Using Fishery-independent Surveys to Estimate Densities of Queen Conch, *Strombus gigas*, Populations in St. Croix, U. S. Virgin Islands

Usando Encuestas Independientes de la Pesqueria para Estimar las Densidades del Caracol Rosa, *Strombus gigas*, en St. Croix, E.E.U.U. Islas Virgenes

À l'aide de Sondages Indépendamment pour Estimer la Densité de Lambi, *Strombus gigas*, à Sainte-Croix, USA Îles Vierges

JENNIFER C. DOERR and RONALD L. HILL
NOAA Fisheries Service, 4700 Avenue U, Galveston, TEXAS 77551 USA.
Jennifer.Doerr@noaa.gov. Ron.Hill@noaa.gov.

ABSTRACT

Conventional stock assessment methods have been ineffective for determining the population status of queen conch throughout the Caribbean, mainly due to the lack of fishery-independent data. We examined queen conch populations on the northeastern coast of St. Croix, U.S. Virgin Islands, using a radial survey sampling technique with sample sites stratified by depth, habitat type, and management regime, encompassing both open and closed fishing areas. We completed 503 radial surveys and located 4773 conch, representing a cumulative density of approximately 302 conch per hectare. Densities of juvenile conch were highest in open fishing areas outside of Buck Island Reef National Monument (BIRNM) due to larger areas of available seagrass habitat. Densities of adult conch were highest inside the BIRNM on macroalgae and sand where many were observed mating and laying egg masses. Overall length frequencies showed a bimodal distribution, driven largely by conch found within the BIRNM. Length distributions by habitat were variable but showed a trend toward larger conch in reef, macroalgae, and sand habitats compared to a more even distribution in seagrass.

KEY WORDS: Queen conch, U. S. Virgin Islands, radial survey, density, habitat

INTRODUCTION

The queen conch, *Strombus gigas*, is a highly valued marine resource throughout the Caribbean, but population numbers in the U.S. Virgin Islands have been severely reduced since the 1970 - 1980s (Wood and Olsen 1983). In the U.S. Virgin Islands, a series of management measures has been implemented over the last several decades to avoid complete stock collapses. These measures have included size restrictions, commercial and recreational bag limits, a 5-year fishing moratorium, and seasonal closures during peak spawning months. However, to understand the effects of management measures on animal populations there must be adequate data to conduct reliable stock assessments. Fishery-dependent data, relying on reported landings and measures of effort, is presently insufficient for understanding conch population status in the region. Fishery-independent studies become a critical component of stock assessments in these cases, especially when they generate habitat-based density data that can be incorporated into these models.

METHODS

We surveyed queen conch populations on the northeastern coast of St. Croix, U.S. Virgin Islands from September 2010 to September 2011 using a radial survey sampling protocol. Sample sites were randomly stratified by depth, benthic habitat type, and management regime, ensuring that open and closed fishing areas were adequately sampled. At each sample site we dropped a weighted line attached to a buoy and recorded the location using a hand-held GPS receiver. Divers descended to the bottom where they clipped a 10-meter survey line above the weight, and recorded water depth. The divers swam the end of the survey line in a circle and searched the entire area (314 m^2) for conch. Shell length and lip thickness of each conch encountered was measured *in situ* and recorded, and any mating activity and the presence of egg masses was noted. Benthic habitat type was visually characterized by both divers and recorded. After returning to the boat, the divers discussed the habitat and assigned it a category following the NOAA NCCOS benthic habitat map definitions (Kendall et al. 2001).

To determine potential relationships between conch densities and environmental characteristics we used DTREG Predictive Modeling Software to run univariate classification and regression tree (CART) analysis (www.dtreg.com, P.H. Sherrod, 2003 - 2013). This is a suitable technique for analyzing complex ecological data that may involve nonlinear relationships, interactions, and missing values (De'ath 2000). We performed regression tree analyses on density data for juvenile, adult, and all conch grouped together, using three explanatory variables (water depth, habitat type, and management regime). Based on breaks in conch distribution present in the raw data, water depth was binned into four groups at 0 - 10 m, 11 - 15 m, 16 - 20 m, and 21 - 30 m for the regression tree analysis. Sampling date was not included since preliminary analysis indicated no relationship between conch density and the time of year we surveyed.

We conducted 503 radial surveys covering nearly 16 hectares (ha) across 12 habitat types including colonized pavement, linear reef, patch reef, scattered coral-rock, sand, macroalgae, and seagrass of varying densities (designated as 10 - 30%, 30 - 50%, 50 - 70%, and 70 - 90% patchy, and continuous). We located and measured 4773 queen conch (3690 juveniles and 1083 adults), representing a cumulative density of 302 conch per ha. Juvenile conch had an overall density of 233.69 per ha, while adult densities were much lower at 68.59 per ha. Densities of conch were similar inside the Buck Island Reef National Monument (BIRNM – closed fishing area) and the open fishing areas.

RESULTS AND DISCUSSION

The regression tree analysis for juvenile conch showed that habitat type was the strongest variable for predicting density, followed by management zone and water depth. The model predicted that the highest densities of juveniles could be found in patchy 30 - 50% and continuous seagrass in 11 - 15 m of water within the boundaries of the closed fishing zone. The tree explained 30% of the variance in juvenile densities. The adult conch regression tree also showed that habitat type was the strongest predictor variable, while water depth was second and management zone was third. The tree for adults also explained 30% of the overall variation and indicated that the highest densities occurred in the 21 - 30 m depth group within the boundaries of the BIRNM.

Distributions of queen conch populations are influenced by a suite of environmental characteristics including habitat type, water depth, and physical oceanographic features. Habitat type is generally considered to be the most important factor related to conch distribution and density patterns, but conch densities may be more strongly influenced by interaction effects between environmental variables when analyzed concurrently. One of the objectives of this study was to describe differences in conch densities and distribution by habitat type (12 levels), management regime (2 levels), and water depth (4 levels). Traditional statistical methods become increasingly complex when multiple factors are considered, but classification and regression trees are a much simpler technique that can be used to describe interactions among numerous factors.

Densities of both juvenile and adult conch were primarily influenced by habitat type, specifically the various seagrass categories, which follows the reported results of many conch distribution studies. However, the second most important factor for juveniles was management regime, while for adult conch it was water depth. The highest densities for adults occurred across a variety of habitat types within deeper areas of the BIRNM. Densities in shallower waters were influenced more by specific habitat type, with higher densities in 10 - 30% and 70 - 90% patchy seagrass, scattered coral-rock, and colonized pavement. These results and this type of analytical method can be useful in designing marine reserves to ensure not only that sufficient types and areas of the desired habitats are enclosed, but also that complex ecological interactions are properly considered to achieve successful results.

LITERATURE CITED

De'ath, G. and K.E. Fabricius. 2000. Classification and regression trees: a powerful yet simple technique for ecological data analysis. *Ecology* **81**:3178-3192.

Kendall, M.S., M.E. Monaco, K.R. Buja, J.D. Christensen, C.R. Kruer, M. Finkbeiner, and R.A. Warner. 2001. Methods used to map benthic habitats of Puerto Rico and the U.S. Virgin Islands. *NOAA Tech. Memo. NOS NCCOS CCMA 152*, Silver Spring, Maryland USA.

Wood, R.S. and D.A. Olsen. 1983. Application of biological knowledge to the management of the Virgin Islands conch fishery. *Proceedings of the Gulf and Caribbean Fisheries Institute* **35**:112-121.