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The provision of advice on the conservation of pelagic sharks associated to fishing activity under EU Sustainable Fisheries Partnership Agreements in the Atlantic Ocean

Specific Contract No 7 under Framework Contract MARE/2012/21

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The provision of advice on the conservation of pelagic sharks associated to fishing activity under EU Sustainable Fisheries Partnership Agreements in the Atlantic Ocean

Specific Contract No 7 under Framework Contract MARE/2012/21

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LIST OF ACRONYMS

B_{MSY}	Biomass at Maximum Sustainable Yield
BSH	Blue shark - *Prionace glauca* (FAO 3 letter code)
CPUE	Catch Per Unit of Effort
DG MARE	Directorate-General for Maritime Affairs and Fisheries
EASME	Executive Agency for Small and Medium-sized Enterprises
ERA	Ecological Risk Assessment
EEZ	Exclusive Economic Zone
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
F_{MSY}	Fishing mortality at Maximum Sustainable Yield
ICCAT	International Commission for the Conservation of Atlantic Tunas
IEO	Instituto Español de Oceanografía
INDP	Instituto Nacional de Desenvolvimento das Pescas
IPMA	Instituto Português do Mar e da Atmosfera
IRD	Institut de Recherche pour le Développement
SFPA	Sustainable Fisheries Partnership Agreement
SMA	Shortfin mako shark - *Isurus oxyrinchus* (FAO 3 letter code)
VMS	Vessel Monitoring System
BTH	Bigeye thresher – *Alopias superciliosus* (FAO 3 letter code)
FAL	Silky shark – *Carcharhinus falciformis* (FAO 3 letter code)
LMA	Longfin mako – *Isurus paucus* (FAO 3 letter code)
OCS	Oceanic whitetip shark - *Carcharhinus longimanus* (FAO 3 letter code)
PSK	Crocodile shark - *Pseudocarcharias kamoharai* (FAO 3 letter code)
SPZ	Smooth hammerhead – *Sphyrna zygaena* (FAO 3 letter code)

ABSTRACT

Project SC-07 under Framework Contract MARE/2012/21 provides scientific advice on the conservation of pelagic sharks associated with fishing activity under EU Sustainable Fisheries Partnership Agreements (SFPA) in the Atlantic Ocean, specifically for Cabo Verde. Several tasks were planned and completed within this project, including: 1) designing an observer programme, 2) designing and implementing a tagging programme, 3) analysing potential local depletion of sharks, 4) identifying biological and ecological sensitive areas, and 5) coordination and communication.

Task nº 1 required the development of protocols for data collection at sea. This included providing identification guides and forms for data collection in Portuguese and reporting forms as well as developing a self-reporting scheme for vessel captains. A database for the observer programme was also developed and training for observers was provided through a capacity building programme.

Task nº 2 involved designing and implementing a tagging programme using satellite telemetry tags. 30 satellite tags were deployed on the main shark species, with a total of 328 tracking days recorded with SPOT GPS tags and 1554 tracking days recorded with miniPATS (1,296 days for blue shark, *Prionace glauca*, and 258 days for shortfin mako, *Isurus oxyrinchus*). The majority of blue shark specimens moved substantial distances, most of the time outside the Cabo Verde Exclusive Economic Zone (EEZ), and in some cases travelling more than 4,000 km across the Atlantic. By comparison, shortfin mako sharks tended to move to areas closer to the African continental shelf.

Task nº 3 analysed the potential local depletion of sharks in the Cabo Verde region based on the catch composition, catch rates (CPUEs) and size distribution. The CPUE time series was standardized using statistical models (GLMs - Generalized Linear Models and GLMMs - Generalized Linear Mixed Models). For both blue and shortfin mako sharks general increasing trends in CPUE were observed. In terms of sizes it was noticed that blue shark catches in the region were composed mainly of adults, while the shortfin mako catches were mainly juveniles. Considering both the abundance indexes and size indicators, local depletion effects are not likely to be occurring for those sharks in the Cabo Verde region, especially as there are no signs of decreasing local abundance (biomass) inside the EEZ. However, the relatively large catch of juvenile shortfin makos might represent a juvenile aggregation area of that species in the region.

Task nº 4 explored biological and ecological sensitive areas using spatial models (GAMs - Generalized Additive Models) to predict the expected blue shark and shortfin mako catch rates and mean size. For both species the higher overall CPUEs were predicted to be mainly outside the Cabo Verde EEZ, in the case of the shortfin mako this was mainly along the African continental shelf.

The final recommendations from this project are: 1) future implementation of the observer programme both in the short and long term; 2) possible continuation of the tagging programme, focusing both on the main shark species and on some of the other less common bycatch species; and, 3) maintaining the detailed data collection

programme from the fisheries operating in the region and periodically updating the catch composition, size distribution and standardized CPUE indicators.

EXECUTIVE SUMMARY

Purpose of the specific contract

"The provision of advice on the conservation of pelagic sharks associated to fishing activity under EU Sustainable Fisheries Partnership Agreements in the Atlantic Ocean" was developed under Framework Contract MARE/2012/21 on the "Scientific advice for fisheries beyond EU waters". The main purpose of this project was to provide advice to the EU Commission on the conservation of pelagic sharks associated to the fishing activity conducted under EU Sustainable Fisheries Partnership Agreements (SFPA) in the Atlantic Ocean, specifically for the geographical area of the Cabo Verde Archipelago.

Tasks of the specific contract

Within the project the following five tasks were planned, executed and completed, including: 1) designing an observer programme, 2) designing and implementing a tagging programme, 3) analysing the potential local depletion of sharks and impacts to the ecosystem in the region; 4) identifying biological and ecological sensitive areas in Cabo Verde and neighbouring waters; and 5) coordination and communication.

Task nº 1 designed and provided training for an observer sampling programme for the fleets capturing sharks in the Cabo Verde Exclusive Economic Zone (EEZ). This included the development of standard protocols for data collection through the provision of identification guides and forms to collect observer data and development of a self-reporting scheme. A database for the Cabo Verde observer programme was also developed, and observer training was provided as part of a capacity building programme.

Task nº 2 designed and implemented a tagging programme for the region of Cabo Verde and the neighbouring waters of the tropical northeast Atlantic, using satellite telemetry tags (miniPAT and SPOT GPS). A total of 30 satellite tags were deployed, namely 25 miniPATs and 5 Fastloc SPOT GPS tags, of which 20 miniPATs and 5 SPOT GPS were deployed in blue sharks (*Prionace glauca* – BSH) and 5 miniPATs were deployed in shortfin mako (*Isurus oxyrinchus* - SMA) sharks, all inside the Cabo Verde EEZ. The ICCAT conventional tagging database (tag-recapture) for the main shark species was also analysed to understand the movements of BSH and SMA between Cabo Verde EEZ and other regions.

Task nº 3 analysed the potential local depletion of sharks in the Cabo Verde region, comparing the shark catch composition, catch rates (catch per unit of effort, CPUE) and size distribution for the major shark species between Cabo Verde EEZ and neighbouring waters. For this, several data sources were analysed, including 1) ICCAT Task II CE (Catch and Effort) database, 2) the INDP database with reported landings from logbooks for the EU fleet, 3) the EU pelagic longline fleets (Portuguese and Spanish) logbook data and VMS information, and 4) data from the EU fishery observer programmes. The relative shark catch composition and trends in the size frequency distributions over time were analysed and compared between Cabo Verde EEZ and neighbouring waters. The CPUE time series trends were standardized for the two main shark species (blue shark and shortfin mako) in order to remove the fishery-dependent effects (i.e., spatial, seasonal and targeting effects). As such, those relative indexes of abundance can be used as population status indicators. This analysis was carried out using Generalized Linear Models (GLMs) and Generalized Linear Mixed Models (GLMMs) statistical models.

Task nº 4 explored the existence of possible biological and ecological sensitive areas in the Cabo Verde region and neighbouring waters, by looking into the spatial and seasonal distributions of the pelagic sharks in the area. Statistical models, specifically Generalized Additive Models (GAMs), were used to model and predict the expected blue shark and shortfin mako shark catch rates and mean size distributions as a function of location and seasonality.

Task nº 5 was related with aspects of coordination and communication of the project. This included the dissemination of the results of the project through different forms of reporting and by organizing a dedicated workshop in Cabo Verde. Dissemination to the scientific community was done.

Task 1 - Observer programme

An observer sampling programme was developed and various documents and guides were provided as deliverables of the project, including:

- Identification guides. These include not only shark species but also other taxa of interest that are commonly caught in the area such as tunas, billfishes and sea turtles;
- Forms to collect observer data. These are already in use by EU observer programmes and ensure that the required data on target, by-catch and discard species, including sharks are collected and recorded properly;
- Self-reporting scheme. This is also currently used by some EU fleets and, consists of a complementary data collection scheme to be used by trained vessel skippers and crews when scientific observers are not present. It allows the skipper to voluntarily provide information on the fishing activity and catch composition, including target species, bycatch and discards;
- Development of a relational database by INDP in consultation with Consortium scientists. This database can store all the logbook and observer data collected from both the EU and other fleets that operate in the Cabo Verde waters.

Observer training was undertaken through two capacity building programmes initiated by Consortium scientists, in 2014 and 2015 at INDP (Mindelo, São Vicente, Cabo Verde). The technicians received training on general aspects of species identification, biology, data analysis and reporting, as well as more specific training on longline fisheries data collection and on-board sampling.

Task 2 - Tagging Programme

The first component of this task analysed the ICCAT conventional tagging databases, which compiles the release and recapture data from the main pelagic shark species in the Atlantic between 1959 and 2014. In general, this tag-recapture data shows high mobility of those pelagic shark species that can move between the Cabo Verde EEZ and other distant regions, including areas in both hemispheres and on both sides of the Atlantic.

The second component of this task was related with the satellite tagging of blue shark and shortfin mako. The 30 satellite telemetry tags (25 miniPAT and 5 SPOT GPS) were deployed between July and October 2016 inside the Cabo Verde EEZ. Juveniles and adults from both sexes were tagged. The individual SPOT tags lasted between 22 and 88 days, and logged a total of 328 days. The miniPAT tags were programmed for deployment periods of 120 days, and an overall total of 1,296 tracking days were recorded for blue sharks and 258 days for shortfin makos.

Most of the tagged blue sharks moved substantial distances. In the majority of cases they migrated to areas outside the Cabo Verde EEZ with some travelling over 4,000 km. They moved in all directions, with no discernible pattern. It was particularly noteworthy that a blue shark, tagged inside the Cabo Verde EEZ (very close to the Cabo Verde Islands) moved a great distance towards equatorial waters. Shortfin makos, however, tended to move from inside the Cabo Verde EEZ towards the African continent, to areas closer to the African continental shelf.

Blue sharks spent most of their time in water shallower than 30 meters. However, there were some diel movements; at night they tended to spend more time in shallower and warmer waters closer to the surface, during the day they would move to deeper, colder waters. Shortfin mako sharks also showed daily diel movements.

Task 3 - Analysis of potential local depletion of sharks in Cabo Verde

Within the Cabo Verde EEZ and its adjacent waters, the main elasmobranch species caught are the blue shark and shortfin mako shark. Less commonly caught species include bigeye thresher, silky shark, longfin mako, oceanic whitetip shark, crocodile shark and the smooth hammerhead. This is in line with what is observed in many other pelagic longline fisheries in other regions of the world.

The main EU fleets reporting shark catches in the region are Spanish and Portuguese longliners, with the majority of the catches reported by Spain. The overall catch trends showed a peak in 2012 but have been declining since then. The corresponding effort has also been decreasing over this period.

During the study period, a general increasing CPUE trend was noticeable for both the blue shark and shortfin mako. For these two main species, the CPUE series were standardized with statistical models in order to be used as relative indexes of abundance. The models are similar to the ones regularly used in ICCAT for the stock assessment of those and other pelagic species. For the blue shark, the final standardized index of abundance in the Cabo Verde EEZ and adjacent waters showed an overall general increasing trend along the entire time series period (2006-2015). For the shortfin mako shark the final standardized index showed an increase in the earlier years (2006-2009), followed by a decrease in 2010 and then an increase in the most recent period (until 2015).

There were also some seasonality aspects in the CPUEs of those sharks. For the blue shark, there are clear seasonal pattern with higher catch rates during the winter months, especially between October and March, and lower catch rates during the summer, mainly between April and September. For the shortfin mako, the seasonal aspects did not seem to be so influential, although there is also some seasonal variability in the catch rates with higher catches early in the year between January and June and lower catches later in the year between July and December.

In terms of size distributions, the blue shark catches in the Cabo Verde region and adjacent waters are composed of relatively large specimens, mainly adults. This contrasts with the shortfin mako catches that are composed mainly by relatively smaller specimens, mainly juveniles. No major temporal variations were observed for the blue shark mean size distribution along the time period. For the shortfin mako, a general decrease trend in the mean size distribution was observed during most of the time series, except in the most recent year (2015), when the mean sizes increased reaching a similar value to the initial years.

Task 4 - Biological and ecological sensitive areas

Using spatial models it was possible to analyse the variability in the expected catch rates and size distributions for both blue shark and shortfin mako shark in the study area.

For the blue shark, overall higher catch rates were predicted mainly outside the Cabo Verde EEZ, especially in the south and southwest regions off the EEZ, while lower CPUEs were expected both in the EEZ and in the northern areas outside the EEZ. Seasonal effects have a very strong influence on the blue shark predicted CPUEs, with higher catch rates expected during the autumn and winter periods and lower rates in late spring and summer. For the shortfin mako shark, it was noticeable that there was a low overall predicted CPUE throughout most of the study area, both in the Cabo Verde EEZ and in most of its adjacent waters. The higher CPUEs for this species are predicted in the eastern region, closer to the African continental shelf waters, outside the Cabo Verde EEZ but in the EEZs of other African countries. For the shortfin mako shark the seasonal effects were not as strong as for the blue shark, with the overall trends relatively constant over all seasons.

There was also considerable variability in the predicted size distribution of both species. For the blue shark the smaller specimens are predicted both inside the Cabo Verde EEZ and in its adjacent waters, especially in the northeastern area, as well as outside the study area towards the southwest. Seasonality is also important with smaller specimens expected during the spring months. For the shortfin mako shark there are also marked spatial effects in the expected sizes, in this case with the smaller specimens expected to occur both inside the Cabo Verde EEZ and in its adjacent waters, especially in the northeastern area. When considering seasonal effects it was observed that smaller shortfin makos are expected in the 1st semester of the year and relatively larger specimens in the 2nd semester.

It is important to note that the overall predicted blue shark sizes are relatively large for the species. As such, most of the blue shark sizes predicted to occur in the study area throughout the entire year correspond mainly to large juveniles and adults. By contrast, the overall expected specimen sizes for the shortfin mako shark are relatively small for the species, with most of the specimens expected to occur in the study area throughout the year corresponding to juveniles, particularly for the females.

Task 5 - Coordination and communications

Within this project, the Consortium produced and delivered several items, including the work-plan, tagging program, observer program, three non-technical papers, one interim report and the draft and final reports. The Consortium also prepared the agenda, materials and presentations for the final project workshop that was held in INDP (Mindelo, São Vicente, Cabo Verde).

Due to the important scientific components and findings of this project, there was also a strong objective to promote the scientific dissemination of the results. One oral communication was presented during an international scientific conference (2016 EEA Conference, Bristol, UK), and the submission of two peer-review papers is planned.

Main conclusions and recommendations

The main conclusions and recommendations from the project are (recommendation highlighted in bold):

- ***Task 1 - Observer programme***
  - Materials and training for establishing an on-board observer programme, including manuals, sampling protocols and a self-sampling programme protocol, with the respective data collection forms, were provided to Cabo Verde scientists and technicians over the course of the project;
  - A relational database was developed by Cabo Verde (INDP) to store current and historical fisheries data, both from the EU and other, non EU, fleets operating in the Cabo Verde region;

- **Recommendations** for the future implementation of the observer programme might involve two steps. In the short term a pilot project could be developed to start the implementation and testing phase of the observer programme. For the long term funds will need to be secured in order to guarantee the long term stability and viability of the programme and the maintenance of a continuous time series of data that can then be used in future stock assessments.

- ***Task 2 - Tagging programme***
  - State-of-the-art satellite telemetry tags were used in the two main pelagic shark species caught by pelagic fisheries inside the Cabo Verde EEZ, specifically the blue shark and shortfin mako shark;
  - In general, the tags showed high mobility of the specimens with movements both inside and outside the Cabo Verde EEZ. In some cases the sharks moved considerable distances over the tagged periods;
  - It is **recommended** that a possible continuation of the tagging programme should focus on the main shark species, especially the shortfin mako where less information is available. Additionally, some future effort should also be put into tagging the other less common species that also interact and can be captured by pelagic longlines, including silky shark, oceanic whitetip, longfin mako, bigeye thresher and hammerheads.

- ***Task 3 - Analysis of potential local depletion of sharks***
  - Blue and shortfin mako are the main shark species captured in pelagic longlines in Cabo Verde (as well as in other oceanic regions of the Atlantic and other oceans);
  - Generalized Linear Models (GLMs) and Generalized Linear Mixed Models (GLMMs) were used to standardize the CPUE time series data. For both species the estimated indices of abundance showed overall increases over the period (2006-2015). This is in line with what has been estimated from other fleets for these species in the North Atlantic from the latest ICCAT stock assessments;
  - Blue sharks captured in the Cabo Verde region are mainly large adult specimens and there were no major trends in the time series of the mean size distribution. By contrast, the shortfin makos captured in the region are relatively small and composed mainly of juveniles. There were some indications of possible declines in the mean sizes over time.
  - Considering the abundance indexes and size indicators, local depletion effects are not likely to be occurring for those two shark species in the Cabo Verde EEZ and adjacent waters, especially as there are no signs of decreasing local abundance (biomass) for any of the species. However, the relatively large catch of juvenile shortfin mako sharks might represent an aggregation area of juvenile specimens for this species in the region.

- It is **recommended** to keep the detailed data collection and update the catch composition, size distribution and standardized CPUE indicators periodically (e.g., every 2-3 years). This is important in order to detect any signs of potential depletion of those species in the region. Particularly for the blue shark that is the most captured shark and for the shortfin mako where there are some signs of decreasing trends in the mean sizes it would be particularly important to continue updating those indexes on a regular basis.

- ***Task 4 - Biological and ecological sensitive areas***
  - The shortfin mako shark seems to have marked region-specific movements and habitat use mainly along the West African continental shelf. This type of region specific movements has also been recently hypothesized for the species in the west Atlantic;
  - The presence of large adult blue sharks in the Cabo Verde region corroborates the hypothesis of the distributional patterns of this species in the North Atlantic, with large adult specimens occurring mainly in warmer tropical waters and juveniles in colder temperate waters;
  - For the shortfin mako the areas closer to the African continental shelf seem to be of particularly importance to the species, with large aggregations of small juvenile specimens.

- ***Task 5 - Coordination and communication***
  - Three non-technical papers were produced to provide general information on the project, including the main objectives, results and conclusions;
  - A workshop was carried out in Cabo Verde (INDP, Mindelo, São Vicente) to present and discuss the findings of the project. This workshop had the participation of scientists, administration (Cabo Verde and EU), journalists, interested NGOs, the fishing sector and general public;
  - An oral communication with results of the project was presented to the international scientific community during the 20th Annual Scientific Conference of the European Elasmobranch Association (EEA) that took place on the 28-30th October 2016 in Bristol, England;
  - Two peer-review papers are planned to be submitted to scientific journals, one with the main results of the indicator analysis and one with the main results from the satellite telemetry.

RÉSUMÉ DÉTAILLÉ

Objectif du contrat spécifique

"La fourniture de conseils sur la conservation des requins pélagiques liée aux activités de pêche dans le cadre des accords de partenariat pour une pêche durable (APPD) de l'Union Européenne (UE) dans l'océan Atlantique" a été développé dans le cadre du contrat MARE/2012/21 portant sur "les conseils scientifiques pour les pêcheries au-delà des eaux de l'Union". Le principal objectif de ce projet était de délivrer auprès de la Commission Européenne des avis relatifs à la conservation des requins pélagiques liée aux activités de pêche dans le cadre des accords de partenariat pour une pêche durable (APPD) de l'Union Européenne (UE) dans l'océan Atlantique, en particulier pour la zone géographique de l'archipel du Cap-Vert.

Tâches du contrat spécifique

Au sein du projet, cinq tâches listées ci-après ont été planifiées, exécutées et réalisées. Ces tâches étaient les suivantes : 1) élaboration d'un programme observateur, 2) élaboration et réalisation d'un programme de marquage, 3) l'analyse de la diminution potentiel des requins et des impacts écosystémiques dans la région, 4) l'identification d'aires biologiquement et écologiquement sensibles dans l'archipel du Cap-Vert et des eaux environnantes, et 5) la coordination du projet et la communication en son sein.

La tâche n°1 a conduit à l'élaboration d'un programme Observateur et a dispensé la formation nécessaire pour le suivi des flottilles capturant des requins dans la zone économique exclusive (ZEE) du Cap-Vert. Cela a inclus le développement de protocoles standardisés pour la collection des données à partir de la fourniture de guides de détermination et de formulaires de collecte ainsi que le développement d'un programme d'auto-échantillonnage. Une base de données relationnelle à l'intention du programme Observateur du Cap-Vert a été développée, et la formation observateur a été dispensée dans le cadre du programme de renforcement des capacités du partenaire.

La tâche n°2 a conduit à l'élaboration ainsi qu'à la réalisation d'un programme de marquage pour la région du Cap Vert et des eaux adjacentes de la zone tropicale Nord-Est de l'océan Atlantique à partir de marques satellites (miniPAT et SPOT GPS). Un total de 30 marques a été déployé, 25 miniPATS et 5 Flastloc SPOT GPS. Parmi ces marques, 20 miniPATS et 5 Flastloc SPOT GPS ont été déployées sur des requins peau-bleu ((Prionace glauca – BSH) and 5 miniPATs ont été déployées sur des requins mako (Isurus oxyrinchus - SMA), toutes au sein de la ZEE du Cap-Vert. Les données de la base de données des marquages conventionnels de la Commission Internationale pour la Conservation des Thonidés de l'Atlantique (CICTA) concernant les principales espèces de requins ont aussi été analysées pour la compréhension des mouvements des BSH et SMA entre la ZEE du Cap-Vert et les autres régions.

La tâche n°3 a étudié la possible raréfaction locale des requins dans la région du Cap-Vert en comparant les compositions spécifiques des prises de requins, des taux de capture (capture par unité d'effort, CPUE) et les distributions des tailles des principales espèces de requins entre la ZEE du Cap-Vert et les eaux environnantes. Pour aborder la question, diverses sources de données ont été analysées, 1) la base de donnée Tâche II CE (captures et effort de pêche) de la CICTA, 2) la base de donnée de l'Institut National du Développement des Pêches (INDP) du Cap-Vert concernant les déclarations contenues dans les journaux de bord de flottilles européennes, 3) les données des journaux de bord et des VMS des flottilles palangrières pélagiques européennes (Espagne et Portugal) et, 4) les données des programmes observateurs embarqués de l'Union Européenne. Les compositions des captures relatives des requins ainsi que les distributions spécifiques des tailles ont été comparées au cours du temps entre la ZEE du Cap-Vert et les eaux environnantes. Les séries temporelles des CPUEs ont été standardisées pour les deux espèces principales, BSH et SMA, dans le but d'éliminer les effets dépendant des pêcheries (spatial, saisonnalité, et effets du ciblage). Tels que, ces indicateurs relatifs d'abondance peuvent être utilisés comme indicateur du niveau d'abondance des populations. Les analyses ont été réalisés à partir de modèles linéaires généralisés (GLM) et modèles linéaires généralisés mixtes (GLMM).

La tâche n°4 a exploré l'existence d'éventuelles zones biologiques et écologiques sensibles dans la ZEE du Cap-Vert et les eaux environnantes. Des modèles statistiques, en particulier le modèle additif généralisé (GAM) ont été ajustés pour modéliser et prédire les taux de captures estimés du BSH et du SMA et la distribution des tailles moyennes en fonction de l'espace et la saisonnalité.

La tâche nº 5 fût liée aux aspects de coordination et communication du projet. Ceci inclut la dissémination des résultats du projet à travers différentes formes de production de rapports et par l'organisation d'un séminaire dédié qui se tiendra au Cap-Vert. La dissémination auprès de la communauté scientifique est aussi envisagée.

<u>Tâche 1 – Programme Observateur</u>

Un programme de collecte de données par des observateurs embarqués a été développé, et divers documents et guides ont été produits en tant que livrables:

- Guides d'identification des espèces. Ils concernent non seulement les espèces de requins mais aussi d'autres taxons régulièrement capturés comme espèces cibles ou captures accidentelles tels que les thons, les poissons porte épée et les tortues marines,
- Formulaires de collecte des données observateurs. Elles sont déjà utilisées dans le cadre de programmes observateurs de l'Union Européenne et assure que les données requises concernant les espèces cibles, prises accessoires et rejets sont collectées et enregistrées correctement,
- Programme d'auto-échantillonnage. Il est déjà mis en place par des flottilles de l'Union Européenne et concerne une collecte de données complémentaires aux

données des journaux de bord par des capitaines et membres d'équipage entraînés lorsque des observateurs scientifiques ne peuvent être présents. Il permet au capitaine volontaire de fournir des informations sur l'activité de pêche et la composition des captures, incluant espèces cibles, prises accessoires et rejets,

- Développement d'une base de données relationnelle par l'Institut National de Développement des Pêches (INDP) en concertation avec les scientifiques du consortium. Cette base de données permet d'archiver les données des journaux de bord et des données observateurs des flottilles de l'Union Européenne et autres flottilles opérant dans les eaux de la ZEE du Cap-Vert.

La formation Observateur a été réalisée à partir de deux actions de développement de capacité initiées par des scientifiques du Consortium en 2015 et 2016 à l'INDP (Mindelo, São Vicente, Cap-Vert). Les participants ont été formés à divers aspects de l'identification des espèces, de la biologie, de l'analyse et de la déclaration des données ainsi qu'à la collecte plus spécifique et à l'échantillonnage à bord des données concernées par les pêcheries pélagiques palangrières.

<u>Tâche 2 – Programme de marquage</u>

La première composante de cette tâche a porté sur l'analyse de la base de données de marquages conventionnels de la CICTA, qui rassemble des données de capture-recapture pour des espèces principales de requins pour l'océan Atlantique entre 1959 et 2014. Ces données témoignent une grande mobilité des espèces qui se déplacent entre les eaux du Cap-Vert et d'autres régions distantes, et ce dans les hémisphère Nord et Sud de l'océan Atlantique.

La seconde composante de cette tâche était reliée au déploiement de marques marquage électroniques sur des requins peau-bleu et requins mako. Un total de 30 marques (25 miniPAT and 5 SPOT GPS) a été déployé entre Juillet et Octobre 2016 dans la ZEE du Cap-Vert. Des juvéniles et adultes des deux sexes ont été marqués. Les marques SPOT ont été déployées entre 22 et 88 jours et totalisent 328 jours d'émission de données. Les marques miniPAT ont été programmées pour un période déploiement de 120 jours. Au total le nombre de jour d'enregistrement fût de 1296 jours pour le requin peau-bleu et 258 jours pour le requin mako.

La plupart des requins peau-bleu se déplacent sur des distances relativement importantes. Ils migrent vers des régions hors de la ZEE du Cap-Vert avec des distances estimées de plus de 4000 km. Ces déplacements se font dans toutes les directions sans tendance nette. Il a pu être observé un déplacement de grande distance d''un requin peau-bleu marqué dans la ZEE du Cap-Vert vers les eaux équatoriales. En revanche, les requins mako tendent à se déplacer des eaux du Cap-Vert vers la côte de l'Afrique de l'Ouest dans des zones proches du plateau continental.

Les requins peau-bleu occupent en majorité superficielles situées dans les 30 premiers mètres de l'océan. En revanche, il convient de noter l'existence de mouvements nycthéméraux, la nuit les individus restant préférentiellement dans les eaux chaudes de surface et se déplacent dans des eaux froides plus profondes le jour. Ces mouvements nycthéméraux sont aussi présents pour les requins mako.

Tâche 3 – Analyse d'une possible raréfaction locale des requins dans la région du Cap-Vert

Dans la ZEE du Cap-Vert et les eaux adjacentes, les principales espèces de requins sont le requin peau-bleu et le requin mako. Les autres espèces capturées moins fréquemment sont le requin renard à gros yeux, le requin soyeux, le petit requin taupe, le requin pointe blanche océanique, le requin crocodile et le requin marteau commun. Cela correspond à l'observation générale faite pour les autres pêcheries pélagiques palangrières dans d'autres régions de l'océan mondial.

Les principales flottilles européennes déclarant des captures de requins dans la région sont les flottilles palangrières espagnoles et portugaises, avec une majorité de captures déclarées par l'Espagne. La tendance générale de l'évolution des captures annuelles montre un pic en 2012 et une diminution ensuite. L'effort de pêche correspondant a aussi diminué sur l'ensemble de la période.

Concernant la tendance des CPUEs, il peut être noté une augmentation pour les deux espèces, requin peau-bleu et requin mako, au cours de la période étudiée. Pour ces deux espèces, les séries de CPUE ont été standardisées à partir de modèles statistiques afin qu'elles puissent être considérées comme indicatrices de l'abondance relative. Les modèles sont similaires à ceux couramment utilisés par la CICTA pour les analyses des divers stocks exploités. Pour le requin peau-bleu, l'indice de l'abondance relative estimé dans les eaux du Cap-Vert et les eaux adjacentes témoigne d'une tendance à une augmentation pour l'ensemble de la période d'étude (2006-2015). Pour le requin mako, l'indice de l'abondance relative montre un accroissement durant les premières années de la série (2006-2009), suivi d'une diminution en 2010 puis d'un nouvel accroissement au cours de la période plus récente (jusqu'en 2015).

Des tendances saisonnières peuvent être notées dans les séries temporelles de CPUEs des deux populations de requins. Pour le requin peau-bleu, la tendance saisonnière est nette avec des taux de capture, plus élevés au cours des mois d'hiver entre Octobre et Mars, et plus faibles au cours des mois d'été, principalement entre Avril et Septembre. Pour le requin mako ces tendances saisonnières sont moins caractéristiques bien qu'une variabilité saisonnière puisse être décelée avec des taux de captures plus élevés entre Janvier en Juin et plus faibles entre Juillet et Décembre.

En ce qui concerne les distributions des tailles, les captures du requin peau-bleu dans la région du Cap-Vert et les eaux adjacentes sont constituées en majorité de grands individus principalement des adultes. Ceci contraste avec le requin mako dont les captures sont majoritairement représentées par des individus de petite taille principalement juvéniles. Au cours de la période d'étude, aucune variation temporelle majeure n'a été observée pour la taille moyenne du requin peau-bleu. En revanche pour le requin mako, une tendance générale de la diminution de la taille moyenne fût observée pour la majeure partie de la période d'étude, à l'exception de la dernière année (2015) pour laquelle la taille moyenne est similaire à celle observée pour les premières années de la série.

Tâche 4 – Zones biologiques et écologiques sensibles

A partir de modélisation spatiale, il a été possible d'analyser la variabilité des prédictions des taux de capture et des distributions de taille du requin peau-bleu et du requin mako dans la zone d'étude.

Pour le requin peau-bleue, les taux de capture les plus élevés sont estimés hors de la ZEE du Cap-Vert, principalement au sud et sud-ouest de la ZEE alors que les taux de capture plus faibles sont estimés dans le ZEE et dans la partie nord des eaux adjacentes à la ZEE. Les effets saisonniers ont une influence significative sur ces prédictions, avec comme attendu, des taux de capture plus élevés en automne et en hiver et plus faibles au printemps et en été. Pour le requin mako, il doit être relevé des prédictions de CPUE faibles sur l'ensemble des zones d'étude, à savoir la ZEE du Cap-Vert et ses eaux adjacentes. Les CPUEs les plus élevées sont estimées à l'Est de la ZEE du Cap-Vert près du plateau continental dans les ZEEs d'autres Etats africains. L'effet saisonnier est bien moindre que celui observé pour le requin peau-bleu avec des CPUEs relativement constantes sur l'ensemble des saisons.

Les distributions de taille prédites pour les deux espèces montrent une grande variabilité spatiale. Pour le requin peau-bleu, les individus les plus petits sont prédits dans les eaux de la ZEE du Cap-Vert et les eaux adjacentes en particulier dans la région Nord-Est ainsi que dans le secteur Sud-Ouest hors de la zone d'étude. La saisonnalité est importante avec une fréquence plus élevée d'individus les plus petits au cours du printemps. Pour le requin mako, les tailles prédites témoignent aussi d'un effet spatial maqué. Les individus les plus petits sont prédits dans la ZEE du Cap-Vert et les eaux adjacentes en particulier la zone Nord-Est. En relation avec l'effet saisonnier, les individus les plus petits sont prédits pour le 1er semestre de l'année et les individus plus grands au cours du 2ème semestre.

Il est important de relever que l'ensemble des prédictions des tailles du requin peau-bleu concerne des grands individus. Ainsi, les tailles estimées dans la zone d'étude au cours de l'année correspondent en grande partie à de grands individus adultes. Inversement, les tailles prédites pour le requin mako concernent des individus de petite taille, et pour la zone d'étude au cours de l'année, la plupart des individus sont majoritairement des femelles juvéniles.

Tâche 5 – Coordination et communication

Au cours de ce projet, le Consortium a réalisé et diffusé plusieurs produits, incluant le programme de travail, le programme de marquage, le programme observateur, trois documents non techniques, le rapport intermédiaire, le rapport provisoire et le rapport final. Le Consortium a aussi préparé le calendrier du programme, le matériel et les présentations du séminaire de clôture du projet qui s'est tenu à l'INDP (Mindelo, São Vicente, Cap-Vert).

En raison de la nature scientifique de ce projet et de résultats majeurs obtenus, un objectif fort de dissémination de ces résultats a été identifié. Une communication orale a déjà été présentée à l'occasion d'une conférence scientifique internationale en 2016 (Conférence de l'Association Européenne des Elasmobranches, Bristol, Royaume-Uni) et la soumission de deux publications dans des revues à comité de lecture a été programmée.

<u>Principales conclusions and recommandations</u>

Les principales conclusions and recommandations de ce projet sont (recommandation soulignée en caractères gras:

- ***Tâche 1 – Programme Observateur***
    - Matériel et formation pour la mise en place d'un programme Observateur embarqué pérenne, incluant des manuels, des protocoles d'échantillonnage, et un protocole pour un programme d'auto-échantillonnage avec les formulaires dédiés ont été transmis et communiqués aux techniciens et scientifiques du Cap-Vert au cours du projet;
    - Une base de donnée relationnelle a été développée par l'INDP pour l'archivage des statistiques de pêche actuelles et historiques des flottilles européennes et autres en activité dans la région du Cap-Vert;
    - Les **recommandations** pour la future mise en place du programme observateur doivent considérer 2 étapes. A court terme, un projet pilote doit être établi pour le lancement du programme et tester sa faisabilité. Pour le long terme, des financements doivent être assurés pour garantir la stabilité et la viabilité à long terme du projet et assurer la maintenance d'une série temporelle continu de données qui pourront être utilisées dans de futures analyses de l'état des stocks dans le cadre des groupes de travail de la CICTA.

- ***Task 2 - Tagging programme***
    - Des marques électroniques de technologie avancée ont été utilisée pour les principales espèces de requins capturés par les pêcheries pélagiques palangrières dans les eaux de la ZEE du Cap-Vert, en particulier le requin peau-bleu et le requin mako;
    - En général, les résultats des marquages montrent une grande mobilité des individus avec des déplacements dans et hors de la ZEE du Cap-Vert. Dans plusieurs cas, certains déplacements correspondent à des

distances importantes couvertes respectivement à l'ensemble de la période de déploiement de la marque;

- Il est **recommandé** qu'une poursuite possible du programme de marquage doive concerner les principales espèces de requins en particulier le requin mako pour lequel moins de données sont disponibles. De plus, des efforts futurs devraient aussi porter sur le marquage d'autres espèces moins fréquentes mais qui sont en interaction avec les pêcheries pélagiques palangrières telles que le requin soyeux, le requin pointe blanche océanique, le petit requin taupe, le requin renard à gros yeux et les requins marteau.

- ***Tâche 3 – Analyse d'une possible raréfaction locale des requins***
  - Le requin peau-bleu et le requin mako sont les principales espèces de requins capturées par les pêcheries palangrières pélagiques dans la ZEE du Cap-Vert et dans d'autres régions océaniques de l'Atlantique et de l'océan mondial;
  - Des modèles linéaires généralisés simples (GLMs) et mixtes (GLMMs) ont été utilisés pour la standardisation des séries temporelles de CPUEs. Pour les deux espèces, l'indice d'abondance relative estimé montre une augmentation sur l'ensemble de la période considérée (2006-2015). Ce résultat est en accord avec des estimations réalisées pour d'autres flottilles pour ces mêmes espèces dans l'Atlantique Nord lors des dernières analyses de stocks menées par la CICTA;
  - Les requins peau-bleu capturés dans la région du Cap-Vert sont principalement des individus adultes et la taille moyenne des individus capturés ne montre pas de tendance particulière pour la période considérée. En revanche, le requin mako capturé dans la région est essentiellement composé de spécimens de petite taille et une possible diminution de la taille moyenne des captures au cours du temps a été identifiée;
  - Concernant les indices d'abondance et de taille des captures pour les deux espèces, des signes d'une tendance de raréfaction locale dans la ZEE du Cap-Vert et les eaux adjacentes n'ont pu être détectés, en particulier en ce qui concernerait l'abondance locale (biomasse). Pour autant, la capture relativement importante de juvéniles de requins mako pourrait représenter une zone d'agrégation de ces individus pour cette espèce dans la région;
  - Il est **recommandé** de maintenir la collecte de données détaillées et de mettre à jour périodiquement la composition spécifique des captures, les distributions de tailles et les indices de CPUEs standardisées (e.g. chaque 2-3 ans). Ceci est essentiel dans le but de détecter d'éventuels signes de raréfaction locale de ces espèces dans la région. En particulier, pour le requin peau-bleu et le requin mako qui sont les

espèces les plus capturées et notamment pour le requin mako pour lequel des signes d'une diminution de la taille moyenne ont été détectés, une mise en jour de ces indices sur une base régulière serait de première importance.

- ***Tâche 4 – Zones biologique et écologiques sensibles***
  - Le requin mako semble avoir des déplacements et une utilisation de l'habitat régionalement marqués en particulier le long du plateau continental de l'Afrique de l'Ouest. Ce type de mouvements régionalement spécifiques a récemment été suggéré pour l'espèce dans l'Atlantique Ouest;
  - La présence d'adulte de requin peau-bleu de grande taille dans la région du Cap-Vert corrobore l'hypothèse du modèle de distribution spatiale de l'espèce dans l'océan Atlantique Nord avec des spécimens de grande taille principalement distribués dans les eaux tropicales chaudes et des juvéniles fréquentant des eaux tempérées plus froides;
  - Pour le requin mako, la zone près du plateau continental africain semble représenter un habitat essentiel pour l'espèce avec des agrégations importantes de juvéniles de petite taille.

- ***Tâche 5 - Coordination et communication***
  - Trois documents généraux ont été produits pour fournir des informations générales sur le projet, rassemblant les principaux objectifs, résultats et conclusions;
  - Un séminaire est en cours de préparation au Cap-Vert (INDP, Mindelo, São Vicente) pour présenter et discuter les résultats et conclusions du projet. Ce séminaire s'adressera aux scientifiques et personnels administratifs (Cap-Vert et UE), journalistes, aux ONGs intéressées ainsi qu'au grand public;
  - Une communication orale de certains résultats du projet a été présentée à l'occasion d'une conférence scientifique internationale (Conférence de l'Association Européenne des Elasmobranches, Bristol, 28-30 Octobre 2016, Bristol, Royaume-Uni);
  - Deux publications dans des journaux à comité de lecture sont prévus d'être soumis, en particulier une publication sur les principaux résultats des analyses des indicateurs, et une publication concernant les résultats majeurs obtenus à partir des marquages électroniques.

1 INTRODUCTION

1.1 Purpose of the specific contract

DG MARE commissioned the IEO led consortium for the Framework Contract (FWC) MARE/2012/21, 'Scientific advice for fisheries beyond EU waters'. Within this FWC, the Specific Contract Nº 7 (SC 07 - The provision of advice on the conservation of pelagic sharks associated to fishing activity under EU Sustainable Fisheries Partnership Agreements in the Atlantic Ocean) was requested with the purpose of providing to the EU Commission advice on the conservation of pelagic sharks associated to fishing activity under EU Sustainable Fisheries Partnership Agreements (SFPA) in the Atlantic Ocean, and specifically for the geographical area of the Cabo Verde Archipelago.

1.2 Tasks of the specific contract

The Specific Contract started in February 2015 and was completed in April 2017. The following tasks were planned, executed and completed during the project:

- Designing of an observer programme - Design and training for an observer sampling programme for the fleets capturing sharks in the Cabo Verde EEZ, including development of standard protocols for data collection and a database for the Cabo Verde observer programme.
- Designing and implementation of a tagging programme - Design and implementation of a tagging programme for the regional area of Cabo Verde and neighbouring waters of the tropical Atlantic, using electronic data collection tags with satellite transmission (Popup Archival and Spot Transmitting Tags). 30 tags were deployed covering the two major shark species caught in Cabo Verde waters (blue shark, *Prionace glauca* - BSH); and shortfin mako, *Isurus oxyrinchus* - SMA).
- Analysis of potential local depletion of sharks and impacts to the ecosystem - Analyses of the shark catch composition, catch rates (CPUEs - catch-per-unit-of-effort) and size distribution for the major shark species in Cabo Verde and neighbouring waters.
- Identify biological and ecological sensitive areas in Cabo Verde and neighbouring waters - Analyses of the spatial distribution of pelagic sharks in Cabo Verde and neighbouring waters and identification of potential biological and ecological sensitive areas such as nursery grounds.
- Coordination and communication - Dissemination of the results of the project, through different forms of reporting and by organizing a dedicated workshop in Cabo Verde.

1.3 Contents of the report

The Final Report of the project documents in detail the aim of the project, the methods used for each task and analysis, the main outputs, conclusions and final recommendations of the project. We also provide full detail of all the deliverables that were submitted, as well as a comprehensive list of all meetings and documentation produced and submitted. Moreover the details of the project dissemination both for the scientific community and the general public are provided. Finally, we inform about some of the difficulties encountered during the project execution, and how those difficulties were addressed by the consortium scientists in a positive and successful manner.

In terms of structure of this report, the initial sections provide the Abstract with the summarized details of the work, and the Executive Summary with the main outcomes and results. The methodology used for completing the tasks performed during the project is detailed in Section 2 with full and comprehensive details provided for each specific task. The Results are provided in Section 3 and are organized by task. Each of those sections is organized in a number of sub-sections, with each providing specific details and results of the specific objectives within each task. The discussion of the main results of the study is provided in Section 4 and the main conclusions and final recommendations are summarized in Section 5. Due to the important amount of information analysed, processed and the multiple number of outputs created, several annexes were compiled and added at the end of the report.

2 METHODOLOGY

2.1 Task 1 - Observer programme

For this task, an observer sampling programme was developed, including the provision of identification guides and forms to collect observer data, development of a self-reporting scheme and definition of the required observer coverage. Full details of this programme were provided in the Deliverable #4 of this project, and copies of the forms, ID guides and self-sampling programme are included in Annex I of this report. Observer training was provided through capacity building actions, specifically in 2014 under an ICCAT/Japan Data and Management Improvement Project (JDMIP) and in 2015 through this project.

The complete details of the activities that took place within this programme and the capacity building actions that were developed are provided in section 3.1 (Results - Task 1) of this report.

2.2 Task 2 - Tagging programme

As part of Task 2 (tagging), the ICCAT conventional tagging database[1] for the main shark species was analysed. A filter was applied to this data to subset only specimens that were tagged and/or recaptured in the Cabo Verde EEZ and/or in the 300 nm adjacent zone[2] (Figure 1). The species analysed were the two main shark species of interest, specifically the blue shark and the shortfin mako.

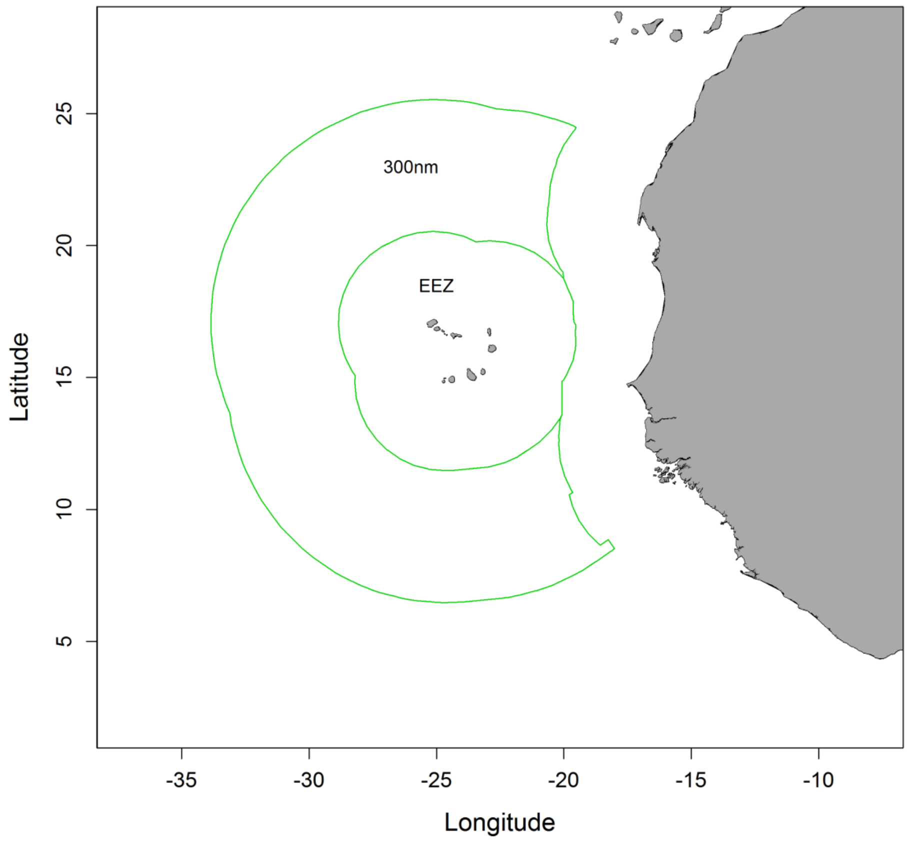

Figure 1. Map with an illustration of the Cabo Verde EEZ and the 300 nm adjacent waters outside the EEZ defined for the purpose of this study.

An electronic (satellite) tagging programme was also developed under Task 2 of this project. A total of 30 satellite tags were acquired and deployed, namely 25 miniPATs and 5 Fastloc GPS SPOT tags from Wildlife Computers. Of those, 20 miniPATs and 5 GPS SPOTs were deployed in blue sharks and 5 miniPATs were deployed in shortfin mako sharks, all inside the Cabo VerdeCape Verde EEZ.

The sharks were restrained alongside the vessel and handled carefully, and those in the best condition were selected for tagging in order to maximize post-release survivorship. Each tagged shark was identified, measured, and the sex and maturity stage determined (juvenile vs. adult, based on size and sex). Additional data recorded

[1] ICCAT Conventional Tagging Database. Available from https://www.iccat.int/en/accesingdb.htm.

[2] For the purpose of this report, the adjacent zone is defined as the area of water 300 nautical miles (nm) adjacent to the Cabo Verde EEZ.

for each tagged specimen included tagging location (latitude and longitude), date and time.

The technology of the two types of satellite tags used works differently. The miniPAT tags archive detailed depth and temperature time-series data and use the light-based information for geo-locations. On the contrary, the Fastloc GPS SPOT tags use GPS based geo-locations that are much faster and provide more precise estimates, but do not record depth and temperature profiles. As such, both tags were used to provide complementary information on the sharks habitat use and movements. The miniPATs were programmed to archive data on depth, temperature and light levels for periods of 120 days, with that deployment period duration chosen based on the experience of the research team tagging pelagic sharks, where such period has been shown to provide a good compromise between deployment duration and transmission success. Full details of the tagging templates used in the miniPAT and Fastloc GPS SPOT tags are shown below:

Tagging template used in the miniPAT tags (RTF format):

```
Serial Number: 13P0508
Report date: 07-Jul-2016 23:23:34 UTC
  General
    Tag Identification
      Serial Number  13P0508
      Tagware Version  2.4k
    Argos PTT
      PTT Uplink ID  15423:212
      PTT ID Dec  160157
      PTT ID Hex  F0FD7D4
      Repetition Interval  60 seconds
  Data To Transmit
    Daily Messages
      Light Level Geolocation Messages  Always Transmit
      Daily Data Messages  Never Transmit
    Time-Series
      Depth Messages  Always Transmit
      Temperature Messages  Always Transmit
      Sampling Interval  600 Seconds
    Summary Messages
      Transmit MLT Messages  Always Transmit
      Transmit Histogram Messages  Always Transmit
      PDT Messages  Always Transmit
        PDT Resolution  high
      Summary Period  6 Hours
      Histograms
        Time-at-Temperature (C)
          Number of TAT Bins  12
          TAT Limits  3;6;9;12;15;18;21;24;27;30;33;>33
        Time-at-Depth (m)
          Number of TAD Bins  12
          TAD Limits  5;10;20;40;70;100;150;200;300;500;800;>800
  When To Release
    External Release Device False
    Planned:
      Date or Days after deployment:   120 days
    Exceptions:
      Immediately Release if depth exceeds 1700m:  False
      The Following events will trigger a Release if depth exceeds:  10 meters
      And the event lasts longer than:  3 days
        Floats at surface  False
        Stays Deeper than:  Disabled
        Constant Depth Range  (+/- 2.5m)
    Flash size (MB)  16
    Archive Storage Capacity (KB)  16225
    All Sensors Sampled at a Rate of  3 Seconds
    Homing Pinger Setup
      Enable Homing Pinger  False
      Ping Interval  1 seconds
```

Tagging template used in the Fastloc GPS SPOT tags (XML format):


```
<tag>
  <serial_number>15U1035</serial_number>
  <tag_type>SPOT6-F</tag_type>
  <tagware_platform>UT</tagware_platform>
  <tagware_version>1.00a-5209</tagware_version>
  <name>Coelho / Fw0567</name>
  <features_config>
    <argos_config>
      <ptt_decimal>160152</ptt_decimal>
      <ptt_hex>F0FD78B</ptt_hex>
    </argos_config>
    <wet_dry_config>
      <conductivity_threshold>auto</conductivity_threshold>
    </wet_dry_config>
    <data_interval_seconds>3</data_interval_seconds>
  </features_config>
  <data_config>
    <time_at_temperature>off</time_at_temperature>
    <percent_dry_timeline>off</percent_dry_timeline>
  </data_config>
  <transmission_config>
    <dry_delay_seconds>0</dry_delay_seconds>
    <transmission_attempts_per_message>10</transmission_attempts_per_message>
    <transmission_hours>
      <hour>0</hour>
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    </transmission_hours>
    <at_sea>
      <repetition_rate_seconds>45</repetition_rate_seconds>
      <patterns>
        <pattern>
          <start_days>0</start_days>
          <loop_step>1</loop_step>
          <steps>
            <step>
              <number>1</number>
              <hours>24</hours>
              <limit_type>total</limit_type>
              <pinger_enabled>false</pinger_enabled>
              <argos_transmission_limit>100</argos_transmission_limit>
              <fastloc_snapshot_limit>4</fastloc_snapshot_limit>
            </step>
          </steps>
        </pattern>
      </patterns>
    </at_sea>
    <haul_out>
      <repetition_rate_seconds>90</repetition_rate_seconds>
    </haul_out>
  </transmission_config>
</tag>
```

The miniPATs were rigged with monofilament leaders secured with stainless steel crimps and encased in plastic tubing. An umbrella-type nylon dart (Domeier et al., 2005) was used to attach the tags laterally to the shark dorsal musculature below the first dorsal fin, using the methodology described by Howey-Jordan et al. (2013) (Figure 2). For the SPOT tags, the attachment mode was with a fin mount system in the first dorsal fin provided by the tag manufacturer.

Figure 2. Photograph of a satellite PAT tag fixed in the dorsal musculature below the first dorsal fin of a pelagic shark.

The archival data of the miniPAT tags were processed and analysed for the depth and temperature time series profiles along the deployment period. The percentages of habitat utilization in terms of time-at-depth and time-at-temperature were calculated and analysed separately for the daytime and night-time periods to assess the daily shark habitat use. The habitat utilization was also analysed separately for males and females, as well as juveniles and adult specimens, to determine if habitat use varied by sexes and/or maturity stages. For this analysis the depth profiles were categorized into 30 m depth classes. Additionally, the minimum and maximum daily depths recorded were also analysed.

For estimating geographical daily positions, the Fastloc GPS tags have a receiver that provides locations approaching the quality of those obtained from traditional GPS receivers. The Fastloc GPS signals are processed by the tags, compressed into a snapshot and then transmitted over the ARGOS satellite system. The transmitted snapshots are then processed by an algorithm to generate the specimen locations.

For the miniPATs, the daily locations were calculated based on the light levels recorded that were processed using state-space statistical models (GPE3 software, processed through the tag manufacturer web portal). The miniPATs provide observations on twilight, sea surface temperature and dive depth, and the state-space modelling approach uses those observations and the corresponding reference data, along with a simple diffusion based movement model, to generate time-discrete gridded probability surfaces throughout the deployment. The corresponding oceanographic reference data used was from NOAA Optimum Interpolation SST V2 High Resolution for the sea surface temperature, and from NOAA ETOP01 global relief model, Bedrock version, for bathymetry. The grids used were 0.25*0.25 degrees of latitude * longitude. From those probability surfaces, the most likely animal locations for a given day/time were derived. Likelihood surfaces were generated using the "raster" (Hijmans, 2016) and "ncdf4" (Pierce, 2015) packages for the R language for Statistical Computing v3.2.0 (R Core Team, 2015).

2.3 Task 3 - Analysis of potential local depletion of sharks

2.3.1 Data collection

The data collected and analysed for this task included 1) ICCAT Task II CE (Catch and Effort) database; 2) the new INDP database with the reported logbook catches for the EU fleet; 3) the EU pelagic longline fleets (Portuguese and Spanish) logbook data to which VMS information was added for obtaining precise locations; and 4) data from the EU fishery observer programmes.

The ICCAT Task II CE database is in general much less detailed than the other sources as the catch and effort are reported in varying units and degrees of precision. Specifically, the catches can be reported in either biomass (kg) or number (n), and the spatial resolution includes 1*1, 5*5, 5*10, 10*10 or 20*20 degree squares/rectangles which hinder fine scale spatial analysis. The logbook data reported to Cabo Verde that is now being compiled in the new INDP database is more detailed and was used to provide a general overview of the reported catch and effort of sharks inside the Cabo Verde EEZ. It should be noted that this data has only been compiled for the EU fleets and for the years 2010-2013. The EU fleets logbooks (with VMS) and observer data is more detailed and was analysed mainly to provide the detailed analysis on the sharks catch composition, catch rate trends and size distributions in the region. This data was available and analysed between 2006 and 2015. However, the year 2008 was not included in the catch and effort (CPUE) analysis, due to issues external to the project regarding the database acess and format, which did not allow linking the catch, effort and location (VMS) data. All fisheries parameters and indicators were compared between the Cabo Verde EEZ and the neighbouring 300nm area, according to the study areas previously defined.

2.3.2 Catch composition

Using the detailed logbook and fishery observer data, the relative shark catch composition over time was calculated and plotted. This was analysed for the general Cabo Verde area, as well as in a detailed analysis for the comparison between the Cabo Verde EEZ and neighbouring 300 nm area.

2.3.3 Size distribution

The annual trends in the size frequency distributions and mean sizes were analysed and plotted by area, sex and quarter of the year. Size data were tested for normality with Kolmogorov-Smirnov normality tests with Lilliefors correction (Lilliefors, 1967), and for homogeneity of variances with Levene tests (Levene, 1960). Specimen sizes were compared between regions (Cabo Verde EEZ and adjacent area), sexes and quarters of the year using non-parametric k-sample permutation tests (Manly, 2007).

The median sizes at maturity used to define immature and mature specimens were based on the ICCAT Sharks Working Group report (Anon., 2014) for the North Atlantic shark stocks, as follows:

- Blue shark (males) = 200.1 cm Fork Length (FL);
- Blue shark (females) = 185.1 cm FL;
- Shortfin mako (males) = 182.5 cm FL;
- Shortfin mako (females) = 286.5 cm FL.

2.3.4 CPUE trends and standardization

The time series of the catch per unit of effort (CPUE, biomass in Kg/1000 hooks) for the EU longline fleets (Portuguese and Spanish) were plotted for the main shark species. This allowed following the trends over time and also assessing seasonality effects in the catch rates. The CPUE time series trends were standardized in order to remove the fishery-dependent effects (i.e., spatial, seasonal and targeting effects) and estimate relative indexes of abundance that can be used as population status indicators. For the standardization process, the response variable considered was catch per unit of effort (CPUE) measured in biomass of live fish (kg) per 1000 hooks deployed. The standardized CPUEs were estimated with statistical models using Generalized Linear Models (GLMs) and Generalized Linear Mixed Models (GLMMs).

The CPUE standardization was carried out for the blue shark and shortfin mako. The data of those species has different characteristics, and as such different models were tested and applied in each case. Specifically, the blue shark is relatively common in the catches and has a low percentage of fishing sets with zero catches, while the shortfin mako is rarer in the catches with a much higher percentage of fishing sets with zero catches. The presence of fishing sets with zero catches results in a response variable of CPUE=0, that can cause mathematical problems for fitting the models, and as such different approaches were tested and applied in each case.

Four different modelling methodologies were used and compared, specifically tweedie, gamma, lognormal and delta lognormal models. For the tweedie models the nominal CPUE was used directly as the response variable given that this distribution can handle a certain proportion of zeros (mass) and a continuous distribution for the non-zeros. For the gamma and lognormal models the response variable was defined as the nominal CPUE + constant (c), with c set to 10% of the overall mean catch rate. The value of c=10% of the mean has been recommended by Campbell (2004), as it seems to minimize the bias for this type of adjustments. Further, and in a comparative study, Shono (2008) showed that when the percentage of zeros in the dataset is low (<10%), the method of adding a constant to the response variable performs relatively well. The final tested approach was a delta-lognormal model that uses and combines two different models, specifically a binomial model for the proportion of positive catches and a lognormal model for the expected CPUEs in the positive sets.

The covariates considered and tested in the models were:

- Year: analyzed between 2006 and 2015;
- Seasonal effects (quarters of the year, 4 categories): 1 = January to March, 2 = April to June, 3 = July to September, 4 = October to December;
- Spatial/area effects: tested as 5*5 or 10*10 degree grids;
- Targeting effects: based on the SWO/SWO+BSH ratio of captures.

Interactions between pairs of variables were considered and tested in the analysis and used in the final models if significant. Specifically, interactions not involving the year factor were considered as fixed factors in GLM type models, while interactions involving the year factor were considered as random variables within GLMM models.

In terms of targeting effects, the differences in fishing strategy reflect the increased economic importance of sharks among the EU pelagic longline fleets which traditionally targeted swordfish almost exclusively. These changes in target species were incorporated into the model by a proxy based on the ratio of the swordfish catch and the combined swordfish and blue shark catches by set. This ratio is in general considered a good proxy indicator of target criteria more clearly directed at swordfish versus a more diffuse fishing strategy aimed at the two main species (i.e., swordfish and sharks). Moreover, this methodology has been consistently applied both to the EU fleets (Portuguese and Spanish) that have a similar method of operation, including applications to the Atlantic and Indian Oceans (e.g., Ramos-Cartelle et al., 2011; Mejuto et al., 2012; Santos et al., 2013; Coelho et al., 2014). This ratio factor used as proxy for targeting effects was calculated by set and categorized into ten levels using the 0.1 quantiles.

Other approaches for including targeting effects into the CPUE standardization process have been tested in the past. Specifically for the Portuguese pelagic longline fishery, Coelho et al. (2015a) tested a cluster analysis based on the catch composition of the 10 major species or species-groups, in an analysis as suggested by He et al. (1997) and that has been successfully applied for CPUE standardization of other fleets (e.g. Wang and Nishida, 2014, for the Taiwanese fleet in the Indian Ocean). Coelho et al. (2015a) demonstrated that for the Portuguese pelagic longline fleet (EU fleets in general), given that the catches are largely dominated by the two major species (i.e., swordfish and blue shark) the use of ratios or clusters resulted in very similar results.

The significance of the explanatory variables in the CPUE standardization models, as well as the interactions, were assessed with likelihood ratio tests comparing each univariate model to the null model (considering a significance level of 5%), and by analyzing the deviance explained by each covariate. Goodness-of-fit and model comparison was carried out with the Akaike Information Criteria (AIC) and the pseudo coefficient of determination (R^2). Model validation was carried out with a residual analysis. The final estimated indexes of abundance were calculated by least square means (LSMeans or Marginal Means), that for comparison purposes were scaled by the mean standardized CPUE in the time series.

Statistical analysis for this section of the study was carried out with the R language for Statistical Computing v3.2.0 (R Core Team, 2015) using several additional libraries: "MASS" (Venables and Ripley, 2002), "reshape" (Wickham, 2007), "ggplot2 (Wickham, 2009), "car" (Fox and Weisberg, 2011), "nortest" (Gross and Ligges, 2012), "maps" (Becker et al., 2013), "maptools" (Bivand and Lewin-Koh, 2013), "tweedie" (Dunn, 2013), "shapefiles" (Stabler et al., 2013) and " lsmeans " (Lenth, 2014).

2.4 Task 4 - Biological and ecological sensitive areas

Generalized Additive Models (GAM) were used to predict the expected blue shark and shortfin mako shark catch rates (CPUEs) and size distribution as a function of location (latitude and longitude) along the study area and quarter of the year. Due to the data shape and characteristics, the models used were lognormal GAMs for modelling the CPUEs and Gaussian with identity link function for modelling the sizes.

The predictors in the models were given by the smooth functions of latitude and longitude plus a parametric component for the quarters of the year. The smooth terms for the location covariates were estimated by maximum likelihood with thin plate regression splines (Wood, 2003). The significance of the model parameters was tested with likelihood ratio tests comparing nested models, including the significance of the interactions between latitude, longitude and quarter of the year. Goodness-of-fit was assessed with the Akaike Information Criterion (AIC; Akaike, 1973) and with the final deviance explained. A residual analysis was carried out for model validation. The expected mean catch rates and sizes were mapped along the study area and for each quarter of the year.

The analysis for this section was carried out using the R language for statistical computing v3.2.0 (R Core Team, 2015) using the following additional libraries: “car” (Fox and Weisberg, 2011), “classInt” (Bivand, 2013), “ggplot2” (Wickham, 2009), “gmodels” (Warnes et al., 2013), "KernSmooth" (Wand, 2015), “lme4” (Bates et al., 2013), “maps” (Becker et al., 2013), “mapplots” (Gerritsen, 2013), “maptools” (Bivand and Lewin-Koh, 2013), “mgcv” (Wood, 2006, 2011), “perm” (Fay and Shaw, 2010), “plyr” (Wickham, 2011), “rgdal” (Bivand, et al., 2013), “scales” (Wickham, 2012) and “shapefiles” (Stabler, 2013).

3 RESULTS

3.1 Task 1 - Observer programme

For this task an observer sampling programme was developed, including the provision of identification guides and forms to collect observer data, development of a self-reporting scheme and definition of the required observer coverage. Due to practical reasons regarding the working language of the local technicians, the local Institute (INDP) required that the ID guides, manuals, templates and database should be developed in Portuguese, which was done by the Consortium.

The different documents were provided in Deliverable #4 of the project and are also shown in detail in Annex I of this report. Those include:

- Identification guides: identification guides to be used by the observers, as well as dichotomous identification keys, previously developed for the EU longline fleet observer programmes were presented and provided to the local focal point of the project. Those guides were also used during the capacity building activities that took place in Cabo Verde during the project. These identification guides and dichotomous keys do not only cover shark species, but also other taxa commonly caught in the area that are of interest to the observers, such as tunas, billfishes and sea turtles;

- Forms to collect observer data: data forms developed by EU observer programmes were adapted to ensure the collection of data on target and by-catch species, including sharks. The forms provided include specific forms regarding the collection of:
  - Fishing gear characteristics;
  - Longline set data (including geographical location, effort, bait and additional oceanographic data such as sea surface temperature, wind and sea condition);
  - Catch and by-catch data (for individual specimens, including species identification, fate, status at haulback, size, sex and maturity stage);
  - Discard data;
  - Biological samples, such as vertebra, genetic tissue and spines.

- Development of a self-reporting scheme: this sampling scheme is complementary to the data collected on board by the observers, consisting of a dedicated electronic logbook to be filled in by skippers in trips when scientific observers are not present. Those forms enable skippers to self-report a wide variety of data (including fishing gear characteristics, longline set information, catch composition and size/weight of retained and discarded catch), and enables the estimations of live and processed weight of the retained catch. A manual of procedures has been produced to help skippers to fill in the logbook and self-report their fishing activity including the retained and discarded catch;

- Development of a relational database: this database was developed by INDP in consultation with Consortium scientists and is property of INDP. The database was developed to store all the logbook and observer data collected, including from both the EU and other fleets that operate in the Cabo Verde waters. Queries were prepared and can be further developed as appropriate and needed, as well as protocols for data entry and accessibility/confidentiality. A specific module of the database is dedicated for storage of fishing activity and catch reported by foreign fleets operating in the Cabo Verde EEZ under past and current international fisheries agreements.

For the observer training component of the project, in 2014 under the ICCAT/Japan Data and Management Improvement Project (JDMIP), researchers from the Consortium (namely IPMA) provided a training course to 18 local technicians and 5 fisheries inspectors from Cabo Verde. Within the scope of the present project, and in strait collaboration with ICCAT/JDMIP (which funded the attendance of the local technicians), additional observer training was conducted at INDP in April 2015 (5 days), in which 9 students (7 technicians and 2 inspectors) received formation on general aspects of species identification, biology, data analysis and reporting. This course was focused on fisheries and biology of highly migratory tuna and tuna-like species, exploited by local fisheries and/or caught within the scope of SFPAs. Of those 9 students, additional formation specific to longline fisheries data collection, onboard sampling and reporting was provided to 4 technicians, as those were indicated by INDP as the ones likely start as observers in the Cabo Verde observer programme. Some images of the training workshop are provided in Figure 3. The deliverable of this work (Deliverable #4) was submitted before the deadline in May 2015 and provided in Annex I of this report.

The items covered during the training course are provided bellow and included the following:

- Brief overview on pelagic longline fisheries;
- General review on pelagic fish biology;
- Pelagic species identification (elasmobranchs, bony fishes and marine turtles);
- Sampling design and sample processing;
- Data analysis:
    - Brief overview and introduction to the open-source R language;
    - Linear and non-linear models;
    - Weight-weight, length-length and length-weigh relationships and modelling;
    - Age & growth modelling;
    - Size/age at maturity modelling;
    - Development of examples applied to fisheries biology data.

The additional items covered with the 4 technicians more specific to the longline fisheries observer programme and sampling included the following:

- Pelagic longline fisheries operations;
- Onboard data collection and sampling;
- Self-sampling programme;
- Data reporting.

After the course, a questionnaire was distributed to the participants in order to assess the relevance and quality of the formation. The results are presented in Annex II of this report, and showed that the training course provided was considered very interesting and important by all the trainees, highlighted both by the technicians and fishery inspectors that attended to the course.

Figure 3. Photographs of the training workshop organized at the local fisheries Institute of Cabo Verde (INDP), where the local technicians received formation aiming the implementation of the observer programme.

The implementation of the observer programme (2nd part of Task 1) is the responsibility of the Cabo Verde administration and INDP. However, the Consortium scientists continue to collaborate with INDP in trying to facilitate contacts with the EU fishing sector in order to engage skippers from the EU longline fleet with potential future activity in the Cabo Verde waters under the EU-Cabo Verde SFPA. The Consortium also continues collaborating with INDP in the development of the MS Access relational database for storing the datasets. Figure 4 shows some screen captures of the relational database that has been developed and is currently being used for data collection and analysis.

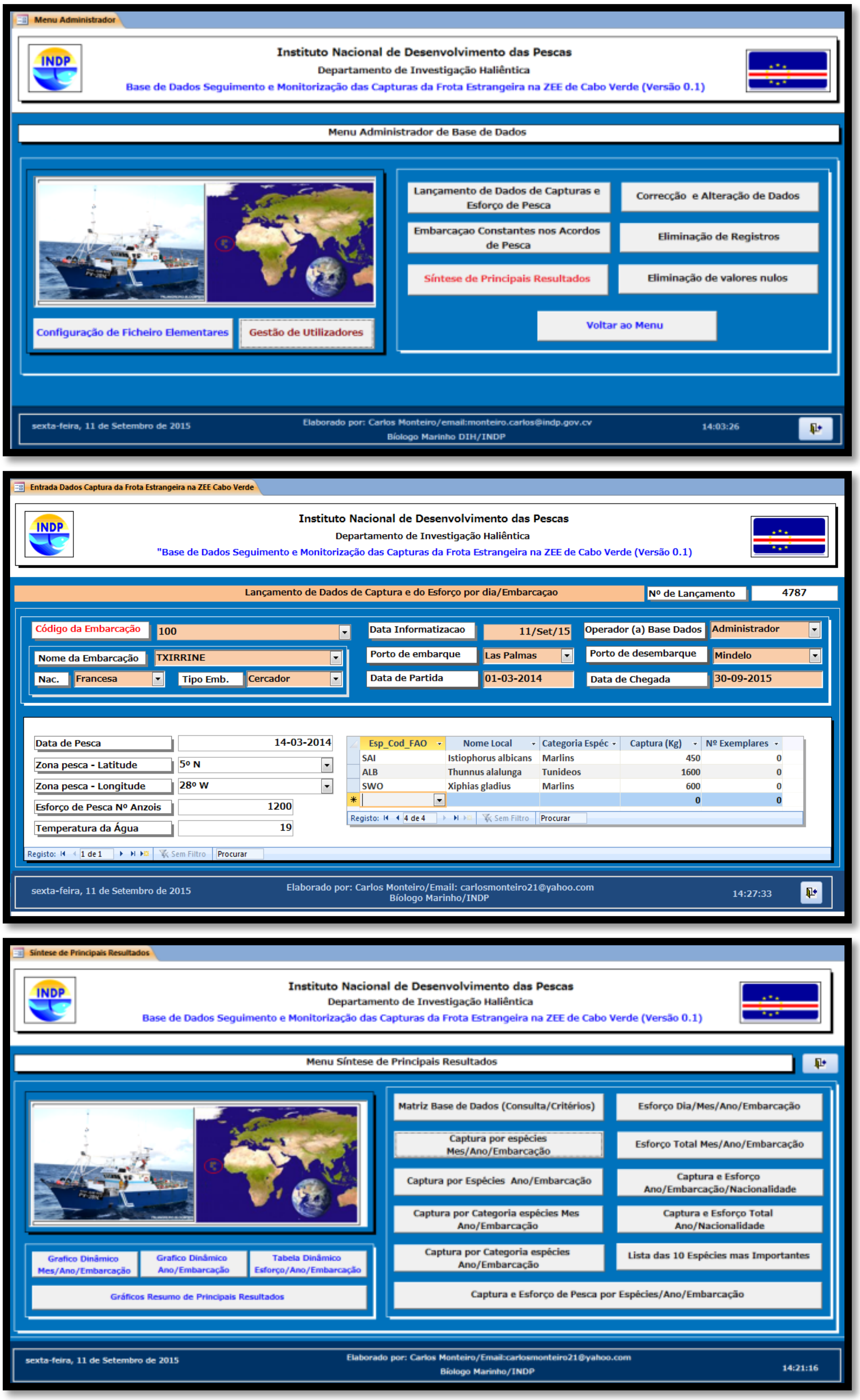


Figure 4. Screen captures of the relational database (MS Access, in Portuguese) developed by the local Institute of Cabo Verde (INDP) in collaboration with the Consortium to hold historical and new data from pelagic fisheries operating in the Cabo Verde EEZ. The top screen shows the main interface of the database, the middle screen the interface for data entry, and the bottom screen the interface for synthesis of results. The data shown in the screen captures is provided for illustration purposes only.

3.2 Task 2 - Tagging programme

3.2.1 Conventional tagging

The analysis of the ICCAT conventional tagging databases depicts the captures and recaptures of shortfin mako and blue shark in the Cabo Verde EEZ and surrounding area. The database compiles the tagging and recapture information of pelagic sharks in the ICCAT area, and includes data between 1959-2014 for blue shark and 1962-2014 for shortfin mako.

Specifically, for the blue shark 573 specimens were released and 214 recaptured within the EEZ and 300 nm adjacent waters (Figure 5). From those, only 6 specimens were both released and recaptured inside the study area (Figure 6). The average time at liberty was of 86 days, excluding one individual that was at liberty for 1396 days. However it is not possible to know if these sharks remained in the area or if they migrated outside and returned to the area as conventional tagging data is limited to tagging and recapture locations. Most of the blue shark specimens recaptured in the Cabo Verde EEZ were tagged in areas at considerable distances, particularly in the temperate northwest and northeast Atlantic. Some specimens were tagged in the southern hemisphere in the southeast Atlantic (Figure 5).

Regarding the shortfin mako, there were 6 releases of shortfin mako and 4 recaptures in the study area (Figure 7 and Figure 8). There was no individual both tagged and recaptured inside the EEZ. Some of the specimens recaptured inside the Cabo Verde EEZ were tagged at considerable distance from the area, specifically in the temperate northwest Atlantic, showing that this species is also capable of occasional large scale transatlantic movements.

In general, the tag-recapture data available from conventional tagging shows the high mobility of those pelagic shark species that can move between the Cabo Verde EEZ and other distant regions, including areas in both hemispheres and both sides of the Atlantic.

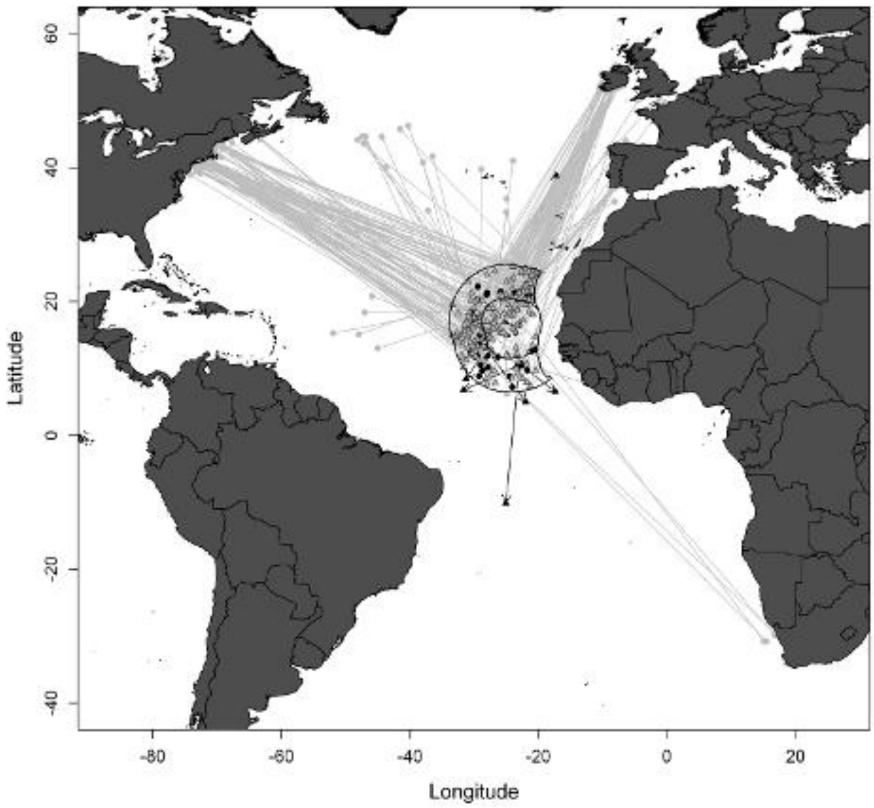


Figure 5. Map of the North Atlantic Ocean showing large scale movements of the blue shark, *Prionace glauca*, tagged and/or recaptured within the Cabo Verde EEZ or the 300 nm adjacent waters. Circles represent releases and triangles represent recaptures; black colour represents individuals that were captured inside the Cabo Verde EEZ or within the 300 nm adjacent waters but recaptured outside these areas and grey colour represents individuals that were recaptured inside the Cabo Verde ZEE or within the 300 nm adjacent waters but tagged outside these areas. (Source: ICCAT conventional tagging database).

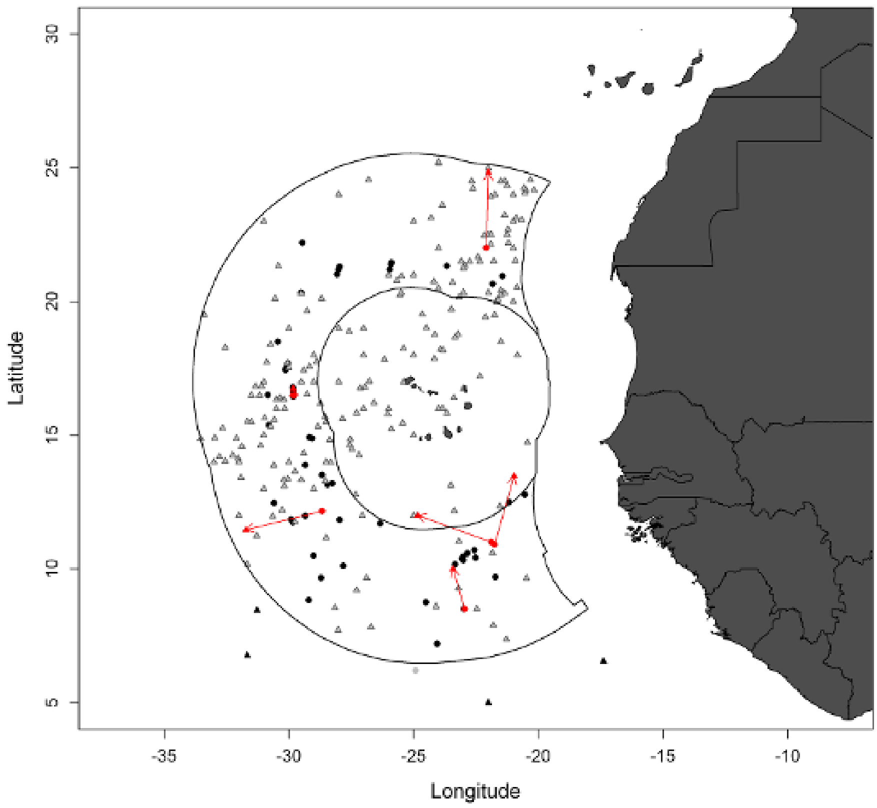


Figure 6. Map of the Cabo Verde area showing small scale movements of the blue shark, *Prionace glauca*, tagged and/or recaptured within the Cabo Verde EEZ or the 300 nm adjacent waters. Circles represent releases and triangles represent recaptures; black colour represents individuals that were captured inside the Cabo Verde EEZ or within the 300 nm adjacent waters but recaptured outside these areas and grey colour represents individuals that were recaptured inside the Cabo Verde ZEE or within the 300 nm adjacent waters but tagged outside these areas. Red circles, triangles and arrows represent individuals that were both released and recaptured within the Cabo Verde EEZ and the 300 nm adjacent waters. (Source: ICCAT conventional tagging database).

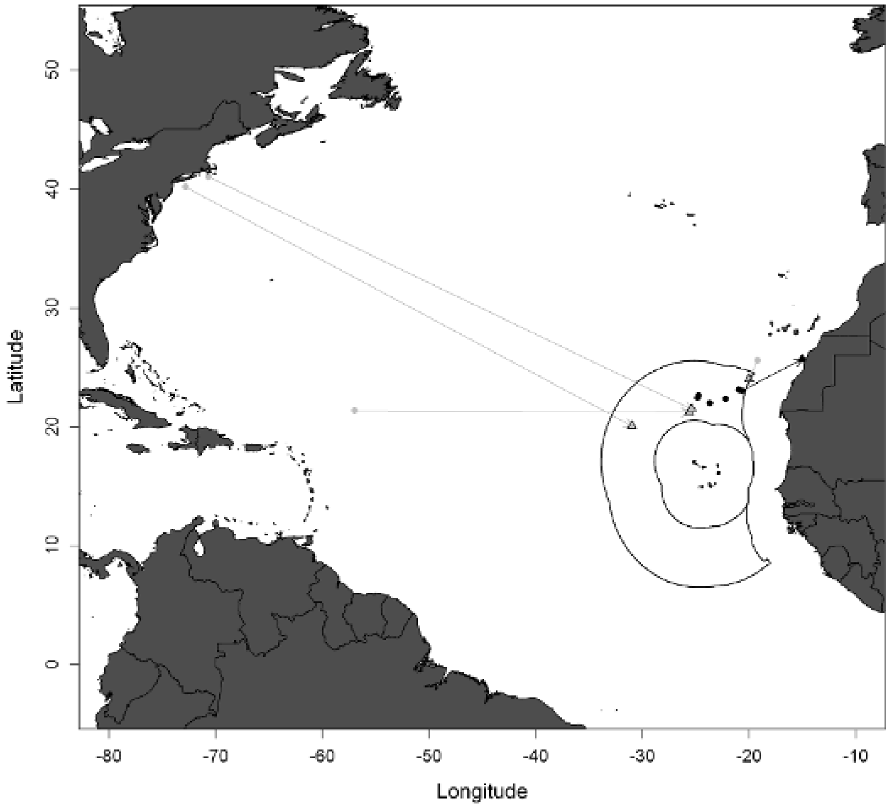


Figure 7. Map of the North Atlantic Ocean showing large and small scale movements of the shortfin mako shark, *Isurus oxyrinchus*, tagged and/or recaptured within the Cabo Verde EEZ or the 300 nm adjacent waters. Circles represent releases and triangles represent recaptures; black colour represents individuals that were captured inside the Cabo Verde EEZ or within the 300 nm adjacent waters but recaptured outside these areas and grey colour represents individuals that were recaptured inside the Cabo Verde EEZ or within the 300 nm adjacent waters but tagged outside these areas. (Source: ICCAT conventional tagging database).

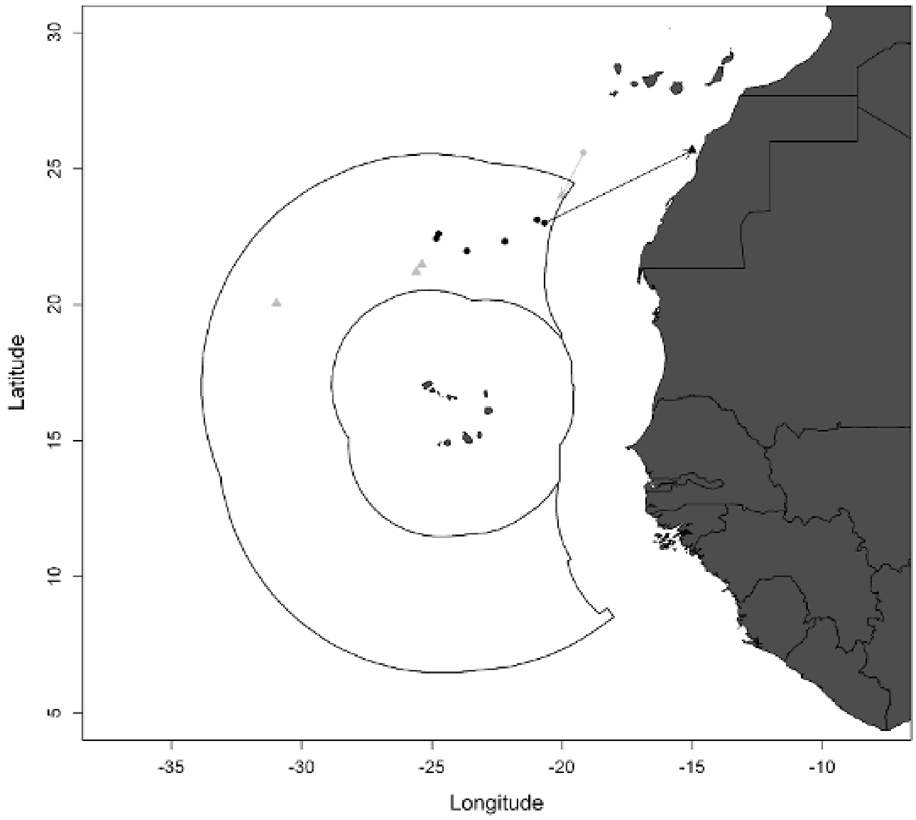


Figure 8. Map of the Cabo Verde area showing small scale movements of the shortfin mako shark, *Isurus oxyrinchus*, tagged and/or recaptured within the Cabo Verde EEZ or the 300 nm adjacent waters. Circles represent releases and triangles represent recaptures; black colour represents individuals that were captured and tagged inside the Cabo Verde EEZ or within the 300 nm adjacent waters but recaptured outside these areas and grey colour represents individuals that were recaptured inside the Cabo Verde EEZ or within the 300 nm adjacent waters but tagged outside these areas. (Source: ICCAT conventional tagging database).

3.2.2 Satellite tagging

The satellite tags were deployed between July and October 2016 inside the Cabo Verde EEZ, as defined in the tagging plan and project objectives (Figure 9). Tagged specimens included both sexes (males and females) and both juvenile and adult specimens (Table 1). Data from 6 SPOTs deployments (5 SPOT tags, with one tag used twice) and from 24 miniPATS (of the 25 deployed), transmitted successfully.

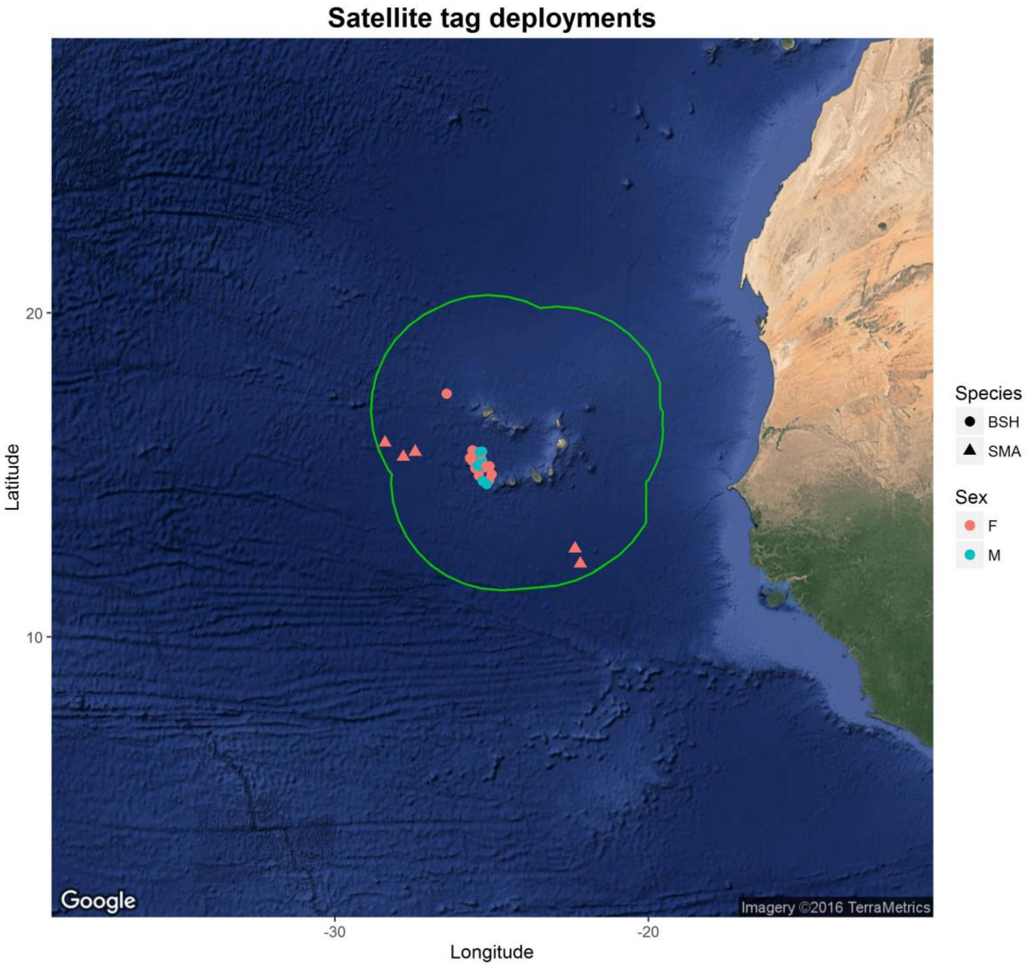


Figure 9. Map with the location of the satellite tag deployments, with the representation of the Cabo Verde EEZ.

The SPOT tags (6 deployments) had duration periods between 22 and 88 days, with 2 of the tagged specimens fished (recaptured) after 50 and 77 days at liberty. In one of the cases, the vessel that recaptured the shark contacted the Consortium scientists immediately after the recapture event and the vessel crew, that had experience deploying scientific telemetry tags, was able to re-deploy the tag on another blue shark specimen a few days later (Table 1). Overall, the deployed SPOT tags recorded data on 328 tracking days for the 6 blue shark specimens (Table 2)

The miniPAT tags were programmed for deployment periods of 120 days (4 Of the 25 deployed tags (20 on blue shark and 5 on shortfin mako), 10 tags the full deployment period and popped-up on the expected date (8 blue sharks shortfin makos), 10 specimens suffered post-release mortality (7 blue sharks shortfin makos) between 1 and 26 days at liberty, 1 blue shark was recaptured fishing vessel after 71 days at liberty, 2 blue sharks dived to the maximum tag (~1850m) after 56 and 76 days at liberty and the tags released to avoid to excessive pressure, 1 tag had premature release (shedding) after 12 days, tag failed to transmit

Table 2). Overall, a total of 1,296 tracking days were recorded for blue sharks and 258 days for shortfin mako (Table 2).

Table 1. Detailed list of tags used and deployed within the project with the respective specimen characteristics (species, size, sex and maturity stage) and deployment information (date and geographical location).

ArgosID	TagType	Species	SizeFL (cm)	Sex	Maturity	Deployment		
						Date	Lat	Long
160152	SPOT6-F	BSH	205	F	Adult	28-Jul-16	15.50	-25.38
160153	SPOT6-F	BSH	195	M	Adult	29-Jul-16	14.83	-25.17
160154	SPOT6-F	BSH	180	F	Juvenile	28-Jul-16	15.48	-25.37
160154-2	SPOT6-F	BSH	190	F	Juvenile	28-Oct-16	17.53	-26.33
160155	SPOT6-F	BSH	175	M	Juvenile	28-Jul-16	15.65	-25.52
160156	SPOT6-F	BSH	170	M	Juvenile	29-Jul-16	14.80	-25.17
160157	miniPAT	BSH	180	F	Juvenile	28-Jul-16	15.20	-25.23
160158	miniPAT	BSH	195	M	Adult	28-Jul-16	15.23	-25.23
160159	miniPAT	BSH	180	F	Juvenile	28-Jul-16	15.30	-25.27
160160	miniPAT	BSH	210	M	Adult	28-Jul-16	15.35	-25.30
160161	miniPAT	BSH	180	F	Juvenile	28-Jul-16	15.38	-25.30
160162	miniPAT	BSH	195	F	Adult	28-Jul-16	15.62	-25.47
160163	miniPAT	BSH	180	F	Juvenile	28-Jul-16	15.58	-25.47
160164	miniPAT	BSH	210	F	Adult	28-Jul-16	15.58	-25.45
160165	miniPAT	BSH	200	F	Adult	28-Jul-16	15.60	-25.48
160166	miniPAT	BSH	200	F	Adult	28-Jul-16	15.60	-25.47
160167	miniPAT	BSH	185	F	Juvenile	28-Jul-16	15.15	-25.22
160168	miniPAT	BSH	195	F	Adult	28-Jul-16	15.38	-25.32
160169	miniPAT	BSH	200	M	Adult	28-Jul-16	15.13	-25.20
160170	miniPAT	BSH	185	F	Juvenile	28-Jul-16	15.12	-25.18
160171	miniPAT	BSH	195	F	Adult	28-Jul-16	15.15	-25.22
160172	miniPAT	BSH	195	F	Adult	28-Jul-16	15.42	-25.33
160173	miniPAT	BSH	195	F	Adult	28-Jul-16	15.17	-25.22
160174	miniPAT	BSH	200	F	Adult	28-Jul-16	15.43	-25.35
160175	miniPAT	BSH	210	M	Adult	28-Jul-16	15.57	-25.43
160176	miniPAT	BSH	210	F	Adult	28-Jul-16	15.55	-25.43
160177	miniPAT	SMA	200	F	Juvenile	02-Aug-16	12.17	-21.98
160178	miniPAT	SMA	150	F	Juvenile	24-Sep-16	15.87	-28.37
160179	miniPAT	SMA	175	F	Juvenile	06-Sep-16	12.67	-22.28
160180	miniPAT	SMA	180	F	Juvenile	20-Sep-16	15.67	-27.23
160181	miniPAT	SMA	155	F	Juvenile	19-Sep-16	15.65	-27.93

Table 2. Detailed information for the tag pop-up data, with the geographical location, number of tracking days, distance covered (Km) and tag/ specimen fate.

ArgosID	TagType	Species	Pop-up				Tag/Specimen Fate
			Lat	Long	Track days	Track dist (km)	
160152	SPOT6-F	BSH	19.41	-25.48	50	1,818	Fished
160153	SPOT6-F	BSH	8.189	-18.291	62	1,949	Full deployment
160154	SPOT6-F	BSH	15.43	-28.65	77	1,251	Fished
160154-2	SPOT6-F	BSH	14.50	-28.29	29	590	Full deployment
160155	SPOT6-F	BSH	18.82	-23.07	22	503	Full deployment
160156	SPOT6-F	BSH	13.47	-33.76	88	2,218	Full deployment
160157	miniPAT	BSH	19.51	-28.91	121	1,934	Full deployment
160158	miniPAT	BSH	20.92	-26.70	56	2,128	Max depth
160159	miniPAT	BSH	13.25	-25.98	12	248	Premature release
160160	miniPAT	BSH	18.40	-16.97	121	4,676	Full deployment
160161	miniPAT	BSH	-	-	-	-	Failed
160162	miniPAT	BSH	17.42	-27.83	19	560	Mortality
160163	miniPAT	BSH	15.04	-25.32	9	200	Mortality
160164	miniPAT	BSH	-0.41	-24.77	121	4,407	Full deployment
160165	miniPAT	BSH	22.16	-27.93	76	2,568	Max depth
160166	miniPAT	BSH	14.99	-27.68	26	489	Mortality
160167	miniPAT	BSH	20.42	-26.32	121	4,860	Full deployment
160168	miniPAT	BSH	14.73	-26.15	17	348	Mortality
160169	miniPAT	BSH	12.15	-22.62	121	4,431	Full deployment
160170	miniPAT	BSH	17.14	-25.81	9	281	Mortality
160171	miniPAT	BSH	17.51	-17.10	121	4,192	Full deployment
160172	miniPAT	BSH	18.48	-31.43	121	3,912	Full deployment
160173	miniPAT	BSH	17.94	-27.14	30	918	Mortality
160174	miniPAT	BSH	18.25	-16.80	121	4,360	Full deployment
160175	miniPAT	BSH	15.51	-25.31	3	35	Mortality
160176	miniPAT	BSH	13.27	-30.62	71	1,613	Fished
160177	miniPAT	SMA	9.89	-18.29	121	4,295	Full deployment
160178	miniPAT	SMA	18.04	-28.37	10	342	Mortality
160179	miniPAT	SMA	10.23	-20.75	3	297	Mortality
160180	miniPAT	SMA	16.652	-18.384	121	3,150	Full deployment
160181	miniPAT	SMA	15.96	-27.96	3	72	Mortality

In terms of strait line movements, and for the blue shark, most of the specimens tagged inside the Cabo Verde EEZ moved substantial distances and, on most cases, to areas outside the EEZ. There was no definitive pattern in the displacements as there were cases of sharks moving on all directions, including towards the east, west, north and south (Figure 10). Particularly noteworthy was a blue shark that was tagged inside the Cabo Verde EEZ very close to the Cabo Verde Islands, and that moved a great distance towards equatorial waters (Figure 10). For the shortfin mako, one specimen was tagged inside the EEZ southeast of the Islands and moved southeast towards the African continent closer to the continental shelf at the latitude of the Bijagós Islands in Guinea Bissau, while other specimen also moved closer to the African shelf but to the east of the Cabo Verde Islands (Figure 10).

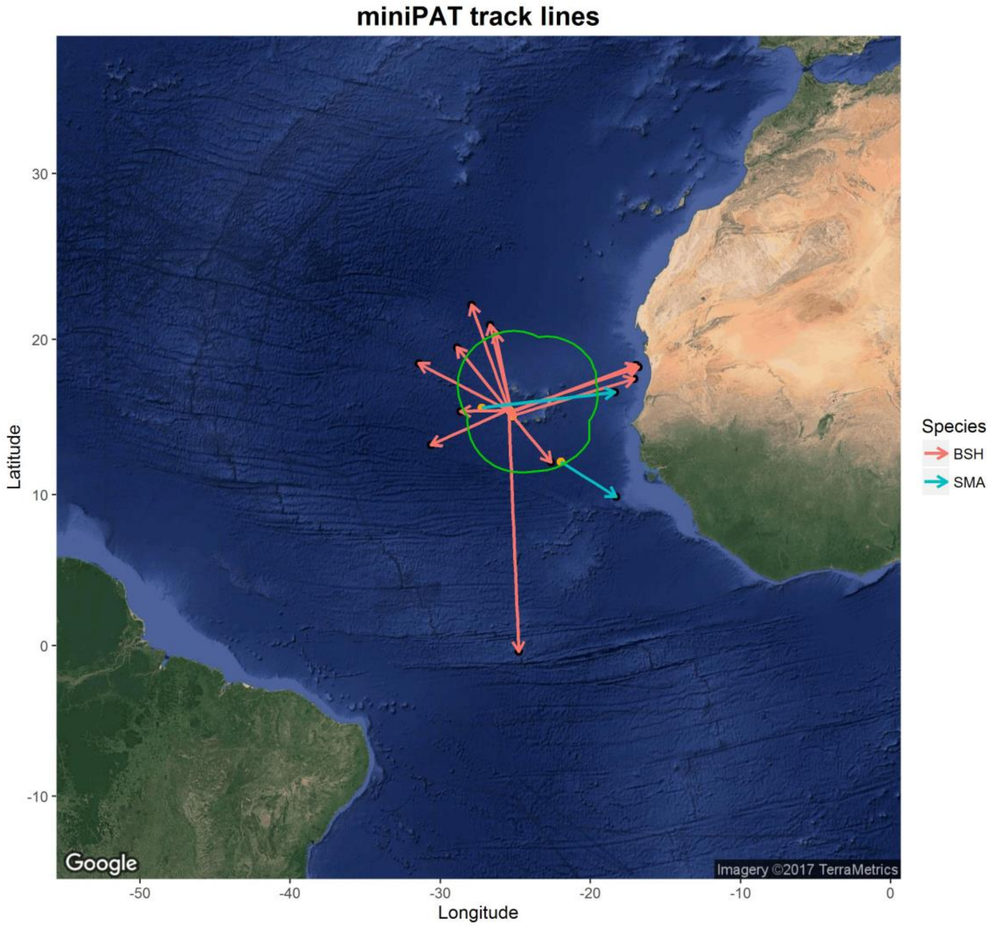


Figure 10. Map of the tracking lines (strait lines) between deployment and pop-up locations of the minPAT tags deployed on blue shark and shortfin mako. Only tags with tracking days > 20 days are shown, in order to exclude specimens that suffered post-release mortality after tagging and/or were fished (recaptured) very close to the tagging location.

Consortium scientists from IPMA are also coordinating other projects that have deployed satellite telemetry tags in pelagic sharks, specifically within the ICCAT Shark Research and Data Collection Programme (ICCAT/SRDCP) and within the Portuguese funded project (LL-Sharks - Mitigação das capturas de tubarões na pescaria de palangre de superfície, Project Promar Ref 31-03-05-FEP-44). Those projects have deployed satellite tags on shortfin mako sharks, with a total of 9 miniPATs deployed on the northeast Atlantic between August 2015 and January 2016, including areas bordering the Cabo Verde EEZ, other regions of the northeast Atlantic, and the equatorial Atlantic (Figure 11).

From those additional tags, it is noteworthy the use that the shortfin mako sharks give to the continental shelf area, along the African continent. All the specimens that were tagged in the Cabo Verde EEZ bordering waters (west of Cabo Verde Islands) moved east towards the African continental shelf. The 2 specimens that were tagged in more temperate waters of the northeast Atlantic, southwest of Portugal, moved south mainly along the African continental shelf, one to the latitude of the Canary Islands and the other further south to the latitude of Cabo Verde. Finally, one specimen was tagged in equatorial waters and also moved towards the African continent, in this case closer to the Bijagós Islands in Guinea Bissau, in an area that was also used by one of the shortfin mako sharks tagged in the Cabo Verde EEZ within this project (Figure 10 and Figure 11).

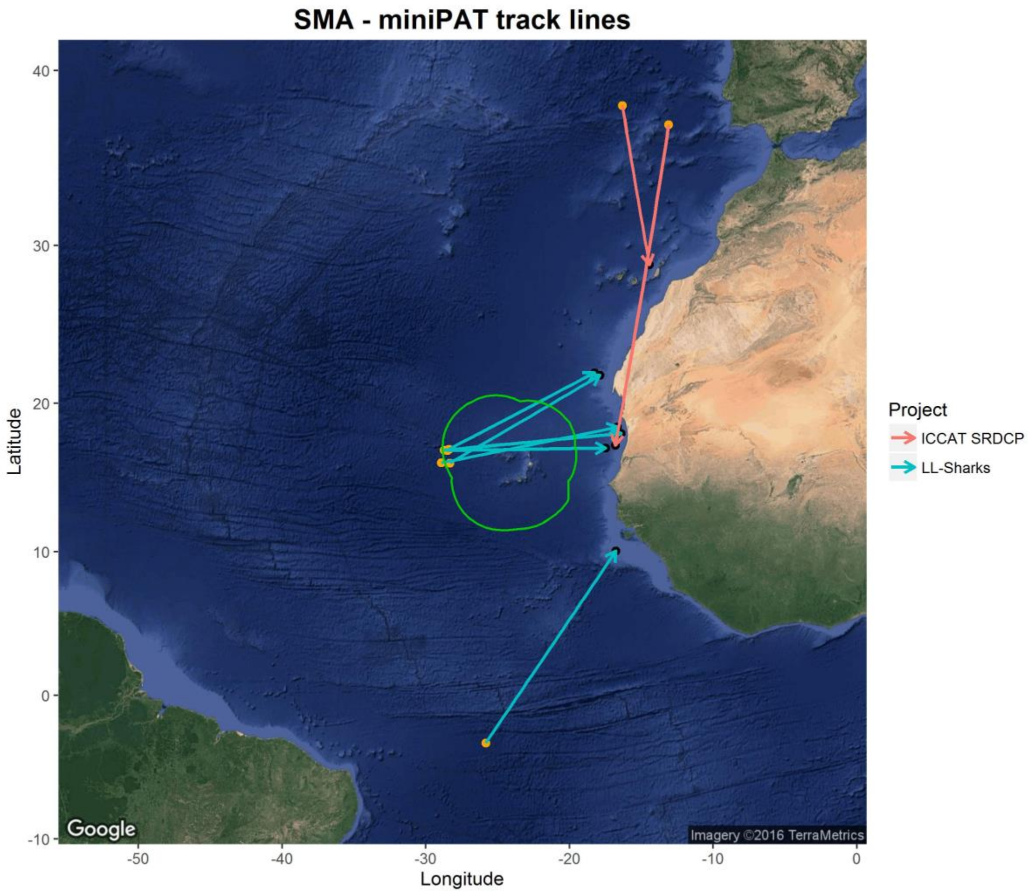


Figure 11. Map of the tracking lines (strait lines) between deployment and pop-up locations of minPAT tags deployed in the northeast Atlantic within other projects coordinated by consortium scientists (IPMA), specifically within the *ICCAT Shark Research and Data Collection Programme* (ICCAT SRDCP) and Project LL-Sharks (*Mitigação das capturas de tubarões na pescaria de palangre de superfície*, Project Promar Ref 31-03-05-FEP-44). All the tags represented are from shortfin mako sharks with tracking days > 20 days, in order to exclude specimens that suffered post-release mortality after tagging and/or were fished very close to tagging location.

From the miniPAT tag data, and using the light, temperature and depth data, it was possible to estimate the most likely tracks from the individual sharks, showing the displacements between the tagging and pop-up locations. Again, it was noteworthy that most sharks did not stay for long periods in the Cabo Verde EEZ, with some specimens using the western areas outside the EEZ, some specimens moving closer to the African continental shelf, and some specimens moving great distances to the south, in one case to equatorial waters (Figure 12). A similar pattern was obtained with the GPS SPOT tags, showing the sharks also moving outside the Cabo Verde EEZ, but in this case mainly towards western and southeastern directions (Figure 13).

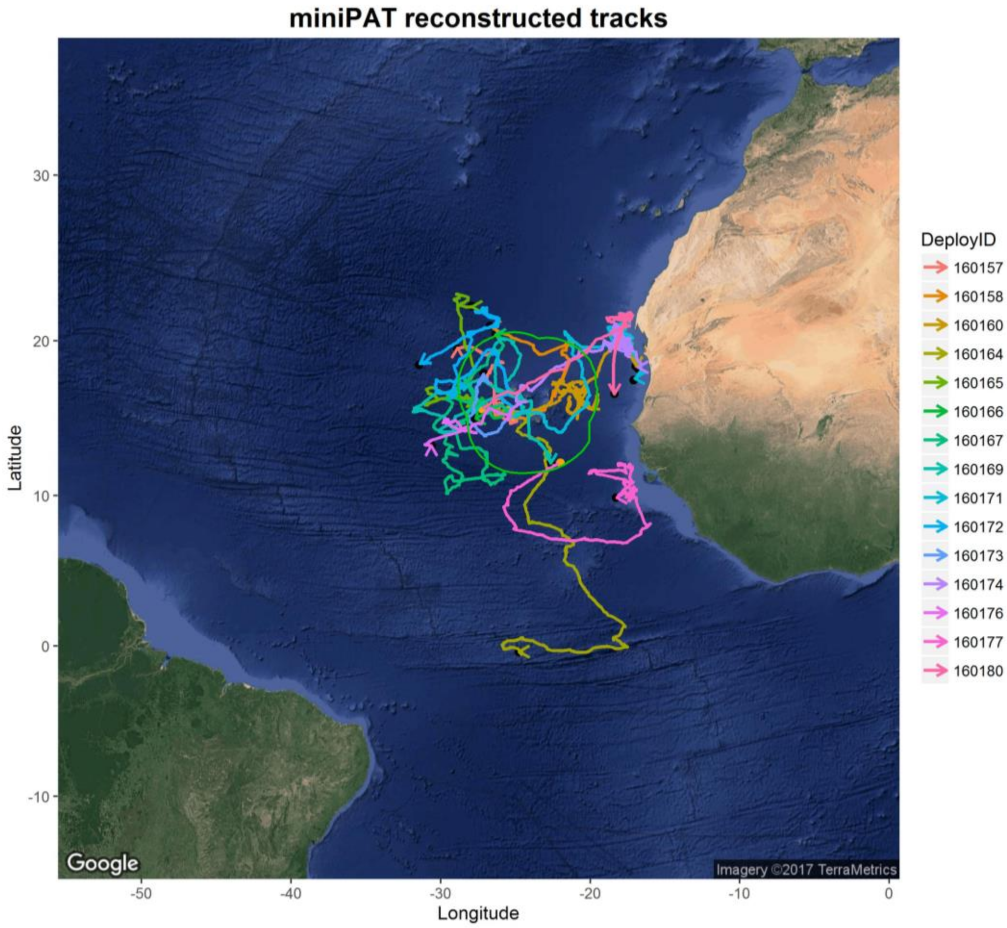


Figure 12. Map of the tracking lines (reconstructed tracks) of the miniPAT tags deployed on blue shark and shortfin mako. Only tags with tracking days > 20 days are shown, in order to exclude specimens that suffered post-release mortality after tagging and/or were fished (recaptured) very close to tagging location.

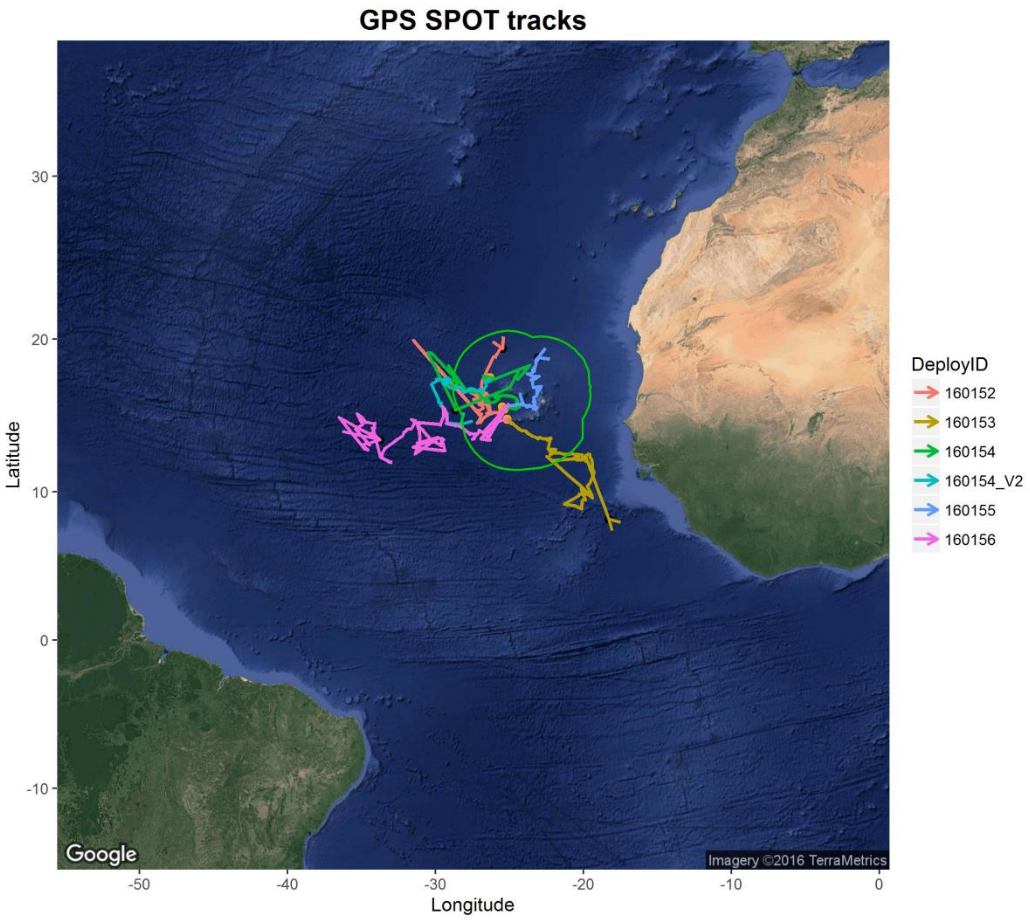


Figure 13. Map of the tracking lines using the Fastloc GPS SPOT tags deployed on blue sharks in the Cabo Verde EEZ.

In terms of habitat utilization, for the blue shark it was noticeable the daily habitat use differences in terms of depth. Even though the sharks spent most of the time in shallower waters of less than 30 m depth, there was a tendency for the sharks to spend most of the night-time period in shallower and warmer waters closer to the sea surface and most of the daytime period in deeper and colder waters (Figure 14). The mean depth during the night-time period was 40.3 m (SD=60.6) while during the daytime period was 120.9 m (SD=123.3), with those differences statistically significant (permutation test: diff= 80.7, p-value < 0.01).

These general patterns of habitat utilization followed similar trends for both males and females, and for adults and juveniles, but some differences were noted. While for the night-time period the trends were almost identical for both sexes and maturity stages, for the daylight hours there were some differences between sexes with the males tending to be deeper than the females (Figure 14). Specifically, the median depth of the specimens was 35.5 m and 29.5 m for males and females, respectively, during the night-time. During the daytime period, the differences were much more noticeable, with median depths of 183.5 m for the males and 65.5 m for the females.

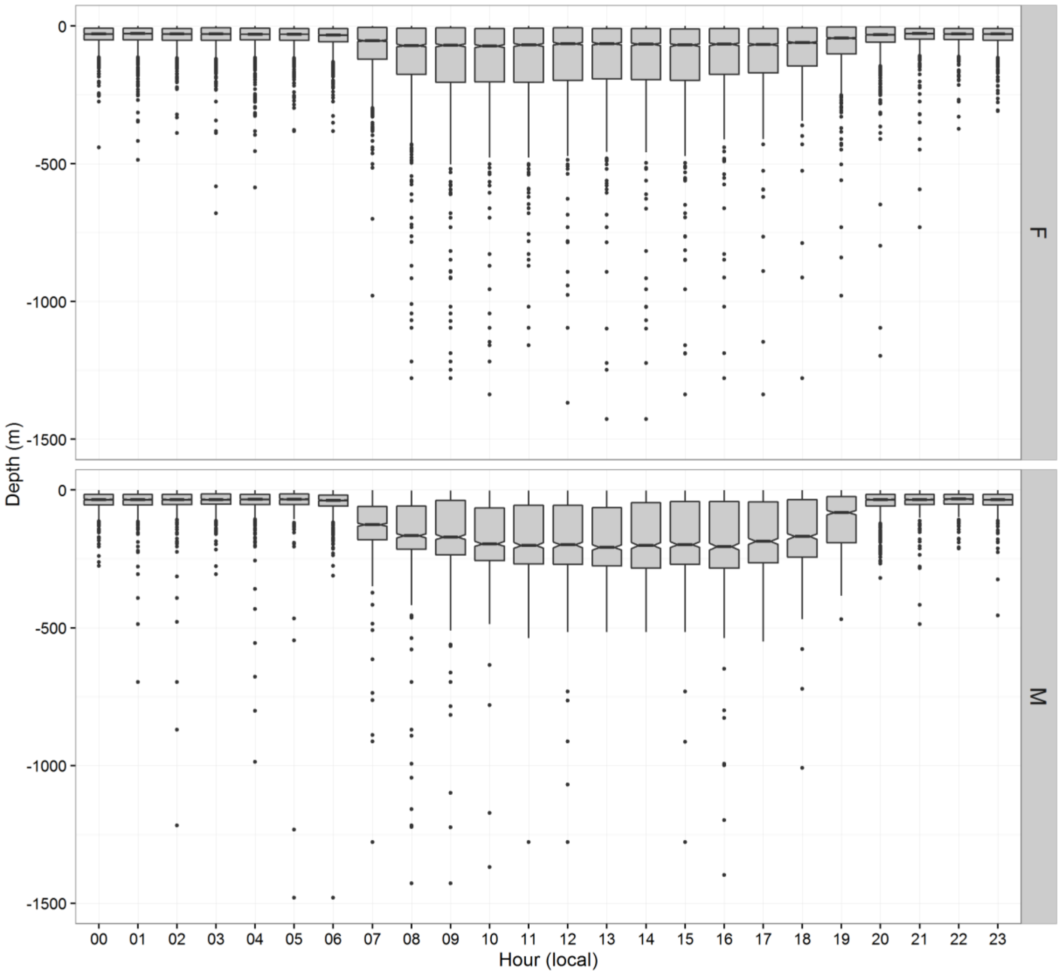


Figure 14. Blue shark habitat utilization with the data categorized in one hour time classes during the day (24h), separated by sex (F=females and M=males).

The modal depth class for both males and females and both during the day and night time periods was the 0-30m depth class, even though the sharks tended to spend more time at those depths during the night, specifically 43.5% of the time for the males and 50.9% for the females. By the contrary, during the daytime the utilization of those shallower depths decreased to 21.1% for the males and 35.6% for the females (Figure 15). During the daytime period the sharks tended to also use deeper waters, especially the males that spent 42.1% of their time between 180 and 300 m depth (Figure 15).

When comparing adults and juveniles the patterns of habitat depth utilization were very similar. The main depth class used was also the shallower 30 m of depth, particularly during the night. Specifically, during the night the adults spent 49.1% and the juveniles 49.0% of their time in the first 30 m depth. During the day, those percentages of habitat utilization in shallower waters decreased to 31.9% for the adults and 32.2% for the juveniles (Figure 16). During the day, there was also the utilization of deeper waters, but again the patterns were similar for both adults and juveniles. Specifically, the adults spent 27.9 of their time between 180-300 m depth, while the juveniles spent 20.9% of the time at the same depth range (Figure 16).

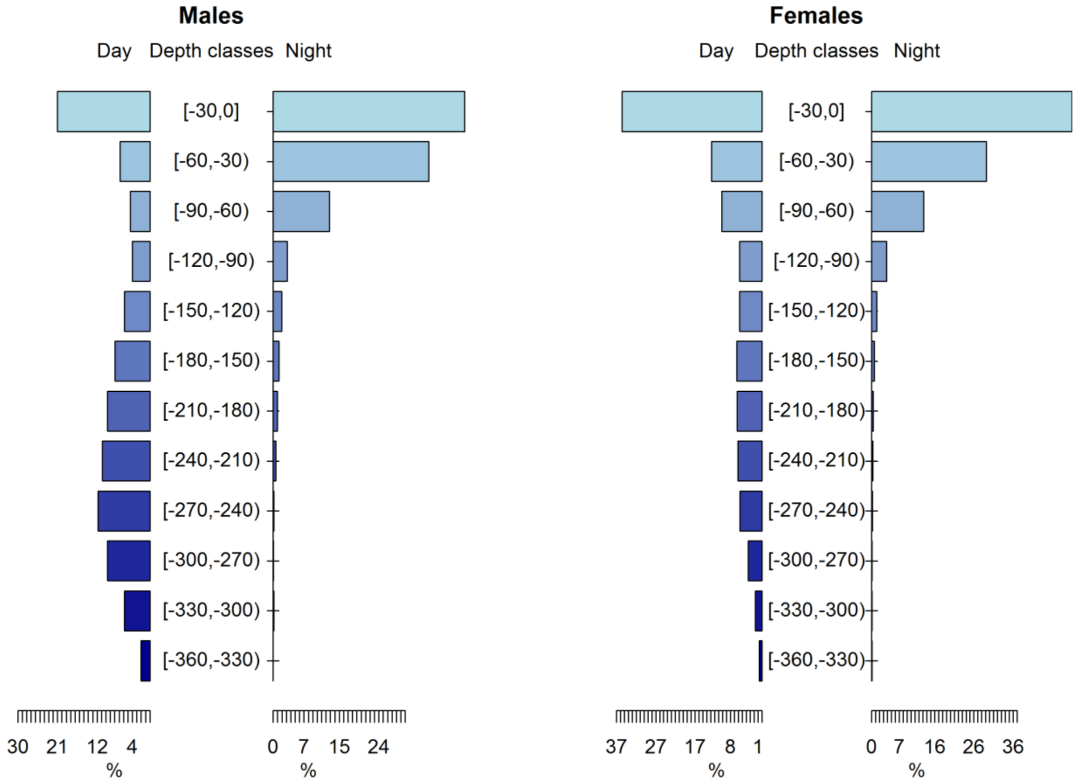


Figure 15. Utilization of vertical habitat for male and female blue sharks for the daytime and night-time periods. Depth classes are categorized in 30m intervals.

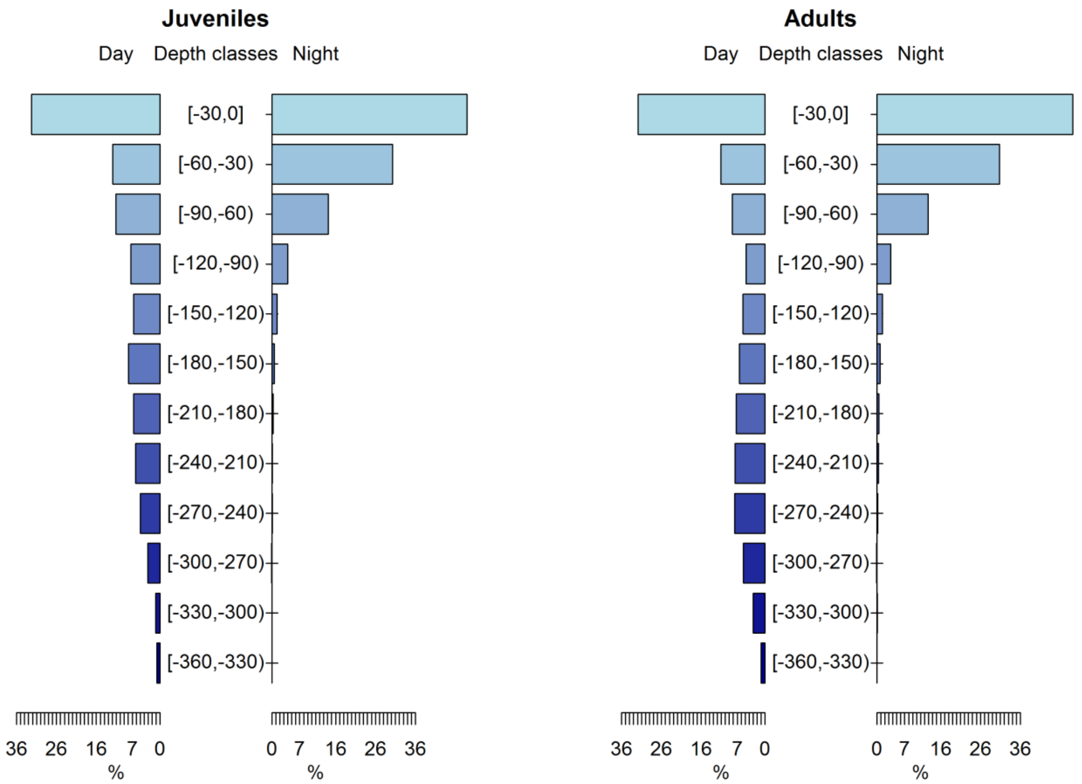


Figure 16. Utilization of vertical habitat for juvenile and adult blue sharks for the daytime and night-time periods. Depth classes are categorized in 30 m intervals.

For the shortfin mako shark there were also differences in terms of the habitat use. As fewer specimens were tagged it was not possible to make comparisons between sexes or maturity stages, and only an overall analysis was made. Like in the blue shark, there was also a clear tendency for the shortfin mako sharks to spend most of the night-time period in shallower and warmer waters closer to the sea surface and more of the daytime period in deeper and colder waters (Figure 17). The mean depth during the night-time period was 35.2 m (SD=25.6) while during the daytime period was 70.5 m (SD=74.8), being those differences statistically significant (permutation test: diff= 35.3, p-value < 0.01).

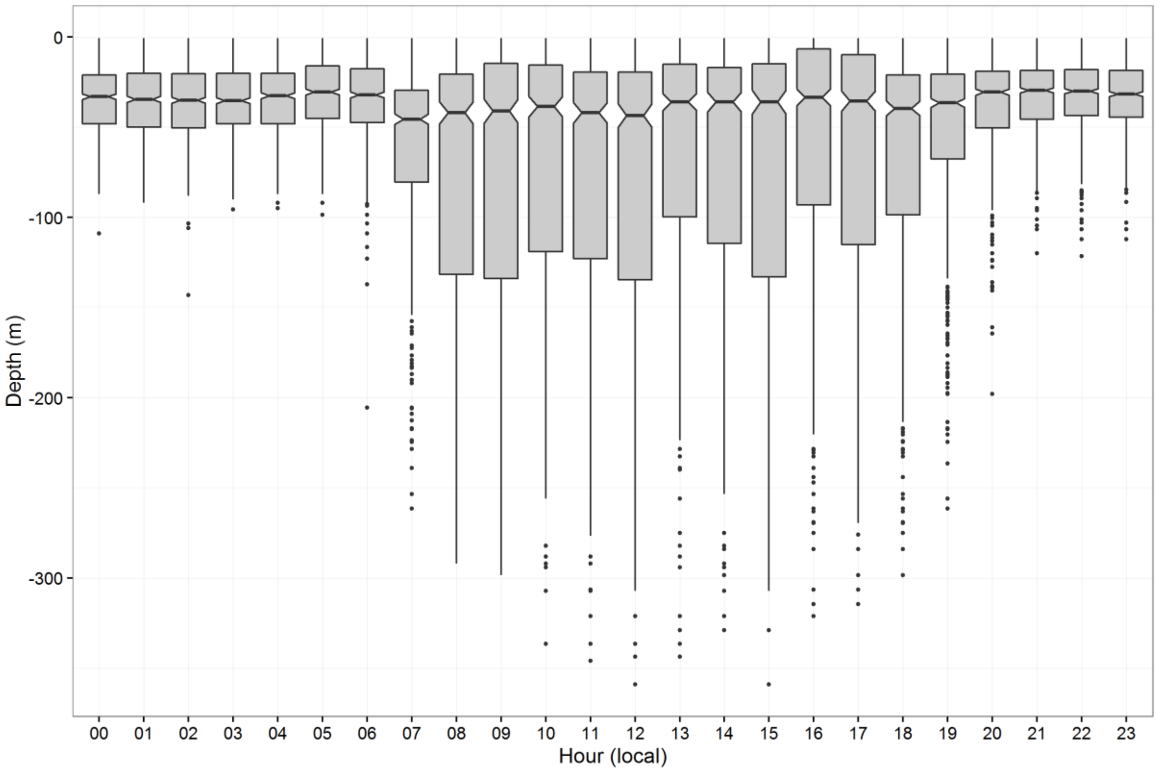


Figure 17. Shortfin mako shark habitat utilization with the data categorized in one hour time classes during the day (24h).

In terms of habitat utilization, the modal depth class for SMA both during the day and the night was also in relatively shallow waters, but in this species slightly deeper than in the blue shark, specifically in the 30-60 m depth class (Figure 18). Shortfin mako sharks spent 85.8% of their time during the night and 66.0% during the day in the first 60 m of the water column. Like in blue shark, shortfin makos also spent part of the day in deeper waters, mostly down to around 240 m depth (Figure 18).

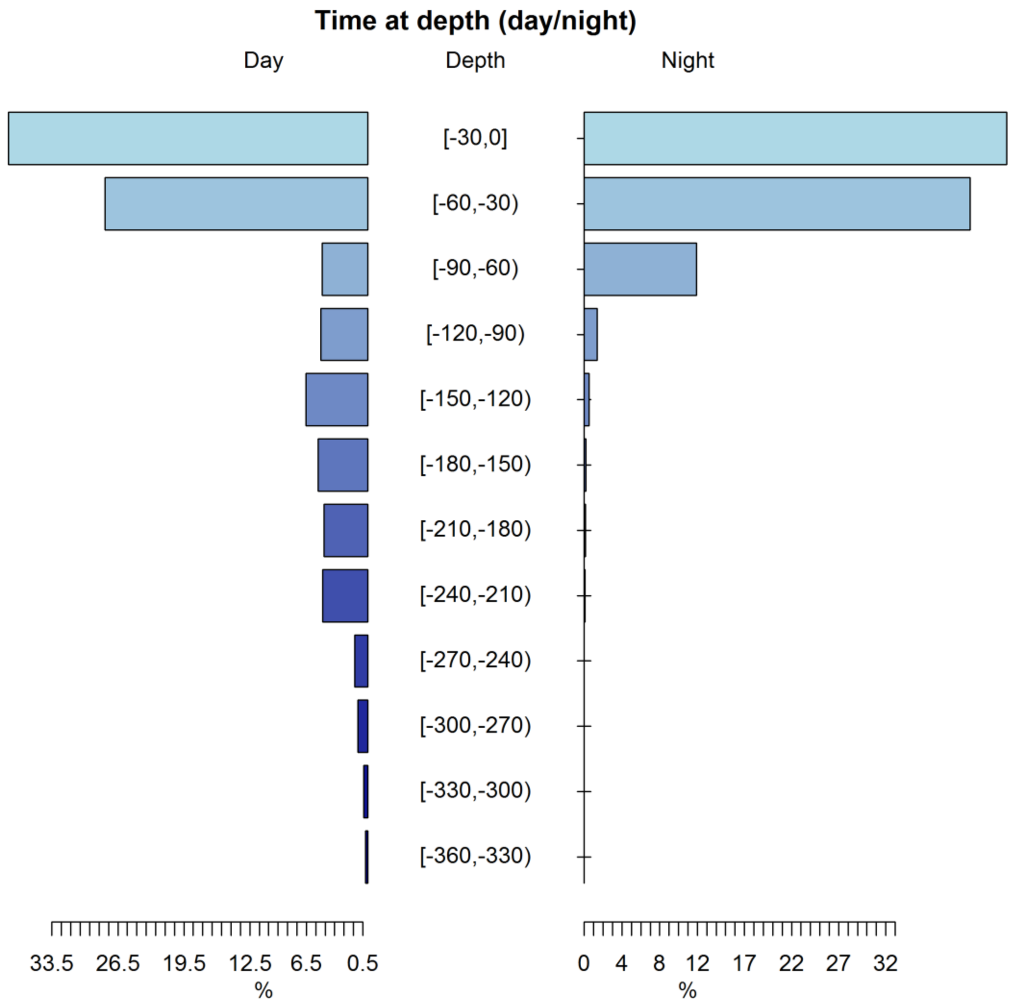


Figure 18. Utilization of depth habitat for shortfin mako sharks during the daytime and night-time periods. Depth classes are categorized in 30m intervals.

3.3 Task 3- Analysis of potential local depletion of sharks

3.3.1 Description and status of the main shark species

The blue shark and shortfin mako represent the two main species captured in pelagic longline fisheries, often representing more than 50% of the total catch and more than 90% of the elasmobranch catch (Coelho et al., 2012a).

Blue shark, *Prionace glauca*

The blue shark is one of the widest ranging of all sharks, found throughout tropical and temperate seas from latitudes of about 60°N to 50°S (Figure 19). It is a pelagic species mainly distributed from the sea surface to depths of about 350 m, even though deeper dives of up to 1000m have been recorded (Campana et al., 2011). The blue shark is an oceanic species capable of large scale migrations (Queiroz et al., 2005; Silva et al., 2010; Campana et al., 2011), but it can also occasionally occur closer to inshore waters, especially in areas where the continental shelf is narrow (Last and Stevens, 2009).

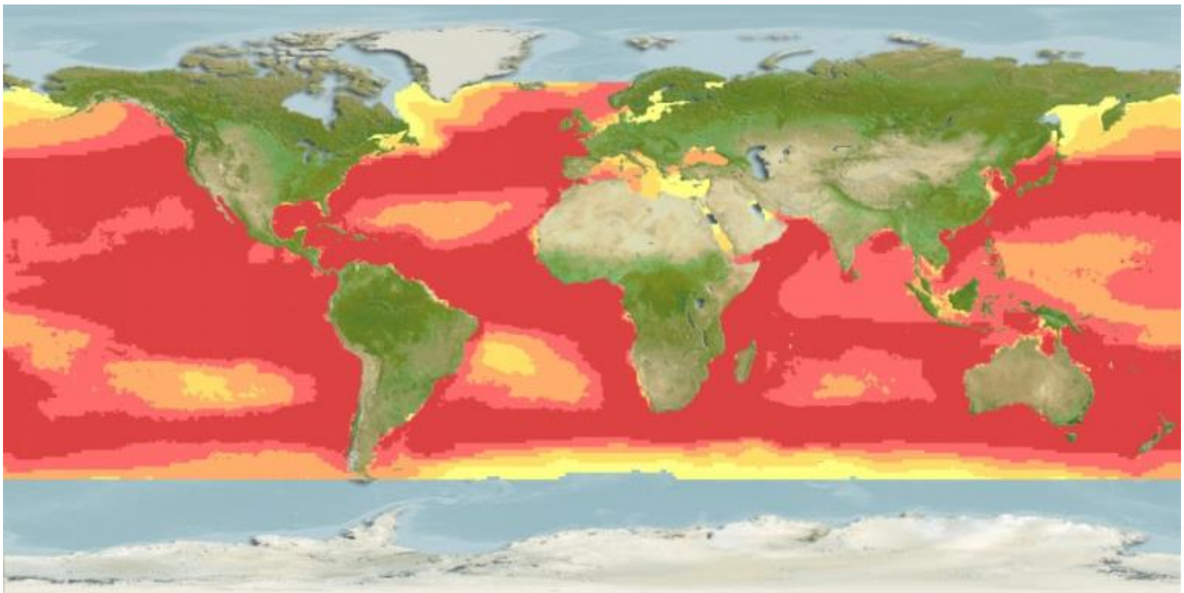


Figure 19. Global distribution map for the blue shark, *Prionace glauca*. The colour scale represents the relative probabilities of occurrence, with red and yellow representing higher and lower probabilities of occurrence, respectively. Map generated from Fishbase (Froese and Pauly, 2012) using AquaMaps, a presence-only species distribution model (Ready et al., 2010).

The blue shark reaches a maximum size of about 380 cm total length (TL), and size at 50% maturity for the Atlantic has been estimated at 218 cm TL for males and 221 cm TL for females (Pratt, 1979). The blue shark is a placental viviparous shark, and shows a relatively high fecundity within the elasmobranchs, producing an average of 35 pups per litter (Zhu et al., 2011), with the maximum litter size recorded being 135 pups, after a gestation period of 9-12 months (Compagno, 1984; Castro and Mejuto, 1995; Snelson et al., 2008). The pups are born at 35-50 cm TL, and the reproductive cycle has been reported as seasonal in most areas, with the young being born usually in the spring and summer (Pratt, 1979; Stevens, 1984; Nakano, 1994; Hazin et al., 1994). Age and growth studies have suggested that longevity is of about 20 years, with the males maturing at 4-6 and females at 5-7 years of age (Stevens, 1975; Cailliet et al., 1983; Nakano, 1994; Skomal and Natanson, 2003; Lessa et al., 2004; Blanco-Parra et al., 2008; Megalofonou et al., 2009). The diet of the blue shark consists mainly of small pelagic fishes and cephalopods, particularly squid (Vaske Jr. et al., 2009; Markaida and Sosa-Nishizaki, 2010; Preti et al., 2012). However, small sharks, seabirds and invertebrates such as pelagic crustaceans have also been reported to be taken as food (Compagno, 1984).

Blue sharks are a highly migratory oceanic species, with complex movement patterns and spatial structure probably related to the reproduction cycles and prey distribution

(Montealegre-Quijano and Vooren, 2010; Tavares et al., 2012). Some tagging studies have shown extensive movements of blue sharks in the Atlantic, with numerous trans-Atlantic migrations probably accomplished by using the major oceanic current systems (Stevens, 1976; Stevens 1990; Queiroz et al., 2005; Silva et al., 2010; Campana et al., 2011). At least in the north Atlantic, data on the distribution, movements and reproductive behaviour seems to suggest a complex reproductive cycle, involving major oceanic migrations associated with mating areas in the north-western Atlantic and pupping areas in the north-eastern Atlantic (Pratt, 1979; Stevens, 1990).

The blue shark is the most abundant of all pelagic sharks. It can be captured by a variety of fishing gears, most captures take place as bycatch in pelagic longlines targeting tunas and swordfish (Aires-da-Silva et al., 2008; Stevens, 2009; Coelho et al., 2012b; Amorim et al., 2015; Fernandez-Carvalho et al., 2015b). This species is currently listed as Near Threatened by IUCN, the International Union for the Conservation of Nature (Stevens, 2009). Ecological Risk Assessments (ERAs) were carried out for priority species of pelagic sharks in the Atlantic in 2010 and 2012 (Cortés et al., 2010; Cortés et al., 2012), and the blue shark was shown to have an overall intermediate vulnerability because it is the most productive of all pelagic shark species. Similar results were obtained for the Indian Ocean blue shark managed by IOTC (Murua et al., 2012). For the Atlantic, the last blue shark stock assessments (north and south stocks) were carried out by ICCAT in 2015 (Anon., 2015). For the south Atlantic the uncertainties were high and it was not possible to discard the hypothesis that in recent years the stock may have been at a level near B_{MSY} and that fishing mortality has been approaching F_{MSY}, implying that increases in fishing mortality could push the stock to be overfished and experiencing overfishing (Anon., 2015). For the north Atlantic the stock was unlikely to be overfished and subject to overfishing, even though there were also high levels of model uncertainty reported (Anon., 2015).

Shortfin mako, *Isurus oxyrinchus*

The shortfin mako is also a widespread pelagic shark species, occurring in temperate and tropical waters of all oceans from about 60ºN to 50°S (Figure 20). It occurs from the surface to at least 500 m depth, and occasionally is found close to inshore waters where the continental shelf is narrow (Compagno, 2001). The shortfin mako is probably the fastest of all sharks, and is among the most active of all fishes. Like other Lamnidae sharks, it is an endothermic species that uses a heat-exchanging circulatory system to maintain muscle and visceral temperatures above that of the surrounding water, which allows a higher level of activity (Carey et al., 1981; Bernal et al., 2001). Tagging studies in the northwest Atlantic have shown that shortfin makos can make extensive migrations of more than 3,000 km (Casey and Kohler, 1992), even though it has been suggested that trans-Atlantic migrations are not as common as in the blue shark.

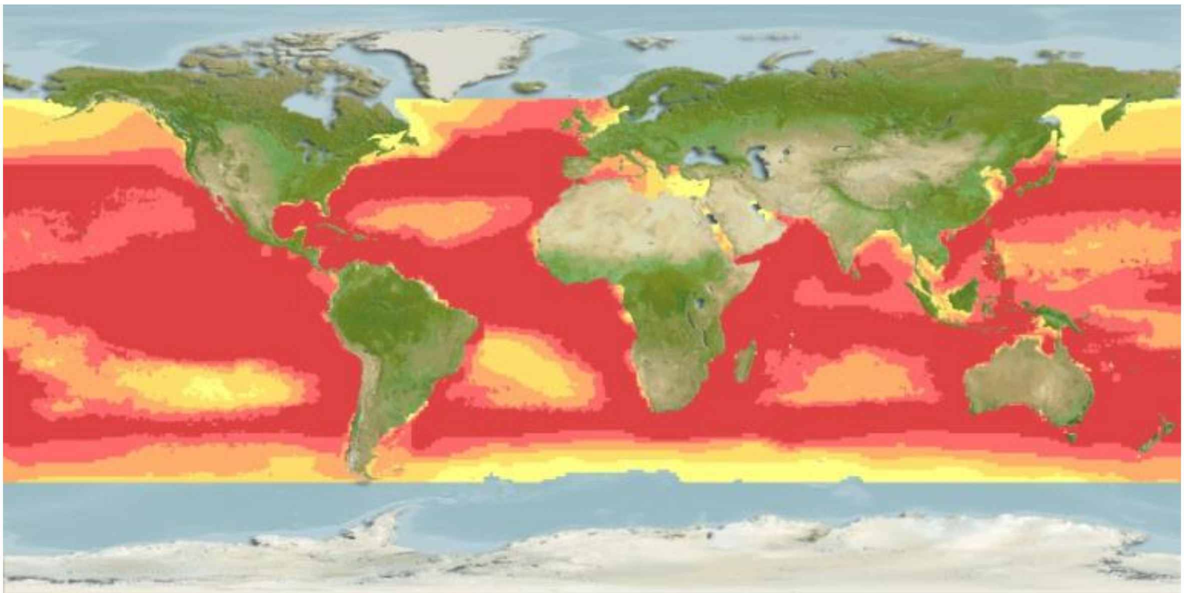


Figure 20. Global distribution map for the shortfin mako, *Isurus oxyrinchus*. The colour scale represents the relative probabilities of occurrence, with red and yellow representing higher and lower probabilities of occurrence, respectively. Map generated from Fishbase (Froese and Pauly, 2012) using AquaMaps, a presence-only species distribution model (Ready et al., 2010).

The shortfin mako reaches a maximum size of about 4 m (Compagno, 2001). Initial age and growth studies in the western north Atlantic suggested that two pairs of growth bands are laid down each year in their vertebral centra, at least in young specimens (Pratt and Casey 1983). However, recent evidence using marginal increment analysis (Ribot-Carballal et al., 2005) and bomb radiocarbon (Campana et al., 2002, Ardizzone et al., 2006) indicates that the alternative hypothesis (one pair of growth bands per year, as suggested by Cailliet et al., 1983) is valid, at least for the larger and older specimens. Compagno (2001) reports that males reach a maximum size of 296 cm and females reach almost 4 m. Longevity has been estimated as 29-32 years (Bishop et al., 2006; Natanson et al., 2006). The shortfin mako is aplacental viviparous and oophagous. The gestation period is long (15-18 months) and it has a three year reproductive cycle (Mollet et al., 2002). Litter size is 4-25 pups, with the pups having a size of 60-70 cm at birth (Compagno, 2001). There is a large difference in size at maturity between the sexes. In the northwest Atlantic, males reach maturity at about 195 cm and females at about 265-280 cm (Pratt and Casey 1983, Stevens 1983, Cliff et al. 1990). Age at maturity has been determined at 7-9 years for males and 19-21 years for females (Bishop et al., 2006; Natanson et al., 2006). The diet of shortfin makos has been reported to consist mainly of teleost fishes including mackerels, tunas, bonitos and other scombrids, anchovies, herrings, whiting and other gadids, sea basses, swordfish and may other species. It can also feed on cephalopods and other elasmobranchs (Stillwell and Kohler, 1982; Stevens, 1984; Cliff et al., 1990). It can also eat sea turtles, dolphins and occasionally detritus (Compagno, 1984).

In the Atlantic, Casey and Kohler (1992) suggest that the core distribution in the northwest Atlantic is between 20-40°N, bordered by the Gulf Stream in the west and the mid-Atlantic ridge in the east. In the northeast Atlantic it is presumed that the Strait of Gibraltar might be a nursery ground (Buencuerpo et al., 1998 and Tudela et al., 2005). The area between 17° to 35°S off the coast of Brazil seems to be an area of birth, growth and mating in the southwest Atlantic (Amorim et al., 1998).

The shortfin mako is one of the most valuable shark species for its high quality meat, which can be utilized fresh, frozen, smoked and dried-salted for human consumption. The liver oil can be extracted for vitamins (Compagno, 2001). Big-game sports angling for this species is widespread, and shortfin makos have become the subject of ecotourism diving in recent years, especially off southern California, South Africa and the Maldives (Compagno, 2001). It is an important and valuable species for pelagic longlines, drifting and set gillnets and on hook-and-line fisheries. This species is currently listed as Vulnerable by IUCN (Cailliet et al., 2009). The Ecological Risk Assessments carried out for pelagic sharks in the Atlantic in 2010 and 2012 (Cortés et al., 2010; Cortés et al., 2012), showed that the shortfin mako was one of the most vulnerable of all species analysed, due to its relatively low productivity and high susceptibility. The last shortfin mako stock assessments in the Atlantic (north and south stocks) were carried out by ICCAT in 2012 (Anon., 2012). The results indicated in general that the status of both the north and south Atlantic stocks seemed healthy with a low probability of overfishing. However, the models also showed apparent inconsistencies between estimated biomass trajectories and CPUE trends, producing high uncertainties in the estimates, particularly in the south Atlantic. For the Atlantic, the high uncertainty in past catch estimates and deficiency of some important biological parameters, particularly for the southern stock, are still obstacles for obtaining reliable estimates of current status of the stocks (Anon., 2012).

3.3.2 Catch composition

In the Cabo Verde EEZ and the 300 nm adjacent waters, the catch composition within the elasmobranchs is largely dominated by blue shark (BSH) and followed by shortfin mako (SMA). Other less frequent elasmobranch species that are occasionally captured in the region include the bigeye thresher (BTH), silky shark (FAL), longfin mako (LMA), oceanic whitetip (OCS), crocodile shark (PSK) and smooth hammerhead (SPZ). However, it should be noted that most of those other species are either no-retention species in ICCAT and/or listed in CITES, and therefore those other species are discarded and not retained onboard.

Overall, the relative ratios of the catch composition varied very little along the time series (Figure 21). A comparison between the catch composition in the Cabo VerdeCape Verde EEZ and the 300 nm adjacent waters is presented in Figure 22. Similarly to the overall case, when the data was analysed for each region separately the dominant species was the blue shark in both regions followed by the shortfin mako, and showed little variation along the time series. The values of the relative percentages of the catch composition by major shark species are presented in Table 3.

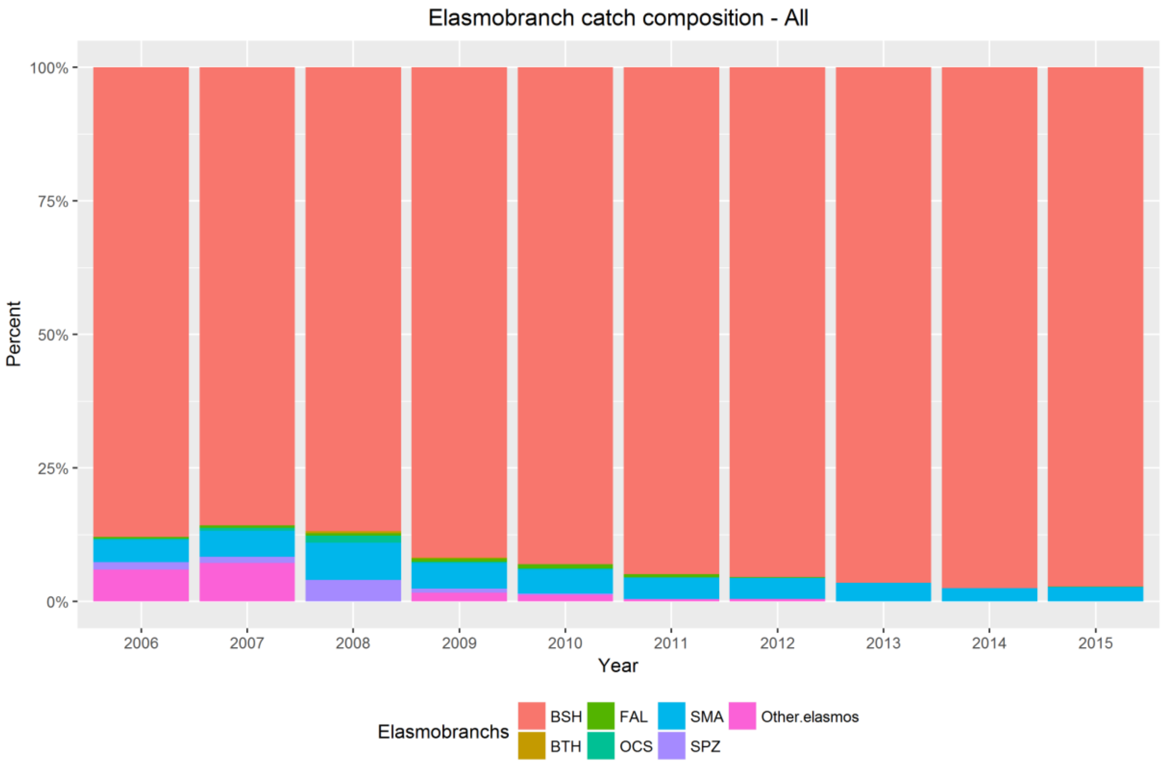
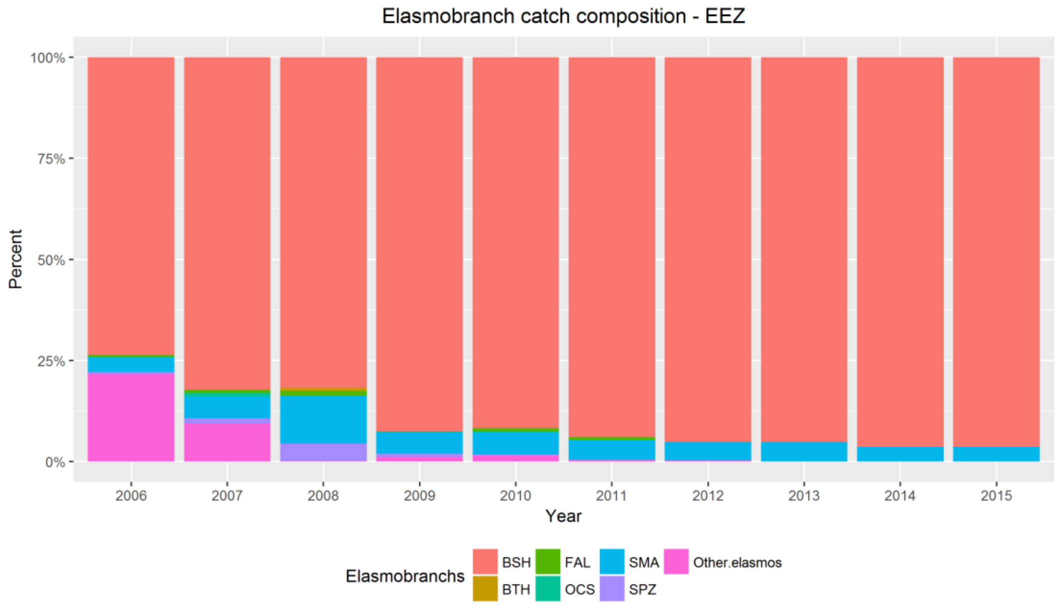


Figure 21. Relative catch composition (based in catches in biomass) of elasmobranchs in the Cabo Verde EEZ and 300 nm adjacent waters.



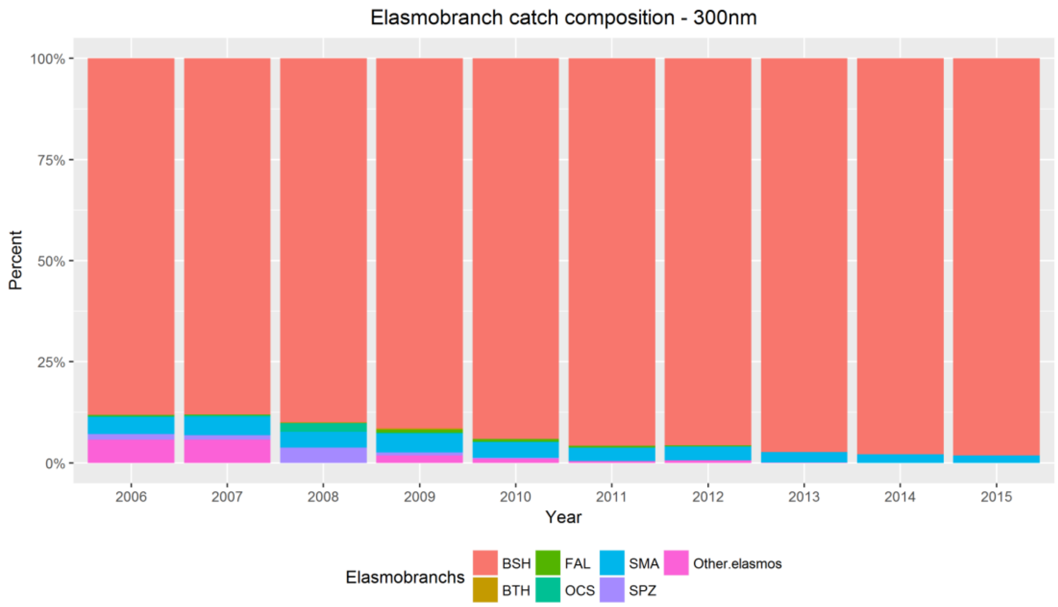


Figure 22. Relative catch composition (based in catches in biomass) of elasmobranchs in the Cabo Verde EEZ (above) and 300 nm adjacent waters (below).

Table 3. Percentages of the catch composition (weight) of major shark species in the Cabo Verde EEZ and 300 nm adjacent waters.

FAO code	Species	Species composition(%)		
		EEZ	300 nm	Combined
BSH	Blue shark	93.4	94.5	94.1
SMA	Shortfin mako	4.7	3.3	3.8
SPZ	Smooth hammerhead	0.2	0.3	0.3
FAL	Silky shark	0.3	0.3	0.3
OCS	Oceanic whitetip	0.1	0.1	0.1
BTH	Bigeye thresher	<0.1	<0.1	<0.1
Other elasmos.		1.2	1.4	1.3

3.3.3 Catch per unit of effort (CPUE) distribution and trends

The total reported shark catches by the EU fleets for the Cabo Verde EEZ are available between 2007 and 2015 from logbooks. The total shark catch trend shows an increase in the earlier period, between 2007 and 2012, followed by a decline for the more recent years, until 2015 (Figure 23).

The two main EU fleets reporting shark catches in that period are the Spanish and Portuguese fleets, with the majority of the landings reported by Spain. The trends for Portugal are more stable during the time period, with the peak taking place between 2009 and 2011. The catches from Spain are the driver of the main overall trends, with the peak in catches taking place in 2012 (Figure 24). The corresponding effort has also been decreasing in the same period, but in this case the data has only been compiled by INDP for the period 2010-2013. Specifically, there has been a significant decrease in effort during the time period, especially between 2010 and 2012, and with 2013 effort relatively similar to 2012 (Figure 25).

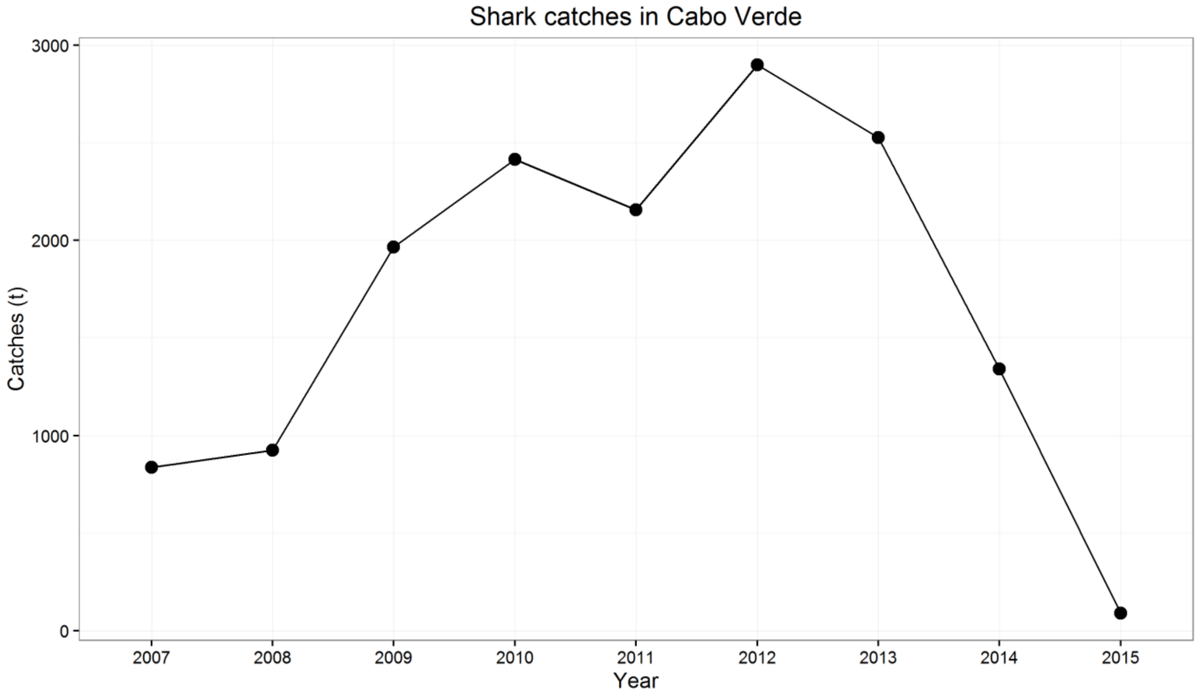


Figure 23. Total shark catches from the Cabo Verde EEZ reported by the EU fleet from logbook data.

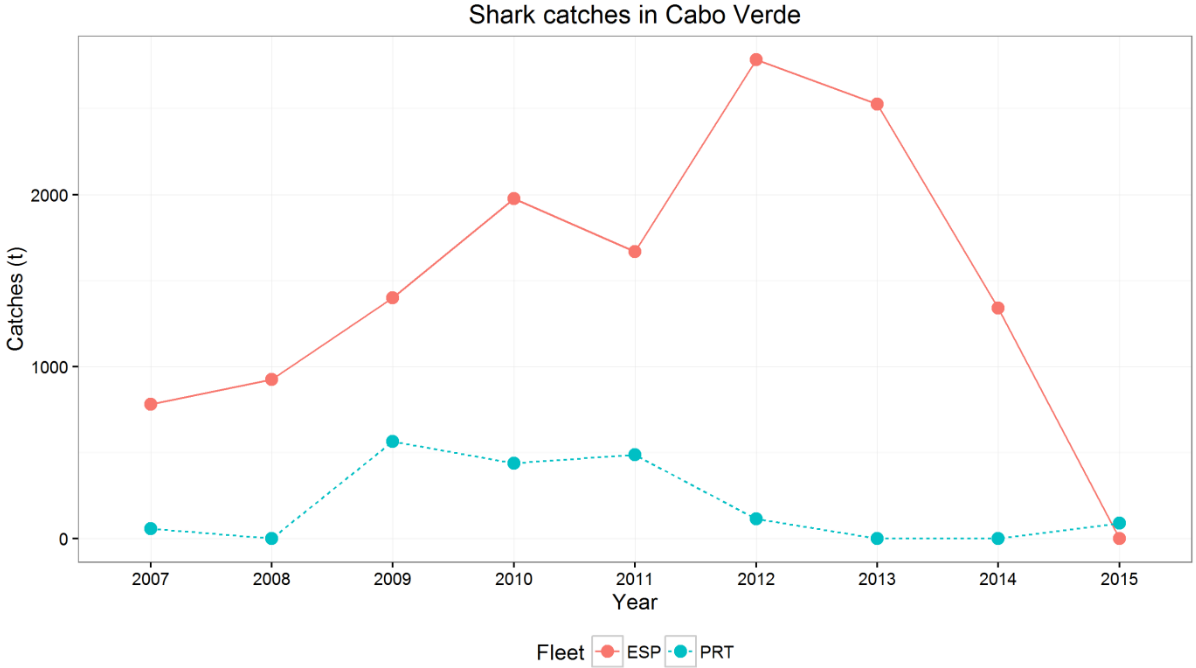


Figure 24. Total shark catches from the Cabo Verde EEZ specified by fleet (EU-Spain and EU-Portugal) from logbook data.

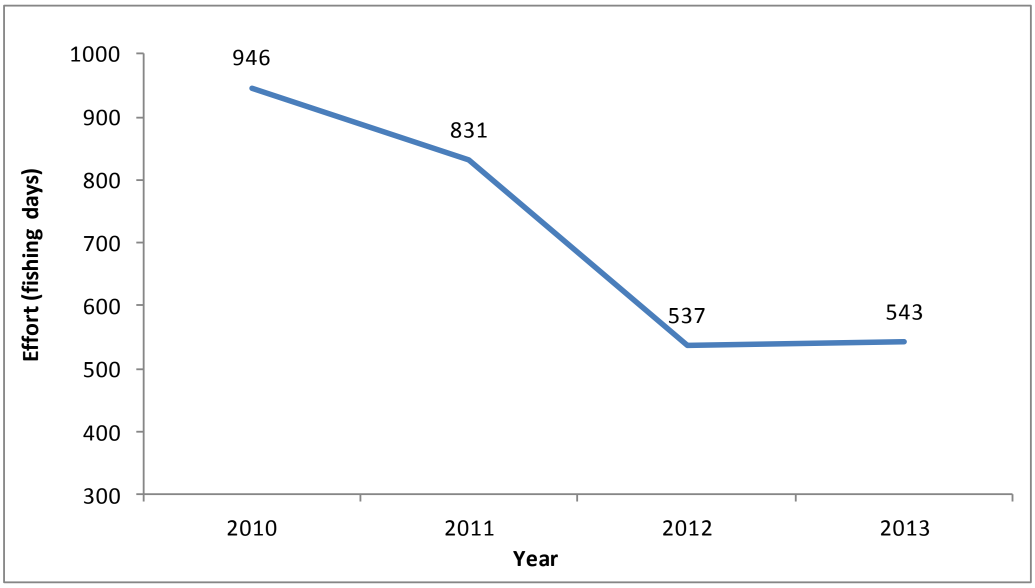
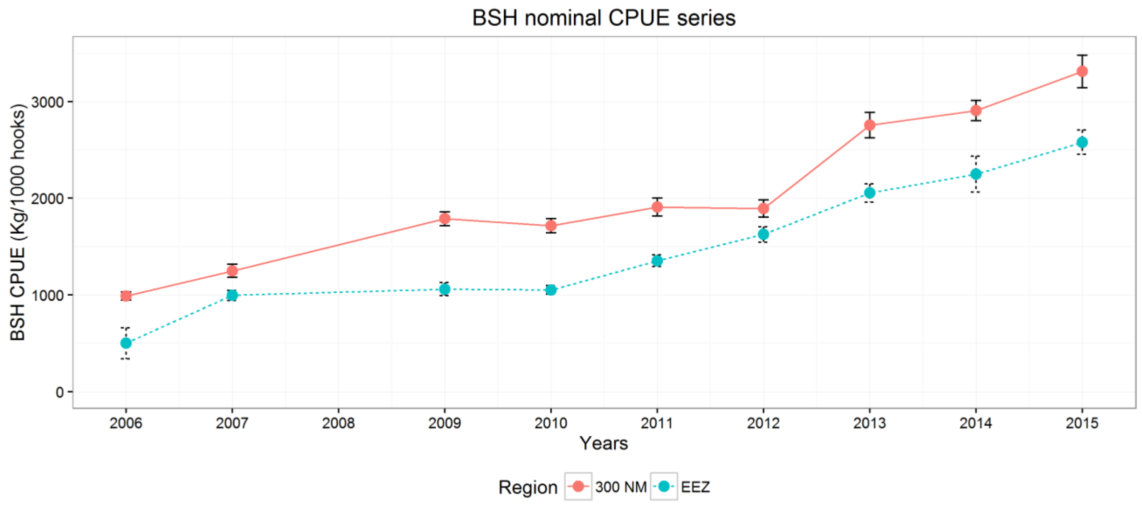


Figure 25. Total effort (fishing days) reported by the EU fleet for the Cabo Verde EEZ between 2010 and 2013, compiled in the INDP database.

Using the more detailed data from the logbooks and observer programs, it was possible to analyse the time series trend of combined information of catch and effort in terms of nominal CPUE. When considering both the Cabo Verde EEZ and the 300 nm adjacent waters, a general increasing CPUE trend for both the blue shark and the shortfin mako was observed. More specifically, for the blue shark there was a progressive increase along the entire time series between 2006 and 2015, while for the shortfin mako there was an increase mainly in the earlier years, between 2006 and 2009, and then a more stable period between 2009 and 2015. In the Cabo Verde EEZ there were general increasing trends for both the blue and shortfin mako sharks (Figure 26). When considering only the 300 nm adjacent waters to the Cabo VerdeCape Verde EEZ, the blue shark showed a general increase in the CPUE trend along the entire period, while the shortfin mako showed an increase until 2010 followed by a more stable period for the more recent years (Figure 26).



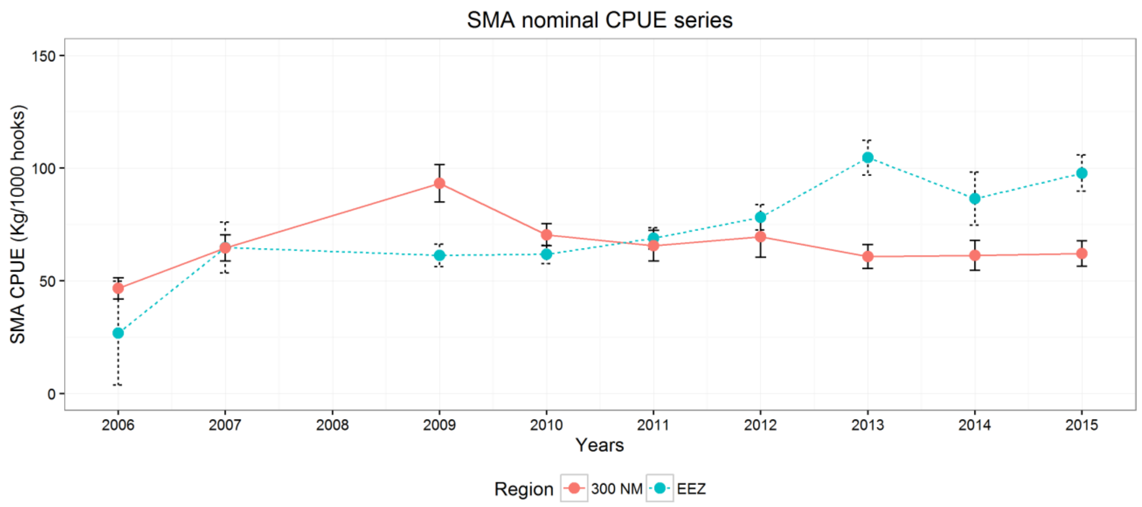


Figure 26. Time series of nominal catch per unit of effort (CPUE, biomass in Kg/1000 hooks) for blue shark (above) and shortfin mako (bellow) in each of the study areas, specifically in the Cabo Verde EEZ and the 300 nm adjacent waters to the Cabo Verde EEZ. The error bars refers to the 95% confidence intervals (CI).

In terms of the spatial CPUE distribution, higher blue shark catch rates occurred mainly outside the Cabo Verde EEZ, in the 300 nm adjacent waters, especially in the western area (Figure 27). For the shortfin mako shark, higher CPUEs were also observed in the limits and outside the Cabo Verde EEZ, but for this species mainly in the eastern areas towards the African continent (Figure 28).

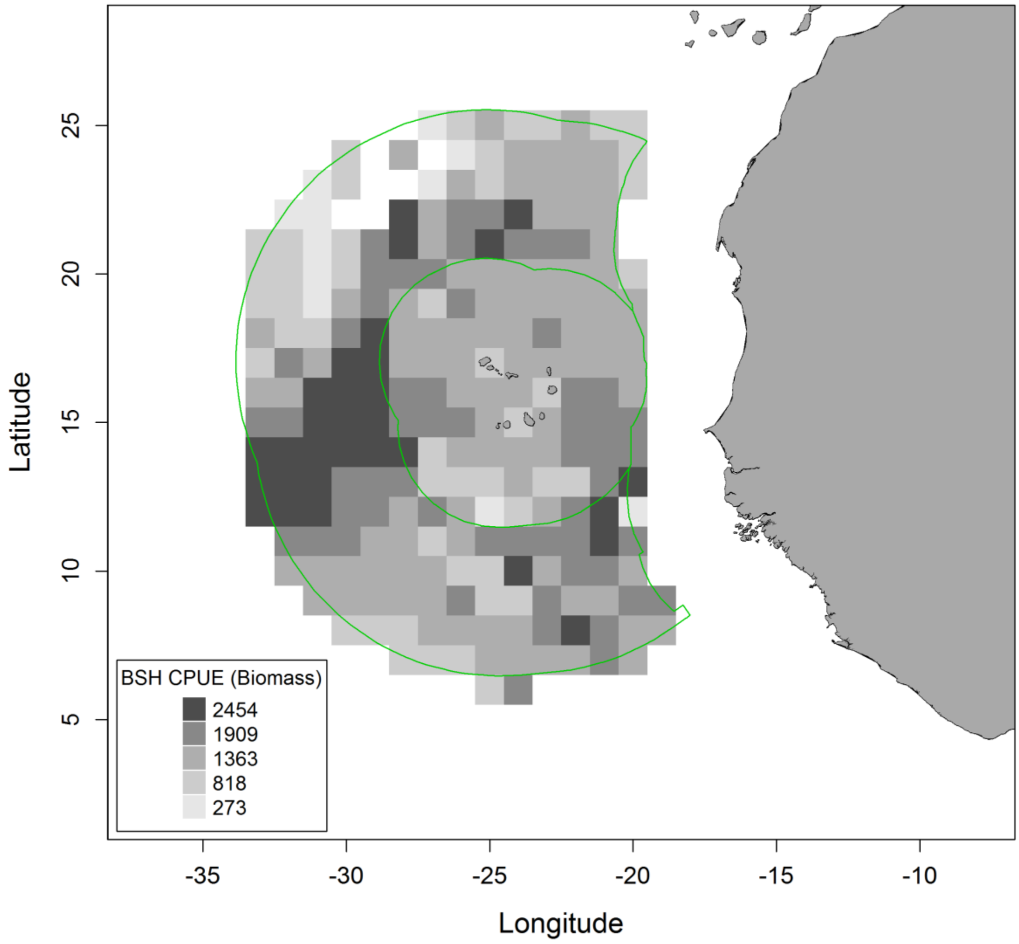


Figure 27. Spatial distribution (in 5°*5° squares) of blue shark catch per unit of effort (CPUE, biomass in kg/1000 hooks) in the Cabo Verde EEZ and 300 nm adjacent waters. Data is combined for 2006-2015.

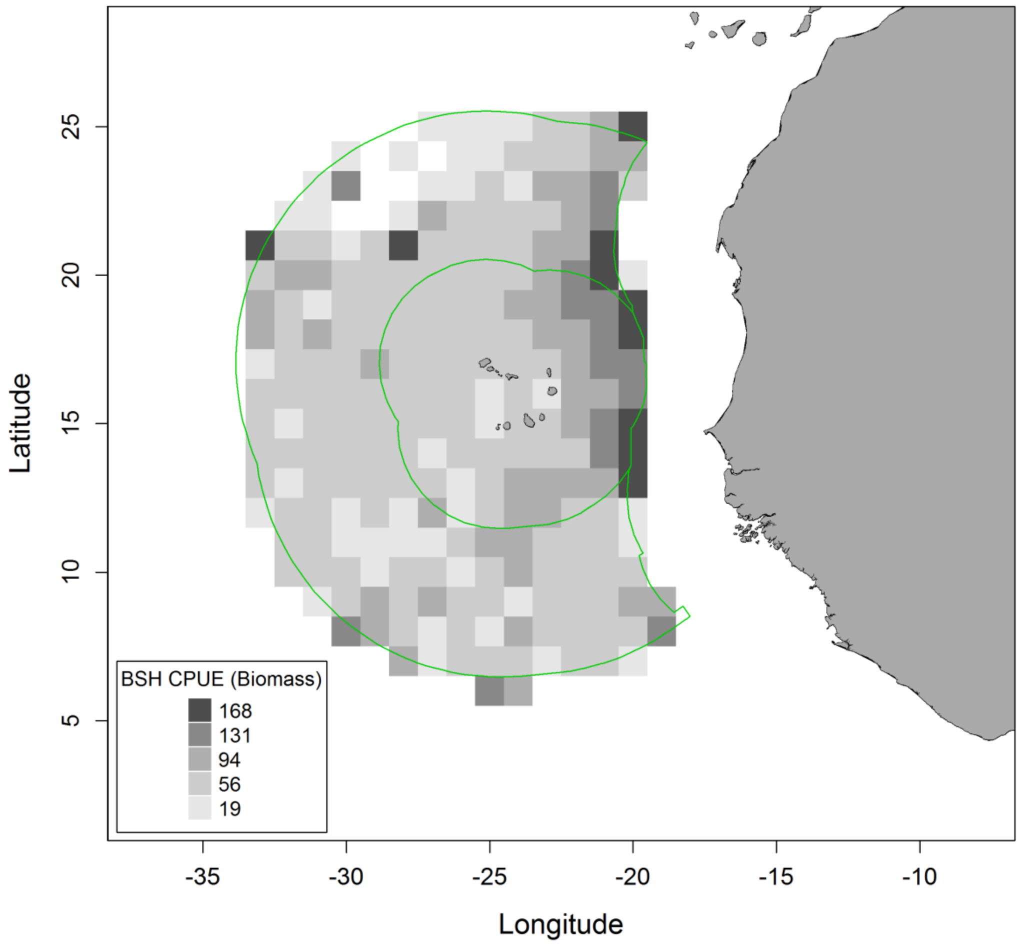
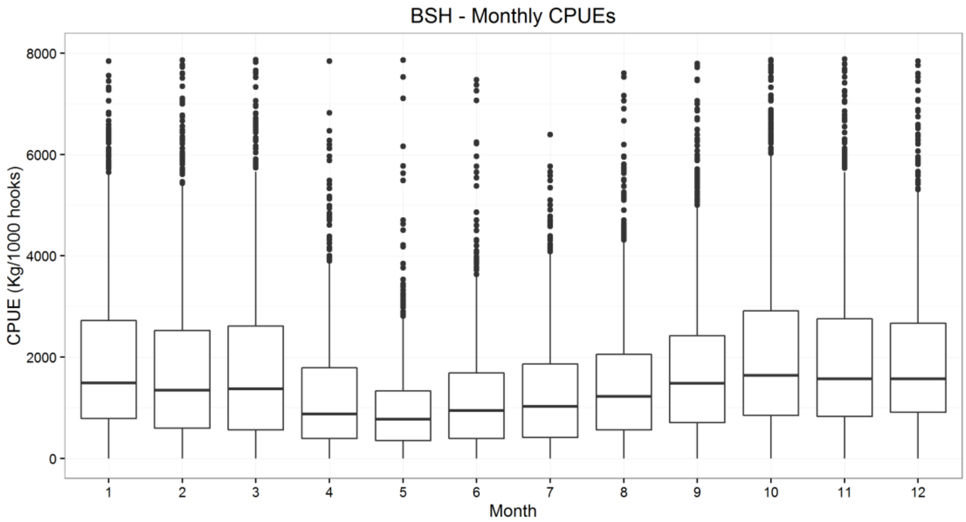


Figure 28. Spatial distribution (in 5°*5° squares) of shortfin mako catch per unit of effort (CPUE, biomass in kg/1000 hooks) in the Cabo Verde EEZ and 300 nm adjacent waters. Data is combined for 2006-2015.

By analysing the monthly CPUE trends of those two main shark species it was possible to describe the seasonality of the presence and capture of those sharks in the region. For the blue shark there are clear seasonal trends in the study area of the Cabo Verde EEZ and adjacent waters, with higher catch rates during the winter months, especially between October and March, and lower catch rates during the summer, mainly between April and September (Figure 29). This is in contrast to the shortfin mako, where there seems not to be a clear seasonal pattern, although the catch rates are higher early in the year between January and June, and lower catches later in the year, between July and December (Figure 29).



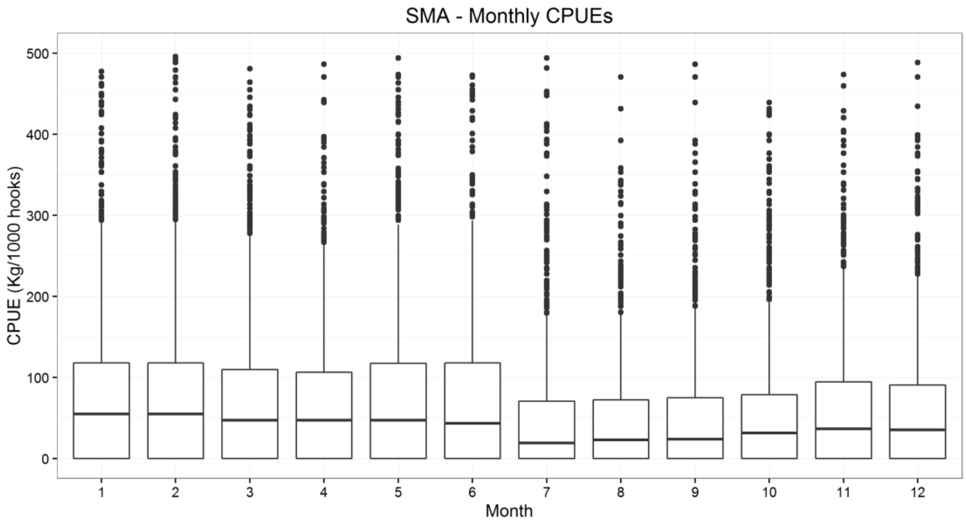


Figure 29. Seasonality in the nominal catch per unit of effort (CPUE) in biomass for blue shark (above) and shortfin mako (bellow) in the Cabo Verde EEZ and 300 nm adjacent waters.

3.3.4 CPUE standardization of blue shark

The nominal CPUE of blue shark showed an increasing trend along the entire time series considered (Figure 30). The percentage of fishing sets with zero catches of blue shark was low, specifically 2.9%. There was a slight decrease in the sets with zero catches in the earlier period until 2011, followed by a slight increase for the more recent years (Figure 30). In terms of data distribution, the nominal blue shark CPUEs were highly skewed to the right and became more normal shaped in the log-transformed scale (Figure 31).

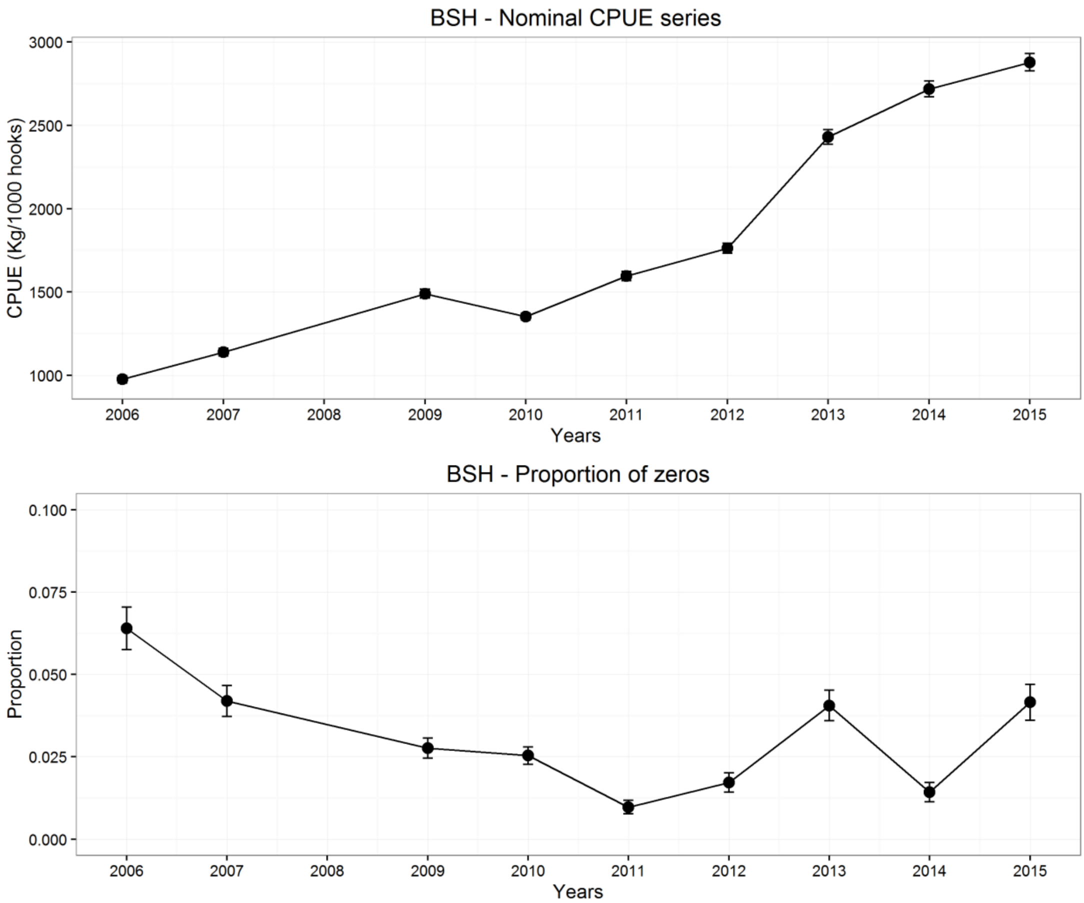


Figure 30. Time series of nominal catch per unit of effort (CPUE, biomass in Kg/1000 hooks) (above) and proportion of fishing sets with zero catches (bellow) for blue shark captured by the EU (Portugal and Spain) pelagic longline fleets in the Cabo Verde EEZ and 300 nm adjacent waters, between 2006 and 2015. The error bars refer to the standard errors.

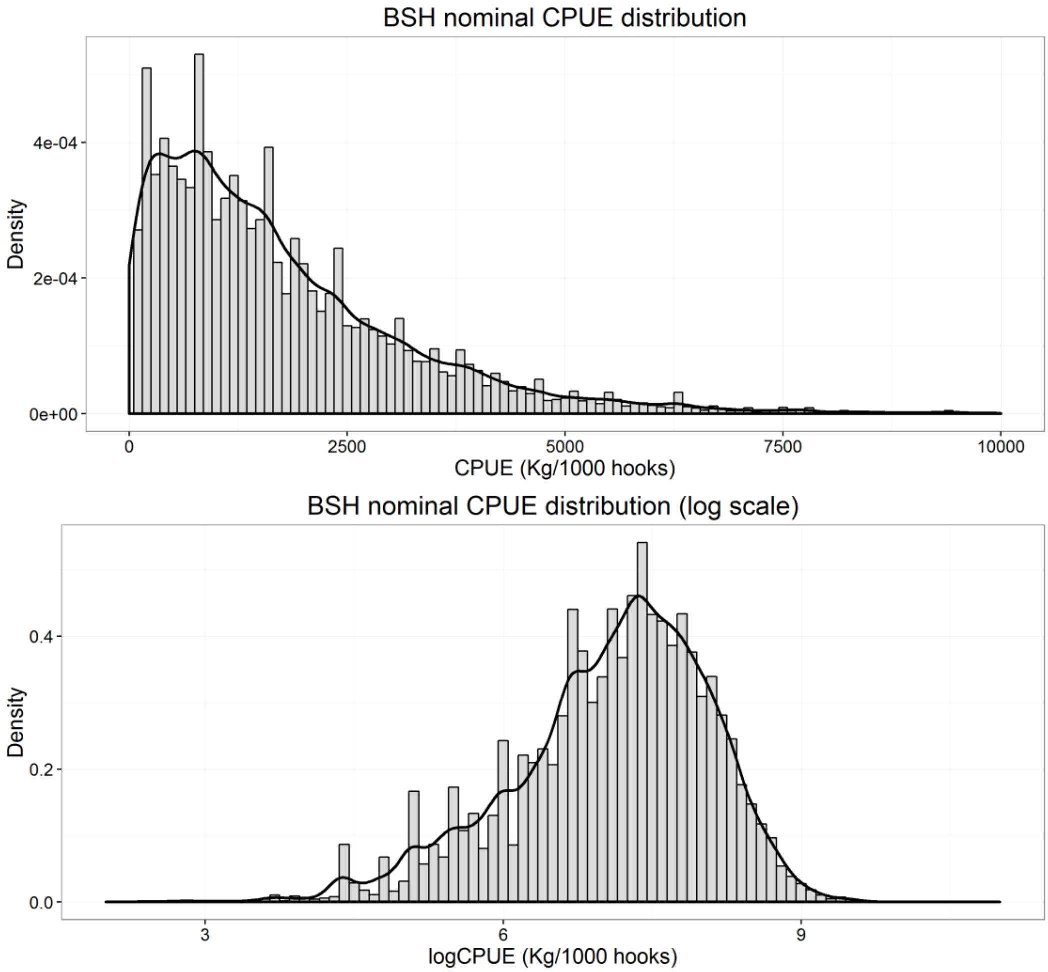


Figure 31. Distribution of the nominal blue shark (BSH) catch per unit of effort (CPUE) in the Cabo Verde EEZ and 300 nm adjacent waters, in non-transformed (top) and log-transformed (bottom) scales.

Of the various candidate models tested, the best fit was obtained with a lognormal GLMM model. All the explanatory variables tested for the blue shark CPUE standardization were significant and contributed significantly for explaining part of the model deviance, including the effects for year, quarter, area and targeting (Table 4). The interactions of quarter with targeting were also significant and included in the model as a fixed variable, as well as the interaction between year and quarter that was included as a random effect. On the final fitted model, the factors that contributed most for the deviance explanation were the targeting, followed by year, quarter and area (Table 4). In terms of model validation, the residual analysis, including the residuals distribution along the fitted values, the QQ plots and the residuals histograms, showed that the model used to standardize the CPUEs was adequate with no major outliers or trends in the residuals (Figure 32).

The final standardized index of abundance for the blue shark in the Cabo Verde EEZ and adjacent waters between 2006 and 2015 shows an overall general increase along the entire time series period, similar to what is observed in the nominal CPUE series (Figure 33).

Table 4. Deviance table (Anova type II) of the parameters used for the blue shark CPUE standardization model for the Cape Verde EEZ and 300 nm adjacent waters using a lognormal GLMM. For each parameter it is indicated the degrees of freedom (Df), the deviance (Dev), the residual degrees of freedom (Resid. Df), the residual deviance (Resid. Dev), the F-test statistic and the significance (p-value).

Model variables	Df	Dev	Resid. Df	Resid. Dev	F-stat	p-value
(Intercept only)			18808	13902.1		
Year	8	1689.9	18800	12212.2	646.4	< 0.001
Year + Quarter	3	760.0	18797	11452.2	775.2	< 0.001
Year + Quarter + Area	11	645.3	18786	10806.9	179.5	< 0.001
Year + Quarter + Area + Target	9	4613.2	18777	6193.6	1568.5	< 0.001
Year + Quarter + Area + TargetRatio + Quarter:Target	27	66.1	18750	6127.5	7.5	< 0.001

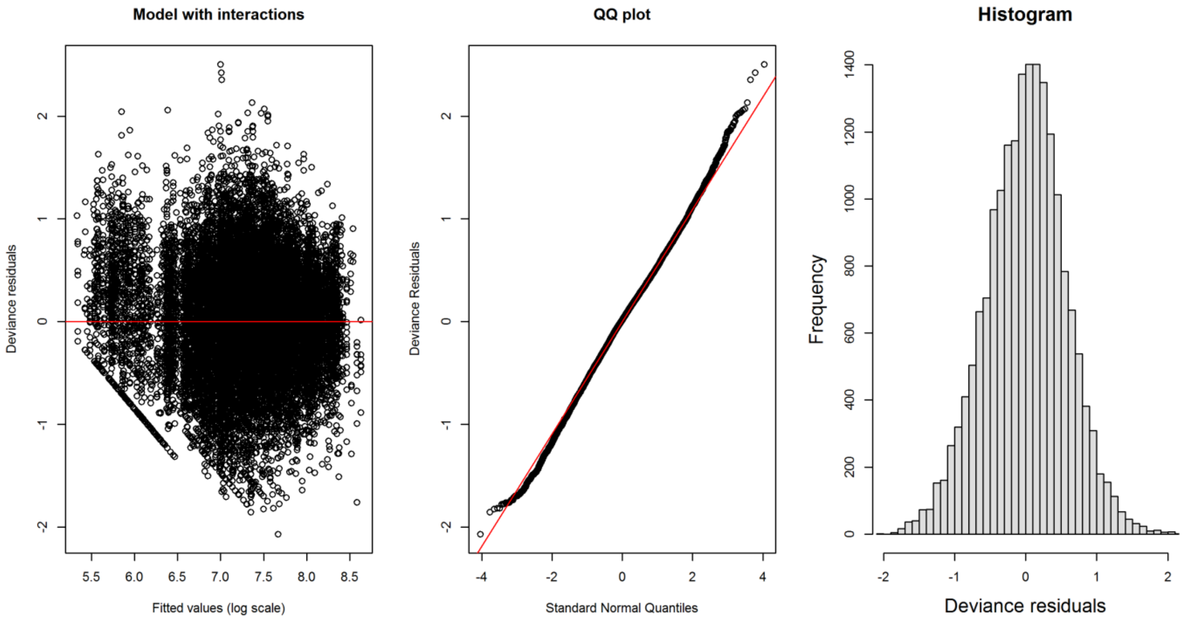


Figure 32. Residual analysis for the final model (lognormal GLMM) for the blue shark CPUE standardization in the Cape Verde EEZ and 300 nm adjacent waters. The plots represent the residuals along the fitted values (left), the QQPlot (middle) and the histogram of the distribution of the residuals (right).

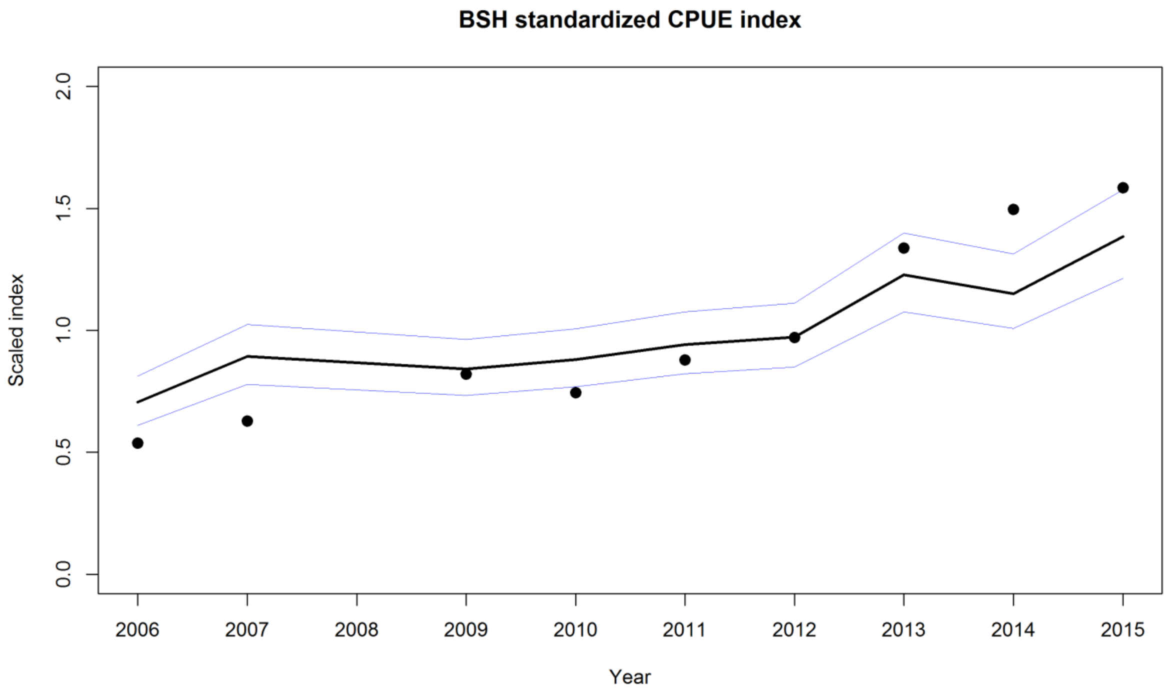


Figure 33. Standardized CPUE series for blue shark in the in the Cape Verde EEZ and 300 nm adjacent waters. The blue lines represent the 95% confidence intervals of the standardized series and the black dots represent the nominal CPUEs. Both series are scaled by their respective mean to facilitate the comparison.

3.3.5 CPUE standardization of shortfin mako

The overall nominal CPUE of shortfin mako shark showed an increasing trend in the initial years between 2006 and 2009, followed by a more stable period for the more recent years (Figure 34). The overall percentage of fishing sets with zero catches of shortfin mako (37.7%) was much higher than for blue shark. Higher proportion of sets with zero shortfin mako catches were observed in the earlier years, and a progressive decrease for the most recent years (Figure 34). In terms of distribution, the nominal shortfin mako shark CPUE distribution was also highly skewed to the left and became more normal shaped in the log-transformed scale (Figure 35).

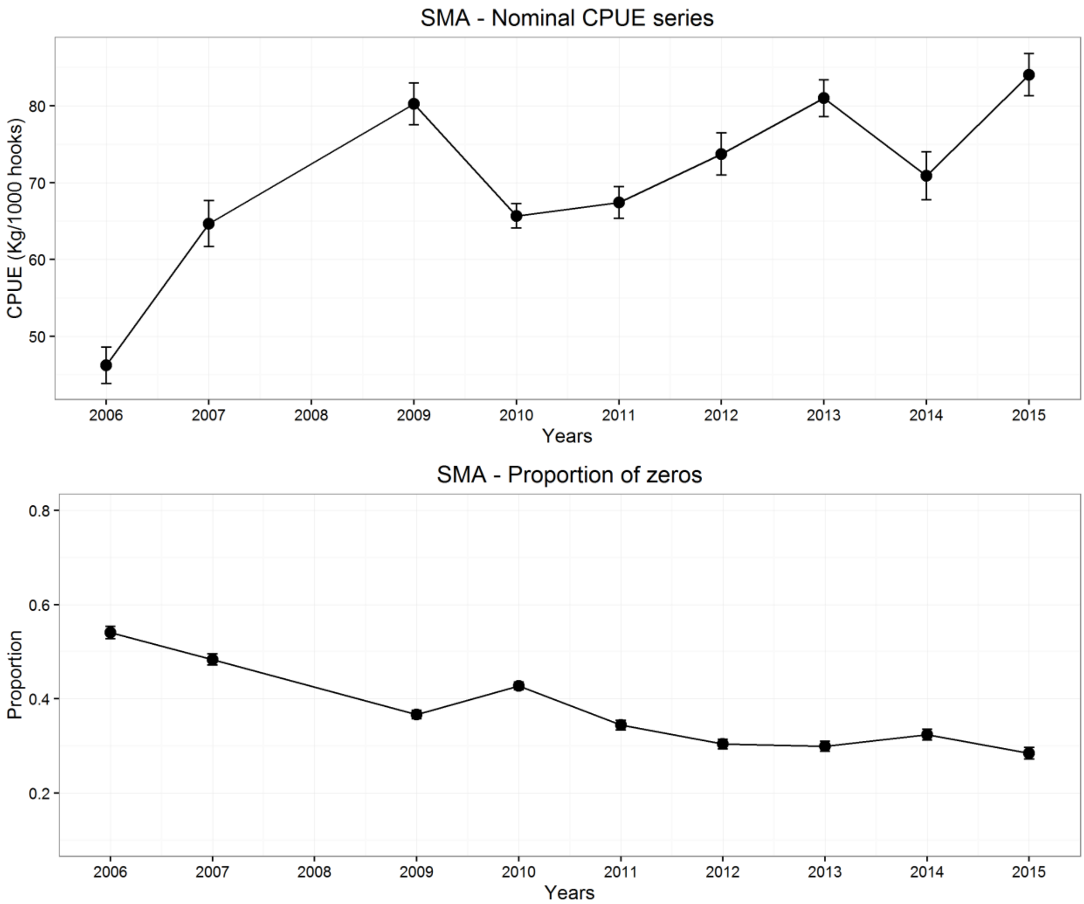


Figure 34. Time series of nominal catch per unit of effort (CPUE, biomass in Kg/1000 hooks) (above) and proportion of fishing sets with zero catches (bellow) for shortfin mako shark captured by the EU (Portugal and Spain) pelagic longline fleets in the Cabo Verde EEZ and 300 nm adjacent waters, between 2006 and 2015. The error bars refer to the standard errors.

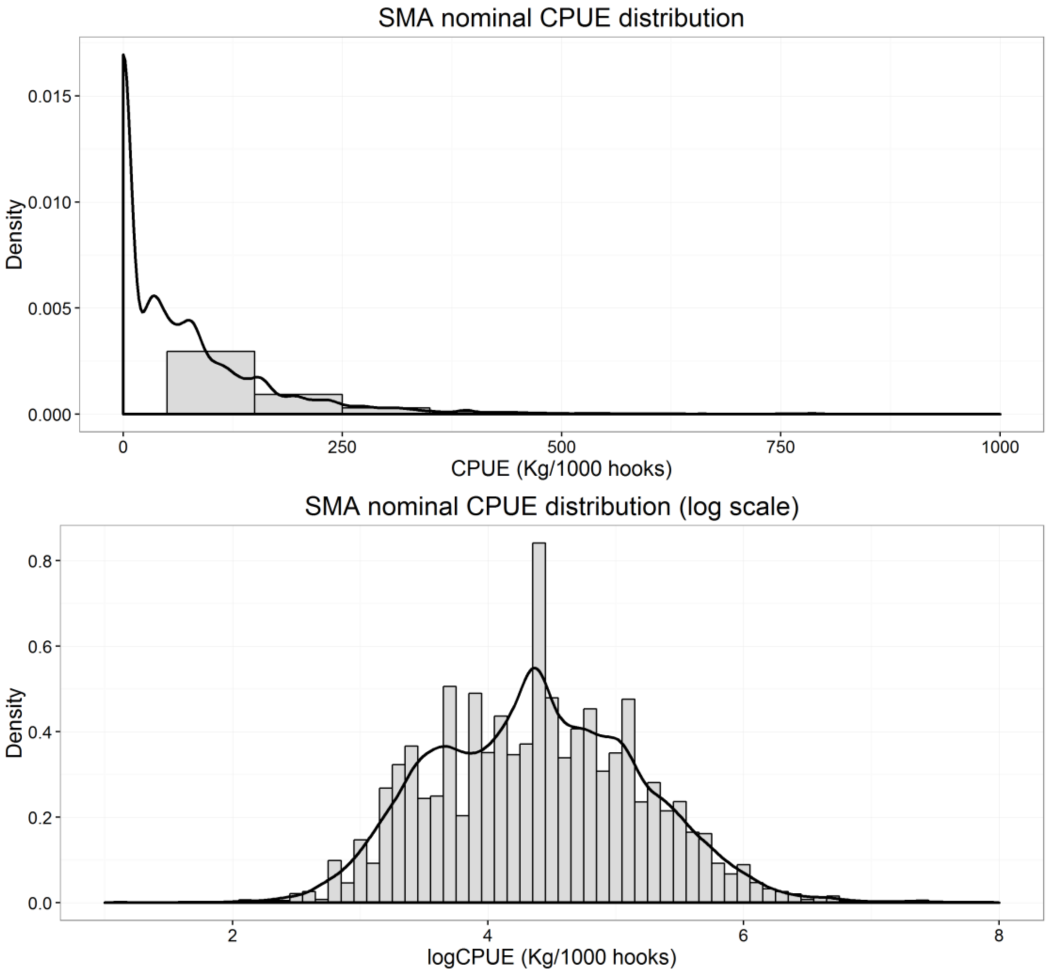


Figure 35. Distribution of the nominal shortfin mako shark (SMA) catch per unit of effort (CPUE) in the Cabo Verde EEZ and 300 nm adjacent waters, in non-transformed (top) and log-transformed (bottom) scales.

Given the high percentage of zeros in the data and the shape of the distribution of the positive sets the model that best fit the data was a tweedie GLM. In terms of the CPUE standardization for using as a relative index of abundance, all the explanatory variables tested for the shortfin mako model were significant and contributed significantly for explaining part of the model deviance, including the effects for year, quarter, area and target (Table 5). The interactions of quarter with targeting were also significant and included in the model as a fixed effect. On the final fitted model, the factors that contributed most for the deviance explanation were the area, followed by quarter, year and targeting (Table 5). In terms of model validation, the residual analysis, including the residuals distribution along the fitted values, the QQ plots and the residuals histograms, showed that the model used to standardize the CPUEs was adequate and no major outliers or trends were noticeable in the residuals (Figure 36).

The final standardized index of abundance for the shortfin mako shark in the Cabo Verde EEZ and adjacent waters between 2006 and 2015 shows an increase in the earlier years until 2009, followed by a decrease in 2010, and then again slightly increased in the most recent year until 2015 (Figure 37).

Table 5. Deviance table (Anova type II) of the parameters used for the shortfin mako shark CPUE standardization model for the Cabo Verde EEZ and 300 nm adjacent waters using a using a tweedie GLM. For each parameter it is indicated the degrees of freedom (Df), the deviance (Dev), the residual degrees of freedom (Resid. Df), the residual deviance (Resid. Dev), the F-test statistic and the significance (p-value).

Model variables	Df	Dev	Resid. Df	Resid. Dev	F-stat	p-value
(Intersept only)			18835	495286		
Year	8	5022.0	18827	490264	21.9	< 0.001
Year + Quarter	3	8412.5	18824	481852	97.6	< 0.001
Year + Quarter + Area	11	22221.2	18813	459630	70.3	< 0.001
Year + Quarter + Area + Target	9	4538.6	18804	455092	17.6	< 0.001
Year + Quarter + Area + TargetRatio + Quarter:Target	27	2317.9	18777	452774	3.0	< 0.001

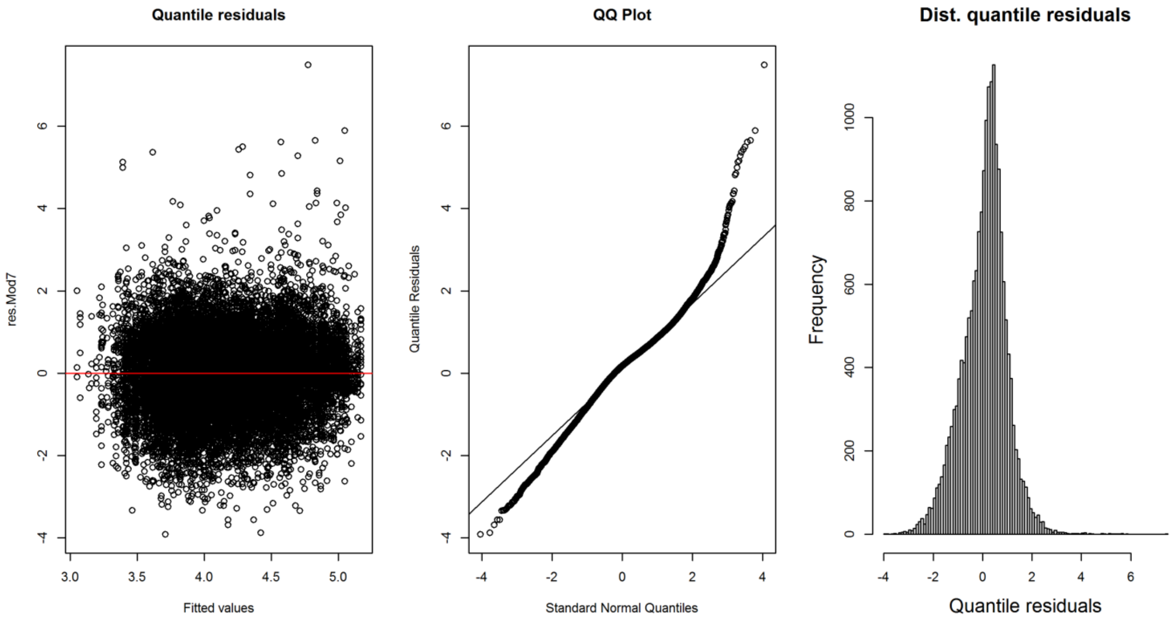


Figure 36. Residual analysis for the final model (tweedie GLM) for the shortfin mako shark CPUE standardization in the Cabo Verde EEZ and 300 nm adjacent waters. The plots represent the residuals along the fitted values (left), the QQPlot (middle) and the histogram of the distribution of the residuals (right).

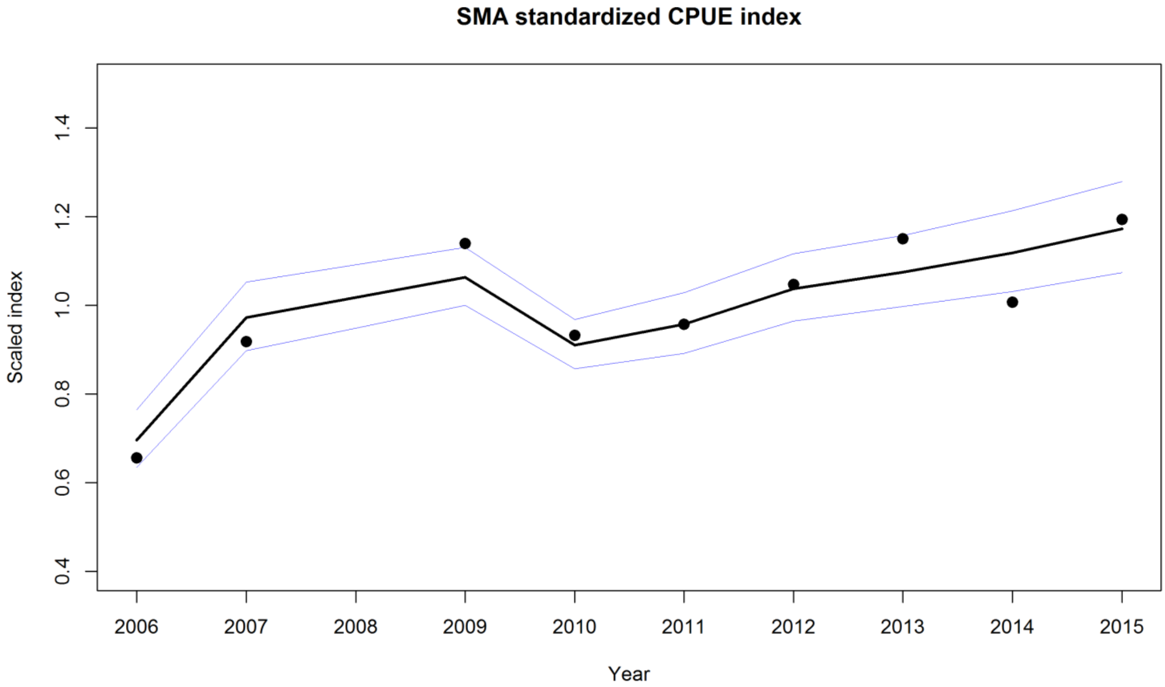


Figure 37. Standardized CPUE series for shortfin mako shark in the in the Cabo Verde EEZ and 300 nm adjacent waters. The blue lines represent the 95% confidence intervals of the standardized series and the black dots represent the nominal CPUE series. Both series are scaled by the means to facilitate the comparison.

3.3.6 Size distribution of the major shark species

In terms of size distributions, blue sharks caught in the Cabo Verde region were relatively large specimens with mean sizes of 210.9 cm FL (SD=17.9) inside the Cabo Verde EEZ and 205.3 cm FL (SD=21.5) in the 300 nm adjacent waters (Figure 38). Those differences observed in the mean blue shark sizes in the two areas were significant (K-Sample Asymptotic Permutation Test: $Chi^2 = 88.9$, df = 1, p-value < 0.001), meaning that in the Cabo Verde EEZ the blue sharks are significantly larger than in the 300 nm adjacent waters. Considering that the mean estimated blue shark size-at-maturity for the North Atlantic is 185 cm FL for females and 200.1 cm FL for males (Anon., 2014), the catch of blue sharks in the Cabo Verde EEZ and neighbouring waters is likely to be composed mainly by adults.

For the shortfin mako shark the mean sizes were 149.4 cm FL (SD=24.5) inside the Cabo Verde EEZ and 142.2 cm FL (SD=36.6) in the 300 nm adjacent waters. In this species the observed differences between areas was also statistically significant (K-Sample Asymptotic Permutation Test: $Chi^2 = 13.4$, df = 1, p-value < 0.001), meaning that in the Cabo Verde EEZ the shortfin makos are also significantly larger than in the 300 nm adjacent waters (Figure 38). Considering that the mean estimated shortfin mako size-at-maturity for the North Atlantic is 275-298 cm FL for females and 180-

185 cm FL for males (Anon., 2014), the catch of shortfin makos both in the Cabo Verde EEZ and neighbouring waters is likely to be composed mainly by juveniles.

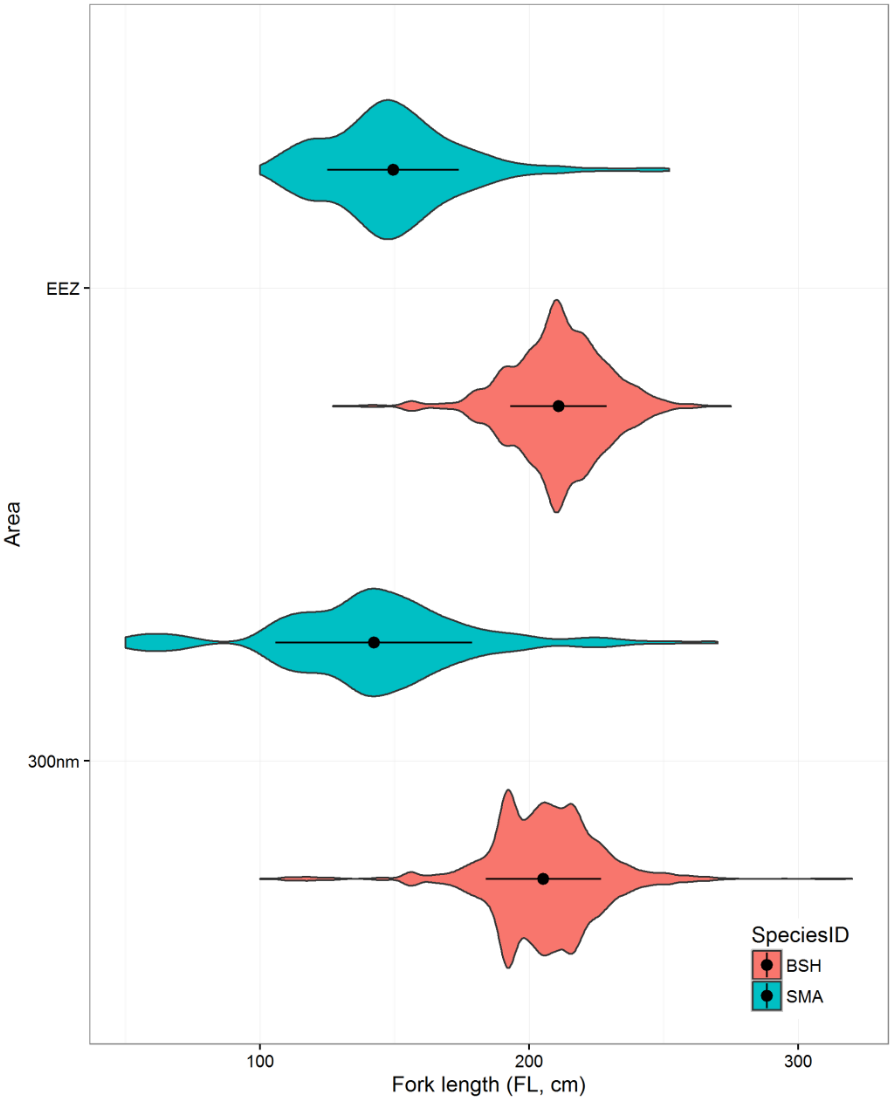


Figure 38. Size frequency distributions (violin plots) of the main shark species (BSH - blue shark and SMA - shortfin mako) in the Cabo Verde EEZ and 300 nm adjacent waters. The point and lines inside the plots represent the mean ± standard deviations.

In terms of seasonality in the mean sizes, larger blue sharks are captured in the 1st, 3rd and 4th quarters of the year, while the smaller specimens being captured mainly in the 2nd quarter, both in the Cabo Verde EEZ and adjacent waters (Figure 39). Those seasonal differences in the blue shark sizes were statistically significant (K-Sample Asymptotic Permutation Test: $Chi^2 = 180.1$, df = 3, p-value < 0.001).

For the shortfin mako, the smallest specimens were captured in the 1st and 2nd quarters and the larger specimens in the 3rd and 4th quarters, with those trends similar both in the Cabo Verde EEZ and adjacent waters (Figure 39). Those seasonal differences in the shortfin mako sizes were statistically significant (K-Sample Asymptotic Permutation Test: $Chi^2 = 113.9$, df = 3, p-value < 0.001).

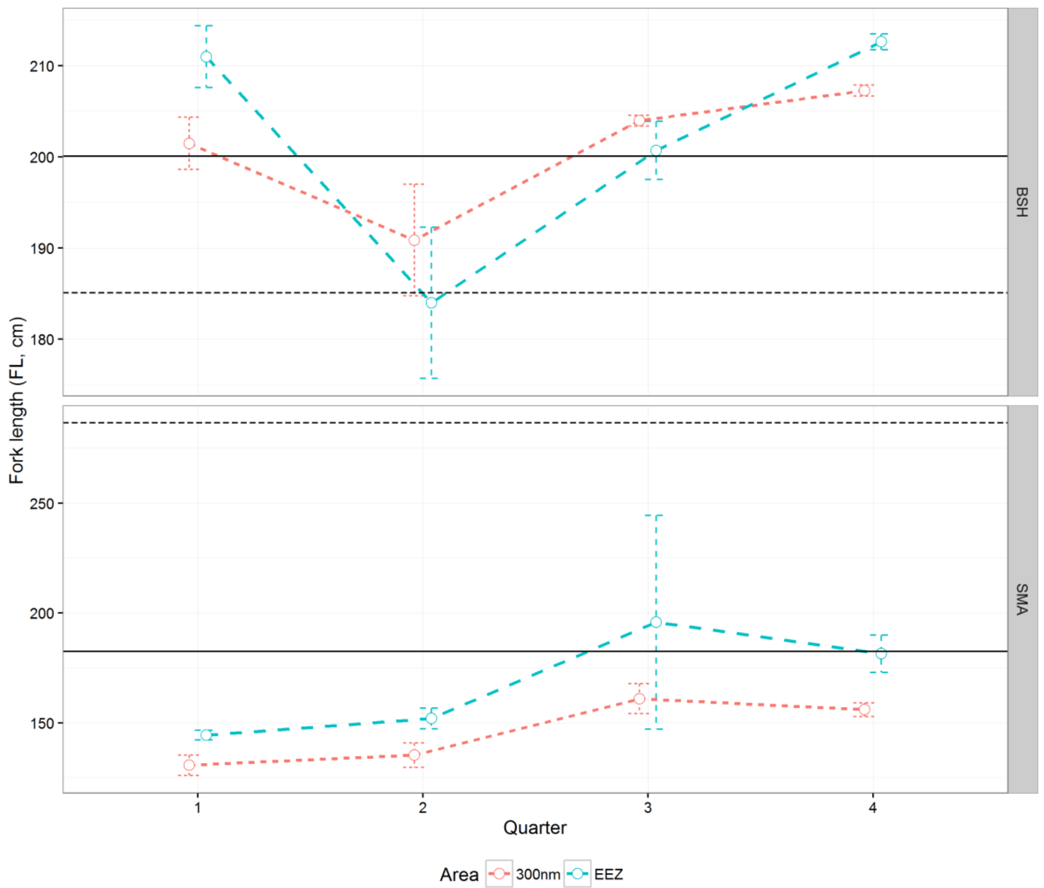


Figure 39. Seasonal mean sizes of the main shark species (BSH - blue shark and SMA - shortfin mako) in the Cabo Verde EEZ and 300 nm adjacent waters. The error bars refer to the 95% confidence intervals (CI). Values for sizes at first maturity (L50) are indicated for males (solid lines) and females (dashed lines) of each species (Anon., 2014).

In terms of temporal trends in sizes, no major variations were observed for the blue shark with the mean sizes relatively stable along the time period both in the Cabo Verde EEZ and 300 nm adjacent waters (Figure 40). However, the mean annual differences in the blue shark sizes were statistically significant (K-Sample Asymptotic Permutation Test: $Chi^2 = 573.3$, $df = 7$, $p\text{-value} < 0.001$). By contrast, there was a general decreasing trend in the mean catch sizes for the shortfin mako during the same period, except in the most recent year (2105) when the mean size was again larger and similar to the initial years (Figure 40). The mean annual differences in the shortfin mako sharks were also statistically significant (K-Sample Asymptotic Permutation Test: $Chi^2 = 136.4$, $df = 8$, $p\text{-value} < 0.001$).

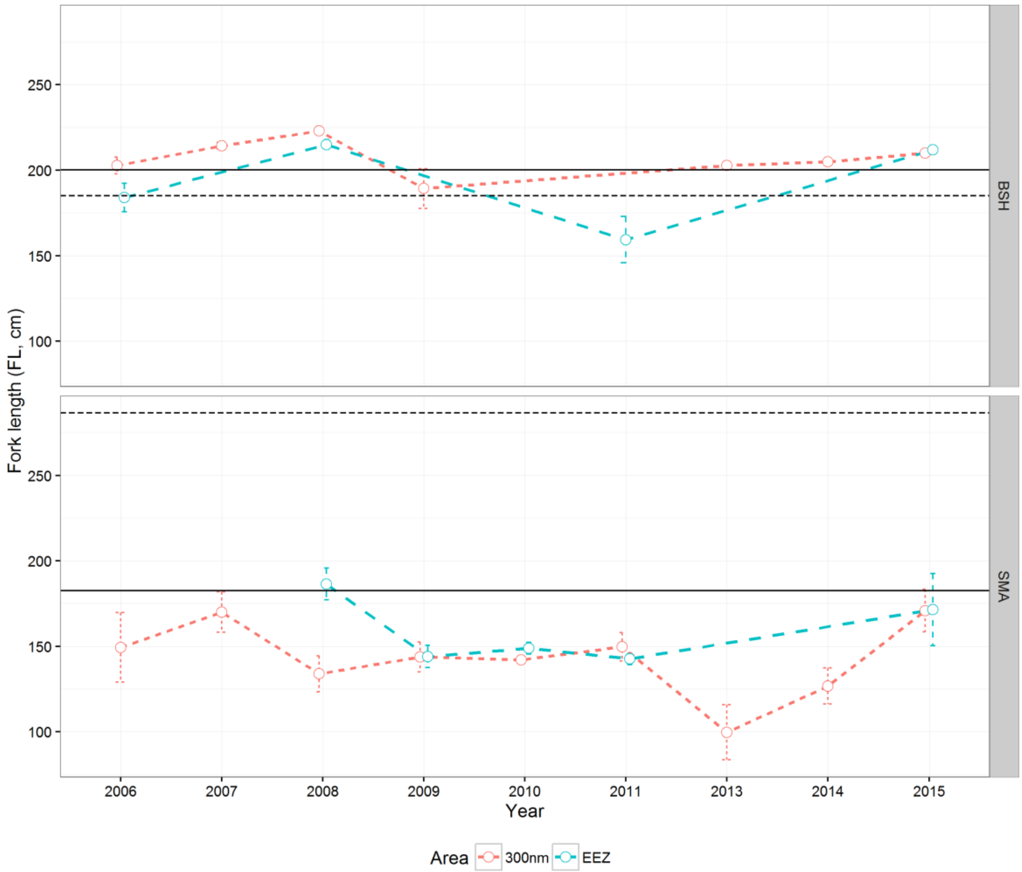


Figure 40. Time series trends of the mean sizes of the main shark species (BSH - blue shark and SMA - shortfin mako) in the Cabo Verde EEZ and 300 nm adjacent waters. The error bars refer to the 95% confidence intervals (CI). Sizes at first maturity (L50) values are indicated for males (solid line) and females (dashed line) of each species (Anon., 2014).

3.4 Task 4 - Biological and ecological sensitive areas

3.4.1 Spatial distribution of the satellite tagged sharks

For the blue shark there were differences in the spatial distribution of the satellite tagged sharks, when comparing between males and females. In general, males moved less and stay closer to the Cabo Verde islands, while females moved more and travel greater distances to other areas (Figure 41 and Figure 42). When comparing maturity stages, there were also differences, with juveniles moving less and the adults travelling to greater distances (Figure 43 and Figure 44). For the shortfin mako the probability of distributions was closer to the African continental shelf, mainly outside the Cabo Verde EEZ (Figure 45).

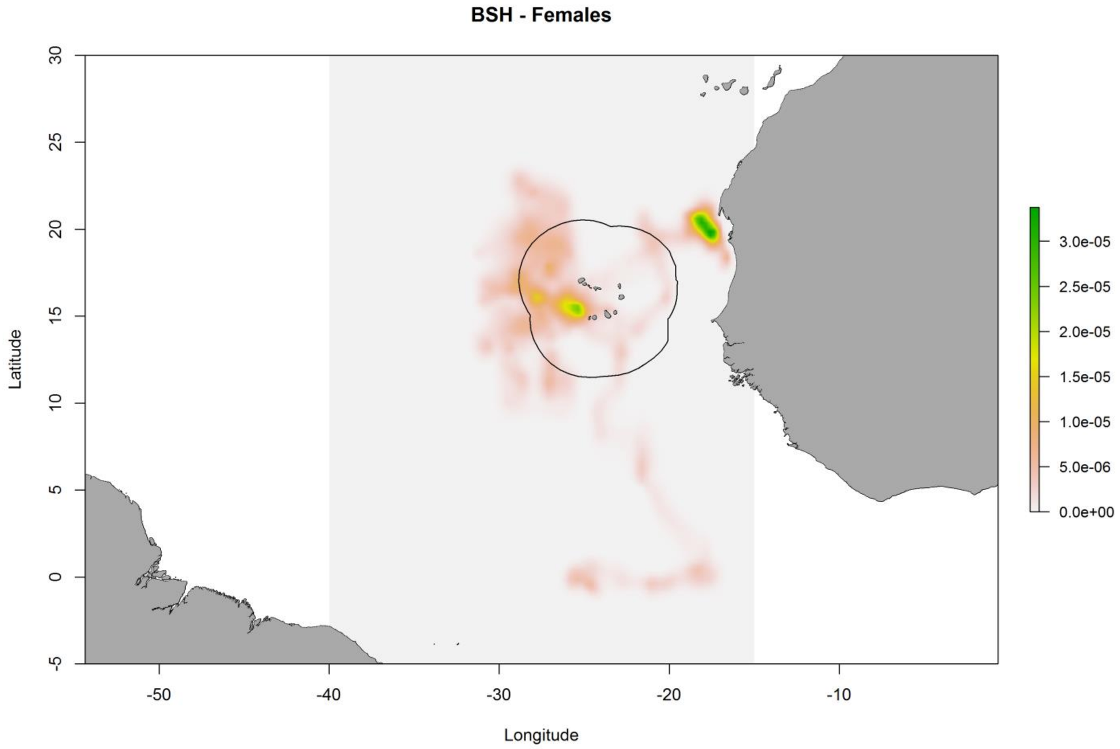


Figure 41. Probability surfaces of the spatial distribution of satellite tagged female blue sharks (BSH) in the Cabo Verde EEZ, tropical northeast Atlantic.

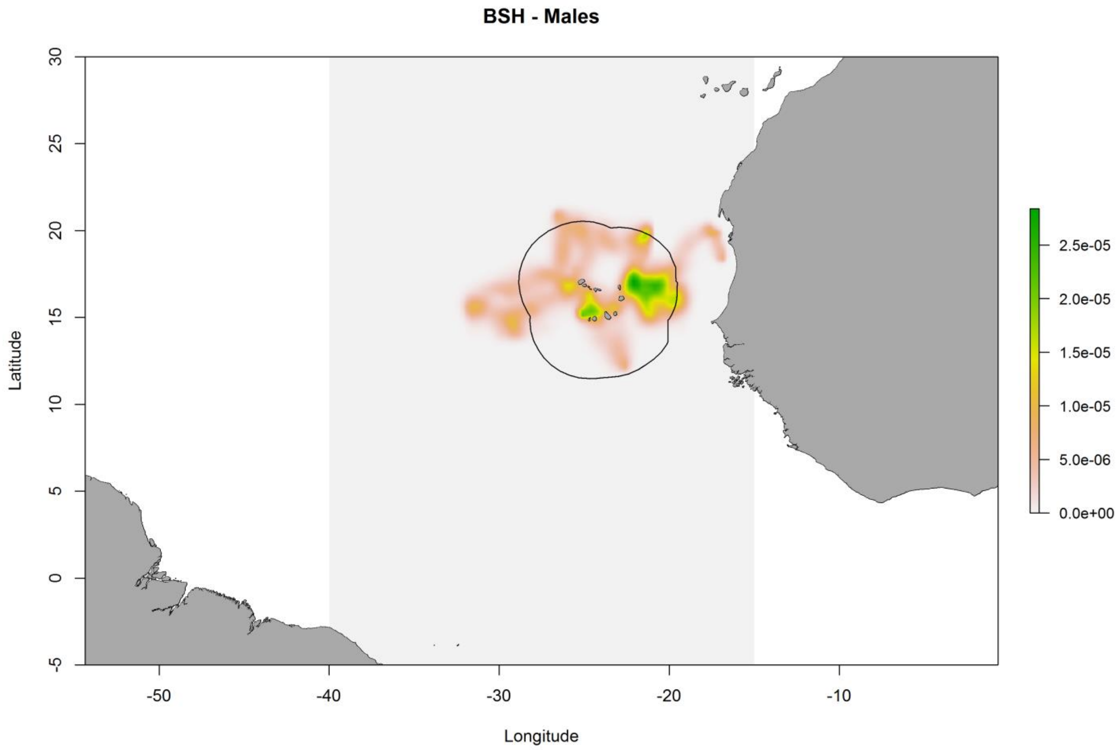


Figure 42. Probability surfaces of the spatial distribution of satellite tagged male blue sharks (BSH) in the Cabo Verde EEZ, tropical northeast Atlantic.

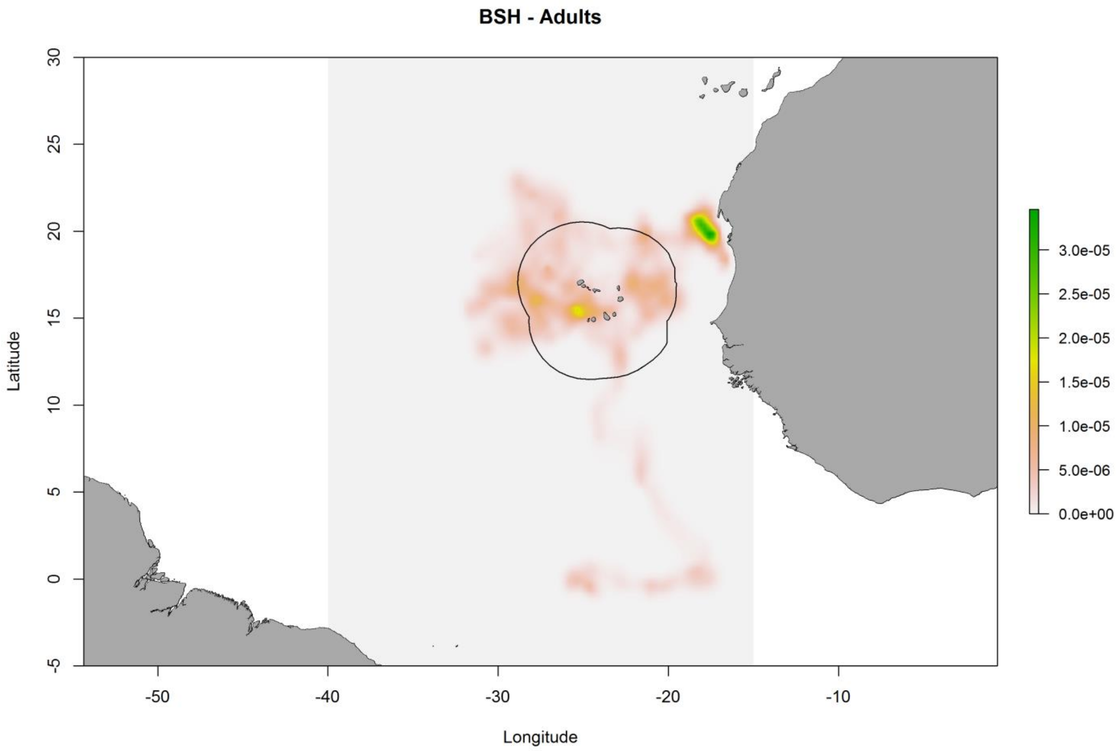


Figure 43. Probability surfaces of the spatial distribution of satellite tagged adult blue sharks (BSH) in the Cabo Verde EEZ, tropical northeast Atlantic.

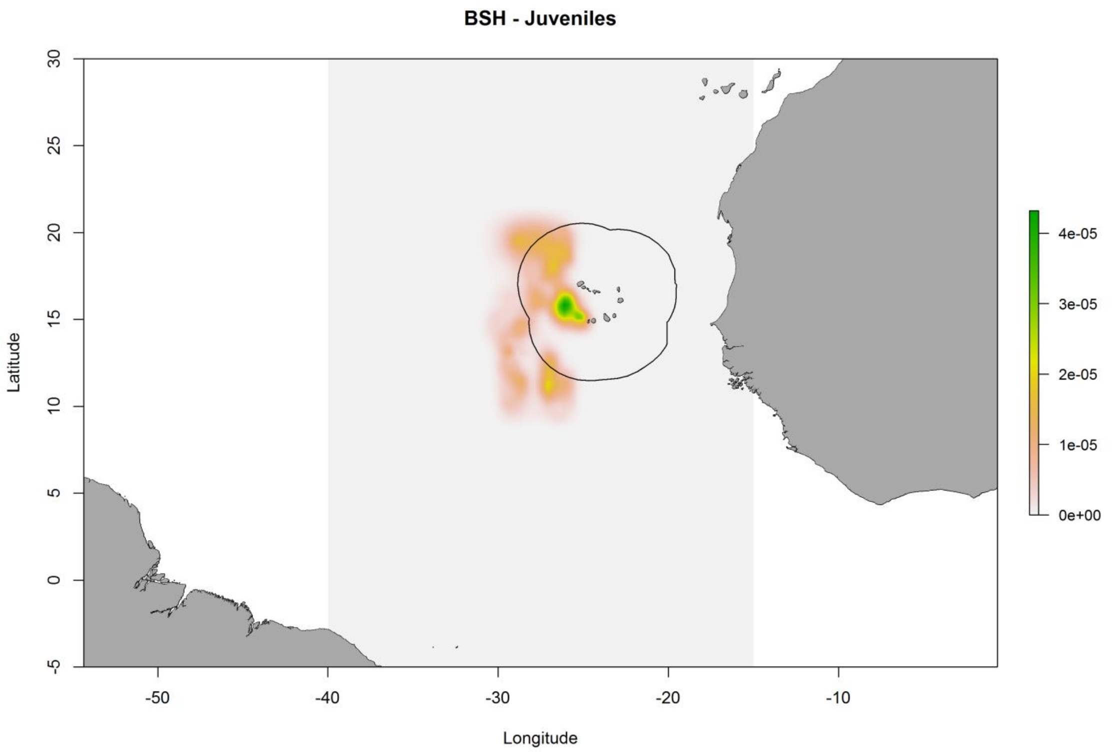


Figure 44. Probability surfaces of the spatial distribution of satellite tagged juvenile blue sharks (BSH) in the Cabo Verde EEZ, tropical northeast Atlantic.

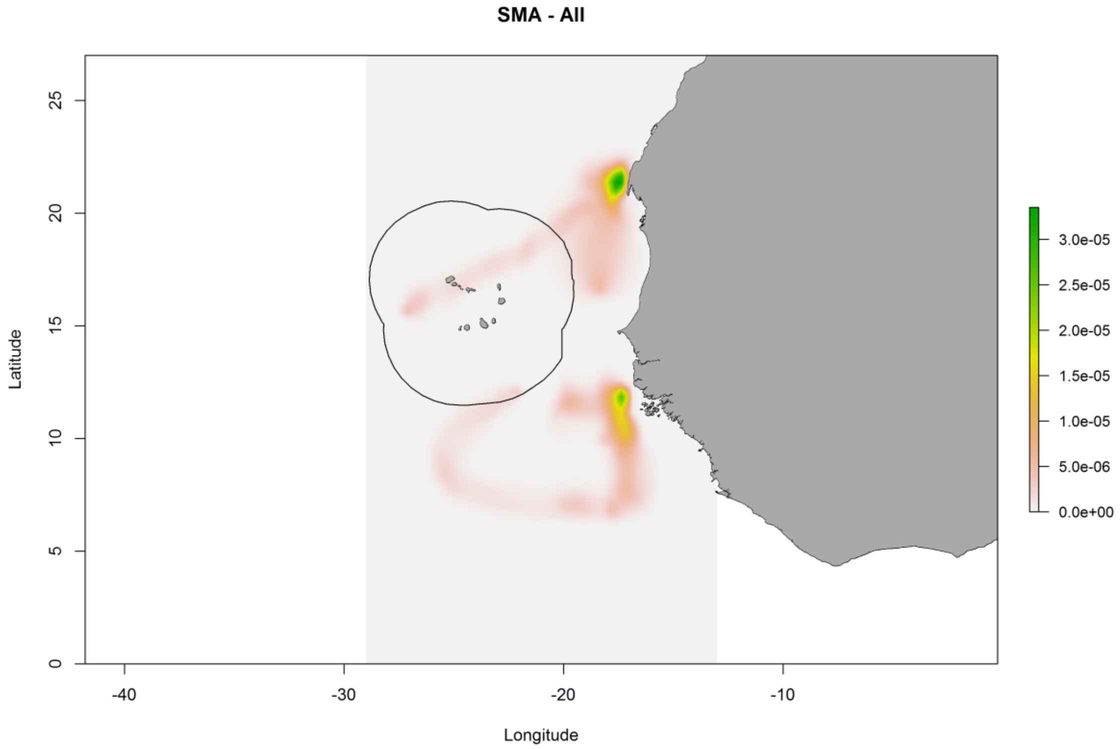


Figure 45. Probability surfaces of the spatial distribution of satellite tagged shortfin mako shark (SMA) in the Cabo Verde EEZ, tropical northeast Atlantic.

3.4.2 Spatial and seasonal prediction of catch rates

There was considerable variability in the expected catch rates (CPUEs) of both blue shark and shortfin mako in the study area when taking into consideration the catch location (spatial effects) and quarter of the year (seasonal effects).

For the blue shark, overall higher CPUEs were predicted to occur outside the Cabo Verde EEZ, especially in the south and southwest regions off the EEZ, while lower CPUEs are expected both in the EEZ and also in the northern areas outside the EEZ (Figure 46). When seasonality was also considered, higher CPUEs are predicted during the winter and autumn (quarters 1 and 4), while much lower overall CPUEs are predicted in late spring and summer, especially during quarter 2 (Figure 47). The substantial seasonal effects in the blue shark catch rates predictions, are in line with the observations described previously in section 3.3.3 of this report on nominal catch rated.

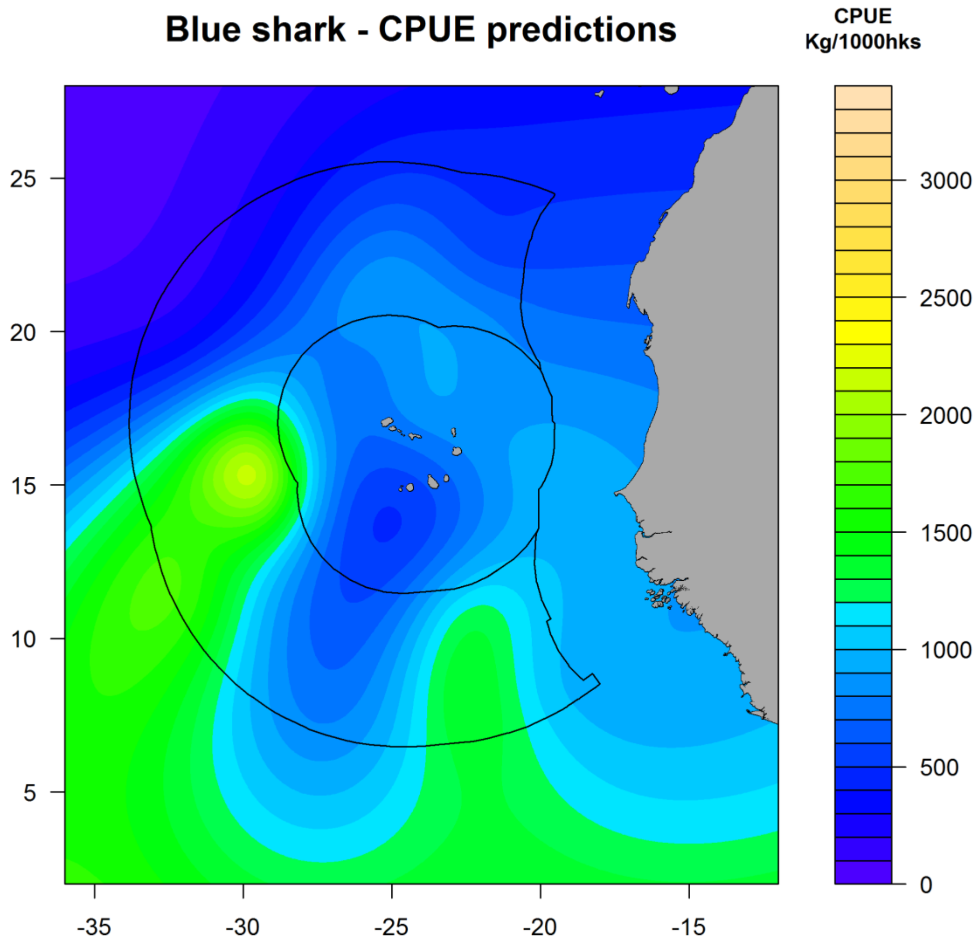


Figure 46. Prediction of the catch rates (CPUEs) of blue shark in the Cape Verde EEZ and adjacent waters. The predicted values are the result of a Generalized Additive Model (GAM) with lognormal distribution, taking into consideration the smooth terms of catch location estimated with thin plate regression splines.

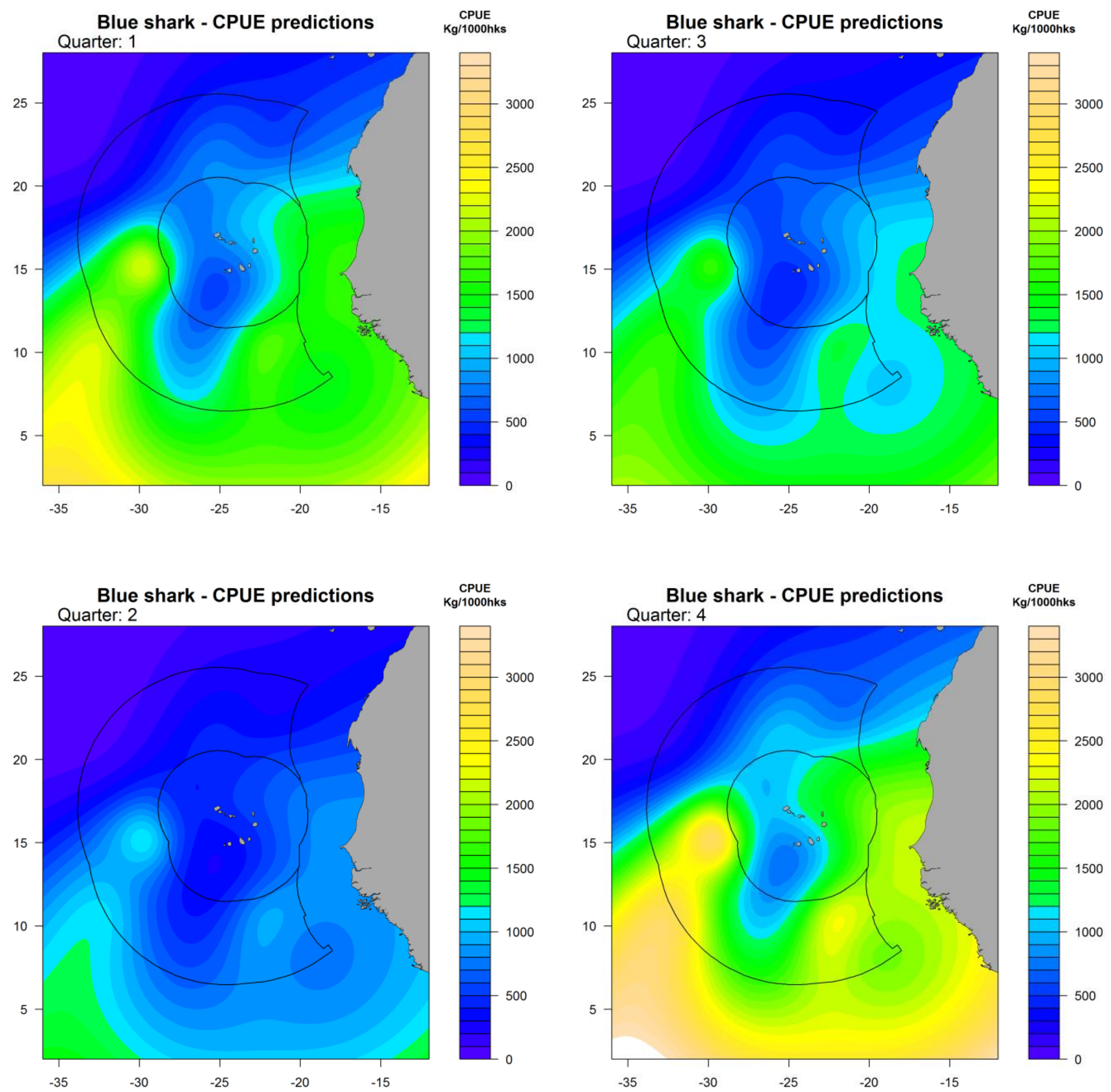


Figure 47. Seasonal prediction of the catch rates (CPUEs) of blue shark in the Cape Verde EEZ and adjacent waters. The predicted values are the result of a Generalized Additive Model (GAM) with lognormal distribution, taking into consideration the smooth terms of catch location estimated with thin plate regression splines and the quarter of the year used as a parametric term.

For the shortfin mako shark, a very low CPUE along most of the study area, including both the Cabo Verde EEZ and most of the adjacent waters was predicted. The higher CPUEs for this species are predicted in the eastern region, closer to the African continental shelf waters (Figure 48). For the shortfin mako shark the seasonal effects were not as noticeable as for the blue shark, and the overall trends were constant along all the quarters of the year (Figure 49).

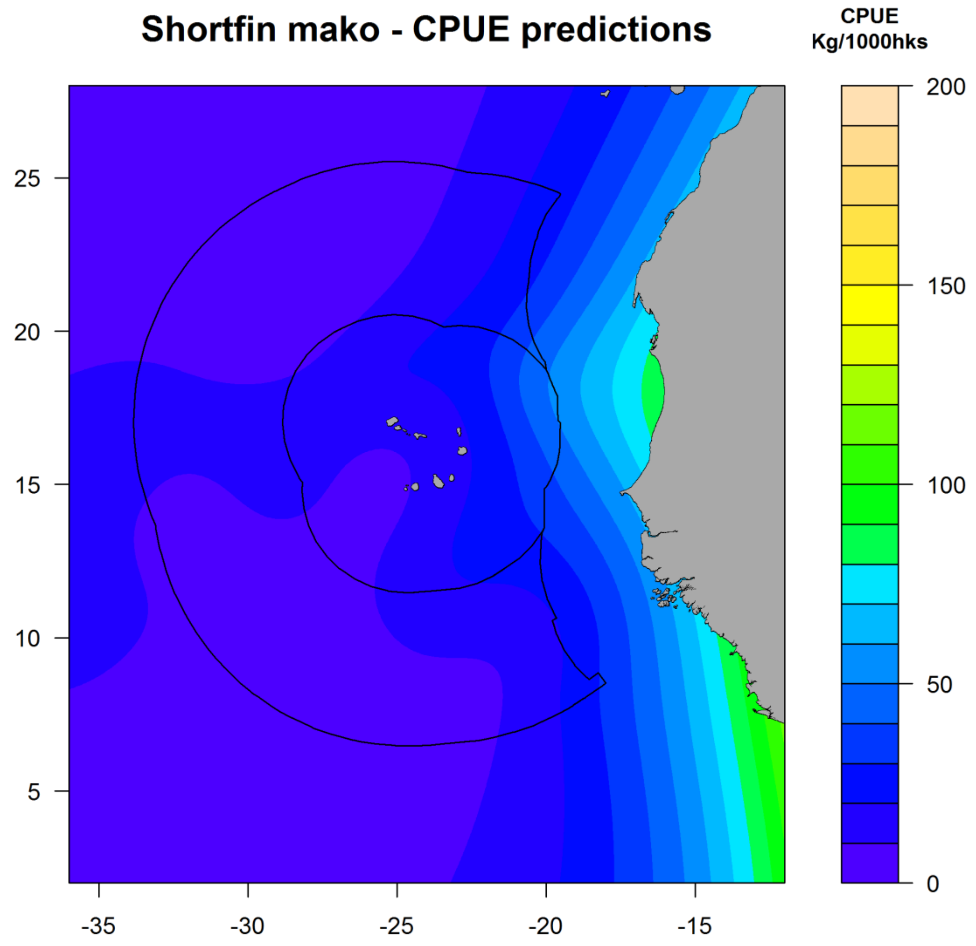


Figure 48. Prediction of the catch rates (CPUEs) of shortfin mako shark in the Cabo Verde EEZ and adjacent waters. The predicted values are the result of a Generalized Additive Model (GAM) with lognormal distribution taking into consideration the smooth terms of catch location estimated with thin plate regression splines.

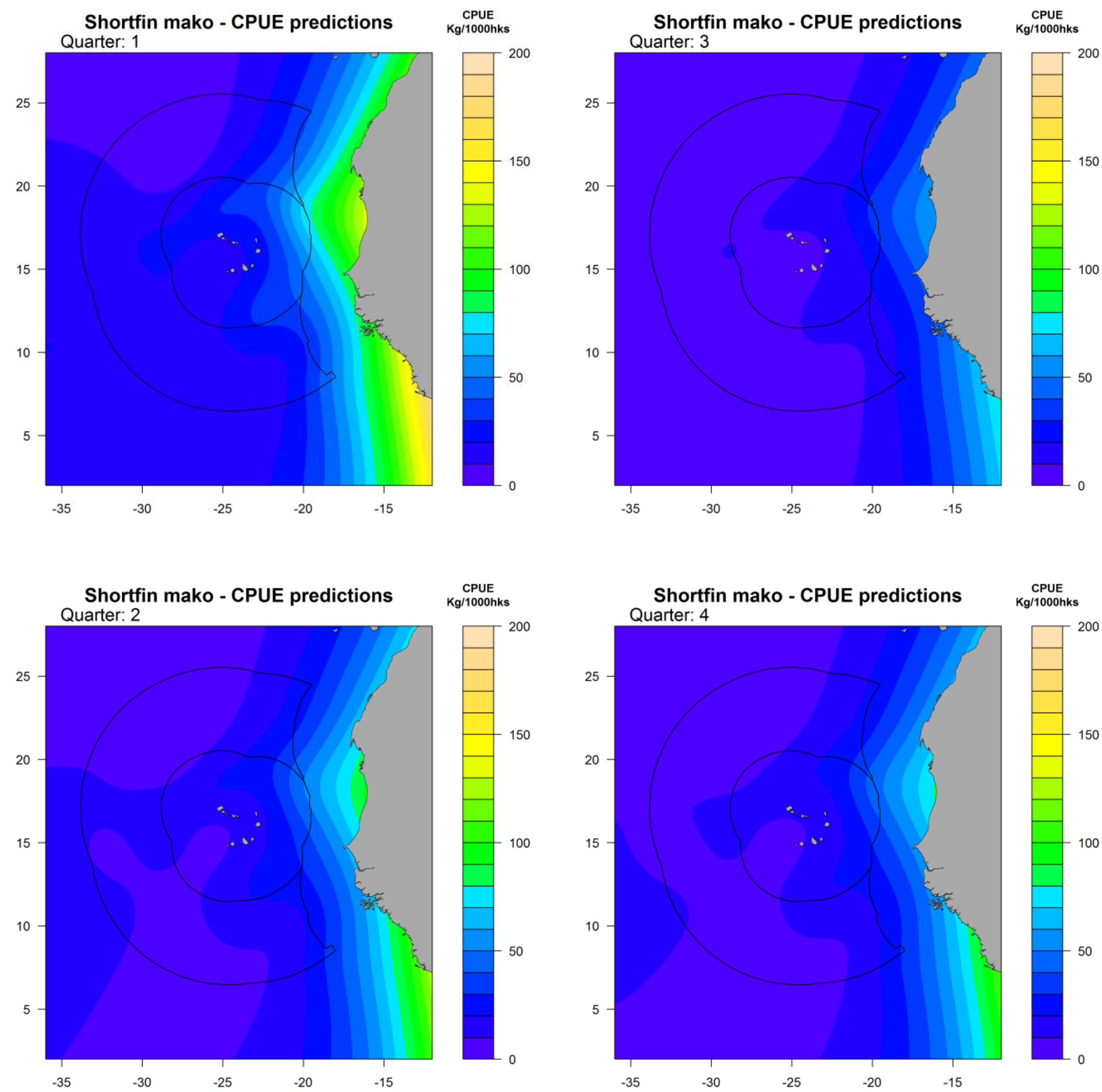


Figure 49. Seasonal prediction of the catch rates (CPUEs) of shortfin mako shark in the Cabo Verde EEZ and adjacent waters. The predicted values are the result of a Generalized Additive Model (GAM) with lognormal distribution, taking into consideration the smooth terms of catch location estimated with thin plate regression splines and the quarter of the year used as a parametric term.

3.4.3 Spatial and seasonal prediction of the size distributions

There was also considerable spatial and seasonal variability in the predicted size distributions of both species when taking into account the catch location (spatial effects) and quarter of the year (seasonal effects).

For blue shark, in general the smaller specimens were predicted both inside the Cabo Verde EEZ and the 300 nm adjacent waters, especially in the northeastern areas, as well as outside the study area towards the southwest (Figure 50). Seasonality is also important in the blue shark predicted sizes, with overall smaller specimens expected during the spring months in quarter 2 (Figure 51). Nonetheless, it is important to note that the overall predicted blue shark sizes are relatively large for the species, given that blue sharks mature at 185.1 cm FL (females) and 200.1 cm FL (males). As such, most of the blue shark sizes predicted to occur in the study area along the entire year corresponds to large juveniles and adults.

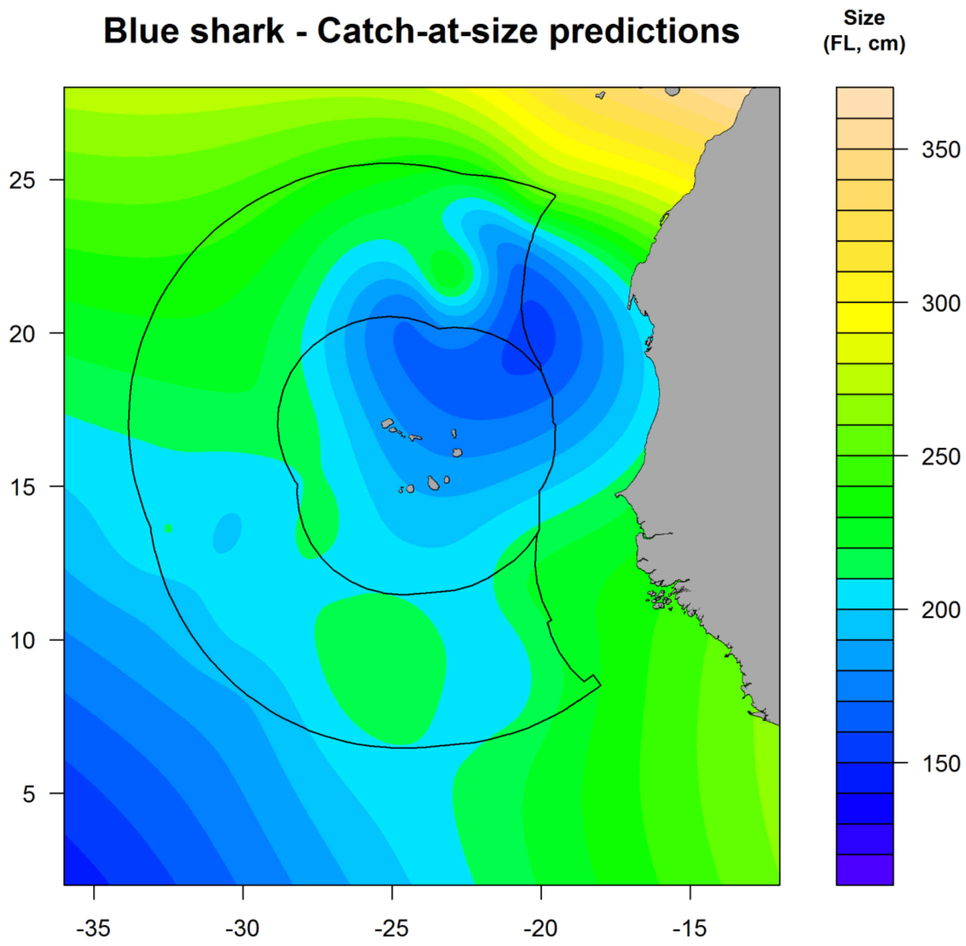


Figure 50. Prediction of the size distribution of blue shark in the Cabo Verde EEZ and adjacent waters. The predicted values are the result of a Generalized Additive Model (GAM) with Gaussian distribution and identity link function, taking into consideration the smooth terms of catch location estimated with thin plate regression splines.

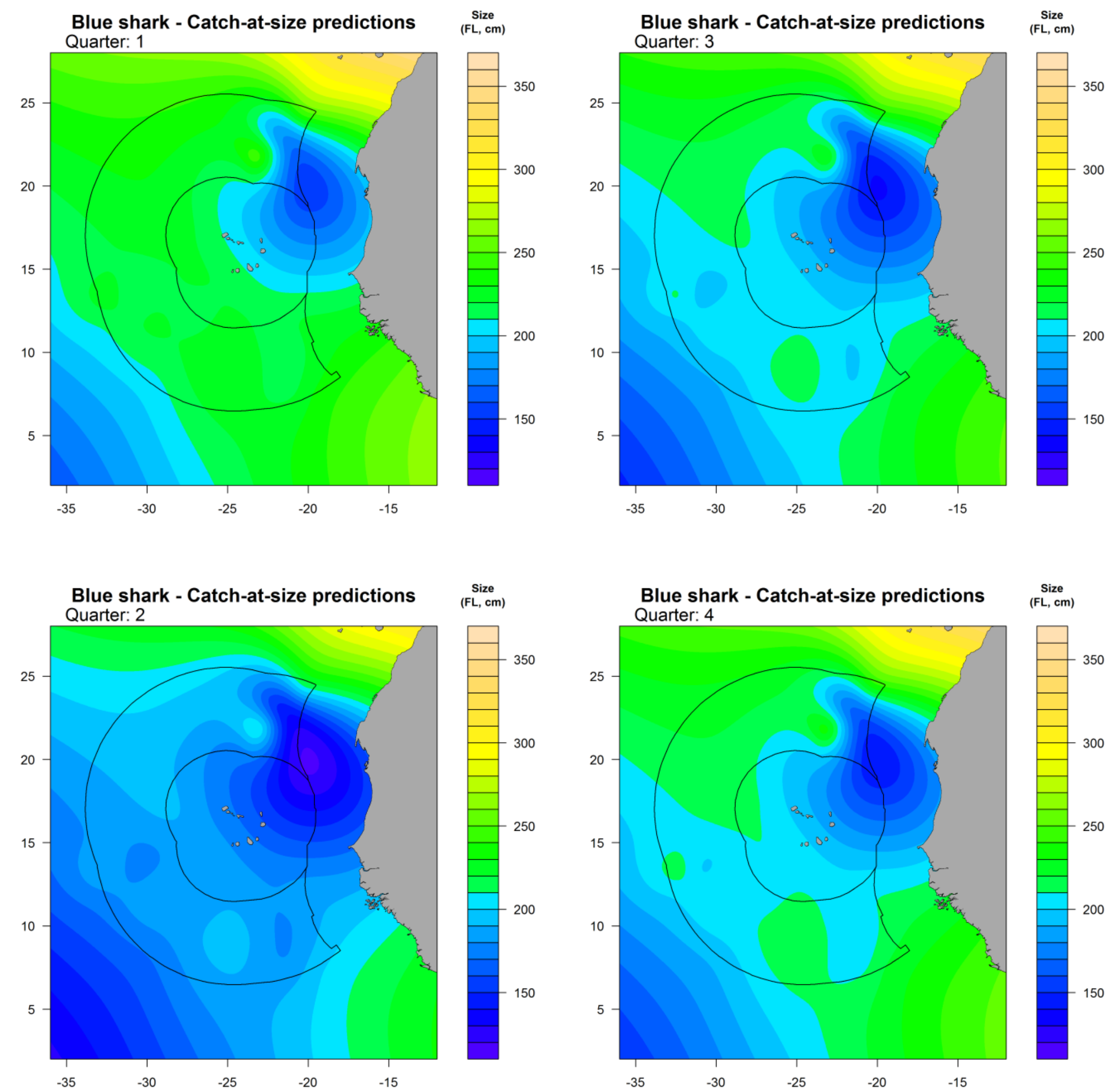


Figure 51. Seasonal prediction of the size distribution of blue shark in the Cabo Verde EEZ and adjacent waters. The predicted values are the result of a Generalized Additive Model (GAM) with Gaussian distribution and identity link function, taking into consideration the smooth terms of catch location estimated with thin plate regression splines and the quarter of the year as a parametric term.

For shortfin mako, there were also marked spatial effects in the predicted size of the specimens, in this case with smaller specimens expected to occur both inside the Cabo Verde EEZ and adjacent waters, especially in the northeastern area (Figure 52). When the seasonal effect were considered, overall smaller specimens are expected to occur in the 1st half of the year, during quarters 1 and 2, and larger specimens are expected to occur mainly in the 2nd semester (Figure 53). Contrary to the blue shark, in the case of the shortfin mako shark overall expected specimen sizes are relatively small for the species, given that shortfin mako sharks mature at 286.5 cm FL (females) and 182.5 cm FL (males). As such, most of the shortfin mako specimens expected to occur in the study area along the entire year, particularly the females, correspond to juveniles.

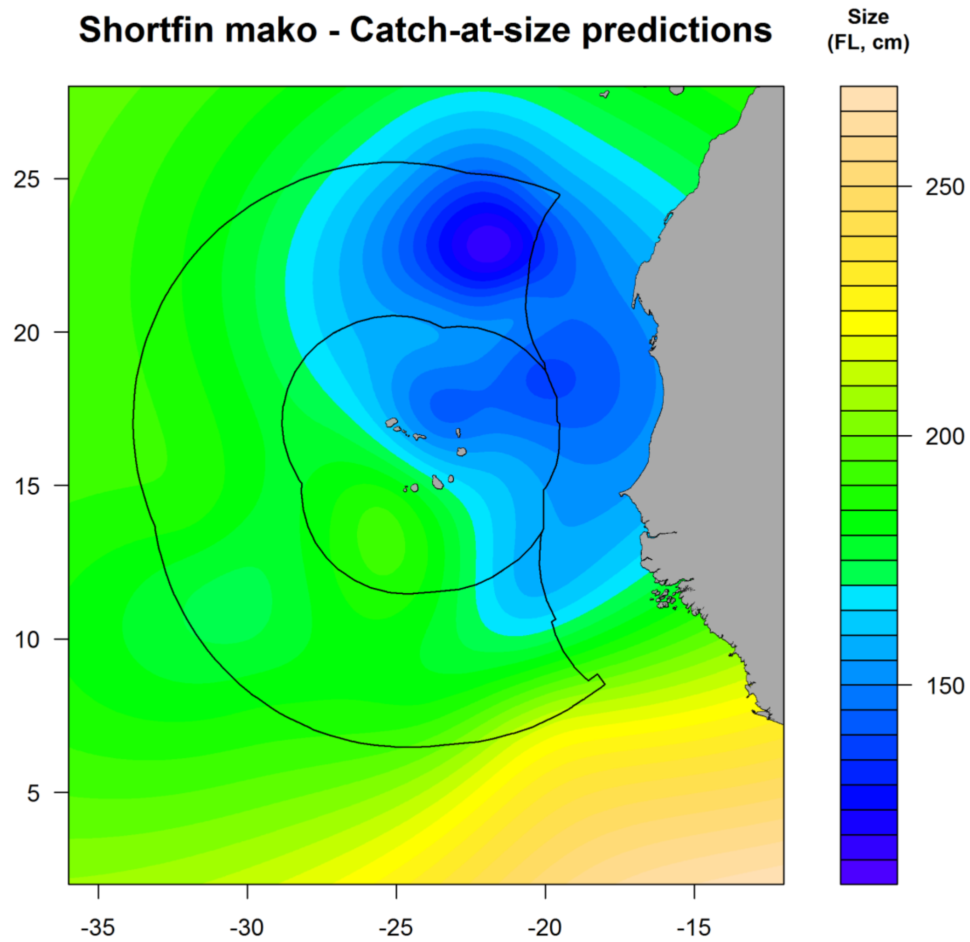


Figure 52. Prediction of the size distribution of shortfin mako shark in the Cabo Verde EEZ and adjacent waters. The predicted values are the result of a Generalized Additive Model (GAM) with Gaussian distribution and identity link function, taking into consideration the smooth terms of catch location estimated with thin plate regression splines.

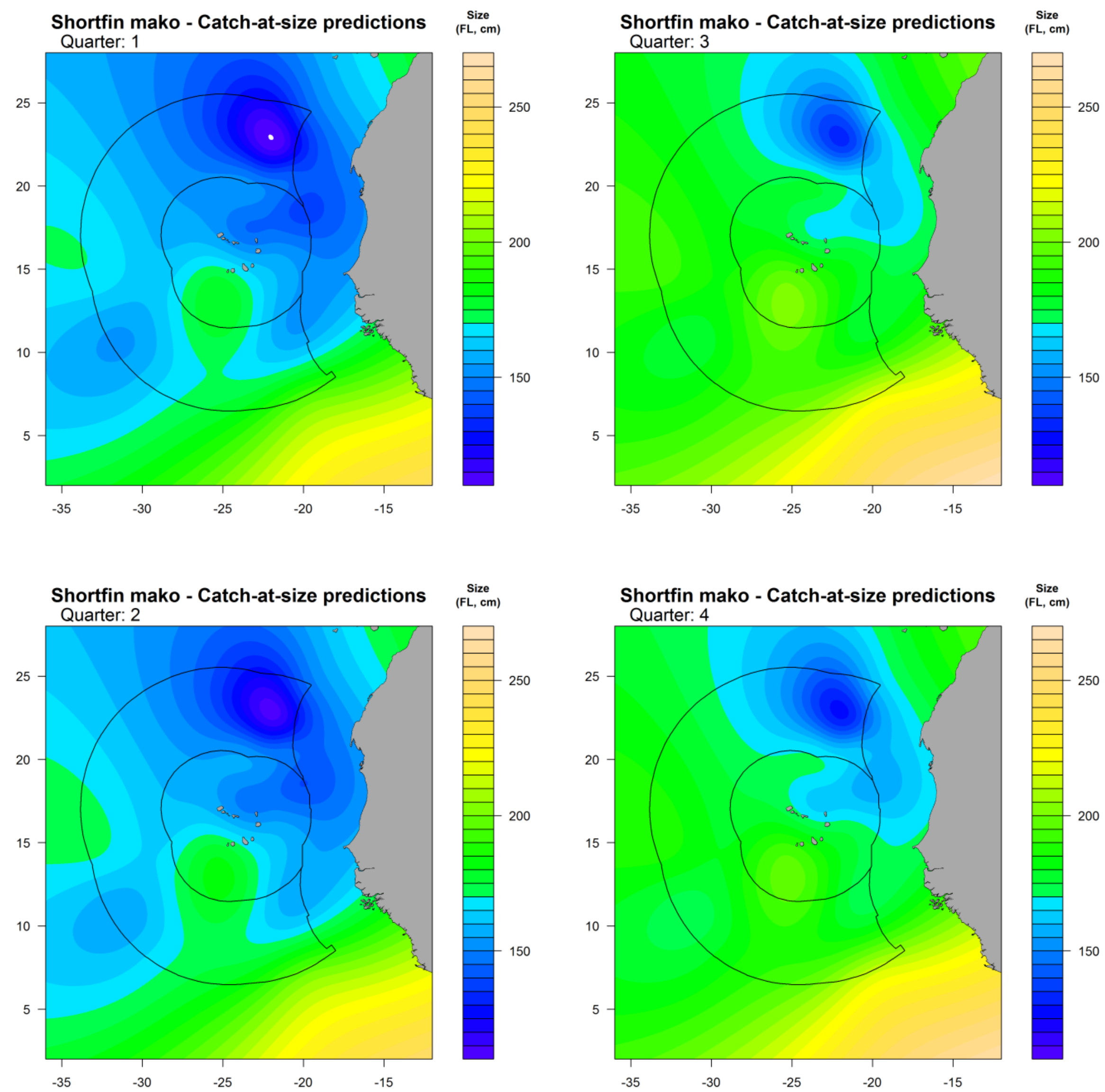


Figure 53. Seasonal prediction of the size distribution of shortfin mako shark in the Cabo Verde EEZ and adjacent waters. The predicted values are the result of a Generalized Additive Model (GAM) with Gaussian distribution and identity link function, taking into consideration the smooth terms of catch location estimated with thin plate regression splines and the quarter of the year used as a parametric term.

3.5 Task 5- Coordination and communication

Within this project and specifically under Task 5 (coordination and dissemination), the Consortium was expected to produce and deliver several items, including the work-plan, tagging program, observer program, three non-technical papers, an interim report and the draft and final reports, as well as the attendance and preparation of presentations for a workshop to be held in Cabo Verde.

All the deliverables for this project have been produced and delivered on time (Table 6). The list of the deliverables submitted with this project, as well as their delivery dates are shown below in Table 6.

Table 6. List of deliverables of this project with the respective name, association to each task, nature (R = Report, O = Other - specify), dissemination level and delivery date.

Del no.	Deliverable name	Task no.	Nature	Dissemination level	Delivery date
1	Non-technical paper #1	5	R	Consortium, European Commission/EASME and Cabo Verde	**Delivered** 19/03/2015
2	Work plan	5	R	Consortium, European Commission/EASME and Cabo Verde	**Delivered** 8/04/2015
3	Tagging programme	2	O (Plan)	Consortium, European Commission/EASME and Cabo Verde	**Delivered** 15/04/2015
4	Observer program	1	R	Consortium, European Commission/EASME and Cabo Verde	**Delivered** 18/05/2015
5	Interim report	5	R	European Commission/EASME	**Delivered** 18/09/2015
6	Non-technical paper #2	5	R	Consortium, European Commission/EASME and Cabo Verde	**Delivered** 19/02/2016
7	Non-technical paper #3	5	R	Consortium, European Commission/EASME and Cabo Verde	**Delivered** 19/04/2017
8	Workshop	5	O (Outline/Agenda, & Presentations)	Scientists, fisheries administrations and NGOs	**Delivered** 24/03/2017
9	Final report (draft)	5	R	European Commission/EASME	**Delivered** 19/03/2017
10	Final report	5	R	European Commission/EASME	**This report (Delivered)** 19/04/2017

Due to the important scientific component and findings of this project, the scientific coordinator presented an oral communication during an international scientific conference, namely during the 20th Annual Scientific Conference of the European Elasmobranch Association (EEA), that took place from the 28-30th October 2016 in Bristol, England. This was done with the agreement of EASME/DG-MARE, and in strait collaboration between the several scientists that participated in the study, both from the EU and Cabo Verde. The abstract of the work presented is provided in Annex VII of this report, and the scientific reference of the work is:

- Coelho, R., Macías, D., Ortiz de Urbina, J., Martins, A., Monteiro, C., Bach, P., Murua, H., Rosa, D., Abaunza, P. 2016. Local indicators for global species: the case study of the Cabo Verde pelagic sharks captured within the EU Sustainable Fisheries Partnership Agreements. Oral Communication presented at the 20th Annual Scientific Conference of the European Elasmobranch Association (EEA), 28-30 October, Bristol, England.

Additionally, the submission of two peer-review papers is envisioned to further and in a more formal way disseminate the results of this study to the scientific community. This will also be done in strait collaboration between the EU and Cabo Verde scientists that participated in the study. The subjects of the two planned scientific papers are:

- Indicator analysis of the main pelagic shark species captured by pelagic fisheries in the Cabo Verde region (northeast Atlantic).
- Tagging and habitat use of the main pelagic shark species (blue shark and shortfin mako) in the northeast Atlantic (Cabo Verde).

4 DISCUSSION

4.1 Observer programme

The observer programme materials provided during this project are adequate for allowing biological and fisheries data collection both from fishery observers and from skippers and crews through a self-sampling program. These materials, including the observer manual, ID and biology guides, data reporting templates and self-sampling programme are currently used in EU national observer programs. The data collected are processed and reported to ICCAT where they contribute to the regular shark stock assessments carried out by the Species Working Group, as needed.

The next recommended step is to follow up with the implementation of the observer programme. The materials and training have been provided to the Cabo Verde scientists and technicians through this project, but the implementation of the programme is the responsibility of Cabo Verde administration. There will be costs associated with its development, mainly related with the observers' salary/time, therefore funding sources will need to be secured before any development can start. It is important to emphasize that observer programs need financial stability over long periods of time so that data can be collected over long time series; this is needed for the analysis of CPUE and other types of trends that can be used in the stock assessment models. In the short term it might be feasible to design and implement a pilot project. This would determine if the overall programme, as was designed, is adequate for the specific needs of Cabo Verde and would provide recommendations and suggestions for any future changes.

We therefore recommend that, in the medium to long term, funding sources are secured over relatively long periods of time (multiple years) so that the data collection of long and representative time series can be assured, in a way that they can contribute to the ongoing shark stock assessments carried out regularly by ICCAT. In the short term, we recommend that a pilot project is designed so that Cabo Verde could start testing the implementation of the observer and self-sampling programmes, highlighting any issues prior to the commencement of the full program.

4.2 Tagging programme

During the project, tagged blue and shortfin mako sharks showed considerable movement. This can be seen from both conventionally tagged and recaptured specimens compiled by ICCAT and from animals tracked using satellite tags.

The conventional tags recorded transatlantic large scale migrations both species, especially for the blue shark, and to a lesser extent inter-hemispheric movements were also recorded. This seems to corroborate that for both species the stocks are wide-spread within each hemisphere of the Atlantic and it is not likely that those species are forming local stocks or populations. It also suggests that the currently used ICCAT stock delimitation areas at the 5ºN for those shark species seem to be in general adequate.

Data from satellite tagged blue sharks (tagged inside the Cabo Verde EEZ) showed very variable movements in all directions, with sharks moving both inside and outside the EEZ. They were seen using most of the area and moving great distances in different directions over the observation period but there was no definitive or clear pattern in these movements. Satellite tagged shortfin mako showed clearer patterns of movement; sharks tagged in the Cabo Verde EEZ tended to move towards the West African continental shelf, this is consistent with previous observations of shortfin mako sharks that had been tagged by other projects. For the shortfin mako, therefore, it seems that areas closer to the African continental shelf, outside the Cabo Verde EEZ but in the EEZ of other African continental countries, are of particular importance. This was also confirmed by the distribution maps that were created in Task 4 of this study and that are discussed below.

In terms of vertical habitat use, a general diel movement pattern was noted for both species. However, this was not as clearly defined as on some other pelagic shark species, for example for the bigeye thresher shark where these movements are much more consistent (Coelho et al., 2015b). Both blue and shortfin mako sharks spent most of the time in relatively shallow water, both during the day and night, although there was a tendency for them to spend more time in shallower and warmer waters at night and to move to deeper and cooler waters during the day. It was interesting to note that blue sharks did show some differentiation between sexes especially during the day when males were distributed in deeper waters than females.

Although most of the blue shark movements seen during this project were in the first 400 m of water, there were several very deep dives recorded that were considerably deeper than the previous maximum recorded depth of around 1000 m (Campana et al., 2011). Several specimens were recorded diving down to approximately 1800 m at which point the tags maximum depth release mechanism was activated to prevent tag mechanical failures due to excessive pressure. Those sharks were showing, in general, a normal behaviour and diving speeds so it seems that blue sharks can occasionally reach such depths.

The study initially proposed deploying 40 satellite tags. This number was considered to be a very large and significant number compared to previous studies using similar tags. However, due to bureaucratic difficulties and delays in the tag acquisition process, it was only possible to acquire 30 tags, 25 miniPATs and 5 SPOTs. As a result the consortium scientists proposed an alternative tagging strategy focusing only on the Cabo Verde EEZ; as this was the main area of interest and it would ensure that enough data could be collected to give meaningful results. This was discussed and agreed between all scientists, including those from Cabo Verde, and also with EASME and DG-MARE during the coordination meetings. The consortium scientists are also involved in other projects that have deployed satellite tags in the eastern Atlantic region, including in the Cabo Verde EEZ. Those data were also made available, presented and analysed in an integrated way within the results of this project. Most other projects that have deployed satellite tags on pelagic sharks in other regions and oceans have used considerably fewer tags. As an example, previous studies using this technology (considering all oceans) have used between one and nine tags for shortfin mako (Loefer et al., 2005; Stevens et al., 2010; Abascal et al., 2011), and between four and 40 for blue shark (Campana et al., 2009; Teo et al., 2004; Moyes et al., 2006; Stevens et al., 2010), for most other shark species the researchers have normally deployed less than ten (Hammerschlag et al., 2010). For tuna and tuna-like bony fishes the number has varied but is generally less than 40 (e.g., 17 for bigeye tuna, *Thunnus obesus*, as described by Arrizabalaga et al., 2008; 35 for Atlantic bluefin tuna, *Thunnus thynnus*, as described by Stokesbury et al., 2004). In light of this the present study, with the results from the 30 deployed tags in the Cabo Verde EEZ, combined with the additional information from other projects should be considered a state-of-the-art study for pelagic shark satellite tagging.

We would recommend that the tagging programme should continue with the focus on the two main shark species highlighted in this study as they represent the majority of the shark catches in the region. The shortfin mako shark had fewer tags deployed, a strategy designed to reflect the relative proportion of the shark catches in the region, however it would be worth providing extra funds to deploy additional tags. Other pelagic shark species in the region are also present but were not the focus of this tagging programme, as the strategy of this specific programme was to focus on the two main species that represent more than 95% of the shark catch. While they might not be as common in the region they can also interact and be by-caught in pelagic longline fisheries, most are now discarded due to ICCAT retention bans. Those species include the silky shark, oceanic whitetip, bigeye thresher and hammerheads, and as such some effort should also be put on tagging those more rare species in the future.

4.3 Analysis of potential local depletion of sharks

In the region of the Cabo Verde EEZ and the 300 nm neighbouring waters, the elasmobranch catch composition is largely made up of blue shark followed by shortfin mako. This is common in pelagic longline fisheries operating in other regions of the Atlantic Ocean (e.g., Castro et al., 2000; Mejuto et al., 2009; Coelho et al., 2012a; Frédou et al., 2015), and is also seem in other oceans (e.g., Santos et al., 2013). The other less frequently captured elasmobranch species, which include threshers, silky shark, longfin mako, oceanic whitetip, hammerheads and the crocodile shark are also recorded in similar proportions in pelagic longlines from other regions (e.g., Coelho et al., 2012a).

A CPUE standardization procedure was carried out for the two main shark species. This used statistical models, in this case Generalized Linear Models (GLMs) and Generalized Linear Mixed Models (GLMMs), to remove the fishery-dependent effects of the nominal CPUE data (i.e., spatial, seasonal and targeting effects). This allowed the estimation of relative indexes of abundance that can then be used as population status indicators. Standardized CPUE series are also often used in stock assessment models by most RFMOs.

The final models chosen and used for the blue shark and shortfin mako differed, mainly due to the differences in the data characteristics of those two species, in particular in relation to the percentage of zeros catches. For blue shark the overall percentage of zeros (i.e., fishing sets with zero blue shark catches) was low (2.9% of total sets) and therefore the model that best fit the data was a GLMM with lognormal distribution adding a constant to the response variable to deal with the zeros. In this case the constant used was 10% of the overall mean catch rate, this figure has been tested and recommended by some previous studies as it seems to minimize the bias for this type of adjustments (Campbell, 2004). Studies have also shown that when the percentage of zeros is lower than 10%, which was the case here the method of adding a constant to the response variable works well (Shono, 2008).

For the shortfin mako the occurrences of zeros in the datasets were higher (37.7%). This creates additional mathematical problems when fitting the models to the data. In this case, the model that best fit to the data was a tweedie GLM. Tweedie distributions, also called compound Poisson–Gamma distributions, are a generalization of the exponential family that are defined by a mean, a dispersion parameter and an index parameter (Dunn, 2004). When the index parameter takes values between 1 and 2, which was the case in this study, the distribution is continuous for positive real numbers and has an added discrete mass at 0, which allows the flexibility of modeling both the zeros and the continuous non-zeros in the same process. The use of tweedie models has been applied mainly to other fields of science (e.g., modelling rainfall precipitation) but there are increasing examples applied to fisheries science, specifically in CPUE standardization models (e.g., Candy, 2004; Shono, 2008; Coelho et al., 2013).

Results from the CPUE standardization process showed that the estimated index of abundance for the blue shark increased over the entire time series, between 2006 and 2015. For the shortfin mako the abundance index was more variable, showing an increase in the earlier years of 2006-2009, followed by a decrease in 2010, and then an overall slight increase in the more recent period until 2015.

Size distribution trends can also be used as stock status indicators and it was observed that the catch of blue shark in the Cabo Verde region is mainly composed of relatively large, adult specimens. There were no major variations in the time series trends, with the mean sizes relatively stable along the time period, both in the Cabo Verde EEZ and adjacent waters. This indicates that there are no signs of population declines, in this case assessed by the mean size, for the blue shark. By contrast, the catches of shortfin makos are composed mainly of relatively small and juvenile specimens, and there was a general decreasing trend in the mean catch size during the same period, except in the most recent year (2015) when the mean size was larger and similar to the initial years. This catch composed mainly of juvenile specimens and the general decreasing trend in the mean size trend over the period might be an indicator of some possible overfishing for this species. However, this was not corroborated by the standardized CPUE signal that was still increasing over the same period.

The overall conclusions of this task are that the size indicators for blue shark seem to indicate an apparently stable population, while for the shortfin mako a large catch of juveniles and a possible declining trend in the mean sizes was observed. In terms of abundance, the estimated indices of abundance for both species showed in general an increasing trend, especially for the blue shark. Together these results seem to show that it is unlikely that these two shark species are going through local depletion effects in the Cabo Verde EEZ and adjacent waters as there are no signals of decreasing local abundance (biomass) for any of the species. However, the relatively large catch of juvenile shortfin mako sharks and the decreasing trend in mean sizes should be noted as it may indicate that the Cabo Verde region is functioning as an aggregation area for juvenile specimens of this species that are vulnerable to the fisheries taking place in the region. Thus, the fishery and fishery indicators for shortfin mako should be closely monitored based on observer programs, recommended in Task 1 of the project, to avoid shortfin mako population moving to an overfishing state in the area.

One important aspect of this project is that it uses detailed data exclusively from the EU fleets that operate in the Cabo Verde region (Portugal and Spain) but it should be noted that other fleets from other countries also operate in the region. Some analysis such as CPUE standardization undertaken during this project, involves the use of highly detailed operational data (i.e., detailed set level data) that is often either not collected or, if collected, not shared and made available due to data confidentially issues. As such, the results presented here should be interpreted as representative only of the EU fleet component; the effects of other fleets operating in the region were not considered. It should be noted that the newly developed database by Cabo Verde (INDP) is now ready to receive data from those other fleets (in addition to the EU data), if these data are provided and become available in the future it might be possible to further analyse those trends for the multiple fleets that operate in the Cabo Verde EEZ waters.

It is important to put these results and conclusions within a wider Atlantic perspective. For the blue shark, the Ecological Risk Assessments carried out both in the Atlantic and Indian Oceans showed that this species is the most productive of all pelagic shark species and therefore capable of sustaining relatively high levels of fishing mortality when compared to other less productive sharks. Still, the overall vulnerability status was determined to be intermediate, mainly due to the also relatively large susceptibility of blue shark to pelagic fisheries, predominately pelagic longlines. The last Atlantic blue shark stock assessments were carried out by ICCAT in 2015 and showed that for the north Atlantic the stock was unlikely to be overfished or subject to overfishing, even though there were high levels of uncertainty (Anon., 2015). This contrasts with the South Atlantic stock were it was not possible to discount that in recent years the stock may have been at levels near B_{MSY} and that fishing mortality has been approaching F_{MSY}, implying that future increases in fishing mortality in the southern stock of blue shark could push the stock to an overfished and experiencing overfishing state (Anon., 2015). The standardized CPUE increasing trends observed in this study for the blue shark in the Cabo Verde region, are in line with the trends from the other fleets that were used in the last stock assessment by ICCAT. Specifically, for a number of fleets that operate in the North Atlantic, including both eastern and western regions (Portugal, Spain, Japan, US, Taiwan, Venezuela and Ireland), this general increasing trend has also been registered since the mid-2000s (Figure 54).

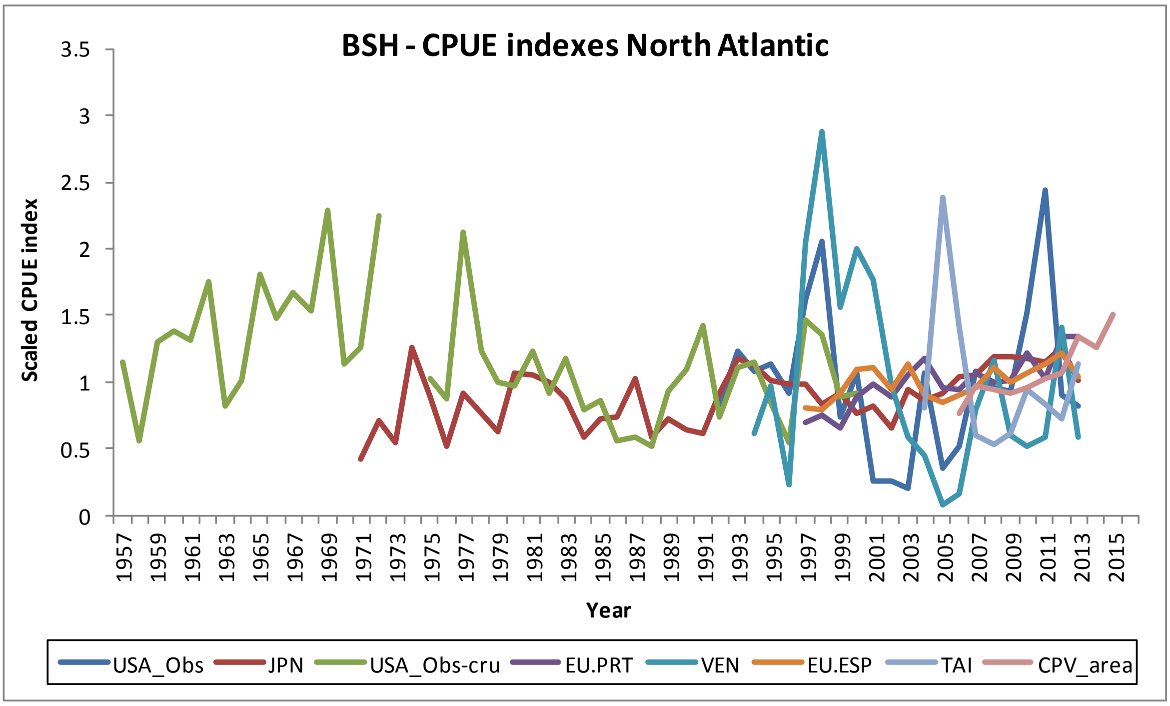


Figure 54. Standardized CPUE series used for the North Atlantic blue shark in the last ICCAT stock assessment in 2015 (adapted from Anon, 2016). Cabo Verde region abundance index estimated in this study is added to the figure. For comparison purposes, the indices are scaled by their respective means for the overlapping years. Fleet/area codes used are: USA_Obs = USA observer data; USA_Obs-cru = USA observer + research cruise data (as used in Aires-da-Silva et al., 2008); data JPN = Japan; EU.PRT = EU.Portugal; VEN = Venezuela; EU.ESP = EU.Spain, TAI = China.Taiwan and CPV_area = Cabo Verde region (from this study).

For the shortfin mako the Ecological Risk Assessments carried out in the Atlantic and Indian Ocean ranked the species as one of the most vulnerable of all pelagic sharks, mainly due to their very low productivity and high susceptibility to fisheries, especially pelagic longlines. In the last shortfin mako stock assessment carried out by ICCAT in 2012, the results indicated that the status of both the north and south Atlantic stocks seemed to have a low probability of overfishing. However, the models also showed apparent inconsistencies between estimated biomass trajectories and CPUE trends, producing high uncertainties in the estimates, particularly for the south Atlantic (Anon., 2012). In terms of the CPUE indexes, the fleets from the North Atlantic that submitted data and indices for that last assessment (Portugal, Spain, Japan and the US) also showed, like in the present study for the Cabo Verde region, a high variability but an overall increasing trend for the most recent years, especially after the early 2000s (Figure 55).

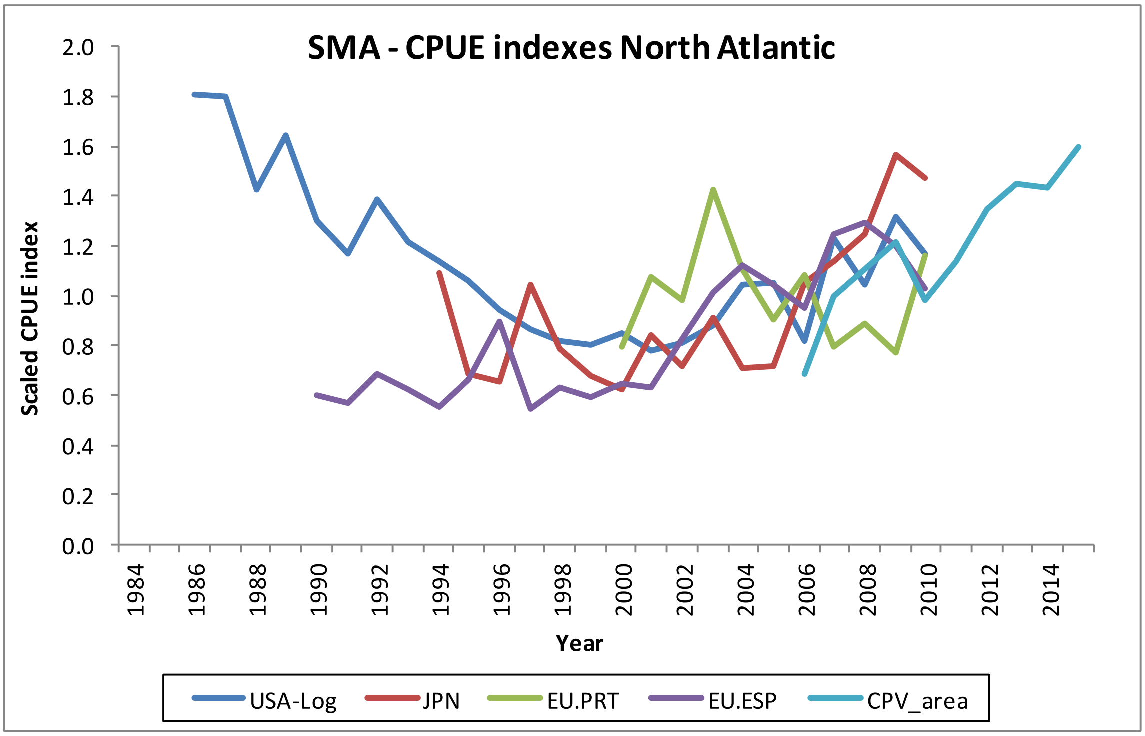


Figure 55. Standardized CPUE series used for the North Atlantic shortfin mako shark in the last ICCAT stock assessment in 2012 (adapted from Anon, 2016). Cabo Verde region abundance index estimated in this study was added. For comparison purposes, the indices are scaled by their respective means for the overlapping years. Fleet/area codes used are: USA_Log = USA from logbook data; JPN = Japan; EU.PRT = EU.Portugal; EU.ESP = EU.Spain and CPV_area = Cabo Verde region (from this study).

4.4 Biological and ecological sensitive areas

Statistical models were fitted to predict both the expected CPUE and the mean size distributions over the region taking into account spatial and seasonal aspects. Higher CPUEs (by weight) were predicted outside the Cabo Verde EEZ for both blue and shortfin mako shark. For the shortfin mako, in particular, it is notable that considerably higher CPUEs are predicted along the African continental shelf, in areas outside the Cabo Verde EEZ but inside the EEZ of other West African countries. This shows that even though the shortfin mako is an oceanic and pelagic shark species it seems to have a strong relationship with continental shelf areas, especially the juveniles as most of the catches observed were juveniles. A recent study used satellite telemetry to map the movements of shortfin mako shark in the west Atlantic (US and Mexico). It concluded that the shortfin mako, in that, displayed very region-specific movements and, in that particular case, they showed little distributional overlaps between the Gulf of Mexico and Caribbean Sea with the western North Atlantic (Vaudo et al., 2017). In the eastern Atlantic, our study reached similar conclusions in that a comparable situation might be occurring off West Africa, with shortfin makos showing the same type of region-specific movements mainly along the West African continental shelf area.

In terms of seasonality, there were particularly marked effects for the expected CPUEs of blue shark. Specifically, higher catch rates are expected during the autumn and winter months while lower overall CPUEs are expected in late spring and summer. Those predictions, and in particular the marked seasonal effects in the catch rates of blue shark, are in line with the observations on the catch rates from the fishery, described in Task 3 of this study.

There was considerable variability in the expected mean size for both species taking into account spatial and seasonal effects. One important note, however, is that even though those spatial and seasonal effects are important, in general the overall size of blue sharks was expected to be composed of mainly relatively large adult individuals while the overall size of shortfin mako sharks was expected to be mainly composed of relatively small, juvenile individuals. This was consistent over the entire region and throughout the year. Both the spatial and seasonal effects were also influential in the expected mean size, in the case of the blue shark with the smaller specimens occurring in the area mainly in the spring months (quarter 2), in the case of shortfin makos the smaller specimens are expected to occur mainly in the 1st semester during the winter and spring months.

When comparing those results within an Atlantic wide perspective, it is important to note that, although there is some information on blue shark, there is little information available on the shortfin mako or other pelagic shark species. Blue shark shows a strong latitudinal stratification pattern in all oceans, with a tendency for the larger adult specimens to occur in warmer equatorial and tropical regions and the smaller juveniles occurring in colder temperate waters (Mejuto and García-Cortés, 2005). However, for other species the opposite pattern has been found. For example, for the bigeye thresher in the Atlantic the smaller and younger sharks tend to concentrate predominantly in the tropical regions, while the larger specimens seem to prefer temperate areas of the northern and southern Atlantic (Fernandez-Carvalho et al., 2015a).

In general, the movement of sharks through the oceans can be influenced by several factors, such as migration and availability of prey (Carey et al. 1990), temperature (Nakano 1994), sex, and stage/age segregation (Strasburg 1958; Pratt 1979; Kohler et al. 2002; Nakano and Seki 2003; Montealegre-Quijano and Vooren 2010). For the pelagic sharks all those factors seem to contribute to their distribution patterns, but the relations with changes in growth and reproductive stage are particularly important. For the North Atlantic, Pratt (1979) suggested that mating of blue shark takes place off southern New England in late May and early June, then the embryos take 9–12 months to develop, and are born from April to July. Based mainly on tagging data, Stevens (1990) added that adult sharks in the Northwest Atlantic seem to move offshore into the Gulf Stream. Nursery areas for the blue shark in the North Atlantic have been described for the Mediterranean Sea and off the Iberian Peninsula, and in the Central North Atlantic off the Azores Islands (Aires-da-Silva et al., 2008; Vandeperre et al., 2014a, 2014b). Based on this study, the tropical Northeast region around the Cape Verde Islands appears to be an area that is also important for adult blue sharks. This corroborates a previous report by Nakano and Stevens (2008) which concluded that the West Africa region is an important area for the concentration of large adults, including pregnant females.

As a final conclusion of this task, the Cape Verde region would appear to be part of the Atlantic wide distributional cycle where the species in this study move through their life cycles. The blue shark specimens show widespread and large scale movements in and out of the Cabo Verde EEZ as well as into much more widespread regions. The presence of the large adults in the Cabo Verde region corroborates the previously hypothesised distributional patterns in the North Atlantic, with the large adult specimens occurring mainly in warmer tropical waters and the juveniles in cold temperate waters at higher latitudes. In the case of the shortfin mako, although the entire region appears to be an aggregation area for juveniles, the region closer to the African continental shelf, mainly on the edge and outside the Cabo Verde EEZ, seems to be of particular importance to this species, with large aggregations of small juvenile specimens.

5 CONCLUSIONS AND RECOMMENDATIONS

The following are the main conclusions and recommendations from the project:

- **Task 1 - Observer programme**
  - Materials and training for establishing an on-board observer programme, including manuals, sampling protocols and a self-sampling programme protocol, with the respective data collection forms, were provided to Cabo Verde scientists and technicians within the course of the project;
  - A relational database was developed by Cabo Verde (INDP) to store current and historical fisheries data, including those from the EU and other fleets operating in the Cabo Verde region;

  - **Recommendations** for the future implementation of the observer programme might involve two steps. In the short term, a pilot project could be developed to start the implementation and testing phase of the programme. In the longer term, funds will need to be secured in order to guarantee the long term stability and viability of the programme and the maintenance of a continuous time series of data that can then be used in future stock assessments.

- **Task 2 - Tagging programme**
  - State-of-the-art satellite telemetry tags were used in the two main pelagic shark species caught by pelagic fisheries inside the Cabo Verde EEZ, specifically the blue shark and shortfin mako;
  - In general, the tags showed high mobility of the specimens with movements both inside and outside the Cabo Verde EEZ. In some cases the sharks moved considerable distances over the tagged periods;
  - It is **recommended** that a possible continuation of the tagging programme should focus on the main shark species, especially the shortfin mako for which less information is available. Additionally, some future effort should also be put in the other more rare species that also interact and can be captured by pelagic longlines, including silky shark, oceanic whitetip, longfin mako, bigeye thresher and hammerheads.

- **Task 3 - Analysis of potential local depletion of sharks**
  - Blue shark and shortfin mako are the main shark species captured in pelagic longlines, both in Cabo Verde as well as in other oceanic regions of the Atlantic and other oceans;
  - Generalized Linear Models (GLMs) and Generalized Linear Mixed Models (GLMMs) were used to standardize the CPUE time series data. For both species the estimated indices of abundance showed overall increases over the time series period (2006-2015). For both species those CPUE trends are in line to what has been estimated from other fleets in the North Atlantic during the last ICCAT stock assessments;
  - Blue sharks captured in the Cabo Verde region are mainly large adult specimens and there were no major trends in the mean size time series. By contrasts, the shortfin makos captured in the region are relatively small and composed mainly by juveniles, and there were some indications of possible declines in the mean sizes over time.
  - Considering the abundance indexes and size indicators, local depletion effects are not likely to be occurring for those two shark species in the Cabo Verde EEZ and adjacent waters, especially as there are no signs of decreasing local abundance (biomass) for any of the species. However, the relatively large catch of juvenile shortfin mako sharks might represent an aggregation area of juvenile specimens for this species in the Cabo Verde region.

  - It is **recommended** to keep the detailed data collection and update the size and standardized CPUE indicators periodically (e.g., every 2-3 years). It is important to follow and re-assess the status of the main shark species periodically using such indicators, in order to detect any signs of potential depletion of those species in the region. Particularly for the shortfin mako where there are some signs of a decreasing trend in the mean sizes, it would be particularly important to continue updating those indexes in a regular basis.

- **Task 4 - Biological and ecological sensitive areas**
  - Statistical models were used to predict the spatial and seasonal effects in the catch rates and sizes of the blue shark and shortfin makos;
  - The shortfin mako sharks seem to have marked region-specific movements and habitat use, mainly along the West African continental shelf. This type of region specific movements has also been recently hypothesized for this species in the west Atlantic;
  - The presence of the large adult blue shark in the Cabo Verde region corroborates the hypothesis of the distributional patterns of this species in the North Atlantic, with large adult specimens occurring mainly in warmer tropical waters and juveniles in colder temperate waters;
  - For the shortfin mako the areas closer to the African continental shelf seems to be of particularly importance to the species, with large aggregations of small juvenile specimens.

- **Task 5 - Coordination and communication**
  - Three non-technical papers were produced to provide general information on the project, including the main objectives, results and conclusions;
  - A workshop was carried out in Cabo Verde (INDP - Mindelo, São Vicente) to present and discuss the findings of the project. This workshop had the participation of scientists, administration (Cabo Verde and EU), journalists, interested NGOs, fishing sector and general public;
  - An oral communication was presented to the international scientific community during the 20th Annual Scientific Conference of the European Elasmobranch Association (EEA) that took place on the 28-30th October 2016 in Bristol, England;
  - Two peer-review papers are planned to be submitted to scientific journals, specifically one paper with the main results of the abundance and size indicator analysis, and one paper with the results from the satellite telemetry. Consortium scientists from the EU and Cabo Verde involved in this work will be co-authors of the works.

6 ACKNOWLEDGEMENTS

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The authors would also like to acknowledge and thank Miguel N. Santos, formerly in IPMA when this project started and now in the ICCAT Secretariat. Miguel N. Santos was the original designer and coordinator of this project and contributed significantly to the original planning and work that was carried out.

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ANNEXES

ANNEX I - OBSERVER PROGRAMME

(Deliverable Nº 4 of the project)

Observer programme for Specific Contract No. 7

The provision of advice on the conservation of pelagic sharks associated to fishing activity under EU Sustainable Fisheries Partnership Agreements in the Atlantic Ocean

under the

FRAMEWORK CONTRACT – MARE/2012/21 - Scientific advice for fisheries beyond EU waters

Summary

This document presents the activities undertaken to design an observer programme for Cabo Verde and provides the generated outputs (Deliverable # 4 of this Specific Contract).

An observer programme was designed for the Cabo Verde EEZ (first part of Task 1 of Specific Contract 7) with the objective of supporting shark data collection consistent with ICCAT Recommendations on reporting Task I and Task II data (Art-IX in ICCAT Convention, Rec. 05-09 and Res. 66-01), as well as by-catch and discard data (ICCAT Rec. 11-10). This observer programme could cover fleets fishing in Cabo Verde waters under license agreements and eventually a Cabo Verde domestic fleet. The observer programme was developed in collaboration with the fisheries institute in Cabo Verde (INDP), based on data collection methods and protocols currently used by observers within EU National observer programmes (such as the European tuna longline observer programme developed under the EU Data Collection Framework[3]) managed by IPMA and IEO. Although these observer programmes have been successfully implemented on the EU (Portuguese and Spanish) longline fleets operating throughout the Atlantic Ocean, particularly in North-eastern tropical waters, the current programme has been adapted specifically for the EU longline fleets operating in the Cabo Verde EEZ. This should ensure that the information needed to monitor shark catches is properly collected, for retained catches and discards from target fisheries and those fisheries with shark by-catch.

The implementation of the observer programme (second part of Task 1 of Specific Contract 7) is the responsibility of INDP. However, the Consortium will collaborate with INDP and try to facilitate contacts with the EU fishing sector in order to engage skippers from the EU longline fleet with potential future activity in the Cabo Verde waters under the EU-Cabo Verde Sustainable Fisheries Partnership Agreement.

[3] Council Regulation (EC) No 199/2008 of 25 February 2008 and Commission Regulation (EC) No 665/2008 of 14 July 2008.

Objective:

The main objective of this document is to provide a summary of the activities undertaken that contribute towards an observer programme in Cabo Verde, which once implemented ensures that the fleets fishing in the Cabo Verde EEZ under international fisheries agreements, and eventual Cabo Verde domestic fisheries, collect shark fishery data following ICCAT recommendations on reporting Task I and Task II data (Art-IX in ICCAT Convention, Rec. 05-09 and Res. 66-01), as well as by-catch and discard data (ICCAT Rec. 11-10).

Summary of activities implemented and actions being developed:

Programme activities included capacity building, the provision of reporting templates, a procedures manual, identification guides, development of a specific database and a self-reporting platform. A number of these activities have already been implemented, while others are still being developed. For that purpose, the Scientific Coordinator of the project visited Cabo Verde in April 2015 and met the local focal point from INDP. During a period of a week a number of activities were developed and several decisions were made, defining the implementation of this observer Programme according to the timeline included in Deliverable #2 – Work plan. Among the agreed decisions, it is worth noting that due to practical considerations, the local Institute required that the identification guides, manuals, templates and database should be developed in Portuguese.

What follows is a description of the different activities that have already been implemented and of the actions that are being developed within this observer Programme, aiming the full implementation according to the agreed schedule:

- Provision of identification guides – an identification guide to be used by the observers, as well as dichotomous identification keys, previously developed for the EU longline fleet observer programmes were presented to the local focal point of the project. These were then adapted taking into account the regional taxa. These identification guides and keys do not only cover shark species, but also other taxa commonly caught in the area such as tunas, billfishes and sea turtles. The identification guides and keys are provided as *Appendix I* of this Deliverable #4.

- Provision of forms to collect observer data - data forms developed by EU observer programmes were adapted to ensure the collection of data on target and by-catch species, including sharks. These include specific forms regarding the collection of:
  - Fishing gear characteristics;
  - Longline set data (including geographical position, effort, bait and additional oceanographic data such as sea surface temperature, wind and sea condition);
  - Catch and by-catch data (for individual specimens, including species identification, fate, status at haulback, size, sex and maturity stage);
  - Discard data;
  - Characteristics of collected samples, such as vertebra, genetic tissue and spines.

  The forms prepared are provided in *Appendix II* of this Deliverable #4.

- Observer training – in 2014 under the *ICCAT/Japan Data and Management Improvement Project*, researchers from the Consortium (namely IPMA) provided a training course to 18 local technicians and 5 fisheries inspectors from Cabo Verde. This capacity building initiative, which took place at INDP in April 2014, aimed at improving fisheries data collection in Cabo Verde, focused particularly on sharks and billfishes. Within the scope of the present project, an additional observer training was conducted at INDP in April 2015, in which 4 local technicians, who had previously attended the 2014 workshop, received additional training aimed at the implementation of this observer programme. Training included revision of the identification guide and keys, completing the observer templates and forms, and use of the electronic logbook developed for the voluntary self-reporting from the skippers.

- Development of a self-reporting scheme – this is complementary to the data collected on board by the observers, consisting of a dedicated electronic logbook to be filled in by skippers when no observers are present. It enables skippers to self-report a wide variety of data (including fishing gear characteristics, longline set information, catch composition and size/weight of retained and discarded catch), and enables estimations of live and processed weight of retained catch. A manual of procedures has been produced to help skippers to fill in the logbook and self-report their fishing activity and retained and discarded catch. The Manual for the voluntary self-reporting of fisheries data is included in *Appendix III* of this Deliverable #4.

- Development of a specific database (DB) – this will be used to store all the observer data collected. Queries will be developed as appropriate, as well as protocols for data entry and data accessibility/confidentiality. A specific module of the DB will be dedicated for storage of fishing activity and catch reported by foreign fleets operating in the Cabo Verde EEZ under past and current international fisheries agreements. In April 2015 the Scientific Coordinator of the Project and the local Institute staff discussed the structure of the DB, which is currently being developed by the IT person at INDP.

- Definition of required observer coverage - generally, by-catch of a commonly encountered species or one that has low variance in the catch rates can be measured with a lower level of coverage than by-catch of a rare species or those with high variability in the catch rates. Literature and simulations suggest that coverage levels of at least 20% for common species and 50% for rare species in a fishery with more than a few thousand sets per year would give reasonably good estimates of total by-catch. However, 5-10% coverage would be more realistic. INDP is currently compiling the information that has been reported by EU vessels. Once this is concluded, it will be possible to determine the number of sets (and/or trips) to be covered throughout the year to achieve such coverage. This is scheduled to be concluded in July 2015.

DELIVERABLE # 4: Observer programme

Appendix I

Manual for identification of species caught by pelagic longlines in the Cabo Verde EEZ

(*In Portuguese*)

Introdução

Este manual visa facilitar a identificação das espécies mais vulgarmente capturadas na pescaria de palangre derivante de superfície e como proceder à medição do seu comprimento, tendo em vista o reporte voluntário de informação através do preenchimento do Livro de Pesca por parte dos Mestres das embarcações de pesca. Para tal, na primeira parte são apresentados esquemas gerais e a designação morfológica das partes que compõem o corpo dos peixes ósseos, cartilagíneos e tartarugas. Numa segunda secção, apresentam-se *chaves-dicotómicas* para espécies de bico, atuns, tubarões e tartarugas, bem como uma breve descrição e fotos de outras espécies não pertencentes aos grupos atrás referidos. Na terceira secção apresentam-se listagem das espécies habitualmente capturadas na pescaria de palangre de superfície, incluindo os códigos alfa da FAO, bem como os nomes científicos e nomes comuns em Português, Espanhol e Inglês. Por fim, são apresentados esquemas de como devem proceder à medição do tamanho em função dos diferentes grupos de espécies.

Morfologia dos principais grupos de espécies

De seguida, nas figuras 1 a 4, apresentam-se esquemas gerais e a designação morfológica das partes que compõem o corpo dos peixes ósseos, cartilagíneos e tartarugas. Esta informação ajudá-lo-á a mais facilmente compreender a terminologia utilizada na identificação das espécies.

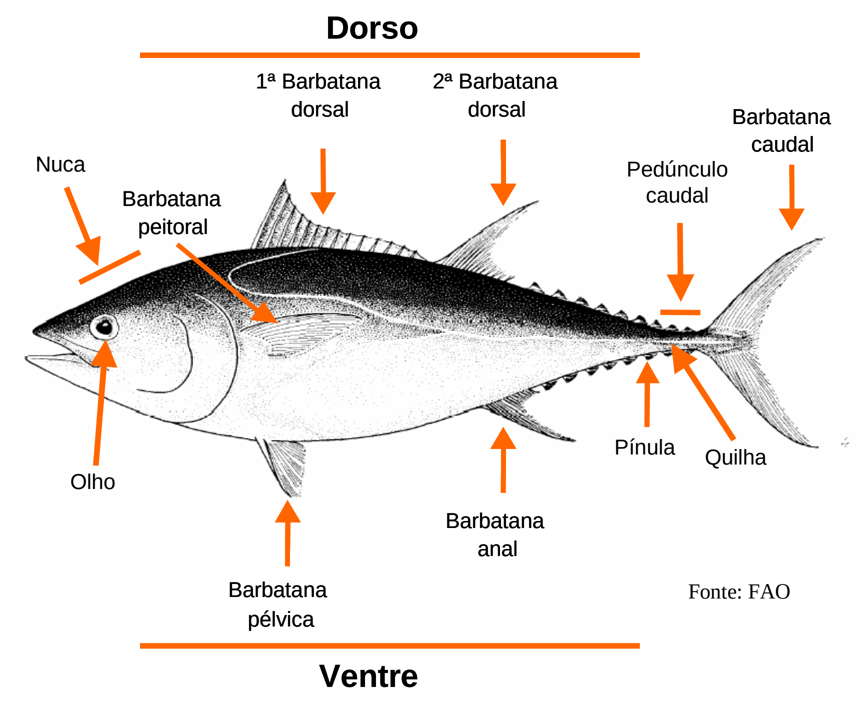


Figura 1. Esquema geral e designação morfológica das partes que compõem o corpo dos peixes ósseos capturados com palangre derivante de superfície.

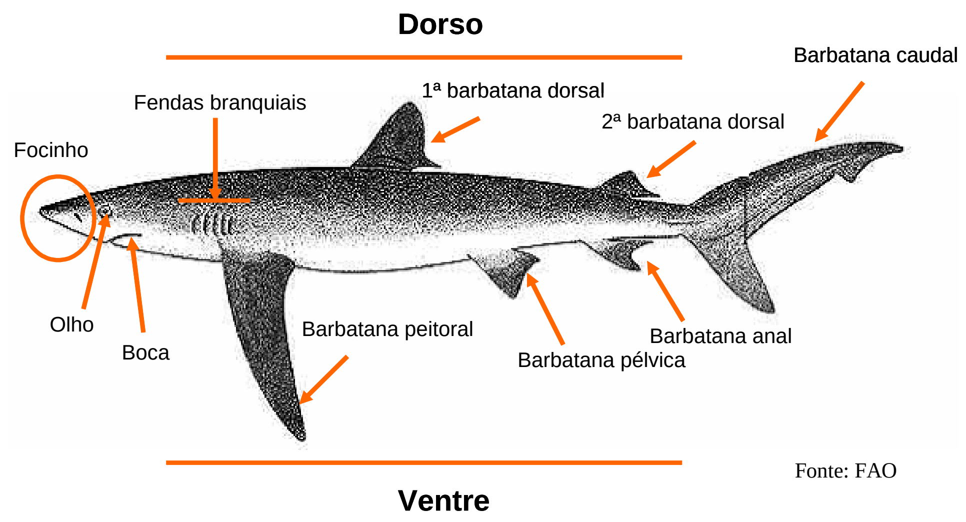


Figura 2. Esquema geral e designação morfológica das partes que compõem o corpo dos tubarões capturados com palangre derivante de superfície.

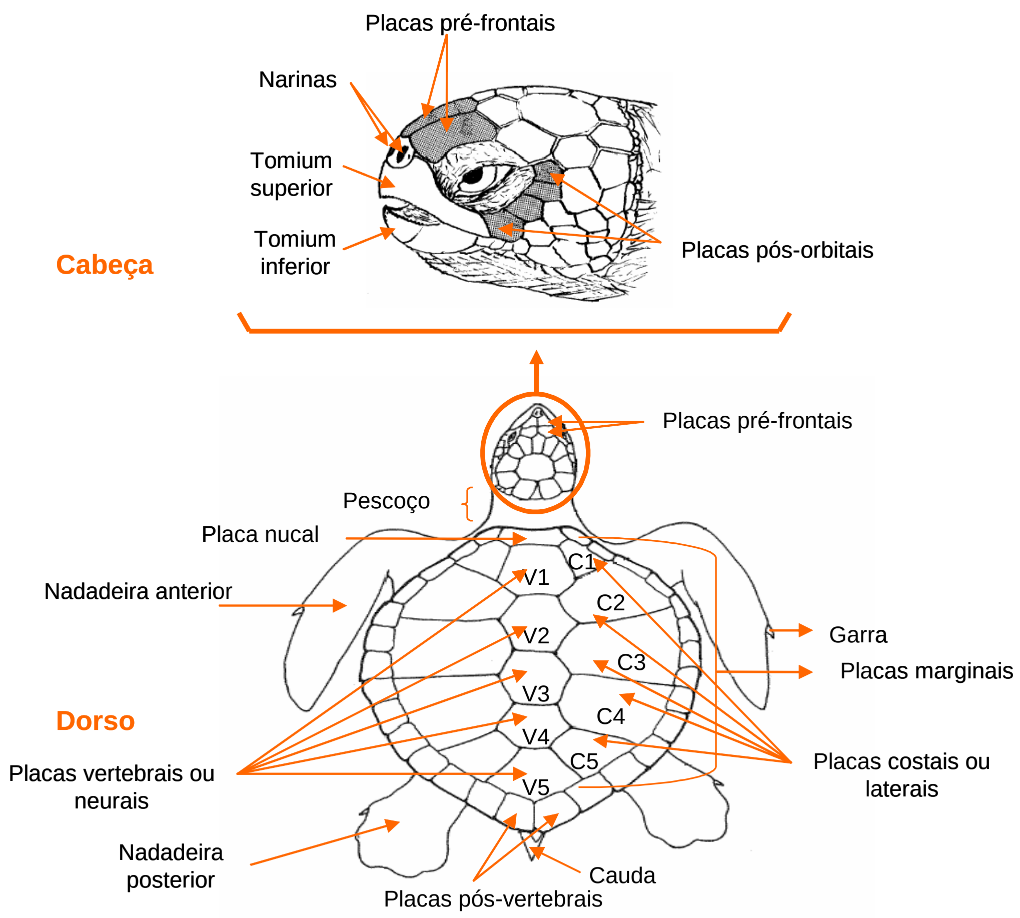


Figura 3. Esquema geral e designação morfológica das partes que compõem o dorso e a cabeça de uma tartaruga marinha.

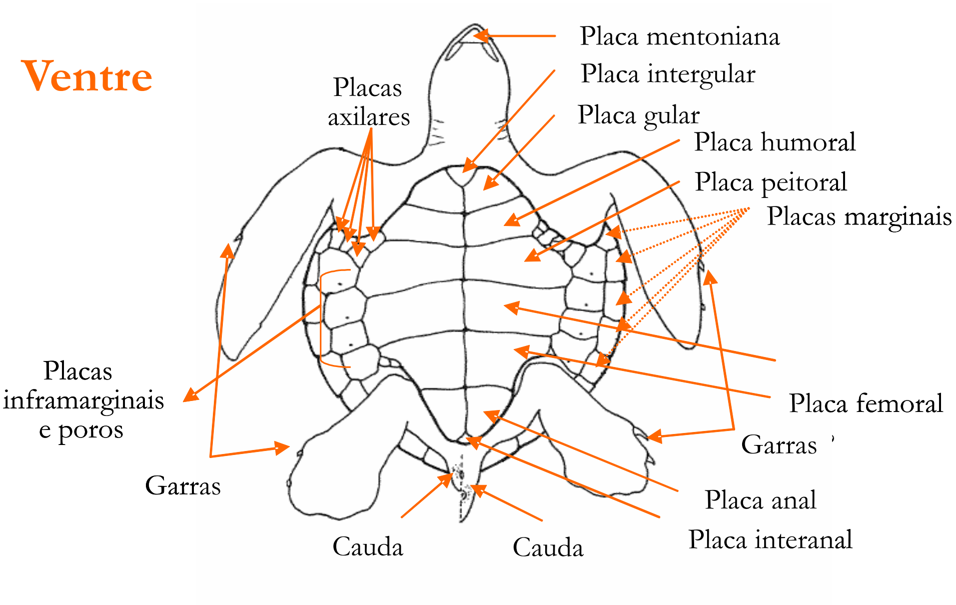
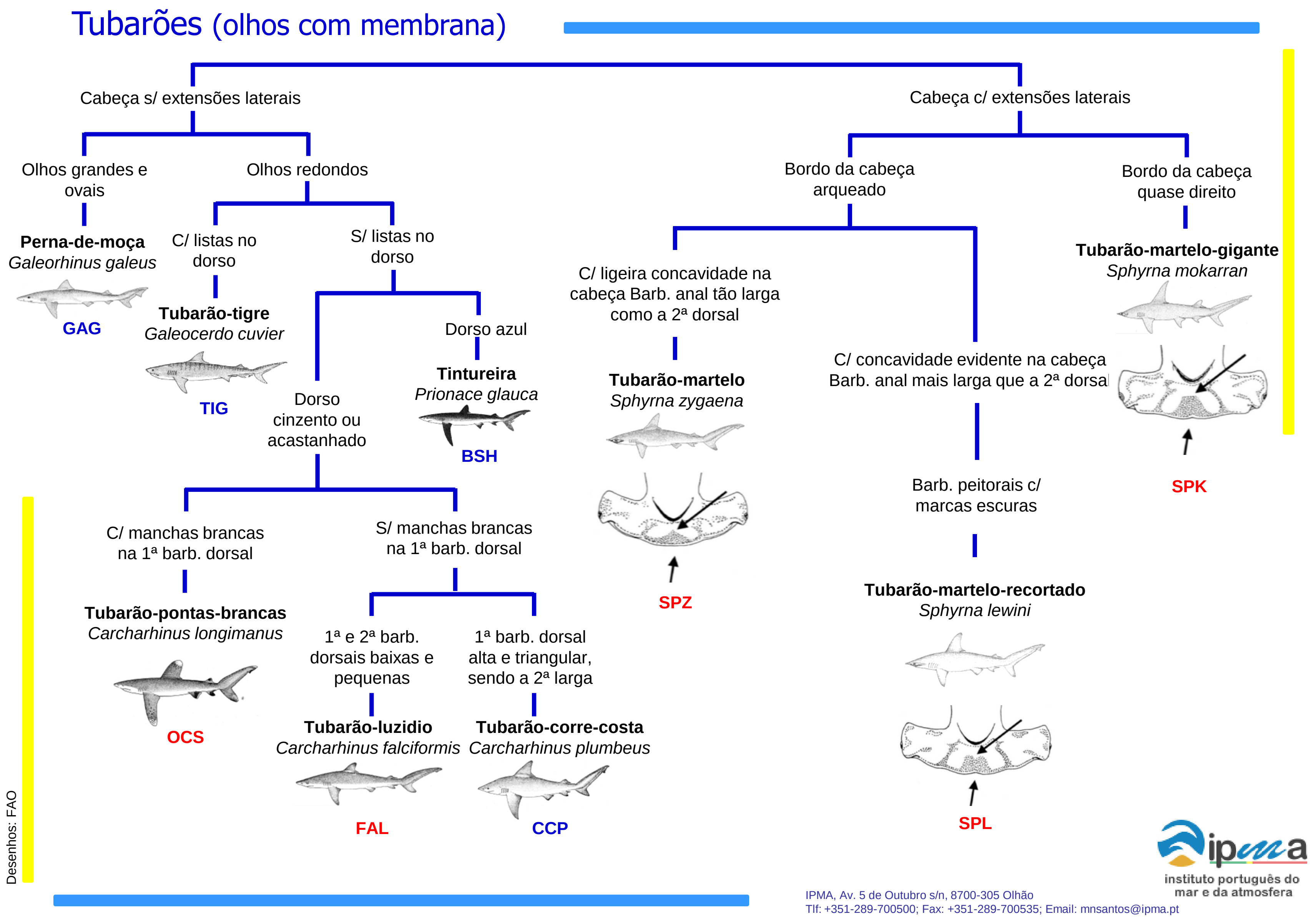


Figura 4. Esquema geral e designação morfológica das partes que compõem a região ventral (plastron) de uma tartaruga marinha. À esquerda estão representadas algumas características das fêmeas e à direita características dos machos.

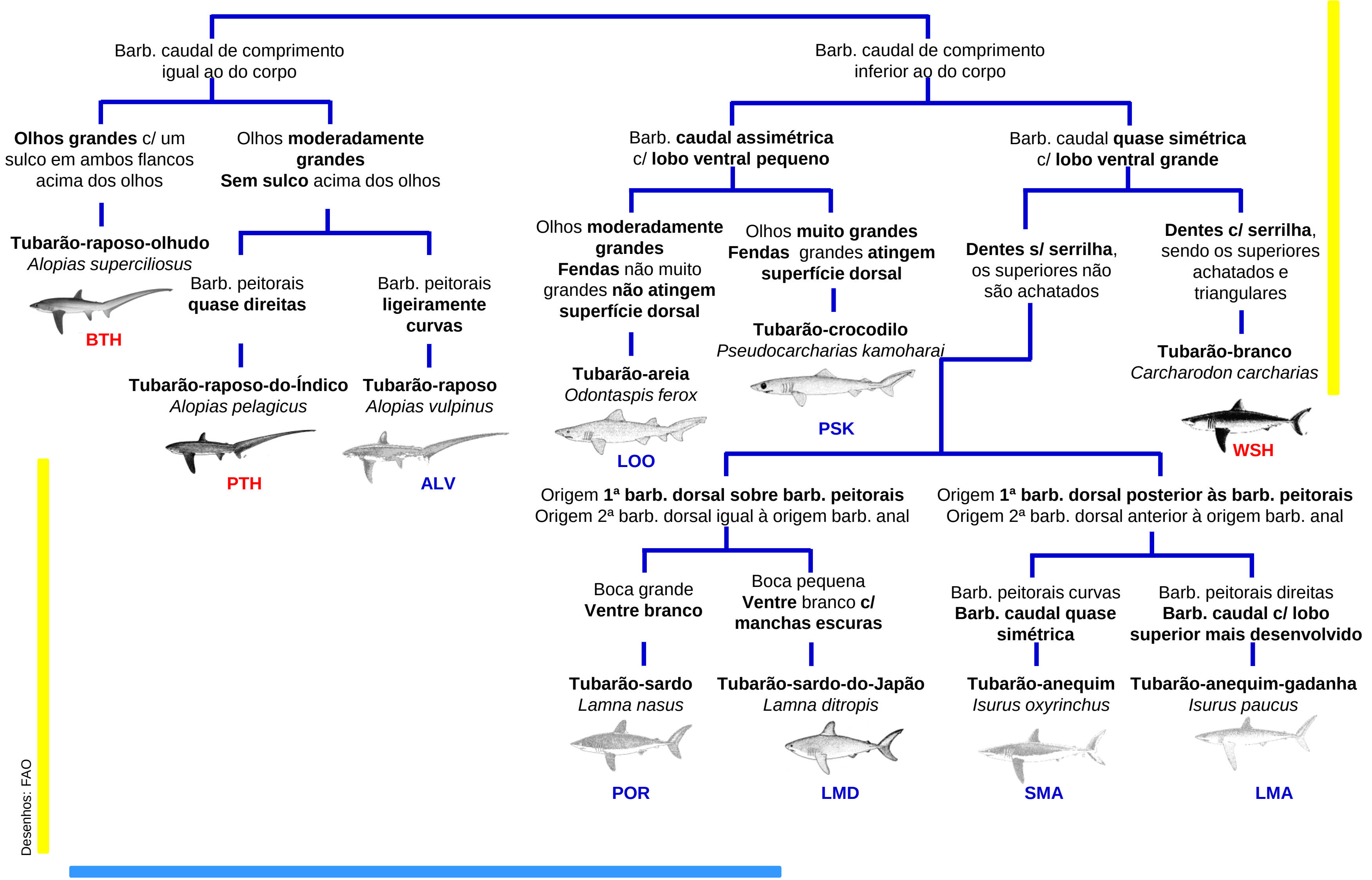
Chaves de identificação

A maneira mais utilizada para uma rápida identificação das principais espécies capturadas na pescaria de palangre de superfície, consiste na utilização de fichas de identificação organizadas segunda chaves-dicotómicas - método utilizado na classificação de seres vivos, que apresenta em cada nível duas alternativas mutuamente exclusivas. Isto é, cada conjunto de alternativas encaminha-nos para dois grupos distintos de espécies com os mesmos caracteres. Não é objectivo destas chaves dicotómicas incluir todas as espécies existentes, mas apenas um grupo restrito, como, por exemplo, as espécies que será espectável capturar na pescaria de palangre de superfície. Neste manual incluímos 4 fichas de identificação de espécies baseadas em chaves dicotómicas para tubarões, peixes-de-bico, atuns e tartarugas. Por outro lado, recorrendo a algumas fotografias que têm vindo a ser compiladas pelo IPMA, bem como de outras encontradas na bibliografia, listam-se mais algumas espécies de peixes ósseos e cartilagíneos, vulgarmente capturadas nesta pescaria.

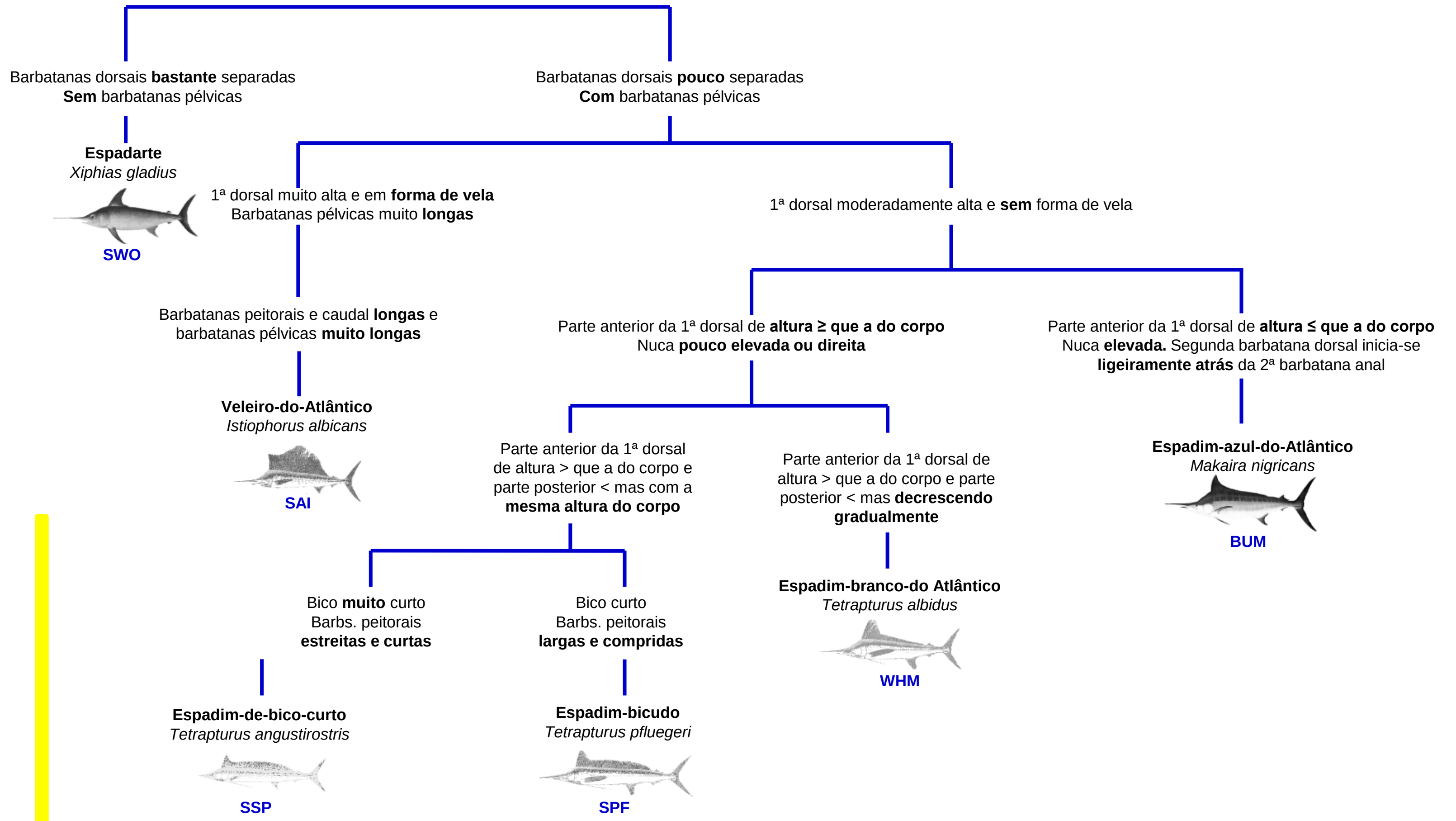
Alerta-se para o facto de as espécies protegidas e/ou cuja retenção está actualmente proibida, pela ICCAT ou outras entidades, estarem identificadas nas fichas com o **código FAO** a vermelho (ex. tubarões: SPZ, SPL, SPM, OCS, FAL, etc; tartarugas: DKK, TTL, etc).


Tubarões (olhos com membrana)
Cabeça s/ extensões laterais
Cabeça c/ extensões laterais
Olhos grandes e ovais
Olhos redondos
Perna-de-moça
Galeorhinus galeus
GAG
C/ listas no dorso
S/ listas no dorso
Tubarão-tigre
Galeocerdo cuvier
TIG
Dorso azul
Tintureira
Prionace glauca
BSH
Dorso cinzento ou acastanhado
C/ manchas brancas na 1ª barb. dorsal
S/ manchas brancas na 1ª barb. dorsal
Tubarão-pontas-brancas
Carcharhinus longimanus
OCS
1ª e 2ª barb. dorsais baixas e pequenas
1ª barb. dorsal alta e triangular, sendo a 2ª larga
Tubarão-luzidio
Carcharhinus falciformis
FAL
Tubarão-corre-costa
Carcharhinus plumbeus
CCP
Bordo da cabeça arqueado
Bordo da cabeça quase direito
C/ ligeira concavidade na cabeça Barb. anal tão larga como a 2ª dorsal
Tubarão-martelo
Sphyrna zygaena
SPZ
C/ concavidade evidente na cabeça Barb. anal mais larga que a 2ª dorsal
Barb. peitorais c/ marcas escuras
Tubarão-martelo-recortado
Sphyrna lewini
SPL
Tubarão-martelo-gigante
Sphyrna mokarran
SPK
Desenhos: FAO
ipma
instituto português do mar e da atmosfera
IPMA, Av. 5 de Outubro s/n, 8700-305 Olhão
Tlf: +351-289-700500; Fax: +351-289-700535; Email: mnsantos@ipma.pt

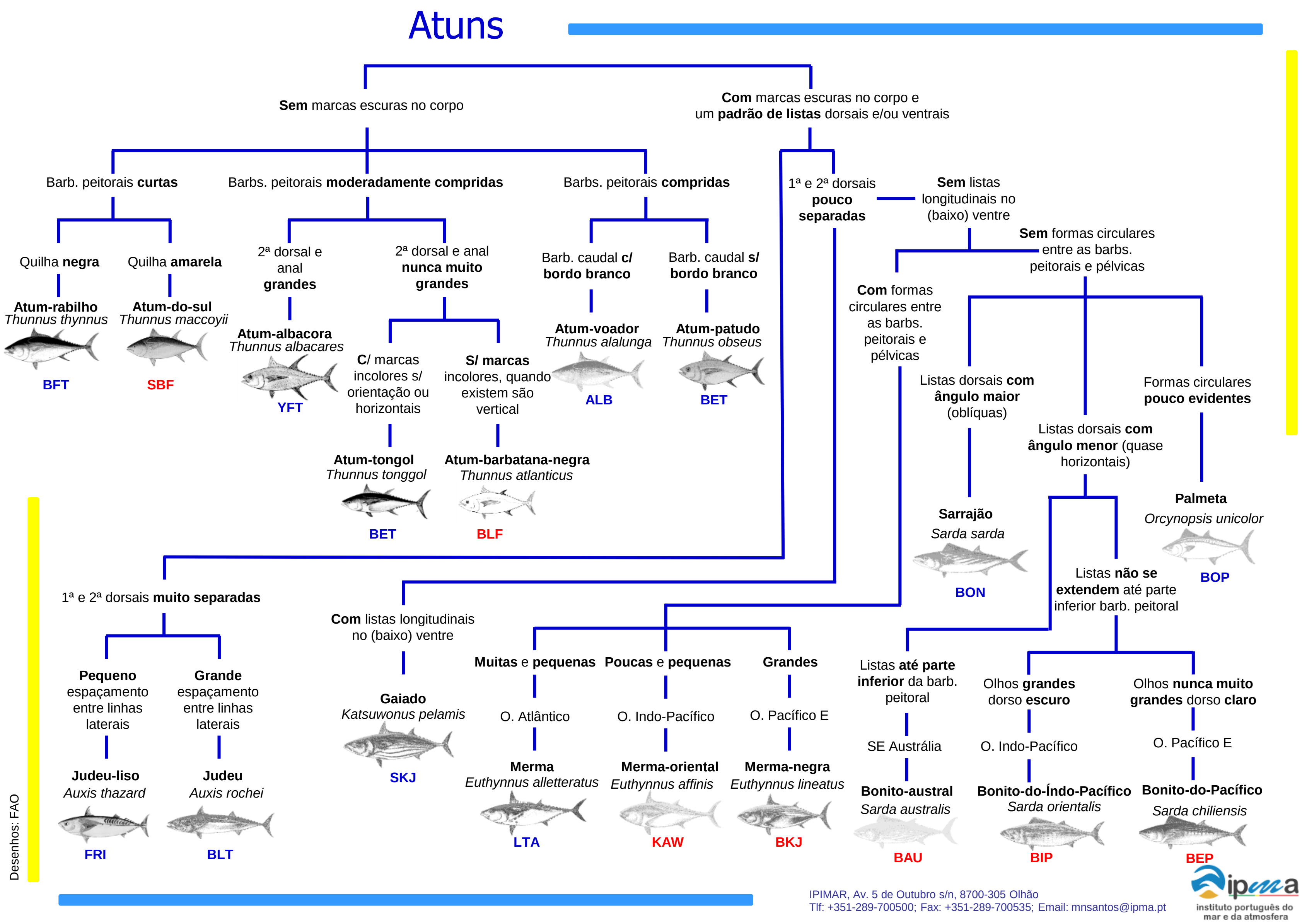
Tubarões (olhos sem membrana)



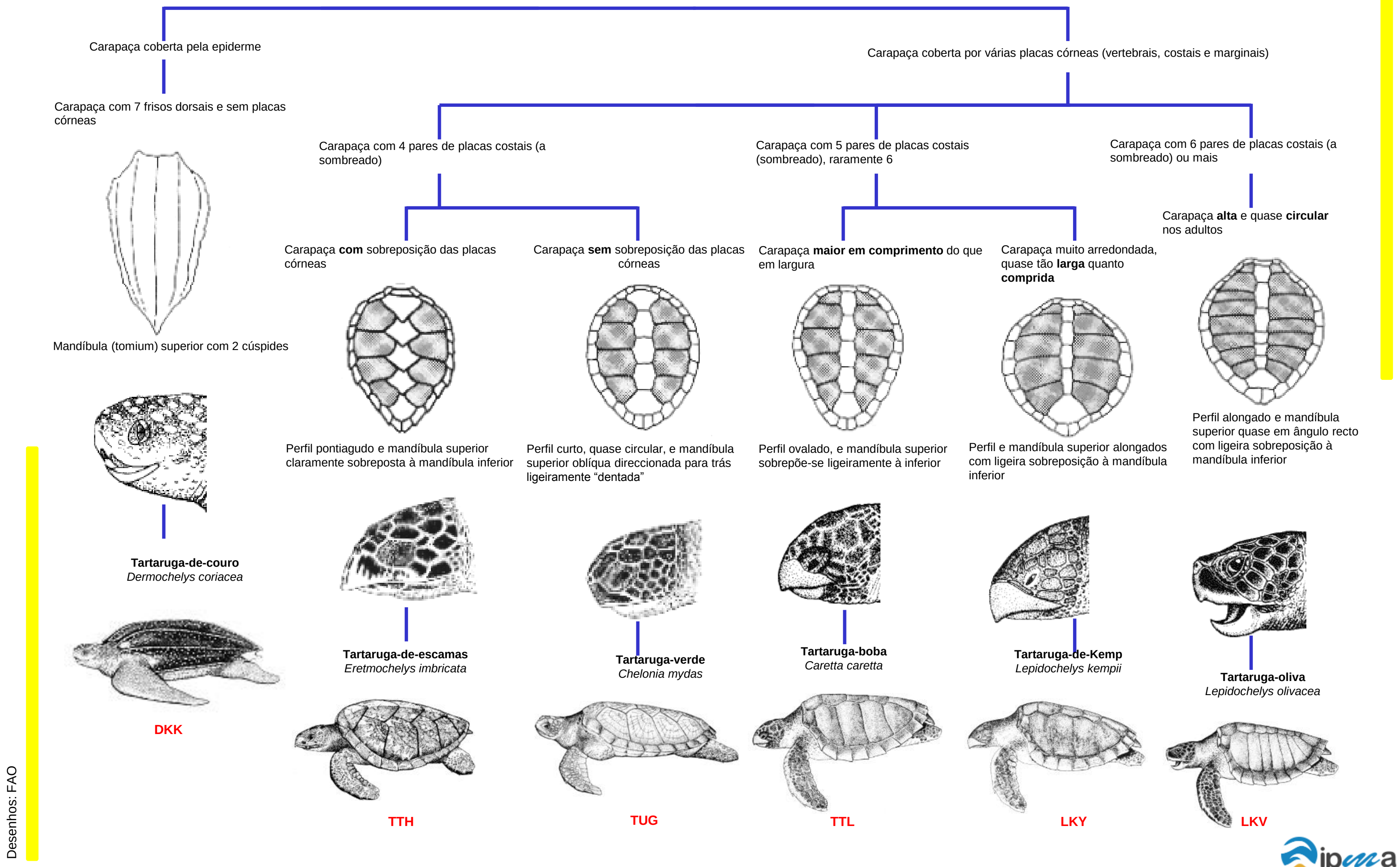
Peixes de bico



Desenhos: FAO


Atuns
Sem marcas escuras no corpo
Com marcas escuras no corpo e um padrão de listas dorsais e/ou ventrais
Barb. peitorais curtas
Barbs. peitorais moderadamente compridas
Barbs. peitorais compridas
1ª e 2ª dorsais pouco separadas
Sem listas longitudinais no (baixo) ventre
Quilha negra
Quilha amarela
2ª dorsal e anal grandes
2ª dorsal e anal nunca muito grandes
Barb. caudal c/ bordo branco
Barb. caudal s/ bordo branco
Sem formas circulares entre as barbs. peitorais e pélvicas
Com formas circulares entre as barbs. peitorais e pélvicas
Atum-rabilho
Thunnus thynnus
BFT
Atum-do-sul
Thunnus maccoyii
SBF
Atum-albacora
Thunnus albacares
YFT
C/ marcas incolores s/ orientação ou horizontais
S/ marcas incolores, quando existem são vertical
Atum-voador
Thunnus alalunga
ALB
Atum-patudo
Thunnus obseus
BET
Listas dorsais com ângulo maior (oblíquas)
Formas circulares pouco evidentes
Listas dorsais com ângulo menor (quase horizontais)
Atum-tongol
Thunnus tonggol
BET
Atum-barbatana-negra
Thunnus atlanticus
BLF
Palmeta
Orcynopsis unicolor
BOP
Sarrajão
Sarda sarda
BON
Listas não se extendem até parte inferior barb. peitoral
1ª e 2ª dorsais muito separadas
Com listas longitudinais no (baixo) ventre
Pequeno espaçamento entre linhas laterais
Grande espaçamento entre linhas laterais
Gaiado
Katsuwonus pelamis
SKJ
Muitas e pequenas
Poucas e pequenas
Grandes
Listas até parte inferior da barb. peitoral
Olhos grandes dorso escuro
Olhos nunca muito grandes dorso claro
O. Atlântico
O. Indo-Pacífico
O. Pacífico E
SE Austrália
O. Indo-Pacífico
O. Pacífico E
Judeu-liso
Auxis thazard
FRI
Judeu
Auxis rochei
BLT
Merma
Euthynnus alletteratus
LTA
Merma-oriental
Euthynnus affinis
KAW
Merma-negra
Euthynnus lineatus
BKJ
Bonito-austral
Sarda australis
BAU
Bonito-do-Índo-Pacífico
Sarda orientalis
BIP
Bonito-do-Pacífico
Sarda chiliensis
BEP
Desenhos: FAO
IPIMAR, Av. 5 de Outubro s/n, 8700-305 Olhão
Tlf: +351-289-700500; Fax: +351-289-700535; Email: mnsantos@ipma.pt
ipma
instituto português do mar e da atmosfera

Tartarugas



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Peixes ósseos mais comuns

Código: **SWO**

Espécie: *Xiphias gladius;*

Nome comum: Espadarte (PT); Pez espada (ES)

Características: Olho grande; bico achatado; barbatana dorsal falcada com a base estreita; sem barbatana pélvica.

Código: **BET**

Espécie: *Thunnus obesus;*

Nome comum: Atum-patudo (PT); Patudo (ES)

Características: Olho grande; corpo arredondado; pequenas barbatanas posteriores à segunda dorsal e à anal de cor amarela com uma margem negra larga; barbatanas peitorais pontiagudas e prolongando-se posteriormente á base da 2ª barbatana dorsal.

Código: **YFT**

Espécie: *Thunnus albacares;*

Nome comum: Atum-albacora (PT); Rabil (ES)

Características: Segunda barbatana dorsal e barbatana anal muito compridas, sobretudo nos adultos maiores; pequenas barbatanas posteriores à segunda dorsal e à anal de cor amarela com uma margem negra larga; barbatanas peitorais prolongando-se até ao centro da 2ª dorsal;

Código: **ALB**

Espécie: *Thunnus alalunga;*

Nome comum: Atum-voador (PT); Atún blanco (ES)

Características: Zona mais alta do corpo a meio do comprimento ou posterior; margem branca na periferia da barbatana caudal; barbatanas peitorais muito longas, prolongando-se posteriormente em relação à 2ª barbatana dorsal.

Código: **BFT**

Espécie: *Thunnus thynnus;*

Nome comum: Atum-rabilho (PT); Atún común, Cimarrón (ES)

Características: Barbatanas peitorais curtas; pequenas barbatanas posteriores à segunda dorsal e à anal de cor amarela com margem negra; quilha caudal amarela nos adultos.

Código: **SKJ**

Espécie: *Katsuwonus pelamis;*

Nome comum: Gaiado (PT); Listado (ES)

Características: Coloração azulada; 4 a 6 linhas escuras longitudinais na zona ventral; quilha caudal proeminente.

Tubarões mais comuns

Código: **BSH**

Espécie: *Prionace glauca;*

Nome comum: Tintureira (PT); Quella, Tiburón azul (ES)

Características: Corpo bastante delgado, focinho comprido e cónico. Dentes superiores em forma de adaga com bordos serrilhados. Dentes inferiores com a cúspide alta e estreita, bordos serrilhados apenas nas pontas. Dorso azul-escuro, extremidades das barbatanas peitorais escuras.

Código: **SMA**

Espécie: *Isurus oxyrinchus;*

Nome comum: Tubarão anequim (PT); Marrajo dientuso (ES)

Características: Corpo em forma de torpedo, focinho pontiagudo. Quilha longitudinal forte no pedúnculo caudal.

Barbatana caudal grande com os lobos superior e inferior semelhantes. Barbatanas peitorais mais pequenas que o comprimento da cabeça. Dentes grandes, em forma de lâminas, sem cúspides acessórias laterais. Ventre branco, dorso azul.

Código: **BTH**

Espécie: *Alopias superciliosus;*

Nome comum: Tubarão-raposo-olhudo, Zorro-olhudo (PT); Zorro ojón (ES)

Características: Barbatana caudal muito longa, quase tanto como o resto do corpo. Sulco frontal por cima dos olhos, prolongando-se para trás. Olhos grandes. Barbatanas peitorais falciformes, estreitas e arredondadas nas extremidades. Coloração branca do ventre que não se prolonga para os flancos.

Código: **FAL**

Espécie: *Carcharhinus falciformis;*

Nome comum: Tubarão-luzidio (PT); Tiburón jaquetón (ES)

Características: Corpo delgado, focinho cónico. Dentes superiores triangulares, cúspide quase direita, com serrilhas fortes na base e finas na ponta. Dentes inferiores com uma cúspide direita e uma base larga. Presença de crista inter-dorsal. Dorso cinzento a castanho amarelado; extremidades das barbatanas normalmente com coloração lisa, sem marcas escuras.

Código: **OCS**

Espécie: *Carcharhinus longimanus;*

Nome comum: Tubarão-de-pontas-brancas (PT); Tiburón oceánico (ES)

Características: Corpo relativamente entroncado, focinho curto e arredondado. Primeira barbatana dorsal grande com uma extremidade larga e arredondada; barbatanas peitorais muito grandes. Dorso cinzento azulado, escuro; extremidades das barbatanas dorsal, peitoral e lobo ventral da caudal esbranquiçadas, com a presença de pequenos pontos escuros.

Código: **SPZ**

Espécie: *Sphyrna zygaena;*

Nome comum: Tubarão-martelo-liso (PT); Cornuda cruz, Pez martillo (ES)

Características: Margem anterior da cabeça muito curvada, sem incisão mediana. Margem posterior das barbatanas pélvicas ligeiramente côncava. Barbatanas normalmente com coloração lisa e sem marcas escuras.

Outras espécies de peixes ósseos

Código: **LEC**

Espécie: *Lepidocybium flavobrunneum;*

Nome comum: Escolar-preto (PT); Escolar negro (ES)

Características: Corpo alongado e fusiforme com olhos grandes. Coloração uniforme castanha escura com as margens das barbatanas geralmente mais escuras. Duas barbatanas dorsais separadas sendo a primeira menor do que a segunda.

Código: **OIL**

Espécie: *Ruvettus pretiosus;*

Nome comum: Escolar-preto (PT); Escolar negro (ES)

Características: Corpo alongado e fusiforme com os olhos mais pequenos que o Escolar-preto. Coloração uniforme castanha escura com as margens das barbatanas geralmente mais escuras. Duas barbatanas dorsais sendo a primeira menor do que a segunda.

Código: **DOL**

Espécie: *Coryphaena hippurus;*

Nome comum: Dourado (PT); Lampuga (ES)

Características: Corpo alongado e achatado. Coloração variável entre macho e fêmea que variam entre tonalidades douradas, azuis, verdes e brancas.

Código: **AMB**

Espécie: *Seriola dumerili;*

Nome comum: Peixe-limão (PT); Pez limón (ES)

Características: Corpo fusiforme. Dorso de coloração cinzenta azulada que se torna cinzento claro no ventre. Com uma risca horizontal amarela em toda a extensão do corpo.

Código: **WAH**

Espécie: *Acanthocybium solandri;*

Nome comum: Serra-da-Índia (PT); Peto (ES)

Características: Corpo alongado em forma de torpedo O dorso é verde-azul e os lados prateados, com barras verticais de cor azulada-cobalto, que atravessam a linha lateral. A barbatana dorsal é longa. A barbatana anal é pequena e a caudal é simétrica, largamente bifurcada.

Código: **ALX**

Espécie: *Alepisaurus ferox*;

Nome comum: Lírio-ferro ou dragão (PT); Pes dragon (ES)

Características: Corpo comprido e achatado. Boca grande e cheia de pequenos dentes, alguns caninos bem desenvolvidos. Barbatana dorsal alta e com uma base grande. Duas barbatanas peitorais grandes.

Código: **GES**

Espécie: *Gempylus serpens*;

Nome comum: Lanceta (PT); Escolar de canal (ES)

Características: Corpo comprido e achatado. Boca grande. Barbatana dorsal com uma base grande mas baixa. Duas barbatanas peitorais pequenas.

Código: **MOX**

Espécie: *Mola mola;*

Nome comum: Peixe-lua (PT); Pez luna (ES)

Características: Corpo alto e redondo/oval. Boca pequena na ponta do focinho. Barbatanas dorsal e anal com uma base pequena mas altas. Não tem pedúnculo caudal.

Código: **MRW**

Espécie: *Masturus lanceolatus;*

Nome comum: Peixe-lua-rabudo (PT); Pez luna (ES)

Características: Corpo alto e oval. Boca pequena. Olhos muito pequenos. Barbatanas dorsal e anal com uma base pequena mas altas. Barbatana caudal pequena mas evidente na extremidade posterior do corpo.

Outras espécies de peixes cartilagíneos

Código: **PLS**

Espécie: *Pteroplatytrygon violacea*;

Nome comum: Uge-violeta (PT); Raya violeta (ES)

Características: Corpo delgado com nariz arredondado e disco angular. Cauda com pelo menos com o dobro do comprimento do disco, e vulgarmente com um espinho longo. De cor uniforme, violeta, púrpura ou azulescuro-esverdeado.

Código: **MAN**

Espécie: várias espécies;

Nome comum: Raia-manta (PT); Mantas y diablos (ES)

Características: Corpo em forma de losango, com uma cauda longa. Dorso de cor escura e face ventral de cor clara.

Lista de espécies de peixes associadas à pesca com palangre derivante de superfície

Código FAO	Nome científico	Nome comum		
		Português	Espanhol	Inglês
ALB	*Thunnus alalunga*	Atum-voador	Atún blanco	Albacore
ALV	*Alopias vulpinus*	Tubarão-raposo (Zorro)	Zorro	Thresher
ALX	*Alepisaurus ferox*	Lírio-ferro (Dragão)	Pes dragon, Sable	Long snouted lancefish
AMB	*Seriola dumerili*	Charuteiro-catarino	Pez de limón	Greater amberjack
BET	*Thunnus obesus*	Atum-patudo	Patudo	Bigeye tuna
BFT	*Thunnus thynnus*	Atum-rabilho	Atún común, Cimarrón	Northern bluefin tuna
BIL	Istiophoridae	Peixes de bico	Agujas, Marlines, Peces vela	Marlins, sailfishes, etc.
BLM	*Makaira indica*	Espadim negro	Aguja negra	Black marlin
BLT	*Auxis rochei*	Judeu	Melva, Melvera	Bullet tuna
BOM	*Sarda sarda*	Sarrajão	Bonito del atlántico	Atlantic bonito
BOP	*Orcynopsis unicolor*	Palmeta	Tasarte	Plain bonito
BSH	*Prionace glauca*	Tintureira	Quella, Tiburón azul	Blue shark
BSK	*Cetorhinus maximus*	Tubarão-frade	Peregrino	Basking shark
BTH	*Alopias superciliosus*	Tubarão-raposo-olhudo (Zorro-olhudo)	Zorro ojón	Bigeye thresher
BUM	*Makaira nigricans*	Espadim azul do atlântico	Aguja azul del atlántico	Atlantic blue marlin
DOL	*Coryphaena hippurus*	Dourado	Lampuga	Common dolphinfish
FAL	*Carcharhinus falciformis*	Tubarão-luzidio	Tiburón jaquetón	Silky shark
FRI	*Auxis thazard*	Judeu-liso	Melva	Frigate tuna
GAG	*Galeorhinus galeus*	Perna-de-moça	Cazón	Tope shark
GES	*Gempylus serpens*	Lanceta		Snake mackerel
LAG	*Lampris guttatus*	Peixe cravo	Lolita	Opah
LEC	*Lepidocybium flavobrunneum*	Escolar preto	Escolar negro, Cochinilha	Escolar
LMA	*Isurus paucus*	Tubarão anequim de gadanha	Marrajo momo	Longfin mako
LOT	*Thunnus tonggol*	Atum-tongol	Atún tongol	Longtail tuna
LTA	*Euthynnus alletteratus*	Merma	Bacoreta	Little tunny, Atlantic black skipjack
MOX	*Mola mola*	Peixe-lua	Pez luna	Ocean sunfish
MSP	*Tetrapturus belone*	Espadim do mediterrâneo	Marlin del mediterráneo	Mediterranean spearfish
OCS	*Carcharhinus longimanus*	Tubarão-de-pontas-brancas	Tiburón oceánico	Oceanic whitetip shark
OIL	*Ruvettus pretiosus*	Escolar	Escolar clavo	Oilfish

Lista de espécies de peixes associadas à pesca com palangre derivante de superfície

Código FAO	Nome científico	Nome comum		
		Português	Espanhol	Inglês
PLS	*Dasyatis violacea*	Uge-violeta (Ratão)		Pelagic stingray
POA	*Brama brama*	Xaputa	Japuta	Atlantic pomfret
POR	*Lamna nasus*	Tubarão sardo	Marrajo sardinero	Porbeagle
RMM	*Mobular mobular*	Jamanta	Manta	Devil fish
SAI	*Istiophorus albicans*	Veleiro do atlântico	Pez vela do atlántico	Atlantic sailfish
SKJ	*Katsuwonus pelamis*	Gaiado	Listado	Skipjack tuna
SMA	*Isurus oxyrinchus*	Tubarão anequim	Marrajo dientuso	Shortfin mako
SPF	*Tetrapturus pfluegeri*	Espadim bicudo	Aguja picuda	Longbill spearfish
SPL	*Sphyrna lewini*	Tubarão-martelo-recortado	Cornuda común	Scalloped hammerhead
SPM	*Sphyrna mokarran*	Tubarão-martelo-gigante	Cornuda gigante	Great hammerhead
SPN	*Sphyrna* spp.	Tubarões-martelo	Cornudas, Peces martillo	Hammerhead sharks
SPZ	*Sphyrna zygaena*	Tubarão-martelo	Cornuda cruz, Pez martillo	Smooth hammerhead
SSP	*Tetrapturus angustrirostris*	Espadim-de-bico-curto	Marlin trompa corta	Shortbill spearfish
SWO	*Xiphias gladius*	Espadarte	Pez espada	Swordfish
TIG	*Galeocerdo cuvier*	Tubarão-tigre	Tintorera tigre	Tiger shark
TUN	*Thunnus* spp.	Atuns	Atunes	Tunas
WAH	*Acanthocybium solandri*	Serra-da-Índia	Peto	Wahoo
WHM	*Tetrapturus albidus*	Espadim branco do atlântico	Aguja blanca del atlántico	Atlantic white marlin
WSH	*Carcharodon carcharias*	Tubarão-de-São-Tomé	Jaquetón blanco	Great white shark
YFT	*Thunnus albacares*	Atum-albacora	Rabil	Yellowfin tuna

Espécies de tartarugas marinhas capturadas na pescaria de palangre derivante de superfície

Código FAO	Nome científico	Nome comum		
		Portugês	Espanhol	Inglês
TTL	*Caretta caretta*	Tartaruga-boba	Caguama	Loggerhead turtle
DKK	*Dermochelys coriacea*	Tartaruga-de-couro	Tortuga laúd	Leatherback turtle
TTH	*Eretmochelys imbricata*	Tartaruga-de-escamas	Tortuga de carey	Hawksbill turtle
LKY	*Lepidochelys kempii*	Tartaruga-de-kemp	Tortuga lora	Kemp's ridley turtle
LKV	*Lepidochelys olivacea*	Tartaruga-olivacea	Tortuga golfina	Olive ridley turtle
TUG	*Chelonia mydas*	Tartaruga-verde	Tortuga blanca	Green sea turtle

Medidas padrão

A medida usualmente recolhida para os tubarões e atuns e utilizada para fins estatísticos é a do comprimento linear à furca (**CF**). Isto é, a medição deve ser efectuada desde a ponta do focinho até ao extremo posterior do raio caudal mais curto (furca) (Figuras 5 e 6). Esta medida **não deve incluir a curvatura do corpo**, sendo por isso medida em linha recta. No momento da medição, cada exemplar deve estar sobre uma superfície lisa e em posição horizontal.

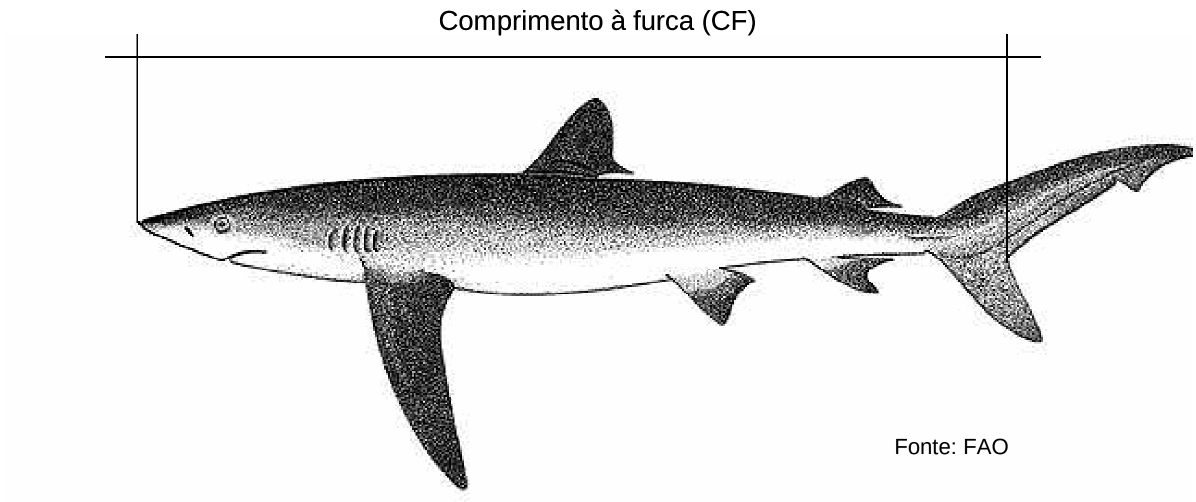


Figura 5. Medida frequentemente recolhida aos tubarões.

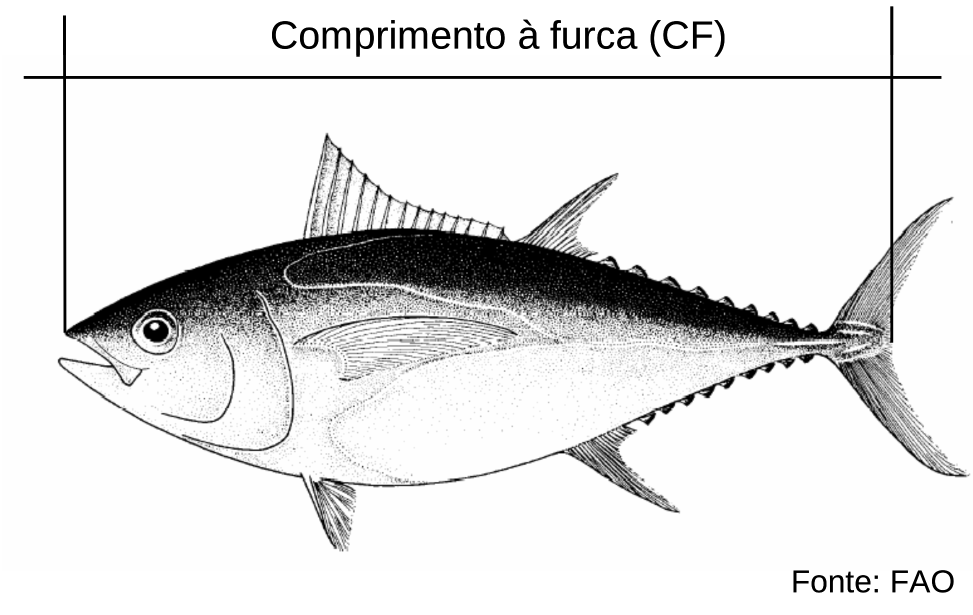


Figura 6. Medida frequentemente recolhida aos atuns e afins.

As características morfológicas de algumas espécies, nomeadamente a forma do corpo, condicionam a medição do CF. Este é o caso dos peixes-de-bico em que a medida estabelecida é a correspondente à medida da mandíbula inferior à furca ("Lower-Jaw-Fork-Length" - **LJFL**) (Figura 7).

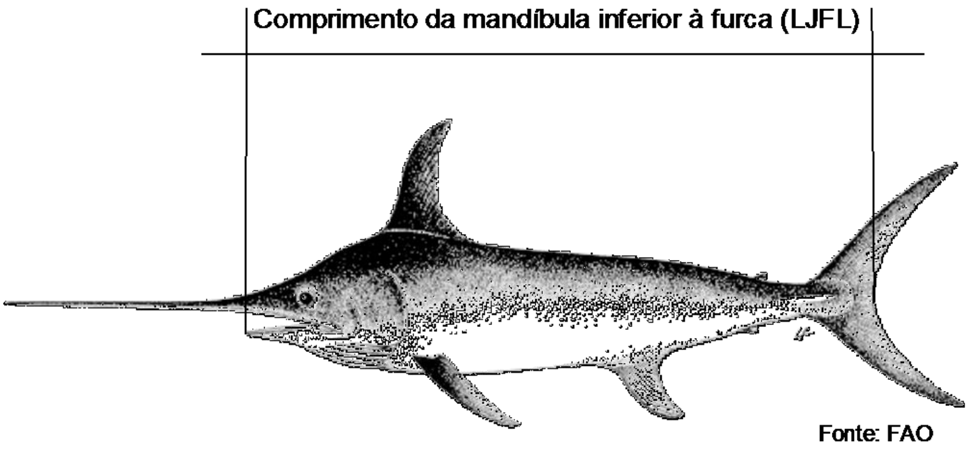


Figura 7. Medida frequentemente recolhida aos peixes-de-bico.

No caso das tartarugas marinhas são habitualmente recolhidas duas a três medidas (**CV**, **CD** e **LD**, *vidé* Figura 8). Neste caso as medidas correspondem ao comprimento curvo, isto é, não deve ser medido de forma linear mas sim de forma a que a fita métrica acompanhe a forma da carapaça da tartaruga.

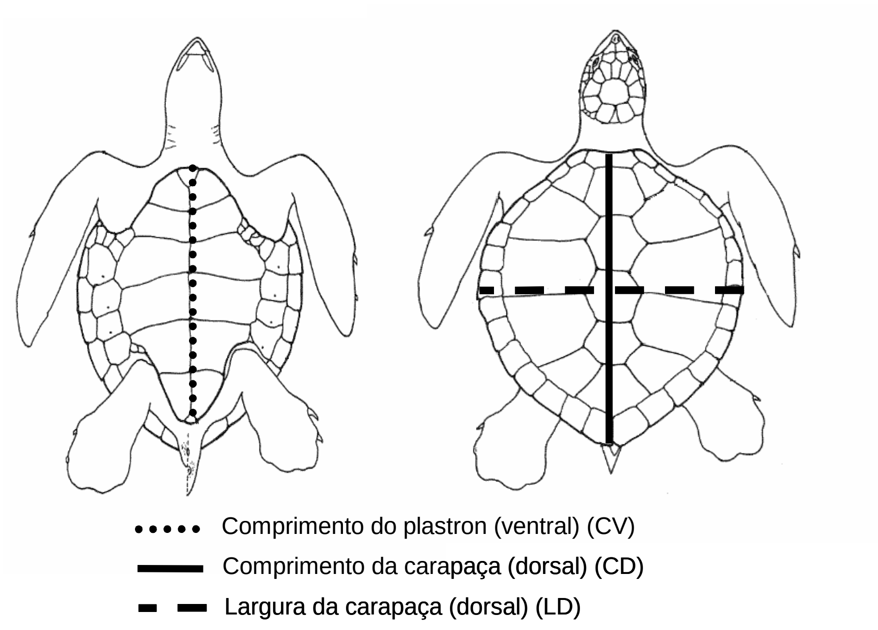


Figura 8. Medidas frequentemente recolhidas às tartarugas marinhas.

DELIVERABLE # 4: Observer programme

Appendix II

Forms for collection of fishing, catch and bycatch data

(*In Portuguese*)

Introdução

Este manual visa facilitar a utilização das fichas de amostragem usadas para a recolha de dados de capturas e da pesca relativos à pescaria de palangre de superfície.

O ficheiro de recolha de dados está em formato EXCEL e dividido em 3 folhas para a recolha dos diferentes dados necessários durante as operações de pesca com palangre. Na primeira folha são recolhidos os dados relativos às características de cada lance de pesca, na 2ª folha os dados relativos às capturas dos exemplares, e na 3ª folha a recolha de dados biológicos especificamente em termos de características de embriões que possam surgir durante a captura de fêmeas grávidas.

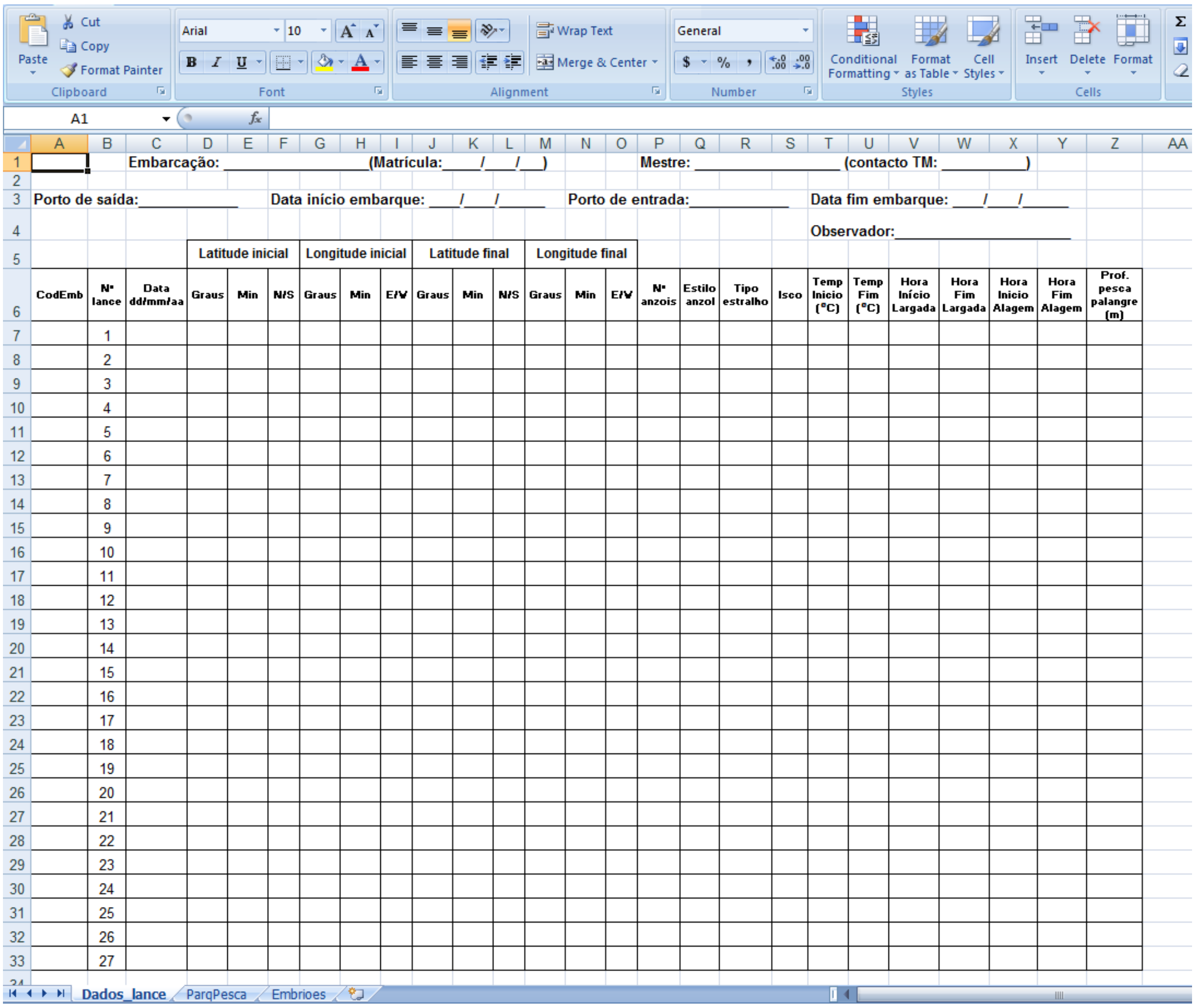
Estas fichas de amostragem devem ser impressas e levadas abordo pelos observadores para serem preenchidas durante as operações de pesca, e os dados devem ser depois colocados numa base de dados.

Dados relativos aos lances de pesca

A 1ª folha, chamada "Dados_lance", diz respeito às características dos lances de pesca efetuados durante a viagem, e está exemplificada na Figura 1.

Esta folha tem um cabeçalho onde se indicam as características gerais da viagem, nomeadamente nome da embarcação e do mestre, porto de saida e de entrada do navio, data de início de final da viagem e nome do observador que efetuou a missão. Nesta folha, cada linha de dados a preencher corresponde a 1 lance de pesca, e devem-se preencher os seguintes campos de dados:

- Código da embarcação;
- Nº de lance: número sequencial que deve ser preenchido antes do início da viagem;
- Data do lance, incluindo dia, mês e ano;
- Localização do lance em graus, minutos e segundos, quer do início como do fim do aparelho;
- Esforço de cada lance, medido em número de anzois colocados;
- Estilo de anzol usado, tipicamente anzol tipo J ou Circular; especificar caso seja usado outro tipo;
- Tipo de estralho usado, tipicamente monofilamento ou aço;
- Isco usado;
- Temperatura superficial da água do mar que no início como no final do lance;
- Hora do início e fim da largada do aparelho;
- Hora do início e fim da recolha do aparelho
- Profundidade de pesca do lance (profundidade a que os anzois estão colocados na coluna de água).



Embarcação: ________________(Matrícula:____/___/___) Mestre: ________________ (contacto TM: __________)

Porto de saída:____________ Data início embarque: ___/___/_____ Porto de entrada:____________ Data fim embarque: ___/___/_____

Observador:____________________

			Latitude inicial			Longitude inicial			Latitude final			Longitude final													
CodEmb	Nº lance	Data dd/mm/aa	Graus	Min	N/S	Graus	Min	E/W	Graus	Min	N/S	Graus	Min	E/W	Nº anzois	Estilo anzol	Tipo estralho	Isco	Temp Inicio (ºC)	Temp Fim (ºC)	Hora Início Largada	Hora Fim Largada	Hora Inicio Alagem	Hora Fim Alagem	Prof. pesca palangre (m)
	1																								
	2																								
	3																								
	4																								
	5																								
	6																								
	7																								
	8																								
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Figura 1: Ficha de amostragem para recolha de dados dos lances de pesca durante a pescaria de palangre.

Dados relativos às capturas

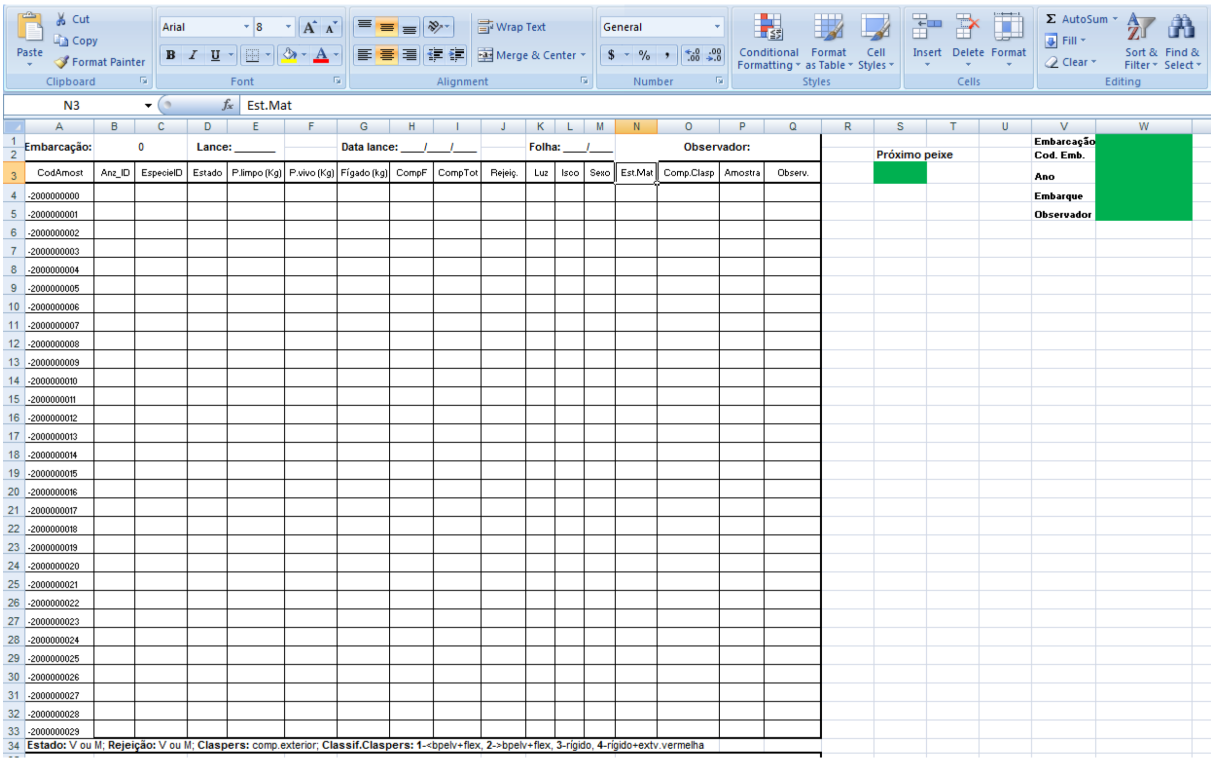
A 2ª folha, designada "ParqPesca", diz respeito às características das capturas efectudas em cada uma dos lances de pesca, e está exemplificada na Figura 2.

Esta folha tem um cabeçalho onde se indica a embarcação, o lance a que se referem as capturas, a data do lance e a identificação do observador. Nesta folha, cada linha de dados corresponde a um exemplar capturado, incluindo espécies alvo da pescaria e capturas acessórias.

Os detalhes relativos à identificação das espécies assim como da recolha de dados de tamanhos estão detalhados no ***Manual de identificação de espécies capturadas na***

pescaria de palangre de superfície na ZEE de Cabo Verde (Anexo I) deste protocolo. Para cada exemplar capturado, devem-se preencher os seguintes dados:

- Código da amostra: número sequencial único pré-programado para refletir o código da embarcação, o código da missão e o número sequencial de exe3mplares capturados durante a viagem;
- Identificação do anzol;
- Identificação da espécie, usando dos códigos de 3 letras da FAO;
- Estado no momento de captura: V=vivo, M=morto;
- Peso limpo, vivo e do fígado (kg);
- Comprimento furcal e total (cm);
- Estado no caso de ser rejeitado: V=vivo, M=morto;
- Luz no caso de terem sido usados lanternas nos anzóis;
- Tipo de isco usado;
- Sexo do exemplar: M=macho e F=fêmea;
- Estado de maturação (*ver detalhes na secção seguinte*);
- Comprimento dos claspers: para os elasmobrânquios machos;
- Recolha de amostras: especificar se foram recolhidas amostras biológicas, por exemplo vértebras, tecido para genética, espinhos, etc.
- Observações: outras observações relevantes que possa ser registadas durante o processo de pesca, incluindo a presença de parasitas, marcas de acasalamento emarcas de predadores.


Embarcação: 0 **Lance:** _______ **Data lance:** ___/___/___ **Folha:** ___/___ **Observador:**

CodAmost	Anz_ID	EspecieID	Estado	P.limpo (Kg)	P.vivo (Kg)	Fígado (kg)	CompF	CompTot	Rejeiç.	Luz	Isco	Sexo	Est.Mat	Comp.Clasp	Amostra	Observ.
-2000000000																
-2000000001																
-2000000002																
-2000000003																
-2000000004																
-2000000005																
-2000000006																
-2000000007																
-2000000008																
-2000000009																
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-2000000022																
-2000000023																
-2000000024																
-2000000025																
-2000000026																
-2000000027																
-2000000028																
-2000000029																

Estado: V ou M; **Rejeição:** V ou M; **Claspers:** comp.exterior; **Classif.Claspers:** **1**-<bpelv+flex, **2**->bpelv+flex, **3**-rígido, **4**-rígido+extv.vermelha

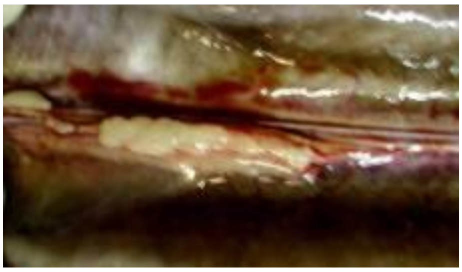
Próximo peixe

Embarcação
Cod. Emb.
Ano
Embarque
Observador

Figura 2: Ficha de amostragem para recolha de dados dos exemplares capturados durante a pescaria de palangre.

Descrição dos estados de maturação em tubarões

<u>Machos</u>



<u>Estado 1 - Imaturos</u>

Descrição: *Claspers mais pequenos que a barbatana pélvica e flexíveis; testículos pequenos, filamentosos e de coloração branca.*

<u>Estado 2 – Em desenvolvimento</u>

Descrição: *Claspers de tamanho idêntico ou maior que as barbatanas pélvicas mas ainda flexíveis; testículos maiores que no estado 1; podem estar ligeiramente convolutos; ductos encontram-se espiralados.*

<u>Estado 3 – Maturos</u>

Descrição: *Claspers totalmente desenvolvidos e rígidos, com o comprimento superior à barbatana pélvica; testículos podem apresentar diferentes tamanhos embora se apresentem sempre bastante convolutos e não muito irrigados; ductos encontram-se muito espiralados.*

<u>Estado 4 – Activos</u>

Descrição: *Extremidade dos claspers encontram-se dilatadas e vermelhas (canais abertos); testículos muito segmentados e irrigados; ductos muito espiralados*

Fêmeas

Estado 1 - Imaturas

Descrição: *Ovários pequenos, de aspecto granuloso ou com oócitos de pequenas dimensões (até cerca de 1 cm de diâmetro); útero com aspecto filamentoso, normalmente entre 2 a 5 mm de largura; glândula oviducal não está diferenciada.*

Estado 2 – Em maturação

Descrição: *Ovário de maior dimensão que no estado 1 e com oócitos em diferentes níveis de desenvolvimento, podendo, os maiores, ter cerca de 3 cm de diâmetro; não existem oócitos atréticos no ovário; útero mais largo que no estado 1 mas ainda relativamente estreito.*

Estado 3 – Maturas

Descrição: *Ovários com oócitos vitelados de grandes dimensões, os quais podem atingir 9 cm de diâmetro; podem ser facilmente contados e medidos. Nota: Deve-se contar e medir diâmetro dos ovos em cada lobo antes de proceder à recolha de todo o tracto reprodutivo.*

Estado 4 – Em desenvolvimento

Descrição: *Útero bastante alargado devido à presença de ovos no seu interior mas ainda não se conseguem distinguir embriões; útero não apresenta aspecto segmentado.*

Estado 5 – Diferenciação

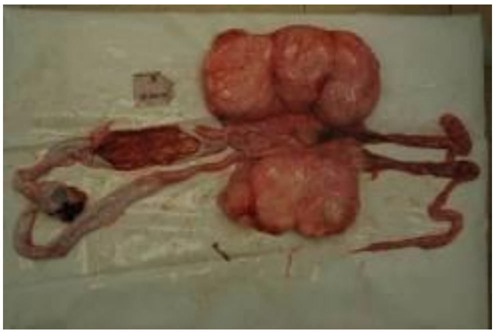
Descrição: *Vitelo encontra-se segmentado no interior do útero, e é possível distinguir-se pequenos embriões, não pigmentados; cada embrião possui um saco vitelino grande.*

Estado 6 – Extrusão

Descrição: *Os embriões encontram-se formados e pigmentados dentro do útero, com sacos vitelinos muito reduzidos.*

Estado 7 – Pós-nascimento

Descrição: Útero *encontra-se vazio mas dilatado e irrigado; o ovário pode apresentar oócitos atréticos (côr amarelo forte e/ou rosado-acastanhado) de grandes dimensões.*



Estado 8 – Repouso

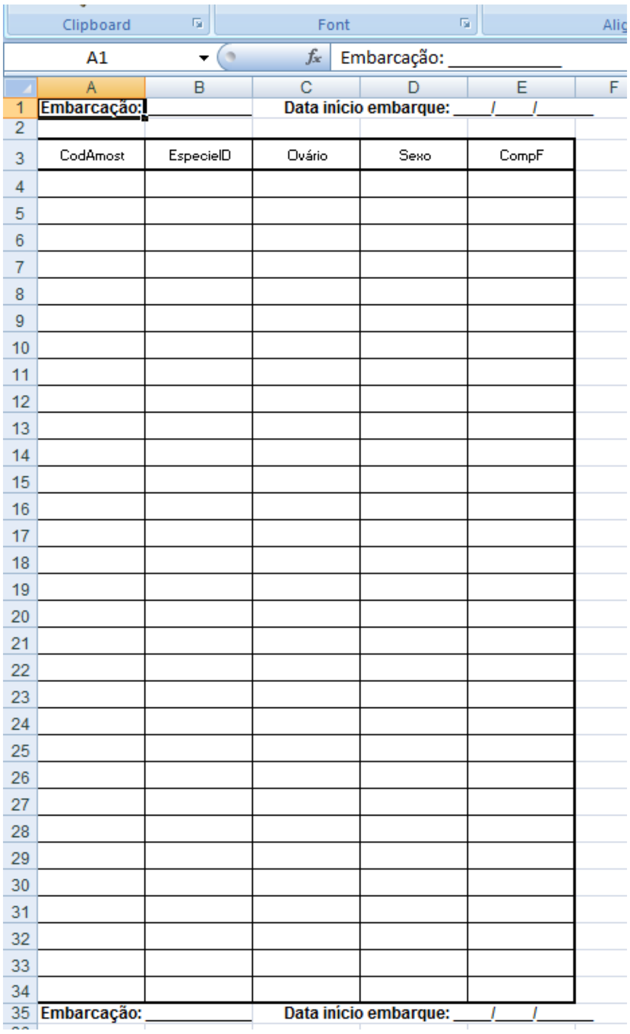
Descrição: *Estado semelhante ao 2, distinguindo-se deste devido à presença de muitas atrésias no ovário e do útero estar mais alargado e irrigado, dando a ideia de que já libertou embriões.*

Dados relativos aos embriões

A captura de fêmeas grávidas com embriões pode providenciar importantes dados biológicos, e como tal esses dados devem ser recolhidos.

A folha para recolha desses dados chama-se "Embrioes" e está exemplificada na Figura 3. Nesta folha, cada linha de dados refere-se a dados de cada um dos embriões, devendo-se preencher os seguintes dados:

- Código da amostra: código único sequencial usado anteriormente na ficha "ParqPesca" relativo à fêmea grávida que continha os embriões;
- Identificação da espécie, usando dos códigos de 3 letras da FAO;
- Ovário onde está o embrião a ser amostrado: Esq=Esquerdo e Dir=Direito;
- Sexo do embrião: M=macho e F=fêmea;
- Comprimento furcal do embrião (cm).



Embarcação: ____________ Data início embarque: ____/____/______

CodAmost	EspecieID	Ovário	Sexo	CompF

Embarcação: ____________ Data início embarque: ____/____/______

Figura 3: Ficha de amostragem para recolha de dados dos embriões.

DELIVERABLE # 4: Observer programme

<u>Appendix III</u>

Manual for voluntary self-reporting of fisheries data

(*In Portuguese*)

Estimado mestre:

A União Europeia (UE) e Cabo Verde aprovaram recentemente um novo Protocolo relativo ao Acordo de Pesca Sustentável entre as Partes. O protocolo, que é válido até 2018, está em linha com os princípios estabelecidos na recente reforma da Política Comum de Pesca (PCP) e permitirá que navios de pesca da UE capturem atuns e outras espécies de peixes grandes migradores nas águas de Cabo Verde. Também inclui medidas adicionais para melhorar a sustentabilidade das actividades pesqueiras, tais como a redução da capacidade de pesca com arte de palangre derivante de superfície, um mecanismos de monitorização das capturas de tubarões e a exclusão das pescarias de palangre de superfície e de cerco até a 18 milhas náuticas da linha de costa. Por outro lado, as Partes comprometeram-se a respeitar em absoluto as medidas adoptadas pela Comissão Internacional para a Conservação do Atum do Atlântico (ICCAT).

A melhor forma de suprimir lacunas no conhecimento e melhorar a conservação e gestão dos tubarões pelágicos capturados no âmbito das actividades pesqueiras realizadas no quadro do recentemente assinado Protocolo, é dispor de informação que reflicta a faina pesqueira de forma fiável. Este objectivo é facilmente atingível se pudermos contar com a sua colaboração no preenchimento deste livro de pesca electrónico lance após lance.

A compilação desta informação permite-nos analisar e compreender aspectos fundamentais da biologia das espécies capturadas, bem como dispor de informação básica que permita uma correcta avaliação do estado de conservação dos mananciais e, ainda, sugerir aos decisores políticos as melhores medidas de gestão tendo em vista uma exploração sustentável dos recursos pesqueiros. Por outro lado, se for preenchido de forma sistemática julgamos que poderá facilitar a sua habitual tarefa de contabilizar as quantidades capturadas, tanto por lance como por maré.

Este livro electrónico que, agora, lhe é distribuído **não substitui de forma alguma o diário de pesca oficial**. Importa destacar que a informação que nos vier a disponibilizar tem **carácter sigiloso**, **será apenas utilizada para fins científicos** e **jamais será divulgada** pelo Instituto Nacional de Desenvolvimento das Pescas (INDP) de Cabo Verde.

Uma vez preenchidas as suas folhas do ficheiro electrónico, para o qual sugerimos que leia atentamente as páginas que se seguem, agradecemos que nos envie o(s) ficheiro(s). Para tal, poderá enviá-las pelo correio electrónico (e-mail) para o seguinte endereço:

albertino.martins@indp.gov.cv

Poderá também entregá-lo(s) directamente a qualquer um dos amostradores do INDP que habitualmente trabalham no Porto Grande (Mindelo), ou ainda, entrega-lo na Sede do Instituto no Mindelo (São Vicente).

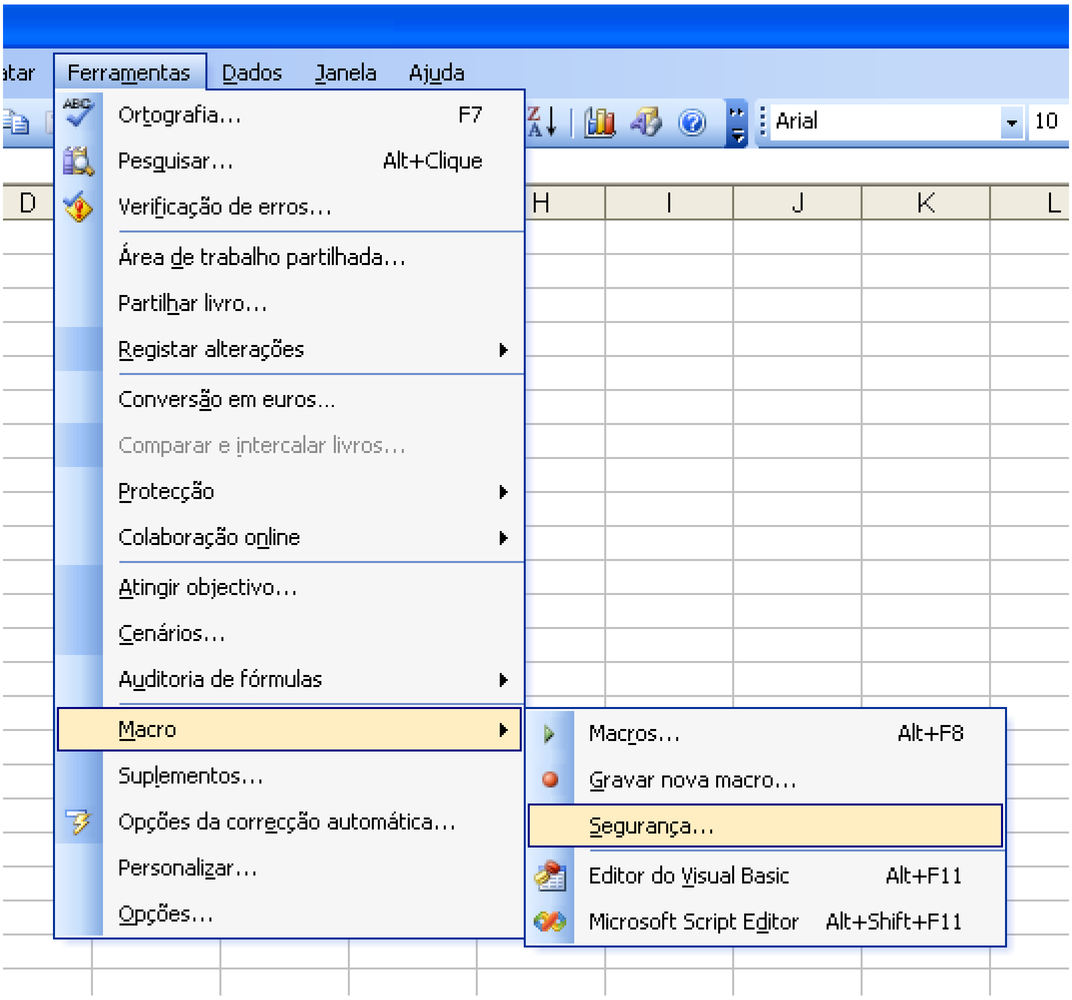
É da maior importância que preencha o livro de pesca de forma o mais completa possível e com dados reais. Se recebermos informação deturpada, as conclusões das nossas análises não serão realistas. Por este motivo, **agradecemos que anote todos os tamanhos dos peixes capturados, incluindo os de menor dimensão e os rejeitados**. Se o fizer correctamente, obterá automaticamente estimativas das capturas por espécie e tipo de peso (vivo e limpo).

Agradecemos antecipadamente a sua colaboração, esperando que esta iniciativa seja útil e não hesite em enviar-nos os seus comentários ou sugestões.

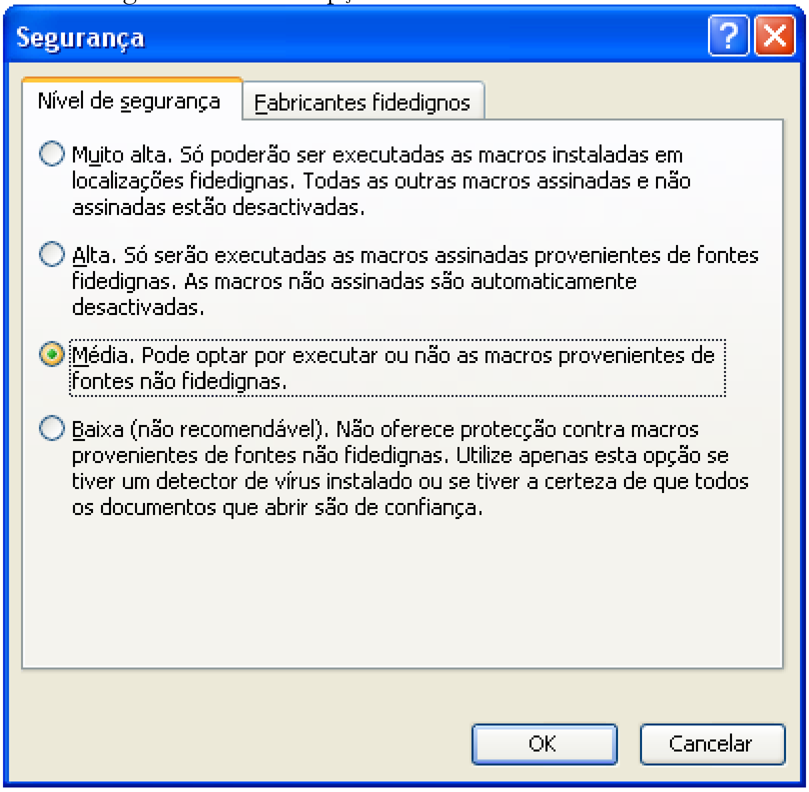
A sua colaboração é muito importante!

Instruções de instalação do ficheiro

1. Se estiver a utilizar o Office 2003 siga os próximos passos. Caso esteja a utilizar o Office 2007 ou posterior passe directamente para o número 5
2. Abrir o EXCEL e antes de abrir o ficheiro (Livro_de_pesca.xls) modificar a configuração em Ferramentas, Macro, Segurança (se não aparecer a opção Macro, carregar no símbolo Expandir que está no fim do menu Ferramentas)

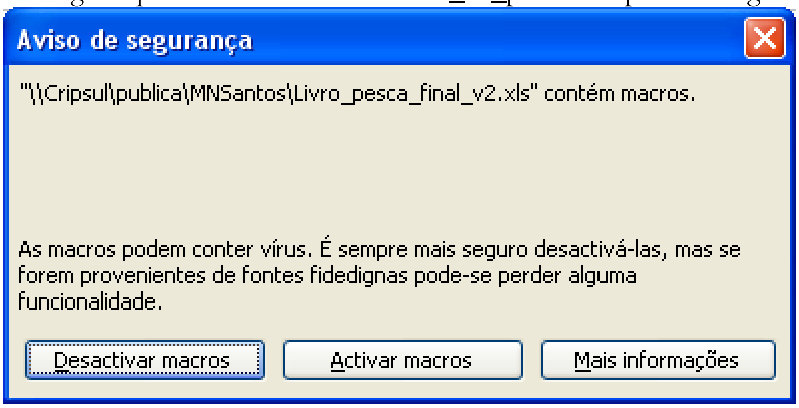


3. Em seguida escolher a opção Média



Esta operação só precisa de ser realizada uma vez. Daqui para a frente pode começar no passo seguinte.

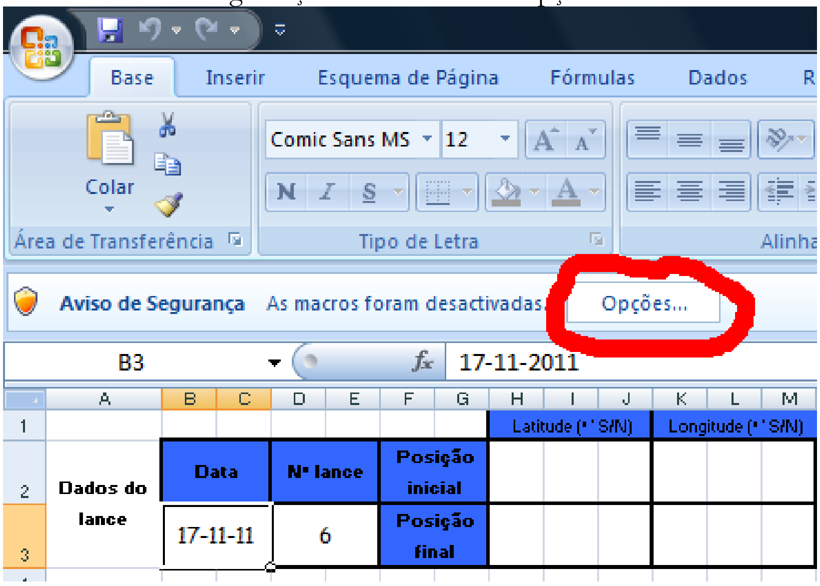
4. Agora quando abrir o ficheiro livro_de_pesca.xls aparece a seguinte janela



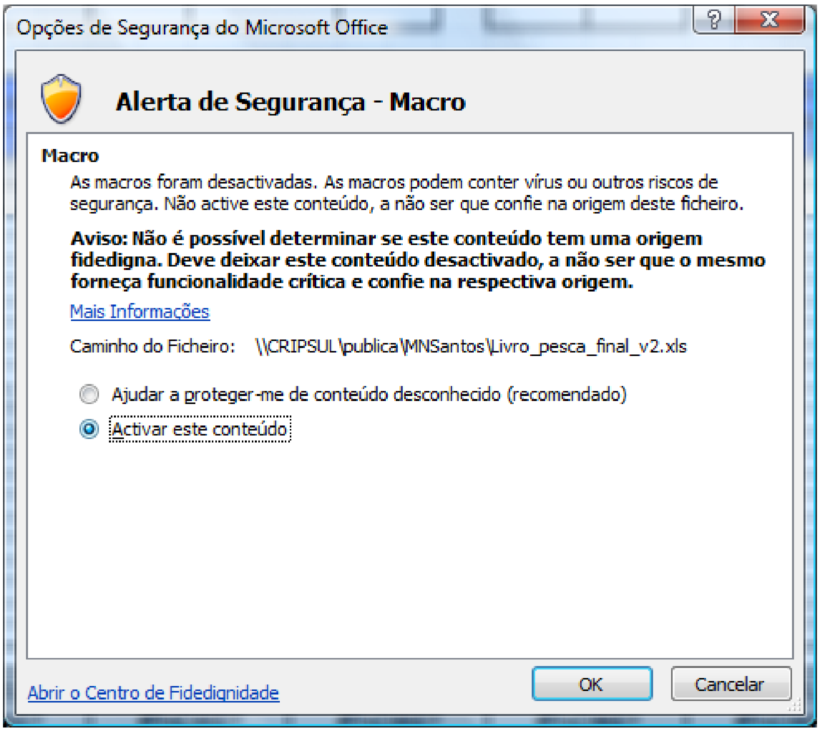
Escolha a opção Activar macros. **O ficheiro está pronto a utilizar**

Caso utilize o Office 2007 ou posterior

5. Quando abre o ficheiro livro_de_pesca.xls aparece uma barra por cima da folha de cálculo com um Aviso de Segurança. Clicar no botão Opções



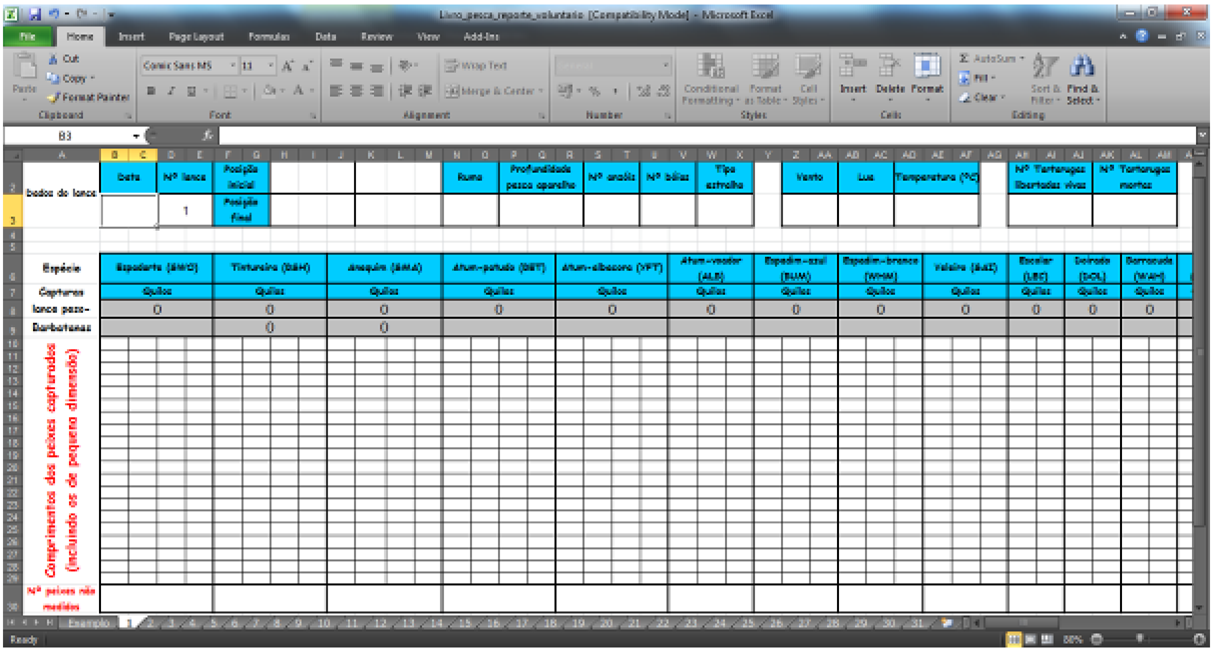
E escolher a opção "Activar este conteúdo"



O ficheiro está pronto a utilizar. Cada vez que abrir o ficheiro é necessário executar o passo 5, caso contrário o programa não efectuará os cálculos das capturas.

Instruções de preenchimento ficheiro

O ficheiro (Livro_de_pesca.xls) está preparado para recolher informação sobre o lance de pesca e as capturas. Para cada lance deve preencher uma folha. O Livro tem 31 folhas (na base da janela), correspondentes ao máximo de 31 lances por mês.

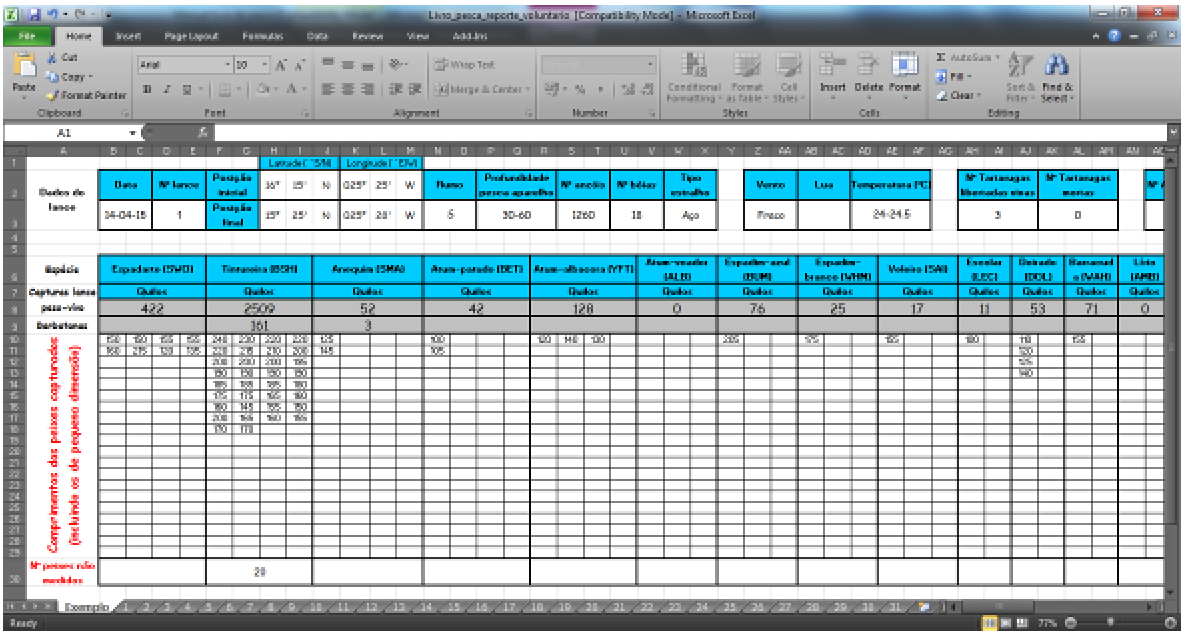


Na folha Exemplo, dá-se um exemplo do tipo de informação a preencher.

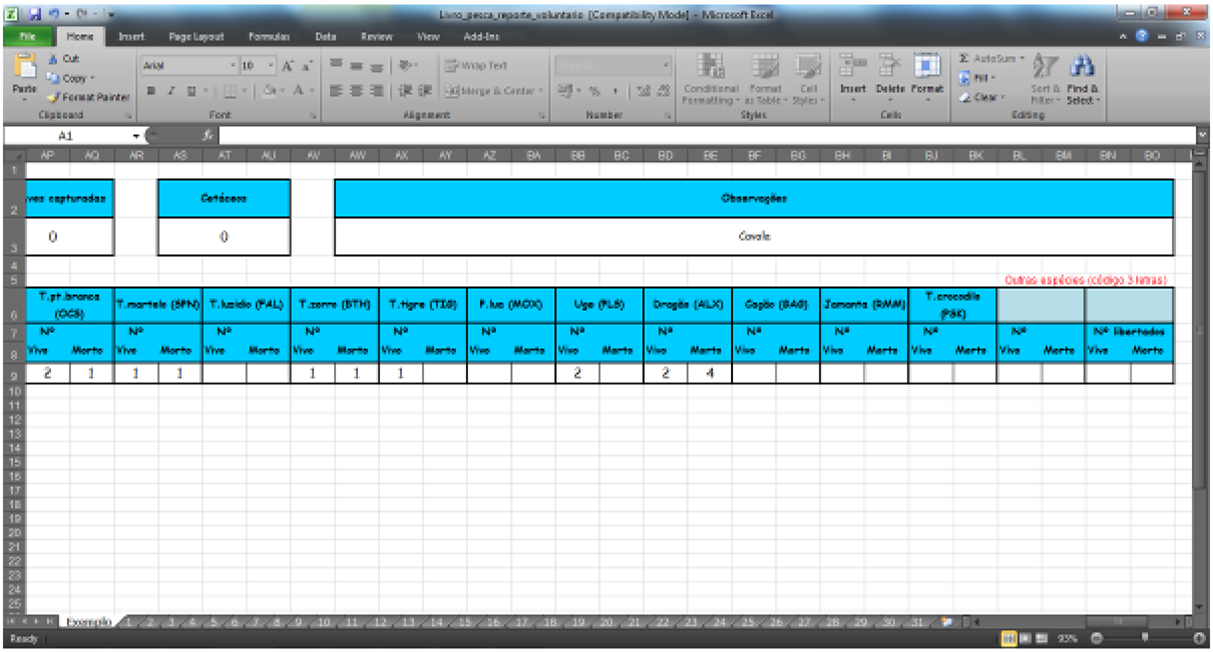
1) Comece por gravar o ficheiro com um novo nome, por exemplo: BoaSorte_Jun_2015

2) Na folha 1, relativo ao lance 1, comece por preencher os dados do lance (ex. data, posição inicial e final, nº de anzóis e bóias, temperatura da água, etc)

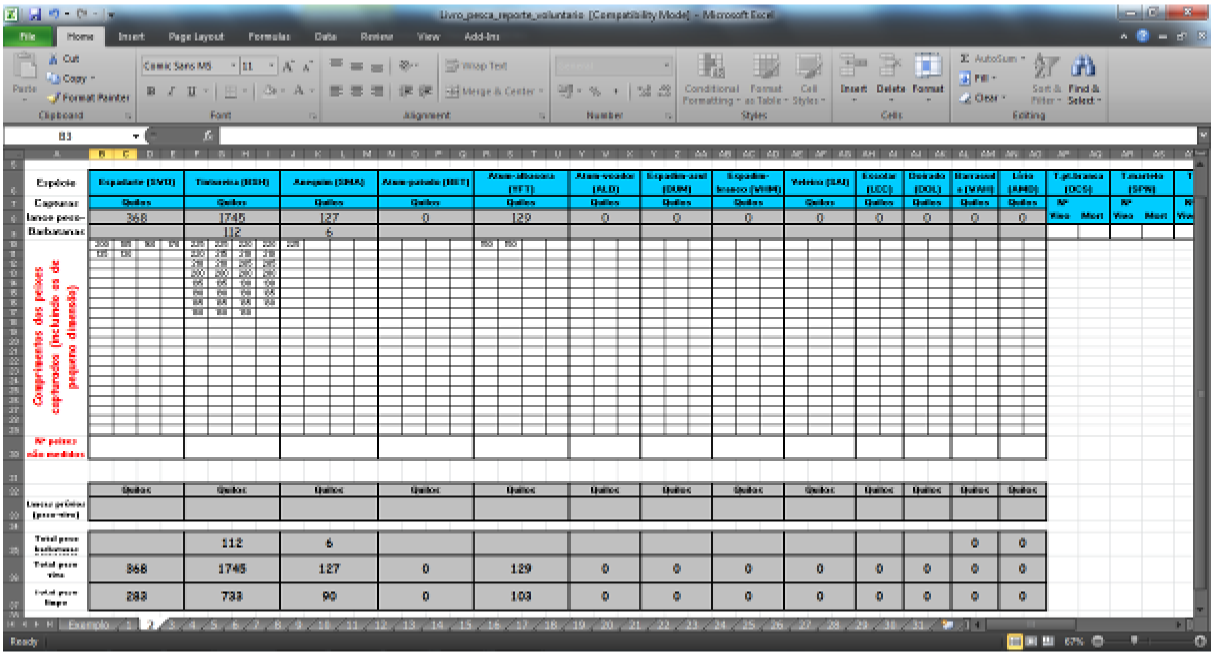
3) De seguida preencha os dados relativos aos comprimentos dos peixes das diferentes espécies capturadas, mesmo daquelas que são devolvidas ao mar. Caso não tenha medido todos os peixes, deve indicar **o número de peixes não medidos**. Se não medir nenhum peixe, o programa não poderá estimar o peso da respectiva captura.



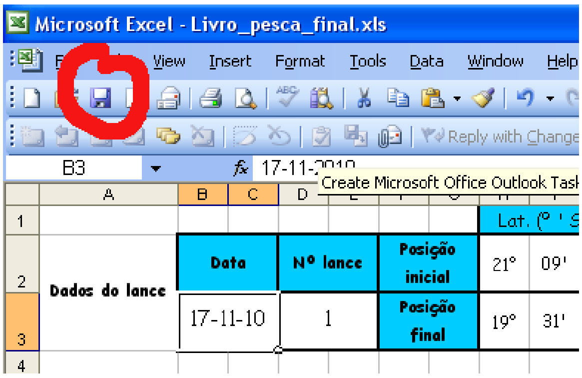
4) No final deve indicar também o nº de tartarugas libertadas vivas e mortas e se houve interacção com cetáceos. No campo Observações pode indicar qualquer informação que considere útil (ex. tipo de isco, tipo de anzol e estralho, etc). O número de peixes rejeitados vivos e mortos das restantes espécies (ex. OCS, FAL, BTH, PLS, etc) devem ser indicados nos respectivos campos. Existem à direita, 2 campos livres para outras espécies bastando indicar o respectivo código FAO (3 letras).

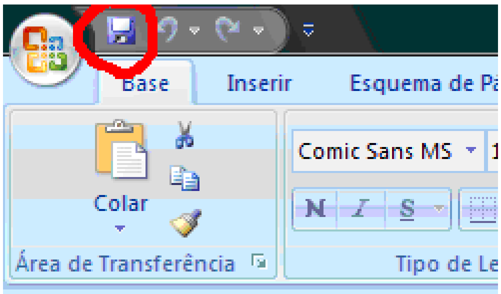


Uma vez concluído o preenchimento, o Livro de pesca calcula automaticamente por espécie (células cinzentas): o peso do lance (peso-vivo), o peso-vivo dos lances anteriores, o peso-limpo e peso-vivo total capturado nos lances já realizados e o peso (verdadeiro) das barbatanas no lance e no total da maré.



5) Após introduzir toda a informação deve gravar o ficheiro, bastando para tal clicar no botão indicado (à esquerda Office 2003; à direita Office 2007)





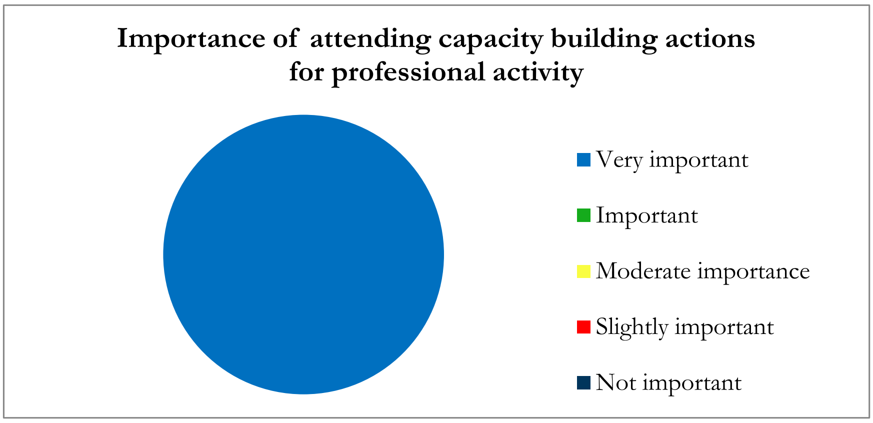
6) No final do mês (ou da maré se esta tiver menos de 31 lances), o ficheiro deve ser enviado para o seguinte endereço electrónico albertino.martins@indp.gov.cv. Caso a maré continue, deve voltar a abrir o ficheiro original (Livro_de_pesca.xls) e a gravá-lo com um nome diferente do anterior, por exemplo BoaSorte_Jul_2015.xls

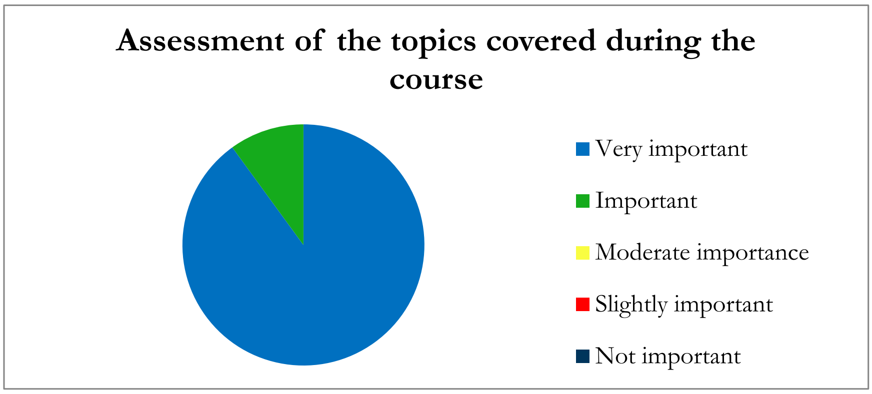
7) No final do ano o IPIMAR elaborará um relatório que lhe será enviado, sobre a actividade por si desenvolvida ao longo do ano, com mapas e tabelas das capturas por maré. Para tal, quando nos enviar o ficheiro deverá indicar-nos a morada para onde o relatório deve ser enviado. **A informação que vier a disponibilizar é absolutamente sigilosa e apenas será utilizada com fins científicos. A informação não será disponibilizada a ninguém** e apenas o mestre e aqueles a quem ele o permitir, terão acesso ao relatório.

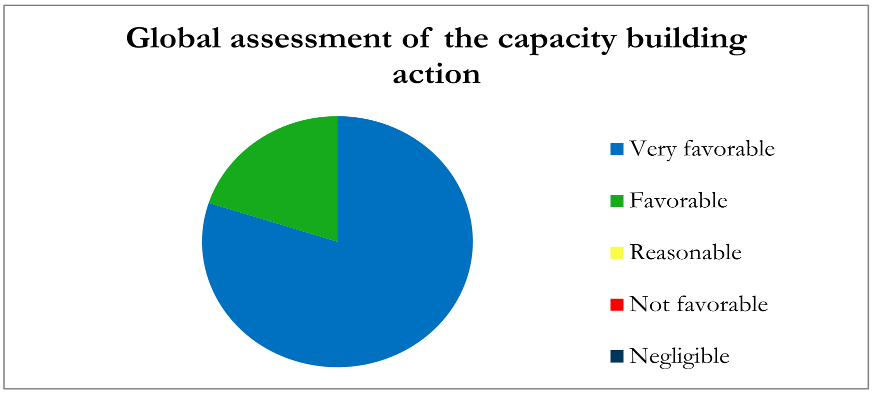
Obrigado pelo seu apoio!

ANNEX II - STUDENT SURVEY FROM THE TRAINING COURSE

A questionnaire was distributed at the end of the course to the 9 participants, showing that the training course was considered very interesting and important by all the trainees. This aspect was highlighted both by the technicians and fishery inspectors that attended to the course:







ANNEX III - NON-TECHNICAL PAPER #1

(Deliverable Nº 1 of the project)

Conservation of pelagic sharks associated with fishing activity under the EU-Cabo Verde Sustainable Fisheries Partnership Agreement

The European Union (EU) and Cabo Verde have agreed on a new Protocol to the Sustainable Fisheries Partnership Agreement between the parties. The protocol, which is valid until 2018 is fully in line with the principles of the recent reform of the Common Fisheries Policy (CFP) and will allow EU vessels to fish tuna and other highly migratory species in Cabo Verdean waters. It also provides measures to improve the sustainability of fishing activities such as a reduction in surface long-liners fishing capacity, a monitoring mechanism for shark catches and a ban on fishing within 18 nautical miles of the shore for surface long-liners and purse-seiners. Both parties committed to fully respect all recommendations made by the International Commission for the Conservation of Atlantic Tunas (ICCAT).

In order to fill knowledge gaps and improve the conservation and management of pelagic sharks associated with fishing activity under the recently signed Protocol, the EU requested a Consortium of EU research laboratories to carry out a collaborative study with the Cabo Verdean Fisheries Research and Development Institute (INDP). The work will mostly consist of desk-based data collection and research and of field work including a tagging programme for pelagic sharks. The study is inter-disciplinary and brings together international experts in the fields of fisheries monitoring, highly migratory fisheries, species biology and ecology, management and conservation. The study started in February 2015 and will be carried out until August 2016.

Objectives and tasks

The main objective of this collaborative project with INDP is the provision of advice on the conservation of pelagic sharks associated to fishing activity in the Cabo Verde Economic Exclusive Zone (EEZ). The following specific objectives are envisaged:

- Develop and implement an observer sampling programme for the fleets capturing sharks in the Cabo Verde EEZ, including developing standard protocols for data collection and a data base for the Cabo Verde observer programme;

- Design and implement a tagging programme for the regional area of Cabo Verde and adjacent waters of the tropical Atlantic, using electronic data collection tags with satellite transmission (PTT - Popup Archival Transmitting Tags) – 40 tags will be deployed covering two major shark species caught in Cabo Verde waters (blue shark, *Prionace glauca*; and shortfin mako, *Isurus oxyrinchus*);
- Analyse the potential local depletion of sharks and related impacts to the ecosystem;
- Analyse the spatial distribution of pelagic sharks in Cabo Verde and neighbouring waters and identify biological and ecologically sensitive areas such as nursery grounds;
- Disseminate the results of the project, through different forms of reporting and by organizing a dedicated workshop in Cabo Verde.

Five tasks are planned to be executed during the course of the project, involving capacity building, port and onboard catch monitoring, field work, fisheries data collection and analyses, and dissemination of the results.

The Consortium

The participants involved in the project have been selected on the basis of their special skills, expertise and profiles to be complimentary in the implementation of the project tasks. The participating Institutes and experts represent some of the best available expertise in Europe (Portugal, Spain, France and UK) and Cabo Verde. All have been very much involved in the ICCAT's Scientific Committee of Research and Statistics. An independent expert not involved in this study will critically review the work plan and the results of the project.

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(Scientific coordinator and project coordinator)

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Albertino Martins (albertino.martins@indp.gov.cv) – project coordinator INDP

ANNEX IV - NON-TECHNICAL PAPER #2

(Deliverable Nº 6 of the project)

Conservation of pelagic sharks associated with fishing activity under the EU-Cabo Verde Sustainable Fisheries Partnership Agreement

February 2016

The European Union (EU) and Cabo Verde have agreed in 2014 on a new Protocol to the Sustainable Fisheries Partnership Agreement between the parties. In order to fill knowledge gaps and improve the conservation and management of pelagic sharks associated with fishing activity under the Protocol, a Consortium of EU research laboratories is carrying out a collaborative study with the Cabo Verde Fisheries Research and Development Institute (INDP). This study is inter-disciplinary and brings together international experts in the fields of fisheries monitoring, highly migratory fisheries, species biology and ecology, management and conservation. The study funded by the EU started in February 2015 and will be carried out until August 2016.

Development of a scientific observer sampling programme for Cabo Verde

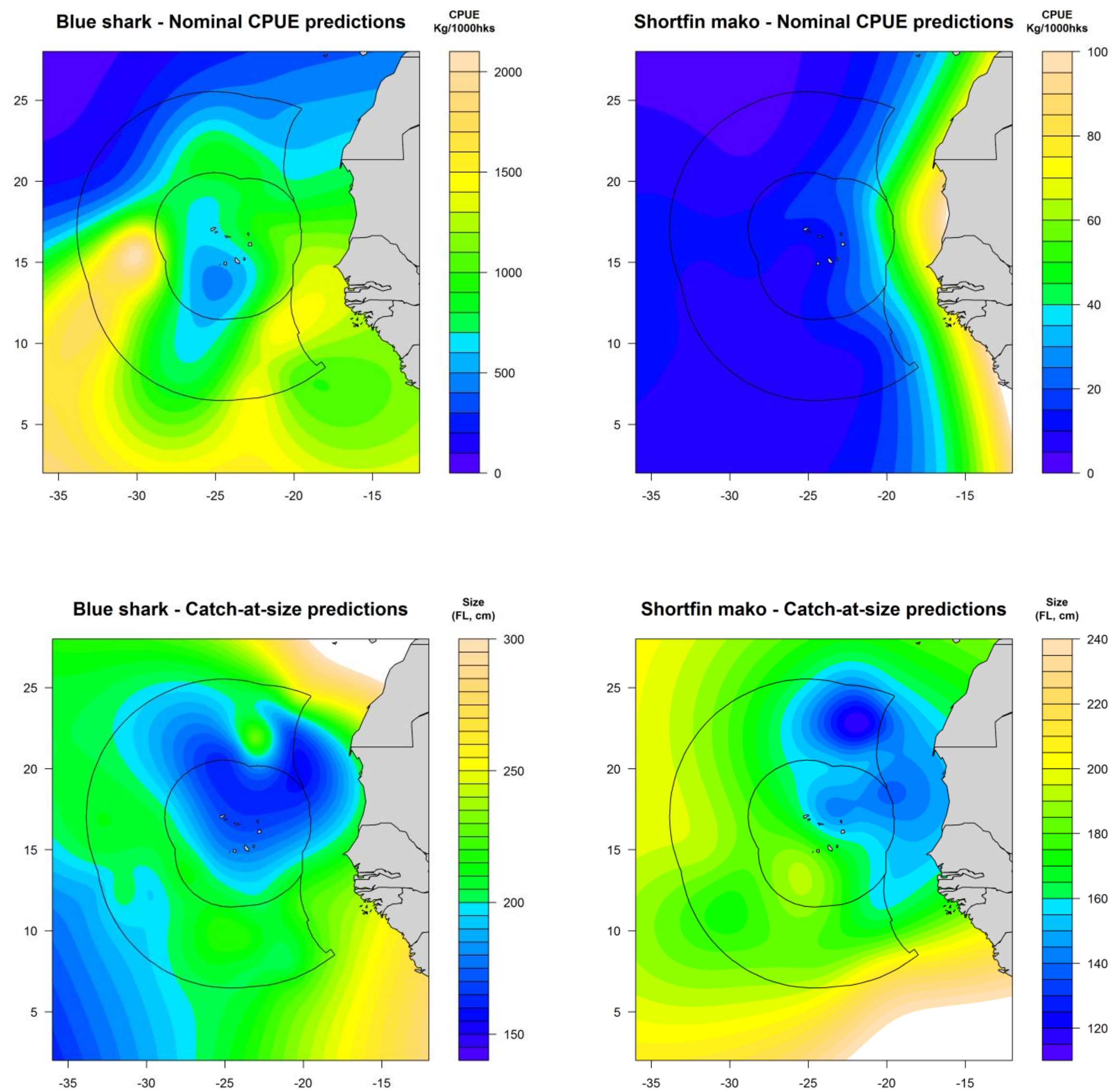
One objective of the project was to develop a scientific observer sampling programme for the fleets capturing sharks in the Cabo Verde EEZ.

A capacity building workshop was organized by the Consortium in collaboration with INDP in Mindelo in April 2015. Standard protocols for data collection were prepared, and an onboard observer manual with species identification and guidelines for data collection were provided. INDP, in colaboration with Consortium scientists, developed a data base for storing the information collected by the Cabo Verde observer programme.

Analysing the spatial distribution of pelagic sharks in Cabo Verde

Another objective of the project was to analyse the spatial distribution of the main pelagic sharks in Cabo Verde and neighbouring waters and identify biological and ecologically sensitive areas. The two main pelagic shark species captured by pelagic longline fisheries are the blue and shortfin mako sharks, which together account for more than 95% of the pelagic sharks catches in the region.

The analysis of the European fleets (Portugal and Spain) revealed that the expected nominal catch rates (CPUE - catch-per-unit-of effort, Kg of live weight per 1000 hooks) of blue shark are higher towards the southern parts of the study area, while for the shortfin mako the expected catch rates are much higher along the coastal areas of the African continent. For both species, the higher catch rates are expected mainly outside the Cabo Verde EEZ, in the immediately adjacent waters.



Smaller blue sharks are expected to occur inside the Cabo Verde EEZ, as well as in the adjacent waters of the north and northeast areas. For the shortfin mako smaller specimens are expected also in the north and northeast, but mainly in the nearby adjacent waters outside the Cabo Verde EEZ. Those areas are particularly sensitive due to the presence of more juveniles of both species.

The Consortium

The participating Institutes and experts involved in the project represent some of the best available expertise in Europe (Portugal, Spain, France and UK) and Cabo Verde. All have been very much involved in the Scientific Committee of Research and Statistics of the International Commission for the Conservation of Atlantic Tuna (ICCAT-SCRS).

(Scientific coordinator / Project coordinator)

For additional information, please contact the coordinators:

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Rui Coelho (rpcoelho@ipma.pt) – Scientific coordinator

Albertino Martins (Albertino.Martins@indp.gov.cv) – Focal Point in Cabo Verde

ANNEX V - NON-TECHNICAL PAPER #3

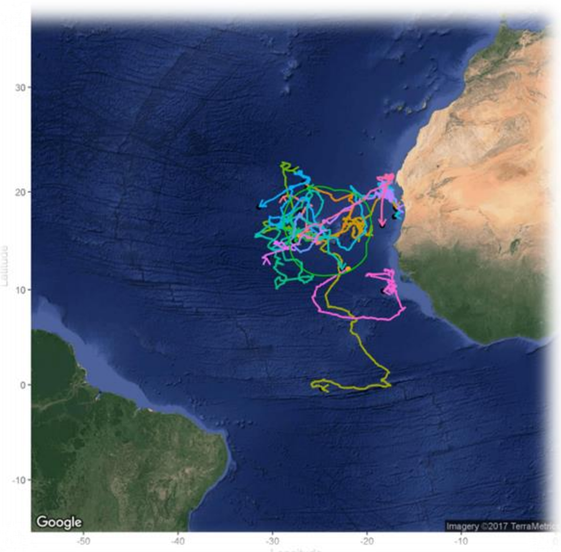
(Deliverable 7 of the project)

Conservation of pelagic sharks associated with fishing activity under the EU-Cabo Verde Sustainable Fisheries Partnership Agreement April 2017

The European Union (EU) and Cabo Verde have agreed in 2014 on a new Protocol to the Sustainable Fisheries Partnership Agreement. In order to fill knowledge gaps and improve the conservation and management of pelagic sharks associated with fishing activity under the Protocol, a Consortium of EU research laboratories carried out a collaborative study with the Cabo Verde Fisheries Research and Development Institute (INDP). This study brought together international experts in the fields of fisheries monitoring, highly migratory species, biology and ecology, management and conservation. The study funded by the EU started in February 2015 and ended in April 2017.

Task 1 - Observer programme

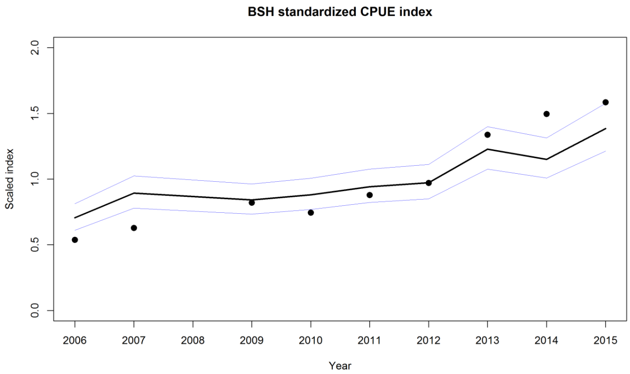
The 1st task designed and provided training for an observer programme for fleets capturing pelagic sharks in the Cabo Verde Exclusive Economic Zone (EEZ). This included the development of standard protocols for data collection, provision of identification guides and forms to collect data, and development of a self-reporting scheme. A database for the Cabo Verde observer programme was also developed, and observer training was provided as part of a capacity building programme.



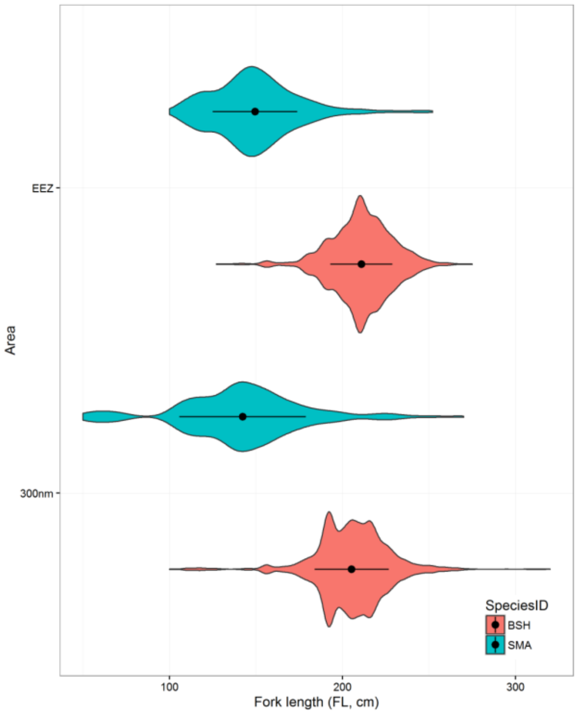
Task 2 - Tagging programme

The 2nd task designed and implemented a tagging programme using satellite telemetry tags. 30 satellite tags were deployed in the main shark species, the blue shark *Prionace glauca*, and shortfin mako *Isurus oxyrinchus*. Tagged blue sharks moved substantial distances, in most cases to areas outside the Cabo Verde EEZ, sometimes travelling over 4,000 km. Shortfin makos tended to move to areas closer to the West Africa continental shelf, which seems to be a particularly important area for this species.

Task 3 - Analysis of potential local depletion of sharks

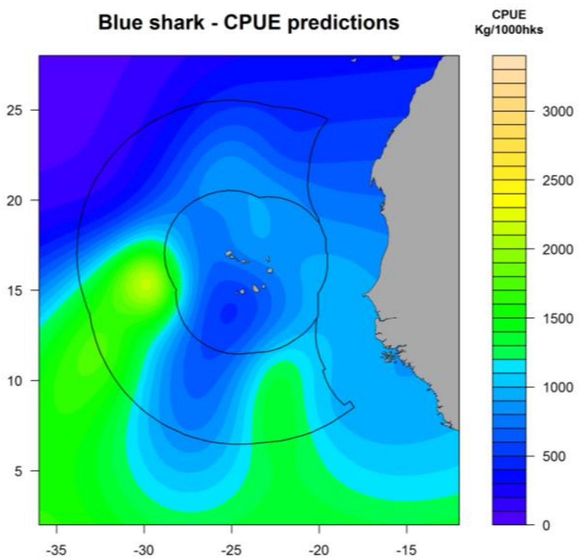


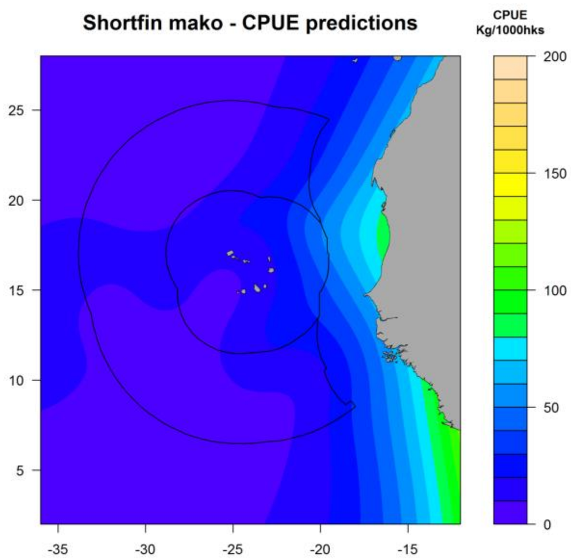
The 3rd task analysed potential local depletion of sharks in Cabo Verde. Several data sources were analysed: 1) the ICCAT Task II CE (Catch and Effort) databases; 2) the INDP database with reported logbook landings from the EU fleet; 3) the EU pelagic longline fleets logbook and VMS data; and 4) EU fishery observer data. The blue shark standardized index of abundance showed an overall increase along the period, while for the shortfin mako the index showed an increase in the earlier years and a more stable period in recent years. In terms of sizes, the blue shark catches in the Cabo Verde region are composed mainly of adults, while for the shortfin mako the catches are composed mainly of juveniles and there are some signs of declining sizes through time.



Task 4 - Biological and ecological sensitive areas

This 4th task used spatial models to predict expected catch rates and size distributions of blue shark and shortfin mako in the region. For the blue shark overall higher catch rates were predicted mainly outside the Cabo Verde EEZ in the south and southwest regions, while for the shortfin mako the higher catch rates are predicted along the African continental shelf waters, outside the Cabo Verde EEZ but in the EEZs of West African countries. Shortfin makos seem to have marked region-specific





movements and habitat use, in this case along the West African continental shelf. The blue shark sizes predicted in the region are mainly composed of large juveniles and adults, while for the shortfin mako the expected sizes in the region throughout the year are mainly juveniles.

Main recommendations of the Project

- The implementation of the observer programme could involve two steps. In the short term a pilot project could be developed to test the programme, while for the long term there is the need for secure long terms funds that can guarantee the stability and viability of the programme;
- For a continuation of the tagging programme the main shark species should continue to be focused (blue shark and shortfin mako). Additional funds should also be used to tag other more rare species that also interact with pelagic longlines, including silky shark, oceanic whitetip, longfin mako, bigeye thresher and hammerheads;
- Considering the current indicators local depletion effects are not likely to be occurring on the main pelagic shark species in Cabo Verde. However, it is recommended to keep the detailed data collection and update those indicators periodically (e.g., every 2-3 years). Particularly for the shortfin mako where most of the catch are juveniles and there are some signs of decreasing trends in the mean sizes, it is particularly important to update those indexes regularly.

The Consortium

The participating Institutes and experts involved in the project represent some of the best available expertise in Europe (Portugal, Spain, France and UK) and Cabo Verde. All have been very much involved in the Scientific Committee of Research and Statistics of the International Commission for the Conservation of Atlantic Tuna (ICCAT-SCRS).

(Scientific coordinator / Project coordinator)

For additional information, please contact the coordinators:

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- Rui Coelho (rpcoelho@ipma.pt) – Scientific coordinator
- Albertino Martins (Albertino.Martins@indp.gov.cv) – Focal Point in Cabo Verde

ANNEX VI - WORKSHOP OUTLINE, AGENDA, LIST OF PARTICIPANTS AND RECOMMENDATIONS

(Deliverable 8 of the project)

Aconselhamento científico sobre a conservação de tubarões pelágicos associados a actividades pesqueiras no âmbito do Acordo de Pesca Sustentável entre a UE e Cabo Verde *(Framework Contract MARE/2012/21)*

Cabo Verde e a União Europeia (UE) aprovaram em 2014 um Protocolo relativo ao Acordo de Pesca Sustentável entre as Partes, válido até 2018. Este Protocolo, em linha com os princípios estabelecidos pela Política de Pescas de Cabo Verde e a Política Comum de Pesca (PCP) da União Europeia, permitirá que navios de pesca da UE capturem atuns e outras espécies de grandes migradores nas águas de Cabo Verde. O Protocolo inclui medidas adicionais para melhorar a sustentabilidade das actividades pesqueiras, tais como a redução, relativamente ao anterior Protocolo, da capacidade de pesca com arte de palangre derivante de superfície, mecanismos de monitorização das capturas de tubarões e a exclusão das pescarias de palangre de superfície e de cerco até 18 milhas náuticas da costa. Por outro lado, as Partes comprometeram-se a respeitar as medidas adoptadas pela Comissão Internacional para a Conservação do Atum do Atlântico (ICCAT).

Por forma a suprimir lacunas no conhecimento e melhorar a conservação e gestão dos tubarões pelágicos capturados no âmbito das actividades pesqueiras realizadas no âmbito do Protocolo assinado, a UE requereu a um Consórcio de Institutos de Investigação Europeus a realização de um estudo colaborativo com o Instituto de Investigação e Desenvolvimento da Pesca de Cabo Verde (INDP). Os trabalhos consistiram maioritariamente na recolha de dados da pesca e acções de investigação, incluindo um programa de marcação dirigido a tubarões pelágicos. Este estudo tem carácter multidisciplinar e conta com peritos internacionais na área da monitorização da pesca, pescarias de grande migradores, biologia e ecologia pesqueira, gestão e conservação de recursos marinhos. Os trabalhos iniciaram-se em Fevereiro de 2015 e prolongar-se-ão até Abril de 2017.

Objectivos e tarefas

O principal objectivo deste estudo colaborativo é o aconselhamento científico tendo em vista a conservação dos tubarões pelágicos associados a actividades pesqueiras na Zona Económica Exclusiva (ZEE) de Cabo Verde. O projecto incluiu 5 tarefas envolvendo no seu conjunto acções de formação, trabalho de mar e telemetria de satélite, recolha e análises de dados da pesca e disseminação dos resultados alcançados. Os objectivos específicos incluem:

- Desenhar um programa de observadores científicos dirigido às frotas pesqueiras que capturam tubarões na ZEE de Cabo Verde, através da realização de acções de formação, elaboração de protocolos de recolha de dados da pesca e criação de uma Base de Dados no INDP para compilar a informação recolhida no âmbito dos Programas de Amostragem;

- Desenhar e implementar um Programa de marcação de tubarões na zona de Cabo Verde e áreas adjacentes da região tropical do Atlântico NE, utilizando dispositivos de transmissão de dados por satélite – foram colocadas 30 marcas de satélite nas duas principais espécies de tubarões pelágicos capturados nas águas de Cabo Verde (tubarão-azul, *Prionace glauca*; e tubarão-anequim, *Isurus oxyrinchus*);
- Analisar possíveis efeitos de depleção local de tubarões pelágicos e efeitos colaterais no ecossistema pelágico;
- Analisar a distribuição espacial dos tubarões pelágicos nas águas de Cabo Verde e zonas adjacentes, e identificar potenciais áreas de elevada sensibilidade biológica e ecológica tais como zonas de criação para estas espécies;
- Disseminar os resultados do projecto, sob a forma de diferentes tipos de documentos e através da organização em Cabo Verde de um seminário dedicado a esta temática.

O Consorcio

Os participantes neste projecto foram seleccionados tendo em conta os seus conhecimentos, experiência profissional e perfil, por forma a serem complementares na implementação das diferentes tarefas previstas. Os Institutos e peritos envolvidos incluem alguns dos mais reconhecidos neste domínio na Europa (Portugal, Espanha, França e Reino Unido) e Cabo Verde. Todos eles têm tido um grande envolvimento nos trabalhos desenvolvido pelo Comité Permanente de Investigação e Estatísticas (SCRS) da ICCAT. Um perito externo independente e não envolvido no projecto fará uma revisão crítica do plano de trabalhos e dos resultados alcançados.

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(Scientific coordinator and project coordinator)

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The provision of advice on the conservation of pelagic sharks associated to fishing activity under EU Sustainable Fisheries Partnership Agreements in the Atlantic Ocean

Specific Contract No 7 under Framework Contract MARE/2012/21

Workshop final do Projecto - INDP, Mindelo, Cabo Verde - 24 Março 2017

WORKSHOP AGENDA

Sessão da manhã

- 9h00 - 9h30: Recepção e registo dos participantes
- 9h30 - 10h00: Abertura da sessão (Administração de Cabo Verde + DG-MARE)
- 10h00 - 10h15: Introdução ao contrato framework MARE/2012/21 (IEO)
- 10h15 - 10h30: Introdução ao Proj SC-07 - Tubarões pelágicos em Cabo Verde (IPMA)
- 10h30 - 11h00: Pausa para café
- 11h00 - 11h30: Tarefa 1 – Programa de observadores (INDP)
- 11h30 - 12h00: Tarefa 2 – Programa de marcações (IPMA)
- 12h00 - 12h30: Discussão e encerramento da sessão da manha (discussão e sessão de perguntas/respostas com o participantes)
- 12h30 - 14h00: Pausa para almoço

Sessão da tarde

- 14h00 - 14h45: Tarefa 3 – Indicadores locais do estado das populações de tubarões pelágicos (IPMA)
- 14h45 - 15h15: Tarefa 4 – Zonas biológica e ecologicamente sensíveis (INDP)
- 15h15 - 15h45: Pausa para café
- 15h45 - 16h00: Tarefa 5 – Coordenação e Comunicação (IEO)
- 16h00 - 16h20: Recomendações finais do projecto (IPMA + IEO + INDP)
- 16h20 - 17h00: Discussão final e encerramento da sessão (discussão e sessão final de perguntas/respostas com o participantes)

List of workshop participants

56 participants from National institutes, administration, universities, NGOs and fishing sector attended the workshop.

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55.	Manuel Maria Martins	Ass. Pescador Maio	9992155
56.	Risiene Gil Baptista Alves	Ass. Pescador Paul	5864398

List of acronyms:

- INDP – Instituto Nacional de Desenvolvimento das Pesca
- DNEM – Direção Nacional Economia Marítima

- UNICV (FECM) – Universidade de Cabo Verde (Faculdade Ciência do Mar)
- ACOPESCA – Autoridade Competente do Produtos da Pesca
- Delegação MAA – SV – Delegação d Ministérios de Agricultura e Ambiente
- CMSV – Camara Municipal de São Vicente
- PRAO.CV – Projecto Regional de Pesca para a África Ocidental em Cabo Verde
- FCCV – Fazenda de Camarão Cabo Verde
- EU – União Europeia
- NOAA/NMFS - National Marine Fisheries Service, USA
- IEO – Instituto Espanhol de Oceanografia, Spain
- IPMA - Instituto Português do Mar e da Atmosfera, Portugal
- ONG's – Organizações não Governamentais
- FMB – Função Maio Biodiversidade
- APESC – Associação de Armadores de Cabo Verde

Main discussions and recommendations from the workshop participants

In general, all participants in the workshop agreed with the main findings of the project and agreed with the final recommendations proposed by the project. Additional discussions and specific recommendations provided by the workshop participants are summarized below:

Task 1:

- The self-sampling programme seems promising and a good alternative when there are no observers onboard. The workshop participants noted, however, that the data from this type of sampling scheme will be mainly useful for the main species, and there will be the need for specific training for the fishing crews and skippers;
- The workshop participants noted that because those highly migratory resources also move and are impacted by fisheries in the EEZs of other west African countries, in terms of management there is also the need to coordinate with the West Africa Sub-regional Fisheries Commission (CSRP). The Consortium scientists clarified that for those highly migratory species (tuna-like species including oceanic sharks) the inter-governmental Commission responsible for the management is ICCAT. However, all agreed that involving the CSRP would be good for more integrated and coordinated management actions, as well as for possibly establishing regional observer programmes of fleets that operate in various EEZs;
- The workshop participants made a final comment on the importance of separating scientific from compliance observers. The Consortium scientists clarified that the entire programme that was developed in this project was exclusive for scientific observers. All participants agreed that it is of utmost importance to keep those two roles well separated.

Task 2:

- The workshop participants recognized that the satellite tagging that was carried out by the project represents the state-of-the-art technology, and that the number of tags deployed is representative and in general higher than what most studies have used in the past;
- Some workshop participants noted that the fishing activity is an economic activity with high economic profits and therefore should co-fund scientific and monitoring activities.

Task 3:

- The workshop participants discussed the indicators that were used, recognizing that those are in line with the state-of-the-art practices currently used for stock assessments;
- One workshop participant questioned the abundance indices presented and mentioned that from personal scuba diving observations has noticed that coastal

sharks have almost disappeared from the coastal waters of Cabo Verde over the past 20 years. The Consortium scientists clarified that this study addressed exclusively the pelagic sharks captured within the SFPA with the EU, and that those coastal sharks mentioned are not impacted by the EU pelagic longline fleets but might be impacted by other coastal (non EU) fleets;

- All workshop participants (including the Consortium scientists) agreed that while the current indicators point that there are no signs of local depletion of the main pelagic sharks in Cabo Verde, it is important to keep and strengthen the detailed data collection from the various sources and update those indicators periodically (e.g., every 2-3 years as proposed by the project recommendations seems adequate).

Task 4:

- The workshop participants discussed issues related with Ecosystem Approach to Fisheries Management (EAFM). The Consortium scientists, also involved in EAFM at both ICCAT and IOTC levels, were able to provide detailed explanations of the current development status of EAFM in those tuna-RFMOs;
- In summary, EAFM in tuna-RFMOs is in general in its infancy but there is progress and much work starting at present. The Ecosystems Working Groups of those tuna-RFMOs (SC-ECO in ICCAT and WPEB in IOTC) are now developing Ecosystem Report Cards to summarize ecosystem indicators, and the EAFM process is now part of the dialogue meetings between scientists and managers;
- All workshop participants recognized that EAFM should be carried out at the regional level (ICCAT in the case of the Atlantic) and not necessarily at local/national level. However, and following the same process that was done by this project, it might be possible to develop local EAFM indicators in the future specific for the Cabo Verde region (including particularly target, bycatch and environmental indicators).

Task 5:

- The workshop participants agreed that it is important to disseminate the results of scientific projects at various levels, as is being done by this project. This includes this final project workshop, the dissemination to the general public by non-technical papers, and also the dissemination to the scientific community with the publication of peer-review papers and presentations in scientific meetings as is being done.

ANNEX VII - SCIENTIFIC PRESENTATION AT EEA

Abstract of the oral communication presented during the 20th Scientific Conference of the European Elasmobranch Association (EEA), 28-30th October 2016, Bristol, England.

Local indicators for global species: the case study of the Cabo Verde pelagic sharks captured within the EU Sustainable Fisheries Partnership Agreements

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3: INDP - Instituto Nacional de Desenvolvimento das Pescas (Cabo Verde)
4: IRD - Institut de Recherche pour le Développement (France)
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Abstract:

Pelagic sharks are an important bycatch in pelagic swordfish longline fisheries. In the Cabo Verde Archipelago (tropical NE Atlantic), pelagic shark catches can reach important levels, sometimes higher than the target species. Due to the increased concern on the status of shark species, an EU funded project (MARE/2012/21 - SC7) was developed to provide scientific advice on the conservation of pelagic sharks associated with the EU fishing activity, in a collaboration between several EU and Cabo Verde research Institutes. A satellite tagging program was established with the deployment of 30 satellite tags in blue and shortfin mako sharks in the Cabo Verde EEZ, showing that those species are highly mobile. Stock status indicators for the main species were created, including analysis of size frequency distributions over time and standardized catch-per-unit-of-effort (CPUE) indexes. The standardized CPUEs have been stable for the past 10 years, indicating no signs of local depletion. In terms of sizes, the blue shark catch is composed mainly of adults, which is a sign of a healthier population. By the contrary, the catch of shortfin mako is composed mainly of juveniles, which is a cause of concern. The biomass and size distributions were modeled with spatial and seasonal models (GAMs) identifying locations where juveniles are predominantly concentrated and that should be prioritized for conservation. This work presents new information on the status of pelagic sharks in the Cabo Verde region, and can now be used to promote more sustainable fisheries in the region.

Keywords: Fisheries, Indices of abundance, Pelagic sharks, Population trends, Satellite tagging, Spatial modeling.

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