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Bridging the gap between fisheries science and society: exploring fisheries science as a social activity

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Much has been written about the poor relations between fisheries scientists and lay people, but the experience of two field biologists suggests that good relations can exist and have a positive impact on the exchange of knowledge across the "science"—"society" divide. This article is a first attempt to map the contact points between fisheries scientists and lay people and to explore the spin-offs these can have. It presents the results of two surveys conducted with participants at the November 2015 MYFISH/ICES Symposium on "Targets and limits for long term fisheries management": a real-time Kahoot survey of the audience and a longer, on-line survey some participants filled out following the symposium session. The survey results generally support the supposition that fisheries scientist-society interactions are extremely varied and that much in the way of information exchange and mutual learning can occur. However they also show that trust issues remain in the fisheries management community, but not just between scientists and lay people: fisheries managers and environmental non-governmental organizations may be less trusted by scientists than are lay people. The study concludes by discussing how future studies should be designed and focused and with an invitation for comments from the ICES community.

Keywords: fishers and fishing industry, fisheries science, interaction, lay ecological knowledge, lay people, resource users, social actors, social capital, stakeholders, trust.

Introduction

Fisheries management is about managing people interacting with fisheries and their associated ecosystems (Hilborn, 2007). The complexity of this task has led to the current policies and "calls" for research proposals with respect to fisheries management that state that social science and/or stakeholders (The word "stakeholder" is used in this article here in a narrow sense to mean "resource users" and indicating fishers and those associated with the fishing industry. It is recognized that scientists and fisheries managers also have a stake in their research, as they themselves often recognize. In the lead author's experience, this point is always made in project meetings by fisheries scientists when the concept of "stakeholder" is introduced.) must be included in work that has traditionally been dominated by natural scientists (Hartley and Robertson, 2009; Hill *et al.*, 2010; Wiber *et al.*, 2012). The integrated research required raises important questions about the relationships between experts in the "natural" and "social" sciences on the one hand, and between "scientists" in general and "society" on the other (Ignaciuk *et al.*, 2012; Hind, 2015; Stephenson *et al.*, 2016). This article focuses on the relationship between these natural scientists and the non-scientists (in terms of formal training) with whom they interact.

The relationship between scientists and the people around them ("non-scientists" or lay people) has been explored from many vantage points. The critical literatures of constructivism and post-modernism, science and technology studies (STS),

transdisciplinary research, and the literatures on lay knowledge (LK), local ecological knowledge (LEK), and their many variants frequently suggest that the two communities are isolated or separated from and at odds with each other epistemologically, ontologically, institutionally and personally, with scientific knowledge more valued than other forms of knowing. They tend to argue that conventional science is not as objective as it thinks it is while experience-based knowledge is more empirical than conventional scientists recognize.

Many scientists ("Science" has many meanings. This single word can encompass both "natural" and "social science"; social scientists employ formal methodologies in the search for data and causal connections that are as objective, valid and reliable as possible; they often distinguish themselves from natural science on the basis of their primary subject matter rather than method, even though the specifics of methods do vary. Here the focus is on "natural science". For reasons of convenience in this context only, references to "scientists" and "fisheries scientists" in this article refer to those operating in the domains of natural science.) also see a clear divide. From their perspectives, LK is extremely varied in nature or quality. It is hard to incorporate into a traditional database or analyze scientifically. Fisheries management institutions such as the National Marine Fisheries Service (NOAA) and the organization and network, the International Council for the Exploration of the Seas (ICES) report difficulties in incorporating what is often seen as "not-science"-based knowledge into its work, although both recognize the need to do so (MIllar *et al.*, 2004; ICES, 2014; Hind, 2015).

This article looks at fisheries management to suggest that while there can be real barriers to genuinely integrative research and the co-production of knowledge across the science-society divide, more positive interaction and knowledge integration may be taking place on a daily basis than meets the eye. It argues that the relationship between the community of fisheries scientists and the communities in which they operate is complex and that the multiplicities of interactions this brings with it can work to undermine divisions. In taking this approach, the article joins the growing recognition that the supposedly clean division between the two communities is a false dichotomy (Stephenson *et al.*, 2016).

One approach to understanding the relationship between this fisheries (natural) science community and lay people is to understand better how fisheries scientists actually work, that is, to look at fisheries science as a social activity. This approach is inspired by the authors' observations of the field research of two biologists, one of whom has joined us in writing this article. Scientific researchers frequently have contact with the public in official fora as mandated by law, regulation or research grant, and these venues and contacts are important. But surprising amounts of informal contact can take place between lay people and scientists as scientists routinely go about their work. All of these contacts can have real if not deliberate consequences: LK can be absorbed into science and lay people can learn about science. Such a web of contacts can help build the social capital (social connectedness and mutual trust) that makes management and societal development successful (Putnam, 1993; Pretty and Ward, 2001; Bowles and Gintis, 2002; Pretty, 2003; Parakevopoulos, 2010; Henry and Dietz, 2011; Glenn *et al.*, 2012; Holm and Soma, 2016).

This article is a first attempt to map the personal contact points between fisheries scientists and lay people, in particular resource users, in formal and informal settings and to explore the spin-offs these can have. It focuses particularly on the activities of natural scientists, and in so doing, this initial effort reports primarily on their perspectives. It presents the results of two surveys conducted with participants at the November 2015 MYFISH/ICES Symposium on "Targets and limits for long term fisheries management" in the session entitled "Incorporating Societal Concerns into Science": a real-time Kahoot survey of the audience and a longer survey the audience was asked to fill out following the symposium session. The results of the surveys generally support the supposition that fisheries scientist-society interactions are extremely varied, that they are influenced by many variables, and that they can and do take place beyond the officially recognized fora. The results suggest much in the way of information exchange and mutual learning. They also reveal that trust issues remain important, but may be less of an issue between scientists and resource users than they are with respect to managers and environmental non-governmental organizations (ENGOs). Given the limitations of the surveys, these results can only be provisional and exploratory but they support the idea that a more comprehensive study of the practice of science in a social context is needed. One goal of this article is to serve as a platform for further research and it actively invites comments by the ICES community.

Fisheries science as a social activity

It is readily accepted that the non-scientific community possesses knowledge highly relevant to fisheries management, such about as the fishing industry, fisheries technology and regulations and the community in which they live (Murray *et al.*, 2006; Wilson *et al.*, 2006; Stephenson *et al.*, 2016). Successful fisheries management, however, cannot do without knowledge about relevant stocks and natural systems needed for stock assessments. The focus here is what knowledge with respect to the natural environment—such as basic factual knowledge (e.g. when and where the spawning of a given species occurs or how abundant a species has been in the past) and how natural systems work (as evidenced by hypotheses about causality)—lay people possess and can contribute to fisheries management. This article accordingly addresses the relationship between scientists engaged in the natural science work of fisheries management (henceforth "fisheries scientists") and lay people.

The science-society interface has been tackled from many perspectives which explore the nature of knowledge and the implications of designating some forms of knowledge as "scientific". Constructivist and post-modern studies in the philosophy and sociology of science locate a critical divide between those who claim a scientific approach to knowledge and others that is rooted in epistemology (the nature of knowledge) and ontology (the nature or reality and being) (for an application to environmental management, see Raymond *et al.*, 2010). This literature argues convincingly that while "science" (including fisheries science) has the ideal of producing "objective", "fact-based" "knowledge", it frequently falls short of this ideal (Kuhn, 1962; Foucault, 1970; Feyerabend, 1975; Jasanoff, 2004; Negev and Teschner, 2013). From these perspectives, conventional science, described often as "Newtonian" (Berkes *et al.*, 2000), "normal" (Petts and Brooks, 2006), "Mertonian" (Dankel *et al.*, 2015), "positivistic" or "neo-positivistic" (Johannes, 1998; Huntington, 2000) is inescapably permeated and shaped by personal and societal interests. The recognition and selection of problems to be solved and the way efforts to solve them are organized, prioritized and funded are

socially defined and embedded in institutions; the result can be that conventional science tends to speak to the concerns prioritized by its developed, western-oriented, neo-liberal, rationalistic, and capitalistic context (Pierotti and Wildcat, 2000; Ruddle and Davis, 2012).

The STS literature further stresses the inter-relationship between privileged "ways of knowing" and technologies on the one hand and social, economic and political structures on the other (Jasanoff, 2004). It too explains how the selection of research questions and what qualifies as knowledge and scientific analysis influence, and are influenced by, non-scientific factors. Supposedly neutral research supports dominant institutions and mentalities; the designation of something as "scientific" privileges certain knowledges, professions, mentalities, and skill sets over others and by doing so, affects the distribution of power in society (Kuhn, 1962; Foucault, 1970; Feyerabend, 1975).

Studies of LK (Petts and Brooks, 2006), LEK (Wilson *et al.*, 2006; Ruddle and Davis, 2011; Taylor and Loë, 2012), Traditional Ecological Knowledge (Pierotti and Wildcat, 2000; Haggan, *et al.*, 2007), local knowledge (Negev and Teschner, 2013), experiential knowledge (Bundy and Davis, 2013), indigenous ecological knowledge (Haggan, *et al.*, 2007; Davis and Ruddle, 2010) and place-based knowledge pick up many of these themes and apply them to instances of costal, fisheries and other management issues (for a very useful overview of this literature see Hind, 2015), frequently in connection with rural coastal communities. These literatures tend to share the view that conventional science does not make use of valuable and real knowledge possessed by people who do not have the proper scientific credentials. They can portray scientists (and managers) as too arrogant, narrow-minded, territorial or simply preoccupied to take notice of the very real expertise that local people have to offer (Berkes *et al.*, 2000; Baelde, 2007) or sometimes, to notice the very real contributions that local people already *do* make (Berkes *et al.*, 2000; Huntington, 2000; Stanley and Rice, 2007; Silvano and Valbo-Jørgensen, 2008). It is sometimes suggested that scientists and officials find challenges to their presumed superior knowledge to be personally unsettling and threatening (Johannes, 1998; Petts and Brooks, 2006; Taylor and Loë, 2012). Sometimes, however, scientists may simply not know how to reconcile the standards for evidence they have been trained to require with knowledge that is presented in informal, frequently anecdotal, ways (personal experience, Petts and Brooks, 2006). The portrait of the scientist—lay person relationship these literatures paint is one of one-sided dominance by "scientists" with little or no contract between the communities and still less mutual trust.

For their part, fisheries scientists may actively resist seeing lay people as sources of data and information. In this view, lay people may have a good deal of knowledge but not the kind that can be easily translated into useful scientific data; from this perspective, lay people lack the formal training, the patience and the neutrality required. Training in fisheries (or any) science takes years and the scientific method requires clear protocols and meticulous record keeping. In addition, one objective of fisheries science has been to get away from the intrusion of politics and economics into scientific work; straying from accepted scientific best practice might open this door again.

There are then two core issues. First, there is the quality of knowledge that lay people possess and whether it can be utilized in scientific work. It is evident that non-scientists frequently learn through extended experience of their engagement in activities. Local resource users may, for example, have spent years observing and learning about the resources and their ecosystems they depend upon and may have special insights into short-term fluctuations and long-term changes. Their success year after year in managing these suggests that lay people have gotten a lot about these resources right (Neis *et al.*, 1999). This knowledge can then be usefully applied in resource management. Helping to fill in the gaps in data-poor fisheries is a relatively recognized and accepted role for lay people (Beaudreau and Levin, 2014; Anon, 2015), but the critical literatures usually suggest contributions that can or should go beyond this, such as shaping research agendas and framing hypotheses. However, second, there is the issue of the relationship between science and lay people. The critical literatures tend to report cases of lacking or unsuccessful contact between scientists and lay people. There is accordingly little trust between the two, making it difficult for scientists and lay people to work productively together in the co-production of knowledge.

Despite these literatures, there is in many places today better, more systematic contact between fisheries scientists and lay people, including resource users, than ever before. The cooperation of stakeholders is widely recognized to be critical to management success and it is now a fairly common practice for researchers to present their projects to local communities and resource users and to invite their input. Granting agencies frequently require the inclusion of key resource users in proposed projects and multi-disciplinary and trans-disciplinary studies are increasingly sought (Oughton and Bracken, 2009). Fisheries management regimes usually require meetings with advisory councils that include resource users and other lay people in the process of formulating, promulgating and implementing regulations; scientists are usually a part of this general procedure. Such public meetings and advisory councils are broadly endorsed as "best practice" that results in better policy, and greater commitment and compliance on the part of those concerned (FAO, 1995; Wilson *et al.*, 2006; Baltic Sea 2020, 2009; Henry and Dietz, 2011; Glenn *et al.*, 2012). The "Citizen Scientist" (CS) movement, in which lay people are actively encouraged to participate in scientific projects, is increasingly popular and widespread. This approach has a long history with some projects stretching back decades, although CS projects focused on marine and coastal resources are comparatively few and more recent (Silvertown, 2009; Roy *et al.*, 2012; Thiel *et al.*, 2014; Cigliano *et al.*, 2015).

In addition, there are increasing numbers of reports of successful interaction among scientists and lay people of all sorts. The authors have witnessed and engaged in a series of projects involving extensive formal and informal contact among natural science researchers and a variety of local people. This contact has led to the spontaneous offer of assistance by lay people to researchers in carrying out scientific work, the exchange of sensitive information among researchers and lay people and the incorporation of local knowledge into research questions and hypotheses [e.g. Norwegian Research Council (NRC) projects JANUS and CHASES] (The JANUS project (Modeling an interdisciplinary early warning system for future fisheries scenarios: A socio-bio-economic value chain evaluation) is NRC project number 216604. CHASES (Revealing consequences of land-use change and human activity on anadromous salmonids and the ecosystem services that they provide) is NRC project number 255110. CHASES is the extension of much previous work funded by a great variety of local and national institutions, including governmental institutions [such as the Norwegian Environment Agency

and county governors], aquaculture companies and land owner associations.). These are not isolated events. There are many similar reports. To take just a few examples, the EU seventh Framework Programme project MY-FISH, which provided the occasion for this work, sought industry input in order to improve management indictors and targets; the EU project KNOWFISH actively sought ways to integrate LEK and research-based knowledge into management (Wilson *et al.*, 2006); Stephenson *et al.* (2016) stress the growing number of collaborative projects such as the EU-funded project GAP 2; Hartley and Robertson (2009) report some success in knowledge integration and exchange and trust building in New England; Hill *et al.*, (2010) note the use of such knowledge in data-poor contexts in developing countries and in New Zealand).

Despite this flurry of activity, the relationship between scientists and lay people and the degree to which interaction and knowledge exchange take place with respect to defining and carrying out the core scientific work, remain open to question (Weible and Sabatier, 2009). Much of the LK, LEK, and associated literature focuses on the potential for the use of lay/local knowledge in fisheries science and management, rather than successes in incorporating it into conventional approaches (Hind, 2015, p. 2; but see Stephenson *et al.* 2016 for an alternative view) (The amount of new and useful knowledge, especially about causal relationships, that resource users may have to offer has also been questioned. See e.g. Wilson *et al.*, 2006.). Researchers who study interdisciplinary and transdisciplinary research routinely report that genuinely integrated research is difficult and rare, and frequently does not take place at the levels of formulating research questions and plans (e.g. Ignaciuk *et al.*, 2012). Surveys of Citizen Science projects (Roy *et al.*, 2012; Thiel *et al.*, 2014) show that lay people most frequently participate in such projects as data collectors but fairly rarely in the formulation of research questions or the research design. Formal cooperative settings may privilege some forms of knowledge and presentation over others, and may not serve well to capture LK about nature.

This article explores these issues by focusing on the activities of fisheries scientists and the contact these generate with lay people and takes a first look at what spin-offs these can have. Fisheries science is a mixture of activities and practices taking place within very specific institutional and other contexts and funded (usually) by sources other than the purse of the individual scientist (Jasanoff, 2004). Not everything that fisheries scientists actually do is usually categorized as science. Nielsen and Holm (2007), e.g. recognize four functions of fisheries management in which scientists are often involved in some way: diagnostics, intervention, objectives and policy making; Dankel *et al.* (2015) note that scientists associated with ICES are called upon to wear many "hats": fisheries plan developer, reviewer, judge and messenger. This article is first and foremost focused on the scientific work itself, although it is in practice impossible to isolate effectively this activity from the others that scientists engage in.

In attempting to limit the concept of scientific activity to core activities such as generating research questions, developing and carrying out research plans and collecting data, it becomes clear that the term "fisheries science" can still include many different kinds of activities. These activities bring with them different degrees and kinds of interaction with lay people in the course of carrying out the work. The two biologists, whose work has inspired our own, have very different projects but share the experience of carrying out "field" research over a relatively long period of time in specific localities. One of the authors has spent 10 years engaged in the meta project of tagging and tracking anadromous species such as sea trout and salmon and spends many weeks every year in the field (as described in Davidsen *et al.*, 2013; Eldøy, *et al.* 2015; Flaten *et al.*, 2016); the other has spent over 40 years investigating his home fjord (although his research has brought him to the water for relatively short intervals in any given year). The work of the first researcher brings him into contact with a wide variety of people in rural communities, including sports fishers, owners/managers of aquaculture installations, local officials and community enthusiasts; he and his team are known figures in the community and contact is made in many formal and informal ways. The other has developed working relationships with fishers on the fjord and at landing sites in a more urban area; contact originated through work and mutual assistance and developed over time. These activities are different from laboratory work or data analysis or model building in an office setting or discussing data with representatives of large, sophisticated fishing vessels in advisory meetings. Any single scientist may do all of these things, only a few, or something else entirely. The scientist can accordingly come into contact with lay people in settings other than in the field, ranging from the formal (e.g. advisory meetings) to the informal (talk over food or drink) or a combination of the two (e.g. corridor talks at formal venues). The characteristics of lay people will vary among other things by the nature of the locality, the venue where contact is made, the resource/issue area, culture, educational level, exposure to the scientific method, and many other variables.

The argument here is that contacts and interaction among scientists and non-scientists, the integration of formal and informal knowledge and, at least potentially, the construction of respect and trust is taking place on many levels, including on the micro level, that is, at the level of some personal interactions among scientists and some local or lay people in a wide variety of settings (Huntington, 2000; Stanley and Rice, 2007).

Trust is a key component in fisheries management. This is a complex concept that has many dimensions and can exist at different levels (for a useful review see Rousseau *et al.*, 1998 and Glenn *et al.*, 2012). At its simplest, trust consists of "a belief [about a party's trustworthiness and one's relationship thereto], . . . a decision [to actually trust that party] and . . . an action [of trust] . . . Trustworthiness and trust are two separate qualities", one of the trustee and the other held by the trustor" (Glenn *et al.*, 2012 citing Mayer *et al.*, 1995). Generalized trust and generalized reciprocity (that is trust in society in general and actions taken with the common good in mind and with the assumption that unspecified others will return the favour at some unspecified time) are in turn understood in the social capital literature to be of fundamental importance to well-functioning societies (Putnam, 1993; Pretty and Ward, 2001; Bowles and Gintis, 2002; Parakevopoulos, 2010). Investigating when, where and the degree to which contact generates trust rather than contempt requires studying the practice of fisheries science as it is done today. This article is a first step in that direction.

The surveys

Two surveys form the basis of this article. Insights into research projects in which the primary authors have been involved (Principally, the NRC-funded JANUS and CHASES projects, the University Museum of the Norwegian University of Science and Technology project "The secret life of sea trout" [http://www.

ntnu.edu/web/museum/the-secret-life-of-sea-trou] and the EU seventh framework programme project MYFISH.) and literature led to the development of, first, an on-line questionnaire to explore the relationships between scientists and lay people. The first version of the questionnaire was tested with a small number of scientists employed at the academy, research institutions and management agencies, and their feedback was used to improve the questionnaire. The survey was then carried out by the primary author in association with the MY-FISH/ICES Symposium on "Targets and limits for long term fisheries management". The audience in the session entitled "Incorporating Societal Concerns into Science" was provided with internet links and asked to answer one of four on-line questionnaires following the session. Given the uncontrolled character of sample of respondents (see below) the survey cannot be used for meaningful statistical analysis. It can, however, serve as a basis for generating ideas, refining research questions and framing better hypotheses. The survey was designed to capture the experience and perceptions of fisheries scientists rather than those of lay people. The picture is clearly not complete without the latter's side of the story; this study presumes that capturing one side of the story is useful as a first step and leaves the other side for another day as a necessary further extension of the project.

Symposium participants came from a variety of European countries, Canada, and the United States. Of the 85 people who registered for the symposium, 11% identified themselves as "industry", 5% as NGO (Although there are many types of NGOs, in practice only environmental NGOs were relevant to the results reported here. For that reason, the results refer to ENGOs.); 6% as Manager; and 78% as Scientists (Rindorf, 2015). The degree to which the participants in the symposium who ticked the box "scientist" are representative of what might be called the "fisheries science" community cannot be established; the data also suggest that not all who chose the category "scientist" may be easily classified as a "fisheries scientist" as defined earlier.

To deal with the symposium's mixed audience, the authors used the Survey Monkey programme to produce four versions of an on-line questionnaire. Each version was designed to capture the perspective of each category defined by the symposium: scientist, manager, industry, and NGO. The pool of potential respondents was offered a distinct link for each version of the survey; respondents themselves chose which version of the survey they answered. In addition, the "scientist" version of the questionnaire was designed to capture the experiences of those working in the various fields of "natural" science rather than the "social" sciences. Although both "natural" and "social" scientists are important in fisheries management, it was the perspective of natural scientists that this study sought to capture. The responses of the natural scientists were selected for analysis based on background questions about the respondents' work. All versions of the survey provided opportunities for respondents to comment on the individual questions, to clarify their answers and to give their input on the questionnaire as a whole. The scientist's on-line survey was answered by 16 respondents, 12 of whom can be classified as a natural scientist. One of the test surveys was added to the analysis, making for a total of 13 questionnaires analysed. One respondent took the NGO version of the questionnaire, 4 completed the stakeholder version and none responded as a "fisheries manager". This tally includes 1 respondent who filled out both the science and stakeholder versions. Because the number of NGO and industry/fisher responses was low, these were used in only a highly limited way in this article. The list of questions is provided in Appendix A.

The on-line survey was, second, supplemented by a real-time survey of the audience attending the hour-long session. This was done using the interactive "Kahoot" internet-based programme. The Kahoot software allows for a maximum of 25 questions with a maximum of 4 responses to each question. A total of 51 audience members logged into this Kahoot project at some point during the session; roughly 45 participated in most of the 25-question survey. Participation in a Kahoot survey requires a stable internet connection that can accommodate multiple users simultaneously and a lap-top or smart phone; that the number of participants fluctuates in a Kahoot survey is a common experience that may or may not be attributable to the technology. The list of Kahoot questions and answer choices is provided in Appendix B.

Neither the on-line nor the Kahoot survey collected sensitive personal information or contained background questions specific enough for the identification of any single respondent. Neither the IP- nor e-mail addresses of respondents were collected nor can the authors link completed questionnaires to specific people. For these reasons, according to the guidelines provided by the Norwegian Center for Research Data (NSD), neither survey required registration or formal ethics clearance from the NSD.

Of the 13 responses to the on-line survey that are included here, many described their primary work as some aspect of modeling (5, including predator-prey interactions, multi-species communities, and species interactions), stock assessment (3) or fish population dynamics (1), with some overlap among these categories. Several (7) specifically described their work as related to management in some way ("science for management advice", "fisheries advice", "to design models of multi-species communities with a view to them being used in the advice process", "developing research programme within fishing community"), including stock assessment.

Only two respondents spent as much as 3–4 weeks per year conducting field research (most specialized in marine systems), three spent 1–2 weeks, and eight spent <1 week per year. The limited time spent "on the water" by most respondents detracts from the project's initial goal of collecting interactive research practices that bring field researchers and lay people together, but it does serve to suggest that the up-take of lay person and stakeholder knowledge should be considered with respect to other contexts as well as the local. The on-line survey was designed to capture such contexts by asking respondents to describe what kind of non-scientists they interact with and whether these were locally, nationally or internationally oriented.

Findings

The clarity of categories

The on-line survey and corridor conversations following the interactive session indicate that the boundaries between the categories (scientist, stakeholder, NGO, and fisheries manager) are not always clear. It was difficult for some respondents to choose a single category (e.g. "scientist" OR "stakeholder"). As noted earlier, one respondent informed the authors that he filled out two on-line questionnaires, one as a scientist and the other on as a person working for the fishing industry. The sole NGO respondent noted that her organization initiated, funded and participated in research projects; all four industry respondents (including the duplicated response) indicated that stakeholders

Table 1. Reported engagement of scientists with selected stakeholders (on-line survey).

	Q1. and 3. In your research, have you engaged with stakeholders (aside from scientific communities) such as direct resource users or NGO? If so, are these primarily local, national, or international?				
Type of stakeholder	**local**	**national**	**international**	**Not Applicable**	**Don't Know**
Fishing vessel owner/operator	3	8	2	0	1
Fisher—crew	4	4	1	0	1
Recreational fishing boat owner/operator	1	0	0	0	4
Fishing industry	2	8	6	0	1
Union/fishers' representative	1	6	4	0	0
Other interest group	0	3	4	1	0
Environmental NGO	1	5	8	0	0
Pressure group	0	1	1	2	1

(industry/fishers) have participated in research projects; two reported employing scientists, two report contributions to a research fund and one reported the direct funding of needed research.

Modes of interaction among scientists and stakeholders

Almost all respondents reported interaction with various kinds of stakeholders (fishing vessel owners/operators, fishermen/crew, recreational fishermen, fishing industry representatives, unions/fishers' organizations, interest groups, environmental NGOs, pressure groups) operating at the local, national and international levels. Respondents also added categories of stakeholders overlooked by the questionnaire, such as processors, retailers, managers and community councils. Although the original idea was to capture interaction with lay people in the process of field research, this group of respondents interacted with stakeholders on the "national" and the "international" levels more than on the local. Even so, responses indicate that interaction with stakeholders is a very common experience. Despite the mixed pool of respondents, most of these stakeholders with whom contact was reported were still fishers or their representatives (Table 1).

Most fisheries scientists reported a range of ways in which they come into contact with stakeholders. Ranging from the formal (the majority of the contacts reported) to the informal. Some (4) participated in a research project in which stakeholders were partners or were a part of research projects which have stakeholders on its advisory board (on-line survey Q 5). One reported interaction with stakeholders though ICES benchmark workshops. Seven worked on a project that actively sought the collection of stakeholder knowledge (On-line survey Q 6). One wrote that his contact with local fishers was simply an on-going and routine: "they are valuable knowledge persons". A majority (8) also indicated that they had professional contact with stakeholders beyond the setting of a particular research programme. Although two respondents reported that they did not participate in a project involving stakeholders as partners or advisors (on-line survey Q 5) and three reported participation in a current project that does not explicitly involve soliciting stakeholder knowledge (on-line survey Q 6), only one reported no contact with stakeholders at all. This respondent's specialty was given as "stock assessment" which could mean principally work in modeling with data supplied by others. Given the sample bias of those asked to complete the survey—participants at a symposium related to a research project deliberately designed to build social concerns into management targets—this is not a surprising result.

The Kahoot survey (Table 2) asked scientists how they interacted with resource users as they conducted their research. The results support the idea that there is much and varied contact, suggesting in turn multiple avenues by which local knowledge might become known to scientists.

The on-line survey also asked questions that sought to broaden our understanding of the ways these two groups (scientists and stakeholders) interact. Respondents were asked directly whether stakeholders assisted with the respondent's work, and if so, in what way (On-line survey, Q 11). The modest on-line survey effort turned up equally modest support for this idea, although a fairly even sprinkling of respondents reported that stakeholders assisted with: (i) the provision of equipment or transport; (ii) advice on time and/or place for sampling; (iii) placement of sampling, monitoring or other equipment; (iv) monitoring of research equipment; and, (v) data collection or provision of data. At least one respondent had experienced each of these, and a few reported that stakeholders frequently or always helped with advice on "time and/place for sampling", "placement of sampling", "monitoring or other equipment", "data collection or provision of data", and "provision of equipment/transport". Only four reported "spontaneous, unexpected or unscheduled help from fishers or industry" (On-line survey, Q 13), an experience reported by the two researchers who inspired this study.

All 13 respondents to the on-line survey also reported that they had presented a research project or its result to stakeholders or a relevant community. All of these reported this to be a positive experience. Some also reported participation in activity that could be classified as "teaching". Only one reported teaching with respect to school; others reported presentations, demonstrations or a similar activity for local fishers (three) or the local community (three).

The on-line survey also asked respondents whether they had contact with stakeholders "outside of a research project setting" (Q 16). Only 23% (3 of 13) did not; 62% (8 of 13) reported professional contact outside of such a setting and 30% (4 of 13) reported contact in a social setting. This question does not capture the full range of social interaction that might take place among scientists and stakeholders, e.g. the conversations that might take place at "down times" on deck, at a pier that both use, or at dinner following a meeting. The responses do, however, hint at more complex interaction than that which takes place within the

Table 2. How and to what degree do stakeholders help researchers carry out their research? (Kahoot survey).

Q 11. Do Stakeholders help researches carry out their research in a formal or informal way? **Q 12. If you answered yes to Q 11, how frequently do stakeholders assist in your research?**						
Questions\answers	**Never**	**Seldom**	**A few times**	**Many times**	**No answer**	**Stakeholders' assistance (%)**
Provision or collection of data?	3	5	16	9	18	76%
Provision of equipment or transport?	12	6	13	11	9	57%
Advice on placement of sampling or monitoring equipment?	12	7	9	11	12	51%
Helping to monitor or keep track of equipment as a favour?	15	9	9	2	16	31%

Table 3. Do stakeholders (e.g. resources users, fisheries managers or environmental NGOs) influence the development of research questions/hypotheses? (Kahoot survey).

Do _____ influence the development of research questions/hypotheses?							
Stakeholder	**Never**	**Sometimes**	**Often**	**Usually**	**No response to this question**	**Total Responses**	**Total Registered**
Q 6. Resource users	1	25	12	11	2	49	51
Q 7. Fisheries managers	2	11	13	20	5	46	51
Q 8. Environmental NGOs	9	26	6	5	5	46	51

confines of a setting officially designated the place where interaction is supposed to take place.

Input from stakeholders

The knowledge and concerns of lay people may find their way into research in formal or informal and in overt or more subtle ways. For example, input may be overtly solicited from stakeholders; interaction with stakeholders can stimulate thought and generate research hypotheses or provoke direct testing of stakeholder hypotheses. In addition, interaction may shape the interests and concerns of researchers in less recognized or conscious ways. Most respondents also reported that stakeholders "influenced" their research in some (unspecified) way (on-line survey, Q 7). Using a scale from 1 "no" influence to 5 "total" influence, no respondent reported no influence at all. Reported influence ranged from little (level 2, 46%), to a modest degree (level 3, 23%) to strongly (level 4, 23%). Respondents subsequently (on-line survey, Q 10) reported that stakeholders (specified as "e.g. fishers, industry") "influenced" their research objectives (8), hypotheses (5), and research design/plan (7). One speculated that such influence probably takes place through "the 'historical relationship' with fisheries science as such" and another reported working directly with stakeholders to" develop technological measures to mitigate bycatch and collect prey samples for analysis of trophic interactions". Only one of the 13 reported impact on research method; only one reported no impact in any of these categories.

The mixed group of the Kahoot survey was also asked whether various actors (resource users, fisheries managers and environmental NGOs) influence the development of "research questions/hypotheses". Their responses are indicated in Table 3. All but one respondent answered that resource users influenced the development of these, with 47% (23) selecting "often" or "usually", and 51% (25) "sometimes". Fisheries managers were reported to have the most influence on these, ENGOs the least.

Ranking stakeholder knowledge

The inclusion of the stakeholders' perspectives in scientific research is more likely when stakeholders are considered to be knowledgeable. A complaint often made by scholars writing about LK and LEK is that scientists do not credit non-scientists with having much knowledge. Scientists were asked in the on-line survey to evaluate the knowledge of stakeholders (defined as fishers/industry) with whom they have come into contact. These findings are reported in Tables 4 and 5.

Overall, fisheries scientists considered the resource users they work with to be modestly or highly knowledgeable. Interestingly, they ranked fishers and industry to most likely be "extremely knowledgeable" about gear and gear usage, factual knowledge about fish species and local custom and practice. However, seven respondents also ranked the knowledge of fishers and industry about the ecosystem as "four" or better. At the same time, only four respondents ranked fishers' and industry knowledge of "science in general" as "four" or better.

The Kahoot survey results suggest that fishers, the fishing industry and other scientists are considered to have generally good knowledge in relation to scientists' research areas while ENGOs are credited with relatively poor knowledge about their (the respondents') specialty. Perhaps the most surprising result of the Kahoot survey is that more participants in this survey ranked "fishers/industry" knowledge with respect to their own specialty as "generally good" (45%) than ranked the knowledge of other scientists (41%), fisheries managers (39%), or NGOs (25%) as "generally good." On the other hand, 77% ranked NGO knowledge as "generally poor" (29%) or "so-so/uneven" (48%).

Respondents answering the on-line survey were asked in an open-ended question (on-line survey, Q 30) to specify what they would like to learn from stakeholders. This can suggest the kind of knowledge that scientists think stakeholders can provide. Of the 13 respondents included in this analysis, 12 provided an answer. Most were interested in knowledge about species and the environment (such as the location, distribution and availability of

Table 4. Scientists' ranking of the knowledge of other groups (on-line survey).

Q 14. In general do you consider the stakeholders (fishers/industry) you work with/come into contact with to be knowledgeable? Please rank your perception of their general knowledge in the following areas:							
Area	**1 (little or no knowledge)**	**2**	**3**	**4**	**5 (Extremely knowledgeable)**	**Not applicable**	**Total**
Science in general	2	2	5	4	0	0	13
Your research	1	4	4	4	0	0	13
Factual knowledge about fish or other marine species (e.g. species identification, location, migration, etc.)	0	2	1	3	7	0	13
The ecosystem, nature	2	1	3	6	1	0	13
Gear and gear usage	0	0	2	0	10	1	13
Laws and regulations	0	1	2	3	6	1	13
Local custom and practice	0	1	2	2	7	1	13
Community custom and practice that affect fishing or marine conditions	0	1	2	3	6	1	13
Other fishers	0	2	0	5	5	1	13
Industry/market	0	1	2	5	4	1	13

Table 5. Scientists' ranking of the knowledge of various groups (Kahoot Survey).

_____ 's knowledge of my area/specialty/profession is. . ..							
Group	**Generally poor**	**Generally so-so/uneven**	**Generally good**	**Not applicable**	**Total responses**	**No answer**	**Registered**
Q 6. Fishers/industry	9	13	20	2	44	7	51
Q 7. Scientists	6	16	19	5	46	5	51
Q 8. NGOs	13	21	11	2	47	4	51
Q 9. Fisheries managers	7	23	17	0	47	4	51

species, and trends and changes in species or the environment), the practice of fishing (such as rates and causes of bycatch, rates and causes of accidents, fishing dynamics, and general experience), the impact of regulations or some mixture of these.

Certainly these answers depend very much on individual experience and research field but the specific responses given suggest that these scientists have identified a mixture of knowledges that the industry and fishers could provide. This in turn suggests recognition of and respect for the on-site or otherwise specific knowledge that stakeholders can offer. It also suggests willingness to accept input from sources that are not, strictly speaking, scientific in nature.

Trust and respect

The on-line survey explicitly asked respondents to report on the trustworthiness of various groups (on-line survey Qs 16–20); both the Kahoot and the on-line surveys asked respondents to characterize various groups with respect to specific aspects of and actions related to trust, such as the impartiality of scientists and fisheries managers and the honesty of stakeholders in reporting data (Kahoot Qs 16–18; on-line survey Q 22), whether scientists experience interference with or sabotage of their work (on-line Q 23; Kahoot Q 24) and whether a given group is actually open to the input of others (Kahoot Qs: 12–15).

Using a scale from 1 (very little) to 5 (very much), the 13 natural science respondents ranked the trustworthiness of these stakeholders as "3" or better; and 8 (62%) ranked them at "4" or better (on-line survey, Q 17). The group was on the whole more skeptical with respect to environmental NGOs (only 2, or 15%, ranked ENGOs as "4" or better) (The few industry/fisher respondents ranked the trustworthiness of ENGOs lower than did scientists: half ranked their trustworthiness as "1"; the average of score was 1.75.). With respect to the degree to which they believed that stakeholders considered the respondents themselves to be trustworthy, all ranked this at "3" or better, and 9 at "4" or better (on-line survey, Q 18). Asked specifically whether they felt that fishers respected them (personally) (on-line survey, Q 21), most (8 of 13, or 62%) scored this as "4" or better. This pattern shifts somewhat with respect to the degree that scientists feel that stakeholders respect "'scientists' in general" (on-line survey, Q 19): here the majority answer (7 of 13 or 54%) is a lower score of "3". Discussions with scientists in preparation for this survey brought up the question as to whether respect for science among lay people has actually decreased over the years. Of the sample group of 13, none reported a decrease in respect for science and the great majority (9 of the 13 who answered this question) answered that respect has increased over the years. Because the on-line survey was designed first and foremost to investigate science-stakeholder relationships, science respondents were not asked whether they felt that ENGOs trusted them. This was unfortunate because, as it turns out, the relationship between scientists and ENGOs is one of the most troubled of those investigated.

The issue of the reputation of ENGOs was shown in sharper relief by the Kahoot survey (Table 6). Participants were asked whether various groups are open to suggestion/help/criticism from others.

This mixed audience selected NGOs as the least open to external input, with 46% (21 of 46) of respondents answering that NGOs are not open at all to external input and 37% (17 of 46) selecting "sometimes" as the best characterization. Still, the most

Table 6. Mixed group's assessment as to how open scientists, environmental NGOs, fisheries managers and fishers are to suggestion, help or criticism from others (Kahoot survey).

	Answer choices						
Question	**No!**	**Sometimes**	**Frequently**	**Usually**	**Total answers**	**No answer**	**Registered**
Q 12. Are scientists open for suggestions/help/criticism from non-scientists?	6	24	5	11	46	5	51
Q 13. Are environmental NGOs open to suggestion/help/criticism from others?	21	17	4	4	46	5	51
Q 14. Are fisheries managers open to suggestion/help/criticism from others?	5	26	7	6	45	7	51
Q 15. Are fishers open suggestion/help/criticism from others?	9	30	4	4	47	4	51

popular answer with respect to all categories (except NGOs) was "sometimes", suggesting that the broadly shared perception of at least some barriers among all of these groups is correct. Again, the audience was a mixed group and responses for any single category are a mix of perception of one's own group as well as assessments of other groups. Still, it may be significant that scientists and fisheries managers were judged to be more open to suggestions and criticism compared with NGOs and fishermen; it is equally interesting that a large majority of answers with respect to all groups ranked fell into the category of "no" or "sometimes".

The Kahoot group was also asked to rank the fairness and honesty of the various groups (Qs 16–18). A total of 68% responded that scientists are "usually" and "frequently" "objective and impartial in their work"; 31% reported that that fisheries managers are "frequently "and "usually ""fair and impartial in their judgments and applications of rules". Only 11% thought "stakeholders" (i.e. fishers and the fishing industry) are "frequently" honest about "reporting data and information even if it is not to their advantage"; none choose to characterize stakeholders as "usually" honest in this respect.

Both the on-line survey and the Kahoot survey asked whether scientists had experienced any interference with their scientific work (on-line Q 23; Kahoot Q 24). About half (46 and 51%, respectively) reported that they have never witnessed or suffered from the deliberate obstruction or sabotage of scientific research, while about 20% indicated first-hand knowledge of one or more significant episodes (15 and 24%, respectively).

Discussion

There are many documented instances of contact between fisheries scientists and lay people that have yielded poor and even hostile relationships; these have had good coverage from the critical literatures and are fairly common in writings on fisheries (see e.g. Finlayson, 1994). The two scientists who inspired this study; however, have developed good relationships with many local people and these have contributed to the improvement of knowledge building about fisheries and fish species; the broad commitment to participatory management is built on the assumption that building this kind of social capital is possible. This study suggests that much contact takes place. What might turn contact into the trust and respect that constitute social capital?

One key variable in building good relationships with local lay people may be time spent by the scientist in the field. The two scientists who inspired this work collect field data, spending at least 3–4 weeks on site or on the water each year, and have done so for many years. These scientists have a track record in the area and a long term commitment to it; key lay people have had time and opportunities to get to know them, and to collaborate with them on projects. Most respondents who answered the on-line survey, however, did not fit the description of the idealized field biologist. Of the 13 who answered the on-line survey, only 2 spent as much as 3–4 weeks in the field on average over the last 3 years, while 8 spent a week or less in the field. The two who did spend 3–4 weeks in the field have worked for over 10 years in their areas. They varied slightly in their estimations of stakeholder (fishers/industry) knowledge, with one ranking this at about the study's average over the 10 categories (see Table 4) and the other scoring stakeholder knowledge slightly higher. They differ more substantially from each other, however, with respect to trust. One reported a high level of trust (score of 5) with respect to stakeholders, did not think that stakeholders withheld information and had never experienced sabotage of his work; the other was more skeptical about stakeholders (score of 3), reporting incidents of minor obstruction of his work and stating that stakeholders frequently withhold information.

Meaningful conclusions cannot be drawn from two responses but these two do suggest that while time on site may be helpful in building relationships, it is unlikely to be enough. For example, the type of work done and whether it responds to local concerns or is directly related to management decisions may have much to do with how "honest" a lay person—such as a fisher or industry representative—might be. In addition, as Dankel *et al.* (2015) have pointed out, scientists may have multiple roles in the management process and these are likely to change over the course of their careers; these experiences will colour contacts and influence opinions on both sides. Future studies would have to capture much more clearly the background of the scientists, the kind of work they do, their role in the management process, and how and in what capacity they come into contact with lay people; it will also be important to contextualize the work (e.g. the general status of the resource and the history of fisheries management of the area). Clearly, if the intent is to understand the way that field fisheries biologists relate to local lay people, a larger sample of field biologists is required.

It should be noted, however, that local lay people with whom a scientist comes into contact may not fit the classic LEK image. Murray *et al.* (2006) suggest that LK is in transition and even at the local level is progressively less tied to the highly local contexts and culturally distinctive ways of knowing that the first generations of LK and LEK literature sought to capture (Stephenson *et al.*, 2016). In addition, the recent work by Macdonald *et al.*, 2015 shows that attitudes and values (including those relating to

science) can vary greatly within groups, with some resource users very much open to the scientific approach. A future study should allow for more precision in identifying the characteristics of lay communities (e.g. size, how rural and isolated, how dependent on fisheries, etc.) and individuals (e.g. background, education, profession, and social position) with whom the scientist is interacting, what information she is providing, what form that information takes and the circumstances under which the information is provided.

On-site data collection in the "field", however, represents only a small part of the whole of "fisheries science". Most respondents to the survey spent less than a week a year in the field (8 of 13 respondents to the on-line survey) and these report most contacts at the "national" or "international" rather than the "local" level. The knowledge of lay people operating at the national or international level may not easily be classified as "traditional", "local ecological", or "place-based"; however, some of it may still be classified as experience-based LK (as in Petts and Brooks, 2006). Those who are integrated into the cultural mainstream of western societies, who routinely work with regulatory bodies, who represent large companies or unions and whose work brings them into frequent contact with fisheries scientists may find it easier to talk to, provide information to and be taken seriously by scientists. They may even have scientific training: the boundaries between "scientist" and "lay person" can be very porous (Murray *et al.*, 2006).

Trust remains important at all these levels and in the full range of management contexts, but this study suggests that trust issues exist with respect to all of these. In the Kahoot survey, 89% (41 of 46 respondents) answered that, generally speaking, generic stakeholders are "never" or only "sometimes" "honest about reporting data/information even if it is not to their advantage." However—while the size and composition of the responding group do not allow the establishment of causal linkages – the results of the on-line survey do mildly suggest that respondents characterize "stakeholders you work with" as more trustworthy and knowledgeable than are stakeholders in general. There may also be a connection between knowing stakeholders or lay people and respect for their knowledge. Many found the "stakeholders" they work with (identified as "fishers and the fishing industry", on-line survey Q14) to be very knowledgeable in many areas, although not in all, but there is a large variation of answers within each category. Similarly, scientists report that resource users influence their research objectives, research design and plan, and hypotheses but there is also significant variation within these categories. Establishing more precisely which stakeholders the scientist is describing and how long the scientist has known them, in what capacity, how often they interact and the relationship between these variables and levels of trust and respect should also be a part of a future study.

These general issues extend to the fisheries management community in general. These exploratory surveys suggest that fisheries scientists are more consciously skeptical of the knowledge of ENGOs than of that of stakeholders. Generic "fisheries managers" do not come out much better: in the Kahoot survey, 69% (31 of 45) responded that fisheries managers were not or were only sometimes "fair and impartial in their judgments and applications of rules". Perhaps the most surprising finding was turned up by the Kahoot survey. In a room full of professionals dedicated to many facets of fisheries management, only 36% (17 of 47) respondents characterized fisheries scientists in general as "frequently" "objective and impartial in their work" and only 32% (15 of 47) selected "usually". The consensus of the literature may be that trust is an essential element for good management and the successful exchange of knowledge, but trust still seems too thin on the ground.

In the symposium session, and on-line and Kahoot surveys, few scientists displayed the arrogant attitude towards LK sometimes ascribed to "scientists" in the literature. In interviews conducted in preparing the questionnaires and in corridor talk after the symposium presentation, however, some fisheries scientists stated that they have witnessed such arrogance on the part of other scientists. Whether scientists are perceived by lay people as arrogant is a question for lay people to answer, a point which highlights the fact that the voices of lay people are missing from this study. They would have to be a part of a comprehensive study of trust and respect for LK.

This study leads to many additional questions. The on-line questionnaire did not allow respondents to characterize the knowledge they valued from resource users as experiential or scientific or some mixture of the two. It also did not permit the identification of which kind of LK finds its way into scientific work and to what degree, or for identifying how, when and why this influence takes place. Similarly, the study uncovers reports of obstruction and sabotage but does not allow for clarification as to how respondents define "obstruction", "sabotage", or "significant incidents" and for identifying exactly who they believe to be responsible for these. Are these euphemisms for withholding or misreporting data or something more?

Altthough the surveys reported here capture some general views about groups such as "scientists", "ENGOS", "Fisheries Managers", and "fishers/industry", a future survey should be designed to break down these categories and perhaps to develop better terminology or categories. As suggested above, the categories used obscure the differences within groups and the possible overlaps among them. People with scientific backgrounds may work for NGOs, industry, unions, and fishers' organizations. Interest organizations and resource users may employ science themselves through the direct financing of research, hiring their own researchers, reading the literature, participating in consultative processes that produce "calls" for research, and by gathering evidence in attempts to challenge management decisions.

In addition, the meaning of the term "stakeholder" is at once disputed and vague. Although the surveys placed this term in context (frequently specifying that this meant "fisher/industry" or "resource user") and the meaning of the term was explained during the interactive session, a better strategy is to drop the term in favour of one that is less contested and more precisely defined

Future work in addressing these issues will require a mixed-methods approach (e.g. Haggan *et al.*, 2007; Moses and Knutsen, 2012; Hind, 2015). The broad pattern of interactions among the key actors of fisheries management community may well be mapped by a larger, more nuanced survey that focuses on particular categories of scientists and resource users, with a larger and more targeted sample. A large-scale survey might also focus more on the kind of knowledge exchange that takes place and under what conditions. However, grasping the relationships and mechanisms of knowledge exchange and trust building among key actors may best be done through extended interviews, ethnographic studies, workshops and the observation of interaction between scientists and lay people in a variety of settings.

Conclusion

Although much literature suggests a hostile relationship between scientific and lay communities, the division between these two broad communities is not as sharp as may be supposed. Interaction between the two communities does take place, and sometimes on positive and mutually beneficial terms. LK can be absorbed into the scientific world in a variety of ways, including through both formal and informal contacts. It can cascade through the system, informing the scientific process from the bottom up. Different types of research and different research settings can mean that the ways in which this happen can differ. The nature and extent to which this happens requires a highly contextual study of the practices of fisheries science, that is, fisheries science as a social activity. Readers are invited to share their experiences with the authors.

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Appendix A: On-line survey questions

The on-line survey contained 45 questions. The questions from the core questionnaire for scientists are reported here.

1. In your research, have you engaged with stakeholders (aside from scientific communities) such as direct resource users or NGOs?
2. What kind of stakeholder do you engage with?
3. In your research, have you engaged with/do you engage with other community actors (other than referred to in question 2, above)?
4. Are these primarily local, national or international?
5. Are stakeholders (e.g. fishing industry or fishermen) a part of your research project(s) as official partners or as members of an advisory/consultation board?
6. Do you participate in a project that has the explicit objective of collecting stakeholder knowledge? Here we are talking about experience-based knowledge (from work, life experience, and interaction with nature) rather than research-based knowledge.
7. On a scale of 1–5, where 1 = no influence and 5 = 100% influence, how much do stakeholders (fishers, industry) influence your research on average?
8. What sources does your research funding come from?
9. Have stakeholders such as the fishing industry and/or interest organizations financed your research in part or entirely?
10. Do stakeholders (e.g. fisher, industry) influence your research objectives, hypotheses, design and/or plan(s)? Select as many as apply.
11. Do stakeholders help in carrying out your research in a formal or informal way? (select as many as apply)

12. If you answered yes to question 11, how frequently do stakeholders assist in your research? Please tick the relevant boxes.
13. Have your experienced spontaneous, unexpected or unscheduled help from fishers or industry?
14. In general, do you consider the stakeholder (fishers/industry) you work with/come into contact with to be knowledgeable? Please rank your perception of their general knowledge in the following areas: (i) science in general; (ii) your research; (iii) factual knowledge about fish or other marine species (e.g. species identification, location, migration, etc.); (iv) the ecosystem, nature; (v) gear and gear usage; (vi) laws and regulations; (vii) local custom and practice; (viii) community custom and practice that affects fishing or marine conditions; (ix) other fishermen; (x) industry/market.
15. In general, do you consider the NGOs you work with to be knowledgeable? Please rank your perception of their general knowledge in the following areas: (i) science in general; (ii) your research; (iii) factual knowledge about fish or other marine species (e.g. species identification, location, migration, etc.); (iv) the ecosystem, nature; (v) gear and gear usage; (vi) laws and regulations; (vii) local custom and practice; (viii) community custom and practice that affects fishing or marine conditions; (ix) other fishermen; (x)) industry/market.
16. Do you have social or professional contact with these stakeholders outside of of a specific research setting?
17. On a scale of 1–5, where 1 is very little and 5 is very much, please rank how trustworthy the stakeholders you work with are, generally speaking.
18. On a scale of 1–5, where 1 is very little and 5 is very much, please rank how trustworthy you think stakeholders consider YOU to be (That is, do you feel they trust you?)
19. On a scale of 1–5, where 1 is very little and 5 is very much, please rank how trustworthy you think stakeholders consider "scientists" in general to be?
20. On a scale of 1–5, where 1 is very little and 5 is very much, please rank how trustworthy environmental NGOs are, generally speaking.
21. Do you feel fishers respect you?
22. Do you think stakeholders withhold important information/data from you?
23. Have you ever experienced interference with or sabotage of your research?
24. If you are working on a research project, was stakeholder or SME involvement required by your grant?
25. If you are currently engaged in a research project, did you bring into the project stakeholders or NGOs that you knew previous to starting the project?
26. Have you participated in the presentation of a research project or its results to stakeholders or the relevant community?
27. If your answer to question 26 was yes, do you feel this was a useful and positive experience?
28. Have you participated in any teaching activity aimed at the local community?
29. Is stakeholder (e.g. fisher/industry) involvement in your research on the whole: (i) positive or (ii) negative?
30. What can you learn/would like to learn from stakeholders, especially end resource users such as the fishing industry or fishermen? (open question)
31. Are you willing to collaborate with stakeholders or involve them in future research?
32. Are you willing to work with NGOs in the future?
33. Have stakeholders' view of "science" changed over time (your perspective)?
34. Where do you work?
35. What do you consider to be your discipline? (open question)
36. What is your primary work? Describe briefly (open question)
37. What kind of ecosystem do you work with primarily? (i) coastal, (ii) sea, (iii) fjord, (iv) other
38. How much time, on average (per year) have you been engaged in "field" research (that is, research in which you personally collect samples, participate in research cruises, tag fish, or similar activities) over the last 3 years?
39. How long have you been employed in your present position?
40. How long have you done research in your current geographic area/species?
41. Number of years as a professional since graduation/degree
42. What is your age?
43. What is your educational level?
44. I feel this questionnaire captured interaction with stakeholders: (rank from 1 to 5 with 1 = poorly and 5 = well).
45. If you have comments about this questionnaire, we welcome your feedback! Please use this space to comment on the clarity or applicability of the questions, what you feel is missing, etc. (open question).

Appendix B: The Kahoot real-time survey

The Kahoot programme allows for a total of 25 questions and limits the length of questions to 95 characters and the possible answer choices to a total of four. Each answer may contain up to 60 characters.

1. Do stakeholders help researchers carry out their research in a formal or informal way?
Answer choices: yes, no
2. If yes, was the provision or collection of data?
Answer choices: never, seldom, a few times, many times
3. If yes, was this the provision of equipment or transport?
Answer choices: never, seldom, a few times, many times
4. If yes, was this advice on placement of sampling or monitoring equipment?
Answer choices: never, seldom, a few times, many times
5. If yes, was this helping to monitor or keep track of equipment as a favour?
Answer choices: never, seldom, a few times, many times
6. Do stakeholders (resource users) influence the development of research questions/hypotheses?
Answer choices: never, sometimes, often, usually
7. Do fisheries managers influence the development of research questions/hypotheses?
Answer choices: never, sometimes, often, usually
8. Do environmental NGOs influence the development of research questions/hypotheses?
Answer choices: never, sometimes, often, usually
9. Do scientists have casual/informal contact with stakeholders (fishers/resource users)?
Answer choices: never, sometimes, often, usually
10. Do scientists share and explain their work with local people outside of formal meetings?
Answer choices: no, never; yes, sometimes; yes, frequently; don't know/can't answer

11. Who do you work most closely with?
Answer choices: stakeholder/resource user, scientists, NGOs, fisheries managers
12. Are scientists open for suggestions/help/criticism from non-scientists?
Answer choices: no!, sometimes, frequently, usually
13. Are environmental NGOs open to suggestion/help/criticism from others?
Answer choices: no!, sometimes, frequently, usually
14. Are fisheries managers open to suggestion/help/criticism from others?
Answer choices: no!, sometimes, frequently, usually
15. Are fishers open to suggestion/help/criticism from others?
Answer choices: no!, sometimes, frequently, usually
16. Scientists are usually objective and impartial in their work.
Answer choices: no way!, sometimes, frequently, usually
17. Stakeholders are honest about reporting data/information even if is not to their advantage.
Answer choices: never, sometimes, often, usually
18. Fisheries managers are fair and impartial in their judgments and applications of rules.
Answer choices: not at all!, sometimes, often, usually
19. Fishers/Industry knowledge of my area/specialty/profession is . . .
Answer choices: generally poor, generally so-so or uneven, generally good, not applicable
20. Scientists' knowledge of my specialty/area/profession is . . .
Answer choices: generally poor, generally so-so or uneven, generally good, not applicable
21. Environmental NGO knowledge of my specialty/area/profession is . . .
Answer choices: generally poor, generally so-so or uneven, generally good, not applicable
22. Fisheries managers' knowledge of my specialty/area/profession is . . .
Answer choices: generally poor, generally so-so or uneven, generally good, not applicable
23. I feel that my counter-parts respect me . . .
Answer choices: little, generally speaking; really depends; rather much, generally speaking
24. I have witnessed or suffered from the deliberate obstruction or sabotage of scientific research.
Answer choices: never, some small stuff now and then, one or more significant episodes, stuff happens all the time
25. What kind of ecosystem are you most engaged with?
Answer choices: Coastal, sea/ocean, fjord, other