Exotic Species, Naturalisation, and Biological Nativism

NED HETTINGER

Philosophy Department,
College of Charleston
Charleston, SC 29424, USA
Email: hettingern@cofc.edu

ABSTRACT

Contrary to frequent characterisations, exotic species should not be identified as damaging species, species introduced by humans, or species originating from some other geographical location. Exotics are best characterised ecologically as species that are foreign to an ecological assemblage in the sense that they have not significantly adapted with the biota constituting that assemblage or to the local abiotic conditions. Exotic species become natives when they have ecologically naturalised and when human influence over their presence in an assemblage (if any) has washed away. Although the damaging nature and anthropogenic origin of many exotic species provide good reasons for a negative evaluation of such exotics, even naturally-dispersing, nondamaging exotics warrant opposition. Biological nativists' antagonism toward exotics need not be xenophobic and can be justified as a way of preserving the diversity of ecological assemblages from the homogenising forces of globalisation. Implications for Yellowstone National Park policy are explored.

KEYWORDS

Exotics, native, nativism, naturalisation, Yellowstone National Park

> 'Invasive alien species … homogenise the diversity of creation. … Weeds – slowly, silently, almost invisibly, but steadily – spread all around us until, literally encircled, we can no longer turn our backs. The invasion is now our problem, our battle, our enemy. … [We must] act now and act as one [in order to] beat this silent enemy.'
>
> Former U.S. Interior Secretary Bruce Babbitt (1998)

Environmental Values **10** (2001): 193–224

> 'I just hate them. They are genetically deviant miscreants that have no rightful place on this planet. We all have to be a part of this war on weeds.'
>
> Former Montana Governor Marc Racicot (Associated Press 1999)

> 'It's hard to imagine a New England roadside without its tawny day lilies and Queen Anne's lace, yet both these species are aliens marked for elimination. … Could it be these plants have actually improved the New England landscape, adding to its diversity and beauty? Shouldn't there be a statute of limitations on their alien status?'
>
> *Harper's* editor Michael Pollan (1994)

The presence of exotic species has become one of the major ecological evils that environmentalists are called upon to resist. Environmentally-sensitive people are waging war on flora and fauna judged to be exotic. Nature lovers poison hillsides covered with leafy spurge (*Euphorbia esula*) and shoot mountain goats (*Oreamnos americanus*) from cliffs. What are we to make of such policies and the attitudes that underlie them?

It is well-known that the spread of exotic species has caused – and continues to cause – significant environmental degradation, including extinction of native species and massive human influence on natural systems. What is less clear, however, is how we are to conceptualise exotic species. Consider, for example, the U.S. National Park Service's exotics policy. It requires treating mountain goats migrating south out of the Absoroka Mountains into Yellowstone National Park as exotics to be removed because they are descendants of human-introduced populations. The policy also requires that if mountain goats move into the Park from the west, they be treated as welcome natives because these goats come from a population not established by humans (Wagner 1995: 10). Or consider the wild pigs (*Sus scrofa*) in the Hawaiian rainforest, whose ancestors were brought to Hawaii by Polynesians perhaps 1500 years ago.[1] Are they still an exotic species or have they 'naturalised' despite constituting an ongoing threat to the native biota in this extinction capital of the world? One commentator put his finger on the problem of understanding exotic species when he said, 'The terms "exotic" and "native" … are … about as ambiguous as any in our conservation lexicon (except perhaps "natural")' (Noss 1990: 242).

Nor is it clear what justifies a negative evaluation of exotic species. In human affairs, nativist policies favouring native inhabitants over immigrants are morally troubling. Are biological nativists who eschew planting alien species and who eradicate those they encounter unwittingly supporting a xenophobic prejudice that is very much in evidence in many countries' treatment of immigrants? Is the assumption that exotics are bad and damaging an unfair stereotype that ignores the variety of exotic species? Are there good reasons for opposing exotics that are human-introduced or is such opposition mere misanthropy?

This essay sifts through the mix of biological theorising and philosophical evaluation that constitutes this controversy over understanding, evaluating, and responding to exotic species. I propose a precising definition of exotics as any species significantly foreign to an ecological assemblage, whether or not the species causes damage, is human introduced, or arrives from some other geographical location. My hope is to keep separate the distinct strands typically woven into this concept while still capturing most of our fundamental intuitions about exotics. In section I, I critically examine several proposals for distinguishing between native and exotic species and advance an ecological account whereby a species is exotic to the extent that it has not significantly adapted with the local ecological assemblage. In section II, I identify problems with defining exotics as human-introduced species. Section III outlines the argument for why the human introduction of species creates disvalue and traces some consequences of this evaluation for the U.S. Park Service's exotics policy. Section IV critically evaluates the notion that exotics must be or invariably are damaging. In section V, I explore how exotic species become native via the processes of ecological naturalisation and the washing away of human influence on their presence in ecosystems. Finally, in section VI, I argue that the foreignness of exotic species gives us a reason to disvalue them and that such a biological nativism, like certain cultural purisms, is praiseworthy and not xenophobic.

I. WHAT IS AN EXOTIC SPECIES?

Talk of exotics brings to mind species like kudzu (*Pueraria lobata*), a vine introduced to the United States from Japan and China as a porch plant in 1876. Kudzu was promoted as livestock forage and in the 1930s, the U.S. Department of Agriculture paid farmers to plant it for erosion control. Kudzu can grow almost a foot a day and it now chokes out trees in the southeastern U.S., blanketing about 7 million acres (Stewart 2000).[2] Kudzu is paradigmatic of the popular conception of exotics: it was introduced by humans, causes damage, and originates from a distant geographical location. Such exotics exemplify a major premise of the environmental worldview: ignorant human alteration of nature that destroys nature's balance.

Although the exotic species of concern to environmentalists typically are human introduced, damaging, and geographically remote, we should not conceptualise exotics in these ways. The fundamental idea underlying the concept of an exotic species is a species that is alien or foreign. Such a species is foreign in the sense that it has not significantly adapted with the local species and to local abiotic environment. I develop this notion by comparing it with alternative accounts of the exotic/native distinction.

Geographical considerations are typically taken as what distinguishes natives from exotics. Exotic species are seen as species that are away from home;

they hail from some other place and are presumptively out of place. In contrast, natives are those who come from the region which is their home. Consider an analogy with human nativity: a native South Carolinian is seen as one who was born and raised in South Carolina. If we translate this idea to species, we get the notion that a native species is one that originated as a species in this particular place; this region is where the species comes from. On this account, exotics are species that originally evolved in some other place. Woods and Moriarty (2001) call this the 'evolutionary criterion'.

Specifying the natives of a region as those that originally evolved there is both too stringent a requirement and perhaps overly broad. Too stringent because, by this criterion, humans would be native only to Africa. But all species move around. Species evolve in one locale, then migrate or expand their range to other places, and thrive for thousands of years perfectly at home in these new regions. Few species in a region would be natives if we accepted this evolutionary origin criterion of native species.[3] To see why this criterion may be overly broad, consider that when a species first evolves, it may be quite alien to the species that are long-time inhabitants of a region. This would be especially likely if its evolution was so rapid that other inhabitants did not have time to adapt. John Rodman (1993: 149) suggests that introduced species of tamarisk (*Tamarix)* in southwestern United States may have evolved into new species. Perhaps these species are sufficiently foreign to the local ecological assemblage that they ought to be considered exotic. If so, we have a species that is exotic in its place of origin (and not native anywhere).

Species are often said to be native to a river, a region, or a continent. Such a geographical use of 'native' can be quite misleading. Imagine someone selling 'native South Carolina trees' along the South Carolina coast. That Carolina hemlock (*Tsuga caroliniana*) is 'native to South Carolina' hides the crucial fact that it has adapted with ecological assemblages found in the Blue Ridge escarpment and not with those found on the coastal plain. A species from the mountains of South Carolina might be more exotic to the sandy soil of the South Carolina coast than a species from the Mexican desert. Although exotics are often characterised as species that cross political or geographical boundaries, I argue that we should think of exotics instead as species that are found in foreign ecological zones.

John Rodman and Holmes Rolston have offered ecological accounts of the native/exotic distinction which should be distinguished from the account I am proposing. Rodman suggests that a native species is one that is a well-integrated member of a self-regulating and balanced community. He says, 'The essence of exoticality is existence outside a community, lack of membership in a community of mutual dependence and mutual controls' (1993: 150). For Rodman, to become native, an immigrant species must join a community, depend on it, and be part of its system of mutual controls.

In a similar vein, Holmes Rolston argues that mustangs (*Equus caballus*) in the American West are not native species in part because they are not 'good adapted fits' there, despite being present for several centuries after escaping from European-introduced domestic populations. Although the U.S. Congress has deemed that they belong on the western range, Rolston points out that 'nature, not Congress, decides what is an integral part of the natural system'. Even though horses were present in North America thousands of years earlier, those horses went extinct naturally, 'presumably no longer fit for an altering landscape'. Rolston argues that 'the western ranges in this hemisphere developed without them', and although the introduced mustangs have survived, they are not 'good adapted fits on today's landscape, where there have been dramatic changes in climate, predation pressure, disease and parasite vectors and so on' (1994: 115). That the mustangs are not good adapted fits is further evidenced by the fact that they overpopulate and contribute to the degradation of their range.

The idea that native species – unlike exotics – have adapted to the local environment is helpful. But both Rodman and Rolston have more in mind than this. For them, a native is not simply one that has adapted with other natives but is one that has adapted *well*. For Rolston, the immigrant must not only 'fit' the ecosystem, that is, be an 'integral part of the natural system', but also be 'a good adapted fit'.

I do not think we should require that natives fit an ecosystem, much less be good fits. There might be 'native misfits' as well as 'exotic fits.' A native South Carolinian, for example, might be a deranged criminal and a drain on the state's social system, while an exotic Yankee from 'up north' may be an model citizen of South Carolina. Consider that the Asian long-horned beetle (*Anoplophora glabripennis*) recently discovered devouring trees in Chicago is also an important threat to trees in its native range (Corn et al. 1999). Barnacles are an example of species that proliferate wildly in their native ranges. The U.S. National Park Service even has management policies to deal with 'native pests' (National Park Service 1988). Unless one accepts an idyllic conception of perfectly-harmonious natural systems, one must admit that native species can wreak havoc in their native ranges.[4]

Similarly, we should not assume that natives are well-integrated into 'balanced' and 'self-regulating communities', as Rodman would have it. Presupposing a tightly integrated and balanced, community conception of natural systems is highly controversial given the recent emphasis in ecology on disequilibrium, instability, disturbance, and heterogeneous patchy landscapes (Hettinger and Throop 1999). Although there may well be many tightly integrated and balanced ecological communities (when described from certain scales and perspectives), numerous natural aggregations of species are not appropriately characterised in this fashion. Rodman's characterisation of natives would rule out the existence of species native to such 'unbalanced' assemblages.

Nevertheless, Rodman's and Rolston's characterisations of native species point us in the right direction. Native species will have significantly adapted with resident species and the local abiotic environment, not in the sense that they necessarily have become good fits or are controlled by others, but in the sense that native species will have 'forged ecological links' (Vermeij 1996: 4) with some other natives. Natives will have 'responded to each other ecologically' and frequently evolutionarily (Vermeij 1996: 5). Natives are established species (i.e., more or less permanent residents) tied to some other residents via predation, parasitism, mutualism, commensalism, and so on. Often native species will have affected the abundance of other native individuals, perhaps altering the frequencies of alleles in the gene pool of native populations and thus exerting selective pressure on other natives. A native species will also likely have adapted to the abiotic features of the local environment.

Let me stress again that by 'adapted' I do not mean 'positively fit in'. A species has adapted when it has changed its behaviour, capacities, or gene frequencies in response to other species or local abiota. Aggressively competing is as much adapting as is establishing symbiotic relationships. By adapted, I also do not mean fit or well-suited to survive in an environment. Species that have historically adapted in my sense may go extinct and species that have never actually adapted to a local assemblage may nonetheless be suited to survive there.

In contrast with native species, an exotic species is one that is foreign to an ecosystem in the sense that it has not significantly adapted to the resident species and/or abiotic elements that characterise this system and, perhaps more importantly, the system's resident species have not significantly adapted to it.[5] On the account defended here, species that are introduced to new geographical locations by humans, or that migrate or expand their ranges without such assistance, may or may not be exotics in these new regions. Species are exotic in new locations only when the species movement is ecological and not merely geographical. That is, if a species moves into a type of ecological assemblage that is already present in its home range(s), then the immigrant species is not exotic (foreign) in this new locale: It will already have adapted with the species and types of abiotic features there. If, on the other hand, the species movement results in its presence in a type of ecological assemblage[6] with which it has not previously adapted, then the species is an exotic in this new location.[7]

For example, when cattle egrets (*Bubulcus ibis*) made their way from Africa to South America, they became exotics because the ecological assemblages they encountered were significantly distinct from those from which they came. When the first finches appeared on the Galapagos Islands, they were exotics because they had not adapted with the local species and to the local environment (Woods and Moriarty 2001). A seed stuck to a log travelling from Japan to Hawaii will likely produce a plant that is exotic in this new location, because that species of plant is unlikely to have adapted with the residents of the habitat it now inhabits.

In contrast, when bison (*Bison bison*) expand their range north or west out of Yellowstone National Park into the surrounding grasslands, they are not exotics because they enter a habitat with species with which they have adapted. Similarly, a person who moves from Mississippi to South Carolina is still in her 'native southern range', whereas a person moving from New Jersey to South Carolina is out of her native range, even though the distance travelled is roughly the same. What counts is ecological difference, not geographical distance.

Whether a species is exotic to an assemblage is a matter of degree. The greater the differences between the species, the abiota, and their interrelationships in the old and new habitats, the more exotic an immigrant will be. After passing a certain threshold of difference, we can be quite comfortable with judgements about a species being exotic. For example, Japanese snow monkeys (*Macaca fuscata*) in the thermal areas of Yellowstone National Park would clearly be exotic because little if anything in the Park has ever adapted with any species of monkey. But there will be borderline cases where neither the designation exotic nor nonexotic is clearly appropriate.[8] For example, the mountain goats that are moving into Yellowstone Park from the north would be neither clearly exotic nor nonexotic to the Yellowstone assemblages they join, if the flora, fauna, and abiota in their native habitat is somewhat but not all that similar to those they encounter in Yellowstone.

By requiring that a native species has actually adapted to (some of) the other natives in an ecological assemblage, we allow for the possibility of 'exotic fits'; that is, aliens that arrive in new ecosystems but are well-suited to them. Westman (1990: 254) calls this phenomenon 'preadaptation' and says it is possible because different species can play functionally similar roles. For example, even if Asian snow leopards (*Panthera uncia*) could play the same ecological roles that the restored grey wolves (*Canis lupus*) play in the Yellowstone assemblage, this would not make them native. For elk (*Cervus elaphus*), moose (*Alces alces*), and coyote (*Canis latrans*) (among others) and snow leopards have never actually adapted to each other, and thus the leopards are exotic even if they are well-fit for a top predator niche in the ecosystem.[9] Similarly, even if an Asian immigrant to the U.S. fitted easily into American culture, she would still not be native. In contrast, individuals who grew up overseas in American communities would be relatively native on their arrival into the U.S.

II. EXOTICS AND HUMAN-INTRODUCED SPECIES

Although exotics are often defined as human-introduced species, the examples of cattle egrets moving to South America and the Galapagos' first finches show that exotic species need not be introduced by humans. Nor need human-introduced species be exotics.[10] Species that humans place into an assemblage as part of a restoration project are often not exotics. For example, the restoration of

grey wolves to Yellowstone Park is not exotic introduction, even though humans captured wolves from Canada and released them in regions (Wyoming and Montana) hundreds of miles south of their home. Despite the fact that the individual organisms involved were not previously in the recipient assemblages and despite the fact that they were put there by humans, on the account given here, the released wolves are not an exotic species.

It might be argued that the native prey in Yellowstone find the introduced wolves 'foreign' because they as individuals have never encountered such a creature.[11] Yellowstone elk and moose, accustomed to running from coyotes, now find themselves trying to outmanoeuvre a much larger and more powerful canine. But elk and moose as species have adapted with wolves, and so although the individual elk and moose in Yellowstone would not have had experience avoiding wolves, they are members of species that have adapted to the immigrant wolf species. Grey wolves have adapted with the species in this ecological assemblage and thus the restored wolf species is not exotic to Yellowstone.

One might think *of course* human restoration of species does not count as exotic introduction, because restoration implies returning a species to a place it previously resided and that ensures the species is native, not exotic. But not all human-caused return of species should count as native restoration. When humans return a species to a location where the ecological assemblage is significantly different from that present when the species was last there, human 'restoration' should count as exotic introduction, not native restoration.[12] Consider Michael Soulé's (tongue-in-cheek?) suggestion that we think of the 'reintroduction' to North America from Africa of camels and elephants as 'restoration' of 'native taxa'(1990: 235). Camels and elephants roaming North American seems a paradigm case of the presence of exotics, even though their genera once inhabited this landscape. Soulé argues that although they went extinct over ten thousand years ago, this was 'only moments ago in evolutionary time' and 'most of their plant prey survived'. If it were true that the plant prey of these animals are still adapted to them, that would count against seeing these species as exotics. But presumably much else in the present day ecological assemblages in North America would not have adapted to these creatures and thus their 'restoration' should be considered the introduction of significantly exotic species. Similarly, returning dinosaurs to the North American continent (by way of frozen and cloned DNA) would be exotic introduction and not native restoration, because these species would not have adapted with the species present on the continent today.

Those who equate exotics with human-introduced species will have a hard time explaining why human return of species need not count as exotic introduction and accounting for cases (like the above) where it is. For example, the U.S. National Park Service's management guidelines define exotic species as 'a species occurring in a given place as a result of direct or indirect, deliberate or accidental action by humans'. A native species is defined as 'a species that occurs

and evolves naturally without human intervention or manipulation'. The guidelines go on to say that, 'Species that move into an area without the direct or indirect aid of humans are considered native. … Those that invade with human intervention are considered to be exotic' (National Park Service undated: 284). Unfortunately, by these definitions, the restored Yellowstone wolves are exotic species.[13]

Another Park Service document qualifies the definition of exotics to avoid this problem. Exotics, it says, are 'species occurring in a given place as a result of direct or indirect, deliberate or accidental action by humans (not including deliberate reintroductions)'. But what rationale is there for excluding human reintroductions from the category of exotics, if one is defining exotics as human-introduced species?[14] The document goes on to provide a reason that could justify such an exclusion: 'For example, the construction of a fish ladder at a waterfall might enable one or more species to cross that natural barrier to dispersal. … The exotic species introduced because of such human action would not have evolved with the species native to the place in question and, therefore, would not be a natural component of the ecological system characteristic of that place' (National Park Service, 1988: 4:11). But if the reason that human reintroduction of species are not exotic introductions is that such species have adapted with the local natives, then the human-introduced definition of exotics has been abandoned in favour of the criterion of exotics defended here, namely, species that have not significantly adapted with the local ecological assemblage.[15]

Even human introduction of species to locations they have never previously existed need not count as exotic introduction. As long as the resident species have adapted with the introduced species, the immigrant will not be exotic. Consider a case in which an ecological assemblage moves en masse to a new location, except for one species who is left behind (perhaps a forest edge assemblage is receding and one tree species cannot move fast enough). If humans were to place this straggler species into this assemblage, the species would be significantly adapted with the other species there and hence not exotic on the account defended here. Or consider introducing a fish species into a high mountain lake previously devoid of that species of fish because a waterfall blocks its dispersal pathway. This need not count as exotic introduction, if the life forms in the lake had adapted with that species of fish and if that species had adapted to abiotic conditions like those in the lake.

A controversial endangered-species project involves just such an introduction. There is a proposal to poison all the fish species in Cherry Lake/Upper Cherry Creek, Montana and then introduce the endangered westslope cutthroat trout (*Oncorhynchus clarki lewisi*). All of the major fish species in this aquatic system were introduced by humans in the early 1900s, including Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*) which are native to and endangered in Yellowstone Park waters, fifty miles away. The project is touted as

native rather than exotic introduction on the grounds that westslope cutthroats, unlike those slated for poisoning, are 'native to the upper Missouri drainage' (of which Cherry Lake/Creek is a part), even though they have never been in Cherry Lake/Upper Cherry Creek.

On the account of exotics given here, that westslope cutthroats are 'native to' (i.e., found in) that drainage is only relevant if it signals a similarity between the ecological assemblages in different parts of the drainage. The mere geographical fact that this species exists in other parts of the drainage is not relevant. If the insect prey base (and other species) in Cherry Lake/Upper Cherry Creek have significantly adapted with westslope cutthroats, then humans placing that fish there is not exotic introduction. Otherwise westslope cutthroats would be exotics there, despite being present in other areas of the drainage.

III. DISVALUING HUMAN-INTRODUCED EXOTICS AND U.S. PARK SERVICE POLICY

Although exotics need not be human introduced, recently many – likely most – are introduced by humans, including those that are the most exotic in their new habitats. Modern humans regularly transport exotics distances, speeds, and between ecological assemblages that do not frequently occur (or are impossible) with naturally-dispersing exotics.[16] When an exotic species is introduced by humans, whether directly or indirectly, intentionally or nonintentionally, this provides one reason for the negative appraisal commonly levelled at such species. This negative evaluation is justified independently of whether the human-introduced exotic causes damage. Negatively evaluating human-assisted immigrant species – and not those arriving on their own – is a controversial value judgement. It is supported by a number of reasons, briefly outlined below.[17]

Massive human alteration of the earth is ongoing (Vitousek 1997). Perhaps half of the planet's surface is significantly disturbed by humans, and half of that is human dominated (Hannah et al. 1993). Humans are increasingly influencing, altering, and controlling the planet's natural systems. The result is a radical diminution in the sphere of wild nature on earth. An important reason to value natural areas and entities is because they are relatively free of human influence. Such a valuation is essential if nature as independent other is to continue to flourish on this planet. Respect for nature as independent other is a key environmental value, in part because proper human flourishing requires that humans be part of a world not of their own making. It would be tragic were humans to live in a totally human-made world.[18] A positive evaluation of natural areas and entities to the extent that they are wild is a rational and justified response to the increasing human dominance of the earth's natural systems and the resulting rarity of earthen nature significantly uninfluenced by humans.[19]

The presence of human-introduced species diminishes the wildness of natural systems and thus provides a reason for disvaluing exotic species when they are human introduced. For example, Yellowstone Lake has been humanised by the introduction of lake trout (*Salvelinus namaycush*) and the Park is less wild as a result. Even though lake trout have been present in much smaller Park lakes for about a century (Schullery and Varley, 1999), their recent introduction into Yellowstone Lake threatens to significantly increase human influence over Park processes. Lake trout prey on the much smaller Yellowstone cutthroat trout, which in turn are an important food source for other Yellowstone species, including grizzly bears (*Ursus arctos*) and bald eagles (*Haliaeetus leucocephalus*). Rather than feeling in touch with wild natural processes, a knowledgeable angler who catches a lake trout while fishing for cutthroat trout in Yellowstone Lake will be reminded of humans and their ill-advised acts. Removing these lake trout will make Yellowstone a wilder, less human-influenced place, as did closing the garbage dumps to grizzly bears.

Some charge that there is misanthropy behind such a distinction in value between human introduced and naturally-dispersed exotics (Scherer 1994: 185). But valuing humans, even loving humanity, is quite compatible with not wanting humans or their works everywhere, especially in National Parks and wilderness areas.

One of the mandates of U.S. National Parks like Yellowstone is to let nature take its course. Yellowstone's let burn policy, honoured in the breach, is one manifestation of that policy, as was the Park's refusal to let wildlife veterinarians treat bighorn sheep who were falling from cliffs because of partial blindness caused by a native disease (Rolston 1994: 112). As a natural area where human influences should be minimised, the negative evaluation of human-introduced exotics is especially compelling and Yellowstone has a strong reason to remove human-introduced exotics. For closely related reasons, the Park has a strong rationale for welcoming naturally-dispersing aliens. The presence of such exotics is a manifestation of wild nature, a world that made us rather than one we have made. Removing naturally-dispersing exotics would (typically) increase human control and manipulation over natural systems.

The suggestion that the Park let nature take its course and welcome naturally-arriving exotics might be opposed by those who believe National Parks should preserve and restore native species and ecosystems. Insofar as exotic species, including naturally-dispersing exotics, displace native species and replace native ecosystems with new assemblages, they constitute a threat to native species and ecosystems. If the Park's goal is to 'preserve vignettes of primitive America' – to use the often quoted language of the Starker Leopold report (1963) – then the Park should oppose all exotics, whether human or naturally introduced, for such exotics will likely alter the character of these primitive vignettes.

But National Parks like Yellowstone should not be in the business of trying to prevent nature from changing on its own. Respect for wild nature should lead

such parks to minimise human-induced change and typically to let nonanthropogenic changes take place. Natural parks should attempt to preserve natural processes, not some particular status quo in nature. Thus Yellowstone has a strong reason to welcome naturally-dispersing exotics. This rationale fits with the National Parks management guidelines that count naturally-arriving exotics as 'natives' and thus presumably sanctions their arrival (National Park Service, Undated).

There are limits to this welcome, however. If naturally-dispersing exotics cause sufficient damage, they may warrant control. The policy of letting nature take its course is not absolute. Respect for wild natural processes can be outweighed by concern for certain outcomes in nature. For example, the protozoan parasite (*Myxobolus cerebralis*) that causes whirling disease (an affliction that cripples some fish species) is a recent European immigrant to Yellowstone's ecosystems. If this species somehow travelled from Europe into Yellowstone without the aid of humans, the Park would be hard pressed to justify welcoming such a naturally-dispersing exotic. If the parasite threatened to destroy the entire Yellowstone cutthroat population, the Park would have strong reasons not to let nature take its course.[20]

IV. EXOTICS AND DAMAGING SPECIES

Some define exotic species as those that damage the new regions they occupy (Scherer 1994: 185). Indeed, exotics have caused massive amounts of damage, both ecologically and economically. For example, in the late 19th century, a fungus (*Cryphonectria parasitica*) imported on nursery stock from Asia caused the chestnut blight, decimating a tree species that comprised 25 percent of eastern U.S. forests and removing an important faunal food source in the process (Pimentel et al. 1999, citing Campbell). More recently, Zebra mussels (*Dreissena polymorpha*) were found in the U.S. Great Lakes, having arrived from Europe in ship ballast water in the late 1980s. This species has already spread to most of the aquatic ecosystems in the eastern U.S. and is causing an estimated $5 billion in yearly damage by invading and clogging water intake pipes, water filtration, and electric generating plants (Pimentel et al. 1999, citing Khalanski). Exotic diseases such as A.I.D.S. and influenza cause untold human suffering and death and the threat they pose is increasing with rapid transportation and human incursion into new ecosystems.

Pimentel et al. (1999) estimate that there are about 50,000 species of non-U.S. origin in the country, a fifteenth of the estimated total of 750,000 species. (This figure does not include exotic species whose origin is from other regions of the U.S.) Between one quarter and one fifth of the plants found in the country's natural ecosystems are of non-U.S. origin, as are one in ten birds (Pimentel et al. 1999). According to Pimentel et al., the yearly quantifiable damage these species

cause is at least $138 billion. Culprits include human, animal, and plant diseases ($41 billion), weeds ($34 billion), European and Asiatic rats ($19 billion), insects that destroy crops and forests ($17 billion), cats ($14 billion), and zebra mussels ($5 billion). Pigeons (*Columba livia*), fire ants (*Solenopsis invicta*), starlings (*Sturnus vulgaris*), and feral pigs cost about $1 billion each (Pimentel et al. 1999).

Exotics have caused the extinction of native species. For example, the brown tree snake (*Boiga irregularis*) accidentally introduced on Guam extirpated more than 75 percent of both native species of lizards and forest birds (Pimentel et al. 1999). Exotic species are frequently mentioned as the second most serious cause of species extinction, just behind human-caused habitat destruction. Approximately 40 percent of threatened or endangered species on the U.S. Endangered Species lists are at risk primarily because of exotic species (Pimentel et al. 1999).

Despite the massive ongoing harm such species cause, we should not identify exotics with damaging species. We have already noted that some native species also cause damage.[21] Furthermore, not all immigrants to new ecosystems are harmful. Most get extirpated before they become established. In defence of planting exotics, Michael Pollan argues that 'the great majority of introduced species can't even survive beyond the garden wall, much less thrive' (1994: 55). Moreover, even if an immigrant species establishes itself as a permanent addition to a new habitat, there should be no assumption that the immigrant is weedy or a pest, that it is 'aggressive', or that its arrival constitutes an 'invasion' (i.e., taking over and causing damage). Although some ecological assemblages are highly susceptible to invasion (e.g., recently disturbed ecosystems), many resist invasion quite successfully. According to the 'tens rule', 10 percent of exotics that are introduced into an area succeed in establishing breeding populations and 10 percent of those will become highly invasive (Bright 1998: 25).[22] Even if only 1 percent of exotics typically cause serious problems, this is of little comfort, for as Bright argues, 'since the global economy is continually showering exotics over the Earth's surface, there is little consolation in the fact that 90 percent of these impacts are 'duds' and only 1 percent of them really detonate. The bombardment is continual, and so are the detonations' (1998: 24).

John Rodman argues that because what exotics do when they arrive 'is replace natives, we may suppose that presence of an exotic is bad per se, and invasive behaviour compounds the original sin' (1993: 141). But the assumption that exotics will displace native species is not obviously true. One invasion biologist posing research questions for the field asks whether 'invaders tend to usurp ecological roles of natives or use resources and new ways of life not previously exploited in the recipient community' (Vermeij 1996: 7). Another claims that plant invaders range from 'species with modest resource usurpation spread across many competitors, resulting in no extirpations, to species whose competitive pressure is focused on one or a few resident species' (Westman 1990: 253).

Exotics can even be beneficial in the new habitats they occupy. Vermeij speaks of the 'potentially crucial role invasions and invaders have played in stimulating evolution' and says that 'in the absence of invasions, communities and species and interactions comprising them may stagnate, especially if the economic base of energy and nutrients remains fixed' (1996: 7). Exotics sometimes provide habitat for native species. A species of *Eucalyptus* tree introduced into California from Australia over 120 years ago benefits Monarch butterflies (*Danaus plexippus*) who rely on them during annual migrations (Woods and Moriarty 2001). Eucalyptus also benefits native birds and salamanders (Westman 1990: 255). There are also examples of exotics benefiting endangered species: grizzly bears consume substantial amounts of nonnative clover in Yellowstone Park (Reinhart, et al. 1999) and, in some locations in the U.S., nutria (*Myocastor coypus*) (a South American relative of the beaver) are a principal food source for the endangered red wolf (*Canis niger*).[23]

Consider species like the wild carrot (Queen Anne's lace) (*Daucus carota*) or day lilies (*Hemerocallis*), both European immigrants to the U.S. Michael Pollan's suggestion that these plants have improved the New England landscape – adding to its diversity and beauty – is not implausible. The common apple tree (*Malus sylvestris*) is an import to the U.S. from Europe and West Asia. It is hard to imagine that these apple trees have not benefited the North American landscape.

It is has even been suggested that exotic species introduced into the U.S. have proven beneficial on balance (Corn et al. 1999: 15). Ninety-eight percent of the food crops and animals produced in the U.S. were foreign to North America, including corn, wheat, rice, soybeans, cattle, poultry, and honey bees (Pimentel et al. 1999). The U.S. economic benefits they convey – $800 billion annually, according to Pimentel et al. (1999) – exceeds the estimates of U.S. economic damages caused by exotic species. Treating such economic calculations as a fair assessment of net value or disvalue of exotic species is highly problematic.[24] Nevertheless, it is important to recognise that despite the many disasters caused by introduced exotics, humans have had success introducing, controlling, and benefiting from some exotic species.

The common assumption that exotics must be – or invariably are – harmful results from either unfair stereotyping or accepting an idyllic, balance-of-nature paradigm of natural systems. Pollan makes the case against such stereotyping powerfully: 'The current attack on alien species usually cites a few notorious examples of imported plants that have behaved badly, such as kudzu, Japanese honeysuckle, multiflora rose and purple loosestrife. These demon species are then used to tar the entire class of aliens with guilt by association' (1994: 55). If natural systems were typically comprised of a delicate balance of species well-integrated into communities of members in adapted fit with each other, then the arrival of an outsider not tuned to the system would lead one to expect ecological disaster or ecosystem degradation of some sort. But such a conception of

ecological assemblages is problematic given the recent emphasis in ecology on disequilibrium, disturbance, and fortuitous association of species as the norm for many natural systems. Exotics arriving into these types of systems will not be disrupting any stable balance.[25]

Still, there are good reasons for being suspicious of the disruptive potential of exotic species. Exotics often arrive without the predators, parasites, diseases, or competitors that are likely to limit their proliferation in their native habitat. Local prey, hosts, and competitors of exotics have not had a chance to evolve defensive strategies. Past experience, documented by the familiar exotic-invasion horror stories (some mentioned above), is another reason for suspicion. Nevertheless, as with the connection between human introduction and exotics, one ought not to move from an empirical correlation between the presence of exotics and damaging results to a conceptual connection between exotic species and those that cause damage.

When an exotic species causes serious damage or harm, we have a reason for a negative appraisal of this exotic. When exotics cause harm to human interests, the ground for a negative evaluation of these exotics is fairly straightforward: No one doubts the economic damage zebra mussels have caused in the U.S. Such harm, however, will have to be weighed against benefits the exotic provides. According to Mark Sagoff, zebra mussels are responsible for clearing the organic matter that once choked Lake Erie, which had been given up as dead due to eutrophication (1999: 17).[26] Consider another example: dogs (*Canis lupus familiaris*) were originally introduced to North America by nomads crossing the Bering Strait about 10,000 years ago. Although they have caused significant losses for humans (e.g., feral packs killing livestock and dogs biting people and killing small children), no one would deny the importance of the benefits this one-time exotic species provides.

When exotic species harm or impoverish nonhuman nature, the justification for a negative evaluation is less straightforward. Many worry about whether it makes sense to harm natural systems and they challenge us to provide a principled distinction between harming a natural system and changing it (Throop 2000). (For example, in what sense did the chestnut blight harm or damage eastern U.S. forests as opposed to merely changing them?) But when an exotic species invades a diverse native community and changes it into a virtually uniform stand of a single species vastly diminished in suitability for wildlife habitat or forage (e.g., *Phragmites* in eastern U.S. wetlands, *Melaleuca* in Florida), a negative appraisal on nonanthropocentric grounds seems straightforward. Such an appraisal is also clearly called for when an exotic species, plentiful in its native habitat and present as an alien around the world, causes large numbers of extinctions of other species (e.g., brown tree snakes). The damage to humans and to nonhuman nature that some exotic species have caused is a significant reason to be worried about exotic species.

V. NATURALISATION OF EXOTICS

Species expand their ranges, often moving between types of ecological assemblages. Such migration is a natural phenomenon which enriches ecosystems and drives evolution. As with extinction, humans have taken this natural process and dramatically increased its speed and scale, turning a valuable process into a highly problematic one. When species move into foreign ecological assemblages, they become exotics. Over time, exotic species 'naturalise'[27] and become native. John Rodman claims that 'plants resemble people in that many natives are immigrants that have been in a country long enough to become members and citizens of a community' (1993: 151). Mark Sagoff argues that 'many of the alien species among us have become an integral part of our community and our cuisine – cattle, cotton, corn, and striped bass are surely as American as sunflower seeds, cranberries and Jerusalem artichokes' (1999: 22).

One reason we need a notion of naturalisation is because it is likely that many, perhaps most, of the species in any given ecological assemblage did not first evolve in that assemblage and were originally foreign to it. If exotics never naturalised, then we open ourselves to the peculiar possibility that most of the species in ecosystems are exotics. Although recent and massive human transport of species around the globe has created assemblages where the majority of species are exotics,[28] this is not a plausible way to think about typical ecosystems that are relatively untouched by humans. Thus we need a notion of naturalisation of exotics, or as Michael Pollan (1994: 55) puts it, we need a 'statute of limitations on their alien status'. How should we understand this process of naturalisation by which an exotic becomes native?

Some claim that judgements of naturalisation are subjective and arbitrary. Walter Westman, for example, thinks it takes a 'subjective judgement' to answer the question 'how long must the process of evolutionary accommodation between newcomer and residents last before the species can be considered naturalised or native?' (1990: 252). Echoing Westman, Jonah Peretti says, 'It is unclear how long a species needs to be established in a location before it is considered native. Is a species "naturalised" in 100 years, 1,000 years, or 10,000 years? The distinctions are arbitrary and unscientific' (1998: 185).

I suggest that the process of naturalising and becoming native is neither arbitrary nor purely scientific. On the account proposed here, naturalisation involves philosophical evaluation as well as ecological judgment. To become native, an exotic species must not only naturalise ecologically (i.e., adapt with local species and to the local environment), but it must also naturalise evaluatively. This means that for an exotic to become a native, human influence, if any, in the exotic's presence in an assemblage must have sufficiently washed away for us to judge that species to be a natural member of that assemblage.

Ecological naturalisation

An exotic species naturalises in an ecological sense when it persists in its new habitat and significantly adapts with the resident species and to the local abiota. This is a matter of degree and typically increases over time. Immigrant species will immediately causally interact with elements of the local ecological assemblage, but significant adaptation between the immigrant and residents and between the immigrant and the local abiota takes time and increases over time. Exertion of evolutionary pressure between the immigrant, the residents, and the abiota will also not be immediate.

Determining what is to count as significant adaptation requires context sensitive judgement. Adaptation can continue indefinitely. Whether adaptation is sufficient for ecological naturalisation may depend on the adaptive potential of a particular species/ecosystem complex. If a great deal of adaptation is going to take place (perhaps including co-evolution of the exotic and several resident species), then until this occurs, we likely would not judge the exotic to have ecologically naturalised. On the other hand, if the exotic tends to employ resources and modes of living that were not previously exploited in the recipient habitat, then perhaps not much adaptation need take place before we judge the species to have ecologically naturalised. In highly individualistic and loose assemblages, where few ecological or evolutionary links exist between members and where many species have wide-ranging tolerances to a diversity of abiotic factors (and so are unlikely to have adapted much to local conditions), a newcomer may be no more exotic (that is, unadapted to the local species and abiotic conditions) than are the resident species. Perhaps very little adaptation is sufficient to ecologically naturalise to such an assemblage. Ecological naturalisation can also occur in assemblages where the vast majority of species are human-introduced exotics (e.g., Hawaiian forests, or cities and suburbs where people have eradicated the natives and planted exotics). Over a sufficient time period, a large group of exotics would ecologically naturalise with each other and the surviving natives would also adapt with the new assemblage.

Mark Sagoff has challenged the ecological component of the distinction between exotics and natives and thus the idea that ecological naturalisation is relevant to the distinction.[29] Sagoff argues that the distinction between exotics and natives is purely geographical-historical, with no ecological content or economic implications. For Sagoff, an exotic is simply a species that has come from someplace else (after an arbitrarily determined point in time). Exotics, he suggests, do not differ from natives ecologically, and they will be no more likely to be economically damaging than are natives. Sagoff argues that empirical research by ecologists would not enable them to distinguish the exotic species in an assemblage from those which are not. The only way to tell the difference would be to acquire historical information about the past geographical location of these species.

In response to my suggestion that exotics, unlike natives, will not have significantly adapted with the local assemblages, Sagoff argues that we will always be able to tell plausible, but speculative, 'just so' stories about how the new immigrants to an assemblage have adapted. If an immigrant species establishes itself in a new geographical location, it will undoubtedly have survival skills, such as making or catching its food, avoiding or defending itself against local predators, and so on. Immigrants without such skills will not survive. Such skills (preadaptations) will likely enable us to tell a story about how such species have adapted to the local assemblage (even though they have not).

Sagoff is right that this phenomenon of preadaptation will make it more difficult for ecologists to determine which species are exotics and which are natives. But Sagoff's epistemological conjecture about the difficulty of empirically distinguishing exotics from natives is compatible with my definition of exotics as those that have not significantly adapted with local assemblages. Even if it is true that, absent historical-geographical knowledge, we would have a hard time telling which species have actually adapted with the local assemblage and which – though they can survive there – have not adapted, this does not vitiate the distinction between such species.

Additionally, although Sagoff's epistemological conjecture is intriguing, it is not all that plausible. Invasion biologists – those who study, among other things, the differences between recently-invaded and not recently-invaded assemblages – would likely be able to make reasonable judgements about which species are more likely to be exotic. Numerous considerations would provide reasons for thinking a species is more likely to be exotic (i.e., not significantly adapted with the local assemblage). Consider two: (1) We find that nothing eats a given species and then, a year later, discover that several local species are now eating it; (2) A small number of individuals of a rapidly reproducing species has a genetically-based trait that significantly enhances their fitness in the local environment (perhaps they have a tolerance to a toxic metal in the soil); 5 years later, most of the members of this species have this trait. In general, we could identify an optimal engineering design for a given species that would make it most fit in an assemblage and then use distance of the species from this design as a means to assess the probability and extent of its exoticness.

Westman and Peretti worry about how long an exotic must naturalise before it becomes native. I suggest that the speed of ecological naturalisation will vary depending on the immigrating species and the nature of the local ecological assemblage. Some insects 'quickly adapt to new hosts, even within periods as short as 10 years' (Vermeij 1996: 7) and for plants, 'genetic changes by population level selection can sometimes be found in annual invader species within 25–40 years' (Westman 1990: 254).[30] Species that reproduce more quickly will likely adapt and evolve more quickly and thus will ecologically naturalise more quickly than species with longer generation times.[31]

Evaluative naturalisation

Should ecological naturalisation be all that is required before an exotic species is to be considered native? I think not. Many immigrant species have been in their new habitats long enough to ecologically naturalise (i.e., significantly adapt with local species) and yet we justifiably hesitate to consider them natives. Consider kudzu, perhaps a paradigm case of a nonnative. It has been in the U.S. for 125 years and it is likely to have adapted with local residents and to local abiota to a significant degree in at least some of its habitats. Or consider Holmes Rolston's claim that mustangs on the western range are not natives even though they (and the ecological assemblages with which they interact) have had several hundred years to adapt. Many still consider Hawaiian feral pigs nonnative even after some 1500 years. It is hard to believe that significant ecological naturalisation has not occurred during that time span.[32] The judgements that these species are not yet natives – despite having significantly adapted with resident species and to local abiota – can be explained by treating judgements about naturalisation and the resultant nativity as involving an evaluative component in addition to the ecological one.

Onetime exotic species that are judged to have naturalised and become full-fledged natives are ones that we take to be 'natural' members of their ecological assemblages.[33] For this to be the case, we must judge their presence in these assemblages as not representing significant, ongoing human influence. Human involvement in a species' presence in an assemblage calls into question whether they are natural members of this assemblage. To the extent that an exotic species' presence in ecological assemblages continues to be characterised by ongoing human influence, to that extent we should be unwilling to evaluate the species as having fully naturalised and become native. This is true even if the immigrant species has significantly ecologically naturalised and is thus no longer exotic.

We do not prevent human-introduced exotics from becoming native when we require that they not only significantly adapt but also become natural members of their new assemblages. For exotics can evaluatively naturalise as well as ecologically naturalise. Human influence on natural systems and species 'washes out' over time, like bootprints in the spring snow.[34] Natural processes can once again take control, as when old mining roads erode and vegetation overgrows them. This washing away of human influence over time constitutes evaluative naturalisation and it allows human-introduced exotics that have ecologically naturalised to become full-fledged natives.[35]

A number of factors affect the washing away of human influence and the resultant evaluative naturalisation (Hettinger and Throop 1999: 20–21). First, the greater the human influence, the longer it takes to wash out. Perhaps this is why we are reluctant to think of feral animals as capable of naturalising and becoming natives even over long time-periods. Domestication of animals constitutes significant human influence over them, and so even after several

hundred years we might think that feral horses, for example, are still not native (fully naturalised) on the American range, despite having significantly ecologically naturalised. Withholding the judgement that they have evaluatively naturalised reflects the view that the human influence on those species is of ongoing significance. Consider another example. Human introduction of exotic species that take on keystone roles in ecosystems (or extirpate keystone species) result in greater human influence than does human introduction of nonkeystone exotics. Evaluative naturalisation takes longer when there is more human influence over natural systems to wash away.

Increasing temporal distance from human influence is another factor that contributes to the washing away of such influence. For an exotic species to naturalise ecologically, it must significantly adapt with other natives and the local abiota, and this ensures that it will have some temporal longevity in an assemblage. This longevity may – but need not – be sufficient to ensure evaluative naturalisation. Washout of human influence is a function of a variety of factors, only one of which is temporal distance from that influence. Thus one cannot specify a particular time period in which evaluative naturalisation will occur, other than to say that sufficient temporal distance (e.g., geologic time) can wash away almost any degree or type of human influence. For example, any human influence over landscapes by Pleistocene humans is likely to have long since washed away. To take a fanciful example, suppose that contemporary North American wolves were the descendants of domesticated dogs that Pleistocene peoples brought with them to the continent. Although wolves would thus have been human-introduced exotics, these animals would have long since naturalised both ecologically and evaluatively.

A third factor affecting the washout of human influence is the extent to which a natural system becomes similar to what it would have been absent that influence. If mountain goats would be in Yellowstone Park today except for the fact that human roads and other constructs blocked their migration routes, then even though it is a human-introduced population of goats that is now migrating into the Park, this humanising factor is significantly countered by the washing away of human influence that results from nature returning to a pattern it would have displayed absent that influence. In this case, human action overall would not have influenced the outcome in nature: Mountain goats would be in Yellowstone if humans had not influenced natural systems. In contrast, one reason to think of pigs in Hawaii as not evaluatively naturalised and thus not natives (beyond the fact that they are feral) is that the only realistic way pigs could get to the Hawaiian islands is with human assistance. Thus, it is likely that Hawaiian nature would have remained without pigs virtually forever but for human intervention. Thus it is reasonable to view pigs on Hawaii as representing continuing human influence in this respect.

A fourth factor affecting washout of human influence is the extent to which natural forces have reworked a human-influenced system (independently of

whether the result is similar to what it would have been absent human intervention). For example, if humans introduce coyotes into an area with significant wolf presence, human influence on the assemblage resulting from coyote introduction would be lessened quickly because wolves significantly dominate coyotes. When a human-introduced exotic has naturalised in the ecological sense, natural forces have reworked the affects of human action to some degree. Thus ecological naturalisation contributes to evaluative naturalisation in this dimension as well, though again there is no reason to think that it is sufficient for it.

All of these factors play a role in our judgement about whether a human-introduced exotic has evaluatively naturalised and become a natural member of its new assemblage. A human-introduced exotic that has less impact, that has been in the system longer, that changes the system's trajectory less, and that has been more greatly influenced by natural forces is one that will be more likely to have naturalised in the evaluative sense. Once it has done so, and if it has also ecologically naturalised, it warrants the appellation 'native species'.

Some argue that an exotic species naturalises when it ceases to cause damage to its new environment. A species is not native, on this account, until it fits in and becomes a stable, sustainable, and productive member of its new community. Besides mistakenly intimating that exotics must cause damage, this suggestion falsely assumes that native species never do. More generally, this account of naturalisation assumes a problematic and idyllic balance-of-nature paradigm of natural systems. It also ignores the importance of the idea that natives must be natural (i.e., not significantly human-influenced) members of their assemblages. Human-introduced exotics (including genetically-engineered species) could quickly and dramatically increase the stability and productivity of native assemblages, but this should not lead us to consider these species natives. That human-introduced exotics are judged to be beneficial is not an appropriate reason for conceptualising them as native.

Let me summarise the implications of my account of naturalisation for the distinction between exotics and natives. Exotics are species that have not significantly adapted with the local ecological assemblage. Once a species has significantly adapted (ecologically naturalised), it is no longer exotic. But such a species might still not be native. If it was human introduced and if its presence in the assemblage represents significant and ongoing human influence, then it is not a natural member of this assemblage and so is not native. Perhaps kudzu, western mustangs, and Hawaiian pigs are such examples of species that are no longer exotic (because they have ecologically naturalised), but are not yet natives either (because the human influence on their presence is still significant).

Although human introduction is not part of my account of exotics, it is a factor in my account of native species. Are the problems I identified with the human-introduced account of exotics applicable to my account of natives? Although I need not count the restored Yellowstone wolves as exotics (as must

the human-introduced account of exotics), it might seem that I cannot say that they are natives either, given the significant human involvement in their return to Yellowstone. But because this is return of a species that humans had previously eradicated, the restoration of wolves to Yellowstone is, in one important respect, a lessening of human influence over both Yellowstone and the wolf as a species. Yellowstone with wolves is now like it would be had humans never eradicated them. Similarly, by returning the wolf to its former range, humans are, in one respect, lessening their overall impact on wolves. Thus, in these respects, wolves are natural and hence native members of Yellowstone, despite being restored by humans.

VI. XENOPHOBIA, BIODIVERSITY, AND DISVALUING EXOTICS AS EXOTICS

Nativists are those who favour native inhabitants over immigrants and/or want to preserve indigenous cultures. Biological nativists favour native flora and fauna, and they combat the introduction and spread of exotic species in order to preserve native assemblages. For example, I planted a mimosa tree (*Albizzia julibrissin*) in my yard after seeing the tree around the Lowcountry of South Carolina. They have pink, silk-like flowers in the spring and are beautiful in bloom. When I discovered the tree was an import from Iran and China, I regretted planting it. I was annoyed with myself, as I was with my neighbours, for planting species not native to the barrier islands of South Carolina. Planting natives and shunning exotics helps to preserve the unique character of our local environments.

Such an opposition to exotic species has been compared to a xenophobic prejudice toward immigrant peoples. Michael Pollan, for example, suggests that biological nativism embodies a purist ideology that is reminiscent of the ethos of the Nazis who had a native plant movement of their own, purifying the biology of their country as they purified their culture of Jews (1994: 54). In a similar vein, Jonah Peretti argues that 'nativist trends in Conservation Biology have made environmentalists biased against alien species' and he wants to 'protect modern environmentalists from reproducing the xenophobic and racist attitudes that have plagued nativist biology in the past' (1998: 183, 191).

In contrast, David Ehrenfeld thinks that comparing the antagonism toward exotics with real biases such as racial profiling of African-Americans and Hispanics 'deserves ridicule.' He argues that

> The … analogy, between stereotyping alien species and stigmatising human races is … far fetched. While pejorative generalisations about human races are demonstrably untrue, it is a simple matter to show that gypsy moths, Kudzu vines, and Argentine ants are destructive precisely because they are alien species in new environments.

After noting some exceptions, Ehrenfeld concludes, 'There are more than enough cases in which exotic species have been extremely harmful to justify using the stereotype' (1999: 11).

Ehrenfeld is on shaky ground if the 'ten's rule' is accurate. If only one in one hundred exotics cause serious problems, then stereotypes about the damaging nature of exotic species may be no more statistically grounded than are some of the morally-obnoxious, racial and sexual stereotypes about humans.

Ehrenfeld's response to the charge of bias is also not available to those who separate the notion of exotic species from the idea of being damaging. When exotics are also distinguished from human-introduced species (as I have done), what justification for a negative evaluation of exotics remains? Those who oppose naturally dispersing, nondamaging exotics seem to be doing so because these species are alien, and negatively evaluating a species simply because it is foreign does suggest a xenophobic attitude and a troubling nativist desire to keep locals pure from foreign contamination.

In human contexts, a policy of favouritism for native inhabitants over immigrants is morally troubling. When it is combined with an ideology of racial purity and a fear of 'biological pollution' from those who are different, it is clearly morally obnoxious. In my home state of South Carolina, a great many people believe that blacks and whites should not marry and have offspring. Many dislike Yankees as well, particularly those like myself who have pretensions of naturalising and becoming native. Given the account of exotic species defended here, opposition to exotics must take seriously the criticism that it is xenophobic and supportive of racial purity.

Biological nativists might respond to this criticism by questioning the assumption that because nativism in human affairs is morally troubling, it must also be troubling in environmental affairs. Many acts that wrong humans do not wrong nonhumans (and vice versa). One reason is that plants and animals cannot have hurt feelings resultant from negative evaluations of them, although both can be disadvantaged by such attitudes. If, however, a nativist attitude is itself prejudicial, discriminatory, and irrational, then its condemnation would not depend on toward whom or what it is aimed. Peretti thinks that 'although environmental purism is not inherently racist, there are compelling arguments that nativist purism is undesirable in all spheres – politically, culturally and ecologically' (1998: 188).

Biological nativists' opposition to exotic species can be defended by distinguishing between types of nativism and purism and the reasons for them. While nativisms based on irrational fear, hatred, or feelings of superiority are morally objectionable, I will argue that some versions of both cultural nativism and biological nativism are rational and even praiseworthy. For example, I believe the protection and preservation of indigenous peoples and cultures is desirable. This may involve favouritism for local peoples and opposition to the dilution of local cultures (a kind of purism), but it is based on an admirable attempt to protect

the diversity of human culture. Similarly, biological nativism is laudatory because it supports a kind of valuable biodiversity that is increasingly disappearing.

It might seem strange to oppose exotic species on grounds of biodiversity, for the presence of alien species seems to enhance a region's biodiversity, not decrease it. Mark Sagoff argues that one cannot object to exotics on grounds of loss of biodiversity because 'in the vast majority of instances, newcomers contribute in the sense that they add to the species richness or diversity of local ecosystems' (1999: 18). But this argument takes too narrow a view of biodiversity. Since the breakup of the supercontinent Pangaea some 180 million years ago, the earth has developed into isolated continents with spectacularly diverse ecological regions. Biological nativists value and want to preserve this diversity of ecological assemblages. This diversity is in jeopardy due to modern humans' wanton mixing of species from around the globe. The objection biological nativists can have to exotic species as exotics – at least in the current context – is that although they immediately add to the species count of the local assemblage and increase biodiversity in that way, the widespread movement of exotic species impoverishes global and regional biodiversity by decreasing the diversity between types of ecological assemblages on the planet. For example, adding a dandelion (*Taraxacum officinale*) to a wilderness area where it previously was absent diminishes the biodiversity of the planet by making this place more like everyplace else. Adding a mimosa tree to Sullivan's Island makes the Lowcountry of South Carolina more like some Asian assemblages. When this is done repeatedly, as humans are now doing and at an ever increasing rate, the trend is toward a globalisation of flora and fauna that threatens to homogenise the world's ecological assemblages into one giant mongrel ecology. Bright calls the spread of exotics 'evolution in reverse' (1998: 17) as the branches of the evolutionary bush are brought back together creating biosimilarity instead of biodiversity.

The loss of biodiversity resultant from the presence of exotics is greatly exacerbated by damaging exotics that invade, extirpate endemic species, or turn diverse native assemblages into near monocultures of themselves. But such causal diminishment in diversity is distinct from the conceptual diminution identified here: the mere presence of massive numbers of exotics in a great number of assemblages diminishes the diversity between ecological assemblages independently of whether they physically replace or diminish natives. Note that opposition to exotics on these conceptual grounds avoids the unfair stereotyping charge that must be addressed by those who oppose exotics because they are likely to cause damage.

It might be objected that presence of exotic species can enhance inter-assemblage biodiversity in certain respects, as well as decreasing it in others, and thus that the spread of exotics may not be a threat to overall biodiversity.[36] For example, the movement of Asian snow leopards into Yellowstone Park would

not only increase Yellowstone's species count but it would also make Yellowstone's assemblages differ from those of the Absoroka-Beartooth wilderness to the north in a way they previously did not: Now they diverge in the types of mammals present. While snow leopards in Yellowstone would make Yellowstone's assemblages more like some Asian assemblages, it would also increase differences between Yellowstone and the wilderness areas to the north.[37]

It is true that the presence of exotics can increase inter-assemblage biodiversity in the way suggested. More generally, species movement into new assemblages need not be a threat to overall biodiversity. In evolutionary history, such movement has frequently enriched ecosystems, brought on speciation, and enhanced global biodiversity. Careful planned and monitored human introduction of exotics into selected assemblages might be able to enhance biodiversity as well. But this is no defence for the blind and large-scale human introduction of exotics that is taking place on the planet today. In today's world, the increase in inter-assemblage diversity due to snow leopards' presence in Yellowstone would not last. Snow leopards would quickly find their way (or be introduced) into the Absoroka-Beartooth wilderness, and the increase in regional biodiversity would be lost. If we focus on individual cases of exotic introduction – without considering the cumulative impact of massive numbers of exotic introductions over time – we may be able to convince ourselves that the presence of exotics is benign (or even beneficial) in terms of biodiversity. But in the context of the current flood of exotics, such a focus is myopic. The logical end point of the ongoing, massive spread of exotics is that ecological assemblages in similar climatic and abiotic regions around the world will be composed of the same species. This is a clear case of biotic impoverishment.

Recent calls to accept the increasing cosmopolitanisation of the planet's biota have come from Peretti (1998), Pollan (1994), and Soulé (1990). Dale Jamieson (1995: 340) suggests that

> It is not implausible to suppose that we may come to see our preference for isolated, indigenous ecosystems as anachronistic; and instead come to favour ecosystems that are more cosmopolitan, in much the same way in which many people now prefer multicultural experiences to those which are provincial. A celebration of alien plants and surprising biological juxtapositions may be more in tune with the postmodern world than attempts to protect native species.

Such calls ignore the great value lost as the ever rising flood of exotics diminishes the diversity between ecological assemblages. In the current context, opposition to exotics as exotics (i.e., as foreign species) is justified in order to preserve inter-assemblage biodiversity.

In addition to this tragic loss in biodiversity, the spread of exotics also helps to undermine an important feature of human community. Globalisation of flora and fauna contributes to the loss of a human sense of place. As Mark Sagoff

perceptively argues, native species 'share a long and fascinating natural history with neighbouring human communities… . Many of us feel bound to particular places because of their unique characteristics, especially their flora and fauna. By coming to appreciate, care about, and conserve flora and fauna, we, too, become native to a place' (1999: 22). Using knowledge of – and love for – local native species to help ground a sense of place will no longer make sense in a world where most of these species are cosmopolitan.

Just as the spread of exotic species threatens to homogenise the biosphere and to intensify the loss of a human sense of place, so too economic globalisation and the cosmopolitanisation of humans threaten to impoverish the diversity of the earth's human cultures and to undermine people's senses of community. Keeping a dandelion out of Yellowstone is much like keeping Wal-Mart out of a small New England town or McDonald's out of India. Kudzu in the American South is like T.V. in Nepal, a threat to the diversity of the planet's communities and ways of life.

The cosmopolitanisation of humans is multifaceted and so how we should evaluate it is complex. Humans are already cosmopolitan in a biological sense: our species has proliferated wildly all over the planet, much like an aggressive weed that destroys local biodiversity and homogenises the land. Is human cosmopolitanisation in a social/political sense undesirable as well? A worldly person with wide international sophistication will lack the narrow provincialism that often underlies xenophobia and is thus likely to be more knowledgeable and respectful of cultural and natural diversity. On the other hand, a person who treats the whole world as her home, with no attachments to nation states or particular regions, is less likely to understand, care about, or defend local cultural practices or biotic communities. A cosmopolitan person is also likely to be culturally eclectic, choosing appealing cultural practices from around the world rather than adopting those from home. Such a cosmopolitan way of life is parasitic on other people maintaining local cultural practices.[38] Social/political cosmopolitanisation of humans in these senses is not conducive to the preservation of people's sense of local community and I think it an open question whether, on balance, this cosmopolitanisation contributes to the culturally homogenising forces of economic and biotic globalisation. My southern friend who worries about the affects Yankees are having on South Carolina is not all wrong.

The attempt to preserve differing cultures and small town community life by minimising certain types of foreign influence need be neither racist nor xenophobic, and it can be a praiseworthy attempt to protect valuable cultural diversity. When Jewish parents lobby their children to marry other Jews or when people who live in the southern U.S. send their children to southern colleges, the attempt is to preserve diverse cultural practices with significant value, not to reinforce or perpetuate prejudices, fear, or hatred of those who are different. I am not claiming that morally abhorrent motives are never present in the cultural and biological nativism/purism movements. My point is that they need not be present

and that types of both cultural nativism/purism and biological nativism/purism can be morally praiseworthy.

Consider the contrast between the biological nativist's commendable desire for local biotic purity and the racists' contemptible desire for human racial purity. In certain respects their goals seem similar, for just as it would be unfortunate for all ecological assemblages to become the same, so too it would be unfortunate to lose racial differences between people and for humans to instantiate one mongrel species. But marriage between blacks and whites in South Carolina (or worldwide for that matter) poses no real threat to the existence of these differing races and the opposition to miscegenation is typically based on fear, dislike, or perceptions of inferiority of the other race. In contrast, the mass importation of exotics does significantly threaten biodiversity and biological nativists typically do not believe in the superiority of the species native to their lands. The charge that biological nativists are xenophobic ignores their admiration of foreign flora and fauna in their native habitats. Although biological nativists favour native biotic purity, they do so in the name of global biodiversity, the preservation of the spectacular diversity between Earth's ecological assemblages. Ironically, it is those who favour the cosmopolitanisation of plants and animals that support purity of an invidious sort: in that direction lies a world with the same mix of species virtually everywhere.

Opposition to exotics as exotic can thus be both rational and praiseworthy. Being a foreign species is a disvalue when humans are flooding the earth's ecological assemblages with exotics. Given the significant and ongoing homogenisation and cosmopolitanisation of the biosphere by humans, we may justifiably oppose exotic species even if they have arrived under their own power and cause no physical damage.

VII. CONCLUSION

Exotic species are best characterised as species that are foreign to an ecological assemblage in the sense that they have not significantly adapted with the biota and abiota constituting that assemblage. Contrary to frequent characterisations, exotics need not cause damage, be introduced by humans, or be geographically remote. Exotic species become natives when they have ecologically naturalised and when human influence over their presence in ecological assemblages (if any) has washed away. Although the damaging nature and anthropogenic origin of many exotic species provide good reasons for a negative evaluation of such exotics, in today's context, even naturally-dispersing, nondamaging exotics warrant opposition. Biological nativists' antagonism toward exotics need not be xenophobic nor involve unfair stereotyping, and it can be justified as a way of preserving the diversity of ecological assemblages from the homogenising forces of globalisation.[39]

NOTES

[1] The contemporary pigs are a cross between the Polynesian-introduced pigs and more recently-introduced European wild boars. For a useful discussion of this example, see Mark Woods and Paul Moriarty (2001).
[2] Kudzu has its defenders. Mark Sagoff points out that besides providing erosion control and forage, it is a nitrogen-fixing legume that nourishes the soil. Some southern cooks serve fried Kudzu leaves and Kudzu products include fibre purses and condiments. When the vine covers telephone poles and wires, it might be viewed as providing an aesthetic benefit.
[3] Christopher Bright (1998: 21) seems to accept this evolutionary origin criterion of the native/exotic distinction. Exotic species, he says, are organisms that 'take up residence in ecosystems where they did not evolve'. If one defines the spatial scale of ecosystems broadly enough, e.g., the North American 'ecosystem', then most species may well be native to the 'ecosystems' (i.e., continents) they currently inhabit.
[4] There are limits to the damage natives can cause their home ecosystem(s). If natives are too damaging, they would destroy the habitat on which they depend and drive themselves extinct. Those parasites that destroy their hosts (and are unable to jump to other host species) are examples.
[5] When I say that exotics 'have not significantly adapted *with* local species', I am referring to this reciprocal adaptive process.
[6] Although this account of exotic species utilises a notion of types of ecological assemblages, these types should not be seen as rigid or clearly delineated. Species groupings are historically contingent and are not fixed packages that come and go as units (Jablonski 1991). Types of ecological assemblages often grade into each other ('ecotones'), and species mix and match in many different ways. I do assume that few, if any, ecological assemblages are completely transitory. If there are assemblages where species arrive and leave so quickly that no significant adaptation occurs among the residents, my account holds that all species in such assemblages are exotics.
[7] Some suggest that what turns a native species into an exotic is crossing a 'natural barrier to dispersal' (e.g., an ocean, mountain range, and so on). But a human barrier to dispersal could also isolate ecological assemblages sufficiently for a crossing species to be exotic. Although species can be exotic without doing so, crossing a barrier to dispersal certainly increases the likelihood a species will have arrived in an ecological assemblage with which it has not adapted.
[8] I use the exotic/nonexotic contrast here, because some nonexotics (i.e., significantly adapted species) are not yet natives, if their presence represents significant ongoing human influence. See the discussion in section V on evaluative naturalisation.
[9] An immigrant species that has not adapted with the particular species in the new assemblage but that has adapted to closely related species would be less exotic in virtue of having done so.
[10] On my account, although human introduction is not relevant in determining if a species is exotic, it is relevant in determining if a species is native. See the discussion on evaluative naturalisation in Section V.
[11] I thank Marc Bekoff for this objection.
[12] I put 'restoration' in scare quotes because one might plausibly argue that restoration of species only occurs when a species is returned to an ecological assemblage sufficiently

similar to one it once inhabited, and not when it is simply returned to an earlier geographic location.

[13] These definitions also put the Park Service in the unusual position (mentioned above) of claiming that mountain goats moving into Yellowstone from the north are exotics but those that may move in from the west are not.

[14] It is also not clear why only 'deliberate' reintroductions are excluded. If deliberately putting a species back where it once was is not to introduce an exotic, why would inadvertently doing so count as exotic introduction? Furthermore, as was argued above, deliberately returning species long since departed (e.g., the Pleistocene megafauna or dinosaurs) should count as exotic introduction. Thus some deliberately-reintroduced species should not be excluded from the category of exotics.

[15] The Society for Restoration Ecology also defines exotics as human-introduced species. According to the Society, an exotic is 'one that was introduced, either intentionally or unintentionally, by human endeavour into a locality where it previously did not occur' (quoted from Scherer 1994: 185). Besides ruling out naturally-dispersing exotics a priori, this definition would count 'restored' Pleistocene megafauna or dinosaurs as nonexotic.

[16] Consider some human vehicles used by hitch-hiking exotics: Ship ballast water, pallet wood, and aeroplane wheel-wells.

[17] For a fuller discussion of the reasons for disvaluing human influence on nonhuman nature (and for valuing wildness), see Hettinger and Throop (1999).

[18] For a compelling discussion of the horror of a totally humanised, artifactual world, see Lee (1999), especially pp. 194–203. According to Lee, bringing about such a world manifests 'moral blindness to something other than ourselves' (p. 119) and makes us guilty of 'ontological impoverishment'. In such a world 'humankind is then imprisoned within an existential or ontological solipsism of its own making' (p. 194), leading to a 'narcissistic civilisation' able to express wonder and awe only at its own handiwork. Failing to recognise and protect the value of nature as independent other would express 'human collective egomania' (p. 203).

[19] The fact that many people do not seem to value wildness, but instead fear it or profess dislike for things not under human control does not provide a sufficient reason for scepticism about this value. See Hettinger and Throop (1999: 16–17) for a response to scepticism about wildness value based on this fact.

[20] In the Section VI, I provide another reason why the Park Service might resist naturally-dispersing exotics: such exotics can decrease the diversity between ecological assemblages.

[21] Mark Sagoff has made the provocative (and in my view dubious) suggestion that exotics are no more likely to be harmful than are natives.

[22] Daniel Simberloff claims that 15% of the foreign species established in the U.S. have become serious problems (Simberloff 1997). Pimentel et al. (1999) claim that 30 percent of exotic insects that are established in forests have become serious pests.

[23] That an exotic benefits some species, even endangered ones, is compatible with it being harmful overall. Perhaps nutria is a good example. The population of this species is exploding and nutria cause severe damage to marsh vegetation, converting it to open water which destroys habitat for birds and fish (Corn et al 1999: 82). Presumably red wolves would have found something else to eat had nutria not been introduced.

[24] In this comparison, costs are mainly the costs to humans that are relatively easy to quantify. Pimentel et al. (1999) note that 'if we had been able to assign monetary values

to species extinctions and losses in biodiversity, ecosystem services, and aesthetics, the costs of destructive non-indigenous species would undoubtedly be several times higher than $138 billion/yr.'

[25] Compare Westman (1990: 257) on the implications of different paradigms in ecology for our understanding of exotics.

[26] Stevens' (2000) discussion of the zebra mussel's role in degrading New York's Hudson river suggests it is highly unlikely that this organism should be seen as providing a net ecological benefit and casts doubt on Sagoff's claim that it alleviates eutrophication.

[27] The term 'naturalise' is frequently used by botanists to refer to species that came from some other region and have formed self-sustaining local populations. The account of naturalisation developed below requires much more than this.

[28] Soulé (1990) claims that Hawaii has 4,600 exotic plants, three times the number of native plants.

[29] See Sagoff (1999). Some of the ideas attributed to Sagoff below come from correspondence with him.

[30] Contrast this with John Rodman's claim that one hundred years 'seems scarcely time enough for a plant species to adapt and become a member of a community' (1993: 143).

[31] Will more tightly-integrated ecological assemblages adapt to exotics more quickly or slowly than looser assemblages? In tightly-integrated assemblages, there are more causal connections among member species and thus more accommodations that will likely take place as a result of a newcomer. This might suggest that ecological naturalisation will take longer. On the other hand, tight causal connections between members may speed up the adaptation process when compared with looser ecological assemblages.

[32] That these pigs have cross bred with more recently-introduced European wild boars strengthens the grounds for continued exoticness.

[33] By 'natural', I here mean the degree to which nonhuman nature is not altered, influenced, or controlled by humans. For a response to the objection that human influence on nonhuman nature is perfectly natural, see Hettinger and Throop (1999: 18–19).

[34] The bootprint analogy is Holmes Rolston's.

[35] When human influence over a natural system has sufficiently washed out of that system, any negative value that attached to the system in virtue of its being human influenced washes away with the humanisation. This is one reason that people do not (and should not) judge lingering effects of pre-Columbian Native Americans on the contemporary North American landscape as decreasing its naturalness or wildness value in the way they do and should judge more recent human influence as a loss of such value. Even if pre-Columbian Native Americans introduced exotic species to the continent, or moved species between ecological assemblage types within the continent, any resultant human influence on the landscape and negative value associated with such influence has significantly washed away and pales in comparison to the human influence on the continent and resultant loss of wildness value caused by recent Euro-American-introduced exotics.

[36] I thank Bill Throop for articulating this objection.

[37] Judging increases or decreases in biodiversity is tricky. When biodiversity between ecological assemblages is at issue, much depends on how one carves up or counts types of ecological assemblages. For a helpful discussion of types of biodiversity, see Rolston (1994: 34–40).

[38] Similarly, the United States as the great melting pot of nationalities from around the world reaps energy and rewards from other cultures that have maintained their identities.

[39] I thank Beverly Diamond, Todd Grantham, Arch McCallum, Shaun Nichols, Mark Sagoff, Bill Throop, Billy Want, and Hugh Wilder for helpful comments. I also thank Mark Woods and Paul Moriarty for kindly sharing an early version of their paper on exotic species.

REFERENCES

Associated Press 1999. 'State's War on Weeds Gets Serious', *Bozeman Daily Chronicle*. October 15: 7.

Babbitt, Bruce 1998. 'Kudzu, Kudzu, Kill! Kill! Kill!', *Harper's Magazine*. July: 17–18.

Bright, Christopher 1998. *Life Out of Bounds: Bioinvasion in a Borderless World*. New York: W. W. Norton & Co.

Corn, M.L., Buck E.H., Rawson J., Fischer E. 1999. *Harmful Non-Native Species: Issues for Congress*. Washington, DC: Congressional Research Service, Library of Congress. Available at http//www.cnie.org/nle/biodv26.html.

Ehrenfeld, David 1999. 'Andalusian Bog Hounds', *Orion*. Autumn: 9–11

Hannah, Lee, Lohse, David, Hutchinson, Charles, Carr, John L., and Lankerani, Ali 1993. 'A Preliminary Inventory of Human Disturbances of World Ecosystems', *Ambio* **23**: 246–50.

Hettinger, Ned and Throop, Bill 1999. 'Refocusing Ecocentrism: De-emphasizing Stability and Defending Wildness', *Environmental Ethics* **21**: 3–21.

Jablonski, David 1991. 'Extinction: A Paleontological Perspective', *Science* **253**: 756.

Jamieson, Dale 1995. 'Ecosystem Health: Some Preventive Medicine', *Environmental Values* **4**: 333–44.

Lee, Keekok 1999. *The Natural and the Artefactual*. Lanham, MD: Lexington Books.

Leopold, A.S., Cain, S.A., Cottam, C.M., Gabrielson, I.N., and Kimball, T.L. 1963. 'Wildlife Management in the National Parks', *Report of U.S. National Park Service Advisory Board on Wildlife Management to Secretary of Interior*. Washington, D.C.

National Park Service, U.S. Department of the Interior 1988. *Management Policies*.

National Park Service, U.S. Department of the Interior Undated. *Natural Resource Management Guidelines.* NPS–77.

Noss, Reed 1990. 'Can We Maintain Our Biological and Ecological Integrity?' *Conservation Biology* **4**: 241–43.

Peretti, Jonah H. 1998. 'Nativism and Nature: Rethinking Biological Invasion', *Environmental Values* **7**: 183–92.

Pimentel, D., Lach, L., Zuniga R., and Morrison D. 1999. *Environmental and Economic Costs Associated with Non-indigenous Species in the United States*. Presentation at American Association for the Advancement of Science, Anaheim, CA, January 1999. For text, see http://www.news.cornell.edu/releasesljan99/species_costs.html.

Pollan, Michael 1994. 'Against Nativism', *New York Times Magazine*. May 15: 52–55.

Reinhart, D., Haroldson, M., Mattson, D., and Gunther, K. 1999. 'The Effect of Exotic Species on Yellowstone's Grizzly Bears.' Paper delivered at the *Yellowstone National Park Conference on Exotic Organisms in Greater Yellowstone: Native Biodiversity under Siege*. Mammoth Hot Springs. October 11–13.

Rodman, John 1993. 'Restoring Nature: Natives and Exotics', in Jane Bennett and William Chaloupka (eds) *In the Nature of Things: Language, Politics, and the Environment*, pp. 139–53. Minneapolis: University of Minnesota Press.

Rolston, Holmes, III 1994. *Conserving Natural Values*. New York: Columbia University Press.

Sagoff, Mark 1999. 'What's Wrong with Exotic Species?' *Report from the Institute for Philosophy and Public Policy* **19** (Fall): 16–23.

Scherer, Donald 1994. 'Between Theory and Practice: Some Thoughts on Motivations Behind Restoration', *Restoration and Management Notes* **12**: 184–88.

Schullery, P. and Varley, J.D. 1999. 'The Yellowstone Genetic Reservoir: Quandaries and Consequences of Exotic Introductions in Yellowstone National Park'. Paper delivered at the *Yellowstone National Park Conference on Exotic Organisms in Greater Yellowstone: Native Biodiversity under Siege*. Mammoth Hot Springs. October 11–13.

Simberloff, D. 1997. 'Impacts of introduced species in the United States'. Published by the U.S. Global Change Research Information Office. October 6. Available at http://www.gcrio.org/CONSEQUENCES/vol2no2/article2.html.

Soulé, Michael 1990. 'The Onslaught of Alien Species, and Other Challenges in the Coming Decades', *Conservation Biology* **4**: 233–39.

Stevens, William 2000. 'Zebra Mussels Star in Hudson's Ecological Melodrama', *New York Times* (April 4): F1.

Stewart, Doug 2000. 'Kudzu: Love it – or Run', *Smithsonian* **31**: 65–70.

Throop, William 2000. 'Eradicating the Aliens', in William Throop (ed) *Environmental Restoration: Ethics, Theory, and Practice*, pp. 179–191. Amherst, NY: Humanity Books.

Vermeij, Geerat 1996. 'An Agenda for Invasion Biology', *Biological Conservation* **7**: 83–89.

Vitousek, Peter 1997. 'Human Domination of Earth's Ecosystems', *Science* **277**: 494–99.

Wagner, Frederic H. et al. 1995. *Wildlife Policies in the U.S. National Parks*. Washington, D.C.: Island Press.

Westman, Walter 1990. 'Park Management of Exotic Species: Problems and Issues', *Conservation Biology* **4**: 251–60.

Woods, Mark and Moriarty, Paul 2001. 'Strangers in a Strange Land: The Problem of Exotic Species', *Environmental Values* **10**: 163–91.