

PROCEEDINGS OF THE EUROPEAN
ELASMOBRANCH ASSOCIATION
ANNUAL SCIENTIFIC CONFERENCE

18 years on, Prepared for the Future

7th to 9th November 2014
Leeuwarden
The Netherlands

Colophon

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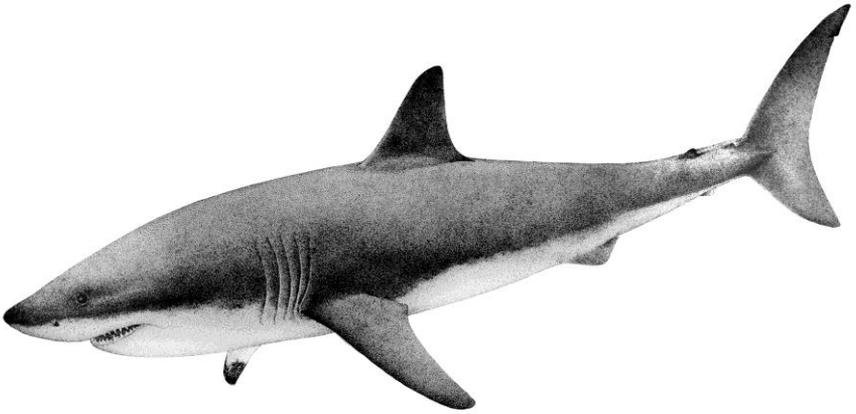
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FOREWORD



Foreword

Welcome to the 18th European Elasmobranch Association Annual Scientific Conference. We are honoured to host the event this year in Leeuwarden at Van Hall Larenstein University of Applied Sciences. The theme of this year's meeting is '18 years on – Prepared for the Future'. A lot has changed since the EEA was founded in the mid-1990s, but the absolute necessity of science-based management for the protection of sharks and rays world-wide, has not.

Elasmobranchs are increasingly included in high level policy agreements and scientific knowledge is essential in the dialogue with policy and managers. The underlying theme of this conference is how this knowledge can help coordinate the information necessary for the development and implementation of management measures for sharks and rays.

We are fortunate to have a large number of exciting presentations and posters on stock-assessment, distribution & tagging, husbandry & biology, as well as elasmobranch policy. We have also arranged to have break-out sessions on Saturday during the lunch break during which you can get together to discuss subjects of mutual interest and set up joint initiatives. There is also plenty of opportunity for networking and socialising. The reception on Friday evening, the celebratory dinner and after-party on Saturday, but also in Leeuwarden itself. Leeuwarden is a vibrant town with a charming centre and a wide selection of restaurants and bars. It is the capital city of the northern Province of Fryslân and will be the Cultural Capital of Europe in 2018.

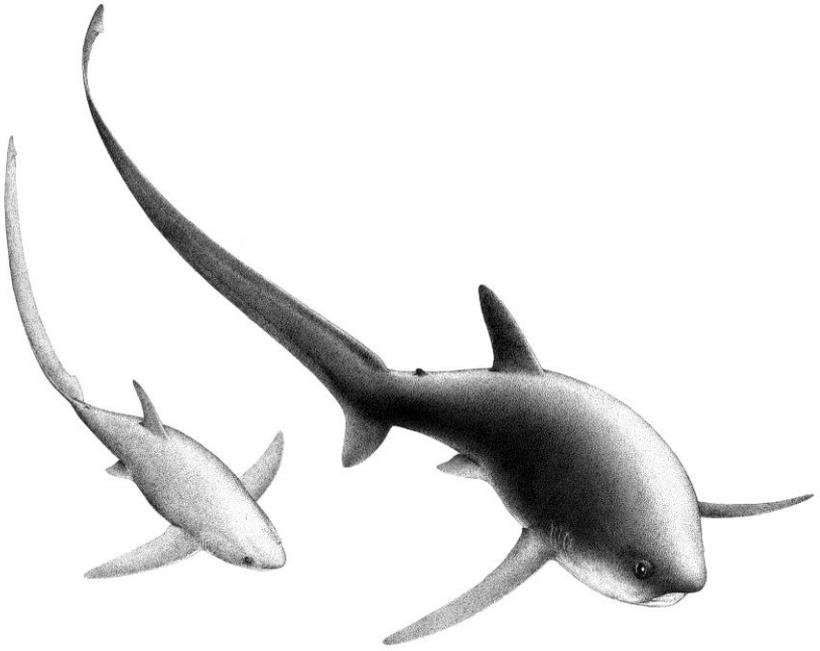
As one of the founding members of the EEA I am personally very proud to be part of the organisation of this conference and to see how far we have come in the past 18 years. It is inspiring to see how many people have worked together to make EEA 2014 possible. I am convinced that the EEA and its members are playing a continuing role in shark and ray research and conservation world-wide, and I believe that we are prepared for the future

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

Paddy Walker

President European Elasmobranch Association (EEA)
Chair Dutch Elasmobranch Society (NEV)
Associate Professor VHL University of Applied Sciences

PROGRAMME & SESSIONS



Programme EEA2014

DAY 1 – Friday 7th

Registration desk opens at 11.00

- 11.30 - 12.30 Annual General Meeting (AGM)
- 12.30 - 13.30 Lunch
- 13.30 – 17.30 Session 1 – Elasmobranch Policy
- 18.00-20.00 Evening reception

DAY2 – Saturday 8th

- 9.00 – 12.30 Session 2 – Stock Assessment & Management
- 12.30 – 14.00 Lunch & Breakout Sessions
- 14.00 – 18.00 Session 3 – Distribution & Tagging
- 19.30-22.30 Celebratory Conference Dinner & Auction
- 23.00 – 1.00 After Party

DAY 3 – Sunday 9th

- 9.00 – 13.15 Session 4 – Husbandry & Elasmobranch Biology
- 13.15-14.00 Awards and Closure
- 14.00 End of Conference (packed lunch provided)

Session 1 – Elasmobranch Policy – 13.30 – 17.30

TIME	SPEAKER	TITLE
<i>13.30 - Opening of Conference</i>		
14.00	Keynote 1: Euan Dunn – Royal Society for the Protection of Birds	Developing MPAs – a BirdLife perspective
14.30	A. Hood	No Limits? No Future
14.45	B. Seret	Shark attacks at Reunion Island (South-western Indian Ocean): overview, hypothesis, prevention and risk reduction measures
15.00	<u>L. Kingma</u> & P. Walker	Rays of Hope - Discard survival in North Sea Rays
15.15	K. De Meyer	Shark conservation the Dutch Caribbean
<i>15.30 – 16.00 Coffee Break</i>		
16.00	Keynote 2: Angelo Villagomez – Pew Charitable Trusts	Sharks, Science, CITES, & Sanctuaries
16.30	<u>A.O. Debrot</u> , I.J.M. van Beek & G. v. Buurt	Shark abundance on the deep island slopes of the Dutch Caribbean ABC-islands: A potential conservation and research opportunity
16.45	T. Bervoets	The Implementation of a Shark Sanctuary and Continued Conservation Management Activities on a Small Island Caribbean State in the Dutch Caribbean of presentation
	<u>A. de Blacij</u> , <u>L. Kingma</u> , W.J. Strietman, M. vd Water & P. Walker	Towards a Shark and Ray Management Plan for the North Sea : Cost Effectiveness Analyses and the role of stakeholder participation
17.15	J. Richardson	Incorporating fishermen’s knowledge into sustainable sourcing guidance
<i>17.30 Closure of day 1</i>		

Session 2 – Stock Assessment & Management – 9.00 – 12.30

TIME	SPEAKER	TITLE
9.00	Key Note 3 Enric Cortés - National Oceanic and Atmospheric Administration (NOAA)	A brief history of Atlantic shark stock assessment in the USA: past, present, and future
9.30	<u>P. Lorance</u> , N. Leblanc, E. Stéphan & A. Tétard	Stock Reduction Analysis of selected ray stocks
9.45	<u>J. F. Silva</u> , S. R. McCully Phillips, J. R. Ellis & S. Kupschus	Demersal elasmobranchs in the western English Channel
10.00	C. Gordon	Understanding Undulates through the Great Eggcase Hunt
10.15	<u>R. Gračan</u> , S.A. Heppell, G. Lacković, B. Lazar	Age and growth dynamics of spiny dogfish, <i>Squalus acanthias</i>, in the Adriatic Sea (Eastern Mediterranean Sea)
<i>10.30 – 11.00 Coffee Break</i>		
11.00	<u>A. Barash</u> , E. Pickholtz, R. Pickholtz, G. Rilov & L. Blaustein	Shark aggregations at power plants: describing an emerging phenomenon based on fishermen's observations
11.15	<u>A.E. Bester-van der Merwe</u> , D. Bitalo, S. Maduna & K. Gledhill	Application of molecular techniques in conservation management of elasmobranchs, identifying the way forward
11.30	<u>M. Frost</u> , C.S. Jones, L.R. Noble & F. Neat	Population genetics and spatial management for the conservation of the critically endangered common skate species complex
11.45	<u>S. Weigmann</u> , M.F.W. Stehmann & R. Thiel	New findings from Area 51 – Chondrichthyans of the deep western Indian Ocean
12.00	<u>J.A. Thorburn</u> , F. Neat, D. Bailey, L.R. Noble & C.S. Jones	A Case for Static Marine Protected Areas in Managing a Highly Mobile Elasmobranch (<i>Squalus acanthias</i>)
12.15	P.A. Walker	New Horizons for elasmobranch fisheries management
<i>12.30 – 14.00 Lunch & Breakout Sessions</i>		

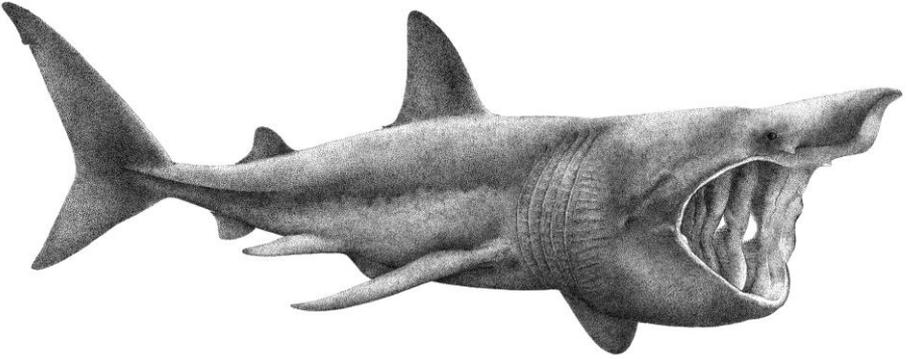
Session 3 – Distribution & Tagging – 14.00 – 18.00

TIME	SPEAKER	TITLE
14.00	<u>H. J.L. Heessen</u> , N. Daan & J.R. Ellis	Elasmobranchs of the North-East Atlantic Shelf
14.20	<u>J. Barker</u> , et.al.	Stock Reduction Analysis of selected ray stocks
14.35	N. Brevé	Why not involve anglers in your elasmobranch studies?
14.45	<u>E. Winter</u> & N. Brevé	Starry smooth-hounds tagged in the Netherlands on the move
15.00	Poster Pitches	
<i>15.30 – 16.15 Coffee Break & Poster Session</i>		
16.15	<u>A. Lopez</u> & I. Zanella	Conservation of coastal critical habitats of scalloped hammerhead shark (<i>Sphyrna lewini</i>) in the Easter Pacific Ocean
16.30	<u>E. Meyers</u> , J.Barker, R.Haroun & D.Rödder	Patterns in the abundance, distribution, and behaviour of the Angel Shark (<i>Squatina squatina</i>) in the Canary Islands
16.45	<u>E. de Sabata</u> & S. Clò	A ten-year wrap-up of Operazione Squalo Elefante, basking shark field research in the Mediterranean
17.00	<u>S. Hilbourne</u> , K. Collins & D. Ramirez	Atmospheric and oceanographic influences on whale shark (<i>Rhincodon typus</i>) seasonality in the Bay of La Paz, Mexico
17.15	<u>L. Lieber</u> , et.al	Genetic monitoring of basking sharks in the North-East Atlantic: shark habitat use in the Marine Protected Area (MPA) versus marine renewable energy (MRE) designation debate
17.30	<u>I. Zanella</u> & A. Lopez	Habitat use and local movements of bull shark (<i>Carcharhinus leucas</i>) at Guanacaste Conservation Area, Costa Rica
17.45	<u>R.W. Bullock</u> , et.al	Assessing the Effects of Prey Interactions on Habitat Use Patterns and Foraging Effort in Lemon Sharks

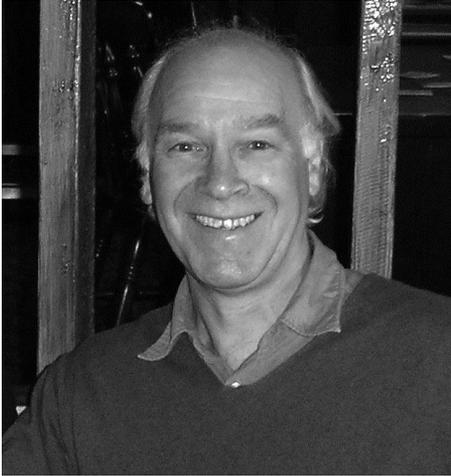
Session 4 – Husbandry & Elasmobranch Biology – 9.30 – 14.00

TIME	SPEAKER	TITLE
9.30	Key Note 4 João Correira – Flying Sharks	Can public aquaria help change the World?
10.00	J.D. Hibbitt	Managing the genetics of a species in captivity: <i>Raja undulata</i>
10.15	<u>A. Gautier</u> , A. Bosseboeuf, P. Auvray, P. Sourdaïne	Spermatogonial stem cells: towards the preservation of shark species?
10.30	<u>F. Dhellemmes</u> , J.S. Finger, S.H. Gruber, T.L. Guttridge	Exploring personality and a simple learning process in the juvenile lemon shark, <i>Negaprion brevirostris</i>
10.45	G. Wiersma	Making sharks and shark research visible – The first two years of the Dutch Shark Society
11.00	Poster Pitches	
<i>11.20 – 12.00 Coffee Break</i>		
12.00	M. Janse	European captive breeding programs: one step further
12.15	<u>D.G. Swift</u> , E.J. Brooks, V. Savolainen	Analysis of carcharhinid transcriptomes reveals evidence of positive selection in genes associated with an evolutionary reversal to aplacental viviparity
12.30	<u>A.M. Luger</u> , P. Kamminga, L.A.J. Nagelkerke	Morphological diversity in the palatoquadrate in extant sharks in relation to feeding strategy
12.45	<u>M. de Graaf</u> , I.J.M. van Beek, W. van Looijengoed, T. van Kuijk, T. Stoffers & L.A.J. Nagelkerke	Diversity, spatial distribution and relative abundance of reef sharks using stereo baited remote underwater video around the windward islands of the Caribbean Netherlands
13.00	M. van de Water	Return of sharks and rays in the North Sea
<i>13.15 – 14.00 Awards and Closure</i>		

KEYNOTE ADDRESSES



Keynote 1 Euan Dunn



Dr Euan Dunn is Principal Marine Advisor at the Royal Society for the Protection of Birds (RSPB), Europe's largest wildlife charity and UK partner of BirdLife International. He is responsible for wide-ranging national and international policy development and advocacy on the ecosystem approach to fisheries management, particularly interactions between fisheries and marine birds.

A key focus of his work is promoting environmental integration in the Common Fisheries Policy. He has represented BirdLife on the North Sea Advisory Council (NSAC) since its establishment ten years ago. He chairs the NSAC's Spatial Planning Working Group, a major focus of which has been the engagement of the fishing sector with the Habitats Directive and, in particular, developing fisheries management measures for the Dogger Bank. He is also a former Board member of the Marine Stewardship Council (MSC).

Developing MPAs – a BirdLife perspective

Friday November 7th 14.00-14.30

This presentation will draw on the experience of the RSPB (as UK BirdLife partner) in setting up Marine Protected Areas in UK waters and in the surrounding regional seas. The policy background is one of political failure to progress the establishment of MPAs at any pace commensurate with the need for site protection (e.g. in 1998 ICES was already flagging the need for closed areas to protect relict populations of North Sea common skate). This need is all the more compelling with the mounting pressures on our seas and marine life, not least from climate change. So it's a 'long game' and requires persistent application and advocacy. The RSPB has therefore had a long-standing commitment to a well-managed network of MPAs for the protection of seabirds and their critical habitats, and has pushed for the designation of European Marine Sites (especially SPAs) and national marine protected areas. In this context, we will look at, variously: the push for the necessary legislative change, the identification, selection, and delineation (boundary-setting) of sites, and their robust management. Effective stakeholder engagement, and generating the necessary public support, also play vital roles.

In addressing these issues, I will touch on the exciting research and modelling that RSPB, on behalf of UK Governments (plural because of the increasingly devolved governance) is undertaking to identify candidate offshore foraging sites for seabirds. I will also address (1) our response to the inertia of the UK to establish offshore MPAs for birds; (2) the role of the RSPB in promoting the establishment of the 'sandeel box' off the east coast of Scotland (a measure which has now been in place since 2000); and (3) challenges and lessons learned from the role of the North Sea Advisory Council (in which I chair the Spatial Planning Working Group) in developing fisheries management measures for the complex Dogger Bank Special Areas of Conservation (SACs) under the jurisdiction of, respectively, the UK, Netherlands and Germany.

Keynote 2 Angelo Villagomez



Angelo O'Connor Villagomez is an indigenous conservationist from the island of Saipan in the Northern Mariana Islands. He has more than a decade of experience working on environmental policy and community outreach in small island developing states in the Pacific and Caribbean. Angelo received his education at Rollins College and the University of Richmond. He has led The Pew Charitable Trusts shark sanctuary program since 2013.

Sharks, Science, CITES, & Sanctuaries

Friday 7th of November 16.00-16.30

The shark fin trade is a global issue. Hong Kong is the hub of the global shark fin trade, but over 120 countries have participated in the trade in the last 10 years. A global approach to shark conservation requires that we tackle both issues of supply and demand, and the trade between importing and exporting countries, at both the international and local level.

There are a range of management options for protecting threatened shark species with various governments, scientists, and environmental advocates calling for different polices. Angelo Villagomez, manager of The Pew Charitable Trusts shark sanctuary program, will discuss how consumer campaigns, trade restrictions, and strong domestic measures work together to reduce the overall global mortality of sharks.

Keynote 3 Enric Cortés



Enric Cortés holds a BS in Biology from the University of Barcelona, Spain, an MS in Biology and Living Resources from the University of Miami Rosenstiel School of Marine and Atmospheric Science, and a PhD in Animal Biology from the University of Barcelona. After spending several years at Mote Marine Laboratory in Sarasota, Florida, as a post-doctoral scientist, Enric became a research associate at Florida State University. Dr. Cortés was hired by the National Oceanographic and Atmospheric Administration in 1998 and has worked out of the Panama City Laboratory, Florida, since then, leading Atlantic shark stock assessments and the shark population biology program. He is currently the chairman of the shark species group of the International Commission for the Conservation of Atlantic Tunas. Enric has diverse fields of interest and expertise that include feeding ecology, life history theory, demographic methods, quantitative fisheries techniques, and stock assessment methods. More recently, Dr. Cortés has been working on application of methods more suitable to data-poor situations, which are often encountered when working with chondrichthyan fishes.

A brief history of Atlantic shark stock assessment in the USA: past, present, and future.

Saturday 8th of November 9.00-9.30

The status of shark stocks on the US Atlantic coast has been assessed since the 1990s as a result of the implementation of the first Atlantic shark Fishery Management Plan in 1993. Models used to assess stock status have evolved as data availability improved. However, of the now more than 40 species managed, only 11 have been assessed owing to a variety of reasons. I will review the main methods used for assessing shark populations in the US western North Atlantic, the data required to apply those methods, and summarize current stock status of the different species. I will pay particular attention to the data still needed to conduct better assessments as well as the factors that limit better management of these resources. I will then identify some promising methods that have been developed for data-poor situations.

Keynote 4 João Correia



João P. S. Correia is the founder and General Manager of Flying Sharks, a company that specializes in marine live animal brokerage. It is dedicated to promoting a sustainable use of the oceans, through providing consultancy and quality marine animals to institutions focusing on education and research on the marine environment.

He has a PhD from the University of Aveiro in Portugal in shark and ray commercial fisheries and has worked for nearly 20 years in and with aquaria and zoos world-wide, as well as for the Portuguese research institute IPMAR. He is the founder and member of the Board of the Portuguese Association for the Study and Conservation of Elasmobranchs, which is a member of the EEA.

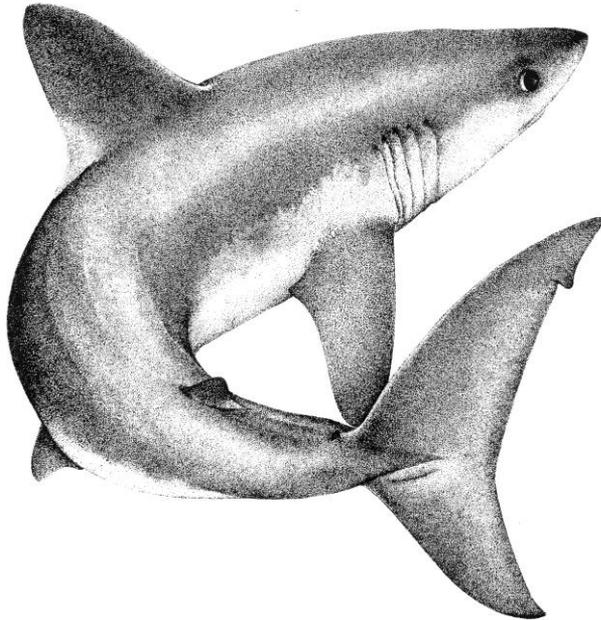
João is a prolific writer and presenter of scientific results, but can just as easily engage a class of school children, undergraduates or politicians with his in-depth knowledge and hands-on experience of sharks and rays.

Can public aquaria help change the World?

Sunday 9th of November 9.30-10.00

Public aquaria and zoos have come a long way from early XXth Century facilities focused exclusively on displaying live animals to an audience thirsty for novel and interesting sights. As the end of the millennium approached, zoological institutions took on a role of leadership, steering the public towards a more enlightened view on the environment, conservation and education. This presentation reports on a myriad of such examples, ranging from the world famous 'Sea Food Watch' card promoted by the Monterey Bay Aquarium, or even 'The Great Egg Case' hunt promoted by Shark Trust and strongly supported, and disseminated, by Sea Life Centres worldwide. Likewise, the European Association of Zoos and Aquaria has led nearly a dozen conservation campaigns, ranging from Apes, to Carnivores, to Bushmeat, amongst many other environmental issues crying for attention. These campaigns enjoy monumental support from the millions of visitors that zoos and aquaria welcome through their admission gates every year and these efforts have raised nearly 4 million euros thus far. These are but a few of multiple examples where the public aquaria, and zoo, community are spearheading the conservation of the natural world and education of society.

ABSTRACTS ORAL PRESENTATIONS



No Limits? No Future

A. Hood

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From 2006 to 2013 the Shark Trust and the European Elasmobranch Association worked, as founder members of the Shark Alliance, towards the adoption of a Community Plan of Action for Sharks (CPOA-sharks) and a revision of the EU shark finning regulation ((EC) No.1185/2003): seeking to remove loopholes in the regulation and relieve the burden of enforcement of a complicated and excessively lenient fin to carcass ratio. In 2009 the CPOA-sharks was adopted (COM(2009) 40) presenting a framework for sustainability and from 2013 the EU fleet were obliged to land sharks with their fins *naturally* attached ((EU) No.605/2013). Integral to compliance with the regulation is the annual requirement to report to the European Commission on implementation of the finning regulation by 1st May, at the time of writing many of those Member States with shark fishing interests have yet to do so. Despite this the EU continues to champion fins *naturally* attached as best practice within high seas fisheries managed by Regional Fisheries Management Organisations.

Five years after the adoption of the CPOA-sharks the Shark Trust is revisiting the potential of the CPOA-sharks and asking why more has not been achieved. In this context, and amidst the potential ramifications of the discards ban, in May 2014 the Shark Trust launched its *No Limits?* campaign www.nolimitsnofuture.org. *No Limits?* highlights, to the public and governments alike, the urgent need to introduce science-based catch limits for Blue Sharks, Shortfin Mako, Tope, smoothhounds and catsharks – species with escalating fisheries and accounting for over 97% of reported Atlantic and Mediterranean shark landings. *No Limits?* presents a simple request to EU Member States: stand by the pledges you adopted five years ago within the CPOA-sharks, and stop uncontrolled shark fishing now!

Keywords: CPOA-sharks, catch-limits, Europe

**Shark attacks at Reunion Island (South-western Indian Ocean):
overview, hypothesis, prevention and risk reduction measures**

B. Seret

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Since 2011, a series of shark attacks has been occurring at Reunion Island, a small French territory situated in the South-western Indian Ocean. Shark attacks have always been recorded from this island with 1 or 2 cases per year in average. However, for the last three years, 13 cases with 5 fatalities happened, causing locally a real “shark crisis”. An overview of these attacks is given, along with the various hypothesis to be tested to explain this recent increase in shark attack rate; the measures taken or planned to reduce the risk are presented.

Keywords: Reunion Island, shark attack

Rays of Hope - Discard survival in North Sea Rays

I. Kingma and P. Walker

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Rays (*Rajidae*) are vulnerable to fishing pressure due to their specific life history characteristics, which include slow growth, late ages at maturity, and the production of a limited number of young. These properties, combined with the limited data available on ray stocks in North Sea, have led policy makers to apply a precautionary approach in setting catch limits and systematically reduce the total allowable catch (TAC) for rays with 10% each year.

As of January 2016 a landing obligation will be in place for the North Sea demersal fisheries. Rays are taken as bycatch in this fisheries and the restrictive ray TAC makes these species potential ‘choke species’. As elasmobranchs are considered to be among the most resilient species when it comes to discarding it is hoped they will be exempt from the landing obligation. At this time however, data on discard survival from commercial operations is too limited to give clear recommendations on the survivability of these species.

To advance the knowledge needed for the management of these species the Dutch Elasmobranch Society will start a cooperative research programme involving fishing operators in the Dutch demersal fleet. This programme aims to: (1) bridge the knowledge gaps on ray demographics, catch and bycatch, as species specific landings data for rays is lacking for most areas; (2) develop a set of measures based on spatial/ temporal information, gear selectivity and best practice for on board handling to optimize discard survival. Cooperation between scientist and fishermen is a key part of the project as this will be essential for successful implementation of the proposed measures.

The baseline data and constraints for the research will be presented as well as the outline for necessary protocols.

Keywords: rajidae; landing obligation; discards; stakeholder participation

Shark Conservation in the Dutch Caribbean

K. De Meyer

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The Dutch Caribbean Nature Alliance (DCNA) is a regional network of protected areas, which supports and assists the parks and conservation organizations on Bonaire, Curaçao, Saba, St. Eustatius and St. Maarten.

A recent study by IMARES has indicated that 36 shark species are present in the waters of the Dutch Caribbean. These include a healthy deep-water shark population around the ABC islands as well as the second recorded sighting of the globally endangered Basking Shark. Although there are no targeted shark fisheries within the Dutch Caribbean, sharks are killed when they are caught by artisanal fishers and there is documented illegal fishing by foreign vessels. And whilst we do not yet know enough about our shark populations the evidence points to the fact that they are all but gone.

With shark conservation initiatives already underway on St. Maarten and Saba, DCNA is poised to launch a three year campaign to build popular support for shark conservation, ban commercial and targeted fishing for sharks and establish shark sanctuaries as safe haven for sharks

Keywords: Dutch Caribbean; conservation; shark sanctuary

Shark abundance on the deep island slopes of the Dutch Caribbean ABC-islands: A potential conservation and research opportunity

A.O. Debrot, I.J.M. van Beek and G. v Buurt

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Large marine apex predators have become exceedingly rare in shallow neritic waters around most Caribbean islands, including the ABC-islands (Aruba, Bonaire, Curacao) of the Leeward Dutch Caribbean. This is especially the case for several species of sharks. In May 2000, 24 2-hr long deepwater submersible dives were conducted off the islands of Aruba, Bonaire and Curacao, at depths ranging between 80-900 m. Eight shark sightings were recorded, amounting to 6 different species, among which the endangered *Hexanchus griseus*. These observations suggest a surprising diversity and density of deepwater sharks around the steep island slopes of leeward Dutch islands. This is further supported by anecdotal accounts by deepwater snapper fishermen regarding frequent nuisance shark hinder, and clearly contrast to the very low abundance of sharks in the shallow near shore environment. Several additional deepwater sharks can be recorded for the island based on opportunistic catch and collection records, including *Hexanchus nakamurai*. We ascribe this apparent abundance of deepwater sharks around these islands to the combination of steep island slopes and generally strong currents that greatly hinder effective deepwater snapper fishing and keep deepwater fishing effort around these islands very low. We conclude by emphasizing the major contrast between deep and shallow water shark abundance and diversity in the Leeward Dutch Caribbean and highlight the deepwater shark populations of these islands as a seemingly fortuitous conservation and research opportunity.

Keywords: Dutch Caribbean

The Implementation of a Shark Sanctuary and Continued Conservation Management Activities on a Small Island Caribbean State in the Dutch Caribbean of presentation

T.Y. Bervoets

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On the 11th of October 2011 the Minister of Economic Affairs of ST. Maarten the Honorable Franklyn Myers issued a Ministerial Decree banning the hunting and capturing of sharks and rays in the territorial waters of St. Maarten; a small island-country that is part of the Kingdom of the Netherlands. The ban came amidst a drastic reduction of the shark population, with the resident population of especially Caribbean Reef Sharks being reduced. The management entity of the Man of War Shoal Marine Protected Area noticed many of the larger females disappearing and a significant amount of fishing related injuries on juvenile males. A wide scale lobby was conducted coupled with a valuation study examining the worth of a single shark to the economy of the island. After wide scale negotiations the ban was put in place for territorial waters of St. Maarten. Now with the ban in place the management entity of the Marine Park is conducting a wide-scale tag and release project involving acoustic and visual tags as well as visual monitoring and citizen science reports. All of these efforts combined contribute to the management and of the island's shark population.

Keywords: Shark Conservation, Policy, St. Maarten, Dutch Caribbean

Towards a Shark and Ray Management Plan for the North Sea: Cost Effectiveness Analyses and the role of stakeholder participation

A.T. de Blacij, P.A. Walker, I. Kingma, M. v.d Water, & W.J. Strietman

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Since 2012 the Dutch government has given priority to the position of sharks and rays in all aspects of national and international policy. This means that for the implementation of the Marine Strategy Framework Directive (MSFD) a management plan is required, in which the steps to be taken to achieve the policy objectives for these species are outlined. Although the plan is intended for the Dutch part of the North Sea, international cooperation is essential.

There are 18 species of sharks and rays in the North Sea populating all ecological niches from coastal to offshore, pelagic and demersal. These species are characterised by their late maturity and low fecundity, making them extra sensitive to enhanced mortality by fishing and loss of coastal and offshore habitats for nursery and feeding. Many of the species are included in international policy and conservation guidelines as threatened and some are locally extinct in the North Sea.

The management plan has been written over a period of 18 months during a participative process in which scientists, NGOs, fishermen, fisheries representatives and government officials were invited to share their expertise to help formulate management objectives. We made use of a cost-effectiveness analysis (CEA) to propose, formulate and structure the management measures. The CEA is based on currently available information and input from experts. Although there is insufficient information to carry out a complete CEA, we can use it to assess the acceptance of the proposed measures to stakeholders.

This paper examines the interactive process used to formulate management objectives for sharks and rays in the Dutch part of the North Sea, explores the different styles of participation of stakeholders in this process, and looks at outcomes of the CEA carried out.

Keywords: MSFD; cost effectiveness; stakeholder participation; management plan

Incorporating fishermen's knowledge into sustainable sourcing guidance

J. Richardson

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As the importance of elasmobranchs within marine ecosystems is acknowledged, research into abundance, distribution and life-history has expanded rapidly. This in turn has supported much greater public awareness of their key roles as marine top predators. The result has been a significant shift in the management of elasmobranch fisheries over the last decade – from a complete absence of management, to a growing number now included in the EU Common Fisheries Policy.

Tracking this has been a groundswell in consumer demand for sustainable seafood products – a trend clearly visible in supermarket sourcing policy throughout the UK. Focusing on UK skate fisheries, as this shift continues, the commercial fishing industry has repeatedly questioned the datasets used by fisheries scientists – with fishermen concerned at perceived flaws in the methodology employed in the scientific trawls on which fisheries management and policy is based. In addition, isolated incidents of inaccurate media reporting have resulted in supermarkets removing skate wings from shelves, with financial ramifications for the fishing industry and seafood retail sector.

In an attempt to address this, the Shark Trust is developing a guide outlining species-specific information on the sustainability of regional UK skate fisheries. Central to this is merging ICES Recommendations with fishing industry data and knowledge on local skate populations. The objective is to provide clear guidance for the seafood retail sector and consumers on the sustainability of skate fisheries, enabling confidence in the sustainability of skate products while continuing to support effective management and conservation of threatened species. Challenges to date include sourcing and validating relevant fishing industry data for UK skate fisheries.

Keywords: Skate, Sustainable sourcing, Regional fisheries

Stock Reduction Analysis of selected ray stocks

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Currently there exist no quantitative stock assessments of rays in the northeast Atlantic and only few worldwide. To address this short coming this study uses the Stock Reduction Analysis (SRA) method for a number of European ray stocks. SRA is based on an age-structured deterministic production model, which estimates stock biomass and harvest rates from the time-series of catches, life-history characteristics (von Bertalanffy growth and natural mortality parameters) and one or several abundance indices. The abundance index time-series should include at least 3 years, which do not need to be consecutive. Rays stocks are data-poor, in particular catches were not reported by species historically and although the situation improved in recent years, catch by species data often remain uncertain. Life history characteristics are also uncertain. As a consequence every studied stock is modelled using two or three alternative assumptions regarding the time-history of catches or life-history characteristics. Results are presented for the cuckoo ray (*Leucoraja naevus*) and the thornback ray (*Raja clavata*) of the Bay of Biscay and Celtic Sea and for the undulate ray (*R. undulata*) in the English Channel. The few studied examples suggest that plausible stock trajectories can be derived from limited data. Continued efforts to reconstruct historical catch time series by species and to obtain abundance indices from surveys or on-board observations should allow estimating stock biomass and harvest rate using SRA for a range of elasmobranch stocks.

Keywords: Stock assessment, skates

Demersal elasmobranchs in the western English Channel

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In 2006 a new CEFAS beam trawl survey was initiated in the western English Channel, with the main policy aim of providing age-based indices for commercially important sole *Solea solea* and plaice *Pleuronectes platessa*, as well as providing information on other demersal fish and ecosystem components. The random stratified sampling design allows a better understanding of the fish assemblages within the area, thus adopting an ecosystem monitoring approach, where additional environmental data are collected which can inform Marine Strategy Framework Directive (MSFD) descriptors.

The western English Channel is an important area for a number of elasmobranchs, with about 30 species known to occur, 15 of which were recorded in the survey time series. Species of interest including undulate ray *Raja undulata*, which is locally abundant and, prior to their prohibited status, was an important commercial species in some inshore areas.

Preliminary results on the relative abundance, spatial distribution and size frequency for all dogfish, skates and rays encountered during 2006–2014 are presented. Results indicated that species including common skate *Dipturus batis*-complex, cuckoo ray *Leucoraja naevus*, thornback ray *Raja clavata* and undulate ray showed persistent associations with specific sites, with lesser-spotted dogfish *Scyliorhinus canicula* and starry smooth-hound *Mustelus asterias* distributed over much of the survey grid. Juvenile skates were routinely caught, as beam trawls are more selective for smaller fish. Mature specimens of the smaller bodied skate species, such as cuckoo ray, were also represented in the catch, while fewer mature specimens of the larger bodied skate species (e.g. undulate, blonde and thornback ray) were observed.

Keywords: western English Channel, fishery-independent, relative abundance, spatial distribution

Understanding Undulates through the Great Eggcase Hunt

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The Great Eggcase Hunt (GEH) is a Shark Trust citizen science recording project that aims to discover where different species of oviparous shark, skate and ray lay their eggs, while also raising awareness about the diversity of sharks in UK waters. To date, over 54,000 records have been submitted from around the British Isles and the project continues to grow in popularity.

An SOSF funded smartphone app for iPhone and Android devices is under development and shortly due to go live. The app will allow users to navigate through the Identification Tool in order to discover which species they've found, and upload their records along with photographs and a precise location. It is hoped that this app will encourage greater accuracy in records submitted to the project. Whilst the citizen science aspect of the project focuses on all species, the dataset also enables us to zoom in and focus on particular species. For skates and rays, the lack of species-specific data has historically undermined effective management, leading to declines in many species going unnoticed.

The objective of the *Understanding Undulates* project is to improve the resolution of our knowledge of Undulate Ray populations along the southern and southwest coast of England. The Undulate Ray is listed as Endangered on the IUCN Red List and could benefit significantly from protection in areas crucial to its static life-history phase. For the second tranche of English Marine Conservation Zone designations, 37 new sites are being assessed as possible candidates, with two of these sites located on the south coast of England in areas where Undulate Rays are encountered. The Trust is collating eggcase records (both beach records and *in-situ* records) for these areas, with data used to underpin government surveys and contribute to a comprehensive picture of Undulate Ray populations.

Keywords: Eggcase, Undulates, Citizen-science

Age and growth dynamics of spiny dogfish, *Squalus acanthias*, in the Adriatic Sea (Eastern Mediterranean Sea)

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We provide the first information on age and growth estimates for the endangered Mediterranean subpopulation of spiny dogfish, a commercially exploited shark, highly sensitive to overexploitation. We collected samples from 206 specimens caught by commercial bottom trawls in the Adriatic Sea, and utilizing three ageing protocols achieved good agreement between three rounds of readings (average percent error = 1.45%). Growth of spiny dogfish was best described by the Gompertz growth model and the following parameters: k values for males and females were 0.08 and 0.04 year⁻¹, respectively, size-at-birth was from 22.2 to 24.2 cm total length, with a theoretical asymptotic length of 74.9 cm for males and 114.0 cm for females. The age at which 50% of the population is sexually mature was 10.5 years for males and 20.1 years for females. The maximum age was estimated at 23 years for males and 36 years for females, with natural mortality estimates of 0.12 and 0.07 for males and females, respectively. Due to reported demographic parameter estimates, high fishing effort and particularly low resilience of the species to exploitation, it is important to produce proper species-specific management strategy for the spiny dogfish in the region.

Keywords: elasmobranch, ageing, growth models, spine

Shark aggregations at power plants: describing an emerging phenomenon based on fishermen's observations

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While sharks worldwide are experiencing a rapid decline over the past several decades, the status of most populations' remains poorly documented. This is also the case for sharks along the Israeli Mediterranean coast. Along this coast, anecdotal observations suggest that sharks aggregate at warm effluents of coastal power plants. This intriguing and undocumented claim also suggests that some sharks may be quite abundant along the coast. Given intrinsic challenges in measuring shark abundances, fishermen surveys were conducted in order to collect 'local ecological knowledge'. Fishermen were interviewed to reveal whether: a) sharks are sighted more often near power plant outflows than near structurally similar locations (marinas); b) differences occur in sighting frequencies among seasons; c) there is a trend in sighting frequencies of sharks during the past four decades (2013, 20 years earlier and 40 years earlier). A total of 128 fishermen were interviewed at four power plants and four nearby marinas along the shore: Hadera, Tel-Aviv, Ashdod and Ashkelon. Results indicate that: a) sharks are observed much more frequently near power plants at warm water effluents, than in marinas (Fisher exact test: $P < 0.0001$); b) shark sightings peak during the cold season, and are negatively correlated with water temperatures in Hadera ($\rho = -0.961$, $p < 0.0001$, $n = 12$) Ashdod ($\rho = -0.822$, $p = 0.001$, $n = 12$) and Ashkelon (Spearman rank correlation, $\rho = -0.935$, $p < 0.0001$, $n = 12$); and c) there has been an increase in shark sightings between 1993 and 2013 (Wilcoxon signed-ranks, $z = 275.5$, $p < 0.001$, $n = 46$). Shark aggregations occur at power plant effluents most likely due to elevated water temperatures. This can be explained either as a thermoregulatory behavior or due to the high abundance of prey fish observed at the effluent sites. Further research is needed to understand the nature of the recent increase in shark abundance and determine whether conservation and management actions are required.

Keywords: Carcharhinus, Power plants, Fishermen interviews, Aggregations

Application of molecular techniques in conservation management of elasmobranchs, identifying the way forward

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Globally, there is a growing concern for elasmobranchs with fisheries, largely driven by the Asian shark fin market, contributing to a large proportion of this decline. Molecular genetic techniques such as DNA barcoding and genotyping are increasingly being used to assist with conservation management of elasmobranchs worldwide. Southern Africa is a shark biodiversity hotspot hosting high endemism while sharing a high number of species with other parts of the world. Similar to other countries, commercial shark fisheries have increased over the last decade and there is a need to ensure sustainable utilisation and conservation of this fisheries resource. Here, we present an overview of the molecular techniques that are used to assist in the identification of species, assessment of population structure, reproductive modes, cryptic speciation and possible inter-species hybridisation of endemic and cosmopolitan elasmobranch species. We demonstrate application of these techniques for management and conservation of several species affected by fisheries including, *Mustelus mustelus*, *Galeorhinus galeus* and *Carcharhinus brachyurus*. A brief overview of future prospects such as high throughput development of molecular markers and investigation of ecological specialization of locally adapted populations will also be presented. We recommend that acquiring baseline barcode data of all elasmobranchs as a research priority. Furthermore, analysis of population genetic structure on a regional and more global scale will aid in effective management of not only southern African elasmobranchs but also of cosmopolitan species across the world's oceans.

Keywords: molecular techniques, genetics, conservation management, fisheries

Population genetics and spatial management for the conservation of the critically endangered common skate species complex

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The common skate (*Dipturus batis*) is one of the world's largest rajids. Once widely distributed throughout European waters it has undergone severe population declines, as a result of commercial fisheries, and is now critically endangered (IUCN). Previous genetic and morphometric analyses of the common skate revealed cryptic speciation that separated it into two distinct species, the flapper skate (*D. intermedia*) in the northern region of the distribution and the blue skate (*D. flossada*) in southern and offshore areas. Mitochondrial DNA control region sequences and five nuclear microsatellite loci were compared between the blue and flapper skate to determine which species was present in a proposed Marine Protected Area (MPA) on the NW coast of Scotland. Genetic diversity was examined for skates from along the western coast of the British Isles, within and outside the MPA, as well as estimating the population differentiation of the common skate complex along the Eastern Atlantic shelf. The level of spatial segregation between species was investigated by mapping the geographic distribution of the species complex in UK waters.

Microsatellite markers and mtDNA control region sequences indicated *D. intermedia* was the only species within the proposed MPA; no evidence of hybridization between the flapper and blue skate was found. The overall genetic diversity of *D. intermedia* was extremely low in the mtDNA control region and microsatellite loci, and only a single haplotype was found within the MPA population. *D. flossada* had much higher control region diversity indices; however, microsatellite variability was also extremely low. No significant population differentiation between subpopulations of either species has thus far been evident. The extreme vulnerability and low genetic diversity of these two critically endangered species highlights the need for continued monitoring and spatial management of the last remaining refuge populations of the common skate.

Keywords: Common skate, population, genetics

New findings from Area 51 – Chondrichthyans of the deep western Indian Ocean

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The ecosystems and faunal assemblages of the deep western Indian Ocean are poorly known, in particular the biodiversity and distribution of chondrichthyans. So far, 323 of the globally 1186 described and valid species are known to occur in the western Indian Ocean, including 168 of 508 shark, 145 of 631 batoid, and 10 of 47 chimaera species. Compared to nine other major ocean areas, the western Indian Ocean ranks fourth, behind the southwestern Pacific (357 species), eastern Indian Ocean (337 species), and northwestern Pacific (328 species). In the western Indian Ocean, groups with widely distributed, mobile species such as the Lamniformes, Hexanchiformes, and Carcharhinidae are best represented with 94%, 83%, and 53% of their species occurring in this area, respectively. In contrast, orders with mostly shelf species such as the Heterodontiformes, Orectolobiformes, Squatiniformes, and Myliobatiformes are underrepresented, possibly due to the narrow continental shelf of the western Indian Ocean. Furthermore, these orders apparently have differing centers of distribution, i.e. most heterodontiforms occur in the Pacific, most orectolobiforms and myliobatiforms in the eastern Indian Ocean and western Pacific, and most squatiniforms in the Atlantic and western Pacific. Among the speciose chondrichthyan orders, the Rajiformes is least represented with only 15% of its species occurring in the western Indian Ocean. Rajiforms generally inhabit deeper waters in tropical latitudes and most of their taxa have distribution centers in the northern Atlantic or western Pacific. Since 2011, three new shark and two new rajid species, plus one new pseudotriakid and one new anacanthobatid genus have been described. The new shark species belong to the Pristiophoridae, Pseudotriakidae, and Scyliorhinidae, the new Pristiophorus species represents the first generic record from the area. Additionally, existing material indicates that the number of described and valid species in the western Indian Ocean will increase significantly in the medium term.

Keywords: Annotated global checklist, Biodiversity: Biogeography, New species

A Case for Static Marine Protected Areas in Managing a Highly Mobile Elasmobranch (*Squalus acanthias*)

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Static Marine Protected Areas (MPAs) are being increasingly used to aid the conservation of elasmobranchs, although as many elasmobranch species tend to be highly mobile this means static management is only effective for those species that display strong site association or for which the critical habitats are known. However, this is reliant on sufficient knowledge of the behaviour and movement of these species. Spurdog (*Squalus acanthias*) are one such species that are in need of appropriate management due to a 95% decrease in their biomass within the North-East (NE) Atlantic over the last 60 years. Generally considered a highly mobile species, the management of the remaining UK stock is hampered by a lack of knowledge of the species within this region. While previous research suggests that the UK population is one large stock unit undertaking large migrations, research from other global populations has shown that some spurdog display a certain level of site fidelity to coastal areas.

In order to gain insight into the behaviour of coastal spurdog populations in Scotland, a multidisciplinary study was undertaken in Loch Etive on the west coast of Scotland. Using a combination of conventional tags, static active acoustic monitoring, archival data storage tagging (DST) and population genetics to investigate the movement and wider connectivity of spurdog within a partially enclosed water body we suggest that some Scottish spurdog display strong site association and over winter residency within Loch Etive. This on its own has large management implications, with wider implications when combined with the genetic study. Genetic markers show that the spurdog in Loch Etive are part of a wider UK population which suggest that in protecting a small spatial area, much of the genetic diversity of the UK spurdog also benefits from this protection.

Keywords: Residency, Marine protected Area. *Squalus acanthias*

New Horizons for elasmobranch fisheries management

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In the EU, the management of elasmobranchs is addressed in policy frameworks such as the Common Fisheries Policy (CFP) and the Marine Strategy Framework Directive (MSFD). In 2009 the EU adopted the Community Plan of Action for Sharks, which is being implemented in a number of European countries. These policy frameworks share common goals as far as maintaining or restoring healthy fish stocks and marine biodiversity are concerned. However, many elasmobranch fisheries are still considered data poor. Although the ICES Working Group on Elasmobranch Fisheries (WGEF) presents survey trends for over 50 species, management is based on historical catches, with TACs that have been progressively reduced under the precautionary approach. Atlantic sharks and rays show broad biogeography, being found in deep-water, continental shelves and coastal areas, and in both demersal and pelagic communities. Some species demonstrate high site fidelity while others migrate thousands of km, moving between Europe and North America and frequently crossing management jurisdictions. Many species are taken as by-catch in mixed fisheries and often discarded. Traditional age-based stock-assessments are frequently not suitable or cannot be applied. The diversity of species, ecosystems and fisheries, combined with data limitations, create substantial challenges for the development and implementation of robust assessment and management systems. This paper will explore the basis for a new EU project within the Horizon 2020 framework.

Keywords: stock-assessment; policy; EU; Horizon 2020

Elasmobranchs of the North-East Atlantic Shelf

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Data on elasmobranchs will be presented, based on an analysis of more than 60.000 hauls made with research vessels in the Celtic Sea, North Sea and Baltic Sea in the period 1977–2013. Most of the data originate from ICES coordinated international trawl surveys, but data of a number of national surveys have also been used. Focus will be on differences in distribution, depth distribution, length-frequencies (by area, depth or season), and time series of abundance. The information presented will be part of a broader ecological fish atlas of the area that is expected to be published in 2015.

Keywords: distribution, abundance, surveys, length-frequencies

Protecting the last angel shark stronghold in the Canary Islands

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The angel shark (*Squatina squatina*) was once common throughout Europe's seas, but the intensification of demersal fishing practices over the last 100 years has caused widespread decline of this species. As a result, angel sharks are locally extinct from much of their historic range and are listed as Critically Endangered on the IUCN Red List. The last known population stronghold is in the Canary Islands, but here too angel sharks are under threat. The Zoological Society of London (ZSL) and Universidad de Las Palmas de Gran Canaria (ULPGC) set up the Angel Shark Project in 2013, to protect the last known angel shark population stronghold in the Canary Islands. Between 2005 and 2010 the number of recreational angler licenses in the Canary Islands nearly trebled, from 40,000 to 116,000 licenses, and has continued to rise to date. There is additional fishing pressure from over c. 830 registered charter fishing boats. The combined effect of an expanding sportfishing community, wide-spread use of bottom fishing techniques and the use of lethal handling techniques is having an adverse impact upon the angel shark, which is a slow growing and late maturing species. We have recently been awarded funding to work side by side with the sportfishing community to reduce sportfishing-related angel shark mortality by:

- Creating a best-practice guide to catch and release to show how small changes to fishing, handling and landing techniques will dramatically increase angel shark survival.
- Developing a sportfisher-led citizen science tag and release project to reveal angel shark movements around the archipelago.
- Encouraging sportfishers and divers to report angel shark sightings through our online database (Poseidon), to provide vital ecological data to inform a conservation strategy for the region.

Keywords: sport fishing, best-practice, tagging, conservation

Why not involve anglers in your elasmobranch studies?

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Elasmobranchs are vulnerable to over fishing due to their specific life-style characteristics which result in slow and long reproductive cycles. As a result, elasmobranch populations have decreased substantially in areas with high exploitation. The EU shark action plan (CPOA) which also includes skates and rays, wishes to turn the tide. However, without scientific knowledge, effective fisheries measures are quite difficult to define. And this is where sport fishers (fishing with rods, practicing catch & release, not selling fish) can support elasmobranch studies, and also decision making. Angling has several benefits over commercial fisheries: e.g. anglers can fish for specific species, on specific spots such as deep water, and can do so without hardly any by-catch, also the survival rate of elasmobranchs being caught on rods is very high. And to prove this, we already have had several good results with tag & release programs in the UK and the NL.

And there is another catch: the socio-economic benefits derived from sea angling for elasmobranch species provide a much needed boost to local economies. A 'Best Value' approach to stock management, which recognises there is far greater potential for social and economic value if the goal of fisheries management objectives for certain elasmobranchs were aimed at supporting the development of the recreational sea angling sector.

Anglers represent an importantly large group of eyes and ears. This could help to distribute the study-results fast, and also help fisheries measures become more easily accepted. E.g. the Scottish Shark Tagging Program resulted in Scotland's sharks being the most protected in Europe and a Marine Protected Area (MPA) covering 800 sq. km. to conserve the common skate populations.

So, why not involve anglers in your elasmobranch studies? This is exactly what we wish to achieve: an EU-wide elasmobranch tagging and research program using anglers.

Keywords: Sport fishing, tagging, EU Shark Action plan

Starry smooth-hounds tagged in the Netherlands on the move

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Sportvisserij Nederland and IMARES started a long-term tagging program on starry smooth-hounds (*Mustelus asterias*) in 2011. In co-operation with local recreational and professional fishermen, tagging was carried out in the Oosterscheldt and along the North Sea coast of Zeeland, in the southern part of the Netherlands. The sharks were tagged with rototags. During 2011-2014, over 2000 starry smooth-hounds were tagged and over 80 recaptures were reported. Here we present the tagging results and biological knowledge on the starry smooth-hound as obtained within the mark-recapture program during 2011-2014. There is a clear seasonal pattern in the tagging-recapture data. During summer starry smooth hounds were present along the southern Dutch coast. During autumn they move to the English Channel and during winter some of them go as far as the Bay of Biscay (> 1000 km one-way trip). Most recaptures were made in front of the southern Dutch coast, the English Channel and north-eastern Bay of Biscay, but two outliers were recaptures for the Scottish and Norwegian coast. Most recaptures were made by trawling and gillnet fisheries. The fact that the Dutch recreational fishermen sometimes catch very small starry smooth hounds suggests that the marine waters around Zeeland are used as a pupping and nursery habitat. The catches of large females, especially in the eastern Oosterscheldt is another indication for this.

Keywords: tagging; *mustelus asterias*; distribution; smooth-hound

Habitat use and local movements of bull shark (*Carcharhinus leucas*) at Guanacaste Conservation Area, Costa Rica

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The Guanacaste Conservation Area (GCA) is located in northwestern Costa Rica, is an UNESCO World Heritage Site in and has an important MPA (43,000 ha). This AMP is characterized by the phenomenon of upwelling, causing a drastic decline of surface water's temperature (14 ° C) during the dry season. In GCA are located the "Bat Islands", which are visited by tourist divers to see the natural congregations of bull sharks (*Carcharhinus leucas*). The bull shark has a worldwide distribution; it is migratory and live in coastal waters, in marine and freshwater ecosystems. Bat Islands are located in the boundaries of GCA' MPA, which are constantly visited by illegal fishermen, they approach into the MPA looking for snappers and sharks. In spite of the critical habitats presents at GCA, the ecology, the behaviour and the habitat use of bull sharks are never study in this MPA. The aim of this project is promote the bullshark conservation toward the local communities and governmental sector, by the study of its population in GCA. In order to accomplish this aim, the researchers carry out subaquatic visual counts and an acoustic tagging program. Between June 2013 and August 2014, eleven bull sharks are tagged with acoustic transmitters. The information was recorded by on receiver located in San Pedrillo, Bat Island. The receiver has recorded more than 27,000 detections, mainly during daylight hours. The data showed a strong fidelity of females to the islands, the detections during the dry season are significantly less than during the rainy season. The tendency to stay during daylight hours in the island, it probably related to reproductive aspects, since it is common to see females with post-copula marks. In turn, the absence of detections during the night suggests that bull sharks move to other surrounding areas to feed.

Keywords: Bull shark, *Carcharhinus leucas*, tagging, Habitat use

Patterns in the abundance, distribution, and behaviour of the Angel Shark (*Squatina squatina*) in the Canary Islands

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The critically endangered Angel Shark (*Squatina squatina*) has suffered a vast fragmentation and deterioration of its former distribution, leaving the Canary Islands as a unique “hotspot”, where this species can still be regularly encountered. However, information on its spatial distribution patterns and abundance are almost unknown. Volunteer citizen-science programs, including those performed by recreational divers may generate a significant data pool, and at the same time this engagement contributes to raise public awareness on shark ecology. We have successfully involved the recreational SCUBA diving community in the Canary Islands to register Angel Shark sightings using an online database tool. Divers were required to submit the exact coordinates, water temperature and depth of their sightings, as well as other relevant data such as size, sex and behavior. Records were validated using supplied pictures and/or examining the locations of sightings. Within a 4-month period we have received more than 200 validated records, covering areas with no previous records. We also identified aggregation sites and nursery areas. This study provides the first insights on the patterns of the abundance, distribution and behavior of the Angel Shark populations in the Canary Islands.

Keywords: citizen science, diver survey, endangered species, distribution

A ten-year wrap-up of Operazione Squalo Elefante, basking shark field research in the Mediterranean

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Operazione Squalo Elefante is an on-going project on basking sharks started in Italy in 2005, the only field study on this species in the Mediterranean Sea.

After ten years we present an overview of the results of this project, including:

- The identification of the only two known seasonal aggregation areas in the area
- A Mediterranean basking shark tissue samples
- Basking sharks as possible indicators of microplastics in the pelagic environment
- A Mediterranean basking shark photo ID bank
- The creation of a network of observers and operators to report sightings/captures and collect tissue samples from stranded or by-caught animals.

OSE aims to increase the knowledge of this endangered and protected species contributing information on its ecology, population numbers and structure in the Mediterranean sea; identify aggregation areas and reduce accidental captures in some of the most sensitive areas in their range as sharks migrate along the Italian coast; investigate possible connections with the Atlantic stock; raise public awareness; promote good management practices and active participation in local stakeholders. Operazione Squalo Elefante is run with the generous support of the Prince Albert II of Monaco Foundation.

Keywords: basking sharks, Mediterranean

Atmospheric and oceanographic influences on whale shark (*Rhincodon typus*) seasonality in the Bay of La Paz, Mexico

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Global aggregations of juvenile whale sharks (*Rhincodon typus*) commonly exhibit definitive seasonality allowing for relatively accurate predictions of presence and absence at known aggregation sites. The location of the whale sharks when absent from these sites and the potential oceanographic and biological drivers that affect their presence as well as potential habitat use, are largely unknown. Understanding critical habitats for whale sharks is essential on both a regional and global scale for proper management. The increasingly economically valuable whale shark aggregations in the Bay of La Paz, Mexico have displayed considerable inter-annual variation in the timing and duration of seasonality. Oceanographic and atmospheric variables have previously been shown to explain changes in whale shark abundance in Ningaloo, Australia and the Indian Ocean. In order to investigate the spatial and temporal patterns of whale shark occurrence in relation to oceanographic and atmospheric features in the Bay of La Paz, sightings data collected by experienced researchers over 10 seasons between 2003 and 2013 were used to analyze changes in seasonality. Monthly averaged atmospheric and oceanographic variables, including sea surface temperature and chlorophyll levels, obtained by remote sensing, as well as wind speed and direction, and Multivariate El Niño Southern Oscillation Index, were compared with the number of unique individual whale sharks identified per month over the 10 seasons. We will present the findings of this preliminary investigation and identify the parameters that best explain the changing seasonality. A Maximum Entropy model will later be used to delineate important regional habitats for this vulnerable and highly migratory species.

Keywords: *Rhincodon typus*, seasonality, oceanographic drivers, Maximum Entropy

Genetic monitoring of basking sharks in the North-East Atlantic: shark habitat use in the Marine Protected Area (MPA) versus marine renewable energy (MRE) designation debate

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The filter-feeding basking shark (*Cetorhinus maximus*) is the largest fish in the Northeast Atlantic, where it is currently classified as 'Endangered' (IUCN Red List). Each summer, basking sharks appear in hundreds in coastal waters around Ireland, southern England, West Scotland and the Isle of Man. These persistent, seasonal aggregations may represent a significant proportion of the global population. However, little is known about the basking shark's life history, and no reliable population estimates are available at either global or regional scales. Therefore, as part of the current Scottish Marine Protected Areas (MPA) Project, basking sharks have recently been included in the search feature list for Scottish territorial waters.

Despite possible MPA designations, the rapid expansion of marine renewable energy (MRE; offshore wind-, tidal- and wave- generated) installations has introduced a high level of uncertainty surrounding their potential impacts as they may spatially overlap with basking shark key sites and migration pathways. Consequently, there is an urgent need to develop resource-efficient methods for monitoring basking sharks over time to assess potential effects of environmental and anthropogenic change. Molecular markers can often augment traditional approaches to population monitoring, costing less and proving more reliable for estimates of abundance and site occupancy by elusive species. We have developed a statistically powerful marker set of 22 species-specific microsatellites allowing for individual identification and first estimates of basking shark effective population size, global structure and genetic diversity. Through genetic recaptures, we are providing evidence of inter- and intra-annual site fidelity at key sites, and new insights into movement patterns.

Furthermore, high-throughput sequencing data have been screened to produce a novel, 384 SNP (single nucleotide polymorphism) chip from the basking shark genome to allow more precise and robust future genetic monitoring and more in-depth analyses regarding patterns of relatedness at key sites.

Keywords: Basking shark, habitat use, genetics, microsatellites

Assessing the Effects of Prey Interactions on Habitat Use Patterns and Foraging Effort in Lemon Sharks

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Coastal nursery sites provide critical refuge for young sharks. Delineating how sharks use these habitats and interact with other species helps us to better understand their ecological role and develop sound marine management policy. In this ongoing study we assess the effects of distribution and abundance of prey species on lemon shark behaviour, in Bimini, Bahamas. For this study we developed a 'tag package' comprised of a CEFAS G6A tri-axial accelerometer and a Sonotronics PT4 acoustic transmitter. Tag packages are externally attached to the first dorsal fin of sharks. Accelerometers provide quantitative behavioural data used to identify potential foraging attempts and acoustic transmitters are used to actively track large juvenile (0.8-1.2m) and sub-adult (1.2-2.0m) lemon sharks. We surveyed the study site for prey communities using baited remote underwater video stations (BRUVS). Thus far 12 sharks have been tagged for periods ranging 3 to 5 days. Accelerometer and telemetry data show distinct, tidally mediated patterns in diel movements and foraging effort in lemon sharks. Relative abundance data from 150 BRUVS deployments show abundance and distribution of prey species to vary greatly within the study site. We aim to identify overlap between patterns in shark movements and foraging effort with prey availability, demonstrating the importance of predation and inter-species interactions in the daily habitat use patterns of lemon sharks. This research is supported by a grant from the Bimini Biological Field Station Foundation.

Keywords: accelerometer, BRUVS, inter-species interactions, telemetry

Conservation of coastal critical habitats of scalloped hammerhead shark (*Sphyrna lewini*) in the Easter Pacific Ocean

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The scalloped hammerhead shark, *Sphyrna lewini*, is an endangered and emblematic shark species in the Eastern Tropical Pacific Seascape (ETPS). It is characterized for being migratory. Females give birth to their young in coastal waters. Here, the young are afforded food and protection while they grow and reach sexual maturity. When sharks reach their adult stage, they begin large migrations, changing from coastal habitats to oceanic ones. Aggregation sites for scalloped hammerhead sharks have been identified on several oceanic islands in the ETPS (Coco, Malpelo and the Galápagos Archipelago), but little is known about their use of coastal areas. This study aims to describe the scalloped hammerhead sharks movements in aggregation sites of Golfo Dulce, South Pacific of Costa Rica. Fisheries-dependent biological data (size-TL, weight, sex, reproductive status) was gathered for *S. lewini* during artisanal fishing trips between May 2010 and May 2011 in Golfo Dulce. Based on the fisheries dependent data from on board observations, three aggregations sites were selected using the following technical criteria: 1- Sites where individuals of *S. lewini* are found all the year; 2- Sites where the relative abundance was higher; 3- Sites where the vulnerability is higher; 4- Sites where the fishing survival was lower. Three acoustic receivers were installed and 10 hammerhead sharks were tagged with acoustic transmitters in the selected habitats. Between June 2011 and July 2012, the receivers recorded almost 40.000 detections. All the sharks marked were reported by the receivers, showing daily movements between receivers. Sharks are present on the selected habitats between 09:00 and 22:00, during this period of time, 90% of the detections occur. Hammerhead sharks probably move to other places at night and during the early morning to feed.

Keywords: Critical habitats, *S. lewini*, Golfo Dulce

Managing the genetics of a species in captivity: *Raja undulata*

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Over a number of years, UK aquaria have been collaborating in a managed breeding program for the endangered and protected Undulate ray, *Raja undulata*, with European aquaria recently becoming involved. To further enhance this program, recent and ongoing genetic research is being undertaken for the first time on this species of skate. This presentation will explain the work that has begun, through collaboration between SEA LIFE and Manchester University, to establish the genetic primers and microsatellites needed to allow the development of a concise pedigree and family tree of the existing population. The benefits that this information will bring in the strategic mating of animals will be discussed while highlighting how this research could aid in-situ conservation and fisheries management of the species. There will also be a short update on the European aquarium studbook for the Blacktip reef shark (*Carcharhinus melanopterus*) discussing findings relevant to the scientific community.

Keywords: Undulate ray, Raja, DNA, Studbook

Spermatogonial stem cells: towards the preservation of shark species?

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Spermatogonial stem cells (SSCs) are crucial for the initiation and the maintenance of spermatogenesis. In vertebrates, SSCs markers (Thy1, GFR α 1...) were identified and validated after cell sorting and transplantation in a recipient. Transplantations successfully gave rise to trout gametes in salmon recipients. So, this technique was proposed as a mean to produce gametes of endangered species through domestic species recipients. SSCs molecular markers and regulations are well studied in Osteichthyes; in contrast, very few data are available in Chondrichthyes whereas a high proportion of these fishes are threatened. So, we studied the SSCs niche in the little-spotted catshark, *Scyliorhinus canicula*, an abundant chondrichthyan species on the Normandy coast. Several spermatogonial markers were identified allowing the distinction of several cell subpopulations. An *in vitro* model of the testicular germinal area containing the potential SSCs was established. This primary cell co-culture was used to study the conservation between Osteichthyes and Chondrichthyes of the GFR α 1 pathway to regulate the SSCs fate. GFR α 1 ligand, the Glial cell line-Derived Neurotrophic Factor (GDNF), was shown to promote proliferation and to decrease apoptosis. GDNF also increased the number and size of colonies and their content in stem cells. So, chondrichthyan spermatogonia seem to share common molecular markers and regulation pathways with other vertebrates, like mammals and teleostean fishes. Transplantation of SSCs in the little-spotted catshark is now a challenge to take up.

Keywords: small spotted catshark, reproduction, spermatogonial stem cells

Exploring personality and a simple learning process in the juvenile lemon shark, *Negaprion brevirostris*

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Personality has been widely studied in the animal kingdom and can have important implications. For instance, some personality traits have been directly related to the individuals' mortality rate and fecundity. However, despite extensive research few studies have explored animal personality and its interaction with simple learning processes, such as habituation (a reduction of response to novelty over time). Studies examining personality traits frequently use experimental setups that investigate exploration of a novel environment (NE). However, although extensively used within the personality literature, few researchers identify the actual trait observed (i.e. activity vs. exploration) as well as investigate the effect that repeated exposure has on trait expression. Here we introduce the juvenile lemon shark (JLS), as a model species for personality research and present results from a series of experiments examining: 1) personality in the context of a NE, and 2) expression of personality after repeated exposure to the NE. To accomplish this, twenty-eight JLS (sex ratio 1:1, mean total length \pm SD = 68.5 \pm 6.3 cm) were captured intermittently over a 6-month period in South Bimini, Bahamas. Sharks were housed in a semi-captive holding pen (10m diameter) built in shallow water. The experimental arena "novel environment" was a large rectangle (10x6m), demarcated by zones and connected to the holding pen via a start box. During experiments individual sharks were ushered in this box (every other day for 6 replicates) and their emergence time and visit to zones were recorded. Individual visits to zones within the first trial were shown to be a relevant indicator of the exploration personality trait. Habituation was expressed by every individual; however exploration had a strong direct effect on it, with individuals visiting more zones in their first trial habituating faster. Demonstrating that personality influences a simple cognitive skill, this study advances our understanding of elasmobranchs behavioural ecology.

Keywords: Personality, habituation, elasmobranchs, animal behaviour

Making sharks and shark research visible – The first two years of the Dutch Shark Society

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After their years of work for a number of non-profit organisations in marine conservation, Peter Verhoog and Georgina Wiersma returned to their home country. Even though the Netherlands have a relatively long coastline along the North Sea and the well-known Delta works, sharks and rays seemed to be non-existent to a wide audience, and several species have nearly disappeared from the Dutch waters already. Shark conservation? It was a non-issue: there are no sharks, so why conservation? The existing Shark Action Plan is mainly a matter of government organisations and scientists and not known to a general audience. Still... the first reports of higher shark catches by recreational anglers, and media reports about 'large sharks flooding the Dutch coasts' showed the need to inform people about the importance of sharks – before media would get out the message out about the danger of sharks. A simple, effective information platform, presenting simple knowledge about (Dutch) sharks and elasmobranch research in general. The Dutch Shark Society was born. DSS established a relation with partners already working in the elasmobranch field: several Dutch seawater aquariums with breeding programmes, National Park Oosterschelde and the Dutch Recreational Angling Society; weir fishers to document the Dutch sharks and rays in their natural environment. Results were published on a wide scale, i.e. in National Geographic Magazine and can freely be used by NGOs working on elasmobranch conservation. The Society uses its wide network to establish links between organisations and regularly publishes about (worldwide) citizen science and elasmobranch research in international and national media. After two years there are school presentations, collaboration with the British Shark for the Great Egg case Hunt and other organisations - DSS is a recognised non-profit organisation with a large group of followers - featured on national Dutch Television, in newspapers and magazines. Dutch sharks DO exist and they DO need our protection!

Keywords: Dutch elasmobranch, platform, media relations

European captive breeding programs: one step further

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Public zoos and aquaria are important tools to communicate towards the general public about nature education and conservation. Two organizations: the European Association of Zoos and Aquaria (EAZA) and European Union of Aquarium Curators (EUAC) are platforms for interdisciplinary collaboration. Husbandry information in the widest sense is shared between the members. This will increase the overall standard and knowledge. A next step in this field is collaboration within breeding programs. For decades this common approach is used on mammals and birds and since 2007 the first programs have started on elasmobranch species. The programs are organized within the Fish and Aquatic Invertebrate Taxon Advisory Group (FAITAG). Every species has its own program leader, which knows all details about the European captive population. This program leader will also compile husbandry and health information about the specific species and can be an important link between scientific researchers, IUCN Species specialist group and public aquarium world. This presentation will give an overview of the European captive elasmobranch population by using the results of a census in 2011. Within the 66 public aquaria that participate within the census 14% of all elasmobranch species are kept. Of these species 44.6% are bred in captivity. During a workshop, a Regional Collection Plan (RCP) was developed where all species kept in Europe were discussed on the CITES and IUCN status as well as their potential for a breeding program. The presentation will give an overview of the current programs and show a few examples.

Keywords: breeding, husbandry, census

Analysis of carcharhinid transcriptomes reveals evidence of positive selection in genes associated with an evolutionary reversal to aplacental viviparity

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All vertebrates initially feed their young using yolk reserves, and some live birthing (viviparous) species provide extra, maternal nutrition via a placental connection. The majority of live birthing sharks nourish their young using a yolk-sac. In some species this later develops into a placenta, providing additional nutrition. All sharks of the Carcharhinidae family are live birthing and all of these species but the tiger shark (*Galeocerdo cuvier*) develop placental connections after exhausting yolk-sac reserves. We used RNA-Seq to sequence the transcriptomes of the aplacental tiger shark and six placental carcharhinid sharks. We identified 1,172 putative orthologs between the seven species. We constructed a phylogenetic tree and employed a maximum likelihood approach with site and branch-site tests to infer signatures of positive selection in these orthologs. The site test found evidence of positive selection in 114 sets of orthologs. A significantly larger proportion of orthologs exhibiting evidence of positive selection were associated with immunity ($p < 0.05$) and nervous system development ($p < 0.05$) compared with the total number of orthologs. The branch-site test found signatures of positive selection in eight sequences of the tiger shark lineage. *SET9*, *BNIP3L* and *PHP14* are associated with placental disorders in humans. *DGCR14* and *ϵ -COP* are associated with nervous system development. *CMPK-like* is associated with sexual reproduction, and *DNTTIP1* and *translin* are associated with immunological mechanisms. These results provide important information about the genomic basis of the evolution of aplacental viviparity in the tiger shark lineage, which likely reflects an evolutionary reversal in reproductive strategy.

Keywords: aplacental viviparity, carcharinids

Morphological diversity in the palatoquadrate in extant sharks in relation to feeding strategy

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This study focuses on the morphology of the palatoquadrate, and its relationship with feeding strategies in sharks. This is the first study on a large scale, comparing 87 different species (143 specimens, 1-3 per species covering 27 families and 8 orders). All specimens were scanned using computed tomography techniques, and 3D images were created using the software package Mimics. Variance in morphology was quantified by placing 14 landmarks based on their functional homology using Landmark Editor. The results were processed in MorphoJ for further statistical analysis. The variance in palatoquadrate morphology was quantified using principal component analyses. Species were categorized into one of four diet groups based on literature: fish and cephalopod eaters, hard benthos, soft benthos, and generalists. To correlate the morphological variance with the diet, canonical variate analysis was performed on PCA results with diet as *a priori* group. The results from the CVA gave a significant difference in shape of the palatoquadrate between feeding guilds. Feeding guilds were strongly correlated with phylogeny, but within phylogenetic groups consistent differentiation according to feeding guild was found by creating a phylomorphospace. The results from the phylomorphospace showed that there is a phylogenetic signal which needs to be taken into account. However, as the previous results showed comparing species with a higher degree of relatedness, most of the variation in morphology is likely attributed to adaption to feeding strategies. Studying the variation in morphology showed that fish and cephalopod eating sharks have elongated jaws with a higher process on the anterior end for muscle attachment, suitable for ram feeding. Hard benthos eaters have shorter, robust jaws for crushing prey, as well as a higher bridge on the anterior end. Soft benthos eaters have jaws suitable for suction feeding, as they have short jaws, smaller dentition, and a larger orbital articulation process.

Keywords: Palatoquadrate, morphology, diet, phylogeny

Diversity, spatial distribution and relative abundance of reef sharks using stereo baited remote underwater video around the windward islands of the Caribbean Netherlands

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The most likely cause for the decline of many elasmobranchs is the combination of high fishing pressure and slow reproductive life-history characteristics. A key ambition of the Dutch Caribbean Nature Policy Plan 2013-2017, is the effective implementation of shark protection. The first step towards effective protection is to conduct a base-line survey and to develop robust, quantifiable objectives and reference points for conservation (and fisheries) in order to be able to evaluate the performance of management actions. Stereo Baited Remote Underwater Video Survey (BRUVS) is a non-invasive method to study species richness, relative abundance and accurate length frequency of fish species such as sharks. In this study we used BRUVS to conduct a base-line survey of sharks on St Eustatius, Saba and the Saba Bank. Shark assemblages were structured by habitat complexity, depth and to a lesser extend management zone. Overall, the shark populations appeared to be in reasonably healthy state. Relative abundance of the different shark species was higher than reported for similar BRUV studies within the Caribbean. A possible explanation for the current status of the shark populations in the Caribbean Netherlands is the lack of destructive industrial-scale fishery practices (directed shark fisheries, shark finning, long-lining or gillnetting). The establishment of a formal shark sanctuary in the Caribbean Netherlands would prevent the future development of such destructive fishery practices without completely restricting the occasional landing of sharks as by-catch in the existing artisanal, small-scale fishery.

Keywords: elasmobranchs, conservation, fisheries, Saba, St Eustatius

Return of sharks and rays in the North Sea

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Sharks and rays are characteristic of the North Sea ecosystem. They are top-predators and perform a vital ecosystem function. Unfortunately, nine out of eighteen North Sea shark and ray species are listed as critically endangered, endangered or near threatened on the IUCN Red List. Six species are doing relatively well. The status of the remaining three species cannot be determined due to lack of data. The majority of sharks and rays and their habitats are poorly protected. Habitat restoration and protection alone are not enough to encourage shark and ray recovery in the Dutch part of the North Sea, as the probability of repopulation of species such as the Common skate and the Thornback ray is small. Therefore, reintroduction programs might need to be an inclusive part of future elasmobranch management in the North Sea. WWF together with the NEV, the North Sea Foundation, the Dutch Angler Association and numerous aquaria in the Netherlands have developed a project that encompasses a reintroduction program according to IUCN/SSC Guidelines for Re-introduction of species. Shark and ray eggs will be raised in aquaria and made visible for the public. Next to that the project aims to build capacity for the management and protection of key spawning grounds and nursery areas, build capacity for management measures that reduce shark and ray by-catches in commercial fisheries and build commitment and willingness in the political arena to implement effective management measures that improve the protection of rays and sharks and their habitats.

Keywords: reintroduction, husbandry, management, North Sea

POSTER PRESENTATIONS



Poster Presentations

Feasibility of the reintroduction of the thornback ray (Raja clavata) to the Wadden Sea

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The ecosystem of the Wadden Sea appears to be out of balance, with an absence of top predators, such as large fish.. The reasons are not clear, but it is thought that fisheries (also in the North Sea), habitat loss and climate change might play a role. In the last century the thornback ray (*Raja clavata*) was caught in and outside the Wadden Sea and Natuurmonumenten, a nature conservation organization, wants to explore the feasibility of reintroducing this species to the Wadden Sea. For this the IUCN-guidelines for reintroduction will be applied to find out how to meet the criteria and to make an inventory of criteria that have not been achieved, to identify future research. The thornback ray was chosen to be the prime candidate, not only because they used to be in the Wadden Sea, but due to their important role in the food web and predation on crustaceans. Results from a recent mussel bed restoration programme, show that there is a lot of predation by crustaceans on mussel seed, which may limit the development of the mussel banks. This poster will show the framework necessary to identify the essential steps to be taken for the reintroduction of a top predator, the thornback ray, to the Wadden Sea. It will contain background information on the projects that lead to this research, a history of the thornback ray in the Wadden Sea and the positive effects should reintroduction be feasible.

Keywords: Thornback Ray, reintroduction, IUCN-Guidelines

Pour old wine in new bottles: How ancient's museum data can help in understanding actual distribution of endangered sawfishes

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Pristidae (sawfishes) are actually considered as the most threatened elasmobranchs worldwide. From the five species currently described, 3 are listed as Critically endangered and 2 as Endangered from the IUCN Red List 2013 assessment and their population encountered dramatic decrease in most of their distribution range. Usefulness information on species distribution, population structure and life history parameters are still lacking to establish efficient management measures. In 2012, in complement to its field research involvement and conservation project on sawfishes in Western Africa, DRDH has started a follow up of the rostrum Internet black-market in France and has got closer to French and international museums in order to increase its sawfish rostrums samples. Morphometric data from 176 rostrums from 4 sawfishes species have been analyzed in order to find out which criteria grows up simultaneously with of the rays and may not be good candidate for identification. Each rostrum was processed individually either by direct measurements with calliper and measuring tape or photographic support. Teeth count (right and left), rostrum width (basal and apex), and teeth parameter were collected as well as all available value data as geographical origin, sex, total length of the animal or capture parameters. Various ratios were tested (through R) by species and juvenile and adult subgroup (determined via average Length at maturity literature data available). Statistic analysis has been then conducted through Principal Component Analysis (PCA), distance matrix (Hellinger transformation) and dendrograms (Ward method) were calculated to test alternatively inter and intra species variations. Some species identification criteria have been highlighted and used to propose a new and simple identification guide, easy to handle as well on field research as for museum collection data. Increasing Pristidea knowledge will aim, therefore, to strengthen the efforts engaged for Global Conservation Strategy of these endangered species.

Keywords : Sawfishes, Morphometric data, Endangered species, Identification guide

A multiple models investigation on age and growth of the speckled ray (*Raja polystigma*) from Sardinian seas

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Age and growth of the small Mediterranean endemic skate, *Raja polystigma* Regan 1923 were studied through the annuli counts in vertebral centra. During the period between 2012 and 2013 a total of 183 speckled rays (97 females, ranging from 115 to 590 mm in TL and 87 males with TL among 118 and 521 mm) were caught through experimental (MED.I.T.S.) and commercial trawl surveys. From each individual total length (TL in mm) total mass (TM in g) in addition to the gender and maturity stage were recorded, then vertebral centra were extracted from the thoracic cavity. Annuli counts were made by two readers through the observation of vertebral sections stained in Alizarin Red. Readings showed a good reproducibility (Percent Agreement = 86.8, %, Cv = 7.0, Index of Average Percent Error = 5.177). The oldest skate observed was a female estimated at age 11 (TL = 590 mm) while the oldest male was aged 8 (TL = 521 mm). Four different models were applied on length at age data: the common von Bertalanffy growth function, the Exponential, and finally the Gompertz and the Logistic functions. According to the Akaike's Information Criterion values the Logistic model ($L_{\infty} = 691.49 \text{ mm} \pm 10.21$; $K = 0.26 \pm 0.008$; point of inflection = $4.03 \text{ y}^{-1} \pm 0.147$), followed by Gompertz function, provided the best fitting curve, showing a higher growth rate and consequently a lower L_{∞} value than what obtained with the VBGF ($L_{\infty} = 784.49 \text{ mm} \pm 12.2$; $K = 0.11 \pm 0.004$; $t_0 = -1.718$). This result was obtained also for females and males separately. Given the best fitting results achieved with the Gompertz and the Logistic functions, *R. polystigma* seems to grow relatively faster during the first few years as previously reported for other batoid species.

Keywords: *Raja polystigma*, age & growth, vertebral centra, multiple models.

Economic importance of the starry smoothhound to anglers in the Netherlands

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The socio-economic value of the Starry smooth-hound (*Mustelis asterias*) to anglers in the Netherlands is much more than the price commercial fishers get for landing a Starry smooth-hound. For decades these sharks have been nearly absent in the Dutch coastal waters. However, since 2010 this has changed and they are more abundant than they were, and as a consequence they became a relative important sport fish. Angling charters and anglers do not earn money by selling the fish; they earn something that may have a much higher value. The socio-economic value for an angler of catching a shark is an experience that will always stay with them. In addition, the value of that catch may be much more than a commercial fisher gets for landing the shark. For example: on the 4th of September 2014, three starry smooth-hounds were caught and sold for less than a euro. In comparison: if one angler wants to go fishing for sharks in the Netherlands this person will spend about 120 euro for a day of shark angling. Commercial fishers have all kinds of by-catch. Demersal fishers who want to catch flatfish or shrimp may also land sharks. Unfortunately little is known about elasmobranch fish in the southern North Sea, and due to a lack of information, such as on migration, nursery areas and behaviour, it is difficult to assess effective fisheries management measures. This is why Sportvisserij Nederland started a tagging-recapture programme.

Keywords: Economic importance, starry smooth-hound, anglers

Suitability of lesser spotted dogfish (*Scyliorhinus canicula*) as indicator of trace metals pollution in the Spanish Marine Strategy monitoring programs

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The Marine Strategy Framework Directive (MSFD, 2008/56/EC), is the main instrument for the protection of the marine environment in Europe. The Spanish initial assessment of the environmental status of their national marine waters, has revealed several gaps and lack of information and knowledge regarding descriptor 8 (contamination and its effects) in all Spanish waters. In particular, there is a need to identify a fish species that could be used as pollution indicator for the Spanish Atlantic and Mediterranean waters. The lesser spotted dogfish (*Scyliorhinus canicula*), could be considered as an alternative species to those broadly used in northern Europe. In order to assess the suitability of this specie as indicator of pollution for MSFD purposes, this study evaluated trace metals levels (As, Hg, Cd, Cu, Zn, Cr and Ni) in muscle tissue of specimens collected in three different Spanish geographical areas: two in the North (Galician and Cantabrian areas) and one in the South. Females were collected by IEO scientific staff aboard research vessels during 2012. The analysis of muscle tissue samples includes a nitric acid digestion in a microwave oven. Metals were analyzed by Atomic Absorption Spectrometry (F-AAS, GF-AAS, CV-AAS). The quality of the analyses is demonstrated by the results obtained in intercalibration exercises, such as QUASIMEME. The internal QC includes analyses of duplicate samples and procedural blanks as well as control charts of CRMs. Only statistically significant differences were observed between the three zones for As and Hg. Regarding Pb, all samples analyzed were below or close to the detection limit for the analytical method used. For other metals concentrations, no significant differences between zones were observed. Further studies on the influence of environmental and biological factors on metal dynamics are needed. Experimental values for Hg, Pb and Cd were far below the EU maximum levels for human consumption established by EC Regulations.

Keywords: Lesser spotted dogfish, trace metals, Atlantic, Spain

First record of the blacktip reef shark *Carcharhinus melanopterus* (Carcharhiniformes: Carcharhinidae) from the Tropical Eastern Pacific

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The blacktip reef shark *Carcharhinus melanopterus*, is one of the most common Indo-Pacific reef sharks. On April 29, 2012 at 20:00 hrs., a blacktip reef shark, was caught during a tagging expedition studying population dynamics of the whitetip reef shark *Triaenodon obesus*, in Chatham Bay, Isla del Coco National Park. Chatham Bay is located on the north side of Isla del Coco between coordinates 5°33'25.28"N, 87°02'53.11"W and 5°33'04.71"N, 87°02'13.76"W. Positive identification of the species was attained by analysis of the following distinctive characters (Compagno 1998, Compagno 2005):

1. Short rounded snout with large anterior nasal flaps.
2. Black tips on all fins, including the edge of the caudal fin's upper lobe Figs.
3. Light band that borders the black mark on the first dorsal fin.
4. Distinctive body color: yellow-brown dorsal surface and white underside, with conspicuous dark bands on the flanks that extend back towards the pelvic fins.

The shark's size (89cm TL) together with the low calcification of its claspers, suggests the individual was a juvenile. This is the first record of a blacktip reef shark from Isla del Coco National Park and from the Tropical Eastern Pacific (Allen & Robertson 1998, Robertson & Allen 2008). Garrison (2005) identified over 270 fish species (including 7 sharks and 4 rays) at Isla del Coco: 30 species have a circumtropical or circumglobal distribution and over 40 species are reported from scattered Indo-Pacific locations or throughout the Indo-Pacific Ocean (most of these are bony fish, e.g. the genus *Thalassoma*, that probably traveled 5000km with floating debris to arrive in the Eastern Pacific Ocean (EPT). Several Indo-Pacific elasmobranchs are present at Isla del Coco, including the silvertip (*Carcharhinus albimarginatus*) and the white-tip shark (*T. besus*). Their distribution extends into the continental waters of Central America. Other example is the marble ray (*Taeniura meyeni*); is only present at Isla del Coco and Galapagos Islands in the Tropical Eastern Pacific, and absent from the central American mainland (Grove & Lavenberg 1997). The presence of a juvenile blacktip reef shark at Isla del Coco suggests that a pregnant female traveled at least 5000km and arrived at Isla del Coco to give birth at Chatham Bay. *C. melanopterus* possibly represents a new arrival for Isla del Coco National Park.

Keywords: Blacktip reef shark, Isla del Coco National Park, Tropical Eastern Pacific

Feeding ecology of the Mediterranean endemic speckled skate, *Raja polystigma*, from Sardinian waters

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The stomach contents of 328 speckled skates, *Raja polystigma*, caught in the seas surrounding Sardinia (central western Mediterranean) were examined with respect to fish size, sex, season and depth in order to study the feeding ecology of this Mediterranean endemic species. Samples, 104 to 593 mm in TL, were collected at depths between 37 and 660 m during experimental trawl surveys in the period 2005–2011. In the 312 full stomachs (%Cv = 4.88) 67 prey items were found, belonging to seven main taxa: Crustacea, Osteichthyes, Chondrichthyes, Mollusca, Polychaeta, Priapulida and Sipunculida. Levins' index value was low ($B_i = 0.14$). Diet was based on Crustaceans (%PSIRI = 77.17), particularly Mysids, and Teleosts (%PSIRI = 14.72). Trophic level was 3.49 (s.e. = ± 0.53). The feeding patterns changed with growth (ANOSIM, global R 0.169, $P < 0.001$). Crustaceans' importance progressively decreased (%PSIRI = 91.39, 77.35 and 45.65 among immature, subadults and adults, respectively), while Teleosts were consumed more intensively (%PSIRI = 4.13, 11.71 and 41.96). Nevertheless, Morisita's index showed a high degree of trophic niche overlap ($C_H > 0.90$ for all combinations). This is probably due to the high consumption of Mysids during all life stages, as revealed by the SIMPER test. Some seasonal and bathymetrical changes in the alimentary pattern were observed, although not statistically significant (ANOSIM global R 0.077, $P < 0.001$ for winter and summer and global R 0.073, $P < 0.001$ for depth strata). Particularly, some differences in Crustaceans' composition were noticed. Mysids' consumption increased with depth, while Decapods were preyed to a lesser extent. During winter Amphipods and Isopods grew in importance, while Mysids' consumption decreased. No alimentary differences were found between males and females (global R -0.004, $P = 0.86$).

Keywords: *Raja polystigma*; feeding ecology; Mediterranean sea

Skates as target monitoring species for demersal fish community in the Bay of Biscay

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The Marine Strategy Framework Directive (MSFD) requires EU Member States sharing marine regions to cooperate using the Regional Seas Conventions. The Comm Dec 477/2010 explicitly suggests the calculation of Large Fish Indicator (LFI) to implement the MSFD in Member States (MSs). When applying the established rationale to develop the LFI in the southern Bay of Biscay it was observed that a remarkable proportion of the biomass of the large fish community was made up, inter alia, by 2 skates (*Raja clavata* and *Raja montagui*). The abundance trend of both species followed the general trend of the indicator calculated. Certain interannual variability is observed across the time series. Lower biomass values characterise the first part of the time series due to the heavy fishing activity exerted in the area during the previous years (Modica et al., 2014; Sanchez & Olaso 2004). Contrariwise, in the second part of the period analysed the LFI increase steadily, as does the biomass of these two sensitive species. The higher values in LFI have been linked to the decrease in fishing mortality performed on the community considered, with an effect delayed 6-7 years in this demersal community (Modica et al., 2014). These results suggests that skates, as sensitive species, could be considered as indicator species for monitoring indirect effect of fishing impacts on the whole demersal fish community in the Cantabrian Sea. Other parameters, commonly used such as mean length, and sex-ratio have been calculated to check the general status of both populations across 21-y time series.

Keywords: Skate, Marine Strategy Framework Directive, monitoring species, demersal community

Egg capsules description of the most common Rajid species living in Sardinian waters (Central-Western Mediterranean)

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The Rajidae family represents the most numerous group among cartilaginous fish, having 30 genus and 245 valid species. In the Mediterranean basin, this group is represented by 4 genus and 15 species. Egg capsules are widely recognized as important in species identification and also provide relevant information concerning their reproductive biology, systematic and phylogenetic relationships. For these reasons we focused the attention on the description of egg capsules belonging to six of eight valid Rajid species present in Sardinian waters (Central-Western Mediterranean): *Dipturus oxyrinchus*, *Raja asterias*, *R. brachyura*, *R. clavata*, *R. miraletus* and *R. polystigma*. A total of 145 egg capsules were obtained from the *uteri* of gravid females to confirm their species specific identification. Then these were photographed and preserved in 80% ethanol. The general morphology, several morphometric measurements (in millimeters), fresh color, texture, presence and position of attachment tendrils, presence and shape of *velum* and keel were recorded. All egg capsules analyzed showed a rectangular shape, with the only exception of the thornback ray *R. clavata* that presented a square shape. The blonde ray *R. brachyura* and the longnosed skate *D. oxyrinchus* showed the biggest egg capsules length (CL) (mean \pm S.D., CL= 122.8 ± 6.9 mm, and CL= 103.6 ± 5.5 mm, respectively). Egg capsules of the starry ray *R. asterias* (CL= 48.9 ± 3.1 mm) and of the brown ray *R. miraletus* (CL= 46.9 ± 3.5 mm) reached the smallest sizes. Furthermore, egg capsules were generally well keeled, except those of the speckled ray *R. polystigma* and of *R. asterias* that showed narrow lateral keels. *R. miraletus* egg capsules did not have these lateral extensions.

Keywords: Rajidae, egg capsules, morphometry, Central-Western Mediterranean

Conversion factors for skates (Rajidae) in Sardinian seas (Central-Western Mediterranean Sea)

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The availability of updated biological information is essential to any successful fisheries management plan. An example could be to analyze the main size conversion factors, commonly used to estimate values from one or more known body measurements and particularly helpful when a specimen is damaged and may also serve as a tool for species identification. In the Mediterranean Sea, limited morphometric information on skates (Rajidae) has been reported, mainly in association with reproduction and growth studies. The goal of this paper is to estimate relationships between different body measurements to increase the information relative to the most common skate species in Sardinian seas (Central-Western Mediterranean): *Dipturus oxyrinchus*, *Lencoraja circularis*, *Raja asterias*, *R. brachyura*, *R. clavata*, *R. miraletus* and *R. polystigma*. For each species, total length (TL), disc width (DW), disc length (DL) and length up to the first dorsal fin (D1L), all in millimeters, and total weight (TW), in grams, were taken. An exploratory analysis of morphometric ratios (DW:TL, DL:TL, DL:DW, D1L:TL) was performed and the least-squares method was used to estimate the parameters of the linear expressions $TL=aDW+b$, $TL=aDL+b$, $TL=aD1L+b$ and $DW=aDL+b$. The relationship between TW and TL was fitted and the function was log-transformed. All species showed an allometric growth ($b>3$). Differences in the morphometric ratios were observed within species. *L. circularis* and *D. oxyrinchus* showed the most distinctive shapes, relative to the other species: the former showed a narrower disc in relation to TL, the latter had the disc longer in relation to TL. Both skates had the disc longer than wide. The results indicated that the conversion factors were useful to determinate catch size, explore life history change. Moreover, these factors could made morphological comparisons between different species from different geographical areas and should be considered a useful tool to discriminate skate species.

Keywords: Rajidae, biometry, conversion factors, Central-Western Mediterranean

Study of deep sea elasmobranchs in the El Cachucho MPA (Cantabrian Sea) using non-invasive methods

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The use of non-invasive methods is becoming more and more crucial particularly in the study of singular habitats or vulnerable species such as deep water elasmobranchs. The use of baited cameras and environmental variables measurements using landers (benthic oceanographic platforms) is an important tool for the study of Marine Protected Areas (MPAs) for instance, the El Cachucho MPA (Le Danois Bank). These methods are specially recommended for sampling in MPAs where other options that may be damaged to the sea floor or species are not acceptable. In June 2014, five moorings of a specific lander designed at IEO Santander, were deployed on the sea floor at different depths ranging from 501 to 960 m for a period of 24-26 h. A high resolution camera took pictures each 2 minutes interval. Species were attracted using bait (mainly mackerel and horse mackerel). The lander was also equipped with a CTD Seabird 37, an Aquadopp single-point current meter an Acoustic Doppler Current Profiler (ADCP) and a 12 thermistors chain to record hydrodynamic and hydrographic fields (currents, temperature and salinity) both near-bottom and the vertical structure above the seafloor. In total 8 elasmobranch species and 2 skates were identified. Depth zonation was evident and in general terms the leafscale gulper shark (*Centrophorus squamosus*) and Portuguese dogfish (*Centroscymnus coelolepis*) were the most recorded species at greater depths. However also blackmouth dogfish (*Galeus melastomus*), birdbeak dogfish (*Deania calcea*) and velvet belly (*Etmopterus spinax*) were abundant species and turn out to be some of the species with shorter first arrival time. This time response and its relation to the tide period and currents speed and direction is explored.

Keywords: Bait camera; deep-water elasmobranchs; MPA; Cantabrian Sea

Catch and released survival estimation of deep water sharks using bottom longline in the Cantabrian Sea (NE Atlantic)

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Deep-water sharks are considered highly vulnerable species due to their life characteristics and very low recovery capacity against overfishing. Limited information exists on some aspects of their biology and in particular about the survival capacity of these species to fishing gears, which is supposed to be negligible.

Recently a tagging project (DEEPCON) has been conducted on deep-water sharks in the North of Spain (Cantabrian Sea, NE Atlantic) aim at studying their behaviour and migration patterns. In addition survival estimates were obtained to assess the usefulness of this technique for future studies. During 2012 and 2013 several longlines were set in the El Cachucho MPA (Le Danois Bank). Deep water sharks were caught using bottom longline at depths ranging from 900 to 1200 m. The mean number of hooks used was approximately 950 in each set and soaking time was restricted to 3 hours maximum. Sharks were carefully removed from the hooks by the crew. Survivorship was qualitatively evaluated according to the fish health condition and response after the capture of the fish and posterior release. Four criteria was chosen: 1) Good 2) Moderate 3) Poor and 4) Dead (or nearly dead). In the 4 case sharks were obviously not released and kept on board. Several deep water sharks were caught however 46% of the catch corresponded to the birdbeak (*Deania calcea*), the 27% were leafscale gulper sharks (*Centrophorus squamosus*) and the 15% corresponded to the Portuguese dogfish (*Centroscyllium coelolepis*). The species with highest survival rate was *C. squamosus*; nearly 40% of the catch was in good condition. In the case of *C. coelolepis* only the 16% were good and the 65% were moderate. *D. calcea* estimates were approximate 24% good and 59% moderate.

Keywords: Survival, deep-water sharks, longline, Cantabrian Sea

Maximising smartphone technology in marine recording projects

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Growing acknowledgement of the value and role of citizen science is allowing members of the public to play a far greater and more effective role in elasmobranch research, and potentially feed into conservation and management policy. Recognising this, the Shark Trust has developed smartphone apps aimed at increasing the flow and quality of records for two key Shark Trust citizen science projects: the Great Eggcase Hunt (GEH) and the Angler Recording Project (ARP). Each app was developed with a different objective in mind. The GEH receives a high volume of records (over 54,000 to date) however unverified records have produced a number of spurious entries in the dataset. As such, it is important to increase the number of records submitted which include photographs of the eggcase, allowing the record to be verified. The smartphone app should increase both the flow and the quality of records submitted to the project, thereby improving knowledge of egg-laying species and those marine areas important to various stages in their life history. In contrast, the ARP receives fewer records (approx. 8000 to date), due primarily to a general reticence on the part of sea-anglers to engage in recording projects. The smartphone app will make catch recording and reporting as simple and straight-forward as possible, with the objective of increasing the volume, accuracy, and geographic and demographic spread, of records submitted. Ultimately, as the dataset grows, trends in the abundance and distribution of species throughout UK waters – including many listed as Critically Endangered – may be visible, which can contribute to more effective fisheries management and conservation.

Keywords: Citizen-science, Eggcase, Angling

Note on remarkable accidental catches of juvenile shortfin mako sharks in Italy

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The shortfin mako shark (*Isurus paucus*) is listed as Critically Endangered in the Mediterranean. The species was considered common throughout the area but since 2000 there have been few records in the area. Here we report 9 juvenile makos caught between 2012 and 2014, including the remarkable catch of five juvenile mako sharks within one month in different locations of North-Eastern Sardinian waters and four from other areas of the Central Mediterranean sea.

Keywords: *Isurus paucus*, Mediterranean

The Stellaris project

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The Stellaris Project is monitoring the largest known breeding area of the nursehound (*Scyliorhinus stellaris*) in the Mediterranean sea, a species whose basic biology is very poorly known. It is classified as DD (Data Deficient) in the Italian Red List of vertebrate species and as Near Threatened (outlook: Vulnerable) in the IUCN regional Red List of endangered species. This project is monitoring embryos onsite in the rocky Santa Croce Bank in the Gulf of Naples (Italy), between -20 and -45m of depth, with regular monthly diving check-ups. Here we present preliminary observations on seasonal deposition, development times, egg mortality and possible predators, human interaction and photo-identification of large living animals. This project is also proving to be a formidable educational tool. The large diving community in the area was involved in a special event, a BioBlitz, where divers “adopted” their own shark egg and are now monitoring the development of “their” baby shark with regular monthly check-ups. Continuous updates, photos and videos are being posted online on the project’s website and social media profile, and has been featured on national media, thus reaching a much wider audience. This has proven to be a powerful awareness and educational tool to sharpen divers’ interest in sharks, increase their general environmental awareness and induce a sense of responsibility towards the marine environment. This project, run by MedSharks since 2012, is a spin-off of the Mermaid’s Purse project, launched with a special grant from the Save Our Seas Foundation and diving certification agencies.

Keywords: *Scyliorhinus stellaris*

Undulate ray population structure along French coasts inferred from tagging data and genetic analysis: preliminary results

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In the Celtic seas and the Biscay/Iberian ecoregions, most of skate species are little known. It's particularly the case for species that seems to have patchy coastal distributions which are not well sampled by the scientific fishery-independent surveys. Information on the mixing between skates of different areas and the stocks structures are needed for management purposes. In order to help to clarify the undulate ray (*Raja undulata*) population structure, we used conventional tagging and molecular markers analysis. 4438 skates have been tagged along the French Atlantic coasts between 2012 and 2014 and 1164 tissue samples have been collected from 7 locations. We present preliminary results from 405 tagged skates recaptured and from the analysis of the polymorphism at 5 nuclear microsatellite loci for 117 individuals from 4 locations.

Keywords: *Raja undulata*, population structure, tagging, genetic

Detecting genetic differentiation and connectivity among *Raja clavata* populations within the Mediterranean Sea

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The thornback ray *Raja clavata* is widely distributed in Mediterranean, Black Sea and the Atlantic coasts of Europe and Africa. The species has high commercial value in European waters; it is locally commercially important in Mediterranean where it is part of the by-catch associated with demersal fisheries. Because the recent decreases in abundance and distribution, the species was assessed in the IUCN Red List as Near Threatened. This study deals with the genetic diversity and the connectivity between Mediterranean and Atlantic samples in order to acquire useful information for management and conservation purposes. A total of 235 individuals were collected from eight sampling areas of Western, Central and Eastern Mediterranean and from Northeastern Atlantic and they were analyzed at nine polymorphic microsatellite loci. Low levels of genetic diversity were found ($uHe=0.477$), with the highest values recorded in the North Sea (0.525) while the lowest in the Tyrrhenian Sea (0.432). A subtle but significant overall genetic differentiation was detected among all the investigated populations ($F_{st}=0.039$, $P<0.05$). Nevertheless, Mantel test allowed the rejection of the hypothesis of isolation by distance. No genetic differences were found grouping samples according to the two major geographical areas (Mediterranean vs Atlantic, AMOVA: $F_{CT}=0.007$, NS). However, a significant differentiation emerged within the Mediterranean among Western /Central/Eastern samples (AMOVA: $F_{CT}= 0.047$, $P<0.05$). In particular, Cyprus was found to be highly divergent from all the other samples, showing the highest pairwise F_{st} and D_{est} values. According to the Bottleneck results, all the investigated populations showed a substantial demographic stability. These data provide a significant contribution for the planning of an effective management model, ensuring sustainability of resource.

Keywords: *Raja clavata*, genetics, connectivity, Mediterranean Sea

Poster Presentations

An advice about the process to come to a supported recovery plan for sharks and rays in the Dutch EEZ, regarding the MSFD

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The aim of the research is to give an advice on the process to come to a supported recovery plan for sharks and rays in the Dutch EEZ, regarding the MSFD. The focus of our research is on the experiences of the consultative group and their expected role in the future process of the recovery plan for sharks and rays. There is a decline in the shark and ray population in the North Sea. The NEV has been given the assignment to formulate the supported recovery plan in accordance with stakeholders. This has led to the formation of a consultative group. The NEV wants to know how the process until now has been experienced by the consultative group, and what their opinion is on the follow up of the process. By means of a questionnaire the experiences until now will be evaluated. As for the follow up of the process a discussion forum will be used to gather the opinion of the consultative group. All results will be analysed, after that an advice will be given to the NEV.

Keywords: evaluation, project process, stakeholders

Elasmobranch Diversity in German Waters

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Preliminary results of elasmobranchs recorded in German waters of the North and Baltic Seas are presented. Catch records were obtained by analysis of historical to current literature as well as original data gathered from relevant German museum collections. In addition to German institutions, data from northern European museums have also been integrated to the study and maps of catch locations of selected species are presented. Six species of sharks have been recorded so far in German waters, all of these in the North and two in the Baltic Sea. Ten skates and rays belong to the recorded elasmobranch species, of which nine have been documented in the North and five in the Baltic Sea. Some formerly common species have shown steep declines in their abundance and are today threatened with extinction, while others are naturally rare or have only been recorded once.

Keywords: Elasmobranchs, diversity, Germany

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