Developing Policies to COMBAT INVASIVE SPECIES

Global trade—and now global warming—are making the problem of invasive species ever more challenging. From surveillance to cooperative management, ***Rebecca Epanchin-Niell*** *explores options to control these damaging invaders.*

In 1909, Tokyo Mayor Yukio Ozaki presented the US government with 2,000 young cherry trees to be planted around Washington, DC's tidal basin. The gift was part of a beautification effort for the National Mall.

There was one problem. When the trees arrived in Washington in early 1910, inspectors discovered they were infested with damaging roundworms and insects. The trees would have to be destroyed.

US Secretary of State Philander Knox informed Japanese Ambassador Yasuya Uchida of the bad news:

> *The United States has suffered immense damage to its trees and its agriculture generally by various injurious insects not indigenous but introduced from foreign countries, and . . . the introduction of any new kind might result in the future in the enormous detriment to fruit growers and agriculturists of the country. From this point of view, the Department of Agriculture seems to have no choice but the painful duty of ordering the destruction of the trees.*

Skillful diplomacy smoothed over any potential hurt feelings, and a new shipment of pest-free cherry trees arrived in 1912, the same year that Congress passed the landmark Plant Quarantine Act, among the first federal legislation dealing with importation of exotic species.

More than 100 years later, exotic pests remain very costly to the American economy, imposing billions of dollars in damages on crops and ecosystems. Invasive species are now a staple of news reports:

» The Burmese python, likely introduced as a pet and now taking up residence in the Everglades, dines on everything from small mammals to endangered birds and even alligators.

» The Asian tiger mosquito—thought to have arrived in the Port of Houston in 1985 in a shipment of used tires—is now a backyard menace in 26 contiguous states and Hawaii.

» The zebra mussel, most likely brought over from Russian freshwater lakes in ballast water, is now driving native mussel species to near extinction and clogging water intake pipes at electric utilities from the Great Lakes to the Mississippi basin.

» The emerald ash borer, probably introduced to the United States in the 1990s in wood packaging material, is responsible for the loss of more than 100 million ash trees since its first detection in 2002, with devastating economic and ecological impacts.

How Invasives Arrive

Invasive species are yet another manifestation of human impacts on the global environment, as human activity is far and away the main driver of species spreading to new areas. Many invasive species have even been introduced intentionally by individuals unaware of the potential negative consequences. To take a notorious example, the European starling arrived in 1890 as part of Eugene Schieffelin's effort to bring every bird mentioned in Shakespeare's plays to America. Many other invasive plants and animals were initially introduced as part of the horticultural or pet trade and subsequently became established in the wild.

Another important way that new invasive species arrive is by hitchhiking on other shipments, as in the case of the pests that accompanied the first gift of cherry trees from Japan. The increase in global trade and travel has exacerbated this phenomenon, with pests arriving on agricultural products, in packing material, in ballast water, and in passenger baggage.

Trade in live plants is a particularly important pathway, as it not only directly introduces plant species that have the potential to become invasive, but more importantly, it also is the most frequent medium for intro-

A captured 13-foot-long Burmese python is displayed as part of The Florida Fish and Wildlife Conservation Commission's Python Challenge 2013, a month-long program of harvesting the invasive species from public lands.

duction of non-native pests of agricultural and natural resources worldwide. Of invasive forest insects and pathogens taking root in the United States in the last 150 years or so, an estimated 70 percent are thought to have arrived on imported live plants.

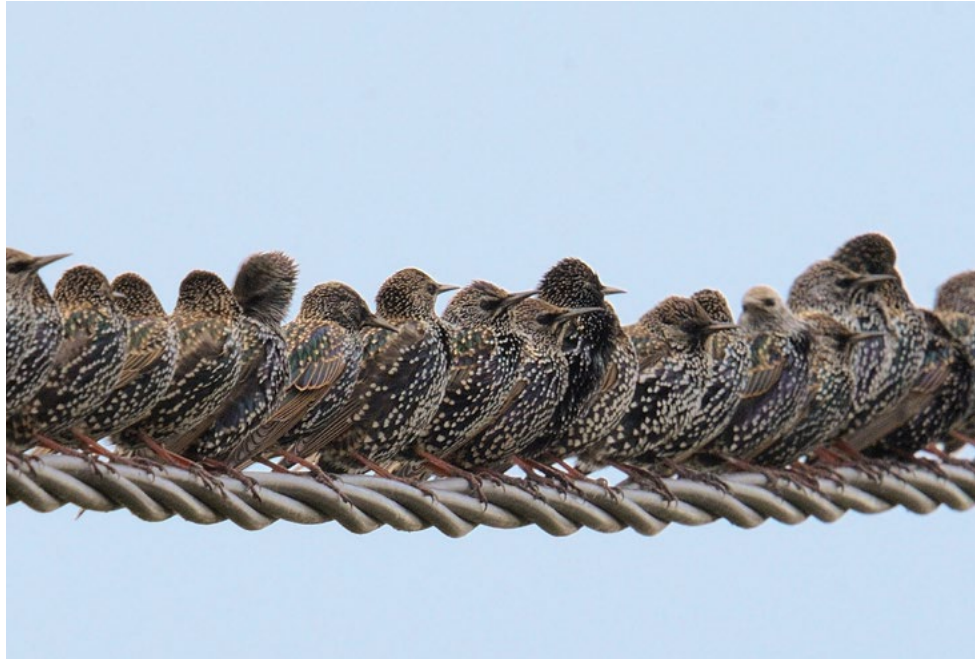
But not all alien species qualify as invasive. At a minimum, the species must be able to take hold and flourish in its new surroundings. Most introduced species are not able to do so, but a small percentage can, benefiting from the lack of natural controls like predators, competition, and climate fluctuations that would otherwise keep their populations in check. From a policy perspective, the species must also be harmful to be counted as invasive. The US government's official definition is an alien species "whose introduction causes or is likely to cause economic or environmental harm or harm to human health."

And although not all introduced species are harmful—in fact, of the food crops grown in the United States today, only a handful are actually native—enough are damaging to create serious risks for many parts of the economy. For example, the emerald ash borer alone is estimated to cause $850 million in local government control expenditures annually, as communities treat or remove urban ash trees devastated by this pest.

Developing a Toolkit for Response

The challenge facing policymakers is how best to respond to the problem. The sheer size of global trade and population flows make it impossible to thoroughly inspect each border crossing for the presence of invasives, and their tenacity once established make complete eradication impossible in many cases.

Rather than a single strategy, a portfolio of approaches is required. The first is to keep invasives from arriving in the first place. A number of measures are available



Introduced to the United States as part of a plan to populate the country with all the birds mentioned in Shakespeare's works, European starlings now compete with native species and destroy crops.

to reduce trade-associated pest introductions, including the creation of "blacklists" of banned goods, pre-treatment protocols for goods and materials (such as packing crates) known to harbor damaging pests, and inspections.

But limited resources are available for inspections compared to the volume of shipments. For example, more than 2.5 billion plants are imported to the United States each year. Inspection of these imports typically has been performed by approximately 65 full-time equivalent employees, resulting in an average flow of more than 18,000 plants per inspector per hour. Guidelines have typically recommended inspecting about 2 percent of this imported plant material. Given these limited samples and the small size and cryptic nature of many plant pests, invading pests cannot be excluded via inspection alone.

The USDA Animal and Plant Health Inspection Service, the entity responsible for the regulation of plant imports, has determined the need for the continued development of risk-based strategies to better target inspections. My colleagues and I are currently working on a project to offer guidelines for improved inspection targeting—for example, determining which types of plants and from what origins should receive more inspection—and designing inspection schemes that will increase incentives to exporting countries to reduce pest levels. One of the unique features of this work is that we also are incorporating the incentives and strategic behavior of exporters into our analysis. For example, risk-based inspection schemes, which inspect "dirtier" pathways more intensively, can encourage exporters to reduce pest levels in order to avoid costs associated with inspections.

But even the best-designed inspection strategy will not be 100 percent effective. This is where the importance of surveillance for new outbreaks comes in. How can we

best detect a newly establishing population early, when it is less costly to contain or eradicate? Again, this is a case where the resources available to governments do not allow for total coverage, and cost-effective targeting must take place. As such, with colleagues, I have been developing models to determine how surveillance efforts should be targeted across the landscape in order to detect new invasive species populations most cost-effectively, based on how invasion risk, damages, and costs are distributed across the landscape.

For example, to address New Zealand forest owners' concerns about potential future introductions of wood-boring pests that could devastate the timber industry, we developed a model to evaluate the costs and benefits of implementing a trap-based surveillance system for early detection. We found that implementing the program would provide positive net benefits of around $300 million over the next 30 years by allowing for a higher probability of wood-borer eradication and exclusion. We also showed how trapping efforts should be allocated across port regions, with more traps in areas with higher rates of pest introduction and greater proximity to at-risk forest resources.

For those species that slip though both inspections and surveillance, the question becomes one of management: Where should we be controlling them and how? This requires a thorough understanding of the economic losses being incurred, the costs of the interventions, how invasions spread across the landscape, and any risk–risk trade-offs, such as the side effects of additional pesticide and herbicide use. For example, some of my work has identified spatial strategies for controlling invasive species—by targeting control to protect at-risk resources and strategically using landscape features, such as mountains and rivers, as natural barriers to reduce the costs of management.

Further complicating the management of established invasive species is the challenge that they can spread across jurisdictional boundaries—between neighboring ranches, or even from the land of one management agency to another's. If a land manager in one location fails to control an invasive species, it can then spread to new areas or reinvade locations where it has previously been controlled. So coordinating approaches to control invasive species across properties can be critical for effective management. We have been conducting research to identify when coordination is most essential and how it can be encouraged to reduce the economic impacts of invasions.

A Growing Challenge

The need for effective invasives policy will only continue to grow as trade continues to expand and open up new pathways for the arrival of pests. A wild card is climate change: the hallmark characteristic of invasives is their adaptability, and it is possible they will be best positioned to take advantage of longer growing seasons, expanded ranges, and other phenomena associated with a warming world. ●

FURTHER READING

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