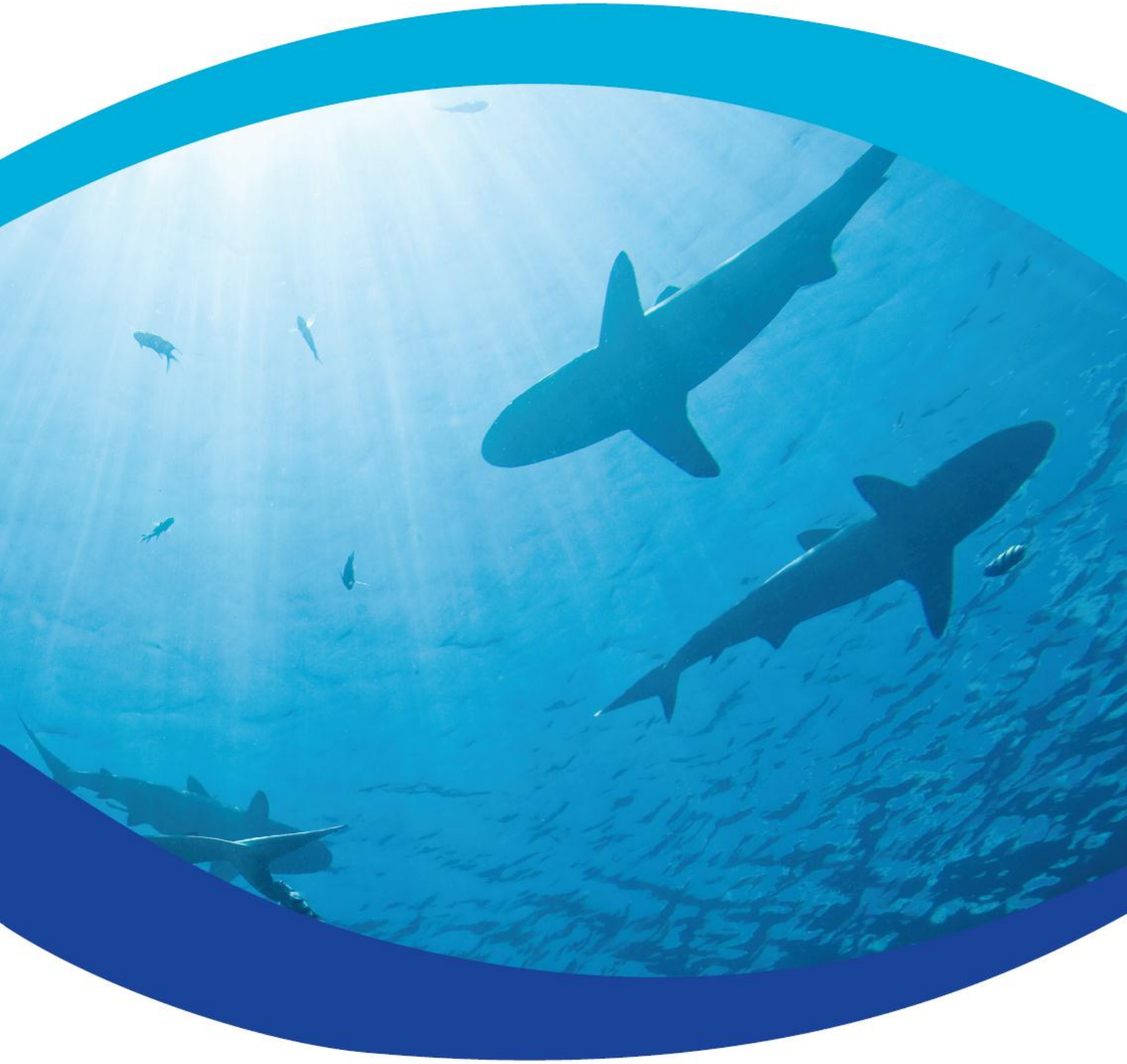
Irish Elasmobranch Group



14th European Elasmobranch Association Conference

Hosted by the Irish Elasmobranch Group

10th – 12th November 2010
Galway, Ireland

CONTENTS

WELCOME

The Irish Elasmobranch Group (IEG) was established in August 1997, by scientists involved in shark, skate and ray research in Ireland, with the primary goal of bringing together all those interested in these fish. The IEG is a non-profit organisation with the aim of promoting research, education and conservation of sharks, skates and rays in Irish waters. Membership is open to anyone with an interest in these amazing animals. For further information, please visit http://www.irishelasmobranchgroup.org/

The IEG is delighted to be hosting the European Elasmobranch Association 14th Annual Scientific Conference and would like to welcome all delegates to Ireland. This promises to be an exciting conference, both scientifically and socially, and the IEG looks forward to welcoming you to Galway, a unique and vibrant city and the ideal venue for the EEA conference 2010. Located on the west coast of Ireland it is a popular tourist destination at all times of the year. We hope you find time to explore Galway and the surrounding areas and we have provided some information in your welcome packs to help you plan your visit. If there is anything you need help with just ask one of the IEG committee members.

IEG Committee

Dr Aaron Henderson, Dr Edward Farrell, Emmet Jackson, Sean Fitzpatrick and Dr Edward Fahy

Acknowledgments

The IEG are very appreciative for the support received from the EEA, Galway Atlantaquaria, Failte Ireland and Galway Crystal. A big thank you must also be extended to Dr Sharon Rothwell for all her help given to the organisation of this event.

Marine Institute

The Marine Institute was created under the Marine Institute Act in 1991 to "undertake, to co-ordinate, to promote and to assist" in the development of marine research and development in Ireland. Since then, it has grown into an internationally respected science body with over 200 staff, two purpose-built vessels – RV Celtic Explorer and RV Celtic Voyager, a research facility near Newport, Co. Mayo and now a custom-built headquarters and laboratory facility at Rinville, Oranmore on the shores of Galway Bay. The Marine Institute is also the coordinating body for Sea Change – A Marine Knowledge, Research & Innovation Strategy for Ireland 2007-2013.

To learn more about the Marine Institute (see www.marine.ie)

The IEG would like to extend a warm thank you to the Marine Institute for permitting the 2010 EEA Conference to be held in their fantastic headquarters.

Bord Iascaigh Mhara

Bord Iascaigh Mhara (BIM), the Irish Sea Fisheries Board, is the Irish State agency with responsibility for developing the Irish Sea Fishing and Aquaculture industries. BIM's mission is to provide commercially relevant and innovative services to the Irish seafood industry that drive growth opportunities, add value, enhance competitiveness and create jobs in a sustainable, natural resource based industry for the benefit of coastal communities.

The agency provides a range of services including advisory, financial, technical, business development and training supports to all sectors of the Irish seafood industry. For further information, please visit www.bim.ie

The IEG would like to extend a warm thank you to BIM for supporting the EEA Conference.

TIMETABLE

Thursday 11th November

09.10 - 9.30 Welcome and opening address

KEYNOTE

09.30 - 10.00 Nicholas Dulvy - Threat and extinction risk in sharks, rays and chimaeras

Session 1 – The Porbeagle

10.00 - 10.20 **Armelle Jung** - Biological data on the porbeagle shark (*Lamna nasus*) in North-east Atlantic.

10.20 - 10.40 **Nicolas Pade** - Population Structure of the Porbeagle sharks, *Lamna nasus,* in the North Atlantic Ocean.

10.40 - 11.00 **Ryan Saunders** - Winter migration and diving behaviour of porbeagle shark, *Lamna nasus*, in the Northeast Atlantic.

11.00 - 11.30 Coffee + Cake Break

Session 2 – Molecular Studies

11.30 - 11.50 **Simon Berrow** - Slime: a new sampling technique for obtaining samples for genetic and other studies.

11.50 - 12.10 **John Mulley** - Cartilaginous fish as models for Evolutionary Developmental Genomics.

12.10 - 12.30 **Andrew Griffiths** - Utilising Genetic Markers to Explore Taxonomic Questions in Understudied Species of European Elasmobranch.

12.30 - 12.50 **Sean Fitzpatrick** - Population genetics in the open ocean – a global assessment of genetic structuring in the blue shark (*Prionace glauca*).

13.00 - 14.00 Lunch Break

14.00 - 14.20 **Ana Veríssimo** - Genetic population structure of the Portuguese dogfish *Centroscymus coelolepis* and the leafscale gulper shark *Centrophorus squamosus* within the Eastern Atlantic.

14.20 - 14.40 **Stefano Mariani** - Population Genetic Structure of the long-nosed velvet dogfish, *Centroselachus crepidater*, across the Deep North Atlantic Seascape.

14.40 - 15.00 **Fausto Tinti** - Cryptic speciation and evolutionary history of the *Raja miraletus* species complex.

15.00 - 15.20 **Leslie Noble** - Antipodean white sharks on a Mediterranean walkabout?: historical dispersal of a top marine predator accounts for an endangered anomalous population.

15.20 - 16.00 Coffee Break

Session 3 – Fisheries

16.00 - 16.20 **Bernard Seret** - Recent investigations on sharks and rays of the French fisheries.

16.20 - 16.40 **Maurice Clarke -** Trends in abundance and distribution of deepwater sharks to the west of the Ireland and Scotland from trawl survey data

16.40 - 17.00 **Gary Hannon** - Irish Elasmobranchs in Commercial Fisheries.

17.00 - 17.10 Wrap up and close of Day 1

Friday 12th November

Session 4 – Management & Conservation

09.00 - 09.20 **Edward Farrell** - Smooth-hounds in the Northeast Atlantic: a conservation concern?

09.20 - 09.40 **Francesco Ferretti** - Long-term change of the Adriatic demersal elasmobranch community in response to prolonged human disturbance.

09.40 - 10.00 **Anesh Govender** - Estimates of fishing, natural and total mortality from female to embryo ratios: A model illustrated for the milk shark *Rhizoprionodon acutus* from Oman.

10.00 - 10.20 **Sonja Fordham** - Progress and Challenges in European Shark Conservation.

10.20 - 10.40 **Rima Jabado** - The status of sharks in the United Arab Emirates.

10:40 – 11:00 Coffee + Cake Break

Session 5 – Biology

11.10 - 11.30 **Johannes Waligora** - Skin characteristics of sharks in relation to calcified dermal structures.

11.30 – 11:50 **Massimiliano Bottaro** - First description of the ampullae of Lorenzini in the longnose velvet dogfish *Centroselachus crepidater* (Bocage and Capello, 1864) from the NE Atlantic: morphology, histochemistry and ecological hypothesis.

11:50 - 12.10 **Al Reeve** - The effects of short-term blood storage on shark haematological parameters, using *Iago omanensis* as a model species.

12:30 - 13:30 Lunch Break

13.30 - 13.50 **David Jacoby -** The sexual interactions and social networks of a benthic shark.

13.50 - 14.10 **Cheryl Nicholson** - Ex situ conservation and behaviour of captive sand tiger sharks (*Carcharias taurus*).

14.10 - 14.30 **Niriniony Rabehagasoa** - Use of isotopic analysis of vertebrae and muscle in reconstructing diet and trophic position of the blue shark (*Prionace glauca*) and silky shark (*Carcharhinus falciformis*) in the Indian Ocean.

14.30 - 15.30 Poster Session with coffee break

Session 6 - Tagging Studies

15.30 - 15.50 **Simon Berrow** - Tagging the elusive basking shark in Irish waters.

15.50 - 16.10 **Eric Stéphan** - Satellite tracking of basking sharks in the NE Atlantic.

16.10 - 16.30 **Nuno Queiroz** - Space-use and Lévy flight search patterns of blue sharks *Prionace glauca* in relation to environmental gradients in the North-eastern Atlantic.

16.30 - 16.50 **Victoria Wearmouth** - Movement and behaviour patterns of the critically endangered common skate *Dipturus batis* revealed by electronic tagging.

16.50 - 17.00 EEA President closing

KEYNOTE

THREAT AND EXTINCTION RISK IN SHARKS, RAYS AND CHIMAERAS

Nicholas Dulvy

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A quarter of a century ago Sonny Gruber and Charles Manire warned the conservation world that sharks may be headed toward extinction. Since then the scientific community has grown and risen to the challenge of evaluating the threats to and status of not just sharks but also of skates, rays and chimaeras. Here I review: (1) the links between life histories, demography and extinction risk, (2) the evidence that fishing has caused declines of skates, (3) the evidence for local and regional extinctions of sharks and rays, (4) the global IUCN Red List status of all chondrichthyans. Finally, I end with a summary of the future challenges and opportunities in the population and community ecology and conservation of chondrichthyans, including EDGE Sharks - a new approach to prioritise species for conservation.

Keywords: demography, population dynamics, fisheries, conservation

SESSION 1 – THE PORBEAGLE

BIOLOGICAL DATA ON THE PORBEAGLE SHARK (LAMNA NASUS) IN NORTH-EAST ATLANTIC

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In 2008 and 2009, the French National Committee of Marine fisheries and Sea Farming (CNPMEM) and the Association pour l'Etude et la Conservation des Sélaciens (APECS) worked together in the frame of a collaborative program on French porbeagle (*Lamna nasus)* longline fishery called EPPARTIY. Since the early 60's a seasonal target longline fishery took place during spring and summer in the North-East Atlantic waters. The objectives of the study were to collect accurate data on the fishing activity and to enhance the knowledge on the species. For that purpose, thanks observations on board fishing vessels and samples on landing site, biological data and samples were collected from a total of 1770 sharks. Information on sex-ratio, sexual maturity, length frequency, length-weight relationship, and age estimation are presented as well as results on trophic ecology.

Segregation between males and females appears in the sex ratio depending on the season and the fishing area. Majority of mature sharks were captured in the South Ireland area while the length frequencies in the St George Channel show a high proportion of juveniles. Results show a significant difference in growth between male and female and between the North-East and North-West Atlantic populations. Isotopic analysis ($\delta^{13}C$ and $\delta^{15}N$) of muscles samples and stomachs contents indicate a difference in the feeding behaviour between porbeagle in the St George Channel and the South Ireland or Bay of Biscay. At least, the study confirms the opportunist diet of the porbeagle shark.

Keywords : porbeagle shark, North-East Atlantic, biological data, trophic ecology

POPULATION STRUCTURE OF THE PORBEAGLE SHARKS, LAMNA NASUS, IN THE NORTH ATLANTIC OCEAN

N. Pade, C. Gubili, C. Testerman, D.W. Sims, C.S. Jones and L.R. Noble

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The porbeagle, *Lamna nasus*, is a large regionally endothermic elasmobranch of the family Lamnidae. The distribution of this pelagic species in the North Atlantic Ocean appears to be uniform, yet capture-mark-recapture studies suggest the presence of disjunct populations in the east and west. To assess the genetic structure of *L. nasus*, we assayed 220 individuals using five polymorphic microsatellite loci and sequenced the mitochondrial DNA control region of 158 samples from six areas of the North Atlantic. A further 14 South Atlantic porbeagle sharks were sequenced for comparison and phylogeogenetic analysis. An 818 base pair fragment of the mitochondrial DNA control region revealed population connectivity and with high genetic diversity observed across the North Atlantic. However, this high diversity was characterised by closely related haplotypes. However, no significant differences were observed between the North-East and North-West Atlantic and phylogenetic analyses detected no structuring or grouping of haplotypes specific to one geographical region. Similarly, microsatellite loci screened showed high genetic diversity, yet no pan-Atlantic divergence, suggesting panmixia in this species in the North Atlantic and no evidence of sex biased dispersal. However, significant haplotype frequency differences were detected between the North and South Atlantic.

Phylogeographic analysis revealed significant population expansion in the North Atlantic during the mid-Pleistocene (~450 000 years ago). Divergence time between the northern and southern hemispheres appears to be much more recent (11 000 ya), suggesting the populations last shared a common ancestor at the end of the last glaciations. However, the detection of one North Atlantic mtDNA haplotype in the South Atlantic suggests that current warm equatorial waters do not necessarily represent and impassable barrier to dispersal.

Keywords: Elasmobranch, cross-amplification, population genetics, temperate shark

WINTER MIGRATION AND DIVING BEHAVIOUR OF PORBEAGLE SHARK, *LAMNA NASUS*, IN THE NORTH-EAST ATLANTIC

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Porbeagle shark is one of the top marine predators in the north Atlantic. However, little is known about its biology, abundance or spatial ecology in this region. Here we present results on the migration and behaviour of three porbeagles tagged with archival pop-up tags off the northwest coast of Ireland that reveal important information on winter diving and migratory behaviour. One shark migrated over 2400 km to the northwest of Morocco, residing around the Bay of Biscay for approximately 30 days. The other two sharks remained more localised in off-shelf regions around the Celtic Sea/Bay of Biscay and off western Ireland. The sharks occupied a broad vertical depth range (0- 700 m) and temperature range (c. 9-17 ^{o}C), with notable variations in diving behaviour between individuals. There were distinct day-night differences in depth distribution with each shark positioned predominantly higher in the water column during the night-time than during the day. Night-time depth distribution also appeared to be driven by the lunar cycle during broad-scale migration through oceanic waters. A 29.7 day cycle (a lunar 'month') in night-time depth distribution was observed for one shark, and moon phase and night-time depth distribution was negatively correlated. Our results show that porbeagle sharks occupy and traverse regions of high fishing activity where they are potentially vulnerable to population depletion. Such large scale movement outside the ICES area underlines the need for international coordination in assessment and management.

Keywords: Diving behaviour, lunar cycle, migration, porbeagle shark, satellite tag

SESSION 2 – MOLECULAR STUDIES

SLIME: A NEW SAMPLING TECHNIQUE FOR OBTAINING SAMPLES FOR GENETIC AND OTHER STUDIES

Simon Berrow[1], Emmett Johnston[1], Chrysa Gubili, Catherine Jones,

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Genetic diversity of basking sharks is remarkably low with very little differentiation worldwide. However, the study of basking shark population genetics is constrained largely by lack of samples, with only 84 individuals available worldwide in the two studies to-date. During a basking shark tagging study in Ireland in 2009, on occasion a shark would strike the boat with its tail on tagging. It was noticed on one occasion that black slime (mucus) was left behind on the bow of the tagging boat. A sample of this slime was collected, DNA extracted from it and successfully amplified with basking shark specific primers. Further field trials using a scraper demonstrated that slime could be collected easily from sharks, provoking minimal reaction. This simple, rapid and effectively non-invasive sampling approach presents considerable potential for exploring the population genetics of basking sharks in more detail than was hitherto possible. During 2010 we intend to supply a large number of samples from known gender sharks to improve resolution of basking shark population structure and effective population size in the NE Atlantic, determine relatedness of sharks sighted together, and assist in identifying markers suitable for gender determination. There is also potential to obtain samples for additional studies such as stable isotopes or physiological (hormone) studies of basking sharks. The utility of mucus samples in studies of other elasmobranchs has not been explored, but clearly there may be a significant potential in other species with surface slime.

Keywords: Basking Shark, Tagging, Movements, Site Fidelity, Abundance

CARTILAGINOUS FISH AS MODELS FOR EVOLUTIONARY DEVELOPMENTAL GENOMICS

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Cartilaginous fish have been somewhat left behind in the genome era – the lack of a tractable laboratory model system has limited their use for many types of research and the absence of a vocal community has caused them to be overlooked by genome sequencing centres. However, the introduction of new "next-generation" DNA sequencing platforms look set to revolutionise the field of genomics and will lead to a massive increase in available whole genome sequences. Preliminary studies using these technologies suggest that cartilaginous fish could be extremely useful for reconstructing the ancestral vertebrate genome and particularly the role of gene and genome duplication in shaping the evolution of vertebrate development. The utility of these new technologies for generating transcriptomes and extremely large numbers of molecular markers for population genetics will also be discussed.

Keywords: Genomics, Genetics, Evolution, DNA sequencing

UTILISING GENETIC MARKERS TO EXPLORE TAXONOMIC QUESTIONS IN UNDERSTUDIED SPECIES OF EUROPEAN ELASMOBRANCH.

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The recent discovery (or re-discovery) that the common skate (*Dipturus batis*) actually comprises two species has highlighted the dearth of knowledge that concerns many European elasmobranchs, but the skates and rays in particular. These groups pose a difficult challenge to ecologists and taxonomists, due to their high levels of morphological conservatism they typically demonstrate. The application of molecular markers to questions concerning their taxonomy and population biology may therefore be especially illuminating.

As part of our on-going work focusing on the population structure of skates around the United Kingdom, we have had the opportunity to characterise elasmobranch samples originating from both the north east Atlantic and Mediterranean. Applying mitochondrial DNA control region sequencing to these broad collections of specimens has allowed us to begin assessing long-standing hypotheses concerning the taxonomic distinctiveness of stocks of elasmobranchs inhabiting the Mediterranean Sea and Atlantic Ocean. So far, the results have been surprising. Samples of longnose skate sequenced from Northern Scotland/Norway and Mallorca shared no haplotypes in common, perhaps supporting historic suggestions based on differences in adult and eggs size that Mediterranean skate form a distinct stock. Conversely, the analysis of dogfish (*Scyliorhinus canicula*) samples across a similar geographic scale, where they demonstrate well documented differences in size between Mediterranean and Atlantic populations, failed to find strong genetic support for defining these stocks as distinct species, or sub-species. Further analysis of other species of skates found differing levels of genetic heterogeneity at this broad scale that may reflect the differing molecular markers employed or the distribution of samples, but the results highlight the difficulties in generalising patterns of population structure between species.

POPULATION GENETICS IN THE OPEN OCEAN – A GLOBAL ASSESSMENT OF GENETIC STRUCTURING IN THE BLUE SHARK (*Prionace glauca*)

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The blue shark, *Prionace glauca*, is a large pelagic elasmobranch that is heavily exploited in directed and incidental fisheries worldwide. Despite its historical abundance and high productivity, some studies suggest severe declines in numbers over a relatively short period of time. Sound conservation and management of any exploited fishery requires a fundamental understanding of the population substructuring of the species involved, information that is currently lacking for the blue shark. In response to this pressing conservation need, we performed a comprehensive assessment of the global population genetic structure of this far ranging species. Screening almost 1,000 individuals with 16 microsatellite markers, we conduct the largest study of this kind yet undertaken for any species of shark and report a subtle but significant level of genetic structuring of the blue shark on a global scale. This finding suggests that although adult blue sharks are among the most vagile animals on the planet, geneflow is generally restricted to within ocean basins.

Keywords: Blue shark, microsatellite, population structure

GENETIC POPULATION STRUCTURE OF THE PORTUGUESE DOGFISH *CENTROSCYMUS COELOLEPIS* AND THE LEAFSCALE GULPER SHARK *CENTROPHORUS SQUAMOSUS* WITHIN THE EASTERN ATLANTIC

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The Portuguese dogfish *Centrosycmnus coelolepis* and the leafscale gulper *Centrophorus squamosus* are two widely distributed species of deepwater sharks with great importance to commercial fisheries in the eastern North Atlantic. Both species are considered depleted off western Europe and a zero catch has been advised by the ICES since 2008. Despite the current state of these resources, little is known regarding the population structure of either species. In our study, the patterns of population structure of *C. coelolepis* and *C. squamosus* were evaluated using nuclear microsatellite markers and nucleotide sequences of mitochondrial DNA gene regions. Sample collections were obtained from continental slope waters off Ireland, mainland Portugal, Madeira, Mauritania and South Africa, as well as from the mid-Atlantic ridge off the Azores. High levels of genetic diversity were found at the nuclear microsatellite loci (mean allelic richness and mean genetic diversity: 7.9-8.5 and 0.76-0.78, respectively, in *C. coelolepis*; 11.0-13.0 and 0.73-0.77, respectively, in *C. squamosus*) although low diversity was recovered from mtDNA regions (haplotype number and diversity: 16 and 0.64, respectively, in *C. coelolepis*; 23 and 0.56, respectively, in *C. squamosus*). The intraspecific levels of genetic diversity were remarkably similar among sample collections and no significant genetic differences were detected by pairwise tests of genetic differentiation, regardless of marker type. The null hypothesis of panmixia within the sampled area could not be rejected for either species, suggesting that enough gene flow is occurring among locations to avoid the accumulation of pronounced genetic differences.

Keywords: deepwater squaloids; population structure; Atlantic.

POPULATION GENETIC STRUCTURE OF THE LONG-NOSED VELVET DOGFISH, *CENTROSELACHUS CREPIDATER*, ACROSS THE DEEP NORTH ATLANTIC SEASCAPE

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Investigating population connectivity in the deep sea is one of the priority tasks in modern marine biology, especially in long-lived, poorly understood species that are targeted by commercial exploitation. Deep sea sharks are among the most vulnerable, and yet least known, vertebrate inhabitants of the ocean's depths, and significant efforts are needed to gauge the nature of their biodiversity, life-history and habitat use.

We obtained samples of the long-nosed velvet dogfish, Centroselachus crepidater, between the northeast and the central Atlantic Ocean, and screened them using a suite of seven polymorphic microsatellite marker loci and the mitochondrial DNA control region. Data were analysed in a hierarchical fashion, testing: *i*) for genetic structuring between northern (Rockall/Rosemary's bank) and southern (Azores/Great Meteor bank) areas, and *ii*) for consistency between nuclear and mitochondrial markers within areas, in order to examine sex-biased dispersal and patterns of long-term isolation and secondary contact.

Results show contrasting signals between types of genetic markers and help delineating complex evolutionary processes, acting at different time scales, to shape the current patterns of genetic variation in this species.

Keywords: Deep Sea, Gene flow, North Atlantic

CRYPTIC SPECIATION AND EVOLUTIONARY HISTORY OF THE *RAJA MIRALETUS* SPECIES COMPLEX

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The brown skate *Raja miraletus* is a relatively small skate distributed from Mediterranean and North Eastern Atlantic to South Western Indian. The brown skate exhibits high levels of ecological and morphological stasis, although a subtle but significant variation of meristic characters over its range led McEachran, Seret and Miyake. (*Copeia* 1989: 629-641) to recognize at least three distant parapatric populations in the Mediterranean, West and South Africa. Upwelling areas at Cape Blanco (21° N) and at Cape Frio (18° S) may act as barriers to divide these populations.

We retrieved phylogeographic patterns and measured genetic variation among these populations by analyzing geographic samples from Mediterranean, Senegal, Angola and South Africa at two mtDNA loci (cytochrome oxidase I and large RNA ribosomal subunit) and at the genomic amplified fragment length DNA polymorphic loci.

Phylogeographical patterns are extraordinarily consistent with morphological patterns in identifying three main clades and two major genetic breaks at Cape Blanco and Cape Frio, as observed by McEachran *et al*. (1989). However, new relevant issues for taxonomy, zoogeography, evolution and conservation of Raja miraletus are:

1) genetic distances among the three clades are at the species levels rather than at the population levels;

2) these three taxa are likely reproductively isolated units;

3) the South African clade appears to be more ancient than the Central West African and Mediterranean;

4) subtle but significant genetic polymorphisms within the Mediterranean indicated population structuring.

As a result, Raja miraletus is likely a complex of at least three cryptic species, whose populations showed identical or slightly different rough external morphology. The evidences of cryptic speciation in skates and elasmobranches are becoming more and more numerous, suggesting that the evolution of non-visual mating signals could be a triggering factor for reproductive isolation and speciation processes.

Keywords: cryptic speciation, evolutionary animations; phylogeography; population genetics; reproductive isolation

SPECIATION OF THE THORNBACK RAY, *RAJA CLAVATA* (LINNAEUS, 1758), IN CENTRAL MEDITERRANEAN

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The Mediterranean ichthyofauna includes 17 Rajidae family representatives (Fischer *et al.,* 1987); 15 occur in the Algerian basin (Hemida *et al*., 2007). Diversity of coloration patterns was previously reported in rajids (Dieuzeide *et al*., 1953; Aloncle, 1966; Capapé *et al.,* 1980; McEachran and Matheson, 1985; Mnasri *et al.*, 2009). Observations made on specimens caught off Algerian coasts and Sicilia showed a great variability on morphology and polychromatism of some ray species (*Raja asterias*, *R. brachyura*, *R. polystigma*, *R. montagui*) especially on thornback ray, *Raja clavata (Lin*naeus, 1758). These specimens are described and analysed in this work and compared by phenetics and cladistic methods in order to improve knowledge of systematics of the species. Skates data were collected during investigations conducted from 1998 to 2002. The specimens were measured to the nearest millimeter, after identification based on characters given by the referenced guides: disk shape, thorns, dark stripes on tail. Twelve morphometric measurements were carried out in 82 specimens, according to the gender and the site, and standardized by the program Sizestd (Senar *et al.*, 1994): total length, disk length, disk-width). Data were mainly analysed using techniques concerning with PCA (principal components analysis) and DA (discriminant analysis) performed by Stastistica software (Statsoft, 1997). The species was divided in 2 groups after multivariate analysis, according to the presence and absence of the thorns. The specimens, in each category showed 4 different patterns of dorsal surface. In 2003, we assessed the mitochondrial diversity through genotyping 20 thornback rays caught off the Algerian coasts. The mitochondrial gene 16 S and CR (Control Region) were amplified and sequenced. Cladograms (built by neighbour joining and maximum parcimony methods) do not confirm the phenetics conclusion but reveal haplotypes with low genetic diversity. However the cladistic study support earlier multidimensionnal results of rajids comparison (Hemida *et al*., 2007).

Keywords: Morphometrics, 16 S gene, d-loop, cladistic, Algerian basin.

ANTIPODEAN WHITE SHARKS ON A MEDITERRANEAN WALKABOUT?: HISTORICAL DISPERSAL OF A TOP MARINE PREDATOR ACCOUNTS FOR AN ENDANGERED ANOMALOUS POPULATION.

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The provenance of white sharks (*Carcharodon carcharias*) in the Mediterranean is both a conundrum and an important conservation issue. Considering this species' propensity for natal philopatry, any evidence that the Mediterranean stock has little or no contemporary immigration from the Atlantic would suggest it is extraordinarily vulnerable. To address this issue we sequenced the mitochondrial control region of rare Mediterranean white sharks. Unexpectedly the juvenile sequences were identical although collected at different locations and times, showing little genetic differentiation from Indo-Pacific lineages, but strong separation from geographically closer Atlantic/western Indian Ocean haplotypes. Historical long distance dispersal, likely a consequence of navigational error during past climatic oscillations, and potential founder effects are invoked to explain the anomalous relationships of this isolated 'sink' population, and highlight the present vulnerability of its nursery grounds.

Keywords: Mediterranean; white shark; mitochondrial DNA; conservation; migration

SESSION 3 – FISHERIES

RECENT INVESTIGATIONS ON SHARKS AND RAYS OF THE FRENCH FISHERIES

Bernard Seret & Antonin Blaison

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In the frame of the action plan to support the French fisheries (Plan Barnier) launched in 2008, the ministry of fisheries entrusted the research institute IRD to carry out a series of studies on the sharks and rays of the French fisheries. These studies included: 1) the production of a field guide to help the fisherman to better identify these fishes, 2) the estimate of the conversion factors of shark and skate commercial species, 3) the estimate of the main reproduction parameters of these fishes, and 4) an analysis of the fishery data collection system. Main results of these studies are presented.

Keywords: field guide, conversion factors, reproductive biology, fishery data, France

TRENDS IN ABUNDANCE AND DISTRIBUTION OF DEEPWATER SHARKS TO THE WEST OF THE IRELAND AND SCOTLAND FROM TRAWL SURVEY DATA

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Landings of deepwater sharks from the northeast Atlantic were first recorded in the late 1980s. The rapid expansion of the fishery during the 1990s has been followed by an equally rapid decline in landings of the two most commercially important species (Portuguese dogfish and leafscale gulper shark). Recent ICES advice for these species has been for a zero catch based on an analysis of commercial catch-rate data which indicates that both species are severely depleted. However, the assessments for these, and other deepwater shark species, are hampered by a lack of species specific landings data. Fishery independent surveys provide species-specific data which can be used to monitor trends in stock abundance. Two trawl surveys are currently carried out in the deepwater to the west of the British Isles by Marine Scotland Marine Laboratory (1998 onwards) and the Marine Institute, Ireland (1993-2000; 2006 onwards). In this paper we present spatio-temporal trends in survey abundance and size composition for a range of deepwater shark species based on the combined survey data set. The observed trends are then considered in relation to commercial fishery data over the past 15 years.

Keywords: deepwater, shark, survey data

IRISH ELASMOBRANCHS IN COMMERCIAL FISHERIES

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The Sea-Fisheries Protection Authority (SFPA) is tasked with commercial fishery enforcement in Irish Waters. Sharks, Skates and Rays are an important part of Irish commercial fisheries. In total, 39 species of shark and 19 species of skate and ray have been documented historically in Irish Waters. However, only a fraction of these could be considered to be commonly caught by the commercial fishing industry in Irish Waters. Irish and EU fishing fleets are involved in bycatch fisheries for elasmobranch species within the Irish EEZ. A profile of individual fisheries is discussed. This includes landing figures, fishing areas, vessel types and what the elasmobranchs are used for. Recent conservation measures have been introduced which have seen some of the more commonly caught species, (e.g. spurdogs, *Squalus acanthias*) now being illegal to land. The deep-sea shark species have recently been classified as having a zero quota, and from 2011, at least 12 deep-sea shark species will be prohibited to be landed in Irish Waters. Traditionally when Irish fishermen have caught elasmobranchs, they have lumped together all sharks as, e.g. "shark", and all skates and rays as, e.g. "rays". This is not allowed any more for many species. This introduces challenges for the industry and the SFPA, e.g. from an identification point of view. This presentation will overview the recent history of commercial elasmobranch fisheries and will highlight the concerns for these fisheries in the future.

Keywords: Irish, Commercial, Elasmobranch, Fisheries, Legislation

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SESSION 4 – MANAGEMENT AND CONSERVATION

SMOOTH-HOUNDS IN THE NORTHEAST ATLANTIC: A CONSERVATION CONCERN?

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The starry smooth-hound (*Mustelus asterias,* Cloquet) and the common smooth-hound (*Mustelus mustelus,* Linnaeus) are small coastal, demersal sharks found in European waters. There is much confusion over the identification of these species due to the apparently low level of morphological variation between them and the widespread use of ambiguous characteristics to differentiate them. This uncertainty has prevented the accurate delineation of species distributions, inhibited collation of species specific life-history data and impeded the implementation of management and conservation strategies. In order to resolve this, a study was conducted which focused on three keys areas (1) development of a simple genetic identification method (2) estimation of age and growth parameters (3) investigation of reproductive biology.

Large scale application of the genetic identification method confirmed the widespread misidentification of NE smooth-hounds. Despite four years of extensive sampling in the NE Atlantic not a single *M. mustelus* specimen was found. All specimens were confirmed to be M. asterias. This species was previously believed to be short lived, fast growing and early maturing. However, examination of life history characteristics proved the contrary. The length and age at 50 % maturity for males and females were estimated to be 78 cm TL and 4-5 yrs and 87 cm TL and 6 yrs, respectively, which is more than double the previous estimates. Gestation period was ~ 12 months, followed by a resting period of ~12 months, resulting in a biennial cycle, which is different from the annual cycle observed in Mediterranean *M. asterias*. Longevity was estimated to be 13 and 18.3 years for males and females, respectively. The findings of the current study suggest that NE Atlantic M. asterias may be more susceptible to exploitation that previously believed and that management and conservation strategies are now required.

Keywords: Age, growth, misidentification, Mustelus, reproduction

LONG-TERM CHANGE OF THE ADRIATIC DEMERSAL ELASMOBRANCH COMMUNITY IN RESPONSE TO PROLONGED HUMAN DISTURBANCE

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Elasmobranch diversity and abundance can drop considerably after short period of fishing. However, species composition changes in response to exploitation have been observed around the world, with initial and overall decreases of large species, and frequently observed increases of smaller elasmobranchs. Sharks and rays differ in their intrinsic resilience to perturbation, exposure to fishing, and response to changes in the abundance of their predators and competitors.

Here we analyzed a demersal community of elasmobranchs in the Adriatic Sea, a large continental shelf of the Mediterranean where marine ecosystems have been exploited for hundreds of years. In the Adriatic, top predators such as large sharks and marine mammals have been reduced to dysfunctional levels and while fishing exploitation fluctuated over time with an overall increase, there is a drastic difference between the eastern and western side. Such a long exploitation history, peculiar ecological settings, and spatiotemporal contrasts of perturbation, made the region an ideal case to analyze population dynamics over long time scales and across different exploitation regimes.

We combined and standardized catches from five published and unpublished trawl surveys carried out in the area since 1948, by using generalized linear and mixed effect models controlling for technological and environmental covariates. Within a multi model information theoretic approach, we estimated long-term trends in abundance and species-specific ecological requirements of 33 species of sharks and rays. Life histories, fish market and effort data, and historical fishing information from the 19th century were used to explain relative changes in population abundance.

We detected multiple cases of species extirpations, a strong correlation between historical intensity of exploitation and the stage of demersal community degradation, and cases of species increases despite intense fishing. We will discuss whether these patterns represent advanced stages of human-induced ecological change not yet expressed in other similar ecosystems worldwide.

Keywords: meso-predators, long-term changes, generalized linear models, trawl surveys, species extirpation.

ESTIMATES OF FISHING, NATURAL AND TOTAL MORTALITY FROM FEMALE TO EMBRYO RATIOS: A MODEL ILLUSTRATED FOR THE MILK SHARK *RHIZOPRIONODON ACUTUS* FROM OMAN

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In this study, we develop an age structured model that provides estimates of instantaneous mortality rates (total, natural and fishing mortality) in sharks. We illustrate the model with data collected from the *Rhizoprionodon acutus* fishery of Oman. Input data include age estimates, selectivity and maturity at age and female to embryo ratios per age class harvested. Moreover, from the model outputs we suggest that female to embryo ratios can be used to predict fishing mortality rates in shark fisheries. The use of the embryo: female ratio as a predictor of fishing mortality is based on the premise that generally older female sharks would produce more embryos. Hence, the selective removal of older individuals would result in skewed embryo:female ratios. An independent estimate of Z (eg. from a catch curve) is required to constraint the model outputs of M and F.

Keywords: Mortality, elasmobranch, age-structured model

PROGRESS AND CHALLENGES IN EUROPEAN SHARK CONSERVATION

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The record for implementation for the 2009 European Community Plan of Action (CPOA) for the Conservation and Management of Sharks has been mixed. Since the last European Elasmobranch Association (EEA) meeting, the European Union (EU) took significant steps toward heeding scientific advice for depleted spiny dogfish and porbeagle fisheries, but failed in efforts to regulate international trade in the species through the Convention on International Trade in Endangered Species (CITES) and to limit mako fishing through the International Commission for the Conservation of Atlantic Tunas (ICCAT). Fishermen continue to land protected species illegally in the EU (particularly in Spain), EU Member States have not lived up to commitments to protect additional species listed under the Barcelona Convention, and movement by the European Commission to fulfill their pledge to strengthen the EU shark finning ban has been slow. The second half of 2010 offers numerous opportunities for improving CPOA implementation, such as a public consultation on the EU finning regulation, new scientific advice for EU thorny skate fisheries in the Northwest Atlantic, an EU-hosted annual ICCAT meeting, and setting of the 2011 EU total allowable catch limits for sharks and rays. The specifics related to progress and the latest challenges in improving European elasmobranch policies will be detailed with a view toward enhancing the involvement of elasmobranch scientists in the fisheries management process.

Keywords: shark, conservation, fisheries, protection, finning.

THE STATUS OF SHARKS IN THE UNITED ARAB EMIRATES

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Data on the artisanal elasmobranch fishery and the status of sharks in the United Arab Emirates (UAE) are currently sparse. Preliminary studies at landing sites have shown that the elasmobranch catch is increasingly high which suggests unsustainable levels of fishing. Furthermore, it is believed that the UAE is serving as a hub in the Arabian Gulf region for the export and trade in shark fins to Eastern Asia.

To manage this shark fishery and gain a better understanding of the threats sharks face in UAE waters, it is crucial to monitor catch and trade of these animals. However, limited information is available on the composition, abundance, distribution and biology of sharks found in UAE waters. This lack of data limits the development and implementation of management initiatives that could lead to regulations on the exploitation of these stocks and their conservation.

As part of a new research project, interviews with fishermen and research surveys are being conducted at landing sites and in coastal areas across the country. Data collected will include information on the fishery characteristics, species composition, seasonal abundance, feeding ecology, genetics and fin trade of sharks. These results will lay the foundations for future studies on sharks in the UAE as well as provide scientific information to support new management plans.

Keywords: Arabian Gulf, fisheries, fin trade, research, management

SESSION 5 – BIOLOGY

SKIN CHARACTERISTICS OF SHARKS IN RELATION TO CALCIFIED DERMAL STRUCTURES

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Aquatic locomotion among Chondrichthyes is diversified, e.g. chimaeras and some batoids oscillate there pectorals for "underwater flight", other batoids undulate them. Among Selachii only axial and caudal undulation is used as main propulsor however locomotive patterns and e.g. tail anatomy are also diverse. At least four main-types are known: thunniform, generalized, demersal, and a fourth squaliform type. Lateral axial undulation causes skin stress through bending, requiring a structure strong but flexile. The main characteristics of shark skin referring to flexibility, store energy, and body stiffness are putatively determined by collagen fibre patterns. These collagen patterns vary among species and body regions, e.g. trunk and dorsal fin or dorsal and ventral lobe of caudal fin. Former studies explored, that derived sharks (thunniform pelagic hunters) display thick collagen fibre pattern. The ongoing project aims to explore skin characteristics, considering flexibility and histology of European shore sharks, representing shark diversity in ecological and locomotive pattern. Histology (thickness and number of collagen layers, anchoring of denticles), pressure holding, and bending ability will be documented and compared among the species and specific body regions (trunk, fins, caudal peduncle etc.). Of special interest is the relationship to dermal calcified structures (denticles, spines) which has not been in focus of investigation. In theory hard structures on skin and body extensions are supposed to have strong influence on skin characteristics, as shown e.g. in bony fish. Strong ganoid scales in primitive bony fish resist compressive forces and in modern teleosts strong spines in the front of fins ensure body stability; soft spines in the back are used for locomotion. The results will help to understand the role and function of skin and calcified dermal structures during locomotion.

Keywords: locomotive patterns, spines, denticles, collagen fibres

FIRST DESCRIPTION OF THE AMPULLAE OF LORENZINI IN THE LONGNOSE VELVET DOGFISH *CENTROSELACHUS CREPIDATER* (BOCAGE AND CAPELLO, 1864) FROM THE NE ATLANTIC: MORPHOLOGY, HISTOCHEMISTRY AND ECOLOGICAL HYPOTHESIS

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The ampullae of Lorenzini (AL) have been the source of scientific controversy since their discovery 350 years ago but, despite the different point of views on their functions, it is clear that they play a fundamental role in the life of the cartilaginous fishes. In particular, using morphological aspects of sensory systems may enable predictions on ecological relationships between organisms for which direct behavioural observations are difficult or impossible, like the deep-water species.

Here we introduce this approach to study the electroreceptors of the longnose velvet dogfish *Centroselachus crepidater* (Bocage and Capello, 1864), a species regularly caught in the deep-water fisheries on the continental slopes of the Northeast Atlantic. We describes for the first time the ampullary organs in the longnose velvet dogfish and attempt to discuss possible relationships between their anatomical structure and the ecological patterns of this deep-water shark.

AL are were organized in 4 clusters and they were dipped in a dense and abundant gel. AL were numerous and constituted by a canal and by a terminal portion, the ampulla chamber, both filled with gel. The canal was constituted by a single squamous epithelium, showing Alcian positive gel protrusions and WGA and ConA lectins positivity. The ampulla chamber was organized in 11-15 alveoli of pseudostratified epithelium, composed by larger oval cells and pyramidal cells. Alcian blue, pH 2,5, such as WGA and ConA lectins positivity has been observed.

C. crepidater inhabits deep waters where it especially eats mesopelagic fishes and the omogenous distribution of the clusters, the numerous ampullae, such as the high number of the sensory alveoli may suggest an electrosensory system with high spatial resolution ideal for predation on active prey types. Further investigations on diet and visual biology are necessary to completely clarify the real role of the AL in this shark.

Keywords: ampullae of Lorenzini, cartilaginous fishes, deep-water, electroreception, sensory ecology

THE EFFECTS OF SHORT-TERM BLOOD STORAGE ON SHARK HAEMATOLOGICAL PARAMETERS, USING *IAGO OMANENSIS* AS A MODEL SPECIES

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Haematological parameters including cell concentrations, cell sizes, haematocrit and haemoglobin concentration, are assessed for a number of reasons including health monitoring in captive animals, as well as physiological investigations. However, while it is accepted that long-term storage of blood samples has deleterious effects on most parameters, little attention has been paid to the effects of short-term storage (1 – 24 hrs) on such measurements. In this study, basic haematological parameters were assessed at regular intervals over a 24 hour period, using blood samples collected from the bigeye houndshark *Iago omanensis*.

Keywords: *Iago omanensis,* bigeye houndshark, Haematological parameters

THE SEXUAL INTERACTIONS AND SOCIAL NETWORKS OF A BENTHIC SHARK

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Marine predators such as sharks often form single-sex aggregations as part of their diet behavioural cycle. Such aggregations are potentially driven by contrasting reproductive and behavioural strategies between the sexes leading to distinct sexual segregation. There is however no experimental evidence that such predator aggregations are governed by intrinsic social systems demonstrating long-term temporal stability.

Social network analysis offers a versatile theoretical framework with which to study the structure and dynamics of complex systems. Recently, network theory has been adapted to study interactions in animal populations with wide applications in terrestrial and marine vertebrates. During this development, elasmobranchs have been exclusively overlooked.

Presented here are results from a recent captive study which adopts a social network approach in order to better understand the mechanisms which underpin aggregation and segregation in the small spotted catshark (*Scyliorhinus canicula*). Social network structure, temporal stability and activity profiles were analysed to examine the impact of introduced males on social structure of four captive groups (each n = 8) of female catshark. Socially isolated females suffered greater disruption when males and control females were introduced, experiencing greater levels of partner exchange, reduced temporal stability and increased activity levels.

These results indicate that male presence is highly disruptive to weak female-shark social networks; conversely, aggregations demonstrating relatively strong, temporally stable social bonds (at least by some individuals), are particularly resilient to potential male harassment. We highlight that additional 'social constraints' may have disparate influence upon individuals occupying different structural positions within a social network and may thus impact individual fitness unequally.

Keywords: network analysis, sexual segregation, sociality

EX SITU CONSERVATION AND BEHAVIOUR OF CAPTIVE SAND TIGER SHARKS (*CARCHARIAS TAURUS*)

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The behaviour and spatial distribution of sand tiger sharks (*Carcharias taurus*) was recorded to analyse the effects of feeding and reproductive season of these endangered fish in captivity. Males significantly increased swimming speed, while females decreased speed during the mating season. The frequency of pre-copulatory behaviours differed significantly between individuals, and male sharks with the fastest mean swimming speed displayed the most mating behaviours. During the mating season, males spent significantly more time in the areas commonly frequented by females. The nearest neighbour and give-way occurrences, measures which may reflect the dominance hierarchy between sharks, were not influenced by mating season. *C. taurus* individuals who frequently gave-way at encounters were significantly more likely to avoid encounters at distance. Sharks did not change swimming speed in feeding days compared to non-feeding days, and likewise, there was no effect on give-way occurrences depending on feeding. On feeding days, sharks spent significantly more time in and around the sections where they were fed. Swimming speeds were significantly faster during the night time periods, and the sharks are particularly active at night, spending a higher proportion of time patrolling and less time resting. The presence of divers and visitors has no detectable effects on the behaviour or distribution of sharks. In addition a captive mating was observed and filmed during this study.

Keywords : Ex-situ, sand tiger shark, pre-copulatory, behaviour

USE OF ISOTOPIC ANALYSIS OF VERTEBRAE AND MUSCLE IN RECONSTRUCTING DIET AND TROPHIC POSITION OF THE BLUE SHARK (*PRIONACE GLAUCA*) AND SILKY SHARK (*CARCHARHINUS FALCIFORMIS*) IN THE INDIAN OCEAN

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The blue shark, *Prionace glauca*, and the silky shark *Carcharhinus falciformis* are oceanic pelagic predators caught as bycatch by open ocean fisheries. Their respective life history spectrums show strong differences but the situation in the west part of the Indian Ocean is poorly known because of a worrying lack of data. The stable isotope ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) in tissues have a broad array of applications in ecology. The stable isotope ratios of carbon (13C/12C) and nitrogen (15N/14N) in predator tissues are directly related to those of their prey. Knowledge of the trophic ecology of shark populations should provide a greater understanding of their role in the pelagic realm.

Dorsal muscle and vertebra of individuals of blue shark ranged from 34.5 to 304 cm FL and silky sharks ranged from 55.5 to 264 cm FL from the southwestern Indian Ocean were analyzed. Muscles were freeze dried and vertebra dried in an oven. Following drying, vertebrae were sectioned transversally on low speed saw with two diamond blades, cleaned with distilled water and the corpus calcareum was then cut with scalpel into small fragments, representing each annual growth increment. Samples were then ground to a fine powder and lipids were removed with cyclohexane. Isotopic analysis were performed on 0.300 to 0.400 mg of homogenized powder by loading into tin cups and analyzed in a spectrometer.

Stable isotope analyses in soft tissues such as muscle provide dietary information corresponding to several months to one year, depending on species. In contrast, hard tissues as vertebrae grow continuously by accretion of new molecules with no turnover after synthesis. Consequently, sequential $\delta^{13}C$ and $\delta^{15}N$ values along the vertebrae integrate the feeding ecology of an individual over its lifetime. Our study displays preliminary results on the trophic signature of blue shark and silky shark individuals according to size and latitude. Both ontogenic patterns and trophic level at a given size are compared at intra and inter specific levels. The ecological role of the two species on concern is discussed in relation to an ecosystem based approach to fisheries.

Keywords: *Prionace glauca, Carcharhinus falciformis*, isotop, vertebrae, muscle

SESSION 6 – TAGGING

TAGGING THE ELUSIVE BASKING SHARK IN IRISH WATERS

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The movements, site fidelity and behaviour of basking sharks are poorly understood. Satellite telemetry using archival tags has shown broad scale movements over short periods in some areas. Since 2008 we have been deploying individually numbered coloured tags on basking sharks in Irish coastal waters. This cheap and easy technique allow us to explore, abundance, short and long distance movements as well as providing a tagged population for short-term behavioural studies. Eight tags were deployed in 2008 during a pilot study in Counties Kerry and Donegal with a further 104 deployed in 2009. Already during 2010 we have deployed over 100 tags. We had a total of seven confirmed re-sightings of tagged sharks, including two international re-sightings between Donegal and Scotland and two unconfirmed records during 2009.

A yellow tagged shark from Co Donegal was observed amongst a group of 20 sharks off Coll in the Inner Hebrides on 26th June. This equates to a distance of around 140km in 22 days. A yellow tag was recorded on 10 August off Ardnamurchan Point, Isle of Mull a distance of 140km from the tagging site within one month. Local site fidelity was recorded for individual sharks over 4-11 days off Counties Cork, Kerry and Donegal as well as some local movements of up to 20km. Abundance can be estimated through mark-recapture analysis and this has been carried out over in North Donegal during 2009 and 2010, where a crude estimate of 135 sharks in the area in 2009 and around 200-300 sharks 2010. Other studies facilitated through having a tagged population include genetic and chemical analysis. Tagging basking sharks with coloured tags has great potential. Here we present some early findings from this tagging project and explore what other studies could be carried out using this technique.

Keywords: Basking Shark, Tagging, Movements, Site Fidelity, Abundance

SATELLITE TRACKING OF BASKING SHARKS IN THE NE ATLANTIC.

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The basking shark (*Cetorhinus maximus*) is widely distributed but only regularly seen in few coastal areas. Previous satellite tagging studies in NE Atlantic revealed several kinds of movement patterns on the European continental shelf and shelf-break and in one case, a transatlantic migration. They also show vertical movements depending on ocean habitat. In the frame of an international program, we deployed ten pop-up archival transmitting tags on basking sharks, two off the west coast of Brittany (France) within the National Marine Protected Area of the Iroise Sea in June 2009 and eight off the southwest Isle of Man in July 2009. Six males and four females were tagged, ranging in size between 3 and 8 meters. Nine of the ten tags transmitted data through Argos satellites while the last one has been physically recovered on a beach. Two tags popped off prematurely after less than 20 days and are not considered for the analysis. For the 8 remaining tags, deployment periods lasted between 37 and 245 days. Most probable tracks reconstructed with a state-space model are presented as well as changes in depth distribution, and for one shark, daily dive patterns.

Keywords: basking shark, North-East Atlantic, satellite archival tag, geolocation, depth distribution

SPACE-USE AND LÉVY FLIGHT SEARCH PATTERNS OF BLUE SHARKS *PRIONACE GLAUCA* IN RELATION TO ENVIRONMENTAL GRADIENTS IN THE NORTH-EASTERN ATLANTIC

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Identification of habitat preferences for pelagic sharks is of vital importance for effective conservation and management efforts. Pop-up satellite-linked archival tags were deployed in blue sharks *Prionace glauca* in the North-east Atlantic to determine the degree of spatial aggregations. Overall, blue sharks moved south-west of the tagging sites (English Channel and southern Portugal), exhibiting pronounced site fidelity to localised, rich frontal areas, with the estimated space-use pattern being statistically different from a random array. Sharks occupied a broad vertical depth (0 – 1160 m) and water temperature range (7.2° – 27.2°C). Maximum likelihood methods were also used to test for Lévy patterns in relation to environmental gradients from recovered satellite tags. Strong support was found for Lévy search patterns in this species, with one particular individual switching between Lévy and Brownian movement, and back again, as it traversed different habitat types. The spatial occurrence of these two principal patterns was also tested and we found that Lévy behaviour was largely associated with less productive waters (sparser prey) while Brownian movements occurred in more productive shelf habitats (abundant prey). These results are consistent with the Lévy flight foraging hypothesis.

Keywords: blue shark; space-use; site fidelity; Lévy behaviour; thermal fronts

MOVEMENT AND BEHAVIOUR PATTERNS OF THE CRITICALLY ENDANGERED COMMON SKATE *DIPTURUS BATIS* REVEALED BY ELECTRONIC TAGGING

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Understanding animal distributions and habitat utilisation is vital for the management of populations, especially those of endangered species. However, this information is not available for the majority of marine species and is difficult to obtain for those with low population densities. The common skate, *Dipturus batis*, was once abundant and widespread in the North-East Atlantic but is now thought to be locally extinct in the Irish Sea and in the central and southern North Sea, and is listed as Critically Endangered on the IUCN Red List. The constraints of skate body morphology on locomotory mode assume low levels of activity with long periods spent resting on the seabed, therefore predicting a high degree of site fidelity. To investigate this hypothesis we tagged 31 common skate (7 male and 24 female) with depth and temperature-logging data storage tags off the west coast of Scotland between May 2008 and May 2010. Thirteen tags have since been recovered following times at liberty of 0.5 – 12 months. All tags were recovered within close proximity of the release location, suggesting high levels of site fidelity to localised areas. Within these local areas however, time-depth profiles were dominated by periods of high activity, with vertical movements of > 100 m being conducted on a regular, sometimes daily, basis. Intra-individual plasticity was observed in vertical activity patterns with individuals switching between low and high activity patterns. Limited short-term horizontal movements in preferred habitats supporting apparently high foraging activity highlights the need for spatial management of 'refugial' populations of this once widespread fish, that appears now largely extirpated from European waters.

Keywords: Activity, Dive profile, Habitat use, Telemetry, Conservation

POSTER SESSION

1. THE OMAN SHARK PROJECT

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Abtract: Sharks form a large component of fishery landings throughout Arabia, where their flesh is utilised both fresh and dried. However, shark landings have increased dramatically in the last decade, due to the value of shark fin on the export market, and many species now appear to be in decline. The 'Shark Project' is a government-funded initiative to investigate the biology and ecology of the elasmobranchs inhabiting Omani waters, with a view to ensuring the sustainable exploitation of Oman's elasmobranch resources. This presentation provides details of the project's achievements so far, its current work, and its future goals.

2. SKATES AND RAYS EGGCASES COLLECT ON FRENCH COASTS: DEVELOPMENT, FIRST RESULTS AND PERSPECTIVES

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Since 2005, APECS coordinates a national collect of stranded skates and rays eggcases based on public participation, a sister project of the Shark Trust "Great Eggcase Hunt". This project has two main goals: improving knowledge about rays and skates lays spawning areas and increasing public awareness. In 2008, we created and broadcasted an ID guide to introduce the main species of eggcases and to explain how to contribute to the project. We also developed a network of relays points distributed on the French coasts (NGO's offices, offices for tourists, towns councils, public aquariums). For the moment, 40 relays make the public information and data return easier. The program knows an exponential success and today we have recorded more than 300 prospectors and 35000 eggcases of 7 different species. Results in term of number of eggcases collected by species, number of proscpections and geographical and temporal differences are presented. Currently, APECS tries to find some ways to connect eggcases stranded areas with skates and rays spawning areas. We intend to work with divers to confirm the results of eggcases coastal harvests.

Keywords: skates and rays, eggcases, public awarness, spawning areas, public awarness

3. THE SCIENCE OF MERMAIDS' PURSES: USING PUBLIC PARTICIPATION AS A TOOL FOR INVESTIGATING EGGLAYING ELASMOBRANCH NURSERY AREAS IN IRELAND

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Observations of shark and ray eggcases (aka mermaids' purses) on the seashore and underwater can provide valuable information on the location of nursery areas for egglaying elasmobranchs, some of which are endangered or rare. Ireland's eggcase sightings scheme, Purse Search Ireland, has benefited from an enthusiastic response from the public since its launch in 2007, with many schools, diving clubs, anglers and nature enthusiasts reporting their observations of purses. As a result, a total of 2946 eggcases from 10 species of shark, skate and ray have been reported from 170 beaches over a period of three years (80% of which have been identified to species level by project scientists). Not surprisingly, eggcases from Ireland's most common species of inshore shark, the Lesser Spotted Dogfish *Scyliorhinus canalicula*, have been observed most frequently (69.79% of all eggcases identified). Purses produced by the larger, less common Greater Spotted Dogfish, *Scyliorhinus stellaris*, have been reported much less frequently (1.44%). Numerous eggcases from commercial species of skate have also been reported, with the Thornback Ray, Raja clavata, being the most common and widespread (20.83%). Other commercial species have been reported less frequently, ie. the Spotted Ray, *Raja montagui* (5.37%), Blonde Ray, *Raja brachyura* (0.42%), Small Eyed Ray, *Raja microcellata* (0.68%) and Cuckoo Ray, *Leucoraja naevus* (0.13%). Confirmed sightings of eggcases from the critically endangered Common Skate, *Dipturus batis* (0.17%), critically endangered White Skate, *Rostroraja alba* (0.25%) and endangered Undulate Ray, *Raja undulata* (0.93%), are of particular interest, especially since all three species were recently afforded protection by the EU due to their vulnerable conservation status. With some restrictions, these data can be used to identify key nursery areas, providing useful information for conservation purposes.

Keywords: skates, rays, elasmobranch, nursery areas, public participation

4. PHOTO IDENTIFICATION AS A METHOD OF STUDYING BASKING SHARKS IN MANX WATERS

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Photo identification (ID) is a widely used tool in the study of animal populations. It uses naturally occurring, distinctive markings on readily accessible areas of the animal, to distinguish between different individuals within a population. For basking sharks, the most useable area for identification is the dorsal fin, which commonly has nicks and cuts out of its trailing edge, as well as scarring and skin pigmentation patterns. The Manx Basking Shark Watch (MBSW) has been studying basking sharks in Manx waters since 2005, although only had the resources to start dedicated photo ID in 2009. It also has a small set of images from the research vessel from 2008 and from the general public. High quality images of individuals are categorised into those that are readily identifiable ('Well marked'), those that have small markings ('Small nicks') and those which have very limited markings & would be difficult to re-recognise ('Difficult'). By the end of 2009, there were 30 'well marked' individuals, 8 'small nicks' individuals and 16 'difficult' individuals in the MBSW catalogue. An underwater pole camera is used during encounters, to sex the sharks, and this data is used alongside the fin ID images. Of the 54 sharks so far identified, 24 are known to be male and only 6 female. Twelve individuals have so far been re-sighted in a subsequent encounter, with three individuals having been seen in more than one year. Photo ID is continuing in the 2010 field season & by autumn 2010 we will have analysed the resulting data. This ongoing data set will provide information about the site fidelity, local movements and group associations of basking sharks within Manx waters & will hopefully feed into a wider project studying basking shark movements throughout western Britain.

Keywords: basking shark; photo ID; Britain; conservation

5. MULTIPLE FUNCTIONS OF LUMINESCENCE FROM LANTERN SHARK (*ETMOPTERUS SPINAX*) PHOTOPHORES

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In the permanent darkness of the deep sea, many organisms are bioluminescent i.e. they are able to emit a visible light from specialised photogenic structures called photocytes (photogenic cells) or photophores (photogenic organs). The high phenotypic diversity of this phenomenon is generally believed to reflect its great ecological importance as a privilegiate signal for attracting conspecifics, finding food and evading predators.

The role of the luminescence of the velvet belly lantern shark (*Etmopterus spinax*) has been extensively studied in the recent years using varied techniques including pharmacology, luminometry, spectrophotometry and histology. Results indicate that this shark's light emission is more versatile than what was previously believed. The structural complexity of the photophore arrangement and the differential physiological control of these structures suggest indeed the light emission of this shark to possess multiple functions including luminous signalling, camouflage and lightening.

Keywords: bioluminescence, sexual dimorphism, camouflage, luminous signalling.

6. FEEDING ECOLOGY OF SHORT FIN MAKO SHARK IN NORTH ATLANTIC: IS IT A GENERALIST PREDATOR?

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The shortfin mako shark, *Isurus oxyrinchus*, is a pelagic oceanic specie with wide spread distribution in temperate and tropical waters. It is a target species of the surface longline fishery in all the world´s oceans, North Atlantic specially. The mako and others pelagic sharks are important commercial catches and little is known about their trophic relationships, which is an important subject for applying the ecosystem approach to fisheries management. The aim of this study was know the mako shark diet throughout the year. Stomachs of 240 sharks were analyzed. Animals' size ranged from 83 and 285 cm FL (fork length). Sex ratio was 1:1. Makos were collect with pelagic longline onboard commercial fishing vessel "Amel" in North Atlantic waters. The 51% of the specimens showed food (any item) in their stomachs and cumulative prey curves are presented. The digestion index for each prey item was recorded. The species found were placed into eight major groups: teleost undetermined, pelagic teleost, tuna and similar, crustacean, cephalopod, cetacean, others and non living material. The percentage by number, weight, frequency of occurrence, and index of relative importance (IIR) were used to describe their diet. It showed teleosts to be the principal component, mainly pelagic fish (e.g. *Belone belone* and *Alepisaurus ferox*) and pelagic cephalopods of medium size as *Histioteuthis* spp. There were no differences between sexes. On the other hand, we try to shed light on the prey selectivity. Seasonality in food habits was analyzed to determinate if the diet is in accordance with the current availability of food items. A comparison between North Atlantic and South Pacific diets of this species was undertaken.

Keywords: feeding ecology, shortfin mako shark, *Isurus oxyrinchus*, North Atlantic

7. AGE AND GROWTH STUDIES OF THE BLUE SHARK, *PRIONACE GLAUCA* IN THE SOUTH-WEST INDIAN OCEAN

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Validated age and growth estimates are important for constructing age-structured population dynamic models of chondrichthyan fish, especially those which are exploited or accidentally caught by fisheries. The blue shark, *Prionace glauca*, is a ubiquitous oceanic pelagic species and one of the main bycatch species in longline fisheries worldwide. If amount of blue shark fishery data varies widely between oceans, the situation is critical in the Indian Ocean where demographic analysis for this species is rudimentary. In this context, basic knowledge on life history traits must be obtained in order to be able to predict population responses to disturbances, such as fishing pressure.

Our age and growth estimates for blue shark, *Prionace glauca*, in the southwestern Indian Ocean derived from 183 vertebrae collected from sharks ranging from 34.5 to 304 cm Fork Length (FL). Ages were first determined by counting growth bands on vertebrae, the calcified structures most widely used for ageing sharks. At a second step, age estimations were verified through marginal increment analysis. Bomb carbon validation was performed on the vertebrae of a blue shark (FL = 270 cm) captured in the southwest Indian Ocean in 1983.

The length at age key was obtained by individual back calculation. Both von Bertalanffy's and Gompertz's growth models were performed by considering the size at birth as age zero. Geographical and sexual growth patterns are displayed and discussed following population management purposes.

Keywords: Blue shark, life history pattern, vertebrae, bomb carbon validation, back calculation

8. NEW DATA ON AGE AND GROWTH OF SPINY DOGFISH, *SQUALUS ACANTHIAS*, IN THE PACIFIC OFF THE KURIL ISLANDS

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Spiny dogfish, *Squalus acanthias*, in the Pacific waters off the Kuril Islands and Kamchatka occur rather rare, mostly during summer feeding migrations, when it is occasionally caught by drift nets in Pacific salmon fisheries. Published data on its biology in the northwestern Pacific are very scarce. Information on the age and growth rates is limited by two papers from the Sea of Japan published in early past century.

The material for studies of spiny dogfish age and growth rates (spines of second dorsal fin) were sampled from salmon drift net catches in the Pacific waters off the Kuril Islands and southeastern Kamchatka (44°00' – 50°20'N) in 2005-2006. Age of spiny dogfish was estimated using visual method. 267 spines were examined, of which 132 were suitable for age readings.

Spiny dogfish in catches was represented by specimens having total length 67 to 123 cm, body weight 1140 to 5970 g and age 10 to 26 years. Comparison of our data on spiny dogfish growth rates with those in different areas of the world oceans showed that in the Pacific off Kuril Islands and Kamchatka it grows somewhat faster then in the Sea of Japan and the northeastern Pacific, and its growth rates until 15 years are similar with those of spiny dogfish from the Northern Sea.

Female and male growth rates slightly differ. Males are longer then females in most age classes. However females in most cases are heavier as compared to males, especially among older specimens. According to our data, longevity of females is somewhat higher then of males (26 and 25 years, respectively).

The analysis showed that sizes of spine (length, width of base, and length of base) are well correlated with the age of spiny dogfish. The best correlation occurred between age and width of spine base and between age and length of spine base.

Keywords: Spiny dogfish, *Squalus acanthias*, age, growth, northwestern Pacific

9. DISTRIBUTION AND SIZE COMPOSITION OF PACIFIC SLEEPER SHARK, *SOMNIOSUS PACIFICUS*, IN THE NORTH PACIFIC OCEAN

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Pacific slepeer shark, *Somniosus pacificus*, is the most widely distributed and abundant bentho-pelagic shark in the North Pacific. This species plays an inportant role in ecosystems as consumer of various aquatic animals and also is of certain interest for fisheries. Despite high abundance and frequent captures by various fishing gears the data on its distribution and biology remain rather limited.

This contribution is based on the data on bottom trawl surveys and commercial fishing operations conducted in various areas of the North Pacific in 1974-2008 by staff of TINRO-Center and Alaska Fisheries Science Research Center (AFSC, Seattle, USA) as well as by US observers aboard commercial fishing vessels. 7984 catches of Pacific sleeper shark by different fishing gears were analysed, including 1031 those with indication of capture depth.

Pacific sleeper shark is to a greater extent associated with bottom as compared to water column since major areas of its pelagic and near-bottom aggregations occur over shelf and continental slope of the Bering Sea. At the same time, near the bottom this species occurs most frequently in the northwestern Bering Sea, western Gulf of Alaska, along eastern Aleutian Islands, in the Pacific waters off the northern Kuril Islands and southeastern Kamchatka.

In water column, Pacific sleeper shark was observed at depths 5 to 1000 m. The majority of individuals was caught at depth <500 m with maximum catches between 100 and 300 m. Near the bottom this shark occurred on isobaths 14 to 1200 m. Maximum number of captures was registered within 200-700 m depths; increasing of catch rates with capture depth was recorded.

Available data allow us to analyse seasonal and multi-annual changes of character of Pacific sleeper shark spatial distribution in the North Pacific. Data on seasonal changes of capture depth, bottom temperatures inhabited, diurnal dynamycs of catch rates, features of size composition, and seasonal and size-depended changes of condition factor are also provided.

Keywords: Pacific sleeper shark, *Somniosus pacificus*, distribution, bathymetry, size composition, North Pacific

10. DISTRIBUTION AND SEXUAL SEGREGATION IN DEEPWATER CHIMAERA OFF THE COAST OF SCOTLAND

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Very little information exists on the ecology and behaviour of chimaerid fishes mainly due to the depths at which they occur, a lack of targeted sampling and poor taxonomic resolution in historic data. Segregation of populations by sex and/or age classes has been demonstrated in several elasmobranches, but whether segregation occurs in chimaerids, and if so what mechanisms are implicated, remains unknown. This study investigates the distribution patterns of 7 species of chimaera (*Chimaera monstrosa, Hydrolagus mirabilis, Hydrolagus affinis, Hydrolagus pallidus, Rhinochimaera atlantica, Chimaera opalesence* and *Harriotta raleghiana*); examining distribution patterns with relation to sex, size class (maturity class), depth and near bottom temperature. Data were obtained from a trawl survey undertaken by Marine Scotland – Science, Aberdeen, over the period 1998 – 2009. Factorial ANOVA with planned contrasts indicated complex patterns of age and sex related segregation in chimaerids. Recruit and juvenile males and females of *Chimaera opalesence* and *Hydrolagus affinis* were not segregated in relation to depth or temperature; however, adult males and females were statistically segregated (both species $P<0.001$); adult males more common in shallower, warmer sites whilst females were more common in deeper waters (both species $P<0.001$). Adults of *Hydrolagus mirabilis* and *Hydrolagus affinis* were segregated by depth but not by temperature. Data indicate segregation by maturity stage regardless of sex, with juveniles found at greater depths than adults of *Chimaera opalesence*, *Hydrolagus affinis* and *Harriotta raleghiana*. Chimearids such as *Chimaera monstrosa* and *Hydrolagus mirabilis*, are commonly found in commercial by-catch of deep sea fisheries. The impact of these fisheries on the populations of these species is unknown, but the patterns of segregation reported here may have important implications for the protection of these potentially vulnerable populations.

Keywords: Sexual Segregation; Chimeara; Depth; Temperature; ANOVA

11. MONITORING OF ELASMOBRANCHS LANDINGS IN MALLORCA (BALEARIC ISLANDS, NW MEDITERRANEAN). IDENTIFICATION AT SPECIES LEVEL AND UNDERSTANDING OF THE OFFICIAL STATISTICS.

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The monitoring of fisheries capturing elasmobranchs is one of the main measures to be implemented for an appropriate management of the group. But, further to surveys and examining of logbooks, analyses of landings have been based mainly on official statistics rather than on direct observation. This implies a lack of correct identification of the species being landed, which are often pooled into a number of taxa and/or commercial categories. Therefore, accurate values of captures and landings at a species-specific level are not available.

In the Balearic Islands, Palma de Mallorca port represents the main landing site, accounting for ca. 70% of the total biomass landed in the archipelago. During 2009, landings corresponding to elasmobranchs were monitored at the Palma's landing site (65 surveys), with the objectives of: i) correctly identify the species composition of the commercial fraction; ii) determining the biomass for each species; iii) identifying the commercial categories for the species; and iv) comparing the data to those appearing in the official statistics.

More than 7000 boxes containing sharks, rays and skates were sampled, meaning 50 tones. Fifteen sharks and 17 batoids were identified. The most important species were the thornback ray Raja clavata and the smallspotted catshark *Scyliorhinus canicula*, which accounted for 30,3% and 28,3% of the total biomass, respectively. Other species representing more than 3% of the biomass were the blackmouth catshark *Galeus melastomus* (12%), blonde ray *Raja brachyura* (6,6%), blue shark *Prionace glauca* (3,9%) and rough ray *Raja radula* (3,4%). Overall, sharks and batoids contributed 50% each to the total biomass.

Eleven commercial categories were assigned to elasmobranchs, 8 belonging to sharks and 3 to skates and rays. Six of these categories were species-specific, and presented a high degree (>90%) of correspondence with the correct species: *P. glauca, G. melastomus, S. canicula, Dipturus oxyrinchus, Squalus blainvillei* and *Centrophorus granulosus.*

Keywords: elasmobranchs, landings, identification, Balearic Islands

12. THE COMMERCIAL FISHERIES, STATUS AND MANAGEMENT OF SPURDOG (*SQUALUS ACANTHIAS*) AROUND THE BRITISH ISLES

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Spurdog (*Squalus acanthias*) are biologically vulnerable to overfishing, with the Northeast Atlantic stock classified as Critically Endangered on the IUCN Red List. Spurdog are widely distributed in the ICES area and considered to be a single stock. There is a need to better comprehend its biological features, including its highly migratory behaviour, to facilitate the development of effective regional management measures. Commercial landings data from UK vessels (English and Welsh), and data from discard observer trips were analysed to describe some of the spatial and temporal dynamics of spurdog around the British Isles. Major fisheries (by broad gear type and ICES division) were identified, and seasonal patterns in these fisheries described. Where significant numbers of specimens were captured during observer trips, the discard/retention patterns were analysed. These discarding patterns were viewed in the context of the evolution of management measures, which were first brought in for the North Sea (in 2001) and subsequently extended to the Celtic Seas Ecoregion (in 2008). In addition, some existing mark-recapture data are presented to show its potential as a tool to determine the catchability of spurdog in various seasonal fisheries.

Keywords: Spurdog, Northeast Atlantic, Fisheries, Spatial distribution, Temporal changes

13. WHAT HISTORICAL DATA AND PREDICTIVE MODELS CAN TELL US ABOUT ELASMO-BRANCH FUTURE IN THE NORTHERN ADRIATIC SEA

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Elasmobranchs are among the most vulnerable species of the oceans and their populations are declining worldwide. Therefore the assessment of their status and the predictions of the outcomes of management strategies are essential for their conservation. In this study we analysed long term (1945-2008) trends of elasmobranch landings of Chioggia, the major fishing fleet of the Northern Adriatic Sea, and performed surveys at the fish market to assess elasmobranch catch composition, sex-ratio and maturity status of caught males. Historical and present data were used to develop, for two species, *Mustelus mustelus* and *Scyliorhinus canicula*, an individual based model to predict population trends with no management, and under two different management scenarios: reduction of fishing effort and minimum fish catch size.

Elasmobranch landing data documented a dramatic decline, up to almost 98% for skates and 94% for *Scyliorhinus spp*. Landings presented periodic fluctuations, correlated in skates with climate indices (NAOi and WeMOi). Market elasmobranch composition includes 13 species, but is dominated by just one species, *M. mustelus*, representing more than 60% of the landing. A high proportion of males were sexually immature, ranging for the different species from 25% to more than 86%. Our models fit data well and predict that, without management, *M. mustelus* population will decrease of approximately 80%, and *S. canicula* of more than 90% in the next 50 years. Among the modelled management approaches, the one aimed to protect juveniles performed far better than the fishing effort reduction. Landing records, market surveys and modelling results provide different perspectives on elasmobranch in the Northern Adriatic Sea, yet they all indicate the urgent need of management actions to stop the striking elasmobranch decline. The modelling approach delineates a management scenario that could be practicable for these species, given their high survival rates when discarded at sea.

Keywords: long-term data, landing, management, individual based model, trends

14. PHYLOGEOGRAPHIC DISTRIBUTION & BIOGEOGRAPHY OF THE ANGEL SHARK, *SQUATINA DUMERIL*, L.1818, FROM THE NORTHWEST ATLANTIC OCEAN

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The Atlantic angel shark (*Squatina dumeril*) is a demersal elasmobranch found within the continental shelf zones of the Gulf of Mexico and northwest Atlantic Ocean. Currently listed as 'data deficient' on the IUCN Red List, little is known of this species' distribution, abundance and life history characteristics. This study examines the evolutionary history and population structure of *S. dumeril* using mitochondrial DNA control region sequences from the northwest Atlantic (NWA), and western and eastern populations from the Gulf of Mexico (WGOM and EGOM, respectively). Analyses revealed very little variation between sequences, with 10 polymorphic sites giving 18 haplotypes, with the most common haplotype being found throughout all regions. Haplotype diversity was quite high ($h = 0.889 \pm 0.015$) and nucleotide diversity was low ($\pi = 0.0028 \pm 0.00012$), indicative of rapid population expansion after a period of low overall population size. Significant spatial differentiation between NWA and the GOM supports the existence of two lineages, but weak population structure and low differentiation between EGOM and NWA indicates that some genetic exchange is occurring. There are two predicted barriers to gene flow; firstly, between the western and eastern Gulf, and secondly, between the eastern Gulf and northwest Atlantic, the former being the most prominent. The most likely explanation for the biogeography of the Atlantic angel shark is a population split during the Wisconsin glaciations, and southerly migration into glacial refugia, with post-glacial recolonisation northwards once seas warmed. Due to slow molecular evolution in sharks, there may have been insufficient time for stochastic processes to produce large differences in haplotype frequencies. This study supports current US fisheries management banning all landings of *S. dumeril*, with management and conservation units established for a single genetic stock until further genetic and tagging programs can be conducted.

Keywords: Atlantic angel shark, mtDNA, phylogeography, northwest Atlantic

15. THE IMPORTANCE OF SPECIES-SPECIFIC IDENTIFICATION AND RECORDING: IMPROVING THE KNOWLEDGE-BASE IN THE COMMERCIAL AND RECREATIONAL FISHING AND ENFORCEMENT SECTORS

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Chondrichthyans – the Batoids in particular – are an extremely diverse group, displaying some of the greatest intra-species variation of all marine species. The absence of readily accessible, detailed identification materials demonstrating intra-species variation has hindered efforts to effectively assess our remaining shark, skate and ray populations and make appropriate management recommendations. Similarly, the recent profusion of EU and UK commercial fisheries regulations relevant to Elasmobranchs further complicates the jobs of both fishermen and enforcement officers.

The Shark Trust has engaged with a wide range of stakeholders – including commercial and recreational fishers, fisheries enforcement, researchers and government – to develop and distribute ID Guides, commercial Fisheries Advisories and recreational angling 'best practice' and recording resources. The Trust continues to update and refine these resources, making them user-friendly and accessible to all stakeholders.

Keywords: Species-specific, Identification, Fisheries, Enforcement

16. AMPLIFICATION OF DEGRADED NUCLEAR AND MITOCHONDRIAL DNA FROM GREAT WHITE SHARK TEETH

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Characterizing genetic variation by retrospective genotyping of trophy or historical samples of endangered animals is an important tool in conservation genetics. The world's largest predatory shark, the great white shark, *Carcharodon carcharias*, is relevant in this context because it is globally threatened by human exploitation. Here, we describe attempts to amplify DNA extracted from the osteodentine of white shark teeth, and extend these to a 25 year old dried tissue sample. Analysis of the mtDNA D-loop by reconstitution of larger sequences from smaller amplicons is presented. Amplification of short tandem nuclear repeats from the same samples was also attempted. D-loop sequences can be successfully obtained, whilst microsatellite genotyping errors are common, PCR failure being associated with the size of amplicons and DNA degradation. This approach, perhaps especially to species with teeth lacking a pulp cavity, is in its provision of additional resources from rare and endangered species held in uncurated contemporary and historical dry collections. Potentially, this methodology could be employed to analyse forensic samples from shark attack victims, identify the perpetrator species, and broaden the application of trade monitoring, allowing origin identification of an individual; a particularly important aspect of litigation involving protected species. Where substantial archival material is available for retrospective analyses of genetic changes between historical and contemporary shark stocks, this approach may also benefit attempts to elucidate long term effects of fishing pressure on the genetic health of endangered species.

Keywords: teeth, *Carcharodon carcharias*, museum specimens, mitochondrial DNA, genotyping

17. THE MEDITERRANEAN AS AN EVOLUTIONAR CRADLE FOR ELASMOBRANCHS: EVIDENCE FROM SHARK AND RAT META-SPECIES PHYLOGEOGRAPHY

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The Mediterranean is a recently originated marine biota (approximately at the end of the Messianian salinity crisis; 5.33 MYA). Further repeated fluctuations of climatic and hydrogeographical factors have tumultuously tormented the evolutionary history of marine fauna. Here, we investigated the phylogeography of four small-sized species of elasmobranches (*Raja clavata, R. miraletus, Scyliorhinus canicula,* and *Galeus melastomus*) with the aim to assess the generality of phylogeographical patterns and of phylogeographical barriers for the Mediterranean elasmobranches. Target species are widely distributed in Mediterranean and abundant in trawl survey hauls. In addition, they are mainly demersal, with benthic egg and thus exhibiting non-migratory behaviour. Even though these species are very common throughout the Mediterranean Sea and their status is currently not concerned in the IUCN reports, they are severely impacted by bottom trawl fishery.

We analysed nucleotide sequence variation of approximately 300 specimens collected from 4 geographical locations ranging from Western to Eastern Mediterranean at three mtDNA loci: the control region (CR), the NADH dehydrogenase subunit 2 gene (ND2) and the cytocrome oxidase subunit 1 (COI).

Phylogeographic patterns were inferred by analysing haplotype phylogenies and by assessing genetic divergence and demographic histories of population samples. The inferred patterns were discussed according to the past and present patterns of hydrogeographical conditions in order to identify phylogeographic barriers and evolutionary factors that have likely contributed to the diversification of Mediterranean sharks and skates.

Keywords: population structure, thornback ray, brown ray; blackmouth catshark, small-spotted catshark

18. DNA BARCODING OF THE MEDITERRANEAN CHONDRICHTHYANS (ELASMOMED)

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Within ELASMOMED, a regional initiative of the Fish-BOL campaign aiming at the DNA barcoding of Mediterranean chondrichthyans (sharks, skates, rays and chimeras), we have sampled and barcoded ca. 1000 cartilaginous fishes collected from several locations in the Western and Eastern Mediterranean and adjacent Eastern Atlantic. Individuals were obtained from international and national scientific trawl surveys (e.g. MEDITS) or at the fish markets (e.g. Poissonerie de Algiers) and provisionally assigned to species based on the available morphological identification keys and guidelines. Finclip or muscle tissue specimens were collected following Fish-BOL protocol and processed for DNA barcoding at the Canadian Centre for DNA Barcoding (CCDB) of Guelph or at the own molecular labs at the Universities of Bologna, Cagliari and Palermo. Barcodes were deposited in the BOLD under the ELASMOMED Project (http://www.boldsystems.org/views/projectlist.php?&). We obtained 835 COI-5P sequences of high quality (< 1% of Ns) belonging to 58 cartilaginous fish species (Mediterranean: 16 shark species out of the 42 reported in the basin; 19/36 skates and rays; 1/1 chimera; Eastern Atlantic: 27 skates and rays). According to the DNA barcode variation, we get evidence for 1) the high taxonomic resolution and reliability of the barcode identification, 2) the occurrence of species misidentification or missing identification of few sharks and numerous skate individuals based on the external rough morphology during routine data collection of the fishery survey programmes; 3) the geographical cryptic speciation in Atlantic and Mediterranean skates, and 4) the geographical structuring in skates among Atlantic, Western and Eastern Mediterranean population samples. These outcomes highlighted and reinforced general issues which are relevant for understanding the evolution and the population biology of chondrichthyans in the Mediterranean as well as for planning the conservation and management of endangered or declining species (Dulvy & Reynolds 2009; Griffiths *et al*. 2010; Iglésias *et al*. 2009).

Keywords: cryptic species, molecular taxonomy, sharks, skates, species misidentification

19. SKATES OF THE MEDITERRANEAN SEA

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In the Mediterranean Sea the family Rajidae is represented by four genera and 16 possible valid species. The classification of these species is problematical as the identification is made difficult for the lack of simple morphometric references that would allow the use of adequate taxonomic keys. Some uncertainty is present in the taxonomy of this group, also at species level, due to the great individual variety of the biological (age, sex, etc.) and environmental characteristics. Moreover, some species are rarely available and then hardly caught in the scientific surveys, making even more difficult their identification.

The work was produced mainly thanks to the information coming from national and international scientific bottom trawl surveys, funded by the Italian Ministry of Agricultural, Food and Forestry Policies (GRUND trawl survey) and by the European Commission (MEDITS trawl survey).

Capture data of non-target species were analysed with the aim of comparing biomass trends, size distribution of the samplings, biological information, etc.

Since that important comparison, some doubts arose about the proper identification of skate species. The doubts came from the lack of accurate keys for the identification of the species, as the tools used were not able to assure the identification.

The aim of this document is to set the standard for a common effort involving the coordination groups of the GRUND and MEDITS surveys, in order to obtain easy and reliable species identification keys, useful especially during scientific surveys, in the field and in laboratory, but also in monitoring of landings. In this context, some consideration not only about taxonomy but also on stock assessment of exploited resources arose.

Keywords: taxonomy, skates, species misidentification

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