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A forester engages in efforts to eradicate the velvet tree *Miconia calvescens* in Hawaii.

Don't judge species on their origins

Conservationists should assess organisms on environmental impact rather than on whether they are natives, argue **Mark Davis** and 18 other ecologists.

Over the past few decades, 'non-native' species have been vilified for driving beloved 'native' species to extinction and generally polluting 'natural' environments. Intentionally or not, such characterizations have helped to create a pervasive bias against alien species that has been embraced by the public, conservationists, land managers and policy-makers, as well by as many scientists, throughout the world.

Increasingly, the practical value of the native-versus-alien species dichotomy in conservation is declining, and even becoming counterproductive[1]. Yet many conservationists still consider the distinction a core guiding principle[2].

Today's management approaches must recognize that the natural systems of the past are changing forever thanks to drivers such as climate change, nitrogen eutrophication, increased urbanization and other land-use changes. It is time for scientists, land managers and policy-makers to ditch this preoccupation with the native–alien dichotomy and embrace more dynamic and pragmatic approaches to the conservation and management of species — approaches better suited to our fast-changing planet.

The concept of nativeness was first outlined by the English botanist John Henslow in 1835. By the late 1840s, botanists had adapted the terms native and alien from common law to help them distinguish those plants that composed a 'true' British flora from artefacts[3].

Over the next century, many botanists and a few zoologists described and studied introduced species without being aware that others were doing the same. By the time the British ecologist Charles Elton wrote his famous 1958 book *The Ecology of Invasions by Animals and Plants*, some 40 scientists had published descriptions of non-natives, but no consensus had been reached on the desirability of intervening when alien species were introduced.

It wasn't until the 1990s that 'invasion biology' became a discipline in its own right. By this point, partly fuelled by Elton's book, proponents of biodiversity preservation and ecological restoration commonly used military metaphors and exaggerated claims of impending harm to help convey the message that introduced species are the enemies of man and nature.

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The book that began invasion ecology:
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Certainly, some species introduced by humans have driven extinctions and undermined important ecological services such as clean water and timber resources. In Hawaii, for instance, avian malaria — probably introduced in the early 1900s when European settlers brought in song and game birds — has killed off more than half of the islands' native bird species. Zebra mussels (*Dreissena polymorpha*), originally native to the lakes of southeast Russia and accidentally introduced to North America in the late 1980s, have cost the US power industry and water utilities hundreds of millions (some say billions) of dollars in damage by clogging water pipes.

But many of the claims driving people's perception that introduced species pose an apocalyptic threat to biodiversity are not backed by data. Take the conclusion made in a 1998 paper[4] that invaders are the second-greatest threat to the survival of threatened or endangered species after habitat destruction. Little of the information used to support this claim involved data, as the original authors were careful to point out. Indeed, recent analyses suggest that invaders do not represent a major extinction threat to most species in most environments — predators and pathogens on islands and in lakes being the main exception[5]. In fact, the introduction of non-native species has almost always increased the number of species in a region[5].

The effects of non-native species may vary with time, and species that are not causing harm now might do so in the future. But the same is true of natives, particularly in rapidly changing environments.

BIOLOGICAL BIAS

Nativeness is not a sign of evolutionary fitness or of a species having positive effects. The insect currently suspected to be killing more trees than any other in North America is the native mountain pine beetle *Dendroctonus ponderosae*. Classifying biota according to their adherence to cultural standards of belonging, citizenship, fair play and morality does not advance our understanding of ecology. Over the past few decades, this perspective has led many conservation and restoration efforts down paths that make little ecological or economic sense.

Take the effort to eradicate the devil's claw plant (*Martynia annua*), introduced from Mexico to Australia in the nineteenth century, probably as a horticultural oddity. For the past 20 years, the Northern Territory Parks and Wildlife Service, along with hundreds of volunteers, have been manually digging up the plants along 60 kilometres of creek bed in Gregory National Park. ▶

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Management of introduced species such as (left to right) tamarisks, pheasants, honeysuckle and zebra mussels should be based on rational, not emotive reasons.

Today, devil's claw is still found in the park and is abundant in adjacent cattle stations. Is the effort worth it? There is little evidence that the species ever warranted such intensive management — it does not substantially change the fundamental character of its environment by, say, reducing biodiversity or altering nutrient cycling[6].

Another example is the US attempt to eradicate tamarisk shrubs (*Tamarix* spp) introduced from Eurasia and Africa into the country's arid lands in the nineteenth century. These drought-, salt- and erosion-resistant plants were initially welcomed into the United States, first as ornamental species for people's gardens and later as shade trees for desert farmers. Then in the 1930s, when water supplies in eastern Arizona, central New Mexico and western Texas ran short, they were indicted as 'water thieves', and later, during the Second World War, as 'alien invaders'. Beginning in 1942, they became the object of a 70-year suppression project involving herbicides, bulldozers and the picturesquely named LeTourneau Tree Crusher[7].

NEW GUIDING PRINCIPLES

Ecologists have since discovered that tamarisks use water at a rate comparable to that of their native counterparts[8]. And the plants are now the preferred nesting habitat of the endangered southwestern willow flycatcher *Empidonax traillii extimus*.

Tamarisks, which survive under common water-management regimes that destroy native trees and shrubs, arguably have a crucial role in the functioning of the human-modified river-bank environment[9]. Yet between 2005 and 2009 alone, the US Congress authorized US$80 million to support ongoing tamarisk control and eradication.

What, then, should replace the native versus non-native species distinction as a guiding principle in conservation and restoration management?

Most human and natural communities now consist both of long-term residents and of new arrivals, and ecosystems are emerging that never existed before. It is impractical to try to restore ecosystems to some 'rightful' historical state. For example, of the 30 planned plant eradication efforts undertaken in the Galapagos Islands since 1996, only 4 have been successful. We must embrace the fact of 'novel ecosystems' and incorporate many alien species into management plans, rather than try to achieve the often impossible goal of eradicating them or drastically reducing their abundance. Indeed, many of the species that people think of as native are actually alien. For instance, in the United States, the ring-necked pheasant, the state bird of South Dakota, is not native to the great plains of North America but was introduced from Asia as a game bird in the latter half of the nineteenth century.

Specifically, policy and management decisions must take into account the positive effects of many invaders. During the 1990s, the US Department of Agriculture (USDA) declared several species of introduced honeysuckles to be alien (harmful), and banned their sale in more than 25 states. Ironically, from the 1960s to the 1980s, the USDA had introduced many of these same species in land reclamation projects, and to improve bird habitats. Recent data suggest that the agency's initial instincts may have been appropriate. In Pennsylvania, more non-native honeysuckles mean more native bird species. Also the seed dispersal of native berry-producing plants is higher in places where non-native honeysuckles are most abundant[10].

Clearly, natural-resource agencies and organizations should base their management plans on sound empirical evidence and not on unfounded claims of harm caused by non-natives. Another valuable step would be for scientists and professionals in conservation to convey to the public that many alien species are useful.

We are not suggesting that conservationists abandon their efforts to mitigate serious problems caused by some introduced species, or that governments should stop trying to prevent potentially harmful species from entering their countries. But we urge conservationists and land managers to organize priorities around whether species are producing benefits or harm to biodiversity, human health, ecological services and economies. Nearly two centuries on from the introduction of the concept of nativeness, it is time for conservationists to focus much more on the functions of species, and much less on where they originated. ■

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