

## Appendix 4: DCCO Foraging Behavior at Aquaculture Facilities

*Daily Movements and Activity Budgets.* In the Mississippi Delta, DCCOs fly an average of 16 kilometers (10 miles) from their night roosts to feeding sites. Each bird spends about 18 percent of daylight hours feeding; 88 percent of their foraging is done at catfish ponds and 12 percent near roost sites. The average cormorant forages for 60 minutes each day, but spends just 20 minutes underwater in actual pursuit of fish (King et al. 1995).

*Feeding Rates.* Feeding rates may be dependent on the size and abundance of the available fish and the metabolic demands of the birds, and can be quite variable. Actively feeding DCCOs in commercial catfish ponds capture an average of about 5 fish/cormorant/hour (Stickley 1991; Stickley et al. 1992), but can vary from 0-28 (Stickley et al. 1992). Partly because of this variability, the rate of 5 fish/cormorant/hour reported by Stickley et al. (1992) is highly skewed; the median was only 2 fish/cormorant/hour, and the mean was equaled or exceeded at only 3 (21 percent) of the 14 ponds studied. Stickley et al. (1992) did not find a significant relationship between the mean number of DCCOs present and the number of catfish consumed, but ponds with 40 or more cormorants generally had a feeding rate of 1 or fewer fish/cormorant/hour. Similarly, DCCO feeding rates were not related to the density of fingerling catfish, density of all catfish (all size classes combined), or mean length of fish.

*Diet Composition.* DCCOs eat a wide variety of fish, and there is thus a great deal of variation in prey composition, both geographically and seasonally. Nearly all of the published information on diet composition at aquaculture facilities has been gathered in the vicinity of catfish farms in the southeastern United States (Bivings et al. 1989; Conniff 1991; Glahn and Stickley 1992; Glahn et al. 1995; Glahn et al. 1999b; and Glahn and Brugger 1995). These studies show that, among birds taken at winter roosting sites, the average proportion of catfish in the winter diet (by number) is most commonly in the range of 50-55 percent. The proportion varies seasonally from less than 30 percent in October and November to more than 80 percent in February, March, and April.

*Prey Size.* Although DCCOs are capable of taking catfish up to 42 centimeters (16 inches) in length (Campo et al. 1993), studies repeatedly have shown that the vast majority of catfish caught by cormorants at commercial facilities are in the range of 7-20 centimeters (3-8 inches), with most averaging about 10-15 centimeters (4-6 inches) (Schramm et al. 1984; Stickley 1991; Stickley et al. 1992). This range of prey sizes is remarkably close to that of prey taken by cormorants in natural freshwater habitats. In such studies (Durham 1955; Glahn et al. 1998; Hirsch 1986; Hobson et al. 1989; Campo et al. 1993), prey size ranged from 6-21 centimeters (2-8 inches), with a median value of about 12 centimeters (5 inches).

*Prey Preferences.* Lacking a precise knowledge of the species composition and size distribution of the prey population, it is impossible to make definitive statements about prey preferences. However a few tendencies are apparent. For example, the 10-15 centimeter (4-6 inch) fingerling catfish preferred by cormorants in one study represented about 64 percent of the catfish (by number) in the ponds (from Stickley et al. 1992), suggesting that the birds were merely preying on the most readily available fish. In this same study, 1 of the 14 ponds contained gizzard shad in addition to catfish. Nineteen shad were consumed for every catfish eaten, even though the pond contained about 5,100 fingerling catfish/hectare (2,100/acre). The apparent preference for gizzard shad in this instance may be related to their being more easily caught, handled, and swallowed by cormorants (the mean handling time for catfish was 6-7 times greater than that of gizzard shad).

*Daily Food Consumption Rates.* Estimates of daily food consumption rates of DCCOs at or in the vicinity of aquaculture facilities in the southeastern United States vary widely, from 208-504 grams (7-17 ounces, or 0.4-1.1 pounds) (Schramm et al. 1984; Schramm et al. 1987; Bivings et al. 1989; Conniff 1991; Brugger 1993; Glahn and Brugger 1995). Two separate captive cormorant trials were completed by Glahn et al (In Review) in Mississippi, one with out buffer prey and one with buffer prey (golden shiners) to help simulate diet composition of DCCOs in the field. In the non-buffered trial cormorants consumed between 10.2 and 10.5 catfish /bird/day or 516 and 608 grams/fish/day, which supports the daily food demand of 500 grams/fish/bird/day as predicted by the bioenergetics model of Glahn and Brugger (1995). In the buffer prey trial comorants consumed approximately 7 catfish/bird/day closely simulating their expected diet composition in the field (Glahn et al. In Review).