# KEYNOTE ADDRESS

## Are we turning the tide? Eradications in times of crisis: how the global community is responding to biological invasions

*P. Genovesi*

*Chair IUCN ISSG; ISPRA, Via Curtatone 3 – 00185, Rome, Italy. <piero.genovesi@isprambiente.it>.*

**Abstract** Biological invasions are a major driver of the ongoing loss of biodiversity, and if the global community wants to reverse this trend it is crucial that formal commitments be transformed into action. On the basis of the more than 1000 eradications attempted worldwide, we can now say that eradication projects are a powerful conservation tool that has contributed to improving the conservation status of several threatened species. The growing sophistication of the scientific and technical basis of eradications now allows us to target much larger areas than in the past, and the eradication of species in much more challenging taxonomic groups. Also, it is now possible to minimise the risk of undesired effects of eradications, ensuring selectivity of the removal methods and minimised impacts on the environment. Despite these advances, the implementation of removal campaigns is still limited, partly by prejudices and ignorance, but also by serious concerns from a part of society, which we need to take seriously into account. It is important to ensure a correct and transparent flow of information. If the global community wants to fulfil the commitment to reverse the present rate of biodiversity loss, it is crucial to increase the application of invasive species removal campaigns and to support large scale flagship projects, as well as by developing frameworks that permit the rapid detection and removal of newly established invasive species.

**Keywords:** Overview, CBD, invasive alien species, management

### INTRODUCTION

In 2002, the global community committed to achieve, by 2010, a significant reduction in the loss of biodiversity and - in order to verify what has been done to reach this goal - the UN declared 2010 the International Year of Biodiversity. Unfortunately, the indicators that have been collected in recent years show that there is little to celebrate. The global rate of biodiversity loss appears to have increased, and so have most of the pressures affecting the diversity of life on earth. For example, the overall status of birds in different regions of the world from 1988 to 2008 has declined, with the proportion of threatened birds increasing from 11.1% to 12.2% in that 20-year period (Butchart *et al*. 2004), and other taxa appear to be in a worse conservation shape (Vie *et al*. 2009). The continuing loss of biodiversity is particularly alarming on island ecosystems, which host a large proportion of the world endemics. Most threatened species are, in fact, found on islands (Vié *et al*. 2008); about one-fifth of the world's threatened amphibian fauna, one-quarter of the world's threatened mammals and more than one-third of the world's threatened birds are endemic to island biodiversity hotspots (Fonseca *et al*. 2006). And it is these hotspots that have had most of the recent extinctions; 88% of known bird extinctions have been on islands (Butchard *et al*. 2006), mostly because of biological invasions. Invasive species have in fact been identified as a key factor in 54% of all known extinctions, and the only factor in 20% of extinctions (Clavero and Garcia-Berthou 2005).

### ARE WE TURNING THE TIDE?

Instead of recording a mitigation of the drivers of biodiversity loss, all the evidence confirms that the number of invasive alien species is rapidly growing in all environments and among all taxonomic groups (Genovesi *et al*. in press), raising extinction risks for birds, mammals and amphibians (Clavero *et al*. 2009). The most effective way to address this threat is through a combination of prevention measures, early detection at and near borders, prompt eradication of newly-arrived unwanted aliens, and effective management of established invasive species. Eradication is thus a key component of a global response to invasions, and for this reason Dan Simberloff, in his opening speech at the 2001 international conference on island invasive species, stressed the urgent need for a much wider application of this conservation tool. He challenged decision makers and practitioners to be much more ambitious in their efforts to combat invasions, overcoming the prejudices and groundless opposition that have so far limited the potential range of application of removal campaigns. In the present contribution I will thus discuss developments since 2001, and try to assess to what extent we have been able to respond to the call for more action that was launched on that occasion.

### ERADICATION: AN EFFECTIVE RESPONSE TO INVASIONS

There is increasing evidence that successful invasive species removal campaigns have played a crucial role in improving the conservation status of several taxonomic groups. Many endemic and rare species have recovered following the eradication of invasives threatening their persistence. An assessment of red list data has shown that 11 bird, five mammal and one amphibian species have improved their conservation status as a result of eradications of invasive species (McGeoch *et al*. 2010). These positive outcomes are also the result of the significant improvements in the science of eradication over recent decades. As discussed by Alan Saunders in this volume (Saunders *et al*. 2011), the number of multi-species eradications is constantly increasing, and the experience gathered in the last 20 years now minimises the risk of undesired effects of eradications, ensuring selectivity of the removal methods and minimised impacts on the environment. Furthermore, we are increasing our ability to predict potential ecosystem changes caused by the removal of invasive species, and adaptive implementation of eradications has prevented or rapidly mitigated potential unexpected chain reactions (see Courchamp *et al*. 2011; Morrison 2011). We can now target much more challenging taxonomic groups, such as plants and terrestrial invertebrates. Regarding the latter, up to a few years ago invertebrates were generally considered as not eradicable, with few exceptions. In his paper of 2002, Simberloff stressed the need to test whether eradication of insects on continents was really out of the question. The

Pages 5-8 In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). 2011. *Island invasives: eradication and management.* IUCN,Gland, Switzerland.

general pessimism challenged by Simberloff resulted from several unsuccessful eradication campaigns, such as the attempt to remove the red imported fire ant (*Solenopsis invicta*), from the US. However, it must be stressed that these attempts have significantly increased the technical basis of eradication, recently allowing several successful eradications: for example in the Galapagos, but also in several mainland areas of Australia and New Zealand (Hoffman *et al*. 2010; Hoffmann 2010).

## GLOBAL OVERVIEW OF ERADICATIONS

Several recent reviews of eradications have been published (Veitch and Clout 2002; Nogales at al. 2004; Campbell and Donlan 2005; Genovesi 2005; Howald *et al*. 2007; Genovesi and Carnevali 2011), with the most up-to-date and comprehensive one for vertebrate eradications on islands being in this volume (Keitt *et al.* 2011).

These publications, and the data presented at the 2010 conference, show that globally 1129 eradication programmes have targeted alien species of plants or animals on the mainland or islands. This number is very likely an underestimate, since many eradications go unreported, especially those of plants. Of the projects I considered, 86% were reported as successful (n=911; 819 vs. 93), and 97.07% were carried out on islands (n= 1,129; 1096 vs. 33). Some 94.6% of reported eradications targeted vertebrates (n= 1,119; 1059 vs. 60), but as already mentioned, this in part reflects the difficulty of accessing plant management data, as well as records of invertebrates eradications (i.e. no global review of mosquito eradications has been published so far, to my knowledge).

Eradications range from large scale programes addressing widely distributed invasives to the removal of a few individuals established in a still restricted range. Both extremes are of crucial importance. We need large scale, ambitious programmes to verify the potential of eradications, and at the same time to show the public and decision makers the results that can be obtained. At the same time we need examples of routine detection and localised eradication projects, to show how invasions can be addressed at their very early stages, through well-designed and well-implemented operational frameworks.

Regarding the first case, several programmes that have been initiated and, if successfully completed, will indeed provide excellent evidence on the potential of this tool. One example is the ongoing eradication of the ruddy duck (*Oxyura jamaicensis*) from Europe. This programme is particularly challenging. The species was imported intentionally into the UK where it became established in the 1960s. The ruddy duck hybridises with the endangered white-headed duck (*O. leucocephala*) (Muñoz-Fuentes *et al*. 2007), putting at risk the survival of this rare species, which has a total population of only 3000 pairs in the entire Palaearctic (Henderson and Robertson 2007). Removing the introduced species is particularly complex for several reasons. Firstly, the core European population of the ruddy duck is in UK, and it is thus in this country that most of the control actions have to be undertaken. However, reproduction is mostly in Spain, and so no crucial impact is recorded in the country that is responsible for the main removal operations. Furthermore, individuals or small populations of ruddy ducks occasionally appear in other European countries, such as France, the Netherlands or the Baltic countries. If any of these countries will not enforce the needed management activities the entire eradication programme may be undermined. But despite these complex challenges, the results of European action so far appear very encouraging. A Pan-European action plan was approved by parties of the Bern Convention in 1999. The eradication of the UK population of ruddy duck commenced in 2005 by the competent authorities (see Henderson, 2009 for an update). The eradication cost of the campaign (£3.3 M for the first phase of work) has partly been covered with financial support from the European Commission. As a result, 90% of the UK population had been removed by winter 2008/2009. Despite some opposition from animal rights groups, the control programme had the support of all major British conservation organisations and most of the general public. Hybrids are systematically culled in Spain, by a removal protocol that minimises the risk of removing the native species. As a result of these control activities, the Spanish population of white-headed ducks has grown from the 22 breeding pairs in 1977 to the present 2100-2600. When the eradication is completed, this will indeed represent a unique example of cooperation for conservation, and of the results that can be obtained with adequate planning and effective international coordination frameworks.

Another example of encouraging international cooperation to carry out an eradication is the planned removal of the Canada beaver (*Castor canadensis*) from Tierra del Fuego (Malmierca *et al*. 2011). The beaver was introduced to Tierra del Fuego in 1946 for fur production and has established in over 27,000 km of waterways and 7,000,000 ha of Argentina and Chile. This species has a huge impact on forests, steppes and meadows, as well as on infrastructure; calling for the launch of a coordinated eradication campaign. However, cooperation between Chile and Argentina was inhibited by the tensions and conflicts that have characterised the relations between the two countries after the Beagle Conflict in the 1970s and 1980s. Despite these diplomatic tensions, in 2006 Chile and Argentina signed a cooperation agreement for eradicating the beaver. A feasibility study completed in 2008 by an international team, concluded that the eradication is possible although very difficult, and will require at least 9 years work, and an overall investment of at least 33 million USD.

But even if these large scale projects provide good examples of what can be achieved with adequate commitment and resources, it is also crucial that countries improve their ability to carry on prompt eradications immediately after a new invader has arrived into their territory. Prompt detection and response is, in fact, by far the most effective and economically convenient way to address new invaders, as shown by a review of plant eradications carried out in New Zealand by Harris and Timmins (2009). They found that early removal of plants costs on average 40 times less than removals carried out after an invasive plant has widely established.

One example of an effective approach to early detection and rapid response to invasions is the California Weed Action Plan (Schoenig 2005). This plan is enforced through a partnership between state agencies and key stakeholders. It is based on an official list of noxious weeds for which it is mandatory to act promptly, and is based on a budget of about USD 2.5 M/yr. Early detection of new infestations is ensured by the involvement of a network of biologists, and trained farmers and volunteers. The State weed programme provides grants for local weed control activities of about USD 1.5 M/yr. The application of the action plan has led to the successful removal of over 2000 infestations, and to the complete eradication of 17 weeds from the State.

## CONCLUSIONS

Biological invasions are growing at an alarming rate and are a major driver of biodiversity loss, but also affect our economy, health, and the ecosystem services we rely on. The most effective way to reduce these threats is to enforce prevention measures, by establishing stringent biosecurity policies at the national, regional and global scale. However, when prevention fails, eradication is indeed one of the most concrete and cost-effective responses to invasions, and this tool can eventually reverse the present rate of biodiversity loss. The more than 1000 recorded eradications have reflected significant technical advances that now allow the targeting of much more challenging species and areas than in the past, and allow minimal undesired environmental effects. For example, we now know that - with adequate planning, effective techniques and sufficient resources – many ant infestations could be removed from the world. And projects such as the ongoing eradication of the ruddy duck in Europe indicate that many widely established invasive species – such as the red fox (*Vulpes vulpes*) in Tasmania (Parkes and Anderson 2011) or the beaver in Tierra del Fuego - could be removed with long-term commitment and adequate resources.

However, in most cases eradications are still realised at the single small-island level, there are no examples of completed large scale flagship projects – carried on invasive species widely established on mainland - and there are very few cases of structured national frameworks ensuring early detection and rapid removal of new invasions, as in the case with the Californian weed programme. The still very limited implementation of eradication programmes is in part the result of the opposition and prejudices of different sectors of the society. For example, fierce opposition by a few animal rights groups contributed to the failure of the attempt to eradicate the American grey squirrel (*Sciurus carolinensis*) from Northern Italy (Genovesi and Bertolino 2001; Bertolino and Genovesi 2003). And the growing opposition in New Zealand to the use of aerial baiting (expressed for example in the film "*1080: Poisoning Paradise*") or petitions to stop the control of feral camel (*Camelus dromedarius*) populations in Australia, are other more recent examples of this phenomenon.

The opposition to eradications also finds support in the lack of real commitment by countries. In fact, although 55% of countries have implemented specific national legislation, and many more have formally committed to increase their efforts to tackle the threat of invasions (McGeoch *et al*. 2010), the level of on-the-ground action has not grown apace with these largely token formal commitments. A more structured application of eradications will require effective national policies, clear legal tools, and financial and institutional support. Apart from existing obstacles at the national level, action on a global scale is also far from being satisfactory. The Convention on Biological Diversity in 2002 led the conference of the parties to adopt the decision VI/23 on invasive alien species, and provided detailed guiding principles for its implementation. However, no global binding tool on invasions has been adopted, and the guiding principles have thus remained largely on paper. This lack of global action was stressed by the G8 Environment meeting held in 2009 in Syracuse, which adopted a final charter on biodiversity that included the urgent need to develop global early warning and rapid response systems.

If the global community really intends to reverse the present trends of biodiversity loss, it is urgent that world leaders translate all the technical work done in the last 30 years, as well as turning the adopted commitments into concrete action, particularly by giving priority to addressing biological invasions on islands, as this may significantly curtail the continuing decrease of species numbers.

The scientific community must communicate better the value of eradications, building on the many success stories; "flagship" large-scale projects are crucial in this respect, and it is important to support these campaigns. We must also address the growing concerns in some sectors of society (see Cowan and Warburton 2011), reducing as much as possible the undesired side effects of eradications, and always ensuring a transparent flow of information. Last but not least, the scientific community should encourage the development of a global programme of work based on an agreed set of priorities and with effective early warning systems. This is a crucial condition for ensuring rapid responses to new invasions.

## ACKNOWLEDGEMENTS

Several colleagues and friends provided data, information and comments for this contribution. I thank in particular Lucilla Carnevali, Joe Di Tomaso, Iain Henderson, Ben Hoffman, Brad Keitt, Robert Leavitt, Fernanda Menvielle, Arturo Mora, John Parkes, Alan Saunders, Paolo Sposimo and Dick Veitch. Finally I want to thank Andrew Burbidge and Dan Simberloff for their very helpful comments on an earlier draft of this paper.

## REFERENCES

Bertolino S. and Genovesi P. 2003. Spread and attempted eradication of the grey squirrel (*Sciurus carolinensis*) in Italy, and consequences for the red squirrel (*Sciurus vulgaris*) in Eurasia. *Biological Conservation 109*: 351-358.

Butchart S.H.M.; Stattersfield A.J. and Brooks T.M. 2006. Going or gone: defining "Possibly Extinct" species to give a truer picture of recent extinctions. *Bulletin of the British Ornithologists' Club 126A*: 7-24.

Campbell K. and Donlan C. 2005. Feral goat eradications on islands. *Conservation Biology 19(5)*: 1362-1374. Boston, Mass.: Blackwell Scientific Publications.

Clavero M.; Brotons, L.; Pons P. and Sol D. 2009. Prominent role of invasive species in avian biodiversity loss. *Biological Conservation 142(10)*: 2043-2049.

Clavero M. and Garcia-Berthou E. 2005. Invasive species are a leading cause of animal extinctions. *Trends in Ecology and Evolution 20*: 110.

Courchamp, F.; Caut, S.; Bonnaud, E.; Bourgeois, K.; Angulo, E. and Watari, Y. 2011. Eradication of alien invasive species: surprise effects and conservation successes. In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). *Island invasives: eradication and management*, pp. 285-289. IUCN, Gland, Switzerland.

Cowan, P. and Warburton, B 2011. Animal welfare and ethical issues in island pest eradication. In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). *Island invasives: eradication and management*, pp. 418-421. IUCN, Gland, Switzerland.

Fonseca, G.A.B. da; Mittermeier, R.A. and Mittermeier, C.G. 2006. *Conservation of island biodiversity: importance, challenges, and opportunities*. Washington DC: Center for Applied Biodiversity Science at Conservation International.

Genovesi, P. 2005. Eradications of invasive alien species in Europe: a review. *Biological Invasions 7(1)*: 127-133.

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.A. (ed.). *The great reshuffling: human dimensions of invasive alien species,* pp. 113-119. IUCN, Gland Switzerland and Cambridge, UK.

Genovesi, P.; Butchart, S. H. M.; McGeoch, M. A. and Roy, D.B. *In press*. Monitoring trends in biological invasion, its impact and policy responses. In: Collen, B.; Pettorelli, N.; Durant, S. and Baillie, J. E. M. (eds.). *Biodiversity monitoring and conservation: bridging the gaps between global commitment and local action*. Wiley-Blackwell, Cambridge.

Genovesi, P. and Carnevali, L. 2011. Invasive alien species on European islands: eradications and priorities for future work. In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). *Island invasives: eradication and management*, pp. 56-62. IUCN, Gland, Switzerland.

Harris S. and Timmins S. M. 2009. Estimating the benefit of early control of all newly naturalised plants. *Science For Conservation 292*: 1-25.

Henderson I. 2009. Progress of the UK Ruddy Duck eradication programme. *British Birds 102(December)*: 680-690.

Henderson I. and Robertson P. 2007. Control and eradication of the North American ruddy duck in Europe. In: Witmer, G. W.; Pitt, W. C. and Fagerstone, K. A. (eds.). *Managing vertebrate invasive species: proceedings of an international symposium*. USDA/APHIS/WS, National Wildlife Research Center, Fort Collins, CO.

Hoffmann B. D. 2010. Ecological restoration following the local eradication of an invasive ant in northern Australia. *Biological Invasions 12*: 959-969.

Hoffmann B. D.; Abbott K. L. and Davis P. 2010. Invasive Ant Management. In: Lach, L.; Parr, C. L. and Abbott, K. L. (eds.). *Ant ecology*, pp. 287-304. Oxford University Press.

Howald G.; Donlan C. J.; Galván J. P.; Russell J. C.; Parkes J. and Samaniego A. 2007. Invasive rodent eradication on islands. *Conservation Biology 21(5)*: 1258-1268.

Keitt, B.; Campbell, K.; Saunders, A.; Clout, M.; Wang Y.; Heinz, R.; Newton, K. and Tershy, B. 2011 The Global Islands Invasive Vertebrate Eradication Database: A tool to improve and facilitate restoration of island ecosystems. In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). *Island invasives: eradication and management*, pp. 74-77. IUCN, Gland, Switzerland.

Malmierca L.; Menvielle M. F.; Ramadori D.; Saavedra B.; Saunders A.; Soto Volkart, N. and Schiavini A. 2011 Eradication of beaver (*Castor canadensis*), an ecosystem engineer and threat to southern Patagonia. In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). *Island invasives: eradication and management*, pp. 87-90. IUCN, Gland, Switzerland.

McGeoch M. A.; Butchart S. H.; Spear D.; Marais E.; Kleynhans E. J. and Symes A. 2010. Global indicators of biological invasion: species numbers, biodiversity impact and policy responses. *Diversity and Distributions 16(1)*: 95-108.

Morrison S.A. 2011. Trophic considerations in eradicating multiple pests. In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). *Island invasives: eradication and management*, pp. 208-212. IUCN, Gland, Switzerland.

Muñoz-Fuentes V.; Vilà C.; Green a. J.; Negro J. J.; and Sorenson M. D. 2007. Hybridization between white-headed ducks and introduced ruddy ducks in Spain. *Molecular Ecology 16(3)*: 629-638.

Nogales M.; Mart A.; Tershy B. R.; Donlan C. J. and Veitch, D. 2004. A review of feral cat eradication on islands. *Conservation Biology 18(2)*: 310-319.

Parkes, J.P. and Anderson D. 2011. What is required to eradicate red foxes (*Vulpes vulpes*) from Tasmania? In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). *Island invasives: eradication and management*, pp. 477-480. IUCN, Gland, Switzerland.

Saunders, A.; Parkes, J.P.; Aguirre-Muñoz, A. and Morrison, S.A. 2011. Increasing the return on investments in island restoration. In: Veitch, C. R.; Clout, M. N. and Towns, D. R. (eds.). *Island invasives: eradication and management*, pp. 492-495. IUCN, Gland, Switzerland.

Schoenig, S. 2005. California Noxious and Invasive Weed Action Plan. Retrieved from http://www.cdfa.ca.gov/phpps/ipc/noxweedinfo/pdfs/noxious_weed_plan.pdf.

Veitch, C.R. and Clout, M.N. 2002. *Turning the tide: the eradication of invasive species*. IUCN Invasive Species Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Vié J.; Hilton-Taylor C. and Stuart S. N. 2008. *Wildlife in a changing world: an analysis of the 2008 IUCN Red List of Threatened Species*. Gland, Switzerland: IUCN.