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Communication between scientists, fishery managers and recreational fishers: lessons learned from a comparative analysis of international case studies

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Abstract The management of recreational fisheries benefits from good collaboration between scientists, managers and recreational fishers. However, the level of collaboration largely depends on the levels of effective communication among the different stakeholders. This paper presents the views of scientists, managers and fishers concerning the quality of communication in eleven case studies of recreational fisheries. Case studies were synthesised and common reasons why communication did not always flow as intended were identified. The prevalent barriers to good communication, and therefore collaboration included a lack of rigorous scientific information transfer from scientists to fishers and managers, a fear from fishers that management actions will limit fishing opportunities, pre-existing antagonism between commercial and recreational fisheries, and fishers' suspicion of science. Overcoming these issues is paramount to improve collaboration and participatory processes that help lead to robust, well-accepted management actions.

KEYWORDS: anglers, collaboration, communication, fishers, managers, recreational fishing, scientists.

Introduction

A growing body of literature recognises that numerous benefits accrue from including stakeholders in fisheries management decisions using formal participatory processes (Johnson & Martinez 1995; Hatcher *et al.* 2000; Kennelly & Broadhurst 2002; Waterton & Ellis 2006; Granek *et al.* 2008; Policanski 2008; Ihde *et al.* 2011; McPhee 2011; Stenekes & Sahlqvist 2011). However, there is little systematic application of scientific knowledge about the factors promoting public participation or other deliberative processes in natural resource management (Schusler *et al.* 2003). A key step in all forms of collaborative management is committing to a process of mutual learning in which participants agree that they individually do not have all the answers (Schusler *et al.* 2003). Plummer and FitzGibbon (2007) asserted that deliberation via communication enables social learning and may enhance social capital, both of which are requisites for adaptive collaborative management. Establishment of trust and respect among stakeholders and effective communication is essential for the success of such collaborative projects (Johnson & Van Densen 2007) because collaborative management ultimately relies on human relationships. Facilitating such interactions presents a formidable challenge because stakeholders usually have considerably diverse interests and values. If adaptive collaborative management is viewed as a process, then resource managers must understand that they may need to facilitate social interactions that, on the surface, only superficially address resource issues but which are crucial in arriving at a successful outcome (Plummer & FitzGibbon 2007).

Against this background, the call for improved communication and better understanding of the different perspectives among fishery scientists, managers and the recreational fishing sector has been identified as a pressing need in recreational fisheries management throughout the world (e.g. Quinn 1992; Delaney & Murray 2002; Schusler *et al.* 2003; Hasler *et al.* 2011). Without effective communication, fishery science may remain alienated in the recreational fisheries management space and thus not applied to its full potential (Schratwieser 2006). This could potentially lead to poor management actions and weak uptake of novel scientific insights. This challenge is not unique to recreational fisheries, but forms the focus of the present paper.

To improve collaboration and communication, it is helpful if stakeholders share perspectives and values, or are at least aware of potentially diverging opinions. Hasler *et al.* (2011) noted differences among recreational fishers, managers and researchers in terms of the perceived need and desirable level of fishers' involvement in the management of fisheries. In particular fishers thought their involvement was not intensive enough and that managers can be poor collaborators at times. This suggests that managers and scientists may occasionally do a less-than-ideal job in either communicating with fishers or in soliciting their input into decision-making processes. Hasler *et al.* (2011) also concluded that a disagreement of opinion can provide fertile ground for improving communication and building better partnerships between fishers, researchers and managers. However, to foster better relationships, it is first necessary to understand the barriers to good communication. Although problems of communication have previously been identified as a potential source of conflict (Wall & Callister 1995; Cargile *et al.* 2006), the published literature also generally reflects only the views of scientists. This paper attempts to include the perception of managers and fishers – the latter being those who have to act on management decisions.

This paper documents some of the findings and discussions of a workshop on 'Communication and collaboration between science and management in recreational fisheries' held during the 6th World Recreational Fishing Conference in Berlin, Germany on 3 August 2011. Participants were encouraged to contribute by providing a written description of their experience of communication with other stakeholders, of which 11 responded. Among these, six report the views of scientists, two of managers, one of a free diver, one from scientist-anglers and one from a manager-angler. Among the case studies, seven referred to freshwater and four to marine recreational fisheries. The target-species relevant to the case studies presented ranged from multiple fish species to crustaceans. Fishers in the case studies used rods to catch fish (referred in the text as anglers), nets and in one study free divers were used to observe fish underwater. Some of the programmes in the case studies are completed and others are ongoing.

The overall objective of this paper is to identify any common and recurring issues that impede or enhance communication between the different groups involved in recreational fisheries. First, the case studies are summarised within their own geographical, socio-political and ecological contexts. Common barriers to establishing constructive communication among recreational fisheries stakeholders are then identified along with their consequences and then the approaches that were attempted to remove barriers are presented. Finally, in view of the lessons learned, the remaining challenges are discussed.

Case studies

G1: Impediments to communication between scientists and recreational fisheries managers in Germany (scientist's experience)

There is no tradition of sophisticated management-oriented research in the German inland recreational fisheries system. Furthermore, there is no overarching scientific or management body that local angling clubs as fishing rights holders can adhere to as there are 16 different fishing laws and associated fisheries agencies, multiple umbrella organisations and thousands of close, but spatially separated clubs. The situation is further aggravated as there are two national umbrella organisations: one that originated from the former East Germany and one from West Germany: both organisations have different traditions regarding collaboration with fisheries scientists in the different German states. In addition, each organisation has varying ties and relationships with the research institutes interested in recreational fisheries science. Scientists mainly publish in English-speaking journals in a publish-or-perish environment, which reduces incentives for communication with lay people. Few people attempt to bridge the gap between scientific research (which often helps drive management outcomes) and the responsibility of communicating science back to stakeholders. All of these aspects have created a major barrier in the communication of science, in particular for hotly debated and contested topics resulting in a partial breakdown of science communication within Germany. Moreover, one of the two umbrella organisations has developed a negative attitude to academic-based fisheries science in recent years, further reducing their uptake of new scientific information.

F: Communication breakdown between recreational anglers and scientists, Lake Annecy, France (scientist's experience)

The recreational fishery in Lake Annecy has gained such an importance (1200 boat licences and 600 angling licences) that the commercial net fishery has become marginalised (only four commercial fishers since 1998). Communication and collaboration between scientists and both groups of fishers were initially effective and were even cited as an example of best practice. Everybody was content as there were enough fish to sustain harvest from both recreational anglers and commercial fishers. However, after 15 years of scientific analysis of daily statistics and volunteers' logbooks, scientists showed that the resource was fully exploited and could not withstand additional fishing effort without being unsustainable. It also became apparent that recreational anglers had a larger impact on fish populations than commercial fishers. Recreational anglers refuted this conclusion, their association radicalised and conflicts occurred in May 2007 (Gerdeaux & Janjua 2009). The communication between the groups has not yet resumed (Sebi & Gerdeaux 2008) because of the staunch denial of recreational anglers.

N1: Unforeseen consequences of fragmentary communication in the Norwegian marine angling tourism (scientist's experience)

In Norway, conflicts between commercial fishers and marine angling tourists are common. Commercial fishers have called for stricter regulation of the angling tourism sector and in 2006 and 2010, respectively, an export limit for sea fish caught by tourists, and minimum size limits were introduced (Fiskeridirektoratet 2011a,b) to limit the export of fish by some tourist angling groups. However, according to Borcht (2009) the implementation of this limit was the result of pressure from the commercial fishing industry, rather than based on scientific advice. At the time of the implementation, no statistically reliable catch estimates were available (Vølstad *et al.* 2011), and no impact assessment for the regulation had been carried out. For example, the number of tourist bookings dropped and it was reported that cancellations occurred because of the new regulation (Nilssen 2006). Moreover, although minimum size limits have been shown to increase the practice of regulatory catch and release (Harper *et al.* 2000), only limited advice was given to angling tourists on how to release undersized fish.

In 2010, a working group was set up by the Ministry of Fisheries and Coastal Affairs to develop further management regulations. This working group consisted of members from many organisations and included the commercial fishers. Scientists were invited as resource persons instead of being included as full members, which limited, and still limits, their ability to communicate scientific advice to the working group.

IA: Communication of complex scientific message to anglers, a salmonid conservation project in Northern Italy and Austria (scientist's experience)

The aims of this project were to genotype the local marble trout, *Salmo marmoratus* Cuvier, and brown trout, *Salmo trutta* L., to identify indigenous relic populations, to provide conservation management measures and to establish breeding strains for stock restoration. Two major studies were embedded into this programme, both adopting a similar methodology, but with the communication of the scientific result directed by fisheries stakeholders in Austria and by scientists in Northern Italy. This resulted in striking discrepancies in the way the scientific results were communicated to the angling public.

N2: Involvement of Norwegian recreational fishers in lobster management improved the communication with scientists (scientist's experience).

In Norway, new regulations for recreational and commercial fisheries of the European lobster, *Homarus gammarus* L., were introduced in 2008. In this fishery, recreational fishers were dominating the effort and catches (Kleiven *et al.* 2011, 2012). Initially recreational fishers were doubtful about the authenticity of data collected by scientists, leading to disagreement regarding stock status and management needs. Recreational fishers were suspicious because the data were collected in collaboration with commercial fishers, had a poor geographical resolution and included only a rough approximation of the catch per unit effort for the whole season. To stimulate collaboration and communication between researchers and recreational fishers, a successful joint monitoring programme was initiated in 2007 in which a selection of recreational fishers volunteered to keep a detailed catch diary throughout the fishing season (see Kleiven *et al.* 2012).

G2: Using the Internet to communicate and share data from and amongst recreational anglers in Germany (scientist-angler's experience)

The recreational angling community holds a wealth of historical data, which have seldom been used for monitoring, scientific and management purposes. Furthermore, these data are rarely used outside of the angling community because they have diverse formats, are often not digitised, processed and analysed, and is typically not easily accessible.

More than 10 years ago, the Internet-based FishWatcher facility was introduced (Froese & Pauly 2011), and anglers and fish watchers have been uploading their catch records and observations including their geo-locations (Ueberschär & Teltow 1999). However, although the facility has been established for a decade, contributions from anglers have been disappointing. Only 2200 records from anglers and fish watchers have been uploaded.

D: Improving communication by immersion of science in recreational fishery management in Denmark (manager's experience)

Danish anglers have a long tradition of stocking trout because of the relatively poor state of their rivers. Since about 1960, governmental stocking plans were generally established in close collaboration with scientists and anglers. A governmental levy on fishing licences was introduced in 1990. Since then a central committee comprising representatives from ministerial authorities, biologists, non-governmental organisations and angler organisations has determined how the levy funds are distributed among management activities. Most scientific advice regarding commercial and recreational fishing for the whole country is traditionally provided by only one university (the Danish Technical University), in close association, and proximity, to the government's fishing authorities. This management structure has been instrumental in improving the communication between the different groups and a tight cooperation now exists between scientists and anglers who are shifting from stocking activities to river restoration.

S: Improving communication when scientists are not the experts – fish behaviour observation by free divers in coastal Spain (recreational free diver's experience)

Fish abundance is declining in many coastal waters of Spain, making recreational fishing increasingly challenging. To be successful, recreational fishers now have to become experts in fish behaviour. A project from the Spanish National Research Council (CSIC) called 'Analysis of Wild Fish Distribution around Marine Fish Farms' was developed in Catalonia in 2010 and 2011. Two methodologies to monitor fish populations using visual census (scuba and free diving) were compared. Information about fish movements and preferred habitats was required to determine distributions and behaviours. The bulk of scientific data from this project was therefore based on observations made by non-scientists (free divers). Since the completion of this project, strong communication exists between scientists and free divers.

A1: Improving communication in adverse conditions, mobilising the efforts of recreational anglers to support research in Victoria, Australia (scientist's experience)

A history of conflict existed in Victoria between trout anglers and scientists regarding threatened native fish, in particular the barred galaxias, *Galaxias fuscus* Mack, a small freshwater fish. On 7 February 2009, which later came to be known as 'Black Saturday', large wildfires brought tragedy to Victoria and 173 people died in the small town of Marysville at the heart of the barred galaxias range. Scientists working on recovery plans for the species undertook fish rescues for some populations (Lyon & Hames 2009; Hames 2010). The tragedy of the situation proved to be a major catalyst for successful communication and collaboration between scientists, conservationists and trout anglers.

A2: Improving communication by collaborations between recreational fisheries managers, scientists and fishers in New South Wales, Australia (scientist's experience)

In New South Wales, a modest annual fishing licence fee (costing less per year than a carton of beer) generates approximately $13 million per annum, which is spent on a variety of management, research, enhancement, safety, education and communication programmes designed to improve recreational fishing. All funds are placed into a Saltwater Trust and a Freshwater Trust, the expenditure of which is assessed by two corresponding stakeholder-based committees. The recommendations of these two committees are then fed to, and approved by, the Minister via a Ministerial Council. The existence of such a ongoing funding leads to excellent management outcomes following constant communication via a series of working groups, project steering committees and informal discussions involving scientists, managers and fishers.

C: Improving communication by simplifying and networking in recreational fishery management, British Columbia, Canada (manager-angler's experience)

The Freshwater Fisheries Society of British Columbia (FFSBC) is a non-profit organisation that works in partnership with the provincial government to deliver a fish stocking programme as well as provide conservation fish culture services that support steelhead, *Oncorhynchus mykiss* (Walbaum), and sturgeon recovery programmes. FFSBC's not-for-profit status allows them to enter into formalised research partnerships with academic experts in the fields of ecology, physiology, fisheries management and human dimensions. These partnerships are jointly supported by FFSBC and the Natural Sciences and Engineering Research Council of Canada and have greatly increased their capacity to take a multi-disciplinary approach to recreational fisheries management.

Freshwater Fisheries Society of British Columbia also has a positive relationship with angling groups and individual anglers. The organisation is seen to promote the interests of, and be an advocate for, anglers – not as a regulating agency. One example of successful communication among government, stakeholders and FFSBC is an angling advisory committee that meets to collaborate and inform management decisions regarding recreational fisheries.

Barriers to communication between scientists, managers and fishers, and the consequences

The lessons learned from the case studies (synthesised in Table 1) identified a variety of obstacles than can thwart seamless communication between scientists, recreational fishery managers and recreational fishers. Several generalities can be drawn among the problems encountered.

Language

From the scientists' perspective, it seems that the limited scientific background of fishers and managers (as in the G1, IA, N1 cases) and the language barrier (G1, G2, IA) can be major barriers to effective communication and collaboration between scientists, fishers and managers. Generally, scientists share their experience through peer-reviewed publications presented in a technical way, often using jargon for which often no easy synonyms exist. Such publications are difficult to access and to understand by most fishers.

Preconceived fears and suspicions

The second most prevalent reason for poor communication was the fear that scientific input to management will result in fewer or restricted fishing opportunities (S, G1, G2). Fishers and managers often become suspicious about scientific recommendations and can feel that they are biased or impractical. Such concerns can be exacerbated by using science that is too complicated or poorly explained.

Diverging interests between commercial and recreational fishers have been previously reported (Sullivan 2003; Cooke & Cowx 2006; Holdsworthe & Walshe 2011) and were identified in the case studies as another major barrier to good communication. This was particularly acute in the French case of Lake Annecy. The sometimes bureaucratic face of management that makes fishers suspicious of science and managers appeared to be another major hurdle in several places (C, F, G2, S). Recreational fishers also reported that the exclusive capture of knowledge by scientists was the main reason of poor communication between the two groups (S).

Conflict of values

The conflict between anglers valuing fishing for non-native trout and scientists working for the conservation of native species was an obstacle to good communication in

Table 1. Synthesis of eleven case studies presented at the Sixth World Recreational Fishing Conference (Berlin 3 August 2011) outlining the main barriers to good communication, the solutions attempted and the cases where problems were reported

Problems	Possible solutions	Study cases where reported
Limited scientific background of fishers (7)	Organising information meetings	A2, F, G1, N1, N2
	Do not involve fishermen in complex project	A1, F, IA, N2
	Pitch the information at the anglers' level of understanding	A2, F, G1, N2
	Scientists need to blend with fishers	F, G2, N2
Fear that management direction will limit fishing opportunities (6)	Organising information meetings	A2, F, G1, G2, N1
	Scientists need to blend with fishers	A2, F
	No government link	C, D
	Celebrate success, accolade to stakeholders	A1, A2
Fishers' suspicion of science(5)	Mutual understanding among stakeholders knowledge	C, F, N2, A2, S
	Involve fishers in research programs	A2, N2, S
	Recognise fishers as experts	S
	Acknowledge fishers' contribution	N2
Antagonism commercial-recreational fisheries (3)	Keep fishers informed	F, G2, N1
	Equitable distribution of the resource based on scientific input	F
Conflict of interest/values (3)	Involvement of all stakeholders	A2, C, F
	Use of a facilitator	A1, F
Socio-cultural barrier (2)	Recognise fishers as experts	F, G2
Exclusive capture of knowledge by scientists (1)	Recognise fishers as experts	S
Personalities clashes (1)	Use of a facilitator	A2
Interpretation of science by the media (1)	None identified	IA
Management suspicious of science (1)	None identified	G1
Politics (1)	None identified	G1

The figures in brackets indicate the number of cases where the problem was identified. Coding: A1 = Victoria, Australia; A2 = New South Wales, Australia; C = British Columbia, Canada; D = Denmark; F = France; G1 = Germany, science uptake; G2 = Germany, smartphone application; IA = Italy-Austria; N1 = Norway, marine angling tourism; N2 = Norway, lobster fishery; S = Spain.

the Australian example from Victoria. This is an example of a value conflict resulting from varying preferences by fishers and conservation-oriented scientists. This conflict led fishers to draw assumptions about scientists' work being biased to support native fish, and they therefore became fearful of having reduced access to the trout resource. However, fishers are not the only ones guilty of making assumptions. In the Italian-Austrian programme, project leadership erroneously assumed that anglers fully understood and accepted the need for conservation of endangered native salmonids, and that the support of anglers towards indigenous species conservation would be forthcoming without any special education or dedicated information.

Funding is essential for good fisheries management (A2), yet how that money is allocated did not appear to create major problems in communication except in the initial phases of the Danish case and in Germany where informing people was absent (G1). Notwithstanding these two cases, when there are significant resources available for programmes, communication processes can become easier, as demonstrated in New South Wales, Australia. In the Victorian case, the conflict between fishers and scientists had festered, and no resources had been allocated to building an effective relationship, but relationships improved when staff specifically dedicated to communication became involved.

Lack of clarity on the use of online data

In the second German (G2) case study involving Internet-based recreational data, anglers were initially not keen to contribute by uploading their records. The lack of willingness exhibited could have been that their records would become visible to the entire community, i.e. anglers did not consider uploading their data simply because they did not want to disclose it or attract commercial fishing boats to their favourite fishing spots. Other reasons for the low participation may be a lack of obvious benefits to anglers and lack of precise communication about how data would be used in the future. Another problem was that the FishBase facility was not advertised within angling communities as it was only one of hundreds of options available in this application. Moreover, the FishWatcher online version did not provide any feedback features such as e-mail to send catch records.

The media

The perception about the role of the angling media was frequently that science is of limited interest to readers and, consequently, tended to publish fragmentary, oversimplified information that is often unable to convey complex scientific results adequately to the public (G, IA). For example, the label of 'ancestral trout' used in the Italian-Austrian case was invented and widely used by the media to catch public attention. This strategy ignored the fact that there was no single genetic entity to preserve, but a series of isolated, locally restricted trout populations that were all worthy of improved conservation. As a result, this fragmentary mode of science communication was criticised by the academic community and resulted in a breakdown in communication between anglers and scientists.

Knowledge gap between science and fishing practices

In addition to the above, scientists' limited knowledge of the local communities and their fishing activities also meant that at least initially, seeking information from anglers was a serious hurdle to constructive, effective communication. (F G2, N1).

Compared with fishers and scientists, fishery managers were generally satisfied with their interactions with scientists suggesting that for them, communication is not a problem or if it was, it has now been resolved (A2, C, A2). This is a substantial improvement in the less-than-stellar record of interaction between managers and scientists previously reported in the United States (Parrish *et al.* 1995) and is a significant achievement given the complexity of managers' responsibilities (Pringle 1985).

Proposed solutions

Using plain language

The use of simple language by scientists and managers is considered the ubiquitous solution to reduce communication problems caused by anglers' lack of scientific understanding and language differences. Keeping fishers informed by organising informative meetings has been reported before (Sullivan 2003; Stenekes & Sahlqvist 2011) and is another common remedy. For example, talks during annual meetings of fishing associations, or supplying information in angler journals and magazines are common approaches. Peer-to-peer communication among anglers was also generally acknowledged as highly trusted and effective. In addition, it is recommended to employ bridging people who have scientific background but work on the ground, and may serve as facilitators between science and anglers.

Sharing knowledge

It was expected that the majority of views expressed at the workshop would come from those having a scientific background, as the workshop was part of a scientific conference. However, many scientists working in the fisheries field are active recreational fishers themselves, and it was noted that the knowledge of both worlds was a valuable asset when communicating. In several instances it even helped to overcome scientific barriers – e.g. in the second German example. In the French case study, the scientist in charge realised that he had to take the first step in communicating with fishers by asking them what they knew. Throughout the second Norwegian case, it was important for the scientists to think like recreational fishers when communicating with them. The communication and collaboration between the two groups was further enhanced when fishers saw that the data they collected were valued and used for research and management. The overarching lesson is that constant feedback to recreational fishing volunteers (in this case personal reports) is crucial for maintaining interest in reporting catches and sharing other information on fishing practices.

Using online resources to keep everyone informed

In Denmark the use of the Internet was an effective way to keep stakeholders informed and to stimulate discussion through appropriate fora. Furthermore, the web page consultants engaged were not only the editors of the homepage, but they also participated in meetings attended by local angling clubs and politicians. In short, they made governmental fisheries management visible to the end-users and brought scientists closer to anglers. This guaranteed that anglers were always supplied with the most up-to-date information. In the second German case, the use of Smartphone Applications has opened new avenues for stimulating participation in collecting and sharing fishing data within the community including the provision of related applications in different languages. These latest technical developments and the means of the Web 2.0 and FishBase will hopefully alleviate most of the original barriers to communication between angling groups and eventually scientists, and managers.

Involving fishers in projects at the appropriate level

When fishers have sufficient understanding of science, they can be involved in research projects, and there have been several calls to engage them in fisheries management (Granek *et al.* 2008; Arlinghaus *et al.* 2002; Gray & Jordan 2010). In the Norwegian lobster case, a selection of recreational fishers is now collecting data to evaluate potential spill-over effects of marine reserves. In addition, assigning fishers with responsibilities for data recording and collection, study site selection, sampling methods and descriptions of fish behaviours resulted in mutually beneficial collaborations (G2, N2, S). In these situations, fishers felt truly involved in the management process and took ownership of the results, which, in turn, lent credibility to the results (see also Walters 1986). A sense of ownership stimulated pride in their contribution and encouraged them to collaborate further. Conversely, research involving genetics or complex statistics may be of less interest to many fishers and therefore less likely to achieve similar outcomes (IA).

Bringing stakeholders together

The management models from British Columbia and Denmark demonstrated that the integration of academic research into a group that promotes angling and works closely with government can break down many barriers regarding communication flow around scientific research and management. These models effectively bring all stakeholders, including government, fishers and non-profit interest groups, together to work collaboratively to achieve effective management of the resource. Management outcomes can be negotiated at a level that all parties understand and so facilitate effective decision making.

However, final authority does not always lie with stakeholders. A recurrent comment during the workshop was that decisions that reduce fishing opportunities are generally made by managers rather than by collaborative committees involving all stakeholders (N1). It must be noted, that while consideration is given to the viewpoints of stakeholders, when conservation is warranted, fisheries managers still retain the authority to override the advice and wishes of the collaborative process. Nevertheless, as long as the reasons for decisions are clearly communicated to stakeholders, respect can be maintained throughout the process. A good example of this process occurs in British Columbia where an angling advisory team composed of government managers, stakeholders and a non-profit society discuss pertinent fisheries concerns and try to reach consensus on fisheries issues. Management responsibility is not delegated away from the government but the advisory team's goal is to inform decision making.

In some cases scientists need to recognise that there are substantial gaps in their knowledge around local fisheries and that traditional knowledge can offer valuable insights and experience. For example, when knowledge on some species is fragmentary, the experts can be the people who fish for that species (Johannes *et al.* 2000). This traditional knowledge or citizen knowledge (Danylchuk *et al.* 2011) is particularly valuable when dealing with poorly known species (Granek *et al.* 2008) or when the assignment is to describe some aspects of fish biology that cannot be obtained by classic scientific methods. It has also helped restore the public's trust in science (Stenekes & Sahlqvist 2011). The Spanish case illustrated the usefulness of traditional knowledge particularly well. In this case scientific expertise was provided by local free divers who could observe the true behaviour of animals, knowledge that enables scientists to do better experiments and draw robust conclusions. The Norwegian lobster fishery example also highlighted that citizen knowledge was particularly useful because the data were collected in a structured way, adhering to rigorous principles of science. Furthermore, scientists can also benefit when relying on citizen science as they can use these interactions to learn about common angling techniques, patterns in species abundances and more, as they develop hypotheses to test (Danylchuk *et al.* 2011). Citizen science also helps to create and support local facilitators, who often become significant portals between communities and scientists.

Using an appropriate, neutral facilitator

The whole process of collaboration between stakeholders can also be made easier by involving a neutral facilitator who can prevent some participants from dominating and help elicit multiple viewpoints (Irwin *et al.* 2011), or by removing the seemingly bureaucratic face of governmental management, as in the British Columbian example. A project facilitator or champion, whether in the community, in the responsible management agency, or in an academic institution, can motivate partners, encourage commitment and provide continuity and support to the partners during the planning and implementation of multi-stakeholders programmes (A1, D). Respected and knowledgeable leaders who have previous organisational experience are critical for legitimacy and reduce the costs associated with coming to agreement and finding effective solutions (Ostrom *et al.* 1999). This can help balance trade-offs, prevent coercive or purposefully negative behaviour and keep parties focused on their common goals and interests rather than their positions (Pinkerton 1994; Andanovich 1995). The French case study further recommended choosing such a facilitator with the same socio-cultural background as other stakeholders.

Case-specific solutions

The potential advantages and disadvantages that could arise when prioritising endemic species for conservation were also presented to anglers in the Italian-Austrian and Victorian examples. A booklet was published, written and edited in tight cooperation between scientists and stakeholders and was primarily aimed to infuse a sense for nature conservation to the public. This was highly successful in the Victorian case.

For the second German example, problems of privacy related to anglers making their catch records available on the Internet were technically alleviated by developing an application that protected angler's privacy by enhancing the architecture of the mobile application (Tschersich *et al.* 2011).

Finally, the celebration of positive achievements was reported as an effective way to help reluctant collaborators appreciate the value in investing in communication, conflict resolution and collaboration in the example from Victoria, Australia.

Remaining challenges

Popularising the message

Scientists involved in the case studies identified a lack of scientific understanding by recreational fishers as the main obstacle to good communication. By contrast, the scepticism of fishers about science was identified as being due to the overconfidence and 'righteousness' of scientists. Such entrenched positions are typical of the Deficit Model that communication scholars describe as 'A one-way, top-down, communication process, in which scientists fill the knowledge vacuum in the scientifically illiterate public' (Miller 2002; Nisbet & Scheufele 2007). However, there were also several examples of science communication fitting a second type of model called the Contextual model, which has a two-way flow of communication between scientists and other stakeholders (Wynne 1992). In this model, the scientific message delivery follows a three-step process. The first is to gain the trust of non-scientists through positive interactions. Secondly, scientists need to take time to understand the audience's core values and beliefs. And thirdly, they need to frame their message to enable non-scientists to understand the importance of the issue and to forge their opinions accordingly (Nisbet 2007; Nisbet & Scheufele 2009). Encouragingly, the first two steps were apparent in all case studies covered but, unfortunately, the final step, which is the key one, requires greater effort.

Scientists, or key facilitators that have a scientific background, need to popularise science by using language and illustrations that can be easily understood by fishers and managers. Although it is reasonably easy to explain some scientific aspects of a fishery, such as fish behaviour, it is far more difficult to use simple language to explain genetics (IA), statistical analyses (N2) or complex mathematical modelling.

Managing expectations

It is important for fishers and managers to acknowledge that scientists often cannot do cutting edge science, collect rigorous data, teach, supervise and deliver quality communication. They are becoming more and more restricted on budgets (and therefore time and resources) and are required to publish their research in the peer-reviewed literature. However, both peer-reviewed and mass-media publications have their limits in efficiently transmitting research outcomes to anglers. Some of the research carried out by academic scientists is not necessarily of an applied nature and may not be directly applicable to fix management problems (Cullen 1990). When involved in such fundamental research, it is important that fishery scientists acknowledge, up front, that their science is not of a direct problem-solving nature so that expectations of fishers and managers remain realistic. However, to be realistic in their expectations of what science can do, fishers and managers also need to engage with inherent aspects of science like uncertainty and complexity. Waterton *et al.* (2001) pointed out that this challenge may be the real bottleneck in the salient communications between different stakeholders.

Managing the tension

The perceived tension between commercial and recreational fishers has no easy solution. In the French case, an attempt was made to provide an equitable share of the resource between the groups based on scientific input. Initially this approach was successful at reducing the tension between the two groups, but the problem has not yet been satisfactorily solved (Sebi & Gerdeaux 2008). In the case of the Norwegian marine recreational fishery, quotas were set for both recreational and commercial fisheries. However, catch data were only available from one segment of the angling tourism industry, preventing any accurate estimation of the total catch. Consequently the tension between the two groups remains.

It should also be recognised that the management of recreational fisheries may require substantially different approaches than the management of commercial fisheries (Post *et al.* 2002; Johnston *et al.* 2010). The excellent co-operation between fishers, scientists and managers concerning commercial fisheries management in certain countries like Norway (Skaret & Pitcher 2006) has shown that it is possible to develop a highly effective fisheries management regime that more or less satisfies all stakeholder groups. The challenge now is to establish a similar co-operative framework to develop effective management of recreational fisheries by reducing the scientific misunderstandings of fishers. It is also essential for managers to understand what criteria fishers use to accept or refuse a scientific message (Weeks & Packard 1997).

Getting the media on board

The challenge to use the media in a positive way is to get the main decision-makers (who attract the most media attention) and the media themselves to recognise that a news item regarding a fisheries issue that is based on sound science is more palatable and believable to the public than an item based on fishers' opinions (A2). However, this is easier said than performed. Scientists wish that the media would broadcast their message accurately and that this transfer of knowledge will make readers scientifically literate; however, the priority of the media is to interest their main audience and this is where scientific messages can be sensationalised or inaccurately reported, as in the Italian-Austrian case. Scientists often become very guarded due to the inadequacy of media reporting, and often choose to share their results only through the peer-reviewed process. Despite this risk, scientists need to maintain a good relationship with the media as the media is the most important communication vehicle to engage them with other stakeholders and the owners of the fisheries – the public. A challenge is to popularise the scientific message or deliver it in a particularly engaging way, without compromising accuracy (A1, A2).

Most of the problems of good communication identified in this comparative analysis are well known in the social sciences arena. The challenge is for people involved in fisheries as scientists or managers to seek and take onboard the advice from social scientists as to how best communicate with other groups. This will be particularly warranted in difficult instances such as during a downturn in the fishery or when trying to justify hard regulations that will affect fishers.

Conclusion

This comparative analysis did not attempt to represent, or to solve, the complete list of possible hurdles when communicating among recreational fishing stakeholders. However, it should help scientists, managers and fishers to consider many of the relevant issues when planning a new project or when trying to stimulate the involvement of other stakeholders. In essence, this suggests that effective fisheries management is a matter of how successfully people who participate in the fisheries sector collaborate with each other to achieve particular goals (Quinn 1992; Radomski 2003). If the above are accepted, then it is fair to state that while it is important for people involved in the management of fisheries resources to have technical skills, it is also important for them to have people skills (Pinkerton 1994; Ehrlich 2002; Delaney & Murray 2002; McPhee 2011). The catalysts for developing and implementing these people skills can take diverse forms. An optimistic note of this analysis was that even a natural disaster, such as that described in the Victorian case study, or a lack of scientific knowledge making local fishers the experts in the Spanish case study, became fertile ground for long-lasting and successful communication and collaborations.

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