

Can science writing collectives overcome barriers to more democratic communication and collaboration? Lessons from environmental communication praxis in southern Appalachia

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Abstract

Despite compelling reasons to involve non-scientists in the production of ecological knowledge, cultural and institutional factors often disincentivize engagement between scientists and non-scientists. This paper details our efforts to develop a bi-weekly newspaper column to increase communication between ecological scientists, social scientists and the communities within which they work. Addressing community-generated topics and written by a collective of social and natural scientists, the column is meant to (1) foster public dialogue about socio-environmental issues and (2) lay the groundwork for the co-production of environmental knowledge. Our collective approach to writing addresses some major barriers to public engagement by scientists, but the need to insert ourselves as intermediaries limits these gains. Overall, our efforts at environmental communication praxis have not generated significant public debate, but they have supported future co-production by making scientists a more visible presence in the community and providing easy pathways for them to begin engaging the public.

Keywords: science writing; democratization; public engagement; journalism; co-production

In *A People's History of Science*, Clifford Conner likens science to a skyscraper, arguing that the twentieth-century triumphs of quantum theory and genetics research are “the sophisticated filigrees at its pinnacle that are supported by—and could not exist apart from—the massive foundation created by humble laborers” (2005, p. 2). This is more than a sympathetic nod to the knowledge of “hunter-gatherers, peasant farmers, sailors, miners, blacksmiths, folk healers, and others” whose livelihoods imparted to them a deep understanding of nature (Conner, 2005, p. 2). Rather, Conner is arguing that scientific knowledge is fundamentally co-produced, that the intellectual work of non-scientists is central to modern science. We go a step farther to argue that there is value in more *intentionally* co-producing scientific knowledge through communication, engagement, and collaboration.

Recently, numerous scholars have argued and/or illustrated that the democratization of science can enhance both scientific knowledge production and environmental policy and management (Bocking, 2004; Corburn, 2005; Fischer, 2000; Kleinman, 1998) and a range of professional organizations and government agencies, including the National Science Foundation and Ecological Society of America, have promoted science–society interaction (Bickford, Posa, Qie, Ahimsa, & Enoka, 2012; Funtowicz & Ravetz, 1993; Pace et al., 2010). These initiatives have prompted a proliferation of public communication and engagement strategies using virtually every medium available: print, television, radio, blogs and podcasts, social media, public lectures, citizen juries, debates and dialogues, school curricula, museum exhibitions, public art, comic strips, novels, science cafés, online databases, films, participatory mapping, citizen science programs, and more.

However, efforts to develop public engagement strategies that support the co-production

of ecological knowledge continue to face significant challenges. Harding (2000) argues that the scientific ideal of producing universalizable knowledge presents a basic epistemological challenge to pluralism, a tension that we think is exacerbated by the social organization of science. As science becomes an increasingly expensive and formalized domain of specialized experts, the gap between scientific and non-scientific epistemologies seems to be growing, increasing scientific controversies, public distrust of science, and some scientists' reluctance to communicate with the public (Mikulak, 2011). Furthermore, scientific institutions' incentive structures and professional cultures typically promote top-down communication of results through peer-reviewed articles and passive reliance on journalists to seek out relevant scientific work, as well as the privileging of "important" policy making communities rather than direct and active scientist communication with the broader public (Besley & Nisbet, 2011; Shanley & López, 2009; Suleski & Ibaraki, 2010). "Enhanc[ing] the ability of society to respond appropriately to environmental signals" (Cox, 2007, p. 5) will require that we find ways to overcome the epistemological, social, and cultural barriers to scientists' participation in communication, engagement, collaboration, and learning.

In this paper, we describe our efforts to address some of these barriers through one particular mechanism: a collectively written, regularly produced science newspaper column written by social and natural scientists from the Coweeta Long Term Ecological Research (LTER) Program. This column is a form of "praxis-based environmental communication research" (Endres, Sprain, & Peterson, 2008) and part of a broader action-research project that seeks to democratize environmental knowledge production and governance in southern Appalachia. That is, through the column we aim not only to communicate science to the public, but also to promote dialogue about environmental issues among more diverse and inclusive

publics, to advance theory about environmental communication, and to lay the foundation for the co-production of ecological knowledge via collaboration among scientists and non-scientists and integration of diverse ways of knowing the natural world. Newspapers provide numerous opportunities for dialogue and collaboration, particularly when envisioned as part of a long-term and multi-faceted strategy of engagement. Our other action-research activities—including community environmental dialogues (or what we call translational dialogues), collaboration workshops that guide scientists and decision-makers through research–governance collaborations, participation in community events such as farmers' markets and heritage festivals, and long-term participant-observation with environmental groups—are designed to feed into the newspaper column and to support any collaborative impulses that the column may produce.

Our “Science, Community, and Public Policy” column is a distinct form of science communication because of its regularity (it appears in the local newspaper every two weeks), its emphasis on iterative, dialogical, and collective processes of soliciting topics and synthesizing science, and its ability to provide an avenue for various LTER scientists to engage with the public. Through the steps we take to produce the column, we seek to better understand how to develop a form of science writing that escapes the “deficit model” and becomes more interactive. Can we implement a more democratically minded communication strategy in an unfavorable context marked by institutional disincentives?

We begin this article by summarizing the varied motivations, strategies, and challenges for environmental science communication, public engagement, and the co-production of ecological knowledge. We then describe our broader action-research project and its context before elaborating on the newspaper columns themselves. Our experiences confirm many of the acknowledged barriers to scientists’ participation in public communication and collaboration, but

also reveal an undiscussed dynamic: scientists' engagement activities are affected by their desire to maintain already-existing public relationships that support their research. We conclude with reflections about what we have achieved, where we have fallen short, and how we might refine our communication process to deepen the dialogical co-production of ecological knowledge. In short, this process has not stimulated direct public debate, but it has helped establish the foundation for future collaboration and co-production by giving scientists a visible presence in the region and providing them with easy steps to begin engaging with the public.

Science communication, public engagement, and co-production

Science communication is often represented as a fairly passive and uni-directional process of translation and education and distinguished from public engagement or public participation in science, which are idealized as more active and interactive processes in which non-scientists collaborate in the conduct of science with possibilities for deep co-production of ecological knowledge based on multiple ways of knowing the environment. Our experiences suggest that the hierarchization of these forms of engagement actually impedes progress toward stronger science–society relationships. Conceptualizing public engagement or democratization as a continuum (Kleinman, 1998; Shirk et al., 2012) is valuable not because it allows us to see which activities "go farthest," but rather because it enables us to analyze how the relationships established through some activities (like communication) might affect other forms of engagement.

By contrast, motivations for engagement are perhaps a stronger basis for distinguishing among initiatives, because different motivations lead to distinct processes and, often, divergent outcomes. Fiorino (1989) defines three broad rationales for public engagement:

(1) *instrumental rationales*, or hopes that engagement will benefit scientists themselves

- or their professional community, for example by building public trust in science, improving scientists' reputation, garnering financial support for research, or preempting distrust of new technologies (see, for example, Anonymous, 1999; Domegan, 2010; Priest, 2001);
- (2) *substantive rationales*, or hopes that engagement and increased public understanding of science will contribute to broad social goods such as economic development, environmental decision-making, or other aspects of well-being (see, for example, Besley & Nisbet, 2011; Nadkarni, 2004; Whitmer et al., 2010), or that they will inspire environmental ethics and raise “the initial alarm” about key environmental issues (Bocking, 2004; Pace et al., 2010, p. 293); and.
- (3) *normative rationales*, or beliefs that public engagement is “simply... the right thing to do” (Stirling, 2008, p. 268) because it contributes to the democratic values of inclusiveness, participation, and accountability.

The goal of co-producing ecological knowledge straddles substantive and normative rationales. Knowledge co-production is a “collaborative process of bringing a plurality of knowledge sources and types together” (Armitage, Berkes, Dale, Kocho-Schellenberg, & Patton, 2011, p. 996).¹ Scientists who advocate for co-production argue that more intentional strategies for public engagement and democratization—as opposed to the inevitable and often accidental forms of co-production that Conner describes in *A People's History of Science*—will further advance science itself, produce knowledge more appropriate to complex policy challenges, and help to democratize society. From this perspective, individuals from different social positionalities hold different but complementary knowledge. Bringing these different

¹ Although often conflated, there is an important difference between knowledge co-production in the sense we use it here and the broader notion that science and society are co-produced (Jasanoff, 2004).

knowledges together can generate new and better questions, original insights, and innovative approaches to project design and analysis (Baars, 2011). Achieving co-production, however, typically requires new systems for communication and collaboration (Armitage et al., 2011).

The science communication and public engagement activities of other Long Term Ecological Research sites illustrate this point. The LTER network includes 25 ecological research groups producing large amounts of scientific data and scholarship in specific ecosystem types over multiple decades. In recent years, communication and engagement have become priorities across the LTER network, and several LTERs have begun promoting science-based resource management and policy-making (Driscoll et al., 2012). Of these efforts, the *Science Links* program at the Hubbard Brook Ecosystem Study in New Hampshire is perhaps most relevant to our work. It was established in 1998 in response to a study demonstrating that much of the existing scientific literature was too fragmented to offer policy makers the global and integrated picture that they needed and was conducted at inappropriate scales for informing policy (Driscoll, Lambert, & Weathers, 2011). To address these problems, the Hubbard Brook Research Foundation assembled teams of 10-12 scientists and 4-6 policy advisors who collaboratively analyzed and synthesized scientific literature on key policy topics, producing new insights at policy-relevant scales, and modeled the probable consequences of different policy scenarios.

Hubbard Brook offers several lessons about public engagement that are particularly relevant for our work. First, it shows that productive engagement around science does not simply involve taking already-finished and packaged knowledge and sharing it with new groups; rather, it often involves the creation of new knowledge through synthesis, the consideration of different scales, and the analysis of alternative scenarios. Public engagement can, perhaps, be best thought

of not as the communication *of* science, but as communication *as part of* science. Second, the Hubbard Brook researchers found that this new process of knowledge production was best achieved through intentional co-production via early and continuous integration of knowledge from the ecological sciences and the policy realm. The success of these interdisciplinary and transdisciplinary engagements all hinged on trust, which was developed through sustained, long term, and iterative dialogues and the assumption of an impartial, non-advocating stance by the science–policy teams.

Challenges to science communication, public engagement, and co-production

While the models for public engagement and communication are advancing, numerous studies show that professional incentive structures and communication dynamics continue to pose formidable challenges to effective scientist engagement with the public and the promotion of co-production. In a survey of 268 researchers from 29 countries, Shanley and López (2009) found that, though scientists believed public engagement was important to address socio-ecological issues, few actually conducted public communication or engagement activities, in part because they believed that such things as engagement with the media, production of educational materials, and publication in popular media were “inconsequential in measuring scientific performance” (Shanley & López, 2009, p. 537). Large surveys of researchers in the UK (The Royal Society, 2006), France (Jensen, 2011), and Argentina (Kreimer, Levin, & Jensen, 2011) also suggest that promotion and tenure systems and professional pressures to generate funds and conduct original research for peer-reviewed publication disincentivize outreach and public engagement, though Dudo (2013) argues that these external disincentives may be less important than scientists self-report and Poliakoff and Webb (2007) also highlight the important role of scientists’ past experience in public engagement, their evaluation of public engagement as

enjoyable, and their sense of their own capacity.

Professional norms and incentives regarding engagement are complex. Peters et al.'s (2008) survey of 1354 scientists contradicted the common belief that scientific culture devalues public engagement: almost as many respondents believed that engagement with the media would be viewed positively by their peers as believed it would be viewed negatively (for other examples of positive attitudes toward journalistic engagement, see Chapman et al., 2012; Corley, Kim, & Scheufele, 2011). Besley and Nisbet's (2011) meta-analysis of surveys of US and UK scientists shows that they tend to see interactions with journalists as positive experiences and value engagement with journalists and policy makers as important ways of advancing scientific literacy, effective policy, and their own careers.

However, both studies also found substantial resistance to communication with the public. Peters et al. (2008) found that many scientists are reluctant to communicate with the public via the media because they fear a lack of control in interview situations, think that journalists are unpredictable, and fear being misquoted. Besley and Nisbet (2011) found that scientists tend to believe that the public is uninformed and they dismiss engagement with the general (non-policy maker) public as unrewarded and relatively unimportant. Davies' (2008) focus groups revealed that scientists continue to imagine public communication as a one-way process to inform a rather ignorant public, giving them the feeling that it is both difficult and dangerous. More in-depth interviews conducted by Mizumachi, et al. (2011) also found that scientists were reluctant to communicate with the non-scientist public because: 1) doing so is troublesome and time consuming; 2) they feel pressure to conform to disciplinary norms regarding what a scientist is and does; 3) such outreach is outside the scope of their work; 4) they do not perceive the benefit of doing so; and 5) they worry about speaking directly with the

public.

Beyond the question of scientists' willingness to engage the public, a host of studies have raised questions about the effects of public engagement initiatives. Many public engagement initiatives illustrate the difficulty of framing conversations in a way that is sufficiently open to permit publics to engage on their own terms, adequately focused to generate concrete results, and sophisticated enough to transcend dominant framings of science and technology in terms of risks (Doubleday, 2007) or dominant political-ecological agendas (Corburn, 2005; Stirling, 2008). For example, several evaluations of the extensive and well-funded public engagement projects around nanotechnology concluded that they failed to live up to the rhetoric of egalitarian, democratic, upstream engagement (Kurath & Gisler, 2009; Powell & Colin, 2008). Public dialogues were often initiated after major decisions on research and development had already been made and included little opportunity for the public to significantly contest or alter the direction of science and technology development. Even the most advanced projects struggled to challenge the traditional expert/lay dualism through new identity positions that did not contrast “a unified science to an illiterate public” and failed to translate public engagement into policy impacts (Kurath & Gisler, 2009: 569). Nonetheless, the rationales for public engagement remain compelling and suggest ongoing experimentation with processes to democratize and co-produce science.

Fortunately, many scientists choose to engage the public despite these challenges, often using intermediaries such as science journalists, boundary organizations (Guston, 2001), and information brokers (McNie, 2013) to reduce transaction costs and assuage their fears of misspeaking in public. While these intermediaries are useful, they often fail to include the scientists themselves, creating missed opportunities to build the direct connections between

scientists and non-scientists that are necessary for the co-production of knowledge. Because co-production is one of the central goals of our project, we tried to develop our science writing process in a way that would bring scientists and non-scientists into direct dialogue without confirming scientists' concerns about engagement. *How* this process of communication involves scientists is of central importance, and the issue we turn to next.

The Coweeta Listening Project: writing science as a collective

The Coweeta LTER is one of only three LTER sites with a history of including social science research and a broader regional view in its portfolio. Our research has therefore expanded from an analysis of ecological dynamics in the uninhabited watershed managed by the US Forest Service at the Coweeta Hydrologic Laboratory to a consideration of socio-ecological processes across Southwestern North Carolina. While the LTER remains predominantly an institution for natural and physical scientists, a number of social scientists have been incorporated into the research team and an anthropologist has been appointed Lead Project Investigator (PI).

In May 2010, a small group of social scientists at the Coweeta LTER initiated the Coweeta Listening Project (CLP) as a new avenue for public communication and collaboration. Our vision for the CLP is twofold: first, to create mutually beneficial partnerships between the social and ecological scientists working within the Coweeta LTER, and second, to create mutually beneficial relationships between the LTER and the broader communities living in southern Appalachia. The CLP has grown to more than ten members, including people from various career stages and disciplines, though primarily in the social sciences. Most of the members of the Coweeta Listening Project are motivated by the normative and substantive rationales described above, and by the desire to advance science through intentional and

democratic forms of co-production, but the scientists and non-scientists that we work with and speak to represent the entire range of rationales.

The most regular activity of the CLP Writing Collective is to write a 700-900 word, bi-weekly newspaper column for *The Franklin Press*, the most widely read newspaper in Macon County, North Carolina, the site of the USFS Coweeta Hydrologic Lab and most of the Coweeta LTER's research. The column emerged out of conversations and organizing efforts with community members when we were initially developing the CLP's public-science engagement strategies. Members of the CLP considered several media strategies such as radio shows, town hall meetings, video podcasts, and the column. We ultimately decided that a newspaper column was a good match for our motivations for public engagement, our particular social and political context in Macon County, and our resources—both human and financial. Early focus group discussions with community members and advocates working with several environmental organizations suggested that a column might be our most effective mode of intervention in local conversations about the environment. We opted for a *print newspaper* because of low internet use in the region (Zickuhr & Smith, 2012), the social importance that newspapers have to the local community, and the fact that newspapers reach different audiences than do many typical channels of science communication (Wertheim, 2010: 17). And we chose *this particular paper*, *The Franklin Press*, due to its high circulation and reputation for political neutrality. As Wertheim (2010) argues, reaching a broader audience will require that we go out to them, in the places and formats where they are already engaged. Finally, we chose *collective authorship* to increase the number and variety of voices in the paper commenting on ecological and scientific issues. Collective authorship also alleviates researchers' concerns that they might be vilified for writing on politically sensitive topics.

Because the goal of the CLP is to democratize ecological knowledge production, we chose a form of communication that is regular, broadly accessible, and that responds to community-identified knowledge needs. *The Franklin Press* offers opportunities for readers to respond via letters to the editor and the popular "Rants and Raves" feature, and we actively solicited additional stories or comments in every column, via our e-mail and postal addresses and our web site. In addition, several articles directed readers toward other public engagement activities that we were conducting. As the Hubbard Brook experience shows, however, the democratization of science depends on relationships of mutual trust and respect, which often require long-term and iterative processes and direct connections between scientists and non-scientists. Regular presence in a respected community institution like *The Franklin Press* is one way we are seeking to establish rapport, build trust, and create a long-term conversation around environmental issues. Through the column, we are therefore trying not only to provoke immediate feedback but also to lay the foundation for future dialogues and partnerships.

While people often assume that our "target" audience is the non-scientist public, successfully democratizing science also depends on us articulating to the Coweeta LTER's ecological scientists how the CLP and public engagement are relevant to their work. At the outset, we hoped to engage ecological scientists by giving them the lead role in drafting each column. While the column idea received vocal support from Coweeta LTER co-PIs and some USDA Forest Service scientists at the Coweeta Hydrologic Lab, we found it difficult to enroll most of the ecological scientists in the process of actually drafting, writing, and editing the column. Between late 2010 and early 2011, we developed a portfolio of several articles, but it proved difficult to solicit additional ecologist-led columns.

These challenges came to a head at a Coweeta LTER meeting at the University of

Georgia in 2011, when many of the co-PIs were in attendance. One co-PI questioned CLP leadership in an honest, sincere attempt to understand how they ought to engage given that that particular co-PI did not live in Macon County and did not have time for another activity on their to-do list. In particular, the co-PI voiced concern about writing an article that might open them to unwanted public criticism and inhospitable messages. Further concerns were voiced about how writing articles would impact researchers' access to private lands in the county, noting that Coweeta LTER researchers had developed hard-won relationships with landowners over a period of years and that a controversial column under their name might jeopardize these relationships. These concerns underscored the fact that Coweeta LTER scientists experience many of the same hurdles that inhibit other scientists' public engagement: limited incentive to participate, already feeling pressed for time, unclear benefits of public engagement, and concern about the possible negative effects of being in the spotlight. Importantly, though, they also demonstrate that scientists do not turn away from public engagement only because they are *disconnected* from the public, but also because they are *connected* to the public in ways that are useful for research precisely because they are limited and can be carefully controlled to avoid misunderstanding or controversy. Our initial strategy of relying on ecologists to devote extra energy, thought, and time to our project was dependent on the very resources Coweeta LTER scientists themselves struggled to devote to their already ongoing projects.

After this episode, we shifted our approach from hands-on involvement of ecological scientists in collaborative writing to a logistically more pragmatic, community-focused, approach to developing articles. Our column is now typically written as follows: Instead of relying on the ecological scientists to write articles, members of the CLP collect and identify community ecological concerns through our interviews and informal conversations. As social scientists with

backgrounds in environmental policy and governance, participatory research, and grassroots activism, the other aspects of our work include a range of interviews, community meetings, and participant-observation. Immersion in the region through these activities generates column topics and helps to create the relationships necessary for co-production, albeit in a slightly mediated form (we are members of the LTER, but most of us are not natural or physical scientists).

Once we identify a topic of broad interest, one member of the Writing Collective reviews relevant Coweeta LTER science that can speak to this issue and writes a first draft that puts this science in the local perspective. The Writing Collective's lead editor circulates the draft to the entire collective and to the scientists whose research we report on. These readers have one week to offer suggestions, which the lead editor considers when revising the article before its final submission to *The Franklin Press*. This may seem like a subtle change, but it relieved pressure on ecological scientists so that they could spend less time on the process while still contributing to the CLP's efforts and to the community's knowledge of ecological science.

The columns run in the Macon Outdoors section under the title "Science, Public Policy, Community," and authorship is attributed to the Coweeta Listening Project Writing Collective, rather than to individuals. We retain copyright over published articles and republish them on our website (<https://listening.coweeta.uga.edu/>) alongside additional resources like original peer-reviewed research, maps, related media, and other action- or policy-oriented literature. This platform also allows for comments, with the idea that their comments and concerns (whether in the newspaper or via the web site) will be re-circulated to LTER scientists, continuing the circle of communication.

Findings on environmental communication via writing collectives

The CLP has now produced 40 columns for *The Franklin Press* addressing everything

from stream clearing, to steep slope development, to rainfall and climate change. Our experiences confirm many difficulties cited in the literature, prompting us to shift from an idealistic vision of ecological scientists directly engaging with non-scientists from the community and moving toward a more logistically pragmatic approach in which social scientists act as intermediaries. Delivering an article to the paper on time every two weeks, focusing it on a community-derived environmental topic, and grounding it in scientific literature from fields about which we are not experts pose real challenges. Nonetheless, we have found some success with collaborative authorship with scientists and graduate students, who were often more willing to participate, and having non-specialists write the first draft of a column to ensure that it is clear and accessible.

This experience has taught us a number of lessons about the science communication process, which we group roughly into “internal” lessons about the process and our scientists and “external” ones about the broader public. In terms of internal lessons, one difficulty relates to direct engagement with public media without using journalists to create content. While some science communication efforts attempt direct engagement in order to avoid misrepresentations by journalists (Evans, 2010), our engagement was less concerned with misrepresentation and more concerned with a desire to foster the long-term trust necessary for effective collaboration and ethnographic research. But the tight deadlines of journalism are a challenge for scholars accustomed to slower, longer writing projects that accommodate their other professional responsibilities. Writing a bi-weekly column continues to challenge the CLP Writing Collective, and though our production has been consistent during the academic semester, we have had some lags in production due to end-of-semester exam periods, school vacations, and summertime research and conference travel.

Interestingly, our process of collaborative writing and translation by social scientists led to a type of controversy that we did not anticipate. Because each column was not written exclusively by a single researcher to discuss her own research, the collective editorial process drew attention to disagreements in scientific opinion. In an early 2011 column, for example, we drew on the work of two Coweeta LTER scientists to write about land use decisions in areas near streams (riparian zones). During the editing process, these two scientists both challenged the lead author's representation of the scientific issues at hand, but they did so in conflicting ways. The differences grew larger, too, as we edited the document. Indeed, the editing process only seemed to draw out more disciplinary differences. Several times, CLP members deemed the ecological scientists' edits too technical for a newspaper, thus adding to the difficulty. More than a dozen emails were exchanged and it ultimately took a face-to-face meeting with both scientists and the lead author to hammer out exactly what the article ought to say. In a less collegial set of relationships, this circumstance could have created resentment. In our case, relationships were not harmed, but the situation still illustrated the potential for controversy over translations of scientific research. Furthermore, by provoking interaction across their scientific differences, this column encouraged both scientists to more fully engage with other scientific perspectives.

A third internal lesson is that changes in science communication can threaten or destabilize institutional relationships. One important example of this is our earlier discussion of scientists' concerns that communication might negatively affect their relationships with landowners. Another example is broader. Because the Coweeta LTER's research activities were traditionally carried out at the USDA Forest Service Coweeta Hydrologic Laboratory, many people erroneously conflate the two organizations. While we are careful to speak only for the LTER, some of our Forest Service counterparts have expressed concern about our science

communication activities. By actively engaging with the public, we change their historical status as some of the primary shapers of representations of science in the region, and this is particularly problematic to them given that we share a name but have different rationales for engagement.

A final internal consideration is that this model for translating ecological science, because it relies on social scientists as intermediaries, could have interesting implications for the relationship between social and ecological scientists working within the Coweeta LTER. Social scientists are in the minority among the co-Investigators of the Coweeta LTER. Many Coweeta LTER ecological scientists, like many ecological scientists more generally, have somewhat limited understandings of what social scientists do (the inverse is, of course, also true). Our leading role in these columns runs the risks of confirming stereotypes that social scientists are educators and outreach officers rather than researchers (Endter-Wada, Blahna, Krannich, & Brunson, 1998; Welch-Devine & Campbell, 2010); these columns and the entire effort to promote public engagement and co-production are, in fact, a component of our research about science communication and scientist–public interactions.

From the external perspective of Macon County residents, it has been more difficult to judge how effective we have been. As Rogers writes, “we know little about how audiences make sense of [complex scientific] information... when they encounter it in newspaper, television, and radio reports” (2000: 553). In our case, limited resources have precluded a widespread evaluation of reader reactions to the column. We therefore cannot say conclusively to what extent the columns have imparted new knowledge, prompted people to interrogate their own behaviors, influenced policy, or changed how scientists and non-scientists perceive one another. However, in our other action-research and ethnographic activities, and in interviews with the newspaper editors, we consistently hear from Macon County residents who “appreciate” the columns and

even detail what they have learned from them, we receive positive input from local environmental organizations, and we are often asked by residents of other counties if we could write for their newspapers as well. In these small ways, we believe that local discussions around environmental science are growing broader and more iterative, and that the column is helping to establish the Coweeta LTER as a recognized community institution, both of which are essential pre-conditions for more extensive collaboration and co-production. Moving forward, we hope to convene focus groups that further explore community perceptions of our newspaper columns, and engaged ethnographic work with local environmental advocates on issues such as stream health, forest management, and fracking should provide further insights into how these columns shape scientist–non-scientist relationships.

Though one motivation for translating scientific knowledge and engaging the public is to address urgent ecological issues, the CLP has had mixed results in inserting our voices into debates on these issues in Macon County and southern Appalachia more broadly. In one example, our columns translating science for best land use practices in riparian zones have addressed common residential land management practices: clearing streams of large woody debris rather than leaving it in the stream and cutting all vegetation along stream banks. While landowners have good reason to believe they are improving stream health and aesthetics by clearing this debris and vegetation, they actually are harming the stream’s vitality. Our column has made accessible to Maconians both ecological scientific knowledge about stream management and social scientific knowledge about landowner rationales for these practices. We have also noted significant enthusiasm from Coweeta LTER ecological scientists, often grounded in a deficit-model view of the public, about articles that aim to “improve” individual residents’ land management practices.

On the other hand, directly involving ecological scientists in this process has illustrated some of the dynamics that work against effective public engagement by scientists. In some instances, the “instrumental rationales” identified by Fiorino (1989) encouraged scientists to *withhold* their knowledge in order to avoid controversy. While other scholars have examined the extent to which fear of controversy demotivates public engagement by scientists, few have examined in depth the contours of these fears. In southern Appalachia, ecological issues involving local regulation are often controversial, and we have failed to produce timely, relevant columns on some critical issues because of these controversies. For example, in early 2011, just as the columns were becoming a regular feature in *The Franklin Press*, a county ordinance regulating residential development on steep mountain slopes became a political hot topic. Not only was the ordinance politically provocative, but so too were a suite of landslide hazard maps produced by the North Carolina Geological Survey (NCGS). The ordinance used the maps to identify high-risk areas that would be subject to the steep slope regulation. In a region long known for its general skepticism toward government intervention on private lands, it was unsurprising that a vocal minority of Maconians opposed the ordinance and the steep slope maps. Throughout 2011, the public debate turned especially controversial—so much so that some scientists were hesitant to write any column offering a scientific assessment of landslides, human activity on steep slopes, or of the NCGS’s mapping techniques for fear of damaging relationships with local landowners and of exposing themselves to public comment or legal accountability. While some in the CLP wanted to draft a column immediately, a steep slope column was delayed until 2012, months after the ordinance had been tabled.

The reluctance of some scientists to enter the controversial political discussion about steep slopes shows why ambitions to speak to pressing local issues can falter, even at this

moment when our contacts in Macon County were specifically requesting that the CLP draft a column on the topic. Because the CLP represents the Coweeta LTER and has colleagues at the Forest Service's Coweeta Hydrologic Laboratory, our interventions and visions for engagement are subject to the concerns, temperance, and future research plans of scientists. And because their work depends on a sometimes fragile network of relationships with landowners, anonymity and silence are often productive for research even while they work against other goals, namely more focused and meaningful engagement necessary to inform public debate and policy. As a complement to our columns, we have surveyed and interviewed all of the Coweeta LTER scientists about their views on knowledge production and public engagement, creating a baseline that we can re-visit in coming years to see how the CLP's public engagement activities have altered scientists' perspectives.

Finally, although this column has built rapport that we can use for other types of engagement, we have faced challenges sparking dialogue directly related to these columns. We have not yet seen real conversation in a public forum (whether a community event, a letter to the editor, or through our web site) around our columns in which local residents support, challenge, or reshape our presentations. In order to encourage more dialogue, we have tried to broach more controversial topics, we have used non-scientists as sources of information, we have occasionally included non-scientists in the editorial process, and we have explicitly requested that people share their personal experiences and knowledge, but to no avail. Because we want to engage diverse segments of the public, including those who may be unsympathetic to discussions of the environment, we are looking for additional ways to encourage feedback. Tapping into social media may be a partial solution, even in this low-connectivity region, but we think that further changes to the writing *process* may also be necessary. A logical next step may be to enlist

Maconians in the actual research and drafting of the columns, providing their own experiences and perspectives and marrying them with (or contrasting them with) Coweeta LTER science. We have begun to do this by partnering with a local land trust to write articles directly related to their campaign for stream health, but sharing our column with other Maconians may also be valuable.

Conclusions

Communication is not only about content and form, but also about the relationships established through the communication process. The social and material effects of environmental science communication are shaped by how information is constructed and with whom, at what stage different groups are brought in as interlocutors and collaborators, and how scientific results are disseminated. As described here, the Coweeta Listening Project has developed a collective writing process that begins with community environmental concerns, engages scientists in the drafting of newspaper columns to address these concerns, and then promotes community dialogue about the final product. Our hope is that this iterative, dialogical, and collective process will not only provide scientific information to the public, but more importantly will spur public dialogue about environmental issues and construct the foundations for collaboration and the co-production of ecological knowledge. One of the great challenges, however, is to create communication and public engagement processes that address scientists' concerns and hesitations.

Our model of collective authorship is promising in a number of ways. Bringing social scientists into the communication process helps foreground community concerns and provides resources for translating science into locally relevant terms. Because our social scientists are conversant in the literature on science communication and democratization, they have also helped frame our columns in a more dialogical and less pedantic style. Additionally, the

collective acts somewhat like a boundary organization, addressing some of scientists' key concerns about public engagement, including the time it takes from other professional responsibilities, distrust of journalists and fears of misrepresentation, and concerns about being singled out and exposed to public scrutiny. However, we are more than simple intermediaries because we seek to do more than repackage scientific information; we use communication as the first step in connecting scientists with diverse publics in order to bring different types of knowledge together in productive synergies.

Of course, science communication and knowledge production can only be democratized when scientists and non-scientists see the value of collaboration. Our columns have drawn attention to the Coweeta LTER as an information resource. Unfortunately, the issues that pique public interest in thoughtful engagement with science are often shrouded in controversy, which discourages scientists from sharing their knowledge or encourages them to frame findings in particularly narrow, irrelevant, and thus innocuous ways. In fact, one of the most important findings of this work is that scientists are often reluctant to engage the public not because they think such engagement is unimportant, and not only because they lack incentives or a professional culture favorable to engagement, but also because public communication and engagement require new, more extensive and intensive forms of interaction, which threaten the very limited, nearly anonymous, and largely silent social relations that make it easy to get in and out of research sites on public and private lands.

While segments of the public seem largely receptive to our columns and scientists appreciate them, we have been less effective at illustrating to scientists how public knowledge can enrich their work, a critical ingredient for meaningful collaboration and co-production. We have brought public knowledge to scientists' attention during meetings and research proposal

development workshops. However, because non-scientists have not used the columns as a springboard for dialogue with scientists, we may need to find other avenues for non-scientists to directly share their knowledge, perhaps not only as sources of inspiration for the columns, but also as co-authors and information sources. This may be particularly effective if we can enroll non-scientists to work alongside those scientists who are amenable to public input, typically those whose research addresses *socio*-ecological and/or applied concerns at the scales that matter to local residents. At the same time, we will continue to explore other methods of community engagement that can bring non-scientists into the scientific process (such as the translational dialogues and collaboration workshops) and we have already begun working with LTER scientists to build participatory activities into new research proposals.

We view our communication process as an ongoing experiment, which we will continue to analyze and refine as we attempt to move Coweeta LTER science toward a more engaged and democratic model. As we move forward, additional research will need to examine readers' responses to these columns, our experiments with further modifications to the writing collective's process, and how we can further leverage science writing as a key element in our portfolio, both on its own and to advance our other public engagement activities.

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