

Identifying Biodiversity Hotspots of Threatened Endemic Bony Shorefishes in the Greater Caribbean to Inform Area-specific Conservation Planning Priorities

La Identificación de los Puntos Críticos de Biodiversidad Peligro Shorefishes Peligro Óseas Endémicas en el Gran Caribe para Informar Prioridades Planificación de la Conservación de Áreas Específicas

Identifier les Points Chauds de Biodiversité de Shorefishes Osseuses Menacées Endémiques dans la Grande Caraïbe pour éclairer les Priorités Spécifiques de la Région de Planification de la Conservation

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EXTENDED ABSTRACT

The rising threat from the invasive lionfish, the persistent degradation of sensitive coastal habitats, and the continuance of overexploitation in the greater Caribbean is of concern to fish conservationists. Establishing marine protected areas (MPAs) is one solution used to mitigate these threats. By definition, the goal of an MPA is to preserve biodiversity and ecological function; however, a lack of comprehensive species-specific data can inhibit its effectiveness (Margules and Pressey 2000). Designating MPAs without full knowledge of the distribution of threatened species can unintentionally concentrate fishing effort in areas important to the species that most need conservation (Baum et al. 2003). Furthermore, implementing conservation action aimed towards threatened species increases the value of an MPA's conservation outcomes (Pressey et al. 2015). Identifying those species at an elevated risk for extinction via the objective, but adaptable, methods developed by the IUCN Red List is a stepping stone that can be used to systematically inform conservation priorities. The recent IUCN Red List assessments of the nearly 1,400 marine bony shorefishes of the greater Caribbean allows, for the first time, comprehensive analyses of the impact of pervasive region-wide threats on this ecologically and economically important group. The purpose of this study was to support regional conservation planning by detecting areas with the highest numbers of threatened endemics and subsequently identify opportunities for adjusting management plans or expanding MPA coverage. Results from such an analysis can also inform the targets of large-scale conservation initiatives such as the Caribbean Challenge, the SPAW List of Protected Areas, and the Aichi Biodiversity Targets.

The biogeographic region referred to as the greater Caribbean extends from Cape Hatteras, North Carolina (USA) to the border of French Guiana and Brazil, including Bermuda, the Gulf of Mexico and Caribbean Sea (Robertson and Cramer 2014). A shorefish was defined as any marine bony fish that inhabits the continental shelf area (generally shallower than 200 meters depth). Based on these restrictions, a list of 1,361 species was generated and approximately 1,000 of them had not been previously assessed for the Red List. In order to support the Red List process, data were compiled on each species' habitat, population, distribution, and threats by workers at the Global Marine Species Assessment. Generalized polygonal distributions maps were drawn in ArcGIS based on data compiled from published literature and point records in the Smithsonian Tropical Research Institute's online database of Caribbean shorefishes (Robertson and Van Tassell 2015) and then standardized by clipping to a 100 km shoreline buffer and maximum depth of 200 meters. Each of the 1,000 unassessed species was then assigned a global-level extinction risk category by species experts during three Red List workshops held from 2011-2013. Distribution maps were also vetted by the experts during the assessment process. Following the recently completed review by Red List experts, all assessments are scheduled for publication on the IUCN Red List website within the next year.

If a species meets quantitative thresholds related to either population decline and/or range size, it can qualify for threatened, which corresponds to the risk levels of Vulnerable, Endangered, or Critically Endangered. In addition, a species was considered endemic if its range was completely within the region's boundaries or had only minor extensions along the continental shelf beyond them. Overall, there are 65 threatened shorefishes that occur in the greater Caribbean, 45 of which are endemic. The majority of these threatened endemics (89%) are small-bodied with highly restricted ranges and are susceptible to habitat degradation. The most common major threat categories recorded for these taxa are exploitation, estuary degradation, the invasive lionfish, and coral reef degradation (Figure 1). Additionally, 40% are impacted by more than one major threat; for example, six species are threatened by the invasive lionfish and coral reef degradation.

Species richness was determined by transforming the polygons to raster format with a cell size of 10 km² and adding the rasters together. Maps of established MPAs were extracted from the NOAA Marine Protected Areas Center and the World Database of Protected Areas and an ArcGIS intersect tool was used to identify species distributions that overlap with MPAs in hotspot areas. Results of the richness analysis show that the top three hotspots are located in Belize (17 species), central Panama (13), and Grand Cayman Island (13). Six other areas scattered throughout the region have 12 species each

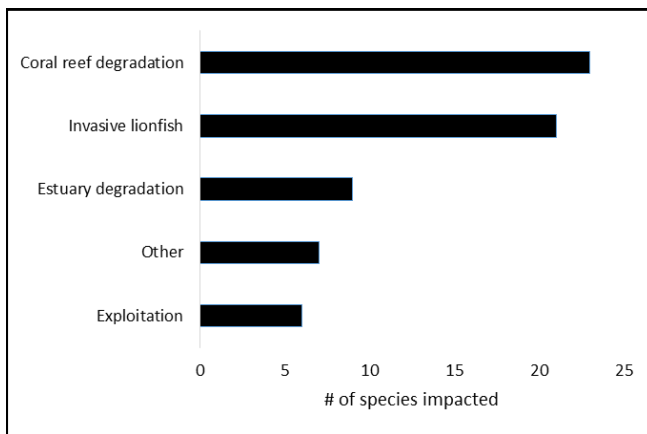


Figure 1. The number of greater Caribbean threatened endemic marine bony shorefishes (45 species) impacted by major threat category. Eighteen species are impacted by more than one threat category.

(Figure 2). Off Belize, 17 species distributions intersect with the South Water Caye Marine Reserve, which is also part of a UNESCO World Heritage site. Seven of these species are nearly or completely endemic to Belize; four of them are impacted by the invasive lionfish and all by habitat degradation.

As conservation action is often funding-limited, results from extinction risk assessments and spatial analyses communicate opportunities to prioritize resources towards areas with high vulnerability for biodiversity loss. This study demonstrates the utility of combining spatial and Red List data to inform conservation planning. For example, the Belize World Heritage site has been on the Danger List since 2009 due to impacts from coastal development; as a result, site management undergoes annual review. The availability of this framework presents the opportunity to include these new data on threatened

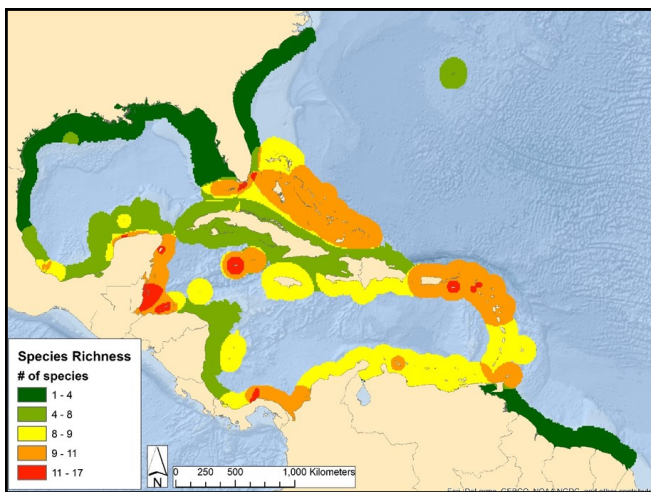


Figure 2. Richness analysis for the 45 threatened endemic marine bony shorefishes of the greater Caribbean. Areas in red indicate the highest numbers of species, while dark green indicates the lowest. Cells containing the maximum of 17 species are located only off Belize; other red areas contain between 11-13 species.

species and evaluate the current plan’s capacity to improve and monitor their survival. These new data can also be applied in the Bahamas, where an expansion of the MPA network was recently proposed. According to results from the richness analysis, 12 threatened endemics occur near Eleuthera Island, which is more than any other area in the country. Since there are no MPAs currently designated or proposed in the vicinity of this hotspot, conservation managers may consider potential opportunities to adjust coverage. Future reassessments of these threatened species on the Red List would allow managers to monitor the progress of conservation over time.

LITERATURE CITED

Baum, J.K., R.A. Myers, D.G. Kehler, B. Worm, S.J. Harley, and P.A. Doherty. 2003. Collapse and conservation of shark populations in the Northwest Atlantic. *Science* **299**(5605):389-392.

Margules, C.R. and R.L. Pressey. 2000. Systematic conservation planning. *Nature* **405**(6783):243-253.

Pressey, R.L., P. Visconti, and P.J. Ferraro. 2015. Making parks make a difference: poor alignment of policy, planning and management with protected-area impact, and ways forward. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* **370** (1681).

Robertson, D.R. and K.L. Cramer. 2014. Defining and dividing the Greater Caribbean: Insights from the biogeography of shorefishes. *PLoS ONE*, **9**(7), e102918.

Robertson, D.R. and J. Van Tassell. 2015. *Shorefishes of the Greater Caribbean: Online Information System. Version 1.0.* Smithsonian Tropical Research Institute, Balboa, Panamá.