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Diet of the Double-Crested Cormorant in Western Lake Erie*

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Abstract

Sport and commercial fishing factions are concerned about the potential impact the double-crested cormorants (*Phalacrocorax auritus*) may have on fish species of interest. Our objectives for this study were to determine the diet of double-crested cormorants in western Lake Erie, and to compare fish consumption of double-crested cormorants with that of walleye to determine diet overlap. Food of double-crested cormorants was determined from stomach contents of 302 birds collected in western Lake Erie. The diet of double-crested cormorants consisted primarily of young-of-the-year gizzard shad (*Dorosoma cepedianum*), emerald shiners (*Notropis atherinoides)* and freshwater drum (*Aplodinotus grunniens*). In the spring, freshwater drum were the most frequently occurring food in the stomachs and comprised the greatest portion of the diet by weight. Young gizzard shad became the most abundant prey and comprised the largest percent by weight in the stomachs from the end of July through October. Emerald shiners were abundant in the diet during June, September, and October. Cormorants fed on fish in western Lake Erie in similar proportions to that caught by trawls. The diet of cormorants and walleyes were similar from July through October with significant overlap in the diet. Results from this study indicate impacts of cormorants at current population levels in Lake Erie are not detrimental to sport and commercial fisheries. Therefore, control for the purpose of reducing competition with prey fish (e.g., walleye and perch) is not warranted at this time.

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In the Great Lakes, the population of the double-crested cormorant (*Phalacrocorax auritus*) has increased at an average annual rate of 29% from 1970 - 1991 (Weseloh et al. 1995) and 23% from 1990 - 1994 (Belant and Tyson in review). The first documented colony in Lake Erie was established in 1939 (Langlois 1950). In Lake Erie, cormorants first nested on West Sister Island in 1992, and by 1997 there were approximately 1,500 nesting pairs on the island (M. Shieldcastle, Ohio Div. Wild., unpubl. data). In 1997, East Sister and Middle Islands had nesting colonies with 3,000 and 1,000 nesting pairs, respectively (C. Weseloh, Canadian Wild. Ser., pers. commun.).

Results of studies on cormorant diets generally indicate that cormorants are opportunistic feeders and do not select any particular species (Campo *et al* 1993, Hobson *et al* 1989, Ludwig *et al* 1989). In the Great Lakes, alewives (*Alosa pseudoharengus*) and minnows (Cyprinidae) are predominant in the diets. (Craven and Lev 1987, Ludwig et al. 1989).

There are mounting concerns by sport and commercial fisherman that double-crested cormorants will deplete preferred Lake Erie fish (e.g., walleye (*Stizostedion vitreum*), yellow perch (*Perca flavescens*) and smallmouth bass (*Micropterus dolomieui*)). In addition to the concerns of fishermen, there are mounting concerns by conservation biologists that the increasingly large cormorant colonies will displace waterbird (e.g., herons and egrets) colonies. There is also a concern that rare or endangered plants may be destroyed from highly acidic feces which cormorants deposit in and under nesting trees.

The magnitude of double-crested cormorant piscivory in western Lake Erie has been estimated from a bioenergetics model (Madenjian and Gabrey 1995). Information on the specifics of the diet, such as species, life stage, and size, has not been identified. This information will lead to a greater understanding of the predator-prey dynamics associated with cormorants and their prey.

Our objectives were to: (1) determine the diet of double-crested cormorants in western Lake Erie and (2) compare fish consumption of double-crested cormorants with that of piscivorous fish, such as walleye, to determine diet overlap.

Diet composition of double-crested cormorants was determined from stomach contents of adults and juveniles collected in waters adjacent to Middle Island, West Sister Island, and in Sandusky Bay (Figure 1). As many as 20 adult or juvenile cormorants were collected every 2 weeks from 15 April through 15 October. Cormorants were shot with a 12-gauge shotgun (with non-toxic steel shot) as they returned to their nest or roost sites from foraging in the lake. Immediately after collection, 10% formalin was injected into the bird's stomach to fix the stomach contents.

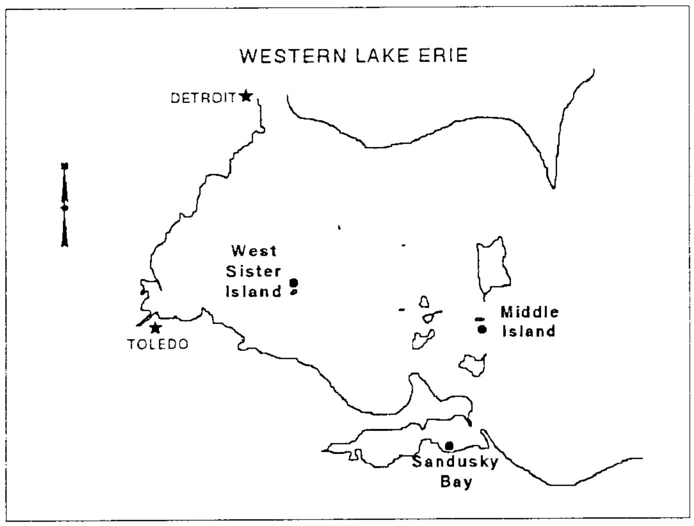

Figure 1. Locations of double-crested cormorant collection sites in western Lake Erie, 1997.

All food items were identified to species. Fish in cormorant stomachs were identified from whole specimens, partial fish (e.g., backbone with flesh), and fragments such as scales, otoliths, and other diagnostic bones. Whole fish were measured to nearest mm of total length. When possible, standard and backbone lengths were measured from partially digested fish. Equations from Knight et al. (1984) and Kayle (Ohio DNR, unpublished) were used to convert standard and backbone lengths to total lengths. Wet weight of fishes, at the time of ingestion, were estimated using total length-wet weight regressions (Kershner, unpublished data).

Ohio Division of Wildlife made monthly (May - September) fish assessments at 41 sites in western Lake Erie. Fish were collected with a 10-meter bottom trawl which was towed for 10-minutes. During monthly (July - October) assessments, the contents of walleye (*Stizostedion vitreum*) stomachs were removed immediately after capture and examined for food contents. Each food item was identified to taxus, and length measurements (total, standard, and back bone length) were taken from each prey item. The diets of 251 walleye (83 - 702 mm) were compared to that of double-crested cormorants collected during the same months (July - October) to determine extent of diet overlap.

To determine relationships between prey fish in cormorant diets and in trawl catches, we used a measure of prey selection by using Chesson's Alpha (Chesson 1978, 1983). Values greater than 0 indicate the food item was selected for. Determination of diet overlap was calculated using the index described by Schoener (1970).

We collected 302 cormorants from April 15 - October 15, 1997, of which 248 (82%) contained food items in the stomach. There were 7,794 prey samples representing 15 species of fish and two invertebrates (Table 1). Gizzard shad was the most abundant food item, most frequently occurring, and comprised the largest percent by weight. Emerald shiner was the next most numerous and third most frequently occurring prey consumed. Although freshwater drum were not extremely abundant, they were the second most frequently occurring by stomach and comprised the second most by weight. Yellow perch and walleye, which are important sport and commercial fish in Lake Erie, made up less than 1% by number and only 3% by weight. White bass were ingested by almost 9% of the cormorants collected and made up nearly 5% of prey consumed. The average weight of stomach contents in each cormorant was 252.5 g (SE 8.72). The mean weight of all prey in each stomach for male cormorants (x=278.8 g, SE=12.0) was greater than for females (x=224.7 g, SE=11.8) in western Lake Erie ($P<0.001$).

During the first two months (April and May) of sampling, the number prey items per stomach were relatively low, 4.4 and 2.5 prey per stomach, respectively. Emerald shiners were the most abundant prey in the diets during April - June, ranging from <1 to 15 per cormorant stomach in June. From July - October young-of-the-year (YOY) gizzard shad dominated the number of prey eaten per month. Young-of-the-year gizzard shad first appeared in the diet during the later half of July. The largest number of food items found in a single cormorant stomach was 323 during July, of which 321 were YOY gizzard shad. Emerald shiners made up nearly 50% of the diet (by number), during September and October; averaging 11.8 (SE=3.8) in September and 16.6 (SE=3.5) in October.

Table 1. Composition of prey species found in stomachs of double-crested cormorants collected from western Lake Erie from April - October, 1997.

Species	% Num.	Total Length (mm) Mean	SE	% Freq.	% Wt.
Alewife	0.0	40.0	-	0.4	<0.1
Gizzard Shad	69.8	74.7	0.6	50.0	48.3
Smelt	0.0	88.0	-	1.2	<0.1
White Perch	0.1	96.3	44.8	1.6	0.2
White Bass	0.5	144.3	14.7	8.9	4.6
Freshwater Drum	1.3	265.2	5.6	33.9	33.4
Bullhead	0.0	-	-	0.4	-
Carp	0.1	126.0	4.5	0.4	0.3
Emerald Shiner	27.3	66.9	0.4	33.5	8.5
Unid. Minnows	0.0	-	-	0.4	-
Centrarchid	0.0	-	-	0.8	<0.1
Pumpkinseed	0.0	-	-	0.8	<0.1
Smallmouth Bass	0.0	136.2	13.6	0.8	0.3
Yellow Perch	0.2	148.2	19.5	5.2	1.0
Walleye	0.1	269.2	44.6	2.4	0.9
Catfish	0.1	335.8	6.3	1.6	2.5
Stonecat	0.0	-	-	0.4	0.9
Crayfish	0.0	-	-	0.8	-
Snails	0.0	-	-	0.4	-
Unknown	0.3	-	-	6.9	-

The importance of each of the four major prey taxa varied each month during the study. Freshwater drum was the most frequently occurring food item in cormorant stomachs from April - July and remained in the diet through October (Figure 2). Gizzard shad equaled freshwater drum in importance as a food item in July and was the most frequently occurring food item from August - October. Emerald shiners occurred in the diet frequently in June and then again in September and October. White bass occurred in the diet from June - September, as did smelt in May (12.5%). Catfish and stonecats occurred in the diet more frequently in the spring.

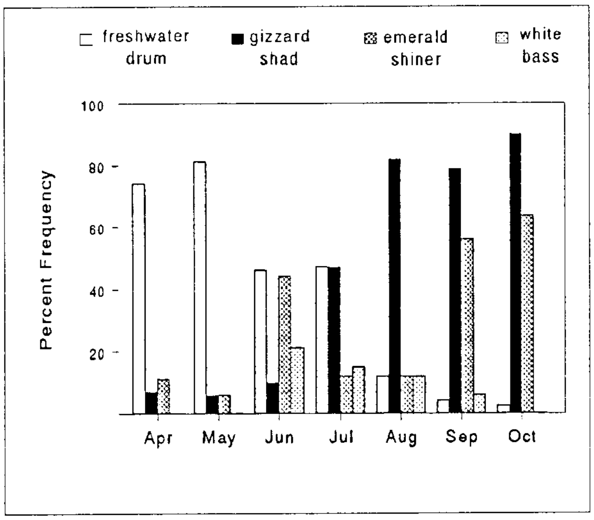

Figure 2. Monthly percent frequency of prey items in double-crested cormorants from Lake Erie in 1997.

The proportion of biomass by prey category varied among months. During spring and early summer (April - July), large prey species, such as freshwater drum, white bass, and channel catfish, comprised the largest percent of the biomass. Freshwater drum accounted for the greatest percent from April - July (Figure 3). Small prey, like YOY gizzard shad and emerald shiners, dominated the biomass from July - October. From August - October, YOY gizzard shad comprised the greatest percent of the monthly diet by weight. Emerald shiners accounted for almost 25% of the weight of prey consumed in June. There were other species which contributed to the diet of cormorants. White bass comprised from <1% during September to nearly 15% in June.

In general, cormorants did not exhibit a preference for specific fish species, as determined by Chesson's Alpha (Chesson 1978, 1983). Cormorants appeared opportunistic in their foraging habits; however, some selection for older and larger fish may have existed. Young-of-the-year gizzard shad were selectively eaten in September (α=0.622); yearling and older gizzard shad were selected in June (α=0.988), July (α=0.985), and September (α=1.000). Yearling and older freshwater drum were selected for during May (α=0.984) and from July - September (α values ranged from 0.291 to .695). Cormorants fed on prey fish that were of similar lengths to those in trawl catches. However, prey fish which were large and may not have been well represented in trawl catches (i.e. freshwater drum and white bass) were more common in cormorant stomachs.

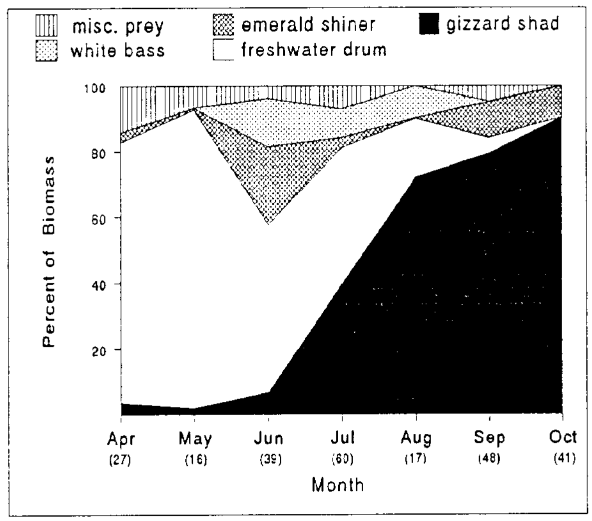

Figure 3. Monthly percent biomass for prey items from cormorant stomachs in 1997.

Double-crested cormorants and walleyes shared much of the same food resources in western Lake Erie (Figure 4). Gizzard shad made up the largest proportion by mean percent wet weight in the diets for both cormorants and walleye. Other species such as, emerald shiners and white bass also were found in both predators' stomachs. Freshwater drum was the only prey species which was found in cormorants' diet but not in walleye stomachs. Dietary overlap in the prey fish resources was further evident after calculating Schoener (1971) diet overlap values from July - October (Table 2). Overlap is generally considered to be biologically significant when the value exceeds 0.60 (Zaret and Rand 1971). Each monthly overlap value was approaching or over 0.60. Diet overlap was highest in October.

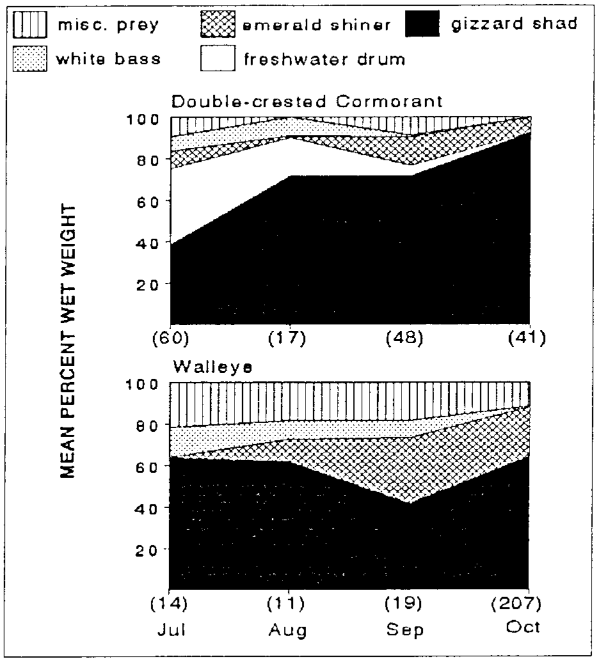

Figure 4. Mean percent wet weight of prey consumed by cormorants and walleye from western Lake Erie during July - October in 1997.

A calculation of diet overlap values by sex indicated that the diet of female cormorants more closely mirrored that of walleyes. Freshwater drum comprised a minor portion of the female cormorants' diet and were not consumed by walleyes. Hence, the presence of freshwater drum in the male cormorant's diet lowered their overlap values with walleye diets and the near absence in female stomachs increased their overlap values with walleye diets.

Results from this study seem to indicate that impacts of cormorants (at current population levels) to the sport and commercial fishery in Lake Erie are minimal because sport fish do not comprise a major component of the diet. Similar conclusions were drawn from other diet studies in which sport or commercial fish were obvious components, but were not heavily impacted by cormorant predation (Maruca 1995, Hobson et al. 1989, and Craven and Lev 1987).

Table 2. Diet overlap values for double-crested cormorants and walleye in western Lake Erie, July - October 1997, from Schoener (1971). Values were calculated by sex and sexes combined for cormorants.

	Double-crested cormorants		
Month	Males/ walleye	Females/ walleye	Sexes combined/ walleye
July	0.458	0.619	0.532
August	0.400	0.637	0.614
September	0.612	0.591	0.602
October	0.814	0.851	0.827

We have demonstrated that diets of cormorants and walleyes substantially overlap suggesting potential competition between the two species. Concern over cormorant impacts on the forage fish base in Lake Erie is greatest in fall, but there may be some selective predation by cormorants and walleye which reduces competing interactions. Fall also is the time in which migratory waterbirds, such as double-crested cormorants and red-breasted mergansers, use western Lake Erie as a feeding and resting area. Madenjian and Gabrey (1995) employed a bioenergetics model to estimate predation by waterbirds on fish populations in Lake Erie. Results from the model indicated that predation by all species of waterbirds consumed an equivalent of 15.2% of the prey biomass which supports walleye populations in western Lake Erie for a single growing season. Predation by cormorants on fish accounted for only 1.7% of the biomass which supports walleyes for one year. Even if the nesting double-crested cormorant population doubled, the model calculated that predation of forage fish would only modestly increase (Madenjian and Gabrey 1995). Presently, impacts of cormorants on the forage base does not warrant control measures for cormorants on Lake Erie.

The bottom trawl used to assess the Lake Erie fish community has its own set of biases associated with it. Because of biases associated with this gear, other indicators of prey availability have been developed. An index of prey availability derived from walleye prey-size selectivity has proved useful for forage assessment in western Lake Erie (J.

Tyson, Ohio Div. Wild., unpubl. data). Since cormorant diets were similar to walleye diets, the possibility exists to construct an index from cormorant diets, as well. Constructing a prey availability index from cormorant diets could provide an additional tool for assessing annual forage fish composition and abundance.

Although cormorants do not appear to have adverse impacts on the fishery in Lake Erie, their increasing populations may have detrimental effects on other nesting waterbirds (e.g., herons, egrets) on Lake Erie Islands. Future research should focus on effects of cormorants nesting in proximity to other waterbirds and reducing cormorant numbers or nesting populations in proximity to other nesting waterbird colonies.

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