

European Elasmobranch
Association
Annual Science Meeting

“Are we there yet?”

What developments in the science and policy landscape
have delivered for shark and ray conservation



Leiden 2-5 November 2021

ABSTRACTS OF THE EUROPEAN ELASMOBRANCH ASSOCIATION ANNUAL SCIENTIFIC CONFERENCE

Are we there yet?

“What developments in the science and policy landscape have delivered for shark and ray conservation”

2nd to 5th November 2021

Leiden

The Netherlands

Colophon

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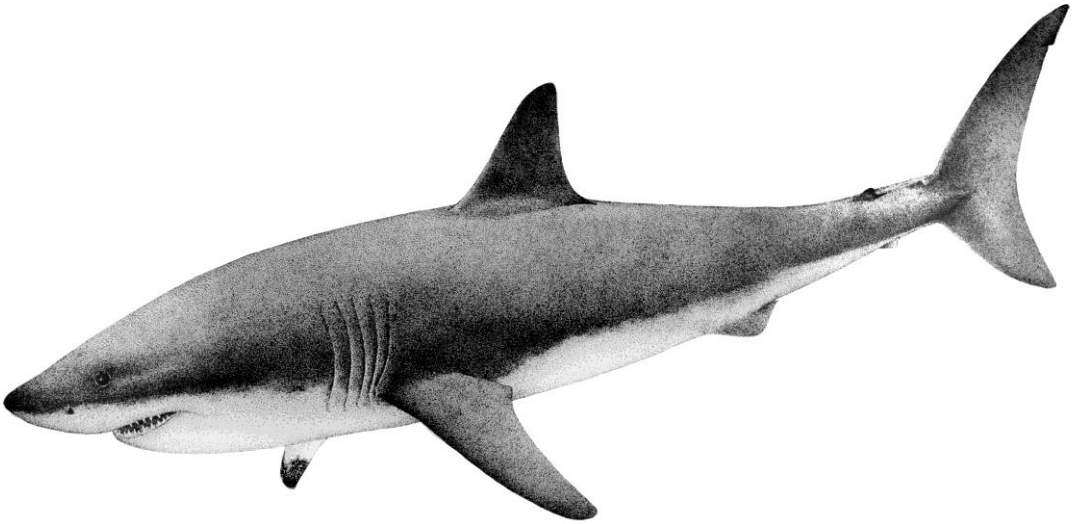
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FOREWORD



Foreword

Welcome to the 24th European Elasmobranch Association Annual Scientific Conference. After having postponed the meeting last year due to the pandemic we are delighted that we can host the event this year in Leiden at Naturalis Biodiversity Centre as a live meeting, as well as having an online day. The theme of this year's meeting is *"Are we there yet? What developments in the science and policy landscape have delivered for shark and ray conservation"*. The understanding of shark, skate and ray populations and our technological capabilities to study the species are increasing. Policy objectives are in place to protect species and habitats, as well as aiming for ecologically diverse and dynamic oceans and seas which are clean, healthy and productive. We want to explore how these advances have translated into changes underwater.

We are delighted that we have a large number of stimulating presentations and posters on spatial and temporal dynamics, science to underpin conservation and management, advances in science in the coming decades, new technologies, how to do science on a shoestring and looking at elasmobranchs from a global perspective. The key-note speakers will be giving inspiring and thought-provoking presentations and will give us new perspectives for our work. To enable broad discussions, we have arranged to have break-out sessions on Thursday afternoon during which you can get together in groups to discuss subjects of mutual interest and set up joint initiatives. There is plenty of opportunity for networking and socialising. The reception on Wednesday evening, the dinner on Thursday, but also in Leiden itself. The beautiful city of Leiden has an centuries-old city centre with canals, city gates, bridges, windmills, a castle, an observatory, and various historical buildings. It is also home to the oldest university in the Netherlands.

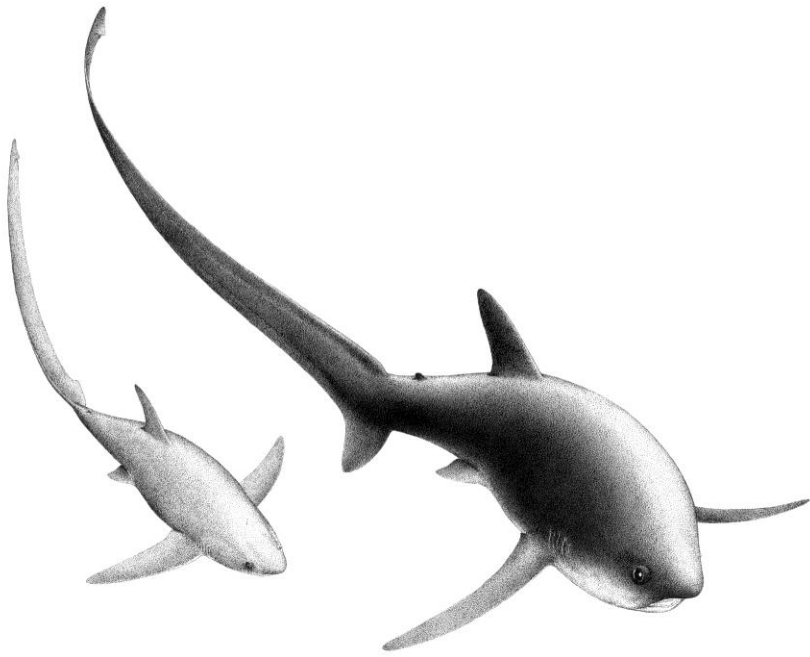
It is inspiring to see how people have worked together to make EEA2021 possible and how lucky we are to be able to meet up in person. We are convinced that the EEA and its members are playing an significant role in shark and ray research and conservation world-wide, and will continue to play an important role in moving things forward to deliver for healthy shark and ray populations.

We wish you all a stimulating, rewarding and enjoyable conference.

Paddy Walker & Irene Kingma

Dutch Elasmobranch Society (NEV)

PROGRAMME & SESSIONS



Programme EEA2021

Day 1- November 2nd 2021 (online day):

10:00 – 10:10 Opening
10.10 – 10:50 Key note: James Thorburn – St Andrews University
10:50 – 12:15 Online presentations and pitches
12.15 End of online day

Day 2- November 3rd 2021:

12:00 Registration opens
13.00 Opening address
13.20 Key note: Ali Hood – Shark Trust
14:00 Session 1
14.30 Poster Pitch
15. 00 Coffee Break
15.30 Session 2
17.00 End Day 2
18:30 – 20:30 Icebreaker reception

Day 3- November 4th, 2021:

8.30 Coffee
9:00 Key note Sophy McCully – CEFAS
9.40 Session 3
10.40 Poster pitches
10.50 Coffee Break
11.15 Session 4
11.55 Poster pitches
12.00 Lunch Break + museum visit
13.30 Key note Alec Moore – Bangor University
14.10 Session 5
15.45 Tea Break
16.00 Breakout session
17.30 End Day 2
19.00 Conference dinner and Auction

Day 4- November 5th 2021:

08:30 Coffee
9.10 Key note Angelo Villagomez – The Pew Charitable Trusts
9.50 Session 6
10.45 Coffee
11.15 Session 7
13.00 Closing address
13.15 End of conference, packed lunch served

Program day 1 (Online day)
2 November 2021

Session 1	Session title	Spatial and temporal dynamics of sharks and rays
10:00-10:10	Opening	
10:10-10:50	Key note James Thorburn	A multidisciplinary approach to identifying the footprint of an MPA for a migratory benthic species
10:50-11:05	Kirsty Magson	Citizen Science reveals the population structure and seasonal preference of whale sharks in the Gulf of Thailand
11:05 - 11:20	Jordan Moss	Effectiveness of length-based stock assessment models in a data-limited, mixed fishery: a case study from Sri Lanka
11:20 - 11:35	Paco Pinto	Sharks protected in Spain
11:35 - 11:50	Joanna Barker	Progress towards safeguarding Angelsharks in Wales using heritage, education and research
11:50-12:00	Rebecca Gillham	Mediterranean Angels: progressing subregional action for angel sharks
12:00 - 12:05	Damian Villagra	Life-history traits of batoids (Superorder Batoidea) in the Northeast Atlantic and the Mediterranean <i>5 minute pitch</i>
12:05 - 12:10	Sofia Graça Aranha	At-vessel mortality of demersal and deep-sea Chondrichthyes caught in crustacean bottom-trawlers in the Southern coast of Portugal <i>5 minute pitch</i>
12:10-12:15	Suzanne Poeisz	Historical trophic ecology of some divergent shark and skate species in the Dutch coastal North Sea zone <i>5 min pitch</i>
END OF DAY 1		

Program day 2
3 November 2021

Session 2	Session title	Underpinning shark and ray conservation and management
13:00-13:20	Opening	
13:20-14:00	Key note Ali Hood	Back to the Future: a journey through 20 years of shark & ray conservation
14:00-14:10	Timm Reinhardt	Encouraging synergies between fisheries and environmental science and policy, to improve elasmobranch conservation
14:10-14:20	Carlotta Mazzoldi	Evaluation of survival rates if juveniles of commercial elasmobranch species: is the post-capture release of early life stages an effective fishery management measure
14:20-14:30	Paddy Walker	Good Environmental Status for elasmobranchs – are we there yet?
14:30-15:00	Poster Pitches – Session I	
15:00-15:30	coffee	
15:30-15:40	James Thorburn	A multidisciplinary approach to identifying the footprint of an MPA for a migratory benthic species
15:40-15:50	Carlo Zampieri	Individual-Based Models as a tool for elasmobranch conservation
15:50-16:00	Jurgen Batsleer	INNORAYS: improving our knowledge base for North Sea rays using electronic monitoring
16:00-16:10	Laura Lemey	Raywatch - a study on the population biology and survival of seven ray species in the Northeast Atlantic
16:10-16:20	Ulrich Martin	Using stable isotope analysis to explore the trophic ecology of Taiwanese deep-sea sharks
16:20-16:40	Tadzio Bervoets	Shark Research in the Dutch Caribbean
16:40-16:50	Melanie Meijer zu Slochteren	St Maarten shark conservation and research
16:50-17:00	Ayumi Kuramae Izioka	Tag and recapture data for bycatch of nurse sharks in lobster fishery on the Saba Bank (Dutch Caribbean)
17:00-17:10	Irene Kingma	Haven't we forgotten something? Urgent need for management of tope shark (<i>Galeorhinus galeus</i>) in the EU
END OF DAY 2		
18:30 – 20:30	Icebreaker reception – Grand Café de Burcht - Leiden	

Program day 3 - morning
4 November 2021

Session 3	Session title	Advances in science for the coming decades
9:00 - 9:40	Key note Sophy McCully-Phillips	Mid-life musings: progress or regress
9:40 - 9:50	Daniel van Berkel	Genetic diversity and population structure of the starry smooth hound in the Northeast Atlantic Ocean
9:50 - 10:00	Eleanor Greenway	Comparisons of age estimations for the thornback skate (<i>Raja clavata</i>) and blonde skate (<i>Raja brachyura</i>) using truncal and caudal vertebra
10:00-10:10	Bree Taylor	Estimating age in elasmobranchs: intra-individual disparity in band counts of the thornback ray (<i>Raja clavata</i>)
10:10-10:20	Sophie Loca	Skate-ing over the issue: taxonomic nuances, revised distribution and conservation implications for flapper skate <i>Dipturus intermedius</i>
10:20-10:30	Edgar Eduardo Becerill-Garcia	Exploring a new alternative for the study of reproduction in threatened chondrichthyans: a minimal invasive approach
10:30-10:40	Annemieke Hermans	EMV-scape, a baseline of EMF on the Dutch Continental Shelf
10:40-10:50	Poster Pitches – Session II	
10:50-11:15	coffee	
11:15-11:25	Naturalis	
11:25-11:35	Pablo Garcia-Salinas	Elasmobranch sperm cryopreservation as a novel tool for ex situ conservation
11:35-11:45	Lucien Besnard	Mercury isotope clocks estimate dispersal timing from natal area in hammerhead shark
11:45-11:55	Carolina de la Hoz Schilling	DNA barcoding as a tool to explore elasmobranch diversity in eDNA off the Banc d'Arguin, Mauritania
11:55-12:10	Poster Pitches – Session III	
12:10-13:30	Lunch +museum visit	

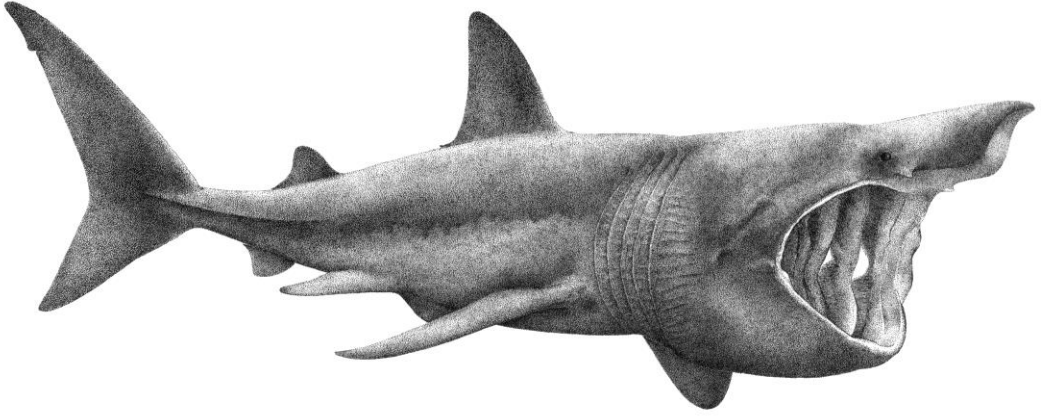
Program day 3 - afternoon
4 November 2021

Session 4	Session title	Shark and ray research on a shoestring
13:30-14:10	Key note Alec Moore	Alternative approaches to researching sharks & rays in data-poor regions
14:10-14:20	Jorge Moreno	Spying on the devil's lair: remote monitoring of the seasonal aggregation of <i>Mobula tarapacana</i>
14:20-14:30	Benjamin Marsaly	Movement patterns of tiger shark <i>Galeocerdo cuvier</i> around Tahiti and Moorea, French Polynesia, South Pacific
14:30-14:40	Ruairi Gallagher	Fast forwarding marine biodiversity surveys
14:40-14:50	Andre Steckenreuter	Emerging technologies in acoustic telemetry
14:50-15:00	Adi Barash	SPOTTED - a web-based game for photo identification
15:00 - 15:15	OCEARCH Chris Fischer	The OCEARCH Model for Advancing Shark Research and Education
15:15 - 15:30	OCEARCH Bob Heuter	OCEARCH’s North Atlantic White Shark Study: Scope, Techniques, and Results
15:30 - 15:45	OCEARCH Bryan Franks	Seasonal fidelity by white sharks (<i>Carcharodon carcharias</i>) in the western North Atlantic over multiple spatial and temporal scales
15:45-16:00	Tea	
16:00-17:30	Breakout sessions These are workshop style sessions centred around one theme or question with a maximum of 15 participants. 1 Fowler: stronger partnerships for saving sharks 2 Bervoets: when you start from nothing 3 Thorburn: not so common skate 4 Hood: #MakeTime4Makos 5 Heuter: strengthening your research questions 6 Steckenreuter: next level in tracking sharks	
END OF DAY 3		
19:00 – 21:30	Conference dinner	

Program day 4
5 November 2021

Session 5	Session title	A global perspective on sharks and rays
9:10-9:50	Key note Angelo Villagomez	Working in Small Islands: Adventures in Shark Conservation Lessons learned the hard way so you don't have to
9:50-10:00	Guido Leurs	The status of guitarfishes within two large intertidal areas in West Africa
10:00 - 10:10	Romarc Jac	Cold and dark who wants to live here?
10:10 - 10:20	Yarra Grossmark	Large-scale distributions of migratory species in the Mediterranean - insights from the MECO project
10:20 - 10:30	David Ruiz-Garcia	Mediterranean ghosts of the deep - a review for the understanding of their ecology and risks
10:30 - 10:45	Willem Renema	Naturalis -TBC
10:45-11:15	coffee	
11:15-11:45	Reports on Breakout sessions	
11:45 - 11:55	Matteo Barbato	Too young to die: mapping birthing sites of the endangered sandbar shark (<i>Carcharhinus plumbeus</i>) to inform conservation in the Mediterranean Sea
11:55 - 12:05	Sandrine Serre	A closer look to coastal aggregation of porbeagle sharks in the English Channel
12:05-12:15	Timo Staeudle	Spatio-temporal distribution and abundance of thornback ray (<i>Raja clavata</i>) in the North Sea and the Eestern English Channel
12:15-12:25	Matthias Schäber	I know what (some) tope did last summer
12:25-12:35	Michael Williamson	The impact of changing oceanic conditions and habitat stress on the movement connectivity of reef shark species
12:35-12:45	George Balchin	Investigating multiscale temporal trends and the effect of diving tourism on shark top predators in the Egyptian Red Sea
12:45:13:00	Closing address	
End of EEA2021		

KEYNOTE SPEAKERS



Keynote 1 James Thorburn

Queens University Belfast

A multidisciplinary approach to identifying the footprint of an MPA for a migratory benthic species

As an elasmobranch research scientist for over a decade, Dr James Thorburn has been pivotal in providing data to inform management. Collaborating with the University of St Andrews Scottish Oceans Institute (SOI) and Marine Scotland Science (MSS), The Centre for Environment, Fisheries and Aquaculture (CEFAS), and The Scottish Shark Tagging Programme (SSTP), Dr Thorburn has produced scientific publications on elasmobranch spatial ecology. He now works as a Postdoctoral Research Fellow at the University of St Andrews and Queen's University in Belfast.

Dr Thorburn enjoys the challenge of the temperate environment and is dedicated to highlighting the incredible biodiversity of elasmobranchs in UK waters. Throughout his career, he has worked on the flapper skate population off the west coast of Scotland, as well as working with tope, spurdog and porbeagle. He is now working with SeaMonitor to investigate the movement ecology and habitat use of flapper skate and basking sharks along the Scottish and Irish coasts. He also works to engage stakeholders; regularly collaborating with recreational anglers, and he has been integral to the development of Best Practice Guidelines for recreational angling in the UK.

Whilst he specialises in telemetry, Dr Thorburn has not focused his career around a particular methodology. Instead, he has employed a broad range of sampling methods to study the critically endangered flapper skate in the Loch Sunart to the Sound of Jura marine protected area. His work has been critical to evaluating the success of the MPA (the only one of its kind in Europe that is expressly designated for the protection of skates), and subsequently, both he and the flapper skate work was highly commended in the RSPB Nature of Scotland Awards in 2020.

By continually studying flapper skates for nearly 15 years, Dr Thorburn has learned many lessons about what makes an MPA successful and has experience with monitoring an endangered species as their populations start to recover. This unique approach has provided Dr Thorburn with a high level of knowledge about one particular species in one particular place. He sees this as an opportunity to allow others to succeed in a similar fashion. It is his hope that his knowledge can be applied to the designation of new MPAs and aid in the recovery of other endangered elasmobranchs around the globe.

Keynote 2 Ali Hood

Shark Trust

Back to the Future: a journey through 20 years of shark & ray conservation

Ali Hood has been a powerhouse of elasmobranch conservation for over 20 years. As the Director of Conservation at the Shark Trust, Ms Hood regularly contributes to expert groups in the UK and EU, and frequently engages with the European Commission and UK Devolved Administrations. She also represents the Trust as a cooperating partner to the Convention for Migratory Species (CMS) and as an observer to The International Commission for the Conservation of Atlantic Tunas (ICCAT), The Northwest Atlantic Fisheries Organization (NAFO) and The General Fisheries Commission for the Mediterranean (GFCM). Additionally, she is a member of the IUCN Shark Specialist Group (IUCN SSG). Ms Hood is also a regular media commentator for issues surrounding shark and ray conservation. She was recently presented with an award for Outstanding Achievement in Marine Conservation by the International Fund for Animal Welfare.

With a background in marine environmental sciences, Ali Hood is determined not to peddle environmental despair and seeks to remind the conservation community that there have been at least a few successful recoveries in the past. She focuses on embracing triumphs and bringing positive energy towards engaging with industry and stakeholders. Yet, she is also renowned for her polite persistence in demanding improvements to conservation measures for threatened elasmobranchs.

As a Steering Group member for the Shark Alliance campaign since 2006, Ms Hood was instrumental in securing the adoption of the EU Community Plan of Action for Sharks in 2009 and in furthering the 2003 EU finning ban, through the EU Fins Naturally Attached regulations of 2013. Ms Hood is currently contributing to the conservation plan for angel sharks and guitarfish in the Mediterranean, and as a founding partner of the Shark League coalition, which works to advance regional conservation of sharks and rays in Europe.

In the face of non-sensical obstructions and obstinate resistance from certain EU member states, Ms Hood's efforts have been vital in the continued fight for the Shark Trust's No Limits? No Future campaign, to protect Atlantic mako and blue sharks.

Ms Hood has achieved enormous successes in the past, but she is acutely aware that no conservation legislation is set in stone, and all require continuous support and investment. She is determined to continue to hold the EU accountable, but is equally aware that opening-up hard-won legislation for amendments is a serious gamble.

Ms Hood's presentation will explore progress and priorities in EU shark conservation, and look to the lessons of previous campaigns and current challenges.

Keynote 3 Sophy McCully-Phillips

CEFAS

Mid-life musings: progress or regress

Dr. Sophy McCully-Phillips has contributed enormously to shark and ray research for over 15 years. As a Senior Fisheries scientist at The Centre for Environment, Fisheries and Aquaculture Science (CEFAS), Dr McCully-Phillips focuses on elasmobranch biology, ecology, assessment and management. She acts as scientific advisor to the UK government through The Department for Environment, Food and Rural Affairs (DEFRA) and addressed elasmobranch issues as a UK delegate for The International Commission for the Conservation of Atlantic Tunas (ICCAT) and The Indian Ocean Tuna Commission (IOTC). Dr McCully-Phillips also works closely as part of the Working Group for Elasmobranch Fishes (WGEF) under The International Council for the Exploration of the Sea (ICES) and is Regional Vice-Chair of the Northern European Group of the International Union for the Conservation of Nature Shark Specialist Group (IUCN SSG).

Through her role at CEFAS, Dr McCully Phillips takes an evidence-based approach to elasmobranch research ensuring that conservation plans are not limited to a few key threatened species of sharks and rays. By studying the biology of more vulnerable species, Dr McCully-Phillips is able to see each assessment through from start to finish; taking her projects from data collection in the field, to assessment at ICES and all the way through to advising government.

With the realisation that charismatic species often draw attention away from others that also need attention, Dr McCully-Phillips is passionate about ensuring that we also work towards protecting the species which are commonly overlooked. Many of these species are hindered by data deficiencies, but it is Dr McCully-Phillips' firm belief that not having enough data is not an excuse to do nothing. As a result she has contributed to modernising the data-limited assessment process for elasmobranchs; by utilising Productivity Susceptibility Analyses (PSA) to prioritise each species based on their relative threat level. Her 2015 data-limited, PSA-based assessment highlighted the vulnerability of starry smoothhounds (among others) as an overlooked non-quota species and her subsequent study of them in 2015 emphasised the need for biologically-meaningful management measures. The PSA methods have subsequently been adopted by ICES as a data-limited approach and have been used in support of advice for some of the most data-limited elasmobranch species. Dr McCully-Phillips' passion comes from seeing the impact of her work and hopefully making a difference. As a working mother, embracing an upcoming milestone birthday, Dr McCully-Phillips would like to make her keynote speech a personal one. Looking back over where elasmobranch conservation and management was 40 years ago, she wonders where we will be in 40 years' time. With advancing technologies and a new drive to prioritise conservation and management based on scientific evidence, Dr McCully-Phillips is hopeful that, even when improvements seem to be made excruciatingly slowly, we will stay positive, continue to adapt and keep pushing forwards.

Keynote 4 Alec Moore

Bangor University

Alternative approaches to researching sharks & rays in data-poor regions

Dr Alec Moore has worked widely on elasmobranch biodiversity, biology, ecology, fisheries, and conservation. Currently a postdoctoral fisheries scientist at Bangor University's School of Ocean Sciences (Wales), Dr Moore has voluntarily contributed to elasmobranch science for over 20 years, and took a unique route into academia.

Whilst working as an environmental consultant in Kuwait, Dr Moore was shocked by the lack of research on the sharks and rays in the Persian/Arabian Gulf, so he began his own independent research that culminated in a PhD by Published Works. This led to species discoveries - two new stingrays and a 'lost' shark, and co-authoring the first elasmobranch identification guide for The Gulf.

Dr Moore has been a member of the IUCN Shark Specialist Group for the Indian Ocean since 2007, and has contributed to numerous Red List Assessments, the Global Sawfish Conservation Strategy, and an Arabian Seas Red Listing.

His tenacity, self-determination and passion have led Dr Moore to produce novel and important work: dozens of scientific publications cover a range of topics from artisanal fisheries in West Africa, the parasites of catsharks, the extinction of sawfishes in the Arabian region, and the urgent need for guitarfish conservation to avoid a similar fate.

With no funding or formal research institute links through most of his research career, Dr Moore is a passionate advocate of using inexpensive, alternative and opportunistic data sources such as sampling at fish markets, in museums and from historical documentary sources.

He is now focusing his attention on understanding long-term changes to the diversity and abundance of sharks and rays, including in British waters.

As we enter the UN Decade of Ecosystem Restoration alongside targets for rebuilding fisheries, we need to understand what we have lost - and what we are restoring to. His passion for 'historical ecology' draws on centuries-old articles from explorers and naturalists, and under-utilised, yet priceless, natural history museum specimens, and aims to re-awaken knowledge that has been lost from our collective memory.

Keynote 5 Angelo Villagomez

The Pew Charitable Trusts

Working in Small Islands: Adventures in Shark Conservation Lessons learned
the hard way so you don't have to

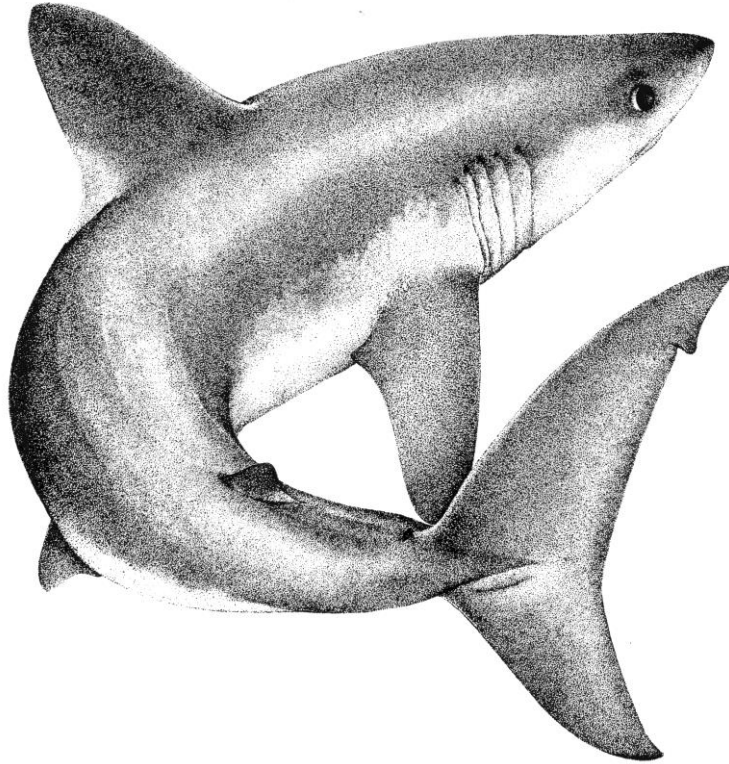
Mr Angelo O'Connor Villagomez has been a champion for Marine Protected Areas (MPAs) for over a decade. As a devoted biologist and environmental policy expert, Mr Villagomez has worked with The League of Conservation Voters (LCV), The Smithsonian Institution, The Mariana Island Nature Alliance (MINA) and Mission Blue. Mr Villagomez is now the senior officer of marine protection at The Pew Charitable Trusts and campaigns manager for The Blue Nature Alliance.

With skills as a scientist, but also in socio-economics and politics, Mr Villagomez has assisted with the passing of dozens of new conservation laws to protect threatened sharks. He has contributed to fin trade bans, the designation of some of the world's first shark sanctuaries, and advocating for sharks through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Yet Mr Villagomez's true calling is an advocate for MPAs, currently working alongside the Blue Nature Alliance partners to achieve a goal to protect 18 million square kilometres of ocean by 2030. Working to designate new MPAs, and to expand and improve upon those already in place, Mr Villagomez is dedicated to protecting the last remnants of ocean wilderness. Mr Villagomez is playfully known as 'The Godfather of the Mariana Trench' thanks to his efforts to designate the region as a Marine National monument. He was also instrumental to the expansion of the Papahānaumokuākea Marine National Monument - currently the second largest protected area in the world. He was also pivotal in writing to the International Union for the Conservation of nature (IUCN) resolution to protect 30% of all our oceans.

Born on Guam, with both Irish-American and Chamorro heritage, Mr Villagomez has a unique perspective on the differing opinions of two very different worlds. He is acutely aware that those who carry the greatest burden of environmental destruction, are rarely those who are the root cause of it. An outspoken voice for Indigenous peoples, Mr Villagomez is determined that historical power imbalances will be addressed, and he is dedicated to ensuring that communities in both developed and developing nations are equally represented by conservationists.

ABSTRACTS ORAL PRESENTATIONS



A multidisciplinary approach to identifying the footprint of an MPA for a migratory benthic species

Thorburn, J., Wright, S., Lavender, E., Dodd, J., Wright, P., Collins, P., Houghton, J., and James, M.

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Spatial management tools, such as Marine Protected Areas, are increasingly being used to help conserve and manage marine species including elasmobranchs. It is important to understand the wider impact such sites may have within the species range. The Critically Endangered flapper skate (*Dipturus intermedius*) shows varying levels of residency within a core area of its current distribution. This led to the Loch Sunart to the Sound Jura (LStSoJ) MPA being designated to support the species' conservation. Despite high localised knowledge of this species' spatial ecology in the MPA, its wider movements and connectivity to other areas are less well known. There is limited evidence from mark and recapture and photo ID data that skate move outside the MPA to areas in southwest Scotland and Northern Ireland. To investigate these movements in greater detail, 45 skate were tagged with archival tags (depth and temperature) inside the MPA boundaries. Twenty-five archival depth records, spanning from 3-772 days, were recovered. Tidal patterns within the depth data were identified using a Hidden Markov Model, which were used to estimate daily location. The modelled movements showed most skate to be highly localised within the MPA, but with some individuals undertaking wider movements. A subsequent acoustic telemetry project on skate have helped validate the modelled movements. The archival and acoustic data build on the mark and recapture and photo ID data by further demonstrating movements by mature males and females between the MPA, Northern Ireland and southwest Scotland. The combination of different data sources contributes significantly to our understanding of both the footprint of the LStSoJ MPA as well as demonstrating its connectivity with other regions, helping to inform the development of a coherent network of spatial management throughout the species' distribution.

Keywords: Marine Protected Areas, movement ecology, connectivity, flapper skate

Citizen science reveals the population structure and seasonal presence of whale sharks in the Gulf of Thailand

K.Magson, E.Monacella, C.Scott, N.Buffat, S.Arunrugstichai, M. Chuangcharoendee, S.Pierce, J.Holmberg & G.Araujo

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The seasonality and populations of the whale shark *Rhincodon typus* within Thai waters are poorly studied. We used citizen science to collect images to shed light on the population within the Gulf of Thailand at the tourist destination of Koh Tao and its surrounding islands. With little to no sightings being reported prior to the early 2000's we used this approach to identify a total of 178 individuals from 249 initial sightings. These sightings were between 2004-2019 with 84% coming from 2015-2019 due to the start of the identification program. Of 178 individuals the sex was noted in 27% with a female to male ratio of 2:1. Whaleshark seasonality and modified maximum likely suggests a year-round transient population with an increase in sightings following the monsoon cycles. One individual was re-sighted internationally over 700km away and adds to the need for further citizen scientist involvement especially in data poor regions. Even with the limitations of reliable information, these citizen scientists can fill in the gaps and allow for continued research in the field.

Keywords: lagged identification rate, photo-ID, participatory science, Koh Tao

Effectiveness of length-based stock assessment models in a data-limited, mixed fishery: A case study of *Neotrygon indica* from Sri Lanka

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Coastal elasmobranchs are the predominant component of secondary catches in Indian Ocean artisanal fisheries, but stock assessments for this group are challenging given the scale, diversity, and unorganized structure of these fisheries. The Length Based Spawning Potential Ratio (LBSPR) offers a conceivable solution; however, its assumption of logistic selectivity (typical of trawl fisheries) contrasts the combinations of passive gears in most artisanal fleets, which typically produces dome or bimodal selectivity curves. This study conducted a data-limited assessment for *Neotrygon indica* in Sri Lanka, focusing on fine-tuning the LBSPR for elasmobranch life history and assessing its applicability to artisanal fleets under different scenarios. A combination of length-frequency (n=1,533) and ageing data (n=142) was used. The positive correlation between fecundity and size/age in the assessment model was reduced, to better reflect the reproductive strategy of elasmobranchs. The impact of different fishing methods on the model was simulated under four selectivity scenarios (dome, bimodal, young, and old). Each scenario ran for three years with increasing sample sizes. The results showed Spawning Potential Ratio (SPR) for the true data varied between 0.25-0.35, suggesting a depleted stock. Bimodal and dome scenarios highlighted the impact of sample size in reducing the overall uncertainty. The bimodal scenario was particularly vulnerable to outliers at low sample sizes. Targeting older individuals produced the healthiest stock estimates although, this is perhaps associated with reductions in the age to fecundity correlation. This work shows the LBSPR, under certain conditions, can be used in artisanal fisheries displaying non-logistic selectivity. However, under such scenarios, a larger proportion of the overall catch should be sampled. Further work in quantifying the uncertainty of data-limited methods will enable fisheries managers to better assess elasmobranch bycatch and make informed management decisions, ensuring species resilience and sustainable livelihoods for stakeholders.

Keywords: Data-limited Methods (DLMs), Selectivity, Management, Life-history

Sharks protected species in Spain.

Paco Pinto de la Rosa

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Spain was and is still one of the major sharks fishing country worldwide. Spain has been working hard for many years in order to protect as many species of sharks as possible. Both the Central Government and the Andalusian Government (South Spain) are working together to develop this hard work. Although both Governments started very late from our personal opinion, at least both of them have started.

There are seven Laws regulate the sharks species which are prohibited to catch, to commercialize, to transship and to disembark. These Laws are:

1) **Law ARM/2689/on 28 September 2009:** this law prohibits Spanish fishing boats to catch, to transship, to disembark and to commercialize sharks of the family Sphyrnidae (hammerheads sharks) and Alopiidae (thresher sharks).

2) **Law 139/ on 4th February 2011 for the Special Protection of Endangered Species:** this law protects eleven species of sharks: tope shark (*Galeorhinus galeus*), sandtiger shark (*Carcharias taurus*), great white shark (*Carcharodon carcharias*), shortfin mako shark (*Isurus oxyrinchus*), porbeagle shark (*Lamna nasus*), basking shark (*Cetorhinus maximus*), smalltooth sandtiger shark (*Odontaspis ferox*), angular roughshark (*Oxynotus centrina*), sawback angelshark (*Squatina aculeata*), smoothback angelshark (*Squatina oculata*) and angelshark (*Squatina squatina*).

3) **Law of the European Union/2336 on 14th December 2016:** this law protects sixteen deep sea species: gulper sharks (*Centrophorus* sp.), black dogfish (*Centroscyllium fabricii*), portuguese dogfish (*Centroscymnus coelolepis*), longnose velvet dogfish (*Centroselachus crepidater*), kitefin shark (*Dalatias licha*), great lanternshark (*Etmopterus princeps*), catsharks (*Apristurus* sp.), frilled shark (*Chlamydoselachus anguineus*), birdbeak dogfish (*Deania calcea*), blackmouth catshark (*Galeus melastomus*), mouse catshark (*Galeus murinus*), bluntnose sixgill shark (*Hexanchus griseus*), velvet belly lanternshark (*Etmopterus spinax*), sailfin roughshark (*Oxynotus paradoxus*), knifetooth dogfish (*Scymnodon ringens*) and greenland shark (*Somniosus microcephalus*).

4) **Law of the European Union/2025 on 17th December 2018:** this law protects fifteen species: catsharks (*Apristurus* sp.), frilled shark (*Chlamydoselachus anguineus*), gulper sharks (*Centrophorus* sp.), portuguese dogfish (*Centroscymnus coelolepis*), longnose velvet dogfish (*Centroselachus crepidater*), black dogfish (*Centroscyllium fabricii*), birdbeak dogfish (*Deania calcea*), kitefin shark (*Dalatias licha*), great lanternshark (*Etmopterus princeps*), velvet belly lanternshark (*Etmopterus spinax*), mouse catshark (*Galeus murinus*), bluntnose sixgill shark (*Hexanchus griseus*), sailfin roughshark (*Oxynotus paradoxus*), knifetooth dogfish (*Scymnodon ringens*) and greenland shark (*Somniosus microcephalus*).

5) **Law of the European Union/1241 on 20th June 2019 on the Conservation of Fishery Resources:** this law protects: basking shark (*Cetorhinus maximus*), great white shark (*Carcharodon carcharias*), smooth lanternshark (*Etmopterus pussillus*), angelshark (*Squatina squatina*), bluntnose sixgill shark (*Hexanchus griseus*), Alopiidae (thresher sharks), Carcharhinidae (requiem sharks), Sphyrnidae (hammerhead sharks), Isuridae (mako sharks) and Lamnidae (mackerel sharks).

6) **Law of the European Union/123 on 27th January 2020:** this law concerns fishing vessels of the European Union and not European Union in the waters of the European Union, and the species protected are: leafscale gulper shark (*Centrophorus squamosus*), portuguese dogfish (*Centroscymnus coelolepis*), kitefin shark (*Dalatias licha*), birdbeak dogfish (*Deania calcea*), great lanternshark (*Etmopterus princeps*), tope shark (*Galeorhinus galeus*), porbeagle shark (*Lamna nasus*), whale shark (*Rhincodon typus*), piked dogfish (*Squalus acanthias*), oceanic whitetip shark (*Carcharhinus longimanus*), silky shark (*Carcharhinus falciformis*), ghost catshark (*Apristurus manis*), blurred smooth lanternshark (*Etmopterus bigelowi*), shorttail lanternshark (*Etmopterus brachyurus*), great lanternshark (*Etmopterus princeps*), smooth lanternshark

(*Etmopterus pussillus*), velvet dogfish (*Zameus squamulosus*), Alopiidae(thresher sharks) and Sphyrnidae (hammerhead sharks).

7) **Law of the Andalusian Government 2020:** this law protects: frilled shark (*Chlamydoselachus anguineus*), bluntnose sixgill shark (*Hexanchus griseus*), piked dogfish (*Squalus acanthias*), (*Centrophorus* sp.), birdbeak dogfish (*Deania calcea*), black dogfish (*Centroscyllium fabricii*), great lanternshark (*Etmopterus princeps*), velvet belly lanternshark (*Etmopterus spinax*), portuguese dogfish (*Centroscymnus coelolepis*), longnose velvet dogfish (*Centroselachus crepidater*), knifetooth dogfish (*Scymnodon ringens*), greenland shark (*Somniosus microcephalus*), angular roughshark (*Oxynotus centrina*), sailfin roughshark (*Oxynotus paradoxus*), kitefin shark (*Dalatias licha*), sawback angelshark (*Squatina aculeata*), smoothback angelshark (*Squatina oculata*), angelshark (*Squatina squatina*), whale shark (*Rhincodon typus*), sandtiger shark (*Carcharias taurus*), smaltooth sandtiger shark (*Odontaspis ferox*), thresher shark (*Alopias vulpinus*), basking shark (*Cetorhinus maximus*), great white shark (*Carchorodon carcharias*), shortfin mako shark (*Isurus oxyrinchus*), porbeagle shark (*Lamna nasus*), catsharks (*Apristurus* sp.), mouse catshark (*Galeus murinus*), tope shark (*Galeorhinus galeus*), silky shark (*Carcharhinus falciformis*), oceanic whitetip shark (*Carcharhinus longimanus*), scalloped hammerhead (*Sphyrna lewini*), great hammerhead (*Sphyrna mokarran*) and smooth hammerhead (*Sphyrna zygaena*).

Keywords: protected species by law

Progress towards safeguarding Angelsharks in Wales using heritage, education and research

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The Critically Endangered Angelshark (*Squatina squatina*) is part of one of the most threatened chondrichthyan families in the world. Despite a predicted 58% decline in their geographic extent over the last 50 years (Lawson et al. 2020), a population remains off the coast of Wales. Very little is known about the status, ecology or location of important habitats for Angelsharks in Wales, a critical data gap especially as this is one of the last known Angelshark populations in the northern most part of their range (Barker et al. 2020).

Angel Shark Project: Wales, a collaborative project led by ZSL and Natural Resources Wales, was launched in 2018 to safeguard Angelsharks in Wales with fishers and coastal communities, using heritage, education and research. Over the last four years, we have gathered over 2,220 Angelshark records dating back to 1812 from fisher engagement, archival research, digital platforms and a community roadshow across Wales (Barker et al. 2020).

These data have been vital to investigate Angelshark distribution and ecology in Wales, but also to develop the Wales Angelshark Action Plan. Launched in 2020, the Action Plan provides a priority list of actions and research to be completed over the next five years to work towards a joint vision of a thriving population of Angelsharks in Wales.

This presentation will highlight the multidisciplinary approach needed to gather Angelshark records, develop the Action Plan and highlight some significant milestones from the last six months.

Keywords: Angelshark, Action Plan, Multidisciplinary

Mediterranean angels: progressing subregional action for angel sharks

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The Mediterranean is not only considered to be a biodiversity hotspot for chondrichthyans, but it has also been recognized as a hotspot for extinction risk for this increasingly vulnerable class of animals.

Angel sharks are considered one of the most threatened families of chondrichthyan in the world (Dulvy et al., 2021). Three species of Critically Endangered angel shark inhabit the Mediterranean Sea. Whilst regional legislation is in place for all three species, implementation of regulations is lacking, and national legislation not always in place. The multijurisdictional nature of the Mediterranean further adds to the complexity of adopting and implementing appropriate management.

Following the development of the Mediterranean Angel Sharks: Regional Action Plan (Gordon et al., 2019), SubRegional Action Plans are being developed to facilitate further coordinated action in the region. Commencing with priority regions where angel sharks are understood to be present and protection is vital e.g., Aegean Sea and Crete, Tunisia, and Libya. Collaboration is at the heart of the SubRAP process with multiple partners (> 30 involved to date) and regional stakeholders engaged through virtual workshops and meetings to establish threats, goals, objectives, and actions at a subregional level. Here we present an update of this ongoing work with a view to extending the range.

References:

Gordon, C.A., Hood, A.R., Al Mabruk, S. A. A., Barker, J., Bartolí, A., Ben Abdelhamid, S., Bradai, M.N., Dulvy, N.K., Fortibuoni, T., Giovos, I., Jimenez Alvarado, D., Meyers, E.K.M., Morey, G., Niedermuller, S., Pauly, A., Serena, F. and Vacchi, M. (2019) Mediterranean Angel Sharks: Regional Action Plan. The Shark Trust, United Kingdom. 36 pp.

Dulvy NK, Pacoureau N, Rigby CL, Pollom RA, Jabado RW, Ebert DA, Finucci B, Pollock CM, Cheok J, Derrick DH, Herman KB, Sherman CS, VanderWright WJ, Lawson JM, Walls RHL, Carlson JK, Charvet P, Bineesh KK, Fernando D, Ralph GM, Matsushiba JH, Hilton-Taylor C, Fordham SV and Simpfendorfer CA. (2021) Overfishing drives over one third of all sharks and rays toward a global extinction crisis. *Current Biology* 31.

Keywords: angel shark, Mediterranean, Critically Endangered, conservation action plan

Life-history traits of batoids (Superorder Batoidea) in the Northeast Atlantic and the Mediterranean

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Life-history traits provide a way to estimate the vulnerability of both individuals and populations of a species to disturbance (e.g., overexploitation, climate change). Life-history traits compilations for species of batoids in the Northeast Atlantic (NEA) and the Mediterranean Sea (MED) are scarce, outdated, and generally limited to a local or a regional scale. From a literature review, values of 10 life-history traits were compiled, describing the growth, reproductive and feeding strategies of 14 batoids in the NEA and the MED. Via a principal components analysis (PCA) the main drivers of variance and (groups of) similar species were identified. Significant data gaps were revealed for natural mortality and lifespan, and for most of the life-history traits of small-eyed (*Raja microocellata*), shagreen (*Leucoraja fullonica*), and sandy (*Leucoraja circularis*) ray. Flapper (*Dipturus* sp. cf. *intermedius*) and white (*Rostroraja alba*) skate were found to be different from the rest of the species due to their larger sizes, relatively slow growth, and late maturity, and therefore vulnerable to overexploitation. *Raja* spp. and *Leucoraja* spp. rays were smaller due to a faster growth rate, which may make them more susceptible to die after being discarded. Nonetheless, life-history traits were found to vary among regions where the same species occur. Fisheries management should use growth and reproductive traits in space to assess species and stock vulnerability to anthropogenic and natural disturbances. Future research should be directed towards filling important data gaps and identifying the drivers behind life-history traits plasticity in skates and batoids.

Keywords: plasticity, growth, reproduction, ray

A multidisciplinary approach to identifying the footprint of an MPA for a migratory benthic species

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Portugal is the number one country in Europe on seafood consumption per person (57 kg/year), and the South-Southwest coasts are the most relevant fishing areas for crustacean bottom-trawl activities targeting mostly shrimps and crayfishes. According to past studies conducted in this area, demersal and deep-sea Chondrichthyes bycatch correspond to ca. 40% of the total catch from bottom-trawl activities, which is of great concern because these species are among the most vulnerable organisms due to increased pressure and depth, and decreased temperatures that leads to a slower growth rate. During the Delasmop project, the Chondrichthyes at-vessel mortality (AVM) rates were estimated – the proportion of dead individuals when brought aboard - by analyzing 1,199 individuals from 21 different species. A total AVM of 84% was registered, and the increased air exposure time and deeper fishing depths were two variables that significantly influenced results contributing to higher AVM rates, whereas the haul duration did not seem to affect AVM rates (3-8hrs). The project is still underway, thus other technical, environmental, and biological parameters are being addressed to further understand parameters that may constrain Chondrichthyes vitality state, directly affecting their AVM rates. This information will be combined with data obtained on board the research vessel Mário Ruivo, to propose good practices to reduce the bycatch of Chondrichthyes and increase their survival chances when discarded.

Keywords: fisheries; sharks; skates; chimaera

Historical trophic ecology of some divergent shark and skate species in the Dutch coastal North Sea zone.

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Over the last century the fish community of the Dutch coastal North Sea zone has lost most its shark and skate species. Whether their disappearance has changed the trophic structure of these shallow waters has not been properly investigated. In this study historical dietary data of sharks and skates, being in the past (near)-residents, juvenile marine migrants and marine seasonal visitors of the Dutch coastal North Sea zone were analyzed for the period 1946–1954. Near-resident and juvenile marine migrant species were demersal while all marine seasonal visitors species were pelagic. Based on stomach content composition, the trophic position of four of the various shark and skate species could be reconstructed. The (near)-resident species, the lesser spotted dogfish, the marine juvenile migrant, the starry smooth hound, and the benthopelagic marine seasonal visitor, the thornback ray, had a benthic/demersal diet (polychaetes, molluscs and crustaceans), while the pelagic marine seasonal visitor, the tope shark, fed dominantly on cephalopods and fishes. Diet overlap occurred for fish (tope shark and lesser spotted dogfish), for hermit crabs (lesser spotted dogfish and starry smooth hound) and for shrimps (thornback ray and starry smooth hound). Trophic position ranged from 3.2 for thornback ray preying exclusively on crustaceans to 4.6 for the tope shark consuming higher trophic prey (crustaceans and fish). The analysis indicates that most of the shark and skate species were generalist predators. The calculated trophic positions of shark and skate species indicate that those species were not necessarily at the top of the marine ecosystem food web, but they might have been the top predators of their particular ecological assemblage.

Encouraging synergies between fisheries and environmental science and policy, to improve elasmobranch conservation

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Over 20 species of pelagic elasmobranchs were listed in CITES Appendix II between 2002 and 2019. Most of these species were historically targeted by fisheries, and some are still important in fisheries and trade. FAO Members and CITES Parties have for many years, at their respective meetings, urged closer engagement and coordination between national environment and fisheries departments so as to improve the conservation and management of sharks. The Regional Fishery Bodies (RFBs) can play an important role, and several tuna RFMOs had already prohibited the retention of some threatened pelagic shark species before they were listed in Appendix II of CITES. This presentation describes an ongoing initiative of the German Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and German Federal Agency for Nature Conservation (BfN) to promote synergies between CITES and RFBs on behalf of shark conservation and management, recognising that their common objectives are the recovery of depleted stocks, delivering sustainable fisheries and trade, and reducing the future need for strict protection measures. This project seeks to improve mutual understanding of the mandates, concerns and tools available to both sectors, and the potential for further harmonizing the efforts of RFBs and CITES to deliver more effectively the protection and sustainable use of sharks.

Keywords: CITES, RFBs, sustainable fisheries

Evaluation of survival rates of juveniles of commercial elasmobranch species: is the post-capture release of early life stages an effective fishery management strategy?

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Fishery management of sharks, skates and rays is challenging, because they often constitute either the by-catch or discard. Reducing fishing impacts, by means minimum mesh sizes, shark excluder devices etc., may interfere with fishing activities, making these strategies not easily acceptable by fishers. In the Mediterranean Sea, the poor conservation status of elasmobranchs is alarming and calls for effective and practically applicable strategies. Within the Italian monitoring programs of the Marine Strategy Framework Directive (MSFD, Directive 2008/56/EC), we are investigating the potential of a management strategy that includes the release of juveniles of commercial elasmobranch species. In 2020 and 2021, through 65 on-board fishing trips, using different fishing gears (otter trawling, pelagic trawling, gill nets) in different MSFD subregions, we evaluated the At-Vessel Mortality (AVM; after the sorting activities of the fishers), Short-term post-release mortality (St-PRM; two hours after capture, on board) and Long-term post-release mortality (Lt-PRM; 72 hours after capture, at laboratory). For the AVM, we analyzed 1764 individuals of 15 species; for the St-PRM 463 individuals of 8 species; for the Lt-PRM 100 individuals of 5 species. AVM varied according to area, fishing gear and species, reaching 4-24 % in the shallow water of the Adriatic Sea, and 70% in the deeper water of the Ligurian Sea. The St-PRM and Lt-PRM were generally low, below 10% for all the analyzed species. Releasing elasmobranch juveniles is regularly done by some fishers, at least in the Adriatic Sea, despite not being legally enforced. To rigorously explore the potential efficacy and sustainability of extending this practice we are constructing individual based population dynamics models to assess the expected recovery of populations according to different minimum conservation sizes and survival rates.

Keywords: Survival rates, trawling, gill nets, fishery management

Good Environmental Status – are we there yet?

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In the coming year there are some good opportunities to improve protection of sharks and rays in the Netherlands, in particular in terms of habitat and site protection. A number of crucial policy dossiers such as N2000 legislation and the Marine Strategy Framework Directive (MSFD) are now being evaluated and will be revised in the coming years. Sharks and rays are not yet included in the protected area policy in the Netherlands and these revisions could remediate the situation.

Conclusions from a previous review of the MSFD stated that the status of sharks and rays still gives cause for concern, although there are signs of recovery for some species. However, Good Environmental Status (GES) cannot currently be determined due to lack of knowledge and the absence of indicators. Indicators are necessary in the policy cycle for determining measures, monitoring programmes and policy evaluation. In order to work towards protecting sharks and rays in Dutch waters, it is important that Good Environmental Status (GES) indicators for sharks and rays are developed.

Currently the status of shark and ray populations are evaluated according to Descriptor 1 of the MSFD, which looks at species distribution, population size and population condition. These are difficult to implement due to lack of quantitative information. This paper will explore if a different approach might be necessary to identify good environmental status for elasmobranchs.

Keywords: MSFD; indicators; Good Environmental Status; life-cycle

A multidisciplinary approach to identifying the footprint of an MPA for a migratory benthic species

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Spatial management tools, such as Marine Protected Areas, are increasingly being used to help conserve and manage marine species including elasmobranchs. It is important to understand the wider impact such sites may have within the species range. The Critically Endangered flapper skate (*Dipturus intermedius*) shows varying levels of residency within a core area of its current distribution. This led to the Loch Sunart to the Sound Jura (LStSoJ) MPA being designated to support the species' conservation. Despite high localised knowledge of this species' spatial ecology in the MPA, its wider movements and connectivity to other areas are less well known. There is limited evidence from mark and recapture and photo ID data that skate move outside the MPA to areas in southwest Scotland and Northern Ireland. To investigate these movements in greater detail, 45 skate were tagged with archival tags (depth and temperature) inside the MPA boundaries. Twenty-five archival depth records, spanning from 3-772 days, were recovered. Tidal patterns within the depth data were identified using a Hidden Markov Model, which were used to estimate daily location. The modelled movements showed most skate to be highly localised within the MPA, but with some individuals undertaking wider movements. A subsequent acoustic telemetry project on skate have helped validate the modelled movements. The archival and acoustic data build on the mark and recapture and photo ID data by further demonstrating movements by mature males and females between the MPA, Northern Ireland and southwest Scotland. The combination of different data sources contributes significantly to our understanding of both the footprint of the LStSoJ MPA as well as demonstrating its connectivity with other regions, helping to inform the development of a coherent network of spatial management throughout the species' distribution.

Keywords: Marine Protected Areas, movement ecology, connectivity, flapper skate

Individual-Based Models as a tool for elasmobranch conservation

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Elasmobranchs are globally facing a strong decline in the last century. Compared to other fish species, their life history traits (e.g., large size, slow growth, late sexual maturity, low fecundity) and their typical behaviours (e.g., long migrations, aggregations) make them vulnerable to fishing pressure, especially due to their high catchability before they have reached the sexual maturity. Management actions are strongly needed to reduce human pressure and support elasmobranch conservation. However, testing their effectiveness can be complicated, especially when comparing different solutions, and pilot projects can be effort and time consuming. In this study, developed as part of Italian monitoring programs of the European Marine Strategy Framework Directive (MSFD, 2008/56/EC), we propose the use of a single species model approach, Individual-Based Modelling (IBM), as a tool for comparing the effects of different management measures on fishing activities. IBMs simulate the main processes of the life cycle of each individual, so compared to traditional population dynamics models, this approach can give a better representation of reality, by emphasising the intraspecific variability of life history traits, when informed by proper data collection. In the Northern Adriatic Sea, a sub-basin of the Mediterranean Sea, we applied this approach to two populations of demersal sharks (*Mustelus* spp. and *Squalus acanthias*), both commercially valuable species often fished when still sexually immature, to estimate the minimum retainable size at which the populations should be not suffering further decline by taking into account the post-capture survival rates. Although this kind of models are complex and require many species-specific information on life history traits, so that model uncertainty must be explored rigorously, they are useful screening tools to systematically identify and select, within a pool of options, promising management actions which aim toward elasmobranch conservation and sustainability of fisheries.

Keywords: ecological modelling, intraspecific life history variability, fishery management, elasmobranch conservation

INNORAYS: Improving our knowledge-base for North Sea rays using 'Electronic Monitoring'

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Under the EU landing obligation the transition from landing quota to catch quota may impede fishing activities. Especially in mixed fisheries when restrictive catch quota are fully exploited at an early stage. In this context, skates and rays are managed under a restrictive combined TAC making them potentially one of the main choke species within demersal mixed fisheries in the North Sea. For most of the elasmobranch stocks in the North Sea advice is based on an indicative trend of available scientific survey data. Current survey time-series, however, were initiated primarily to estimate recruitment of the main commercially exploited stocks and sample comparatively few elasmobranch species with any degree of effectiveness. This results in imprecise estimates and greater uncertainties within stock assessments. INNORAYS is an EMFF funded project aiming to gain insight in the catch composition of different ray species in commercial catches using 'Electronic Monitoring' (EM) on board commercial fishing vessels. By manually reviewing random samples of video recordings we will produce representative samples of ray catches on the commercial fleet. To validate EM observations of rays, observer trips are used in which on-board observers determine the species composition, numbers and weight of rays in the catch. As EM still requires much human labour, costs are still relatively high and the human resources needed for video review can be a limiting factor. As such, we explore the potential of automated detection of ray species in monitoring the catches. Improved data collection of commercial catches, i.e. landings and discards, of these species will contribute to better understand and manage 'the choke effect', stock assessments in general and, eventually, more sustainable fisheries management. Also, if practically feasible, such system is expected to be applicable to the registration of other species and benefit the European policy objective of 'Fully Documented Fisheries'.

Keywords: Fishing opportunities, discards, Electronic Monitoring, science-industry cooperation

Raywatch – A study on the population biology and survival of seven ray species in the Northeast Atlantic

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“Raywatch” is a two-year EMFF-funded project aiming to improve data collection for skates caught in Belgian fisheries as part of the National Data Gathering Programme (NDGP). Within Raywatch biological, catch and vitality data will be collected for seven skate species; thornback ray (*Raja clavata*), blonde ray (*Raja brachyura*), spotted ray (*Raja montagui*), undulate ray (*Raja undulata*), small eyed ray (*Raja microocellata*), sandy ray (*Leucoraja circularis*) and cuckoo ray (*Leucoraja naevus*) in the Western Waters and English Channel. A data collection protocol was established and integrated into the existing standardized NDGP program. Total catch weights and length frequencies for the discard and landing fraction were collected per sex. Thus far, a total of 4165 skates were sampled from January 2021 onwards, of which 901 thornback rays, 387 blonde rays, 85 undulate rays, 2326 spotted rays, 288 small eyed rays and 178 cuckoo rays. During a selection of the trips, skates were scored along a four-point vitality scale based on the amount of injuries and the liveliness of the individual (Vitality class A/B/C/D = excellent/good/poor condition, or dead respectively, Catchpole, et al., 2017). For all species combined, preliminary data indicates that most skates were in excellent condition (37%, vitality class A), 26% were scored as “good” (B), 26% as “poor” (C) and 10% was dead at the time of scoring (“D”), resulting in an immediate survival on board of 90%. A subset of the sampled (dead) thornback and blonde rays were taken to the lab, where maturity was assessed based on the stages discriminated in the WKSEL3 (ICES). Our preliminary data shows that the most commonly encountered stages are “immature” and “developing”. Finally, using the newly collected biological data we will develop alternative stock assessment models for a selection of the species.

Keywords: Rajidae – Fisheries Management – Discard Survival – Stock Assessment

Using stable isotope analysis to explore the trophic ecology of Taiwanese deep-sea sharks

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Despite the ecological importance of sharks and the increasing human pressure applied on deep-sea ecosystems, little is known about the ecology of deep-sea sharks. The role that they play in their food-web might be different from their surface relatives as a lot of deep-sea sharks' species are smaller. The elusiveness, difficulty to access their environment, and inability for deep-water sharks to survive in aquaria pose major challenges in data collection. The most common method to study trophic ecology is the analysis of stomach contents. However, such analyses present limitations: (1) only recent preys are found, (2) there is a bias depending on tissue digestive rates, and (3) deep-sea sharks' stomachs have a relatively high probability of being empty. A high number of individuals are thus necessary to determine their diet. Alternative methods are more and more used instead of stomach content analysis such as fatty acid profiling, DNA metabarcoding, or stable isotope analysis (SIA). They can provide interesting insights into the trophic ecology of deep-sea sharks, even on a relatively low number of individuals.

We used stable isotope analysis with stomach content determination to explore the trophic ecology of five deep-sea shark species (*Danae profundorum*, *Etmopterus brachyurus*, *Etmopterus molleri*, *Galeus sauteri*, *Squaliolus aliae*) obtained with the help of fishers in Taiwan. $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{34}\text{S}$ isotope ratios were measured on muscle and liver samples. Isotopic niches were then calculated together with other ecological data. We used mixing models with potential prey collected in the same trophic network to understand the trophic role of these sharks.

Keywords: Shark, deep-sea, stable isotope, trophic ecology

Shark research in the Dutch Caribbean

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This presentation outlines the Shark Conservation work executed in the Dutch Caribbean from 2015 to current. It will include explanation on our policy, scientific and community outreach work towards the conservation of the species.

St. Maarten shark conservation and research

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Education and outreach efforts executed on St Maarten to improve shark conservation under the Save our Sharks project. Acoustic Telemetry research of Caribbean reef and nurse sharks to determine their movement patterns to enhance protection. Tiger shark research and movement patterns showing a possible nursery.

Tag and recapture data for nurse sharks on the Saba Bank

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The Nurse shark (*Ginglymostoma cirratum*), is a relatively abundant elasmobranch in the Caribbean region, yet despite this, little is known about its habitat use or spatial ecology. In the Dutch Caribbean, spatial management measures such as the Yarari Marine Mammal and Shark Sanctuary help to protect all elasmobranchs, but this protection is based on mitigating impacts that will negatively affect the population levels. For many elasmobranchs in the region, including nurse sharks, the population status is not known and so there is no baseline for which to base management measures against.

Here, we present the initial results from a mark and release programme for nurse sharks on the Saba bank. This data was collected through a collaboration with lobster fishermen operating in the area. Nurse sharks caught in lobster traps were tagged and released. This presentation will describe these movements, and highlight how this data has implications for determining space use and fisheries interactions. Data sets such as this can be pivotal in providing estimates of population size, helping to provide a baseline value for which to base management measures on.

Haven't we forgotten something? Urgent need for management of tope shark (*Galeorhinus galeus*) in the EU

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We explain why, after over a decade of inaction to sustainably manage the exploitation of tope shark (*Galeorhinus galeus*) in European waters the only logical outcome is to have a full retention ban.

The biology of tope sharks makes them highly vulnerable to overexploitation. The species is present in all European waters both inshore and in the open ocean and migrates over long distances, individuals were tracked from the West of Scotland to the Azores and back and from the Irish sea into the Baltic. Females are estimated to start giving birth at 10 to 15 years old and only have pups once every three years. The worldwide decline of this species, mainly caused by unsustainable fishing, has led the World Conservation Union (IUCN) to change its status from Vulnerable to Critically Endangered on Red List for endangered species.

Scientist and civil society have indicated the vulnerability of this species for year and stressed the need for sustainable management. However no measure that restrict landings in any meaningful way have been taken by the EU. The International Council for the Exploration of the Sea has advised on a sustainable catch level for tope shark since 2013 but recorded catches have consistently exceed the scientific advice.

In this context a catch prohibition (including bycatches, transshipment and landings) with a prompt release requirement for all tope caught would make sense as it is in line with the international conservation status of the species and is a readily enforceable measure that adheres to the level playing field between EU and non-EU fishers.

Genetic diversity and population structure of the starry smooth hound in the northeast Atlantic Ocean

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The starry smooth hound (*Mustelus asterias*) is a small demersal shark species that occurs in the northeast Atlantic Ocean. The species is assessed as “Near Threatened” due to an estimated population decrease of 25% over the past three generations. Current management is based on the presence of a single stock-unit. However, spatial differences were observed with females in the Celtic and Irish Seas being larger at maturity and having a later parturition season compared to females in the southern North Sea and English Channel. These spatial differences suggest the presence of one or more subpopulations. Multiple subpopulations are more vulnerable to (over)exploitation than a single larger stock, therefore, additional information on the population structure of *M. asterias* is essential. Genetic tools provide a powerful method to gain insight in the genetic diversity and thereby population structure of a species. The present study analysed the genetic diversity of *M. asterias* by obtaining a tissue sample of 15 pups and 59 females captured in seven regions in the northeast Atlantic Ocean. Each tissue sample yielded a DNA sequence of 6000 nucleotides, a third of the mitochondrial DNA. In the 74 specimens, 18 distinct DNA sequences were found, covered by 34 mutations. Unexpectedly, no relationship was found between the two proposed subpopulations and haplotype distributions. However, the nucleotide diversity in *M. asterias* was remarkably low and comparable to heavily exploited shark species. Three main genetic clusters were found with a high degree of genetic distance in-between. There was a lack of expected haplotypes between these three main clusters. The low nucleotide diversity in combination with the genetic clustering suggest a historic bottleneck. It is recommended to increase the sample size of the dataset with tissue samples of pups, since these specimens give the highest accuracy of genetic diversity of one or multiple stock-units.

Keywords: *Mustelus asterias*, stock-unit, management, haplotypes

Comparisons of age estimations for the thornback skate (*Raja clavata*) and blonde skate (*Raja brachyura*) using truncal and caudal vertebrae

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Age and growth were estimated from 100 thornback skate (*Raja clavata*) and 46 blonde skate (*R. brachyura*) using both truncal and caudal vertebrae and the outcomes were compared. Vertebrae were cleaned using a newly developed protocol and stained with crystal violet (0.005%) for up to 24 hours. Results show age estimations for both species from caudal vertebrae were significantly lower compared to age estimations from truncal vertebrae ($P < 0.01$). Future studies should address the validation of the technique which would make it possible to demonstrate if there are consistent underestimations of age from caudal vertebrae as compared to truncal vertebrae.

Keywords: Age, North Sea, Raja, vertebrae

Estimating age in elasmobranchs: intra-individual disparity in band counts of the thornback ray (*Raja clavata*)

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A handful of studies in recent years call the reliability of vertebral band counts as an ageing method for elasmobranchs into question, some suggesting band deposition relates more closely to somatic growth rather than age. In this study, forty-one thornback rays (*Raja clavata*) caught as bycatch in North Wales scallop dredge fisheries in the Irish Sea were examined to analyse the variability in age estimates both within specimens and between readers. Vertebrae were collected from three regions (scapular, thoracic and caudal), along with thorns found on the caudal region. A new method for determining clarity for vertebral sections was trialled using image processing software to derive pixel values. Age was found to differ significantly between regions and structures, with caudal thorns presenting an age estimate almost a full year younger than scapular and thoracic vertebrae. Caudal vertebrae were estimated half a year younger than thoracic vertebrae, this region also being 3.1% less clear than the thoracic region. No significant differences in clarity or age variation were found based on animal or structure size. Additionally, age counts exhibited high dissimilarity between novice and more experienced readers, with the experienced reader exhibiting more uniform age estimates between regions and structures compared to the higher dissimilarity of the novice readers. These results imply age estimates are dependent on clarity rather than structure and animal size. As annual band periodicity has been verified for *R. clavata* in the past, it could be hypothesised that while band deposition is annual, bands are not all equally visible. The findings of this study point towards thoracic vertebrae as the most suitable for ageing, with caudal vertebrae and thorns being estimated conservatively in comparison.

Keywords: age disparity, band deposition, Rajidae, skeletochronology

Skate-ing over the issue: taxonomic nuances, revised distribution and conservation implications for flapper skate, *Dipturus intermedius*

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Dipturus skate living in the north-eastern Atlantic and Mediterranean are often misidentified and misreported, due to the high degree of morphological similarities within the genus. This has resulted in poor taxonomic resolution in landings data over much of the 20th century in the region, hampering the effective assessment of the various skate species. Such taxonomic uncertainty can lead to errors in estimating population viability and distribution range and can impact on fisheries management considerations and perceived conservation status. Take for example the common skate, which current evidence has shown is best explained as a species complex, composed of the larger-bodied flapper skate (*D. intermedius*) and the smaller-bodied common blue skate (*D. batis*). A number of the management and conservation initiatives developed prior to the separation continue to refer to the complex, which is problematic for the conservation of this critically endangered species. Within the fisheries industry, confusion still surrounds the complex, and their distinct ecologies and life histories are yet to be fully elucidated. We set out to build a higher resolution picture of the distribution of *D. intermedius*, using both molecular data and a combination of survey, angler and fisheries data, in addition to expert witness statements. We present for the first time a revised distribution of *D. intermedius*, which was more constrained and coastal compared to that of the 'common skate' complex, with most observations recorded from Norway and the western and northern seaboard of Ireland and Scotland, and occasional specimens from as far south as Portugal and the Azores. It was not possible to confirm the presence of flapper skate within the Mediterranean. Overall, the examination of confirmed species-specific records has significantly reduced the known extant range of the species and indicates a possibly fragmented distribution range.

Keywords: Dipturus, Distribution, Conservation, Phylogenetics

Exploring a new alternative for the study of reproduction in threatened chondrichthyans: A minimal invasive approach

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At present, there are no minimally invasive methods for the simultaneous analysis of steroid hormones in muscle and dermal tissue of chondrichthyans. The objective of the present work is to explore the development and implementation of a minimally invasive method for the study of the reproduction of chondrichthyans through the analysis of steroid hormones in muscle and skin biopsies. For the development of the extraction method, samples of 2 mL of blood serum and 150 mg of gonad, liver, muscle, and skin of the sickle-fin smoothhound *Mustelus lunulatus* (n = 7) and the diamond ray *Hypanus dipterus* (n = 19) were used in different stages of maturity (juvenile; adult; pregnant; and postpartum); which were processed by liquid chromatography with triple quadrupole mass spectrometry for their quantification. This allowed the simultaneous detection of nine hormones, including testosterone, progesterone, 17 β -estradiol, estrone, 17-hydroxyprogesterone, androstenedione, cortisol, cortisone, and corticosterone; which is higher than 93% of the studies published to date and constitutes the first hormone extractions performed on chondrichthyan dermis. Extraction efficiencies of all hormones and tissues ranged between 18-104%; while the detection and quantification limits were 0.37-1.31 ng/mL and 1.25-4.17 ng/mL, respectively. The preliminary results of the hormonal profiles coincide with that reported in previous studies, when observing hormonal peaks characteristic of each stage of maturity. These preliminary results allowed the testing of white shark *Carcharodon carcharias* skin biopsies (50 mg). In this case, steroid hormones were extracted using a liquid-liquid extraction, with the first results showing an extraction efficiency ranging between 80-91%. RSD for cortisol, androstenedione, 17-hydroxyprogesterone, progesterone and testosterone were all below 20, with no ion suppression in the matrix. Pending additional results, the authors hope that these results will benefit the study of threatened sharks and rays worldwide.

Keywords: reproduction, skin, minimal-invasive, hormones

EMV-scope, a baseline of EMF on the Dutch Continental Shelf and the possible effects on benthic elasmobranchs

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Submarine power cables generate electromagnetic fields that can be measured up to tens of meters in the water column. With the transition to producing more offshore renewable energy it is to be expected that the number as well as the capacity of these cables will greatly increase. Submarine power cables connecting Offshore Wind Farms to shore, and interconnector cables that link countries, cut across long stretches of seafloor intersecting with foraging habitat and migration routes of marine species. Elasmobranchs, specifically rays, skates and sharks are especially sensitive to electromagnetic fields as they use the ampullae of Lorenzini for orientation and to find prey under the sand. The effects of anthropogenic electromagnetic fields on elasmobranchs are largely unknown. The potential effects can include behavioral changes as for example foraging or cause avoidance/attraction and therefore may result in an impact on orientation and migration. These negative effects could negate the positive effects resulting from the trawl-fishing ban in offshore wind parks which have the potential to boost elasmobranch populations. Important knowledge gaps are the need for dose-response levels of different species and age groups. In addition, in-situ levels of electromagnetic fields in relation to parameters as wind levels, burial depth and substrate are needed in order to determine the need for mitigation. The present study (1) creates a baseline of the electromagnetic fields present on the Dutch Continental Shelf, (2) conducts a risk assessment of the possible barrier formation and attraction zones based on dose-effect studies from literature and (3) discusses these results in relation to mitigation measures and required research.

Keywords: Electromagnetic fields, Marine Renewable Energy Development, Submarine power cables, Behavioral effects.

Elasmobranch sperm cryopreservation as a novel tool for ex situ conservation.

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Elasmobranchs are one of the most endangered groups of vertebrates on the planet. Given this situation, *ex situ* conservation strategies could be useful for multiple species. However, to assure the success and sustainability of these strategies, breeding programs, and reproductive techniques should be implemented. Among these reproductive techniques, sperm preservation is a potential tool almost never used in elasmobranchs. In fact, there are no widespread preservation protocols for elasmobranch sperm, and shark sperm cryopreservation has never been achieved before. Here we present a series of successful cryopreservation protocols for elasmobranch sperm, tested in 10 species, including sharks and rays considered Critically Endangered according to IUCN criteria. We have formulated a sperm extender (in mM; 433 Urea, 376 NaCl, 120 Trimethylamine N-oxide, 8.4 KCl, 50 Glucose, 7 CaCl₂·2H₂O, 3.5 NaHCO₃, 0.08 Na₂SO₄, 1.4 MgSO₄; pH 6.5; Osmolality 1000 mOsm/kg) useful for different species, where sperm keep its motility for up to 36 days at 4 °C. The cryopreservation of sperm was achieved by supplementing our extender with different combinations of cryoprotectants: methanol, dimethyl sulfoxide (DMSO), and fresh egg yolk. Samples were frozen inside a styrofoam box using liquid nitrogen vapor. Pre-freezing and post-thawing sperm quality was assessed by analyzing spermatozoa motility and membrane integrity. In rays, the use of 10% DMSO or 10% methanol produced post-thawing motility values higher than 40%. In sharks the combination of 5% DMSO, 5% methanol, and 10% egg yolk produced mean values close to 35%. Overall, the addition of egg yolk increased the post-thawing motility values, by up to 42.1% in samples with initial motility values of 70%. For the first time, shark sperm cryopreservation has been reported, broadening our knowledge of the reproductive techniques that can be applied to elasmobranchs and laying the foundations of the first cryobanks for the long-term storage of their sperm.

Keywords: fish reproduction, sperm cryobanking, ex situ conservation, reproductive assisted techniques

Mercury isotope clocks estimate dispersal timing from natal area in hammerhead shark species

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Mobile marine species shift habitats throughout their life history, connecting different ecosystems with broad chemical signatures that are integrated in animal tissues. Among them, smooth hammerhead sharks (*Sphyrna zygaena*) birth in coastal areas where they remain for an unknown period before migrating to pelagic waters. In the Mexican Pacific, juvenile smooth hammerhead sharks are heavily fished by artisanal anglers. The survival of young individuals is yet critical for the recruitment in adult populations and to maintain the species biomass. Characterizing natal grounds and quantifying the age at which smooth hammerhead sharks leave them is therefore crucial for implementing efficient management plans to protect early life stages and maintain adult populations. For the first time, we used mercury isotopes as molecular 'clocks' to estimate the age at which smooth hammerhead sharks migrate from their inshore natal grounds. 'Clocks' approach integrates tissue turnover rates and shark isotopic compositions at different stages of habitat transition to estimate 'time-since-immigration' in the pelagic habitat. We sampled juvenile smooth hammerhead sharks, ranging from 66 to 192 cm (total length), across the Pacific coast of Mexico and analyzed their muscle $\Delta^{199}\text{Hg}$ values. Mean $\Delta^{199}\text{Hg}$ values decreased with age, illustrating a shift from epipelagic prey for young-of-the-year individuals in shallow natal ground to mesopelagic prey in individuals approaching maturity. Based on the distributions of isotopic 'clock' input parameters, we generated distributions of smooth hammerhead shark residency time in the pelagic habitat and back-calculated an estimation of their age of departure from natal ground. This study offers a new application of mercury isotopes to estimate key spatial ecology information for the conservation of mobile shark species. Moreover, it clarifies the poorly understood life cycle of smooth hammerhead sharks by providing an estimate of their residency time in natal areas, a still unknown ecological characteristic for the species.

DNA barcoding as a tool to explore elasmobranch diversity in eDNA off the Banc d'Arguin, Mauritania

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Mauritania, although rich in natural, marine resources, including some of the most abundant fisheries resources in the world, is a developing country that has not received as much international attention from the scientific community as other developing nations concerning their shark and ray stocks and species diversity. In 1976, the country established the largest marine protected area in West Africa, the Banc d'Arguin National Park (PNBA), around the ecologically significant Banc d'Arguin bay. Although historically heavily exploited, the PNBA now only allows subsistence fishing to their indigenous Imraguen population and has put in place a ban on almost all shark fishing since 2003. In spite of these efforts, some illegal, unreported and unregulated (IUU) fishing activities targeting elasmobranchs are still taking place within its borders that supply an international demand for shark fins. Due largely to its unique hydrological regime and topographical properties, the Banc d'Arguin is known to host a variety of rare and threatened shark and ray species as well as the endemic and Critically Endangered False shark ray, *Rhynchorhina mauritaniensis*. However, according to local surveys, shark and ray abundance has continued to decline considerably in the last few decades with some species now possibly being locally extinct. This study provides a genetic sequence reference database based on DNA barcoding of locally collected tissue samples from shark and ray landing and processing sites. These also revealed the presence of potentially new, undescribed species in the region and confirmed the increase in geographical range of other previously unrecorded species. Environmental DNA from locations spread across the Banc d'Arguin are analyzed and compared against the custom-made database in order to explore current species diversity in the PNBA that can serve as a baseline for future studies, monitoring activities and management strategies.

Keywords: West Africa, genetics, metabarcoding, conservation

Spying on the devil's lair: Remote monitoring of the seasonal aggregation of *Mobula tarapacana*

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Seamounts are biodiversity hotspots for pelagic and oceanic species like the sickle fin devil ray, *Mobula tarapacana*. As such, this endangered species (IUCN) aggregates during the summer at two offshore Seamounts in the Azores archipelago. The aim of our research was to investigate the aggregation at Princess Alice seamount using cost-effective remote video. A stationary camera system was used to monitor the diel and season patterns of abundance. Generalized linear models were tested to investigate the anthropogenic and environmental effects on abundance patterns. Abundance increased in the evening periods in contrast with the mornings. The diving industry impact was found not significant, while the environmental model showed interesting preliminary results. The results showed that mobulas tend to depart from the seamount in Mid-September. Despite some limitations, our research has validated this cost-effective methodology to monitor seasonal aggregations of *Mobula tarapacana* at remote locations, providing valuable information at daily and monthly time scales. Furthermore, this methodology showed great monitoring potential for a wide range of species, including resident and occasional pelagic visitors.

Keywords: Remote video, cost effective, *Mobula tarapacana*, seamount.

Movement Patterns of the Tiger Shark, *Galeocerdo cuvier*, around Tahiti and Moorea, French Polynesia, South Pacific

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Although French Polynesia is the biggest shark sanctuary in the world, little is known about the movements of the shark species distributed there. Here we used acoustic telemetry to study the movement patterns of tiger sharks (*Galeocerdo cuvier*) around the islands of Tahiti and Moorea, French Polynesia, during the 2014-2016 period. Acoustic transmitters were ingested or externally attached at the base of the sharks first dorsal fin and provided acoustic data on 10 individuals during the study period. Preliminary analysis suggests seasonal and strong spatial variability in the use of the Tahitian coastal area. Two sites stand out by their high numbers of detections and high levels of residency: the “Vallée Blanche” site (NW of Tahiti) and the Papenoo outer reef (N of Tahiti). However, temporal patterns of activity at these two sites are different. If the regular practice of shark-feeding likely explains the presence of tiger sharks at the Vallée Blanche during the day, the intense activity at the Papenoo acoustic station suggests the presence of a natural aggregation site in this area. In addition to increasing our knowledge about their ecology, understanding tiger sharks’ movement patterns in French Polynesia is crucial to assess the effects of shark-feeding practices and the efficiency of the sanctuary implementation.

Keywords: Acoustic telemetry, movement patterns, behavior, tiger shark

Fast forwarding marine biodiversity surveys.

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FjordStrong is a Marine Biodiversity Consultancy specialising in sustainable and non-invasive surveys through a suite of patented video-based tools and bespoke automation software. Our aim is to provide a bridge between the commercial interests of the blue growth initiative and the sustainability demands of the current political agenda across the EU, with a special focus on protecting demersal elasmobranchs.

As a university spinout company, our services are complemented by access to cutting edge research (e.g. multi-spectral 3D imaging) and novel statistical techniques allowing us to provide rapid and quantitative results for biodiversity indices, species occurrences, abundances and length-estimations. By focusing on video-monitoring methods, our data can be used to provide effective and communicative content to stakeholders, a benefit which can aid the swift progression of projects while our robust surveys are suitable for long term monitoring of changes over time and space.

FjordStrong is eager to develop future collaborators and showcase our sustainable surveying tech so listen in to hear about our start-up journey, our ambitious projects and how we can help fast-forward marine biodiversity surveys.

Keywords: monitoring; marine biodiversity; video-based tools

Emerging Technologies in Acoustic Telemetry: Real-time Data of Animal Movements and Environmental Variables

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Acoustic telemetry is a well-established tool that has been used around the world for more than three decades to get an understanding of the spatio-temporal movements and associated behaviour of a wide range of aquatic animals. One of the technological highlights in recent years has been the possibility of real-time observations of aquatic animals and their environment utilizing Innovasea's Fathom Live system. Data is available via the mobile phone net or Wi-Fi (satellite connection is under development) and can be accessed through a secured account on the Fathom Live Dashboard using a mobile/desktop device. This system provides real-time notifications when tagged animals are near receivers or the current state of environmental variables. It will allow, for example, to detect when migratory species are on the move, alert the public and/or stakeholders if an area may be unsafe due to an animal's presence, identify an endangered or threatened species near anthropogenic structures such as power facilities, the intrusion of an invasive species in a body of water, and other crucial management decisions. Unlike with satellite tags, animals do not need to break the surface to be detected. There are also fewer limitations on tag size and battery life, meaning a broader selection of animals can be tracked. Fathom Live provides a phenomenal way to engage the public by letting them "track" species in their specific area or the world abroad. The development of an accompanying cloud-centric database (Fathom Central) makes this innovative system the ideal platform for stakeholders and researchers with remote access to all collected data in a secure and easy way. The integrated tools also provide useful features such as animated detection maps, visualization of diagnostic information and environmental variables, and management of all related metadata. Such systems are now in use at several global installations.

Keywords: Acoustic Telemetry, real-time data, fish tracking, environmental variables

SPOTTED – a web-based game for photo identification of the bluespotted ribbontail ray

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The bluespotted ribbontail ray (BSR, *Taeniurops lymma*) is a widely distributed species, commonly found in coral reefs. Despite its abundance, little is known about the life history and ecological traits of the species. BSR have noticeable bright blue spots, arranged in distinct patterns on their dorsal side. We took advantage of this morphological feature to develop a system for identifying BSRs at the individual level. Such a system can help to estimate the population size and occurrence patterns. Since 2018, photographed observations of cartilaginous fish from Eilat, Red Sea, were collected following the MECO protocol. Out of 1500 observations, 513 are of BSR, placing it as the most observed elasmobranch species in Eilat. For photo identification, we have developed a web-based game - SPOTTED. SPOTTED game users are shown two pictures of BSRs and are asked to determine, based on the spot patterns, whether it is the same individual appears in both pictures (positive match). The user's answers are subject to approval by a researcher, pairs that receive positive scores from many users are prioritized. Since December 2020, using 779 pictures of BSR, 140 matches have been identified through the system. These matches revealed 27 individuals observed on 2-10 different occasions, and in a time span of between a few hours and 6 years. Individuals were almost always seen in the same area, even over a period of years. These preliminary results demonstrate the ability of a simple, user-friendly platform to help quickly and accurately identify individuals, while engaging the public in the scientific process. The game provides a platform that can be easily utilized for collecting data on various species, especially in cases where there is no possibility or desire to set up a complicated automated system or as initial labelling tool for AI systems.

Keywords: photo ID, citizen science, science communication, population biology

The OCEARCH Model for Advancing Shark Research and Education

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OCEARCH is a nonprofit, data-centric organization built to help scientists collect previously unattainable data in the ocean. Since 2007, OCEARCH has conducted 42 expeditions in nine countries, focusing on comprehensive studies and public awareness of the ocean's top predators, sharks. Using the unique facilities of its research ship, OCEARCH provides unprecedented access to large sharks in the wild for advanced studies of their biology, conservation status, and human impacts. By merging the talents of world-class fishermen with multinational science teams at the forefront of elasmobranch biology, the rate of scientific output is accelerated and the need for overall sample size is reduced. Begun as a "platform of opportunity" for an individual researcher with a single project, OCEARCH now manages a collaborative program involving more than 40 scientists with over 20 unique projects on each expedition. Overall, the organization has served the needs of more than 200 scientists in the Pacific, Atlantic, and Indian Oceans. Beyond the research activities of these scientists, OCEARCH advances public awareness through its Global Shark Tracker app and website, social media, and STEM educational programs. A core value of the organization is open access, that is, OCEARCH gives away all its intellectual content, including research data and educational programs, to the public for free. With this approach OCEARCH has adapted the Google business model to build scale and monetize that scale to support shark research and education. The OCEARCH model uses the following guiding principles to advance shark research: 1) Collaboration, by uniting different groups such as fishermen, scientists, educators, and filmmakers to increase our knowledge on sharks; 2) Inclusion, allowing the world to participate in real time through open access on a large scale; and 3) Innovative Funding, through the use of brand-integrated content, conscious consumerism, and philanthropy, with no reliance on government funding.

Keywords: collaboration, inclusion, business model

OCEARCH's North Atlantic White Shark Study: Scope, Techniques, and Results

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Although extensive studies of the white shark have been conducted in Australia and New Zealand, South Africa, the eastern Pacific and other regions, our knowledge of white shark biology and behavior in the western North Atlantic (WNA) has been relatively limited. Beginning with preliminary work in 2012-2013, and then each year since 2016, the nonprofit organization OCEARCH has conducted 17 expeditions from Florida, US to Nova Scotia, Canada to support a large-scale, collaborative, multi-institutional program of research on WNA white sharks. This program comprises 24 unique projects by 42 principal investigators from 29 research organizations. To date (as of 10 Sep 2021), 74 white sharks of four life stages (YOYs, juveniles, subadults, adults) of both sexes have been caught, measured, sampled, examined, tagged, and released in WNA coastal waters of the US and Canada. Studies of these animals include: 1) population assessment (distribution and abundance by size/sex, movement ecology, global and familial population genetics, and ectoparasite population markers); 2) reproduction (endocrinology, reproductive organ activity, semen assessment, and seasonality of reproductive behavior); 3) feeding ecology (diet structure and nutritional condition); 4) sensory studies of visual, gustatory, and olfactory systems; 5) understanding of environmental threats through assessments of general health, stress response, and contaminant levels; and 6) microbiology and biomedicine (microbiome characterization and antibiotic isolation). Through this integrated research we are maximizing the information obtained from each individual shark, which minimizes the number of animals we must sample. We also are able to compare results across disciplines by obtaining a suite of samples from each shark throughout the range of the WNA population. Major findings and techniques employed in the 24 projects will be reviewed in this summary of OCEARCH's North Atlantic White Study, which will shift its geographic focus to the eastern North Atlantic and Mediterranean Sea in late 2022.

Keywords: white shark, Atlantic, telemetry

Seasonal fidelity by white sharks (*Carcharodon carcharias*) in the western North Atlantic over multiple spatial and temporal scales

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An animal's movement patterns are, inherently, a reflection of a combination of selection pressures on the population and learned experiences within an individual's lifespan, resulting in behaviors that should maximize fitness. Site fidelity, repeated re-use of an area, is an example of a behavior which can confer multiple benefits to the individual including optimizing foraging, mating, physiology, and ultimately, survival. A thorough understanding of the presence and scale of fidelity in large, migratory, marine species is important in elucidating their role in marine ecosystems and in developing successful management strategies. To that end, we analyzed satellite and acoustic tracking data for 48 white sharks in the western North Atlantic Ocean over a multi-year period to better understand their intra- and inter-annual movement patterns with a focus on defining the scope of fidelity for this population. Results suggest that individual white sharks are philopatric to multiple areas within their range. Coarse-scale fidelity was seen in a majority of animals tracked over multiple years whereby sharks showed a preference for summer foraging areas as well as general regions for overwintering. Fine-scale fidelity was also observed with individual sharks returning to the same summer areas (within 1-3 km) in subsequent years after migrating thousands of kilometers during the intervening months. The level of fidelity observed suggests that these animals are using complex navigational cues and refining their space use to likely maximize biological and ecological efficiencies. While this level of fidelity provides a benefit to the individual and the population, there is potential for negative impacts when conditions change, e.g., climate change. While fidelity has been observed by white sharks elsewhere, these results are the first clear evidence of multi-year fidelity in the western North Atlantic demonstrating the importance of long-term datasets to identify and define behavioral strategies in long-lived, wide-ranging marine species.

Keywords: Telemetry, migration, philopatry

The status of guitarfishes within two large intertidal areas in West Africa.

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Guitarfishes and wedgefishes are among the most threatened elasmobranch species groups, caused by overfishing and coastal habitat degradation. These species are highly adapted to utilize benthic habitats and are often associated with coastal ecosystems. Off the West African coast, the blackchin guitarfish (*Glaucostegus cemiculus*) and common guitarfish (*Rhinobatos rhinobatos*) are frequently captured in local artisanal fisheries. Here, guitarfishes are believed to play an essential role within the functioning of large intertidal areas, like the Banc d'Arguin (Mauritania) and the Bijagos Archipelago (Guinea Bissau). Long-term data on the artisanal fisheries within the Banc d'Arguin National Park indicates that catches of guitarfishes continue to rise, with a doubling in catches from 1.4 kg per fishing day in 2006 to 2.8 kg per fishing day in 2020. Here, the blackchin guitarfish is among the ten most captured species. Reconstructed population trends based on semi-structured interviews with the fishing communities in the Bijagos Archipelago indicate a clear decline in catch-per-unit-effort of guitarfishes over the past 40 years. Based on a recent initiated fishery observer program, guitarfishes are among the most captured species within the archipelago. Length frequency and direct field-observations of newborn blackchin guitarfishes suggest the intertidal mangrove forests of the Bijagos Archipelago may be an important nursery area for this critically endangered species. In addition, the fishery observer program also led to first documented record of the elusive African wedgefish (*Rhynchobatus luebberti*) in the archipelago since 2006. The trophic ecology of guitarfishes indicates that these species use these large intertidal areas along the West African coast as feeding areas. Our results show contradicting trends for both areas, but show high exploitation rates and ongoing threats for these endangered species. We furthermore highlight the importance of long-term fishery data and local capacity building, and the reconstruction of essential population trends using local ecological knowledge.

Keywords: coastal ecology, fisheries, population trends, marine conservation

Cold and dark who wants to live here?

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The continental shelf and deep waters are heavily subjected to anthropogenic pressures like fishing and climate change-related environmental changes. One of the consequences is the drastic decline of commercially exploited stocks and associated collateral damage to bycatch species, many of them being chondrichthyans. Squaliform sharks and chimaeriformes are estimated to be the most threatened marine orders due to high bycatch rates. In many areas, including the northern Northeast Atlantic, they are poorly understood and knowledge of their distribution and its environmental drivers are urgently needed to inform species-specific monitoring and management plans. Two examples, and our study species, are the rabbitfish (*Chimaera monstrosa*) and the velvet-belly lanternshark (*Etmopterus spinax*) which are common in Norwegian and Icelandic waters with very high annual bycatch rates. Using three decades of national and international survey and environmental data and applying a combination of statistical models and GIS mapping tools, our study revealed that temperature and depth are the crucial environmental factors driving the distribution and abundance of both species. Both prefer similar spatial and ecological habitats, that is, deep and cold waters, but feed on different trophic levels. Despite an increase in abundance, environmental changes throughout the last decades seem to have largely influenced the distribution of both species, as they have moved to deeper and more northerly waters. As this exposes them to potential interaction with larger fishing operations in the north and in deeper waters, their vulnerability to bycatch has most likely increased. Our study highlights the value of survey data and especially long-time series in improving our understanding of species ecology as well as trends over time, and underlines the potential of historical marine ecology to provide 'baselines' for management. Indeed, understanding historical changes in distribution allows for predictive future distributions in the light of projected climatic changes.

Keywords: Chondrichthyans, kriging, habitat use, Global warming

Large-scale distributions of migratory species in the Mediterranean - insights from the MECO project

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Elasmobranchs are highly threatened globally; 25% of species are estimated to be endangered by the IUCN. This disturbing trend is more significant in the Mediterranean, where over half of the species represented in the basin are at risk. Yet, there is still a considerable knowledge gap about distribution, abundance, and critical habitats of Elasmobranchs in the Mediterranean to create effective conservation and management plans; this is especially true when looking at migrating species.

The MECO project aims to diminish this gap by utilizing social media. Local scientists join forces to search the media, contact the public, and create a verified database of elasmobranchs observations. The project has collected over 7000 observations of 70 species from around the Mediterranean, including large migratory species. *Prionace glauca* and *Cetorhinus maximus* observations were mainly restricted to the eastern basin with 306 and 51 sightings (respectively), mainly in France (109,19), Italy (13, 66), and Greece (0,62). *Carcharhinus plumbeus*, with 131 observations, is found primarily in the eastern basin (Israel (63), Gaza (15), Libya (18), and Italy (15)). *Mobula mobular* observations (103) suggest a possible migration pattern from the eastern Mediterranean during winter to the western Mediterranean in summer. Additionally, the data also suggests a nursery ground for *Isurus oxyrinchus* in the eastern Mediterranean. Out of 172 sightings for the species, 56 are juveniles.

Migratory species conservation requires a solid dataset describing distribution and seasonality; the information from the MECO project can provide such datasets. We hope our initiative will further grow, shedding more light on the status of the Mediterranean elasmobranchs.

Keywords: Migratory species, conservation, Mediterranean, citizen science.

Mediterranean ghosts of the deep – a review for the understanding of their ecology and risks

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Ghost sharks (subclass Holocephali), are one of the least-studied groups of cartilaginous fishes in the Mediterranean Sea. Their occurrence in deep-sea environments, low commercial value, and difficulties for discerning the identity of the two species present in the Mediterranean may have influenced the paucity of attention. *Chimaera monstrosa* is widely distributed along the Mediterranean, although some aspects of its population status remain largely scarce. Conversely, the existence of *Hydrolagus mirabilis* in the Mediterranean is still uncertain. In this study, we synthesized the information provided by the scientific literature published between 1920 and 2020 (N=154) on

the Mediterranean ghost sharks. The abundance of *Chimaera monstrosa* may be higher in some regions of the northwestern Mediterranean, particularly, in the Alboran Sea and Gulf of Lion, but appears to be less common in northern Spain, the Adriatic Sea and in the southern Mediterranean. There is, however, a scarcity of studies in its southern range. It has been reported at depths of 100–1660 m, but is most abundant between 550 and 650 m. This is contrary to previous assumptions which reported maximum abundance at 300–500 m. Although the species is widespread in the Mediterranean, it exhibits different trends at the regional level, with declines in the Tyrrhenian, Adriatic and Aegean Seas and stable trends in the Alboran Sea. On the other hand, *Hydrolagus mirabilis*, has only been reported on three occasions between 2011 and 2015 in the southern Tyrrhenian Sea and the southern and eastern Levant Sea at depths of 400–700 m. The morphological similarity between both species could have made its presence in the Mediterranean to go unnoticed previously. The standardization of data collection is a priority that needs to be addressed to ensure correct species identification, assess regional abundance trends, and better understand population structure across the region.

Keywords: Marine Protected Areas, movement ecology, connectivity, flapper skate

Too young to die: mapping birthing sites of the endangered sandbar shark (*Carcharhinus plumbeus*) to inform conservation in the Mediterranean ea

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The declining status of elasmobranch populations in the Mediterranean Sea is alarming. Reversing such dramatic trends requires tackling fishing pressure using different methods, including a fine-tuned spatial resolution conservation strategy, incorporating robust scientific evidence on fundamental ecological aspects such as spatial use at different life stages and its overlap with fishery grounds. Using landing and effort data of a small-scale fishery, this study unambiguously identified a multiyear birthing site of the sandbar shark (*Carcharhinus plumbeus*), an endangered neritic species, in the northern Adriatic Sea. In summer 2019 and 2020, the majority of landed sandbar sharks were categorized as neonate given the presence of fresh umbilical scar, caught from the same fishing ground.

Then, such novel information was combined with a literature review on the presence and absence of newborns across Mediterranean subbasins to construct an ecological model predicting suitable birthing areas for the sandbar shark across the Mediterranean Sea. A generalized linear model was fitted to a presence and absence observations and performed strikingly well, with a percentage of correct predictions of 99.2%. Indeed, high probability of suitability were evidenced in known birthing sites (northern Adriatic Sea and Gulf of Gabés); furthermore other Mediterranean coastal areas were also predicted to be suitable for birthing, but limited data monitoring may have concealed the actual occurrence of birthing. The model highlights how important near-shore habitats are for sandbar shark recruitment and shows key birthing areas that critically overlap with fishing activities, where conservation actions should be implemented.

This methodology could be extended to other neritic elasmobranchs, whose transboundary migratory nature requires spatially explicit conservation efforts.

Keywords: neritic shark, spatial management, birthing, Mediterranean Sea

A closer look to coastal aggregation of porbeagle sharks in the English Channel

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Porbeagle (*Lamna nasus*) is a ubiquitous species (Sub-Antarctic, North Atlantic, Mediterranean) whose populations have been strongly affected by fisheries over the last decades, both as a targeted or as a by-catch species. North of the Atlantic, the eastern and western stocks are largely isolated and considered separately for management and assessment. Since 2010, fishing has been banned in European waters and onboard European fleets. Based on historical data (2000-2020) Based on French fisheries observation program (ObsMer) in three regions (Bay of Biscay, Celtic Sea, English Channel), we analyzed the spatial distribution of porbeagle catches. We showed that most of catches are immature individuals distributed within the whole study area with a predominance of males in the English Channel and the South of the Celtic Sea and a predominance of females elsewhere. Furthermore, in the last decade, reported sightings of porbeagles are increasing during summer along the French coast in the English Channel. Sexed individuals were all females, raising questions about the functional roles (i.e. post-partum rest or sex-segregation) of these coastal ecosystems for this epipelagic species. In order to investigate the behavior of porbeagles near the coast, individuals were equipped with PSATs tags, to unravel their horizontal movements. Thus, we observed that spatial distribution of catches and migration patterns match the hypothesis of sex segregation of females along the French coast with seasonal aggregation of both sex along the continental shelf of the Bay of Biscay. Overall, our results suggest that the connection between the regions rely on their functionality in the life cycle of porbeagle

Keywords: porbeagle, tagging, by-catch, migration

Spatio-temporal distribution and abundance of Thornback ray (*Raja clavata*) in the North Sea and the Eastern English Channel from 1988-2020

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Skates and rays are common bycatch species of fisheries, susceptible to overfishing because of their life history characteristics. Their stock management suffers from data limitations and a lack of analytical stock assessments. A global TAC, common for all Rajidae species as the current management measure, is often reached through bycatch before the fishery's main target species quotas, such as for flatfish. This often results in a substantial fraction of Rajidae being discarded to avoid a choke species effect, with limited discard data available. Among Rajidae species, *Raja clavata* is the most landed species with the highest commercial interest in the English Channel and North Sea (ECNS) area. Their stock has been depleted in the 1990s with trends of recovery of catches observed over the last decade. Due to its classification as a data limited stock it is assessed by ICES with survey specific trend-based analysis methods.

The present study investigates a hierarchical Bayesian modelling (Integrated Nested Laplace Approximation) to assess the spatio-temporal distribution of *Raja clavata* in the ECNS area and provide proxies of reference points for relative population size and biomass. This approach allows to account for spatio-temporal components across combined survey catch data from the International Bottom Trawl Survey, Beam Trawl Survey and Channel Ground Fish Survey (1988-2020).

Preliminary results show an increase in the abundance and biomass of *Raja clavata* in the ECNS area in the last decade. Furthermore, a notable expansion of the population abundance and distribution towards the coast of the Netherlands can be observed over the last decade. The spatio-temporal consideration and the combination of survey data across the ECNS area provide promising insights into past and present distributions and reference points for analytical stock assessments for data limited marine populations.

Keywords: Rajidae, spatio-temporal distribution, abundance, North Sea

A coastal shark on a mission

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Sharks are declining worldwide due, in large part, to conflicts with human activities such as fisheries, and increasingly because of habitat loss and climate change. Consequently, sharks are species at risk, many of which remain data deficient due to monitoring gaps and blind spots about their importance and value. Highly mobile sharks are more at risk of coming into contact with human activities such as fisheries, putting high bycatch pressure on shark populations; in Norway, spurdog (*Squalus acanthias*) bycatch of 200-410 tons are landed annually. Yet relatively little is known about their large-scale movements and habitat preferences, as well as their population dynamics after the stock collapse in the late 1990s. We here used a variety of data types and methods, a.o. survey, fishery and environmental data, dissections, satellite tagging and spatial mapping to decipher the spatial distribution, movement patterns and life history composition of spurdog in Norwegian waters. We found that they prefer relatively warm and shallow waters within their distribution area in the northern Northeast Atlantic. This is in line with the results from our satellite tagging study of ten females, where the reconstructed tracks indicated that they stay close within Norwegian coastal waters; also in line with available fishery, survey, and baited remote underwater video data. Our dissection of almost 4,000 bycaught individuals found that most individuals were <15 years of age with a mean age at maturity of 15.3 years for Norwegian waters; much lower than previous estimates. In addition, our analysis indicated the potential for a much swifter recovery of the stock than previously projected. These findings are now used to inform national and international assessments as well as the mapping of vulnerable marine habitats. The next steps will involve increasing our understanding of how changing environmental conditions might affect spurdog, and other cartilaginous species.

I know what (some) tope did last summer

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Tope (*Galeorhinus galeus*) are a threatened, highly migratory shark species. Clear and consistent information on migration pathways and depth usage of adult tope remain sparse, suggesting a high plasticity in migration and behavior. Considered benthopelagic, tope are mainly distributed around continental shelves and slopes. Nonetheless, adult tope have been shown to undertake far-ranging seasonal migrations, and offshore distributions are also known. To shed some light on the distribution and behavior of this understudied species, we deployed pop-up satellite archival tags on adult tope in the German Bight/southeastern North Sea during their seasonal summer aggregations around Helgoland Island and also near a presumed mating site in southwest Scotland. Time series data from the tag deployments were used to identify depth distributions and migration pathways. Some individuals followed far ranging migration trajectories leaving coastal regions, crossing the continental shelf into the deep oceanic waters of the Northeast Atlantic. Once in an oceanic habitat, drastic behavioral changes and shifts in habitat usage became evident.

Keywords: pop-up satellite tags, diurnal vertical migration, deep scattering layers

The impact of changing oceanic conditions and habitat stress on the movement connectivity of reef shark species

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Climate change is predicted to have profound consequences for marine ecosystems and, as such, may have a significant impact on the movement ecology of many marine species. Coral reef ecosystems are highly threatened and sensitive to the effects of climate change. As important reef shark habitat, increased stress to coral reefs has the potential to impact the movement, residency and behaviour of these species with implications for wider tropic interactions. Acoustic telemetry is frequently utilised for quantifying habitat connectivity and space use in marine species, such as reef sharks. In addition, environmental data from satellite remote sensing is now more available and accessible to scientists and researchers. Combining data from acoustic telemetry and satellite remote sensing will facilitate investigation into the impact of changing environmental conditions on the behaviour and movement in reef shark species. Here, we utilise a series of environmental variables known to impact coral reef health, combined into a coral reef stress exposure index (CRSEI), metrics from network analysis and generalised additive mixed models to investigate how changing environmental stress on coral reefs can alter reef shark movement, residency and space use. We found that increased stress exposure on coral reef habitats reduced the movements and connectivity of reef sharks and increased residency behaviour. Variables such as depth, SST variability, SST anomaly, cloud and current were found to be important predictors of connectivity in reef shark species in this region. As climate change is predicted to increase stress on coral reef ecosystems, this may lead to long term reductions in connectivity with important repercussions for coral reef functional ecology and reef shark conservation. These results show the impact that changing oceanic conditions can have on reef shark species and that integrating multiple environmental variables is essential when investigating connectivity and movement in marine fauna.

Keywords: coral reef; movement; shark; stress

Investigating multiscale temporal trends and the effect of diving tourism on shark top predators in the Egyptian Red Sea

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Unsustainable anthropogenic exploitation, and relatively high vulnerability to population loss, threaten the existence of marine top predators globally, as well as the vital ecological functions that they perform. Data that facilitates accurate mapping of multiscale spatiotemporal dynamics of top predators is therefore vital to effective management and conservation of marine ecosystems. Furthermore, with the increasing popularity of ecotourism, investigation of the effect of non-lethal exploitation of these species, is also a conservation priority. Here we use a generalized additive modeling approach to investigate long-term and seasonal trends, as well as the effect of shark diving tourism, on the presence of 4 endangered or critically endangered shark top predators (*Carcharhinus amblyrhynchos*; *Carcharhinus longimanus*; *Alopias pelagicus*; *Sphyrna lewini*). All data were collected by professional SCUBA guides over 7 years, across 4 isolated, coral reef habitats in the Egyptian Red Sea. Clear species-specific seasonality was observed for all species, as well as significant long-term trends. The direction and extent of these observed long-term trends varied across species, with presence either consistently declining, or fluctuating throughout the study period. We found no evidence of a detrimental effect of shark diving tourism on shark presence. The mechanisms underlying differing long-term trends need investigation, while the seasonality of all species should inform effective management. The results illustrate how the growing, non-lethal, and economically valuable industry of shark diving tourism has the potential to provide valuable long-term monitoring data in a cost-effective manner, whilst avoiding the pitfalls of other low-cost methods, and minimising harmful exploitation.

Keywords: Presence monitoring, seasonal variation, diving tourism, top predator

POSTER PRESENTATIONS



Behavioural response to capture as an indicator of post-release conditions: the case study of two smooth-hound sharks (*Mustelus mustelus* and *Mustelus punctulatus*; Family Triakidae) in the northern Adriatic Sea

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Elasmobranchs often constitute the bycatch of several fishing gears. According to the commercial value of the species and size, they can be landed or discarded. However, release does not guarantee the survival of the individuals because capture-induced stress and physical damages can jeopardise long-term survival. Thus, analysing how animals react is crucial to understand post-capture survival. This study, developed as part of the Italian monitoring programs of the European Marine Strategy Framework Directive (MSFD, 2008/56/EC), focused on two smooth-hound sharks, *Mustelus mustelus* and *Mustelus punctulatus*, fished with bottom otter trawls and gillnets in the northern Adriatic Sea (Mediterranean Sea). The mortality rates and conditions of captured sexually immature smooth-hound sharks at hauling (At-Vessel, AV) and in the following 2 hours (Shortterm, St) were evaluated using a vitality score from 1 (intense physical activity) to 4 (absence of body movements) and through capsizing test, directly onboard the fishing vessel. Conditions and mortality rates were then evaluated in the following 72 hours (Long-term, Lt) through capsizing test and behavioural observations (three times per day) in laboratory tanks. Vitality and behavioural data were compared between fishing gears and sexes. Preliminary results showed that in both types of fishing gear the survival rate is high and generally vitality improved or remained stable during the 2-hours observation. Furthermore, the percentage of surviving individuals after 72 hours did not vary according to the vitality score assigned at the time of capture. Behavioural analysis showed that males and females differed in swimming activity during the 72-hours monitoring. Swimming alteration could lead to a fitness reduction of released individuals. This study shows that behavioural analyses can critically contribute to the evaluation of long-term consequences of capture and therefore to understand if release is an effective management strategy for conservation.

Keywords: Survival rates, swimming behaviour, trawling, gill-nets

A stitch in time saves nine? Checking the current status of *Hexanchus griseus* in the Mediterranean Sea through the fishermen's eyes

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Fishermen from 9 countries distributed throughout the Mediterranean Sea were interviewed between March and November 2019 with the aim of compiling information about the current impact of fisheries on a large deep-water shark species, the bluntnose sixgill shark (*Hexanchus griseus*). A total of 382 professional fishermen belonging to 6 different gears (bottom trawling, bottom longline, surface longline, trammel nets, gillnets and polyvalent) took part in the study. Bottom trawlers were the most interviewed fishermen (n=148) and the best fleet coverage was obtained for bottom longline (38.89%). Results showed most captures of *H. griseus* occur in the Western and Central Mediterranean Sea, particularly during the warm months of the year and most commonly by bottom trawlers and bottom longliners. At-vessel mortality (AVM) was rather low in all gears but a slightly higher degree of individual mortality is suggested in trammel and gillnets. The population trend of *H. griseus* in the Mediterranean Sea could not be inferred from the interviews as answers were highly variable, but the overall trend in some countries may suggest this species is showing signs of population decrease. Results of this study are mostly aligned with the latest IUCN's assessment but also recommend reviewing the current status of *H. griseus* in the Mediterranean basin. Further empirical research on post-release mortality would also be advisable to implement measures that help reduce this source of mortality.

Keywords: Bycatch, fishermen, Mediterranean, bluntnose sixgill shark

Population Structure and Relative Abundance of Elasmobranch Species Utilizing Inshore Waters of Khor Al Saadiyat, Abu Dhabi

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The ecology of elasmobranchs is poorly documented along the Arabian Gulf coast of the United Arab Emirates, and what is known about these animals locally comes mainly from market surveys. The present study was undertaken as a pilot field-based initiative to explore the status of elasmobranchs in UAE coastal waters, with a geographic focus on the mangrove region of Khor Al Saadiyat and adjacent islands, northeast of Abu Dhabi. Baited longlines were used to survey the study area between September 2019 to March 2021, during which 71 batoids representing five species, were encountered. The two most abundant species were the halavi guitarfish (*Glaucostegus halavi*) and Pakistan whipray (*Maculabatis arabica*), both of which are categorized as Critically Endangered by the International Union for the Conservation of Nature. Given the relatively high abundance of these species in the study area, it is recommended that conservation measures be put in place to protect their populations.

Keywords: Elasmobranchs, guitarfish, whipray, CPUE

Preliminary analyses of fishery and biological characteristics of skates (Rajiformes) in the Adriatic Sea

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Skates are highly vulnerable to fishing due to their large body size, in addition to the life cycle traits common to most elasmobranchs. Skates are becoming economically important in Mediterranean fisheries, because of the depletion of many commercial bony fish. This study focuses on two species of Rajiformes, *Raja asterias* and *Raja clavata*, in the northern Adriatic Sea, in relation to Chioggia's fishing fleet. The official landing data of the Chioggia Fish Market from 1945 to 2020, available in the Clodia database (University of Padova) was used to analyze the catch trend of the skates over time. Specific data such size, sex ratio, sexual maturity and diet for *R. asterias* and *R. clavata* were investigated through periodic visits at the fish market from 2012 to 2020 and samples during scientific boardings. This data allowed to analyze the changes in the landed size in the 9-years study period for both species. In males the disc width (DW) decreased by 7.7 cm in *R. asterias* and by 10.2 cm for *R. clavata*, in females by 6.9 cm for *R. asterias* and by 4.1 cm for *R. clavata*. Through the analysis of stomach contents, the diet of *R. asterias* and *R. clavata* was assessed to be mainly composed by the class of Malacostraca (95.8% in *R. asterias*, 75.4% in *R. clavata*) and Actinopterygii (3.7% in *R. asterias*, 24.6% in *R. clavata*). The estimated size of sexual maturity (DW50) in males was of 29.7 cm ($t_{117} = 53.29$, $p < 0.001$) in *R. asterias* and 44.3 cm ($t_{118} = 58.83$, $p < 0.001$) in *R. clavata*, in females it was of 35.4 cm ($t_{40} = 120.1$, $p < 0.001$) in *R. asterias* and 52.9 cm ($t_{35} = 0.17$, $p = 0.87$) in *R. clavata*. This important biological information can be useful to support population dynamics studies and management measures of skates in the northern Adriatic Sea.

Keywords: Adriatic Sea; Fisheries science; *Raja clavata*; *Raja asterias*

Comparative anatomy of the reproductive structures of rays and skates

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The superorder Batoidea, constitutes one of the most threatened groups of vertebrates on the planet. Strengthening *ex situ* conservation strategies could be a way of addressing this situation, but to do it, captive breeding programs must be improved. Sperm extraction and artificial insemination are two techniques commonly used in other threatened species, which could also be used in batoids. However, these reproductive techniques should consider the morphology and location of the reproductive structures to be truly effective. The lack of knowledge on that wide diversity of morphologies of the reproductive system can hamper the processes of sperm obtention and artificial insemination, and even harm the animals. Here, we present a comparison of the reproductive anatomies of 11 distinct batoid species, emphasizing the important differences when performing sperm extraction or artificial insemination. Both male and female animals, belonging to the Rajidae, Dasyatidae, Torpedinidae, and Myliobatidae families, were studied. The overall structure of the female reproductive system is similar among the different species studied. The reproductive tract is composed of the ovaries (one or two depending on the species), two oviducts with oviducal glands, two uteri, and a series of sphincters (or isthmus). The greatest differences observed (shape and size of the cervix, uterus, and nidamental gland) are related to the different modes of reproduction among oviparous, viviparous, and ovoviviparous animals. In males, the general structure of the reproductive system is similar in all the species observed: the testes (one or two depending on the species) epididymis, vas deferens, Leydig gland, seminal vesicle, alkaline gland, urogenital papilla, and claspers with clasper glands. Some differences can be observed in the number, shape, and position of the urogenital pores leading to the reproductive ducts, as well as in the morphologies of the seminal vesicles, which can be important during the cannulation for sperm extraction.

Keywords: fish reproduction, sperm extraction, *ex situ* conservation, reproductive assisted technics

Comparative anatomy of the reproductive structures of sharks and chimaeras

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The chondrichthyan fishes, which comprises sharks, rays, and chimeras, are one of the most threatened groups of vertebrates. Given this situation, one possible strategy for the protection of these species could be the use of ex situ conservation projects. However, to develop sustainable ex situ conservation programs, captive breeding techniques, such as sperm extraction and artificial insemination, should be used. Nevertheless, the different reproductive morphologies found in this group can difficult both processes. Therefore, a comparison of the reproductive anatomy of 8 distinct chondrichthyans, with emphasis on those important differences when performing sperm extraction or artificial insemination, is presented. Sharks and chimeras belonging to the Scyliorhinidae, Carcharhinidae, Centrophoridae, Etmopteridae, Hexanchidae, and Chimaeridae families were obtained from commercial fisheries, public aquaria, and stranding events. The overall structure of the female reproductive system is well preserved among the different species studied. The system is composed of the ovaries (one or two depending on the species), two paired oviducts with oviducal glands, two uteri, and a series of sphincters (or isthmus) that isolate the different parts of the reproductive tract. The greatest differences observed (shape and size of the cervixes, uteri, and oviducal glands) are related to the different modes of reproduction. In males, the overall structure of the reproductive system in both sharks and chimaeras is similar, although chimaeras show unique secondary sexual characters of their group, such as the presence of a frontal tenaculum and prepelvic claspers. The reproductive system is formed by the testes (one or two depending on the species) epididymis, vas deferens, Leydig gland, seminal vesicle, urogenital papilla, and claspers with siphonal sacs. However, there are some differences between the different morphologies of the seminal vesicles and the urogenital papillae, which can be important during the processes of cannulation to extract sperm.

Keywords: fish reproduction, sperm extraction, ex situ conservation, reproductive assisted technics

Environmental education: an effective tool to improve conservation of sharks and rays?

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Sharks and rays have always evoked irrational and contradictory attitudes and, until recently, have been thus excluded from most conservation efforts, despite their populations are declining worldwide. In most cases, fear of sharks is associated with poor knowledge. Therefore, environmental education, being the main tool engaging the general public with species and habitat conservation, might be effective in improving the perception about elasmobranchs and consequently increase people's willingness to protect them. To test this, in the context of the Life Elife (Elasmobranchs Low-Impact Fishing Experience) project, we developed two questionnaires to be submitted to people lacking specific knowledge about elasmobranchs. To evaluate the effectiveness of the educational events through a direct comparison, the questionnaires include the same 19 questions and are directed to people not-experiencing ("pre") and experiencing ("post") educational activities related to elasmobranch biology and conservation. To date, only the "pre" questionnaire was distributed in Italian, English and Greek (420, 56 and 98 answer collected, respectively); therefore, only the results on what can be considered the starting point before specific education are included. Most of the people indicated that sharks and rays strongly evoke respect (84%), interest (73%) and awe (72%) and only 25% and 33% indicated fear and danger as the main feelings. However, basic knowledge on elasmobranch is poor, as only 24% of the persons correctly identified all the species of sharks and rays and surprisingly 21% identified swordfishes as sharks. Accordingly, 62% of the people that said they had never eaten shark meat, unknowingly did eat it. Nonetheless, 65% of the answering people thinks that elasmobranchs are endangered and 50% is willing to change behavior, including stopping eating shark meat, to improve their conservation. The results indicate that focused educational activities, improving basic knowledge, are needed.

Keywords: environmental education, questionnaire, general public, attitudes

Population dynamics and life-history of elasmobranchs in the North Sea

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Over the past 50 years, intensive fishing pressure on many commercial species has led to declines in catches and diminishing stocks. The effects of exploitation are exacerbated on elasmobranch species (sharks, skates and rays) due to their laggard life-history traits (low fecundity and late maturity) which increases their vulnerability to fishing activities. The obligatory movement to sustainable fisheries management is restrained by the lack of knowledge of population size, distribution and life history information in a number of elasmobranch species. Life-IP and EFMZV projects aim to improve our current understanding of population dynamics and life-history of elasmobranchs in the North Sea. The deployment of ‘pop-off’ data storage tags (pDSTs) and ‘pop-off’ satellite archival tags (PSATs) will provide new insights into species distribution and migration. Furthermore, the collection of life-history data such as age, growth, maturity, diet and fecundity estimates contribute to a better understanding of population dynamics and the role species’ play in the ecosystem. New data regarding population dynamics and life-history of elasmobranchs will result in better management, conservation and a move towards more sustainable fishing activities.

Keywords: Elasmobranch, life-history, North Sea, tag

The influence of Lyme Bay MPA on the inshore elasmobranch community

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Fishing (both targeted and incidental) has caused approximately one third of chondrichthyans to be considered threatened globally, which is particularly alarming considering the apparent role elasmobranchs play in maintaining ecosystem health. Evidence is mounting to support the use of well-managed MPAs to address elasmobranch declines under specific conditions. However, studies to date have focussed on a few charismatic species in tropical MPAs, whilst the value of temperate MPAs remains uncertain. This study aimed to better understand the efficacy of temperate MPAs for elasmobranch conservation, using the 206km² bottom-towed fishery exclusion zone in Lyme Bay MPA (South West UK) as a case study. An annual BRUV survey was conducted in Lyme Bay from MPA establishment in 2008 until 2019. Videos were analysed to quantify: species richness and maximum number of individuals per species observed within a single frame (N_{max}) for sites inside the MPA and in comparable control sites. Species richness was compared using a rarefaction analysis, meanwhile, generalised linear models (GLMs) were used to evaluate the importance of factors (year and MPA treatment) in driving key elasmobranch species (*Scyliorhinus canicula* and *Raja clavata*) abundance or probability of occurrence. 6 elasmobranch species were detected in Lyme Bay, two of which only occurred inside the MPA, including critically endangered *Galeorhinus galeus*. Both *S. canicula* abundance and probability of *R. clavata* occurrence were significantly positively correlated with year across all treatments, indicating bay-wide population recovery over time. The probability of *R. clavata* occurrence was significantly greater inside the MPA, whilst *S. canicula* was significantly more abundant outside the MPA. Robust evidence for MPA driven elasmobranch recovery in the form of an interaction between time and MPA treatment was not detected for either species. Findings do however indicate the importance of Lyme Bay MPA as an elasmobranch habitat, with differing importance among species.

Keywords: MPAs, BRUVS, temperate, conservation

Stable isotopes provide evidence of a trophic shift in the lesser spotted dogfish *Scyliorhinus canicula* from the Central Tyrrhenian Sea Authors

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The lesser spotted dogfish *Scyliorhinus canicula* is one of the most abundant demersal sharks in the Mediterranean Sea and the one most resilient to the impact of human activities; for that reason, the understanding of its ecological habits is fundamental to provide biological information for fishing management and conservation. The diet of *S. canicula* has been studied through stable isotopes and stomach contents analyses in different areas of the Atlantic Ocean and in the central-western Mediterranean Sea. However, there is a lack of studies in the Tyrrhenian Sea and in other biological matrixes such as cartilage. In this regard, the use of stable isotope analysis using vertebrae allows the analysis of stable isotopes in different stages of the shark's life given that the vertebrae grow by concentric rings during the growth of the individual: the central rings will accumulate trophic information on the immature stages of the animals, while the marginal rings will accumulate information on the mature stages. Stable isotopes ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) in the vertebrae of *Scyliorhinus canicula* from the central Tyrrhenian Sea were analyzed to explore a potential trophic ecology shift in relation to sex, life stages, and seasons. The values of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ evidenced significant differences just between immature and mature sharks ($U' = 1392$, $P < 0.0001$ for $\delta^{13}\text{C}$; $U' = 1385$, $P < 0.0001$ for $\delta^{15}\text{N}$). Differences in values of $\delta^{15}\text{N}$ could be related to a segregation by size of *S. canicula* in which mature vertebral growth rings showed higher values of $\delta^{15}\text{N}$ (mean 5.41‰ SD $\pm 1.29\text{‰}$), compared with lower values found in immatures (mean 2.78‰ SD $\pm 1.52\text{‰}$). Immature vertebral growth rings showed $\delta^{13}\text{C}$ values related to oceanic areas (mean -22.56‰ SD $\pm 1.26\text{‰}$), while the values observed in mature specimens (-20.03‰ SD $\pm 1.34\text{‰}$) were linked to coastal environments.

Keywords: Scyliorhinidae, Mediterranean Sea, stable isotopes, vertebrae

Steroid hormones and chondrichthyan reproduction: What do we know?

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The study of the reproductive aspects of chondrichthyans through the analysis of steroid hormones has been carried out for more than five decades in several species around the world. This scientific knowledge constitutes the basis of the reproductive endocrinology of chondrichthyans, which has provided relevant information regarding their sexual maturation, gametogenesis, mating seasons, gestation periods, and parturition. The present study summarizes the existing literature on steroid hormones in chondrichthyan reproduction and identifies future research directions addressing critical knowledge gaps in the reproductive physiology of this taxon. A total of 59 peer reviewed scientific papers from 1963 to 2020 were reviewed and the following parameters analysed: species, steroid hormones, biological matrix, field sampling (year, location), and methodology (assays, sample size, precision, and recoveries). We provided a summary of the methods, biological matrices, and the functions of up to 19 hormones on the biology of 34 species of chondrichthyans that have been analysed until 2020. Most studies used radioimmunoassay as the main methodology (76.3%; $n = 45/49$); while the most frequent biological matrix used was plasma (69.5%; $n = 41/49$). A Kernel's heat map was generated to present the scientific effort according to geographic location and evidenced a lack of research in high biodiversity areas for chondrichthyans worldwide. The implications of the study of steroid hormones for the conservation of chondrichthyans are discussed, as only 2.9% of the species of this group have been analysed and most of the scientific effort (93.2%; $n = 55/59$ papers) has focused on the analysis of less than six hormones.

Keywords: physiology, reproductive hormones, scientific effort, biological matrix

Non-invasive adhesive tagging: essential for behavioral research on electromagnetic fields

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Behavioral research on elasmobranchs is needed to implement and optimize conservation efforts and ensure adequate mitigation for anthropogenic influences. Currently the standard in in-situ behavioral research of elasmobranchs is though placing a tag in the skin, muscle or cartilage of the fish. Due to the size of multi-sensor tags and stress associated with placement this method is not suitable for smaller elasmobranchs, and/or for short a duration. In a controlled ex-situ setting behavioral research is often carried out by analyzing video data. Video data is however not suitable to detect all parameters that might be of interest, as for example research on the behavioral response to electromagnetic fields. Non-invasive tagging methods might prove ideal to carry out this type of research. Current non-invasive methods include harnesses and suction cups, which might influence behavior in short term application. Attaching tags using adhesives is, to our knowledge, only applied to larger elasmobranchs with smooth skin. Recent research by Hussain et al 2018 shows the possibilities for long term deployment using adhesives on rough skinned small elasmobranchs. With this research we aim to investigate different adhesive methods suitable for short term deployment. Firstly an inventory will be made of the available adhesives suitable for use in the marine environment. The adhesives will then be tested on deceased fish exposed to different flow conditions and temperatures. Finally the adhesives that perform to specifications will be tested on live individuals in a controlled environment. The results will be applied in short term behavioral research in a controlled setting focusing on benthic elasmobranch response to anthropogenic electromagnetic fields. If successful this research will further the field of tagging, reducing handling and placement stress and broadening the parameters to be monitored ex-situ.

Keywords: Elasmobranchs; behavioral research; non-invasive; tagging

Tainted chords: A reproductive health assessment of guitarfish in highly polluted environments

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This project will provide the first reproductive health assessment in guitarfish exposed to copper mining contamination. The model organism is the banded guitarfish *Zapteryx exasperata*, which is a frequently captured elasmobranch species in Mexico. It is classified as Data Deficient (IUCN) despite being a frequent inhabitant of the coastal and vulnerable ecosystems of California (USA) and the Baja California Peninsula (Mexico). The objective of the study is to describe the effects of mining pollutants on the reproductive health of this batoid species by analyzing hormonal profiles, tissue damage and the concentration of contaminants. During April 2021, a total of 20 mature females (TL= 85.2; \pm 3.69 SD) were caught by local fishermen affected by copper mining in the town of Santa Rosalía, Gulf of California, Mexico. Reproductive health will be evaluated with three different perspectives: 1) concentration of 23 inorganic pollutants in tissues; 2) histopathology to identify cell damage and diseases; and 3) reproductive and stress hormonal profiles (9 steroid hormones). All individuals and their organs were weighed and stored accordingly to each analysis. Gonadosomatic index showed an average of 5.26 (\pm 0.67 SD), while the average hepatosomatic index was 1.36 (\pm 1.18 SD). The average condition factor of the fish was 0.59 (\pm 0.05 SD), with a maximum of 0.72 and a minimum of 0.49. These preliminary results constitute a first indicator of physiological stress in the individuals analyzed. Histological and trace elements analyses are currently ongoing and will confirm affectations in the organs of this species.

Keywords: pollution, guitarfish, histology, hormones.

Titan encounters: Interactions between white sharks and squids in Guadalupe Island, Mexico

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Shark-cephalopod interactions have been documented in trophic ecology studies around the world. However, there is scarce information regarding the encounters between white sharks *Carcharodon carcharias* and squids in the eastern North Pacific Ocean. Here we provide evidence of interactions between white sharks and large squids in Guadalupe Island, Mexico. Using non-invasive techniques, we found the presence of evident scars made by large squids on the body of the white sharks, mainly on the head and trunk, of at least 14 sharks recorded during August– December in the years 2008, 2012, 2013, 2017 and 2019. The mean length of the white sharks was 3.7 m (SD \pm 0.6; total length), although most sharks with scars were adult and subadult males ($n = 9$; 64%). One of these males was photographically recaptured during the same season in which the individual showed new scars, confirming that the squid-white shark interaction likely occurs near Guadalupe Island. Our results highlight the importance of the twilight zone for white sharks and the use of shared habitat and trophic interactions between squid and white sharks. Future ecosystem studies should consider both species for management and conservation purposes.

Keywords: *Carcharodon carcharias*, cephalopods, trophic interactions, predation

Elasmobranch egg case predation in the Dutch North Sea

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Since 2014 elasmobranch egg cases that are washed up on the Dutch North Sea beaches can be registered by beachcombers using the Great Eggcase Hunt database. For this study, individuals often registering multiple egg cases were asked to send these to the authors for a predation study. After disposing of heavily damaged (over 50% gone) egg cases, a total of 736 egg cases of six different elasmobranch species (*Raja microocellata*, *Raja brachyura*, *Raja montagui*, *Raja undulata*, *Raja clavata*, *Scyliorhinus canicula*) were examined. All egg cases were scored for number of predation marks, the condition of the egg case and status of the hatching slit. The shape of the predation marks was classified into five types: parabolic, circular, elongated, scratched and irregular shaped and it was noted whether or not the boreholes were complete. Predation rate across species was 14.4%. Results show no discernible difference in proportion of egg cases with any kind of predation mark between species, which is beneficial for future analysis and conservation strategies, as the same approach can be used for all species. The presence of multiple incomplete predation marks on 38% of predated egg cases shows evidence of site selection by the predator. This site selection, as well as borehole shape and diameter found points to gastropods and octopus as potential predators.

Keywords: elasmobranch, egg case, gastropod, boreholes

Do different survey methodologies provide similar outcomes in shark abundance assessments?

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Relative abundance estimates based on baited-hook captures and baited remote underwater video stations (BRUVS) observations were compared for the same study area on the eastern Caicos Bank, Turks and Caicos Islands. The most abundant species for both methodologies was the Caribbean reef shark *Carcharhinus perezii*. The second most abundant species in each case was the nurse shark, *Ginglymostoma cirratum*; however, the order of species abundance thereafter differed. There were also magnitudinal differences in relative abundance between the two methodologies. Therefore, the use of different gears to survey shark populations can have an appreciable impact on relative abundance estimates. Consequently, the inherent biases of each technique should be considered when planning shark abundance surveys.

Keywords: Elasmobranch, CPUE, gear selectivity

Analysis on the interaction between pelagic sharks and recreational fishing in the Northern Adriatic Sea: first insight into catch rate and the use of space

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Due to the commercial fishery activities, pelagic sharks are increasingly threatened in the Mediterranean Sea and their populations have suffered a drastic decline. Their elusive and migratory nature and the lack of systematic data collection further increase the difficulties in studying such species. However, they are still often caught as by-catch by recreational fishing, specifically using a fishing technique called drifting targeting the Atlantic bluefin tuna (*Thunnus thynnus*).

Using drifting recreational fishery, this study was conducted to estimate the catch rate of pelagic sharks and to focus on their seasonal presence and abundance in the Northern Adriatic Sea.

During the two years of data collection, from May to September 2020 and May to September 2021, 17 fishers filled a logbook for every fishing trip: fishing coordinates date, time of fishing, and the hook size. In case of a sight or a capture of sharks, the species, the time of capture or sighting, the sex and the estimated length was reported.

Between 2020 and 2021 data collection, we recorded 202 fishing trips and a total number of 109 sharks (3 species), including *Alopias vulpinus* (n=14), *Carcharhinus plumbeus* (n=3) and *Prionace glauca* (n=92). The highest Catch Per Unit Effort per month values recorded were in June 2020 (CPUE=0.1345) and August 2021 (CPUE=0.1348). The size distribution of the estimated TL (cm) for *P. glauca* was between 30 and 225 cm. The success in the collaboration between researchers and recreational fishers during this data collection highlights how this approach turned out to be interesting to fill the knowledge gap about many ecological aspects of the pelagic sharks. As demonstrated by this study, the citizen science is confirmed as a precious instrument to increase the management of these species in the Mediterranean Sea and should be improved and spread along all the basins.

An updated checklist of chondrichthyans of Calabria (Central Mediterranean, southern Italy), with emphasis on rare species

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The Mediterranean Sea is an area of high biodiversity for the cartilaginous fishes and Calabria lying in its centre, between the Tyrrhenian and the Ionian seas, divides it into western and eastern parts. The position of this Italian region is strategic to collect data about chondrichthyans. In this contribution the checklist of chondrichthyans of Calabrian seas is reported. Data presented is derived from twenty-one years of opportunistic and active surveys from 2000 to 2021. A total of 56 species of chondrichthyans is present in Calabrian seas: 34 sharks, 20 rays, and 2 chimaeras. These species represent approximately 63% of the total reported for the Mediterranean. Approximately 71% of Calabrian species have been reported in the Tyrrhenian Sea, 50% in the Ionian Sea, and 33% in the Strait of Messina. According to IUCN criteria, new records of Endangered and Critically Endangered species (i.e., *Carcharodon carcharias* [Linnaeus, 1758], *Lamna nasus* [Bonnaterre, 1788], *Cetorhinus maximus* [Gunnerus, 1765], *Mobula mobular* [Bonnaterre, 1788], *Sphyrna zygaena* [Linnaeus, 1758]) are reported, together with the first record of *Raja brachyura* Lafont, 1873 for the Ionian coasts, one of the few confirmed records of *Somniosus rostratus* (Risso, 1827) for the eastern Mediterranean and probably third confirmed record of the rare chimaera *Hydrolagus mirabilis* (Collett, 1904) for the Mediterranean.

Keywords: Cartilaginous fish; distribution; Calabria; conservation

Insight on the trophic ecology and trophic level of 7 elasmobranch species inhabiting the northern-central Adriatic Sea

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Predation is a strong driver influencing and structuring communities. Sharks and rays are among the most important predators and their predatory activity is one of the most influential in the marine ecosystem. Elasmobranch populations have been severely depleted in the past and obtaining reliable information on their trophic relationships is important to better understand the potential consequences that their disappearance might have on the community.

Nitrogen and Carbon stable isotope analysis was used to evaluate trophic level differences among 7 elasmobranch species inhabiting the northern-central Adriatic Sea. Additionally, stomach content analysis, through the identification of the ingested preys, was used to highlight potential differences related to sex, size and season in the diet of three of the most abundant species (*Mustelus mustelus*, *M. punctulatus* and *Scyliorhinus canicula*). Among the investigated species, *Squalus acanthias* and *Myliobatis aquila* occupy the highest and the lowest trophic level, respectively, and in *S. acanthias*, *Pteroplatytrygon violacea*, *M. mustelus* and *M. punctulatus*, smaller animals occupy lower trophic levels than adults. For *M. mustelus* and *M. punctulatus*, the ontogenetic shift has been confirmed also from stomach content analysis, the diet of larger animals, better predators, being richer in fishes and larger crustacean. No ontogenetic shift was observed in *S. canicula*, however the diet differed between the sexes, likely because they are known to sexually segregate. Surprisingly, the diet of *M. mustelus* and *M. punctulatus* is more similar to the diet of *S. canicula* rather than to the diet of the congeneric species. This larger divergence in their diet preference is likely necessary to reduce the pressure of competition between these two species sharing a very similar morphology. The confirmed mesopredatory position of the studied species suggests that the steep decline that their population experienced might deeply impact the northern-central Adriatic community and deserves further investigation.

Keywords: Mesopredators, Nitrogen and Carbon isotopes, stomach content analysis, northern-central Adriatic Sea

New record of *Hexanchus griseus* in the northwestern Mediterranean with insights into its biology and feeding ecology

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The bluntnose sixgill shark, *Hexanchus griseus*, is a worldwide distributed deep-sea shark that inhabits outer continental shelves and upper slopes up to 2500 m deep. On 15th March 2021, a male of *H. griseus* was incidentally captured in El Grao de Castellón, Spain (39.60°N, 0.42°E), by a commercial bottom trawler (550-730 m deep). The total weight and 38 morphometric measurements were taken. The presence of ectoparasites was also recorded (*Demoleus heptapus*, n=24). The animal was dissected, to analyse the stomach contents and assess his reproductive status. The specimen measured 251.2 cm in total length (TL) and weighed 86.2 kg. The claspers were fully calcified, and the testes, epididymis, and clasper sac were fully developed. The sperm obtained showed a motility value of 87.4%. All these traits are associated to a sexually mature individual, although maturation for this species in the Mediterranean was previously thought to occur at larger sizes (270-300cm). The stomach contained the right pectoral fin and part of the thoracic region of a freshly ingested juvenile striped dolphin (*Stenella coeruleoalba*). *Hexanchus griseus* is considered an apex predator, however, it remains uncertain whether they can capture large active prey species. They exhibit some adaptations potentially related to stealthy predation, such as positive buoyancy, slow motion, quick bites, and thermal inertia as well as higher activity rates during night. Additionally, their feeding kinematics are similar to those of other predators that actively capture large elusive prey. *Hexanchus griseus* has been observed scavenging on cetacean carcasses on multiple occasions. However, no other predatory marks or scavenging fauna were observed on the dolphin remains, which would have been expected in a carcass. Nonetheless, its absence does not necessarily indicate the active capture of the dolphin, as *H. griseus* is believed to scavenge on carcasses at early decomposition stages.

Keywords: predation, scavenging, *Stenella coeruleoalba*, stomach contents

Morphologically and genetically confirmed records of the little gulper shark *Centrophorus uyato* (Squaliformes: Centrophoridae) from Cypriot waters

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The family Centrophoridae (Chondrichthyes: Squaliformes) comprises two genera: *Centrophorus* and *Deania*, known as gulper sharks, a group of small to medium-sized benthopelagic species that occur worldwide except for the polar seas. The taxonomy within this elasmobranch group has been problematic almost since its origin, raising confusion over the identification of several species. As an example, although two species of *Centrophorus* have been identified in the Mediterranean Sea, the gulper shark *C. granulosus* (Bloch & Schneider, 1801) and the little gulper shark *C. uyato* (Rafinesque, 1810), recent molecular and morphometric studies supported the presence of a unique taxon in this region, corresponding to the small-sized species of the genus, namely *C. uyato*. In our study the macroscopic characteristics of all specimens captured incidentally off the southern coast of Cyprus resembled those of *C. uyato*. Furthermore, the partial nucleotide sequences of two mitochondrial DNA gene regions, the cytochrome c oxidase subunit I and the 16S ribosomal RNA, genetically confirmed the presence of the little gulper shark in Cypriot waters. Herein, we also present all the known-to-date records of the gulper sharks in the Mediterranean Sea, probably referred to as *C. uyato*, which is the only verified *Centrophorus* species in this region. Nevertheless, the overall distribution of *C. uyato* needs revision as soon as a definite taxonomic assessment is achieved. Towards this achievement, the establishment of an international network of experts that will implement a holistic taxonomic assessment for the gulper sharks by applying both molecular and morphometric tools, is highly recommended.

Keywords: Cyprus; elasmobranchs; genetics; Mediterranean Sea

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