

## URUGUAYAN RESEARCH PROGRAM FOR PELAGIC SHARKS IN THE SOUTHWEST ATLANTIC OCEAN

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### SUMMARY

*Uruguayan longliners operating in the Southwest Atlantic Ocean targeting swordfish and tunas also regularly capture elasmobranch fishes as bycatch. Among them, the blue shark (Prionace glauca) and the shortfin mako (Isurus oxyrinchus) constitute the two main shark species captured, but several other species are also occasionally captured. DINARA (Dirección Nacional de Recursos Acuáticos), is the Uruguayan governmental entity responsible for the monitoring and management of fisheries and harvesting of aquatic resources. DINARA is also responsible for the National Observer Program on board fishing vessels (PNOFA), and of fishery independent surveys carried on board the R/V Aldebarán. Both the observer program and research cruises represent opportunities for the collection of a wide variety of biological samples that are of ultimate importance to the work of the SCRS, particularly the sharks working group. Throughout this document we present the current Uruguayan pelagic sharks Research Program for the Southwest Atlantic Ocean, and provide details regarding the collection of shark samples already taken as well as for the near future as per ICCAT Recommendation 13-10.*

### RÉSUMÉ

*Les palangriers uruguayens opérant dans le Sud-Ouest de l'océan Atlantique ciblaient l'espadon et les thonidés capturent également régulièrement des poissons élamobranques en tant que prises accessoires. Parmi ces prises accessoires, le requin peau bleue (Prionace glauca) et le requin-taube bleu (Isurus oxyrinchus) constituent les deux principales espèces de requins capturées, même si plusieurs autres espèces sont aussi occasionnellement capturées. La DINARA (Dirección Nacional de Recursos Acuáticos) est l'entité uruguayenne gouvernementale responsable du contrôle et de la gestion des pêcheries et des captures des ressources aquatiques. La DINARA est également chargée du Programme national d'observateurs à bord des navires de pêche (PNOFA) et des campagnes de recherche indépendantes des pêcheries réalisées à bord du navire R/V Aldebarán. Le programme d'observateurs et les campagnes de recherche permettent 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 uruguayen sur les requins pélagiques couvrant le Sud-Ouest de l'océan Atlantique et fournit des informations détaillées sur la collecte d'échantillons de requins ayant déjà été prélevés et à prélever à court terme conformément à la Rec. 13-10 de l'ICCAT.*

### RESUMEN

*Los palangreros uruguayos que operan en el Atlántico sudoeste y se dirigen al pez espada y a los tónidos capturan también regularmente elasmobranquios de forma fortuita. Entre 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. La DINARA (Dirección Nacional de Recursos Acuáticos) es la entidad gubernamental uruguaya responsable del seguimiento y la ordenación pesquera y de la captura de los recursos acuáticos. La DINARA es también responsable del Programa nacional de observadores a bordo de buques pesqueros (PNOFA) y de las prospecciones independientes de las pesquerías llevadas a bordo del R/V Aldebarán. Tanto el programa de observadores como los cruceros de*

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*investigación representan oportunidades para recopilar 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 actual programa uruguayo de investigación sobre tiburones pelágicos en el Atlántico sudoeste y se presentan detalles sobre la recopilación de muestras de tiburones ya recogidas y que se tienen que recoger en un futuro cercano de acuerdo con la Recomendación de ICCAT 13-10.*

#### KEYWORDS

*Research program, conservation and bycatch mitigation, shark biology and ecology, pelagic longline fisheries*

## 1. Introduction

Several pelagic shark species are captured by pelagic fisheries that operate in the Atlantic Ocean (Clarke *et al.* 2014). Some of these species are being considered as priority for conservation by many countries and RFMOs. In 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, an Ecological Risk Assessment prepared by Cortés *et al.* (2010) provides a range of vulnerabilities for the most important pelagic shark species subject to ICCAT longline fisheries in the Atlantic Ocean. The approach identifies those species which are more, or less, at risk. As recognized by the Sharks Species Group, poor shark fisheries data quality (and quantity) as well as biological knowledge gaps are limiting factors affecting the provision of the scientific advice to the Commission.

Throughout this document we present a brief description of the research actions being carried out, samples collected at the moment and plans for the near future regarding pelagic sharks caught by the Uruguayan 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 the currently prohibited species.

## 2. Objectives

The general aim of this research program is to improve our knowledge regarding the biology and ecology of pelagic sharks caught by the Uruguayan longline fishery in the Southwest Atlantic Ocean.

The specific objectives cover a wide range of issues, including biological and ecological aspects.

### 2.1 Life history studies

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

1. Age and growth
2. Reproduction

Ageing sharks and modelling the growth of their populations will be accomplished by reading and validation of growth increments on vertebrae. Ideally 5-10 samples per sex and 5-10 cm size classes will be collected for each shark species. A section of 5-10 vertebrae will be removed, ideally beneath the first dorsal fin base, from selected specimens, frozen onboard the fishing vessels and then transported frozen to DINARA laboratory. Once in the laboratory, the vertebrae will be processed using age and growth protocols for elasmobranchs (Goldman *et al.* 2012). On the mid to long-term, we expect to be able to model the growth of different shark species populations (e.g. using von Bertalanffy growth models, as well as others), and estimate parameters that can then be used in stock assessment models, such as age-length keys, age at maturity, longevity, maximum size, growth rates and natural mortality (Campana 2001). The blue shark age and growth study conducted by Uruguay has been finished, and will be published in the near future. Results on this study have already been presented to ICCAT's Sharks Group (Mas *et al.* 2015 SCRS/P/2015/014).

Reproductive aspects of pelagic shark species will be recorded by onboard fishery observers as well as by technicians onboard the R/V Aldebarán. Specifically, data on the maturity stages (including histological samples), fecundity, seasonality and sex-ratio of the embryos will be recorded and used for the analysis. This data is of great relevance for understanding not only the spatial-temporal dynamics of the populations, including their reproductive cycle, but it also allows the estimation of specific biological parameters that can be used in population dynamics models, such as age structured models with age-specific fecundities (Cortés *et al.* 2012).

## **2.2 Trophic studies**

The main objectives of the trophic studies are:

1. Determine the diet composition of pelagic sharks in the Southwest Atlantic Ocean,
2. Identify changes in the diet according to ontogenetic and sexual differences as well as by spatial and seasonal trophic variability.

Diet studies will have two different approaches; one will be based on conventional stomach contents analysis (Hyslop 1980) and the other by means of stable isotopes analysis of C and N (Hussey *et al.* 2012). Samples for both types of studies will be collected by the observer program as well as in research campaigns. As pelagic sharks stomachs are very big, a preliminary analysis of the contents will be done on board, and the contents will be collected and preserved for a detailed analysis in the laboratory. For the stable isotopes analysis, tissue samples (muscle, skin, fat, liver) will be collected and preserved frozen. These studies will be first carried out in the main captured species (blue shark (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*)).

## **2.3 Tagging studies**

Tagging studies have three main objectives:

1. Determine migration patterns along the Southwest Atlantic Ocean, assessing seasonal movements as well as possible critical habitats such as mating and nursery areas.
2. Study habitat preferences in terms of depth and temperature.
3. Determine survivorship of sharks released alive.

The first objective will be covered mainly with the ICCAT Collaborative Tagging Program in which Uruguay has been participating since early 2007. Double tagging will also be carried out with the aim of assessing tag type-specific attaching performance. Results on this study have already been presented to ICCAT's Sharks Group (Domingo *et al.* 2016).

For the second objective ARGOS satellite transmitting tags (Wildlife Computers SPOT, SPLASH, Mk10-PAT, Mini-PAT) will be deployed. At the moment, Uruguay is working together with NOAA and ICCAT on the tagging of blue sharks and shortfin mako, with the possibility of covering other species in the near future. These tags are particularly suitable to track large-scale movements and behavior of large marine species, and can be set to acquire and transmit data for periods ranging from a few weeks to several months, or even years.

The third objective is to determine the survivorship of sharks once released as this does not necessarily mean that these will survive. This objective is part of ICCAT's Shark Research and Data Collection Program, which at the moment is focused only on the shortfin mako, using survival Mini-PAT tags.

## **2.4 Genetic studies**

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

1. Study the population genetic structure, assessing the degree of connectivity between different regions across the Southwestern Atlantic Ocean.
2. Establish a phylogenetic relationship between the different populations.

3. Contribute to the knowledge of the different populations for stock identification, fisheries management and conservation initiatives purposes.

Population analysis will be based on mitochondrial DNA sequences and microsatellite markers (nuclear DNA), sampled from muscle and/or fin clips that will be collected and stored in 95% ethanol. Samples will be analyzed by DINARA's Laboratory of Genetics. This objective will try to cover as much species as possible. However, as many species are seldom caught, we are considering the possibility of collaborating with other countries Programs.

The information gathered from this component of the study will be extremely important for assessing the genetic diversity within the species across the Southwest Atlantic Ocean as well as the genetic structure and connectivity among different populations (Heist 2012). This is very important as the establishment of biological meaningful fishing stocks is essential for a correct management of the fisheries.

### **2.5 Fishing Mortality**

This aspect will have two main objectives.

1. Determine survivorship of sharks released alive (see point 3 of *Tagging Studies*).
2. Assess sharks hooking mortality.

For the second objective, hooking mortality will be determined by assessing the condition (alive or dead) of the individuals at hauling.

### **3. Sampling**

The Research Program will be conducted by the LaRPe (Laboratorio de Recursos Pelágicos - DINARA), and will cover mainly all the research campaigns on board DINARA's research vessel, and the Scientific Observer Program on board the Uruguayan fleet, as well as other fleets with a fishing agreement with Uruguay.

The Program considers all shark species that are captured. According to the NPOA – Sharks Uruguay 2015 (Forselledo & Domingo, 2015) at least 21 species of sharks and 4 species of batoids have been captured by the Uruguayan pelagic longline fishery. However, the Program will focus on the most commonly captured species, as well as those considered as high priority in the NPOA – Sharks Uruguay 2015 (in press) and the top 10 ranked species of the Ecological Risk Assessment recently conducted by the Sharks Species Group of the SCRS. The species would be: blue shark (BSH), shortfin mako (SMA), porbeagle (*Lamna nasus*, POR), bigeye thresher (*Alopias superciliosus*, BTH), smooth hammerhead (*Sphyrna zygaena*, SPZ), common thresher (*A. vulpinus*, ALV), scalloped hammerhead (*S. lewini*, SPL), copper shark (*Carcharhinus brachyurus*, BRO) and night shark (*C. signatus*, CCS).

In the case of shark species for which retention is prohibited by ICCAT, scientific observers on board commercial fishing vessels will be authorized only to take samples from dead animals. This action will avoid the need to bring on board live specimens. In the case of the R/V, samples will be collected from dead and live animals, as the handling performed by the scientific and fishermen personnel tries to minimize all types of damage and trauma to the animals. Also, in the case of the R/V, live specimens will be tagged to collaborate with the ICCAT tagging program.

All samples collected will be kept on board until the arrival of the vessel to port. After that, samples will be processed and kept at DINARA's laboratories.

**Table 1** presents the number of data and samples collected during two pelagic resources campaigns (2014 and 2015) on board DINARA's Research Vessel. Both campaigns operated in the Uruguayan EEZ and were conducted by the LaRPe.

#### 4. Reporting

As it is recommended by ICCAT (Rec. BYC 13-10), the progress, activities and results of the Uruguayan Research Program for Pelagic Sharks will be reported every year to the Shark Species Group and to the SCRS. The Research Program will be open for discussion and advice of other research groups in order to improve it.

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**Table 1.** Number of specimens captured by species and number of samples collected to accomplish with the objectives of the Uruguayan research program for pelagic sharks.

Species	N° Captured	Genetic studies	Trophic studies	Life history studies		Tagging studies		Fishing mortality	
		N° of samples	Stable isotopes N° of samples	Reproduction N° of examined individuals	Age and growth N° of samples	Conventional N° of tagged individuals	Satellite N° of tagged individuals	Hooking mortality	
<i>Carcharhinus brachyurus</i>	BRO	1	----	----	1	----	1	----	100%
<i>Prionace glauca</i>	BSH	458	14	9	327	1	279	3	100%
<i>Lamna nasus</i>	POR	1	1	1	1	1	----	----	100%
<i>Isurus oxyrinchus</i>	SMA	2	1	1	1	1	1	1	100%
<i>Sphyrna zygaena</i>	SPZ	19	11	11	5	10	----	----	100%
<i>Mobula japanica</i>	RMJ	1	1	----	----	----	1	----	100%
<i>Mobula thurstoni</i>	RMO	1	1	----	----	----	1	----	100%
<i>Pteroplatytrygon violacea</i>	PLS	14	2	----	2	----	5	----	100%