ARE ALL ALIEN INVASIONS BAD?

In July, the New Zealand government announced its intention to eradicate all rats, stoats and possums from the entire country by 2050 to save native birds such as the kiwi.

It's an ambitious plan, perhaps impossible to pull off with the methods available today, but it's a stark reminder that invasive alien species today constitute perhaps the greatest extinction threat to animal populations world-wide.

Birdlife International, a charity that works to save endangered birds, reckons that of the 140 bird species confirmed to have gone extinct since 1500, invasive alien species were a factor in the demise of at least 71—an impact greater than hunting, logging, agriculture, fire or climate change.

Rats, cats and diseases were the biggest culprits, contributing to the extinction of 41, 34 and 16 species, respectively. Most of these were on islands.

The dodo on Mauritius, emblematic of extinction, was wiped out less by hungry sailors than by the rats, pigs, dogs and cats they brought with them. Hawaii once had 55 species of honeycreeper; today just 17 remain, thanks largely to rats and avian malaria, transmitted by alien mosquitoes brought by people. Guam has lost nine species of bird to an introduced snake.

But continents aren't immune to invasion by alien species.

In the Mississippi River, it is Asian carp; in the Everglades, Burmese pythons; in the Great Lakes, Russian zebra mussels; in the South, Indochinese kudzu vine.

In Australia, cane toads from South America; in Lake Victoria in Africa, water hyacinth from the Amazon; in Germany, Chinese mitten crabs; in the Caribbean, lionfish from the Pacific. A fungus spread by African clawed toads (used in laboratories) has wiped out frogs in Central America.

On my farm in Northern England, three native species of animal are being extinguished by alien invaders from North America: the white-clawed crayfish by the signal crayfish; the water vole by the mink; and the red squirrel by the gray squirrel. Himalayan balsam flowers and Japanese knotweed infest the woods.

Aliens turn into pests away from home because they encounter naive and ill-equipped competitors or prey, and they leave behind their diseases and predators. Globalization is increasing the flow. An insect that would have struggled to survive a long journey by ship can stow away on board a plane.

Today only Australia and New Zealand, whose isolated fauna and flora are especially vulnerable to

invasives, take biosecurity really seriously.

European countries, by contrast, are lax in allowing exotic pets. In Britain, pet raccoons (native to North America) and raccoon dogs (native to China) have escaped into the wild and may one day establish breeding populations that would devastate native wildlife.

A paper published last month by a team of ecologists, led by Regan Early of the University of Exeter in Britain, points out that whereas most invasive alien species (IAS) have affected rich countries so far, the developing world is increasingly at risk:

> "Many of the global biodiversity hot spots that are highly vulnerable to invasion are found in countries that our results suggest have little capacity to respond to IAS (in particular Central America, Africa, Central Asia and Indochina)."

None of this is to say that invasive species are always a threat. They can bring positive effects, too, by increasing biodiversity within a region.

Ascension Island in the Atlantic was once a barren volcanic rock, but is now much greener thanks to a deliberate policy, suggested by Charles Darwin, of bringing in plants from elsewhere in the tropics to create a forest ecosystem.

Dov Sax of Brown University points out that New Zealand once had approximately 2,000 native plant species, has gained approximately 2,000 nonnative species that now have self-sustaining populations, and yet has lost fewer than 10 native plant species.

Another positive effect is that invasive species sometimes improve, rather than harm, ecosystem services—the quality of water, soil or air. Zebra mussels were so effective in filtering the water of Lake Erie that they made its water clear. In the American Southwest, the endangered willow flycatcher has taken to nesting on alien tamarisk bushes, embarrassing conservationists who spent millions trying to eradicate the plant for the sake of the bird.

The best way to fight invasive aliens is often with other aliens: Go back to their native country, find an insect or fungus that eats them, and bring it in to help.

Early horror stories when alien predators introduced to control alien prey turned on native wildlife instead—cane toads in Australia, stoats in New Zealand—have given way to much more cautious and careful scientific introductions of highly specific control organisms. Done right, such biological control is indispensable.

The Centre for Agriculture and Biosciences International is an international agency that scours the native homes of invasive alien pests for predators that can control them. It found a rust fungus that

has reduced the infestation of rubbervine weed from Madagascar in Queensland, Australia—by up to 90% in some areas. The Centre used two parasitic wasps to control the mango mealybug from Asia, which did huge damage to mango trees in Benin in Africa.

Vaccines that cause sterility are another promising weapon. Spreading food coated with such a vaccine could render a species sterile, causing its numbers to fall. This approach is working well in the lab with pigs—invasive species in various places—and may soon help to fight gray squirrels in Britain.

Genomics is the latest weapon. The Aedes mosquito that spreads dengue and zika in the Americas is an invasive alien, from Africa. A biotech firm called Oxitec has devised a way of suppressing its population using mass releases of genetically modified males (males don't bite), which father offspring that cannot mature. In trials in Brazil, this method has achieved more than 90% suppression of numbers.

The next step is even craftier. Using a mechanism called "gene drive," it is possible in the laboratory to create a genetic variant that will gradually infect an entire population of a species with infertility. Whether such a technique would work in the wild, and how it could be safely controlled, or reversed if it began to affect the species back in its native range, are still unanswered questions.

Many nonnative species are here to stay, and many are welcome additions to biodiversity of a country. But scientists are going to be very busy over the next few decades working to reverse the damage done by some and to prevent the arrival of others.

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