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GUILTY UNTIL PROVEN INNOCENT

Preventing Nonnative Species Invasions

*by Jason Van Driesche
& Roy Van Driesche*

PREVENTION IS A CONCEPT THAT DOES NOT COME NATURALLY TO MOST AMERICANS. We are a culture that places full faith in our ability to emerge victorious from battle no matter what the odds, and the American approach to danger and uncertainty has always been to go in guns blazing and sort things out after the smoke clears. It should therefore come as no surprise that one or another government agency or conservation organization is always declaring a “war on weeds.” Though few would say it in so many words, Americans think prevention is for wimps.

But the war on invasive species is a war that can only get worse. International commerce and travel are growing exponentially, and trade is destroying natural barriers between ecosystems just as fast as it removes barriers to the movement of goods. In a world whose motto has become “No limits,” the cost of this loss of ecological isolation is growing daily. The time has come to admit that there are some battles that are better prevented than fought. With a little luck, we might learn some ecological humility before the casualties become too great.

Preventing Accidental Introductions

Preventing accidental introduction of pests is something everyone can agree on in theory. There is a general social consensus that certain kinds of organisms—mostly plant and animal pathogens, insect pests, and obvious weeds—are not welcome. Where disagreement begins is on how high to raise the bar. How much benefit is society willing to forgo, and how much regulation will people put up with in order to avoid accidental pest introductions? Thoughtful evaluation of these choices demands a clear understanding of what constitutes high- and low-risk activities, a

This article was excerpted from the recent book, *Nature Out of Place: Biological Invasions in the Global Age* by Jason Van Driesche and Roy Van Driesche (Island Press, Fall 2000).

realistic assessment of the power of inspection systems to erect protective barriers, and a creative approach to developing proactive programs to identify and reduce risk.

High- and Low-Risk Importation Patterns

The level of risk imposed by a given type of importation depends more than anything on the ecological relationship between the source and destination of the product being moved. Importation of untreated larch logs from Siberia to western North America, for example, would be inherently risky in that ecological similarities between the two regions make it highly likely that pests that arrive on imported logs would thrive at the expense of native tree species. In contrast, mahogany logs imported to New York would pose little threat to the local forest ecosystem, even if they occasionally brought their bark beetles or borers with them. These species would have no local hosts and would be unable to survive.

However, the relative degree of risk of a given pattern of importation depends not only on the nature of such relationships, but also on the volume and character of the cargo itself. Overall, importation patterns that pose a high risk of pest introduction involve commodities that are moved between regions with similar climates and plants, commodities that are moved in large quantities on a regular basis, and commodities that readily conceal pests. Conversely, the risk of accidental pest introduction is relatively lower for commodities that are imported from regions with less rigorous climates, commodities that are moved to areas where similar plants are not present to serve as hosts, and commodities that are moved in small quantities. Any estimate of the degree of risk of a given action is based on an educated but ultimately subjective assessment of the net effects of all the above factors.

Government efforts to reduce risks often entail placing conditions on importation that regulate how and where different kinds of imported goods from different points of origin must be handled. Importations that pose a high risk of accidental introduction are generally regulated more heavily than those that are considered to pose a low risk, but even with importation patterns that are essentially guaranteed

to carry pests, regulation is much more commonly used than outright prohibition. For instance, one common stipulation of an importation permit is that a given item may be imported to certain parts of the country but not to others. But relying on such limited permission is a poor strategy for controlling the risk of invasion, for national borders are the only practical line of defense. Ultimately, the only reasonable way to handle high-risk importations is to prohibit them entirely.

Inspections as a Tool for Detecting Invaders

To slow the rate of uninvited nonnative species introductions, most countries inspect incoming materials in an effort to detect stowaway organisms. This usually consists of asking travelers if they are carrying such high-risk items as fruit, seeds, or live plants, items that generally are either potential pests themselves or potential hosts of insects or pathogens. Inspectors are also responsible for reviewing the documentation and checking the contents of commercial shipments of goods, be they tankers full of wood chips or planeloads of roses.

Given the large and increasing volume of food, ornamental plants, wooden packing materials, and nursery stock shipped internationally each year, inspectors typically are limited to spot checks of a few shipments. Inspections are therefore filters—not barriers—and they often miss nonnative invaders at either of two levels. First, the fact that only a tiny fraction of shipments are actually inspected provides ample opportunity for organisms to be missed by simple noninspection. Although inspectors focus their efforts on high-risk shipments (making actual inspection efficiency somewhat higher), much is missed. Second, even for shipments actually checked by an inspector, some kinds of organisms can easily be overlooked, especially if they are hidden—wood-boring insects in packing material, for example—or invisible, such as pathogens that have not yet caused visible symptoms. The chestnut blight, for example, entered the country on apparently healthy Asian chestnut (*Castanea mollissima*) seedlings. Even if these trees had been inspected, detection would have been impossible without the help of plant pathologists and without enough time to take and culture samples before shipments were released.

Relying on inspection as a primary barrier instead of as a final check is akin to trying to filter a river of muddy water with a handkerchief. It will fail.

Similarly, the Asian longhorned beetles (*Anoplophora glabripennis*) that are now killing maples in the New York and Chicago regions invaded as beetle larvae inside wooden crates used to ship manufactured goods from China. Such internal or microscopic organisms are extremely difficult to spot, even with concerted effort.

Inspection is effective only if the nature and volume of the cargo that inspectors are charged to examine are constrained by sensible policies regarding what can and cannot be brought into the country. Relying on inspection as a primary barrier instead of a final check is akin to trying to filter a river of muddy water with a handkerchief. It will fail.

Active Prevention of Species Movement

For species known to be dangerous or pathways very likely to promote movement of unwanted species, governments can create proactive programs to reduce the rate of introduction. Some states have their own proactive efforts against particularly threatening species. For example, Hawai'i has mobilized a major effort to prevent invasion of the brown tree snake (*Boiga irregularis*), an Asian predator that would drive many of its remaining native bird species to extinction. Hawaii's approach has two major components: snake-proofing the airports on Guam and inspecting cargo from Guam as it arrives in Hawai'i. The fewer snakes there are at airports and in warehouses on Guam, the less likely it is that they will stow away in crates or other goods leaving Guam. And in Hawai'i, a combination of fences, snake-detecting dog teams, and protocols for responding to snake sightings provide a means of detecting snakes should they arrive on airplanes from Guam. In the longer run, though, the overall density of snakes on Guam must be reduced—by introduction of pathogens or other means—so that Guam's threat as a source of infestation to the rest of the northern Pacific islands is permanently lowered. Anything else is simply a holding action.

Another form of active prevention has been applied to the movement of aquatic species in the ballast water of cargo ships. The bilges of large ocean vessels are floating aquaria, picking up a variety of species (mostly plankton and other invertebrates) in

the coastal waters of one continent and then discharging them in another when ballast water is pumped out at the port of destination. This route of entry became a concern in North America in the early 1990s following the discovery that zebra mussels (*Dreissena polymorpha*) had been accidentally introduced into the Great Lakes via ballast water. The high cost of the zebra mussel invasion in North America prompted the passage of a law requiring ships to exchange ballast water in the high seas or treat ballast water with chemicals. These and other regulations, while not yet robust, have the potential to change what was a high-risk pattern of international trade into a relatively low-risk one.

Invited Species That Become Invasive

Though the techniques for prevention differ, the same fundamental logic that applies to reducing the likelihood of accidental introductions also applies to minimizing the risk of unintended impacts of deliberately imported species. Keeping out accidental stowaways focuses on the composition and size of the regulatory wall erected; evaluating species for deliberate importation concerns when it is acceptable to open the gates. Unfortunately, the same misunderstanding of the nature of biological risk that allows for one accidental introduction after another also prevents the creation of a comprehensive system of evaluation for proposed introductions. Until there is a fundamental shift in public understanding of risk that allows for a much more vigorous and proactive approach to both wall-building and gatekeeping, prevention efforts will only delay invasions, not prevent them.

The presumption of innocence and the focus on individual rights rather than collective risk define the dirtylist approach.

There are two approaches commonly in use for the evaluation of proposed introductions.

“Dirtylists” identify species that are known or presumed to be harmful and prohibit their importation and release. This approach to prevention is grounded in the assumption that species proposed for importation are innocent until proven guilty and is the principal approach used in the United States. “Cleanlists” consist of species for which the preponderance of evidence indicates relatively low risk of invasiveness or harm and allows for their importation without review. Australia and New Zealand have pioneered this approach to prevention. The track record of this second approach is too short to draw conclusions yet about its practical effectiveness. However, there is great promise in the fact that cleanlists substitute a presumption of guilt for the presumption of innocence that underlies the dirtylist approach.

Dirtylists and Their Shortcomings

Whether a dirtylist is at all useful depends largely on the length of the list and the thoroughness of the efforts to determine if it is reasonably complete. At its simplest, a dirtylist is merely a roster of a country’s past mistakes—that is, of introductions already made and therefore largely irrelevant to prevention. If species are prohibited only after they have invaded and caused damage, the only benefit of compiling such lists is the chance they offer to slow the spread of new invaders to as-yet-uninvaded areas within the same country.

A more useful approach would be one in which the listing agency actively seeks information about species in advance of importation requests for the purpose of better recognizing species that should be dirtylisted, perhaps because they are pests elsewhere or have features—such as tolerance of a wide range of habitat conditions—that suggest they might readily become pests. Australia is presently trying proactive review of South African plants to dirtylist species

likely to be invasive in Australia before they are requested for import.

In a regulatory climate dominated by economics, though, any particular strongly proactive dirtylisting attempts are likely to run into political difficulties. Importers whose income would be affected if the range of importable species were reduced are likely to object vigorously to any such attempt to dirtylist anything but obviously damaging species. They are likely to argue, often persuasively, that they are suffering undue economic harm and that there is no clear proof that any particular suspicious species is risky enough to merit exclusion. Within a standard framework of risk analysis, the importers’ arguments are sound because the risk that any particular species will actually become invasive is quite small. Unless there is nearly incontrovertible evidence of likely damage, few risky species will be dirtylisted based on this approach to risk evaluation.

Herein lies the fundamental limitation of dirtylists. Excluded species are the special category, not the default classification. This means that people have a right to bring in any new species they want, unless its importation has been proven so obviously detrimental that it warrants prohibition. The presumption of innocence and the focus on individual rights rather than collective risk define the dirtylist approach and place such large constraints on its use as to render it of limited value. It is the direct equivalent of how pesticides were regulated before passage in 1947 of the original pesticide control act (FIFRA), which shifted the burden of proof from government to industry. Before 1947, government health officials had to prove on a case-by-case basis that a particular pesticide residue was dangerous. After the passage of FIFRA, pesticide companies wishing to market a pesticide had to prove the product was safe. Though the system certainly has its defects, its orientation at least allows for the possibility of improvement.

Cleanlists: A Proactive Approach

If one takes the view that people do not have any intrinsic right to import nonnative species, then the burden should be on importers to show that the species to be brought in will not cause harm. Since the ability to identify invasive spe-

cies in advance is limited and the consequences of being wrong are great, such a conservative approach—one that makes prohibition the default and permission the exception—is the only sensible strategy. This shifting of the burden of proof is the key to effective prevention.

Such a presumption of possible harm is the principle underlying the cleanlist approach. All nonnative species are assumed to be potentially damaging, and only those that appear unlikely to become invasive are allowed to be imported. But even use of cleanlists may present difficulties. For small groups of relatively well known species like birds, mammals, and other vertebrates, cleanlisting is probably technically feasible. For large groups like insects and plants, it is not. There are so many species in each of these groups (many of them unknown) that to even make a list of all species—let alone gauge the potential invasiveness of each—simply is not possible.

However, the power of the cleanlist approach is not so much in the lists of permitted species that are generated as in the fact that anything not yet reviewed is presumed to be unsafe. The practical consequence of this approach would be to eliminate frivolous species importations, for only those with real social, economic, or ecological benefit would be worth the time and expense required to demonstrate noninvasiveness. Introductions would still happen, but only after careful consideration.

Current U.S. Policy Regarding Nonnative Species

The inability of the U.S. government to formulate a coherent national policy on the importation of nonnative species (accidental or deliberate) derives largely from the fact that people have very different feelings about different kinds of organisms. As a consequence, the process of evaluation for each kind of species begins with a different set of assumptions about the relative threat a given class of organisms presents. These assumptions have their origins more in cultural history than in ecological science, but their influence over policy is profound. The United States' agricultural roots condition people to see most plants (es-

pecially beautiful or edible ones) as beneficial and most insects that eat plants as suspicious at best. It also predisposes us to look favorably upon most mammals, birds, and fish, especially game species. Most everything else simply fails to register. But invasive species come in many varieties, and effective prevention demands a levelheaded and ecologically based approach to evaluating the potential benefit and harm of each proposed introduction.

For the most part, nonnative plants are assumed to be innocent and beneficial—and therefore noninvasive. Importation is forbidden only for a tiny handful of plants (under 200 species, most of which are crop weeds or parasitic plants). While invasiveness in natural areas has long been poorly reflected in the species chosen for dirtylisting, the recent inclusion of several invaders of natural areas (such as the shrub *Mimosa pigra*, the Australian paperbark tree *Melaleuca quinquenervia*, and the invasive marine seaweed *Caulerpa taxifolia*) suggests the beginning of an expansion – albeit a slow and tentative one – of the scope of prohibitions.

Importation of any herbivorous insect or plant pathogen is forbidden unless specifically authorized; any species that attacks plants is viewed as a potential threat to agriculture. (This policy applies to both accidentally introduced plant pests and those proposed for introduction as biological control agents.) Plant importation is recognized as the major route of such invasions, and as a consequence, laws were passed early in the twentieth century that require inspection and quarantine of imported plants. It is important to note, however, that inspections are only for insects and diseases; in general, the plants themselves are not an object of scrutiny.

The blanket prohibition on introduction of plant feeders is not without holes. For example,

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butterfly houses routinely import herbivorous insects, often with little or no review. The fact that butterfly importations are generally permitted highlights the non-ecological foundation of importation policies; for species that do not “look” threatening are more likely to be let in regard-

less of their actual impacts. Whether butterfly houses will be a source of species invasions is not yet certain, as importation of butterflies for such purposes is a relatively new phenomenon. The likelihood is that in the long term, they will.

Importation of non-herbivorous insect species for use as pets, biological control agents, or other commercial purposes is generally viewed favorably by the federal government. Biological control agents for insect pests were for many years viewed as inherently safe, wholly beneficial, and contributing to increased public safety by reducing the use of pesticides on crops. In more recent years, several cases of negative impacts of biological control agents on nontarget species have been identified, and both the scientific community and the public at large have begun to evaluate biocontrol introductions more carefully. Other avenues of introduction of non-native insects are still subject to little or no scrutiny. For example, imported species of cockroaches and spiders are now commonly available in pet shops. Given that most such species do not eat live plants, most are not regulated by federal plant protection acts. Some states (such as Florida) have recently passed legislation banning their sale, but the ease with which such species can be shipped across state lines significantly limits the effectiveness of regulation at anything but the federal level.

Importation of “wildlife” (roughly, terrestrial vertebrates) poses two problems, only one of which is covered by current laws in the United States. First, nonnative wildlife can vector disease that might affect native wildlife, a threat addressed in comprehensive quarantine laws. However, current laws do not address the threat of in-

vasion of natural areas by imported wildlife species themselves. Importers must show only that the imported species is not a disease vector and that it is not a rare or threatened species in its area of origin. (Some states do prohibit such introductions on grounds of invasion potential,

but again, state laws are of limited effectiveness.) Wild elephants roaming the west Texas plains seems far-fetched, but wild emu in Georgia appear to be a reality following the collapse of the emu-rearing craze. Whether they will prove damaging is not yet known, but the fact is that their release has introduced a major new animal to the ecosystem.

A series of disasters in the nation’s waters have heightened governmental awareness of the impacts of introduced species on aquatic environments and resources. In particular, the economic impacts of zebra mussels run into the billions of dollars, and zebra mussels threaten dozens of species of native mussels with extinction. Other aquatic species threaten to degrade (or have already degraded) the productivity of shell and fin fisheries in Chesapeake Bay. These and other problems spurred the passage of a federal law requiring ships entering the Great Lakes to treat their ballast water chemically or exchange ballast water on the high seas, as stated earlier. The next logical step is to extend this requirement to all U.S. ports and eventually to all shipping by means of an international treaty.

Other aspects of the aquatic species threat, however, remain unaddressed. Fish reared commercially (for food or for sale to hobbyists) may themselves become unwanted invaders of native habitats. The blue tilapia (*Oreochromis aureus*), for example, has invaded the habitat of threatened native fish in parts of the western United States. However, because fish farming is an agricultural enterprise, fish species under cultivation are considered a valuable resource, and the threats they pose to native ecosystems are largely ignored.

Developing Better Policies for Prevention

The development of a better system of prevention is not just a technical matter of framing more comprehensive legislation. The effectiveness of even the most comprehensive set of new laws will be constrained by the degree to which they deal with two key issues: *free trade* and *accountability*. Integrating protection measures into trade policy and creating a funding mechanism for mitigation of damage serve as a platform on which sound prevention measures can be developed.

The Dilemma of Free Trade

Laws prohibiting the entry of a given type of product on grounds of prevention of invasions have at times been attacked as protectionist measures in disguise. Under current world treaties on trade, such practices are subject to challenge by the country whose products are excluded. For example, when the United States prohibited the use of packing crates made of untreated wood for shipping of commercial goods from China to America in 1998, the Chinese government objected on the grounds that such measures constituted an unfair barrier to trade. Though China eventually dropped its objections once it became clear that untreated wood crates had been the source of the Asian longhorned beetle invasion, this kind of conflict will only become more common under the strongly pro-trade regulatory regime that now dominates at the international level.

Efforts to limit trade to prevent pest invasion and protect local biodiversity will increasingly have to be defended in World Trade Organization dispute panels against opposing interests whose economic concerns would be hurt by such restrictions. How will the still-uncertain ecological and economic costs of potential invasions be judged against the easily quantifiable economic costs if permission to import a specific good is denied? What is missing is a broad body of knowledge of the social and economic consequences of nonnative species invasions. Since loss of the amenities that natural systems provide is often incremental, few people realize just how enormous a weight pests already present impose on economic use and enjoyment

of the natural world. A recent study by David Pimentel of Cornell University attempted to quantify the negative economic impacts of invaders and estimated that invasive nonnative species currently cause about \$137 billion in damage annually in the United States alone. Many more studies of this kind are needed because, until prevention speaks the language of economics and well as ecology, it will consistently take a back seat to free trade.

A System of Accountability

When invasions happen—and they will continue to occur even under a well-designed prevention program—who should pay to mitigate their effects, whose economic impacts alone can run into millions or even billions of dollars? Under current law, it would be difficult if not impossible to assess blame and impose damages. Unfortunately, society operates on the assumption that unless specific violations of importation regulations occur, invasions are no one's fault. Even if it was willful negligence that led to the introduction of a new pest, the offending party is not responsible for anything more than the fines associated with such violations. A shipping company could be fined for failing to flush bilges before entering coastal waters, but it could not be held responsible for the costs imposed on society by any new invaders that it happens to carry in its ballast water.

In any case, it is often impossible to link most invasions to the persons or corporations responsible. One alternative would be to take a cue from the insurance industry and levy a fee on international shipments in proportion to their potential to cause biotic invasions. All groups benefiting from trade in nonnative species (or types of cargo that can carry them) would be required to pay into a mitigation fund based on the volume and nature of the cargo they carry. Money raised would then be held in reserve to allow rapid funding of efforts to eradicate new invaders or develop biological control programs for pests if they are only detected after eradication is no longer possible. Such a system would require that businesses and individuals trading in risky organisms take collective responsibility for resolving the problems that arise from their activities. Such a pooled system would sidestep the obvious defense made by

Until prevention speaks the language of economics as well as ecology, it will consistently take a backseat to free trade.

such groups that only a small percentage of non-native species become damaging and would instead recognize the even more compelling truth that these few species, while not numerous, affect large areas and impose huge economic and ecological costs.

Placing “Filters” Between Ecosystems and Trade

Even though outright prohibition of all vectors of species movement is not feasible, a few well-chosen measures would serve to reduce the number of new introductions per year. Proposed changes in federal laws or regulations regarding prevention of introductions might logically be organized around a series of “filters” designed to protect native ecosystems from damaging invasion. Since the legal context of species importations and trade regulation in general is constantly changing, the following points—or filters—provide a brief indication of possible new legislation and regulations needed without proposing specific, detailed pieces of legislation.

- 1. Encourage the preferential use of local native species from local seed sources.** An executive order requiring that all federal agencies use only native species for landscaping, revegetation, and other activities, unless there is a compelling reason to use a nonnative species; and requiring the same of all state and local units of government and private organizations that receive federal funds.
- 2. Encourage the preferential use of nonnative species that, based on experience, appear to be highly unlikely to become invasive.** A law prohibiting the deliberate introduction of any new nonnative species without review, and either providing federal funding for evaluation of requests to import species or mandating payments by importers (or both).

- 3. Develop robust inspection services to detect and exclude unwanted stowaway organisms.** Revised regulations giving postal and customs inspectors the authority and the funding to inspect both domestic and international mail and cargo suspected of carrying prohibited species; new laws that impose substantial penalties for the interstate or international shipment of prohibited species without permission.
- 4. Identify high-risk species and/or vectors of introduction.** Increased funding for APHIS, the federal agency charged with these matters; new legislation giving APHIS an express mandate to prohibit permanently and totally the importation of any species whose life history suggests the potential for invasiveness, and to control high-risk pathways of introduction.
- 5. Create a remediation fund that would be available for rapid response to new invasions.** A law imposing a fee on all economic activities that serve as vectors of species introduction; new regulations and inter-agency agreements that create a system of detection and response to new invasions using funding generated by the new fee.

The Federal Executive Order on Invasive Species

The process of developing a series of protective filters between invasive species and native ecosystems has already begun. On February 3, 1999, President Clinton took a significant step toward creating a comprehensive nonnative species policy with Executive Order 13112. This order is binding on all federal agencies and requires them to:

1. Identify any actions they may be taking that promote harmful nonnative species invasions.
2. Prevent the introduction of harmful invasive species.
3. Monitor harmful invasive species (in their lands or areas of responsibility) and take rapid, appropriate action to reduce spread of such species.

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4. Restore native species and habitats affected by invasive species.
5. Conduct research on invasive species and develop new technologies for their suppression.
6. Promote public education on the impacts of invasive species.

More broadly, the executive order requires creation of an Invasive Species Council to serve as an advisory committee at the highest levels of the federal government. The job of the council (now underway) is to oversee the implementation and coordination of the executive order within and among the relevant federal agencies. The council encourages planning at multiple levels of government, provides guidance to agencies on how to prevent or control damage from invasive species, facilitates the development of an information network among federal agencies for monitoring and documentation, establishes a coordinated set of databases on nonnative species, and prepares a National Invasive Species Management Plan (see www.invasivespecies.gov for more information). An important feature of this plan will be to review existing and prospective approaches and legal authorities for preventing the introduction and spread of invasive species—that is, to determine if new laws or regulations are needed and, if so, in which areas.

The Council and Plan offer an unprecedented opportunity to create a coordinated and comprehensive system for preventing and managing nonnative species problems. If the federal agencies responsible for working with the Council and implementing the Plan follow through on the intent of the executive order, the United States may be able to slow the rate of new introductions significantly. This may be the best chance we will ever have to institute effective policies of prevention while there are still invasions to prevent. 🐼

Suggested Reading

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Williamson, M. 1996. *Biological Invasions*. Chapman and Hall, London.

Web Sites

National Invasive Species Council

(<http://www.invasivespecies.gov>)

Official site of the interagency effort to implement the Executive Order. A draft management plan is available for download.

Invaders Database System

(<http://invader.dbs.umt.edu>)

A compendium of publications, invasion histories, and pest descriptions. Also offers an alert service and a database searchable by region and topic. Focuses largely on plants.

American Lands Alliance's Invasive Species Page

<http://www.americanlands.org/forestweb/invasive.htm>

Information on current national invasive species policy issues.

Animal & Plant Health Inspection Service

(<http://www.aphis.usda.gov>)

Information on major regulatory issues. Special reports on “hot topics.”