Fisheries Science Collaborations:

The Critical Role of the Community

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Fisheries Science Collaborations: The Critical Role of the Community

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The present paper is based on a collation of information, through both a literature review and an internet search, on North American programs that involve some kind of scientific collaboration between fishers and fisheries scientists. It identifies four basic models of such collaboration and offers examples of collaborative activities that seem to fit into each of them. The first model defers to the expertise of the scientist for all major decisions and creates a strong programmatic distinction between what is science, and shall be done by scientists, and what are other, related activities that can be carried out by others. Various kinds of tagging programs, fisher advisory boards, at-sea research collaboration and many other activities fit this model. The second model, traditional ecological knowledge, recognizes that fishers have available to them a unique, local knowledge of the resource that can make a supplementary contribution to fisheries science. Several government, community and environmental groups are engaged in finding, recording and using this knowledge. The third model, competing constructions, sees collaborations on science as part of an ongoing contestation about the nature and condition of the resource that cannot help but be a part of and expresses the political and legal aspects of management. This is the model that most accurately describes the day-to-day activities of the various stakeholder groups that work with scientists. The fourth model, community science, is beginning to emerge through efforts at fisheries co-management. These programs involve aspects of the three other kinds of programs. They recognize and seek to incorporate the leadership of scientists, the importance of fisher's knowledge, and the inherently political nature of management-related fisheries science.

In many ways, science is the quintessential community effort. Admittedly, the word community does not evoke the mythos of the loan genius staying loyal to his (in the mythos) revolutionary insight until the rest of the world is finally convinced. Day-to-day science, however, is very much a community effort, and that is to say it is more than just a group effort. Science relies on a group with a culture, with shared values and behavioral expectations.

This need for community collaboration is a trait that science shares with fisheries management, which is an attempt to find ways for a group of people to sustainably share a resource. Robert Merton (1968), one of the founding figures in the sociology of science, identified four basic norms in science. The norm of community cooperation was the first. The other three were universalism (i.e., that claims of fact are subjected to preestablished, impersonal criteria), disinterestedness, and organized scepticism. Fisheries management does not share these other norms with science. The fisheries management community is made up of people that are interested by definition, often take truth claims very personally, and reserve much more scepticism for the motivations of other stakeholders than for the inferences they draw from their own observations of the management issue at hand.

Given these differences what does it mean for scientists to collaborate with other stakeholders in creating knowledge about the fisheries resource? This is the question this paper begins to address. The paper is based on a collection that I have made, both through a literature review and through an internet search, for North American programs that do some kind of collaborative fisheries science. The results cannot be taken as either comprehensive nor representative. Indeed, no central location lists these programs, and no resources were available for an extensive search. The collection was done in an opportunistic manner. Save where journalarticles are cited, the information collected is from either a program's own public literature, short correspondences with program officers, or electronically available newspaper reports. None of the in-depth interviews mentioned here were done specifically about the programs. One obvious empty spot is that only two programs involving indigenous peoples are included. This paper is an initial foray that begins the job of outlining what is being done in this area and developing some grounded theory to relate the activities to one another. I hope that it makes the case that enough interesting work is being done that a more systematic search would be worth an investment of resources.

This search has uncovered what I take to be four basic models of collaboration. These models reflect both the content of these programs and the social science literature, as it currently stands, on science and natural resources. The models are cumulative in that each one incorporates many factors from the earlier ones.

The first model is the most widely recognized and is based on a programmatic separation between scientists doing science, and other stakeholders who participate in the scientific enterprise in certain prescribed ways. Scientists are seen as the experts and the best way to get an accurate picture of nature is to rely on their professional judgement. I call this the “deference model.”

The second model, which has become quite common and well accepted in the last 20 years, is the “traditional ecological knowledge” (TEK) model. It posits that scientists and fishers see the world differently because of differences in training, experience and culture. TEK incorporates the deference model because it sees traditional knowledge as local and specific, asopposed to the general knowledge of scientists. TEK is meant to supplement and refine the work of scientists.

The third model is the “competing constructions” model. These collaborative efforts result from competition between different pictures of the resource that are constructed by interest groups that compete with each other in the fisheries policy arena. These differences are not based on “disinformation,” which is of course also always a problem. They result from the different questions that honest people ask and the different answers they find useful. These kinds of collaborative programs draw on both the work of professional scientists and TEK to mobilize scientific knowledge in support of specific constructions of the resource.

The fourth model is the “community science” model in which collaborative fisheries science appears in the context of fisheries co-management and/or community development. These programs will often both defer to the knowledge of professional scientists and respect TEK. They also take into account the competing constructions of various stakeholder groups and use collaborative science as a way to resolve and move beyond these disputes. They are characterized by an open discourse about all the aspects of the scientific problems.

The remainder of the paper takes each of these models in turn. Each section begins with a discussion of what the model is and how it relates to the relevant literature on science as a social practice. After that, a number of examples of collaborative fisheries science are discussed that seem to reflect that model more than the others. In assigning these examples to the models, of course, the models become “ideal types,” and the real-life programs can only be placed in the closest match.

The Deference Model

The deference model is the most widely accepted “common sense” idea of science as a social process. It assumes that Merton’s (1968) basic norms of science are in place and running smoothly. Scientists are highly trained individuals who belong to an exclusive guild that shares its information and takes responsibility for policing its own members. They are cautious, not easily convinced, and have objective procedures for identifying what is true and what is not. They work in institutional settings that protect them from the material implications of their results so they can more easily maintain their own objectivity. They are the people that society has trained and given the institutional and physical tools to decide what is true about our natural environment. That is their job and they are the best ones to do it.

Four kinds of collaborative fisheries science efforts exhibit this straight-forward, deferential approach to science.

The most widespread type of collaborative work is **data gathering for scientists** in which fishers and others basically act as research assistants. One common form of this data gathering are fishers, both recreational and commercial, who participate in tagging studies. The participate the most basically by returning tags, but also with their placement. Perhaps the most venerable of these programs is the Apex Predators Cooperative Shark Tagging Program that has been in place since 1962 and has tagged more than 147,000 fish (Kohler, et al. 1998, Shark Tagger 1997).

In addition to tagging, data gathering takes many other forms. The Big Creek Ecological Research Reserve provides a launch site for small-scale fishers in exchange for both data gathering and cooperation with a marine reserve (Caroline Pomeroy, per. com.). Commercial andrecreational fishing organizations help organize data gathering. The Blue Water Fishermen’s Association, for example, both tags fish and collects gonad samples (Gail Johnson, per.com.). Fishers commonly are required to allow observers on board who contribute to both enforcement and gather various kinds of scientific data (Wilson *in press*). Logbook programs are used by both Canada's Department of Fisheries and Oceans (DFO) and the US National Marine Fisheries Service (NMFS) as part of the stock assessment process. The recreational equivalent, angler diaries, have been used by many agencies in both the US and Canada to assess stocks and to assess the accuracy of recreational fishing surveys (Connelly and Brown 1995). A large number of recreational groups seem to be involved in these sorts of collaborative activities.

The Fishing Industry and Research Scientists Together (FIRST) is an innovative, collaborative program that brings together the West Coast Seafood Processors Association, the National Fisheries Institute (NFI), NMFS, Oregon Fish and Wildlife, and the Oregon State University. They are training fish plant workers to sample fish brought to the plant. These workers are being trained to record the sex, length, species and maturity of the fish. Their results are being checked against those of professionals. The effort is proving to be a very successful supplement to the efforts of the six people that the State of Oregon employs to sample the 200 million pounds of groundfish landed in the state (FIRST 1998).

Much of this information gathering, particularly the logbook programs, has moved from voluntary to required status. In New England, The Disaster Relief Fund was established by Congress to aid fishers whose livelihoods are being substantially curtailed due to the collapse of the groundfish and required cutbacks on many other species. NMFS is currently proposing that "Vessels and crew members who participate in the program would be expected to participate in aday of research for every day for which they received compensation. If vessel owners are not asked to participate in at-sea research, they will be required to supply socio-economic information, including tax returns for five years, so that managers will have more complete information regarding the economics of the commercial fishery " (NOAA 1999).

As NMFS's suggestion about requiring data in exchange for aid reflects, scientists see this kind of data gathering as more and more critical. In an interview, one state fisheries scientist told me that his state's fisheries management agency can no longer do without the constant, voluntary cooperation of the fishing in research. The state budgets are too low and the need for information seems to constantly increase. He also pointed out that this was a great way to establish and maintain good relationships with the industry. These considerations raise some real questions about the wisdom of NMFS' suggestion that research be exchanged for funds that Congress has provided for the fishers' relief. If the extraction of data become coercive and/or commodified (these payments are as much as $1500.00 a day), and in the case of tax returns extremely intrusive, then voluntary cooperation may become much rarer.

A second, well established type of deferential collaboration is the use of **industry advisors in scientific funding.** The Saltonstall-Kennedy Program is an example. This program funds research specifically to benefit the US Fishing Industry. Industry advisors are involved in the grant selection process. The proposals are first ranked by accredited experts according to their technical merits and are then reviewed by the industry advisors according to their importance to the industry. These processes are kept strictly separate. The scientists are deferred to as the ones able to make technical or scientific judgements, which come first, then those proposals that are found technically competent are passed to the industry for ranking in terms of their needs. Thesame basic approach is often used by Sea Grant. The Gulf Oyster Industry Program, which administered by Louisiana Sea Grant is an example that was created in response to industry requests and is structured with the same, strict division of labor (Supan 1999).

Fishers participating in research through providing **research platforms, logistical support and at-sea collaboration** is one of the most effective and venerable types of research interaction between fisheries scientists and fishers. In an interview, a senior fisheries scientist lamented that a decline in this kind of research, common before the mid-1970s, has contributed to a loss that he sees in the credibility of fisheries science among fishers. Before that time, fisheries scientists would often spend years on fishing boats during their careers. Before 1976, he had spent four years at sea doing research, but only two months of this time had been on a research vessel, the rest was on fishing boats.

On board collaboration still goes on. Interestingly, all the current examples I came across focused on the development of new fishing techniques to reduce waste and bycatch. (There are other programs, however, the GLOBEC global oceanography program is using fishing vessels.) During its development, the Nordmore Grate was extensively tested by scientists in collaboration with the industry (Gail Johnson, per.com.) Collaboration by the shrimp industry was instrumental in the development of turtle exclusion devices. In Massachusetts the Division of Marine Fisheries is engaged in a very substantial collaborative effort to develop and test the another bycatch reduction device, the raised footrope trawl. This is an experimental fishery that began with a single boat in 1994, three boats in 1995; 15 in 1996, 30 in 1998, and they hope to have 40 boats working this fall. The rest of the fleet has been cooperation in the research as well. This is a team effort, with a skipper playing the main coordinating role (Arnold Carr per. com.). Massachusettsgill netters also aided in the development of pingers to reduce the bycatch of harbor porpoises. Farrington et al. (1998) did their work on hook selectivity and post-release mortality on board commercial longliners. One scientist involved in bycatch reduction said “if we are going to be successful, we have to have fishermen involved in the research with us right from the start.” (Chris Glass quoted in Highsmith 1997:p3).

Issue oriented collaborations initiated by fishing groups are the last type of collaboration that seem to best fit the deference model. These are groups of fishers that want particular kinds of research done and fund professional scientists to either do the research for them or, more commonly, to collaborate with them on the research.

The American Fishermen’s Research Foundation was started in 1971 as a joint program of the tuna processing and tuna harvesting industries in the US, Canada, New Zealand and Tahiti. The funding is directly linked to tuna sales. The processors involve include the largest names in the business, e.g. Star Kist, Bumble Bee, and Chicken of the Sea, as well as smaller firms. The harvesters are represented through the Western Fishboat Owners Association. The foundation has a two main emphases: monitoring of the tuna stocks and reducing waste. According to their web site, they work closely with NMFS scientists “on all projects.” They have been involved in tagging programs, temperature and conductivity measurements, and have maintained a voluntary logbook program for twenty-five years.

Recreational fishing groups are also involved in initiating and sponsoring collaborative research. One interesting example is the Wild Salmon Center in Oregon which both funds research and involves anglers directly in research. They are focused on the production of quality research on salmon and trout around the Pacific Rim, which they link to both conservation andcommunity development efforts. They have a very innovative program of organizing research trips to such places as Kamchatka, where they work in collaboration with fisheries scientists from Moscow State University. These trips, which are fairly expensive, are packaged as a exciting fishing / research / educational experiences. The Sea-Run Cutthroat Coalition (SRCC) is a coalition of smaller angling groups in Washington State. They have been involved in: the Angler Survey Project which used volunteer anglers to record data on local populations: the Hood Canal Fin Clipping program where they worked with Washington Department of Fisheries and Wildlife (WDFW) for three consecutive years in several-day long clipping efforts and subsequent fish-ins which collected data on size, presence or absence of adipose fins, in order to understand the impact of hatchery-released fish; and, collaborations with WDFW biologists to evaluating the impacts of timber harvest, road construction, and a new dam (Jauquet and Schorsch 1997). Five of the Sea-Run Cutthroat Coalition fishing clubs have also provided funding for a bibliography project that resulted from managers and biologists complaints that much of the sea-run cutthroat trout literature was unpublished (Jauquet and Schorsch 1997).

The Traditional Ecological Knowledge Model

Traditional and/or indigenous ecological knowledge is a model that has received growing attention over the last twenty years. Grenier (1998) defines indigenous ecological knowledge as “the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area.” This model first emerged in Third World contexts where it was attached to issues such as intellectual property rights (Juma and Ojwang 1992), the conservation of biodiveristy (Juma 1991), and gender (Khasiani 1992), as well as to resource management (Wamwala 1989). Respect for traditionalknowledge, and its use in practical development programs, has become a widely accepted and promoted approach among global and rural development agencies and practitioners.

The TEK model both incorporates, and is a challenge to, the deference model. No one claims that TEK produces generalizable, scientific information. The emphasis is on local information that can supplement the generalizable knowledge produced by mainstream science. In this sense the TEK model builds upon the deference model. However, the TEK model makes two important claims. The first is that traditional, local knowledge reflects the thinking of local people, including fishers, and, therefore, is critical to producing a picture of nature that will be accepted as legitimate. The second claim is that the local knowledge, while not generalizable, is just as valid as that produced by formal science. From the perspective of science as a social process, this is its crucial difference with the deference model: the scientist is no longer assigned the role of the gatekeeper who has the final word on what is or is not known to be true about nature. In this model, the scientist now has one among perspective on what is true among others.

In fisheries the critical insight of TEK is that fishers have broad knowledge of the resource that is not being adequately harnessed. Fishers's insights are often described, even by fishers, as "anecdotal," in contrast to the systematic data gathered through statistically valid population sampling procedures. Fishers's insights, however, are not anecdotes in the sense of random stories. They are the result of observations that they make within the context of long-term experience with what is and is not an important indicator of the health of fish stocks. The Canadian groundfish collapse has become something of a symbol for people who want TEK to be taken seriously in management. Some authors suggest that these managers relied too heavily on population models and ignored the warnings of inshore fishers that the stock was in trouble(Grafton and Silva-Echenique 1997). Others have warned, however, that there really was no clear, unified message coming from the inshore fishers at that time. While seemingly all the gillnet fishers had noted changes in since the early 1980s, the traditional inshore fishers were giving mixed messages (Felt 1994). The critical lesson, following Felt (1994), is that this knowledge is so local and contextual that considerable knowledge about the locality itself is needed to read and evaluate it.

Most TEK based research collaborations takes the form of **systematically recording fishers knowledge**. Canadians have been taking the lead trying to find ways of making use of fishers's ecological knowledge. A large TEK research project out of Memorial University of Newfoundland

(Neis et. al 1996, Fischer et al. 1997) has brought together both natural and social scientists as part of a broader project on dealing with “Sustainability in a Changing Cold Ocean Coastal Environment.” One of their goals is for “fish workers to be gathering their own ecological knowledge, and to help enhance their role in fisheries science and management” (Barbara Neis quoted in Muzyachka 1995). This project’s TEK work includes both commercial and recreational fishers (Sutton 1999).

The Canadian Government is also involved in fisheries TEK. Phone surveys and logbooks of fishers knowledge of capelin have been used to monitor and understand stock changes (Melanie Morris per. com.). TEK investigations with Aboriginal people in northern Manitoba, done by government scientists, have helped identify the impact of dams on the fisheries (James Waldrum per. com.) In the US, new work on TEK has emerged from new concerns with essential fish habitat (Pederson and Hall-Arber 1999)

Several **local community and environmental efforts** are incorporating TEK into their efforts to achieve management and sustainable development goals. Extensive work on TEK has also been carried out since 1995 by first Ted Ames and now Bill MacDonald at the Island Institute in Maine. The Island Institute is an environmentally-focused community development group that works, as you might expect, on the year-round island communities. Ted Ames is a long-time commercial gillnetter and scientist, who carried out, among other TEK investigations, a series of interviews with retired fishers that resulted in a report on cod and haddock spawning grounds in the Gulf of Maine (Ames 1998). A similar, environmentally-focused community development group is the Alaska Marine Conservation Council. They did a study of the red king crab around Kodiak, Alaska which involved interviews with commercial and subsistence fishers, homemakers, processors and research biologists. A third organization that brings fisheries TEK into achieving sustainable development goals is the Fundy Marine Ecosystem Science Project, which is affiliated with, indeed helped initiate, the Bay of Fundy Ecosystem Project. This is a coalition that began through the efforts of scientists from various public and private agencies and universities that had a common interest in the Bay of Fundy. They began as scientists but quickly reached out to involve other stakeholders. Their basic program is mainstream science, but they also seek to incorporate TEK in their research.

TEK investigations have resulted in some general insights about the ways that fishers view the ocean resource. Some investigators argue that fishers tend to see fisheries as more chaotic systems in which small perturbations may have substantial future consequences (Smith 1990). Fishers see the ocean as a textured and differentiated place, while the population models of the fisheries scientists treat it as uniform and homogeneous. Fishers often make derisivecomments about transect-based surveys that fisheries scientists use to gather fisheries-
independent data. Even some skippers that collaborate at sea with these surveys view transects as "non-ecological " (Pálsson 1995). Smith (1990) quotes one fishers response to such surveys: "Jeesus! Don't they understand that fish swim." Fishers are argued to emphasize the importance of habitat considerations, while managers emphasize population dynamics (Berkes 1993, Pinkerton 1989). Finally, fishers are said to view the resource in smaller temporal and spatial scales than do the managers (Smith 1995). These insights are helpful for understanding that the knowledge cultures of fishers and scientists can be quite different, but they should not be overdrawn. People's capacities should not be equated with the models they use. Fishers are perfectly capable of understanding how a population model can be a useful tool, and fisheries scientists appreciate the complexity of small-scale differences in ocean habitat.

The Competing Constructions Model

Scientific knowledge gets used for many things that people may not immediately associate with science. For example, scientific facts get used as symbols; different groups use them like flags to rally around an issue or raise money (Hajer 1995). Scientific facts also get used to trigger management decisions, providing objective criteria for the invocation of rules. People select different facts from fisheries science to put together an overall picture of the resource that fits their needs. In spite of the insults about "disinformation" that get bandied about when tempers flair over management disagreements, there is not necessarily anything sinister about all of this. The scientific questions that people ask, and the answers that they find useful, are always related to some agenda. This is true in the highest scientific ivory tower, it is certainly true throughout fisheries science.

Understanding science as competing constructions of nature reflects a great deal of empirical work in the sociology of science. After Merton (1968) the sociology of science took a much less deferential attitude toward science, a change that was based on a series of detailed studies of how knowledge was actually produced in laboratories (Latour 1987). These studies showed that laboratories are places where knowledge is constructed and that science, as social process, is a progressive selection of what works based on what has worked in the past and what is likely to work in the future (Sismondo 1993). The closer an observer gets to the site of production of knowledge the less possible it becomes to determine if the knowledge is objective or constructed (Aronowitz 1988). Latour (1987) points out the importance of "black boxes"; knowledge which is taken for granted while other knowledge is built on it. While in the ideal every study is replicated and verified, in reality it is both very difficult to exactly replicate anything, and scientists' incentives urge them to put their energy into undiscovered paths. If a result is useful it is likely to be used.

As a result of this work, a few sociologists have argued for a so-called "strong-form social constructivism," in which the results of science were said to have little to do with empirical reality. This is the use of the term "social construction" that has become best known among natural scientists, who have found the whole idea both unsound and threatening (Gross and Levitt 1994). Most sociologists, however, have move well past this extreme position. Cole's (1992) review of the sociology of science literature found no cases which demonstrated a social construction of the content of science, as opposed to its foci of attention or rate of advance.

Institutional sociologists such as Barnes (Barnes et al. 1996) and Shapin (1994) have shaped a middle ground between ignoring social influences on the construction of scientificreality and strong-form constructivism. Barnes draws on Kuhn's (1970) idea of the paradigm. A paradigm, in Kuhn's original concept, is a set of basic scientific questions being asked and a set of principle's that determine the validity of findings. Barnes grounds paradigms in local scientific communities. A theory that is found to be antecedently implausible within such a community, will have a hard time competing with one that seems initially very plausible, and this plausibility comes from the consensus of the community. This consensus is a social construction of reality. However, it is shaped and given direction by empirical experience, and strong community norms seek to maintain as much objectivity as possible.

In fisheries science, these local scientific communities operate within professional and stakeholder groups. Fisheries science is a form of "mandated science," (Jasanoff 1990, Salter 1988), i.e. it is a science that is trying to respond to political and legal, rather than scientific, questions. This is the key to understanding the competing constructions model of collaboration; scientists working with different groups, be they the government, the fishing industry, or environmentalists, are part of a community that is determining what questions are important and what answers are relevant in terms of particular legal, political and economic agendas. Government scientists have to try to answer questions such as "has this particular fishery exceeded this legally set limit" because that is the overall agenda of the community for which they work. This is the reason that the strict institutional separation of science and management (which is a very good idea), such as is done in Europe, cannot completely overcome the problem. No matter how protected they are from political and bureaucratic influence, the scientists must seek to answer the questions that arise from the on-the-ground management situation.

Each of the major players in fisheries management and the scientists that work with them, therefore, will tend to construct a version of nature that fits their needs. This means, to put things as simply as possible: that government scientists will tend to construct a picture of nature that is more amenable to bureaucratic management than it really is; environmentalists, who always have to solve the problem of mobilizing their constituents, will tend to construct a picture of nature that is more threatened than it really is; and fishers will tend to construct a picture of nature than can sustain more fishing than it really can. It is becoming more and more common for fishing groups, responding to the same practice by the government and environmentalists, to hire their own scientific consultants. Again, there is nothing sinister about this, it is not "junk science," this is what happens when people have to use science and scientific facts to solve their real-life problems.

Scientific collaborations that reflect the competing constructions model are going on all the time. Finlayson (1994), for example, gives an extensive description of the politics of fisheries science related to the collapse of the northern cod. These collaborations are not the ones people want to show off. None of the examples of collaboration sent me by Fishfolk subscribers when I asked for them were of this type. The ones I know the most about are the ones I have observed, although I can infer their existence behind things I have read. I have sat, as have many of my readers, in management meetings and listened to managers, scientists and lawyers collaborating on how they will either deal with or avoid law suits or challenges by politicians. I will relate only one, I think instructive, example.

A few years ago I witnessed an intense collaboration between fishers and scientists. There were around twenty people in the room. Both commercial and recreational fishermen from aparticular state sat for three or four hours, putting their heads together with scientists from that same state to create a strategy for challenging a Stock Assessment Review Committee report that threatened them and that they felt was inaccurate. The meeting had been organized by a council member. What follows is a verbatim extract from my field notes, covering about three minutes of the meeting, and edited to protect the identity of participants as required in my invitation to attend:

> **Council member / commercial industry rep**: At the Council meeting they [NMFS] will have XX data .
> **Lawyer who works with the recreational industry:** We have to be ready. You can't just walk in and react to NMFS' data. You go in with complete XX data which shows no truncations in year classes.
> **Council member / recreational industry rep**: in spite of [NMFS official's] softening stance we still have to go in with as much data as we can.
> **Lawyer:** Hard data with length, CPUE, and [the state agency] needs to verify us. **Scientist A:** We can get it on their web site.
> **Scientist B:** Agrees with this.
> **Scientist C:** We can use the most recent stock assessment.
> **Fisher**: We can't go in with just a feeling, we need data.
> **Scientist C:** [Two types of] boats we have. We need a list of [another type] boats. We need the anecdotal information listed out.
> **Scientists D:** We should request the ... data ...from NMFS.

This was a real collaborations between scientists, fishermen, and other members of the fishing community who take scientific facts very seriously. They were convinced that their case had merit and they were prepared to do what it took to win. This meant selecting the most defendable scientific facts that suited their goals. It also meant being ready, if other facts were used to challenge their facts, to push these challenging facts back close to their point of origin in order to reveal the subjective decisions and black boxes that were behind them (Aronowitz 1988, Latour 1987).

As it turned out they did win. Interestingly, many of the people who were present are more often than not opposed to each other over management issues. This is part of the reason they take science as seriously as they do. When you don't know who might be your opponent or ally a month from now, credibility and integrity are very important assets. An important part of this is real respect for science.

The competing constructions model is the most comprehensive one that we have looked at yet. It incorporates the deference model because scientists are still the crucial spokespersons about what is true, but it recognizes that the knowledge they produce depends on the questions being asked and on the whole community that is involved in the production of knowledge. It also, as the example shows, incorporates TEK where this is appropriate in knowledge construction. What the competing constructions model does is place scientific collaboration into the real world of fisheries politics where the outcomes matter the most.

It is not necessary to give other examples that fit the competing constructions model. Indeed, this model of collaboration between fishers and scientists describes the most common collaborations of all. They happen every time a group that employs scientists and has an interest in fisheries shows up at work.

Science as Community

If people develop different beliefs about scientific truth in perfectly honest ways, and these ways fit quite nicely into the interests they have in how fisheries management should be done, then is there to be any outcome but perpetual conflict between multiple right answers? Fortunately, human beings are too clever to fall, at least all the time, into that trap. Many people involved in fisheries are creating innovative institutions to bring about collaborations in sciencethat recognize that these differences are going to exist and use open communications to try to move beyond them. They are bringing the dynamics of “community” into the fisheries science process.

In doing so they are incorporating the other three models. They defer to the expertise of the trained scientists and give them the leadership roles in the collaborative process. They respect the importance of TEK. They realize and take into account the fact that different understandings of the resource, and different ideas of what should be done, are going to reflect the practical problems in people’s fishery-related lives. It is noteworthy that most (but not all! and this is a hopeful sign as well) of the programs emerged in areas with serious resource depletion problems, and that some of them were a response to intense conflict between stakeholders.

I have come across two types of collaborative projects that fit the science as community model. The first is **programs initiated by the fishers** themselves. The Fisheries Survival Fund (FSF) is a group of seventy plus scallop boats based mainly in New Bedford MA. This group initiated a collaborative research project that includes NMFS, the University of Massachusetts at Dartmouth, and the Virginia Institute of Marine Sciences. This coalition looked at scallop abundance in areas off of New England that had been closed as a way to protect the groundfish stocks. The data they gathered convinced the government to open a portion of the area to scalloping. The research effort continues (Jim Kendall per. com.). The FSF, in a way, straddles the competing constructions and the science as community models. While they are definitely an ongoing multi-stakeholder coalition, some environmental groups have criticized the effort.

The Southeast Alaska Regional Dive Fisheries Association (SARDFA) unites 560 fishers from five communities who are diving for sea urchins, geoducks and sea cucumbers. Their basicmandate is community economic development and their philosophy is that management should go hand in hand with the development of a fishery, rather than waiting for a crisis. Dive fishers and processors have been supporting research and management with their own funds in order to supplement to the work of the Alaska Department of Fish and Game. This had been going on on an ad hoc basis until the creation of SARDFA, a process which began with local government support and culminated in its official creation through State legislation (Julie Decker per. com.). Julie Decker, the

Executive Director reports that ongoing research collaboration with the state has led fishers to be more cohesive and organized because they are forced to work out clear proposals for research. They are beginning to learn to participate in research design and the interpretation of the results. She reports a slow, ongoing increase in trust between the fishers and the scientists that is creating a more responsive management system, but one that requires more effort to achieve (Julie Decker per. com.).

While SARDFA is an effort to avoid crisis and conflict, the Fundy Fixed Gear Council (FFGC) emerged from crisis and conflict. Fisheries in South-west Nova Scotia experienced a series of protests in 1996 due to some controversial government management decisions involving ITQS, quota allocations, and other issues. The protests led to a mediation through which the fixed gear quota was divided geographically and this gave an opportunity for a co-management effort. The FFGC was set up to manage the fixed gear in three counties. They have organized their science activities around a Research and Advisory Committee that includes fishers, community members, environmentalists, community development workers and scientists. They emphasize an eco-system approach to their collaborative work on stock assessments, habitat mapping and other research goals (Bull 1998).

One of the most established of the cooperative research groups is also in Nova Scotia: the Fishermen and Scientist Research Society (FSRS), which began in 1993. It is a partnership between 156 fishers and 42 scientists that emphasizes participating in and enhancing stock assessments by providing “information that only fishermen can obtain on a daily basis”(King 1999 p9). The FSRS does not lobby. It sets its own research priorities, but it also supports itself through specific research projects done on a contract basis with DFO and other agencies. King (1999) reports that building trust between the fishers and the scientists has been both their greatest challenge and accomplishment. The key to success has been timely feedback and direct communications.

The FSRS began with a pilot program involving both fishermen and scientists. The following programs were **not initiated by groups made up of fishers**.

One group with a particularly interesting start began when an environmental group, the Conservation Law Foundation, enlisted Dee Hock, the founder and CEO of Visa and Visa International, to find ways for the different groups in the Gulf of Maine work together. The result was the

Northwest Atlantic Marine Alliance (NAMA). NAMA began essentially as a conflict resolution effort that hoped to create fisheries co-management: "management by combat doesn't work"is how Hock put it (quoted in Fried 1998). NAMA has been heavily involved in the negotiations around the Disaster Relief Fund, discussed above. They are helping to set up meetings to identify research priorities and establish protocols (Craig Pendelton per.com.). Craig Pendelton, a fisherman and NAMA's Coordinating Director, says that groups are planning research togther that have never communicated before and doing the fisheries science work is part of the "glue"that keeps them together. It is still a struggle, however, to get the industryparticipating at "a more professional level" and influencing management still feels like "taking down the iron curtain" (Craig Pendelton per.com.).

The major impetus for the St. Georges Bay Ecosystem Project has come from Xavier University and DFO. The program partners include native and non-native fisher's organizations. The program takes an eco-system based approach to management and is involved in collating as much data as they can about St. Georges Bay, including both the results of mainstream science and TEK. The goals of the program also include improving the working relationship between both harvesters and scientists and developing the harvester's scientific literacy (Davis and Heyer 1999). This project is in the area affected by recent, intense conflicts over native fishing rights, however, and this will certainly present them with some overwhelming challenges in trying to meet these goals. Hopefully, it will be in a position to make a contribution to moving the community through these problems.

These types of cooperative programs are also found in freshwater, recreational fisheries. Freshwater fisheries management in Nova Scotia involves considerable open interaction between the Inland Fisheries Division of the Department of Fisheries and Aquaculture (DFA) and the recreational fishing community, which has a number of opportunities to raise concerns about both existing management and the need for more management (Michael Robinson per. com.). They work through provincial angling organizations that are deeply involved in collaborative research and often take responsibility for major research programs. The Nova Scotia Salmon Association heads the Adopt-a-Stream program and the River Watch program, and The Fisheries Institute of Nova Scotia takes the lead in examining proposed legislation that may affect the fisheries. Extensive special research efforts are coordinated by angler associations. The CanadianAssociation of Smallmouth Anglers (CASA) has just completed in a five year study of Smallmouth bass in conjunction with Inland Fisheries - the parameters of which were negotiated between CASA and scientists from the DFA (Michael Robinson per.com.).

Conclusion

Buttel and Taylor (1992) argue that our understand of science as a social process has been caught in the four cells of a typology created by two dichotomies: that between deferring to the scientists' authority and demystifying the scientific enterprise; and, that between seeing science as developing abstract ideas and seeing science as serving particular material forces in society. Maturity of understanding, they argue, means resolving these two dichotomies and using the insights offered by each cell.

Their argument seems to be applicable at a programmatic as well as the conceptual level. The programs that this paper has termed "community science" seek to resolve both the tension between deference to the knowledge of scientists and respect for the knowledge of fishers, and the tension between using science in pursuit of particular interests and using science as a tool to produce, to paraphrase a tired set of words, the best possible scientific understanding of the resource.

This paper has presented a number of efforts at collaboration in fisheries science following Each of these models incorporates the previous one. Each one is more complex and nuanced than the one before and gives a more comprehensive picture of how collaborative science is actually being done. I would also hypothesize that these models often represent the historical progression of the relationship between fisheries science and fisheries management in periods of import changes in the resource and its management; from business as usual through intense conflict to attempts to manage and contain that conflict.

These collaborations also reflect the literature on co-management. Jentoft (1999) and others have argued that healthy fishing stocks depend on healthy fishing communities. Concern with com-munities in management is not, and should not be, based on a romantic fascination with fishing communities as such. Concern with communities is based on the fact that communities mobilize assets that aid effective management. In this case the community-based groups provide opportunity for communications that make it possible to overcome the fact that no single stakeholder group can build as accurate a practical, management oriented, scientific understanding of the resource as they all can working together. The most difficult issues, as is the case for co-management in general, is how to overcome the problem that larger scales present in maintaining the kind of nuanced, content-rich communications that make management effective.

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