A new policy for management of Double-crested Cormorants in the United States and an example of its implementation

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Abstract
In the fall of 2003, the U.S. Fish and Wildlife Service (USFWS), in cooperation with USDA-Wildlife Services (USDA-WS), completed an Environmental Impact Statement (EIS) for the management of Double-crested Cormorants (DCCOs) in the United States. The USFWS subsequently published new regulations to implement the EIS proposed strategy. One part of the new regulations, a "public resource depredation order" (PRDO), allows state wildlife agencies, tribes, and USDA-WS to control DCCOs on a localized level to protect fish, wildlife, plants, and their habitats in 24 states. We'll discuss this new policy and will highlight the management activities, including monitoring and evaluation efforts, occurring in one of the states working under the PRDO: those of the USDA-WS program in Michigan which, in 2004 and 2005, implemented a plan to reduce DCCO foraging in the Les Cheneaux Islands area of Lake Huron as a means of improving the yellow perch fishery.

Background
Populations of the Double-crested Cormorant (*Phalacrocorax auritus* DCCO) increased dramatically throughout the 1980s and 1990s, most notably in the eastern United States (and Canada) and around the Great Lakes in particular (USFWS 2003a, Wires et al. 2001, Hatch and Weseloh 1999). Corresponding to this biological trend were increases in the occurrence of resource damages and in the level of concern over real and potential damages associated with DCCOs (USFWS 2003a). While there is no debate that DCCOs eat fish and destroy vegetation, assessing the actual ecological and economic impacts of these phenomena can be challenging. However, a growing body of evidence in the United States and Canada over the last several years highlights the reality of the true impacts that abundant DCCO populations can have on their environment (Taylor and Dorr 2003; see Table 1). Nonetheless, it should be noted that the preponderance of evidence shows that for all categories of resource damages associated with DCCOs, the degree of significance (ecological, economic, aesthetic, etc.) varies considerably from location to location. Accordingly, in many locations, there may be no compelling need to manage DCCOs.
In the United States, nearly all bird species are protected by the Migratory Bird Treaty Act (MBTA) of 1918, and the conservation of their populations is a responsibility of the U.S. Department of the Interior Fish and Wildlife Service (USFWS). Thus, when the increasing abundance of DCCOs (and the subsequent upward trend in resource conflicts) brought them to the forefront of migratory bird management priorities, it was USFWS, rather than individual states, that led the effort to develop a new policy for addressing DCCO issues. In 1999, USFWS announced to the public its intent to revisit its policy for DCCO management and, in keeping with the National Environmental Policy Act, to prepare an Environmental Impact Statement (EIS) and hold public meetings on the issue. The Wildlife Services program of the U.S. Department of Agriculture (USDA-WS) was a cooperating agency in the development of the EIS.

Tab. 1 *Examples of Resource Conflicts.*

Citation	Location	Nature of damage
Jarvie et al. 1999	Lake Ontario, Ontario	Habitat destruction
Shieldcastle and Martin 1999	Lake Erie, Ohio	Habitat destruction
Wywialowski 1999	North America	Economic loss to catfish producers
Ross and Johnson 1999	Lake Ontario, New York	Predation on stocked salmonids
Glahn et al. 2000	Mississippi Delta	Economic loss to catfish producers
VanDeValk et al. 2002 and Rudstam et al. 2004	Oneida Lake, New York	Sport fish impacts
Fielder 2004	Lake Huron, Michigan	Sport fish impacts
Hebert et al. 2005	Lake Erie, Ontario	Habitat destruction
Weseloh et al. 2005	Great Lakes	Effects on other nesting birds
Casselman and Marcogliese 2005	Lake Huron, Ontario	Reduced forage fish abundance

Four years, 22 public meetings, and more than 12,000 public comments later, USFWS published, in August of 2003, the Final EIS. An EIS is a science-based document that analyzes alternative courses of actions and their anticipated environmental effects; its purpose is to aid in the decision-making process. The specific goal of the DCCO EIS was to develop a strategy that would: reduce DCCO conflicts in the United States, enhance the flexibility of wildlife agencies in dealing with DCCO conflicts, and ensure the conservation of healthy DCCO populations. It examined 6 potential management strategies and selected as the proposed action the public resource depredation order (PRDO) alternative. This alternative created a new regulation, and modified an extant one, to authorize the "take" (a legal term that refers to the killing of a bird or egg) of DCCOs in certain states for specific purposes. USDA-WS selected the PRDO, in combination with the regional population reduction alternative, as their proposed action; however, without USFWS authorization, they cannot implement regional population reduction.

The new policy

A regulatory approach to DCCO management was necessary because, in accordance with the MBTA, a migratory bird cannot be killed (including the destruction of eggs) except as authorized by regulation. Although non-lethal management can be effective up to a certain point, wildlife managers saw a need to be able to engage in limited lethal control and even localized population reduction to mitigate DCCO-induced resource damages. At the time of the EIS, the regulatory framework for control of DCCOs included depredation permits (issued to either an agency or an individual) or the aquaculture depredation order. Developed in 1998, the aquaculture depredation order authorized commercial aquaculture producers to shoot DCCOs on their property to alleviate the impacts of Cormorant predation on aquaculture stock. The Final EIS led to the modification of this aquaculture depredation order to allow lethal control of DCCOs at winter roost sites. This was largely in response to a USDA-WS report on managing DCCO damage to southern aquaculture which stated that, based on their experience harassing and shooting DCCOs at roosts near fish farms, allowing control at roosts would help aquaculture producers significantly reduce the number of birds on their farms (Glahn et al. 2000).

The most significant regulatory change that came out of the Final EIS, however, and the focus of this paper, was the public resource depredation order (PRDO). This regulation authorizes officials of state wildlife agencies, USDA-WS, and Native American tribes to control DCCOs to protect fish, wildlife, plants, and their habitat. It applies to 24 states (Alabama, Arkansas, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, New York, North Carolina, Ohio, Oklahoma, South Carolina, Tennessee, Texas, Vermont, West Virginia, and Wisconsin); those where relatively significant conflicts occurred, where DCCO populations had been increasing most dramatically, and/or that were along the flight paths of migrating DCCOs. In being specific to "public resources," this depredation order's purpose is to protect natural resources that are managed by public agencies for public benefit. It is not intended to protect privately-owned resources from damages caused by DCCOs, although depredation permits may still be obtained for damages of this nature.

In order to balance the latitude granted to agencies under the PRDO with the responsibility to ensure the long-term conservation of DCCOs and other species, USFWS included a number of terms and conditions in the regulation. For example, agencies must take care not to harm other migratory birds or threatened and endangered species while implementing DCCO control actions. They must obtain landowner permission if they wish to work on private lands and must abide by all applicable State (and other) laws in carrying out activities under the PRDO. Reporting and recordkeeping requirements are also part of the regulations. At a minimum, agencies must send an annual notification letter and must submit an annual report of their activities. In the case of actions that go beyond damage mitigation to localized population management, extra requirements take effect. The reporting and recordkeeping provisions are intended to help USFWS keep track of the take of DCCOs under the PRDO and to understand the intent of the control actions, as well as to encourage agencies to gather information that will enhance knowledge of DCCO management and its effects on both DCCOs and co-occurring resources.

Justification

The question of scientific justification for the new regulation was an important one that came up during its development. Some individuals and organizations felt that the "best available science" did not justify the PRDO. USFWS's position was that there was enough biological evidence, as well as concern among resource professionals, to justify an approach that would allow agencies to manage DCCOs locally to alleviate resource damages, while recognizing that there were some who desired greater scientific rigor. Management agencies can not always make decisions based solely on science, especially in the area of wildlife damage management where preventive action may be necessary to avoid the occurrence of impacts. Wildlife damage management is itself a science, that of reducing damage or other problems associated with wildlife, and is an integral part of the field of wildlife management (The Wildlife Society 1990).

Even in situations where the scientific evidence for impacts seems clear, science alone does not answer the value-laden questions associated with determining whether or not certain resources are worth protecting at the expense of others (Sarewitz 1996). The father of American wildlife management, Aldo Leopold, noted the values dilemma as it relates to the control of piscine predators when he wrote: "The fisherman perhaps feels no loss in this sacrifice of one kind of wildlife for another, but the ornithologist is ready to bite off ten-penny nails" (Leopold 1966: 286). In effect, what USFWS's decision amounted to was that it would no longer, in the 24 states where the PRDO applied, make that value judgment for other agencies. The conservation of DCCO populations is still fundamental, of course, but within the bounds of that imperative and according to the purpose, terms, and conditions of the PRDO, agencies now have considerably more leeway to decide when DCCO management is justified.

At the time the Final EIS was completed, USFWS did not find large-scale regional population reduction of DCCOs to be adequately justified. The purpose of the PRDO is to allow key agencies to conduct *localized* Cormorant damage management, meaning that the particular birds being managed must occur in the same geographic area as the resources being protected. Because of significant uncertainties about whether fewer DCCOs would actually mean fewer problems (since distribution can be as important as numbers in determining impacts); what the necessary scale of control would be; and whether that scale was biologically, socially, and economically feasible, USFWS chose to focus on local control, while acknowledging a possible role for broader population management in the future.

As stated in the preamble to the regulations: "To address DCCO populations from a broader and more coordinated perspective, a population objectives approach will likely need to be considered over the long term. In the future, if supported by biological evidence and appropriate monitoring resources, (USFWS) may authorize management that focuses on setting and achieving regional population goals. Until then, our strategy will continue to focus on alleviating localized damages" (USFWS 2003b: 58023).

Implementation and preliminary findings

Since the PRDO wasn't finalised until late in 2003, the first year of implementation on the northern breeding grounds occurred in 2004. That spring and summer, control activities under the PRDO were carried out in the Great Lakes region (in the states of New York, Vermont, and Michigan), where the largest concentrations of breeding DCCOs in the eastern U.S. exist, and further south in Arkansas. Of these states, New York and Vermont had in fact been implementing DCCO control (under authority of depredation permits) for several years previous. From October 2003 to September 2004, a total of 2,337 DCCOs were killed and just over 16,000 nests were destroyed or had their eggs oiled. These activities were conducted to protect vegetation and habitat; other birds (black-crowned night-heron *Nycticorax nycticorax*, great blue heron *Ardea herodius*, great egret *Ardea alba*, common tern *Sterna hirundo*); and fish (yellow perch *Perca flavescens*, walleye *Stizostedion vitreum*, smallmouth bass *Micropterus dolomieui*) from damages associated with DCCOs. In 2005, all four of these states continued DCCO management, with the addition of Texas and Minnesota as well.

We highlight here the DCCO management activities conducted by the USDA-WS program in Michigan in 2004. USDA-WS is the federal agency authorized by Congress to protect agriculture and other resources from wildlife damages. USDA-WS uses an Integrated Wildlife Damage Management (IWDM) approach; IWDM integrates and applies all approved methods of prevention and management to reduce wildlife damage, including cultural practices, habitat modification, animal behaviour management, local population reduction, or a combination of these methods (USDA 1997). USDA-WS first became involved with DCCO management through working with aquaculture producers, especially catfish farmers in the south-eastern U.S., to alleviate economic damages caused by DCCO predation at fish farms. However, as recreational, aesthetic, and ecological damages associated with DCCOs have become more prominent, USDA-WS has become increasingly involved with helping address these conflicts in recent years.

The main purpose of the Cormorant damage management program being implemented by USDA-WS in the Les Cheneaux Island (LCI) area of northern Michigan is to reduce DCCO foraging pressure on yellow perch. This 36-island archipelago, located in northern Lake Huron, stretches for 12 miles along the south-eastern end of Michigan's Upper Peninsula and is part of an 80-mile stretch of northern Lake Huron shoreline that is designated as one of The Nature Conservancy's "Last Great Places." Since the early 1900s, one of the main attractions of the LCI portion of Lake Huron has been its yellow perch fishery (Diana et al. 1987, Fielder 2004). Starting in the late 1970s, the yellow perch fishery there underwent a significant decline; it then remained fairly stable through the mid-1990s and, finally, fell to the point of near total collapse in 2000 (Fielder 2004). This decline in fishing quality has impacted the area both economically and recreationally and many residents of communities in the region have complained that increasing DCCO numbers were the cause of the yellow perch crash, given that simultaneous to the decline and collapse of the fishery there occurred a significant increase in the abundance of nesting DCCOs in the LCI (Diana et al. 1987, Belyea et al. 1999, Fielder 2004).

DCCOs have made a remarkable comeback in Michigan since the DDT-induced population low of the 1970s. In 1976, they were placed on the state's endangered species list (MDNR 2005) and in that same

year, the first observation of nesting in Michigan occurred. By 1986, more than one thousand DCCO nests could be found in the state (MDNR 2005). Using 1997 survey results, Wires et al. (2001) estimated Michigan's DCCO abundance at more than 30,000 pairs. In 2005, Michigan's Great Lakes breeding population was estimated at 25,787 nests (D.V. Weseloh, unpubl. data). The LCI population trend mirrors that of the state as a whole. In 1980, DCCOs established naturally at St. Martins Shoal, in the western part of the islands (Diana et al. 1997). DCCO numbers increased nearly 6-fold from the early 1990s to a local breeding population of over 5,500 nests in 2002 (Fielder 2004). Trexel (2002) found that growth of the LCI DCCO population had slowed and was probably stabilising.

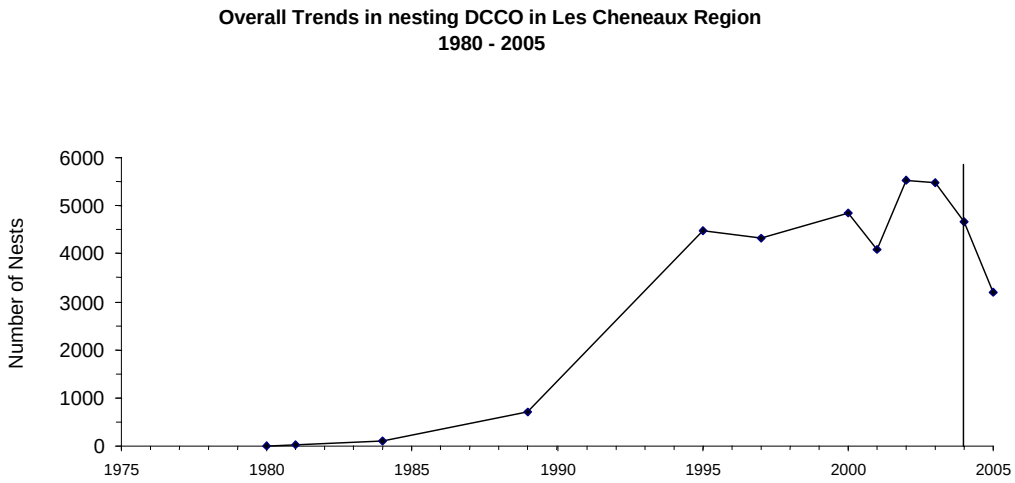

Fig. 1 *Nesting DCCOs in the Les Cheneaux Islands, 1980-2005 (vertical line indicates when control began).*

In 1995, researchers investigated the degree to which DCCO predation on yellow perch competed with anglers. This study examined the diet of DCCOs and evaluated yellow perch population data. Researchers found that yellow perch were a regular part of DCCO diet in April while perch were spawning but then switched over to abundant alewives for the remainder of season. Researchers estimated that DCCOs consumed between 270,000 and 470,000 yellow perch but concluded that the overall impact of DCCO predation was low, due partly to estimate of an overall high abundance of yellow perch that year, and because most perch consumed were less than the 178 mm minimum length limit of the sport fishery (Diana et al. 1997, Belyea et al. 1999). Abundance of alewives (*Alosa pseudoharengus*) was also relatively high (a trend that reversed in the late 1990s), likely acting as a buffer to DCCO predation on yellow perch (Fielder 2004). Alewives are a common food source for DCCOs in the Great Lakes (Hatch and Weseloh 1999) and indeed were the most important diet item for DCCOs in the LCI that year (Diana et al. 1997, Belyea et al. 1999). Despite the conclusion from the 1995 data that DCCO predation was not a significant factor on the perch fishery, the fishery was collapsed by 2000 (Fielder 2004). Yellow perch total annual mortality rate remained very high in 2000 (88%) despite the decline of fishing activity (D. Fielder, pers. comm.).

Another anomalous factor in 1995 was that northern Michigan experienced warm spring weather, which caused yellow perch to spawn earlier than usual. Thus, many of the larger spawning fish were less susceptible to DCCO predation because they had spawned and dispersed before the birds arrived in the area (Belyea et al. 1999). Fielder (2004) re-evaluated the data related to the yellow perch decline in the LCI, noted that the "timing of the rise in the Cormorant population coincides closely with the collapse of the yellow perch fishery and such a predation scenario would account for the continued high total annual mortality rate and decline in mean age," and concluded that DCCO predation was a likely part of the explanation for the collapse.

In light of this evidence, USDA-WS implemented a Cormorant damage management program in the LCI in the spring and summer of 2004. The program is part of a pilot project to investigate the feasibility of reducing DCCO foraging in the LCI as a means of improving yellow perch survivorship, with the goal of improving the yellow perch fishery. The strategy is fairly straightforward: reduce the local DCCO breeding population and, assuming negligible immigration of birds from outside the study area, foraging pressure should be reduced. To judge the program's success, the USDA-WS National Wildlife Research Center's Mississippi Field Station is conducting monitoring and evaluation efforts in the area. The

methods used to decrease foraging pressure were to reduce reproduction, by oiling eggs, at colonies in the area and to remove, by shooting, a portion of breeding adults. In 2004, the program achieved an approximately 99% reduction in reproductive success and removed 14% of the breeding population (the target was 15%). Birds were shot at nests early in the breeding season (before hatching) and later in the season decoys were used with considerable success.

Also in 2004, USDA-WS launched a pilot project to address impacts thought to occur during spring migration when high numbers (1,000+) of DCCOs forage in the mouth of the Potagannissing River on Drummond Island (east of the LCI) during the perch spawning period. To address this situation, which existed for a relatively brief period at a fairly small area, a different approach was tried: non-lethal harassment with pyrotechnics reinforced by a limited amount of lethal shooting. Another element of the Drummond Island approach that was unique was the use of local residents as volunteers to augment efforts by USDA-WS employees. Approximately 16 locals were trained and operated under a set of guidelines established by USDA-WS. The plan worked very well, with DCCOs quickly learning to avoid the mouth of the river. During 312 hours of harassment and shooting over 22 days, 98% of DCCOs were deterred from landing on the river. Based on the best information available, this equates to an estimated 6,000 pounds of perch that were not consumed by DCCOs at this location. The reduction in DCCO foraging pressure may also have resulted in a better yellow perch spawn (S. Scott, pers. comm.).

The role of research began during initial planning of DCCO management in the LCI. Stage-based population models, coupled with lessons from existing management efforts in Canada, were used to determine the optimal management strategy to reduce local DCCO numbers. Previous research on DCCO population demographics had shown that egg-oiling alone was unlikely to reduce numbers for an extended period of time due to high survival and longevity of adult birds (Dolbeer 1998, Blackwell et al. 2002). This information, combined with evaluations of DCCO management in Canada (Bédard et al. 1999), suggested that a combination of egg-oiling and lethal take of adults would best meet management goals.

To determine if control efforts were actually reducing DCCO foraging pressure, USDA-WS conducted aerial surveys of DCCOs in 2003, to obtain baseline data before control was implemented. At the same time, state agencies conducted nest counts and surveys of fisheries in the LCI area. These activities were continued again in 2004. In addition to surveys, research and evaluation efforts include food habits studies and evaluations of movement and distribution associated with management activities, using VHF and satellite telemetry. Preliminary telemetry data suggests that LCI DCCOs forage extensively throughout the region. Telemetry data have also highlighted the connection between DCCOs breeding in this region and utilizing areas of aquaculture production during migration. These data highlight the complexity and regional aspects of resource depredation issues associated with DCCOs.

Preliminary findings from 2003 and 2004 suggest that the breeding colonies being managed are indeed the source of most of the DCCOs foraging in the LCI and that management efforts contributed to a reduction in the overall numbers of DCCOs nesting and foraging in the LCI (Figures 1 and 2). Catch per unit effort of yellow perch increased since initiation of management (Figure 3). While this information is correlative and further monitoring and evaluation is necessary, trends in the opposite direction would preclude a conclusion that management efforts had been successful. Additionally, increasing trends in yellow perch numbers provide further opportunity to evaluate management effects on the fishery.

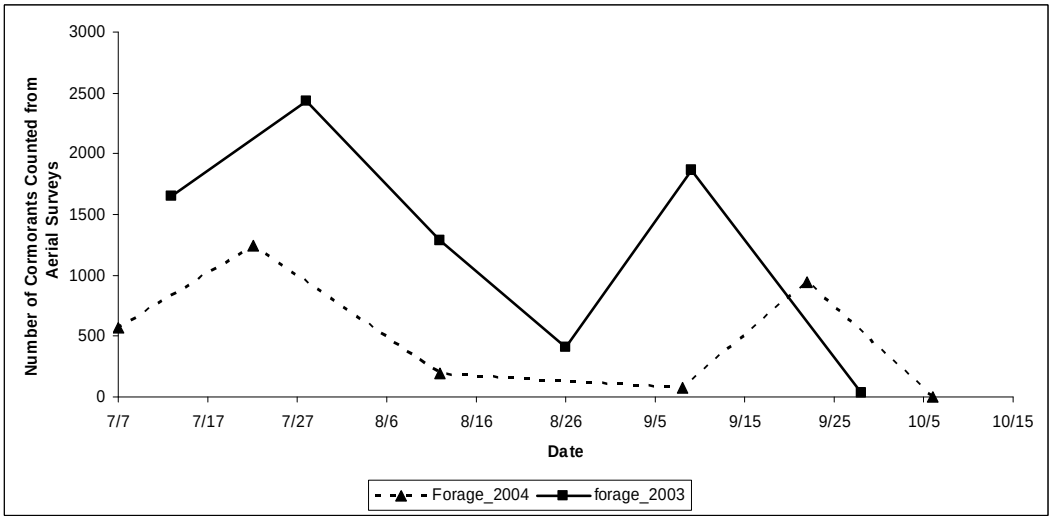

Fig. 2 *DCCO foraging numbers in the Les Cheneaux, 2003 and 2004.*

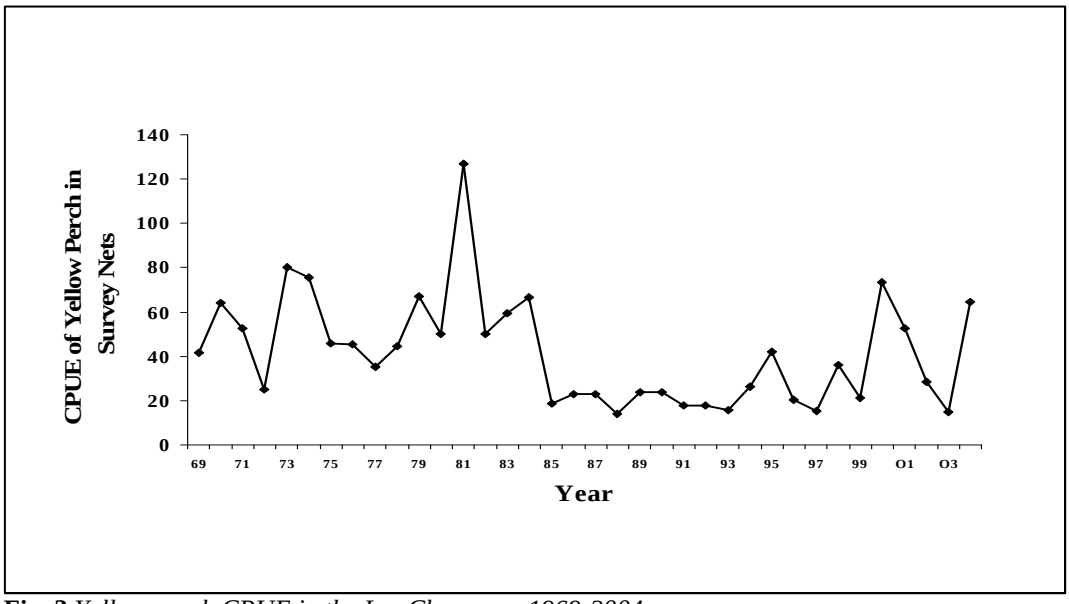

Fig. 3 *Yellow perch CPUE in the Les Cheneaux, 1969-2004.*

Conclusion

The DCCO management program in Michigan is just one of several projects that have been implemented, or are being planned, under authority of the PRDO to address localized DCCO damages. With the intensified management of DCCOs taking place under the PRDO, the need for interagency cooperation, research, and monitoring has increased greatly. Each of these factors is crucial if management strategies are to succeed at both reducing resource conflicts and ensuring the long-term conservation of DCCO populations. A flexible and responsive adaptive management program supported by research and monitoring can adjust to the dynamic and changing needs of managers, their constituents and wildlife populations. Essentially, combining research, monitoring, and management can be a useful method for reducing risk of undesirable outcomes associated with management activities and ensuring management goals are met. Achieving this goal requires considerable commitment and coordination among all parties involved.

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