On principles and standards in ecological restoration

Higgs, Eric; Harris, Jim; Murphy, Steve; Bowers, Keith; Hobbs, Richard; Jenkins, Willis; Kidwell, Jeremy; Lopoukhine, Nik; Sollereder, Bethany; Suding, Katie; Thompson, Allen; Whisenant, Steve

DOI:
10.1111/rec.12691

Restoration Ecology
THE JOURNAL OF THE SOCIETY FOR ECOLOGICAL RESTORATION

STRATEGIC ISSUES ARTICLE

On principles and standards in ecological restoration

Eric Higgs[1,2], Jim Harris[3], Stephen Murphy[4], Keith Bowers[5], Richard Hobbs[6], Willis Jenkins[7], Jeremy Kidwell[8], Nikita Lopoukhine[9], Bethany Sollereder[10], Katherine Suding[11], Allen Thompson[12], Steven Whisenant[13]

The Society for Ecological Restoration (SER) has long debated how to define best practices. We argue that a principles-first approach offers more flexibility for restoration practitioners than a standards-based approach, is consistent with the developmental stage of restoration, and functions more effectively at a global level. However, the solution is not as simple as arguing that one approach to professional practice is sufficient. Principles and standards can and do operate effectively together, but only if they are coordinated in a transparent and systematic way. Effective professional guidance results when standards anchored by principles function in a way that is contextual and evolving. Without that clear relation to principles, the tendency to promote performance standards may lead to a narrowing of restoration practice and reduction in the potential to resolve very difficult and diverse ecological and environmental challenges. We offer recommendations on how the evolving project of restoration policy by SER and other agencies and organizations can remain open and flexible.

Key words: codes of ethics, principles, professional practice, scope of restoration, standards

Implications for Practice

- A flexible, open approach to restoration practice is required to address a rapid scaling up of restoration investment, climate change, human needs, scientific uncertainties, and locally appropriate innovations in practice.
- A principles-first approach exemplified in the Society for Ecological Restoration's "Code of ethics" and "Ecological restoration in protected areas" offers flexible and adaptable models for professional practice in a wider variety of settings.
- An approach to professional practice based on performance standards may limit innovation and the reach of ecological restoration.
- Principles and standards can operate effectively together, but only if carefully coordinated and, generally, principles should precede standards.
- Performance standards can provide valuable advice for restoration practitioners, if underlain by clear principles and scientific evidence.

Introduction

The long-held promise of ecological restoration becoming widespread and adopted by organizations at all levels is upon us (Aronson & Alexander 2013; Perring et al. 2015). In the last half-decade, international organizations have adopted restoration within their policies (Alexander et al. 2011) and international agreements have set ambitious restoration targets (Suding et al. 2015; Cowie et al. 2017). Of course, there is heightened activity in restoration at all levels and across all biomes; it is truly a remarkable time for the often urgent tasks of helping recover damaged, degraded, or destroyed communities, ecosystems, and landscapes.

The Society for Ecological Restoration (SER) has introduced a succession of policies to guide practice. From discussions in the 1980s and 1990s about the definition of restoration through the *SER International Primer on Ecological Restoration* (SER 2004) and subsequent guidance including the *Code of ethics* (SER 2012), the joint World Commission on Protected

Author contributions: All contributors wrote and edited the article.

[1]School of Environmental Studies, University of Victoria, Victoria, British Columbia, Canada V8P 5C2, and Groningen Institute for Evolutionary Life Sciences, University of Groningen, University of Groningen, Groningen 9700 CC, The Netherlands.
[2]Address correspondence to E. Higgs, email ehiggs@uvic.ca
[3]Cranfield Institute for Resilient Futures, Cranfield University, Cranfield Mk43 OAL, U.K.
[4]School of Environment, Resources, and Sustainability, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada
[5]Biohabitats, Inc., Charleston, SC 27613, U.S.A.
[6]School of Biological Science, University of Western Australia, Perth, Western Australia 6009, Australia
[7]University of Virginia, Charlottesville, VA 22904–4126, U.S.A.
[8]Department of Theology and Religion, University of Birmingham, Birmingham B15 2TT, U.K.
[9] Ottawa, Ontario, K1N 0C4, Canada
[10]Faculty of Theology and Religion, University of Oxford, Oxford 0X2 6GG, U.K.
[11]Institute of Arctic and Alpine Research, University of Colorado, Boulder, Boulder CO 80309–0334, U.S.A.
[12]School of History, Philosophy and Religion, Oregon State University, Corvallis, OR 97331, U.S.A.
[13]Department of Ecosystem Science and Management, Texas A&M University, College Station, TX 77843–2138, U.S.A.

doi: 10.1111/rec.12691

Areas–SER *Ecological Restoration for Protected Areas* (hereafter "WCPA–SER Principles"; Keenleyside et al. 2012), and the *International Standards for the Practice of Ecological Restoration* (hereafter "SER Standards"; McDonald et al. 2016), the boundaries of restoration remain actively negotiated (Hallett et al. 2013; Shackelford et al. 2013). A signal challenge for the design of policy guidance is determining how much flexibility is accorded practitioners, who are wrestling not only with ecological degradation but also emerging ecological novelty, human livelihood and food security issues, and intensively transformed landscapes. Thus, policy guidance is partly about the demarcation of boundaries, and whether these are set wide or narrow.

We believe the proposal for performance standards in the SER Standards tied to the target of "a local native ecosystem," which "aims to characterize the condition of the ecosystem as it would be had it not been degraded" (McDonald et al. 2016, p 6), forces a narrowing of the range of acceptable practices for restoration. We recommend a series of changes that position SER's policy advice in a broader framework based on a "principles-first" approach. First, we distinguish between principles and standards, which are often blurred. Second, we raise concerns about placing standards at the center of restoration policy. Finally, we return to the arguments for a flexible and open view of restoration, and conclude with a series of proposals. As the SER Standards is considered by SER to be a "living document," our aim is to contribute to its refinement and place it within a comprehensive approach to restoration policy for SER and other agencies and organizations.

The implications for restoration are significant. In the case of recent policy guidance from the United Nations Convention to Combat Desertification based on the SER Standards (Cowie et al. 2017; Orr et al. 2017), restoration is portrayed as "pre-existing biotic integrity, in terms of species composition and community structure…" What lies beyond restoration is rehabilitation, which is weakly defined internationally and encompasses a wide range of activities (e.g. reclamation, revegetation) along what is asserted in the SER Standards as a "restorative continuum." Thus, much of what is practiced as restoration in heavily transformed landscapes in Europe, emerging novel ecosystems in Australia, or ecosystems tied to food security in Africa would not fit this model of restoration. There is the risk of disenfranchising restoration practitioners, and allowing a growing range of practices to lie outside the ambit of restoration. An implication is that these practices would not be informed and criticized by the debates and discourse of restoration. It is not abstract concern that motivates our analysis, but a strong commitment to effective practice under conditions of diverse conditions and rapid change.

Principles and Standards

In general, a principle serves as the foundation for particular beliefs, while a standard is used as a comparative measure or norm. These terms are sometimes used interchangeably, which muddies an important distinction. One cannot in any conventional sense *measure* a principle. However, principles can generate guidelines for practice that can further be refined in terms of best practices and measurable standards. Both principles and standards are commonplace in directing the actions and behavior of professionals across a wide variety of fields. Codes of ethics, which comprise the central core for most professional behavior, offer various combinations of both principles and standards. Best known perhaps are medical codes of ethics that typically depend on four widely accepted ethical principles—autonomy, nonmaleficence, beneficence, and justice—that inform rules and standards, which help medical professionals make decisions in particular cases (Beauchamp & Childress 2012). Because those rules and standards are visibly justified by background principles, they do not withdraw discretion entirely and instead encourage necessary deliberation, professional training in disciplinary practices, and checks and balances (e.g. ethical review boards)—all of which may result in revision or evolution of specific standards.

Standards are typically prescriptive, providing detailed and measurable guidance that limits potentially risky or damaging behavior. Further, standards can emphasize the excellence of practitioners or performance of defined criteria. They serve often to provide defined and precise norms to practitioners operating under legislative and policy directives. Standards tend to function well when there is widespread and agreeable knowledge about how systems function, and a regulatory environment that demands accountability and risk minimization.

As many organizations have found (e.g. ICAEW 2017), standards and principles can sometimes be difficult to reconcile. They can operate effectively together, but only if they are coordinated in a transparent and systematic way. For example, the Institute of Chartered Accountants of England and Wales (ICAEW) acknowledges that ethical conduct can rest on both principles and standards. The ICAEW along with the International Federation of Accountants adopts a principles approach as "robust and flexible," and more specifically because it can reflect the nearly infinite variations that result from practice, cope with rapid change, avoid "mechanistic 'box-ticking'" approaches, and encourage professional judgment and responsibility. Alternatively, advocates of a standards approach argue that compliance with rules is more "prescriptive and leave little room for misunderstanding" (ICAEW 2017). Effective professional guidance results when standards anchored by principles function in a way that is contextual and evolving.

The WCPA–SER Principles deploy three principles: restoration, done well, must be effective, efficient, and engaging. Effective restoration, for example, "establishes and maintains an ecosystem's values." This principle is reinforced by a series of guidelines that give specification to the principle, including avoiding harm, reestablishing ecosystems, structure, function, and composition, enhancing resilience, restoring connectivity, encouraging and reestablishing traditional cultural values and practices, and ensuring research and monitoring. These are further supported by best practices, recommended processes for practice, and case studies. As principles articulate guidance with greater generality, ranging over a larger set of possible applications, they require more careful interpretation by practitioners for application in particular situations. The

WCPA–SER Principles were not designed to provide standards, although there is nothing incompatible with development of standards emerging out of shared practices, challenges, or jurisdictions.

The SER Standards are based on national standards developed for Australia (McDonald et al. 2017). There are six "key concepts:" (1) appropriate local native reference ecosystem (while accounting for environmental change); (2) identifying key attributes for target ecosystems; (3) assisted natural recovery; (4) highest and best effort toward full recovery; (5) incorporating all relevant knowledge; and (6) effective stakeholder engagement. Performance standards are prominent in (4), which introduces a five-star recovery wheel including species composition, structural diversity, ecosystem function, external exchanges, absence of threats, and physical conditions. The aim is to provide precise criteria for what determines restoration, and to set up a scale toward full recovery. The SER Standards do invoke the WCPA–SER Principles. They are described in the Introduction Appendix 1 as "underpinning" principles, but there is no apparent integration with the subsequent six "key concepts." Taken together, the title, the key concepts, and the express aim to "provide standards to guide practitioners" suggest a standards-first policy.

Principles Come Before Standards

Acknowledging that principles and standards can and should be coordinated, we argue that principles should take priority. Promoting standards before emphasizing and establishing principles may steer the development of restoration in a direction away from its origins as a practice emphasizing adaptation, flexibility, experience, and innovation in the face of ecosystem complexities, shifting policies and legal frameworks, and cultural differences in how restoration is constituted. Below, we highlight some of the concerns arising from a standards-first approach.

Responsibility Should Be Favored Over Compliance

A standards approach that emphasizes metrics rather than responsibility and excellence potentially diminishes the role of good professional judgment gained through experience, education, and adaptive capacity. Performance standards can discourage the adaptive creativity needed to cope with such changes and this can encourage a compliance mindset that becomes pertinacious rule-following. Some of the innovation in restoration practice depends on trial and error, experimentation, and tinkering, which may well be suppressed by increasingly defined and rigid performance standards.

The Majority of the Planet Probably Exhibits Conditions Where Current Standards Can No Longer Be Met

A significant portion of the biosphere has experienced anthropogenic climate and other biogeochemical changes, species invasions, and land/water/marine-use alterations that render some ecosystems effectively irreversible (Perring & Ellis 2013). Expectations for restoration that establish a "gold standard" for restoration practice based on "an appropriate local native reference ecosystem" may discourage practitioners from working in heavily degraded environments due to direct anthropogenic pressures or the normal trajectory of ecosystem dynamics. We are concerned about an artificial divide between "restoration" and "restorative activities" (sensu McDonald 2016, p. 34) such that "restoration" in the manner defined in the SER Standards is an unattainable target for an increasingly large number of sites globally.

Quantification

Some attributes of restoration are congruent with clear paths for quantification. However, some features of restoration, for instance community/social engagement, are harder to reconcile with numerical measures. An emphasis on performance standards risks pushing less quantifiable aspects of restoration into the shadows. For example, while the National Vegetation Classifications (http://usnvc.org) were developed simply as a means of describing the vegetation composition of habitats, in practice some have been taken as an "essential species presence and abundance" inventory. The problem is that deviation from seeing such classifications only as a numerical, descriptive *inventory* is that management interventions are now often designed to return to this "norm" even if the ecosystem is changing in response to new conditions. The peril of trying to convert qualitative ideas into quantitative measures is a central problem in the SER Standards. For example, table 3 of the SER Standards leads to what might look like an ordination. The gradient is broken into five discrete categories, each accorded between one and five stars. Either judgment is needed in distinguishing the breaks between categories or a more precise quantification approach is required to identify unambiguous categories. The former is inconsistent with ordination and the latter is not offered.

Diversity

While the nascent science of restoration ecology points to patterns, there are so few law-like regularities that obtain across global biotic, abiotic, and cultural diversity. The difficulties in conducting successful restoration are many, but are crucially affected by the complexities of ecosystems themselves and the variety of ecosystems. A practitioner addressing degradation in the fynbos ecosystems of South Africa, for example, will share challenges with those working on shrublands in different parts of the world, but local environmental, social, and ecological conditions can also create uniquely difficult challenges.

Fledgling Development

An approach emphasizing standards risks impeding the development of a dynamic field with many still-open questions. Significant strides have propelled restoration in the last three decades, but restoration is still young and shifting in response to new challenges. Ecology itself is still a young and dynamic field with current competing theories, based on cutting edge empirical evidence and experimentation, which are often contradictory. Some other, better established professional practices, for example in engineering and accounting, which are well-founded on known physical laws or agreed policies and

lack a comparable degree of diversity, can support precise standards to guide professional practice. Thus, restoration has some distance to travel in obtaining clear and verifiable results for evidence-based standards that are broadly applicable.

Discussion

Principles and guidelines are compatible with standards that encourage professional excellence; that is, with a culture of practice that rests on best-available knowledge and techniques, sensitivity to the human communities engaged with the ecosystems being restored, and humility (e.g. as described in SER's *Code of ethics*). The practice processes described in section 3 of the SER Standards and section 5 of the WCPA–SER Principles encourage excellence. They are not, however, compatible with general *performance* standards, such as those advanced by the five-star system in the SER Standards. Such performance standards can be effective at smaller scales, with advanced, evidence-based knowledge of restoration outcomes, and in well-defined regulatory and policy settings. In such instances, standards would ensure consistency and at least a minimal level of success for a burgeoning restoration industry. Otherwise, it is more effective to emphasize practitioner excellence and role responsibility in debating and defining flexible approaches to shifting ecosystems.

Directional environmental change and intensification of invasive species make restoration less predictable and call into question some fundamental assumptions about references and the significance of historical antecedents in classical restoration (Higgs 2017). Before widespread global ecological change began to trouble restoration, there were difficulties faced by the SER in developing a stable concept of restoration in the 1990s (Higgs 2003). These complexities continue to haunt the search for consistently quantifiable benchmarks, which is why the WCPA–SER Principles recommended simple but widely held principles, guidelines, and best practices. In the search for appropriate boundaries, emphasizing an open flexible approach with clear principles allows more types of activity to be practiced (Temperton et al. 2014). The abstract quality of these constitutional debates hits the ground with the launch of SER's new Certified Ecological Restoration Practitioner Program (Nelson et al. 2017), in which matters of appropriate practice are prominent.

Is restoration sufficiently well developed to adopt performance standards that are applicable globally? The struggle to find scientific regularities, practice breakthroughs, social license, and economic support that will allow restoration to scale-up quickly is daunting. There are unlikely to be quick fixes. This is not to undermine the accomplishments of restoration, which are many and impressive. But, there is much more to come in the future than there has been in the past.

Some might argue that the SER Standards already invoke principles. However, there are at least two problems with the way in which this is accomplished. First, the principles are extracted from the WCPA–SER Principles without the structure that gave them coherence (i.e. guidelines, best practices, case studies). Together, this created the elements of operational guidance that could be tailored to a wide variety of settings (despite the emphasis on protected areas). Second, little effort is made to give the principles priority, and to allow articulation with the subsequent "key concepts." It is also the case that both the SER Standards and the WCPA–SER Principles remain in active circulation, providing distinctly different approaches to restoration.

Conclusion and Recommendations

Globally, we suggest the best path is to settle on widely accepted principles, and continuously refine guidelines, catalogue and distribute examples of restoration (both successes and failures), encourage excellence in practice, and adopt performance standards only in settings that warrant this level of precision. Hopefully in the near future there will be a critical scaling up of restoration support that will allow sustained and adequately funded applied research and training, especially for those who work in regions ravaged by conflict, widespread environmental degradation, and poverty. It is also important to acknowledge the significant role that cultural practices play in shaping restoration practice and ensuring its success. In the end, it is healthy to have methodological pluralism in restoration practice. Approaches that make sense in Canada might be less applicable in Australia, Angola, or Laos, and vice versa. A principles-first approach, especially through "engagement," one of the three WCPA–SER Principles, or the variation of "benefits and engages society" (Suding et al. 2015), gives priority to ecological *and* cultural diversity. With a rapid scaling up of restoration ambition, principles of this kind point to the need for evolved principles that address rapid change and severe land degradation challenges.

What most restoration ecologists wish for is that restoration be conducted to encourage sound professional judgment, best-available knowledge, and innovation. We hope that this also holds for those who advise and implement the applicable regulations, policies, and laws. We offer five recommendations.

1. Future versions of the SER Standards document be renamed "International *principles and* standards for the practice of ecological restoration."
2. Advice from the WCPA–SER Principles and SER's Code of ethics documents is incorporated at or near the beginning of the revised SER Standards to provide significant background and foundation. There are at least two ways of doing this. The first is a weaker version in which the two documents are given more prominence in defining restoration and key concepts. A stronger approach would be to adopt a version of the sequence of advice provided in the Principles, namely that *principles* are followed by *guidelines*, which in turn are fleshed out in terms of *best practices*. It is difficult to know whether the "key concepts" in the Standards serve a similar function to the "guidelines" in the Principles, but some effort toward congruence would help.
3. Standards of the kind described in "key concept 4" could be offered as examples rather than generalized advice alongside other performance standards from other regions. This would

solve two significant issues. First, it would allow greater flexibility in describing an "appropriate local native reference ecosystem," or perhaps avoid this issue entirely (i.e. allow different versions of this to develop across regions). Second, it would step around the complicated issues raised in this article about the transition from normative standards to ordinated rankings as suggested by the five-star ranking system.

4. There is no doubt that as restoration continues to gain momentum and prominence, and becomes increasingly enshrined in international, national, and other levels of law and policy (Palmer & Ruhl 2015), a comprehensive research strategy is needed to search for evolving regularities, realistic targets, effective performance measure, and so on. There remain as many questions as there are answers, which is never an easy message to convey during a rapid scaling up.
5. While research in professional and other areas of practical ethics has much to offer in clarifying the roles and relationships between principles and standards, this has not been done specifically for ecological restoration. Such work is crucially needed in support of offering sound practical advice to ecological restoration practitioners.

Acknowledgments

We are grateful to the Templeton World Charities Foundation for support of a workshop in May 2017 at the Millard Learning Centre on Galiano Island, Canada, at which this article was conceived (among many other discussions). We appreciate substantial advice and insights from George Gann and several anonymous reviewers.

LITERATURE CITED

Alexander S, Nelson CR, Aronson J, Lamb D, Cliquet A, Erwin KL, et al. (2011) Opportunities and challenges for ecological restoration within REDD+. Restoration Ecology 19:683–689

Aronson J, Alexander S (2013) Ecosystem restoration is now a global priority: time to roll up our sleeves. Restoration Ecology 21:293–296

Beauchamp T, Childress J (2012) Principles of biomedical ethics. 7th edition. Oxford University Press, Oxford, United Kingdom

Cowie AL, Orr BJ, Sanchez VMC, Chasek P, Crossman ND, Erlewein A, et al. (2017) Land in balance. The scientific conceptual framework for land degradation neutrality. Environmental Science and Policy 26:25–35

Hallett LM, Diver S, Eitzel MV, Olson JJ, Ramage BS, Sardiñas H, Statman-Weil Z, Suding KN (2013) Do we practice what we preach? Goal setting for ecological restoration. Restoration Ecology 21:312–319

Higgs ES (2003) Nature by design: people, natural process, and ecological restoration. MIT Press, Cambridge, Massachusetts

Higgs ES (2017) Novel and designed ecosystems. Restoration Ecology 25:8–13

ICAEW (Institute of Chartered Accountants of England and Wales) (2017) Principles versus rules debate. http://www.icaew.com/technical/ethics/ethics-in-business/general-ethics/principles-versus-rules-debate (accessed 7 Feb 2018)

Keenleyside KA, Dudley N, Cairns S, Hall CM, Stolton S (2012) Ecological restoration for protected areas: principles, guidelines and best practices. IUCN, Gland, Switzerland

McDonald T, Gann GD, Jonson J, Dixon KW (2016) International standards for the practice of ecological restoration – including principles and key concepts. Society for Ecological Restoration, Washington D.C.

McDonald T, Jonson J, Dixon KW (2017) National standards for the practice of ecological restoration in Australia. 2nd ed. Restoration Ecology 24:S6–S32

Nelson CR, Bowers K, Lyndall JL, Munro J, Stanley JT (2017) Professional certification in ecological restoration: improving the practice and the profession. Restoration Ecology 25:4–7

Orr BJ, Cowie AL, Castillo Sanchez VM, Chasek P, Crossman ND, Erlewein A, et al. (2017) Scientific conceptual framework for land degradation neutrality. A report of the science-policy interface. United Nations Convention to Combat Desertification (UNCCD), Bonn, Germany

Palmer MA, Ruhl JB (2015) Aligning restoration science and the law to sustain ecological infrastructure for the future. Frontiers in Ecology and the Environment 13:512–519

Perring MP, Ellis E (2013) The extent of novel ecosystems: long in time and broad in space. Pages 66–80. In: Hobbs RJ, Higgs ES, Hall C (eds) Novel ecosystems: intervening in the new ecological world order. Wiley, Chichester, United Kingdom

Perring MP, Standish RJ, Price JN, Craig MD, Erickson TE, Ruthrof KX, Whiteley AS, Valentine LE, Hobbs RJ (2015) Advances in restoration ecology: rising to the challenges of the coming decades. Ecosphere 6:1–20

SER (Society for Ecological Restoration) (2012) Code of ethics. http://www.ser.org/page/CodeofEthics/Code-of-Ethics.htm (accessed 25 Sep 2017)

Shackelford N, Hobbs RJ, Burgar JM, Erickson TE, Fontaine JB, Laliberté E, Ramalho CE, Perring M, Standish RJ (2013) Primed for change: developing ecological restoration for the 21st century. Restoration Ecology 21:297–304

Society for Ecological Restoration International Science and Policy Working Group (2004) The SER International primer on ecological restoration. Society for Ecological Restoration International, Tuscon, Arizona

Suding K, Higgs E, Palmer M, Callicott JB, Anderson CB, Baker M, et al. (2015) Committing to ecological restoration. Science 348:638–640

Temperton VM, Higgs E, Choi YD, Allen E, Lamb D, Lee C-S, Harris J, Hobbs RJ, Zedler JB (2014) Flexible and adaptable restoration: an example from South Korea. Restoration Ecology 22:271–278

Coordinating Editor: Margaret Palmer

Received: 21 November, 2017; First decision: 17 December, 2017; Revised: 7 February, 2018; Accepted: 7 February, 2018; First published online: 24 March, 2018