Fletcher Distinguished Lecture Series

Invasive Species and the Public Good

A summary of a forum and speaker series exploring the human and political dimensions of invasive species

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Fletcher Distinguished Lecture Series

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This speaker series was made possible by the generous support of the Fletcher Foundation, a not-for-profit private charitable organization created by Alphonse Fletcher, Jr., who graduated in June 2004 from the Yale School of Forestry & Environmental Studies. The Foundation is most strongly committed to projects that better the community at large.
Executive Summary

The need for communication on how invasive species affect human welfare is critical. Although formal research, experimental on-the-ground management, public education, and prevention campaigns addressing invasive species have flourished in the past several years, they have focused primarily upon known and anticipated environmental consequences and methods of control. Equally important, however, is the effect of invasive species upon the public good—how humans are impacted by the problem, and how they are coming together to surmount it.

The Fletcher Distinguished Lecture Series: Invasive Species and the Public Good, hosted by the Yale School of Forestry & Environmental Studies in the spring of 2005, addressed this aspect of the problem through an opening forum and a series of six lectures. It featured prominent ecologists, federal policy-makers, and leaders of non-governmental organizations. They illustrated the severity of the problem, described innovations in ecological management, and explained how regional and cross-sector alliances are helping to control invasive species in the U.S. and abroad.

This series provided the kind of multi-disciplinary, multi-sector learning that is crucial for successful environmental planning and management. Solving complex problems such as invasive species requires collaboration among diverse parties, who rarely have opportunities to interact. We therefore made every effort to publicize the series beyond academia to natural area managers, local politicians, plant nursery operators, landowners, and others. Our efforts paid off—lecture audiences consisted of a wide variety of stakeholders.

This volume summarizes the nine lectures and one group discussion that comprised “Invasive Species and the Public Good.” Chris Dionigi, Faith Campbell, and Jeff Fisher review relevant domestic and international policy and trade issues. Joan Ehrenfeld describes how invasive species are changing ecosystem properties, and David Pimentel highlights their economic impact. Elizabeth McCance and Sarah Reichard discuss multi-sectoral alliances and public participation. John Drake explores ethical questions, and Jeff McNeely describes the effect of invasive species on human livelihoods around the world. Dan Simberloff’s lively and frank discussion with members of the Yale community concludes the volume.

Certain themes appear throughout the lectures. Over and over again, speakers reiterate the need for stronger prevention strategies against future invasions, communication between sectors, and prioritization by politicians and the public. To their credit, the lecturers also recommend ways to achieve these objectives. They include the following:

- Extend the reach of academics beyond the university by developing practical decision-making tools for practitioners.
- Use ecological expertise to train community members in the grunt work of invasive species management, and do some hands-on work themselves.
- Approach opponents with respect and generosity; assume their good intentions and identify commonalities.
- Trust the professional competency of other agencies and organizations to forge mutually supportive alliances.
- Accept the frustrations inherent to collaboration by recalling the importance of bringing diverse talents and perspectives together.
- Use economic data to support arguments about the importance of the invasive species problem. People listen to numbers.
- Find out what community members and politicians care most about, and experiment with strategies for reaching them by explicitly addressing their concerns.
- Tell success stories—affirm that the situation is not hopeless.

Issue press releases, not just scientific papers, on ecological findings with distinct policy implications.
As we intended, the “Invasive Species and the Public Good” series helped raise awareness about how invasive species are affecting the public welfare, such that the environmental community is better equipped to address this aspect of the problem. The discourse that emerged from the series sets the stage for further collaboration between diverse stakeholders, fostering innovative approaches to invasive species management in the future. We welcome comments and suggestions from all readers of this Review.

Issue Introduction

Organisms of every kind, from microbe to mammal to beautiful plant, can be invasive. The problems they cause are equally diverse. The negative effect of invasive species upon biological diversity has been well documented, and ecologists agree about the seriousness of their impacts. Not only are invasive species environmentally harmful; as the lectures in this volume make clear, they also harm human welfare. A few examples illustrate the range of consequences:

- The brown tree snake damages electrical wires and bites children in Guam.
- The Samoan subterranean termite attacks New Orleans’ culturally valuable live oaks.
- Chestnut blight eliminated the American chestnut from the northeastern U.S. in the early 20th century.
- Zebra mussels have clogged water intake pipes and valves of power plants throughout the Great Lakes region.
- In Southeast Asia, golden apple snails first introduced as a new protein source are now destroying rice paddies.

The microbe that causes foot and mouth disease has killed livestock and transferred to humans in several countries worldwide.

Perhaps most dramatically, David Pimentel and others have estimated that the damages caused by invasive species cost $120 billion annually in the U.S. alone.

Their effect on humans is one of the most salient criterion for defining invasive species in the first place. For a species to be considered invasive, it must be causing notable harm to biodiversity or human interests such as economics or health. It also must have established itself in a region or habitat in which it did not originally occur. This definition contains contentious nuances, as several of the summaries in this volume indicate. For example, what qualifies as “original” appearance? Who defines harm? How harmful must the species be to be considered invasive? For general purposes, however, the criteria offered here are more than adequate.

While species have been moving around the globe for millennia, the rate at which they do so has increased dramatically. International trade facilitates species exchange both intentionally—horticultural plants and “useful” animals, for instance—and not, as with the insects and pathogens that accompany trade goods and human travel unseen. The vast majority of introduced species do not become invasive; indeed, our livelihood depends heavily on species that originated elsewhere. Of those that do eventually cause problems, many do so only after a significant lag time. Others may act invasive in some places and not in others. These qualities make it difficult to predict which species will become invasive, or when or where they will do so.

The lectures presented here address the invasive species problem from a variety of perspectives, but return consistently to a few critical points. Several deserve special emphasis:
Governments have uniformly failed to prioritize invasive species prevention and control. Policy-makers only respond to problems when they are obviously costly or otherwise harmful. People worried about invasive species have to find more effective ways to emphasize the severity of this problem.

It is difficult or impossible to identify accountable parties for the damages that invasive species cause.

Cooperation between sectors—not only those on the same scale (e.g. international agencies) but also between large-scale and small-scale—is critical.

Ultimately, hands-on work is what will control invasive species. Getting this done requires a great deal of public education and participation.

The point reinforced most often is that successful invasive species management requires better cooperation between sectors: public and private, international and local, ecological and political. As Elizabeth McCance stated, collaboration “extends limited resources, fights threats at a regional level, and combines knowledge to create the best programs and strategies possible for managing invasive species and conserving biodiversity.” It is in this collaborative spirit that we offer up Invasive Species and the Public Good as a resource for readers of all kinds.

Presenters:

**AN INTERNATIONAL PERSPECTIVE**

**JEFFREY MCNEELY**
Chief Scientist, World Conservation Union (IUCN)

The world is shrinking. Continents were once well separated, with distinct flora, fauna and cultures in different parts of the world. Now, we’re all connected by the global economy. While this connectedness has provided many benefits, it also brings costs and among the chief costs today are the spread of invasive species and the problems they cause.

Local trade has increased about forty times over the last 40 years or so, from $192 billion in 1965 to almost $8 trillion in 2004. But it isn’t just goods that move around the world—recent figures show that about 700 million people traveled internationally last year. People are little ecosystems running around, with at least 600 species of bacteria in each of their mouths alone. As tourists go from here to there, they carry all sorts of organisms and parasites along with them.

At any harbor anywhere in the world, be it Shanghai, New York or Dar es Salaam, big ships are unloading big containers. Six million of these containers are in movement at any one time, and even in the U.S., which is very concerned about security issues, customs officers are only able to inspect about 2% of the containers. In much of the rest of the world, officials are able to look at virtually none of them, enabling species to enter unimpeded.

One major problem with invasive species has to do with purposeful introductions, bringing in species for agroforestry or biocontrol, for instance. Usually this is done for economic reasons—perhaps as a profitable food source or biocontrol measure. Too many of these introductions have occurred without enough information on how the species will affect ecology and economics. They also raise the central question of who benefits from these introductions and who pays the costs.

“Decision-makers have a very hard time dealing with prevention because it means putting up money before problems arise.”

— Jeff McNeely
For instance, the huge Nile perch was introduced to Lake Victoria for harvesting. Exporting the fish, mostly to Europe, brings in tens of millions of dollars a year for a few people in East Africa. This has made the fish too expensive for most local people to eat, and their protein intake and nutrition have diminished as a result. Another problem is that the predatory perch has dramatically reduced populations of the estimated 300 endemic species of cichlid fish found in Lake Victoria. (Ironically, the fish have been able to make a comeback in some places by finding shelter in the invasive and extremely damaging water hyacinth.) Another case is the golden apple snail, introduced into Southeast Asia from South America to add protein to people's diets. The problem is that the snails love rice, and have been destroying rice paddies throughout the region. They also carry rat lungworms, flukes, and other potential human parasites. The Food and Agriculture Organization of the United Nations (FAO) has identified a biological control and put predatory fish into the rice fields, but the problem is not yet being controlled.

The invasive species problem affects many sectors—global trade, human livelihoods, agricultural economics, water management, climate change, genetic engineering, and more. This is why many people believe it is an issue deserving much more attention from the global community. Avian influenza is one example of these sectors coming together. It is rampant in Southeast Asia today, and epidemiologists are very concerned that it could turn into an epidemic as serious as the influenza that killed 20-40 million people in 1918. Like SARS and other microbial diseases, avian influenza is the kind of invasive species that brings together the health community with biologists and ecologists.

How is the international community addressing the invasive species problem? A few possibilities stand out.

**International Cooperation**

The Convention on Biodiversity (CBD) calls for parties to prevent the introduction of those species that threaten ecosystems, habitats, or species, and to attempt to control and/or eradicate them. That convention has been ratified by 188 countries. The only four countries that have failed to ratify it are Iraq, Brunei, the Holy See, and – yes – the United States. Even so, often the largest delegation to the Conference of the Parties is from the U.S., attending as observers, so the convention is still influencing the U.S. even without explicit membership. The Convention has embraced the Global Invasive Species Programme, whose fifty partners are working together to address the problem, trying to build sufficient political support and scientific information to deal with it more effectively.

**Prevention**

In virtually all cases, prevention is better than cure. Ecologists know this and can demonstrate it, but decision-makers have a hard time dealing with prevention because it means putting money up front before problems arise. They need to see the problem before they spend money on it, and so we need to be a lot more convincing about the need for prevention.

With sufficient capacity and political will, countries can stop invasive species before they enter a new place. Better quarantine and inspection is one way to do that. In Hawaii, for instance, the Department of Agriculture is careful about preventing tourists from leaving with fruit because they are worried about exporting the damaging med fly as well. Already countries such as Australia and New Zealand are very strict about what travelers can bring in to the country.

Another way to prevent invasive species from being exported is assessing them first for invasiveness potential. IUCN is working with the World Agroforestry Center and the World Fish Center to make sure that any species introduced for economic reasons has been assessed very carefully to make sure it is not likely to become invasive. Doing this well requires more investment in research, and in a few years there may very well be technologies that identify and evaluate species much more rapidly. Some people have suggested strict measures such as allowing only finished products to be shipped internationally. That would presumably diminish the amount of insects and other organisms moving around
the globe. Only about 1% of introduced species become invasive, however, so raw products don’t need to be banned entirely—especially given the political uproar that would ensue. Products just need to be moved around much more carefully.

Invasive Species in Protected Areas
Protected areas are not pristine: most protected area managers are likely to say that one of their biggest management problems is invasive species. Hawaii Volcanoes National Park has a huge problem with an invasive pig. Ngorongoro Crater in Tanzania, a World Heritage Site, has about 10,000 hectares covered with non-native Mexican poppy. This plant is not palatable to any of the native grazers, so that large areas are devoid of the wildlife that tourists come to see. IUCN is working with agencies throughout the world to include invasive species management in their plans for protected areas.

Economic Policies and Tools
It’s amazing that there are actual subsidies to introduce nonnative species. That funding should be redirected towards research and management programs, and more funding should be secured by imposing fines on the people responsible for bringing invasive species in. Also, while the benefits of controlling, preventing, and/or eradicating invasive species far outweigh the costs of doing so, decision-makers are not aware of this. The message must be conveyed to them more effectively. Another economic point is that mechanisms have already been established within international trade agreements to control invasive species. The World Trade Organization (WTO) allows countries to place tariffs on invasive species trade, and the General Agreements on Tariffs and Trade (GATT) allow trading partners to take all necessary measures “to protect human, animal, or plant life or health.” These mechanisms should be emphasized and used more strongly.

To encourage the WTO and others to think more seriously about this, perhaps the countries with the most serious invasive species problems—South Africa, New Zealand and the U.S.—should force the issue onto the agenda. There are problems associated with this approach, of course. Australia has been affected by invasive species more than just about any other country, but it’s more worried about trade than invasive species. For this reason, Australia would not join a decision of the CBD that controlled trade of invasive species. The U.S. would also be likely to obstruct any such move, and has a very loud voice in the WTO. But if other countries push it on to the agenda and if the public starts pushing it as well—maybe stimulating groups like Greenpeace to protest on the streets—the WTO might start taking it seriously.

With increasing globalization, species are going to be moving around more than ever. Some people have said that 20,000 years from now, people will look back at this moment in history as the “Homogocene,” an era in which a formerly diverse world became much more homogeneous, with the same species found in all the appropriate habitats around the world. This is not a dramatic threat, but an insidious one. It calls for humans to put a higher priority on conserving diversity, in part by controlling invasive species. It calls us to pay more attention to this problem, and especially to encourage people in power to take urgent action to address it.
Effects on Ecosystems

JOAN EHRENFELD
Professor of Ecology, Evolution, and Natural Resources, Rutgers University

Invasive species can cause two kinds of changes. First, they affect interactions among individuals or species by altering resource use and predator/prey relationships, by hybridizing with native species, and by changing trophic cascades. Second, they change the physical environment and the ways in which species interact with it. Together, they result in the alteration of ecological communities. Perhaps most frightening, these changes can create alternative stable states—self-perpetuating environments that are very difficult to return to their original, desirable form. Each of these types of consequences deserves specific attention, and some of the most significant ones will be described here.

Diversity can either increase or decrease as a result of invasive species. High diversity is not always a good thing, because sometimes an influx of invasive species causes a net increase in community diversity but eliminates unique characteristics of the original community. Trophic cascades can also change because of invasive species. For example, in California’s Channel Islands, historically, golden eagles had colonized the island periodically and preyed on the island fox, but were unable to maintain permanent populations. When feral domestic pigs became established on the islands, they became a novel source of food for the eagles. This enabled the eagles to establish permanent populations, and their numbers increased dramatically. This in turn caused a large increase in predation on the island fox, bringing that species near extinction. This case exemplifies the kind of systemic effects that occur because of links between invasive and other species.

When invasive species have changed whole ecosystems, even removing the exotic will not change the system back to its original state.

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When invasive species have changed whole ecosystems, even removing the exotic may not change the system back to its original state because a new set of ecological processes have been established with the invading species. Such ecosystem impacts include changes to fire regimes, geomorphology and sedimentation, hydrology, and nutrient cycles. A few examples will help convey the seriousness of these changes. Cheat grass (Bromus tectorum) in the American west and molasses grass (Melinum minutiflora) in Hawaii and South America eliminate other species while developing contiguous fuels that increase fire frequency and intensity beyond the tolerance of native species. With more frequent burning, these grasses gain a competitive advantage and perpetuate the fire regime.

In the Yangtze River Basin in China, smooth cord grass (Spartina alterniflora)—a species needing much protection in the eastern U.S.—grows so tall that it reconfigures estuaries, alters sedimentation levels, and causes severe economic damage by eliminating shipping channels and beds for crustaceans. Arundo donax, or giant reed, has caused major hydrological problems in South Africa by reducing available water runoff by about 8%. Changes in nutrient fluxes, such as Japanese barberry (Berberis thunbergii) increasing nitrification rates in areas it has invaded in the eastern U.S., often create adverse conditions for native species.

All of these changes are mediated through specific traits of the invasive species—growth rates, size, shape, litter chemistry, decomposition rates, root characteristics, microbial relationships, and more. The structure of the Norway maple canopy, for instance, tremendously reduces light transmission, preventing virtually any native species from regenerating in its shade. Plants such as phragmites, kudzu, and cheat grass are so large and/or grow so densely that they outcompete other species simply by virtue of their biomass. Phenology, or the timing of plant activity, is another important trait. Barberry can begin photosynthesizing while the native understory plants are still dormant, giving it an advantage in terms of growth and nutrient uptake. Roots of invasive species can give them advantages as well; the Centaurea thistle in western grasslands has a very long tap root that outcompetes the shallow, fibrous root systems of the native bunch grasses.
Knowing the traits of invasive species and the quality of ecosystem changes can help researchers improve their management techniques. A major area of research now is the development of methods to manipulate the environment to reduce the growth of invasives, based on knowledge of the specific physiological traits that have allowed the species to become invasive. Another related research area is the exploration of methods of manipulating the environment to favor native species instead of eliminating invasives. Specific, well-researched control strategies will reduce invasive species problems without forcing the removal of every last stem of cheat grass or molasses grass.

Deer have become invasive in many parts of the northeastern US due to lack of predator pressure and increased suburban habitat.

**Economic Consequences**

**David Pimentel**

Professor of Ecology and Agricultural Sciences, Cornell University

The number of species that have invaded the United States is estimated at over 50,000. Given that the total number of species in this country is approximately 750,000, this is a significant portion. It’s probably a conservative estimate, because microbes and plants make up most of the invasives and aren’t noticed easily. Many of the introduced species are going about their business in nature without causing problems, and therefore we know little about them. Maybe 10 or 20 percent of the introduced species become problematic.

The rate of species introductions has increased a great deal as a result of globalization and more frequent human movement around the world. For instance, the last time we looked, about 234 organisms had been imported into San Francisco Bay. It took over a hundred years to introduce half of these species. The second half appeared just in the last thirty five years and invasives now make up 97% of all the individual organisms and 99% of the biomass in the bay.

They also impose an enormous economic burden on society—the direct costs of invasive species are estimated conservatively at $120 billion each year in the U.S. alone (the full economic analysis is available at [http://www.news.cornell.edu/releases/Jan99/species_costs.html](http://www.news.cornell.edu/releases/Jan99/species_costs.html)). Policy-makers tend to respond most rapidly and strongly to economic problems, so this kind of analysis can go a long way in convincing them to enact effective invasive species prevention and management policies.

The best way to convey information about the economic consequences of invasive species is through examples. Obviously there are many to choose from, but the ones provided here give a good general idea of how much these species are costing society. The estimates were derived with best available data and in some cases back-of-the-envelope calculations.

“Even 'back-of-the-envelope' calculations go a long way in convincing people that invasive species really are worth doing something about.”

— David Pimentel
**Ethical Considerations**

**John Drake**

Postdoctoral Research Fellow, National Center for Ecological Analysis and Synthesis

Invasive species bear on environmental and human welfare in numerous ways. Examples of impact on human welfare are: interference with production of economically valuable species, including cultivated (e.g. agriculture) and uncultivated (e.g. fisheries) species; polluting sources of fresh water; and involvement in pathways of disease transmission. Because these impacts on welfare will be differentially distributed in society, invasive species raise new questions for distributive justice as it pertains to individual exposure to environmental hazards and opportunities to exploit natural resources. As with other questions of distributive justice, these questions will only be answered by earnest ethical reflection and open deliberation.

The first philosophical problem associated with invasive species is how to define them. Roughly, invasive species are those introduced species that cause harm—but what counts as harm? A desirable or otherwise innocuous species can become harmful either through evolution or because of a change in what we consider as harm. Also, species that are beneficial in one ecosystem or to some sectors of society may cause problems elsewhere. For our purposes, harmful species are those that measurably, negatively affect humans.

The second problem is to identify the different ways in which introduced species can be harmful. Three (not necessarily exhaustive) possibilities are effects on conservation, effects on production and the potential for future production, and effects on human health.

This leads into questions of ethics: How are harms from invasive species distributed? Conversely, who benefits from the commercial and recreational activities that result in species invasions? Are these the same people who are harmed, or are they different? How are the

<table>
<thead>
<tr>
<th>Invasive Species</th>
<th>Impacts</th>
<th>Estimated Annual Cost</th>
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<tbody>
<tr>
<td>Agricultural pests</td>
<td>Crop loss, plus pesticide costs</td>
<td>$33 billion</td>
</tr>
<tr>
<td>Rats</td>
<td>Fire; structural damage</td>
<td>$19 billion</td>
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<tr>
<td>Domestic cats</td>
<td>Songbirds</td>
<td>$17 billion</td>
</tr>
<tr>
<td>West Nile virus</td>
<td>Human health; control costs</td>
<td>$2.5 billion</td>
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<tr>
<td>Zebra mussels</td>
<td>Aquatic systems, utilities</td>
<td>$1-2 billion</td>
</tr>
<tr>
<td>Mites</td>
<td>Honeybees</td>
<td>$82 million</td>
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A few examples show how these estimates were derived. One could argue the details, but the point here is that first of all these numbers are very hard to come by and secondly they are most likely conservative.

An invasive arthropod is negatively affecting honeybees in the United States. Honeybees, both native and introduced varieties, are highly beneficial—their pollination is worth about $40 billion a year in the U.S. A single honeybee makes 10 trips to the field on bright days, pollinating about 100 blossoms on each trip. Honeybees in New York State alone are pollinating over a trillion blossoms a day, and there’s no way humans could replicate that. But the introduced mite from Asia is attacking the Italian honeybee and causing many problems, costing $82 million yearly.

One interesting case is the damage that introduced domesticated cats impose on bird populations. The cats aren’t invasive in the traditional sense but they can act that way. There are about 63 million domestic cats in the U.S., and 30 million of them are allowed outside. Many others are feral. Researchers found that each outdoor cat kills an average of 8 birds every year, and then calculated the value of each bird life based on a set of proxy variables; how much money birders and hunters spend, and the cost to replace birds after the Exxon Valdez oil spill. The value they decided upon was $30 per bird, and so the final figure was that cats kill 570 million birds at a cost of at least $17 billion annually.

The brown tree snake came to Guam via military equipment that had been on other islands. It has caused the extinction of more than a dozen birds and about the same number of amphibians. It also crawls up electrical poles, gets into transformers, and cause power outages. It costs at least $2 million to reconstruct those transformers each year.

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"Individuals responsible for introducing invasive species will often be insulated from the problems."

— John Drake
benefits from trade and travel distributed within and among societies? Are they concentrated to a few fat cats, or do they accrue to all the individuals in society in the form of greater and better public services and more efficient economies?

In some cases, benefits are highly concentrated to a few individuals and harms are widely distributed. Under these conditions, it might be appropriate to tax or fine individuals responsible for introducing species for the harms that result from their actions. But in many cases the responsible party is difficult to identify, and the costs and benefits are dissipated throughout society. In these cases, no specific individual could be held legally (or morally?) responsible.

The introduction of invasive species in ballast water exemplifies how harm can be distributed unevenly. Ships not loaded with cargo carry water in tanks to compensate for the lack of weight. After reaching their destinations, they discharge the water and load goods. Thus, ships move organisms all around the world so that ballast water is now the leading pathway for the introduction of invasive aquatic species.

Here a potential for inequity arises from the fact that the ships introducing the most ballast water are those delivering raw materials like wood chips, petroleum, and metal ores. Such ships typically transport materials only in one direction and transport ballast water in the other direction, often with the raw materials coming from developing nations. Thus, there is a net flux of goods to developed nations and ballast water to developing nations, introducing more invasive species to developing nations. It is likely that gains from trade do not adequately compensate for this asymmetry.

Although invasive species are the result of a global economy and systems for commerce, the responsibility for monitoring, detecting, and controlling invasive species falls to individual nations. This creates another inequity, in that nations are differentially capable of dealing with these problems. Scientific research, investment in environmental planning and protection, and governmental responsiveness to environmental problems are all stronger in developed countries. For this reason, the problem of invasive species is a global one that will worsen if left to individual societies.

Inequities exist within societies as well, between individuals that draw their livelihoods from commerce and those who depend directly on the environment. For instance, people who make their livings by fishing suffer much more when invasive species disrupt food webs, prey on harvestable fish stocks, and increase parasitism and disease. Often, individuals responsible for introducing invasive species (individuals with commercial interests) will be insulated from these problems.

How can inequities be addressed and the entrenched systems that generate them reformed? This question is not unique to invasive species, but extends to all concerns about environmental, economic, health, and social inequities. Thus, existing conceptual frameworks for dealing with these problems in other arenas should be useful. Developing fair and effective invasive species policy will require a sincere dialogue about all aspects of the invasive species problem, not the least important of which are ethical considerations.
Cooperation, Coalition-Building, and the Role of Academics

Sarah Reichard
Assistant Professor of Conservation Biology, University of Washington

People in horticulture have always been celebrated for enhancing the environment with attractive and useful plants, but in the last several years the environmental community began criticizing them for what they had previously been congratulated on. This is because most invasive plants have arrived via horticulture. The situation was unproductive, confrontational, and no action was being taken to improve it.

By the mid-1990s, a few people from each side decided it would be worthwhile to try to cooperate somehow. Some ecologists began thinking about having a workshop on the issue, bringing the diverse parties together to talk and perhaps realize they actually had a lot in common.

What finally catalyzed this workshop was a section of the U.S. National Invasive Species Management Plan, which came out in 2001. It stated that by 2003, the National Invasive Species Council must have developed “a fair, feasible, and risk-based comprehensive screening system” for newly introduced species, and that by 2006, it would work “to formulate a realistic and fair phase-in evaluation,” including possibly codes of conduct for purposeful introductions. The workshop had enough interest and participation that it allowed ecologists to take a leadership role in engaging the various horticultural enterprises in the effort.

In December 2001, representatives from universities, environmental non-profits, the nursery industry, gardening clubs, government agencies, landscape architects, and others came together in St. Louis and eventually created what came to be called the “St. Louis Declaration” or “St. Louis Protocol.” All attendees were invited, some chosen for their previous involvement on the issue and others for their skepticism about it. People with dissenting opinions were included so that their voices could be heard and the best possible code of conduct could be developed. Ultimately, 37 groups endorsed the codes of conduct—an unexpected number. The proceedings of this meeting and all the codes of conduct are available at www.centerforplantconservation.org/invasives.

The meeting began by setting up a guiding principle for each group’s code of conduct. It took three and a half days, but eventually all 65 participants agreed to it. The principles include minimizing harm, sustaining both national scope and regional perspective, and continuing professional training. Each group took these principles and developed their codes in private, then brought them back for discussion with the full group. They did not have to adopt what was discussed, but they at least received a great deal of feedback from the other groups.

As an example of a code of conduct, here is what the nursery professionals developed. Note that academics could support each of these points through research and educational extension.

- Ensure that invasive potential of new introductions is assessed.
- Identify physical alternatives to invasives.
- Phase out existing stock of agreed-upon invasive species.

Phasing out is preferable to immediate termination because it gives nursery owners a financial break—if they already have the inventory, it would be a huge loss to have to just get rid of the plants. This was the most controversial point, but it was eventually adopted.

In 2002, a follow-up to the St. Louis meeting occurred. The same participants returned to report on what had happened. While many were excited about the progress—some had collaborated on projects, developed workshops, or written articles on the issue—and most had endorsed the code, it didn’t seem as though they actually had the means to do many of the things they were supposed to. The meeting organizers decided to make it easier for them by facilitating the implementation process, and this has helped somewhat.
Academics can play an important role in helping nursery professionals, botanic gardens, gardening clubs, and other groups follow their codes of conduct. One thing academics can do is create tools for understanding and managing invasive species that are accessible to people outside academia, such as those in the nursery industry. It’s great if there are models that can predict a species’ potential for invasiveness, but they don’t do much good in the ‘real world’ if they are difficult to use. For example, one complex model was refined into a more understandable decision tree, which traces geographic, phylogenetic, and biological information about species and recommends that potential new plant introductions be rejected, accepted or evaluated further.

Academics can get involved in many more ways. To name just a few:

- Use research capacity to refine species evaluations and better understand the nuances of invasive species biology.
- Develop alternatives to invasive species through research on plant breeding, hybridization, and genetic engineering. Test and promote these alternatives with the public using social science research methods.
- Participate in early detection. For instance, university facilities and resources can be made available to the public for identifying potentially invasive plant species. The University of Washington’s Hyde Herbarium offers this service, and is working with community officials to expand it.
- Organize and participate in weed pull events. These events are educational experiences for volunteers, and promoting education is exactly what academics are supposed to do. They just have to be willing to step out of the ivory tower. Volunteers really do learn a lot, and spread information to their friends and neighbors. They ask why someone is planting butterfly bush (invasive in several regions of the US) or why the nursery is selling it. This is the kind of activity that really affects change, and it requires little except the donation of some time and expertise.
- Encourage students to develop an invasive species protocol for their campus or nearby natural areas. Graduate students at the University of Washington did that for the school’s forest, and the policy will be implemented soon.

It might require some risk-taking for academics to get out beyond the university to work on the invasive species issue, but there’s tremendous potential for change if and when they do. Science and research alone are not going to solve invasive species problems. Strong alliances between sectors will do a much better job of changing the situation.

Purple loosestrife, a long-time favorite of the horticulture industry because of its beautiful pink color, is invading fresh water wetlands in the United States, reducing biodiversity of wetland plants and animals.
Alliances and Public Participation
Elizabeth McCance
Director of Conservation Programs, Chicago Wilderness

Communities need a better understanding of the effects of invasives and how best to manage them. Achieving this goal requires collaboration and coordination between many different groups. While collaboration can be time-consuming and difficult, it extends limited resources, fights threats at a regional level, and combines knowledge to create the best programs and strategies possible for managing invasive species and conserving biodiversity.

Chicago conjures up images of a big city—9 million people live there, and the city has some of the country's great cultural institutions. Wilderness is the last thing one might associate with a city of this size. But there are 250,000 acres of protected natural areas in the ecoregion encompassing northeastern Illinois, northwestern Indiana, and southeastern Wisconsin. Early residents of Chicago protected natural areas through a unique forest preserve system. Today, the forest preserves and other public lands protect a variety of community types, including some of the best remaining examples of globally rare oak savannas and prairies.

Marking off preserves is not enough to conserve biodiversity, particularly in a fragmented urban area. These relatively small, scattered natural areas are threatened by further fragmentation, poorly planned development, and lack of management. The urban landscape has led to the loss of landscape scale ecological processes such as fire, which enables the establishment of invasive species. Poorly planned development can pose a number of threats, including the use of invasive species.

These threats operate at a regional scale. In this context, it does not make sense to work on a site-by-site basis, rather a multi-pronged approach is needed. Fences will not keep invasive species out; it requires a combination of land management strategies with policy, educational work, and research to fight the threat of invasives. Recognizing this need for an ecosystem management approach to conservation, thirty-four organizations banned together in 1996 to form Chicago Wilderness. Since its founding, the consortium has recognized the need to work on a regional scale, to collaborate, to think about whole systems, to restore whole ecosystems, and to manage adaptively.

Today Chicago Wilderness consists of more than 175 organizations, including government agencies, non-profit groups, research and educational institutions, and park districts, and covers the whole metropolitan Chicago region. Teams composed of members' staff and volunteers work in four strategic areas—natural resource management, science, education and outreach, and sustainability—to collectively determine the highest priority needs and how to best address those needs. Once determined by group processes, the work is carried out through collaborative projects undertaken by the member organizations. Some examples of Chicago Wilderness collaborative projects are:

*Plants of Concern Program*
This program uses volunteers to monitor rare plant species, using protocols developed by professional land managers. Currently, 120 volunteers are working with 45 landowners to monitor 800 element occurrences of 81 species. One thing that volunteers look for is the occurrence of invasive species threatening the rare plant. They report this information to the landowners so that they can address the threat in their management plans.

*Woods Audit*
To establish the baseline status, the 140 volunteers and professionals assessed the health of woodlands in the Chicago Wilderness region by surveying 238 randomly selected plots. They ranked the quality of the plot based on canopy trees, invasive species frequency, and the Floristic Quality Index, a measure developed by Swink and Wilhelm that combines measures of plant fidelity to high quality areas and species diversity. The Woods Audit provides a regional assessment against which the consortium can measure progress towards its goals of controlling invasive species and improving ecological health.
Effective messages about controlled burns
Following on the development of the burn training program, the Chicago Wilderness Education and Communications Team investigated how to communicate most effectively with the public regarding prescribed burns. People have a tendency to call the fire department when they see smoke, which in turn can be disruptive on a controlled burn as it diverts burn crew attention. Using surveys and focus groups, the project team developed templates for pamphlets, postcards, and press releases to accompany a controlled burn, which are available to all Chicago Wilderness members.

Invasive Earthworms
In addition to monitoring, management, and communication, Chicago Wilderness conducts research on invasive species. A recent project looked at the relationship between invasive earthworms and the invasive buckthorn. Results indicated that the two species interact to alter soil composition, making it more favorable to further buckthorn invasion.

As these examples show, by working at a regional level, sharing information and expertise to develop high priority strategies, and collaborating, the Chicago Wilderness consortium implements a multi-pronged approach involving the community, volunteers, and professional groups to combat invasive species and conserve biodiversity.

Mighty Acorns
Several Chicago Wilderness programs are targeted to schoolchildren. Mighty Acorns is for 4th through 6th graders, and pairs classrooms with specific sites. Students visit the same site three times a year to do restoration work, including brush cutting, and to see the results of their work. Today there are 80 schools, 300 teachers, 8,000 children, and countless volunteers working with 18 land-owning agencies. Seventy percent of the children are from at-risk or underserved communities. These children not only conduct significant restoration work at their sites, but also gain an understanding of stewardship.

Early Warning Rapid Response System
This project uses volunteers to help alert natural resource managers to new invasive species. Instead of developing a new network of volunteers, however, it relies on existing volunteer programs, including Plants of Concern, the Volunteer Stewardship Network, and other groups such as bird, frog, and butterfly monitoring networks. Project leaders determine which species have a high potential for invading the Chicago Wilderness region, and then develop information cards on each to give to the volunteers, so they can be on the look out. The premise of this system is that it is easier to control invasive species before they get established than afterwards.

Midwest Ecological Burn Training Program
Recognizing a common dissatisfaction with available training programs, Chicago Wilderness members developed their own, which focuses on Midwestern ecosystems and managing them with controlled burns. This program illustrates one benefit in working collaboratively. The natural resources management agencies take turns running this training program each year. Because all the agencies were involved in the development of the program, they are comfortable sending staff to the training. Between 70 and 100 agency staff and 30 to 50 volunteers take the training course each year, increasing the region's capacity to control invasives through this strategy.
INTERNATIONAL TRADE AND COOPERATION FOR ADDRESSING INVASIVE SPECIES RISKS

JEFFREY P. FISHER
AAAS Fellow and Conservation Officer, U.S. Department of State,
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The invasive species problem is inherently an international one, making it imperative to address it at this scale. It is estimated that invasive species could easily represent 5% of the global economy—trillions of dollars. The first introduction of a non-native species to the lands and waters of the United States—whether intentional or not—can most often be traced back to an international vector or pathway. Hence, global initiatives on invasive species range from multilateral conventions to regional learning networks, to public education campaigns. Some of these efforts are described here, along with ideas on what gaps exist in how the international community is dealing with invasive species.

International Negotiation and Cooperation
International negotiations provide an opportunity to address the globally shared problem of invasive species. A few of the most prominent are described below.

Parties to the Convention on Biological Diversity (CBD) are committed to “prevent the introduction of, control, or eradicate those alien species which threaten ecosystems, habitats, or species.” The convention recognizes invasive species as a primary reason for the loss of biodiversity. This was a critical step in raising international attention about the link between invasive species and sustainable biodiversity. The CBD parties recognized that alien species were a cross-cutting issue, impacting all seven thematic areas of the Convention. The secretariat of the CBD’s global invasive species program serves as a clearinghouse for technical information on the subject. The CBD’s global taxonomy initiative addresses capacity building needs in systematics that are essential not only for improving our understanding of biodiversity overall, but also for the early detection and rapid response programs essential for informed invasive species management.

The International Plant Protection Convention (IPPC) examines problematic plants and pests and sets the standards by which trade-related grievances about plant commodities are arbitrated by the World Trade Organization (WTO). For example, the International Standards for Phytosanitary Measure specifically addresses guidelines for conducting pest risk analyses, including genetically modified organisms, and contains information on the requirements for treating wood packaging material to prevent its potential as a vector for harboring plant pests. If a country brings a grievance to the WTO about an import or export restriction of a potentially invasive commodity, the WTO will make its decision based on these and other IPPC guidelines—that is, if the commodity in question is regulated as an invasive plant or plant pest.

The International Civil Aviation Organization (ICAO) has recently begun to recognize the potential for invasive species spread via air travel, and adopted a resolution in 2000 on “Preventing the Introduction of Invasive Alien Species.” This resolution urged States to collectively support and cooperate on efforts to prevent the spread of invasive species via international civil aviation. One of the most infamous invasive species, the brown tree snake, entered Guam by plane in World War II and has decimated the island’s native birds and lizards. The ICAO resolution is intended to prevent such invasions in the future.

The International Maritime Organization (IMO) convened the International Ballast Water Convention in February 2004 to address, among other issues, the pathway of ballast water and ballast sediments for aquatic invasive species. Many harmful species, such as the zebra mussel and the round goby, arrive via ballast water. The Convention will become effective twelve months after ratification by 30 States, representing 35 percent of world merchant shipping tonnage. The Convention’s 15-plus guidelines are under development, and represent the real substance of the convention, and the real measure for whether nations such as the U.S. will move towards ratification. Signatories to the Convention will be required to implement a plan that ensures that ballast water management practices and discharges meet a prescribed discharge standard.

“No agreements or eradication strategies are risk-free, and waiting around for a perfect plan is both costly and foolhardy.”
— Jeff Fisher
The InterAmerican Biodiversity Information Network includes an invasive species component, as do about 150 other databases. With funding from the World Bank, United Nations Environment Program, and Global Environmental Facility, these databases are being integrated into a Global Invasive Species Information Network, which is intended to serve as a central portal for linking to the extensive number of databases on invasive species that already exist.

The consequences of free trade agreements on invasive species can be both positive and negative. There are few opportunities within the language of the agreements to push for specific actions on the issue, but annexes to the agreements can do so. The Environmental Cooperation Agreement is what has allowed invasive species to be addressed, for example, in the North American Free Trade Agreement language. However, language doesn’t mean much unless there is funding to back it up. With few exceptions, such as the $55,000 allocated to the U.S./Chile Environmental Cooperation Agreement, that funding is nonexistent. Still, language is a necessary first step that allows the subject of invasive species to enter discussion with senior environmental ministers. The Central American Free Trade Agreement provides an opportunity to incorporate invasive species issues from the beginning. This is particularly important because significant threats exist in trade with Central America, particularly in horticulture and ornamental fish.

Regional Efforts

International conventions such as the ones described here are valuable, but they are far from the most efficient way to control and manage invasive species. Regional and bilateral agreements and projects are generally much more efficient. A few examples are worth mentioning.

The USDA Agricultural Research Service operates six labs around the world to evaluate the efficacy of different biocontrol methods on a regional scale.

The Great Lakes Fisheries Commission combines U.S. and Canadian efforts to control the sea lamprey, which is primarily responsible for the demise of lake trout in the Great Lakes. The U.S. provides approximately $12 million annually for sea lamprey control, as obligated through an interpretation of the Boundary Waters Treaty. This program has been highly effective, resulting in the reduction of the sea lamprey population by roughly 90 percent.

The British-based Center for Applied Bioscience International (CABI) is developing a specific invasive species strategy for the Caribbean.

The Asian Pacific Economic Cooperation (APEC), which consists of 21 countries that rim the Pacific, has received substantial international attention. Several of its working groups—Marine Conservation, Transportation, and Fisheries—address invasive species as a trade issue. However, the working groups do not communicate well with each other, making it difficult to implement change. An upcoming cross-sectoral APEC strategy meeting on invasive species promises to be an important event to improve coordination on the issue, and discuss the trade linkages.

Small, developing island nations, which are particularly susceptible to invasion, often don’t have the capacity to deal with the problem or even know the problem exists. Peer learning networks are developing in the Pacific to link island states and encourage communication between them about invasive species management.

Risk Assessment and Management

It is widely known that trade is the principal pathway for the introduction of new species, and probably has been since the beginning of human history. Risk always accompanies trade, so unless trade ceases entirely, the threat of invasion will always be present through this pathway. The context should therefore be on managing that risk, not only through import control mechanisms, but also through screening and rapid response tools, and non-regulatory approaches such as improving best management practices of industry. Risk should be assessed based on the probability that a species will be established and the likely
Invasive species can be plants, animals, or microorganisms, and they are found in habitats that range from homes to lakes and rivers to fields and rangelands to the open ocean. At times, the invasive species challenge seems daunting, and their spread inevitable. However, significant progress is being made and we have tremendous natural resources that need our protection. Prevention is critically important, because once introduced, widely invasive species often become permanently established resulting in irreversible impacts. Cooperative planning and commitment to action are essential to preventing invasive species. Prevention is in turn supported by research, education and outreach, and international cooperation efforts.

Invasive species cross jurisdiction and geographic boundaries and therefore require coordination. In 1999, over 500 scientists and resource managers encouraged President Clinton to sign Executive Order 13112 (EO). The EO created the National Invasive Species Council (NISC) to coordinate federal invasive species efforts. NISC is co-chaired by the Secretaries of the Interior, Agriculture, and Commerce and includes the Secretaries of: Defense, State, Transportation, Health and Human Services, Treasury, Homeland Security; and the Administrators of the U.S. Environmental Protection Agency, the U.S. Agency for International Development, NASA, and the U.S. Trade Representative. NISC is charged with EO oversight and the preparation and update of the National Invasive Species Management Plan (Plan). The Plan was issued in 2001, and its 57 action items serve as the overall blueprint for federal invasive species efforts. Within these 57 action items there are about 170 identifiable actions. NISC is advised by the nonfederal Invasive Species Advisory Committee (ISAC).

Public Education
Ultimately, international negotiation is insufficient for managing invasive species without local engagement—people out there pulling weeds and making informed decisions about what to buy and plant. Public education is a necessary complement to large-scale work. One excellent example is the branding campaign recently started by the pet industry, which Wal-Mart, Petco, and other major aquarium purveyors have endorsed. The “Habitatude” branding program is being promoted to educate buyers not to release their aquarium fish into local waters. The Fish and Wildlife Service runs another education initiative with its “aquatic hitch-hiker” campaign signs telling people at boat launches how to avoid transporting invasive species. We need more of these types of passive message campaigns to educate and engage the public.

In conclusion, it should be emphasized again that prevention is key. No agreements or eradication strategies are risk-free, and waiting around for a perfect plan is both costly and foolhardy. The problem now is the lack of economic tools, monitoring techniques, or surveillance data to convince policy-makers that this is a critical issue. While the international community is moving with difficulty towards solutions, the examples provided above show that it is indeed progressing in a positive direction.
The problem of invasive species is a diverse cross-cutting issue and the coordination challenge is significant. The 13 members of NISC oversee about 35 agencies that deal with invasive species in some way and they work under about 25 federal statutes. The federal government spends roughly $1.2 billion on invasive species each year. There are over 300 programs, 150 groups, and 170 organizations involved in the issue. To maximize resources, greater leadership and coordination is needed at all levels so that actions are complementary, cost effective, and efficient.

Each federal agency has its own way of doing business, policies, and statutory mandates that often intersect when invasive species are concerned. NISC provides a forum that encourages interdepartmental cooperation and communication. Funding is a major challenge because invasive species management is costly. Therefore, emphasis is placed upon prevention which is greatly augmented by public education, but the costs of controlling invasive species can leave relatively few resources for public outreach and other supportive actions. A final challenge for NISC is to ensure the involvement of the scientific community with both on-the-ground managers and decision makers. Working with experts across a wide range of subject discipline areas is absolutely essential to the overall invasive species effort. With invasive species, we will be successful to the extent that we are able to work together.

**Barriers to Effective Invasive Species Policies in the United States**

**Faith T. Campbell**
Senior Policy Representative, The Nature Conservancy

A great many political issues contribute to the invasive species problem and create barriers to improving the situation. This presentation reviews the main barriers to effective invasive species management and concludes with suggestions on how to overcome them.

**Inadequate Funding and Lack of Prioritization**

The federal government spends about $1 billion annually on invasive species prevention, control, and management. This is less than 1% of the total annual cost that invasive species place on our society, according to David Pimentel. Furthermore, most of the agencies that are assigned some responsibility for keeping out unwanted organisms do not place a high priority on natural resources and biodiversity. They focus instead on agriculture and human health.

**Free Trade**

Each one of the containers, planes, ships, and packages moving across national boundaries (and ecosystems) could be carrying something harmful with it. Free trade is risky in terms of invasive species—especially when trade officials and beneficiaries ignore potential risks and react carelessly to known ones. On the other hand, while halting trade would be the most effective way to prevent new introductions, it would cause a societal burden. Many gradations exist between free and no trade, but right now the U.S. is pretty far toward the free trade side. Instead of preventing introductions while minimizing disruption to trade, the government’s tendency has been to facilitate trade and only secondarily try to keep species out. But while trade economists believe that non-tariff measures, including quarantine regulations, constitute major (and perhaps increasing) obstacles to trade, they concede that they have little data on which to base this statement.

“Federal spending on prevention and control is less than 1% of the amount that invasive species are costing citizens each year.”

— Faith Campbell
Unstated Levels of Protection

The World Trade Organization stipulates that the stringency of protective measures must be tied directly to a chosen level of protection, but the U.S. has ducked the critical obligation of establishing one. “Level of protection” is a bureaucratic term that helps establish the relative importance afforded regulations designed to prevent bioinvasion in comparison to other societal values. In effect, this level is the price that society is willing to pay to reduce problems associated with invasive species, not just in money but in foregone opportunities for trade or other activities that are likely to introduce organisms. Without a stated level of protection, it’s impossible to justify impacts on trading partners or determine whether a management strategy is effective.

Uncertainty and Insufficient Attention to Science

Uncertainty is a central problem associated with invasive species management. You never know whether any particular shipment has something damaging in it. Several international trade agreements require pest assessments, risk identification, and mitigation methods, all of which require a lot of certainty—which often doesn’t exist. Countries have to act without surety that what they are doing is appropriate. A related problem is that international standards are based on multi-lateral negotiations and compromises, and are usually not influenced enough by sound science. For example, two types of wood treatment were adopted despite the virtual absence of scientific evidence showing that they would be effective, and now we’re seeing that one of them is actually a very serious ozone depleter.

Insufficient Quarantine Regulations

According to international trade agreements, a species may enter a country without quarantine if it is already present and unrestricted in that country. For instance, because the hemlock woolly adelgid is well-established in the United States, the Animal and Plant Health Inspection Service (APHIS) has no authority to prevent its entry in the future. This is problematic because new adelgids arriving in the country could be genetically different from those already present, perhaps better adapted to the cold and able to survive further north. While APHIS does treat the adelgid as a significant pest, it has no official, mandatory regulations to control it.

Active Opposition

Finally, opponents block effective action. For at least a decade, experts have been calling for more pre-importation evaluation of the possible invasiveness of deliberately introduced plants and animals, but the “living industries”—horticulture, livestock, pets, seafood, and others—are against regulations that would limit their trading capacity, for obvious reasons.

Recommendations

An effective prevention program requires the following criteria, among others:

- A sufficient level of protection applied to all potentially invasive alien species, not just those that qualify as “quarantine pests.”
- Prevention of introductions of all potentially invasive species, not just those that directly threaten agriculture or the economy.
- Fiscal liability for the agencies or industries responsible for invasive species problems.

Most importantly, the environmental community has to address the main challenge—most people do not know or care about protecting biodiversity. They have to be convinced that biodiversity matters enough to allocate substantial resources towards its conservation. Until politicians and the public believe that protecting plants really is important, nothing much is going to change.
Discussion with Dan Simberloff
Professor of Ecology and Evolutionary Biology and Director of the Institute for Biological Invasions, University of Tennessee

Dan Simberloff agreed to participate in a round-table discussion with Yale students, faculty, and guests. We found the conversation to be so compelling and relevant to the topic of “Invasive Species and the Public Good” that we decided to publish much of it here. We thank Baird Callicott, Charlotte Pyle, David Cherney, Aaron Welch, Allie Shenkin, Helen Poulos, Maura Bozeman, Mary Tyrrell, Ann Camp, and Maura Leahy for their participation in this discussion, and David Skelly and Alexander McIntosh for instigating it.

MB: Do you think invasions are inevitable now?

DS: No, but a lot of people do. I talk with policy people, congressional aides and such, who all say that invasions are inevitable, but I think it’s an excuse. You see examples where laws have worked very well, like New Zealand’s 1993 Biosecurity Act. Where these laws exist there are fewer new invasions and greater success dealing with existing ones. They have not cost very much, either.¹ And the problem hasn’t yet overwhelmed us—we have not yet become the “Planet of Weeds” that David Quammen wrote about.² If you are any kind of competent naturalist, you would still be able to tell where you were if dropped anywhere in the world (aside from cities, that is).

AC: Do you think science might be insufficient in dealing with problems as pernicious as invasive species? That insisting on more and more science is not really helping the problem but detracting from other things that could be done?

DS: There are certainly instances where there’s too much science. Look at what the government is doing with climate change—asking for more and more science without acting on the issue. Finding invasives quickly and limiting them rigorously is a huge opportunity that’s not being acted

¹Finding invasives quickly and limiting them rigorously doesn’t require a lot of science, just a lot of grunt work.”
—Dan Simberloff
upon, and it doesn’t require a lot of biology or even a lot of science, just a lot of grunt work. Many people who are good at dealing with the problem aren’t scientists at all. Some just like to shoot things, others to whack plants.

MT: But people out there whacking plants can just make things worse. Isn’t some science necessary to shape management on a basic level?

DS: I often advocate forming armies of volunteers, and usually it works very well, but you can’t send them out with root wrenches unless they have some idea what to do.

MT: Right—a certain amount of intelligent applied science is needed to do this successfully.

DS: The problem is that this kind of science is not the kind likely to get you a National Science Foundation (NSF) grant. That money isn’t going towards research that provides insight into existing problems, but rather to issues on the forefront—genetics and the like. Funding for invasive species research could be coming from other agencies, but it’s not. The U.S. Environmental Protection Agency (EPA) should be dealing with this issue, but it has typically construed itself as dealing primarily with statutes. In any case, now its budget has been drastically cut. The U.S. Forest Service funds invasive species work without demanding the kinds of papers that NSF and some other funders do, but it doesn’t have much money to distribute.

ML: How do you think information can be transferred from academics to managers more effectively? What can managers do to access the latest and best research?

DS: Academics shouldn’t peddle their ideas just because they can. With respect to helping managers figure out what’s really useful and what isn’t—managers need better training or people to go to, but they’re terribly busy people. They work even harder than scientists, and it’s hard for us to tell them they should be out taking courses or reading journal articles or what have you. The real need is for honest brokers between managers and academia. There are some good examples of this in regards to invasive plants. The Nature Conservancy has an Internet site that provides everything you need to know about invasive plants. If you still have questions, you can call up and get a really clear answer. Without resources like this, I think there would be much bigger problems. Managers could waste a lot of time on ideas that wouldn’t pan out.

AS: You call for an integrated agency to deal with invasive species. What would that be like, and would there be enough science to guide it?

DS: I wouldn’t want it to be a regulatory agency, exactly, but more analogous to the Centers for Disease Control and Prevention (CDC). It would have a scientific staff and integrative function that currently doesn’t exist at all. To be frank, one of the best things about this agency would be its release from the U.S. Department of Agriculture (USDA). Eighty-five percent of the funding for invasive species goes to USDA, which has not done a very good job of dealing with this problem. Also, this new agency could tap the academic sciences, have its own scientific staff, and probably also get away from the NSF problem I talked about earlier. This entity would not shy away from applied science, and would pursue social science as well.

DC: What are we trying to achieve in terms of invasive species management? Michael Soulé talks about “re-wilding,” intentionally reintroducing species to the U.S. that had been extirpated—large carnivores, for instance.

DS: We shouldn’t be bringing in new species at all, or very few of them, either deliberately or not. We should shut down the pathways known to be likely to bring in invasive species. Michael has a view of re-creating a sort of pristine nature. Other people are often accused of being nativists for arguing that North American species belong in North America. To me these are almost aesthetic judgments, and it is difficult
to argue on these grounds. However, we know about all the ecological and economic problems invasive species are causing, and with all that knowledge we just shouldn’t be bringing them in.

CP: Following up on the large carnivores: In Connecticut we see native fishers returning and “invading,” as it were, making some people worried about them attacking cats and small children, things like that. You could argue that fishers belong in the landscape, but there’s not enough habitat for them now because the landscape has become so fragmented. This means they go to unexpected places—maybe places closer to people—and their populations are expanding. Cases like this present a new idea of what invasions are—socially, rather than biologically, defined.

AC: There’s a similar problem with cougars in the west, which are returning now and are killing people. I imagine that large carnivores wouldn’t go over well with a large portion of the population. There’s a major social aspect to these issues.

DS: I’m not a politician or sociologist, I don’t know how to get people to think differently about it. Soulé sees re-wilding almost as a religious cause, and is very eloquent about it. I don’t know if that works. I agree with him generally, but I had agreed with most of his views to begin with.

CP: I see that almost religious sentiment among ecologists that native plants and animals are “right”—I use the fisher as an example. Ann used the cougar—but again, these come up pretty strongly against human concerns, and I wonder what scientists would say in defense of the natives coming back.

DS: As I said, I think this is an aesthetic issue, or ethical. Scientists wouldn’t be able to say much except “They belong here” or “They were here first.” Preferring cats over fishers, or vice versa, is a value judgment. Cats kill millions of songbirds, for example. The real issue should be how a species affects an ecosystem, not whether or not it’s technically native.

With respect to native species or invasive—first, “invasive” is an odd word. The government defines it basically as something that bothers us. Natives can be invasive, at least in terms of “bothering” and otherwise affecting us—for instance, we see Douglas fir ruining prairies and white-tailed deer decimating forest understories. In 95% of these “native invasive” cases, though, it’s because humans have done something to change the habitat.

BC: It sounds like you’re saying that there’s a natural way things ought to be—you sound a little xenophobic

DS: I don’t think I’m xenophobic, and the reason I am opposed to introducing new species has nothing to do with “it’s always been this way.” Invasive species are threatening the very existence of other species. The Endangered Species Act lists 1,800 species now, and almost half of them have invasive species listed as one of the primary threats. In the U.S., we have about 7,000 introduced species established in nature. One thousand are defined as problematic, and about 600 of those were deliberately introduced. We obviously have not been very good at predicting which will and will not be harmless, as any ecologist who is looked at this carefully will agree. There just isn’t enough knowledge yet for accurate prediction.

AC: Would you be in favor of introducing a species that could provide the same function as an invasive one if it weren’t invasive?

DS: In principle, I don’t object to that. My concern is that we had better be really sure that it is strictly a functional equivalent, and not doing something else we hadn’t considered in addition to doing what we wanted it to do.

BC: I have a question about definitions. In our discourse today, we’ve talked about native species, exotic species, and invasive species. I have also heard about “harmful non-indigenous species.” What do you think is the best way to define these things?
DS: I have used “non-indigenous” as opposed to “exotic” or “alien,” both of which have negative connotations. “Non-indigenous” is exactly right, I think, even though it implies comparison to pre-European settlement. For 99% of the species, there would be no ambiguity with this term. But I’ve decided there’s nothing we can do about it, as the media is going to use “exotic” and “alien” no matter what.

ML: How do you think we can convince the public about the seriousness of the invasive species problem?

DS: I don’t know, but in the past twenty years there has been a major shift in public debate about it. Twenty years ago, most people (except scientists) didn’t even know it was a problem. By fifteen years ago, some scientists and a few members of the public knew about specific regional cases, and the public in general didn’t care a whole lot. Ten years ago the issue started appearing in newspapers, and then almost all the public knew about the issue and how widespread it was. That attention has increased ever since. Everyone seems to know about it, but very few are making it a priority.

As I said earlier, I don’t think this is a hopeless situation. I am no expert on molding public opinion, but I’ve seen many initiatives at levels ranging from global to local that have engaged people in this issue. I’m most impressed with various citizen action groups—innumerable organizations have projects to remove invasive introduced plants, for example. My hope is that, as these groups flourish and proliferate, they will generate the critical mass needed to achieve effective policies at the national and international levels.

4 http://rewilding.org/
Resources for More Information

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**Resources for More Information**

Global Invasive Species Database  
www.issg.org/database

Global Invasive Species Programme  
www.gisp.org

Heinz Center Non-Native Species Task Group  
http://www.heinzctr.org/Programs/Reporting/Working%20Groups/Non-native/index.htm

Information Management System, APHIS  
www.invasivespecies.gov

Invasive.org: Images of Invasive Species  
www.invasive.org

Invasive Species Initiative, The Nature Conservancy  
http://tncweeds.ucdavis.edu

Invasive species weblog  
http://invasivespecies.blogspot.com

IUCN Invasive Species Specialist Group  
www.issg.org

National Invasive Species Council  
www.invasivespecies.gov

U.S. Executive Order 13112 establishing a National Invasive Species Council  
http://www.invasivespecies.gov/laws/execorder.shtml

U.S. Fish and Wildlife Service  
http://invasives.fws.gov

U.S. National Invasive Species Management Plan  
http://www.invasivespecies.gov/council/nmp.shtml

Working With Nursery and Landscape Professionals  
St. Louis Declaration; Codes of Conduct  
www.centerforplantconservation.org/invasives
Additional Readings


The Yale Forest Forum (YFF) was established in 1994 by a diverse group of leaders in forestry to focus national attention on forest policy and management in the United States. The group convened the Seventh American Forest Congress to collaboratively develop and articulate a common vision of forest management to diverse stakeholders.

Since its founding in 1901, the Yale School of Forestry & Environmental Studies has been in the forefront of developing a science-based approach to forest management, and in training leaders to face their generation's challenges to sustaining forests.

The School's Global Institute of Sustainable Forestry continues this tradition, in its mission to integrate, strengthen, and redirect the School's forestry research, education, and outreach to address the needs of the 21st century and a globalized environment. The Global Institute fosters leadership through innovative programs, activities, and research to support sustainable forest management both domestically and worldwide.

In pursuit of these ideals, GISF has developed several programs to carry on the work of the Institute, including the Program on Private Forests, the Program on Forest Certification, The Forests Dialogue, the Program on Forest Physiology and Biotechnology, the Program on Forest Health, the Program on Landscape Management, and the Program in Tropical Forestry.

The Yale Forest Forum is now the convening body of the Global Institute of Sustainable Forestry. Through YFF, the Institute holds events at the Yale School of Forestry & Environmental Studies involving stakeholders from all sectors.