Preliminary Analysis of Movement Patterns and Population Characteristics of a Red Hind, *Epinephelus guttatus*, Spawning Aggregation in St. Croix, U.S. Virgin Islands: Using Acoustic Telemetry for Conservation and Management

El Análisis Preliminar de los Patrones de Movimiento y Características de la Población de una Cierva Roja, *Epinephelus guttatus* , Agregación de Desove en St. Croix , Islas Vírgenes Estado Unidenses: Utilizando Telemetría Scústica para la Conservación y Gestión

L'analyse Préliminaire des Habitudes de Déplacement et les Caractéristiques de la Population d'un Arrière Rouge, *Epinephelus guttatus* , l'agrégation de Frai à Sainte-Croix , Îles Vierges Américaines : Aide de la Télémétrie Acoustique pour la Conservation et la Gestion

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EXTENDED ABSTRACT

Epinephelus guttatus form transient fish spawning aggregations (FSA) (Colin et al. 1987). These repeated gatherings of conspecific species occur at predictable temporal and spatial scales (Domeier 2012). Historically, FSAs have been protected and now fished (Johannes 1978). This has caused overfishing to result in their extirpation and related stock crashes, and endangered status of targeted species (Sadovy de Mitcheson et al. 2012, Cornish and Eklund 2003).

In 1993, a seasonal area closure was established for an *E. guttatus* FSA at Lang Bank, St. Croix, USVI (Figure 1a,b). One key metric for a healthy spawning population is a bimodal size distribution between genders since they are protogynous changing sex from female to male. A study in the USVI by Nemeth et al. (2006) of two *E. guttatus* FSAs after ten years of seasonal protection found an increase in fish size and abundance at the Red Hind Bank, St. Thomas and a decrease at the Lang Bank FSA, St. Croix. At the site that decreased, Nemeth found a nearly identical female to male size structure, and hypothesized that it might be related to several factors including poaching, but also the placement of the closed area boundary since it was located only 600 m away from the FSA. Normal movement patterns of fish during the spawning season were thought to be crossings the boundary resulting in their increased exposure to fishing pressure. In 2005, a year-round ban was implemented on the use of all bottom tending gear types within the seasonal area closure boundaries of the Lang Bank FSA (70 FR 62079; October 28, 2005). No subsequent test has determined the effectiveness of this management measure.

Our research aims to improve the design of closed area boundary placement of *E. guttatus* FSAs by incorporating a better understanding of their temporal and spatial life history patterns. We hypothesize that the placement of closed area boundaries has an effect on the Lang Bank FSA population of *E. guttatus*. We also hypothesize that the ban on bottom tending gear has an effect on the Lang Bank FSA's length frequency.

We formed an acoustic array (Figure 1c) by placing ten acoustic receivers at the FSA site and the expected fish migratory path (Nemeth et al. 2007). The detection range of each acoustic receiver is 800 m. To ensure overlap in the array, we spaced them 600 m apart. We collected fish by combined methods of hook and line and trap fishing conducted at and around the FSA site. Total length (cm) and weight (g) of all collected fish were measured, and gender determined with the use of a cannula. An acoustic transmitter was surgically implanted within the body cavity of four males and four females (n = 8). Fish were released by divers at the FSA site to safeguard against predation, and to visually confirm post-operative survivorship.

Preliminary results from the 2014 spawning season reveal transmitter detections within the acoustic array. However, receivers placed along the area closure's western boundary did not record any transmitter detections. Because there was no recorded transmitter detections along the area closure boundary, we reject our first hypothesis (that fish are regularly crossing the boundary during the spawning season), although, more testing is required for conclusive results. Transmitter detections were limited to only a few receivers located in the northeastern extent of the acoustic array. Tagged fish did not follow their expected western path and might have traveled beyond the array's detection range in northern, southern or eastern headings. These results reveal that additional acoustic receivers are needed to detect suspected movements. The information provided by these preliminary results allow us to make adjustments to our research that will continue through the 2015 spawning season.

Population characteristics also showed the transition to a bimodal size distribution based on percentages of total lengths recorded. In addition, there is a significant increase ($t = 4.23$, $df = 255$, $p < 0.001$) in male average lengths between 2004 and 2014. These findings show promise that the 2005 management measure may be effective. We tentatively accept our second hypothesis.

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Figure 1a. Map of the Caribbean with St. Croix encircled.

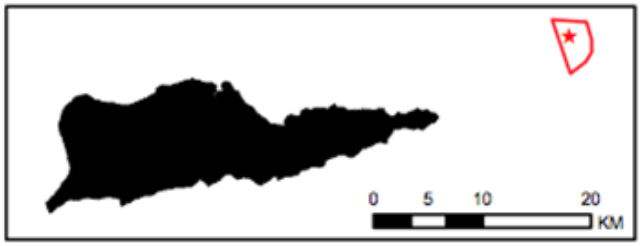
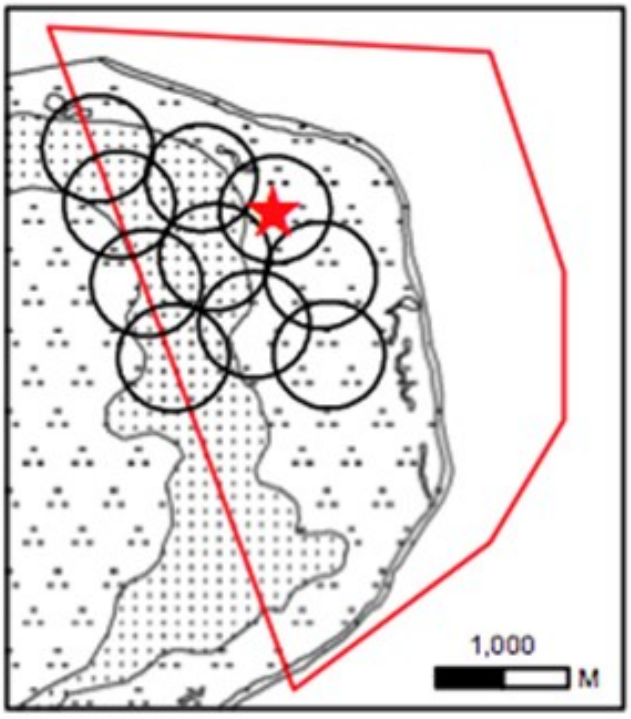


Figure 1b. Map of St. Croix with the star of Lang Bank FSA site encircled by the seasonal closure boundary.



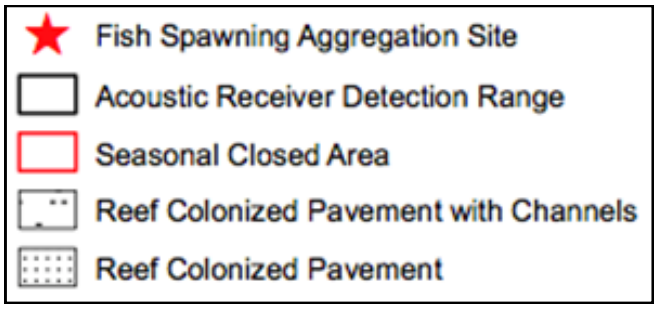


Figure 1C. Study site of the Lang Bank FSA and release location of fish tagged with acoustic transmitter (n=8). The FSA site is identified by the star and is surrounded by a polygon representing the seasonal closure boundary. Circles within the closure represent the detection range (800 m) and placement for each of the ten acoustic receivers forming the acoustic array. Benthic habitat types are identified within the figure key.