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PERSPECTIVES AND NOTES

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We have a long way to go if we want to realize the promise of the "Decade on Ecosystem Restoration"

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1 | INTRODUCTION

People have conquered the Earth and altered ecosystems (Vitousek, Mooney, Lubchenco, & Melillo, 1997) to the extent that some have suggested that we have entered the Anthropocene epoch (Steffen, Crutzen, & McNeill, 2007). Yet, people can also restore degraded ecosystems. On March 1st, 2019, the United Nations designated the period of 2021–2030 as the "Decade on Ecosystem Restoration" (UNEA, 2019; see MARN, 2019 for context). This is laudable; yet, it is also naïve because it implies that restoration practitioners actually have the evidence to guide them (Cooke et al., 2018). Despite many calls for restoration efforts to clearly state objectives and implement rigorous monitoring programs, this rarely occurs (Block, Franklin, Ward Jr, Ganey, & White, 2001; Suding, 2011). In fact, restoration is often as much an art as it is a science (Van Diggelen, Grootjans, & Harris, 2001). We applaud the restoration practitioners who devote their lives to restoration and have in many cases produced significant restoration gains, and we acknowledge that many restoration efforts do indeed achieve at least partial success. However, the evidence for restoration efficacy is mixed and action without evidence has no guarantee of effectiveness. If restoration actions are ineffective, they are a waste of precious resources that could have been invested in something that actually works and at worst they could actually do more harm than good (Pullin & Knight, 2009a).

We worry that a decade from now we may be reflecting on the vast financial resources invested in restoration with negligible (because interventions did not work) or immeasurable (because outcomes were not evaluated) benefits for ecosystems, biodiversity, and humanity. The evidence base to guide restoration practitioners is scant and potentially biased given publication bias (Jennions & Moeller, 2002), the lack of appropriate controls and replication, and little long-term monitoring to determine the circumstances in which restoration actually works (Wortley, Hero, & Howes, 2013). One thing we do know is that active (versus passive) restoration often fails to achieve desired outcomes (Jones et al., 2018). Some researchers have called for an "effectiveness revolution" (Keene & Pullin, 2011)—something that is certainly germane to restoration. What is effective? And in what context? Synthesis activities can guide us but the reality is that restoration science remains imperfect and infrequently supported by a robust evidence base (Cooke et al., 2018).

We could use this decade as an opportunity to build coalitions of diverse stakeholders to coordinate what efforts are needed to understand where and when restoration is most effective. If we use it instead to attempt large-scale restoration projects without good evidence for efficacy, we are

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engaging in a high risk, 10-year experiment (i.e., UNEA, 2019). And unless standard practice changes, we will likely not know if we have failed or succeeded, partly because of insufficient monitoring but also because of a lack of mechanisms to report and scale-up local level activities to a global scale. This could undermine future efforts to engage in effective restoration and obtain appropriate resources to do so. Of course, there is also immense risk in not doing anything, which is not our goal. Rather, we need to think creatively and rationally about how to overcome the issues raised here—something that will require practitioners, scientists, regulators, planners, and diverse stakeholders to engage one another and actively collaborate.

Although we do not pretend to have all the solutions to this problem, we briefly share a number of high-level ideas on how to make the "Decade on Ecosystem Restoration" lead to meaningful conservation gains and yield a legacy that extends far beyond a 10-year period. We also recognize that there are instances where the ideas presented below have been embraced but this is far from universal.

2 | PROTECT WHAT WE HAVE

Although we recognize the value of restoration-done-right, it is almost always preferable to avoid having to restore in the first place (Young, 2000). The idea of protecting and buffering key habitats and ecosystems from human impact should be viewed as a central aspect of the Decade on Ecosystem Restoration.

3 | ENGAGE IN LARGE-SCALE (BOTH IN TERMS OF SPACE, TIME, AND REPLICATION) SCIENCE TO GENERATE THE BEST POSSIBLE EVIDENCE BASE

It would have been visionary to have combined the announcement of the "Decade on Ecosystem Restoration" with the announcement of a coordinated and well-funded science program focused on priority topics and ecosystems. For example, envision a mangrove restoration study that contrasts three different techniques (with appropriate before-after-control-impact design) and does so at 20 sites in coastal nations around the tropics over a 10 year period. Restoration science at that scale simply does not happen due to lack of funds and funding agencies that do not prioritize restoration science. Such an approach would enable direct comparison and yield the statistical power needed to reduce uncertainty while still attempting to engage in real restoration (Oksanen, 2001).

4 | IDENTIFY WHAT SEEMS TO WORK, CONSIDER HOW IT CAN BE SCALED (UP OR DOWN), SHARE IT, AND STUDY IT

Many of the restoration success stories can be framed as "bright-spots" which have been touted as a grass-roots approach to achieving a good "Anthropocene" (Bennett et al., 2016). However, the bright-spot concept needs to be extended to include a formal "science" component to learn the contexts in which different interventions succeed or fail. There is certainly room for much creativity and harnessing the expertise of on-the-ground practitioners. However, such expertise should be combined with rigorous experimentation or adaptive management. There also need to be better mechanisms for restoration practitioners to share their successes (and failures) with peers. For example, the journals *Environmental Management*, *Restoration Ecology*, and *Conservation Science and Practice* all have article types intended to enable practitioners to share their work. Efforts to share evidence must also recognize that failures are a vital aspect of learning (e.g., Catalano, Lyons-White, Mills, & Knight, 2019).

5 | ADOPT A BEST-PRACTICES APPROACH TO RESTORATION SCIENCE TO ENSURE THAT WE HAVE THE OPPORTUNITY TO LEARN FROM RESTORATION PROJECTS

Far too often, there is a lack of monitoring and science to evaluate the success of restoration projects (Block et al., 2001). This is a major lost opportunity. Funders of restoration projects should recognize the inherent value in allocating some of the budget to monitoring and science. Specific, measurable, ambitious, realistic, and time-bound (SMART) goals for restoration projects should be identified and funders should invest in monitoring progress toward them. Relatedly, the monitoring and science have to be good enough to contribute to the evidence base in a meaningful way. There may be instances where the evidence-base is sufficient such that routine monitoring is not always required but at present, it seems more common to not monitor or do so with insufficient rigour.

6 | MINE THE EXISTING EVIDENCE BASE

The use of systematic review (Roberts, Stewart, & Pullin, 2006) and meta-analysis techniques (Jones et al., 2018) in the last decade has revealed that a number of restoration interventions simply do not work (e.g., placement off in-stream structures fail to benefit salmonid populations; Stewart, Bayliss, Showler, Sutherland, & Pullin, 2009). There are many other such analyses that could be done to help guide the practice of restoration and identify the characteristics of science that is of sufficient quality to be considered part of the evidence base (Pullin & Knight, 2009b).

7 | ANCHOR DECISIONS IN A SOBER EVALUATION OF BENEFITS, RISKS, AND UNCERTAINTIES

Restoration activities are often initiated despite missing key pieces of information. Sometimes this is justified, for example, when *not* acting quickly could lead to extinction of a species and monitoring appears to be the best option using available evidence. But, without a clear examination of potential risks and benefits, there is no way of knowing whether limited conservation resources are being wisely spent on a restoration project. Evaluations of social and economic risks and benefits are particularly neglected in restoration practice (Wortley et al., 2013). Full accounting of benefits, risks, and uncertainties would help determine the aspects of a project where reducing uncertainty could alter key decisions. These aspects could then become targets for empirical research or evidence synthesis.

8 | STRENGTHEN PARTNERSHIPS BETWEEN PRACTITIONERS AND SCIENTISTS TO CREATE A COMMUNITY OF PRACTICE

The front line of the Decade on Ecosystem Restoration will be the many thousands of restoration practitioners. Yet, they cannot do it alone. There is need for better partnerships between practitioners and scientists to support restoration practice and learn from it. Relatedly, there is also need to ensure that practitioners are part of broader policy discussions about restoration. Human dimension research focused on understanding what practitioners need and providing forums for them to interact with scientists and peers from other regions could be profitable for creating a community of practice (recognizing that the Society for Ecological Restoration is actively trying to do this). Building incentive structures at academic and funding institutions to promote applied science could help spur more such collaborations.

9 | SEIZE THE OPPORTUNITY TO ENGAGE THE PUBLIC

It is our hope that the Decade on Ecosystem Restoration will serve as a platform to inform the public about the need for restoration, and in doing so hopefully build public and political will for ecosystem protection. There are also ample opportunities to involve volunteers in hands-on restoration (Miles, Sullivan, & Kuo, 1998) or in monitoring (i.e., citizen science; Huddart, Thompson, Woodward, & Brooks, 2016). Planning at the global, national, and local levels is needed to determine how to best seize this opportunity—something we are unsure is happening. Indeed, this could go a long way to achieving the "restorative culture" called for by Cross, Nevill, Dixon, and Aronson (2019).

10 | CONCLUSION

If and when we have figured out how to deliver restoration that achieves meaningful conservation targets at scale, a "decade" on ecosystem restoration would be prudent and timely. A better approach given current realities would be investment into restoration science that evaluates restoration outcomes so we can accomplish restoration results at scale. Today we are not much further along from when Menz, Dixon, and Hobbs (2013) provided a four-point plan (which was built upon by Suding et al., 2015) to ensure that restoration sustains or enhances ecological values. The impetus for that paper was an IUCN effort to restore 150 million hectares of disturbed and degraded land globally by 2020—the so called "Bonn Challenge" (http://www.bonnchallenge.org/). Although there have been many pledges and some investments in on-the-ground restoration activities, we are unaware of any evidence regarding the extent to which such activities occurring as part of the Bonn Challenge have been "proven" to be effective. Targets that focus on spatial extent rather than direct measures of ecological structure and function (Kollmann et al., 2016; including resilience; Standish et al., 2014) fail to reflect what restoration scientists understand to be important (Menz et al., 2013; Perring et al., 2015; Wortley et al., 2013). Ecological restoration is still in its infancy and remains an emerging discipline where the science and practice are often poorly aligned (Miller et al., 2017) which is in itself a major impediment to evidence-based conservation and practice (Schwartz et al., 2019). There is great urgency to resolve the science questions and determine what works so that we can embark on a decade of ecological restoration that is evidence-based and effective. We implore governments and restoration partners to first focus on getting restoration right, through increasing investment in restoration science (following the guidance provided here and elsewhere—such as in Perring et al., 2015 and

Gann et al., 2019), before simply "doing restoration." We do need to "roll up our sleeves" (sensu Aronson & Alexander, 2013) but action must be guided by evidence. If we are to realize the promise of the decade before us the many to follow could be transformational in helping to achieve the Anthropocene we desire. By raising these ideas here and when considered alongside the complementary paper by Young and Schwartz (2019) it is our sincere hope that it will catalyze immediate action by our community to achieve the greatest potential conservation gains from the Decade on Ecosystem Restoration.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICS STATEMENT

The authors are not aware of any ethical issues regarding this work.

AUTHOR CONTRIBUTIONS

S.J.C., J.R.B., and H.P.J. authors contributed to idea generation and writing.

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