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Quo Vadimus

Integrating fishers' knowledge research in science and management

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Fishers' knowledge research (FKR) aims to enhance the use of experiential knowledge of fish harvesters in fisheries research, assessment, and management. Fishery participants are able to provide unique knowledge, and that knowledge forms an important part of "best available information" for fisheries science and management. Fishers' knowledge includes, but is much greater than, basic biological fishery information. It includes ecological, economic, social, and institutional knowledge, as well as experience and critical analysis of experiential knowledge. We suggest that FKR, which may in the past have been defined quite narrowly, be defined more broadly to include both fishery observations and fishers "experiential knowledge" provided across a spectrum of arrangements of fisher participation. FKR is part of the new and different information required in evolving "ecosystem-based" and "integrated" management approaches. FKR is a necessary element in the integration of ecological, economic, social, and institutional considerations of future management. Fishers' knowledge may be added to traditional assessment with appropriate analysis and explicit recognition of the intended use of the information, but fishers' knowledge is best implemented in a participatory process designed to receive and use it. Co-generation of knowledge in appropriately designed processes facilitates development and use of fishers' knowledge and facilitates the participation of fishers in assessment and management, and is suggested as best practice in improved fisheries governance.

Keywords: collaborative research, cooperative research, fishers' knowledge research, integrating fishers' knowledge, local knowledge, participatory research, stakeholder involvement.

The recent article by Hind (2015) provided an important historical account of "fishers' knowledge research" (FKR) including designation of "waves" in the development of research approaches and traditions related to the study of fishers' knowledge. It is good to see the attention to this important topic and the effort to both evaluate the historical development of the research area and to assess the level of inclusion of fishers' knowledge in mainstream fisheries science (and management).

As an interdisciplinary group of researchers who have been studying the science–policy interface and trying to facilitate the

inclusion of fishers' knowledge in science and management in Europe, Canada, and Australia, we take the opportunity to further the discussion Hind (2015) started along three lines. We suggest: (i) It is important to dispel any false dichotomy that "FKR" is very separate from "established approaches" to fisheries science, (ii) There is more to FKR than meets the eye, including some relevant work that has integrated fishers knowledge, but that can be missed if "FKR" is defined narrowly, and (iii) Recent examples of the integration of fishers' knowledge provide evidence of an emerging path forward for this important topic. In this paper, we expand on each of these points and discuss current research initiatives that aim to integrate FKR in the science and management processes.

A false dichotomy re: "FKR"

Hind (2015) defined FKR as "the study of the experiential knowledge . . . that fish harvesters accumulate while operating in their respective fisheries", and stated that "those who seek in different guises to achieve greater consideration for this experiential knowledge in mainstream fisheries science and management can be considered fishers' knowledge researchers". While this is an appropriately broad definition and context, the Hind paper goes on to focus primarily on a subset of social science-dominated research that specifically defines itself as FKR, and pits that research against (or in contrast to) "mainstream fisheries science". This creates a false and counter-productive dichotomy. It is true that a subset of FKR includes work that is highly critical of mainstream fishery science, particularly in the early stages (Hind's second and third waves of FKR). We note, however, that this is not a comprehensive assessment of the field, and particularly not of the approaches that currently dominate. While some FKR in the subset referenced by Hind has failed to be embraced by contemporary fisheries assessment and management processes, others have been more fully integrated (see below). Through a narrow literature search, Hind has inadvertently come to emphasize a divide that we contend has been addressed in much recent research.

Central to the summary of literature presented by Hind (2015) is the impact of hard disciplinary boundaries in an "established" fisheries research and management system, dominated by natural science/marine ecology, that is, non-accepting of FKR. Fisheries science is, and always has been, an interdisciplinary field (Ricker, 1977; Cushing, 1988; Smith, 1994). It is true that, fisheries biology has dominated fisheries research and fisheries management activities over the past 50 years, with less attention paid to marine ecology, fisheries economics, and fisheries social science. While the inclusion of FKR may have been impeded by the disciplinary boundaries, we would argue that mainstream fisheries science and FKR are not two distinct entities or poles, but rather overlapping regions along a gradient.

There is more to FKR than meets the eye

Any literature search based primarily on the use of the words 'fishers' knowledge' and related variations (including fishers' ecological knowledge, fishers' data, localized knowledge, ecological knowledge) in the title and abstract (Hind, 2012, 2015) will not pick up a broad and increasing literature aimed at incorporating the experiential knowledge of fishers in research and management. What will remain hidden are many studies, both academic and applied, in which fishers have been interviewed for their institutional, technical, social, economic, or ecological knowledge, or those where they have been included in participatory research approaches. A search using keywords such as "participatory research", "collaborative research", "cooperative research", "joint research", "stakeholder involvement", and "fisheries and participation" (Table 1) will better capture the breadth of relevant studies encompassing fishers' knowledge in (applied) research.

Table 1. A comparison of the prevalence of keywords used by Hind (2015; top) vs. those proposed in this paper (bottom) in papers published by *ICES Journal of Marine Science* 1981–2015.

	Title/abstract/text		Title/abstract only	
	Occurrences		Occurrences	
Keyword/keyphrase	1981–2004	2005–2015	1981–2004	2005–2015
Fishers' ecological knowledge	1	4	0	0
Localized knowledge	2	6	1	1
Fishers' data	0	13	0	2
Ecological knowledge	4	30	2	3
Fishers' knowledge	0	32	0	7
Total	7	85	3	13
Observations from the fishery	1	1	1	0
Participation by fishery	0	3	0	1
Participation by industry	1	5	1	0
Participatory research	0	6	0	2
Stakeholder involvement	1	22	2	3
Collaborative research	4	24	0	0
Joint research	4	45	1	2
Fishery-dependent data	0	49	0	13
Cooperative research	60	340	0	1
Total	71	495	5	22

Integration of fishers' knowledge and FKR

It is important to define what one means by knowledge in discussing FKR. Knowledge has diverse aspects. There are differences between knowledge and expertise, and between the information and the process or context in which it is used (e.g. Hill *et al.*, 2010; Wiber *et al.*, 2012). In addition to readily observed attributes of fisheries, there is a wealth of tacit knowledge, which is possessed by fishers, fisheries managers, and scientists and well described in social science literature (Pálsson, 2000; Wilson *et al.*, 2006). Based on our experience, "science" and "fishers" knowledge' should not be considered in separate categories (Hind, 2015). We suggest that relevant fishers' information can, and should be, incorporated as part of the scientific basis of evaluation and management. Furthermore, it is important to identify opportunities for co-construction and collaboration in the use of knowledge, and to evaluate how these impact the way the resource is managed.

We contend that FKR has both a spectrum of knowledge/information and a gradient or continuum in the types and degree of integration of that knowledge in fisheries assessment and management (Figure 1). The *information* ranges from fishery observations to fishers experiential knowledge. The *integration* ranges from minimal represented by information sampled by others, through that provided by fishers or through collaborative arrangements, to knowledge gathered jointly in participatory governance regimes with the greatest integration. FKR therefore ranges from fishers providing information to scientists, to collaboration in research, through to governance regimes in which fishers both contribute knowledge and actively participate in research

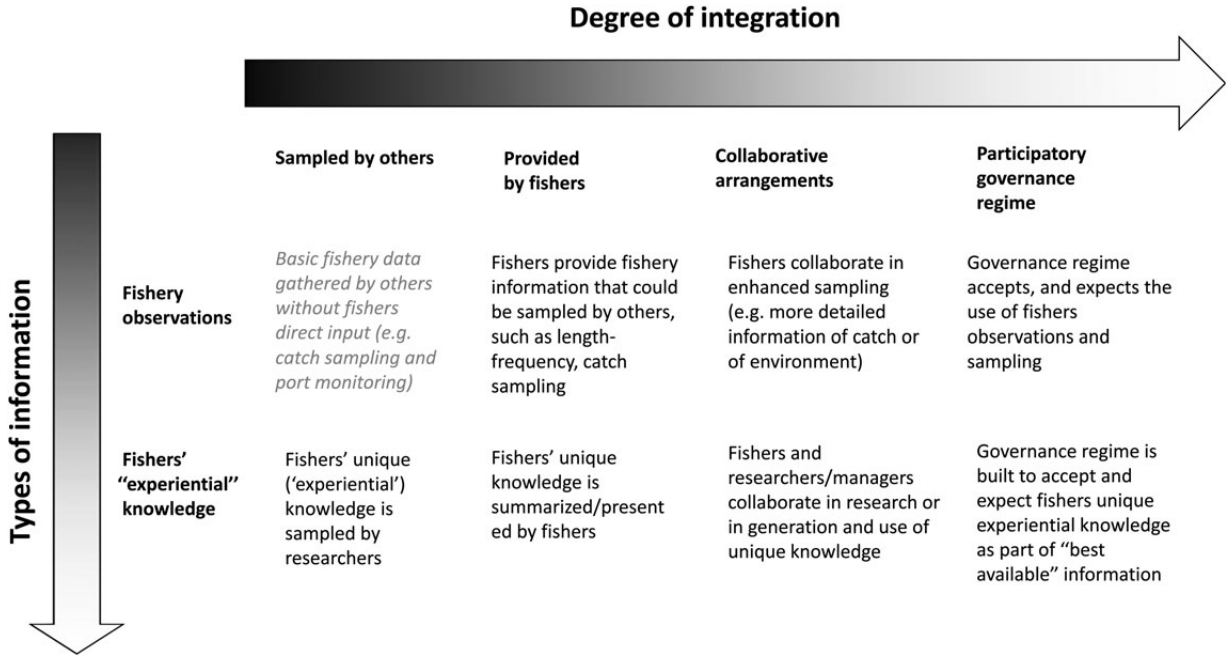

Figure 1. Spectrum of the types of contribution and degree of integration of fishers' knowledge in fisheries assessment and management. All but the italicized cell are considered examples of "Fishers Knowledge Research".

and management. In our opinion, only one cell in Figure 1 (basic fishery information sampled by others) is not part of FKR.

Examples of the diversity of FKR

There are many examples of the use of fishers' information. Armstrong *et al.* (2008) summarized contributions of the fishing industry to research through various forms of partnership, and inclusion of fishers information has been the subject of recent symposia, for example, the Second Symposium on Fishery-dependent Information (Rome, Italy, March 2014; Dörner *et al.*, 2014; see also Graham *et al.*, 2011), and the Symposium on Fishing Vessels as Scientific Platforms (Lima, Peru, April/May 2014; Melvin *et al.*, 2015). These demonstrate an increasing value placed on industry information, use of industry vessels as platforms, and great progress in the generation of "fishery-dependent" data. Examples of the acknowledgement of the importance of industry/fisher knowledge in achieving positive outcomes are demonstrated in the discussion of co-management models in Australia (Neville *et al.*, 2008; Hollamby *et al.*, 2010). While all of these fit the broad definition of integrating the experiential knowledge of fishers into research and management, they differ in the degree of fishers' participation from the use of fishing industry' information to collaboration (working together) to co-constructed projects (in which research is conceived, designed, and implemented jointly).

There is increasing interest, internationally, in the use of experiential knowledge and to more collaborative or participatory research and governance arrangements. This is illustrated, for example, by recent collaborative networks established specifically to foster more participatory approaches, to define priority research questions, and undertake research aimed at improving the contribution of fishers' knowledge to science and management. The GAP2 project (http://gap2.eu/) includes 13 fisher-science partnerships across 11 countries in Europe designed to demonstrate the role and value of stakeholder participation in research within the context of fisheries governance (Kraan *et al.*, 2013; Mackinson and Wilson, 2014; Stange *et al.*, 2014; Holm *et al.*, in preparation). The Canadian Fisheries Research Network (CFRN, http://www.cfrn-rcrp.ca/Public-Home-EN) has linked members of the fishery with academics and government scientists and managers in collaborative research projects around questions of critical importance to industry and management across Canada. The network will be identifying best practices for generation and integration of fishers' knowledge, including the importance of close collaboration in construction ("co-construction") of the research projects. The Australian Fisheries Research and Development Corporation (FRDC)—a government statutory authority—has established a number of Industry Partnership Agreements (IPAs; http://frdc.com.au/research/applying_funding/Pages/other_fund_mechanisms.aspx) that explicitly acknowledge the extensive knowledge retained in the industry. FRDC also acknowledges the increasingly evident importance of industry and fisher buy-in and ownership of research to achieve adoption and uptake.

Collaborative development of knowledge (or development of common knowledge; Schwach *et al.*, 2007) changes the focus from a unidirectional relationship—taking something from fishers and fitting it into use in the science and management domain—to a two-directional relationship. In this regard, knowledge is understood as a co-construction between researcher and respondents, which is different from an approach where knowledge, usually in the form of data, can be "collected". In a co-constructed process, science itself becomes scrutinized for its credibility, legitimacy, and saliency (Cash *et al.*, 2003). The increased transparency that cooperation brings also improves the quality of science (and scientific practices). Participation in research and the provision of critical information is a major pathway to participation in, and acceptance of, fisheries assessment and fisheries management (e.g. Stephenson *et al.*, 1999).

Fisheries organizations are increasingly hiring scientists to help them organize their own data-collection as well as help them in participatory settings with science (Peterman, 2009), and we predict that this will become a trend.

Opportunities for improving the integration of fishers' knowledge?

The incorporation of fishers' knowledge has been a theme going back decades. Fishers working on the water, for much if not the entire year, have a stronger presence in the marine environment than academic or governmental researchers. Fishers also have an impressive amount of contextual and experiential knowledge about the social and ecological system of which they are a part. This extends beyond target species to the ecosystem, and includes diverse social, economic, and governance aspects of the fishery and of human behaviour in the fishery. The issue and challenge is how to best incorporate the presence, experience, and knowledge in understanding and managing the system.

Fishery assessment and management are changing. The fishery is increasingly recognized as a "system" with ecological, economic, social, and institutional aspects that require integrated, interdisciplinary (or transdisciplinary) approaches and a more participatory governance structure (for example, as put forward in the definitions of ecosystem-based fisheries management by Long *et al.*, 2015, and in the concept of "Fisheries Management Science" by Stephenson and Lane, 1995). Decision-making for a fishery system requires diverse types of information and methods to support both tactical and strategic decisions that must be integrated across multiple spatial and temporal scales. This demands a blending of "best information" from fishers, scientists, and management. The unique contribution of fishers' experiential information is emphasized in this context, and is critical to evaluation and management (it is part of "best available information"). So too is fishers' participation, which is required throughout the process. This demands a legitimate, participatory governance structure (Kooiman *et al.*, 2005). Research on the science–policy interface shows how the issues of credibility and legitimacy of the knowledge base that feeds management decisions are paramount (Brooks, 2010; Dankel *et al.*, 2012; Pascoe *et al.*, 2013; Röckmann *et al.*, 2015; Holm and Soma, 2016).

Past projects and recent networks have done much to try to define best practice and to show proof of concept with respect to fishers' knowledge. There has been considerable progress in including fishers' information (especially biological information) and of making it useful in "mainstream" research and assessments. Past work has largely been about making the information fit the prevailing scientific process including development of acceptable protocols to ensure the credibility of information, but there has also been progress towards modifying fisheries assessment and management systems to accept this valuable and important information (Stephenson *et al.*, 1999; Greiner *et al.*, 2012; Stange *et al.*, 2014).

As mentioned previously, it is important that fishers' knowledge not be appropriated as researchers' knowledge, but is integrated respectfully. In our experience, there is a legitimate fear that research may be labelled "participatory", but fishers' participation remains minimal (e.g. Silver and Campbell, 2005). Even where participation is good, transfer of knowledge does not always seem to happen effectively (Rice, 2005). Our recent networks and collaborations have been studying how to move this forward, not only in terms of generating fishers knowledge for existing processes, but especially in the area of changing the process/governance to allow more interdisciplinary, co-constructed research through participatory processes. While there is no single recipe, the process of collaboration in interdisciplinary (or multidisciplinary) approaches to fishery evaluation and management including appropriate social and economic methodology is key. It is not trivial to integrate diverse academic disciplines (see, for example, Jacobsen *et al.*, 2011; Phillipson and Symes, 2013) and constituents (industry, academics, and government)–but it is a necessity and the development of guidelines and best practice for participatory research remains an important area of investigation (e.g. Mackinson *et al.*, 2011; Mackinson *et al.*, 2015). There is certainly a need to better engage and include the experiential knowledge of fishers. While this has been recognized for some years as a strategic gap in fisheries science and management, there is some urgency now with the needs of more comprehensive evaluation consistent with an ecosystem approach. Knowledge, including personal skills and tacit knowledge, and information is at the core of both assessment and management. Until recently, the primary industry information has been ecological data used for stock assessment, but management requires more and different information as a result of evolving emerging holistic approaches. Much of this new information relates directly to the experience of the fishery and social/economic aspects, and is therefore best or even uniquely provided by fishery participants. Such approaches are increasingly being undertaken in the development of fisheries management plans in Australia through the inclusion of social objectives as negotiated with fishers, in the pursuit of ecologically sustainable development-based outcomes for fisheries management (Brooks *et al.*, 2015). Similarly, in Europe, there is increased attention in broadening the disciplinary basis of ICES advice (e.g. "integrated" ecosystem advice; Dickey-Collas, 2014, and more recently the Strategic Initiative on Human Dimensions; http://www.ices.dk/community/groups/Pages/SIHD.aspx).

A large part of the problem of incorporating FKR has been that established processes of governance seemed unable or unwilling to incorporate it. There is a spectrum of issues. The issues surrounding the benefits and weaknesses of fishery-dependent vs. fishery-independent information are quite well described in the literature (e.g. Graham *et al.*, 2011). This literature has demonstrated that collaborative approaches have overcome traditional issues of data quality, survey design, and potential biases in sampling. Information previously obtained by a third party, such as an "observer", can be more effectively contributed directly by fishery participants, thereby moving the fishery to the right in Figure 1. A more significant issue in our view is that much of the FKR to date has been academic work whereas much of the government processes–fed by applied research–have been more exclusive of fisher knowledge. The capacity to sample, analyse, and synthesize information is heavily biased in many jurisdictions towards collection and analysis of standard ecological information, and there is insufficient capacity or methodological experience to adequately collect and present fishers' knowledge. Development of a capacity to enhance the historically social science work–of surveying, triangulating, ensuring representativeness and informed consent, collating, and analysis–is a substantial undertaking which initially will require considerable time, financial, and expertise resources. We suggest that this is an important issue to resolve. Management decisions are becoming more complex, as there is the need to balance many different concerns of multiple uses of marine resources and a changing environment, and active stakeholder participation is more widely accepted as necessary. Experience of the success of this

varies from one region to another, but it is increasingly apparent that potential problems such as conflict of interest and perception of bias are readily controlled, and the benefits outweigh the problems. Extensive experiments, which have been academically reported, with co-management and the integration and validation of fisher and industry knowledge and experience have been undertaken in Australia (Neville *et al.*, 2008; Hollamby *et al.*, 2010; Mazur, 2010), and although the level of success relative to the aspiration has been debated, the clear benefit of increased fisher and industry engagement is recognized. Further to this, and not reported in the academic, but existing in grey literature, is the success of integrating fisher knowledge in the co-construction of fisheries management plans (South Australian Management Plan for the Commercial Marinescale Fishery—Part B Management arrangements for the taking of Sardines, 2014; http://pir.sa.gov.au/__data/assets/pdf_file/0005/12776/Sardine_Management_Plan.pdf). Where fishers are involved (participatory processes), there tends to be more use of their information, knowledge, and experience. Rather than a linear process, in which knowledge is generated by experts in isolation and then fed into management, we see emerging governance solutions that are providing new arenas for co-creation of knowledge for management.

The inclusion of stakeholder knowledge as part of an "extended peer community" in science for policy has been underpinned in the literature under the concept of "post-normal science" (Funtowicz and Ravetz, 1993). Because science for policy is inherently uncertain, with high stakes and value judgements that affect data interpretation, it is necessary to have "... the inclusion of an ever-growing set of legitimate participants in the process of quality assurance of the scientific outputs "(Funtowicz and Ravetz, 1993, p. 752). These methods are transferable directly to fisheries science (Ulrich *et al.*, 2010; Dankel *et al.*, 2012; Röckmann *et al.*, 2012) and are being attempted, for example, in the ICES Working Group on Marine Systems (ICES, 2014).

Collaborative research and science/industry partnerships are capable of broadening the knowledge basis for management and are critical parts of emerging participatory management frameworks and instruments which are designed to receive, and to act on such knowledge.

Collectively, our projects point to the following conclusions:

- Fishers' knowledge is part of "best available information". Fishery participants are able to provide unique knowledge (information, perspective, sampling, and participation). It is obvious that any aspiration to manage using best available information should make the most of the information and experience of those closest to the fishery.
- FKR (although it may not always be called that in the literature) is part of the new and different information, and the interpretation of that information, required in evolving "ecosystem-based" and "integrated" management approaches. Mainstream processes (although still dominated by ecological objectives, and slow to change) are increasingly requesting integration of ecological, economic, social, and institutional considerations. FKR is a necessary element of this integration. At the same time, members of the fishery are increasingly interested and able to contribute, so there is both a push and a pull for the information.
- Fishers' knowledge includes, but is much greater than, fishery information (sometimes referred to as fishery-dependent information). It includes ecological, economic, social, and institutional knowledge, experience, and critical reflection on/analysis of experiential knowledge.
- Fishers' knowledge is not a single/discrete item, but part of a continuum of knowledge much of which is shaped by involvement/participation.
- Fishers' knowledge may be added to traditional assessment with appropriate analysis and explicit recognition of the intended use of the information, but fishers' knowledge is best implemented in a more participatory process better designed to receive and use it. Such a process would have to be designed to integrated diverse types of information.
- Co-generation of knowledge, in appropriately designed participatory processes, facilitates development and use of fishers' knowledge, and is suggested as best practice in improved fisheries governance.

There are several indications of both changing attitudes and changing needs and demands that should speed continued development towards incorporation of FKR. Management systems are beginning to value fishers' knowledge. Research funding is tight, so partnering is necessary to get value and efficiency and to allow (even encourage) information from the fishery. There is also increasing political expectation for collaboration and participation of civil society in matters relating to governance. Research funding institutions/agencies are encouraging/demanding collaborative approaches. We additionally expect that stakeholder participation in policy development and management will become essential for legitimacy of management processes. While many stakeholders will call for participation in management directly, they will still be expected to "earn their say"—which means showing that their input has value. Engaging in research and provision of information (data) will become the principle route to do this in a policy context of evidence-based decision-making. Management authorities will increasingly embrace collaboration, in part because they will be unable to do all that is expected of them to meet commitments, given the expanding nature of ecosystem-based and integrated management approaches and budgetary constraints. As collaborative approaches become more common, there will be a wave of interdisciplinary researchers and experience, so that FKR will increasingly become the norm. Such participatory research will develop "standards", and will deliver quality controlled, credible and more readily usable results for management.

Hind (2015) has done a considerable service in highlighting the importance of FKR in a paper that will reach a broad audience, but our diverse experience indicates that substantial progress has been, and continues to be made on integrating fishers knowledge into science and management. In this paper, we draw attention both to existing collaborative initiatives and an emerging path forward. We predict (and look forward to) a rapid increase in the incorporation of FKR through further emergence of collaborative, participatory research and management approaches.

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