Fisheries Research 199 (2018) 53–62

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Fine-scale population structure of *Lobatus gigas* in Jamaica's exclusive economic zone considering hydrodynamic influences

Kimani A. Kitson-Walters[a,*], Adam S. Candy[d], Nathan K. Truelove[c], Marcia E. Roye[a], Mona K. Webber[b], Karl A. Aiken[b], Stephen J. Box[c]

[a] Biotechnology Centre, 2 St. John's Close, University of the West Indies, Mona Campus, Jamaica
[b] Department of Life Sciences, 4 Anguilla Close, University of the West Indies, Mona Campus, Jamaica
[c] Smithsonian National Museum of Natural History, Smithsonian Marine Station, Fort Pierce, FL, USA
[d] Environmental Fluid Mechanics Section, Faculty of Civil Engineering and Geosciences, Delft University of Technology, The Netherlands

ARTICLE INFO

Handled by: Dr. J Viñas

Keywords:
Queen conch
Jamaica
Genetics
Lobatus gigas
Microsatellites
Hydrodynamics
Ocean currents

ABSTRACT

Jamaica is one of the few remaining countries in the Caribbean region with an abundant population of *Lobatus gigas* (queen conch) able to sustain a lucrative fishery. Efforts to understand and maintain queen conch populations must involve an investigation into genetic connectivity. This connectivity facilitates population replenishment and continuity via the transport of veliger larvae by ocean currents. Due to the lack of knowledge in this regard to queen conch populations in Jamaica, the fine-scale population structure of *Lobatus gigas* populations in the country's Exclusive Economic Zone (EEZ) has been analysed by comparing the allele frequencies of nine microsatellite loci on a total of 459 individuals collected across twelve sites encompassing nearshore and offshore locations. Samples were grouped into five broad scale geographic clusters for statistical analysis. Our findings indicate that a weak but significant population structure exists (Global Fst = 0.004, p = 0.01) suggesting that mainland Jamaica acts as a weak divide between populations north and south of the island. Greater levels of connectivity are suggested between north coast populations and those present at the Formigas Bank, an offshore site northeast of the island. The island's primary conch fishing ground located offshore on Pedro Bank, receives limited gene flow from the other sampled populations and may be heavily dependent on local recruitment or receive recruits from sources external to Jamaica's EEZ. An analysis of surface ocean currents strongly supports these three findings and further that conch populations on Pedro Bank very likely receive recruits from sources distinct to those that supply nearshore populations. Further genetic studies into the recruitment patterns and sources for the community on Pedro Bank are therefore critical to ensure sustainable management of this commercially threatened population. Decades of intense fishing pressure has resulted in the establishment of the Allee effect on the island shelf, significantly hampering reproduction and consequently recruitment. If the question of recruitment on Pedro Bank is not addressed, further development of the Allee effect there and eventual population exhaustion are inevitable. These findings, their implications and recommendations for the management of the queen conch fishery in Jamaica are discussed.

1. Introduction

The conservation of commercially and ecologically important species has become a multidisciplinary effort that has evolved far beyond just biological and environmental monitoring, to now including genetic methods. The field of conservation genetics has proven to be an informative tool in understanding the complex interactions of populations across spatial and temporal scales. Using this approach, we conduct the first examination of the fine-scale population structure of a commercially endangered species, the queen conch (*Lobatus gigas*), in one of the last remaining abundant populations within the species' geographic range (Aiken et al., 1999; Prada et al., 2008; Tewfik 1997). The queen conch supports an export-focused industrial scale fishery in Jamaica that is based on Pedro Bank, the island's primary fishing ground. The increase in demand for conch in the early 1990s led to unsustainable increases in annual exports with 7500 t exported between 1993 and 1999 (Aiken et al., 2006). Jamaican exports accounted for 46% of conch meat exported internationally during this time (Thiele 2001), with exporters making an average of US$ 8 million/year between 1997 and 2000.

* Corresponding author.
E-mail addresses: kimash21@gmail.com, kimash21@hotmail.com (K.A. Kitson-Walters).

https://doi.org/10.1016/j.fishres.2017.11.010
Received 1 May 2017; Received in revised form 18 October 2017; Accepted 10 November 2017

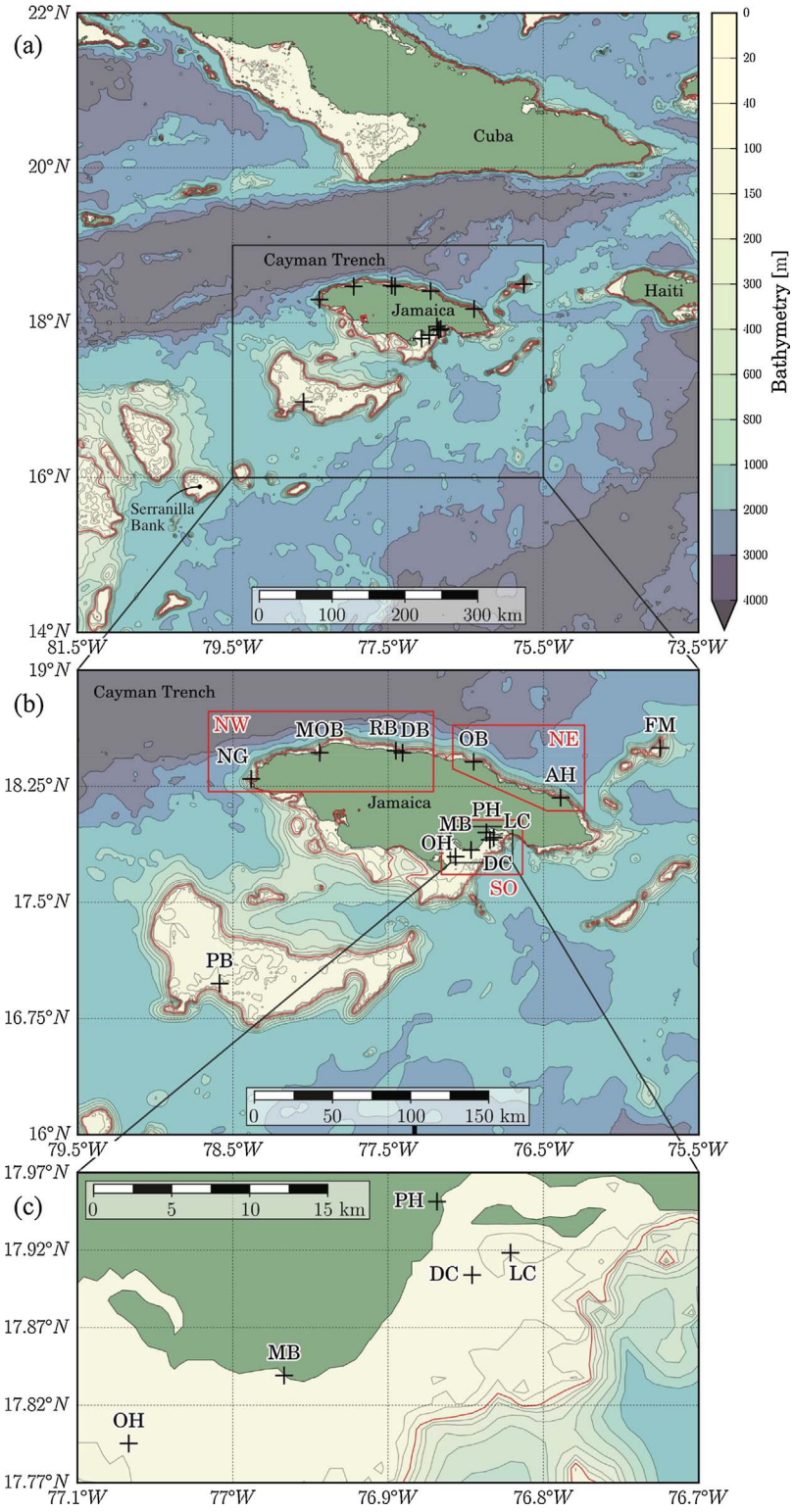

Fig. 1. Map of sample site groupings together with sea bed ocean bathymetry of (a) the regional Caribbean Sea surrounding Jamaica, Pedro Bank and the sampled sites (b) the coastal waters and (c) the eastern side of the Southern Shelf of Jamaica. Bathymetry data derived from the updated 2014 version, 30 arc-second grid General Bathymetric Chart of the Oceans (GEBCO, 2014; Weatherall et al., 2015) and presented under an equidistant cylindrical projection (with distances approximately accurate to the scale shown). To identify the location of submerged atolls, notably Pedro Bank and Formigas Bank, a red line marks the 100 m depth contour. Sample sites are marked by black crosses and labelled, including: Negril (NG), Montego Bay (MOB), Rio Bueno (RB), Discovery Bay (DB), Orcabessa Bay (OB), San San (AH), Lime Cay (LC), Port Henderson (PH), Drunkenman's Cay (DC), Old Harbour Bay (OH), Manatee Bay (MB), Pedro Bank (PB) and Formigas Bank (FM). Grouped sample sites, based on their proximity to mainland Jamaica, are boxed in red in (b), and include Northwest (NW), Northeast (NE) and Southeast (SE). The location of SE sites are more accurately shown in (c) and in the context of sea bed bathymetry. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Prior to the industrialization of the fishery in the 1990s, queen conch exports were less than 50 t per year (Aiken et al., 2006). In 1992, severe exploitation of the conch fishery in the Caribbean resulted in the species being listed in Appendix II of the Convention on International Trade in Endangered Species [CITES] (Thiele 2001). The convention requires permits for collection and export to be issued by the relevant authorities only if the authority is satisfied that any removal will not be detrimental to the survival of the affected population (Prada et al., 2008). Efforts to implement measures for sustainable use of the queen conch fishery in Jamaica have been limited to restricting the number of licensed conch fishers, setting of quotas and the designation of marine reserves (Aiken et al., 2006; Morris 2012). These measures along with stock assessments via abundance surveys are the only tools currently used by Jamaican authorities to manage a marine territory that is more than sixteen times the size of mainland Jamaica; the mainland is approximately 10,991 km^2 while the Exclusive Economic Zone (EEZ) is approximately 181,190 km^2 (Qu et al., 2001; U.S. Department of State 2004). In order to sustainably manage a fishable resource such as the