What Kind of Scientist Are You? Science and Interdisciplinary Research

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Abstract
Scientific research that crosses disciplinary boundaries ("interdisciplinary research") – and in particular, research that crosses academic boundaries to engage with industry, government and non-government agencies, and the broader public – can be rewarding personally and yield novel approaches and findings. While the scholarly literature suggests that interdisciplinary approaches are of immense value, interdisciplinary research carries challenges to academics, particularly in terms of funding and in relation to finding an academic "home." In this article, the author outlines what is meant by interdisciplinary research and reflects on her career leading from graduate school to tenure. She illustrates how the interdisciplinary projects she has been involved in have been both rewarding and challenging. While not every scientist must be interdisciplinary, she concludes that being open to such an approach has many advantages.

Keywords
Landscape ecology; Interdisciplinary research; Transdisciplinary research; Applied science

Résumé
La recherche scientifique qui dépasse les frontières disciplinaires (la recherche « interdisciplinaire ») —et, particulièrement, celle qui dépasse les frontières académiques pour s'engager avec l'industrie, les agences gouvernementales et non-gouvernementales et le public—peuvent être personnellement enrichissantes et engendrer de nouvelles approches et résultats. Même si la littérature académique

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indique que les approches interdisciplinaires ont beaucoup de mérite, la recherche interdisciplinaire pose des défis aux universitaires, notamment par rapport à l'obtention de subventions et la possibilité de trouver un chez-soi académique. Dans cet article, l'auteure décrit ce que l'on entend par recherche interdisciplinaire et réfléchit sur son propre parcours, des études supérieures à la titularisation. Elle montre ainsi comment les projets interdisciplinaires auxquels elle a participé ont été à la fois enrichissants et stimulants pour elle. Elle conclut que, bien que chaque savant ne doive pas être interdisciplinaire, être ouvert à une telle approche a plusieurs avantages.

Mots clés
Écologie du paysage; Recherche interdisciplinaire; Recherche transdisciplinaire; Sciences appliquées

Introduction

Often, when I tell people at parties that I'm a landscape ecologist, they ask me what kinds of shrubs to put in front of their house, or whether I could redesign their flower bed. I have to explain I am not a landscaper or a landscape architect. When I explain that I'm a scientist, they seem a bit puzzled, because most people picture a scientist in a white lab coat surrounded by test tubes. When they ask what kind of research I do, they think I'm a wildlife biologist, a planner, a forestry scientist, a geographer, or a conservation biologist. Which one they land on depends largely on which project I describe first. If I get to describe a few of them, I usually get a puzzled look and the question: "So, what kind of a scientist are you?" I think the confusion is due to the fact that landscape ecology is a highly interdisciplinary discipline (Naveh & Lieberman, 1994; Turner, Gardner, & O'Neill, 2001; Wu, 2006), and I engage in a range of research that crosses traditional disciplinary boundaries.

I was about halfway through my master's degree when I started to become aware that landscape ecology was a subdiscipline of ecology with an identity of its own. What first attracted me to landscape ecology was its big-picture approach and the fact that landscape ecologists thought about how the spatial context influenced the ecological systems they were studying. I had always liked maps and mapping but wanted to be an ecologist and not a geographer. The explicitly spatial focus to ecological research that landscape ecology offered was very appealing. As well, much of the research in landscape ecology research is linked to real-world problems. I found this attractive as well, because it matched the idealistic notions about "saving the earth" I had had as an undergraduate enrolled in environmental science.

Another aspect of landscape ecology that appealed to me was that it involved participants from many different backgrounds. Andersen (2008) points out that landscape ecology is practised by researchers with diverse academic training, including (but not limited to) ecologists, geographers, landscape architects, planners, managers, historians, botanists, and wildlife biologists. Tress, Tress, and Fry (2004), in a paper that reflected on the "state of landscape ecology," concluded that much of the strength of landscape ecology is that it integrates research from different, more traditionally defined disciplines. Although challenges have been identified within the field of landscape ecology in terms of understanding how to integrate research concepts across disciplinary boundaries (Moss, 2005) and whether landscape ecology should be

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considered a discipline unto itself (Tress et al., 2004; Wiens, 2005), the general consensus is that the integrative aspect of landscape ecology holds much promise for future research.

So, what kind of scientist am I? In this article, I reflect on my experiences as a scientist engaged in interdisciplinary work. I outline how interdisciplinarity is defined in the literature and discuss some of the advantages and challenges in engaging in this kind of work. I also discuss the debates between the merits of "basic" and "applied" science, outline why I feel this debate is arbitrary, and illustrate with examples from my own research.

What is interdisciplinary research?

Interdisciplinary research is defined many ways (Aboelela et al., 2007). In general, definitions of interdisciplinarity often emphasize the integration of two or more different disciplines with the goal of solving problems. For example, an interdisciplinary approach to understanding a particular chronic medical condition in health research might include physiologists, nutritionists, behavioural scientists, molecular biologists, and mathematicians (Aboelela et al., 2007). Aboelela et al. (2007) concluded that interdisciplinary research occurs along a continuum from low to higher degrees of synthesis across disciplines. Tress et al. (2004) further distinguish research that includes explicit involvement with non-academic sectors. They label this "transdisciplinary" work (though others might label it "applied" research). However, just because a research team has members from different academic units, that does not make a project interdisciplinary. Tress et al. (2004) contend that many initiatives that claim to be interdisciplinary have discipline-specific goals and modes of operation and minimal communication and collaboration outside of traditional disciplinary sciences. This echoes an investigation by Rhoten (2004) of research centres and programs that claimed to be interdisciplinary, but which in reality had very little integration across disciplines.

I see myself as a scientist who is engaged in interdisciplinary research. I am first and foremost a scientist, but I am a scientist who feels most productive when part of a team of researchers from across disciplines. I feel I can advance research in novel and interesting ways by engaging in this kind of research, and by having a diversity of projects. In my case, my interdisciplinary research has been of different forms. My first three graduate students worked on projects that *could* be described, respectively, as aquatic ecology, marine biology, and wildlife biology. A year into my tenure-track position, a senior colleague wondered why I had students working on fish, seals, and coyotes and how I could be an expert on three such different species and systems. I cheekily answered that, to me, "they were all dots on a map," and that the projects had in common big questions about how organisms used space. Though my answer was probably a little too glib, it did reflect my perspective that landscape ecology is a discipline in which one can apply universal questions about spatial patterns and ecological process to a multitude of systems. Each student also had a co-supervisor or committee member who was a system or taxonomic expert, and I found the collaboration to be immensely rewarding. I was able to learn about new organisms and systems, and my colleagues learned about theory and practice in landscape ecology. I like to think the students benefited from being exposed to thinking from different

disciplines, as well as seeing that the members of their supervisory committee were willing to admit that they could learn a lot from each other.

I have since branched out even more and engaged in collaboration outside of science. My first experience as a principal investigator (PI) was on a research project investigating the relationship between protected areas and sustainable forest management. The research team involved people with backgrounds in tourism studies, environmental studies, and resource management as well as partners from First Nations, industry, government, and non-government organizations. The first few times we engaged with our non-academic partners, we found that discussions quickly became heated because people from different sectors had different views (and values) for some of the terminology we used. We spent the first six months of the project just trying to understand each other's terminology and worldviews, a common challenge to interdisciplinary research (see Bracken & Oughton, 2006). Although six months may seem like a long time to debate terminology, we found that we could not move forward until we laid out a clear set of mutually agreed-upon definitions and a conceptual framework. The importance of dialogue should not be underestimated; as Edwards and Gibeau (2013, p. 240) summarize, "If people cannot agree how to talk, how will they be able to talk?" We decided that this discussion across our divergent perspectives was important enough that one of the project outputs was an article about the process of reconciling our understanding of terminology and the end result (Duinker, Wiersma, Haider, Hvenegaard, & Schmiegelow, 2010), which we hope will help future debates around forestry issues move forward more quickly.

Following that project, I joined a team led by a social geographer and comprised of biologists, political scientists, planners, and engineers. The project explored "the Participatory Geoweb," which meant we were examining how the general public engaged with online mapping to advance knowledge and/or action on different environmental issues. Our team encountered some of the same initial challenges of trying to figure out how to talk across disciplinary boundaries, but my experience on the first project had given me some of the skills in listening, reading outside my own discipline, and sharing my scientific worldview with non-scientists that I think helped move that project forward. Again, the group felt that the opportunity to engage academics across disciplines was an immensely valuable way to improve networking within the research team (although it also proved to be frustrating at times), to provide opportunities for innovation, and to allow everyone on the team, from PI to undergraduate assistants, to learn (Tudge et al., 2012). For example, one of the students on the project felt that having the opportunity to interact with researchers from a diverse array of backgrounds "helped to place his research in context of broader ideas" (Tudge et al., 2012, p. 10). One of the most valuable aspects of the collaborative, interdisciplinary nature of the project was that the research was focused on how to harness online technologies to engage non-academic partners. Because we as a research team had to first figure out how to effectively collaborate across both disciplines and physical distances (the team members were located in nodes from coast to coast in Canada), we were able to experience first-hand how some Web-based collaborative tools were more effective than others, which then helped to inform how and why Web tools might or might not work to engage members of the public on environmental issues (Tudge et al., 2012). Within my own university, my involvement

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in the project facilitated collaboration with two colleagues in the Faculty of Business Administration; we are currently conducting research on ways to improve digital citizen science data (Parsons, Lukyanenko, & Wiersma, 2011) and manage a citizen science website (www.nlnature.com), which is having impacts on tourism and wildlife monitoring in the province of Newfoundland and Labrador.

Basic versus applied science

Most of the research I have described above has a real-world link, and thus may be called "applied" (as opposed to "basic") science. In simplest terms, "basic science" is perceived as scientific research free from external influence (sometimes called "pure science"), while "applied science" is research that links to real-world problems or applications (Pielke & Byerly, 1998). Within this dichotomy, landscape ecology would most often fit (and indeed sometimes explicitly identifies itself as) under the category of "applied." But, as Nudds and Villard (2005) point out, the distinction between "basic" and "applied" science is really an artificial distinction. All scientific research involves thinking critically and applying scientific hypothesis testing to a variety of problems to improve reliability of knowledge (Nudds & Villard, 2005). In an empirical investigation to compare research productivity in so-called basic versus applied science at a single European university, Ranga, Debackere, and von Tunzelmann (2003) concluded that neither form of research seemed to negatively impact the other, and indeed productivity appeared to be due to the *combination* of basic and applied research (lending credence to the notion that these should not be considered separate entities). Thus, I rarely label myself as an "applied" scientist, even though, in these times of tighter funding, some funding bodies explicitly require an external partner and an (often industrial) application. Conversely, it has been hypothesized to me by others that proposals to other funding bodies are more likely to be funded if they veer more *toward* the "basic" research end of the spectrum. However, I do not have any evidence to support this hypothesis.

So why conduct interdisciplinary (and "applied") research?

Collaborating with colleagues outside one's discipline can be very rewarding and allows one to continually learn new things. From the beginning, my research program has involved collaboration with partners outside academia. Working with government, industry, and non-governmental organizations has allowed me to learn how to apply science to real-world problems. These rewards have been personal and intellectual, and research on interdisciplinarity suggests that such intrinsic rewards are commonly expressed as motivators for those who engage in research outside their home discipline (Campbell, 2005; Rhoten, 2004; Rhoten & Parker, 2004). Furthermore, the ability to collaborate across disciplines has also been identified as a critical skill for conservation careers outside academia (Blickley et al., 2012; Edwards & Gibeau, 2013). Lawton (2007) and Gibeau (2012) have suggested that when scientists are willing to step beyond their disciplinary boundaries and engage with the public and/or policy realms, they can better influence real-world issues and decisions. Researchers who are already comfortable working outside their own discipline are more likely to be comfortable engaging with members of the public. Moreover, if done well, such engagement beyond disciplinary silos can contribute to increasing scientific literacy of the general public (Eagleman, 2013).

I experienced this first-hand through a collaborative project that linked principles of connectivity (from my own discipline of landscape ecology) to concepts of fish movement (from aquatic ecology) to solve real-world problems of evaluating stream integrity and informing culvert replacement schedules in a national park (Bourne, Kehler, Wiersma, & Cote, 2011; Cote, Kehler, Bourne, & Wiersma, 2009; Mahlum, Cote, Wiersma, Kehler, & Clarke, 2013). In this project, our team's work influenced both policy (reporting on ecological conditions) and management (decisions on where to spend money on culvert restoration). It also contributed to public outreach – the park's education staff turned the research topic into a series of YouTube videos and an outdoor theatre program. I wonder how many scientists have had the experience of watching talented performers and educators turn their research into a piece of musical theatre; it certainly was more engaging than a dry journal paper!

I believe that the interdisciplinary approach and real-world links I have fostered in my lab have also benefited my students. I think that the resulting dynamic has contributed to some of their success; all of my graduate students who entered the workforce have found rewarding careers related to their research – as ecologists in consulting firms that work closely with industry or as research scientists and wildlife managers who advise on policy within territorial, state, and federal governments.

Challenges to interdisciplinary research

Undertaking interdisciplinary research can carry challenges. A key challenge can be finding funding to support research. Moss (2005) posits that because landscape ecology encompasses aspects of many disciplines, it can have difficulty fitting into academic institutions (and presumably funding bodies). Because landscape ecology includes aspects of ecology, geography, and planning, which are usually housed in different academic units and funded by different agencies, landscape ecologists might encounter difficulty finding an academic and/or funding "home." Although many funding bodies call for and state they support interdisciplinary research (e.g., many of the Networks of Centres of Excellence in Canada emphasize collaborative teams from multiple disciplines), the traditional Tri-Council funding bodies tend to be more focused within discrete disciplines. Two of my environmental history and geography colleagues had a grant proposal to investigate the historical impact of toxins on communities in Northern Canada rejected on technical grounds by the Social Sciences and Humanities Research Council (SSHRC). The reason was that because the themes of historical health impacts and public health responses appeared as one small component of the larger research program, SSHRC administrators decided (without the input of peer review) that it the proposal was ineligible. SSHRC administrators advised my colleagues to direct the proposal to the Canadian Institutes of Health Research (CIHR), even though the proposed work was in no way medical research and there were no medical or toxicological researchers on the team. I have been told that some of my publications "don't count" in Natural Sciences and Engineering Research Council (NSERC) competitions because they are not in natural science and engineering journals, even though they contain or are based on scientific research. Since many funding bodies are housed within a single discipline (e.g., health or social sciences) and the peer review of grant applications is within a single disciplinary framework (e.g., NSERC evaluation committees are structured along disciplinary lines), proposals for interdisciplinary work, or from a researcher with a list of

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publications that crosses disciplines, can be at a disadvantage in grant competitions (Metzger & Zare, 1999).

Despite the collegiality that interdisciplinary work can entail, individuals engaged with research across disciplines can find themselves isolated from their "home" discipline (Metzger & Zare, 1999), and graduate students in particular may be challenged to find an intellectual community that supports them (Golde & Gallagher, 1999; Tress, Tress, Fry, & Antrop, 2005). Personally, I still feel at home in my traditional biology department, even if many of my collaborations are extra-departmental. Research suggests that faculty and graduate students who do end up feeling isolated may do so for a good reason; traditional academic structure and the culture of universities tend to work against fostering interdisciplinarity (Rhoten, 2004).

Another perceived disadvantage is that engaging in interdisciplinary work is risky for early-career scientists, at least those aiming for a career in academia (Metzger & Zare, 1999; Rhoten & Parker, 2004). This disadvantage is likely due to the fact that researchers engaged in interdisciplinary work often must spend time learning new terminology and/or techniques and spend energy in figuring out how to collaborate across disciplinary boundaries (Campbell, 2005; Golde & Gallagher, 1999). While personally rewarding, these activities do not yield tangible benefits in terms of publications, and thus overall productivity may be diminished and an individual may be perceived as less competitive in the job market. Even when research is productive, researchers may have difficulty finding journals that publish interdisciplinary research (Turner & Carpenter, 1999), although, happily, under the new online, open access publishing model, this is becoming less of an issue (Campbell, 2005).

Conclusions

So, what kind of a scientist am I? I find myself asking this question as I reflect back on the road I have taken to achieving tenure and look forward to the next stage of my career. Labels are only so helpful, and when I get tired of explaining at parties that, no, as a landscape ecologist, I can't tell you what lawn fertilizer to use, I sometimes just say "I'm a scientist" when asked what I do for a living. Ultimately, I'm a scientist who is curious about a lot of things. Curiosity is what attracted me to science from an early age. That curiosity has landed me in a position at a university where I have the freedom to pursue any research question I choose. For me, that means many different projects with different questions, involving research teams across disciplines. I have been fortunate to land in situations that have introduced me to new collaborators and engaging research questions, and I am confident that these research networks will lead to further exciting research opportunities. I recognize my position as a tenured university faculty member is an immense privilege. Despite the funding and productivity challenges of interdisciplinary research, I will continue to pursue this path, because ultimately, I feel that it is a valuable way to advance knowledge related to real-world problems.

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