



SHARKS
INTERNATIONAL
VALENCIA 2022



Images © Steve Jones and Sean Chinn

ONLINE EVENT | 10-14 OCTOBER 2022

ABSTRACT BOOKLET

SHARKS INTERNATIONAL 2022

#SharksInt2022 | si2022.org

Sponsored by



In association with



Contents

Monday 10 th October, 2022.....	4
Biology & Life History 1	4
Threatened Species - Spotlight on Angel Sharks, Sawfish & Rhinorays 1	6
Threatened Species - Spotlight on Angel Sharks, Sawfish & Rhinorays 2.....	9
Movements & Habitat Use 1	12
Fisheries & Trade 1.....	15
Movements & Habitat Use 2.....	18
Fisheries & Trade 2.....	20
Movement & Habitat Use 3.....	23
Tuesday 11 th October, 2022.....	2
Movements & Habitat Use 4.....	2
Fisheries & Trade 3.....	5
Movements & Habitat Use 5.....	7
Fisheries & Trade 4.....	10
Movements & Habitat Use 6.....	12
Biology & Life History 2	15
Threats Beyond Overfishing 2.....	24
Wednesday 12 th October, 2022.....	27
Threatened Species - Spotlight on Mackerel Sharks 1	27
Citizen Science & Environmental Education 1	30
Citizen Science & Environmental Education 2	32
Sensory Biology, Feeding Habits & Metabolism 1	34
Citizen Science & Environmental Education 3	37
Genetics 1	39
Citizen Science & Environmental Education 4	42
Thursday 13 th October, 2022	45
Behaviour, Physiology & Discard Survival 1	45
Genetics 2	48
Threats Beyond Overfishing 3.....	51
Genetics 3	55
Threatened Species - Spotlight on Mackerel Sharks 2.....	58
Behaviour, Physiology & Discard Survival 2.....	60
Threatened Species – Spotlight on Mackerel Sharks 3.....	62
Sharks & Humans 1	65
Friday 14 th October, 2022.....	68

Sharks and Humans 2.....	68
Technical Innovation in Research Methods 1.....	69
Sensory Biology, Feeding Habits & Metabolism 2.....	72
Threatened Species – Spotlight on Angel Sharks, Sawfish & Rhinorays 3.....	75
Technical Innovation in Research Methods 2.....	76
Threatened Species – Spotlight on Angel Sharks, Sawfish & Rhinorays 4.....	80
Posters (Online)	83

Monday 10th October, 2022

Biology & Life History 1

Giulia Bressan

CoNISMa; University of Padova

Shark tale: a study of tail morphology and ecology.

1. Giulia Bressan; CoNISMa; University of Padova.
2. Monica Barone; Food and Agriculture Organization of the United Nation, Fisheries Resources Consultant (FAO).
3. Fabrizio Serena; Institute for Marine Biological Resources and Biotechnologies (IRBIM); National Research Council (CNR).
4. Carlotta Mazzoldi; University of Padova.

The earliest Chondrichthyes appeared 400 million years ago and have maintained their overall body shape essentially unchanged since their origins. This long evolutionary history has brought them to develop body and fin characteristics and an efficient swimming mode that allow them to occupy different habitats successfully. According to recent hydrodynamics studies, compared to the other fins, the tail is the one that plays a crucial role in overall locomotor functions and its shape appears to be correlated with the habitat occupied by the shark. Previous works have investigated this correlation analysing museum specimens or scientific illustrations, while those that have focused on live animals were able to study only few individuals of few species. Using photos taken from freshly fished sharks here, we investigated the diversity of the form of caudal fins in 37 species belonging to 3 orders to verify the relationships between the variability of shape and occupied habitat. Geometric morphometric analysis was used to study the shape of the tail through the positioning of 5 landmarks. Moreover, the aspect ratios of the caudal fins were calculated. Information regarding the habitat and bathymetric range occupied by each species was obtained from scientific database. Relations between the occupied habitat and caudal fin shape were investigated taking into account phylogenetic relationships.

This study contributes to the understanding of the relation between morphology and ecology in the light of the evolution of sharks.

Keywords: sharks caudal fins; morphology; ecology

SI Abstract Ref: 261

Cristina Rodríguez-Cabello

Spanish Institute of Oceanography (IEO). Oceanographic Centre of Santander

Fitting a biphasic growth model to the elasmobranch *Scyliorhinus canicula* (L. 1758) in the Cantabrian Sea (NE Atlantic).

1. Cristina Rodríguez-Cabello. Spanish Institute of Oceanography (IEO).
2. Larissa Modica. Spanish Institute of Oceanography (IEO).
3. Francisco Sánchez. Spanish Institute of Oceanography (IEO).

A number of different models have been developed to describe growth (e.g., von Bertalanffy, Gompertz, Logistic), however no single growth model provides the best fit for describing a population growth. This study presents the results obtained by fitting a biphasic growth model to describe lifetime growth of *Scyliorhinus canicula* population in the Cantabrian Sea (NE Atlantic). Data used for all these models was based on tag-recapture database updated from a tagging program conducted in the study area since 1993. A total of 14091 lesser spotted dogfish have been tagged during this period, 7638 males and 6453 females respectively from which 496 were recaptured. Parameters obtained from Lester growth model (LGM) provided a juvenile annual growth rate ($h = 57.4 \pm 1.2$ mm) and reproductive investment ($g \sim 0.20$). Besides, after conversion, the following von Bertalanffy growth parameters (VBGC), for sexes combined, valid only for post reproductive lifetime, were: $L_{inf} = 84.5$ cm; $k = 0.083$, $t_0 = -2.25$. Growth models (VB), such as Gompertz or logistic were compared and differences were discussed taking into account both life history traits and fishing pressure acting on the population studied. Finally mortality estimates (M) based on previous growth models were calculated. Parameters derived from growth models are used to estimate important life history traits.

Keywords: *Scyliorhinus canicula*; growth models; tag-recapture; biphasic growth; Cantabrian Sea

SI Abstract Ref: 260

Dr Joni Pini-Fitzsimmons

School of Natural Sciences, Faculty of Science and Engineering, Macquarie University

First evidence of sound production in wild stingrays

1. Dr Lachlan C. Fetterplace, Department of Aquatic Resources, Institute of Coastal Research, Swedish University of Agricultural Sciences & Fish Thinkers Research Group
2. J. Javier Delgado Esteban, Whale Nation Studio
3. John Gaskell, Reef Catchments & Sharks and Rays Australia
4. Dr Barbara E. Wueringer, School of Natural Sciences, Faculty of Science and Engineering, Macquarie University & Sharks and Rays Australia

Sharks, rays, and skates - the elasmobranchii - are currently not known to actively produce sounds in the wild. Here, we present multiple records of voluntary sound production in the wild, by two species of stingray, namely the mangrove whipray *Urogymnus granulatus* and the cowtail stingray *Pastinachus ater*. Sounds recorded from both species are characterised by a series of very short and loud clicks and appear to serve the purpose of agonistic displays. In all recorded observations, a ray commenced producing sounds in response to an observer approaching closely, and ceased sound production when the distance between the ray and observer increased. Our study illustrates that elasmobranchs can produce sounds, and that more research into this ability is required.

Keywords: batoidae; sound production; communication; agonistic display; predator avoidance

SI Abstract Ref: 214

Fidji Berio

ISEM, CNRS, IRD, EPHE, Univ. Montpellier, Montpellier, Place Eugène Bataillon, 34090 Montpellier, France

Hatching in an aquarium: first insights from successful breeding of the spotted ratfish (*Hydrolagus colliei*)

1. Fidji, Berio; ISEM, CNRS, IRD, EPHE, Univ. Montpellier, Montpellier, Place Eugène Bataillon, 34090 Montpellier, France.
2. Raphaël, Charron; Planet Ocean Montpellier, Allée Ulysse Odysseum, CS 79562, 34960 Montpellier Cedex 2, France.
3. Jean-Marie, Dagouret; Planet Ocean Montpellier, Allée Ulysse Odysseum, CS 79562, 34960 Montpellier Cedex 2, France.
4. Florent, De Gasperis; Planet Ocean Montpellier, Allée Ulysse Odysseum, CS 79562, 34960 Montpellier Cedex 2, France.
5. Aurore, Éon; Planet Ocean Montpellier, Allée Ulysse Odysseum, CS 79562, 34960 Montpellier Cedex 2, France.
6. Lola, Lambert; Planet Ocean Montpellier, Allée Ulysse Odysseum, CS 79562, 34960 Montpellier Cedex 2, France.
7. Emmanuel, Meunier; VETOFISH, 7 Rue de la Salamandre, 13220 Chateauneuf-les-Martigues, France.
8. Morrigane, Simonet; Planet Ocean Montpellier, Allée Ulysse Odysseum, CS 79562, 34960 Montpellier Cedex 2, France.
9. Nathalie, Verschraegen; Planet Ocean Montpellier, Allée Ulysse Odysseum, CS 79562, 34960 Montpellier Cedex 2, France.
10. Nicolas, Hirel; Planet Ocean Montpellier, Allée Ulysse Odysseum, CS 79562, 34960 Montpellier Cedex 2, France.

Among the numerous aquatic species displayed in aquaria worldwide, chimaeroid fishes play a special role. Not only these scarce and delicate species are very attractive to the visitor's education but they still have unsuspected ecological adaptations to deep-sea environments. Knowledge of these adaptations and life traits of deep-sea species are key elements to their conservation, even for species that are not directly endangered by anthropic activities. The basic nutritional and environmental needs of spotted ratfish (*Hydrolagus colliei*) are known, however, husbandry and breeding of this species still require crucial information to be successfully achieved. Successful breeding was first reported in Japan in early 2000 with barely one year of survival. In Europe, the EUAC Ratfish Monitoring Program reported mating behaviors between captive *H. colliei* specimens as well as egg-laying for more than two decades. However, few hatchings only were reported between 2008 and 2015, with subsequent poor survival rates. Since 2018, Planet Ocean Montpellier (POM, France) aquarists observed an increased number of egg cases in tanks, inducing a greater number of hatchings in 2019. To date, the oldest *H. colliei* specimens born in captivity at POM are more than three years old. Since 2019, egg cases and juveniles are closely monitored and embryonic development is regularly recorded. This presentation will focus on *H. colliei* husbandry and breeding at POM, in an attempt to reconcile observations from aquarists and research. It will include environmental and developmental data that have been collected for 16 years on embryos, juveniles, and mature specimens.

Keywords: chimaera; breeding; aquarium

SI Abstract Ref: 44

David Jimenez Alvarado

IU-EcoAqua, University of Las Palmas de Gran Canaria.

New mechanism for the identification of nursery areas of the Critically Endangered Angelshark (*Squatina squatina*) in the Canary Islands archipelago.

1. David Jiménez Alvarado; IU-EcoAqua, University of Las Palmas de Gran Canaria & Angel Shark Project: Canary Islands
2. Eva Meyers; Zoological Research Museum Alexander Koenig & Angel Shark Project: Canary Islands
3. Michael Sealey; Angel Shark Project: Canary Islands
4. Maria Belén Caro; Angel Shark Project: Canary Islands
5. Hector Toledo; Angel Shark Project: Canary Islands
6. Charlotte Pike; Zoological Society of London & Angel Shark Project: Canary Islands
7. Joanna Barker; Zoological Society of London & Angel Shark Project: Canary Islands

The Angelshark (*Squatina squatina*) is listed as Critically Endangered by the IUCN and the Spanish Catalogue of Endangered Species. It has suffered a decline across Europe of at least 80% during the last century, mainly attributed to overfishing and habitat degradation. However, a uniquely large stronghold for this species remains in an island archipelago in the middle of the East Atlantic Ocean – the Canary Islands.

In the Canary Islands this species has an idyllic place to develop its life cycle, with no trawling or directed fishing activity, a variety of environmental conditions and abundant prey. A key part of their life cycle occurs in nursery areas, where the offspring are born and spend their first life stages. Since 2015, the Angel Shark Project: Canary Islands (ASP:CI) has conducted different studies focused in these areas, designed to assess nursery area criteria established by Heupel *et al.* 2007. ASP:CI have then developed a point-based mechanism to compare different sites and identify those that are confirmed, potential and possible nursery areas.

To date, ASP:CI have discovered seven confirmed nursery areas, six potential nursery areas and 42 sites where juveniles are present but need further study. Further, this talk will describe some of the environmental and biological drivers of juvenile Angel shark distribution across the archipelago.

ASP:CI nursery area research was funded by Shark Conservation Fund, Disney Conservation Fund, Save our Seas Foundation, The Biodiversity Consultancy, BIAZA, German Elasmobranch Group and WWF Netherlands.

Keywords: Angelshark; *Squatina squatina*; nursery area; Squatinidae; Canary Islands

SI Abstract Ref: 366

Mia Groeneveld

Department of Genetics, Stellenbosch University, South Africa

Towards resolving genetic differences and population distributions of rhino rays from the Southwest Indian Ocean region

1. Mia J. Groeneveld; Department of Genetics, Stellenbosch University, South Africa
2. Aletta E. Bester- van der Merwe; Department of Genetics, Stellenbosch University, South Africa
3. Aidan, Price; Department of Genetics, Stellenbosch University, South Africa
4. Juliana D. Klein; Department of Genetics, Stellenbosch University, South Africa
5. Michaela, van Staden; Department of Genetics, Stellenbosch University, South Africa
6. Mark E. Bond; Department of Biological Sciences, Florida International University, Florida, USA
7. David A. Ebert; Pacific Shark Research Center, Moss Landing Marine Laboratories, Moss Landing, USA and South African Institute for Aquatic Biodiversity
8. Jeremy, Kiszka; Department of Biological Sciences, Florida International University, Florida, USA
9. John, Nevill; Environment Seychelles, Mahé, Seychelles
10. Angus, Macdonald; School of Life Sciences, University of KwaZulu-Natal, South Africa
11. Bruce, Mann; Oceanographic Research Institute, Durban, South Africa
12. Rhett, Bennett; Wildlife Conservation Society
13. Katie S. Gledhill; Fish Ecology Lab, University of Technology Sydney, Broadway, Sydney, Australia

Rhino rays or wedgefishes (*Rhynchobatus spp*) are threatened by illegal trade globally and in the Southwest Indian Ocean (SWIO) due to their high-value fins on the international shark-fin market. *Rhynchobatus australiae* and *Rhynchobatus djiddensis* are classified as Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species, yet little is known about the distribution of genetic diversity and populations across the SWIO region. This hinders assessments of population trends that are required for effective conservation strategies. Previous molecular species identification confirmed all samples from South Africa and Mozambique to be *R. djiddensis* while those from Madagascar, Tanzania and Seychelles were identified as *R. australiae*. Here we investigated the genetic diversity and connectivity within and between species and sampling locations using sequence data from three mitochondrial gene regions (cytochrome oxidase I, nicotinamide adenine dehydrogenase subunit 2, mitochondrial control region) and 9 nuclear microsatellite markers developed from high-throughput sequencing data. We also developed molecular resources to aid in accurate species identification and

subsequent genetic analysis, including complete annotated mitogenomes of *R. djiddensis* and *R. australiae* and optimized eDNA (environmental DNA) metabarcoding assays based on the 12S and 16S ribosomal RNA gene regions. This knowledge could further the genetic characterization of populations of these and related species and promote the taxonomic resolution of the *Rhynchobatus* species complex.

Keywords: Ion Torrent sequencing; microsatellites; mitochondrial DNA; mitogenomes; wedgefish

SI Abstract Ref: 4

Héctor Toledo Padilla

Angel Shark Project: Canary Islands

The value of scientific data, citizen science, and collaboration with stakeholders in developing a Recovery Plan

1. Héctor Toledo; Angel Shark Project: Canary Islands
2. Eva Meyers; Zoological Research Museum Alexander Koenig & Angel Shark Project: Canary Islands
3. Joanna Barker; Zoological Society of London & Angel Shark Project: Canary Islands
4. David Jiménez-Alvarado; Universidad de Las Palmas de Gran Canaria & Angel Shark Project: Canary Islands
5. Charlotte Pike; Zoological Society of London & Angel Shark Project: Canary Islands
6. Michael Sealey; Angel Shark Project: Canary Islands
7. Belén Caro; Angel Shark Project: Canary Islands

The Canary Islands have been identified as a unique stronghold for the Angelshark, *Squatina squatina*, because it can be seen relatively frequently by divers and fishers. The species is highly susceptible to accidental capture in fisheries and habitat degradation, due to its benthic ecology and coastal location. This has caused the species to be listed as Critically Endangered on the IUCN Red List, and action is required for its protection.

In 2019, Angelsharks were listed in the Spanish Endangered Species List for Canary Islands waters, under “In danger of extinction” (highest category within this legislation). In accordance with this listing, it was required that a Recovery Plan be developed, including appropriate measures for the management and conservation of Angelsharks.

Angel Shark Project: Canary Islands (ASP:CI) ran a series of in-person and online surveys to collate information on Angelshark interactions, perceptions and possible measures to improve their protection with three main user groups: divers, recreational fishers and commercial fishers. This information was used alongside ASP:CI scientific data and a collaborative workshop with stakeholder representatives to identify the location of conservation areas and co-design specific conservation measures in order to safeguard the future of Angelsharks in their uniquely large stronghold. This presentation will outline our key findings and the importance of using a participatory approach to design conservation measures for a Critically Endangered species. This work, led by ASP:CI, was funded by Shark Conservation Fund and through a contract with the Canary Islands Government, co-financed by the FEDER 2014-2020 Operational Program.

Keywords: Angelshark; Canary Islands; recovery plan; co-design; conservation measures

SI Abstract Ref: 287

Renata Daldin Leite

Universidade Federal do Paraná (UFPR)

Dichlorodiphenyldichloroethylene (DDE), a legacy agrochemical metabolite, in the Critically Endangered Brazilian guitarfish *Pseudobatos horkelii* from Southeastern Brazil

1. Renata Daldin, Leite; Universidade Federal do Paraná (UFPR)
2. Ana Paula Chaves, Silva; Universidade de São Paulo (USP)
3. Eloísa Pinheiro, Giaretta; Universidade Federal do Paraná (UFPR)
4. Natascha, Wosnick; Universidade Federal do Paraná (UFPR)
5. Natalia, Guimarães; Universidade Federal do Rio de Janeiro (UFRJ)
6. Amanda Pontes, Lopes; Fundação Oswaldo Cruz (Fiocruz)
7. Francieli Casanova, Monteiro; Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio)
8. Carlos, Massone; Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio)
9. Renato, Carreira; Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio)
10. Marcelo, Vianna; Universidade Federal do Rio de Janeiro (UFRJ)
11. Rachel Ann, Hauser-Davis; Fundação Oswaldo Cruz (Fiocruz)

Dichlorodiphenyltrichloroethane (DDT) is a broad-spectrum pesticide banned in Brazil since 1998. One of its main metabolites, dichlorodiphenyldichloroethylene (DDE), is highly persistent, fat-soluble and extremely toxic to aquatic organisms. Scarce studies in elasmobranchs are available, and none have been performed for the Brazilian guitarfish *Pseudobatos horkelii*. Herein, DDE concentrations were determined in the livers of 22 Brazilian guitarfish individuals, five non-pregnant adult females, two pregnant females, 10 embryos (eight females, two males) and five adult males and correlated to the hepatosomatic index (HSI), gonadosomatic index (GSI) and condition factor (CF) for all groups. Maternal transfer was confirmed, as embryos contained detectable amounts of DDE, albeit lower than in all adult groups. Higher concentrations were found in adult males compared to non-pregnant adult females and embryos, and intermediate values were observed for adult pregnant females. The

higher values observed in males may reflect the maternal contaminant offloading processes through female ovulation and pregnancy processes, resulting in lower DDE concentrations, as noted for other elasmobranchs. The positive correlations noted between DDE and the IHS and negative correlations between DDE concentrations and the IGS for all groups (including embryos) indicate potentially deleterious systemic health effects for the liver and reproductive systems, respectively, beginning in the womb and indicating serious concerns for the species. Finally, negative correlations between DDE concentrations and the FC indicate that this pesticide metabolite may result in potential general health effects. This is the first study to assess DDE concentrations and maternal offloading processes in this Critically Endangered species.

Keywords: legacy agrochemicals; organochlorine pesticide; maternal contaminant offloading; DDE; morphometric indices
SI Abstract Ref: 279

Ryan J. Nevatte

School of Natural Sciences, Macquarie University, North Ryde, New South Wales, Australia

Population structure of commercially fished sawsharks in southern Australia

1. Jane E. Williamson; School of Natural Sciences, Macquarie University, North Ryde, New South Wales, Australia
2. Barbara E. Wueringer; School of Natural Sciences, Macquarie University, North Ryde, New South Wales, Australia; Sharks and Rays Australia, PO Box 575, Bungalow, Queensland, Australia
3. Michael R. Gillings; School of Natural Sciences, Macquarie University, North Ryde, New South Wales, Australia

Sawsharks are demersal sharks characterised by a distinctive saw-like rostrum with a pair of long barbels on the ventral surface. In Australia, two sawshark species – the common (*Pristiophorus cirratus*) and southern (*P. nudipinnis*) sawshark – are frequent by-catch in commercial fisheries and sold for human consumption. Although harvesting is currently considered sustainable, much of the biology of these sharks is poorly understood. In particular, it is unknown whether these species display genetically distinct populations throughout their ranges. Such information is necessary for effective management decisions in fisheries.

We examined whether *P. cirratus* and *P. nudipinnis* display genetically distinct populations in the waters of southern Australia. Analysis of two mitochondrial genes (Cytochrome-b and ND5) indicated that the two species are structured differently, with *P. cirratus* consisting of two populations and *P. nudipinnis* consisting of one population. Tests for population expansion also highlighted differences between the species. Signatures of population expansion were detected in *P. nudipinnis* whilst *P. cirratus* showed an overall signature of stable population size, with evidence of expansion in one mitochondrial lineage. The observed population structure and expansion signatures are likely due to oceanographic changes in southern Australia during the Pleistocene. These results provide important information for management of sawsharks in commercial fisheries and demonstrate that population structure in closely related species within the same region can differ, and therefore requires investigation at the species level.

Keywords: population genetics; fisheries; *Pristiophorus*; biogeography
SI Abstract Ref: 251

Cat Gordon

The Shark Trust

Conservation planning for angel sharks in the Mediterranean

Cat A Gordon, Ali R Hood

Angel sharks (Squatinae) are amongst the most threatened families of chondrichthyan species, with 13 of the 23 described species in a threat category. Reliance often falls on reports of incidental catch, citizen science, social media, and interviews with fishers to increase knowledge of distribution. Over recent years, in the wake of the Eastern Atlantic and Mediterranean Angel Shark Conservation Strategy and inception of the Angel Shark Conservation Network, many more records have been unearthed from the Northeast Atlantic and Mediterranean.

The Mediterranean Angel Sharks: Regional Action Plan sets out a roadmap for the three Critically Endangered species encountered in this region - Sawback Angelshark (*Squatina aculeata*), Smoothback Angelshark (*S. oculata*), and Angelshark (*S. squatina*). SubRegional Action Plans have since been developed for the Aegean Sea, Northern Levant Sea, Cyprus, Southern Ionian Sea and Tunisia, with a view to facilitating further coordinated action by engaging regional stakeholders (e.g. governments, industry) to better protect angel sharks.

Varying levels of management and compliance in each region means key policy actions are adapted according to requirement. In working with regional partners, focus is on advancing policy developments, implementing existing regulations, and improving fisher awareness/engagement to reduce bycatch mortality. Collaborative action is essential to build capacity for angel shark conservation.

Through the development of SubRegional Action Plans, along with the global angel shark ID guide, it's hoped that a spotlight will be shone on this threatened family and highlight the importance of catch monitoring and management measures to prevent other species from following declining trends.

Keywords: angel sharks; Squatinidae; implementation; conservation planning; Mediterranean

SI Abstract Ref: 207

Rossana Maguino

ecOceánica

Fisheries of the cryptic angelshark (*Squatina spp.*) in northern Peru

1. Rossana Maguino Napurí: ecOceánica
2. Daniella Biffi: ecOceánica, Texas Christian University
3. Keny Kanagusuku: Universidad Científica del Sur
4. Alejandra Mendoza: ecOceánica
5. Renán Flores García: Instituto Tecnológico Contralmirante Manuel Villar Olivera
6. María Isabel Sanjinez Medina: Instituto Tecnológico Contralmirante Manuel Villar Olivera
7. Gerson Talledo Peña: Universidad Nacional de Tumbes
8. Dean Williams: Texas Christian University
9. Shaleyla Kelez Sara: ecOceánica

Worldwide, angel sharks (family Squatinidae) are the third most threatened family of chondrichthyans. In the Southeast Pacific, two species are recorded: *Squatina californica* and *Squatina armata*. In Peru, between 1996 and 2001, the sixth most fished shark species was the *S. californica*. The catch of *S. californica* in Peru has declined by more than 90% between 2001 and 2020. A recent study conducted in Peru, confirmed the presence of *S. californica* and *S. armata*, and reported a potential third undescribed cryptic species (*Squatina sp.*). This study aimed to characterize the biology and fisheries of *Squatina spp.* in northern Peru. Five landing sites were evaluated between 2017 and 2019 (552 days). A total of 1,565 angelsharks were recorded (average total length 84.8 cm [SD=13.0, range: 27.7-101 cm], 56% female). Ninety-seven percent of the landings were from Puerto Pizarro (PP), the most northern site. Ninety-nine percent of the individuals landed in PP (n = 337) came from fishing areas in Ecuador. Tissue samples of 110 individuals were barcoded using the mitochondrial cytochrome c oxidase I (COI) gene. Sixteen samples were identified as *S. californica* and 94 as *S. sp.* Most of the *S. sp.* samples were from Puerto Pizarro (n = 78). The results are concerning since direct capture of sharks has been prohibited in Ecuador since 2007. Moreover, the study highlights the need for accurate landing reports in Peru given the steep decline of the total catch of angelsharks.

Keywords: Ecuador; DNA barcoding; illegal; bycatch; pregnant females

SI Abstract Ref: 181

Ryan Daly

1. Oceanographic Research Institute 2. South African Institute for Aquatic Biodiversity

Long-term catch trends and risk assessment of the Critically Endangered white-spotted wedgefish (*Rhynchobatus djiddensis*) from South Africa.

1. Ryan, Daly; Oceanographic Research Institute & South African Institute for Aquatic Biodiversity.
2. Denham, Parker; Department of Environment, Forestry and Fisheries & University of Cape Town.
3. Jeremy, Cliff; KwaZulu–Natal Sharks Board & University of KwaZulu–Natal.
4. Gareth, Jordaan; Oceanographic Research Institute.
5. Nkabi, Nomfundo; KwaZulu–Natal Sharks Board.
6. Rhett Bennett; South African Institute for Aquatic Biodiversity & Wildlife Conservation Society.
7. Bruce, Mann; Oceanographic Research Institute.

The white-spotted wedgefish (*Rhynchobatus djiddensis*) is a Critically Endangered shark-like ray in the family Rhinidae. Throughout its Western Indian Ocean distribution, it is targeted for its valuable meat and fins and is reported to have undergone major population declines. This study used two independent long-term (37 and 40 years) time-series catch data from competitive shore angling and shark nets to investigate the size composition and catch per unit effort (CPUE) and conduct a risk assessment for the population on the east coast of South Africa. From 1977 to 2017 the competitive shore fishery captured 7,703 individual *R. djiddensis*, whilst shark nets in the same region captured 2,856 individuals from 1981 to 2017. Although the mean annual sizes of net-caught individuals were above the size of reported sexual maturity, there was little evidence to suggest that any individuals captured were reproductively active. Standardized CPUE from the competitive shore fishery declined substantially between 1977 and 2017 and shark net catches exhibited a significant ($p < 0.05$) fourfold decline in annual nominal CPUE from 1981 to 2017. Ultimately, a risk assessment showed a 65.1% decline in abundance over a period of three generation lengths, which indicates that the sampled population of *R. djiddensis* in South Africa should be classified as Endangered. It is critical that the drivers of this population decline are identified and addressed to improve the conservation outcomes for this extremely vulnerable species.

Keywords: wedgefish; Critically Endangered; West Indian Ocean Conservation

SI Abstract Ref: 65

Lucy Mead

Institute of Zoology, Zoological Society of London; Queen Mary University of London

Spatio-temporal and sex-specific patterns of residency and space-use in adult Angelsharks (*Squatina squatina*) in Europe's largest marine reserve

1. Lucy Mead; Institute of Zoology, Zoological Society of London
2. David Jiménez Alvarado; Universidad de Las Palmas de Gran Canaria
3. Eva Meyers; Zoological Research Museum Alexander Koenig
4. Joanna Barker; Zoological Society of London
5. Michael Sealey; Angel Shark Project: Canary Islands
6. Maria Belén Caro; Angel Shark Project: Canary Islands
7. Hector Toledo; Angel Shark Project: Canary Islands
8. Charlotte Pike; Zoological Society of London
9. Matthew Gollock; Zoological Society of London
10. Adam Piper; Institute of Zoology, Zoological Society of London
11. Gail Schofield; Queen Mary University of London
12. David M.P. Jacoby; Lancaster University

Understanding of species distribution and space-use is an essential prerequisite for effective marine conservation and management, and with a third of all chondrichthyan species now threatened with extinction, a chronic lack of data on basic ecology compounds extinction risk for many species. *Squatina squatina* (hereafter Angelshark), a bottom-dwelling coastal shark, is currently listed as Critically Endangered on the IUCN Red List of Threatened Species. Despite recent conservation attention, there remains a significant lack of ecological data related to this species, and understanding of Angelshark behaviour, distribution and movement remains extremely limited. In the present study, acoustic telemetry was used to collect detailed data on movement, residency and space-use in adult Angelsharks within the La Graciosa Marine Reserve in the Canary Islands, with the aim of addressing key knowledge gaps and informing conservation policy. Between July 2018 and April 2022, 104 adult Angelsharks (72 females, 32 males) were tagged with acoustic transmitters and detected across 12 receivers. Significant sexual variation was found in space-use and seasonal presence in the study area, with results suggesting some localised sex-segregation outside of Winter months, when presence of both males and females peaked. While detections were concentrated in the shallow waters between La Graciosa and Lanzarote (up to 24m depth), notable use of an offshore location (86m depth) indicated utilisation of deep-water habitat, not previously observed in this species. The present findings have implications for Angelshark conservation, particularly in relation to sex-specific space-use and use of deep waters across the study area and more widely.

Keywords: Angelshark; *Squatina squatina*; acoustic telemetry; spatial ecology; sex segregation

SI Abstract Ref: 242

Joanna Barker

Zoological Society of London; Angel Shark Project; Project SIARC

Angel Shark Project: Wales – understanding the distribution, ecology and habitat use of Critically Endangered Angelsharks (*Squatina squatina*) in the northernmost part of their range.

1. Joanna Barker; Zoological Society of London | Angel Shark Project
2. Jake Davies; Zoological Society of London | Natural Resources Wales
3. Ben Wray; Natural Resources Wales
4. Nick Dunn; Imperial College London | Zoological Society of London
5. Isabel Apetroaie; Imperial College London
6. David Curnick; Zoological Society of London
7. Alice Chamberlain; Zoological Society of London
8. Charlotte Pike; Zoological Society of London
9. Sarah Davies; Zoological Society of London | Natural Resources Wales
10. Eva Meyers; Zoological Research Museum Alexander Koenig | Angel Shark Project
11. David Jiménez Alvarado; Universidad de Las Palmas de Gran Canaria | Angel Shark Project
12. Monika Goralczyk; Imperial College London
13. Surshii Patel; Zoological Society of London
14. John O'Connor; Welsh Federation of Sea Anglers
15. Jim Evans; Welsh Fishermen's Association
16. Rowland Sharp; Natural Resources Wales
17. Matthew Gollock; Zoological Society of London
18. Fenella Wood; University of Aberdeen
19. James Rosindell; Imperial College London
20. Charlie Bartlett; Fisher
21. Brett Garner; Fisher
22. Dafydd Jones; Fisher
23. Declan Quigley; Sea Fisheries Protection Authority

The Critically Endangered Angelshark (*Squatina squatina*) is part of one of the most threatened families of elasmobranch (sharks, skates & rays) in the world. Despite a predicted 58% decline in their geographic extent over the last 50 years, a population remains off the coast of Wales, in the northernmost part of their range. Angel Shark Project: Wales (ASP:W) was launched in 2018 with the aim to safeguard Angelsharks in Wales with fishers and coastal communities, using heritage, education and research.

Over the last five years, we have gathered 2,231 Angelshark records dating back to 1812 using a multidisciplinary approach via fisher engagement, archival research, digital platforms and a community roadshow across Wales. A combination of quantitative analysis, qualitative analysis and species distribution modelling have been used to interrogate the data and investigate Angelshark distribution and ecology in Wales.

We will present key insights from these analyses, specifically the spatial and environmental trends in Angelshark distribution and what biological parameters may be driving these. We will also highlight the importance of integrating community voices and local ecological knowledge within the study of rare species, and how the results contribute towards delivering the Wales Angelshark Action Plan.

ASP:W is funded by On the Edge, Welsh Government's Nature Networks Fund and National Lottery Heritage Fund, with in kind support from Natural Resources Wales.

Keywords: Angelshark; ecology; distribution; multidisciplinary; LEK

SI Abstract Ref: 334

Zachary Riskin

Large Marine Vertebrates Research Institute Philippines

Tails from the sea: pelagic thresher shark presence at a coastal seamount in the Ticao-Burias Pass protected seascape

1. Zachary Riskin, Large Marine Vertebrates Research Institute Philippines
2. Alessandro Ponzo, Large Marine Vertebrates Research Institute Philippines
3. Joshua Rambahiniarison, Large Marine Vertebrates Research Institute Philippines
4. Martina Spakowski, Large Marine Vertebrates Research Institute Philippines

Pelagic species presence at Manta Bowl in the TBPPS was investigated using remote underwater video surveys. Globally renowned as a reef manta ray (*Mobula alfredi*) cleaning station, this coastal seamount also hosts other endangered and protected species of megafauna including whale sharks (*Rhincodon typus*), oceanic manta rays (*Mobula birostris*), scalloped hammerhead sharks (*Sphyrna lewini*), and pelagic thresher sharks (*Alopias pelagicus*). This study discusses the presence of pelagic thresher sharks at Manta Bowl. Pelagic thresher sharks are classified as Endangered on the IUCN Red List and are vulnerable to overexploitation. This study took place between August 2018 and August 2019, with 335 out of 384 days (87.2%) monitored. There was pelagic thresher shark presence on 120 of these days (35.8% of total days monitored) with a total of 211 thresher shark encounters determined over the study period. The study found that 43.6% of thresher shark encounters took place in the late morning, and seasonal peak was observed during the cool dry months of the Amihan season (52.1% of encounters were recorded between December and February). Despite the listing of pelagic thresher sharks in the CITES appendix II in 2016 and its subsequent implementation in 2017, both targeted and non-targeted catch of the species continues unmonitored and unmanaged. Considering the declaration of the protected status of the Ticao Burias Pass Protected Seascape in 2018, this seamount represents a key habitat for the conservation of this species. As such, fishery management interventions are urgently needed.

Keywords: pelagic thresher sharks; coastal seamount; RUV surveys

SI Abstract Ref: 19

Jarius Bradley

CIBIO-InBIO,

Patterns of residency and space use of arctic skates (*Amblyraja hyperborea*) across a developing Arctic fishery ground

1. Jarius Bradley; University of Delaware
2. Nigel Hussey; University of Windsor
3. Aaron Carlisle; University of Delaware

Understanding residency patterns and space use of a species is key to implementation of sustainable and productive conservation management practices. Characterization of movement patterns of species within an ecosystem can provide insight into why animals use particular habitats, such as for feeding or reproduction, or how movements are regulated by various biotic or abiotic factors. Furthermore, by describing the fine scale movements of a species within an ecosystem, patterns of habitat use, movement corridors, and focal areas can be identified, at both the population or individual levels. Due to the logistical challenges of working in the Arctic, these types of studies have historically been limited compared to temperate or tropical climates. The Arctic Skate (*Amblyraja hyperborea*) is a high latitude, deep water species that is commonly caught as bycatch in both Canadian commercial and indigenous community fisheries. The life history characteristics of skates makes them vulnerable to overexploitation, and careful management is required. In this study, we used acoustic telemetry consisting of 81 receivers to study patterns of movement and residency of Arctic skates in Scott Inlet, Canada, the location of a developing community fishery for Greenland halibut. Our goal is to characterize residency patterns and space utilization of 52 skates across 6 years throughout the community fishing ground. The intent is to elucidate both how the skates distribute themselves within the region as well as identify how sex, size, and reproduction may impact these dynamics. Through understanding these movement metrics, bycatch of Arctic skate can be reduced and appropriate management formulated.

Keywords: fish conservation; ecosystem-based fisheries management; population dynamics; communities and ecosystems; elasmobranch ecology

SI Abstract Ref: 71

Walter Pisco

Instituto Politécnico Nacional (CICIMAR); MIGRAMAR

Habitat suitability of whale shark *Rhincodon typus* in the Eastern Tropical Pacific Ocean

1. Lic. Walter Pisco: Instituto Politécnico Nacional y MIGRAMAR
2. PhD. César Peñaherrera: MIGRAMAR
3. PhD. Alex Hearn
4. PhD. Héctor Guzman

Whale shark (*Rhincodon typus*) are listed as endangered by the International Union for Conservation of Nature (IUCN). The species is found globally in tropical and warm-temperate regions with high productivity. In the Eastern Tropical Pacific (ETP) it can be found in coastal and offshore waters from the Gulf of California (Mexico) to the coast of Perú, including offshore islands, where its presence has been associated with primary productivity systems and oceanic fronts present in the region. This study aims to describe the effect of sea surface temperature, current velocity, chlorophyll-a and bathymetry on the habitat suitability of whale sharks at important aggregation sites in the ETP. A total of 93 individuals were tagged using satellite transmitters during expeditions carried out between 2011 and 2012 along ETP. A total of 2399 occurrence data were obtained, which were then used to create species niche models for the ETP using Maxent model. Sea surface temperature explained 42% of the suitable habitat, followed by chlorophyll-a and current velocity with 33.5% and 20.2% respectively. Finally, bathymetry accounted for 3.9% of the model. The habitat suitability index was high in areas close to the equatorial strip and change seasonally. The models indicate that suitable habitat is related to areas where non-directed fisheries can affect the shark, as well as other threats such as entanglements and ship strikes. This information contributes to the knowledge that should be considered in management measures for the conservation of the species.

Keywords: climate preferences; niche; distribution; fundamental niche; habitat mapping

SI Abstract Ref: 120

Olaia Cacho Movellan

CICIMAR-IPN

Shark abundance and the effect of recreational diving in the Revillagigedo Archipelago

Olaia Cacho Movellan; CICIMAR-IPN and Pelagios KAKUNJA

The Revillagigedo Archipelago is a region of great ecological importance, and it is considered a hub shark conservation. The presence of nine species of sharks in the area attracted diving activity within the park since 1980's. The present study aims to determine the abundance of sharks using two methodologies: visual censuses (UVC) and baited underwater video stations (BRUVS), as well as to evaluate the effect of recreational diving on sharks. Relative abundances of various shark species per dive site and per sampling year (2015-2019) were calculated for UVCs and constrained by MaxN for BRUVS (2014). Contingency tables were made to determine significant differences in the abundance of the five most abundant shark species associated to site and year. *Triaenodon obesus* was the most abundant shark with 90% occurrence in 2018, followed by *Sphyrna lewini* 80% in 2015. We found significant differences ($p < 0.05$) in the abundances related to the site and year of sampling. On the other hand, six species were recorded in the BRUVS, but only two were the most abundant: *Carcharhinus albimarginatus* and *Carcharhinus falciformis*. Roca Partida was the most sampled place with a total of 270 dives, followed by El Boiler with 139 dives. We found a higher probability of observing larger groups of sharks with smaller groups of divers, however, this was not significant. Therefore, the Revillagigedo archipelago serves as a refuge for different species of sharks, with Roca Partida being the site with the greatest abundance.

Keywords: visual censuses; baited underwater video stations; generalized additive models

SI Abstract Ref: 14

Natalie Klinard

Integrated Fisheries Lab, Department of Biology, Dalhousie University

Exploring the seasonality of coastal reef shark populations worldwide

1. Natalie Klinard; Integrated Fisheries Lab, Department of Biology, Dalhousie University
2. Christopher Mull; Integrated Fisheries Lab, Department of Biology, Dalhousie University
3. M. Aaron MacNeil; Integrated Fisheries Lab, Department of Biology, Dalhousie University

Reef sharks have experienced widespread declines across much of the world's coral reefs as a result of decades of overexploitation. Large knowledge gaps regarding the abundance of reef sharks worldwide have limited effective restoration and management of coastal shark populations. Although recent research has assessed the global status of reef sharks, it presents a snapshot in time with little indication of temporal variability in abundance. Identifying how seasonal changes in the environment influence abundance is important to ensure sampling is conducted at appropriate temporal scales to accurately quantify abundance, assess the role of reef sharks within communities and ecosystems, and ultimately implement suitable

monitoring and management strategies. To explore seasonality in coastal reef shark populations worldwide, we used data from baited remote underwater video systems (BRUVS) in 371 sampling locations as part of a dedicated global survey across 58 countries, states, and territories. We developed a set of Bayesian hierarchical models that incorporate a continuous seasonal function to develop a predictive model of reef shark seasonality in abundance globally. Determining how seasonality influences reef shark abundance worldwide provides context to global catch records and abundance measures, allowing us to refine and standardize abundance estimates, and aiding in determining the most appropriate time of year for sampling.

Keywords: FinPrint; BRUVS; abundance; seasonality; coral reefs

SI Abstract Ref: 189

Jeremy Vaudo

Guy Harvey Research Institute, Nova Southeastern University

Long-term movements of silky sharks, *Carcharhinus falciformis*, in the Eastern Tropical Pacific Ocean

1. Jeremy Vaudo; Guy Harvey Research Institute, Nova Southeastern University and Save Our Seas Foundation Shark Research Center, Nova Southeastern University
2. Pelayo Salinas de León; Save Our Seas Foundation Shark Research Center, Nova Southeastern University and Charles Darwin Foundation
3. Ryan Logan; Guy Harvey Research Institute, Nova Southeastern University and Save Our Seas Foundation Shark Research Center, Nova Southeastern University
4. Bradley Wetherbee; University of Rhode Island and Guy Harvey Research Institute, Nova Southeastern University
5. Mahmood Shivji; Guy Harvey Research Institute and Save Our Seas Foundation Shark Research Center, Nova Southeastern University

Despite the silky shark, *Carcharhinus falciformis*, being ubiquitous in tropical and sub-tropical pelagic waters and the second most common species found in the fin trade, little is known about its long-term horizontal movements. We tagged 40 silky sharks (7 males and 33 females) within the Galapagos Marine Reserve (GMR) with SPOT satellite tags during February and July 2021. Sharks were tracked for up to 374 days, with 25 sharks tracked for over 200 days and 18 sharks for over 300 days. All but one shark left the GMR, however, sharks were observed within the reserve during all months of the study and individuals were often in the reserve for months at a time. The number of sharks present within the reserve per month tended to decrease over the course of the year, but increased during February and March 2022, suggesting the Galapagos Islands may serve as a seasonal aggregation site. Female sharks leaving the reserve often displayed directional western movement traveling up to ~4000 km from the reserve. Despite large longitudinal movements, these movements were markedly latitudinally constrained, with most shark locations falling between the equator and 5° N latitude. Male sharks did not make long directional movements. Overall, for a wide-ranging species, silky sharks spent a great deal of time within the protected waters of the GMR, but their seasonal movements still put them at risk from commercial fisheries operating in the region, evidenced by the capture of three of the tagged sharks to date.

Keywords: satellite telemetry; habitat use; tracking; pelagic

SI Abstract Ref: 200

Rachel Bustamante

Earth Law Center

Rights of nature approach to Shark conservation: a Panama case study

Rachel, Bustamante, Earth Law Center

On February 24, 2022 Panama's President, Laurentino Cortizo, signed Law 287, "that recognizes the rights of Nature and the obligations of the state related to these rights". This signifies a shift to a proactive conservation approach, recognizing the intrinsic worth and inherent Rights of Nature, while offering an opportunity to fulfill gaps in national legislation. By extension, this law recognizes the rights of Sharks and their habitats.

This talk analyzes the threats depleting Shark populations while presenting ample evidence to justify enhanced conservation to sustain the ecological role of this species. Panama, one of the most biodiverse countries worldwide, was selected as a case study due to the country's demonstrated efforts to environmental conservation, including the country's legal recognition of the Rights of Nature (having now been enacted in law and policy in more than thirty-five countries worldwide), as well as the observed high presence of industrial and artisanal fishing that threatens several species with extinction. This case can act as a microcosm of the conflicting economic interests that prevent enhancing Shark protection, while highlighting imaginative opportunities for holistic, rights-based and equitable solutions. For example, opportunities will be explored to implement Law 287 through supplementary conservation policy based upon best available science to conserve and restore Sharks, thereby helping safeguard the capacity of marine sustenance, coastal economies, and the future health of the Ocean against climate impacts, and in fact, to help retain the country's very name meaning—"abundance of fish".

Keywords: Rights of Nature; Rights-based approaches; Shark Conservation Policy; Panama

SI Abstract Ref: 83

Devanshi Kasana

Florida International University

Tracking shark fisheries and meat trade in Central America

1. Devanshi Kasana; Florida International University
2. Hector Daniel Martinez; Belize
3. Jessica Quinlan; Florida International University
4. Elisa Areano; Fundación Mundo Azul
5. Julio Francisco Sánchez Jiménez; Fundación Mundo Azul
6. Ana Paula Barbosa Martins; Dalhousie University
7. Christopher Mull; Dalhousie University
8. Elizabeth Babcock; University of Miami
9. M Aaron MacNeil; Dalhousie University
10. Demian Chapman; Mote Marine Laboratory

Global demand for shark products continues to drive overexploitation in many nations. Understanding the trade and consumption of shark-derived products is currently dominated by literature focusing on shark fins while markets for shark meat on global, regional, and domestic scales remain poorly understood. However, the trade in shark meat continues to surpass fins contributing to food security and livelihoods in many coastal areas of the world. To understand the global trade in shark meat and the fisheries supplying these markets, it is crucial to build baselines for catch and consumption at national scales. We investigate one important supply chain in Central America, which is predominantly driven by the demand for shark meat. Shark meat is infrequently consumed in Belize yet shark fishing occurs there to supply an export market in neighbouring Guatemala, where seasonal demand for shark meat peaks during the Catholic Lenten season. We disaggregated landings and trade data in Belize to the species level using multiple approaches and found trade from Belize to Guatemala involves at least 19 shark species, including several listed on the Convention on International Trade of Endangered Species (CITES). We will present species-specific baselines for production and consumption in both nations based on DNA barcoding of markets. This information will bridge critical knowledge gaps in understanding the regional dynamics of shark meat trade in Central America. Understanding this trade network has implications for the management of domestic fisheries in these nations, the implementation of international trade regulations, and the conservation of species supplying this demand.

Keywords: shark meat; Central America; trade; consumption; CITES

SI Abstract Ref: 127

Nidhi Gloria D'Costa

Recent Graduate from Marine Affairs Program, Dalhousie University, Halifax, NS B3H 4R2, Canada; Research Assistant at Worm Lab, Department of Biology, Dalhousie University, Halifax, NS B3H 4R2, Canada

Identifying priority areas for shark conservation through the lens of global anti-finning legislations

1. Nidhi, D'Costa; Marine Affairs Program, Dalhousie University, Halifax, NS B3H 4R2, Canada.
2. Laurene, Schiller; School of Public Policy and Administration, Carleton University, 1125 Colonel by Dr, Ottawa, ON K1S 5B6, Canada.
3. Leonardo, Feitosa; Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, United States.
4. Sara, Orofino; Environmental Markets Lab, University of California, Santa Barbara, 93117, United States.
5. Echelle, Burns; Environmental Markets Lab, University of California, Santa Barbara, 93117, United States.
6. Darcy, Bradley; Environmental Markets Lab, University of California, Santa Barbara, 93117, United States.
7. Boris, Worm; Department of Biology, Dalhousie University, Halifax, NS B3H 4R2, Canada.

Shark conservation is being hampered by increased fishing pressure and regulatory shortcomings in many regions, resulting in population losses for several species. A growing market for high-value shark fins, has fueled much of the demand for shark products since the 1990s. National and international policy has tried to end the wasteful practice of shark finning by requiring sharks to be landed whole and with their fins naturally attached (FNA), or even prohibiting shark fishing entirely in so-called shark sanctuaries. This study examines anti-finning regulations across 278 exclusive economic zones (EEZs) and four regional fisheries management organizations (RFMOs). Results show that as of 2020 only 36.7% (n=102) of EEZs were covered by a FNA ban and only around 10% (n=28) of EEZs had a complete ban on shark fishing. Some of the largest shark fishing countries (e.g., Pakistan, Iran) had weak legislation. Thirteen expert interviews were undertaken to contextualize and cross-reference these analyses. Over the last two decades, all respondents indicated a declining (n=11) or constant (n=2) trend in shark finning, with rising use of whole sharks and growing markets for shark meat and other goods. Overall, these findings point to places where existing procedures should be strengthened and present regulations can be improved to reduce shark finning and, eventually, shark mortality, at both the RFMO and national levels.

Keywords: finning; anti-finning bans; shark sanctuaries; EEZs; tRFMOs

SI Abstract Ref: 142

Sarah J. Nicholson

Toronto Metropolitan University (formerly Ryerson University)

We are unwittingly wearing shark: an analysis of squalene origin in finished cosmetics.

Sarah J. Nicholson; Toronto Metropolitan University

Anthropogenic activities, including exploitative fishing to harvest shark liver oil for cosmetic use, pose a significant threat to sharks. While trade records and routes for shark fins and meat are relatively well documented, little is known about the use and distribution of other commodities like shark liver oil. We do know shark liver oil is the richest natural source for squalene, that the squalene market was valued at \$129 million USD in 2020, and that the cosmetic industry is squalene's principal end use market. Endpoint market monitoring is crucial for improving our understanding of the shark trade, and tracking compliance with trade laws and sourcing policies. Carbon ratio analysis of $\delta^{13}\text{C}$ using gas chromatography - combustion - isotope ratio mass spectrometry (GC-C-IRMS) has been shown to successfully determine squalene's source even in finished cosmetic samples of mixed squalene origin. A 2015 study used this method to test skin creams, and found that 20% contained shark squalene. Here we complete a broader investigation of squalene's use and composition in different types of cosmetic products. Using GC-C-IRMS, we found shark squalene in 26% of cosmetic samples, and in 31% of these cases, squalene was of a mixed plant/shark origin. Half of the top 20 global beauty brands contain shark squalene, 89% of products containing shark squalene identify as cruelty-free, and 37% identify as vegan. This research points to the urgent need for species-specific analysis of the shark squalene in trade, and greater transparency and oversight in the cosmetic industry.

Keywords: squalene; squalane; shark liver oil; cosmetics; makeup

SI Abstract Ref: 147

Chelsey Young
NOAA Fisheries Service

Conserving the threatened oceanic whitetip shark (*Carcharhinus longimanus*) in the U.S. Pacific Islands and beyond

1. Chelsey Young; NOAA Fisheries Service, Pacific Islands Regional Office
2. David O'Brien; NOAA Fisheries Service, Pacific Islands Regional Office
3. Asuka Ishizaki; NOAA Fisheries Service, Western Pacific Regional Fishery Management Council
4. Mark Fitchett; NOAA Fisheries Service, Western Pacific Regional Fishery Management Council
5. John Carlson; NOAA Fisheries Service, Southeast Fisheries Science Center

The oceanic whitetip shark (*Carcharhinus longimanus*) was described historically as one of the most abundant pelagic shark species in tropical seas worldwide. Currently, the species is classified as Critically Endangered under the IUCN Red List and listed as threatened globally under the U.S. Endangered Species Act due to significant population declines and threats of overfishing and the international shark fin trade. In the Western and Central Pacific, the species has declined by more than 90% since 1995, with bycatch-related mortality in pelagic longlines representing the most significant source of mortality. In efforts to conserve the oceanic whitetip shark in U.S. Pacific waters, NOAA Fisheries has taken targeted steps under domestic authorities to end overfishing and recover the species. These steps include developing a draft recovery plan highlighting necessary recovery actions for the Western and Central Pacific population. It also includes developing regulations and international recommendations to end overfishing, including an industry-led initiative to require a gear change in Hawaii's pelagic longline fishery from wire leaders to monofilament and minimize trailing gear to increase survivorship of hooked oceanic whitetip sharks. While these efforts are expected to help end overfishing and contribute to the recovery of oceanic whitetip sharks in the region, the species is highly migratory, occurs in the waters of 50+ countries, and is caught incidentally in numerous fisheries throughout the region, with the United States representing only ~5% of the total catch. Therefore, international collaboration will be critical to successfully conserving the oceanic whitetip shark beyond U.S. waters.

Keywords: oceanic whitetip shark; threatened species; conservation; fisheries management
SI Abstract Ref: 178

Ana Barbosa Martins
Dalhousie University

Uncovering the Shark Meat Trade in Brazil

1. Ana Barbosa Martins; Dalhousie University
2. João Braullio L. Sales; Universidade Federal do Pará
3. Jonathan S. Ready; Universidade Federal do Pará
4. Jorge Nunes; Universidade Federal do Maranhão
5. Natascha Wosnick; Universidade Federal do Paraná
6. Rachel Hauser-Davis; Fundação Oswaldo Cruz
7. Paulo dos Santos; Universidade Estadual Paulista
8. Jones Santander-Neto; Instituto Federal de Educação, Ciência e Tecnologia do Espírito Santo
9. Marcio de Araujo Freire; Universidade Federal do Rio Grande
10. Luis Gustavo Cardoso; Universidade Federal do Rio Grande
11. Cezar Fernandes; Universidade Federal do Delta do Parnaíba
12. Lucas Werner; Associação de Tubarões da Costa - RN
13. Cláudio L. S. Sampaio; Universidade Federal de Alagoas
14. Luis Rodrigues-Filho; Universidade Federal do Pará
15. Christopher Mull; Dalhousie University
16. Elizabeth Babcock; University of Miami
17. Aaron MacNeil; Dalhousie University

Understanding the trade in shark and ray meat is challenging given the overall lack of data, with uncertainty surrounding total volume and species composition of catches, domestic consumption, imports, and exports. Additionally, marketing of shark and ray meat under different or broad generic names (e.g., *cação*, *arraia*) distorts fisheries statistics and consumer transparency. This challenge is particularly acute in Brazil, a top fishing nation and the largest importer of shark and ray meat in the world, resulting in high production and demand, as well as diverse and widespread markets, both national and international. Recognizing Brazil's major role in the meat trade and the potentially increasing threats to shark and ray populations, the primary focus of this study is to uncover the shark and ray meat trade along the coast of Brazil. We conduct surveys at important landing sites for sharks and rays, fish markets, and supermarkets across 10 coastal states. Various methods are applied for data collection, such as photographs, samples of biological material for DNA sequencing, and interviews with stakeholders. This information is critical for a comprehensive understanding of the use of shark and ray meat for livelihoods, and the impacts of catch and trade of shark and ray meat along the Brazilian coast, helping to identify species at potential risk of extinction, contributing to CITES listings, and promoting sustainable fisheries strategies.

Keywords: Elasmobranchii; Fisheries; Shark Trade; ;
SI Abstract Ref: 113

Leonardo Manir Feitosa

Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, USA

Refining the distribution and assessing the extinction risk of *Sphyrna tudes*

1. Leonardo, Manir Feitosa; Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, USA.
2. Christopher, Mull; Department of Biology, Dalhousie University, Halifax, NS B3H 4R2, Canada.
3. Ana Paula, Barbosa Martins; Department of Biology, Dalhousie University, Halifax, NS B3H 4R2, Canada.

Sphyrna tudes is a small-bodied, poorly understood species of hammerhead shark. In 2019 *S. tudes* was listed as Critically Endangered by the IUCN, with an estimated population reduction of 80% or more across its range in less than 40 years. The rapid decline of *S. tudes* can be attributed to overfishing, mostly as bycatch in gillnet fisheries targeting the Acoupa weakfish and shrimp trawling, as well as coastal habitat degradation across its limited geographical and depth range. Unfortunately, the distribution of *S. tudes* has been mistakenly reported over decades, mainly due to errors in species identification or inaccurate species distribution models. Here, we refine *S. tudes* distribution by cross-validating species distribution models (SDMs) with a comprehensive literature review and individual record checking, and assess its spatial extinction risk through Bayesian Additive Regression Trees (BART). Our SDM results demonstrate that, while suitable habitat extends from southeastern Brazil to the Gulf of Mexico, the most important region in the world for this species is likely to be Northern South America. Given that suitable habitat is constrained to coastal areas and dissolved oxygen was the most important variable for the SDMs, we employed the BART with two possible scenarios: (1) fishing pressure reduced to zero and (2) mangrove areas increased by 100%. Our analyses demonstrate that *S. tudes* has a smaller suitable range than previously considered with intensive fishing pressure, and its capture in fisheries need to significantly decrease to avoid extinction.

Keywords: small-eye hammerhead shark; Critically Endangered; species distribution models; Bayesian Additive Regression Trees; Western Atlantic Ocean

SI Abstract Ref: 201

Jaime Penadés-Suay

Associació LAMNA; Universitat de València

How geography and specificity determine tapeworm communities of blue sharks (*Prionace glauca*)

1. Jaime, Penadés-Suay; Associació LAMNA; Universitat de València
2. Ana, Jarque-Rico; Universitat de València
3. Jesús, Tomás; Universitat de València
4. Francisco Javier, Aznar; Universitat de València

Over the last two decades there has been an effort to unveil community patterns of elasmobranch cestodes at a macroecological scale, but analyses at infracommunity level are still scarce. In this work the helminth community parasitizing 37 blue sharks (*Prionace glauca*), both juveniles and adults, is described and compared with previous studies, performing a global assessment of the relative role of the ecological and evolutionary factors in structuring their local tapeworm assemblages. Shark came from two different non previously surveyed regions: Northeast Atlantic (Galicia, Spain) and Western Mediterranean (Valencia, Spain). Helminths from nine different taxa were identified, of which four presented adult specimens and have already been describe infecting blue sharks: *Platybothrium auriculatum*, *Prosobothrium armigerum*, *Anthobothrium caseyi* and *Molicola horridus*. The five other taxa could not be identified at species level because of their poor condition. All six previous studies providing infracommunity data about blue sharks encountered a group of four cestode species, thus described here as the 'core' community parasitizing blue sharks worldwide. Other cestode infections in blue sharks are discussed and a checklist of adult cestodes infecting the spiral valve of blue sharks is provided. At a global geographic scale, tapeworm communities of blue sharks were composed by 10 cestode taxa, 7 of which are exclusive to this host species and share two fundamental traits: their cosmopolitan distribution and their belonging to cestode genera that typically infects carcharhinids. Showing that the influence of ecological factors upon their tapeworm communities is highly constrained by a strong host specificity.

Keywords: parasitology; blue sharks; Cestodes; global distribution; especificity

SI Abstract Ref: 229

Bryan R. Franks

Marine Science Research Institute, Jacksonville University

It's about that time: Examining migratory behavior and potential departure cues for white sharks (*Carcharodon carcharias*) in the western North Atlantic Ocean

1. Bryan, Franks; Marine Science Research Institute, Jacksonville University, Jacksonville, FL, USA
2. John, Tyminski; OCEARCH, Park City, UT, USA
3. Nigel, Hussey; Integrative Biology, University of Windsor, Windsor, ON, Canada
4. Camrin, Braun; Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA, USA
5. Alisa, Newton; OCEARCH, Park City, UT, USA; ZooQuatic Laboratory, LLC, Baltimore, MD, USA
6. Christopher, Fischer; OCEARCH, Park City, UT, USA
7. Brett, McBride; OCEARCH, Park City, UT, USA
8. Simon, Thorrold; Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA, USA
9. Robert, Hueter; OCEARCH, Park City, UT, USA; Center for Shark Research, Mote Marine Laboratory, Sarasota, FL, USA

Describing temporal patterns of space use for migratory marine species can provide insights into the biology and ecology of these animals including their role in ecosystem function. Identifying potential triggers for migration, over multi-year time scales can provide a deeper understanding of the physiological and ecological underpinnings of behavior. To examine migration timing and identify biotic and abiotic factors associated with migratory behavior in white sharks in the WNA, we used data from 65 sharks tagged with a combination of satellite and acoustic tags. Tag-based horizontal and vertical movement data from 2012-2022 were used to discern temporal patterns of space use for individual sharks. Dates of departure from and arrival to residency areas were compared to a number of environmental factors (e.g. absolute temperature, delta temperature over time, photoperiod, moon phase) to determine their influence on migration timing. While there was substantial individual variability in migratory routes and timing, abiotic factors including temperature appear to be significant drivers of departure timing from residency areas. Ongoing analyses are exploring the presence and scale of intra-annual variability among individuals along with inter-annual variability within individuals tracked for longer than one year. By providing information on multiple individuals over a broad spatiotemporal scale, these findings provide key information to better understand white shark migration and space use in the region. With changing ocean conditions, elucidating the effects of these changes on oceanic predators and their migratory behavior will be critical to understanding the comprehensive impacts to marine ecosystems.

Keywords: migration; telemetry; ecology

SI Abstract Ref: 269

Francesco Garzon

MarAlliance; University of Exeter

Spatial ecology of the first recorded oceanic manta ray population in the Eastern Atlantic Ocean

1. Francesco, Garzon; MarAlliance, University of Exeter
2. Zeddy, Seymour; MarAlliance
3. Rachel, Graham; MarAlliance, University of Exeter

The oceanic manta ray (*Mobula birostris*) is a circumglobally distributed species, but little to no information exists for many parts of their range. The eastern Atlantic Ocean is a particularly data-deficient area, where manta ray presence has seldom been reported and no description of the distribution, movement, and connectivity of populations within the region exists. This study makes use of satellite telemetry conducted in Cabo Verde, coupled with ecological niche modelling, to provide the first description of an oceanic manta ray population in the eastern Atlantic ocean and the most likely distribution of the species in this region.

Repeated surveys between 2015 and 2019 and data from 11 satellite-tracked individuals revealed a reliable and continued presence of manta rays in the archipelago, although the number of sightings was considerably lower than those reported for some of the major aggregation sites for the species and no individual was ever re-sighted. Ecological niche modelling suggests connections between the Gulf of Guinea and Cabo Verde, and revealed stable pockets of habitat within Cabo Verde.

The role of Cabo Verde in the life-history of oceanic manta rays in the region remains to be elucidated, though the low abundance and re-sighting frequency, coupled with modelling suggesting seasonal expansion and contraction of suitable habitat, suggests that Cabo Verde might be a key stop-over on a potentially longer movement corridor along the eastern Atlantic Ocean.

Keywords: manta ray; species distribution modelling; eastern central Atlantic; satellite tracking

SI Abstract Ref: 271

Kristen Koyama, Chelsey Young, John Carlson
National Marine Fisheries Service

Developing a recovery plan for the threatened oceanic whitetip shark under the U.S. Endangered Species Act: metrics, actions, and challenges

1. Kristen Koyama; NOAA Fisheries, Office of Protected Resources
2. Chelsey Young; NOAA Fisheries, Pacific Islands Regional Office
3. John Carlson; NOAA Fisheries, Southeast Fisheries Science Center
4. Adrienne Lohe; NOAA Fisheries, Office of Protected Resources

The oceanic whitetip shark (*Carcharhinus longimanus*) is a globally distributed, highly migratory, pelagic shark species that was once considered one of the most abundant sharks in tropical seas globally. Due to significant population declines resulting from threats of overfishing and the international shark fin trade, the oceanic whitetip shark was listed as threatened throughout its range under the U.S. Endangered Species Act (ESA) in January 2018. As required by the ESA, the U.S. National Marine Fisheries Service (NOAA Fisheries) is developing a draft recovery plan for the oceanic whitetip shark that serves as a roadmap to recovery and outlines the path and tasks needed to restore the species to the point where it no longer requires the protections of the ESA. The draft recovery plan identifies both demographic and threats-based criteria to ensure population viability and reduction of threats to the species, as well as comprehensive management, research, and outreach actions needed to successfully reach those criteria. While NOAA Fisheries has the responsibility to develop recovery plans, successful implementation of the oceanic whitetip shark recovery plan will require participation and cooperation from numerous government agencies, stakeholders, international organizations, and non-governmental organizations around the world. This presentation will highlight key elements of the draft recovery plan and opportunities for public and stakeholder involvement in the recovery planning and implementation process.

Keywords: oceanic whitetip shark; threatened species; Endangered Species Act; recovery; fisheries
SI Abstract Ref: 190

Brendan Shea

Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, VA, 24061, USA; Beneath the Waves, Inc., PO Box 126, Herndon, VA, 20172, USA

Using Big Data to test the effects of spatial protection in remote island shark sanctuaries

1. Brendan, Shea; Virginia Tech / Beneath the Waves.
2. Austin, Gallagher; Beneath the Waves.
3. Lindsay, Bomgardner; Virginia Tech.
4. Francesco, Ferretti; Virginia Tech.

Sharks were historically abundant throughout oceanic regions; however, today many populations are threatened with extinction. Recent conservation efforts include the creation of large-scale marine protected areas (LMPAs), with a major expectation of LMPAs being the potential to conserve highly migratory species like sharks. In the last 15 years, 17 nations or territories have established 'shark sanctuaries', whereby the targeting or retention of sharks is prohibited within territorial waters. Yet, the conservation impacts of such sanctuaries remain unclear. Migratory species may spend limited time in protected areas, and while targeting sharks is prohibited, commercial fishing continues in many sanctuaries. Though sharks caught in sanctuaries are mandated to be released, at-vessel and post-release mortality rates can be significant, particularly in longline fisheries. We combined data from regional fisheries management organizations and satellite remote sensing sources to model longline fishing effort and generate estimates of annual shark catch and mortality in eight Western Pacific shark sanctuaries. We developed a predictive model that estimates the number of longline hooks deployed using satellite-derived vessel positioning data, then generated standardized catch-per-unit-effort rates for 11 species and genera using fisheries observer data and quantified total shark catch. Finally, we predicted total mortality using species-specific at-vessel and post-release mortality rates gleaned from the literature. We find that longline bycatch remains a significant yet undercounted source of mortality for sharks within sanctuaries. Given the data gaps in regional stock assessments for many pelagic species, we discuss the implications of our findings for stock management across the wider fishing region.

Keywords: shark sanctuary; marine protected area; bycatch; big data; fisheries
SI Abstract Ref: 217

Danny Poulding
The Shark Trust

The role of The Shark Trust Fisheries Advisories in promoting compliance and good practice within elasmobranch fisheries.

1. Danny, Poulding; The Shark Trust
2. Ali, Hood; The Shark Trust

Within NE Atlantic waters, the legislative framework in which elasmobranch fisheries operate can be both diverse and complex. Commercial fishers, recreational anglers, processors and fisheries regulators can find the relevant legislation and regulation difficult to interpret and implement. Lack of understanding of such regulations may result in low levels of support within the fishing industry and subsequent reduced levels of compliance, thereby undermining the effectiveness of any management measures. Additionally, species within elasmobranch fisheries can often be similar in appearance and difficult to accurately identify. A history of aggregated landings in some commercial elasmobranch fisheries has also contributed to unreliable catch and discard data. Improving elasmobranch fisheries data is of prime importance in achieving sustainably managed stocks. In both recreational and commercial fisheries, inappropriate handling of elasmobranch catches prior to release can also contribute to increased post release mortality, further undermining those management measures designed to reduce fishing mortality. For over 10 years, The Shark Trust has produced Fisheries Advisories for the fishing industry with the aims of protecting vulnerable elasmobranch species and promoting sustainable elasmobranch fisheries. The Fisheries Advisories are used in numerous sectors of the fishing industry and by multiple government agencies, in the UK and EU, and have been translated into seven languages. In order to determine their effectiveness, The Shark Trust Fishery Advisories are critically assessed using survey and interviews with various end users from within the fishing industry and fisheries regulation. Future development opportunities for the Fisheries Advisories are discussed.

Keywords: fisheries; guidance; identification; legislation; discard-reporting
SI Abstract Ref: 220

Antonia Klöcker
Institute of Marine Research, Norway

Predicting shark hotspots at the northern edge using species distribution models

1. Antonia Klöcker, IMR
2. Dr Kristina Ø Kvile, NIVA
3. Dr Mikko Vihtakari, IMR
4. Dr Claudia Junge, IMR

The endangered basking shark (*Cetorhinus maximus*) is experiencing pressure from fisheries, coastal development, and climate change. Yet, fundamental information about its spatio-temporal habitat use is lacking at the edges of its northern range, increasing the vulnerability to human activities. Species distribution models provide a powerful tool to investigate how environmental factors influence shark occurrence over annual and sub-annual time scales. Here, I will present preliminary results for such relationships in basking sharks along the Norwegian coast, based on observations collected as part of a national Citizen Science project called "Dugnad for havet". In my talk, I will highlight predicted hotspots of basking shark occurrences in Norway based on a high-resolution species distribution model and discuss the potential of using citizen science observations in such models. In conjunction with in-situ tracking data, these results will allow us to investigate the co-occurrence of obtained distributional hotspots with current and future human activities and highlight areas of elevated scientific and management importance at the northern edge of the species' distribution in the light of competing management priorities and a changing climate.

Keywords: species distribution models; spatio-temporal hotspots; bycatch; spatial management
SI Abstract Ref: 314

Marta Ferraro

Groningen University; Wageningen Marine Research

Evaluating models of advice for Thornback ray

1. Marta, Ferraro; Groningen University; Wageningen Marine Research.
2. Jurgen, Batsleer; Wageningen Marine Research.
3. Katinka, Bleeker; Wageningen Marine Research

Elasmobranch are characterized by specific life history traits that make them vulnerable to fishing and other anthropogenic factors. In the North Sea, rays and skates are mainly caught as bycatch, and have low commercial value. Studies are working toward defining a picture of the status of their populations and addressing the mortality inferred by fisheries. Currently population status is derived from a trend based analysis of scientific survey time series. Rajidae stocks fall in ICES category 3, including data-deficient stocks which lack analytical assessments and whose advice is given under a precautionary approach since 2012. Recently, new empirical approaches linked to life-history traits and fishing history have been developed. In this study, different approaches applied within ICES have been compared for the landings advice of thornback ray, *Raja clavata*. This is the main commercially important Rajidae species. Among them are the two trend-based rules “2 over 3” and “2 over 5”, currently employed for the advice of the Rajidae complex, and the empirical rules rfb and rb. This study aims at providing an overview of the implications of the main data-deficient models for the advice of Thornback ray, exploring the possibilities for conservation of Rajidae species in the North Sea.

Keywords: bycatch; Rajidae; data-limited; management; conservation

SI Abstract Ref: 365

Nadia T. Rubio-Cisneros

1 Laboratorio de Biología de la Conservación y Desarrollo Sustentable de la Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Monterrey, Nuevo Leon, Mexico; 2 Mar Sustentable Ciencia y Conservación, A.C. Monterrey, Nuevo Leon, Mexico.

Interdisciplinary science to Remember Sharks on Holbox Island

1. Nadia T. Rubio-Cisneros Laboratorio de Biología de la Conservación y Desarrollo Sustentable de la Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Monterrey, Nuevo Leon, Mexico; Mar Sustentable Ciencia y Conservación, A.C. Monterrey, Nuevo Leon, Mexico; Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, University of California San Diego, United States;
2. Ilse Martínez School of Environmental Studies, University of Victoria, Victoria, BC, Canada
3. Juan Carlos Perez Departamento de Ciencias de la Sustentabilidad, El Colegio de la Frontera Sur, Lerma, Campeche, Mexico; Jeffrey Glover Department of Anthropology, Georgia State University;
4. José Ignacio González Laboratorio de Biología de la Conservación y Desarrollo Sustentable de la Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Monterrey, Nuevo Leon, Mexico

The millennial coastal exploitation by humans has modified and depleted coastal food webs throughout the globe. Coastal shark fisheries increased worldwide in the late 20th century due to global demand for shark products. In Quintana Roo, coastal environments harbored diverse and numerous coastal sharks for millennia. This interdisciplinary research documents the presence and exploitation of sharks on Holbox Island by integrating archaeological data, fishers' Local Ecological Knowledge (LEK) surveys with a spatial component, open interviews, and literature analyses. Studying LEK of top predators in islands that are contemporary touristic hotspots for global tourism and face environmental threats provides an opportunity to examine the long-term availability and exploitation of top predators as a fishery resource and as a cultural and biodiversity component. Seventy-eight LEK fishers' surveys allowed documenting over 15 shark species that were common in the Holbox region from families Carcharhinidae, Sphyrnidae, Lamnidae, and Ginglymostomatidae. Archaeological shark records also denote the high presence of shark families in the area. LEK fishers' surveys also documented the exploitation of sawfishes. The geospatial component of the survey allowed identifying 20 sites that were important for sharks near the coastal area of Holbox. Results contribute to understanding shark-human interactions through time and generate baseline knowledge that can help fisheries and biodiversity management. The above is relevant since the local economy relies on healthy coastal landscapes and biodiversity. Our methodology and results can help other Islands that face growing tourism like Holbox and have insufficient data on fishing activities and landscape biodiversity.

Keywords: interdisciplinary science; Local Ecological Knowledge; sharks; islands; tourism

SI Abstract Ref: 280

Leonardo Manir Feitosa

Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, USA

Assessing habitat use of three tropical coastal stingrays (*Hypanus spp.*) through stable isotopes and vertebral microchemistry

1. Aristóteles, Philippe, Queiroz; Programa de Pós-Graduação em Biologia Animal, Departamento de Zoologia, Universidade Federal de Pernambuco, 50670-901, Recife, Pernambuco, Brazil.
2. Leonardo, Manir Feitosa; Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, USA.
3. Francisco, Marcante Santana; Laboratório de Dinâmica de Populações Aquáticas (DAQUA), Unidade Acadêmica de Serra Talhada (UAST), Universidade Federal Rural de Pernambuco, 56909-535, Serra Talhada, Pernambuco, Brazil.
4. Rosângela, Lessa; Laboratório de Dinâmica de Populações Marinhas (DIMAR), Departamento de Pesca e Aquicultura, Universidade Federal Rural de Pernambuco, 52171-900, Recife, Pernambuco, Brazil.

Understanding habitat use patterns on a species-specific basis is crucial information for more effective fisheries management. In this study, we employed two techniques – stable isotopes of muscle tissue and vertebrae microchemistry – to analyze and compare the habitat use of three co-occurring species of coastal Myliobatiformes stingrays in different stages of their life cycles. We sampled a total of 37 individuals comprising *Hypanus guttatus* (n = 14), *H. marinae* (n = 11), and *H. berthelutzae* (n = 12). We estimated the proportional contribution of marine and estuarine sources to the diet using SIMMR, a Bayesian stable isotopic mixing model, while the vertebrae microchemistry data were analyzed through permutational analysis of variance (PERMANOVA). Overall, both analyses clearly demonstrate strong differences in habitat use between species. Both SIMMR and microchemistry results revealed that *H. guttatus* displays several entry and exit movements in estuarine areas, while *H. marianae* has a high specificity for its coral reef habitats, and the prevalent use of deeper waters (between 50 and 100 m deep) by adults of *H. berthelutzae*. Within species, PERMANOVA results yielded significant differences in habitat use between sexes for *H. guttatus*, and *H. berthelutzae*, while *H. marianae* displayed no differences between sexes or life stages. This is the first study to ever use data from stable isotopes and vertebrae microchemistry in elasmobranchs, which demonstrate to be accurate descriptors of the distinct environments these species occupy. Furthermore, they provide a more holistic understanding of the habitat use of these species across different time scales.

Keywords: Dasyatidae; movement ecology; Northeast Brazil; stable isotopes; vertebrae microchemistry
SI Abstract Ref: 285

Sofia Green

Galapagos Whale Shark Project

Decade-long whale shark tracking from the Galapagos: identifying region specific anthropogenic risks in the Eastern Pacific

Sofia M Green, Alex Hearn, Jonathan R Green, Leo Zurita, Bryan Vallejo

Region specific anthropogenic impacts on whale sharks in the areas around the Galapagos and the Eastern Pacific have not yet been assessed. During the past decade we have gathered data on whale shark movements achieved through active tracking through satellite tagging and passive tracking through photo identification efforts. Between 2011-2021 we have tagged 106 whale sharks with 129 tags, 124 of which gave enough data for analysis. We have also identified 522 individuals through the global catalogue of whale sharks (sharkbook.ai). These data are helping us decipher the movement ecology of whale sharks in the region, which anthropogenic impacts affect them most, and where in the ETP they are most heavily impacted. For this purpose we are examining the impact of purse-seine fisheries, vessel strikes, and the effects of El Niño/La Niña ocean phenomena on whale shark movements as a proxy for climate change impact. Fishing and marine traffic hotspots are identified using open source AIS data and measured through spatial density analysis and spatial overlap with the movement patterns of whale sharks in the area using QGIS and R. Further connectivity and population indices are reviewed by applying models based on the lagged identification rate to the Galapagos photo-ID dataset. This study is complementary to the recent publication by Womersley et al. 2022 which analysed vessel traffic impact around the globe and identified the Eastern Pacific as the area where whale sharks had the highest overlap with fishing vessels.

Keywords: anthropogenic impact; movement ecology; telemetry; photo identification; spatial analysis
SI Abstract Ref: 296

James Ketchum

Pelagios Kakunjá

Long-term movement patterns of tiger sharks around isolated oceanic islands

1. James T. Ketchum; Pelagios Kakunjá
2. Mauricio Hoyos-Padilla; Pelagios Kakunjá
3. Alex Hearn, Universidad San Francisco de Quito
4. Randall Arauz, Centro de Rescate de Especies Marinas Amenazadas
5. Yannis P. Papastamatiou, Florida International University
6. Chris Fischer, OCEARCH
7. Miguel Gómez-García, Pelagios Kakunjá
8. Peter Klimley, Biotelemetry Consultants

The Eastern Tropical Pacific (ETP) is a large expanse of ocean exceptionally rich in biodiversity with abundant sharks and other marine predators, particularly around the oceanic islands of this region. However, shark populations are declining, and little is known about their ecology, migratory movements, and spatial dynamics. Hence, our main goal was to study an apex predator in the ETP from their northernmost refuges (Marías, Revillagigedo) to their southern abodes (Galapagos). We tagged 35 tiger sharks, *Galeocerdo cuvier*, with coded acoustic transmitters (V16) and 13 sharks with satellite tags (SPOT), in Marías, Revillagigedo, Cocos and Galapagos islands from 2010 to 2018. Tiger sharks resided for longer periods of time and remained at the islands for weeks, months and even years, especially in the warmer months, before performing large-scale movements. Some of the large-scale movements were between the Revillagigedo and the Gulf of California, and between the Galapagos and 200 km south of Malpelo and the northern coast of Ecuador. Our results show that most tiger sharks were resident and moved over short distances within a home range of less than 100 km around different oceanic islands in the ETP, whereas few individuals moved exceptionally large distances of 2000 km or more. Such movements have strong implications in the design of protective zones around isolated oceanic islands and in the description of movement corridors for mobile apex predators in the ETP.

Keywords: movements; satellite telemetry; acoustic telemetry; migratory corridors; Eastern Tropical Pacific
SI Abstract Ref: 310

Eleanor Greenway

University Research; Wageningen Marine Research

Diel vertical migrations of blonde skate (*Raja brachyura*) and spotted skate (*R. montagui*) in the Northeast Atlantic.

1. Eleanor, Greenway; Wageningen University Research; Wageningen Marine Research
2. Jurgen, Batsleer; Wageningen Marine Research
3. Jan Jaap, Poos; Wageningen University Research; Wageningen Marine Research
4. Hendrik, Winter; Wageningen Marine Research

Horizontal and vertical movements of marine organisms are reflective of habitat preference and behavioural patterns in activity. The development of electronic tags allowed studies into the migrations and movements of many marine species. However, such studies into the vertical movements of benthic predators remain understudied. In this study, blonde skates, *Raja brachyura*, and spotted skates, *R. montagui*, were tagged with CEFAS G5 'pop-off' data storage tags in the North Sea and English Channel. Tagging took place on commercial and survey vessels in 2021 and 2022, and 81 individuals were tagged. As of June 2022, data from 7 tags were successfully acquired after tags were found by fishers or beachcombers. Diel vertical migrations, time-at-depth profiles and activity budgets were used to determine space-use patterns and preferences concerned with depth and temperature for mature individuals. The outcomes of this research will contribute a deeper understanding of the underlying processes that drive fish movements and distribution.

Keywords: Activity budgets; diel vertical migration; Northeast Atlantic; Rajidae; tagging

SI Abstract Ref: 215

Tuesday 11th October, 2022

Movements & Habitat Use 4

Mark Erdmann

Conservation International Aotearoa

First insights into the movement ecology of Aotearoa's oceanic manta rays *Mobula birostris*

1. Mark Erdmann, Conservation International Aotearoa
2. Edy Setyawan, University of Auckland
3. Lydia Green, Manta Watch New Zealand
4. Clinton Duffy, New Zealand Dept of Conservation
5. Scott Tindale, Tindale Marine Research Charitable Trust

Unlike reef manta rays, the movement ecology of endangered oceanic manta rays (*Mobula birostris*) is poorly understood. In Aotearoa New Zealand, *M. birostris* are known to occur off the North Island during at least the spring and summer months, but their distribution and habitat use is largely unknown. Here we provide preliminary observations on the movements and diving of *M. birostris* in northern New Zealand using satellite telemetry. A total of eight adult *M. birostris* were tagged with SPLASH10F GPS Fastloc satellite tags (n=7) and miniPAT archival satellite tags (n=1) off the northeast coast of the North Island of New Zealand in 2019 and 2021. Tagging duration ranged from 9-199 days, with minimum distances covered by each individual ranging from 249-4,447 km. Analysis of these tracks suggest that oceanic mantas off northeastern New Zealand spend the majority of their time (>84%) in surface waters (<50m depth), with occasional dives to the seafloor in 70-120m depth. Importantly, six of the tagged individuals migrated northwards out of NZ coastal waters during the month of March as water temperatures cooled, with three of them reaching Fiji or Tonga before their tags released. Of these 6 migrating individuals, five made repeated dives (2-6 dives/individual) below 1000m, which we postulate may be to aid in navigation during northward migration. Our study provides first insights into the movement ecology of *M. birostris* in New Zealand and suggests targeted future research directions to better understand the movements and habitat use of this important yet poorly-known endangered species.

Keywords: manta ray; satellite telemetry; New Zealand

SI Abstract Ref: 348

Hannah Martin

MarAlliance

A baseline assessment of sharks and rays in Coiba National Park using baited remote underwater videos (BRUVs)

Hannah, Martin; MarAlliance. Julie, Berry; Coiba Dive Centre. Rachel T., Graham; MarAlliance.

Baseline assessments provide information on species assemblages that can inform conservation actions through identifying biodiversity hotspots or investigating the influence of different environmental factors on species abundance and richness. Coiba National Park and its Special Zone of Marine Protection in Panama situated in the Eastern Tropical Pacific is a unique area of marine endemism and high biodiversity. Several studies have been conducted in the area on the assemblage and ecology of corals, cetaceans and selected shark and turtle species along with the socio-economic impacts of fisheries; however, the assemblages of sharks and rays have yet to be quantified. Using baited remote underwater videos (BRUVs), we created a baseline assessment of these two groups and investigated the influence of protection status and seasonality on species richness and abundance. Three shark species and eight ray species were observed on the BRUVs (n=203 deployments). Species abundance and richness were found to be higher within the Coiba marine protected area (MPA) compared to surveys outside of the park's boundaries. Species abundance and richness were not found to be significantly different between the wet and dry seasons. The results from this study will help to inform conservation strategies and support greater management effectiveness in the Coiba National Park and the surrounding area. With a well-enforced and successful MPA, Coiba can not only provide an example of effective marine protection but it also has the potential to attract more tourists to the area, providing an essential economic boost post-COVID.

Keywords: Panama; conservation; Marine Protected Area; Eastern Tropical Pacific; management

SI Abstract Ref: 317

Sebastian Kraft

Centre of Marine Sciences (CCMAR), University of the Algarve

Seasonal movement patterns of the common stingray (*Dasyatis pastinaca*) in and out of a temperate coastal marine protected area

1. Sebastian, Kraft; Centre of Marine Sciences (CCMAR), University of the Algarve, Campus de Gambelas, Faro, Portugal
2. David, Abecasis; Centre of Marine Sciences (CCMAR), University of the Algarve, Campus de Gambelas, Faro, Portugal

Marine protected areas (MPAs) are regarded as a useful tool to protect elasmobranchs. However, these species are generally not a primary target when designing MPAs and how they benefit from these remains to be better understood. To this end, acoustic telemetry has shown to be a very fitting tool. The Arrábida marine park is a temperate coastal MPA off the Portuguese West coast, near two important fishing ports, Sesimbra and Setúbal. The common stingray (*Dasyatis pastinaca*) is a medium-sized viviparous ray found mostly in shallow waters from Norway to Senegal and the Mediterranean. This species is caught throughout its range and is currently classified as vulnerable by the IUCN. To study their space use and residency in this MPA, 28 individuals were tagged with acoustic transmitters and monitored for an average of 625 days and up to over 1000. Average residency was low (Residency Index=0.211) ranging from RI=0.002 to RI=0.588. Their presence in the marine park was markedly seasonal, highest during the coldest months and with virtually all individuals leaving during the warmer months of the year. During their absence, individuals were detected in the nearby Sado estuary, where they likely remained for reproductive purposes as suggested by the literature on *Dasyatis*. This pattern was repeated at least twice by seven individuals during the entire monitoring period. These results show common stingrays are not protected year-round by this marine park, which they leave during the reproductive season. We discuss additional measures that could be considered to improve their protection.

Keywords: acoustic telemetry; Dasyatidae; residency; movement; conservation

SI Abstract Ref: 311

Jonathan D. Mitchell

The University of Western Australia, Queensland Government, Department of Agriculture and Fisheries

Using a multi-disciplinary approach to manage shark bycatch and depredation at an offshore marine park

1. Jonathan D. Mitchell; The University of Western Australia and Queensland Government, Department of Agriculture and Fisheries
2. Victoria Camilleri-Asch; The University of Western Australia and Queensland University of Technology
3. Fabrice R.A. Jaine; Integrated Marine Observing System (IMOS) Animal Tracking Facility, Sydney Institute of Marine Science and Macquarie University
4. Victor M. Peddemors; New South Wales Department of Primary Industries, Fisheries
5. Tim J. Langlois; The University of Western Australia

Shark bycatch and depredation occurs frequently in the offshore marine parks surrounding Lord Howe Island, Australia. This causes loss of bait, fishing gear and catch for fishers and sharks can be injured or killed when bycaught. To understand this shark-fisher conflict and identify ways to mitigate it, we applied a multi-disciplinary approach including acoustic telemetry, vessel tracking, logbook data and surveys of local fisher knowledge. Galapagos sharks (*Carcharhinus galapagensis*) were tagged with acoustic transmitters and detected within a receiver array and charter fishing vessel activity was determined using Vessel Monitoring System data. Kernel density analyses assessed the spatial and temporal overlap between shark detections and fishing vessel presence, identifying several areas where higher fishing effort overlapped with greater shark detections, predominantly at shelf edges. Substantially higher residency values were recorded for three individuals at a location where fish waste was regularly discarded, suggesting a change in movement patterns resulting from food provision. Statistical models indicated that detection rates were higher in locations with higher fishing activity, greater bathymetric complexity and during summer. Logbook data showed a mean annual catch of 1,114 sharks with >95% released. Fishers reported methods that they currently use to reduce shark interactions, including fishing deeper than 100m, switching from rod and reel to handlines and electric reels, using jigs and lures instead of bait and rotating fishing locations. Diversifying target species also reduced shark interactions. The novel multi-disciplinary approach used in this case study should be adopted elsewhere to help characterise and manage shark-fisher conflicts.

Keywords: shark-fisher conflict; marine parks; Galapagos shark; acoustic telemetry; vessel tracking

SI Abstract Ref: 16

Ellie Moulinie

Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC), Rue Philippe Plantamour 20, 1201 Genève, Switzerland

MantaCam: One year continuously monitoring reef manta rays at a key aggregation site in Seychelles

1. Henriette Grimmel; Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC), Rue Philippe Plantamour 20, 1201 Genève, Switzerland
2. Lauren Peel; (a) Pendoley Environmental Pty Ltd, 12a Pitt Way, Booragoon, WA 6154, Australia, (b) Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC), Rue Philippe Plantamour 20, 1201 Genève, Switzerland, (c) The Manta Trust, Catemwood House, Norwood Land, Corscombe, Dorset DT2 0NT, UK
3. Ellie Moulinie; Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC), Rue Philippe Plantamour 20, 1201 Genève, Switzerland
4. Dillys Pouponeau; Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC), Rue Philippe Plantamour 20, 1201 Genève, Switzerland
5. Robert Bullock; Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC), Rue Philippe Plantamour 20, 1201 Genève, Switzerland

High-resolution, long-term datasets are critical in documenting ecosystem and population changes, as well as for differentiating natural changes from those caused by humans. Mobilising the resources necessary to collect such data for vulnerable shark and ray populations, however, remains a major challenge in elasmobranch conservation and research. Here, we used two low-cost, high-resolution camera rigs (MantaCams) to monitor the presence and residency of reef manta rays (*Mobula alfredi*) within a marine protected area in Seychelles, near-continuously for a year (April 2021 to April 2022). The MantaCams were set-up to capture images every ten seconds at a key manta aggregation site offshore of D'Arros Island and were sequentially deployed every few days to maximise site coverage throughout the year. The analysis of 1,326,926 MantaCam images from 133 deployments resulted in 913 sightings of 152 individuals (74 males, 76 females, 2 unknown), including the identification of 43 new mantas. MantaCams also observed nine adult females that were in various stages of pregnancy, as well as various instances of courtship behavior. To-date, the sighting records from the MantaCams comprise 34 % of all records collected since the establishment of the Seychelles Manta Ray Project in 2013, and were associated with the identification of more new individuals at this site than had been recorded in any year prior for the whole country. Collectively, this highlights the value of remote camera deployments to long-term, marine monitoring programs for vulnerable fauna that display high site fidelity.

Keywords: *Mobula alfredi*; MantaCam; Seychelles; site fidelity; population monitoring

SI Abstract Ref: 304

Muhammad Moazzam

WWF-Pakistan

Conservation of sharks in Pakistan: a dilemma

Muhammad Moazzam

Pakistan has an important shark fisheries contribution annually about 12,000 m. tons. Although there is no aimed fishery for sharks in Pakistan but sharks are caught as bycatch of gillnet, longline and trawl fisheries. Tuna gillnet fishery is major contributor of pelagic sharks in Pakistan whereas sting rays and rhino sharks are mainly harvested through bottom-set gillnets in coastal and offshore waters. At present, wings of stingrays are exported from Pakistan to southeast Asia which is in addition to shark fins which is traditionally being exported to Hong Kong for almost two centuries. Although there are a number of laws which are enacted to manage shark in Pakistan both at federal and provincial levels. Pakistan is a signatory of the CITES Agreements and as such no sharks (or their fins) included on various appendices can be exported, however, shark fins including those in the Appendix-II are exported from Pakistan. Provincial Wildlife law of Sindh puts a blanket ban on catching sharks, however, the concerned Department has no infrastructure for the implementation on this law. In addition, Provincial Fisheries Departments have put ban on catching and marketing of CITES listed sharks and all rhino sharks, however, there is no control on catching and marketing of these species. There is no two opinions that shark resources are dwindling in Pakistan and despite adequate legislative cover, there is no effective implementation mechanism. It is feared that major depletion of sharks species or even their extinction.

Keywords: shark; Pakistan; legislative control of sharks; shark fins; CITES

SI Abstract Ref: 195

Bhagyalekshmi Venugopal

University of Kerala, India

Fisheries, livelihood and conservation of rays along South Indian coast

1. Bhagyalekshmi Venugopal
2. Bijukumar, A.

India is one of the leading elasmobranch fishing nations which is driven by the bycatch and small-scale targeted fishing. The continuous decline in shark landing and increased demand of sea-food has instigated the demand of other chondrichthyans such as rays, guitarfishes and skates in the country. The surveys and reports of these batoids landed along the coast are based on commercially significant and conservation prior species. When batoids are extremely susceptible to population decline from overexploitation, a species-specific list of batoids exploited in the fishery is inevitable. We recorded 45 species of batoids (under genus *Benthobatis*, *Narcine*, *Torpedo*, *Tetronarce*, *Narke*, *Dipturus*, *Orbiraja*, *Acroteriobatus*, *Rhinobatos*, *Glaucostegus*, *Rhynchobatus*, *Rhina*, *Gymnura*, *Plesiobatis*, *Brevitrygon*, *Himantura*, *Pateobatis*, *Pteroplatytrygon*, *Maculabatis*, *Urogymnus*, *Neotrygon*, *Taeniurops*, *Aetobatus*, *Rhinoptera* and *Mobula*) from the major and minor harbours and landing centre's along the coast of 4 leading maritime states in south Indian, irrespective of fishery value. The analysis of landing shows that batoid fishery in the country is still driven by highly threatened species. The electric rays, skates, small guitar fishes and stingrays with no fishery value are equally exploited as the bulk catch of these species with low turnover in fishery get auctioned for high amounts by the small-scale factories producing fish manure and animal feed. Consequently, the fisherman retains the non-commercial bycatch during trawling. The study draws attention towards reconsidering the fisheries regulation and conservation acts in India.

Keywords: Elasmobranchs; Batoids; threatened species; commercial fishing; non-commercial species

SI Abstract Ref: 121

Irene Kingma

Dutch Elasmobranch Society

What have EU policy changes delivered for shark and ray conservation in Europe?

1. Irene Kingma; Dutch Elasmobranch Society
2. Paddy Walker; Dutch Elasmobranch Society

Two decades ago the situation for sharks and rays in European waters was pretty grim. There were no limits for fisheries on elasmobranchs and endangered species did not have protection. Many species were in decline or had populations and historically low levels.

A concerted effort by conservationist around Europe has led to a substantial increase in protective management measures aimed at improving the status of sharks and rays in EU waters, but are we there yet? Have these changes in the policy landscape yielded a significant result in the ocean?

We present an overview of EU internal laws and regulations that apply to elasmobranch management with a validation of the level of change that has been achieved at a species level with an in depth analysis of several measures to pin point where the key to effective conservation of elasmobranchs lies. We differentiate between management of skates and rays, which are traditionally harvested commercially, and sharks which, with a few exceptions, tend to be bycatch species in EU fisheries. We end with clear policy recommendations and follow up actions for legislators and, who knows, maybe even a song!

Keywords: policy; fisheries; Europe; North-East Atlantic; EU

SI Abstract Ref: 111

Fahmi

Research Centre for Oceanography BRIN – Indonesia

A review of target shark fisheries in the Lesser Sunda Islands: do they support the sustainable shark fishing program in Indonesia?

1. Fahmi; Research Centre for Oceanography BRIN – Indonesia
2. Selvia Oktaviyani; Research Centre for Oceanography BRIN – Indonesia
3. Wanwan Kurniawan; Research Centre for Oceanography BRIN – Indonesia
4. Benaya Simeon; Sustainable Fisheries Management Scientific Forum of West Nusa Tenggara, Indonesia
5. Soraya Gigentika; Sustainable Fisheries Management Scientific Forum of West Nusa Tenggara, Indonesia

The shark fishery in Tanjungluar Lombok is one of the largest target shark fisheries in Indonesia. Fishers from this location mainly use surface longlines to catch pelagic sharks in the eastern Indian Ocean and adjacent waters. We used 20-year landing data to identify a possible decline in shark production due to the fishery. A daily basis catch data collection has been applied at Tanjungluar since 2014. This method provided more robust data and showed a stable catch pattern rather than using the sampling-based method applied earlier. In general, the total catch of sharks caught by the surface longline fisheries varied from around 300 individuals per month in the low season to more than 1000 individuals in the peak season. Two CITES-listed species, *Carcharhinus falciformis*, and *Sphyrna lewini* were dominant in the shark catch composition within the last two decades. The silky shark contributed around 20-60% of the total shark catch every month and showed an upward trend in the catch from 2005 to 2021. Interestingly, the implementation of either CITES mechanisms for the species or the national shark management program seemed to have no or less impact on this target fishery. We discussed some possible factors that may sustain the shark fishery.

Keywords: the eastern Indian Ocean; pelagic shark; *Carcharhinus falciformis*

SI Abstract Ref: 116

Elisabeth Fahrni Mansur

Wildlife Conservation Society Bangladesh

CITES listings catalyze improved conservation prospects for sharks and rays in Bangladesh

1. Elisabeth, Fahrni Mansur; Wildlife Conservation Society (WCS) Bangladesh
2. Nadim, Parves; Wildlife Conservation Society (WCS) Bangladesh
3. Mohammad, Shamsuddoha; Wildlife Conservation Society Bangladesh
4. G M Masum, Billah; Wildlife Conservation Society Bangladesh
5. Brian D., Smith; Wildlife Conservation Society Bangladesh

Unsustainable catches, driven in part by illegal trade, threaten 70% of the 52 shark and 85% of 71 ray species confirmed or suspected to occur in Bangladesh. Reported landings of elasmobranchs from targeted and non-targeted small-scale and industrial fisheries have declined by half from 6,234 tons over the past two decades, while official exports of dried shark fins (combined with fish maw) spiked at over 2,000 tons between 2018-2020. There is growing concern about the harmful effects of overfishing these apex predators on local livelihoods, food security, and the national economy.

CITES Appendix I and II listings of globally threatened sharks and rays have catalysed efforts to improve their conservation management in Bangladesh. In 2021, the Bangladesh Wildlife Act was amended to strictly protect species assessed as Critically Endangered or Endangered in the IUCN Red List and/or listed in CITES Appendix I, and to regulate possession and trade of species assessed as Vulnerable and/or listed in CITES Appendix II. Non-Detriment Finding assessments for four species/species groups, including 15 CITES Appendix II listed species, confirmed the need for improved interagency collaboration, monitoring, and trade transparency. These NDFs also highlighted the need to reduce non-target catches and domestic consumption and trade that will not necessarily be reduced through stricter regulations on international trade. Improved prospects for conservation management of elasmobranchs initiated through collaborative research, policy development, trainings, and educational outreach exemplify how CITES listings can catalyse institutional collaboration and empower government and non-government stakeholders to implement evidence-based conservation plans.

Keywords: CITES; conservation planning; interagency collaborations; national policy development; inclusive communication

SI Abstract Ref: 86

Lydia Green

1; Manta Watch New Zealand Charitable Trust, 2; Manta Trust

Overview of population demographics and habitat use of *Mobula birostris* in Aotearoa New Zealand.

1. Lydia Green, Manta Watch New Zealand Charitable Trust
2. Edy Setyawan, University of Auckland
3. Mark Erdmann, Conservation International Aotearoa

Despite being fully protected in New Zealand waters since 2011, significant gaps remain in our knowledge of nearly all aspects of the oceanic manta's (*Mobula birostris*) life history and ecology in New Zealand. This lack of data has hindered comprehensive conservation management planning for this globally threatened species; New Zealand's Department of Conservation currently lists the species as "Data Deficient" in terms of its threat classification. A focused effort to better understand the New Zealand oceanic manta population over the past four years has resulted in a significant increase in knowledge of this species' population dynamics and habitat use. Combining citizen science and dedicated research efforts, 618 verified sightings spanning the time period of 1994 to 2022 have been collated from New Zealand waters, including 103 ventral photographic IDs, comprising 71 females, 26 males and 6 individuals of unknown sex. Furthermore, preliminary findings from intensive field work conducted in 2021-22 suggests that New Zealand supports a significant and healthy population of *M. birostris*. Observations include extensive feeding aggregations of more than 50 individuals, sightings of heavily pregnant females feeding alongside subadult males (disc widths of 590cm and 300cm respectively) and numerous accounts of active courtship displays. Moreover, this population shows very low incidence of injuries (17 %). These initial findings support the hypothesis that *M. birostris* are resident for at least part of the year in Aotearoa New Zealand and likely reproducing there and suggest that this population may be critical in global conservation efforts to recover this endangered species.

Keywords: photo ID; endangered species; population dynamics; oceanic manta ray; New Zealand

SI Abstract Ref: 303

Gency L. Guirhem

1. AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Pasaia, Spain; 2. Institute of Marine Fisheries and Oceanology, College of Fisheries and Ocean Sciences, University of the Philippines Visayas, Iloilo, Philippines.

Modelling the spatio-temporal distribution of devil rays in the western Indian ocean using observer data from the EU tropical tuna purse seine fishery

1. Gency L. Guirhem; AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Pasaia, Spain; Institute of Marine Fisheries and Oceanology, College of Fisheries and Ocean Sciences, University of the Philippines Visayas, Iloilo, Philippines.
2. Haritz Arrizabalaga; AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Pasaia, Spain.
3. Leire Lopetegui-Eguren; AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Pasaia, Spain.
4. Hilario Murua; International Sustainable Seafood Foundation, Washington, DC, USA.
5. Nerea Lezama-Ochoa; Institute of Marine Sciences, University of California Santa Cruz, Santa Cruz, USA; Mobula Conservation, La Paz, Mexico.
6. Shane P. Griffiths; Ecosystem and Bycatch Program, Inter-American Tropical Tuna Commission, La Jolla, CA, USA.
7. Jon Ruiz Gondra; AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Pasaia, Spain.
8. Philippe S. Sabarros; MARBEC, Univ Montpellier, CNRS, Ifremer, IRD, Sète, France; Institut de Recherche pour le Développement, Ob7, Sète, France.
9. Jose Carlos Baez; Instituto Español de Oceanografía, Centro Oceanográfico de Málaga, Fuengirola, Spain; Instituto Iberoamericano de Desarrollo Sostenible (IIDS), Universidad Autónoma de Chile, Temuco, Chile.
10. Maria José Juan-Jordá; AZTI, Marine Research, Basque Research and Technology Alliance (BRTA), Pasaia, Spain

The European Union and Seychelles tropical tuna purse seine fishery in the western Indian ocean incidentally captures three species of devil rays, the spinetail devil ray (*Mobula mobular*), the sicklefin devil ray (*M. tarapacana*), and the bentfin devil ray (*M. thurstoni*), all currently classified globally as Endangered by the International Union for the Conservation of Nature. We used observer data collected on tropical tuna purse seiners in 2010-2020 to analyse the relationship between the presence/absence of devil rays in the catches and the environmental conditions, the spatial and temporal variability of fishing locations, and fishing operational variables. We found that higher probability of capture was predicted in areas with relatively high chlorophyll-a concentrations, high sea surface temperature fronts, and low sea surface height. This may indicate that the presence of this planktivore species might be associated with mesoscale features resulting in elevated biomass of zooplankton. We also found higher probability of catching devil rays in sets on free-swimming schools of tuna than in sets on fish aggregating devices and smaller tuna catch sets. The spatial predictions identified two important areas (the Mascarene Plateau and central Indian Ridge) persistent throughout the year with higher probabilities of catching a devil ray, and two seasonal important areas (the western Arabian Sea and Equatorial Region) with higher catch probabilities during the winter monsoon regime (December-March). Information on the spatio-temporal and environmental preference of devil rays is crucial to support more holistic spatial management and conservation strategies to further reduce the bycatch of these species.

Keywords: devil rays; Mobula; spinetail devil ray; bycatch; species distribution models

SI Abstract Ref: 21

Hannah Calich

University of Western Australia

Physiological biomarkers provide insights into tiger shark movement

1. Hannah J. Calich; University of Western Australia
2. Ana M.M. Sequeira; Australian National University
3. Bianca S. Rangel; University of São Paulo
4. Shannon G. Moorhead; University of Miami
5. Abigail Tinari; University of Miami
6. Carolyn Cray; University of Miami
7. Duncan J. Irschick; University of Massachusetts Amherst
8. Emily R. Nelson; University of Miami
9. Robert H. Michener; Boston University
10. James A. Sulikowski; Arizona State University
11. Charitha Pattiaratchi; University of Western Australia
12. Austin J. Gallagher; Beneath the Waves
13. Neil Hammerschlag; University of Miami

Physiological processes influence the movement behavior of animals. Understanding relationships between physiology and behaviour can lead to breakthroughs in species' movement ecology but linking ephemeral physiological conditions with movement patterns has been an ongoing challenge. This is especially the case for migratory, free-roaming species notorious for displaying highly variable movement over large spatiotemporal scales. Physiological and biological variables, termed "biomarkers", can describe underlying physiological processes that influence movement, such as energy storage and utilization, growth, and development. Here, we aimed to determine the relative influence of physiology on intra-specific movement patterns of a highly migratory apex predator, the tiger shark (*Galeocerdo cuvier*). We accomplished this by analyzing 50 measured biomarkers for nutritional and energetic condition, metabolism, morphology, reproduction, and health, in addition to seasonality, on the dispersion and scale of tiger shark movement across multiple temporal periods (7 – 25 days). Overall, nutrition-related biomarkers had the largest relative influence on movement, followed by metabolic hormones, energy substrates, and morphology. Reproductive state, health, and season had negligible influence on the movement patterns observed across the temporal periods considered. These results emphasize the importance of tiger sharks acquiring, storing, and mobilizing energy to support their movements, providing important knowledge about their movement ecology. Our work presents a novel approach for addressing the challenge of linking movement patterns of free-roaming species to their physiology and has wide applicability for future studies investigating the drivers of individual variation in movement of highly mobile species.

Keywords: movement ecology; physiology; satellite tag; boosted regression trees; Atlantic Ocean

SI Abstract Ref: 177

Nakia Cullain

Dalhousie University; Marine Megafauna Foundation

Zavora Bay: A new critical area for reef manta rays within Africa's largest identified population

1. Michelle Carpenter; University of Cape Town
2. Stephanie K. Venables; Marine Megafauna Foundation
3. Andrea D. Marshall; Marine Megafauna Foundation
4. Derek P. Tittensor; Dalhousie University
5. Heike K. Lotze; Dalhousie University

Mozambique is a hotspot for threatened and data deficient species of sharks and rays, yet a lack of site-specific information hinders the development of local and national species management plans. The largest identified population of reef manta rays (*Mobula alfredi*) in Africa aggregate within a 350 km upwelling zone that extends from the Bazaruto Archipelago in the north, to Zavora in the south. An 88% decline in sightings of *M. alfredi* along the Mozambican coastline represents one of the largest declines on record. However, Zavora (a remote and less explored bay in the region), still has consistent and frequent sightings of reef manta rays. Using sightings and photo-ID data from dive surveys conducted during 2009-2021, we investigate sightings trends, habitat preference, and population demographics of *M. alfredi* in Zavora Bay. Our results indicate that compared to other sites in Mozambique, abundance estimates for Zavora are still high, albeit on the decline. Our results also indicate a shift from consistent year-round sightings to a seasonal aggregation from July-November, with complete abandonment of a previously favoured cleaning station. The site and seasonal affinity of *M. alfredi* in Zavora Bay highlights the importance of understanding fine-scale site use within the larger home range of this population to develop local management strategies. Our findings provide evidence that Zavora Bay is a critical visitation site for reef manta rays in Mozambique and should be considered a conservation priority area for this threatened species.

Keywords: threatened species; Mozambique; habitat preference; photo-ID; management

SI Abstract Ref: 174

Benjamin Marsaly

School of Marine Science and Policy, University of Delaware

Movement patterns of the sicklefin lemon shark, *Negaprion acutidens*, around Tahiti and Moorea, French Polynesia, South Pacific.

1. Benjamin, Marsaly; School of Marine Science and Policy, University of Delaware, Lewes DE, USA.
2. Pierpaolo, Brena; PSL Research University: EPHE-CNRS-UPVD USR 3278 CRIOBE, Perpignan, France.
3. Eric, Clua; PSL Research University: EPHE-CNRS-UPVD USR 3278 CRIOBE, Perpignan, France.

The sicklefin lemon shark, *Negaprion acutidens*, is globally understudied compared to its sister species the Atlantic lemon shark, *N. brevirostris*. Although it has been heavily targeted by artificial provisioning activities until 2017, its movements are still unknown in the Society Islands, French Polynesia. Here, we used acoustic telemetry to study the residency and movement patterns of the sicklefin lemon shark between June 2014 and July 2015. We deployed 21 receivers on the outer reefs of Tahiti (n=11), Moorea (n=7), and Tetiaroa (n=3), an atoll located approximately 50 km north of Tahiti and Moorea. A total of 17 mature individuals were tagged internally by ingestion or externally using a speargun. Preliminary analyses indicate that sharks were primarily detected around Moorea and at the Vallée Blanche, northeast of Tahiti, while no individuals were detected in Tetiaroa. The number of detections is higher where shark-feeding occurred during the study period and decreases with the distance from tagging location. Globally, the detections mostly occurred during the day, suggesting that adult sicklefin lemon sharks use the outer reef during the day and move to deeper waters at night. Therefore, the sicklefin lemon shark seems to be highly resident and could be impacted by artificial provisioning activities at a small spatial scale. Considering that artificial provisioning is now forbidden in French Polynesia waters, such data is crucial to understand the long-term impacts of this activity on sharks movements, and could pave the way for further studies focusing on dishabituation process regarding artificial provisioning in shark species.

Keywords: spatial ecology; residency; acoustic telemetry

SI Abstract Ref: 171

Sweta Beura

Zoological Survey of India

Integrative taxonomy, species composition, distribution and current status of deep-sea chondrichthyans of India

1. Kinattumkara Bineesh; Zoological Survey of India
2. Sweta Beura; Zoological Survey of India

India is one of the leading chondrichthyan fishing nations. Most of the deep-sea chondrichthyans species are poorly known due to their low market value and low targeted sampling for research activities. In India, deep-sea chondrichthyans are caught both as targeted and bycatch, there is a lack of data on deep-sea chondrichthyans, despite their high market demand and catch. The objective of this study was to characterize the catch composition of deep-sea chondrichthyans, using extensive trawl catch data of commercial deep-sea shrimp fishery. The present paper is an attempt to provide new information on catch, integrative taxonomy, species composition current distribution, fleet size, trade and usage of deep-sea chondrichthyans in India. This study based on the landing site surveys conducted during the years 2017-2021 at major fish landing centres along the west and east coast of India and Andaman and Nicobar Islands. The present findings revealed 47 species under 19 families caught in commercial and artisanal fisheries. Trawl surveys show that *Cephaloscyllium silasi* distribution restricted to off Kerala and South Andaman Islands of India. *Hexatrygon bickelli* and *Squalus hemipinnis* were confirmed from Kerala and Andaman Islands respectively. Highest diversity in the landings was observed at Kerala with several species recorded during the present study was new to Indian waters. Fishery was dominated by species belonging to families Echinorhinidae, Centrolophidae, and Rhinochimaeridae. Continued monitoring and collection of biological and taxonomical data from additional sources is recommended for better management measures for sustainable utilization of deep-sea chondrichthyans from Indian waters.

Keywords: deep-sea Chondrichthyans; species composition; diversity; Indian EEZ; conservation

SI Abstract Ref: 350

Alifa Bintha Haque

University of Oxford

Mitigating elasmobranch product trade: A market analysis for made-to-measure interventions

1. Alifa Bintha Haque; Nature-based Solutions Initiative, Department of Zoology, University of Oxford, Zoology Research and Administration Building, 11a Mansfield Rd, Oxford OX1 3SZ, UK
2. Rodrigo Oyanedel ; The Interdisciplinary Centre for Conservation Science, Department of Zoology, University of Oxford, Oxford, UK.
3. Rachel D. Cavanagh; British Antarctic Survey, High Cross, Madingley Road, Cambridge, UK, CB3 0ET

The global trade in elasmobranch products contributes to dramatic declines in elasmobranch populations. Recognising realistic and context-appropriate solutions to mitigate trade requires a thorough grasp of elasmobranch marketplaces that are notoriously inadequate where products originate, predominantly in the global south. We assessed the market components of the elasmobranch fin trade in the Bay of Bengal, Bangladesh, using a framework designed for wildlife markets utilising mixed-method approaches. We found that markets are supply-driven and complex. Fins are supplied from protected and unprotected species, targeted and by-caught, and traded with other fishery and elasmobranch products. We highlighted challenges due to no reporting, limited monitoring and the difficulties in segregating species/products of different legal statuses. An unjust power structure between low-access harvesters and high-access actors with finances, market information and social ties was evident. The discriminative power exercising influenced unsustainable trade by high-access actors attaining excessive and unequal benefits from the market and often impacting independent decision-making of low-access actors (e.g., adopting conservation measures). We found ambiguous clarity about legality, growing distrust between fishers and fishery managers/policy-makers, and confusion regarding the infrequent seizures resulting from limited awareness, acceptance and no collaborative approach preceding law-making and enacting. These led to increased conflicts, corruption, non-compliance and unwillingness to report catch. Actors' behaviours are driven by diverse motivations, requiring a sophisticated regulation for reducing catch and trade, with local and global benefits. We provided targeted management recommendations to mitigate unsustainable trade, e.g., sustainable catch quotas, better financial arrangements, improved access to incentives for low-access actors, and other market solutions.

Keywords: Bay of Bengal; market-based solutions; wildlife market; wildlife trade; shark/ray

SI Abstract Ref: 59

Andhika Prima Prasetyo

Centre Fisheries Research, Ministry for Marine Affairs and Fisheries, Indonesia

Shark-dust: high-throughput DNA sequencing of processing residues unveils rife trade in endangered sharks and rays

1. Andhika, Prasetyo; School of Science, Engineering and Environment, University of Salford, Salford, UK / Centre Fisheries Research, Ministry for Marine Affairs and Fisheries, Indonesia
2. Joanna, Murray; Centre for Environment, Fisheries and Aquaculture Science, Lowestoft, UK
3. Firdaus, Agung; Directorate for Conservation and Marine Biodiversity, Ministry for Marine Affairs and Fisheries, Indonesia
4. Efin, Muttaqin; Wildlife Conservation Society Indonesia Program, Indonesia
5. Naiara, Sales; Department of Biological Sciences, University of Chester, UK
6. Allan, McDevitt; School of Science, Engineering and Environment, University of Salford, Salford, UK
7. Stefano, Mariani; School of Biological and Environmental Sciences, Liverpool John Moores University, Liverpool, UK

Trade restrictions have been established to counteract the rapid global decline of sharks and rays. This has resulted from high fishing pressure, by-catch and market demand for certain products (e.g. fins). Tackling the illegal trade of endangered species poses enormous challenges for authorities, including taxonomic ambiguity, product variety, logistical issues for inspections and trade flow complexity. Traditional genetic techniques have been developed, but these techniques are either time-consuming or species-specific, and generally fail to provide a comprehensive picture of the biological complexity underlying trade patterns. Here, we explore a powerful, alternative option, based on the high-throughput sequencing of trace DNA fragments retrieved from dust and scraps left behind by trade activities. We collected 28 'shark-dust' samples from seven processing plants across Java, Indonesia, and generated shark and ray sequences through DNA metabarcoding. We also collected individual tissue samples (175) in the same processing plants and identified the species by high-throughput barcoding (HTB) for comparison. Over 74% of reads belonged to CITES-listed species i.e. hammerhead sharks (*Sphyrna spp.*), silky shark (*Carcharhinus falciformis*), bigeye thresher shark (*Alopias superciliosus*) and the recently CITES-listed giant guitarfish (*Glaucoctegus typus*). A total of 75 shark and ray genera (representing half of the chondrichthyan orders) were identified, with 20 more taxa detected using the dust samples than those identified using tissue samples. Furthermore, dust samples were shown to effectively capture the species diversity being exploited. We argue that this 'shark-dust' approach is likely to become a powerful and cost-effective monitoring tool wherever elasmobranchs are traded.

Keywords: trade monitoring; CITES; DNA metabarcoding; sharks and rays; Indonesia

SI Abstract Ref: 26

Pierluigi Carbonara

COISPA Tecnologia & Ricerca

Mitigation trials in South Adriatic pelagic longline: first results from the MedBycatch project

1. Pierluigi, Carbonara: COISPA Tecnologia & Ricerca
2. Giulia, Prato: WWF Italy
3. Walter, Zupa: COISPA Tecnologia & Ricerca
4. Simone, Niedermüller: WWF Mediterranean
5. Andrea, Bellodi: Cagliari University
6. Maria Cristina, Follesa: Cagliari University

In the Mediterranean surface longlines (SL) the shark and ray bycatch represents around 10-15% in biomass of the total catch and the highest bycatch was found in the Alboran and Adriatic Sea. The blueshark (*Prionace glauca*), considered by IUCN as Critically Endangered in the Mediterranean, represent over 70% of the chondrichthyan catch. In this context in South Adriatic pelagic longline fishery were tested two type of bycatch mitigation trials: circular hook and chancing fishing strategy.

About the circular hook in a SL were used alternatively two type of hooks: circular (C-type), normal type (J-type). In 5 fishing days an experimental SL was used and the CPUE, bycatch-rate and %Bycatch was calculated for the C-hook and J-hook. The results showed that there were no significant differences in terms of CPUE, bycatch-rate and %bycatch between the two types of hooks. While the bluesharks caught by C-type hook showed a significantly better condition than the J-type.

In the fishing strategy used by fisherman the SL fishing mostly during the night. During two consecutive fishing trips (FT) with at least 3 fishing days each, in one FT was used the standard fishing strategy (strategy 1: SL fishing mostly during the night) and in the other the reverse fishing strategy (strategy2: SL fishing mostly during the day) was used. The CPUE, bycatch-rate and %bycatch for the two fishing strategy showed that in the strategy 2 any blue shark was caught, while for the target species a significant reduction about the 30% was observed.

Keywords: bycatch; *Prionace glauca*; circular hook; fishing strategy

Marta Cambra

Escuela de Biología y Centro de Investigación en Ciencias del Mar y Limnología de la Universidad de Costa Rica

Ecological drivers shaping elasmobranch assemblages at Cocos Island, a near-pristine ecosystem

1. Marta Cambra; Escuela de Biología y Centro de Investigación en Ciencias del Mar y Limnología de la Universidad de Costa Rica
2. Isaac Chinchilla; Área de Conservación Marina Cocos del Sistema Nacional de Areas de Conservación de Costa Rica
3. Geiner Goffin; Área de Conservación Marina Cocos del Sistema Nacional de Areas de Conservación de Costa Rica
4. Mario Espinoza; Escuela de Biología y Centro de Investigación en Ciencias del Mar y Limnología de la Universidad de Costa Rica

Cocos Island is known to have one of the largest biomass levels of predatory fish in the tropics, yet our knowledge of the drivers affecting elasmobranch abundance and distribution patterns is limited. This study examined the effect of spatial, seasonal, and environmental drivers on elasmobranch assemblages at Cocos Island using baited remote underwater video stations (BRUVS) between 2016 and 2020. Elasmobranchs were detected in 95% of the BRUVS, with stations having on average 2.7 ± 1.6 species and 6.3 ± 6.5 ind/hour largely overcoming the mean relative abundance reported by BRUVS in other protected reef systems. A total of 13 species comprised the elasmobranch assemblage of Cocos Island, which was clearly divided between pelagic and benthic environments. Depth and habitat were identified as the major factors structuring elasmobranch assemblages in benthic environments, although substrate cover, distance to the coast and season were also significant predictors. Significant indicator species with stronger species-habitat associations were the silky shark *Carcharhinus falciformis* dominating pelagic habitats, the white tip reef shark *Triaenodon obesus* and the black tip reef shark *Carcharhinus melanopterus* dominating warm shallow areas with coral or rocky reefs, the scalloped hammerhead shark *Sphyrna lewini* associated with pinnacles at greater distances from the coast and the silvertip shark *Carcharhinus albimarginatus* with preference for deeper sandy areas in bays and inshore sites. This study represents the first attempt at describing ecological patterns of elasmobranch assemblages removing human presence from the water and using a systematic research survey in benthic and pelagic environments of Cocos Island.

Keywords: Costa Rica; baited remote underwater video stations; multivariate regression trees; distance based redundancy analysis; generalized additive mixed models

SI Abstract Ref: 151

Larissa Modica

Spanish Institute of Oceanography (IEO)

Elasmobranch diversity in the Aviles canyon system (NE Atlantic) and habitat modelling

1. Larissa Modica; Spanish Institute of Oceanography (IEO C.O Santander)
2. Cristina Rodríguez-Cabello; Spanish Institute of Oceanography (IEO C.O Santander)
3. Francisco Sánchez; Spanish Institute of Oceanography (IEO C.O Santander)

Information on the distribution and habitat preferences of ecologically important species is essential for their management and protection. The Avilés Canyon System (ACS) located in NE Atlantic Waters (Cantabrian Sea) was declared as Site of Community Importance (SIC) within the Nature 2000 network based on Habitat Directive 92/43/CEE. Therefore several surveys have been conducted to identify the presence of vulnerable habitats and species and to achieve a better understanding of the ecosystem function.

Biomass data were gathered from two otter trawls datasets (2010 and 2011) within two different projects: LIFE+INDEMARES and ERDEM. Data were over dispersed due to the species typical spatial preferences, (a lot of zeros together with some very high values samples), thus zero-inflated GAM (Generalized Additive Models) with a negative binomial distribution were applied to predict species biomasses in the study area for the four most abundant chondrichthyans: *Scyliorhinus canicula*, *Raja clavata*, *Galeus melastomus*, *Chimaera monstrosa*. A broad set of environmental variables were available to link with biomasses, but after a linear regression with a Pearson correlation test to avoid overestimation of explained variance just six environmental layers were used: depth, BPI broad, Q50 phi, S0, organic matter content (OM) of the sediments and the categorical variable bottom type.

The variable that better explains their distribution is depth. The variances explained varied between 72.9% for *G. melastomus* and 82.6% for *S. canicula*. All the species studied showed a clear bathymetric distributional pattern probably linked more to feeding behavior and prey availability than to specific environmental conditions.

Keywords: elasmobranch diversity; Aviles Canyon System; habitat; distribution models; NE Atlantic

SI Abstract Ref: 123

Johann MOURIER

Université de Corse Pasquale Paoli, UMS 3514 Plateforme Marine Stella Mare

Dive into the social life of elasmobranchs: Investigating social and collective behaviour in sharks and rays

Social and collective behaviours as well as group formation are found across the animal kingdom including sharks and rays. Animal aggregations may result from a common requirement for shared resources or favourable environmental conditions and are not necessarily driven by social attraction between individuals. In contrast, social groups rely on active social preferences between individuals. Although they have been considered mostly solitary organisms, improvements in analytical tools and the technology used to study behaviours in the wild has led to the confirmation that many elasmobranch species were more social than previously thought and to a better understanding of the form, structure, function and ecological significance of associations and grouping in sharks and rays. Here, I present some case studies I have been conducting or involved in, illustrating research on aggregations, social and collective behaviour in wild elasmobranchs. This includes species with gregarious or solitary life styles. This overview aims at presenting the latest advancements in analytical techniques (especially social network analysis) and field technology (e.g. photo-identification, acoustic telemetry, biologging, video recording or drone) used to study elasmobranch aggregating patterns and social systems, and discussing the benefits and costs of grouping and socializing in these taxa.

Keywords: social behaviour; collective behaviour; social networks; biologging; aggregations

SI Abstract Ref: 118

Ben D'Antonio

*Ocean Graduate School and the UWA Oceans Institute, University of Western Australia, Perth, WA, Australia;
Australian Institute of Marine Science, Indian Ocean Marine Research Centre, Perth, WA, Australia*

Drivers of fine-scale vertical and horizontal movement of whale sharks at Ningaloo Reef, Western Australia

1. Ben, D'Antonio; Ocean Graduate School and the UWA Oceans Institute, University of Western Australia, Perth, WA, Australia & Institution & Australian Institute of Marine Science, Indian Ocean Marine Research Centre, Perth, WA, Australia
2. Luciana C Ferreira; Australian Institute of Marine Science, Indian Ocean Marine Research Centre, Perth, WA, Australia
3. Mark Meekan; Australian Institute of Marine Science, Indian Ocean Marine Research Centre, Perth, WA, Australia
4. Lilian Lieber; Queen's University Marine Laboratory, Portaferry, Northern Ireland
5. Paul G. Thomson; Ocean Graduate School and the UWA Oceans Institute, University of Western Australia, Perth, WA, Australia
6. Chari Pattiaratchi; Ocean Graduate School and the UWA Oceans Institute, University of Western Australia, Perth, WA, Australia
7. Patti Virtue; Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia
8. Andrew Brierley; Gatty Marine Laboratory, School of Biology, University of St Andrews, Fife KY16 8LB, Scotland, UK
9. Chloe M Power; Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia
10. Ana M. M. Sequeira; School of Biology and ANU College of Science, The Australian National University, Canberra, Australia
11. Michele Thums; Australian Institute of Marine Science, Indian Ocean Marine Research Centre, Perth, WA, Australia

Whale sharks (*Rhincodon typus*) are thought to seasonally aggregate in coastal waters to take advantage of foraging opportunities provided by enhanced localised productivity. To test this hypothesis, we examined the links between the movements of whale sharks and prey availability at Ningaloo Reef, Western Australia. In 2018, we sampled the water column using fisheries echosounder (Simrad EK60) transects and dedicated target trawls via ship-based surveys to describe the distribution, abundance and density of zooplankton prey in the vicinity of concurrently tracked whale sharks (using Fastloc-GPS tags). Using generalised additive mixed models, we examined whale shark kernel utilisation density (horizontal movement) and time-at-depth (calculated per 5 m depth bins) and (response variables) in relation to various prey measurements ($n \text{ per m}^3$). There was a positive relationship between whale shark horizontal movement and prey density. Sharks tended to move along the 40-60 m depth contours, which were characterised by pronounced bathymetric features accumulating higher densities of prey near the seabed. However, despite shark horizontal movements centred within areas of high prey density, there was no relationship between shark time-at-depth and prey density. Sharks displayed consistent patterns of repeated descents and ascents through the water column with individuals spending ~49% of time within the upper 5 m of the water column, irrespective of vertical prey distribution. We suggest these vertical movements may reflect the difficulty of feeding on prey in the lower water column compared to filter feeding near the sea surface.

Keywords: foraging ecology; movement ecology; hydroacoustics; whale sharks; marine megafauna

SI Abstract Ref: 107

Rebecca Lipscombe
Southern Cross University

Habitat use and movement patterns of tiger sharks (*Galeocerdo cuvier*) in eastern Australian waters

1. Rebecca Lipscombe; Southern Cross University
2. Julia Spaet; University of Cambridge
3. Anna Scott; Southern Cross University
4. Chi Hin Lam; University of Massachusetts
5. Craig Brand; New South Wales Department of Primary Industries
6. Paul Butcher; New South Wales Department of Primary Industries/Southern Cross University

Understanding the movement of highly mobile marine predators is vital for effective conservation and management. Despite being targeted in shark control programs, our knowledge of tiger shark (*Galeocerdo cuvier*) movement and habitat use off eastern Australia is limited. To investigate the habitat use and movements in this region, 16 sharks (157–384 cm total length) were tagged with MiniPAT pop-up satellite archival tags in 2018 and 2019. Eleven of these individuals were also fitted with satellite-linked radio transmitting tags. After release, most sharks moved off the continental shelf and travelled north, associating with seamounts as they moved toward Queensland. While at liberty, they transited through temperate, sub-tropical and tropical waters, spending the majority of time in the upper 50 m of the water column and at temperatures between 22–25 °C. Horizontal movement was focused in offshore waters beyond the continental slope. Increased movement over shelf waters occurred mainly during the austral spring and summer when the East Australian Current encroaches on the continental shelf. Broad latitudinal movement along the east coast of Australia was evident and highlights the connectivity between tropical and warm temperate regions.

Keywords: archival tag; Carcharhinid; satellite tag; shark management; geolocation

SI Abstract Ref: 105

Wade VanderWright

Simon Fraser University

Metabolic morphology and ecological lifestyle in sharks

1. Wade, VanderWright; Simon Fraser University
2. Jennifer, Bigman; NOAA
3. Anthony, Iliou; Simon Fraser University
4. Nick, Dulvy; Simon Fraser University

Metabolism underpins life histories, population dynamics, and extinction risk. Morphological traits that are linked to an organism's metabolism may provide a first approximation to the ecological needs to support growth, survival, and reproduction. Here we examine the relationship between respiratory physiology (i.e. gill slit height in proportion to total length) and activity level (caudal fin aspect ratio) in nearly all extant shark species (n=456). Gill slit heights and caudal fin aspect ratios were collected and measured from the field guide *Sharks of the World* (Ebert 2013). We used a Bayesian-phylogenetic inference model that accounts for each species' maximum size, primary habitat type, and evolutionary history. We found a strong positive relationship between gill slit height and activity level. We also show that primary habitat had a strong effect on this relationship with pelagic sharks exhibiting the highest gill slit heights and activity levels while deep water sharks showed the opposite trend. These findings suggest that proxies for metabolic demand may be available via external and easy to measure morphological traits and natural history. Insight into the metabolic demand of these animals may allow us to estimate vital life history traits that could inform ecological risk assessments.

Keywords: metabolic theory of ecology; gill-oxygen limitation theory; macroecology; shrinking fishes

SI Abstract Ref: 2

Katherin Soto-López

Escuela de Sistemas Biológicos e Innovación Tecnológica, Universidad Autónoma Benito Juárez de Oaxaca (ESBIT-UABJO), Oaxaca de Juárez, México; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Baja California Sur, Méx

Morphometry and histology to assess the maturity stage of three endangered devil ray species (Elasmobranchii: Mobulidae) from the Gulf of California

1. Katherin, Soto-López; Escuela de Sistemas Biológicos e Innovación Tecnológica, Universidad Autónoma Benito Juárez de Oaxaca (ESBIT-UABJO), Oaxaca de Juárez, México; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Baja California Sur, México.
2. Rosa Isabel, Ochoa-Báez; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Baja California Sur, México.
3. Felipe, Galván-Magaña; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Baja California Sur, México.
4. Javier Noé, Serrano-López; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Baja California Sur, México.
5. John, O'Sullivan; Monterey Bay Aquarium, Monterey, California

Devil rays of the genus *Mobula* are subject to fishing exploitation worldwide, the population's reductions are evidenced by a decline in the number of catches of these rays, for this reason, they are considered vulnerable to overexploitation. Limited biological knowledge on these species has forced the use of precautionary conservation measures in some countries where intensive fishing occurs. There is few information about the reproductive biology of these species. This study aimed to describe the reproductive activity of three endangered species of the genus *Mobula* (*Mobula munkiana*, *Mobula thurstoni*, and *Mobula mobular*) in the Gulf of California. Reproductive organs were collected during 7 years of commercial fishing (2001–2007), and data on population structure, sex ratio, gamete production, and the number of offspring per breeding period were obtained. Maturity stages were determined through histological analysis of the gonads for both sexes, and the size at maturity was estimated based on anatomical and histological characteristics of the specimens caught. According to the results, there is an urgent need to apply strict conservation measures, such as fishery closures during the breeding season (May to September) or the establishment of catch sizes after specimens have reached sexual maturity, mainly in the countries where these rays are caught.

Keywords: *Mobula mobular*; *Mobula munkiana*; *Mobula thurstoni*; reproduction; Gulf of California

SI Abstract Ref: 51

Mark Royer

Hawai'i Institute of Marine Biology

The Right Stuff: Scalloped hammerhead sharks are metabolically poised for intensive and potentially anoxic deep dives

1. Mark, Royer; Hawai'i Institute of Marine Biology
2. Danielle, Garcia; University of Hawai'i at Mānoa
3. Kevin, Weng; Virginia Institute of Marine Science
4. Carl, Meyer; Hawai'i Institute of Marine Biology
5. Kim, Holland; Hawai'i Institute of Marine Biology
6. Jeff, Drazen; University of Hawai'i at Mānoa

Scalloped hammerhead sharks (*Sphyrna lewini*) routinely perform rapid deep dives to forage on meso and bathypelagic prey. These deep dives consist of intensive burst swimming followed by resting periods in the surface mixed layer. Swimming muscle temperature profiles suggest *S. lewini* suppress their gill function as a means to reduce convective heat loss. Such intensive swimming behavior coupled with supposedly reduced respiration raises questions concerning the aerobic and anaerobic metabolic capacity of their white swimming muscle. Measuring the activity rates of key enzymes used in aerobic and anaerobic metabolism provides an indirect indicator of the metabolic potential of a tissue. Here we measured the maximal activities of aerobic enzymes citrate synthase (CS), malate dehydrogenase (MDH) and anaerobic enzymes pyruvate kinase (PK) and lactate dehydrogenase (LDH) from white swimming muscle of *S. lewini* and were compared to those measured from other coastal, deep-dwelling, and highly active endothermic shark species. *Sphyrna lewini* had significantly higher activity levels of LDH, an anaerobic enzyme, and MDH, an aerobic enzyme. Results indicate the white muscle tissue of *S. lewini* is highly anaerobic dependent for burst swimming but has a high potential for lactate buildup. High activity rates of MDH indicate the potential for lactate to be rapidly reduced under aerobic conditions such as those experienced in the surface mixed layer between dives. These physiological adaptations likely enable *S. lewini* to remain highly active while suppressing gill function during deep dives and thereby exploit a very different ecological niche from sympatric shark species.

Keywords: scalloped hammerhead; deep diving; enzyme; lactate; metabolic poise

SI Abstract Ref: 52

Aaron Judah

Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada

Functional integrity and vulnerability of shark and ray communities across the world's coral reefs

1. Aaron, Judah; Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada
2. Matthew, McLean; Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada
3. Christopher, Mull; Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada
4. Ana, Barbosa Martins; Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada
5. M. Aaron, MacNeil; Department of Biology, Dalhousie University, Halifax, Nova Scotia, Canada; Ocean Frontier Institute, Dalhousie University, Halifax, Nova Scotia, Canada

Sharks and rays support many ecological roles in coastal marine ecosystems, however widespread overfishing and habitat loss have resulted in population declines. Despite the intrinsic vulnerability of shark and ray populations due to their life-history characteristics, such as slow growth, low fecundity and late reproductive maturity, shark and ray functional community structure from a trait-based approach has rarely been quantified. Here, we provide a global assessment of shark and ray functional community structure among 230 tropical coral reefs in 42 nations across three ocean basins. We find that socio-economic conditions mediate shark and ray functional diversity, functional originality (the uniqueness of the community based on their traits) and functional dispersion (the overall breadth of trait combinations). Higher human gravity is strongly associated with degradation of all functional biodiversity metrics, while the trait structure of highly populated areas favour benthic and invertivorous sharks and rays. Large-bodied, pelagic and benthopelagic, deep diving, piscivorous and higher order carnivorous species are less abundant under increased human impacts. Biogeographically, Atlantic assemblages are more functionally original and diverse than Pacific assemblages, which are more represented by traits indicative of reef sharks rather than rays, such as fusiform body shape, ram ventilation and pelagic or benthopelagic lifestyles. Closed marine protected areas support substantially higher functional biodiversity than restricted and openly fished areas. Our findings illustrate the large-scale functional degradation of shark communities on coral reefs but identify spatial management tools as powerful avenues for protecting shark and ray functional integrity.

Keywords: coral reefs; functional traits; functional diversity; bruvus; conservation

SI Abstract Ref: 102

Boryshpolets Serhii

Faculty of Fisheries and Protection of Waters, University of South Bohemia in České Budějovice, South Bohemian Research Center of Aquaculture and Biodiversity of Hydrocenoses, Zátíší 728/II, Vodňany 389 25, Czech Republic.

The role of viscosity in the sperm motility of elasmobranch species.

1. Serhii Boryshpolets; Faculty of Fisheries and Protection of Waters, University of South Bohemia in České Budějovice.
2. Borys Dzyuba; Faculty of Fisheries and Protection of Waters, University of South Bohemia in České Budějovice
3. Pablo García-Salinas; Grupo de Acuicultura y Biodiversidad, Instituto de Ciencia y Tecnología Animal, Universitat Politècnica de València
4. Víctor Gallego; Grupo de Acuicultura y Biodiversidad, Instituto de Ciencia y Tecnología Animal, Universitat Politècnica de València
5. Anatolii Sotnikov; Faculty of Fisheries and Protection of Waters, University of South Bohemia in České Budějovice
6. Juan F. Asturiano; Grupo de Acuicultura y Biodiversidad, Instituto de Ciencia y Tecnología Animal, Universitat Politècnica de València

Elasmobranchii belongs to an old evolutionary class of vertebrates that diverged 450 mya. These species present a wide diversity of reproductive strategies while preserving the ancient mode of internal fertilization. Moreover, many of them are considered endangered and may be extinct soon. Understanding the principles of sperm motility and sperm physiology is essential to developing assisted reproductive techniques for this species group. Additionally, it is also important from evolutionary and general physiological perspectives as a part of reproduction studies.

Elasmobranchii species possess relatively big spermatozoa (compared to bony fishes), with an elongated spiral shape head and tail similar to one currently existing (but later diverged) in birds, reptiles, and amphibians, which can be considered an evolutionary ancient. These particular structures may be associated with the necessity to penetrate viscous ovarian fluid or the jelly layer of eggs, suggesting environmental viscosity as the driving force which shapes big-sized spermatozoa head to the spiral shape during evolution.

In the present study, we observed spermatozoa motion by regular and high-speed video microscopy to visualize sperm and flagellar motion in three different Elasmobranchii species: the freshwater ray *Potamotrygon motoro*, the marine skate *Raja asterias* and the shark *Scyliorhinus canicula*. We investigated the effect of surrounding media viscosity on spermatozoa motility parameters and their ability to propagate, release from spermatozeugmata, and perform directional changes. Our results suggest that the surrounding media's viscosity regulates spermatozoa motility and may affect its performance during fertilization in the Elasmobranchii species.

Keywords: cartilaginous fishes; fish reproduction; spermatozeugmata

SI Abstract Ref: 186

Atlantine Boggio-Pasqua

Aix-Marseille University

Whitespotted eagle ray (*Aetobatus narinari*) age and growth in wild (*in situ*) versus aquarium-housed (*ex situ*) individuals: implications for conservation and management

1. Atlantine, Boggio-Pasqua; Aix-Marseille University, France.
2. Kim, Bassos-Hull; Sharks and Rays Conservation Research Program, Mote Marine Laboratory, Sarasota, FL, USA.
3. William H., Aeberhard; Swiss Data Science Center, ETH Zürich, Switzerland.
4. Lisa A., Hoopes; Research and Conservation Department, Georgia Aquarium, Atlanta, GA, USA.
5. Denise A., Swider; Discovery Cove, Orlando, FL, USA.
6. Krystan A., Wilkinson; Sharks and Rays Conservation Research Program, Mote Marine Laboratory, Sarasota, FL, USA.
7. Manuel, Dureuil; Shark and Ray Conservation Centre, Dartmouth, Canada.

The whitespotted eagle ray (*Aetobatus narinari*), a large pelagic migratory ray with an endangered status on the IUCN red list, displays slow growth and late maturity life history characteristics based on available literature. Historically, its age and growth parameters have been reported through vertebral aging methods. However, the periodicity of vertebrate band pair formation, which is used for aging, has not been validated for this species, making aging accuracy and thus the resulting growth parameters uncertain. In this study, we used both a frequentist and Bayesian method of estimating sex-specific von Bertalanffy growth parameters (DW_{∞} , k) in wild recaptured versus aquarium-housed rays. Additionally, we estimated growth from repeated measurement data collected from aquarium-housed rays, to obtain growth parameters while allowing for individual variability. Between 2009 and 2020, 590 whitespotted eagle rays were caught, measured, tagged and released along the southwest coast of Florida. Thirty-four were recaptured between 5–1413 days at liberty. Nineteen additional rays were collected, transported and maintained at Georgia Aquarium, Atlanta, with regular size and weight monitoring. Wild whitespotted eagle rays were found to grow faster and mature earlier than previously thought, with Bayesian estimates of $k = 0.28 \text{ year}^{-1}$ in females, and $k = 0.30 \text{ year}^{-1}$ in males. Aquarium-housed individuals seemed to grow slower and reach smaller sizes, although data provided by the aquariums showed variable growth patterns depending on the facility. Life history parameters and growth trajectories generated from this study offer valuable information to aid with future conservation management strategies of this endangered species.

Keywords: eagle ray; life history; age and growth analysis; maturity; longevity

SI Abstract Ref: 227

Florencia Cerutti

Charles Darwin Foundation

Vulnerability of chondrichthyan fishes of the Eastern Tropical Pacific to climate change

Cerutti-Pereyra, F., Denker, L., Espinoza, M., Fallo-Mejía, P., Finucci, B., Galván-Magaña, F., Hacohe, A., Hearn, A., Hoyos-Padilla, M., Ketchum, J., Moya, A., Navia, A., Pazmiño, D., Ramírez-Macías, D., Rummer, J., Salinas-de-León, P., Sosa-Nishizaki, O., Stock, C., Chin, A.

Climate change is an environmental emergency threatening species and ecosystems globally and leading to a critical need to understand how marine species will be affected. Vulnerability assessments provide a framework to assess climate impacts combining species' exposure to a stressor, their sensitivity, and their capacity to adapt. We used an Integrated Risk Assessment to evaluate the vulnerability of 132 chondrichthyan species in the Eastern Tropical Pacific (ETP) to climate change and identified eight climate change factors most relevant for the region. The overall vulnerability for 23% of ETP chondrichthyans is High and 76% are Moderately vulnerable to climate change. Most of the Highly vulnerable species are batoids (77%), and most (90%) are coastal species or linked to coastal ecosystems through nurseries. Ocean warming, in combination with hypoxia and acidification, will have the most widespread effect on ETP chondrichthyans, but coastal species and those with reliance on coastal habitats will also contend with changes sea level rise and salinity from freshwater inputs. Vulnerability increases with synergies with other anthropogenic factors already occurring in the region, thus mitigating the impacts of climate change on ETP chondrichthyans include addressing issues with overfishing and habitat destruction too. Specific actions may be required for species at higher risk including protecting coastal bays and estuarine habitats, addressing fisheries sustainability, and reducing mortality. This assessment also identified knowledge gaps concerning ETP chondrichthyans and highlights the need of further understand the impacts of climate change on ETP habitats and processes.

Keywords: risk assessment; climate change; sharks; batoids; chimeras

SI Abstract Ref: 90

Franco Cristiani

Universidad Nacional del Comahue, Bariloche, Rio Negro, Argentina; CESIMAR, CENPAT-CONICET, Puerto Madryn, Chubut, Argentina

Immune and endocrine reproductive parameters of the chimaera, *Callorhynchus callorhynchus*, inhabiting a human-impacted area in Patagonia, Argentina. Preliminary results.

1. Franco, Cristiani; Universidad Nacional del Comahue, Bariloche, Rio Negro, Argentina; CESIMAR, CENPAT-CONICET, Puerto Madryn, Chubut, Argentina.
2. Cynthia A., Awruch; CESIMAR, CENPAT-CONICET, Puerto Madryn, Chubut, Argentina; School of Natural Sciences, University of Tasmania, Tasmania, Australia.
3. Gabriela M., Palacios; CESIMAR, CENPAT-CONICET, Puerto Madryn, Chubut, Argentina.

In an increasingly stressed marine environment due to anthropic activities, the assessment of wildlife health becomes imperative. Marine organisms are exposed to a complex mix of pollutants which can compromise their wellbeing. Due to the life-history characteristics, use of habitats and distribution, Chondrichthyans are prone to bioaccumulate and biomagnify significant amounts of pollutants. Knowledge of immune and reproductive impairments on wild individuals can serve as an early alert of potential conservation threats. In this study we present preliminary results on immune and reproductive parameters of the elephant fish, *Callorhynchus callorhynchus*, inhabiting an anthropic impacted area. Elephant fish were captured by rod and reel from shore between October 2021 and April 2022, in the Golfo Nuevo, Chubut, Argentina. Hematological parameters and reproductive hormonal profiles are presented, constituting the first report for this species. Erythrocytes, thrombocytes and five types of leucocytes (lymphocytes, monocytes, heterophils, eosinophils and neutrophils) were characterized by light microscopy. Progesterone, estradiol and testosterone were measured in juveniles and adults of both sexes. This study provides baseline physiological information for the species, contributing to an ongoing research on the responses of the immune and reproductive systems within an ecotoxicological context.

Keywords: physiology; ecotoxicology; chimaera; immunology; reproduction

SI Abstract Ref: 99

Maria Auxiliadora Sabando Plaza
University of Delaware

Metal heads: Physiological and neurological effects of methylmercury on a small coastal elasmobranch, *Mustelus canis*

1. Maria Auxiliadora Sabando Plaza; University of Delaware
2. Dr. Mi-Ling Li; University of Delaware
3. Dr. Jon Cohen; University of Delaware
4. Dr. Aaron Carlisle; University of Delaware

As mid to upper trophic level predators, elasmobranchs are well known to have elevated levels of mercury and its more toxic, organic form methylmercury (MeHg). The lethality of methyl mercury across different taxa has been well researched, and its sub lethal effects have only been investigated in depth at the scope of human health with no focus on fish that have the highest mercury burden. However, the sub lethal effects of exposure to MeHg, which are known to impact animal behavior, cognitive ability, and physiology, remains largely undescribed. In this study, we establish baseline information on how the physiology of a small, coastal, demersal, elasmobranch species (*Mustelus canis*, smooth dogfish) is impacted by prolonged, sub lethal exposure of this widespread and potent contaminant. We assess sublethal effects of different levels of exposure using different physiological parameters including aerobic scope measured via oxygen consumption, growth rate, body condition, and food consumption. As a secondary objective we will use a novel approach where we assess cognitive impacts by measuring learning ability and memory through operant conditioning. Behaviors, such as foraging, prey capture, swimming behavior, memory, and learning are critical for many species of elasmobranchs yet are likely impacted by exposure to MeHg. Hence, assessing effects on physiology and behavior after sub-lethal exposure can give us an idea of how important physiological and cognitive processes may respond to changing ocean contaminant conditions.

Keywords: methylmercury; physiology; cognition; sublethal effects
SI Abstract Ref: 141

Dr Vincent Raoult

School of Environmental and Life Sciences, University of Newcastle, NSW, Australia; School of Natural Sciences, Macquarie University, North Ryde, NSW Australia

Reliance of young sharks on threatened estuarine habitats for nutrition implies susceptibility to climate change

1. Yuri, Niella; School of Natural Sciences, Macquarie University, North Ryde, NSW Australia
2. Vincent, Raoult; School of Environmental and Life Sciences, University of Newcastle, NSW Australia
3. Troy, Gaston; School of Environmental and Life Sciences, University of Newcastle, NSW Australia
4. Kyle, Goodman; School of Natural Sciences, Macquarie University, North Ryde, NSW Australia
5. Rob, Harcourt; School of Natural Sciences, Macquarie University, North Ryde, NSW Australia
6. Vic, Peddemors; NSW Department of Primary Industries, Sydney Institute of Marine Science, Mosman, Sydney, New South Wales, Australia
7. Amy, Smoothey; NSW Department of Primary Industries, Sydney Institute of Marine Science, Mosman, Sydney, New South Wales, Australia

Climate change and urbanization of coastal areas are impacting estuarine habitats globally. While these regions are important for the early-life development of many aquatic species, links between habitat use and foraging ecology are not well known. Thus, it is essential to understand the importance of threatened habitats for animals inhabiting estuaries to promote their conservation and improve ecosystem management. This study examined the importance of estuarine habitats as feeding grounds for juvenile bull sharks (*Carcharhinus leucas*) in the Clarence River, a nursery area where the species is targeted by commercial fisheries in New South Wales, Australia. Juvenile sharks ($n = 54$) ranging from one to ~6.5 years-old, together with particulate matter and several primary producer species of mangrove and saltmarsh, were sampled for $\delta^{13}C$, $\delta^{15}N$ and $\delta^{34}S$ stable isotopes. Bayesian mixing models and a Generalized Additive Mixed Model were used to investigate the contribution of estuarine habitats to the diet of bull sharks and changes with growth. The importance of resources consumed from within mangrove habitats for juvenile bull shark resource use was minimal but slightly increased with age, with younger sharks (<2.5 years) relying on prey feeding on sources derived from particulate organic matter, while older juveniles (4–6.5 years) preyed on species that relied mostly on threatened saltmarsh habitats. Our findings highlight the important linkages between habitats of conservation concern and species redistribution in response to climate change, particularly as the animals could be moving towards new areas lacking suitable estuarine habitats.

Keywords: bull sharks; stable isotopes; trophic ecology; shark nursery; stable isotopes
SI Abstract Ref: 183

Flávia F. Petean

Instituto Tecnológico de Chascomús, Consejo Nacional de Investigaciones Científicas y Técnicas, Universidad Nacional de San Martín, Av. Intendente Marino Km. 8,2 (B7130IWA), Chascomús, Buenos Aires, Argentina

Natural history of the Brazilian marine stingray *Hypanus berthallutzae* Petean, Naylor & Lima (2020): knowledge and gaps

1. Leonardo O. S. Espinosa; Instituto de Oceanografia, Universidade Federal do Rio Grande, Campus Carreiros, Av. Itália Km. 08, 96203-900, Rio Grande, RS, Brasil
2. Flávia F. Petean; Instituto Tecnológico de Chascomús, Consejo Nacional de Investigaciones Científicas y Técnicas, Universidad Nacional de San Martín, Av. Intendente Marino Km. 8,2 (B7130IWA), Chascomús, Buenos Aires, Argentina

The coastal marine stingray species *Hypanus berthallutzae* is endemic to Brazil and occurs south of the Amazon river mouth to São Paulo state, besides some oceanic islands and reefs. Until its description, *H. berthallutzae* specimens were identified as *H. americanus* and due to its recent recognition, few studies on the natural history of *H. berthallutzae* have been published using its current name. However, many previous studies were done with *H. americanus*: specimens now recognized as *H. berthallutzae*. To identify the existing knowledge on the natural history of this stingray, we surveyed online databases for studies accomplished with Brazilian specimens using a combination of keywords related to its location and species. A total of 123 searches returned 93 documents with information on *H. berthallutzae*. These were divided into 15 categories according to their research area, and the commonest ones were Ecology (33%) and Fisheries (24%). Overall, studies report larger females than males (TL/DW >75 vs. >51) and in a higher sex ratio (female:male, 21.3:1), with nursery areas in Rio Grande do Norte and Fernando de Noronha. Besides, *H. berthallutzae* represents approximately 5% of captured batoids in Southeastern Brazil when sequencing the mitochondrial marker COI, and occurs in depths varying from 0 to 77.5 m. However, we noticed a lack of studies concerning Reproduction, Physiology, and Evolution of this stingray, areas that should be the focus of future studies since it is already a Vulnerable species under the IUCN Red List assessment and is currently suffering from a high artisanal fishing pressure.

Keywords: Lutz's stingray; ecology; fisheries; evolution; vulnerable

SI Abstract Ref: 238

Janis Argeswara

Marine Megafauna Foundation

Sizing up the Nusa Penida MPA manta rays

1. Janis, Argeswara; Marine Megafauna Foundation
2. Maulana M, Priadhi; Marine Megafauna Foundation
3. Aulia, Zeintrinanda; Marine Megafauna Foundation
4. Elitza, Germanov; Marine Megafauna Foundation; Centre for Sustainable Aquatic Ecosystems, Harry Butler Institute, Murdoch University, Perth, Western Australia, Australia ; Environmental and Conservation Sciences, Murdoch University, Perth, Western Australia, Australia

Manta rays have some of the lowest productivity rates of elasmobranchs and are threatened with extinction. Knowledge gaps in birth and growth rates, and habitats used by young persist. A previous study identified critical habitats for *Mobula alfredi* in the Nusa Penida Marine Protected Area, Indonesia. However, vital demographic data are outstanding, including manta ray sizes and the maturity status of 47% of females, which lacked visual maturity indicators in the previous study. Here we measured manta rays using laser and stereophotogrammetry to classify individuals into age groups. We measured 135 individuals, of which 65.9% were females and 32.6% were males. More than half (52.8%) lacked visual maturity indicators for females, while males were primarily adults. The average measurement for females was 4.18m (SE±0.06), and; 3.55m (SE±0.05) for males. Based on the size of maturity assessed elsewhere, 3.2 m for females and 2.7m for males, 98.6% of females and 100% of males we measured were deemed mature. Manta rays that were classified as mature based on visual observations averaged 4.27m (SE±0.05) for females and 3.55m (SE±0.06) for males. Nusa Penida's manta rays are more similar in size to those reported in Mozambique, and Japan, and larger than those in Raja Ampat, Indonesia, Hawaii, and the Maldives. Going forward we will measure more juvenile individuals and aim to measure them repeatedly using stereophotogrammetry to allow growth-rate calculations and assist in testing nursery criteria by identifying Young-of-the-Years.

Keywords: manta rays; stereophotogrammetry; laser-photogrammetry; Indonesia; growth rates

SI Abstract Ref: 289

Francisco Emanuel Polanco Vásquez

1; Instituto Politécnico Nacional. Centro Interdisciplinario de Ciencias Marinas; 2; Wildlife Conservation Society.

Reproductive biology of the longtail stingray *Hypanus longus* (Garman, 1880) caught in the Pacifico of Guatemala.

1. Francisco, Polanco-Vásquez; Instituto Politécnico Nacional. Centro Interdisciplinario de Ciencias Marinas; Wildlife Conservation Society.
2. Rosa, Ochoa-Báez; Instituto Politécnico Nacional. Centro Interdisciplinario de Ciencias Marinas.
3. Felipe, Galván-Magaña; Instituto Politécnico Nacional. Centro Interdisciplinario de Ciencias Marinas.
4. Katherin, Soto-López; Instituto Politécnico Nacional. Centro Interdisciplinario de Ciencias Marinas.
5. Jose, Moreira-Ramírez; Wildlife Conservation Society.

The longtail stingray *Hypanus longus*, is distributed from México to Ecuador. At present, it is the most commercially important ray in south of Mexico and Central America. The goal is to know the reproductive biology of this ray species in order to gather biological information for application into fisheries management plans. The morphometric data from 2659 organisms (1248 females, 1411 males) were obtained from January 2019 to February 2021. The females had an average size of 83.32 ± 22.34 cm disc width (DW) (41-178 cm DW); while in males the average size was 78.18 ± 10.46 cm DW (47-109 cm DW). There were no significant differences between the sizes of females and males (Mann-Whitney $p=0.2768$). The sexual ratio was 0.88H:1M ($\chi^2=13.12$; $p<0.05$), males were the most numerous group. In terms of reproductive parameters, 495 organisms (219 females and 276 males) were analyzed. The L50 was 105.42 cm DW for females and 75.73 cm DW for males. Both values are lower than the sizes previously reported for this species. Also using histology we found that mature males had fully developed sperm; whilst mature females developed uterine milk-secreting crypts in the trophonemata. The fecundity of females was 1 to 6 embryos. The sexual ratio of the embryos was 0.76H:1M, ($\chi^2=0.83$; $p>0.05$). This species have an asynchronous reproductive system. This is the first study about the reproductive biology on this species in Southern Mexico and the Central American Pacific.

Keywords: reproduction; Guatemala Pacific; rays; artisanal fisheries

SI Abstract Ref: 290

Laurent Duchatelet

UCLouvain, Marine Biology Laboratory

From whom does this giant glow come? First approach to the bioluminescence of *Dalatias licha*

1. Laurent Duchatelet, UCLouvain, Marine Biology Laboratory
2. Jérôme Mallefet, UCLouvain, Marine Biology Laboratory

Among luminous elasmobranchs, the kitefin shark, *Dalatias licha*, is a giant reaching up to 1.8 m. Here, through pharmacological and histological studies, bioluminescence of the largest luminous vertebrate is unveiled. Light organ (photophore) histology and bioluminescence control mechanisms are compared with known luminous elasmobranchs (Etmopterus species and *S. aliae*). Photophore histology revealed a conserved structure among the Dalatiidae family. Dalatiidae sharks harbor photophores constituted of a single photocyte (light emitting cell) encapsulated in a pigmented layer, surmounted by an iris-like structure (ILS) and topped by one or several lens cells. Etmopteridae photophores are more complex. They are composed of a black round shaped pigmented sheath encompassing group of photogenic cells, a lens formed by 2 to 3 lens cells, and an ILS formed by chromatophores. In parallel, a similar hormonal control of the light emission is highlighted. Melatonin triggers light production, while alpha-melanocyte stimulating and adrenocorticotrophic hormones inhibit it. For both families, ILS pigment motion is involved in a mechanical regulation of the light emission. Recently, an extraocular opsin (encephalopsin) was also demonstrated as playing a role in the light emission control in Etmopteridae. The encephalopsin presence was recently described during the ontogenic development of the photophore from the dalatiid *S. aliae*. Hence leading to the search for *D. licha* extraocular opsin. By integrating the new data on the largest luminous vertebrate, *D. licha*, to previous researches, a comparative analysis will be conducted to highlight a clear bioluminescent structure and control mechanism conservation throughout evolution in luminous deep-sea sharks.

Keywords: deep-sea sharks; bioluminescence control; Dalatiidae; Etmopteridae; hormones

SI Abstract Ref: 322

Jenny Bortoluzzi

Trinity College Dublin, The University of Dublin

Baby blues? The reproductive state and nutritional ecology of female blue sharks, *Prionace glauca*, in Irish waters.

1. Jenny Bortoluzzi; Trinity College Dublin, The University of Dublin
2. Nicholas Payne; Trinity College Dublin, The University of Dublin
3. Martin J. Kainz; WasserCluster Lunz and Danube University Krems
4. James Gelslechter; University of North Florida
5. Lucy Harding; Trinity College Dublin, The University of Dublin
6. Alison Boyce; Trinity College Dublin, The University of Dublin
7. Luke Harman; University College Cork
8. Matthew Cobain; Trinity College Dublin, The University of Dublin
9. Haley Dolton; Trinity College Dublin, The University of Dublin
10. Grace McNicholas; Trinity College Dublin, The University of Dublin and the Marine Institute
11. David Edwards; West Cork Charters
12. Maria McGuinness; University College Cork
13. Thomas K. Doyle; University College Cork
14. Andrew L. Jackson; Trinity College Dublin, The University of Dublin

Despite being one of the most abundant pelagic and most wide ranging shark in the world, much still needs to be learnt about blue shark biology and ecology. As the most frequently fished oceanic shark, the population is reported to have declined by up to 70% in the Atlantic, which raises concerns about the future survival of the species. Life history parameters and knowledge of a species' ecology are key for management and conservation, particularly when the protection of larger areas is not feasible. In Irish waters, the population of blue sharks present during the late spring to early autumn is predominantly female but information about their reproductive status and feeding ecology during this time is lacking. Here, we integrate the results from sex steroid hormone analysis (progesterone and 17 β -oestradiol) in blood plasma to assess reproductive status. In addition, using omega-3 polyunsaturated fatty acids (PUFA) in both plasma and muscle tissues, we investigate the effect of nutrition and diet strategies on the reproductive state of female blue sharks. We will also present data on hydrogen stable isotopes of PUFA to indicate the ability of blue sharks to perform endogenous conversion of dietary PUFA into important physiological omega-3 PUFA.

Keywords: reproductive state; fatty acids; sex steroid hormones; feeding ecology; nutrition

SI Abstract Ref: 343

Felicie Dhellemmes

Bimini Biological Field station

What did we learn from six years of shark personality research?

1. Jean Sebastien, Finger; Bimini Biological Field station
2. Joffrey Baeyaert; Algarve University
3. Raquel Braun; Bimini Biological Field station
4. Liam Dickson; Queen Mary University London
5. Tristan Guttridge; Bimini Biological Field station
6. Harry Gray; Cardiff University
7. Nigel Hussey; Windsor University
8. Matthew Smukall; Bimini Biological Field station
9. Jens Krause; Leibniz Institute of freshwater Ecology and Inland Fisheries

In behavioural ecology, interest in the study of animal personality (i.e. consistent individual differences in behaviour) has increased in the last two decades as it is believed to have important ecological and evolutionary consequences. These consequences are especially pronounced when personality covaries with other behaviours (i.e. behavioural syndrome) or with life-history (i.e. pace-of-life syndrome). So far, studies of personality on behavioural, and pace-of-life-syndromes have produced ambiguous outcomes, and the prominence of studies on captive animals in the literature may be a reason for inconclusive results.

To address this knowledge gap, we tested personality in wild juvenile lemon shark (*Negaprion brevirostris*) from 2012 to 2018 to investigate the emergence of behavioural and pace-of-life-syndromes under relevant ecological pressures.

We first explored how to quantify meaningful personality traits in our study species. We then investigated (1) whether a behavioural syndrome existed between two consistent traits and whether the appearance of the syndrome was context dependent, (2) whether a growth-mortality trade-off was mediated by personality and (3) whether personality could predict the foraging habitat of sharks and whether this link was context-dependent.

Overall, our research suggest that ecological conditions play a crucial role in the emergence and the shaping of personality and trait association. This work offers a possible explanation for the ambiguous results of previous studies and highlights the importance of increasing the focus on wild study systems in future animal personality research. Along with recent revisions of the personality research framework, this work may help paving the way for future shark-personality research.

Diego Fallas-Madrigal

Biomolecular Laboratory, Center for International Programs and Sustainability Studies, Universidad Veritas, San José, Costa Rica

Research and conservation of the eagle ray (*Aetobatus laticeps*)

1. Alejandra, Castelo-Corona Sebastian; Centro Interdisciplinario de Ciencias Marinas, La Paz Baja California Sur, México
2. Maria del Socorro, Gonzáles-Ramos, Biomolecular Laboratory, Center for International Programs and Sustainability Studies, Universidad Veritas, San José, Costa Rica.

The Pacific white-spotted eagle ray *Aetobatus laticeps*, has been recently separated from the Atlantic *A. narinari* based on both morphological and genetic evidence. This species is distributed from the Gulf of California to Ecuador, where different research efforts have been done. Considering the conservation need and lack of information in this species, we have studied its population, habitat use, and spot pattern variation along its distribution. By using different methodologies, we have found 132 individuals in Oaxaca (Mexico), and 72 in the north of Costa Rica. First recorded sizes in Jalisco (Mexico) ranged from 50 to 130 cm in disc width, and encounter rates were found to be significantly in spring seasons with SST fluctuation of 25°-27°C. Furthermore, a first assessment of the spot pattern in northern Costa Rica showed 17 distinctive spots, and an additional putative eagle ray species from Cocos Island with a spot pattern resembling to its sister species, *A. ocellatus*. Now in a regional scale we are continuing studying this species with new aims, such as spot pattern change, diversity pattern along its distribution, site fidelity, population structures, as well as contributing in global efforts to study the white spotted eagle rays.

Keywords: spotted eagle ray

Noémie Coulon

Laboratoire de Biologie des Organismes et Ecosystèmes Aquatiques (BOREA) MNHN, CNRS, IRD, SU, UCN, UA, 35800, Dinard, France

Northeast Atlantic elasmobranchs on the move: different responses to climate change across functional traits and phylogeny

1. Noémie, Coulon; Laboratoire de Biologie des Organismes et Ecosystèmes Aquatiques (BOREA) MNHN, CNRS, IRD, SU, UCN, UA, 35800, Dinard, France
2. Sophie, Elliott; Game & Wildlife Conservation Trust, Fordingbridge, Hampshire, SP6 1EF, England
3. Nils, Teichert; Noémie, Coulon; Laboratoire de Biologie des Organismes et Ecosystèmes Aquatiques (BOREA) MNHN, CNRS, IRD, SU, UCN, UA, 35800, Dinard, France
4. Thomas, Barreau; Service des stations Marine, CRESCO, Dinard, France
5. Alexandre, Carpentier; Laboratoire de Biologie des Organismes et Ecosystèmes Aquatiques (BOREA) MNHN, CNRS, IRD, SU, UCN, UA, Université de Rennes 1, Rennes, France

Ongoing climate change is responsible for shifting the distribution of many marine species and may lead to changes in community structure and ecosystem functioning, especially where species perform unique functions such as elasmobranchs. However, this issue has been rarely studied in these species due to the limited amount of occurrence data and may have led to an underestimation of the underlying threats. It can be circumvented by identifying functional traits that explain range shifts in elasmobranchs rather than by studying individual species responses. Therefore, our aim was to detect and quantify distribution changes in demersal elasmobranchs in response to ocean acidification and increasing sea temperature and assess whether such changes can be attributed to their functional traits. To undertake this study, we collated scientific bottom trawl surveys data from 1997-2020 across the European continental shelf and employed a multispecies joint distribution model to model their habitat and understand potential variations in distribution with time according to sea water temperature and pH. The responses of trophic level, reproductive guild, preferred depth and latitudinal range traits according to these climate change variables were equally explored. From this analysis we highlight species whose range has shifted over the past two decades. Community structure variations are described over time and functional groups that are appear to be more vulnerable to future climate changes identified. Fishing pressure is also tested as a complementary factor affecting elasmobranch distribution over time

Keywords: climate change; elasmobranchs; functional traits; jSDM; shift

SI Abstract Ref: 265

Natascha Wosnick

Universidade Federal do Paraná

The effects of arsenic, lead and mercury muscle assimilation on physiological pathways in the Brazilian Guitarfish, *Pseudobatos horkelii*

1. Natascha, Wosnick; Universidade Federal do Paraná
2. Natalia, Guimarães; Universidade Federal do Rio de Janeiro
3. Renata Daldin, Leite; Universidade Federal do Paraná
4. Ana Paula Chaves, Silva; Universidade de São Paulo
5. Eloisa Pinheiro, Giareta; Universidade Federal do Paraná
6. Amanda Pontes, Lopes; Fundação Oswaldo Cruz
7. Francielli Casanova, Monteiro; Pontifícia Universidade Católica do Rio de Janeiro
8. Carlos, Massone; Pontifícia Universidade Católica do Rio de Janeiro
9. Renato, Carreira; Pontifícia Universidade Católica do Rio de Janeiro
10. Marcelo, Vianna; Universidade Federal do Rio de Janeiro
11. Rachel Ann, Hauser-Davis; Fundação Oswaldo Cruz

Metal contamination is one of the emerging threats with the potential to negatively affect marine animals, being of particular relevance to coastal mesopredators with resident behavior due to the expressive influx of anthropogenic origin across their home range. Currently, most toxicological investigations with elasmobranchs are focused on toxic metals and human consumption outcomes. Nevertheless, the effects of contamination on the systemic health of exposed animals have been systematically neglected. That said, this study aimed to evaluate the potential effects of muscle assimilation of arsenic, lead, and mercury on the anaerobic metabolism and buffering capacity of the Brazilian Guitarfish through the assessment of serum lactate and pH. Arsenic concentrations ranged from 0.97 to 79.7, lead from undetectable to 0.07, and mercury from 0.03 to 0.49. Surprisingly, a positive correlation between arsenic and pH was detected, and higher pH was observed in more contaminated animals. Taken together, the results indicate that arsenic, lead and mercury accumulation in the muscle does not affect anaerobic metabolism nor the buffering capacity of exposed *Pseudobatos horkelii*. However, it is not possible to rule out the deleterious effects on other physiological processes, such as aerobic metabolism. Complementary analyses are needed to elucidate the unexpected correlation between higher arsenic values and the observed alkalosis as well as the higher pH levels on guitarfishes presenting higher levels of the metals assessed in this investigation.

Keywords: toxicology; physiology; guitarfish; marine pollution

SI Abstract Ref: 284

Iliana Araceli Fonseca Ponce

Proyecto Manta Pacific Mexico; Instituto Nacional de México campus Bahía de Banderas

Physical and environmental drivers of oceanic manta ray (*Mobula birostris*) sightings at an aggregation site in Bahía de Banderas, Mexico

1. Iliana Araceli, Fonseca Ponce; Proyecto Manta Pacific Mexico; Instituto Nacional de México campus Bahía de Banderas.
2. Aldo Alfonso, Zavala Jiménez; Proyecto Manta Pacific Mexico; University of California, Campus Santa Cruz.
3. Octavio, Aburto Oropeza; Scripps Institution of Oceanography.
4. Adrián, Maldonado Gasca; Instituto Nacional de México, Campus Bahía de Banderas.
5. Felipe, Galvan Magaña; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas (CICIMAR-IPN).
6. Rogelio, González Armas; Centro Interdisciplinario de Ciencias Marinas (CICIMAR-IPN).
7. Joshua David, Stewart; Marine Mammal Institute, Department of Fisheries, Wildlife, and Conservation Sciences, Hatfield Marine Science Center, Oregon State University; The Manta Trust.

In Banderas Bay, Mexico, an important aggregation site of oceanic manta rays occurs adjacent to a major human population center (Puerto Vallarta) in a region of high vessel traffic and fishing effort. Manta rays in this population have 10 times the per-capita incidence of injuries from vessel strikes and fishing gear entanglements compared to an offshore population of mantas at the protected Revillagigedo Islands, only ~300 miles away. To identify the locations and periods of highest risk of anthropogenic impacts on this population, we have been surveying coastal habitats in Banderas Bay at weekly intervals in partnership with local fishermen since 2014, collecting in-situ environmental data and recording sightings of manta rays. We show that the El Niño Southern Oscillation has an extremely strong influence on the occupancy probability of manta rays in Banderas Bay, and that there is a clear seasonal cycle of visitation to the region. We also show significant relationships between occupancy and sea surface temperature, lunar phase and tidal range. We found that the presence of manta rays was positively related to some zooplankton taxonomic groups such as copepods, cladocerans and fish larvae. We hypothesize that mantas are primarily feeding on mesopelagic prey in a submarine canyon adjacent to the aggregation area and using the shallow nearshore zone for thermal recovery. This information on seasonal, physical, and environmental drivers of manta ray occupancy creates opportunities for dynamic management strategies that may prevent and mitigate anthropogenic impacts on this vulnerable population.

Keywords: zooplankton; filter-feeder; elasmobranch; GAM; ENSO

SI Abstract Ref: 295

Guia Consales

Department of Physical Sciences, Earth and Environment, University of Siena, Via Mattioli 4, Siena 53100, Italy
Department of Integrative Marine Ecology (EMI), Genoa Marine Centre (GMC), Stazione Zoologica Anton Dohrn–National Institute of Marine Biology,

The blackmouth catshark, *Galeus melastomus*, as potential bioindicator for Mediterranean deep-sea environment contamination

1. Guia Consales; Department of Physical Sciences, Earth and Environment, University of Siena, Via Mattioli 4, Siena 53100, Italy; Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn - Italian National Institute for Marine Biology, Ecology and Biotechnology, Genoa Marine Centre, c/o CNR-IAS, Via De Marini, 6 16149 Genoa, Italy
2. Massimiliano Bottaro; Department of Integrative Marine Ecology (EMI), Genoa Marine Centre (GMC), Stazione Zoologica Anton Dohrn–National Institute of Marine Biology, Ecology and Biotechnology, Villa del Principe, Piazza del Principe 4, 16126 Genoa, Italy.
3. Cecilia Mancusi; ARPAT - Regional Agency for Environmental Protection of Tuscany, Via Marrani 114, 57126 Livorno, Italy.
4. Alessandra Neri; Consortium for the Inter-University Center of Marine Biology and Applied Ecology “G.Bacci”, Viale Nazario Sauro 4, 57128 Livorno, Italy
5. Maria Pia Mordente; Department of Physical Sciences, Earth and Environment, University of Siena, Via Mattioli 4, Siena 53100, Italy
6. Maria Bisignano; Department of Physical Sciences, Earth and Environment, University of Siena, Via Mattioli 4, Siena 53100, Italy
7. Letizia Marsili; Department of Physical Sciences, Earth and Environment, University of Siena, Via Mattioli 4, Siena 53100, Italy; Inter-University Center of Cetacean Research (CIRCE), Via Mattioli 4, Siena 53100, Italy

The deep-sea is the largest and most productive habitat of the planet, but scarce information regarding pollution is available. The Mediterranean is one of the most anthropized maritime areas, where old and new generation contamination pose a threat to the conservation of local biodiversity. For this reason, it is an excellent natural laboratory for studying the impacts of these chemical compounds in the deep-sea.

As the chondrichthyans are important consumers below 400 m, we studied the presence of organochlorine contaminants-OCs, from the Ligurian Sea to the Gulf of Naples, in the blackmouth catshark, *Galeus melastomus*, a widely distributed deep-water opportunistic species.

Hexachlorobenzene-HCB, polychlorinated biphenyls-PCBs, and dichlorodiphenyltrichloroethane and its metabolites-DDTs, were determined in the liver and muscle of 73 specimens.

PCBs were the most abundant and the use of an enriched op' formula of DDT was highlighted. As well as the use of Dicofol especially in the Gulf of Naples, the most anthropized study site. Despite the higher levels of all the three OC group in the liver compared to those detected in the muscle, our findings suggest that this tissue could be used as indicator of chronic exposure to pollutants, but to clearly understand the real impacts of pollutants in the deep sea further studies in others areas is needed. In this framework, *G. melastomus* presents interesting features to serve as potential bioindicator for the Mediterranean deep-sea due to its feeding habits, remarkable abundance and current conservation status ("Least Concern" for the Mediterranean IUCN Red List).

Keywords: bioindicator; deep-sea; *Galeus melastomus*; Mediterranean Sea; organochlorine contaminants (OCs)

SI Abstract Ref: 31

Wednesday 12th October, 2022

Threatened Species - Spotlight on Mackerel Sharks 1

Marc Aquino Baleytó

CICIMAR-IPN

Diving deeper into the underlying white shark behaviors at Guadalupe Island, Mexico

1. Marc, Aquino-Baleytó; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Mexico
2. Vianey, Leos-Barajas; University of Toronto, Toronto, ON, Canada
3. Timo, Adam; University of St Andrews, St Andrews, UK
4. Mauricio, Hoyos-Padilla; Pelagios-Kakunjá, La Paz, Mexico
5. Omar, Santana-Morales; Ecocimati AC, Ensenada, Mexico
6. Felipe, Galván-Magaña; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Mexico
7. Rogelio, González-Armas; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Mexico
8. Christopher G., Lowe; Department of Biological Sciences, California State University Long Beach, Long Beach, California, USA
9. James T., Ketchum; Pelagios-Kakunjá, La Paz, Mexico
10. Héctor, Villalobos; Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, La Paz, Mexico

1. Fine-scale movement patterns are driven by both biotic (hunting, physiological needs) and abiotic (environmental conditions) factors. The energy balance governs all movement-related strategic decisions.
2. Marine environments can be better understood by considering the vertical component. From 24 acoustic trackings of 10 white sharks in Guadalupe Island, this study linked, for the first time, horizontal and vertical movement data and inferred six different behavioral states along with movement states, through the use of hidden Markov models, which allowed to draw a comprehensive picture of white shark behavior.
3. Traveling was the most frequent state of behavior for white sharks, carried out mainly at night and twilight. In contrast, area-restricted searching was the least used, occurring primarily in daylight hours.
4. Time of day, distance to shore, total shark length, and, to a lesser extent, tide phase affected behavioral states. Chumming activity reversed, in the short term and in a nonpermanent way, the behavioral pattern to a general diel vertical pattern.

Keywords: Bayesian inference; behavioral states; energy costs; movement strategies; telemetry

SI Abstract Ref: 136

Enrico Gennari

Oceans Research Institute; Rhodes University; South African Institute for Aquatic Biodiversity

Exploring recovery potential for white sharks (*Carcharodon carcharias*) in South Africa: is prohibition enough?

1. Heather Bowlby; Fisheries and Oceans Canada.
2. Neil Hammerschlag; University of Miami.
3. Dylan Irion; University of Cape Town.
4. Enrico Gennari; Oceans Research Institute; South African Institute for Aquatic Biodiversity

It is often difficult to assess whether a prohibition to exploitation ensures effective conservation or recovery of a particular at-risk, wide-ranging species, especially with the continued presence of different types of pressures within its range. This is the case for white sharks (*Carcharodon carcharias*) in South Africa, which have been protected since 1991, yet recent declines at two aggregation sites have renewed conservation concerns. Empirical data on population dynamics, the magnitude of threats, and regional trends for white sharks remain largely unavailable, yet there is widespread acceptance that conservation decision-making should not be delayed because of scientific uncertainty. To facilitate a better understanding of risks for precautionary management and provide guidance on possible appropriate actions, we used simulation modeling of four life history scenarios for white sharks contextualizing the potential population response to multiple levels of mortality. Most scenarios indicated that annual removals in the tens of individuals would substantially limit the potential for and magnitude of any abundance increase following prohibition in 1991. Average known removals of white sharks occurring in the bathers protection program since the 1990s have typically remained higher than these thresholds. If white sharks in southern Africa are characterized by a long lifespan and/or a small population size, the proportion of trajectories declining or becoming functionally extinct over the next generation could be substantial. These results highlight the specific challenges associated with the conservation of white sharks in South Africa, and suggest new mitigation measures may be required to ensure functional protection and population recovery

Keywords: white shark; conservation; bathers protection program; management; South Africa

SI Abstract Ref: 108

Adrienne Gooden

Flinders University - Southern Shark Ecology Group

Does the increase in shark activity during wildlife tourism lead to higher energy expenditure?

1. Thomas, Clarke; Flinders University - Southern Shark Ecology Group, Department for Environment and Water
2. Lauren, Meyer; Flinders University - Southern Shark Ecology Group, Georgia Aquarium
3. Charlie, Huveneers; Flinders University - Southern Shark Ecology Group

Wildlife tourism is expanding globally, as is the need to quantify its potential impacts on the species targeted. Studies on the effects of marine tourism on wildlife have focused on documenting behavioural changes, but whether changes affect the energy budgets and ultimately the survival prospects of these animals is largely unknown. This is particularly acute for large predatory sharks that are difficult to study but economically and ecologically important. To assess the effects of cage-diving on white shark energy expenditure, animal-borne cameras and accelerometer loggers were deployed on 18 white sharks (*Carcharodon carcharias*) at a cage-diving site (Neptune Islands Group Marine Park, South Australia) and recorded shark activity for 489.7 hours. A random forest machine learning algorithm was used to predict their behaviours based on 38 hours of acceleration data with behaviours confirmed from the animal-borne cameras. The presence of cage-diving vessels led to white sharks being more active and spending more time undertaking high-energy swimming (vectorial dynamic body acceleration [VeDBA] 0.04 ± 0.03 g; doubled) and bursts of acceleration (VeDBA 0.44 ± 0.38 g; seven-fold increase) while decreasing low-energy swimming (1.5-fold). However, once put in the context of daily energy budget and accounting for the duration of cage-diving activities (~6 hours per day), energy expenditure was not substantially affected by wildlife tourism, with the presence of cage-diving vessels leading to a 0.4 – 0.7 % increase in field metabolic rate. Our findings show that while food-based tourism can influence white shark behaviour and increase energy expenditure, the overall impact on field metabolic rates and daily energy budget is minimal.

Keywords: animal-borne camera; accelerometer; metabolic rate; wildlife tourism; machine learning

SI Abstract Ref: 92

Charlie Huveneers

Flinders University

Effects of wildlife tourism on white shark associative behaviour and implications for human safety

1. Yuri Niella, Flinders University
2. Hugh Pederson, Innovasea
3. Charlie Huveneers, Flinders University

While wildlife tourism may impact the animals involved, it plays a critical role in public awareness and conservation. Understanding changes in animal behaviour in response to tourism activities can inform the trade-offs between negative impacts and socio-economic benefits. The movements of 133 white sharks were tracked with acoustic telemetry between 2013 and 2021 at the Neptune Islands, Australia. We used three behavioural variables (i.e. daily hours of arrival, time spent near cage-diving boats, and residency) to investigate whether tourism led to associative behaviour using a combination of k-mean clustering with Generalised Additive Mixed Models and Analysis of Variance. Significant clusters of individuals were found for all variables tested. Different trends were observed between clusters, but did not vary within individuals from the same clusters, suggesting complex individual temperaments. Some sharks tended to arrive earlier to match the arrival of the cage-diving boats, but the residency and amount of time near cage-diving boats significantly decreased over time for some other sharks. There are public claims that cage-diving activities may condition white sharks to interact with boats, potentially increasing shark bite risk. Our results suggest that while some associative behaviour was observed, a loss of response to the stimulus used to attract sharks, i.e. habituation, might also be occurring. White shark cage-diving is a global industry, dispelling myths about these iconic animals. Despite complex temperaments across different individuals, long-term impacts of cage-diving activities affecting white shark behaviour are unlikely.

Keywords: wildlife tourism; cognitive behaviour; associative learning; acoustic tracking; white shark cage-diving

SI Abstract Ref: 77

Olga M. Azevedo

Department of Biology, Ecology and Earth Sciences, University of Calabria, Italy

The influence of environmental factors on individual behaviour of bait-attracted white sharks in South Africa.

1. Olga, M. Azevedo; Department of Biology, Ecology and Earth Sciences, University of Calabria, Italy.
2. Ana, M. Correia; Interdisciplinary Centre of Marine and Environmental Research; Department of Biology, Faculty of Sciences, University of Porto, Portugal.
3. Giuseppe, Rijillo; Department of Biology, Ecology and Earth Sciences, University of Calabria, Italy.
4. Gianni, Giglio; Department of Biology, Ecology and Earth Sciences, University of Calabria, Italy.
5. Chiara, Romano; Department of Biology, Ecology and Earth Sciences, University of Calabria, Italy.
6. Francesca, Reinero; The Sharks Studies Centre, Scientific Institute, Italy.
7. Primo, Micarelli; The Sharks Studies Centre, Scientific Institute, Italy.
8. Emilio, Sperone; Department of Biology, Ecology and Earth Sciences, University of Calabria, Italy.

Feared by some and loved by others, the white shark (*Carcharodon carcharias*) is a charismatic species, targeted by different research studies over the last decades. Advances in biologging tags allowed to track the hidden distribution of these predators. However, there is still a lack of knowledge about the influence of environmental factors on their behaviour. Indeed, considering the global distribution of white sharks, it is a challenge to understand the processes influencing their lifecycle, and to assess the anthropogenic disturbances to their populations. Dyer Island in South Africa is a well-known aggregation area for *Carcharodon carcharias*, with an established cage-diving ecotourism industry. This activity was used as a platform of opportunity to collect data on the sharks' behaviour. We applied an ethological approach to investigate the influence of environmental factors on the complexity of individual behaviours. The biotic conditions of the moment had a different impact on the reactions of females and males towards the bait. Females performed a higher number of behaviours under daylight, lower sea surface temperatures, short wavelets, clear skies, under La Niña events, and high tides. Males behaved more complexly at dusk, medium sea surface temperatures, large wavelets, few clouds, high tides and elevated moonlight. White sharks often swim over recreational waters or fishing areas and human encounters, fishing mortality, and climate change are pressures that need to be addressed. The applied ethological approach increases knowledge on how the species responds to environmental factors, therefore informing policy-makers and supporting its conservation.

Keywords: white shark; environmental factors; behaviour

SI Abstract Ref: 50

Sian Liddy

University of Sydney, School of Life and Environmental Sciences

Characterising shark holobionts, the myth of the lone predator

1. Sian Liddy; University of Sydney
2. Amy Smoothey; NSW Department of Primary Industries
3. Jadranka Nappi; University of New South Wales
4. Sebastian Vadillo Gonzalez; University of Sydney
5. Torsten Thomas; University of New South Wales
6. Ezequiel Marzinelli; University of Sydney

Shark populations are declining globally, yet many aspects of their physiology and life history are still poorly understood. Most of our understanding and management of sharks is based on our knowledge of their biology and interactions with other macro-organisms. Sharks live, however, in the ocean in a "soup" of microorganisms. Evidence from systems as diverse as plants, invertebrates and humans shows that microorganisms associated with these hosts play critical roles in their health and function. Our understanding of host-microbiome interactions in sharks is limited, but such knowledge can help develop more robust conservation management tools. Here, we characterised the microbiome of Great White, Bull, Port Jackson and Dusky Whaler sharks in Australia via 16S rRNA gene amplicon sequencing. To understand what influences variation in microbial community structure within and between shark individuals and species, we assessed bacteria associated to functionally distinct body regions within each shark. There was strong variation between body regions, as well as between species. We discuss potential drivers of such variation and the microbial taxa and functions associated with these differences. This is the first step in understanding the role microbes play in the health and function of sharks.

Keywords: holobiont; microbiome; *Carcharodon carcharias*; *Carcharhinus leucas*; *Heterodontus portusjacksoni*

SI Abstract Ref: 22

Li Jin Chai

Marine Research and Conservation Foundation

Malaysia Whale Sharks: distribution, seasonality and threats

1. Li Jin Chai, Borneo Marine Research Institute, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu Sabah, Malaysia; Malaysia Whale Sharks, Kota Kinabalu, Sabah, Malaysia
2. Gonzalo Araujo, Malaysia Whale Sharks, Kota Kinabalu, Sabah, Malaysia; Marine Research and Conservation Foundation, Somerset, UK
3. Nasrulkhakim bin Maidin, Sabah Parks, P.O. Box 10626, 88806 Kota Kinabalu, Sabah, Malaysia
4. Elvin M. Bavoh, Sabah Parks, P.O. Box 10626, 88806 Kota Kinabalu, Sabah, Malaysia
5. Ruzlee Jumaatin, Sabah Department of Fisheries, 4th Floor, Wisma Pertanian Sabah, Jalan Tasik, 88624 Kota Kinabalu, Sabah, Malaysia
6. B. Mabel Manjaji-Matsumoto, Borneo Marine Research Institute, Universiti Malaysia Sabah, Jalan UMS, 88400 Kota Kinabalu Sabah, Malaysia; Malaysia Whale Sharks, Kota Kinabalu, Sabah, Malaysia

Whale sharks (*Rhincodon typus*) were targeted by fisheries in Asia into the 2000s leading to declines in regional abundance and its uplisting to 'Endangered' in the IUCN Red List. The Philippines hosts one of the largest populations globally, and Indonesia hosts at least five known aggregation sites. In contrast, little is known about whale sharks in Malaysia. Here, we used citizen science, survey effort and data mining to understand the species in Malaysia. We recorded 162 whale shark encounters from news outlets, social media posts and contributions to the global database 'Sharkbook.ai' from 1996-2021. Of these, 80 whale sharks were identified using their unique spot patterns ranging 3.5-6.0 m in total length, most of whose sex was undetermined (83%). This juvenile-dominated population demographic is consistent with neighbouring countries. Using photo-ID one individual was matched between Pulau Redang and Chumphon in Thailand. Similarly, a whale shark from Philippines was matched to Pulau Sipadan, Sabah. Both Sipadan and Redang have the highest incidences of whale sharks in Malaysia, where these sharks appear to be navigating through like that observed elsewhere (e.g. Galapagos). In contrast, whale sharks encountered along the west coast of Sabah (e.g. Pulau Gaya) appear to be capitalising on zooplankton. Through citizen science and online reports, we report at least four whale sharks mortalities in Malaysia from anthropogenic causes (plastic ingestion and direct harvest). Further work is needed to elucidate whale shark movements within and away from Malaysia, as well as understanding their feeding ecology and persistent threats.

Keywords: *Rhincodon typus*; endangered; citizen science; Southeast Asia; population demographics

SI Abstract Ref: 320

Harriet Allen

The Shark Trust

The Great Eggcase Hunt - 20 years of citizen science

1. Harriet, Allen; The Shark Trust
2. Cat, Gordon; The Shark Trust
3. Ali, Hood; The Shark Trust

The Great Eggcase Hunt is a citizen science initiative that has been running since 2003. In nearly 20 years, the project has received >22,000 submissions from ~7,500 people, totalling ~334,000 eggcases from 18 oviparous elasmobranchs around the British Isles. This dataset provides an opportunity to monitor public engagement with the project, tracking its growth and spread over both space and time. Analysis of this dataset can be used to pick out patterns, such as the seasonality of public engagement, and to identify locations that are lacking in records and may require more effort. The project has grown considerably since its beginning; from 54 submissions totalling 128 eggcases, from 25 locations around the British Isles (mostly in the Southwest where the Shark Trust is based) in its first year, to ~1,100 submissions totalling >27,500 eggcases, from >700 locations (covering the majority of the British Isles from the Isle of Wight to Orkney) in the first half of 2022 alone. As well as citizen science engagement, the data from this project allows hotspots for eggcases and potential egg-laying grounds to be identified, as well as further developing our understanding of eggcase morphology (e.g., the Common Skate complex). Although established in the British Isles, the Great Eggcase Hunt receives submissions from around the world, including across Europe and the Mediterranean, as well as Australia, South Africa, and the USA. The project continues to grow, with identification resources in development for different regions and an app to make the submission process even easier.

Keywords: citizen science; eggcases; oviparous; Rajidae; Scyliorhinidae

SI Abstract Ref: 224

Elitza Germanov

Marine Megafauna Foundation, West Palm Beach, Florida, United States of America 1; Centre for Sustainable Aquatic Ecosystems, Harry Butler Institute, Murdoch University, Perth, Western Australia, Australia 2; Environmental and Conservation Sciences, Murdoch University, Perth, Western Australia, Australia 3

A decade of manta ray research and conservation in Indonesia

1. Elitza S. Germanov
2. Andrea D. Marshall
3. Simon J. Pierce
4. Lars Bejder; Marine Mammal Research Program, Hawaii Institute of Marine Biology, University of Hawaii at Manoa, Honolulu, Hawaii, United States
5. I. Gede Hendrawan; Faculty of Marine Sciences and Fisheries, Universitas Udayana, Denpasar, Bali, Indonesia
6. Neil Loneragan; Faculty of Fisheries and Marine Science, Bogor Institute of Agriculture, Bogor, West Java, Indonesia

Manta rays have some of the lowest estimated population growth rates for elasmobranchs, making them susceptible to drastic declines from human threats. A decade ago, Indonesia simultaneously hosted one of the largest fisheries for mantas, along with a major manta ray tourism industry. The high value of tourism was a strong argument for protection, but knowledge of habitat use was necessary to create effective policy. Galvanizing tourism operators and the public, we used citizen science to address knowledge gaps, identify manta ray hotspots, and provide baseline population data. We showed that manta rays routinely moved beyond established conservation and tourism areas into areas of high fishing activity, warranting nationwide species protection. That was then legislated in 2014.

Subsequently, we have provided longer-term characterizations of the habitat use, demographics, and remaining human threats to manta ray aggregations within the Nusa Penida Marine Protected Area (MPA) and the Komodo National Park (NP). Using a combination of active researcher and citizen science we established a high degree of site affinity to two sites within the Nusa Penida MPA. One site was crucial for adult cleaning and mating, and the other for feeding juveniles. Habitat use in Komodo NP follows a similar pattern, with four key sites identified.

Ongoing threats to manta rays in these areas include entanglement in fishing gear, plastic pollution, and growing tourism. Future research aims to assess population dynamics and trends, and to characterize additional critical habitats in the region.

Keywords: photo-ID; population structure; movement; site use; coral triangle region

SI Abstract Ref: 149

Jennifer Keeping

University of Glasgow

Much ado about stingrays

1. Jennifer Keeping, University of Glasgow
2. David Bailey, University of Glasgow
3. Charlotte Hopkins, University of Hull

This presentation intends to showcase the works completed during my MSc by research projects concerning the stingrays of southern Mozambique, the research gaps I have identified therein and the preliminary results of my forthcoming PhD projects. I intend to summarise the findings of the two published manuscripts from my MSc studies; the first detailing the validation of the computer-aided, photo-identification of the small eye stingray, *Megatrygon microps*, which is among the largest and most unique species of stingrays in the world. The second manuscript describes the trends in the sightings of stingray in southern Mozambique, using citizen-science collected data to determine seasonality and small-scale habitat movement of stingrays in the diving region of Tofo, Mozambique.

I am now undergoing PhD research to continue to work on filling the many research gaps that I have identified during the MSc work. My PhD topics include the use of stable isotope analysis to determine feeding ecology, habitat use and movements of multiple stingray species in the Inhambane provincial region. These data will compliment the photo-ID and diver observations already completed, whilst increasing our knowledge surrounding the differing trophic roles of each stingray species, their importance to the ecosystem and, most notably, reveal more about their movements to the ocean zones that are unavailable with the satellite and acoustic tags traditionally used in movement telemetry studies.

Keywords: stingray; mozambique; ecology; stable isotope; photo-ID

SI Abstract Ref: 129

Georgia Jones

Bournemouth University

UK recreational shark angler practices, perceptions and attitudes; bridging the gap between scientists and anglers for the benefit of sharks

1. Jones, G.C.A.
2. Murphy, S.
3. Rudd, H.
4. Somerfield, P.
5. Thomas, S.F.
6. Stewart, B.D.

Recreational anglers are important stakeholders in global fisheries and have capacity to provide valuable data for scientific research and conservation management of threatened species. Recreational angling for sharks has a long history in the UK, and is seeing a renewed surge in popularity, but tensions exist between anglers and scientists over mistrust of how data will be used and issues around some cases of poor shark handling. The result has been a loss of data sharing and a stymied understanding of UK shark populations, especially for several threatened species that are considered data-poor. Here we present the results of the first project initiated by a new collaboration 'Shark Hub UK', which aims to bring anglers and scientists together as equals, for sharks. Our questionnaire was completed by 169 anglers from right around the UK and provided novel insights into the distribution and intensity of recreational angling activities for UK sharks, the handling methods currently employed and angler attitudes towards shark management and data sharing. The results will guide future shark handling best-practice guidance for anglers, rebuild trust between anglers and scientists, and highlight avenues for key future research into UK shark ecology and conservation.

Keywords: recreational angling; best-practice handling; UK sharks; stakeholder engagement

SI Abstract Ref: 80

Katie Hindle

A Rocha Kenya

Biodiversity and conservation of elasmobranchs in Watamu Marine National Park, Kenya

1. Katie, Hindle; A Rocha Kenya.
2. Eric, Thurania; A Rocha Kenya.
3. Peter, Musila; A Rocha Kenya.
4. Colin, Jackson; A Rocha Kenya.
5. Stanley, Baya; A Rocha Kenya.
6. Queen, Harare; A Rocha Kenya.
7. Robert, Sluka; A Rocha International.

The no-take MPA in Watamu Kenya houses a diversity of IUCN Red List threatened elasmobranchs and serves as a nursery area for at least one of these species. The surrounding community is growing in its understanding of the intrinsic and natural capital value of these species through creative educational opportunities both in schools and among artisanal fishers.

Ten elasmobranch species were observed using four methods (BRUVs, Timed Swims, Beach walks, and Diving surveys): *Taeniura lymma*, *Glaucostegus halavi*, *Carcharhinus melanopterus*, *Neotrygon caeruleopunctata*, *Himantura gerrardi*, *Himantura uarnak*, *Triaenodon obesus*, *Torpedo sinuspersici*, *Aetobatus narinari*, and *Rhincodon typus*. The most abundant species were *Carcharhinus melanopterus*, *Taeniura lymma*, and *Neotrygon caeruleopunctata*. Elasmobranchs were observed most often over sand habitat (56%) followed by seagrass (33%), and coral (11%).

Larger Blacktip reef sharks (*Carcharhinus melanopterus*), majority females were seen August – November. Most small pups appeared along the shallow sandy areas along the length of WMNP's beach from October onwards with a decline of larger sharks around this time. Footage of a shark that appears to show afterbirth with a larger male following was recorded in early November possibly indicating WMNP as an important pupping ground.

Environmental education created awareness among community members. Programs were conducted in 8 schools reaching 320 students and 10 community groups reaching 237 individuals. An artisanal fishing competition was held for the first time which involved the use of hooks of a specific size to emphasize the importance of sustainable fishing methods and conservation of elasmobranchs.

Keywords: MPA; nursery; guitarfish; shark; ray

SI Abstract Ref: 72

Jennifer Olbers
WILDTRUST

A cross-disciplinary approach to the protection of South Africa's threatened sharks and rays

1. Jennifer, Olbers; WILDTRUST
2. Nikki, Chapman; WILDTRUST
3. Sandile, Ntuli; WILDTRUST
4. Summer, Newton; WILDTRUST
5. Jean, Harris; WILDTRUST
6. Lauren, van Nijkerk; WILDTRUST
7. Jeremy Cliff; Research Associate of University of KwaZulu-Natal

South Africa is a global hotspot for chondrichthyan diversity while providing important habitats for many threatened species. Despite a rich history of shark research and management in South Africa, there are knowledge gaps, inadequate statutory interventions ensuring adequate protection, and a lack of capacity to effectively enforce current legal provisions. Furthermore, public perceptions about sharks are in general, negative, and based on incorrect information. To improve the protection of threatened (Vulnerable, Endangered, and Critically Endangered) species, prioritizing South African endemics, the WILDTRUST through their marine programme, WILDOCEANS, together with the Shark Conservation Fund and many other partners, implemented a 3-year Shark and Ray Protection Project. A campaign called Shark Attack was launched in March 2020, highlighting the plight of South Africa's chondrichthyans and actively attempting to shift negative perceptions and inspire positive action through its website, social media platforms, and traditional media. The following content are available for download online: database and annotated checklist comprising all known chondrichthyan species found in South African waters, detailed status reports on 90 threatened and/or endemic species, a field guide of threatened and endemic species for law enforcement officers, online species ID workshops, draft recommendations for improved statutory modifications to SA legislation, shark and ray systematic conservation plan report, with associated R-scripts, highlighting essential habitats for shark and ray MPA's or shark sanctuaries, trade toolkit for law enforcement in numerous ports of entry and various information pack and policy brief for decision-makers. The presentation aims to highlight the successes of this collaborative project.

Keywords: conservation; southern africa; threatened species; endemic; Chondrichthyes

SI Abstract Ref: 48

Evan Prasky
Northeastern University

Quantifying angler perceptions about shark depredation through stakeholder engagement

1. Evan, Prasky; Northeastern University
2. Marcus, Drymon; Mississippi State University
3. Amanda, Jefferson ; Mississippi-Alabama Sea Grant
4. Mandy, Karnauskas; National Oceanic and Atmospheric Administration
5. Savannah, Swinea; Northeastern University
6. Steven, Scyphers; University of South Alabama

The Gulf of Mexico (GoM) is home to 31 federally managed reef fish species that are both commercially and recreationally important for communities in the region. These fish are federally managed through a series of stock assessments and a scientific understanding of natural lifecycles. Depredation, defined as the partial or complete removal of a captured species by a non-target species, is a cause of increased mortality and is not well quantified or understood. Mounting voices from anglers in the community suggest depredation is not only a prevalent and pervasive issue across the Gulf but also is rapidly increasing. Because of this, fisheries managers cannot effectively capture true population numbers derived from stock assessments. Depredation is a complex social-ecological issue that occurs between a multitude of species and is not required to be reported. Therefore, we have turned to anglers across the GoM to gain insights into their perceptions, interactions, and identification of the main causes and drivers of depredation to better assist in the classification and characterization to increase the accuracy of fisheries managers' stock assessments. To do this, we distributed a Gulf-wide survey (n = 1044) that focused on building cognitive maps to highlight the perceptions anglers have on depredation. We also asked questions that quantified key factors that have influenced depredation, such as seasonal variation and fishing habits, to better understand the human-wildlife conflict that depredation is causing. Using the information gathered, we can begin to more accurately assess how depredation impacts anglers and stock assessments.

Keywords: shark depredation; human-wildlife conflict; cognitive maps; community perceptions; stakeholder attitudes

SI Abstract Ref: 33

Robert Priester

Okeanos – University of the Azores

Trophic ecology and coastal habitat use of two sympatric shark species in the Azores archipelago (mid-Atlantic) assessed with CNS stable isotope analysis

1. C. Robert, Priester; Okeanos – University of the Azores.
2. Jan, Dierking; GEOMAR Helmholtz Centre for Ocean Research Kiel.
3. David, Abecasis; CCMAR – Centre of Marine Sciences, University of Algarve
4. Pedro, Afonso; IMAR/Okeanos – University of the Azores

The anthropogenic exploitation of marine resources has caused drastic declines of large predatory fishes. Amongst these, sharks are of major conservation concern due to their high vulnerability to overfishing and role as top predators. The Azores Islands, Mid Atlantic, are thought to serve as essential fish habitat (EFH - waters necessary to fish for spawning, breeding, feeding or growth to maturity) for tope (*Galeorhinus galeus*) and smooth hammerhead (*Sphyrna zygaena*) sharks, but data to better assess this role are scarce. To address existing knowledge gaps, here we provide the first comparative assessment of the trophic ecology, ontogenetic shifts with increasing shark size and niche partitioning of *G. galeus* and *S. zygaena* around the Azores based on simultaneous $\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{34}\text{S}$ (CNS) stable isotope analysis. Overall, shark isotopic niches, obtained using a 3D-Bayesian ellipse approach, indicated a strong role of mixed coastal-benthic resources, but with clear differences between life stages consistent with intra- and interspecific niche partitioning. Whereas tope shark showed a significant ontogenetic shift to higher trophic levels within the coastal-benthic prey niche, smooth hammerhead sharks exhibited significant decreases in $\delta^{34}\text{S}$, consistent with an increasing reliance on coastal-benthic prey with growing size. The co-occurrence of juveniles of two shark species of high conservation concern, and the role of coastal-benthic prey in their diet, highlight the importance of healthy coastal habitats for the conservation of these emblematic predators in the wider Atlantic, and of the important role of Azores coastal areas as EFH.

Keywords: Simultaneous carbon nitrogen and sulfur stable isotope analysis; 3D niche hypervolume; niche partitioning; communal shark nursery; ontogenetic shift

SI Abstract Ref: 168

Sabrina Riverón

Marine Predator Research Group, School of Natural Sciences, Macquarie University

Morphology influences niche dynamics in two large sympatric sharks from Uruguayan waters

1. Sabrina, Riverón; Marine Predator Research Group, School of Natural Sciences, Macquarie University.
2. Vincent, Raoult; School of Environmental and Life Sciences, University of Newcastle; Marine Ecology Group, School of Natural Sciences, Macquarie University.
3. David J., Slip; Taronga Institute of Science and Learning, Taronga Conservation Society Australia.
4. Federico, Mas; National Directorate of Aquatic Resources (DINARA).
5. Martín, Laporta; National Directorate of Aquatic Resources (DINARA), Atlantic Fisheries Management Unit; Campus DoMar, International Campus of Excellence, University of Santiago de Compostela.
6. Inés, Pereyra; National Directorate of Aquatic Resources (DINARA), Atlantic Fisheries Management Unit.
7. Santiago, Silveira; National Directorate of Aquatic Resources (DINARA), Atlantic Fisheries Management Unit.
8. Robert G., Harcourt; Marine Predator Research Group, School of Natural Sciences, Macquarie University.

Prey availability in an environment does not ensure that prey will be consumed by a predator, as they must also be detected, captured and handled. Predator morphology imposes limitations on prey selection due to biomechanical constraints, making some prey functionally inaccessible and thereby shaping predators' trophic niches. We assessed how two important components of morphology (tooth shape and body length) influence prey selectivity and trophic niche in two large-bodied sympatric sharks with contrasting feeding modes. The first species capture prey using spear-shaped, grasping teeth (*Carcharias taurus*), while the second has multi-cuspid cutting teeth used to serrate larger prey (*Notorynchus cepedianus*). Stomach content analysis and isotopic values of $\delta^{13}\text{C}$, $\delta^{34}\text{S}$ and $\delta^{15}\text{N}$ from muscle and liver were used to characterize trophic niche and prey selection. As gape-limited *C. taurus* grew, their consumption of teleosts decreased inversely to chondrichthyans. By contrast, non-gape limited *N. cepedianus* consumed teleosts and chondrichthyans in similar proportions, along with marine mammals, but with no clear relationship to body size. As body length increased, both species consumed prey from higher trophic levels (higher $\delta^{15}\text{N}$), but *N. cepedianus* accessed prey at relatively higher trophic levels. $\delta^{13}\text{C}$ and $\delta^{34}\text{S}$ remained substantially unchanged with body length since gape and dentition are less limiting for these tracers. Morphological characters play an essential role in predator prey selection and may be the primary mechanism facilitating resource partitioning in marine predators. Their inclusion in ecological studies will help understand prey choice and how it shapes trophodynamics in marine ecosystems.

Keywords: marine predator; trophic ecology; stable isotopes; stomach contents; Southwestern Atlantic

SI Abstract Ref: 270

Erin Spencer

Florida International University

Using biologgers to estimate energy expenditure and consumption rates of great hammerhead sharks (*Sphyrna mokarran*)

1. Erin Spencer, Florida International University
2. Lisa Hoopes, Georgia Aquarium
3. Gil Iosilevskii, Technion
4. Yannis Papastamatiou, Florida International University

Top predators play an important role in ecosystem food webs, and quantifying predators' energetic needs is key to understanding their rate of consumption on lower trophic levels. Metabolic costs are the largest components of an organism's energy budget, and measuring an organism's metabolic rate in the field provides an estimate of how much an organism must consume. We used biologgers to record depth, temperature, speed, tri-axial acceleration and tri-axial magnetism of great hammerhead sharks (*Sphyrna mokarran*) tagged off of the Atlantic and Gulf coasts of Florida. We then used previously-established hydrodynamic models of great hammerheads derived from wind tunnel experiments to convert measures of swim speed from sampled sharks into energy consumption rates. Preliminary analysis of four sharks indicate sampled individuals would need to consume an average of approximately 1.27 lbs of food per day to account for metabolic costs, varying with speed and size of the animal. These results further our understanding of the ecological role of great hammerheads, a critically endangered predator, by allowing us to calculate how much prey they may be removing from local ecosystems.

Keywords: biologging; energetics; great hammerhead sharks; biologgers

SI Abstract Ref: 288

Brianna Cahill

Harbor Branch Oceanographic Institute, Florida Atlantic University

Breaking bags and crunching clams: Assessing whitespotted eagle ray interactions with shellfish aquaculture gear

1. Brianna, Cahill; Harbor Branch Oceanographic Institute, Florida Atlantic University.
2. Kayla, McCulloch; Rosenstiel School of Marine and Atmospheric Science, University of Miami.
3. Breanna, DeGroot; Harbor Branch Oceanographic Institute, Florida Atlantic University.
4. Kim, Bassos-Hull; Mote Marine Laboratory.
5. Matthew, Ajemian; Harbor Branch Oceanographic Institute, Florida Atlantic University.

Shallow coastal waters are commonly used in shellfish aquaculture for "grow-out" of bivalves like the Northern Quahog (*Mercuraria mercenaria*). These grow-out locations have substantially higher clam densities than the surrounding environment and potentially attract molluscivores. Inspired by clammer reports of predator-inflicted damage to grow-out gear, we assessed the capacity of a highly mobile predator (whitespotted eagle ray *Aetobatus narinari*) to detect and interact with clams housed within a suite of industry standard antipredator materials. Experiments were conducted in mesocosms where rays were exposed to unprotected clams (control), clams inside polyester mesh clam bags (dipped in a latex net coating and non-dipped), and under high density polyethylene (HDPE) or chicken wire cover netting. Gear interactions were quantified from video footage throughout the course of the experiment and clam mortality was assessed after its completion. Rays interacted with antipredator gear significantly more than control plots, with particularly long durations noted for clam bags covered with HDPE netting. While rays were capable of consuming clams through bags, antipredator treatments reduced clam mortality by 4-10x compared to control plots. Double-layered (i.e., bags with cover netting) treatments exhibited the lowest clam mortality ($0.6 \pm 0.1\%$), highlighting the utility of this type of protection in shellfish aquaculture.

Keywords: Batoid; shellfisheries; behavioral ecology

SI Abstract Ref: 294

Ulrich Martin

UCLouvain, marine biology laboratory

A comparison of deep-sea sharks trophic ecology over large spatial scales.

1. Ulrich, Martin; Université Catholique de Louvain
2. Gilles, Lepoint; Université de Liège
3. Jérôme, Mallefet; Université Catholique de Louvain

An important diversity of sharks lives in the depths of the oceans around the world. The trophic ecology of these species is still poorly known due to the difficulties to access this remote environment and observing individuals directly. Indirect observations have proven useful in addressing this issues through the use of stomach contents analyses mainly. This method provides essential information but is subjected to a series of biases: only recent prey can be observed, different tissues have different digestion rates and a lot of stomachs might be empty. Other approaches such as stable isotopes (SIA) or fatty acid profiling (FAP) are more and more recognized to achieve more comprehensive ecological data.

We used SIA to explore the trophic ecology of different deep-sea shark communities across the world. A total of 21 species were considered, coming from five locations separated by large distances: Chatham Rise plateau in New Zealand, Taiwan, Kerguelen Islands, Gascogne strait and Mediterranean Sea. $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{34}\text{S}$ isotope ratios were measured on muscle and liver samples after lipid, TMAO and urea extraction. Isotopic niches were then calculated using Bayesian statistical methods. The ecological inferences were compared between the different locations, considering parameters such as spatial scale, latitude, longitude or taxonomic classification to try and explain the similitude and differences observed. This work was supported by a travel research grant from FNRS Belgium.

Keywords: deep-sea sharks; trophic ecology; stable isotope

SI Abstract Ref: 323

Corina Silva

California State University Long Beach- Shark Lab

Shark Lab Education and Outreach

Corina, Silva; CSULB Shark Lab

The Shark Lab has long been a keystone in elasmobranch research in the local Long Beach community and global shark knowledge. With so much innovation in new technology and research techniques to study behavior and ecology of marine animals, the lab has a wealth of scientific findings to make readily available and applicable to the public and students of all ages. Our mobile outreach program, called Shark Shacks, travels across southern California beaches and ocean piers to reach thousands of beachgoers and lifeguards. Additionally, the Shark Lab has begun to implement new educational programs specific to K-12 classrooms focusing on getting students interested in Science, Technology, Engineering and Math (STEM). Beginning with virtual and transitioning to in-person programming, curricula encompass content covering shark biology, technology, and careers in these STEM fields. Our outreach and education efforts are focused on informing beach goers across all ages about shark behavior and how to stay safe while enjoying the ocean. For K-12 students, the goal of the lab is to increase access to dynamic and interesting fields across disciplines and invoke excitement about fields they may have never seen themselves in. All our programming is free of charge and open to diverse audiences across southern California and beyond.

Keywords: education; outreach; stem; k-12 ; school

SI Abstract Ref: 11

Ian Campbell

PADI AWARE Foundation

The Global Shark Census - can citizen science add value to research?

1. Ian Campbell; PADI AWARE Foundation
2. Andrew Chin; James Cook University

One of the fastest growing fields in marine conservation is the development and expansion of citizen science projects. Shark and ray conservation is a particularly appealing field for citizen science projects, yet the majority of the existing programmes are uncoordinated and vary greatly in effort and level of participant expertise. The recent review of emergent research and priorities for shark and ray conservation (Jorgensen *et al.* 2022) identified an urgent need to increase coordination, leadership and collaboration between scientists, governments and community groups.

PADI (The Professional Association of Diving Instructors) and The PADI AWARE Foundation have a successful track record of developing and implementing successful large-scale citizen science initiatives. Our existing Dive Against Debris has been successful in coordinating the global efforts of millions of divers conducting marine debris surveys, leading to data contributing towards ground-breaking research.

In 2023, the PADI AWARE Foundation will seek to replicate the success of Dive Against Debris and launch the Global Shark Census. This initiative aims to coordinate the efforts of PADI's global network of 6,600 dive centres, 128,000 PADI Professionals and 15 million registered and active PADI divers to collect shark and ray datasets that will actively contribute towards the development of management measures, augment academic research and bring scale to conservation advocacy. This presentation will outline the opportunities to harness data collection on an unprecedented scale.

Keywords: citizen science; conservation; divers; data collection

SI Abstract Ref: 139

Re'em Neri
Sharks in Israel

Mining social media for Elasmobranch fishery data in conflict zones: The Gaza strip as a case study

1. Re'em, Neri; Sharks in Israel
2. Adi, Barash; Sharks in Israel
3. Uri, Neri ; Tel Aviv University

A huge gap in environmental information exists in conflict regions where environmental access to scientists ranges from unsafe to impossible. Previously unknown knowledge of Elasmobranchii presence, composition, and distribution can provide valuable information regarding the exploitation of elasmobranch species and for creating comprehensive conservation strategies. However, the diversity, ecology, behavior, and many other characteristics of these species in conflict zones remain virtually unknown, which is a major cause for concern.

Traditional species surveys rely on in-situ observations and municipality regulations forcing fisheries to self-report their catch. Conflict areas present a unique challenge, lacking formal regulation or scientific access. Here, we report the first use of social media monitoring ("iEcology") of the extent of the Elasmobranch fishery in the Gaza strip, a conflict region previously lacking any information. Our database consists of 3 years of daily reported catch from 8 markets in the Gaza strip. We collected 584 data points belonging to 2348 individuals of 14 species. The analysis of the data suggests temporal, spatial, and seasonal trends in elasmobranch catch distribution are affected by changes in the access to maritime areas due to local conflict escalations and de-escalations.

We demonstrate this approach as a relatively accurate and inexpensive data analysis procedure, allowing the quantification and normalization of multiple unrelated observations of caught and targeted fish into a uniformed geo-spatial-temporal system-making it a prime candidate for future endeavors in other conflict zones in coastal regions.

Keywords: Elasmobranch fishery; iEcology; social media; conflict zones

SI Abstract Ref: 173

Lindsay Laughner
Field School Foundation

Research, educate, and explore the world with sharks and field school

1. Dr. Julia Wester
2. Dr Catherine Macdonald
3. Lindsay Laughner

Studies have shown that STEM education leads to better public perceptions and understanding of science and the broader impact of its role in society. As charismatic species, sharks and rays can be used as ambassador species for increasing the reach of both STEM and ocean education. This talk will present the programs, experiences, and lessons to date from Field School and the Field School Foundation, a set of hybrid research-education programs operating in Miami-Dade, Florida and centered on that community's connections to Biscayne Bay. Biscayne Bay is a large, fragile marine estuary with considerable marine biodiversity, including of several endangered elasmobranch species. To communicate the role that sharks have in the ocean and educate families on the impact they are having on them, accessible resources are needed. Through a combination of student and citizen science participation and ready-to-deploy classroom lesson plans that integrate the research program and local ecosystems, these programs help to teach data and ocean literacy, build communication skills, and develop locally-relevant STEM curriculum that differentiates research for general audiences at multiple levels. Field School creates a safe and inclusive environment for students to learn and develop hands-on skills, as students apply what they are learning and seeing the impact they have first hand. Our education programs and curriculum are free, and available for students of all ages, to connect people locally and globally to sharks in Biscayne Bay, Florida, as we research, educate, and explore, the world of sharks together.

Keywords: research; education; programs; curriculum

SI Abstract Ref: 211

Jessica Winn

Stellenbosch University

Global phylogeography and population genomics of the commercially exploited smoothhound shark

1. Jessica Winn: Stellenbosch University
2. Aletta Bester-Van der Merwe: Stellenbosch University
3. Simo Maduna: The Norwegian Institute of Bioeconomy Research

Accelerated global warming and over-exploitation of marine species threaten to eradicate the unique genetic archives of modern Chondrichthyans (sharks, rays, and chimeras), an evolutionarily robust lineage with a 400-million-year genealogy. Understanding the impact of rapidly changing global conditions on elasmobranchs (sharks and rays) and devising conservation responses relies on the identification of unique genetic populations adapted to specific environmental niches. This research focuses on delineating the global phylogeography of the common smoothhound shark, *Mustelus mustelus*, using whole mitogenome data from 9 sampling populations collected across the species' distribution range. The same samples have been used to generate reduced-representation sequencing (RRS) (RADSeq) data in order to reveal associations between single nucleotide polymorphism (SNP) alleles and environmental variables hypothesized to drive selection while controlling for the confounding effects of neutral genetic structure. It is predicted that species inhabiting the rapidly warming, yet diverse, biogeographic regions of South Africa and the Mediterranean Sea are likely locally adapted to their environment which can lead to differences in genetic variation among populations even in the face of high gene flow. The eventual goal is to better characterize the genomic mechanisms of environmental adaptation and provide a system for predicting responses to new selective challenges in this species and exploited houndsharks. The mitogenomes of four such species have been sequenced and submitted for publication, providing an opportunity to increase the resolution of phylogenomic studies and conduct more extensive population genomics investigations to better inform management strategies.

Keywords: phylogenomics; population genomics; Triakidae; phylogeography; local adaptation

SI Abstract Ref: 1

Fenella Wood

University of Aberdeen

Genomic investigation and kinship provide insights into a highly mobile shark

1. Fenella, Wood; University of Aberdeen.
2. Tanja, Schwanck; University of Aberdeen
3. James, Thorburn; University of St. Andrews
4. Andrew, Meharg; Queens University Belfast
5. Leslie, Noble; Nord University
6. Catherine, Jones; University of Aberdeen

Spurdog (*Squalus acanthias*) are a wide-ranging, highly mobile, small shark found in temperate seas across the globe. Once a commercially important species, they have experienced severe declines and are now listed as Endangered in the Northeast Atlantic. Despite a zero total allowable catch, they can be caught as bycatch, which as an aggregating species, can comprise of up to <10 tonnes in a single catch. This may impact population size, with subsequent effects on genetic diversity.

Previous research using microsatellite markers suggested that aggregations may contain closely related individuals. As the loss of kin groups can rapidly erode selectable genetic diversity, understanding the genetic composition of spurdog across the British Isles is crucial to assess the potential impact of their removal by fishing on population sustainability. Single Nucleotide Polymorphism (SNP) markers are being used to understand the genetic diversity and population structuring of spurdog across the British Isles. Kinship will also be investigated to reveal whether relations are found within sampled aggregations. This may subsequently provide insight into their aggregating behaviour, in terms of origin and persistence as a group, as well as the genetic diversity of the spurdog that they represent.

Keywords: kinship; genomics; genetic diversity; aggregating species

SI Abstract Ref: 97

Mahmood Shivji

Save Our Seas Foundation Shark Research Center, Nova Southeastern University

Global population genomics assessment of the critically endangered great hammerhead shark

1. Mahmood Shivji; Save Our Seas Foundation Shark Research Center, Nova Southeastern University.
2. Cassandra Ruck; Save Our Seas Foundation Shark Research Center, Nova Southeastern University.
3. Nicholas Marra; Governors State University.
4. Michael Stanhope; Cornell University.
5. Andrea Bernard; Save Our Seas Foundation Shark Research Center, Nova Southeastern University.

The great hammerhead (*Sphyrna mokarran*) is an iconic, large-bodied shark species distributed worldwide in tropical to warm temperate seas, in habitats ranging from coastal to semi-oceanic waters. Great hammerhead shark fins have high value in the international fin trade. Overexploitation coupled with high bycatch mortality has caused steep declines in much of its distribution, resulting in an IUCN Red List assessment of great hammerheads as “Critically Endangered” globally. Since little knowledge existed about the population genetic dynamics of this species to inform conservation management, we used a high-resolution, bi-organelle, genomics approach to assess the population structure and genetic diversity of this species across large parts of its global distribution. Analyses with Single Nucleotide Polymorphism markers (n=162; 1816 SNPs) revealed three highly distinct global populations, comprising great hammerheads from the Western Atlantic, Red Sea/Persian Gulf and east/west Australian coasts, with no population structure observed within these large regions. Analyses using 176 complete mitochondrial genome sequences (mitogenomes), in contrast, revealed matrilineal genetic distinctiveness on smaller spatial scales, including between the western North Atlantic and Caribbean, and within the western Indian Ocean, consistent with female philopatry. There was no evidence for population differentiation with either SNP or mitogenome markers between western and northeastern Australia sampled great hammerheads. Notably, global mitogenome-based phylogeographic analyses revealed that Australian great hammerheads are highly evolutionarily divergent from western Indian and western Atlantic conspecifics.

Keywords: great hammerhead; population genomics; population structure

SI Abstract Ref: 24

Ana Veríssimo

CIBIO-InBIO; Associação BioPolis

Screening the immune gene diversity of Cartilaginous fish – relevance to management and evolution

1. Ana, Veríssimo;
2. Martin, Flajnik;
3. Arnaud, Gaigher;
4. Tereza, Almeida;
5. Yuko, Ohta;
6. Antonio, Muñoz;
7. Fabiana, Neves;
8. Alessia, Rota;
9. Beatriz, Dias;
10. Filipe, Castro;
11. André, Machado;
12. Pedro, Esteves;
13. Bárbara, Serra-Pereira;
14. Teresa, Moura.

This talk showcases the relevance of studying immune genes in Cartilaginous fish, providing specific examples of their relevance to fisheries management and conservation, and to understand the evolution of this ancient group. Genetic diversity at immune genes is driven by pathogen-induced selection, leading to locally adapted populations and reduced migrant fitness. Thus, immune genes may be better at detecting biologically relevant population units compared to neutral markers (e.g. nuclear microsatellites), improving stock delimitation. Also, preserving immune gene diversity across populations is key to ensure their adaptive potential against future pathogens and environmental changes. These features make immune genes prime candidate markers in improving stock identification and the sustainable long-term management of vulnerable marine species. On the other hand, Chondrichthyans are the oldest living jawed vertebrates with the basic features of adaptive immunity; thus, they are a key group in the evolution of vertebrate adaptive immunity and are essential to identify its ancestral and derived features. Also, given the group’s long evolutionary history and remarkable ecological diversity, different lineages experienced different environmental stressors and pathogenic agents, perhaps resulting in different immune response mechanisms and genetic makeup. Here, we show results contrasting genetic diversity patterns at neutral vs. immune genes for commercially exploited shark species, and their implication to population structure reconstruction. We also uncover the high diversity of immune gene (MHC) lineages in Chondrichthyans compared to previous assumptions, and unravel how Chondrichthyan genomics contribute to reconstructing the primordial immune complex at the dawn of jawed vertebrates.

Keywords: Immunogenetics; non-neutral markers; fisheries; ecological diversity; adaptive evolution

SI Abstract Ref: 259

Ana Filipa Sobral

1Okeanos R&D Centre, Department of Oceanography and Fisheries, University of the Azores, Horta, Portugal

Filling the gap: conservation genetics of endangered migratory elasmobranchs - from oceanic islands to ocean basins

1. Ana, Sobral; Okeanos R&D Centre, Department of Oceanography and Fisheries, University of the Azores, Horta, Portugal.
2. Emily, Humble; Royal (Dick) School of Veterinary Studies and the Roslin Institute, University of Edinburgh, EH25 9RG, UK.
3. Pedro, Afonso; Marine and Environmental Sciences Centre (MARE), Department of Oceanography and Fisheries, University of the Azores, Horta, Portugal
4. Rob, Ogden; Royal (Dick) School of Veterinary Studies and the Roslin Institute, University of Edinburgh, EH25 9RG, UK

The survival of chondrichthyans is a major marine conservation concern, with over one-third of species currently at risk of extinction due to their exceptional vulnerability and low resilience to high levels of exploitation. However, our extremely limited knowledge of their basic ecology hampers the implementation of proper management and conservation actions. There is also a knowledge gap on the genetic diversity and population structure of these species at different spatial scales. This is especially true for migratory species that, at different stages of their life, depend on the restricted coastal habitats of oceanic islands. Understanding the degree of genetic connectivity allows to define population boundaries and infer dispersal patterns, while describing genetic diversity will allow to inform appropriate measures to preserve it. To fill this knowledge gap, we used a genetic multi-marker approach focused on two key migratory and endangered species of contrasting life histories and behavior: tope shark (*Galeorhinus galeus*) and sicklefin devil ray (*Mobula tarapacana*). We evaluated population structure and assessed connectivity at different spatial scales – from ocean basins to the island groups within the Azorean archipelago - through the analysis of Single Nucleotide Polymorphism (SNP) markers and Mitochondrial DNA (mtDNA). The results of this project will provide science-based knowledge to support suitable management and conservation actions, regionally and globally.

Keywords: conservation; genetics; connectivity; endangered; elasmobranchs

SI Abstract Ref: 357

Cindy Gonzalez

Florida International University

The hidden hammerhead: *Sphyrna alleni* sp. nov., a new species of bonnethead shark (Carcharhiniformes, Sphyrnidae) from the Caribbean and the Southwest Atlantic

1. Cindy Gonzalez; Predator Ecology and Conservation Lab, Biological Sciences Department, Florida International University, Miami, Florida, U.S.A.
2. Baptiste Postaire; Tropical Marine Ecology Lab, University of la Réunion, Saint- Denis, Réunion Gavin Naylor; Florida Program for Shark Research, Florida Museum of Natural History, University of Florida, Gainesville, Florida, U.S.A
3. Rob Robins; Florida Museum of Natural History, University of Florida, Gainesville, Florida, U.S.A
4. William Driggers; NOAA Fisheries, Southeast Fisheries Science Center, Mississippi, U.S.A
5. Susana Caballero; Laboratorio de Ecología Molecular de Vertebrados Acuáticos, Departamento de Ciencias Biológicas, Universidad de Los Andes, Bogotá, Colombia
6. Kevin A. Feldheim; Pritzker Laboratory for Molecular Systematics and Evolution, Field Museum of Natural History, Chicago, Illinois, U.S.A.
7. Alejandro Quiroga; Laboratorio de Ecología Molecular de Vertebrados Acuáticos, Departamento de Ciencias Biológicas, Universidad de Los Andes, Bogotá, Colombia
8. Demian Chapman; Center for Shark Research, Mote Marine Laboratory, Sarasota, Florida, U.S.A

Hammerheads (Carcharhiniformes, Sphyrnidae) are a recent radiation of 10 described shark species, characterized by their laterally expanded head ("cephalofoil"). All hammerhead species are listed in threatened categories by the International Union for the Conservation of Nature (IUCN) due to overexploitation. Genetic analyses of one species, the bonnethead shark (*S. tiburo*) reveal that it is possibly a species complex, with one species occurring in the Western Atlantic from the U.S.A to Mexico and another occurring from Belize to Brazil. Morphometric, meristic, and genetic variation was used to examine differences between these cryptic species and describe them. Sixty-one morphometric measurements and three meristic characters (vertebral count, lower and upper rows of functional teeth) were taken from 23 bonnetheads, 12 from Placencia, Belize and 11 from Florida, U.S. For the morphometric data an allometric formula was used to standardize any effect caused by differences in size of the individuals. These data were analyzed with univariate and multivariate statistics. There were no significant differences in the morphology of the two species, however, there were non-overlapping vertebral counts between Florida and Belize specimens. Variation at two mitochondrial markers (cytochrome oxidase I and control region) and 12 nuclear microsatellite loci are also partitioned between these two species. The genetic and meristic characters clearly differentiate these species and enable formal descriptions of *Sphyrna tiburo* from the U.S.A. to Mexico, and *S. alleni* from Belize to Brazil. The latter is already likely threatened with extinction throughout its range.

Keywords: Bonnethead shark; mtDNA; nuclear DNA; phylogeography; *Sphyrna alleni* sp. nov

SI Abstract Ref: 248

María del Pilar Blanco Parra

Consejo Nacional de Ciencia y Tecnología-Universidad Autónoma del Estado de Quintana Roo

Citizen science as a tool to get baseline ecological and biological data on sharks and rays in a data-poor region

1. María-del-Pilar Blanco-Parra, Consejo Nacional de Ciencia y Tecnología, Universidad Autónoma del Estado de Quintana Roo, Fundación Internacional para la Naturaleza y la Sustentabilidad
2. Angelli Argaez Gasca, Universidad Autónoma del Estado de Quintana Roo
3. Camila Alejandra Reyes Rincón, Universidad del Bosque
4. Nicté Ha Gutiérrez Martínez, Universidad Autónoma del Estado de Quintana Roo
5. Carlos Alberto Niño-Torres, Universidad Autónoma del Estado de Quintana Roo, Fundación Internacional para la Naturaleza y la Sustentabilidad

The Mexican Caribbean is in one of the regions with the greatest diversity of elasmobranchs in the world. However, the population status of most of the shark and ray species in this region is unknown. We used a citizen science program based on divers to collect data about the diversity, abundance, and distribution of elasmobranchs in this region. We visited dive centers in six locations and performed structured interviews with divemasters, instructors, and owners of the diving centers. In total, 79 divers were interviewed, of which 69% had more than five years' experience diving in the Mexican Caribbean. Divers could identify 24 elasmobranch species for this region. Most of the divers (82%) reported a decrease in sightings of sharks and rays. Rays were the most frequently sighted species by divers (89%), and the spotted eagle ray (*A. narinari*) was the most common elasmobranch species reported in the region. Citizen science was a useful approach gathering for baseline information about sharks and rays in the Mexican Caribbean, increasing our knowledge of the abundance and distribution of some species in this region. Citizen science affords the opportunity to obtain long-term data that can be useful for management and conservation.

Keywords: sharks; rays; monitoring; human dimension; scuba diving

SI Abstract Ref: 230

Nadia T. Rubio-Cisneros

1 Laboratorio de Biología de la Conservación y Desarrollo Sustentable de la Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Monterrey, Nuevo Leon, Mexico 2 Mar Sustentable Ciencia y Conservación, A.C. Monterrey, Nuevo Leon, Mexico. 3 Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, University of California San Diego, United States

Generating baseline socioecological data on the past and current Human Perceptions of sharks' presence on Cozumel Island: a hotspot for global tourism

1. Nadia T. Rubio-Cisneros, Laboratorio de Biología de la Conservación y Desarrollo Sustentable de la Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Monterrey, Nuevo Leon, Mexico; Mar Sustentable Ciencia y Conservación, A.C. Monterrey, Nuevo Leon, Mexico.
2. Center for Marine Biodiversity and Conservation, Scripps Institution of Oceanography, University of California San Diego, United States;
3. Teresa Martín, Mar Sustentable Ciencia y Conservación, A.C. Monterrey, Nuevo Leon, Mexico; Corales Vivos Cozumel.
4. Izaizel L. Cruz-Gómez, Universidad Nacional Autónoma de México, Facultad de Ciencias.
5. Francisco Rodríguez-Castillo, Universidad Autónoma de Quintana Roo, Campus Cozumel, Laboratorio de Observación e Investigación Espacial.
6. Oscar Frausto-Martínez, Universidad Autónoma de Quintana Roo, Campus Cozumel, Laboratorio de Observación e Investigación Espacial.
7. Blanca A. Quiroga-García, Comisión Nacional de Áreas Naturales Protegidas, Parque Nacional Arrecifes de Cozumel
8. Juan Carlos Pérez Jiménez, Departamento de Ciencias de la Sustentabilidad, El Colegio de la Frontera Sur, Lerma, Campeche, Mexico
9. Rodrigo A. Núñez-Inzunza, Centro de Investigación y de Estudios Avanzados. Unidad Mérida.
10. Félix A. Vázquez-Pech, Universidad Autónoma de Yucatán, Facultad de Medicina Veterinaria y Zootecnia.
11. José Ignacio González-Rojas, Laboratorio de Biología de la Conservación y Desarrollo Sustentable de la Facultad de Ciencias Biológicas, Universidad Autónoma de Nuevo León, Monterrey, Nuevo Leon, Mexico

Socioecological data on sharks is scant for many islands of Latin America. Our goal is to develop baseline information on the diversity and presence of sharks through time. On Cozumel, The Arrecifes de Cozumel National Park and the Isla de Cozumel Flora and Fauna Protection Area have high biodiversity and interconnectivity between ecosystems as mangroves, seagrasses, and coral reefs part of the Mesoamerican Barrier Reef.

Since 2021 we have collected 90 Local Ecological Knowledge (LEK) fishers' surveys with a geospatial component. Scuba diving has been a central activity on the island since the 70s. Together with fishers' LEK, we are documenting divers' perceptions of the environment. In collaboration with diving enterprises, we have integrated a database with 45 records documenting shark sightings. Combining the above data using geospatial tools, we have over 15 polygons around the island

where Nurse Shark (*Ginglymostoma cirratum*), Great Hammerhead Shark (*Sphyrna mokarran*), Scalloped Hammerhead Shark (*Sphyrna lewini*), Black Tip Shark (*Carcharhinus limbatus*), Caribbean Reef Shark (*Carcharhinus perezi*), and Tiger shark (*Galeocerdo cuvier*) have been documented. Preliminary underwater observations allowed establishing shark presence and qualitative descriptions of the aquatic habitats. Sharks' literature and historical pictures are being collected. Narratives manifested a decrease in shark presence during the last 15 years. Responses attribute this to excess maritime traffic and mass tourism. Our novel interdisciplinary data proves LEK can provide information on species' existence, behavior, and ecology. Preserving Cozumel's natural capital, including sharks, is critical given that local people depend on healthy ecosystems for their local economy and well-being.

Keywords: islands; sharks; traditional knowledge; fishers; divers

SI Abstract Ref: 281

Abigail Campbell

Northeastern University

Assessing fisheries interactions and population demographics of oceanic whitetip sharks (*Carcharhinus longimanus*) through citizen science and photo identification

1. Melanie Hutchinson; NOAA Cooperative Institute for Marine & Atmospheric Research.
2. Molly Scott; NOAA Cooperative Institute of Marine & Atmospheric Research.
3. Lacey Scheeler; University of Hawai'i. Deron Verbeck; I Am Aquatic.

Oceanic whitetip sharks (*Carcharhinus longimanus*) were listed as threatened under the Endangered Species Act in 2018, and stock assessments indicate that populations in the western and central Pacific are historically and currently overfished. However, large data gaps remain in relation to the basic biology, ecology and population structure of this species. Photographic identification is a common and non-invasive method used to evaluate metrics of elasmobranch population demographics, abundance, residency and movement, and social behaviors. The main Hawaiian Islands are a known 'hotspot' for *C. longimanus* where they typically exhibit seasonal residency; a finding that is also supported by local fisher knowledge. This study describes the results of the Hawaii Community Tagging Program, a citizen science initiative in which fishers, divers and snorkelers submitted images of *C. longimanus* interactions around the main Hawaiian Islands beginning in 2008. Over 2000 images of *C. longimanus* were analyzed, and dorsal fin patterns were used to determine the number of unique and resighted individuals. To date, this study has identified 313 unique individuals with 15 resights; the sex ratio of females to males is approximately 2:1 (169 females and 81 males identified). We identified 45 females (~26%) with scarring or injuries from potential mating interactions and 85 individuals (~34%) carried evidence of previous fishing interactions. The information obtained from this study can help provide baseline information regarding the population demographics, residency and fishery interactions of *C. longimanus* around the main Hawaiian islands to help inform conservation and management measures for this protected species.

Keywords: photo identification; protected species; fishery interactions; Elasmobranch conservation

SI Abstract Ref: 299

Alejandra Mendoza

ecOceanica

Whale shark tourism and conservation through citizen science

1. Alejandra Mendoza; ecOceanica
2. Rossana Maguiño-Napuri; ecOceanica
3. Shaleyla Kelez; ecOceanica
4. Dení Ramirez; Tiburón Ballena Mexico

Whale sharks are globally threatened; in Peru, there is no further regulation for the species than a fishing ban. Since 2014, we have been working in northern Peru with local communities to create awareness and gather data of whale shark encounters. In 2018, we start training stakeholders, such as fishermen and tour operators in how to offer responsible whale shark tourism activities to help them improve their practice and to help us collect data for the project. We implemented workshops to present the Best Practice Guidelines, and to receive feedback. We used an ethogram to collect whale shark behavior related to the boat and swimmers during fieldwork, additionally in every encounter we recorded injuries if found. To date, we have trained 53 boat Captain and crew, in data collection and we have recommended the best practices for observation and swimming with the species. During fieldwork, we found that 85% of the sharks react to the swimmers by changing direction (89%), diving (61%), and/or swimming faster (59%). Moreover, 88% of sharks were encountered with injuries or signs of being injured recently.

The recommendations from the training workshops were collected, and together with our results, a manual for good practices for whale shark tourism was prepared for the Peruvian government which is now in its final stage of review.

Keywords: eastern Pacific; ethogram; behavior; management

SI Abstract Ref: 326

Paula Carlson

IUCN Shark Specialist Group's Aquarium Working Group

Engaging Aquarium Scientists in Global Shark Conservation through the IUCN Shark Specialist Group's Aquarium Working Group

1. Michael Farquhar – Two Oceans Aquarium
2. Paula Carlson – Dallas World Aquarium
3. Lisa Hoopes – Georgia Aquarium
4. Nuria Baylina, Oceanario de Lisboa
5. Max Janse, Royal Burgers' Zoo
6. Shawn Larson, Seattle Aquarium
7. Rui Matsumoto, Okinawa Churaumi Aquarium
8. Laura Simmons, Sea Life Sydney Aquarium
9. Kelly Timmins, Atlantis The Palm

Elasmobranchs (sharks and rays) face a range of conservation challenges contributing to extensive population declines. Consequently, there has been considerable global effort to address these declines and the IUCN's Shark Specialist Group (SSG) has been central to many of these efforts by bringing together experts from around the world. For the first time, an Aquarium Working Group (AWG) has been formed within the SSG to recognize the role which public aquaria play in the conservation of sharks and rays. The AWG has nine members from around the world, and has identified four priority tasks:

1. Develop a position statement for the SSG on the role of aquariums in elasmobranch conservation.
2. Compile life history information from Critically Endangered elasmobranchs in aquariums to inform conservation action, with a focus on sawfishes, rhino rays (wedgefishes and guitarfishes), and south American freshwater stingrays.
3. Develop a SSG position statement on *ex-situ* elasmobranch release, rescue, and re-introduction.
4. Develop SSG messaging and graphics on elasmobranch conservation for aquarium exhibits, outreach, and education programs.

In addition to introducing the AWG, we will present the findings of a global survey focused on the current extent of elasmobranch release, rescue, and re-introduction within the aquarium community.

Keywords: aquarium; coordination; conservation; communication

Thursday 13th October, 2022

Behaviour, Physiology & Discard Survival 1

Maitane Grande
AZTI

Post-release survival of accidentally captured silky shark in tuna purse seiners

1. Iñigo, Onandia; AZTI
2. Maitane, Grande; AZTI
3. José Maria, Galaz; ECHEBASTAR
4. Jon, Uranga; AZTI
5. Nerea, Lezama-Ochoa; AZTI/Current Institution: NOAA
6. Jefferson, Murua; AZTI
7. Jon, Ruiz; AZTI
8. Igor, Arregui; AZTI
9. Hilario, Murua; ISSF
10. Josu, Santiago; AZTI

Tagging programs are key to evaluate post-release mortality of Endangered, Threatened, and Protected species that are caught incidentally in fishing operations. This work presents results of a tagging program conducted on purse seiners under ECHEBASTAR company, aimed at assessing post-release survival of silky sharks caught in association with tuna schools and released according to the Code of Good Practices. During two fishing trips sixty silky sharks were tagged (28 and 32 silky sharks in the first and second trip, respectively) with 37 SPATs and 23 MiniPATs, and blood samples were collected in 124 sharks for lactate concentration measurement to be used as an indicator of shark survival. A vitality index based on state and behavior at release was also assigned to all the sharks caught accidentally. The overall predicted survival of silky shark was close to 40% based on vitality index derived from tagged sharks. The overall survival rate predicted using lactate concentration threshold was more variable among trips going from 35% to 60% in the first and second trip, respectively. Shark survivorship decreased as the fishing operation advanced and vitality index declined. This post-release survival estimates duplicate previous estimations on purse seiners. The experience gained over time in the application of best practices and fauna release devices (i.e. the bycatch conveyor belt) installed on-board contributed to reducing shark mortality in the purse seiner fishery.

Keywords: Silky shark; *C. falciformis*; post-release survival; FADs; purse seiner

SI Abstract Ref: 307

Andrew Chin
James Cook University

Reducing hammerhead bycatch in the Great Barrier Reef: testing alternatives to mesh nets

1. Andrew Chin, James Cook University
2. Sushmita Mukherji, James Cook University
3. Allan Bobbermen, Hinchinbrook Seafoods
4. John Page, JP Consultants

Mesh net fisheries can result in bycatch of species of conservation interest (SOCl) such as dugongs and hammerhead sharks. In the Great Barrier Reef, bycatch mortality of both SOCl and of undersized/unwanted fishes has severely affected the fishery's social license and has exacerbated conflict, especially with recreational fishers. However, trap type gears can help reduce mortality. Tunnel nets are large mobile fish traps that guide the catch into a tunnel where the catch remains free-swimming until brailing and sorting. Bycatch is released in very good condition. Larger species including SOCl such as marine turtles, sharks, and rays are prevented from entering the tunnel by large mesh grids, and remain free swimming in a holding area until release. Increasing regulatory pressure and public scrutiny of net fisheries in the Great Barrier Reef are driving efforts to find solutions to improve sustainability and community support for fisheries while maintaining fisher livelihoods. Here we describe the results of a small-scale feasibility trial using tunnel net gears in the shallow coastal waters of the Great Barrier Reef. Expert tunnel net fishers worked with local net fishers to trial and test the use of tunnel nets. The gear works, fishers can catch fish and SOCl species such as hammerheads and batoids were released unharmed. However, the suitability and feasibility of these gears requires careful consideration and while the gear is technically feasible, its commercial viability remains unknown. The perspectives and attitudes of commercial fishers and other stakeholders engaged during the trials will also be presented.

Keywords: hammerhead; bycatch; fishing gear; protected species; conservation

SI Abstract Ref: 157

Marta D. Palacios

Ecology and fisheries vulnerability of the Munk's devil ray in the Mexican Pacific.

1. Marta D. Palacios, CICIMAR, Instituto Politecnico
2. Abel Trejo Ramírez, Mobula Conservation
3. Donald A. Croll, Ecology and Evolutionary Biology Department, University of California Santa Cruz
4. Felipe Galván Magaña, CICIMAR, Instituto Politecnico
5. Kelly M. Zilliacus, Ecology and Evolutionary Biology Department, University of California Santa Cruz
6. Joshua D. Stewart, The Manta Trust
7. John B. O'Sullivan, Monterey Bay Aquarium,
8. Edgar M. Hoyos Padilla, Pelagios Kakunja A.C.
9. James T. Ketchum, Pelagios Kakunja A.C.
10. Rogelio González Armas, CICIMAR, Instituto Politecnico

Munk's pygmy devil ray (*Mobula munkiana*) are medium size, zooplanktivorous filter feeding elasmobranchs. Native to the Eastern Tropical Pacific and listed as Vulnerable on the IUCN Red List, their aggregative behavior exacerbates its captured as targeted catch and as incidental bycatch in both artisanal and large-scale fisheries. By employing multiple approaches (acoustic telemetry, stable isotopes, traditional tagging, and photometry), we collected data to complete life history gaps such as the identification of critical habitats, migratory routes, and aggregative behavior patterns at the Mexican Pacific. At the same time, we assess their rates of post-release mortality from artisanal gillnet fisheries in Mexico using acoustic tags to understand the population-level effects of survival due to fisheries impacts on this species. To date, results of acoustic tags in *M. munkiana* individuals (n=108), traditional tags (n=95), blood samples for isotopes analysis (n=69) and photometry surveys (n=60) have allow us to describe a nursery area within the Marine Protected Area of Espíritu Santo Archipelago, and a reproductive ground for the species in La Ventana Bay in Baja California Sur. Pupping and mating periods are linked to spring and summer (April to June) seasons. Size and sex segregation is present in this species, including a differentiation in their diet as they grow, switching from euphausiids to mysids as main prey. Migratory patterns repeat across four years connecting at least 2 different Marine Protected Areas in the southern Gulf of California.

Keywords: mobula; nursery area; mating ground; migratory movements; marine protected area

SI Abstract Ref: 103

Taylor Grosse

Curtin University, Department of Primary Industries and Regional Development (Fisheries WA)

An integrated approach for assessing the survival of discarded sandbar sharks, *Carcharhinus plumbeus*, captured in longlines

1. Taylor Grosse; Curtin University, Department of Primary Industries and Regional Development (Fisheries WA)
2. Cynthia Awruch; University of Tasmania, Centro para el Estudio de Ecosistemas Marinos (CESIMAR) - Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET)
3. Euan Harvey; Curtin University
4. Ben Saunders; Curtin University
5. Chris Dowling; Department of Primary Industries and Regional Development (Fisheries WA)
6. Daniela Waltrick; Department of Primary Industries and Regional Development (Fisheries WA)
7. Matias Braccini; Department of Primary Industries and Regional Development (Fisheries WA)

The sandbar shark (*Carcharhinus plumbeus*) has a global distribution and is caught by commercial and recreational fishers. We assessed the post-release survival of sandbar sharks caught in longline surveys conducted in Western Australia (WA) using an integrated approach that combined the use of hook-timers, release condition staging, satellite tagging, and blood physiology (adrenocorticotropic hormone, corticosterone, and lactate). Of the 57 individuals examined, 88% were "alive and strong" with 100% initial survival when released after a maximum of four hours on the hook. Of the 13 satellite-tagged individuals, 100% survived. Sharks dived up to 307 m deep and showed cyclical depth movement patterns with some individuals moving up and down the water column both day and night, while others moved almost exclusively at night, corresponding with the movement patterns of squid, a common prey item of sandbar sharks. The concentration of blood metabolites did not show a linear pattern with time on hook. The 100% survival rate within four hours on the hooks suggests the use of longlines for surveying sandbar shark abundance has no deleterious consequences.

Keywords: stress physiology; sPAT tags; release condition; Chondrichthyes

SI Abstract Ref: 29

Leonardo Manir Feitosa

Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, USA.

Patterns and trends in the fate of sharks caught in global tuna fisheries

1. Leonardo, Manir Feitosa; Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, USA.
2. Sara, Orofino; Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, United States; Marine Science Institute, University of California, Santa Barbara, California, USA; Environmental Markets Lab, University of California, Santa Barbara, California, USA.
3. Echelle, Burns; Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, United States; Marine Science Institute, University of California, Santa Barbara, California, USA; Environmental Markets Lab, University of California, Santa Barbara, California, USA.
4. Nidhi, D'Costa; Department of Biology, Dalhousie University, Halifax, NS B3H 4R2, Canada.
5. Laurene, Schiller; School of Public Policy and Administration, Carleton University, 1125 Colonel by Dr, Ottawa, ON K1S 5B6, Canada.
6. Darcy, Bradley; Bren School of Environmental Science and Management, University of California, Santa Barbara, 93117, United States; Marine Science Institute, University of California, Santa Barbara, California, USA; Environmental Markets Lab, University of California, Santa Barbara, California, USA.

Fisheries bycatch is a significant threat to shark populations worldwide. Thus, understanding bycatch fates – if an animal is retained or discarded, dead or alive – is key information for estimating the bycatch impact on shark populations. Here, we analyze the data on fates of sharks caught in the Convention Area of three tuna Regional Fisheries Management Organizations (RFMO): Western Pacific (WCPFC), Indian (IOTC) and Atlantic (ICCAT) Oceans, to infer bycatch fate patterns between 2012 and 2018. We calculate fate proportions from each RFMO for 68 taxa identified at the genus or species level. We find substantial variation in the reported categories and post-capture fates across RFMOs. No sharks were reported retained in WCPFC, with sharks being either discarded alive (average 66%) or dead (average 33%). While live discards were the most frequent in IOTC, they report 15% retention on average. Live discards show an increasing trend in ICCAT over the same period, peaking at 25% in 2017. Given the different rates of observer coverage for each RFMO, we refrain from comparing bycatch fates across them. Regarding CITES-listed species, we observed 100% live discards of whale sharks in ICCAT and IOTC, while almost 100% retention of mako sharks caught by ICCAT managed vessels. Mako sharks were also the most frequently retained species in IOTC. Overall, our analysis demonstrates that ICCAT represents most shark retention across RFMOs, which primarily comprises mako sharks. We further note that our results are likely influenced by the scarcity of available observer data, especially in IOTC and ICCAT.

Keywords: Fisheries bycatch; Selachii; tRFMOs; Catch retention; Fisheries discards

SI Abstract Ref: 208

Juliana Klein

Molecular Breeding and Biodiversity Research Group, Department of Genetics, Stellenbosch University, Private Bag XI, Stellenbosch 7602, South Africa

Adaptive divergence despite high genetic connectivity in bronze whaler sharks (*Carcharhinus brachyurus*) in Southern Africa

1. Juliana, Klein; Molecular Breeding and Biodiversity Research Group, Department of Genetics, Stellenbosch University, Private Bag XI, Stellenbosch 7602, South Africa
2. Maduna, Simo; Norwegian Institute of Bioeconomy Research (NIBIO), Division of Environment and Natural Resources, PO Box 115, NO-1431, Ås, Norway; Reel Science Coalition. Cape Town, South Africa
3. Matthew, Dicken; KwaZulu-Natal Sharks Board, Private Bag 2, Umhlanga Rocks 4320, South Africa; Department of Development Studies, School of Economics, Development and Tourism, Nelson Mandela University, PO Box 77000, Port Elizabeth 6031, South Africa
4. Charlene, da Silva; Department of Forestry, Fisheries and Environment, Private Bag X2, Rogge Bay 8012, South Africa
5. Soekoe, Michelle; Reel Science Coalition. Cape Town, South Africa
6. Meaghan, McCord; South African Shark Conservancy, Hermanus 7200, South Africa
7. Warren, Potts; Department of Ichthyology and Fisheries Science, PO Box 94, Rhodes University, Grahamstown 6140, South Africa
8. Aletta; Bester-van der Merwe; Molecular Breeding and Biodiversity Research Group, Department of Genetics, Stellenbosch University, Private Bag XI, Stellenbosch 7602, South Africa

The bronze whaler or copper shark (*Carcharhinus brachyurus*) is a large coastal shark with a wide distribution across a highly heterogeneous environment and is one of the most exploited elasmobranchs in South Africa. Here the aim was to assess the distribution of neutral and adaptive genomic diversity in this vulnerable species in the South-East Atlantic and South-West Indian Ocean region using putatively neutral and candidate single nucleotide polymorphisms (SNPs). Samples were collected across a representative distribution range from the east coast of South Africa to Angola and prepared for massively parallel sequencing on an Illumina platform using a restriction site-associated DNA (3RAD) library preparation protocol. Generated sequencing reads were processed with an optimized bioinformatic pipeline and resulted in thousands of SNPs genotyped in 64 samples. The analyses of putatively neutral SNPs revealed moderate and evenly distributed levels of genomic diversity across sampling sites. Multivariate and clustering analyses demonstrated a high degree of gene flow with no significant population structuring among or within ocean basins. Genotype-environment analysis performed using redundancy analysis identified SNPs significantly associated with mean sea surface temperature, pH and oxygen. These candidate SNPs indicated the presence of at least two clusters and deep divergence between individuals from South Africa, Namibia and Angola. These results provide evidence for local adaptation to specific environmental conditions in a highly mobile shark despite high levels of gene flow. This is expected to inform management strategies and policy at the national and regional level for conservation of *C. brachyurus* populations.

Keywords: Southern Africa; single nucleotide polymorphisms; genetic connectivity; genotype-environment association; adaptive divergence

SI Abstract Ref: 255

Fola-Matthews, Omolara Opeyemi

University of Lagos, Nigeria.

Identification of shark species off the nigerian coast using dna barcoding

1. Omolara, Fola-Matthews; University of Lagos, Nigeria
2. Olufemi, Soyinka; University of Lagos, Nigeria
3. Daphne, Bitalo; National Coffee Research Institute, Mukono Uganda.

Nigeria is one of the shark fishing nations in Africa, but its catch data on elasmobranchs are still recorded in aggregates 'sharks' and 'rays' with no further species-specific details. The major reason for this is most of the shark specimens look identical in morphology and field identification of some closely related species is difficult. Also, fisheries managers and scientists find it tricky to identify poorly preserved and deteriorating specimens or those lacking the key diagnostic features for identification. This study used DNA barcoding as a method to identify shark species from four different landing areas off the Nigerian Coast and two major fish markets in Lagos, Nigeria. 128 dorsal fins were sampled. 27 of these did not provide successful sequence results, while 101 (77.7%) provided a Chondrichthyan sequence that was matched to reference specimens in a DNA barcode database. Three species of sharks were identified, with all three of CITES importance, (17.8% Critically Endangered, 61.4% Endangered, 20.8% Vulnerable). Fisheries managers can use this information to assist in identification and make informed decisions on conservation and management issues.

Keywords: DNA barcoding; sharks; Nigeria; CITES; BOLD

SI Abstract Ref: 213

Franck Pichot
MARBEC

Development of a 12S marker gene database for the environmental DNA metabarcoding of marine megafauna

PICHOT Franck

All living organisms leave traces of DNA in their environments. This DNA can be released through urine, gametes, blood, mucus, skin loss etc. This DNA can be collected in the water column through filtration, and is then called environmental DNA or eDNA. The metabarcoding of this eDNA is a new technique which can then be used to accurately estimate marine biodiversity with more accurate value, including rare, cryptic, elusive or invasive species.

The aim of this project is to obtain genetic sequences from sharks, skates, rays and marine mammals at a global scale with a view to assign species to their 12S mitochondrion barcodes from eDNA samples. The barcode database is the cornerstone of any eDNA study in conservation. Thus, we're looking for collaborations with aquariums and museums worldwide to collect tissues (fin clip (1.5 x 0.5 cm) on the caudal fin or blood (200µL) store in pure alcohol or frozen for missing species. With this sample (at least two individuals from each species) we will be able to extract the DNA and then complete the 12S marker gene database for these species. The advantage with this technique in addition to revealing the dark diversity is to be non-invasive for the species. Ultimately it will improve the knowledge (biogeography, presence in marine reserves, depth) such a collaboration would make it possible to take advantage of the competences of each one for a common objective: the conservation of threatened species.

Keywords: eDNA; Elasmobranchs; monitoring; assessment; biodiversity

SI Abstract Ref: 196

Arnaud Gaigher

CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Vairão, University of Porto, Portugal;
Research Unit for Evolutionary Immunogenomics, Department of Biology, University of Hamburg, Germany.

Geographic distribution of MHC genetic diversity in the small-spotted catshark (*Scyliorhinus canicula*)

1. Arnaud, Gaigher; CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Vairão, University of Porto, Portugal.
2. Alessia, Rota; CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Vairão, University of Porto, Portugal.
3. Fabiana, Neves; CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Vairão, University of Porto, Portugal.
4. Pedro, Cardoso; CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Vairão, University of Porto, Portugal.
5. Andrew, Griffiths; School of Biosciences, University of Exeter, UK.
6. Samantha, Hook; University of Manchester, UK.
7. Sandra, Rebocho; University of Lisbon, Portugal.
8. Antonio, Muñoz-Mérida; CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Vairão, University of Porto, Portugal.
9. Tereza, Almeida; CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Vairão, University of Porto, Portugal.
10. Teresa, Moura; Division of Modelling and Management of Fishery Resources (DivRP), Portuguese Institute for the Ocean and Atmosphere (IPMA), Algés, Portugal.
11. Bárbara, Serra Pereira; Division of Modelling and Management of Fishery Resources (DivRP), Portuguese Institute for the Ocean and Atmosphere (IPMA), Algés, Portugal.
12. Ana, Veríssimo; CIBIO-InBIO, Research Centre in Biodiversity and Genetic Resources, Vairão, University of Porto, Portugal.

Due to their exceptional levels of functional genetic diversity, genes of the major histocompatibility complex (MHC) represent ideal candidates to reveal genetic differentiation among geographical regions and ultimately improving genetic stock identification of commercially exploited shark species. In addition, from an evolutionary perspective, because of the major role of MHC in pathogen resistance, MHC diversity can be expected to be locally adapted to pathogens, resulting in a more pronounced genetic structure in these genes compared to neutral expectations. Alternatively, balancing selection at the geographic scale can lead to a weaker genetic structure compared to the neutral population structure if, for instance, prevailing pathogens are the same over the whole study area. To distinguish between these scenarios, we sequenced MHC-II β genes using high-throughput sequencing technology in an extensive number of small-spotted catsharks (*Scyliorhinus canicula*) sampled across the entire European geographic distribution (N=600). All samples were also genotyped with 11 neutral microsatellite markers as a baseline to contrast with MHC diversity and genetic structure. Our preliminary results suggest that this species has three different MHC-II β genes, with the typical characteristics of functional MHC-II β genes: high number of alleles and high sequence divergence between alleles. We also show that MHC diversity in catsharks vary across regions, probably involving both demographic and selective forces. This study provides interesting perspectives for the understanding of

evolutionary mechanisms involved in MHC diversity but also shows that the MHC system provides prime markers to stock delimitation, which is essential knowledge for sustainable long-term management of vulnerable marine species.

Keywords: small-spotted catshark; differentiation genetic; major histocompatibility complex; conservation

SI Abstract Ref: 187

Alejandro Jesús Molera Arribas
IMEDMAR-UCV

The xenobiotic biomonitor potential of the small spotted catshark (*Scyliorhinus canicula*): a year long evaluation on heavy metal and microplastic accumulation.

1. Alejandro Jesús Molera Arribas : IMEDMAR-UCV,
2. Samuel Acevedo Quilis: IMEDMAR-UCV,
3. José Gamez Perez: UJI (Universitat Jaume I),
4. Ana Maria Hernandez Martinez: IMEDMAR-UCV,
5. José Tena Medialdea: IMEDMAR-UCV

The small-spotted catshark *Scyliorhinus canicula*, is a demersal Scyliorhinid shark species commonly found in Mediterranean and Northeastern Atlantic waters. The philopatric and sedentary nature of female *S. canicula*, along with its high abundance among bottom trawl bycatch; stock exploitation resilience and widespread distribution could support the xenobiotic biomonitoring potential of this species. A year long study was performed from November 2019 to November 2020 within which 300 mature female specimens were gathered. Intramuscular Cu, Pb and Cd concentrations were determined via graphite furnace atomic absorption spectroscopy (GFAAS), while the digestive tract of each captured individual was pre-treated via alkaline extraction and vacuum filtration for its subsequent visual characterisation and polymer species Identification via RAMAN spectroscopy. Stable mean concentrations of Pb, Cd and Cu were observed in muscle tissues throughout the year with significant differences occurring only between non consecutive months. Spatial analysis shows the existence of well-defined heavy metal concentration hotspots occurring in certain points of the study site within which certain individuals surpassed the 0.05 and 0.3 $\mu\text{g}\cdot\text{g}^{-1}$ (ww) maximum threshold for safe human consumption established by the European commission Regulation (EC) No 1881/2006). Macroplastics, mesoplastic and microplastics were identified within *Scyliorhinus canicula* gastric tracts with plastic counts ranging between 3 to 32 units. Different plastic polymers were identified, with a higher presence of Polyethylene terephthalate (PET), Polyamide (PA) and polypropylene (PP).

Keywords: biomonitor; *Scyliorhinus canicula*; heavy metal; fisheries; microplastics

SI Abstract Ref: 363

Robert Bullock

Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC), Rue Philippe Plantamour 20, 1201, Geneva, Switzerland

Too hot to handle: Investigating the impacts of large-scale ocean warming events on the apparent survival and body condition of juvenile shark populations

1. Robert Bullock; Save Our Seas Foundation D'Arros Research Centre (SOSF-DRC), Rue Philippe Plantamour 20, 1201, Geneva, Switzerland.
2. Ornella Weideli; (a) Dr Risch Medical Laboratory, 9490 Vaduz, Liechtenstein, (b) PSL Research University, Université de Perpignan, 66860, Perpignan, France.

Global climate change has fundamental impacts on the structure and function of marine environments. Examining the associated effects on threatened species using these environments is a major challenge for scientists and conservationists. This study investigated the effects of the 2016 extreme temperature event on the apparent survival and body condition of juvenile populations of two threatened carcharhinid shark species using a nursery habitat at St Joseph atoll, Seychelles. 228 blacktip reef sharks *Carcharhinus melanopterus* and 189 sicklefin lemon sharks *Negaprion acutidens* were caught during mark-recapture experiments over four years from 2014-2017. Mark-recapture modelling was used to estimate apparent survival (ϕ) and probability of recapture (p) for both species. Best-fit models indicated distinct differences around the 2016 thermal event with a 12% reduction in apparent survival of *C. melanopterus* (ϕ - 2014 + 15 = 0.65, ϕ - 2016+2017 = 0.53) and a 14% reduction in *N. acutidens* (ϕ - 2014, 15, 17 = 0.82, ϕ - 2016 = 0.68). Fulton's condition factor was used estimate changes in body condition over the study period and evidenced significant decreases in body condition around the thermal event for both species. Findings from this study indicate a significant effect of large-scale ocean warming events on the fitness and survival of juvenile shark populations. How to tackle this ubiquitous threat will be a key question for shark science moving forward.

Keywords: mark-recapture; ocean warming; elasmobranch; survival; nursery site

SI Abstract Ref: 309

Jessica Savage

Royal Holloway University of London; Institute of Zoology; Zoological Society of London

Assessing the global geographical overlap between filter-feeding megafaunal elasmobranchs and plastic pollution

1. Jessica, Savage; Royal Holloway University of London.
2. Tom B., Letessier; Institute of Zoology.
3. David, Morritt; Royal Holloway University of London.
4. Marcus, Rowcliffe; Institute of Zoology.
5. Heather, Koldewey; Zoological Society of London.

Plastic is ubiquitous in the environment and is known to have negative impacts on marine ecosystems. Marine organisms can entangle in discarded fishing gear, ingest plastic debris, and accumulate leached toxic chemicals in their tissues. Filter-feeding megafaunal elasmobranchs, including the reef manta ray (*Mobula alfredi*), giant manta ray (*Mobula birostris*), whale shark (*Rhincodon typus*) and basking shark (*Cetorhinus maximus*) are exposed to the risk of plastic pollution, due to their low trophic level and their habitat overlap with known areas of plastic accumulation. They are also important flagship species for conservation with an additional value for ecotourism.

This piece of work explores the global geographical overlap between these species and plastic distribution to identify the populations at risk. We use publicly available databases of species occurrences to build a maximum entropy distribution model for the four species. We then overlay those with plastic debris data, including macroplastics such as discarded fishing gear, and microplastics distributions from existing plastic dispersal model outputs. This allows us to calculate the exposure of the four species to the risks of plastic ingestion and entanglement in discarded fishing gear.

This overlap analysis will allow us to build testable predictions of ingestion and entanglement risk based on overlap between debris and filter-feeder distributions, and in the future assess these predictions by evaluating existing evidence of exposure at different locations. We also hope the results of this study will focus mitigation policies and actions to the relevant priority locations.

Keywords: plastic pollution; filter-feeder; Elasmobranch; Maxent model; risk assessment

SI Abstract Ref: 172

Clemency White

University of Exeter

Fish and ships: Soundscaping urban shark nurseries

1. Clemency, White; University of Exeter
2. Catherine, Hobbs; University of Exeter
3. Andrew, Radford; University of Bristol
4. Matthew, Witt; University of Exeter
5. Steve, Simpson; University of Bristol

Sound in the marine environment is used across taxa to inform behaviour, however human activities now often pollute natural cues, masking or modifying important information. Anthropogenic disruption of marine sensory landscapes is known to negatively affect the distribution, behaviour and physiology of marine mammals, teleost fish and various invertebrate phyla. While relatively little is known about the mechanisms and capabilities of hearing in sharks, multiple studies have shown that they detect and respond (physiologically and behaviourally) to low frequency sounds (<1500 Hz). During juvenile development, sharks often display site fidelity to coastal habitats, such as mangroves, coral reefs and seagrass beds, where human disturbance can often be concentrated. One extreme example of this is in the Biscayne Bay, Miami, USA, where there is a high density and diversity of sharks along a heavily developed coastline with high levels of boating activity. Understanding which sounds sharks detect, respond to and are influenced by in situ has received little attention. To address this knowledge gap, we present the characterisation of the Biscayne Bay soundscape from an elasmobranch perspective (i.e. mapping spatial and temporal patterns of acoustic conditions at low frequencies, including in the particle motion domain). Specific attention is paid to describing the biological and anthropogenic contributions to the soundscape that fall within known hearing sensitivities. Our results are discussed in the context of potential ecological roles of sound in shark ecology and the impacts of anthropogenic noise on sharks. We will use this opportunity to open conversations on how deepening our understanding of elasmobranch sensory systems and multi-sensory integration may be applied to conservation initiatives.

Keywords: bioacoustics; shark nurseries; soundscape; pollution; sensory ecology

SI Abstract Ref: 166

Chiara Romano

University of Calabria; University of Messina; ARPAT Livorno1

Plastic ingestion in two syntopic species of deep-sea sharks from central Mediterranean

1. Chiara, Romano; University of Calabria
2. Giorgia, Zicarelli; University of Messina
3. Carmen, Valentino; University of Calabria
4. Samira, Gallo; University of Calabria
5. Sharon, Chiriaco; University of Calabria
6. Gianni, Giglio; University of Calabria
7. Francesco Luigi, Leonetti; University of Calabria
8. Cecilia, Mancusi; ARPAT Livorno
9. Emilio, Sperone; University of Calabria

Plastics are synthetic materials made by long-life polymers, that persist for hundreds of years in the environment. This is the real plastic pollution problem. Every year enormous amounts of plastic debris are poured in the marine environment. In this work we investigated the presence of plastic remains in the stomach contents of three populations of *Scyliorhinus canicula* and *Galeus melastomus*, two of the most common deep demersal shark species in Mediterranean, along the Tyrrhenian coast of Italy. Both shark species have an opportunistic benthic scavenger behaviour. We obtained animals thanks to MEDITS survey and stomach contents were analysed in laboratory under a microscope. We discriminated plastic by shape (fibres, scrapes, sphere, and film) and colour (orange, black, white, blue, yellow, red, grey and green). The most common plastic remains founded in stomach were

- scrapes in both sharks' populations in Lazio
- film for lesser spotted dogfish and fibres for blackmouth catshark in Tuscany
- fibers for *Scyliorhinus canicula* and films for *Galeus melastomus* in Liguria.

About colour discrimination, *Scyliorhinus canicula* ingested more grey and yellow plastics in the three populations than *Galeus melastomus*, which ingested, on the contrary, more black and white fragments. Ingestion seemed to be accidental for shapes, but for colours maybe the feeding behaviour of the two species could affect the choice.

Keywords: plastic; deep-sea sharks; mediterranean

SI Abstract Ref: 140

Charlotte Birkmanis

The University of Western Australia

Shark occurrence around Australia: now and into the future

1. Charlotte Birkmanis, The University of Western Australia.
2. Jennifer Freer, British Antarctic Survey.
3. Julian Partridge, The University of Western Australia.
4. Leigh Simmons, The University of Western Australia
5. Michelle Heupel, Australian Institute of Marine Science and James Cook University.
6. Ana Sequeira, The University of Western Australia.

Many of the world's shark populations are in decline indicating the need for improved conservation and management. A better understanding of their distribution and habitat requirements is vital for habitat protection and effective fisheries management, essential to maintain viable populations. Alongside this, oceans are warming worldwide and how such temperature variation will influence sharks requires investigation. We used statistical modelling tools to assess occurrence, habitat suitability and potential climate change effects for pelagic sharks from the Carcharhinidae and Lamnidae families in Australian waters and the adjacent high seas using shark occurrence records compiled from offshore commercial fisheries. We collated environmental and spatial predictors known to affect shark occurrence and developed generalised linear models to determine the extent of suitable habitat for pelagic sharks within the Australian continental Exclusive Economic Zone (EEZ). As well managed and appropriately located marine protected areas (MPAs) may enhance shark conservation, we quantified the amount of suitable habitat contained within existing MPAs. Our results indicate sea surface temperature (SST) to be a significant predictor of pelagic shark distribution, and even though highly suitable habitat was limited in MPA zones closed to fishing, Australia has strict fisheries legislation protecting pelagic sharks. With SST an important determinant of pelagic shark habitat suitability, we then examined the impact of increasing ocean temperatures in the future using an ensemble of climate models under two emission scenarios. Our predictions highlight how future SSTs are likely to shift the location of suitable pelagic shark habitat for both shark families within the Australian EEZ.

Keywords: conservation; marine protected areas; statistical modelling; fisheries; climate change

SI Abstract Ref 47

Olga Novillo-Sanjuan

Associació LAMNA - Universitat de València

Assessment of metal pollution in batoids near a western Mediterranean coastal lagoon

1. Olga Novillo-Sanjuan; Associació LAMNA - Universitat de València

2. Jaime Penadés Suay; Associació LAMNA - Universitat de València

Concerning pollution, non-essential metals have been historically present in the Mediterranean, sometimes reaching levels that could be harmful for marine biota. Despite the fact that batoids are a significant part of Mediterranean food webs, little is known about the threats that this metal pollution may represent to this group. In this study, we analyzed mercury (Hg), lead (Pb) and cadmium (Cd), in livers and muscle from 90 batoids of three different species: *Dasyatis pastinaca* (N=30), *Myliobatis aquila* (N=30) and, *Torpedo torpedo* (N=30). Our aim was to quantify these metals in a historically polluted area, the coast next to l'Albufera (East Spain), a coastal lagoon that discharges water into the sea. Besides, we studied whether metal concentration could be correlated with the different position in the food web of these species and with their size. In general, mercury was the most abundant metal, closely followed by lead and, lastly, cadmium was found in very low concentrations (mean±SD w.w. in muscle: 31.4±11.2 µg/g of Hg; 16.51±4.8 µg/g of Pb and 0.33±0.2 µg/g of Cd; in liver: 31.4±11.2 µg/g of Hg; 16.51±4.8 µg/g of Pb and 0.33±0.2 µg/g of Cd). Regarding biometric parameters, *D. pastinaca* and *T. torpedo* showed the highest metal concentration; in accordance to their higher position in the foodweb, in comparison with *M. aquila*. Results indicate that these batoids do not seem to be threatened by metals in the area, possibly reflecting either a low metallic pollution of their surroundings or their low mobilization from the sediments.

Keywords: batoids; metal pollution; food web; bioaccumulation

SI Abstract Ref: 274

Romarc Jac

Havforskningsinstituttet (Institute of Marine Research)

Moving North, season 1 - Are deep-sea sharks affected by warming water?

Continental shelf and deep ocean waters are subjected to anthropogenic pressures such as fishing and climate change-related environmental stressors. Sharks in temperate waters are predicted to move poleward in response to climate change. However, their distribution through space and time remains poorly understood, limiting the potential to understand how they are responding to environmental stressors. Knowledge of the abundance and its environmental drivers of this threatened marine group is needed to inform sustainable management. Generalized additive models and mapping were performed on a 26-year scientific survey time-series in the Norwegian Sea and environmental data to model the impact of climate change on the distribution and abundance of two shark species living in deep and cold waters: *Etmopterus spinax*, and *Galeus melastomus*, at the northern fringe of their ranges, together with the distribution of their potential prey species. Both shark species significantly shifted their abundance northwards, and local abundances have declined to various degrees over the last seven years. The warming of northern waters across the last three decades seems the main driver of a northward shift in the local abundance of these two shark species and their prey. This indicates that climate change is likely a major driver of large-scale abundance patterns for sharks, even among deep-sea species. In a global warming context, survey data, long-term series and international cooperation are required to record extended shifts and better conserve transboundary species.

Keywords: Climate change, Community shift, Barents and Norwegian Sea ecoregions, Species distribution modelling, Transboundary conservation

Floriaan Devloo-Delva*Australian National Fish Collection, NCMI, CSIRO***From rivers to ocean basins: Global population structure of the Bull Shark**

1. Floriaan, Devloo-Delva; Australian National Fish Collection, CSIRO; School of Natural Sciences, University of Tasmania.
2. Christopher, Burridge; School of Natural Sciences, University of Tasmania.
3. Peter, Kyne; Research Institute for the Environment and Livelihoods, Charles Darwin University.
4. Juerg, Brunnschweiler; Independent Researcher.
5. Demian, Chapman; Department of Biological Sciences, Florida International University.
6. Patricia, Charvet; Universidade Federal do Paraná - UFPR - Programa de Pós-Graduação em Engenharia Ambiental.
7. Xiao, Chen; College of Veterinary Medicine, South China Agricultural University.
8. Jeremy, Cliff; KwaZulu-Natal Sharks Board; School of Life Sciences, University of KwaZulu-Natal.
9. Ryan, Daly; Oceanographic Research Institute, South African Association for Marine Biological Research; South African Institute for Aquatic Biodiversity.
10. J. Marcus, Drymon; Coastal Research and Extension Center, Mississippi State University; Mississippi-Alabama Sea Grant Consortium.
11. Mario, Espinoza; Centro de Investigación en Ciencias del Mar y Limnología & Escuela de Biología, Universidad de Costa Rica.
12. Daniel, Fernando; Blue Resources Trust.
13. Laura, Garcia Barcia; Department of Biological Sciences, Florida International University.
14. Kerstin, Glaus; Faculty of Science, Technology and Environment, School of Marine Studies, The University of the South Pacific.
15. Blanca Idalia, González-Garza; Centro de Investigación y Estudios Avanzados del Instituto Politécnico Nacional.
16. Michael, Grant; College of Science and Engineering, Centre for Sustainable Tropical Fisheries and Aquaculture, James Cook University.
17. Rasanthi M., Gunasekera; Oceans and Atmosphere, CSIRO.
18. Sebastian, Hernandez; Biomolecular Laboratory, Center for International Programs, Universidad VERITAS.
19. Susumu, Hyodo; Laboratory of Physiology, Atmosphere and Ocean Research Institute, University of Tokyo.
20. Rima, Jabado; Elasmobranch Project.
21. Sébastien, Jaquemot; Laboratoire ENTROPIE, UMR 9220 CNRS/IRD/Université de La Réunion.
22. Grant, Johnson; Department of Primary Industries and Fisheries, Aquatic Resource Research Unit.
23. James, Ketchum; MigraMar; Pelagios-Kakunja.
24. Hélène, Magalon; Laboratoire ENTROPIE, UMR 9220 CNRS/IRD/Université de La Réunion.
25. James, Marthick; Menzies Institute for Medical Research, University of Tasmania.
26. Frederik, Mollen; Elasmobranch Research.
27. Stefano, Mona; Institut de Systématique, Evolution, Biodiversité, ISYEB, Muséum National d'Histoire Naturelle; CNRS, Sorbonne Université; EPHE, Université des Antilles; EPHE, PSL Research University.
28. Gavin, Naylor; Florida Museum of Natural History; University of Florida.
29. John, Nevill; Environment Seychelles.
30. Nicole, Phillips; School of Biological, Environmental, and Earth Sciences, The University of Southern Mississippi.
31. Richard, Pillans; Oceans and Atmosphere, CSIRO.
32. Bautiste, Postaire; Laboratoire ENTROPIE, Université de La Réunion.
33. Amy, Smoothey; NSW Department of Primary Industries, Fisheries Research, Sydney Institute of Marine Science.
34. Katsunori, Tachihara; Laboratory of Fisheries Biology and Coral Reef Studies, Faculty of Science, University of Ryukyus.
35. Bree, Tillet; Translational Research Institute, University of Queensland, Diamantina Institute.
36. Jorge, Valerio; Centro de Investigación en Ciencias del Mar y Limnología & Escuela de Biología, Universidad de Costa Rica.
37. Pierre, Feutry; Oceans and Atmosphere, CSIRO.

The Bull Shark, *Carcharhinus leucas*, faces varying levels of exploitation in fisheries and shark control programs around the world. Baseline information regarding the species' life-history, reproductive behaviour and global or regional connectivity is crucial to evaluate fishery impacts and its conservation status. In this study, we obtained samples from nearly 1,000 sharks from 19 different sampling locations for the first global-scale assessment of population structure in this cosmopolitan species. Using a recently developed DNA capture approach (DArTcap), all samples were genotyped for 3,400 nuclear markers. In addition, the full mitochondrial genomes of 384 Indo-Pacific samples were also sequenced. Reproductive isolation was inferred at an ocean basin scale (eastern Pacific, western Atlantic, eastern Atlantic, Indo-West Pacific) with signals of separate island populations (Japan and Fiji). Bull Sharks appear to maintain reproductive connectivity using shallow coastal waters as dispersal corridors, whereas large oceanic distances and historical land bridges act as barriers. The removal of Bull Sharks from insular populations, such as Japan and Fiji, may precipitate local decline that cannot readily be replenished by immigration, which can in turn affect ecosystem dynamics. We note that females tend to return to the same area for reproduction, which makes them more vulnerable to local threats and an important focus for management actions. Finally, we provide new genetic markers that can assign provenance and sex from DNA samples which will prove valuable for future monitoring of the international fin and meat trade.

Keywords: genetic connectivity; close-kin; fisheries forensics

SI Abstract Ref: 109

Emily Humble

University of Edinburgh & The Manta Trust

Uncovering the mysteries of manta rays using genomics

1. Emily Humble; The University of Edinburgh & The Manta Trust
2. Jane Hosegood; The Manta Trust & Bangor University ^{1,2}; 2. Guy Stevens; The Manta Trust.
3. Mark de Bruyn; Bangor University & The University of Sydney
4. Simon Creer; Bangor University
5. Gary Carvalho; Bangor University
6. Amelia Armstrong; University of Queensland
7. Ramon Bonfil; Océanos Vivientes A. C.
8. Mark Deakos; Hawaii Association for Marine Education and Research (HAMER)
9. Daniel Fernando; Blue Resources Trust
10. Niv Froman; The Manta Trust
11. Lauren Peel; Save Our Seas Foundation, D'Arros Research Centre
12. Stephen Pollett; The Manta Trust
13. Joshua Rambahiniarison; Large Marine Vertebrates Research Institute Philippines
14. Alessandro Ponzo; Large Marine Vertebrates Research Institute Philippines
15. Helen Senn; RZSS WildGenes
16. Joshua Stewart; Oregon State University & The Manta Trust
17. Sabine Wintner; KwaZulu-Natal Sharks Board & University of KwaZulu-Natal
18. Rob Ogden; The University of Edinburgh

Oceanic (*Mobula birostris*) and reef manta rays (*Mobula alfredi*) are among the most iconic species in our oceans yet significant knowledge gaps remain about fundamental aspects of their biology. For example, it remains a mystery both how their widespread distributions have arisen and the extent to which populations are connected within them. This information is crucial not only for establishing appropriate spatial scales for management, but for assessing population viability into the future. We address this using high-resolution genomic data for over 200 manta ray samples (*M. birostris*: n = 120, *M. alfredi*: n = 126) collected from across their entire distribution. We show that despite their recent divergence, oceanic and reef mantas display striking differences in population structure at a global scale, which is associated with significantly different levels of genetic diversity both between and within species. These findings indicate fundamental differences in colonisation strategy and migratory behaviour and highlight potentially vulnerable populations in need of heightened protection. We will examine these results in light of what is currently known about manta rays and discuss our findings in the context of global conservation management.

Keywords: manta rays; genetics; conservation; connectivity; management

SI Abstract Ref: 95

Kim Eustache

École Pratique des Hautes Études / CRIOBE UMR3278 / University of Amsterdam

Genealogy reconstruction for a blacktip reef shark population to reveal life history traits and reproductive patterns

1. Kim, Eustache; École Pratique des Hautes Études / CRIOBE UMR3278 / University of Amsterdam
2. Serge, Planes; CNRS/École Pratique des Hautes Études / CRIOBE UMR3278

Blacktip reef sharks (*Carcharhinus melanopterus*) are a widespread Indo-Pacific reef shark species listed as vulnerable on the IUCN Red List for endangered species because of poaching, habitat loss and anthropogenic perturbations. Around the Island of Moorea (French Polynesia), the Center for Island Research and Environmental Observatory (CRIOBE) sampled 1700 adult and juvenile blacktip reef shark fin clips over a 13-year timespan. In Moorea, blacktip reef sharks give birth in shallow coastal lagoon areas, enabling neonate and juvenile sharks to withstand predation and to find sufficient foraging resources. For this PhD project, parentage analysis was conducted on the 1700 fin clip samples using genetic analyses (microsatellite DNA markers) to reconstruct the pedigree of the population. The resulting genealogy aims at defining life history traits such as the number of juveniles per litter, mother offspring resource allocation at birth (by using body condition and blood metabolite data), longevity and juvenile survival rates. The pedigree will also enable to evaluate the recruitment success of adult individuals (when offspring of an adult individual reaches adulthood), natal philopatry (females returning to their birthplace to parturition) in adult female individuals and the presence of dominant individuals (individuals which, on average, have higher reproduction rates) within the population. The results will provide a better understanding of the functioning of blacktip reef shark populations making it possible to provide information to local decision makers on the best strategies that can be developed to improve reef shark conservation.

Keywords: reef sharks; genetic analysis; genealogy; pedigree analysis; conservation

SI Abstract Ref: 79

Emma Williams

Celtic Deep, Marine Conservation & Research Foundation, Newcastle University

Non-capture methods reveal blue shark population genetics in the UK

1. Emma Williams,
2. Gonzalo Araujo,
3. James Kitson,
4. Evelyn Jensen,
5. Richard Rees

Despite blue sharks (*Prionace glauca*) being the most prevalent and most fished of any shark species, our understanding of their population genetic structure is limited. Large-scale genetic sampling is an important tool for the conservation and management of vulnerable and elusive species and can provide greater insight into estimates of population structure, abundance, and even behavioural ecology. While traditional genetics studies have relied more heavily on invasive techniques and expertise, novel non-invasive genetic sampling can offer an effective substitute. Furthermore, less invasive techniques have the potential to increase genetic studies' applications whilst reducing costs. This study determined the efficacy and application of using a novel non-invasive technique to collect genetic material from free-swimming blue sharks for population genetic studies. The study took place in the Celtic Sea, UK, where we collected 39 epidermal swabs from a total of 11 free-swimming blue sharks using a toothbrush and freediving approach. Regions of the mitochondrial CO1 and control region, and nuclear ribosomal ITS2 regions, were successfully amplified from the samples. Results across all three markers support the existence of low genetic variation between regions, however, genetic structuring remains a possibility that requires further investigation. Results from the mitochondrial control region showed the correct identification of individuals across multiple samples, demonstrating this method's application for long-term mark-recapture studies. We recommend future studies investigate contamination mitigation, improvement of amplification techniques, and determine the application of samples for other population genomics analyses, such as high throughput sequencing.

Keywords: non-invasive; *Prionace glauca*; genetics; novel; DNA

SI Abstract Ref: 68

Timo Michael Staeudle

Wageningen University & Research

Genetic diversity and population structure of *Raja clavata* in the North-East Atlantic

1. Timo, Staeudle; Wageningen University & Research.
2. Jurgen Batsleer; Wageningen Marine Research.
3. Jim Ellis; CEFAS.
4. Eleanore Greenway; Wageningen University & Research.
5. Pascal, Lorence; Ifremer.
6. Hendrik-Jan, Megens; Wageningen University & Research.
7. Klaas Sys; ILVO.
8. Verena, Trenkel; Ifremer.
9. Jan Jaap, Poos; Wageningen University & Research.

Thornback Ray (*Raja clavata*) is a relatively abundant commercial skate species occurring in coastal waters of the North-East Atlantic and Mediterranean, listed by the IUCN as Near Threatened. It is the dominant skate species caught in commercial fisheries in northern European seas. Historically, regional population declines have been observed, although increased landings indicate increases in population size in several areas over recent decades.

This study describes the genetic diversity and population structure of *Raja clavata* hierarchically among ecoregions, spanning the Greater North Sea (GNS), Celtic Sea (CS), and Bay of Biscay and Iberian coast (BB), as well as within ecoregions by ICES Divisions. Over 8000 samples were collected (2004 – 2022) and genotyped. Subsequent quality control resulted in a SNP dataset of >4000 SNPs for analyses.

Estimates of genetic diversity are provided among and within ecoregions. Small yet significant genetic differentiation was evident globally ($F_{st,global} = 0.0042$) and among all ecoregions via pairwise F_{st} ($F_{st,GNS-CS} = 0.003$, $F_{st,CS-BB} = 0.007$, $F_{st,GNS-BB} = 0.009$; p -values < 0.01). Only ICES Divisions 4b and 4c in the GNS ($F_{st,4b-4c} = 0.00004$, $p = 0.144$) showed no significant genetic differentiation within ecoregions. AMOVA, discriminant component analysis, and admixture modelling provide further evidence and describe the population structure on both hierarchical population levels investigated.

This is the largest known genetic study of *Raja clavata*, to our knowledge. This research helps to inform stock identification and thus assessment, conservation and fisheries management, by accounting for genetic population structure at different spatial scales in the North-East Atlantic.

Keywords: population structure; genetics; SNP; elasmobranch; North-East Atlantic

SI Abstract Ref: 62

Francesca Romana Reinero

Sharks Studies Center-Scientific Institute, 58024 Massa Marittima, Italy; Department of Biology, Ecology and Earth Sciences, University of Calabria, 87036 Rende, Italy; Department of Political Science and CEFOP-LUISS, LUISS Guido Carli University, 00197 R

Influence of environmental factors on prey discrimination of bait-attracted white sharks from Gansbaai, South Africa

1. Francesca Romana, Reinero; Sharks Studies Center-Scientific Institute, 58024 Massa Marittima, Italy
2. Emilio, Sperone; Department of Biology, Ecology and Earth Sciences, University of Calabria, 87036 Rende, Italy
3. Gianni, Giglio; Department of Biology, Ecology and Earth Sciences, University of Calabria, 87036 Rende, Italy
4. Antonio, Pacifico; Department of Political Science and CEFOP-LUISS, LUISS Guido Carli University, 00197 Rome, Italy
5. Primo, Micarelli; Sharks Studies Center-Scientific Institute, 58024 Massa Marittima, Italy

Influence of environmental factors on prey discrimination of bait-attracted white sharks were studied over a six-year period (2008-2013) at Dyer Island Nature Reserve (Gansbaai, South Africa). This work deepens previous published study on surface predatory behaviour of bait-attracted white sharks conducted in the same area where, from 240 predator-prey interactions observed in the same period, both immature and mature white sharks were attracted from the seal shaped decoy rather than the tuna bait, except for the years 2008 and 2011. Tide ranges, underwater visibility, water temperature, and sea conditions are, in decreasing order, the factors that drive white sharks to the prey choice. High tide reduces the minimum depth from which sharks could approach seals close to the shore, while a good visibility helps the sharks to use their vision ability to implement predatory choices to energetical richer prey, the odorless seal shaped decoy. On the contrary, warmer water is associated both with an increasing and diversity of teleosts which are prey of white sharks and to an increase of phytoplankton that reduces the underwater visibility, driving them to the tuna bait choice. Finally, sea condition was almost always slightly rough, ensuring a good average underwater visibility. Recommendations for future research work at this site are presented.

Keywords: Elasmobranch; environmental effects; predation; prey choice; sensory ecology

SI Abstract Ref: 64

Simon Berrow

1; Irish Basking shark Group, Merchants Quay, Kilrush, Co Clare, V15 E762, Ireland 2; Marine and Freshwater Research Group, Galway-Mayo Institute of Technology, Dublin Road, Ireland

Annual courtship 'torus' behaviour of basking sharks *Cetorhinus maximus* identified in Irish waters

1. David W. Sims, Marine Biological Association of the United Kingdom, The Laboratory, Citadel Hill, Plymouth PL1 2PB, UK
2. Simon D. Berrow, Irish Basking shark Group, Merchants Quay, Kilrush, Co Clare, V15 E762, Ireland
3. Ken M. O'Sullivan, Woodview Park, Ennistymon, Clare, Ireland
4. Nicholas J. Pfeiffer, MERC Ecological Consultants, Loughaunbeg, Inverin, Galway, Ireland
5. Richard Collins, Irish Basking shark Group, Merchants Quay, Kilrush, Co Clare, V15 E762, Ireland
6. Kev L. Smith, Woodview Park, Ennistymon, Clare, Ireland
7. Brianna M. Pfeiffer, MERC Ecological Consultants, Loughaunbeg, Inverin, Galway, Ireland
8. Paul Connery, MERC Ecological Consultants, Loughaunbeg, Inverin, Galway, Ireland
9. Nuno Queiroz, CIBIO/InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos/Rede de Investigação em Biodiversidade e Biologia Evolutiva, Campus Agrário de Vairão, Universidade do Porto, 4485-668 Vairão, Portugal
10. Nicolas E. Humphries, Marine Biological Association of the United Kingdom, The Laboratory, Citadel Hill, Plymouth PL1 2PB, UK
11. Freya C. Womersley,
12. Emily J. Southall Marine Biological Association of the United Kingdom, The Laboratory, Citadel Hill, Plymouth PL1 2PB, UK

Many elasmobranchs exhibit complex courtship rituals. The function of large aggregations of basking sharks engaged in circling behaviour largely remains a mystery. We present, underwater and aerial video recordings of multiple circling groups of basking sharks in late summer (August to September) during years 2016–2021 in Ireland. Groups comprised females and males numbering between 6 and 23 individuals that were not filter feeding. Grouped sharks swam slowly in a clockwise or anticlockwise rotating 'torus' (diameter range: 17–39 m) consisting of circling individuals layered vertically from the surface to a maximum depth of 16 m. Within a torus, sharks engaged in close-following, echelon, close flank-approach or parallel swimming behaviours. Total body lengths of circling sharks overlapped known lengths of sexually mature individuals. In some toruses female body coloration was paler than that of males. Within a torus individuals associated with most other members rapidly (within minutes) indicating toroidal behaviours facilitate multiple interactions. Torus members also interacted through fin-fin and fin-body contacts, rolling to expose ventral surfaces to following sharks, and breaching behaviour. We also confirmed that a torus forms from shark following behaviour, and can change rotation direction frequently. Collectively, our observations explain a courtship function for non-feeding circling groups. This study highlights the importance of coastal waters off western Ireland as critical habitats supporting courtship reproductive behaviour of endangered basking sharks, the first such habitats identified for this species globally. This has important conservation implications for a species recently given legal protection status in Ireland.

Keywords: basking shark; courtship; torus; behaviour; Ireland
SI Abstract Ref: 89

Sofia Gabriel

Quantitative Marine Science Program, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia

Fine-scale spatial usage of a coastal beach area by white sharks (*Carcharodon carcharias*) as estimated by a Hidden Markov Model informed by acoustic array data

1. Sofia, Gabriel; Quantitative Marine Science Program, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia
2. Paige, Eveson; CSIRO Oceans and Atmosphere, Hobart, TAS, Australia
3. Russ, Bradford; CSIRO Oceans and Atmosphere, Hobart, TAS, Australia
4. David, Moreno; Fisheries and Aquaculture Centre, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia
5. Jayson, Semmens; Fisheries and Aquaculture Centre, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia
6. Toby, Patterson; CSIRO Oceans and Atmosphere, Hobart, TAS, Australia

White shark movements are typically observed over large spatial scales (100s-1000s km²). However, observation of fine-scale movement behaviour of white sharks is necessary to improve our understanding of their usage of near-shore coastal areas where there is an increased probability of interactions between sharks and humans. Based on passive acoustic data from a dense, but non-triangulating, array we investigated the fine scale movement of white sharks at a coastal beach within a nursery area off Hawk's Nest, New South Wales from 2010-2015. Using a spatial Hidden Markov Model (HMM) we were able to estimate white shark movement tracks during each shark visit to the array based on detection binning over 5-minute time intervals. The HMM also enabled direct estimation of the probability of detection as a function of distance from shark to acoustic receivers. The HMM-estimated movement tracks predict heavy utilisation of very shallow water close to the high-water mark by the sharks. Additionally, the southern end of the beach appears to be a focus for short term white shark residency at the beach. The movement tracks estimated here allowed the first high-resolution investigation of white shark movements in the Hawk's Nest nursery area and demonstrate the potential for estimation of fine-scale position data from non-triangulating passive acoustic monitoring arrays deployed in other coastal marine areas.

Keywords: Hidden Markov Models; animal movement; acoustic telemetry; *Carcharodon carcharias*
SI Abstract Ref: 130

Chelsea Gray and Emmett Johnston

Irish Basking Shark Group; George Mason University and Irish Basking Shark Group; Queen's University Belfast; National Parks and Wildlife Service

Making a Difference: how to realize policy change.

1. Chelsea Gray; Irish Basking Shark Group; George Mason University and
2. Emmett Johnston; Irish Basking Shark group; Queen's University Belfast; National Parks and Wildlife Service

Shark research and conservation efforts are typically driven by a desire to inform the status assessment and increase the level of protection afforded to the target species. However, the translation of scientific findings and or conservation initiatives into real world policy change is a persistent challenge for non-governmental organisations and academics. Basking sharks are listed by the IUCN as globally endangered. Ireland is significant to basking sharks in the Northeast Atlantic, however until 2022, they were not protected under domestic legislation. To help others overcome this disconnect we describe and review the methods that the Irish Basking Shark Group (IBSG), a volunteer research and outreach organisation, deployed to realize a change in legislative status for the species in Irish waters.

Between 2009 and 2022 the IBSG delivered approximately forty research, outreach and legislative change initiatives designed to raise the awareness, understanding and appreciation of basking sharks in Irish and International waters. No individual action or effort stream (i.e., public outreach, scientific research or political lobbying) delivered alone. Rather an integrated approach that melded internationally significant research studies with locally orientated ocean literacy initiatives' and strategically timed media campaigns provided the maximum leverage of policy makers.

Lastly, we consider how these experiences can be applied to other species or scaled up to regional forums. Our goal here is to provide a road map for similar conservation efforts through sharing our experience in attaining protection for the basking shark in Irish wildlife legislation, the first fish to be given this status.

Keywords: basking shark; science communication; conservation; policy; outreach
SI Abstract Ref: 209

Lucy Harding

Trinity College Dublin

Capture heats up sharks

1. Lucy, Harding; Trinity College Dublin
2. Austin, Gallagher; Beneath the Waves
3. Andrew, Jackson; Trinity College Dublin
4. Jenny, Bortoluzzi; Trinity College Dublin
5. Haley, R, Dolton; Trinity College Dublin
6. Brendan, Shea; Beneath the Waves
7. Luke, Harman; University College Cork
8. David, Edwards; West Cork Charters
9. Nicholas, Payne; Trinity College Dublin

Catch-and-release fishing is an important component of ecotourism industries and scientific research worldwide, but its total impact on animal physiology, health and survival is understudied for many species of sharks. We combined biologging and blood chemistry to explore how this fisheries interaction influenced the physiology of two widely distributed, highly migratory shark species: blue sharks (*Prionace glauca*), and tiger sharks (*Galeocerdo cuvier*). Nineteen sharks were caught by drum line or rod-and-reel angling; subcutaneous body temperature measurements were taken immediately upon capture, with 6 individuals also providing subsequent subcutaneous body temperature measurements via biologging as they swam freely for several hours post-release. We found that short-term capture caused shark body temperature to increase significantly and rapidly, with increases of 0.6 – 2.7°C for blue sharks (mean $1.2 \pm 0.6^\circ\text{C}$) and 0.5 – 0.9°C for tiger sharks (mean $0.7 \pm 0.2^\circ\text{C}$), and with capture-induced heating rates of blue sharks averaging $0.3^\circ\text{C min}^{-1}$ but as high as $0.8^\circ\text{C min}^{-1}$. These heating rates were 3-8 times faster than maximum rates encountered by our biologging sharks swimming through thermally stratified waters. Biologging data showed that body temperatures underwent gradual decline after release, returning to match water temperatures approximately 10 – 40 mins post-release. Blood biochemistry showed variable lactate/glucose levels following capture; however, these concentrations weren't correlated with the magnitude of body temperature increase, nor body size or hooking time. These perturbations of the natural state could have immediate and longer-term effects on the welfare and ecology of sharks caught and future research could focus on exploring these effects.

Keywords: catch-and-release; body temperature; thermal ecology; physiology; capture

SI Abstract Ref: 96

Hannah Medd

American Shark Conservancy

The recreational shore-based shark fishery in Florida, USA; catch rates, mortality rates and updates

1. Hannah B. Medd; American Shark Conservancy
2. Emma Kent; Carleton University
3. Jessika D. Guay; Carleton University
4. Jacqueline M. Chapman; Carleton University
5. Vivian M. Nguyen; Carleton University
6. Steven J. Cooke; Carleton University
7. Jill L. Brooks; American Shark Conservancy/Carleton University

Recreational, rod and reel, shore-based shark fishing is a popular activity along the coast of Florida, USA. The recent review of NOAA's recreational fishing data resulted in a six-fold increase in the estimation of effort, catch and harvest by all shore-based anglers. A portion of these data are collected in part by intercepting anglers at fishing access points, however, it may not capture those involved in shore-based shark fishing which occurs mostly at night in locations with relative low fishing activity. We analyzed responses to our online survey of Florida shore-based shark fishing permit holders representing a subset that specifically target great hammerhead (*Sphyrna mokarran*) to better describe angler demographics, motivations, gear types, and behaviors. We will also present survivorship data on the great hammerheads caught and released with pop-off archival satellite tags (PSATs) to estimate the post-release mortality rates of this species in the shore-based fishery and insights into the diversity of species caught in this fishery, including several species with upcoming stock assessments. These data, both the human dimension and the mortality rates, are important to decision-makers for calculating Annual Catch Limits across the commercial and recreational sectors as well as provide evidence for the development of best practices for the angling community.

Keywords: recreational fisheries; post-release mortality; great hammerhead; human dimension

SI Abstract Ref: 180

Sofia Graça Aranha

CCMAR, University of Algarve

Stress indicators in deep-sea sharks from bottom trawl fisheries in Southern Portugal

1. Sofia, Graça Aranha; CCMAR, University of Algarve
2. Aurélien, Tambuté; University of La Rochelle
3. Alexandra, Alves; CCMAR, University of Algarve
4. Pedro, M. Guerreiro; CCMAR, University of Algarve
5. Ivone, Figueiredo; Portuguese Institute of the Sea and Atmosphere (IPMA)
6. Pedro, Rocha; University of Algarve
7. Tiago, Marsili; OLSPS International Lda.
8. Alexandra, Teodósio; CCMAR, University of Algarve
9. Teresa, Modesto; CCMAR, University of Algarve

Crustacean bottom-trawlers are responsible for 70% of discards in the south of Portugal and deep-sea sharks are expressive bycatch, due to their overlap with fishing grounds, low commercial values and/or fishing regulations. Most individuals are discarded either dead or in poor physical condition. The physiological consequences of this type of capture in elasmobranchs are poorly understood.

This study analyzed stress-related physiological parameters of four common deep-sea shark, sampled from two different trawling procedures: one conducted onboard a commercial crustacean bottom-trawler (longer haul duration and heavier codend weight) and the other conducted onboard a research vessel (shorter haul duration and lighter codend weight).

A total of 120 individuals from the species *Etmopterus pusillus*, *Etmopterus spinax*, *Galeus melastomus* and *Scymnodon ringens* were studied. Plasma was collected onboard and frozen until analysis. The concentrations (mmol/L) of plasma electrolytes (Na⁺, Cl⁻, Ca²⁺, Mg²⁺) and energy metabolites (glucose, lactate) were measured and related to specific trawling conditions, specimen vitality and survival.

Differences between commercial and research hauls were observed. Commercial hauls were marked by significantly high concentrations of Na⁺, Cl⁻, Mg²⁺ and lactate, whilst research hauls presented higher concentrations of glucose and Ca²⁺. Specifically, commercial hauls caused significant increases in Cl⁻ and lactate for *S. ringens* and Na⁺ for *E. pusillus*, and a decrease in glucose concentrations for *E. pusillus*.

A complete analysis of the relation between physiological stress indicators and trawling variables should provide further insight to establish additional recommendations to increase the welfare and the effective management of discarded deep-sea sharks.

Keywords: plasma; physiology; secondary responses; conservation; survival

SI Abstract Ref: 335

Andrea Bernard

1: Save Our Seas Foundation Shark Research Center; 2: Guy Harvey Research Institute; 3: Nova Southeastern University, Fort Lauderdale, FL, USA.

Population genomic dynamics of the shortfin mako shark in the Atlantic

1. Andrea Bernard; Save Our Seas Foundation Shark Research Center and Guy Harvey Research Institute, Nova Southeastern University, Fort Lauderdale, FL, USA.
2. Marissa Mehler; Save Our Seas Foundation Shark Research Center and Guy Harvey Research Institute, Nova Southeastern University, Fort Lauderdale, FL, USA.
3. Kimberly Finnegan; Save Our Seas Foundation Shark Research Center and Guy Harvey Research Institute, Nova Southeastern University, Fort Lauderdale, FL, USA.
4. Mahmood Shivji; Save Our Seas Foundation Shark Research Center and Guy Harvey Research Institute, Nova Southeastern University, Fort Lauderdale, FL, USA.

Pelagic sharks are highly threatened by overfishing and in urgent need of science-based conservation management. A key need is improved information on the population genetic structure and diversity of these ecologically important taxa. The shortfin mako shark (*Isurus oxyrinchus*) is an oceanic, globally widespread species known for its capacity for long-distance movements spanning thousands of kilometers. This species is listed as globally 'Endangered' by the IUCN Red List of Threatened Species, and Atlantic makos are considered overfished and in decline. We investigated the population genetic dynamics of shortfin mako sharks in the Atlantic Ocean using a high-resolution, bi-organelle, multi-marker, genomics approach. We sequenced 86 complete mitochondrial genomes (mitogenomes) (16,999-17,002 bp) and genotyped 4236 single nucleotide polymorphisms (SNPs) in 105 sharks across the Atlantic and found contrasting patterns of genetic population structure across DNA markers. Mitogenome sequences indicated matrilineal population genetic structure across northern and southern hemispheres, while nuclear-based SNPs showed high connectivity and ocean basin-wide panmixia. Mitogenome genetic diversity in Atlantic shortfin makos was high compared to other elasmobranchs assessed at the population mitogenome level, and nuclear diversity was high compared to migratory shark species assessed with SNP markers, boding well for the genetic recovery of Atlantic shortfin makos if further population declines can be halted.

Keywords: population genomics; shortfin mako shark; connectivity; mitogenome; single nucleotide polymorphism

SI Abstract Ref: 226

Chris Fischer

OCEARCH

Accelerated progress in global shark research and conservation by OCEARCH

1. Chris Fischer; OCEARCH
2. Brett McBride; OCEARCH
3. Robert Hueter; OCEARCH & Mote Marine Laboratory
4. Nicole Ralston; OCEARCH
5. Stephanie Brown; OCEARCH

Since 2007, OCEARCH has conducted 44 expeditions in nine countries focusing on comprehensive research and public awareness of sharks and other marine vertebrates. Our goal is to provide the data to return balance, abundance, and ecological health to our oceans, starting with rebuilding populations of its top predators. By donating the unique facilities, capabilities, and skilled crew of our 40m research ship to the scientific community at no cost, OCEARCH provides unprecedented access to large sharks in the wild for advanced studies of their biology, conservation status, and human impacts. Using the Google business model to build and monetize scale, we follow these principles to advance shark research: 1) broad collaboration, uniting fishermen, scientists, educators, and policymakers to rapidly increase our knowledge on sharks; 2) the 3Rs of animal research, minimizing the number of sharks needed to answer the maximum number of questions, while ensuring the health and safety of each shark studied; 3) inclusion, allowing the world to participate in real time through open access to new scientific data; and 4) innovative funding, from brand-integrated content, conscious consumerism, and philanthropy. OCEARCH has facilitated the work of more than 200 scientists in the Pacific, Atlantic, and Indian Oceans, resulting in 75 peer-reviewed publications, and we have advanced public awareness through our Global Shark Tracker™ app and website, social media, and STEM educational programs. With our multi-year study of the white shark in the Western North Atlantic completed, we are bringing our ship to Europe and the Mediterranean in 2023.

Keywords: collaboration; open access; business model; Mediterranean; white shark

SI Abstract Ref: 233

Robert Hueter

OCEARCH & Mote Marine Laboratory

Across the Pond: White shark research from the Western North Atlantic to Europe and the Mediterranean Sea

1. Robert Hueter; OCEARCH & Mote Marine Laboratory
2. Alisa Newton; OCEARCH
3. John Tyminski; OCEARCH
4. Brett McBride; OCEARCH
5. Chris Fischer; OCEARCH

With the completion of a multi-year comprehensive study of white shark biology in the Western North Atlantic (WNA) by OCEARCH and its collaborators, knowledge of the WNA population has rapidly surpassed the level previously attained in Australia and New Zealand, South Africa, and the eastern Pacific. A total of 19 expeditions along the North American Atlantic coast have supported the multidisciplinary work of 45 investigators from 30 organizations to advance 25 individual research projects. By maximizing the number of projects served and minimizing the handling stress for each individual shark, we applied the principles of Reduction and Refinement to study spatial ecology and behavior, reproduction, trophic ecology, environmental health and physiology, population genetics, microbiology and biomedicine, and more aspects of WNA white sharks. Results include a comprehensive understanding of the life history, critical habitats, and threats to YOY, juvenile, subadult, and adult white sharks in the WNA, where the population is currently rebuilding. We next turn our attention and resources to the white shark population of the Eastern North Atlantic (ENA) and Mediterranean Sea, where studies of white sharks have been largely restricted to fisheries records and anecdotal observations, indicating a declining population. In 17 ENA and Mediterranean countries to date, we have established a network of 70 researchers from 55 organizations to collaborate in OCEARCH expeditions in 2023-2025. Focal regions of study will include Scotland, Ireland, England, and France, the western Mediterranean including Malta and Tunisia, and the eastern Mediterranean including the Aegean and Adriatic Seas.

Keywords: white shark; North Atlantic; Mediterranean; multidisciplinary; OCEARCH

SI Abstract Ref: 231

Alisa L. Newton

OCEARCH; ZooQuatic Laboratory, LLC

Western North Atlantic white shark (*Carcharodon carcharias*) baseline health assessment and plasma one-alpha hydroxycorticosterone response during scientific sampling, tagging, and release

1. Alisa, Newton; OCEARCH; ZooQuatic Laboratory, LLC
2. Nicole, Stacy; University of Florida, School of Veterinary Medicine
3. Catharine, Wheaton; Disney's Animals Science and Environment
4. Carolyn, Cray; University of Miami
5. Michael, Hyatt; Wildlife Conservation Society, New York Aquarium
6. Tobey, Curtis; National Marine Fisheries Service
7. Gregory, Metzger; South Fork Natural History Museum and Nature Center
8. G. Christopher, Fischer; OCEARCH
9. Natalie, Mylniczenko; Disney's Animals Science and Environment

Health assessments in wildlife populations are essential to understanding individual animal, in situ population, and ecosystem health in the face of current and future natural and anthropogenic environmental disturbance. Creating species specific baselines for health comparisons is a critical need across all elasmobranch species. The effectiveness of conservation strategies and scientific sampling protocols that involve handling and live release can be impacted by the animals' physiological stress response and post-capture mortality. A complete understanding of elasmobranch corticosteroid response to handling, and how changes in blood biochemistry and acid-base analytes relate to this response and predict post-release survival are currently lacking. We report the results of health assessments in white sharks (N=74) sampled as part of a multidisciplinary study in the Western North Atlantic between 2016 and 2022. Physical exam, hematology, plasma chemistry, protein electrophoresis, and acute phase protein responses were evaluated, and preliminary relative reference intervals created along with descriptive statistics. We additionally report the one-alpha hydroxycorticosterone (1aOHB) response to scientific handling of a subset (N=38) of the study animals, using a monoclonal antibody-based enzyme immune assay (EIA). Relationships between all analytes and biologic data (morphometrics, life-history stage [YOY, juvenile, subadult, adult], season, and region) were explored. We further compared 1aOHB values with blood chemistry, acid-base and blood gas alterations traditionally used to monitor stress response. This study creates a baseline for white shark health assessment in the Western North Atlantic, accounting for intrinsic and extrinsic factors, and contributes to a better understanding of their stress response to scientific handling.

Keywords: white shark; health assessment; stress physiology; one-alpha hydroxycorticosterone; reference interval

SI Abstract Ref: 282

Clara Sánchez Latorre
CICIMAR

Ontogenetic trophic shifts in the pelagic thresher shark *Alopias pelagicus* from both coasts of Baja California Sur, México

1. Clara Sánchez Latorre; CICIMAR
2. Felipe Galván Magaña; CICIMAR
3. Arturo Tripp Valdez; CICIMAR
4. Fernando Elorriaga Verplancken; CICIMAR
5. Alejandra Piñón Gimete; CICIMAR
6. Antonio Delgado Huertas; IACT (CSIC-UGR)

The pelagic thresher shark is an important species in fisheries of Mexico and Ecuador; however, we know few about their biology to recommend management or conservation plans. Understanding the life history of pelagic species is important to ensure their survival. The aim of the present study was to evaluate the trophic ontogeny of *Alopias pelagicus* from both coasts of Baja California Sur (BCS), Mexico, based on the analysis of stable isotope ratios of carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) of vertebra and muscle. A total of 199 vertebral and 73 muscle samples were analyzed. For Bahía Tortugas (Western coast BCS), mean vertebra isotopic $\delta^{15}\text{N}$ values were $12.24 \pm 1.08\text{‰}$ (AIR) and $\delta^{13}\text{C}$ $-15.1 \pm 0.65\text{‰}$ (V-PDB); while muscle $\delta^{15}\text{N}$ values were $16.59 \pm 0.66\text{‰}$ and $\delta^{13}\text{C}$ $-17.13 \pm 0.39\text{‰}$. For Santa Rosalía (Eastern coast BCS), mean vertebra isotopic $\delta^{15}\text{N}$ values were $14.69 \pm 1.18\text{‰}$ and $\delta^{13}\text{C}$ $-14.23 \pm 0.55\text{‰}$; while muscle $\delta^{15}\text{N}$ values were $17.81 \pm 0.8\text{‰}$ and $\delta^{13}\text{C}$ $-16.4 \pm 0.36\text{‰}$. These results showed higher $\delta^{15}\text{N}$ values in Santa Rosalía as a result of baseline differences between the two regions; whereas $\delta^{13}\text{C}$ values were lower in Bahía Tortugas, suggesting a more oceanic behavior ($p < 0.05$). In Santa Rosalía, there were significant differences by sex in vertebrae for $\delta^{15}\text{N}$; whereas $\delta^{13}\text{C}$ showed ontogenetic shifts, indicating that neonates feed on more coastal areas than juveniles or adults ($p < 0.05$). Neither sex nor ontogenetic differences were observed in Bahía Tortugas ($p > 0.05$), evidencing a high overlap between their isotopic niches. The average trophic level obtained for both tissues was ~ 4 , which corresponds to a tertiary predator.

Keywords: vertebra; muscle; stable isotopes

SI Abstract Ref: 301

Gabriella Hancock

California State University, Long Beach

Personal experience predicts behavioral indicators of tolerance for interactions with sharks and stingrays

1. Katie D. Dudley; California State University, Long Beach
2. Dede Long; California State University, Long Beach
3. Christopher G. Lowe; California State University, Long Beach

Global conservation efforts are critical as the world's ecosystems are under threat from numerous man-made sources. Humans' behavioral intentions to support conservancy for diverse species and their habitats are predicated on key intrinsic (cognitions, beliefs, affects) and extrinsic factors. One such critical extrinsic factor which is subject to individual differences is former personal experiences with certain animals, such as previous encounters with different species in the wild. This work examined individuals' self-reported previous experience with two different animal species (sharks and stingrays) to determine their effects on behavioral expressions of tolerance (i.e., willingness to engage in activities in the water at beach facilities that have experienced confirmed sightings of these species within different timeframes). Results inform the design of instructional and promotional materials intended to promote elasmobranch conservation as well as safety materials (e.g., training, signage) that convey information pertaining to risk at beach and oceanic recreation facilities.

Keywords: tolerance; conservation; psychology

SI Abstract Ref: 18

Michael Hoarau

Centre Sécurité Requin

Innovative shark mitigation measures tested in Reunion Island towards the reduction of human - shark interactions

1. Michael Hoarau ; Centre Sécurité Requin
2. Jean Gadenne ; Centre Sécurité Requin
3. Arnault Gauthier ; Centre Sécurité Requin
4. Eric Hoarau ; Centre Sécurité Requin
5. Christophe Mulquin ; Centre Sécurité requin
6. Willy Cail ; Centre Sécurité Requin
7. Hervé Geollot ; Vigies Requins Renforcées

Since 2011, the intensity of unprovoked human-shark interaction has dramatically increased on the coast of Reunion Island, with a total of 31 human-shark interactions including 11 fatal shark bites. Most of these interactions occurred within the most popular beaches of the island.

The main shark species responsible for these interactions is the bull shark (*Carcharhinus leucas*). Faced with this unprecedented situation, the French government instituted a ban on all nautical activities around the island and decided to implement a comprehensive strategy to mitigate the risk of human-shark interactions. To ensure the implementation of this strategy, the Reunion Shark Security Centre was officially created in April 2016 and became since June 2020 a French governmental agency. The main objectives of this institution are to coordinate and implement operational mitigation measures contributing to reduce the shark risk in Reunion, as well as to promote mitigation measures reconciling ocean users' safety and the conservation of marine biodiversity using technological innovations.

For the past six years, many innovative mitigation measures have been tested in Reunion waters and other parts of the world. These measures include a highly regulated shark control program using smart drumlines, the creation of new tools to detect potentially dangerous sharks, as well as testing commercially available shark deterrent devices. Thanks to all of these measures, the ban on nautical activities has now been partially lifted in specific areas of the island, with further development to come in the near future.

Keywords: mitigation measures; bull shark; innovation; shark deterrent

SI Abstract Ref: 91

Francesca Pancaldi

WWF Mexico

WWF whale shark management strategy in La Paz Bay: an example of conservation

1. Francesca, Pancaldi; WWF Mexico
2. Eduardo, Nájera Hillman; WWF Mexico
3. Ixchel, López Olvera; WWF Mexico
4. Dení, Ramírez Macías; Tiburón Ballena México- Conexiones TerraMar
5. Gloria Mariel, Suárez Gutiérrez; RED de Turismo Sustentable y Desarrollo Social A.C.
6. Jesús, Martínez Hernández; RED de Turismo Sustentable y Desarrollo Social A.C.
7. Dilia, Meza Castro; Comisión Nacional de Áreas Naturales Protegidas (CONANP)

The whale shark (*Rhincodon typus*) is an endangered species that seasonally aggregate in the Bay of La Paz, an important feeding ground for juvenile individuals. During the last 20 years, touristic activities involving this species has exponentially increased, growing negative pressure on the animals. Since 2010 The World Wildlife Fund (WWF) in collaboration with the Foundation Telmex Telcel (Alliance WWF-Foundation Telmex Telcel) support the conservation of the whale shark in this region of Mexico. Conservation actions so far implemented include funding local scientists to constantly monitor the presence of the animals and to generate information that is useful in decision-making by the government, encourage education and outreach, support training for guides and captains involved in the touristic activity, habitat improvement through the maintenance of Natural Protected Areas in a post-covid context, and the support to the local authorities in the management of the area of observation. Recently a control center formed by a long distance camera, monitor, and computer was established to guarantee an efficient vigilance of the touristic activity. These actions have achieved a decrease in the shark injuries of 26% since 2016. The collaboration between the civil society organizations such as WWF, private entities, researchers, governs, and local community is essential to achieve the conservation of vulnerable species.

Keywords: whale shark; conservation; civil society organization; management plan; La Paz

SI Abstract Ref: 210

Arnault Gauthier

Centre Sécurité Requin

Are shark deterrents an effective protection against human-shark interactions?

1. Arnault, Gauthier, Centre Sécurité Requin.
2. Michaël, Hoarau, Centre Sécurité Requin.
3. Sébastien, Jaquemot, Université de la Réunion.
4. Charlie, Huveneers, Flinders University.
5. Eric, Chateauminois, Centre Sécurité Requin.
6. Jean, Gadenne, Centre Sécurité Requin.
7. Eric, Hoarau, Centre Sécurité Requin.

Over the past few years, the number of human-shark interactions have been on the rise globally. A range of measures meant to mitigate the risk of an interaction has been deployed worldwide, such as preventive fishing or exclusion nets. More recently, the use of a personal shark deterrent has become a popular option for ocean users. Several types of these shark deterrents exist and typically rely on optical, olfactory, magnetic, or electrical stimuli to repel sharks that get too close to the wearer. Until recently, these devices were rarely tested independently and in a robust manner. However, this has now changed and through these recent studies, we learned that not all of these devices were effective in repelling sharks, and that electric shark deterrents are generally the most effective type. However, not all of these deterrents are as effective as the others, and their effectiveness may also vary between shark species.

Throughout this presentation, we will go over the existing types of personal shark deterrents to identify their advantages and drawbacks, the results of recent investigations on their effectiveness, but also potential future development for this technology.

Keywords: shark bite; shark interactions; shark deterrents

SI Abstract Ref: 194

Ana Ferreira

Oceanário de Lisboa

The Chondrocensus, a platform for engagement and collaborative conservation.

1. Ana, Ferreira; Oceanário de Lisboa
2. Carlos, Taurá; Oceanogràfic Valencia
3. Jennie, Janssen; National Aquarium
4. Tony, Niemann; Tracks Data Solutions

The International Census of Chondrichthyans in Human Care (aka the ChondroCensus) launched in 2019 at www.sharksandraysproject.com, as part of the framework of the Association of Zoos & Aquariums (AZA) Saving Animals From Extinction (SAFE) Sharks and Rays program. This global census has grown to contain 250 species from 237 facilities across 54 countries world-wide as of May 2022. Besides getting an update count of Chondrichthyans at human care, this platform intends to make this collection of data a truly useful tool for engaging in meaningful, strategic, and collaborative conservation. Stakeholder Teams can complete a survey providing basic husbandry info and add their organizational accrediting body. These data can then be searched by region, organizational accrediting body, genus or species, sex, and the surveyed husbandry criteria. In addition to streamlining periodic reporting required by organizational accrediting bodies, these new features will also anonymously connect stakeholders with each other and with the research community to advance husbandry practices and facilitate collaborative chondrichthyan conservation efforts. Teams always remain anonymous and thus maintain control over their data, as search results are only shown as the number of Teams per ChondroCensus Region. Thus, each stakeholder facility's Team Coordinator holds the critical role of whether their Team chooses to respond to any requests for connection or information, thereby identifying themselves as stakeholders of the species a search query pertains to.

Keywords: Chondrichthyans; international; census; aquariums

SI Abstract Ref: 228

Leonardo Guida

Australian Marine Conservation Society

Saving Aussie sharks & rays - the conservation needs of threatened endemic elasmobranchs in Australian waters

Dr Leonardo Guida

Australia is a global hotspot of elasmobranch endemism, making it a global conservation priority to protect the evolutionary diversity of elasmobranchs. Australia is one of 21 regions in the world containing 'triple threat hotspots', regions characterised by the presence of threatened species in high levels of richness, endemism, and evolutionary distinctiveness. The recent 'Action Plan for Sharks and Rays 2021' identifies one third (36%) of Australia's threatened elasmobranch species being endemic. South-eastern quadrant of Australia (southern Queensland through to eastern Victoria) is a region with a high level of incidence of threatened species as a direct result from commercial fishing. Within this region, there are several state-managed fisheries as well as the federally-managed Southern and Eastern Scalefish and Shark Fishery, Australia's largest by area and volume. To address these issues and support the recovery of threatened endemic species, I will highlight the opportunities that exist in Australian fisheries management, Australia's environmental laws, and collaborations with NGOs in linking research to policy. The conservation needs for Australian endemic elasmobranchs are urgent, globally recognised, and forecasted to be successful if appropriate actions are implemented.

Keywords: endemic; endangered; shark; Australia; conservation

SI Abstract Ref: 36

Friday 14th October, 2022

Sharks and Humans 2

Zalina Bashir Ali

University of Aberdeen, United Kingdom

Using elasmobranch bycatch data to model species distributions and inform conservation management

1. Zalina Bashir Ali; University of Aberdeen, UK.
2. Rebekka Allgayer; University of Aberdeen, UK.
3. Kara Layton; University of Aberdeen, UK.
4. Aurore Ponchon; University of Aberdeen, UK.
5. Justin Travis; University of Aberdeen, UK.
6. Kooi Chee Ho; Marine Research Foundation, Malaysia.
7. Nicholas Pilcher; Marine Research Foundation, Malaysia.

The short-term socioeconomic impacts of marine spatial conservation measures to the fishing industry, such as the implementation of no-take zones or marine protected areas, often result in these proposals being met with opposition or skepticism, at best. Hence, when spatial conservation measures are implemented to protect a target species or population, they must be strategically located as to maximize their effectiveness, although the field surveys that traditionally underpin this work are time- and resource-intensive. Researchers are therefore increasingly utilizing species distribution models to identify locations of high conservation value. In this study, we aim to establish priority areas for the protection of sharks and rays based on predictions of their distribution in the waters surrounding the Malaysian state of Sabah, in north Borneo. Considering the global decline of elasmobranchs, it is vital for interventions such as spatial conservation management measures to be implemented rapidly and effectively. Here, we use extensive, multi-year bycatch datasets from the Marine Research Foundation for modelling the ranges of species distributions and occurrences of sharks and rays in Sabah. The results of this work will support recommendations for local elasmobranch management measures.

Keywords: species distribution models; spatial conservation management; Elasmobranch bycatch; Malaysia

SI Abstract Ref: 193

Nick Dunn

Institute of Zoology, Zoological Society of London | Imperial College London

Advancing environmental DNA methods for monitoring sharks and rays

1. Nicholas Dunn; Institute of Zoology, Zoological Society of London | Imperial College London
2. David Curnick; Institute of Zoology, Zoological Society of London
3. David Jiménez Alvarado; Universidad de Las Palmas de Gran Canaria | Angel Shark Project
4. Samantha Andrzejczek; Hopkins Marine Station, Stanford University
5. Isabel Apetroaie; Imperial College London
6. Joanna Barker; Zoological Society of London | Angel Shark Project
7. Barbara Block; Hopkins Marine Station, Stanford University
8. Aaron Carlisle; School of Marine Science and Policy, University of Delaware
9. Taylor Chapple; Hatfield Marine Science Center, Oregon State University
10. Jake Davies; Zoological Society of London | Natural Resources Wales
11. Sarah Davies; Zoological Society of London | Natural Resources Wales
12. Rosalie Dowell; Institute of Zoology, Zoological Society of London | Imperial College London
13. Francesco Ferretti; Department of Fish and Wildlife Conservation, Virginia Tech
14. David Jacoby; Lancaster Environment Centre, Lancaster University, Lancaster
15. Eva Meyers; Zoological Research Museum Alexander Koenig | Angel Shark Project
16. Robbie Schallert; Hopkins Marine Station, Stanford University
17. Margaux Steyaert; Institute of Zoology, Zoological Society of London | Oxford University
18. Sam Weber; Centre for Ecology and Conservation, University of Exeter
19. Michael Williamson; Institute of Zoology, Zoological Society of London
20. Ben Wray; Natural Resources Wales
21. Vincent Savolainen; Imperial College London
22. Chris Carbone; Institute of Zoology, Zoological Society of London

In the last decade, there has been an upsurge in the number of studies that utilise environmental DNA for detecting elasmobranchs, focusing on identifying the presence or absence of species. In this talk, we will explore the application of eDNA methods for long-term and fine-scale monitoring of elasmobranch species. We will present the results from eDNA metabarcoding to assess the diversity of elasmobranchs around a remote atoll in the Chagos Archipelago Marine Protected Area (MPA), showing that eDNA can detect a wide range of elasmobranch species seldom recorded in the MPA. We applied species-specific eDNA methods to assess the distribution of two dominant reef shark species across the archipelago and show that detections were significantly higher around the well-protected atoll of Diego Garcia compared to atolls in the north of the MPA, where detection showed no relationship with concurrent visual surveys or activity hotspots revealed through acoustic telemetry. We infer that populations around the northern atolls have been suppressed by illegal, unregulated and unreported (IUU) fishing activity and that eDNA methods may be limited when investigating species at low population density. In addition, we will showcase how species-specific eDNA methods to investigate the seasonal presence of the Critically Endangered Angelshark (*Squatina squatina*) and thornback ray (*Raja clavata*) over the course of a year in Wales. Using both case studies, we emphasise the potential of eDNA methods for elasmobranch monitoring and highlight areas of further research that will be required as they move beyond detection validation into real-world conservation applications.

Keywords: environmental DNA; monitoring; coastal; Marine Protected Area; IUU

SI Abstract Ref: 354

Dr Chantel Elston

South African Institute for Aquatic Biodiversity

First insights into large-scale movements of a benthic stingray

1. Paul Cowley; South African Institute for Aquatic Biodiversity
2. Taryn Murray; South African Institute for Aquatic Biodiversity
3. Matthew Parkinson; South African Institute for Aquatic Biodiversity

The movements of stingrays have often been quantified over small localized scales however, it still remains largely unknown whether species display site fidelity or dispersal and to what extent they may connect coastal habitats. This information is vital to inform population dynamics, ecological roles and best management practices for this threatened faunal group. Blue stingrays *Dasyatis chrysonota*, endemic to southern Africa, are hypothesized to move from shallow inshore habitats to deeper offshore waters during winter, making them a model species to investigate these large-scale movement questions. Twenty-seven individuals were monitored using the Acoustic Tracking Array Platform (ATAP – a nation-wide network of acoustic receivers) for up to 4.5 years. Individuals displayed site fidelity to defined regions of the coast with the majority of detections being recorded in the shallow bay/coastal shelf they were tagged in. However, important movement corridors linking different habitats were identified (inshore vs offshore and coastal bay vs coastal shelf habitats). Modelling highlighted this habitat use was influenced by month and temperature, with individuals displaying restricted movements to the shallow bay habitat in summer when deeper waters were colder. The large collaborative nature of the ATAP allowed for the monitoring of a benthic stingray across large spatial scales (hundreds of kilometres) for the first time, challenging preconceived notions that small undulatory batoids cannot

travel large distances (many individuals travelled up to 200 km). Lastly, the current Marine Protected Area zonation may be insufficient to protect blue stingrays from further population declines in South Africa.

Keywords: acoustic telemetry; South Africa; *Dasyatis chrysonota*; habitat connectivity; site fidelity

SI Abstract Ref: 324

Stephan Bruns

Biology Department, College of Science, UAE University, Al Ain, United Arab Emirates

The role of Abu Dhabi's nearshore marine environments in the ecology of elasmobranch fishes

1. Stephan Bruns, Biology Department, College of Science, UAE University, Al Ain, United Arab Emirates
2. Aaron C. Henderson, Biology Department, College of Science, UAE University, Al Ain, United Arab Emirates

The present study was undertaken to assess the diversity, relative abundance and habitat association of elasmobranchs fishes in the nearshore environment on the eastern site of Abu Dhabi, with a focus on how environmental factors impact habitat use and species composition in the shallow lagoons in the world's hottest sea. Stereo – baited remote underwater video systems (Stereo-BRUVS) in combination with continuous abiotic factor monitoring were used to study elasmobranchs within the area. A great range of environmental changes among the seasons were recorded in salinity and temperature. The video survey recorded two shark species, the blacktip reef shark *Carcharhinus melanopterus* and the Arabian carpet shark *Chiloscyllium arabicum*, two shark like rays, halavi guitarfish *Glaucostegus halavi* and the giant guitarfish *Rhynchobatus djiddensis* and six ray species, the honeycomb stingray *Himantura uarnak*, the leopard whiplay *Himantura leoparda*, the pink whiplay *Pateobatis fai*, the cowtail stingray *Pastinachus sp.*, the Arabic whiplay *Maculabatis arabica* and the eagle ray *Aetobatus ocellatus*. Despite the extreme environmental conditions, the habitat is used by a number of batoids, from which three species are declared critically endangered by the IUCN. This indicates the potential importance of the area in the species life cycle and therefore, the need of conservation management and continuous environmental monitoring in context of a changing climate.

Keywords: Chondrichthyes; biodiversity; environmental factors; nearshore habitats; stereo-BRUVS

SI Abstract Ref: 298

Amos Barkai

OLSPS, Cape Town Western Cape, South Africa

EMREP - Development of Integrated Electronic Monitoring and Reporting (iEMR) technology for fisheries in Portugal

1. Amos, Barkai; OLSPS, Cape Town Western Cape, South Africa
2. Sofia, Ramos; University of the Algarve, Campus da Penha, 8005-139 Faro

The EMREP project aims to develop technology that integrates electronic reporting (ER) and electronic monitoring (EM) technologies to create an integrated, onboard, monitoring and reporting solution (iEMR) for commercial fishing fleets. As part of the project, the iEMR system is being tested onboard a Portuguese bottom-trawl fishing vessel. It provides a combined tool for the collection of commercial and scientific fishing data, focusing on finding ways to reduce elasmobranch bycatch. The iEMR system makes use of the Olrac fishing eLog system, presently used on hundreds of vessels across fisheries worldwide. The Olrac eLog uses advanced data and communication technologies to facilitate a more accurate, reliable, and efficient approach to the collection, reporting and management of commercial fishing data. Its main advantage is its ability to record data during fishing operations, which can then be used to compile and send out reports needed by a wide range of interested and permitted recipients (commercial, scientific, compliance and management, etc.). The system is also linked to a web-server where data and images from many units across an entire fleet can be stored, analyzed and viewed by different permitted recipients. This iEMR solution provides an innovative and holistic solution to the ever-increasing demand for high quality data within the field of fish resource management. The system is simple to use, allows for data of all kinds (numerical, lookups, free text and images) to be collected and reported and thus transforms every vessel using it into a reliable data collection platform.

Keywords: electronic monitoring; data management; integrating technology; Elasmobranch bycatch; bycatch mapping

SI Abstract Ref: 198

Jaelen Nicole Myers
James Cook University

Integrating distribution and behavioural data from drones to study fine-scale habitat use of stingrays in intertidal flats

1. Jaelen, Myers; James Cook University
2. Carlo, Mattone; James Cook University
3. Kevin, Crook; James Cook University
4. Michael, Bradley; James Cook University
5. Marcus, Sheaves; James Cook University

Stingrays are ubiquitous in marine ecosystems across the world and perform a variety of functional roles that support ecosystem health and stability. Coastal intertidal flats provide productive nursery habitats for juvenile rays, making them key areas to target for conservation and management of at-risk species. However, little research has been dedicated to studying distribution patterns or behavioural ecology of juvenile rays in estuaries, limiting our capacity to identify critical ray habitats or understand the roles of different species within them. From 2020-2022, we conducted observational surveys of ray communities across intertidal estuary flats in North Queensland using unmanned aerial drones (UAVs). Our aim was to evaluate fine-scale habitat use patterns by integrating spatio-temporal distribution and behavioural data. We found species compositions varied across locations based on their spatial features, and there was evidence of species-specific habitat partitioning within sites. Daily movements of rays were generally characterized by individuals moving into the upper intertidal flats during rising and high tidal periods and returning to subtidal zones during ebb and low periods. Incorporating behaviours showed that foraging may be a primary driver for these movements, and species-specific behaviours may further contribute to differential habitat use. In some locations, ray activity was evidenced by dense, patchy clusters of feeding pits, suggesting there is fine-scale variability for where feeding occurs within larger habitat areas. Overall, making comparisons beyond single-site contexts broadened our understanding about spatio-temporal distributions of rays in intertidal estuaries. More behavioural studies will be useful for linking specific activities to ecological functions.

Keywords: habitat use; behaviour; aerial drone; stingray; spatio-temporal distribution

SI Abstract Ref: 38

Taryn-lee Perrior
Flinders University

The elephant in the room: assessing the foraging ecology of *Callorhinchus milii* across Australia and New Zealand

1. Taryn Perrior; Flinders University
2. Dr Lauren Meyer; Flinders university
3. Prof Charlie Huveneers; Flinders University

The functions of mesopredators often overlooked, despite their role as ecologically-vital trophic links. Elephant fish, *Callorhinchus milii*, are presumed to be a regionally-important mesopredator across southern Australia and New Zealand, yet little is known about their ecology. We investigated the foraging ecology of *C. milii* across two locations in Australia (Bass Strait and Robe) and New Zealand (Southeast and Southwest) using stomach content, stable isotope and fatty acid analysis to enable the assessment of spatial variations in feeding across different spatial scales. *Callorhinchus milii* mostly fed on preys from non-complex habitat, although diet of *C. milii* varied between all sampled locations, with differences in muscle being primarily driven by higher $\delta^{13}\text{C}$ and 16:0 within Robe and Bass Strait summer identifying more pelagic foraging. Lower $\delta^{13}\text{C}$ and higher 20:5 ω 3 within Bass Strait winter, Southeast and Southwest New Zealand identified non-complex demersal foraging. In addition to similar $\delta^{15}\text{N}$, *C. milii* within Bass Strait summer and winter, and Robe predominantly fed on polychaetes (0.785), and teleost + cephalopods (0.137), and Southeast New Zealand mostly feeds on polychaetes (0.660) annually. Within liver, the same trends were seen, although lower $\delta^{13}\text{C}$ and higher 18:1 ω 9 within Bass Strait summer, and lower $\delta^{13}\text{C}$ and higher 22:6 ω 3 within Southeast New Zealand identified more deep-sea foraging. With similar $\delta^{15}\text{N}$, *C. milii* within Bass Strait summer and winter predominantly fed on polychaetes (0.423) and teleost + cephalopods (0.132), Robe on polychaetes (0.755), and teleost + cephalopods (0.132), and Southeast New Zealand on teleost + cephalopods (0.504), and crustaceans (0.188) seasonally. Our findings improve our understanding of *C. milii* trophic ecology, and chimaera ecology more broadly, for which minimal information is currently available.

Keywords: chimaera; biochemical tracers; stomach content analysis; trophic ecology; Geographic comparison

SI Abstract Ref: 355

Chloe Roberts
Flinders University

Trophic niche overlap and segregation among elasmobranch predators in a unique island environment

1. Chloe, Roberts; Flinders University
2. Lauren, Meyer; Flinders University
3. Charlie, Huveneers; Flinders University

The processes that allow co-occurring predators to avoid competitive exclusion is the subject of many ecological questions, with resource partitioning the most widely accepted process enabling coexistence. The degree to which predators overlap or divide resources can be explored by quantifying their trophic niche, which is a multidimensional space governed by a species' prey preferences, habitat, and trophic level. Here, we use fatty acids and stable isotopes to quantify trophic niche width and overlap among tiger (*Galeocerdo cuvier*), dusky (*Carcharhinus obscurus*), and Galapagos sharks (*Carcharhinus galapagensis*) from Norfolk Island, an isolated offshore island 800 nm off the east coast of Australia, and determine the variation in overlap across three years. Results reveal substantial overlap between dusky and Galapagos sharks but segregation from the tiger sharks, with all three species contracting and expanding their trophic niches among years but remaining segregated. Changes in trophic niches among years highlights predator ability to adapt to fluctuating resources. Yet, niche overlaps between species remained consistent, indicating stable predatory role and competitive pressure. Temporal variability in the feeding ecology of marine predators is an important component of species' ecology to consider when managing populations, since species that can contract or expand their niche are better able to adapt to environmental change.

Keywords: trophic niche; sharks; stable isotopes; fatty acids; niche overlap

SI Abstract Ref: 312

Lauren Meyer
Flinders University

The diet of tiger sharks on Norfolk Island inferred from biochemical markers

1. Lisa Hoopes; Georgia Aquarium
2. Charlie Huveneers; Flinders University

Norfolk Island is a small island in the Pacific Ocean, ~1,400 km east of Australia that supports a broad diversity of temperate and tropical marine life, including many shark and pelagic fish species. In particular, Norfolk Island is home to a large aggregation of mature female tiger sharks *Galeocerdo cuvier*, with unknown diet, foraging ecology, and movement patterns. While the reliability of this aggregation makes Norfolk Island an ideal site to uncover the ecology of these top predators, no work to date has quantitatively explored what tiger sharks consume in this region, or how long they spend in these coastal waters. The local community has also raised concerns about the disposal of cow offal, rubbish, and fish frames, which are presumed to attract the tiger sharks that are observed feeding at the disposal sight. Here, we used stable isotopes and fatty acids from 60 tiger shark blood and muscle samples collected in 2020 and 2021 to quantify the role of cow offal in the diet of these generalist predators. Despite the frequent observation of tiger sharks consuming cow offal, isotope models suggest that local seabirds are the predominate prey source for these large tiger sharks sampled around Norfolk Island.

Keywords: fatty acid; isotope; trophic
SI Abstract Ref: 292

Patrick J. Burke
School of Natural Sciences, Macquarie University

Multi-disciplinary approach to reveal trophic niche differences and competition avoidance between two temperate shark species

1. Patrick J., Burke; School of Natural Sciences, Macquarie University.
2. Lauren, Meyer; College of Science and Engineering, Flinders University.
3. Vincent, Raoult; School of Environmental and Life Sciences, University of Newcastle.
4. Charlie, Huveneers; College of Science and Engineering, Flinders University.
5. Jane E., Williamson; School of Natural Sciences, Macquarie University.

Quantifying the trophic role of an animal is key to understanding its ecology and ecosystem function. Despite the regular occurrence of sawsharks in Australian temperate fisheries, there remains limited information on their trophic ecology or niche. We used fatty acid and stable isotope profiles, along with stomach content analysis to investigate the trophic ecology of two sympatric species of sawsharks, the common sawshark (*Pristiophorus cirratus*) and southern sawshark (*Pristiophorus nudipinnis*) in south-eastern Australia. C, N and S isotopic analysis of sawshark muscle revealed that *P. nudipinnis* fed at a higher trophic level than *P. cirratus*. Stomach contents also showed that *Pristiophorus nudipinnis* fed on a mix of benthic and pelagic species while *P. cirratus* foraged predominantly on benthic species. This benthic-pelagic partitioning between species was further supported by fatty acid analysis where *P. nudipinnis* fatty acid profiles had higher levels of tracers associated with dinoflagellate basal sources (16:1/16:0, 22:6ω3) than *P. cirratus*, indicating a reliance on pelagic food webs. These data suggest that these two sympatric species may display resource partitioning to avoid competition. Furthermore, that these mesopredators play a substantial role in the pelagic food web which was previously unknown and demonstrates the value of incorporating multiple biochemical tracers to provide a comprehensive representation of an animals trophic ecology.

Keywords: trophic ecology; sawshark; stable isotope; fatty acid; Australia
SI Abstract Ref: 252

Maria Pozo-Montoro
Macquarie University, Australia

Olfactory capabilities of mako shark and blind shark assessed using anatomical and molecular methods.

1. Laura Ryan; Macquarie University, Australia.
2. Oliver Griffith; Macquarie University, Australia.
3. Jemma Geoghegan; University of Otago, New Zealand.
4. Nathan Hart; Macquarie University, Australia

Sharks have been associated with an infamously powerful sense of smell. However, research on the sensory biology of this taxa is still scarce, although it is critical for the development of more selective fishing gear and more efficient shark deterrents. Notably, the selective pressures that shape the olfactory organs of sharks and their effect on olfactory capabilities are poorly understood. Here, a multidisciplinary approach combining anatomical and molecular techniques was used to characterise the olfactory organs of two shark species: the pelagic, shortfin mako (*Isurus oxyrinchus*) and the benthic blind shark (*Brachaelurus*

waddi). The total sensory surface area of the olfactory organs—a traditional proxy of olfactory capabilities—is relatively larger in *I. oxyrinchus* due to greater coverage of sensory epithelium and more extensive secondary folding of the lamellae. However, examination of the de novo-assembled olfactory transcriptomes reveals a more diversified olfactory receptor repertoire in *B. waddi*. These findings suggest that sharks may rely on different olfactory strategies (i.e. more extensive olfactory organs and/or more diversified receptor repertoires) that may be related to the characteristics of the water flow within their olfactory organs, their ecological needs (trade-off sensitivity over diversity of odorants detected) and/or phylogeny. Consequently, these findings indicate that multidisciplinary studies considering the anatomical and molecular traits of the olfactory system of sharks are required to fully comprehend the olfactory capabilities of this group.

Keywords: neuroecology; sensory biology; olfactory rosette; RNA-seq; olfactory receptors

SI Abstract Ref: 67

Colombo Estupiñán-Montaño

Fundación Alium Pacífico

Feeding ontogeny of the silky shark, *Carcharhinus falciformis*, in the Eastern Tropical Pacific of Colombia.

1. Colombo Estupiñán-Montaño
2. Daniel J. Villalobos-Ramírez
3. Felipe Galván-Magaña
4. Fernando R. Elorriaga-Verplancken
5. Manuel J. Zentina-Rejón
6. Alberto Sánchez-González
7. Carlos J. Polo-Silva
8. Antonio Delgado-Huertas⁶

The trophic patterns of predators are the result of differences in habitat use and the relationship with the environment and their prey during their life cycle. The study of the feeding ontogeny of large predators is difficult due to their high mobility, which leaves part of their life poorly understood. This study describes the trophic ontogeny of *Carcharhinus falciformis* in the Colombian Pacific. Vertebrae from 12 specimens were analyzed, obtaining a total of 61 vertebral collagen samples grouped into four maturity stages and eight age groups. The $\delta^{13}\text{C}$ values indicate that the different categories of *C. falciformis* makes use of coastal and oceanic zones (-17.8‰ to -14.0‰). The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values (9.4‰ to 12.4‰) suggest that *C. falciformis* is a species that can occupy different trophic positions (PTs: 3.4-5.6). Isotopic values estimated in *C. falciformis* show small ontogenetic changes in habitat use and prey consumption that were related to age and sex. Additionally, *C. falciformis* showed narrow (SEAC: 0.14‰^2) and broad (SEAC: 3.16‰^2) isotopic niches in the different categories, due to a high trophic interaction between them. In conclusion, *C. falciformis* shows a greater preference for oceanic areas, indicating that the oceanic islands of the southeastern Pacific may be important feeding sites, and Colombian mangroves may be used as potential breeding areas. In addition, this species reflects ontogenetic changes in area use and prey consumption, which leads the species to occupy different trophic positions and show changes in feeding-related to body growth/age, as well as two sex-related migratory patterns.

Keywords: ontogeny; stable isotopes; vertebrae; maturity stages; trophic level

SI Abstract Ref: 40

Aylin Ulman

Mersea Marine Consulting

Angel shark (Squatinae: *Squatina squatina*, *Squatina oculata*, *Squatina aculeata*) records, age validation techniques, and conservation strategies for Turkey

1. Emre Yemişken, Istanbul University.
2. Aylin Ulman, Mersea marine Consulting.
3. Taner Yildiz, Istanbul University.
4. Mehmet Gökoğlu, Akdeniz University.
5. Sara Al Mabruk, Higher Institute Libya.
6. Lütfiye Eryılmaz, Istanbul University.
7. Persefoni Megalafonou, University of Athens

Three species of angel sharks are distributed in the Mediterranean Sea (*Squatina squatina*, *Squatina oculata* and *Squatina aculeata*), all of which are critically endangered. They only remain now in a few pockets surrounding the Mediterranean basin, and mostly at alarmingly low levels. These species have considerable knowledge gaps relating to their age and growth. This study experimented three ageing techniques on *Squatina squatina* which were unable to yield clear results, due to a lack of reference data, but can be used to improve future studies. Since 2018, their catch and landing have become prohibited both in the European Union and Turkey, hence fishers no longer report these catches in fear of penalties. Therefore, each angel shark record is extremely important in understanding their distribution, habitat use and remaining hotspots with the aim of protecting their last refuges. This study adds seven new angel shark records for Turkish waters, three *Squatina squatina*, three *Squatina aculeata* and one *Squatina oculata*, confirming all three species are still currently found in the region and denoting parts of the Aegean Sea as remaining hotspots. The presence of all three species should warrant immediate conservation actions to improve their prospects and protect them from localized extinction.

Keywords: fisheries management; aging techniques; Squatinidae; Elasmobranchii; Eastern Mediterranean

SI Abstract Ref: 61

Natascha Wosnick

Universidade Federal do Paraná; Associação MarBrasil

Is release a good strategy for incidentally captured guitarfish? a physiological approach to inform fisheries management and elasmobranch conservation.

1. Natascha, Wosnick; Universidade Federal do Paraná, Associação MarBrasil
2. Eloísa Pinheiro, Giareta; Universidade Federal do Paraná, Associação MarBrasil
3. Samuel Balanin; Universidade Federal do Paraná, Associação MarBrasil
4. Leonardo de Paula Rios; Associação MarBrasil
5. Patricia Charvet; Universidade Federal do Ceará
6. Renata Daldin Leite; Universidade Federal do Paraná, Associação MarBrasil

One of the main components of effective fisheries management is post-capture survival rates. Globally, Rhino rays are the most threatened among all vertebrates, and bycatch poses a significant challenge to their conservation. Moreover, most species are endemic to areas where inspection is scarce and fisheries management is difficult to implement (i.e., low and middle-low-income countries). In these situations, recovery plans based on fishers' participatory management through bycatch release is a promising strategy. However, it is necessary to understand how species respond to capture as well as how they recover from it. The present study aimed to investigate the recovery capacity of incidentally captured Shortnose Guitarfish through the analysis of energy markers (β -hydroxybutyrate and glucose) and circulating levels of lactate. *Zapteryx brevirostris* captured by artisanal fleets were donated to our research group and kept fasted and monitored for 120 hours before release. Blood samples were collected shortly after capture and right before release. The results indicated that all guitarfish depleted their β -hydroxybutyrate reserves, concomitant to glucose mobilization and high levels of circulating lactate upon capture, indicating allostatic overload and lactic acidosis. After 120 hours, all subjects were able to recover their β -hydroxybutyrate stores, and both glucose and lactate levels were significantly lower. The results indicate great recovery potential in *Z. brevirostris* - strongly affected by bycatch despite its low selling price. The species is currently listed as "Endangered" globally, and recovery plans based on bycatch release proved to be effective based on their recovery capacity.

Keywords: conservation physiology; stress; commercial fisheries; release

SI Abstract Ref: 267

Vicky Fong

Marine Megafauna Foundation

Using Drones to Assess Volitional Swimming Kinematics of Manta Ray Behaviors in the Wild

1. Vicky, Fong; Marine Megafauna Foundation.
2. Sarah, Hoffmann; Merck Animal Health.
3. Jessica, Pate; Marine Megafauna Foundation.

Drones have become increasingly popular tools to study marine megafauna but are underutilized in batoid research. We used drones to collect video data of manta ray (*Mobula cf. birostris*) swimming and assessed behavior-specific kinematics in Kinovea, a semi-automated point-tracking software. We describe a 'resting' behavior of mantas making use of strong currents in man-made inlets in addition to known 'traveling' and 'feeding' behaviors. No significant differences were found between the swimming speed of traveling and feeding behaviors, although feeding mantas had a significantly higher wingbeat frequency than traveling mantas. Resting mantas swam at a significantly slower speed and wingbeat frequency, suggesting that they were continuously swimming with the minimum effort required to maintain position and buoyancy. Swimming speed and wingbeat frequency of traveling and feeding behaviors overlapped, which could point to other factors such as prey availability and a transitional behavior, influencing how manta rays swim. Additionally, we present preliminary swimming kinematics data of a 'surface feeding' behavior. As 'surface feeding' was only observed in larger, and possibly mature, individuals, future research should investigate any ontogenetic separation of behaviors and kinematics. These baseline swimming kinematic data have valuable applications to other emerging technologies in manta ray research.

Keywords: manta ray; behavior; kinematics; drones

SI Abstract Ref: 100

Nico Fassbender

University of Western Australia; Marine Futures Lab

Behavioural patterns in marine predators - how does reef habitat complexity affect the distribution and habitat use of reef sharks?

Nico, Fassbender; University of Western Australia

Increases in shark fishing and the frequency of climate disturbance events in the last decades have led to a global decline in reef shark populations and degradation of the coral reefs they inhabit. A recent study documented that sharks were absent from 20% of the 371 reefs surveyed (MacNeil et al., 2020). Indian Ocean areas were highlighted as in crucial need of protection and were identified as having great potential to implement shark-based management approaches.

The aim of this research is to understand how coral reef complexity influences shark habitat use at fine scales. I will use seabed Baited Remote Underwater Video Systems (BRUVS), acoustic telemetry, faecal DNA (fDNA) swabbing, and coral and fish diversity and biomass monitoring datasets to document the fine-scale distribution and habitat use patterns of three reef shark species, the grey reef shark (*Carcharhinus amblyrhynchos*), blacktip reef shark (*Carcharhinus melanopterus*), and sharptooth lemon shark (*Negaprion acutidens*). Their behaviour will then be correlated to reef complexity acquired from 3D structure from motion (SfM) photogrammetry modelling to understand how future reef homogenization may affect shark behaviour.

The distribution of sharks is frequently studied at large spatial scales over 100s to 1000s of kilometres. My research, focused on small scale distributions across 100s to 1000s of metres and the drivers of these patterns with respect to habitat complexity and prey availability, is a novel and conservation-relevant addition to the existing literature. The outcomes of this research can be utilized by practitioners across the Indian Ocean and Indo-Pacific region and will not only further our understanding of the intrinsic fine scale behaviour of these predators, but aid in the planning, implementation and management of marine protected areas (MPAs) in the region.

Keywords: reef sharks; habitat complexity; fine scale behaviour; low-cost high-tech; Seychelles

SI Abstract Ref: 106

Kathryn Flowers

Florida International University

Drivers of ray sightings on baited remote underwater videos in the tropical Western Atlantic Ocean

1. Elizabeth Babcock; University of Miami.
2. Yannis Papastamatiou; Florida International University.
3. Michael Heithaus; Florida International University.
4. Euan Harvey; Curtin University.
5. Michelle Heupel; Integrated Marine Observing System.
6. Aaron MacNeil; Dalhousie University.
7. Mark Meekan; Australian Institute of Marine Science.
8. Colin Simpfendorfer; James Cook University.
9. Demian Chapman; Mote Marine Laboratory.

****Please note there are many local collaborators who will be co-authors on this work. I will present a slide with all of their names if my talk is accepted. Thank you for understanding.**

Rays are threatened globally by overfishing, habitat loss, climate change, and pollution. In the tropical Western Atlantic Ocean, rays are part of artisanal, commercial, and recreational fisheries, yet management is sparse and hindered by a lack species-specific population data. Drivers of ray abundance and habitat use in the region are not well-understood. To address these knowledge gaps, we compared ray sightings per unit effort (MaxN) across gradients of human pressure (market gravity), fishing regulations, fishing gear, predator abundance (shark MaxN), and environmental variables using a baited remote underwater video station (BRUVS) dataset provided by Global FinPrint. Over 3500 BRUVS were set on coral reefs in 17 countries from the United States to Brazil that detected at least nine ray species (*Aetobatus narinari*, *Hypanus americanus*, *H. berthalutzae*, *H. marianae*, *Mobula sp.*, *Narcine bancroftii*, *Pseudobatos lentiginosus*, *Styracura schmardae*, *Urobatis jamaicensis*). Factors influencing MaxN of the most common ray species and pooled MaxN of all rays will be presented. We will discuss the implications of our results for local and regional management.

Keywords: batoids; BRUVS; Caribbean; relative abundance

SI Abstract Ref: 125

Hugo Sanchez Gomez

Centro de Investigaciones Biologicas del Noroeste; Pelagios Kakunja A.C.

The importance of a no-take zone for top predators in the Mexican Pacific: implications for the conservation and management of predatory fish

1. Hugo Sanchez Gomez; Centro de Investigaciones Biologicas del Noroeste; Pelagios Kakunja A.C.
2. James Thomas Ketchum; Pelagios Kakunja A.C.
3. Edgar Mauricio Hoyos Padilla; Pelagios Kakunja A.C.
4. Eduardo Francisco Balart Paez; Centro de Investigaciones Biologicas del Noroeste
5. Miguel Grau Gomez; Pelagios Kakunja A.C.

We used 140 pelagic BRUVS (244 recording hours) to compare the diversity and abundance (MaxNhr) of pelagic fishes between at a no-take (Revillagigedo Archipelago, RA) and a mostly unprotected region (southwestern Gulf of California, SGC). While mesopredator fishes such as carangids, snappers and skipjacks dominated the assemblages of the SGC (73.4% of total abundance), the RA showed a higher dominance of top predators (62.42% of total abundance). Species such as the yellowfin tuna (*Thunnus albacares*), silky shark (*Carcharhinus falciformis*), silvertip shark (*C. albimarginatus*) and Galapagos shark (*Carcharhinus galapagensis*) showed high abundances in the RA. These carcharhinid species showed the highest number of sightings of all fishes in the RA (frequency of appearance > 50%), which highlights the importance of this marine reserve for the conservation of predatory fishes. With this information, we intend to establish a baseline for monitoring the pelagic predators in both regions.

Keywords: sharks; marine reserves; Revillagigedo; conservation; monitoring

SI Abstract Ref: 300

Francesco Ferretti

Virginia Tech

From data deficient to big data in shark conservation

1. Francesco Ferretti; Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, Virginia, USA
2. Jeremy Jenrette; Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, Virginia, USA
3. Filippo Bargnesi; Polytechnic University of Marche, Ancona, Italy
4. Stefano Moro; Stazione Zoologica Anton Dohrn, Rome, Italy
5. Zac Liu; Hopkins Marine Station of Stanford University, Pacific Grove California, USA
6. Cheryl Butner; Hopkins Marine Station of Stanford University, Pacific Grove California, USA
7. Edward Fox; Department of Computer Science, Virginia Tech, Blacksburg, Virginia, USA
8. Steven Haddock; Monterey Bay Aquarium Research Institute, Moss Landing, California, USA
9. Trevor Hastie; Department of Statistics and Department of Biomedical Data Science, Stanford University, Palo Alto, California, USA
10. Salvador Jorgensen; University of California Santa Cruz, Santa Cruz, California, USA
11. Fiorenza Micheli; Hopkins Marine Station of Stanford University, Pacific Grove California, USA

Sharks are declining rapidly because of their vulnerable life histories and the direct and indirect impacts of fishing and habitat modification. For this reason, they are among the most endangered animals in the ocean. Meanwhile, they are also among the most poorly quantified groups of vertebrates on the planet, as basic information on abundance, distribution, and life-history is lacking for most species. Hence there is an urgent need to collect and analyze data on sharks to increase our understanding of their ecology, develop effective conservation actions, and reverse their loss. Here we show how crowdsourcing, web data-mining, and machine learning techniques can fill this critical information gap. We are building the largest database of shark occurrence records by implementing sharkPulse, a modular crowd-sourcing platform that combines smartphone and web applications, social network and website crawling, and image analysis to fill knowledge gaps in global shark populations. We will illustrate the architecture of this platform and show how hundreds of thousands of online images can be sourced and transformed into shark sightings. We explore the opportunities from crowdsourcing, artificial intelligence, big-data approaches, and social network mining to quickly and cost-effectively fill major knowledge gaps in shark distribution and characterize their status and drivers of decline. We also list a series of challenges that need to be addressed to efficiently source this information continuously and produce efficient and real-time monitoring of global shark populations.

Keywords: citizen science; web data-mining; machine learning; big data; global shark populations

SI Abstract Ref: 337

Jeremy Jenrette

Virginia Polytechnic Institute and State University

Shark detection and classification with machine learning

Jenrette, Jeremy., ZY-C, Liu., Chimote, Pranav., Fox, Edward., Hastie, Trevor., and Ferretti, Francesco

Suitable shark conservation depends on well-informed population assessments. Direct methods such as scientific surveys and fisheries monitoring are adequate for defining population statuses, but species-specific indices of abundance and distribution coming from these sources are rare for most shark species. We can rapidly fill these information gaps by boosting media-based remote monitoring efforts with machine learning and automation.

We created a database of 53,345 shark images covering 219 species of sharks, and packaged object-detection and image classification models into a Shark Detector bundle. The Shark Detector recognizes and classifies sharks from videos and images using transfer learning and convolutional neural networks (CNNs). We applied these models to common data-generation approaches of sharks: collecting occurrence records from photographs taken by the public or citizen scientists, processing baited remote camera footage and online videos, and data-mining Instagram. We examined the accuracy of each model and tested genus and species prediction correctness as a result of training data quantity.

The Shark Detector can classify 47 species pertaining to 26 genera. It sorted heterogeneous datasets of images sourced from Instagram with 91% accuracy and classified species with 70% accuracy. It located sharks in baited remote footage and YouTube videos with 89% accuracy, and classified located subjects to the species level with 69% accuracy. All data-generation methods were processed without manual interaction.

As media-based remote monitoring appears to dominate methods for observing sharks in nature, we developed an open-source Shark Detector to facilitate common identification applications. Prediction accuracy of the software pipeline increases as more images are added to the training dataset. We provide public access to the software on our GitHub page.

Keywords: data-mining; image classification; Instagram; machine learning; sharks

SI Abstract Ref: 160

Kathryn Anne Ayres

CICIMAR-IPN; Pelagios Kakunja

Seasonal aggregations and movements of blacktip sharks (*Carcharhinus limbatus*) at Cabo Pulmo National Park, Gulf of California, Mexico

1. Kathryn, Ayres; CICIMAR-IPN.
2. James, Ketchum; Pelagios Kakunja.
3. Rogelio, González Armas; CICIMAR-IPN.
4. Felipe, Galván Magaña; CICIMAR-IPN.
5. Alex, Hearn; Universidad San Francisco de Quito.
6. Fernando, Elorriaga Verplancken; CICIMAR-IPN.
7. Edgar Mauricio, Hoyos-Padilla; Pelagios Kakunja.
8. Stephen, Kajiura; Florida Atlantic University.

Blacktip shark (*Carcharhinus limbatus*) aggregations can be observed along the coastline of Cabo Pulmo National Park (CPNP), a no-take marine protected area in the Gulf of California. Unoccupied Aerial Vehicle (UAV) surveys were completed bi-weekly (every two weeks) over a stretch of sandy habitat for three consecutive years between January 2019 and December 2021. *C. limbatus* abundance ranged between 1 and 1229 sharks (282 ± 43 , mean \pm SE) in winter months (December – April), when sea surface temperature (SST) was below 25 °C. Time of day, year and photoperiod were also significant predictors ($p < 0.01$) of abundance according to the Generalized Additive Model (GAM). Results from sharks tagged with acoustic ($n = 20$) and satellite tags ($n = 4$) indicated a northerly migration in late spring, before returning to CPNP in winter.

Keywords: UAV; aerial survey; acoustic telemetry; satellite tracking; Generalized Additive Model

SI Abstract Ref: 104

Charlotte Pike

Zoological Society of London / Angel Shark Project: Canary Islands

Establishing a method to identify and prioritise areas for protection of Angelshark (*Squatina squatina*) in the Canary Islands.

1. Maria Belén Caro; Angel Shark Project: Canary Islands
2. Hector Toledo; Angel Shark Project: Canary Islands
3. David Jiménez Alvarado; Universidad de Las Palmas de Gran Canaria
4. Eva Meyers; Zoological Research Museum Alexander Koenig & Angel Shark Project: Canary Islands
5. Joanna Barker; Zoological Society of London & Angel Shark Project: Canary Islands
6. Michael Sealey; Angel Shark Project: Canary Islands
7. Charlotte Pike; Zoological Society of London & Angel Shark Project: Canary Islands
8. Matthew Gollock; Zoological Society of London

The Angelshark (*Squatina squatina*) was formerly common across the East Atlantic and Mediterranean Seas, but has undergone dramatic declines over the last 50 years. Despite this reduction, the Canary Islands remain a uniquely large stronghold for the species, where Angelsharks can still be observed frequently. Protection of Angelsharks in the Canary Islands is therefore of vital importance to ensure the survival of the species, as threats such as habitat loss and accidental capture in fisheries still impact Angelsharks in these waters.

In 2019, Angelsharks were listed in the Spanish Endangered Species List for Canary Islands waters, under the category “In danger of extinction”. In accordance with this listing, it was required that a Recovery Plan be developed, including the delineation of areas relevant to the conservation of the Angelsharks (ARCA), where specific measures should be implemented.

In order to identify ARCA in the Canary Islands, Angel Shark Project: Canary Islands (ASP:CI) completed geospatial analysis of Angelshark distribution using available data, from both scientific surveys and citizen science sightings. Using this data, alongside current knowledge of Angelshark ecology, ASP:CI were able to determine specific criteria to delineate ARCA in the Canary Islands. We will present these methods whilst discussing the limitations related to designating critical areas for data limited species, and highlighting the importance of translating scientific evidence into policy action.

This work, led by ASP:CI, was funded by Shark Conservation Fund and through a contract with the Canary Islands Government, co-financed by the FEDER 2014-2020 Operational Program.

Keywords: Angelshark; distribution; mapping; spatial protection; management

SI Abstract Ref: 332

Veronika Biskis

University of the Sunshine Coast

Sawfish spotters fill data gaps critical for protection in Queensland, Australia

1. Veronika Biskis, University of the Sunshine Coast.
2. Dr Kathy Townsend, University of the Sunshine Coast
3. Dr Barbara Wueringer, Sharks And Rays Australia

In Australia, effective management of critically endangered sawfishes is a difficult task, in part due to remaining habitat being extremely remote and expensive to reach. Since the federal recovery plan was put in place in 2015, field investigation in Queensland has been limited to a select few river systems, not allowing for a full-scale species distribution assessment. In 2017, Sharks And Rays Australia launched a public sightings campaign targeted at recreational fishers to fill knowledge gaps in population abundance and spatial ecology. Since then, over 950 submissions have been received Australia-wide from members of the public. Data from Queensland encounters reported to have taken place between 1998 and 2022 were analysed, representing equal temporal distribution before and after federal protection.

Sighting locations were analysed for association with commercial and recreational fishing pressure and environmental protection measures. Size and year of capture were shown to be negatively correlated, even over a relatively short time span of 20 years. Condition of the animal also varied with species, size and method of capture, indicating a varied impact on sawfishes through different fishing methods.

This study provides first insights into key habitat for different life history stages on the Queensland coast since becoming federally protected. Additionally, findings highlight the importance of citizen science as a reliable data source, and a platform for the direct involvement of the recreational fishing community in protecting critically endangered species.

Keywords: sawfish; citizen science; fisheries; distribution; conservation

SI Abstract Ref: 347

Michael James Sealey

Angel Shark Project: Canary Islands

The value of citizen science “Count the Angels” events towards the study of Angelsharks (*Squatina squatina*) in the Canary Islands.

1. Michael James, Sealey; Angel Shark Project: Canary Islands
2. Leire, Gabiola Hernández; Universidad de Alicante
3. Joanna, Barker; Zoological Society of London & Angel Shark Project: Canary Islands
4. Charlotte, Pike; Zoological Society of London & Angel Shark Project: Canary Islands
5. Héctor, Toledo; Angel Shark Project: Canary Islands
6. Belén, Caro; Angel Shark Project: Canary Islands
7. Eva, Meyers; Zoological Research Museum Alexander Koenig & Angel Shark Project: Canary Islands
8. David, Jiménez-Alvarado; Universidad de Las Palmas de Gran Canaria & Angel Shark Project: Canary Islands
9. Alexander Lehnen; Angel Shark Project: Canary Islands

As the popularity of recreational scuba diving grows, so does the will of scuba divers to contribute towards the protection and conservation of the marine environment. This growth has been accompanied by the establishment of a citizen science movement aimed to engage and recruit scuba divers in data collection for research. This innovative tool has been used in the Canary Islands to gather data on the Critically Endangered Angelshark (*Squatina squatina*) through an annual event named Count the Angels (CTA), which has been completed for four years (2018-2021).

The CTA event is organised under the direction and supervision of the Angel Shark Project: Canary Islands. During four days, participating dive centres and clubs carry out two coordinated dives at scheduled hours and register specific data, including Angelshark sightings. The last CTA event was held from the 4 to the 7 of December 2021, with a total of 37 participating dive centres and clubs, 107 dives registered and a total of 166 Angelsharks recorded throughout five of the Canary Islands. The collected data has allowed different analysis including shark size and sex ratio, behaviour patterns, encounter probability and abundance estimates for the different islands.

This unique and growing event is an example of how citizen science can be a valuable tool not only to support Angelshark research, but also as a mechanism to create awareness and engage scuba divers towards the conservation of a Critically Endangered species.

CTA events were funded by Shark Conservation Fund, Disney Conservation Fund and WWF Netherlands.

Keywords: Angelshark; canary islands; citizen science; scuba divers

SI Abstract Ref: 352

Rima Jabado

Elasmo Project, Dubai, United Arab Emirates

Rhino rays – uncovering the drivers behind their exploitation in data-poor areas

1. Rima W. Jabado, Elasmo Project, Dubai, United Arab Emirates
2. Niang Alioune, Institut Mauritanien de Recherches Océanographiques et de Pêches (IMROP), Mauritania
3. Mamadou Ba, Parc National du Banc d'Arguin (PNBA), Mauritania
4. Luc B. Badji, Institut Universitaire de pêche et d'Aquaculture (IUPA), Dakar, Sénégal
5. Alissa Barnes, Elasmo Project, Dubai, United Arab Emirates
6. Helene Buchholzer, Blue Resources Trust, Colombo, Sri Lanka
7. Daniel Fernando, Blue Resources Trust, Colombo, Sri Lanka
8. Ramajeyam Gobiraj, Blue Resources Trust, Colombo, Sri Lanka
9. Divya Karnad, Department of Environmental Studies, Ashoka University, Sonapat, Haryana, India
10. Buddhi Maheshika, Blue Resources Trust, Colombo, Sri Lanka
11. Sushmita Mukherji, CSIRO-UTAS Quantitative Marine Sciences PhD Program, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, Australia
12. Akshay Tanna, Blue Resources Trust, Colombo, Sri Lanka
13. Sahan Thilakarathna, Blue Resources Trust, Colombo, Sri Lanka

Rhino rays are facing a global conservation crisis. These 67 species (families Pristidae (Sawfishes), Glaucostegidae (Giant Guitarfishes), Rhinidae (Wedgefishes), Rhinobatidae (Guitarfishes), and Trygonorrhinidae (Banjo Rays)) have limited productivity making them extremely susceptible to overexploitation. Rhino rays face an uncertain future with 68.7% considered threatened with extinction according to the IUCN Red List of Threatened Species. We focus on understanding the status and uncovering the drivers behind their exploitation in four data-poor countries: India, Mauritania, Senegal, and Sri Lanka. These species richness or endemism hotspots are data-poor in terms of fisheries, have some of the poorest coastal communities, and species' distributions overlap with intense and increasing fishing pressure. Data were collected by interviewing fishers and traders to record historical knowledge and current perceptions, as well as landing site surveys to collect data on species and

assess how fisheries impact them. Results suggest that species exploitation is not always driven by the fin trade but also by demand for their meat, often consumed locally. Landing site surveys indicate a low abundance of species while fishers describe historical high abundances, indicative of potential localized extinctions going unnoticed. The complexities in understanding these fisheries at the local scale highlight that conventional fisheries management measures are unlikely to yield results, especially when governance is weak in terms of enforcement and policy implementation. Adaptive local actions are needed with solutions based on fisher engagement to ensure their livelihoods and nutritional needs are taken into consideration while identifying potential mitigation measures or solutions to reduce demand.

Keywords: conservation; threatened species; guitarfish; wedgefish; Rhinopristiformes

SI Abstract Ref: 170

Posters (Online)

Ana Lúcia Furtado Soares

Ludwig-Maximilians Universität München, University of Munich

Elasmobranch fisheries in Angola: a fishers' perspective

Andhika Prima Prasetyo

Centre Fisheries Research, Ministry for Marine Affairs and Fisheries, Indonesia

Shark-dust: High-throughput DNA sequencing of processing residues unveils rife trade in endangered sharks and rays

Alan Heriberto Delgado Ramos

Centro Interdisciplinario de Ciencias Marinas (CICIMAR)-IPN

Reproductive biology of the grey smoothhound *Mustelus californicus* (Gill, 1864) in Bahía Tortugas, Baja California Sur, México.

Akshay Tanna

Blue Resources Trust

Where have all the sawfishes gone? Perspectives on declines of these Critically Endangered species in Sri Lanka

Amanda Pontes Lopes

Laboratory of Environmental Health Assessment and Promotion, Instituto Oswaldo Cruz/Fiocruz, Av. Brazil, 4.365, Manguinhos, Rio de Janeiro, 21040-360, Brazil 1; Postgraduate Program in Biodiversity and Health (PPGBS), Instituto Oswaldo Cruz/Fiocruz 2; Department of Chemistry, Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Rua Marquês de São Vicente, 225, Gávea, 22453-900 Rio de Janeiro, RJ, Brazil 3; Center for Food Analysis, Technological Development Support Laboratory, Federal University of Rio de Janeiro, Cidade Universitária 21941-598, RJ, Brazil 4; National Institute of Health Quality Control, Oswaldo Cruz Foundation, Rio de Janeiro 21040-900, RJ, Brazil 5; Graduate Program in Sanitary Surveillance (PPGVS), National Institute of Health Quality Control 6;

Lanthanum contamination in Groovebelly Stingray (*Dasyatis hypostigma*) in the tropical Southeast Atlantic

Amanda Pontes Lopes

Laboratory of Environmental Health Assessment and Promotion, Instituto Oswaldo Cruz/Fiocruz, Av. Brazil, 4.365, Manguinhos, Rio de Janeiro, 21040-360, Brazil 1; Postgraduate Program in Biodiversity and Health, Instituto Oswaldo Cruz/Fiocruz 2; Department of Chemistry, Pontifical Catholic University of Rio de Janeiro (PUC-Rio), Rua Marquês de São Vicente, 225, Gávea, 22453-900 Rio de Janeiro, RJ, Brazil 3;

Ampullae of Lorenzini Ti and As contamination in Groovebelly Stingrays (*Dasyatis hypostigma*) from the tropical Southeast Atlantic

Antonia Klöcker

Institute of Marine Research (IMR)

On the edge – Deciphering migration patterns of basking sharks in the Arctic

Amani Webber-Schultz

Friday Harbor Labs; New Jersey Institute of Technology

Comparative Morphology and Flow Analysis of Dermal Denticles at the Nares of the Pacific Spiny Dogfish, *Squalus suckleyi*

Pierluigi Carbonara

COISPA Tecnologia & Ricerca

Trophic niche and feeding behavior of the blue shark, *Prionace glauca*, in the South Adriatic Sea (Central Mediterranean)

Jorge I. Rosales-Vásquez

1 Fundación Mexico Azul; 2 Grupo de Investigadores Libres Sphyrna

New record of the eastern Pacific black ghost shark *Hydrolagus melanophasma* James, Ebert, Long & Didier, 2009 (Chondrichthyes, Holocephalii, Chimaeriformes) from Cabo San Lucas, Baja California, México

Catarina Pereira Santos

MARE | Marine and Environmental Sciences Centre

Sharks in the anthropocene - a systematic map of global research efforts

Carlos Daniel Becerra Hernández

Laboratorio de Ecología de la Salud, Facultad de Ciencias, Universidad Autónoma de San Luis Potosí.

Presencia de microplásticos en contenido estomacal de tiburones del Pacífico Norte Mexicano.

Andrea Di Tommaso

Università della Calabria

Spatio-temporal distribution of *Carcharhinus melanopterus* in Koh Tao (Thailand) through UAV

Francesco Maria Achille Consoli

Veterinary Histology and Pathology, Atlantic Center for Cetacean Research, University Institute of Animal Health and Food Safety (IUSA), University of Las Palmas de Gran Canaria, Arucas, Las Palmas, Spain 1.

Anatomical study of the head of the Angelshark (*Squatina squatina*) by diagnostic imaging techniques

Francesco Maria Achille Consoli

Veterinary Histology and Pathology, Atlantic Center for Cetacean Research, University Institute of Animal Health and Food Safety (IUSA), University of Las Palmas de Gran Canaria, Arucas, Las Palmas, Spain

Ultrasound as a diagnostic imaging tool for studying the internal anatomy of the Angelshark (*Squatina squatina*)

Frida Lara Lizardi

Orgcas/ Migramar

A new approach for shark conservation, Proyecto Tiburón

Georgios Rallis

iSea, Environmental Organisation for the Preservation of the Aquatic Ecosystems

Discovering the feeding habits of rays in the Ambracian Gulf

Gustavo Montero Hernández

Institute for Animal Health and Food Safety (IUSA), Veterinary School, Universidad Las Palmas de Gran Canaria (ULPGC), Arucas, Spain; Department of Mathematics, Universidad de Las Palmas de Gran Canaria, Campus de Tafira, Las Palmas de Gran Canaria, Spain; Aquarium Poema del Mar, Fundación Loro Parque (Las Palmas de Gran Canaria, Spain)

Hematological and plasma biochemical parameters of the round stingray (*taeniura grabata*)

Harriet Allen

Shark Trust

20 years of the Great Eggcase Hunt

Harriet Allen

Shark Trust

Shark Log – a citizen science project

J. Juan Rendón-Herrera

Facultad de Ciencias del Mar, Universidad Autónoma de Sinaloa, Mazatlán, Mexico; Cátedras CONACYT, Consejo Nacional de Ciencia y Tecnología, CDMX, Mexico.

Multiple Paternity in two smooth-hound sharks from the northern Gulf of California

Katherin Soto-López

Escuela de Sistemas Biológicos e Innovación Tecnológica Universidad Autónoma Benito Juárez de Oaxaca; Centro Interdisciplinario de Ciencias Marinas (CICIMAR)- IPN

First record of clasper malformation of *Pseudobatos buthi* (Chondrichthyes: Rhinobatidae) in the Gulf of California

Zaccagnini Lucas

Institut Universitaire Européen de la Mer ; Des Requins et des Hommes

Environmental DNA detection of threatened shark species and commercially valuable tuna genus on an unstudied seamount in the Colombian Pacific Ocean

Marja J. Kipperman

Royal (Dick) School of Veterinary Studies and the Roslin Institute, University of Edinburgh, EH25 9RG, Edinburgh, UK

Conservation genetics of the Bowmouth guitarfish (*Rhina ancylostoma*) in the Indian Ocean

Marcela Alvarenga de Almeida Simões

CIBIO, Research Centre in Biodiversity and Genetic Resources, InBIO Associate Laboratory – Universidade do Porto, Campus de Vairão, Vairão 4485-661, Portugal; BIOPOLIS Program in Genomics, Biodiversity and Land Planning, Campus de Vairão, Vairão 4485-661, Portugal; Departamento de Biologia, Faculdade de Ciências, Universidade do Porto, Porto 4099-002, Portugal; Faculdade de Ciências e Letras de Assis, Universidade Estadual Paulista “Júlio de Mesquita Filho” (UNESP), Assis 19806-900, São Paulo, Brasil; Department of Marine Science, The University of Texas at Austin, Marine Science Institute, Port Aransas 78373, Texas, USA; Universidade do Estado de Minas Gerais (UEMG), Frutal 38200-000, Minas Gerais, Brasil; Instituto de Biociências de Botucatu (IBB), Universidade Estadual Paulista “Júlio de Mesquita Filho” (UNESP), Botucatu 18618-689, São Paulo, Brasil;

Years of extensive and inadvertent consumption of endangered sharks and rays in Brazil unraveled through DNA analysis: How can we do better?

Mohsen Rezaie-Atagholipour

Qeshm Environmental Conservation Institute (QECI), Qeshm Island, Hormozgan, Iran

Flat and fragile: threats to rays in Iranian waters

Nidhi Gloria D'Costa

Institution 1: Recent Graduate from Marine Affairs Program, Dalhousie University, Halifax, NS B3H 4R2, Canada; Institution 2: Research Assistant at Worm Lab, Department of Biology, Dalhousie University, Halifax, NS B3H 4R2, Canada; Institution 3: Research collaboration with Environmental Markets Lab, University of California, Santa Barbara, 93117, United States.

Identifying priority areas for shark conservation through the lens of global anti-finning legislations

Pablo Morón-Elorza

Fundación Oceanográfica

Capillary Zone Plasma Protein Electrophoresis Analysis in Nursehound Sharks (*Scyliorhinus stellaris*) Maintained Under Human Care

About Paul

Des Requins et Des Hommes

Photo- Identification catalogue : a free diving and collaborative project to evaluate porbeagle shark (*Lamna nasus*) ecological behavior off Brittany French coasts ...or further !

Pablo Dufflocq

Food Quality Research Center - Universidad de Chile

Assessing food fraud in the Chilean chondrichthyan meat market

Pablo Dufflocq

Food Quality Research Center

Population structure of Shortfin Mako and Porbeagle shark: two highly migratory and threatened species present in Chile

Ruben Dario Morales-Gamba

Federal University of Amazonas; National Institute of Amazonian Research

Progesterone receptors and sperm aggregates in active male genital ducts of *Potamotrygon wallacei* (Chondrichthyes - Potamotrygonidae)

Ryan J. Nevatte

School of Natural Sciences, Macquarie University, North Ryde, New South Wales, Australia

Crossed saws: Evidence of hybridisation between Australian sawsharks

Sergio Madrigal-Mora

Department of Biological Science and Mathematics California State University Long Beach.

Movement and residency patterns of *Ginglymostoma unami* in a Marine Management Area in the north Pacific coast of Costa Rica.

Thomaz Stefani Fuzetti

Universidade Federal do Paraná (UFPR); Universidade Federal do Ceará (UFC).

Diagnosis of recreational shark and ray fishing off the coast of São Paulo, southeastern Brazil

Vasco Pissarra

Marine and Environmental Sciences Centre (MARE), Faculdade de Ciências, Universidade de Lisboa (FCUL), 2750-374 Cascais, Portugal.

Fishermen's perceptions on the importance and use of sharks in sao tome island (gulf of guinea, west africa)

Dalrun Kaldakvisl

Laxfiskar

Shark fishing in Iceland. A marine environmental history

Yan Torres

1. Marine Vertebrate Evolution and Conservation Lab – Evolve, Departamento de Biologia, Centro de Ciências,, Universidade Federal do Ceará, Fortaleza, Campus do Pici, Bloco 909, 60440-900, Fortaleza, CE, Brazil

Spotting the gaps: frontiers in Potamotrygoninae genetics

Zachary Mühlenweg

Archipelagos Institute of Marine Conservation

Establishing a Protocol for Coastal Elasmobranch Biodiversity Assessments

Agustí Torres

SHARK MED

Innovative BRUVs to support knowledge and conservation of sharks in the Balearic islands through citizen science

Gislayne Mendoza

San Francisco de Quito University

Validating taxonomic entities from the eagle rays in the Eastern Tropical Pacific: the presence of *Aetobatus ocellatus* in Galapagos (Ecuador)

Lydie Couturier

Environmental Integration Programme, France Energies Marines

Monitoring the habitat use and movements of sharks and rays in a context of offshore wind energy development

Rachel M. Aitchison

Pacific Shark Research Center, Moss Landing Marine Laboratories, San Jose State University, Moss Landing, CA, USA

Redescription of Southwestern Indian Ocean Rhinobatos (Rhinopristiformes: Rhinobatidae)

Dr Chantel Elston

South African Institute for Aquatic Biodiversity

Seasonal estuary use by stingrays in South Africa

Arlin Gabriela Ramos Rodriguez

Universidad Autónoma del Estado de Quintana Roo, Unidad Académica Cozumel, Quintana Roo, Av. Andrés Quintana Roo, Colonia San Gervasio, C.P. 77600 Cozumel, Mexico.

Age and growth of the banded guitarfish, *Zapteryx exasperata* (Jordan & Gilbert 1880), in the Gulf of California, México.

Stephen Bergacker

Université libre de Bruxelles; Vrije Universiteit Brussel

Biogeography of Indo-Pacific Spotted Eagle Rays (*Aetobatus ocellatus*)

Mauro Sinopoli

Department of Integrative Ecology (EMI), Interdepartmental Centre of Sicily, Stazione Zoologica Anton Dohrn - Italian National Institute for Marine Biology, Ecology and Biotechnology, Palermo, Italy.

First observations on the feeding habit of the blackspotted smooth-hound, *Mustelus punctulatus*, from the Marine Protected Area of the Egadi Islands (Central Mediterranean Sea)

Danielle Davenport

School of Biomedical Sciences, The University of Queensland

Genetic signatures of population decline in white shark (*Carcharodon carcharias*, L.) populations: a natural history investigation.

Hannah Rudd

Angling Trust

Shark Hub UK: A model for building and maintaining resilient relationships between recreational shark anglers and scientists to research and conserve sharks

Shigehiro Kuraku

National Institute of Genetics, Japan; RIKEN BDR, Japan

Squalomix: consortium for analyzing chondrichthyan fish genome sequences