

Spatial Distribution, Relative Abundance and Size Composition of Reef-associated Sharks on St Eustatius, Saba and the Saba Bank (Caribbean Netherlands)

Distribución Espacial, Abundancia Relativa y Composición por Tamaño de los Tiburones de Arrecife de Santa Eustaquio, Saba y de Saba Bank (Caribe Neerlandés)

Distribution Spatiale, Abondance Relative et Composition de Taille des Requins de Récif de Saint-Eustache, Saba et du Saba Bank (Pays-Bas Caraïbéens)

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EXTENDED ABSTRACT

Introduction

Sharks are as apex predators of major importance for the balance and health of many marine food webs (Baum and Worm 2009, Osgood and Baum 2015) and are therefore also important for human exploitation of these systems (Haas et al. 2017). Recent declines of many shark species have been attributed to a combination of slow reproductive life-history characteristics (Cortés 2000) and high levels of fishing pressure (García et al. 2008). The Caribbean region has traditionally been an area with relatively low fishing intensity (Fitzpatrick and Keegan 2007), but regional non-sustainable fishing activities steeply increased since the 1950s, resulting in a collapse of some coastal ecosystems in the last decades (Dulvy et al. 2014). Despite this major increase in fishing activity, fisheries data on sharks in the Caribbean is sparse or absent for most species, although indications of extensive fishing activities targeting sharks occur (Arocha et al. 2002). After localised extinctions of shark species have been observed (Stallings 2009), some Caribbean regions have established special fisheries legislation to protect sharks (Morgan et al. 2009). The Caribbean Netherlands takes a lead in regional protection of sharks with the recent establishment of a ‘shark sanctuary’ in the EEZ waters surrounding Bonaire and Saba in 2015 and St Eustatius in 2018, in which sharks are protected from fisheries by law. The Nature Policy Plan (2013 - 2017) for the Caribbean Netherlands indicates that shark protection has a high priority. A first step towards effective protection is conducting a base-line survey to determine current shark abundance and developing robust, quantifiable objectives and reference points for conservation and fisheries in order to be able to evaluate the performance of management actions.

Methodologies

The aim of this study was to undertake a base-line survey on the spatial distribution, relative abundance and size composition of reef-associated sharks in St Eustatius, Saba and the Saba Bank, windward islands of the Caribbean Netherlands. The submerged Saba Bank and the islands of Saba and St Eustatius are located in the north-eastern Caribbean and are part of the inner arc of the Lesser Antilles. From 2012 to 2014, 376 sites were surveyed with stereo Baited Remote Underwater Video (sBRUV) deployments. Baited video surveys (sBRUV) are a standardized, non-invasive method to study shark assemblages across broad spatial scales (Cappo *et al.*, 2004). This technique is spreading rapidly in shark research since 2009 (Brooks et al. 2011, Bond et al. 2012, White et al. 2013, Espinoza et al. 2014). Video deployments were manually analysed for shark presence and individual sharks were measured using stereo-video, enabling accurate length measurements. Shark observations per island were indicated in Figure 1. Habitat effects mean probability of occurrence for *G. cirratum*, *C. perezi* and all shark species combined were shown in Figure 2. Mean probability of occurrence was defined as the chance of observing a shark in a 45 min video deployment within 8 m distance of the cameras.

Results

A total of 153 sharks belonging to six species were recorded. Mean probability of observing at least one shark per recording is 0.29. In 4.3% of the video deployments two or more sharks were observed. Nurse shark *Ginglymostoma cirratum* was the most frequently observed species (n = 78) followed by Caribbean reef shark *Carcharhinus perezi* (n = 62), blacktip reef shark *Carcharhinus limbatus* (n = 6), tiger shark *Galeocerda cuvier* (n = 5), great hammerhead shark *Sphyrna mokarran* (n = 1) and silky shark *Carcharhinus falciformis* (n = 1). Significant spatial differences in geographic location were found for abundances of *G. cirratum* and *C. perezi* (Figure 2). Mean probability of observing *G. cirratum* and *C. perezi* on St Eustatius and the Saba Bank was found to be twice as high as compared to Saba. Habitat complexity and depth also had significant effects on total shark abundances. Mean probability of observing a reef-associated shark increased with habitat complexity and decreased with depth. The effect of management zone was not significant. Individuals of *G. cirratum* were significantly larger on the Saba Bank and in sites with low habitat complexity. Despite the observation of

larger individuals of *C. perezii* in deeper waters, no significant effects on mean length were observed.

Discussion

In general, *G. cirratum* is the most commonly observed shark species on reefs in the Caribbean region, most likely because of its limited value for reef fisheries (Ward-Paige *et al.*, 2010). Relative abundance (expressed as mean probability of occurrence in one video observation) of *G. cirratum* varied between 0.11 (Saba) and 0.17 (Saba Bank) and is similar to densities found by Brooks *et al.* (2011) in the Bahamas. Relative abundance of *C. perezii* varied between 0.13 (Saba) and 0.25 (St Eustatius), and is higher than reported in similar sBRUV studies in the Bahamas (Brooks *et al.* 2011) and Belize (Bond *et al.* 2012). A mean relative abundance for the greater-

Caribbean of 0.10 was found by Ward-Paige *et al.* (2010) in a large-scale Underwater Visual Census (UVC) study between 1993 and 2008. This study shows that reef-associated sharks (other than *G. cirratum* and *C. perezii*) are largely absent on the reefs throughout the Caribbean. A possible explanation for high numbers of shark observations compared to other areas in the greater-Caribbean is the lack of destructive industrial-scale fishery practices (directed shark fisheries, shark finning, long-lining and gillnetting) in the Caribbean Netherlands. Ward-Paige *et al.* (2010) revealed that reef-associated sharks occurred mostly in areas with strong fishing regulations in place and without high population density. Judging by total shark abundances, the shark populations of the Saba Bank, Saba and St Eustatius appear to be in reasonably healthy state compared to other areas in the Caribbean. Furthermore, the

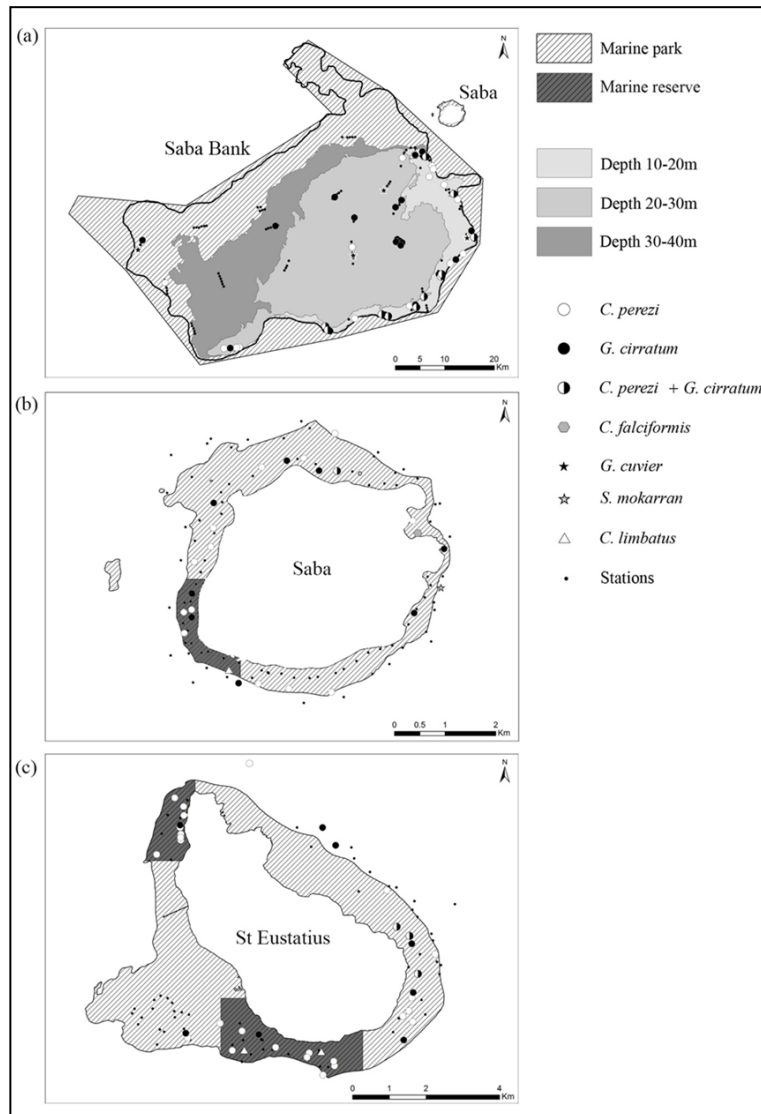


Figure 1. Distribution of sampling stations and sharks over (a) the Saba Bank, (b) Saba and (c) St Eustatius in Caribbean Netherlands.

vast majority of observed sharks were juveniles, indicating that these shallow waters may be used as nursery areas.

KEYWORDS: Elasmobranchs, conservation, *C. perezii*, *G. cirratum*, habitat preference

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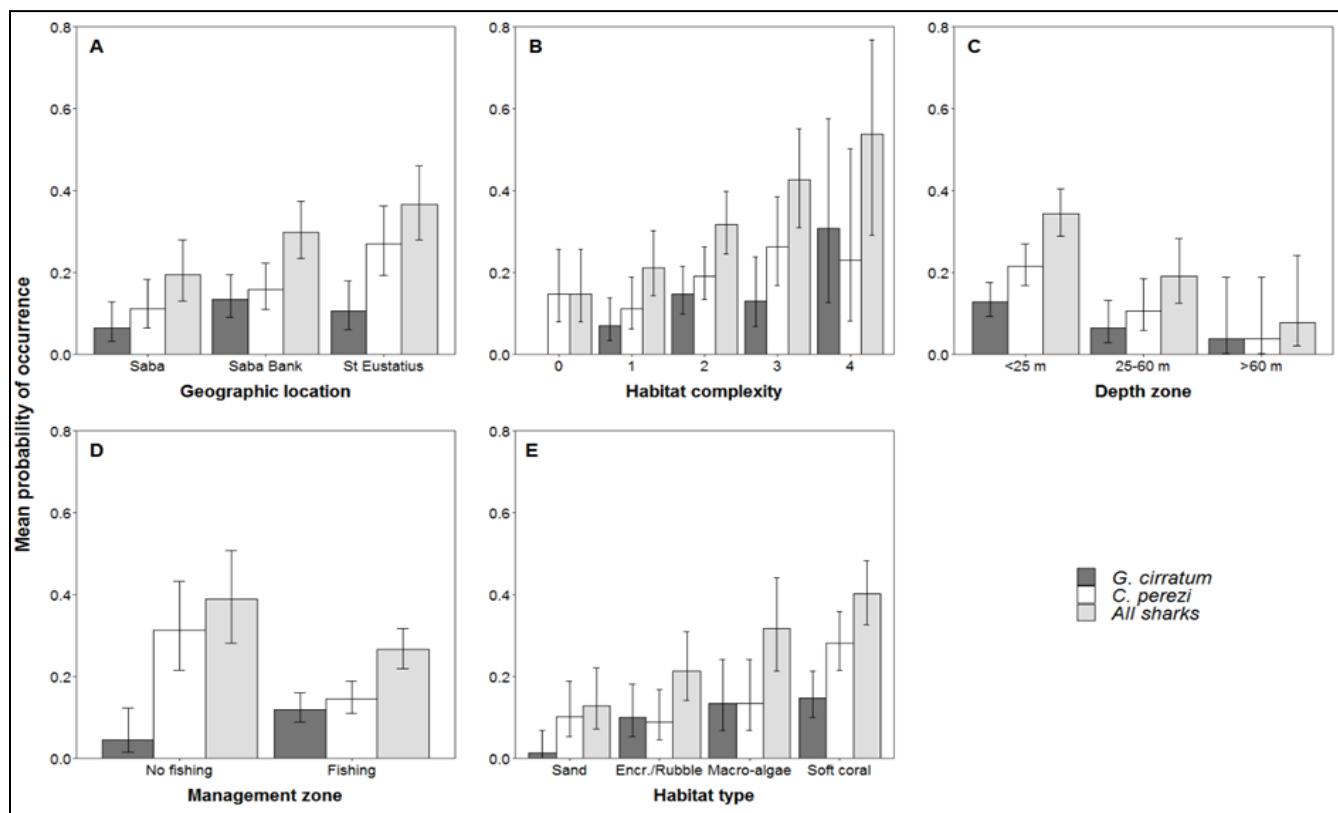


Figure 2. Effects of geographical area (A), habitat complexity (B) and type (D), depth zone (C) and management zone (E) on the mean probability of occurrence of the reef shark species observed in this study. Error bars indicate Confidence Intervals (CI).