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Contribution to the Symposium: '*Fishery-Dependent Information*'

Introduction

From cooperative data collection to full collaboration and co-management: a synthesis of the 2014 ICES symposium on fishery-dependent information

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In this paper, we synthesize information presented at the 2nd Fishery Dependent Information (FDI) Conference, held in Rome, Italy, from 2 to 6 March 2014. We review current issues and advances in the collection, interpretation and application of fishery-dependent data, and highlight emergent findings in the field. Key issues include (i) the design and collection of data associated with commercial and recreational fisheries and the use of these data to support conventional and novel approaches to fisheries science and management and (ii) the role of fishers in co-management and policy setting. We noted that since the 2010 FDI conference a paradigm shift towards full engagement of key stakeholders started to take place. It also became evident that trust between stakeholders, managers, and scientists is necessary to develop efficient fishery monitoring programmes. While building such trust among key players often begins in informal settings, eventually one must evolve structured, formalized, and agreed processes for such interactions. We also conclude that because of the diversity of fisheries any determination of "best practices" may be difficult. Instead, we provide a list of "best principles" emerged from the conference.

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

Introduction

The need to establish sustainability as the cornerstone of fisheries policy is well recognized and reflected in many initiatives by governments and international organizations at national, regional, and global scales. Fisheries are complex socio-ecological systems that occur in a dynamic environment, and significant advances are required to obtain the information needed to manage them. Under an ecosystem approach to fisheries (FAO, 2003), the scope of fisheries management is even broader, requiring a very large knowledge base for decision-making. Expanding this knowledge requires an increased understanding of many areas, ranging from the impact of fisheries on resources and ecosystems, to social, economic, and governance aspects of the fishery "system". Initiatives such as the recent reform of the EU Common Fisheries Policy (EU, 2013), the United States' National Ocean Policy (USA, 2010), and the introduction of new concepts like results-based management, self-management and reversal/sharing of the burden-of-proof, create additional informational challenges. Information needs for small-scale fisheries are perhaps even more complex. These fisheries provide food and livelihoods to billions of people, but their sustainability is difficult to achieve because policy implementation is often difficult and data availability is poor (FAO, 2012). Participation of stakeholders at all levels of the fisheries system—from defining data to be collected and formulation of knowledge through to decision-making, policy development, and implementation—is essential for profitable and sustainable fishing practices.

To address these issues, the Fishery Dependent Information (FDI) 2014 symposium was held at the FAO headquarters in Rome, from 3 to 6 March 2014. There were 168 participants from 33 developed and developing countries. The conference assembled scientists, fishing industry representatives, policy makers, and other stakeholders to discuss how to make best use of data and information emerging from fishing activities and how to merge that information efficiently with data from other sources.

The international conveners are the authors of this paper. The programme included 96 verbal presentations, 48 posters and included 4 morning keynotes, followed by poster and verbal presentations in concurrent or plenary sessions during the week (see Supplementary material, unpublished conference programme). Most of the keynotes, presentations, and posters touched on the conference's complementary themes of data collection and collaboration. The symposium also included two workshops and a theme session on EcoFishMan, discussed in more detail later in this paper.

The symposium advanced some of the ideas from the 1st symposium held in Galway, Ireland in 2010 (Graham *et al.*, 2011). At that symposium, the question of "how to get to a situation where fishers are the customers and consumers of scientific data and advice?" was clearly articulated. We see this as the first step in a paradigm shift from the conventional practice of "scientists ask(ing) fishers to provide data for scientific analysis" towards full engagement of key stakeholders and a mutual understanding that "scientists should also be asking fishers what services they need to help maintain sustainable and viable fisheries." We saw considerable evidence of this paradigm shift during the 2014 conference.

Keynote addresses

The invited keynote contributions were intended to set the scene at the beginning of each day, identifying opportunities and challenges linked to the collection and use of fishery-dependent information by addressing the topic from different angles. The keynote speakers presented unique perspectives on fisheries management, fish sales organizations, privatization of the fishery resource, and industry engagement from a social science perspective. All the keynote presentations led to lively debate in subsequent sessions, which enriched the symposium by addressing basic issues.

The first keynote was presented by Richard (Rick) B. Robins, Chairman of the Mid-Atlantic Fishery Management Council, USA, with the title "The need for effective fisheries stakeholder integration in fisheries science and management—identifying opportunities and challenges through US regional examples". Stakeholder confidence in fisheries management systems is strongly influenced by the degree and nature of stakeholder participation in fisheries data collection and in the regulatory process. In the 37 years since the United States passed the landmark Fishery Conservation and Management Act, regional fisheries management systems have ended overfishing and rebuilt several depleted stocks. However, the same system has yielded mixed results in terms of stakeholder confidence in fisheries science and management. While many stocks in the Mid-Atlantic region were experiencing rebuilding and recovery after years of overfishing, many fishers were simultaneously disengaging from the management process. This was largely attributable to the perception that their participation and input did not have a meaningful impact on resulting management decisions. In recent years, fishery managers and scientists have attempted to address this problem in a variety of ways and with varying degrees of success. Using the recent efforts of the Mid-Atlantic Fishery Management Council and other regional examples, this presentation highlighted ways in which critical gaps in stakeholder confidence have been addressed through significant and meaningful opportunities for stakeholder participation in fisheries data collection and management. In conclusion, this keynote showed how stakeholder participation led to better data collection.

The second keynote address was presented by Otto Gregussen, CEO of the Norwegian Pelagic Fishermen's Sales Organization (NSS), Norway. This presentation concerned the fish sales organizations as providers of fisheries data. NSS is a nation-wide producer organization, owned and governed by Norwegian fishers. NSS is a leading marketplace for first-hand sales of pelagic fish in the Northeast Atlantic. All sales are conducted via an electronic auction that runs 4–8 times every day, 365 d a year. NSS also undertakes invoicing of catches, ensuring timely payments to the fishers. In Norway, first-hand sales through sales organizations are mandatory. This provides a unique and instantaneous insight of the total harvest of all species when it comes to volumes, prices, catch areas and landing places. Information is publicly accessible in real time on the NSS' website and forwarded electronically to the Directorate of Fisheries, and hence available to the Institute of Marine Research (IMR). In addition, information such as mean length of catch and landing, fat content and catch position is provided allowing IMR to request catch samples from individual vessels for more detailed biological analysis. NSS is seen as an important provider of fisheries-dependent data for fisheries research and management. In this presentation, transparency, accuracy of data, and the engagement of fishers were detailed to reveal a highly valuable source of information which should be utilized even more by the scientific community. The importance of near real-time information systems was stressed as being vital for planning fishing operations, informing the market, monitoring fishing effort, and validating input data quality. While the keynote

focused on an advanced data collection system, it also became evident that trust and collaboration between Norwegian fishers, scientists, and managers was an important pre-requisite for this effective monitoring system.

The third keynote concerned responsive fisheries management experiences from New Zealand and was presented by Daryl Sykes, CEO of the NZ Rock Lobster Industry Council, New Zealand. This presentation emphasized that a rights-based management framework enabled much greater opportunity for commercial operators to contribute to and actively participate in fisheries management and decision-making processes. The fishing industry and the various support service enterprises which contribute to the catching and marketing of seafood products aspire to security and certainty and to a range of cultural and/or lifestyle standards. Decades of fisheries management literature anticipated that the fishing industry would respond favourably to, and behave differently within, rights-based management regimes. The combination of tradable rights and output controls to constrain removals from fish stocks has existed in New Zealand fisheries since 1986. New Zealand rock lobster fisheries were included into the Quota Management System in April 1990. The lobster industry immediately made a positive response in terms of collective responsibility, stewardship, and custodial attitude, which also led to an improved data collection system. The presentation tracked the record of management transitions in New Zealand lobster fisheries including failures and successes, and highlighted the benefits of industry participation and cooperation to achieve both improved biological and economic outcomes.

The final keynote was presented by Marloes Kraan, IMARES, The Netherlands. Based on research in Ghana and the Netherlands, this presentation outlined the role fishers play in fisheries governance and research. Two main issues were addressed: the issue of trust, and policy implications of cooperative research. It is increasingly acknowledged that fishers could have a role in fisheries management and research but a clear definition of that role is lacking. Utilizing fishers in research makes sense as they have a lot of knowledge of where and how to catch fish. Likewise having them involved in management improves compliance if rules are understood and agreed upon. In addition, improvements in data collection aspects can be expected. Many will acknowledge that fisheries management is more about managing people than about managing fish. One might also argue that if people depend on fisheries for their livelihood, they will have developed rules to manage the activity; thus management and governance is not an act of governments alone. Nevertheless, there are certain aspects that are crucial to make this happen. Involving fishers in management and research requires time, flexibility, open-mindedness, listening skills, and dealing with uncertainty, some of which may be new skills for scientists and managers. Marloes Kraan's comments regarding the vital role social science can play in fisheries management resonated strongly among the participants.

Symposium synthesis

In the second FDI symposium, the changing face of fisheries management and the related data and knowledge needs were addressed. Holding this conference in Rome reminded participants of Justinian the Great—Emperor of Rome from 527AD to 565AD—who first identified the concept of public ownership of natural resources. This point was made by Rick Robins in the first keynote of the conference and encouraged participants to remember that fishers, scientists, and managers are all involved in the stewardship of the world's fisheries resources on behalf of the owners of those resources—the general public. Such responsibility was further highlighted by recognizing that seafood feeds 4.5 billion people and that fisheries play an important role for income generation, employment, and culture. It is generally agreed that fisheries data and information feeding into scientific advice in support of fisheries management and governance has to come from different sources and must be properly integrated. To this end, there is a need for participation and engagement of all stakeholders. Under the banner of "Fishery Dependent Data", the conference explored a number of concepts and challenges. Areas such as renewed and more participatory management strategies; data collection and interpretation with strong integration of fishers and fishing communities; improved strategies for sampling commercial catches and monitoring changes in the ecosystem; data precision and quality from observer and self-sampling programmes; and use of data derived from technologies such as automatic identification or vessel monitoring systems and on-board camera systems were among the many topics covered in the 17 theme sessions. These can be organized under two broad headings (i) the design and collection of data associated with commercial and recreational fisheries and the use of these data to support conventional and novel approaches to fisheries science and management and (ii) the role of the fishers themselves in co-management and policy setting (the role of fishers as key stakeholders).

Diversity of fisheries

"Best practice" messages were difficult to identify because of the diversity of fisheries represented at the conference and their varying biological and economic resources, management regimes, legal systems, technological resources, and cultural attitudes. Instead, the conference is, perhaps, best viewed as a sampling of these different aspects of fishery systems, raising awareness about the challenges and benefits involved in the collection and interpretation of the data, as well as the purpose of certain types of data for fisheries policy. Because data solutions cannot be prescriptive and need to be tailored to individual situations one can conclude that any determination of "best practices" may be difficult and, perhaps "best principles" should be developed rather than "best practices".

Incorporating fishers' information

It is often suggested that information provided by fishers does not meet conventional, scientific standards, yet one could argue that, from an empirical view, observations from fishers often initiate the process of the scientific method, leading to the articulation of formal research hypotheses and experimental designs to test them. Consequently, observations from fishers should be considered a crucial part of empirical science. It was highlighted that even anecdotal reports from fishers, for example, the sporadic catch of species that have never been observed in a region before, have significant value and should be taken into account as an indicator when designing more formal research; for example, in the context of climate change and the presumed geographical shift of marine species and stocks (see Supplementary material, unpublished abstract by Cadrin *et al.*). Examples of fruitful collaboration between fishers and scientists during surveys were highlighted (see Supplementary material, unpublished abstract by Boois *et al.*), as well as the valuable contribution that fisher communities make to monitoring and assessing multiple aspects of the fisheries system (see Supplementary material, unpublished abstract by Najih *et al.*). The importance of taking into account fishery

communities' experiences to assess the socio-economic impact caused by management decisions was stressed (see Supplementary material, unpublished abstract by Goti and Döring).

Fishers asking specific questions

While many of the presentations focused on ways to improve the precision, accuracy, and use of fishery-dependent data in conventional applications, it was interesting to note a number of presentations where specific questions identified by fishers were answered through an analysis of fishery-dependent data. For example, it was noted that fishers often detect environmentally driven changes in fish distribution more quickly than can be derived from time-series analysis of fishery-independent data (see Supplementary material, unpublished abstract by Cadrin *et al.*). This demonstrated how the fishers' perceptions (observations leading to hypotheses) of these changes were in fact well founded through a cooperative research programme. Cooperative research programmes did show that perceptions were well founded, and well-founded perceptions also led to development of cooperative research programmes. In a similar light, others noted how Norwegian fishers questioned the appropriateness of particular gears in the Lofoten cod fishery (see Supplementary material, unpublished abstract by Nedreaas). Fishers hypothesized that certain gears were removing too many older fish and experienced spawners which were felt to be important in initiating migration patterns (leading fish). Analysis of gear- and age-specific catch rates confirmed that this was indeed the case and showed how long-term fishery-dependent data could be used to support bottom-up management initiatives. Other presenters described ways that fishers are limiting bycatch through a self-managed data collection and analysis programme and several other examples of the real-time use of fishery-dependent data by fleets subject to bycatch restrictions were raised during discussions (e.g. see Supplementary material, unpublished abstract by O'Keefe *et al.*).

Trust, respect, and buy-in of key stakeholders

A considerable burden of stewardship on all stakeholders to manage, exploit, and sustain marine resources for the common good was mentioned by Rick Robins in his keynote presentation and also by others during the conference. However, as the primary economic stakeholders, it is clear that when fishers feel disenfranchised from the process, the management system is more likely to fail. In the United States, stock rebuilding is the driving policy objective and strict rebuilding time frames override social and economic considerations. Under these constraints, obtaining buy-in from key constituents who are already economically stressed is very difficult and may compromise the success of the recovery plan—"it's difficult to be green when you're in the red". The need for trust and respect among fishers, scientists, and managers and the need for buy-in from the key stakeholders were emphasized throughout the conference. But one should consider that while trust and respect among individuals are essential to success in the context of formal committees, meetings, and workshops, trust and respect among the various players in fisheries often begins at sea. It goes without saying that trust and respect are equally important for the goal of meeting fishery management objectives and it became evident that buy-in is much more likely when fishers have a direct role in deciding among management alternatives. This can only be achieved in a structured and formalized communication process where objectives and process are agreed upon. Such a process ensures longevity in management arrangements and policies that extend beyond the involvement of particular individuals. In the United States, the Regional Fishery Management Councils established under Federal legislation (Magnuson-Stevens Fisheries Conservation and Management Act, MSA) strive to maintain this type of process but it may be difficult for individual fishers to engage due to the time commitments required. However, stakeholder involvement in policymaking is an essential aspect of federal fisheries management in the United States and there are some noteworthy examples of success. In Alaska, the North Pacific Fishery Management Council is responsible for fisheries regulation and management under MSA and most productive federal fisheries take place in the Eastern Bering Sea. These are, for the most part, large-scale, industrial fisheries with well-established catch share programmes and cooperatives. In some fisheries, such as the pelagic trawl fishery for walleye pollock, cooperatives function in a largely independent fashion and manage catch and bycatch among cooperative members and within overall catch and bycatch limits established by the Council (Gilman *et al.*, 2006). Bycatch of Pacific salmon species is also managed among cooperatives through binding agreements which require vessels to relocate when directed to do so by an analyst who evaluates observer-reported catch and bycatch data daily (Witherell *et al.* 2002). This type of co-management can also be effective without the types of binding, formal agreements described above. For example, the fishery for Atlantic Sea Scallops which takes place off the Northeast Coast of the United States, under the jurisdiction of the New England Fishery Management Council, is constrained by bycatch of yellowtail flounder. Some members of this fleet voluntarily report catch and bycatch information to an analyst based at the University of Massachusetts. Reports provided back to the fleet by this analyst allow vessel operators to fish more efficiently and reduce bycatch. Thus, this type of co-management can take place under MSA, although it is clearly more effective when the fishery is managed through cooperatives that have catch share privileges and can establish binding legal agreements (O'Keefe and DeCelles, 2013).

The benefits of stakeholder involvement was also apparent in the establishment of seven Regional Advisory Councilss) within the EU Common Fisheries Policy (CFP) after its 2002 reform (EC, 2002), and recently turned into Advisory Councils as a result of the 2013 reform (EU, 2013). The Advisory Councils are stakeholder-led organizations that provide the European Commission and EU Member States with recommendations on fisheries management matters. In addition to the seven existing Advisory Councils, the new CFP (EU, 2013) foresees the creation of four new Advisory Councils for the Black Sea, Aquaculture, Markets and Outermost regions. Engagement of stakeholders in the EU scientific advisory process was exemplified in a presentation on the Scientific, Technical, and Economic Committee for Fisheries (STECF) (see Supplementary material, unpublished abstract by Ribeiro *et al.*,) advising the European Commission on fisheries management (EC, 2005). In 2006, the first STECF Expert Working Groups (EWGs) have been opened to stakeholders as observers on a trial basis; now all EWG meetings are open with priority given to Advisory Council representatives. A key success story of stakeholders' involvement is certainly STECF's work on development, evaluation, and impact assessment in support of European fisheries plans as described by Simmonds *et al.* (2011). Similar success stories can be seen in other fisheries and regions, and was exemplified in Darryl Sykes' keynote presentation about self-management of the New Zealand rock lobster fishery.

The take home message is that the management process must engender a sense of responsibility among the key stakeholders and

with this comes a sense of ownership. In other words, empowerment through participatory management is achieved when there is a sense of ownership of the resource. Results obtained by the EU FP7 research projects GAP2 [e.g. for the octopus fishery in Galicia (NW Spain)] and EcoFishMan (presented in a dedicated theme session; for a summary of the EcoFishMan session see below) further added to this picture. Another perspective on the benefits of ownership was provided in Otto Gregussen's keynote presentation about the Norwegian industrial pelagic fishing fleet. This example illustrates well how a highly organized and financially strong fleet can engage successfully in co-management. Similar successes were noted among large-scale fishing operations in Alaska and elsewhere.

Participatory engagement with stakeholders

The notion of participatory engagement with stakeholders was explored during the keynote of Marloes Kraan and theme session presentations, for example, by posing a number of questions. Who are legitimate stakeholders, how do managers and/or scientists interact with them? Is this interaction simply something people feel required to do, or is it something that people want to do and wish to gain benefit from? There is a risk of "participation washing" where actors feel the requirement to consult, but in fact all they do is divulge views and opinions and thus fail to explore those of the stakeholders and *vice versa*. This can lead to greater exclusion rather than better cooperation. It is therefore important to let stakeholders express their views with open rather than leading questions which are formed around the preconceived views of the scientists or managers. While stakeholder involvement was generally seen as highly beneficial to design and implement fisheries management schemes (Eayrs *et al.*, 2015), the application of full stakeholder engagement in management schemes—especially where it concerns decision-making—is far from common practice at a global scale (Little *et al.*, 2014; see Supplementary material, unpublished abstracts by Pastoors *et al.*, Fischer *et al.*, and McGuire *et al.*). The advantages and disadvantages of self-sampling programmes and reference fleets were also presented (see Supplementary material, unpublished abstracts by Kraan, Uhlmann *et al.*, and Celić *et al.*). Several contributions discussed the issue of stakeholder involvement and highlighted experiences and challenges from different parts of the world and at different scales. Particular attention was given to small-scale fisheries in two dedicated theme sessions (see Supplementary material, e.g. unpublished abstracts by Sobo, and Jones) and a workshop on the "barefoot ecologist" (see below).

Workshop "The barefoot ecologist"

Fisheries management often follows an authority-centred approach, where scientists assess stocks' status and managers/politicians are responsible for defining rules and their implementation. However, shifts to approaches with varying levels of stakeholder (i.e. fisher) involvement also occur worldwide. Monitoring small-scale fisheries continues to be a basic challenge, especially in areas with multiple (small) stocks and associated fisheries. The problem is even more severe as it is often accompanied by a lack or limits of funding for fisheries agencies and research (Prince, 2003). The "barefoot ecologist" concept is seen as an approach to tackle this challenge where "barefoot ecologists" could be defined as community managers who have been trained in some basics of fisheries data collection and analysis. "Barefoot ecologists" need to be equipped with a generic toolbox containing features such as rapid assessment techniques, rule of thumb management strategies, and mapping stocks and survey design tools. The tool box should also provide for assessment models, simulation and visualization, and remote referencing and data mining (Prince, 2004). The "barefoot ecologist" concept provides for the timely and cost-effective development and implementation of management regimes. It is designed to account for the characteristics of local, small-scale fisheries.

Enhancing data collection and analyses

With the benefits of monitoring programmes comes the challenge of balancing sampling protocols and objectives, particularly when competing resources are at stake. For the Bering Sea pollock fishery, innovative sampling designs have been developed for genetic sampling of bycaught Chinook salmon which complement observer-based enumeration to allow accounting against a cap. Strategies based on genetic analysis from fishery- and survey-derived samples have also been applied in Europe, for example, to understand the population structure and origins of highly exploited species such as hake, sole, herring, and cod (Nielsen *et al.*, 2012). Genetic and genomic approaches that support fishery management frameworks were identified a number of speakers (e.g. see Supplementary material, unpublished abstract by Martinsohn *et al.*,) and such approaches are also referred to in legislation (EC, 2009). Certain types of fishery-dependent data that may not be commonly collected or utilized could be very beneficial for stock assessments and subsequent fisheries management. For instance, annual monitoring of maturity status in the catch of mullet and hake in the Aegean Sea could improve studies of exploitation patterns in the Mediterranean (see Supplementary material, unpublished abstract by Vasilakopoulos and Maravelias). Likewise, collecting information on the age composition of Chinook bycatch in the Bering Sea pollock fishery informs management as to the impacts of the bycatch on regional stocks of origin (Ianelli and Stram, 2015; Stram and Ianelli, 2015).

Sampling design and data collection protocols influence methods chosen to estimate unintended catch or bycatch. Total bycatch of seabirds in Norwegian coastal fisheries using data collected via surveys and reference fleets were compared using several different ratio estimators (see Supplementary material, unpublished abstract by Fangel *et al.*). However, it was noted that additional statistical approaches and sampling plans would need to be explored to account for the excess number of zeros in the data. Innovative techniques for catch estimation are needed in data poor situations, though these carry additional challenges related to catch validation. In countries or regions where mainly information on target catch is available, information from multiple sources (i.e. landings, biological surveys, information from commercial, and recreational resource users) could be integrated for stock evaluation and management advice (see Supplementary material, unpublished abstract by Obatola *et al.*).

EU Common Fisheries Policy reform: Landing obligation

The recent reform of the EU central fisheries management legislation, the CFP, and in particular the landings obligation (the "discard ban") were addressed in several presentations including those discussing methods to estimate catch and discards in data poor situations, and how to integrate data sources to enhance the level of information available for assessments (see Supplementary material, unpublished abstract by Uhlmann *et al.*). The landings obligation provided an energetic and sometimes controversial focal point for a number of discussions; this was particularly apparent during the sessions on Electronic Monitoring (EM) which explored the general implications and utility of this expanding

technology. It is evident that EM when deployed effectively within a broader monitoring and data collection system can be effective in improving compliance and providing more comprehensive catch, bycatch, and effort data. Practical issues were also raised and possible solutions discussed (van Helmond *et al.*, 2015). EM was discussed also in comparison with observer-based monitoring schemes. About the latter, there have been improvements in sampling design in response to changes in fishery management (see Supplementary material, unpublished abstracts by Palmer *et al.*, and Cornou *et al.*). Ethical considerations of EM in the context of "Fully Documented Fisheries" (FDF), however, were of particular concern to some participants. Monitoring in general and technological monitoring approaches in particular were further explored in a dedicated workshop on "Landings to Catch Based Management– Challenges and Benefits" (see below).

Workshop "From Landings to Catch Based Management – Challenges and Benefits"

There is a growing tendency towards management approaches where catches are fully accounted for to quantify total fishing mortality and impacts of fishing on non-target species. This is in contrast to the approach used in many (but not all) jurisdictions where catch removals are monitored and regulated based on landings rather than total catches. Under this construct, fishers may choose to discard (and not record) part of their catch for several reasons. This may be due to lack of market; or premiums for a particular size or quality of fish which encourages fishers to preserve their catch (quota) allocation for more valuable fish. Fishers may be obliged to discard fish due to legislative reasons such as minimum size limits. Multispecies fisheries managed through single species catch limits can present particular challenges. In the absence of catch-based regulations fishing may be allowed to continue where quota remains for some species even when catch limits are exhausted for others.

However, the transition from landings to a catch-based approach, especially in mixed-species fisheries which are managed through individual, single species quotas or cap limits on protected or vulnerable species, presents significant challenges for commercial fisheries. In such complex fisheries, the introduction of catch-based management may have significant economic impact and generate uncertainty and insecurity. Unless fishers are able to adapt, there will be losses due to underutilization of available quota for some species after a fishery has been restricted or closed (choked) due to the uptake of quota limited species. Thus, more flexible approaches to fisheries management or even the notion of pooled species quotas may be required. Managing mixed-species fisheries through single species quotas may also need to be reconsidered. This may require approaches where trade-offs would need to be made between certain species, where some species may be underexploited and others overexploited relevant to agreed reference points, for example, F_{MSY}.

Full catch retention/accounting policies are likely to require high levels of at-sea monitoring to ensure compliance, particularly when fisheries are heavily restricted due to single species catch limits. Ensuring compliance with an obligation to retain and/or document catches that could result in premature closure of fisheries is difficult to envisage without the deployment of effective wide scale at-sea observer programmes and/or EM systems. High or full coverage using observers can be expensive and the costs could equate to a significant percentage of the revenue generated from the fishery. Similarly, EM systems require capital investment and provide large volumes of data that require dedicated infrastructure and resources to manage. While EM and/or full observer coverage could provide for a level playing field, there are also potential ethical costs, particularly with EM systems, fishers may feel a "big brother syndrome" and viewed as an invasion of privacy. While the goal of catch-based management is ultimately to quantify total fishing mortality and maintain mortality levels within advised levels, there are clearly a number of barriers and considerations that need to be considered. However, there are positive aspects to fully documented approaches. Seafood certification is of importance in many countries, with many key retailers limiting their product range to stocks and/or fisheries that have been independently certified against a particular standard. Full catch documentation (fully documented fishery or FDF) may be required for such certification and can also promote techniques and technologies to reduce unwanted catches as these are counted against catch limits. Fishers will optimize their available fishing opportunities and minimize catches fish with little or no market value (Graham *et al*, 2007). FDF may also permit the loosening or removal of other prescriptive management and regulatory approaches such as technical regulations on gear construction.

Theme session EcoFishMan

The EU FP7 EcoFishMan project has devised a new "Responsive Fisheries Management System" (RFMS) in collaboration with key stakeholders in European fisheries. The vision of the EcoFishMan project was to contribute to a basicly new approach to fisheries management in Europe that can be accepted by stakeholders, governments, authorities, and industries alike, and thus could have a significant impact on the future of fisheries policy. RFMS outlines a process for transferring responsibility for fisheries management to the fishers (resource users), if they document and achieve specified management objectives. Ecological, economic, and social aspects are taken into account, as well as ways to improve cooperation and mutual understanding between policy makers and stakeholders to facilitate its implementation. Stakeholder's involvement is strengthened by taking into account their knowledge and requirements.

The RFMS is supposed to be implemented in stages and customized for each fishery. EcoFishMan assessed the feasibility of different policy options as a first step to recommend alternatives for each fishery. Stakeholders confirmed that there is an interest in using RFMS as a process for involving the industry in management and data collection, and recommended that this should be initiated in suitable pilot cases in Europe. It also provides a template for drafting discard mitigation plans as part of the newly reformed EU CFP (EU, 2013). The new system gives fishers more responsibility for managing and reporting their own activities. The responsibility for detailed allocation and control of individual quotas and compliance is moved away from centralized government towards the fishers. This will lead to a higher degree of local ownership of both fish and data. Also transparency of decisions and transgressions will increase. The project results were detailed through 15 presentations at FDI and ended with an open panel debate.

Conclusions

This conference showcased ways in which different styles of fishery-dependent data collection and collaboration among stakeholders can improve fisheries management and ultimately, the sustainability of fisheries resources. A key theme of the conference was the importance of trust, and how to build among fishers, scientists, and policy makers. Data collection offers opportunities for collaboration and trust-building, and collaboration builds trust for more effective policies.

While the identification of best practices was difficult due to the diversity and range of approaches used, several "best practices" became evident. Examples of "best principles" regarding the collection and utilization of fishery-dependent information that emerged from the conference were:

(i) Fishers and fisher communities provide valuable information to monitoring and assessing many aspects of the fisheries system through their long-term local knowledge and experience.

(ii) Rather than discard information from fishers as "anecdotal", one should see it as a crucial, observational starting point of the scientific method.

(iii) Engaging fishers in data collection and decisions about management alternatives improves trust in the science and buy-in to policy measures.

(iv) While trust often is first developed in informal settings, a structured and formalized communication process is often necessary to achieve buy-in to policy measures.

(v) Listening to fisher views and asking the right questions.

(vi) Cooperation among all stakeholders requires time, flexibility, open-mindedness, listening skills, and creativity.

A paradigm shift could be noted at this conference compared with the FDI 2010 conference and this was evident in many ways. A view shifted from the conventional practice one of "scientists ask(ing) fishers to provide data for scientific analysis" towards one in which "scientists should also be asking fishers what services they need to help maintain sustainable and viable fisheries."

We hope that you will enjoy reading the articles published in this special issue of the *ICES Journal of Marine Science*.

Supplementary material

Supplementary material is available at the *ICESJMS* online version of the manuscript.

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