

Building Capacity for Sustainable Fisheries Management in the U.S. Caribbean: Queen triggerfish age, growth, and maturity.

Creando capacitación para el manejo sustentable de las pesquerías en las aguas del Caribe de E.E.U.U.: Peje puerco edad, crecimiento y madurez.

Création d'une formation pour la gestion durable des pêches dans les eaux de la Caraïbe des États-Unis : âge, croissance et maturité de "Queen triggerfish".

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EXTENDED ABSTRACT

The primary goal of fisheries management is to ensure the long-term sustainable harvest of species and minimizing the ecological impacts while at the same time balance the cultural, economic, and food security needs of a jurisdiction. This is often achieved through a relatively complex and scientifically rigorous stock assessment process that results in management recommendations. One of the most important suits of inputs for this involves documenting the age structure of a stock. In the U.S. Caribbean, no current information is available on queen triggerfish population age structure, sex-specific and combined growth rates, and age-at-sexual maturity despite the importance of queen triggerfish as one of the top commercially landed reef fish species. The objectives of our ongoing research on queen triggerfish life history are: 1) Investigate age, growth, and mortality across the US Caribbean Island-based management platforms; 2) Document reproductive biology, including size- and age-at-sexual maturity, reproductive seasonality, and reproductive potential/output.

To-date, we have collected and processed 2,154 samples from across the U.S. Caribbean 67-473 mm FL. All sample were measured in for length (SL, FL, TL mm) and weighted (g). Gonads were process using methods described in Rivera Hernandez et al. (2019); otoliths Figure 1) extracted and read according to the methods described in Shervette et al. (2021b). Radiocarbon ageing validation utilizing eye lens cores followed the methods described in Shervette et al. (2020). Radiocarbon ageing validation for age estimates from sagittal otoliths resulted in an age range of 0-23 y. Age estimates from over 2000 samples resulted in the following VBGF parameter estimates: $L_{\infty} = 430$ mm FL; $K = 0.15$ and $t_0 = -0.59$ solid line (Figure 1). Males were larger at the same age as female, indicating sexual dimorphism in this species. The largest and oldest queen triggerfish, including mega-spawner females, occurred in deeper shelf waters (> 30 m depth); a similar trend of increasing size and age for triggerfish with depth was also documented for gray triggerfish *Balistes capriscus* (Kelly-Stormer et al. 2017). We obtained 23 queen triggerfish samples caught with hook and line by commercial fishers in waters offshore of South Carolina and North Carolina, U.S.A., (SC/NC) from 2013-2021; mean/maximum size and age of the SC/NC fish were larger than those from Caribbean waters (Figure 2). The maximum age documented for queen triggerfish in the current study was 40 y and the fish was a female caught in Oct 2021.

Ageing validation results from our efforts demonstrated that sagittal otoliths provide accurate age estimates for queen triggerfish; the method we developed for estimating age in triggerfish using otoliths has resulted in an increase in the current understanding of longevity for our species. Past research on queen triggerfish age and growth utilized sections of the first dorsal spine to estimated ages for samples from the north Caribbean (1983-1984) resulting in a maximum estimated age of 7 y (Manooch and Drennon 1989); and samples from Brazil (1997-1999) resulting in a maximum estimated age of 14 y (Albuquerque et al. 2011). The bombradiocarbon validated methods using otoliths as the ageing structure has increased our understanding of longevity for this species from 14 y to 40 y.

Notable differences occur in gear used and depths fished for commercial catches of queen triggerfish among U.S. Caribbean islands. In the island of Puerto Rico, queen triggerfish is caught using a combination of traps, hook-and-line, and spearfishing, predominantly at depths < 25 m; in St. Croix, USVI, the queen triggerfish are mainly target by spearfishing at depths < 25 m and fishers selectively spear "plate size fish" for the market, creating a self-imposed slot limit of mostly mature individuals and excluding larger fish, such as mega-spawner females that occur in deeper waters. In St. Thomas/St. John, queen triggerfish are mainly caught via traps at depths at or greater than 30 m; for trap-caught fish, funnel size may limit the number of fish > 450 mm FL that can successfully enter the trap.

Reproductive biology for Puerto Rico and St. Croix was assessed previously in Rivera Hernandez et al. (2019) using reproductive histology; queen triggerfish were determined to be gonochorists and females exhibit group-synchronous oocyte development with indeterminate fecundity. The reproductive season for queen triggerfish in the north Caribbean waters occurs from December to August (Rivera Hernandez et al. 2019). We analyzed the sexual maturity data in the current study for fish collected 2013-2021 and documented the following: size at sexual maturity (L_{50}) for males = 190 mm FL; and for females is 233 mm FL; male age at sexual maturity (A_{50}) = 2.7 y and female A_{50} = 4.6 y suggesting that males mature younger than females.

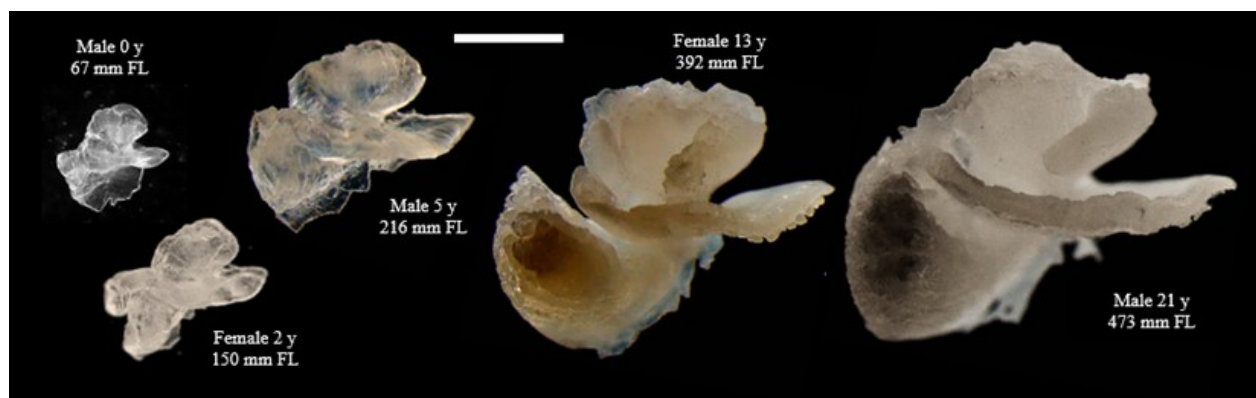


Figure 1. Examples of left sagittal otoliths from queen triggerfish across a spectrum of sizes and ages. Scale bar = 1 mm.

Overall, this research provided a more accurate method for assessing queen triggerfish population age structure and documented that maximum age was far greater than originally thought. We also provided critical information on size and age at sexual maturity. Ongoing analyses will determine mortality rates and examine gear-related biases on sex ratios. Future sampling efforts should include fisheries-independent collections of queen triggerfish; we also recommend targeted sampling efforts to better understanding reproductive behavior and timing of spawning aggregations in association with the moon phases. Our collaborative efforts in conducting this research combined the expertise of local fishers and scientists; our findings provide critical information in multiple areas to assist fisheries managers in evaluating the current stock status of this species. Our efforts demonstrate the interest and willingness of local fishers to collaborate and provide information to evaluate the status of the species that are important to fisheries. This work also demonstrates how research on fisheries species can be enhanced through collaborations among fishers, local scientists, and external experts to build capacity in the region to provide the best science available towards fisheries management needs.

KEYWORDS: life history, collaborative fisheries research, bomb radiocarbon age validation

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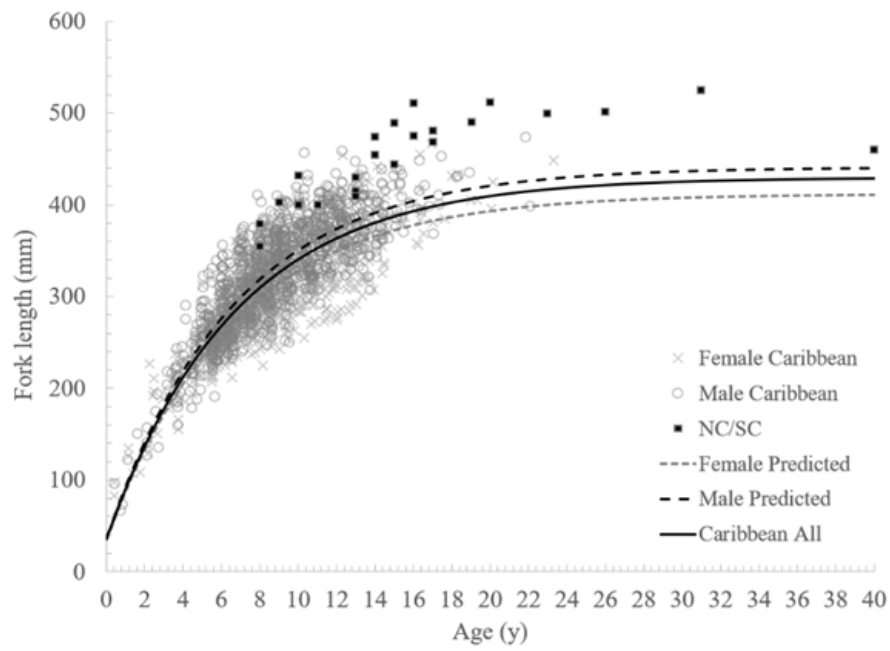


Figure 2. Length-at-age and von Bertalanffy growth curves based on age estimates from the sagittal otoliths of queen triggerfish