A Multi-criteria Spatial Analysis to Determine Key Management Areas for Sharks in the Gulf of Mexico and Mexican Caribbean

Análisis Espacial Multicriterio para Determinar Áreas Clave de Manejo de Tiburones en el Golfo de México y el Caribe Mexicano

Une Analyse Spatiale Multi-critères pour Déterminer les Zones Clés de Gestion pour les Requins dans le Golfe du Mexique et les Caraïbes Mexicaines

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EXTENDED ABSTRACT

Worldwide, shark populations are declining due to fishing and degradation of their nursery and feeding areas. Because of the extent of damage and lack of effective management, it is difficult that depleted shark populations could easily recover (Ferretti et al. 2010). Sharks play an essential role in the marine ecosystem as predators but, unfortunately, they are among the most extinction-prone taxa due to their life history traits such as delayed maturity, large size, and low fecundity (Musick 2005).

Studies on the northern Gulf of Mexico (GOM) indicate a decline in coastal and oceanic shark populations (Baum and Myers 2004). Worldwide, Mexico is sixth in shark catches but according to the Mexican National Fisheries Chart (DOF 2012) in the Economic Exclusive Zone 50% of shark catch are juveniles and pregnant females. In the Mexican fishery statistics, there are no catch records per shark species (CONAPESCA 2004, Salomón 2012) where records rely on common names such as "cazón" or "tiburón" (INAPESCA 2012). The aim of this work was to determine key areas for shark conservation in the GOM, based on a multiple-criteria analysis.

We determined shark species distribution in both the GOM and the Mexican Caribbean using information from the World Sharks Assessment database (Lucifora et al. 2009). From such database, we estimated total species richness per spatial unit. The database presents a spatial precision (pixels) of one degree of latitude-longitude in size. Additionally, we categorized shark species based on the following criteria:
  i)   IUCN risk categories (IUCN 2015),
  ii) Inclusion in the Mexican National Fisheries Chart (2012), and
  iii) The Intrinsic Vulnerability Index (Cheung et al. 2005).

Based on a matrix of species distribution, we used a multi-criteria analysis, to define key areas for shark conservation based on species richness and species presence at each pixel. We mapped the conservation value in order to identify geographic areas where the most susceptible species are present.

We found 60 shark species in Mexican waters (out of 88 in the GOM). Based on the multiple-criteria analysis, we found highest conservation values mainly in the center of the GOM (Figure 1) with conservation values of 0.8 to 1.0. The southern GOM (off the Yucatan Peninsula, Mexico) showed values between 0.7 to 0.8 and the lowest values per pixel were found off Tamaulipas, south of Veracruz and Quintana Roo (between 0.3 to 0.6), depending on the precise part of the map. And very few pixel were found with the value 0.1 to 0.2, the lowest values of the scale.

We found areas with high vulnerability value (0.7 to 1) located geographically within natural protected areas (NPAs) in Mexico, as Arrecife Alacranes National Park and Ría Lagartos Biosphere Reserve. However, these NPAs may protect only a small fraction of shark species. Key conservation areas found on this analysis are located mainly on Open Ocean in the GOM. Consequently, it is necessary to incorporate new management tools different from NPAs and offering a real advantage to large, mobile, and migratory species. In addition, it is necessary the incorporation of an appropriate system of catch records at shark species level to make the estimation of demographic trends possible. Although the main strategy for conservation in Mexico rely on NPAs, in marine ecosystems such strategies are underrepresented and the bias is more evident when considering that out of the entire EEZ only 1.38% of the oceanic environments are protected under any decree (Koch 2015).

KEYWORDS: Sharks, Gulf of Mexico, fisheries, IUCN, mapping

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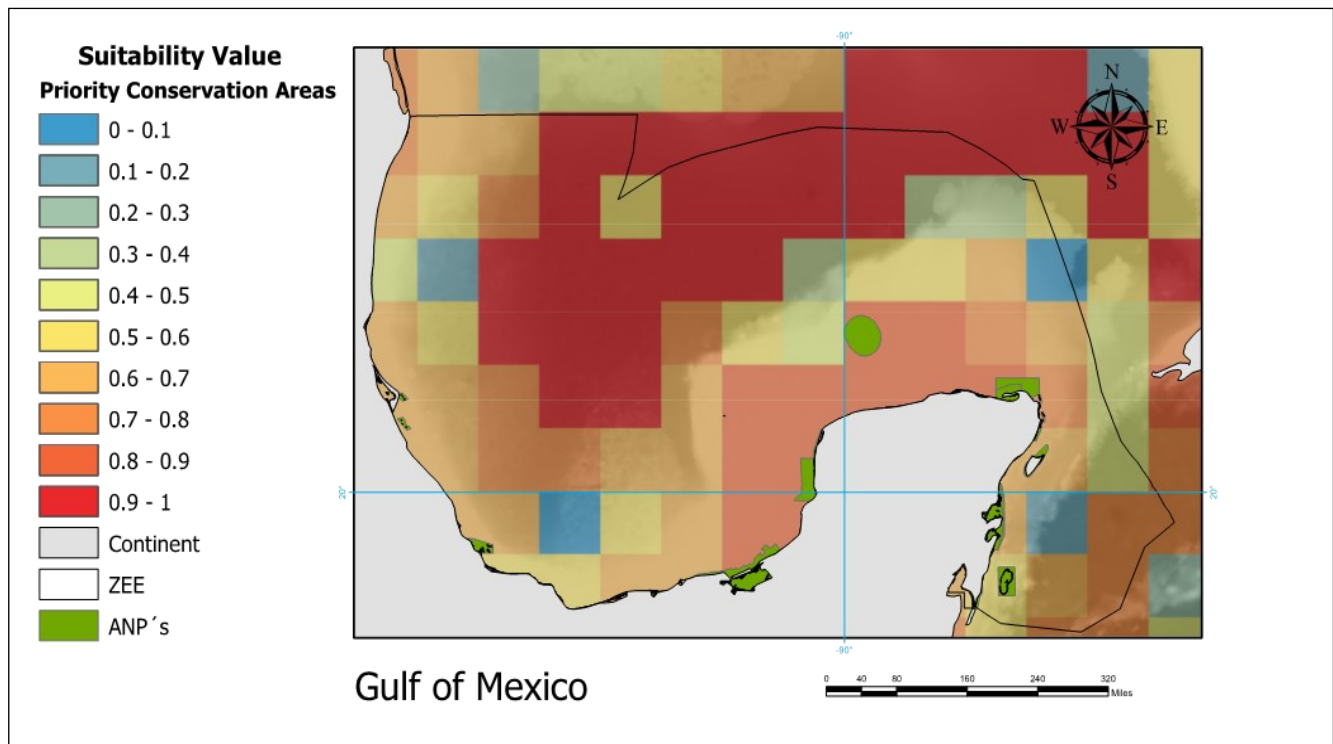

Figure 1. Multi-criterial Index to determinate the key conservation areas for shark species in the Gulf of Mexico.