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OPINION ARTICLE

Bridging Restoration Science and Practice: Results and Analysis of a Survey from the 2009 Society for Ecological Restoration International Meeting

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Abstract

Developing and strengthening a more mutualistic relationship between the science of restoration ecology and the practice of ecological restoration has been a central but elusive goal of SERI since its inaugural meeting in 1989. We surveyed the delegates to the 2009 SERI World Conference to learn more about their perceptions of and ideas for improving restoration science, practice, and scientist/practitioner relationships. The respondents' assessments of restoration practice were less optimistic than their assessments of restoration science. Only 26% believed that scientist/practitioner relationships were "generally mutually beneficial and supportive of each other," and the "science–practice gap" was the second and third most frequently cited category of factors limiting the science and practice of restoration, respectively ("insufficient funding" was first in both cases). Although few faulted practitioners for ignoring available science, many criticized scientists for ignoring the pressing needs of practitioners and/or failing to effectively communicate their work to nonscientists. Most of the suggestions for bridging the gap between restoration science and practice focused on (1) developing the necessary political support for more funding of restoration science, practice, and outreach; and (2) creating alternative research paradigms to both facilitate on-the-ground projects and promote more mutualistic exchanges between scientists and practitioners. We suggest that one way to implement these recommendations is to create a "Restoration Extension Service" modeled after the United States Department of Agriculture's Cooperative Extension Service. We also recommend more events that bring together a fuller spectrum of restoration scientists, practitioners, and relevant stakeholders.

Key words: alternative research paradigms, practical relevance, restoration extension service, science–practice gap, SERI survey.

Introduction

Ideally, restoration ecologists provide ideas, guidance, and rigorous data that benefit restoration practitioners, whereas practitioners put the science into practice, exchange insights with the scientists, and make their project sites available for them to develop and test their theories. Developing and strengthening a more positive, beneficial relationship between scientists and practitioners has been a central goal of the Society for Ecological Restoration International (SERI) ever since its inaugural meeting in 1989. Many pioneering restoration scientists similarly believed that the work of restoration ecologists and practitioners was and should be closely related and interdependent. For example, in their classic *Restoration Ecology, A Synthetic Approach to Ecological Research*, Jordan et al. (1987) wrote that "both the restorationist and the restoration ecologist seek to reconstruct the system—the one in order to conserve it, the other in order to test ideas or to demonstrate an understanding of it. Recognizing this, and taking advantage of it, might provide a solid basis for a closer, two-way relationship similar to the one that exists in medicine, where clinical work and basic research often proceed hand in hand."

Up until the late 1980s, however, ecological restoration was still largely the domain of on-the-ground practitioners. Although the journal *Ecological Restoration* (published by the University of Wisconsin Arboretum) had been documenting these early practitioner efforts since 1981, only a few scientists at that time were exploring the scientific underpinnings of ecological restoration and the potential of restoration projects for testing ecological hypotheses (c.f. Holdgate & Woodman 1978; Bradshaw & Chadwick 1980; Jordan et al. 1987; Cairns 1988).

The appearance of SERI's journal *Restoration Ecology* in 1993 was a significant and long-overdue step toward melding restoration science and practice. In the late 1980s, the National Science Foundation (NSF) in the United States

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also launched an eight-year Special Program to fund research in conservation biology and restoration. Following another workshop organized by the NSF in 1996 to encourage more scientists to become involved in restoration, Clewell and Rieger (1997) identified 15 specific research areas where ecologists could make substantial contributions to the practice of restoration ecology.

Unfortunately, these efforts did not lead to research proposals and scientific programs with direct relevance to the practice of ecological restoration. For instance, in a review of NSF's Special Program, Allen et al. (1997) noted that "there are now thousands of restoration and reclamation projects across the country, but only a small portion of them has been planned, scrutinized, and measured by ecologists and other scientists." Similarly, although papers such as Clewell and Rieger (1997) have been widely cited, few ecologists have performed the kind of practically valuable research programs they call for. Consequently, the discipline and literature of restoration ecology have remained dominated by ecological studies conducted in restoration settings rather than research programs and papers that actually inform and facilitate on-the-ground restoration efforts (Bainbridge 2007; Cabin 2007a,b; Halle 2007). Ecologists have also begun to realize that performing practically-relevant research requires more than high-profile academic publications (Wright et al. 2009). For example, a survey of stream restoration practitioners (Bernhardt et al. 2007) found that less than 1% of over 300 restoration projects were actually informed by scientific journal papers.

On the other hand, because practitioners rarely write the kind of rigorous, peer reviewed papers that might interest restoration ecologists, their literature is seldom cited in academically-oriented ecological publications (Clewell 2009). Many practitioners also continue to rely on protocols that they developed themselves before the discipline of restoration ecology rose to its present prominence. Academically-trained researchers often criticize these protocols and the practice of ecological restoration in general for not being sufficiently "scientific" and tend to view practitioners as undisciplined and overly reliant on "uninformed gut feeling decisions" (e.g. Pohlon et al. 2007). Practitioners frequently retort that such ecologists have little comprehension of or experience with the actual practice of restoration in the messy real world.

Fortunately, however, there now appears to be growing interest from both sides to address these kinds of problems. For instance, SERI's new web-based "Global Restoration Network" (SERI 2010) aims to "link research, projects, and practitioners in order to foster an innovative exchange of experience, vision, and expertise," and this journal initiated the "*Implications for Practice*" section requiring authors to highlight the practical implications of their work. Additionally, recent books (e.g. Temperton et al. 2004; Falk et al. 2006) have begun to analyze the gap between restoration scientists and practitioners.

In this spirit, we organized a special session at the 2009 SERI World Conference in Perth, Australia, entitled *Developing and Strengthening Mutually Beneficial Relationships among Restoration Ecologists and Practitioners*. Prior to this conference, we also sent an on-line survey to all of the SERI registrants to learn more about their perceptions of and ideas for improving the science of restoration ecology, the practice of ecological restoration, and the relationship between these two disciplines. Here we present and discuss the results and implications of this survey.

Methods

We designed a brief, confidential, on-line survey comprised of seven multiple choice and three open-ended questions (Table 1). Between July 27th and August 17th, 2009, SERI emailed invitations to take this survey to all of the Perth delegates that did not check the privacy box on their web registration form. After analyzing all of the completed surveys, we created a series of post hoc categories to encapsulate the answers to our open-ended questions and assigned each response to the most appropriate category.

Results

Multiple Choice Questions

Seventy-one percent (381/536) of the delegates that received SER's invitation to take our survey (536 of the 686 total delegates) completed at least the multiple choice portion of it. Sixty-two percent of these respondents lived in Australia or the Pacific, 16% in North America, and 10% in Europe (Table 1). Almost one-third (31%) classified themselves as government employees, followed by academics (25%), students (17%), and private-sector employees (14%). Half of the respondents were involved with research related to ecological restoration, almost one-quarter (23%) designed, managed, administered, or funded restoration projects, and 15% were restoration practitioners.

Although 80% of respondents considered the science of restoration ecology to either be "in great shape and getting stronger" or at least on the right track, 45% classified the actual practice of ecological restoration as "still not widely and/or adequately performed," (Table 1 & Fig. 1). When asked their perception of the relationship between the practice and science of restoration, 26% of the respondents believed they were "mutually beneficial and supportive," 53% thought they were "occasionally mutually beneficial and supportive of each other and occasionally independent of and irrelevant to each other," and 11% considered this relationship to be either "independent of and irrelevant to each other" or "occasionally independent of and irrelevant to each other and occasionally competitive and antagonistic" (Table 1).

When asked their perception of the practice of ecological restoration relative to other fields of conservation such as ecosystem management, forestry, and wildlife management, 9% felt that the separation was mostly clear and distinct, 40% believed that these other fields were sometimes identified as "ecological restoration" in ways that diminished "real" ecological restoration, and 32% acknowledged that the term "ecological restoration" was sometimes applied inappropriately but did not see this as particularly problematic (Table 1).

Table 1. Anonymous on-line questionnaire administered to delegates at the 2009 SERI World Conference in Perth, Australia between July 27th and August 17th.

Multiple Choice Questions

1. Where do you live?

   A. Australia/Pacific (237)
   B. North America (61)
   C. Latin America/Caribbean (15)
   D. Middle East (1)
   E. Europe (39)
   F. Africa (7)
   G. Asia (21)

2. Select the below statement that best describes your present or most recent occupation with relevance to ecological restoration.

   A. I am a student (63)
   B. I am an academic employee (95)
   C. I am a government employee (119)
   D. I am employed by a non-profit organization (31)
   E. I practice ecological restoration as a volunteer (5)
   F. I am employed in the private sector (54)
   G. I own, manage, or lease private land, and I conduct ecological restoration on it (7)
   H. None of the above (7)

3. Select the below statement that best describes your present involvement.

   A. I perform research that is directly or indirectly relevant to ecological restoration (191)
   B. I am a restoration practitioner (58)
   C. I design, manage, administer, direct, or fund restoration projects (86)
   D. I issue permits or otherwise regulate projects for a public agency (7)
   E. I teach people about ecological restoration (19)
   F. I am involved in ecological restoration but from another perspective, such as journalism, art, philosophy, or environmentalism (15)
   G. I have essentially no direct involvement with ecological restoration (5)

4. Select the below statement that best characterizes your point of view about the present status of the ***PRACTICE*** of ecological restoration.

   A. It is in great shape and getting stronger and more powerful every year (13)
   B. It is starting to gain a significantly large group of supporters and adequately trained practitioners (179)
   C. It is still not widely and/or adequately performed (171)
   D. I am not in a position to meaningfully answer this question (18)

5. Select the below statement that best characterizes your point of view about the present status of the ***SCIENCE*** of restoration ecology.

   A. It is in great shape and getting stronger and more powerful every year (30)
   B. It is starting to gain a significantly large group of supporters and adequately trained scientists (236)
   C. It is still not widely and/or meaningfully performed (89)
   D. I am not in a position to meaningfully answer this question (26)

6. Select the below statement that best characterizes your point of view about the present ***RELATIONSHIP*** between the practice of ecological restoration and the science of restoration ecology.

   A. They are in general mutually beneficial and supportive of each other (98)
   B. They are occasionally mutually beneficial and supportive of each other and occasionally independent of and irrelevant to each other (202)
   C. They are in general independent of and irrelevant to each other (20)
   D. They are occasionally independent of and irrelevant to each other and occasionally competitive and antagonistic (23)
   E. They are in general competitive and antagonistic of each other (0)
   F. I am not in a position to meaningfully answer this question (38)

7. Select the below statement that best characterizes your perception of the practice of ecological restoration relative to other fields of conservation (e.g. ecosystem management, forestry, wildlife management, etc.).

   A. The separation between the practice of ecological restoration and practices in other fields of conservation is mostly clear and distinct (33)
   B. Management practices in other fields of conservation are sometimes identified as "ecological restoration" in ways that blur and/or diminish "real" *ecological restoration*, which is a significant problem that should be addressed (153)

Table 1. Continued

C. I am aware that the term "ecological restoration" is sometimes applied inappropriately, but this does not seem like an important issue that needs to be addressed (122)
D. I am not in a position to meaningfully answer this question (122)
E. I have no strong opinion on this subject (73)

Open-Ended Questions

8. Briefly state what you believe is the single most important factor currently limiting the practice of ecological restoration, and what you believe could and should be done to remedy this situation (300)
9. Briefly state what you believe is the single most important factor currently limiting the science of restoration ecology, and what you believe could and should be done to remedy this situation (282)
10. Please feel free to share any additional relevant comments in the space below (80)

Numbers in parentheses are the number of delegates that selected each answer (multiple choice questions) or provided a written response (open-ended questions).

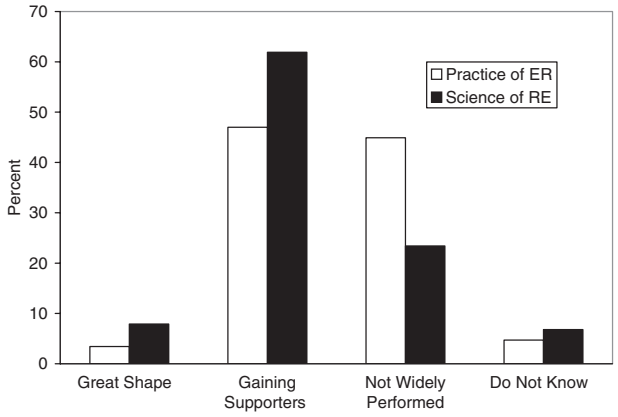

Figure 1. Results of multiple choice survey questions asking delegates attending the 2009 SERI World Conference to assess the present status of the practice of ecological restoration and the science of restoration ecology ($N = 381$).

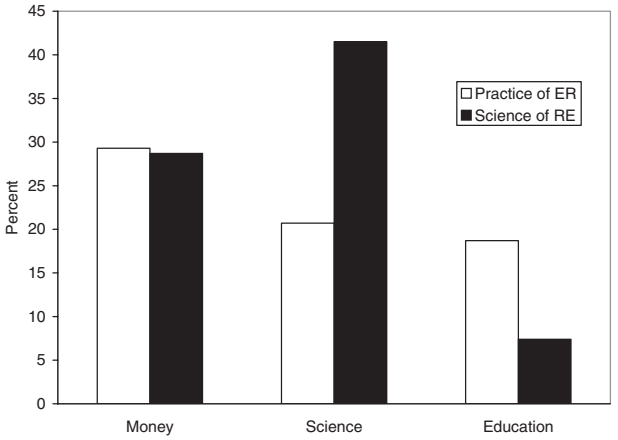

Figure 2. Results of open-ended survey questions asking delegates at the 2009 SERI World Conference to state what they believed was the single most important factor currently limiting the practice of ecological restoration and the science of restoration ecology ($N = 300$ and 282 for these two questions, respectively).

Open-Ended Questions

Over two-thirds of the delegates' responses to our questions asking them to state what they believed was the "single most important factor currently limiting the practice of ecological restoration" and "single most important factor currently limiting the science of restoration ecology" (Table 1) fell into the same three major categories (Fig. 2). About 30% believed that "money" was the most important limiting factor. Some delegates simply stated that there was not enough funding to do necessary projects or research; others added that funding too often was unreliable, poorly administered (e.g. inappropriate restrictions and time-frames), and/or did not allow for on-going maintenance, monitoring, and assessment.

"Science" (21%) was the next most commonly identified factor limiting the practice of restoration. Comments within this category focused on the "science–practitioner gap," shortfalls in scientific and restoration knowledge, inadequate monitoring and assessment, and problems associated with small-scale, short-time frame, reductionist research models. Almost as many respondents (19%) identified "education" as the most important factor limiting the practice of restoration. These comments included the continuing absence of public awareness of and appreciation for restoration and inadequate training and education within relevant industries, government agencies, and the general public.

The most commonly identified factor (42%) limiting the science of restoration ecology was "science" itself. Many once again stressed the need for better links between this science and the actual practice of restoration, while others focused on gaps in our knowledge and problems with the scope and framework of our research paradigms. Relatively few (7%) respondents identified "education" as the most important factor limiting restoration science.

Most of the delegates who responded to our invitation to share additional thoughts reiterated the importance of improving restoration science and knowledge, bridging the science–practitioner gap, and creating more and better educational programs. Some also discussed clarifying and codifying our restoration mission, philosophy, and/or standards. Proposed solutions tended to address what each respondent perceived as the major limiting factor or factors. For instance, those that believed money was limiting argued that we should prioritize obtaining more funding for restoration research

and on-the-ground programs, while those that believed the science–practice gap was limiting argued for various reforms to help bridge this gap.

Discussion

At least within this particular survey population (composed of delegates to the 2009 SERI World Conference, of which 60% were from Australasia and nearly 30% North America and Europe) there was substantially more optimism about the present status of the science of restoration ecology relative to the present status of the practice of ecological restoration. However, 42% of the delegates believed that science itself was the single most important factor limiting the science of restoration, but only 21% believed that science was the most important factor limiting the practice of restoration. The "science–practice gap" was the second and third most frequently cited factor limiting the science and practice of restoration, respectively ("insufficient funding" was first in both cases). Further analysis of these comments confirmed our hypothesis that despite some recent progress, this gap remains a major barrier to more and better restoration.

Are restoration ecologists ignoring the needs of practitioners, or are practitioners ignoring relevant science produced by restoration ecologists? Even though there were three times more researchers than practitioners within our survey population, their comments consistently favored the practitioners. Although only a very few respondents faulted practitioners for ignoring available science, many criticized restoration ecologists for ignoring the pressing needs of practitioners, performing irrelevant research, and/or failing to effectively communicate their work to nonscientists. Some also argued that ecologists had more to learn from practitioners than practitioners did from ecologists. On a more positive note, many of the researchers themselves were aware of these problems and seemed committed to addressing them.

We concur with these sentiments and similarly believe that the practice of ecological restoration has directly benefited the academic discipline of restoration ecology. For example, this practice has at least partly served as Bradshaw's (1987) "acid test" of ecology and helped "invigorate" the science (Young et al. 2005), although we also believe that more interaction between practitioners and scientists throughout project planning, implementation, and monitoring is necessary for restoration to be a "complete" acid test (Temperton et al. 2004). Yet conversely, despite the recent proliferation of scientific publications on restoration ecology, restoration practice remains more advanced than restoration theory (Comin 2010), and thus the extent to which the work of practitioners has benefited from restoration research remains unclear.

The challenge of bridging the scientist–practitioner gap is by no means unique to restoration—people within fields ranging from agriculture to medicine have been struggling to connect science to the "real" world ever since disciplinary science emerged (Rosenberg 1971). Given the magnitude of today's environmental crises and the extent to which many politicians and decision-makers continue to ignore the recommendations of scientists studying these problems, it is not surprising that bridging the science/practitioner gap has proven to be particularly difficult in disciplines that involve both the environment and a diverse assemblage of human stakeholders (Bradshaw et al. 2008, Sunderland et al. 2009). For instance, conservation biology, which from the beginning similarly dedicated itself to an activist, problem-solving agenda, has and continues to struggle to close its own considerable science/practitioner gap (e.g. Ehrenfeld 2000; Whitten et al. 2001; Kleiman 2003; Cabin 2007a; Sunderland et al. 2009).

One reason why this chasm has proven so intractable is that scientists and practitioners typically work within separate institutional and cultural settings with very different expectations and values (e.g. Allen et al. 2001; Higgs 2005; Young et al. 2005; Cabin 2007a,b; Temperton 2007; Shanley & López 2009). Moreover, some of the goals of sciences like restoration ecology (e.g. generalizable knowledge and conceptual frameworks) often conflict with those of applied disciplines like ecological restoration (e.g. site-specific knowledge and timely on-the-ground solutions). Thus to address these kinds of inherent conflicts we need to facilitate on-going interactions between these two groups so that the general, conceptual science and site-specific practitioner knowledge continually inform and refine each other (Hobbs and Yates 1997; Hobbs and Harris 2001).

What else can we do to help develop and strengthen mutually beneficial relationships between restoration ecologists and practitioners? Although the SERI delegates who took our survey offered an impressive diversity of insightful responses to this question, most of their suggestions fell within one or both of two general recommendations: (1) Develop the necessary political support that will ultimately lead to more overall funding for restoration science, practice, outreach, and educational programs; and (2) Create and support (through journal publications, funding competitions, employment opportunities, etc.) alternative research paradigms and programs that truly inform and facilitate the work of practitioners and promote more open and honest exchanges between restoration scientists and practitioners.

We concur with these recommendations and believe that SERI and other relevant organizations should strive to follow them. One potentially effective way of implementing these recommendations is to create a "Restoration Extension Service" modeled after the United States Department of Agriculture's Cooperative Extension Service, which has successfully disseminated knowledge from the agricultural sciences to relevant stakeholders and relayed the problems of these stakeholders back to the scientists (Cash et al. 2006). This new organization could similarly be supported by government funds generated by fees for activities that take advantage of or risk damage to ecosystem services. Ideally, this Restoration Extension Service would be staffed by people who could both facilitate effective communication among the diverse members of the restoration community and provide the kind of leadership and coalition building skills that could ultimately result in greater political

and financial support for restoration science and practice (e.g. Olsson et al. 2004). The growing number of new, more holistic restoration education and training programs (Aronson 2010) suggests that there may soon be an increasing number of young professionals that would be willing and able to effectively take on these critically important responsibilities.

Finally, we believe that SERI and other relevant organizations should organize more activities that bring together a broader and more balanced spectrum of restoration scientists, practitioners, and stakeholders (c.f. Aronson & van Andel 2006; Walker & Salt 2006). The insights and coalition building that would likely emerge from these interactions could then be applied to real-world restoration projects and research programs. This in turn could provide us with another potentially powerful tool to help bridge the gap between the science of restoration ecology and the practice of ecological restoration.

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