An introduction to the proceedings and a synthesis of the 2010 ICES Symposium on Fishery-Dependent Information

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Current problems and issues concerning the collection and use of fishery-dependent information are reviewed and selected papers in the pages following highlight emergent findings in the field. Key issues include relationships between stakeholders, especially fishers and scientists, and how to develop these constructively, the increasing demands on the quality and range of data on fishing activities and exploitation rates needed to promote the ecosystem approach to fishery management, and technological advances that have allowed new approaches and insights.

Keywords: ecosystem effects, fishery-dependent data, fishery management, stakeholders.

Introduction

Fishery management within an ecological framework requires many different types of information. These include data on fish resources, the aquatic environment, fishing fleets, fishing methods, fish markets, and socio-economic factors such as income and employment. When these data derive from studies of fishing activities as practiced commercially or in subsistence and recreational fisheries, they are said to be fishery-dependent, as opposed to the fishery-independent type that derive from, for example, research-vessel surveys of fish stocks. This paper and those that follow it focus on the collection, evaluation, and application of fishery-dependent data.

There are many issues to be considered. In recent years, fishery management has moved away from the traditional idea of fish stocks being independent units that can be assessed in isolation, with the key factor being the amount of fishing that a stock can sustain to achieve some optimum yield. Nowadays, however, more general questions arise within a very wide field. Although the exploitation prospects for a given stock are still important, there is increasing concern about the impact of fishing on the environment and, more generally, its effects at an ecosystem level (FAO, 2003a; Garcia, 2005; Smith et al., 2007). This is the concept of ecosystem-based fishery management, or more broadly and encompassing the human element, the ecosystem approach to fisheries (EAF), which has been widely adopted as the most appropriate way forward. Hence, implications for the ecosystem and its biodiversity, economically healthy fisheries, fishers’ livelihoods, discards, and the incidental mortality of protected species, notably mammals, seabirds, and reptiles, can no longer be ignored. Further, considerable improvements in the range and quality of fishery-dependent data have been necessary to meet the demands of such ecosystem approaches. Socio-economic and biological factors are important in these considerations (Pascoe, 2006).

In particular, data now have to be collected for the entire catch, not just the proportion landed at ports. Hence, we need to know about discards (fish caught but dumped at sea, to comply with regulations, or to optimize the value of the overall landings, whose mortality is often unknown but in some cases is very high; see Kelleher, 2005) and bycatches (catch components that may be retained, but are not the primary target of the fishery). To achieve this, the traditional reliance on sampled landings needs to be supplemented with new approaches that provide a more complete picture of what happens during commercial, subsistence, or recreational fishing activities. This can be done by posting human observers on fishing vessels. Also, novel techniques for the remote monitoring of fishing activities have been developed and are useful for addressing some of these information needs. These include on-board television cameras, and vessel monitoring systems (VMs; Gerritsen and Jordon, 2011), which transmit operational data on board to a shore base via a satellite link.

In the past, management authorities have generally undertaken the collection of fishery data, with little direct involvement of the fishers. This is no longer a preferred option. It is recognized that the industry as a key stakeholder should have a substantive role in the management process, including data collection (Pita et al., 2007).
This means that fishers and scientists need to cooperate constructively, with a mutual understanding of common aims and objectives. Historically, there has been some mistrust between the two groups and, unfortunately, that continues today. Fishers are often concerned about data collected for scientific and management purposes being used potentially for compliance monitoring or for further restricting their fishing opportunities. Scientists are inclined to criticize the views of fishers as being anecdotal and not properly supported by objective evidence. Nevertheless, there is growing realization on all sides that scientists and fishers need to promote better communication and transparency in a joint approach to the many difficult problems of fishery management in the 21st century. To achieve this successfully, there needs to be agreement in principle on the overall objectives and a building of mutual trust among stakeholders.

To address these challenges, the first ICES Symposium on Fishery-Dependent Information was held at the National University of Ireland, Galway (NUIG) from 23 to 26 August 2010. There were 229 participants from 30 developed and developing countries around the world. The symposium attracted considerable media coverage, with publicity in TV bulletins, plus news articles in the trade and general press. The participants covered a wide range of interests—commercial fishers, industry representatives, fishery managers and policy-makers, and scientists from many disciplines.

In addition to ICES, the symposium was sponsored by the Marine Institute (Foras na Mara), Galway, the UN Food and Agriculture Organization (FAO), the Institute of Marine Research, Bergen, the US National Oceanic and Atmospheric Administration, the Research Council of Norway, and Fælte Ireland (the National Tourist Development Authority). The substantial contribution of the sponsors was much appreciated. It allowed, in particular, funding support for 19 participants from developing countries who would otherwise not have been able to attend.

The symposium conveners were William Karp (USA; Chair), Norman Graham (Ireland), Richard Grainger (FAO), and Kjell Nedreaas (Norway), and they were ably assisted by an international Steering Committee that included Jerry Fraser (USA), Steven Kennelly (Australia), Kwame Koranteng (FAO), Philip MacMullen (UK), and Martin Pastoors (The Netherlands). There was an almost overwhelming response to the call for abstracts. The Steering Committee had a difficult task in selecting those that could reasonably be fitted into the tight symposium timetable. Eventually, 87 verbal presentations and 61 posters were included in the official programme.

Each day the symposium began with a keynote address in plenary, followed by two concurrent sessions of verbal presentations, on topics chosen hopefully to ensure that participants could attend all the presentations of most interest to themselves. At the end of each session, an overview was presented of the posters relevant to that session, and finally a panel of experts debated some hot issues of the day prompted by questions from the floor. One evening too, there was a special poster session with participants mingling socially with authors in the poster-presentation area. On the final day of the symposium, there was a final plenary session in which Lisa Borges (European Commission) had the difficult task of giving an overview of the proceedings, and the key issues and problems that had been highlighted by the various presentations.

**Keynote addresses**

The invited keynote contributions were intended to set the scene at the beginning of each day, highlighting controversial and difficult issues that should be addressed by such a symposium. The keynote speakers performed admirably in that task, presenting different perspectives, some of which challenged the traditional views of the main scientific audience. Although most of the keynotes are not presented as formal publications in this volume, they did lead to lively debate in the subsequent sessions, which enriched the symposium by addressing basic issues.

The first keynote was presented by Steve Murawski, Chief Science Advisor to NOAA Fisheries, USA, with the eye-catching title “News of the death of fishery-dependent data has been exaggerated”. Despite increasing concerns about the quality and reliability of fishery-dependent data, scientists and managers still rely heavily on such data to inform stock assessments and management decisions on catch and bycatch allowances. Many analysts have argued for less reliance on fishery-dependent data and, hence, increased dependence on research-survey assessments. Nevertheless, the need for fishery-dependent and fishery-independent (research-survey) information have increased with the advent of sophisticated and data-hungry assessment and ecosystem models; more comprehensive management information is needed to support catch-sharing, spatial management, and other approaches. Fortunately, great advances have been made in the methods for collecting and analysing fishery-dependent data, and there has been encouraging progress in achieving good cooperation between stakeholders in this work. Hence, the use of fishery-dependent data is very much a live issue; any news of its demise is certainly premature.

The second keynote was presented by Lorcan O’Cinneide, CEO of the Irish Fish Producers Organization. This presentation concerned the different perceptions, lack of mutual understanding, and inadequate communication between fishers and scientists. The viewpoints of fishery biologists and fishers frequently diverge regarding the state of fish stocks and many other key aspects of the marine ecosystem. There is a constant tension between the two that has become accentuated with the growing awareness of the potential for environmental damage through overfishing, the strong reliance on scientific advice by fishery managers and political decision-makers, and hence the importance of science as an income driver for fishers and ancillary businesses. The origins of this conflict lie partly in cultural backgrounds and divergences between the supposedly rational and objective nature of the scientific process, as gauged against the economic focus of commercial fisheries. Nevertheless, fishers and scientists have an enormous amount that they can contribute to each other’s understanding. It is essential for the future that the integration of such information can be brought to the centre of the scientific and advisory processes in a manner that has the necessary rigour to be credible and analytically useful.

The third keynote was presented by Peter Gullestad, Specialist Director in the Norwegian Directorate of Fisheries, concerning policy indicators based on fishery-dependent data. It is well known that fishery policies are subject to conflicting objectives. These include the economic aspirations of fishers, the need to maintain viable coastal communities, and ecosystem considerations of sustainability and biodiversity. Policy- and decision-makers need reliable information on how the fishery sector is performing over time according to these various objectives. Some progress has
been made in deriving simple indicators that describe features of the economic and ecological performance of fisheries; several such indicators are currently used for fishery-management purposes in Norway. This approach depends on the collection of data from different sources, involving both official agencies and the industry, with due regard to the quantity and the quality of information needed to provide reliable and useful indicators.

The final keynote was presented by Sebastian Mathew of the International Collective in Support of Fishworkers (ICSF), India. The presentation focused on the contribution fishers should have in the EAFM. It needs to be recognized that EAFM is as much about the impact of fishing on targeted fish stocks and on the habitat as it is about the impact on fishing of habitat degradation from natural and anthropogenic factors. In developing countries, often with poor institutional capacity for generating timely and reliable information for managing fisheries, integrating the knowledge possessed by fishers and their communities with scientific data can contribute to the ecosystem approach. The challenge is to identify and validate such knowledge and to create policy and legal space to include it in management procedures in a more systematic way, taking account of good practice in industrialized countries. The conditions for achieving this aim in developing countries notably include the need for fishers and their communities to see tangible benefits from their participation in such activities.

Symposium sessions
Eight sessions covered six topic areas with important relevance to FDI, and summaries of many of the key issues and emergent findings for each topic area are presented below.

The role of technology, data collection, and management in mitigating illegal, unregulated, and unreported fishing
This theme in many ways underscored the plight of world fisheries. IUU (illegal, unregulated, and unreported) fishing means missing data that are important for scientific and management use. The quality of fishery data is highly variable between different jurisdictions. Essential data-collection systems are often under-resourced or non-existent. The use of such data for compliance purposes is another concern. These problems combine to characterize IUU fishing as an unacceptable practice that cannot be ignored. The timely availability and effective use of information is the key to improving transparency in the global fisheries sector and through that to eliminating IUU fishing (FAO, 2001).

Even when high-quality information is available, it is often not used effectively, in particular because the industry may insist upon confidentiality. The rationale for this is doubtful. Although motivated by economic interests, they have no right to exploit marine resources at the expense of the wider community and mankind’s natural heritage. The need is for greater transparency and acceptance that fishery managers, not the industry, should set the rules. That is not to say that fishers cannot participate in the process, but a balanced approach is required that avoids spurious claims to confidentiality privileges. The need for comprehensive fishery data to be available for control and enforcement activities, with industry involvement where appropriate, also needs to be acknowledged. Information from international VMS has become a new possibility for raising documented catches to total catches, providing an accurate assessment of the total fishing effort and sailings of fish-carrier vessels.

Analysing rare occurrences in fishery-dependent datasets
Analysis of the limited data on bycatch of protected species is difficult because of the disproportionate number of zeros in rare-event datasets. Data on protected-species bycatches are commonly collected by fishery observers, but information obtained directly from fishers is also important, especially for artisanal fisheries that often cannot easily accommodate observers at sea or in the field. Whatever the source, it is important to validate the collected data to ensure that they are accurate and representative of the broader fleet. As regards bycatch-estimation, alternative methods exist based on sophisticated but different models. Several bycatch estimates and confidence intervals may come from the analysis of one rare-event dataset and informed averaging is needed to determine the final result. However, the limited precision of rare-species estimates needs to be recognized when considering bycatch quotas, and ideally, such estimates should be integrated with demographic information to assess population-level impacts.

The successful implementation of conservation policy depends on building industry cooperation and trust, with appropriate incentives to improve data collection or fishing practice. New analytical approaches to estimating bycatches of rare species are important, but there is a broader consideration on how to balance resource use with conservation objectives. The common goal of all concerned is precise estimation of incidental bycatches and assessment of their ecological and economic effects. Maintaining transparency and engaging industry in the conservation process will help to promote new ideas and better compliance with mitigation measures, hopefully resulting in more effective conservation strategies for the future.

Technologies for monitoring and data collection
A remarkable range of technologies is now being applied to monitor and collect fishery data. They include VMSs that record fishing activities in time and space, with real-time transmission to a shore station, electronic logbooks that store (and often transmit by satellite-phone link) traditional catch-and-effort information, electronic monitoring techniques that involve video surveillance of the fishing deck often coupled with other sensors, and acoustic instruments (echosounders and sonars), which are becoming ever more sophisticated for fish detection and measurement. These technologies provide traditional and new information at fine spatial scales and near real-time availability, supporting multiple objectives, from scientific research to compliance monitoring. A key feature is the need for fisher participation in the collection of data for management or scientific purposes. Challenges include the integration and management of voluminous and sometimes disparate data, the importance of fully understanding management needs when developing new programmes, and considering how best to use the technological resources that are now available. It is generally the case that innovation is more rapid in the private sector than in government, but managers and scientists need to continue to work closely with fishers to identify new opportunities for technological innovation which will inevitably continue in the years ahead.

Fishery management and policy issues relevant to FDI
The primary purpose for collecting, analysing, and disseminating fishery-dependent information is to support policy-making for the fishery sector and, in particular, fishery management.
The principle of using the best scientific evidence available as the basis for management decisions is enshrined in the UN Convention on the Law of the Sea of 1982 (UN, 2010), and many other international instruments, including the Code of Conduct for Responsible Fisheries of 1995 (FAO, 2011), which also addresses applications of the precautionary approach. In recent years, the emphasis has been shifting towards management within the broader context of an EAF, which, by definition, includes the human element. The collection of fishery-dependent data has changed accordingly, most significantly with the adoption of the FAO Strategy for Improving Information on Status and Trends of Capture Fisheries (FAO, 2003b), and the EU’s Data Collection Framework (EC, 2008), both of which address the increasing need for data on economic and social factors as well as more comprehensive data on traditional aspects such as fleet structure, biological sampling, and impacts of fisheries on the ecosystem. These changing needs have been addressed to some extent, with both good and bad examples reported for fisheries in different parts of the world. There are issues about the quality and the quantity of information needed to support policy formulation and implementation schemes, and also the data required to evaluate the performance of such measures better in practice. New management measures can result in changed fisher behaviour. These sometimes have unexpected and negative impacts, e.g. displacement of effort that simply transfers the overexploitation to another fishery, but others, e.g. real-time closures for cod in the North Sea, have demonstrated the intended and positive results. Some measures to reduce discarding have proved successful, others not.

A prominent current issue is the burden of proof, which seems to be directed increasingly onto the fishers, though many stakeholders consider that this responsibility should not rest with fishers alone, but be borne by a partnership also involving scientists and managers. In general, co-management, results-based management, and longer term plans can provide positive developments, but it is important to ensure that such approaches replace micromanagement and do not just add yet another bureaucratic layer. Even in data-poor fisheries, progress can be made towards better sustainability by using more holistic and integrated approaches that include human and ecological dimensions and by incorporating risk-based methods to deal with uncertainty. The need to anticipate the effects of climate change is a further complexity. Nevertheless, enormous challenges remain and progress is expected to be gradual as lessons, such as many debated in the theme session, are learned.

**Data quality, evaluation, and control**

*Traditional and novel data-collection methods*

Basic issues include whether the data collected are a sample or a complete census, indirectly or directly related to the target parameters, understanding the underlying assumptions, and assessing uncertainties (errors, bias, and precision). Sampling protocols should take account of objective-based minimum requirements in terms of data range, quantity, and quality. Modern techniques, such as satellite-based geographic information systems and VMS, greatly improve the spatial and temporal resolution of fishery data and have potential for further development and application. A consistent classification and understanding of fishing activities and communities is necessary for appropriate sampling and analyses of catch data.

In general, to evaluate and control data quality, a sampling programme needs to have stated objectives, a sampling frame identifying fishing activities and participating vessels, a statistically sound sampling scheme covering all relevant factors, and an estimation strategy including how to quantify errors. Key to this is the standardization and integration of data within so-called supply chains, guaranteeing consistency and accuracy, and adhering to data-protection obligations. The implication is that scientists need to embrace more business and information technology thinking, as practiced in the commercial world, which could then allow major improvements in the accuracy, timeliness, and agility of fishery advice.

The data source is another consideration, e.g. observer and industry records. Observers record a wider range of data on more species than would normally be expected of fishers, so observer and industry data sources are complementary; it is not a question of one or the other. The funding of sampling programmes is a key issue. Too often, it is short-term and insecure. For example, the Russian work on cod and haddock stocks in the Barents Sea is financed by a scientific quota allocation within the relevant total allowable catch. The vagaries of this funding scheme have led to highly variable sampling coverage from year to year.

In developing countries, insufficient human and financial resources often result in poor information and limited use of statistics. Strengthening multisectoral cooperation may be an important and cost-effective first step to improve matters, because important data are available across different agencies. Inland fisheries have their own problems; however, freshwater and marine fishing communities have much to learn from each other, especially concerning small-scale fisheries. Global inland catch statistics are still underreported, perhaps considerably. Better statistics are urgently needed to assess the impacts of human non-fishery activities, the effectiveness of fishery management, and value in terms of national food security and wealth. There are many challenges to be addressed.

*Data collection through on-board observers and self-sampling by fishers*

It is easy to assume that the data generated by professional observers are accurate. Many presentations in this session tested that basic assumption and examined some of the institutional and structural aspects of collecting and collating data. Others considered the human aspects of establishing and monitoring self-sampling regimes.

Comparison of the data gathered by on-board observers with the landed weights recorded by dockside monitors can reveal striking differences. These could be due at least in part to species-related quota restrictions. Another type of problem arises when a fishery assessment requires the collation of data gathered by many state, national, and regional management organizations that may all be working to different standards and reporting schedules. Where no single body can exercise exclusive authority, the lack of coherence can reach chronic levels.

Self-sampled catch data can be subject to both wilful and naive sources of error. Geographic and quantitative declarations can be distorted by commercial interests to some extent, and the apparent relationship between depth and fish distribution could be affected by lax observations or by regulatory drivers. Self-sampling programmes are unlikely to succeed if the fishers lack incentives and a vision of the potential utility of the data being generated. There are particular difficulties in setting up self-sampling...
regimes in the very different circumstances of specific applications. In the Norwegian recreational fishery, the problems are mainly geographic because of the very long coastline, and no official requirement to register guesthouses that frequently offer tourists the use of small boats. In contrast, a survey of artisanal fishing in the Niger delta had to start from basic principles of assessing levels of literacy, issuing writing materials such as pencils and notepads, and trying to exercise a degree of quality control over the resulting data.

This session was an enlightening introduction to the wide range of issues raised in these very different approaches to generating fishery-dependent information.

Application of fisher knowledge in scientific assessments and fishery management

There is growing realization that we need to go beyond the current paradigm of commercial fishers being simply considered data providers. In many jurisdictions, fisher input to the analytical assessment process is solely the provision of spatial and temporal catch-and-effort statistics through official catch logbooks, for example. However, fishers possess detailed knowledge of fish behaviour and distributions, because it is central to their livelihoods and business success. Much of the discourse between fishers and scientists lies in perceived differences between fisher knowledge and the results of analytical assessments. Moreover, fishers often feel that the result of more science is further restrictions on fishing businesses and that their role is one of information provider with little say on how that information is used. Although there is broad and growing recognition that incorporating fisher knowledge into the assessment process is both desirable and beneficial, difficulties in achieving this remain a key obstacle to progress. However, there are some examples where enhanced cooperation between fishers and scientists through industry–science fora or joint research programmes has improved fishery-dependent data and their utility for research and management. Recent experience shows that better governance is often achieved with a bottom-up approach, where fishers themselves are involved centrally in decision-making and management. Should fishers believe that their potential contribution to management and policy-making has been ignored or is simply absent, their sense of well-being diminishes, and they will likely feel disengaged from a remote decision-making process.

In many developing countries, limited resources preclude the establishment of comprehensive data-collection frameworks. Obtaining census data under these circumstances is not feasible. Similar problems exist where stocks are exploited by large numbers of small-scale fishers. However, survey-based data obtained through interviews or self-sampling programmes can provide useful biological and economic indicators for assessment purposes, the development of management measures, and better understanding of the social importance of these fisheries.

The current paradigm is that scientists ask fishers to provide data for scientific analysis, whereas scientists should also be asking fishers what services they need to help maintain sustainable and viable fisheries. The position of the fisher in the management system is key to achieving this. The overarching conclusion is that data and information flows are unidirectional, and frameworks to discuss with data-providers the scientific meaning, significance, and interpretation of the information are generally lacking. Integration and cooperation between fishers, scientists, and managers need to be enhanced and encouraged, to identify data deficiencies and new sources of information that may be useful for understanding the status of stocks and the fisheries that depend on them. Such cooperation can also result in key stakeholders having more confidence in scientific work, helping to develop management actions that are better tailored to local circumstances, are more likely to succeed, and will encourage good governance.

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