
CAN ECOLOGICAL RESTORATION MEET THE TWIN CHALLENGES OF GLOBAL CHANGE AND SCALING UP, WITHOUT LOSING ITS UNIQUE PROMISE AND CORE VALUES?¹

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ABSTRACT

The words we use to describe phenomena in science shape our understanding of those phenomena, much more so than we often realize. This is especially true in fields driven by strong policy agendas, like restoration ecology and the practice of ecological restoration. The twin challenges of accelerating global change and upscaling global restoration practice make it more imperative than ever to define the terms and the scope of ecological restoration clearly, and differentiate it from other ameliorative land management practices like rehabilitation. Poor definitions and loose use of language will otherwise lead to muddled conception and planning of projects, confused and disappointed stakeholders, and failure to exploit the enormous potential of this radical conservation strategy for both human well-being and the recovery of biodiversity and ecosystem functions. It is also important to be aware of the rhetorical devices that have given some momentum to the so-called “novel” ecosystems concept within the restoration community. The advocates of this concept initially used it to alert restorationists to the gravity of the global change challenge. But it has been unfortunately formulated through increasingly polemical language to effect a major and dangerous policy shift: abandoning the pursuit of the ambitious but still valid promise inherent in the phrase “ecological restoration,” in favor of the management of degraded landscapes for diminished ecosystem goods and services. While we are always “restoring the future,” there is no good reason to abandon the goal of restoring ecosystems to their historical trajectories, and the historical reference system remains an essential tool for the identification of the specifics of this goal. The author considers the contributions to the symposium from these perspectives. He concludes that if we clarify the language we use about restoration, and are appropriately mindful of the dynamics of global change and the complex social and ecological dynamics of large-scale restoration, this discipline and practice can indeed mature to become the gold standard and cutting edge for conservation in this century.

Key words: Ecological restoration, global change, historical reference system, historical trajectory, “novel” ecosystems concept, restoration ecology, scaling up.

Articles in scientific journals are supposed by many to be model outcomes of Olympian objectivity. A hypothesis is articulated to expand the boundaries of our knowledge; experiments are designed to test that hypothesis; data are collected and dispassionately analyzed, and any new findings set out. After peer review and revision, the whole process is communicated through the article’s publication.

While such a procedure is indeed the *sine qua non* of good science, and extremely useful to society, this brief account hides as much as it reveals.

What’s missing? The degree to which language shapes understanding. Observed from a humanities perspective, the words we use in science, just as much as in literature or history, are frequently not neutral descriptors. The words scientists use to denote their hypotheses, data, and conclusions may

favor implicit ideological biases, policy preferences, and social values. Words are charged with layers of meaning that we ignore at the cost of much misunderstanding, wasted time and energy, and wasted opportunities. And these charged words may be combined to create similes, and especially metaphors, that again may often pass unnoticed, but which powerfully amplify the biases, preferences, and values being promoted.

This is especially true in scientific fields (and related practices) that are driven by a policy imperative. The field under discussion here, which encompasses both the theory of restoration ecology and the practice of ecological restoration, is clearly a good fit for this category: it is driven by the need to reverse environmental degradation. So it is laden, from the get-go, indeed from the very phrases we use

¹ I would like to thank Leighton Reid and James Aronson for inviting me to moderate the symposium, and Peter and Diane Wyse-Jackson for their hospitality. I would also like to acknowledge very helpful and challenging comments on drafts of this article from Curt Meine, Tein McDonald, Leighton Reid, and James Aronson. However, I am solely responsible for whatever errors of fact (or opinion!) it may contain.

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to describe its theory and practice, with assumptions about value and meaning. To recognize this does not invalidate the field in any way, but it should alert us to the charges carried by the words we use in our discourse about it.

Throughout this article I will seek to interrogate the meanings and implications of the words under discussion, not only “restoration” but also “historical,” “novel,” “rehabilitation,” and others. Semantic discussions are often infuriatingly pedantic, and I will try to avoid that pitfall. Nor is it my intention to play the role, as one symposium participant put it, of “acting like the word police.” I don’t believe that the definitions I will argue for are rooted in dogmatic or prescriptive thinking. It is simply essential to find the best words to describe the field as clearly as possible. We need to scrutinize and critique how key words are used to ensure that we are communicating with each other accurately when we talk about restoration, and distinguish this activity from other forms of ecological management.

“Restoration” on its own is a very potent word in the English language and, as far as I know, in most languages. It resonates with hope, with the promise that a better order of things is returning. It is always used, to the best of my knowledge, in this upbeat, positive sense. We speak of a person being “restored to health” after an illness; conversely, we speak of the “recurrence” of their disease but never of its restoration.

Marry “restoration” to “ecology,” which itself carries many feel-good associations in our culture,¹ and the offspring is a heady cocktail. And this stimulating fusion makes the phrases “restoration ecology” and “ecological restoration” remarkable and energizing: just to say the words is to utter a kind of mantra that seems to run counter to the dominant environmental narrative of our era. This narrative, sometimes described as “declensionist,” is heavily inflected (with good cause) by gloomy tones of continuous decline, even of doom.

(From hereon, for simplicity, I will generally refer only to “ecological restoration,” and then just to “restoration,” but obviously the points I am making here apply equally to restoration ecology.)

¹ For example, consider how “ecology” is now frequently applied as a metaphor in business organization jargon, almost always with positive connotations. Indeed, the fundamental insight of ecology—that all things in nature are interconnected—itself echoes earlier philosophical and religious intuitions of an integrated universe in which actions have broadly predictable consequences; this seems much more upbeat to most humans than the concept of a universe of randomly associated elements—and much more resonant with our experience of the world.

On the one hand, then, the instantly upbeat chord sounded by “ecological restoration” is a very good thing, and timely. Doom-laden narratives tend to be disabling, not empowering; it has recently become a commonplace of environmental writing that, as Tony Juniper puts it, “we desperately need a new storyline” (Juniper, 2015). For most of the public, in most of the world, ecological restoration is still a new story, and many people are astonished, delighted, and moved to action when they hear about it for the first time.

But precisely because of the feel-good resonance of “ecological restoration,” it sometimes seems that everyone wants a slice of it. Advocates of environmental interventions that fall far short of the high standards of this discipline, which is rooted in the recovery of a system’s historical trajectory, now want to stick the restoration brand on their projects, rather as the label “eco” is now misleadingly attached to hundreds of products on our supermarket shelves. I’m not saying we should be proprietorial about the restoration brand. On the contrary, everyone is most welcome to use it—as long as they follow the instructions on the tin, as it were.

This mainstreaming of the restoration concept is a happy indication of its relevance, but unless it is accompanied by clear definitions and standards it will rapidly become deeply problematic, for two reasons. Firstly, it will discredit good restoration, because less rigorous interventions will not generally achieve the goals implied by the labeling. Secondly, such mislabeling also denies less rigorous—but still often very valuable—interventions a clear place in their own right along the spectrum of ameliorative land management. The best discussion of this issue that I am aware of can be found in the National Standards for Ecological Restoration drawn up by the Society for Ecological Restoration Australasia (SERA), which distinguishes restoration clearly and helpfully from activities like rehabilitation and mitigation (SERA, 2016).

I will return, again and again, to this issue of the distinctiveness of restoration, and the importance of defining all our terms clearly, in considering points raised at our symposium. Two great and related challenges dominated all of our discussions.

One was the impact on restoration of rapidly accelerating global environmental change. What does the restoration word mean when the ice caps are melting?

The other is the rather sudden embrace of “restoration” strategies on an unprecedented scale by the UN, national governments, and corporations. What does the restoration word mean when it is

applied to millions of hectares, often by entities that have shown very little appetite for conservation in the past?

It is ironic that restoration should be popularized just at the moment when global change is forcing its pioneers to reformulate their core principles. So for both discussions, it is vital that we mind our language very carefully indeed.

While using the restoration word, we must be absolutely clear-sighted about the environmental dangers that we face if we are to overcome them. And that makes it all the more incumbent upon us, as citizens and scientists, to check the positive resonance of the restoration phrase against the reality on the ground, even as we welcome the adrenaline it pumps into our resolve. That's a tricky and ongoing double process, one I've been attempting to engage with, from a humanities perspective, for more than a decade now.

A phrase coined by those cultural and political activists who confronted fascism in the 1930s may help us deal better with this painful dilemma. They said that their epoch demanded "pessimism of the intellect, but optimism of the will."² The environmental movement, likewise, needs to banish illusions, but also foster hope, in our own very troubling era.

TOO GOOD TO BE TRUE?

I first heard the phrase "ecological restoration" pronounced at a prairie burn excursion with Peter Matthiessen, which formed part of the International Writers' Program at the University of Iowa in 2003. I initially thought that the phrase's promise, insofar as I could grasp it at all, was much too good to be true.

Like many of us, I had unreflectively absorbed a Manichean model of the human relationship with nature throughout my life. Essentially, this model suggests that we can only do one of two things with our environment. We can develop it for our own use, and thus inevitably, to a greater or lesser extent, degrade and even destroy it. Or we can "preserve" what remnants of wilderness remain, in the classic national park paradigm, limiting the human presence in such reserves to tourists and scientists.

So the very notion that we could conjoin these two words, ecological and restoration, and thus reverse degradation and augment biodiverse communities and ecological processes, was at once astonishing and stimulating. But it was still just a notion—I had no

idea whether, and to what extent, ecological restoration was feasible at all. One can restore a car or a painting, for sure, but can we really restore something as complex as a degraded ecosystem? Cynical European that I am, I suspected that I was witnessing an exercise in Midwestern romantic nostalgia, an expression of that well-meaning but hopelessly naive bright-sidedness that bathes so much American discourse.

I've had the stimulating privilege, over the intervening years, of visiting dozens of ecological restoration sites in five continents, and working with a diverse multitude of restoration ecologists and ecological restorationists. This research led to a book in which I attempted to answer two questions: what is ecological restoration, and can it become a viable conservation strategy for our times? (Woodworth, 2013).

And so I found myself, in the fall of 2016, in the curious position, for a journalist with no formal training in science, of moderating a symposium presented by distinguished restoration scientists at a critical moment for the field of restoration. And now I find myself writing an article for a learned journal reflecting on comments made by those colleagues on that occasion. I hope this context goes some way to explaining the approach I take to this subject, very different from my colleagues in tone and content, but I hope a useful complement to their discourse of science.

I will try to respond, very briefly at this point, to the questions that motivated my book, and thus, I guess, reveal my own biases on the subject before I comment on those of my much more highly qualified symposium colleagues.

The first and theoretical question is much harder to answer in a restricted space than the second practical one, but it is worth trying because my answer will inform and shape everything else that I have to say here.

WHAT IS ECOLOGICAL RESTORATION?

The most cited short definition is that agreed, after years of often contentious debate, for the opening sentence of the Society for Ecological Restoration (SER) Primer in 2004: "Ecological restoration is an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability" (Clewell et al., 2004).

This is a good place to start. It's worth noting the implicit assumption about the resilience of ecosystems here. Our "intentional activity" only "*initiates* or *accelerates* the recovery of an ecosystem" (italics added) (Clewell et al., 2004). It's assumed that the ecosystem

² This quotation is often attributed to the Italian Marxist Antonio Gramsci, but it seems likely that he was paraphrasing the French intellectual and playwright Romain Rolland.

does most of the work itself, as indeed it does. So ecological restoration is an activity that concedes considerable autonomy to the ecosystem under conservation. We don't rebuild it, much less "engineer" it or "design" it. We recreate the conditions, if you like, in which it can once again rebuild itself, flourish, and evolve. As we will see below, those conditions may need to be protected in perpetuity through our more, or less, active management.

However, the reference to "health" and "integrity" may not be so helpful to measuring restoration success, because these are metaphors which, however appropriate in cultural terms, are difficult to quantify scientifically.

But the Primer moves on quickly to a much more useful conceptualization of ecological restoration as the attempt "to restore an ecosystem to its historic trajectory" (Clewell et al., 2004). This phrase reminds us that ecosystems are *both* dynamic, always on the move, *and* rooted in site-specific co-evolution. Ecological restoration does not mean any kind of return to a static past state, though it is sometimes caricatured as such by critics, including the advocates of the so-called "novel" ecosystems theory (see below for discussion of this theory). But understanding a site's ecological past is vital to guiding a restoration project into the future. As the Primer continues, "Historic conditions are the ideal starting point for restoration" (Clewell et al., 2004).

It is this central referencing of history³ that distinguishes ecological restoration from other forms of ameliorative management of degraded systems (see below). It sets the bar very high, because it requires practitioners to understand the biodiverse communities and ecosystem processes that have characterized

a system in the past, to estimate where they might be today had the system not been degraded, and to take the actions most likely to put the system back on that track, as it were.

It is based on the core assumption that those communities, processes, and functions that have co-evolved on a site over eons are the most appropriate to that site. Therefore we should draw on local historical reference models and attempt, as far as our limited but ever-expanding ecological knowledge allows us, to repair or replace those parts of that living web that have become damaged or lost, and protect the capacity for co-occurring species to continue evolutionary interactions among themselves and for individual species to adapt and evolve with respect to their own distinct but ever-changing environment.

The "novel" ecosystems advocates have attempted to decouple restoration from reference to the ecological history of a site, but such decoupling sucks all the substance from the word "restoration" (Jackson, 2009).⁴ Managing degraded sites for whatever services their new components may provide is a quite different kind of land management to restoration. Such management may be a valid exercise, at least as an experiment, but should not be confused or conflated with restoration. That said, it is of course true, as we will see repeatedly throughout this article, that the current acceleration of global change puts ever-increasing and ever-shifting pressures on the trajectory of many sites into the future. These pressures must be taken into account on a case-specific basis in restoration projects, making our field's already highly complex form of ecological management even more challenging.

Restoration is therefore clearly a very ambitious enterprise. Less ambitious forms of ameliorative land management are very useful to human society, and often bring significant conservation benefits. But if ecological *restoration* is to achieve its goals, even partially, then it is important to distinguish it from *rehabilitation*, which enhances, but does not restore, degraded indigenous ecosystems, and *mitigation*, which simply reduces, or compensates for, the impacts of degradation. These distinctions are expanded on in SERA's very helpful National

³ After I had produced the first draft of this article, SER published the "International Standards for the Practice of Ecological Restoration" (<<http://www.ser.org/?page=SERStandards>>). These standards draw heavily on the Australian Standards document and are excellent in many respects. However, for reasons that do not appear cogent or compelling to me, the authors of both documents have chosen to dispense, partly in the case of SERA and altogether in the case of SER, with the use of the term "historical reference system" and "historical" generally. They have replaced it with "local native ecosystem," a major departure from the SER Primer. This seems to me to be an unfortunate and misplaced response to the caricaturing of "historical reference system" and "historical trajectory" as "nostalgic" or "romantic" by the "novel" ecosystem advocates. The study of history, in any field, if carried out rigorously, can only be instructive; the study of the ecological history of a site remains crucially important for restoration. The new standards have been presented as a "living document," still subject to discussion by the SER membership, and the authors say they will take on board revisions and new developments. It will be interesting to see how this new semantic turn in SER's key documents will be received.

⁴ See Jackson and Hobbs (2009: 567–568): "For many ecosystems, restoration to a historic state is anachronistic. . . ecological restoration finds new moorings in emphasizing ecosystem function, goods and services." The authors go on to suggest that the new goal of restoration is "developing our capacity to engineer ecosystems successfully."

Standards for the Practice of Ecological Restoration in Australia (SERA, 2016).⁵

IS RESTORATION POSSIBLE AT ALL?

So, in discussing the contributions to the Symposium, a key issue for me is to establish what role ecological restoration can play in the very large-scale projects now on the international table under various “restoration” rubrics. But first I need to attend to my own second question: is ecological restoration, as defined above, a viable conservation strategy for our times? Indeed, is it possible at all, even at small scales?

My initial research for my book soon revealed that, at least at relatively small physical and short temporal scales, ecological restoration does indeed “work,” though it is much more difficult to achieve a satisfactory degree of restoration success in some ecosystems than in others. Good as this news is, it is also important to note that every restoration project reveals troubling knowledge gaps that may undermine, at undetermined points in the future, whatever success the project currently enjoys. As A. D. Bradshaw astutely pointed out early in the development of the field, restoration is “the acid test of our ecological understanding” (Bradshaw, 1987). If Bradshaw is right, then that understanding is frequently still inadequate to fully implement restoration goals. That, however, is no cause for despair. On the contrary, each such failure offers us an opportunity to narrow that gap and do better at the next attempt, as in any other field of entrepreneurial endeavor.⁶

Another key factor, of course, is funding, and the general level of socio-economic support. Ecological restoration, done well, does not generally come cheap. The context here is deeply distressing. Our societies invest vast sums of money to expand, enhance, maintain, and repair the built environment. But we often balk at even paltry budgets for the maintenance of our ever-more degraded natural environment, which is the ultimate source of all our

economic and cultural development. It clearly cannot much longer sustain us without a major paradigm shift away from our dominant economic model of unregulated consumer capitalism. This model is based on a false premise: that natural resources are either infinite, or infinitely substitutable through technological advances. It also assumes the delusional notion that human happiness consists in the acquisition of ever-increasing quantities of consumer products. Everything I write about restoration here has to be understood in that context: it will only make a difference on a global scale if our societies accept the need for many other fundamental changes.

Where ecological restoration is properly funded, however, the results can be both spectacularly good and surprisingly affordable. A justifiably famous instance is the post-mining restoration of the richly biodiverse jarrah forest in Southwest Australia after bauxite mining, at a cost of roughly 1% of the annual profits the mining company involved, Alcoa, makes from the site. Anyone who is, understandably, skeptical of the field’s potential would find the literature on this enterprise instructive (see key research in “Ecosystem Restoration,” 2007).

It also rapidly became clear to me that any degree of sustained restoration project success depends on its level of engagement with the human communities associated with the restoration site, right from the formulation of the project. This is an element that some restorationists have ignored at a tragically high price and remains an ongoing issue (Woodworth, 2013).⁷

But even as I was learning about increasing rates of ecological restoration success in practice, and observing the young field of restoration ecology take theoretical shape and raise its profile, the global environmental cards were being reshuffled at an alarming rate. Evidence of accelerating global change, in terms of climate, expanding human footprint, and the spread of alien invasive species, was accumulating rapidly and beginning to dominate the agenda of restoration discussions.

It is now obvious that recognition of the challenge presented by this “great acceleration” (IGBP, 2015) and energetic and flexible adaption to all its aspects are essential if restoration is to make an increasing contribution to conservation, indeed, if it is to continue to make any contribution at all.

⁵ See <<http://www.seraustralia.com/standards/appendix1.html>>. Of course, the problem of categories and definitions is greatly compounded by the difficulty of translation to other languages, and also differing usage between different countries and regions within single languages like English, Spanish, or Chinese. But the creation of international restoration targets challenges us, more than ever, to acknowledge and work to overcome these difficulties.

⁶ In a memorable aside during his symposium presentation, Pedro Brancalion reminded us that mistakes are necessary if restoration is to advance, like any other field, through genuine innovation: “500 mistakes are 500 lessons learned about how not to restore.”

⁷ The controversial history of the North Branch Restoration Project in the Chicago region is a case in point, though the lessons have been well learned, if not by that project’s veterans, then certainly by the broader restoration movement in Chicagoland, Chicago Wilderness: see Woodworth (2013: 87–132).

A SURPRISING AND TROUBLING DEVELOPMENT

However, it has been surprising, and troubling, to see how some leading figures in restoration, and in conservation generally, have responded to this challenge. They have moved, in a few short years, from expressing legitimate concerns about the difficulties that restoration faces in these new (and still rapidly changing) circumstances, through questioning whether historically based restoration is still a relevant strategy at all, to embracing a “new ecological world order.”

They have argued that we should rebrand degraded ecosystems with the positive label “novel.” This is a most unfortunate semantic shift with very detrimental real-world consequences for policy and practice, in my view. In our culture, “novel” is an adjective almost entirely associated with positive characteristics: it is a synonym for “desirable” and “sexy.” These authors also coined the phrase “new ecological world order” for the current state of the global environment, another positive phrase masking our degraded reality, which is surely much more accurately described as “new ecological world DISorder” (see Hobbs et al., 2006, and also Woodworth, 2013: 413–433, for a fuller discussion of the “novel” ecosystems theory from my point of view). Increasingly, they have shifted toward advocating the abandonment of most efforts to restore ecosystems, arguing that instead we should simply manage—or even “engineer”—degraded systems for whatever goods and services such systems may still offer us.⁸ Indeed, some of them have gone so far as to question the whole concept of degradation (Hobbs, 2016).

It is all the more remarkable (and rather ironic) that, at this critical moment in the internal restoration debate, international policymakers should be proposing restoration targets at a scale on which no one has ever operated before. The 2011 “Bonn Challenge” aspires to restore 150 million hectares of degraded or deforested lands by 2020, extended to 350 million hectares by 2030 (Bonn Challenge, 2011). The UN Convention on Biological Diversity aims at restoring 15% of degraded ecosystems worldwide by 2020 (CBD, 2010).

There is a staggering gap between typical restoration projects to date, which have often been as small as a few hectares and usually operate within a single ecosystem, and the prospect of restoring millions of hectares across many types of ecosystems. This puts the restoration movement in a position that

is both enviable and invidious: its practical application is being mainstreamed and upscaled in the international public sphere, just when its core principles are being most hotly debated theoretically, and its practical achievements to date face unprecedented threats from global change. Its mettle is being tested like never before.

Our symposium, “Ecological Restoration in a Changing Biosphere,” and this issue of the *Annals* focus on how restoration theory and practice should respond to these two key issues for contemporary restoration: global change and “scaling up.” Our speakers contributed a wide range of perspectives on these questions, with differing emphases, diverse geographical experience, and sometimes differing conclusions. Yet they all found a stimulating vigor in the concept of ecological restoration, albeit with many modifications and new learnings. Their contributions strongly indicate that restoration can make a vital, increasing, and enduring contribution to conservation in our century and beyond. In the survey of these contributions that follows, I will seek to highlight some of the most illuminating—and problematic—points that emerged in the course of our discussions. Obviously, readers will need to look at the texts themselves to appreciate the full range of arguments, and detail, presented.

It was fitting that the first and youngest contributor, Leighton Reid, should choose the subject of “Restoration Longevity.” He reported that the question of how long a restored ecosystem can persist into the future is acknowledged by practitioners as one of the most important knowledge gaps in the field. Obviously, this is partly because, in such a young discipline, very few projects have existed for more than a few decades, at most.

However, Reid rightly stressed that we really should already know a great deal more about restoration longevity, at least over relatively short periods, than we do today. The reason we don’t is one of restoration’s rather shameful little secrets: most projects, once established, are not then monitored for very long, if at all. And even when they are monitored, restorationists have tended not to discuss their failures (Zedler, 2007).

Failure to monitor is often due to lack of funding, as Reid said, but in my own research I also sometimes found that restorationists, both volunteer and professional, are often not very motivated to monitor, period. They find it more exciting to move on to the challenge of a new degraded site than to manage and maintain a site they had already cleared, for example, of invasive alien plants. The result can be that the last state of a restoration site is worse than

⁸ See Jackson and Hobbs (2009) and recent publications in this vein for general readers by Marris (2011) and Peirce (2015).

the first: a single wave of restoration activity can have the same impact as pruning, and within a few years the invasives may be back, more widespread, and more vigorous than before the restoration activity took place.

One reason for this “clear quickly and move on” attitude is rooted in the early assumptions of some influential restoration ecologists. Those writing in the 1970s and 1980s did not put great stress on monitoring. Many of them imagined that, once the restoration process had been effectively initiated, the ecosystem would maintain itself in self-sustaining evolution, without significant further management. If such a comforting and convenient outcome were ever likely even then, on a very limited number of sites, then the speed of 21st century global change, in both its ecological and social manifestations, greatly reduces its likelihood anywhere in today’s world. Changing climate and returning or new invasives are no respecters of restored sites (though restored sites may be more resilient in resisting their impacts) and changing land use may also bring new human threats to a restored area.

While all this is widely understood by now, funding for monitoring remains hard to find, especially if it is to be sustained over a long period. But this is a very false economy in restoration budgeting: if societies are to invest in restoration on the envisaged grand scale across the globe, they have a right to expect a reasonable degree of confidence that such projects are durable, and that confidence can only be developed if monitoring is built into the budget, long term and from the outset.

Looking to the future, as public and private agencies move to meet the massive restoration targets now being set, we should be vigilant to ensure that monitoring becomes universal and rigorous. The dangers of a “clear quickly and move on” approach on these new spatial scales are obvious, and if we are lax about monitoring these upscaled projects, it will undermine the credibility of the restoration model as they mature.

ENGAGING COMMUNITIES, SECURING LONG-TERM FUNDING

Reid was clear that social factors will be vital determinants of restoration longevity, but he pointed out that their specifics will shift over different timescales. For a start, the quality of the people and management directly involved is crucial: “Restoration projects are like symbiotic organisms in the sense that the fate of the ecosystem is often tightly linked to the fate of the organization that manages it” (Reid, 2016).

And he added that: “key factors are that restoration projects engage communities, that government policies are supportive, that projects have consistent long-term funding. . .and that land tenure is secure” (Reid, 2016).

Reid offered astute observations on the shifting requirements of restoration management over time: “Throughout a restored ecosystem’s lifespan, some basic conditions that need to be met include having strong community support and secure land tenure. In the early years, technical issues must also be resolved or preempted to establish a recovering ecosystem and prevent seedling mortality. Over decadal timescales, challenges shift from being predominantly technical to more political and market oriented. Prior threats can remain, like susceptibility to stand-replacing fires, but in addition, restoration projects must change hands as land manager careers turn over, and generational and political priorities shift, creating new situations that are difficult to foresee. Beyond a century, the factors contributing to longevity become more theoretical, more difficult to study empirically, and increasingly analogous to preventing old-growth deforestation” (Reid, 2016).

Of course, biological factors are also determinant for restoration site survival, and special skills now need to be developed to build resilience into projects exposed to our century’s unprecedented shifts in climate, human population, land degradation, multiplying alien introductions—and so on: “There are also several ways that local project managers can plan for longevity in a changing biosphere. For example, Dunwiddie et al. (2009) suggest increasing component redundancy (i.e., the number of individuals, species, or communities to be restored) to reduce vulnerability to disturbances; increasing functional redundancy to maintain biodiversity and ecosystem functionality even after some components are lost; and increasing connectivity so that organisms can track their niches as they shift in space” (Reid, 2016).

He concluded that, to a very considerable extent, knowledge of all these factors means that restoration longevity is both predictable, and manipulable, through adaptive management, despite the challenges of accelerating global change and scaling up.

It is clear throughout his contribution that Reid is referring to the concept of ecological restoration more or less according to the SER definition, though he points out that his comments on longevity also apply to less rigorous forms of ameliorative land management. So it is striking that Robin Chazdon, whose far-ranging international and institutional expertise places her very well to understand the practical

implications of scaling up envisaged under the new proposals from Bonn and New York, used a significantly different concept under the rubric of “Forest Landscape Restoration (FLR).” She made it clear that FLR is an “entirely different concept from ecological restoration,” though she added that ecological restoration could be a “component part” of this strategy (Chazdon, 2016).

She defined FLR as “a holistic process that aims to regain ecological integrity and enhance human well-being in deforested, human-impacted, or degraded forest landscapes.” She saw this broader brushstroke approach as the best way of meeting the “huge implementation challenge” of the “unprecedented opportunity to transform degraded and unproductive lands into functional landscapes that offer multiple benefits to society and future generations” (Chazdon, 2016).

RESTORATION AND REHABILITATION: A TRICKY DISTINCTION

The focus here is clearly on services to human societies rather than on the restoration of biodiversity and ecosystem processes per se. There is considerable merit in this approach, given the hugely complex and diverse socio-ecosystems that will be impacted by the goals of the Bonn Challenge and CBD cited above.

However, following the helpful Environmental Repair Pyramid in the SERA National Standards document (SERA, 2016; <<http://www.seraustralia.com/standards/appendix1.html>>; fig. 3.), the “R-word” in FLR should arguably be *rehabilitation* rather than *restoration*. It’s important to note that SERA uses rehabilitation in a positive sense, as a legitimate but ecologically less rigorous substitute for ecological restoration whenever conditions make the latter impracticable. SERA describes rehabilitation as “the process of reinstating degrees of ecosystem functionality on degraded sites where restoration is not the aspiration, to permit ongoing provision of ecosystem goods and services including support of biodiversity.”

Returning to my opening comments about the way words are charged with meaning, this distinction between *restoration* and *rehabilitation* is much more than an academic or a semantic quibble. I accept that we should be mindful of the danger that over-prescriptive definitions may limit innovation or inhibit urgently needed action on the ground. But it is confusing and damaging when rehabilitation projects, not committed to achieving the full recovery of historical trajectories that restoration aspires to, have the restoration label attached to them. A perfectly good rehabilitation project may be accused

of not reaching a target it never aimed for, while the reputation of restoration as a conservation strategy will be undermined.

This is indeed a doubly tricky distinction, because rehabilitation is often charged with negative meaning for environmentalists. It has been used, especially by the extractive and agricultural sectors, to dress up grotesquely inadequate and inappropriate cosmetic actions after degradation of landscapes. Yet it has strong positive connotations in terms of human health and the recovery of muscular function, for example, and there is no reason why reputable rehabilitation projects should not enjoy similar status in the environmental world.⁹ So to describe FLR as rehabilitation rather than restoration is not to denigrate it in any way, but to clarify the (very important) goals it seeks to achieve. This then raises a crucial question that has not been widely considered: should the Bonn Challenge or the CBD be using the word “restoration” to describe their ambitious new targets?

Chazdon also argued that natural regeneration, sometimes entirely spontaneous, sometimes assisted by human management depending on site-specific conditions, is the best way to achieve rapid FLR on a large scale. This is probably especially true in the tropics, where growth rates are much faster and biodiversity generally much richer, than in temperate zones.

There are, of course, many overlaps between the desiderata for ecological restoration and FLR. For example, Chazdon rightly and repeatedly stressed the vital importance of engaging affected communities in the FLR process:

“The key to implementing FLR is reaching a balance of social and ecological benefits based on a spectrum of land uses and an active process of planning and decision making among multiple stakeholders” (Chazdon, 2017).

Nevertheless, I feel obliged to enter three caveats or questions arising from Chazdon’s contribution.

The first, following on my arguments above, is that while global, national, and regional commitments to “restore” millions of hectares are heartening developments, it would be helpful if the range of actions and targets envisaged in such proposals was much more clearly articulated. Ecological restoration should be the gold standard, and where that standard is not applied, the term *restoration* should not be

⁹ These things are never simple, since words constantly acquire new resonances: the unfortunate tendency of certain celebrities to treat addiction “rehab” as a revolving door publicity exercise has also given the term a negative human connotation.

used. Following the SERA model, *rehabilitation* should be used instead, in my opinion.¹⁰

However, readers will also want to consider Karen Holl's rather different take on this issue, below. When I raised this question with Chazdon while researching this article, her response suggests that more thought still needs to be given to defining the nature and scope of FLR:

"FLR is not any one thing. Interventions can include ecosystem restoration and various forms of rehabilitation that do not aim to return to a previous ecosystem state. The terminology is problematic and several of us are trying to improve the terminology as well as the conceptualization (how and when to apply the terminology and how the terms are interrelated).

"SER is firmly grounded in ecosystem restoration and hasn't embraced FLR. But I agree that there is an important distinction between restoration and rehabilitation, even though it can be very fuzzy in the case of managed natural and semi-natural systems" (Chazdon, pers. comm., 2016).

It's true, of course, that ecological restoration will usually be more expensive than rehabilitation, which is a less complex, less labor-intensive, and less time-consuming option. But we should not let that factor alone rule out restoration, especially where the organizations responsible for degradation are making significant profits from their activities. It is worth restating that our societies invest vast sums in our built infrastructure as a matter of course, but neglect to invest in the natural infrastructure that underpins all economies and cultures. If we are to reverse degradation in this century, we must begin to spend a great deal more on restoring our natural infrastructure than we have heretofore. The benefits can be seen to far outweigh the costs if natural capital accounting is adopted. See comments on James Aronson's presentation, below, for further discussion of natural capital accounting.¹¹

My second and related caveat is that it is also very important, if FLR is to achieve real gains for both biodiversity and dynamic ecosystem processes, that

¹⁰ The recently published SER International Standards (see previous footnote 3) replace the simple but effective Pyramid of Environmental Repair in the SERA standards with a "Restorative Continuum." I have not had time to compare these two figures in detail, but I fear that the continuum figure blurs rather than clarifies distinctions that need to be made.

¹¹ Natural capital accounting builds in the full economic values of the costs and benefits of our environmental impacts, and is being adopted by a rapidly increasing number of governments and institutions. See Aronson et al. (2007) and The Economics of Ecology and Biodiversity Reports at <www.teeb.org>.

the "ecological integrity" it entails is very clearly defined. There is a spectrum between the complete recovery of biotic communities aspired to by ecological restoration and the paucity of species, or even monoculture, which has characterized far too much low-rent post-logging or post-mining rehabilitation to date. If FLR is to make a distinctive contribution, then its standards for "ecological integrity" should be toward the upper end of that spectrum.

Thirdly, more attention should be paid in FLR, especially when natural regeneration is its engine, to the problem of alien invasive plants. There is a very real danger that unassisted natural regeneration could, in a world now so widely infested by invasive aliens, frequently open the floodgates to vast areas of biomass with chronically diminished biodiversity.

In the course of her symposium contribution considering the research directions that forest restoration needs to take, Karen Holl argued that the rigorous clarification of project-specific goals may be a more practical way to achieve a better match between the aspirations of a remediation effort and its outcome than theoretical discussion of first principles:

"Instead of attempting to enforce a singular definition of restoration for all projects, it is critical that each global initiative and local project clearly define their goals and specific objective. For example, is the goal of a specific tropical forest restoration project to sequester carbon, provide habitat for an endangered bird species, improve water quality, provide timber and/or non-timber forest products to the land owner, or more than one of the preceding goals? Explicitly stating those goals is critical for transparency and honesty about the potential benefits of specific projects, to select the most appropriate restoration methods, and to evaluate whether the restoration targets have been achieved" (Holl, 2016).

She noted one of the more frustrating aspects of any remediation enterprise, which is that "the differing suite and intensity of barriers to recovery lead to high variation in the rate and trajectory of forest recovery, even at small spatial scales" (Holl, 2016).

In response, she argued that "test[ing] active restoration methods at a small scale prior to implementing large-scale restoration projects is crucial. These preliminary projects can be invaluable to inform the most efficient use of resources and enhance the likelihood of restoration success" (Holl, 2016).

In the same vein, she continued: "A wise strategy, if socially feasible, is to wait a few years before actively intervening in restoration to assess the rate and composition of natural recovery. If a site recovers

a subset of native woody species quickly, planting seeds or seedlings of later successional, large-seeded species that do not rapidly colonize (i.e., enrichment planting) may be more cost-effective than extensive initial tree planting” (Holl, 2016).

Indeed, she pointed out that, where natural regeneration is quick and effective, rushing into active restoration can actually cause significant damage, to seedlings, for example. However, where natural recovery is slow, extensive tree planting may indeed be required.

Holl succinctly identified four critical areas where the field of forest restoration needs to move forward: “increasing (1) the spatial and (2) the temporal scales of both restoration implementation and scientific studies; (3) better integrating a diverse set of stakeholders in the restoration planning and evaluation process; and (4) improving knowledge sharing across restoration projects in different regions to learn from successes and failures” (Holl, 2016).

Readers seeking specifics under these headings will find them in abundance in her article, and there is no need to repeat them here. But her conclusion is worth quoting in full. After some upbeat remarks about recent successes in restoration, she reminded us of a vital but sometimes forgotten aspect of restoration: it is essential to preserve whatever relatively undisturbed systems remain in the region, both as guide and historical reference system, and as source for appropriate biological materials.

“The many social, ecological, and economic challenges to forest restoration and the generally slow recovery of the full complement of forest species and functions highlight the importance of protecting the remaining old-growth tropical forest while simultaneously working collaboratively to restore tropical forests across the landscape” (Holl, 2016).

STILL IN THE STONE AGE OF RESTORATION

The specifics of Holl’s own research, with its replicated experiments in alternative methods of forest restoration, is an encouraging example of how sophisticated restoration ecology has become. However, as Pedro Brancalion reminded us with a bracing metaphor in his verbal presentation, this is no time to for self-congratulation.

“We are still in the Stone Age of restoration,” he said at the symposium, warning us that “the huge gap between restoration science and practice may undermine the recovery of native ecosystems in vast extensions of degraded lands” (Brancalion, 2016). He stressed that this gap creates problems at both ends of the science-practice spectrum: “A relevant limitation in the Information Age is the fact that academic

advances have not been adequately translated to practice, and practice has advanced without benefiting from the full potential of science and technology to improve human activities” (Brancalion & van Melis, 2017).

Given his experience with Brazil’s Atlantic Forest Restoration Pact, one of the few already existing projects that can serve as a prototype for the upscaling now envisaged, this warning should be heeded.

WHAT REMEDIES DID HE PROPOSE?

Brancalion pointed out that “large-scale restoration will not be obtained by the simple sum of small-scaled projects implemented by traditional restoration approaches” (Brancalion, 2016). What we need, he said, is to foster a culture of innovation across all aspects of restoration, from propagation methods to the ways we communicate restoration ideas to multiple stakeholders. The concept of innovation is sometimes understood as a synonym for “hi-tech,” but while Brancalion envisaged a major role for new technologies, he also argued for “better use of existing funds and low-cost solutions” (Brancalion, 2016). In his presentation, he gave a vivid example from Brazil, where indigenous ecological skills in seed collection are combined with industrial agricultural means of propagation to achieve species-rich restoration over broader areas.

He rightly contrasted the massive budgets routinely allocated to research and development in fields like medicine and industrial agriculture with the virtual absence of such investment in restoration. Once again, we encounter the often-neglected fact that the most significant barrier to restoration in most cases is not an abiotic or biotic one, but a socio-economic-political resistance. Brancalion hopes that the very scale of the new projects will attract research and development financing. This would indeed be welcome, but it behooves restorationists to be vigilant regarding who invests, and why, and with what conditions. The flow of money must not tear restoration adrift from its root concern, the recovery of historically appropriate ecosystem trajectories, and their concomitant biodiversity and processes.

Like Chazdon, Brancalion questioned whether active intervention by humans, as opposed to natural regeneration, is necessarily the best way forward for restoration at the scales we are now contemplating. He commented that “While formal restoration programs have invested large amounts of funds to plant trees in some few hectares in tropical regions, unplanned socio-economic shifts in society, as described by the Forest Transition Theory, have

been the main drivers of forest cover increase in the tropics” (Brancalion, 2016).

However, we surely need to be careful here, because “forest cover increase” in itself is in no way a synonym for ecological restoration. And several questions are begged when he continues that: “an alternative approach [to active intervention] is to consider restoration practitioners as promoters of best conditions for nature recovery in each land portion where restoration is ecologically viable and socio-economically feasible” (Brancalion, 2016).

What exactly do we mean here by “nature recovery,” for example? If the target is something less than a return to the system’s historical trajectory, as he suggests below, we should surely not be using the word *restoration*, but *rehabilitation*. In the same vein, who decides, and on what criteria, where and when restoration is ecologically viable and socio-economically feasible?

Brancalion and van Melis (2017) sketch out the parameters and challenges of the implications of scaling up rather well. As readers of their contribution will see, they offer a wealth of detailed proposals for innovation in the science and practice of restoration, in capacity-building, governance, and in building linkages between these four areas. But I fear our efforts will be unnecessarily hindered and subject to most unfortunate confusions, if our field does not very quickly establish internationally accepted definitions for the various related but distinct approaches to what our Australasian colleagues have denominated “environmental repair.”

I am particularly concerned that they frame the problem as requiring a “shift in the restoration mindset”:

“In brief, the restoration mindset will have to shift from the strict recovery of a native ecosystem to the establishment of a new economically viable land use, and restoration practices will have to explore the costs and economic benefits of different approaches to support decision-making” (Brancalion & van Melis, 2017).

The danger here is that the restoration baby is thrown out with the bathwater. They are absolutely right to insist that viable economic land use is vital within many of the areas under discussion. But the core restoration goal of recovering native ecosystems should not be abandoned. Rather, the range of land management goals within the Bonn Challenge and CBD programs should be clarified, and they should not have the label “restoration” attached where ecological restoration is not the goal. We also need to clarify whether the costs and benefits of these projects are accounted for under unregulated market

economics, or under rigorous natural capital accounting.

I think we may need another symposium (or more!) to begin to untangle these complex issues. What matters here is to have made a start.

History, as I have used it so far in this essay, has referred to the ecological histories of the sites we aspire to restore. Curt Meine’s contribution to our seminar did not neglect this aspect, but he also called our attention to another history that we ignore at our peril—the history of conservation theory and practice itself. As the biographer of Aldo Leopold, Meine is perfectly qualified to draw on the writings of this seminal figure to shed badly needed light on the heated debate about so-called “novel” ecosystems (see above) that has divided the restoration movement over the last decade.

A MORE NUANCED RESPONSE TO ECOSYSTEM CHANGE

Aware of the damage this debate has often done, Meine reminded us that Leopold’s thinking “resisted simple polarities and dichotomies” and encompassed the whole range of land management options, from agriculture to wilderness. He hoped that revisiting restoration’s history may offer “a more nuanced approach to the realities of ecosystem change” and that “we may be able to find space for reconciliation, or at least accommodation” between the “divergent views” that have emerged (Meine, 2016).

I should declare an interest here, as one of those who has robustly criticized the “novel” ecosystems advocates, and the “new conservation” school of thought in general, because of what I regard as their negative impacts on conservation policy. I inevitably comment on Meine’s contribution through a particular lens.

However, what I found most illuminating in his survey is the reminder that the issues that arouse such passions now were, albeit in slightly different forms, very present in Leopold’s own times, mind, and writing. But Leopold’s mind, like Walt Whitman’s, could contain multitudes and dance with contradictions. It seems that we need to learn those lessons afresh.

A common misconception about conservation history among contemporary environmentalists (and their critics!) is the notion that our forebearers in restoration were guided by the idea of wilderness, of a “pristine” past unstained by human impacts, that we now know to be illusory. I confess to having shared this misconception until Meine put me right on it, and I would still argue that this flawed concept has had a detrimental effect on much Midwestern restoration thinking and practice.

What is abundantly clear from Meine's research, however, is that Leopold's own writing does not support this vision, and he was most keenly aware of the impacts of humanity on nature, in this quotation, for example:

"The hope of the future lies not in curbing the influence of human occupancy—it is *already too late for that*—but in creating a better understanding of the extent of that influence and a new ethic for its governance" (Leopold, 1933: 21; italics added).

We also tend to think that the chronic degradation we are seeing in our time is something entirely new, but that false impression is dispelled by Meine's description of Wisconsin's Coon Creek watershed and its surrounding region in the 1930s:

"The Upper Midwest in the 1920s and 1930s was a wrecked landscape... accelerated and detrimental anthropogenic environmental change was a stark and immediate reality. Conditions were not merely 'novel'; they were disastrous" (Meine, 2017).

I'm tempted to add that so-called "novel" conditions usually are disastrous, though there are exceptions. We are back to the meaning of words again, and the way they shape our perceptions. Applying the sexy and intriguing label "novel" (first invented as an editorial embellishment) to degraded systems is most unfortunately misleading. It has led its leading exponent, Richard Hobbs, to shift from writing heartfelt laments for lost systems to describing what has replaced them as "not degraded, just different."¹²

Had the "novel" ecosystems theory been dominant in his period, Leopold might not have considered it worthwhile to direct the very robust ameliorative land management at Coon Creek which, as Meine described so vividly, recovered not only its soil and agricultural productivity but also at least some of its native biodiversity, after extensive human intervention following broad and deep engagement with farmers and landowners. This was not ecological restoration as we understand it today, but it was a prototypical and instructive rehabilitation endeavor with some of the same outcomes.

All that said, something has changed radically since Leopold's time. Hobbs and his colleagues were entirely right to raise red warning flags about the rapidly increasing rates of multiple environmental changes, which are likely to complicate the already complicated task of ecological restoration more and

more with every passing year. As Meine put it, "the pace and intensity of such change are new and different and more consequential." He summed up the opposed positions in the "novel ecosystems" debate very succinctly indeed:

"If amid such change we see continuity (however strained) with the past, then we may regard ecological restoration as a critically important and necessary response to these trends. If we see intractable thresholds of change, and hold that we have crossed those thresholds, then restoration is simply unviable and unattainable. Much therefore hinges on the definition of *novelty* in ecosystems, and the practical limits on and opportunities for effective restoration" (Meine, 2017).

For Meine too, as a historian and writer, the meanings of words are critical.

"If we equate *conservation* with a simple and static notion of *preservation*, and regard restoration as a separate undertaking that seeks to reestablish lost or degraded ecological qualities, then the idea of 'novel ecosystems' obviously presents fundamental challenges to the very notion of restoration. If, however, we regard conservation as encompassing varied and dynamic relationships between humans and nature, and ecological restoration as one expression of those changing relationships, then restoration remains vital and relevant" (Meine, 2017).

Again, I refer readers to Meine's article to enjoy to the full the detail and sweep of his dialectic. Others will extract different learnings from the piece, perhaps, but two sentences remain key to me. Firstly, for Leopold, history and change are intimately interlinked, and we must embrace both forces:

"To see *why* it is, how it *became*, and the direction and velocity of its changes—this is the great drama of the land..." (Leopold, 1933).

And secondly:

"Leopold's experience showed that, however 'novel' the environmental conditions, it was still possible to restore a meaningful and ecologically significant measure of ecological function, process, and diversity to degraded biological communities" (Meine, 2017).

The next presentation, from James Aronson, brought the symposium's focus back to the relationship between a degraded ecosystem's previous states and restoration strategies going forward: "We use the past," he said, "to help us decide where to go in the future. This is not to turn the clock back, but to maintain historical continuity" (Aronson, 2016). He stressed that this did not mean espousing "unachievable aims of historical fidelity," but rather that "past success is often a good indicator of potential future success" (Aronson et al., 2017).

¹² See Jackson and Hobbs (2009), Hobbs (2016), and recent publications in this vein for general readers by Marris (2011) and Peirce (2015).

This led him to a robust defense of the historical reference system against its leading critics like Richard Hobbs:

“. . . The reference ecosystem model does not define a rigid ‘goal’ or an absolute target; rather it provides a beacon or pointer to a desirable future, and it dramatically helps in the vital process of consensus-building among stakeholders. . . Furthermore, the use of history does not imply that we seek to walk backward into the future, so to speak, or grieve, or cling nostalgically to the past” (Aronson et al., 2017).¹³

A FAMILY OF RESTORATIVE ACTIVITIES

After a sympathetic but critical review of four influential schematic figures from ecological restoration literature over the last 30 years, James Aronson proposed (with his colleagues James Blignaut and Thibaud Aronson) an illuminating new figure elucidating the helpful metaphor of a “family” of restorative activities. These are to be deployed when upscaling across heterogeneous landscapes that have undergone widely varying levels of human impact. By placing “environmental remediation,” “reparation and recuperation,” “ecological rehabilitation,” and “ecological restoration” within a single family, this figure suggests that all these activities contribute to the recovery of damaged ecosystems, and that none of them should be dismissed as environmentally negative.

However, the figure rightly does not ascribe equal value to these activities, but places them in a hierarchy. This ascends from the least effective¹⁴ (environmental remediation) to the most effective (ecological restoration). This could provide a very useful and accessible guide to large-scale restoration across landscapes formed by complex mosaics of diverse ecological types and human uses. It deserves to be considered very carefully as a complementary companion—or alternative—to the SERA “environmental repair pyramid” and SER “restorative continuum” described previously. However, Aronson explicitly insisted that his figure differs “in many ways” from the SER continuum “and should not be conflated with that idea” (Aronson et al., 2017).

Aronson’s presentation had another emphasis, also reflected in an axis of this figure: the restoration of natural capital. This is a framework he sees as

particularly appropriate to scaled-up ecological restoration. This concept expresses his call for a “holistic approach combining eco-centric and anthropocentric values” (Aronson et al., 2017). He also threw a call for a new ethical paradigm into this complex mix.

It is both the strength, and the potential weakness, of Aronson’s position that he attempts to marry many of the aspects of classical ecological restoration (especially the historical reference system) with both an ethical viewpoint and a pragmatic recognition that unless stakeholders in a landscape see significant economic benefits from its restoration the movement will never develop critical mass.

This tension between the ecological importance of the core goals of restoration, and the necessity of finding ways to engage entire and diverse human communities in the enterprise, will no doubt be an essential element in the debates about how to operationalize the concept on a much larger scale than ever before.

If Curt Meine’s presentation had the steadying effect of anchoring our current anxieties meaningfully in the context of the past, Don Falk’s keynote address pitched us bracingly into the uncharted future, launched from startling developments in the present, but always rooted in clear ecological restoration principles.

It was salutary to be reminded of the gravity of our global situation, where the World Economic Forum last year listed failure to mitigate climate change as an equivalent (but more likely) threat to humanity than the use of weapons of mass destruction. Multiple distinct but related threats are increasing, from alien invasive species (including pest insects) to wildfires. To what extent, Falk asked, can ecological restoration play a role in assisting ecosystems to adapt to changes that are now inevitable or already occurring, regardless of what environmental measures may be implemented now or in the future?

He argued that the most appropriate starting point for this discussion is a regional scale, because climate change will have varying impacts across the planet, but more or less similar effects across a region.

A TRIPLE STRATEGY: RESISTANCE, RESILIENCE, AND REORGANIZATION

In the American Southwest, where Falk works, the effects of climate change are already evident in the increasing size and severity of forest wildfires. In Arizona the increases since 2000 have been by a factor of 10.

¹³ The last sentence is a reference to repeated criticisms of ecological restoration goals from the Hobbs camp, asserting that they are based on romantic nostalgia for a lost past. See especially Hobbs (2013).

¹⁴ That is, effective in increasing biodiversity, functionality, resilience, and services.

Falk proposed that *resilience ecology*, developing a triple strategy of resistance, recovery, and reorganization, is a vital supplement to restoration ecology in these new circumstances. Given the severity of contemporary and likely future disturbances, he said, “many ecosystems, once disturbed, are unlikely to return spontaneously to their pre-disturbance condition” (Falk, 2016). I would note in passing that this is a point that must give us further pause for thought about over-reliance on natural regeneration as a shortcut to restoration.

“While ecological restoration efforts can reverse some of these changes,” he continued, “others may be inevitable and *even adaptive*” (italics added) (Falk, 2017). I take this to mean that the changes actually help the system to maintain itself, albeit in an altered state, and it would be counterproductive to attempt to reverse them. “Differentiating between these outcomes represents the crux of the problem of how to apply the ecology of resilience under future conditions of disturbance and climate in a way that maintains diverse and sustainable communities” (Falk, 2017).

In other words, he was arguing that global changes may demand that we apply triage to entire ecosystems, deciding which ones are still susceptible to restoration strategies, and which ones are better left to develop along a new trajectory.¹⁵ This may seem close to “novel” ecosystems theory, and indeed it represents the best version of how that theory might have developed, had it not become distorted by rhetoric and hubris.

In my view, Falk’s thinking parts company from the “novel” theorists in that he recognizes not only that the “bedrock principle of restoration” is rooted in attention to the ecosystem’s “pre-disruption reference condition,” but also that “reference conditions are necessarily dynamic, and in any reasonable form of restoration ecology these are understood to represent a dynamic range of variability, not static conditions” (Falk, 2017).

This is a far cry from the straw man erected by the “novel” theorists who, in their eagerness to “engineer” and “design” ecosystems, tend to caricature restoration as attached to a romantic notion of returning to a fixed past.

Again, I must refer readers to Falk’s rich text for specific examples of how detailed observation and experiment can assist in accentuating innate resilient tendencies in ecosystems under extreme stress from global change. Sometimes his solutions

are indeed, and necessarily, radical: “Resilience ecology departs from the traditional domain of restoration in this third phase, which potentially involves intentional reorganization of ecological communities” (Falk, 2017).

He continued: “A relatively conservative example of adaptive restoration beyond the reference condition would be the outplanting of different genotypes of a target species from those found in a restoration area where the species occurs presently.

“This approach falls outside of a traditional restoration paradigm, in the sense that forest structure and species composition are being modified proactively outside of the strict historical range of variability. Such pro-adaptive strategies exemplify a resilience-oriented approach and may be required in some cases in order to protect larger values at risk” (Falk, 2017).

He went on to consider more radical options still, like assisted migration. But the great strength of this “re-evaluation of the premises of traditional restoration theory” is that Falk was absolutely lucid about where restoration and resilience overlap, where they may part company, and what the price of such a divergence may be: “the loss of iconic populations represents a fundamental ethical challenge to a resilience-based paradigm” (Falk, 2017).

“The reference framework remains valid in many circumstances, perhaps most, because of the powerful inertia of ecological legacies as well as the imperfectly understood ability of species and populations to persist and recover from disturbance and changing environments. *Relaxing the centrality of the reference condition is a significant departure from traditional restoration principles and cannot be undertaken lightly or without careful consideration*” (Falk, 2017) (italics added).

RESTORATION: A CUTTING-EDGE CONSERVATION STRATEGY

This brings us back to one of the key questions raised by our symposium discussions. How can the ecological restoration movement confront the challenges presented by accelerating global change, while simultaneously accelerating restoration activities on an unprecedented scale, without losing its bearings, its core values? How can it do so without losing the hopeful promise that the word restoration generates, and yet not fall into the moral hazard of promising what it cannot deliver?

Without the concept of the reference system, based on research into the ecological history of the site and its local analogues, we cannot restore its trajectory of inter-related ecosystem functions and indigenous biodiversity into the future. We will never do this perfectly, of course, and the challenges of global

¹⁵ We need to be very careful here to remember that ecosystems include people, many of whom may have little wealth and power, when we consider applying triage at this kind of scale.

change and scaling up will make it harder to do it well, but if this is not our model we have no hope of approaching the restoration target.

And if we confuse the very specific demands of the task of restoration with those of less demanding, though still valuable, ameliorative land management activities, we will also make it harder for ourselves to reach the restoration target. To avoid that confusion, we need to continue to mind our language well, to continually clarify the unique nature of the restoration enterprise through using words appropriately and accurately.

If we persevere in this work of theoretical elucidation and are appropriately mindful of ecological dynamics under the impacts of global change, and the complex social and economic prerequisites (and benefits) of large-scale ecological restoration, then this discipline and practice can indeed mature to become the gold standard and cutting edge for conservation in this century. As sober observers from outside the field have suggested, nothing less than our planet's future may depend on our success in these undoubtedly difficult endeavors.¹⁶

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¹⁶ *Science* devoted a special supplement to the field in 2009, introduced by an editorial that included this accolade: “Our planet's future may depend on the maturation of the young discipline of ecological restoration. . . In its short life it has assumed a major role in sustainable development efforts across the globe” (Roberts et al., 2009).

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