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Review paper

Being relevant: Practical guidance for early career researchers interested in solving conservation problems

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ABSTRACT

In a human-altered world where biodiversity is in decline and conservation problems abound, there is a dire need to ensure that the next generation of conservation scientists have the knowledge, skills, and training to address these problems. So called "early career researchers" (ECRs) in conservation science have many challenges before them and it is clear that the status quo must change to bridge the knowledge–action divide. Here we identify thirteen practical strategies that ECRs can employ to become more relevant. In this context, "relevance" refers to the ability to contribute to solving conservation problems through engagement with practitioners, policy makers, and stakeholders. Conservation and career strategies outlined in this article include the following: thinking 'big picture' during conservation projects; embracing various forms of knowledge; maintaining positive relationships with locals familiar with the conservation issue; accepting failure as a viable (and potentially valuable) outcome; daring to be creative; embracing citizen science; incorporating interdisciplinarity; promoting and practicing pro-environmental behaviours; understanding financial aspects of conservation; forming collaboration from the onset of a project; accepting the limits of technology; ongoing and effective networking; and finally, maintaining a positive outlook by focusing on and sharing conservation success stories. These strategies move beyond the generic and highlight the importance of continuing to have an open mind throughout the entire conservation process, from establishing one's self as an asset to embracing collaboration and interdisciplinary work, and striving to push for professional and personal connections that strengthen personal career objectives.

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1. Introduction

Conservation biology emerged as a novel multi-disciplinary field of enquiry in the 1980's (see Wilcox and Soulé, 1980) to confront the crisis of global biodiversity loss (Soulé, 1986). Through time, the term "conservation science" has been adopted to better reflect the notion that biology is only one part of the conservation puzzle (Balmford and Cowling, 2006), with human behaviour and socio-economic aspects being equally if not more important than biology to solving conservation problems (Schultz, 2011; Kareiva and Marvier, 2012). Today, many researchers around the globe self-identify as engaged in conservation science research; however, there is growing recognition that using conservation science to frame research alone (e.g., Salafsky et al., 2002) fails to adequately ensure that practitioners are provided with the information they need to make informed decisions and to act accordingly (Sutherland, 2009). Indeed, many knowledge gaps still remain for specific taxa, ecosystems, and problems (Lawler et al., 2006), but even when knowledge is in hand, challenges remain with bridging the knowledge–action divide (Clark, 1993; Cook et al., 2013).

Over the last decade there has been increased emphasis on providing conservation practitioners with the information they need to act (Clark et al., 2002) and actually solve conservation problems (Gibbons et al., 2011). For example, scientists and practitioners (including managers and policy makers) have been working collaboratively to identify research priorities that, if addressed, would lead to meaningful changes in practice and policy (e.g., Braunisch et al., 2012; Pullin et al., 2013). Similarly, there is recognition that publishing one's work in peer reviewed journals is insufficient for engendering the public support needed to make meaningful changes in human behaviour that underlie conservation problems (Arlettaz et al., 2010). To be relevant conservation scientists today need to do more than conduct research on self-identified topics of interest and publish their work in peer-reviewed outlets.

The next generation of conservation scientists are desperate to step forward and make meaningful strides in solving the pressing conservation problems that we have failed to address to date (reviewed in Young, 2000 and Balmford and Cowling, 2006) or that are emerging in the face of novel threats (Sutherland and Woodroof, 2009; Rands et al., 2010). So called "early career researchers" (ECRs) have many challenges before them and it is clear that the status quo must change. Here we identify practical strategies that ECRs can adopt to become more relevant. Strategies and concepts presented are derived from a variety of outlets, including personal experience as ECRs (all but one of the authors), review of salient literature, and sage advice received from mentors. In this context, "relevance" refers to the ability to contribute to solving conservation problems through engagement with practitioners, policy makers, and stakeholders. We challenge the status quo for ECR professionals in conservation science entering the work force (as per Noss, 1997). Our intention is not to be prescriptive but rather get the community to think about what might work in their particular context. We can and must do better to train the next generation of ECRs, recognizing that much of this training will occur outside of the traditional classroom. It is our collective hope that the ideas presented here will offer ECRs a framework for enhancing their relevance in the field of conservation science, and lead to rapid and meaningful advances in conservation policy and action that attempts to reverse the biodiversity crisis we face today.

2. Strategies for being relevant in conservation

We do not presume that the strategies listed here cover all possible means of increasing relevance. Nonetheless, we submit that we have identified those that are of high priority. We also acknowledge that there is some level of overlap in strategies as one might expect in a multi-disciplinary, mission-oriented topic such as conservation.

2.1. Take off the blinders

Conservation science inherently crosses disciplines and scales. The ability to view each aspect of a conservation project and how it fits within the 'big picture' is necessary to ensure the goals remain relevant within the current research and political framework. There is increasing recognition that scale is important to conservation (Holling, 1993; Cooke et al., 2014) because conservation problems exist at specific spatial or temporal scales and conservation policy is constrained by institutional, jurisdictional, and political scales (Gibson et al., 2000). Conservation problems often exist at high levels (i.e., long-term, global, cross-jurisdictional), whereas experimental arenas and political influence may exist at lower levels (i.e., local, constrained by the political and budgetary cycle and jurisdictional constraints; Cash et al., 2006). In science, scale mismatch can negatively affect the development of research necessary to inform policy and management. Conservation scientists therefore require perspective for assessing the scale at which a conservation problem exists and designing experiments whose results will correspond to the scale at which policy is formulated. Learning to approach and manage scale in conservation research is an important skill for ECRs aspiring to generate relevant science. However, scale is a challenging concept because it requires considerable experience and perspective, which is inherently lacking among ECRs.

There is an important philosophical element to consider when addressing scale in conservation science; data collected at discrete time points or in specific locales do not necessarily provide information that is transferable across temporal scales or at spatial scales with limited relevance to higher-level processes (i.e. species or population-level; Cumming et al., 2006). Indeed, there is an inherent mismatch in scale between what can be studied and what must be known to make recommendations or decisions (Schneider, 2001). For example, if one studies movement ecology and demographic processes of an imperilled population but only does so at the periphery of the species range, that knowledge is unlikely to be germane to the entire distribution. Or if one studies bycatch mortality of an imperilled fish species in a riverine system and only does so for one year, it is very possible that one could fail to detect important contextual drivers related to inter-annual variation in climate, fish condition, and parasite burdens (Raby et al., in press). Matching scale is necessary for designing experiments that produce representative findings (Gibson et al., 2000). Collecting data to create models that generate single, seemingly elegant solutions (Ostrom, 2007) introduces bias and misses nuances in data when findings are ascribed to higher (macro) or lower (micro) level processes (Gibson et al., 2000). This emphasizes the importance of matching the level at which a problem is studied within the scale at which it exists, for example, using data from local populations to address local conservation concerns. Inevitably, there is an inherent uncertainty in managing ecosystems (Holling, 1993) because data represent a subset of a population and models are based on averages. Uncertainty may be considered a downfall of scientific research and a reason for limited integration of scientific knowledge within management (Sutherland et al., 2004). Consideration of scale can limit this uncertainty and maximize the applicability of research at the proper level across scales.

ECRs are developing skills and generating knowledge that has the capacity to inform policy (Lubchenco, 1998). In conservation, ECRs must strive to produce impactful and timely research that is useful for conservation practitioners. With this in mind, ECRs may face struggles beyond that of established conservation scientists because they are often involved in projects with limited timescales. While some are lucky enough to work with long-term datasets or as part of long-term projects, the majority of M.Sc., Ph.D., post doctoral, and contract positions must be completed within a specific timeline. Thus, there is limited time to ensure end-points of a given research project match the scale at which their research can be applied. To be more effective in this context, ECRs need not take off the blinders that restrict the ability to see a problem and the scales and levels at which it exists. Research needs to concentrate on generating data that are translatable to the scales at which a given conservation problem exists and consider the political scale at which the necessary policy solutions will be addressed. In other words, scale matches are required. Moreover, research must be disseminated in a timely manner given the dynamic nature of many conservation problems and the transient nature of the political cycle (Cash et al., 2006). Appreciating and matching the scale upon which scientific research is likely to be relevant can guide ECRs in ensuring that their research is relevant to policymakers, and that the research attains its potential for advancing conservation.

2.2. Evidence matters but comes in different forms

One thing nearly every ECR is familiar with, and indeed have had instilled in their thinking, is the concept of evidence-based reasoning. Using observable phenomenon to validate or dismiss various hypotheses (known generally as the *Scientific Method*), is a foundational concept for many ECRs, and often permeates into subjective decision making in day-to-day life. The strength of this course of thinking is that it allows for new information to refute or shift current paradigms, dynamically evolving the current status of "knowledge". Applying the scientific method of problem solving to conservation issues, however, has not always yielded tractable results and many conservationists have recognized the need to incorporate holistic worldviews and disparate sources of evidence to invoke meaningful progress on conservation problems (Ludwig et al., 2001; Brooks and McLachlan, 2008).

Interpretations of information, and even definitions, are derived from different knowledge sources (Freitag, 2014). Similar to different "learning styles", the production of evidence, or relevant information for making decisions, depends on the experiential background of the individual or stakeholder group (Raymond et al., 2010). That is to say, what is held as objectively "true" evidence is dependent on the context in which that information is generated and perceived. Local and traditional sources of ecological knowledge (LEK, and TEK, respectively) are increasingly being leveraged as tools for conservation practitioners (Huntington, 2000; Brooks and McLachlan, 2008). For example, local Inuit TEK of common eider duck (*Somateria mollissima sedentaria*) overwintering sites and feeding behaviour on the Belcher Islands enabled researchers to characterize constraining environmental factors (e.g. tidal currents) to best identify key areas for formal protection of the species (reviewed in Gilchrist et al., 2005). These forms of knowledge show us that evidence exists along a continuum of spatial, temporal, and experiential scales, but nevertheless can offer unique and insightful perspectives that may guide traditional Western scientific approaches (see Fig. 1 in Raymond et al., 2010). Further, it is becoming increasingly recognized that implementing management strategies can be enhanced through co-operative co-management involving multiple stakeholder groups (Huntington, 2000; Berkes and Turner, 2006). There are a growing number of success stories for the integrated management of conservation issues, and this is likely to become the norm as environmental challenges continue to emerge. However, ECRs may be faced with a conflict between traditional schools of thought regarding knowledge acquisition (i.e. the rigorous scientific method), and alternate forms such as LEK or TEK (see Gilchrist and Mallory, 2007). This can be particularly problematic when entering or applying for new research programs, where the status quo may prevent the integration of certain forms of knowledge.

Given that diverse knowledge sources exist, incorporating and balancing varied worldviews into cohesive conservation agendas remains a challenge for ECRs. Moving beyond acknowledgement of this reality, ECRs are faced with the task of integrating knowledge sources and implementing action plans that consider an array of stakeholder views on conservation issues (Raymond et al., 2010). Epistemology is the study of the nature of knowledge, and this methodology calls on ECRs to think critically and reflectively on the source and merit of different information sources. Evaluating and debating the merit and authenticity of disparate forms of evidence is often aggravated by a deep distrust between stakeholder groups and the values they represent (e.g., Castello et al., 2013). It follows, then, that much work is needed to support and stimulate interactive decision-oriented discussion between knowledge groups, user groups, and conservation managers to identify which knowledge can be deemed trustworthy (Huntington, 2000; Sutherland et al., 2013). Recommendations for facilitating this process include initiating information exchanges early and often, and the use of knowledge-brokers or groups who exchange information at the interface of different knowledge groups (Raymond et al., 2010; Freitag, 2014). The concept of adaptive co-management has been heralded as a promising path towards successful integration of diverse knowledge sets (Raymond et al., 2010).

In thinking about the generation of different types of knowledge, how different research activities yield different forms of evidence, and how to integrate diverse knowledge sets to address conservation problems, we inherently recognize the social and environmental context of conservation issues (Berkes and Turner, 2006). This recognition of diverse worldviews and alternative sources of information has emerged as a central theme in conservation science recently, as evidenced in the topics discussed in this article. In line with this concept, we advocate the concepts of inter-disciplinarity, and working with diverse worldviews to stimulate creative solutions (see Sections 2.8, 2.10). We also acknowledge the need for knowledge brokers, and a dynamic, self re-evaluating process similar to adaptive co-management to address current and emerging conservation issues. Reflecting on the importance of diverse perspectives is an imperative practice for ECRs to enhance their own relevance, as well as facilitate meaningful work in the realm of conservation science.

2.3. Don't be a parachute scientist

Ignorance and disregard of local conditions and/or knowledge as described above is a condition that is prevalent in Western sciences. Here we will term it "parachute science". This parachute science approach is likely an effect of the methodology that Western science employs (i.e. scientific method and quantifiable data) whereby an inherent distrust of local knowledge is prevalent among researchers stemming from a lack of such knowledge being quantifiable in a traditional sense (Drew and Henne, 2006; Van Eijck and Roth, 2007). Gilchrist and Mallory (2007) argue that the acceptance of TEK requires the same form of scientific scrutiny as the acceptance of scientific data. From the local's perspective, this parachute science approach, coupled with potential dyssynchrony of worldviews and/or a lack of understanding of the scientific method, has strained relationships between conservation scientists and local peoples (Hawkins, 2005; Baron, 2010; Achenbach, 2015). Regardless whether or not TEK is being used in a research project, building strong relationships with local peoples is often a key component of successful conservation-oriented field studies and can enhance the project in a number of ways. Because of the deep cultural and spiritual connections with their environment, local peoples often have an intimate knowledge of the life history attributes of species occupying their surroundings; knowledge that may not be apparent to scientists working here (Berkes et al., 2000; Garibaldi and Turner, 2004; Drew, 2005; Drew and Henne, 2006). As well, by living in the environment for many years, locals may have a wealth of historical knowledge concerning changes in biodiversity, population dynamics and range shifts in species present in the area (Garibaldi and Turner, 2004; Drew, 2005; Service et al., 2014). Indeed, the historical biological information provided by locals can synchronize quite well with that of traditional scientific sources in some circumstances indicating a potentially useful source of information in quantifying previous and/or before impact conditions in the environment (Service et al., 2014). The integration of locals into various conservation based projects has been seen to greatly enhance the success of a number of projects and as such, ECRs should work to implement and integrate local knowledge into their work as well (Becker and Ghimire, 2003; Kinsella, 2004; Drew, 2005).

To improve the success of field based conservation efforts, a healthy relationship must be built with local peoples and stakeholders. Open dialogue and the integration of locals into projects have been suggested as effective methods by which conservation scientists can seek to establish better relationships with local peoples (Becker and Ghimire, 2003; Kinsella, 2004; Hawkins, 2005). Additionally, incorporating species of significance to locals (i.e. cultural keystone species) into research programs is also believed to be a method by which conservation scientists cannot only improve relationships with locals but enhance the success of their projects as well (Garibaldi and Turner, 2004; Garibaldi, 2009). As such, ECRs should look to conduct conservation research in a local context that integrates and engages local peoples within the project—not just dropping in like a parachutist and then leaving without building stable and lasting mutually-beneficial relationships based on respect.

2.4. Failure: a viable outcome

Failure is inevitable. No matter ones experience level, background or field of study, failure should be expected. By definition, failure, is: 1. omission of occurrence or performance, and 2. lack of success (Merriam-Webster 2015). Embracing the spirit of Thomas Edison's words, "I haven't failed. I've just found 10 000 ways that won't work". we propose here that ECRs should not view failure, whether personal or scientific, as an end but as a means; a failure is an opportunity for learning and for being adaptive in a changing environment.

Regarding professional failures, omitting skills or practices such as networking, community involvement, collaboration, or any of the aforementioned items in this article has the potential to lead to failure in some form or another. Failing, for example, to communicate results in a way appropriate for target audiences may lead to the failed uptake of recommendations by resource managers or conservation practitioners. Similarly, failing to collaborate with local groups may lead to an absence of support or funding for a project. As an educated, intelligent and professional individual, failures such as these should not be feared or be entirely unexpected; cautionary thinking is important, but over-thinking or fear may lead to insufficient action or total inaction, potentially resulting in the dreaded failure. The majority of conservation actions have some chance of failure (Game et al., 2013). Generally, conservation failures stem from the failure to identify a problem exists or the failure to achieve conservation goals (due to technical failure, poor implementation, loss of support, etc.) (Game et al., 2013).

Science, as well as the vast majority of professional fields, grows through the discovery and exploitation of opportune events and timing. For example, adaptive management is a tool based on such learning processes and aims to reduce uncertainty over time by employing continuous monitoring of a system and the systematic re-evaluation and refining of management goals and objectives, often based on poor performance of some aspects of the management framework (Gunderson, 1999). Thus, not every attempt to discover or exploit will be successful but whether failure or success occurs, information is still acquired, improving long-run management outcomes (Gunderson, 1999; Keith et al., 2011). Since every failure presents an opportunity for learning, it also increases the likelihood that future, more informed attempts by a more knowledgeable self will be successful (Shepherd, 2004). This manner of thinking can be similarly applied to the concept of adaptive management in conservation.

Though failure is a typically less-than-appealing option, it is inevitable. It is critical to embrace failures for the information and experience they provide and utilize them as the viable outcomes that they are. This is of particular importance for ECRs, where experiences are limited and the interpretation of failure as valuable information is crucial to maintain focus and motivation. Stepping outside of one's comfort zone and reaching out to those participating in relevant research or using applicable tools will reduce the risk of future failures by those interested in solving similar problems.

2.5. Creativity ain't just for artists

Traditional training rarely emphasizes creativity as an essential skill for a successful scientist; scientific training endeavours to strengthen logical reasoning, with little focus on intuition (Scheffer et al., 2015). However conservation science arguably requires such expertise to successfully address and solve today's complex environmental and societal problems. In broad terms, creativity within a conservation science context is the ability to transcend traditional beliefs or practices to develop useful new ideas, strategies, and techniques to more effectively sustain Earth's biodiversity (Aslan et al., 2014). More than a skill, this quintessential human trait is evident in past conservation successes (see Nagendran and Horwich, 1992; Janiskee, 2008; Enderson, 2005) yet it is rare to find a conscious effort being made to cultivate creativity in scientific training, research, or practice (Aslan et al., 2014). There is a call for ECRs to foster creativity in their lives in order to keep up with the ever-evolving and increasingly complex conservation problems they are tasked to solve. Notably, ECRs are perhaps those that can make the most revolutionary breaks with tradition, as the naiveté that can be characteristic of young scientists or those venturing in from other fields allows them to ask if a traditional method or theory can be used or tested in a novel way (Loehle, 1990).

While many misconceptions exist in the scientific community in regards to the creative process, there are straightforward ways in which an ECR can overcome these barriers to creative problem solving. For example, there is a common misconception that creativity is something one is either born with or lacks, and there is no hope of training one to be ingenious. However, the literature presents creativity as a learned trait, rather than an innate skill (Sternberg, 2000). A strategy to foster creativity is to surround oneself with unfamiliar people, concepts, and points of view (Aslan et al., 2014). It has been shown that groups of individuals with varied backgrounds have a broader knowledge base and are better at generating new ideas relative to groups that share similar backgrounds (Paulus, 2000). It is the same on the individual level—someone with diverse experiences can more readily find creative solutions to a problem. There is also the familiar misconception that creativity requires too much time and detracts scientists' focus from the academic pressures to write grants, teach, and publish (Loehle, 1990). Not pursuing creative activities may result in lost opportunities for risk-taking experimentation and breakthroughs.

Embracing the cycle of learning, struggling with a problem, and reflection is essential to fuelling creativity (Aslan et al., 2014). The third part of this cycle – reflection – is often overlooked as a valuable part of the creative process. Quiet time spent away from a problem promotes creative insights by facilitating new connections in the brain that can illuminate hidden relationships (Carlsson et al., 2000; Scheffer et al., 2015). Something as simple as going for a walk, as Charles Darwin himself was disposed to do, allows for time to reflect and pursue questions in creative ways (Loehle, 1990). Compounded with the misconception that creativity demands too much time is the misunderstanding that too much risk is involved. Investment in creativity, a perceived threat to short-term productivity, may itself appear risky (Aslan et al., 2014). Furthermore, there is a cultural understanding in scientific community that silence and inaction are preferred when adequate evidence is not yet available (Maguire, 1991). Given the consequences of failure in conservation science, it is understandable that taking risks by attempting new approaches or entertaining new ideas and applications is minimized. Yet, avoiding such risk can repress creativity and impede novel solutions (Aslan et al., 2014). The key is to manage risk appropriately and to use tools such as decision frameworks (Maguire, 1991) so that creative ideas can be tried and allowed to fail without jeopardizing a project or its stakeholders. Furthermore, ECRs can reframe risks as challenging opportunities rather than threats, to influence willingness to take risks, and to sustain one's efforts in the face of challenge (Bandura 1997).

Equipped with these strategies to foster creativity in their lives, ECRs can feel confident stepping outside of professional comfort zones, taking the time to recognize diverse communities, engaging in higher risk projects, and valuing time for reflection and fun along with hard work (Aslan et al., 2014). Academic knowledge and skills as taught at a given time in history will be inadequate to meet the needs of a rapidly changing world (Sternberg and Kaufman, 2010). Creativity may therefore be more important now than ever.

2.6. Everyone's a scientist

Everyone has the potential to be a contributor to scientific discovery and conservation, particularly because everyone is a part of the conservation problems faced on planet Earth. Citizen science projects provide the opportunity to facilitate conversations, and combine the efforts of researchers and citizens. As an ECR seeking answers to mitigate biodiversity loss, engaging in research that exploits the advanced dialogue between society and researchers can facilitate one's ability to influence human behaviour, gather informative data, and inform policies.

Human behaviour is not effectively changed by education alone, however by inviting interested parties to participate in science data collection and/or restoration projects conservationists can help foster positive attitudes towards conservation (Schultz, 2011; Dickinson et al., 2012). Projects like the Monarch Larva Monitoring Project (Oberhauser and Prysby, 2008) and the Neighborhood Nest Watch (Evans et al., 2005) have helped instil beneficial behaviours and actions from participants, such as backyard habitat improvement for migratory butterflies and bird species (Bruyere and Rappe, 2007; Crall et al., 2013; Toomey and Domroese, 2013). Recruiting and retaining participants can be a challenge that requires organizers to hone in on participant motivation, and may be influenced by updating participants with details on the results of their involvement so they may visualize the difference they can make (Whitelaw et al., 2003). Through inclusion of citizen scientists, ECRs can increase the temporal and spatial scales of their research allowing more data to be collected, or area to be restored, than could be done by an ECR and a research team alone (Devictor et al., 2010; Dickinson et al., 2012). Additionally, ventures that involve the community at large may lead to their future support on pro-environmental policies. For example, volunteers who actively monitor air and water pollution and have been integral in advising India's National Ambient Air Quality Standards (sipcotcuddalore.com, Conrad and Hilchey, 2011).

While positive changes to community behaviour are beneficial outcomes to citizen science, ECRs committing to using volunteer collected data need to be wary of inter-volunteer variability and participant bias (Dickinson et al., 2012) and should account for these factors in project design and data analysis. ECRs interested in pursuing collaboration with volunteers to meet their research goals can help refine their methodology by referring to pre-existing citizen science projects or using existing data from projects that are open-source (Dickinson et al., 2012). Those willing to pursue novel projects can utilize online resources such as Cornell's toolkit, SciStarter networking site to connect citizens and scientists, and the ECAST network that hosts workshops, seminars bring together managers, scientists, citizens and government to discuss developments, progress, difficulties, and policy (Dickinson et al., 2012). With some consideration, citizen science can help ECRs promote their research goals through community involvement, garnering the support and the public opinion needed to inform positive policy changes, all helping ECR goals seem more tangible.

2.7. Breaking "bad" behaviour

Conservation is a human derived concept (Cowling, 2005). As such, the actions of all levels of society (i.e., individuals, communities, industry, governments) are what determine the outcome of conservation goals (Schultz, 2011, 2014). Solving pressing conservation issues will take more than to focus efforts on the problems and the scientific method. Without developing solutions framed around human behaviour, conservation goals are arguably impossible to achieve (Schultz et al. 2011). Historically, human behaviour has been overlooked and undervalued in the field of conservation science (Mace and Hudson, 1999; Schultz, 2011). ECRs can become more relevant by conceptualizing conservation problems from the perspectives of social and behavioural sciences (Saunders, 2003; Schultz, 2014).

Human behaviour is malleable; bad habits and actions can be changed by encouraging individuals towards pro-environmental behaviours with the use of social "treatments" (De Young, 1985; Osbaldiston and Schott, 2011; Schultz, 2014). By influencing human thinking and social norms, it is possible to stimulate proactive responses to environmental issues (De Young, 1993, 2000). This is a particularly important, yet difficult task, in developed countries because these societies are increasingly seeking urban lifestyles and comfortable living—becoming further disconnected from nature with each subsequent generation (Schultz, 2002, 2011). The stronger the perceptions of human connectedness with nature, the more likely humans will engage in behaviours that reduce their ecological footprint (Kals et al., 1999; Gosling and Williams, 2010).

Pro-environmental Behaviours (PEBs) are either harmless or beneficial human actions towards the natural environment (Steg and Vlek, 2009). These behaviours require humans to make informed decisions by weighting the costs and benefits associated with their choice of actions (Schultz, 2014). Behaviour is motivated by intrinsic factors such as the strong beliefs, values, and attitudes that every individual maintains (i.e., values–attitude–behaviour hierarchy; Dietz et al., 1998; Schultz et al., 2005). The task for ECRs is to systematically motivate individuals to modify their values and attitudes for adopting PEBs. To be highly influential with promoting pro-environmental behaviours, ECRs should focus on addressing high impact behaviours that proportionally few engage in, and identify barriers against change (including structural and information barriers; Steg and Vlek, 2009). By pairing the appropriate behavioural tools to overcome the targeted barriers (either perceived or structural) and highlighting the benefits and outcomes of the pro-environmental behaviours (Steg and Vlek, 2009; reviewed in Schultz et al. 2014), ECRs have the potential to stimulate change.

Conventional strategies such as education and advertising campaigns are failing to engage humans in pro-environmental behaviours (Schultz, 2011; McKenzie-Mohr and Schultz, 2014). ECRs need to go beyond with regard to motivating and persuading all levels of society to change their actions and habits that are impacting the environment. There are four major categories of tools taken from the social sciences (reviewed in Osbaldiston and Schott, 2011) that can be used to promote PEBs: (i) Convenience—making actions easier for people; (ii) Informational—provide meaningful/reliable information to justify performing a PEB; (iii) Monitoring—giving people feedback, using rewards/incentives, or continual prompts; (iv) Social-Psychological—this can include instilling conservation-oriented ideas in people who are not engaging in PEBs (i.e., social modelling, cognitive dissonance, social norms), commitment, or "foot in the door" treatment where once one has developed small acts of PEB in people it will inevitably encourage higher impact PEBs.

Interventions should be adjusted according to the degree of the perceived barriers and benefits at the sociological scale of interest (e.g., individuals, communities, corporations; reviewed in Steg and Vlek, 2009; Schultz, 2014). Importantly, changing behaviour takes time (see adoption–diffusion theory; Norton and Bass, 1987), but encouraging even simple acts of PEBs (e.g., low pressure shower heads, consuming sustainable products, recycling) can combine to mitigate pressing environmental problems (Osbaldiston and Schott, 2011). Solving conservation issues is accomplished by breaking down "bad" behaviours, which can benefit from the knowledge and tools from social and psychology fields. Only then will we be able to address the underlying barriers that are impeding pro-environmental behaviours to achieve conservation goals.

2.8. *Build bridges, not walls*

Many of the dilemmas encountered in conservation science have been well documented and alleviated, yet humans are undoubtedly still failing at resolving some of these core issues (Balmford and Cowling, 2006). Climate change (Schneider and Root, 2002), forestry (Steele and Stier, 2000), and animal migration challenges (Cooke et al., 2008) represent some of the pre-eminent problems that are rooted by their requirement for interdisciplinary studies. This idea involves bridging between disciplines in pursuit of creating a comprehensive understanding of the big picture. Conservation challenges are often complex such that they cannot be effectively addressed with a single-minded approach (Daily and Ehrlich, 1999; Newell, 2001; Rhoten and Parker, 2004). Rather, ECRs must make an effort to look outwards and adopt interdisciplinary strategies to learn, integrate, and expand across diverse fields. Multiple dimensions including ecological, socio-economic, and political feed into one another in an interactive network. A classic example of such unlikely unions is the integration of social sciences and economics into conservation, thereby considering human values in solutions. Farley et al. (2010) used this principle in a program focused on the conversion of mangrove habitat to aquaculture in the Philippines. Through transdisciplinary workshops involving academics, non-government organizations, local governments and communities, the gross economic value of mangrove ecosystems was quantified, and results were presented to local media and government agencies. Their efforts resulted in the cessation of aquaculture ponds to preserve mangroves in the region. Environmental economics and sustainable development models are some of the strategies used to publicize the importance of conservation in everyday decisions in today's media (Ekins et al., 2003; Lélé and Norgaard, 2005). By crossing these boundaries, ECRs can unravel opportunities for effective communication and gain insight into alternative models and mechanistic approaches (Balmford and Cowling, 2006).

Venturing beyond disciplinary safe grounds is not an easy task with a number of inevitable obstacles that are likely to arise. Sankar et al. (2007) argued that interdisciplinary studies are not focused, thereby forcing an individual to surrender their disciplinary value. Where language and vocabulary are not common among various fields, there will be a struggle with unfamiliar literature (Campbell, 2005; Fox et al., 2006). Working with experts across diverse experiences and cultures (Sankar et al., 2007) will introduce difficulties with unanimous publishing strategies, coupled with limited funding opportunities for interdisciplinary research (Campbell, 2005; Daily and Ehrlich, 1999; Fox et al., 2006). Moreover, conflicting interests and perspectives upon decision-making will generate power struggles among individuals, as noted previously (Campbell, 2005; Lélé and Norgaard, 2005). In academia, higher education is often structured around traditional, homogeneous research practices or simply adopts interdisciplinary labels (Lélé and Norgaard, 2005; Rhoten, 2004). Interdisciplinary research is costly in terms of time and effort, however the rewards that it provides will be crucial for ECRs to actively engage in finding solutions.

There exists a number of ways in which ECR professionals can foster interdisciplinary skills to advance their potential in conservation science. This includes maintaining a deep expertise along with a broad vision for application across fields. A clear vision must be established from the start among colleagues through effective communication, stressing the importance of sharing collective over personal goals. With respect to collegiality and attitude, it is advisable for ECRs to build and embrace strong interpersonal relationships. This involves offering mutual respect, removing any pre-determined assumptions, maintaining an open personality and being flexible when needed (Campbell, 2005; Fox et al., 2006). Ultimately, accomplishing this will require ECRs to move beyond traditional academic systems that merit single disciplinary practices. By training young professionals to be interdisciplinary, they will be comfortable to seek collaborations when challenges arise.

2.9. Money talks

Economics is a necessary evil regarding the conservation of nature. Unfortunately, maintaining intact ecosystems and protecting habitat can be very costly, and funding is often a limiting factor in conservation efforts (Balmford et al., 2002). Understanding this, a good foundation of economics can provide ECRs with relevant context for raising awareness and public support for conservation issues. Increasingly, policy makers are seeking economic advice on how to efficiently and effectively design conservation policies (Barrett et al., 2013), largely because economics supplies an identifiable currency—environmental benefits into monetary measure (Naidoo et al., 2008). Furthermore, conservation viewed through an economic lens can provide a holistic understanding to pressing problems, and bring clarity to solutions by: (i) providing greater insights into the forces behind ecological loss and degradation; (ii) helping us understand that when marginal costs are equal to marginal benefits, conversion of ecosystem structure to economic output should stop; and (iii) providing a mean by which scarce resources can be efficiently allocated towards conservation (Farley, 2010). ECRs can certainly benefit by delving into economic theory and practice as it relates to conservation, especially for the above reasons, but also because behind most of the world's conservation problems is an economic decision that led to the issue materializing in the first place.

Of great importance to conservation is the economic valuation of nature. Economic systems often undervalue the provision of ecosystem goods and services, and consequently, these life-support systems are liable to be inadequately conserved by society (Tisdell, 2011). This may be due to the difficulty in fundamentally understanding species interaction and ecological functioning, which leads to uncertainty in representing ecological tangibles in economic terms (Perry, 2013). As a result, this enables the existence of a perpetual dissonance on how to properly value nature and how that ties into economic decision-making. The dichotomy endures because economics largely deals with goods that are substitutable (relative scarcity; e.g., a shrimp farm for a mangrove forest) and ignores goods that are non-substitutable (absolute scarcity; e.g., extinct species) (Baumgärtner et al., 2006; Underwood and King, 1989). However, ecological economics often view biodiversity from an absolute standpoint, which implies that there is no choice, and hence beyond the scope of economic analysis (Baumgärtner et al., 2006). Both approaches offer important insights for conservation but are difficult to reconcile (Baumgärtner et al., 2006). Regardless, valuation is enjoying increasing recognition as a powerful tool, with the purpose of informing conservation policies (Matulis, 2014) and demonstrating tangible economic benefits to humans (Naidoo et al., 2008). The economic benefits are of particular importance since the resulting measures can be compared to existing economic measures or serve as awareness for policy makers (Naidoo et al., 2008). While we believe environmental valuation to be a valuable tool, ECRs need to remain mindful of the nuances associated with valuing biodiversity—while there is great importance of understanding economic forces, the arguably limited understanding of ecological processes limits how broadly this concept can apply.

2.10. Start with a partner

Despite broad recognition that science and management action must develop synergistically to effectively meet management outcomes or develop policy, they continue to be practiced in isolation (Knight et al., 2008; Arlettaz et al., 2010; Laurance et al., 2012). Scientists often feel that decision-makers fail to accept scientific knowledge and output, while decision-makers often feel that scientists fail to produce science that addresses applied conservation issues (Pullin et al., 2004; Fazey et al., 2005; Roux et al., 2006; Gibbons et al., 2008; Laurance et al., 2012). There is also a growing trend for conservation scientists to demonstrate how a project is policy-relevant during the grant application phase. In many cases, scientists design and execute experiments and then push their findings onto managers with the expectation that it will be adopted immediately in management and policy (Roux et al., 2006). This approach rarely leads to conservation success.

Co-creation of the research agenda can resolve this division from the outset (Roux et al., 2006; Cooke, 2011). When scientists involve practitioners and decision-makers early on in the creation of the research, those individuals or organizations can influence the research to increase the potential that it will be applicable to their management and policy (Milner-Gulland et al., 2010; Burbidge et al., 2011; Laurance et al., 2012). There have been several exercises performed by conservation scientists and practitioners to identify the most important conservation science problems that need current research to address (Sutherland et al., 2009, 2013; Fleishman et al., 2011). It is unclear from the literature in most cases where research truly reflects deep partnership from the early phases of project definition, but one such example involves work on bycatch where engagement of both fishers and fisheries managers is regarded as crucial to success (e.g., Jenkins and Garrison, 2013).

ECRs are in an advantageous position to bridge the research-implementation gap because they are in the formative period of their conservation research projects. This affords ECRs the ability to open up their programs to include early input and collaboration from conservation practitioners into the research agenda so that their science addresses the 'real' problems the practitioners are facing. However, ECRs must ensure that they maintain core research objectives in the face of what could be persuasive influence from policy makers and donors throughout this process to avoid potential project 'high-jacking'; in order for conservation scientists and practitioners to successfully collaborate in the co-creation of the research agenda, they must communicate and build a trusting relationship (Sutherland et al., 2013). ECRs are poised to engage with conservation practitioners from the outset to co-produce science that effectively confronts conservation problems.

2.11. Techno-fix or Tech-no-fix?

The current need for conservation science stems from persistent exploitation of nature by humans facilitated largely by technological developments over the past centuries (Angermeier, 2000). The current culture in conservation science places technology in high regards purporting that conservation has benefited tremendously from technological advancements, and effectively allows remediation of past environmental mistakes. Indeed, the development of technological tools has brought forth a variety of changes in management techniques and strategies for conservation (e.g., Wan et al., 2004; Cooke et al., 2013; Shafer et al., 2015). However, an inconvenient detail widely ignored is that mechanistic, reductionist science and technologically driven remediation efforts have also been perpetrators of environmental problems, resulting in the need for conservation in the first place (Huesemann, 2001). Furthermore, although technological advancements are attractive and beneficial in some circumstances, there are limitations and ethical concerns for ECRs to take heed of; it is not feasible to rely on engineering a technological solution to all conservation problems (Katz, 1992; Angermeier, 2000; Huesemann, 2001).

Technological development proceeds rapidly and is often not allotted sufficient time to study and explore potential risks and consequences; the precautionary principle is rarely followed. For example, controversial geoengineering technologies used for large scale climate manipulation (see Zhang et al., 2014) are currently being considered as stopgap methods to mitigate the effects of climate change, but significant ecological, political, ethical, and moral issues arise with the potential use of these controversial technologies (Barrett et al., 2014; Bahn et al., 2015; Symons and Karlsson, 2015). The consequences of geoengineering, much like the very problem it is proposed to mitigate (i.e., climate change), cannot be accurately predicted (Barrett et al., 2014). When considering the use of technological solutions to conservation problems the precautionary principle should be applied by ECRs, who are often on the forefront of technological developments and are typically the first researchers presented with opportunities to employ new technologies.

Rather than removing the agent of decline, a central concept in conservation, there appears to be a growing culture relying on technological developments to engineer solutions to complex conservation problems, searching for a "silver bullet" solution. Increasing reliance on technological solutions risks becoming a crutch for conservation biology, something ECRs should approach with circumspection. Technology *may* contribute to solving conservation problems – and indeed many technologies have great potential and contribute vitally important knowledge to conservation science – but examples where technology alone has provided true solutions to conservation issues are somewhat limited.

2.12. Be in the node

Networking has been called the most important aspect of career development. Networking contacts are the top source of candidates for job interviews, and the majority of high calibre jobs are filled by a candidate that is sourced through personal contacts (Hansen, 2013). Networking encompasses any proactive attempts by an individual to create personal and professional relationships by sharing information with a wide variety of people (de Janasz and Forret, 2007), and making an effort to encourage other people to want to know more about you (Hansen, 2013). Recently, networking was one of the top skills listed as part of non-academic job descriptions in science (Blickley et al., 2013). Unfortunately, many ECRs lack the knowledge and skills required to effectively network, while others may choose not to participate in networking behaviour all together (de Janasz et al., 2014). Further, the number of highly qualified personnel entering the conservation science job market has increased competition, so successful candidates need to stand out now more than ever. We believe that, with the numerous technological, academic, and professional networking outlets, ECRs from all backgrounds can find a networking technique that is effective for achieving their personal career objectives.

One of the major tools available to all ECRs is online social media (Papworth et al., 2015; Parson et al., 2014). As the two most popular social media websites in the world, Twitter and Facebook have become a soapbox through which scientists are sharing journal articles, advertising their thoughts and opinions on recent science, posting updates from conferences, and circulating information about professional opportunities and upcoming events (Bik and Goldstein, 2013; Bennett, 2014). LinkedIn, academia.edu, and Researchgate are now the leaders in professional social media sites, giving ECRs a platform to garner information on the interests and work experience of researchers from around the globe. Participation in social media can be passive, taking up information as it is released, or active, posting about the user's conservation interests, career goals, and actively seeking interactions with specific users that have the power to create opportunity for the ECR. This can be particularly valuable for ECRs hoping to garner the attention of certain groups of people, though they must be willing to reach out and make connections.

However, for some ECR this kind of networking activity runs the risk of inducing a networking placebo effect, causing users to believe they are effectively establishing contacts when in reality they are not making tangible progress. While social media can be extremely effective, only a handful of ECRs use it to its full potential and achieve real gains through its use. In this way, these sites can actually hinder professional growth rather than advance it; posting material online to make it available feels good, but there is no way of knowing if that material is reaching the target audience (i.e. potential employers, collaborators). Generally speaking, it is still the responsibility of the ECR to reach out and establish meaningful connections. Participation in face-to-face activities such as academic societies, scientific conferences, and local meetings arguably remain the most effective mechanism to reach networking goals (Hansen, 2013). ECRs must be able to identify which networking technique creates the most meaningful relationships—i.e., relationships that have the ability to positively affect the ECR's career.

Through various networking avenues, ECRs can hone scientific communication skills that are useful when conducting outreach activities such as public events, media correspondence, and communication with policy makers. Being able to communicate scientific findings in an elegant, engaging, and meaningful way is a challenge that ECRs must face to achieve meaningful change in management strategies. Indeed, if conservation science is to make a difference, it is absolutely imperative that results are communicated to those who draft policy in a way that inspires action (Farley et al., 2010).

Networking is the mechanism that facilitates collaboration. In this way, diversifying your networks and placing yourself as the node between networks facilitates knowledge sharing, creative thinking, and eventually interdisciplinary collaboration, factors that we believe are integral to maintaining relevance as an ECR. Funding agencies and academic institutions are looking for research programs that foster interdisciplinary research and publication (Porter et al., 2012). Further, effective conservation science involves the participation of numerous user groups, agencies, and academic bodies; the more people you know amongst these groups, the more relevant and effective your research initiatives will become. For this reason, we believe that a relevant ECR not only actively builds their network, but is also not afraid to be in the node, creating the link that joins unique skill sets from different professional arenas.

2.13. Move beyond "the sky is falling"

Human alterations to the biosphere and the associated biodiversity crisis provide researchers with many opportunities to document problems. There is no shortage of "sky is falling" papers that describe problems and generate hype (which is not necessarily a bad thing in terms of building awareness and political will; Ladle et al., 2005) among the public (e.g., no fish in the oceans by 2048 (Worm et al., 2006); and major declines in North American bee populations (Cameron et al., 2011)). However, how often do we hear about success stories—development of effective solutions to these problems that reverse population declines? Conservation problems are dynamic and complex, which require effective problem-solving strategies to develop meaningful solutions. Conservation scientists and practitioners are well aware of these growing environmental problems, yet solution development appears to take a 'backseat' to problem identification (Salafsky et al., 2002). In fact, the majority of conservation science today is based around characterizing patterns (e.g. population decline, loss of habitat) and to some extent identifying the 'cause-and-effect' relationships of problems, with comparatively little attention given to identifying and rigorously testing potential evidence-based solutions that might solve these problems (Richmond et al., 2007). Striving to generate effective solutions to conservation issues, should be at the forefront of conservation science, yet this is rarely the case. Conservation scientists and practitioners need to take the next step towards solution development, refinement and adoption.

There are a number of approaches to solving problems in the conservation sciences, and many of these approaches show promise if implemented and followed through. For example, taking an Interdisciplinary Problem Solving (IPS) approach can be effective in generating conservation solutions by integrating data and perspectives from multiple disciplines (e.g. sciences, economics, politics), to develop a holistic picture of a conservation problem and the alternatives to address the problem (Clark, 1993; Clark et al., 2001). Two key examples illustrating the effectiveness of the IPS strategy are present in the comprehensive approach developed by Clark et al. (2005) to address the large carnivore–landowner conflicts occurring in the Yellowstone National Park (YNP) region; and the strategic approach Clark et al. (2008) developed for addressing the failing polar bear conservation effort in Northern Canada. Another effective problem solving strategy is the Practice-Based (PB) approach. The basis of the PB approach is to identify constructive solutions that already exist within a system, and adapt and apply those solutions to current relatable problems (Brunner and Clark, 1997). For example, an ecosystem management plan developed for the Tongass National Forest in southeast Alaska, was considered so successful that it now serves as a model for adaptation elsewhere (Kirchhoff et al., 1995; Brunner and Clark, 1997).

Both the IPS and PB approaches are only two strategies out of a multitude of problem-solving approaches that can be effective in generating meaningful solutions to conservation issues; however to be effective, they first need to be implemented and followed through to have any chance at success. Although developing meaningful and effective solutions to conservation problems is complex and challenging, it is also necessary. As conservation problems continue to appear and grow, it is necessary to adapt and adjust our focus from problem identification, to solution development. To that end, the next generation of conservation scientists and practitioners are encouraged to not fall into the "sky is falling" trap by focusing only on problem identification. Instead, efforts to close the loop, take action, and develop solutions are sorely needed.

Section	Strategy	Take home message
2.1	Take off the blinders	Maximize conservation impact by knowing the appropriate scale of a project
2.2	Evidence matters but comes in different forms	Integrate different forms of knowledge to increase scope of conservation initiatives
2.3	Don't be parachute scientist	Maintain positive relationships with locals in areas of conservation concern
2.4	Failure: a viable outcome	Understand that outcomes have important lessons and strengthen conservation science
2.5	Creativity ain't just for artists	Don't be afraid to step outside of your comfort zone and be creative
2.6	Everyone's a scientist	Understand the potential of citizen science and community engagement
2.7	Breaking "bad" behaviour	Encourage pro-environmental behaviours through example
2.8	Build bridges, not walls	Cross disciplinary boundaries to form integrative conservation approaches
2.9	Money talks	Be willing to view conservation through an economic lens
2.10	Start with a partner	Involve practitioners and policy makers from the onset of a project
2.11	Techno-fix or tech-no-fix?	Embrace and account for the inherent limitations of new technologies
2.12	Be in the node	Know how to network effectively and in a variety of forms
2.13	Move beyond "the sky is falling"	Maintain a positive outlook to prevent becoming disenchanted with conservation science

Box I. An outline of the thirteen practical strategies that Early Career Researchers (ECRs) can employ to ensure relevance within the framework of conservation science.

2.14. Synthesis

We have presented a list of thirteen strategies (framed as practical guidance) for increasing the relevance of ECRs in conservation science that, when employed, will strengthen the ability of ECRs to effectively solve conservation issues. The list is not exhaustive and we certainly hope that this paper will spark more creative dialogue and spirited discourse on both training the next generation of conservation scientists and on ensuring that the conservation science community has the relevant skills to reverse the decline in biodiversity and solve pressing conservation problems. Of particular note is that most of the strategies listed above cost little if anything to embrace. However, we recognize that some of the strategies proposed here require notable time investment. Of late there have been calls for "slow science" (Alleva, 2006) which may be a necessary consequence of those committed to truly being agents of change in the conservation of biodiversity, albeit recognizing that speed matters in crisis disciplines (Nguyen et al., in press). Donaldson and Cooke (2014) argue that the most important metric for ECRs with an interest in conservation is a focus on influence (which is to some extent a combination of the quality and quantity of research but also about relevance and application). (See Box I.)

To embrace the ideas presented here, one does not need to rush out and register for various career development courses (although some courses in environmental economics, human dimensions and evidence assimilation and synthesis would be desirable). Rather, it is more important to simply reframe how one thinks about and approaches conservation problems and solutions. Keeping human behaviour and socio-economic considerations in mind is an important step that is often overlooked in standard training in conservation science. Similarly, there is a need to embrace creativity, and recognize that stakeholders themselves may have the solutions to problems if we were only better at listening and engagement. In today's world of technological fixes, the need to recognize that technology alone will not enable us to engineer our way out of conservation problems, nor is it a failsafe replacement for effective network building. The only way to advance conservation science is to change the way in which we approach conservation problems and ensure that our training and actions are relevant and well communicated; the next generation of conservation scientists has a lofty job ahead and the sooner that they learn how to be relevant, the more effective they will be at solving conservation problems.

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