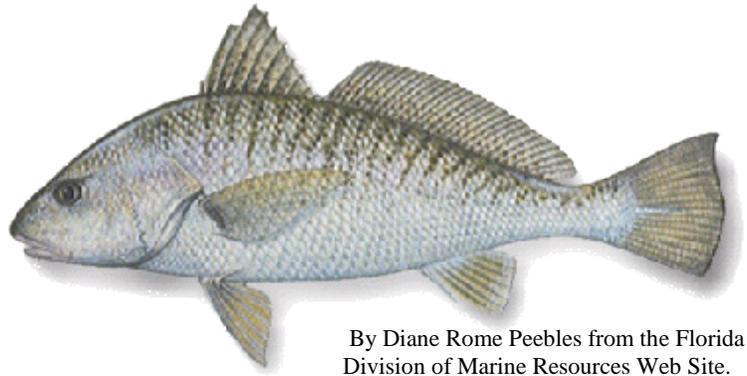


Atlantic Croaker

Micropogonias undulatus

Contributor: J. David Whitaker
(SCDNR)

Revised 2013: Chris McDonough
(SCDNR)



By Diane Rome Peebles from the Florida
Division of Marine Resources Web Site.

DESCRIPTION

Taxonomy and Basic Description

The Atlantic croaker is the only representative of the genus in the western North Atlantic. This species gets its name from the deep croaking sounds created by muscular action on the air bladder. It is one of 23 members of the family Sciaenidae found along the Atlantic and Gulf of Mexico coasts (Mercer 1987). The species has a typical fusiform shape, although it is somewhat vertically compressed. The fish is silvery overall with a faint pinkish-bronze cast. The back and upper sides are grayish, with brassy or brown spots forming wavy lines on the side (Manooch 1988). The gill cover has 3 to 5 prominent spines, and there are 3 to 5 small chin barbels. It has a slightly convex caudal fin.

Atlantic croaker south of Cape Hatteras reach maturity after one year at lengths of 140 to 180 mm (5.5 to 7 in.) and have previously been thought to not survive longer than one or two years (Diaz and Onuf 1985). More recent data, however, has expanded the age range with ages as high as 7 in South Carolina (ASMFC, 2010). Also, sections of Atlantic Croaker otoliths removed from archeological excavations near St. Augustine, Florida indicated that coastal Indians from the First Spanish period captured fish with a maximum age of 15 years (Hales and Reitz 1992). North of Cape Hatteras, the fish matures a year later at lengths greater than 200 mm (8 inches). The age range in the mid-Atlantic region for Croaker is greater with age 12 fish landed in Virginia and North Carolina in 2001 (Bobko et al. 2003; NCDMF 1999) and 15 to 17-year-old fish recently landed by the Chesapeake Bay Multispecies Monitoring and Assessment Program (ChesMMAP). The Atlantic Croaker reaches a maximum length of 500 mm (20 inches) (Hildebrand and Schroeder 1927). Catches of large Atlantic Croaker appear to be relatively common on Chesapeake Bay, but large individuals of Atlantic Croaker are rare in South Carolina. Bearden (1964) speculated that small Croaker from South Carolina may migrate north, but limited tagging studies could not corroborate that assertion.

Atlantic Croakers have been part of a mixed-stock commercial fishery on the Atlantic coast since the 1800s. Atlantic Croakers are caught commercially with a wide variety of gear. The dominant types include gill nets, pound nets, haul seines, and trawls. Atlantic Croaker is also a major component of “scrap fisheries”. A scrap fishery is one in which fish species that are unmarketable as food, due to size or palatability, are sold unsorted, usually as bait. Small Atlantic Croakers have also been a major part of the bycatch in the Southeastern Atlantic shrimp trawl fishery (Hoar et al. 1992; Nance 1998), and while the use of turtle excluder devices (TEDs) and by-catch reduction devices (BRDs) has reduced this bycatch, the overall impact of the trawl fishery on the Croaker population and the magnitude of the reduction through the use of TED’s

and BRD's is difficult to quantify. Currently there are no monitoring efforts for by-catch composition of the shrimp trawl fishery along the Southeastern Atlantic Coast of the US.

Diamond et al. (2000) concluded that late juvenile mortality resulting from bycatch was not the most important factor affecting Atlantic Croaker populations. Evidence suggests that the oceanic larval stage is more critical to the success of the stock with small changes in mortality causing great changes in recruitment rates (Norcross 1983; Diamond et al. 2000). Published natural mortality rates are typically determined from the entire age range of the population. Natural mortality rates assumed for Atlantic Croaker in past studies have largely been based on catch curves or life history analogies such as maximum age. For example, Ross (1988) estimated a total mortality rate (Z) value of 1.3 for ages 1 through 5 (based on scale ages) using a catch curve analysis of North Carolina haul-seine catches. Barbieri et al. (1994a) estimated Z values for Atlantic Croaker in the Chesapeake Bay using several approaches. Based on a maximum age of 8 years (derived from otolith ages), they estimated $Z=0.55$ using Hoenig's (1983) method and $Z=0.58$ using Royce's (1972) approach. In addition to natural mortality, bycatch mortality has the potential to have large negative impacts on population growth rates, and while bycatch reduction devices (BRDs) can reduce this potential, it is not known what that effect has on the population level. Additionally, bycatch mortality has likely diminished substantially in recent years compared to historic levels because of the decline in shrimp trawling effort. While fishing mortality rates will vary depending on the assumed rate of natural mortality, the estimated rates of fishing mortality used in the 2010 stock assessment (ASMFC 2010) ranged from 0.1 to 0.4 with a targeted level of 0.6 in order to maintain maximum sustainable yield in the fishery (termed F_{msy}).

Status

The Atlantic Croaker is not a federally or state listed species. The Atlantic States Marine Fisheries Commission oversees the management plan, with limited management recommendations for the Southeastern US Atlantic. The most recent stock assessment for Atlantic Croaker determined that the Atlantic stock (including South Carolina) is not overfished and is not currently undergoing overfishing (ASMFC 2010). The previous stock assessment (ASMFC, 2005) broke the stock into two regional management units (the mid-Atlantic and south Atlantic) due to lack of fit in the population models for the southern region. Thus, the coastwide assessment in 2005 was based on the mid-Atlantic region only. This was corrected with more extensive and better data for the 2010 stock assessment, and the entire stock of Croaker were considered and managed for the entire Atlantic coast. The primary reason for this was a lack of any biological indicators giving justification for breaking the stock into two regional components for management purposes.

POPULATION SIZE AND DISTRIBUTION

The Atlantic Croaker is a very common species in the waters of South Carolina. It occurs in coastal waters from Cape Cod, Massachusetts to Campeche Bank, Mexico, and possibly from southern Brazil to Argentina (Mercer 1987). The species has an extended spawning season—depending on the coastal area—that can range from October through April (ASMFC 2010). Adults in spawning condition have been found in depths of 7 to 131 m (23 to 430 ft.) north of

Cape Hatteras, and from 5 to 50 km (3 to 31 mi.) offshore of South Carolina in depths of 40 to 91 m (131 to 298 ft.) (Bearden 1964).

Studies of marine fishes have consistently shown that the Atlantic Croaker is among the most common fishes in State waters. Bearden (1964) noted that Atlantic Croaker was second only to Star Drum, *Stellifer lanceolatus*, in trawl samples collected in South Carolina from 1953 to 1962. Keiser (1977) found that Atlantic Croaker was the 3rd most abundant fish in samples taken off South Carolina on shrimp trawlers in 1974 and 1975, trailing Spot (*Leiostomus xanthurus*) and Atlantic Menhaden (*Brevoortia tyrannus*). Wenner and Sedberry (1989) examined fishes in the coastal waters off the Southeastern United States using trawls and found Atlantic Croaker to be the 2nd most abundant species following Spot. Whitaker et al. (1989) conducted experimental trawling in South Carolina's sounds in 1986 and 1987 and found Atlantic Croaker present in 55 of 89 samples taken. South Carolina Department of Natural Resources' (SCDNR's) SEAMAP program samples regularly trawled stations in nearshore coastal waters, and found Atlantic Croaker to be 2nd only to Spot in terms of abundance for the period 1989 to 2004 (24.0% to 12.6%). However, in 2004, Atlantic Croaker fell to the 8th most abundant species. Trawling conducted in 2001 through 2002 in South Carolina's estuarine waters as part of the SCDNR's Estuarine and Coastal Assessment Program (SCECAP) found Atlantic Croaker to be the 4th most abundant species behind white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*) and Spot (Van Dolah et al. 2004). Among the recreationally important drum species, Atlantic Croaker ranked 5th in catch rates from 1981 to 2012 (NMFS, 2013). The drum species which ranked higher include (in ascending order): Spot (*Leiostomus xanthurus*), Whiting (*Menticirrhus americanus*), Red Drum (*Sciaenops ocellatus*), and Spotted Seatrout (*Cynoscion nebulosus*). The overall ranking of Atlantic Croaker as part of South Carolina's recreational catch has declined since the 1980s. Atlantic Croaker typically ranked in the top 3 from 1981 to 1990, but dropped to an average rank of 5th from 1991-2000 and 4th from 2001-2012.

Joseph (1972) examined historical landings and catch-per-unit-effort data for Atlantic Croaker stocks in the mid-Atlantic states and Chesapeake Bay and concluded that fluctuations in abundance over the previous 80 years were largely attributable to the natural environment, namely temperature. He noted that unusually cold winters could decimate larval and juvenile fish. More recent evidence indicates that year-class strength is decoupled from larval supply and is determined by temperature-linked, overwinter survival of juveniles (Hare and Abel 2007). Hare and Abel (2007) hypothesized that the environment drives the large scale variability in Atlantic Croaker abundance and distribution, but fishing and habitat loss decrease the resiliency of the population to periods of poor environmental conditions and subsequent weak year classes.

Additionally, there is archeological evidence for changes in the population age structure of Atlantic Croaker in the south Atlantic region. Hales and Reitz (1992) examined Native American middens and Spanish colonial sites in Florida for Atlantic Croaker otoliths and found large fish (12 to 46 cm or 5 to 18 in.) that were present from 2000 BC to the mid-16th century. They concluded that there has been a severe reduction in size and age of Atlantic Croaker in the southeast within historic times due to overfishing or habitat degradation. This reduction could be related to mechanized commercial shrimp trawl bycatch since the early 20th century.

Recreational landings in South Carolina, as determined by a Marine Recreational Information Program Survey (MRIPS), suggest considerable variability in catch, which probably is at least partially related to fluctuations in stock abundance. Peak catches occurred in 1984 after which there was a steady decline until the mid-1990s. Catches stayed below the long term mean (LTM) until 2003 when it began to increase and subsequently stayed higher than the LTM in most years thereafter (Figure 1).

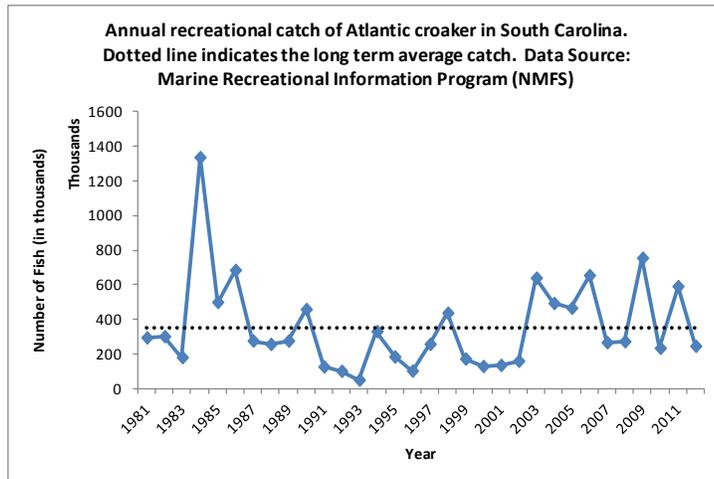


Figure 1: Annual recreational Atlantic Croaker catch in SC

Fishery-independent data collected routinely with trawls along South Carolina beaches by the SEAMAP program of SCDNR indicate variability in abundance as suggested by catch per unit of effort (CPUE) data. There was a general downward trend in CPUE, defined as the mean weight of Croaker per tow, but there was an overall decline from 1991 through 1997 followed by a steadily increasing trend from 1998 through 2012. While peak years have occurred in the two most recent years (2011 and 2012), most years in the 2000s stay at or near the LTM in catches (Figure 2).

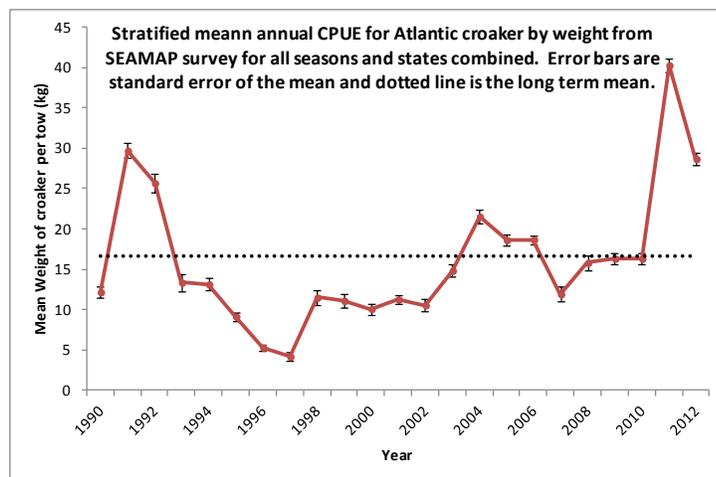


Figure 2: Stratified mean annual CPUE by weight from SEAMAP.

Two additional SCDNR fishery independent surveys also encounter Atlantic Croaker as a commonly caught species. Both are estuarine based inshore surveys. The first is a trammel net

survey that samples monthly in shallow water intertidal estuarine habitats in 7 different estuaries throughout South Carolina. This survey has been ongoing since 1990. The second survey is an electroshock survey that occurs in low salinity brackish and tidal freshwater estuaries and was designed to compliment the trammel net survey. The electroshock survey has been ongoing since 2002. Both surveys encounter Atlantic Croaker but at different life stages. The electroshock survey encounters primarily young-of-the-year juveniles that have recently settled in the estuaries. The trammel net survey captures age 1 Croaker and older and represents mostly adult Croaker. Both surveys show year to year variability in abundances based on differences in recruitment and environmental variables; however, there was a very similar trend in annual abundances between the two surveys. Since the electroshock survey caught young-of-the-year juveniles and the trammel net caught mostly age 1+ fish, we put a one year lag in the electroshock annual abundance in order to match up years between the two surveys. This resulted in a significant positive correlation ($r = 0.719$) between the two indexes indicating a high degree of synchrony between them (Figure 3). This indicates a consistent pattern of abundance in Atlantic Croaker in South Carolina estuaries for the 2001-2012 time period.

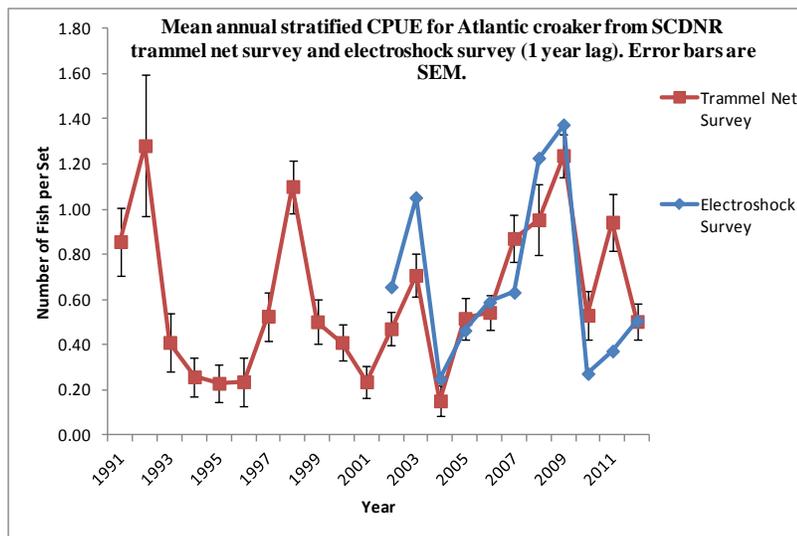


Figure 3: Mean annual stratified CPUE from SCDNR.

HABITAT AND NATURAL COMMUNITY REQUIREMENTS

The Atlantic Croaker has a down-turned mouth, making it well-suited for its bottom-feeding life style. Adults spawn offshore, producing larvae that are carried into the coastal inlets by tidal currents. Larvae ride the “salt wedge” which moves along the bottom into estuaries (Bearden 1964). Atlantic Croaker larvae have a day-night (diel) distribution in the water column that is opposite of that for most planktonic animals (Comyns and Lyczkowski-Shultz 2004). This “reverse diel vertical migration” means they are more common in deeper water during daylight compared to night. Optimal habitat for post-settlement juvenile Atlantic Croakers is the low salinity zone in the upper portion of the estuary. Peterson et al. (1999) demonstrated in controlled laboratory experiments that Atlantic Croaker grew considerably faster in salinities of 5 parts per thousand (ppt) than those growing in 20 ppt or a variable salinity (5 to 20 ppt). Young Atlantic Croaker first recruit to the upper estuarine areas and gradually move seaward toward higher

salinities as they become larger (Bearden 1964). Lower salinity estuaries typically had larger numbers of Atlantic Croaker compared to higher salinity estuaries, indicating that survival and growth are enhanced by lower salinities and/or other factors that might be related to salinity (Bearden 1964). Miglaresse et al. (1982), also working in South Carolina estuaries, found that salinity affects size distribution, and Chao and Musick (1977) found that Atlantic Croakers were most abundant in lower salinities in the York River, Virginia. However, others have suggested that depth and food preference may be related to size distribution (Miglaresse et al. 1982).

Rogers et al. (1984) found that seasonal freshets of river flow were important to estuarine-dependent species including Atlantic Croaker. They noted that it was striking that low salinity and freshwater areas serve as primary zones of recruitment and that peak recruitment and utilization periods occur during the period of maximum riverine influence, temporarily creating “a much larger proportion of the preferred habitat.” Ross (2003) concluded that oligohaline habitats (low salinity: 0.5-5.0 ppt) provided better habitats for Spot and Atlantic Croaker because mortality rates are lower there. There are several alternative explanations of why mortality rates are lower in the lower salinity areas including: reduced predation, lower respiration rates (compared to high salinity), and higher growth rates.

Parker (1971) noted that the “large concentrations of Croaker were always observed in shallow waters less than 1.2 m (4 ft.) deep and in close proximity to a source of fresh or brackish water.” Parker also noted that these habitats were generally soft mud bottoms with large quantities of detritus. It was suggested these shallow areas provide abundant food and protection from predators. Bearden (1964) also found that young Atlantic Croaker were most often found in small tidal creeks where bottoms are composed of soft mud and decomposing organic matter. He noted that larger Atlantic Croaker were found on a great variety of bottom types, but were most abundant on “bottoms composed of mud and sand mixture, particularly near the mouths of tidal sounds and several miles offshore.” Miller et al. (2002), working in Delaware Bay, found that young Atlantic Croaker used the entire range of marsh creek habitats. When found in deeper waters of the bay, Croaker were most abundant over the mud bottoms.

In summary, it appears that the lower-salinity upper reaches of estuaries are optimal habitat in South Carolina for young Atlantic Croaker. Survival and growth rates appear to be higher in low salinity areas although the reason(s) is unknown. Atlantic Croaker move seaward as they become larger, using the deeper channels to migrate. Mud bottom habitats throughout the estuary appear to be important to the species regardless of depth. Atlantic Croaker is a significant and ubiquitous component of the near-shore and inshore benthic fish community and as such, this species is a valuable indicator species of the relative health of estuarine benthic finfish and their associated habitat.

CHALLENGES

Since colonial times, size and age structure of Atlantic Croaker populations appears to have changed drastically in ways that are consistent with added heavy fishing pressure (Hales and Reitz 1992). Adequate freshwater flow into the Coastal Zone appears to be very important to the species. Inadequate freshwater flow into estuaries when juveniles are on the nursery grounds could negatively affect the species. Loss of shallow saltmarsh habitats through construction of

seawalls in the upper reaches of tidal creeks could also be detrimental. Additionally, compromised water quality resulting from nutrients and chemicals associated with untreated storm water from coastal development could negatively affect the species, particularly the juveniles while in the nursery habitats

The potential impacts of chemical pollutants on Atlantic Croaker and other fishes are just now coming to light. Endocrine disrupting chemicals (EDCs) such as organo-chlorines, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and alkylphenols are being investigated for impacts on fishes. Thomas (1990) found that female Atlantic Croaker exposed to cadmium had elevated levels of reproductive hormones resulting in precocious ovarian growth; exposure to lead, benzene(a)pyrene, and the PCB Aroclor 1254 each caused a decline in circulating steroid hormone levels and ovarian growth. McCarthy et al. (2003) demonstrated that environmentally realistic loadings of a PCB (Aroclor 1254) in eggs of Atlantic Croaker through dietary exposure and maternal transfer can have significant effects on survival and growth rates of larvae. In a separate study, Khan and Thomas (1996) showed that Aroclor 1254 significantly blocks testicular growth in Atlantic Croaker.

Overfishing is a potential problem for Atlantic Croaker stocks, although the most recent stock assessment concluded that the species is not overfished in South Carolina. Because the species remains very common in coastal waters and it matures at a relatively small size, there appears to be adequate numbers of spawners to sustain the local stocks. Regardless, without the necessary information to fully assess the population trend for this species, overfishing is a possibility with increased fishing effort. In addition to any directed fishing effort, the effects of by-catch mortality from the shrimp trawling fishery remains an unknown, and possibly significant, source of Atlantic Croaker mortality at the population level.

CONSERVATION ACCOMPLISHMENTS

Actions taken by the South Atlantic Fishery Management Council in Amendment 2 to Shrimp Management Plan (SAFMC 1996) and by the Atlantic States Marine Fisheries Commission in the Weakfish Management Plan (ASMFC 1994) have resulted in the mandatory use of by-catch reduction devices in shrimp trawl nets. Studies have shown that these devices are useful in reducing by-catch-related fishing mortality of fishes including Atlantic Croaker. Additionally, the South Carolina General Assembly closed most of the area in the State's sounds and bays to shrimp trawling in 1986, thus reducing fishing mortality and providing greater survival of juveniles. Another legislative action by South Carolina eliminated small mesh gill nets in the state's estuaries and significantly reduced the length of recreational gill nets to 30.5 m (100 ft.).

CONSERVATION RECOMMENDATIONS

- Research ways to improve catch data in order to determine population trends of Atlantic Croaker.
- Quantify the level of Atlantic Croaker by-catch from the South Carolina commercial shrimp trawling fishery and associated mortality levels.
- Examine the age structure of Atlantic Croaker in South Carolina.
- Examine movement patterns of adult Atlantic Croaker through tagging studies.

- Determine natural and fishing mortality rates of Atlantic Croaker in South Carolina.
- Examine effects of pollutants on Atlantic Croaker individuals and the stock as whole.
- Examine environmental factors that may affect abundance of Atlantic Croaker.
- Examine ecological interactions between Atlantic Croaker and other species, including Red Drum.
- Research the impacts of disease on mortality of Atlantic Croaker.
- Partner with appropriate agencies in North Carolina and Georgia to develop agreements to maintain adequate water flow into coastal estuaries.
- Work with the South Carolina Department of Health and Environmental Control's Office of Coastal Resource Management (SCDHEC-OCRM) and the Army Corps of Engineers (ACOE) to minimize the loss of salt marsh habitat to construction projects in the Coastal Zone.
- Along with OCRM and other partners, work with municipal and county planners to work toward reducing the negative impacts of urban development to sensitive areas in coastal marshes.
- Improve and maintain water quality and reduce the input of contaminants by working with municipalities to improve and implement Best Management Practices (BMPs).
- Develop a regional fishery management plan for the Atlantic Croaker to address conservation issues range-wide.

MEASURES OF SUCCESS

One measure of success would be to improve monitoring programs for Atlantic Croaker such that a stock assessment and population trends can be developed. By conducting the above mentioned research, a regional management plan can be developed through partnerships with other state agencies. Although there appears to be much variability in catch per unit data from year to year, the ultimate measure of success will be to document stable population trends over long-term periods for the Atlantic Croaker.

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