

The coupling of St. John, US Virgin Islands marine protected areas based on reef fish habitat affinities and movements across management boundaries

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Abstract

NOAA's Biogeography Branch, National Park Service (NPS), US Geological Survey, and the University of the Virgin Islands (UVI) are using acoustic telemetry to quantify spatial patterns and habitat affinities of reef fishes. The objective of the study is to define the movements of reef fishes among habitats within and between the Virgin Islands Coral Reef National Monument (VICRNM), the Virgin Islands National Park (VIIS), and Territorial waters. In order to better understand species' habitat utilization patterns among management regimes, we deployed an array of hydroacoustic receivers and acoustically tagged reef fishes. A total of 150 fishes, representing 18 species and 10 families were acoustically tagged along the south shore of St. John. Thirty six receivers were deployed in shallow nearshore bays and across the shelf to depths of approximately 30m. Example results include the movement of lane snappers and blue striped grunts that demonstrated diel movement from reef habitats during daytime hours to offshore seagrass beds at night. The array comprised of both nearshore and cross shelf location of receivers provides information on fine to broad scale fish movement patterns across habitats and among management units to examine the strength of ecological connectivity between management areas and habitats.

Key words: Acoustic Tracking, Coral Reef, Fish, Habitat Utilization, Telemetry

Introduction

Study Area and Background

Coral reefs in the US Virgin Islands and in Virgin Island National Parks have declined in recent decades. The establishment of the Virgin Islands Coral Reef National Monument (VICRNM) in 2001 provides approximately 5,143 hectares of additional NPS marine managed area off the island of St. John, USVI. To assess the long-term effectiveness of management regulations and VIIS and VICRNM as marine protected areas (MPAs) it is necessary to conduct investigations that can provide data on the movement of reef fishes within areas across and outside NPS boundaries. NOAA digital benthic habitat maps coupled with movement patterns of fishes provide a spatial framework to address questions concerning linkages among adjacent habitats and how the mosaic of habitats connect in the seascape that structure reef fish distribution patterns.

Material and Methods

Island Scale

To determine the movements of reef fishes along the entire south shore of St. John and portions of its

eastern bays within and outside VICRNM and VIIS, 36 receivers were deployed (Fig. 1).

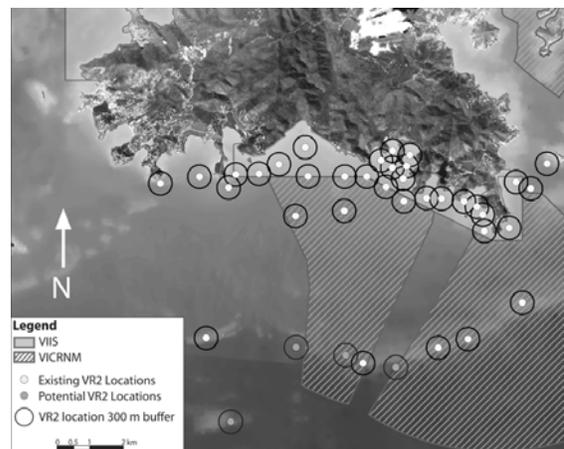


Figure 1. Location of VR2 VEMCO Hydroacoustic Receivers around St. John, USVI.

Each of the acoustic receivers has a nominal detection range of 300m. Based on our knowledge of the distribution of habitats and reef fish ecology, we

deployed receivers in shallow nearshore bays and across the shelf to depths of approximately 30m. Receivers were located within reefs and adjacent to reefs in seagrass, algal beds, or sand habitats and within and outside of VIIS and VICRNM. This array provides data to define “island scale” patterns of reef fish movements.

Fine Scale

To define fine scale movement of reef fishes and their habitat affinities, of the 36 receivers found within the entire array, 9 of these receivers were concentrated in the Lameshur Bay complex. The receivers were deployed to ensure “overlap” among detections of acoustically tagged fishes and to ensure all habitats within the bay were covered by the fine scale array (Fig. 2).

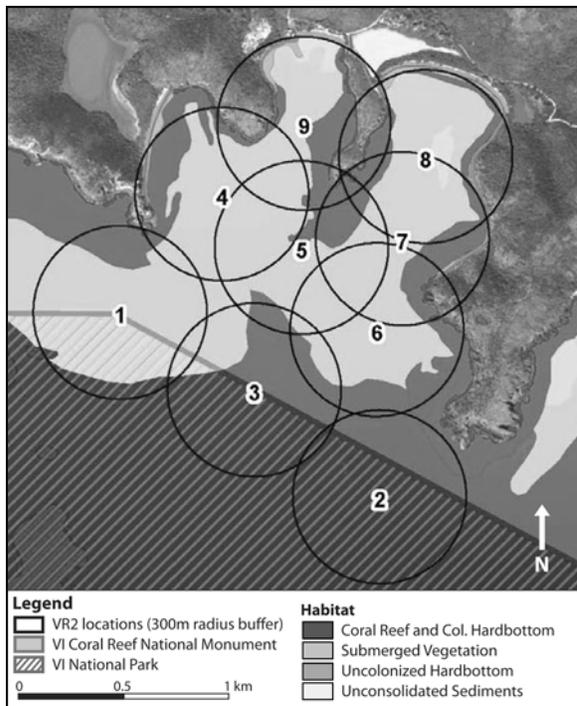


Figure 2. Location of acoustic receivers in Lameshur Bay.

Acoustic Tagging

We surgically implanted VEMCO V9-2L-R64K transmitters into the stomach cavities of captured fishes (Fig. 3). A 1cm incision was made 1cm off-center from the ventral midline behind the pelvic fins and a small acoustic transmitter (22mm) was placed within the body cavity. The incision was closed with two surgical sutures and the fish were observed to ensure adequate recovery. After holding fish for 24 hours in post surgery recovery tanks, they were released at a location in close proximity to their original capture location.

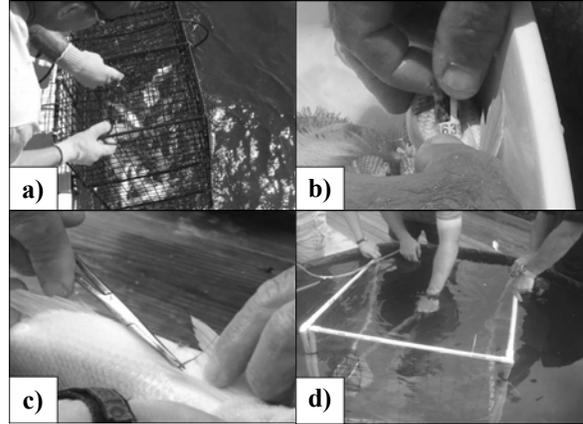


Figure 3. a) Fish traps used to capture fish; b) surgical implanting of acoustic transmitters; c) closing incision with surgical suture; and d) a crowder used to minimize handling and stress in the holding/ recovery tank.

Results

Lameshur Bay-wide Habitat Utilization

The greatest number of total detections were recorded at Station 5 (55%), followed by Station 3 (20%), and Station 6 (16%), respectively (Fig. 4). This is despite the fact that 51% of all of the releases during this period of the study (July 2006 to April 2007) occurred at Station 6, with 27% released at Station 5 and 22% at Station 4. In addition, the receiver at Station 5 stopped collecting data after December 15, 2006 due to memory limitations. The dense seagrass bed adjacent to Yawzi Point (Station 5) may have resulted in shorter migration distances to nighttime foraging areas that were still within the detection range of Station 5 (Fig. 5).

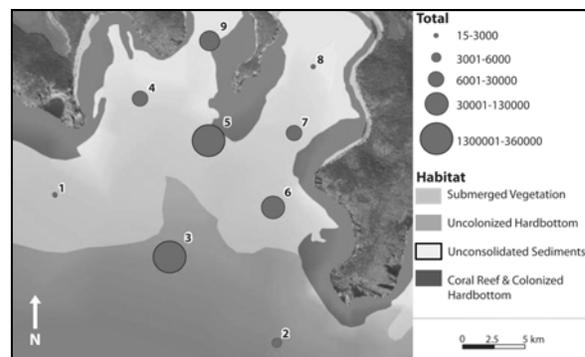


Figure 4. Total number of detections by receivers from July 2006 to April 2007.

Individual Fish Movement – Lane snapper (*Lutjanus synagris*)

Figure 6 is a plot of receiver detections for an individual lane snapper (29cm TL) undergoing sun-synchronous migrations into and out of Lameshur Bay between July 12, 2006 and April 5, 2007 (268 days; night= 0:00-4:00 and 20:00-24:00, crepuscular= 4:00-8:00 and 6:00-20:00, daytime=8:00-16:00). The

data indicate daytime site fidelity with the eastern side of Lameshur Bay and a regular departure from the bay at sunset and a return to the bay at sunrise.

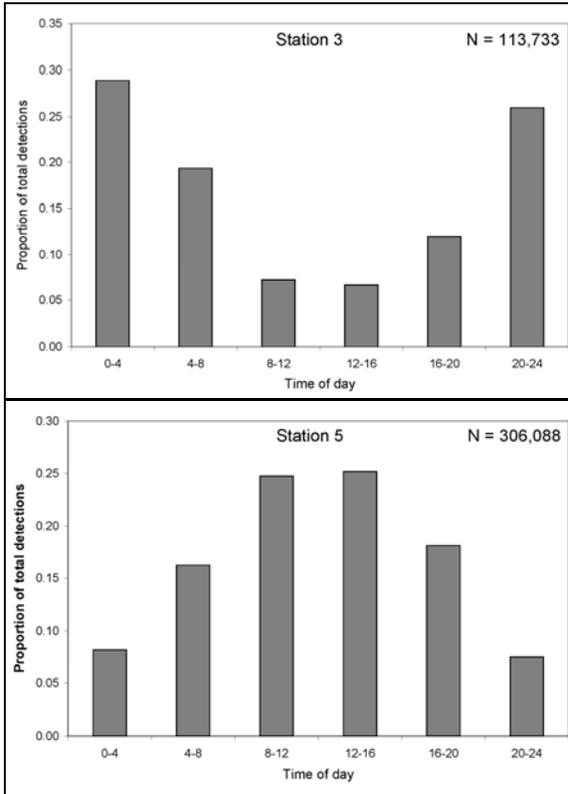


Figure 5. Proportion of total detections by time of day for: a) Station 3 and b) Station 5.

This movement pattern is further highlighted in Figure 7 that shows at approximately sunset this fish was detected at Station 2 and was likely leaving the bay since it was not detected on any other receiver at night. It appears the fish migrated offshore into deeper water to presumably to forage and returned back to Lameshur Bay at sunrise.

Discussion

The joint NOAA, NPS, USGS, and UVI acoustic tracking of reef fishes found around St John, USVI is providing a wealth of information to define reef fish movements and habitat utilization patterns. These data have been and will continue to be used to define the ecological connections between the VIIS, VICRNM, and USVI Territorial waters. This work directly supports NPS and Territorial management of living marine resources by evaluating the efficacy of marine protected areas, defining species habitat affinities and determining the temporal patterns of reef fishes at island-wide and fine scale spatial extents.

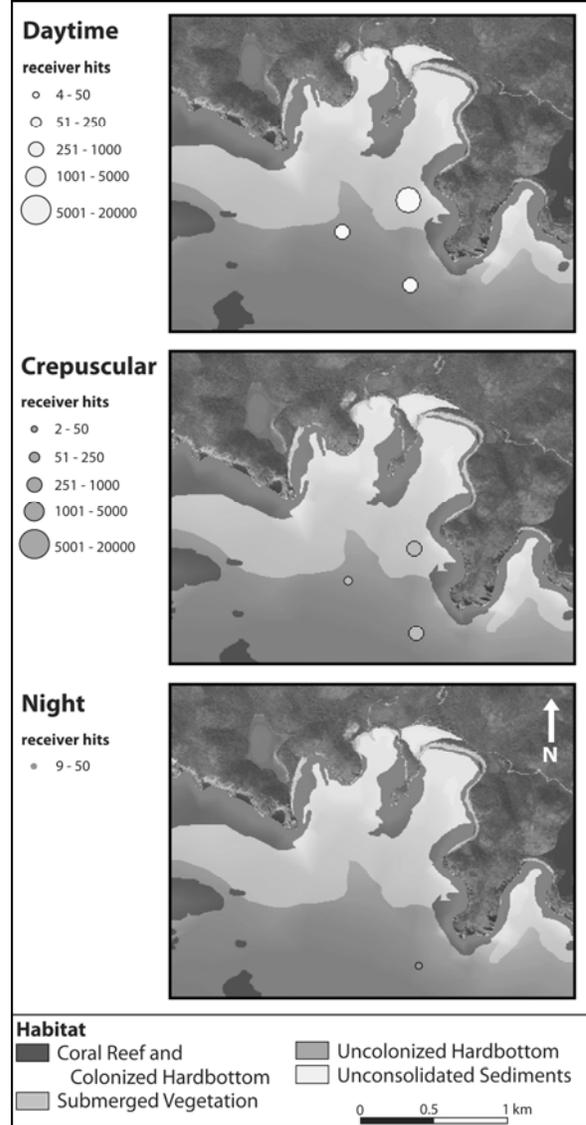


Figure 6. Detection patterns for a lane snapper by time period.

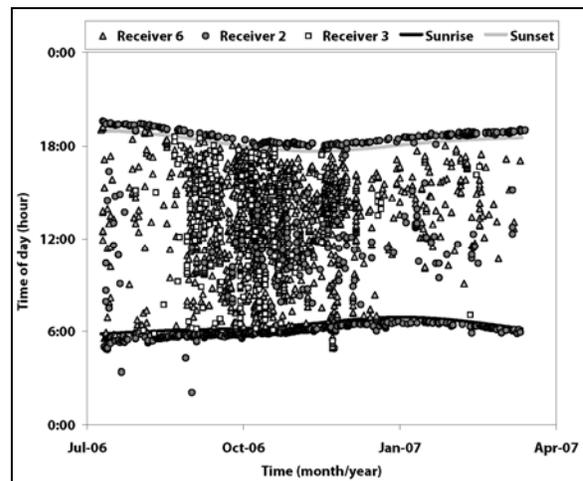


Figure 7. Data for lane snapper indicating sun-synchronous nocturnal migrations and high daytime site fidelity.

The next steps in the work are to continue to analyze the acoustic returns of individual fishes detected across the receiver array and to deploy 4 additional receivers to better elucidate the connectivity between the relatively deep mid-shelf reef area found offshore of southern St. John and within the VICRNM to VIIS and nearshore territorial waters. Plans are to continue the study to at least December of 2009 and then determine if and when to move the receiver array to additional locations within the USVI.

Acknowledgements

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