RESTORATION AND "NOVEL ECOSYSTEMS": PRIORITY OR PARADOX?[1]

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ABSTRACT

The practice of ecological restoration is challenged by accelerating rates and expanding scales of anthropogenic ecosystem change. The concept of "novel ecosystems" has become a focal point of intramural debate, leading restoration practitioners and researchers to reject, defend, revise, and reframe prior premises and goals. In a world of rapid environmental change, restoration can be seen, depending on one's perspective, as more necessary than ever, or as essentially futile. By revisiting restoration's history and defining a more nuanced approach to the realities of ecosystem change, we may be able to find space for reconciliation, or at least accommodation, of these divergent views. Aldo Leopold recognized as early as the 1930s that human impacts on the "biotic community" are pervasive; that "wilderness is a relative condition"; that conservationists must recognize "the dynamics of [the land's] past history and probable future." At the same time, he pursued restoration as a necessary new dimension of conservation and proposed his "land ethic" as "a mode of guidance for meeting ecological situations so new or intricate" that society had not yet evolved an effective ethical response. Since Leopold's generation, the "great acceleration" in global environmental change has altered the context in which we assess the promise and potential of restoration. It has only deepened, however, the need for conservation science, policy, ethics, and practice to engender resilient landscapes. Ecological restoration remains an essential means of doing so, albeit with redefined aims and methods.

Key words: Aldo Leopold, ecological restoration, land ethic, novel ecosystems, resilience, wilderness.

"Conservation, viewed in its entirety, is the slow and laborious unfolding of a new relationship between people and land."

—Aldo Leopold (1940: 6)

It hardly needs to be said that we live in a time of rapid change. The "great acceleration" of the post-World War II era continues apace, with compounding impacts on the Earth's biophysical systems, biological diversity, and ecosystem goods and services (Steffen et al., 2015). It is also a time of rapid demographic, economic, technological, political, and cultural change. Moreover, these environmental and social changes interact synergistically. It has always been thus, but the pace and intensity of such change are new and different and more consequential.

Conservation has evolved continually over the last century in response to the complex realities of social and environmental change (Meine, 2013). Debates and discussions about the meaning, values, and goals of conservation are nothing new. Now, however, conservation finds itself caught in an intense and persistent vortex. Over the last decade a "battle for the soul of conservation science" has been playing out, with important implications for ecological restoration (Kloor, 2015: 74). Much of this involves our appreciation of ecosystem change, the human role in effecting those changes, and the perils and potential of new technologies to respond to change. It also involves one's understanding of conservation history, and whether the current "battle" is indeed new and different or just the latest expression of tensions inherent in conservation.

Restoration science, policy, and practice are at the heart of these changes and debates (Woodworth, 2013). In the view of Hobbs, "just as [restorationists] are getting on their feet, all the rules are changing. . . .Is the word restoration still relevant? Is restoration still a useful concept?" (quoted in Woodworth, 2013: 384). Aronson et al. (2016: 392) have countered that restoration aims not to reconstruct vanquished ecosystems, but to reestablish disrupted ecological trajectories; that "historical continuity is what is being recovered." To make progress amid the vortex of competing claims and concerns, it seems we will need some new combination of ecological wisdom,

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historical insight and synthesis, forbearance, and imagination.

History and Novelty

Over the last decade the term "novel ecosystems" has been advanced to describe ecosystems that have experienced extreme degrees of change (Hobbs et al., 2006, 2013). "Novelty" in ecosystems has become a flash point of continuing intramural debate in ecological restoration, leading practitioners and researchers to reject, defend, revise, and reframe prior premises and goals (Woodworth, 2013). In a world of accelerating environmental change, restoration can be seen, depending on one's perspective, as a priority or as a paradox—as more necessary than ever in forging a sustainable future, or as essentially futile. It is unclear if these views can be reconciled or at least accommodated.

If restorationists are to achieve such reconciliation or accommodation, it seems necessary to recognize tensions over several underlying premises. One premise involves our understanding and appreciation of rapid environmental change. 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 (Morse et al., 2014; Murcia et al., 2014; Radeloff et al., 2015).

Another premise involves our view of the evolution of conservation and the relationship of ecological restoration to it. 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. Thus, the idea of novelty tests the viability of ecological restoration, and restoration conversely tests the practical relevance of novelty to conservation.

These are obviously complex matters. By revisiting restoration's history and defining a more nuanced approach to the realities of ecosystem change, we may be able to find more common ground. So much of our conversation—as scientists, conservationists, restoration practitioners, historians, landowners, and citizens—involves calibrating our timescales so that we can understand better the place and the moment in which we find ourselves and how we got here. History is essential in allowing us to define more carefully the rates, scales, types, and impacts of the changes we are experiencing. That awareness in turn can clarify our conservation responsibilities and opportunities. History, in short, far from being rendered obsolete by "novelty," is necessary to define it.

Aldo Leopold and the Foundations of Ecological Restoration

Aldo Leopold would appreciate restoration's dilemma. "Conservation," he wrote (1937: 75), "without a keen realization of its vital conflicts, fails to rate as authentic human drama; it falls to the level of a mere Utopian dream." Leopold's later framing of a "land ethic," and his expression of that ethic in his own life and work (particularly his restoration work), has provided a north star of sorts for several generations of conservationists, especially in North America. Now, amid rapid change at the global scale, the question is whether Leopold's legacy—or any of the experience of prior generations—is even relevant.

We return to Leopold because he was a pioneering figure in ecological restoration, long before he became a widely recognized ecological thinker and an iconic figure in the environmental movement (Jordan & Lubick, 2011; Court, 2012). His work as a restoration practitioner and researcher predates the maturing of the field—or even the phrase "ecological restoration." (From the 1920s to the 1940s Leopold regularly used the verb "restore" and its variants in much like the modern ecological sense, but he also used terms like "replanting," "restocking," "rebuilding," "reintroduction," "reconstruction," and "land doctoring.") In reviewing his record we gain glimpses into the field's origins, before the lines of our contemporary debates were fixed.

Leopold was a conservationist of unique breadth (Meine & Knight, 1999). His contributions to conservation in the early 20th century spanned fields from forestry and wildlife management to wilderness protection and agriculture. He drew upon his extensive field experience to foster new approaches to conservation policy, economics, and ethics, and to inspire new directions in the environmental humanities. The key point for present purposes is that Leopold's early work in ecological restoration was not pursued in isolation. His ecological insight fed his integrated approach to conservation values and land

stewardship practices (Meine, 2014). As a consequence of his breadth and curiosity, Leopold resisted simple polarities and dichotomies. Amid the current "battle" for conservation's soul and the difficult dilemmas facing ecological restoration, his story can provide a more subtle reading of the evolution of restoration and conservation in general (Minteer, 2017).

To gain that benefit, however, it is helpful to briefly highlight several key aspects of Leopold's scientific framework and conservation outlook in these years. First, Leopold did not hold an absolute view of wilderness. Leopold was a devoted defender of wildlands, his understanding of the values of the wild evolving over a lifetime of advocacy (Meine, 2010). At no point, though, did he adhere to a pure definition of wilderness. "Wilderness," he wrote, "exists in *all degrees*, from the little accidental wild spot at the head of a ravine in a Corn Belt woodlot to vast expanses of virgin country. . .. Wilderness is a *relative condition*. As a form of land use it cannot be a rigid entity of unchanging content, exclusive of all other forms. On the contrary, it must be a flexible thing, accommodating itself to other forms and blending with them" (Leopold, 1925: 399; italics added). This stands in contrast to the accusation, fashionable and much promoted in recent years, that conservationists and environmentalists have historically been beholden to an illusory concept of "pristine" wilderness (e.g., Kareiva et al., 2011; Marris, 2013). Were this strawman real, it would have precluded any active restoration or stewardship activity under the name of "conservation" in Leopold's day, or in subsequent decades (Meine, 2015). It did not.

Leopold also addressed this reality from the other end of the wildland-to-humanized land continuum. In his landmark book *Game Management* (1933), the first text in the new field, Leopold wrote: "Every head of wild life still alive in this country is already *artificialized*, in that its existence is conditioned by economic forces. . .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). Leopold understood the historic and pervasive impact of humans on landscapes, though obviously without the depth or detail that we have since gained. However, that understanding was no excuse for passivity in the face of assaults on wildness through inexorable development or industrial-scale domestication.

Again, this stands in contrast to the contemporary charge that conservationists have historically failed to take into account the legacy or reality of the human role in ecosystems. The claim is that "we must stop imagining ourselves nurtured by a nonhuman nature and accept the reality that it is only by transforming nature that we survive and thrive" (Ellis, 2015: 26). Leopold held no such illusions. Yet his aim as a conservationist was not an indiscriminate "transforming" of nature, but the "respectful guidance (as distinguished from domination) of the intricate ecological processes of nature" (Leopold, 1935a: 3). Restoration was in his time a new and emerging mode of "respectful guidance." It was not, however, the only expression of respect for land. Leopold's advocacy for wildland protection was relentless, and restoration was a complement to, not a substitute for, protection. He regarded "[w]ilderness is a resource which can shrink but not grow. . . . the creation of new wilderness in the full sense is impossible" (Leopold, 1949: 199–200). Protection, sustainable use, and restoration were necessary—not exclusive—means of caring for land within a broader and more integrated definition of conservation (Meine, 2004).

Another indictment of conservation, lodged persistently over the last 25 years, is that conservationists and environmentalists have historically bound themselves to a view, now obviously outmoded, of static ecosystems and the "balance of nature" (e.g., Botkin, 1990). It follows that ecological restoration that seeks to recover that static state and reestablish that "balance" is bound to fail. Early in his career Leopold explicitly rejected any such view of nature. In *Game Management* (Leopold, 1933: 387–388) he observed: "It is astonishing how few of those who have learned by rote rule or 'nature study' the *statics* of the land's present inhabitants or condition, ever learn to read the *dynamics* of its past history and probable future. To see merely what a range is or has is to see nothing. To see *why* it is, how it *became*, and the direction and velocity of its changes—this is the great drama of the land. . .." In this particular application, Leopold's work to restore game populations was but one part of his larger aim of conserving land.

Such statements are not cherry-picked from Leopold's literary or professional record. They are representative of Leopold's understanding of human/nature relationships, which was informed by the most advanced natural science and environmental history of the day. Nor was Leopold alone. His professional influence during his own lifetime and in subsequent decades reflected in large part his insights into the reality of ecological dynamics, the ever-changing human role in nature, and the potential for

constructive human engagement with ecological processes. He undertook restoration as a necessary new aspect of conservation practice, "a positive exercise of skill and insight, not merely a negative exercise of abstinence or caution" (Leopold, 1939: 296). At least as far as Leopold served as a founding figure of modern ecological restoration, his grasp of our profoundly changing biosphere was built into the field from its origins.

On the Path to a Land Ethic: Three Restoration Sites

As noted above, restoration for Leopold served as both a cornerstone and an expression of his land ethic. In 1924 Leopold relocated from the American Southwest, where he had spent the first 15 years of his career with the U.S. Forest Service (USFS), to Madison, Wisconsin (where he served as associate director of the USFS Forest Products Laboratory, later joining the faculty of the University of Wisconsin) (Meine, 2010). He could hardly have chosen a time or place more predisposed to innovation in conservation practice, ideas, and ethics. The Upper Midwest in the 1920s and 1930s was a wrecked landscape. Over the previous century the region's northern forests had been cut over, and its southern prairies and savannas thoroughly converted to agriculture. Half of Wisconsin's wetlands had been drained. Game species had been heavily exploited and widely extirpated, and other wildlife populations disrupted or depleted due to the rapid loss and conversion of their habitats. For Leopold's generation of conservationists, throughout North America but especially in the Midwest, accelerated and detrimental anthropogenic environmental change was a stark and immediate reality. Conditions were not merely "novel"; they were disastrous.

In response, conservationists had addressed the damage through restoration measures, of a sort. By the 1910s, reforestation in the cutover lands was being developed and promoted as both a conservation response and an economic necessity. By the mid-1920s a movement was afoot, driven by recreational hunters, to "restore" the great Horicon Marsh, dammed and then drained over the previous half century, in eastern Wisconsin. As important as these projects were as conservation actions, they were pre-ecological in their conception, undertaken without systematic ecological science or methods in mind. As a science, ecology was still maturing. This in fact would be among Leopold's key contributions: incorporating the emerging science into the natural resource management professions, and applying it to the challenge of restoring or rehabilitating damaged lands (Warren, 2016).

Between 1933 and Leopold's death in 1948, he participated both personally and professionally in a number of early restoration efforts. Three of these serve to illustrate the varied aims and approaches of restoration as a nascent conservation practice.

(1) the university of wisconsin arboretum

Perhaps best known among restoration practitioners is the University of Wisconsin Arboretum, home to some of the earliest pioneering projects in ecological restoration (Court, 2012). Overseen in part by Leopold, who served as its research director, the UW Arboretum was established on farmlands then on the periphery of Madison. As a university facility, priority was given at the arboretum to education, research, and experimentation in restoring the site's prairies, savannas, and woodlands.

At the dedication of the Arboretum in June 1934, Leopold defined the function of the Arboretum as providing "a reconstructed sample of old Wisconsin, to serve as a benchmark, a starting point, in the long and laborious job of building a permanent and mutually beneficial relationship between civilized men and a civilized landscape" (Leopold, 1934a: 5). In the reworked and published version of his address, Leopold restated the aim in more specific terms, emphasizing the scientific and ethical value of the undertaking: "If civilization consists of cooperation with plants, animals, soil, and men, then a university which attempts to define that cooperation must have, for the use of its faculty and students, places that show what the land was, what it is, and what it ought to be. . . . It is with this dim vision of its future destiny that we have dedicated the greater part of the [University of Wisconsin] Arboretum to a reconstruction of original Wisconsin, rather than to a 'collection' of imported trees" (Leopold, 1934b: 60; see Callicott, 1999). Prior generations of Euro-Americans had assumed that land ought to be transformed for immediate economic gain. Leopold was now suggesting that another option was possible and needed: the restoration of land for the sustaining of civilization.

In these harshest years of the Dust Bowl, such pronouncements were more than mere rhetorical flourishes or hyperbole. They were statements of the urgent responsibilities being thrust upon a generation. The value of preserving and restoring the mid-continent's prairies was plain to ecologically informed conservation practitioners. Leopold (1935b: 6) made the point the following year, in a short essay on the occasion of the founding of The Wilderness Society,

dedicated to the protection of wilderness areas on the nation's public lands:

> [Botanist and prairie ecologist John] Weaver at Nebraska finds that prairie soils lose their granulation and their water-equilibrium when too long occupied by exotic crops. Apparently native prairie plants are necessary to restore that biotic equilibrium which we call conservation. ... Here then is a new discovery which may illuminate basic questions of national policy. On it may hinge the future habitability of a third of the continent. But how shall it be followed up if there be no prairie flora left to compare with cultivated flora? And who cares a hang about preserving prairie flora except those who see the values of wilderness?

From the perspective of conservation history, several points stand out in this statement. In making his case, Leopold does not offer as his example of wilderness an idealized vista of mountain scenery or old forests, but of the nation's much-used and transformed grasslands. He ties the need for preservation to the aim of sustained "habitability." He suggests that these traditionally conflicting approaches to conservation—protection and management—cannot only be compatible, but must become complementary.

The emphasis in the Arboretum restorations was on reestablishment of the species composition of the land's ecological communities. Leopold's now-awkward reference to "original" Wisconsin reveals that he held at this point to a classic North American Eurocentric historic baseline of pre-settlement conditions (though in other and later writings he demonstrated a more flexible, pragmatic view). In this he anticipated what Woodworth (2013: 395), following Jordan and Lubick (2011), terms the "ecocentric restoration" model or approach: "...to bring into being, on a degraded site, a new ecological community, in as many respects as possible, an ecosystem that existed there in the past." Even in this case, however, the ecocentric value did not stand alone; what was intrinsically "good" for the ecosystem in undertaking restoration was also good for the long-term well-being of people living in and with that system.

(2) THE COON CREEK WATERSHED

Less well known than the UW Arboretum, but initiated simultaneously, was the Coon Creek soil conservation project in western Wisconsin. By the late 1920s the Coon Creek watershed, in the heart of the erosion-prone Driftless Area of the Upper Mississippi River, had been subject to destructive land use practices for some 80 years. Leopold (1935c: 206) described the consequences for the watershed and for its human inhabitants:

> Every rain pours off the ridges as from a roof. The ravines of the grazed slopes are the gutters. In their pastured condition they cannot resist the abrasion of the silt-laden torrents. Great gashing gullies are torn out of the hillside. Each gully dumps its load of hillside rocks upon the fields of the creek bottom, and its muddy waters into the already swollen streams. Coon Valley, in short, is one of the thousand farm communities which, through the abuse of its originally rich soil, has not only filled the national dinner pail, but has created the Mississippi flood problem, the navigation problem, the overproduction problem, and the problem of its own future continuity.

In the words of a long-time district conservationist for the U.S. Department of Agriculture at Coon Valley, "everything was pretty much unraveled" (University of Wisconsin—Cooperative Extension, 2014). That unraveling of the socio-ecological system could be halted and reversed only if the problem were addressed at the scale at which it had occurred: the entire watershed. The Coon Creek watershed thus became the first watershed restoration demonstration project in the nation, overseen by the newly established (1933) U.S. Soil Erosion Service, soon to become, in 1935, the USDA Soil Conservation Service (now the Natural Resources Conservation Service).

Leopold served as advisor to the project and importantly shaped its innovative approach. It was not a sideline interest for him. In his Southwestern years, Leopold had devoted himself to understanding the dynamics of watershed function and the phenomenon of human-exacerbated soil erosion. He brought to the vulnerable hills and valleys of western Wisconsin the experience and insight of an applied landscape ecologist.

The Coon Creek watershed became not only an exercise in conservation crisis response, but a laboratory for land rehabilitation. Leopold pushed the new agency and its cooperating private landowners to strive for a new and higher conservation goal. "Sound soil conservation," he wrote, "implied not merely erosion control, but also the integration of all land crops. ... a reorganized system of land use, in which not only soil conservation and agriculture, but also forestry, game, fish, fur, flood-control, scenery, songbirds, or any other pertinent interest were to be duly integrated" (Leopold, 1935c: 206). The key word was *integration*. The restoration of hydrological and ecological function required a coordinated approach that recognized all the values inherent in the landscape. It further required collaboration among the various players in the community, including farmers, other landowners, bankers, technicians, researchers, educators, and workers in the recently mustered Civilian Conservation Corps

(Meine & Nabhan, 2014). Restoration necessarily involved both the natural and the human community.

The conservation efforts in the Coon Creek landscape would stabilize the watershed in a matter of years and provide lasting economic and ecological benefits (Trimble, 2012). As a historical case study in ecological restoration, it corresponds less to the ecocentric model than the "restoration of natural capital" approach (Aronson et al., 2006: 22), with an emphasis on sustaining ecosystem goods and services and improving the ecological functions of the landscape for human benefit. The aim was not to reestablish a vanquished ecological community and its attendant species composition. Priority was given to immediate problem-solving, enhancing economic and ecological resilience, and coordinating conservation aims.

While quite different from the UW Arboretum, the Coon Creek watershed provided another example of conservationists striving, through restoration, toward "a permanent and mutually beneficial relationship" between people and land. As Trimble (2012: 208) notes, "while humans were responsible for the environmental degradation of the Hill Country, they were also responsible for the almost miraculous recovery of the region." Having been conceived as an emergency response to rampant gully erosion, it yielded not only stabilized soils, but rejuvenated base flows, revived trout streams, enhanced wildlife populations, scenic quality, agricultural productivity, and community economic stability, all embraced within a more resilient watershed.

(3) The Leopold Family Shack and Farm

"On this sand farm in Wisconsin, first worn out and then abandoned by our bigger-and-better society, we try to rebuild, with shovel and axe, what we are losing elsewhere" (Leopold, 1949: viii). With those words from the foreword to *A Sand County Almanac*, Leopold shared his most personal experience in ecological restoration with a reading audience that would ultimately include millions and become global in scope. Leopold acquired the derelict farm along the Wisconsin River north of Madison in early 1935, on the heels of his experiences at the UW Arboretum and Coon Valley. Those projects, and his recent appointment to the University of Wisconsin faculty, no doubt influenced the evolution of his aims as a private landowner. Originally conceived as a place for Leopold and his family to indulge their shared hobbies of archery and hunting, the land quickly took on additional roles as an outdoor classroom, naturalist's retreat, restorationist's laboratory, literary landscape, and conservation proving ground.

Situated along the river floodplain, the land was barren by the time Leopold came to it. The native prairies and savannas had been converted to agriculture in the mid-1800s. Decades of marginal farming had depleted the thin and sandy soils, and the prior landowner had abandoned the property (Laubach, 2014). Of the former farmstead, only a small chicken coop remained standing. When Leopold acquired the land, he gave priority to stabilizing the sands, rebuilding the soils, and rejuvenating the plant and animal communities—and to making the chicken coop (the "Shack") habitable for a family of six.

Leopold brought to the task his extensive professional expertise, but this was a more intimate activity and commitment, undertaken with his family, students, and close friends. And although aesthetic values had always been an important component of Leopold's conservation calculus, these now came to the foreground, especially as Leopold began to compose the lyrical essays inspired by the family's stewardship experience. The Shack provided Leopold with a place to combine thought and action, theory and practice, science and narrative—with restoration at the core of that experience. Before acquiring the Shack, he had written, "What more delightful avocation than to take a piece of land and by cautious experimentation to prove how it works. What more substantial service to conservation than to practice it on one's own land?" (Leopold, 1991: 172). Now he had that opportunity and responsibility.

In terms of restoration approaches, the Leopold family's Shack experience is not so easily characterized, its aims and methods blurred perhaps by the intensely personal nature of the effort. In seeking to "rebuild ... what we are losing elsewhere," the Leopolds worked to restore both ecological function and composition. The establishment of pine plantations to hold the soil was an early priority and an ongoing annual family activity. But equal time and effort were devoted to reestablishing the prairie and oak savanna flora, and to encouraging native fauna as well.

Estella, a paleobotanist and the youngest of the five Leopold children, recalled that, in the local landscape of the Shack, the family incorporated nonnative ornamentals—lilacs and hostas. "So why did we bring in these special plants to decorate the yard? We had a relation—even an emotional connection—to certain plants, and we wanted to have them near us" (Leopold, 2016: 190). But they also started a native wildflower garden and made regular family excursions to nearby remnant prairies to procure seeds and specimens. For the Leopolds, as for

ecological restoration in general, land stewardship entailed both priorities and paradox.

The practice and study of restoration—of working to rebuild biological diversity, ecological function, and beauty in radically altered or heavily degraded landscapes—allowed Leopold finally to propose a revolutionary redefinition of conservation. Beyond both a utilitarian economic definition focused on sustained yields and a preservationist definition focused on aesthetics and recreation, Leopold saw conservation increasingly in terms of the healthy socio-ecological functioning of land as an entire ecological community, with special urgency given to sustaining its co-evolved native diversity (Warren, 2016). In the last decade of his life, Leopold adopted the phrase "land health" to embrace the array of landscape qualities, processes, and trends that concerned him as a practicing conservationist: the stability and fertility of soils; the functioning of hydrological systems; "the disappearance of plant and animal species without visible cause, despite efforts to protect them, and the irruption of others as pests despite efforts to control them" (Leopold, 1949: 194).

In one of many efforts he made to distill and clarify the concept, he proposed that land health "expresses the cooperation of the interdependent parts: soil, water, plants, animals, and people. It implies collective self-renewal and collective self-maintenance" (Leopold, 1942: 265). In his final formulation of "The Land Ethic" (Leopold, 1949: 221), he refined the thought further: "A land ethic ... reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservation is our effort to understand and preserve this capacity."

In focusing on land health, Leopold linked what we now call "resilience" to "restoration" and "responsibility." As noted above, Leopold was well aware of the dynamism of ecological systems and of human impacts on the land. It was in fact the reality of anthropogenic ecological change that required, in his view, an evolutionary advance in human ethical concepts. In "The Land Ethic" he came close to capturing this in our contemporary sense of novelty: "An ethic may be regarded as a mode of guidance for meeting ecological situations *so new or intricate*, or involving such deferred reactions, that the path of social expediency is not discernible to the average individual" (Leopold, 1949: 203; italics added).

At the University of Wisconsin Arboretum, in the Coon Creek watershed, on the family's "worn-out" farm, and in other sites where he worked in these years, Leopold encountered lands that had in just a few human generations been "radically modified for human use." In a 1946 manuscript, "The Land-Health Concept and Conservation," Leopold noted that the "wholesale conversion of land with modern tools" involved "many irreversible changes" (Leopold, 1946: 513, 516). Yet, while allowing that ecosystem alterations and conversions were inevitable, he did not hesitate to characterize extreme ecological change—especially in the industrial age—in terms of "disorganization" and "derangement." As a scientist, Leopold lauded objectivity as the "great moral contribution" of science. As a conservationist, he could not be so dispassionate. "Objectivity is possible only in matters too small to be important, or in matters too large to do anything about" (Leopold, 1946: 518). As a practitioner of ecological restoration, he was personally and professionally committed to "doing something" about obvious land degradation.

Novelty, Restoration, and Resilience

Since Leopold's generation, the "great acceleration" of global environmental change has dramatically altered the context in which we assess the potential of restoration. Time has only deepened, however, the need for conservation science, policy, ethics, and practice to pull together in engendering resilient landscapes. Ecological restoration remains an essential means of doing so, albeit with redefined aims and methods. Between the 1930s and 1980s restoration science and practice developed only intermittently, with the straightforward aims of mitigating environmental degradation and reestablishing ecological communities at relatively limited scales. Since the 1980s, the ultimate "wicked" problem of global change and sustainability has reframed older conservation approaches. Restoration has had to respond by comprehending the complexity and dynamism of ecosystems, recognizing the relative nature of historic baselines, expanding its spatial scales, integrating social needs and concerns, and facing the reality of global climate change.

These changes have altered the aims of ecological restoration and made it both a priority and a paradox. Restoration finds itself in a bind. It has been, almost by definition, a backward-looking pursuit; yet it is also, and has always been, forward-looking. It is still in the business of considering "what the land was, what it is, and what it ought to be." If restoration ever had illusions about "going back" or adhering to single, strict baselines, it no longer does (Balaguer et al., 2014; Corlett, 2016). For some, these realities seem to render ecological restoration inadequate, if

not futile. For others, they make restoration's mission even more important, urgent, and vital: to deploy restoration more quickly, on a far greater scale, with far more resources, than we ever have before.

What to do amid this tension? Redford et al. (2013: 3) describe the challenge: "[The] future world will not be a slightly older version of the world that we currently inhabit. Rather, it will have a significantly altered climate, changed sea levels, novel pests and diseases, non-analog ecological communities, and a human population with changed priorities. . . .The transformed world of 2050 will demand new strategies and new approaches in conservation." Yet, it is a safe bet that the structure of "wicked" conservation problems will remain the same in 2050 as it was in 1950, or 1850. Systemic problems require systemic solutions. In conservation this means engendering whole, resilient landscapes through integrated approaches in which the solutions to one problem also contribute to solving other related problems.

And in conservation, all problems are related. We can no longer avoid the fact that our varied "issues" and needs—from climate change, biodiversity loss, and compromised freshwater systems, to social justice, economic equity, and human health—are bound together. If some continue to regard restoration as somehow nostalgic in its aims, it may be because it carries a conviction that we cannot respond to systemic problems in the future by ignoring the past. 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.

Conservation's unique role and responsibility is to see connections within and across landscapes, to "[find] ways to increase opportunities for biodiversity and natural processes in all contexts, from natural to seminatural and human-built ecosystems" (Martin et al., 2016: 6110). Restoration is relevant at every point along the spectrum of human impact, from the most intact wildlands to the most "novel" anthropogenic ecosystems (not forgetting the global commons of the atmosphere and the oceans). But restoration will mean, and require, different things at different points along that spectrum (Miller & Bestelmeyer, 2016). As Radeloff et al. (2015: 2065) note, "Measuring novelty, making the best forecasts possible of future environments and ecosystems, and identifying appropriate management responses for different levels and types of novelty will be major challenges for applied ecology and conservation for decades to come."

These challenges have already begun to reshape restoration science, policy, and practice (Woodworth, 2013). Unlike earlier phases in its development, restoration has begun to integrate and meet multiple social and ecological goals, and to coordinate at larger scales and across the landscape. Restoration is increasingly undertaken through new modes of collaboration, participatory methods, and community-based and community-driven processes. It is developing new economic mechanisms and incentives while applying principles of adaptive management. Such strategies were present only in embryonic form, if at all, when restoration emerged. They are now priorities.

Ecological restoration, under the rapidly changing conditions of the present and into the indefinite future, will look and act differently than it has in the past. But it will, I think, still be serving a land ethic that is itself continually evolving. If we do not have all the answers, and have not yet sorted through all the complexities and paradoxes, restoration and stewardship of our land, and care for people and our human communities, are nevertheless utterly essential if we are to build the world we know we need to bring forth in—and for—the generations to come. As botanist, ecologist, and writer Robin Kimmerer (2013: 338) notes in *Braiding Sweetgrass*: "Restoring land without restoring relationship is an empty exercise. It is relationship that will endure and relationship that will sustain the restored land. Therefore, connecting people and the landscape is as essential as reestablishing proper hydrology or cleaning up contaminants. It is medicine for the earth."

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