A Framework for Designing Marine Protected Areas for Sharks and Rays in Mozambique

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Photo: Kin Cheung/AP

ENVIRONMENTAL PROBLEM

Worldwide, shark and ray populations are under increasing threat of extinction. Since the 1970s, global abundance of sharks and rays has declined by 71% due to overfishing, habitat destruction, and the shark-fin trade. This rapid decline in shark and ray populations has far-reaching consequences for marine ecosystems as these apex predators help regulate and maintain the balance of marine food webs. The loss of these important species could dramatically impact the livelihoods of the millions of fishers around the globe who depend on the ecosystem services that these important species provide.

PROJECT SIGNIFICANCE

Mozambique is a global hotspot for shark and ray species richness, endemism, and evolutionary distinctiveness, with over 146 different species identified to date. With a coastline spanning more than 2,770 km, Mozambique is home to millions of people that are dependent on marine resources for their livelihoods. Artisanal fisheries and industrial fleets impose extensive fishing pressure on sharks and rays throughout the region. An estimated 37% of shark and ray species found in Mozambique are considered threatened with extinction according to the IUCN Red List (IUCN 2020) due to overexploitation from fisheries.

Marine protected areas (MPAs) that prohibit the fishing of sharks and rays can serve as a vital tool in conserving these important marine predators. Despite having the highest diversity of sharks and rays in the Western Indian Ocean, Mozambique has no MPAs specifically aimed at protecting these species.

The government is currently working with Wildlife Conservation Society (WCS) to improve the management of sharks and rays. They are developing a National Plan of Action for shark and ray conservation, as well designing an expanded network of marine protected areas, with a goal of protecting 30% of the Mozambique exclusive economic zone (EEZ). While the MPA planning process will identify priority areas for general marine conservation, our project focuses specifically on sharks and rays, and aims to bring scientific rigor to designing reserves for these species.

Here, we lay out the framework of our spatial prioritization that identified key areas to protect based on shark and ray distribution, critical habitats, and known fishing pressure. The results from our model will identify important areas for shark and ray conservation and can help inform how to incorporate these species needs into the ongoing MPA planning process.

PROJECT OBJECTIVES

The goal of this project is to ensure the long-term persistence of sharks and rays in Mozambique through an expanded MPA network. To achieve this goal, we identified priority areas to protect the most at-risk shark and ray species using a systematic spatial prioritization that considered different types of fishing pressure to pinpoint areas where conservation efforts should be targeted.

APPROACH

To provide recommendations to WCS and the Mozambique government on location of a network of marine protected areas for sharks and rays, we used a spatial prioritization to identify priority areas to protect for the most at-risk shark and ray species within Mozambique's EEZ. When designing a network of MPAs for specific species, ecological factors, such as habitat and species range, are important characteristics to consider. However, long-term success of MPAs also depends on a number of other factors such as community engagement and buy-in, governance, and enforcement.

Our approach included the following key phases:

Identify the most at-risk species, critical habitats, and aggregation sites

- 16 sharks and 11 rays that are the most in need of improved management based on their conservation status and how highly they are targeted
- 5 critical habitats including coral reefs, mangroves, seagrass, seamounts, and knolls
- 3 known aggregation sites

Determine threats & stakeholders

- Sharks & rays are caught intentionally or as bycatch in all fisheries in Mozambique
- Over 9.5 million pounds of sharks were reported harvested in Mozambique in 2018, with many more million pounds likely unreported

Create a spatial prioritization model to systematically rank priority areas

- Used species range maps and critical habitats as conservation features and set representation targets for each feature
- Created five different fishing pressure layers, to explore how reserve design changed depending on which fisheries were included and whether the goal was to avoid conflict with fishers or target areas with high fishing pressure

RESULTS

To analyze optimal reserve designs, we conducted several sensitivity analyses to determine appropriate parameters, including whether to lock existing MPAs, Key Biodiversity Areas, and aggregation sites into the design. In addition, we tested various boundary penalty values, that impact design fragmentation, as well as a range of conservation targets. The following results show MPA network designs that cover 20% of the Mozambique EEZ and include at a minimum 20% of each species' distribution, 20% coverage of each critical habitat, and the four existing MPAs.

Photo: Mako – Steve De Neef

Baseline Scenario

A network of MPAs that would protect important areas for sharks and rays based on the probability of their distribution and location of suitable habitats, without any consideration of stakeholders or fishing pressure.

Minimize Impact on Fishers

A network of MPAs that would protect the important areas for sharks and rays that do not overlap with areas of high fishing pressure, thus keeping the best fishing grounds open and minimizing the impact these MPAs would have on fishers.

Maximize Protection

A network of MPAs that would protect the important areas for sharks and rays and also prioritize areas where fishing pressure is highest. Given that fishing is the greatest threat to sharks and rays, this scenario would provide maximum conservation benefits.
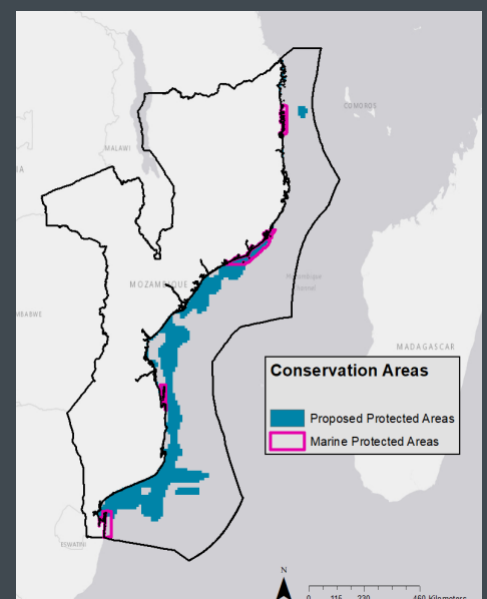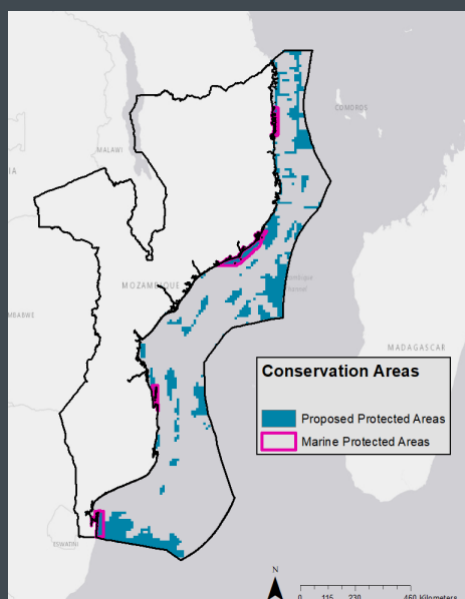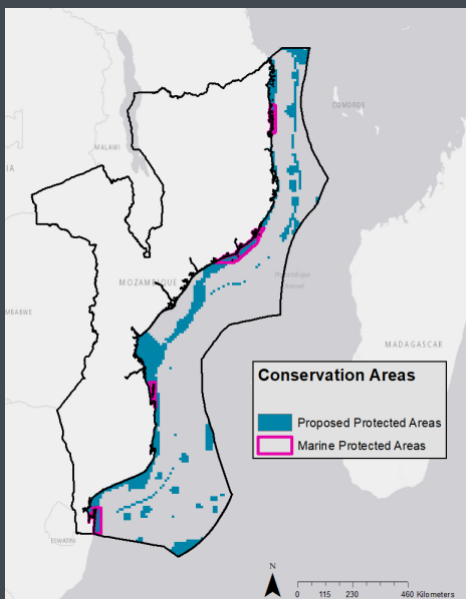
IMPACTS & CONCLUSIONS

Well-designed MPAs can play a key role in conserving sharks and rays around the globe

- For MPAs to be successful they require carefully planned objectives, buy-in from local communities, and strong enforcement.

Our model can assist with identifying locations that are critical for shark and ray conservation

- This project will help improve marine conservation in Mozambique by contributing to WCS's ongoing efforts to design an expanded MPA network and develop a National Plan of Action for sharks and rays.

Additional data can be incorporated into our reproducible model as it becomes available in the future

- Sharks and rays have existed for over 400 million years, yet there are still many unknowns surrounding species biology, ecology, and movement.

Our model will contribute to a larger, ongoing conservation effort: development of a multi-national MPA network in the Western Indian Ocean

- Since sharks and rays are highly migratory it is important to coordinate conservation efforts internationally.

- This model can bring additional scientific rigor to the MPA planning process.

ACKNOWLEDGEMENTS