REVIEW OF THE DOUBLE-CRESTED CORMORANT MANAGEMENT PLAN, 2003:

FINAL REPORT OF THE AOU CONSERVATION COMMITTEE'S PANEL

J. Michael Reed[1], Douglas Causey[2], Jeremy J. Hatch[3], Fred Cooke[4], and Larry Crowder[5]

[1]*Department of Biology, Tufts University, Medford, MA, 02155, USA;*

[2]*Museum of Comparative Zoology, Harvard University, 26 Oxford St., Cambridge, MA 02138 USA;*

[3]*Department of Biology, University of Massachusetts, Boston, MA 02125 USA;*

[4] *Larkins Cottage, 6 Lynn Road, Castle Rising, Norfolk PE31 6AB, UK;*

[5]*BRL 315, Duke University Center for Marine Conservation, Nicholas School of the Environment and Earth Sciences, 135 Duke Marine Lab Road , Beaufort, NC 28516-9721 USA*

The Double-crested Cormorant (*Phalacrocorax auritus*) is a migratory piscivorous bird with bicoastal and inland distributions in North America. Coastal breeding populations extend from Alaska to Mexico and from Newfoundland to Cuba, while inland breeders occur widely, southwards from northern Alberta.

The extent of the historical range and numbers of this species is poorly known, in part because frequent persecution by humans makes the baseline difficult to establish. Increases of numbers during the 20th century were interrupted throughout the range from about 1950-1970 in association with adverse impacts of bioaccumulated pesticides (Hatch and Weseloh 1999). Since the early 1970s, however, cormorants have increased widely and it is likely that continental numbers have reached an all-time high. In the Great Lakes populations, the annual rate of increase from 1970 to 1991 was about 29%, from 89 nests to almost 26,000 nests (Weseloh et al. 1995). However, there have been recent regional declines (since 1990) in West Coast- Alaska populations and possibly in the Atlantic region (Tyson et al. 1999). As numbers have increased, cormorants have become increasingly involved in bird-human conflicts, principally involving (a) commercial and (b) recreational fishing primarily in the northeastern and north-central U.S., (c) aquaculture in the southeastern U.S., and to a lesser extent (d) local impacts on vegetation and other bird species near cormorant colonies and roosts (reviewed in Nettleship and Duffy 1995, Tobin 1997, Hatch and Weseloh 1999, Glahn et al. 2000). Effects of cormorants on aquaculture are well documented, but the other conflicts are poorly supported (see below). The other concern is whether documented impacts warrant control of cormorants, and over the methods of control. Conflicts in the United States over predation of fish have most conspicuously concerned cormorants inland, especially those nesting around and migrating past the Great Lakes and Vermont, and those wintering in the southeastern states.

For purposes of discussing numbers and management, the cormorants nesting in the U.S.A. and Canada have been divided into four regions: West Coast-Alaska, Interior, Atlantic, and Southeast U.S.; those nesting in Mexico are not considered. The biological realities of these divisions are unclear (Hatch and Weseloh 1999). On the other hand, the arena for management is confined to the US, even though actions at wintering sites may affect birds that breed in Canada (where the species is managed at the Provincial level; Hatch and Weseloh 1999).

In response to heightened concerns about human-cormorant conflicts, the U.S. Fish and Wildlife Service (USFWS), as the responsible Agency in the U.S., issued a depredation order in 1998 (USFWS 1998) to allow some shooting at some aquaculture facilities without federal permits. Legal "take" under the depredation order and depredation permits from 1998-2001 was estimated at 46,664 birds per year (USFWS 2003). Much of this take was from Atlantic and Interior populations (USFWS 2003). In 2001, the USFWS presented a Draft Environmental Impact Statement on Double-crested Cormorant Management (USFWS 2001) that outlined alternative plans and justifications for reducing Double-crested Cormorant numbers; this Plan was finalized in 2003 with the issuances of the final rule establishing the Public Resource Depredation Order (October 8, 2003; FR 68 58022).

The alleged magnitudes of the effects that Double-crested Cormorants have in each of the conflicts listed above, the proposed management options, and their anticipated outcomes, are controversial. Consequently, the AOU Committee on Conservation formed a panel (comprising the five authors of this report) to review the Draft Environmental Impact Statement (DEIS), focusing on the scientific evidence pertaining to each purported problem, and to provide feedback to the USFWS. On behalf of the AOU, we filed formal comments on the DEIS and proposed management plan in February 2002; we subsequently reviewed the Final EIS (FEIS) (USFWS 2003). This report presents an overview of the perceived problems with Double-crested Cormorants, a critique of the DEIS and FEIS, including the alternative actions selected by USFWS and U.S. Department of Agriculture (USDA), and the conclusions of this Panel on the FEIS. We report on both agencies because each is playing a role in cormorant management. The USFWS is responsible for protecting bird species covered under the Migratory Bird Treaty Act (which includes cormorants), and thus is responsible for assuring that no birds are taken without permits, while ensuring the continued health and persistence of cormorant populations. In certain cases, the USFWS may authorize take by promulgating regulations that allow take without annual permits, but that establish criteria, limits, and other provisions to ensure the continued health and persistence of cormorant populations. These regulations are known as depredation orders. The USDA, particularly through APHIS (Animal Plant Health Inspection Service), is responsible for wildlife damage management. The USFWS and APHIS, therefore, overlap in cormorant management responsibilities, but prefer different management strategies; however, APHIS actions are still limited by those authorized by the USFWS.

We also make suggestions for subsequent actions for reducing conflicts between humans and cormorants. We recognize that while scientific information is necessary for addressing the conflicts, it is not sufficient to resolve situations with substantial social and economic dimensions. Based on comments made in response to the DEIS that were reported in the FEIS, we anticipate continued high-profile discussions about Double-crested Cormorant impacts and control measures.

DOUBLE-CRESTED CORMORANT BACKGROUND AND CONTROVERSIES

The Double-crested Cormorant is commonly considered to comprise six formerly allopatric breeding populations that serve as the basis for the current taxonomy of five subspecies (Hatch and Weseloh 1999). The nominate subspecies (*P. auritus auritus*), which breeds in interior and eastern North America, is the most numerous and presents the greatest concern for conservation and human economic conflict. The largest numbers nest around the Great Lakes and in Manitoba. The largest concentrations of wintering birds tend to be along the gulf coast of Mexico and the southern US, and on the flood plain of the lower Mississippi and along the coasts of North Carolina and South Carolina (Siegel-Causey 1999, Christmas Bird Count data, http://www.mbr-pwrc.usgs.gov/bbs/htm96/cbc622/ra1200.html). These wintering populations and their explosive increase in the past two decades are the source of much of the trouble experienced with Double-crested Cormorants and human aquaculture activities (Weseloh et al., 1995).

Double-crested Cormorants nest near water, and as in all continental cormorants the size of breeding colonies in continental interiors correlates with their proximity to feeding areas (van Eerden et al. 1995a). Within this restriction, they are breeding site generalists (Siegel-Causey 1988). By virtue of wing morphology and aerodynamics, cormorants are indifferent fliers and do not range far from roosting or breeding areas (Pennycuick 1989, 1991). Colony and roost sites, as a consequence, are located near foraging areas, tend to be patchily distributed throughout the landscape, and concentrate large numbers of birds. There is ongoing debate whether birds in colonies share information about feeding areas, but the phenomenon of social feeding in cormorants is well documented (van Eerden et al. 1995b)

There is evidence from European studies on Great Cormorants (*Phalacrocorax carbo sinensis*) that cormorants are philopatric and that the size of individual colonies correlates positively with fish availability (van Eerden and Gregersen 1995). Extending this reasoning, it is likely that some of the recent Double-crested Cormorant increase is due to increased fish aquaculture and resulting greater overwinter survival associated with a large food supply.

Perceptions and Potential Areas of Conflict. – It is clear that several groups of stakeholders have conflicting opinions about the natural activities of Double-crested Cormorants and the extent to which these activities affect human interests. It is important to evaluate these perceptions as well as the biological reality of the perceived effects, and if these perceptions are warranted, create a reasonable management plan to reduce the conflicts. The primary areas of potential conflict include commercial fishing, sport and recreational fishing, and aquaculture. They include predation of desirable fish, use of natural resources, use of human resources, public health and safety (by affecting water quality), interactions with other wildlife, and aesthetics. Some of the potential impacts overlap and interact with others, and some may be local in nature (i.e., could be a pond or ponds on one farm, or several farms in an area) while others may be noticeable throughout the distribution of the species. Of the potential conflicts between cormorant and human resource use, predation of desirable fish is the central concern (Siegel-Causey 1999). It was these concerns that lead to early depredation orders and eventually to the Draft EIS.

Commercial and recreational fisheries. – Humans have altered the feeding opportunities for cormorants not only by building large aquaculture facilities that house dense populations of fishes, but also by altering wild foraging opportunities. In many aquatic systems, heavy fishing pressure has reduced the abundance of large predatory fishes, enhancing populations of smaller forage fishes (Weseloh et al. 1995). Food web alterations in the past also have led to increased opportunities for establishment of non-native fishes such as alewife (*Alosa pseudoharengus*) in the Great Lakes (e.g., Kitchell et al. 2000). A century of scientific research on Double-crested Cormorant diet and feeding behavior indicates that cormorants favor schooling and slow moving fishes as well as being attracted to high densities of fishes, which can occur when forage fishes are released from predation (Hatch and Weseloh 1999). The FEIS documents the public perception of decline in creel catch of large game fishes such as small-mouth bass (*Micropterus dolomieui*) and yellow perch (*Perca flavescens*). We have no doubt some anglers perceive declines in the quality of their fisheries, but only 3 states (Arkansas, Tennessee, Texas) reported that Double-crested Cormorant predation was thought to be of major importance to sport or commercial fisheries; eight states reported a perception of moderate importance (DEIS section

4.2.2; FEIS section 3.2.2). The questions we address below concern the evidence for impacts and the effectiveness of proposed actions.

Aquaculture. – The local impacts of piscivorous birds at aquaculture ponds and hatcheries are well known and have been the subject of numerous studies (e.g., Wywialowski 1999, Blackwell et al. 2000, Tobin et al. 2002, Dorr et al. 2004, Keller and Carss 2003). The greatest density of freshwater aquaculture development in North America is located within the potential wintering range of cormorants and other waterbirds. Aquaculture ponds in the southeastern U.S. can be quite large (>20ha), simply designed as shallow pools, where fish are fed by spraying food onto the surface. The question we address below is whether or not the proposed management actions will effectively reduce the amount of fish taken by cormorants from these facilities.

ALTERNATIVE ACTIONS CONSIDERED BY THE DEIS AND ACTION SELECTED

The USFWS generated six alternative management options (A – F) that were evaluated on their anticipated abilities to reduce conflicts associated with Double-crested Cormorants, increase management flexibility, and conserve "healthy" Double-crested Cormorant populations. All alternatives require some form of permit application for lethal take, and all allow for non-lethal management methods. In addition, all alternatives require long-term population monitoring.

Alternative A: No Action – This option would leave in place current management policies and practices, which can include non-lethal management techniques, and depredation permits, particularly at aquaculture facilities. Depredation includes shooting adults and young, and destroying eggs and nests.

Alternative B: Non-lethal Management – This alternative would no longer allow lethal take of cormorants or eggs, but would allow continued use of non-lethal control methods (e.g., harassment, habitat modification).

Alternative C: Increased Local Damage Control – This alternative would expand current wildlife damage management to include a broader range of resource conflicts, including lethal control at winter roost sites in 13 states and allowing lethal take at public fish hatcheries (which was prohibited before), and would relax restrictions for take at aquaculture sites and at any site where there is information or judgment that cormorants are detrimental to any resource. This would include detrimental effects on everything from endangered species to vegetation under roost sites, as long as the actions did not affect the viability of the Double-crested Cormorant.

Alternative D: Public Resource Depredation Order – This alternative facilitates increased killing at any life-history stage by allowing a greater array of agencies to authorize depredation orders, including killing birds "about to commit" depredation, or killing birds to prevent depredation, of public fish resources or any other resource (e.g., habitat). It expands lethal control as a management option from 13 to 24 states, including "all lands and freshwater", and includes public and commercial aquaculture facilities. It also allows take during the winter months (October-April) at roost sites near aquaculture facilities.

Alternative E: Regional Population Reduction – Under this alternative, the United States would be divided into an unspecified number of regions, and in each region a committee would develop Double-crested Cormorant population goals. These goals would be based on "multi-agency reviews", and "other" values would be considered in setting population targets. Control efforts would be fairly open ended, allowing lethal techniques to be used anywhere – nesting, roosting, and wintering sites, aquaculture facilities, and apparently anywhere else cormorants might be found; non-lethal techniques would be allowed, but would be voluntary. The objective would be to achieve the population goal as quickly as possible.

Alternative F: Regulated Hunting – Federal and state wildlife agencies would collaborate to create open seasons and bag limits for hunting Double-crested Cormorants. Hunting seasons would coincide with waterfowl hunting seasons. All other actions allowed under Alternative C also would be allowed.

The USFWS selected Alternative D for proposed action. It will require new regulatory strategies, allow depredation permits on public and private lands, expand lethal take allowed near aquaculture facilities, create new depredation orders, allow lethal take of nests, eggs, young, and adults, and allows for the possibility of creating regional population objectives like those discussed under Alternative E. On 18 November 2003 the USDA/APHIS/WS issued a Record of Decision in which they adopted the EIS prepared by the USFWS but decided to implement Alternative E instead of Alternative D (http://policy.fws.gov/library/03-25500.pdf). This decision followed earlier advocacy for flyway-level management (Glahn et al. 1999).

EVALUATION OF THE ENVIRONMENTAL IMPACT STATEMENT

The panel's review concluded that the Draft and Final EIS are flawed for the following reasons:

1) the scientific evidence supporting the proposed action is weak;
2) the analysis of the data is simplistic;
3) the management plan proposed by USFWS is inadequate and has a poorly evaluated potential to be effective;

4) the consequences of the proposed action on the cormorants are unknown, and appear to be punitive instead of mitigatory;

5) the assessment of success is unclear; in the DEIS, success is based on public perception and not on scientific results. The FEIS is not clear on how success will be assessed; and

6) there is no adequate mechanism for monitoring the population effects of the plan, nor for deciding when to terminate management actions.

Furthermore, we find that the FEIS fails to discriminate effectively between facts and opinions, uses economic arguments without sufficient demonstration of their accuracy, and disregards geographic scale. For these and the details below, we cannot support the proposed management plan, Alternative D, presented in the EIS. Below we focus our discussion on, a) the scientific evidence for Double-crested Cormorants causing significant impacts to fisheries or aquaculture, b) the probable effectiveness of Alternative D in reducing the impact, c) the means for estimating cormorant take, and d) difficulties in monitoring effectiveness of the management methods. All of these criticisms apply also to Alternative E, selected for implementation by USDA: comments on this Alternative are included at appropriate points. We end with suggestions for research on unresolved issues.

A potentially important point is to distinguish public and private resources, because it could affect the motivation and options for management, as well as the strength of a claim of economic damage. Marine fish and most freshwater fish are public resources; fish in aquaculture and hatchery facilities are private resources.

Cormorants and Commercial, Recreational Fisheries. – There are two questions to be asked regarding Double-crested Cormorants and fisheries: 1) Do Double-crested Cormorants have significant impacts on commercial or recreational fishing? and 2) Are the proposed management activities likely to reduce impacts if they exist?

The majority of available studies fail to show that Double-crested Cormorants have significant impact by predation on desirable fish (i.e., species and size classes targeted by sport fishing). For example, Birt et al. (1987) found significantly lower fish densities in bays used by Double-crested Cormorants for foraging, but they were not feeding on commercially important fish species. Studies that report depletions of desirable fish by cormorants only quantify fish numbers at local spatial scales (i.e., only a subset of a biological population), or are based on small samples (reviewed by Trapp et al. 1999; Table 1). Some recent studies, however, suggest that local depletions of fish by fish-eating birds could cause depletions of the species concerned over a larger area (Nagasawa 1998, Stapanian et al. 2002, Weseloh et al. 2002). Studies to evaluate fish depletion at the fish-population level by cormorants have not been done, and because of the mobile nature of fish, and their patchy distribution, it would be difficult to quantify depletion. Studies of other piscivorous bird species mostly show no evidence of biologically significant impacts on natural fish populations (Roby et al. 2003, Stapp and Hayward 2002), although at least one study demonstrated a significant negative impact of Lesser Scaup (*Aythya affinis*) at an aquaculture site (Wooten and Werner 2004).

Determining precisely what fish are taken by cormorants, however, can be difficult. First, many prey fish are identified by their otoliths, and the identification of the otoliths to species is easiest with undamaged otoliths from large fish. Reliable identification is reduced as the otoliths are degraded by digestive action in the cormorant stomach, and with smaller size classes of fish prey. Otoliths from small-sized smallmouth bass are nearly indistinguishable from those of other small fish, and the longer the otoliths are digested, the more problematic their identification (Adams et al. 1999) citation in Johnson). Furthermore, there has been no attempt to quantify or address the variation in size of otoliths and estimated sizes of fish taken, thus all of the discussions on whether or not cormorants take adult-sized fish are speculative. However, the association between freshly dissected otoliths and body size of the bass and perch they came from is significant because it forms the premise for diet reconstruction from food samples and pellet regurgitations.

For example, Johnson et al. (1999) summarized the results of 11 studies on creel surveys, diet analysis of cormorant pellets, and fisheries biology of the common and economically important fish in the eastern basin of Lake Ontario, including the waters around Little Galloo Island, New York. In these studies the primary sources of data that associate cormorants with economically important fish species come from identification of prey in regurgitated pellets and regurgitated food from chicks and, rarely, adults. These findings indicated that, the proportion of smallmouth bass (*Micropterus dolomieui*) taken by cormorants ranged from 0.4% of the total diet (1996) to 2.2% (1994), with the median amount around 1.0%. The primary food items were small bottom feeding fish and other species not rated as highly desirable by sports fishermen (e.g., alewife, troutperch *Percopsis omiscomaycus*, sculpin *Cottus* spp.).

Extrapolating from proportions of fish in cormorant diets to effects on populations of particular prey fish is not simple. For example, Houde (1987) has shown that even small changes in average survival in the larval stages of many marine fishes can have a large effect on recruitment. Life history population models (Marschall and Crowder 1996, Quinlan and Crowder 1999, Diamond et al. 2000) all show the highest elasticity (a measure of the age class to which population growth is most sensitive) for mortality in the late larval to early juvenile stages. In the case of cormorant predation on smallmouth bass and perch, the mortality attributable to cormorants is not on larvae, so anticipated impacts on recruitment might be modest.

The conclusion that Double-crested Cormorants normally take an insignificant number of game fish is supported by other studies as well (Derby and Lovvorn 1997, Belyea et al. 1999, Trapp et al. 1999, Simmonds et al. 2000, Burnett et al. 2002, Russell et al. 2002, Stapanian 2002), all of which are cited in the FEIS. There can be local conditions where Double-crested Cormorants cause management problems, but the demands for a change in the current management approach appear to be driven by perception and not by scientific evidence. Many factors contribute to variation in recreational and commercial catches and the systems where perceived problems are the greatest are those where over-fishing, exotic species invasions, stocking of apex predators and perhaps climatic variability are greatest (Siegel-Causey 1999). To single out cormorants as the cause of these perceived problems is not justified by the science reviewed in the FEIS. The FEIS recognizes that the economic importance of commercial fishing in some regions has "experienced a steady decline for reasons unrelated to fish-eating birds" (page 45), and also acknowledges the general lack of documented effects on economies due to cormorant predation of game fish, but concludes nevertheless that action needs to be taken. In fact, in direct response to a question from the Public regarding the DEIS, the FEIS states that the USFWS believes that agencies do not need to wait until there is a demonstrated effect before taking action (question 53, p. 130).

Consequently, we conclude that the USFWS has not made a strong scientific case for a major change in policy regarding public resources and has responded to stakeholders on weak evidence. Fisheries ecosystems are changing under a plethora of factors, only one of which is cormorant predation, and focusing remediation solely on cormorants does not appear to be justified. In the FEIS it is acknowledged (p.59) that “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. (2003) examined the problem of basing decisions to manage cormorants on data that are scientifically inadequate. The next paragraph of the FEIS states that evaluating other potential impacts to fish populations was beyond the scope of the FEIS. We believe that this should have been central to the EIS.

Cormorants and Aquaculture. – The evidence for cormorant impacts on aquaculture systems is much more extensive than for openwater fisheries. However, the methods proposed in the FEIS to reduce such impacts under Alternative D have been shown to be ineffective or at best to have only short term local effects. First, controlling cormorants by lethal or non-lethal means has been a very local approach, and every study to date shows that constant and continuing effort must be taken to keep birds off ponds (Glahn et al. 2000). Cormorants habituate to static or automated deterrents quickly, and killed birds are soon replaced from nearby. Second, lethal means of regulating cormorant numbers have not yet met with success (Thompson et al. 1995, Belant et al. 2000, Glahn e t al. 2000). Similar findings have been reported from other parts of the world (Keller and Lanz 2003, Hayama 2002, Bechard and Marquez-Reyes 2003, Parrott et al. 2003). Consequently, killing birds at roosts near aquaculture ponds or on the ponds is likely to create only short-term respite and may also push birds into other areas where they might become a problem. Local reductions on the non-breeding grounds would have a trivial impact on a continental scale, and thus the same problem will recur in the next season when new wintering birds appear. Cormorants are not the only fish predator on aquaculture ponds; herons and pelicans have similar behaviors but are not as common at present (Glahn et al. 2000). Selectively culling the most numerous species of fish predator, Double-crested Cormorants, from aquaculture ponds could result in an increase in numbers of other piscivorous bird species, shifting the problem to the other bird species rather than reducing fish take. The first two problems were raised in the FEIS and then were ignored.

Double-crested Cormorants are opportunistic feeders, and they are able to range over great distances in search of food, particularly during the non-breeding season, preferentially aggregating at rich food sources (Hatch and Weseloh 1999). As a consequence of localized culling, fish aquaculture and hatchery sites could become large population sinks, where killed birds are replaced by others seeking a rich food source. The continuing influx of new birds means that such aquaculture sites would become the last places for cormorant numbers to decline even if continental numbers were declining rapidly (Bregnballe et al. 1997, van Eerden and van Rijn 1997). The DEIS acknowledged that prime foraging areas might be the last to be abandoned (p. 81) although this acknowledgement was absent from the FEIS. Consequently, we anticipate that Alternative D would result in massive kills of Double-crested Cormorants before any compensating effect is seen, and that the efforts on the wintering ground would have to continue indefinitely. The DEIS states that the offered solution might fail because of the foraging and ranging behavior of the species but later concludes that, "Nonetheless, population reductions would likely make efforts to manage … more effective." (p. 82). No explanation or evidence is provided for this conclusion. The FEIS also omitted this insight, but not the conclusion. This aspect of potential ineffectiveness applies to the reduction of regional numbers proposed in Alternative E.

Other potential concerns. – Other concerns associated with Double-crested Cormorants addressed by the FEIS were not supported by scientific evidence, or at most showed that the impact would be localized to the immediate sites of colonies or roosts . This included impacts to other birds, vegetation, water quality, and federally listed species.

Estimated take. – The Final EIS suggests that 160,000 birds per year would need to be killed to resolve cormorant conflicts (USFWS 2003). This number is admitted to be a guess and would require that 150% more cormorants would be killed annually in each participating State than in the period 1998-2000 (p. 56). The Draft EIS reported a very different estimate of the cormorant take required to resolve cormorant conflicts. Based on a simple deterministic model, the DEIS concluded that 250,000 birds per year would need to be killed. No assessment of these estimates is provided, nor was an explanation of the difference between the two estimates. Presumably the USFWS concluded that the model used in the DEIS was insufficient, but it is not clear how the estimate in the FEIS was derived. Also, although the FEIS notes that there are five subspecies or regional populations of Double-crested Cormorants, and that the reported conflicts are not evenly distributed among the subspecies, all evaluations of management alternatives and impacts are made treating Double-crested Cormorants as a single continental population. Predicted effects of management should be estimated at least at the subspecies / regional level. Since monitoring must be addressed regionally, regional models of the effects of cormorant management would allow more efficient adaptive management.

We therefore conclude that the USFWS has no defensible estimate of the expected take and, based on the foraging behaviors of cormorants discussed above, this could be much higher than suggested and yet still have no long-term effect in alleviating economic losses in hatcheries and aquaculture sites. Furthermore, more than half of the Double-crested Cormorants of concern breed in Canada, and there is no discussion at all relating to the international implications of cormorant take in the non-breeding grounds. The reductions in regional numbers proposed under

Alternative E would require widely-coordinated actions throughout the annual cycle. Inter-governmental discussions between USFWS, CWS and the provincial agencies are essential and have not been identified.

Population monitoring. – This section of the FEIS is seriously flawed. No evidence is given that any specified reduction in Double-crested Cormorant numbers could be achieved in either short or long term, or that the USFWS would have sufficient data to monitor what population changes occur as a result of actions under Alternatives D or E. The FEIS reports eight systems already in place that could be used for Double-crested Cormorant monitoring. However, none of the methods is likely to be effective for cormorants. Specifically, Christmas Bird Counts (CBCs), band recovery data, and North American Regional Reports are ineffective for Double-crested Cormorants due to their low density of population samples through time and stochastic sampling regimes. Most of the cormorants reported on CBCs entail challenging observations at a small number of coastal sites. Band recovery data works well only with large numbers of marked birds and appropriate distribution of banding effort in time and space. No expansions of this banding are proposed. Data from the North American Regional Reports allow detection only in range – abundance estimates are unreliable – and no range criteria for adaptive management are presented. The final approach suggested in the FEIS for monitoring cormorants is use of reports of cormorants killed under Depredation Permits and Depredation Orders. However, it is unclear what the relationship would be between these reports and extant population sizes or trends

It is important that an effective monitoring plan be developed and implemented to assess population-wide effects of management actions. The likely effects of killing many cormorants will not be limited to local areas; consequently, wider monitoring is essential and has not been proposed. .The monitoring outlined in the FEIS (4.3.7) lacks four critical components. First, it lacks sufficient details about monitoring methods. We suggest that efforts to develop a monitoring plan would benefit from investigating programs such as that by Bird Studies Canada's Coastal Waterbirds Survey in British Columbia. In addition, the monitoring outlined in the FEIS lacks biologically defensible local target goals for population reduction; it lacks a statistical power analysis to determine the intensity, locations, and frequency of counts to demonstrate that target declines can be detected; and it lacks specific management actions that would occur if the target population decline is achieved or exceeded. The monitoring plan needs to include areas where Double-crested Cormorants breed and winter outside of the target areas where cormorant take occurs to determine if this take is having undesired results elsewhere. These "unmanaged" areas should also have biologically defensible target declines in population size below which killing elsewhere would stop.

LESSONS FROM EUROPE?

Current problems with cormorants are not unique to North America; similar issues have arisen in Europe, Asia, and Australia.   In Europe the principal cormorant of concern is the 'Continental' subspecies of the Great Cormorant *P. c. sinensis,* and the growth of cormorant numbers as well as the conflicts with fisheries have followed a similar time-course to those involving *P. auritus*. (The 'Atlantic' subspecies *P. c. carbo* occurs on both sides of the North Atlantic, principally as a coastal breeder, and is not at present a problem from the public's perspective, although introgression is not occurring (Hatch et al. 2000)). An international Cormorant Research Group has arisen (with largely European membership) and organized a series of conferences; the proceedings of the 5th conference (in December 2000) were recently published (Keller and Carss 2003).

Particular strengths in knowledge of the European cormorants, compared to the North American, lie in extensive demographic information. Much of this is attributable to a long-term study at a large colony in Denmark during a period of rapid growth and then stabilization of numbers (Bregnballe 1996). Recent mathematical modeling of cormorant populations has indicated likely ineffectiveness of culls (killing adults) (Frederiksen et al. 2001) and later work examined local effects, especially winter site-fidelity (Frederiksen et al.2003). The practical failure of culling in situations where there can be a large turnover of individuals was shown by work in Bavaria (Keller and Lanz 2003). As in North America, the evidence that cormorants have major effects on fishery-species is weak and killing of cormorants has been authorized in response to stakeholders' concerns rather than scientific evidence.

The European cormorants travel between countries, some of them very densely populated, where there are diverse stakeholders under different laws and traditions and often speaking different languages. The existence of conflicts is no surprise, and recent responses are instructive. A 2-year project (2000-2001), funded by the European Union *Reducing the conflict between cormorants and fisheries on a pan-European scale* (REDCAFE), sought to deliver solutions to these problems by fostering discussions between stakeholders in a rigorous, coordinated and equitable manner. Recognizing that the conflicts involve not only biology but also have important social and cultural dimensions, the project aimed to open communication channels and facilitate dialogue and collaboration. Seven main stakeholder groups were identified: commercial fishermen, recreational fishermen, aquaculturalists, avian/wetland conservationists, fisheries scientists, avian ecologists and social scientists. This project illustrates how integrated multidisciplinary approaches to the management of cormorant-fisheries conflicts can be developed, including a case study of conflict resolution (final report, Carss 2003). This document provides a plan for progress (section 3.7) that includes linking with stakeholders to exchange information, identify conflicts (including among various fishing interests), create a more open process for input on fisheries management, and addressing research needs. Based on results from REDCAFE, there will be a continuing international, interdisciplinary approach for addressing cormorant and fisheries conflicts in Europe (INTERCAFE, http://www.intercafeproject.net, D. Carss and M. Marzano in review).

CONCLUSIONS AND RECOMMENDATIONS

In conclusion, we find that (a) there is no good evidence presented in the FEIS that cormorants cause significant fisheries problems except at aquaculture and hatchery sites; (b) the solutions proposed, primarily increased take, would likely be ineffective at aquaculture and hatchery sites yet potentially destructive to continental cormorant populations; (c) how 'success' of a control program would be defined is unclear; and (d) there is no monitoring program in place or proposed that could evaluate success, or detect effects on continental cormorant populations,. Consequently, it appears that what the USFWS plans to do constitutes persecution of a bird species rather than a solution to the real problems of declining fisheries and depredation at aquaculture and hatchery sites. We have several recommendations for helping to resolve these issues.

(1) Public perceptions and public attitudes related to the natural history of cormorants need to be addressed. It would be a mistake, in our opinion, to proceed with a purely biological approach to a problem that likely is substantially one of sociology and economics. We suggest

that a pro-active program of research, public education, and outreach be undertaken. It is possible that scientific research on the environmental sociology of cormorant-human interactions, performed by sociologists, would provide substantial benefits.

(2) Serious attention must be given to finding innovative and economically appropriate methods for excluding piscivorous birds from fixed site facilities, such as aquaculture ponds and hatcheries, or reducing the attractiveness of such sites. Applying existing methods has often been ineffective, especially at large and extensive aquaculture ponds, developed before avian piscivores were recognized to be such a problem. New solutions are needed and radical redesigns should be considered. Methods being examined include buffer ponds containing fish species more preferred by cormorants, fish refugia, as well as wires and nets. (These last excluders can create hazards of entanglement and death for diverse fish-eating birds) Detailed studies of what attracts cormorants (and other piscivores) to particular ponds (looking at the ponds from a cormorant-perspective) might lead to effective changes in feeding regimes, water-depths, or other unanticipated features.

(3) Further study is needed to understand better the causes and possible mitigation of declining yields in sport-fishery. Single-factor explanations for complex phenomena are unlikely to be helpful in finding solutions to problems that affect people's recreation or livelihoods.

(4) Management planning would benefit from new data collection on fish take by cormorants, in a variety of regions, including species and size/age classes, and the relationship between local take and fish densities and dynamics at larger (fish population) spatial scales. These data then could be incorporated into computer simulations of likely population responses by both fish and cormorants. These models also need better data on cormorant movement

behaviors and likely responses to the creation of population sinks if significant cormorant shooting occurs at aquaculture facilities, and should be specific to each management region.

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Table 1. Studies of potential effects of Double-crested Cormorant on commercial/sport fisheries cited in the EIS.

Study	Lake / Location	Conclusion
Haws (1987)	Minnesota	No impact on game fish
Campo et al. (1993)	Texas	No significant impact
Glahn et al. (1998)	Southeastern U.S.	No significant impact
Belyea et al. (1999)	Lake Huron	Minimal impact on perch
Johnson et al. (1999)	Ontario	Estimate reduced consumption, but long term effects unknown
Lantry et al. (1999)	eastern Ontario	Reduce smallmouth bass
VanDeValk et al. (1999)	Oneida	Reduced walleye, perch
Simmonds et al. (2000)	Oklahoma	At high densities could impact fish