

# PREFACE

## Turning the tide of biological invasion: the potential for eradicating invasive species

*M. N. Clout<sup>1</sup> and C. R. Veitch<sup>2</sup>*

<sup>1</sup> *Centre for Invasive Species Research, SGES, University of Auckland, Private Bag 92019, Auckland, New Zealand. E-mail m.clout@auckland.ac.nz* <sup>2</sup> *48 Manse Road, Papakura, New Zealand.*

### THE THREAT TO GLOBAL BIODIVERSITY

The effects of alien invasive species on biodiversity have been described as “immense, insidious and usually irreversible” (IUCN 2000).

There is no doubt that invasive species can cause severe economic and ecological damage (Mack *et al.* 2000). They may soon surpass habitat loss as the main cause of ecological disintegration globally (Vitousek *et al.* 1997, Chapin *et al.* 2000) and are probably already the main cause of extinctions in island ecosystems. The breaching of biogeographic boundaries by the widespread, recent human transport of species has caused rapid and radical change in biological communities, including multiple extinctions. To minimise further extinctions and other ecological changes, the most important priority is to reduce the risks of new invasions. After prevention, the next priority is to eradicate existing invasive species, where this is possible. These aims are embodied in the United Nations Convention on Biological Diversity, which states that parties to this convention should “prevent the introduction of, control or eradicate, those alien species which threaten ecosystems, habitats or species”.

Extinction is irreversible, but there is a growing realisation that biological invasions themselves can sometimes be reversed. With good planning, adequate techniques and sustained effort, it is now possible to eradicate many types of invasive species, especially in the early stages of an invasion, or where a population is confined to an island or limited habitat.

Turning the tide of biological invasion by eradicating invasive species can yield substantial benefits for biodiversity conservation, by raising opportunities for ecological restoration and the re-introduction of threatened species. It can also yield major economic benefits, by permanently removing the cause of damage to crops, livestock or native biodiversity, and obviating the need for costly perpetual control. Where feasible, eradication is typically more environmentally sound and ethically acceptable than long-term control. Sustained control may involve the perpetual use of toxins, trapping or shooting, and can entail more environmental risks and many more animal deaths than a

brief eradication campaign. In this context, the recent successful action by animal ethicists to prevent the eradication of an incipient population of grey squirrels (*Sciurus carolinensis*) in Italy is a particularly sad example (Genovesi and Bertolino 2001). Many more squirrels will undoubtedly die in control attempts in the years to come than would have been killed in eradication of the initial population. Likely consequences of this invasion (as with so many others) are damage to crops and natural ecosystems and the decline of native species.

### CONDITIONS FOR ERADICATION SUCCESS

There is a well-accepted set of conditions which must be met for the eradication of any population (Bomford and O'Brien 1995). These standard conditions for success are proper planning, a commitment to complete, putting the entire population of the target species at risk, removing them faster than they reproduce, and preventing re-invasion. Additional conditions, which are often necessary and always desirable, are support from local people and an ability to demonstrate the benefits of the eradication programme.

It is easiest to meet the necessary eradication conditions for isolated, small populations of species with low reproductive rates and no dormant life stages. Not surprisingly, the most notable successes to date have therefore involved the eradication of vertebrates (especially mammals) from isolated islands. Over the past 20 years, as techniques and confidence have improved, it has proved feasible to eradicate even quite small vertebrates from larger and larger islands. For example, in New Zealand, Norway rats (*Rattus norvegicus*) are now being eradicated from islands up to 11,000 ha in area. This is more than three orders of magnitude larger than the islands from which this species was first eradicated *c.* 40 years ago (Fig. 1).

It is fortunate that invasive mammals are among the easier species to eradicate, because they are also among the most ecologically damaging, especially on islands. Many extinctions of vulnerable birds, reptiles, and plants have been attributed to introduced mammals (Atkinson 1989), so the increasing ability to eradicate them is especially significant.

Established populations of plants, insects and other species with dormant life stages (eg. soil seedbanks) and high intrinsic rates of increase present more of a challenge for eradication, even in isolated populations. Typically, the eradication of plant populations involves a long campaign, involving the sustained removal of individuals before they set seed. In the longer term these species will be just as damaging to ecosystems as the more rapid and visible impact of many mammals.

In many situations, the feasibility of eradication will also be affected by risks to non-target species. This may prevent the use of certain techniques and limit the use of others. In some situations the risks to non-target species (including livestock, pets, crops and people) currently precludes the attempted eradication of some invasive species. However, some non-target deaths are acceptable if eradication of the invasive species is achieved and recovery of the affected non-target species is likely to be rapid. For example, in the course of the eradication of brushtail possums (*Trichosurus vulpecula*) from Kapiti Island, New Zealand, 181 birds were killed in traps, 39% of which were kereru (*Hemiphaga novaeseelandiae*) (Cowan 1992). Following the possum eradication (and subsequent eradication of rats by poisoning), the forest recovered substantially and kereru abundance rose up to six fold (Veltman 2000).

A factor that often affects the feasibility of any eradication is the dispersal abilities of the weed or pest species concerned. This affects re-invasion potential and may dictate continued vigilance even when the original population has been eradicated. For example, plants that are dis-

persed by birds or wind are more likely to re-invade an isolated island than those that depend on browsing mammals, gravity, explosion, or water dispersal. Human transport remains the most likely re-invasion pathway for most invasive species, emphasising the fact that prevention of invasion is of the utmost importance.

## ADVANCES IN CAPABILITY AND KNOWLEDGE

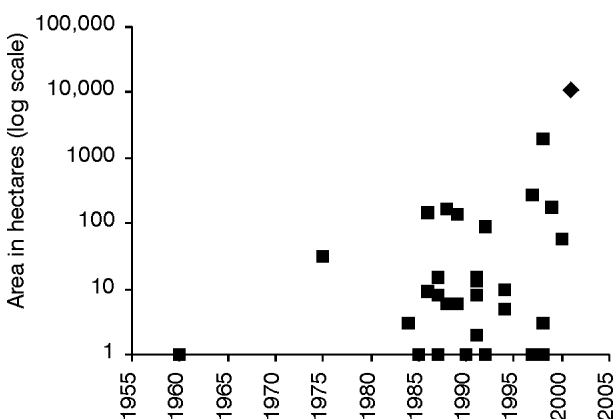
There have been substantial recent advances in our ability to eradicate invasive species, exemplified by the increasing size of islands from which invasive vertebrates such as rodents have been eradicated (Fig. 1). We can anticipate more successful eradications of invasive vertebrate species, as existing technology and approaches are applied. Eradications of invertebrates and plants may pose greater challenges and require more sustained campaigns, but the general principles remain the same and there have been notable successes, some of which are described in this volume.

A topic which merits greater attention when planning eradications is that of ecosystem response to species removals (Zavelata *et al.* 2001). There may be unexpected (and sometimes unwanted) consequences of eradications, such as the ecological release of invasive plants when an introduced herbivore is removed, or irruptions of prey species after the removal of a predator. Such effects need to be borne in mind when planning eradications. Knowledge of the ecological relationships of invasive species is a key prerequisite when planning their removal from an ecosystem. These relationships raise opportunities as well as risks: for example it is possible to remove invasive prey species (e.g. rodents) and their introduced predators (e.g. cats) in a single poisoning operation, through deliberate secondary poisoning of the predators via their toxic prey.

As more eradications are attempted worldwide, it is increasingly important that lessons are learned from each and every one of these attempts (whether successful or unsuccessful) and that the information gained and skills learned are shared. This volume (and the conference on which it was based) is a contribution to the vital process of sharing knowledge to combat the threat of invasive alien species.

## ACKNOWLEDGMENTS

Our aim in organising the 2001 ISSG Conference on Eradication of Invasive Species and editing its proceedings into a peer-reviewed volume was to bring together conservation practitioners and scientists who are at the forefront of the battle against alien invasive species. This volume is intended to share their insight and practical experience with a wider audience. We thank all of the participants at the



**Fig. 1** Increasing size of New Zealand islands from which Norway rats (*Rattus norvegicus*) have been eradicated: 1960-2001 (square symbols) (Veitch 1995), and the yet-to-be-confirmed Campbell Island eradication (diamond symbol).

conference, especially those who have contributed papers to this volume. We also thank all those who peer-reviewed papers and assisted in other ways with its production. Special thanks are due to Carola Warner, secretary to the IUCN Invasive Species Specialist Group, who helped us throughout with the task of compiling this book

## REFERENCES

- Atkinson, I. A. E. 1989. Introduced animals and extinctions. In Western, D. and Pearl, M. (eds.). *Conservation for the twenty-first century*, pp. 54-69. Oxford, New York.
- Bomford, M. and O'Brien, P. 1995. Eradication or control for vertebrate pests. *Wildlife Society Bulletin* 23: 249-255.
- Chapin, F. S.; Zavaleta, E. S.; Viner, V. T.; Naylor, R. L.; Vitousek, P. M.; Sala, O. E.; Reynolds, H. L.; Hooper, D. U.; Mack, M.; Diaz, S. E.; Hobbie, S. E. and Lavorel, S. 2000. Consequences of changing biodiversity. *Nature* 405: 234-242.
- Cowan, P. E. 1992. The eradication of introduced Australian brushtail possums, *Trichosurus vulpecula*, from Kapiti Island, a New Zealand nature reserve. *Biological Conservation* 61: 217-226.
- Genovesi, P. and Bertolino S. 2001. Human dimension aspects in invasive alien species issues: the case of the failure of the grey squirrel eradication project in Italy. In: McNeely, J. (ed.). *The great reshuffling: human dimensions of invasive alien species*, pp. 113-119. IUCN, Gland, Switzerland.
- IUCN 2000. *Guidelines for the prevention of biodiversity loss due to biological invasion*. IUCN – The World Conservation Union, Gland, Switzerland.
- Mack, R. N.; Simberloff, D.; Lonsdale, W. M.; Evans, H.; Clout, M. and Bazzaz, F. A. 2000. Biotic invasions: causes, epidemiology, global consequences and control. *Ecological Applications* 10: 689-710.
- Veitch, C. R. 1995. Habitat repair: a necessary prerequisite to translocation of threatened birds. In M. Serena, (ed.). *Reintroduction biology of Australian and New Zealand fauna*, pp. 97-104. Surrey Beatty & Sons, Chipping Norton, Australia.
- Veltman, C. 2000. Do native wildlife benefit from possum control? In T. Montague (ed.). *The brushtail possum: biology impact and management of an introduced marsupial*, pp. 241-250. Manaaki Whenua Press, Lincoln, New Zealand.
- Vitousek, P. M.; D'Antonio, C. M.; Loope, L. L.; Rejmanek, M. and Westbrooks, R. 1997. Introduced species: a significant component of human-caused global change. *New Zealand Journal of Ecology* 21: 1-16
- Zaveleta, E. S.; Hobbs, R. H. and Mooney, H. A. 2001: Viewing invasive species removal in a whole-organism context. *Trends in Ecology and Evolution* 16: 454-459.