8th European Elasmobranch Association Conference

21st - 24th October 2004
Zoological Society of London

Hosted by:

ZSL
LIVING CONSERVATION

SHARK TRUST

Presentation programme

Friday 22nd	
9.15 – 10.00	**Registration.**
10.00	**Welcome by Shark Trust Chair.**
10.10	**Welcome by EEA Chair.**
Session 1	**Current perspectives in the management and conservation of elasmobranchs. (Session chair: Jim Ellis).**
10.20 – 11.00	**Keynote address: John Morrissey, Biology of a new species of gulper shark from the Caribbean Sea.**
11.00 – 11.15	**Title**: Spatial dynamics of white sharks in South Africa. **Authors**: R. Bonfil, S. O'Brien, M. Meÿer, R. Johnson, M. Scholl, H. Oosthuizen, D. Kotze, S. Swanson and M. Paterson.
11.15 – 11.30	**Title:** The implications of 17 years of basking shark volunteer sightings data for basking shark conservation in the UK and Ireland. **Authors:** J. I. Doyle, J. Solandt, S. Fanshawe, C. Duncan and G. Saville.
11.30 – 11.45	**Title**: The role of CITES in shark conservation and management. **Author**: S. Fowler.
11.45 – 12.00	**Title:** Biodiversity and conservation of North Eastern Atlantic and Mediterranean skates and rays (Chondrichthyes: Rajidae). **Authors**: P. Pasolini, T. Bakken, M. Bertozzi, F. Hemida, C. Mancusi, J. Palsson, F. Serena, C. Turan, N. Ungaro, E. Valsecchi, J. Ellis and F. Tinti
12.00 – 12.15	**Title**: Identifying critical habitat of basking sharks in the north east Atlantic Ocean: using electronic tags, surveys and sightings data. **Authors:** E. J. Southall, D. W. Sims and J. D. Metcalfe.
12.15 – 12.30	**Title**: Conservation of freshwater elasmobranchs. **Author**: R. A. Martin.
12.30 – 13.30	**Lunch and poster session.**
Session 2	**Current perspectives in the management and conservation of elasmobranchs. (Session chair: Sarah Fowler).**
13.30 – 13.45	**Title**: Plan of Action for the conservation and management of sharks in UK waters. **Authors**: S. Fowler, C. B. Mogensen and T. Blasdale.
13.45 – 14.00	**Title**: Conservation genetics of three species of lamniform sharks. **Authors**: C. Jones, J. Sarginson, M. Antsalo, A. Martin, D. Sims, J. Metcalfe and L. Noble.
14.00 – 14.15	**Title:** The traditional shark fisheries of south west Madagascar: a study of two villages in the Toliara region. **Authors**: A. R. McVean, R. Walker and E. Fanning. **CANCELLED**
14.15 – 14.30	**Title**: Long-term changes in the distribution and abundance of two shark species in waters around Scotland. **Authors**: K. M. MacKenzie, D. Beare , E. Jones and C. T. Marshall.
14.30 – 14.45	**Title**: Habitat-specific differences in diel vertical migration of the basking shark and its conservation implications. **Authors**: D. W. Sims, E. J. Southall, G.A. Tarling and J. D. Metcalfe.
14.45 – 15.00	**Title**: Movements and residence times of grey nurse sharks (*Carcharias taurus*) within nominated protected areas. **Authors**: B. Bruce, J. Stevens and N. Otway.
15.00 – 15.30	**Afternoon break – poster session.**
Session 3	**Current perspectives in the management and conservation of elasmobranchs. (Session chair: John Morrissey).**

15.30 – 15.45	**Title**: Basking shark sightings in Brittany waters (France) from 1997 to 2004. **Authors**: E. Stéphan, A. Jung and S. Blanchard.
15.45 – 16.00	**Title:** Seasonal migration of thornback rays and implications for closure management. **Authors:** E. Hunter, F. Berry, A. A. Buckley, C. Stewart and J. D. Metcalfe.
16.00 – 16.15	**Title:** The potential for wildlife tourism to contribute towards elasmobranch conservation: A case study of the South African cage-diving industry. **Author**: J. Dobson.
16.15 – 16.30	**Title**: The release of sharks from public and private aquariums. **Author**: H. Koldewey.
16:30 – 16.45	**Title**: Conservation status of Mediterranean sharks and rays. **Authors**: R. D. Cavanagh and A. Abdulla. **CANCELLED**
16:45 – 17.00	**Title**: Assessing the threat status of UK elasmobranchs. **Authors**: J. Ellis, N. Dulvy, S. Jennings, M. Parker-Humphreys and S. Rogers.
17.00	**CLOSE.**
19.30	Conference dinner.

Saturday 23rd	
9.30 – 10.00	**Registration.**
Session 4	**Current perspectives in the management and conservation of elasmobranchs. (Session chair: David Sims).**
10.00 – 10.30	**Keynote address: Bernard Sèret, Shark fisheries and conservation in the Seychelles Island: a case study.**
10.30 – 10.45	**Title:** Habitat distribution of the basking shark (*Cetorhinus maximus*) in the Mediterranean: implications for conservation. **Authors:** A. Mancini and A. Abdulla.
10.45 – 11.00	**Title:** Elasmobranch captures in the trammel net fishery associated to MPAs in the Balearic Islands. **Authors:** G. Morey, J. Moranta and B. Morales-Nin. **CANCELLED**
11.00 – 11.15	**Title:** EEA in Perspective: past, status quo and future tasks - a steep road ahead? **Authors:** B. Frentzel-Beyme.
11.15 – 11.30	**Title**: Electrosensitive fish and coastal renewable energy developments in UK waters. **Author**: A. B. Gill.
11.30 – 11.45	**Title**: Population structure of the thornback ray, *Raja clavata* L. in southern England waters. **Authors**: M. Chevolot, G. Hoarau, A.D. Rijnsdorp, W.T. Stam and J.L. Olsen.
11.45 – 12.00	**Title**: Studies of an exceptionally large feeding aggregation of whale sharks (*Rhincodon typus*) off Quintana Roo, Mexico. **Authors**: R. Hueter, G. Cano, F. R. Suarez and J. Tyminski.
12.00 – 13.00	**Lunch and poster session.**
Session 5	**Elasmobranch biology and ecology. (Session chair: Nick Dulvy).**
13.00 – 13.15	**Title:** Cloning and expression of alpha and beta subunits of the Na, K-ATPase from the euryhaline bull shark, *Carcharhinus leucas.* **Authors:** L. Meischke and G. Cramb.
13.15 – 13.30	**Title:** Relax immobility in sharks: preliminary results on Caribbean reef sharks. **Authors:** R. S. Avogadri and F. Gioelli.

13.30 – 13.45	**Title:** Mechanisms underlying sexual segregation in a sexually monomorphic elasmobranch. **Authors:** V. J. Wearmouth, D. W. Sims, J. C. Partridge, I. C. Cuthill and J. D. Metcalfe.
13.45 – 14.00	**Title:** Reproductive biology of the spiny dogfish, *Squalus acanthias,* in the eastern Mediterranean Sea. **Authors**: A. Chatzispyrou and P. Megalofonou.
14.00 – 14.15	**Title:** Electromagnetic fields generated by marine power cables and their potential impact on electrosensitive fish. **Authors:** G. Vella.
14.15 – 14.30	**Title**: Individual variability in electroreceptive behaviour of a benthic shark, the lesser spotted dogfish (*Scyliorhinus canicula*). **Authors**: J. A. Kimber and Andrew B. Gill.
14.30 – 14.45	**Title**: Age and growth of the blue shark, (*Prionace glauca*), at western coast of Baja California Sur, Mexico. **Authors**: M. del Pilar Blanco-Parra, F. Galván-Magaña and J. F. Márquez-Farias.
14:45 – 15.15	**Afternoon break – poster session.**
Session 6	**Elasmobranch biology and ecology. (Session chair: Andrew Gill).**
15.15 – 15.30	**Title**: Sharksucker induced behaviour in captive bull sharks. **Authors**: J. M. Brunnschweiler.
15.30 – 15.45	**Title**: Prey species and size preference of nursery-bound juvenile lemon sharks, *Negaprion brevirostris.* **Authors**: S. P. Newman, S. H. Gruber and R. D. Handy.
15.45 – 16.00	**Title**: Deepwater sharks most currently found in Canary Islands. **Authors**: A. S. Rafel, A. B. Hernández and P. P. Alayón.
16.00 – 16.15	**Title**: Foraging excursions of female dogfish to and from 'home' refuges. **Authors**: N. Hutchinson, D. W. Sims and D. Morritt.
16.15 – 16.30	**Title**: In the sharks' cradle. **Authors**: S. Clò and E. de Sabata.
16:30 – 16.45	**Title:** Migratory Behaviour of the thornback ray, *Raja clavata* L., in the southern North sea. **Authors:** E. Hunter, A. A. Buckley, C. Stewart and J. D. Metcalfe.
16:45 – 17.00	**Title**: Teeth sexual dimorphic development in *Raja asterias* (De La Roche, 1809): ontogenetic and seasonal pattern analysis related to the reproductive biology. **Authors**: A. Colasante, U. Scacco and M. Vacchi.
17.00 – 17.15	**Title**: Overview of white shark (*Carcharodon carcharias*) research at Seal Island, South Africa. **Authors**: R. A. Martin, N. Hammerschlag and C. Fallows.
17.15	Close of meeting.

Friday 22nd October

Presentation Abstracts

Abstracts as submitted by authors.

10.20 – 11.00
KEYNOTE: Biology of a new species of gulper shark from the Caribbean Sea.

***J. F. Morrissey**, D. M. McLaughlin, J. A. Olin, R. H. Buch, N. Carroll and C. P. J. Sanford.*
Hofstra University Marine Laboratory, 114 Hofstra University, Hempstead, NY 11549-1140, USA.
(Email: john.f.morrissey@hofstra.edu).

Fifty-four specimens of a putative new species of *Centrophorus* were obtained off the north coast of Jamaica via horizontal longline between August 2000 and March 2002 from depths of 250-913 m. Discriminant function analysis was performed on 65 morphometric measurements of 54 museum specimens and 30 Jamaican specimens. This multivariate analysis supports the validity of *C. acus*, *C. granulosus*, and *C. uyato* in the NW Atlantic and suggests that our Jamaican form is a new species, distinguished by the length of its snout, pelvic inner margin, caudal subterminal margin, and caudal fin. Vertebral counts also separate these four species. Age of the Jamaican specimens was determined from cross-sectioned dorsal fin spines. Growth curves were constructed and size and age at maturity determined for all readable samples. In addition, the retina of this deep-water gulper shark were compared to the retinas of *Alopias vulpinus*, *Isurus oxyrinchus*, and *Prionace glauca*.

These epipelagic sharks have retinas composed of both rod and cone photoreceptors in ratios of 17:1, 16:1, and 20:1, respectively, whereas our Jamaican *Centrophorus*, a mesobenthic species, has a rod-only retina.

Investigations into eight different regions of the retinas, four central and four peripheral, exhibited no indication of intraretinal variation in terms of photoreceptor abundance, distribution, outer-segment length, inner-segment length, or width. As expected, interspecific variation in these characteristics was observed. Last, the reproductive biology of 8 males and 51 females has been examined.

This species is sexually dimorphic, with females attaining a larger size than males. The smallest mature male was 81.2 cm total length whereas the smallest mature female was 91.5 cm total length. Females are aplacentally viviparous with a maximum of two pups per litter and a gestation period of three years. The pups acquire nutrition via their large external yolk sacs. There was no evidence of additional maternal contributions to the nourishment of the embryos. Oocytes continued to develop throughout gestation. Most females carrying developing embryos had two large (>3.3 cm), equally developed ovarian oocytes, which leads us to believe that they ovulate soon after parturition. This species seems to exhibit complete sexual segregation during the non-breeding season, with mature males being completely absent from the study site during the summer months.

11.00 – 11.15
Spatial Dynamics of White Sharks in South Africa.

R. Bonfil[1]*, S. O'Brien*[1]*, M. Meÿer*[2]*, R. Johnson*[3]*, M. Scholl*[4]*, H. Oosthuizen*[2]*, D. Kotze*[2]*, S. Swanson*[2] *and M. Paterson*[2]*.*
[1] *Wildlife Conservation Society, 2300 Southern Boulevard, Bronx, New York, 10460 USA.*
(Email: rbonfil@wcs.org, sobrien@wcs.org).
[2] *Marine and Coastal Management Branch, Department of Environmental Affairs and Tourism, Private Bag X2, Roggebaai 8012, Cape Town, Western Cape, South Africa.*
(Email: mmeyer@deat.gov.za, Oosthuiz@deat.gov.za, dkotze@deat.gov.za, swanson@deat.gov.za).
[3] *Department of Zoology and Entomology, University of Pretoria, Pretoria 0002, South Africa.*
(Email: Johnson@maxitec.co.za).
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(Email: MScholl@WhiteSharkTrust.org).

Great white sharks (*Carcharodon carcharias*) have for long been the focus of intense media attention, however information about their ecology and in particular their movements and migrations is still very limited. Their populations are vulnerable to mild levels of mortality from commercial fisheries and trophy hunters as a result of their biological profile. Currently, protection for this species is limited to jurisdictional waters of only five countries including South Africa. We have used satellite telemetry to investigate the spatial dynamics of great white sharks off the Western Cape of South Africa. Between June 2002 and May 2004, white sharks of both sexes ranging in size from 230 to 420 cm TL were fitted with pop-up archival satellite transmitting ("PAT") tags (n = 25) and near-real-time satellite tags (n = 18). Our results show that white sharks make long-distance coastal migrations (>1000 km) to locations off KwaZulu-Natal and beyond off Mozambique, where they are not protected. They also make frequent small-scale migrations (<1000 km) to other areas on the Eastern Cape and Western Cape, and remain in preferred bays for extended periods of time. Results about white sharks' depth and temperature preferences are also shown. The implications of these movements and migrations for the management and conservation of South African white sharks are discussed and the need for more comprehensive international protection is highlighted.

11.15 – 11.30

The implications of 17 years of basking shark volunteer sightings data for basking shark conservation in the UK and Ireland.

***J. I. Doyle**, J. Solandt, S. Fanshawe, C. Duncan and G. Saville.*
Marine Conservation Society, Unit 3 Wolf Business Park, Alton Road, Ross-on-Wye, HR9 5NB, UK.
(Email: jo@mcsuk.org).

The Marine Conservation Society (MCS) has analysed 17 years of basking shark sightings data reported through the Basking Shark Watch Project, a voluntary sightings scheme. The scheme enables us to compare spatially, and to a certain extent, temporally between areas where sharks are abundant and those areas where sharks rarely occur. Results from a report published in 2003 indicated 'hotspots' where sharks were recorded in considerable abundance. Within these hotspot regions key areas have been identified on a local scale (10's of kilometres), which appear to be of particular importance to basking sharks. Temporal patterns of sightings indicate a shift from south-west waters in the early part of the summer season (May/June) to northern waters in later summer (August/September). Reports also include data on shark size, allowing changes in the population's size class to be identified over space and time. As there is little accurate historical or present scientific data on the population numbers and structure of basking sharks in UK and Irish waters this data, although collected by non-scientific methods, is invaluable. Combining the results of recent basking shark telemetry studies with MCS sightings data is beginning to help us understand their movements and behaviour. As such the sightings reports from the general public have implications for the future conservation and management of this protected species.

11.30 – 11.45
The role of CITES in shark conservation and management.

S. Fowler.
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The 13th meeting of the Conference of Parties to the Convention on International Trade in Endangered Species (CITES) takes place just before the 2004 EEA Conference. CITES Parties will debate a review of the 2002 Resolution on the Conservation and Management of Sharks and a proposal to list white shark *Carcharodon carcharias* on Appendix II of CITES. If adopted, the latter listing will regulate and ensure the sustainability of international trade in white shark products. Although the white shark listing proposal has received most attention, the 2004 CITES Conference has the potential significantly to improve much broader international shark conservation and management measures worldwide, provided that important draft Decisions recommended by the CITES Secretariat and Animals Committee are adopted. These include holding an international technical workshop on shark conservation and management, seeking the development, adoption and implementation of new international agreements and regional instruments for the conservation of high seas, pelagic and straddling shark stocks, and requesting that States improve their management of fisheries and trade in a number of elasmobranch taxa of special concern (these include spiny dogfish *Squalus acanthias*, tope shark *Galeorhinus galeus*, porbeagle shark *Lamna nasus*, deepwater gulper sharks *Centrophorus* spp., freshwater stingrays family Potamotrygonidae, sawfishes family Pristidae, guitarfishes order Rhinobatiformes, and devil rays family Mobulidae). This paper will report on the process leading into the Conference, the debates and outcomes of the meeting, and their implications for the management and conservation of elasmobranchs in Europe and internationally.

11.45 – 12.00

Biodiversity and conservation of North Eastern Atlantic and Mediterranean skates and rays (Chondrichthyes: Rajidae).

***P. P. Pasolini**, T. Bakken. M. Bertozzi, F. Hemida, C. Mancusi, J. Palsson, F. Serena, C. Turan, N. Ungaro, E. Valsecchi, J. Ellis and F. Tinti.*
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In the NE Atlantic-Mediterranean region 32 species of skates and rays (Rajidae) are currently reported and 9 are endemics. Documented population declines and local extirpations make Rajidae as one of the most vulnerable groups of marine fishes. In spite of this, basic data, such as taxonomic, biological and demographic information, are scant or lacking for several species. Throughout the implementation of MED_SKATE - an on-line databank of the biodiversity of NE Atlantic and Mediterranean Rajidae (http://www.med-skate.unibo.it) - we have investigated the species diversity of NE Atlantic-Mediterranean skates to fill part of this gap of information in order to prioritise conservation programs of threatened species.

Data collection was carried out through the network of collaborators and consisted of the acquisition of biological data; tissue samples and scaled digital pictures of all Mediterranean valid species from different areas and of several NE Atlantic species. MED_SKATE includes more than 800 individual records and data for 10 geographic local faunas. The comparative analysis of some biological traits suggested that in the Mediterranean most species could be really threatened by the intense trawl fisheries. Using species-specific DNA markers we have carried a first extensive molecular survey that improved the identification, systematic and evolution of rajid species.

Presently, MED_SKATE represents a unique scientific tool where referenced information and samples of Rajidae can be deposited, aggregated and retrieved. It is also auspicated that more local collaborators will join the operative network of MED_SKATE, improving the monitoring and conservation of more local rajid faunas.

12.00 – 12.15

Identifying critical habitat of basking sharks in the north east Atlantic Ocean: using electronic tags, surveys and sightings data.

E. J. Southall[1]*, D. W. Sims*[1] *and J. D. Metcalfe*[2]*.*
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[2] *CEFAS, Lowestoft Laboratory, Pakefield Road, Lowestoft, NR33 0HT, UK. (Email: j.d.metcalfe@cefas.co.uk).*

There is concern that the population levels of basking sharks (*Cetorhinus maximus*) in the northeast Atlantic have been reduced by human exploitation and have yet to recover. However, in the absence of reliable population size estimates based on appropriate scientific data, it remains difficult to assess the current status of this species. If population size is to be estimated accurately, surveys must be undertaken in the areas used by the major part of the basking shark population. In addition, their movements and behaviour between preferred habitat need to be investigated. In this paper we will describe how electronic tags are being used to track the large-scale movements of sharks and what this tells us about their habitat selection processes. A new consortium-based project will also be introduced which aims to identify critical habitat of basking sharks by incorporating behavioural data with surveys and sightings data.

12.15 – 12.30
Conservation of Freshwater Elasmobranchs.

R. A. Martin.
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Fishery management and biology of freshwater elasmobranchs have received little study. The low taxonomic and morphological diversity of freshwater elasmobranchs compared with freshwater bony fishes and marine cartilaginous fishes suggest that fresh water may be a marginal habitat for elasmobranchs. Most freshwater elasmobranchs occur in tropical riverine and lacustrine ecosystems of developing countries with enormous, rapidly expanding human populations. Increasing levels of direct anthropogenic exploitation and habitat modification, degradation, or destruction threaten many freshwater elasmobranch stocks. Obligate freshwater elasmobranchs with limited geographic distributions are most at risk, but euryhaline species (some of which breed in fresh water) are also threatened by increasingly intensive artisanal and small-scale commercial fisheries, tourist sport fisheries, and coastal development/degradation. Specific threats to euryhaline and obligate freshwater elasmobranchs are identified and socioeconomic issues affecting their conservation are discussed. Suggested priorities for research on and management of freshwater elasmobranchs are offered.

13.30 – 13.45
Plan of Action for the Conservation and Management of Sharks in UK waters.

*S. Fowler[1], C. B. Mogensen[2] and **T. Blasdale**[3].*
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The FAO's voluntary International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) calls upon states to prepare Shark Assessment Reports (SARs) and, if they have fisheries, to develop and implement National Plans of Action (Shark Plans). The term "shark" is taken to include all chondrichthyans. The EU is developing a shark plan on behalf of Member States, however, the IPOA calls upon states to take action regardless of actions taken at a regional level and so it is appropriate for the UK to develop its own Shark Plan. This report includes a brief description of chondrichthyan fisheries in UK and adjacent waters which could stand as an interim SAR (although a full SAR should be prepared as soon as possible) and makes recommendations for the content of a Shark Plan. The UK has commercial and recreational fisheries for sharks including coastal and shelf fisheries, deep-water fisheries and pelagic fisheries and these are briefly described. The state of the stocks is described noting the inadequacy of landings data and consequent lack of reliable stock assessments for most species. Many of the actions required to manage shark fisheries in UK waters are the exclusive competence of the EU, however, the UK can impose additional measures within its 12 nautical miles territorial waters and take action to improve the quality of landings data and scientific advice. Recommended actions include those which can be implemented at a UK level and should be included in a UK Shark plan as well as those which are recommended for EU action. Some UK Overseas Territories also have chondrichthyan fisheries and should be encouraged and assisted in developing Shark Plans of their own.

13.45 – 14.00
Conservation genetics of three species of Lamniform sharks.

*C. Jones[1], J. Sarginson[1], M. Antsalo[1], A. Martin[2], D. Sims[3], J. Metcalfe[4] and **L. Noble[1]**.*
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[2] Department of Environmental, Population, and Organismic Biology, University of Colorado, Boulder, CO 80309, USA.
[3] Marine Biological Association of the UK, Citadel Hill, Plymouth PL1 2PB, UK.
[4] Centre for Environment, Fisheries & Aquaculture Science, Lowestoft Laboratory, Suffolk NR33 0HT, UK.

Continued overexploitation of shark stocks has resulted in the collapse of many large coastal and oceanic species in the North-West Atlantic; with some reduced by up to 89%. It is well accepted that the vulnerability of shark species to overfishing is a consequence of their low intrinsic rates of increase, due to low fecundity and late maturity. However, little account has been taken of a phenomenon we have recently demonstrated in Great White sharks which makes them potentially even more vulnerable to area overfishing - that of sex-biased dispersal. Our work has demonstrated white sharks may be at an increased risk because females remain at their birth place, or return to pup. We are developing molecular genetic tools to investigate the population genetic structure and dynamics of the Lamniformes, and to determine how widespread this phenomenon is in lamnoid sharks because of its immense impact upon conservation measures. Preliminary data for the Porbeagle (*Lamna nasus*) suggest that there is long-distance dispersal between disjunct northern and southern hemisphere populations, as evidenced by the lack of population differentiation in nuclear genetic markers. However, maternally inherited markers show a greater degree of population differentiation, suggesting that although females of this species may migrate more than white sharks, dispersal appears male biased. Investigations are now extending to the plankton-eating basking shark (*Cetorhinus maximus*), the world's second largest fish species. Little is known about stock structure, annual migration circuits, the relationship between regional population declines and global trends, and whether populations are discrete.

14.00 – 14.15
The traditional shark fisheries of south west Madagascar: a study of two villages in the Toliara region.

***A. R. McVean**, R. Walker and E. Fanning.*
Society for Environmental Exploration, 50-52 Rivington Street, EC2A 3QP, London, UK.
(Email: gus_mcvean@yahoo.co.uk).

Traditional shark fisheries in Africa are largely poorly documented. Fisheries management plans for fisheries targeting chondrichthyan species are typically based on studies with limited spatial resolution or detail compromising their efficacy and potentially reducing the effectiveness of national and regional plans. South west Madagsacar is an area which is poorly documented with regard to many of its marine resources. This study presents a detailed investigation of the directed shark fisheries of two villages south of Toliara - Soalara and Maromena - presenting a description of the fishery in these villages and catch data for periods of 12 and 10 months respectively. Results from a total of 1,164 catch records, including members of at least 13 species, with an estimated total wet weight of over 123mt are reported with hammerhead sharks (*Sphyrna* spp.) representing 29% of sharks caught and 24% of the total wet weight. These findings, in conjunction with anecdotal evidence collected from fishers, indicate a fishery of considerable social and economic importance that is showing signs of decline, possibly as a result of changing fishing practices associated with the intervention of outside agencies.

Presentation cancelled.

14.15 – 14.30

Long-term changes in the distribution and abundance of two shark species in waters around Scotland.

***K. M. MacKenzie*[1]**, *D. Beare*[2] , *E. Jones*[2] *and C. T. Marshall*[1].
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[2] *Fisheries Research Service, Aberdeen, UK.*

The abundance and geographical distribution of two small species of shark, the lesser-spotted dogfish, *Scyliorhinus canicula*, and the spurdog, *Squalus acanthias*, in waters around Scotland were investigated for the 78-year period from 1925 to 2003. The data originated from the groundfish trawl surveys carried out by the Fisheries Research Service (FRS), Aberdeen. Abundance trends (in catch per unit effort) were determined by generalized additive models (GAMs). Distribution was investigated by plotting annual abundance onto maps of the survey area using GIS, and comparing years. The lesser-spotted dogfish exhibited an upward trend in abundance, while the spurdog fluctuated largely without a distinct directional trend over the period. Both species are more abundant around the West Coast of Scotland, with particular density around the Outer Hebrides. Lesser-spotted dogfish were also found to be abundant in the Solway Firth and around the north-west continental shelf edge, with a possible increase in abundance and distribution around the shelf edge. From analysis of the quarter one surveys carried out only in the North Sea, both sharks appear to be declining in abundance in this area.
Possible reasons for the observed trends in abundance and distribution are discussed, including life history traits, interactions with other species, and habitat preferences. It is suggested that lower levels of exploitation, greater adaptability and comparatively r-selected life history is responsible for the increase in *S. canicula* compared with *S. acanthias*. Further studies are suggested to clarify the observed trends.

14.30 – 14.45

Habitat-specific differences in diel vertical migration of the basking shark and its conservation implications.

D. W. Sims*[1]*, E. J. Southall*[1]*, G. A. Tarling*[2] *and J. D. Metcalfe*[3]*.

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Megaplanktivores such as filter-feeding sharks are at the apex of a very short food chain (phytoplankton-zooplankton-shark) and have been shown to be sensitive indicators of sea-surface plankton availability. Their tendency to feed for long periods at the surface has also brought about their exploitation by harpoon fisheries. Similarly, shipborne and aerial population surveys count the number of surfacing sharks to assess distribution and abundance. However, no study has yet to determine whether the probability of sighting sharks at the surface is location-specific within its geographic range. A key factor likely to control vertical habitat selection of plankton-feeding sharks is the diel vertical migration (DVM) of zooplankton. Based on the first high-resolution archival data collected for a plankton-feeding fish species we show that DVM patterns of the basking shark (*Cetorhinus maximus*) reflect habitat type and zooplankton behaviour. In deep, well-stratified waters sharks exhibited normal DVM (nocturnal ascent) by tracking migrating sound-scattering layers characterised by Calanus and Euphausiids. Sharks occupying shallow, inner-shelf areas near thermal fronts conducted reverse DVM (nocturnal descent) possibly due to zooplankton predator-prey interactions that resulted in reverse DVM of Calanus. Hence, the probability of sighting basking sharks at the surface ranges from 0.01–0.60 depending on habitat. Shipborne surveys undertaken in each habitat at the same time as trackings reflect these differences. Our results indicate basking sharks are at greater risk from harpoon fisheries in seasonally persistent frontal habitat, and that population surveys need to be stratified to account for this habitat-specific bias.

14.45 – 15.00

Movements and residence times of grey nurse sharks (*Carcharias taurus*) within nominated protected areas.

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Grey nurse sharks (*Carcharias taurus*) have been protected in Australian waters since 1984. However, despite this protection, their numbers have continued to decline and the east Australian population is now listed as critically endangered. This continued decline is in part due to their extremely low fecundity, but also to their behaviour of aggregating in specific areas (Critical Habitat Sites – CHS) where they remain vulnerable to incidental capture. Protection of nineteen of these sites has been suggested as a management option to reduce fishing impacts on the species. However, to ensure the effectiveness of such protection zones, information on both residence times and the areas around CHS that grey nurse use when they are present is required. We used direct acoustic tracking and acoustic monitoring stations to determine the frequency and duration of visits by individuals to several sites and their diel movements around these sites. Grey nurse were seasonally resident and individuals were continually detected for up to 30 days. Residency was episodic, with some sharks leaving and returning on an irregular basis. Movement between CHS up to 700 km apart was recorded for some tagged sharks. Sharks were active both day and night, moving extensively around and in some cases up to 1200 m from CHS. Although normally observed swimming within a few metres of the bottom, some tracked sharks swam mid-water up to 30 m above the bottom and on two occasions sharks swam rapidly to the surface followed by an equally rapid descent to mid-water or returning to the bottom.

15.30 – 15.45
Basking shark sightings in Brittany waters (France) from 1997 to 2004.

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Basking shark sightings in French waters have been related for a long time and a little dedicated fishery took place in south Brittany from the middle of the 40's until the end of the 80's. Despite this occurrence of the species, very few studies have been conducted in France what led the APECS to begin a public sightings record scheme in 1997. The aim of this low cost method was to gather general data on basking shark in French waters, to identify particular localities for more details investigations and also to raise public awareness. This work presents the data obtained from this public scheme in Brittany, from 1997 to 2004. Sightings occur mostly during spring and summer and present a general northerly progression along the Brittany coasts during the season. Some hotspots for shark sightings have been identified. Although this study only provide a picture of the spatial and temporal distribution of surface sightings in Brittany waters, a collaboration with other European organisations would conduct to a European conservation plan of the species and of the habitats of interest in northeast Atlantic.

15.45 – 16.00
Seasonal migration of thornback rays and implications for closure management.

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Previous studies of the thornback ray, *Raja clavata* L., have suggested that these form local sub-populations, between which few individuals are thought to transfer. This feature of the biology of thornback rays coupled with late maturation and low fecundity make these fish highly vulnerable to localised extinction due to fishery exploitation. A significant decline in the abundance of a range of commercially exploited elasmobranchs has further highlighted a growing need for sustainable management strategies.

Although subject to a total allowable catch, there are no additional conservation measures currently in operation in the North Sea aimed at protecting them. To investigate the potential impacts of closure management on this fishery, we used data from 75 mature thornback rays, tagged with electronic data storage tags and released in the Thames Estuary (United Kingdom), to determine seasonal movements and distribution patterns. The fish were at liberty between 1999-2001, during which period we also collected commercial fishing catch data.

Geo-spatial analytical techniques were applied to integrate data on the seasonal distribution of the fish with a spatial and temporal analysis of catch and fishing effort data. The impact of closed areas in the Thames Estuary is considered firstly in terms of the likely conserving effect on existing ray stocks, and secondly, the potential benefits to the commercial fishery in terms of increased ray stock biomass and yield. In addition, we will also examine the potential impact on fisheries for other commercial species.

16.00 – 16.15

The Potential for Wildlife Tourism to Contribute Towards Elasmobranch Conservation: A Case Study of the South African Cage-Diving Industry.

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Wildlife tourism can contribute towards species conservation through various mechanisms, including, the education of tourists, assisting in scientific research and proving economic incentives to conserve species. This paper examines the role in which the cage-diving industry based in the Western Cape, South Africa is able to contribute towards the conservation of the Great White shark and other Elasmobranch species. Semi-structured interviews were carried out with cage-dive tour operators, representatives from the Environment and Tourism Department's Marine and Coastal Management section and white shark researchers. Nine observations of cage diving tours were undertaken in Gansbaai, False Bay and Mossel Bay. Content analysis of brochures and web sites examined operator representations of white sharks in promotional material. The study found that there are areas of good practice in relation to shark protection although there are inherent contradictions in the construction of the tours. Many operators reinforce the 'Jaws' stereotype by using aggressive images of Great White sharks in their marketing campaigns, shark handling and, in certain cases, through the sale of souvenirs. Educational / interpretive information tended to lack reference to shark conservation issues and information was predominately given reactively rather than proactively. The government has attempted to regulate the industry via the use of a permit system and code of conduct. However problems of issuing and enforcing permits has resulted in a reliance on operator self-regulation and greater emphasis on client satisfaction rather than shark protection.

16.15 – 16.30
The release of sharks from public and private aquariums.

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Sharks are widely held in zoos and aquariums and, increasingly, education and awareness of the conservation issues facing these large marine predators is being shared with millions of visitors. In general, their life history means that these fishes are currently unlikely candidates for captive breeding and re-introduction programmes. However, an important benefit of captive breeding programmes is the collection of information about reproductive strategies, growth rates, maturity and other life history parameters. This information may be used by policy makers, with appropriate caution, to help formulate elasmobranch conservation management strategies.

The release of captive sharks has occurred historically and continues today. In general, little thought has been given to the scientific robustness of such activities and in some cases re-introduction has been used as a means of disposal of unwanted specimens, against the recommendations of the IUCN Reintroduction Specialist Group and other professional organisations' guidelines. One area of increasing concern is the release of sharks from the private sector, specifically from misguided acquisitions of species that grow large yet are available in the hobby, such as nurse sharks.

The release of sharks as currently practiced has no obvious conservation benefit, other than data collection through tagging related research, and raises some significant concerns. It is clear that a more definitive policy needed to be developed and this is being undertaken by the respective North American and European Taxon Advisory Groups (AZA, EAZA/EUAC) with the IUCN RSG Fish Section Chair. Criteria will provide a way of evaluating current practices and may eliminate some of the current industry collection practices.

This paper will present the outcomes of public aquarium efforts to minimise the negative effects of shark releases and maximise the conservation benefits of sharks in aquariums. The release of sharks is not currently part of any conservation management plan, but their use in public education programmes in aquariums is a vital component of their conservation.

16.30 – 16.45
Conservation Status of Mediterranean Sharks and Rays.

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The *IUCN Red List of Threatened Species*^{TM} is the most comprehensive source of information on the global conservation status of plants and animals. The IUCN Shark Specialist Group has a programme to complete Red List assessments for all chondrichthyans through a series of regional Red List workshops. The results from the Mediterranean Red List workshop are presented here. The Mediterranean Sea is known to be an important habitat for chondrichthyans, home to 86 species. Case studies will be discussed to illustrate the overall status of chondrichthyans in the region where almost half are considered threatened (Critically Endangered, Endangered or Vulnerable). These include Sand Tiger Sharks that aggregate at specific sites and are especially vulnerable to coastal fisheries. The Common Skate, once common but highly vulnerable to trawling, has virtually disappeared from the region. Other species of particular concern include Sawfishes and Angel Sharks. There is limited information for many of the Mediterranean species with approximately 30% classified as Data Deficient which indicates a lack of scientific and fisheries data but does not exclude these species from being a conservation concern. Further research on such populations, including Hammerheads, Guitarfishes and the Speckled Skate, is urgently needed. The Regional Red List will be published and distributed to governments, research institutions, and other agencies responsible for marine resource conservation and management. The Red List will contribute to the UNEP Action Plan for the Conservation of Cartilaginous Fishes in the Mediterranean, highlighting particular threats and detailing recommendations for action.

Presentation cancelled.

16.45 – 17.00
Assessing the threat status of UK elasmobranchs.

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Elasmobranch fishes are susceptible to over-exploitation and many species subject to important commercial and recreational fisheries and may be of conservation importance. Traditional fisheries stock assessment methods are not always appropriate for elasmobranch fishes, primarily because of a lack of species-specific landing data. Hence, other methods of determining the overall status of elasmobranch fishes are required. For demersal elasmobranchs, the best data sources are generally life-history information and fishery-independent survey data. We apply a number of threat criteria (e.g. IUCN, American Fisheries Society and Texel-Faial) to the dominant elasmobranchs in UK waters with emphasis on comparative life histories and the decline criterion for abundance and geographic occupancy.

Saturday 23rd October

Presentation Abstracts

10.00 – 10.30
KEYNOTE: Shark fisheries and conservation in the Seychelles Island : a case study.

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In the Seychelles Islands (western Indian Ocean) sharks have been traditionally exploited, but the recent development of industrial and semi-industrial fisheries has caused a growing concern for the sharks populations. Concurrently, the Seychelles have developed an important eco-touristic activities with some of them focused on shark diving. The Seychelles have been one of the first countries to fully protect the whale shark in its waters. In 2002, the Seychelles Fishing Authority asked the author to provide an overview of these economic activities related to sharks and to propose some recommendations for their sustainability in respecting the shark populations and biodiversity.

10.30 – 10.45
Habitat distribution of the Basking Shark (*Cetorhinus maximus*) in the Mediterranean: implications for conservation.

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Cartilaginous fish are known to be a large diversified group occupying a great variety of habitats and displaying different life strategies. Populations are dynamic and fluctuations may depend on oceanographic and biological parameters, and commercial exploitation. However, there is a lack of life-history and habitat distribution data in many areas and this has traditionally impeded conservation efforts. In this paper we present a regional GIS database that can serve as a useful tool and model for the identification of hotspots for shark conservation in the Mediterranean. The pelagic Basking Shark, *Cetorhinus maximus,* is used as case study as it is globally endangered, wide-ranging in the Mediterranean, and unlike many other cartilaginous fishes, distribution data for this species is available. Species distribution was examined in relation to a number of bio-physical variables such as sea surface temperature, chlorophyll density, and bathymetry. Furthermore, interactions with fisheries were explored with particular emphasis given to body size at landing, catch effort, gear type and fishing season. Our synthesis is presented as a series of spatial overlays showing species distribution in the Mediterranean over a 20-year time series. Specific areas of overlap between shark occurrence, habitat range, and commercial fishing are identified and the conservation implications discussed. Our analysis is a first step in providing a decision support tool for implementing regional and national conservation plans of action, in particular, the United Nations Mediterranean Action Plan for Cartilaginous Species. This project can be extended to include other endangered Chondrichtyans in the Mediterranean, specifically those whose ecology may result in high susceptibility to fishing.

10.45 – 11.00

Elasmobranch captures in the trammel net fishery associated to MPAs in the Balearic Islands.

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The incidence of elasmobranchs in the trammel net fishery operating associated to three marine reserves in the Balearic Islands was analysed from 14 surveys. Within these three marine reserves the commercial fishery is allowed but some restrictions have been established referred to effort (number of nets and hooks, mesh size and close season). Between 2000 and 2004, 684 hauls (205.2 km of net) were performed over *Posidonia oceanica*, rocky and bare sand mixed bottoms, at depths ranging from 8 to 46 meters. 698 elasmobranch specimens were caught, belonging to 12 species (10 batoids and 2 sharks), and they represented 9.9% in abundance and 28.5% in biomass of the total fish catch. The most abundant species were *Dasyatis pastinaca*, *Raja radula* and *Torpedo marmorata*, making up 48.3%, 24.6% and 15.3%, respectively, of the elasmobranch capture. Overall, the abundance of some elasmobranch species presented differences between inside and outside the marine reserves, and also some seasonal trends were detected.

Presentation cancelled.

11.00 – 11.15
EEA in Perspective: past, status quo and future tasks - a steep road ahead?

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Including a short review of the history of the EEA, a summary of the elasmobranch conservation status in Europe is presented and the contribution of the EEA to it. With a focus on the recent developments of elasmobranch conservation in Europe, a projection of necessary actions in the future and further possibilities are suggested for discussion.

11.15 – 11.30
Electrosensitive fish and coastal renewable energy developments in UK waters.

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In 2001, 18 consents for the development of offshore windfarms were approved around the coast of England and Wales. During 2003, a further 15 consents were approved in three strategic areas - the Thames, Humber and Mersey bays. These 2nd stage developments will have a much larger environmental footprint owing to their greater number of wind turbines and being located further offshore. All the windfarms have multiple wind turbines, which are interlinked with electric cables, and a main cable connection to shore. Because of the extent of the electric cables (both A.C. and D.C.) and the worrying status of elasmobranch populations within the coastal zone a priority area for research identified by the UK Collaborative Offshore Wind Research into the Environment (COWRIE) group was electromagnetic fields (EMF) generated by offshore windfarm power cables and their possible effect on organisms sensitive to EMFs. Here I discuss findings based on recent developments in our understanding of electricity production by the offshore windfarms and relate these to their potential interaction with elasmobranchs. Based on these interactions I also present a possible route map as an initial template for cooperative initiatives between elasmobranch conservation management and the offshore renewables industry.

11.30 – 11.45
Population structure of the Thornback ray, *Raja clavata* L. in Southern England waters.

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Before the 1950's the skate *Raja clavata* was common in the central/southern North Sea. Since then it has become scarce, probably because of mixed fisheries. In the North Sea, it has now disappeared from the Dutch coasts, and its distribution is restricted to the southeastern English coasts. The decrease of the stock has led to the question of their sustainability due to their biological characteristics like high maturity age, large size at birth, slow growth rate, low fecundity and high juvenile survival rates. Moreover skates are characterized by no larval pelagic stage, and apparent low dispersal based. Thus, skate populations may be genetically differentiated at a small geographical scale. In this context, the sustainability of locally discrete or patchy subpopulations should remain only as long as the subpopulations remain connected.
We investigated the population structure of the thornback ray of 14 locations in Southern England waters using 5 microsatellite loci. Significant population structure was found with a global F_{ST} = 0.013, however, this structure was not correlated with geography nor any obvious environmental factors. The significance of this population structure will be discussed.

11.45 – 12.00

Studies of an exceptionally large feeding aggregation of whale sharks (*Rhincodon typus*) off Quintana Roo, Mexico.

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Whale sharks (*Rhincodon typus*) are known to inhabit nearshore waters off Mexico at the transition between the Gulf of Mexico and Caribbean Sea in the summer, but little research has been conducted on the sharks in this area. Our U.S.-Mexico collaborative team began preliminary studies of these sharks off Quintana Roo in summer 2003 and have continued this research through 2004. Using a combination of aerial and on-water surveys, oceanographic sampling, tagging and tracking, genetic sampling, and collaborations with local fishermen and guides, we are investigating the number, distribution, behavior and migration of these whale sharks and their relationship to conspecifics observed in other parts of the Gulf, Caribbean and other regions. The sharks begin to appear in the area in May and are found there through September, apparently feeding on plankton associated with a summer upwelling. Well over 100 sharks, and perhaps many more, appear to be present in the area each summer. Documented sizes range from approximately 3.5 to over 10 m in total length with both sexes represented. To date we have tagged over 130 individuals in the area with conventional external tags, attached satellite PAT tags to three and acoustic transmitters to five, tracked one animal actively for 4.5 hr, and obtained genetic tissue samples from 15 sharks. Resightings of tagged animals are being reported. Results of this research are being used to enact conservation action plans to protect this exceptionally large and predictable feeding aggregation of whale sharks in Mexican waters.

13.00 – 13.15

Cloning and expression of alpha and beta subunits of the Na, K-ATPase from the euryhaline bull shark, *Carcharhinus leucas.*

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Few vertebrates can rival the bull shark when considering salinity tolerance. It is able to survive in water ranging from 0 to 53 ppt by precisely controlling the composition of their body fluids. This requires the expression, function and coordination of several ion transporters and channels including the Na, K-ATPase. In this study, juvenile bull sharks were acclimated to either freshwater (0 ppt) or seawater (35 ppt). Following the amplification, cloning and sequencing of the entire bull shark Na, K-ATPase alpha and beta subunits of the gene, nucleic acid probes were used in Northern blot analyses to quantify messenger RNA expression in the osmoregulatory tissues, the gill, rectal gland, kidney and intestine. Using antibodies raised to the known sequences of both subunits, protein expression of Na, K-ATPase alpha and beta subunits have been compared in the gill, kidney and intestine of FW and SW acclimated sharks.

13.15 – 13.30
Relax Immobility in sharks: preliminary results on Caribbean reef sharks.

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Immobilization of sharks for husbandry, medical cures and research purposes currently relies on Tonic immobility techniques, that consist in rolling the shark onto his back and are often associated with use of hooks. A more recent technique, applied for tourist entertainment, allows to immobilize sharks performing massage on their snout. This manipulation induces in sharks a trance-like state, thus the name Trance immobility. Both techniques, Tonic and Trance immobility, relies upon shark feeding and induce in sharks an uncosciousness state, that allows manipulation by researchers. In the present study a Caribbean reef shark (Carcharhinus perezi) was approached without feeding and handled without inducing unconsciousness. Several Caribbean reef sharks were approached in Grand Bahama waters applying a technique named “shark pretending”: the researcher (“pretender”) standed on the sea bottom and offered food to sharks with a sequence of predetermined movements, according to shark approach direction. Once a shark was close enough, the pretender hid food and grabbed shark’s head, performing massage on its snout by thumb circular movements. Some individuals responded positively and one female showed a very peculiar behaviour: following the manipulation, the shark became relaxed without losing consciousness, thus the new name Relax immobility, and let the pretender remove parasites from its dorsal fin. Suprisingly, after this first experience, the same individual went spontaneously and repeatedly back to the pretender, without food attraction, and approached the same pretender also one day later, suggesting memory capacity and learning behaviour. Results obtained in these preliminary studies encourage further trials on more individuals.

13.30 – 13.45
Mechanisms underlying sexual segregation in a sexually monomorphic elasmobranch.

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Sexual segregation is considered a general characteristic of shark populations, yet its underlying causes remain poorly understood. Identifying sex differences in behaviour is important for the successful management of marine fish populations due to the potential for differential exploitation of the sexes. The lesser spotted dogfish, *Scyliorhinus canicula*, provides a useful model species with which to investigate sexual segregation as they are not sexually dimorphic with respect to body size (unlike many viviparous species). Moreover, they can be studied in both the laboratory and at sea and recent research has revealed that the sexes of this species exhibit alternative behavioural strategies. Through the application of acoustic telemetry it has been shown that females, although nocturnally active in deeper water once every one to three days, refuge in shallow water caves for up to 70% of the time. Male dogfish, however, do not refuge but exhibit low activity in deep water by day and increase activity as they move into shallow areas at dusk to feed, before returning to deep water at dawn. Current research explores the role of female refuging behaviour using an integrative approach of field-based acoustic and archival tracking and complementary laboratory manipulations. This research will improve our understanding of the causes underlying sexual segregation not only in sharks, but in animals in general.

13.45 – 14.00

Reproductive biology of the spiny dogfish, *Squalus acanthias,* in the eastern Mediterranean Sea.

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The reproductive biology of the spiny dogfish, *Squalus acanthias*, in the eastern Mediterranean Sea was studied by examining 141 specimens collected in the South Aegean Sea and Levantine Basin, from June 2003 to May 2004. Females ranged from 320 to 710 mm in total length (TL) and their gonadosomatic index (GSI) varied from 0.09 to 10.76, with higher values in August. The presence of vitellogenic oocytes and developing oviducal glands and uteri indicated that females begin to mature at 550 mm TL. Males ranged from 350 to 820 mm in TL and their GSI varied from and 0.06 to 3.85 with higher values recorded in July. GSI values suggested that spermatogenesis and vitelogenesis begun on February. Hepatosomatic index (HSI) was also variable in both sexes, ranging from 6.94 to 28.99 (mean 14.1) in females and from 3.60 to 18.65 (mean 11.2) in males. The maximum HSI values were recorded in August for females and April for males. Twenty females ranging from 570-710 mm in TL were found to be pregnant, with 1 to 5 embryos in their uterus. The embryos TL ranged from 72-195 mm, while their body weight ranged from 1.6-30 g. A positive relationship was found between maternal length and the number of pups per litter.

14.00 – 14.15
Electromagnetic fields generated by marine power cables and their potential impact on electrosensitive fish.

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In 2002 the Collaborative Offshore Wind Research into the Environment (COWRIE), a trust fund set up by the Crown Estate based on the refundable financial deposits made by Round I windfarm developers, commissioned a preliminary assessment of electromagnetic fields (EMF) generated by UK offshore windfarm cables. The objectives of this study focused on mathematically modelling the likely EMF emitted from a sub-sea power cable to help elucidate the potential impacts of EMF generated by wind farm power cables on marine groups such as the elasmobranchs. The EMF generated by a 132kV XLPE three-phase submarine cable with an AC current of 350 amps buried at a depth of 1m was modelled with the 'Maxwell 2D' software program. The results of the model simulations showed that a power cable with perfect shielding i.e. where conductor sheathes are grounded, does not generate an electric field directly. However, a magnetic field is generated in the local environment by the alternating current in the cable. This in turn, generates an induced electric field close to the cable within the range detectable by electrosensitive fish species; in the model used, this resulted in a predicted electric field of approximately 91μV/m in seawater above a cable buried to 1m. An electric field of this strength is on the boundary of electric field emissions that are expected to attract and/or repel elasmobranchs. Considering the number of offshore wind farms currently proposed around the UK and the vulnerable status of many benthic elasmobranch populations, potential mitigation is discussed and recommendations are made for further research through modelling and more importantly, *in-situ* observations.

14.15 – 14.30
Individual variability in electroreceptive behaviour of a benthic shark, the lesser spotted dogfish (*Scyliorhinus canicula*).

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All elasmobranchs use electroreception (principally for finding prey and conspecifics). Although we know each elasmobranch species is able to detect electric fields we have very little knowledge of how electroreceptive behaviour varies. Any variation will determine in part the ecological success of an individual who relies on electrosense. We determined the variability in behavioural reponse of the benthic shark, the lesser spotted dogfish (*Scyliorhinus canicula*) to a range of artificial prey type electric fields (E-fields based on electric currents: 0, 0.9, 9.0 and 90.0mA). Squid scent was added to the experimental tanks to stimulate foraging, and a hierarchy of behavioural responses of the dogfish was recorded: 1- Response to scent; 2- Movement towards source; 3- Turning response to E-field and 4- Biting of E-field source. Individuals differed significantly in their response to the scent. Following a response to scent there was significant individual variability in approach, turn and bite responses to the electrodes emitting the E-field. The results of this work provide the first determination (to our knowledge) of individual variability in E-field locating behaviour of an elasmobranch species. This type of research significantly strengthens our ability to predict the ecological consequences to fish of using electric fields to locate potential food. The research also enhances our knowledge for interpreting how benthic elasmobranchs may respond to changes in their electrical environment such as those associated with electricity production by offshore wind power developments.

14.30 – 14.45

Age and growth of the blue shark, (*Prionace glauca*), at western coast of Baja California Sur, Mexico.

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The blue shark is widely distributed in the world's oceans. It is also the most abundant species captured in the shark fishery on the west coast of Baja California Sur. In the present study, the growth of the blue shark, *Prionace glauca*, was investigated based on reading the growth rings in the vertebrae of 204 sharks using the silver-nitrate staining technique to protrude the growth rings. Examined size range was 81–270 cm total length (TL) averaging 158 cm LT. Males were more abundant than females. Sixteen ages were found for males and 12 age groups for females. Age four (134 cm TL) represent 19% of the sample for males and for females 22% were represented by age seven (165 cm TL). The von Bertalanffy growth parameters were: L¥ = 299.85 cm LT, K= 0.1, to = -2.44, for males; L¥ = 237.5 cm LT, K= 0.15, to = -2.15, for females and L¥ = 303.4 cm LT, K=0.1, to= -2.68, for combined sexes. These parameters were similar to the estimate for this species in other regions of the North Pacific Ocean.

15.15 – 15.30
Sharksucker induced behaviour in captive bull sharks.

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This is the first description of sharksucker induced behaviour in sharks in a captive environment. To enhance the understanding of the sharksucker / shark interaction, the behaviour of two captive bull sharks was monitored. Both sharks showed sharksucker induced behaviour patterns previously described for other free-ranging shark species. Bull sharks showed an increased swimming speed during sharksucker attachment. With regard to the attachment position, sharksuckers attached to different body parts on the female and male shark. This paper further supports the hypothesis that sharksucker attachment irritates hosts and that costs and benefits are unevenly distributed among the two organisms.

15.30 – 15.45

Prey species and size preference of nursery-bound juvenile lemon sharks, *Negaprion brevirostris.*

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Prey preference was determined by quantitatively comparing the dietary composition of 642 juvenile lemon sharks (averaging 54.7 ± 0.3 cm precaudal length, mean ± S.E., range 43.5 to 90.0 cm), with concurrent sampling of prey communities at Bimini, Bahamas, between March 2000 and March 2003. Juvenile lemon sharks only preyed upon 49 (29 %) of the 175 species identified within the nursery, and demonstrated prey preference with proportions of prey families in the diet significantly different to those found in the environment ($\div^2$, $P < 0.001$). The most preferred prey of juvenile lemon sharks (in rank order) were toadfish > barracuda > parrotfish > filefish > mojarra. Prey sizes were obtained for 350 dietary items, of which 85 % were calculated using regressions relating bone lengths to total length. Juvenile lemon sharks demonstrated positive size selection, with an over-representation of the larger prey available in the environment in their diet (Kolmogorov-Smirnov test, $P < 0.001$). Mojarra were consumed in proportion to the distribution of fish lengths in the environment, suggesting that their importance in the diet may be due to preferred sizes in the environment as well as their ease of capture. Juvenile lemon sharks demonstrated a preference for slower-moving prey that were easier to capture, while avoiding larger, faster and harder to catch species. The degree of selection exhibited by juvenile lemon sharks was greatest when prey were more abundant, suggesting that lemon sharks may conform to the optimal foraging theory.

15.45 – 16.00
Deepwater sharks most currently found in Canary Islands.

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Due to the closeness of the great sea beds to the coastline of the Canary Islands (27º- 30º N; 19º-12 W) many deepwater species, and among them many sharks, are wholly integrated in the dynamic of the ecosystem of the islands; opposing to every continental zone where these species are to be found far away from the coast. Two factors are essential to analyse the structure of the Canarian marine ecosystem. On one hand, due to the steepness of the sea depths the dimensions of the island platforms are small; and on the other hand, the waters surrounding the islands are oligotrophic and so the biomass or density of population of each species is low and therefore the global production capacity of this ecosystem is highly limited. In this paper we number a list of species and we give some data on the abundance, vertical distribution and biology of the most common sharks (more than 10 records) that live in deep waters (more than 1000 m depth) of the Canary Islands. There are records from 8 species from the families *Dalatiidae* (*Velvet Dogfishes* and *Lantern Sharks*) and *Centrophoridae* (*Gulper Sharks* and *Birdbeak Dogfishes*) from the order *Squaliformes* (*Dogfish Sharks*).

16.00 – 16.15
Foraging excursions of female dogfish to and from 'home' refuges.

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Technological advances in telemetry systems are allowing behavioural ecologists to examine the movement of fishes with more accuracy and at finer scales than ever before. Such progress means that elasmobranch behaviour that has previously been alluded to in the laboratory can now be tested under natural conditions in the field. In this new study we examine the behaviour of lesser spotted dogfish (*Scyliorhinus canicula*) females in a semi-enclosed marine lough in the Republic of Ireland. Individuals tracked using a radio linked acoustic system are shown to carry out discrete foraging trips in areas of habitat where the abundance of prey species is relatively high. Foraging excursions consist of distinct commuting periods interspersed with phases of area restricted foraging activity. Examination of tracks shows that animals exhibit "central place foraging" behaviour, returning to specific refuges between bouts of foraging.

16.15 – 16.30
In the sharks' cradle.

S. Clò[1] *and E. de Sabata*[2].
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Each year, as spring turns into summer, dozens of sandbar sharks (*Carcharhinus plumbeus*) enter a shallow bay on the Mediterranean coast of Turkey. Over 100 individuals have been photo-identified since 2001 based on scars and markings on their bodies. Several individuals are re-sighted every year, and three have been re-sighted over three subsequent years. The large majority of the bay population is composed of mature females, many of which are very large and presumably pregnant, but mature males visit the bay as well. In 2004 the birth of a shark was filmed, and two lifeless newborns wrapped in their placenta were recovered from the sea floor. The exact length at birth of Mediterranean sandbar sharks was thus established for the first time. The birth and the stillborns allow us to identify this bay as a nursery area for sandbar sharks, the only one currently known for the Mediterranean sea.

16.30 – 16.45
Migratory Behaviour of the thornback ray, *Raja clavata* L., in the southern North sea.

***E. Hunter**, A. A. Buckley, C. Stewart and J. D. Metcalfe.*
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We have studied the seasonal migration patterns of the thornback ray, *Raja clavata* L., in the Thames Estuary and Southern Bight of the North Sea (United Kingdom). Although found throughout the European continental shelf, the relatively high density of thornback rays in the Thames Estuary make this an important stock centre where local fisheries still seasonally target these fish. Historical data from conventional tagging studies have suggested that the majority of rays tagged within the Thames Estuary remain there throughout their lives.

Here we describe the results of experiments in which 197 thornback rays were tagged with electronic data storage tags and released in October 1999 and 2000. A geolocation method using tidal data recorded when rays remained on the sea-bed over a full tidal-cycle was used to reconstruct the movements of the fish throughout their time at liberty. Depth and temperature data provided further information about the behaviour and location of the fish. Data from these experiments were compared with the results of conventional tagging experiments.

Our results demonstrate that, contrary to predictions, rays were not restricted to the Thames Estuary, but moved more widely in the southern North Sea. We observed a seasonal pattern of migration related to the reproductive cycle. Rays were dispersed in relatively deep water outside the inner Thames Estuary during the autumn and winter when the fish were feeding, then aggregated in the inner Thames Estuary during the spring and summer, when reproduction takes place. The differences between the results of conventional and electronic data storage tagging programmes are discussed.

16.45 – 17.00

Teeth sexual dimorphic development in *Raja asterias* (De La Roche, 1809): ontogenetic and seasonal pattern analysis related to the reproductive biology.

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Different teeth morphology is a common sexual feature in several species of *Rajidae*. Present literature for *Raja asterias*, the commonest skate in the central Tirrenian Sea, reports few information about sexual teeth dimorphism. The aim of this work is to investigate the possible changes in teeth shape with size and with the achievement of maturity in males and females of this species. A total of 300 individuals of *Raja asterias* were collected in the central Tirrenian Sea from bottom otter trawlers and fish markets located in the research area. We present here our results, obtained using an image acquiring programme, on differences of teeth shape development between sexes related to the reproductive biology of the species.

17.00 – 17.15
Overview of White Shark (*Carcharodon carcharias*) research at Seal Island, South Africa.

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Predatory behaviour, residency patterns, and social organisation of White Sharks were studied at Seal Island in False Bay, South Africa, from 1997-2003. Of 2088 predatory attacks on Cape Fur Seals (*Arctocephalus pusillus pusillus*) recorded during the study period, frequency and success rate were analysed according to 12 biotic and abiotic factors. Attacks were primarily on lone incoming YOY seals, were spatiotemporally clustered at the primary pinniped entry/exit point at the south terminus of the Island, and occurred almost exclusively during winter (May-September), mostly within two hours of sunrise. Predatory success rate averaged 47%, but increased to 55% under scotopic conditions and decreased to 40% under photopic conditions. Certain individual White Sharks exhibit idiosyncratic predatory behaviour resulting in success rates up to 80%, suggesting some degree of trial-and-error learning. Using total pigmentation pattern, analysed according to 68 discrete topographic regions, 262 individual White Sharks were catalogued and their residency patterns and intraspecific associations discerned from re-sightings data. Individuals were re-sighted as often as 28 times over the study period, suggesting a high degree of philopatry. Residence times for individuals ranged from 1-18 days, averaging 2-3 days. Known individuals appear to travel in loose groups of 2-6. Sixteen categories of overt agonistic behaviour have been defined and documented, appearing to occur only between individuals of separate groups. Social hierarchy under baited contexts appears to be largely size-dependent, with individuals as little as 5% longer dominant over smaller conspecifics, but sex and degree of melanism may also be factors.

Poster Presentations

Three-dimensional movements of captive Mobulids (*Manta birostris* and *Mobula mobular*).

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The movements and behaviour of elasmobranchs are believed to have an important function in communication both within and between species. Compared to most other elasmobranchs, the rays in the Myliobatiformes have an extremely large brain. Areas of the brain that are especially well developed are those responsible for the coordination of movement. This suggests that the fine scale control of swimming behaviour may have an important role in their life history and ecology. We used a three-dimensional computer-based movement analysing and measuring system to study the characteristic 'flying-like' swimming movements of captive Mobulids (a female *Manta birostris*, 3.5 m wing-span and a female *Mobula mobular*, 1.8 m wing-span). With this method, we analysed the leading edge of the swimming surface. The serial position of the leading wing edges during swimming formed a three-dimensional surface that could be mathematically described. An analysis of these surfaces detected significant differences in swimming patterns between the two genera that were not obvious in visual-based analyses. Our preliminary investigations suggest that this method may be useful in comparing the swimming behaviour of captive and wild mobulids, swimming differences between sexes, as well as species-specific responses to environmental cues.

Preliminary data on the ampullary organs in the rabbit fish *Chimaera monstrosa* (Linnaeus, 1758).

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[4] Fisheries, Recreation and Biodiversity, Environment Agency, Warrington, United Kingdom.

The rabbit fish *Chimaera monstrosa* (Linnaeus, 1758) is a deep-sea demersal species distributed in the Mediterranean and in the NE Atlantic. The presence of ampullary structures (functionally and structurally) homologous to the ampullae of Lorenzini have been shown to exist in Chimaeriformes but few data are available about these highly specialized electroreceptors in this group. The present research was undertaken for a better understanding of these sensory organs in *C. monstrosa*. Specimens of *C. monstrosa* were collected in the Gulf of Genoa, Ligurian Sea (NW Mediterranean Sea), by professional bottom trawlers and after deep anaesthesia by MS 222 and dissection, samples of ampullae of Lorenzini were fixed in paraformaldehyde and differently prepared for LM and SEM observation. The renewal of the sensory epithelium and the innervation of the ampulla were studied by the immunohistochemical method and the TUNEL reaction. In *C. monstrosa* the ampullae of Lorenzini are mainly distributed in the rostral cephalic portion, where their large external pores are evident. As already observed in other species of cartilaginous fishes, the ampullae showed an enlarged terminal portion subdivided in sensory alveoli filled with a gelatinous mucopolysaccharide substance. Cell proliferation occurs in well defined areas, such as at the periphery of the central cap and in the flat epithelium located on the partitions between alveoli. Nerve fibres enter in the dilated portion of the ampulla, then branch and end beneath sensory cells. Relationships with taxonomic and ecological features may also occur and need to be further investigated also in other species of Chimaeriformes.

Length at first maturity for two species of lantern sharks (*Etmopterus spinax* and *E. pusillus*) occurring in south Portugal.

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Elasmobranchs, due to their characteristic slow growth rate, delayed reproductive effort, geared towards the production of small progeny, and long gestation period, are highly susceptible to overexploitation. *Etmopterus spinax* and *E. pusillus* are two species of lantern sharks that are captured in large quantities in some deep-water fisheries along the Portuguese coast and are always discarded. Specimens from these species were collected from February 2003 to May 2004 from deep-water fisheries and classified as mature or immature. Maturity ogives were fitted and size at first maturity estimated for each sex of each species. Both species are late maturing, with the maturity sizes varying between 75% and 87% of the maximum observed sizes, depending on species and sex. For both species, females tended to mature and grow to larger sizes than males. The maturity sizes as percentage of maximum observed sizes estimated in this study are similar to the values observed by other authors for other deep-water squalids. The late maturation of these deep-water shark species makes these populations extremely vulnerable to increasing fishing mortality.

Dermal and dental sexual dimorphisms in the lesser-spotted catshark (*Scyliorhinus canicula*).

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Generally, the reproductive biology of many elasmobranch species is not well understood. However, reproduction has been widely studied in the lesser-spotted catshark (*Scyliorhinus canicula*). The existence of a sexual dimorphism in this species has previously been documented with regard to head, tooth and jaw length and width. However, the existence of a sexual dimorphism has not been established with respect to skin thickness or other tooth characteristics. Sexually mature lesser-spotted catsharks were collected from the Solent and jaw, teeth and skin samples were removed. The teeth were removed from the jaw and the cusps were manually counted. Males possessed significantly fewer cusps (P <0.001). The central cusp of each tooth was measured at the base and the tip. Both dimensions showed a significant difference (P <0.001), with males possessing wider central cusps. Skin samples taken from the area below the dorsal fin and above the lateral line were analysed. Both dermal and epidermal thickness was measured. In each case there was a significant difference with females having thicker dermal and epidermal layers. (P<0.001). This data shows that males have larger teeth compared to females, but that females have thicker skin compared to males. Since it has been previously shown that there is no difference in the diet of male and female catsharks, this suggests that these sexual dimorphisms may relate to the reproductive biology of the species. We are presently analysing whether these gender differences occur throughout the year and whether they occur in immature specimens.

Migratory Behaviour of the thornback ray, *Raja clavata* L., in the southern North sea.

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We have studied the seasonal migration patterns of the thornback ray, *Raja clavata* L., in the Thames Estuary and Southern Bight of the North Sea (United Kingdom). Although found throughout the European continental shelf, the relatively high density of thornback rays in the Thames Estuary make this an important stock centre where local fisheries still seasonally target these fish. Historical data from conventional tagging studies have suggested that the majority of rays tagged within the Thames Estuary remain there throughout their lives.

Here we describe the results of experiments in which 197 thornback rays were tagged with electronic data storage tags and released in October 1999 and 2000. A geolocation method using tidal data recorded when rays remained on the sea-bed over a full tidal-cycle was used to reconstruct the movements of the fish throughout their time at liberty. Depth and temperature data provided further information about the behaviour and location of the fish. Data from these experiments were compared with the results of conventional tagging experiments.

Our results demonstrate that, contrary to predictions, rays were not restricted to the Thames Estuary, but moved more widely in the southern North Sea. We observed a seasonal pattern of migration related to the reproductive cycle. Rays were dispersed in relatively deep water outside the inner Thames Estuary during the autumn and winter when the fish were feeding, then aggregated in the inner Thames Estuary during the spring and summer, when reproduction takes place. The differences between the results of conventional and electronic data storage tagging programmes are discussed.

NB – This poster is in addition to an oral presentation of the same title.

An investigation into the structure of the olfactory organs of the lesser spotted catshark (*Scyliorhinus canicula*).

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The sense of olfaction in elasmobranchs is well documented as being highly developed and sensitive, and is thought to play a role in many aspects of their life history. There has been speculation that olfaction plays a vital role in courtship and mating via the use of sex pheromones in some shark species. Investigations into the structure of the olfactory organ of some teleost species have revealed a sexual dimorphism in the structure of the olfactory system with males having larger olfactory organs to smell females. The current study investigates the morphometrics and structure of the olfactory system in order to determine if a sexual dimorphism exists in the lesser-spotted catshark. Sexually mature males and females (i.e. > 500 mm body length) were obtained from the Solent region and olfactory organ morphometrics and structure were compared. There was no significant difference between males and females in the lengths and widths of the nares and the olfactory organs. The relative weight of the left nostril did not differ, however the right olfactory organ was significantly heavier in males ($P = 0.008$) compared to females. Moreover, males had significantly more olfactory lamellae ($P < 0.001$) in the left and right organs compared to females. Since it has been shown that male and female catsharks do not differ in their choice of prey, the data suggests that the gender differences in olfactory organs may relate to reproduction and the possible detection by males of sex pheromones released by females.

New record of chimaeroid fish for the North Eastern Atlantic.

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Chimaera monstrosa is actually the only species belonging to the genus *Chimaera* reported for NE Atlantic. In this work we noticed the presence of a second species, *Chimaera* sp., having a geographical and bathymetrical distibution partially overlapping with *C. monstrosa*. The two species have been compared on the basis of morphological and genetic characters. Morphometric measurements were taken on twenty four specimens, twelve males and twelve females, for each species, collected at depths ranging from 280-1350 m, along the continental slope from the west of the British Isles to the west of Brittany. All the specimens were introduced in the collections of the “Muséum national d’Histoire naturelle”. *Chimaera* sp. can be distinguished from *C. monstrosa* by body, fin and eye coloration as well as by the morphology of the claspers. Other differences are pointed out from the comparison of morphometric measurements concerning for example the claspers, the spine and the eye. A tissue sample was taken on four specimens of *Chimaera* sp. and one specimen of *C. monstrosa* and a fragment of about 1500 nucleotides, including the major part of the 16s rRNA, was amplified and sequenced. Comparison of our sequence of *C. monstrosa* with a sequence available in GenBank showed no intraspecific variability. Comparison of the sequences obtained on the four specimens of *Chimaera* sp. showed an intraspecific variability of 0 to 0.3%. The interspecific variability between *C. monstrosa* and *Chimaera* sp. was found to be 3.8 to 4.1%, supporting the results based on the morphological comparison. The relationships between all Chimaeroids of the NE Atlantic are under investigation by molecular phylogenetics techniques.

The traditional shark fisheries of south west Madagascar: a study of two villages in the Toliara region.

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Traditional shark fisheries in Africa are largely poorly documented. Fisheries management plans for fisheries targeting chondrichthyan species are typically based on studies with limited spatial resolution or detail compromising their efficacy and potentially reducing the effectiveness of national and regional plans. South west Madagsacar is an area which is poorly documented with regard to many of its marine resources. This study presents a detailed investigation of the directed shark fisheries of two villages south of Toliara - Soalara and Maromena - presenting a description of the fishery in these villages and catch data for periods of 12 and 10 months respectively. Results from a total of 1,164 catch records, including members of at least 13 species, with an estimated total wet weight of over 123mt are reported with hammerhead sharks (*Sphyrna* spp.) representing 29% of sharks caught and 24% of the total wet weight. These findings, in conjunction with anecdotal evidence collected from fishers, indicate a fishery of considerable social and economic importance that is showing signs of decline, possibly as a result of changing fishing practices associated with the intervention of outside agencies.

NB – This poster is in addition to an oral presentation of the same title.

Observations on age and sexual maturity of blue shark, *Prionace glauca*, in the Mediterranean Sea.

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During 1998-2000, a total of 579 blue sharks ranging in total length (TL) from 70 to 359 cm were sampled in the Mediterranean Sea to study their sexual maturity using observations on gonadal development and clasper morphology and rigidity. Caudal vertebrae were collected from specimens between 84 and 305.5 cm TL and vertebral ring counts were used to estimate age. Males were predominant (60,1 %) and sex ratio showed an increase of the males as size progressed. Gonad observation revealed that females smaller than 120 cm TL had immature ovaries with invisible eggs while ovaries with visible yolked eggs were present in specimens larger than 120 cm TL. Ovaries weight varied from 4 to 137 g and maximum oocyte diameter reached 21.1 mm in mature females. All males smaller than 125 cm TL were immature presenting not calcified claspers that did not reach the posterior end of the pelvic fins. Males larger than 187 cm were all mature presenting heavy calcified claspers, which extended much more than the posterior end of the pelvic fins. Total length at first maturity in females ranged from 205 to 215 cm, while the values for males were from 185 to 195 cm. A significant linear relationship was found between TL and diameter of caudal centra ($r=0.79$; $P<0.05$). Age estimates ranged from 0+ to 8+ yr and age at first maturity was estimated about 4 yr.

The historical collection of Chondricthyes of the comparative anatomy museum of the University of Bologna.

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The comparative anatomy museum of the University of Bologna holds about 4,000 vertebrate specimens. Most of them come from the historical collection of the museum director Antonio Alessandrini (1819-1861), others are later preparations of director Sebastiano Richiardi (1871) and recent acquisitions of specimens we prepared in our laboratory. We undergo a revision of the specimens dealing on Chondricthyes filing it in a database containing the original description and number of Alessandrini, the modern nomenclature, the status and kind of conservation, a modern description, the distribution and ecology of the species and a photo. The exhibition on the anatomy of Chondricthyes contains about forty skeletons or parts of the skeleton. Of interest is a very large oral jaw of a white shark fished in 1827 in the Adriatic Sea and exposed for some time in the fish market of the city. About twenty dried specimens deal with circulatory, respiratory and digestive systems. Very fine is the preparation of the gills of *Hexanchus griseus* perfused with colored wax to emphasize the respiratory vessels. Thirty liquid (alcohol or formalin) preserved specimens show different apparatuses. Our work deals also on the hystological collections of slides representing microscopic structures like the electric lobes of the brain of *Torpedo* and other.

Deepwater sharks most currently found in Canary Islands.

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Due to the closeness of the great sea beds to the coastline of the Canary Islands (27º- 30º N; 19º-12 W) many deepwater species, and among them many sharks, are wholly integrated in the dynamic of the ecosystem of the islands; opposing to every continental zone where these species are to be found far away from the coast. Two factors are essential to analyse the structure of the Canarian marine ecosystem. On one hand, due to the steepness of the sea depths the dimensions of the island platforms are small; and on the other hand, the waters surrounding the islands are oligotrophic and so the biomass or density of population of each species is low and therefore the global production capacity of this ecosystem is highly limited. In this paper we number a list of species and we give some data on the abundance, vertical distribution and biology of the most common sharks (more than 10 records) that live in deep waters (more than 1000 m depth) of the Canary Islands. There are records from 8 species from the families *Dalatiidae* (*Velvet Dogfishes* and *Lantern Sharks*) and *Centrophoridae* (*Gulper Sharks* and *Birdbeak Dogfishes*) from the order *Squaliformes* (*Dogfish Sharks*).

NB – This poster is in addition to an oral presentation of the same title.

Prey selectivity by juvenile lemon sharks (*Negaprion brevirostris* Poey 1868) under semi natural conditions in a sub tropical lagoon in Bimini, Bahamas.

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The degree of selectivity exhibited by juvenile lemon sharks towards a prey species was determined by presenting individual sharks with differing relative abundances of two prey species and recording the prey choice. The majority of studies on elasmobranch diet have reported the prey items found in the stomach of a number of sharks however, the extent to which an elasmobranch specialises on one prey type has never been demonstrated. Similarly it is unclear whether sharks display periodicity when feeding or are asynchronous and consume prey at all times of the day or night.

Individual sharks were exposed to differing relative abundances of two prey species. An electivity index (E*) and a chi squared goodness of fit test were used to elucidate the selectivity of the sharks. Further analysis enabled the sharks' functional response curve towards the prey items to be determined and any size selection in prey items identified. Stomach contents of the sharks were analysed to identify the times that feeding took place.

Results demonstrated that at all abundances of prey the sharks were highly species selective towards yellowfin mojarra (mean E* 0.326) whilst displaying almost complete negative selection for grey snapper (mean E* -0.939). A type II functional response curve (r^2= 0.9121) supported evidence that sharks are specialist predators. No size selection of prey items was observed. Stomach content analysis indicated that sharks are asynchronous feeders.

The selectivity of sharks arises as a result of the behavioural and morphological characteristics of the prey species.

Conserving endangered basking sharks: population size and critical habitat in northeast Atlantic waters.

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The basking shark (*Cetorhinus maximus*) is the world's second largest fish and has been exploited by humans for at least two hundred years. There is current concern that past fisheries have reduced populations to low levels and that some stocks still show little signs of recovery. The basking shark is listed as vulnerable on the IUCN Red List of Threatened Species, and was recently included on Appendix II of CITES. To address these concerns, scientific information on the status of specific populations needs to be collected. However, to date there have been few attempts to identify preferred habitats of basking sharks, their distribution and movements, and no reliable estimates of population size have been made.
In response to the urgent need for comprehensive information on this species the Esmée Fairbairn Foundation funded a project initiated by the Marine Biological Association (MBA) to collate and combine behavioural, survey and sightings data of basking sharks collected by six UK charities into a single, unique database. The six consortium partners are the MBA, Marine Conservation Society, Marine Environmental Research/UK Wildlife Trusts, Hebridean Whale and Dolphin Trust, International Fund for Animal Welfare, and The Shark Trust. These data will help define their critical habitat in UK waters, resulting in the first practical information for assessing the appropriateness of the present UK marine protected area for endangered basking sharks and whether extension of this zone is required. This information will be vital for identifying population trends and in establishing future conservation and management plans for this species.

Age and growth estimation of captive specimens of sandbar shark *Carcharhinus plumbeus* based on vertebral growth marks.

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Vertebral sections of four captive specimens of sandbar shark, *Carcharhinus plumbeus*, were analysed. Comparisons were made between different planes of sectioning and different vertebrae. Two of these specimens were neonates, showing only the birth mark in their vertebral centra, and they allowed validating the location of the hatching mark. The largest specimen, a female 200cm TL, lived 5 months in aquaria after being captured, and presented 22 rings in its vertebral centra. The last specimen, a young female 90.5cm TL, was born in captivity, and presented one clear annual mark and an additional mark which was interpreted as a stress mark. The measurement of distances between consecutive marks allowed estimating individual growth rates in the two largest specimens.

The population biology of the thornback ray, *Raja clavata* L. in Caernarfon Bay, North Wales.

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Amid concern about the status of skates and rays in Welsh waters the present work set out to provide up-to-date information on the population biology of the thornback ray *Raja clavata* in North Wales. The von Bertalanffy growth parameters for males were L_{inf} = 100.9cm, k = 0.18yr^{-1} and t_0 = -0.95yrs, while L_{inf} = 117.6cm, k = 0.16yr^{-1} and t_0 = -0.7yrs for females. Male *R. clavata* reached 50% maturity at a total length of 58.8cm and 3.9yrs, which was smaller and younger than females for whom L_{50} and A_{50} were 70.5cm and 5.3yrs, respectively. Although previously over-exploited, the present estimate of total mortality (Z) was 0.48-0.49yr^{-1} which, in terms of replacement mortality (calculated as 0.7 yr^{-1}), suggests no immediate prospect of recruitment failure. The potential for the recovery of a depleted population is discussed in relation to the Allee effect, along with recommendations for future studies into population genetic structure that could be incorporated into the development of effective conservation and management strategies.

Basking shark movements and seasonal decadal patterns of zooplankton abundance: temporal and spatial congruence?

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Planktivorous free-ranging elasmobranchs, such as *Cetorhinus maximus* (basking shark), feed in neritic and pelagic environments circumglobally. Within these environments they can exploit oceanographic features (*e.g.*) frontal systems, which aggregate zooplankton prey and support primary and secondary productivity. Using movement trajectories reconstructed from pop-up archival tagging, zooplankton abundance data from the Continuous Plankton Recorder Survey and satellite derived sea surface temperature we investigate basking shark habitat utilisation.

Real-time coincident monitoring and subsequent mapping of forage availability on comparable temporal and spatial scales to basking sharks is not practicable. However, the CPR Survey provides a unique data source from which to recreate the most probable prey fields encountered by these planktivores.

Using a numerical modelling based approach we investigate the prey encountered by these planktivores. When integrated, forage availability and thermal conditions are most likely to determine movements on both coarse and fine scales; as such our approach attempts to understand movement in context with the heterogeneous environment in which these animals live.

Smooth Hammerhead Shark (*Sphyrna zygaena*) off Angola.

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This paper describes the spatial distribution and morphometric characteristics of four specimens of the smooth hammerhead shark, *Sphyrna zygaena,* caught in shallow coastal waters, during a pelagic survey carried out in Angolan waters by R/V 'Dr. Fridtjof Nansen' in July-August 2003. The individuals were caught in two stations with a bottom trawl. Morphometric measurements were taken and the determination of stomach content and presence of parasites were made macroscopically on board the vessel. The preys were identified to the lowest taxa possible. All specimens were immature males with full stomachs. Morphometric measurements were expressed as a percentage of total length for each specimen caught. The stomachs contained mostly digested remains of fish. There is no other published record of *S. zygaena* from Angolan waters; therefore this record represents an extension of its distributional range. A comparison is made with previous descriptions of the species.

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Acronyms

APECS – Association Pour l'Etude et la Conservation des Sélaciens

ARPAT – Agenzia Regionale per la Protezione Ambientale della Toscana

CCMAR – Centre of Marine Sciences

CEFAS – Centre for Environment, Fisheries and Aquaculture Science

CSIRO – Commonwealth Science and Industrial Research Organisation

CCW – Countryside Council for Wales

DARPA – Defence Advances Research Projects Agency

D.E.G – Deutsche Elasmobranchier Gesellschaft

FRS – Fisheries Research Service

ICRAM – Instituto Centrale per la Ricerca scientifica e tecnologica Applicata al Mare

IMEDEA – Mediterranean Institute for Advanced Studies

IUCN – The World Conservation Union

JNCC – Joint Nature Conservation Committee

MBA – Marine Biological Association of the United Kingdom

NMA – National Marine Aquarium

ZSL – Zoological Society of London

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