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Project PAE2022-MPA1: Protocols to designate and evaluate MPAs in the SIOFA Area

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Abstract	

The main goal of this project was to provide options for a protocol of designation and monitoring of currently existing as well as new marine protected areas (MPAs) under SIOFA's jurisdiction. Five tasks were completed: (1) reviewing SIOFA's and other regional management organization reports and the general scientific literature, (2) reviewing SIOFA historical databases, (3) implementing spatial statistical methods for evaluating and monitoring MPAs, (4) developing options to optimise the acquisition of new relevant data, and (5) developing options for protocols for designating new MPAs.

Two SIOFA reports, from 2017 and 2019, deal with principles and protocols for MPAs, and these largely agree with those of other regional organizations and with findings in the exponentially growing scientific literature on MPAs.

Two SIOFA databases relevant to designate and monitor MPAs (catch-effort and observers) revealed that there are sufficient data to conduct advanced spatial analysis with statistical models for both, designation and monitoring of MPAs. These databases need further editing and curating to correct wrong records and the addition of variables: (a) a fishing haul identifier to cross-reference catch-effort and observers databases and (b) environmental variables of (i) particular

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fishing hauls (depth, water temperature, weather) and (ii) open-access databases (sea surface temperature, chlorophyll-a).

For designation and monitoring of MPAs we demonstrated two statistical methodologies applied to catch-effort and observers databases: the Species Archetype Model (SAM) and Spatial Generalized Linear Models (SGLM). SAM conducts simultaneous analysis of all species and their connection with environmental covariates while SGLM involve first selecting a group of species of interest and then building the spatial distribution. Both methods yielded consistent results, indicating the existence of two hot spots of diversity south of Madagascar.

We reviewed protocols for the designation of MPAs from the IUCN, USA, European Union and Australia, finding that IUCN protocol is the de facto standard, and it offers flexibility in the degree of protection. Current SIOFA protocol for the designation of MPAs follows similar principles as the IUCN protocol.

We advise continued use of SIOFA's MPAs protocol, reinforced with the statistical methodologies SAM and SGLM, for quantitative delimitation of boundaries of new MPAs and continued monitoring of currently existing MPAs.

Recommendations

The authors of the report recommend that:

- 1. The most recent and commonly used definition of MPA internationally is that provided by the International Union for Conservation of Nature (IUCN): a clearly defined geo-graphical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values.

- 2. The area of the Southern Indian Ocean Fisheries Agreement (SIOFA) covers the open ocean/high seas between eastern Africa and Western Australia and therefore, the methods for designating, monitoring, and evaluating the MPAs in the open ocean/high seas are directly relevant to this project.

- 3. The SIOFA advice to monitor protected areas can be summarized by the following practices: (1) Vessel Monitoring System (VMS) to track the location of the fishing vessel, (2) log-book systems to record the presence of targeted organisms in the monitoring program, and (3) on-board observer programs to record targeted organisms in the monitoring program from the fisheries catch and collect other required information.

- 4. Scientific papers related to MPAs have increased steadily in numbers, currently producing about 500 studies each year. The term "design" is the keyword with the highest appearance in the scientific studies related to MPA, followed by the term "monitor" and "success".

- 5. SIOFA databases appear sufficient to conduct quantitative spatial analysis leading to the spatial definition, evaluation and monitoring of MPAs thereof, although the currently existing databases need inclusion of a few additional variables and improvements in data quality and completeness.

- 6. Bioregions are the fundamental concept underpinning the definitions of marine protected areas and there are recent methodological advances to define bioregions.

- 7. Species Archetype Model for block data in the Observer database and Spatial Generalized Linear Models for point data are two recent statistical methods for the evaluation and monitoring of MPAs. Both these methods were applied yielding new insights into benthic and demersal species assemblages.

- 8. Two hot-spots of organisms of special interest were mapped south of Madagascar.

- 9. The IUCN protocol for designation of MPAs is referenced as a standard in some countries with advanced marine management and it offers flexibility for gradual implementation.