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Cannibalism of Juveniles by Adult Common Snook (*Centropomus undecimalis*)

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Cannibalism is probably common to many fish species, but has been documented for relatively few. This study provides the first documentation of intercohort cannibalism (juveniles cannibalized by adults) for common snook, *Centropomus undecimalis*, all instances of which occurred in putative nursery habitats.

Cannibalism is probably common in many fish species (FitzGerald and Whoriskey, 1992), but has been documented for relatively few. For example, Smith and Reay (1991) found documentation of cannibalism in 36 of 410 teleost families, but conjectured that cannibalism has likely been observed in many additional species. If a common occurrence, cannibalism can have population regulation implications (reviewed in Smith and Reay, 1991). Cannibalism of younger (smaller) individuals by older (larger) conspecifics (intercohort cannibalism) is the most common form of cannibalism in fishes (Smith and Reay, 1991). For species with potential for intercohort overlap in habitat use, cannibalism rates may have important management implications (e.g., Mann, 1982).

Common snook, *Centropomus undecimalis* (Bloch), is a tropical and subtropical, estuarine-dependent, euryhaline species that is ecologically and economically important throughout its range, especially in Florida (Taylor et al., 2000). The general pattern of its life history is known, but ecological details are lacking for numerous life stages. The general life history is as follows: adult snook spawn in passes and inlets at the mouths of estuaries (Taylor et al., 1998); larval planktonic stage is approximately 2 wk (Peters et al., 1998); juvenile habitats are shallow, complex, meso- to oligohaline habitats (Peters et al., 1998; A. J. Adams and R. K. Wolfe, unpubl. data). This life history strategy serves to decouple local reproduction from recruitment of new individuals into the population. In Charlotte Harbor, Florida, the location of this study, postsettlement [< 20 mm standard length (SL)] and juvenile snook occupy shallow creeks and tidally connected ponds fringed by red mangroves (*Rhizophora mangle*) (A. J. Adams and R. K. Wolfe, unpubl. data). Juvenile snook reach 150–180 mm SL by 1 yr of age and 300 mm SL by 2 yr (Taylor et al., 2000), and in Charlotte Harbor remain abundant in or near these habitats throughout the year until reaching 250–300 mm SL.

Adult snook (>300 mm SL) enter Charlotte Harbor mangrove creek habitats sporadically during summer, but use these habitats frequently during colder winter months (A. J. Adams and R. K. Wolfe, unpubl. data) when age-0 juveniles are most abundant, so are potential predators of juvenile snook. Because juvenile and adult snook occur concurrently in winter, a study was conducted to determine whether cannibalism occurred in these shallow creek and tidally connected pond habitats. It is also possible that intercohort cannibalism can occur between juvenile year classes (i.e., age-1 cannibalize age-0; age-2 cannibalize age-1). This paper is the first to document intercohort cannibalism by wild *C. undecimalis*. [Cannibalism by *C. undecimalis* in aquaculture settings is common (N. Brennan, pers. comm.); however, aquaculture-based cannibalism by fishes is common, even for species with little or no cannibalism in the wild (reviewed in Smith and Reay, 1991).]

Materials and Methods

Charlotte Harbor is a 700-km^2 subtropical, coastal plain estuary that receives freshwater from three rivers and numerous mangrove creeks, and is connected to the Gulf of Mexico through five inlets (Hammett, 1990; Poulakis et al., 2003). Sampling of adults for incidence of cannibalism occurred in four mangrove-lined creeks and four tidally connected ponds on the eastern shoreline of the estuary in two winter seasons: year 1, Jan.–April 2003; year 2, Nov.–Dec. 2003, Feb.–March 2004. Snook ≥140 mm SL were captured using a 30 m × 1.8 m center bag seine (25-mm mesh). Snook were measured (SL), and stomach contents obtained at the site of capture by lavage: a semi-flexible plastic tube was inserted down the throat into the stomach, and ambient water was pumped into the stomach to force out the stomach contents. Once lavage was complete, snook were released. Effluent containing stomach contents was examined on site to deter-

TABLE 1. Standard length (mm) of cannibalistic common snook, *Centropomus undecimalis* and of individuals they cannibalized.

Cannibalistic snook	Prey snook
278	48
313	77
312	113
591	117
610	121
651	141

mine whether juvenile snook were present. Only instances in which juvenile snook were readily recognized in the field were recorded as cannibalism (i.e., stomach content evaluation was cursory, so did not include examination of otoliths, scales, or vertebrae), thus making this an extremely conservative estimate.

RESULTS AND DISCUSSION

Stomach contents of 127 and 153 snook were examined in year 1 and year 2, respectively. Three instances of cannibalism occurred in each year. All instances of cannibalism were recorded in larger snook (smallest cannibalistic snook = 278 mm SL; Table 1), even though size range of lavaged snook was 141–660 mm SL (mean = 278.6). Mean size of cannibalistic snook was greater than noncannibalistic snook ($t = 1.969$, $P < 0.05$, $df = 277$). In Year 1, 65.8% of captured snook had food in their stomachs, and of those with food, cannibalism occurred in 3.8%. In Year 2, 58.6% of snook had food in their stomachs, and 3.4% of these fish exhibited cannibalism. Because the estimate of cannibalism in this study is extremely conservative (lavage may not have completely sampled stomach contents; stomach content examination was cursory—only easily recognizable remains were classified as snook), the rate of cannibalism may be higher. Size of cannibalistic adults and prey juveniles was positively correlated (Pearson correlation coefficient = 0.81, $P < 0.05$; Table 1). All cannibalized juvenile snook were < age 1.

Cannibalism is most common among piscivorous fishes (reviewed in Smith and Reay, 1991), and has been attributed to numerous factors. In general, cannibalism occurs when larger fish prey upon smaller fish—a relationship common to typical predator–prey relationships. Thus, cannibalism may be similar to a predator–prey relationship when disparate size classes of a species co-occur (e.g., Buckley and Livingston, 1997), so may simply be intraspecific predation (Dominey and Blumer, 1984). However, in this study, the simple mixing of size classes was not sufficient to cause cannibalism—there was no intercohort cannibalism observed in smaller fish.

For some species, cannibalism becomes more common as prey becomes scarce or as prey quality declines (reviewed in Smith and Reay, 1991). In this study, the 10 most abundant prey species (e.g., *Lucania parva, Menidia peninsulae*) were small (<50 mm SL), and were likely a suitable prey base for young juvenile snook. In contrast, juvenile snook (ranked 10th in total abundance of all creek fishes) represented the largest individuals of the 10 most abundant species, so may have represented a higher quality prey source for larger adults. Thus, cannibalizing juveniles may have been nutritionally more efficient for adult snook if overall prey quality was low (reviewed in FitzGerald and Whoriskey, 1992).

Diet analysis of adult snook in open estuarine habitats of Charlotte Harbor further suggests prey size preference by adults that might increase the chance of cannibalism in mangrove creek and tidal pond habitats. Although there was no cannibalism in 694 adult snook examined in open estuarine habitats of Charlotte Harbor, prey size (diet composed primarily of fish) and snook size were significantly and positively related (Blewett et al., 2006), and this was the trend in this study (Table 1). Other species in which cannibalism occurs also tended to select for larger prey (Juanes, 2003). In addition, the percentage of snook stomachs containing food was similar between Blewett et al. (62%) and this study. Thus, it appears that the co-occurrence of adult and juvenile snook in putative nursery habitats (mangrove creeks and tidal ponds) during winter exposes the juveniles to potential conspecific predators.

Cannibalism of juveniles by adult snook was observed in successive years, there was a positive relationship between cannibalistic snook and prey snook size, and adult and juvenile snook seasonally co-occur in putative nursery habitats. Given that a theorized attribute of nursery habitats is lowered predation risk, documented sources of predation in nursery habitats should be investigated.

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