Comment

Increasing Conservation Impact and Policy Relevance of Research through Embedded Experiences

LEKELIA D. JENKINS,* SARA M. MAXWELL,† AND ERIK FISHER‡

*School of Marine and Environmental Affairs, University of Washington, 3707 Brooklyn Avenue NE, Seattle, WA 98105, U.S.A.
†Marine Conservation Institute and University of California Santa Cruz, 100 Shaffer Road, Santa Cruz, CA 95060, U.S.A.
‡School of Politics and Global Studies, Consortium for Science, Policy and Outcomes, Center for Nanotechnology in Society, Arizona State University, PO Box 875603, Tempe, AZ 85287-5603, U.S.A.

As researchers in conservation science and the field of science, technology, and society, we believe Rudd's (2011) framework, described in "How Research-Prioritization Exercises Affect Conservation Policy," for conceptualizing research has practical value. Rudd explores means to increase research impacts through techniques such as big-question exercises and exercises to determine best practices. As an additional means to increase the impact and policy relevance of conservation research, we suggest researchers embed themselves in the daily working environment of other communities, such as government offices, nongovernmental organizations (NGOs) or disparate scientific fields, to learn about the constraints and opportunities that influence conservation work in these communities.

In his thorough treatment of research impacts, Rudd presents the benefits and shortcomings of two frameworks for understanding and improving research impacts on policy in theory and in practice. Following Beyer (1997) and Amara et al. (2004), his first framework classifies research impacts as conceptual (policy makers are sensitized to new issues and change their beliefs), instrumental (policy decisions are affected directly by results of scientific research), and symbolic (results of scientific research are used to support established policy positions). In his second framework, which he bases on Shaxson (2009), Rudd classifies research issues into 4 domains according to the extent that scientific knowledge is fully developed and the policy issue is clearly articulated: domain of uncertainty (low scientific knowledge, low policy articulation), domain of evidence (low scientific knowledge, high policy articulation), domain of partisanship (high scientific knowledge, low policy articulation), and domain of best practices (high scientific knowledge, high policy articulation). Rudd highlights the importance of scientists understanding "the pathways through which research influences policy," but he notes that most research has had little impact on policy making "due to the difficulty of linking specific research outputs with explicit changes in policy and regulations." Rudd also discusses how the "domain of uncertainty" can be a particularly difficult context in which to conduct impactful research because both the articulation of the policy issue and the scientific knowledge is low. This domain often lends itself to unaligned research (i.e., research unrelated to policy and with uncertain policy value) (Rudd 2011). We agree that big-question exercises and exercises to determine best practices can address some concerns about unaligned research, but it can also require the resource-intensive engagement of a large group (Sutherland et al. 2011).

We highlight embedded experiences as another means to increase research impact, even in the domain of uncertainty, which can be more easily applied by individual scientists and tailored to specific research interests. Spending an intensive period enmeshed in the culture and operations of other work communities allows scientists to bridge the gaps between research outputs and policy change, and research outputs and conservation impact. The embedded experience, which can range from conducting highly structured research to being a casual participant-observer in another community, gives scientists opportunities to build personal relationships with their counterparts that may improve the impact of their work on conservation policy and practice. These relationships can facilitate the spread of new ideas, including those with conceptual impacts that alert policy makers to new ideas (Rogers 1995). An embedded

email kikij@uw.edu
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scientist may also learn the constraints and initiatives specific to a particular community—knowledge that can be used to better link research outputs to policy needs and opportunities.

In the United States, the American Association for the Advancement of Science (AAAS) Science and Technology sponsors policy fellowships in which "accomplished scientists and engineers . . .participate in and contribute to the federal policymaking process while learning firsthand about the intersection of science and policy." These fellows serve a 1- to 2-year term, working full-time in executive and legislative branch offices. Fellows routinely cite how the experience and knowledge they gained in the program allowed them to increase the impact of their work. For example, during her fellowship Susan E. Campbell worked with the U.S. Agency for International Development (USAID) and was tasked with establishing an approach to international development and aid in Asia that would limit undesirable effects on biological diversity. Campbell's background as a biologist allowed her to quickly identify experts and assimilate the available scientific information pertaining to locations in Asia with a high concentration of native and endemic species. Her embedded experience gave her a deeper understanding of the organizational culture of USAID and their partner organizations. She was able to identify a realistic and viable approach to development that USAID had not considered and that potentially had more conservation benefit than other options. Campbell's idea was to maximize the level of scrutiny in environmental-impact assessments beyond the standard to more thoroughly evaluate the environmental impacts of all development. This approach offers environmental-impact oversight to a larger area and could lead to protection of areas as needed rather than protection of a limited number of areas with high levels of biological diversity as originally planned. Campbell's approach was favorably received and pursued because it allowed USAID to increase the potential for conservation benefits by leveraging their resources for environmental impact assessments and well-informed aid decisions, rather than establishing protected areas that were outside their authority to govern.

Fellows often cite that after the fellowship program the policy relevance of their work increased. Ripple effects include serving on government advisory committees, establishing research programs that provide data for implementing specific conservation laws, and filling gaps in data government managers had been struggling to fill. Their embedded experiences often allow them to address local issues and specific present and future needs than is possible with big-question exercises and exercises to determine best practices.

Where formal embedded experiences are not available, as is often the case in developing countries, informal embedded experiences can be useful. An international team of scientists used satellite tracking to study sea turtles in Gabon through an informal collaboration with the Wildlife Conservation Society (WCS), an NGO that plays a large role in managing parks in the region. The researchers worked from the WCS local offices and lived and worked with park managers and rangers for months at a time, learning the day-to-day operations and limitations of park management. As a result of this embedded research experience, participants tailored their research to meet the needs of WCS park managers through their in-depth understanding of the resource constraints of the community. Their findings are being used by WCS and Parcs Nationaux Gabon to redesign a marine protected area in the region (Witt et al. 2008; Maxwell et al. 2011). The embedded scientists returned to Gabon for meetings to shepherd their findings through management changes, where they capitalized on their relationships with park managers made during the embedded experience (Jenkins & Maxwell 2011).

Embedded experiences can help make the "domain of uncertainty" more tractable for conducting research that informs policy, management, and practice. For example, embedded researchers can intricately explore the social and institutional practices that may affect emerging policy-relevant developments and render them more visible to researchers, decision makers, and stakeholders. Engaging a diversity of stakeholders in semistructured reflection on their own practices, knowledge, and assumptions not only informs research and policy agendas, but also alters behavior and informs expectations and thus promotes conservation. Such stakeholder engagement complements big-question exercises and exercises to determine best practice, which play important roles in creating research agendas but tend to extract information from a narrower set of stakeholders (for instance, scholarly perspectives rather than those of practitioners) and may therefore limit discussion. Embedded researchers can rapidly transition through multiple expert and practitioner settings, integrate potentially transformative information and perspectives into these settings, compile the knowledge of a breadth of stakeholders, and put information into the relevant research and policy contexts. Embedded researchers can also identify issues whose policy relevance may still be emerging. Such embedded and early assessments can help researchers better align research choices and decisions with policy goals (Macnaghten et al. 2005). For example, if researchers were to identify an issue that is rapidly moving from the "domain of uncertainty" toward the "domain of evidence," they could conduct research aimed at producing robust and reliable results that could be used to inform policy.

The experiences of a set of embedded researchers are helping to inform governance of nanotechnology, an issue in the realm of uncertainty. Many laboratories work with engineered nanoparticles (tiny objects of 1–100 nanometers that can exhibit novel physical and biological properties) for which the environmental effects are currently unknown, despite toxicological studies. Although these particles do not appear in nature and may enter animal and plant cells, no specific federal or international regulations exist that pertain to these particles, despite rising concerns (Committee to Develop a Research Strategy for Environmental Health Safety Aspects of Engineered Nanomaterials & National Research Council 2012). Some nanotechnology practitioners, taking a novel approach to embedded research, have opened their laboratories to humanists and social scientists trained in conducting "socio-technical integration" (Fisher 2007). These embedded researchers are part of the Soci-Technical Integration Research (STIR) program that operates in over a dozen nations (Wynne 2011) and typically spend 3 months or more as participant-observers in nanotechnology and other laboratories. Using ethnographic and other techniques, these researchers help laboratory workers reflect on the often-underappreciated social and environmental aspects of their research and on what research changes they might make on the basis of their reflections.

These embedded researchers have found that some laboratories routinely dispose of engineered nanoparticles in municipal waste streams, where they could enter the environment. Yet they have also found that engaging with laboratory workers about this issue during the normal course of laboratory experiments can lead the practitioners to change their disposal practices and call for regulatory clarity in this area (B. Miorin and T. Benn, unpublished report). Embedded research within the fields of medical genetics (Conley 2011) and industrial biotechnology (Schuurbiers 2011) have produced similar policy-relevant changes in laboratory practices. Inviting embedded humanists, social scientists, or even stakeholders into laboratories and field sites for in-depth and ongoing dialogue can be another valuable and flexible way to align research objectives, conservation values, and policy outcomes.

In addition to use of big-question exercises, exercises to determine best practices, and the two frameworks Rudd presents, we encourage the conservation community to make greater use of embedded experiences to improve the conservation and policy relevance of their research.

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