Islands, the “watered lands” known as *Ieglands* in Old English, serve as microcosms of the interactions between humans and their finite natural environments. Islands comprise approximately 3 percent of total global land area, yet they have harbored a high percentage of biodiversity, including many marvelous endemics such as giant Galápagos tortoises (*Geochelone nigra*), New Caledonia geckos (*Rhacodactylus leachianus*) the size of small dogs, and the pygmy mammoth of Siberia’s Wrangel Island (now extinct, *Mammutthus primigenius*). Since the fall of the last pygmy mammoth some 4,000 years ago, the majority of species extinctions have occurred on islands. The islands of Oceania provide a stark example: prior to human settlement, they were home to over 2,000 now-extinct bird species.1 Humans played a direct role in many of these losses, as in the overhunting of New Zealand’s 12-foot-tall flightless moa. But the main culprit was often introduced invasive mammals, such as rats, cats, foxes, and goats. This threat is even more pervasive today; invasive mammals exist on over 80 percent of the world’s islands, and consequently nearly half of the threatened mammal and bird species on the World Conservation Union’s (IUCN) Red List are island species.

Unique evolutionary histories predispose island plants and wildlife to being

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C. JOSH DONLAN is the founder and director of Advanced Conservation Strategies, which is dedicated to reversing biodiversity loss through the development of innovative, self-sustaining, and cost-effective solutions derived from the integrated analyses of biological, economic, sociopolitical, and technological threats and opportunities. He is a senior fellow at the Robert and Patricia Switzer Foundation and the Environmental Leadership Program.
overly impacted by invasive mammals. Prior to the onslaught of invasive species, islands were generally drama free, with few mammalian predators or large herbivores. Insular species therefore commonly lack behavioral, physical, and life-history defenses: plants are not resilient to mammalian herbivory (overgrazing), and wildlife evolved without knowing predation. Consequently, hardy introduced herbivores, such as feral goats and donkeys, devastate island plant communities by stripping vegetation that may be unable to regrow. As omnivores, feral pigs eat fruits and plants and raid eggs from nests of birds and reptiles. Invasive rats and feral cats have decimated native island rodent, reptile, and bird populations and extirpated numerous seabird colonies by attacking breeding adults or eating eggs and chicks year after year. Invasive rats alone are responsible for at least 50 documented extinctions, including the world’s only flightless songbird (*Xenicus lyaletti*). Rats drove this wren to extinction on the main islands of New Zealand, and, in 1894, a single cat belonging to the lighthouse keeper of Stephen’s Island killed what are believed to have been the last birds of this species.

### Early Efforts at Eradication

In the 1960s, rats wiped out the last population of yet another wren (*Xenicus longipes*). This time, however, New Zealanders began fighting back. Around the same time, hundreds of white-faced storm petrels (*Pelagodroma marina*) died after rats invaded Maria Island, a speck off the coast of New Zealand about the size of a football field. A group led by biologist Don Merton, a pioneer in the rescue and recovery of birds, spread rodenticide around the island to try to control the rat population. A few years later, much to the group’s amazement, the rats were gone. A decade later, in an effort to protect breeding seabirds, biologist Dick Veitch and others conducted a similar rat-control program on the slightly larger 74-acre (30 ha) Titi Island and significantly reduced, but did not eradicate, the rats. Then, in 1976, about 50 New Zealand researchers and conservationists met to discuss how to control invading rats on hundreds of New Zealand’s satellite islands. The compounding challenges led them to the dismal conclusion that “[w]e have control methods, and methods for reducing populations, but complete extermination on islands is remote or at least a very, very difficult thing indeed.”

Luckily, a handful of conservationists were not deterred. They continued testing new techniques, and developed bait stations armed with rodenticide that could be systematically placed over an entire small island, providing a precise system for dispensing rodenticide while minimizing accidental poisoning of other wildlife. (The most commonly used rodenticide is an anticoagulant; rats

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Source: Bill Henry

Feral cats are a threat to seabird colonies worldwide. Laysan albatross (*Diomedea immutabilis*) colonized Guadalupe Island, Mexico, in 1983, and were growing exponentially until fewer than 20 cats killed 60 individuals, equal to half the breeding subpopulation.
Twenty years ago, removing rats from an island the size of a football field was a daunting challenge.

Today, eradicating rats from a remote sub-Antarctic island larger than Washington, DC, is a reality. By 1983, rats had been eradicated from several small New Zealand islands, and silencing the death knell of native birds became a possibility. However, most conservationists remained skeptical about scaling up to larger islands with well-established rat populations.

But the diehards kept at it. In 1988, they placed 743 bait stations throughout the 420 acres (170 ha) of Breaksea Island in New Zealand’s spectacular Fiordland. In 21 days, the rats were dead. Breaksea created conservation headlines and became one of the largest invasive-predator-free habitats in the Fiordland. Researchers had “created” new, safe habitat for endangered species like the kakapo (Strigops habroptilus), the world’s only nocturnal parrot, which was subsequently translocated there. The New Zealanders demonstrated to the world that islands, small and large, could be saved.

Today, the removal of rats and other invasive mammals from islands has become a powerful tool for biodiversity conservation. In New Zealand alone, rats have been eradicated from more than 100 islands. Conservation practitioners elsewhere have successfully adopted these and other techniques, resulting in 332 successful invasive rodent eradications worldwide to date. Those eradications have restored many ecosystems, repatriated hundreds of breeding seabird colonies, and saved dozens of species from extinction. For example, the fewer than a 100 kakapo left in the wild survive only on islands where rats and other invasive predators were removed. In addition, the world’s remaining tuataras (Sphenodon punctatus), the unique last member of the ancient group of reptiles, persist on only a few New Zealand islands that have been rendered free of invasive predators.

New technology and techniques are also drastically improving our ability to remove invasive mammals. GPS-aided aerial broadcast of rodenticide by helicopter with agricultural bait buckets hanging below can now deliver bait with cutting-edge precision, spreading it onto every square yard of an island. This allows for more cost-effective rat removals on larger and larger islands. In the largest rat eradication to date, in 2001, Norway rats (Rattus norvegicus) were removed from the 44-square-mile (113 km²) Campbell Island, New Zealand. The entire population of Campbell Island teal (Anas nesiotis)—a flightless and nocturnal duck—survived only on nearby rat-free Dent Island. In the 1980s, 11 of the remaining teals were brought into captivity for breeding, and, in 2004, the birds were reintroduced to Campbell Island, where broods of new ducklings are now monitored with excitement. Twenty years ago, removing rats from an island the size of a football field was a daunting challenge. Today, eliminating rats from a remote sub-Antarctic island larger than Washington, DC, is a reality.
New wildlife management techniques have also improved our ability to avoid unintentional damage to native island species. In 2002, black rats (*Rattus rattus*) were to be removed from Anacapa Island, off the coast of California, but the island was also home to the endemic Anacapa deer mouse (*Peromyscus maniculatus anacapae*), which is equally susceptible to the poison. To deal with this novel challenge, researchers determined that mice across Anacapa’s three islets were genetically similar and functioned as a metapopulation, meaning that individuals occasionally moved among the separated populations. They then ensured that there was at least one free-living population of native deer mice at all times, and staggered the rodenticide broadcast over two years among the three islets. As a safeguard, a captive population of Anacapa mice of requisite genetic diversity was held for future reintroductions. Additionally, raptors and owls that faced potential poisoning from eating dead rats or deer mice were captured and then released after the eradication campaign was completed.

The project was a success. Rats were eliminated, and after a series of translocations between islets and reintroductions from the captive population, native Anacapa deer mouse populations recovered completely. Seabirds also benefited greatly. The endangered Xantus’s murrelet (*Synthliboramphus hypoleucus*) and other seabirds that rats had once heavily preyed upon now successfully breed on the island in record numbers. These days shipwrecks, which were the major cause of rat introductions onto islands, are relatively rare. Nonetheless, reintroduction prevention measures are in place on-island to ensure that these benefits are permanent.

Other examples from the Aleutian Islands and the Galápagos illustrate the complexity of invasive mammal removals, but ultimately, their potential for global species conservation.

**Foxes in the Aleutian Islands**

Alaska’s Aleutian Islands are one the world’s last truly wild places. The Maritime National Wildlife Refuge encompasses 4.9 million acres (2 million ha) on more than 2,500 islands, providing nesting areas for over 40 million seabirds. Despite their remote location, the Aleutians have not been spared the impacts of invasive mammals. Russians discovered the islands more than 200 years ago and intentionally released Arctic and red foxes (*Alopex lagopus* and *Vulpes vulpes*) on more than 450 islands as food sources and for fur harvesting. Foxes subsequently ravaged waterfowl, shorebird, seabird, and ptarmigan nesting sites, preying on eggs, nestlings, and adult birds. The endemic Aleutian cackling goose (*Branta hutchinsii leucoparia*) was
Feral goats on Isabela Island, Galápagos, where they were overgrazing and degrading habitat until they were eradicated in 2006.

extirpated from all but three islands. Predation was so severe that it precipitated ecosystem changes: because fewer seabirds transported fertilizing nutrients to land from the ocean via their guano, grasslands converted to tundra.11

Refuge staff began removing foxes from the Aleutian archipelago in 1949. Dedicated trappers have spent long, lonely stints year after year on these demanding islands—foxes have now been eradicated from 40 islands, totaling almost 2,000 square miles (5,000 km²).12 Recovery of waterfowl, shorebird, and ptarmigan populations has been dramatic, and nesting seabird populations have increased four- to fivefold. These successes represent grand strides in protecting the Northern Hemisphere’s most important seabird nesting grounds. A translocation program saved the Aleutian cackling goose.13 Foxes remain on just nine islands, which managers are now targeting, in addition to turning to the challenge of removing rats from the archipelago.

Herbivores in the Galápagos

Both Wallace and Darwin witnessed the destruction of St. Helena Island by goats in the nineteenth century. Introduced in the 1200s, goats are responsible for at least 11 plant extinctions, although the real number is unknown because
the first botanical surveyor arrived 300 years after the goats were introduced. Although goats still roam St. Helena, many Galápagos islands are recovering from introduced herbivory.

In 1961, goats were removed from the 29-acre (12 ha) islet of Plaza Sur. By 2000, the Galápagos National Park and Charles Darwin Foundation successfully rid seven other islands of goats via more opportunistic campaigns that involved ground-hunting. In the late 1990s, the Global Environmental Facility (GEF) and others funded Project Isabela—a campaign of unprecedented scale to remove goats from the largest islands of the Galápagos. Their plan was to first eradicate feral pigs and goats from the 224-square-mile (580 km²) Santiago Island. After refining techniques, the project moved to Isabela Island, an area of 1,771 square miles (4,590 km²), the largest such action ever attempted.

Removing goats from an area almost the size of Rhode Island required leveraging new technology and new hunting and monitoring techniques. It integrated GPS and GIS technology into all facets of the campaign, large-scale aerial hunting by helicopter, ground-based hunting with specialized dogs, and the use of “Judas goats”—radio-collared individuals that are released to join remaining goats, thereby unwittingly revealing the whereabouts of the stragglers. Altogether, more than 150,000 goats were removed from Santiago and Isabela. Widespread ecosystem recovery has been swift; entire plant communities are rebounding, benefiting giant tortoises and endemic Galápagos rails (Laterallus spilonotus). Focus has now shifted toward removing goats from the last four islands in the archipelago. After hundreds of years, the persistent destruction caused by introduced herbivores on the Galápagos is coming to an end.

The Future of Island Conservation

Similar wildlife conservation gains have been achieved on islands around the globe, targeting other invasive predators and herbivores. To date, there have been close to 800 successful invasive-mammal eradications that have stopped extinctions and restored island ecosystems, safeguarding seabirds and island species on dozens of archipelagos. Importantly, these conservation gains are commonly cost-effective. In western Mexico, a number of organizations have collaborated to remove 42 populations of invasive mammals from 26 islands, resulting in the protection of 88 endemic terrestrial vertebrates and 201 seabird colonies for less than $50,000 per taxon/colony. Tackling even greater challenges, conservationists have now adapted eradication techniques to create habitat “islands” on New Zealand’s two main islands. Even though full-scale eradication there remains impossible for now, the expectation is that

Densities of the endemic Galápagos rail (Laterallus spilonotus) increased on Santiago following the eradication of feral pigs and goats.
Preventing extinction is at the center of biodiversity conservation, and the removal of invasive mammals from islands is one of society’s most powerful tools to do that.

Invasive predator populations can be sufficiently suppressed within these habitat “islands,” allowing native wildlife populations to stay strong.

Restoration is now taking place on larger islands throughout the world, and conservation practitioners are targeting more biologically complex places—which will bring both vast conservation opportunities and new challenges. We need to continue developing new techniques that increase the cost-effectiveness of eradication campaigns and that mitigate impacts on native nontarget island wildlife. More research is needed on the removal of feral cats and house mice, two of the most difficult invasive mammals to eradicate. Because people live on larger islands, future eradication campaigns will need to integrate education programs to prevent accidental reintroductions of invasive animals and to clarify social and economic gains that come with native ecosystem restoration, such as improved agricultural and human health. Finally, a regional and global analysis to prioritize islands in need of eradication campaigns could maximize native species conservation and particularly benefit seabirds.

From the Indian Ocean to the sub-Antarctic, conservation practitioners are following the lead of those stubborn New Zealanders who were not willing to lose the last of their native wildlife. Preventing extinction is at the center of biodiversity conservation, and the removal of invasive mammals from islands is one of society’s most powerful tools to do that. We can no longer afford lengthy eradication campaigns because too many island species are on the brink of extinction. It will be vital that we strive to safely eradicate invasive mammals from islands faster (and cheaper) to maximize the conservation return. With a burning desire to rewild islands, we can.