

## Theme Session on Elasmobranch Fisheries Science (N)

### ICES CM 2005/N:01

#### **Comparison of trends in long term survey data for *Squalus acanthias* with a preliminary stock assessment for this species**

Emma Jones, Doug Beare, Helen Dobby, and Kirsteen MacKenzie

Spurdog (*Squalus acanthias*) is a relatively small viviparous squaliform shark that has become one of the most commercially important elasmobranch species caught in the northeast Atlantic. Although the landings of this species have been declining for a number of years, the status of the stock in this area is not well understood. The assessment is hampered by the lack of age-structured catch data and by uncertainties in historic total landings due to the common practice of recording landings as general 'dogfish' rather than in species specific categories. Fishery independent data should therefore be considered an important source of information on the stock status. This paper explores the spatial and temporal trends in abundance, size distribution and sex ratio obtained from Scottish trawl survey data and discusses how such data may be useful from a stock assessment perspective. To conclude, perceived changes are compared to results from preliminary stock assessments (based largely on commercial data), conducted by the ICES Working Group on Elasmobranch Fishes (WGEF).

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### ICES CM 2005/N:02

#### **Age, growth and maturity of the broad nose skate, *Bathyraja brachyurops* (Fowler, 1910) and the gray tail skate, *Bathyraja griseocauda* (Norman, 1937) around the Falkland Islands**

N. Baumgartner, A. I. Arkhipkin, Z. N. Shcherbich, and P. Brickle

The age and growth of 222 *Bathyraja brachyurops* and 172 *B. griseocauda* were determined from specimens collected around the Falkland Islands on board vessels between 2000–2004. The specimens were aged by the incremental analysis of caudal thorns stained with silver nitrate. Three readers read all of the structures with estimates by the most experienced reader showing the least variation. Counts made from the increments on thorns were compared to those taken from sectioned vertebral centra of the same animal and were found not to be significantly different in both species. The maximum estimated ages determined from thorns were 18 and 16 years of *B. brachyurops* males and females respectively, and 20 and 29 years for male and female *B. griseocauda* respectively. The growth of both species was best described by the von Bertalanffy growth function. *Bathyraja brachyurops* had higher growth rates than *B. griseocauda*. For *B. griseocauda* the total length at 50% maturity was calculated to be 118.8 cm for females and 107.7 cm for males, while for *B. brachyurops* it was 79.5 cm and 61.9 cm in females and males respectively. Females were found to grow faster in both species and matured at a larger size. The slower growth and later maturity of *B. griseocauda* is probably related to the colder environmental conditions of their habitat, as this species occurs in deeper waters.

Keywords: Age estimation; growth, elasmobranchs, *Bathyraja brachyurops*, *B. griseocauda*.

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### ICES CM 2005/N:03

#### **Non-destructive assessment of the effects of small-scale fisheries on tropical shark stocks**

Mark Meekan and Mike Cappel

Baited underwater video systems (BRUVS) were used to examine the influence of small-scale fisheries on reef and pelagic shark stocks on coral reefs in northern Australia. BRUVS were deployed in different habitats on reefs and in

open water where Indonesian fishermen were allowed to access shark stocks and on reefs protected from any form of fishing. Within reefs, there were clear differences in species composition of sharks amongst habitats. Silvertip whalers (*C. albimarginatus*) were seen only in deeper waters, and White-tip Reef sharks (*Triaenodon obesus*) were only seen on the seabed mostly in the lagoons and reef edges. The Grey Reef Shark (*C. amblyrhynchos*) was seen in all habitats sampled, at the surface and on the bottom, but more commonly outside the lagoons. The largest (~3m) Tiger (*Galeocerdo cuvieri*) and Great Hammerhead (*Sphyrna mokarran*) sharks were sighted in lagoons. There was a striking difference in the species composition and abundance of sharks between reefs open to fishing and protected reefs. BRUVS recorded 88 sharks from 8 species in 75 deployments on protected reefs, but only 14 sharks from 5 species in 28 deployments on reefs open to fishing. When corrected for sampling effort, our study shows that sharks were on average from 17 to 4 times more abundant at on protected than open reefs. We conclude that overfishing by the small-scale, traditional Indonesian fishery is the most plausible explanation of these differences in abundance of sharks between open and protected reefs.

Keywords: Non-destructive, video, shark, abundance, small-scale fishery, traditional.

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## ICES CM 2005/N:04

### Spatial distribution and abundance trends of main elasmobranch species in the Bay of Biscay and Celtic Sea from bottom trawl surveys

J. C. Mahé and J. C. Poulard

Data were collected during the French EVHOE surveys covering the Bay of Biscay and the Celtic Sea from respectively 1987 and 1997 to 2004. 26 species of elasmobranchs were recorded in the Bay of Biscay and 19 species in the Celtic Sea. Spatial distribution of the dominant species are presented and biomass and abundance indices as well as length distribution were analysed for trends. Increasing trend in abundance were identified for *Scylorhinus canicula*, *Galeus melastomus* and *Leucoraja naevus* in the Bay of Biscay. Mean length showed a decreasing trend for *Scylorhinus canicula*, *Leucoraja naevus* and *Raja clavata* in the Bay of Biscay and for, *Leucoraja naevus* in the Celtic Sea. These results suggest some increasing strength in the recruitment of *Scylorhinus canicula* and *Leucoraja naevus* in the Bay of Biscay.

Keywords: Sharks, rays, Celtic Sea, Bay of Biscay, spatial distribution, abundance, bottom trawl surveys.

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## ICES CM 2005/N:05

### Fatty acid composition of sleeper shark (*Somniosus pacificus*) liver and muscle reveals nutritional dependence on planktivores

Ron Heintz, Lawrence Schuafli, Mike Sigler, and Lee Hulbert

Sleeper sharks (*Somniosus pacificus*) are large elasmobranchs found in the temperate and boreal portions of the north Pacific. At high latitudes they are frequently observed near the surface and in littoral areas. They are known to consume fast swimming prey such as salmon and have been identified as potential predators of pinnipeds, many of which have rapidly declining populations in the north Pacific. The objective of this study was to identify energy sources used by sleeper sharks by examining their fatty acid compositions. We sampled the triacylglycerols (TAG) from the liver and muscle of 15 sleeper sharks and compared the compositions to those of potential prey, as identified by their stomach contents. TAG comprised approximately 73% and 78% of the muscle and liver lipids, respectively. Monounsaturated and unsaturated fatty acids dominated the muscle TAG, accounting for more than 86% of all fatty acids examined. Similarly, saturated and monounsaturated fatty acids accounted for 95% of the liver TAG, 85% of that total was saturated. Both tissues contained high concentrations of C22:1n11 and C20:1n11, fatty acids derived from the alcohols of calanoid copepods. Comparisons of the shark fatty acid compositions with those of prey suggest Pacific herring, cetacean blubber, yellowfin sole and walleye pollock are important energy sources. These results are consistent with other reports describing stomach contents and suggest that sleeper sharks are not significant predators of pinnipeds.

Keywords: Fatty acids, *Somniosus*, diet, triacylglycerols.

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## **ICES CM 2005/N:06**

### **North Sea elasmobranchs: distribution, abundance and biodiversity**

Niels Daan, Henk Heessen, and Remment ter Hofstede

Based on data from the International Bottom Trawl Survey IBTS, an overview is given of the distribution and trends in abundance of the elasmobranchs occurring in the North Sea. In a separate analysis, the information is integrated in fine-scale ( $10^{\circ} \times 10^{\circ}$ ) spatial biodiversity indices of the elasmobranch community, by applying a novel method of correcting for differences in sampling effort. The implications for management and conservation are discussed.

Keywords: North Sea, elasmobranchs, distribution, abundance, diversity.

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## **ICES CM 2005/N:07**

### **A preliminary investigation on shelf edge and deepwater fixed net fisheries to the west and north of Great Britain, Ireland, around Rockall and Hatton Bank**

Nils-Roar Hareide, Dominic Rihan, Myles Mulligan, Philip McMullen, Greta Garnes, Maurice Clark, Paul Connolly, Peter Tyndall, Robert Misund, Dag Furevik, Andrew Newton, Kjartan Høydal, Tom Blasdale, and Odd Børre Humborstad

Since the mid-1990s, a fleet of up to 50 vessels have been conducting a gillnet fishery on the continental slopes to the West of the British Isles, North of Shetland, at Rockall and Hatton bank. These vessels, though mostly based in Spain are registered in the UK, Germany and other countries outside the EU such as Panama. The fishery is conducted in depths between 200 and 1200 meters, with the main target species being monkfish (200–800 m) and deepwater sharks (800–1200m). These fisheries are not well documented or understood and they seem to be largely unregulated, with little or no information on catch composition and discards.

Vessels currently participating in the fishery are reported to use up to 250 km of gear, and the nets are left fishing unattended and hauled every 3-10 days with trip lengths varying between 4–8 weeks. The amount of fishing gear used in the fisheries, the lengths of the fleets, and the fact that the nets are unattended much of the time, make it very likely that a large quantity of nets are lost, while there is also evidence of illegal dumping of sheet netting.

The long soak times in these fisheries result in a high proportion of the catches being unfit for human consumption.

Keywords: Deepwater Shark Fisheries, ghostfishing.

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## **ICES CM 2005/N:08**

### **Why hasn't fisheries science enabled managers to implement precautionary elasmobranch management, and could other tools complement their efforts?**

Sarah Fowler and Charlotte B. Mogensen

Fisheries science demonstrates that elasmobranchs are highly vulnerable to depletion by fisheries and slow to recover from such depletion. There is international agreement that applying the precautionary approach to fisheries management in general and elasmobranch fisheries in particular should be given high priority. Stock assessments and CPUE data clearly indicate that some European species, including regional endemics, are seriously depleted. Regardless, the EU has still not adopted sufficient fisheries management measures to address these issues and/or to reverse these trends. There is limited monitoring, control and surveillance activity focused on elasmobranchs in EU waters and compliance with the requirement to record catches (whether retained or discarded) is almost non-existent. Nevertheless, imperfect data should not be used to justify inaction by policy-makers or managers and elasmobranchs are a perfect example of the need to apply a precautionary approach to management. It is suggested that biodiversity instruments, such as CITES, could be important complementary tools for the conservation, management and recovery of elasmobranch stocks.

Keywords: Elasmobranchs, precautionary approach, CITES.

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## ICES CM 2005/N:09

### Size, age and sexual maturity of blue shark, *Prionace glauca*, in the Mediterranean Sea

Persefoni Megalofonou, Dimitris Damalas, and G. De Metro

Blue sharks, ranged from 70 to 359 cm in total length (TL), were sampled from the swordfish and tuna fishery in the Mediterranean Sea during the four-year period 1998–2002. Males were predominant (60.1% male, 39.9% female) and sex ratio showed an increase of the males as size progresses. Gonad observation revealed that females smaller than 120 cm TL had immature ovaries with invisible oocytes while ovaries with visible yolked oocytes were present in specimens larger than 120 cm TL. Ovary weight varied from 4 to 137 g and maximum oocyte diameter was 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 was estimated at 210 cm in females and 190 cm in males. Caudal vertebrae were collected from specimens between 84 and 306 cm TL and vertebral ring counts were used to estimate age. Age estimates ranged from 0<sup>+</sup> to 8<sup>+</sup> years and age at first maturity was estimated about 4 years.

Keywords: blue shark, size distribution, age, sexual maturity, Mediterranean Sea.

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## ICES CM 2005/N:10 - Withdrawn

### Age and growth of the northeast Atlantic stock of *Squalus acanthias*

Ayeesha Power, Edward Fahy, Maurice Clarke, and Edgar McGuinness

It is considered that a unitary stock of *Squalus acanthias*, the spurdog, resides in the northeast Atlantic. This stock has been subjected to heavy fishing pressure in various parts of its range, notably in Norway, Scotland and Ireland. Preliminary estimates of stock status suggest that the stock is now depleted. This small pelagic shark is one of the few elasmobranchs for which a validated ageing technique is available. This technique was applied to the NEA stock, based on sampling from Irish commercial trawl fisheries and research surveys (2002–2004). The age range encountered in the NEA stock was 0 to 32 years. It is clear that this is a slow growing stock with limited ability to withstand heavy fishing pressure. The results of these age estimates are presented in the light of other studies of age and growth of squalid sharks. Implications for sustainable exploitation of this and other squalid shark stocks are discussed.

Keywords: *Squalus acanthias*, age, growth, spurdog.

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## ICES CM 2005/N:11

### Skates in the Barents Sea: stock status and catch by fishing fleet

Konstantin V. Drevetnyak, A. V. Dolgov, K. M. Sokolov, E. V. Gusev, and A. A. Grekov

Annual trawl surveys conducted by Polar Research Institute of Marine Fisheries and Oceanography (PINRO) in the Barents Sea during 1998–2003 have been used for estimation of abundance and biomass of the five species of skates (Thorny skate, *Amblyraja radiata*; Arctic skate, *Amblyraja hyperborea*; round skate, *Rajella fyllae*; blue skate, *Dipturus batis*; spinytail skate, *Bathyraja spinicauda*). The paper presents estimation of total skate catch during international trawl and long-line fishery for demersal fish in the Barents Sea and adjacent waters. The estimation was based on a method used at PINRO to determine catch of demersal fish taken as bycatch. Initial data to estimate total catch of skates in the study area were official international landings of demersal fish and database on species composition of catches gathered by Russian research observers onboard fishing vessels. The estimated catch of skates showed to be much higher than the official landings, which indicated that a large proportion of the skate catch was not used for production but discarded back to the sea.

Keywords: Abundance, Barents Sea, biomass, discards, landings, skates, survey.

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## ICES CM 2005/N:12

### Reproductive biology, growth and feeding habits of *Raja asterias* (Delaroche, 1809), from the north Tyrrhenian and Ligurian Sea (Italy), with some notes on trends in landings

F. Serena, M. Barone, C. Mancusi, and A. J. Abella

A lack of basic life history information on the starry ray (*Raja asterias*) has hampered an accurate assessment of north Tyrrhenian population. In an attempt to fill this void, the maturity, growth and feeding habits of this species were investigated. A total of 563 specimens, 292 females and 271 males were collected from commercial activity and research vessels, over the period March 2001 – August 2002. Data on LPUE of *R. asterias* from commercial landings of beam trawl and bottom trawl nets were collected and recorded on a monthly basis. Univariate seasonal ARIMA models were used for the analysis and forecast of data that regards the period July 1990 to December 2004. The maturity stages were assigned on the basis of visual inspection of reproductive tracts and histological study of ovaries and testes. The length at 50% maturity for males was 51 cm total length and for females was 56 cm TL. A scale for identifying maturity stages is proposed. The von Bertalanffy growth parameters were estimated ( $L_{\infty} = 67,45$ ;  $K = 0,454$ ;  $t_0 = 0,23$ ) and compared with the data proceeding from the direct reading of the vertebral sections, which have supported the indirect evaluation. Seasonal feeding habits were investigated. *Osteichthyes Perciformes* and *Crustacea Decapoda* were the main prey of the starry ray, though *Crustacea Anfiboda* was more important prey for juveniles and *Osteichthyes* for adults. The model obtained by analysing the LPUE series of the beam trawl shows seasonality and a steady situation over time, confirmed by the model developed on LPUE series of the bottom trawl.

Keywords: Shark fisheries, Western Mediterranean Sea, life history, sexual maturity, age, diets, time series analysis.

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## ICES CM 2005/N:13

### Changes in the abundance, size and habitat associations of skates in the southern Gulf of St. Lawrence, 1971–2002

Douglas P. Swain, H. P. Benoît, and T. R. Hurlbut

Three species of skates commonly occur in the southern Gulf of St. Lawrence: thorny skate *Amblyraja radiata*, winter skate *Leucoraja ocellata*, and smooth skate *Malacoraja senta*. We describe changes in their abundance, size composition and distribution, based on 32 years of monitoring by a bottom-trawl survey. Biomass and the abundance of mature skates decreased over the 1971–2002 period, by 80–90% for thorny and winter skates and to a lesser degree for smooth skates. In contrast, abundance of juvenile thorny and smooth skates increased from the mid 1980s to a peak in the mid 1990s. The increase in the abundance of juvenile skates in the 1990s coincided roughly with a collapse in the biomass of large-bodied demersal teleost fishes, a dramatic decline in fishing effort, a cooling of bottom waters in the southern Gulf and decreasing abundance of mature skates. The decline in the abundance of large skates may be an effect of fishing, though reported landings of skates are very low. Dramatic changes in the habitat associations and geographic distribution of thorny skate have also occurred in recent years. In the 1990s, their geographic range contracted sharply and their distribution shifted into a narrow band of warm deep waters. These changes may be responses to declining abundance or to the cooling of bottom waters in the 1990s. These results for the southern Gulf contrast those observed on Georges Bank and in the North Sea, where small elasmobranch species that are not targeted by fisheries increased in biomass as groundfish stocks declined.

Keywords: climate change, density-dependent, elasmobranchs, geographic range, habitat selection, indirect effects of fishing, population declines.

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## ICES CM 2005/N:14

### Biology and fishery of rays, *Bathyraja brachiurops* and *B.griseocauda* around the Falkland Islands

Vladimir Laptikhovsky, Alexander Arkhipkin, Paul Brickle, and Joost Pompert

*Bathyraja brachiurops* and *B.griseocauda* are commercially important ray species that are targeted by specialised trawlers in the Falkland waters. A total of 8,460 *B. brachiurops* and 9,332 *B.griseocauda* were sampled in 1993–2005. *B. brachiurops* attains 83 cm disk width (DW) (>15 kg) and inhabits depths ranging from 60 to 500 m, but mostly between 100 and 200 m. Females with fully formed egg capsules were caught throughout the Falkland shelf, throughout the year in depths ranging from 103 to 307 m. Hatchlings were found between 101 and 346 m. Juveniles are planktivorous, while adults fed on rock cod and *Loligo* squid. *B.griseocauda* attains 114 cm DW (>30 kg) and was found in depths varying between 106 and 523 m, but typically between 200 and 300 m. Hatchlings and most of large rays (>1 m TL) of the latter species were found in waters deeper than 400 m, suggesting that *B.griseocauda* may spawn in deep water throughout the year. Juveniles prey upon amphipods and isopods, large animals fed on squid, fish, whelks and isopods. The commercial aggregations of these two species were spatially separated. *B. brachiurops* was most abundant to the north of East Falklands, whereas *B.griseocauda* predominated in the north of West Falklands. In addition, *B.griseocauda* were found in deeper waters than *B. brachiurops*. The spawning grounds of these species were also spatially segregated. Such segregation is thought to reduce interspecific competition and should be taken into account when managing these fisheries.

Keywords: *Bathyraja*, Southwest Atlantic, biology, fishery.

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## ICES CM 2005/N:15 - Withdrawn

### Study on the aggregations of small-spotted catshark (*Scyliorhinus canicula*, L.) in the Cantabrian Sea

C. Rodríguez-Cabello, F. Sánchez, and I. Olaso

The small-spotted catshark (*Scyliorhinus canicula*, L. 1758) is a quite abundant shark in the Cantabrian Sea frequently found in small groups segregated by sex or size. Several factors potentially influencing these aggregations; depth, near bottom temperature, near bottom salinity, fish length and diet composition, were examined. The bathymetric distribution and termic habitat of both males and females have been described and no significant differences have been found. *A priori* adult males and females are not highly discriminated by any of these environmental variables based on a multivariate analysis. The diet composition varies with body size but it is quite similar in both sexes. An increase in feeding intensity has been found in adult females compare to males.

Keywords: Sexual segregation, Behaviour, *Scyliorhinus canicula*, Cantabrian Sea, Canoco analysis.

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## ICES 2005/N:16

### The potential impact of commercial fishing activity on the ecology of deepwater chondrichthyans from the west of Scotland

Emma Jones, Maurice Clark, Helen Dobby, Doug Beare, Nolwenn Trinkler, Finlay Burns, Francis Neat, Paul Fernandes, and Kevin Peach

Since the early 1990s the deepwater (400m to 2000m) shelf edge habitat west of the British Isles has been targeted by commercial fishers. The fishery is aimed at teleosts such as black scabbardfish and roundnose grenadier. A smaller component of the catch is, however, composed of chondrichthyans, i.e., the elasmobranchs (skates and rays) and chimaeras (rabbitfish). Until recently these were discarded, but now they are actively targeted and landed for human consumption. Chondrichthyans are particularly sensitive to high harvesting levels because of slow growth rates, high longevity and low fecundity. Data that might be used to quantify the effects of fishing in these areas are sparse because of the technological challenges involved in fishing to these depths. In this study data from scientific deepwater trawl surveys collected by British and Irish fisheries research institutes were combined and the database carefully interrogated. This revealed recent (1990–2004) changes in the distributions, depth preferenda, size structure and overall numbers caught per unit effort for a range of chondrichthyan species. For example, the abundance of the shark *Daenia calcea* declined sharply since the early 1990s. These changes are discussed in the context of landings and effort data and we assess the potential impact that fishing activity is having on this group of fish.

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## ICES CM 2005/N:17

### Age and growth of *Raja clavata* Linnaeus, 1758 – evaluation of ageing precision using different types of caudal denticles

Bárbara Serra-Pereira, I. Figueiredo, P. Bordalo-Machado, I. Farias, T. Moura, and L. Serrano Gordo

Dermal denticles are useful tools in taxonomic and phylogenetic studies focusing Chondrichthyes. In particular, *Rajidae* species can be differentiated, among other characteristics, by the disposition and morphology of these structures along the dorsal surface. Three types of dermal denticles can be defined: prickles, thorns and bucklers. The first ones are found all over the body, while the remaining are present on restricted body locations. On a recent work, caudal thorns were successfully used for ageing rays and skates from Falkland Islands, but seemed inappropriate to age Atlantic species. The present paper analyses different types of denticles from the caudal region of *Raja clavata*, using specimens, caught in Portuguese waters, with total length ranging from 13 to 89 cm. The distance from the centrum origin to the distal edge of each growth band and the band width were measured using an image analysis software, TNPC 4.0. Discriminant analysis was used as an exploratory statistical tool to identify different groups of caudal thorns from the median region. Thorns from each different group were further analyzed for ageing purposes. Following pre-established criteria on ageing reproducibility, one of the groups was selected and ages were assigned for each sampled specimen. Von Bertalanffy growth model was adjusted to age-at-length data separately for each sex. Although females attain larger sizes than males, no major differences were observed on growth rates between sexes.

Keywords: *Raja clavata*, dermal denticles, ageing precision, age, growth, Portugal.

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## ICES CM 2005/N:18

### Description of Portuguese mixed-fisheries with positive landings of *Raja brachyura* Lafont, 1873 and *Raja montagui* Fowler, 1910

Bárbara Serra-Pereira, I. Figueiredo, P. Bordalo-Machado, I. Farias, T. Moura, and L. Serrano Gordo

In Portugal, as in most European countries, rays and skates are important commercial resources, targeted only by a small segment of the fishing fleet. In fact, most of the landings are mainly the by-catch of other fleets. Ray landings are commonly not discriminated by species and their value is simply assigned according to specimens' size. Portuguese total ray landings are relatively uniform along years, yet this does not necessarily imply that the populations of different species are evenly stable. This study constitutes a first approach to describe and characterize the landings from fishing fleets operating at Peniche – the main Portuguese port with landings on rays and skates. In order to identify the different fishing métiers, cluster analysis was conducted based on 8 landing categories, representing more than 70% of the total catch. Métiers were defined according to the fishing gear, the season, the main landing categories and the principal ray size classes caught by the vessels. The ray species composition analysis revealed that *Raja brachyura* is the most common within the métiers and the major catch of gillnet vessels, while *R. montagui* is mainly caught by the longline métier. Biological samples collected under this study indicated that *R. montagui* reproduces along spring months and has an estimated growth rate similar to *R. brachyura*, but attains a smaller maximum size.

Keywords: Mixed-fisheries, multivariate analysis, métiers, reproduction, age, growth, *Raja brachyura*, *Raja montagui*, Portugal.

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## ICES CM 2005/N:19

### Demographic analysis and exploitation vulnerability of beaked skate (*Dipturus chilensis*) off the Chilean austral zone

Juan Carlos Quiroz and Rodrigo Wiff

The beaked skate (*Dipturus chilensis*) is an important component of elasmobranch commercial fisheries on the central-austral zone off Chile, extending from Talcahuano (36°44'S) to Cabo de Hornos (55°13'S). Nevertheless, the fishery management on this specie comprises only the central zone (36°44'S–41°28'S) leaving the austral zone (41°28'S–55°13'S) without any regulation on fishing effort. As a result of this, the fishing pressure increases dramatically on the austral zone, where the potential consequences on the population are unknown. In the absence of rigorous fishery-biological data, we proposed a matrix population model in order to assess the demographic traits under different fishing mortality levels. A Leslie Matrix model was performed defining changes by age classes in terms of life history parameters. Uncertainty levels of the models output was computed by a Monte Carlo method applied to survival, age at maturity and fertility. Three scenarios were evaluated according to different assumptions about survival, fishing mortality rate and age at first capture. According to these scenarios, the population abundance increases slowly without exploitation, with a 3% to 15% increase per year. The population reaches stability at reduced mortality levels (0.31 year<sup>-1</sup>), showing that these results are consistent with estimations on other *rajidae* skates. Elasticity to survival analysis suggests it is the juveniles who contribute the most to population growth rate variations. The sustainable mortality rate has a positive and non-linear relationship with the age at first capture. The results are discussed in the context of phylogenetic classification and how these characteristics are linked with conservation procedures.

Keywords: Demographic analysis, *Dipturus chilensis*, Leslie Matrix.

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## ICES CM 2005/N:20

### Abundance and distribution of rays in the south Ligurian and north Tyrrhenian Sea

F.Serena, C. Mancusi, M. Barone, and A. J. Abella

Data on abundance and distribution of skates collected from 1985 to 2004 during scientific trawl surveys as part of the Italian national GRUND project (GRUppo Nazionale risorse Demersali) and from 1994 to 2004 during the Mediterranean MEDITS project (MEDiterranean Trawl Survey) were analysed. Despite of the objective difficulties in the identification at specific level of the skates, especially due to a high morphological interspecific variability, in the study area were recorded 11 of the 15 skates species assumed to be present in the Mediterranean Sea. 4836 skates specimens were captured (4116 during the Grund and 720 in the Medits). The total catch in weight and number calculated for km<sup>2</sup> of the specimens caught during the scientific bottom trawls showed that some species (*R. clavata*, *Raja miraletus*) are very abundant in the catches, while others can be considered rare (*Raja circularis*, *Raja fullonica*). Multivariate statistical techniques were utilized for the analysis of catches and time series regarding the more abundant species, *R. clavata*, *R. miraletus* and *R. polystigma*. Although the analysis of the annual trends of the total Biomass Index and Density Index for all the strata in the whole area highlight clear fluctuations, the time series suggest a positive trend.

Keywords: skates, western Mediterranean Sea, bottom trawl surveys, abundance.

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## ICES CM 2005/N:21

### Age, growth and maturity of four commercial *bathyradjid* species from the Falkland Islands' Interim Conservation Zone

Michael J. Gallagher and Conor P. Nolan

Between 1994 and 1996, samples of four commercial *bathyradjid* species were collected on commercial fishing vessels and scientific research cruises within the Falkland Islands' Interim Conservation Zone (FICZ) (Falkland Islands: 51.45°S, 59.30°W). Vertebral and caudal thorn samples were collected from 198 *Bathyraja brachyurops*, 141 *B. griseocauda*, 42 *B. albomaculata* and 47 *B. scaphiops* along with associated data, to enable age, growth and maturity to be assessed. Growth estimates were derived from sagittal sections of vertebrae stained with crystal violet and whole caudal thorns stained using silver nitrate. Analysis of covariance demonstrated a significant difference ( $P < 0.05$ ) in the length at age data between the sexes for vertebral band count readings for *B. brachyurops*. No significant differences were observed between structures within sex for each species. Although length at age data was similar between structures and within structure by sex for each species, coefficients of variation and age bias plots revealed lower band resolution for thorns relative to that of vertebrae for the largest *B. griseocauda*. Von Bertalanffy growth estimates (range:  $k = 0.011$ ; female *B. griseocauda*, using thorns, to  $K = 1.38$ ; male *B. scaphiops*, using sagittal sections) and age at 50% maturity estimates (range: 8.50 years; female *B. scaphiops* to 24.78 years; female *B. griseocauda*, using sagittal sections only) revealed that these species are slow growing and mature at an advanced age. The impact of commercial fishing on the life history characteristics of each species is discussed.

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## ICES CM 2005/N:22

### Separation of species data from national landing figures

Graham Johnston and Maurice Clarke

In many instances, landings data for elasmobranchs are detail poor, with catch data supplied variously to species, genus or even family level. The amount of detail supplied varies with individual fishing vessels, and also by how the information is stored and/or provided at national level. There can also be misidentification problems, for example, landings of Leafscale Gulper Shark, *Centrophorus squamosus*, can be declared in its own right, or as Siki shark, *Centroscymnus coelolepsis*, Faux Siki or as a component of deepwater sharks. Similar problems apply to shelf dogfish and to rays. This creates difficulties in separating out landings by species for stock assessments. This paper details how further information can be mined from data such as these, and how this was done for the 2005 Working Group on Elasmobranch Fishes (WGEF).

Keywords: Elasmobranch, data mining, working group, stock assessment, landings figures.

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## ICES CM 2005/N:23

### Spatial distributions (1989–2004) and preferential habitats of Thornback ray and Lesser spotted dogfish in the eastern English Channel

C. S. Martin, S. Vaz, B. Ernande, P. D. Eastwood, F. Coppin, S. Harrop, G. J. Meaden, and A. Carpentier

Thornback ray (*Raja clavata*) and Lesser spotted dogfish (*Scyliorhinus canicula*) are commercially exploited in the eastern English Channel. As part of the CHARM Project (<http://charm.canterbury.ac.uk>), data originating from the Channel Ground Fish Survey (CGFS, carried out by IFREMER) and the East Channel Beam Trawl Survey (ECBTS, carried out by CEFAS) were compiled for the period 1989-2004. Based on an earlier study, the role and place of both species as a structuring part of the fish community in the eastern English Channel will be discussed, and the spatial extent of their preferential sub-communities in the area will be presented. Annual maps of spatial distribution (in number of fish/sq-km) of Thornback ray and Lesser spotted dogfish were produced by geostatistical interpolation allowing for the investigation of seasonal and inter-annual variations in spatial patterns. Suitable habitat modelling based on quantile regression enabled to relate the species abundances to significant environmental parameters, the resulting equation being used to map habitat suitability using GIS. The spatially structuring role of the environment for these two species will be discussed (in the light of increasing human disturbances and climatic change). This work aims to increase our scientific understanding of the spatial distribution of these two species, in order to better manage their exploitation and protect their preferential habitats. The latter is particularly relevant since the Eastern English Channel shows intense human-based activities, such as shipping and aggregate extraction, in addition to fisheries.

Keywords: eastern English Channel, CHARM, GIS, *Raja clavata*, *Scyliorhinus canicula*.

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## ICES CM 2005/N:24

### Comparison of the effects of exploitation on theoretical long-lived fish species with different life-history strategies and the implications for management

Edd Codling, Ciaran Kelly, and Maurice Clarke

A stage-based simulation model is used to investigate the effect of exploitation on theoretical populations representing long-lived elasmobranch and teleost species with different life-history strategies. A comparison is made between the effect of exploitation on the elasmobranch 'k-strategists' and other teleost species that are 'r-strategists'. We

demonstrate the effects of stage-based exploitation on a typical long-lived elasmobranch population and discuss the implications of this when designing a management plan to ensure survival of the stock.

Keywords: elasmobranch, k-strategy, r-strategy, exploitation, management plan.

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## ICES CM 2005/N:25

### Long term dynamics of chondrichthyan fish community in the upper Tyrrhenian Sea

Francesco Ferretti, Ransom A. Myers, Fabrizio Serena, and Paolo Sartor

Dramatic declines of shark and ray populations have been documented in many places around the world. There is some evidence that analogous declines occurred in the Mediterranean Sea, but data on elasmobranch exploitation have been historically scattered and hard to summarize. By combining data from commercial landings, commercial catch rates, and scientific trawl surveys, we reconstructed the dynamics of elasmobranch communities in the upper Tyrrhenian Sea since the 1890s. These data were integrated using generalized linear mixed effects models, in which the changes in depth distribution as well as abundance were modelled for each species. Commercial catch rate data begins in 1890 from fixed traps, which provide reasonable estimates of trends in coastal shark populations. Trawl surveys began in 1922 and continued sporadically until 1985 when annual surveys were instituted, i.e. the GRUND and MEDIT surveys. We standardized all the historical sources of information we had to predict the variation of species abundances in relation to commercial exploitation and changes in the assemblage of the whole fish community. At least eight elasmobranch species were totally lost from the region. These were large, mainly coastal and late maturing species such as *Squatina squatina*, *Squatina aculeata*, *Squatina oculata*, *Mustelus mustelus*, *Mustelus asterias*, *Galeorhinus galeus*, *Dipturus batis* and *Rostroraja alba*. Small early maturing species as well as sharks whose bathymetric ranges fall outside historically exploited grounds appear more resistant to fishing pressure.

Keywords: Abundances, Elasmobranchs, Fishing exploitation, generalized linear models, Mediterranean Sea.

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## ICES CM 2005/N:26

### Food composition and distribution of elasmobranchs on the shelf and upper slope of the Eastern Central Atlantic

F. A. Patokina and F. F. Litvinov

As the top predators elasmobranchs play a key role in oceanic ecosystems. The same time the quantitative data on their feeding are rare and sparse. The present paper is aimed to summarize the data available on feeding and distribution of elasmobranchs on the shelf and slope of Sierra Leone and Guinea. There were investigated food composition and distribution of 19 elasmobranchs species, 458 stomachs in total. The data were collected in three AtlantNIRO trawl surveys in 1983-1984. There were identified 93 food items: fish – 53, crustaceans – 26, cephalopods: 9, other (polychaetes, sipunculoids, gastropods, bivalves, salps) – 5. Out of all the items investigated 11 were pelagic ones (fish – 7, cephalopods - 4) and 82 bottom and near-bottom species. The data on spatio-temporal variability of food composition are presented. Interspecific competition is considered, the classification of elasmobranchs by food preference is proposed.

Keywords: elasmobranchs, Eastern Central Atlantic, food composition, distribution.

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## ICES CM 2005/N:27

### **The quantitative assessment of heterodonty in the Blue shark *Prionace glauca* and its modification through the life history**

F. F. Litvinov and V. V. Laptikhovskiy

The blue shark *Prionace glauca* is the most abundant and widespread elasmobranch and one of the most prominent large predatory nektonic species of the World ocean. This is one of the keystone elements of the oceanic ecosystem, influencing living resources in the open oceanic and neritic waters, populations of submarine mounts, etc. Despite of this, the species morphology and life story are poor known. The present paper is aimed to quantitative assessment of heterodonty in the blue shark and its modifications through the life history. Surface indices and linear and discriminant analysis were applied that allowed to define two distinctive categories in lower teeth shape: the awl- and the knife-shaped. Allometrical changes in teeth shape through ontogenesis are described. The beginning of sexual heterodonty in adolescent sharks is related to maturation, and results in appearance of the awl-shaped teeth in adult males. The sexual heterodonty, which emerged as a possible adaptation for sexual behaviour patterns, lead to different food preferences and spatial segregation of sexes. The possible ways of oceanisation of the coastal bottom and demersal elasmobranch as consequence of divergence in the foraging niches between males and females are discussed. The methods used allow tracing and quantitatively assessing the group and individual variability in the teeth shapes. These methods were successfully tested and may be recommended for zoological practice in analyses of variability of curvilinear projections: scales and bones, body patches etc.

Keywords: blue shark, heterodonty, sexual dimorphism, allometric changes.

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## ICES CM 2005/N:28

### **Diet comparison of four ray species [*Leucoraja naevus* (Müller & Henle, 1841); *Raja brachyura* Lafont, 1873; *Raja clavata* Linnaeus, 1758 and *Raja montagui* Fowler, 1910] caught along the Portuguese continental coast**

Inês Farias, I. Figueiredo, B. Serra-Pereira, P. Bordalo-Machado, T. Moura, and L. Serrano Gordo

Skates and rays represent more than 40% of Elasmobranch landings in NE Atlantic. In Portugal, as in most European countries, these species are commonly landed under the generic designation *Raja* spp. After a pilot sampling program on the identification of skates and rays landings composition, *Raja clavata* and *Raja brachyura* were found to be the most common species. *Leucoraja naevus* and *Raja montagui* represented nearly 40% of the remaining sampled specimens. Diet studies are important for the comprehension of biological and ecological interactions and its subsequent information can be integrated in stocks evaluation methodologies. The present paper analyses the diet of the four mentioned rajid species (*Leucoraja naevus*, *Raja brachyura*, *R. clavata* and *R. montagui*) from mainland Portugal based on the examination of stomach contents. Food items were identified to the minimum taxon possible. For a quantitative analysis, the index of relative importance, the percentage frequency of occurrence and the percentages by number and by weight were determined for the major taxonomic groups found, including Polychaeta, Crustacea (divided into 9 categories), *Cephalopoda* and *Osteichthyes*. Multivariate analysis results indicated different ontogenic shifts on the diet of each species. In general, these species exhibited heterogeneous feeding habits, with Crustacea (decapods) and *Osteichthyes* being identified as the more frequent preys. Differences on diet composition were also registered among areas and seasons.

Keywords: Diet, stomach contents, *Leucoraja naevus*, *Raja brachyura*, *Raja clavata*, *Raja montagui*, index of relative importance (IRI), feeding strategy plot.

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## ICES CM 2005/N:29 – Poster

### Observations on the biology and ecology of the deep sea shark, *Centrophorus granulosus*, in the eastern Mediterranean Sea

Persefoni Megalofonou and A. Chatzisprou

The gulper shark, *Centrophorus granulosus*, is a deep sea shark that reproduces through aplacental viviparity. A total of 43 specimens caught occasionally by long lines and bottom trammel nets around the island of Crete were studied. Their size ranged from 585 to 840 cm in total length and from 2000 to 4650 g in total weight. Significant length-weight and other morphometric relationships were estimated. Overall males outnumbered females by a sex ratio males/females almost 1:0.59 which was significantly different from a 1:1 sex ratio. Most of the specimens were mature. Gonad weight (GW) in conjunction with clasper length (CL) were secure indicators of maturity stage in males. In females numerous maturing ova (stage II) occupied the ovaries along with ripe ova. Mature ova (stage III) showed greater numbers in the left than in the right ovary. The number of ripe ova in individual ovaries ranged from 1 to 6. Mean ovum weight between ovaries was significantly different. Two females were recorded to bear candles in their uteri with undeveloped fetuses. The examination of the stomach contents revealed that their prey consists mainly of teleosts and cephalopods.

Keywords: gulper shark, *Centrophorus granulosus*, sexual maturity, stomach content, Mediterranean Sea.

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## ICES CM 2005/N:30 – Poster

### Depth distribution of the velvet belly lantern shark, *Etmopterus spinax*, in southern Portugal

Rui Coelho, Ivone Figueiredo, Pedro Bordalo Machado, and Karim Erzini

The velvet belly lantern shark is a small sized deep-water squalid that is commonly found along the Portuguese coast in deep waters, mainly on soft bottoms. In this study, 67 scientific 1 hour bottom trawls were carried out during June 2003, off the Southern and South-Western Portuguese coasts, at depths that ranged, in average, from 84 to 786 m. All *Etmopterus spinax* specimens captured were sexed, measured and weighed. A total of 396 specimens were captured (192 males and 204 females), with total lengths that ranged from 9.8 to 41.1 cm. Trawls were grouped in 100 m depth intervals and relationships between total size of specimens and depth class established. The depth class where most specimens occurred was the 500 m depth class (252 specimens representing 63.6% of the total capture), with a CPUE of 15.75 specimens per 1 hour of trawling, and with most of the length classes present. A size-depth relationship was found, with larger individuals caught at greater depths. Females were captured in a wider depth range (from 200 to 700 m) than males (from 300 to 600 m).

Keywords: *Etmopterus spinax*, depth distribution, depth range, Portugal

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## ICES CM 2005/N:31 – Poster

### Deep-water elasmobranches of the Azores: a vertical distribution

A. Rosa, M. Pinho, G. Menezes, and O. Melo

In this paper data from fifteen bottom longline surveys, carried out between 1995 and 2004 is used to resume all available information on elasmobranches off the Azores. The vertical distribution of the elasmobranches caught in Azorean waters from surface to 2200 m is presented. Sampling design for the Azorean elasmobranches will be discussed under the vertical distribution and ecosystem types defined for the Azores. Comparison with known assemblages of the commercial demersal and deep-water species will be used to discuss possible fishing impacts on elasmobranches. Additionally, taxonomy of all sharks and rays caught in the Azores waters is presented. Some basic biological information, like length distribution, mean length, length-weight relationship is also presented for some

selected species. Biological sampling effort to support future work on growth, reproduction, genetics and trophic studies is also resumed.

Keywords: deep-water elasmobranches, vertical distribution, surveys, fishing, Azores archipelago.

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