

Report of the FAO Workshop on the Assessment and Management of Deepwater Fisheries

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Dunedin, New Zealand

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The purpose of this workshop was to discuss technical issues related to the assessment and management of deepwater stocks. This report, prepared by session chairs, summarises discussions and considerations of possible ways forward. A list of participants, the agenda and abstracts are appended.

Session 1- Abundance Estimation

Presentations in this session covered aspects of trawl, acoustic and egg surveys; the use of catch per unit effort (CPUE) data; and tag and recapture data. The presentations referred to ongoing work in the northeast, northwest and southeast Atlantic, the Ross Sea and waters around New Zealand. Species covered included orange roughy, redfish, smooth oreo dory, Antarctic toothfish, and a wide range of species from the northeast Atlantic.

In discussion, the question arose as to what made abundance estimation of deepwater and deepsea species special (or not). For some deepwater species, such as orange roughy, it was noted that they have low productivity, are highly aggregating, often but not exclusively around underwater features, and that they react to survey and fishing gear not just at the time of capture but also over longer periods. The reasons for aggregating behaviour (e.g. suitable conditions or learned behaviour) were discussed but no conclusions were reached. It was recognized that more work on fish behaviour is highly desirable. It was also noted that low productivity in deepwater may not be universal. Some "deepwater" species (particularly those with long pelagic phases, strong diurnal migration patterns, or preferred depths above about 800 m) have moderate levels of productivity.

Egg surveys were discussed but were considered unlikely to be a good means of estimating abundance for a variety of reasons. Problems with the use of CPUE to index abundance were noted (also in Session 3). Trawl and acoustic surveys were viewed as potentially the most useful methods for estimating abundance. Both could be used to create relative abundance indices, although the use of acoustics is difficult even for relative abundance estimation when the target species is also associated with other species during the survey period. Both methods present problems with respect to the estimation of absolute abundance. For acoustics, difficulties include target strength identification and target species identification. For trawl surveys, estimating catchability is problematic.

The use of Remotely Operated Vehicles (ROVs) and Autonomous Underwater Vehicles (AUVs) was discussed. The potential to use such technology in its own right for abundance estimation, or in experiments to estimate catchability of trawls was noted.

Most participants agreed that technical work alone was not sufficient for the many problems associated with abundance estimation to be solved. Rather, a greater understanding of fish behaviour (natural and in response to fishing and research vessels and gear) is needed. In

particular, further work is needed on factors influencing aggregating behaviour. ROVs and AUVs may offer opportunities in this respect.

Other issues of concern included those relating to stock structure, distribution and movement. Obtaining some form of relative or absolute abundance estimates may be feasible, but their validity will depend on appropriate survey designs that take account of underlying distributions and movements.

In general, it was accepted that there is no one best way to estimate abundance but that often a range of methods analysed individually or in combination could offer the best way forward. In some areas, trawl and acoustic surveys are in regular use and the estimates and indices derived are used in stock assessments with varying degrees of success – often depending on the availability and quality of other data sources.

The costs of surveys are high and it was recognised that the cost-benefit of surveys was a consideration in deciding on best ways forward in any circumstance. Dedicated research cruises undoubtedly provide the best means of providing abundance estimates, and can often undertake a wider range of associated work at the same time. However, the use of industry-based surveys (especially acoustic surveys) may provide useful inputs for stock assessments.

Session 2 – Biology and Age and Growth

This was a varied session, with nine papers covering a wide range of topics. These included biological characteristics of deepwater fish species in the North Atlantic, New Zealand and Chile, stock structure, age and growth, climate change effects, and relationships between oceanographic features and fisheries. In addition, IFREMER researchers presented a video on an ROV cruise that examined aspects of catchability between video and trawl catches.

Given the variety of presentations, and the time available, the discussion was limited and focused on key gaps in knowledge.

1. Biological characteristics can vary widely between species, but many feature high longevity, slow growth rates, high age at maturity and low fecundity. Session participants recognised that many (but not all) deepwater species have relatively low annual production to biomass ratios. For such stocks, this means that sustainable yield levels are relatively low, and recovery from depleted states can be slow.
2. Routine data collection and analysis is critical, and this should not be restricted to data needed for immediate stock assessment purposes. Biological characteristics (e.g. size-at-maturity) can change as fish stock size changes. Such characteristics should therefore be monitored as ancillary inputs to evaluating stock status. Density dependent effects need to be considered in the stock assessment, as estimates of catchability, maturity, growth rates, spawning success and other factors may change.
3. Stock structure is generally poorly known for most deepwater species. Their depth means that direct methods to monitor distribution and movements (like tagging) can rarely be applied. Methods to determine stock relationships were not reviewed,

but the importance of knowing stock boundaries to plan research and management was acknowledged.

4. Biological parameters are often poorly known, and variable. It was noted in discussion that several deepwater species (e.g. orange roughy and hoki) do not spawn each year. This means that reliance upon gonad stage data to determine age at maturity, or the maturity ogive, may be misleading. In the case of orange roughy, there is a transition zone in the otolith that appears to mark the onset of spawning. However, the frequency of spawning is important, in terms of the proportion of the population available to the fishery or the biomass survey each year, particularly if the proportion varies between years.
5. Ageing is a requirement for monitoring population status, as well as evaluating changes over time. Technology has given a lot more confidence to the interpretation of otolith rings as annual, with chemical and radiometric methods and improved validation. In the absence of initial data, general age and growth estimates may be available from other areas or fisheries. Production ageing is still needed, however, in the major fisheries.
6. There is a pressing need to try to understand the ecological processes affecting biological variability. Without this, predictive modelling can be misleading. At the least, consideration should be given to trophic interactions and links between deepwater demersal fish and the mesopelagic energy source.
7. Stock-recruitment relationships, and levels of recruitment, are poorly known for most, if not all, deepwater species. Yet this is important for understanding changes in stock size, and for the management of sustainable fisheries.

Session 3 – Assessment of Deepsea Fisheries

A total of seven papers were presented in this session; however, two of these were more closely related to the topic of Session 4 (below). Topics covered in the other five papers included hyper-depletion in orange roughy fisheries (the situation where commercial CPUE decreases at a faster rate than abundance itself), and assessment methodologies and results for Namibian orange roughy, Patagonian toothfish, New Zealand hoki, and northeast Atlantic (ICES region) deepwater sharks.

Based on the presentations and the outcome from ensuing discussions, session participants identified a number of key data gaps and data needs for stock assessments of deepwater species. The three most important data needs, in order of priority, are:

1. Catch data – at the minimum, it is essential to know the amount and location of fisheries catches. This needs to be collected at an appropriate spatial scale given the localised aggregations formed by many deepwater species. It would also be useful to collect data on length frequency distributions of target species, and catches of by-catch species;
2. Valid indices of relative abundance – preferably, these should be fishery-independent but, realistically, they are likely to be fishery-dependent commercial catch rates. It will be extremely difficult to develop “valid” interpretations of the

indices at the beginning of a fishery; however, programmes should be developed to collect data on relevant factors such as the relationship between commercial CPUE and abundance, selectivity by fisheries, stock boundaries, migration patterns, and the dynamics of aggregating behaviour; and

3. Estimates of absolute abundance – ultimately, these are needed to estimate long-term sustainable yields. They can be obtained either from a fishery-independent survey that provides estimates of absolute abundance (e.g., an acoustic survey) or an assessment model that estimates absolute abundance based on catch and relative abundance.

Other data needs that may be crucial for some stocks, and will almost always improve the accuracy and precision of assessments if available, include:

4. Relative or absolute estimates of recruitment;
5. The relationship between stock size and recruitment; and
6. Age data.

Regarding the importance of ageing fish, although age information is essential for estimating population productivity, session participants concluded that it is less important to devote resources to ageing stocks for which age and growth information already exists for other stocks of the same species. Estimation of ages – which enables estimation of growth rates, natural mortality, and sometimes recruitment – was crucial for determining sustainable yields for orange roughy fisheries when they were first initiated. It wasn't until development of a validated ageing system that it became evident that orange roughy is characterised by unusually low growth rates, low natural mortality, high age at maturity, and high longevity. Ageing of other orange roughy populations has demonstrated some differences in these life history parameters, but such differences may not be sufficient to justify initiation of major research initiatives on ageing, particularly if resources are limited. It may make more sense to give higher priority to other data needs, such as the need for abundance indices, and simply adopt the age-length keys, growth parameters and natural mortality estimates from a similar stock.

Finally, in order to satisfy wider objectives that are often mandated by international agreements or national policy, it may be necessary to augment existing, or to set up new, programmes to provide data on:

7. Ecosystem considerations, such as by-catch species, other associated species, and effects of fishing on habitat.

Session participants also briefly discussed the situation of multi-species fisheries for which it is extremely difficult to obtain species-specific data on catch and abundance. These may need to be assessed and managed as species assemblages, with application of the precautionary approach with regards to setting catch or effort limits.

Session 4 – Management of Deepsea Fisheries

Presentations in this session covered descriptions of management arrangements for high seas orange roughy, deepsea and deepwater fisheries in New Zealand; development of high seas

fisheries in the western Indian Ocean; and frameworks for management advice including reference points.

Discussion time did not permit consideration of all issues. Some issues (e.g. the need for new legal instruments and the use of MPAs in fisheries management) were therefore intentionally deferred, as it was thought highly likely that they would receive much attention at the Deepsea 2003 conference to be held the following week. Discussion was focused on four main areas:

1. **Biological reference points:** Session participants discussed differences between advisory frameworks based on control rules using target and limit reference points, and management procedures that consider the assessment and management systems in concert using various performance measures to evaluate outcomes. In general, the use of evaluation approaches to derive robust management procedures is seen as desirable. However, in the case of many information poor fisheries, the feasibility of doing this is questionable (see 3 below). Appropriate target reference points were discussed and it was noted that for many low productivity stocks, target biomass levels used for management purposes vary from about 30% to 55% or higher of the unexploited level. It was suggested that rather than setting targets, a more useful approach may be to concentrate on avoiding a lower biomass (typically 20% of unexploited) with a high probability (typically 90%). Depending on the uncertainty inherent in any assessment and projection, the implied target biomass would vary but would likely fall within the range of typically adopted targets. The use of fishing mortality reference points was briefly discussed. Some scientists consider fishing mortality reference points to be superior.
2. **The need for an ecosystem approach to fisheries management:** It was generally agreed that the single most important first step in moving towards an ecosystem approach to fisheries management is to get single species fishing mortality under control and, in particular, to reduce it to appropriate levels where necessary. In order for this to happen, it is essential to develop better integration of assessment and management of marine resources with appropriate management frameworks that ensure single stock management whilst taking account of wider environmental or ecosystem issues.
3. **Data-poor situations:** There was considerable discussion on how to deal with data poor situations. In many cases, there may be little or no information available to set initial catches or to assess stock status or estimate reference points. Adaptive management may be useful but there is a tension between adaptive management procedures that probe for information (and therefore require that catches be high enough (or low enough) to create contrast in datasets) and the adoption of a precautionary approach (which would suggest low catches for low productivity stocks; see 4 below). Evaluated (adaptive) management procedures may also be problematic in that as information rapidly accrues, the assumptions used in modeling may quickly become untenable and lead to the need for re-evaluation. Discussed here and in Session 2 was the possibility of conducting meta-analyses as a means of garnering the maximum possible benefit from the dispersed global data on deepwater stocks, fisheries and associated habitats. Such an analysis could provide a means for setting initial catch limits for new fisheries as a basis for adaptive and/or precautionary management.

4. **Precautionary Approach:** The approach of treading carefully and restricting catches in early fishery phases was advised. In New Zealand, new orange roughy fisheries are voluntarily capped at 500t while information is gathered. CCAMLR does not allow new fisheries unless they are explicitly permitted, with permit conditions such as data collection requirements. Although there was general support for such approaches, it was pointed out that the approach has generally failed to halt apparently rapid declines in biomass of low productivity stocks for which it appears that initial biomass has almost invariably been overestimated.

General Discussion

The workshop considered the potential value of a hypothetical RFMO: “The Commission for the Conservation of Deepwater Fish Stocks”. There was no discussion on the logistics of creating such an organization, but rather whether or not it could have merit from a scientific and management viewpoint. It was recognized that to have merit, such an organization would need to be global and that it would need to consider a carefully agreed set of stocks. Although such an organization would have no ability to manage stocks within national jurisdictions, it could serve a management purpose for high seas fisheries by, for example, setting catch limits; determining data collection protocols, research planning and coordination; and providing compliance regimes. It would also provide a forum for the better exchange of data, technologies and assessment-management approaches. This would be highly advantageous given the lack of data or information on deepwater fish species globally, as it would enhance the ability of scientists working on such fisheries to exchange information and views.

A related proposal was presented during Session 3. It was suggested that a network be established for the investigation of deepsea fisheries and resources among scientists belonging to APEC economies. Again, workshop participants generally supported the concept, but did not discuss the logistics of such an endeavour in detail.

Overall, whilst recognizing the wide variety of life histories of deepwater fish species, workshop participants highlighted the observation that many species have a low productivity to biomass ratio and will therefore also have low sustainable yields. As for all fisheries, the pressing need is for complete and accurate catch and effort information, ideally at a highly disaggregated level, together with valid biomass indices (relative at least and ideally absolute if possible). Abundance estimates may be based on suitably modelled commercial catch rates (CPUE), or on trawl, acoustic or possibly visual techniques. The integration of commercial-based and research vessel-based data collection schemes needs further investigation. In addition to basic catch data and abundance information, early fishery and ongoing otolith sampling should be undertaken to give the potential of ultimately incorporating age information into assessments.

Whilst stock assessment or management procedures may be able to provide good bases for decision-making, the collection of appropriate ancillary biological data to be used in more comprehensive analyses may be crucial for elucidating patterns in population distribution and viability (e.g. contractions or expansions of spatial or temporal distribution).

The need for further work on stock structure was also identified as another key area of research.

Summary: Best Ways Forward

Workshop participants identified the following eight actions as the main immediate priorities for improving the assessment and management of deepsea resources.

1. Formulate management objectives more explicitly;
2. Incorporate biological reference points and/or performance measures into management procedures;
3. Implement management systems that promote data collection (e.g. adaptive management);
4. Conduct cooperative research with the industry and other stakeholders;
5. Implement management procedures that don't have high information needs (e.g. design "triggers" for opening and closing fisheries);
6. Integrate assessment and management (using, for example, Management Strategies Evaluation (MSE) techniques);
7. Ensure use of collective experience world-wide (using, for example, "meta-analyses"); and
8. Adhere more closely to the precautionary approach.