October 2015
Volume 53
Number 5
Article # 5FEA4
Feature

Collaborative Research Seed Grants for Integrating Knowledges and Creating New Knowledge

Abstract

Incorporating different ways of knowing in research and management has the potential to bring creativity to environmental problem-solving through integrating ways of knowing and innovation via co-producing knowledge. To gain these benefits, North Carolina Sea Grant Extension offers small annual grants called Fisheries Resource Grants to paired fisher and scientist investigators with research ideas grounded in practical application. A decade-long retrospective of water quality-focused projects reveals the potential to successfully integrate and innovate relevant information for problem-solving, but also to lay the groundwork for future collaborative research to continue that legacy.

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Introduction

Incorporating different ways of knowing in research has the potential to bring creativity to environmental problem-solving. Democratizing knowledge in this way dictates the use of new methodologies for knowledge creation and integration, leading many researchers to participatory science (Fischer, 2002). In many ways, participatory science is a new name to common Extension practices and has become more complex over time (Miller-Rushing, Primack, & Bonney, 2012). North Carolina funds participatory science through its Fisheries Resource Grant (FRG) program, founded in 1994 to encourage co-produced applied fishery research. My research uses water quality projects from the FRG program as a case study to determine if and how they met the expectations of collaborative research for complex environmental problems so often left to experts. This case study will help to inform Sea Grant practice and could help other Extension programs structure participatory science programs.

The case study is evaluated using expectations of high-performing collaborative research programs from the literature along the avenues of successfully integrating different ways of knowing and using that integration to create something more than the sum of its parts, what I am calling innovation. Table 1 is a summary of these expectations and serves as a helpful reference as I describe the details of this case study as well as in thinking through similar programs in other contexts.

Table 1.

Summary of What to Look for in Collaborative Research projects

Integration	Innovation
Strong role of a boundary organization	More relevant research design
Quantity and quality of participation	Better acceptance of new knowledge
Trust and respect among participants	Stronger connections to co-management

Integration: How to Recognize the Multiplicity of Legitimate Ways of Knowing

In order to fully realize the benefits of diversity, knowledges and associated power should be carefully integrated (Collins & Evans, 2002). As Nadasdy (1999) warns, integration is difficult because information comes in many forms and knowledge holders may distrust what the integrator uses their knowledge for. Integration may be eased through new institutions specifically tasked with equitable integration (Nadasdy, 1999) and/or participatory research, in its many forms (Fischer, 2002).

North Carolina Sea Grant fulfills the role of an information management institution—defined as an institution that structures political, economic, and social interaction around knowledge, or in short, "rules of the game" (North, 1990). They serve as a boundary organization, defined as an institution that connects people in different sections of a social network and increases capacity for them to work together (Wyborn, 2015). They create official roles in boundary management, formally allocate participant roles, and provide forums for coproducing knowledge (Cash et al., 2003). They also serve the boundary role by navigating the ethical space of diversity—establishing protocols for conducting research and orchestrating collaborative research (Shackeroff & Campbell, 2007).

Like other efforts to combine knowledge bases early and in comfortable settings (LaValley & He, 2008; Woosnam, Jodice, VonHarten, & Rhodes, 2008), NC Sea Grant chooses to manage its collective knowledge through facilitating participation to combine ways of knowing in its FRG program. Participation offers the opportunity to elevate experiential knowledge as legitimate by offering knowledge holders a place to contribute in their own voice (Cash et al., 2003). The Shirk et al. (2012) typology of participation attempts to identify program traits that aid knowledge integration: quantity and quality of participation. Trust and respect among participants and for the newly created information (Jasanoff, 2004) also indicate successful integration.

Innovation: How to Create More Than Blended Ways of Knowing

In the words of Fortmann and Ballard (2009), "science done collaboratively by local people and professional scientists can and has developed better understandings of conservation and of rural livelihoods." These better understandings come through three main avenues: more relevant research design and interpretation (Daniell, White, Ferrand, Ribarova, & Coad, 2010; Fortmann & Ballard, 2009; Knapp, Fernandez-Gimenez, Kachergis, & Rudeen, 2011), better acceptance of the new knowledge (Johnson, 2010; Lauber, Stedman, Decker, & Knuth, 2011; Reid, Williams, & Paine, 2011;

Shackeroff & Campbell, 2007), and stronger connections to co-management efforts (Berkes, 2009; Lauber et al., 2011). This analysis uses these three avenues as indicators of high quality collaboration.

Extension at Work: The Fisheries Resource Grant Program

According to its authorizing legislation, the purpose of the FRG program is "to work within priorities established by the Grants Committee to protect and enhance the State's coastal fishery resources". Priorities are established every 5 years as part of Sea Grant's strategic plan, which currently states:

> We need better information about how coastal and ocean ecosystems function and how human activities affect these habitats and living resources. We need citizens who understand the complexities of coastal environments and the interactions between human use and the health of coastal ecosystems. We need management and decision-making processes that are based on sound information, involve everyone who benefits from the beauty and bounty of America's coastal resources and include mechanisms to evaluate trade-offs between human and environmental needs.

The strategic plan then champions "strong partnerships with all stakeholders" as the means to meet these goals, referring to strong participatory programs like FRG. These strategic plan goals are where FRG derives its participation and outreach requirements. There are no legal specifications for how success of the program is measured.

The law authorizing the FRG program states "every proposal shall include substantial involvement of residents of NC who are actively involved in a fishing related industry." The initial intent of the program was to solicit project ideas grounded in local knowledge from the fishing community to be explored with the help of scientists. According to the Request for Proposals in 2012, cooperation is established through a collaborative arrangement involving "substantial involvement of NC fishers" or written endorsements from fisher supporters. Specifics have varied over the program's history, but grants support a 1- or 2-year time-frame with $20,000-$75,000 budgets. In order to meet program goals, Sea Grant staff offer proposal- and result-writing assistance for both scientists and fishermen.

A mixed committee of 11 reviews proposals: three Sea Grant employees, two Division of Marine Fisheries employees, two members of the Marine Fisheries Commission, and one member from each of the four Regional Advisory Committees. Each member is appointed by their agency, and fishermen are eligible to be appointed through the Marine Fisheries Commission or the Regional Advisory Committees. Through these, the FRG program is part of greater NC co-management efforts that include advisory councils, agency commissions, and other institutions designating seats at the table to ensure diverse ways of knowing.

Methods

Fifteen projects relating to water quality and habitat (out of a total of 242 FRG projects) were identified through a search of Sea Grant's online archive of "FRG and water quality" followed by a browsing of listed projects in the "environmental pilot" category. The search was restricted to projects since 2001 to ensure discussion of projects under current institutional oversight (and one older added later).

Through interviews and review of relevant documents, I characterized the nature of the collaboration and looked for signs of successful integration and innovation, both self-reported and through final products. For interviews, I identified the primary investigators listed in the Sea Grant archives for each of the projects and added other key researchers and Sea Grant staff based on referrals, leaving out school-age participants for confidentiality reasons. The final interviewees consisted of five Sea Grant staff members, seven fishers, and 19 scientists. These participants each discussed their experiences with the project in a semi-structured interview. Each interview lasted around 45 minutes, and most were performed in person. Questions covered the general history of the project, learning that took place, outreach and policy connections, and reflections on FRG program goals and success.

Document review started with the final report submitted for each project and snowballed to include other outreach and policy products listed in that report or identified in interviews. One project was not yet finished, so had no documents to review. Others each listed three to 11 papers, presentations, reports, testimony, etc.

Interviews were transcribed, then transcripts and documents coded in NVivo 10 (QSR International) using a grounded theory approach (Charmaz, Denzin, & Lincoln, 2000); I coded for themes as they emerged from the data. Results below present trends in the investigated projects supported by representative quotes from interviews.

Results and Discussion

Integration: Characterizing Collaboration

Collaboration quality varies through different stages of the scientific process, the first of which is idea and hypothesis generation. Many ideas took root in the local base of "common knowledge" (scientist), which is then digested into a scientific proposal by at least one investigator. Contrary to Sea Grant staff expectation, ideas originated evenly across knowledge types with six of the 15 projects were scientist-generated, five fisher-generated, and three jointly generated (Table 2). Referring to one of these joint ideas, a scientist classified the types of participatory idea generation: "so while it wasn't a 'let's sit down and brainstorm and come up with something that we all want to work on' it was very much a 'we're interested in tackling the water quality side of an issue somehow?'" (scientist).

Table 2.
List of Projects and Who Generated the Idea (as reported by authors)

Year	Title	Idea generated by
2010	Linking Variation in Effluent Quality to Hatching Success and Larval Survival in Blue Crabs	Scientist
2007	An Environmental Pilot Study to Determine Causes of Water Quality Decline in an Active Shellfish Production Area,	Fisher

	Middens Creek, Carteret County, NC and Development and Implementation of Strategies to Reverse Water Quality Declines	
2007	Effects of Different Water Conservation Practices on Effluent Reduction and Economics of Hybrid Striped Bass Production	Fisher
2007	A Total Quality System (TQS) for Grading, Traceability and Marketing North Carolina Seafood	Not sure
2007	Low Impact Development Pilot Study to Reduce Fecal Coliform into Core Sound	Joint
2006	Effects of Land Use Change on Juvenile Fishes and Brown Shrimp Abundance in North Carolina's Estuarine Nursery Habitats	Scientist
2005	Stone Crab Mortality Rates Associated with Claw Harvest at Varying Water Temperatures	Fisher
2005	Assessment of Blue Crab in the Cape Fear Estuary	Joint
2004	The effect of water quality on nocturnal food web in the Cape Fear River Basin	Scientist
2004	Functional Evaluation of Fish Habitat Quality: Juvenile Southern Flounder	Scientist
2002	Determining the Role of Dead Water in the Albemarle Sound Blue Crab Fishery	Fisher
2002	Stakeholders Perceptions of Water Quality: New Approaches to Assessing and Responding to Public Involvement	Scientist
2001	Hypoxia and Estuarine Nursery Habitat Quality: An Experimental and Modeling Approach Linking Low Dissolved Oxygen with Fish Survival and Growth	Scientist
2001	Potential Impacts of Bottom Trawling on Water Column Productivity and Sediment Transport Processes	Joint
1998	Shrimp and Crab Trawling Impacts on Estuarine Soft-Bottom Organisms	Fisher

Field work is the easiest and most common place to foster collaboration, credited largely to a sentiment of "I like going out on the water" (scientist). All but one project that relied on historical data involved both a scientist and stakeholder in the field. During fieldwork, collaboration directed the research process, with many participants referencing discussions on the water regarding how to structure the project around field logistics and maintaining useable data for later applications. For one project, the scientist commented "this has been a very different process; information is coming from all these different angles and I think most of the time... it's not really [like that]" (scientist).

Data analysis and reporting is where the collaboration most often breaks down according to types of expertise. Scientists focus on data analysis and drawing final conclusions, while fishers decide how to incorporate findings into practice: "[she's] scientifically educated to be able to drizzle down all the information into a 'here's your answer'... my job is the fieldwork and they do the desk work" (fisher). This trend is most apparent in the final reports (Table 3), where authorship credit to fishers is not guaranteed (there were more fisher or jointly-generated ideas than fisher or jointly authored final reports). Of the nine final reports turned in, six gave authorship credit to both scientists and fishers, two did not credit the fisher, and one did not credit the scientist. The remaining six final reports were never submitted, largely from the early days of the program and from scientist-only authored proposals.

All projects included participation in more than one stage of research, and collaborators reported frequent meetings with ample opportunity for discussion, especially during field work. The short duration of these projects (no more than 2 years) also increased collaboration intensity; interviewees described frequent phone calls and shared meals to swap ideas. One scientist effused about the necessity of intensity:

> We still talk regularly. Because if you don't they tend to feel like you were just using them to get out and get your samples or whatever. They'll... come into the lab and we made sure everybody's comfortable enough to come in and just start talking. And that tends to be, I think, one of the reasons we've gotten along so well is you have to invest that time. Which is the one commodity most of us don't have much of (scientist).

Table 3.

Types of Result Products Separated by Type of Authorship

	Joint authorship	**Scientist-authored**	**Fisher-authored**
Academic journal articles (theses)		16 (9)	1
Sea Grant reports, outreach, and talks	9	3	1
Professional talks	3	18	1
Presentations to policymakers	5	4	1
Informal education and interactions	6	7	1

Integration: Sea Grant Staff on the Boundary

The FRG program functions with a large amount of facilitation by Sea Grant staff, which serves as a boundary organization by orchestrating participation. This happens primarily at a pre-proposal workshop, where Sea Grant staff facilitates introductions. According to one scientist, "the folks they have working extension are top-notch and they're really in touch with the community... they're a really good facilitator of that relationship" (scientist). The staff largely pulls from people they know through past projects. Other connections occur through state co-management committees, where a number of both the scientists and fishers have served. The downside to these networking strategies is that sometimes the program is perceived as "really hard to get in to, ... perhaps not an open fair playing ground" (scientist) because reviewers like funding people they know and trust (staff).

Sea Grant staff and the review panel emphasize that outreach, and application are required. One scientist who also served as a reviewer said "the biggest problem I saw with their final reports is that they hadn't done or hadn't fully done the outreach component they said they were going to do and I would almost every time hammer them on that" (scientist) by withholding the final 25% of funding until the outreach was complete. The review panel also aided extension work through offering staff help and sponsoring venues.

These efforts cultivate a social network of collaborative research relationships through trust that also blend into related co-management networks, such as advisory councils or state commissions. Sea Grant staff can be viewed as initiating and maintaining collaborative research endeavors with the characteristics of young organizations to maximize the benefits of early collaboration, including creativity, energy, and a strong role of trust in maintaining the institution (Jawahar & McLaughlin, 2001). The staff responds to issues and adapts from year to year based on solicited feedback and experiences from that year. Adaptation helps ensure the program cannot be steered away from the underlying mission of utilizing multiple ways of knowing (Dale & Armitage, 2011).

FRG resources often support the youngest generation of investigators. FRG funds exploratory, often graduate student projects, as "the budget's way too small for most ... [so] a lot of the faculty use it as 'let's fund this graduate student and this is their thesis'... it's a unique funding source" (scientist). Students often take responsibility for ensuring needed communication within the project and producing outreach. The funds also tend to support younger fishers, especially with children possibly entering the fishery: "if [we] don't have children or something involved ... [we] could care less about what [we] do" (fisher). Another fisher told how the grants provide an outlet for entrepreneurial ideas in the fishing community, investing in high-risk but potentially high-reward ideas.

For many, FRG served as "an introduction that led to something else" (scientist). Young scientists and fishers create a social network where they "find out that they really aren't that different people" (scientist). According to staff, "the fishing partners who have been doing this all of their lives have taught scientists a lot of stuff about practical aspects of doing research and I think that the science partners have done very well with dispelling a lot of myths and folklore" (staff), bringing the conceptual gap between fishers and scientists closer. By focusing on a committed group of younger investigators, the FRG program creates collaborative thinkers for future creative endeavors. Both parties learn a collaborative process and how to adapt while incorporating different types of expertise. One of the most prominent benefits of FRG is its seed-grant nature—it funds creative ideas later used to leverage larger research grants or community development efforts. These new boundary spanners may then go on better connect information to policy (Hoppe, 2005).

Innovation: Meeting the Promises of Co-Production?

This study looked for three avenues of innovation through co-producing knowledge. First, more relevant research design and a better understanding of the system were achieved through investigators learning empathy for each other. Learning during the projects was "a valuable two-way street" (scientist). Scientists reported learning 11 topics from fishers, while fishers learned 10 topics from scientists (Table 4). Both quantity and variety of learned topics were comparable for each direction of information flow. The topics extended beyond science to include increased empathy, adaptability, and recognition that "fisher" and "scientist" are not single entities.

Table 4.

Topics Participants Learned from Each Other

Things Scientists Learned From Fishers
About the fishery/full view of the system
Feasibility of fieldwork
Dealing with citizens
Adaptability and diversity of the fishery
Empathy
How to stand up to public officials *
Human behavior and risk aversion
New methods for fishing *
Case-specific information *
'Fisher' is not a single entity
Why applied research is important
Things Fishers Learned From Scientists
Case-specific information *
Research methods
How to stand up to public officials *
Scientific philosophy (e.g. can't prove a hypothesis, just disprove it)
Scientific process
How to interpret data
How to use statistics
Details of water quality

New methods for fishing *	
What regulators can do	

The information topics learned also move beyond the expected basic information exchange (Maurstad, 2002) to shared new knowledge amongst the groups, represented in topics identified by both groups. Many interviewees mentioned that they learned how different types of knowledge fit together, what types of knowledge are needed to see the whole system, and how diverse experiences lead to creative solutions, for example:

> It takes so many different things from the law to the science to being politically savvy to technical issues and people tend to have their strengths and weaknesses and when you have a group together you find that different people have different ways to contribute... but it's just the creativity that it brings to the issues. (fisher).

Empathy and respect played a large role in connecting knowledge diversity with creativity, as "what you acquire is a sensitivity to the fact that it's a shared resource... when you think of solutions now is that you tend to widen the options" (scientist). Shared new knowledge is the source of creativity in problem-solving mentioned by interviewees. The emergent creativity is part of the learning shift from gaining individual facts to figuring out how different ways of knowing fit together (Collins & Evans, 2002).

The second indicator of innovation is if results of collaborative research have a different reception by end users than either traditional scientific or industry research alone. Finding those users was the first challenge, as results took a different format than one might expect. Only five of the projects produced peer-reviewed academic publications (Table 2), though there may be more forthcoming as a result of graduate student theses. Instead, each project resulted in at least two presentations given in places ranging from local schools to international meetings. According to one scientist, "it was mostly talks... presented a few sort of public talks and then we certainly gave talks at scientific conferences, so it was a combination of the two." People could not give specifics or even quantify the number of talks given, making exact impact difficult to measure.

Most investigators (13) believed that results from FRG were well received, as co-production provides an early vetting program before the information is used in public. Local trust is an important part of gaining reception as "any time you get somebody who lives in a watershed and is an integral part of that community... it's really the only way to very effectively communicate because people know who you are and they trust you" (scientist BK). Respect for collaboratively produced knowledge is increasing as people "are coming around to the realization that fishermen possess a lot of knowledge" (scientist DG). In addition, people "tend to receive that more positively because they think 'she's had to listen to somebody else about this'" (scientist LC), that the idea had already been vetted. One person expected positive reception because they "rarely have done a project without industry participation" (DG). In the reverse, three people felt their results were not better received because their project was not all that successful in fostering collaboration. In short, as different ways of knowing became recognized and valued, the different types of information become seen as legitimate and necessary (Fortmann & Ballard, 2009). Given the information is trusted through the collaborative research process, it legitimizes new sorts of interdependent expertise in which the investigators invested increased confidence.

Finally, the third indicator of successful collaboration is a strengthened connection to co-management, defined as collaborative management that distributes some decision-making power to stakeholders (Heikkila & Gerlak, 2005). This connection manifested in two ways with the FRG projects: through direct presentations to decision-makers and through investigators also wielding political power through taking seats on advisory councils after the project. Part of the strategic goal of Sea Grant is to smoothly incorporate science, citizens, and policy; they coordinated FRG to achieve this goal through both these formal mechanisms and through cultivating a social network with more fluid boundaries between those three categories. Participant appreciation of Sea Grant's role as a boundary organization (see earlier) speaks to how this social network was formed and maintained.

Conclusions

Collaborative research takes many forms, and the U.S. Extension System, including state Sea Grants, have a culture of high-quality collaboration between industry and science as well as direct applications to management and community practice. The FRG program is one example of this, and while most projects tackle industry questions like gear development or aquaculture technique, the subset of projects focused on the complex problem of water quality demonstrates that collaborative research has great potential to creatively problem solve by integrating existing bases of expertise and innovating new ideas as a result. Looking back at Table 1, the FRG program showed evidence of both integration and innovation. Across both sets of metrics, the FRG program supported a forward-thinking group of relatively young researchers who used the program as a seed grant to launch careers in which diverse ways of knowing are respected and incorporated. Future research should focus on these long-term effects and the network connections continually maintained by these scholars in both academia and industry. For now, the social network created has increased trust and respect among fishermen and scientists and uses Sea Grant staff in their role as boundary spanners to initiate and maintain relationships that produce well-respected research with immediate ties to management.

Acknowledgements

This work was funded by the Ramus Fund, which focuses on research in the coastal waters of North Carolina. The author would like to extend hearty thanks to all of the investigators for giving their time for interviews and project tours and especially the NC Sea Grant staff that donated time for interviews and answered countless emails for help locating documents.

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