

Developing a Shark Management Plan for Bermuda: An Alternative Approach

El Desarrollo de un Plan para la Gestión de los Tiburones en las Bermudas: Un Método Alternativo

Élaboration d'un Plan de Gestion des Requins dans les Bermudes: Une Méthode Alternative

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EXTENDED ABSTRACT

Sharks are in decline globally (Robbins et al. 2006), generating concern at national and international levels. However, management bodies in smaller jurisdictions often lack the resources to carry out comprehensive assessments of the status of local shark populations and their associated fisheries. Here, we present the results of an alternative approach for assessing the shark fishery in Bermuda.

In Bermuda, the Department of Environment and Natural Resources (and its precursors) recognises the importance of monitoring local shark fishing, and has required the submission of weighed landings data for key species of shark since 1987. However, many species are reported under 'miscellaneous other sharks' and, even for species that are reported individually, the numbers of individual fish caught may not be reported. Further, there are no data on the age of sharks caught or the fishing methods used. Importantly, in the absence of useful data on fishing effort, the landings data that are available are difficult to interpret as it is unclear if the declining trends in landing reflect the decline of shark populations in Bermuda waters, or if these declines reflect a change in shark fishing practices or effort.

The 16 species sharks known to be found in Bermudian waters are afforded some protection under Bermudian law. This protection includes: the prohibition on removing the fins from a shark at sea under the Fisheries Act 1972, protection of the Whale shark (*Rhincodon typus*) under the Protected Species Order 2012, in accordance with sections 5 and 5A of the Protected Species Act 2003, requirement for a licence for vertical and longlines with more than five hooks, and a permit for the use of multi-hook lines deployed to specifically target sharks. Additionally, limited protection for sharks may further be derived from the establishment of 29 permanent marine protected areas and two seasonally protected areas established in accordance the Fisheries Act 1972.

However, there are still significant gaps in knowledge as to the status of shark populations and other areas of Bermudian shark biology, including biodiversity and fishing practices in Bermudian waters. It was therefore recognised that a National Plan of Action needed to be developed to enhance monitoring and protection of species potentially vulnerable to fishing pressures.

Despite the gaps in formally collected data, Bermuda has a richness of local knowledge, with families having fished the same areas for generations. This study therefore presented an opportunity to open dialogue with the local fishers on the topic of shark management, as well as to gain insight into the current shark fishing practices and perceptions of population trends. In this study, in association with the Bermuda Government's Department of Environment and Natural Resources, we combined published data on shark trends and susceptibility to fishing with semi-structured interviews. This study aimed to answer five main questions:

- i) What species of shark are caught in Bermudian waters?
- ii) Which fishing gears are used to target shark or catch shark as bycatch in Bermudian waters?
- iii) What are the end uses of shark landed in Bermudian waters?
- iv) What is the vulnerability to overfishing of each of the different sharks in Bermudian waters?
- v) How do the local resource users perceive changes in shark population and requirements for different management schemes?

We conducted semi-structured interviews (Daw et al. 2011) with 31 shark fishing stakeholders (26 fishers and five conservationists) to examine current fishing and marketing practices. The interview results were analysed using semi-quantitative and qualitative methods. Additionally, to identify any species that are particularly vulnerable to overfishing, the rebound potential of the shark species known from Bermuda waters was calculated by applying a derived Euler-Lotka equation to published life history data (Smith et al. 1998, Márquez-Farías and Rosales-Juárez 2013). The fisheries landings data for the past 40 years were collated, and then examined in the context of the new information.

Our interviews recorded that 10 of the 16 shark species known to inhabit Bermudian waters were subject to some form of fishing pressure, and that the most commonly reported and most lucrative end use was the production of shark hash from Galapagos Shark (*Carcharhinus galapagensis*) pups, a popular local dish associated with important cultural events. Details also emerged about a marketing initiative that led to a brief spike in the targeting and landing of sharks, particularly larger Galapagos Sharks, in the late 1980s. We assessed species-specific vulnerability to gear types used in Bermudian waters, identifying six gears regularly used for shark fishing. Of these, rod and reel fishing was the most commonly reported, and is currently a gear type without shark-specific regulations. We were also able to map the pupping locations of the Galapagos Shark, and collect the first data on pupping of Tiger Sharks (*Galeocerdo cuvier*) in Bermudian waters. Additionally, the study highlighted the presence of several species not currently on the recognised species list for Bermuda.

In questions about the perceived status of local shark populations, the most common response from those surveyed was that shark populations around Bermuda have declined in the past 30 years. However, of the frequent shark fishers, only a minority believed additional management of sharks was necessary, because of a perception that local fishing has a negligible effect on shark populations.

The rebound potential of the shark species known from Bermuda waters was calculated by applying a derived Euler-Lotka equation to published life history data. Of the commonly caught shark species, this analysis identified the Short Fin Mako (*Isurus oxyrinchus*) as particularly susceptible to overfishing. However, we found this broad analysis is extremely sensitive to gaps in reliable data. Therefore, given the paucity of life history data on many of the Gulf and Caribbean shark species, and the remarkable phenotypic plasticity (Branstetter et al. 1987) displayed by sharks across their range, results from this type of analysis must be interpreted with caution. This generalised metric, along with international management recommendations from entities such as the International Union for Conservation of Nature (IUCN), the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on the Conservation of Migratory Species of Wild Animals (CMS), was combined with the stakeholder-derived data to develop a management plan for sharks in Bermuda waters.

This study highlights the importance of engaging resource users when developing management plans and demonstrates how their input may be used to evaluate exploited populations. This approach may be useful for gathering information from other data-poor small scale fisheries to assist with the development of management plans.

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