Report of the Symposium

Hosted by the Scientific Council of the Northwest Atlantic Fisheries Organization (NAFO) 11–13 September 2002

Elasmobranch Fisheries: *Managing for Sustainable Use and Biodiversity Conservation*

The **Symposium** *Elasmobranch Fisheries*: *Managing for Sustainable Use and Biodiversity Conservation***,** was held at the Palacio de Congreso, Santiago de Compestela, Spain, and was co-convened by D. W. Kulka (DFO, NAFO), J. A. Musick (VIMS, co-chair, IUCN Elasmobranch Species Specialist Group), M. G. Pawson (CEFAS) and T. I. Walker (PIRVic) during 11–13 September 2002. It was attended by 119 participants from Argentina, Australia, Brazil, Canada, Faroe Islands, France, Germany, Ireland, Italy, Mauritania, Mexico, Namibia, New Zealand, Portugal, Russia, Scotland, South Africa, Spain, Sweden, Netherlands, United Kingdom, and United States of America (refer to List of Participants).

Santiago de Compostela, Galicia, Spain

In the Keynote Address, Sarah Fowler, Naturebureau International and co-chair, IUCN Shark Specialist Group, pointed out that increased public awareness of the vulnerability of elasmobranch stocks and the impact of fishing over the past decade has led to a significant increase in the national and international fisheries management instruments directed toward this component. The recent history of international shark conservation and management initiatives and action plans for delivering conservation and sustainable use of elasmobranchs, particularly FAO's International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks), was reviewed. Despite these initiatives, landings of and international trade in elasmobranchs has increased during the past decade. It was concluded that progress and commitment in all but a few fishing states has been less than adequate.

The remainder of the Symposium considered current research, advances and impacts of elasmobranch fisheries in many different locations around the world in the context of four themes: Life History and Demographic Analysis; Stock Identity; Stock Assessment and Harvest Strategies and Biodiversity Maintenance. Three invited speakers addressed specific issues within the four sessions. In addition to the invited papers, the program comprised 53 oral presentations and 30 posters.

Session I: Life History and Demographic Analysis (J. A. Musick, covenor)

This session comprised 16 presentations: 8 focused on sharks, 4 on batoids, 2 on Chimaeras, and 2 were of a general nature concerning comparative life histories of elasmobranches. Of the posters, 6 described life history aspects of batoids, 2 on sharks. The invited paper by J. A. Musick elaborated on the inherent vulnerability of elasmobranch fishes to over-harvesting and ultimately stock collapse because of their life history characteristics: slow growth, long lifespan, late maturing and low fecundity. These demographic parameters lead to low intrinsic rates of population increase, which in turn minimizes the rate of sustainable fishing mortality (F). Indeed, some species may be so constrained that even low levels of F may lead to negative population trajectories: exceptions are smaller species which live in temperate or tropical environments.

Co-conveners (left to right): Mike Pawson, David Kulka, John Musick and Terry Walker

Subject matter presented in this session was diverse. In applying life table models to Portuguese dogfish (*Centroscymnus coelolepis*), matrix models might offer more insight into sustainable management of elasmobranch stocks than traditional assessment models. An investigation of the Irish ray fishery incorporated port sampling, commercial transaction data and logbook data to determine species, size and sex of batoids taken in this mixed species fishery. Although total mortality (Z) was shown to be relatively high, demographic analysis of all species except *Raja montagui* still indicated positive population growth. Aspects of age, growth and reproduction of the salmon shark (*Lamna ditropis*) were described for the eastern North Pacific. Growth rates of these sharks which are endothermic, maintaining a constant, elevated body temperature were higher than for ectothermic sharks inhabiting the same cold-water habitats. In addition, growth rate, length-at-age and weight-at-length were observed to be higher in eastern than in western Pacific salmon sharks.

Rabbitfish (*Chimaera monstrossa*) constitutes up to 15% of the discarded bycatch in deepwater trawl fisheries off Ireland. It was shown that rabbitfish are a long-lived (~40 years) and late maturing, with low fecundity. For commercial ray species from the Irish Sea, smaller species were shown to have faster growth rates and all species had rather abrupt onset of maturity. Age, growth and reproduction was described in the barndoor skate (*Dipturus laevis*), a species severely depleted in the western North Atlantic. Age at maturity was determined to be lower than previously assumed and the species was found to be common on parts of Georges Bank. Distribution, growth and reproduction were described in the white-spotted skate (*Bathyraja albomaculata*) from the Falkland Islands. Dorsal thorns were sectioned to determine age (although the method has not been validated) and age and size at maturity as well as seasonal reproductive and migration patterns were described.

Reproductive biology of the thorny skate (*Amblyraja radiata*) was described for the outer Grand Bank (NAFO Division 3N). This species apparently has slow growth and late maturity and limited fecundity. Age, growth and reproduction in the lesser-spotted dogfish (*Scyliorhinus canicula*) were described off Ireland. Males grow faster than females in this species, a situation common among elasmobranches. However, the author also found that males reach a larger size. The combination of faster growth and larger size is unusual and the evolutionary implications of this were discussed.

Density dependent compensation was investigated in the sharpnose shark (*Rhizoprionodon terraenovae*) in the Gulf of Mexico, a small subtropical shark with relatively fast growth. Growth rate increased and length and age at maturity decreased in response to increased fishing mortality. No increase in fecundity was observed nor would it be expected in viviparous species in which the size of the uterus constrains the number of young that can be carried to term. Reproduction was reviewed in lamniform sharks, which are oophagous or adelphophagous. In this group of large and commercially important species, developing embryos are nourished in utero by unfertilized eggs produced in large numbers by the female.

Both fishery dependent and independent data sets were used to determine demographics and status of the dusky shark (*Carcharhinus obscurus*) in the western North Atlantic. The species takes 21 years to mature and has a 3-year reproductive cycle during which it produces around 8–10 young. This species has declined by 80–90%, and demographic modeling suggests that population recovery is doubtful, even though the species is protected by recent fishing regulations. Bycatch mortality remains high (>50%) in the directed shark long-line fishery. Another study found that size at maturity has declined in female spiny dogfish (spurdog, *Squalus acanthias*) in the North Atlantic in response to over-fishing. Litter size remained constant, although the average size of recruits declined because of fewer large females (pup size is correlated with female size).

Data from the literature were used to create stage-based population models with subsequent elasticity analysis to determine how mortality (M) and fertility (F) influence population growth rates (r) in elasmobranchs. The author found a negative association between species size and elasticity of fecundity and a positive relationship between size and elasticity of adult and juvenile stages. Information from similar analyses might be useful in determining management strategies.

Sonic telemetry was used with fixed receivers in a small bay in Florida to obtain direct estimates of natural and fishing mortality in neonate blacktip sharks (*Carcharhinus limbatus*). Both natural and fishing mortality were found to be very high (60–90%) for the first 15 weeks of life, after which survivorship increased drastically.

To summarize:

1. Breeding age of elasmobranches should be defined as the age at which females actually bear young or lay eggs, and not when ova begin to mature. This is especially relevant to demographic modeling.
2. Size selectivity of fishing gear may affect the growth curves that result from sampling the catch and may not actually represent growth in the general population.
3. More research is needed on the effect of density-dependent compensation on vital rates in elasmobranches.
4. More research is required to provide empirical estimates of natural mortality by age.
5. More research is needed on demographics, stock structure, habitat utilization and both ontogenetic and seasonal migrations in deepwater elasmobranches.
6. Managers need to pay closer attention to life history differences among species taken in mixed species fisheries. In mixed fisheries, different life history characteristics among the catch components can be problematic. Large, slow growing, long-lived elasmobranches may be depleted or locally extirpated while more productive fishes continue to drive the fisheries.

Session II: Stock Identity (M. G. Pawson, convenor)

This session comprised 13 papers and 5 posters covering approaches to stock identification in relation to assessment and management; movement patterns and spatial structure; distribution and related population biology; population genetics; and a fisherman's perspective on fishery developments. A common theme was the lack of information on the relationship between stock structure and those parts of a species' population that are subject to exploitation, even in fisheries with a long history of exploitation and management.

Four papers reported studies on the behaviour of individual fish using fishery-independent techniques (archival, acoustic and satellite tags), and these have begun to reveal hitherto unsuspected patterns of movements (white sharks in Australia, basking shark off the west coast of the UK, thornback ray in the southern North Sea, and juvenile sandbar shark along the Virginia shore). In three cases, there is evidence of movement into areas where conventionally-tagged individuals have not been recaptured. Philopatry, a tendency to stay in or return to a breeding, nursery or feeding area, was observed in all species. This has implications for assessments based on CPUE data, where local depletion may obscure overall population trends, and because the sampled population (for tagging or biological studies, usually where the species can most readily be caught) may not be representative of the population as a whole.

Progress was reported in the development of genetic markers for species recognition and stock delineation, of sharks in the western Atlantic and rays in the Mediterranean Sea respectively, but there is, as yet, little evidence that this approach may soon be used to identify management units. It was also shown that measured population parameters (growth, maturity, meristics etc) vary considerably in time and space, partly because there are few, if any standardized protocols for data collection and analysis. This limits their use in stock identity.

Analyses of elasmobranch data from standard trawl surveys from the NAFO Regulatory Area, waters around the British Isles and in the western Mediterranean showed that these are valuable indicators of stock structure and distribution. There are similar data sets and other sources of information that should be investigated with this goal in mind.

Tagging studies, especially those providing information on scale and rate of dispersal and migrations and some ability to interpret why these are taking place, currently provide most of our knowledge on stock identity of elasmobranchs. Philopatry introduces complications to knowledge of stock units and to our ability to interpret population trends and status from data representing only part of a self-supporting stock unit. Clearly, this provides a less than solid basis upon which to develop management actions, though development of spatial models that recognize these features in population structure, and in the patterns and evolution of fisheries is a promising solution.

Session III: Stock Assessment (D. Kulka, convenor)

Fourteen papers described fisheries and monitoring (4 papers) and highlighted a variety of assessment techniques applied to elasmobranch stocks (10 papers). The latter focused mainly on innovative modeling and assessment methodologies. Of the posters, 1 described biomass dynamics/catch effort trend analysis and 8 provided descriptions of fisheries or described development of elasmobranch assessment techniques.

Elasmobranchs often make up a significant component in fisheries directed for other species, particularly those prosecuted in deep water. This was illustrated in a study of the deep water fisheries off Portugal. Portuguese dogfish (*C. coelolepis*) and Leaf-scale Gulper shark (*Centrophorus squamosus*) made up the major part of total annual elasmobranch landings, although a great deal of variation was observed among areas fished and fleet. Socio-economic implications were also discussed in the context of conservation *vs* exploitation. Elasmobranch trawl fisheries in the Sicily Strait were also described. A monitoring program identified a complex catch, 26 species of elasmobranchs belonging to 11 families. *Raja batis* and several other species regarded as unusual for the area were reported to be common in the catches. Landings and discard amounts were estimated (more than half discarded) and depth relationships were given. Two fisheries for blue shark (*Prionace glauca*) were also described. New markets for long standing fishery off Baja California Mexico (dating back to the 1880s) led to expansion of the fleet to larger vessels. Small vessels captured mainly juveniles while the larger vessels took larger fish. Moderate downward trends in catch rates were observed. The value of careful monitoring practices was illustrated in a presentation describing a recently initiated experimental artisanal fishery in the Bay of Biscay. Fishery observers recorded very detailed information on fishing locations and times, gears, species compositions, size and sex distributions in the catches. A dramatic drop in the CPUE over a short period (3 years) was observed.

Most of the papers described methodologies used to assess elasmobranchs. Very often, data (input) was the key limiting factor. Assessments often rely on very basic data such as species integrated catch series and catch rates, or fishery independent indices. For example, where CPUE is not species disaggregated, while the rate might remain relatively stable, some of the more vulnerable (the elasmobranchs) components might well be in decline. One study showed how port sampling and survey data could be used to split aggregated catch data by species. The multispecies rajid fishery off the Falkland Is. is another case illustrating data deficiencies. In the absence of detailed biological knowledge or catch at age information or even a species specific breakdown of the catches, simple production models incorporating species aggregated catch/effort data were used to estimate sustainable levels of exploitation. The status of sharks taken in nets set near beaches of South Africa (to minimize the risk of shark attack) was also assessed on the basis of limited information. Given that effort was relatively constant through space and time, catch was used an index of abundance. Although effort was not high, catches of 4 species showed a significant decline (removing the confounding affect of the annual sardine run). Uncertainty about local stock depletion and philopatry was noted. The issue of local stock depletion that would not be observed in spatially aggregated assessments was also noted in several other papers.

Where appropriate data are available, elasmobranch assessments have been based on quite a variety of methods from demographic analysis, surplus production models and, more recently, models that require age-disaggregated input as well as knowledge of life history (age and growth), stock structure and spatial distribution. As is the case for all fish stock assessments, no matter how sophisticated the model, the interpretation of the results are constrained by assumptions in the input variables. It was pointed out that applying different models can result in very different results.

In some cases, appropriately detailed data such as age-disaggregated data are available and a number of cases were illustrated. Various approaches used in the assessment of NE Atlantic deepwater sharks were presented. A European research project (DELASS) was initiated in 2000 to remedy some of the deficiencies aimed at collecting the required data and developing appropriate stock assessment models. Ageing elasmobranchs is generally more difficult than for teleosts. Generally, vertebrae are used but spines also contain annual rings. One paper described the age and growth of bull sharks (*Carcharhinus leucas*) from the Gulf of Mexico. For this study, four different techniques were applied to enhance ring definition of the vertebrae. Validation was done by marginal increment analysis. The study described the Von Bertalanffy parameters for the species. An age-structured model was implemented using a Bayesian approach. Information from multiple gears and fishery independent surveys was applied to Atlantic Sharpnose Shark. It was pointed out that a good understanding of life history parameters was important to the integrity of the model. Limited knowledge of life history leads to uncertainty in the model outcome. One paper dealing with sandbar sharks (*Carcharhinus plumbeus*) presented an age/sex structured population dynamics model that took into account biological and fishery characteristics. This presentation illustrated the advantage of accounting for such aspects as pupping areas or spatial aspects of shark dynamics in the model. Another paper dealing with gummy sharks (*Mustelus antarcticus*) employed a variant of the Integrated Analysis Method, also an age/sex structured population dynamic model that incorporated catch, length-frequency and release-recapture data. Issues raised were the spatial consistency on the stock's peculiarities of the pupping process and fishery over time, gear composition and affect on the analysis. A Bayesian stock production assessment of NE Atlantic spurdog was fitted to survey and commercial CPUE data. Demographic techniques were used to convert prior distributions for age specific fecundity and natural mortality (based on tagging data and maximum age/length).

A GIS approach was used in one study to investigate changes in the fishery for and abundance of kitefin shark (*Dalatias licha*). Fishing ground, depth, distance to fishing ports, and seasonality in species catches were overlaid to yield a spatio-temporal perspective of the fishery. Least cost pathways may be useful for managers to evaluate resource exploitation sustainability, identify potential fishing grounds and selecting suitable resource conservation measures.

Deep water sharks may be even more vulnerable to exploitation than orange roughy, a deepwater teleost well known to decline rapidly soon after the implementation of fisheries. Thus, stocks are often observed to decline soon after commencement of a fishery. Problems in assessing elasmobranches related mainly to the non-availability of appropriate input data in addition to the rate at which these species decline once they are exploited. Combining species and gears was recognized as less than appropriate, yet in many cases, only aggregated data were available. It was suggested that a more pre-emptive management approach is required for elasmobranchs in the form of conservative measures (management plans that include immediate implementation of quotas and restrictions). The issue is not the methods used to assess elasmobranchs (generally quite sophisticated) but rather data deficiencies and less than adequate managements measures derived from the advice given (and the political will to implement same). The first key step is to improve the data through enhanced monitoring programs, including ones that involve the fishers or employ independent observers.

Session IV: Harvest Strategies and Biodiversity Maintenance (T. I. Walker, convenor)

Thirteen papers were presented relating to sustainable use, biodiversity conservation, and maintenance of ecosystem structure and function.

Sustainable use

Several papers on the shark fishery of southern Australia provided examples of fisheries where there is a long history of monitoring, biological research, stock assessment and management. The invited speaker indicated that harvest strategies can be evaluated using deterministic models to capture the biology of the species taken and the dynamics of the fishery. Harvest strategies are evaluated in terms of performance measures that relate to average catches, catch variability, and resource conservation. The need for risk assessment as part of the assessment of fisheries and good consultative processes engaging fishery managers, scientists, fishers and other stakeholders were emphasized. The fishery of southern Australia demonstrates that, with the one important exception of the school shark (*Galeorhinus galeus*), the target, byproduct, and bycatch of chondrichthyan catches by gillnets and longlines are sustainable. School shark was identified as having very low productivity and in need of tight fisheries management.

Chondrichthyans, having low biological productivity are vulnerable to the effects of fishing. Several species from other parts of the world were identified as having been markedly depleted: notably the sandbar shark (*C. plumbeus*), spiny dogfish and several species of skate in the Atlantic. On a broader scale, dogfish, and chimaeras occurring in deep water on the continental slopes of the world appear to be at high risk. These animals inhabit cold water and have particularly low productivity; their habitat area is small compared with the continental shelves and abyssal plains. In contrast, species such as gummy shark (*M. antarcticus*) and Atlantic sharpnose shark (*R. terraenovae*) were shown to be highly productive and can sustain stable fisheries.

Attention was drawn to the need of giving special protection to both pre-recruits and breeding animals in a harvested population. It was demonstrated that the mesh size used in a fishery can be tuned to minimize the impact on small sharks and large sharks. Choice of mesh size is a balance between the efficient take of target species and minimizing bycatch. It was also argued that closed areas are probably the only available method of conserving some species.

In terms of the fin trade data in Hong Kong, whereas the data appear to be incomplete, it is possible to estimate number of sharks killed by application of raising factors to available numbers of fins in batches of known weight for known species (recorded by traders or determined from genetic testing). A major component consists of blue shark (*P. glauca*) and several other pelagic species taken in oceanic waters. More direct estimates of blue, shortfin mako (*Isurus oxyrinchus*) and porbeagle sharks (*Lamno nasus*) taken as bycatch in the tuna longline fishery of New Zealand were made from at sea observer programs. There, following a decline in the catch during the early 1990s, there was a rapid rise in catch during the past 10 years, in response to the high demand for shark fins on Asian markets. As most of the catch of blue sharks comprises males and there is evidence of stock structuring, the presenter emphasized the need for international collaboration for the assessment of these pelagic species.

It is not always feasible to undertake detailed assessment of every species and there is a need to apply rapid assessment techniques to identify those species at high risk and in need of special management or protection. Application of this approach was presented for northern Australia, where species were compared on the basis of biological productivity and catch susceptibility quantified on the basis of various biological attributes (e.g. longevity, fecundity, proportion breeding, distribution in relation to the fisheries and position in water column in relation to the fishing gear).

Biodiversity conservation

Much of the world chondrichthyan catch is reported as 'unspecified species' or is not reported at all. Several papers reported progress on evaluation of bycatch and byproduct species through on-board observers during normal commercial fishing operations. Other papers reported progress on catch evaluation from fishery-independent trawl, longline and gillnet surveys, or experimental fishing. Data were presented that indicate bycatch of chondrichthyans can be reduced by the application of Bycatch Reduction Devices including Turtle Exclusion Devices.

Ecosystem structure and function

Most trawl, longline, and gillnet fisheries catch large numbers of chondrichthyan species and the number of animals taken varies greatly between species. In general, a small number of species dominate the catch. Chondrichthyans are clearly important in the ecosystem and some are apex predators. It also appears, in some regions at least, that the biggest animals in the ecosystem tend to be chondrichthyans.

Surveys of catches from the artisan fisheries of the coastline from Sierra Leone to Ghana indicate that the assemblages of the chondrichthyan fauna change from inshore across the continental shelf and down the continental slope. Another survey with trawl and longlines off the eastern and western coasts of Ireland indicate that dogfishes form the dominant species on the slope and that the predominance of dogfishes on the slope increases with increasing depth. Similarly, as indicated by a poster presentation, the dogfishes were much more significant in the fish communities of the deeply submerged seamounts than those of the more shallowly submerged seamounts of the Sierra Leone Rise in the Gulf of Guinea.

An ecosystem model for the Cantabrian Sea using ECOPATH was presented that incorporates fish biomass estimates, biological parameters, stomach contents data, and catches and discards. The model also includes the trophodynamics of phytoplankton, zooplankton, benthos, and demersal and pelagic communities. The model was used to evaluate the effects of various fishing gears and closed areas on chondrichthyan populations and catches. Other papers highlighted the complex spatial, temporal and depth effects on stomach contents of sharks.

Conclusion

Considerable attention has been focused on elasmobranchs and their exploitation in recent years in various parts of the world. The Council was introduced to some general issues generated from the discussions at the symposium:

1. Elasmobranchs are generally more vulnerable to exploitation and are slower to recover than other fish species due to life history characteristics such as low natural mortality, slow population growth and low reproductive rate. Deep water sharks are particularly vulnerable.
2. Of particular concern is the low intrinsic rates of increase in elasmobranch stocks. When taken in mixed fisheries where some species are more productive, the possibility exists that some elasmobranchs may be extirpated while target species and the fishery remains viable.
3. Information for the management of elasmobranch stocks needs to be greatly improved. Unrestricted fishing with ineffective monitoring, management and controls is typical for many of the world fisheries.
4. Increased public awareness of the vulnerability of elasmobranch stocks and the impact of fishing over the past decade has led to a significant increase in the national and international fisheries management instruments directed toward this group, although many remain poorly implemented.

In addition, participants at the 2002 NAFO Symposium on Elasmobranch Fisheries call for:

- NAFO to establish effective management measures for thorny skate and direct the NAFO Scientific Council to investigate the status and management needs of other elasmobranchs in NAFO waters;
- Fishing nations, regional fishery management organizations, and FAO to increase investment in elasmobranch biological and fishery research and management;
- NAFO and all fishing nations, even in the absence of complete fishery data, to implement precautionary quotas and measures to reduce bycatch for particularly vulnerable species;
- All shark-fishing nations, but especially the major fishing nations, to produce a National Plan of Action for their elasmobranchs;
- FAO and developed countries to provide the technical expertise to assist developing nations in the preparation of their National Plan of Action and the assessment and management of fisheries taking sharks.

Symposium Schedule

Oral Presentations

Session I: Life History and Demographic Analysis (Convenor: J. Musick)

Paper No.	Author(s) and Title
1.1	**Invited Paper**: MUSICK, J. Life history and demographic analysis.
1.2	CARVALHO, L., M. QUARESMA and I. FIGUEIREDO. First approach to the application of life table models to the Portuguese dogfish (*Centroscymnus coelolepis*).
1.3	GALLAGHER, M., F. JEAL and C. P. NOLAN. An investigation of the Irish ray fishery in ICES Divisions VIIa and VIIg.
1.4	GOLDMAN, K. J. and J. A. MUSICK. Growth and demographic dynamics of salmon sharks in the eastern and western North Pacific: a spatially structured population?
1.5	CALIS, E., E. JACKSON, C. P. NOLAN and F. JEAL. An insight into the life history of the rabbitfish *Chimaera monstrosa* with implications for future resource management.
1.6	CARLSON, J. and I. BAREMORE. Changes in biological parameters of Atlantic sharpnose shark, *Rhizoprionodon terraenovae*, in the Gulf of Mexico: evidence for density-dependent regulation?
1.7	CASTRO, J. I. Patterns of reproduction in the *Oophagous lamniform* sharks.
1.8	FRISK, M. G., N. K. DULVY and T. J. MILLER. Combining elasticity analyses and life history traits of elasmobranchs as indicators of vulnerability to exploitation.
1.9	GALLAGHER, M., C. P. NOLAN and F. JEAL. Age, growth and maturity of the commercial ray species from the Irish Sea.
1.10	GEDAMKE, T., W. D. DUPAUL and J. A. MUSICK. Observations on the distribution and life history of the barndoor skate (*Dipturus laevis*) in the Georges Bank closed area II.
1.11	HENDERSON, A. C., A. I. ARKHIPKIN and J. N. CHTCHERBICH. Distribution, growth and reproduction of the white-spotted skate *Bathyraja albomaculata* around the Falkland Islands.
1.12	HEUPEL, M. R., C. A. SIMPFENDORFER and R. E. HUETER. Direct estimation of survival and mortality of juvenile blacktip sharks, *Carcharhinus limbatus*, using telemetry data.
1.13	DEL RÍO IGLESIAS, J. L. Some aspects of the thorny skate (*Raja radiata* Donovan, 1808) reproductive biology in NAFO Division 3N.
1.14	IVORY, P. and F. JEAL. Age determination, growth and reproduction in the lesser-spotted dogfish, *Scyliorhinus canicula* (L.).
1.15	MARQUEZ-FARIAS, J. F., D. CORRO-ESPINOSA and J. L. CASTILLO-GENIZ. Biology of the pacific sharpnose shark, (*Rhizoprionodon longurio*), caught in Sinaloa, Mexico.
1.16	ROMINE, J. G., J. A. MUSICK and G. H. BURGESS. Life history parameters of the dusky shark, *Carcharhinus obscurus*, revisited and their implications to estimates of population increase.
1.17	SOSEBEE, K. A. Are density-dependent effects on elasmobranch maturity possible?

Session II: Stock Identity
Convenor: M. G. Pawson

Session III: Stock Assessment
Convenor: D. W. Kulka

Paper No.	Author(s) and Title
3.1	APOSTOLAKI, P. and M. MCALLISTER. Providing advice for the management of sandbar shark (*Carcharhinus plumbeus*). Application of an age- and spatially-structured model.
3.2	PRIBAC, F., A. E. PUNT, T. I. WALKER and B. L. TAYLOR. The value of length, age and tagging data in a stock assessment of a length selective fishery for gummy shark.
3.3	SIMPFENDORFER, C. A. and G. BURGESS. Assessment of the status of the Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) using an age-structured population model.
3.4	CLARKE, M. G., P. LORANCE and R. OFFICER. Approaches to the assessment of deepwater sharks in the northeast Atlantic.
3.5	DUDLEY, S. F. J. Shark catch trends and effort reduction in the beach protection program, KwaZulu-Natal, South Africa.
3.6	FIGUEIREDO, I., L. S. GORDO and P. B. MACHADO. Deep-water sharks fisheries from off the Portuguese continental coast.
3.7	HAMMOND, T. R., C. DARBY, J. R. ELLIS and M. G. PAWSON. Bayesian assessment of NE Atlantic spurdog using a stock production model, with prior for intrinsic rate of increase set by demographic methods.
3.8	MACHADO, P. B. Finding trends on the fishery and abundance of kitefin shark, *Dalatias licha* (Bonaterre, 1788), from off Azores throughout a GIS spatial analysis.
3.9	SOLDAT, V. T. Spiny dogfish (*Squalus acanthias* L.) of the Northwest Atlantic Ocean (NWA).
3.10	WAKEFORD, R. C., A. J. AGNEW, D. A. J. MIDDLETON and J. H. W. POMPERT. Fisheries conservation of a multi-species skate and ray community in the Falkland Islands.
3.11	CRUZ-MARTÍNEZ, A., X. CHIAPPA-CARRARA and V. ARENAS-FUENTES. Age and growth of bull shark *Carcharhinus leucas* from the southern Gulf of Mexico.
3.12	SCACCO, L., F. ANDARLORO, S. CAMPAGNUOLO, L. CASTRIOTA and M. VACCHI. Cartilaginous fish catches in the Sicily Strait trawl fisheries.
3.13	LUCIO, P., V. ORTIZ DE ZÁRATE, G. DIEZ, C. RODRÍGUEZ-CABELLO and M. SANTURTÚN. Description of an Experimental Artisanal Fishery Targeting Blue Shark in the Bay of Biscay, 1998–2000.
3.14	SOSA-NISHIZAKI O., E. FURLONG-ESTRADA, J. A. REYES-GONZÁLEZ and J. C. PÉREZ-JIMÉNEZ. Blue shark (*Prionace glauca*) fishery in Baja California, Mexico: an example of artisanal and middle scale fisheries interaction.
3.15	PASTOORS, M. A. Stock assessments of elasmobranchs in North-East Atlantic: making the most of the data.

Session IV: Harvest Strategies and Biodiversity Maintenance
Convenor: T. Walker

Poster Presentations

Life History

Participants at Poster Presentations

Poster No.	Author(s) and Title
P.1	COELHO, R., L. BENTES, C. CORREIA, J. M. S. GONÇALVES, P. G. LINO, P. MONTEIRO, J. RIBEIRO and K. ERZINI. Fisheries biology of the undulate ray, *Raja undulata*, in the Algarve (southern Portugal).
P.2	GALLAGHER, M., C. P. NOLAN and F. JEAL. The structure and growth processes of the caudal thorns of Bathyrajids.
P.3	JEAL, F., D. FOLEY and M. GALLAGHER. Gonad maturity and age in male rajids.
P.4	RODRIGUEZ-CABELLO, C. and F. SÁNCHEZ. Growth estimates of the lesser spotted dogfish (*Scyliorhinus canicula*) in the Cantabrian Sea.
P.5	SOSEBEE, K. A. and A. WHITTINGHAM. Maturity of skates in northeast United States waters.
P.6	KESKIN, C., M. SUHENDAN, O. MUAMMER and N. UNSAL. Research on the relationship between meat yield quality and the liver weight of the thornback ray (*Raja clavata* L. 1758) in the Black Sea.
P.7	STENBERG, C. Life history of the piked dogfish (*Squalus acanthias* L.) in Swedish waters.
P.8	CHARVET-ALMEIDA, P., M. L. GÓES DE ARAÚJO, and M. PINTO DE ALMEIDA. Reproductive aspects of freshwater stingrays (Chondrichthyes: Potamotrygonidae) in the Brazilian Amazon Basin.

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Participants of the Symposium on *Elasmobranch Fisheries: Managing for Sustainable Use and Biodiversity Conservation*, 11–13 September 2002.

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