Environmental History Advance Access published April 25, 2012

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Integrity, Stability, and Beauty: Aldo Leopold's Evolving View of Nonnative Species

Abstract

Aldo Leopold's distaste for introduced species was initially largely utilitarian, focused on his belief that they were usually less productive than natives. Catalyzed by a meeting with Charles Elton in 1931, as well as by his own developing land ethic and notion of land health, Leopold's focus shifted to the impact of nonnatives on native species, communities, and ecosystems. He depicted nonnative species not only as symptoms of land illness but often as causal, through their disruption of a type of biotic integrity that underlies land health. He also pointed to their frequent destabilizing effects, often associated with a loss of biotic diversity. Leopold manifested an aesthetic aversion to nonnatives, tacitly at first but more explicitly as his land aesthetic matured and became closely linked to his land ethic. Some of his statements regarding nonnatives can be interpreted as displaced nativism, but they more likely reflect aesthetic judgments and ecological concerns.

Daniel Simberloff, "Integrity, Stability, and Beauty: Aldo Leopold's Evolving View of Nonnative Species," *Environmental History* (2012): 1–25.

doi:10.1093/envhis/ems044

> "Restock with the best adapted species, the native species always preferred."
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> —Aldo Leopold, "Mixing Trout in Western Waters" (1918, 102)
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> "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."
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> —Aldo Leopold, *A Sand County Almanac* (1949, 242)

Introduction

Aldo Leopold was not the first prominent conservationist to sound an alarm about nonnative species. For instance, George Perkins Marsh included an extended passage on them in *Man and Nature*.[1] However, Leopold wrote about them often and with increasing focus and urgency in the 1930s, anticipating concerns that did not surface widely among conservationists until several decades later.[2] Today, invasions by nonnative species are the subject of a growing science, invasion biology, engaging thousands of researchers worldwide, many of them studying the very sorts of problems that Leopold noted. However, from the initiation of the modern field in the 1980s, invasion biology has been controversial.[3] Some social scientists have charged that antipathy toward nonnative species often reflects xenophobia, racism, or nativism.[4] More recently, a small but vocal group of ecologists have echoed this claim and have also argued that conservationists have exaggerated the ecological threats of nonnative species and that it is often futile in any case to attempt to prevent or manage them.[5] For example, Matthew Chew, an historian and ecologist prominent among the critics, has suggested that nativism prevalent in the United States at the beginning of Leopold's career motivated some of his writings on nonnative species.[6] A review of Leopold's ideas about introduced species and their impact is timely.

At least nine of Leopold's writings are primarily about nonnative species, and several of his famous works on other subjects show an acute perception of a growing dominance of American landscapes by nonnative species. Consider one of his last essays, "The Good Oak," written as his health declined in 1948 and published posthumously in *A Sand County Almanac*.[7] The essay is revered for the eloquence with which Leopold traces Wisconsin's landscape history in reverse by associating events with the rings revealed as he and his wife Estella sawed ever more deeply into an old lightning-killed oak. Among these events are the appearance of several nonnative species,

including the stocking of Atlantic salmon in a nearby lake in 1875, the stocking of the first Old World carp in Wisconsin in 1879, the arrival that year of quack grass from Europe, the stocking of smelt from the Atlantic Ocean in the Great Lakes in 1909, the establishment of Asian pheasants in 1916 in a county near the oak, and the arrival of the first starling from Europe in Wisconsin in 1923.

Leopold's concern with nonnative species began with his earliest publications and persisted until his death; three essays in *A Sand County Almanac* treat them in some detail; one of these is wholly focused on nonnative species. However, the nature of this concern evolved substantially during his lifetime. Historian Julianne Lutz Warren traces Leopold's lifelong intellectual journey and the ever-expanding scope of his conception of how humans interact with their biotic and abiotic environment, culminating in his land ethic aimed at land health.[8] Philosopher J. Baird Callicott depicts a parallel and closely linked development of Leopold's land aesthetic.[9] Leopold's thinking about nonnative species evolved apace with his land ethic and land aesthetic, and he increasingly saw them as integrally associated with these two fundamental conceptions.

Early Writings

Leopold's first publication on nonnative species, in 1918 ("Mixing Trout in Western Waters"), treats the introduction of European brown trout, brook trout from the eastern United States, rainbow trout from several parts of the United States, and various subspecies of American cutthroat trout into southwestern streams previously inhabited only by a native cutthroat subspecies, the black-spotted trout.[10] Unlike many of his peers in wildlife management, Leopold did see potential problems with introducing trout into streams.[11] His main concern was hybridization, which he thought would reduce trout populations because the hybrids would be either infertile or less fertile than what he called "pure stock," and he called for more research on the degree of hybridization and its impact on reproduction.[12] Until the very end of "Mixing Trout," Leopold's worry about hybridization seems unrelated to the nonnative status of the introduced individuals. Rather, it is that they will be maladapted to the location, so hybridization will lead to less production. The fact that he is not antipathetic to nonnative species simply by virtue of their origin is clear because he even advocates particular nonnative species rather than the native black-spotted trout in certain habitats. In letters to A. H. Dinsmore of the US Bureau of Fisheries and J. W. Johnson of the US Department of Agriculture Forest Service, Leopold continues this theme, describing the problem as the need to extend fishing into lower and warmer waters and asking whether brown trout could serve this purpose.[13]

"Mixing Trout" ends abruptly and enigmatically: "Restock with the best adapted species, the native species always preferred."[14] This admonition mirrors a "Game and Fish Handbook" that Leopold had compiled in 1915 for the US Forest Service, District 3, which opens the section on which fish species to introduce to "empty" or depleted waters with this injunction: "Ordinarily native and indigenous species are preferable. For District 3 the following are best."[15] However, the immediately following list includes brook trout and small- and large-mouthed bass, none of which are native to District 3 (the Southwest). Perhaps the most straightforward way to interpret the last line of "Mixing Trout" is that it is self-contradictory. On the one hand, use the best adapted species, whether native or not, as he seems to be arguing earlier in the paper, but, on the other hand, prefer native species, no matter what. Warren suggests that Leopold feared that, in the absence of substantial ecological knowledge, it would be easy to cause problems by introducing a nonnative, and native species are most likely to be best adapted.[16] However, his use of "always" is puzzling, as he had pointed earlier in the paper to situations in which the native is not best adapted, and the sentence has no conditional clause, such as "if two species seem equally well adapted."

Published soon after "Mixing Trout," "Forestry and Game Conservation" also has an enigmatic statement: "But game management should always prescribe a mixed stand—that is, the perpetuation of every indigenous species."[17] The essay lacks context for the stress on native species here, but a subsequent sentence seems indicative: "The attractiveness, and hence the value of our forests as hunting grounds, is easily doubled by retaining our extraordinary variety of native big game."[18] Perhaps attractiveness can be read here simply as visual attractiveness, an aesthetic matter (see later).[19] However, toward the end of "Forestry," Leopold points for the first time to major impacts of nonnative species that we would today classify as ecological, although he does not specifically describe them as such: "Foresters are quite properly concerned over the threatened commercial extinction of chestnut by blight and white pine by blister rust."[20] Both chestnut blight and white pine blister rust are Old World pathogenic fungi that devastated populations of dominant trees in wide swaths of North America after their introduction around 1900.

The next year, Leopold first described preference for native species (e.g., American heath hen over Chinese pheasant) as an "ethical" matter: "On the other hand, the Wild Lifer regards the perpetuation of native species as an end in itself, equal if not greater in importance than the perpetuation of 'something to shoot.' It may be safely concluded that as to this point the Wild Lifer enjoys the advantage of an ethical as well as of a utilitarian objective."[21] He does not explain this ethical judgment. This skepticism about rearing and releasing nonnative game was followed in the 1930s by papers such as "Grand-Opera Game," in which the preference seems frankly grounded in

both visual and aural aesthetics, and "Chukaremia," which advocates natives on the utilitarian basis that they will usually be more productive if land is managed properly.[22] A 1925 memorandum from Leopold to the district forester of the Wichita National Forest and Game Preserve advised that, "to facilitate ecological studies, the introduction of exotics should be carefully avoided."[23]

In the 1920s, however, Leopold was still advocating the use of nonnatives on utilitarian grounds in certain circumstances. In papers published in 1921 and 1924, he suggested planting nonnative species such as tamarisk (salt cedar) in place of native willows to stop erosion and gullying because livestock eat willows but not some nonnatives.[24] In short, his consideration here was utilitarian. He even followed this advice himself. Around 1920, according to a 1960 interview with his son Luna Leopold, Aldo Leopold planted a tamarisk in the backyard of the family home in Albuquerque.[25] Leopold was apparently aware that tamarisk could spread quickly. According to Luna, in 1931 he remarked (regarding a seedling they noted on a road crossing Rio Galisteo in New Mexico) that "given time, tamarisk will cover such channels extensively, as it propagates rapidly."[26] In retrospect this recommendation to plant tamarisk, although quite in line with federal agency recommendations of the 1920s and even 1930s, was ill-advised, as tamarisk has now become a major pest.[27] The first alarm that tamarisk is dangerously invasive, uses massive amounts of water, and can replace native vegetation was sounded in the 1940s, and by the 1950s, tamarisk invasion was widely regarded as a major ecological problem, causing severe water loss in arid areas because of the tree's deep roots and substantially changing organic matter dynamics in watercourses that had previously lacked much vegetation.[28] Tamarisk even qualified as part of a widely publicized list of 100 of the World's Worst Invasive Alien Species.[29]

A Fateful Meeting

In 1931 Leopold met the English ecologist Charles Elton at the Matamek (Labrador) Conference on Biological Cycles (figure 1). He is thought to have read Elton's 1927 book, *Animal Ecology*, with its many references to impacts by nonnative species, by early 1931, and the Matamek meeting with Elton and their subsequent interactions largely shaped Leopold's ecological thinking and, I believe, his views on nonnative species.[30] Their long friendship beginning at that meeting is described in detail by historians and conservation biologists Curt Meine and Julianne Lutz Warren and termed a "mutual admiration society" by historian Susan L. Flader and J. Baird Callicott.[31]

Although often considered the founder of modern invasion biology, Elton is better seen as having adumbrated a field that developed independently in the 1980s when ecologists rediscovered his work.[32] Although his popular 1958 book on the spread and impacts of

Figure 1: Aldo Leopold, Charles S. Elton, and William Rowan (left to right) at the Matamek Conference on Biological Cycles, Labrador, 1931. Leopold met Elton at Matamek and maintained an extensive correspondence with him until his death. Credit: Courtesy of the Aldo Leopold Foundation.

introduced species, *The Ecology of Invasions by Animals and Plants*, is sometimes cited as having founded invasion biology, Elton was greatly concerned with biological invasions well before 1958, publishing substantially on them beginning with the 1927 ecology book.[33] His earliest interest in invasions was initially largely academic. As an animal ecologist, Elton saw them as probes into ecological communities, their impacts reflecting the nature and importance of interspecific interactions in structuring communities. However, beginning in the late 1930s, Elton's concern with nonnative species was increasingly focused on their conservation impacts—threats to the existence of native species and communities—and his publications reflected this expanded focus.[34]

The ongoing interaction with Elton is key to a transformation in Leopold's thinking on nonnative species. As noted earlier, before 1931 Leopold's concern with such species appeared to be largely utilitarian. He believed that in most circumstances natives would outproduce exotics. Subsequently, although the utility of nonnative species remained a lifelong thread in Leopold's conception of appropriate land management, the ethical and aesthetic threads of his thinking on natives became increasingly prominent as he wove a land ethic and land aesthetic based on knowledge of the integrity and functioning of ecosystems. That he pointed in his 1931 conversation with his son Luna to what we would now term "invasiveness" of tamarisk suggests that he was already sensitive to the ecologically detrimental impacts of some nonnatives. The meeting that year with Elton surely enhanced and perhaps crystallized this sensitivity.

Nonnative Species in a Land Ethic

In 1932 an anonymous report in the "Journal of Forestry" quotes a statement by Leopold, "made public by the American Game Association," as having called current game propagation practices "a melting pot that has failed to work" for utilitarian reasons.[35] He is cited as contending that native game are more popular than exotic game and better adapted to their original ranges, but also as arguing that "clean farming" methods of the day were destroying the habitat of native quail and prairie chickens. On this latter point, he was certainly correct, and his recognition of the impact of clean farming was an early aspect of the "land sickness" and "land health" concepts that later become a cornerstone of his conservation thinking.[36]

Also in 1932, Leopold felt called upon to rebut biologist T. T. McCabe, who had criticized a game plan of Leopold's as entailing too much use of exotic species.[37] Leopold's defensive, acerbic reply emphasizes that he does not favor nonnatives, but in some places the habitat is so devastated that no natives can survive there. He would love to use only native species, but for "the unpleasant fact that America consists largely of business men, farmers, and 'Rotarians,' busily playing the national game of economic expansion."[38]

In 1935, for the first time, Leopold clearly based his antipathy to nonnative species on ecological grounds, providing a tentative reason for why native species are crucial to land health. Referring to the ecologist John Earnest Weaver, Leopold wrote, "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 stability which we call conservation."[39] This passage seems to imply an evolved coadaptation of native plants, animals, and soils, although Leopold is not yet very explicit about the evolutionary underpinnings.[40] In 1936 and 1941, Leopold again referred to Weaver's suggestion that native vegetation is needed to restore prairie soil.[41] Leopold's conception of the ecosystem by this time relied heavily on Elton's discussion of how members of a biotic community interact somewhat the way organs in a body work together, and on the writings of plant ecologists Frederic Clements and Arthur Tansley on the integration of the community with the physical environment, including soil and water, in the ecosystem.[42]

"A Biotic View of the Land" reflects Elton's influence on Leopold's thinking about nonnatives even more explicitly, with a sketch of a "biotic pyramid" clearly modeled on the pyramid of numbers described by Elton (figure 2).[43] Further, the sketch includes arrows depicting the transfer of energy among the biotic components and (after death) the soil, exactly paralleling Elton's discussion of energy

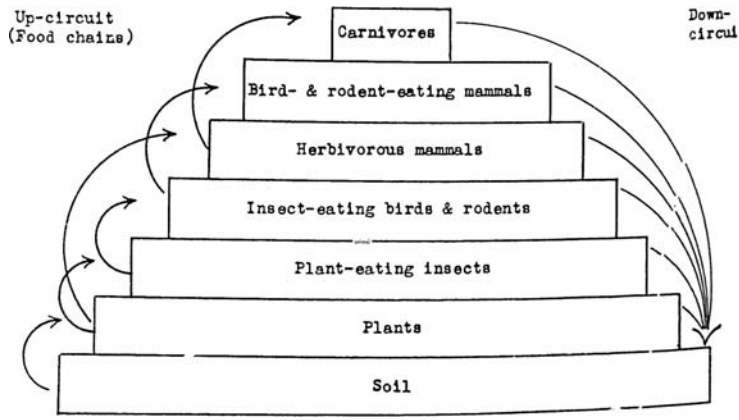

Figure 2: Aldo Leopold published this "biotic pyramid," which uses arrows to depict energy transfers in the environment, in the essay "A Biotic View of the Land" for the Journal of Forestry in 1939. Leopold modeled it on Charles Elton's pyramid of numbers. Leopold saw maintenance of this energy transfer as crucial to "land health" and believed that non-native species were likely to disrupt it. Credit: Journal of Forestry 37, 9: 728.

flow. Leopold poses the particular problem with nonnative species as an original hypothesis: "That the native plants and animals kept the energy circuit open; others may or may not."[44] Elton had described several examples of introduced animal species disrupting food chains, but he had not related this disruption in energy flow specifically to the pyramid of numbers. Leopold elaborates further on the rationale for the hypothesis: coevolutionary changes among component species in an ecosystem are generally slow, while the introduction of nonnative species constitutes an abrupt challenge to the native ecosystem. Some nonnative species thus "get out of bounds" as pests and diseases, and some native species are extinguished. Leopold repeated his pyramidal ecosystem model in "The Land Pyramid" in *A Sand County Almanac*, with the same hypothesis about the likelihood of disruption of energy flow by nonnative species.[45]

In an unpublished paper written in 1942, Leopold remarks that certain nonnative species are beneficial to humans on utilitarian grounds but others are disastrous: "Along with the deliberate and beneficial substitutions come many accidental ones (Japanese beetle, creeping Jenny, Canada thistle, chestnut blight, blister rust), most of which are bad, some ruinous."[46] He then builds on the ecological hypothesis he first hinted at in 1939, raising the possibility that retaining species diversity reduces instability. He admits he cannot prove this, appealing to a "probability based on evolution."[47] In this and another paper the same year, Leopold calls for more "naturalistic" alternatives to introducing nonnative species and several other practices he deplores.[48] This appeal is part of his developing view of

communities and ecosystems in general: long periods of coevolution have adapted native species to one another and to the physical environment in such a way as to be self-sustaining and to optimize various ecosystem properties, and it is very difficult to change parts of an ecosystem (say by introducing nonnative species) without threatening what he termed the "health" of the whole system.

Just two years later, in 1944, Leopold elaborated on this theme in an unpublished typescript titled "Conservation: in Whole or in Part?", examining the relationship between diversity and stability.[49] This typescript is replete with discussion of many of the native Wisconsin species that have been lost, of many nonnative species that have been introduced, and about the likelihood that some of the additions contributed to some of the losses. It seems implicit in this manuscript that these added species have caused instability, but Leopold never quite says this explicitly in the typescript. He does include an extended lament in which he returns to the land health concept, analogizing nonnative species to pains and ailments: "All too familiar are those symptoms of land-illness caused by the importation of exotic diseases and pests. There is no mystery about such pains and ailments as the white pine blister rust, chestnut blight, gypsy moth, Dutch elm disease, the corn borer, the Norway rat, the starling, the house mouse, the Canada thistle, and the creeping jenny or German carp."[50]

In a paper written for the canceled 1945 North American Wildlife Conference, Leopold emphasizes again the impacts of many nonnative species but concedes that some native species have also become pests: "These runaway populations include weeds, pests, and disease organisms. Usually these runaways have been foreigners (like the carp, Norway rat, Canada thistle, chestnut blight, and white pine blister rust) but native species (like the June beetle and various range rodents) are clearly also capable of pest behavior."[51] Citing a book review by Elton that delves widely into the general problem of nonnative species, he adds a malaria-bearing African mosquito in South America to his usual litany of North American invasions.[52]

In 1946 Leopold wrote a major paper, left in pencil at his death, specifically relating land health and sickness to nonnative species, arguing that "world-wide dominance of plant and animal weeds" is a symptom of land-sickness and positing the existence of some sort of integrity of communities of native species that confers stability: "It is necessary to suppose, therefore, that a high degree of interdependence exists between the capacity for self-renewal and the integrity of the native communities."[53]

Finally, three papers in the posthumously published *A Sand County Almanac* deal substantially with nonnative species and reflect Leopold's mature perspective, firmly grounding in his land ethic the ethical issue associated with them. "The Round River" is built around the Clementsian idea of the ecosystem as superorganism,

with maintenance of all its parts crucial to its integrity. Again Leopold appeals to coevolution as the underlying cause of the reliance of stability on diversity, citing "the tacit evidence of evolution, in which diversity and stability are so closely intertwined as to seem two names for one fact."[54] A critique of "clean farming" returns to the issue of why nonnative species are so often destabilizing: "Can stability be synthesized out of imported plants and animals? . . . No living man really knows."[55] In "The Land Ethic," which synthesizes earlier writings (especially "A Biotic View of the Land") but contains significant parts added in 1947, Leopold again stresses coevolution as the reason why nonnative species are so likely to become runaways that destabilize native ecosystems and why it is difficult if not impossible to construct stable, "healthy" ecosystems out of them.[56] The coevolutionary changes that adapt species to one another and to the physical environment are usually slow and local, on the scale of at least millennia, and in the "world-wide pooling of faunas and floras, some species get out of bounds as pests and diseases, others are extinguished" as the intricate, evolved regulatory mechanisms break down.[57]

"Cheat Takes Over," published in 1941 but revised for *A Sand County Almanac*, is an entire essay on the impact of nonnative species developed through the detailed description of a single mega-invasion in the American West, that of cheatgrass.[58] After an initial quick scan of several prominent invasive plant pathogens and animals, Leopold turns to cheatgrass as "a new ingredient of the melting pot," listing myriad impacts of this Eurasian plant before closing with mention of other invaders, including two he repeatedly cites in various writings: the starling and common carp.[59] This essay, one of the few in his oeuvre that deals entirely with nonnative species, does not explicitly delve into their relationship with land health and land illness. However, the description of the interrelationship between cheat and overgrazing by introduced hooved livestock imported from its native range, and of the interaction of cheat and wildfire as the key mechanism by which cheat replaces native plants maladapted to fires but crucial to wildlife, makes the point that coevolution is the key to why native species coexist stably in communities and why introduced species are likely to disrupt the coexistence.

The Charge of Nativism

The historian and biologist Matthew Chew suggests another reason for Leopold's dislike of nonnative species, claiming the introduced trout "violated Leopold's sense of piscigeographical propriety" and terming his attitude toward them "nativistic."[60] Calling Leopold a nativist is to compare his dislike of nonnative species with a prejudice against human immigrants. Chew goes further in this linkage, citing the fact that Leopold deplored certain game management practices

with use of another metaphor widely applied to humans: "a melting pot that has failed to work."[61] Historian Curt Meine cites an earlier similar charge in a letter sent in 1993 to the editor of the *Iowa State Daily* criticizing the mission of Iowa State University's Leopold Center for Sustainable Agriculture and castigating Leopold as a "Nazi" and "racist" who "believed in the superiority of the Nordic race."[62]

Certainly part of the quote attributed to Leopold in the 1932 *Journal of Forestry* report betrayed an animus toward nonnative species that goes beyond concerns about land health. The report quotes Leopold as saying: "Thoughtless importation of Mexican quail, which diluted the hardy northern bobwhite blood in Massachusetts to an almost fatal point, is a constant threat against quail future in the rigorous climate to which native birds have become suited."[63] Bobwhite quail from other regions *were* transplanted to New England during this period in an attempt to redress a decline in quail populations caused by habitat change. Although hybridization occurred, there was no evidence that hybridization rendered the entire population less well adapted or had anything to do with the decline of bobwhite quail in Massachusetts.[64] The wording of this passage is typical of nativist metaphors for nonnative species in the United States in the late nineteenth and early twentieth centuries.[65] Chew doubts that Leopold was unaware of the "scientific racism" common in the United States in 1932 and argues that "there is no particular reason to suppose that Leopold's attitude diverged markedly from the spirit of the age."[66] He even takes Leopold's biographers to task for failing to explore Leopold's thinking in this regard: "Although Leopold applied arguments to wildlife introduction that were virtually identical to [Madison] Grant's regarding immigration, Leopold's biographers have not specifically engaged with this issue, and it remains to be seen whether any useful evidence exists to support such an analysis."[67]

In fact, however, Chew is far too categorical. Although it is true that Leopold's reasoning for deploring nonnative trout is obscure in his 1918 paper, and that the wording attributed to him in the quote on quail parallels Grant's arguments against miscegenation, Leopold's thinking about introduced species evolved greatly over his short life, as I have shown. By 1932 Leopold was squarely focused on ecological concerns. Further, Leopold's most explicit use of the melting pot metaphor that displeases Chew, the 1932 report on game propagation practices, is accompanied by explicit reasons for saying the melting pot is not working, and these have nothing to do with nonnativeness per se.[68] Rather, they are partly utilitarian and partly about habitat destruction, the latter foreshadowing his ideas about "land sickness" and "land health."

In addition to metaphors relating to immigration, Leopold frequently used military and political metaphors to describe nonnative species.

Sociologist Brendon M. H. Larson deplores such metaphors, arguing that they hinder understanding of biological invasions and have potentially harmful social consequences.[69] Certain of these metaphors describe some analogies so aptly that they are almost inevitable. In warfare, an enemy invades, establishes a foothold, spreads, and may be halted by a Maginot Line. All of these terms have been used in the popular press and occasionally in scientific writing to describe biological invasions; if one looks at maps of military campaigns and biological invasions, one would be surprised if these metaphors had not been used.[70] Historian Peter Coates suggests that such terminology in the early twentieth century might in some instances have reflected an underlying xenophobia, but that later writing reflected concerns about ecological impact.[71]

It is unsurprising that Leopold, a writer whose metaphors often dazzle and resonate widely (e.g., "land health" and "land sickness"), should coin some striking ones in discussing nonnative species. His "Fifth Column of the Fencerow" addresses primarily Old World quack grass (called a "parvenu" in "Illinois Bus Ride" of *A Sand County Almanac*), which replaces more "desirable" native grasses but includes a slap at common carp: "Like the foreign carp which is quietly displacing the native fishes of our lakes and rivers by his superior voracity and reproductive powers, so is this foreign grass [quack grass] quietly displacing the native plants of our roadsides and fencerows by its superior powers of suckering, seeding, and choking."[72] Something more is probably at play here than a simple reaction to ecological impacts of carp, as evidenced by the fact that Leopold, an astute naturalist, misidentifies the nature of the impact of common carp. That he was extremely concerned with carp is manifested by extensive correspondence and publications about them in his archival materials and his occasional references to them among lists of harmful nonnatives, despite his never detailing their impact (figure 3).[73] Common carp is probably the most destructive fish species introduced to North America, but not by virtue of superior voracity and reproduction.[74] Common carp feed largely on the bottom and so do not directly compete with most native fishes. Rather, their consequential impacts are indirect: increasing turbidity, uprooting plants, and pumping large amounts of phosphorus into the water. In short, they make a terrible mess. Perhaps simple aesthetic distaste explains Leopold's animus toward carp, or perhaps it is partly that they are foreign. It is noteworthy that, in this paper, Leopold never says why native species are more desirable than either quack grass or carp.

Similarly, in "Bluebirds Welcome," Leopold sees starlings and English sparrows as legitimate targets for a swift death, while bluebirds, owls, and hawks are "desirable": "Bluebirds once nested in towns and villages, as well is in open country. English sparrows and starlings have completely routed them from urban habitats, and are

Figure 3: Aldo Leopold stands with two common carp seined in a dredged borrow pit in Beaver River Refuge, Utah in 1941. Leopold kept an extensive file on introduced carp and wrote about their impact in "Fifth Column of the Fencerow." Credit: Courtesy of the Aldo Leopold Foundation.

now by way of routing them from farmyards as well. Hence an accurate .22 rifle is a good tool for rebuilding bluebird prosperity. The trouble with the rifle is that it may be turned against hawks and owls, or other birds just as desirable as bluebirds."[75] However, he does not explain the desirability of the natives and the undesirability of the nonnatives.

"The Outlook for Farm Wildlife" contains a subtler term than "fifth column" but one nonetheless pejorative: "On the University of Wisconsin Arboretum, an area dedicated to the rebuilding of the original native landscape, the Siberian honeysuckle is calmly usurping the understory of all woods, and threatens to engulf even the marshes."[76] Leopold had previously used exactly the same metaphor in "Biotic Land-Use": "Some sober ecologists predict that a few generalized plants and animals will ultimately usurp the whole globe."[77] "Usurp" means "to appropriate wrongfully" (*Oxford English Dictionary*) and in these instances would assign an agency to plants and nonhuman animals. In these two essays, it seems clear that what is "wrong" with the nonnatives is their participation in land illness, but certainly the metaphoric "usurp" is a far stronger term than, say, "replace."

Fifth columnists, parvenus, usurpers, stowaways—his metaphors surely suggest Leopold harbored a general distaste for nonnative species. However, this need not reflect xenophobia. His concern based on utilitarian grounds persisted throughout his life. In

"Chukaremia," he uses the gray partridge ("Hungarian partridge") and chukar partridge from Eurasia to frame an entirely utilitarian diatribe against imported game animals in general: most game introductions are failures, and introductions avoid dealing with habitat management, which is the real solution to declining game.[78] Here Leopold sees nothing inherently bad or dangerous about nonnative species simply because they are introduced. Leopold begins a further consideration of the Hungarian partridge a year later with the same utilitarian view: "Some, like the starling in America or the rabbit in Australia, are pests. Some are useful additions to the rural landscape, only partially competitive with native species."[79] Clearly this is not a blanket indictment against all nonnative species. In *Game Management*, Leopold asserts that "all land must produce" and exemplifies how this goal may be met for huntable game by showing that the habitat of Iowa if properly managed could support ten Eurasian pheasants for every hunter.[80] In short, certain nonnative species may be acceptable for utilitarian reasons. More than utility, however, beginning in the 1930s the major basis for Leopold's general distaste for nonnative species was his growing understanding of ecological integration and land health. It is noteworthy that the references to fifth columnists, parvenus, usurpers, stowaways, and desirability are all in the 1940s.

Meine notes that Leopold's father was initially displeased that Aldo had chosen to marry Estella Bergere, a Spanish-Italian Catholic with Jewish forebears.[81] He reports no particular prejudices on Aldo's part. A legendarily happy marriage to someone of Latin and Jewish heritage would not be incompatible with a tinge of nativism, but it is unlikely that any biographer would find Leopold a committed xenophobe. Utilitarian and ecological considerations are a sufficient explanation for his growing concern with introduced species. Meine shows how readers have selectively focused on particular writings of Leopold and interpreted them through the lenses of their own interests and viewpoints, leading to divergent views of Leopold the man and his beliefs.[82] The idea that Leopold's thinking on introduced species derives from nativism perhaps exemplifies this phenomenon.

The Land Aesthetic

Throughout Leopold's writings are descriptions of the beauty (usually visual, sometimes aural) of various species, communities, and ecosystems. As noted previously, early in his career, Leopold gave the "attractiveness" of native forests as a reason to preserve them, although without a clear indication of what he meant by "attractiveness."[83] His 1933 book *Game Management* has a chapter "Game Economics and Esthetics" advancing the notion that part of the management goal should be the aesthetic development of both the hunter and the average citizen, and that this implies maintaining the greatest

possible variety of indigenous birds and mammals.[84] In "Grand-Opera Game," the appeal of natives over nonnatives is described with an aesthetic metaphor: "pheasant shooting is a good show, but quail and prairie chicken are grand opera," and, as "pretty" as bushes may be, quail top them "with that even prettier whistle: 'Bobwhite.'"[85] "Farm Arboretum Adds to Home Beauty," an essay written in 1940 about nonnative species replacing natives in Wisconsin, focuses largely on visual aesthetics, describing some native plants as of "startling beauty."[86] The importance he ascribed to aesthetics is well illustrated by the fact that Leopold defended European chicory in Iowa because "during hot dry weather this tough immigrant is the only member of the botanical melting-pot courageous enough to decorate with ethereal blue the worst mistakes of realtors and engineers."[87] "Farm Arboretum," however, contains an appeal to jingoism in raising concern with nonnatives on aesthetic grounds. Leopold complains that Wisconsin has surrounded its capitol building with European maples. These maples gnawed at Leopold, at least on aesthetic grounds; he complained about them again in 1942: "One of the irrefutable indictments of Wisconsin's 'taste in natural objects' is the fact that our capitol square is planted with European maples. I have yet to hear a 4th of July orator who has noticed this."[88] Once again he preferred the appearance of native plants: "Foreign trees and shrubs, almost without exception, give no color in fall. The leaves simply freeze off because the species is not quite adapted to our climate."[89] Similarly, in an unpublished handwritten manuscript, "The Prairie: The Forgotten Flower," referring to a house on a Wisconsin prairie, Leopold laments that "We have here restored, at great pains, the architecture and furniture of a 1830 household, and then set it in a landscape monopolized by stowaways from Asia."[90]

Callicott has described Leopold's "land aesthetic" as "a systematic theory of natural beauty and the criteria for its appreciation."[91] He observes that the "picturesque" aesthetic tradition that has until recently dominated Western appreciation of natural beauty values natural entities, such as species, communities, ecosystems, and landscapes, to the extent that they adhere to the formal requirements of painting (including landscape painting): perspective, balance, having a foreground, middle ground, and background, and the like.[92] This might be termed a "surface" aesthetic. Leopold's land aesthetic, by contrast, is partially cognitive, reflecting a deep understanding of the ecological workings and context of a natural entity, as well as of its evolutionary history. As Callicott puts it, "Leopold's land aesthetic, like his land ethic, is self-consciously informed by evolutionary and ecological biology."[93]

Callicott provides many examples to show that Leopold was acutely aware that he was advocating a new kind of nature aesthetic.[94] For instance, in 1935 Leopold calls for the "conservation of landscape

beauty" while lamenting the US National Park Service emphasis on scenic beauty as a case of "esthetic ricketts."[95] In "Wilderness" in *A Sand County Almanac*, he decries "that under-aged brand of esthetics which limits the definition of 'scenery' to lakes and pine trees."[96] Perhaps Leopold's scorn for an artificially naturalistic aesthetic of nature, and incidentally the aesthetic value of introduced species, is best captured in a sardonic passage of "Round River": "Through processes of plant succession predictable by any botanist, the prairie garden becomes a refuge for quack grass. After the garden is gone, the highway department employs landscapers to dot the quack with elms, and with artistic clumps of Scotch pine, Japanese barberry, and Spiraea. Conservation Committees, en route to some important convention, whiz by and applaud this zeal for roadside beauty."[97] To Leopold in "Country" (*A Sand County Almanac*), even such superficially "tedious" landscapes as the Kansas plains acquire aesthetic value by virtue of knowledge of their biology and history.[98]

Leopold assigned great importance to evolution in the development of a valid land aesthetic, an importance superbly captured in "Marshland Elegy" of *A Sand County Almanac*, in which the tremendous sweep of time through which the marsh organisms and their complex interactions evolved is represented by the detailed evolutionary history and ecology of the sandhill crane.[99] This history bestows on the marsh "a paleontological patent of nobility, won in the march of eons."[100] As Callicott points out, neither the crane nor the marsh is inherently beautiful in the formal sense, but "evolutionary literacy can alter and deepen perception."[101]

Callicott also associates Leopold's "undisguised contempt" for cheatgrass and other European invaders with this deepened perception.[102] If he is correct, some of the rather mysterious preferences for natives and dislike of nonnatives noted previously may stem from aesthetic concerns. Several statements, beginning with the culminating sentence of "Mixing Trout," seem almost to reflect a visceral response to nonnative species that may reflect aesthetic distaste. Possibly the mysterious "attractiveness" of native as opposed to exotic game in Leopold's discussion of forestry and game management also at least partially reflects his aesthetic judgment.[103] Consider again the enigmatic last line of "Mixing Trout," which Chew calls "nativist."[104] To the average nonichthyologist, differing aesthetic qualities for cutthroat trout and various introduced trout in the Southwest would be far subtler than the aesthetic distinction between, say, a cheatgrass monoculture and native North American prairie, or between a pheasant and a bobwhite quail. Further, Leopold in 1915 and 1918 had not plumbed as deeply as in the 1930s and especially the 1940s into the aesthetic questions that led him to a mature land aesthetic. But it is not inconceivable that, in addition to possible utilitarian motives, a young observer as ecologically perceptive as Leopold could have sensed something

"aesthetically wrong" or "aesthetically improper" with a European or eastern North American trout in a southwestern stream. As Leopold said without explanation, referring to foreign ornamental plants, they "do not belong."[105] Probably the introduced elements were as "inharmonious" to Leopold as exotic trees were to botanist Charles Sprague Sargent as he argued with Frederick Law Olmsted about which plants to use in a restoration project, but Leopold did not feel, either in 1918 or in a popular one-pager for farmers in 1940, the need to elaborate on aesthetic disharmony.[106]

Conclusion

Leopold's view of nonnative species appears to have evolved from an early concern with human utility into an attention to the ecological impacts of nonnatives on native species, communities, and ecosystems. This latter attention was part and parcel of his developing notion of a land ethic based on ecosystem integrity as the key to maintaining entire functioning ecosystems. He believed that nonnative species might not maintain the patterns of energy flow through the biotic community that he saw as key to the persistence of the ecosystem and its functions. Further, he feared that through their elimination of native species, they might decrease the stability of the ecosystem that Leopold believed was generated by diversity. He sought reasons for why nonnative species would disrupt energy flow patterns and eliminate native species in the long, slow coevolutionary process that native species undergo in association with one another and with their physical environment, which the suddenly arrived nonnatives bypass. Beyond this ethical problem with nonnative species, and even before he had considered nonnatives in this light, Leopold had a low-level antipathy toward them, manifested in a number of pejorative metaphors. Antipathy toward nonnative species during the late nineteenth and early twentieth century has been shown to have occasionally reflected a nativism toward immigrant humans that was then quite pervasive in the United States.[107]

However, a more likely basis in Leopold's case (although one not necessarily mutually exclusive with nativism) is an aesthetic discord he felt that nonnative species struck. As Leopold developed his land aesthetic apace with his land ethic, aesthetic concerns had an increasing resonance for him. For Leopold, both aesthetic value and ethical value spring from a deep understanding of the complex interrelationships and the evolutionary history of ecosystem components. Many of his readers have concurred. Indeed, one of his most often quoted statements comes from "The Land Ethic": "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."[108] For Leopold, "integrity" meant maintenance of the parts of nature necessary for the health

and stability of the land, and human ignorance of many of the mechanisms maintaining stability dictated saving all the parts.[109] "Integrity" surely also meant maintaining all the original species in the community and not exchanging them for new ones. Although the essay is nominally about ethics, and integrity and stability are key to Leopold's land ethic, it is striking that "beauty" is a coequal term in this statement. This phrasing indicates the importance Leopold assigned to his land aesthetic and its tight interrelationship with his land ethic. For him, beauty could not be separated from ecological function.[110] Integrity in an aesthetic sense could no more be maintained by adding a nonnative species than could the integrity of the Mona Lisa be maintained by adding a moustache or a necklace, even a pretty necklace. Small wonder that Leopold's mature views of nonnative species should be dominated by both ethical and aesthetic concerns.

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Notes

To Julianne Lutz Warren I owe a great debt for continuing inspiration, insights, and encouragement. I thank Louise Robbins and two anonymous referees for thoughtful criticism of an earlier draft, Sara Kuebbing for discussion and assistance with references, and Bernard Schermetzler for access to and help in using the Aldo Leopold Archives at the University of Wisconsin.

1 George Perkins Marsh, *Man and Nature* (New York: Scribner, 1865), 53–112.

2 Daniel Simberloff, "The Rise of Modern Invasion Biology and American Attitudes towards Introduced Species," in *Invasive and Introduced Plants and Animals. Human Perceptions, Attitudes and Approaches to Management*, ed. I. D. Rotherham and R. A. Lambert (London: Earthscan, 2011), 121–35.

3 Daniel Simberloff, "Charles Elton— Neither Founder Nor Siren, But Prophet," in *Fifty Years of Invasion Ecology*, ed. David M. Richardson (New York: Wiley, 2011), 11–24.

4 Daniel Simberloff, "Confronting Introduced Species: A Form of Xenophobia?" *Biological Invasions* 5 (2003): 179–92.

5 Mark A. Davis, Matthew K. Chew, et al. [17 other authors], "Don't Judge Species on Their Origins," *Nature* 474, no. 7350 (2011): 153–54. Several rebuttals quickly followed, notably Daniel Simberloff et al. [and 140 other authors], "Non-Natives: 141 Scientists Object," *Nature* 475, no. 7354 (2011): 36.

6 Matthew K. Chew, "Ending with Elton: Preludes to Invasion Biology" (Ph.D. diss., Arizona State University, 2006, 93–174).

7 Aldo Leopold, *A Sand County Almanac, with Essays on Conservation from Round River* (New York: Ballantine Books, 1970), originally published as *A Sand County Almanac and Sketches Here and There* (New York: Oxford University

Press, 1949); Curt Meine, *Aldo Leopold. His Life and Work* (Madison: University of Wisconsin Press, 1988), 477–520.

8 Julianne Lutz Newton (now Julianne Lutz Warren), *Aldo Leopold's Odyssey* (Washington, DC: Island Press, 2006).

9 J. Baird Callicott, "Leopold's Land Aesthetic," *Journal of Soil and Water Conservation* 38 (1983): 329–32; J. Baird Callicott, "The Land Aesthetic," in *Ecological Prospects: Scientific, Religious, and Aesthetic Perspectives* , ed. C. Chapple (Albany: State University of New York Press, 1994), 169–83.

10 Aldo Leopold, "Mixing Trout in Western Waters," *Transactions of the American Fisheries Society* 47, no. 3 (1918): 101–2.

11 Anders Halverson explores trout introductions in *An Entirely Synthetic Fish: How Rainbow Trout Beguiled America and Overran the World* (New Haven: Yale University Press, 2010).

12 We now know that, among these introductions, only the congeneric rainbow trout and subspecies of cutthroat can hybridize with black-spotted trout (brook trout and brown trout, in different genera, cannot produce viable embryos with black-spotted trout). Subsequently, introduced rainbow trout have hybridized with various native species (e.g., Apache trout and gila trout) throughout the American West, and this hybridization and the fact that the hybrids, far from being sterile, are fertile and backcross is partly responsible for the presence on the US Endangered Species Act list of five trout species or subspecies.

13 Aldo Leopold, letter to A. H. Dinsmore, July 10, 1922. Aldo Leopold Archives, University of Wisconsin (http://digital.library.wisc.edu/1711.dl/AldoLeopold), 9/25/10-4: Species and subjects, Box 005, Folder 8, 753; Aldo Leopold, letter to J. W. Johnson, July 6, 1922. Aldo Leopold Archives, University of Wisconsin (http://digital.library.wisc.edu/1711.dl/AldoLeopold), 9/25/10-4: Species and subjects. Box 005, Folder 8, 748.

14 Leopold, "Mixing Trout," 102.

15 Aldo Leopold, *Game and Fish Handbook* (Albuquerque: USFS, USDA, D-3, September 5, 1915), *Organization and Environment* 23, no. 2 (2010): 233–37, 236. In 1915 Leopold avers, as the rationale for stocking fish, that "An empty water is an idle resource" (235). In retrospect, this injunction to stock fish controverts the land ethic that he subsequently developed, as later research has shown that fishless lakes are far from "empty" and that introducing fish to them massively affects populations, communities, and entire lake ecosystems, disrupting the patterns of energy flow that were integral to Leopold's conception of land health. See, for instance, R. A. Knapp, K. R. Matthews, and O. Sarnelle, "Resistance and Resilience of Alpine Lake Fauna to Fish Introductions," *Ecological Monographs* 71, no. 3 (2001): 401–21.

16 Julianne Lutz Warren, "Weaving a Wider Net for Conservation: Aldo Leopold's Water Ethic," *Organization and Environment* 23, no. 2 (2010): 220–32.

17 Aldo Leopold, "Forestry and Game Conservation," *Journal of Forestry* 16 (1918): 404–11, 410.

18 Leopold, "Forestry," 410.

19 There was precedent for such an aesthetic preference for native species in the landscape architecture and gardening literature of the late nineteenth and early twentieth centuries, expressed for example by the botanist Charles

Sprague Sargent in his argument with Frederick Law Olmsted over plantings along the Muddy River in Massachusetts: "It is not easy to explain why certain plants look distinctly in place in certain situations and why other plants look as distinctly out of place in the same situations.... We have become accustomed to see certain plants adapted by nature to fill certain positions in combination with certain other plants in a given region; and all attempts to force nature, so to speak, by bringing in alien elements from remote continents and climates, must inevitably produce inharmonious results." See Charles Sprague Sargent, "Editorial," *Garden and Forest* 1 (1888): 266.

20 Leopold, "Forestry," 410.

21 Aldo Leopold, "Wild Lifers vs. Game Farmers: a Plea for Democracy in Sport," *Bulletin of the American Game Protective Association* 8, no. 2 (1919): 6–7.

22 Aldo Leopold, "Grand-Opera Game," in *The River of the Mother of God and Other Essays by Aldo Leopold*, ed. Susan L. Flader and J. Baird Callicott (Madison: University of Wisconsin Press, 1991), 169–72; Aldo Leopold, "Chukaremia," *Outdoor America* 3 (1938): 3.

23 Aldo Leopold, "Memorandum for District Forester Kelly," November 22, 1925. Aldo Leopold Archives, University of Wisconsin (http://digital.library.wisc.edu/1711.dl/AldoLeopold), 9/25/10-3: County, state, and foreign files, Box 009, Folder 3, 362–67. See p. 3 of memorandum.

24 Aldo Leopold, "A Plea for Recognition of Artificial Works in Forest Erosion Control Policy," *Journal of Forestry* 19 (1921): 267–73; Aldo Leopold, "Pioneers and Gullies," *Sunset Magazine* 52, no. 5 (1924): 15–16, 91–95.

25 T. W. Robinson, *Introduction, Spread, and Areal Extent of Saltcedar (Tamarix) in the Western States*, Geological Survey Professional Paper 491-A (Washington, DC: US Government Printing Office, 1965), A5.

26 Robinson, *Saltcedar*, A5.

27 Matthew K. Chew, "The Monstering of Tamarisk: How Scientists Made a Plant into a Problem," *Journal of the History of Biology* 42, no. 2 (2009): 231–66.

28 For a history of perception, see Chew, "Monstering"; for the impact of salt cedar, see K. C. McDaniel, J. M. DiTomaso, and C. A. Duncan, "Tamarisk or Saltcedar, *Tamarix* spp.," in *Assessing the Economic, Environmental and Societal Losses from Invasive Plants on Rangeland and Wildlands*, ed. J. K. Clark and C. L. Duncan (Champaign: Weed Science Society of America, 2005), 198–222; T. A. Kennedy and S. E. Hobbie, "Saltcedar (*Tamarix ramosissima*) Invasion Alters Organic Matter Dynamics in a Desert Stream," *Freshwater Biology* 49, no. 1 (2004): 65–76.

29 S. Lowe, M. Browne, S. Boudjelas, and M. De Poorter, *100 of the World's Worst Invasive Alien Species: A Selection from the Global Invasive Species Database* (Auckland: The Invasive Species Specialist Group, World Conservation Union, 2000).

30 Charles S. Elton, *Animal Ecology* (New York: Macmillan, 1927); for references on invasion impacts, see Simberloff, "Neither Founder"; for date of reading, see Meine, *Aldo Leopold*, 283.

31 Meine, *Aldo Leopold*; Newton (Warren), *Odyssey*; Flader and Callicott, *River of the Mother of God*, 224.

32 For view of Elton as founder, see Anthony Ricciardi and Hugh J. MacIsaac, "The Book That Began Invasion Biology," *Nature* 452, no. 7183 (2008): 34; David M. Richardson and Petr Pyšek, "Fifty Years of Invasion Ecology— the Legacy of Charles Elton," *Diversity and Distributions* 14, no. 2 (2008): 161–68; for demurral, see Simberloff, "Neither Founder."

33 Charles S. Elton, *The Ecology of Invasions by Animals and Plants* (London: Methuen, 1958); for Elton as founder, see Ricciardi and MacIsaac, "Book That Began"; for Elton's early publications on invasions, see Simberloff, "Neither Founder."

34 Daniel Simberloff, "Charles Elton: Pioneer Conservation Biologist," *Environment and History* (forthcoming).

35 Anonymous, "Game System Deplored as 'Melting Pot,'" *Journal of Forestry* 30 (1932): 226–22.

36 See, for example, Leonard A. Brennan, "How Can We Reverse the Northern Bobwhite Population Decline?" *Wildlife Society Bulletin* 19, no. 4 (1991): 544–55.

37 T. T. McCabe, "More Game Birds in America, Inc.," *Condor* 33, no. 6 (1931): 259–61; Aldo Leopold, "Game and Wild Life Conservation," *Condor* 34, no. 2 (1932): 103–6.

38 Leopold, "Game and Wild Life," 103.

39 Aldo Leopold, "Why the Wilderness Society?" *The Living Wilderness* 1, no. 1 (1935): 6.

40 Leopold cannot be faulted for lack of detail on this point; it was not until the late twentieth century that ecologists and evolutionists substantially understood the evolutionary processes and even the nature of the interactions between organisms and the soil. This is an area of intensive current research, not least as it bears on the impact of nonnative species. See, for example, Ragan M. Callaway and Eric T. Aschehoug, "Invasive Plants versus Their New and Old Neighbors: A Mechanism for Exotic Invasion," *Science* 290, no. 5491 (2000): 521–23; Callaway, *Positive Interactions and Interdependence in Plant Communities* (Dordrecht, The Netherlands: Springer, 2006).

41 Aldo Leopold, "Means and Ends in Wild Life Management" (1936), in Flader and Callicott, *River of the Mother of God*, 237; Aldo Leopold, "Roadside Prairies" (1941), in *Aldo Leopold. For the Health of the Land. Previously Unpublished Essays and Other Writings*, ed. J. Baird Callicott and Eric T. Freyfogle (Washington, DC: Island Press, 1999), 137–39.

42 Elton, *Animal Ecology*, 50–63. On Clements and Tansley, see Meine, *Aldo Leopold*; Callicott, "The Land Aesthetic"; Newton (Warren), *Odyssey*.

43 Aldo Leopold, "A Biotic View of the Land," *Journal of Forestry* 37, no. 9 (1939): 727–30; Elton 1927, *Animal Ecology*, 68–70.

44 Leopold, "Biotic View," 729.

45 Leopold, *Sand County Almanac*, 251–58.

46 Aldo Leopold, "Biotic Land-Use," in Callicott and Freyfogle, *River of the Mother of God*, 206.

47 Aldo Leopold, "Biotic Land-Use," in Callicott and Freyfogle, *River of the Mother of God*, 206. The relationship between diversity and stability has been a

persistent, contentious theme in academic ecology (see Kevin S. McCann, "The Diversity-Stability Debate," *Nature* 405, no. 6783 [2000]: 228–33) and was the key take-home message from Elton's 1958 monograph on invasions, in which resistance to disruption by nonnative species is one proposed stability-enhancing benefit of high native species diversity. However, this idea did not become prominent in the ecology literature until after the 1958 monograph. The 1958 monograph is generally cited as an early inspiration for the subsequent interest in the idea (e.g., see Daniel Goodman, "The Theory of Diversity-Stability Relationships in Ecology," *Quarterly Review of Biology* 50, no. 3 [1975]: 237–66; William W. Murdoch, "Diversity, Complexity, Stability and Pest Control," *Journal of Applied Ecology* 12, no. 3 [1975]: 795–807). This notion was not present in Elton's 1927 book; nor does it appear in any of Elton's writings before 1958, despite Elton's frequent discussion (beginning in 1927) of the drastic fluctuation of population sizes in nature and the possible means by which these are controlled before species become locally extinct. Elton in 1958 adduces six reasons from the ecology literature (three involving observations on impacts of nonnative species) for hypothesizing that diversity begets stability. Strikingly, just before listing these reasons, Elton (142) quotes Leopold (*A Sand County Almanac*) on reasons to preserve the more than 20,000 noneconomically important species of Wisconsin: "Yet these creatures are members of the biotic community, and if (as I believe) its stability depends on its integrity, they are entitled to continuance" (from "The Land Ethic," 245–46). This theme persistently intrigued Leopold in the 1940s. In "Biotic Land Use" (203), his first major writing on the land health concept (see Newton [Warren], *Odyssey*), he wrote, "What, in the evolutionary history of this flowering earth, is most closely associated with stability? The answer, to my mind, is clear: diversity of flora and fauna .... Stability and diversity are associated. Both are the end result of evolution to date. To what extent are they interdependent? Can we retain stability in used land without retaining diversity also?" In "Conservation in whole and in part" (1944, in Flader and Callicott, *River of the Mother of God*, 312), Leopold turned to paleontology and the historical record: "The net trend of the original community was thus toward more diversity of native forms and more and more complex relations between them. Stability or health was associated with, perhaps caused by, this diversity and complexity." He reiterated this theme in "Round River" of *A Sand County Almanac* (192–93): "That all these should survive as an internally balanced community for so many centuries shows an astonishing stability in the original biota. Science cannot explain the mechanisms of stability ... stability and diversity were apparently interdependent." It is not inconceivable that Elton's inspiration for this idea and for seeking ecological data to test it was in fact Leopold. Simberloff (Elton, Pioneer Conservation Biologist) has suggested that, although abundant evidence shows that Elton greatly influenced Leopold's ecological thinking, Elton's views on conservation largely arose from his own observations and the findings of academic ecology, with scant evidence of a direct influence from Leopold. The diversity-stability hypothesis may be a counterexample.

48 Aldo Leopold, "Land-Use and Democracy," *Audubon Magazine* 44, no. 5 (1942): 259–65.

49 Aldo Leopold, "Conservation: in Whole or in Part?" in Flader and Callicott, *River of the Mother of God*, 310–19.

50 Leopold, "Conservation: in Whole or in Part," 314.

51 Aldo Leopold, "The Outlook for Farm Wildlife," in *Transactions of the Tenth North American Wildlife Conference*, ed. E. M. Quee (Washington, DC: American Wildlife Institute, 1945), 165–68.

52 Charles S. Elton, "The Biological Cost of Modern Transport," *Journal of Animal Ecology* 13, no. 1 (1944): 87–88.

53 Aldo Leopold, "The Land-Health Concept and Conservation," in Callicott and Freyfogle, *For the Health of the Land*, 218–26, 219, 221.

54 Leopold, *Sand County Almanac*, 200.

55 Ibid., 199–200.

56 For composition of "Land Ethic," see Meine, *Aldo Leopold*, 501–4.

57 Leopold, *Sand County Almanac*, 254.

58 Aldo Leopold, "Cheat Takes Over," *The Land* 1 (1941): 310–13.

59 Leopold, "Cheat," 310.

60 Chew, "Ending with Elton," 99.

61 Chew, "Ending with Elton," 121–22; Anonymous, Game System.

62 Curt Meine, "The *Secret* Leopold," in *Correction Lines: Essays on Land, Leopold, and Conservation*, ed. C. Meine (Washington, DC: Island Press, 2004), 161–83, 179.

63 Anonymous, "Game System," 227.

64 Leopold is surely referring to a monograph by John C. Phillips (*Wild Birds Introduced or Transplanted in North America*, Technical Bulletin 61 [Washington, DC: US Department of Agriculture,1928], 26–27) and a book by his friend, wildlife biologist Herbert L. Stoddard (*The Bobwhite Quail. Its Habits, Preservation and Increase* [New York: Charles Scribner's Sons, 1931], 479–89), both of which Leopold cites in *Game Management*. Phillips asserts without evidence that hybridization is changing the "hardy" bird to make it unsuitable for northern climes, by "dilution of the indigenous stock" (27), although he concedes that habitat change probably plays a role in the population declines. Stoddard, citing Phillips plus some of his own data, is much more tentative, suggesting the "possibility" of lowered cold resistance but admitting that, despite the "infusion of Mexican blood, . . . the stock as a whole has been changed very little" (485).

65 A contemporaneous example is a statement by the Danish-American midwestern landscape architect and native plant advocate, Jens Jensen: "The gardens that I created myself shall . . . be in harmony with their landscape environment and the racial characteristics of its inhabitants. They shall express the spirit of America and therefore have to be free of foreign character . . . the Latin and the Oriental crept and creeps more and more over our land, coming from the South, which is settled by Latin people, and also from other centers of mixed masses of immigrants. The Germanic character of our race, of our cities and settlements was overgrown by foreign [character]. Latin has spoiled a lot and still spoils things every day" (Jensen 1937, cited by Joachim Wolschke-Bulmahn, in Wolschke-Bulmahn, J. 1995. "Review of R. E. Grese, *'Jens Jensen: Maker of Natural Parks and* Gardens,'" *Journal of Garden History* 15 [1995]:54–55; Wolschke-Bulmahn, "Introduction," in *Nature and Ideology. Natural Garden Design in the Twentieth Century*, ed. J. Wolschke-Bulmahn [Washington, DC: Dumbarton Oaks, 1997], 1–9); cf. Peter A. Coates, *American Perceptions of*

Immigrant and Invasive Species: Strangers on the Land (Berkeley: University of California Press, 2007).

66 Chew, "Ending with Elton," 122.

67 Ibid., 132.

68 Anonymous, "Game System."

69 Brendon M. H. Larson, "The War of the Roses: Demilitarizing Invasion Biology," *Frontiers in Ecology and the Environment* 3, no. 9 (2005): 495–500; Larson, *Metaphors for Environmental Sustainability. Redefining Our Relationship with Nature* (New Haven: Yale University Press, 2011).

70 Simberloff, "Confronting Introduced Species"; Simberloff, "Invasional Meltdown Six Years Later—Important Phenomenon, Unfortunate Metaphor, or Both?" *Ecology Letters* 9, no. 8 (2006): 912–19.

71 Coates, *American Perceptions*.

72 Aldo Leopold, "Fifth Column of the Fencerow," *Wisconsin Agriculturist and Farmer* 68, no. 17 (1941): 11.

73 Aldo Leopold Archives, University of Wisconsin (http://digital.library.wisc.edu/1711.dl/AldoLeopold) Series 9/25/10-4: Species and subjects Box 005. Carp., 871–99.

74 Peter W. Sorensen and Przemyslaw Bajer, "Carp, Common," in *Encyclopedia of Biological Invasions*, ed. Daniel Simberloff and Marcel Rejmánek (Berkeley: University of California Press, 2011), 100–4.

75 Aldo Leopold, "Bluebirds Welcome," *Wisconsin Agriculturist and Farmer* 68, no. 8 (1941): 16.

76 Leopold, "Outlook," 167.

77 Leopold, "Biotic Land-use," 206.

78 Leopold, "Chukaremia."

79 Aldo Leopold, "The Hungarian Partridge Pioneers," *Bulletin of the Agricultural Experiment Station, University of Wisconsin* 446(1939): 21–22.

80 Aldo Leopold, *Game Management* (New York: Charles Scribner's Sons, 1933), 398.

81 Meine, *Aldo Leopold*, 115.

82 Meine, "The Secret Leopold."

83 See n. 20.

84 Leopold, *Game Management*, 403.

85 Leopold, "Grand-Opera Game," 169, 172.

86 Aldo Leopold, "Farm Arboretum Adds to Home Beauty," *Wisconsin Agriculturist and Farmer* 67, no. 10 (1940): 4.

87 Aldo Leopold, "What Is a Weed?" (1943) in Flader and Callicott, *River of the Mother of God*, 306–9.

88 Leopold, "Farm Arboretum," 4.

89 Aldo Leopold, "Farming in Color," *Wisconsin Agriculturist and Farmer* 69, no. 2 (1942): 4.

90 Aldo Leopold, "The Prairie: the Forgotten Flower" (handwritten manuscript, 1942). Aldo Leopold Archives, University of Wisconsin, (http://digital.library.wisc.edu/1711.dl/AldoLeopold), 9/25/10-6: Writings. Box 018, Folder 2, 128–31.

91 Callicott, "Leopold's Land Aesthetic"; Callicott, "The Land Aesthetic," 170; J. B. Callicott, "Leopold's Land Aesthetic," in *Nature, Aesthetics, and Environmentalism. From Beauty to Duty*, ed. Allen Carlson and Sheila Lintott (New York: Columbia University Press, 2008), 105–18.

92 Cf. Allen Carlson, "Aesthetic Appreciation of the Natural Environment," in Carlson and Lintott, *Nature, Aesthetics, and Environmentalism*, 119–32; Carlson, "Nature and Positive Aesthetics," in Carlson and Lintott, *Nature, Aesthetics, and Environmentalism*, 211–37.

93 Callicott, "The Land Aesthetic," 176.

94 Callicott, "Leopold's Land Aesthetic"; Callicott, "The Land Aesthetic."

95 Aldo Leopold, "Land Pathology," in Flader and Callicott, *River of the Mother of God*, 216.

96 Leopold, *Sand County Almanac*, 268.

97 Ibid., 193.

98 Callicott, "Leopold's Land Aesthetic" (2008); Yuriko Saito, "The Aesthetics of Unscenic Nature," in Carlson and Lintott, *Nature, Aesthetics, and Environmentalism*, 238–53.

99 Callicott, "Leopold's Land Aesthetic" (1983); Callicott, "The Land Aesthetic"; Callicott, "Leopold's Land Aesthetic" (2008).

100 Leopold, *Sand County Almanac*, 103.

101 Callicott, "The Land Aesthetic," 175.

102 Callicott, "The Land Aesthetic," 175.

103 See n. 20.

104 See n. 14 and 60.

105 Leopold, "Farm Arboretum," 4.

106 See n. 19.

107 Coates, *American Perceptions*.

108 Leopold, *Sand County Almanac*, 262.

109 Newton (Warren), *Odyssey*.

110 Ibid.