

A PLAGUE
of RATS
and
RUBBER-
VINES



THE GROWING
THREAT OF
SPECIES INVASIONS

YVONNE BASKIN

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A SCOPE-GISP Project

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ONE

Introduction: Confronting a Shrinking World

"We must make no mistake: we are seeing one of the great historical convulsions in the world's fauna and flora. We might say, with Professor Challenger, standing on Conan Doyle's 'Lost World,' with his black beard jutting out: 'We have been privileged to be present at one of the typical decisive battles of history—the battles which have determined the fate of the world.' But how will it be decisive? Will it be a Lost World?"

—Charles Elton, *The Ecology of Invasions by Animals and Plants*, 1958

"In contrast with the aftermath of prehistoric mass extinctions, human-dominated landscapes will encourage the generalist species to proliferate—all the more so as natural controls (predators, parasites) are preferentially eliminated. The upshot could well be a 'pest and weed' ecology, with all that implies for evolutionary history."

—Norman Myers, in the journal *Science*, 1997

Just a twenty-minute drive from downtown Auckland, on a steep slope behind Mick Clout's home, a lush remnant of primeval New Zealand forest remains. Spared from fire, ax, and plow because of its rugged aspect, the site still shelters two hectares of towering tree ferns, nikau palms, and the native evergreen trees the Maori, New Zealand's Polynesian settlers, call kahikatea. One fall day, as a light rain dripped soundlessly through the dense canopy and onto the rust-colored duff of the forest floor, several of us ventured into those woods hoping to see a pair of New

Zealand pigeons that had taken up residence. The legendary chorus of native birdsong that greeted the first European colonists has all but vanished, and what's left of New Zealand's forests are now disquietingly silent. As we listened for the cooing of pigeons, we suddenly heard instead a high-pitched call, eerily familiar to me yet startlingly out of place on this Southern Hemisphere island: the bugling of a North American elk.

Fortunately, the elk stag was confined on a neighboring game farm, along with the European red deer hinds imported to breed with him. Only a few times each year does a hind jump the fence and invade the forest to strip the bark from Clout's palms or damage the understory. Elsewhere in New Zealand, however, invading alien deer and elk cause severe damage to forests, rivaling the destructiveness of the invasive brushtail possums brought here long ago from Australia, which strip some 18,000 metric tons of leaves each night from forests like these. Clout, a professor of ecology at the University of Auckland and chair of the Invasive Species Specialist Group of the World Conservation Union (IUCN), maintains poison bait stations throughout this forest patch to kill the possums, which threaten not only the trees but also nesting pigeons and other native birds. It is possums, European ferrets, rats, and other furry alien invaders that have helped to silence the birdsong in New Zealand's forests. Along a creek at the foot of the slope, Clout pointed out other, more benign-looking invaders that nevertheless menace his remnant forest: recent garden fugitives such as wandering jew, willow, pampas grass, and privet now advancing along the streambed or upslope into the forest, threatening to choke out the native plant life that provides shelter and sustenance for the pigeons and other surviving birds.

As we walked back out of the woods and toward the house, we could see North American mallards dabbling about in rain puddles on the road below. The lush hills beyond were forested with California Monterey pines and Australian eucalyptus. It could have been a scene in San Diego but for the elk. An American or European visitor can easily feel at home amid the biota of Auckland and, indeed, much of the rest of New Zealand. That's because half the plant species and all the mammals (except for two native bat species) came from somewhere else. And New Zealand is not the only place to which many of these same plants and animals have been moved.

You will see many of the same beasts and much of the greenery in Cape Town or Sydney, Kuala Lumpur or Paris, San Francisco or Santiago.

The biological *déjà vu* of travelers today is the result of a massive game of musical chairs we have played with life on the earth, especially during the past 500 years. The extent and thoroughness of this rearrangement of plants, animals, and microbes is stunning, yet far from finished. We can find American beavers in Tierra del Fuego, African antelopes in New Mexico, Madagascar rubbervines in Queensland, and European pines in South Africa. On our increasingly connected planet, global trade and travel are accelerating the movement of organisms to places they could not have reached without our help. Their arrival is not always a cause for lament. We have transformed the living world in many ways that greatly enrich and sustain us, filling fields the world over with apples and wheat and gardens with geraniums and roses. But much of the transformation has been clumsy and careless at best, and we have created a growing litany of self-inflicted wounds. Among the freshest are the intercontinental movements of tree-killing Asian long-horned beetles, crop-devastating citrus canker, unstoppable zebra mussels, and deadly West Nile encephalitis and foot-and-mouth pathogens. These high-impact newcomers are called invasive alien species. It is the urgent need to reduce the ecological and economic fallout from the ongoing tide of invaders that is the subject of this book.

On the ecological side, the unique natural heritage that each region enjoys is increasingly besieged, not only by direct human activities but also by the overwhelming tide of new life we are introducing, deliberately or accidentally. Most alien creatures that escape or are loosed into the wild either perish or settle into new communities with little disruption. But a significant number—including the possums and privet shrubs, deer and willows, and myriad other species introduced into New Zealand—spread aggressively and invade in their new environments. These invaders dominate, disrupt, outcompete, prey on, hybridize with, or spread disease among native species or alter the terms of life in the community by changing the soil, the available light or water, the frequency of fire, or even the structure of the landscape.

Ecologists now rank biological invasions second only to habitat loss as

a threat to native biodiversity in much of the world. (*Biodiversity* is a shorthand term ecologists use for biological diversity, the rich web of life in a community or region.) The threats come from an unlikely array of misplaced creatures, from rust fungus and avian malaria parasites to rubbervines, melaleuca trees, blackberry bushes, goats, snails, and tiny scale insects that can suck the life from trees and shrubs. Few places on the earth remain untouched by such invaders. Even in the Antarctic, seals have been exposed to cattle diseases and penguins to poultry virus. On a tiny scale, the crowd of strangers that threatens to overrun Clout's bit of forest exemplifies the beleaguered status of natural areas worldwide, from Yellowstone National Park to the Everglades, from Hawaii to the Galápagos Islands, from the mountains of the South African Cape provinces to the Italian Apennines.

On the economic and social side, the organisms ecologists call invaders are called weeds, pests, or emerging diseases when they threaten human enterprise and well-being. Invasive alien species create hardships across a spectrum of human activities, altering the character and economic potential of our lands and waters; threatening our health and that of our crops, forests, and livestock; diminishing recreational values and even our sense of place. In the United States alone, ecologist David Pimentel estimates, invasive species cause \$137 billion per year in losses, damage, and control expenses.

Most of us have heard *something* about biological invasions. The topic is hitting the headlines and television news reports with increasing frequency. News, by nature, focuses on the striking, the singular, and the menacing new arrivals: West Nile encephalitis virus striking down people and birds in the Northeast, Asian long-horned beetles denuding parks and boulevards of beloved old shade trees, zebra mussels choking off water pipes along the Great Lakes, Formosan termites attacking the historic French Quarter of New Orleans, Africanized bees advancing across the Southwest, and Asian gypsy moths and Mediterranean fruit flies (Medflies) breaching the border.

Even as I listened to the elk bugling through the tree ferns near Auckland, the *New Zealand Herald* was trumpeting an alarm about the third

snake in a month to have wriggled out of a shipping container in that snake-free land. Behind the scenes, quarantine inspectors in New Zealand were concerned about an outbreak of foot-and-mouth disease in Japan, the same strain that would strike South Africa six months later and finally burst into world headlines when it hit Great Britain and parts of Europe.

What you will seldom learn from sporadic news accounts, however, is that foot-and-mouth disease and Asian gypsy moths, as well as a host of weeds and pests that will never make headlines, are all manifestations of the same growing problem—the uncontrolled movement of species worldwide, driven by the increase in global trade and travel. Only a small fraction of species that invade new regions spur rapid and dramatic transformations of landscapes, devastating disease outbreaks, crop failures, or other misery. Instead, most invaders manifest themselves in slower, more subtle ways, such as chronic degradation of habitats and landscapes, attrition of native plants and animals, or deterioration of the ecological life-support services that regulate soil fertility, plant growth, and water quality and flow.

Unfortunately, it is difficult to spark a sense of urgency or lasting commitment to action in the face of chronic problems, although they can sometimes be more devastating in the long run than the headline grabbers. Even more troubling is that this kind of gradual ecological degradation can be literally invisible to those of us who cannot easily tell one plant or insect from another, at least beyond our gardens. Nearly half of the world's people now live in urban areas; thus, many of us confront invaders directly only when new termites attack our homes or bugs our boulevard trees or microbes our health. Even those of us who spend a fair amount of time outdoors in parks, forests, or wilderness areas often cannot recognize subtle changes taking place on the land. Because most of us lack a detailed knowledge of the natural plant and animal communities around us, few can spot the strangers or detect the decline of natives as long as landscapes are still green and humming with life. I still cannot name or cite the origin of most of the grasses and wildflowers I see around my Montana home. For years, I never gave much thought to the tall, yellow-flowered plants that grew denser each summer around a foothill trail near Bozeman.

I have since learned that this plant is Eurasian leafy spurge, and now I can see that its invasion has crowded out the lupines, harebells, yarrow, horsemint, and other native plants that once flourished along the trail. What I could not see from the trail is that this invasion is causing more than just a change in the scenery. Spurge now dominates some 728,000 hectares of land in Montana and North Dakota, robbing native deer and elk as well as exotic cattle of palatable forage and depressing the value and productivity of rangelands. What's more, leafy spurge is just one in a lineup of invading weeds—most of them still invisible to me—that continue to degrade the American West both economically and ecologically.

Another stumbling block to recognition and then to possible remedy is that some regions have been so utterly transformed for so long that few people know what lived there before or how the native plant and animal community once functioned ecologically. For those who are familiar with the native flora and fauna of a region, however, invasions are often the most visible element of biological change today, far more apparent than the marginalization or impending elimination of native biodiversity that the invaders may be hastening. Many heavily invaded regions may even host more species than ever before, at least temporarily, a fact that causes some skeptics to ask "What's the problem?" But in many localities, the species count will fall back as natives disappear. What's more, a steady or even increased local species count can mask a global loss of species. Too often, unique, rare, and localized species have been replaced by a cosmopolitan set of species that can be found the world over: eucalyptus and Monterey pines, brown trout and mosquito fish, starlings and bulbuls, Medflies and gypsy moths, black rats and feral goats, lantana and water hyacinth. (A feral animal or plant is one that has escaped from domestication or cultivation and become wild.) While these replacements keep the local numbers high, the earth's total tally of living species declines. What's more, these cosmopolitan replacements homogenize our experience of the world.

The very look and feel of any given place, along with the life in it, is much like any other today, and we are all poorer for it, whatever the species count. The same forces that are rapidly "McDonaldizing" the world's diverse cultures are also driving us toward an era of homogenized, weedy,

and uniformly impoverished plant and animal communities that ecologist Gordon Orians has dubbed the Homogocene. It is a play on the naming of geologic time periods that I translate loosely from its Greek roots as “the epoch of sameness or monotony.” The invasive species phenomenon poses such a threat to human health and livelihoods that ecologist Michael Soulé wonders why it has not become a “motherhood issue.”

Few governments have raised the issue to motherhood priority, although New Zealand and Australia have come close. Nevertheless, the political will to act on the problem of biological invasions (bioinvasions, for short) is growing. Heightened awareness of bioinvasions has developed at the same time that nations have been implementing an unprecedented round of global trade liberalization agreements. These agreements have accelerated the worldwide movement of vessels, cargo, and people—and, as a consequence, the risk of new invasions. As the volume and value of goods traded soared during the 1990s, so did the number of organisms in motion, incidentally or intentionally. Accelerating and costly invasions have caused many governments to begin to rethink their quarantine systems for excluding unwanted organisms and their often lax oversight of deliberate imports of new plants and animals. In the United States, the arrival of the zebra mussel in the Great Lakes in the late 1980s—with its damaging and costly habit of encrusting and fouling everything from boat hulls to industrial water intake pipes—was the first of a number of incursions that brought the issue of bioinvasions into the spotlight. In 1999, at the urging of 500 scientists and land managers, President Bill Clinton issued an executive order creating the National Invasive Species Council. In early 2001, the council released a management plan designed to improve the country’s capacity to prevent the introduction of invasive alien species and control their spread.

At the international level, the Convention on Biological Diversity, or Biodiversity Treaty, signed at the United Nations’ Earth Summit in Rio de Janeiro in 1992, recognized the threat that invading species pose to biodiversity. One provision, Article 8h, calls on member nations to “prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.” The treaty took effect in 1993, and some

180 countries have ratified it (the United States, unfortunately, is one of the few that have not). One responsibility of each treaty nation is to prepare a national biodiversity strategy and action plan; a key issue for nations in the early 1990s was how to approach the implementation of Article 8h. Few countries at the time had the awareness or knowledge to address the problem of invasive alien species. In 1996, the Norway/United Nations Conference on Alien Species brought representatives from eighty nations together with scientists and technical experts on bioinvasions. At that meeting, the concept for the Global Invasive Species Programme (GISP) was born. GISP was established in 1997 to gather an international team of biologists, natural resource managers, economists, lawyers, and policy makers who could help bring the issue of bioinvasions to the forefront of the international agenda and support the implementation of Article 8h of the Biodiversity Treaty. This book is part of the GISP effort.

GISP is operated by a consortium (rich in both acronyms and experts) consisting of the Scientific Committee on Problems of the Environment (SCOPE), a nongovernmental scientific organization; CAB International (CABI), an organization long involved in on-the-ground management of invading alien species; and IUCN, the international conservation organization whose specialist group on invaders is headed by Mick Clout. This consortium operates in partnership with the United Nations Environment Programme (UNEP). The goal of the scientists involved in this project has been to develop new tools, evaluate best management practices, and articulate a new global strategy and action plan to help nations come to grips with the problem of bioinvasions. With those goals accomplished, GISP is now involved in helping nations put the tools and the strategy to work in protecting not only biodiversity but also human health and well-being.

Although scientific and technical approaches are indispensable in managing the problem, bioinvasions are fundamentally a human phenomenon, driven by economic activity and by our choices as consumers, travelers, gardeners, pet owners, fishermen, and so on. We are the ones who set species in motion, and all of us, as individuals, families, communities, and nations, must be involved in the solution. For that reason, the GISP partners wanted a book that would reach a broader audience with their find-

ings. Stanford University biologist Harold A. (Hal) Mooney, chairman of the GISP Executive Committee, asked me to write it. Over a two-year period, I shadowed the experts as they gathered to devise early warning systems, analyze the pathways and vectors by which species are moving, consider the problems of risk assessment and economic analysis, examine the status of laws and international instruments, and spell out the best management practices for both preventing new invasions and controlling or eradicating established invaders. In addition, I visited sites around the world, from New Zealand and Australia to South Africa and the Galápagos Islands, where people are already putting such practices to work.

Chapters 2 through 5 of this book detail the extent and consequences of our rearrangement of the earth's species, exploring the often colorful history of past plant and animal movers, from fifteenth-century seafarers to contemporary plant hunters and reptile fanciers. As we'll see throughout the book, the human context and human motivations have changed surprisingly little over the centuries. Besides the flowers, snakes, and exotic game animals that we are still moving deliberately between continents, a vastly greater number of creatures is hitchhiking in ballast tanks and shipping containers and tucked in with the cut flowers, timber, grain, and fruit that is constantly in motion around the world. These first chapters detail both the economic and the social toll of invaders and their adverse effects on native species and natural communities. Trying to capture the economic and ecological effects of bioinvasions throughout the world in a few chapters involved difficult choices about what to include and what to leave out. It would be all too easy to expand the litany of loss and woe, disaster and degradation. Instead, I have chosen to devote more space to the search for solutions.

Chapters 6 through 12 explore the search for solutions, from sophisticated efforts to stop invaders at the border to strategies for preserving what we value in severely invaded lands. They detail the efforts of scientists to identify patterns and clues that could tell us which few species among the vast numbers of those in motion will succeed as invaders. This elusive predictive power has taken on new importance as countries attempt to clamp down on the importation of risky new species. These chapters also

examine the trend pioneered in Australia and New Zealand toward a guilty-until-proven-innocent approach to the introduction of new species and the tensions between this type of precautionary approach and the drive for freer trade. We'll visit with inspectors in one of the world's strictest border quarantine systems as they check everything from incoming mail to used car imports to the boot treads of tourists. We'll follow the work of frontline surveillance teams that provide early warning of pest, weed, and disease incursions and allow nations to respond rapidly to nip invasions in the bud. We'll investigate innovative efforts to minimize the damage caused by established invaders and examine a growing shift in management focus away from simply defeating invaders and toward restoring ecosystems. This approach is the key to optimism, for even much-abused and invaded lands harbor species, communities, and processes that people value and want to preserve. One chapter focuses entirely on the Galápagos, where scientists and national park administrators, faced with a rising human presence in the islands, are working on all fronts at once, from quarantine to control, to try to avoid the mistakes that long ago caused massive swamping of native biodiversity in most of the world's other archipelagos. The final chapter recaps the challenges we face as individuals and nations in preserving what we value in an increasingly homogenized world.

Because we'll be traveling far and wide in the pages ahead, the following section provides a road map to some of the underlying themes and values I will be bringing to the issue of bioinvasions.

We are all in this together. The same forces bring invaders to all countries and inflict invasions on all social and economic sectors, from agriculture, industry, and conservation to public health.

There are no remaining forbidden cities or untouched places. Any of us can travel almost anywhere in thirty hours or less, and more and more of us do. The middle of nowhere takes MasterCard and serves McDonald's hamburgers and KFC chicken. Trade and tourism link us together in the need to address the global movement of damaging species. Your weeds or moths can be mine with a crate of grapes, my mites and mildews yours

with a garden cutting slipped through the airport in an otherwise law-abiding gardener's carry-on.

Conflicts between various economic sectors remain, of course. Agriculture, forestry, horticulture, the pet trade, and other economic enterprises not only are plagued by exotic weeds, pests, and pathogens but also thrive on exotic plant and animal species. Most of the world's food comes from crops grown and livestock raised beyond their centers of origin. Some of these species, like the farmed elk and deer in New Zealand, escape to invade natural areas and damage conservation, recreational, and aesthetic values. Because agriculture makes little distinction between exotic and native weeds and pests, agricultural solutions to invasions, from herbicides and pesticides to biological controls, or biocontrols, have often been applied with scarcely a nod to biodiversity, public health, and other values of society.

It is vital, however, to acknowledge our common interest in the prevention of new invasions. In most countries, departments of agriculture and, to a lesser extent, of public health have the most experience, funding, and responsibility for whatever quarantine and control infrastructure exists. This experience and organization needs to be enlisted in support of broader social and ecological concerns. At the same time, we cannot let the larger issue of invasive alien species be absorbed and lost within narrowly focused weed and crop pest programs.

My intent is not to condemn all alien or imported species, only the invaders, defined as those that escape control and cause ecological or economic harm.

Exotics feed the world, and often the soul. No one is advocating that we confine wheat to the Levant and potatoes to the Andes or take the cuisine of Italy back to its pre-tomato past. And this book is certainly not about giving up lilacs, peonies, and tomatoes in my Montana garden. Its topic is the thousands of misplaced organisms that are ecological or economic scourges in new settings: zebra mussels, rabbits, goats, mosquito fish, cheatgrass, water hyacinth, lantana, miconia, cottony cushion scales, gypsy moths, Dutch elm disease.

It is also important to avoid treating the depredations of invasive alien species such as the ones just listed as a morality play or simplifying a com-