

Conclusions of Deepsea Chondrichthyan Workshop

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Background

Deepsea chondrichthyan fishes are defined as bathyal species, occurring deeper than 200m (the shelf break). They are characterised by low growth rates, reproductive rates, high longevity, and low metabolic rates. This means that certain deepsea chondrichthyans are more vulnerable to over-exploitation than perhaps any other marine species group, and certainly more than those that occur in shallow water. Preliminary results from the IUCN Shark Specialist Group's Red List assessments indicate that commercially-exploited species of deepsea sharks are among the marine taxa at highest risk of extinction.

Although the world's continental slope habitat represents only a relatively small area of the oceans compared with shelf and pelagic habitats, it supports the greatest diversity of chondrichthyan species. Most occur within a limited depth range and have a much more restricted distribution than species in other habitats.

Most deepsea chondrichthyans are taken in multispecies fisheries or as bycatch in target fisheries for more abundant, valuable teleosts and crustaceans. There are some important target deepwater chondrichthyan fisheries, some of which are driven by international demand for their products (particularly liver oil). Although most attention is focused on sharks, batoid and chimaeroid biodiversity and fisheries are important in some regions.

Fisheries

Those deepwater chondrichthyan fisheries for which baseline data are available have been unsustainable. Unfortunately, however, data are only available for a very few fisheries. Case studies presented at the workshop (e.g. Australia, Namibia) demonstrate that small numbers of vessels operating target fisheries can seriously deplete previously unexploited stocks in just a few years of fishing. While localised fishing pressure depletes local stocks rapidly, adjacent populations may, in some cases, be relatively unaffected. Recovery of depleted stocks is likely to be extremely slow because of these species' life history constraints.

Although most target fisheries for deepsea chondrichthyans are short-lived because of this pattern of rapid depletion, these species will still continue to be taken as bycatch. Mixed deepwater fisheries are, in most cases, not managed for chondrichthyans, which may potentially be extirpated by fisheries supported by more abundant or productive teleosts or invertebrates.

These results highlight the importance of obtaining baseline data prior to the development of new deepwater fisheries in previously unexploited areas. This can only be achieved by significant investment in research or by monitoring the very early stages of carefully regulated exploratory fisheries.

Species composition and stocks

Much of the world's oceans remain unexplored and regional bathyal faunas remain undefined.

Species composition in deepwater fisheries is incompletely known. Chondrichthyan taxonomy is uncertain and recording often poor and inaccurate. This is partly due to the lack of up to date identification tools and inadequate monitoring. In many chondrichthyan fisheries there is little or no effort to undertake species identification or monitoring at species level. Monitoring for species, sex and size composition at landing sites is hampered by the landing of 'trunks' without heads, fins or claspers, or livers and fins without carcasses; these data are essential for stock assessment and management.

Complete stock structure and distribution is unknown for all species of deepsea chondrichthyan fish; and completely unknown for most species in most regions.

Some species are endemic to small areas and do not range far. Others are apparently very widely distributed and highly migratory, but because different sexes, reproductive stages and age classes are often segregated in separate areas and at different depths, it is relatively easy to remove a whole vital section of the population (e.g. all pregnant females) in a relatively localised fishery. Different States may also catch different parts of the stock, different sexes or life stages, and set their own quotas and management measures without considering what is happening to the stock in other parts of its range.

Recommendations for fisheries management and monitoring

Although this group of fishes does not require any unique management measures compared with those applicable to other species, management is more challenging because the available stock and sustainable harvest potential is so much lower for all chondrichthyans, even more so in relatively unproductive deep water. Management is made more complex by the international or high seas location of some fisheries, where state fisheries management may not be applied other than by controls over flag vessels.

Given their vulnerability, it is absolutely essential that a precautionary approach be taken for the management of deepsea chondrichthyans.

Adequate monitoring of catches and landings is essential for effective management of fisheries. This requires the following actions:

- Recording of reliable species data in catches, landings and trade.
- Preparation of good identification guides and wider use of these in observer programmes and landing sites monitoring.
- Improved use of observers in commercial fisheries
- Development of standard carcass forms: Sharks should be landed with fins attached in order to improve reportings of landings and facilitate identification at species level. Batoids should be landed with wings attached. Trunks should be landed with livers. Reporting should include both species and their products.

Educational programmes are needed to explain to managers and stakeholders why far more careful management is needed for this group than for other taxa.

In the absence of resources for research, it is particularly important to involve fishers in the monitoring and management of the resource and to take full advantage of data collection on board commercial vessels.

Given the extremely low productivity of this taxonomic group, it will be necessary to adopt a fishery area management approach. This will require a thorough understanding of the relative productivities of teleosts and chondrichthyan species and their critical habitats. It is important to implement a suite of management tools, which should include effort reduction or restriction and the establishment of large closed areas covering a maximum depth range on the slope, in order to yield optimum benefits for both target and bycatch species and biodiversity conservation.

Ideally, deepwater fisheries should not be initiated until fisheries-independent surveys have been undertaken in order to produce a baseline, stock assessments and management advice. In those States (the majority) where resource limitations make this approach impossible, it is essential to minimise the impact of the early stages of the fishery and carefully monitor developing fisheries from the outset, ensuring that managers and scientists work closely with fishers to obtain maximum data from exploratory fisheries.

Closed areas can be an important fisheries management and biodiversity conservation tool. If closed areas are to be used, managers ideally need to understand stock structures, movements and long term migrations to determine critical habitats, how large an area should be closed, and whether there is scope for seasonal closures as a management tool. Their establishment must be accompanied by baseline surveys (e.g. population size, structure) at time of closure in order to be able to determine the effects of closure. Where such surveys are not possible, the establishment of large closed areas (particularly if possible before fisheries become established) may be very important for species conservation and reducing the overall impact of fisheries on deepwater stocks.

Provision of regional workshops for transfer of expertise, training in appropriate monitoring tools and methods, are important for training scientists and managers in the management of these vulnerable species.

Recommendations for Research

An improved research baseline is essential for management of deepsea chondrichthyans. This requires significantly increased research investment, including fishery-independent surveys, more use of fisheries data, tagging, telemetry, genetic analysis *etc.* Effort needs to be focused on the following subjects:

1) Taxonomy

Many species are still undescribed. Large numbers of sympatric species complexes are not yet resolved. These issues must be resolved in order to prepare the basic identification guides necessary for accurate data collection and to define species and stock distribution. Must have:

- More collection and better curation of specimens using standardised methods
- Morphometric data collection and analysis

- Photographic records
- Genetic analysis as a supplement to other techniques

2) Life history

- **Age and growth.** Techniques for determining age and growth are problematic and data largely lacking for most deepsea species. Validation so far not achieved for any species and may not be possible for some using current techniques.
- **Reproductive parameters.** Reproductive parameters (annual fecundity, maternity ogives) are essential for the simplest modelling but largely unknown for most species. Annual production of young/eggs, duration of development and interbreeding intervals are all needed, but extremely poorly understood. These data are important to determine recruitment and required for construction of basic demographic models, but are available for only a small number of species. Information necessary for stock assessment (time series of abundance and extracted catch) is incomplete or absent for all species.
- **Trophic ecology.** Determination of trophic level is needed to define community structure and provide data for ecosystem models (which should distinguish clearly between chondrichthyans and teleosts). Include consumption rates and interspecies dynamics. Food habits are known for some species, but not for most, while ontogenetic, regional and seasonal variation is largely unstudied. Partitioning between co-occurring species is also often overlooked and unrecorded. Basic metabolic studies necessary for trophic modelling are wholly absent. More direct observations of behaviour and movements from submersibles.
- **Physiology.**

3) Stock structure

- Identify unit stocks
- Define geographic and depth distribution and movement patterns
- Investigate geographic segregation by size, sex and ontogenetic stage
- Determine proportion of stocks occurring outside fished areas
- Modelling.

Ecosystem models require far better understanding of environmental parameters associated with different species (productivity, temperature, depth etc.), life histories, productivity etc. Research tools include population genetics, telemetry, pop up tags, sonic tags.

4) Bioamplification and bioaccumulation

Much higher natural levels of mercury in tissues; much higher levels of PCBs and other toxic substances regardless to proximity to sources of anthropogenic contamination. Significant bioamplification occurs because of high trophic level and bioaccumulation through long life-span. Average contamination is often more than double WHO standards. Squaloids, in particular, appear to accumulate particularly high levels of contamination. Studies in both the northern and southern hemisphere have identified high levels of reproductive malformation (hermaphroditism) in a number of species of deepsea sharks.