A GENERAL OVERVIEW OF THE PORTUGUESE PELAGIC SHARKS RESEARCH PROGRAM IN THE ATLANTIC OCEAN

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SUMMARY

*Portuguese longliners targeting swordfish and operating in the Atlantic Ocean regularly capture elasmobranchs as bycatch. Of those, the blue shark (Prionace glauca) and the shortfin mako shark (*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, deploying fishery observers on longline vessels to collect fisheries 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 SCRS, particularly the sharks working group. In this document we present the current Portuguese pelagic sharks research program for the Atlantic Ocean, and provide details regarding the collection of shark samples for the near future (over the next 5 years) as per ICCAT Recommendation 13-10.*

RÉSUMÉ

Les palangriers portugais ciblant l'espadon et opérant dans l'océan Atlantique capturent régulièrement des élasmobranches comme prises accessoires. Parmi ceux-ci, le requin peau bleue (Prionace glauca) *et le requin-taupe bleu* (Isurus oxyrinchus) *constituent les deux principales espèces de requins capturées, même si plusieurs autres espèces sont aussi occasionnellement capturées. IPMA, l'Institut portugais de la mer et de l'atmosphère, est responsable du Programme national de collecte des données et déploie des observateurs des pêcheries sur les palangriers afin de recueillir des données sur les pêcheries et prélever des échantillons. Par conséquent, IPMA a actuellement les moyens et la possibilité de prélever une gamme variée d'échantillons biologiques qui sont d'une extrême importance pour les travaux du SCRS, notamment le Groupe d'espèces sur les requins. Ce document présente le programme de recherche actuel portugais sur les requins pélagiques pour l'océan Atlantique et fournit des informations détaillées sur la collecte d'échantillons de requins pour l'avenir proche (au cours de ces cinq prochaines années) conformément à la Recommandation 13-10 de l'ICCAT.*

RESUMEN

*Los palangreros portugueses que dirigen su actividad al pez espada y que operan en el océano Atlántico suelen capturar regularmente peces elasmobranquios como captura fortuita. De ellos, la tintorera (*Prionace glauca*) y el marrajo dientuso (*Isurus oxyrinchus*) son las dos principales especies de tiburones capturadas, aunque ocasionalmente se capturan también otras especies. El IPMA, el Instituto portugués del mar y la atmósfera, es el responsable del Programa nacional de recopilación de datos y asigna observadores en los palangreros para recopilar datos y muestras de las pesquerías. Por ello, el IPMA cuenta actualmente con la oportunidad y los medios para recoger una amplia variedad de muestras biológicas que son de gran importancia para el trabajo del SCRS, especialmente para el Grupo de especies de tiburones. En este documento, se presenta el programa portugués de investigación sobre tiburones pelágicos en el Atlántico y se presentan detalles sobre la recopilación de muestras de tiburones para el futuro cercano (en los próximos 5 años) de acuerdo con la Recomendación 13-10 de ICCAT.*

KEYWORDS

Shark life history, Genetics, Tagging, Migrations, Longline gear selectivity, By-catch mitigation

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).

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A great variety of sharks species are found within the ICCAT Convention area, from coastal to oceanic species. Among these, several pelagic shark species are currently present in the ICCAT 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 ICCAT Convention area. Therefore, the current knowledge on ICCAT 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 Sharks Working Group, 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, in the early 2000's EU-Portugal started a data collection and research program for its pelagic longline fishery, which as the pelagic sharks as a major component. What follows is a brief description of the research actions being carried out and plans for the near future (2015-2019) regarding pelagic sharks caught on the Portuguese longline fishery. Following ICCAT Recommendation 13-10 (Recommendation on biological sampling of prohibited shark species by scientific observers), detailed information is provided regarding the request for sampling three of those currently prohibited species.

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 Atlantic Ocean.

The specific objectives cover a wide range of issues, including biological, ecological and gear technology (mitigation) aspects. These studies will run in parallel with similar studies in the Indian Ocean, and often within the scope of the SCRS Sharks Working Group cooperative research initiatives involving research Institutes from other ICCAT Contracting Parties.

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. Ideally 10-15 samples per sex and 10 cm size classes will be collected for each shark species. 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 Equatorial and Northeastern tropical Atlantic 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 behavior 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 Atlantic 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. In fact, the question on what happens to the sharks once discarded still remains unanswered for most species 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 genetic component of this project will have three main objectives:

1. Identify the quantity and geographical distribution of mitochondrial DNA haplotypes of various shark species in the Atlantic Ocean;
2. Develop microsatellite *loci* using next generation sequencing techniques;
3. Establish a phylogenetic relationship between the different populations and;
4. 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 fishing operations and stored in 95% ethanol. The samples will then be sent to the Laboratory of Biology and Fish Genetics in the Federal University of São Paulo, Brazil (UNIFESP), 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 Atlantic 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 investigate mitigation measures for shark bycatch, specifically assessing the impact of the use of wire traces on the Portuguese pelagic longline swordfish fishery. This will be done by comparing the catch rates of target and bycatch species and at-haulback (on vessel) shark mortality, from traditional monofilament traces to those obtained with wire traces and using different bait type (squid *vs.* mackerel).

3. Samples collection and experimental fishing

Taking into consideration the results of the Ecological Risk Assessment recently conducted by the Sharks Working Group of the SCRS, we will give priority to 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. **Figure 1** shows the major geographical areas of activity of the Portuguese pelagic longline fleet

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 trips of 20-90 days per year, covering a wide geographical area in the Atlantic Ocean, particularly on the Northern Hemisphere. Preliminary catch data gathered within this program during 2011 and 2012 resulted in the catch of 15 shark species. The most frequently species caught consisting of blue shark (*Prionace glauca*, BSH) and shortfin mako (*Isurus oxyrinchus*, SMA). Other species accidentally caught included bigeye thresher (*Alopias superciliosus*, BTH), oceanic whitetip (*Carcharhinus longimanus*, OCS), smooth hammerhead (*Sphyrna zygaena*, silky shark (*C. falciformis*, FAL), SPZ) and crocodile shark (*Pseudocarcharias kamoharai*, PSK). At a much lower level were also caught longfin mako (*I. paucus*, LMA), porbeagle (*Lamna nasus*, POR) and tiger (*Galeocerdo cuvier*, TIG).

Funding for biological sampling is already guaranteed until 2016. Further, funding is also available to tag 10 shortfin mako sharks (possibly during the 2nd semester of 2014) with PSAT, and to develop additional experimental fishing (comparison monofilament vs. wire traces) during a 2-3 month trip.

4. Number of samples to collect and chronogram

Based on the already available samples, **Table 1** details the number of samples expected to be necessary to collect by area within the course of the project. **Figure 2** details the chronogram of the sample collection, analysis and reporting, although this shall be revised on an annual basis depending on the success of sampling.

5. Reporting

On an annual basis EU-Portugal commits to report to the SCRS on the activities carried out during the previous year and to present the results achieved within the scope of this research program, as per ICCAT Recommendation 13-10.

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Table 1. Detailed number of samples expected to be collected within the course of the project (2015-2019). In brackets the existing number of samples (as by July, 2014).

Species	Currently prohibited in ICCAT	North Atlantic		South Atlantic	
		Vertebrae	Genetic tissues ($1cm^2$ of muscle)	Vertebrae	Genetic tissues ($1cm^2$ of muscle)
BSH	No	215 (785)	300 (200)	900 (155)	400 (100)
SMA	No	430 (80)	320 (80)	410 (90)	310 (90)
LMA	No	315 (85)	320 (80)	365 (35)	365 (35)
OCS	Yes	250 (150)	300 (100)	290 (110)	300 (100)
SPZ	Yes	270 (130)	320 (80)	215 (185)	320 (80)
FAL	Yes	350 (50)	360 (40)	390 (10)	390 (10)

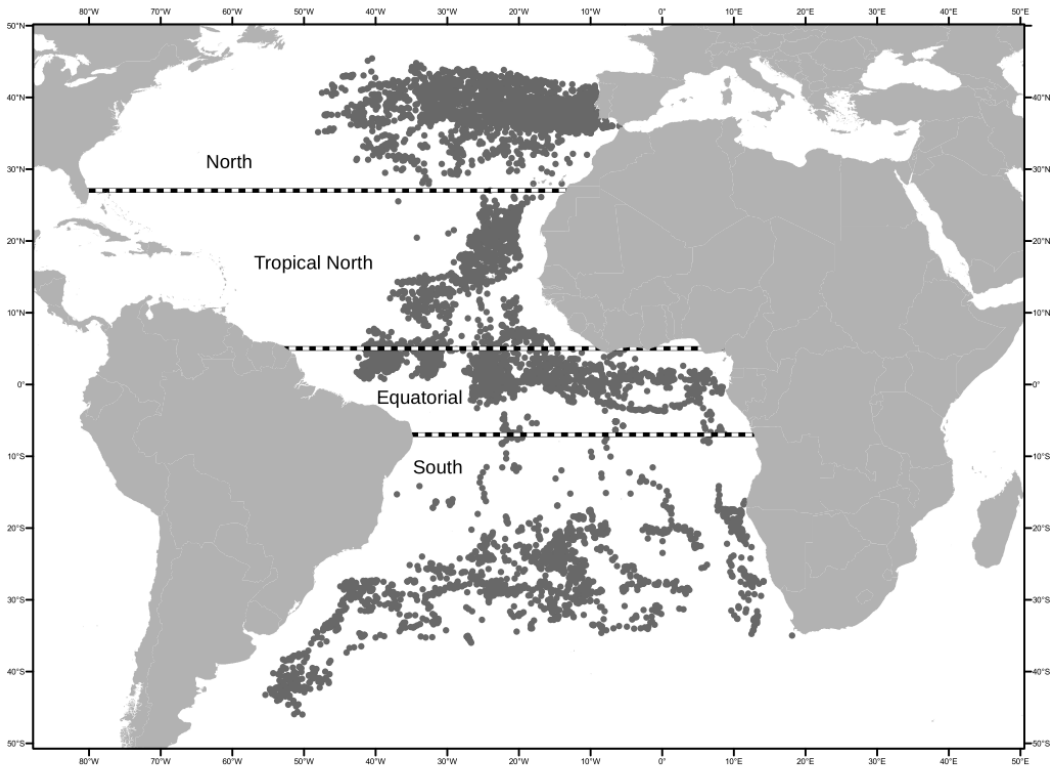

Figure 1. Major areas of activity of the Portuguese pelagic longline fleet in the Atlantic Ocean. Dots represent the geographical position of the fishing sets where fisheries data and samples have been collected since the beginning of the project (and as by July, 2014).

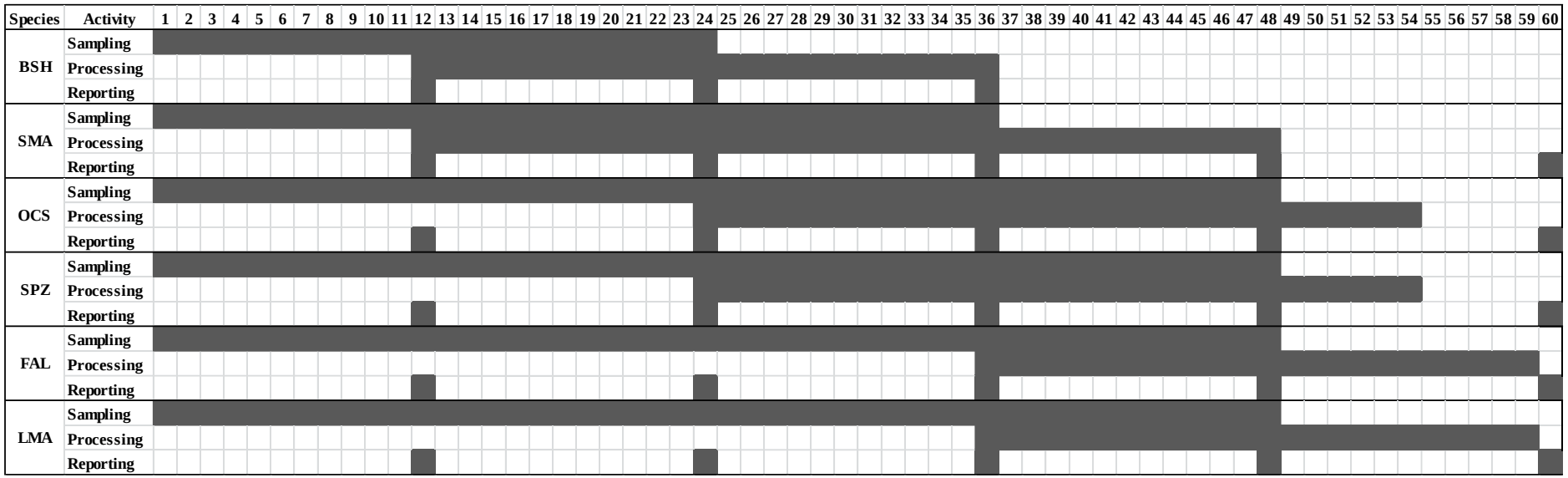

Figure 2. Chronogram of sampling activities forecasted for the 5 year period of the project.