We identified, located, and tracked soniferous estuarine fishes (in families Sciaenidae, Batrachocephidae, Triglidae, and Blenniidae) in a shallow saltwater marsh creek using a seven-element hydrophone array.

Introduction

Soundscape recordings allow listeners to determine the presence and activities of soniferous animals in an area (Piątkowski et al., 2011), and these recordings have been used to learn about both terrestrial (Fischer et al., 1997) and aquatic environments (Parks et al., 2014; Luczkovich and Sprague, 2022). If we want to learn about animals that we cannot see, we can listen to them. But most sounds are recorded with a single hydrophone provide little information about the locations and movements of the sound-producing animals in the recording because hydrophones are omnidirectional at low frequencies. Therefore, we deployed a seven-hydrophone array in a very shallow saltwater creek to learn about the locations of sound producers and their movements.

Methods

The study site was a Clambank Creek, a saltwater creek at the University of South Carolina Baruch Marine Field Laboratory in the North Inlet-Winyah Bay National Estuarine Research Reserve near Georgetown, SC, USA (see Fig. 1). We deployed an array of seven HTI 96-Min hydrophones (High Tech, Inc., Long Beach, MS, USA) in water depths of 1.00 m to 1.70 m by wading into the water and mounting the hydrophones on rods connected to cinder block anchors placed on the creek bed. (See Fig. 2) The array configuration was sub-optimal with hydrophone locations influenced by bottom conditions and our ability to secure the hydrophone in-place while wading. We determined the hydrophone positions by triangulating to known reference positions using a laser rangefinder and validating them using a Wide Area Augmentation System-enabled Global Positioning System (WAAS-GPS).

To calibrate the array, we produced impulsive sounds underwater at five positions, determined by triangulation of laser rangefinder measurements and WAAS-GPS. We used the delays of the calibration sounds between hydrophones to calibrate the array, solving sound propagation equations for the hydrophone positions.

We recorded sounds using an eight-track simultaneous-sampling digital recorder (Zoom F8, Tokyo) for 24 hours at each reference point and calibration sounds at Clambank Creek. The Clambank marsh water quality monitoring station is located on the pier on the bottom-left of the image (Satellite image obtained from Google Earth.)

Figure 1: The study site shown on a map of the southeastern United States. (Map generated using Google Earth.)

Figure 2: Positions of the reference markers, hydrophones, and calibration sounds at Clambank Creek. The Clambank marsh water quality monitoring station is located on the pier on the bottom-left of the image. (Satellite image obtained from Google Earth.)

Figure 3: Hydrophone positions with fish detections at Clambank Creek. F1–a sea robin detected at 2017-06-01T18:28:21 (UTC-4); F2–a spotted seatrout Cynoscion nebulosus detected at 2017-06-01T18:28:21 (UTC-4); F3–the same spotted seatrout as F2 detected at 2017-06-01T18:30:21; F4–a striped blenny Chasmodes bosqui found at 2017-06-01T18:28:21. The arrow shows the position of the spotted seatrout between F2 and F3. (Satellite image obtained from Google Earth.)

Using the time delays between array channels, we determined the locations of many fish in the recordings, including those shown in Fig. 3. We followed a spotted seatrout as it vocalized continually while moving between points F2 and F3 in Fig. 3 over 60 s.

Discussion and Conclusion

We have demonstrated that sound-producing fish can be located and tracked using a hydrophone array deployed in a sub-optimal configuration in very shallow water. The measurements of the calibration sound positions with a laser rangefinder had sufficient accuracy to calibrate hydrophone positions acoustically with results that were consistent with independent WAAS-GPS measurements. Using the hydrophone positions we were able to locate and track vocalizing fish in the recordings. In the future we will use this technique to locate groups of fishes producing sound and determine how these fish move throughout the day.

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References


