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BRIEF PRESENTATION OF THE PORTUGUESE RESEARCH PLAN FOR THE IMPROVEMENT OF KNOWLEDGE ON PELAGIC SHARKS CAUGHT IN THE SWORDFISH FISHERY IN THE INDIAN OCEAN

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SUMMARY

Portuguese longliners targeting swordfish and operating in the Indian Ocean regularly capture elasmobranch fishes as bycatch. Of those, the blue shark (*Prionace glauca*) and the shortfin mako (*Isurus oxyrinchus*) constitute the two main shark species captured, even though several other species are also occasionally captured. IPMA, the *Portuguese Sea and Atmospheric Institute*, is responsible for the National Data Collection Program, which maintains fishery observers on those vessels to collect data and samples. Therefore, IPMA has currently the means and opportunity to collect a wide variety of biological samples that are of ultimate importance to the work of the IOCT scientific commission. In this report we present the current Portuguese program research on sharks in the Indian Ocean, and propose the research plans for the near future (over the next 5 years), following IOTC Resolution 13/06.

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1. Introduction

Elasmobranchs (sharks, skates and rays) catches in recent years have increased significantly (Barker & Schluessel, 2005), mainly due to an increased demand for shark products (namely shark fins for Asian markets), but also as the result of by-catch from other fisheries (Stevens *et al.*, 2000). However, the information on these species life history, population parameters and migrations is still very limited (Fowler *et al.*, 2005). Elasmobranchs are generally known for having K-strategy life cycles, characterized by slow growth rates and long lives, and reduced reproductive potential with few offspring and late maturity. These characteristics make these fishes extremely vulnerable to fishing pressure, with overexploitation occurring even at relatively low levels of fishing mortality (Smith *et al.*, 1998). Once these populations start to decline, it can take several decades before recovery can take place (Stevens *et al.*, 2000).

A great variety of sharks species are found within the IOTC Convention area, from coastal to oceanic species. Among these, several pelagic shark species are currently present in the IOTC databases and are currently impacted by commercial and recreational fisheries. However, there is still limited information about their life cycles, biological parameters, movement patterns and habitat utilization, and in the general impact of tuna fisheries in their populations in the IOTC Convention area. Therefore, the current knowledge on IOTC fisheries capturing sharks is causing concerns on their conservation status and management, due to the gaps in the available catch, effort and discard data. Thus, as recognized by the WPEB, poor shark fisheries data quality (and quantity) and biological knowledge gaps are limiting factors affecting the provision of the scientific advice to the Commission. Moreover, the efficiency of some recent management regulations implemented is still to be assessed.

Therefore, recently EU-Portugal has started a data collection and research program for its pelagic longline fishery, which as the pelagic sharks as a major component. Following IOTC Resolution 13/06 (*on a scientific and management framework on the conservation of shark species caught in association with IOTC managed fisheries*), what follows is a brief description of the research actions being carried out and plans for the near future regarding pelagic sharks caught on the Portuguese longline fishery.

2. Objectives

The general aim of the pelagic shark component of this research program is to promote advances in the current knowledge on these species caught by the Portuguese longline fishery within the swordfish longline fishery in the Indian Ocean.

The specific objectives cover a wide range of issues, including biological, ecological and gear technology aspects. These studies will run in parallel with similar studies in the Atlantic Ocean.

2.1. Life history and population dynamics of major shark species

Specific objectives of this task are to estimate population parameters in terms of:

1) Age and growth;

2) Reproduction;

3) Mortality and demographic analysis.

Ageing the sharks and modelling the growth of the populations will be accomplished by processing hard-structures of the specimens, specifically vertebrae. To accomplish this, a section of 8-10 vertebrae will be removed from selected specimen, frozen onboard the fishing vessels and then transported frozen to IPMA laboratory (Algarve, southern Portugal). Once in the laboratory, the vertebrae will be processed using age and growth protocols for elasmobranchs (Cailliet, 1990). Within this task we expect to be able to model the growth of the

populations (e.g. using von Bertalanffy growth models), and estimate parameters that can then be used in stock assessment models.

For the reproduction component of the study the data will be recorded by onboard fishery observers. Specifically, data on the maturity stages, fecundity, seasonality and sex-ratio of the embryos will be recorded and used for the analysis. This data is relevant for understanding not only the spatial-temporal dynamics of the populations, but it also allows the estimation of some parameters that can be used in population dynamics models, such as Leslie matrices that can use age/stage specific fecundities.

Mortality parameters (Simpfendorfer *et al.*, 2004) and demographic models (Cortés, 1998) that rely mostly on biological data will be carried out on those shark populations. Those models will allow the estimation of important population dynamics parameters such as intrinsic rates of population increase and population doubling times. Those models will also allow the determination of the current trends of these populations (stable, decreasing or increasing), and simulate different population responses within the framework of different fisheries scenarios.

2.2. Tagging studies

The tagging component of this project will have three main objectives:

1) Determine migration patterns along the Southwest Indian Ocean, assessing possible critical habitats such as mating and nursery areas;

2) Study habitat preferences in terms of depth and temperature;

3) Determine survivorship of sharks discarded alive.

ARGOS compatible Popup Archival Transmitting tags (PAT) will be deployed on selected shark species. These tags are particularly suitable to track large-scale movements and behaviour of large marine species, and will be programmed to stay with the sharks for periods of 30 to 210 days.

The obtained information will provide insights on migratory patterns and habitat utilization of those species in the Indian Ocean, as well as on the existence of possible critical habitat areas, such as mating and nursery areas.

Other main objective of this task is to determine the survivorship of sharks once released from the commercial fishing vessels. Within the scope of IOTC fisheries all thresher sharks (Family Alopiidae) should be released (IOTC Resolution 12/09) and such measures might be extended to other species. However, the question on what happens to the sharks once discarded still remains unanswered and the fact that a specimen is discarded alive does not necessarily means that it will survive the trauma of the fishing process. Therefore, calculating those long-term survival rates is extremely important not only to assess the efficiency of such management measures, but also to be used within the assessment models.

2.3. Genetic studies

The tagging component of this project will have three main objectives:

1) Identify the quantity and geographical distribution of mitochondrial DNA haplotypes of the various species in the Indian Ocean;

2) Establish a phylogenetic relationship between the different populations and;

3) Provide guidance on the geographical boundaries of the different populations/stocks for purposes of fisheries management and conservation initiatives.

For the population analysis based on mitochondrial DNA sequences and microsatellite markers, muscle and/or fin clips will be collected from selected species caught during the fisheries and

stored in 95% ethanol. The samples will then be sent to the Laboratory of Biology and Fish Genetics in the State University of São Paulo, Brazil (UNESP), where our collaborative research partners will be responsible for processing the samples and analyzing the data.

The information gathered from this component of the study will be extremely important for inferring the genetic diversity within the species across the Indian Ocean and will provide insights on the structure of the populations. This is very important as the establishment of biological meaningful fishing stocks is essential for a correct management of the fisheries.

2.4. Gear technology studies

The gear technology study aims to assess the impact of the use of wire traces on the pelagic longline gear (swordfish fishery). This will be done by comparing the catch rates and haulback (on vessel) mortality, from traditional monofilament traces to those obtained with wire traces.

3. Samples collection and experimental fishing

Taking into consideration the results of the Ecological Risk Assessment presented to the WPEB in 2012 (Murua et al., 2012), we will give priority to those species ranked on the top 10. Therefore, and because sample collection is limited to those fishing trips where a scientific observer is present onboard, the program is expected to run for at least 5 consecutive years.

Samples for estimating the life history parameters and genetics will be collected within the scope of the "European Data Collection Framework", ongoing at the IPMA in Portugal. Within this program we are currently capable of maintaining fishery observers' onboard commercial longliners for 90-100 days per year, covering a wide geographical area in the southwest Indian Ocean. Preliminary catch data gathered within this program during 2011 and 2012 resulted in the catch of 11 sharks species, most of which consisting of blue shark (*Prionace glauca*, BSH) and shortfin mako (*Isurus oxyrinchus*, SMA). Other species accidentally caught included silky shark (*Carcharhinus falciformis*, FAL), smooth hammerhead (*Sphyrna zygaena*, SPZ), bigeye thresher (*Alopias superciliosus*, BTH) and crocodile shark (*Pseudocarcharias kamoharai*, PSK). At a much lower level were also caught longfin mako (*Isurus paucus*, LMA), oceanic whitetip (*Carcharhinus longimanus*, OCS), porbeagle (*Lamna nasus*, POR), tiger (*Galeocerdo cuvier*, TIG) and scalloped hammerhead (*Sphyrna lewini*, SPL).

Funding is already available to tag 20 shortfin mako sharks (possibly during 2014) with PSAT. On the other hand, funding is also guarantee to develop experimental fishing (comparison monofilament *vs.* wire traces) during a 3-4 month trip, which shall start in October 2013.

4. Reporting

On an annual basis EU-Portugal commits to report to the WPEB and the Scientific Committee the activities carried out during the previous year and the results achieved within the scope of this research program.

5. References

Barker, M. J., Schluessel, V., 2005. Managing global shark fisheries: suggestions for prioritizing management strategies. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 15: 325–347.

Cailliet, G.M., 1990. Elasmobranch age determination and verification: an updated review. In: Pratt, H.L., Gruber, S.H. & Taniuchi, T. (Eds.), Elasmobranchs as living resources: advances in the biology, ecology, systematics, and the status of the fisheries. US Department of Commerce, pp. 157-165.

Cortés, E., 1998. Demographic analysis as an aid in shark stock assessment and management. *Fisheries Research*, 39: 199-208.

Fowler, S.L., Cavanagh, R.D., Camhi, M., Burgess, G.H., Cailliet, G.M., Fordham, S.V., Simpfendorfer, C.A., Musick, J.A., 2005. Sharks, rays and chimaeras: the status of the chondrichthyan fishes. Gland, Switzerland and Cambridge, IUCN Shark Specialist Group: 462 pp.

Murua, H., Coelho, R., Santos, M.N., Arrizabalaga, H., Yokawa, K., Romanov, E., Zhu, J.F., Kim, Z.G., Bach, P., Chavance, P., Delgado de Molina, A., Ruiz, J. 2012. Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC). IOTC-2012-WPEB-31: 16p.

Simpfendorfer, C.A., Bonfil, R., Latour, R.J., 2004. Mortality estimation. In: Musick, J.A. & Bonfil, R. (Eds.), Elasmobranch fisheries management techniques. Asia-Pacific Economic Cooperation, Singapore, pp. 165-186.

Smith, S. E., Au, D. W., Show, C., 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. *Marine and Freshwater Research*, 49: 663-678.

Stevens, J. D., Bonfil, R., Dulvy, N. K., Walker, P. A., 2000. The effects of fishing on sharks, rays, and chimaeras (chondrichthyans), and the implications for marine ecosystems. *ICES Journal of Marine Science*, 57: 476-494.