Management of Double-Crested Cormorants in the Eastern Basin of Lake Ontario, 1999-2003: *A Summary and Recommendations*

James F. Farquhar, Irene M. Mazzocchi, Russell D. McCullough
New York State Department of Environmental Conservation
Watertown, NY 13601

James H. Johnson
Tunison Laboratory of Aquatic Science
U.S. Geological Survey
Cortland, NY 13045

Introduction

Recent growth of double-crested cormorant (*Phalacrocorax auritus*) populations within the Great Lakes region is well documented (Hatch and Weseloh 1999). Intensive study of Lake Ontario, eastern basin cormorant diet was initiated in 1992 to address concerns of anglers and natural resources managers relative to cormorant-fish relationships. In 1994, NYSDEC began efforts to prevent colonization of new sites within the eastern basin to satisfy recommendations of a Citizen Task Group (Gotcsik 1995), and to protect black-crowned night heron (*Nycticorax nycticorax*) breeding on Gull and Bass islands. Following a year of intensive research in 1998, NYSDEC established a link between cormorant predation and declines in the quality of the smallmouth bass (*Micropterus dolomieui*) fishery within the eastern basin (Schnieder et al. 1999). A comprehensive cormorant management plan was developed and implemented within the affected area in 1999 (Farquhar et al. 2003a). Included in the management effort were objectives to improve the quality of the smallmouth bass fishery, maintain the diversity and presence of waterbird species nesting within the basin, and to reduce the number of breeding cormorants to levels below which fishery impacts were observed (a population associated with 1,500 pairs). This report summarizes the initial five years of comprehensive cormorant management, reports progress towards achieving objectives, and provides recommendations for the future.

Methods

The eastern basin cormorant management program involves six action/study components: egg oiling/nest removal, diet assessment, cormorant telemetry, colonial waterbird monitoring, warmwater fish stock assessment, and eastern basin creel survey. Collectively these components are designed to achieve waterbird and fisheries objectives and permit evaluation of management actions taken. Specific descriptions of methods employed are described in detail by Dorr et al. (2003) and Mazzocchi (2003) for cormorant telemetry work; Eckert (2004) for warmwater fish stock assessment; Farquhar et al (2003b) for colonial waterbird monitoring; Johnson et al(2004) for diet assessment; McCullough et al (2004) for egg oiling/nest removal and McCullough and Einhouse (2004) for the eastern basin creel survey.

Results

<u>Effects of management on the cormorant population</u>
Since nest removal began in 1994 on Gull, Calf and Bass Islands, a total 35 nests have been successful (2003) in spite of annual nesting attempts by as many as 1,235 breeding pairs (2000). The Little Galloo Island (LGI) cormorant population has fallen 25% from 5,681 nests in 1999 to 4,251 in 2003 following five years of egg oiling. The observed reduction in cormorant nest numbers on LGI during the five years has been relatively consistent with numbers predicted in the April

2000 FEIS (NYSDEC 2000) prepared for cormorant management in the eastern basin. Overall, within the basin, total cormorant presence has declined slightly from 1999 levels (9,330 vs. 8,712 nests in 2003), due to increases in numbers on un-managed nesting colonies in Canadian waters.

Telemetry studies (VHF and satellite) conducted in 2000-2002, on Pigeon, Snake, and Little Galloo Islands have provided valuable insight into cormorant movements associated with management activities. In a VHF telemetry study conducted in 2000 and 2001 on Snake and Pigeon Islands, nest site fidelity ranged from 44%-75% (Mazzocchi 2001, 2002). These islands are not subject to management, but are prone to frequent investigator disturbance and suspected un-authorized harassment. On LGI in 2001, nest site fidelity was 60% for birds that had treated (egg oiled) nests. A higher percentage (79%) of cormorants in an undisturbed (control) sub-colony exhibited nest site fidelity than did managed nests (50%) on LGI in 2002. Results from the 2002 study also indicated that birds from treated nests departed from the nesting colony on average 16 days earlier than untreated nests (Mazzocchi 2003).

Results from the 2000 and 2001 satellite telemetry studies indicate that 71% (n=22) of the tagged cormorants showed fidelity to their nesting colony (LGI) during the entire 10 week monitoring period for both years (Dorr et al. 2002, 2003). However, 8 of the 9 birds that left and did not return during control activities, did not leave until just prior to the 4th oiling treatment. Of all the cormorants that moved during or after control activities, only 8% (n=2) relocated to the vicinity of another active colony long enough to successfully fledge young (> 3 mo).

Overall, both VHF and satellite studies suggest that disturbance, which includes activities such as egg oiling, may influence the movement of cormorants during the breeding season, but did not result in complete abandonment of LGI during the nesting period. More importantly, few cormorants relocated to other active colonies for long enough periods to successfully raise young.

Trends in Fish Consumption

Little Galloo Island

Since 1999, alewife (*Alosa pseudoharengus*) (36%), yellow perch (*Perca flavescens*) (24%), and minnows (11%) have been the major items in the diet of cormorants from Little Galloo Island (LGI). Overall, prey fish including alewife, minnows, three-spine stickleback (*Gasterosteus aculeatus*), trout-perch (*Percopsis omiscomaycus*), slimy sculpin (*Cottus cognatus*) have made up about 57% of the diet; panfish including yellow perch, pumpkinseed (*Lepomis gibbosis*), rock bass (*Ambloplites rupestis*), bullhead (*Ameiurus nebulosus*) about 39%; and gamefish (mostly smallmouth bass) approximately 4% of the diet. Since 1999 cormorants from LGI have consumed an estimated 92.5 million fish including 52 million prey fish (32 million alewife, 9 million minnows, 6 million three-spine stickleback, 2.5 million slimy sculpin and 1.5 million trout-perch), 37 million panfish (23 million yellow perch, 8 million pumpkinseed, 5.5 million rock bass) and 3.5 million gamefish (3.3 million smallmouth bass).

The comprehensive studies examining the feeding ecology of double-crested cormorants at LGI have revealed several important trends. The most pronounced trend is seasonal variation in diet composition. Two clear patterns are evident. The first is the annual dominance of yellow perch in the diet during the pre-chick (late April to mid June) and post-chick (August – September) feeding periods and the overwhelming dominance of alewife in the diet during the chick feeding (mid-June to early August) period. This pattern is thought to be associated with the in-shore movement of alewife to spawn. Another important trend that has been detected is a general decrease in daily fish consumption by cormorants over the season. Two trends relative to predation on smallmouth bass have also been documented including increased consumption of bass late in the season and a decrease in the size of bass consumed over the season.

Pigeon and Snake Islands

The diets of cormorants at Pigeon and Snake Islands are uniquely different from each other and also from cormorants at LGI. From 1999 to 2003 cormorants at Pigeon Islands consumed mainly three-spine stickleback (34%), alewife (22%) and yellow perch (18%). Yellow perch (38%) dominated the diet of cormorants at Snake Island and were followed in order of importance by minnows (14%), three-spine stickleback (13%) and alewife (10%). The round goby (*Neogobius melanostomus*), an invasive fish species, was not observed in the diet of Snake Island cormorants until 2002 when it made up 2% of the diet. In 2003, round

goby was the major prey (29%) in the diet of Snake Island cormorants, replacing yellow perch.

Fish consumption by cormorants from Pigeon Island declined each year from 1999 (15.3 million fish consumed) to 2003 (1.1 million fish consumed). In 2002, cormorants abruptly deserted the Pigeon Island colony when raccoons gained access to the island and nests remained few in 2003. Fish consumption by cormorants from the Snake Island colony has not declined similar to what has been observed at the LGI or Pigeon Island colonies. From 1999 to 2003, cormorants from the Pigeon Island colony have consumed about 40 million fish including 11 million three-spine stickleback, 9.5 million yellow perch, 8.5 million alewife, 3 million rock bass and 0.8 million smallmouth bass. During this same period cormorants from Snake Island consumed about 37.5 million fish including 14 million yellow perch, 5 million three-spine stickleback, 5 million minnows, 4 million alewife, 2.5 million round goby, 2 million pumpkinseed, 2 million rock bass and 0.4 million smallmouth bass.

Effects of Egg Oiling on Fish Consumption

Since initiation in 1999, egg oiling has resulted on average in a 96% reduction in cormorant chick production, a 28% reduction in cormorant feeding days, and a 24% reduction in total fish consumption. Overall, the number of fish "saved" due to the egg oiling program is estimated to be about 29.5 million including 14.8 million alewife, 5.8 million yellow perch, 2.3 million rock bass, 2.3 million minnows and 1.7 million smallmouth bass. In 2003, the combined effects of fewer adult cormorants and reduced chick production resulted in an estimate of 50% fewer cormorant feeding days than before management began in 1998.

Effects of management on other waterbirds

The effects of cormorant management on other waterbirds has been monitored annually. Reaction to human intrusion has been evident as measured by flushing distance, defensive behavior, and time off active nests. Nest predation resulting from human disturbance was found not to exceed 2% in the case of ring-billed gulls (*Larus delawarensis*), but was not observed in other species (Farquhar et al 2003b). Nest counts for black-crowned night heron, ring billed gull, herring gull (*Larus argentatus*) and caspian tern (*Sterna caspia*), on Gull, Calf, Bass and Little Galloo Islands have followed a stable or increasing trend since the program began in 1999. Great black-backed gull (*Larus marinus*) numbers have risen and fallen annually with no apparent trend.

Fish population indices and trends in Angling Quality

Smallmouth bass have shown a cyclic pattern of abundance over a 28-year sampling history, with obvious peaks in abundance measure estimates (catch-per- unit-effort or CPUE) around 1980 and 1989. These peaks were directly attributable to recruitment of large numbers of bass from the strong 1973 and 1983 year classes, respectively (Chrisman and Eckert 1999). Catches of age 2-4 bass in the assessment netting also indicated strong year classes in 1987, 1988, 1995, and 1997 (Casselman et al. 2002, Eckert 2000). Despite the presence of four strong year classes since 1987, smallmouth bass catches began an overall pattern of decline in 1990. Lantry *et al*.(1999) linked an increase in the relative mortality of age 3-6 smallmouth bass to growth of the eastern basin cormorant population. Loss of bass within these age classes occurred at a point when they were at a size susceptible to cormorant predation, but not yet recruited to the recreational fishery. The two lowest CPUE estimates among the years sampled were recorded in 2001 and 2002. In 2003, smallmouth bass CPUE rose slightly with an estimate of 5.43 fish per net gang

The decline of smallmouth bass in the eastern basin is in direct contrast to smallmouth bass population assessments conducted near Pultneyville, NY (20 miles east of Rochester) in 1976-79 and in 2000-01, utilizing the same standard net gangs and methods as the eastern basin warm water assessment (Eckert and Pearsall 2002). Mean smallmouth bass CPUE at the Pultneyville sample site rose from 15.35 bass in 1976-79 to 82.62 bass in 2000-01, a 438% increase. Eastern basin mean CPUE estimates declined from 27.59 bass in 1976-79 to just 4.00 bass in 2000-01, an 86% decrease.

With a total harvest of 19,000 fish, the 2003 eastern basin bass fishery was the smallest documented to date (McCullough and Einhouse 2004), following a pattern of decline similar to index gill netting. A 1978 creel census reported over 183,000 smallmouth bass harvested from the Eastern Basin (Panek 1981) at a time when the smallmouth bass abundance index, based on assessment netting, was 26.04 fish/net-night (Eckert, personal communication). In 1984, eastern basin smallmouth bass were at a low abundance (index 12.44 fish/net-night) and a creel survey reported about 91,000 harvested

(NYSDEC 1989a). A creel survey in 1998 found a much lower smallmouth bass harvest of approximately 36,000 fish (McCullough and Einhouse 1999). Despite reduced smallmouth bass fishing quality (catch and harvest rates) no reduction in angler effort during the bass season was detected in 1998. In fact, effort appeared to have increased relative to 1978 and remained relatively unchanged compared to 1984. Estimated effort declined by almost 150,000 angler-hours (41%) between 1998 and 2003. The decline in harvest between earlier studies and 1998 was due to lower harvest rates. The decline in smallmouth bass harvest between 1998 and 2003 is more attributed to reduced angler effort.

Discussion

The eastern basin cormorant research and management program has been highly successful from an operational standpoint. Progress towards lowering overall cormorant numbers, reducing cormorant predation on warmwater fish species, and maintaining local waterbird diversity are apparent. Disturbance to other colonial nesting birds has been monitored and detrimental effects to population viability are not apparent. Our understanding of cormorant diet, movement associated with management, and overall fish-waterbird dynamics have also improved during the period.

Success as measured in terms of meeting eastern basin management goals and objectives, however, is not yet fully realized. Most significantly, the desired response in restoring the structure and function of the warmwater fish community, particularly improvements in smallmouth bass populations, have not occurred based on current monitoring. We still believe achieving fisheries objectives are closely linked to cormorant numbers associated with 1,500 breeding pairs within NY waters of the eastern basin. Based on reductions in fish consumption resulting from five years of management effort, we are perhaps two-thirds of the way towards reductions necessary to meet the fish community objective. While solid progress towards reducing cormorant impacts to the warmwater fish community is evident, management constraints from 1999-2003 did not allow us to reach the objective within the five year period.

NYSDEC's plan (NYSDEC, 2000) includes provisions for removal of adult cormorants to reduce cormorant numbers to desired levels by 2004, but removal of adult cormorants was not permitted under annual USFWS depredation permits issued to NY from 1999-2003. Recent changes in USFWS policy allow for take of adult cormorants to protect public resources. A more rapid reduction in cormorant population levels is now possible, although the desired effect on numbers and associated fish consumption would likely not occur until 2005 if implementation begins in 2004.

Recommendations

1. Use the authorizations contained in the new USFWS Cormorant Depredation Order beginning in 2004, to promote a more rapid course to cormorant numbers at which a fishery response is expected. Under provisions of the Order, limited experimental adult cormorant removal on LGI should be implemented in accordance with NYSDEC's 2000 Environmental Impact Statement.
2. Continue to maintain a baseline annual data set on cormorant diet. Sample size and frequency of pellet collections for diet studies should be reduced, but not eliminated-. The need to continue diet studies should be re-evaluated when cormorant numbers have been reduced to desired levels.
3. Continue to monitor Lake Ontario and St. Lawrence River cormorant nest numbers, nesting effort and success. The efficacy of egg oiling, nest removal and other management should be documented annually to ensure adequate assessment of the program can be made.
4. Population monitoring efforts directed at other waterbird species should continue as part of the eastern basin management program. Monitoring activities provide a useful index to help determine positive or negative effects of cormorant control efforts
5. Annual warm-water fish stock assessments should continue as they have since 1976. This long term database provides the best index to fish population trends currently available in the eastern basin. Information collected in these assessments is a critical component in measuring success of cormorant management.
6. An eastern basin creel survey should be considered within two years of either reaching cormorant population goals or following a three year trend of increases in smallmouth bass CPUE in assessment netting.

7. Monitor and evaluate wider scale population dynamics of cormorant colonies. Evaluate how emigration and immigration between colonies, year to year fidelity to colony sites, and pioneering of new colony sites may affect management program strategies and goals.

Acknowledgments

We thank Brian Dorr, and Albert Schiavone for helpful comments on the draft manuscript. Collectively, over the past five years, several individuals have provided their insights to the management program and/or to interpretation of data. Among these, Tom Eckert, Brian Edmonds, Steve Lapan and Albert Schiavone from NYSDEC; Brian Dorr, Tommy King, Jimmy Taylor and Scott Werner from USDA; and Robert Ross from USGS have made major contributions.

References

Casselman, J. M., D. M. Brown, J. A. Hoyle and T. H. Eckert. 2002. Effects of climate and global warming on year-class strength and relative abundance of smallmouth bass in eastern Lake Ontario. Pages 73-90 *in* D.P. Philipp and M.S. Ridgway, editors. Black Bass: ecology, conservation, and management. American Fisheries Society, Symposium 31, Bethesda, Maryland.

Chrisman, J. R. and T. H. Eckert. 1999. Population trends among smallmouth bass in the eastern basin of Lake Ontario, 1976-97. Section 2 in Final Report: To assess the impact of double-crested cormorant predation on smallmouth bass and other fish of the eastern basin of Lake Ontario. NYSDEC Special Report - February 1, 1999. New York State Department of Environmental Conservation, Bureau of Fisheries, Albany, N.Y.

Dorr, B., D. T. King, and S. J. Werner. 2002. Intercolony and regional movements of double-crested cormorants breeding in eastern Lake Ontario. NYSDEC Special Report. Albany, N.Y.

Dorr, B., J.D. Taylor II, S. J. Werner, D. T. King, J. F. Farquhar III, I. M. Mazzocchi, and R. D. McCullough. 2003. Effects of Egg-Oiling on Double-crested Cormorant Movements in Eastern Lake Ontario. NYSDEC Special Report. Albany, N.Y.

Eckert, T. H. 2000. Summary of 1976-99 warm water assessment. Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Niagara-on-the-Lake, Ontario, March 28-29, 2000.

Eckert, T. H. 2004. Highlights of the 2003 Lake Ontario fishing boat census. Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Grand Island, NY, March 30-31, 2004.

Eckert, T. H. and W. Pearsall. 2002. Comparisons of warm water gill netting: Pultneyville and eastern basin. Great Lakes Fishery Commission, Lake Ontario Committee Meeting, Buffalo, NY, March 26-27,2002.

Farquhar J. F., R. D. McCullough and A. Schiavone. 2003a. 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. Pages 325-334 *in* I.G. Cowx, ed. Interactions Between Fish and Birds: Implications for Management. Blackwell Science Ltd., Oxford, U.K.

Farquhar, J. F.,III, I. M. Mazzocchi, and R. D. McCullough. 2003b. Human harassment anddouble-crested cormorant *Phalacrocorax auritus* nesting at three colonies in eastern Lake Ontario, New York, USA: observations from a management program. pp. 319-324 in T. M. Keller, D. N. Carss, editors. Vogelwelt 124 (suppl.), Cormorants: ecology and management.. Freising, Germany.

Gotcsik, F. S. 1995. Using a citizen task force to develop management objectives for double-crested cormorants in eastern Lake Ontario and Oneida Lake: a case study and analysis. Public Involvement and Environmental Communications, 7364 East main St.., Lima, NY, USA.

Hatch, J. J., and D. V. Weseloh. 1999. Double-crested cormorant (*Phalacrocorax auritus*) *in* A. Poole and F. Gill, editors. The Birds of North America. The Academy of Natural Sciences, Philadelphia, Pennsylvania, USA, and The American Ornithologists Union, Washington, D. C., USA.

Johnson, J.H., R.M. Ross and J.F. Farquhar. 2004. The effects of egg oiling on fish consumption by Double-crested Cormorants on Little Galloo Island, Lake

Ontario, in 2003. Report to the Lake Ontario Committee, Great Lakes Fishery Commission March 2004.

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. Section 12 in Final report: to assess the impact of Double-crested Cormorant predation on the smallmouth bass and other fishes of the eastern basin of Lake Ontario. NYS Department of Environmental Conservation Special Report, Albany, N.Y.

Mazzocchi, I. M. 2001. Double-crested Cormorants and VHF Telemetry On Lake Ontario, 2000. NYSDEC Special Report. Albany, N.Y.

Mazzocchi, I. M. 2002. Double-crested Cormorants and VHF Telemetry On Lake Ontario, 2001. NYSDEC Special Report. Albany, N.Y.

Mazzocchi, I. M. 2003. Progress Report. Double-crested Cormorants and VHF Telemetry on Lake Ontario, 2002. NYSDEC Special Report. Albany, N.Y.

McCullough, R. D. and D. W. Einhouse. 1999. Lake Ontario - eastern basin creel survey 1998. Section 4 in Final report: to assess the impact of Double-crested Cormorant predation on the smallmouth bass and other fishes of the eastern basin of Lake Ontario. NYS Department of Environmental Conservation Special Report, Albany, NY.

McCullough, R.D. and D.W. Einhouse. 2004. Eastern basin of Lake Ontario creel survey, 2003. Report to the Lake Ontario Committee, Great Lakes Fishery Commission March 2004.

McCullough, R. D., J. F. Farquhar and I. M.Mazzocchi. 2004. Cormorant management activities in Lake Ontario's eastern basin. Report to the Lake Ontario Committee, Great Lakes Fishery Commission March 2003.

NYSDEC. 1989. New York State Great Lakes Angler Survey. Volume II. NYS Department of Environmental Conservation, Albany, NY.

NYSDEC. 2000. Final Environmental Impact Statement: On proposed management of double-crested cormorants in U.S. waters of the eastern basin of Lake Ontario. NYSDEC, Watertown, NY.

Panek, F. M. 1981. The warmwater sport fishery of eastern Lake Ontario. N.Y. Fish and Game Journal, 28(2):178-190.

Schnieder, 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. Section 1 in Final report: to assess the impact of Double-crested Cormorant predation on the smallmouth bass and other fishes of the eastern basin of Lake Ontario. NYS Department of Environmental Conservation Special Report, Albany, NY.