.9 young fledged per nest (Vermeer 1969) were observed in Manitoba and Alberta, respectively. Average productivity for the Great Lakes, between 1979 and 1991, ranged from 1.5 to 2.4 young per nest (Weseloh et al. 1995). Roby et al. (1998) and Collis et al. (2000) estimated that cormorants in the Columbia River Estuary fledged an average of 1.6 and 1.2 chicks on East Sand Island and 2.1 and 1.6 chicks on channel markers in the estuary during 1997 and 1998, respectively. Fowle et al. (1999) estimated productivity to be 2.5 young fledged per nest on Young Island in Lake Champlain, Vermont. Wires et al. (2001) reported that fledging success for DCCOs is typically 1.2-2.4 young per nest.

**Survivorship**

Average lifetime production has been estimated at 3.28 young per female (van der Veen 1973). Mean adult life expectancy was approximated at 6.1 years, with an estimated first-year survival rate of 48 percent, second-year survival rate of 74 percent, and 3+ years survival rate of 85 percent (van der Veen 1973). Madenjian and Gabrey (1995) estimated DCCO survival rates at: 58 percent from age 0 to age1; 75 percent from age 1 to 2 and age 2 to 3; and 80 percent for ages 3 to 4 and beyond. This is similar to survival rates estimated in European Great Cormorants: 35-54 percent in the first year, 75 percent in the second year, and 85 percent for year three and beyond (Veldkamp 1997, Bregnballe et al. 1997). Blackwell et al. (2002) estimated that annual survival of Lake Ontario DCCOs from fledging to just before age 1 was 30-35 percent and annual adult survival was 85 percent. Mean annual productivity for Lake Ontario DCCOs was estimated at 1.7-2.5 young per nest (Blackwell et al. 2002).

A major mortality factor throughout the species' range is predation. Johnsgard (1993) cited several studies indicating the following species as predators of DCCO chicks and/or eggs: California Gulls, Ring-billed Gulls, Herring Gulls, Great black-backed Gulls, American Crows, Fish Crows, Northwestern Crows, Common Ravens, and Bald Eagles. The British Columbia Wildlife Branch has associated DCCO colony failures with disturbance by Bald Eagles and predation by Northwestern Crows and Glaucous-winged Gulls (1999 unpubl. data).

Other causes of mortality include disease (e.g., Newcastle disease which killed over 20,000 DCCOs in colonies in the Great Lakes, Minnesota, and North and South Dakota in 1992 [Glaser et al. 1999]), illegal human persecution, and entanglement in fishing gear (Hatch and Weseloh 1999). Cormorant populations are influenced by both density-dependent and density-independent factors (Cairns 1992a), with age of first breeding, occurrence of non-breeding, and clutch abandonment the demographic parameters most likely to respond to density (Hatch and Weseloh 1999). In a population model developed for great cormorants in Europe, Bregnballe et al. (1997) assumed three types of density dependent mechanisms: increased exclusion of potential breeders, reduced fledgling production, and increased food competition on wintering grounds.

Cormorants, like other fish-eating birds, accumulate contaminants from the fish they eat. DCCO populations declined dramatically in association with high levels of contaminants during the 1960s and early 1970s. In fact, eggs of Herring Gulls, DCCOs, and Common Terns were found to contain some of the highest levels of organochlorine compounds in the world (Struger et al. 1985). Effects of chlorinated hydrocarbons on DCCOs have been most studied in the Great Lakes, where breeding populations had accumulated high contaminant burdens and showed severe impacts (Ryckman et al. 1998, Hatch and Weseloh 1999). Avian eggs and carcasses in Wisconsin were examined and contained detectable levels of several organochlorine contaminants (Dale and Stromborg 1993). The effects of these contaminants on DCCOs includes eggshell thinning (Anderson and Hickey 1972, Postupalsky 1978), elevated embryonic mortality (Gilbertson et al. 1991), reproductive failure and population declines (Weseloh et al. 1983, 1995), increased adult mortality (Greichus and Hannon 1973), increased embryonic abnormalities and crossed bills (Fox et al. 1991, Yamashita et al. 1993, Ludwig et al. 1996), egg mortality (Tillitt et al. 1992), and brain asymmetry (Henschel et al. 1997).

Over the years, the Service and the Canadian Wildlife Service have used fish-eating birds such as cormorants to study the impacts of long-term exposure to persistent lipophilic environmental contaminants within the Great Lakes ecosystem (Fox et al. 1991). Contaminant levels started decreasing in the 1970s and have continued to do so up to the present, with most associated biological parameters improving accordingly (Hatch and Weseloh 1999) . For example, by 1995, most contaminant residues in DCCO eggs had declined by 83-94 percent (Ryckman et al. 1998). However, contaminant levels in Great Lakes DCCOs continue to be significantly higher than in most other parts of North America (Somers et al. 1993, Sanderson et al. 1994), partly because of the long hydrologic retention times and depth of the Great Lakes, which renders them particularly sensitive to chemical inputs (De Vault et al. 1996).

Little work has been done on the effects or occurrence of metals in cormorants. Mercury is most often reported, but no effects have been identified in the wild (Hatch and Weseloh 1999). Methyl mercury is highly toxic; animal studies have indicated that chronic exposure to high mercury levels is associated with kidney damage, reproductive problems, nervous system effects, and other health problems (Johnson et al. 1998). In New Brunswick, total mercury concentrations in tissues of DCCOs were highest of nine seabird species examined (Braune 1987). A study in the Carson River, Nevada, found that DCCOs had the highest mercury concentrations of three species examined (Henny et al. unpubl. data). Additionally, recent research on loons in New York State and New England has shown that loons are exposed to high levels of methylmercury in these areas (“Loons sound alarm on mercury contamination,” Natl. Geog. Today, May 16, 2003). Because of their similar niche, it can be safely assumed that DCCOs also harbor high mercury levels in certain areas. However, contaminants are not currently a significant limiting factor of DCCO populations at the regional or continental scale.

*Double-crested Cormorant Foraging Ecology.* DCCOs are rarely seen out of sight of land and are opportunistic, generalist feeders, preying mainly upon abundant fish species that are easy to catch (usually slow-moving or schooling fish, ranging in size from 3-40

cm [1.2-16 in]), although most commonly less than 15 cm (6 in). Glahn et al. (1998) reported that availability (i.e., abundance), rather than size, is probably the most important factor in prey selection, but given equal availability DCCOs prefer prey fish that are greater than 7.5 cm (3 in) in length. They also suggested that prey fish accessibility is important in DCCO prey selection. Neuman et al. (1997) attributed variation in DCCO diet in Lakes Huron, Erie, and Ontario to movements of fish into shallow spawning areas and to spatial heterogeneity of fish habitat.

Studies indicate that DCCOs have strong habitat preferences with respect to depth, distance from the breeding colony, and distance from nearest shore (Stapanian and Bur 2002). The prey of Atlantic birds suggests that they feed at the bottom of the water column, while that of Pacific and inland birds suggests that they feed in mid-water. DCCOs usually forage in shallow, open water (less than 8m) within 5 km of shore (Hatch and Weseloh 1999), although they will go farther. In freshwater lakes, DCCOs forage at fairly shallow depths and likely take prey from all levels fairly uniformly (Johnsgard 1993). A study examining DCCOs in the western basin of Lake Erie found that the most significant foraging pressure occurred in areas within a 20 km radius of nesting colonies, within 3 km of shore, and in waters less than or equal to 10 m in depth (Stapanian et al. 2002). Neuman et al. (1997) determined that cormorant foraging distances at Little Galloo Island (Lake Ontario) ranged from 3.7 to 20 km (with an average distance of 13 km). Custer and Bunk (1992) reported that birds from two colonies in the Wisconsin waters of Lake Michigan foraged an average of 2-2.4 km from the colonies, with over 90 percent of flights being within 9 km of the colonies. In Texas, Campo et al. (1993) found that the average estimated distance from the foraging area to the nearest shore ranged from 20 to 975 meters.

DCCOs respond rapidly to high concentrations of fish and will congregate where fish are easily caught, such as "put and take" lakes, stocking release sites, and aquaculture ponds (Hatch and Weseloh 1999, Wires et al. 2001). The DCCO appears to be almost completely diurnal in its feeding habits. When pursuing prey, it dives from the surface and chases fish underwater. While bottom-feeding is usually solitary, DCCOs may form loose foraging flocks when feeding on schooling prey. In this way, birds create a line that moves forward as individuals at the rear fly short distances to "leapfrog" diving birds in the front. DCCOs engaged in this behavior have been documented in Georgian Bay, Ontario; Massachusetts; and Green Bay, Wisconsin, as have Great Cormorants in The Netherlands (Glanville 1992, Custer and Bunck 1992, van Eerden and Voslamber 1995, Hatch and Weseloh 1999). Observations of such behavior were also mentioned frequently during the public scoping period. For specifics of foraging behavior at aquaculture facilities see Appendix 3.

### 3.2.2 Fish

Among natural resource agencies, a survey conducted by Wires et al. (2001) indicated that DCCO predation was perceived to be of major importance to sport and/or commercial fish in at least three States (Arkansas, Tennessee, and Texas), and of moderate importance in at least eight States (Alabama, Connecticut, Louisiana, Maine, Massachusetts, New York, Rhode Island, and Virginia). The APHIS/WS MIS database

reveals that, from FY 1995-2001, of the 29 States reporting losses to natural resources, 27 reported losses to wild fish species. During public scoping, letters received from the following States indicated concern about impacts to sport fisheries: Arkansas, Georgia, Illinois, Kansas, Kentucky, Louisiana, Maine, Michigan, Nebraska, New York, North Dakota, Ohio, Oklahoma, Oregon, Texas, Vermont, Wisconsin, and Wyoming.

The diet of DCCOs consists largely of fish (generally slow-moving or schooling species), with some occurrence of aquatic animals such as insects, crustaceans, reptiles, and amphibians (Johnsgard 1993, Hatch and Weseloh 1999). Trapp et al. (1999) conducted a review of diet studies carried out between 1923 and 1994 and found that of 75 fish species detected as DCCO prey items, only 29 species comprised more than 10 percent of the diet at a specific site and, of those 29, five species consistently comprised greater than 10 percent of the diet: alewife, brook stickleback, ninespine stickleback, yellow perch, and slimy sculpin. These results confirm the popular notion that the DCCO is an opportunistic feeder, utilizing a wide diversity of prey. A review of the diet literature by Wires et al. (2001) indicated that, in general, sport and commercial fish species do not contribute substantially to DCCO diet, although they and Trapp et al. (1999) both cited exceptions to this rule.

In general, DCCO diet varies highly among locations and tends to reflect the fish species composition for each location, making it necessary to examine diet on a site-specific basis (Belyea et al. 1999, Wires et al. 2001). But some regional generalizations can be made about fish consumed by DCCOs. On the Pacific coast, no single species emerged as the most important prey item in past studies, although some species were very important in certain regions. In the Columbia River Estuary, diet composition differed at the two main colonies. At Rice Island, salmonids were the most important prey item with stickleback and peamouth also being important; at East Sand Island, shad, herring, and sardine were the most important prey items, with salmonids and starry flounder also important (Collis et al. 2000). In other areas, fish such as shiner perch, sculpin, gunnel, snake prickleback, sucker, and sand lance proved important components of DCCO diet (Wires et al. 2001). Aside from Pacific salmonids, several of which are Federally-listed as threatened or endangered, the populations of none of these fish species are a regional or national concern.

In the Great Lakes, fish species such as alewife and gizzard shad, appear to be the most important prey items. Stickleback, sculpin, cyprinids, and yellow perch and, at some localities, burbot, freshwater drum, and lake/northern chub are also important prey fish species (Wires et al. 2001). Stapanian et al. (2002) wrote that, “Diet and foraging studies in the Great Lakes suggest that cormorants are opportunistic foragers that eat mostly small prey fish, such as young-of-the-year and yearling gizzard shad…, emerald shiner…, freshwater drum…, alewives…, and sticklebacks…,” most of which have little sport or commercial value, while noting that “cormorants consume large quantities of smallmouth bass and yellow perch in the waters near Little Galloo Island in Lake Ontario.” Studies suggest that considerable temporal variation exists in the diet of Great Lakes DCCOs (Johnson et al. 2002, Neuman et al. 1997); this can likely be attributed to fish movement, much of which is related to spawning (Johnson et al. 2002).

In the southeastern U.S., most of the diet consists of shad, catfish, and sunfish species (Wires et al. 2001). In the Atlantic region, diet varies to a great extent, with no single species emerging as most important. In coastal habitats, cod, sculpin, cunner, and gunnel are important as well as sand lance and capelin. Where DCCOs are found inland or at estuaries, alewife, rainbow smelt, stickleback, smallmouth bass, yellow perch, pumpkinseed, cyprinids, and salmonids (mainly Atlantic salmon) are important prey items (Wires et al. 2001). Of these species, Atlantic salmon are Federally-listed as threatened, smallmouth bass and yellow perch are important sport fish, and cod, alewife, and rainbow smelt are commercially fished. Concern about impacts of DCCO predation on these fish has been expressed.

Table 8. Geographic Range of Common DCCO Prey Species

| |
|---|
| Largemouth Bass: originally ranged in the Atlantic slope watersheds south of Maryland, the St. Lawrence River basin, Great Lakes, and Mississippi River basin to northeastern Mexico. They have been stocked throughout the United States. |
| Smallmouth Bass: originally ranged from Minnesota to Quebec, including the Great Lakes, southward to northern Alabama, and west to eastern Kansas and Oklahoma. Because of its sporting qualities, it has been introduced to many other states, Canadian provinces, and 41 other countries. |
| Channel Catfish: naturally occurred in the central and eastern United States and southern Canada. They ranged throughout the Mississippi River drainage to northeast Mexico; to the east from the St. Lawrence River, along the western slope of the Appalachian Mountains to central Florida. They were conspicuously absent along the watersheds of the Atlantic seaboard. The species has been widely introduced for sport fishing throughout the United States. |
| Walleye: native range is throughout most of eastern North America, including Great Lakes, but has been introduced to Western North American streams where habitat is suitable. |
| Northern Pike: range is extensive, greater than any other freshwater game fish. Pike can be found throughout the northern half of North America, including the Great Lakes. |
| Yellow Perch: on the Atlantic coast, range from South Carolina north to Nova Scotia. They can also be found west through the southern Hudson Bay region to Saskatchewan, including the Great Lakes, and south to the northern half of the Mississippi drainage. |
| Bluegill: original range includes most of central and eastern United States, north into southern Canada. |
| Alewife: native to the Atlantic Coast and entered the upper Great Lakes through the Welland Canal. Alewife populations have become established in Great Lakes and many landlocked lakes in New York, Maine, Connecticut, and other New England states. |
| Gizzard Shad: Mississippi and Atlantic drainages, including the Great Lakes. |
| Rainbow Smelt: essentially a marine species with chief distribution along Canadian coastal waters. Intruded into fresh waters of northeastern U.S. and the Great Lakes. |

*Health of the Great Lakes: An Overview.* In order to examine the cormorant population explosion in the U.S. and Canadian Great Lakes and its impact to fisheries from an "ecological" perspective, it helps to examine the ecosystem health of the Great Lakes. An excellent overview of the aquatic community health of the Great Lakes is that of a working paper presented at the State of the Lake Ecosystem Conference (Koonce 1995). This discussion is derived largely from that source. By most standards, the Great Lakes ecosystems are "extremely unhealthy." The most notable justifications for this description are the Lakes' dramatic loss of biological diversity and the establishment of non-indigenous populations (Koonce 1995).

The Great Lakes Fact Sheet produced by Environment Canada's Ontario Region (available online at http://www.on.ec.gc.ca/wildlife/factsheets/fs_cormorants-e.html) provides a concise summary of the "rise and fall of Great Lakes fish populations":

Great Lakes fish populations have undergone some profound changes in the last 60 years. One of these was the dramatic decline of large predatory fish, primarily Lake Trout and, to a lesser extent, Burbot. In Lake Ontario the most dramatic declines of these species occurred in the late 1930s and 1940s, while in Lake Huron they occurred during the 1940s and 1950s. The decline of the predatory fish was caused by many factors, including years of heavy fishing, the invasion of the sea lamprey, the loss of spawning areas. Increased amounts of toxic contaminants entering the lakes may have also been a factor.

With the decline of larger predatory fish, the smaller fish species underwent an unprecedented population explosion. The main species involved in this increase were Rainbow Smelt and Alewife, neither of which was native to the upper Great Lakes. Rainbow Smelt were introduced to the Great Lakes in Michigan in 1912. They spread slowly through the lakes, becoming common in Lakes Michigan and Huron by the

1930s and in Lakes Ontario and Erie by the late 1940s. Alewife were abundant in Lake Ontario by the 1890s but did not become common in Lakes Michigan and Huron until the demise of the Lake Trout in the mid-late 1940s.

Thus, for a period of 30 years (1950s - 1970s) these smaller prey species increased in a manner more or less unchecked by any predatory fish or birds higher up the food web. The smaller prey fish came under heavy predation pressure in the 1980s, with the massive stocking of salmon and trout in most of the Great Lakes. As a result, the population of smaller fish decreased. However, in spite of this predation, Alewife remained abundant throughout much of the Great Lakes and were fed upon heavily by cormorants during this period.

Indeed, fish play a major role in structuring aquatic ecosystems. At least 18 fish species of historical importance have declined significantly or disappeared from one or more of the Great Lakes (Koonce 1995). Accompanying these changes in native biodiversity have been a series of invasions and introductions of non-native fish species. Species that have established substantial populations include: sea lamprey, alewife, rainbow smelt, gizzard shad, white perch, carp, brown trout, Chinook salmon, coho salmon, pink salmon, rainbow trout, ruffe, rudd, fourspine stickleback, and two species of goby. In total, 139 non-native aquatic organisms (including plants, invertebrates, and fish) have become established in Great Lakes ecosystems (Koonce 1995).

These changes in the biodiversity of the Great Lakes have been, and continue to be, caused by a number of chemical, physical, and biological stresses, the most important of which include: (1) large-scale degradation of tributary and nearshore habitat for fish and wildlife; (2) imbalances in aquatic communities due to population explosions of invading species such as sea lamprey, alewife, white perch, and zebra and quagga mussels; (3) reproductive failure of lake trout; (4) alterations of fish communities and loss of biodiversity associated with overfishing and fish stocking practices; and (5) impacts of persistent toxic chemicals on fish and wildlife (Koonce 1995).

Koonce (1995) also noted that "evaluation of the health of the aquatic community of the Great Lakes is complicated," mainly due to three important factors. First, identification of factors responsible for particular population effects (e.g., increased mortality rates or decreased reproductive rates) is difficult because different factors can produce similar effects on populations. Second, since populations and communities are adaptive, with healthy communities able to self-regulate in the presence of internal/external stresses, a variety of "healthy" states may be functionally equivalent (in at least an ecological sense). Third, the Great Lakes are disturbed ecosystems for which there are no undisturbed communities to serve as benchmarks for recovery; thus, "the determination of the wellness of an ecosystem requires a value judgment."

### 3.2.3 Other Birds

In a survey conducted by Wires et al. (2001), impacts to other bird species were reported by the States of Arkansas, Illinois, Iowa, Maine, Massachusetts, Michigan, Mississippi, New York, Ohio, Vermont, and Wisconsin. Impacts to other colonial waterbirds, particularly herons and egrets, were reported most often and these impacts were associated mainly with habitat degradation and competition for nest sites. During our EIS public comment periods, several resource agencies expressed concern about actual or potential impacts to other birds.

Over the course of their life cycle, individual DCCOs may interact with other species of birds in a variety of ways. These interactions may involve competition for nest sites, competition for food, and disease transmission.

Table 9. Avian Associates of DCCOs (Source: Kaufman 1996 and Ehrlich et al. 1988)

| |
|---|
| American White Pelican: Habitat includes lakes, marshes, salt bays. Total population probably declined through first half of $20^{th}$ century, but has increased substantially since 1970s. |
| Anhinga: Habitat includes cypress swamps, rivers, and wooded ponds in the southern U.S. |
| Black-crowned Night-Heron: Habitat includes marshes and shores; roosts in trees. Populations probably declined in $20^{th}$ century due mostly to habitat loss; in recent years, overall population is generally stable or increasing, but declining in the U.S. Great Lakes. See Table 10 below. |
| Brandt's Cormorant: Habitat includes rocky areas along Pacific coast. Local populations fluctuate, but overall numbers probably stable. |
| Caspian Tern: Habitat includes large lakes, coastal waters, beaches, bays. Overall population probably stable, perhaps increasing. |
| Common Tern: Habitat includes lakes, ocean, bays, beaches. Northeastern populations probably lower than they were historically. Some inland populations declining, including Great Lakes. |
| Great Black-backed Gull: Habitat mostly includes coastal waters and estuaries along the Atlantic coast. Populations increasing and breeding range steadily expanding. |
| Great Blue Heron: Habitat includes marshes, swamps, shores, tideflats; very adaptable. Common and widespread, numbers stable or increasing. |
| Great Cormorant: Habitat includes ocean cliffs with some found on large inland rivers in winter. North American population (also found throughout Europe) has increased dramatically in recent decades, and breeding range has expanded southward along Atlantic coast. |
| Great Egret: Habitat includes marshes, ponds, shores, mudflats. Nearly decimated by plume hunters in $19^{th}$ century, recovered in $20^{th}$ century. In recent decades, breeding range has gradually expanded northward, with some evidence that southern populations have declined. |
| Herring Gull: Habitat includes ocean coasts, bays, beaches, lakes, piers, farmlands, dumps. Populations increased greatly in $20^{th}$ century and breeding range expanded. |
| Neotropic Cormorant: Habitat includes tidal waters and lakes in the southern U.S. After declines in Texas numbers in the 1950s and 1960s, is increasing again and may be spreading north inland. |
| Pelagic Cormorant: Habitat includes cliffs and other rocky areas along Pacific coast. Population probably stable, with close to 75% occurring in Alaska. |
| Ring-billed Gull: Habitat includes lakes, bays, coasts, piers, dumps, plowed fields. Populations high and probably still increasing. |
| Snowy Egret: Habitat includes marshes, swamps, ponds, shores. Nearly decimated by plume hunters in $19^{th}$ century, recovered in $20^{th}$ century. Has expanded breeding range northward in recent decades; populations increasing. |
| Western Gull: Habitat includes coastal waters, estuaries, beaches, offshore islands, city waterfronts. Common, with overall numbers stable. |

Table 10. Comparisons of population estimates of Black-crowned Night-Herons in the Great Lakes in 1976–80, 1989–91, and 1997–2000 (from Blokpoel and Tessier 1998; Cuthbert et al. 2002; C. Weseloh unpubl. data; L. Harper unpubl. data)

| **Body of Water** | **1976–1980** | | **1989–1991** | | **1997–2000** | |
|---|---|---|---|---|---|---|
| | No. of breeding pairs | No. of colonies | No. of breeding pairs | No. of colonies | No. of breeding pairs | No. of colonies |
| Lake Michigan | 558 | 11 | 859 | 10 | 927 | 11 |
| Lake Huron | 491 | 12 | 562 | 13 | 810 | 19 |
| Lake St. Clair | 0 | 0 | 98 | 2 | 0 | 0 |
| Lake Erie | 4,220 | 2 | 1,719 | 5 | 529 | 3 |
| Niagara River | 65 | 1 | 213 | 2 | 185 | 3 |
| Lake Ontario | 362 | 6 | 1,221 | 12 | 1,514 | 10 |
| *TOTAL* | *5,696* | *32* | *4,672* | *44* | *3,965* | *46* |

### 3.2.4 Vegetation

Concern about negative impacts of nesting and roosting DCCOs to vegetation has been expressed by the public as well as natural resource professionals. In a survey conducted by Wires et al. (2001) respondents from Alabama, Arkansas, Connecticut, Florida, Iowa, Maine, Maryland, Michigan, New Hampshire, New York, North Carolina, Ohio, Oklahoma, Rhode Island, Vermont, and Wisconsin reported impacts to trees, while the States of Iowa, Maine, Maryland, Michigan, New Hampshire, Ohio, Oklahoma, Vermont, Virginia, and Wisconsin reported impacts to herbaceous layers.

DCCOs seem to prefer nesting in trees to nesting on the ground, and trees are probably used by older, more experienced, earlier-breeding individuals (Weseloh and Ewins 1994). Along the Pacific coast, however, DCCOs nest primarily on the ground, either in low vegetation or on the barren ground of offshore islands and coastal cliffs. Typically, islands with avian breeding colonies have less vegetative cover than adjacent islands with none and, in general, plant species diversity tends to be low in colonial waterbird nesting colonies (Chapdelaine and Bédard 1995). The chief concerns associated with DCCO-induced vegetation damage are displacement of other colonial waterbird species (caused by habitat changes) and harm to plant species/communities of special management significance. Into the latter category falls the Carolinian forest vegetation type, the northernmost geographic extension of the eastern deciduous forest ecosystem. In Canada, even though the Carolinian vegetation zone makes up only 1 percent of Canada's total land area, it boasts a greater number of species of flora and fauna, many of which are considered rare, than any other ecosystem in Canada (http://www.carolinian.org/Cc1.htm).

### 3.2.5 Federally-listed Species

A concern among members of the public and wildlife professionals, including Service and Wildlife Services personnel, is the impact of damage management methods and activities on non-target species, particularly Threatened and Endangered species.

Another concern is potential impacts to Threatened and Endangered species caused by DCCOs themselves. For example, during the public scoping period, the Maine Department of Inland Fisheries and Wildlife listed DCCO predation on stocked and native Atlantic salmon as an issue of concern. Additionally, during the DEIS comment period, the State of Washington stated their concern about impacts of DCCO predation on wild salmonids.

Section 7 of the Endangered Species Act (ESA), as amended (16 U.S.C. 1531-1543; 87 Stat. 884), provides that, "The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this Act" (and) shall "ensure that any action authorized, funded or carried out ... is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of (critical) habitat ..." Consequently, we completed an intra-Service biological evaluation and informal Section 7 consultation under the ESA for the proposed action.

## 3.3 Socioeconomic Environment

Concerns about increasing DCCO populations extend beyond the biological to include social and economic impacts as well.

### 3.3.1 Water Quality and Human Health

The major human health concern expressed during public scoping was contamination of water supplies by DCCO excrement. Eight States expressed concern over possible DCCO-related impacts to water quality in a survey conducted by Wires et al. (2001). Those States were Alabama, Arkansas, Connecticut, Maine, Massachusetts, Michigan, Rhode Island, and South Carolina. Additionally, residents of Henderson, New York, near Little Galloo Island in eastern Lake Ontario (home to a very large DCCO colony), expressed concern about DCCOs presenting a threat to their groundwater.

Waterbird excrement can contain coliform bacteria, streptococcus bacteria, Salmonella, toxic chemicals, and nutrients, and it is known to compromise water quality, depending on the number of birds, the amount of excrement, and the size of the water body. Although the 1992 Section 305(b) State Water Quality Reports indicate that, overall, the Nation's groundwater quality is good to excellent, many local areas have experienced significant groundwater contamination. The sources and types of groundwater contamination vary depending upon the region of the country, but those most frequently reported by States include: leaking underground storage tanks, septic tanks, municipal landfills, agricultural activities, and abandoned hazardous waste sites (EPA 1992). Concerns about water quality and DCCOs exist on two levels: contaminants and pathogens.

*Contaminants.* Elevated contaminant levels associated with breeding and/or roosting concentrations of DCCOs and their potential effects on groundwater supplies are the major concerns regarding DCCO impacts to human health. Metals and toxic organic chemicals typically originate in industrial discharges, runoff from city streets, mining activities, leachate from landfills, and a variety of other sources. These toxic chemicals,

which are generally persistent in the environment, can cause death or reproductive failure in fish, shellfish, and wildlife. In addition, they can accumulate in animal tissue, be absorbed in sediments, or find their way into drinking water supplies, posing long-term health risks to humans (EPA 1992).

The most toxic and persistent environmental contaminants include chlorinated hydrocarbons (also known as organochlorine chemicals; e.g., PCBs, dioxin-like compounds, and certain pesticides such as DDT). These compounds are lipophilic (meaning they become chemically bound to fat molecules) and accumulate in individual organisms via a process known as bioaccumulation. Then, as a result of biomagnification, these chemicals, bound in organisms, occur at greater concentrations with each step of the food chain. Thus, species at the top of the food chain, such as DCCOs, harbor the greatest, and most toxic, levels of these contaminants.

*Pathogens. Escherichia coli* (*E. coli*) are fecal coliform bacteria associated with fecal material of warm blooded animals. There are over 200 specific serological types of E. coli and the majority are harmless (Sterritt and Lester 1988). Aquatic birds can be a source of fecal contamination of water resources. For example, Simmons et al. (1995) used genetic fingerprinting to link fecal contamination of small ponds on Fisherman Island, Virginia to waterfowl. Klett et al. (1998) were able to implicate waterfowl and gulls as the source of fecal coliform bacteria at the Kensico Watershed, a water supply for New York City. Also, fecal coliform bacteria counts correlated with the number of Canada Geese and gulls roosting at the reservoir (Klett et al. 1998). Additionally, excessive numbers of resident Canada Geese can affect water quality around beaches and in wetlands (Draft EIS: Resident Canada Geese Management, USFWS 2002).

### 3.3.2 Economic Environment

*Commercial Aquaculture Production.* The APHIS/WS Management Information System (MIS) database reveals that, from FY 1995-2001, aquacultural resource losses to DCCO predation were reported in 33 states, with catfish, baitfish, and trout being the most commonly identified fish species. In 1996, roughly half (53 percent) of U.S. catfish farmers considered DCCOs to be a problem, with farmers from Mississippi (77 percent), Arkansas (74 percent), and Alabama (50 percent) most likely to have DCCO conflicts (Wywialowski 1999). In the Mississippi Delta, 87 percent of catfish farmers surveyed felt that they had a bird problem and losses to birds (harassment costs plus value of fish lost) were estimated at $5.4 million, or 3 percent of total sales (Stickley and Andrews 1989). A survey conducted by Wires et al. (2001) found that DCCO predation at aquaculture facilities was perceived as a “major” problem in at least 6 States (Alabama, Arkansas, Louisiana, Mississippi, Tennessee, and Texas). It was perceived as a “moderate” problem in the States of Connecticut, Florida, Illinois, Maine, Massachusetts, Oklahoma, and Rhode Island.

Aquaculture, the cultivation of finfish and invertebrates in captivity, has grown exponentially in the past several decades (Price and Nickum 1995, Glahn et al. 2002). The principal species propagated in the United States are catfish, trout, salmon, tilapia, hybrid striped bass, mollusks, shrimp, crayfish, baitfish and ornamental tropical fish

(Price and Nickum 1995; USDA 2000a). A 1998 census revealed that the U.S. domestic aquaculture industry represents slightly over 4,000 farms, with total sales reaching $978 million (USDA 2000a). Freshwater and saltwater farms accounted for over 320,700 and 92,600 acres (129,884 and 37,503 ha) of production, respectively, in 1998 (USDA 2000a). The 13 State southern region represented over two-thirds of the reported farms and total sales, followed by the western region, eastern region, north-central region, and the tropical and subtropical region, respectively (USDA 2000a). USDA (2000a) reported the top five States in U.S. aquaculture sales in 1998 were Mississippi, with sales of $290 million of catfish; Arkansas, with $84 million of catfish and baitfish; Florida, with $77 million of ornamental fish, mollusks and other products; Maine, with $67 million of Atlantic salmon; and Alabama, with $59 million of catfish.

**Catfish Industry**

Channel catfish production is the largest segment of the aquaculture industry, and the one which appears to be most susceptible to predation by DCCOs. See Appendix 3 for details of DCCO foraging behavior at aquaculture facilities. Catfish production accounts for approximately 50 percent of the aquaculture industry in the U.S. (Mott and Brunson 1997. Catfish growers in 13 States reported sales of $488 million during 1999, with the top four production states of Mississippi, Alabama, Arkansas, and Louisiana accounting for 96 percent of the U.S. total sales. Mississippi farms represented over half of the catfish sales in 1999, with slightly over $294 million dollars in sales. There were more than 76,612 hectares of catfish ponds in the United States as of January 1, 2000. The four principal catfish-producing States accounted for 95 percent of this total, with Mississippi alone accounting for about 58 percent (USDA-NASS 2000a). About 90 percent of Mississippi's ponds are found in northwest Mississippi; this region, known as the Mississippi Delta, includes 16, 000 $km^2$ of the Mississippi River alluvial plain (Glahn et al. 2002). This intensively farmed region includes catfish farms interspersed with cotton, soybean, rice, and corn fields and contains over 10 percent of its original wetland habitat, consisting of cypress swamps and bayous (Glahn et al. 2002).

**Other Industries**

Louisiana and Arkansas together represent 90 percent of the baitfish production in the U.S. (Price and Nickum 1995). A National Agricultural Statistics Service 1998 Census of Aquaculture (USDA 2000a) reported that Arkansas baitfish growers accounted for $23 million in sales in 1998, which represented over 60% of U.S. baitfish sales.

Trout producers in 20 states reported sales of $76.9 million in 1999, with Idaho, North Carolina, California, and Pennsylvania representing the top 4 states in production. Idaho accounted for almost half of the trout sold in the U.S. in 1999 (USDA-NASS 2000a). In 1993, the Atlantic salmon industry was valued at $55-60 million (Price and Nickum 1995). A National Agricultural Statistics Service 1998 Census of Aquaculture (USDA-NASS 2000b) reported that 47 salmon producers in the U.S. reported sales of over $103 million, with Maine accounting for over $64 million in sales.

USDA (2000) reported in 1998 there were 345 ornamental fish growers in the U.S. with $69 million in sales. Florida was reported dominating the industry, accounting for 171 of the ornamental fish growers and 81 percent of total U.S. sales (USDA 2000a).

USDA-NASS (2000b) reported over $10 million in reported crayfish sales in 1998. The crayfish aquaculture industry is centered primarily in Louisiana, accounting for approximately 92 percent of U.S. production. Freshwater crayfishes have been most commonly used as food and fish bait but are also commercially used in the pet trade as pets and food for predaceous pet fishes, and in the academic community for teaching and research purposes (Huner 1997). Between 1960 and 1996, commercial crayfish acreage in Louisiana increased from 800 ha to 45,000 ha (Glahn et al. In Press).

*Recreational Fishing Economies.* The many public benefits provided by recreational fishing are supported by an extensive body of Federal legislation and international treaty conventions. These include the Anadromous Fish Conservation Act of 1985, the Fish and Wildlife Coordination Act, the Fish and Wildlife Act of 1956, the Great Lakes Fishery Act of 1956, the Great Lakes Fish and Wildlife Restoration Act of 1990, and the Boundary Waters Treaty of 1909 between the United States and Great Britain (USFWS 1995). Moreover, Executive Order 12962, signed by President Clinton in 1995, recognizes the social, cultural, and economic importance of recreational fisheries and directs Federal agencies, to the extent practicable and where permitted by law, "to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities..." (USFWS 1997).

The Service's responsibilities related to recreational fisheries management include administering the Fisheries Across America grant program, in which the Service pursues cost-sharing opportunities with non-Federal entities to enhance recreational fishing opportunities by restoring aquatic ecosystems and native fish populations. Under the Land and Water Conservation Fund, the Service also acquires lands and waters that address the needs of recreationally important species. On National Wildlife Refuges, the Service manages recreational fisheries such as rainbow trout, arctic char, grayling, and sheefish in Alaska, and largemouth bass and sunfish in the lower 48 States. Outside of Federal lands, the Service assists States and Tribes with management of migratory interjurisdictional recreational fish species of national concern, such as Atlantic and Pacific salmon and lake trout. Finally, the Service, through its National Fish Hatchery System, propagates fish that are important to the survival, maintenance, and restoration of recreationally valuable stocks of freshwater, anadromous, and coastal fisheries (USFWS 1997).

Recreational fishing benefits local and regional economies in many areas of the U.S. As participation in a recreational fishery increases, so does the total amount of money entering local and regional economies as angler expenditures. In this way, growth of recreational fishing can stimulate economic activity (Royce 1987 in Ross 1997). During public scoping, concern was expressed that increased DCCO predation has negatively impacted recreational fisheries which has, in turn, impacted the economies of communities that rely heavily on income associated with recreational fishing.

In 2001, 34.1 million adult anglers in the United States spent $35.6 billion and fished the equivalent of 557 million days. These anglers spent an average of $1,046 on fishing-related expenses (USDI/USDC 2002). When adjusted to account for economic-multiplier effects, anglers' annual spending was shown to have a nationwide economic impact of about $108.4 billion, support 1.2 million jobs, and add $5.5 billion to Federal and State tax revenues (ASA 1996). Additionally, through the Federal Aid in Sport Fish Restoration Program, a portion of the money that is spent by anglers on equipment and supplies is used to support sport fish restoration, management, or enhancement programs, including research activities, boating access development and maintenance, aquatic resource outreach and education projects, land acquisition, hatchery construction, and habitat enhancement. The States with the highest levels of annual fishing expenditures in 2001 were: Florida ($4.1 billion), California ($2.0 billion), Texas ($2.0 billion), Minnesota ($1.3 billion), North Carolina ($1.1 billion), New York ($1.1 billion), and Wisconsin ($1.0 billion).

In addition to measuring expenditure levels, "net economic value" is an indicator of the economic benefit to individual participants; it is measured as participants' willingness to pay beyond what they spend to participate. Adding the net economic values of all individuals who participate in an activity derives the value to society (Boyle et al. 1998). For example, the mean net economic value per year for trout fishing in California, Idaho, Nevada, Oregon, and Washington is estimated at $126 per angler. The net economic value per *day* for the same angler would be $12. For bass and trout fishing in New York, the mean net economic value per year is estimated at $150, or $10 per day. However, we did not use net economic value determinations because we felt it would not add much substance to the analysis.

**The Great Lakes**

The total annual fishing expenditures for all eight Great Lakes States (IL, IN, MI, MN, NY, OH, PA, and WI) combined amounted to $6.7 billion in 2001 (USDI/USDC 2002). Outdoor recreation in the Great Lakes makes a substantial contribution to the region's economy and quality of life (Allardice and Thorp1995). The 2001 National Survey of Fishing, Hunting and Wildlife-Associated Recreation indicated that 1.8 million U.S. anglers fished the Great Lakes that year. Great Lakes anglers participated in 23 million days of fishing, or an average of 13 days per angler. Two types of fish, perch and "black bass" (largemouth and smallmouth bass, etc.), dominated fishing activity, together comprising 58 percent of the time spent fishing. Walleye and salmon fishing made up 22 and 17 percent, respectively, of fishing activity in the Great Lakes (USDI/USDC 2001).

Great Lakes sport fishing results in a substantial economic impact, particularly for coastal communities that are near popular fishing spots. Various studies (Brown et al. 1991, Connelly and Brown 1988) have provided evidence for the positive relationship between Great Lakes fisheries and tourism-related economic benefits to local communities. In 2001, total U.S. Great Lakes fishing expenditures were projected at $1.3 billion. Trip-related expenditures, including food, lodging, transportation and guide/package fees amounted to $776 million and equipment-related costs totaled about $ 498 million.

Expenditures per angler were figured at about $690 for the year. About half of Great Lakes sport fishing is done from boats, some of which make up a growing charter fishing industry. Since the mid-1970s, roughly paralleling the growth in sport fishing, the number of charter boats increased from 500 to more than 3,000 (USDI/USDC 2002; USDI/USDC 1997; Dawson et al. 1988). The current number of charter boats in the Great Lakes is unknown, but has reportedly dwindled in recent years.

The dynamics between the availability of sport fish and the willingness of sport anglers to spend money in pursuit of their prey is poorly known, at least in well-documented, quantitative terms. A 1976 survey of licensed New York State anglers suggested that days of angler participation in bass fishing were found to be significantly influenced by angler preferences, travel costs to angling sites, proximity of neighboring sites, and the quantity of shoreline distance available for angling (Menz 1981). In a survey conducted in 1996, 65 percent of 35 million adult anglers nationwide reported that "they did not fish as often in 1996 as they would have liked" for two key reasons: (1) family or work commitments (43 percent) and not enough time (21 percent). "Not enough fish" was listed as a main reason by only 1 percent of respondents (USDI/USDC 1997).

**New York**
In New York, 1.3 million anglers fished for 19.3 million days and spent $ 1.1 billion in 2001 (USDI/USDC 2002). The Lake Ontario fishery alone has been estimated to generate over $100 million in annual angler expenditures (Connelly et al. 1990) and, in 1996, an estimated 188,000 anglers spent a daily average of about $34 en route and at location fishing in Lake Ontario and its bays (Connelly et al. 1997).

The eastern basin of Lake Ontario is an important tourist destination, but one that faces major economic challenges. Jefferson and St. Lawrence counties, for example, have some of the highest unemployment rates in the State of New York (Schusler and Decker 2000). The area is rich in natural and scenic resources and the success of many local businesses is closely related to the fish and wildlife resources of the region. Thus, many communities look to recreation (such as fishing) and tourism for "economic salvation" (Schusler and Decker 2000). In 1996, anglers spent $40.9 million in Jefferson County (Brown et al. 2002). Throughout the 1990s a number of businesses that depend heavily on eastern basin sport fisheries experienced declines in business (Brown et al. 2002).

Recreational fishing is also economically important to the Oneida Lake area. In 1996, fishing trips to Oneida Lake generated an estimated $10.6 million (Cornell Cooperative Extension of Onondaga County 2000). In that same year, an estimated 50,850 anglers spent a daily average of $18 en route and at location fishing in Oneida Lake (Connelly 1997). A report of the socioeconomic impacts associated with declining fisheries on New York's Oneida Lake came to the following conclusions based on surveys of local marinas and sporting good shops: hundreds of anglers had moved their boats from the lake's marinas, fewer out-of-state anglers were coming to the area, daily boat rentals had declined, bait and tackle business had declined, and fewer anglers were participating in local fishing derbies (Schriever and Henke 2000).

*Commercial Fishing.* The two chief areas where DCCO impacts to open water commercial fish stocks are a potential concern are the Great Lakes and New England (both riverine and coastal). During scoping, we received a small number of complaints about such impacts and we thus limited our discussion of this issue in the DEIS. Upon further consideration, we decided to include commercial fishing discussions in the FEIS environmental analysis. Overall, the economic importance of commercial fishing in both of these areas has experienced a steady decline for reasons unrelated to fish-eating birds. The Great Lakes Fishery Resources Restoration Study (USFWS 1995) noted that: "Historically, large numbers of lake trout, lake whitefish, lake herring, walleye, blue pike, lake sturgeon, yellow perch and other fish populated the Great Lakes and supported a major commercial fishing industry. In Lake Ontario, Atlantic salmon were gone by 1900 and sturgeon were severely depleted. Populations of commercially valuable fish further declined precipitously during the 1950s and 1960s due to a combination of factors, including overfishing, sea lamprey predation, competition with nonindigenous nuisance species, and pollution." Today, commercial fishing activity in the U.S. Great Lakes is highest in Lake Erie and northern Lake Michigan (Hebert et al. 1999). Commercially exploited fish species include lake trout, lake whitefish, smelt, bloater chubs, perch, and alewife (EPA 1995, Crane 1996). Commercial fishing continues to face pressure on several fronts, including toxic contaminants, pressure by sport fishing groups to limit commercial catch, and restricted harvest methods (EPA 1995). In New England, commercial extinction of Atlantic groundfish stocks has occurred in recent years.

Between 1990 and 1996, the reported commercial harvest of yellow perch in New York waters averaged 16,524 kg per year (Cluett 1997 *in* Burnett et al. 2002). In 1999, total U.S. Great Lakes commercial landings for walleye and yellow perch were valued at $14,830 and $2.6 million, respectively (http://www.st.nmfs.gov/pls/webpls/MF_GL_LANDINGS.RESULTS). In comparison, the Northeast's commercial oceanic and estuarine fisheries produced domestic landings worth $1.098 billion dockside in 1999, an increase of $98 million over 1998. Finfish landings brought in $360 million in 1999, representing 33% of the revenue generated in the region. Shellfish landings brought in $739 million, accounting for the remaining 67 percent of revenue. (NOAA 2001; http://www.nefsc.noaa.gov/sos/econ/#regsum).

### 3.3.3 Fish Hatcheries and Environmental Justice

The Service has a responsibility to conserve, restore, enhance, and manage the Nation's fishery resources and aquatic ecosystems for the benefit of future generations. Federal stewardship of the Nation's fishery resources has been a core responsibility of the Service for over 120 years. The National Fish Hatchery System (NFHS) was established in 1871 by Congress through the creation of a U.S. Commissioner of Fish and Fisheries. The original purpose of the NFHS was to provide additional domestic food fish to replace declining native fish populations. Cultured fish were used to replace fish that were lost from natural (drought, flood, habitat destruction) or human (over-harvest, pollution, habitat loss due to development and dam construction) influences, to establish fish populations to meet specific management needs, and to provide for the creation of new and expanded recreational fisheries opportunities. The NFHS also has a unique responsibility in helping to recover species listed under the ESA, restoring native aquatic

populations, mitigating for fisheries lost as a result of Federal water projects, and providing fish to benefit Tribes and National Wildlife Refuges.

The Service's responsibility to provide fish stock to Tribes raises an Environmental Justice concern. 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.

Additionally, States and Tribes manage numerous public fish hatcheries across the country. For example, in Oregon, approximately 80 percent of all trout harvested come from Oregon fish hatcheries. In Wisconsin, fourteen State hatcheries raise fish such as walleye, steelhead, lake trout, and suckers. Texas fish hatcheries, such as the Texas Freshwater Fisheries Center, not only raise fish to stock lakes and rivers, but also offer opportunities for entertainment and education. Additionally, nine of eleven Great Lakes Indian Fish and Wildlife Commission member Tribes operate tribal fish hatcheries, annually stocking millions of fry and fingerlings into reservation and off-reservation waters. The costs associated with raising hatchery stock can be significant. For example, in 2001, the Oneida Lake Hatchery in New York spent approximately $265,000 producing fry, pond fingerlings, and advanced fingerlings for stocking Oneida Lake (Richard Colesante, NYSDEC, Warmwater Hatchery Program Supervisor, pers. comm.).

### 3.3.4 Property Losses

Private property losses associated with DCCOs include impacts to privately-owned lakes and ponds that are stocked with fish, damage to boats and marinas or other properties found near DCCO breeding or roosting sites, and damage to vegetation on privately-owned land.

Conover (2002) noted the conflict arising when publicly-owned wildlife inflicts damage on private property. He noted that for "individual property owners who are suffering from wildlife damage, it is in their self-interest to stop the damage by any means possible, including lethal methods." On the other hand, the perspective of others is such that they see "their wildlife, which they own as members of society, being destroyed for someone else's private gain." These people are not really impacted by the wildlife damage and so "their sentiments may lie with the wildlife and not with the property owners."

### 3.3.5 Existence and Aesthetic Values

One sensible philosophy toward wildlife management is that it aims "to increase the net value of the wildlife resource for society while avoiding those actions which might cause the irrevocable loss of any part of this resource" (Conover 2002). Wildlife resources provide numerous benefits to society. Positive values of wildlife can be grouped into several categories, including physical utility, monetary, recreational, scientific, ecological, existence, and historic values (Giles 1978), while negative values include damages associated with loss of agricultural productivity, destruction of property, human

injuries or fatalities, and loss of biodiversity. In general, human-wildlife conflicts occur more frequently and with more intensity as wildlife populations increase (Conover 2002).

Existence value is the value a person associates with the knowledge that a resource 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 2000a). Existence value is independent of the size of the wildlife population (Conover 2002).

In addition to existence value, wildlife has aesthetic value. In fact, aesthetic benefits are one of the qualities commonly attributed to wildlife (Decker and Goff 1987). Aesthetic value refers to our sense of beauty and is, by nature, subjective and difficult to quantify. Koonce (1995) noted that, "a pathology from one perspective…may be a beneficial condition to another." He gives an example of how, in Lake Ontario, the need to supplement salmonids via stocking, in order to work around the failure of lake trout reproduction, is a pathological symptom (at least from a naturalistic perspective). Yet many recreational anglers prefer catching non-native Chinook salmon and view emphasis on lake trout rehabilitation as disagreeable if it means a declining Chinook fishery. Thus, to some individuals or groups of society, aesthetic value is maximized when ecosystems are recovered to historic pristine levels while, to others, the existence of a good sport fishery is the epitome of "beautiful."

Aesthetic and existence value benefits are much more difficult to quantify than are economic impacts. No studies have been carried out to estimate the dollar value that Americans assign to DCCOs and, if there were, this value would certainly vary considerably from person to person. While we were not able to quantify the existence or aesthetic value of DCCOs to various stakeholders, we still feel that these are valuable concepts because they remind us that, although the direct economic benefits of DCCOs may be limited when compared to economic impacts, they are not devoid of value.

### 3.3.6 Issues Raised, but Eliminated from Detailed Study

*Air and Soil.* There are no significant impacts to air quality associated with DCCOs and none of the potential management actions would affect air quality.

Service biologists conducted sampling of soil/guano beneath DCCO nest trees on islands in Green Bay in 1987 and 1988 and found elevated PCB and DDE levels (Dale and Stromborg 1993). In 1999, soil/guano samples carried out by a private consulting firm found high levels of PCBs, DDE, and mercury on Little Galloo Island (LGI) in the eastern Lake Ontario waters of New York, home of one of North America's largest DCCO colonies and greater than 55,000 Ring-Billed Gulls (Anon. 1999; J. Farquhar, NYSDEC, pers. comm). The report showed that, from a limited pool of soil samples, PCBs, DDE, and mercury were detected in levels below that for an "inactive Hazardous Waste Site" designation, but in three samples levels did exceed the thresholds

recommended for an “unlimited human use” designation (such as a playground for children). However, human use of LGI, and most other DCCO colony sites, is very limited. Greater numbers of samples are necessary to draw more scientifically accurate conclusions about soil contaminant levels at LGI and other areas where DCCO excrement accumulates. Currently, there is not enough information to evaluate DCCO management alternatives in regard to this impact area.

*Aircraft Damage and Safety.* Wildlife-aircraft interactions may result in loss of human life and/or injury to passengers or people on the ground. The risk that birds pose to aircraft is well documented with the worst case reported in Boston in 1960 when 62 people were killed in the crash of an airliner which collided with a flock of starlings (Terres 1980). Wildlife strikes may cause expensive structural and mechanical damage to aircraft even if they do not result in a crash (Blokpoel 1976; Cleary et al.1997). In the United States in 1994, the estimated cost of bird strikes to military aircraft was $112 million (Conover et al. 1995). The cost of wildlife aircraft strikes to civil aviation for 1990-1998 in the United States was estimated to be in excess of 461,165 hours/year in aircraft down time, $253.02 million/year in direct monetary losses, and $132.96 million/year in associated costs (Cleary et al. 1999). Associated costs include passenger delays, labor, parts, and costs associated with emergency services and ferrying damaged aircraft to repair facilities.

All birds are potentially hazardous to aircraft and human safety; however, DCCOs typically do not forage or loaf in abundance near airports, making them less likely to be involved in collisions (USDA-APHIS 1999). According to the Federal Aviation Administration’s Bird Strike Database, there were a total of 26,644 reported bird strikes to civil aircraft in the U.S. from 1990-2000, with 16 of the strikes involving cormorants. Of these 16 strikes, 3 were classified as minor and resulted in wing damage to the aircraft, 2 were classified as substantial requiring major repair and grounding of the aircraft, and 11 were reported as strikes with no damage/reported damage to aircraft. The risk to aircraft safety associated with DCCOs is low and not considered to be a significant impact area. Current depredation permit practices allow for DCCO control when necessary to ensure aircraft safety.

*Affected Human Communities.* Social impacts refer to changes in the affected area’s customary condition of the human environment. Specifically, this refers to changes in the way people live, work, play, and relate to one another. A large part of the concern caused by DCCOs stems from alterations in the “way of life” that is familiar to those who live or recreate in areas where DCCO numbers are increasing. For example, residents of and visitors to the Great Lakes region view outdoor recreation not only as a quality of life issue, but as a “way of life” (USFWS 1995). Declines in the quality of sport fishing in these and other areas are a major concern as is evidenced by the level of participation from anglers in the public scoping process.

Based on responses received during the public scoping period, DCCOs do not appear to be a significant issue for Native American Tribes. We received three letters from Tribes or members of Tribes: (1) a member of the Kiowa Tribe of the State of Oklahoma felt

that since waterbirds are sacred, they should be given to Tribal people for use in their native ceremonies; (2) the White Mountain Apache Tribe of Arizona recommended that we use a hunting season to manage DCCOs; and (3) a Conservation Officer from the Wampanoag Tribe of Gay Head (of southeastern Massachusetts) said that they have experienced some trouble with DCCOs roosting on the Tribal Shellfish Aquaculture Program's spawning/rearing cages and recommended limited hunting.

In the Great Lakes, fish are valuable economically and as an important food supply for a number of Native American Tribes who engage in commercial and subsistence fishing, particularly in Lake Superior and northern Lakes Michigan and Huron. For example, the Chippewa/Ottawa Indians annually harvest an average of 1.1 million kg from their Lake Michigan commercial lake trout fishery (USFWS 1995). However, we did not receive comments during scoping from regional Tribes expressing concern about DCCO impacts. No scientific evidence has implicated DCCOs as having a major negative impact on lake trout reintroduction in the Great Lakes, although they have been known to consume stocked smolts (USFWS 1995).

Potentially affected human communities occur anywhere DCCOs and people coexist. Of particular concern are areas where DCCOs are abundant and viewed as a nuisance. We received a number of scoping comments expressing concerns about negative cultural impacts such as young people losing a safe and healthy form of recreation, retired citizens no longer being able to enjoy their favorite pastime, and parents losing the opportunity to pass on recreational knowledge to their children. Unfortunately, research on the sociocultural impacts associated with changes in a community's recreational patterns is limited and it would be very difficult to analyze the effects of DCCO management alternatives on this impact area in a meaningful way.

*Historic and Cultural Resources.* "Historic and cultural" aspects of the environment generally include historic properties, other culturally valued pieces of real property, cultural use of the biophysical environment, and such "intangible" sociocultural attributes as social cohesion, social institutions, lifeways, religious practices, and other cultural institutions (http://npi.org/nepa/whatare.html). These could include:

- Historic sites, buildings, districts, structures, and objects with historic, architectural, archeological, engineering, and cultural values.

- Historical objects such as the equipment that might be found in a surplus industrial facility, objects found at or excavated from an archeological site, and objects associated with the history and culture of an Indian Tribe or Native Hawaiian group.

- Documents with historic, folkloric, or archeological significance.

- Places of traditional religious or cultural importance to an Indian Tribe or Native Hawaiian organization.

- Locations regarded by a community or neighborhood, or others, as contributing to its "sense of place."

- The traditional religious and cultural practices of a community, neighborhood, Indian Tribe, or Native Hawaiian group (http://gsa.gov/pbs/pt/call-in/envbook/page41.htm).

For the most part, the effects of DCCO populations or management actions related to them would have very minor, if any, impacts on these types of resources. Control activities are not anticipated to have any significant negative impacts on historic sites or other resources. In the cultural category, three issues of concern have been raised: 1) cormorants are considered “sacred” to some Native American Tribes, 2) the religious practice of abstaining from work on Sundays (i.e., observing the “Sabbath”) is inhibited by the need to patrol aquaculture ponds seven days a week to protect them from DCCO depredation, and 3) popular fishing areas could be considered an important part of a specific area’s “sense of place” and DCCOs are viewed by some members of the public as inhibiting that value. Presumably, some Tribes would disagree with killing DCCOs, while the latter two cultural concerns would be alleviated by control actions that contributed to less DCCO presence. Due to lack of empirical information, a full analysis of these concerns is not possible.

# CHAPTER 4: ENVIRONMENTAL CONSEQUENCES

## 4.1 Introduction

The "environmental consequences" section of an EIS "forms the scientific and analytic basis for the comparison [of alternatives]" (40 CFR 1502.16). This chapter analyzes the environmental consequences of each of the five alternatives in relation to issues identified in Chapter 3, AFFECTED ENVIRONMENT, and in comparison to the No Action alternative to determine if impacts would be greater, lesser, or the same. Thus, the No Action alternative is the baseline for the analysis. Details of the alternatives are laid out in Chapter 2, ALTERNATIVES. As stated in the CEQ regulations, "the agency's preferred alternative is the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical and other factors."

NEPA requires disclosures of direct, indirect, and cumulative effects as well as mitigation measures. If a management activity greatly changes the amount or quality of an environmental factor (i.e., those issues identified in Chapter 3), the effect qualifies as significant. Significant effects may be positive or negative. Significant effects of some management activities may be unavoidable, have different short and long-term consequences or involve irreversible changes. Some negative effects may be mitigated to a level of insignificance.

**Management Activities**

- Shooting
- Oiling or destruction of eggs
- Nest destruction
- Cervical dislocation
- $CO_2$ asphyxiation
- Harassment (may include pyrotechnics, scarecrow devices, propane exploders, live ammunition, vehicle horns, etc.)

**Environmental Factors**

- DCCO populations
- Fish
- Other birds
- Vegetation
- Threatened and Endangered species
- Water quality and human health
- Economic conditions (aquaculture, recreational fishing, and commercial fishing)
- Hatcheries and Environmental Justice
- Property losses
- Existence and aesthetic values

## 4.2 Environmental Analysis of Alternatives

### 4.2.1 Impacts to Double-crested Cormorants

### Alternative A: No Action

The average actual take, as reported, under the depredation order and depredation permits in recent years (1998-2001) is 46,664 DCCOs per year. Since the total estimate of the continental DCCO population is 2 million, this represents an average annual take of approximately 2.1 percent of the continental population. However, the vast majority of this mortality affects Atlantic and Interior DCCOs while on their wintering grounds (since most of it is take associated with the aquaculture depredation order) so it is not spread evenly across the continent but concentrated in the southern U.S. The Breeding Bird Survey trend (mean percent change per year) for DCCOs in the U.S. and Canada, from 1990-2002, was 7.29 percent ($P = .00127$)(Sauer et al. 2002). Tyson et al. (1999), using a different survey technique, estimated that the overall mean percent annual change for the continental population of DCCOs from 1990-1994 was 2.6 percent although regional trends varied considerably from this average.

Appendix 4 presents an overview of DCCO management techniques. The chief management actions taken under this alternative are shooting (especially at aquaculture facilities), egg oiling, and harassment. Shooting at aquaculture facilities is, by itself, not considered an effective technique for controlling DCCO populations (Thompson et al. 1995; Simmonds et al. 1997). Indeed, despite the take of greater than 200,000 DCCOs in the U.S. since 1987, neither numbers of wintering birds nor of breeding birds appear to have been adversely impacted. This is supported by the continued steady growth seen in DCCO populations and by the observations of two papers on this topic: (1) Belant et al. (2000) documented lethal control at aquaculture facilities in the southeastern U.S. (including Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee) to evaluate the effects of these control activities on winter DCCO populations. Based on depredation permit data for 1987-1995, they estimated that 35,332 DCCOs were taken under 847 permits. The authors concluded that lethal control at aquaculture facilities did not adversely impact regional winter or continental breeding populations; and (2) Glahn et al. (2000a) concluded that the reported take of 9,557 DCCOs under the aquaculture depredation order by Mississippi aquaculture producers had no "apparent impact" on the number of DCCOs wintering in the Delta region.

Table 11. Annual Estimated Take Under No Action Alternative

| Year | Reported take under permits | Estimated take under Depr. Order (MN) | Estimated take under Depr. Order (southern)[1] | Total take (does not include eggs) | Percentage of estimated continental population |
|---|---|---|---|---|---|
| 1998 | 12,484 | 2,100 | 29,634 | 44,218 | 2.2% |
| 1999 | 12,385 | 1,600 | 38,098 | 52,083 | 2.6% |
| 2000 | 10,493 | 2,200 | 33,990 | 46,683 | 2.3% |
| 2001 | 21,669[2] | 2,000 | 20,000[3] | 43,669[2] | 2.3% |

[1]See Appendix 5 for the methodology we used to estimate this take.
[2]This number includes all reported take under depredation permits and *some* reported take under the depredation order.
[3]These numbers are estimates based on the assumption that levels of take did not change significantly in 2001.

Table 12. Number of DCCO Depredation Permits Issued by Region

| USFWS Region | Number of Permits – 2001 |
|---|---|
| 1 (CA, ID, NV, OR, WA) | 12 |
| 2 (AZ, NM, OK, TX) | 4 |
| 3 (IA, IL, IN, MI, MN, MO, OH, WI) | 21 |
| 4 (AL, AR, FL, GA, KY, LA, MS, NC, SC, TN) | 140 |
| 5 (CT, DE, MA, MD, ME, NH, NJ, NY, PA, RI, VA, VT, WV ) | 5 |
| 6 (CO, KS, MT, ND, NE, SD, UT, WY) | 14 |

Currently, egg oiling activities are conducted at Lake Champlain, Vermont; Eastern Lake Ontario, New York; and Oneida Lake, New York. In recent years, the New York State Department of Environmental Conservation has oiled DCCO eggs on islands in eastern Lake Ontario [19,862 DCCO eggs (1999); 15,118 (2000); 14,620 (2001); and 13,977 (2002)]. The project has continued in 2003. The Vermont Department of Fish and Wildlife oiled 9,569 eggs on islands in Lake Champlain in 1999 and 4,595 eggs there in 2000. It continued to oil DCCO eggs in 2001, 2002, and 2003.

Johnson et al. (2000a) found egg oiling to be "an effective technique to reduce the reproductive success of [DCCOs]" on Little Galloo Island in Lake Ontario and estimated that, due to egg oiling efforts, 8,300 fewer chicks were produced there in 1999. Farquhar et al. (2001) concluded that two years of intensive egg oiling on Little Galloo Island resulted in an estimated 98 percent reduction in DCCO reproductive success. However, Weseloh et al. (2002) observed that this success was probably highly localized. They pointed out that during the same time period that DCCO nest numbers declined at Little Galloo Island, the population on High Bluff Island (110 km to the northwest) increased from 2,442 pairs to 8,105 pairs and the entire Lake Ontario DCCO population increased from 17,066 to 24,344 pairs. Indeed, data collected by the Service (based on annual reports prepared by NYSDEC biologists) confirm this. It appears that while numbers on managed islands in New York have generally decreased, total numbers for the Eastern Basin and Upper St. Lawrence River area have remained steady. USFWS (2003) concluded that "declines from reduced reproductive output on Little Galloo Island are not yet affecting the area population."

Managers at Oneida Lake, New York, have been engaged in intensive DCCO harassment efforts each fall since 1998. Cormorant numbers were reduced by 61 to 98 percent in 1998 and 80 to 98 percent in 1999-2001 compared to lakewide population estimates conducted during 1995-1997. Local biologists believe that the hazed DCCOs continued further south in their migration in reaction to the harassment (NYSDEC press release). In Lake Champlain, Vermont (USFWS 1999b), and eastern Lake Ontario, New York (USFWS 1999a), the goal of preventing colonization on specific islands by DCCOs was achieved through nest removal activities.

Night roost harassment is a common technique for managing DCCO depredation at catfish farms. Tobin et al. (2002) found that only 11 percent of harassed DCCOs returned to the same roost within 48 hours, compared with an 81 percent rate of return for unharassed DCCOs. Glahn et al. (2000a) observed that, while roost dispersal programs continue to shift DCCOs away from areas of high catfish concentration, such results are "temporary at best." The number of known night roosts within the Mississippi Delta region has increased recently, making monitoring and harassment more difficult (Aderman and Hill 1995, Tobin et al. 2002).

Conclusion: Current management practices (shooting, egg oiling, and harassment) have had no significant impact on regional or continental DCCO populations.

**Alternative B: Non-lethal Management**

The main population effects of non-lethal management efforts would be spatial (i.e., moving birds to different areas where they may be more or less of a problem). Nest removal activities, as noted above, can prove effective at preventing the establishment of breeding birds or, at sites where birds have previously nested, can be used to lower reproductive success. In the case of harassment, birds may be prevented from reproducing during a specific breeding season or may suffer reduced reproductive success because of time and energy expenditures involved in finding new nesting areas, but this technique is generally believed to have negligible impacts on local populations when practiced on a relatively small scale (USFWS 1999a,b). If prevention of colonization is practiced intensely, annually, and over a large enough area, it may be effective at managing regional populations (Bregnballe et al. 1997).

Conclusion: An entirely non-lethal approach to cormorant damage management would not significantly affect DCCO populations on a regional or national scale.

**Alternative C: Increased Local Damage Control Alternative**

The main difference between management activities conducted under Alternatives C, D, and E would be the degree to which and by whom they are conducted. Under Alternative C, we estimate that depredation permit issuance would increase by no more than 30 percent, leading to mortality of approximately 15,400 adult and/or juvenile DCCOs annually (the average take under depredation permits for 1998-2000 = <11,800; 30 percent increase in mortality = 15,400).

Egg mortality might also increase. The majority of breeding pairs in the Interior and Atlantic populations (73 and 59 percent, respectively) will be exempt from egg oiling under this alternative because they nest in Canada (Hatch 1995, USFWS 1998b). Under this alternative, the goal of egg oiling efforts would be to decrease DCCO production on a very localized (i.e., colony) scale. Thus, it is unlikely that increased egg oiling efforts would have any significant impact on continental or regional DCCO populations.
Under this alternative, shooting at winter roosts would be authorized. Glahn et al. (1999) proposed that, in order to maximize the effectiveness of shooting DCCOs at reducing depredation damage, shooting birds at winter roosts should be allowed. Anecdotal

evidence indicates that DCCOs are wary birds and are difficult to kill at aquaculture facilities (Hanebrink and Byrd 1989; Conniff 1991; Price and Nickum 1995). Empirical evidence has confirmed this. At two aquaculture facilities in the Mississippi Delta, during 3,000 total hours of effort in which maximum take was not limited, only 290 DCCOs (12 percent of the 2,500 authorized) were killed over a 19-week period (Hess 1994). Glahn (2000) also found that, despite deploying skilled marksmen to shoot DCCOs in winter roosts, only a relatively small number of DCCOs (<5% of the roosting population) were killed, mainly due to the dispersal effects of shooting at them. This effect has been observed elsewhere, as reported by Aderman and Hill (1995):

> Collecting efforts to assess the diets of roosting [DCCOs] (Glahn et al. 1995) also were a source of harassment. For example, after the initial shotgun blasts at Goose Pond roost, all the cormorants present (c. 1,000) departed and did not return. Roost counts five days after collection revealed that such disturbance usually caused a decrease in numbers of cormorants at a site. Efforts at night to capture cormorants at roosts also reduced bird numbers. Mott et al. (1990) also noted a decrease in the numbers of roosting [DCCOs] following nighttime harassment activities.

For these reasons, Glahn (2000) concluded that allowing DCCOs to be shot at roosts is "unlikely to result in a large number of birds killed." We estimate that take under the expanded aquaculture depredation order would increase by 25 percent, leading to about 44,875 adult and/or juvenile DCCOs being killed under the aquaculture depredation order each year (average annual take under depredation order for 1998-2000 = <35,900; adding 25 percent comes to <44,875).

In their analysis of various management strategies for Great Cormorants in Europe, Bregnballe et al. (1997) observed that, since the outcome depends on the extent of competition in the population and the degree of density-dependence working within the population, it is difficult to predict quantitative impacts on cormorant population size. Even for species, such as mallards, for which there is a highly structured annual system of resource monitoring and data analyses, certainty in predicting the population effects of management actions has remained elusive (USFWS 2000c). In total, we predict DCCO take under this alternative would be <60,275 (~44,875 + 15,400) birds per year, or 3.0 percent of the estimated continental population.

Conclusion: Given the current population growth parameters and overall population status of DCCOs, it is very unlikely that the increased mortality associated with this alternative would significantly impact regional or continental DCCO populations. This alternative would be somewhat more effective than the No Action alternative in addressing impacts. It would probably resolve some localized problems, but it would not enhance the flexibility of other agencies to manage DCCOs.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
Relative to the No Action alternative, a public resource depredation order would likely result in a marked increase in the annual mortality of adult and/or juvenile DCCOs. In 24 States, 137 agencies (24 State fish and wildlife agencies, 89 Federally-recognized Tribes, and 24 APHIS/WS state programs) will be eligible to participate in the public resource

depredation order, although not all agencies are expected to participate (since participation is strictly voluntary).

To estimate how many birds will be taken per State we used historic data and factored in any other special considerations. For example, from 1998 to 2000 the total annual take of DCCOs in the contiguous U.S. for depredation control purposes averaged 47,662 birds (2.4 percent of the estimated continental population of 2 million birds). This figure largely represents take at aquaculture facilities in the southern U.S. Since agencies that participate will be able to shoot DCCOs with greater efficiency than aquaculture producers (e.g., they will have more resources to expend and will be able to focus their activities in areas in which cormorants are concentrated in greatest abundance) we increased this figure. Thus, compared to take under the aquaculture depredation order (average of 2,760 birds killed annually per participating State from 1998-2000 [total estimated take under depredation order divided by 13]), we assume that 150 percent more DCCOs would be killed annually in each participating State under this alternative, or about 4,140 per State. Multiplying the figure of 4,140 by 24 (the number of States where the public resource depredation order applies) amounts to an estimated annual take of 99,360 adult and juvenile DCCOs.

Assuming that take under the public resource depredation order will be additive to the 60,275 birds estimated to be taken under depredation permits and the expanded aquaculture depredation order, the estimated total mortality under this alternative would be 159,635 birds, or roughly 8.0 percent of the continental population.

Table 13. Estimated Take Under Proposed Action

| | |
|---|---|
| Depredation permits and expanded Aquaculture Depredation Order | 60,275 |
| Public Resource Depredation Order | 99,360 |
| **TOTAL** | **159,635** |

Adoption of this alternative could also result in moderate reductions in annual recruitment of DCCOs at some colonies by means of egg oiling, egg destruction, or nest destruction. In the last few years, just two States have conducted intensive egg oiling under the authority of depredation permits but more would likely do so under the public resource depredation order. Since DCCOs are relatively long-lived birds, egg oiling would have to be conducted repeatedly over a period of many years before any effect on adult populations would be evident. Without extensive regional coordination of efforts, the overall impact of egg oiling on continental and regional DCCO populations would likely be minimal.

The majority of breeding pairs in the Interior and Atlantic DCCO populations (73 and 59 percent, respectively, which amounts to approximately 60 percent of total breeding birds) will be exempt from control activities carried out during the breeding season under this alternative because they nest in Canada (Hatch 1995, USFWS 1998b). Most of the breeding birds that will be affected by increased mortality under this alternative will be

from the U.S. portion of the Interior population. DCCOs affected by winter control or shot during migration will be mostly from the Interior and Atlantic populations.

In general, we can predict that under this alternative, one of 3 things will happen when lethal control of birds (not eggs) is implemented: (1) shooting will serve as more of a harassment tool than an effective means of culling and birds will simply relocate; (2) birds in the local population will be killed and the population reduced as a result; or (3) birds in the local population will be killed without the population being reduced overall because turnover is high (shot birds are replaced by new birds) or because increased mortality stimulates density-dependent compensation.

Conclusion: We predict that this alternative has a much greater likelihood of successfully minimizing conflicts with DCCOs than the No Action alternative. It will enhance the flexibility of other agencies such that they will be able to conduct control activities more readily where necessary; at the same time, it has sufficient reporting and monitoring requirements and other restrictions to ensure the long-term conservation of DCCO populations.

**Alternative E: Regional Population Reduction**

According to demographics information (section 3.2.1), DCCO populations are thriving and have, for the most part, steadily increased over the past 20 years. It is unlikely that the long-term sustainability of continental DCCO populations would be threatened significantly by efforts to reduce local and regional populations, if done in a controlled and coordinated manner.

Veldkamp (1997) commented that, with respect to population-level control measures, since cormorants have "remarkable reproductive skills," only massive long-term and large scale measures are likely to result in a significant population reduction. Reduction of regional DCCO populations would be carried out via extensive localized control efforts. Glahn et al. (2000b) suggested that DCCO populations be managed on a "flyway" basis, using a goal-oriented population model to guide management decisions. The objective would be to reduce localized conflicts by managing regional cormorant populations. While no consensus on the biological and/or social carrying capacities for DCCOs currently exists (and thus we cannot realistically state population objectives at this time), insights from population modeling and resource economics, in addition to dialogue among interested agencies and organizations, could contribute to the development of biologically and socially acceptable population goals (Glahn et al. 2000b). As stated in the analysis of the No Action alternative, current damage control efforts help to reduce cormorant depredations but apparently have little overall effect on regional populations (Belant et al. 2000, Glahn et al. 2000a, Mott et al. 1998). Therefore, methods of control such as shooting, egg oiling, and nest destruction would need to be implemented at a greater level, with the likelihood that some local populations of DCCOs would be significantly reduced or eliminated.

The difficulty with attempting to reduce populations as a means of alleviating wildlife damage is overcoming the population's ability to compensate for increased mortality. In

fact, in *Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management*, Conover (2002) wrote, "it usually is very difficult to suppress wildlife populations to a low enough level where the population cannot recover within a short period." This is because increased mortality reduces intraspecific competition and thus increases birth rates and immigration (because increased mortality provides transient individuals a better opportunity to move into the area). Both of these factors help nullify any population reduction caused by lethal control. Nonetheless, Bregnballe et al. (1997) concluded that control measures did lead to populations stabilizing at lower levels.

Conclusion: The development of regional DCCO population objectives and implementation of large-scale (as opposed to local) population reduction efforts could prove an effective means of managing this species. However, the achievement of these objectives will require levels of management intensity, agency coordination, financial commitment, and research and monitoring efforts much greater than those which currently exist.

**Alternative F: Regulated Hunting Season**

The number of DCCOs killed by hunters would depend on the length and timing of the hunting season, hunter success, and the number of States participating. The number of hunters participating in a DCCO hunting season would probably be low compared to other game species because of two key factors. First, many hunters would not be interested in killing a non-traditional species such as cormorants. Due to the aquatic nature of DCCO habitat, it is expected that, in addition to those interested in only hunting DCCOs (e.g., for depredation control purposes), other participants would largely be waterfowl hunters. Bédard et al. (1999) commented that cormorants do not inspire respect among waterfowl hunters and would likely not be used as "real game." Second, most hunters would not wish to consume DCCOs because of low palatability and/or because they carry high contaminant loads.

Hunting of DCCOs could take place at any area open for legal waterfowl hunting. In particular, DCCOs would be hunted in open water feeding and loafing areas and at roosting locations. To maximize participation, hunting seasons could follow similar seasons as waterfowl and take place during the fall, winter, and migration months with juvenile and adult birds of both sexes being harvested, although males would probably be taken at a higher rate than females (Campo et al. 1993, Glahn et al. 1995, Glahn et al.1999). Since hunters would not need a depredation permit to hunt DCCOs, we expect that more DCCOs would be killed than under the No Action alternative. Hunter avoidance behavior exhibited by DCCOs would limit the total number of DCCOs harvested (Glahn et al. 2000a, Bregnballe et al. 1997). As noted above, DCCOs are notoriously difficult to shoot. However, decoys and blinds have been used to successfully lure DCCOs into shooting range (Bur et al. 1999, Glahn et al. 1995) and could increase the success of hunting DCCOs (USFWS 1998b).

Conover (2001) wrote that hunting is one of the "few human activities that reinforces an animal's fear of humans." Bregnballe et al. (1997) predicted that hunting would lead to increased shyness toward humans and would more greatly restrict cormorants' choices of

breeding and feeding areas and loafing and roosting sites. As a result, more individuals would stay in safe (i.e., non-hunted) areas and competition would increase for available resources. This could lead to increased density-dependent effects on populations.

Take under this alternative would include the number of DCCOs killed under the No Action alternative in addition to the number of birds harvested under a hunting season. Annual DCCO mortality (hunters + permits + aquaculture depredation order) is expected to be no more than 10 percent (~200,000 birds) of the estimated continental DCCO population. Because of the buffering effect of density-dependence, the relationship between hunting pressure and population size is not linear and thus the actual effects on populations cannot be predicted with high accuracy (Bregnballe et al. 1997). Nonetheless, model predictions by Bregnballe et al. (1997) showed that hunting cormorants in the fall would lead to a lower overall population and to a lower breeding population; these effects will be more pronounced the higher hunting mortality is and the weaker density-dependent winter mortality is. Thus, we can conclude that the increased mortality caused by hunting could, depending on the length of the season and hunter interest in shooting cormorants, be an important tool in reducing the overall size of the cormorant population.

Conclusion: We predict that a hunting season would have a greater impact on DCCO populations than the No Action alternative. From a cost effectiveness standpoint this alternative has many advantages as hunters would shoulder much of the cost rather than agencies. However, there are serious administrative, legal, and ethical challenges associated with this option.

### 4.2.2 Impacts to Fish

**Alternative A: No Action**

Determining the effect of predation on the dynamics of prey populations is neither a simple nor a straightforward task (Banks 2000, Krebs 1995). The information necessary for determining impact, or lack of impact, in even the simplest cormorant-fishery systems is complex and difficult to acquire (Wires et al. 2002). For example, the findings of a study that examined the relationship between Great Cormorants and fish populations in England were deemed “uncertain” by the authors because of the complex nature of such systems and the difficulties inherent in relating cormorant predation to changes in fishery performance and in separating the effects of piscivorous birds from other factors affecting fish populations (Davies et al. 2001).

In addition to predation pressure, many other environmental and human-induced factors affect fish populations. These can be classified as biological/biotic (overexploitation, exotic species, etc.), chemical (water quality, nutrient and contaminant loading, etc.) or physical/abiotic (dredging, dam construction, hydropower operation, siltation, etc.). Such factors may lead to changes in species density, diversity, and/or composition due to direct effects on fish year class strength, recruitment, spawning success, spawning or nursery habitat, and/or competition (USFWS 1995). It is beyond the scope of this document to examine these factors in relation to DCCO predation at every place of interest.

Based on a review of the DCCO diet literature, Trapp et al. (1999) concluded that, relative to other biotic and abiotic factors, DCCOs have a minor overall impact on sport fisheries, with localized exceptions. The management implication of this conclusion is that it would not be biologically-justified to make the general assumption that DCCOs cause negative impacts to fisheries in all or even most of the places where they forage. However, as they stated (and as has become increasingly clear since that time), exceptions occur, and it is also not biologically-justified to assume that DCCOs have no negative impacts on local fisheries.

Russell et al. (2002) found that the proportion of trout in the diet of Great Cormorants on river trout fisheries, one in northwestern England and another in southeastern England, varied considerably. In the former, trout represented 85 percent of the diet by weight; in the other, trout represented only one percent of the diet by weight. They concluded that there is a "need to assess potential impact on a case by case basis." In the U.S., Derby and Lovvorn (1997) found that the percentage of sport and commercial fish in the diets of DCCOs in a Wyoming river varied widely, from 0.6 percent to 93 percent, and appeared to depend on local food availability. Although they were unable to determine whether cormorant predation rates were compensatory or additive, they acknowledged that, "piscivorous birds can substantially affect fish stocks, depending on bird densities and availability of alternative prey." While these studies were inconclusive about the actual impacts on fish stocks, they highlight the importance of continuing research on cormorant-fish interactions.

In order to fully understand fisheries impacts related to predation, DCCO diet must be evaluated in terms of the number of DCCOs in the area, the length of their residence in the area, and the size of the fish population of concern (Weseloh et al. 2002). While most, but not all, studies of cormorant diet have indicated that sport or other human-valued fish species do not make up high percentages of DCCO diet, conclusions about actual fisheries impacts cannot be based on diet studies alone. Nisbet (1995) referred to this as the "body-count" approach (i.e., counting the numbers of prey taken rather than examining the effects on prey populations) and noted that it is necessary to also "consider functional relationships between predation and output parameters." Stapanian (2002) also noted that "in order to quantify the effects of cormorant piscivory, reliable estimates of the fishery in question are needed."

Stapanian (2002) observed that "Rigorous, quantitative studies suggest that the effects of cormorants on specific fisheries appear to be due in part to scale and stocks of available prey." Indeed, negative impacts are typically very site-specific and thus DCCO-fish conflicts are most likely to occur on a localized scale. Even early cormorant researcher H.F. Lewis recognized that cormorants could be a local problem at some fishing areas (Milton et al. 1995). In sum, the following statements about DCCO feeding habits and fisheries impacts can be concluded with confidence from the available science:

(1) DCCOs are a generalist predator whose diet varies considerably between seasons and locations and tends to reflect fish species composition.

(2) The present composition of cormorant diet appears to have been strongly influenced by human-induced changes in the natural balance of fish stocks.
(3) "Impact" can occur at different scales, such that ecological effects on fish populations are not necessarily the same as effects on recreational or commercial catches, or vice versa.
(4) Cormorant impact is generally most significant in artificial, highly-managed situations.
(5) Because environmental and other conditions vary locally, the degree of conflicts with cormorants will vary locally.

To illustrate number four above, the following example was sent to us by the Idaho Fish and Game Regional Fishery Manager (D. Scully, pers. comm.):

> The best quantitative information from the Southeast Region that we have on negative impacts of piscivorous birds on sport fisheries is from 66-acre [27 ha] Springfield Reservoir. In 1994 we found that although we stocked 129 catchable size (9-inches) rainbow trout per acre the first week of May, almost none of these fish were observed in a subsequent creel survey. Angry Memorial Day weekend anglers accused the Department of lying and not stocking any trout. We stocked an additional 8,500 trout and made daily observations on bird activities at the reservoir. We found that on the day of stocking few piscivorous birds were present. However by the fourth day after stocking over 200 cormorants were observed at a given time. A week later, gillnet and electrofishing surveys found very few trout, but did catch large numbers of Utah chubs of the same size as the stocked trout. The naive newly stocked trout were quickly removed whereas the cautious chubs survived. Or possibly there was a preference by the birds for the trout. No matter what the reason, it became obvious that we could no longer sustain a trout fishery at Springfield Reservoir based on 9-inch long or smaller trout.

Moreover, in Europe, direct effects associated with Great Cormorant predation have been reported in fish ponds or in rivers or small, artificially-stocked lakes where high densities of fish are raised (van Eerden et al. 1995).

Local variability of DCCO conflicts is demonstrated by our examination of DCCO-fish interactions for four specific areas (and one region) where information is sufficient to analyze potential interactions: Oneida Lake, New York; eastern Lake Ontario, New York; Les Cheneaux Islands, Lake Huron, Michigan; Lake of the Woods, Minnesota; and southeastern lakes, ponds, and reservoirs. In this section, we present conclusions; further details on these specific areas can be found in Appendix 6.

*Oneida Lake, New York.* DCCOs are an important fish predator in Oneida Lake with the potential to alter the lake's fish populations (L. Rudstam, Cornell Univ., pers. comm.). Cormorants consume older yellow perch and walleye targeted by anglers, intermediate size or pre-recruitment perch and walleye, and smaller age-0 to age-1 perch and walleye. Cornell University biologists Rudstam and Adams (cited in Wires et al. 2001) based their conclusion of effect on perch and walleye on the following: 1) the timing of the disappearing adults coincides with the increase in DCCOs; 2) the size of the fish eaten by DCCOs coincides with the size of the fish that have increased mortality; and 3) at least for walleye, the number of fish missing is comparable to the number estimated to be consumed by DCCOs . VanDeValk et al. (2002) found that while DCCO consumption of

*adult* percids has little effect on angler harvest, consumption of *subadults* is likely to reduce future angler harvest of yellow perch and, to a lesser extent, walleyes.

*Eastern Lake Ontario, New York.* In 1999, the New York State Department of Environmental Conservation's Bureau of Fisheries and the USGS Biological Resources Division prepared an extensive report assessing the impact of DCCO predation on smallmouth bass and other fishes of the eastern basin of Lake Ontario. They found that, based on gill net sampling, dramatic declines in smallmouth bass abundance have occurred there since the early 1990s. The main results reported by Lantry et al. (1999) in this report were: 1) the mortality of age-3 to 5 smallmouth bass increased substantially after 1988; 2) loss rates of this magnitude could severely limit numbers of adult smallmouth bass recruited to the fishery; and 3) DCCO predation on 3-5 year old bass was significant enough to cause the observed declines in the smallmouth bass population. Lantry et al. (2002), examining the relationship between smallmouth bass and DCCOs in the eastern basin of Lake Ontario, found that after the number of DCCOs nesting on Little Galloo Island in New York exceeded 3,500 pairs in 1989, survival of young smallmouth bass began to decline. The authors wrote:

> Despite production of strong year classes in 1987 and 1988, abundance of smallmouth bass measured from gill net surveys declined to its lowest level by 1995 and remained there through 1998. Stable or increasing catch and harvest rates in other local fisheries along the U.S. shore suggested that declines in smallmouth bass abundance in the eastern basin were not related to water quality. Stable or increasing growth rates for smallmouth bass age 2 and older since the 1980s further indicated that food resource limitation was also not the cause for declines in abundance. Comparisons of estimates of size and age-specific predation on smallmouth bass by cormorants with projected smallmouth bass population size indicated that much of the increased mortality on young smallmouth bass could be explained by cormorant predation.

Burnett et al. (2002) analyzed DCCO predation on yellow perch in the eastern basin of Lake Ontario and concluded that "cormorant predation had the potential to play an important role in regulating perch population levels in the eastern basin during the 1990s" while noting that increased abundance of walleye could have contributed to the observed increases in mortality of young yellow perch.

*Les Cheneaux Islands, Lake Huron, Michigan.* Fisheries investigations carried out concurrently with DCCO diet investigations in the Les Cheneaux Islands area found that DCCOs removed only 2.3 percent of the available yellow perch biomass and accounted for less than 20 percent of the total annual mortality of perch. Overall, cormorants accounted for 0.8 percent of the mortality of legal-sized perch, whereas summer sport fishing accounted for 2.5 percent. The conclusion was that DCCOs had minimal impact on the local yellow perch population (Belyea et al. 1999).

*Lake of the Woods, Minnesota.* For the last decade, there has been no clear upward or downward trend in year class strength for either walleye or sauger. Preliminary evidence from Minnesota Department of Natural Resources fisheries reports does not indicate that DCCOs are impacting game fish populations, as various population indices have indicated strong populations of walleye, sauger, perch, and northern pike in the lake. However, specific modeling that factors all types of juvenile fish predation, including DCCOs, has not yet been done in this lake (K. Haws, MDNR, pers. comm.).

*Southeastern lakes, ponds, and reservoirs.* Two of the studies examined (Glahn et al. 1998, Campo et al. 1993) did not find evidence of significant impact to fisheries caused by DCCO predation. A third study (Simmonds et al. 2000), using modeling, found that at particularly high levels of predation, fisheries could be negatively impacted. It is difficult to make broad conclusions about the impacts of DCCOs on fisheries at ponds, lakes, and reservoirs across such a broad geographical area. Generally, the lower availability of prey refugia often found in smaller waterbodies, especially manmade ones, will make prey more susceptible to predation. Additionally, at any pond or reservoir within the geographical range of DCCOs where sport fish are managed at levels intended to maximize recreational catch, it is highly likely that these areas will be utilized for foraging by DCCOs.

Estimations of the beneficial effects on fisheries associated with DCCO control efforts have been made using information on average DCCO consumption and estimations of the amount of fish that were not consumed due to management actions. However, without associated DCCO foraging data and fisheries data, it is difficult to accurately predict the long-term impacts to specific fish populations. Johnson et al. (2000a) determined that DCCOs from the Little Galloo Island (Lake Ontario, New York) colony consumed approximately 13.25 million fewer fish in 1999, the first year of extensive egg oiling activities, than in 1998. They estimated that 8,300 fewer DCCO chicks were produced on the island in 1999, which reduced fish consumption by 348,000 kg (766,000 lbs). Two species, alewife and smallmouth bass, were believed to have benefited the most since their contribution in the diet was known to be substantially greater during the chick-feeding period than during the pre-chick feeding period. Additionally, they found that fish consumption in 1999 was only 45 percent by number and 58 percent by weight of the mean of the previous seven years for Little Galloo Island DCCOs.

Conclusion: Currently, conflicts with sport fisheries are a significant cause of *concern* associated with abundant DCCO populations, but only in a few places have negative impacts been empirically confirmed. In at least one area (Little Galloo Island, New York) control activities (egg oiling) being carried out to protect other resources are believed to also be beneficial to local fisheries.

**Alternative B: Non-lethal Management**
Non-lethal management techniques to benefit fisheries involve temporarily moving DCCOs away from a specific fishery (e.g., harassment and/or nest removal), altering fish release practices, or physically separating DCCOs from fish. Techniques such as altered stocking practices have proven useful in reducing cormorant depredation at least temporarily. Moore (2001) noted that increasing the size of trout stocked and varying the timing of stocking were effective in improving angler success and reducing the proportion of fish taken by Great Cormorants at two still-water trout fisheries in the United Kingdom. In 1996, to address concerns over DCCOs feeding on stocked fish, the New York State Department of Environmental Conservation altered stocking methods to include stocking fish further offshore, stocking streams earlier in the spring before DCCOs return from wintering areas, and stocking nearshore areas at night so that fish can

disperse before daylight. These efforts were considered to be effective in reducing predation on recently-stocked fish (J. Farquhar, NYSDEC, pers. comm.).

Van Dam and Asbirk (1997) predicted that continuous roost disturbance and efforts to prevent the establishment of new breeding colonies could benefit local fisheries in the vicinity, especially at inland sites, but this would likely require highly intensive harassment efforts. Disturbance efforts on Oneida Lake, New York, involving limiting the number of successful DCCO nests to 100 in the spring and then hazing migrating birds in the fall, have been estimated to reduce predation on walleye by about 45 percent (NYSDEC press release). In the first year of implementation, the program was roughly estimated to have reduced DCCO consumption by 30,000 walleye and 90,000 perch (USDA-APHIS 1998). The long-term impact of this reduced DCCO fish consumption on fish populations has not been examined.

Conclusion: Non-lethal control efforts can, if carried out intensively, reduce DCCO predation in the short-term at the site-specific level. Some important setbacks of this approach are that it moves birds to other areas where they are likely to continue to come into conflict with other resources, it limits management flexibility in cases where lethal control might be the most appropriate option, and it can lead to habituation in which the birds are no longer frightened by the techniques. Thus, overall, it is considered to be less effective than the No Action alternative.

**Alternative C: Increased Local Damage Control Alternative**

Under this alternative, shooting, egg oiling or destruction, nest destruction, and harassment would be used somewhat more frequently than under the No Action alternative. Shooting birds may benefit fish by reducing DCCO predation through the immediate effect of removing depredating birds and the secondary effects of scaring away other birds and reinforcing non-lethal harassment efforts. Additionally, killing birds, as opposed to harassing them, avoids the problem of merely moving DCCOs to another area where they could potentially cause damage. However, if shooting is attempted in a systematic way for a given area, its benefits will be limited when the area's turnover rate is high (i.e., DCCOs killed are quickly replaced by new birds moving through). Responses of DCCOs to localized control efforts will vary from site to site depending on the movements of birds to and from the particular area.

A key factor for determining effects on fish populations is whether or not overall predation levels are actually reduced as a result of DCCO control efforts. Egg oiling has been shown to help reduce predation levels on local fish populations, as described under the No Action alternative.

Control efforts will be most effective at reducing predation when multiple management actions are coordinated across a large area or where the "source" of depredating birds is concentrated (such as at a colony or roost) and localized control is targeted toward these birds. The specific effects on fish populations and/or the likelihood of recovery of the fishery are difficult to predict when there is uncertainty about the role of DCCO predation relative to other factors limiting fish populations.

Conclusion: This alternative would require other agencies to seek Service approval before initiating control activities (similar to the No Action) but in cases where strong evidence for openwater fishery impacts caused by DCCOs exists, the Service would issue depredation permits. Thus, this alternative would be more effective at reducing impacts than the No Action alternative.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
This alternative would give States, Tribes, and APHIS/WS more flexibility in deciding when to carry out control efforts to protect fish from DCCO depredation. As stated above, the main factor that determines effects on fish populations is whether or not overall predation is actually reduced as a result of DCCO control efforts and how that relates to other factors limiting the fishery. The discussion under Alternatives B and C, above, are equally applicable here.

Conclusion: Because agencies would be able to implement control measures more readily and would have the opportunity to engage in preventive measures and limited localized population control measures, this alternative will be more effective at alleviating DCCO-fish conflicts than the No Action alternative.

**Alternative E: Regional Population Reduction**
As described under the No Action alternative, localized population control efforts have been shown to reduce predation levels on local fish populations. It is likely that regional reductions in DCCO numbers would further reduce predation levels and in the long-term could benefit fisheries even more than localized control efforts.

Conclusion: Reducing regional populations of DCCOs would be more likely to alleviate cormorant-fish conflicts than the No Action alternative. However, based on fishery impacts alone, largescale population reduction is not a biologically justified option at this time.

**Alternative F: Regulated Hunting Season**
The impact of hunting on DCCO populations would be variable based upon hunter participation and success. The effects of any hunting-induced population changes would depend on similar factors as those discussed in the alternatives above (population turnover rates, environmental factors, etc.).

Conclusion: Since hunters would be able to target DCCOs in areas where they are causing fish depredation problems (assuming they had landowner permission), it is more likely that hunting would have positive impacts on fisheries than the No Action alternative. As previously mentioned, there are legal, administrative, and ethical challenges pertinent to this option.

### 4.2.3 Impacts to Other Birds

**Alternative A: No Action**

As stated in Chapter 3, numerous concerns about DCCOs causing negative impacts to other birds have been expressed to the Service. While "concern" about impacts does not equate to scientific proof as such, one would expect that the likelihood of observations and concerns actually reflecting reality increases as the number of concerns increases, especially when the observers are trained resource professionals. Here are a few examples of the concerns that have been raised:

- The Ohio Department of Natural Resources stated that increases in DCCO numbers "have caused extensive damage to terrestrial island habitats in Lake Erie that are important to several species of rare Ohio birds" and noted that the "habitat alteration/competition problem [from DCCOs] is quite discouraging given the lack of alternative nesting sites for colonial waterbirds."
- The Vermont Department of Fish and Wildlife expressed concern that habitat on Young Island in Lake Champlain, which was "once a mix of trees and herbaceous vegetation that supported breeding populations of black-crowned night-heron, cattle egret, snowy egret, black duck, mallard, goldeneye, and common merganser," had been completely destroyed by cormorants (and gulls) so that the other species had left.
- The New York State Department of Environmental Conservation commented, during public scoping, that they are concerned about "the impacts that cormorants have on other colonial-nesting species [such as Common Terns, a State-listed threatened species]."
- An independent researcher noted that "The disastrous effects of the cormorant colony on Home Pond [Gardiner's Island, New York] are unequivocal. Cormorants and their profuse guano...have denied the 'right to life' of a heron/egret/ibis colony of several species; eight-plus pairs of nesting ospreys; nesting black ducks and gadwall..." (P. Spitzer, pers. comm.).
- The decision to carry out an intensive DCCO population reduction program in the St. Lawrence River estuary in Québec was made to "protect unique insular plant communities whose destruction was affecting colonies of great blue herons, [black crowned night-herons], and common eiders" (Bédard et al. 1999).

Based on their observations in the Great Lakes, Weseloh et al. (2002) suspected that cormorant nesting could affect other colonial waterbirds in at least three ways: (1) if the nesting island is small, an increase in the number of DCCO nests could reduce the amount of space available for nest construction by other species; (2) on islands where night-herons or egrets nest in trees or shrubs, DCCOs may take over these nests or the shrubs; and (3) where DCCOs nest in tall trees with small herons nesting below them, falling guano and nesting material may be enough to lead to herons abandoning their nests. Ludwig et al. (1995) noted that DCCOs "may have significant competitive advantages over the other species with which they compete for nest sites" in Great Lakes ecosystems.

DCCOs almost always nest in close association with other species of colonially-nesting birds, both ground- and tree-nesters. In the United States Great Lakes, for example, 97 percent of all active DCCO colonies (between 1976 and 1999) were associated with other species of colonial waterbirds (Scharf and Shugart 1998, USFWS unpubl. data). To examine the question of whether there is evidence to suggest that increases in recent years in the number of nesting DCCOs at multiple-species breeding colonies have had a direct effect on the numbers of other colonially-nesting waterbirds, we analyzed data from the U.S. Great Lakes for three time periods: 1976-1977, 1989-1991 (Scharf and Shugart 1998), and 1997-1999 (USFWS unpubl. data).

*Herons and Egrets.* Impacts to egret species are a concern. Blokpoel and Weseloh (CWS, unpubl. data) stated that Great Egrets "may suffer from nest site competition, or takeover, from cormorants, especially on East Sister Island (Lake Erie) and Chantry and Nottawasaga Islands (Lake Huron)." Localized concern about displacement of Snowy Egrets by DCCOs has led to the issuance of depredation permits to authorize egg oiling activities for enhancing avian diversity in New York and Vermont.

Suspected impacts to heron species have raised concerns as well. The Great Blue Heron is a frequent nest associate of the DCCO. Over the approximately 25 years that comprehensive surveys of the U.S. Great Lakes have been conducted, Great Blue Herons are known to have nested at 26 colony-sites. The number of colony-sites known to have been occupied by herons increased from 13 (1976-1977), to 18 (1989-1991), to 19 (1997-1999). Over the same time periods, the mean number of heron nesting pairs per occupied colony-site increased slightly: 27, 30, and 34. Analysis by Cuthbert et al. (2002) indicated that on a *regional* scale Great Blue Heron colony trend is independent of cormorant presence ($X^2 = .45$, df = 1, $p > 0.5$).

An examination of site-specific observations between DCCOs and Great Blue Herons reveals that there were 29 site-specific instances in which cormorants nesting in association with Great Blue Herons increased between adjacent time periods. Trends of Great Blue Herons with respect to cormorant increases were about equally mixed: in 16 instances Great Blue Herons also increased (mean of 16 pairs), while in 13 instances they declined (mean of eight pairs). The mean net changes per colony-site in these 29 instances were gains of 261 pairs of cormorants and two pairs of Great Blue Herons. Nesting populations of Great Blue Herons were not correlated with nesting populations of DCCOs, nor were changes in populations between adjacent time periods correlated with increasing populations of cormorants.

The Black-crowned Night-Heron has frequently been mentioned as a species that is negatively affected by DCCOs in the Great Lakes (Jarvie et al. 1999, Shieldcastle and Martin 1999, Cuthbert et al. 2002, Weseloh et al. 2002). Night-herons are known to have nested at 26 colony-sites in the Great Lakes. The number of colony-sites known to have been occupied increased from 12 (1976-1977), to 15 (1989-1991), to 23 (1997-1999). Over the same time periods, the mean number of nesting pairs per occupied colony-site declined steadily: 24, 18, and 13. Analysis by Cuthbert et al. (2002) indicated that on a

regional scale night-heron colony trend is influenced by cormorant presence ($X^2 = 4.97$, df = 1, $p > 0.025$).

An examination of site-specific observations between DCCOs and night-herons reveals that there were 29 site-specific instances in which cormorants nesting in association with night-herons were documented to increase between adjacent time periods. In 12 of those instances, night-herons also increased (mean of seven pairs), and in 17 instances they declined (mean of 11 pairs). The mean net change per colony-site was a gain of 677 pairs of DCCOs and a loss of four pairs of night-herons. Nesting populations of Black-crowned Night-Herons were not correlated with nesting populations of cormorants, nor were population changes between adjacent time periods correlated with increasing populations of cormorants.

A New York State Department of Environmental Conservation biologist provided evidence of direct displacement of Black-crowned Night-Herons by DCCOs at the local level on Gull Island, a one acre site situated on the edge of Henderson Bay, within the greater eastern basin of Lake Ontario. Black-crowned Night-Herons have been sporadically documented as a nesting species on Gull Island. A more "permanent" presence began to develop in the late 1980s, presumably from birds displaced from Little Galloo Island, where DCCO numbers were increasing. By 1993, 30 pairs of night-herons were breeding on the island. In 1993, DCCOs also established an arboreal colony of about 150 nests there. Larger trees were removed from the island late in 1993 to deter DCCO from maintaining the newly established colony in future years. Since 1994, the NYSDEC has annually removed DCCO nests from the island in order to maintain shrubby vegetation for use by night-herons. Count data for night-herons from 1995-1999 have revealed a stable number of nests ranging from 41-46 each year. In 2000, DCCOs re-established a breeding colony on the island beginning in late April. Attempts to displace the cormorants did not begin, however until 15 May, at which time 478 nests were occupied (and removed). One hundred and ten (110) of the nests were arboreal, either in box elder or directly above night-heron nests in the tops of dogwood shrubs. Night-heron nest numbers dropped by about half under these conditions, and remained at this level through the breeding season in spite of cormorant removal. Based on field observations and professional judgment, it was hypothesized that direct guano deposition by DCCOs resulted in the observed abandonment by night-herons. Although Gull Island was apparently partially abandoned by Black-crowned Night-Herons due to the direct effects of DCCOs, suitable nest sites were utilized on nearby Bass Island, where numbers increased from 6-12 annual nests over the past three years (1997-99) to 35 in 2000. On Bass Island, DCCO usage was not in proximity to night-heron nesting sites (J. Farquhar, NYSDEC, unpubl. data).

Weseloh et al. (2002) reported that the displacement of night-herons from their colony site after DCCOs began to nest there "may have occurred" at 7 sites in Lake Ontario: Pier 27 (Hamilton Harbour), Tommy Thompson Park (Toronto), and at Scotch Bonnet, Pigeon, West Brother's, Snake, and Little Galloo Islands. In 2000, 28 percent of night-heron sites visited had been abandoned "in light of increasing cormorant numbers or were in imminent danger of being overrun by cormorants" (Weseloh and Havelka, CWS,

unpubl. data). They concluded that night-herons may be leaving historical nesting areas and establishing new colonies because of DCCOs. Observations by Cuthbert et al. (2002) of nesting DCCOs and Black-crowned Night-Herons at Epoufette and Green Islands, Lake Michigan, noted no direct interactions between the two species. There was some overlap in tree species used for nest sites between DCCOs and night-herons; however, they appeared to separate themselves spatially when utilizing the same tree (Cuthbert et al. 2002). The authors noted that "cormorant impact on great blues and black-crowns may be greatest on small forested islands where cormorant fecal material kills all woody vegetation and eliminates nest habitat for these species" (Cuthbert et al. 2002).

*Gulls and Terns.* The impact of DCCOs on ground-nesting terns and gulls appear to be minimal, at least in the Great Lakes (USFWS 1999a). Herring Gulls are the most ubiquitous of the colonial waterbirds nesting in the U.S. Great Lakes, where they are known to have nested at 74 colony-sites. The number of colony-sites known to have been occupied increased from 56 (1976-1977), to 63 (1989-1991), to 70 (1997-1999), while the mean number of nesting pairs per occupied colony-site varied over these same time periods: 148, 247, and 114. There were 88 site-specific instances in which DCCOs nesting in association with Herring Gulls increased between adjacent time periods. Changes in Herring Gull numbers in relation to cormorant increases were about equally mixed: in 42 instances they increased (mean of 172 pairs) and in 46 instances they declined (mean of 54 pairs). The mean net changes per colony-site in these 88 instances was a gain of 253 pairs of cormorants and a loss of 4 pairs of Herring Gulls.

Ring-billed Gulls are known to have nested at 30 colony-sites in the U.S. Great Lakes. The number of colony-sites known to have been occupied increased from 15 (1976-1977), to 20 (1989-1991), to 22 (1997-1999), and the mean number of nesting pairs per occupied colony-site increased over these same time periods: 374, 1328, and 1786. There were 35 site-specific instances in which DCCOs nesting in association with Ring-billed Gulls increased between adjacent time periods. In 18 of those instances, Ring-billed Gulls also increased (mean of 343 pairs), and in 16 instances they declined (mean of 598 pairs). The mean net changes per colony-site in these 35 instances were gains of 338 pairs of cormorants and 18 pairs of Ring-billed Gulls. Nesting populations of Ring-billed Gulls were positively correlated with nesting populations of cormorants, but population changes between adjacent time periods were not correlated with increasing DCCO populations.

Caspian Terns are known to have nested at nine colony-sites in the U.S. Great Lakes. The number of colony-sites known to have been occupied increased from 3 (1976-1977), to 5 (1989-1991), to 7 (1997-1999), and the mean number of nesting pairs per occupied colony-site remained fairly stable over these same time periods: 537, 437, and 566. There were 11 site-specific instances in which DCCOs nesting in association with Caspian Terns increased between adjacent time periods. In eight of those instances, Caspian Terns also increased (mean of 198 pairs), and in three instances they declined (mean of 249 pairs). The mean net changes per colony-site in these 11 instances were gains of 1,440 pairs of DCCOs and 27 pairs of Caspian Terns. Nesting populations of

Caspian Terns were positively correlated with nesting populations of DCCOs, and population changes between adjacent time periods were likewise positively correlated with population increases of DCCOs.

Numbers of Caspian Terns on Little Galloo Island, eastern Lake Ontario, New York, were higher in 2001 than in previous years, after three years of intensive DCCO egg oiling activities. Great Black-backed Gull numbers on Little Galloo Island had increased in 2001 compared to previous years. Ring-billed Gull and Herring Gull numbers had declined somewhat but this was not believed to be associated with recent egg oiling efforts on the island since the egg oiling activity was removed from most of the gull nesting areas and since declines in these two species had apparently started before the egg oiling program began in 1999 (J. Farquhar, NYSDEC, unpubl. data).

The Common Tern is considered to be endangered, threatened, or a species of special concern in six Great Lakes States and Ontario, as well as being a USFWS species of management concern in the U.S. Great Lakes. Competition with Ring-billed Gulls is considered a major factor in their decline in the Great Lakes (Scharf et al. 1992) although displacement by DCCOs may also occur (USFWS 1999a).

*Cormorants and Anhingas.* Along the Pacific Coast, the DCCO's range overlaps broadly with those of the Pelagic Cormorant and Brandt's Cormorant. Populations of Pelagic and Brandt's Cormorants, species which nest in association with DCCOs on the Pacific coast have fluctuated in response to El Niño conditions but, overall, their numbers have remained stable or increased (Carter et al. 1995a).

Great Cormorant populations in North America appear to have increased dramatically and expanded their range southward in recent decades (Kaufman 1996). Populations of Neotropic Cormorants appear to be increasing and spreading geographically (C. Hunter, FWS, pers. comm.). Populations of Anhingas appear to be stable except for a decline in Texas numbers (BBS trend for 1990-1998 was a statistically significant mean annual decline of 17.98 percent). Under the aquaculture depredation order, some incidental take of Neotropic Cormorants and Anhingas may occur in southern States (where their range overlaps with that of DCCOs). In particular, it can be difficult to distinguish juvenile DCCOs from Neotropic Cormorants, while Anhingas are more distinguishable because of their bill structure. The declining trend for Anhingas in Texas started well before the depredation order came into effect and is not believed to be related to by-kill. There is no evidence that incidental take is a threat to populations of other cormorant species or Anhingas. See Appendix 7 for guidelines on distinguishing DCCOs from Anhingas and Neotropic Cormorants.

*Food Competition.* A review of the vast literature on DCCO food habits and foraging behavior revealed little information about potential food competition with other birds. DCCOs are opportunistic in their foraging habits, feeding on a large variety of fish species. In any given situation, individual DCCOs can be expected to prey on those species that are most abundant and most easily captured (Trapp et al. 1999, Wires et al. 2001).

The DCCO is one of at least 73 bird species found in freshwater or saltwater habitats of the United States whose diet consists primarily of fish. Food competition between these species is reduced by differences in foraging techniques and the substrates in which prey are hunted. By defining specific foraging techniques and substrates, DeGraaf et al. (1985) categorized these 73 species into no fewer than 17 different foraging guilds or categories. DCCOs and six other species were placed in the "water diver" guild (species that dive from the surface to pursue underwater prey, and that forage in brackish, freshwater, and saltwater habitats). The most likely food competitors of the DCCO are loons, grebes, pelicans, other species of cormorants, and mergansers, although there is currently no evidence to show that competition for food has negatively impacted these species.

Ainley et al. (1981) compared and contrasted the diets and feeding habitats of DCCOs and Pelagic and Brandt's Cormorants. They found that DCCOs fed primarily on schooling fish (66-67 percent compared to 22-60 percent for Pelagic and Brandt's) that occurred at relatively shallow depths (22-33 percent ranged from the water surface to mid-depths compared to 11-14 percent in that range for Pelagic and Brandt's) over flat bottoms (63-67 percent compared to 20-38 percent for Pelagic and Brandt's).

Kirsch (1995) concluded that DCCOs were not competing for food with herons and egrets along the Upper Mississippi River where forage fish (especially gizzard shad) were not limited. Cormorants forage differently and in different habitats than herons and egrets, further reducing the potential for competition.

Ecological differences and limited geographic overlap between DCCOs and Neotropic Cormorants helps restrict foraging competition between the two species (Johnsgard 1993). Limited foraging competition may exist between Anhingas and DCCOs in areas where they both occur, such as in Florida, but this is poorly documented. Owre (1967 *in* Johnsgard 1993) suggested that different fish-catching strategies of the two species in southern Florida may reduce competition for food, even though both fed on slow-swimming centrarchids.

Densities of DCCO prey fish (winter flounder; American plaice; and grubbies) were measured in four Prince Edward Island bays located at varying distances from two large cormorant colonies (Birt et al. 1987). Fish densities were significantly (83 percent) lower in two bays used by cormorants for feeding than in two bays outside their foraging range (i.e., 3.6 versus 21.0 fish/transect). These findings provide evidence of prey depletion, and suggest the possibility of prey competition between DCCOs and other fish-eating diving birds.

*Disease Transmission*. The disease most often associated with DCCOs is Newcastle disease, which is chiefly a disease of the central nervous system and is caused by infection with a type of avian paramyxovirus. Newcastle disease was first identified as a source of mortality in DCCOs in Québec in 1975 (Kuiken et al. 1998). Some of the largest epizootics of Newcastle disease occurred in western Canada in 1990, when at least

5,000 DCCOs died, and in 1992 in western Canada, the Great Lakes area, and the north central U.S., when some 20,000 DCCOs died. In all cases, most, if not all, of the dead birds were juveniles (Kuiken 1999, Kuiken et al. 1998, Glaser et al. 1999). A 1995 epidemic in Saskatchewan, Canada, led to a 32-64 percent mortality rate among juvenile DCCOs (Kuiken et al. 1998). In 1997, Newcastle disease was diagnosed in juvenile DCCOs from breeding colonies at Salton Sea (CA), the Columbia River estuary (OR), and Great Salt Lake (UT) by the National Wildlife Health Center. Mortality of juveniles varied from "not abnormal" to greater than 90 percent (Kuiken 1999).

In a survey conducted by Wires et al. (2001), two out of 49 respondents reported documented cases of disease transmission involving DCCOs. This involved the outbreak of Newcastle disease in Michigan in 1992 (mentioned above). While Newcastle disease is considered a serious threat to poultry, there has been only one reported incident in ten years directly linking DCCOs to an outbreak of the disease in domestic poultry (Mixson and Pearson 1992, Kuiken 1999). Evidence suggests that Newcastle disease is not an important cause of mortality in other wild bird species that nest in close association with DCCOs (Kuiken et al. 1998, Kuiken 1999).

*Disturbance Caused by Management Actions.* There is no evidence that current management practices are a threat to the population viability of any bird species. The intensive egg oiling efforts on Little Galloo Island, New York have not impacted other nesting waterbirds on the island (USFWS 2003). Carney and Sydeman (1999) noted that nesting colonial waterbirds, when disturbed by humans, often flush from their nests, during which time nest contents can be spilled, exposed to predation, or harmed by exposure to the elements. Nest abandonment may also occur. These authors emphasized "the varied responses of individual species and populations to...disturbance," while also noting that in many cases "significant impacts on reproductive performance of colonial waterbirds" may occur.

In general, the extent of impacts to other birds varies by species, time of year, and location. Risks to other birds from DCCO management vary depending on the level of cohabitation and the degree of disturbance (van Dam and Asbirk 1997). Harassment activities aimed at preventing DCCOs from nesting, roosting, or feeding at particular sites can clearly lead to indirect impacts on other bird species, with the greatest risk of impacts involving actions that occur at multi-species breeding colonies.

Bayer (2000) noted that DCCO harassment efforts at various estuaries along the northern Oregon Coast caused disturbance to "waterfowl," "herons," and Black Brant but no biological impacts associated with this disturbance were noted. In the final Environmental Assessment for the take of cormorants and gulls on Lake Champlain Islands, Vermont (USFWS 1999b), non-lethal management techniques were considered very likely to disrupt other nesting species. In particular, it was believed that "pyrotechnics...would frighten non-target species sharing islands with cormorants, and could result in abandonment by gulls and common terns." For this reason, the requirement that non-lethal management techniques be used before the authorized egg oiling and nest/egg destruction activities was waived. Hazing activities conducted at

Oneida Lake, New York, did not negatively impact Common Terns, largely because the timing and specific location of DCCO harassment efforts took into consideration the presence of terns (NYSDEC press release).

*Benefits to Other Species.* Depredation permits have been issued to the States of New York and Vermont for the purpose of enhancing avian diversity, including Black-crowned Night-Herons. The USFWS Environmental Assessment for the take of cormorants on Lake Ontario Islands, New York predicted that night-herons would benefit from reduced DCCO recruitment caused by egg oiling (USFWS 1999a). Habitat manipulation and DCCO nest removal efforts on Gull and Bass Islands in eastern Lake Ontario are presumed to have contributed to the stable night-heron population on that site (NYSDEC 2000, USFWS 2003).

Gull species that nest in association with DCCOs may benefit from the presence of cormorants due to the increased availability of food on the islands, including fish remains and chick regurgitates. Gulls also routinely prey on cormorant eggs and young nestlings when nests are left unattended (J. Trapp, FWS, pers. comm.). Given the abundant, and sometimes nuisance, status of certain gull populations, this may or may not be desirable from a management perspective. In the Great Lakes, habitat has been created for American White Pelicans on islands denuded by DCCO guano (S. Lewis, USFWS, pers. comm.).

It is believed that the Common Tern could benefit from reduced DCCO recruitment where suitable island nesting sites are otherwise limited. Thus, from 1995-1999, the Service issued a permit to Vermont to destroy DCCO nests and eggs on five islands in Lake Champlain, in order to reduce competition with Common Terns. Additionally, permits have been issued since 1999 to Vermont and New York to oil DCCO eggs and destroy nests to benefit Common Terns.

Conclusion: The significance of DCCO-related impacts to other birds is a matter of scale. Large-scale impacts on regional or continental populations of other colonial waterbirds have not been documented (Cuthbert et al. 2002), but evidence is strong that DCCOs have had negative impacts on other bird species at a localized level (Weseloh et al. 2002). DCCO control efforts carried out in the vicinity of other birds, especially at nesting colonies, must be done so with caution in order to minimize incidental negative impacts.

**Alternative B: Non-lethal Management**
Under this alternative, while the risk of birds being killed directly is minimal, the threat of disturbance caused by DCCO harassment efforts is considerable. When carried out on a limited and localized level, non-lethal activities are unlikely to threaten populations of colonial waterbirds. However, if practiced on a broader level (such as might be required to enhance the effectiveness of an entirely non-lethal management regime) and at multi-species colonies, negative population impacts could occur as a result of repeated nest failures.

Conclusion:  This alternative would be less effective than the No Action alternative at addressing DCCO impacts on other birds and could potentially cause serious disturbance to other species.

**Alternative C: Increased Local Damage Control**
In addition to harassment activities, this alternative authorizes shooting, egg oiling, and nest destruction, all of which could lead to increased human disturbance of mixed species breeding colonies but this can be mitigated to insignificance as shown in control efforts on Little Galloo Island, New York (USFWS 2003).  Increased shooting authority could lead to greater incidental take, especially for look-alike species, but this is not likely since the shooting would be carried out mainly by trained resource professionals and because the Service would be cautious in its issuance of depredation permits in areas with high numbers of look-alike species.  Under the expanded aquaculture depredation order, the likelihood of incidental take of look-alike species at roosts would increase slightly.  See Appendix 7 for guidelines on distinguishing DCCOs from Neotropic Cormorants and Anhingas.

Conclusion: By permitting control actions in specific situations where DCCOs are having negative impacts, this alternative is more likely to benefit other birds than the No Action alternative.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
We anticipate that more DCCO control actions will occur under this alternative than the No Action alternative.  This increases the risk of incidental take or disturbance to non-target species.  At some mixed species colonies, it would not be advisable to conduct DCCO control at all because of the risk of disturbing other breeding birds; at other sites, careful planning would reduce the likelihood of significant disturbance.

In the DEIS we reported that increased incidental take of look-alike species such as Anhingas, Neotropic Cormorants, Great Cormorants, Pelagic Cormorants, and Brandt's Cormorants may occur.  Because of subsequent geographic limitations on the public resource depredation order, the risk of incidental take now only applies to Anhingas and Neotropic Cormorants.  See Appendix 7.

Conclusion:  This alternative has a high likelihood of allowing agencies to effectively manage DCCOs to reduce impacts to other birds.  Caution must be exercised to minimized disturbance to non-target species, especially during the nesting season.

**Alternative E: Regional Population Reduction**
The relationship between reduced regional populations of DCCOs and effects on local populations of other birds is not completely clear.  Local management of DCCO colonies to benefit other birds would continue under this alternative.  However, because of the need for intensive management to attain reduced regional population objectives, this alternative could result in considerably increased disturbance of bird species that feed, nest, or roost in association with DCCOs and increased incidental take of look-alike species (especially other cormorant species).

Conclusion: Relative to the No Action alternative, the direct and indirect negative impacts of DCCOs on other birds are more likely to be reduced under this alternative. Increased disturbance to non-target species would likely result.

**Alternative F: Regulated Hunting Season**

If this alternative served to reduce regional or continental DCCO populations it could help reduce direct and indirect negative impacts to other bird species. If it had no effect on populations its effectiveness at reducing these impacts would be limited since most of the conflicts between DCCOs and other birds occur during the breeding season and hunting would take place outside of the breeding season. By-kill, especially of look-alike species such as Great Cormorants, Neotropic Cormorants, and Anhingas, would occur more frequently than under the No Action alternative. For example, in the Canadian province of Prince Edward Island, legal hunting of DCCOs reduced local Great Cormorant populations by 50 percent (Korfanty et al. 1997). However, geographic restrictions and identification guides could help reduce the risk of incidental take.

Conclusion: Hunting is no more likely than the No Action alternative to effectively reduce negative impacts on other bird populations unless it had the effect of reducing DCCO populations overall. Increased disturbance to non-target species would likely result.

### 4.2.4 Impacts to Vegetation

**Alternative A: No Action**

DCCOs destroy their nest trees by both chemical and physical means, due to accumulation of guano, which is highly acidic, and removal of foliage for nesting material (Palmer 1962, McNeil and Leger 1987, Scharf and Shugart 1981, Weseloh and Ewins 1994, Weseloh and Collier 1995). Cormorant guano, or excrement, disturbs the ionic equilibrium in forest soils (Haynes and Goh 1978), thus killing ground vegetation and eventually the nest trees. Furthermore, DCCOs damage vegetation by stripping the leaves from trees and even breaking branches due to the combined weight of the birds and their nests (Weseloh and Ewins 1994).

Some specific examples of damage caused by DCCOs to vegetation/habitat include:

- Weseloh and Ewins (1994) observed that, up until 1980, all DCCO nests on eastern Lake Ontario's Little Galloo Island were in trees. They noted that several large willow and hackberry trees, which were "alive and in relatively good health in 1978-79, have simply died or crumbled." Consequently, the number of ground nests on Little Galloo Island increased significantly after the early 1980s (Weseloh and Ewins 1994).
- Moore et al. (1995) reported that DCCOs began nesting in cottonwood trees at Hamilton Harbor, Lake Ontario in 1986, and that since that time the trees have gradually died, with only 24 percent remaining alive by 1993.
- Lemmon et al. (1994) observed extensive damage to trees containing DCCO nests on the Norwalk Islands off the coast of Connecticut. They noted that, "branches

above and within a six to eight foot radius of cormorant nests were stripped of their foliage... [while]... lower limbs extending beyond the nests had normal foliage... [and]... the ground cover and lower sections of the trees below the cormorant nests were whitewashed with guano."

- The State of Michigan expressed concern about "the impact of large cormorant nesting colonies on the underlying vegetation" and noted that "many well-vegetated Great Lakes islands have been drastically impacted by these cormorant colonies, often reducing them to barren landscapes."
- Shieldcastle and Martin (1999) reported that the Ohio Division of Wildlife and the Service are concerned, biologically and aesthetically, about the arrival of nesting DCCOs on West Sister Island National Wildlife Refuge and other islands in Lake Erie because of their potential impacts on vegetation.
- Korfanty et al. (1999) also noted that DCCO-induced habitat destruction on Carolinian islands in western Lake Erie is a major problem and that DCCO colonies have killed trees and shrubs on several islands in Lake Ontario, Lake Huron and at Lake of the Woods.
- On Pilot Island in Lake Michigan's Green Bay, evidence exists of DCCOs colonizing and killing all of the white cedars there (as well as displacing the herons that were using the trees). These islands experienced a "major loss of mature trees" due to guano accumulation and defoliation caused by nesting and roosting DCCOs (Shieldcastle and Martin 1999).
- Vegetation on other Great Lakes islands (Hat and Spider Islands in Lake Michigan, for example), some of which are managed as National Wildlife Refuges, has also been changed significantly by DCCOs (S. Lewis, USFWS, pers. comm.).
- In Rhode Island, a DCCO nesting area on an Audubon Society of Rhode Island preserve in the upper Sakonnet River, which once constituted a mature deciduous forest of beech, oak, and hickory, has been observed to be "rapidly losing all its tall vegetation and may eventually become unsuitable for wading birds" (M. Lapisky, pers. comm.).
- In Canada, damage to island vegetation in the St. Lawrence River estuary of Québec was described by Bédard et al. (1995) as "severe, ecologically measurable and aesthetically real" and led the Québec Ministère de l'environnement et de la faune to initiate a DCCO population control program.
- In the first study to quantitatively examine the impact of DCCOs on plant communities in the Great Lakes, Weseloh et al. (2002 Waterbird Society Annual Meeting abstract) assessed forest cover on East Sister and Middle Islands in Lake Erie and determined that DCCO nest density was negatively correlated with canopy cover in parts of Canada's last remaining Carolinian vegetation. They observed that from 1995-2001 DCCOs were "rapidly affecting island vegetation."

Depredation permits have been issued to the States of Vermont and New York for the purposes of enhancing habitats on islands in Lake Champlain and the eastern basin of Lake Ontario. On Gull and Bass Islands, removal of DCCO nests has minimized encroachment of cormorants into the shrubby vegetation (box elder and dogwood) used by Black-crowned Night-Herons (Farquhar 2002).

**Alternative B: Non-lethal Management**
Harassment and nest removal can be effective at protecting vegetation where used to prevent the establishment of DCCOs. Where they are already established but irreversible damage has not yet occurred, non-lethal techniques will be limited in effectiveness (because, for example, habituation occurs more quickly). This alternative would be less effective than the No Action alternative because it does not allow the use of the full range of available techniques.

**Alternative C: Increased Local Damage Control**
Impacts to vegetation would be dealt with more effectively than under the No Action alternative since permit issuance practices would be less stringent. To the extent that control activities under this alternative prevent the establishment of DCCOs, vegetation at specific locations will be protected. If permits are issued for aggressive management of specific DCCOs that are affecting specific areas, then it is possible that established birds could be removed. Where vegetative damage has already occurred, recovery will be slow or non-existent, depending on the particular habitat type and thus it may be fruitless to conduct DCCO control for the purpose of enhancing vegetation.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
In areas where irreversible damage has not occurred, impacts to vegetation will be minimized since agencies will be able to control DCCOs more readily. To the extent that control activities prevent the establishment of DCCOs, vegetation at specific locations will be protected. Some agencies may engage in aggressive management of specific DCCOs affecting specific areas and this should help alleviate damage to vegetation. Where vegetative damage has already occurred, recovery will be slow or non-existent, depending on the particular habitat type and thus it may be fruitless to conduct DCCO control for the purpose of enhancing vegetation.

**Alternative E: Regional Population Reduction**
Impacts to vegetation would be dealt with more effectively than under the No Action alternative since the ability to control DCCOs causing such problems would be enhanced and, eventually, there would be fewer DCCOs. With population reductions originating at the local level and objectives focusing on reducing damage, control activities carried out under this alternative should help alleviate significant damage to vegetation. Where vegetative damage has already occurred, recovery will be slow or non-existent, depending on the particular habitat type.

**Alternative F: Regulated Hunting Season**
Impacts to vegetation would most likely be reduced more effectively than under the No Action alternative. In some cases, people would be able to target specific DCCOs damaging vegetation, although it should be noted that hunting would not be allowed during the breeding season and this is when DCCOs are the most destructive. If the establishment of hunting seasons across the U.S. led to lower regional populations of DCCOs, this would be helpful in alleviating vegetation damages.

### 4.2.5 Impacts to Federally-listed Species

**Alternative A: No Action**

Under the No Action alternative, there are two potential levels of relationship to species protected under the Endangered Species Act. The first is impacts associated with DCCOs themselves and the second is impacts associated with DCCO control actions. In the case of the former, the best studied impacts are those to listed salmonids in the Pacific Northwest and in Maine. With regard to Pacific salmonids, multi-disciplinary science reviews have found no compelling scientific evidence that predation has been a *primary* cause for recent declines (USFWS 2000b), although that does not mean that they are an insignificant part of overall mortality on salmonid smolts. While the role of avian predation and the relationship of increasing survival of listed salmonid smolts in the estuary to numbers of adult returns is relatively unknown, numerous initiatives are underway throughout the Columbia River Basin to decrease in-river smolt mortality as a means to aid the recovery of listed salmonid stocks. These include control of predatory northern pikeminnows (a native fish known to prey on salmonid smolts), relocation of a large Caspian Tern colony to a new location at the mouth of the estuary, and modifications of extensive systems of estuary pile dikes to preclude use by DCCOs as foraging platforms. Management actions to reduce avian predation, primarily focused on Caspian Terns, have resulted in substantial reductions in smolt losses to avian predation in the estuary (Collis et al. 2000). Research and monitoring activities are continuing to further refine estimates of DCCO smolt consumption and to determine the need for further management actions (BPA 2001).

With regard to Atlantic Salmon in Maine, loss of smolts to DCCOs foraging on New England rivers is believed by some biologists to be a potential limiting factor to the recovery of Atlantic salmon populations (Moring 1987 and Moring et al. 1995 in Blackwell et al. 1997). However, there is currently no scientific evidence to substantiate this claim. Milton et al. (1995) wrote: "information on river-specific salmon stocks and environmental and habitat factors affecting these stocks is insufficient to consider cormorants a factor affecting their survival or limiting their growth at this time."

Currently, there is no evidence that DCCO management actions have led to the take of any Threatened or Endangered species or that DCCO control efforts are having significant impacts on these species.

**Alternative B: Non-lethal Management**

Bayer (2000) found that hazing of cormorants on a few northern Oregon Coast estuaries was not correlated with improved hatchery returns of salmonids. Nor have average spawning ground counts of wild coho salmon, winter steelhead, and fall chinook increased since hazing began. Bayer observed that "Returns may not have increased with hazing because it was ineffective in substantially reducing predation, because smolts saved by hazing died anyway, or because other factors such as unfavorable ocean conditions may have been much more important in affecting smolt survival than hazing." Without incorporating proper mitigation measures, harassment activities associated with this alternative could have deleterious effects on listed species that occur in association

with DCCOs. Overall, impacts to Threatened and Endangered species would probably be similar to the No Action alternative.

**Alternative C: Increased Local Damage Control Alternative**

Impacts to Threatened and Endangered species would be the same as under the No Action alternative.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**

Consultation under the Endangered Species Act was completed between the Division of Migratory Bird Management and the Division of Consultations, HCPs, Recovery and State Grants. Based on information from the DCCO proposed rule and an intra-Service Biological Evaluation (to request a copy of this BE, contact the Division of Migratory Bird Management), incorporating the following conservation measures would avoid adverse effects on the bald eagle, interior least tern, wood stork, and piping plover:

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.

**Alternative E: Regional Population Reduction**
It is unclear what the actual effects of this alternative on Threatened and Endangered species would be. Without incorporating proper mitigation measures, control activities associated with this alternative could have deleterious effects on some listed species that occur in association with DCCOs. Reductions of DCCO populations could alleviate impacts on listed species if these are occurring.

**Alternative F: Regulated Hunting Season**
It is unclear what the actual effects of this alternative on Threatened and Endangered species would be. Without incorporating proper mitigation measures, control activities associated with this alternative could have deleterious effects on some listed species that occur in association with DCCOs. Localized reductions of DCCO populations associated with hunting could alleviate impacts on listed species if these are occurring.

**4.2.6 Impacts to Water Quality and Human Health**
**Alternative A: No Action**
Currently, depredation permits have only been issued for the control of DCCOs that are a direct source of water pollution (e.g., birds roosting over a water storage area). None have been issued for indirect pollution of groundwater, since it can be difficult to show a direct relationship between DCCOs and compromised water quality. The organochlorine contaminants found in many fish and birds were (and many continue to be) introduced into the environment by human activities. There is little scientific discussion of the relationship between bird abundance, contamination of ground water, and associated human health impacts. We were unable to locate any references in the literature or elsewhere of elevated bacterial counts or contaminant levels caused by DCCOs threatening human health.

Clearly, DCCOs, by virtue of being a top predator, harbor contaminants that are found in the Great Lakes ecosystem and convey these to the waters that they inhabit. While there is a great deal of literature examining the levels and effects of various contaminants in DCCOs (cf. Elliott et al. 1989, Bishop et al. 1992a, Powell et al. 1997, Rattner et al. 1999, etc.), there is no documentation of effects on humans caused by direct contamination from DCCO excrement, feathers, or carcasses. In 1999, testing by a New York State-accredited environmental laboratory (Chopra-Lee, Inc.) found no chemical contaminants in either of two residential groundwater wells near Little Galloo Island (home of a large DCCO colony in eastern Lake Ontario) that were sampled, although elevated bacterial counts were measured (Anon. 1999).

DCCOs are not considered to be a significant threat to groundwater supplies in general, although they may be a direct source of contamination in cases where they nest or roost near water supplies (however, examples of this are uncommon).

**Alternative B: Non-lethal Management**
Where impacts are directly related to the presence of specific birds, harassment may help alleviate these conflicts (e.g., where birds only needed to be moved away). However,

since lethal control is useful for enhancing harassment efforts, this alternative would be less effective than the No Action alternative.

**Alternative C: Increased Local Damage Control Alternative**
Controlling DCCOs in localized situations would likely not eliminate, or necessarily even alleviate, human health risks associated with contaminants due to the effects of other piscivorous birds, the persistence of organochlorine chemicals in Great Lakes waters, and bioaccumulation of those chemicals from fish to humans. Where DCCOs are a direct source of bacterial contamination, this alternative would allow for as effective control as the No Action alternative.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
Relative to the No Action alternative, *local* water quality–to the extent that it is impacted by DCCOs–would be expected to improve under this alternative. Concentrations of pathogens (e.g., *E. coli*) in local water bodies might decline proportionally to reductions in the number of DCCOs associated with actions to protect public resources. Since DCCOs are merely a means by which chemical contaminants may be distributed within aquatic ecosystems, not a direct source of the contaminants themselves, reductions in cormorant numbers are not expected to reduce *overall* contaminant levels.

**Alternative E: Regional Population Reduction**
Similar to the discussion under the previous alternative, *local* water quality would be expected to improve relative to the No Action alternative, to the extent that it is impacted by DCCOs. Since DCCOs are merely a means by which chemical contaminants may be distributed within aquatic ecosystems, not a direct source of the contaminants themselves, reductions in cormorant numbers are not expected to reduce *overall* contaminant levels.

**Alternative F: Regulated Hunting Season**
Similar to previous conclusions, *local* water quality–to the extent that it is impacted by DCCOs–would be expected to improve under this alternative relative to the No Action alternative. Since DCCOs are merely a means by which chemical contaminants may be distributed within aquatic ecosystems, not a direct source of the contaminants themselves, reductions in cormorant numbers are not expected to reduce *overall* contaminant levels.

The human consumption of DCCOs would, for health reasons, not be advisable due to high contaminant loads. Statewide advisories are commonly issued to warn the public of the potential for widespread contamination of certain species of fish or certain species of wildlife. Mercury, PCBs, chlordane, dioxins, and DDT (DDE and DDD) were at least partly responsible for 99 percent of all fish consumption advisories in effect in 1999 (EPA 1999a). All waters of the Great Lakes and their connecting waters are under advisory for restricted consumption of fish or certain wildlife coming from these waters (EPA 1999a). Seventeen States (Alabama, Connecticut, Florida, Indiana, Louisiana, Maine, Massachusetts, Michigan, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Rhode Island, Texas, and Vermont) and Washington, D.C. currently have statewide advisories in effect. In any State where there is a statewide advisory against the consumption of fish, DCCOs should not be consumed.

**4.2.7 Economic Environment (Aquaculture, Recreational Fishing Economies, and Commercial Fishing)**
**Alternative A: No Action**
**Aquaculture**
As stated by Curtis et al. (1996), "predation problems are to be expected when aquaculture facilities are constructed on known migratory routes or in areas where fish-eating birds are known to congregate." This appears to be precisely the case with the southern aquaculture industry, especially that of the Mississippi Delta region. This is noted merely as biological fact; it should be added that early fish farmers could not have foreseen the DCCO population explosion or the extent to which these birds would alter their migration routes in response to new food sources such as fish farms. Curtis et al. (1996) advised that such areas should be avoided or the presence of fish-eating birds should be taken into consideration when designing aquaculture facilities. However, for many aquaculture producers it is either too late to take these factors into consideration or the costs of doing so are prohibitive. See Appendix 8 for an overview of aquaculture production and estimated control expenses in the 13 States included in the aquaculture depredation order.

The actual magnitude of DCCO-related economic impacts to the aquaculture industry depends on many different variables, including the value of the fish stock, the time of year the predation is taking place, and the number of depredating birds present. The frequency of occurrence of DCCOs at a given aquaculture facility can be a function of many interacting factors, including: (1) size of the regional cormorant population; (2) the number, size, and distribution of ponds; (3) the size distribution, density, health, and species composition of fish populations in the ponds; (4) the number, size, and distribution of "natural" wetlands in the immediate environs; (5) the size distribution, density, health, and species composition of "natural" fish populations in the surrounding landscape; (6) the number, size, and distribution of suitable roosting habitat; and (7) the variety, intensity, and distribution of local damage abatement activities.

Glahn et al. (1999) found that as much as 75 percent of the diet of DCCOs in certain roosting areas of the Mississippi Delta consisted of catfish and, according to bioenergetic models, cormorants can exploit as much as 940 metric tons of catfish per winter. Price and Nickum (1995) noted that the aquaculture industry has small profit margins so that even a small percentage reduction in the farmgate value due to predation is economically important. Stickley et al. (1992) estimated that in a 9-hour foraging day with birds feeding at an average rate, 100 DCCOs could cause a loss of approximately $400 to a Mississippi fish farmer. Bioenergetics modeling on DCCOs estimated that losses to the Mississippi Delta catfish industry over the winters of 1989-90 and 1990-91 approximated 20 million and 19 million fingerlings, respectively. This was equivalent to approximately 4 percent of the fingerling class, representing approximately $2 million in fish losses (Glahn and Brugger 1995). Glahn et al. (2000) used this same model to predict current predation rates on fingerling catfish in the Delta region based upon the recent doubling in the wintering DCCO population, with estimated losses resulting in the removal of 49 million fingerlings valued at $5 million.

Controlled experiments by Glahn et al. (2002) investigating predation losses by DCCOs confirm previous estimates of cormorant damage and have started to examine output parameters at harvest with and without predation. Using sampling weights of fish inventoried from captive cormorant trials, they calculated a 19.6 percent biomass production loss from DCCO predation. At the commercial pond scale this level of predation corresponds to a loss of 6,800 kg (15,000 lbs) valued at $10,500 or almost 5 times the value of the fingerlings lost. Using this ratio, catfish production losses to Mississippi Delta catfish farmers may currently approach $25 million or 8.6 percent of all catfish sales in Mississippi. Furthermore, they examined the economic effects of cormorant predation on net returns in an enterprise budget for an average 130 hectare catfish farm using data collected from captive cormorant trials and standard budgeting techniques. Enterprise budgets resulted in a 111 percent loss of profits based upon a 20 percent production loss observed at harvest from simulating 30 DCCOs feeding at a 6 hectare catfish pond for 100 days (Glahn et al. 2002).

Because DCCOs are adept at seeking out the most favorable foraging and roosting sites, they are rarely distributed evenly over a given region, but rather tend to be highly clumped or localized. In the Mississippi Delta, the number and location of roost sites are dynamic, and depredations have been found to be "temporarily highly concentrated on ponds in close proximity to active roost sites" (USDA 2000). Thus, it is not uncommon for some fish farmers in a region to suffer little or no economic damage from DCCOs, while others experience exceptionally high losses.

Much of the bird depredation to baitfish and the tropical fish industries have been associated with wading birds rather than DCCOs (Avery et al. 1999; Hoy 1994; Hoy 1989; USDA-APHIS 1997a). Impacts of cormorants on baitfish and tropical fish are not well known (Brugger 1995). Similar wading bird impacts are seen within the crayfish industry with White Ibis, Yellow-crowned Night-Herons, and Great Egrets being the main predatory bird species (Price and Nickum 1995). Cormorants have been documented eating crayfish on their northern breeding grounds (Blackwell et al 1997; Lewis 1929; Ludwig et al. 1989; Neuman et al. 1997; Weseloh and Collier 1995) and depredation has been observed on crayfish farms in Louisiana (USDA-APHIS 1997a; Huner and Jeske 2001). Based on available scientific studies the impacts of cormorants on commercial crayfish production are unclear (Huner and Jeske 2001).

Under the No Action alternative, a combination of lethal and non-lethal control techniques is used to reduce economic impacts to aquaculture producers. See the discussion of Alternative B in this section for discussions of non-lethal techniques. No control tool is 100 percent effective against predation losses (OTA 1995), however depredations on aquacultural stock are less than they would be without lethal control (Glahn et al. 2000a). Shooting to kill birds is commonly used by producers to control DCCO depredation at commercial freshwater aquaculture facilities. The 1998 aquaculture depredation order authorized the unlimited take of depredating DCCOs at aquaculture facilities in 13 States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Minnesota, Mississippi, North Carolina, Oklahoma, South Carolina,

Tennessee, and Texas). In other States, depredation permits are issued by the Service Regional Migratory Bird Permit Offices for significant economic impacts to aquaculture producers. Glahn et al. (2000a) estimated that without such lethal damage control programs, the impact of DCCO depredation on the catfish industry would likely have more than doubled in the late 1990s compared to earlier years.

A report from the head of the aquaculture program at Langston University in Oklahoma shows the usefulness of variety in depredation control techniques (C. Kleinholz, pers. comm.):

> [The university] applied for its first depredation permit when a group of approximately 400 cormorants were suddenly observed on 2, one-acre catfish/trout ponds during late 1984. Within the 30 days that elapsed to obtain an expedited permit, approximately 900 rainbow trout and 3000 channel catfish fingerlings were eaten by the cormorants, despite daily hazing. Our management strategy from that time has been to shoot all birds legally permitted, as soon as they appear at the pond site(s). Since, 1996, we have also used 15' x 15' grids of synthetic baling twine suspended over the ponds to discourage cormorants from landing in the ponds, which appears to have reduced visitation to both facilities…. We are very fortunate to be included in the current depredation order for cormorants. The cyclic nature of cormorant occurrence at our facilities would have resulted in severe depredation without the order, since our depredation permit allowed the take of only 25 birds annually. In 1998, shortly after the [aquaculture] depredation order was issued, we had a very large fall flight of cormorants that stayed in the area for almost three months. We killed 85 birds and hazed several thousand more during that period.

**Recreational Fishing Economies**

Depredation permits have not been authorized for the take of DCCOs to benefit communities whose economies are closely coupled with the quality of recreational fishing. This is because (1) the Service does not issue permits for this reason and (2) the relationship between increased DCCO abundance (and predation) and subsequent declines in angler participation and spending is undocumented. Trapp et al. (1999) surveyed the States asking, "Is there documented evidence that increased DCCO populations have affected local economies associated with the sport fishing or tourism industries?" Of the 12 responding States, none reported any *documented* evidence that DCCOs had affected local economies associated with the sport fishing or tourism industry.

We do not doubt the reality or disregard the importance of the economic changes occurring in communities whose economic health is closely tied to recreational fishing. However, analyzing the relationship between DCCO predation, fishery impacts, angler participation, and economic effects is very complex and, at this point, is limited to qualitative predictions. The Oregon Department of Fish and Wildlife, in reply to the survey conducted by Trapp et al. (1999), commented that,

> [while] we can document the economic effect of decreased salmon populations through closure of commercial fisheries and formerly popular sport charter fisheries, and declining sales of salmon harvest tags...we believe that DCCO predation is only one of a number of causative factors which in total are responsible.

In areas where the evidence shows that DCCOs are impacting fisheries and associated recreational catch (e.g., eastern Lake Ontario and Oneida Lake, New York), it is easier to

assume that they may be having negative impacts on the economies of surrounding communities. As stated in chapter 3, a report on the economic impacts of sport fishery declines in eastern Lake Ontario found that a number of businesses that depend heavily on eastern basin sport fisheries experienced declines in business throughout the 1990s (Brown et al. 2002). The authors stated that, "we feel reasonably confident that we have documented at the correct order of magnitude a large decline in coastal fishing and boating-related activity over the 13-year period between 1988 and 2001," but also noted that, "putting a dollar value on the portion of the decline that is attributable to cormorants is impossible" (Brown et al. 2002). The declines that they documented include fewer boat trips (lakewide), fewer charter boats (lakewide), lower angler expenditures (in Jefferson and Oswego counties), and economic losses to marinas and charter and guide services. Overall, they estimated that the total impact of the decline in expenditures across the two-county (Jefferson and Oswego) economy was $10.9 million. The authors correlated this information with the evidence from NYSDEC biological data showing that DCCOs are negatively impacting the eastern Lake Ontario smallmouth bass fishery and concluded that there is a high likelihood that DCCO depredation is contributing to these economic impacts while noting that "additional factors may also be operating" (Brown et al. 2002).

**Commercial Fishing**

Historically, impacts to open water commercial fish stocks were one of the more important problems associated with DCCOs (cf. Mendall 1936). Today, concerns about declines in openwater commercial fisheries are shadowed by concerns about negative impacts to recreational fisheries and aquacultural stocks, although they do still exist. For example, in a March 2000 letter, the State of Maine Department of Marine Resources stated that, "During the past 20 years, alewife runs have declined dramatically. Of the 34 rivers and streams that have supported commercial alewife fisheries, only eight continue to support commercial harvests. The remainder have been closed to harvest for almost a decade to allow rebuilding of the runs. In spite of closures, these runs continue to remain at low levels. Every spring, large concentrations of cormorants are observed in the upper estuaries of rivers that support alewife runs. We believe that cormorant predation on these low level spawning runs is very high and may be having significant impacts on the ability of these stocks to recover to former levels of historical abundance."

Additionally, the States of Maine, New York, and Rhode Island each expressed concern about potential impacts to the commercial winter flounder fishery by DCCOs. For example, the Rhode Island Division of Fish and Wildlife stated that, "significant anecdotal information exists regarding severe predation of juvenile winter flounder in coastal salt ponds and all near-shore marine waters of the state."

Blackwell et al. (1995) noted that examinations of DCCO diet in a variety of habitats have shown that primary prey species are fish of little or no commercial value and cited several studies that confirm this notion. They pointed out that commercial groundfish populations (Gadidae, Bothidae, and Pleuronectidae) in the Gulf of Maine have declined drastically, probably due to increasing exploitation since the 1960s (Blackwell et al. 1995) and that, as groundfish populations have decreased, cartilaginous fishes (Squalidae

and Rajidae) have filled their ecological niches, thereby adding competition to the other factors threatening their numbers. Thus, groundfish species such as flounders and Atlantic cod, which were present in Mendall's (1934, 1936) DCCO diet data in the same area (Penobscot Bay), were noticeably absent from Blackwell et al.'s (1995) list of highest ranking prey species.

Commercial fish generally do not appear to make up a significant part of DCCO diet, as the following studies suggest:

- Ludwig et al. (1989) examined 8,512 regurgitated DCCO food items from Lakes Huron, Michigan, and Superior and did not find any lake trout or common whitefish, two commercially important species. Fish species of local commercial importance constituted 12 percent by number (34 percent by weight) of these food items, including yellow perch (13 percent by weight), smelt (8 percent by weight), and sucker (7 percent by weight).
- In the Apostle Islands of Lake Superior, Wisconsin, there was a concern in the mid-1980s that DCCOs were feeding heavily on commercially valuable whitefish. A subsequent study showed that the diet consisted primarily of forage fish such as sticklebacks, burbot, sculpins, and chubs. No more than 3 percent of the fish eaten by DCCOs were whitefish (Craven and Lev 1987).
- A study conducted in western Lake Erie found that DCCO diet primarily consisted of gizzard shad, emerald shiner, and freshwater drum, suggesting that impacts of DCCOs at current population levels were not detrimental to sport and commercial fishing (Bur et al. 1999).

Work with the Great Cormorant in Europe has not found evidence of significant impacts to commercial fisheries. On a lake in southern Germany, Keller (1995) found that the total catch of whitefish by Great Cormorants amounted to just 3.2 percent of the total commercial catch of this species. Larger consumption rates were found for other commercial species such as eel (22.3 percent) and pike (6.2 percent). It was estimated that cormorants took 3.3 percent of total annual fish production, while commercial fishermen took 28 percent. Just as with recreational fisheries, however, examinations of impacts to commercial fisheries should be evaluated on a site-by-site basis whenever possible. We were unable to find any documented evidence of significant impacts to commercial fisheries caused by DCCOs.

In Sweden, Great Cormorants are viewed as a problem by commercial fishermen, mainly because they injure or consume fish in fishing gears (Engström 1998). In studies carried out on six lakes and one coastal area, Engström (1998) found that fishermen may encounter, at most, an average of 8 percent (by weight) of fish damaged by cormorant predation. How much fish was removed from the fishing gear by cormorants was not known, but it was determined to be most likely that such predation affected smaller fish species of lesser economic value. Engström (2000) also found that commercially important species such as eel and pikeperch were absent or made up only a very small part (0.2 percent) of the diet of cormorants in a lake in south-central Sweden and that, for pikeperch, there was no evidence showing that such small out take would have a negative

impact on commercial yields. Examples of DCCO-induced damage to commercial catches in the Great Lakes also exist. One commercial fishermen reported that he no longer fishes his pound nets in the spring because DCCOs chase the whitefish in the pots and spear many of them, lowering the market quality of the catch. Trap net fishers also experience DCCO damage to fish in the pot, but to a much lesser degree since the pot is submerged (S. Lewis, USFWS, pers. comm.).

Wires et al. (2001) noted that "Where cormorants are consuming commercial fishes, isolating the role of cormorant predation relative to other sources of mortality is difficult. Thus the magnitude of impact due to cormorant predation is often unknown." Under the No Action alternative, no depredation permits have been issued in recent years to alleviate DCCO damages to openwater commercial fisheries.

**Alternative B: Non-lethal Management**
**Aquaculture**
Surveys of aquaculturists reveal that harassment patrols are commonly utilized, despite the fact that few producers consider them very effective. Stickley and Andrews (1989) reported that 60 percent of respondents who reported using harassment techniques used vehicle patrols combined with shooting to repel (not to kill) birds; of these, 13 percent found this combination to be very effective, 47 percent somewhat effective, and 40 percent not effective. Of these same respondents, 9 percent utilized pyrotechnics regularly; of these, 24 percent found pyrotechnics to be very effective, 57 percent somewhat effective, and 19 percent not effective. Catfish producers implementing roost dispersal activities may reduce depredation to fish stocks for a period of time, but only temporarily (Glahn et al. 2000; Glahn et al. 1996; Mott et al. 1998; Tobin et al. 2002). Damage abatement activities typically shift bird activities from one area to another, thereby reducing damage at one site while often increasing it at another (Aderman and Hill 1995; Mott et al. 1998; Reinhold and Sloan 1999; Tobin et al. 2002). Nisbet (1995) referred to harassment as a "negative-sum game" because, "in most cases, it merely moves [DCCOs] to other ponds, where more harassment is needed, which moves them to other ponds, and so on, thereby increasing the total burden on the industry."

The degree to which lethal control is cost efficient will vary with circumstances. See Appendix 9 for more information on cost effectiveness of various control techniques. For some producers, a harassment program combined with occasional shooting of birds may be most cost efficient. For others, it may be more efficient in the long-term to adjust management techniques (e.g., stock rates, feeding methods, and/or timing of fry/fingerling transplant) and install devices that will physically exclude fish-eating birds. In Arkansas, the use of simple barriers (i.e., twine strung across ponds at 30 m intervals) limited the number of DCCOs landing on ponds by 2 to 4 fold (A. Radomski, USDA/ARS, unpubl. data). While such techniques hold promise, it would be a mistake to assume that such techniques are more effective than lethal techniques.

Glahn et al. (2002) provide a thorough overview of some of the challenges associated with changes in catfish culture practices:

…a number of possible alternatives have been proposed by several authors (Barlow and Bock 1984, Moerbeek et al. 1987, Mott and Boyd 1995). These include reducing pond size, delaying stocking and reducing stocking rates. Although implementation is seemingly thwarted by tradition, such strategies may be simply flawed based on economic risk assessment. For example, reducing pond size would facilitate the installation of bird exclusion systems, but pond construction cost, a major capital expenditure, increases as pond size decreases (Garrard et al. 1990). Although new ponds being built have decreased slightly in size from 6 ha to 4.8 ha (Hanson, unpublished report), there is no information to suggest that these might be small enough to make exclusion practical. Delaying stocking of fingerlings until late spring after cormorants leave is also often suggested (Glahn et al. 1995, Mott and Boyd 1995, Mott and Brunson 1997). However, delaying stocking is not compatible with the multi-batch cropping system and may increase the risk of more devastating stress-related disease outbreaks that are prevalent at water temperatures later in the spring.

Night roost harassment is another technique for non-lethal management of DCCO depredation. It involves "teams of people [firing] exploding and whistling pyrotechnics at birds in roosts and at birds flying into the roosts in the evening" (Tobin et al. 2002). A survey of catfish producers in the southern U.S. (Wywialowski 1998, 1999) revealed that 14 percent reported using night roost harassment, mostly in Mississippi (32 percent of all Mississippi catfish producers). Mott et al. (1998) concluded that, although harassment of roosts does not eliminate the DCCO predation problem at catfish farms, it does cause DCCOs to temporarily shift their roosting activity to locations along the Mississippi River, thereby reducing the number of cormorants on or near catfish ponds. Producers in the intensely harassed area reported spending less on harassment patrols which saved an average of $1,406 and $3,217 per year during the winters of 1993-94 and 1994-95, respectively (Mott et al. 1998). Overall, night roost harassment is not considered to be sufficient for eliminating the need to practice other forms of DCCO control at aquaculture facilities, although it appears to be effective at decreasing losses (Littauer et al.1997; Mott et al. 1998; Reinhold and Sloan 1999, Tobin et al. 2002). Mott et al. (1998) concluded that, "To be most effective, all roost sites within a large geographic area need to be harassed simultaneously, or at least harassed on a weekly basis, to prevent cormorants from moving from site to site or reoccupying previously abandoned sites."

**Recreational Fishing Economies**

The impact of this alternative on local economies that are closely coupled with recreational fishing would probably be worse than the No Action alternative. It is unlikely that non-lethal methods alone would have significant benefits over the long-term to fisheries and economies dependent on recreational fishing.

**Commercial Fishing**

This alternative is no more likely to benefit commercial fishing than the No Action alternative.

**Alternative C: Increased Local Damage Control Alternative**

**Aquaculture**

Depredation control methods should be effective, economically practical, and environmentally sound (OTA 1995). In their evaluation of lethal methods of depredation control at aquaculture facilities, Curtis et al. (1996) stated that:

> The effectiveness of lethal control measures may vary substantially. Lethal methods are most practical and successful when limited numbers of birds are involved in the depredation problem. It is important to note that many problems that appear to involve a limited number of birds actually involve larger numbers of birds than believed due to turnover and replacement. That is, birds that leave a site often are replaced by others. When large numbers of birds are involved, lethal methods typically are not effective or cost efficient. Lethal techniques are most beneficial when used in an integrated problem bird management program to enhance the effectiveness of non-lethal methods. Many operators specifically employ lethal methods for removing birds that are not responding to non-lethal techniques.

Indeed, that is exactly why aquaculture producers in the southern U.S. use an integrated approach of both lethal and non-lethal techniques to manage DCCO depredation. However, partly because DCCOs are hard to shoot on ponds and partly because of high turnover rates at ponds (Tobin et al. 2002), shooting at ponds provides some, but most would argue not enough, relief from DCCO depredation. APHIS/Wildlife Services biologists are of the opinion that winter roost control will help reduce DCCO depredation at aquaculture facilities. The keys for effectiveness are good coordination and adequate manpower (T. King, APHIS/WS, pers. comm.). A USDA (2000) report on reducing DCCO damage to southern aquaculture notes that "Coordinated and simultaneous harassment of cormorants can disperse them from night roosts and reduce damage at nearby catfish farms." It then notes that "Shooting…cormorants reinforces non-lethal harassment" and concludes that shooting at roosts "might enable farmers to reduce the number of birds on their farms significantly without affecting continental or flyway populations."

Since DCCOs in the Mississippi Delta were observed to have a tendency to use the same roosts (Tobin et al. 2002), if these roosts are targeted it is likely that roost control will prove more effective at reducing DCCO damage than shooting DCCOs at ponds alone. Roost control efforts will have the result of either dispersing the roost or, if shooting is done in a stealthy and targeted manner, may result in a large number of DCCOs being killed.

**Recreational Fishing Economies**

It is doubtful that the Service will ever make a regular practice of issuing depredation permits to benefit local economies. However, this alternative would allow for greater responsiveness to concerns about DCCO impacts to fish populations than the No Action alternative. In localized situations, this alternative could lead to an improved fishery and increased angler participation, and thus benefits to local economies that are closely tied to recreational fishing might occur.

**Commercial Fishing**

At this time, there is not sufficient biological evidence to justify controlling DCCOs on a national or local level to benefit open water commercial fisheries. If significant site-specific problems arise in the future, the Service's practice is, and will continue to be, to

issue depredation permits where lethal control is believed to have a high likelihood of alleviating impacts.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
**Aquaculture**
In addition to winter roost control (discussed under Alternative C, above), control efforts associated with the public resource depredation order are likely to have the secondary benefit of reducing DCCO depredation at aquaculture facilities. Thus, Alternative D is more likely to reduce depredations on aquaculture than either the No Action alternative or Alternative C.

**Recreational Fishing Economies**
Management actions associated with this alternative, if they lead to positive impacts on fisheries and subsequent increases in angler participation, could benefit recreational fishing economies relative to the No Action alternative. Local populations of DCCOs that are known to be exhibiting high predation pressure on a specific fishery would need to be targeted in order to maximize the likelihood of real benefits.

**Commercial Fishing**
This alternative does not specifically address the issue of commercial fishing, but the public resource depredation order could have indirect benefits by relieving predation pressure on localized commercial fisheries. It is more likely to have positive impacts than the No Action alternative.

**Alternative E: Regional Population Reduction**
**Aquaculture**
Glahn et al. (1999) concluded that currently available DCCO control techniques are "of limited effectiveness and are becoming increasingly difficult to implement." They predicted that increases in DCCO population sizes will further reduce the effectiveness of these techniques and suggested that effective management of cormorants for reducing depredation to southern aquaculture will likely require more intensive control on the wintering grounds, control on the breeding grounds, or a combination of both. Reinhold and Sloan (1999) also suggested that "management implications should focus more on the long term goals of managing DCCO populations."

However, in discussion and modeling of management scenarios for European Great Cormorants, it has been suggested that reducing the size of the overall population may not result in equivalent reductions in the number of cormorants occurring at high quality foraging areas, such as aquaculture facilities (Bregnballe et al. 1997; Van Eerden and van Rijn 1997 *in* Wires et al. 2001). Because foraging habitats vary in quality and cormorants are efficient at detecting high quality foraging sites, overall population reductions may first cause birds to disappear from least preferred or low quality areas, and declines may be less marked in high quality areas (Hodges 1989; T. Bregnballe, pers. comm. in Wires et al. 2001). Additionally, the scale of damage caused by DCCOs may not be directly related to total numbers in local areas (Bregnballe et al. 1997).

Furthermore, the relationship between control activities carried out in one location and resource conflicts occurring in another is not a predictable one. In the case of southern aquaculture, most of the depredating DCCOs occur for much of the year in northern breeding grounds (e.g., the Great Lakes) and then migrate to wintering grounds in another region (e.g., the Mississippi Delta). By analyzing band-recovery data, Dolbeer (1991) found that birds in the southern Mississippi region originated from breeding areas as far west as Alberta and as far east as New England. The data suggest that, while Lakes Michigan and Superior were the most important sources of DCCOs wintering in the lower Mississippi Valley, significant numbers of DCCOs also came from the region between Saskatchewan and eastern Lake Ontario. Hatch (1995), citing Dolbeer (1991), stated that "wintering birds that eat a Mississippi farmer's catfish could come from anywhere across the 3000 km breeding range of the populations that winter there."

Currently, satellite telemetry is being used to further investigate the migration patterns of DCCOs wintering in Alabama, Arkansas, Louisiana, and Mississippi. Preliminary results of this research also indicate that birds wintering in the Delta region originate from across the Interior population's breeding range (S. Werner, APHIS/WS, pers. comm.). Based on these data, controlling breeding DCCOs to reduce numbers of birds on the wintering grounds would likely require a tremendous effort to be successful and would require a coordinated effort among the four regions. According to J. Glahn (APHIS/WS, pers. comm.), the increase in numbers of DCCOs wintering in the Delta region of Mississippi has been proportionally larger than the increase in numbers of catfish ponds in the area. Thus, it may be that broad reductions in DCCO populations would not eliminate the need to continue local exclusion and harassment efforts; however, lower population levels would likely enhance the effectiveness of localized damage control efforts.

**Recreational Fishing Economies**

In areas where there is an actual causal relationship between DCCO predation, declining fisheries, and subsequent economic impacts, then the reduction of regional DCCO populations would likely be more effective at alleviating economic declines than the No Action alternative.

**Commercial Fishing**

Again, in areas where there is an actual causal relationship between DCCO predation and negative impacts on commercial fishery harvests, then this alternative would likely be more effective at alleviating those impacts than the No Action alternative.

**Alternative F: Regulated Hunting Season**

**Aquaculture**

Hunting would likely reduce depredation of aquaculture stock more effectively than under the No Action alternative, especially if it led to overall reductions in DCCO populations. In addition to killing birds, hunting would be an effective supplement to roost dispersal programs. Glahn (2000) concluded that shooting with live ammunition is at least equally effective as pyrotechnics for dispersing DCCOs from their night roosts. Conover (2001) also noted that hunting is likely to increase the effectiveness of non-lethal techniques.

**Recreational Fishing Economies**
Hunting would probably not have a considerable influence on local economies (especially since the hunting season would not occur while DCCOs were on their northern breeding grounds which is where most economic impacts of this nature are believed to occur). If a hunting season led to reduced DCCO populations then this alternative would likely be more effective than the No Action alternative.

**Commercial Fishing**
Hunting, if it contributed to population reductions, could have localized benefits on commercial fisheries (where DCCO predation is actually depressing fish stocks) and would be more likely to have these benefits than the No Action alternative.

### 4.2.8 Impacts to Hatcheries and Environmental Justice

**Alternative A: No Action**
In a 1990 survey sent to the fisheries chiefs of each State, 33 percent of States reported an increase in DCCO predation in hatchery ponds and raceways (Erickson 1990). During public scoping, the Illinois Department of Natural Resources wrote that their LaSalle Fish Hatchery along the Illinois River has had problems with increasing predation pressure from migrating DCCOs in the late summer and fall. They stated that, in 1997, "production of muskellunge at this hatchery was severely impacted by cormorant predation." The Georgia Department of Natural Resources also reported that their hatchery personnel in southern Georgia "continue to report significant losses of fish to cormorant predation, especially in the fall and winter months." Also during the public scoping period, the States of Kansas, Ohio, Texas, and Wyoming indicated that DCCO predation on hatchery fish has been a problem. Reported instances of cormorant damage to hatchery fish in Texas include the loss of 90 percent of the smallmouth bass 2-year-old brood stock and 13,000 rainbow trout at the Jasper facility (Dukes 1987). Texas Parks and Wildlife Department fish hatchery managers reported that DCCO depredation at six installations increased during 1982-87 and that cormorant depredation had greatest impact on largemouth bass brood stock, goldfish brood stock, and rainbow trout rearing stock (Thompson et al. 1995).

DCCO impacts to hatcheries are generally related to predation, stress, disease, and financial losses to both hatcheries and recipients of hatchery stock. Hatchery fish are stressed by the presence of DCCOs, wounds from strikes, and noisemakers used to scare away DCCOs. This stress leads to a decrease in growth factors as feeding intensity decreases. Additionally, disease and parasites can be spread more easily by the presence of fish-eating birds. For example, some parasites, such as trematodes, complete their life cycle only after an infected fish is consumed by the birds (K. Flanery, USFWS, pers. comm.). Research from the Czech Republic and Mexico has linked cormorants to fish diseases (Moravec et al. 2000, Moravec and Scholz 1994, Vidal Martinez et al. 1994).

Parkhurst et al. (1987) found that human patrols were considered highly successful or better by 30 percent of hatchery managers, of limited success by 60 percent, and not successful by 9 percent. Spencer (1996) reported that two State fish hatcheries in

Georgia used whistlers and cracker shells, and both techniques were considered partially effective against birds in general at each facility. Neither technique was considered effective against "resident" DCCOs however. The manager at Inks Dam National Fish Hatchery (Texas) described attempts at controlling DCCO depredation with non-lethal harassment alone as follows:

> In years past cormorants have rested on dead limbs of a large cottonwood tree in our picnic area right along Lake LBJ. We were unable to shoot birds in this tree because there are houses directly across the lake, a distance of about 150 yards. Although we could not shoot these birds, we always tried to keep them scared off. At first all we had to do was drive by and the cormorants would fly. After a few days it became necessary to drive up to the tree and honk the horn. When this failed to work, I would drive up to the tree in a rapid manner, slam on the brakes as I honked the horn. Once the vehicle was stopped, I would step out of the vehicle and slam the door as loudly as I could. Once again this only worked for a few days. As a last resort, I began to throw rocks and sticks at the cormorants. The cormorants have started roosting in several trees along Lake LBJ. I have been driving down there after dark and scaring them with a spotlight. Each evening it is getting harder to run them out of the trees. During the daytime these same birds swim up and down Lake LBJ. Early in the season they would fly off every time a vehicle drove through the picnic area. Now most of them refuse to fly even when they are harassed with cracker shells (R. Lindsey, USFWS, pers. comm.).

Reports of habituation such as this are typical as DCCOs quickly learn to ignore noisemakers and other scare tactics. Shooting a few birds, on the other hand, has been shown to reinforce harassment efforts.

Covering ponds and raceways with netting is another management option. This has helped reduce depredation at some hatcheries but is not a panacea due to drawbacks such as lack of funding to install and maintain nets (e.g., the manager at Inks Dam National Fish Hatchery estimated that netting their ponds would cost $400,000) and the fact that it makes it considerably more difficult to feed, clean, aerate, and harvest ponds (K. Flanery, USFWS, pers. comm.).

Several managers of National Fish Hatcheries have expressed concern about problems with DCCO predation and not being able to use lethal control on birds at Federal facilities because of Director's Order 27, which states that "kill permits will be issued for use at public facilities only when it has been demonstrated that an emergency or near emergency exists and an [APHIS/WS] official certifies that all other deterrence devices and management practices have failed." For example, the manager at Genoa National Fish Hatchery in Wisconsin expressed concern about DCCO predation on largemouth bass and walleye that are used as host fish for the endangered Higgins Eye mussel. In 1999, this facility experienced "complete loss" in their advanced walleye rearing pond and 50 percent mortality in their largemouth bass rearing pond due to DCCO predation (T. Turner, USFWS, pers. comm.). At Natchitoches National Fish Hatchery in Louisiana, 30,000 channel catfish fingerlings were reduced to less than 1,000 in two days by a flock of cormorants in the late 1980s (K. Kilpatrick, USFWS, pers. comm.). In 1996, Tishomingo National Fish Hatchery in Oklahoma lost 140,000 seven-inch catfish to approximately 400 cormorants, although they typically lose 5,000-10,000 annually (K. Graves, USFWS, pers. comm.).

Additionally, at Inks Dam National Fish Hatchery in Texas, where largemouth bass and channel catfish are raised for distribution to Federal and Tribal waters of the southwestern U.S., concern has been expressed about depredation problems caused by more than 100 resident DCCOs leading to "total loss of production" (N. Kaufman, USFWS, pers. comm.). During 1999-2000, Uvalde National Fish Hatchery in Texas averaged a 93 percent loss in 3 ponds of channel catfish due to cormorant predation. This level of loss caused several last-minute cancellations of scheduled fish deliveries (S. Jackson, USFWS, pers. comm.). When hatcheries experience losses of this magnitude, they cannot fulfill their trust responsibilities to Native American Tribes. Representatives from Service Region 2 (Arizona, New Mexico, Oklahoma, Texas) are concerned that, at National Fish Hatcheries in Region 2, excessive losses of fish destined for stocking on Tribal lands may result in a significant direct economic impact for Native American Tribes. However, this economic impact has not been quantified in any way and no Tribes have commented to us that they have been economically impacted by DCCO predation at hatcheries.

**Alternative B: Non-lethal Management**
Harassment activities are of limited effectiveness at fish hatcheries and, in many cases, exclusion devices are not considered to be cost effective. Thus, depredation at fish hatcheries would be dealt with less effectively under this alternative than under the No Action alternative.

**Alternative C: Increased Local Damage Control Alternative**
Depredation at hatcheries, especially National Fish Hatcheries, would be more effectively reduced than under the No Action alternative since the ability to manage DCCOs causing such problems would be enhanced. Where they occur, if at all, impacts to low income Native American communities dependent on fish raised at Federal hatcheries would also be reduced.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
Relative to the No Action alternative, depredation of some stocks of hatchery fish would very likely be reduced. Where they occur, if at all, impacts to low income Native American communities dependent on fish raised at Federal hatcheries would also be reduced.

**Alternative E: Regional Population Reduction**
Reducing regional populations of DCCOs would likely help reduce depredation of hatchery stocks more effectively than the No Action alternative and would increase the effectiveness of localized lethal and non-lethal damage control techniques. Where they occur, impacts to low income Native American communities dependent on fish raised at Federal hatcheries would also be reduced.

**Alternative F: Regulated Hunting Season**
Hunting would likely help reduce depredation at fish hatcheries more effectively than under the No Action alternative, especially if it led to overall population reductions.

Where they occur, if at all, impacts to low income Native American communities dependent on fish raised at Federal hatcheries would also be reduced.

### 4.2.9 Impacts to Property Losses

#### Alternative A: No Action

The APHIS/WS Management Information System database reveals that, from FY 1995-2001, losses to property were reported in 19 States with structures, trees and shrubs most commonly reported. Respondents to a survey conducted by Wires et al. (2001) reported damages to private property in four States: Connecticut, Maine, Massachusetts, and South Carolina. For example, in a February 1, 2000, letter to the Service, the Maine Department of Inland Fisheries and Wildlife stated that "lower property values at major roosts and large nesting colonies" are an important issue in Maine.

In some cases, the Service has issued depredation permits for DCCOs taking fish from privately-owned and stocked fish ponds. For example, the Hiawatha Sportsmen's Club in northern Michigan, has been issued a permit to reduce DCCO predation on trout, walleye, and perch in stocked ponds. In Texas and Oklahoma, the Service has also issued permits to private stock ponds where DCCOs were having economic impacts. A citizen from Texas sent the following comments on the impact of DCCOs at a small, privately owned fishing lake west of Fort Worth, Texas:

> I have a forty year history on the same small body of water which in the last ten years has been severely impacted by a cormorant problem from mid-November to mid-March of each year. This is a forty acre [16 ha] fishing lake... During the period 1962 to approximately 1992 it was an excellent lake for bass with catch rates of up to 60 for two anglers in a day. It has always been a catch and release lake. I saw the first cormorant on the lake in 1984. By 1992, it was an average of 100 birds per day feeding on the lake... Fishing success began to decline to the point where in 2001 the most fish caught in a single day was 2! ...As the food base in this lake is principally gizzard shad I began to suspect that the cormorants were devastating the bait fish and small bass population during their...stay each year. This observation was further affirmed by numerous catches of bass in the 1990's with cormorant beak scars on their bodies. On October 6, 2001 I commissioned an electrofishing survey of the lake by a professional fisheries management consultant. The results were stunning... Other than fingerlings from the Spring 2001 hatch, one nine inch bass was the only specimen obtained that was less than 18 inches long...the forage base which should have been in a ratio of at least 2:1 [shad to bass] was only .5:1... The consultant that I hired said I could start a restocking program this spring with an initial outlay of $4,000-$5,000 however it would be money thrown away if the feathered predators returned in the fall. If your study requires an economic impact and you need a basis for assessing cormorant damage on a small private lake then let me add that a few years ago I was offered $5,000 per year to lease the lake to a fishing club. (V. Tinsley, pers. comm.)

Financial losses to fishing clubs (both in lost revenues and increased stocking expenses) related to Great Cormorant predation have also been documented in Britain (M. Read, pers. comm.)

Little attention has been given to complaints of fouling vessels or buildings in the literature (Hatch and Weseloh 1999). However, this issue was raised during the public scoping process and has been the subject of requests for depredation permits. For example, the Massachusetts Division of Fisheries and Wildlife noted problems with "small numbers of [DCCOs] perching and defecating on docks and moored boats."

As discussed in Section 4.2.4, DCCOs are capable of killing trees and other vegetation. Lewis (1929) considered the killing of trees by nesting cormorants to be very local and limited, with most trees he observed to have no commercial timber value. However, vegetation damage may be perceived as a problem if the species is rare, or is aesthetically or commercially valued by the landowner (Hatch and Weseloh 1999). Here is the story of a landowner in New York:

> I am an island owner who has been pestered with these birds for the past 3 years. We had 18 nests 3 years ago, last year over 150. I went out to our Islands [on April 16th, 2003] and…the Cormorants are back… These birds are terrible, a nuisance, make a mess, and are quickly destroying our islands… Last December, we put a conservation easement on our islands to keep them forever wild and natural. We intend to make a wildlife refuge and bird sanctuary. What a mess last spring. [When we returned from our winter residence in early May we]…discovered that our islands were taken over and inhabited by [cormorants]. The smell and bird droppings were horrendous to say the least. It took mother nature over 3 months to clean up the islands. Many trees and vegetation were destroyed when hit by the cormorant's waste and droppings.

**Alternative B: Non-lethal Management**
Some property losses could be dealt with effectively through non-lethal management such as harassment or nest removal. Others would necessitate removal of birds. Thus, property losses would be dealt with less effectively under this alternative than under the No Action alternative.

**Alternative C: Increased Local Damage Control Alternative**
Property losses associated with DCCOs would be controlled as effectively as under the No Action alternative.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
Relative to the No Action alternative, property losses would be dealt with more effectively under this alternative. Although property losses do not receive increased consideration under this alternative, control actions associated with the public resource depredation order would likely have the secondary impact of reducing property damage.

**Alternative E: Regional Population Reduction**
Relative to the No Action alternative, property losses would be dealt with more effectively under this alternative. Although property losses do not receive increased consideration under this alternative, *per se*, reductions in regional populations would likely have the secondary impact of reducing property damage.

**Alternative F: Regulated Hunting Season**
Losses to property would be more effectively reduced than under the No Action alternative. In some cases, hunting could be used as a tool to directly control damage to property.

### 4.2.10 Impacts to Existence and Aesthetic Values

**Alternative A: No Action**
*Existence Value.* To some people, any killing of DCCOs or their eggs represents a loss of maximized existence value and therefore anything more than a non-lethal approach compromises this value. Under this alternative, however, a very large population of

DCCOs still exists and threats to existence value have not, for the most part, been raised as a significant concern.

*Aesthetic Value.* While many individuals commented during the public scoping process that DCCOs and their colonies are ugly, there are also those to whom the sight of a cormorant engaging in natural behaviors is viewed as beautiful. Nonetheless, certain species, particularly abundant ones, are more likely to be seen as a nuisance thereby losing much of their net aesthetic value (Conover 2002). Several people also indicated during the scoping process that DCCOs have turned verdant islands or waterfront areas into wastelands through their killing of trees and this has compromised the natural beauty of the areas where they live, work, and/or recreate.

**Alternative B: Non-lethal Management**
*Existence Value.* Existence value would not be compromised under this alternative since no DCCOs would be killed. However, it is possible that not effectively managing an abundant species such as DCCOs could, ultimately, reduce existence value if a lack of management contributed to the species being viewed as a "nuisance" or "pest." As Conover (2001) noted, "[when] a wildlife population increases and the animal becomes abundant, negative values may increase faster than positive ones."

*Aesthetic Value.* Effects on aesthetic value would depend on individual perspective. Those who find DCCOs aesthetically-pleasing would be slightly negatively affected because in many local situations DCCOs would be harassed out of the area and thus would not be available for immediate viewing, although it would not be difficult to find them in other locations. On the other hand, those who view DCCOs as compromising aesthetic values with their presence would appreciate the fact that DCCOs could not be viewed.

**Alternative** C: **Increased Local Damage Control**
*Existence Value.* More DCCOs would be killed under this alternative than under the No Action and thus, to some people, existence value would be compromised. However, overall populations of DCCOs would not be significantly reduced, so effects on existence value would be minimal.

*Aesthetic Value.* Effects on aesthetic value associated with this alternative would vary depending on individual perspective. For those who find DCCOs aesthetically displeasing, reduced presence associated with control actions carried out under this alternative would be viewed positively. For those who appreciate the sight of DCCOs, aesthetic value would be somewhat compromised, compared to the No Action alternative.

**PROPOSED ACTION Alternative D: Public Resource Depredation Order**
*Existence Value.* More DCCOs would be killed under this alternative than under the No Action and thus, to some people, existence value would be compromised. However, overall populations of DCCOs would not be significantly reduced, so effects on existence value would be minimal.

*Aesthetic Value.* Effects on aesthetic value associated with this alternative would vary depending on individual perspective. For those who find DCCOs aesthetically displeasing, reduced presence associated with control actions carried out under this alternative would be viewed positively. For those who appreciate the sight of DCCOs, aesthetic value would be somewhat compromised, compared to the No Action alternative.

**Alternative E: Regional Population Reduction**
*Existence Value.* More DCCOs would be killed under this alternative than under the No Action and thus, to some people, existence value would be compromised. However, overall populations of DCCOs would not be significantly reduced, so effects on existence value would be minimal.

*Aesthetic Value.* Effects on aesthetic value associated with this alternative would vary depending on individual perspective. For those who find DCCOs aesthetically displeasing, reduced presence associated with control actions carried out under this alternative would be viewed positively. For those who appreciate the sight of DCCOs, aesthetic value would be somewhat compromised, compared to the No Action alternative.

**Alternative F: Regulated Hunting Season**
*Existence Value.* More DCCOs would be killed under this alternative than under the No Action and thus, to some people, existence value would be compromised.

*Aesthetic Value.* Effects on aesthetic value associated with this alternative would vary depending on individual perspective. For those who find DCCOs aesthetically displeasing, reduced presence associated with control actions carried out under this alternative would be viewed positively. For those who appreciate the sight of DCCOs, aesthetic value would be somewhat compromised, compared to the No Action alternative.

## 4.3 Further Discussion of Alternatives
This section discusses how each alternative compares to other alternatives, particularly the preferred alternative. It also explains the anticipated direct, indirect, and cumulative effects of each alternative and summarizes the impacts associated with the alternative (as outlined in section 4.2), both independently and in relation to the No Action alternative. Finally, it describes mitigating measures for minimizing significant negative impacts relevant to the proposed action and other alternatives.

### 4.3.1 Alternative A: No Action
*Direct, Indirect and Cumulative Effects.* Under the No Action alternative, DCCOs will continue to have direct effects on the fish they eat (in the wild or in hatcheries), birds with which they co-nest, vegetation they destroy, property they damage, fish farmers whose stock they consume, and (in limited cases) water quality. The significance of these interactions varies at different locations. Direct relationships with commercial fisheries are less clear. DCCOs may have indirect effects on recreational fishing economies and Tribes that rely on hatchery-raised fish.

Cumulative impacts are those impacts on the environment that result from the incremental impact of an action when combined with other past, present, and reasonably foreseeable future actions, regardless of who undertakes these other actions. Under the No Action alternative, conflicts with other birds would likely increase as more habitat was destroyed by DCCOs (although for ground nesting birds this would be beneficial) and other factors (such as development). Predation pressure on fish would continue to be significant in some areas and would contribute to fishery declines. In addition to DCCOs, fish are influenced by chemical, physical, and biological stresses, including habitat degradation, imbalances in aquatic communities due to population explosions of invading species (in the Great Lakes these include sea lamprey, alewife, white perch, and zebra and quagga mussels); reproductive failure; alterations of fish communities and loss of biodiversity associated with overfishing and fish stocking practices; and impacts of persistent toxic chemicals (Koonce 1995). Furthermore, economic damages to aquaculture producers and hatcheries would not be alleviated and might worsen, especially if combined with increases in the cost of the fish that are used to stock ponds and raceways.

By continuing under the status quo, we believe that DCCO impacts would continue to increase and become more prominent. On the sociopolitical side, serious ramifications of continuing to ignore this problem could include the forced (e.g., by Congress) removal of DCCOs from protection under the MBTA, delegation of DCCO management authority to another agency (e.g., APHIS/WS), and increased frequency of illegal DCCO shootings. Biological consequences associated with prolonged continuation of the status quo include further progression of impacts to fisheries, vegetation, other birds, and other resources.

**Table 14. Cormorant Impacts under Alternative A**

| Impacts of Cormorants | Alternative A: No Action |
|---|---|
| DCCO populations | N/A |
| Other bird populations | Suspected conflicts and in some cases confirmed conflicts associated with habitat destruction and nest site competition; significance localized |
| Fish | Suspected and in some cases confirmed conflicts; significance localized |
| Vegetation/habitat | Destruction of vegetation confirmed; significance localized |
| Threatened and endangered species | Suspected but not confirmed conflicts with Atlantic salmon and various Pacific salmonids; very likely, however, that other factors are more important than DCCOs in the decline of salmon |
| Water quality and human health | Accused of being a source of groundwater contamination but this is not confirmed; can cause direct, open water contamination |
| Aquaculture | Confirmed economic impacts on aquaculture production |
| Recreational fishing economies | Correlative evidence that DCCOs are a factor behind economic declines in communities dependent on recreational fishing; not confirmed |
| Fish hatcheries and environmental justice | Confirmed depredation of hatchery stock with significance localized; effect on ability to provide hatchery fish to low-income groups not confirmed |
| Property losses | Confirmed conflicts with some property interests; significance localized |
| Existence and aesthetic values | Effect on values differs with perspective; DCCOs may appeal to some individual's sense of aesthetics, while not appealing to others |

### 4.3.2 Alternative B: Non-lethal Management

*Direct, Indirect and Cumulative Effects.* In summary, the chief direct effects (i.e., those caused by the action(s) and occurring at the same time and place) associated with this alternative would be displacement of nesting, roosting, or feeding DCCO populations and disturbance of bird species that nest, roost, or feed with DCCOs.

Indirect effects (i.e., those caused by the action(s) but occurring later in time or farther in distance) include limited positive impacts to fisheries, vegetation, threatened and endangered species, water quality and human health, aquaculture, hatcheries, and property losses associated with localized displacement of DCCOs. A negative indirect effect could be the relocation of nuisance birds to new areas (possibly where they weren't previously a problem). Intensive, long term disturbance of nesting birds associated with DCCOs could negatively affect their populations on a local and regional scale.

Cumulative effects (i.e., those that result from the incremental impact of the action(s) when added to other past, present, and reasonably foreseeable future actions) associated with this alternative could include even greater abundance of DCCOs, continued destruction of habitat, regional declines in some bird populations, continued fisheries declines, and continued serious depredation of fish stock at aquaculture and hatchery facilities.

*Discussion of Alternative.* The preferred alternative is preferable to Alternative B because it allows for the use of more efficient and effective (i.e., lethal) wildlife damage control techniques. Presumably, if more effective techniques are used, resource conflicts will be dealt with more effectively.

Table 15. Management Activity Impacts under Alternative B

| **Impacts of Management Actions** | **Alternative B: Non-lethal Management** |
|---|---|
| DCCO populations | No significant impact to regional or continental populations; no lethal take |
| Other bird populations | Considerable localized disturbance possible |
| Fish | Could help reduce predation in localized situations |
| Vegetation/habitat | Could help reduce impacts in localized situations |
| Threatened and endangered species | Localized disturbance possible |
| Water quality and human health | Could help reduce impacts in localized situations |
| Aquaculture | Could help reduce depredation in some situations |
| Recreational fishing economies | Unlikely to benefit |
| Fish hatcheries and environmental justice | Could help alleviate some conflicts |
| Property losses | Could help alleviate some conflicts |
| Existence and aesthetic values | Effects on values differs with perspective |

Table 16. Comparison to No Action Alternative

| **Relation to No Action** | **Alternative B: Non-lethal Management** |
|---|---|
| DCCO populations | Fewer birds would be killed (i.e., none) |
| Other bird populations | Could be somewhat effective, but less effective overall |
| Fish | Less effective |
| Vegetation/habitat | Could be somewhat effective, but less effective overall |
| Threatened and endangered species | Virtually the same |
| Water quality and human health | Could be somewhat effective, but less effective overall |
| Aquaculture | Could be somewhat effective, but less effective overall |
| Recreational fishing economies | Virtually the same |
| Fish hatcheries and environmental justice | Could be somewhat effective, but less effective overall |
| Property losses | Could be somewhat effective, but less effective overall |
| Existence and aesthetic values | Compromises existence value less; effect on aesthetics will vary |

### 4.3.3 Alternative C: Increased Local Damage Control Alternative

*Direct, Indirect and Cumulative Effects.* In summary, the chief direct effects (i.e., those caused by the action(s) and occurring at the same time and place) associated with this alternative would be displacement and limited take of nesting, roosting, or feeding DCCOs or their nests or eggs and some displacement of bird species that nest, roost, or feed with DCCOs, as well as limited incidental take. These effects would occur at a higher rate than under the No Action Alternative but are not predicted to be significant.

Indirect effects (i.e., those caused by the action(s) but occurring later in time or farther in distance) associated with this alternative could include positive impacts to fisheries, other birds, vegetation, and aquaculture/hatchery production. Long term effects on DCCO populations are not anticipated to be significant. Regular population monitoring would help ensure this.

Cumulative effects (i.e., those that result from the incremental impact of the action(s) when added to other past, present, and reasonably foreseeable future actions) associated with this alternative could include even greater abundance of DCCOs, continued destruction of habitat, regional declines in some bird populations, continued fisheries declines, and continued serious depredation of fish stock at aquaculture and hatchery facilities.

*Discussion of Alternative.* The preferred alternative is preferable to Alternative C because it allows for greater flexibility in dealing with many types of resource conflicts (i.e., agencies experiencing cormorant damages could, in many cases, plan and implement management actions more readily) and we believe that it will thus reduce those conflicts more effectively.

Table 17. Management Activity Impacts under Alternative C

| **Impacts of Management Actions** | **Alternative C: Increased Local Damage Control** |
|---|---|
| DCCO populations | No significant impact to regional or continental populations; estimated annual take of <60,275 |
| Other bird populations | Local disturbance possible, but could be managed to avoid significant impacts |
| Fish | Likely to help reduce predation in localized situations |
| Vegetation/habitat | Could help reduce impacts in localized situations |
| Threatened and endangered species | No adverse impacts |
| Water quality and human health | Could help reduce impacts in localized situations |
| Aquaculture | Would help reduce depredation |
| Recreational fishing economies | Not likely to benefit |
| Fish hatcheries and environmental justice | Would help reduce depredation |
| Property losses | Could help reduce losses |
| Existence and aesthetic values | Effects on values differs with perspective |

Table 18. Comparison to No Action Alternative

| **Relation to No Action** | **Alternative C: Increased Local Damage Control** |
|---|---|
| DCCO populations | More birds would be killed |
| Other bird populations | Could be more effective |
| Fish | Could be more effective |
| Vegetation/habitat | Could be more effective |
| Threatened and endangered species | Virtually the same |
| Water quality and human health | About the same |
| Aquaculture | Expected to be more effective |
| Recreational fishing economies | Virtually the same |
| Fish hatcheries and environmental justice | Expected to be more effective |
| Property losses | Could be more effective |
| Existence and aesthetic values | Compromises existence value more; effect on aesthetics will vary |

**4.3.4 PROPOSED ACTION Alternative D: Public Resource Depredation Order**

*Direct, Indirect and Cumulative Effects.* In summary, the chief direct effects (i.e., those caused by the action(s) and occurring at the same time and place) associated with this alternative would be increased displacement and take of nesting, roosting, or feeding DCCOs or their nests or eggs and some incidental displacement of bird species that nest, roost, or feed with DCCOs.

Indirect effects (i.e., those caused by the action(s) but occurring later in time or farther in distance) would include, in some but not all situations: reduced predation on some fish populations, reduced destruction of vegetation, less competition with other birds, fewer property losses, and less depredation at aquaculture and hatchery facilities. We do not foresee any significant negative indirect effects associated with this alternative as long as mitigation measures are implemented.

Cumulative effects (i.e., those that result from the incremental impact of the action(s) when added to other past, present, and reasonably foreseeable future actions) are very difficult to predict at this scale. If combined with other beneficial management actions it is possible that, under the proposed action, impacts to all the categories of resources discussed in Chapter 3 would be reduced to a level of insignificance. However, impacts are unlikely to be eliminated because some of the factors that influence these resources are difficult to control (e.g., angler participation rates, growth in the aquaculture industry, island development).

In 2002, the Province of Ontario began ongoing egg oiling efforts at Lake Huron and Lake Ontario DCCO colonies. Such actions should increase the effectiveness of localized control efforts on the U.S. side of the Great Lakes. It is also possible that without significant overall population reduction impacts associated with DCCOs will not be effectively alleviated. However, we expect that enhanced management activities under the proposed action will be effective.

*Unavoidable Adverse Impacts.* This section refers to those adverse effects that cannot be avoided as a result of management activities carried out under the proposed action. Implementation of the proposed action is intended to move toward an overall improved condition, but adverse environmental effects will occur. DCCOs will be killed (and/or their nests and eggs will be destroyed) under this alternative, with the possibility that some local populations would be reduced or eliminated; however, we do not anticipate that impacts would be significant enough to endanger DCCO populations. Disturbance to other bird species that nest, roost, or feed in the vicinity of DCCOs is very likely, although significant adverse effects are not anticipated if mitigation measures are implemented. Aquaculture producers will continue to experience economic losses due to DCCO depredation, although to a lesser degree than under the No Action alternative.

*Short-term Effects and Long-term Productivity.* The control activities carried out under this alternative will, in some cases, lead to short-term disturbance of breeding colonies. However, it is anticipated that these actions will lead to increases in long-term productivity due to the increased avian biodiversity resulting from reduced DCCO

presence. Additionally, it is anticipated that DCCO control activities will lead to increased productivity of specific fisheries and will lessen the overall economic impact of DCCO depredation at aquaculture and hatchery facilities.

*Irreversible or Irretrievable Commitments of Resources.* Expenditure of funds to implement activities in the proposed action would be an irreversible commitment of monetary resources. An irreversible commitment of resources is one that results from an action that prevents an area or a resource type from returning to its natural condition for an extended period of time, or one that utilizes non-renewable resources. The only irreversible commitment of resources anticipated under the proposed action would be the use of fossil fuels for energy as DCCO management activities are carried out.

Irretrievable commitments of resources occur when we forego the opportunity to use or produce a specific resource for a period of time while favoring the production of another resource. The commitments are irretrievable rather than irreversible because the reversal of management decisions would allow uses of these resources to occur again. Management actions under the proposed action could result in irretrievable commitments if they caused any inadvertent damage and subsequent loss of threatened, endangered, or otherwise sensitive wildlife and plant species.

*Conflicts between the Proposed Action and Other Federal, Regional, State, Tribal, or Local Objectives.* Conflicts with the management objectives of other agencies do exist. There are some Federal, State, and Tribal entities that would prefer to manage DCCOs more aggressively. We did our best to be responsive to the concerns of these entities and to enhance their management flexibility as much as we felt reasonable within the context of our responsibility to ensure the conservation of DCCO populations. There are also States and Tribes that would prefer not to manage DCCOs more aggressively.

Table 19. Management Activity Impacts under Proposed Action

| **Impacts of Management Actions** | **PROPOSED ACTION Alternative D: Public Resource Depredation Order** |
|---|---|
| DCCO populations | No significant impact to regional or continental populations; estimated annual take of 159,635 |
| Other bird populations | Local disturbances likely, but can be managed to avoid significant impacts; will help overall |
| Fish | Will help reduce predation in localized situations |
| Vegetation/habitat | Will help reduce impacts in localized situations |
| Threatened and endangered species | No adverse impacts with implementation of conservation measures |
| Water quality and human health | Will help reduce impacts in localized situations |
| Aquaculture | Will help reduce depredation |
| Recreational fishing economies | Not likely to benefit |
| Fish hatcheries and environmental justice | Will help reduce depredation |
| Property losses | Could help to indirectly reduce losses |
| Existence and aesthetic values | Effects on values differs with perspective |

Table 20. Comparison to No Action Alternative

| Relation to No Action | PROPOSED ACTION Alternative D: Public Resource Depredation Order |
|---|---|
| DCCO populations | More birds would be killed |
| Other bird populations | Expected to be more effective |
| Fish | Expected to be more effective |
| Vegetation/habitat | Expected to be more effective |
| Threatened and endangered species | About the same |
| Water quality and human health | About the same |
| Aquaculture | Expected to be more effective |
| Recreational fishing economies | Virtually the same |
| Fish hatcheries and environmental justice | Expected to be more effective |
| Property losses | Could be more effective |
| Existence and aesthetic values | Compromises existence value more; effect on aesthetics will vary |

### 4.3.5 Alternative E: Regional Population Reduction

*Direct, Indirect and Cumulative Effects.* The chief direct effects (i.e., those caused by the action(s) and occurring at the same time and place) associated with this alternative would be considerably increased displacement and take of nesting, roosting, or feeding DCCOs or their nests or eggs and increased disturbance of bird species that nest, roost, or feed with DCCOs.

Several indirect effects (i.e., those caused by the action(s) but occurring later in time or farther in distance) are likely under this alternative. The most significant potential negative effect associated with this alternative is that DCCO populations might be threatened by successive years of population control. However, this is unlikely because the alternative would be conducted in such a way that this risk would be greatly minimized (e.g., through the use of population goals and monitoring). Long term negative impacts to other birds that would be disturbed or killed by DCCO population reduction efforts are an important concern as well but, again, mitigation efforts can be taken to reduce the likelihood of such effects.

Cumulative effects (i.e., those that result from the incremental impact of the action(s) when added to other past, present, and reasonably foreseeable future actions) are very difficult to predict at this scale but the whole idea behind reducing regional DCCO populations is to reduce negative impacts to other resources. If combined with other beneficial management actions it is possible that impacts to all the categories of resources discussed in Chapter 3 could be reduced to a level of insignificance.

**Discussion of Alternative**

The preferred alternative is preferable to regional population reduction because we are still uncertain of the necessity for largescale population management. We believe that an interagency and interdisciplinary discussion of the idea of reducing DCCO populations needs to take place before we draw a conclusion on its necessity and its effectiveness at actually reducing resource conflicts. Additionally, we feel strongly that population management will require a much greater commitment of resources for research, monitoring, and coordination than currently exists.

Table 21. Management Activity Impacts under Alternative E

| Impacts of Management Actions | Alternative E: Regional Population Reduction |
|---|---|
| DCCO populations | Goal would be to significantly reduce regional and/or continental populations to a pre-determined level |
| Other bird populations | Local disturbances very likely, but could be managed to avoid significant impacts |
| Fish | Would help reduce predation |
| Vegetation/habitat | Would help reduce impacts |
| Threatened and endangered species | No adverse impacts with implementation of conservation measures |
| Water quality and human health | Could help reduce impacts in localized situations |
| Aquaculture | Would help reduce depredation |
| Recreational fishing economies | Might help |
| Fish hatcheries and environmental justice | Would help reduce depredation |
| Property losses | Would likely help reduce such losses |
| Existence and aesthetic values | Effects on values differs with perspective |

Table 22. Comparison to No Action Alternative

| Relation to No Action | Alternative E: Regional Population Reduction |
|---|---|
| DCCO populations | More birds would be killed |
| Other bird populations | Expected to be more effective |
| Fish | Expected to be more effective |
| Vegetation/habitat | Expected to be more effective |
| Threatened and endangered species | About the same |
| Water quality and human health | About the same |
| Aquaculture | Expected to be more effective |
| Recreational fishing economies | Might be more effective |
| Fish hatcheries and environmental justice | Expected to be more effective |
| Property losses | Expected to be more effective |
| Existence and aesthetic values | Compromises existence value more; effect on aesthetics will vary |

### 4.3.6 Alternative F: Regulated Hunting Season

*Direct, Indirect and Cumulative Effects.* In summary, the chief direct effects (i.e., those caused by the action(s) and occurring at the same time and place) associated with this alternative would be increased displacement and take of nesting, roosting, or feeding DCCOs or their nests or eggs and increased disturbance and incidental take of bird species that nest, roost, or feed with DCCOs.

Indirect effects (i.e., those caused by the action(s) but occurring later in time or farther in distance) would include, in some but not all situations, positive impacts to fisheries, vegetation, threatened and endangered species, property losses, water quality and human health, aquaculture, and hatcheries. Because hunting would make DCCOs more wary of humans, we anticipate that it will significantly reinforce non-lethal management efforts and increase the effectiveness of these techniques. As long as DCCO populations are adequately monitored and hunting regulations adjusted accordingly, we anticipate that risks to their populations would be minimal. Incidental take of look-alike species would occur under this alternative but would probably not be significant.

Cumulative effects (i.e., those that result from the incremental impact of the action(s) when added to other past, present, and reasonably foreseeable future actions) are very difficult to predict at this scale but we predict that hunting, if combined with other beneficial management actions could reduce impacts to all the categories of resources discussed in Chapter 3 to a level of insignificance.

*Discussion of Alternative.* The proposed action is preferable to hunting largely for ethical reasons. From purely biological and economic perspectives, hunting might prove an effective way to kill numerous DCCOs at minimal expense to the government. However, we have serious reservations about authorizing a non-traditional species to be hunted when it cannot be eaten or widely utilized and feel that there are more responsible and socially acceptable ways of dealing with migratory bird conflicts.

Table 23. Management Activity Impacts under Alternative F

| **Impacts of Management Actions** | **Alternative F: Regulated Hunting** |
|---|---|
| DCCO populations | No significant impact to regional or continental populations; estimated annual take of 200,000 |
| Other bird populations | Local disturbance possible |
| Fish | Might help reduce predation in localized situations |
| Vegetation/habitat | Might help reduce impacts in localized situations |
| Threatened and endangered species | No adverse impacts with implementation of conservation measures |
| Water quality and human health | Could help reduce impacts in localized situations |
| Aquaculture | Likely to help reduce depredation |
| Recreational fishing economies | Not likely to benefit |
| Fish hatcheries and environmental justice | Likely to help reduce depredation |
| Property losses | Likely to help reduce such losses |
| Existence and aesthetic values | Effects on values differs with perspective |

Table 24. Comparison to No Action Alternative

| **Relation to No Action** | **Alternative F: Regulated Hunting** |
|---|---|
| DCCO populations | More birds would be killed |
| Other bird populations | Might be more effective |
| Fish | Might be more effective |
| Vegetation/habitat | Might be more effective |
| Threatened and endangered species | About the same |
| Water quality and human health | About the same |
| Aquaculture | Expected to be more effective |
| Recreational fishing economies | Virtually the same |
| Fish hatcheries and environmental justice | Might be more effective |
| Property losses | Expected to be more effective |
| Existence and aesthetic values | Compromises existence value more; effect on aesthetics will vary |

### 4.3.7 Mitigating Measures

One of the purposes of NEPA review is to prescribe mitigation measures to alleviate negative environmental effects associated with the proposed action. Above and beyond the goal of reducing impacts associated with DCCOs, the Service is responsible for conserving migratory bird populations. Therefore, we recognize the importance of

taking measures to ensure the long-term sustainability of populations of DCCOs and other migratory birds. The risk of significant negative impacts to migratory bird populations will be reduced by exercising the following: 1) prevention, 2) monitoring, and 3) evaluation. These are discussed below.

**1) Prevention**

Under NEPA, there are five ways of dealing with significant environmental effects: avoiding the impact by not taking certain action or parts of an action; minimizing impacts by limiting the degree or magnitude of the action and its implementation; rectifying the impact by repairing, rehabilitating, or restoring the affected environment; reducing or eliminating the impact over time by preservation and maintenance during the life of the action; and compensating for the impact by replacing or providing substitute resources or environments.

The two categories of mitigation most applicable to the current situation are avoidance and minimization. These can be incorporated as conditions that responsible agencies must abide by in undertaking activities under the depredation order (e.g., requirement to use lead shot only, thus mitigating the impacts of lead poisoning on non-target birds and other wildlife). The adoption of monitoring programs (including annual reports) and adaptive monitoring techniques could also be considered mitigation techniques, as well as the provision allowing us to suspend the privilege of agencies to take action under the public resource depredation order.

Carney and Sydeman (1999) noted that techniques such as limiting the number and duration of intrusions (to nesting sites), minimizing physical contact with birds, and moving slowly while in colonies can serve to minimize negative impacts on most colonial waterbird species. They reported that negative impacts to Ring-Billed Gulls were "nearly eliminated" when measures such as visiting colonies early in the day to avoid thermal stress, avoiding unnecessary chick handling, and moving slowly through colonies were carried out.

On islands with mixed seabird colonies in the St. Lawrence River Estuary, Bédard et al. (1999) minimized disturbance to sensitive species such as Razor-billed Auks, Common Eiders, and Black-crowned Night-Herons by coordinating control and census efforts into a single visit. However, they noted that "it is impossible to census colonies in forested sites without killing and disturbing breeding birds at the same time" (Bédard et al. 1995). During DCCO management activities on Little Galloo Island, Lake Ontario, New York, efforts are made to limit the time spent in close proximity to the Caspian Tern (a sensitive species) colony there (NYSDEC 2000). On the other hand, despite extensive DCCO harassment efforts on Gull and Bass Islands in eastern Lake Ontario, numbers of Black-crowned Night-Heron nests have continued to increase (from 60 in 2002 to 83 in 2003; J. Farquhar, NYSDEC, unpubl. data).

Resource managers and wildlife damage professionals must clearly weigh the risks and benefits associated with cormorant control activities occurring near other birds and exercise caution (or choose not to conduct control) to minimize disturbance of non-target

species. Specific recommendations for minimizing impacts when working in mixed-species waterbird colonies include: visiting during early morning and late afternoon hours to avoid thermal stress to eggs/nestlings; monitoring avian predators and avoiding sites with large numbers of predators; focusing efforts on cormorant-dominated colonies; avoiding late nesting season visits to reduce nestling nest abandonment; and training personnel to monitor control activities at waterbird colonies.

Bédard et al. (1995 and 1999) thoroughly described the process by which they conducted DCCO population control in the St. Lawrence River estuary. The population control program was initiated by the Province of Québec, "mostly in response to growing concern about damage to unique island plant and animal communities and incidental destruction of nesting habitat for aquatic species" (1999). After censusing the study area to estimate the population, they determined a more appropriate level, and then used deterministic modeling to understand how best to achieve the desired population reduction. These papers are an excellent resource for any agency considering a population reduction effort and contain considerable information on the model parameters that were used.

Blackwell et al. (2002) also offers managers and biologists an excellent overview of the development of a population growth model for Lake Ontario DCCOs and will be helpful in the evaluation of potential management options. The authors referenced literature values for fertility, age at first breeding, and survival and used those parameters to develop a deterministic stage-classified matrix model. Additionally, the publication "Cormorants and Human Interests" (van Dam and Asbirk, eds. 1997; this document comprises the proceedings of the "Workshop towards an International Conservation and Management Plan for the Great Cormorant," which took place in October 1996 in Lelystad, the Netherlands) has a useful and insightful chapter on population management with sections titled "reducing impacts by reducing overall population size," "factors determining the size of the cormorant population," "the population model," "reducing the size of the cormorant population," and "conclusions" (Bregnballe et al. 1997). Each of the above referenced papers should be considered required reading for any agency contemplating a population control effort and may be obtained by contacting the Division of Migratory Bird Management.

**2) Monitoring**

Population monitoring provides critical information about population change and tells managers the present population status of species (Sauer 2001). Through the North American Waterbird Conservation Plan, "a manual of recommended standardized breeding season population monitoring methodologies has been produced for use by resource agencies and NGOs" has been developed and continues to be updated with new information. This document, titled "Breeding Season Population Census Techniques for Seabirds and Colonial Waterbirds throughout North America" is available online at: http:// http://www.mp2-pwrc.usgs.gov/cwb/manual/. Useful sources of DCCO population information are described below.

A. **Audubon Christmas Bird Count** - The entire CBC database (1900-2000) is available online in a searchable format at www.birdsource.org, but detailed analyses of the CBC data are generally not provided. Additionally, the Patuxent Wildlife Research Center (http://www.mbr.nbs.gov/bbs/cbc.html) has provided an initial analysis of CBC data for the period 1959-1988. As a result, the following information is available for DCCOs:

Table of population trends - http://www.mbr.nbs.gov/bbs/cbct/t1200.html
Graph of annual population indices - http://www.mbr.nbs.gov/bbs/cbcgr/h1200gr.html
Comparison of BBS and CBC indices -
http://www.mbr.nbs.gov/bbs/cbccomp/h1200cp.html
Map of winter spatial abundance/distribution -
http://www.mbr.nbs.gov/bbs/cbcra/h1200ra.html

See Appendix 10 for examples of comparison tables that can be produced using CBC data.

B. **Band Recovery Analysis** - DCCOs were first banded in 1929. In the period 1955-2000 alone, 179,408 cormorants were banded and 8,974 (5.0%) of them were subsequently recovered. This sample of 8,974 banded and recovered cormorants provides an opportunity to monitor trends in survivorship over time. Survivorship is one of the demographic parameters that could be most useful in tracking the impacts of management actions on cormorant populations. Banding data can also be useful for determining links between breeding and wintering grounds. A band recovery file for the DCCO can be obtained on request from the U.S. Geological Survey's Bird Banding Laboratory (http://www.pwrc.usgs.gov/bbl/default.htm).

C. **Breeding Colony Surveys** - The standardized and coordinated inventory and monitoring of colonial waterbird colonies in the United States is still in its infancy (see, for example, http://www.mp1-pwrc.usgs.gov/birds/othbird.html#cwb). Efforts began in a modest way in the early 1970s with development of the Cornell Laboratory of Ornithology's (now defunct) Colonial Waterbird Registry. In the mid-1970s, proposed oil and gas exploration and drilling in U.S. coastal waters prompted initiation of the Outer Continental Shelf Environmental Assessment Program. OCSEAP efforts resulted in extensive inventory of coastal colonial waterbird colonies, with the results published as a series of atlases. Since then, monitoring of waterbird colonies has been conducted with varying degrees of frequency and intensity by Federal and State agencies, nonprofit conservation and environmental organizations, universities, and private individuals. Some of this monitoring data has been published, but most has not, hence the need for an interactive online colony monitoring database. A prototype monitoring database for the West Coast has been developed by the U.S. Geological Survey's Alaska Biological Science Center in conjunction with the Pacific Seabird Group. Similarly, a national monitoring database is under development by the U.S. Geological Survey's Patuxent Wildlife Research Center.

D. ***North American Birds* Regional Reports** - The seasonal regional reports published in *North American Birds* and its predecessors (*Field Notes, National Audubon Society Field Notes, American Birds, Audubon Field-Notes,* and *Bird-Lore*) provide a treasure trove of qualitative and semi-quantitative information on the status, trends, and movements of North American birds. As an example, the Fish and Wildlife Service has compiled (unpublished data) statements made about DCCOs that appeared in 1,674 seasonal reports spanning a 52-year period (fall 1946 to winter 1997-1998). Reading these statements in chronological order provides a vivid picture of the changing status of this species throughout its range.

E. **North American Breeding Bird Survey** - The BBS database is available online in an interactive searchable format at http://www.mbr-pwrc.usgs.gov/bbs/bbs.html, and revised analyses of population trends are provided annually. The BBS was not expressly designed to monitor flocking species such as cormorants, and provides poor coverage of the open water and near shore coastal habitats preferred by this species. Nevertheless, the BBS does provide some useful trend data for the DCCO, and BBS trends closely mirror those derived from the Christmas Bird Count and other sources.

F. **Sea Watches or Coastal Counts** - A Sea Watch or Coastal Count can be viewed as the equivalent of a Hawk Migration Count. Observations are made from a stationary point of all waterbirds moving up or down the coast. Counts are normally made daily throughout the spring or fall migration period. The primary object is to document the seasonal timing and magnitude of migratory flights of coastal waterbirds. These counts are most often conducted by local bird observatories, with some spanning several decades (e.g., Avalon, New Jersey). The number and availability of sea watch/coastal count databases, and their usefulness for monitoring regional trends in cormorants, has not been assessed.

G. **Winter Roost Counts** - Aerial counts have been conducted annually in January or February by APHIS/WS in the Mississippi Delta region of northern Mississippi. These counts provide information on the number, location, and approximate size of cormorant night roosts in the vicinity of one of the major catfish producing areas in the nation. These counts will continue to be conducted annually.

H. **Reports of DCCOs Killed under Depredation Permits and the Depredation Orders** – Reporting and/or recordkeeping requirements are associated with depredation permits and both the aquaculture depredation order and the public resource depredation order. Responsible individuals or agencies are required to report annually the number of DCCOs taken. A periodic review and assessment of this information will allow the Service to track trends in the number of birds being killed.

In addition to monitoring populations, it will be helpful to monitor trends in resource damage levels associated with DCCOs. The Service typically becomes aware of the existence and extent of wildlife conflicts via formal and informal communications with the public, other affected agencies (e.g., APHIS/WS and States), elected representatives (e.g., members of Congress or State legislatures), and Service regional and field offices.

To the extent that our proposed action alleviates damages and conflicts, we anticipate that concerns expressed by these groups will decline significantly. In addition, more quantitative means of tracking trends in DCCO conflicts include:

A. **APHIS/Wildlife Services Management Information System** - This database tracks complaints from landowners about damages to private property and agricultural crops caused by wildlife, including cormorants. Tracking complaints about DCCOs may yield information on the geographic areas in which they are of greatest concern, and may help to determine if control actions are having the desired result of reducing conflicts with human interests.

B. **Trends in Depredation Permit Issuance** - Each Regional Migratory Bird Permit Office keeps records of depredation permits issued by year, species, and resource category. This information could be tracked to follow trends in permit issuance as new management programs are implemented.

C. **Research** - The most meaningful information on the effectiveness of damage control techniques will come from soundly designed and implemented scientific experiments. Unfortunately, carrying out long-term research is the most costly and time-consuming means of obtaining this information. In an ideal world, wildlife management activities would always be accompanied by a thorough and timely monitoring plan. Research needs pertinent to DCCOs have been summarized elsewhere as falling into the categories of: distribution information, demographic information, diet, impacts to fisheries and aquaculture, impacts to flora and fauna, management techniques, and economic impacts (Wires et al. 2001). For our purposes here, we are interested in developing a research program that will help us better understand how implementation of the proposed action impacts DCCOs and other resources. Some examples of research that the Service and its partners such as APHIS/WS, States, Tribes, and universities could carry out, if adequate financial resources were available, include: more frequent regional DCCO population surveys to better understand population changes and status; color banding and satellite transmitter studies to better understand local and regional DCCO movements and survival rates in response to management actions; more DCCO diet studies; fish population monitoring in areas of DCCO management; public attitude surveys before and after implementation of new management strategies.

**3) Evaluation**

Evaluation involves analysis of the information collected during monitoring and other reporting activities. Each year, under the public resource depredation order, agencies are required to provide the appropriate Service Regional Migratory Bird Permit Office with a report detailing activities conducted under the order, including a summary of the number of DCCOs killed and/or number of nests in which eggs were oiled; a statement of efforts being made to minimize incidental take of nontarget species and a report of the number and species of migratory birds involved in such take, if any; a description of the impacts or anticipated impacts to public resources by DCCOs and a statement of the management objectives for the area in question; a description of the evidence supporting the hypothesis that DCCOSs are causing or will cause these impacts; a discussion of other

limiting factors affecting the resource (e.g., biological, environmental, and socioeconomic); and a discussion of how control efforts are expected to, or actually did, alleviate resource impacts. In addition, for actions that are conducted with the intent of reducing or eliminating local breeding populations of DCCOs, agencies must evaluate effects of management activities on cormorants at the control site and evaluate, by means of collecting data or using best available information, effects of management activities on the public resources being protected and on non-target species.

Each year, staff from the Division of Migratory Bird Management will review these agency reports in combination with all other relevant sources of information and develop a summary report. The goal of the summary report will be to assess the overall impact of this program on the long-term conservation of DCCOs and other migratory birds.

# CHAPTER 5: LIST OF PREPARERS

**Lead Author:**
Shauna L. Hanisch, Wildlife Biologist, Arlington, VA
B.S. Wildlife Biology, University of Montana; Master of Public Administration (MPA) with emphasis in environmental and natural resource policy, Boise State University. Five years of professional experience with the U.S. Fish and Wildlife Service.

**Contributors (USFWS):**
Bill Archambault, Region 5, NEPA Coordinator
Fred Caslick, New York Field Office, Ecological Services
John Charbonneau, Washington Office, Economics
Tina Chouinard, Washington Office, Migratory Birds
Suzanne Fellows, Region 6, Migratory Birds
Kyle Flanery, Washington Office, Hatcheries
David Haukos, Region 2, Migratory Birds
Michael Hay, Washington Office, Economics
Chuck Hunter, Region 4, Migratory Birds
Stephanie Jones, Region 6, Migratory Birds
Rob Kelsey, Region 4, Migratory Birds
Denny Lassuy, Region 1, Fisheries
Susan Lawrence, Washington Office, Migratory Birds
Steve Lewis, Region 3, Migratory Birds
Roy Lowe, Region 1, Oregon Coast National Wildlife Refuge Complex
Brian Lubinski, Region 3, Fisheries
Jerry McClain, Region 3, Fisheries
Maura Naughton, Region 1, Migratory Birds
Diane Pence, Region 5, Migratory Birds
David Perkins, Region 5, Fisheries
Cyndi Perry, Washington Office, Migratory Birds
Don Peterson, Washington Office, Federal Program Activities
Jim Serfis, Washington Office, Endangered Species
Ken Stromborg, Green Bay Field Office
Mike Tansy, Seney National Wildlife Refuge
John Trapp, Washington Office, Migratory Birds
Robert Willis, Washington Office, Federal Program Activities
Tara Zimmerman, Region 1, Migratory Birds

**Contributors (State and Other Federal):**
Connie Adams, Cornell University
Jon Anderson, Vermont Department of Fish and Wildlife
Glenn Belyea, Michigan Department of Natural Resources
Mike Bur, U.S. Geological Survey
Jim Farquhar, New York State Department of Environmental Conservation
Larry Garland, Vermont Department of Fish and Wildlife
Katie Haws, Minnesota Department of Natural Resources

Shannon Hebert, APHIS/WS
Carrol Henderson, Minnesota Department of Natural Resources
Jory Jonas, Michigan Department of Natural Resources
Russ McCullough, New York State Department of Environmental Conservation
Noel Myers, APHIS/WS
Pete Poulos, APHIS/WS
David Reinhold, APHIS/WS
Scott Werner, APHIS/WS
D.V. Chip Weseloh, Canadian Wildlife Service
Linda Wires, University of Minnesota

# CHAPTER 6: CONSULTATION AND COORDINATION WITH THE PUBLIC AND OTHER AGENCIES

## 6.1 Introduction

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. About 85 percent of these comments were opposed to the proposed action, the vast majority of which were driven by mass email/letter campaigns promoted by various non-governmental organizations.

## 6.2 Issues of Concern and Management Options Identified During Scoping

A scoping report can be found in Appendix 11. NEPA regulations state that only "significant" impacts be analyzed. Determination of significance was based on interagency discussions, knowledge gained from DCCO research, public involvement, and professional judgment. A majority of the public comments expressed concern over negative impacts associated with DCCOs, especially those relating to sport fisheries (38.7 percent). Some individuals suggested that other reasons for fisheries declines should be examined instead of "scapegoating" cormorants.

NEPA regulations state that only "reasonable" alternatives be evaluated. Determination of reasonableness was based on public involvement, interagency discussions, and professional judgment. Management options and suggestions included: controlling DCCO populations, removing DCCOs from MBTA protection, hunting DCCOs, focusing on non-lethal control, letting States manage DCCOs, changing the depredation permit policy, oiling eggs, giving APHIS/WS more authority, basing decisions on the best science, using population objectives, and increasing education efforts.

In addition to citizen input, twenty seven State agencies provided comments during the public scoping period. Fourteen States (Connecticut, Georgia, Indiana, Iowa, Nebraska, New Hampshire, New York, North Dakota, Ohio, Oklahoma, Rhode Island, Texas, Vermont, Wyoming) expressed a desire for increased flexibility/increased State input in managing cormorants. Twenty-three States (Arizona, Connecticut, Georgia, Illinois, Indiana, Iowa, Louisiana, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New Hampshire, North Dakota, New York, Ohio, Oklahoma, Oregon, Rhode Island, Texas,

Vermont, Wisconsin, Wyoming) stated or implied that, under certain conditions (e.g., evidence pointing toward a problem, displacement of other colonial nesting birds, impacts on natural systems, etc.), increased control should be considered. Five States (Arizona, Minnesota, New Hampshire, North Dakota, South Dakota) stated that they currently have no real problems with DCCOs. Additionally, we received comments from four Canadian agencies whose concerns included potential impacts of management actions on Great Cormorant populations (Nova Scotia) and on declining western DCCO populations (British Columbia).

## 6.3 Public Comments Expressed During the DEIS Comment Period

The DEIS public comment period lasted from November 16, 2001 to February 28, 2002. The Service received 994 letters and held 10 public meetings which together reflected 1,592 different comments. In terms of support for specific management alternatives, 15.4 percent of the overall comments supported Alternative D (the preferred alternative), 12.4 percent supported Alternative E (regional population reduction), 8.1 percent supported Alternative A (no action), 6.0 percent supported Alternative F (regulated hunting), 5.6 percent supported Alternative B (non-lethal control). Less than one percent of the 1,592 comments supported Alternative C (increased local damage control) or some form thereof and 7.3 percent supported some combination of alternatives D, E, and F. The most common specific comments about the proposed action were criticisms that DCCOs were being wrongly blamed (i.e., scapegoated) for fish declines (6.5 percent), that the Service was catering to special interests such as aquaculture and sport fishing (7.3 percent), and that the preferred alternative did not appear to be based on sound science (6.0 percent). Figure 1 shows levels of support for the various alternatives in the DEIS. Table 25 summarizes the comments of State, Tribal, and Federal agencies. FWS responses to all significant comments on the DEIS appear in Chapter 7.

Figure 1. Summary of Support for Alternatives A, B, C, D, E, and F

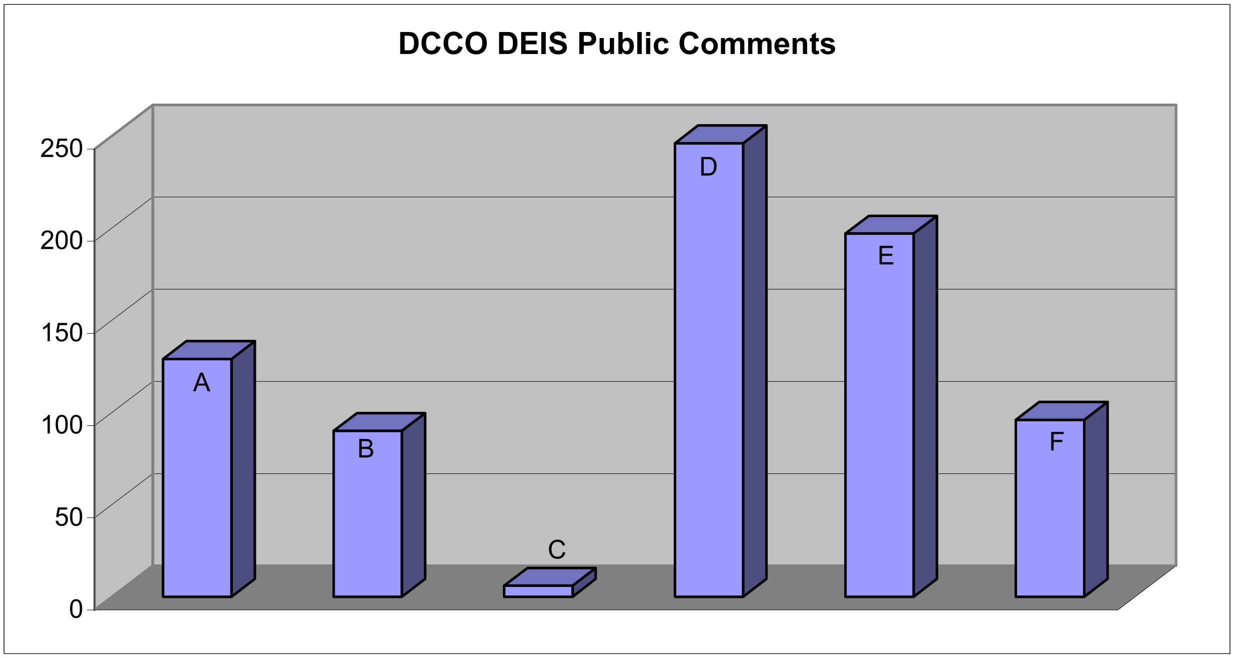


Table 25. Summary of Agency Comments on DEIS

| | |
|---|---|
| Arizona | Supports Alternative D (proposed action) |
| Arkansas | Elements of Alt. D, E, and F should be combined into an effective regional strategy to reduce DCCO populations |
| Florida | Final document needs more details on when the action can be conducted and on monitoring requirements; concerned about potential disturbance of other bird species |
| Georgia | Supports Alternative D (proposed action) |
| Idaho | In Idaho, the No Action alternative would be most applicable |
| Illinois | Agrees with the public resource depredation order if it includes fish in state-owned facilities |
| Louisiana | No problem with Alternative D (proposed action); ability to designate agents is important |
| Maine | Alternative C best suits conditions in Maine; does not endorse hunting of cormorants |
| Massachusetts | Does not object to the proposed action for states which support the Interior population of DCCOs so long as state oversight authority is preserved |
| Michigan | Final rule must include a full array of management options from local to regional population control in the event local measures are not sufficient; FWS should be the lead agency and should provide funding and support |
| Minnesota | Recommends the adoption of Alternative A (No Action) |
| Missouri | Supports the proposed new public resource depredation order |
| Nebraska | Supports both the proposed action and Alternative C; more states should be included under the aquaculture depredation order |
| Nevada | Supports Alternative D (proposed action) |
| New York | Proposed action is the best alternative offered to meet our needs; FWS should take an active role in developing regional population goals |
| Ohio | Proposed action is the most reasonable and responsible approach; ability to designate agents is important |
| Oklahoma | DCCOs should be removed from MBTA protection; supports a combination of Alternatives D, E, and F |
| Ontario | Supports Alternative D (proposed action) |
| Rhode Island | Supports Alternative D (proposed action) |
| Texas | Strongly recommends adding an option that would allow agencies to issue permits to owners of private fishing waters |
| Vermont | Supports Alternative D (proposed action) |
| Washington | Supports Alternative D (proposed action) |
| Wisconsin | Favors Alternative E; believes FWS should manage DCCOs on a flyway basis and provide funding for research and management |
| Wyoming | Supports Alternative D (proposed action) or E |
| Coeur d'Alene Tribe | Proposed action has potential for high take of DCCOs and limits should be established |
| Grand Traverse Band of Ottawa and Chippewa Indians | Recommends population reduction and that an interagency task group on DCCOs be established |
| Sac and Fox Tribe | Alternative D is the preferred option |
| APHIS/Wildlife Services | Supports a population reduction strategy based on scientifically determined population levels and social carrying capacity |

**6.4 List of Agencies, Organizations, and Individuals to Whom the EIS is Being Sent**

We assembled a mailing list for the DEIS. The list includes Federal, Tribal, State, and Provincial agencies; organizations; and individuals and was based on the following: 1) the mailing list that the Division of Migratory Bird Management uses for its Federal

Register notices; 2) individuals, organizations, and agencies that submitted comments during our 1998 aquaculture depredation order Environmental Assessment process; 3) individuals, organizations, and agencies that submitted comments in response to our Notice of Intent published on November 8, 1999 and in response to the DEIS public comment period; and 4) anyone else who has been asked to be placed on our mailing list. We also posted the DEIS on our website (http://migratorybirds.fws.gov). The FEIS, the Notice of Availability for the FEIS, or another type of notification will be sent to all addresses on this mailing list.

## CHAPTER 7: PUBLIC COMMENT ON DEIS AND RESPONSE

**1) Why didn't the USFWS select Alternative A (No Action) as the preferred alternative/proposed action?**
In recent years, it has become clear from public and professional feedback that the status quo is not adequately resolving DCCO conflicts for many stakeholders. Furthermore, our environmental analysis indicated that conflicts were more likely to be resolved under other options than under Alternative A.

**2) Why didn't the USFWS select Alternative B (non-lethal management) as the preferred alternative/proposed action?**
In the wildlife management field, the control of birds through the use of humane, but lethal, techniques can be an effective means of alleviating resource damages, preventing further damages, and/or enhancing non-lethal techniques. It would be unrealistic and overly restrictive to limit a resource manager's damage management methods to non-lethal techniques, even if "non-lethal" included nest destruction and/or egg oiling. Lethal control techniques are an important, and in many cases necessary, part of a resource manager's "tool box."

**3) Why didn't the USFWS select Alternative C (increased local damage control) as the preferred alternative/proposed action?**
Alternative C would still require the issuance of Federal permits before resource managers could conduct management actions to protect public resources. The available evidence suggests that agencies need greater flexibility and timeliness in their ability to manage DCCOs than the permit system allows. Thus, we considered Alternative C to be limited in its potential effectiveness.

**4) Why did the USFWS select Alternative D (public resource depredation order) as the preferred alternative/proposed action?**
Our purpose for the proposed action, as laid out in the DEIS, is 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. Based on internal and interagency discussions, public comments, and biological information relevant to DCCOs and their management, we developed the proposed action, Alternative D, as a strategy that would best balance all three aspects of our purpose.

Specific to the public resource depredation order itself, we believe that since DCCO conflicts tend to be of a localized nature and because timeliness is an important factor in conducting effective control, it is logical to give more authority, within limits, to the agencies that actually deal with the on-the-ground realities of DCCO management.

**5) Why didn't the USFWS select Alternative E (regional population reduction) as the preferred alternative/proposed action? Why doesn't the USFWS manage DCCO overabundance through population reduction? Is the Service planning to**

**manage DCCOs on a "flyway" basis with the development of regional population goals?**

Based on public comments received after publication of the DEIS, it is clear that many agencies and individuals were supportive of Alternative E because of its coordinated, regional approach. FWS understands the logic and appeal of this approach. We manage migratory game birds (e.g., waterfowl) in this way, so it only makes sense to do the same for other species. The difference is that we have considerably more biological information about and resources to conduct monitoring of migratory game birds. Intensive management, such as would be required with a cormorant population objectives strategy, is expensive. Additionally, while many stakeholders portray cormorant conflicts as being a simple overabundance problem whose solution is population reduction, the reality is not so clear. That is, it is unclear whether fewer cormorants would actually mean fewer problems (since sometimes distribution is as important as number in determining impacts), what the necessary scale of control would be, and whether or not that scale of control is biologically and socially feasible. Finally, we would point out that the proposed action (Alternative D) in no way precludes regional coordination, despite being more of a localized damage control approach than a population objectives approach.

**6) Why didn't the USFWS select Alternative F (hunting) as the preferred alternative/proposed action?**

While we recognize the validity of hunting as a wildlife management tool, we feel that the risks associated with it outweigh any potential benefits. We are gravely concerned about the negative public perception that would arise from authorizing hunting of a bird with little consumptive (or "table") value. While it is true that this has been done in the past for other species (e.g., crows), public attitudes are different today than they were thirty years ago when those decisions were made. Additionally, a number of hunters commented that they did not support hunting as a means of cormorant control. Therefore, it is our position that hunting is not, on the whole, a suitable technique for reducing cormorant damages.

**7) What about choosing a combination, or "hybrid," of Alternatives D, E, and F as the proposed action?**

Our planning and decision making efforts led us to conclude that Alternative D alone, and not in combination with any other alternative, is the best option at this time. The reasons stated above for not choosing Alternatives E and F are equally applicable when considering a hybrid alternative.

**8) In the DEIS, did the USFWS consider a range of reasonable alternatives?**

Yes. We selected the six alternatives in the DEIS based on the public scoping period and NEPA requirements. The alternatives adequately reflected the range of public comments and represented what FWS considered to be "all reasonable alternatives."

**9) Will the Service consider an option that allows egg and nest control but not the killing of adult or juvenile DCCOs?**

No. We see no significant qualitative difference between an entirely "non-lethal" alternative, as was analyzed in the EIS, and an alternative that authorizes destruction of eggs but not of adult or juvenile DCCOs.

**10) Why didn't the USFWS more fully consider the option of removing cormorants from the list of birds protected under the Migratory Bird Treaty Act?**

In our view, this is not a "reasonable alternative." DCCOs have been protected under the MBTA since a 1972 amendment to the Mexican convention. Removing DCCOs from MBTA protection would not only be contrary to the intent and purpose of the original treaties, but would require amendment of the original treaties – a lengthy process requiring approval of the U.S. Senate and President and subsequent amendments to each treaty by each signatory nation. Since DCCOs are protected by family *(Phalacrocoracidae)* rather than by species, the end result could be the loss of protection for all North American cormorant species in addition to that of DCCOs. At this time, there appears to be adequate leeway for managing cormorant conflicts within the context of their MBTA protection and, thus, we believe this approach is neither practical nor in the best interest of the migratory bird resource.

**11) Why doesn't the USFWS implement a cormorant bounty?**

We do not consider bounty hunting to be biologically, economically, or ethically appropriate for controlling cormorant damages. Thus, it is not a "reasonable alternative."

**12) Why doesn't the USFWS expand the aquaculture depredation order to more than 13 States?**

At this time, we do not feel there is sufficient evidence that expansion beyond the original 13 States is necessary to further protect commercial aquaculture stock. The issuance of depredation permits for damage at private fish farms is a high priority and therefore it is usually a quick process for aquaculture producers to obtain a depredation permit through their Regional Migratory Bird Permit Office.

**13) Why doesn't the USFWS give producers at saltwater aquaculture facilities the authority to control DCCOs under the aquaculture depredation order?**

We have not seen sufficient evidence that an expansion to saltwater facilities is necessary to protect commercial aquaculture stock. In some cases, problems at coastal sites could be caused by cormorants other than DCCOs and we do not want to greatly increase the likelihood of look-alike species being taken. Where significant economic damage has occurred, saltwater aquaculture producers can apply for a Federal depredation permit through their Regional Migratory Bird Permit Office.

**14) Why doesn't the USFWS just allow cormorant populations to regulate themselves?**

There is a difference between killing limited numbers of birds for localized damage management and population regulation. Our proposed action falls into the former category, not the latter. Thus, for the most part, we *are* allowing DCCO populations to regulate themselves.

**15) Isn't it possible to control cormorant numbers by impacting their fertility rates?**
There are no technologies currently available that have been shown to limit cormorant fertility rates in an economically or logistically effective manner. We can, however, limit their productivity rates through egg oiling and destruction and these activities are allowed under the proposed action.

**16) Doesn't the public resource depredation order violate the Migratory Bird Treaty Act by abrogating the Federal role in managing migratory birds?**
No. First of all, the PRDO by no means puts an end to the Federal role in migratory bird management. The conservation of migratory bird populations is and will remain the Service's responsibility. Second, while the MBTA gives the Federal government (as opposed to individual States) the chief responsibility for ensuring the conservation of migratory birds, this role does not preclude State involvement in management efforts. Bean (1983) described the Federal/State relationship as such (emphases added):

"It is clear that the Constitution, in its treaty, property, and commerce clauses, contains ample support for the development of a comprehensive body of federal wildlife law and that, to the extent such law conflicts with state law, it takes precedence over the latter. *That narrow conclusion, however, does not automatically divest the states of any role in the regulation of wildlife or imply any preference for a particular allocation of responsibilities between the states and the federal government.* It does affirm, however, that such an allocation can be designed without serious fear of constitutional hindrance. In designing such a system, for reasons of policy, pragmatism, and political comity, *it is clear that the states will continue to play an important role either as a result of federal forbearance or through the creation of opportunities to share in the implementation of federal wildlife programs*."

Nowhere in the MBTA is the implementation of migratory bird management activities limited to the Federal government. In fact, the statute specifically gives the Secretary of Interior the authority to determine when take of migratory birds may be allowed and to adopt regulations for this purpose. Additionally, nothing in the proposed action can be construed as being in conflict with the Convention for the Protection of Migratory Birds and Game Mammals between the U.S. and Mexico (under which cormorants are protected).

**17) Isn't the concept of a general public resource depredation order foreign to the purpose of the MBTA (i.e., to protect migratory birds)?**
No. While the core intent of the MBTA is to protect migratory birds, allowances were made in the act itself, the various conventions, and subsequent regulations for dealing with resource conflicts associated with migratory birds (e.g., depredation problems). It was recognized from the earliest days that there could be instances in which migratory birds could conflict with human interests. It would be irresponsible to do nothing but "protect" DCCOs when they are having negative impacts on other resources that are valued by society.

**18) Is the level of analysis conducted in the DEIS sufficient according to the requirements of the National Environmental Policy Act? Did the USFWS properly evaluate the environmental impacts of the proposed action?**
Yes on both counts. The analysis included, as required by NEPA, a discussion of the environmental impacts associated with the various alternatives, unavoidable adverse environmental effects associated with the proposed action, the relationship between short-term uses and long-term productivity, and any irreversible or irretrievable commitments of resources associated with the proposed action. Where new information has come out since publication of the DEIS, this was used to augment the discussion in the FEIS.

**19) In violation of the National Environmental Policy Act, has the Service "arbitrarily limited the scope of the analysis contained in the DEIS, failed to justify the purpose and need for action…[and] illegally segmented the action into smaller component parts in order to avoid a full analysis of all impacts and issues relevant to DCCO management"?**
No, the Service did not arbitrarily limit the scope of the DEIS analysis, nor did it segment the action to avoid a full analysis of impacts. The subject of the DEIS is DCCO management, so it is only logical that we would focus our analysis on DCCOs. The DEIS did not argue that DCCOs alone are to blame for the resource conflicts that they are associated with. In keeping with CEQ's advice to keep EISs "concise…and no longer than absolutely necessary to comply with NEPA" (43 CFR 1502.2(c)) we focused the scope of the analysis on the most relevant factors. We disagree that the purpose and need for the action were not adequately justified. As stated in 43 CFR 1502.1, the purpose of an EIS is "to serve as an action-forcing device to insure that the policies and goals defined in the Act are infused into the ongoing programs and actions of the Federal Government." We are confident that we fulfilled this purpose in the DEIS and FEIS.

**20) Did the Service fail to disclose or evaluate the environmental impacts of the proposed action on threatened or endangered species?**
No. In the DEIS, the Service listed species that "may be affected" by DCCO management as a precursor to its completion of the Section 7 consultation. This consultation was completed for the FEIS.

**21) Isn't the public resource depredation order essentially an "unfunded mandate" for the States?**
No. The PRDO is not a requirement being forced upon the States (or any other agency) by the Federal government. The decision ultimately lies with individual States to choose whether or not to use the authority granted to them by the PRDO. It will be up to them to decide whether DCCO control is a high enough priority within their budget allocation processes.

**22) Were public comments fairly and completely considered?**
Yes. As documented in the public scoping report (Appendix X), all comments, written and verbal, received during the scoping period were fully considered in determining the

scope of issues and the range of alternatives addressed in the DEIS. All the comments received on the DEIS were also fully considered and responded to here in the FEIS.

**23) Is there sufficient evidence to justify the proposed action?**
What constitutes "sufficient" evidence to justify DCCO control is, to a certain extent, a question of values. Among stakeholders concerned with DCCO management we can safely say that there is considerable disagreement over whether or not the proposed action is justified (with some even arguing that the proposed action does not go far enough). FWS and APHIS Wildlife Services, as the lead and cooperating agencies in the EIS process, jointly agree that there is sufficient evidence to justify the proposed action.

**24) Shouldn't the USFWS consider the economic benefits of DCCOs more thoroughly in the FEIS?**
Assigning economic value to any wildlife species is difficult, and it is made all the more so when that species (such as the DCCO) is of little direct use to humans. However, this should not be read to imply that we have no regard for the indirect and intangible values of cormorants as a native part of the North American avifauna. As such, we stated clearly in the DEIS (p2) that DCCOs "have inherent value regardless of their direct use to humans." While an analysis of the economic benefits associated with DCCOs would be interesting, it would be fraught with extrapolation and assumption and would, in the long run, add little value to the comparison of alternatives.

**25) Under the public resource depredation order, is the USFWS evading its responsibility for managing DCCOs from a national perspective? Will the USFWS remain the lead agency in overseeing cormorant control efforts? Doesn't the PRDO fail to coordinate DCCO management at the interstate level?**
We fully understand the necessity of retaining national oversight of DCCO populations and therefore of any DCCO management program, especially one that authorizes States and other agencies to conduct control without a Federal permit. While the PRDO gives States, Tribes, and APHIS Wildlife Services more authority to decide when to conduct DCCO control, we will retain our oversight role in order to keep track of DCCO management activities from a national perspective. The PRDO is by no means intended to inhibit regional or national coordination of DCCO management activities.

**26) Will the public resource depredation order apply to populations of DCCO other than the rapidly increasing Interior and Southern populations?**
The PRDO will apply mainly to DCCOs from the increasing Interior and Southern populations or States affected by those populations. Thus, it will be applicable to 24 States.

**27) Will the USFWS provide funding to agencies that carry out cormorant management under the Public Resource Depredation Order?**
We currently have no plans to fund other agencies. However, in our Congressional budget request, we have asked for increased financial resources to implement the DCCO proposed action. This figure specifically includes money that could be used in

cooperative efforts with States and other agencies to conduct cormorant management, research, and monitoring.

**28) How will the USFWS ensure that cormorant populations remain healthy and sustainable?**

There are a number of methods that, collectively, the Service can use to keep track of the status of DCCO populations. Population monitoring is the best means for understanding changes in a species population over time. Along with other agencies and universities, the Service regularly monitors colonial waterbird populations, including DCCOs. In addition, the Service will be able to estimate population trends using a number of methods (Christmas Bird Count and Breeding Bird Survey data, for example) and, via reporting requirements, will keep track of how many DCCOs are killed under authority of the depredation orders. We will also continue to support and be involved in research efforts.

**29) What is the USFWS doing to allow for more flexibility in managing cormorants that impact private, non-aquacultural resources?**

The proposed action does not authorize actions to benefit private, non-aquacultural resources. However, individuals who experience damages to private resources (e.g., tree damage or loss of privately-owned fish stocks) should contact their Regional Migratory Bird Permit Office about obtaining a depredation permit.

**30) Will the USFWS provide more detail in the FEIS on monitoring and population survey requirements? Will the USFWS establish guidelines for agencies to use in population monitoring and in evaluating the impacts of management actions?**

No, because we do not feel that this level of detail is necessary. While we understand the importance of uniformity in data collection, we have to consider other factors as well. We want agencies to thoroughly evaluate the impacts of their management actions on DCCOs and, in some cases, other resources but we don’t want the requirements to do so to be cost prohibitive.

**31) Will the USFWS provide more detail in the FEIS on the circumstances under which agencies may or may not take actions under the public resource depredation order?**

No, the purpose of the PRDO is clearly stated in the rule. In order to avoid unduly restricting agencies’ flexibility to manage cormorant damages to public resources we do not feel that it is necessary to go into considerable detail beyond stating the purpose of the order. States, Tribes, and APHIS Wildlife Services have a level of knowledge and professionalism sufficient to determine whether actions they take are in accordance with the purpose of the order.

**32) How will the USFWS continue to support cormorant research efforts?**

Involvement in research will continue both through financial assistance (as funding allows) and through direct research activities (such as color banding work being done in Lake Michigan by the USFWS Green Bay Field Office).

**33) What does the USFWS plan to do to educate the public about cormorants and their role in the ecosystem?**

We have prepared fact sheets for public distribution. Information about DCCOs is available at its website http://migratorybirds.fws.gov/issues/cormorant/cormorant.html. Our intention is to distribute fact sheets on the depredation orders in the near future. Beyond DCCOs, we participate in numerous outreach activities around the nation to increase public awareness about the role of migratory birds and other Federal trust species.

**34) Under the public resource depredation order, does the definition of "public resources" include fish in hatcheries?**

Yes. The PRDO applies to Federal, State, and Tribal hatcheries.

**35) Will agencies acting under the public resource depredation order be authorized to designate agents?**

Yes, as long as "agents" abide by the purpose, terms, and conditions of the order.

**36) Will State oversight be preserved under the public resource depredation order?**
Yes, any agency or agent acting under the PRDO must follow all *applicable* State laws. For example, if a State permit is required to authorize a particular control activity, such permit must be obtained before that activity can be conducted.

**37) How is the USFWS going to deal with impacts to non-target migratory bird species associated with DCCO control activities? Couldn't cormorant management do more harm than good to other colonial waterbirds?**

While the proposed action does not authorize the take of any species of migratory bird other than DCCOs, we recognize that "incidental" take may occur and that DCCO control activities could greatly disturb other species, especially at breeding colonies. Under the terms and conditions of the PRDO, responsible agencies must provide a statement of efforts being made to minimize incidental take of non-target species and to evaluate the impacts of any control activities on these species. Regular monitoring of colonial waterbirds will help us keep track of population changes so that we can address declines as necessary.

**38) Will the USFWS more clearly describe allowable control activities in the FEIS/final rule?**
Management activities authorized under the proposed action include shooting, egg oiling or other means of destroying eggs, nest destruction, $CO_2$ asphyxiation, and cervical dislocation. This is clearly stated in the final rule.

**39) Will the USFWS allow depredation permits to be issued for two years instead of requiring renewal every year?**
At this time, depredation permits will continue to be issued on an annual basis.

**40) Is the Service planning to develop a DCCO working group or technical committee?**

The Service has discussed the idea of initiating a cormorant technical committee to promote international, interagency, and interdisciplinary involvement in future cormorant management.

**41) Will the USFWS clarify the procedures by which an agency's authority to act under the public resource depredation order would be revoked?**

Yes, the final rule reflects this clarification.

**42) How does the USFWS define cormorant population viability?**
We have not explicitly defined population viability for DCCOs. By all accounts, current DCCO populations are "viable" (essentially meaning that their long term existence is not threatened) and we fully anticipate them remaining so under the proposed action. In the future, if we decide to manage DCCOs by population objectives, an important task would be to determine more specific levels of population viability.

**43) Shouldn't APHIS Wildlife Services be included as an agency that can act under the public resource depredation order?**

Yes, as the lead federal agency dealing with wildlife damage conflicts it is appropriate for APHIS Wildlife Services to be included. This change is reflected in the final rule.

**44) Is the proposed action the most cost effective management alternative?**
Cost effectiveness is only one consideration among many on which the preferred alternative decision is based. This is a cost effective alternative, although probably not significantly more or less so than other alternatives.

**45) Won't shooting at winter roosts in aquaculture areas just move the birds around?**
The USDA report, "A Science-Based Initiative to Manage Double-Crested Cormorant Damage to Southern Aquaculture" notes that "Coordinated and simultaneous harassment of cormorants can disperse them from night roosts and reduce damage at nearby catfish farms" and cites 3 scientific studies that support this claim. It then concludes that shooting at roosts "might enable farmers to reduce the number of birds on their farms significantly..." Part of the logic behind this is that studies in the Mississippi Delta have shown that, while DCCOs move widely in general, they tend to exhibit high roost fidelity. This implies that shooting birds at roosts (where turnover is lower) is likely to be more effective at alleviating damages than shooting birds just at ponds (where turnover is higher).

**46) Will the proposed action allow for better coordination between USFWS and APHIS Wildlife Services?**

The proposed action does not specifically require better coordination but that is likely to occur since APHIS Wildlife Services, if they choose to, will take on a greater role in cormorant management.

**47) Does the proposed action require the use of non-toxic shot?**
Yes, in all cases where shooting by shotgun is authorized, the use of lead shot is prohibited.

**48) How can the USFWS be sure that increased control under the proposed action will result in alleviation of conflicts?**

No one can predict with 100% accuracy that the proposed action will alleviate all conflicts; indeed, we don't expect the proposed action to alleviate *all* conflicts. Our analysis indicates that the proposed action is highly likely to alleviate many of the impacts associated with DCCOs.

**49) How will the USFWS keep track of DCCOs killed under the public resource depredation order?**
Reporting requirements are directly tied to the PRDO and ADO (meaning any agency or individual acting under authority of the orders must report to us how many birds were killed). USFWS will prepare reports on a regular basis summarizing control activities under the PRDO.

**50) Does the USFWS have the resources to properly implement the proposed action?**
The proposed action is not particularly resource intensive as far as the Service itself is concerned. We anticipate that current staff in the migratory bird program will be able to handle the increased reporting associated with the proposed action.

**51) Why doesn't the USFWS amend the aquaculture depredation order to require reporting by aquaculture producers who take birds?**

We made this change in the proposed and final rules.

**52) Why doesn't the USFWS require that States submit annual fish population surveys for areas where they carry out control?**

We do not believe that annual fish surveys are necessary or that the outcome would justify the extra expense to the States.

**53) Shouldn't agencies have to prove that DCCOs are having real impacts before they can act under the PRDO?**

No. We don't believe that agencies should have to wait until impacts occur and are proven with absolute certainty before they are allowed to manage DCCOs. One of the benefits of the PRDO is that agencies in areas where the risks of significant DCCO impacts are greatest are given more flexibility in taking action, including preventive action. As our partners in the conservation of America's natural resources, we trust that these agencies will act responsibly and in compliance with the purpose of the order.

**54) Why did the DEIS analyze "impacts to water quality and human health" when there is no substantiated evidence of DCCOs having such impacts?**

There are reports of DCCOs nesting/roosting near open water supplies and violating water quality. However, it is true that there is currently no evidence that they are responsible for widespread contamination or are a significant threat to human health. But since impacts to water quality were a significant concern raised during scoping, we felt that it was appropriate to include the issue in the DEIS analysis.

**55) Was the estimate of take in the DEIS accurate?**
Yes, to the best of our knowledge. The estimate has been updated in the FEIS, based on new considerations. However, we must emphasize that these numbers are *estimates*. We tried to be liberal in our estimates to increase the likelihood of over-, rather than under-, estimating take but we won't know the actual number of birds taken until the depredation orders are implemented.

**56) Has the USFWS based its DCCO management decisions on scientific evidence? Does the proposed action have a sound scientific foundation?**
Yes, but not to the degree that all scientists find acceptable. In a perfect world, science would shed light on the causes of resource conflicts and then propose ideal solutions; in reality this often does not occur, largely for reasons entirely out of the control of government agencies. It has long been recognized in the field of natural resource conservation that wildlife management possess elements of both art and science. The Service's stance on science-based management recognizes this truth and acknowledges that resource science, resource management, and social, political, and economic realities all contribute to the Service carrying out its mission to "conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." It is our position that there is sufficient biological and socioeconomic justification to support the proposed action.

**57) Shouldn't the loss of fish caused by fish-eating birds to aquaculture producers just be considered a "cost of doing business" and shouldn't they be responsible for developing a more integrated approach to reducing economic damage associated with fish-eating birds? Does the USFWS realize that the complete elimination of bird predation problems in the aquaculture industry is neither realistic nor desirable?**
We realize that the total elimination of bird depredation problems is unrealistic, but whether or not it is desirable or whether depredation by migratory birds should be just a "cost of doing business" are philosophical issues that are outside the scope of the proposed action. While it seems sensible, from an economical and logistical standpoint, for the aquaculture industry to work to develop long term solutions to prevent excessive losses to depredation (and, in fact, to some extent they are already doing so), it is not within the Service's authority to demand that.

**58) Is there anything inherently "wrong" with the DCCO's population and range expansion?**

No. Population and range expansions of certain wild species are environmental phenomena that can be either "natural," directly associated with human activities, or indirectly associated with human activities. Cormorant control, whether lethal or non-lethal, is not intended to be a form of punishment, but rather is a means to alleviate resource conflicts.

**59) Is the USFWS authorizing greater control just to appease public outcry?**
No, we are authorizing greater control to manage cormorant conflicts more effectively and to allow other agencies more flexibility in dealing with cormorant conflicts.

**60) Is it right to kill fish-eating birds that may have come to be a problem due to human activities (e.g., fish farming, introduction of exotic species, hatchery stocking programs, etc.)?**
Right or wrong, in this case, appears to be a matter of perspective. Most Americans would agree that species extinction, especially when caused by human activities, is wrong. Attitudes about the ethics of wildlife damage management, however, vary widely, often depending on the individual's proximity to the problem. Our role is to help facilitate management of conflicts while ensuring that DCCO populations remain healthy.

**61) Is the role of APHIS Wildlife Services as a "cooperating agency" appropriate?**
Yes. As explained in the EIS, APHIS Wildlife Services plays an important role in the management of cormorant damages, especially to southern aquaculture. The Council on Environmental Quality NEPA guidelines state that "any other Federal agency which has special expertise with respect to any environmental issue…may be a cooperating agency."

**62) Why is the Service reversing its policy of not issuing permits for controlling DCCOs feeding in natural environments?**
Our "policy" of not issuing depredation permits for controlling DCCOs feeding in natural environments is more accurately described as a "practice." Technically speaking, the policy that guides our process for issuing migratory bird depredation permits lies in the regulations found in 50 CFR §21.41. We feel that there is sufficient justification to overturn our past management practice for DCCOs and give agencies in 24 States the authority to take DCCOs when they are feeding in natural environments.

**63) Isn't the proposed action merely an attempt on the part of the USFWS to "pass the buck" of cormorant management on to the States?**
No. As we were considering options for addressing DCCO conflicts more effectively, it became clear that, since many conflicts tend to be localized in nature, a sensible and flexible solution was to allow local agencies more authority in deciding when to control cormorants. States are major contributors to the conservation of American fish and wildlife resources and in most cases they are the agency responsible for managing the resources that DCCOs come into conflict with.

**64) Shouldn't wildlife management rely on sound biological facts instead of the opinion of the public, much of which is uninformed?**

Yes, to the extent possible within the context of other realities we must consider as a public agency. Just as some stakeholders lack an understanding of the ecological complexities associated with cormorants, experts in the life sciences often lack an understanding of the sociological complexities of natural resource management and the realities of living with overabundant DCCO populations.

**65) By controlling DCCOs, isn't the USFWS dealing with a symptom rather than the underlying causes?**

Numerous political, legal, and logistical deterrents prevent us from changing the entire American landscape to make it less desirable for DCCOs. It may be true that controlling cormorants while their environmental needs (e.g., food and habitat) remain abundant has an air of being a "bandage" approach. This is not a significant concern, however, since we are not trying to reduce DCCO populations on a large scale but, rather, are focusing on alleviation of local damages.

**66) Isn't the USFWS "scapegoating" cormorants, or blaming them for problems that aren't really their fault?**

This question reflects an inaccurate perception of the proposed action. The Service recognizes that DCCOs are a valuable part of our nation's avifauna. By allowing other agencies greater authority to manage cormorants we are not "blaming" them for problems but are rather recognizing that they have the potential to cause real conflicts that could be addressed more effectively, in some situations, at the local level. We also recognize that factors other than DCCOs contribute to resource impacts such as fishery declines. However, an exhaustive and comprehensive analysis of these myriad factors is outside the scope of the EIS. Our focus is chiefly on addressing conflicts that are associated with cormorants and then attempting to manage DCCOs, or the resources themselves, to alleviate conflicts.

**67) Isn't the USFWS putting the needs of special interests (e.g., sport fishing and fish farming) ahead of the public interest by controlling cormorants to benefit these resources?**

This question reflects an inaccurate perception of the proposed action. At this point, we are not engaging in widespread control of cormorants to benefit fisheries, although we are authorizing other agencies to carry out limited control where DCCOs have been shown to impact fisheries. Moreover, we are not authorizing, under any circumstances, agencies to threaten DCCO populations to the extent that their existence as part of America's native avifauna is at risk. Additionally, fish in public waters are a public resource in the same way that DCCOs are. Recreational fishing is an important part of our nation's economic base and cultural heritage and is supported by the Federal government in many ways.

**68) Won't the States and other agencies just cave in to political pressure to control DCCOs?**

Political pressure or not, agencies must follow the terms and conditions outlined in the public resource depredation order in order to conduct cormorant control activities. These conditions were established expressly for the purpose of preventing abuses of the authority granted to these agencies under the PRDO.

**69) Isn't it archaic to allow the killing of a species simply because certain people find it to be a nuisance?**
That is a matter of opinion. Regardless, we allow killing of DCCOs only when they are associated with a specific problem, not just because they're considered a pest or a nuisance.

**70) Isn't the real problem here humans and therefore it is people who are in need of "management," not cormorants?**
The answer depends on what exactly is meant by "people management." Certainly, among the broad range of stakeholders, there is a need to promote a better understanding of the biological and sociological complexities associated with cormorant management.

**71) Does the mission of the USFWS "to conserve, protect, and enhance" allow it to adequately deal with the DCCO problem?**
Yes, while "protect" and "enhance" are not terms that many would find conducive to controlling birds to alleviate resource damages, "conserve" is generally used to describe a more balanced management paradigm somewhere between preservation and overutilization.

**72) Isn't it inefficient and counterproductive for APHIS Wildlife Services employees to have to get permission from the USFWS before controlling migratory birds?**
Whether inefficient, counterproductive, or otherwise undesirable, it is plainly illegal under current MBTA regulations, based on the interpretation of the court in *Humane Society v. Glickman* (2000), for other Federal agencies to "take" migratory birds without a Federal permit.

**73) Is it appropriate for the USFWS to decide when and where DCCOs are injurious to public resources that are the legal responsibility of state agencies?**
To some extent, yes. The difficulty that arises when a Federally-managed species (e.g., DCCOs) comes into conflict with a State-managed species (e.g., yellow perch) is balancing national with local interests. An optimal approach would be responsive to local problems while responsible for national interests. We have tried to give agencies as much management flexibility as we felt was practicable within the context of our own legal responsibilities.

**74) Is the proposed action opening the door to widespread control of other fish-eating birds (i.e., setting a precedent)?**
This action does set a specific precedent for more liberal management of overabundant cormorants in a specific region, but not for managing fish-eating birds specifically or bird depredation in general. The latter authority was clearly established in the original language of the MBTA. Some have argued that the proposed action will lead to less tolerance of fish-eating birds. However, past experience has shown that if there is a perception among stakeholders that nothing is being done about their concerns, intolerance also increases. Presently, there is a need to balance responsiveness to immediate concerns and management in the long-term.

| Actions/Comments | R1 | R2 | R3 | R4 | R5 | R6 | Totals |
|---|---|---|---|---|---|---|---|
| **Alt. F - hunting season** | 3 | 13 | 62 | 3 | 15 | | **96** |
| **Alt. E – population reduction** | 3 | 24 | 103 | 29 | 36 | 2 | **197** |
| **Alt. D - proposed action** | 2 | 105 | 58 | 6 | 73 | 2 | **246** |
| **Alt. B - non-lethal management** | 11 | 10 | 21 | 11 | 33 | 4 | **90** |
| Remove DCCOs from **"protected"** status | 1 | 7 | 15 | 2 | 2 | | **27** |
| **Private landowners** or state-designated "agents" should be able to control cormorants | 1 | 11 | 6 | 1 | | | **19** |
| Institute a cormorant **bounty** | | 2 | 4 | | 1 | | **7** |
| Effective **monitoring** is very important | 1 | 1 | 3 | 3 | 8 | | **16** |
| **APHIS/WS** should be more involved in control efforts/issuance of permits | 2 | 1 | | 12 | 2 | | **17** |
| Stay with **No Action** alternative | 27 | 18 | 13 | 13 | 56 | 2 | **129** |
| The proposed action could lead to **overkill** of cormorants; need to set a limit on number of birds taken under Public Resource DO | 1 | | | | 1 | | **2** |
| Expand the Aquaculture DO to include additional states | 1 | 1 | | 1 | 1 | 1 | **5** |
| Proposed action amounts to an "unfunded mandate"; Feds should contribute **funding** | | 3 | 7 | 2 | 3 | 1 | **16** |
| Federal, state, and local **cooperation** is necessary (i.e., regional coordination) | 1 | 1 | 3 | 1 | 3 | | **9** |
| Need to allow for more flexibility in managing **conflicts with private resources** | 1 | 3 | | | 3 | | **7** |
| Agencies should have to **report incidental take of other birds** under Publ. Res. DO; there should be more discussion of disturbance to other species in the DEIS | 2 | | 4 | 2 | 1 | | **9** |
| More detail should be provided on **specific plan for population surveys** | | | | 3 | 1 | | **4** |
| Find some way of making **DCCOs infertile** | | | 1 | | | | **1** |
| More **research** is needed | 2 | | 7 | | 8 | | **17** |
| Hunting or allowing citizens to kill DCCOs would be inappropriate, unethical, etc. | 1 | 0 | 7 | 1 | 5 | 1 | **15** |
| Need to **state more specifically the parameters** under which Agencies will have to operate to implement Publ. Res. DO | 1 | | 1 | 6 | 2 | | **10** |
| FWS needs to **address/research the "real causes" of declining fish populations** (e.g., poor water quality). Cormorants are being killed without adequate justification (**scapegoat**) | 18 | 13 | 16 | 6 | 50 | 1 | **104** |
| FWS needs to increase **education** to counteract the negative public perception of cormorants | 4 | | 6 | | 14 | | **24** |
| NEPA analysis in DEIS is inadequate | 6 | 1 | 3 | 6 | 10 | | **26** |
| Proposed action violates the **MBTA** | 7 | 2 | 8 | 8 | 16 | 1 | **42** |
| **FWS is putting fishing and farming interests ahead** of non-consumptive users and/or is catering to these "special interests" | 21 | 12 | 15 | 10 | 56 | 3 | **117** |
| Include saltwater facilities under Aquaculture Depredation Order | | 1 | | 1 | 1 | | **3** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Aquaculture DO should be expanded to include all effective methods of control both at facilities and at nest/roost sites | 1 | 0 | | | 1 | | **2** |
| A "conservation agreement" rather than a Depredation Order is more appropriate for giving **Tribes** more authority | | | 1 | | | | **1** |
| **Alternative C** is the best option | 1 | | 1 | 1 | 3 | | **6** |
| How was the definition of viable DCCO populations (60% of current #s) determined? Need to define it more clearly | | | 1 | 2 | 3 | | **6** |
| Management decisions in DEIS do not appear to be/should be based on sound **science** | 15 | 10 | 9 | 8 | 51 | 2 | **95** |
| Do not allow private landowners to control cormorants to protect their property | | 2 | | | | | **2** |
| FWS should let **DCCO populations regulate themselves** | 1 | | 1 | | | | **2** |
| **None of the Alternatives** will be effective | | | | 1 | | | **1** |
| Alternatives D and F Combined | | | 48 | 1 | 16 | | **65** |
| Alternatives E and F Combined | 1 | 3 | 12 | 4 | 2 | | **22** |
| Alternatives D, E, and F Combined | 1 | 1 | 1 | 1 | 6 | 1 | **11** |
| Alternatives D and E Combined | 1 | | 3 | 2 | 12 | 1 | **19** |
| Alternative C without the expanded winter roost control | 1 | | 2 | | 4 | | **7** |
| Use $ that would go toward control efforts to support ecologically-sound fish farm technology | 1 | | 1 | | | | **2** |
| Only allow DCCO control on private land when a person's livelihood is at stake | | 1 | | | | 1 | **2** |
| Keep No Action alternative for the Pacific Northwest | 2 | | | | | | **2** |
| DEIS needs better fisheries analysis | | | 1 | | 2 | | **3** |
| Use poison to lower DCCO numbers | | | 1 | | 1 | | **2** |
| Close the sport fishery | | | | | | 1 | **1** |
| No comment | 1 | 9 | 24 | 3 | 19 | 1 | **57** |
| Proposed action is an effort on the Service's part to evade its responsibility to manage DCCOs and to place a burden on States; FWS needs to maintain oversight and leadership | | 2 | 2 | 6 | 3 | | **13** |
| Need more details on law enforcement elements of proposed action | | | 1 | 1 | 1 | | **3** |
| Concerned about loss of state authority under proposed action | | | | | 1 | | **1** |
| Combine Alternatives C and D with E (local damage control with possibility of regional population management later) | | | 1 | | | 1 | **2** |
| Utilize an adaptive management approach to DCCOs | | | 4 | 1 | | | **5** |
| Monitoring requirements are too burdensome | | | 2 | 2 | 1 | | **5** |
| Involve NABCI, Partners in Flight, NAWCP to unite states and provinces in DCCO management; proposed action will be difficult to coordinate | | | 3 | | 1 | 1 | **5** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Establish a DCCO interagency task group, working group, etc. to help in planning | 1 | | 2 | 1 | | | **4** |
| Management options should allow for implementation of preventative actions, not only corrective | | | | | 2 | | **2** |
| Need to ensure consistent interpretation of depredation policy across Regions | | | | | 1 | | **1** |
| The population model in the DEIS is inadequate | | | | | 2 | | **2** |
| The issue of protecting publicly owned natural resources on private lands is not adequately addressed in Alt. D | | | | | 1 | | **1** |
| Service should subsidize the use of non-lethal technology at fish farms | | | | 1 | 1 | | **2** |
| Support Alternative B, with caveat that eggs can be destroyed | 1 | | | | | | **1** |
| Proposed action is punitive not corrective | 1 | | 2 | | 1 | | **4** |
| EIS needs better discussion of economic and aesthetic values of cormorants | | 1 | | | 1 | | **2** |
| States should have to conduct annual fish surveys where they control DCCOs | | | | | 2 | | **2** |
| Change aquaculture depredation order so that individuals must report take | | | | | 2 | | **2** |
| The FWS has arbitrarily limited the scope of the analysis contained in the DEIS, failed to justify the purpose and need for the action, failed to consider a reasonable range of alternatives, failed to fully disclose and adequately evaluate the environmental impacts of the proposed action and its alternatives, and has failed to properly disclose the indirect and cumulative impacts of the proposal | | 1 | | | | | **1** |
| USFWS lacks the resources to implement the proposed action properly | | | | | 1 | | **1** |
| USFWS has no reliable data on DCCOs being killed under the aquaculture depredation order | | | | | 2 | | **2** |
| USFWS should provide annual reports to Congress detailing the costs of the implementation of the proposed action and foregone mandated priorities | | | | | 1 | | **1** |
| It is not appropriate for FWS to decide “where DCCs are injurious to public resources” that are the legal responsibility of other agencies. | | | 1 | 1 | | | **2** |
| DEIS provides evidence of perceived conflicts more than real conflicts | | | 1 | | 1 | | **2** |
| Estimates of numbers of DCCOs that will be killed under the proposed action need to be revisited | | | 1 | | | | **1** |
| Why can't feathers and other bird parts be sold or given away? | | | 1 | | | | **1** |
| Introduce predators to nesting colonies | | | 1 | | | | **1** |
| Burn down the cormorant-only rookeries | | | 1 | | | | **1** |
| Develop training programs for proper instruction of citizens in lethal and non-lethal control techniques | | 1 | | | | | **1** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Reimburse fish farmers for cormorant damages | | | | 1 | | | **1** |
| | **138** | **245** | **440** | **147** | **495** | **22** | **1592** |

**Results for letters 1 - 994; and meeting transcripts**

# CHAPTER 8: REFERENCES CITED


Adams, C., M. Richmond, L. Rudstam, and J. Forney. 1999. Diet of Double-crested Cormorants in a New York Lake with a Long-Term Study of Walleye and Yellow Perch Populations. Cooperative Fish and Wildlife Research Unit, Cornell University, Ithaca, New York, and Cornell Biological Field Station, Bridgeport, New York.

Aderman, A.R. and E.P. Hill. 1995. Locations and numbers of double-crested cormorants using winter roosts in the Delta region of Mississippi. Colonial Waterbirds 18 (Spec. Publ. 1): 143-51.

Ainley, D.G., D.W. Anderson, and P.W. Kelly. 1981. Feeding ecology of marine cormorants in southwestern North America. Condor. 83: 120-131.

Allardice, D.R. and S. Thorp. August 1995. A changing Great Lakes economy: economic and environmental linkages. SOLEC Working Paper presented at the State of the Lakes Ecosystem Conference. EPA 905-R-95-017. Chicago, Ill: U.S. Environmental Protection Agency.

Alvo, R., C. Blomme, and D.V. Weseloh. 2002. Double-crested cormorants, Phalacrocorax auritus, at inland lakes north of Lake Huron, Ontario. Can. Field-Nat. 116(3): 359-65.

Anderson, D.W. and F. Hamerstrom. 1967. The recent status of Wisconsin cormorants. Passenger Pigeon 29(1): 3-15.

Anderson, D.W. and J.J. Hickey. 1972. Eggshell changes in certain North American birds. Proc. Int. Ornithol. Congr. 15: 514-40.

Anderson, J.E. 1991. A conceptual framework for evaluating and quantifying naturalness. Cons. Biol. 5:347-52.

Anonymous. 1999. Little Galloo Island double-crested cormorant toxicology study. Chopra-Lee, Inc. Unpubl. Report.

ASA (American Sportfishing Association). 1996. The economic importance of sport fishing. 10pp.

Avery, M.L., D.S. Eiselman, M.K. Young, J.S. Humphrey, and D.G. Decker. 1999. Wading bird predation at tropical aquaculture facilities in central Florida. North American Journal of Aquaculture 61:64-69.

Baillie, J.L. 1939. Four additional breeding birds of Ontario. Can. Field-Naturalist 53(8): 130-131.

Baillie, J.L. 1947. The double-crested cormorant nesting in Ontario. Canadian Field-Naturalist. 61: 119-26.

Banks, P.B. 2000. Can foxes regulate rabbit populations? J. Wildl. Manage. 64(2): 401-6.

Barlow, C.G. and K. Bock. 1984. Predation of fish in farm dams by cormorants, P. spp. Aust. Wildl. Res. 11: 559-566.

Bayer, R. D. 1989. The cormorant/fisherman conflict in Tillamook County, Oregon. Studies in Oregon Ornithology No. 6.

Bayer, R.D. 2000. Cormorant harassment to protect juvenile salmonids in Tillamook County, Oregon. Studies in Oregon Ornithology No. 9. 66 pages.

Bayer, R.D. and R.W. Ferris. 1987. Reed Ferris' 1930-1943 bird banding records and bird observation for Tillamook County, Oregon. Studies in Oregon Ornithology No. 3, Newport, Oregon.

Bédard, J. A. Nadeau, and M. Lepage. 1995. Double-crested cormorant culling in the St. Lawrence River Estuary. Colonial Waterbirds 18 (Spec. Publ. 1): 78-85.

Bédard, J., A. Nadeau, and M. Lepage. 1999. Double-crested cormorant culling in the St. Lawrence River Estuary: results of a 5-year program. Pages 147-154 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Belant, J.L., L.A. Tyson, and P.A. Mastrangelo. 2000. Effects of lethal control at aquaculture facilities on populations of piscivorous birds. Wildlife Society Bulletin. 28(2): 379-384.

Belonger, B. 1983. Double-crested cormorant study results and recommendations (Green Bay, Wisconsin). Wisc. Dep. Nat. Res., interoffice correspondence to C. E. Higgs, 23 December 1983, File ref. 1720.

Belyea, G.Y., S.L. Maruca, J.S. Diana, P.J. Schneeberger, S.J. Scott, R.D. Clark, Jr., J.P. Ludwig, and C.L. Summer. 1999. Impact of double-crested cormorant predation on the yellow perch population of the Les Cheneaux Islands of Michigan. Pages 47-59 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Birt, V.L., T.P. Birt, D. Goulet, D.K. Cairns, and W.A. Montevecchi. 1987. Ashmole's halo: direct evidence for prey depletion by a seabird. Mar. Ecol. Prog. Ser. 40: 205-8.

Bishop, C.A., D.V. Weseloh, N.M. Burgess, J. Struger, R.J. Norstrom, R. Turle and K.A. Logan. 1992a. An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988), Vol. I, Accounts by locations and species. Canadian Wildlife Service Technical Report Series No. 152: 1-318.

Bishop, C.A., D.V. Weseloh, N.M. Burgess, J. Struger, R.J. Norstrom, R. Turle and K.A. Logan. 1992b. An atlas of contaminants in eggs of fish-eating colonial birds of the Great Lakes (1970-1988), Vol. II, Accounts by chemical. Canadian Wildlife Service Technical Report Series No. 153: 1-350.

Bivings, A.E., M.D. Hoy, and J.W. Jones. 1989. Fall food habits of double-crested Cormorants. U.S. For. Serv. Gen. Tech. Rep. RM-171 (Proc. Great Plains Wildl. Damage Control Workshop 9): 142-143.

Blackwell, B.F., M.A. Stapanian, and D.V.C. Weseloh. 2002. Dynamics of the double-crested cormorant population on Lake Ontario. Wildlife Soc. Bull. 30(2):345-353.

Blackwell, B.F. and W.B. Krohn. 1997. Spring foraging distribution and habitat selection by double-crested cormorants on the Penobscot River, Maine USA. Colonial Waterbirds 20(1): 66-76.

Blackwell, B.F., W.B. Krohn, and R.B. Allen. 1995. Foods of nestling double-crested cormorants in Penobscot Bay, Maine, USA: temporal and spatial considerations. Colonial Waterbirds 18: 199-208.

Blackwell, B.F., W.B. Krohn, N.R. Dube, and A.J. Godin. 1997. Spring prey use by double-crested cormorants on the Penobscot River, Maine. Colonial Waterbirds 20(1): 77-86.

Blokpoel, H. 1976. Bird Hazards to Aircraft. Books Canada Inc. Buffalo, NY 236pp.

Blokpoel, H. and R.M.G. Hamilton. 1989. Effects of applying white mineral oil to chicken and gull eggs. Wildl. Soc. Bull. 17: 435-441.

Blokpoel, H. and A. Harfenist. 1986. Comparison of 1980 and 1984 inventories of common tern, Caspian tern and double-crested cormorant colonies in the eastern North Channel, Lake Huron, Ontario, Canada. Colonial Waterbirds 9: 61-7.

Boyle, K.J., B. Roach, and D.G. Waddington. 1998. 1996 net economic values for bass, trout and walleye fishing, deer, elk and moose hunting, and wildlife watching: addendum to the 1996 National Survey of Fishing, Hunting and Wildlife-Associated Recreation. Report 96-2. U.S. Fish and Wildlife Service, Division of Federal Aid.

BPA (Bonneville Power Administration). 2001. Avian predation on juvenile salmonids in the Lower Columbia River research project: Final Environmental Assessment and Finding of No Significant Impact. DOE/EA-1374. April 2001.

Braune, B.M. 1987. Comparison of total mercury levels in relation to diet and molt for nine species of marine birds. Arch. Environ. Contam. Toxicol. 16: 217-24.

Bregnballe, T., J.D. Goss-Custard, and S.E.A. le V. Dit Durell. 1997. Management of cormorant numbers in Europe: a second step towards a European conservation and management plan. Cormorants and human interests, proceedings of the workshop towards an International Conservation and Management Plan for the Great Cormorant (Phalacrocorax carbo). Pages 62-122.

Brown, T.L., B.A. Knuth, and F.C. Menz. 1991. Lake Ontario's sport fisheries: socioeconomic research progress and needs. Can. J. fish. Aquat. Sci. 48: 1595-601.

Brown, T.L., N.A. Connelly, and C.P. Dawson. 2002. Economic Impacts of Declines in the Sport Fisheries of Eastern Lake Ontario. HDRU Series No. 02-01.

Brugger, K. E. 1993. Digestibility of three fish species by Double-crested Cormorants. Condor 95: 25-32.

Brugger, K. E. 1995. Double-crested Cormorants and fisheries in Florida. Colonial Waterbirds 18 (Spec. Publ. 1): 110-117.

Buckley, P.A. and F.G. Buckley. 1984. Expanding double-crested cormorant and laughing gull populations on Long Island, NY. Kingbird 34: 146-55.

Bur, M.T., S.L. Tinnirello, C.D. Lovell, and J. Tyson. 1999. Diet of the double-crested cormorant in western Lake Erie. Pages 73-85 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Burnett, J.A.D., N.H. Ringler, B.F. Lantry, and J.H. Johnson. 2002. Double-crested cormorant predation on yellow perch in the eastern basin of Lake Ontario. J. Great Lakes Res. 28(2): 202-211.

Cairns, D.K. 1992a. Population regulation of seabird colonies. Current Ornithol. 9: 37-61.

Cairns, D.K. 1992b. Bridging the gap between ornithology and fisheries science: use of seabird data in stock assessment models. Condor 94: 811-24.

Cairns, D.K. 1998. Diet of cormorants, mergansers, and kingfishers in northeastern North America. Canadian Tech. Rep. Of Fisheries and Aquatic Sciences. No. 2225.

Cairns, D.K., R.L. Dibblee, and P.-Y. Daoust. 1998. Displacement of a large double-crested cormorant, Phalacrocorax auritus, colony following human disturbance. The Canadian Field-Naturalist. 112(3): 520-522.

Campo, J.J., B.C. Thompson, J.C. Barron, R.C. Telfair II, P. Durocher, and S. Gutreuter. 1993. Diet of double-crested cormorants wintering in Texas. J. of Field Ornithol. 64(2): 135-144.

Carney, K.M. and W.J. Sydeman. 1999. A review of human disturbance effects on nesting colonial waterbirds. Waterbirds 22: 68-79.

Carter, H.R., G.J. McChesney, D.L. Jaques, C.S. Strong, M.W. Parker, J.E. Takekawa, D.L. Jory, and D.L. Whitworth. 1992. Breeding populationso f seabirds in California, 1989-1991. Unpubl. Report, U.S. Fish and Wildlife Service, Dixon, California.

Carter, H.R., D.S. Gilmer, J.E. Takekawa, R.W. Lowe, and U.W. Wilson. 1995a. Breeding seabirds in California, Oregon, and Washington. Pages 43-49 In Our Living Resources: A Report to the Nation on the Distribution, Abundance, and Health of U.S. Plants, Animals, and Ecosystems. USDI National Biological Service, Washington, D.C.

Carter, H.R., A.L. Sowls, M.S. Rodway, U.W. Wilson, R.W. Lowe, G.J. McChesney, F. Gress, and D.W. Anderson. 1995b. Population size, trends, and conservation problems of the double-crested cormorant on the Pacific coast of North America. Colonial Waterbirds 18 (Spec. Publ. 1): 189-207.

Chapdelaine, G. and J. Bédard. 1995. Recent changes in the abundance and distribution of the double-crested cormorant in the St. Lawrence River, estuary and gulf, Quebec, 1978-1990. Colonial Waterbirds 18 (Spec. Publ. 1): 70-77.

Chipman, R.B., D. Slate, L.E. Garland, and D.E. Capen. In Press. Double-crested cormorant and ring-billed gull damage management on Lake Champlain: are basin wide objectives achievable? 1997 Eastern Wildl. Damage Control Conference.

Chrisman, J.R. and T.H. Eckert. 1999. Population trends among smallmouth bass in the eastern basin of Lake Ontario, 1976-1997 *in* New York State Department of Environmental Conservation Special Report. Albany, NY.

Christens, E. and H. Blokpoel. 1991. Operational spraying of white mineral oil to prevent hatching of gull eggs. Wildl. Soc. Bull. 19: 423-430.

Cleary, E.C., S.E. Wright, and R.A. Dolbeer. 1997. Wildlife strikes to civil aircraft in the United States 1992-1996. U.S. Dept. of Trans., Federal Aviation Admin. Ser. Rep. No. 3. Washington, D.C. 30 pp.

Cleary, E.C., S.E. Wright, and R.A. Dolbeer. 1999. Wildlife Strikes to civil aircraft in the United States 1990-1998. U.S. Dept. of Trans., Federal Aviation Admin. Ser. Rep. No. 5. Washington, D.C. 29 pp.

Collis, K., S. Adamany, D.D. Roby, D.P. Craig, and D.E. Lyons. 2000. Avian predation on juvenile salmonids in the lower Columbia River. Annual Report for 1998 research to the Bonneville Power Administration, Portland, OR (http://www.efw.bpa.gov/Environment/EW/EWP/DOCS/REPORTS/DOWNSTRM/D33475-2.pdf).

Connelly, N.A., and T.L. Brown. 1988. The impact of tourism on employment in New York's coastal areas. Cornell Univ. Dep. Nat. Resour. Res. Extension ser. No. 32: 58pp.

Connelly, N.A., T.L. Brown, and C.P. Dawson. 1990. New York statewide angler survey 1988. New York State Dept. Of Environ. Conserv., Div. Of Fish and Wildlife. Albany, New York.

Connelly, N.A., T.L. Brown, and B.A. Knuth. 1997. Report 1: Angler effort and expenditures in New York statewide angler survey 1996. NYSDEC publication.

Conniff, R. 1991. Why catfish farmers want to throttle the crow of the sea. Smithsonian 22(4): 44-50, 52, 54-55.

Conover, M.R. 2001. Effect of hunting and trapping on wildlife damage. Wildl. Soc. Bull. 29(2): 521-532.

Conover, M. 2002. Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management. CRC Press LLC: Boca Raton, FL. 418pp.

Conover, M.R., W.C. Pitt, K.K. Kessler, T.J. DuBow, and W.A. Sanborn. 1995. Review of human injuries, illnesses, and economic losses caused by wildlife in the United States. Wildl. Soc. Bull. 23:407-414.

Cornell Cooperative Extension of Onondaga County. 2000. The Oneida Lake Book. Syracuse, New York.

Crane, J.L. 1996. Carcinogenic human health risks associated with consuming contaminated fish from five Great Lakes Areas of Concern. J. Great Lakes Res. 22(3): 653-68.

Craven, S.R. and E. Lev. 1987. Double-crested cormorants in the Apostle Islands, Wisconsin, USA: population trends, food habits, and fishery depredations. Colonial Waterbirds 10:64-71.

Curtis, K.S., W.C. Pitt, and M.R. Conover. 1996. Overview of techniques for reducing bird predation at aquaculture facilities. The Jack Berryman Institute Publication 12, Utah State University, Logan, 20pp.

Custer, T.W. and C. Bunck. 1992. Feeding flights of breeding double-crested cormorants at two Wisconsin colonies. J. Field. Ornithol. 63: 203-11.

Custer, T.W., C.M. Custer, R.K. Hines, S. Gutreuter, K.L. Stromborg, P.D. Allen, and M.J. Melancon. 1999. Organochlorine contaminants and reproductive success of double-crested cormorants from Green Bay, Wisconsin, USA. Environ. Toxicol. Chem. 18 (6): 1209-1217.

Cuthbert, F.J., L.R. Wires, and J.E. McKearnan. 2002. Potential impacts of nesting double-crested cormorants on great blue herons and black-crowned night herons in the U.S. Great Lakes region. J. Great Lakes Res. 28(2): 145-154.

Dale, T.B. and K.L. Stromborg. 1993. Reconnaissance surveys of contaminants potentially affecting Green Bay and Gravel Island National Wildlife Refuges. U.S. Fish and Wildlife Service, Green Bay Ecological Services Field Office.

Davies, J.M., B.R. Wilson, T. Holden, M.J. Feltham, J.R. Britton, J.P. Harvey, and I.G. Cowx. 2001. The relationship between cormorant and fish populations at a fishery system in England: an overview. Abstract in the Programme for the International Symposium and Workshop on Interaction between fish and birds: implications for management. University of Hull, England. April 3-6, 2001.

Dawson, C.P. F.R. Lichtkoppler, and C. Pistis. 1989. The charter boat fishing industry in the Great Lakes. Abstract from paper presented at the Northeast Fish and Wildlife Conference. Ellenville, NY.

De Vault, D.S., R. Hesselberg, P.W. Rodgers, and T.J. Feist. 1996. Contaminant trends in lake trout and walleye from the Laurentian Great Lakes. J. Great Lakes Res. 22(4): 884-95.

Decker, D.J. and G.R. Goff, editors. 1987. Valuing Wildlife: Economic and Social Perspectives. Westview Press: Boulder, CO. 424 pp.

Decker, D.J. and L.C. Chase. 1997. Human dimensions of living with wildlife--a management challenge for the 21st century. Wildlife Soc. Bull. 25(4): 788-95.

DeGraaf, R. M., N. G. Tilghman, and S. H. Anderson. 1985. Foraging guilds of North American birds. Environmental Management 9: 493-536.

Derby, C.E. and J.R. Lovvorn. 1997. Predation on fish by cormorants and pelicans in a cold-water river: a field and modeling study. Can. J. Fish. Aquat. Sci. 54: 1480-93.

DesGranges, J. and A. Reed. 1981. Disturbance and control of selected colonies of double-crested cormorants in Quebec. Colonial Waterbirds 4:12-19.

Diana, J.S., G.Y. Belyea, and R.D. Clark Jr. 1997. History, status, and trends in populations of yellow perch and double-crested cormorants in Les Cheneaux Islands, Michigan. Michigan Dept. of Natural Resources Fisheries Division Special Report No. 17.

Diana, J.S., C.A. Jones, D.O. Lucchesi, and J.C. Schneider. 1987. Evaluation of the yellow perch fishery and its importance to the local economy of the Les Cheneaux Islands area. Final Report Grant LRP-8C-7, Coastal Zone Management Program, Mich. Dep. Nat. Resour. Ann Arbor.

Dolbeer, R.A. 1991. Migration patterns of double-crested cormorants east of the Rocky Mountains. J. of Field Ornith. 62: 83-93.

Dow, R.L. 1953. The herring gull-cormorant control program: state of Maine. State of Maine Department of Sea and Shore Fisheries, Augusta, Maine. General Bulletin No. 1. 6 pp.
Drent, R., G.F. van Tets, F. Tompa, and K. Vermeer. 1964. The breeding birds of Mandarte Island. Canadian Field-Naturalist 78: 208-263.

Duda, M.D., S.J. Bissell, and K.C. Young. 1998. Wildlife and the American mind: public opinion on and attitudes toward fish and wildlife management. Responsive Management: Harrisonburg, VA.

Dukes, C. 1987. Portrait of a predator: are cormorants hurting Texas fishing? Texas Fisherman 38 (June): 40-41.

Durham, L. 1955. Effects of predation by cormorants and gars on fish populations of ponds in Illinois. PhD. Dissertation, Univ. Ill. (Urbana-Champaign); 117p.

Ehrlich, P.R., D.S. Dobkin, and D. Wheye. 1988. The birders handbook: a field guide to the natural history of north american birds. New York, NY: Simon and Schuster Inc.785pp.

EIFAC (European Inland Fisheries Advisory Commission). 1988. Report of the EIFAC working party on prevention and control of bird predation in aquaculture and fisheries operations. EIFAC Technical Paper (51). 79pp.

Elliott, J.E., D.G. Noble, R.J. Norstrom, and P.E. Whitehead. 1989. Organochlorine contaminants in seabird eggs from the Pacific coast of Canada 1971-1986. Environ. Monit. Assess. 12:67-82.

Engström, H. 1997. Do cormorants deplete fish numbers close to their breeding colonies? Suppl. Ric. Biol. Selvaggina XXVI: 343-345.

Engström, H. 1998. Conflicts between cormorants (*Phalacrocorax carbo* L.) and fishery in Sweden. Nordic J. Freshw. Res. 74: 148-155.

Engström, H. 2000. Long term effects of cormorant predation on fish communities and fishery in a freshwater lake. In press in Ecography.

Environment Canada. 1994. Great Lakes Fact Sheet (The Fall and Rise of Osprey Populations in the Great Lakes Basin). Minister of the Environment Public Works and Government Services Canada. Catalogue No. En 40-222/1-1994E.

Environment Canada. 1995. Great Lakes Fact Sheet (The Rise of the Double-Crested Cormorant on the Great Lakes: Winning the War Against Contaminants). Minister of the Environment Public Works and Government Services Canada. Catalogue No. En 40-222/2-1995E.

Environment Canada. 1996. Fact Sheet (The Terns of the Canadian Great Lakes). Minister of the Environment Public Works and Government Services Canada.

EPA (Environmental Protection Agency). 1992. The quality of our nation's water. Report to Congress. (http://www.epa.gov/305b/sum1.html).

EPA (Environmental Protection Agency). 1995. The Great Lakes: An Environmental Atlas and Resource Book, Third Edition. Government of Canada: Toronto, Ontario and the U.S. EPA Great Lakes National Program Office: Chicago, Illinois. URL http://www.epa.gov/glnpo/atlas/

EPA (Environmental Protection Agency). 1999. Update: Listing of Fish and Wildlife Advisories. EPA Fact Sheet. EPA-823-F-99-005.

Erickson, K.E. 1990. Summary of survey responses: cormorant predation on state sportfish populations. Unpublished Report prepared by Oklahoma Dept. Wildl. Conserv. for Am. Fish. Soc. 5 pp.

Erwin, R.M. 2002. Integrated management of waterbirds: beyond the conventional. Waterbirds 25 (Spec. Publ. 2): 5-12.

Ewins, P.J. and D.V.C. Weseloh. 1994. Effects on productivity of shooting double-crested cormorants (*Phalacrocorax auritus*) on Pigeon Island, Lake Ontario, in 1993. J. Great Lakes Res. 20(4): 761-767.

Farquhar, J.F., R.D. McCullough, and A.S. Schiavone. 2001. Managing a balance between double-crested cormorant numbers and warmwater fish abundance in the eastern basin of Lake Ontario, New York: preliminary insights from a management program. Abstract *In* the Programme for the International Symposium and Workshop on Interaction between Fish and Birds: Implications for Management. University of Hull, England. April 3-6, 2001.

Fenech, A.S., S. Lochmann, D. Wooten, M. Hoy, and A. Radomski. 2001. Possible effects of double-crested cormorants and largemouth bass predation on crappie in an Arkansas oxbow lake. Abstract *In* the Programme for the International Symposium and Workshop on Interaction between Fish and Birds: Implications for Management. University of Hull, England. April 3-6, 2001.

Ferris, R.W. 1940. Eight years of banding Western Gulls. Condor 42: 189-97.

Forney J.L. 1980. Evolution of a management strategy for walleye in Oneida Lake, New York. New York Fish and Game Journal 27:105-141.

Fowle, M.R., D.E. Capen, and N.J. Buckley. 1999. Population growth of double-crested cormorants in Lake Champlain. Northeast Wildlife 54: 25-34.

Fox, G.A. D.V. Weseloh, T.J. Kubiak, and T.C. Eerdman. 1991. Reproductive outcomes in colonial fish-eating birds: a biomarker for developmental toxicants in Great Lakes food chains (I. Historical and ecotoxicological perspectives). J. Great Lakes Res. 17(2): 153-7.

Fox, G.A. and D.V. Weseloh. 1987. Colonial waterbirds as bio-indicators of environmental contamination in the Great Lakes. Pages 209-216 *In* The value of birds, A.W. Diamond and F.L. Filion, eds. International Council for Bird Conservation Technical Publication No. 6, Cambridge, U.K.

Gabrielson, I.N. and S.G. Jewett. 1940. Birds of Oregon. Oregon State Monograph Studies in Zoology No. 2. Corvallis, Oregon.

Gilbertson, M., T. Kubiak, J. Ludwig, and G. Fox. 1991. Great Lakes embryo mortality, edema and deformities syndrome (GLEM-EDS) in colonial fish-eating birds: similarity to chick-edema disease. J. Toxicol. Environ. Health 33: 455-520.

Glahn, J.F. 2000. Comparison of pyrotechnics verus shooting for dispersing double-crested cormorants from their night roosts. Proceedings Vertebrate Pest Conference (T.P. Salmon and A.C. Crabb, eds.)19:44-48.

Glahn, J.F. and K.E. Brugger. 1995. The impact of double-crested cormorants on the Mississippi delta catfish industry: a bioenergetic model. Colonial Waterbirds 18 (Spec. Publ. 1):137-142.

Glahn, J.F., and A.R. Stickley, Jr. 1995. Wintering double-crested cormorants in the Delta region of Mississippi: Population levels and their impact on the catfish industry. Colonial Waterbirds 18 (Spec. Pub. 1):137-142.

Glahn, J.F., J.D. Pondexter, G.A. Littauer, and R.B. McCoy. 1995. Food habits of double-crested cormorants wintering in the Delta region of Mississippi. Colonial Waterbirds 18 (Spec. Pub. 1):158-167.

Glahn, J.F., A. May, K. Bruce, and D. Reinhold. 1996. Censusing double-crested cormorants (Phalacrocorax auritus) at their winter roosts in the delta region of Mississippi. Colonial Waterbirds 19: 73-81.

Glahn, J.F., J.B. Harrel, and C. Vyles. 1998. The diet of wintering double-crested cormorants feeding at lakes in the southeastern United States. Colonial Waterbirds 21(3): 445-52.

Glahn, J.F., E.S. Rasmussen, T. Tomsa, and K.J. Preusser. 1999a. Distribution and relative impact of avian predators at aquaculture facilities in the northeastern United States. North American Journal of Aquaculture 61:340-348.

Glahn, J.F., M.E. Tobin, and J.B. Harrel. 1999b. Possible effects of catfish exploitation on overwinter body condition of double-crested cormorants. Pg 107-113 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Glahn, J.F., D.S. Reinhold, and C.A. Sloan. 2000a. Recent population trends of double-crested cormorants wintering in the Delta Region of Mississippi: responses to roost dispersal and removal under a recent depredation order. Waterbirds 23:38-44.

Glahn, J.F., M.E. Tobin, and B.F. Blackwell. 2000b. A science-based initiative to manage double-crested cormorant damage to southern aquaculture. USDA/APHIS Wildlife Services National Wildlife Research Center.

Glahn, J.F., S.J. Werner, T. Hanson, and C.R. Engle. 2002. Cormorant depredation losses and their prevention at catfish farms: economic considerations. *In* (L. Clark, Ed.), Proceedings of the Third NWRC Special Symposium, "Human conflicts with wildlife: economic considerations." August 1-3, 2000 in Fort Collins, CO. (http://www.aphis.usda.gov/ws/nwrc/symposia/economics/index.html)

Glanville, E.V. 1992. Co-operative fishing by double-crested cormorants, *Phalacrocorax auritus*. Can. Field-Nat. 106: 522-3.

Glaser, L.C., I.K. Barker, D.V.C. Weseloh, J. Ludwig, R.M. Windingstad, D.W. Key, and T.K. Bollinger. 1999. The 1992 epizootic of Newcastle disease in double-crested cormorants in North America. J. of Wildlife Diseases 35(2): 319-330.

Godin, A.J. 1994. Birds at airports. Pages E1-E4 *In* S.E. Hyngstrom, R. M. Timm, and G.E. Larson, eds. Prevention and control of wildlife damage. Univ. Of Nebraska. Lincoln, NE.

Gorenzel, W.P., F.S. Conte, and T.P. Salmon. 1994. Bird damage at aquaculture facilities. Pages E5-E18 *In* S.E. Hyngstrom, R. M. Timm, and G.E. Larson, eds. Prevention and control of wildlife damage. Univ. Of Nebraska. Lincoln, NE.

Greichus, Y.A., and M.R. Hannon. 1973. Distribution and biochemical effects of DDT, DDD and DDE in penned double-crested cormorants. Toxicol. Appl. Pharmacol. 26: 483-94.

Gross, A.O. 1951. The Herring Gull-cormorant control project. Proceedings of the International Ornithological Congress. 10: 532-6.

Haas, R.C., and J.S. Schaeffer. 1992. Predator-prey and competitive inter-actions among walleye, yellow perch, and forage species in Saginaw Bay, Lake Huron. Mich. Dep. Nat. Resour. Fish. Res. Rep. 1984. Ann Arbor.

Hanebrink, E. and W. Byrd. 1989. Predatory birds in relation to aquaculture farming. Aquaculture Magazine, 15(2): 47-51.

Hatch, J.J. and D.V. Weseloh. 1999. Double-crested Cormorant (*Phalacrocorax auritus*). *In* The Birds of North America, No. 441 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Hatch, J.J. 1995. Changing populations of double-crested Cormorants. Colonial Waterbirds 18 (Spec. Publ. 1): 8-24.
Hatch, J.J. 1984. Rapid increase of double-crested cormorants nesting in southern New England. American Birds 38: 984-88.

Haws, K. 1987. Colony expansion and food habits of double-crested cormorants. Unpubl. Admin. Rep., Minnesota Dept. Natl. Resources. 6 pp.

Haynes, R.J. and K.M. Goh. 1978. Ammonium and nitrate nutrition of plants. Biological Reviews. 53: 465-510.

Heinrich, T. 1999. Large Lake Sampling Program Assessment Report for Lake of the Woods. Minnesota DNR Report.

Henny, C.J., L.J. Blus, S.P. Thompson, and U.W. Wilson. 1989. Environmental contaminants, human disturbance and nesting of double-crested cormorants in northwestern Washington. Colonial Waterbirds 12: 198-206.

Henschel, D.S., J.W. Martin, R.J. Norstrom, J. Elliott, K.M. Cheng, and J.C. DeWitt. 1997. Morphometric brain abnormalities in double-crested cormorant chicks exposed to polychlorinated dibenzo-p-dioxins, debenzofurans, and biphenyls. J. Great Lakes Res. 23:11026.

Hess, K.D. 1994. Effectiveness of shooting double-crested cormorants on catfish ponds and harassment of roosts to protect farm-raised catfish. M.S. thesis, Mississippi State Univ., Mississippi State, MS.

Hirsch, K. 1986. Colony expansion and food habits of double-crested cormorants in Minnesota. Pacific Seabird Group Bull. 13: 32-33.

Hobson, K.A., R.W. Knapton, and W. Lysack. 1989. Population, diet and reproductive success of double-crested cormorants breeding on Lake Winnipegosis, Manitoba, in 1987. Colonial Waterbirds 12:191-197.

Hodges, M. F. 1989. Foraging by piscivorous birds on commercial fish farms in Mississippi. M.S. thesis, Mississippi State Univ., Mississippi State, Mississippi.

Hoy, M.D. 1994. Depredations by herons and egrets at bait fish farms in Arkansas. Aquaculture Magizine 20(1):52-56.

Hoy, M.D., J.W. Jones, and A.E. Bivings. 1989. Economic imoact and control of wading birds and control of wading birds at Arkansas minnow ponds. Eastern Wildl. Damage Control Conf. 4:109-112.

Hoyle, J.A., J.M. Casselman, and T. Schaner. 1999. Smallmouth bass *(Micropterus dolomieui)* population status in eastern Lake Ontario, 1978 to 1998. Lake Ontario Management Unit 1998 Annual Report. http://www.glfc.org/lakecom/loc/mgmt_unit/98_ch8.pdf.

Huner, J. V. and C. V. Jeske. 2001. Observations on the occurrence and food habits of Double-crested Cormorants and Neotropic Cormorants in south Louisiana crawfish ponds. Journal of the Louisiana Ornithological Society. 5(1): 22-30.

Huner, J.V. 1997. The crayfish industry in North America. Fisheries 22(6): 28-31.

Inglis, I.R. 1980. Visual bird scarers: an ethological approach. Pages 121-143 *In* E.N. Wright, I.R. Inglis, and C.J. Feare, eds. Bird Problems in Agriculture: the Proceedings of a Conference “Understanding Agricultural Bird Problems.” BCPC Publications, Croydon.

ISG (Independent Scientific Group). 1999. Return to the river: scientific issues in the restoration of salmonid fishes in the Columbia River. Fisheries 24(3): 10-19.

Jackson, J. A. and B. J. S. Jackson. 1995. The Double-crested Cormorant in the south-central United States: habitat and population changes of a feathered pariah. Colonial Waterbirds 18 (Spec. Publ. 1): 118-130.

Jarvie, S., H. Blokpoel, and T. Chipperfield. 1999. A geographic information system to monitor nest distributions of double-crested cormorants and black-crowned night-herons at shared colony sites near Toronto, Canada. Pages 121-129 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Johnsgard, P.A. 1993. Cormorants, Darters, and Pelicans of the World. Smithsonian Inst. Press: Washington, D.C. 445 pp.

Johnson, B.L., H.E. Hicks, D.E. Jones, W. Cibulas, A. Wargo, and C.T. De Rosa. 1998. Public health implications of persistent toxic substances in the Great Lakes and St. Lawrence Basins. J. Great Lakes Res. 24(2): 698-722.

Johnson, F., and K. Williams. 1999. Protocol and practice in the adaptive management of waterfowl harvests. Conservation Ecology 3(1):8. URL http://www.consecol.org/Journal/vol3/iss1/art8/index.html.

Johnson, F. A., B. K. Williams, J. D. Nichols, J. D. Hines, W. L. Kendall et al. 1993. Developing an adaptive management strategy for harvesting waterfowl in North America. Trans. N. Am. Wildl. Nat. Resour. Conf. 58:565-583.

Johnson, J.H., R.M. Ross, and R.D. McCullough. 2002. Little Galloo Island, Lake Ontario: a review of nine years of double-crested cormorant diet and fish consumption information. J. Great Lakes Res. 28(2); 182-192.

Johnson, J.H., R.M. Ross, and C.M. Adams. 1999. Diet Composition and fish consumption of double-crested cormorants in eastern Lake Ontario, 1998 *In* New York State Department of Environmental Conservation Special Report. Albany, NY.

Johnson, J.H., R.M. Ross, and J. Farquhar. 2000a. The effects of egg oiling on fish consumption by double-crested cormorants on Little Galloo Island, Lake Ontario *In* New York State Department of Environmental Conservation Special Report. Albany, NY.

Johnson, J.H., R.M. Ross, and R.D. McCullough. 2000b. Diet composition and fish consumption of double-crested cormorants from the Pigeon and Snake Island Colonies of Eastern Lake Ontario in 1999 *In* New York State Department of Environmental Conservation Special Report. Albany, NY.

Karwowski, K., J.T. Hickey, and D.A. Stillwell. 1992. Food study of the double-crested cormorant, Little Galloo Island, Lake Ontario, New York. U.S. Fish and Wildlife Service. Cortland, NY.

Kaufman, K. 1996. Lives of North American birds. New York: Houghton Mifflin Co.

Keller, T. 1995. Food of cormorants *Phalacrocorax carbo sinensis* wintering in Bavaria, southern Germany. Ardea 83: 185-192.

Keller, T.M., A. von Lindeiner, and U. Lanz. 1998. Cormorant management in Bavaria, southern Germany–shooting as a proper management tool? Cormorant Research Group Bulletin 3: 11-15.

Keller, T.M. 1999. Is large-scale shooting a proper cormorant management tool? Poster, 23rd Annual Meeting of the Waterbird Society in Grado, Italy, November 8-12, 1999.

King, D.T., J.F. Glahn, K.J. Andrews. 1995. Daily activity budgets and movements of winter roosting double-crested cormorants determined by biotelemetry in the delta region of Mississippi. Colonial Waterbirds 18 (Spec. Publ. 1):152-157.

Kirsch, E.M. 1995. Double-crested cormorants along the upper Mississippi River. Colonial Waterbirds 18 (Spec. Publ. 1): 131-136.

Klett, B. R., D. F. Parkhurst, and F. R. Gaines. 1998. The Kensico Watershed Study: 1993 - 1995. URL http://www.epa.gov/owowwtrl/watershed/Proceed/klett.html

Koonce, J.F. August 1995. Aquatic Community Health of the Great Lakes. SOLEC Working Paper [online] presented at State of the Lakes Ecosystem Conference. EPA 905-R-95-012.

Korfanty, C., W.G. Miyasaki, and J.L. Harcus. 1999. Review of the population status and management of double-crested cormorants in Ontario. Pages 131-146 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Krebs, C.J. 1995. Two paradigms of population regulation. Wildlife Research 22: 1-10.

Krohn, W.B. and B.F. Blackwell. 1996. The double-crested cormorant in Maine. Maine Fish and Wildlife. Summer 1996: 8-12.

Krohn, W.B., R.B. Allen, J.R. Moring and A.E. Hutchinson. 1995. Double-crested cormorants in New England: population and management histories. Colonial Waterbirds 18(Spec. Publ. 1): 99-109.

Kuiken, T. 1999. Review of Newcastle disease in cormorants. Waterbirds 22(3): 333-347.

Kuiken, T., F.A. Leighton, G. Wobeser, K.L. Danesik, J. Riva, and R.A. Heckert. 1998. An epidemic of Newcastle disease in double-crested cormorants from Saskatchewan. Journal of Wildlife Diseases 34 (3): 457-471.

Lagler, K.F. 1939. The control of fish predators at hatcheries and rearing stations. J. Wildl. Manage. 3:169-197.

Lantry, B.F., T.H. Eckert, C.P. Schneider, and J.R. Chrisman. 2002. The relationship between the abundance of smallmouth bass and double-crested cormorants in the eastern basin of Lake Ontario. J. Great Lakes Res. 28(2): 193-201.

Lantry, B.F., T.H. Eckert, and C.P. Schneider. 1999. The relationship between the abundance of smallmouth bass and double-crested cormorants in the eastern basin of Lake Ontario *in* New York State Department of Environmental Conservation Special Report. Albany, NY.

Leger, C. and R. Mc Neil. 1987. Brood size and chick position as factors influencing feeding frequency, growth, and survival of nestling double-crested cormorants, *Phalacrocorax auritus*. Canadian Field-Naturalist 101: 351-361.

Lemmon, C.R., G. Bugbee, and G.R. Stephens. 1994. Tree damage by nesting double-crested cormorants in Connecticut. The Connecticut Warbler 14 (1): 27-30.

Lewis, H.F. 1929. The Natural History of the Double-crested cormorant (*Phalacrocorax auritus auritus* L.). Ru-Mi-Lou Books, Ottawa, Ontario.

Littuaer, G. 1990. Avian predators: frightening techniques for reducing bird damage at aquaculture facilities. Southern Regional Aquaculture Cent. Publication No. 401. 4pp.

Littuaer, G.A., J.F. Glahn, D.S. Reinhold, and M.W. Brunson. 1997. Control of bird predation at aquaculture facilities: Strategies and cost estimates. Southern Regional Aquaculture Cent. Pub. No. 402 (revised), Miss. Coop. Ext. Serv., Mississippi State. 4pp.

Lucchesi, D.O. 1988. A biological analysis of the yellow perch population in the Les Cheneaux Islands, Lake Huron. Mich. Dep. Nat. Resour. Fish. Res. Rep. 1958. Ann Arbor.

Ludwig, J.P., H. Kurita-Matsuba, H.J. Auman, M.E. Ludwig, and C.L. Summer. 1996. Deformities, PCBs, and TCDD-equivalents in double-crested cormorants *(Phalacrocorax auritus)* and caspian terns *(Hydroprogne caspia)* of the upper Great Lakes 1986-1991: testing a cause-effect hypothesis. J. Great Lakes Res. 22: 172-97.

Ludwig, J.P. 1984. Decline, resurgence and population dynamics of Michigan and Great Lakes double-crested cormorants. Jack-Pine Warbler 62: 91-102.

Ludwig, J.P. and C.L. Summer. 1995. Final report of the SERE Group Ltd. study to: model the population of double-crested cormorants in the Les Cheneaux region of Lake Huron, and to collect data relevant to fish species utilization by cormorants and other waterbirds from the northern Great Lakes. The SERE Group, Ltd., Eureka, MI.

Ludwig, J.P., C.N. Hull, M.E. Ludwig, and H.J. Auman. 1989. Food habits and feeding ecology of nesting double-crested cormorants in the upper Great Lakes, 1986-1989. Jack-Pine Warbler 67:117-129.

Madenjian, C.P. and S.W. Gabrey. 1995. Waterbird predation on fish in western Lake Erie: a bioenergetics model application. Condor 97: 141-153.

Marquiss, M. and D.N. Carss. 1997. Fish-eating birds and fisheries. British Trust for Ornithology News. May-June/July-August. No. 210-211: 6-7.

Mason, J.R., and L. Clark. 1997. Avian repellants: options, modes of action, and economic considerations. Pages 371-391 *In* Mason, J.R. Repellents in Wildlife Management (August 8-10, 1995, Denver, CO). Colorado State University, Fort Collins, CO.

Mastrangelo, P., C. Sloan, and K. Bruce. 1997. Incorporating depredation permits into integrated damage management plans for aquaculture facilities. Proc. East. Wildlife Damage Mgmt. Conf. 7:36-43. 1997.

Mathewson, W. 1986. William L. Finley: pioneer wildlife photographer. Oregon State University, Corvallis, Oregon.

Matteson, S.W. 1983. Wisconsin endangered resources report 3: a preliminary review of fishery complaints associated with changes in double-crested cormorant populations in Maine,

Wisconsin, and the Great Lakes Region. Bureau of Endangered Resources, Wisconsin Dept. of Nat. Res. 18pp.

Matteson, S.W., P.W. Rasmussen, K.L. Stromborg, T.I. Meier, J. Van Stappen, and E.C. Nelson. 1999. Changes in the status, distribution, and management of double-crested cormorants in Wisconsin. Pages 27-45 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Mayer, C.M., A. VanDeValk, J.L. Forney, L.G. Rudstam, and E.L. Mills. 2000. Response of yellow perch (Perca flavescens) in Oneida Lake, New York to establishment of zebra mussels (Dreissena polymorpha). Can. J. Fish. Aquat. Sci. 57: 742-754.

McCullough, R.D. and D.W. Einhouse. 1998. Lake Ontario – Eastern Basin Creel Survey, 1998 *In* New York State Department of Environmental Conservation Special Report. Albany, NY.

McLeod, J.A. and G.F. Bondar. 1953. A brief study of the double-crested cormorant on Lake Winnipegosis. Canadian Field-Naturalist 67: 1-11.

McNeil, R. and C. Leger. 1987. Nest-site quality and reproductive success of early and late-nesting double-crested cormorants. Wilson Bull. 99: 262-7.

Mendall, H.L. 1936. The home-life and economic status of the double-crested cormorant, Phalacrocorax auritus auritus (Lesson). Univ. Maine Stud., Second Ser., no. 38. Maine Bull. 39.3. Univ. Press, Orono.

Menz, F.C. 1981. An economic evaluation of the St. Lawrence River-eastern Lake Ontario bass fishery: final report. Clarkson College of Technology Dept. of Economics.

Mills, E.L., L.G. Rudstam, C. Adams, A. VanDeValk, J. Forney, M. Richmond, R. Schneider, and J. Henke. 1998. The Oneida Lake Profile. Cornell University Biological Field Station, Bridgeport, New York.

Milton, G.R. and P.J. Austin-Smith. 1983. Changes in the abundance and distribution of double-crested (*Phalacrocorax auritus*) and great cormorants (*P. carbo*) in Nova Scotia. Colonial Waterbirds 6: 130-8.

Milton, G.R., P.J. Austin-Smith and G.J. Farmer. 1995. Shouting at shags: a case study of cormorant management in Nova Scotia. Colonial Waterbirds 18 (Spec. Publ.): 91-8.

Mitchell, R.M. 1977. Breeding biology of the double-crested cormorant in Utah Lake. Great Basin Nat. 37: 1-23.

Mixson, M.A. and J.E. Pearson. 1992. Velogenic neurotropic Newcastle disease in cormorants and commercial turkeys. NY 1992. Proceedings of the 96$^{th}$ annual meeting of the United States Animal Health Association 1992: 357-360.

Moerbeek, D.J., W.H. van Dobben, E.R. Osieck, G.C. Boere, and C.M. Bungenberg de Jong. 1987. Cormorant damage prevention at a fish farm in the Netherlands. Biological Conservation 39:23-28.

Moore, D. 2001. Experiences of managing the impact of cormorants on large recreational trout fisheries. Abstract in the Programme for the International Symposium and Workshop on Interaction between fish and birds: implications for management. University of Hull, England. April 3-6, 2001.

Moore, D.J., H. Blokpoel, K.P. Lampman, and D.V. Weseloh. 1995. Status, ecology and management of colonial waterbirds nesting in Hamilton Harbour, Lake Ontario, 1988-1994. CWS, Ontario Region, Technical Report No. 213, 38 pp.

Moravec, F. and T. Scholz. 1994. Observations on the development of Syncuaria squamata, a parasite of cormorants, in the intermediate and paratenic hosts. Folia Parasitol. 41(3): 183-192.

Moravec, F., G. Salgado-Maldonado, and D. Osorio-Sarabia. 2000. Records of the bird capillariid nematode Ornithocapillaria appendiculata from freshwater fishes in Mexico, with remarks on Capillaria patzcuarensis. Syst. Parasitol. 45 (1): 53-39.

Mott D.F. and F.L. Boyd. 1995. A review of techniques for preventing cormorant depredations at aquaculture facilities in the southeastern United States. Colonial Waterbirds 18 (Spec. Pub. 1):176-180.

Mott, D.F. and M.W. Brunson. 1997. A historical perspective of catfish production in the southeast in relation to avian predation. Proceedings of the Eastern Wildlife Damage Management Conference 7:23-30.

Mott, D.F., R.D. Flynt, and J.O. King. 1995. An evaluation of floating ropes for reducing cormorant damage at catfish ponds. Proc. East. Wildl. Damage Control Conf. 6:93-97.

Mott, D.F., J.F Glahn, P.L. Smith, D.S. Reinhold, K.J. Bruce, and C.A. Sloan. 1998. An evaluation of dispersing double-crested cormorants from winter roosts for reducing predation on catfish in Mississippi. Wildl. Soc. Bull. 26:584-591.

Neuman, J., D.L. Pearl, R. Black, P.J. Ewins, D.V. Weseloh, M. Pike, and K. Karwowski. 1997. Spatial and temporal variation in the diet of the double-crested cormorant (*Phalacrocorax auritus*) breeding on the lower Great Lakes in the early 1990s. Can. J. Fish Aquat. Sci. 54:1569-1584.

Nichols, James D., Fred A. Johnson, and Byron K. Williams. 1995. Managing North American waterfowl in the face of uncertainty. Annual Review Ecology Systematics 26:177-199.

Nisbet, I.C.T. 1995. Biology, conservation and management of the double-crested cormorant: symposium summary and overview. Colonial Waterbirds 18 (Spec. Pub. 1): 247-252.

NMFS (National Marine Fisheries Service). 2000. Predation on salmonids relative to the Federal Columbia River Power System. Northwest Fisheries Science Center, National Marine Fisheries Service National Oceanic and Atmospheric Administration, Seattle, WA. White Paper.

NOAA (National Oceanic and Atmospheric Administration). 2001. Status of the Fishery Resources off the Northeastern United States, NOAA Report, http://www.nefsc.noaa.gov/sos/econ/#regsum.

NYSDEC (New York State Department of Environmental Conservation). 2000. Final environmental impact statement on proposed management of double-crested cormorants in U.S. waters of the eastern basin of Lake Ontario, New York. NYSDEC: Watertown, NY.

Omand, D.N. 1947. The cormorant in Ontario. Sylva. 3: 19-23.

Palmer, R.S. *Editor*. 1962. Handbook of North American birds, Vol. 1. Yale Univ. Press: New Haven, CT. 567 pp.

Parkhurst, J. A., R. P. Brooks, and D. E. Arnold. 1987. A survey of wildlife depredation and control techniques at fish-rearing facilities. Wildl. Soc. Bull. 15: 386-394.

Peck, G.K. and R.D. James. 1983. Breeding birds of Ontario, nidiology and distribution. Vol. 1: Non passerines. R. Ont. Mus., Toronto.

Pilon, C., J. Burton, and R. McNeil. 1983. Reproduction du Grand Cormoran (*P. carbo*) et du Cormoran à aigrettes (*P. auritus*) aux îles de la Madeleine, Québec. Can. J. of Zool. 61: 524-530.

Postupalsky, S. 1978. Toxic chemicals and cormorant populations in the Great Lakes. Canadian Wildlife Service, Wildlife Toxicology Division Manuscript Report No. 40: 1-25.

Powell, D.C., R.J. Aulerich, J.C. Meadows, D.E. Tillett, and K.L. Stromborg. 1997. Organochlorine contaminants in double-crested cormorants from Green Bay, Wisconsin. II. Effects of an extract derived from cormorant eggs on the chicken embryo. Arch. Environ. Contam. Toxicol. 32: 316-22.

Price, I.M. and D.V. Weseloh. 1986. Increased numbers and productivity of double-crested cormorants, Phalacrocorax auritus, on Lake Ontario. Canadian Field-Naturalist 100: 474-82.

Price, I.M., and J.G. Nickum. 1995. Aquaculture and birds: the context for controversy. Colon. Waterbirds 18 (Spec. Pub. 1):33-45.

Prout, M.W., E.L. Mills, and J.L. Forney. 1990. Diet, growth, and potential competitive interactions between age-0 white perch and yellow perch in Oneida Lake, New York. Transactions of the American Fisheries Society 119:966-975.

Rattner, B.A., N.H. Golden, J.L. Pearson, J.B. Cohen, and L.J. Garrett. 1999. Biological and ecotoxicological characteristics of terrestrial vertebrate species residing in estuaries: double-crested cormorant. URL http://www.pwrc.usgs.gov/resshow/rattner/bioeco/dbcrcorm.htm.

Reinhold, D.S. and C.A. Sloan. 1999. Strategies to reduce double-crested cormorant depredation at aquaculture facilities in Mississippi. Pages 99-106 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest. (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Riley, S.J., D.J. Decker, L.H. Carpenter, J.F. Organ, W.F. Siemer, G.F. Mattfeld, and G. Parsons. 2002. The essence of wildlife management. Wild. Soc. Bull. 30(2): 585-593.

Robinson, W.L. and E.G. Bolen. 1989. Wildlife Ecology and Management, 2nd ed. Macmillan Publ. Co.: New York, NY. 574pp.

Roby, D.D., D.P. Craig, K. Collis, and S.L. Adamany. 1998. Avian predation on juvenile salmonids in the lower Columbia River. 1997 annual report to the Bonneville Power Administration and U.S. Army Corps of Engineers. URL http://www.efw.bpa.gov/Environment/EW/EWP/DOCS/REPORTS/DOWNSTRM/D33475-1.pdf.

Rodgers, J.A. 1988. Fish-eating bird predation at Richloam Hatchery. Final Perform. Rep., Study 7523. Gainesville, FL: Florida Game and Freshwater Fish Commission, Wildlife Research Laboratory. 13 pp.

Rodgers, J.A. 1994. The management of double-crested cormorants at aquaculture facilities in Florida. Final Perform. Rep., Study 7527. Gainesville, FL: Florida Game and Freshwater Fish Commission, Wildlife Research Laboratory. 18 pp.

Romesburg, H.C. 1981. Wildlife science: gaining reliable knowledge. J. Wildl. Manage. 45(2): 293-313.

Roney, K. 1986. 1985 census of pelicans and cormorant colonies in Saskatchewan. Blue Jay 44: 177-9.

Ross, M.R. 1997. Fisheries Conservation and Management. Upper Saddle River, NJ: Prentice Hall.

Ross, R.M. and J.H. Johnson. 1994. Feeding ecology of double-crested cormorants in eastern Lake Ontario. Joint Annual Meeting, the Wildlife Society and American Fisheries Society (New York Chapters), Oswego, New York.

Ross, R.M. and J.H. Johnson. 1995. Seasonal and annual changes in the diet of Double-crested Cormorants: implications for Lake Ontario's Fishery. Great Lakes Research Review 2(1):1-9.

Ross, R.M. and J.H. Johnson. 1997. Fish losses to double-crested cormorants in eastern Lake Ontario: 1993-97. Presented at the Midwest AFS Meeting, December 1997, Milwaukee, WI. Proceedings in press.

Ross, R.M. and J.H. Johnson. 1999. Fish losses to double-crested cormorant predation in eastern Lake Ontario, 1992-97. Pages 61-70 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Russell, I. A. Cook, D. Kinsman, M. Ives, N. Lower, and S. Ives. In Press. Stomach contents analysis of cormorants at some different fishery types in England and Wales. Vogelwelt. XX:xxx-xxx.

Ryckman, D., D.V. Weseloh, P. Hamr, G.A. Fox, and B. Collins. 1998. Spatial and temporal trends in organochlorine contamination and bill deformities in double-crested cormorants *(Phalacrocorax auritus)* from the Canadian Great Lakes. Environ. Monit. Assess. 53: 169-95.

Sanderson, J.T., R.J. Norstrom, J. Elliot, L.E. Hart, K.M. Cheng, and G.D. Bellward. 1994. Biological effects of polychlorinated dibenzo-p-dioxins, debenzofurans, and biphenyls in double-crested cormorant chicks *(Phalacrocorax auritus)*. J. Toxicol. Env. Health 41: 247-65.

Sauer, J.R. 2001. Why Monitoring Matters. Bird Conservation. Issue 13.

Sauer, J. R., J. E. Hines, and J. Fallon. 2003. *The North American Breeding Bird Survey, Results and Analysis 1966 - 2002. Version 2003.1,* USGS Patuxent Wildlife Research Center, Laurel, MD.

Scanlon, P. F., L. A. Helfrich, and R. E. Stultz. 1979. Extent and severity of avian predation at Federal fish hatcheries in the United States. Proc. Ann. Conf. Southeast. Assoc. Fish Wildl. Agencies 32: 470-473.

Scharf, W.C. and G.W. Shugart. 1981. Recent increases in double-crested cormorants in the United States Great Lakes. American Birds 35: 910-11.

Scharf, W.C. and G.W. Shugart. 1998. Distribution and abundance of gull, tern, and cormorant nesting colonies of the U.S. Great Lakes, 1989 and 1990. Publ. 1. Sault Ste Marie, MI: Gale Bleason Envl. Inst., Lake Superior State Univ. Press.

Scharf, W.C., G.W. Shugart, and J.L. Trapp. 1992. Distribution and abundance of gull, tern and cormorant colonies of the U.S. Great Lakes, 1989 and 1990. U.S. Fish and Wildlife Service, Office of Migratory Bird Management, Washington, D.C. 89 pp.

Schneeberger, P.J. and S. J. Scott. 1997. Population dynamics and fishery statistics for yellow perch in Les Cheneaux Islands area. Pages 26-41 *In* J.S. Diana, G.Y. Belyea, and R.D. Clark, Jr., eds. History, status, and trends in populations of yellow perch and double-crested cormorants in Les Cheneaux Islands, Michigan. Mich. Dep. Nat. Resour. Fish. Div. Spec. Rep. 16. Ann Arbor.

Schneider, C.P., A. Schiavone Jr., T.H. Eckert, R.D. McCullough, B.F. Lantry, D.W. Einhouse, J.R. Chrisman, C.M. Adams, J.H. Johnson, and R.M. Ross. 1999. Double-crested cormorant predation on smallmouth bass and other fishes of the eastern basin of Lake Ontario: overview, summary and recommendations *In* New York State Department of Environmental Conservation Special Report. Albany, NY.

Schramm, H. L., Jr., B. French, and M. Ednoff. 1984. Depredation of channel catfish by Florida double-crested cormorants. Progr. Fish-Cult. 46: 41-43.

Schramm, H. L., Jr., M. W. Collopy, and E. A. Okrah. 1987. Potential problems of bird predation for fish culture in Florida. Progr. Fish-Cult. 49: 44-49.

Schriever, W. and J. Henke. 2000. Biological and socioeconomic effects of the proliferation of double-crested cormorants on Oneida Lake, New York. Oneida Lake Association.

Schusler, T.M. and D.J. Decker. March 2000. Lake Ontario Islands Wildlife Management Area Preliminary Situation Analysis. HDRU Series No. 00-2. Human Dimensions Research Unit, Cornell University, Ithaca, NY.

Sheppard, Y. 1994/5. Cormorants and pelicans. Birds of the Wild 3(4): 30-35.

Shieldcastle, M.C. and L. Martin. 1999. Colonial waterbird nesting on West Sister Island National Wildlife Refuge and the arrival of double-crested cormorants. Pages 115-119 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Siegel-Causey, D. 1999. The problems of being successful: managing interactions between humans and double-crested cormorants. Pages 5-14 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest (M.E. Tobin, ed.). USDA Tech. Bull. No. 1879. 164pp.

Simmonds, R.L., Jr., A.V. Zale, and D. M. Leslie Jr. 1995a. Depredation of catfish by double-crested cormorants at aquaculture facilities in Oklahoma. Proc. Great Plains Wildl. Damage Control Workshop 12: 34-37.

Simmonds, R.L., Jr., A.V. Zale, and D.M. Leslie, Jr. 1995b. Effect of piscivorous birds, particularly cormorants, on reservoir and aquacultural fishes in Oklahoma. Final Rep. U.S. Fish and Wildl. Serv., Region 2, Fish. Resour., Albuquerque, New Mexico.

Simmonds, R.L., A.V. Zale, and D.M. Leslie, Jr. 2000. Modeled effects of double-crested cormorant predation on simulated reservoir sport and forage fish populations in Oklahoma. North American J. of Fisheries Management. 20: 180-191.

Simmons, G.M., S.A. Herbein, and C.M. James. 1995. Managing nonpoint fecal coliform sources to tidal inlets. Water Resources Update. 100:64-74.

Somers, J.D., B.C. Goski, J.M. Barbeau, and M.W. Barrett. 1993. Accumulation of organochlorine contaminants in double-crested cormorants. Environ. Pollut. 80: 17-23.

Spencer, M. 1996. Survey of the impacts of double-crested cormorant populations and other avian predators at fishing lakes and fish hatcheries in Georgia. Georgia Dept. of Natural Resources, Wildlife Resources Division, Social Circle, GA.

Stapanian, M.A. 2002. Interspecific interactions, habitat use, and management of double-crested cormorants (*Phalacrocorax auritus*) in the Laurentian Great Lakes: an introduction. J. Great Lakes Res. 28(2): 119-124.

Stapanian, M.A. and M.T. Bur. 2002. Overlap in offshore habitat use by double-crested cormorants and boaters in western Lake Erie. J. Great Lake Res. 28(2): 172-181.

Stapanian, M.A., M.T. Bur, J.T. Tyson, T.W. Seamans, and B.F. Blackwell. 2002. Foraging locations of double-crested cormorants on western Lake Erie: characteristics and spatial associations with prey fish densities. J. Great Lakes Res. 28(2): 155-171.

Sterritt, R. M. and J. N. Lester. 1988. Microbiology for environmental and public health engineers. E. & F. N. Spon, pub. New York.

Stickley, A.R., Jr. 1991. Cormorant feeding rates on commercially grown catfish. Aquacult. Mag. 17: 89-90.

Stickley, A.R., Jr., and K.J. Andrews. 1989. Survey of Mississippi catfish farmers on means, effort, and costs to repel fish-eating birds from ponds. Proceedings of the Eastern Wildlife Damage Control Conference 4:105-108.

Stickley, A.R., Jr., and J.O. King. 1995. Long-term trial of an inflatable effigy scare device or repelling cormorants from catfish ponds. Proc. East. Wildl. Damage Control Conf. 6:89-92.

Stickley, A.R., Jr., G.L. Warrick, and J.F. Glahn. 1992. Impacts of double-crested cormorant populations on channel catfish farms. J. World Aquacult. Soc. 23:192-198.

Stickley, A.R., Jr., D.F. Mott, and J.O. King. 1995. Short-term effects of an inflatable effigy on cormorants at catfish farms. Wildlife Society Bulletin 23:73-77.

Struger, J., D.V. Weseloh, D.J. Hallett, and P. Mineau. 1985. Organochlorine contaminants in herring gull eggs from the Detroit and Niagara Rivers and Saginaw Bay (1978-1982): contaminant discriminants. J. Great Lakes Res. 11(3): 223-30.

Swann, L. 1992. A basic overview of aquaculture: history, water quality, types of aquaculture, production methods. Technical Bull. Series No. 102. Illionois-Indiana Sea Grant Program, Purdue Univ. West Lafayette, IN. 10pp.

Terres, J.K. 1980. The Audubon Society Encyclopedia of North American Birds. Wings Bros. New York, New York.

Thompson, B.C., J.J. Campo. And R.C. Telfair II. 1995. Origin, population attributes, and management conflict resolution for double-crested cormorants wintering in Texas. Colonial Waterbirds 18 (Spec. Pub. 1):181-188.

Tillitt, D.E., G.T. Ankley, J.P. Giesy, J.P. Ludwig, H. Kurita-Matsuba. 1992. Polychlorinated biphenyl residues and egg mortality in double-crested cormorants from the Great Lakes. Environ. Toxicol. Chem. 11: 1281-8.

Tobin, M.E. 1998. Research and management of bird depredation at catfish farms. Proc. Vertebr. Pest Conf. 18:67-70.

Tobin, M.E., D.T. King, B.S. Dorr, and D.S. Reinhold. 2002. Effect of roost harassment on cormorant movements and roosting in the Delta region of Mississippi. Waterbirds 25(1): 44-51.

Trapp, J.L., T.J. Dwyer, J.J. Doggett, and J.G. Nickum. 1995. Management responsibilities and policies for cormorants: United States Fish and Wildlife Service. Colonial Waterbirds 18 (Spec. Pub. 1): 266-230.

Trapp, J.L., S.J. Lewis, and D.M. Pence. 1999. Double-crested cormorant impacts on sport fish: literature review, agency survey, and strategies. Pages 87-96 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest. USDA-APHIS Tech. Bull. No. 1879.

Tucker, C.S. and E.H. Robinson. 1990. Channel Catfish Farming Handbook. Van Nostrand Reinhold, New York. 454pp.

Tyson, L.A., J.L. Belant, F.J. Cuthbert, and D.V. Weseloh. 1999. Nesting populations of double-crested cormorants in the United States and Canada. Pages 17-25 *In* Symposium on Double-crested Cormorants: Population Status and Management Issues in the Midwest. USDA-APHIS Tech. Bull. No. 1879.

U.S. Congress, Office of Technology Assessment, Selected Technology Issues in U.S. Aquaculture, OTA-BP-ENV-171 (Washington, DC: Office of Technology Assessment, September 1995).

USDA (United States Department of Agriculture, Economic Research Service). 2000. Aquaculture Outlook. LDP-AQS-11, Washington, D.C. March 2000.

USDA-APHIS (U.S. Department of Agriculture, Animal and Plant Health Inspection Service). 1989. Animal Damage Control Strategic Plan. USDA- APHIS ADC Operational Support Staff, 4700 River road, Unit 87, Riverdale, MD 20737.

USDA-APHIS (U. S. Department of Agriculture, Animal and Plant Health Inspection Service). 1997a. Bird predation and its control at aquaculture facilities in the northeastern United States. APHIS 11-55-009. Washington, D.C. 17pp.

USDA-APHIS (U. S. Department of Agriculture, Animal and Plant Health Inspection Service). 1997b. Revised: Animal Damage Control Program Final Environmental Impact Statement. Vol. 1-3. Animal and Plant Health Inspection Service, Riverdale, MD.

USDA-APHIS (U.S. Department of Agriculture, Animal and Plant Health Inspection Service). 1998. A Pilot Program to Investigate Techniques To Change Migration and Roosting Patterns of Double-crested Cormorants on Oneida Lake, New York. Castleton, New York.

USDA-APHIS (U.S. Department of Agriculture, Animal and Plant Health Inspection Service). 1999. Environmental Assessment of alternative strategies for the management of damage caused by Ring-billed Gulls and Double-crested Cormorants on Lake Champlain, Vermont and New York. March 12, 1999.

USDA-APHIS (U.S. Department of Agricuture, Animal and Plant Health Inspection Service, Wildlife Services). 2000. Environmental Assessment for Management of Conflicts Associated with Resident Canada Geese in Wisconsin.

USDA-NASS (U.S. Department of Agriculture, National Agricultural Statistics Service). 2000a. Catfish and trout production. Washington, D.C. 27pp.

USDA-NASS (U.S. Department of Agriculture, National Agricultural Statistics Service). 2000b. 1998 Census of Aquaculture. Washington, D.C. 90p.

USDI/USDC (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census). 1997. 1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. U.S. Govt. Printing Office, Washington, D.C.

USDI/USDC (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census). 1998a. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: New York. U.S. Govt. Printing Office, Washington, D.C.

USDI/USDC (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census). 1998b. National Survey of Fishing, Hunting, and Wildlife-Associated Recreation: Texas. U.S. Govt. Printing Office, Washington, D.C.

USFS (U.S. Forest Service). 2001. Midewin National Tallgrass Prairie Land and Resource Management Plan Draft Environmental Impact Statement. Midewin National Tallgrass Prairie, Wilmington, IL. (available at: http://www.fs.fed.us/mntp/plan/index.htm).

USFWS (U.S. Fish and Wildlife Service). 1995. Report to Congress: Great Lakes Fishery Resources Restoration Study.

USFWS (U.S. Fish and Wildlife Service). 1997. Recreational Fishery Resources Conservation Plan. Agency Action Plan, April 10, 1997.

USFWS (U.S. Fish and Wildlife Service). 1998a. Strategic Plan: September 30, 1997 - September 30, 2002. USDI U.S. Fish and Wildlife Service.

USFWS (U.S. Fish and Wildlife Service). 1998b. Establishment of a depredation order for the double-crested cormorant. Final Rule. Federal Register 63: 10550-10561.

USFWS (U.S. Fish and Wildlife Service). 1999a. Final Environmental Assessment Of a U.S. Fish and Wildlife Service Action to Issue a Migratory Bird Depredation Permit For the Take of Cormorants on Lake Ontario Islands, New York.

USFWS (U.S. Fish and Wildlife Service). 1999b. Final Environmental Assessment Of a U.S. Fish and Wildlife Service Action to Issue a Migratory Bird Depredation Permit For the Take of Cormorants and Gulls on Lake Champlain Islands, Vermont.

USFWS (U.S. Fish and Wildlife Service). 2000a. Grizzly Bear Recovery in the Bitterroot Ecosystem. Final Environmental Impact Statement. March 2000.

USFWS (U.S. Fish and Wildlife Service). 2000b. Seabird Predation on Juvenile Salmonids in the Columbia River Estuary. August 2000.

USFWS (U.S. Fish and Wildlife Service). 2000c. Adaptive Harvest Management: 2000 Hunting Season. U.S. Dept. of Interior, Washington, DC. 43pp.

USFWS (U.S. Fish and Wildlife Service). 2003. Finding of No Significant Impact of a USFWS Action to Issue a Migratory Bird Depredation Permit for the Take of Cormorants on Lake Ontario Islands, New York. 29pp.

USFWS/NMFS (U.S. Fish and Wildlife Service and National Marine Fisheries Service). 2000. Status report on Atlantic Salmon. Available at http://news.fws.gov/salmon/asalmon.html.

USFWS/VDFW/NYSDEC (U.S. Fish and Wildlife Service, Vermont Department of Fish and Wildlife, and New York State Department of Environmental Conservation). 2001. Draft Supplemental Environmental Impact Statement: A Long-term Program of Sea Lamprey Control in Lake Champlain.

Van Bommel, S., N.G. Röling, S.E. van Wieren, and H. Gossow. 2003. Social causes of the cormorant revival in The Netherlands. Cormorant Research Group Bulletin, No. 5: 16-25.

Van Dam, C. and S. Asbirk, editors. 1997. Report of the workshop discussions on some management scenarios. Pages 123-129 *In* Cormorants and Human Interests, Proceedings of the

Workshop Towards an International Conservation and Management Plan for the Great Cormorant (Phalacrocorax carbo).

Van der Veen, H.E. 1973. Some aspects of the breeding biology and demography of the double-crested cormorant (*Phalacrocorax auritus*) of Mandarte Island. Ph.D. thesis, University of Grönigen, Grönigen, The Netherlands.

VanDeValk, A.J., C.M. Adams, L.G. Rudstam, J.L. Forney, T.E. Brooking, M.A. Gerkin, B.P. Young, and J.T. Hooper. 2002. Comparison of angler and cormorant harvest of walleye and yellow perch in Oneida Lake, New York. Transactions of American Fisheries Society. 131(1): 27-39.

VanDeValk, A.J., L.G. Rudstam, T.E. Brooking, and A. Beitler. 1999. Walleye Stock Assessment and Population Projections for Oneida Lake, 1998-2001. New York Federal Aid Study VII, Job 103. FA-5-R.

Van Eerden, M.R. and J. Gregersen. 1995. Long-term changes in the northwest European population of cormorants *Phalacrocorax carbo sinensis*. Ardea 83: 61-79.

Van Eerden, M.R. and B. Voslamber. 1995. Mass fishing by cormorants *Phalacrocorax carbo sinensis* at Lake Ijsselmeer, The Netherlands: a recent and successful adaptation to a turbid environment. Ardea 83: 199-212.

Van Eerden, M.R., K. Koffijberg, and M. Platteeuw. 1995. Riding on the crest of the wave: possibilities and limitations for a thriving population of migratory cormorants *Phalacrocorax carbo* in man-dominated wetlands. Ardea 83: 1-9.

Van Gorder, S. 1992. The growth of the aquaculture industry. Alternative Aquaculture Network 9(2):1-2.

Veldkamp, R. 1997. Cormorants *Phalacrocorax carbo* in Europe: population size, growth rates and results of control measures. Pages 21-29 *In* Cormorants and Human Interests, Proceedings of the Workshop towards an International Conservation and Management Plan for the Great Cormorant (Phalacrocorax carbo).

Vermeer, K. 1969. Colonies of double-crested cormorants and white pelicans in Alberta. Canadian Field-Naturalist 83: 36-39.

Vermeer, K. and L. Rankin. 1984. Population trends in nesting double-crested and pelagic cormorants in Canada. Murrelet 65: 1-9.

Vidal Martinez, V.M., D. Osorio Sarabia, and R.M. Overstreet. 1994. Experimental infection of Contracaecum multipapillatum from Mexico in the domestic cat. J. of Parasitology 80(4): 576-579.

Werner, S.J., D.T. King, and D.E. Wooten. 2000. Double-crested cormorant satellite telemetry: preliminary insight. Presented at the ninth Eastern Wildlife Damage Management Conference; State College, PA.

Weseloh, D.V. and J. Casselman. 1992. Calculated fish consumption by double-crested cormorants in eastern Lake Ontario. Colonial Waterbirds 16(2): 63-64.

Weseloh, D.V., and P.J. Ewins. 1994. Characteristics of a rapidly increasing colony of double-crested cormorants (*Phalacrocorax auritus*) in Lake Ontario: population size, reproductive parameters and band recoveries. J. Great Lakes Res. 20(2):443-456.

Weseloh, D.V. and B. Collier. 1995. The rise of the double-crested cormorant on the Great Lakes: winning the war against contaminants. Great Lakes Fact sheet. Canadian Wildlife Service, Environment Canada and Long Point Observatory.

Weseloh, D.V.C. and T.P. Havelka. Potential impacts of double-crested cormorants (Phalacrocorax auritus) on Black-crowned Night-herons (Nycticorax nycticorax) and other colonial waterbirds. Abstract.
International Association of Great Lakes Research conference. Green Bay, WI. 2001.

Weseloh, D.V., S.M. Teeple, and M. Gilbertson. 1983. Double-crested cormorants of the Great Lakes: egg-laying parameters, reproductive failure, and contaminant residues in eggs, Lake Huron 1972-1973. Canadian Journal of Zoology 61: 427-36.

Weseloh, D.V., P.J. Ewins, J. Struger, P. Mineau, C.A. Bishop, S. Postupalsky, and J.P. Ludwig. 1995. Double-crested cormorants of the Great Lakes: changes in population size, breeding distribution and reproductive output between 1913 and 1991. Colonial Waterbirds 18 (Spec. Publ. 1): 48-59.

Weseloh, D.V., C. Pekarik, T. Havelka, G. Barrett, and J. Reid. 2002. Population trends and colony locations of double-crested cormorants in the Canadian Great Lakes and immediately adjacent areas, 1990-2000: a manager's guide. J. Great Lakes Res. 28 (20): 125-144.

White, S. 1999. Introduction to Aquaculture. Maine Sea Grant. 2pp.

Williams, B. K. 1989. Review of dynamic optimization methods in renewable natural resource management. Nat. Resour. Model. 3:137-216.

Williams, B. K., and J. D. Nichols. 1990. Modeling and the management of migratory birds. Nat. Resour. Model. 4:273-311.

Wilson, U.W. 1991. Response of three seabird species to El Nino events and other warm episodes on the Washington coast, 1979-1990. Condor 93: 853-8.

Wires, L.R. and F.J. Cuthbert. 2000. Trends in Caspian tern numbers and distribution in North America: a review. Waterbirds 23(3): 388-404.

Wires, L.R., F.J. Cuthbert, D.R. Trexel, and A.R. Joshi. 2001. Status of the Double-crested Cormorant (*Phalacrocorax auritus*): Eastern and Central North America. USFWS Report.

Wires, L.R., D.N. Carss, F.J. Cuthbert, and J.J. Hatch. In Press. Transcontinental connections in relation to cormorant-fisheries conflicts: perceptions and realities of a "bête noir" on both sides of the Atlantic. Vogelwelt XX:xxx-xxx.

Wywialowski, A.P. 1998. Wildlife-caused losses for catfish producers in 1996. Washington, D.C.: U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Policy and Program Development.

Wywialowski, A.P. 1999. Wildlife-caused losses for producers of channel catfish (*Italurus punctatus*) in 1996. J. World Aquacult. Soc. 30:461-472.

Yamashita, N., S. Tanabe, J.P. Ludwig, H. Kurita, M.E. Ludwig, and R. Tatsukawa. 1993. Embryonic abnormalities and organochlorine contamination in double-crested cormorants *(Phalacrocorax auritus)* and caspian terns *(Hydroprogne caspia)* from the upper Great Lakes in 1988. Environ. Pollut. 79: 163-73.

**Special Acknowledgements:**
Thank you to everyone who took the time to make their voice heard in the matter of cormorant conservation and management. Special thanks to all those who have spent time in the field to help increase our knowledge of cormorants. I'll close with a quote from Aldo Leopold, a man I deeply respect for being not only a man of science, but a man of wisdom. This quote is from Riley et al. 2002:

One of the anomalies of modern ecology is the creation of two groups, each of which seems barely aware of the existence of the other. The one studies the human community, almost as if it were a separate entity, and call its findings sociology, economics and history. The other studies the plant and animal community and comfortably relegates the hodgepodge of politics to the liberal arts. The inevitable fusion of these two lines of thought will, perhaps, constitute the outstanding advance of this century.

**Appendix 1: List of Scientific Names**

**BIRDS**
American Black Duck (*Anas rubripes*)
American Crow (*Corvus brachyrhynchos*)
American White Pelican *(Pelecanus erythrorhynchos)*
Anhinga (*Anhinga anhinga*)
Bald Eagle (*Haliaetus leucocephalus*)
Black-crowned Night-Heron *(Nycticorax nycticorax)*
Brandt's Cormorant (*Phalacrocorax penicillatus*)
Brant *(Branta bernicla)*
California Gull (*Larus californicus*)
Canada Goose *(Branta canadensis)*
Caspian Tern (*Sterna caspia*)
Cattle Egret (*Bubulcus ibis*)
Common Eider *(Somateria mollissima)*
Common Merganser *(Mergus merganser)*
Common Raven (*Corvus corax*)
Common Tern (*Sterna hirundo*)
Double-crested Cormorant (*Phalacrocorax auritus*)
Fish Crow (*Corvus ossifragus*)
Gadwall (*Anas strepera*)
Glaucous-winged Gull (*Larus glaucescens*)
Great Black-backed Gull *(Larus marinus*)
Great Blue Heron *(Ardea herodias)*
Great Cormorant *(Phalacrocorax carbo)*
Great Egret *(Casmerodius albus)*
Herring Gull (*Larus argentatus*)
Least Tern (*Sterna antillarum*)
Little Blue Heron *(Egretta caerulea)*
Mallard *(Anas platyrhynchos)*
Neotropic Cormorant (*Phalacrocorax brasilianus*)
Northwestern Crow (*Corvus caurinus*)
Osprey *(Pandion haliaetus)*
Pelagic Cormorant (*Phalacrocorax pelagicus*)
Piping Plover *(Charadrius melodus*)
Razor-billed Auk (*Alca torda*)
Red-faced Cormorant (*Phalacrocorax urile*)
Ring-billed Gull (*Larus delawarensis*)
Snowy Egret *(Egretta thula)*
Western Gull *(Larus occidentalis)*
White Ibis *(Eudocimus albus)*
Wood Stork (*Mycteria americana*)
Yellow-crowned Night-Heron *(Nyctanassa violacea)*

**FISH**
alewife (*Alosa pseudoharengus*)
American plaice (*Hippoglossoides platessoides)*
American sand lance *(Ammodytes americanus)*
American shad *(Alosa sapidissima)*
Arctic char *(Salvelinus alpinus)*

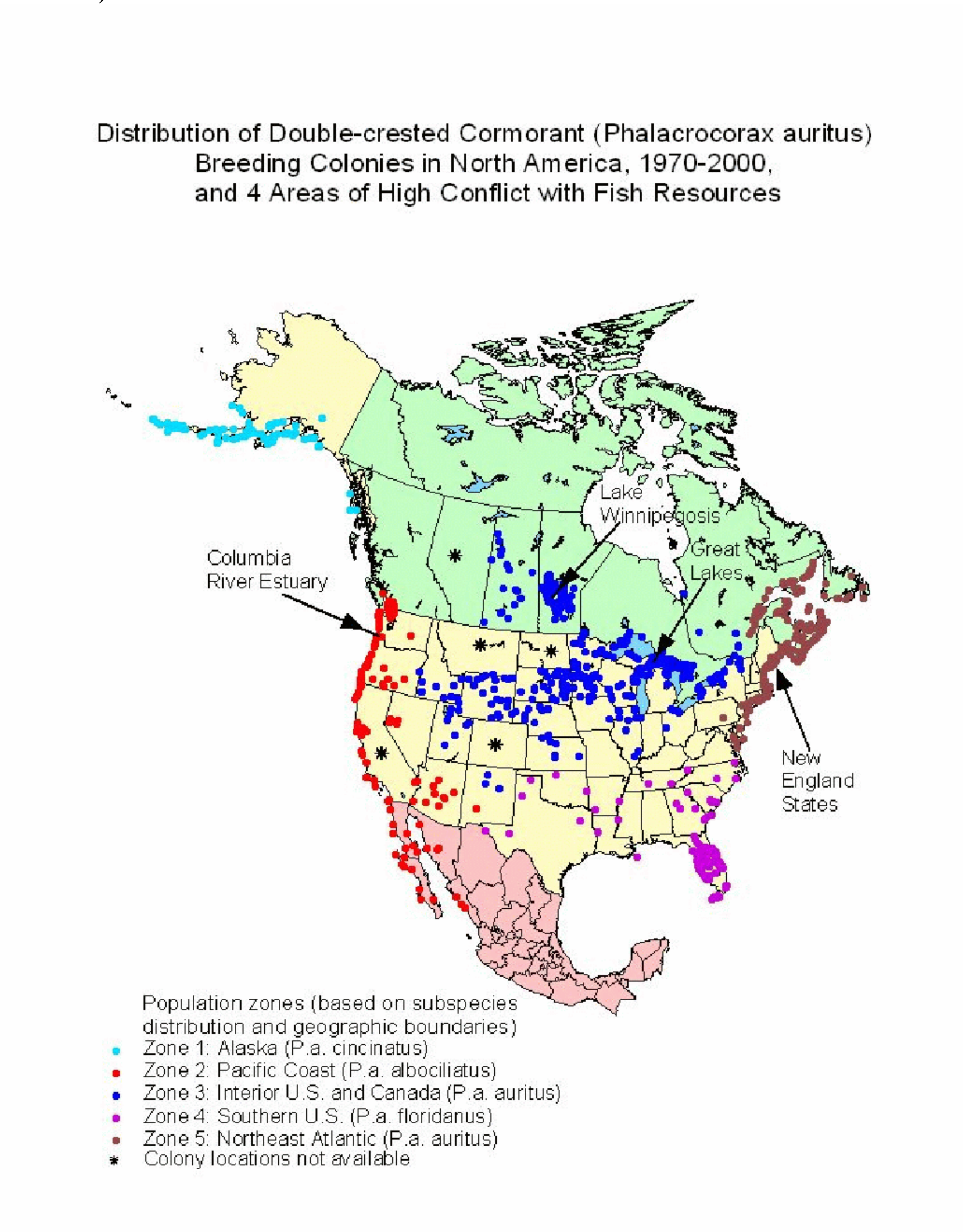
Arctic grayling *(Thymallus arcticus)*
Atlantic cod *(Gadus morhua)*
Atlantic menhaden (*Brevoortia tyrannus*)
Atlantic salmon (*Salmo salar*)
blueback herring (*Alosa aestivalis*)
bluegill (*Lepomis macrochirus)*
brook stickleback *(Culaea inconstans)*
brown trout (*Salmo trutta*)
burbot (*Lota lota*)
capelin *(Mallotus villosus)*
channel catfish (*Ictalurus punctatus*)
coho salmon (*Oncorhynchus kisutch*)
common carp *(Cyprinus carpio)*
chinook salmon (*Oncorhynchus tshawytscha*)
crappie *(Pomoxis spp.)*
cunner (*Tautogolabrus adspersus*)
emerald shiner (*Notropis atherinoides*)
fourspine stickleback *(Apeltes quadracus)*
freshwater drum *(Aplodinotus grunniens)*
gizzard shad *(Dorosoma cepedianum)*
grubbies (*Myoxocephalus aenus)*
lake/northern chub *(Couesius plumbeus)*
lake trout (*Salvelinus namaycush*)
lake whitefish *(Coregonus clupeaformis)*
largemouth bass (*Micropterus salmoides*)
ninespine stickleback *(Gasterosteus aculeatus)*
northern pike *(Esox lucius)*
Pacific salmon (*Oncorhynchus* spp.)
Pacific sand lance *(Ammodytes hexapterus)*
Pacific sardine *(Sardinops sagax)*
peamouth *(Mylocheilus caurinus)*
pumpkinseed *(Lepomis gibbosus)*
rainbow smelt (*Osmerus mordax*)
rainbow trout (*Oncorhynchus mykiss*)
rock gunnel (*Pholis gunnellus*)
rudd *(Scardinius erythrophthalmus)*
ruffe *(Gymnocephalus cernuus)*
sauger *(Stizostedion canadense)*
sea lamprey (*Petromyzon marinus*)
shiner perch *(Cymatogaster aggregata)*
slimy sculpin *(Cottus cognatus*)
smallmouth bass (*Micropterus dolomieui*)
snake prickleback *(Lumpenus sagitta)*
starry flounder *(Platichthys stellatus)*
steelhead (*Oncorhynchus mykiss*)
stickleback (*Eucalia inconstans)*
sunfishes (*Lepomis spp.*)
threadfin shad *(Dorosoma petenense)*
walleye (*Stizostedion vitreum*)
white perch *(Morone americana)*
winter flounder *(Pleuronectes americanus)*

wrymouth (*Cryptachanthodes maculatus*)
yellow perch *(Perca flavescens)*

**INVERTEBRATES**
crawfish *(Procambarus clarkii)*
sand shrimp (*Crangon septemspinosa*)
quagga mussel *(Dreissena bugensis)*
zebra mussel *(Dreissena polymorpha)*

**PLANTS**
beech (*Fagus spp.*)
cottonwood *(Populus spp.*)
cypress (*Cupressus spp.*)
dogwood *(Cornus spp.)*
hackberry (*Celtis occidentalis*)
hickory (*Carya spp.*)
oak (*Quercus spp.*)
willow (*Salix spp.*)

**Appendix 2. Distribution of DCCO Breeding Colonies in North America 1970 – 2000 (From Wires et al. 2001)**



**Appendix 3: DCCO Foraging Behavior at Aquaculture Facilities**

DCCOs clearly respond in a positive way to the presence of shallow-water ponds stocked with high densities of easy-to-capture prey fish. For example, within two weeks of stocking two ponds in Florida with fingerling catfish, twelve DCCOs were feeding in the ponds and roosting on nearby poles. A nearby pond, stocked with 75,000 fish in August 1980, had attracted thirteen DCCOs by September. These birds continued to feed at the pond throughout the fall and winter, and in spring 1981 they nested in a nearby cypress dome. By November 1981, about fifty cormorants were feeding in the pond (Schramm et al. 1984). The positive response of DCCOs to these ponds appears to be a contributing factor to the dramatic increase in the wintering population of cormorants in the fish producing regions of the southern U.S. (Reinhold and Sloan 1999; Glahn et al. 1999; Jackson and Jackson 1995).

*Daily Movements and Activity Budgets*. In the Mississippi Delta, DCCOs fly an average of 16 kilometers (10 miles) from their night roosts to feeding sites. Each bird spends about 18 percent of daylight hours feeding; 88 percent of their foraging is done at catfish ponds and 12 percent near roost sites. The average cormorant forages for 60 minutes each day, but spends just 20 minutes underwater in actual pursuit of fish (King et al. 1995).

*Feeding Rates*. Feeding rates may be dependent on the size and abundance of the available fish and the metabolic demands of the birds, and can be quite variable. Actively feeding DCCOs in commercial catfish ponds capture an average of about 5 fish/cormorant/hour (Stickley 1991; Stickley et al. 1992), but can vary from 0-28 (Stickley et al. 1992). Partly because of this variability, the rate of 5 fish/cormorant/hour reported by Stickley et al. (1992) is highly skewed; the median was only 2 fish/cormorant/hour, and the mean was equaled or exceeded at only 3 (21 percent) of the 14 ponds studied. Stickley et al. (1992) did not find a significant relationship between the mean number of DCCOs present and the number of catfish consumed, but ponds with 40 or more cormorants generally had a feeding rate of 1 or fewer fish/cormorant/hour. Similarly, DCCO feeding rates were not related to the density of fingerling catfish, density of all catfish (all size classes combined), or mean length of fish.

*Diet Composition*. DCCOs eat a wide variety of fish, and thus there is a great deal of variation in prey composition, both geographically and seasonally. Nearly all of the published information on diet composition at aquaculture facilities has been gathered in the vicinity of catfish farms in the southeastern United States (Bivings et al. 1989; Conniff 1991; Glahn and Stickley 1992; Glahn et al. 1995; Glahn et al. 1999b; and Glahn and Brugger 1995). These studies show that, among birds taken at winter roosting sites, the average proportion of catfish in the winter diet (by number) is most commonly in the range of 50-55 percent. The proportion varies seasonally from less than 30 percent in October and November to more than 80 percent in February, March, and April.

*Prey Size*. Although DCCOs are capable of taking catfish up to 42 centimeters (16 inches) in length (Campo et al. 1993), studies repeatedly have shown that the vast majority of catfish caught by cormorants at commercial facilities are in the range of 7-20 centimeters (3-8 inches), with most averaging about 10-15 centimeters (4-6 inches) (Schramm et al. 1984; Stickley 1991; Stickley et al. 1992). This range of prey sizes is remarkably close to that of prey taken by cormorants in natural freshwater habitats. In such studies (Durham 1955; Glahn et al. 1998; Hirsch 1986; Hobson et al. 1989; Campo et al. 1993), prey size ranged from 6-21 centimeters (2-8 inches), with a median value of about 12 centimeters (5 inches).

*Prey Preferences*. Lacking a precise knowledge of the species composition and size distribution of the prey population, it is impossible to make definitive statements about prey preferences. However a few tendencies are apparent. For example, the 10-15 centimeter (4-6 inch) fingerling catfish preferred by cormorants in one study represented about 64 percent of the catfish (by number) in the ponds (from Stickley et al. 1992), suggesting that the birds were merely preying on the most readily available fish. In

this same study, 1 of the 14 ponds contained gizzard shad in addition to catfish. Nineteen shad were consumed for every catfish eaten, even though the pond contained about 5,100 fingerling catfish/hectare. The apparent preference for gizzard shad in this instance may be related to their being more easily caught, handled, and swallowed by cormorants (the mean handling time for catfish was 6-7 times greater than that of gizzard shad).

*Daily Food Consumption Rates*. Estimates of daily food consumption rates of DCCOs at or in the vicinity of aquaculture facilities in the southeastern United States vary widely, from 208-504 grams (7-17 ounces, or 0.4-1.1 pounds) (Schramm et al. 1984; Schramm et al. 1987; Bivings et al. 1989; Conniff 1991; Brugger 1993; Glahn and Brugger 1995). Two separate captive cormorant trials were completed by *Glahn et al (In Review*) in Mississippi, one with out buffer prey and one with buffer prey (golden shiners) to help simulate diet composition of DCCOs in the field. In the non-buffered trial cormorants consumed between 10.2 and 10.5 catfish /bird/day or 516 and 608 grams/fish/day, which supports the daily food demand of 500 grams/fish/bird/day as predicted by the bioenergetics model of Glahn and Brugger (1995). In the buffer prey trial cormorants consumed approximately 7 catfish/bird/day closely simulating their expected diet composition in the field *(Glahn et al. In Review).*

**Appendix 4: Management Techniques**

Wildlife damage control activities generally fall into one of three broad categories: 1) resource management, 2) physical exclusion, and 3) wildlife management (USDA-APHIS 1997b).

**1. Resource Management**

Cultural methods may include facility location, facility design, and fish management (Gorenzel et al. 1994) and are carried out by land owners/managers. The physical location, design, and construction of an aquaculture facility influence the susceptibility of fish to bird predation, while facility design influences success in protecting fish stocks from predation. Fish management may include locating the most susceptible fish species and size close to the center of human activity and near buildings that might be incorporated in a bird exclusion system, and altering fish stocking dates so that vulnerable fish are not stocked when substantial bird numbers are present (Mott and Boyd 1995).

Environmental/habitat modification can be an integral part of wildlife damage management. Since the presence of wildlife is directly related to the type, quality, and quantity of suitable habitat, habitat itself can be managed to reduce or eliminate the production or attraction of certain bird species. In most cases, the land owner/manager is responsible for implementing habitat modifications. Habitat management is most often a primary component of wildlife damage management strategies at or near airports (i.e., to reduce bird aircraft strike problems by eliminating bird nesting, roosting, loafing, or feeding sites). Generally, many bird problems on airport properties can be minimized through management of vegetation and water from areas adjacent to aircraft runways (Godin 1994).

Nest/tree removal is the removal of nesting materials during the construction phase of the nesting cycle or the removal of trees used for nesting/roosting. Nests can be removed or destroyed manually or by use of high pressure water to dislodge nests from trees (Chipman et al. In press). Nest/tree removal has been used to manage DCCOs locally (to eradicate colonies) and regionally (to reduce populations). The technique has been used on both ground and tree nests. Nest destruction on the ground simply involves the physical breakup of nest structures. Tree nests present a greater challenge. Entire trees have been removed, both in private (Anderson and Hamerstrom 1967) and official control efforts (USFWS 1999a, b).

Nest removal, even when successful at preventing colonization attempts, cannot be considered permanent; control must be repeated each time cormorants attempt to nest in areas of concern. It may also eliminate nest substrates for other species. Where DCCOs have already made trees unsuitable for nesting by other species, this may not be an issue; however, removing nest trees may shift DCCO nesting and move them into conflict with other species (Wires et al. 2001). Additionally, because DCCOs frequently nest on the ground, tree removal may only be effective where the substrate is inappropriate for nesting or the threat of mammalian predation is high (Wires et al. 2001).

**2. Physical Exclusion**

Birdproof barriers can be effective but are often cost-prohibitive, particularly because of the aerial mobility of birds which requires overhead barriers as well as peripheral fencing or netting. Exclusion adequate to stop bird movements can also restrict movements of people, including fish maintenance and harvesting operations, and are susceptible to ice and wind damage (Littauer et al. 1997). Barrier systems using wire, line, and string in parallel and grid patterns and polyethylene rope with foam floats have been used for deterring DCCOs (Mott et al.1995; Littauer et al. 1997). The concept is meant to take advantage of the relatively long take-off distance (approximately 30 feet) that DCCOs generally require. Parallel wires should be positioned perpendicular to the prevailing wind as cormorants generally take off and land into the wind. Colored streamers have been used to increase visibility of the wires and strings. However,

cormorants have been known to adapt readily to parallel wires so grid patterns are inherently more effective (Littauer et al. 1997).

**3. Wildlife Management**

A. Non-lethal techniques

*Harassment or animal behavior modification.* This refers to tactics that alter the behavior of wildlife to reduce damage. Animal behavior modification may involve use of scare tactics to deter or repel animals that cause loss or damage (Gorenzel et al.1994; Littauer 1990; Reinhold and Sloan 1999). Numerous techniques and devices can be used to frighten DCCOs. Wires et al. 2001 reviewed these non-lethal techniques by dividing them into three categories: 1) direct human harassment, in which humans attempt to frighten, but not kill, cormorants, 2) simulated human harassment, in which static or animated devices frighten cormorants by simulating human threats, and 3) other harassment, in which the negative stimulus is not necessarily connected to human activity. Some but not all methods that are included in this category are:

- Electronic guards
- Propane exploders
- Pyrotechnics
- Distress calls and sound producing devices
- Repellents
- Scare crows
- Mylar tape
- Eye spot balloons
- Vehicle horn and chase
- Live ammunition

These techniques are generally only practical for small areas. Scaring devices such as distress calls, helium-filled eye spot balloons, scare crows, effigies and silhouettes, mirrors, and moving disks can be effective but usually for only a short time before birds become accustomed and learn to ignore them (Mason and Clark 1997; Mastrangelo et al. 1997, Stickley, et al. 1995; Stickley and King 1995; Mott et al. 1995; Reinhold and Sloan 1999). Littauer et al. (1997) noted that a scaring program must be consistent and aggressive to be successful. Timing is also critical (Mott and Boyd 1995) and therefore harassment must begin as soon as it can be economically justified and continued until all undesirable birds vacate the area (Reinhold and Sloan 1999).

*Human harassment*. As discussed in Wires et al. (2001), the most common form of direct human harassment is ground patrol with pyrotechnics. Patrols may occur on foot or in vehicles and may utilize a variety of pyrotechnics to frighten DCCOs (and, of course, other birds). Pyrotechnics include various shellcrackers, screamers, whistling projectiles, exploding projectiles, bird bangers, flash/detonation cartridges and live ammunition (Lagler 1939; Moerbeek et al. 1987; Hanebrink and Byrd 1989; Stickley and Andrews 1989; Littauer 1990; Brugger 1995; Mott and Boyd 1995; Pitt and Conover 1996; Spencer 1996; Littauer et al. 1997; Reinhold and Sloan 1999). Live ammunition is often used because it is cheaper and more readily available than pyrotechnics (Littauer 1990; Mott and Boyd 1995; Littauer et al. 1997). Cormorants are often frightened from aquaculture ponds simply because of the presence of humans (Hanebrink and Byrd 1989; Spencer 1996; and Reinhold and Sloan 1999). Hodges (1989) concluded, for example, that the presence of humans at aquaculture facilities during critical periods may be the most effective means of keeping DCCOs off ponds.

*Simulated Human Harassment*. To reduce labor costs for harassment patrols, various devices, both static and animated, have been developed to simulate the threat of human activity near areas of concern, usually

aquaculture ponds. These devices range from simple wood cutout scarecrows to elaborate contraptions that create startling movements, emit numerous noises, and flash lights (Wires et al. 2001).

Human effigies/scarecrows have long been used against avian predators at many different types of agriculture fields, despite their general lack of success at preventing depredations (Lagler 1939; Inglis 1980). Increasing both realism and level of animation in scarecrows may improve their ability to scare birds, and combining scarecrows with automated sound devices may enhance the frightening effect (Littauer 1990; Littauer et al. 1997). Stickley et al. (1995) and Stickley and King (1995) tested an inflatable effigy called Scarey Man® on catfish farms in Mississippi, as described in Wires et al. (2001). For relatively short lengths of time (10-19 days), the device significantly reduced the number of DCCOs on the ponds (71-99 percent reduction in number of DCCOs flushed from ponds during ground patrols). Compared to replacement cost of catfish consumed (based on mean DCCO consumption rate in Stickley et al. 1992), Scarey Man® devices were considered to be economically efficient (Stickley et al. 1995). However, evidence of habituation was reported, especially when day roosts were in view of the Scarey Man® devices. Stickley and King (1995) suggested that the device be used where DCCO depredations are "serious."

Another animated scarecrow was described by Conniff (1991). This device was described as a jack-in-the-box scarecrow with inflatable plastic arms, revolving strobe lights, and amplified sounds (130 dB) of horns honking, people shouting, shotguns firing, and birds screaming. The device was declared "ineffectual," indicating that "a cormorant can get used to almost anything."

*Other harassment.* As described in Wires et al. (2001), other means to startle birds into flight have been developed, and many have been used against DCCOs. These include amplified DCCO distress calls; sirens and other electronically generated noises; tin plates, mylar balloons, reflecting tape and other reflectors; and eyespot balloons and raptor silhouettes (Lagler 1939; Barlow and Bock 1984; Moerbeek et al. 1987; Parkhurst et al. 1987; Stickley and Andrews 1989; Littauer 1990; Brugger 1995; Mott and Boyd 1995; Price and Nickum 1995; Spencer 1996; Littauer et al. 1997; Reinhold and Sloan 1999.)

Auditory scaring devices such as propane exploders, pyrotechnics, electronic guards, and audio distress/predator vocalizations are effective in many situations for dispersing damage-causing bird species. However, birds often habituate to such devices, rendering them ineffective. Using a combination of harassment devices prolongs habituation and provides the greatest amount of protection. Frequently changing and moving devices further enhances protection (Gorenzel et al. 1994; Reinhold and Sloan 1999).

Visual scaring techniques such as use of mylar tape (highly reflective surface produces flashes of light that startles birds), eye-spot balloons (the large eyes supposedly give birds a visual cue that a large predator is present), and flags, sometimes are effective in reducing bird damage (Gorenzel et al. 1994; Littauer et al. 1997; Stickley et al. 1995; Stickley and King 1995).

Reviewers have generally found distress calls ineffective against DCCOs for long periods of time (Wires et al. 2001). Hanebrink and Byrd (1989) mention that, while APHIS-WS recommended using amplified distress calls, the calls merely moved birds to different ponds. Littauer (1990a) listed distress calls among other electronically generated noises whose effectiveness was "uncertain," but did note observations of DCCOs apparently being *attracted* to distress calls. Effectiveness of audio and visual scare tactics (specifically distress calls, electronically generated noises, tin plates, mylar ribbon, flash tape, flagging, helium balloons, inflatable eyespot balloons and hawk silhouette kites) have generally been found to be low when deployed by themselves or over long periods of time (Littauer 1990; Spencer 1996; Reinhold and Sloan 1999).

Various noisemakers to scare DCCOs have been developed, including the rope firecracker, which sets off explosions as the rope burns (Littauer 1990) and propane/butane/acetylene cannons, some of which can be programmed to go off at varying intervals and variable numbers of times. The effectiveness of cannons is itself variable (Wires et al. 2001). Stickley and Andrews (1989) reported that 40 percent of respondents used propane cannons. Of these, 60 percent found them to be either somewhat or very effective against DCCOs. Brugger (1995) reported initial success with cannons, but with relatively quick habituation. Conniff (1991) reported that butane cannons eventually became perches for DCCOs. Individuals using propane cannons in Oklahoma and Georgia reported them to be ineffective (Spencer 1996; Simmonds et al. 1995a) and Moerbeek et al. (1987) found gas cannons generally ineffective against Great Cormorants in the Netherlands.

Given the general lack of success with harassment techniques used separately (largely due to habituation), many investigators have concluded that, to be effective, 1) a variety of techniques must be used, 2) techniques should be applied vigorously, 3) location of static and automatic devices should be changed frequently, and 4) the combination of techniques should be altered frequently (Moerbeek et al. 1987; Littauer 1990; Mott and Boyd 1995; Mott and Brunson 1997; Reinhold and Sloan 1999). The recommendation by Littauer (1990a) that use of gas cannons be stopped once habituation begins to occur (to prevent a decrease in their utility at a later date) could probably be applied to all forms of non-lethal harassment (Wires et al. 2001).

*Non-lethal Dispersal at Night Roosts.* Night roost dispersal is used to harass DCCOs from their roosting sites in an effort to re-locate birds away from a particular area or region (Mott et al. 1998; Reinhold and Sloan 1999). The goal of this approach is to keep DCCOs from roosting in the area at night and subsequently to decrease the number of depredating birds within the harassment area during the day. Most discussion of this technique has focused on the Mississippi Delta region where it has been practiced since 1992 (Mott et al. 1998). This type of dispersal program is labor intensive and requires a great deal of organization and coordination to be effective (Reinhold and Sloan 1999; Tobin 1998). Electronic noise generators, amplified recordings, propane exploders, pyrotechnics, and firecrackers can be used to disperse birds. Laser guns can also be used to startle DCCOs in low-light conditions (Wires et al. 2001, Hatch and Weseloh 1999). McKay (1999) reported that laser guns have been used effectively against Great Cormorants in England, Wales, France, and Italy. This technique effectively reduced numbers of birds at night roosts as well as numbers feeding in nearby ponds in England and Wales. However, its widespread use is currently cost prohibitive.

Discussions of the effectiveness of the Mississippi Delta program are limited, but tend to suggest that the program may be numerically and economically effective (Wires et al. 2001). Surveys within harassment areas during the winter of 1993-94 counted 70 percent fewer birds than the previous winter (1992-93) when there was no harassment; surveys from 1994-95 showed a 71 percent decrease from number of birds detected in 1992-93 (Mott et al. 1998). Survey data from aquaculturists in 1994 revealed that 62 percent within the harassment zone reported fewer problems with DCCOs than in previous years, whereas 38 percent outside the zone had the same sentiments; data from 1995 revealed little change, with 74 percent of aquaculturists within the harassment zone reporting fewer problems and 38 percent outside reporting the same (Mott et al. 1998). These perceptions are reflected in the amount of money spent on harassment at individual aquaculture facilities: within the harassment zone, aquaculturists reported an average $1,406 decrease in expenses for harassment at their facilities in 1994, and $3,217 in 1995. Cost of the program was $16,757 in 1994 and $32,302 in 1995. If these costs were divided equally among participating aquaculturists, each would have paid $419 in 1994 and $557 in 1995. Based on a comparison between cost of the night roost harassment program and reductions in harassment expenditures at individual aquaculture facilities, the control program was considered economically effective. However, Reinhold and Sloan (1999) point out that "ever-increasing numbers" of night roosts can limit the success of dispersal programs.

*Prevention of colony establishment.* Another important means of limiting the damages caused by DCCOs is to prevent birds from establishing colonies in areas of concern. Bregnballe et al. (1997) predicted that potential breeders prevented from founding a new colony could be expected to either delay breeding to a later year or to join existing colonies. This would likely have two effects: (1) the population would stabilize sooner and (2) the population would stabilize at a lower absolute population size because the resources available at breeding would be reduced. Without persistent, frequent attempts to harass birds away from potential breeding sites, however, or if individuals attempt to nest at sites that have been previously used for roosting, it is likely that they would be less willing to abandon nesting attempts. Bregnballe et al. (1997) suggested that it might therefore be necessary to shoot some of these individuals to prevent colonization.

B. Lethal techniques

*Egg and nestling destruction.* DCCO eggs and nestlings have been destroyed in attempts to reduce recruitment into populations and to eliminate colonies at specific locations (in conjunction with other forms of harassment). Bregnballe et al. (1997) predicted that the effect of increased egg mortality on autumn population size would be buffered by increased density-dependent chick survival. However, if repeated egg oiling efforts led to near total clutch failure at ground-nesting colonies, the population would be expected to stabilize at lower sizes and the proportion of the foraging area being exploited during breeding would decline. Van Dam and Asbirk (1997) predicted no risk to cormorant populations from reducing reproductive output if it was carried out "under control."

In general, egg and nestling destruction may not be effective at completely eliminating reproduction for individual DCCOs during a nesting season because of their tendency to renest after disturbance. As reported in Wires et al. (2001), in some instances (Lake Winnipegosis, Manitoba; Lake of the Woods, Minnesota and Ontario; St. Lawrence River Estuary, Quebec) local DCCO populations continued to rise despite egg and nestling destruction efforts (Hobson et al. 1989; Baillie 1939, 1947; DesGranges and Reed 1981). In contrast, some investigators have suggested that egg and nestling destruction on a large scale (often in conjunction with killing adults) may have slowed the growth of populations (Weseloh and Collier 1995), stabilized populations, or contributed to declines (Ewins and Weseloh 1994; Sheppard 1994/5; USFWS 1999b). McLeod and Bondar (1954) concluded that consistent destruction of eggs and young appeared to reduce the breeding population fairly effectively on Lake Winnipegosis in the 1940s and 1950s. The key factor is most likely whether density-dependent mechanisms are sufficiently overcome by the specific management actions.

Effectiveness at causing colony abandonment appears to vary; newly established colonies appear to be more easily eliminated than well established ones (Wires et al. 2001). Most recently, egg and nestling destruction, in conjunction with nest destruction and sometimes harassment, has been found to be effective at preventing renesting for a year or more at newly established colonies (USFWS 1999a, b).

Egg oiling has essentially the same result as that of killing eggs and nestlings, but with the added benefit that DCCOs are less likely to abandon nests and lay replacement clutches, making the technique more effective as an annual treatment (Wires et al. 2001). Bédard et al. (1995) report, "None of the eggs in 427 experimentally treated nests hatched in 1987 and nearly half were still tended by adults 49 to 59 days after laying (the remainder having been abandoned and scavenged)." Shonk (1998) reports, "Of the eggs treated with oil, 49 percent were incubated past the expected hatching date. The remainder of the eggs were lost during the incubation." Human disturbance during oiling increases predation by gulls (Shonk 1998), which may cause some DCCOs to renest.

Egg oiling is a method of suppressing reproduction of nuisance birds by spraying a small quantity of food grade vegetable oil or mineral oil on eggs in nests. The oil prevents exchange of gases and causes

asphyxiation of developing embryos. The method has an advantage over nest or egg destruction in that the incubating birds generally continue incubation and do not renest. The EPA has ruled that use of corn oil for this purpose is exempt from registration requirements under the Federal Insecticide, Fungicide, and Rodenticide Act. To be most effective, the oil should be applied anytime between the fifth day after the laying of the last egg in a nest and at least five days before anticipated hatching. This method is extremely target specific and is less labor intensive than egg addling.

Effectiveness at killing embryos is high, with mortality rates approaching 100 percent when the oil/solution is applied correctly (Gross 1951; DesGranges and Reed 1981; Blokpoel and Hamilton 1989; Christens and Blokpoel 1991; Shonk 1998; Bédard et al. 1999). Although laboratory tests found oiling ineffective when applied only to part of an egg (Blokpoel and Hamilton 1989), field tests in which only the tops of eggs were sprayed were highly successful, indicating that careful application to the entire egg surface may not be necessary (Christens and Blokpoel 1991; Bédard et al. 1999). Egg-rolling activities by parents may assist in covering the entire surface (Christens and Blokpoel 1991).

The effectiveness of egg oiling as a population control method can be quite variable. Because DCCO egg laying is not synchronous, only one spraying per summer may not treat enough of the eggs laid that nesting season to have a significant impact on the population, and multiple oiling efforts to overcome this problem may increase the cost of control beyond acceptable levels. Both problems were cited as reasons for the failure of egg oiling efforts in Maine by Dow (1953). If carried out with appropriate intensity, egg oiling can be a very effective means of reducing local populations, although the results are more slowly seen than with culling or a combination of the two techniques. Modeling of the St. Lawrence River Estuary, Québec, DCCO population suggested that egg oiling alone would not be sufficient to bring DCCO numbers to target levels within the desired time frame, leading to the selection of a combined strategy of egg oiling and shooting adults (Bédard et al. 1995).

*Killing adults.* Shooting adults has been a commonly used technique for controlling DCCOs (Matteson 1983; Hobson et al. 1989; Ewins and Weseloh 1994; Sheppard 1994/5; Carter et al. 1995b; Jackson and Jackson 1995; Ludwig and Summer 1995; Weseloh and Collier 1995; USFWS 1999b). Shooting DCCOs is believed to reinforce non-lethal harassment (EIFAC 1988, Hess 1994, Littauer 1990, Mastrangelo et al. 1997, Rodgers 1988 and 1994, Tucker and Robinson 1990, USDA 1994 cited in Glahn et al. 2000b) and is highly selective for target species. Shooting is typically conducted with shotguns or rifles and can be relatively expensive because of the staff hours sometimes required (USDA 1994).

The effectiveness of shooting to kill adults may be limited since DCCOs can be wary and difficult to shoot (Wires et al. 2001). In cases where large numbers of birds are present, it may be more effective as a dispersal technique than as a way to reduce bird densities. A study by Glahn (2000) indicated that shooting DCCOs in roosts was as effective as frightening them with pyrotechnics for dispersing them, and may not result in habituation.

Wires et al. (2001) discussed that the killing of adult DCCOs may be a successful technique for controlling regional populations, but would likely require that large numbers be killed and that the geographic range of the program be sufficiently wide. Killing nesting DCCOs is most likely to be successful at reducing population levels when two conditions are met: (1) scale of control is large enough to overcome the effects of immigration and (2) the control effort is well coordinated, long-term, and sufficiently rigorous to overcome density-dependent compensation mechanisms. The success of a culling program is not only limited to the number of birds removed but also the age and sex of the individuals being removed (Bédard et al. 1999, Ludwig and Summer 1995, Wires et al. 2001). As a means of reducing population levels, it is believed that it is more effective to kill breeding birds than to destroy eggs, nestlings, or fledglings because first-year birds frequently have low survival rates and many would not have survived to breed anyway (Wires et al. 2001).

Shooting adults at colonies may have impacts beyond killing individual breeders because of harassment effects on survivors. Cairns et al. (1998) observed that the abandonment of a large DCCO colony in waters of Prince Edward Island, Canada, seemed to have been caused by shooting and harassment at the colony that had taken place when cormorants first returned to the area in the spring. The birds from the abandoned Ram Island colony apparently shifted to nearby Little Courtin Island. However, since DCCOs usually exhibit strong philopatry and site-fidelity, the displacement was judged to be highly "anomalous." Ewins and Weseloh (1994) reported that the shooting of > 50 adults on Pigeon Island, Lake Ontario, in 1993 (when the colony had 818 pairs) reduced reproductive output for that year: fledging rates were 0.3 vs. 1.6 young/nest on a nearby island that was not subject to shooting. Long-term impacts on the colony were not reported (Wires et al. 2001).

Limited data are available on the effectiveness of killing adults on controlling local populations/colonies (Wires et al. 2001). Matteson (1983) noted that shooting DCCOs at pound nets by fishermen did not prevent the nearby Mink Island, Lake Ontario population from increasing from 40 nests in 1945 to 50 nests in 1956. Ludwig and Summer (1995) analyzed leg band recovery data for DCCO colonies in the Les Cheneaux region of Lake Huron and concluded that, based on the level of immigration into this region, lethal control of adults would have to be Great Lakes-wide to be effective at controlling local populations (see also Korfanty et al. 1999).

The St. Lawrence River Estuary, Québec, control program provides an example of a control effort intensive and expansive enough to reverse DCCO population growth. The goal of a 5-year control program on the St. Lawrence River Estuary, Québec, was to reduce the cormorant population to 10,000 pairs. Culling was halted after only four years, however, due to quicker than anticipated results believed to be caused by the fact that adult male DCCOs were more vulnerable to shooting than adult females (at a ratio of 2:1 males to females). Another goal of this program was to discourage tree nesting. In 1989, the year the culling program began, 43 percent of all nests were in trees; five years later, in 1993, only 27 percent of nests were arboreal (Bédard et al. 1999).

Effectiveness of killing adults relative to other forms of population control are unknown, although it is believed that, individual for individual, killing adults that have survived to breed is more effective at reducing populations than destroying eggs, nestlings or fledglings. Ludwig and Summer (1995:40) estimated that, "From the whole population perspective, killing a young adult just before first nesting will have a 3 to 6 fold greater effect on population control than killing fledglings, chicks or eggs."

Without adequate knowledge of intercolony migration rates it is difficult to predict the minimum scale of control necessary to overcome effects of immigration (Wires et al. 2001). For lethal control to effectively reduce predation levels, the mortality rate must be higher than the immigration rate. This level of lethal control may be difficult to achieve without extensive control efforts. In Bavaria, Germany, the number of Great Cormorants reported shot during the winters of 1995-96 to 1998-99 was approximated at 50 to 100 percent of the average Bavarian winter cormorant population. Despite this high level of mortality, mean winter numbers of cormorants did not substantially decrease. Shooting did not remove birds from water bodies that were supposed to be protected, but simply killed migrant birds which were rapidly replaced by newly arriving individuals. Because mean winter cormorant numbers did not decrease substantially, shooting was considered an inappropriate management tool for reducing overall fish depredation in Bavaria (Keller et al. 1998; Keller 1999).

**Appendix 5. Methodology for estimating take under the aquaculture depredation order**

To estimate take under the aquaculture depredation order we sent out a survey in 2001 to all of the aquaculture producers in the 13 relevant States (using data from our SPITS database). This survey led to an estimated take per producer of 190 DCCOs per year for the year 2000 (however, since the DEIS was written more data came in and the mean take per producer decreased to 159, but we decided to err on the "liberal" side and stay with 190). This number is consistent with Glahn et al.'s (2000) finding that 62 producers in Mississippi killed an average of 154 DCCOs per producer.

For 1998, to estimate take we multiplied 121 (the estimated number of producers in all depredation order States except Arkansas and Minnesota which were excluded because we have reported take data for these States and thus didn't need to estimate) by 154 to come up with an estimate of 18,634 DCCOs killed. We multiplied by Glahn et al.'s estimate instead of our estimate of 190 because the latter was an estimate for the year 2000. To this estimate we then added the reported take for Arkansas and Minnesota.

For 1999, we used the same technique except that we had to estimate take for Arkansas this year. So we multiplied 154 by 237 (the number of producers excluding those in Minnesota) and came up with an estimate of 38,098. To this estimate we then added the reported take for Minnesota.

For 2000, we multiplied 121 (again, all aquaculture producers except those in Minnesota and Arkansas) by 190 (average take per producer based on our survey). This comes to 22,990 to which we added the reported take for Arkansas and Minnesota.

Average annual take under the aquaculture depredation order for the 3-year period equals 35,874. Dividing this by 13 gives an average take per State of 2,760 DCCOs per year.

## Appendix 6: Discussion of Fishery Impacts

Derby and Lovvorn (1997) stated that to evaluate the effects of bird predation on fish populations, "it is best to compare estimated amounts of fish consumed with total populations or production of fish." Furthermore, Cairns (1992b) noted that "the impact of bird predation depends crucially on avian prey size selection and the growth and mortality schedules of the fish populations." Thus, information needs include a thorough knowledge of: the diet of DCCOs, either through diet studies and/or bioenergetics models that indicate food requirements, and the demographics of the fish population, including mortality factors and survival estimates for all segments of the life cycle. However, most research on DCCO-fisheries interactions has examined diet alone, often without any estimates of fish population data. Such food habit studies, while descriptive of the proportion of a fish species in DCCO diet (e.g., by weight or by number), cannot quantify the impacts of DCCO predation on fish populations. As Hatch and Weseloh (1999) stated, "cormorant predation and its impacts are not revealed by mere lists of prey or simple percentages." The following sections discuss DCCO-fishery interactions at specific locations where DCCOs have been suspected of impacting fish populations.

### Oneida Lake, New York

Oneida Lake is the largest lake located entirely in New York State and is well-known for its recreational fishing. Seventy-four fish species have been identified in Oneida Lake, which is managed intensively to optimize recreational fishing opportunities for walleye (Mills et al. 1998). In fact, it has been referred to as the "Walleye Lake of New York State" and provides anglers more fish per acre than any other lake in the Northeast (Cornell Cooperative Extension of Onondaga County 2000).

However, the lake's adult walleye population has decreased during the 1990s from a long term average of 675,000 (1958-1990) to 215,000 in 1999 (VanDeValk et al. 1999). Walleye recruitment and projected stock abundance in Oneida Lake has been estimated by a stock-recruitment relationship model since 1978. Since 1999, the model has overestimated the actual abundance of adult fish, indicating increased mortality of walleye age-1 to 4. For example, this model predicted that 112,000 walleye from the class of 1995 would reach adult size, but only 32,000 actually did (VanDeValk et al. 1999). In addition to increased mortality from age-1 to age 3, walleye mortality has increased during their first year of life (from larvae to first fall). This increase in early mortality is likely due to predation by juvenile and adult fish in the lake. Predation on young walleye has likely increased because the number of larval perch has declined (VanDeValk et al. 1999, Mills et al. 1998). Small yellow perch buffer predation on walleye when they are abundant (Forney 1980). Both increased mortality during the first year and increased mortality between age-1 and 4 have contributed to the declining walleye population in the lake.

Yellow perch are a very important panfish in Oneida Lake. They are sought by anglers throughout the year, and are the main prey of walleye. The dynamics of perch and walleye populations in Oneida Lake are coupled tightly. In the absence of any other dominant forage fish, walleye productivity requires the availability of young perch as prey. For example, walleye consumed 58 percent of the estimated population of age-0 yellow perch and 47 percent of the age-1 yellow perch in the Lake in 1996 (VanDeValk et al. 1999). Similar to walleye, the contribution of yellow perch year classes to the adult stock at age-3 has been predicted by a stock-recruitment relationship model. However, as with walleye, recent forecasts of recruitment have over-estimated year class contributions. These differences between predicted and observed estimates of age-3 and older yellow perch are probably a result of increased predation between age-1 and 3 (VanDeValk et al. 1999).

*DCCO Status and Diet.* Oneida Lake's cormorant population increased from one nesting pair in 1984, to 332 nesting pairs in 1998, 339 in 1999, 365 in 2000, and 260 in 2001. Census data of DCCOs frequenting the lake during April-May of 1998-99 indicates the population can range between 550 and 800 birds (J. Coleman and M. Richmond, Cornell University, pers. comm.). However, there has

historically been a large influx of seasonal migrant birds that stop to feed and roost on the lake. For example, there may be as many as 3,000 cormorants on the lake in October (Adams 1999).

The diet of Oneida Lake's DCCOs varies from year to year, and seasonally, reflecting the absolute abundance of prey species (Adams 1999). Cormorants are known to feed on at least 25 of the 74 fish species known to occur in Oneida Lake; they typically feed on up to eight different fish species daily. As cormorant populations have increased during the last ten years, walleye and yellow perch have been the most abundant fish species consumed, with the heaviest feeding on adult walleye taking place in the fall during the influx of birds. In fact, the estimated number of yellow perch and walleye consumed by DCCOs is comparable to the number of fish "missing" from model predictions (i.e., the difference between the number predicted from the abundance of age-1 fish and the number of age-3 or 4 fish observed later in the lake) (VanDeValk et al. 1999). Cormorants are the main predator on these fish sizes. Adams (Cornell Univ., unpubl. data) found that in the spring of 1996, DCCOs were estimated to have consumed 1,123,800 yellow perch (12.7 percent of the population estimate) and 100,600 walleye (14.4 percent of the population estimate).

In 1997, DCCOs were estimated to have consumed about 15 percent of age-3 and older yellow perch and 7 percent of age-4 and older walleye in 1997. These exploitation rates of adult fish are comparable to the angler exploitation rate. It has been calculated that exploitation rates of cormorants were between 12 and 20 percent of age-1, 2, and 3 walleye (VanDeValk et al. 1999). VanDeValk et al. (2002) found that the number of walleye consumed by DCCOs was similar to the number taken by anglers; however, only DCCOs consumed subadult walleye (age-3 or younger), and only anglers harvested adults (age-4 or older). DCCOs and anglers combined took 7 percent of age 1-3 walleyes and 14 percent of the adult walleye population. DCCO consumption of adult yellow perch was similar to angler harvest, but DCCOs consumed nearly 10 times as many age-2 yellow perch and only DCCOs harvested age-1 yellow perch. DCCOs and anglers together harvested 40 percent of age-1 and age-2 yellow perch and 25 percent of the adult yellow perch population. The authors concluded that DCCO predation on adult percids has little effect on angler harvest, but consumption of subadults will reduce future angler harvest of yellow perch and, to a lesser degree, walleye (VanDeValk et al. 2002).

*Other Factors.* Oneida Lake is undergoing biological changes in response to several factors, including reduced nutrient loading and exotic species. Zebra mussels have clarified the water to record depths, stimulating the growth and distribution of submerged aquatic plants (Mayer et al. 2000). In response, walleye populations have redistributed away from shallow reefs, toward the darker water of weed beds and deeper locations in the lake. Increased water clarity may be contributing to increased mortality of age-0 walleye (a trend revealed since 1992 by index trawl data) by making them more susceptible to predation or cannibalism (Mills et al. 1998). Despite zebra mussel infestation, the lake's zooplankton population has not declined, and remains capable of supporting historic populations of yellow perch and walleye (Mills et al. 1998).

**Eastern Lake Ontario, New York**

Lake Ontario supports a productive sport fishery, albeit one that is changing rapidly (USFWS 1995). Due to its shallow and complex morphometry, much of the eastern basin of Lake Ontario supports a warmwater fish community (Stone et al. 1954 and Hurley 1986 *in* Burnett et al. 2002). Salmonids are the most popular sport fish in Lake Ontario as a whole but, in the eastern basin, some 48 percent of anglers surveyed were fishing specifically for smallmouth bass (McCullough and Einhouse 1999). In fact, smallmouth bass remain the most abundant and widespread sport fish in the eastern basin, attracting over 35,000 directed angler trips in 1998 (NYSDEC 2000). Numerous citizens and the New York State Department of Environmental Conservation (NYSDEC) have expressed concern about the impact of growing DCCO populations in the eastern basin on the smallmouth bass fishery there.

The smallmouth bass is a native of the Great Lakes-St. Lawrence River drainage and a key predator within the eastern basin of Lake Ontario's fish community. Their populations in Lake Ontario have remained relatively stable over the years (USFWS 1995), but dramatic declines have been documented (e.g., through gillnet surveys) in the eastern basin since the early 1990s. For example, the mean catch per unit effort (CPUE) from 1995-1997 was over 50 percent lower than that for 1984-1986 (Chrisman and Eckert 1999).

*DCCO Status and Diet.* DCCOs were first observed nesting on Lake Ontario in 1938. Through the 1960s and early 1970s, DCCOs were absent from Lake Ontario but in 1974 they established a colony of 22 pairs on Little Galloo Island. In 1999, the number of cormorant nests on Little Galloo Island was 5,681 (NYSDEC 2000). The Little Galloo Island colony and two other colonies, on Pigeon and Snake Islands, represent the three largest DCCO colonies in eastern Lake Ontario (Johnson et al. 2000b).

Past diet studies indicated that recreationally important species such as salmonids and smallmouth bass typically do not make up a large proportion of DCCO diet in eastern Lake Ontario. In the early 1990s, the predatory effect of DCCOs was addressed in a report by a special task group of the Lake Ontario Committee. Bioenergetic simulations estimated that DCCOs accounted for 2-3 percent of the total annual predation of pelagic prey fish and did not appear to be a major contributor to lakewide predation effects at that time (USFWS 1995). It should be noted that DCCO populations have increased considerably since the early 1990s and, furthermore, the effects of DCCO predation in a large lake such as Lake Ontario are more likely to be localized than lakewide, thus warranting examination of potential site-specific population impacts.

A study of cormorant food habits in 1992 revealed that only about 3 out of every 1,000 fish eaten by cormorants in the eastern basin was a trout or salmonid. The failure to find coded wire tags (which were used to mark released lake trout) in any of the cormorant food samples suggested that cormorants had little if any impact on the lake trout stocking program in Lake Ontario. Alewife was found to be the most abundant prey species taken, followed by yellow perch and centrarchids (Karwowski 1992). Ross and Johnson (1994) found 32 coded wire tags in 176 pellets collected the day after a stocking event in 1993 at Stony Point, New York. Ross and Johnson (1995) estimated that 7.6 percent of a 1993 lake trout stocking and 8.8 percent of a 1994 stocking were consumed by DCCOs.

Ross and Johnson (1997) found that smallmouth bass represented 0.7 to 2.1 percent (by number) of eastern basin DCCO diet items, with an average estimated annual consumption of 650,000 fish. Johnson et al. (1999) used modeling to estimate that 1.3 million smallmouth bass were consumed by DCCOs in the eastern basin in 1998. In 1993, 1994, and 1998, it was estimated that smallmouth bass contributed an average of 7.2 percent by weight to the diet of Little Galloo Island cormorants. In 1999, Johnson et al. (2000a) estimated that smallmouth bass comprised 3.6 percent of the diet of Little Galloo Island cormorants, amounting to a consumption of approximately 126,000 lbs (~57,000 kg) of smallmouth bass (R. McCullough, NYSDEC, pers. comm.). Yellow perch (28 percent), alewife (27 percent), and cyprinids (18 percent) were the major prey items, by number, of cormorants from the Little Galloo Island colony (Johnson et al. 2000a).

Johnson et al. (2000b) determined that yellow perch was the major prey of DCCOs from the Pigeon (38.4 percent) and Snake (47.7 percent) Island colonies in eastern Lake Ontario, by number. Forage fish, including alewife, cyprinids, threespine stickleback, slimy sculpin, etc. made up 50 percent and 39 percent, respectively, of Pigeon and Snake Island DCCO diets (by number) while smallmouth bass were estimated to have contributed, by weight, 5.1 percent (Pigeon) and 1.7 percent (Snake) of DCCO diet.

Johnson et al. (2002) estimated that fish consumption by DCCOs at the Little Galloo Island colony averaged 32.8 million fish per year over the 9-year period from 1992 to 2000. The biomass of fish

consumed averaged 1.4 million kg per year. Consumption of smallmouth bass averaged 85,300 kg per year, compared to an estimated 24,700 kg taken by sport anglers in 1998. The authors noted that "substantial temporal variation exists in the diet of [Little Galloo Island DCCOs]." They also pointed out that "fish standing stock information for eastern Lake Ontario is not available and, consequently, it is not possible to compare these estimates of cormorant fish consumption to stock size." The authors, however, believe that there is sufficient evidence to suggest that DCCOs "may be taking male smallmouth bass off of nests, with implications for subsequent recruitment and year-class strength" (Johnson et al. 2002).

*Other Factors.* Smallmouth bass populations in the eastern basin of Lake Ontario are dependent on a number of factors, including water temperature (cf. Hoyle et al. 1998), year class strength, time of spawning, food availability, competition, predation pressure, and fishing mortality. Many changes have occurred in the eastern basin of Lake Ontario in recent years that could affect these factors, including reduced lake productivity, the introduction of zebra mussels, increased water clarity, and increased abundance of two piscivorous species, both DCCOs and walleye. Food web alterations and subsequent shifts in nutrient cycling are important changes that may be caused by zebra mussels. However, little is known about the actual impacts of these changes on the population dynamics of smallmouth bass (Chrisman and Eckert 1999). While factors such as reduced productivity, dreissenid (zebra and quagga) mussel abundance and increased water clarity have impacted all of Lake Ontario, smallmouth bass populations are thriving outside of the eastern basin (Schneider et al. 1999) and "evidence exists…that indicates that these factors [are] not the primary force behind bass stock reductions" (Lantry et al. 2002).

**Les Cheneaux Islands, Lake Huron, Michigan**
Since the late 1970s, the yellow perch fishery in the Les Cheneaux Islands of northern Lake Huron, which was economically important to the area for many years, has experienced a marked decline (Lucchesi 1988 *in* Belyea et al. 1999). In the mid-1980s, local concern helped lead to a Michigan Department of Natural Resources study which revealed that growth overfishing (overharvest to the point that size at harvest declines dramatically) may have been at least partially responsible for the decline of the fishery (Lucchesi 1988 *in* Belyea et al. 1999). A 175 mm minimum size limit was instituted in 1987 in an effort to reduce mortality for smaller fish, but it did not help the fishery as predicted (Schneeberger and Scott 1997 *in* Belyea et al. 1999).

Yellow perch populations have been declining in many areas of the Great Lakes for several decades, most likely as a result of repeated recruitment failures (Lucchesi 1988, Haas and Schaeffer 1992). Fisheries managers and sport anglers are both concerned that predation pressure from the abundant and growing populations of DCCOs will either contribute to the further decline of yellow perch fisheries or prevent recovery (Diana et al. 1997).

*DCCO Status and Diet.* In 1980, DCCOs naturally reestablished at St. Martins Shoal, just west of the Les Cheneaux Islands, after many years of absence. Population surveys in 2001 estimated 4,039 DCCO pairs in the Les Cheneaux Islands area (D. Trexel, University of Minnesota, unpubl. data). Since 1980, diet studies in the Great Lakes have shown that alewife is the most prominent prey item for DCCOs in nearly every location where alewife and cormorants are found together (Belonger 1983, Craven and Lev 1987, Karwowski et al. 1992, Ludwig et al. 1989, Ross and Johnson 1994, Weseloh and Ewins 1994).

A study conducted in 1995 (Belyea et al. 1999) by the Michigan Department of Natural Resources and the University of Michigan evaluated cormorant-perch interactions in the Les Cheneaux Islands area and, in particular, evaluated population trends in cormorants and yellow perch and determined the effect of cormorants foraging on the yellow perch fishery. The study found that yellow perch comprised about 10 percent of overall DCCO diet with alewives and sticklebacks being the most common prey items, although yellow perch represented 48 percent of DCCO diet for a short period in April (Belyea et al. 1999). It was estimated that the biomass of yellow perch consumed by DCCOs was 7,100 kg during the

perch spawning season and 4,300 g during the remainder of the year (1995). These biomass estimates correspond to a range of 270,000 to 720,000 individual perch consumed, with the best estimate being 470,000 (Maruca 1997 *in* Belyea et al. 1999). Approximately 7,000 to 17,000 of these fish consumed were figured to be young of the year perch. The authors felt it was a reasonable assumption that removal of up to 17,000 young of the year would not have a substantial effect on yellow perch recruitment (Belyea et al. 1999). As for legal-size perch, mortality caused by cormorant predation and summer sport fishing was low (no more than 3.5 percent) compared to the estimated total annual mortality rate (45 percent). The authors concluded that "other sources of mortality, therefore, accounted for the majority of yellow perch deaths" (Belyea et al. 1999).

*Other Factors.* The waters of the Les Cheneaux Islands comprise a dynamic area of physical and biological complexity. Part of the biological complexity results from proximity to open waters of Lake Huron and the St. Mary's River. The Les Cheneaux sport fishery was consistently dominated by yellow perch, but catches of perch varied nearly six fold in the period between 1979 and 1995. Yellow perch populations vary throughout their range, due in part to differences in year class strength. Sport catches of other species (such as northern pike, smallmouth bass, chinook salmon, pink salmon, and lake trout) in the Les Cheneauxs vary dramatically and could have considerable influence on the fish community of the Les Cheneauxs, whether or not they directly influence yellow perch. Also, white perch were documented for the first time in the 1995 creel survey, and if numbers continue to increase, white perch may affect yellow perch populations through competition as they have in other waters (Parish and Margraf 1990, Prout et al. 1990).

**Lake of the Woods, Minnesota**

Lake of the Woods, located in southeastern Manitoba, southwestern Ontario, and northwestern Minnesota, is one of the larger inland lake systems outside of the Great Lakes. The lake is biologically diverse with respect to the fish found in the system, containing everything from lake trout in the deep Canadian waters, to sturgeon and percids. Lake of the Woods is one of the premier walleye lakes on the continent. While there is some commercial fishing, and native subsistence fishing (on the Canadian side), the primary harvest of game fish species is by recreational anglers. Currently, the lake is managed to optimize recreational opportunities, as well as native fish populations.

The most relevant statistical data has been gathered by the Minnesota Department of Natural Resources, Division of Fisheries, through the large lake sampling program. The primary species of interest are the percids. This group of fish is sampled at a variety of life stages through-fall gill net sampling, seining, and trawling. Several calculations reveal information about relative abundance of fish, although there is no lake-wide population estimate for any species (Heinrich 1999). The historical "catch per unit effort" (CPUE) as measured by gill net sampling reflects recent trends for each of six fish species. These data show that, overall, there has been no general decline in the abundance of any of these species.

*DCCO Status and Diet.* Cormorants were historically present at Lake of the Woods, but declined to a negligible number in the 1950s and 1960s. The population then started to rebound, beginning in the 1970s. The nesting population on the American side of Lake of the Woods has fluctuated from 1164 pairs in 1980, to over 7000 pairs observed in 1990. The population declined following an outbreak of Newcastle disease in the early1990s, and then increased to just over 4500 nesting pairs in 1999.

There is little quantitative information available on diet of cormorants at Lake of the Woods. Sampling of bolus regurgitations by chicks of cormorants at Lake of the Woods (K. Haws, Minnesota DNR, pers. comm.) has indicated that, of 41 samples taken in 1985, by far the greatest representation by number in the samples was yellow perch (72 percent), followed by small amounts of burbot, walleye, and sauger (8 percent), and white sucker. Other inland studies (e.g., at Lake Winnipegosis, Manitoba) have shown that cormorants eat perch, sucker, and cisco (Hobson et al. 1989). Full assessments which include adult food

habits, and food habits over the entire ice-free season, have not been made.

**Southeastern lakes, ponds, and reservoirs**

Many of the inland lakes in the southeastern U.S. (e.g., Millwood Lake, Arkansas; Lake Livingston, Texas, etc.) are reservoirs that were created for purposes such as flood control, water conservation, irrigation, and other beneficial uses such as recreational fishing. Concernsamong anglers regarding DCCO predation on reservoir fishes in the southern Great Plains and in southeastern States have increased in recent years (Simmonds et al. 2000).

During scoping, for example, the Army Corps of Engineers and the Arkansas Game and Fish Commission expressed concerned that cormorants are having a negative impact on fish populations at Millwood Lake, Arkansas. Additionally, the Georgia Department of Natural Resources shared the results of surveys conducted by their Fisheries Management Section (in 1992 and 1994) which documented "significant fish losses" to cormorants at fishing lakes in the southern part of Georgia (while DCCOs in the northern half of the State were generally not a problem).

*DCCO Status and Diet.* In recent years, both wintering and breeding numbers of DCCOs have increased significantly in the southeastern U.S. (Jackson and Jackson 1995, Tyson et al. 1999, Reinhold and Sloan 1999, Wires et al. 2001). Campo et al. (1993) examined the diets of 420 DCCOs from eight public reservoirs in Texas (1986-1987) and found that DCCOs ate fishes that were most abundant in the reservoirs. Shad and sunfishes accounted for 90 percent of the total food items by number. Sport fish (largemouth and white bass, catfishes, and crappies) made up a significant portion of DCCO food by weight, but not by number on some reservoirs. The sport fish taken by DCCOs were much smaller than those taken by sport anglers. The authors concluded that, at that time, "consumption of desired sport fish in reservoirs was an insignificant portion of cormorant diets in Texas."

Glahn et al. (1998) compared percentages of prey species in the diet of DCCOs at Lake Beulah, Mississippi and Lake Eufala, Alabama to the percent availability of these prey species in the lakes. They found that the only sport fish that occurred in the diet in significant numbers were sunfish species, particularly bluegill. They concluded that, with the possible exception of predation on harvestable size bluegill, DCCOs do not appear to have a negative impact on fisheries in the two lakes studied.

Simmonds et al. (2000) stated that "Because cormorants prey on a variety of fish species and sizes and because their residency in Oklahoma is seasonal, their ultimate effect on sport fishery characteristics may be different from that inferred from simple calculations of consumption." They modeled effects of different levels of DCCO predation on standing crops and yields of reservoir sport and forage fish and found that: predation by DCCOs had a moderate or low effect on fish abundances and yields when DCCO abundances approximated those found on most reservoirs in Oklahoma (i.e., 2.5 cormorant days/ha), but effects on fish abundance and yield were severe when high DCCO abundances were inputted (i.e., 23.4 cormorant days/ha, a level actually observed on two reservoirs in one year). At this level of predation, simulated channel catfish and largemouth bass fisheries collapsed and yields of white crappies were greatly reduced.

On Lake Chicot, an oxbow lake on the Mississippi River in Arkansas, mortality rates of age-0 to age-1 crappie have been estimated at 90 percent in recent years. While increasing numbers of DCCOs are suspected by anglers to be the cause of these high mortality rates, the Arkansas Game and Fish Commission reports that an increase in the density of largemouth bass may be having an affect on crappie survival. The University of Arkansas is planning to carry out a study examining the diet and potential impact of both DCCOs and largemouth bass (Fenech et al. unpubl. data).

**Appendix 7: Guidelines for distinguishing Double-crested Cormorants from Anhingas and Neotropic Cormorants**

Neotropic Cormorants (*Phalacrocorax brasilianus*) often occur with DCCOs, particularly in winter, and can easily be confused with them. As described in the Birds of North America account (Telfair and Morrison 1995*), body size, and shape and color of the throat pouch ("gular pouch") are the most reliable distinguishing marks in the field. The Neotropic Cormorant is smaller in body length (61 vs. 74 cm), wingspan (102 vs. 127 cm), and weight (1.4 vs. 2.3 kg). The size, shape, and color of gular pouches also differ considerably. The gular pouch of the Neotropic Cormorant resembles a horizontal V (with the apex pointed backward); is small, pale yellowish brown, and proportionally <50% the size of the remainder of the head; and is bordered behind by a thin white line that outlines the size and shape of the pouch. In DCCOs, the pouch is much larger and is rounded rather than V-shaped in posterior profile. It is also bright orange-yellow and proportionally about as large as the rest of the head. Additionally, from a distance, the tail length of the Neotropic Cormorant is noticeably longer in proportion to body length than that of DCCOs (about 0.4 versus 0.2 of total length). Distinguishing juvenile and immature Neotropic Cormorants from DCCOs is more difficult however, partly because the gular pouches are duller in color at this age. Telfair and Morrison (1995) recommend two references for detailed discussion of this (Clark 1992 and Patten 1993). The best distinguishing feature in immature birds is the color of the patch of skin above the lores, between the eyes and the bill. This area is brighter (yellow-orange) in DCCOs and darker in Neotropic Cormorants.

The Neotropic Cormorant's range includes South and Central America, Mexico, West Indies, and northward to southern New Mexico, north-central Texas, and southwestern Louisiana. In the U.S., Neotropic Cormorants are largely resident along the Gulf Coast of the U.S. from southwestern Louisiana south through Texas. Breeding is restricted to coasts, lakes, and reservoirs. Most breeding colonies are coastal, but since the mid-1970s, colonies have been established in reservoirs, some far into the interior of Texas (Telfair and Morrison 1995).

The Neotropic Cormorant is versatile in climatic and environmental tolerance, inhabiting a wide variety of wetlands in fresh, brackish, or salt water. In coastal areas, it remains close inshore in sheltered bays, inlets estuaries, lagoons, rock outcrops, and islands. In the U.S., its primary habitats are coastal marshes and swamps, as well as inland reservoirs. It nests and roosts primarily in trees (live or dead) but also on sea cliffs, rock outcrops, and human-made structures (Telfair and Morrison 1995).

The Neotropic Cormorant is the only cormorant known to plunge-dive, in which the bird plunges head-first with wings folded against its body. In Texas, it is mostly a solitary forager (Telfair and Morrison 1995).

As described in its Birds Of North America account**, the Anhinga (*Anhinga anhinga*) is "among the most distinctive of North American birds, with long, snakelike neck, straight bill, large fanlike tail…corrugations on its central rectrices, and unique swimming, flight, and behavior patterns." Anhingas are a mostly black waterbird about 75-95 cm in length. They are distinctively shaped with a small head; a very long, often curved neck; a long daggerlike bill; and a long, fan-shaped tail that can be up to 30% of total body length. Their body plumage is entirely black with a patter of silvery to white streaks and spots on the upper back, scapulars, and wing-coverts. Cormorants are somewhat similar in structure, plumage, and behavior, but Anhingas are easily distinguished by having a much longer neck; a longer, more pointed bill (without the distinctive terminal hook found in cormorants); and a longer tail (Frederick and Siegel-Causey 2000).

The Anhinga breeds in the eastern half of Texas, where it is found mainly in the coastal plain and further inland. It can also be found in easternmost Oklahoma (locally and irregularly), southern Arkansas (very

locally), extreme western Tennessee (very locally), central and southern Mississippi, central Alabama, southern half of Georgia, lower coastal plains of South Carolina, and North Carolina south to the Gulf Coast and southern Florida. In the U.S. breeders usually withdraw south in the winter to coastal South Carolina, the southern half of Georgia, southern Alabama, southern Mississippi, southern Louisiana, and the coastal plain of Texas (Frederick and Siegel-Causey 2000).

Their habitat includes shallow, slow-moving sheltered waters with nearby perches and banks available for drying and sunning. Anhingas are rarely found out of fresh water, but generally are not found in extensive areas of open water, and they usually forage in shallow water (Frederick and Siegel-Causey 2000).

Anhingas are often observed swimming, with body submerged and only the head and neck extending out of water; perching with wings and tail spread to dry; or in flight with neck extended, tail spread, and wings held flat (Frederick and Siegel-Causey 2000).

*Telfair, R.C. II, and M.L. Morrison. 1995. Neotropic Cormorant (*Phalacrocorax brasilianus*). *In* The Birds of North America, No. 137 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia and The American Ornithologists' Union, Washington, D.C.

**Frederick, P.C., and D. Siegel-Causey. 2000. Anhinga (*Anhinga anhinga*). In The Birds of North America, No. 522 (A.Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

**Appendix 8: Overview of Aquaculture Production in 13 States**

| State | # of operations in State | Total production acreage in State | # of producers taking DCCOs under Depr. Order per year | Estimated average annual expense to control DCCOs |
|---|---|---|---|---|
| Alabama | 270 (catfish only) | 24,400 (9,882 ha) | 270 | $1,672 |
| Arkansas | 250 | 75,000 (30,372 ha) | 80 | $10,000 - 100,000 |
| Florida | 443 | 7,585 (3,072 ha) | 35 | $1,500 - 2,000 |
| Georgia | 406 | 7,092 (2,872 ha) | 50 | |
| Kentucky[1] | 70 | 400 (162 ha) | 15 | N/A |
| Louisiana | 102 (catfish or minnows); 973 (crawfish) | 14,447 (5,851 ha)(catfish or minnows); 84,635 (34,277 ha)(crawfish) | 50 | $5,000 - 10,000 |
| Minnesota | N/A | N/A | 35 | $1,000 - 2,000 |
| Mississippi | 395 | 111,500 (45,158 ha) | 130 | ~$150 per acre |
| North Carolina | 250 | 2,820 (1,142 ha) | 20 | N/A |
| Oklahoma | 77 | 900 (365 ha) | 77 | |
| South Carolina[1] | 15 | 520 (211 ha) | 9 | N/A |
| Tennessee | 50 | 800 (324 ha) | 20 | N/A |
| Texas[1] | 34 | 580 (235 ha) | 34 | N/A |

[1] = catfish production only; N/A = not available
Source: survey of APHIS/WS State Directors; NASS Catfish Production Feb. 2002

## Appendix 9: Costs of Control Methods and Techniques

*Harassment.* A typical 5 month harassment program at a 200 hectare farm with high DCCO pressure would cost almost $20,000 annually (Littauer et al. 1997). This would include the cost of labor, vehicle expenses, pyrotechnics, and live ammunition. If supplemented with propane exploders and scarecrows, an additional startup cost of $1,000 to $2,000 would be incurred.

An observational food habits study conducted by Stickley et al. (1992) concluded, based upon an average number of 30.5 DCCOs observed feeding on an eight hectare pond stocked at 51,000 fish per hectare, that the fish population would be halved in 30 days if this number of cormorants fed all day. They further concluded, based on the cost of bird patrol harassment on a 200 hectare aquaculture facility over a 5 month period, that costs associated with harassment of DCCOs would be exceeded in 22 days by the losses in this one 8 hectare pond. This means that harassment efforts would prove cost-effective after 22 days at this level of depredation.

The night roost dispersal program used in the Mississippi Delta to harass DCCOs from the fish producing regions during the winters of 1993-95 ranged from $16,757 to $32,302 per year to disperse birds from 30 to 40 night roosts (Mott et al.1998). Costs to disperse DCCOs from night roost sites averaged $400 to $640 per year for each participating farm. Current costs of the roost dispersal program have likely increased based upon the doubling of the wintering DCCO population (Reinhold and Sloan 1999; Glahn et al. 1999; Glahn et al. 2000) and the increase of night roosting sites to more than 65 in the Delta region (Reinhold and Sloan 1999) since the 1995 study was completed.

Adding the cost of labor and materials necessary to patrol a typical catfish farm to the cost of pyrotechnics and live ammunition, Littauer et al. (1997) estimated harassment costs at $132/day. The authors calculated that a farm with an average of 100 DCCOs feeding at any time could experience losses of $400/day (replacement costs); they concluded that there may be instances in which an aggressive harassment program would be cost effective. In a survey of 281 Mississippi catfish farmers, Stickley and Andrews (1989) reported an average of 2.6 person-hours of harassment/day for all bird species, at an annual cost of $7,400; harassment during the 6 month period when cormorants were present averaged $26 per day, or approximately $4,700 for the entire six months. Outside harassment zones, expenditures for harassment at individual aquaculture facilities increased an average of $845 in 1994 and $741 in 1995, suggesting that the harassment program moved DCCOs out of the harassment zone and into surrounding areas (Mott et al. 1998).

*Shooting and egg oiling.* Bédard et al. (1999) provided a “very rough estimate” for the St. Lawrence River Estuary, Québec, control program of $10/adult shot and $3/nest sprayed with oil. Without better economic estimates on the costs of DCCO impacts, the cost effectiveness of population control by any means can not be determined (Wires et al. 2001).

## Appendix 10: Comparison Tables Using CBC Data

**Comparison of Indices of Abundance of Double-crested Cormorants on Christmas Bird Counts: 2002**

| | 2002 | | | 2001 | | | % | 2000-2002 | | | 1990-1999 | | | % |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flyway/Zone | Birds | Counts | Index | Birds | Counts | Index | **Change** | Birds | Counts | Index | Birds | Counts | Index | **Change** |
| Atlantic: | | | | | | | | | | | | | | |
| Northern Zone[1] | 591 | 99 | 6 | 559 | 96 | 5.8 | **3** | 1424 | 288 | 4.9 | 2650 | 866 | 3.1 | **58** |
| Central Zone[2] | 1719 | 121 | 14 | 4017 | 126 | 32 | **-56** | 7279 | 371 | 18 | 12964 | 1200 | 11 | **64** |
| Southern Zone[3] | 176967 | 153 | 1157 | 126273 | 155 | 815 | **42** | 457779 | 461 | 993 | 1371283 | 1369 | 1002 | **-1** |
| Sub-Totals | 179277 | 373 | 481 | 130849 | 377 | 347 | **39** | 466482 | 1120 | 416 | 1386897 | 3435 | 404 | **3** |
| Mississippi: | | | | | | | | | | | | | | |
| Northern Zone[4] | 251 | 89 | 2.8 | 345 | 90 | 3.8 | **-26** | 701 | 267 | 2.6 | 1104 | 838 | 1.3 | **100** |
| Central Zone[5] | 730 | 127 | 5.7 | 13930 | 126 | 111 | **-95** | 15470 | 379 | 41 | 17164 | 1239 | 14 | **193** |
| Southern Zone[6] | 199519 | 84 | 2375 | 124037 | 83 | 1494 | **59** | 473877 | 249 | 1903 | 657222 | 787 | 835 | **128** |
| Sub-Totals | 200500 | 300 | 668 | 138312 | 299 | 463 | **44** | 490048 | 895 | 548 | 675490 | 2864 | 236 | **132** |
| Central: | | | | | | | | | | | | | | |
| Northern Zone[7] | 5 | 14 | 0.36 | 19 | 15 | 1.3 | **-72** | 28 | 43 | 0.65 | 32 | 132 | 0.24 | **171** |
| Central Zone[8] | 90 | 33 | 2.6 | 185 | 32 | 5.8 | **-53** | 326 | 99 | 3.3 | 1919 | 301 | 6.4 | **-48** |
| Southern Zone[9] | 108241 | 115 | 941 | 225317 | 110 | 2048 | **-54** | 338230 | 251 | 1348 | 781920 | 1042 | 750 | **80** |
| Sub-Totals | 108336 | 162 | 669 | 225521 | 157 | 1436 | **-53** | 338584 | 393 | 862 | 783871 | 1475 | 531 | **62** |
| Pacific: | | | | | | | | | | | | | | |
| Northern Zone[10] | 4576 | 48 | 95 | 4328 | 48 | 90 | **6** | 12300 | 140 | 88 | 27877 | 403 | 69 | **28** |
| Central Zone[11] | 12490 | 73 | 171 | 10498 | 73 | 144 | **19** | 33324 | 220 | 151 | 69731 | 629 | 111 | **36** |
| Southern Zone[12] | 20679 | 126 | 164 | 26762 | 127 | 211 | **-22** | 74262 | 378 | 196 | 256074 | 1120 | 229 | **-14** |
| Sub-Totals | 37745 | 247 | 153 | 41588 | 248 | 168 | **-9** | 119886 | 738 | 162 | 353682 | 2152 | 164 | **-1** |
| GRAND TOTALS | 525858 | 1082 | 486 | 536270 | 1081 | 496 | **-2** | 1415000 | 3146 | 450 | 3199940 | 9926 | 322 | **40** |

**Comparing Frequency of Occurrence of Double-crested Cormorants on Christmas Bird Counts: 2002**

| Flyway/Zone | 2002 N | 2002 DCCO's Present | 2002 FREQ | 2001 N | 2001 DCCO's Present | 2001 FREQ | % CHANGE | 2000-2002 N | 2000-2002 DCCO's Present | 2000-2002 FREQ | 1990-1999 N | 1990-1999 DCCO's Present | 1990-1999 FREQ | % CHANGE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlantic: | | | | | | | | | | | | | | |
| Northern Zone[1] | 99 | 55 | 56 | 96 | 56 | 58 | **-3** | 288 | 157 | 54 | 866 | 425 | 49 | **10** |
| Central Zone[2] | 121 | 64 | 53 | 126 | 86 | 68 | **-22** | 371 | 208 | 56 | 1200 | 630 | 52 | **7** |
| Southern Zone[3] | 153 | 128 | 84 | 155 | 142 | 92 | **-9** | 461 | 397 | 86 | 1369 | 1114 | 81 | **6** |
| Sub-Totals | 373 | 247 | 66 | 377 | 284 | 75 | **-12** | 1120 | 762 | 68 | 3435 | 2169 | 63 | **8** |
| Mississippi: | | | | | | | | | | | | | | |
| Northern Zone[4] | 89 | 19 | 21 | 90 | 41 | 46 | **-54** | 267 | 78 | 29 | 838 | 248 | 30 | **-3** |
| Central Zone[5] | 127 | 45 | 35 | 126 | 59 | 47 | **-26** | 379 | 139 | 37 | 1239 | 463 | 37 | **0** |
| Southern Zone[6] | 84 | 71 | 84 | 83 | 71 | 86 | **-2** | 249 | 206 | 83 | 787 | 644 | 82 | **1** |
| Sub-Totals | 300 | 135 | 45 | 299 | 171 | 57 | **-21** | 895 | 423 | 47 | 2864 | 1355 | 47 | **0** |
| Central: | | | | | | | | | | | | | | |
| Northern Zone[7] | 14 | 3 | 21 | 15 | 2 | 13 | **62** | 43 | 7 | 16 | 132 | 21 | 16 | **0** |
| Central Zone[8] | 33 | 14 | 42 | 32 | 18 | 56 | **-25** | 99 | 46 | 46 | 301 | 139 | 46 | **0** |
| Southern Zone[9] | 115 | 101 | 89 | 110 | 96 | 87 | **2** | 251 | 214 | 85 | 1042 | 902 | 87 | **-2** |
| Sub-Totals | 162 | 118 | 73 | 157 | 116 | 74 | **-1** | 393 | 267 | 68 | 1475 | 1062 | 72 | **-6** |
| Pacific: | | | | | | | | | | | | | | |
| Northern Zone[10] | 48 | 39 | 81 | 48 | 34 | 71 | **14** | 140 | 117 | 83 | 403 | 267 | 66 | **26** |
| Central Zone[11] | 73 | 60 | 82 | 73 | 54 | 74 | **11** | 220 | 167 | 76 | 629 | 440 | 70 | **9** |
| Southern Zone[12] | 126 | 107 | 85 | 127 | 103 | 81 | **5** | 378 | 310 | 82 | 1120 | 841 | 75 | **9** |
| Sub-Totals | 247 | 206 | 83 | 248 | 191 | 77 | **8** | 738 | 594 | 80 | 2152 | 1568 | 73 | **10** |
| GRAND TOTALS | 1082 | 706 | 68 | 1081 | 762 | 70 | **-3** | 3146 | 2046 | 65 | 9926 | 6154 | 62 | **5** |

[1] Atlantic Flyway/Northern Zone includes Connecticut, Maine, Massachusetts, New Brunswick, New Hampshire, Newfoundland, Nova Scotia, Prince Edward Island, Quebec, Rhode Island, and Vermont.

[2] Atlantic Flyway/Central Zone includes Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, and West Virginia.

[3] Atlantic Flyway/Southern Zone includes Florida, Georgia, North Carolina, South Carolina, and Virginia.

[4] Mississippi Flyway/Northern Zone includes Manitoba, Michigan, Minnesota, Ontario, and Wisconsin.

[5] Mississippi Flyway/Central Zone includes Illinois, Indiana, Iowa, Kentucky, Missouri, and Ohio.

[6] Mississippi Flyway/Southern Zone includes Alabama, Arkansas, Louisiana, Mississippi, and Tennessee.

[7] Central Flyway/Northern Zone includes Alberta, Montana, North Dakota, South Dakota, and Saskatchewan.

[8] Central Flyway/Central Zone includes Colorado, Kansas, Nebraska, and Wyoming.

[9] Central Flyway/Southern Zone includes New Mexico, Oklahoma, and Texas.

[10] Pacific Flyway/Northern Zone includes Alaska and British Columbia.

[11] Pacific Flyway/Central Zone includes Idaho, Oregon, and Washington.

[12] Pacific Flyway/Southern Zone includes Arizona, California, Nevada, and Utah.

## Appendix 11. Public Scoping Report

***Executive Summary:*** On November 8, 1999, the U.S. Fish and Wildlife Service, in cooperation with USDA-APHIS-Wildlife Services, published a Notice of Intent to prepare an Environmental Impact Statement and national management plan for the double-crested cormorant. This action was in response to increasing populations of cormorants, and subsequent growing concern from the public and natural resource management agencies that cormorants are negatively impacting or pose a threat to resources such as other colonial waterbirds, island vegetation, aquacultural stock, and sport fish populations. Public comment on issues of concern and potential management alternatives was solicited. A Notice of Meetings was published on April 14, 2000, announcing ten public scoping meetings across the United States. Public comments were accepted from the opening of the comment period until June 16, 2000. In summary, over 900 people attended the public scoping meetings, with 239 providing oral comments, and over 1450 submitted written comments. Analysis of the comments was separated by geographic region and into the following groups: private individuals, businesses, non-governmental organizations (NGOs), local government agencies and associations, Federal agencies, State agencies, tribes, Canadian agencies, and legislative officials.

### Background

On November 8, 1999, the U.S. Fish and Wildlife Service, in cooperation with USDA-APHIS-Wildlife Services, published a Notice of Intent (64 FR 60826) to prepare an Environmental Impact Statement and national management plan for the double-crested cormorant (DCCO). This action was intended to address impacts caused by population and range expansion of the DCCO in the contiguous United States. The notice did not identify preliminary alternatives, but rather stated that cormorants have been implicated as being responsible for: (1) economic losses at commercial aquaculture facilities; (2) damage to trees and other vegetation associated with breeding colonies and roosting sites; (3) impacts to other species of migratory birds in the vicinity of cormorant breeding colonies; (4)declines in economic revenues associated with outdoor (primarily fishing-related) recreational activities; (5) declines in populations of sport fish; and (6) lowering of private property values.

The November 8 notice stated that comments on issues, alternatives, and impacts to be addressed in the EIS are being solicited and, in particular, comments of value would: (1) identify and, where possible, quantify impacts caused by increasing cormorant populations; (2) suggest management strategies to resolve such conflicts; and (3) identify determining factors in justifying the need for control, if any.

The notice also stated that the primary issue to be addressed during the scoping phase is to determine which alternatives for managing DCCO populations would be analyzed in the EIS. It indicated that we would prepare a dicussion of the effects, by alternative, in each of the following resource areas: (1) DCCO populations and their habitats; (2) other bird populations and their habitats; (3) effects on other species of flora and fauna; and (4) socioeconomic effects.

### Public Scoping Meetings

A subsequent notice was published on April 14, 2000, identifying ten public scoping meeting locations (65 FR 20194). The ten public scoping meetings, were held in Washington, D.C.; Portland, OR; Burlington, VT; Watertown, NY; Syracuse, NY; Green Bay, WI; Mackinaw City, MI; Hauppage, NY; Jackson, MS; and Athens, TX. Over 900 individuals attended the scoping meetings, at which anyone who wished to present oral and/or written comments was allowed to do so (239 people provided oral comments). A court reporter was present at each meeting in order to provide transcripts of the verbal testimony.

*Washington, DC*
Approximately 10 people attended the Washington, DC meeting. Representatives from the American Bird Conservancy, the Ornithological Council, and the Humane Society of the United States spoke. The primary concern was that management decisions be based on sound science. Other concerns/ideas that were raised include: fish-eating birds are increasingly being "scapegoated" for fishery declines; DCCOs have distinct, regional populations and management options must consider this; other factors, such as habitat destruction and modification, contaminants, hatcheries, and hydropower must also be considered as factors affecting fish populations; education and outreach are extremely important; the current management situation is not necessarily inadequate and the cormorant problem is actually a people problem; the Service needs to cooperate with Canada and Mexico as they develop a management plan; and an interdisciplinary approach is important. Representatives from USDA-Wildlife Services and USFWS Division of Migratory Bird Management and Division of Law Enforcement were present.

*Portland, OR*
Approximately 20 people attended the Portland meeting. Four individuals spoke. The primary concern was cormorant predation on salmonid smolts, from both a sport fishing and an endangered species standpoint. Ideas that were raised included: major reduction in DCCO populations; issuing a permit to kill 6-8 DCCOs each week and examine their stomach contents; conducting a predation study in the lower Columbia River estuary while smolts are there in the spring; and squirting the birds with ammonia to keep them off the breeding grounds. Representatives from the Washington Department of Wildlife, USDA-Wildlife Services, and USFWS Region 1 and Division of Migratory Bird Management were also present.

*Burlington, Vermont*
Approximately 120 people attended the Burlington meeting. Of 32 individuals who spoke, one person stated that we need to learn to coexist with DCCOs and should use only non-lethal control methods. Others who testified were supportive of more aggressive control. Some speakers suggested removing the species from the Migratory Bird Treaty Act, hunting them, or allowing the States to manage them. The major concerns expressed were declines in fishing and associated impacts on Vermont's tourist economy, destruction of island vegetation (from a property, aesthetics, and/or biodiversity perspective), water contamination caused by DCCO excrement, and impacts to other bird species. Representatives from Congressman McHugh's office and the Vermont Department of Fish and Wildlife testified. Also present were representatives from USDA-Wildlife Services and USFWS Region 5 and the Division of Migratory Bird Management.

*Watertown, New York*
Approximately 175 people attended the Watertown meeting. Of 23 individuals who spoke, all were concerned about fishery impacts, economic impacts, and/or human health impacts caused by DCCOs. Nearly everyone stated the need for DCCO population reduction, specifically via hunting. Representatives from Congressman McHugh's office and the New York Department of Environmental Conservation testified. Also present were representatives from USDA-Wildlife Services and USFWS Region 5 and Division of Migratory Bird Management.

*Syracuse, New York*
Approximately 50 people attended the Syracuse meeting. Of 18 individuals who spoke, 17 expressed concerns that DCCOs are causing an ecological imbalance, are a serious detriment to the sport fishery and economy of Oneida Lake, and/or are destroying island vegetation. Most were supportive of controlling, even eradicating DCCO populations in the area. One individual stated that the federal government should

stop protecting special interest groups and leave DCCOs alone. Representatives from USDA-Wildlife Services and USFWS Region 5 and Division of Migratory Bird Management were present.

*Hauppauge, New York*
Approximately 10 people attended the Long Island meeting and five spoke. Comments included: the Service should base their decisions on science and not political pressure; humans should manage predators when they are preying on populations that humans depend upon; oiling eggs is the only acceptable means of control; and DCCOs are damaging sailboats in harbor marinas. Representatives from the New York Department of Environmental Conservation and USFWS Region 5 were present.

*Green Bay, Wisconsin*
About 80 people attended the Green Bay meeting. Of 27 individuals who spoke, 26 were in support of cormorant control. The crowd was firm in its conviction that cormorants are impacting fishing (especially yellow perch) and associated economies, as well as island vegetation and other colonial waterbirds, and should be controlled. A cormorant researcher from the University of Wisconsin testified that studies have consistently shown that yellow perch make up a very small proportion of what is being consumed by DCCOs (he also commented that DCCOs should be kept off certain islands, while acknowledging that it is normal for bird populations to change the composition of island vegetation). Representatives from the Wisconsin Department of Natural Resources, USDA-Wildlife Services, and USFWS Region 3 and Division of Migratory Bird Management were present.

*Mackinaw City, Michigan*
Approximately 140 people attended the Mackinaw City meeting. Of 33 individuals who spoke, all were anti-cormorant. Some of the points made include the following: concern about cormorant impacts (biological and economic) on yellow perch, especially in the spring during spawning, in the Les Cheneaux Islands of Lake Huron; concern about the spread of cormorants to inland lakes such as the Manistique lakes; concern that tax dollars being spent on fish restoration and stocking are being wasted; and concern that anglers are going to Canada because cormorants have decimated the fishing in Michigan. A cormorant hunting season was favored by a number of speakers. Representatives from the Michigan Department of Natural Resources, USDA-Wildlife Services, and USFWS Region 3 and Division of Migratory Bird Management were present.

*Jackson, Mississippi*
Approximately 55 people attended the Jackson meeting. Of 18 individuals who spoke, all but 3 were associated with the aquaculture industry and expressed concern about serious economic impacts related to chasing cormorants off their ponds, in addition to what the birds eat. They stated that the Depredation Order (which allows shooting of birds) is not effective in reducing impacts; population level control is needed. Other comments that were made include: fish farmers need to be more creative and entrepreneurial in finding solutions to reduce DCCO impacts; DCCOs are just doing what comes naturally to them; fish farmers should unionize; and roost harassment efforts are an annoyance to neighboring landowners. Representatives from USDA-Wildlife Services, USDA Agricultural Research Service, Mississippi Department of Fish, Wildlife and Parks, and USFWS Region 4 and Division of Migratory Bird Management were present.

*Athens, Texas*
Approximately 120 people attended the Athens meeting. Of 35 individuals who spoke, all but three were concerned about economic and recreational impacts of DCCO predation on fish in small, private lakes and were in support of increased control, either through removal from the MBTA, a hunting season, or delegation of management to the States. Concerns about human health effects of increasing DCCO

populations were also raised. Other comments included: the EIS and any management actions must be based on sound science; the Service must consider not only negative recreational and economic impacts but also positive direct and indirect value of DCCOs; DCCO management should not impact the rare Neotropic Cormorant and should include education efforts to help people distinguish the two species; and the national management plan should have a regional focus and involve Canada and Mexico. Representatives from the Oklahoma Department of Wildlife Conservation, Texas Parks and Wildlife, and USFWS Region 2 and Division of Migratory Bird Management were present.

Two additional meetings were held in Little Rock, Arkansas (June 5) and in Angle Inlet (Lake of the Woods), Minnesota (June 24), at the request of Congressman Jay Dickey (AR) and Congressman Collin Peterson (MN), respectively.

*Little Rock, Arkansas*
Approximately 100 people attended the Little Rock meeting and 35 individuals spoke. All speakers were concerned about economic impacts on fish farmers and/or impacts on sport fish populations, and were generally supportive of large-scale control. Also raised was the issue of impaired peace of mind to farmers caused by the increasing presence of DCCOs. Representatives from USDA-Wildlife Services, USFWS Region 4 and the Division of Migratory Bird Management were present. Representatives from the Arkansas Game and Fish Commission, the office of Senator Blanche Lincoln, the Arkansas Development Finance Authority, and Congressman Jay Dickey testified.

*Angle Inlet, Minnesota*
About 20 people attended the Minnesota meeting. Of the 10 individuals who spoke, most were very concerned about the impact of DCCOs on local walleye and perch populations and associated economic effects on resorts, charter boats, and recreation fishing. They supported some type of localized control although several people who spoke in favor of DCCO population reduction did not support hunting as a means of accomplishing this. Concern about potential impacts of management actions on colonial waterbirds that nest near DCCOs was also expressed. One speaker stated that management activities should be based on science and that there is more to the value of Lake of the Woods than fish alone. Representatives from the Minnesota Department of Natural Resources (DNR) and USFWS Region 3 and Office of Migratory Bird Management were present. DNR fish survey data were presented and they did not support the contention that sport fish populations have declined in Lake of the Woods. Congressman Collin Peterson testified.

**Written Comments**
Public comments were accepted from the opening of the comment period on November 8, 1999, until June 16, 2000. Over 1450 comments were received, either by mail or electronically (via cormorant_eis@fws.gov). Analysis of the comments was separated by geographic region (USFWS Regions 1-6; no comments were received from Region 7, Alaska) and into the following groups: private individuals, businesses, non-governmental organizations (NGOs), local government agencies and associations, Federal agencies, State agencies, tribes, Canadian agencies, and legislative officials. Comments fell into two categories: (1) issues of concern and (2) suggested management options. Issues of concern included impacts on sport fishing, local economies, aquaculture/commercial fishing, bird species, ecological balance, vegetation, human health and safety, and private property. Management options included population control, leaving DCCOs alone, removing DCCOs from the protection of the Migratory Bird Treaty Act, hunting, focusing on non-lethal control, letting States manage DCCOs, changing the permit policy, oiling eggs, giving USDA-Wildlife Services more authority, basing decisions on the best science, using population objectives, and increasing education efforts.

SUMMARY OF WRITTEN COMMENTS

| | **R1** | **R2** | **R3** | **R4** | **R5** | **R6** | **Unknown** | **Totals** |
|---|---|---|---|---|---|---|---|---|
| ***Issues of Concern*** | | | | | | | | |
| Sport fish impacts | 28 | 213 | 110 | 51 | 147 | 7 | 17 | **573** |
| Economic impacts | 0 | 72 | 20 | 16 | 36 | | 5 | **149** |
| Vegetation impacts | | 31 | 37 | 1 | 26 | | 1 | **96** |
| Destruction/odor caused by DCCO feces | | 34 | 22 | 2 | 22 | | 2 | **82** |
| Private property damage | | 62 | 6 | | 7 | | 1 | **76** |
| General concern over population increase | 1 | 52 | 8 | 2 | 8 | | 1 | **72** |
| Aquaculture/ commercial fishery impacts | 3 | 7 | 6 | 30 | 10 | 2 | | **58** |
| Human health/safety | | 29 | 12 | | 11 | | | **52** |
| DCCOs causing ecological imbalance | | 5 | 18 | 3 | 17 | | | **43** |
| Impacts on other bird species | | | 16 | 1 | 20 | | | **37** |
| DCCOs are non-native | | 4 | 6 | 1 | 13 | | | **24** |
| DCCOs are sacred to Native Americans | | 1 | | | | | | **1** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ***Management Options*** | | | | | | | | |
| Need to control/reduce population | 20 | 126 | 97 | 91 | 125 | 2 | 11 | **472** |
| Remove from MBTA protection | 19 | 113 | 7 | 63 | 26 | 1 | 6 | **235** |
| Don't blame DCCOs/ leave them alone | 22 | 10 | 22 | 14 | 42 | 5 | 103 | **218** |
| Emphasize non-lethal control | 13 | 8 | 16 | 5 | 44 | 2 | 105 | **193** |
| Have a hunting season | 23 | 18 | 29 | 63 | 42 | 1 | 5 | **181** |
| Let States manage DCCOs | 19 | 144 | 5 | 2 | 7 | 1 | 2 | **180** |
| Base decisions on sound science | 13 | 5 | 14 | 11 | 29 | 2 | 55 | **129** |
| Oil eggs | 1 | 2 | 9 | 63 | 22 | | 1 | **98** |
| Give USDA/Wildlife Services more authority | | 3 | 1 | 60 | 1 | 1 | | **66** |
| Do not allow hunting | 1 | 2 | 1 | 3 | 13 | 1 | 25 | **46** |
| Use population objectives in DCCO management | 2 | 2 | 2 | 6 | 9 | 4 | 1 | **26** |
| Need better information | 2 | | 5 | 3 | 4 | | 5 | **19** |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Change permit policy | | 6 | 1 | 3 | 6 | | | **16** |
| Increase education efforts | 1 | | 5 | | 4 | | 3 | **13** |
| Don't do management plan | 1 | | 2 | 2 | 3 | 1 | 3 | **12** |
| Expand depredation order to other states | 2 | | 2 | 1 | 2 | 2 | | **9** |
| Allow eggs to be gathered for food | | | 1 | | | | | **1** |
| **Regional Totals** | **171** | **949** | **479** | **497** | **696** | **32** | **352** | **3177** |
| **Total # of individual letters/ emails:** | | **1458** | | | | | | |

*Private Individuals*
Over 75% of the written comments came from individuals who wrote to express their own personal feelings, ideas, and concerns about the impacts of DCCOs. Although a majority of the letters expressed concern about the impacts of DCCOs on sport fisheries and recommended DCCO population reduction, a great number of individuals suggested that we stop blaming DCCOs for fishery problems and recommended that only non-lethal control efforts be allowed.

*Canadian agencies*
We received comments from four Canadian agencies whose concerns included potential impacts of Service management actions on Great Cormorant populations (Nova Scotia) and on declining western DCCO populations (British Columbia).

*Federal agencies*
The National Marine Fisheries Service expressed concern about the impacts of DCCOs on "fish species that are listed under the Endangered Species Act or fish produced to meet Indian treaty trust responsibility" and recommended that the scope of the national management plan be expanded to include "effects on listed salmonid species and ... impacts on salmon and trout in the inland western states."

Biologists from the USDA-APHIS-Wildlife Services National Wildlife Research Center in Mississippi stated that the goal of the management plan should be to reduce impacts (on commercial aquaculture specifically) and that the best way to accomplish this is through population reduction and science-based management efforts.

*State agencies*
Twenty seven States provided comments on the DCCO EIS and national management plan. Fourteen States (CT, GA, IN, IA, NE, NH, NY, ND, OH, OK, RI, TX, VT, WY) expressed a desire for increased flexibility/increased State input in managing cormorants. Twenty three States (AZ, CT, GA, IL, IN, IA, LA, MI, MN, MO, NE, NH, ND, NY, OH, OK, OR, RI, TX, VT, WI, WY, MA) stated or implied that, under certain conditions (e.g., evidence pointing toward a problem, displacement of other colonial nesting birds, impacts on natural systems, etc.), increased control should be considered. Five States (AZ, NH, ND, SD, MN) stated that they currently have no real problems with DCCOs.

*Local government agencies and associations*
All of the local government agencies that provided comments expressed concern about impacts of DCCOs on sport fish populations, recreational fishing opportunities, sport fish-related economies, and/or vegetation and were supportive of control efforts.

*Non-governmental Organizations (NGOs)*
Comments from NGOs varied greatly and included animal protection organizations, local fishing clubs, scientific organizations, and environmental/conservation groups. Some groups requested that we stop scapegoating DCCOs and look into anthropogenic causes for fishery declines; others emphasized the need for better science to justify any control efforts; and others requested immediate control actions be put into effect to alleviate DCCO impacts.

*Businesses*
All but 5 of 24 businesses that provided comments were either aquaculture facilities, charter services, or other fishing-related businesses. All but one of the businesses expressed concern about the negative impacts of DCCOs on their enterprise. The one pro-cormorant business was a cosmetics company that does not engage in animal testing.

*Legislative officials*
As of July 26, we have received letters from 10 legislative officials (three State and seven Federal) and one caucus (Congressional Sportsmen's Caucus). Each one of these expressed concern about the deleterious impacts of DCCOs on sport fisheries and/or the aquaculture industry.

*Tribes*
Three tribes sent comments regarding management of DCCOs. One tribe from Arizona (White Mountain Apache) stated support for a hunting season on DCCOs. A member of a tribe from Oklahoma (Kiowa) stated that waterbirds are sacred to them and that they would like any birds that are killed to be given to them for use in native ceremonies. The third tribe (Wampanoag/Aquinnah) expressed concern about the possible negative effects of increasing DCCO populations on tribal fishery resources.

**List of Canadian agencies, Federal agencies, State Agencies, Local Governments and Associations, Non-governmental Organizations, Businesses, Legislative Officials, and Tribes Providing Scoping Comments**

*Canadian agencies*
Alberta Environment, Office of the Deputy Minister
British Columbia Ministry of Environment, Land and Parks
New Brunswick Department of Natural Resources and Energy, Fish and Wildlife Branch
Nova Scotia Department of Natural Resources

*Federal agencies*
U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services
U.S. Department of Commerce, National Oceanic and Atmospheric Association, National Marine Fisheries Service

*State agencies*
Arizona Game and Fish Department
Arkansas Game and Fish Commission
Connecticut Department of Environmental Protection
Georgia Department of Natural Resources
Illinois Department of Natural Resources

Indiana Department of Natural Resources
Iowa Department of Natural Resources
Kansas State University
Kentucky Department of Fish and Wildlife Resources
Louisiana Department of Wildlife and Fisheries
Maine Atlantic Salmon Commission
Maine Department of Inland Fisheries and Wildlife
Maine Department of Marine Resources
Massachusetts Division of Fisheries and Wildlife
Michigan Department of Natural Resources
Minnesota Department of Natural Resources
Mississippi State University Extension Service
Missouri Department of Conservation
Nebraska Game and Parks Commission
New Hampshire Fish and Game Department
New York State Department of Environmental Conservation, Division of Fish, Wildlife & Marine Resources
North Dakota Game and Fish Department
Ohio Department of Natural Resources, Division of Wildlife
Oklahoma Department of Wildlife Conservation
Oregon Department of Fish and Wildlife
Plattsburgh, State University of New York
Rhode Island Department of Environmental Management, Division of Fish and Wildlife
South Dakota Department of Game, Fish and Parks
Texas Parks and Wildlife Department
University of Louisiana, Lafayette
Vermont Department of Fish and Wildlife
Washington Department of Fish and Wildlife
Wisconsin Department of Natural Resources
Wyoming Game and Fish Department

*Local government agencies and associations*
Champlain Islands Chamber of Commerce, VT
Curtis Chamber of Commerce and Manistique Lakes Area Tourism Bureau, MI
Lake Florida Improvement Association, FL
Lake Ontario Fisheries Coalition, NY
Lake Puckaway Protection and Rehabilitation District, WI
Northwest Angle and Islands Chamber of Commerce, MN
Oneida Lake Association, NY
Portage Township, MI
State of New York Conservation Fund Advisory Board
Thomas Lake Road Community Association, TX
Town of Orleans Conservation Commission, MA

*Non-governmental Organizations (NGOs)*
Agricultural Council of Arkansas
American Association of Retired Persons, Inc., Chapter 3876, TX
American Bird Conservancy
American Fisheries Society

Animal Protection Institute, CA
Association of Northwest Steelheaders, North Fork Nehalem Chapter, OR
Atlantic States Legal Foundation, Inc., NY
Audubon Society of Central Arkansas
BASS, Inc., AL
Coalition of Louisiana Animal Advocates, LA
Concerned Citizens for Cormorant Control, AR
Connecticut Harbor Management Association, CT
Coon Creek Club, TX
Dixie Lake Hunting and Fishing Club, TX
Eastern Lake Ontario Salmon and Trout Association, NY
Fishers Island Conservancy, Inc., NY
The Ford Plantation, GA
Friends of Animals, CT
Fur Harvester's Association of Jefferson County, NY
Great Lakes Sport Fishing Council
Green Bay Area Great Lakes Sport Fishermen Club, WI
Green Mountain Animal Defenders, VT
International Marine Mammal Project of Earth Island, CA
Lake Champlain International, Inc.
Lake Champlain Walleye Association, VT
Lewis County Association of Sportsmen's Clubs, NY
Marsh Lake Ducks Unlimited, MN
Michigan United Conservation Clubs
National Aquaculture Association
National Audubon Society
New York State B.A.S.S. Chapter Federation
Niagara River Anglers Association Inc., NY
Onondaga County Federation of Sportsmen's Clubs, NY
Pelican Harbor Seabird Station, Inc.
Rainforest Action Network
Rochester Birding Association, NY
Schubert and Associates (on behalf of The Fund for Animals and the Humane Society of the United States)
Society for Animal Protective Legislation
Straits Area Sportsmen's Club, MI
United States Trout Farmers Association
Vermont Audubon Council
Wildlife Management Institute
Wisconsin Wildlife Federation

*Businesses*
After-U Charters, OH
Beauty Without Cruelty, NY
Birch View Resort, MN
Captain's Cove Motel and Marina, NY
Danbury Fish Farms, TX
Fisherman's Choice Charters, WI
Fishin'World, TX

Fish Partners, CA
Fletcher's Bait Service, MN
Flowers Fish Farm, MO
Foster Management, TX
Harry Saul Minnow Farm, Inc., AR
Island Passenger Service of Flag Island, MN
J-E Fishing Enterprises, WI
KB Fish Farm, Inc., AR
Keo Fish Farm, AR
Kirchner's Fishing Kamp, NY
Lake Fork Guide Service, TX
Niagara Mohawk, NY
R.E. Palmer, CPA, Inc., OK
Sea Dog Charters, MI
Ship to Shore Aquafarm, CA
Triple Pugh Farms, AR
West Central Bait, MN
Wild Woods Charter Service, MN

*Legislative officials*
Congressional Sportsmen's Caucus, U.S. House of Representatives
U.S. House of Representatives, Marion Berry, Arkansas
U.S. House of Representatives, Jay Dickey, Arkansas
U.S. House of Representatives, Jack Quinn, New York
U.S. House of Representatives, Bart Stupak, Michigan
U.S. House of Representatives, Don Young, Alaska
U.S. Senate, Blanche Lincoln, Arkansas
U.S. Senate, George Voinovich, Ohio
New York State Assembly, Michael J. Bragman
New York State Senate, James W. Wright
State of Arkansas House of Representatives, Sam E. Angel, II

*Tribes*
Kiowa Tribe of the State of Oklahoma
White Mountain Apache Tribe, Wildlife and Outdoor Recreation Division, AZ
Wampanoag Tribe of Gay Head (Aquinnah), MA