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Questioning the Invasive Species Paradigm

Jono Neiger and Dave Jacke

Concern about invasive species has permeated our society to a point where almost no one doubts that these species are "taking over", causing widespread harm, and should be eradicated. While we applaud the concern and intentions behind the actions of most people involved in fighting invasive species, we fundamentally question many of invasion biology's broad assertions and desire a deeper look at the reality and the science behind the rhetoric. As ecologically-oriented landscape designers and practitioners, we know from direct experience that the way we define a problem determines the set of solutions one finds for it. We believe that the "invasive species crisis" as it is currently defined and framed represents flawed thinking, that we all need much more context, and that the actions being taken in response to this flawed frame are misguided and potentially harmful.

Numerous questions need answering about the field of invasion biology and the 'facts' and assumptions surrounding this issue. How do we define "native," "exotic" and "invasive" species, and are these definitions scientifically valid? Can a non-native or naturalized species become native, if so how, and how do we know when this has occurred? Why are the ecosystem changes we see so widespread and happening so quickly? Are "invasive" species the drivers of this change or passengers along for the ride or some combination? What role do we humans play in these changes and what is the right response? At what time scale and over what spatial scale are we observing these changes and determining impact? We could go on, for the list of concerns we have about the paradigm of invasion biology is long. However, we can summarize our concerns in seven topics: 1. Inadequate definitions, 2. Inflammatory rhetoric, 3. Narrow context , 4. Short time frames 5. Questionable scientific integrity, 6. Questionable money flows, and, 7. Bizarre psychosocial/emotional dynamics. This article focuses on topics 1 through 4.

We are well aware of the fact that we have few answers of our own to some of these questions. While this has held us back from raising our concerns in the past, the emotional tone of the reaction to "invasive" species, and the increasing institutionalization of this flawed frame has gotten to a point where we can keep silent no longer. We encourage everyone to step back from a reactive stance, observe carefully own our projections onto and our role in the ecosystem of which we are part, and only then to take thoughtful action. We would like to see a considered discussion of these issues, with plenty of self-reflection and an absence of vitriol directed at any species or individuals on any "side" of the discussion. We are all in this together, and, to paraphrase our Indian forbears on this continent, we are all relatives.

Inadequate Definitions

The word "native" has many different definitions, as currently used. Often the definition includes the word "non-native", or "invasive". This makes the word at best conceptual, if not so vague it is unusable scientifically. Even if we take the phrase "a plant or animal that lived in a given area before European colonization" as a more-operational definition for "native", many problems arise, for species move all the time. We know that 12,000 years ago our region was covered with a mile or more of ice, and none of the plants

living here now grew here then (more on this below). Recent research discussed in Charles Mann's book *1491: New Revelations of the Americas Before Columbus* indicate that the majority of North and South America were managed heavily for millennia by human populations 10-12 times larger than we previously thought existed. These populations literally crashed—with 90-95% mortality—within years of first European contact because of Eurasian diseases with which they had no genetic experience. What the first European settlers found when they came here were continents that had been released from management for years if not decades, and whose plant and animal populations were shifting and changing radically after the loss of the ecosystem's primary keystone species.

So the question arises: which period of time are we talking about as the basis to define nativity? Why should we choose one time period over another for that snapshot? Shouldn't the definition of "native" apply to all species in all ecosystems if the concept or definition is to be valid, and not apply only to the unique circumstances of the Western hemisphere and its history of European arrival 500 years ago? And how do we know what that species range is or was in 1492, or 1500, or 1600? We have a better idea what they were in 1950, when E. Lucy Braun published her findings of the first, most comprehensive look at the plant communities of the eastern half of North America. But that is far too late a date, isn't it, by the definition of "native" now in use? Are the range maps we use as the "native ranges" compiled using more than one time period? We have looked at many range maps, and never has there been a date given for when the species was in that range, even though we know that species moved far and wide in response to past climate changes. Some of those movements continue today in response to the melting of the glaciers 10,000 years ago, not to mention our current climate changes.

Similarly the word "exotic" has problems as the flip side of "native", and the word "invasive" is used broadly and without true definition. In fact, it is easy to argue that word "invasive" is itself an example of what one could call inflammatory rhetoric.

Inflammatory Rhetoric

in·vade *(verb) To enter by force in order to conquer or pillage.* American Heritage Dictionary, 4th ed.

"Alien invaders, a global environment under attack."
Feanny, 2004

"Attack of the Alien Invaders."
Article title, National Geographic Magazine, March 2005

"Purple loosestrife, an aggressive Eurasian plant that can overrun a North American wetland and reduce its wildlife value to that of a parking lot"
Life Out of Bounds: Bioinvasion in a Borderless World, Bright, 1998

The media has taken hold of the invasive species issue and run with it. There are many books, articles, fliers, fact sheets, websites, speakers, conferences, and journal articles espousing the dangers of invasive species and how to get rid of them. Phrases like "taking over", "biological pollution", "invaders", "planet of weeds" "overrunning" are used to describe these newcomer species and what is happening. Fear is clearly being used to gain public support and motivate behavioral change. In response to quotes such as the above about purple loosestrife, one researcher reviewed 71 scientific studies/articles concerning purple loosestrife, *Lythrum salicaria.* In those articles and papers 29 species were found to use the plant (including insects, deer, rabbits, muskrat, and fish), no evidence was found of

species declines due to loosestrife, and he found evidence lacking that loosestrife out-competes cattails and other species. (Anderson 1995)

From zebra mussels cleaning waterways (Fahnenstiel 1995) to the use of saltcedar (*Tamarix* spp.) for nesting by the federally endangered southwestern willow flycatcher (Sogge 2008) to the high levels of lycopenes in autumn olive (*Eleagnus commutata*; Fordham 2001) it is clear that these newcomer species are interacting with their environments and not all interactions are negative, even if that is our perception at first. (See Theodoropoulos 2003, Ch. 12)

A central question on the issue is, *"Do biological invasions decrease biodiversity?"* The rhetoric says yes. Many scientists say yes… but not all. In an article in Conservation Magazine (April-June 2007) four scientists, "leading thinkers", were asked to scrutinize commonly held assumptions about invasive plants. Dr. James Brown, Distinguished Professor of Biology, University of New Mexico and Dr. Dov Sax, Assistant Professor, University of Georgia Institute for Ecology, say in their section

> " Yes, and no. The fact is we don't know nearly as much about invading species as we need to… At small scales, the extinction of native species has been more than offset by the colonization of invading species… North America presently has more terrestrial bird and mammal species than when the first Europeans arrived five centuries ago. …Out of a total flora of approximately 6,000 vascular plant species, California has more than 1,000 naturalized exotics; yet fewer than 30 natives are known to have become extinct. (Tibor 2001)… The asymmetry holds even on islands and insular habitats." And finally they state " …we are calling for more rigorous scientific evidence to support claims that invading alien species cause major decreases in local biodiversity and damage to wild ecosystems; currently there is little objective evidence to support sweeping claims of wholesale death and destruction."

We are not often told that some scientists doubt the validity of the theories, ideas, and final conclusions of their colleagues. Massive changes in ecosystem structure and function *are* occurring but determining the cause is more difficult than an article in the popular press would lead us to believe.

"Is the preference for native over "non-native" species scientific or is it religious?" asks Mark Sagoff, Director of the Institute for Philosophy and Public Policy at the University of Maryland (Bailey 2000). Sagoff has scrutinized the widely touted economic "costs" of invasive species calculated to be 138 billion dollars per year by Cornell biologist David Pimental (2005). This includes, for example:

- Crop losses in agriculture (mostly *nonnative crops*) from weeds ($24 billion/yr.)
- Herbicides used in U.S. agriculture ($4 billion/yr)
- Control of weeds in lawns, gardens and golf courses ($36 billion/yr—are these native ecosystems?—includes pesticide and herbicide use!)
- Forage losses and "weed" control on overgrazed range and pasture ($6 billion/yr)
- Cost of cats in damage to U.S. bird population. (estimated at $14 billion/yr)

If we want to understand what is happening in ecological systems we'll have to take a step back from this overwhelming rhetoric and look at the science, consider our personal observations, and expand our context as well.

Narrow Context and Short Time Frames

In the northeast corner of North America there have been as many as 24 glaciations in the last 1.4 million years (Schoonmaker 1991; Jorgensen, 1978, p. 58). Our current climate is that of a short (10,000-15,000 year) interglacial period between much longer, more stable,

glacial periods of 50,000 to 100,000 years. The complexity of this interglacial is compounded by human changes to the ecosphere with unknown and potentially dire consequences.

Species movements and ranges:

Since the retreat of the last glacier, about 15,000 years ago there have been huge changes to the northeast regional climate as species began colonizing this raw, scraped land. By 10,000 years ago temperatures were close to today's and by 8,000 and 5,000 years ago the climate was even warmer. (Jorgensen 1978) The region was tundra and boreal forest for thousands of years after the glacial maximum. Pollen studies have revealed a complex process of plant migration into the region and have changed our understanding of plant communities. Many ecologists no longer believe that plants move as communities. Instead organisms migrate at different rates using different routes (Davis 1981). Spruces (*Picea* spp.) dominated the northeast U.S. region 12,000 years ago. 3,000 years later hardwood forests were assembling with oak, maple, elm, and other species. Hickory arrived only 5,000 years ago. The latecomer, American chestnut, arrived in central New England only 2,000 years ago and came to dominate an already assembled ecosystem. 5,000 years ago eastern hemlock (*Tsuga canadensis*) experienced a sudden decline in abundance in the region, possibly from disease outbreak. Within 2,000 years it recovered its previous abundance. These are the time frames that ecosystems work within.

Another species, black locust (*Robinia psuedoacacia*), an important multiple-function species, has been advancing north since the glacial retreat. It was in central Pennsylvania when range maps were drawn. Massachusetts recently declared the tree illegal to buy, sell, or trade since its "natural range" was approximately 150 miles south of the state's border. This rot-resistant tree that could replace our use of imported cedar, redwood, or chemically-treated lumber is now banned though it exists in patches and mixed stands throughout the state. Several mills in western Massachusetts sell the valuable wood.

Connie Barlow, in her book *Ghosts of Evolution* (2000), documents species with bizarre (but tasty) fruits and no apparent dispersal agent. Fruits such as persimmon, pawpaw, avocado, honeylocust, and osage orange are still around though their dispersal agents disappeared in a megafaunal dieoff some 13,000 years ago. Species such as rhinoceros, mastodon, mammoth, ground sloth, peccary, giant bison, and a predatory bird, *Titanis,* roamed the North American continent in the very recent past, geologically speaking, and camels and horses evolved here and escaped the extinction event by dispersing to other continents (Flannery 2002). These "anachronistic" plants have lost their evolutionary dispersal partners but are now evolving in a new ecosystem with human and other dispersal agents. Indeed, the osage orange's "native range" was confined to a narrow corner of current east Texas and Oklahoma, though there is pollen evidence of it having covered much of North America prior to the megafaunal dieoff. European settlers and subsequent generations dispersed osage orange, reversing it's range contraction and probable extinction.

The notion of species range is a tool to understand where species are located in a given time. Without a reference to time the idea of range is useless. Changing ranges are common over short geologic times of several thousand years and even miniscule time frames of hundreds or tens of years. Should we presume that a given species' range is where it was when European settlers came and no more or no less forevermore? Could any honest ecologist stand by this concept?

With a larger context in mind, we conclude that we are in an ever-changing environment. Our task is to understand why these changes are taking place given the multiple factors (primarily anthropogenic) affecting them. Through further questioning we

may come to see that the current species movements, though quick and dramatic, are only part of a continuous ecosystem process having begun eons before.

In Summary

There are numerous questions surrounding the native-invasive species issue. Our exploration of a few areas of concern including definitions, rhetoric, time frames, and context has only raised more questions. These questions call for long-term ecosystem-based studies and assessment of the assumptions underlying current research, and current media material. We need to know who is paying for the research and sponsoring legislation outlawing species. We need to understand how our personal and social history interplay in this emerging story.

Feelings are intense around this issue but we believe that it is worth questioning strongly held beliefs to find what is true within them. If we cannot explore these issues openly then we have truly moved into the territory of dogma. Many of us are working hard to heal our relationship with the natural world, to become "native" to a place. It is uncanny and sadly ironic to find ourselves warring with species dispersing into new habitats (much like ourselves), doing what species have done for eons.

About the Authors

Jono Neiger worked as a restoration biologist with the Nature Conservancy for several years, establishing riparian forest on the floodplain of the Sacramento River in California. Jono is an ecologist/land manager/landscape designer, teaches permaculture design at the Conway School of Landscape Design, and operates a design and implementation firm, Regenerative Design Group in Greenfield, MA.

Dave Jacke has been a student of ecology and design since the 1970s. A recovering nativist, he is the primary author of *Edible Forest Gardens* and a long-time permaculture designer and teacher.

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Glossary of some terms in community ecology and changing ecosystems:

Niche: The functional position of an organism in its environment, comprising the habitat in which the organism lives, the period of time in which it occurs and is active there, and the resources it obtains there. A species' niche is the role that it plays in the community.

Diversity: Most simply, the species richness of a community or area, though it provides a more useful measure of community characteristics when it is combined with an assessment of the relative abundance of species present.

Species richness: The number of species present in a community, measured as the number of species per unit of ground area.

No-analog community: Communities that are compositionally unlike any found today. (Williams, see reference above)

Anthropogenic: Substances, processes etc. of human origin or resulting from human activity.

Native: A species that occurs naturally in an area, and therefore one that has not been introduced by humans either accidentally or intentionally.

Naturalized: 1. An introduced species that reproduces on its own and is well established in a region 2. A species that was originally imported from another country but *now behaves like a native* in that it maintains itself without further human intervention and *has invaded native communities*. (my itlalics)

Invasive species: 1. A species, including its propagules, that is not native to an area in which it occurs and that is capable of causing harm to native species or the natural environment, economic damage, or injury to human health. 2. Any species, native or non-native, which heavily colonizes a particular habitat.

Introduced species: A species living outside its native distributional range, which has arrived there by human activity, either deliberate or accidental. (Wikepedia) "[s]pecies that have become able to survive and reproduce outside the habitats where they evolved or spread naturally" (US EPA)

Indigenous: often synonymous with native.

Succession: The sequential change in vegetation and the animals associated with it, either in response to an environmental change or induced by the intrinsic properties of the organisms themselves.

Disturbance: A temporary change in average environmental conditions that causes a pronounced change in an ecosystem. (Wikepedia)

Competition: The interaction of individuals of the same species (intraspecific competition) or individuals of different species (interspecific competition) at the same trophic level, in which the growth and survival of one or all species or individuals is affected adversely.

Patch (landscape ecology): A relatively homogeneous area that differs from its surroundings. (Wikepedia)

Stress: A physiological condition produced by excessive pressures that are detrimental to the organism.

Assemblage: A collection of plants and/or animals characteristically associated with a particular environment that can be used as an indicator of that environment. The term has a neutral connotation. Its use does not imply any specific relationship between the component organisms, whereas terms such as “community” imply interactions.

Definitions primarily from: A Dictionary of Ecology 4th ed., Michael Allaby, Oxford University Press, 2010