The Effects of Egg Oiling on Fish Consumption by Double-Crested Cormorants On Little Galloo Island, Lake Ontario, in 2006

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For over a decade Little Galloo Island (LGI) has supported the largest colony of double-crested cormorants (*Phalacrocorax auritus*) in the eastern basin of Lake Ontario. Cormorant nest counts on the island since the early 1990's have averaged about 5,270 per year reaching a high of 8,400 in 1996. Since 1992, Johnson et al. (2006) estimate that cormorants from LGI alone have consumed 375 million fish. The proliferation of cormorants in the eastern basin of Lake Ontario has coincided with declines in two important recreational fish species, smallmouth bass and yellow perch. Lantry et al. (2002) and Burnett et al. (2002) provide convincing evidence linking cormorant population increases to declining eastern basin smallmouth bass and yellow perch stocks. Decline of these fish stocks is evident only in the eastern basin, suggesting a localized problem which is consistent with the halo effect where large piscivorous waterbird colonies may deplete local fish stocks (Birt et al. 1987).

In 1999, the New York State Department of Environmental Conservation (NYSDEC) initiated an experimental program to control the reproductive success of cormorants nesting on LGI. The program consists of spraying cormorant eggs with corn oil. Here we report on the effectiveness of the eight years of control measures that were carried out in 2006 with regard to fish consumption.

Methods

NYSDEC staff began treating accessible double-crested cormorant nests on LGI with corn oil beginning on May 3 and ending July 19, 2006. The oiling process was conducted four times over the season on each nest with eggs. Oil was applied from a backpack sprayer unit in sufficient volume to cover the exposed surface of each egg (approximately 6 ml/egg or 0.2 oz/egg). The number of eggs treated per nest was recorded and each nest or group of nests were marked with spray paint to facilitate efficient movement throughout the colony as well as complete nest coverage. Also recorded were the number of nests not treated and the number of chicks present per visit.

The diet composition of double-crested cormorants on Little Galloo Island in 2006 was examined during the chick feeding (June 14 to July 19) and post-chick feeding (August 12 to October 5) periods. Diagnostic fish remains recovered in regurgitated pellets were used to quantify diet composition. Cormorants regurgitate about one pellet per day (Craven and Lev 1987, Orta 1992, Derby and Lovvorn 1997). Consequently, the contents of a pellet approximate mean daily fish consumption. Diagnostic material and eye lenses were removed from the pellets and identified under magnification. Eye lenses were not used in species identification

but were sometimes used to determine the number of fish eaten when lens numbers exceeded fish counts from otoliths and other diagnostic structures. Daily fish consumption was estimated as the mean number of fish per pellet multiplied by a fecal correction factor (1.042) (Johnson and Ross 1996).

To estimate cormorant feeding days and fish consumption by chicks from the Little Galloo colony, we used the model developed by Weseloh and Casselman (unpublished report: Fish consumption by double-crested cormorants on Lake Ontario, Burlington, Ontario). The number of cormorant feeding days is largely based on active-nest counts and estimates of reproductive success (i.e., number of fledglings/nest). Model assumptions include: (1) the population of mature birds is twice that of the active-nest counts, (2) the number of immature cormorants is approximately 10% of the adult population, and (3) residence time for breeding adults, immatures, and young-of-year (YOY) is approximately 158, 112, and 92 days, respectively. To estimate the biomass of fish consumed we assumed that cormorants consumed about 0.47 kg fish per day (Schramm et al. 1984, 1987; Weseloh and Casselman 1992). Since 0.47 kg is about 1 pound, a straightforward estimator of biomass consumed is the number of cormorant feeding days (i.e., 1 cormorant feeding day equals 1 pound of fish consumed). Because of seasonal variation in diet composition, to derive fish consumption estimates, we apportioned the 92 chick feeding days from the Weseloh and Casselman model into 42 days when adult cormorants were actively feeding chicks (chick feeding period) and 50 days post-chick feeding. We adjusted the number of cormorant feeding days and total number of fish consumed to account for 620 cormorants culled at LGI (5/25/06) as part of NYSDEC management programs. To account for the absence of these birds in determining the effects of egg oiling on fish consumption, we subtracted 310 nests (50% of the number of adult birds that were culled) from the total nest count. We estimated fish consumption for each feeding period using the number of chick feeding days (either 42 or 50), the total number of chicks present, the period specific percent diet composition by number, and daily fish consumption estimates.

We estimated reductions in cormorant feeding days and fish consumption annually from egg oiling. For chicks, these estimates were determined from 1999-2006, for immature cormorants, from 2000-2006 and for adult cormorants, from 2002-2006. These time periods assume that the effects on chicks began immediately (1999), the effects on immature birds began one year post initial treatment (2000), and effects on adult cormorants began when they reach maturity at age 3 (2002). To derive projected estimates, a standard of 5,681 nests from 1999 when egg oiling was first started was used. For each subsequent year, that nest count was subtracted from 5,681 (example: 2005 was 5,681-3,401=2,280 fewer nests). That nest count figure was then used to derive adult, immature, and YOY reductions in both feeding days and fish consumption using the standard Weseloh and Casselman model. This estimate plus the annual estimated reduction in feeding days from chicks alone and the actual number of feeding days for each year for the entire colony were summed to provide the projected estimate. Projected feeding day estimates were multiplied by the annual number of fish per pellet (i.e. daily fish consumption) to provide the projected estimate for fish consumption.

Results

In all, 1,050 pellets were examined to describe the diet composition of double-crested cormorants on LGI during the chick and post-chick feeding periods in 2006 (Table 1). Round goby was the major prey species, followed in contribution by alewife, yellow perch, rock bass, cyprinids, smallmouth bass, pumpkinseed, and slimy sculpin. The contribution of round goby in the diet was substantially higher during the post-chick feeding period. Mean daily fish consumption (i.e. number of fish per pellet) was lower during the chick feeding period (7.7) than during the post-chick feeding period (15.6).

The removal of 620, mostly adult cormorants, from the LGI population reduced the number of cormorant feeding days by about 58,300 and reduced total fish consumption by 700,000. Consequently, these feeding days and number of fish were not considered in estimating the effects of egg oiling.

In 2006, the double-crested cormorant peak nest count on Little Galloo Island was 2,730. About 150 cormorant chicks were fed by adults and fledged on LGI from 2,420 nests in 2006, a productivity of 0.055 chicks per nest. Chicks accounted for 13,800 cormorant feeding days from early June to mid October (Table 2). The total number of cormorant feeding days by the LGI colony in 2006 was estimated at 0.88 million (Table 2). We estimated the number of chicks that would have been produced on LGI from 2,420 nests in 2006 in the absence of reproductive suppression (i.e. egg oiling) by using a chick productivity estimate of 1.8 chicks per nest that was observed at nearby Snake Island in 2006. If egg oiling was not undertaken, we estimate that 4,356 cormorant chicks would have been produced on LGI in 2006, a reduction of 97 percent. The number of chick feeding days by the LGI colony was also reduced by 97 percent (400,232 to 13,800). For the entire LGI colony in 2006, reproductive suppression reduced the total number of cormorant feeding days from 1.22 million to 0.88 million (28.0%) and the number of fish consumed from 14.7 million to 10.1 million (31%) (Table 2). The relative magnitude of the reduction in fish consumption caused by reproductive suppression at LGI in 2006 was consistent with what was achieved in the previous 3 years (Figure 1).

We estimate that the 150 cormorant chicks produced on LGI in 2006 consumed about 166,000 fish (Table 3). If egg oiling was not carried out and 4,356 cormorant chicks were produced on LGI in 2006, we estimate that these chicks would have consumed 4.77 million fish (Table 3). Consequently, egg oiling reduced fish consumption by 4.6 million fish in 2006. Using diet composition information for the chick and post-chick feeding periods, the reduced fish consumption represented 3.49 million round goby, 0.44 million alewife, 0.34 million yellow perch, 0.16 million rock bass, 0.09 million cyprinids, and 0.09 million smallmouth bass (Table 3).

Discussion

Since the egg oiling program was initiated in 1999 the number of cormorant nests at LGI has decreased from 5,681 to 2,730. Results achieved by the double-crested cormorant reproductive suppression program on LGI since 1999 have been remarkably consistent. Chick productivity has been reduced from an average of about 2.00 chicks per nest (1992-1998) to 0.07 chicks per nest (1999-2006), a 97% reduction. Since initiated in 1999, egg oiling has resulted in: (1) a 96.1% (range 93.3% to 98.0%) reduction in cormorant chick production, (2) a 29.1% (range 23.9% to 32.7%) reduction in cormorant feeding days, and (3) a 25.9% (range 19.1% to 31.1%) reduction in total fish consumption (Johnson et al. 2000, 2001, 2002, 2003, 2004, 2005, 2006).

We estimate that the cormorant reproductive suppression program on LGI has reduced fish consumption by chicks at the colony by 45.2 million fish since it was initiated in 1999. Included in this estimate are approximately 8.3 million yellow perch and 2.2 million smallmouth bass that were not consumed by cormorants. These two species are especially important since declines in their abundance in the eastern basin of Lake Ontario have been associated with cormorant population increases (Burnett et al. 2002, Lantry et al. 2002).

Cumulative Effects of Egg Oiling

The annual reduction in chick productivity at LGI provides only partial insight into the overall cumulative effects in terms of the reduction in both cormorant feeding days and fish consumption at the colony. Full consideration of the effects of egg oiling on these parameters should include projections for the immature and adult birds that would have been produced annually at the colony in the absence of egg oiling. Since egg oiling was initiated at LGI in 1999 about 2,200 chicks have been fledged compared to an estimated 55,600 if egg oiling had not occurred. If these 53,400 chicks had survived we estimate that fish consumption by chicks alone (45.2 million) would increase to 82.6 million (includes 1.5 million fish attributed to the 2005 and 2006 cull of mostly adult cormorants at LGI) (Figure 2). In addition, the number of cormorant feeding days declined by 67% (2% attributed to cull) (2.71 million to 0.88 million from 1999 to 2006 (Figure 3) and annual fish consumption declined by 57% (3% attributed to cull) (23.6 million to 10.1 million) during the same

period (Figure 4).

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Table 1: Percent diet composition of double-crested cormorants on Little Galloo Island during the chick (6/4/06 to 7/19/06) and post-chick (8/12/06 to 10/5/06) feeding periods in 2006.

	Chick	Post-chick
No. of pellets	450	600
Fish/pellet (adjusted)	7.7	15.6
Round goby	53.5	82.5
Alewife	20.5	5.1
Yellow perch	10.8	5.9
Rock bass	7.4	1.9
Pumpkinseed	0.5	0.5
Cyprinids	1.9	2.0
Smallmouth bass	3.0	1.5
Slimy sculpin	0.5	0.2
Ictalurid	1.4	0.2
Catostomid	0.3	0.2
Esocid	---	---
Trout-perch	1.4	< 0.1
Burbot	0.1	---
Darter	0.5	< 0.1
White perch	---	< 0.1
Walleye	0.1	---
Gizzard shad	---	<0.1
	100.0	100.0

Table 2. Estimated number of chicks produced, chick feeding days, total cormorant feeding days, and the number of fish eaten based on chick productivities of 0.055 (control = egg oiling) and 1.8 chicks per nest (no control) on Little Galloo Island in 2006.

Action	No. of chicks	No. of chick feeding days	Total cormorant feeding days	No. of fish eaten
No control	4,356	400,212	1.22 million	14.7 million
Control (egg oiling)	150	13,800	0.88 million	10.1 million
Difference	4,206	372,652	0.34 million	4.6 million

Table 3: Fish consumption estimates for double-crested cormorant chicks based on chick productivities of 0.055 (control = egg oiling) and 1.8 chicks per nest (no control) on Little Galloo Island in 2006.

	Number of fish consumed		
Species	Control	No control	Difference
Round goby	123,000	3,530,000	3,487,000
Alewife	16,000	460,000	444,000
Yellow perch	12,000	350,000	338,000
Rock bass	6,000	167,000	163,000
Cyprinids	3,000	97,000	94,000
Smallmouth bass	3,000	93,000	90,000
Other	2,000	42,000	40,000
Pumpkinseed	1,000	25,000	24,000
	166,000	4,766,000	4,600,000

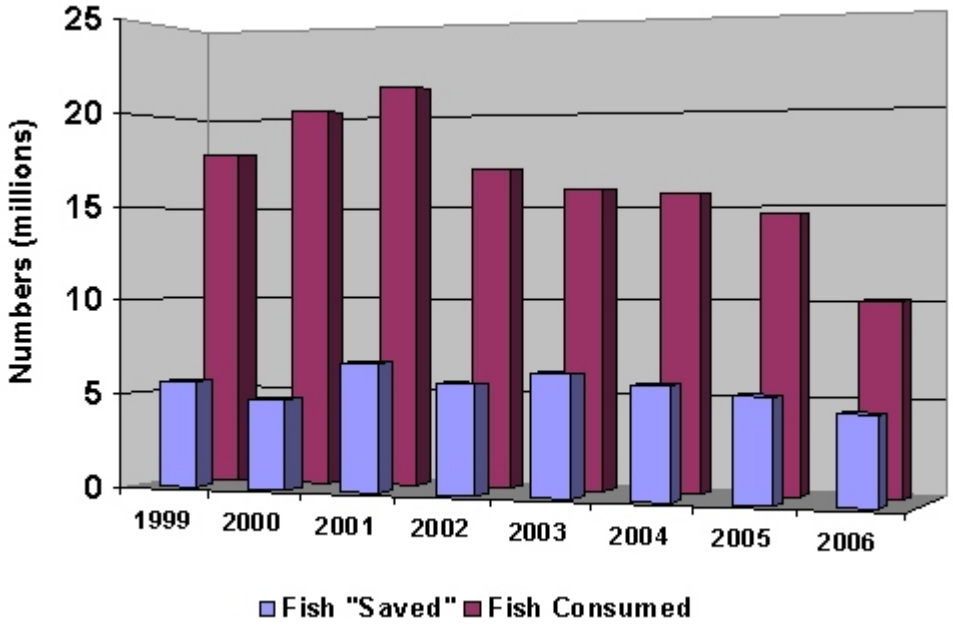

Figure 1. Estimated numbers of fish consumed by double-crested cormorant chicks and estimated number of fish "saved" by cormorant reproductive suppression since 1999 on Little Galloo Island.

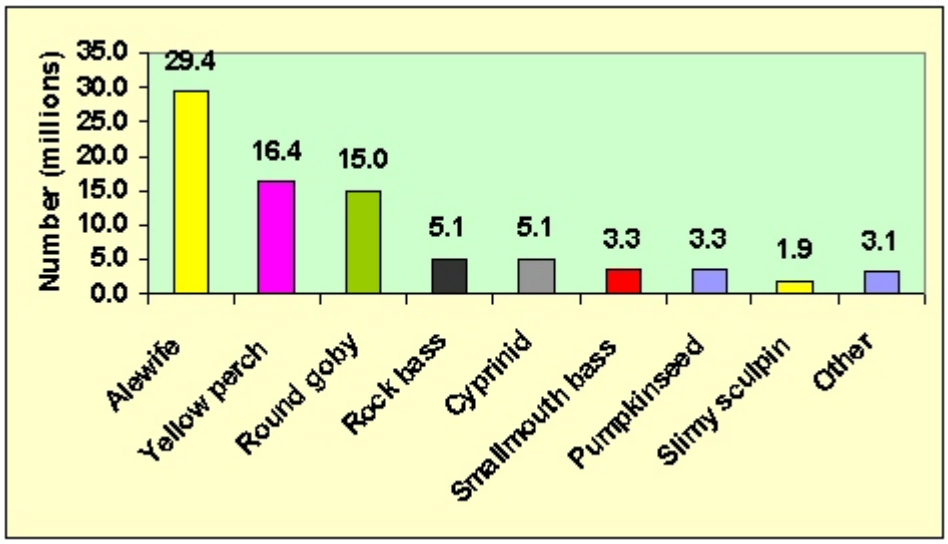

Figure 2. Total Number (millions) of fish "saved" by egg oiling program at Little Galloo Island, 1999-2006.

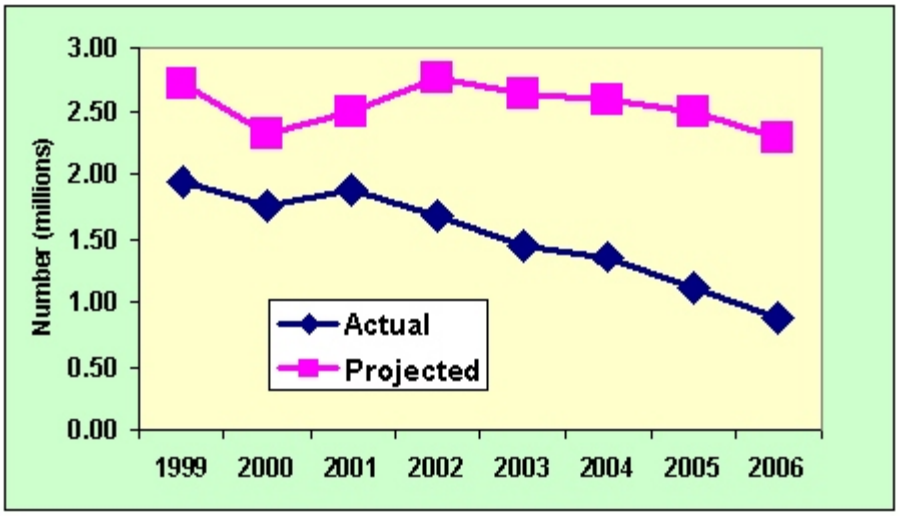

Figure 3. Actual (control-egg oiling) and projected (no control) double-crested cormorant feeding days at Little Galloo Island, Lake Ontario, 1999-2006.

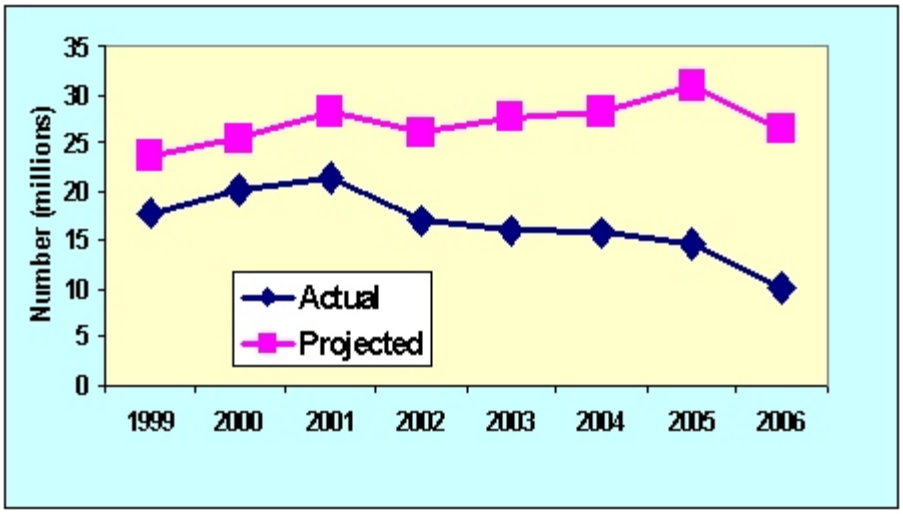

Figure 4. Actual (control-egg oiling) and projected (no control) estimates of double-crested cormorant fish consumption at Little Galloo Island, Lake Ontario, 1999-2006.