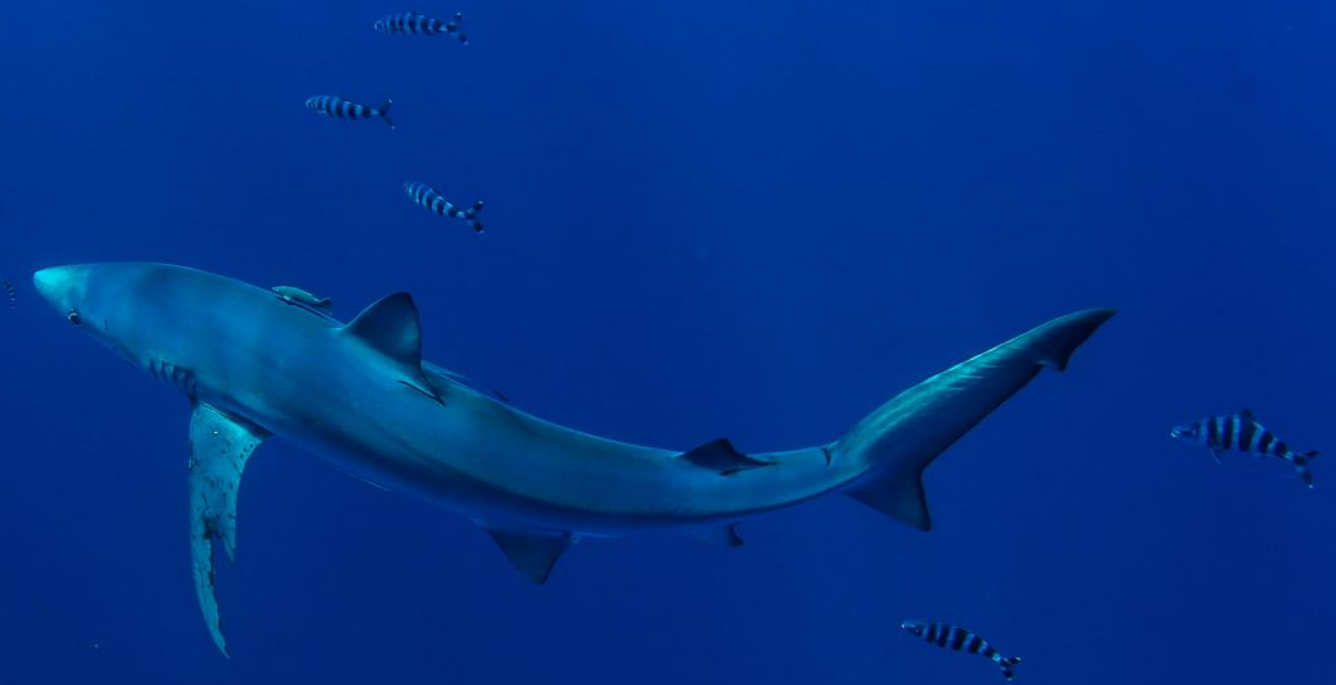


Book of Abstracts



European Elasmobranch Association
22nd annual conference
12 – 14 October, Peniche – Portugal

POLICY AND CONSERVATION FOR A BRIGHTER BLUE FUTURE

**European Elasmobranch Association
22nd annual conference
12 - 14 October, Peniche - Portugal**

Organized by

Associação Portuguesa para o Estudo e Conservação de
Elasmobrânquios & Escola Superior de Turismo e
Tecnologia do Mar do Instituto Politécnico de Leiria.

Welcome to the EEA 2018 and welcome to Peniche!

The Portuguese Association for the Study and Conservation of Elasmobranchs (APECE) and the Polytechnic of Leiria are delighted to host the 22nd Annual European Elasmobranch Association Meeting from 12-14 October held at the Escola Superior de Turismo e Tecnologia do Mar in Peniche, Portugal.

Given the threats faced by cartilaginous fishes all over the World, and in accordance with the EEA's ethos of bridging scientific evidence and conservation policies, the theme for this year's meeting is "**Policy and conservation for a brighter blue future**". We hope this will be an inspiring conference where the best in elasmobranch research is presented and discussed, enhancing knowledge, creating networks, and contributing with the best for our oceans!

The meeting chairs

Luís Alves

Marco Lemos

Sara Novais

Program

Day 1 - 12th of October

[09h00]- Registration desk opens

[09h15]- EEA Board Meeting (EEA Board members only)

[12h30]- Lunch break

[14h00]- Welcome address

Alex Bartolí (EEA president) &

Luís Alves (APECE president & EEA2018 Chair)

[12h15] - Round table discussion: Policy and conservation for a brighter blue future.

Alex Bartolí, Ali Hood, Rui Coelho & Sarah Fowler

Session: Conservation and fisheries management I

Session chairs: Alex Bartoli & Rui Coelho

[15h15] - **I. Nuez** - "Narrowing the gap between reality and knowledge: an update on the current state of medium-sized and large shark populations in the Catalan coast (NW Mediterranean)."

[15h30] - **S. Fowler** - "Trends in Sabah's shark and ray landings, 1996-2018."

[15h45] - **C. Rodríguez-Cabello** - "Synopsis of chondrichthyans in Spanish waters: a review."

[16h00] - **Coffee break**

Session: Conservation and fisheries management II

Session chairs: Alex Bartoli & Miguel Pais

[16h30] - **J. Richardson** - "Species-specific reporting in Falkland Island skate fisheries."

[16h45] - **C. Junge** - "Sharks and fisheries in Norway - now and then."

[17h00] - **I. Zanella** - "Scalloped hammerhead shark sanctuary Golfo Dulce: community and science generating an effective management."

[17h15] - **A. Barash** - "The MECO project (Mediterranean Elasmobranch Citizen Observations): using social media to create a regional database of elasmobranch observations."

[17h30] - **A. Hood** - "Progress and priorities: elasmobranch conservation through RFMOs."

[17h45] - **P. García-Salinas** - "Bycatch recovery in public aquaria: use in ex situ conservation of oviparous elasmobranchs."

[18h00] - **M. Laterveer** - "Reintroduction of critically endangered sharks and rays through breeding: feasible or not? A pilot programme."

[18h15] - EEA Annual General Meeting (**EEA members only**)

[19h15] - **Typical Portuguese "Ice Breaker"** (Must attend! Bring your badge and APECE cup)

Day 2 - 13th of October

Session: Evolution

Session chairs: Claudia Junge & Gavin Naylor

[09h00] - **Gavin Naylor** (Keynote speaker) - "The Chondrichthyan Tree of Life - 400 million years of independent evolution."

[10h00] - **Julia Türtscher** - "The evolutionary history of the tiger shark, *Galeocerdo cuvier*."

[10h15] - **Patrick Jambura** - "The potential fate of the thresher shark - a fossil tale of an alopiid-like shark."

[10h30] - **Lisa Locatello** - "Sexual selection drives divergent patterns of selection on sperm flagellum length in sharks and rays."

[10h45] - **Coffee break**

Session: Environmental effects and stress assessment

Session chairs: Claudia Junge & Gavin Naylor

[11h15] - **Ana Colmenero** - "Is the increase of the pelagic stingray *Pteroplatytrygon violacea* on the beaches of the northwestern Mediterranean Sea due to climate change?"

[11h30] - **Maria Rita Pegado** - "Physiological responses of whitespotted bamboo shark juveniles exposed to ocean acidification."

[11h45] - **Marisa Vedor** - "Physiological constraints of vertical behaviour of two oceanic top predators in the oxygen minimum zone."

[12h00] - **Tania Pelamatti** - "Are oceanic manta rays exposed to the threat of plastic pollution?"

[12h15] - **Francesca Reinero** - "Trace elements concentration in vertebrae of lesser spotted dogfish (*Scyliorhinus canicula*) from central Mediterranean sea (Italy)."

[12h30] - **Paulo Torres** - "Mid-Atlantic elasmobranchs: Suitable metal scouts?"

[12h45] - **Alba Martín-Lázaro** - "Unknown combinations: pollutants, parasites and elasmobranchs."

[13h00] - **Lunch break**

Session: Elasmobranch Biology and Ecology I

Session chairs: Alexandre Marques & Luís Alves

[14h00] - **Nicolas Pinte** - "Aerobic and anaerobic metabolism could be related to swimming capabilities of deep-sea sharks?"

[14h15] - **James Thorburn** - "Short term gender and seasonal variation in depth habitats and diving patterns of a 'coastal' shark species."

[14h30] - **Jenny Bortoluzzi** - "Changing tides: contrasting spatial dynamics of two sympatric shark species at a remote coral atoll."

[14h45] - **Ivo da Costa** - "Thermocline influence on vertical behaviour of marine predators."

[15h00] - **Haley Dolton** - "Assessing the significance of Isle of Man waters for the migratory basking shark (*Cetorhinus maximus*)."

[15h15] - **Manuel Dureuil** - "Important habitats of threatened and data deficient elasmobranchs in Cabo Verde, West Africa."

[15h30] - **Coffee break**

[16h00] - **Poster corner**

Session: Elasmobranch Biology and Ecology II

Session chairs: Alexandre Marques & Luís Alves

[16h30] - **Saoirse Pottie** - "Site fidelity and distribution of zebra shark, *Stegostoma fasciatum*, in the Mozambican Channel."

[16h45] - **Andres López** - "Fidelity of the whitetip shark (*Triaenodon obesus*) in Chatham and Wafer bays, Isla del Coco National Park, Costa Rica."

[17h00] - **Kristina Loosen** - "Predictors of white shark *Carcharodon carcharias* presence at two recreational beaches in a major metropole."

[17h15] - **Valentina Scarponi** - "Predator personalities: the relationship between personality and spatial use of the foraging landscape in an apex predator."

[17h30] - **Jaime Penadés-Suay** - "New evidence on deadly interactions between juvenile swordfish and blue sharks (*Prionace glauca*)."

[17h45] - **Stephanie Spinks** - "Trophic ecology of the elasmobranchs *Galeus melastomus* (Rafinesque, 1810) and *Galeus atlanticus* (Vaillant, 1888) (Chondrichthyes) in the Mediterranean Sea."

[18h00] - **Edgar Becerril-García** - "General observations from a deceased whale shark: Defining protocols during stranding events."

[20h00] - **Gala dinner & Traditional EEA auction**

Day 3 - 14th of October

Session: Elasmobranch Biology and Ecology III

Session chairs: Nuno Queirós & Nuno Vasco Rodrigues

[09h00] - **Ethan Coll-Calvo** - "Feeding habits and trophic position of the endemic speckled ray (*Raja polystigma*) in the western Mediterranean Sea."

[09h15] - **David Ruiz-García** - "Daily movement patterns undertaken by stingrays determined through aerial video-surveillance in SE Australia: applications in ecology & conservation."

[09h30] - **Nathalie Porsiel** - "An approach to explain weird behaviour of juvenile Munk's devil ray (*Mobula munkiana*) along the coastal areas of Gulf of Santa Elena and Punta Descartes, Costa Rica."

[09h45] - **David Jiménez-Alvarado** - "Rays of paradise: Ecology and distribution of the Spiny Butterfly Ray in Gran Canaria, Canary Islands."

[10h00] - **Pauline Lapostolle** - "Rays in Malta- where and when to find them and what we need to consider for management."

[10h15] - **Ana Sobral** - "Photo-identification as a tool for the study of mobulid ray populations in the Azores."

[10h30] - **Coffee break**

Session: Elasmobranch Biology and Ecology IV

Session chairs: Nuno Queirós & Nuno Vasco Rodrigues

[11h00] - **Barak Azrieli** - "Describing biological parameter, habitat use and growth rates of the Blackchin guitarfish (*Glaucostegus cemiculus*) while in a nursery ground."

[11h15] - **Joanna Barker** - "Development of a new acoustic tagging methodology to track Critically Endangered Angelsharks."

[11h30] - **Jessica Rudd** - "Using multi-channel electronic biologging to describe the spatio-temporal occurrence and energetics of breaching behaviour in basking sharks."

[11h45] - **Jorge Fontes** - "New non-invasive attachment and multisensor towed tags for short-term high resolution tagging of deep-diving pelagic sharks and rays."

[12h00] - **Clemency White** - "25 years of tracking: Using long term datasets to infer ontogenetic shift in the lemon shark, *Negaprion brevirostris*, and conservation implications."

[12h15] - **Laurent Duchatelet** - "A microsatellite marker approach of the reproductive strategy in two lanternshark species, *Etmopterus spinax* and *Etmopterus molleri*."

[12h30] - **Fenella Wood** - "Environmental DNA (eDNA) as an ecological tool for locating Angelshark (*Squatina squatina*) nursery sites."

[12h45] - **Best presentation awards**

[13h15] - **Closing remarks**

Alex Bartolí (EEA president) &

Luís Alves (APECE president & EEA2018 Chair)

KEYNOTE

The Chondrichthyan tree of life – 400 million years of independent evolution

by

Dr. Gavin J. P. Naylor

Director Florida Program for Shark Research, University of Florida, USA



Dr. Naylor's research interests encompass exploration of the biodiversity chondrichthyan fishes, phylogenetic inference, protein folding, molecular evolution and the origin of architectural novelty. While seemingly diverse, these topics reflect different facets of an abiding interest in a single issue: understanding how changes in the genome give rise to new features over the course of evolution. If we are to understand how changes in the genome gives rise to new traits, we ideally need to look at the architectural blue-prints immediately before and after the change took place to identify the genomic elements responsible for the novelty. This is hard to do in biology as we rarely have the opportunity to catch trait evolution in action. However, arranging the organisms according to their phylogenetic relationships can tell us the likely ordering of the evolution of traits, and comparing the genomes of a range of organisms in a phylogenetic context, can give us insights into the modifications associated with the origin of new features. Clearly, accurate estimates of phylogenetic relationships are a fundamental prerequisite for understanding the genomic patterns and associated process responsible for the evolutionary origin of new traits.

Oral presentations

Session 1.

Conservation and fisheries
management

Narrowing the gap between reality and knowledge: an update non the current state of medium-sized and large sharks in the catalan coast (NW Mediterranean)

Ignasi Nuez^{1,2}, Manel Gazo^{1,2}, Lluís Cardona¹

¹Department of Evolutionary Biology, Ecology & Environmental Sciences - Universitat de Barcelona, Avinguda Diagonal 643, 08028 Barcelona.

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In order to gather information on the current state of the still existing shark populations and the impact fisheries have had on them, a survey of over 30% of the fishing fleet operating in the Costa Brava (NE Catalonia) was conducted between October 2016 and November 2017. A total of 44 interviews were carried out on trawlers (72,1%), surface longliners (4,7%) and bottom longliners (14%). Skippers and fishermen were asked about identification of 8 shark species - *Alopias vulpinus*, *Prionace glauca*, *Hexanchus griseus*, *Isurus oxyrinchus*, *Cetorhinus maximus*, *Squalus acanthias*, *Mustelus mustelus* and *Galeorhinus galeus*, their frequency, seasonality and factors influencing captures, perception on shark population evolution as “increasing”, “stable” or “decreasing” and drivers of population declines. Results showed that late spring and summer encompassed most of the shark captures- 58%, 49% and 40% in trawlers, bottom longliners and surface longliners respectively. When combining all shark species and fishing gears, most fishermen thought populations were “decreasing” (47.5%) or “stable” (43.2%). *A.vulpinus*, *I.oxyrinchus*, *C.maximus*, *S.acanthias* and *G.galeus* were found to be in decline, whereas *P.glauca* and *H.griseus* were mostly considered to have stable populations. The frequency to which fishermen captured 0 individuals of any of the 8 species was 73,5% last year. *Spatial overlap* (47,5%) and *attraction to fishing activity* (31,4%) were the two factors that best featured the decline in non-protected shark populations, whereas *overfishing* (27,5%) represented the main cause of decline in protected species (*A.vulpinus*, *I.oxyrinchus*, *C.maximus*, *S.acanthias*, *G.galeus*). Results of this study suggest a reduction in the abundance of all species except for *P.glauca* and *H.griseus*, stresses the fact that *S.acanthias*, *M.mustelus* and *C.maximus* are barely caught anymore and calls for the implementation of up-to-date management measures to revert this trend in agreement with local fisheries, as fishing proves to highly affect the viability of shark populations.

Trends in Sabah's shark and ray landings, 1996-2018

Mabel Manjaji Matsumoto¹, Sarah Fowler²

¹ Senior Lecturer & Head of the Endangered Marine Species Research Unit (UEMS), Borneo Marine Research Institute, Universiti Malaysia Sabah, Sabah, Malaysia

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A fish market survey carried out in Sabah, North Borneo, during 1996-97 produced the first baseline for sharks and rays landed in this east Malaysian state. Twenty years later, the Save Our Seas Foundation funded a follow up study to assess changes in species composition and abundance in markets, and contribute to the development of state and federal conservation and fisheries management policies for sharks and rays. Rapid Fisheries Assessment by Market Survey (RFAMS) protocols and log abundance data analyses were applied to compare baseline and current records. Following significant taxonomic changes, 95 species are recorded from Sabah. The majority of elasmobranchs recorded in both surveys were captured in 'take-all' trawl fisheries. We will present the major changes in species composition observed at landings sites and fish markets. Large bodied species of sharks and rays were dominant during the original survey, but are rare today. Small-bodied species, some of which may have been discarded at sea during the 1990s, are now common.

Synopsis of chondrichthyans in Spanish waters: a review

Cristina Rodríguez-Cabello¹, Francisco Sánchez¹, José Carlos Báez², Rafael Bañón³, Alberto Brito⁴, Jesús M. Falcón⁴, Toño Maño⁵, Jorge Baro⁶, David Macías⁶, María José Melendez⁶, Antonio Camiñas⁶, Alberto Arias-García⁷, Juan Gil⁸, Carlos Farias⁸

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In 2015 a request of the Spanish Ministry of Agriculture, Fisheries, Food and Environment joined a group of fish experts to provide a reference list of marine fish species according to five regions (marine demarcations) established in the Spanish Law 41/2010 on the protection of the marine environment. Data were compiled from different sources: primarily based on lists of species observed in the scientific research surveys carried out annually by the Spanish Institute of Oceanography (IEO) in different geographical areas. Also from surveys performed in other specific projects such as INDEMARES project (www.indemares.es). Furthermore, an active search of updated citations from the last years was performed. In this study we provide the list of chondrichthyan species reported in Spanish jurisdictional waters and compare this checklist among bio-geographical areas. A total of 131 chondrichthyans have been reported from Spanish waters, which comprise the 12.2 % of total marine fish (1066 species).

The marine demarcation with highest number of species is the North with 98 species, including those confirmed, (89) and not confirmed (9), and the lowest the LEBA demarcation (Mediterranean Sea) with 70 species. Nevertheless, the marine areas with highest number of species per area are Spanish coast of the Gulf of Cádiz and the Strait of Gibraltar - Alboran Sea. (ESAL). The similarity index indicates that the Canary Islands demarcation (CAN) is by far the most different one in terms of species, whereas the two Mediterranean demarcations ESAL and LEBA are those which show higher similarity. The orders with more fish species distributed in all demarcations are the Rajiformes, Carcharhiniformes and Squaliformes however some variations exist among areas. A total of 37 species are shared by the five demarcations.

Species-specific reporting in Falkland Island skate fisheries

Thomas Farrugia¹, John Richardson²

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The Patagonian shelf and slope waters surrounding the Falkland Islands are a global hotspot for skates, supporting high biodiversity and abundance. Falkland waters also host one of the few commercial target fisheries for skates in the world. A ‘foreign fleet’ fishing industry model is utilised, with management of the skate fishery requiring close collaboration between the *Falkland Islands Fisheries Department* (FIFD) and local and overseas industry partners. The fishery is currently managed as a single multispecies assemblage; skate are winged and skinned at sea, and recorded under RAY/SRX/*Rajidae/Skates and rays*.

Accurate species-specific reporting is central to the sustainability of skate fisheries. As well as generating baseline data on species abundance and distribution, it enables detection of changes in large, often complex skate assemblages. In 2016 the Shark Trust began working with the FIFD to develop species-specific ID materials for skate encountered in Falkland waters. The initial pilot project focuses on skates caught in the longline fishery for Patagonian Toothfish *Dissostichius eleginoides*.

The Shark Trust has long championed species-specific knowledge as the platform for effective management. The Trust has extensive experience working with a broad range of stakeholders in the research and development of identification materials. In 2006 the Trust developed the first industry-focused species-specific skate ID Guides. In 2008, following lobbying by the Shark Trust, the UK government implemented mandatory species-specific reporting of skate and ray landings – a move echoed by the European Commission in 2009. By working closely with the FIFD in the development of practical, multilingual ID materials, it is hoped that species-specific reporting can be implemented for skate bycatch in the Patagonian Toothfish fishery, with the potential to expand into other fisheries.

Sharks and Fisheries in Norway – now and then

Claudia Junge¹, Marlén Knutsen¹, Ole Thomas Albert¹

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Fishery has a long tradition in Norway and plays an important role not only in the country's economy but also in its culture. To date, there is no targeted commercial fisheries for cartilaginous fishes in Norway, however several species are being caught as bycatch in other fisheries, some once targeted themselves. Among those, the spurdog (*Squalus acanthias*) and the porbeagle shark (*Lamna nasus*) are of particular interest for fisheries, and have both been commercially caught in Norwegian waters in the past. Historically, basking sharks (*Cetorhinus maximus*) have been targeted for their livers to produce oil, and their current population status in Norway is unknown. This talk will give a short overview of the fisheries for those three species in the past and the status today, and then focus on one of the species in more detail, the spurdog. Spurdogs underwent population collapses in the recent past throughout large parts of the Atlantic due to overfishing. Our very comprehensive study including over 4,000 spurdogs from Norwegian waters investigated various life history traits, which are crucial for effective species management, and found among other things a much shorter generation time today than previously has been reported, i.e. pre-collapse. This signal is consistent with such events and we also found evidence for a recovering population based on fisheries and survey data. We are using a multi-disciplinary approach to investigate the spurdog as well as other cartilaginous species in Norwegian waters to provide sound data for research-based sustainable management.

Scalloped Hammerhead Shark Sanctuary Golfo Dulce: Community and Science Generating an Effective Management

Ilena Zanella¹, Andrés López²

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The scalloped hammerhead, *Sphyrna lewini*, is specifically threatened by human activities, including targeted fishing. The abundance of *S. lewini* in Isla del Coco National Park, Costa Rica, has decreased by approximately 45% in 21 years. In 2008 the IUCN Red List classified *S. lewini* as Endangered, and in 2013 it was included on the CITES Appendix II list. In the Eastern Tropical Pacific, *S. lewini* is protected in oceanic islands, but a lack of conservation effort in coastal and nursery areas exists, leaving the future population source vulnerable. The aim of this project is to identify and protect coastal critical habitats (such as nursery areas) in Golfo Dulce, Costa Rica. The project started in 2010 and had the following phases: 1) 2010. Collection of Ecological traditional knowledge; 2) 2010-12. Identification of critical habitats in Golfo Dulce; 3) 2012-2016. Study of the residence and fidelity of *S. lewini* in critical habitats identified; 4) 2017. Elaboration of a proposal for the protection of *S. lewini* in Golfo Dulce. Thanks to the collection of fisheries-dependent biological data and acoustic telemetry, we identified critical habitats for newborns and juveniles of the specie in Golfo Dulce. We estimated the spatio-temporal distribution of *S. lewini* in the Gulf and the residence on each habitat (using the Residence and Attendance Index). Based on these results, we started a process with the local fishermen of Golfo Dulce and the support of the Ministry of Environment and National Institutions of Fisheries, to elaborate strategies for the protection of *S. lewini*. In May 2018 the Government of Costa Rica declared the Wetlands of Golfo Dulce as the Scalloped Hammerhead Shark Sanctuary, the first shark sanctuary of Costa Rica. Now, we work with the Government and communities to promote education, trainings and alternatives base on a “blue economy.”

The MECO project (Mediterranean Elasmobranch Citizen Observations): using social media to create a regional database of elasmobranch observations

Adi Barash^{1,2}, Shira Salingre^{2,3}, Ya'ara Grosmark², Shevy Rothman^{3,4}, Vasileios-Orestis Stoilas⁵, Mary Maximiadi⁵, Sezginer Tuncer⁶, Matthieu Lapinski⁷, Ignasi Nuez⁸, Rigers Bakiu^{9,10,11}, Periklis Kleitou^{5,12,13}, Ioannis Giovos⁵

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⁷AILERONS Association, University of Montpellier, France.

⁸SUBMON® – Awareness, study and conservation of the marine environment, Spain.

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¹⁰Albanian Center for Environmental Protection and Sustainable Development, Albania.

¹¹Albanian Academy of Sciences, Albanian Young Academy, Albania.

¹²Marine and Environmental Research (MER) Lab Ltd, Limassol, Cyprus.

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The alarming state of sharks and rays in the world and specifically in the Mediterranean Sea is well known. In order to create effective conservation plans, basic ecological data such as distribution, and abundance are needed. For elasmobranchs, a large gap currently exists between the risk assessments and the basic ecological knowledge, though crucial in identifying important areas of high diversity, and keystone or endangered species.

The MECO project aims to diminish this gap, by utilizing social media. Local scientists are searching the media, contacting the public and creating a large, verified database of elasmobranchs observations.

Initial results from Israel and Greece reveals differences in species composition and seasonality. Data collected from underwater observations yield species richness of 11 in Israel (1024 records) and 19 in Greece (80 records). While in Israel the species richness has remained constant for the last four years, in Greece it is still rising as the project runs for less than 2 years. The most common taxa in Israel were *Dasyatis* spp. (30%), *Taenurops grabatus* (25%) and *Himantura* spp. (16%). In Greece *Dasyatis* spp. comprised most observations (55%) followed by *Gymnura altavela* and *Torpedo marmorata* (7% each).

The most observed species *Dasyatis* spp. showed a peak in observations in Israel around May-June followed by a smaller peak in October while in Greece the main season was June to August.

Observations from fishermen and ports included additional deeper species, adding 9 species in Israel (128 records) and 20 in Greece (336 records). *Hexanchus griseus* was the most reported species in Greece and was observed throughout the year.

The initiative is spreading around the Mediterranean, with scientists from several countries, including Turkey, Spain, France, and Albania recently joining the MECO project. We hope our initiative to further grow, shedding light on the status of the Mediterranean elasmobranchs.

Progress and Priorities: Elasmobranch Conservation through Regional Fisheries Management Organisations

Ali Hood¹

¹*The Shark Trust, UK.*

For the many sharks and rays that are fished by multiple countries, the international actions by Regional Fisheries Management Organizations (RFMOs) have the potential to swiftly safeguard species throughout their ranges. The sharks and rays of the Atlantic Ocean and Mediterranean Sea are particularly beleaguered. International and domestic fisheries management improvements are urgently needed to protect these vulnerable species from overfishing and finning.

Working as a partner of the Shark League for the Atlantic and Mediterranean (a collaboration of Shark Advocates International, Ecology Action Centre, Project AWARE and the Shark Trust) the Trust has been working to deliver shark and ray catch limits that align with scientific advice; strict protections for endangered species; and strong, enforceable bans on shark finning.

This presentation will consider the progress and current priorities for Atlantic and Mediterranean RFMOs – addressing issues that influence the future of some of the most threatened elasmobranch such as the angel sharks and guitarfishes; the most heavily fished species such as Blue Sharks; and the oldest vertebrate on the planet – the Greenland Shark. We will consider where there is potential for sustainable management, the science behind advice for strict prohibitions, and the need for development of bycatch mitigation measures. The challenges posed by aggregated landings data which represents over 80% of the landings (2012-2016) from Mediterranean fisheries will also be explored. Finally we will look at the complementary role that can be played by Multilateral Environmental Agreements such as Convention on International Trade in Endangered Species of Wild Fauna and Flora and the Convention on the Conservation of Migratory Species of Wild Animals.

Bycatch recovery in public aquaria: use in *ex situ* conservation of oviparous elasmobranchs

Pablo García-Salinas^{1,2}, Francisco Javier Aznar³

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²Fundación Oceanogràfic, València. Spain.

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Public aquaria may have a crucial role in *ex situ* conservation through the use of their resources and facilities as part of its commitment to biosphere preservation. The effectiveness of an *ex situ* conservation strategy is evaluated in the present study using bycaught elasmobranch eggs belonging to two ubiquitous model species, *Galeus melastomus* and *Scyliorhinus canicula* obtained from bottom trawlers. The eggs were obtained following six different experimental treatments that accurately imitate future putative situations in which the fishermen might be involved: 1) eggs removed from dead females onboard, 2) eggs removed from viscera kept in water until its extraction on land, 3) eggs removed from viscera kept on the deck until its extraction on land, 4) eggs removed on land from dead females kept in water, 5) eggs extracted on land from dead females kept on deck, 6) eggs recovered from the fishing gear and other substrates.

The eggs were transported to "Oceanogràfic" where effectiveness of each experimental treatment was determined by studying: egg viability, embryo survival and development, and growth curves.

A total of 396 eggs were studied. An average of 62,1% from both species, had a positive development. The survival rate during the experiment was 61,1% in *G. melastomus* and 81,8% in *S. canicula*, being the survival rate independent of the different procedures to which the eggs were treated. The embryo development was normal, with growth curves similar to those obtained from previous reports.

The data obtained proves that egg recovery from bycatches is a feasible procedure for eggs extracted from dead females and for those obtained from the fishing gear. The use of a public aquarium to conduct *ex situ* conservation would ensure the availability of technical and human resources to reduce costs while maximizing the extent of the conservation message to the visitor.

Reintroduction of critically endangered sharks and rays through breeding: feasible or not? A pilot programme

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Worldwide, 25% of all sharks and rays are threatened with extinction (IUCN 2016, Red List of Threatened Species). In European waters, more than 30% of species are endangered. At the beginning of the 20th century, elasmobranchs were frequently found in the Dutch North Sea. Ten out of the twenty shark and ray species that still occur in the North Sea are on the IUCN Red List of threatened species and their habitats are not protected. The angel shark (*Squatina squatina*) and the shagreen skate (*Leucoraja fullonica*) are probably extinct in the Dutch North Sea.

Some populations have disappeared or decreased to such an extent that natural recovery does not seem feasible. Reintroducing sharks and rays which are (locally) extirpated in the North Sea such as the angel shark and the common skate (*Dipturus batis* complex) could possibly be the only way to reinstate these species in Dutch waters.

In 2015, WWF Netherlands and 4 other NGO's started an innovative unique project investigating possibilities for a reintroduction program of endangered eligible North Sea sharks and rays. Pilot species is the thornback ray (*Raja clavata*), still quite rare in Dutch waters.

So far, 300 thornback ray eggs have successfully been reared at the breeding center Blue Linked, which is equipped to breed sharks and rays just for conservation purposes, 300 more will follow until 2019. Both the breeding and the reintroduction programme are set up in accordance with the IUCN Guidelines for Reintroductions and made visible to the public.

The first 30 thornbacks (around 9 months old) were released in October 2017. In order to individually follow released animals, thirty rays did get acoustics tags (VEMCO) in 2018.

The next step will be to breed more endangered shark and ray species such as the common skate and the angelshark. International cooperation is currently being set up and regarded vital for a successful program.

Other pillars of this programme are education, bycatch mitigation, and supporting the establishment of marine reserves in collaboration with all Dutch stakeholders.

Session 2.

Evolution

The evolutionary history of the tiger shark, *Galeocerdo cuvier*

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The tiger shark *Galeocerdo cuvier*, one of the largest predatory sharks in today's oceans, has distinctively notched and serrated teeth, which allow it to cut out pieces of its prey and even crack open shells of sea turtles. It is the only extant species of this genus and has a fossil record extending back at least into the late Miocene (~5 Ma). The fossil record of the genus, however, reaches back even further into the early Eocene (~56 Ma). During the last 200 years, more than sixty fossil species were described based on isolated teeth, with some species even based upon a single tooth. About twenty of these species are still considered valid, among them the well-known Miocene tiger shark *Galeocerdo aduncus*.

Theories about the origin of the living tiger shark, *Galeocerdo cuvier*, his direct ancestors and closest extinct relatives were frequently discussed in the past years, but the history of this exceptional shark still remains obscure.

We compared nearly five hundred teeth of several tiger shark species using geometric morphometrics to investigate significant morphological variations and to verify the validity of the examined species. The clustering of the specimens on the morphospace clearly demonstrated the presence of different species, as well as an ontogenetic shift of tooth morphology in extant juvenile and adult tiger sharks. Our results provide new information about the ambiguous evolutionary history of the tiger shark and suggest that the origin of the extant species *Galeocerdo cuvier* lies back more than twice as long as previously thought.

These data greatly augment our understanding of the complex evolutionary history of this iconic shark lineage, which has been very successful for the last 56 million years but is facing many threats today due to human activities and therefore should be a priority target for future conservation efforts.

The potential fate of the thresher shark - a fossil tale of an alopiid-like shark

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Extant sharks of the order Lamniformes show a relatively low taxonomic diversity (15 species) but display a remarkably varied and specialised set of morphological and ecological traits (high ecomorphological disparity). This reflects the evolutionary history of this group, which diversified and flourished through the Cretaceous and Paleogene (145 mya to 23 mya), bringing forth a high diversity of species, which later declined during the Neogene (23 mya to 2.5 mya).

†*Haimirichia amonensis*, a lamniform shark from the Cretaceous period, was recently only known from teeth and a partially articulated skull. A high cranium width/cranium length (CW/CL) ratio and the occurrence of specialized dermal denticles embedding electrosensory ampullary organs led the authors to the conclusion that †*H. amonensis* developed a novel ecomorphological specialization within the Lamniformes, allowing it a lifestyle similar to the whitetip reef shark (*Triaenodon obesus*) today.

This hypothesis is challenged by a new find of an extraordinary preserved articulated specimen, which's caudal fin resembles the iconic morphology of today's thresher sharks (Alopiidae). For our study, we compared the caudal fin shapes of nine selected carcharhiniform and ten lamniform sharks (including the whitetip reef shark and all three thresher sharks) with †*H. amonensis*, using geometric morphometrics. Although the position within the morphospace, as generated by the PCA (principal component analysis), confirm an alopiid like caudal fin, the pre-caudal length:caudal fin ratio does not support this. Therefore, our results enforce the idea of a unique ecomorphological specialization for this species. By reconstructing its palaeoecology and comparing past abiotic and biotic factors with today's environment, we are giving a potential outlook for today's sharks (in- and excluding human activity) and their future conservation.

Sexual selection drives divergent patterns of selection on sperm flagellum length in sharks and rays

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Postcopulatory sexual selection is a powerful selective force commonly credited with driving the extraordinary diversification of sperm morphology observed among species. In particular, sperm from multiple males often compete for fertilizations (i.e. sperm competition), which is hypothesized to generate selection on sperm morphology, sperm production efficiency, and increased rates of evolutionary diversification in sperm form. However, contradictory empirical results and limited taxonomic scope has led to vigorous debate about how sperm competition influences the evolution of sperm morphology. Here, we use phylogenetically controlled analyses to explore the evolutionary diversification and variance in sperm morphology traits in two basal vertebrate groups, the sharks and rays. Our analyses reveal divergent patterns of selection on sperm flagellum length in both groups. In sharks, species experiencing greater levels of sperm competition produce sperm with longer and less variable flagella, while in rays, sperm flagellum length decreased and head and midpiece variance increased with the level of sperm competition.

Across elasmobranchs, sperm flagellum length exhibited elevated rates of evolutionary diversification compared to sperm head and midpiece length. Our findings demonstrate that the flagellum is an important target of sexual selection in elasmobranchs and provide insight into patterns of selection on the ejaculate in basal vertebrate lineages. More broadly, these results may contribute to expand our knowledge on elasmobranch reproductive strategies, a key step to develop effective programs for the conservation and management of this threatened group of fishes.

Session 3.

Environmental effects
and stress assessment

Is the increase of the Pelagic Stingray *Pteroplatytrygon violacea* on the beaches of the northwestern Mediterranean Sea due to climate change?

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The Pelagic Stingray (*Pteroplatytrygon violacea*) belongs to the family Dasyatidae. It has a circumglobal distribution and occurs in pelagic oceanic waters. According to the literature, this species mate in spring and females move inshore during summer to have their offspring. Their diet is based on small fish and cephalopods.

During summer of 2018 many of these rays have been observed on different beaches of the northwestern Mediterranean Sea. Although in previous years some specimens were reported, this year the presence of these rays on the beaches has been massive. During spring, a reproductive and feeding study of this species was carried out and during summer, given the increase in sightings, their presence on the beaches was monitored and the water temperature of the study area was recorded.

The results showed that in the spring the gonads were not yet fully developed for mating and their diet was based mainly on gelatinous plankton and crustaceans associated with salps, something unusual according to the available literature.

During the monitoring period, between July and August, more than 150 specimens were recorded on different beaches of the northwestern Mediterranean Sea. Although most of the observations were of females, males were also recorded and in some cases males and females were seen mating. These sightings confirm the delay in the reproductive period observed in spring. This phenomenon is probably related to the thermal anomalies found in the study area, where an extend of the winter period was observed; with lower temperatures than normal in spring, and a consequent delay of the spring.

Although the pelagic stingray is currently assessed by the IUCN as Least Concern in the Mediterranean Sea, it is recommended to monitor this species since according to our results it can be strongly affected by changes in oceanographic conditions.

Physiological responses of whitespotted bamboo shark juveniles exposed to ocean acidification

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Ocean acidification is expected to change the ocean's chemistry for future generations and has been concerning the scientific community. Among other effects, it may cause physiological disturbances in the organisms and threaten marine ecosystems as we know them. Thus, it is essential to understand which species might be tolerant and which might be susceptible to these changes. As top predators, sharks are extremely important for the oceans, their top-down control helps maintain their environment's structure. In addition to the already occurring changes in the food-web and anthropogenic pressure from fishing, sharks may also have to deal with the direct effects of ocean acidification. Hence, the purpose of this study was to investigate the potential impacts of ocean acidification on the physiology of juvenile whitespotted bamboo sharks (*Chiloscyllium plagiosum*). After 45 days of acclimation, that began immediately after hatching, sharks were randomly assigned to one of two treatments: control (pH = 8.0) or acidification (pH = 7.7), according to the pH levels expected by the end of the century (pCO₂ ~ 900 μatm). Several ecologically important traits were tested, namely the growth rate, weight rate, ventilation rate, swimming time, Uburst, the fulton index and hepatosomatic index. According to our results their physiology remained mainly unchanged by the exposure to a lower pH. Over the past 400 million years, these cartilagenous fish have been coping with oscillations in the seawater chemistry and thus appear to be resilient to ocean acidification. Nonetheless, these are preliminary results based on a short-term acclimation period and further investigation is needed to determine the potential correlating effects of warming and ocean acidification expected to occur in the future.

Physiological constraints of vertical behaviour of two oceanic top predators in the oxygen minimum zone

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Oxygen Minimum Zones (OMZs) are hypoxic layers delimited vertically by sharp oxyclines present in several regions of the World's oceans. Off Cape Verde, in the eastern tropical Atlantic (ETA), a resident OMZ is found between 200 and 700 m depth, reaching minimum core oxygen levels of 40 $\mu\text{molO}_2/\text{l}$. However, below 90 $\mu\text{molO}_2/\text{l}$ many aerobic processes are compromised and with less than 70 $\mu\text{molO}_2/\text{l}$ of dissolved oxygen in the water only few marine organisms are able to survive like cephalopods, for instance.

Oceanic top predators, such as blue and mako sharks are active swimmers with high oxygen demands. In the ETA OMZ, we observed a large vertical habitat constriction, with blue sharks doing occasional dives deeper than 600 m, while the maximum depth of mako sharks is generally lower than 500 m. Differences in behaviour may have an effect on the physiology of the organisms. We have observed a significantly higher expression of 8-Hydroxyguanosine in blue sharks than in mako sharks, suggesting a higher DNA damage in the first species. Additionally, increased activity of GPx, TAC and 8-Hydroxyguanosine was measured in blue sharks caught in the OMZ in relation to the ones caught in normoxia.

Blue and mako sharks are one of the most caught species by pelagic longline fisheries and whose population has been declining on the past decades. This study suggests sharks have an increased vulnerability in the ETA OMZ, thus effective conservation action plans are in urgent need for these species.

Are oceanic manta rays exposed to the threat of plastic pollution?

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The oceanic manta rays, *Mobula birostris*, filter big volumes of water while feeding on zooplankton. Thus, they are potentially exposed to the growing threat of plastic pollution. Ingested plastics can leach adsorbed toxic pollutants and plastic additives (e.g. phthalates, used as indicators of plastic contamination in animal tissues) that are recognized as endocrine disruptors and toxic for many species. The oceanic manta ray populations of the Gulf of California have been drastically reduced in recent decades, making the Revillagigedo Archipelago and Banderas Bay its last refuge and aggregation areas in the Mexican Pacific Ocean. Samples have been collected from the sea surface using a manta net: floating plastics were found in both areas and we determined the abundance, size and polymer composition of the plastic debris through Fourier transform infrared spectroscopy (FT-IR). Tissue samples (skin and muscle biopsies) of manta rays have been collected during scuba and freediving using a spear pole and underwent chemical extraction and subsequent analysis to measure the concentration of phthalates, organochlorine compounds and polycyclic aromatic hydrocarbons. The same compounds were also analyzed in plastics found in both areas to quantify the pollutants adsorbed on the surface of plastic debris. Measuring phthalates in manta ray biopsies is a valid non-lethal method to investigate possible plastic ingestion occurrence in this species, that is considered vulnerable to extinction by IUCN and is protected in Mexico. This research is a baseline study for plastic debris contamination in the area and for possible ingestion by oceanic manta rays.

Trace elements concentration in vertebrae of Lesser Spotted Dogfish (*Scyliorhinus canicula*) from central Mediterranean Sea (Italy)

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In addition to representing a direct threat to sharks, humans exert strong pressure on these animals, due to the continuous release of polluting elements in the water and the atmosphere. Sharks, as predators at the top of marine food chain, act as final receptors for a series of polluting elements that are regularly discharged into the sea.

The goal of this research was to delineate the heavy metals and other trace elements concentration rates in vertebrae of lesser spotted dogfish *Scyliorhinus canicula* from Central Mediterranean. A total of 75 vertebrae from 75 different spotted dogfish sharks have been collected in front of the coast of Rocchette Punta Ala (Tuscany, Italy). Trace elements concentration has been, then, analyzed with LA-ICP-MS.

Forty-six different heavy metals and trace elements were found in vertebrae. Lead, cadmium, nichel, iron, zinc, manganese, copper and arsenic were the most abundant. The concentration of trace elements and heavy metals was correlated with the sex, length and growth of the sharks. The relationship between trace elements concentration and sex was significant for lead: females accumulated more lead than males and the accumulation probably occurs through the skin and diet. As regards the correlation with the length, arsenic has been significant, increasing its concentration with the increasing of length of sharks. Probably, its accumulation occurs through respiration and diet. Finally, the correlation with the growth rate was extremely significant for zinc and manganese: both metal concentrations increase during the growth of the sharks but the accumulation of zinc occurs probably through diet and skin, while that of manganese only through diet.

As future aims, the effects of the concentration of trace elements on the immune system (in particular on white blood cells) and on some reproductive hormones of these sharks will be analyzed.

Mid-Atlantic elasmobranchs: Suitable metal scouts?

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Metals, especially As, Cd, Hg and Pb, are a source of growing concern given their potential hazards to marine fauna and human health. In this context, elasmobranchs are logical sentinels of these contaminants considering their specific life traits and high trophic levels. The goal of this study was to assess stable isotopes and metal content in *Prionace glauca* and *Isurus oxyrinchus* muscle tissue, according to sex and size, and to analyse these results within and among other species and across regions and geographical areas. Also, it was intended to discuss and evaluate their suitability, together with thornback ray *Raja clavata* and tope shark *Galeorhinus galeus*, previously studied for the same area, as marine bioindicators. *Prionace glauca* and *I. oxyrinchus* shared the same trophic level in a pelagic-based food web and did not present relevant significant differences between genders or metals, except for As. Both species accumulated As and Hg while Cd and Pb were not detected. Generally, metal content was in the same order of magnitude as previous studies, or lower when compared to other less pristine areas. Although the individuals sampled of *P. glauca* and *I. oxyrinchus* were still juveniles, one individual of *I. oxyrinchus* already presented Hg values above regulatory limits. The four studied elasmobranch species demonstrated great potential to be used as environmental sentinels, each presenting different characteristics regarding the key features that defines a good marine bioindicator, allowing long-term monitoring at different temporal and spatial scales. Considering the volcanic nature of the area, the future prospective mining activities and the possible establishment of the Transatlantic Trade and Investment Partnership (TTIP) between Europe and the USA, it is of the foremost importance to continuously monitor this Atlantic region together with its valuable marine resources.

Unknown combinations: pollutants, parasites and Elasmobranchs

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Not much emphasis has been on the effects of parasites in conjunction with pollutants in elasmobranch species. Therefore, there is an extensive need to synthesize the little existing literature, and to identify knowledge gaps and the way forward. Owing to various anthropogenic activities affecting the marine environment, persistent organic pollutants (POPs) and heavy metals are found increasingly in indifferent areas. Despite some pollutants' effects being well documented, few studies have focused on their impact on elasmobranchs. No exception to most other species on the planet, elasmobranchs interact with their immediate environment, for example the parasites that inhabit them. Regarding their diversity in elasmobranchs, the number of cestode species exceeds all of the other metazoan taxa parasitizing elasmobranchs combined. Nevertheless, hundreds of species of elasmobranchs and their complete parasite communities have yet to be examined. However, what happens when parasites and pollutants are combined? In theory, if two potentially damaging elements act together, their effect on the individual is expected to be larger. Combined experiments however have shown different results. Parasites can provoke that an almost neutral factor becomes negative. On the contrary, parasitic worms including cestodes, can bioaccumulate heavy metals from their host body, hence reducing the host's pollution levels. It has been shown in other species that parasites and pollutants might interact in indifferent ways: synergistic, antagonistic or additive. It is still vaguely known what effects parasites together with pollutants have on a given species apart from parasites becoming more important in polluted environments. However, little information is available and even less in elasmobranchs. Moreover, these few studies focus mainly on POPs and heavy metals. What would happen to parasitized elasmobranchs in an environment surrounded by these pollutants? Elasmobranchs in polluted environments could be more at risk than it was thought. Studies including all these factors should be central because their combined effect is yet to know.

Session 4.

Elasmobranch
biology and ecology

Are muscular aerobic and anaerobic metabolisms related to swimming capabilities in deep-sea sharks?

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Currently, the deep-sea sharks' ecology is still poorly known. However, a recent study has measured the swimming capabilities of several deep-sea sharks from New-Zealand giving an interesting ecological feature on these hardly reachable species. In this previous study, luminous deep-sea sharks from Etmopteridae family have a higher cruise swimming speed than non-luminous counterparts and *Dalatias licha* (luminous shark from the second family, Dalatidae). Before this result, the swimming capabilities of deep-sea sharks were only suggested by the indirect measurement of muscles metabolism showing a lower metabolism for deep-sea sharks than shallow-water counterparts. Here we investigate the aerobic and anaerobic muscles metabolism of deep-sea sharks from New-Zealand to confirm if it can really be related with the cruise swimming speed measurement obtained in the previous study. The results could also allow to find physiological adaptations for the high cruise swimming speed of Etmopteridae sharks. For that, the activities of three key enzymes (citrate synthase, malate dehydrogenase, and lactate dehydrogenase) were measured using the absorbance of their cofactors in a spectrophotometer. Results show that aerobic activities in red muscles of sharks can be related to their cruise swimming capabilities. The results are less obvious for the anaerobic metabolism in red muscles where no real significant difference appears. In white muscles, it could suggest better burst activities for the bigger sharks such as *Dalatias licha*. Finally, other metabolic pathways could participate in the swimming capabilities of shark and should be studied in future works.

Short term gender and seasonal variation in depth habitats and diving patterns of a 'coastal' shark species

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Elasmobranchs are, generally speaking, highly mobile with some species performing trans-ocean movements. As well as these wide-ranging geographic movements, many species of shark occupy a wide range of depths. These vertical movements are often in the form of daily vertical movements which are associated with feeding activities, mostly in the form of movement from shallow water at dusk, returning to deeper water at dawn. There are reported examples of 'reverse diel migrations' being reported, where deeper water is occupied at over the hours of darkness. As well as feeding, it has been suggested these diurnal cycles may also allow elasmobranchs to thermoregulate with an animal moving along a temperature gradient in order to regulate or adjust body temperature. Seasonal variation in depth has also been reported, with many species demonstrating a move to deeper waters during colder months, returning to shallower waters when it warms up. The drivers behind seasonal movement have been attributed to the reproductive cycle, temperature requirements or in response to dietary needs. An individual's habitat, including depth preference, is often governed by its sex and life history stage, leading to populations segregating by size and sex, even within local geographic areas, and may be driven by gender requirements for habitat, including temperature, and diet with some seasonal variation.

Tope (*Galeorhinus galeus*) are generally considered a benthopelagic species predominantly found in shelf waters but have been shown to display movements off the continental shelf into deeper water. Here we present findings from archival tags deployed on tope in South Scotland. A difference in diurnal migrations between the sexes was observed in some individuals over a short period of time. Diving behaviour and water column use also appeared to be different between the genders during a seasonal move to deeper water.

Changing tides: contrasting spatial dynamics of two sympatric shark species at a remote coral atoll

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Understanding how animals move around their environment is essential to manage and protect species and ecosystems effectively. Movements in time and space can be triggered by various physical, biological and environmental factors so animal-borne tags are increasingly used by scientists to collect data to track movements and establish where, and for how long, animals spend their time. Network analysis using acoustic telemetry data provides a way to study long-term, fine-scale spatial dynamics of multiple reef shark species. In D'Arros and St Joseph Atoll in the Amirantes (Seychelles), sicklefin lemon sharks (*Negaprion acutidens*) share their activity space with the smaller blacktip reef sharks (*Carcharhinus melanopterus*). Our study aims to determine how these two species co-occur at this location without apparently outcompeting each other. With these objectives in mind, 83 sharks were tracked between 2012 and 2017 using passive acoustic tags and an array of 23 acoustic receivers. The analysis considered factors such as tidal height and sex. We present findings of overlap between the two species and evidence of the tidal cycle as a driver of overlap in activity space use within the atoll. The Indian Ocean is currently data deficient in many areas of elasmobranch research and the work carried out here contributes to filling such gaps about shark space use and potential movement driver. While the studied atoll is being considered for a Marine Protected Area, this new understanding of reef shark movement ecology identified here provides us with a model that may, in turn, be applicable to similar locations in the Indian Ocean and tropical reef ecosystems globally.

Thermocline influence on vertical behaviour of marine predators

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Oceanographic features have been shown to influence the distribution and movements of pelagic predators, such as sharks and tunas. In particular, thermal fronts and the thermocline, are characterized by convergence processes with high levels of primary production which are able to sustain secondary producers and therefore attract large aggregations of marine predators. Pelagic predators are also expected to move through the environment in a manner that maximises encounter rates with prey patches. Lévy flights are a special class of random walk that may represent an optimal solution to the biological search problem in complex landscapes where preys are sparsely and randomly distributed. Nevertheless, the adaptive significance of this strategy in response to specific environmental features in the ocean is unclear. The main objective of this study was to clarify how changes in thermocline gradients (intensity, location) affect the movements and, particularly, the foraging behavior of these marine predators. Results showed that Lévy-like movements are prevalent in pelagic predators and that increases in the Levy exponent were associated with increases in thermocline strength. Furthermore, the turning points movements appeared associated with thermocline location where its distance to the thermocline also decreased with increasing thermocline intensity. Results suggest the thermocline is an important foraging area of increased prey availability where pelagic predators appeared to exhibit central place foraging-like behavior.

Assessing the significance of Isle of Man waters for the migratory basking shark (*Cetorhinus maximus*)

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Satellite tagging of mobile species can support the development of conservation strategies by revealing movement patterns, centers of residency and intra- and inter-annual site fidelity. The basking shark is considered endangered in the northeast Atlantic due to historic over-exploitation, and several key hotspots for its occurrence have been described. Satellite tracking has revealed that basking sharks exhibit inter-annual site fidelity to the western isles of Scotland in summer, but a similar assessment for the Isle of Man, thought to be another key hotspot, is currently lacking. Eleven satellite tags were deployed on basking sharks (*Cetorhinus maximus*) during the summers of 2013, 2015, 2016 and 2017 off the coast of the Isle of Man (IoM), in the British Isles. One individual was bycaught after 133 days of tracking and was subsequently removed from analysis. Ten sharks were tracked for 373 days (median duration), moving 725 km from the deployment site (median straight-line distance). During the summer, nearly half of shark core home ranges (50% kernel density) overlapped with proposed conservation zones in IoM waters ($n = 5$ that provided sufficient data for analysis). Further, analysis of 3,902 public sighting records between 2005 and 2017 revealed a similar pattern, suggesting that protective measures in IoM coastal waters could aid the conservation of basking sharks at the local, regional and international scale. Following residency in the Irish Sea, four sharks moved to Scotland until late summer/early winter and two sharks made long distance movements to Morocco and Norway respectively (the first such record). Sharks exhibited inter-annual site fidelity to the Irish Sea ($n = 3$), one shark to proposed conservation zones within IoM waters and one to the Moroccan Exclusive Economic Zone (winters of 2016 and 2017). We also detail the longest basking shark track to date (2 years 2 months; 798 days).

Important habitats of threatened and data deficient elasmobranchs in Cabo Verde, West Africa

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Cabo Verde is an island nation approximately 570 km off the west African continental coast. The area is a potential hotspots for several highly threatened, data deficient and endemic elasmobranchs (sharks, skates and rays) in the North Atlantic Ocean. However, there is an increasing exploitation pressure on these species and adequate management structures to prevent further depletion or regional extinction are largely absent. Moreover, concentrated elasmobranch research around the islands has just begun in recent years. Here we present first results of the Cabo Verde Elasmobranch Research and Conservation Project initiated in 2015. One major aim of this project is to determine important habitats, in particular by the use of passive and acoustic tags. For the first time, we present movement activities of the Atlantic weasel shark (*Paragaleus pectoralis*), a species endemic to West Africa, and discuss the importance of their core habitat with regards to other species records confirmed during this project, such as the blackchin guitarfish (*Glaucostegus cemiculus*). Acoustic tagging also revealed long-distance migrations from nurse sharks (*Ginglymostoma cirratum*) between islands resulting in new implications for the species' protection. Santa Luzia and Maio have both been identified as multi-species nursery areas with indication of scalloped and smooth hammerheads utilizing the same bay. The presented results give new insights into species' ecology and can aid future conservation strategies.

Site fidelity and distribution of zebra shark, *Stegostoma fasciatum*, in the Mozambican Channel

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Fisheries bycatch poses a serious threat to megafauna species, including many elasmobranchs believed to be important for marine eco-tourism. To assess the threats of bycatch and establish appropriate conservation regimes, it is critical to first quantify the distribution and habitat use of these species. Zebra shark, *Stegostoma fasciatum*, are an endangered species of shark found in shallow waters in the Indo-west Pacific. Their large, charismatic appearance and docile behaviour make them a popular sighting for scuba divers. Bycatch is believed to be a primary cause of the rapid population declines and local extinctions reported in Asia and Indonesia. This study is the first to analyse the spatio-temporal occurrence patterns, site fidelity and distribution of the zebra shark in Africa - prompted by the urgent need for spatial, trend and abundance information on zebra shark both nationally and globally. The study involved a combination of dedicated dive surveys, voluntary collection of information through a citizen science program and interviews with artisanal fishermen. The results of the study demonstrated that zebra sharks show long and short term site fidelity to particular reefs, yet are broadly distributed along coastal shallow areas from Pomene to Sodwana Bay. Interviews with fishermen proved an effective alternative to study the distribution of a rare, non-commercial species and helped overcome the spatial limitations of dive based surveys. This project comes at a crucial time when the national plan of action for shark and ray conservation in Mozambique is under development. The results highlight the importance of developing a more comprehensive NPOA for shark and ray protection that also protects threatened non-CITES listed sharks and rays.

Fidelity of the whitetip shark (*Triaenodon obesus*) in Chatham and Wafer bays, Isla del Coco National Park, Costa Rica

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At least fourteen species of sharks live in the Marine Protected Area of Isla del Coco National Park (ICNP), some are resident species such as the whitetip reef shark (*Triaenodon obesus*); others are migratory and visit the National Park throughout the year, e.g. the scalloped hammerhead shark (*Sphyrna lewini*) and the whale shark (*Rhincodon typus*). Between 2014 and 2016 the team of Mision Tiburon with the support of the rangers of ICNP tagged eighteen sharks with acoustic transmitters (VEMCO V16). During this period the two receivers installed in Chatham and Wafer bays had recorded approximately 250.000 detections. The data showed a very strong fidelity of the *T. obesus* to the Chatham and Wafer bays: only one shark crossed the bay, from Wafer to Chatham; some sharks demonstrated very high index of fidelity to the site (IR=0.9). The number of detections was different between sharks: for example the male "23525" transmitted near than 69,000 detections in Chatham Bay; on the other hand, another male the "23529" have transmitted 4126 detections and stay in the Wafer bay less period. We described a tendency of more detection during daylight hours in the bays (more than 70% of detections); probably related to feed aspects, since it is common to see females and males moving for hunting and feeding at night.

Predictors of white shark *Carcharodon carcharias* presence at two recreational beaches in a major metropole

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The occurrence of white sharks *Carcharodon carcharias* in the False Bay, South Africa follows a clear seasonal cycle. In the austral winter months, white sharks aggregate around Seal Island, but move to inshore areas in summer. However, the drivers of this inshore movement remain a subject of debate. Previous research identified that inshore shark sightings were higher when the water was warmer and during new moon, which led to the prediction that these conditions favour prey availability. In this study, we expand on previous research and investigate a number of environmental and biological variables, including prey availability on shark sightings at two recreational beaches in Cape Town, South Africa. A total of 1209 white shark sightings were recorded from 1 January 2006 - 31 December 2015 at the beaches of Muizenberg and Fish Hoek. We confirmed that shark sightings were clearly seasonal and sightings peaked between 17.49 - 18.57°C sea surface temperature. Fish presence revealed a similar peak at 17.94°C. Randomization tests indicate shark sightings were 66% ($p < 0.001$) more likely when prey fish were present, which supports the prediction of a prey mediated cue. Shark sightings were also influenced by ENSO with more sightings during weak negative ENSO values. These reflect weak La Niña events, which supports previous findings. In addition to providing a better understanding of the ecology of white sharks in False Bay, our results can also be used in shark safety and education programs to reduce shark-human conflicts.

Predator personalities: the relationship between personality and spatial use of the foraging landscape in an apex predator

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Individual differences in behaviour that are consistent across time or context (personalities) are ubiquitous among the animal kingdom and can have significant effects on the ecology and evolution of species. Although recent evidence suggests that elasmobranchs may display individual behavioural differences, only a few studies have investigated the occurrence of personalities in sharks in a robust and quantifiable way, leaving an important gap in our current understanding of these keystone species. White sharks are an excellent study system for investigating the occurrence of animal personalities in elasmobranchs. This threatened apex predator shows seasonal residency at pinniped haul-out sites and pupping areas like seal island in Mossel Bay (SA), therefore increasing the chance of multiple sightings of the same individuals within and between seasons. Here we assessed whether white sharks show individual differences in their foraging strategies and evaluated the relationship between their behavioural variability and spatial ecology. By comparing (i) several measures of the behavioural response of 12 white sharks to controlled, food-mimicking stimuli (tuna head and seal decoy) presented to them from a research boat and (ii) acoustic data on their residency profiles and movement patterns within the bay, we provide novel results showing that white sharks do display significant individual differences in foraging behaviour and in their spatial use of the foraging habitat. An important implication of our results is that white sharks, as individuals, will vary in their exposure to anthropogenic hazards and in their risk for human-animal conflict. This has the potential to contribute significantly to changing public perception of the species and to the development of better human protection and shark conservation strategies.

New evidence on deadly interactions between juvenile swordfish and blue sharks (*Prionace glauca*)

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Since the first report on a deadly interaction between a juvenile swordfish (*Xiphias gladius*) and an adult blue shark (*Prionace glauca*) by Penadés-Suay et al. 2017, four other similar cases have been detected. This paper describes these four new events and compares them with the available information to discuss the nature of this interaction between juvenile swordfish and adult blue sharks. On the 17th of February 2017, an adult male blue shark (TL: 236 cm) appeared stranded in the coast of Garrucha (Spain) with a swordfish rostrum inserted in its cranium. The remaining part of the rostrum measured 180mm in length and 20mm in width at the proximal end. On the 8th of March 2017 an adult female blue shark (TL: 260 cm), with an ongoing pregnancy, was stranded alive in the coast on Ostia (Italy) but died shortly afterwards. An injury posterior to the right eye revealed part of a swordfish rostrum (250mm/30mm) allocated between the eye and the cranium. On the 28th of February of 2018, an adult female blue shark (TL: 260cm) appeared stranded in the coast of Vera (Spain), with an injury anterior to the right eye. The investigators took the specimen to make some tests and found an older injury in the right nostril, keeping a piece of a swordfish rostrum embedded in its tissue. The remaining rostrum bit measured 53mm/12mm. On the 2nd of August 2018, an adult male blue shark was stranded in Manacor (Spain) with a 74mm/16mm swordfish' tip inserted in the snout. Swordfish had previously been reported driving their rostrum into pelagic sharks, allegedly as a defensive strategy. The cases presented in this conference suggests that it is a more frequent interaction than what the lack of evidence in the past suggested.

Trophic ecology of the elasmobranchs *Galeus melastomus* (Rafinesque, 1810) and *Galeus atlanticus* (Vaillant, 1888) (Chondrichthyes) in the Mediterranean Sea

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Galeus melastomus (Rafinesque, 1810) and *Galeus atlanticus* (Vaillant, 1888) are demersal catsharks species that inhabit continental shelves and upper slopes. *G. atlanticus* distribution is limited, only being found in the Alboran Sea (western Mediterranean) and in waters near the Gulf of Cadiz (Atlantic Ocean). *G. melastomus* distribution is wider, covering the eastern Atlantic Ocean from Norway to Senegal and the Mediterranean Sea. The aim of this work is to study the trophic ecology of *G. melastomus* and *G. atlanticus* in the western Mediterranean Sea. A total of 35 specimens of *G. melastomus* and 7 of *G. atlanticus* were sampled during the international MEDITS, bottom trawl survey during the spring of 2017. Additionally, 20 individuals of *G. melastomus* fished by commercial bottom trawlers in Valencia (western Mediterranean Sea) during the winter of 2018 were sampled. Stomach content was quantified and classified to the lowest possible taxonomic level. Numerical abundance of prey (% N), percentage of occurrence frequency (% O) and diversity index of Shannon-Wiener and Simpson were analysed. The results showed that *G. melastomus* and *G. atlanticus* diets were composed mainly of three categories, cephalopods, decapod crustaceans and teleost fish. For *G. melastomus*, crustaceans dominated in number followed by cephalopods and teleost fish all, between 30-36%. The same pattern was followed for the frequency of occurrence, with a 54-58% of presence. Diet varied with the size of the individual and seasonality. For *G. atlanticus*, crustaceans dominated in number with a 67.6%, and in frequency of occurrence the three groups presented the same presence with a 57.1% each. A possible overlap in the niche of both species is possible, since the biological characteristics of both are very similar. Despite this, further studies are needed. Diversity indices showed greater diversity in the diet of *G. melastomus* although limited *G. atlanticus* sample size should take into account.

General observations from a deceased whale shark: Defining protocols during stranding events

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The whale shark *Rhincodon typus* (Smith 1829) is an internationally protected species highly susceptible to the fisheries that could exist in coastal aggregation areas. In the Gulf of California, the seasonal presence of whale sharks is predictable and well studied. However, there is no published information regarding strandings, anatomical observations, or age estimations for this region. The present study aims to provide general data from the necropsy of a dead juvenile whale shark from the Eastern Tropical Pacific, with comments on its anatomy, age estimation, performed studies, and the protocol used for the rescue of scientific samples from a 6 m long shark carcass in Mexican waters. The shark was found deceased in shallow waters in La Paz, México (24.162708 N -110.401079 W) on the 16th of February 2018. The carcass was transported to the Centro Interdisciplinario de Ciencias Marinas (CICIMAR-IPN) by local environmental authorities and scientists. When found, the shark presented several marks on its head that could potentially have been caused by fishing gear. On land, pictures were taken and morphometry was performed prior to the necropsy. Probable cause of death was asphyxia provoked by fatigue. However, a more detailed investigation of the species from the necropsy work is currently on going. The importance of the implementation of a protocol for these stranding events is discussed to make an objective decision regarding the rescue of a whale shark, or to obtain scientific samples from dead individuals that could improve the study of their biology.

Feeding habits and trophic position of the endemic speckled ray (*Raja polystigma*) in the western Mediterranean Sea

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Knowing the trophic ecology of marine predators is essential to understanding their ecological role in ecosystems. Here, by combining analyses of stomach contents and stable isotope values, we examined the trophic ecology (dietary composition and trophic position) of the speckled ray (*Raja polystigma*), a Mediterranean endemic predator. Specifically, we evaluated the effects of sex and maturity-stage on its feeding habits. We also compared the trophic niche and trophic level of the speckled ray with published isotopic data of other sympatric elasmobranchs present in the ecosystem. Results revealed that the speckled ray, independently of the sex and maturity-state, mainly consume shrimps and crabs. Adult specimens also consume to a lower extent fin-fish, cephalopods, polychaetes and, surprisingly, small demersal sharks embryos. When the trophic position and niche of this ray is compared with other sympatric predators, we found that the speckled ray show similar trophic position to other crustacean-consumer elasmobranchs such rays and small demersal sharks. The results of this study provide new insights into the ecological role of this endemic ray species in the Mediterranean Sea and are of crucial importance for management and conservation of this species.

Daily movement patterns undertaken by stingrays determined through aerial video-surveillance in SE Australia: applications in ecology & conservation

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Understanding habitat utilization and animal movement patterns is essential to establish conservation plans. Batoids, the most threatened group of chondrichthyes, are among the least understood vertebrates. Their movement patterns and habitat ranges are under-researched, especially in high-energy surf zones (beaches), where traditional tracking methods are unsuitable.

We provide new insights into stingray behaviour on beaches using aerial video-surveillance, a novel, non-invasive technique which allows the association of movement patterns with habitat structure to be examined. Moreover, it provides information about interactions of the target species with other organisms. The patterns observed in Kiama Surf Beach (New South Wales, Australia) demonstrate that: (1) the studied beach is used by animals transiting between subtidal reefs, (2) adult stingrays show route fidelity and it appears to be along a bathymetric contour, (3) the movement pattern is stable throughout the day, and (4) the occurrence of stingrays within the surf zone is higher during the afternoon.

Taken together, our data highlight the importance of beach areas for batoids and indicates that to avoid habitat fragmentation, it may be necessary to prevent obstruction or alteration of beaches along which batoids transit. Therefore, *in situ* management plans for batoids should consider the preservation of these zones. Furthermore, these findings indicate that the shark nets employed in New South Wales to reduce the entrance of sharks into bathing areas, may also affect batoids indirectly. These nets may limit the access of batoids to surf zones and may alter their displacement routes.

Ultimately, this study demonstrates the usefulness of aerial video-surveillance to study movement patterns and provide behavioural information. Aerial video-surveillance may revolutionize the study of movement patterns of marine megafauna and promote the use of non-invasive methods to monitor displacement routes and habitat use.

An approach to explain weird behaviour of juvenile Munk's devil ray (*Mobula munkiana*) along the coastal areas of Gulf of Santa Elena and Punta Descartes, Costa Rica

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There are growing concerns about the conservation of mobulids worldwide as population trends, for which data exists, are decreasing with the increase of targeted fisheries on the manta and devil rays (Mobulidae). With their gill rakers being of high commercial value on markets for "traditional"(as this is a new trend) Chinese medicine (TCM), the former not economically interesting mobulids got now a worth depleting their populations. For most species of the mobulid family the ecology is poorly known. Even though they are not supposed to be able to cope with even small population depletions through their low fecundity (late sexual maturity, small litter size), is commonly agreed on. This study on juvenile pygmy devil rays, *Mobula munkiana*, was conducted to get a clue of the motivation of the juveniles coming every year to beaches on the northern Pacific coast of Costa Rica in the time of June-September. Additionally to sea water samples for the planktonic composition and the observation of the behavior of these young mobulids, some size parameters and tissue samples were taken for further information on their age/growth, genetics and they got tagged for investigation on movement patterns if recaptured.

Rays of paradise: Ecology and distribution of the Spiny Butterfly Ray in Gran Canaria, Canary Islands

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The Vulnerable (IUCN Red List) Spiny Butterfly Ray (*Gymnura altavela*) has suffered an important depletion from professional and recreational fishing pressure, taken as by-catch in both fisheries across the entire Atlantic waters including the Canary Islands. Particularly, in Gran Canaria we have an important reproduction hotspot where Spiny Butterfly Rays can be regularly encountered.

However, information on the spatial distribution patterns, population structure and abundance of these rays are almost unknown in the Archipelago. In 2017 we launched the project Rays of Paradise to expand the existing knowledge of this species in the Canary Islands, particularly on the island of Gran Canaria. Our aim is to get a better understanding of the seasonal patterns of distribution and abundance along the nearshore areas of the island. We used established citizen science programmes with online databases, coupled with underwater visual surveys, to provide basic insights into the ecology of these rays in Gran Canaria.

Our results show that Gran Canaria is an important aggregation hotspot for this species during the summer season, between May and October, however, the rays are present throughout the year. The Spiny Butterfly Ray form larger aggregations in shallow coastal areas compared to deeper areas, where they are also found. Furthermore, the density of females is higher than males as well as the size of females, which tend to be larger than males. Some areas are only visited by large females.

The information gathered in this study will allow us to better manage the habitat of this species in Gran Canaria and improve its vulnerable conservation status.

Area preferences and impact of selected factors on the occurrence of two ray species in Malta and implications for management

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The Common stingray (*Dasyatis pastinaca*) and the Bullray (*Aetomylaeus bovinus*) are commonly observed in coastal waters around Malta. Increasing human impact through tourism, coastal development, fishing and pollution require management and conservation measures for these two threatened species. For such to be effective, data on the distribution and use of habitat are crucial. Snorkel surveys conducted by Sharklab-Malta since 2011 showed temporal occurrence patterns with *A. bovinus* being spotted from May to August, which might indicate migration behaviour during winter months; compared to *D. pastinaca*, which can be observed from April to November.

A systematic studied on the occurrence within selected bays in Malta identified Golden Bay as "hotspot" for the two species, especially juveniles, indicating the use as nursery area. Correlation analysis of environmental factors showed that sighting probability of *D. pastinaca* decreases with depth and human activity, while the occurrence of *A. bovinus* appears to be positively influenced by increased water temperatures and wave height.

While these tendencies are likely to be driven by niche overlap and resources partitioning through different feeding strategies; they can certainly guide management measures for the conservation of these species by reducing human induced pressures.

Photo-identification as a tool for the study of mobulid ray populations in the Azores

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Despite their charismatic megafauna status, and importance to tourism economy, our understanding of the mobulid rays found in the Azores and the Eastern Atlantic is very limited. Considering their highly migratory nature and current vulnerability, understanding their ecology and behaviour is necessary to support sound management and conservation actions. The Azores archipelago is one of the few places in the world where large schools of *Mobula tarapacana* form predictable aggregations which provide unique opportunities to study these animals using new and non-invasive techniques. Long-term photo-identification databases have proved to be a vital tool for studying and monitoring regional and global manta ray populations. *M. tarapacana* individuals have unique ventral markings, similarly to manta rays, which lead the project to establish the world's first photo-ID database for this species. This long-term photo-ID catalog, established in 2012, consisting of photos submitted by divers, has ~150 *M. tarapacana* and ~30 *Mobula birostris* identified individuals in the region and has provided a valuable insight into population size and structure as well as aggregation dynamics. This is a clear example of the important role citizen science can play in collecting long-term data on these species. The aim of this work is to describe the spatial and temporal patterns of mobulid occurrence in the region, including their aggregation dynamics, and use these data to discuss the ecological importance of Azorean seamounts for mobulid rays.

They grow up so fast: Describing biological parameter, habitat use and growth rates of the Blackchin guitarfish (*Glaucostegus cemiculus*) while in a nursery ground

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Guitarfish are the 6th most threatened family of elasmobranchs in the world. Two species of guitarfish, Common guitarfish (*Rhinobatos rhinobatos*) and the Blackchin guitarfish (*Glaucostegus cemiculus*), were once common throughout the Mediterranean shelf. Both species have suffered severe declines and regional extirpation throughout their range due to their biology (demersal, large body, low fecundity) and habitat use (aggregation in coastal areas for mating and pupping) and are currently considered endangered according to the IUCN red list. While Israel is one of the only countries in the world in which all elasmobranch landings are prohibited, sharks, and especially guitarfish, are still being fished in the Israeli territorial waters both illegally as a targeted species as well as bycatch. Along the Israeli coastline, *G. cemiculus* neonates can be observed in coastal shallow water from the end of August until the end of November. Based on an ongoing study, one location shows especially strong evidence as a nursery ground. Since August 2017, over 400 neonates and juvenile *G. cemiculus* ranging from 23 cm to 77 cm have been captured and measured, with over 250 of these specimens being tagged with PIT tags. Based on umbilical scar presence of captured individuals, the average size at birth is 31.5 cm, with similar frequencies for males and females. Recaptured individuals experience a growth rate of 1 cm per month on average, and residence time of over 10 months at this site. The data gathered thus far supplies much-needed information regarding the species biology and habitat use and describes the use of this location as a nursery ground for this species. There is no species-specific conservation planning currently in place for *G. cemiculus* and identifying such regions will be an immense contribution for these species throughout their range.

Development of a new acoustic tagging methodology to track Critically Endangered Angelsharks

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Limited understanding of adult Angelshark (*Squatina squatina*) habitat use and movement is a major factor preventing effective protection in their last stronghold of the Canary Islands. Without this detailed ecological data, the efficacy of management decisions and conservation initiatives cannot be measured in a rigorous scientific manner. This project was developed to aid this critical knowledge gap through an acoustic tracking study in Spain's largest marine reserve, La Graciosa (North of Lanzarote, Canary Islands).

The Critically Endangered Angelshark is one of the most endangered species in European waters; they are particularly susceptible to the combined impacts of fishing and habitat degradation, due to their coastal location and biology (large, flat-bodied animals with low fecundity). In part due to their threat status, we developed a method to electronically tag adult Angelsharks underwater *in situ*, with an ethically approved external tag attachment methodology.

The Angel Shark Project brought together a collaboration of scientists, conservationists, engineers and an ethical review board, to identify the best approach to ensure minimal impact to the Angelshark. Use of a modified cattle tag at the base of the first dorsal fin was identified as most appropriate. During a meticulous development phase, stock cattle tags and an applicator were modified to gain the following key features: usable underwater; a genetic sample automatically taken during tagging procedure; tag attachment adaptable for differently sized sharks; tag holder camouflaged; built in weakpoint to ensure the shark cannot be entangled.

In July 2018, the first Angelshark acoustic telemetry project was conducted, through deployment of seven acoustic hydrophones in La Graciosa Marine Reserve and successfully fitting acoustic tags onto nine resting adult Angelsharks. A follow-up expedition is being planned to deploy a further 15 tags and through close working with Government officials, results will be used to inform management within the reserve.

Using multi-channel electronic biologging to describe the spatio-temporal occurrence and energetics of breaching behaviour in basking sharks

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Some marine vertebrates, including cetaceans, are known to “breach” – a spectacular display behaviour lunging above the sea surface. Breaching may have important roles in communication, mate-guarding, play or parasite dislodgement, but little is known of breaching behaviour in non-air breathers, such as sharks. Basking sharks (*Cetorhinus maximus*), Europe’s largest shark species, is endangered in the North East Atlantic and anecdotally known to breach. While recent tracking has explained many facets of their spatial distribution, diving and foraging behaviour, their courtship and breeding behaviour remains largely unknown. This study uses state-of-the-art satellite tracking and Daily Dairy movement tags to provide fine-scale information on the spatio-temporal variation of their breaching behaviour. Three sharks were tagged in the Hebrides, Scotland, a key regional hotspot for basking sharks in the north-east Atlantic. Sharks breached throughout the diel cycle with breaching occurring predominantly during the day. One shark breached 60 times over 32 days with up to 4 consecutive breaches in 47 seconds. Breaching is an energetically demanding behaviour for sharks compared with surface foraging; requiring over 100-fold more energy to propel themselves out of the water from up to 57 meters deep at speeds comparable to ambush breaches made by white sharks. Through multidimensional spherical representation, the daily behaviour of basking sharks is represented, highlighting the frequency and extreme energetic requirement of breaching. Should breaching play a function in courtship display, then knowing the timing and location of such behaviour may contribute towards providing adequate protection to areas supporting key life stages of an endangered species.

New non-invasive attachment and multisensor towed tags for short-term high resolution tagging of deep-diving pelagic sharks and rays

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Biologging technology has provided scientists with unprecedented tools to investigate the ecology and behaviour of marine animals, but tag deployment and attachment methods have lagged behind. Electronic tagging of elasmobranchs still essentially involves implanting anchors or drilling the fins of restrained animals. On the other hand, most biologging tools are quite specific and designed to measure and archive/transmit a narrow and specific set of variables providing a limited view of the animal's ecology and behaviour. We propose a new non-invasive approach for deploying innovative high frequency multisensor towed tags for deep diving animals that don't require restraining or manipulation of the animals, neither the attachment of intramuscular anchors. This new multisensot towed tags combine satellite tracking, 3D high frequency accelerometry, speed and imagery to unveil the behaviour of deep diving sharks and pelagic rays. The attachment of a modified fin clamp and a harness systems were tested and are being routinely used to study the fine scale behaviour and habitat use of blue sharks and chelien devil rays in the Azores, mid-north Atlantic. Examples of high frequency multisensor data combined with on-board imagery will be presented. Clamps and harnesses are fitted with galvanic timed releases (GTR) and deployed manually by a free-diver or from the boat using a harness deployment frame. The tags retention can be determined according to the GTR used. Focal observations and biologginged data suggest that both methods produce little or no adverse behavioural reaction of the animals, offering a valid alternative for short term tagging of pelagic sharks and mobulid rays.

25 years of tracking: Using long term datasets to infer ontogenetic shift in the lemon shark, *Negaprion brevirostris*, and conservation implications

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Tracking technologies serve as a tool for elucidating animal movement and behaviour when out of visual range, which is particularly useful for marine species. These methods can be used to produce a detailed baseline of space use, identify ontogenetic shift and inform conservation management. This study compiled active and passive tracking data on the lemon shark, *Negaprion brevirostris*, around Bimini, the Bahamas, between 1992-2018, providing information on space use across a broad timescale. Differences in space use were compared between sexes, life stages (neonate, juvenile, adult) and stages of industrial development (before, during, after) using dynamic Brownian-bridge movement models. Different life stages consistently show clear partitioning in space use across the past 25 years, with home range expanding with ensuing life stages. This is particularly important in neonates, who utilise small activity spaces very close to the island's fringing mangroves for protection from predators during key developmental phases. The successive increase in activity space also suggests that for protection to be effective for *N. brevirostris*, and for other species capable of long range migration, more robust temporal and spatial protection regulations are required. Furthermore, differences in space use before and after industrial development and mangrove removal suggests anthropogenic impacts are changing natural activity patterns. In the context of previous research about *N. brevirostris* life histories and considering the proposed North Bimini Marine Protected Area, this study provides a firm baseline for how populations of *N. brevirostris* use habitat and specifically how they use Bimini. This provides us with tools to better protect Bimini's *N. brevirostris* populations, as well as a starting point for conservation on a global scale.

A microsatellite marker approach of the reproductive strategy in two lanternshark species, *Etmopterus spinax* and *Etmopterus molleri*

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Genetic tool evolution allows a better understanding of reproductive strategies in various marine organisms such as sea turtle, marine mammals, fishes or elasmobranchs. Studies on reproductive strategies in shallow-water sharks using microsatellite variations become more and more popular. According to recent genetic studies, multiple paternity seems to be common within elasmobranch. Conversely, genetic relevant data about deep-sea elasmobranch are poor (i.e. *Squalus mitsukurii* and *Galeorhinus galeus*), mainly due to the difficulty to observed and collected samples from these elusive animals. Due to the lack of data, plans and long-term conservation managements are rare for these deep-sea sharks. Among them, Etmopteridae, are represented by at least 43 species. The velvet belly lanternshark, *Etmopterus spinax* is one of the most studied species mainly due to its ability to emit light (i.e. bioluminescence). Although relatively common, *E. spinax* biological data and life style is limited (i.e. lifespan, stomach content, distribution, parasitism). Comparatively, almost no data is available for the slendertail lanternshark, *Etmopterus molleri*. Most of lanternsharks are highly caught as bycatch by trawling fisheries and discarded at sea due to no commercial value. Given the relative high fishing mortality pressure and the lack of reproduction strategies, genetic diversity and population dynamics information, these lanternsharks may already be facing severe population collapses.

The aim of this work is to focus on the reproductive strategy in two lanternsharks species. We detailed the paternity in 42 litters for the velvet belly lanternshark from Norway and 7 litters for the slendertail lanternshark from Japan using 29 and 20 microsatellite loci newly developed for *E. spinax* and *E. molleri*, respectively. This microsatellite-based reproductive mode study appear to be a promising tool to gain crucial informations for small deep-sea lanternsharks in order to assess population dynamics and management strategy.

Environmental DNA (eDNA) as an ecological tool for locating Angelshark (*Squatina squatina*) nursery sites

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Angelsharks (*Squatina squatina*) are benthic sharks that historically ranged throughout the Northeast Atlantic Ocean, including the Mediterranean and Black Seas. Intensification of demersal fishing and habitat loss are thought to have caused dramatic population declines, with Angelsharks currently listed as Critically Endangered on the IUCN Red List. The Canary Islands (Spain), however, offers a unique stronghold where Angelsharks are commonly encountered. To effectively conserve such a threatened species, it is important to identify and manage areas that are vital to their key life stages, such as nursery sites. To do so, nursery sites need to be located and confirmed; however, this proves challenging because juvenile Angelsharks are difficult to observe due to their camouflaged colouration and burying behaviour under sand. Environmental DNA (eDNA) is increasingly being used in conservation studies as it can offer an alternative or complementary method to identify the presence of animals that are challenging to observe. eDNA has not yet been applied to study Angelsharks or nursery grounds of elasmobranch species; this study is the first to explore this. This project aimed to test the reliability of eDNA and apply eDNA to locate potential nursery sites for further targeted research in the Canary Islands, in collaboration with the Angel Shark Project (ASP). We show that the developed species-specific eDNA tool is reliable in identifying the presence or absence of Angelsharks at beaches across the Canary Islands, through comparison with traditional data collected by the ASP through visual surveys and citizen science. eDNA is a quick, easy method compared to traditional survey methods and provides a good basis with which to identify potential nursery sites where further research can then be concentrated. eDNA will be vital for future surveying throughout the Angelshark's historical range, such as the Celtic Sea, to understand where fragmented populations still occur.

Poster presentations

Transmigration and capture-risk of mako shark in North Atlantic

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The shortfin mako shark *Isurus oxyrinchus* is one of the fastest sharks, reaching speeds of up to 70 km/h. Belonging to family Lamnidae it is the second-most common oceanic shark caught by high seas longlines, mainly because of the high value of shortfin mako fins and meat. North Atlantic reported catches currently exceed 3300 tons annually and the 2017 ICCAT stock assessment confirmed that the North Atlantic stock is overfished.

In this work we tagged a total of 41 makos (17PSATs and 24 SPOTs) with devices from Wildlife Computers and Sirtrack between 2008 and 2017. After generating all tracks we demonstrated three trans-Atlantic migration for this species (> 3,000km). In order to know the degree of fishing risk, these paths were analyzed in relation to the CPUEs calculated from the logbook data of three fishing vessels (data ranging from 1996 to 2018) as a proxy of the "real risk" of capture for mako sharks. In addition we calculated the AIS positions to determinate longliner distribution in North Atlantic, to assess the "potential risk" of capturing makos in open ocean by commercial vessels.

***POSTER CORNER PRESENTATION**

Mysterious strandings of a deepwater shark in Norwegian fjord

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Many shark strandings have been reported and investigated across the world, especially within the last few years. If the rate of those strandings does in fact increase or if there are merely better monitoring programs in place today, is not clear. What we do know however is that in the majority of cases we don't know why a given stranding occurs where and when it does. In some cases the culprits causing the death of stranded sharks could be identified, what is unclear in most cases however is the question of "why now?". What might change the resilience of a local shark population making them locally susceptible to biotic (e.g. parasites, bacteria, fungi) or abiotic (e.g. salinity, oxygen, temperature) factors? We explored reported cases of shark strandings across the globe, looking for trends and similarities. In Norway, we detected that a velvet belly lantern shark, *Etmopterus spinax*, population exhibits repeated mass stranding events in a deep fjord system. *E. spinax* is a small-sized deepwater shark, which is often captured as by-catch in commercial deep-water fisheries and discarded due to its low commercial value. Locally, populations can be large and catches are mostly separated by sex. We sampled 400 *E. spinax* from a recent stranding event, and tested various hypotheses based on previously reported cases, expert consultation as well as local environmental data. This investigation into the causes and drivers of such strandings is especially timely in light of similar recent strandings of various species on e.g. the US coast in California. Results and the most likely scenario are presented, and lively discussions about causes and potential new hypotheses are strongly encouraged!

Comments about landings statistics of sharks and rays; Catalonia as a case study

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Fishery statistics are used to see trends in the populations of some species. This information is not accurate for some groups and may lead to confusion in species that are similar or not so well known to consumers, as in the case of sharks and rays. However, the landings statistics could be useful to evaluate the populations of elasmobranchs which have characteristics that make them very susceptible to overfishing.

In this study we analysed the landings statistics of sharks and rays for the last 17 years and we evaluated if the species were well identified from the fish markets of Catalonia.

Results showed that the number of sharks caught is higher than rays, many of them in danger of extinction. Rays show a constant increase in landings but in the last four years a decline is observed; an important fact considering that more than half of the rays are threatened with extinction. The species with the highest landings is *Raja asterias* and then it disappears from the landings statistics and becomes *Raja sp*, probably due to identification problems of these species in the fish markets. Sharks keep their catches stable; the species with the highest offload are *Galeus melastomus* and *Scyliorhinus canicula*. However, from a monitoring conducted in the fish market we observed that many sharks were erroneously labelled.

It is recommended to be very conservative when evaluating the elasmobranchs at the species level from landings since important bias may exist due to identification problems; however this information can be very useful to observe trends at a general level. In addition, a greater effort is needed in the standardization of landings of sharks and rays in order to be useful when evaluating possible decreases in their populations.

Sharks, rays and quimeras of Seine and Unicorn Seamounts (NE Atlantic Ocean)

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Seamounts are undersea mountains rising relatively steeply at least several hundred meters from the surrounding deep sea floor but do not reach the surface. The Seine and Unicorn Seamounts belong to the Madeira-Tore seamount chain located between the Portuguese mainland and Madeira Island (NE Atlantic). A collection of Chondrichthyes from the Seine and Unicorn Seamounts was studied. The specimens were caught during two research cruises in 2004 and 2017 between the top of the seamounts and 2500 m of depth. Sixteen species belonging to 7 families were collected in the two surveyed seamounts. This work is a contribution to the knowledge increase of seamount-associated fish fauna and a check-list of sharks rays and quimeras species known to date is given.

Madeira Island (NE Atlantic) a nursery area for smooth hammerhead shark, *Sphyrna zygaena* (Linnaeus, 1758)?

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The smooth hammerhead shark, *Sphyrna zygaena*, is a circumtropical species found worldwide in coastal, pelagic, and semi oceanic waters off and on continental shelves of the Atlantic, Indian and Pacific Oceans.

The IUCN lists the smooth hammerhead as Vulnerable globally, but there is a lack of regional information on smooth hammerhead life history, movement patterns, and population dynamics.

Over the last years, 6 smooth hammerhead shark juveniles were caught by fishermen in Madeira suggesting that this can be a nursery area for this species.

Coastal nursery sites provide critical refuge for young sharks. Knowing how sharks use these habitats and interact with other species will help us to better understand their ecological role and implement protection measures.

Suitability of a small MPA for the recovery of an endangered elasmobranch: the undulate ray (*Raja undulata*)

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Rays are presently recognized as a group that raises conservation concerns, given their low resilience to fishing pressure. Using spatial management for the recovery of rays' populations is a promising strategy, and information of the effectiveness of this approach is needed. The undulate ray (*Raja undulata*) is a coastal species that has undergone declines in abundance within its geographic range and is currently classified as endangered by the IUCN. We studied the spatial dynamics of this species in a small marine protected area located in the north-eastern Atlantic, the Luiz Saldanha Marine Park (Portugal). Thirteen individuals were tagged (7 males, 6 females) with acoustic transmitters (expected battery life of 20 months). Passive acoustic telemetry data was collected from May 2014 to June 2017 in the fully protected area and adjacent partially protected area. Movements of tagged specimens were predominantly longitudinal along the coast. Some individuals exhibited year-round residency in the reserve, while others were not solely restricted to the fully protected area and migrated to the adjacent partially protected areas. Individuals generally remained at depths shallower than 40m and exhibited a moderate-high site fidelity within the study area. Results suggest that this species can benefit from small coastal MPAs. However, the recovery of healthy populations regarding abundance and genetics will probably require the protection of more extended sections of coastal areas.

Elevated trawling inside European protected areas undermines potential conservation benefits for elasmobranchs

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Marine Protected Areas (MPAs) are increasingly used as a primary tool to conserve biodiversity and threatened species in the oceans. This is particularly relevant in heavily exploited hotspots such as Europe, where sensitive indicator species such as elasmobranchs (sharks, skates, and rays) are at risk of extirpation. However, MPAs in Europe do not explicitly target elasmobranchs. Here we ask if Europe's current MPA system could be utilized as a potential conservation tool for sharks, skates and rays. We present commercial trawling and elasmobranch hotspots across 20 species. We then investigate industrial trawl fishing and elasmobranch abundance in and around 727 MPAs designated in the European Union. We find that average trawling intensity inside MPAs is elevated at least 1.4 fold compared to non-protected areas and elasmobranchs decreased >70% in abundance in heavily trawled areas. Overall 59% of MPAs are commercially trawled. We conclude that the widespread use of MPAs for industrial fishing undermines potential conservation benefits for many sharks, rays and skates that are vulnerable to commercial trawling activities.

Blue shark occurrences in the Gulf of Lion coastal waters (France) through participatory data collection involving sport fishermen and implications for management

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Increasing human impact through fisheries, coastal development and pollution require management and conservation measures for shark Mediterranean species. Data on the distribution are therefore crucial in order to establish population statement and ecological functions of habitats (nursery, breeding, migration, feeding) especially at a regional scale. Assessed as Critically Endangered in the Mediterranean Sea (IUCN, 2016), the Blue shark (*Prionace glauca*) is regularly accidentally caught by sport fishermen in the Gulf of Lion coastal waters (France) during the summer season. Preliminary results from the “Open Sea” participatory science project led by Ailerons association since 2015 in collaboration with voluntary sport fishermen showed that the Gulf of Lion can support high densities of blue sharks from April to September. Interestingly, this area seems i/ to be used as a nursery by *Prionace glauca* given that most of the observations concerned juvenile stages including Young-Of-the-Year (= < 60 cm), and ii/ to be a potential breeding area as reproduction behaviour evidences (recent body damages on females caused by bites) have been noticed. Still ongoing, this project has therefore a dual objective: raising sport fishermen awareness with intensive information campaign on the promotion of no-kill fishing while collecting ecological and biological data (geographical coordinates, sea conditions, depth, size, sexe, DNA samples) concerning a threatened species, which could certainly guide future management measures by reducing human induced pressures.

Occurrence of the guitarfish species threatened of extinction in the Mediterranean Sea and the northeast Atlantic

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Guitarfishes are one of the most endangered elasmobranchs. They have a wide distribution, but their populations are decreasing fast. Currently there are two species of guitarfish threatened of extinction inhabiting in the Mediterranean Sea and the northeast Atlantic Ocean: *Rhinobatos rhinobatos* and *Glaucostegus cemiculus*. The aim of this study is to analyze the distribution of both guitarfishes as well as to identify their abundance and breeding or mating areas based on scientific papers and citizen science. The results show 33 scientific records of *R. rhinobatos* and *G. cemiculus* in the eastern Mediterranean while in the western Mediterranean scientific reports of these species were almost inexistent. Citizen science allowed to find, for the first time, records of guitarfishes in the Spanish coast. We highlight the existence of a potential hotspot of abundance in the Atlantic Ocean and the sighting of a pregnant female of *G. cemiculus* in the Mediterranean coast (Murcia) which could indicate a potential nursery area. In conclusion, we report for the first time the presence of guitarfish aggregations in the Spanish coast and the detection of a possible nursery area in the western Mediterranean Sea. Since guitarfishes are in danger of extinction, research involving users, scientists and authorities is essential for the preservation of these species and their habitat.

Application of laser photogrammetry on *C. carcharias* in natural environment

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Most morphometric methods of investigation used on large marine organisms are intrusive, as they involve the capture or the killing of the animal. In the last decade new methods and new technologies have been developed able to supply the same morphometric data avoiding contact with the animal. The result of these efforts was the introduction also in the ecological field of laser photogrammetry. Photogrammetry is a non-invasive remote sensing technique that uses digital photography or images to measure objects or, in the case of animals, morphometry. Laser photogrammetry uses two laser beams, parallel to each other, to obtain the real dimensions of a body starting from a digital image. The objective of the present study is to provide a contribution to the definition and validation of the method for the study of white sharks. Data were collected during XIV^o Scientific Expedition in South Africa (2017) managed by Centro Studi Squali and Unical to study the behaviour of *Carcharodon carcharias*. We proceeded to create a system suitable for the study of the white shark, being careful to the problems highlighted in the literature. The realized instrument was equipped with two filming means, in this way the attention was focused on two aspects: the real effectiveness of laser photogrammetry and the efficiency of using a reflex camera compared to an action-cam. The tool made allowed to obtain valid data. From these, estimates of the total lengths of the samples encountered were obtained by processing the frames considered valid using an appropriately defined protocol. The results obtained by the two imaging systems were compared with each other and with the data derived from the visual estimation (traditionally used not invasive method). The comparison of results allowed some indications regarding the effectiveness of the new morphometric measurement system and its degree of reliability.

Shark ecotourism in Cabo San Lucas, Mexico: Ethology and economic revenue

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Shark exploitation through ecotourism has risen in the last few decades. It has been suggested that this activity is useful for shark conservation through environmental education and personal experiences. It is estimated that shark ecotourism in Mexico generates around 12,500,000 USD annually. The present study will be conducted in Cabo San Lucas (CSL), which was the 6th most visited destination in Mexico during 2017. The average surface temperature in CSL is 18°C with seasonal variations of up to 6°C (16-22°C). These range of temperature allows the observation of different shark species throughout the year. During warmer months, it is possible to observe silky sharks (*Carcharhinus falciformis*) and smooth hammerhead sharks (*Sphyrna zygaena*). In the coolest months, it is possible to register shortfin makos (*Isurus oxyrinchus*) and blue sharks (*Prionace glauca*). The present study will describe shark ecotourism in CSL using ethological techniques and a first economic valuation of the resource. The data will be obtained throughout the year with the support of local service providers. This will result in data regarding species, sex, total length and behavior. Ethological observations will be recorded while the sharks are within 10m from the tourists. Data will be registered by the observer and later doublechecked with submarine footage obtained with a GoPro Hero 5 camera. The economic valuation of this activity will be described with surveys filled out by the tourists. These surveys include demographic data like age, sex, occupation, nationality, satisfaction, transportation, lodging questions as well as the motivation for visiting CSL with their perception of conservation after the activity. The expected results are the annual revenue derived from this activity and far-sighted projections based on hypothetical scenarios, the growth potential, and the actual annual revenue.

Utilising data sourced from ecotourism to investigate the affects of environmental and anthropic variables on great white shark behaviour

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Ethical ecotourism companies, in addition to encouraging protection of sharks through continued economic gain to the local community and education of visiting tourists, can be used in scientific research, as they accumulate huge amount of contact time with the animals in the field. White Shark Projects, South Africa volunteered data collected by their onboard crew during tourist excursions from 2009 through 2011, constituting over 950 sampling hours and 2,277 individual great white sharks with behaviour described. Environmental variables related to weather (air temperature, barometric pressure, cloud cover, wind direction and speed), environment (bottom depth, lunar phase, seal activity, sea surface temperature, underwater visibility), and ocean conditions (swell height, tide), and anthropic variables (arrival time, bait type, chum type, total chumming time, location, observer) will be used in a generalised linear mixed model (GLMM) in order to assess which variables are related to high shark abundance, and active and aggressive behavioural states. This study will be the first to use ecotourism data in scientific research, allowing the assessment of the validity of ecotourism data for science. Furthermore, this work will take steps for further understanding great white shark behaviour, using the first model which considers both the affects of anthropic variables and environmental variables, to describe how external factors can influence the behaviours which white sharks exhibit.

***POSTER CORNER PRESENTATION**

FindRayShark project: testing non-invasive technologies to monitor sharks and rays

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Many species of Elasmobranchs are currently under threat from overfishing, since their life history traits make them intrinsically vulnerable to population depletion. Despite decades of research, insufficient knowledge on nearly half the species of elasmobranchs is still impairing our ability to protect them. Assessing the presence, abundance and population status of marine elasmobranchs of high conservation concern is particularly troublesome due to the harmful effects of many traditional sampling techniques and the logistical difficulty of studying these marine organisms, given their generally shy nature, high mobility and low abundance. Thus, a paradigm shift is needed in our approach to acquire knowledge on the distribution and population status of these species.

Project FindRayShark aims to contribute to the conservation of sharks and rays worldwide by implementing a technologically innovative and non-invasive approach to assess their populations, by coupling baited remote underwater video surveys (mono, stereo and spherical) and environmental DNA metabarcoding to survey the presence and abundance of elasmobranch populations locally. Tests have been conducted in a public aquarium and at a pilot study area in Faial Island, Azores, where elasmobranchs are commonly sighted. On the next phase the methods will be applied to the Berlengas Marine Protected Area, western Portugal, where knowledge on elasmobranchs' biodiversity is scarce but urgent.

The non-invasive methods optimised on this project may be applied to other understudied sites worldwide, and their results will allow the proposal of management actions and good practice guidelines adequate for the context of the study area. We also hope to raise awareness through varied dissemination activities to different target groups using project outputs, namely local and national management agencies, tourism operators, and the public at large.

Whatsapp for What's up with sawfishes ?

The use of social media for data collection and community awareness in remote areas, case study of Indonesaw program

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Indonesia is a country wide as a supra region, the fourth most populated nation in the world and one of the top wildlife biodiversity hotspots on Earth. Despite being the first nation for elasmobranch catches, Indonesia still host four of the five sawfishes species worldwide that are listed Critically Endangered and Endangered. WhatsApp is a freeware and cross-platform messaging, the application allows the sending of text messages, images and other media as well as voice and video calls; it is daily used by over 1 billion people. The Indonesaw program aims to evaluate the status of sawfishes in the Indonesian archipelago by developing research surveys on set up of an alert network. The approach is following IUCN Global Strategy for sawfish conservation and set up on the achievements of similar successful project created in western Africa. Indonesian laws protects sawfishes since 1999 and their trade is illegal; nevertheless bycatch still occurs and illegal business was discovered for rostrum but also meat and fins (fresh, frozen or dried). By using new social networks as Whatsapp with fishing communities Indonesaw already succeed in promoting safe-release of 15 live sawfishes (*Anoxypristis cuspidata*) at sea and the collection of recent catches and trade data. This new approach offers a real time method for sensitization but also allows our team to present a first evaluation of the actual sawfish distribution. The relevance of social media utilization in emerging countries is discussed in regards to the importance of conservation challenges in this region of the world.

Everybody wants to see a shark!

Developing of shark observation site on the Israeli coastline

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Requiem sharks are almost non-existent in the Mediterranean Sea, with dramatic population declines of over 90%. Yet around the Israeli coastline, they seem to be relatively abundant. For the past 10 years, at least, these species approach the warm water of coastal power stations in Israel during the winter months. In the Hadera station, every year an increasing number of visitors arrive to observe them, by foot and above and below the water, as well as media reporters. While the growing interest shines a light on the need to protect these species, the same interest creates pressure on the sharks and increases the risk of conflict or harm for both sides.

A new initiative, with collaborators from NGOs and governmental organisations, seeks to ease this pressure and to develop a shark observation site which is managed responsibly while putting the sharks' benefit and conservation in first priority. Last season, we engaged with the local diving community and set up an information stand for the visiting public. We have also done a great deal of planning an observation deck, information boards and underwater markers and buoys for divers and watercrafts. We are considering options regarding the restriction of fishing activity. Best practice guide for all users of the site has been prepared and is pending publication. One of our collaborators, the University of Haifa, is conducting an ecotourism research, which we trust will give a better understanding in the future of how to best manage this site.

We are now facing yet another shark season and with our new plan, we hope the sharks will return safely and that the public will be able to enjoy watching and learning about them, while not jeopardising them or their return.

***POSTER CORNER PRESENTATION**

The project “Shark Attract”: Sharks and rays conservation by enhancing awareness within fishermen communities and society

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Sharks and rays are an extremely diverse group of fishes, with more than 1200 species, present in all marine ecosystems. In the last decades, they have been under increasingly intense fishing pressure, which has been affecting populations worldwide. Their life-history characteristics, such as low fecundity, late sexual maturity and reduced number of offspring, make them a fragile resource, highly vulnerable to overfishing and clearly collide with its fisheries resources dimension. The Shark Attract project aims at tackling sharks and rays conservation through increasing awareness and knowledge with tailor-made activities and actions targeted to different audiences and stakeholders, such as fishermen, students, general public, managers and public authorities. The work plan comprise the analyses of existing data on rays and sharks fisheries trends, as well as the collection of new data in the main fishing harbors along the Portuguese mainland coast, the characterization of the major problems regarding fisheries affecting sharks and rays through interaction with fishermen communities and the implementation of knowledge transfer and awareness actions directed to the different audiences. It is expected that the project generates a solid scientific knowledge regarding sharks and rays fisheries in Portugal, identifies ways to reduce shark fishing mortality (reducing bycatches, enhancing discards or live specimens, changing fishermen practices), and increases the interest, knowledge and awareness of society by these endangered fishes. Outreach activities will be of great importance as they are expected to involve a significant amount of people out of the scientific scope as well, and will allow to raise awareness and increase the perception of the present situation concerning sharks and rays, which may contribute to change mentalities and attitudes, and ultimately to these species conservation.

Is dermal denticle size a good discriminant criteria to identify *Deania* species (Fam. Centrophoridae)?

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Three elasmobranch species of the genus *Deania* are reported from NE Atlantic waters: *D. calcea*, *D. hystricosa* and *D. profundorum*. Whereas *D. profundorum* is easily recognized by the presence of a sub-caudal keel on the lower caudal peduncle, the other two species are mainly discriminated by the size of the dermal denticles and body color. In this study we explore the feasibility of this criterion by examining several individuals (N=32) of diverse size and sex caught in different areas (Le Danois Bank, Aviles Canyon, continental slope) of the Cantabrian Sea. Morphometric measurements of 40 characters, denticle size and genetic analysis were undertaken for each individual. Multivariate analysis was used to check differences among samples. Size and shape of dermal denticles varied according to body region. Furthermore the size of dermal denticles is positive correlated to fish length. Other morphometric characters should be considered for better identification of these species. Reliable and consistent discrimination of *Deania* species is essential for conservation and sustainable management of these deep-water elasmobranchs which are regularly by-catch of deepwater fisheries.

Helminth infracommunities in two torpedo species from the gulf of València: is EOD behaviour affecting their abundance?

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In this project we have studied the intestinal parasitic community of two species of *Torpedo*, 30 *T. torpedo* and 17 *T. marmorata*. The specimens were collected in the ports of València and Perelló, on the west coast of the Mediterranean sea and were captured by trammel fishing nets during March and June 2017. Specimens of three genera of cestodes were identified: order Onchoproteocephalidea (*Acanthobothrium* sp.), order Rhinebothriidea (*Rhodobothrium* sp.) and order Tetraphyllidea (*Anthobothrium* sp.). The characteristics of the host (sex, size and habitat) and the location of parasitic fauna along the intestinal tract were analyzed. Statistically there is no relation between the characteristics of the host and their parasites. The genus *Acanthobothrium* seems to have a preference to be in the middle region of the spiral valve due to a greater absorption of nutrients. It is observed that torpedo have a poor parasite fauna as genus and when compared with other coastal elasmobranchs. The causes could be related to a matter of contact with the parasites (influenced by diet or sedentability) or compatibility. A third hypothesis is studied: whether or not the Electric Organ Discharge used by *Torpedo* species when predating affects parasites. For this, a model species (*Micromesistius poutassou*) was used to compare the effect of electric discharges on *Anisakis* sp., proving that they affect parasites mobility. Further studies need to be done on its effects on parasite capacity of infection.

***POSTER CORNER PRESENTATION**

Effects of ocean acidification over the neuroanatomic development of benthic sharks

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As atmospheric CO₂ levels rise, continuous uptake by the oceans is changing the seawater chemistry, resulting in ocean acidification (OA). Exposure to the foreseen high CO₂ conditions has been reported to trigger an array of behavioral changes across marine taxa, namely in top-predators such as sharks. Nonetheless, the consequences of such conditions over the neuroanatomic development are still widely understudied. Here we investigate the impacts of OA in the early relative brain development rate and neuroanatomy of temperate shark (*Scyliorhinus canicula*) embryos and juveniles reared under either control (400 μ atm) or high CO₂ conditions (900 μ atm | Δ 0.3 pH units) since laid. Using the “OpenT” open-source platform for optical projection tomography, we built three-dimensional neuroanatomic models in order to evaluate OA effects over the brain development patterns across the embryogenesis. Additionally, the activity levels and response to food-related olfactory cues of the juveniles was assessed. Preliminary results suggest changes in the relative size of the optic lobe following exposure to high-CO₂ conditions, with potential consequences in the processing and integration of visual information and thus, the ability to properly respond to environmental cues. Moreover, changes in their behaviour were observed, with OA-exposed individuals showing higher levels of feeding motivation upon cue delivery. Sharks have a crucial role in the balance of the oceans trophic ecology and the population decline seen in recent years may result in a top-down disruption of marine ecosystems. OA may present itself as an additional threat to this k-strategy predator, particularly if affecting the brain-power and behaviour of the new recruits.

Chondrichthyans as bioindicators of marine pollution: a potential tool for environmental monitoring

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Chondrichthyans are regularly found in the bycatch of commercial fisheries in the northwestern Mediterranean. They play an important role as predators so these species could serve as sentinels of pollution in high trophic levels of the marine ecosystems. Samples of the liver of 20 species of chondrichthyans including 1 chimaera, 11 sharks and 8 rays (rajiformes and myliobatiformes), were collected in scientific surveys and from the bycatch's of trawling and longline fisheries between 2011 and 2014. The aim of this study is to evaluate the potential of chondrichthyans as bioindicators of pollution using the carboxylesterase activity (CE) as biomarker of the environmental exposition to determinate contaminants. CEs are a versatile family of enzymes with the ability to metabolize and inhibit many pesticides, pharmaceuticals and other endogenous products, with a particular affinity for the organophosphate pesticides. The CE basal activity was measured with the substrates 4-nitrophenyl acetate (4NPA) and 1-naphtyl acetate (1NA). The substrate 1NA was the one which showed higher enzymatic activities. Higher CE activity was found in the rajiformes species, followed by sharks and the chimaera, with lower activities. *In vitro* sensitivity to the OP Dichlorvos was tested with the species *Scyliorhinus canicula*. The results showed that the substrate 1NA would be the most adequate for biomonitoring, as it was more sensitive to the pesticide in the liver (IC₅₀ = 2.37 µM) and plasma (IC₅₀ = 0.051 µM). The interspecific variation of the CE basal activity and the different inhibitions of the pesticide Dichlorvos and the drug fenofibrate, indicate different sensitivities of each species to determinate pollutants.

***POSTER CORNER PRESENTATION**

The project “BlueSharker”: Blue harks as biomonitors of Atlantic waters through an integrated biomarker assessment

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Marine ecosystems are continuously being burdened with xenobiotic contaminants released by human activities, often resulting in a decline of their resources. Long-lived and top predator marine species such as sharks tend to accumulate particularly high levels of environmental contaminants via bioaccumulation and biomagnification processes. Given their susceptibility to pollutant accumulation, their wide distribution and their importance to the ecosystems, sharks are ideal candidates to be used in marine pollution monitoring studies. The “BlueSharker” project will focus on the potential of blue sharks (*Prionace glauca*) to be used as sentinel species for marine pollution monitoring surveys through the development and application of suitable biological biomarkers. This work will focus on linking the tissue contaminant body burdens of sharks (trace elements and persistent organic pollutants) to their responses at different levels of biological organization: from molecular markers at the gene level, to biochemical parameters at the sub-cellular level related to detoxification, oxidative stress, neuronal function, immune system and energy metabolism, and histological lesions at the tissue/organ level. Moreover, as an ultimate goal, the research team will check if the correlations found between the contaminant levels and the biological responses for the other tissues can be also found in sharks blood and/or skin, which would enable the use of such biomarkers in a less-invasive way in marine biomonitoring programs. Ultimately, this research aims to provide a simple and fast way for assessing the physiological state and general fitness of blue sharks, which given their ecological impact as top predators, will indirectly allow inferring about the quality of the oceans. Moreover, by relating the biological responses with contaminant body burden, an improved understanding on the organisms’ mechanisms to cope with different ocean contamination scenarios will be provided, enhancing the development of a biomarker toolbox for biomonitoring marine environments.

A Devil not so evil: new data from a female *Mobula mobular* (Bonnaterre, 1788) caught in Greece

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The Giant Devil Ray is an epipelagic filter feeder, mainly occurring in the Mediterranean Sea, characterized by low growth rate and low productivity. Most information on *Mobula mobular* derives from incidental bycatch and opportunistic sightings. The species is included in Appendix II of the Bern Convention (1982) and in Annex II of the “Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean” (1996) of the Barcelona Convention (1976); it is also protected by the Greek national legislation (Presidential Decree 67/1981). The IUCN Red list classification for the Giant Devil Ray is ‘Endangered’, mainly due to the scarcity of data and the entanglement in fishing gears as bycatch. Knowledge gaps still exist on *M.mobular* and therefore the status of the species is under investigation. The present study is aiming to contribute valuable information on the biology of the species from observations on a mature female specimen, accidentally caught in long line, in July 2018 in Greece. The devil ray weighted 63.5kg and was reported to iSea, a Greek Environmental Organization, through the citizen science project “Sharks and rays in Greece and Cyprus”. The authors were informed and in collaboration with the members of the iSea took samples from the dead ray only for research purposes. The presence of trophonemata observed in the uterus of the female *M.mobular*, indicated the nourishment of an embryo recently. Morphometric measurements were recorded to the nearest mm and its organs were weighted to the nearest gr in the laboratory. Results were compared to previous reported measurements from the eastern Mediterranean Sea. Additional information on the reproductive biology of *M.mobular* along with data on its distribution and abundance constitute a useful tool for future management and conservation actions for this endangered elasmobranch.

Feeding behaviour of whale shark at Nosy Be (Madagascar) and link to phytoplankton community

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In December 2017 a research expedition was carried out off the island of Nosy Be in Madagascar to study the feeding behavior of the whale shark. We report the behavioral modules of the whale shark and their relationship with the phytoplankton community in terms of biomass and functional groups. In 31 sites, surface water was collected in the following five behavioural conditions: 1. absence of whale sharks, 2. presence of swimming whale sharks, 3. presence of whale sharks in horizontal feeding, 4. presence of whale sharks in vertical feeding, 5. presence of whale shark in vertical gulping.

Two liters of seawater were filtered on filters and stored at -20°C for HPLC analyses to determine phytoplankton pigment spectra. Chlorophyll-a (Chl-a) concentration was used as an indicator of total biomass and biomarker pigments were used as chemotaxonomic descriptors to define the contribution of the main phytoplankton groups to the total Chl-a.

The exhibition of vertical feeding behaviours of whale sharks showed a significant correlation with sites characterized by higher phytoplankton biomass. Since vertical feeding is considered as a strong feeding behaviour, we can assume that the phytoplankton concentration could play a role for the feeding strategy of the species. Chryptophytes, haptophytes and cyanobacteria were the most abundant taxa in term of biomass. The results seem to highlight a certain correlation between behavioral feeding modules exhibited by sharks and the presence of some phytoplankton taxa that might be involved in the release of the DMS. This substance is produced by phytoplankton in response environmental stressors such as ocean acidification nutrient limitation and grazing pressure. Since DMS is a substance characterized by a strong odor, the results seem to highlight the fundamental role of smell in the identification of food sources by the whale shark: this will represent the future aim of the research.

Surface behaviour of bait attracted white sharks and influence of biological and environmental factors

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Individual surface behaviour of white sharks in the presence of bait has been studied from 2005 to 2018 at Dyer Island Nature Reserve (South Africa). Observations were made from a commercial cage-diving boat. We observed 220 white sharks that exhibited 9 different types of individual behaviour: parading, bait following, visual inspection, breach, tail slap, tail stand, spy hop, repetitive aerial gaping, and head-up vertical emerging. We compared the exhibition of these behaviors and the complexity of the ethograms to both biological (sex, age) and environmental (tides, cloud cover, underwater visibility, sea surface conditions, temperature, time of the day) factors. Breach and tail slap were most often performed by male sharks, and tail slap and tail stand were more often performed by mature animals. The general ethogram consisted of an average of 20 behavioural units. The comparison of the ethograms between males and females did not revealed significant correlations, but the ethograms of female white sharks were more complex with more transitions between behavioural units. A significant correlation was observed comparing ethograms of mature and immature white sharks: young sharks performed more complex ethograms with a higher number of behavioural units.

We observed also that environmental conditions affected the sequence and structure of individual behaviors and in particular the approach to the bait, the duration of the ethograms and the complexity of decisional trees and transitional matrices. In particular, we observed a strong influence of the cloud cover and, consequently, underwater visibility

Our observations suggested that the surface behaviour of white sharks is a complex tactical situation in which animals show plastic responses to environmental conditions and according to sex and age.

Drone technology to determine the behavior of *Carcharodon carcharias* in Dyer Island, South Africa and Guadalupe Island, Mexico

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The white shark (*Carcharodon carcharias*) is an apex predator that congregates in some continental and oceanic islands where ecotourism is a frequent activity. Although the ecotourism with this species has been an alternative to the fishing pressure, information about its biology, behavior, and ecology is still scarce and necessary for its management. Studies about the interactions between sharks and baits during ecotourism activity are also still limited. This project aims to describe an ethological comparison of the white shark between Guadalupe Island, Mexico and Dyer Island, South Africa, that shown oceanic and coastal environments, respectively. The behavior will be recorded onboard local tourism boats at these locations. Intraspecific and shark-bait interactions will be registered using drone technology during aerial census of 20 min per flight and 10 m of height at 7:00, 10:00, 13:00 and 16:00 h. The comparison of behavioral patterns in both locations will be useful to describe the effect on behaviour of the environmental factors such as surface temperature, visibility, wind speed, and cloudiness. Sexual behavior patterns will be analyzed in collaboration with citizen science programs, using underwater pictures and videos from the tourists to identify the sex of the animals. This study will be the first to compare the behaviour of two different white shark populations by the use of drones. The results will provide information for tourism, the scientific community, and for the authorities in charge of the improvement and management of this vulnerable species.

Abundance, distribution and behavior of Elasmobranchs with app reports in the Gulf of Papagayo, Costa Rica

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The Gulf of Papagayo, located in northwestern Costa Rica, presents significant touristic infrastructures and year round aquatic activities. Its northern part features an important Marine Protected Area whereas the rest of the gulf is not protected. The substantial diversity of Elasmobranch in this area is responsible for a valuable touristic activity, but information on species, abundance, distribution, behavior are almost unknown. To fill in this gap in wildlife documentation, the organization “Misión Tiburón” created in 2016 a smartphone application called “Misión Tiburón”[®] and successfully drew in sea professionals, especially divers, to report Elasmobranch sightings within the application. Recorded variables included basic diving data (date, GPS coordinates, dive time, depth, water temperature) and quantity, specie, sex, behavior for each Elasmobranch observation. By enhancing direct observation reporting, and engaging Costa Rican citizens and tourists, this project aimed to raise public awareness on Elasmobranch ecology and extinction threats. The present is based on the data collected between 06/01/2016 and 06/01/2018, and specifically describes Elasmobranch population in term of species, distribution and behaviour in relation to its marine environment in the Gulf of Papagayo. In 2 years, more than 1244 observations from all Costa Rican coasts have been reported and validated, among which 64% covered the Pacific coast and particularly the Gulf of Papagayo. We first classified species based on seasonal or resident characteristics, before describing relationships between distribution patterns and specific ocean condition for some species. We show evidence for abundance variations for specific species, both in terms of time distribution (monthly variation) and space distribution (within the gulf). The evolution of these patterns will be studied by continuing diving reports through the application. In future works, impacts of the abundant aquatic recreational activities and their development needs to be evaluated to paint an exhaustive view of the Elasmobranch population and evolution perspectives.

The Great Eggcase Hunt – a citizen science conservation project supporting wider conservation policies

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Since its inception in 2003, the Great Eggcase Hunt (GEH) has utilised the collaborative power of citizen scientists to further research into egg-laying elasmobranchs. To date it has received over 200,000 records and engaged numerous dedicated eggcase hunters. What started as a way to educate the public about shark conservation developed into an effective way of collating important, usable data on the diversity of egg-laying elasmobranchs found around British waters, of which there are 13 species commonly found. The Shark Trust has continued to utilise the information submitted by the public to gain a better understanding of species diversity, relative abundance, and distribution as well as the location of potential egg-laying sites. Data obtained from the project has resulted in an in-depth report celebrating 100,000 submissions, as well as provided updated descriptions detailed in a peer-reviewed publication (with another currently in prep). To support the ease and accuracy of recording and to encourage regular submissions, a smartphone app has been developed and translated into additional languages with project partners. International submissions have been received from as far afield as Australia and Ecuador increasing knowledge of eggcase identification from around the world. A push for divers and snorkellers to look for underwater eggcases in situ supports research into egg-laying grounds and an improved understanding of the substrates eggcases are deposited on. Data collated and analysed from the GEH has allowed the Shark Trust to provide scientific input into conservation policies; most recently the UK government Marine Conservation Zone (MCZ) designation process that aims to identify species and habitats requiring protection. The static life history phase of an oviparous species leaves them at risk to human disturbance. Therefore, understanding the location of egg-laying sites and habitat preference is vital when considering spatial protection. Here we present examples of how this citizen science project is able to support and influence conservation policies affecting elasmobranchs.

Photo-identification of Bull rays (*Aetomylaeus bovinus*) (Geoffroy St. Hilaire, 1817)

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The bull ray *Aetomylaeus bovinus* requires urgent conservation measures, consubstantiated by an upgrade of its IUCN conservation status in 2015 to Critically Endangered for the Mediterranean Sea. This coastal and large but very poorly studied elasmobranch is mainly threatened by habitat degradation and bycatch due to the use of non-selective fishing gears. However, such proximity to anthropic activities offers an advantage to deepen our knowledge of this species. If appropriately applied and fine-tuned, photo-identification is an affordable, accurate and non-invasive technique which allows scientists to reliably identify individuals within a population. Bull rays exhibit very distinctive and individual dorsal colour patterns, bluish strips which remind the reflex of the surface on a sandy bottom. As benthos-pelagic feeders, spending most of their time feeding on the sea floor, bull rays are constantly exposing their natural patterns. Thus, any snorkeler with a camera can gather pictures of the species and contribute to a global demographic scientific initiative. Here we propose a novel, semi-automated photo-identification methodology to study the demography, habitat and ecology of *A. bovinus* populations for the first time as a key tool embedded in a global citizen science initiative. We also present some preliminary results, extracted from the 223 high quality pictures collected during 103 snorkelling surveys ran in Malta and the Canary Islands. At least 15 individuals could be reliably identified, and some re-sightings support eventual sight fidelity and seasonal migrations.

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