Translational Science Partnerships: Key to Environmental Stewardship

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Key to enhancing the societal relevance of ecological knowledge is effective relationship building among scientists, ecosystem managers, and policymakers to create translational science partnerships that have sufficient capacity to address the mounting environmental challenges that confront human society. The Millennium Ecosystem Assessment, the National Research Council's (2009) *New Biology for the 21st Century*, and the National Science Foundation's Advisory Committee for Environmental Research and Education Report provide compelling arguments for greater integration of science within social organizations and policies in order to promote environmental stewardship. Translational science has been adopted by the medical sciences to more effectively disseminate and apply scientific knowledge to improve human life. Although specific definitions of *translational science* are numerous and varied, the term has multidisciplinary problem solving at its core—a goal that is central to ecological science. In contrast, ecological research institutions, including universities, have been less effective in translating ecological knowledge into action compared with the medical sciences. Less effective knowledge translation implies that various obstacles exist to limit the recognition and to impede the development of translational science partnerships that are essential to the dissemination and application of ecological knowledge in social organizations.

A recently completed assessment of the effectiveness of the US Department of Agriculture's (USDA) ecosystem-management programs, which affect 188 million hectares of privately owned rangelands in the United States, provides a unique case study to identify both the major obstacles and potential solutions for the development of translational science partnerships. This project engaged 30 USDA technical specialists and national program staff members and 40 scientists over a four-year period to complete an unprecedented integration of science, management, and policy knowledge within the 60-year history of the rangeland profession. This assessment highlighted five major obstacles, of varying transparency, to the development of translational partnerships and three categories of solutions that may inform the development of translational science in ecology.

The first major obstacle is the potential for competing agendas and motivations that may interfere with the development of trust among stakeholders in aspiring partnerships. The USDA assessment was initiated by the Office of Management and Budget to ascertain the societal benefits derived from federal expenditures on ecosystem management. Consequently, many USDA personnel were focused on scientific validation of the existing conservation programs, whereas research scientists emphasized the incorporation of contemporary scientific knowledge within these programs. These subtle distinctions, in an otherwise common agenda, can create an underlying tension or overt conflict that must be recognized and managed to strengthen emerging partnerships.

Second, uncertainties exist regarding the appropriate procedures to prioritize and integrate scientific and experiential knowledge. Each stakeholder group holds their information source in the highest regard and is less familiar with those of other stakeholders. This issue is compounded by the use of distinct styles of inquiry in science and management that generate unique knowledge sources that can prove difficult to integrate. Science emphasizes hypotheses testing, usually through highly regulated manipulation of a small number of ecological variables at relatively small scales over short time frames, to develop a process-based understanding of ecosystem structure and function. In contrast, managers often obtain experiential knowledge by observing qualitative indicators across large and frequently diverse landscapes to devise management rules of thumb that are based on the successes and failures of management actions and policy recommendations. Knowledge integration proved to be especially challenging in this assessment, because science and management or policy had operated with surprisingly minimal interaction throughout the history of the rangeland profession such that these two knowledge sources had diverged and become embedded within their respective social organizations.

Third, scientific knowledge often lacks sufficient context for successful application to ecosystem management and policy, because these actions occur within complex adaptive systems characterized by ecological, economic, and cultural components that collectively determine system responses and management outcomes. Research programs have, until recently, been focused primarily on ecological—and, to a lesser extent, economic—components to guide management and policy recommendations. It is not surprising that this assessment identified the limited understanding of human goals and values regarding ecosystem management as the most significant knowledge gap and called for greater involvement of social scientists in future research.

Fourth, involvement in translational partnerships is rarely recognized or encouraged by the respective social organizations, and when it is undertaken, it is often relegated to secondary status by its being added to existing high-priority responsibilities. Academic institutions are beginning to recognize the value of *boundary spanners*—individuals who create shared meaning among organizations by relationship building—but these individuals are often self-motivated and

function beyond the norms of traditional academia. Natural-resource agencies would similarly benefit from having boundary spanners on staff, but few incentives exist for interaction with the scientific community, and these interactions may be viewed as being beyond the scope of agency employees' professional responsibilities, and in some cases, they may even be interpreted as being counter to agency goals and interests.

Fifth, natural-resource management agencies are consistently confronted with the need to document the value of societal benefits derived from ecosystem management in order to satisfy political interests that emphasize returns on taxpayer investments. This is extremely problematic, because a protocol does not exist to reliably estimate the potential economic costs of environmental degradation, which may have been averted by effective ecosystem management, and management programs seldom monitor either short- or long-term environmental benefits. The inability to effectively incorporate the potential cost of inaction and to value nonmarket services within cost–benefit analyses greatly undervalues these investments. Consequently, in this assessment, most management programs, regardless of their ecological effectiveness, were determined to be cost ineffective when they were evaluated in the context of the quantified market value of the commodities originating from management actions.

Solutions to navigating these obstacles to promote greater integration of ecological knowledge within social organizations and policies are challenging, and no shortcuts were identified to the time-consuming task of effective relationship building. Solutions will require a reassessment of how scientific knowledge is perceived and valued by various social organizations, as well as organizational and operational modifications to promote knowledge generation and transfer. Three broad categories of solutions emerged from this assessment.

First, knowledge flow within these partnerships must be multidirectional, rather than originating solely from the most-powerful stakeholders. Academic institutions and individual scientists need to recognize that translational science partnerships are not effectively supported by knowledge generation alone but that information flows most effectively through human relationships when stakeholders are provided with the context and implications of scientific knowledge. Similarly, natural-resource management agencies would benefit from having additional boundary spanners on staff to provide rapid evaluation and incorporation of contemporary scientific information and to inform the research agenda of critical knowledge gaps in management and policy issues. The success of this partnership originated from the presence of influential boundary spanners in both the USDA and the academic community, and it is difficult to envision how translational partnerships could be successful without their involvement, especially during the most-challenging phases, when power sharing is essential.

Second, ecological monitoring programs must be funded and implemented to provide the critical information necessary to close the feedback loop between policy implementation and subsequent social and ecological outcomes. Participatory monitoring facilitates communication and decisionmaking among stakeholders, lends credibility to the results generated, and increases the likelihood of acceptance and adoption of the resultant policy recommendations. Unfortunately, the monitoring of ecosystem management and conservation programs has traditionally been viewed as unnecessary, because the inherent value was considered self-evident, or it was envisioned as being too costly. In other cases, monitoring data is collected, but it is not regularly analyzed and interpreted to inform management and policy recommendations in a timely manner. However, in an era of increased accountability for taxpayer investments and greater involvement of multiple stakeholder groups, these assumptions have become increasingly challenged and require a more transparent evaluation of the societal benefits of these investments.

Third, management or policy recommendations are devised and implemented in socioecological systems characterized by a large number of complex and poorly understood human values, goals, and cultural norms. This assessment identified the omission of social metrics associated with ecosystem management as a serious deficiency in the formation of translational science partnerships. Social science can yield greater insight into our social organizations and can inform research approaches to generate a knowledge source that is more relevant to the adaptive management of socio-ecological systems.

Translational science partnerships possess the potential to generate knowledge sources that are more relevant to management and policy concerns and that more effectively translate science to nontechnical audiences. Enthusiastic commitment to this assessment on behalf of the research community and the expressed interest of the USDA in continuing and formalizing these partnerships indicates that this template may be applicable in diverse ecological fields. Medical science refers to translational science with the metaphor "from bench to bedside"; ecological science may be well served by embracing the metaphor "from investigation to institution" to strengthen science–management–policy partnerships as a means of increasing the societal relevance of ecological knowledge.

Reference cited

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